



MONITORING, SURVEILLANCE AND REPORTING PLAN – REVISION 3

KENO HILL SILVER DISTRICT MINING OPERATIONS

August 2015

Prepared for:

ALEXCO KENO HILL MINING CORP.

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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 sample 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, Onek 990 and Lucky Queen Mines are presented in this plan. Additionally, this Plan has been updated to include the Flame and Moth Mine and the associated monitoring proposed as part of the project.

2 WATER QUALITY SURVEILLANCE NETWORK

Currently water quality monitoring is required under care and maintenance Water Licence QZ12-057, and Keno Hill Silver District Mining operations Water Licence QZ12-053 (amendment 1 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 QZ12-053. Refer to Appendix A for Type A Water Licence QZ09-092, 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.

A Groundwater Monitoring Plan for the Bellekeno mine has been developed per Water Licence QZ09-092 in February 2011 and was updated in July 2012 to include the Onek and Lucky Queen mines and has been updated to include Flame and Moth (see Appendix B). This plan outlines monitoring locations and frequency for the Keno District mill and Dry Stack Tailings Facility, the N-AML waste rock disposal areas (Bellekeno and Lucky Queen), and 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.

Additional surface water quality stations and monitoring wells are proposed as a result of mining activities at Flame and Moth. Table 1 outlines the existing and proposed (highlighted in green) sampling stations and schedule for internal and external lab analysis in the area of the Bellekeno, Onek and Lucky Queen mines and in the vicinity of the mill site. Figure 1 and Figure 2 show these existing and proposed surface water and Groundwater monitoring station locations, respectively.

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.

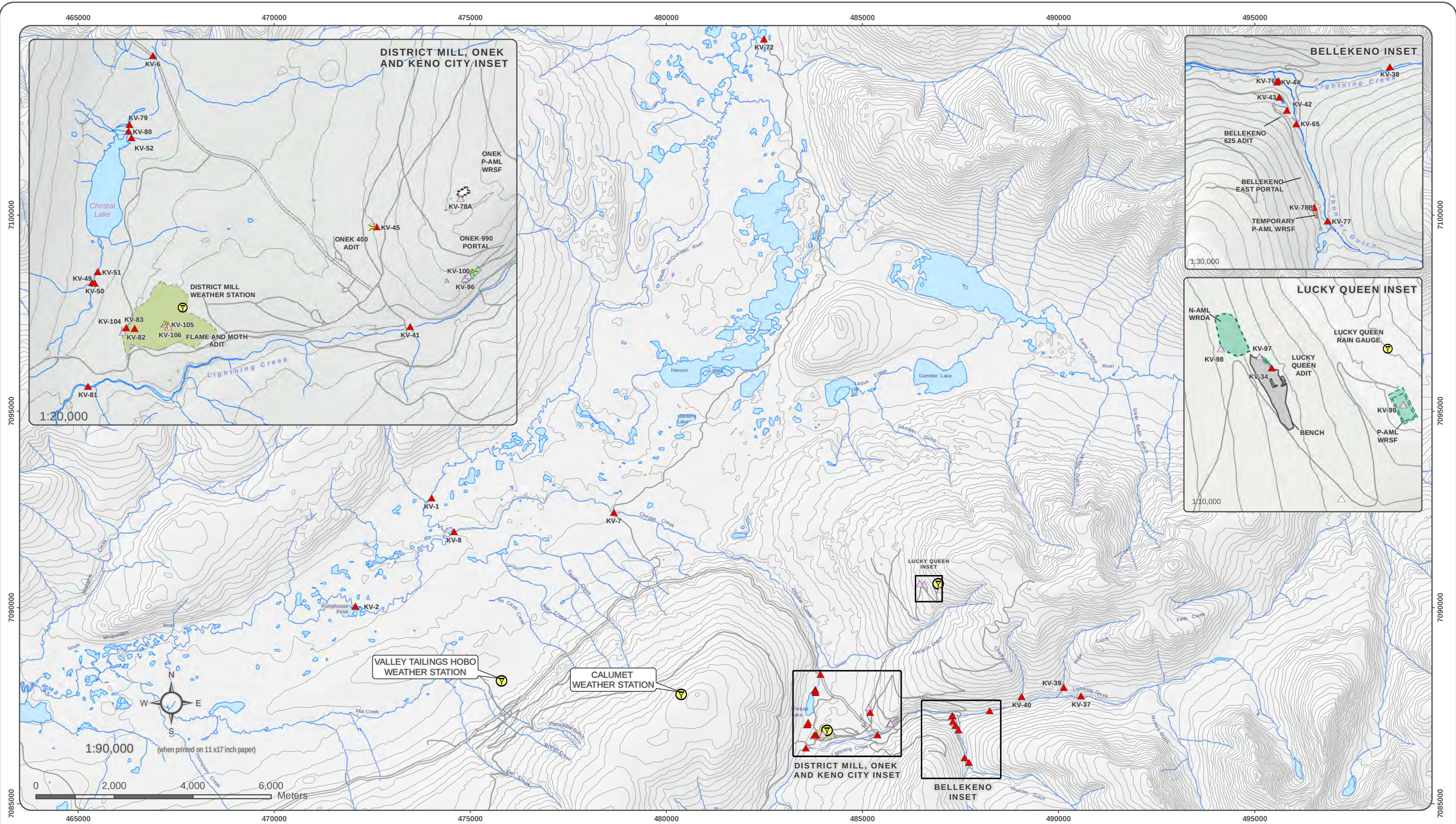
Quality assurance and quality control (QA/QC) protocols have been implemented during collection, storage and shipping of samples. QA/QC procedures conducted by field and laboratory staff including duplicate relative percent difference analysis, analytic matrix spikes, spike blanks, and field, trip and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



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
		QZ09-092	Level	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		
		Existing & Proposed Monitoring																								
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-Revised	D-WD, W	-	D-WD, W	D-WD, W	D-WD, W	D-WD, W	D-WD, W	D-WD	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-	
KV-83	Flame and Moth Mill 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	Q-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W/Q	SA	
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	M-WD	
KV-34	Lucky Queen Adit (underground)	Existing	-	D	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-revised	D-WD	-	D-WD	D-WD	D-WD	D-WD	D-WD	D-WD	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	-	-	M/Q	M/Q	M/Q	-	-	
KV-101	Lucky Queen treatment plant discharge	Pending	-	C	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	SA	
KV-102	Lucky Queen Settling pond	Pending-revised	D-WD	-	D-WD	D-WD	D-WD	D-WD	D-WD	D-WD	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-	
KV-105	Flame and Moth Adit	Proposed	-	C	D	D	D	D	D	D	W	W	W	W	W	W	W	W	W	W	W	W	W	-	-	
KV-104	Flame and Moth Settling Pond Decant	Proposed	D-WD, W	C	D-WD, W	D-WD, W	D-WD, W	D-WD, W	D-WD, W	D-WD, W	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	Q	-	-	
KV-2	South McQuesten River @ Pumphouse	Existing	-	Q	Q	Q	Q	Q	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-	
KV-6	Christal Creek @ Keno Highway	Existing	-	C	M	M	M	M	-	-	M	M	M	M	M	M	M	M	M	M	M	M	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	M	-	-	
KV-8	Christal Creek @ mouth	Existing	-	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	Q	-	-	
KV-38	Lightning Creek u/s Thunder Gulch	Existing	-	Q	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	Q	-	-	
KV-40	Charity Gulch u/s Lightning Creek	Existing	-	Q	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	M	-	-	
KV-44	Bellekeno 625 Seep	Existing - Revised	-	Ms	Ms	Ms	Ms	Ms	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-	-	
KV-45	Onek Adit	Existing	-	D	D	D	D	D	D	D	W	W	W	W	W	W	W	W	W	W	W	W	W	-	-	
KV-49	Hinton Creek u/s Christal Creek	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	M/Q	-	-
KV-50	Christal Creek u/s Hinton Creek	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	M/Q	-	-
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	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	M	-	-	
KV-65	Thunder Gulch u/s of Bellekeno 625	Existing	-	Q	Q	Q	Q	Q	-	-	M	M	M	M	M	M	M	M	-	-	-	M	M	-	-	
KV-76	Thunder Gulch d/s Bellekeno 625	Existing - Revised	-	Q	Q	Q	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	Q	-	-	
KV-78A	Onek P-AML Waste Rock Storage Facility	Existing - Revised	-	-	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 - Revised	Ms	-	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	Q	-	-	
KV-80	Christal Creek u/s Mackeno Tailings	Existing	-	Q	Q	Q	Q	Q	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-	
KV-81	Lightning Creek Southwest of Mill Site	Existing	-	Q	Q	Q	Q	Q	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-	
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	Ms	Ms	-	-	
KV-99	Lucky Queen P-AML WRSF	Pending-revised	-	Ms	Ms	Ms	Ms	Ms	Ms	-	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	-	-	
KV-106	Flame and Moth Temporary Waste Rock Storage Facility	Existing	Ms	-	Ms	Ms	Ms	Ms	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-	
Mine Groundwater Monitoring Wells																										
KV-84Nd	New Well on Fire Hall lot; Keno City Well (ON-MW-3)	Existing - Revised	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-85D	Flame and Moth Site Groundwater Well #1 (PH2) Deep	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	M/Q	M/Q	-	-
KV-85S	Flame and Moth Site Groundwater Well #1 (Shallow)	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	M/Q	M/Q	-	-
KV-86	Flame and Moth Site Groundwater Well #2 (PH5)	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	M/Q	M/Q	-	-
KV-87	Flame and Moth Site Groundwater Well #3 (PH6)	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	M/Q	M/Q	-	-
KV-88D	Flame and Moth Site Groundwater Well #4 (Deep)	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	M/Q	M/Q	-	-
KV-88S	Flame and Moth Site Groundwater Well #4 (Shallow)	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	M/Q	M/Q	-	-
KV-89D	Flame and Moth Site Groundwater Well #5 (Deep)	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	M/Q	M/Q	-	-
KV-89S	Flame and Moth Site Groundwater Well #5 (Shallow)	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	M/Q	M/Q	-	-
KV-91	Bellekeno Waste Rock Disposal Area well #1	Pending	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	-	-
KV-92	Bellekeno Waste Rock Disposal Area well #2	Pending	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	-	-
KV-93	Bellekeno Waste Rock Disposal Area well #3	Pending	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	-	-
KV-94	Bellekeno Waste Rock Disposal Area well #4	Pending	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	-	-
KC-MW-4	Well south of Onek 400 adit	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	M/Q	M/Q	-	-
ON-MW-2	Onek Monitoring Well d/g Project Facilities	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	M/Q	M/Q	-	-
LQ-MW-1	Lucky Queen Monitoring Well d/g N-AML WRDA	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	M/Q	M/Q	-	-
LQ-MW-2	Lucky Queen Monitoring Well d/g P-AML WRSF	Pending	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	-	-
BH39	DSTF phase I area	Existing	M	-	M	M	M	M	-	-	M	M	M	M	M	M	M	M	-	-	-	M	M	M	-	-
KV-107	DSTF phase II expansion area	Proposed	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	-	-

C = Continuous
C-WD = Continuous While Discharging
D = Daily
D-WD = Daily While Discharging
W = Weekly
W-WD = Weekly While Discharging
W/Q = Weekly migrating to quarterly to accord with monitoring frequency pursuant to MMER
M = Monthly
Ms = Monthly (May - Oct)
M/Q = Monitoring to occur monthly for first 12 months, reverting to quarterly thereafter.
Q = Quarterly
A = Annually
SA = Semi-Annually / twice per year (Monitoring to occur semi-annually during the first three years of the study program, with the first sample collected 6 months following the start of operations, and once each year after the third year)
BA = Bi-Annually (every 2 years)



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

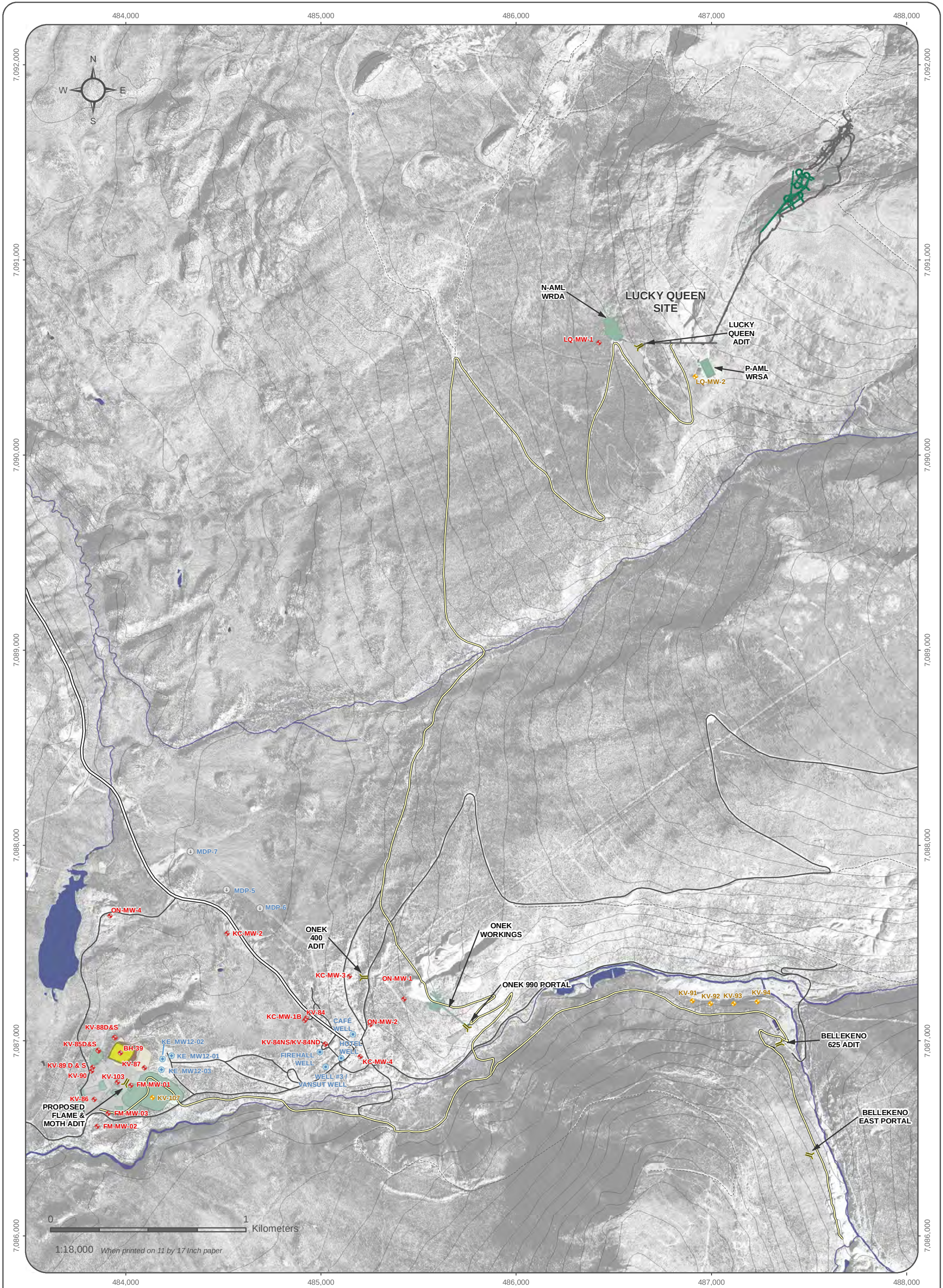
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	Weather Station		Valley Tailings Pond		Highway
	Monitored		Valley Tailings		Secondary Road
	Pending		Keno District Mill Site		Watercourse
	Discontinued		Waterbody		Contour (100 feet)



KENO HILL SILVER DISTRICT MINING OPERATIONS
FIGURE 1
KENO HILL SURFACE WATER
QUALITY MONITORING LOCATIONS
LICENCE Q209-092
SEPTEMBER 2014

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- Mine Adit - Monitoring Well - Pending Monitoring Well - Private Drilled Well	- Public Drilled Well - Water Supply Well - Decommissioned Manual Drive Point	- Existing Building/Structures - Proposed Buildings/Structures - DSTF Cover and Revegetation Phase I-II - DSTF 322k Tonnes Design - Current DSTF	- Haul Road - Silver Trail Highway - Other Road - Limited-Use Road	KENO HILL SILVER DISTRICT MINING OPERATIONS FIGURE 2 KENO HILL SILVER DISTRICT GROUNDWATER MONITORING LOCATIONS
Aerial photograph obtained from Geodesy Remote Sensing Inc., Calgary Alberta. Imagery acquired September 13th and 14th 2006. Site hydrography and contours derived from 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta. Datum: NAD 83; Projection: UTM Zone 8N This drawing has been prepared for the use of Access Mining Consultants Ltd.'s client and may not be used, reproduced or relied upon by third parties, except as agreed by Access Mining Consultants Ltd. and its client, as required by law or for use of governmental reviewing agencies. Access Mining Consultants Ltd. accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without Access Mining Consultants Ltd.'s express written consent.				JUNE 2015 I:\Keno_Area_Mines\FM\Map\02_Permit\WUL_Summer_2015\Fig2_GroundWater_Monitoring_20150618.mxd (Last edited by: mducharme/6/18/2015/18:42 PM)

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 (MMER Schedule 4, see Table 2 below) in a grab sample are less restrictive than the requirements of Water Licence QZ09-092; however a maximum authorized monthly mean concentration is also identified in the MMER, which is half the concentration allowed in a grab sample. The MMER also requires *Daphnia magna* monitoring tests at the same time as acute lethality testing.

Table 2 MMER Authorized Limits of Deleterious Substances

Item	Column 1	Column 2	Column 3	Column 4
	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 1 Environmental Effects Monitoring Study Design has been developed with Environment Canada and the interpretive report has been provided (March 2013; see Appendix T of 2012 QML annual report http://www.emr.gov.yk.ca/mining/pdf/mml_keno_2012_annual_report.pdf). Cycle 2 study will be undertaken in the summer of 2015. Effluent monitoring, acute lethality testing and EEM Study Designs will also be required under MMER for other mines brought online in the KHSD including Flame and Moth.

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 MMER.

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

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)

- b) Benthic Invertebrate Community: Studies conducted in exposure and reference areas and includes sediment sampling for analysis of particle size distribution and total organic carbon content.

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 MMER will be considered final discharge points under Water Licence QZ09-092.

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 non-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 C 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. Since much of the surface development is likely to occur on previously disturbed areas, the likelihood of encountering permafrost at surface is relatively low.

5 PHYSICAL INSPECTION 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 Inspection and Reporting Plan prepared for Water Licence QZ09-092 in June 2013 (Appendix D). The Physical Inspection and Reporting Plan describes scheduled physical inspections of infrastructure associated with the Bellekeno Mine, District Mill, Onek 990 Mine and Lucky Queen Mine operations. Information is collected through use of weekly and monthly checklists and reporting forms. 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.

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.

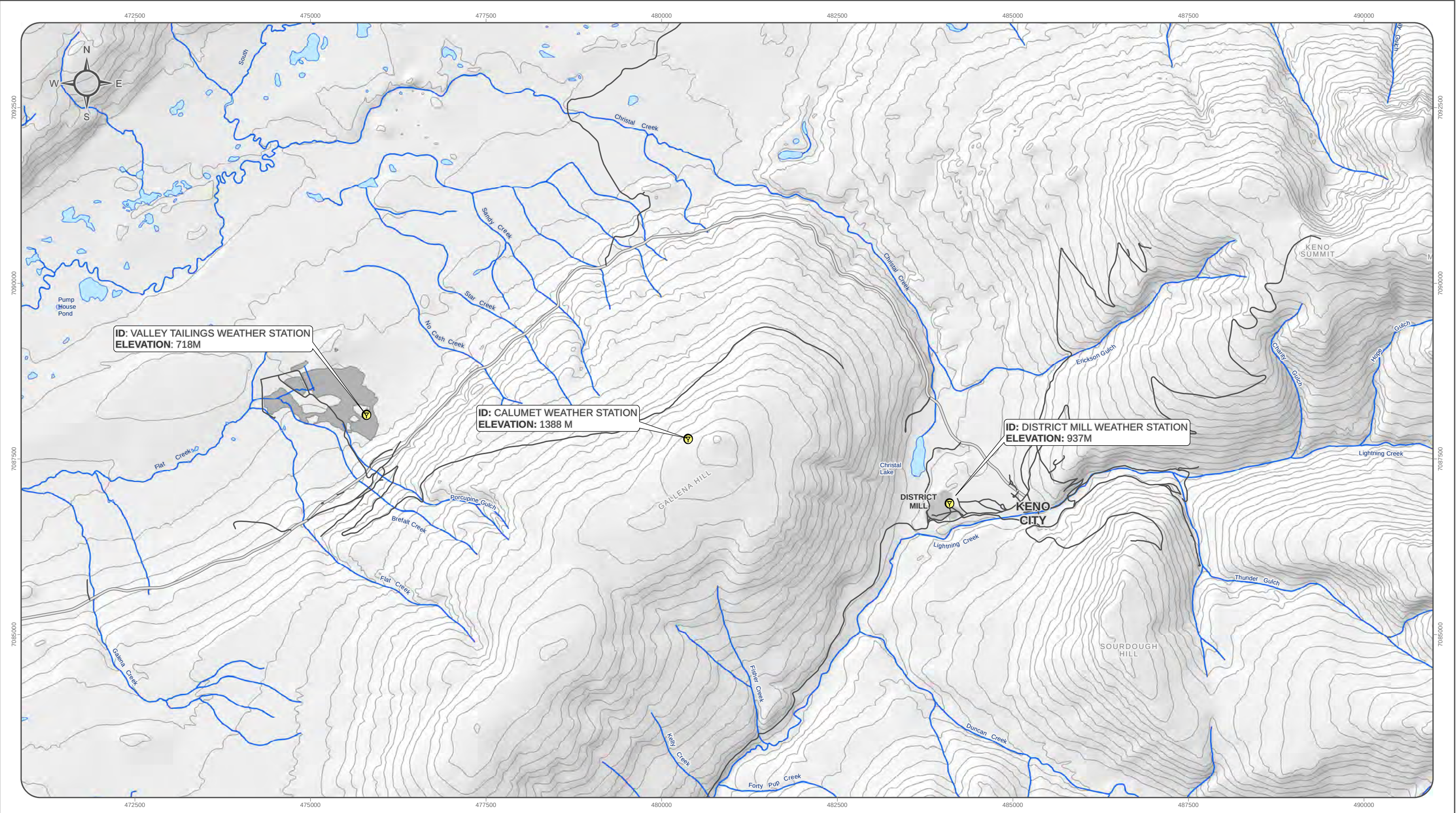
The Physical Inspection and Reporting Plan was updated in accordance with an amended Water Licence QZ09-092 to include provisions for the Onek and Lucky Queen structures. Such facilities would include settling ponds at Onek and Lucky Queen, a temporary ore stockpile at Lucky Queen, as well as a Lucky Queen N-AML waste rock disposal area, and P-AML waste rock storage facilities. The plan will be updated for the inclusion of Flame and Moth infrastructure following the issuance of the Water Licence.

6 METEOROLOGICAL MONITORING

Meteorological data have been collected in the KHSD since 2007 at the Calumet weather station (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. The three meteorological stations are shown in Figure 3.

Alexco also conducted manual snow surveys since 2011 at ten monitoring stations (see Figure 4) 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 m 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.



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

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

1:50,000 (when printed on 11 x17 inch paper)

0 1 2 3 Kilometers

 Weather Station

 Highway
 Road
 Contours (100 ft)

 Watercourse
 Waterbody



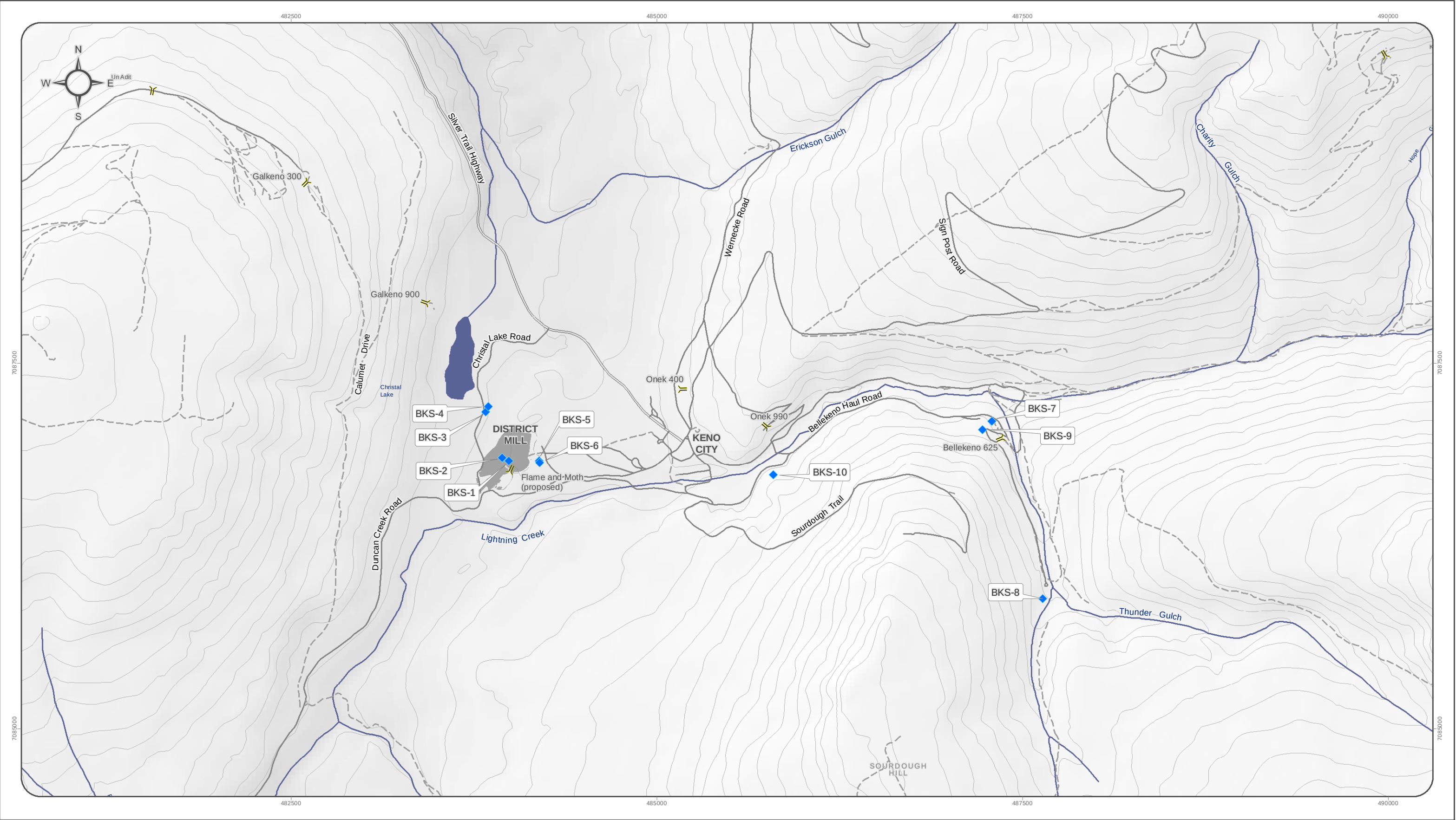
KENO HILL MINING DISTRICT

FIGURE 3

KENO METEOROLOGICAL STATIONS

JANUARY 2015

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

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

1:24,000 (when printed on 11 x17 inch paper)

0 500 1,000 1,500 2,000 Meters

- | | | |
|-------------------------|----------------|-------------------|
| Snow Monitoring Station | Highway | Contours (100 ft) |
| Adit | Secondary Road | Watercourse |
| | Track | Waterbody |



FIGURE 4
KENO SNOW SURVEY STATIONS

NOVEMBER 2013

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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.

Two BGI Omni Ambient Air Quality Samplers 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), which will be submitted to Yukon Government for review and approval as part of the application to amend the Quartz Mining License. The monitoring locations are shown on Figure 5.

The BGI Omni samplers are set up with TSP 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. Four samples per location are collected 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 have reduced data collected.

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 3 below.

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

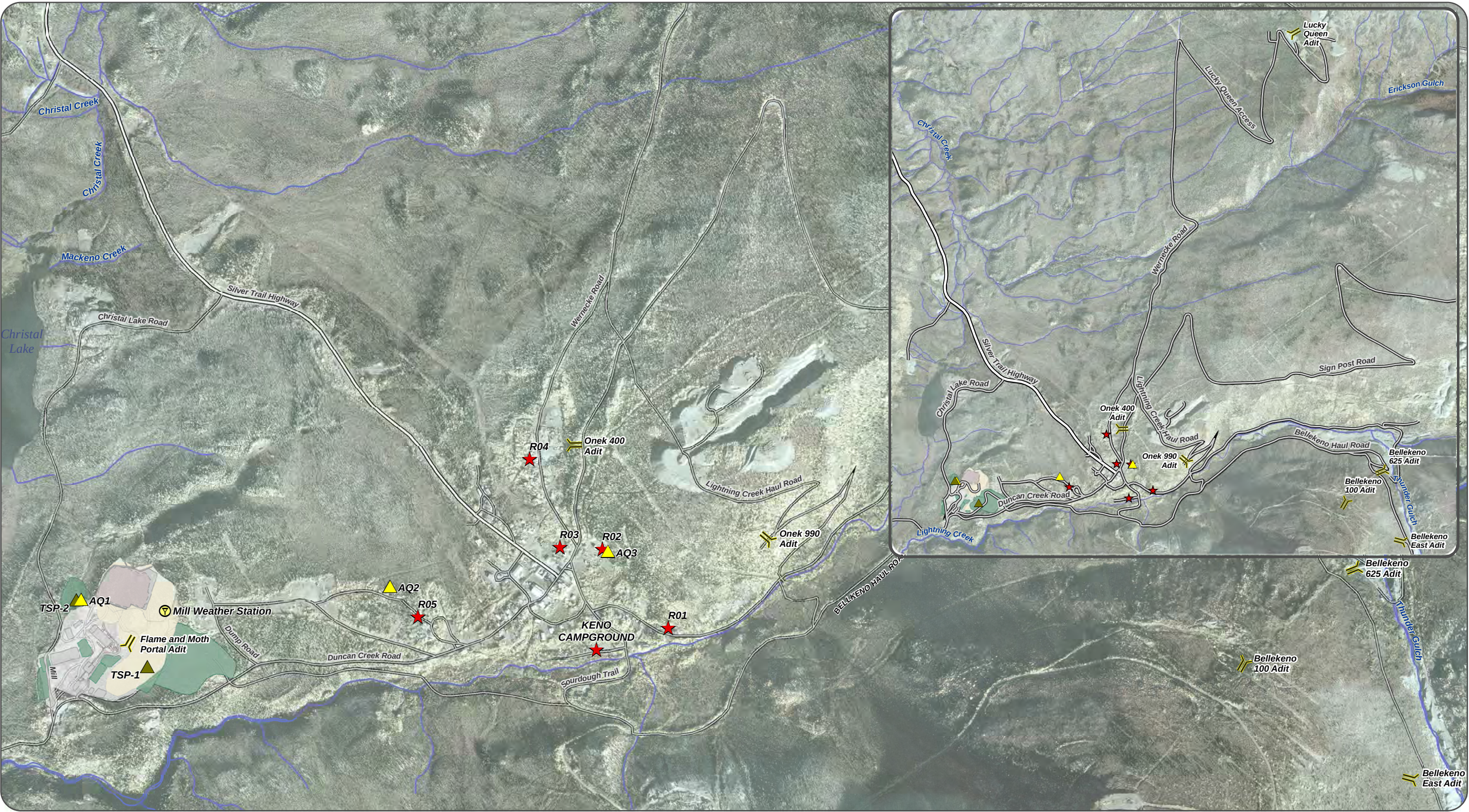
Parameter	Criteria
Antimony	25
Arsenic	0.3
Barium	10
Beryllium	0.01
Boron	120
Cadmium	0.025
Chromium	0.5
Cobalt	0.1
Copper	50
Iron	4

Parameter	Criteria
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:

- 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 2). 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 2).
- The sampler located at TSP-2 (see Figure 2) 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.



Aerial photography flight date: July 13th 2006. Ortho-rectification produced by Challenger Geomatics Ltd. Data obtained from EBA: "As built" spatial data: Mill pond (Y.E.S.), Mill structure, and current DSTF footprints, Roads (In House survey December 11th 2011). Design spatial data: Conveyance and water collection, diversion ditches and berm.

Datum: NAD 83; Projection: UTM Zone 8N

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Main Map: 1:10,000
(when printed on 11 x17 inch paper)

- Proposed Features
- Building/Structures
- DSTF 322k Tonnes Design
- Current DSTF

- Highway
- Secondary Road

- Noise Monitoring Station
- Air Quality Monitoring Station
- Former Dust Monitoring Station
- Weather Station



KENO HILL SILVER DISTRICT MINING OPERATIONS

FIGURE 5
AIR QUALITY AND NOISE
MONITORINGSTATION LOCATIONS

JUNE 2015

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8 NOISE IMPACTS AND SOUND MONITORING

For the period from April 2013 to November 2014, a total of 31 monitoring events were carried out. AKHM has monitored noise at the five locations selected in the NIA (R01 to R05 – see Figure 5) as being potential noise receptors within the 2 km radius study area around Keno City. Starting in November 2013, noise has also been monitored at the Keno City campground. All readings 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. A complete Waste Rock Management Plan was prepared in 2009 and includes detailed descriptions of waste rock monitoring and mine wall testing. The Waste Rock Management Plan was updated in September 2014 to include the Flame and Moth deposits (Access Consulting, 2014b).

10 SPILL CONTINGENCY PLAN

The Spill Contingency Plan specifies that:

“The Licencee shall immediately contact the 24-hour Yukon Spill Report Centre, (867) 667-7244, and implement the Spill Contingency Plan should a spill or an unauthorized discharge occur. 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 submitted to the board not later than 10 days after the occurrence”;

“All personnel shall be trained in procedures to be followed and the equipment to be used in the containment of a spill”; and

“The Spill Contingency Plan shall be posted on site for the term of the Licence”.

For more details, see the Spill Contingency Plan and the Emergency Response Plan submitted for Water Licence Renewal for Flame and Moth updated (December 2013). 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 with respect to Flame and Moth has been updated in June 2015 as required in the Decision Document for the assessment of the Flame & Moth Development and Production Program (YESAB file Number 2013-0161) and will be submitted to Yukon Government for review and approval as part of the application to amend the Quartz Mining License.

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 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 Bellekeno, Onek and Lucky Queen Production Unit Areas (Revision 1 – April 2012) 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 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, gullyng 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 Detailed Reclamation and Closure Plan. The Reclamation and Closure Plan has been updated to include Flame and Moth.

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 Licence (Condition 12). 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

- Access Consulting Group. 2015a Adaptive Management Plan Keno Hill Silver District Mining Operations
- Access Consulting Group. 2015b Noise Monitoring and Management Plan Keno Hill Silver District Mining Operations
- Access Consulting Group. 2014 Waste Rock Management Plan Keno Hill Silver District Mining Operations
- British Columbia. Ministry of Environment. 2009. Air Quality Objectives and Standards.
- British Columbia. Ministry of Environment. 1979. Pollution Control Objectives for Mining, Smelting, and Related Industries of British Columbia.
- Code of Federal Regulations. Title 40 –Protection of Environment, Chapter I – Environmental Protection Agency, Subchapter C – Air Programs, Part 51 – Requirements for Preparation, Adoption, and Submittal of Implementation Plans.
- Environmental Protection Agency, 1995a. User's guide for the Industrial Source Complex (ISC3) Dispersion Models – Volume 1 – User Instructions, Office of Air Quality Planning and Standards Emissions, Monitoring, and Analysis Division Research Triangle Park, North Carolina 27711.
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- Pacwill Environmental. 2008. Original Dry Foam Frisbee-Type Deposit Dust Gauge.
- Patching Associates Acoustical Engineering Ltd. (PAAE). 2014a. Noise Impact Assessment Update, Alexco Keno Hill Mining Corp., Proposed Flame and Moth Mine Project, Yukon Territory. Prepared for Yukon Environmental and Socio-Economic Assessment Board (YESAB), September 23, 2014.
- Patching Associates Acoustical Engineering Ltd. (PAAE). 2014b. Review of Report from Access Consulting Group On Behalf of Alexco Resource Corp. Flame and Moth Project And June 12, 2014 Response to YESAB IR, With Review of the Keno Noise Monitoring Document Review - YESAB March 2009. July 10, 2014.
- Reed, W.R. 2005. Significant Dust Dispersion Models for Mining Operations, Information Circular 9478, Department of Health and Human Services, Center for Disease Control and Prevention, National Institute for Occupational Safety and Health, USA.

APPENDIX A

**TYPE A WATER LICENCE QZ12-053 FOR QUARTZ MINING UNDERTAKING AT KENO HILL SILVER
DISTRICT MINING OPERATIONS**

YUKON WATER BOARD

Pursuant to *Waters Act and Waters Regulation*, the Yukon Water Board hereby grants a Type A water use licence for a quartz mining undertaking to:

Alexco Keno Hill Mining Corp.
Suite 1150-200 Granville Street
Vancouver, BC V6C 1S4

APPLICATION: QZ12-053-1 **LICENCE NUMBER:** QZ09-092

AMENDMENT: This amendment shall be deemed to be amendment 1 of the licence. All clauses and all appendices of water use licence QZ09-092 are hereby withdrawn and replaced by amendment 1.

LICENCE TYPE: A **UNDERTAKING:** QUARTZ MINING

WATER MANAGEMENT AREA: 2 Yukon

LOCATION: Keno Hill Silver District Undertaking claims, near Keno City, Yukon

MAP COORDINATES: Centre (Mill) Latitude: 63° 54' 29" Longitude: 135° 19' 36"

WATER SOURCES: Keno Hill Silver District underground mining: Bellekeno Mine pool, Bellekeno water treatment plant discharge, Lightning Creek, Thunder Gulch, Onek mine water, Lucky Queen mine water and groundwater.

Keno Hill Silver District Mill: Mill Site and dry stack tailings facility collection and sedimentation pond, Galkeno 900, Christal Creek, Christal Lake and groundwater.

Flat Creek Camp: Flat Creek and groundwater.

PURPOSE: To obtain water, store water, and to deposit Waste for the purpose of quartz mining, and operating a domestic water supply and sewage treatment and disposal systems, at the Flat Creek Camp, Keno Hill Silver District Mill, and the Bellekeno, Onek and Lucky Queen Mines.

EFFECTIVE DATE: The effective date of this Licence shall be the date on which the signature of the Chairperson of the Yukon Water Board is affixed.

EXPIRY DATE: August 1, 2020

Approved this 15th day of

May, 2013



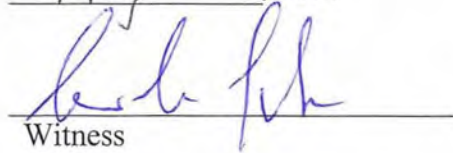
Witness



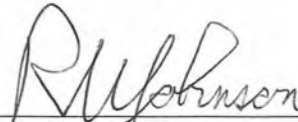
Minister, Executive Council Office
Government of Yukon

Issued this 16th day of

May, 2013



Witness



Chairperson
Yukon Water Board

PART A – DEFINITIONS

“Act” means *Waters Act* and any amendments thereto.

“AMP” means the Adaptive Management Plan submitted as part of the Application and included in the Water Use Register QZ12-053 as exhibit 1.12, and any subsequent revisions.

“Application” means Water Use Applications QZ09-092 and QZ12-053, and any additional submissions and/or revisions submitted to the Board by the Licensee up to the date of the Board’s decision.

“Bellekeno Bioreactor Design and Operation Plan” means the *Bellekeno Bioreactor Design and Operation Plan August 2011* that was submitted to the Board as per clause 88 of QZ09-092.

“Bellekeno Mine” means all quartz mining and supporting activities, occurring on the mineral claims identified in Schedule A of this licence, that are undertaken for the purpose of extracting and processing ore from the Bellekeno Mine as identified in the Application.

“Bellekeno Mine Operations Hydrogeology Plan” means the *Bellekeno Mine Operations Hydrogeology Plan November 2010* that was submitted to the Board as per clause 81 of QZ09-092.

“Board” means the Yukon Water Board.

“Continuous” in the context of flow monitoring means the time averaged measurement of flows with individual measurements completed at least hourly and reported as daily values.

“Dam Safety Guidelines” means the most current version of the Dam Safety Guidelines issued by the Canadian Dam Association.

“Decommissioning and Reclamation Plan” means the *Preliminary Decommissioning and Reclamation Plan* that was submitted as part of the Application and included in Water Use Register QZ12-053 as exhibits 1.10.1 and 1.10.2, and any subsequent revisions.

“DSTF” means the Dry Stack Tailings Facility area and related infrastructure at the Keno Hill Silver District Mill that is to be used for storing the dewatered low sulphur tailings from the Keno Hill Silver District Mill and dewatered treatment sludge from the Bellekeno and Lucky Queen Mines and the District Mill treatment plant.

“EEM” means Environmental Effects Monitoring.

“Keno Hill Silver District Mill” means the building(s), equipment and ancillary infrastructure located at the Keno Hill Silver District Mill Site for the purposes of processing ore.

“Keno Hill Silver District Mill Site” means the area of quartz claims 38642, 56401, 38643, 55599 and 55600 located west of Keno City that will be developed for the purposes of processing Bellekeno, Lucky Queen and Onek Mine ore, disposing of resulting low sulphur

tailings, and disposing of treatment sludge from the Bellekeno Mine, Lucky Queen Mine and the Keno Hill Silver District Mill.

"Keno Hill Silver District Undertaking" means all quartz mining and supporting activities, occurring on the mineral claims identified in Schedule A of this licence, that are undertaken for the purpose of extracting and processing ore from the Bellekeno, Lucky Queen, and Onek Mines as identified in the Application.

"Inspector" means any person designated as an Inspector under the Act.

"Lucky Queen Mine" means all quartz mining and supporting activities, occurring on the mineral claims identified in Schedule A of this licence, that are undertaken for the purpose of extracting and processing ore from the Lucky Queen Mine as identified in the Application.

"MMER" means *Metal Mining Effluent Regulations*.

"Natural Boundary" means the visible high water mark of any lake, river, stream or other body of water where the presence and action of water is so common and usual and so long continued as to mark upon the soil of the bed of the lake, river, stream or other body of water a character distinct from that of the banks thereof, both in respect to vegetation and in respect to the nature of the soil itself. In addition, the best estimates of the edge of dormant or old side channels and marsh areas are considered to be the Natural Boundaries.

"N-AML" means non-acid generating and non-metal leaching.

"Onek Mine" means all quartz mining and supporting activities, occurring on the mineral claims identified in Schedule A of this licence, that are undertaken for the purpose of extracting and processing ore from the Onek Mine as identified in the Application.

"P-AML" means potentially acid generating or metal leaching.

"Permanent Closure" means

- a) a period of cessation of development and production activities that exceeds five years; or
- b) a declaration by the licensee of the permanent cessation of development and production activities followed by implementation of the Decommissioning and Reclamation Plan.

"Pyrite Removal Circuit" means that portion of the milling process that is designed to remove the iron sulphide from the ore for separate treatment and disposal.

"Regulation" means the *Waters Regulation* made under the Act.

"Sludge Management Plan" means the *Sludge Management Plan* that was submitted in application QZ09-092 as exhibit 1.3.14 and any subsequent revisions.

“Spill Contingency Plan” means the *Spill Contingency Plan* that was submitted as part of the Application and included in Water Use Register QZ12-053 as exhibit 1.9.2, and any subsequent revisions.

“Temporary Closure” means a period of cessation of development and production activities between six months to no longer than five years.

“Underground Workings” means all excavations below the surface that have been or will be excavated to extract Waste Rock and ore at the Bellekeno, Lucky Queen, and Onek Mines as defined in this section, including all stopes, declines, adits, shafts, vents and related supports and infrastructure.

“Waste” means any substance as defined as such in the Act and includes treated and untreated water.

“Waste Rock” means rock excavated from underground workings that will not be processed in the Keno Hill Silver District Mill.

“Waste Rock Disposal Area” means an area to be defined or identified within the Waste Rock Management Plan where N-AML Waste Rock is placed either temporarily or permanently.

“Waste Rock Storage Facility” means an area to be defined or identified within the Waste Rock Management Plan where P-AML Waste Rock is placed either temporarily or permanently.

“Waste Rock Management Plan” means the *Waste Rock Management Plan* that was submitted as part of the Application and included in Water Use Register QZ12-053 as exhibit 1.8 and any subsequent revisions.

“Watercourse” means any stream, lake, pond, river, creek, spring, ravine or swamp whether ordinarily containing water or not.

“Wetted Perimeter” means the horizontal extent of the present water level while the work is taking place.

PART B – GENERAL CONDITIONS

Cancellation of Related Water Use Licence

1. The Licensee shall not use water and/or deposit a Waste as authorized under this amendment 1 of QZ09-092, until application has been submitted to the Board for cancellation of water use licence QZ07-078.

Other Laws

2. No condition of the water use licence limits the applicability of any statutory authority.

3. All construction or installation of works authorized by this licence shall occur on property that the Licensee has the right to enter upon and use for that purpose.

Correspondence

4. Where any direction, notice, order or report under this licence is required to be in writing, it shall be given to:
 - a) the Licensee, if delivered, faxed or mailed by registered mail to the following address:

Alexco Keno Hill Mining Corp.
Suite 1150-200 Granville Street
Vancouver, BC V6C 1S4

Fax: (604) 633-4887

and shall be deemed to have been given to the Licensee on the day it was delivered or faxed, or 7 days after the day it was mailed, as the case may be;

- b) the Board, if delivered, faxed or mailed by registered mail to the following address:

Yukon Water Board
Suite 106, 419 Range Road
Whitehorse, YT Y1A 3V1

Fax: (867) 456-3890

and shall be deemed to have been given to the Board on the day it was delivered or faxed, or 7 days after the day it was mailed, as the case may be.

Spills and Unauthorized Discharges

5. 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.
6. 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.

7. 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.
8. The Licensee shall include a summary of all spills or unauthorized discharges that occurred during the year reported, as part of the annual report.
9. All personnel shall be trained in procedures to be followed and equipment to be used in the containment of a spill.
10. 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.

Non-Compliance

11. In the event that the Licensee fails to comply with any provision or condition of this licence, the Board may, with the approval of the Minister, and subject to the Act, cancel the licence.

Fuel and Hazardous Materials Storage and Transfer

12. A complete inventory of chemicals, fuels, oils, lubricants and other hazardous materials relating to the water uses authorized by this licence shall be maintained by the Licensee and filed with the Yukon Water Board.
13. Fuel, lubricants, hydraulic fluids, coolants and similar substances shall be stored and/or transferred a minimum of 30 metres from the Natural Boundary of any Watercourse, in such a way that said substances are not deposited in or allowed to be deposited in waters.

Waste Substances

14. Waste substances shall be used, transported, stored or disposed of in such a manner that they are not deposited, or allowed to be deposited, into any Watercourse or on any surrounding land, unless authorized by this licence.

Annual Reports

15. Annual reports shall be submitted to the Board by the Licensee. Annual reports will be submitted to the Board on or before March 31 for each calendar year.
16. Annual reports shall include the information required by this licence and by the Regulation, including, but not necessarily limited to:
- a) a description of the water use operations carried out during the year reported;
 - b) the quantity of water used each day from each identified water source;
 - c) a detailed record of any major maintenance work carried out or planned to be carried out that could have an impact on water;
 - d) summaries of all data generated as a result of the monitoring requirements of this licence, including analysis and interpretation by a qualified individual or firm and a discussion of any variances from baseline conditions or from previous years' data;
 - e) the inspection results, including photographs, repairs plans for modification required by the physical monitoring program;
 - f) a discussion of proposed changes to the monitoring programs;
 - g) details of any work carried out or planned to be carried out under the Adaptive Management Plan;
 - h) copies of all orders, directions, and correspondence relating to drinking water sampling or analysis from the Medical Health Officer or from a Health Officer;
 - i) results and summaries of all data generated as a result of the meteorological monitoring that is required by this licence;
 - j) a summary of volume and tonnage of Waste Rock generated, including N-AML and P-AML, and where it was placed.;
 - k) an annual update of the Detailed Water Balance Report;
 - l) report on the status of the Decommissioning and Reclamation Plan and any updates to the Plan that have occurred since the previous submission; and
 - m) report on the results of the sediment and benthic invertebrate sampling and monitoring.

Reporting on Water Treatment Plant Performance

17. As a component of the annual report, the Licensee shall submit a performance evaluation report for all water treatment plants. The evaluation shall be carried out by a firm or persons qualified to do so through education or experience relevant to the types of treatment plants being operated. At a minimum, the evaluation shall include:
- a) an analysis of the plants' performances in terms of treatment efficiency, capacity, and compliance;

- b) a review of operators' daily logs, field monitoring data; and
- c) any recommended remedial actions and any actions taken by the Licensee.

Reporting on Physical Inspections and Monitoring

18. 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.
19. 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.

Reporting on Waste Rock Monitoring

20. At a minimum, the Licensee shall record the following during all inspections and provide the details as part of the annual report:
- a) any physical instability including erosion;
 - b) upstream ponding of water and downstream seepage;
 - c) the location of ponding and seepage;
 - d) the volume of flow, field pH, conductivity and concentration of zinc of ponding or seepage;
 - e) visual evidence of sulphide oxidation including snow melt areas or the presence of oxidation products; and
 - f) trends in pH, conductivity, and concentration of zinc and cadmium for any recurring seepage or ponding location.
21. Seepage or ponding locations identified through inspection shall be assigned a unique identifier consistent with monitoring stations in this licence. Descriptions of new locations shall be provided to the Board as part of the annual report.

Reporting on Hydrogeological Monitoring

22. The results of hydrogeological monitoring shall be included in the annual report and shall be accompanied by a certified report by a hydrogeologist interpreting the sources of inflows and contaminant loads into the underground workings.

Monthly Reports

23. Unless otherwise specified in this licence, the Licensee shall forward to the Board a copy of all data collected as part of the monitoring programs of this licence no more than 30 days after the conclusion of the month in which that data was collected. The report shall include graphical analysis of the effluent quality parameters listed in this licence and be in the form required by clauses 26 and 27 of this licence.
24. The first monthly report shall include the location coordinates of those monitoring stations identified in Schedule B – Table 1 Surface Water Monitoring Stations, of this licence, for which location coordinates are not established.
25. Location coordinates for monitoring stations identified in Schedule B – Table 2 Groundwater Monitoring Stations of this licence that are not yet established shall be provided in the first monthly report issued after the monitoring stations have been established.

Reports

26. 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.
27. The Licensee shall upload electronic copies of all reports required by this licence to the Yukon Water 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. Water quality results uploaded to the WATERLINE must be presented in Excel 97-2003.xls format.

PART C – OPERATING CONDITIONSDescription of Water Use

28. The Licensee is hereby authorized to:

Keno Hill Silver District Mining Operations

- a. obtain and use water for a quartz mining undertaking at a maximum combined rate of 414.25 m³/day from treated wastewater from the Bellekeno 625 treatment plant, from the underground workings, as well as from Thunder Gulch, Lightning Creek and groundwater supply wells, as detailed in the following table;

Lucky Queen	56.25 m ³ /day	Underground workings and contingency groundwater well
Onek	112.5 m ³ /day	Underground workings, contingency groundwater well, and Lightning Creek
Bellekeno	245.5 m ³ /day	Underground workings, Bellekeno water treatment plant discharge, Lightning Creek, and Thunder Gulch

Keno Hill Silver District Mill Site

- b. obtain and use water for a quartz mining undertaking at a maximum combined rate of 81 m³/day from treated water from the Galkeno 900 adit, recycled water from the site collection and sedimentation pond, Christal Creek, Christal Lake and groundwater well;

Flat Creek Camp Site

- c. obtain and use water for domestic camp purposes at a combined rate not exceeding a total of 57 m³/day from Flat Creek and the groundwater supply well;

as described in the Application, and subject to the conditions of this licence. Where there is a discrepancy between the Application and this licence, the conditions of this licence shall prevail.

Description of Deposit of Waste

29. The Licensee is hereby authorized to:

- a. direct camp wastewater through wastewater treatment and disposal systems at the Flat Creek Camp site, the Keno Hill Silver District Mill Site, and the Bellekeno Mine and deposit the treated sewage wastewater to ground absorption systems at those locations;
- b. operate a Bellekeno mine discharge treatment system and store water in settling ponds prior to discharge; and deposit up to 864 m³/day of treated mine effluent to Thunder Gulch and Lightning Creek;
- c. deposit up to a maximum of 172.8 m³/day of mine water from the Lucky Queen settling pond or the contingency Lucky Queen water treatment plant to surface application;
- d. store water in Onek settling ponds prior to discharge to surface application or transfer by truck to Bellekeno water treatment plant;

Keno Hill Silver District Mill Site

- e. construct and operate a collection, conveyance, storage and treatment system for mill site runoff, mill upset discharges, and DSTF runoff and seepage;
- f. construct and operate runoff diversion systems to divert up-gradient overland runoff around the mill site and DSTF;
- g. deposit treated effluent to a land disposal system up-gradient of Christal Creek at a rate not exceeding 10 L/s and a total monthly volume not exceeding 0.8% of the corresponding total monthly volume of flow passing monitoring station KV-6 on Christal Creek;
- h. deposit up to a maximum of 322,000 tonnes of Keno Hill Silver District Mill dewatered low sulphur tailings and treatment sludge from the Bellekeno, Lucky Queen Mines and the District Mill treatment plants in the DSTF;

as described in the Application, and subject to the conditions of this licence. Where there is a discrepancy between the Application and this licence, the conditions of this licence shall prevail.

30. Except as authorized by this licence, no Waste shall enter any watercourse as a result of any operation carried out by the Licensee.

Waste Rock

31. The Licensee is hereby authorized to remove a total of 500,000 tonnes of waste rock from the Underground Workings, and:

- a) deposit up to 360,000 tonnes of Onek and Bellekeno N-AML Waste Rock in the Bellekeno Mine N-AML Waste Rock Disposal Area;
- b) deposit up to 80,000 tonnes of N-AML originating from the Lucky Queen Mine in the Lucky Queen N-AML Waste Rock Disposal Area;
- c) deposit up to 100,000 tonnes of P-AML Waste Rock from the Bellekeno underground workings in permanent lined storage cells located on top of the Bellekeno N-AML Waste Rock Disposal Area;
- d) deposit up to 44,000 tonnes of P-AML originating from the Lucky Queen Mine in the Lucky Queen P-AML Waste Rock Storage Facility;
- e) deposit up to 46,500 tonnes of P-AML originating from the Onek and Lucky Queen Mines in the Onek P-AML Waste Rock Storage Facility;
- f) deposit up to 355,000 tonnes of Waste Rock, tailings, and cement in the Bellekeno underground workings;
- g) deposit Waste Rock, tailings, and cement in the Onek and Lucky Queen underground workings;

as described in the Application, and subject to the conditions of this licence. Where there is a discrepancy between the Application and this licence, the conditions of this licence shall prevail.

32. Waste Rock from the Bellekeno, Lucky Queen and Onek underground workings shall be segregated into N-AML Waste Rock and P-AML Waste Rock in accordance with the Waste Rock Management Plan.

33. N-AML Waste Rock can be deposited in the Bellekeno and Lucky Queen N-AML Waste Rock Disposal Areas or used for construction purposes as part of the Keno Hill Silver District Undertakings in accordance with the Waste Rock Management Plan.

34. P-AML Waste rock may be stored temporarily at the surface or left underground for later use as mine backfill. If P-AML Waste Rock is brought to the surface it may be returned underground as mine backfill when logistically feasible or placed into permanent surface storage cells at a Waste Rock Storage Facility in accordance with the Waste Rock Management Plan.

35. At a minimum, the initial 130,000 tonnes of Bellekeno P-AML rock excavated shall be used for mine backfill prior to any permanent P-AML storage cells being loaded at the Bellekeno N-AML Waste Rock Disposal Area.

Tailings

36. All tailings produced from the Pyrite Removal Circuit at the Keno Hill Silver District Mill shall be deposited in the underground workings at a level below the expected long term static water level of the closed Bellekeno mine.

PART D – EFFLUENT QUALITY STANDARDS

37. No Waste discharged from the water treatment systems at the Bellekeno 625 adit shall exceed the following limits:

Parameter	Maximum Concentration in a Grab Sample
pH	6.5 to 9.5 pH Units
Total Suspended Solids	25 mg/L
Ammonia Nitrogen (as N)	5 mg/L
Arsenic (total)	0.1 mg/L
Cadmium (total)	0.01 mg/L
Copper (total)	0.1 mg/L
Lead (total)	0.2 mg/L
Nickel (total)	0.5 mg/L
Radium 226	0.37 BQ/L
Silver (total)	0.01 mg/L
Zinc (total)	0.5 mg/L
Acute Toxicity Testing	
96-hour Rainbow Trout	Non-Toxic, LC ₅₀ (100%)

38. No Waste discharged from the water treatment system at the Lucky Queen Mine (Settling Pond and/or Water Treatment Plant) shall exceed the following limits:

Parameter	Maximum Concentration in a Grab Sample
pH	6.5 to 9.5 pH Units
Total Suspended Solids	25 mg/L
Ammonia Nitrogen (as N)	5 mg/L
Arsenic (total)	0.1 mg/L
Cadmium (total)	0.01 mg/L
Copper (total)	0.1 mg/L
Lead (total)	0.2 mg/L
Nickel (total)	0.5 mg/L
Radium 226	0.37 BQ/L
Silver (total)	0.01 mg/L

Zinc (total)	0.5 mg/L
Acute Toxicity Testing	
96-hour Rainbow Trout	Non-Toxic, LC ₅₀ (100%)

39. No Waste discharged from the water treatment systems at the Onek Settling Pond shall exceed the following limits:

Parameter	Maximum Concentration in a Grab Sample
pH	6.5 to 9.5 pH Units
Total Suspended Solids	25 mg/L
Ammonia Nitrogen (as N)	5 mg/L
Arsenic (total)	0.1 mg/L
Cadmium (total)	0.01 mg/L
Copper (total)	0.1 mg/L
Lead (total)	0.2 mg/L
Nickel (total)	0.5 mg/L
Radium 226	0.37 BQ/L
Silver (total)	0.01 mg/L
Zinc (total)	0.5 mg/L
Acute Toxicity Testing	
96-hour Rainbow Trout	Non-Toxic, LC ₅₀ (100%)

40. No Waste discharged from the water treatment systems at the Keno Hill Silver District Mill Site shall exceed the following limits:

Parameter	Maximum Concentration in a Grab Sample
pH	6.5 to 9.5 pH Units
Total Suspended Solids	25 mg/L
Ammonia Nitrogen (as N)	5 mg/L
Arsenic (total)	0.1 mg/L
Cadmium (total)	0.01 mg/L
Copper (total)	0.1 mg/L
Lead (total)	0.2 mg/L
Nickel (total)	0.5 mg/L
Radium 226	0.37 BQ/L
Silver (total)	0.02 mg/L
Zinc (total)	0.5 mg/L
Acute Toxicity Testing	
96-hour Rainbow Trout	Non-Toxic, LC ₅₀ (100%)

41. The points of compliance for the effluent quality standards included in this licence for the Bellekeno, Lucky Queen and Onek Mines and the Keno Hill Silver District Mill Site shall be the final points of control prior to discharging effluent to the environment at

stations KV-43, KV-97, KV-96 and KV-83, respectively, and if required the Lucky Queen water treatment plant (KV-101).

PART E – DESIGN AND CONSTRUCTION

Design

42. At least 10 days prior to the commencement of construction, the Licensee shall submit to the Board final detailed design construction drawings for those structures for which preliminary design drawings were submitted as part of the Application. The final detailed design drawings must be consistent with the drawings which were submitted as part of the Application and must be sealed by a Professional Engineer licensed to practice in Yukon. All construction shall be carried out in accordance with the final design drawings. As it pertains to the DSTF, the Licensee shall include in the final design:
- a) further characterization of the subgrade below the location of the DSTF, for the purpose of managing slope stability, and to determine specific locations of the drainage layers, ditches, and other up-gradient water diversions; and
 - b) the subgrade characterization shall include field determination of the shallow soil profile including the nature and thickness of organics, and the nature and thickness of ice rich permafrost. The spatial density of characterization locations shall be supported by an appropriate rationale; and
 - c) completed slope stability sensitivity studies related to potential excess pore water pressure that may develop during thawing of ice rich permafrost underlying the facility. The sensitivity analysis shall identify triggers for monitoring of pore pressure during operations; and
 - d) the potential impacts of differential settlement resulting from thawing of underlying heterogeneous ice rich permafrost.
43. Where site conditions require minor modification to the designs submitted to the Board, the Licensee shall notify the Board, at least 10 days in advance, of the details of the modifications or variations from final detailed designs, specifications and quality assurance/quality control procedures previously submitted to the Board, provide a detailed construction schedule and the name and contact number(s) of the construction superintendent. The notice shall be in writing and include an explanation of the reasons for the change and an assessment of the potential impact on the performance of the works. The notice shall be sealed by a Professional Engineer licensed to practice in Yukon.
44. As-constructed (record) drawings and construction reports, including quality assurance and quality control documentation, for all structures and facilities shall be submitted to the Board within 120 days of the completion of construction. Each submission shall be sealed by a Professional Engineer licensed to practice in Yukon.
45. At least 10 days prior to the proposed date of commencement of construction, the Licensee shall submit to the Board a written notification, together with a detailed

construction schedule and the name and contact number(s) of the construction superintendent.

Construction and Operation

46. No heavy equipment shall be operated within the Wetted Perimeter of any Watercourse.
47. All disturbed ground surfaces shall be stabilized in such a manner so as to prevent erosion and surface runoff from carrying sediment into any Watercourse.
48. Construction and maintenance equipment shall be mechanically sound and free of leaks.
49. All works associated with the undertaking shall be maintained in good repair.

Water Pumps

50. All engine driven pumps shall be contained within an impermeable liner/structure that has the capacity to contain 110% of the maximum combined volumetric capacity of the fuel, lubricants and coolants within the engine of the water pump.
51. The Licensee shall provide barriers consisting of fish guards, screens, coverings or nets on all water intakes as follows:
 - a) screens or nets shall have a minimum of 3.5 openings per centimetre and openings no greater than 3.2 millimetres along any given side;
 - b) if a punch plate or similar material is used, the opening shall be no greater than 3.2 millimetres in length or width;
 - c) there shall be no less than 929 square centimetres of open screen for every 205 litres per minute being withdrawn;
 - d) the barriers shall be monitored and maintained to ensure that they function effectively at all times when water is being withdrawn;
 - e) the barriers shall be designed and installed in such a manner that the screen is submerged and a uniform flow distribution is maintained through the total screen area;
 - f) water shall not be withdrawn when the barrier is removed for renewal, repair or inspection; and
 - g) the Licensee shall cease pumping or decanting and take remedial action if there is alteration to the bed or bank of the water channel.

PART F – MONITORING AND SURVEILLANCE

Monitoring Program

52. The Licensee shall comply with the water quality monitoring program and surveillance network program contained in Schedule B of this licence.
53. Monitoring and sampling required as part of this licence shall be carried out in accordance with the procedures and standards described in:
- a) *Guidance Document for the Sampling and Analysis of Metal Mining Effluents*, April 2001, (Report: EPS 2/MM/5), Minerals and Metals Division, Environment Canada;
 - b) *Guidance Document for Flow Measurement of Metal Mining Effluents*, April 2001, (Report: EPS 2/MM/4), Minerals and Metals Division, Environment Canada; and
 - c) *Standard Guide for Sampling Ground-Water Monitoring Wells*, ASTM D4449-01, ASTM International, PA, USA.
54. Testing results for the effluent water quality parameters listed in this licence shall be provided by a laboratory accredited by CALA (Canadian Association for Laboratory Accreditation, or PALCAN (Program for Accreditation of Laboratories – Canada, as managed by the Standards Council of Canada).

Flow and Level Monitoring

55. The Licensee shall operate Continuous stream flow gauging stations at KV-6, KV-34 and KV-41. Data shall be recorded onto data loggers and the data loggers downloaded at least monthly. Manual calibration of the gauging stations shall be completed at least quarterly. The stations shall be established and operational within 90 days of the effective date of this licence.
56. The Licensee shall establish a staff gauge at the Keno Hill Silver District Mill Site collection and sedimentation pond and shall record the pond level daily between April 1 and November 30.
57. The Licensee shall establish flow meters for all pipelines withdrawing water from surface water sources and shall record the cumulative daily volume withdrawn from each surface water source.
58. The Licensee shall monitor the total daily volume of discharges, if any, released from the mill to the Keno Hill Silver District Mill collection and sedimentation pond.

Meteorological Monitoring

59. The Licensee shall establish and maintain a meteorological monitoring station at the Flame and Moth Site. At a minimum, the station shall collect data on precipitation, temperature, and wind speed and direction.

60. The Licensee shall also establish snow courses at the Keno Hill Silver District Mill Site, Bellekeno, Onek, and Lucky Queen Mine sites, and shall collect standard snow survey information from each site.

Groundwater Monitoring

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

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

Sediment and Benthic Invertebrate Monitoring

63. The Licensee shall implement the MMER EEM program which includes monitoring for benthic invertebrates, stream sediments, fisheries, effluent characterization and sub lethal toxicity testing. Sampling locations and monitoring requirements will be specified in the EEM Study Design. All interpretive reports as required under the MMER EEM program shall be filed with the Board as per MMER EEM program reporting requirements.
64. The Licensee shall conduct sediment sampling at the frequency and locations indicated in Schedule B. Sediment sampling shall be carried out as follows:
- a) sediment samples shall be collected in replicates of three from the active channel, directly into high density plastic sample jars, using an aluminum or Teflon scoop;
 - b) samples shall be dried and screened, using sieves at ASTM mesh numbers 10, 20, 40, 60, 100, 140 and 270 (ASTM-E11-61) and the fraction weights shall be recorded; and
 - c) sub-samples composed of material passing and retained on the 100 mesh number sieve shall be analyzed for metals by a 33 element ICP scan. Loss on ignition shall also be determined by heating the sample to 600°C.
65. The Licensee shall conduct benthic invertebrate sampling at the frequency and locations indicated in Schedule B. Benthic invertebrate sampling shall be carried out as follows:
- a) three replicate samples shall be taken from each station/area following the CABIN protocol;

- b) samples shall be preserved with 10% formalin solution, and identified to the lowest possible taxon (usually genus) and counted; and
- c) stream information collected at the time of the benthos collection shall include velocity, depth, temperature, substrate conditions and riparian conditions.

Physical Inspections and Monitoring

- 66. The Licensee shall conduct physical inspection of water retaining and conveying structures, and associated mine waste and earthworks structures in accordance with the Keno Hill Silver District Physical Inspection and Reporting Plan. This plan shall be submitted within 90 days of the effective date of this licence.
- 67. If seepage discharge from any water retaining structures is identified, the Licensee shall report on such discharge as part of the next monthly report in accordance with the Keno Hill Silver District Physical Inspection and Reporting Plan. Within 60 days of the discovery of the discharge, the Licensee shall submit a plan for collecting, testing and managing the discharge. Subject to any required assessments, authorizations or approvals, the Licensee shall implement that plan.
- 68. Annual monitoring and inspection of all water retaining structures shall be carried out by a Professional Engineer licensed to practice in the Yukon. A report prepared by the Professional Engineer shall be submitted as a part of each annual report.

Waste Rock Monitoring

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

PART G – MANUALS, PLANS, AND STUDIES

Water Treatment System Operation Manuals

- 70. Within 90 days of commissioning any new water treatment systems or amending existing water treatment systems the Licensee shall submit to the Board the Water Treatment Systems Operation Manuals or updates. The manual shall include, but not be necessarily limited to:
 - a) details of all system components including: piping, tanks, treatment building, additives storage, flow capacity, filtration system, pond design details, pond volumes, discharge controls and details;
 - b) description of treatment operations, including lime dosing and basis, mixing procedures, polymer additions, filtration, expected retention times in the ponds and basis for these times, bypass events, cold weather operations;

- c) maintenance activities being undertaken to keep the facility in good operating condition and minimize breakdowns, along with a schedule for these activities;
- d) monitoring that will be undertaken to determine influent quality and volumes and to confirm that discharge criteria are met;
- e) details on treatment of contaminants other than metals; and
- f) details about contingency plans and system flexibility to adapt to greater flows and poorer water quality than the system was designed for.

Tailings Characterization Plan

71. Within six months of the effective date of the Licence, the Licensee shall submit to the Board an updated Tailings Characterization Plan.

72. The Tailings Characterization Plan shall include:

- a) the testing procedures to confirm the physical, chemical, and mineralogical properties of the low sulphur tailings which will be deposited at the facility. The procedures are required to determine at least the following properties or characteristics of the low sulphur tailings:
 - i. soil water characteristic curve;
 - ii. tailings gradation;
 - iii. tailings specific gravity;
 - iv. drained and undrained shear strength;
 - v. tailings pore water chemistry; and
 - vi. tailings mineralogy and acid base accounting;
- b) provisions for conducting long-term humidity cell tests of the comingled tailings generated through the processing of ore from the Bellekeno, Lucky Queen and Onek mines. Such tests shall be initiated as required to ensure adequate representation of the comingled tailings deposited in the DSTF as each new ore body is mined, and shall be continued until the make up of the DSTF at the end of operations is known and a steady-state has been established; and
- c) sampling frequencies for confirming the properties of deposited tailings such that the assumed long term chemical and physical behaviour of the tailings stack can be progressively confirmed during operation of the Keno Hill Silver District Mill, and the rationale to support the recommended frequencies.

Detailed Water Balance Report

73. Within six months of the effective date of this licence, the Licensee shall submit a detailed site wide water balance report for the Keno Hill Silver District Mill Site and the Bellekeno, Lucky Queen and Onek Mines. The report shall be based on considering a range of potential input hydrology scenarios in a detailed water balance model developed for the site areas.

74. Input hydrology scenarios shall be developed based on an update of meteorological, stream flow, and groundwater parameters for the site areas including:
- a) updated meteorological inputs including precipitation, snowmelt, evaporation, and evapo-transpiration;
 - b) stream flow monitoring results; and
 - c) short-term and long-term mine inflow predictions.
75. The water balance model shall be capable of modelling all key phases of the project, accounting for production changes, changing surface and underground developments, surface and underground storage volumes, and changing water use requirements associated with the operations and closure phases of the Keno Hill Silver District Undertaking.
76. A subset of the water balance model shall specifically investigate and report on the groundwater, groundwater-surface water interactions and the fate of contaminated seepage/discharges which do not report directly to surface water.
77. A subset of the water balance model shall specifically investigate and report on the water balance of the DSTF that accounts for potential runoff, infiltration, and draindown seepage that may occur at this facility during operations and closure.
78. The water balance report shall be updated annually.

Water Management Plan

79. Within six months of the effective date of this licence, the Licensee shall amend the Bellekeno Water Management Plan to incorporate Lucky Queen and Onek Mines, and submit to the Board a plan titled, "*Keno Hill Silver District Mining Operations Water Management Plan*", and shall implement that plan. The plan shall be based on a detailed water balance and shall include but not be limited to:
- a) Protocols, such as water quality requirements, to identify when and for what purpose water other than treated discharge or mine pool water can be used at the Bellekeno Mine;
 - b) Protocols to identify when and for what purpose water other than Galkeno 900 treated discharge water or water stored at the Keno Hill Silver District Mill collection and sediment pond can be used at the Keno Hill Silver District Mill Site;
 - c) Procedures and methods for accounting for water use at the Bellekeno, Lucky Queen and Onek Mines and Keno Hill Silver District Mill Site;
 - d) Procedures and methods for verifying water balance assumptions and collecting water balance input data such as site runoff, precipitation, evaporation, and DSTF seepage; and

- e) Contingency plans for operations related to flood or drought conditions and high mine inflow conditions.

Receiving Environment Study

- 80. On or before July 1, 2014, the Licensee shall submit the results of a Receiving Environment Study that identifies receiving environment water quality standards appropriate for the long-term goals of closing this undertaking.
- 81. The study shall be consistent with the goal of biological recovery of the Lightning Creek and Christal Creek drainages.
- 82. The study shall include recommendations for monitoring frequency and methodology of the receiving environments and any other necessary locations to ascertain that the Keno Hill Silver District Undertaking is not causing the Receiving Environment Study standards to be exceeded.
- 83. The recommendations of the receiving environment study shall be updated at least annually and whenever studies and/or recommendations are modified as a result of any regulatory approval process.

Sludge Management Plan

- 84. Within six months of the effective date of this licence, the Licensee shall submit to the Board an updated Sludge Management Plan dealing specifically with the Keno Hill Silver District Undertaking and shall implement that plan. The plan shall include physical and geochemical characterization of any sludge generated the Keno Hill Silver District Undertaking and a description of sludge management for Keno Hill Silver District Undertaking treatment sludges both during operations and during closure.
- 85. The Sludge Management Plan shall demonstrate how the Keno Hill Silver District Undertaking sludge is maintained separately from other treatment sludges not authorized by this licence.

Keno Hill Silver District Hydrogeology

- 86. The Licensee shall implement the Bellekeno Mine Operations Hydrogeology Plan. All documentation and data produced as part of this plan shall be certified by a professional hydrogeologist registered with a provincial regulatory organization, and submitted to the Board as part of the annual report.
- 87. Within 90 days of the effective date of this licence, the Licensee shall submit to the Board a plan developed by a professional hydrogeologist for the assessment of the impact of water withdrawal from the mill groundwater well and the local groundwater regime, including the Keno City water source.
- 88. The Licensee shall implement the plan required by clause 87 of this licence within 120 days of the effective date of this licence. All documentation and data produced as part of

this plan shall be certified by a professional hydrogeologist registered with a provincial regulatory organization, and submitted to the Board as part of the annual report.

89. Within 90 days of the effective date of this licence, the Licensee shall submit to the Board a plan developed by a professional hydrogeologist for a groundwater monitoring plan downgradient of the Onek Mine to provide for an understanding of the relationship between the Onek Mine and water quality at the Keno City water source. The plan shall include, at a minimum, but not be limited to, the installation of two sentinel wells (ON-MW-02 and ON-MW-03), and include groundwater modelling and impact assessment for the Keno City area.
90. The Licensee shall implement the plan required by clause 89 of this licence within 120 days of the effective date of this licence. All documentation and data produced as part of this plan shall be certified by a professional hydrogeologist registered with a provincial regulatory organization, and submitted to the Board as part of the annual report.
91. Within twelve months of the effective date of this licence, the Licensee shall submit to the Board an assessment of the hydrogeological connectivity between the historical and new workings at the Lucky Queen and Onek Mines. This assessment shall include, but not be limited to, available information from exploration drilling and groundwater well installation. All documentation and data produced as part of this assessment shall be certified by a professional hydrogeologist registered with a provincial regulatory organization.
92. Not later than six months prior to closure, the Licensee shall submit to the Board a Keno Hill Silver District Mine Closure Hydrogeological Assessment report. The report shall present the following:
 - a) the results of the hydrogeological monitoring of underground workings at the Bellekeno, Lucky Queen, and Onek mines;
 - b) the predicted static water elevation in the underground workings after closure;
 - c) the predicted rate of discharge from the mines after closure;
 - d) the predicted water quality discharging from the mines after closure; and
 - e) the basis for these determinations.

Waste Rock Management Plan

93. Within six months of the effective date of this licence, the Licensee shall submit to the Board an updated Waste Rock Management Plan for the Keno Hill Silver District Undertaking which includes kinetic testing of N-AML and P-AML Waste Rock and shall implement that plan.

Groundwater Monitoring Plan

94. Within six months of the effective date of this licence, the Licensee shall submit to the Board a 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 and Onek Mines, and shall implement that plan.

95. The plan for the Bellekeno Waste Rock Disposal Area shall include the installation of at least four groundwater monitoring wells.
96. The plan for the Lucky Queen P-AML shall include the installation of at least one downgradient groundwater monitoring well.
97. 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;
 - 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.

Bioreactor Design and Operation Plan

98. The Licensee shall implement the Bellekeno Bioreactor Design and Operation Plan. All documentation and data produced as part of this plan shall be submitted to the Board as part of the annual report.
99. The Bellekeno Bioreactor Design and Operation Plan shall be updated annually to account for any changes to the predicted water quantity or quality of discharges from the Bellekeno Mine at closure.

Keno Hill Silver District Adaptive Management Plan

100. Within six months of the effective date of this licence, the Licensee shall submit to the Board an updated AMP and shall implement that plan. The AMP should be based on the contents of the AMP submitted as exhibit 1.12 of Application QZ12-053.
101. In addition to these relevant events already identified in the district wide AMP, the Keno Hill Silver District AMP shall specifically include adaptive management triggers and responses to the following events:
 - a) development of high pore pressures underneath the DSTF;

- b) development of significant erosion of exposed DSTF surfaces;
- c) development of erosion at the Keno Hill Silver District Mill Site discharge area;
- d) transport of sediment from the Keno Hill Silver District Mill discharge area into Christal Creek;
- e) development of large differential settlements at the DSTF;
- f) development of large differential settlements along the conveyance flume from the DSTF to the Keno Hill Silver District Mill Site collection and sediment pond;
- g) exceedance of recommended water quality standards in the receiving environment occurring irrespective of compliance with effluent discharge standards;
- h) identification and assessment of trends in water quality in discharges from at the Keno Hill Silver District Mill or the Bellekeno, Lucky Queen or Onek mine sites for parameters without effluent discharge standards;
- i) identification of groundwater quality impacts at the Keno Hill Silver District Mill or the Bellekeno, Lucky Queen or Onek mine sites;
- j) identification of water quality impacts to Keno City water wells;
- k) identification of water quality changes from N-AML Waste Rock, including results from kinetic testing;
- l) development of erosion and/or permafrost degradation at the discharge to ground areas at the Lucky Queen and Onek mine sites; and
- m) operation of the contingency Lucky Queen water treatment plant

102. At a minimum, the AMP shall include the addition of ammonia, zinc and cadmium to the parameters being used to establish thresholds and monitor trends for changes in water quality.

Keno Hill Silver District Physical Inspections and Reporting Plan

103. Within 90 days of the effective date of this licence, the Licensee shall submit to the Board an amended plan titled, "*Physical Inspection and Reporting Plan*" for all water retaining structures, water conveying structures, and mine Waste structures in the Keno Hill Silver District and shall implement that plan.

104. 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.

105. The Physical Inspection and Reporting Plan shall include the Bellekeno 625 settling ponds, the Lucky Queen and Onek water storage ponds, all N-AML Waste Rock disposal areas and all P-AML Waste Rock storage facilities, the access roads, DSTF, and Mill Site and DSTF collection and sedimentation pond.

PART H – SITE DECOMMISSIONING AND RECLAMATION

106. On or before January 23, 2015 the Licensee shall submit an updated Decommissioning and Reclamation Plan for review. In addition to the plans submitted in the application, the plan shall include updates on all engineered cover designs and modelling of expected cover performance, incorporating the results of ongoing research and data collection (geochemical characterization).
107. Any substantial modification to the Decommissioning and Reclamation Plan shall require an amendment to this licence.
108. Prior to implementation of the Decommissioning and Reclamation Plan, the Licensee shall investigate whether further assessments, authorizations or approvals are required. The results of this investigation shall be submitted to the Board prior to implementation.
109. Subject to clauses 108 and 109 of this licence, and in the event of Temporary Closure, the Licensee shall implement the Temporary Closure provisions of the Decommissioning and Reclamation Plan.
110. Subject to clauses 108 and 109 of this licence, and in the event of Permanent Closure, the Licensee shall implement the Decommissioning and Reclamation Plan.
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SCHEDULE A - MINERAL CLAIMS COVERING THE MINE AND MINE FACILITIES

GRANT NUMBER	GRANT NUMBER	GRANT NUMBER	GRANT NUMBER
59645	59494	12909	12876
55426	12838	55206	55420
YC42578	56401	62341	Y69403
YA17395	83011	13094	62235
YC56120	55544	12931	55319
YC42580	55319	56419	13094
YA17397	38819	62247	
YC56121	59338	12965	
55445	16105	13222	
16097	59316	13032	
YC42628	38643	YA77506	
YC42627	56403	12937	
YC56115	56582	12869	
YC42629	16557	56505	
59387	15207	55389	
55312	55542	59249	
55546	55540	62248	
56402	16375	59250	
56533	15374	62367	
16554	55029	55341	
16585	16569	59248	
55599	56575	55443	
13073	56443	59367	
55271	16170	12880	
59465	59452	55022	
14081	55600	56530	
14327	55120	80178	
38730	16561	55330	
55065	59463	55385	
56534	83012	56515	
38642	55327	82289	
16087	55474	12923	
55475		14002	

SCHEDULE B: TABLE 1 – SURFACE WATER MONITORING STATIONS

Monitoring Station	Description	Northing ¹	Easting ¹
KV-1	South McQuesten River u/s of Christal Creek	7092790	474008
KV-2	South McQuesten River @ Pumphouse	7090036	472076
KV-6	Christal Creek at Keno Highway	7088242	483909
KV-7	Christal Creek at Hanson Road	7092413	478657
KV-8	Christal Creek @ Mouth	7091944	474585
KV-34	Lucky Queen 500 level adit discharge	TBD ³	TBD ³
KV-37 ²	Lightning Creek u/s Hope Gulch	7087776	490315
KV-38	Lightning Creek u/s Thunder Gulch	7087341	488193
KV-39	Hope Gulch u/s Lightning Creek	7087783	490252
KV-40	Charity Gulch u/s Lightning Creek	7087503	488982
KV-41	Lightning Creek u/s bridge at Keno City	7086764	485429
KV-42	Bellekeno 625 Adit	7087062	487363
KV-43	Bellekeno 625 Treatment Pond Decant	7087147	487318
KV-44	Bellekeno 625 Seep	7087195	487361
KV-45	Onek 400 Adit	7087288	485101
KV-49	Hinton Creek u/s of Christal Creek	7086954	483445
KV-50 ²	Christal Creek u/s Hinton Creek	7086897	483575
KV-51	Christal Creek d/s Hinton Creek	7087010	483600
KV-52	Natural Spring to Christal Lake at Old Mackeno pump house	7087869	483756
KV-65	Thunder Gulch Upstream of Bellekeno	7086873	487464
KV-72	South McQuesten River at McQuesten Lake	7104476	482492
KV-76	Thunder Gulch d/s of Bellekeno 625 adit	7087118	487414
KV-77	Thunder Gulch upstream of Bellekeno East	7086013	487742
KV-78a	Onek Waste Rock Storage Facility	7087488	485675
KV-78b	Bellekeno East Temporary Waste Rock Storage Facility	7086158	487605
KV-79	Christal Creek d/s MacKeno Tailings	7088054	483809
KV-80	Christal Lake u/s Mackeno Tailings	7088132	483827
KV-81	Lightning Creek Southwest of Mill Site	7086424	483557
KV-82	Keno Hill Silver District Mill collection and sediment pond	7086769	483839
KV-83	Keno Hill Silver District Mill treatment plant discharge	7086695	483780
KV-96	Onek Settling Pond Decant	TBD ³	TBD ³
KV-97	Lucky Queen Settling Pond Decant	TBD ³	TBD ³
KV-98	Lucky Queen N-AML WRDA Seep Survey	TBD ³	TBD ³
KV-99	Lucky Queen P-AML WRSF	TBD ³	TBD ³
KV-100	Onek Settling Pond	TBD ³	TBD ³
KV-101	Lucky Queen treatment plant discharge	TBD ³	TBD ³
KV-102	Lucky Queen settling pond	TBD ³	TBD ³

¹ Coordinates are UTM Zone 8 NAD 83² Background³ TBD – “to be determined”, station not established at this time.

SCHEDULE B: TABLE 2 – GROUNDWATER MONITORING STATIONS

Monitoring Station	Description	Northing ¹	Easting ¹
KV-84	Keno City Well #1 (ON-MW-03)	TBD ²	TBD ²
KV-85	Keno Hill Silver District Mill Site Groundwater Well #1 (PH2)	7086952	483864
KV-86	Keno Hill Silver District Mill Site Groundwater Well #2 (PH5)	7086707	483836
KV-87	Keno Hill Silver District Mill Site Groundwater Well #3 (PH6)	7086854	484104
KV-88	Keno Hill Silver District Mill Site Groundwater Well #4	TBD ²	TBD ²
KV-89	Keno Hill Silver District Mill Site Groundwater Well #5	TBD ²	TBD ²
KV-90	Keno Hill Silver District Mill Site Groundwater Well #6	TBD ²	TBD ²
KV-91	Bellekeno Waste Rock Disposal Area well #1	TBD ²	TBD ²
KV-92	Bellekeno Waste Rock Disposal Area Well #2	TBD ²	TBD ²
KV-93	Bellekeno Waste Rock Disposal Area Well #3	TBD ²	TBD ²
KV-94	Bellekeno Waste Rock Disposal Area Well #4	TBD ²	TBD ²
ON-MW-02	Keno City Well #2	7087077	485225
KC-MW-4	Keno City Well #3	7086919	485201
LQ-MW-01	Lucky Queen N-AML WRDA	7090577	486425
LQ-MW-02	Lucky Queen d/g of P-AML Waste Rock Storage Facility	TBD ²	TBD ²

¹ Coordinates are UTM Zone 8 NAD 83

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

SCHEDULE B: TABLE 3 - MONITORING SCHEDULE FREQUENCY LEGEND

Symbol	Frequency
C	Continuous
C-WD	Continuous while discharging
D	Daily
D-WD	Daily while discharging
W	Weekly
W-WD	Weekly while discharging
W-WD/Q	Weekly when discharging migrating to quarterly in accordance with monitoring frequency pursuant to MMER regulations
W/Q	Weekly migrating to quarterly to accord with monitoring frequency pursuant to MMER regulations
M	Monthly
Ms	Monthly from May to October
Q	Quarterly: May/July/October/February
SA	Semi-annually (twice per year)
A	Annually
BA	Bi-annually (every two years)

SCHEDULE B: TABLE 4 - FIELD SCREENING MONITORING SCHEDULE

Monitoring Station	Field Parameters							
	Zn	Ammonia	Turbidity	pH	Temp.	Cond.	Flow	Level
Treatment Sites:								
KV-42	D	D	D	D	D	D	C	-
KV-43	D	D	D	D	D	D	C	-
KV-82	D	D	D	D	D	D	-	D
KV-83	D-WD	D-WD	D-WD	D-WD	D-WD	D-WD	C-WD	-
Surveillance Sites:								
KV-1	-	-	-	Q	Q	Q	Q	-
KV-2	-	-	-	Q	Q	Q	Q	-
KV-6	-	-	-	M	M	M	C	-
KV-7	-	-	-	M	M	M	M	-
KV-8	-	-	-	M	M	M	Q	-
KV-34	D	D	D	D	D	D	C	-
KV-37	-	-	-	Q	Q	Q	Q	-
KV-38	-	-	-	Q	Q	Q	Q	-
KV-39	-	-	-	Q	Q	Q	Q	-
KV-40	-	-	-	Q	Q	Q	Q	-
KV-41	-	-	-	M	M	M	C	-
KV-44	Ms	-	-	Ms	Ms	Ms	Ms	-
KV-45	-	-	-	Q	Q	Q	Q	-
KV-50	-	-	-	Q	Q	Q	Q	-
KV-51	-	-	-	Q	Q	Q	Q	-
KV-52	-	-	-	M	M	M	M	-
KV-65	-	-	-	Q	Q	Q	Q	-
KV-72	-	-	-	Q	Q	Q	Q	-
KV-76	Q	-	-	Q	Q	Q	Q	-
KV-77	-	-	-	Q	Q	Q	Q	-
KV-78a	-	-	-	Ms	Ms	Ms	-	Ms
KV-78b	-	-	-	Ms	Ms	Ms	-	Ms
KV-79	-	-	-	Q	Q	Q	-	-
KV-80	-	-	-	Q	Q	Q	-	-
KV-81	-	-	-	Q	Q	Q	-	-
KV-84	-	-	-	Q	Q	Q	-	Q
KV-85	-	-	-	Q	Q	Q	-	Q
KV-86	-	-	-	Q	Q	Q	-	Q
KV-87	-	-	-	Q	Q	Q	-	Q
KV-88	-	-	-	Q	Q	Q	-	Q
KV-89	-	-	-	Q	Q	Q	-	Q
KV-90	-	-	-	Q	Q	Q	-	Q
KV-91	-	-	-	Q	Q	Q	-	Q
KV-92	-	-	-	Q	Q	Q	-	Q
KV-93	-	-	-	Q	Q	Q	-	Q
KV-94	-	-	-	Q	Q	Q	-	Q
KV-96	D-WD	D-WD	D-WD	D-WD	D-WD	D-WD	C-WD	-
KV-97	D-WD	D-WD	D-WD	D-WD	D-WD	D-WD	C-WD	-
KV-98	Ms	-	-	Ms	Ms	Ms	Ms	-
KV-99	Ms	-	-	Ms	Ms	Ms	Ms	-
KV-100	W	W	W	W	W	W	-	D
KV-101	D-WD	D-WD	D-WD	D-WD	D-WD	D-WD	C-WD	-
KV-102	W	W	W	W	W	W	-	D
ON-MW-02				Q	Q	Q	-	Q
KC-MW-4				Q	Q	Q	-	Q
LQ-MW-01				Q	Q	Q	-	Q
LQ-MW-02				Q	Q	Q	-	Q

SCHEDULE B: TABLE 5- DETAILED MONITORING SCHEDULE

Monitoring Station	Parameters								
	Total ICP Metals ¹	Dissolved ICP Metals ¹	Ammonia -N	Nitrite -N	Nitrate -N	Phosphorous	Sulphate	Dissolved Organic Carbon (DOC)	Hardness
Treatment Sites:									
KV-42	W	W	W	W	W	W	W	M	W
KV-43 ²	W	W	W	W	W	W	W	W	W
KV-82	M	M	M	M	M	M	M	M	M
KV-83 ²	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD
Surveillance Sites:									
KV-1	Q	Q	-	-	-	Q	Q	Q	Q
KV-2	Q	Q	-	-	-	Q	Q	Q	Q
KV-6	M	M	M	M	M	M	M	M	M
KV-7	M	M	M	M	M	M	M	M	M
KV-8	M	M	-	-	-	M	M	M	M
KV-34	W	W	W	W	W	W	W	W	W
KV-37	Q	Q	-	-	-	Q	Q	Q	Q
KV-38	Q	Q	-	-	-	Q	Q	Q	Q
KV-39	Q	Q	-	-	-	Q	Q	Q	Q
KV-40	Q	Q	-	-	-	Q	Q	Q	Q
KV-41	M	M	M	M	M	M	M	M	M
KV-44	-	Q	Q	Q	Q	Q	Q	Q	Q
KV-45	Q	Q	-	-	-	Q	Q	Q	Q
KV-49	Q	Q	-	-	-	Q	Q	Q	Q
KV-50	Q	Q	-	-	-	Q	Q	Q	Q
KV-51	Q	Q	Q	Q	Q	Q	Q	Q	Q
KV-52	M	M	-	-	-	M	M	M	M
KV-65	M	M	-	-	-	M	M	M	M
KV-72	Q	Q	-	-	-	Q	Q	Q	Q
KV-76	Q	Q	-	-	-	Q	Q	Q	Q
KV-77	Q	Q	-	-	-	Q	Q	Q	Q
KV-78a	Q	Q	-	-	-	Q	Q	Q	Q
KV-78b	Q	Q	-	-	-	Q	Q	Q	Q
KV-79	Q	Q	-	-	-	Q	Q	Q	Q
KV-80	Q	Q	-	-	-	Q	Q	Q	Q
KV-81	Q	Q	-	-	-	Q	Q	Q	Q
KV-84	Q	Q	-	-	-	Q	Q	Q	Q
KV-85	Q	Q	Q	-	-	Q	Q	Q	Q
KV-86	Q	Q	Q	-	-	Q	Q	Q	Q
KV-87	Q	Q	Q	-	-	Q	Q	Q	Q
KV-88	Q	Q	Q	-	-	Q	Q	Q	Q
KV-89	Q	Q	Q	-	-	Q	Q	Q	Q
KV-90	Q	Q	Q	-	-	Q	Q	Q	Q

KV-91	Q	Q	Q	-	-	Q	Q	Q	Q
KV-92	Q	Q	Q	-	-	Q	Q	Q	Q
KV-93	Q	Q	Q	-	-	Q	Q	Q	Q
KV-94	Q	Q	Q	-	-	Q	Q	Q	Q
KV-96 ²	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD
KV-97 ²	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD
KV-98	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms
KV-99	Q	Q	-	-	-	Q	Q	Q	Q
KV-100	M	M	M	M	M	M	M	M	M
KV-101 ²	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD
KV-102	M	M	M	M	M	M	M	M	M
ON-MW-02	Q	Q	Q	Q	Q	Q	Q	Q	Q
KC-MW-4	Q	Q	Q	Q	Q	Q	Q	Q	Q
LQ-MW-01	Q	Q	Q	Q	Q	Q	Q	Q	Q
LQ-MW-02	Q	Q	Q	Q	Q	Q	Q	Q	Q

¹ ICP Metals include: Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Molybdenum, Nickel, Potassium, Selenium, Silicon, Silver, Sodium, Strontium, Sulphur, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc and Zirconium

² Compliance Points

SCHEDULE B: TABLE 5 - DETAILED MONITORING SCHEDULE (CONTINUED)

Monitoring Station	Parameters								
	Alkalinity	pH	Cond.	TSS	Radium 226	LC ₅₀	Sediment	Benthic	Sub-lethal Toxicity
Treatment Sites:									
KV-42	W	W	W	W	-	-	-	-	-
KV-43 ²	W	W	W	W	W/Q	M	A	-	SA
KV-82	M	M	M	M	-	-	-	-	-
KV-83 ²	W-WD	W-WD	W-WD	W-WD	W/Q	M	A	-	SA
Surveillance Sites:									
KV-1	Q	Q	Q	Q	-	-	-	-	-
KV-2	Q	Q	Q	Q	-	-	-	-	-
KV-6	M	M	M	M	-	-	BA	BA	-
KV-7	M	M	M	M	-	-	-	-	-
KV-8	M	M	M	M	-	-	-	-	-
KV-34	M	M	M	M	-	-	-	-	-
KV-37	Q	Q	Q	Q	-	-	-	-	-
KV-38	Q	Q	Q	Q	-	-	A	A	-
KV-39	Q	Q	Q	Q	-	-	-	-	-
KV-40	Q	Q	Q	Q	-	-	-	-	-
KV-41	M	M	M	M	-	-	A	A	-
KV-44	Q	Q	Q	Q	-	Q	-	-	-
KV-45	Q	Q	Q	Q	-	-	-	-	-
KV-49	Q	Q	Q	Q	-	-	-	-	-
KV-50	Q	Q	Q	Q	-	-	-	-	-
KV-51	Q	Q	Q	Q	-	-	-	-	-
KV-52	M	M	M	M	-	-	-	-	-
KV-65	M	M	M	M	-	-	-	-	-
KV-72	Q	Q	Q	Q	-	-	-	-	-
KV-76	Q	Q	Q	Q	-	M	-	-	-
KV-77	Q	Q	Q	Q	-	-	-	-	-
KV-78a	Q	Q	Q	Q	-	-	-	-	-
KV-78b	Q	Q	Q	Q	-	-	-	-	-
KV-79	Q	Q	Q	Q	-	-	-	-	-
KV-80	Q	Q	Q	Q	-	-	-	-	-
KV-81	Q	Q	Q	Q	-	-	-	-	-
KV-84	Q	Q	Q	Q	-	-	-	-	-
KV-85	Q	Q	Q	Q	-	-	-	-	-
KV-86	Q	Q	Q	Q	-	-	-	-	-
KV-87	Q	Q	Q	Q	-	-	-	-	-
KV-88	Q	Q	Q	Q	-	-	-	-	-
KV-89	Q	Q	Q	Q	-	-	-	-	-
KV-90	Q	Q	Q	Q	-	-	-	-	-

KV-91	Q	Q	Q	Q	-	-	-	-	-
KV-92	Q	Q	Q	Q	-	-	-	-	-
KV-93	Q	Q	Q	Q	-	-	-	-	-
KV-94	Q	Q	Q	Q	-	-	-	-	-
KV-96 ²	W-WD	W-WD	W-WD	W-WD	W-WD/Q	SA	-	-	-
KV-97 ²	W-WD	W-WD	W-WD	W-WD	W-WD/Q	SA	-	-	-
KV-98	Ms	Ms	Ms	Ms	-	-	-	-	-
KV-99	Q	Q	Q	Q	-	-	-	-	-
KV-100	M	M	M	M					
KV-101 ²	W-WD	W-WD	W-WD	W-WD	W-WD/Q	SA	-	-	-
KV-102	M	M	M	M	-	-	-	-	-
ON-MW-02	Q	Q	Q	Q	-	-	-	-	-
KC-MW-4	Q	Q	Q	Q	-	-	-	-	-
LQ-MW-01	Q	Q	Q	Q	-	-	-	-	-
LQ-MW-02	Q	Q	Q	Q	-	-	-	-	-

² Compliance Points

APPENDIX 1

Table of Deliverables

Clause	Deliverable	Frequency	Due
15	Annual Report	Annually: Jan. 1 to Dec. 31	March 31 of the year following the review period
18	Physical Inspections and Monitoring Report	Annually	As part of the Annual Report
22	Hydrogeological Monitoring	Annually	As part of the Annual Report
23	Monthly Reports	Monthly	30 days following the month the data were collected
42	Final detailed design construction drawings	Ongoing	At least 10 days prior to commencement of construction
44	As-constructed drawings and construction reports	Ongoing	Within 120 days of completion of construction
45	Written notification	Ongoing	At least 10 days prior to commencement of construction
70	Water Treatment Systems Operation Manuals	Ongoing	Within 90 days of commissioning
71	Tailings Characterization Plan	Once	Within six months of the effective date
73	Detailed Water Balance Report	Once	Within six months of the effective date
79	Keno Hill Silver District Mining Operations Water Management Plan	Once	Within six months of the effective date
80	Receiving Environment Study	Once	On or before July 1, 2014
84	Sludge Management Plan	Once	Within six months of the effective date

This table lists the deliverables to be submitted by the licensee. In the case of any inconsistency between this table and the licence – Amendment 1, the licence wording shall prevail.

Clause	Deliverable	Frequency	Due
87	Plan for the assessment of the impact of water withdrawal	Once	Within 90 days of the effective date
89	Groundwater monitoring plan	Once	Within 90 days of the effective date
91	Assessment of hydrogeological connectivity	Once	Within 12 months of the effective date
92	Keno Hill Silver District Mine Closure Hydrogeological Assessment Report	Once	Not later than six months prior to closure
93	Updated Waste Rock Management Plan	Once	Within six months of the effective date
94	Groundwater Monitoring Plan	Once	Within six months of the effective date
99	Updated Bellekeno Bioreactor Design and Operation Plan	Every 12 months	Annually
100	Updated Keno Hill Silver District Adaptive Management Plan	Once	Within six months of the effective date
103	Physical Inspection and Reporting Plan	Once	Within 90 days of the effective date
106	Decommissioning and Reclamation Plan	Once	On or before Jan. 23, 2015

This table lists the deliverables to be submitted by the Licensee. In the case of any inconsistency between this table and the licence—Amendment 1, the licence wording shall prevail.

APPENDIX B

GROUNDWATER MONITORING PLAN

(August 2015)



KENO HILL SILVER DISTRICT MINING OPERATIONS

GROUNDWATER MONITORING PLAN

August 2015

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 revised plan is to fulfill the conditions set out in Part G, Clauses 94, 95, 96 and 97 of Water Licence QZ12-053 (hereafter referred to as the Licence) issued to Alexco Keno Hill Mining Corp. (AKHM) on May 16th 2013:

94. Within six months of the effective date of this licence, the Licensee shall submit to the Board a Groundwater Monitoring Plan for both the Keno Hill District Undertaking, including the Bellekeno Waste Rock Disposal Area, Keno Hill Silver District Mill Site and Lucky Queen and Onek Mines, and shall implement that plan.
95. The plan for the Bellekeno Waste Rock Disposal Area shall include the installation of at least four groundwater monitoring wells.
96. The plan for the Lucky Queen P-AML shall include the installation of at least one downgradient monitoring well.
97. For the Keno Hill 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) Where wells are installed into bedrock, the bedrock shall be cored;
 - c) Developing 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;
 - c) Based on baseline groundwater quality, the 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 61 and 62 of the Licence provided additional guidance on the groundwater monitoring program:

61. 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.

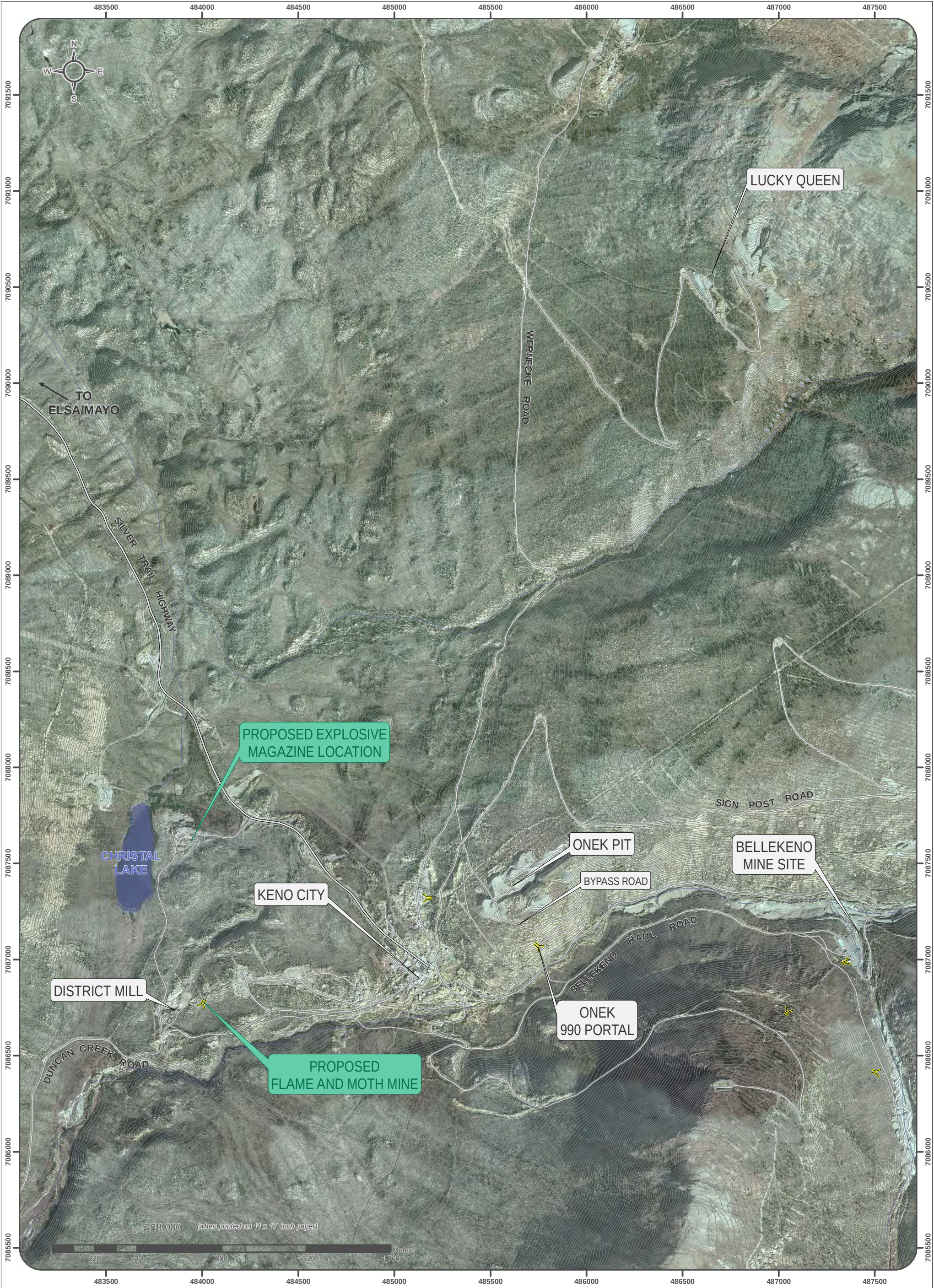
62. Monitoring results should be reviewed after each sampling event to identify groundwater changes, should they occur.
Groundwater wells determined to be subject to seasonal freezing shall have pressure transducers installed when cleared of seasonal ice.

The Plan has also been updated to include the proposed Flame and Moth mine and associated footprint expansion at the District Mill and DSTF.

2 MINE LOCATION AND DESCRIPTION

The Keno Hill Silver District (KHSD) 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 KHSD. Lucky Queen is located approximately 4 km northeast of Keno City and Onek is situated about 500 m northeast of Keno City. The 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 2,200 m downstream from the confluence of Thunder Gulch and Lightning Creek. The Flame and Moth deposit is located adjacent to the District Mill. Please see Figure 1 for the site map.



- Adit
- Highway
- Secondary
- Contour (5 m interval)

Aerial photograph obtained from Geodesy Remote Sensing Inc., Calgary Alberta. Imagery acquired September 13th and 14th 2006. Site hydrography and contours derived from 2006 aerial imagery obtained from Aero Geometrics, Calgary Alberta.

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Datum: NAD 83; Projection: UTM Zone 8N



KENO HILL SILVER DISTRICT MINING OPERATIONS

FIGURE 1
OVERVIEW

JANUARY 2014

I:\Keno_Area_Mines\FMMMap02_Permit\YESAB_IR\Overview20140120.mxd
(Last edited by: jpan:1/21/2014/09:47 AM)

3 PREVIOUS GROUNDWATER STUDIES

SRK Consulting Canada Inc. (SRK) was retained by AKHM to investigate groundwater gradients of 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-85, KV-86 and KV-87, respectively. Key findings of the SRK groundwater investigation (SRK, 2010) include:

- The water table within the bedrock aquifer under the site and within a relatively thick overburden aquifer to the south is at considerable depth (>25 m);
- Water level data from monitoring wells at site and Keno City indicate that groundwater flows from east to west, or from Keno City towards the mill site and Christal Lake;
- These water level data also indicate a shallow gradient between Lightning Creek towards Christal Lake;
- Water quality analyses of samples taken immediately following monitoring well development indicate that in general, concentrations of dissolved anions and metal are low;
- The only notable exceptions are elevated levels concentrations of chloride and sodium in KV-87, which is located downgradient and could be indicative of seepage from the Keno City dump and; elevated concentrations of sulphate in KV-86 and KV-87, which are deemed to be indicative of natural mineralization in this area;
- The likelihood of effects to groundwater quality in general related to the mill and DSTF are considered very low, due to site water management plans for seepage and runoff interception, and collection and treatment if necessary;
- Because groundwater extraction is not planned at the mill site, there will be no effects on the amount of water available for extraction from wells in Keno City, and;
- The chance of water quality being affected in wells in Keno City is considered insignificant due to current understanding of the local groundwater gradient and the large distance between the mill site and Keno City water wells.

The SRK groundwater report, entitled “Bellekeno Groundwater Program” was issued in May 2010, and was submitted to the Board as supplemental information in support of the application for QZ09-092 (Exhibit 1.12 of the public registry). This report is available at <http://www.yukonwaterboard.ca/registers/quartz/QZ09-092/Volume%204/1.12/1.12.pdf>. Prior to issuance of their 2010 Bellekeno Groundwater report, SRK was also retained to complete initial (desktop) assessments of potential impacts of the proposed mill and DSTF site on groundwater quantity and quality (SRK, 2009a; SRK, 2009b).

Interralogic, Inc. conducted a groundwater evaluation for Keno City between October 2010 and March 2012. Two trenches were excavated within a dry stream channel downgradient of the Onek 400 adit in October 2010 to determine if discharge from the adit was following the channel. As part

of the groundwater evaluation Interralogic also completed a Keno City water supply wells field program in fall 2010 to determine water levels, quality, and approximate material transmissivities. Interralogic also sampled five new monitoring wells drilled under the Keno Closure Plan, as well as a monitoring well (ON-MW-01) that was installed in 2011 to understand groundwater elevations near the historic Onek waste rock dumps and open pit.

In order to evaluate the groundwater flow path the wells that were available to measure groundwater levels were gauged and Interralogic came to the following conclusions, which are taken directly from there memo:

- 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 feature that appears to have higher permeability than adjacent geologic units. Evidence for this is (1) the interpretation that groundwater converges toward this feature, (2) 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 (3) the relatively high initial yield of the Firehall well (57 to 96 lpm). The higher permeability feature could be associated with a buried glacial valley (overburden) and/or fracture zone (bedrock).
- Water level contours suggest that groundwater discharges to Lightning Creek east of Keno City. South of Keno City, there appears to be seepage loss from the stream that recharges the groundwater system below the townsite. The zone of high seepage loss from the stream could be associated with the southeast extension of the postulated higher permeability feature.
- At and downstream (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 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. has summarised the results from the drilling and associated air lift testing from the three monitoring well completed. An air lift pump test conducted on well FM-MW-1 for 72 consecutive hours to calculate the potential mine inflows for the Flame and Moth Mine. The maximum predicted flow rate for the Flame and Moth mine has been conservatively calculated to be 35 L/s (Interralogic Inc., 2013).

The Interralogic report concludes that Flame and Moth Mine dewatering will not have a significant impact on surface water flows in Lightning Creek and it is highly unlikely that mine dewatering will have an effect on groundwater levels and the availability of water supply in the Keno City area.

4 REGIONAL GEOLOGY AND HYDROGEOLOGICAL IMPLICATIONS

The long history of mining and exploration in the Keno Hill Silver District 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 SITE GROUNDWATER MONITORING

As per Clause 97a 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 97a 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 97a through the use of the groundwater monitoring network described below in Table 1 and shown on Figure 2. 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 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	7086952	483864
KV-85S	TBD2	Shallow or perched groundwater monitoring	4.2	4.2	-	483858	7086952
KV-86	PH5	Overburden Groundwater Monitoring Well with Pressure Transducer Wire	36	36	-	7086707	483836
KV-87	PH6	Bedrock Groundwater Monitoring Well with Pressure Transducer Wire	57.9	2.7	55.2	7086854	484104
KV-88D		Deep bedrock groundwater monitoring	51.2	-	-	7087016	483946
KV-88S		Shallow or perched groundwater monitoring	3.72	3.72	-	7087016	483942
KV-89D		Deep bedrock groundwater monitoring	39.12	14.5	20.5	7086864	483831
KV-89S	BH17	Shallow or perched groundwater monitoring	4.8	4.8	0	7086844	483825

KV-103		District Mill Supply Well					
FM-MW-1	KAR13 01	Christal Zone	182.3	12	160	7086770	484026
FM-MW-2	KAR13 02	Lightning Zone	244.4	0	244.4	7086562	483854
FM-MW-3	KAR13 016	Mill Fault	195.7	15	180.7	7086628	483910
BH39	BH39	DSTF phase I GW monitoring	7.5	-	-	7086938	483973
KV-107		Proposed well in phase II of DSTF	TBD	-	-	TBD	TBD

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.

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).

The remaining wells, KV-85S, KV-86, KV-87, KV-88D, KV-88S, and KV-89D, in accordance with Clause 97c 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.

Clause 62 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 61b) and then quarterly for water level as per Schedule B (also summarized in Table 7 of this report)

Although Clause 97b, 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:

- o More efficient drilling of both overburden and bedrock;
- o Larger diameter borehole produced using an air-rotary drilling rig is preferable and reduces the chance of bridging during well completion;
- o AKHM did not have a diamond drill program active at site while the monitoring wells were being installed, and;

- o 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 97b; 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 2). 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.

5.1 SHALLOW SUBSURFACE CONDITIONS IN THE DISTRICT MILL AREA

A considerable amount of geotechnical information has been collected from the mill site and the area beneath the DSTF during geotechnical studies in support of preliminary and final design of the DSTF, mill building, mill site pond, ancillary facilities, and site water management infrastructure. This work was carried out by EBA Engineering Consultants Ltd. A summary of the subsurface conditions of the DSTF is provided below and is from the Preliminary Design Report (EBA, 2010):

“Nine boreholes were drilled near the DSTF. Information gathered in these boreholes indicates two general soil profiles in the area:

- glaciofluvial GRAVEL underlain by bedrock and
- SILT and SAND till underlain by gravel and bedrock.

The gravel was encountered along the ridge that crosses the site. The gravel in the area of the DSTF was found in both frozen and unfrozen states. It is typically sandy with trace silt, compact, medium grained, well graded, and brown, and it is underlain by a thin layer of silt and sand till and then bedrock. Bedrock encountered in testholes is a competent quartzite. Subsurface conditions for the gravel area are summarized in Table 2.

Table 2 General Subsurface Conditions for Gravel Area

Soil Unit	Min thickness (m)	Max Thickness (m)	Average Thickness (m)
Gravel	1.3	3.7	2.5
Silt and Sand till	0.2	1.3	1.0
Bedrock (quartzite)	@2.1 mbgs*	@5.0 mbgs*	@3.4 mbgs*

*Meters below ground surface

All silt and sand till encountered in the area of the DSTF was frozen. The silt and sand till typically contains trace gravel and trace clay, is low to non-plastic, olive grey, is underlain by gravel seams within the till and then by quartzite bedrock. Two boreholes on the west side of the ridge, BH15 and BH17, were drilled through the silt and sand layer. The gravel seams were encountered below 16 m depth in BH15, and bedrock was encountered at 14.2 m depth in BH17. One borehole, BH23, was drilled through the till deposit on the east side of the ridge and gravel seams were encountered at 7.6 m depth. Two boreholes, BH24 and BH25, were drilled near a proposed water collection pond. The general soil conditions in this area are gravel fill over glaciofluvial gravel over silt and sand till over glaciofluvial gravel. The glaciofluvial gravel and silt and sand till are similar to the soils described above and are all unfrozen.”

5.2 BEDROCK GEOLOGY AND STRUCTURE IN THE DISTRICT MILL AREA

Exploration drilling in the vicinity of the DSTF by AKHM during the 2010 season has provided additional data from the deeper subsurface in the form of information on rock quality and geological features. This drilling was designed to investigate the historically known mineralisation about the Flame and Moth (District Mill area) underground mine workings and comprised 13 holes for a total of 3,974 metres that were completed from five locations.

Basic rock quality designation (RQD) information that is routinely logged for exploration diamond drill core was supplemented with additional data including Rock Strength, Total Fracture Count, Total Vein Count, Vein Strength and % Vein for some of the District Mill holes.

Table 3 Details of Diamond Drill Hole at the Flame & Moth Prospect (District Mill Site)

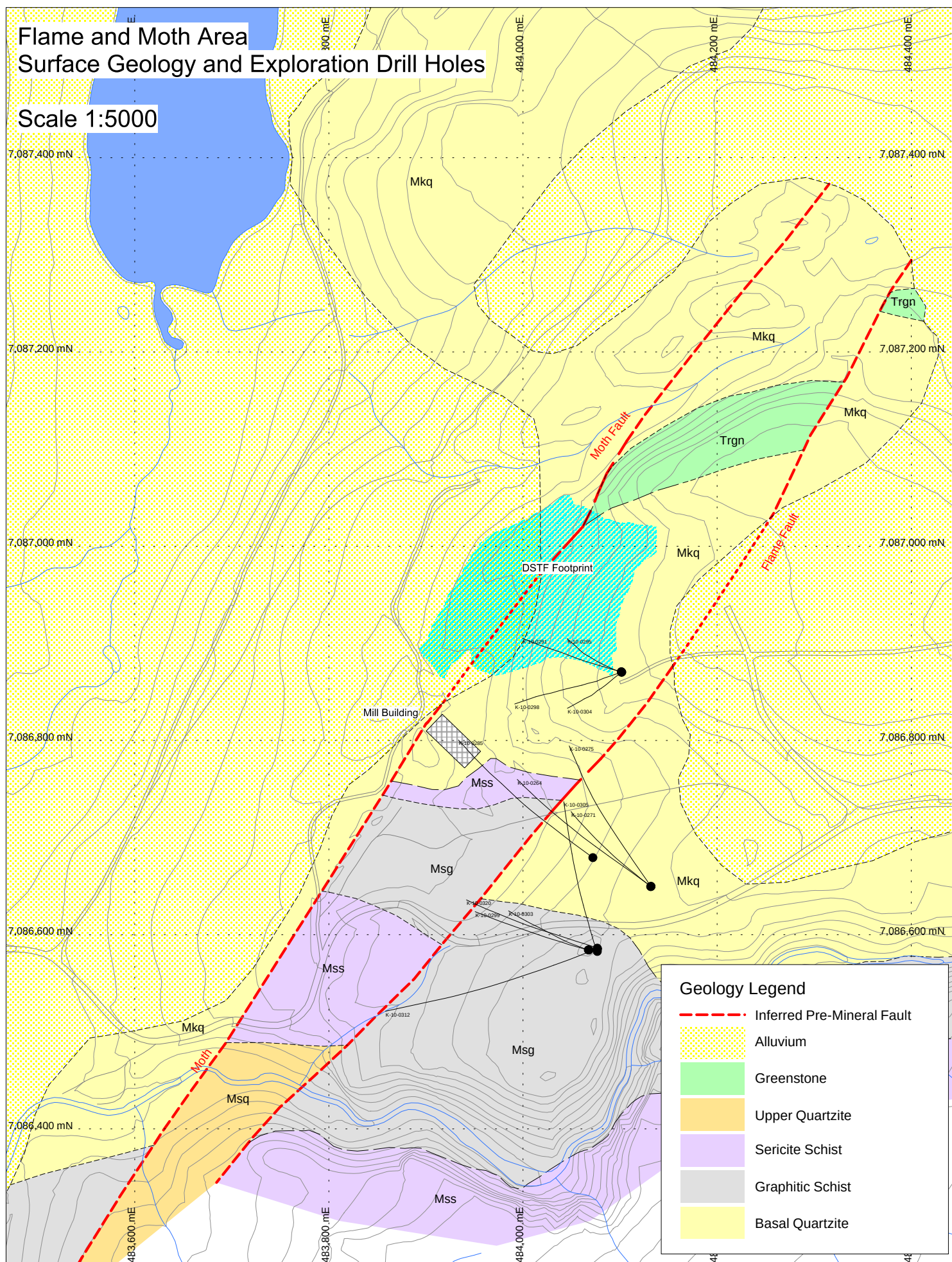
Hole_ID	Total Depth (m)	UTM Easting (m)	UTM Northing (m)	Elev. (m)	Collar Azimuth	Collar Dip	Started	Completed	Core Size
K-10-0264	336.80	484131.8	7086649.8	927.98	306	-60	05/07/2010	20/07/2010	HQ
K-10-0271	347.47	484131.8	7086649.8	927.98	306	-70	21/07/2010	31/07/2010	HQ
K-10-0275	346.57	484131.5	7086649.5	927.98	328	-62	01/08/2010	24/08/2010	HQ
K-10-0285	324.31	484071.9	7086679.4	919.59	306	-50	25/08/2010	06/09/2010	HQ
K-10-0291	192.67	484101.3	7086870.8	936.78	285	-54	08/09/2010	13/09/2010	HQ
K-10-0295	313.94	484101.4	7086870.5	936.78	285	-80	13/09/2010	03/10/2010	HQ
K-10-0298	220.68	484101.5	7086870.4	936.78	250	-60	03/10/2010	11/10/2010	HQ
K-10-0299	306.32	484067.2	7086584.3	923.86	285	-68	05/10/2010	10/10/2010	HQ
K-10-0303	348.08	484067.9	7086584.2	923.85	285	-75	10/10/2010	19/10/2010	HQ
K-10-0304	252.07	484101.7	7086870.3	936.78	230	-75	11/10/2010	19/10/2010	HQ
K-10-0305	352.35	484076.4	7086582.7	924.14	340	-65	20/10/2010	30/10/2010	HQ
K-10-0312	388.93	484076.7	7086585.3	923.89	250	-55	30/10/2010	16/11/2010	HQ
K-10-0320	243.84	484076.5	7086586.1	923.99	290	-55	19/11/2010	26/11/2010	HQ

The interpreted surface geology of the District Mill area is shown in Figure 3. The area is underlain by the Keno Hill Quartzite. Several distinctive east – west striking map units that dip moderately to the south are identified in this area:

- Upper Quartzite (Msq) - Comprising light to dark grey, platy quartzite with grey schist (phyllite) layers.
- Sericite Schist Marker (Mss) – Sericite +/-chlorite schist, schistose grit, minor light grey crystalline limestone.
- Graphitic Schist Marker (Msg) – Medium to dark grey schist (phyllite), locally calcareous.
- Basal Quartzite (Mkq) – Blocky buff, light to medium grey quartzite, locally calcareous. Thin graphitic schist bands are common.
- Greenstone (Trgn) – Chlorite-actinolite+/-calcite greenstone sills, locally with relict phaneritic texture.

Flame and Moth Area Surface Geology and Exploration Drill Holes

Scale 1:5000



As the amount of surface outcrop in the area is poor, the distribution of these rock units as shown on the map is somewhat interpretative. There is however evidence of possibly two significant north-east trending fault structures (Moth and Flame Faults) that offset the stratigraphy and that also host mineralised veins.

There is currently no surface geologic evidence for the presence of any later cross-cutting north-west trending faults.

Two diamond drill holes (K-10-0291, K-10-0295) were completed beneath the footprint of the DSTF from a site that was essentially on outcropping Basal Quartzite. These holes were however drilled at an oblique angle to the dominant stratigraphic structure, and this may affected the quality of the RQD information.

In K-10-0291, two zones displayed increased density of fracture development:

- In quartzite between 88.85 – 96.32 m,
- In a faulted quartzite zone associated with minor mineralisation between 129.84 – 157.28 m.

In K-10-0295, much wider zones in the Basal Quartzite display increased density of fracture development associated:

- Between 8.23 – 87.48 m,
- Between 166.73 – end of hole at 313.94 m.

Some of these fracture zones are associated with minor mineralisation, but may also reflect the thin bedded nature of some of the units.

6 BELLEKENO NON-AML WASTE ROCK DISPOSAL AREA GROUNDWATER MONITORING

Preliminary engineering design based on five (5) boreholes for the Bellekeno Non-Acidic/Metal Leaching (N-AML) Waste Rock Disposal Area (WRDA) was undertaken by EBA Engineering Consultants Ltd. in late 2008 (EBA, 2008). Additional work in support of final design is expected prior to construction. Relevant findings on the subsurface conditions at the proposed WRDA site are excerpted below:

Subsurface Conditions

The subsurface conditions at the site were determined through interpretation of data from the five boreholes advanced by EBA on October 30, 2008. The subsurface conditions consist of sand that is gravely and silty. Bedrock was not encountered in any of the boreholes. The drill lost circulation in the boreholes and prevented the return of cuttings to the surface. A summary of the boreholes and their respective depths is shown in Table 3.

Table 4 Borehole Depths at Bellekeno Site

Borehole Number	Termination Depth (m)
W14101178-BH11(1)	9.0
W14101178-BH12	18.0
W14101178-BH13	12.0
W14101178-BH14	6.0
W14101178-BH15	10.0

Groundwater

Groundwater was not encountered in any of the boreholes at the Bellekeno site.

Permafrost

The moisture content testing completed on the samples collected indicates elevated moisture contents attributed to either the presence of permafrost or increased silt contents of the soils. A ground temperature cable was installed in W14101178-BH11 to 8.0 m. Preliminary readings taken from the ground temperature cable indicate the presence of warm permafrost (-1 to -0.5°C).

Commencement of construction of the (WRDA) is not scheduled at this time. Four groundwater monitoring wells below the Bellekeno WRDA (as per Clause 95 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 5.

Table 5 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 2.

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 62, 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 6.

Table 6 Onek and Lucky Queen 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	7087117	484925
KV-84Nd	Firehall well surrogate	88.4	71	17.4	7086984	485022
ON-MW-2	Downgradient of Onek990 mine	68	7	61	7087083	485244
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	7086921	485197
LQ-MW-1	Downgradient of LQ N-AML	24	11	13	7090576	486426
LQ-MW-2	Downgradient of LQ P-AML	TBD	-	-	TBD	TBD

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 2. 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 than 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 2). 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 2). 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.

9 REVIEW OF RESULTS

Effluent Quality Standards (EQS) for underground and development activities at the Bellekeno, Onek and Lucky Queen mines under WUL QZ12-053 are listed in Table 7. The Bellekeno, Onek and Lucky Queen mines are also subject to the MMER, which specifies authorized discharge limits of deleterious substances for a number of set parameters.

Table 7 Effluent Quality Standards for Bellekeno Mine, Lucky Queen and Onek Mines

Parameter	Maximum Concentration Grab Sample (QZ09-092)
pH	6.5 – 9.5
Suspended Solids	25 mg/L
Ammonia Nitrogen	5.0 mg/L
Arsenic (Total)	0.1 mg/L
Cadmium (Total)	0.01 mg/L
Copper (Total)	0.1 mg/L
Lead (Total)	0.2 mg/L
Nickel (Total)	0.5 mg/L
Radium 226	0.37 BQ/L
Silver (Total)	0.01 mg/L
Zinc (Total)	0.5 mg/L
Acute Toxicity Testing	
96-hour Rainbow Trout	Non-Toxic LC ₅₀ (100%)

Results of all groundwater monitoring activities will be subject to periodic review and interpretation by AKHM. This review and interpretation is important in identifying any potential changes in baseline conditions, and if necessary, trigger mitigation and/or adaptive management measures. The results of these reviews and analyses will be reported with the Annual Report.

10 GROUNDWATER MONITORING SCHEDULE

Groundwater monitoring will follow the schedule as described in Table 8. 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).

Monitoring Well Sampling:

Representative groundwater samples will be collected from each identified site identified in Table 8. 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.

Groundwater Sample Collection and Analyses:

Groundwater samples will be collected in appropriately labelled laboratory grade bottleneare 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.

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 8 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-84	Well SW of Onek 400 adit (deep); Keno City Well	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
KV-84Nd	Bedrock well on Keno Firehall lot to replace KV-84	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
KV-85D	DSTF and Mill Site Groundwater Well #1 (PH2) Deep	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
KV-85S	DSTF and Mill Site Groundwater Well #1 (Shallow)	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
KV-86	DSTF and Mill Site Groundwater Well #2 (PH5)	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
KV-87	DSTF and Mill Site Groundwater Well #3 (PH6)	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
KV-88D	DSTF and Site Groundwater Well #4 (Deep)	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
KV-88S	DSTF and Mill Site Groundwater Well #4 (Shallow)	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
KV-89D	Flame and Moth Site Groundwater Well #5 (Deep)	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
KV-89S	DSTD and Mill Site Groundwater Well #5 (Shallow)	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
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	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
ON-MW-2	Onek Monitoring Well #1 d/g Project Facilities	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	M/Q	M/Q
LQ-MW-1	Lucky Queen Monitoring Well d/g N-AML WRDA	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	M/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
BH39	Phase I of DSTF	Existing	M	M	M	M	-	M	M	M	M	M	M	M	M	M	M	M	M
KV-107	Proposed DSTF expansion area	To be developed	M	M	M	M	-	M	M	M	M	M	M	M	M	M	M	M	M

Legend:

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

11 REPORTING

As per Clause 26 and 27 of Water Licence QZ12-053:

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

27. The Licensee shall upload electronic copies of all reports required by the licence to the Yukon Water Board's online licensing registry, the WATERLINE. Electronic copies shall be submitted in of the following formats: word 97-2033, excel 97-2003 workbooks, or Adobe .pdf format. Water quality results uploaded to the WATERLINE must be presented in Excel 97-2003 .xls format.

12 REFERENCES

- Access Consulting Group, 2009. Keno Hill Silver District Environmental Conditions Report Version 1. Report prepared for Alexco Resource Corp.
- EBA Engineering Consultants Ltd. 2010. Preliminary Engineering Design and Management Plan, Dry-Stacked Tailings Facility, Bellekeno Mine Mill Site, Yukon. Report prepared for Alexco Keno Hill Mining Corp.
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- Interralogic Inc. 2013. Flame and Moth Groundwater Evaluation. November 27, 2013
- SRK Consulting (Canada) Inc. (2010) 2010 Bellekeno Groundwater Program. Report Prepared for Alexco Keno Hill Mining Corp. SRK Project # 1CA009.003.
- SRK Consulting (Canada) Inc. (2009a) Desktop review: Effects of Water Extraction at Christal Lake on Water Levels in the Keno City Community Well. Memorandum to Alexco Keno Hill Mining Corp. SRK Project # 1CE012.003.
- 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



To:	Brad Thrall, Kai Woloshyn	Date:	July 23, 2015
c:	Anders Frappell, P.Eng.; Aaron Nickoli; Justin Pigage	Memo No.:	1
From:	James Kidd	File:	W14103353-01
Subject:	Keno Hill District Mill Site – Blast Plan Analysis		

1.0 INTRODUCTION

Tetra Tech EBA Inc. (Tetra Tech EBA) has been commissioned by Alexco Resource Corp. (Alexco) to provide guidance with regards to blast vibrations and specifically to estimate and assess the potential effects blasting may have on instrumentation installed at the Flame and Moth site. The site is being developed as a new underground mine operation from a portal located in the vicinity of existing mine infrastructure such as the processing plant and dry stack tailings facility. In the development of the decline from the portal blasting will occur which will induce vibrations on existing infrastructure. Elements of the instrumentational infrastructure is considered sensitive to blast induce vibrations. It is understood that the instrumentation consists of 12 ground monitoring wells, 3 proposed ground monitoring wells, 5 ground temperature cells (GTC), and 2 slope inclinometers (SI) installed in the area of the proposed portal.

It is further understood that the blast analysis detailed within this memo will be used as the basis for development of a Peak Particle Velocity threshold limit, for which blasting can move ahead without producing permanent harmful effects on various geotechnical instruments.

1.1 Scope of Work

- Review of proposed blast report data – Tetra Tech EBA reviewed the following data:
 - AutoCAD site plan; containing 22 locations of known geotechnical instrumentation and existing structure.
 - Typical Blast Round Summary Sheet: Amex/Packaged Powder.
 - Grout-Well® – Product Information Sheet: Which contained information pertaining to the ground wells.
- Engineering Analysis and Evaluation - The information obtained from Alexco was analyzed and evaluated in order to establish recommendations for the proposed blast operations.
- Report – This report provides comments on the proposed blast plan and makes recommendations for attenuation. Figures 2a and 2b shows the location of the well sites and instrumentation.

2.0 BLAST VIBRATIONS

This section of the memo details how blast vibrations can be predicted and controlled if the charge weight per delay is known.

2.1 Simultaneous charge

The primary means of controlling vibrations is by controlling the explosive charge weight per delay during firing. A simultaneous charge is defined as anything less than 8 milliseconds per delay. The control of the explosive charge per delay can be obtained by reducing the drilled length per hole or providing more than one delay in each hole, known as decking. Decking is a method of creating unloaded zones within the borehole to enhance explosive performance or limit the charge weight initiated at any given time.

2.2 Scaled distance

Scaled distance is an equation that reduces two controllable variables in the blast to a single variable. The scaled distance is defined as:

$$SD = \left(\frac{D}{\sqrt{W}} \right)$$

Where;

D = Distance from the blast

W = Mass of the explosive per simultaneous charge

2.3 Peak Particle Velocity Predictions

To determine the Peak Particle Velocity (PPV but often referred to as the mean Peak Vector Sum or PVS) the following equation is used;

$$PPV = k \left(\frac{D}{\sqrt{W}} \right)^\beta$$

k and β are site specific constants developed through a scaled distance plot.

We are not aware of any site specific constants determined from previous blasts, therefore Tetra Tech EBA suggests using the following 'Upper Bound – High Confinement' site constants based on the findings of Blasters handbook 18th Edition for measurements of the proposed blasts. We note that these constants are conservative and are mainly dependent on the lithology, number, and nature of fractures plus other site specific conditions.

$$k = 4320$$

$$\beta = -1.6$$

By recording actual blast vibrations on site at known locations and distances from a planned blast, the site specific constants k and β can be determined for the Flame and Moth site and used to better predict future blast vibrations. To carry this out will require a blast monitoring program.

3.0 PROPOSED BLASTS

It is understood that Alexco proposes to develop the portal at the Flame and Moth site by conducting blasting with the utilization of two separately weighted blast plans. These are detailed in Figure 1.

3.1 Typical round loaded with Amex

297.4 kg of Amex explosive (63 % Anfo, 8 % Geldyne, 28 % Xactex) will be distributed over 60 holes. Assuming that the explosives are distributed evenly throughout the holes this gives 4.96 kg / hole.

3.2 Typical round loaded with packaged explosive

348.1 kg of packaged explosive (72 % Geldyne, 28 % Xactex) will distributed over 60 holes. Assuming that the explosives are distributed evenly throughout the holes this gives 5.8 kg / hole.

4.0 DISCUSSION

Due to the proximity of certain sensitive structures (including instrumentation) blast vibration levels should be controlled. Blasting at the specified site should follow either of the two proposed options detailed below. The first option is essentially a prescriptive basis for blast design and considered to have a low risk, the second option is a risk based approach using an observational methodology.

4.1 Option 1

We recommend a peak particle vibration threshold of 50 mm / second be adopted at each sensitive structure (geotechnical instrumentation). Sensitive instrumentation structures are listed in Appendix B.

The vibration threshold for this option is taken as a conservative approach to sensitive structures, and was determined using the following conservative constants.

$$k = 4320$$

$$\beta = - 1.6$$

The 50 mm / s PPV level has been estimated from case studies in which Tetra Tech monitored the effects of ground vibrations in close proximity to sensitive structures. Furthermore, case studies by Matheson (2000) on the blast vibration damage to water supply wells in the United States concluded similar PPV threshold limits at 50 mm / s. For this reason we recommend the blasts be designed to produce vibrations with a velocity less than 50 mm / s.

Figures 2a and 2b present locations of sensitive structures that might be affected by a blast that will produce vibrations greater than 50 mm / sec. Analysis was conducted on Option 1 PPV threshold, relative minimum distances were able to be determined based on the proposed charge weight per delay discussed in Section 3.0.

The minimum required distance for each blast / hole delay are detailed further in Table 1.

Table 1: Typical Blast Round Analysis

Holes per delay	Proposed minimum distance required from blast for estimate PPV ≤ 50 mm / sec (m)	
	Amex	Packaged Explosives
0.333 (2 decks per hole)	24	24
0.5 (1 deck hole)	28	28
1	36	40
2	52	56
3	64	68
4	72	80
5	83	

4.2 Blast Plan Option Two – Risk Based Approach

As an alternative to Option 1, Alexco may elect to take a risk based approach towards the blasting. In this case we recommend that a PPV of 75 mm / second for fully bentonite grouted Ground Monitoring Wells is used, and 100 mm / second for grouted inclinometers. It is understood the ground water monitoring wells are installed with Grout-Well bentonite grouting materials. The bentonite grouting material creates an effective measure for sealing the annular space between a well casing and the borehole wall.

The threshold for Option 2 should be adopted as a risk based approach to blasting and was determined using the following constants.

$k(1) = 1730$ (Blast rounds 1 and 2; during initial open area blast conditions are present).

$k(2) = 4320$ (Blast rounds 3 onwards; Should be adopted after confinement has increased into tunneling conditions unless a monitoring program has developed a site specific constant).

$\beta = -1.6$.

Specific PPV data constants should be developed for the site in the first few blasts and refined accordingly as blasting progresses into full confinement conditions, where an appropriate k constant can be estimated from measured vibrations.

Aside from the initial blast of the portal, tunneling excavations for the proposed project will mostly have one free vertical face, which is also the drilling face, and for this reason relief of the blast is expected to be poor. This results in a high degree of confinement of the blast and therefore higher vibrations can be expected. This is reflected in the selection of 4320 for the k site constant in Options 1 and 2 in lieu of a site specific constant.

The $k(1)$ value was adopted as an upper bound blasting constant from the High Confinement site constants based on the findings of Blasters handbook 18th Edition for measurements of the proposed blasts.

4.3 Vibration Analysis:

Respective to Option Plan 1 (Section 4.1), provided five or less holes are not simultaneously detonated, damage to the monitoring wells and inclinometers outside of the minimum distance is unlikely to be caused from the proposed blasts. Blast vibrations inside the minimum distance (Figure 2a, 2b) may have an effect on the surrounding rock by opening and closing of discontinuities, which may affect the rate of discharge/recharge of monitoring wells.

Option 2 (Section 4.2) is designed with a greater risk approach to development of the heading with respect to the integrity of the instrumentation. Blasting using Option 2 should be undertaken accepting that unknown site constants in the blast analysis may result in alteration or damage to instrumentation which may require repair or replacement after blasting.

When an explosive charge is confined in the ground and detonated, the volume that is permanently deformed is ideally a conical solid with the open end of the cone along the ground surface, or free face. The radius of the open end of the cone is approximately equal to the depth of the borehole. According to Matheson (1997), outside of this conical volume, little permanent deformation takes place. Therefore, in theory instrumentation located outside the 'crater zone' should not sustain damage. Provided blast vibrations surrounding inclinometers do not affect the movement of the probe up and down the PVC piping, there should be no major issues blasting with PPV below the specified threshold limit.

5.0 RECOMMENDATIONS

5.1 Pre Blast evaluation of Instrumentation and Blast Review

- All blast monitoring should be undertaken as described by the International Society of Explosive Engineers Field Practice Guidelines for Blasting Seismographs (2009). This document can be found in Appendix A.
- Site specific constants (k and β) should be developed as blasting progresses.
- If Option 1 is adopted it is recommended that blasts not exceed the PPV threshold limit of 50 mm / second at each sensitive structure (Appendix B).
- An initial blast condition survey should be undertaken on all ground water monitoring wells, slope inclinometers; and ground temperature monitoring wells. This would entail taking a pre and post reading for each of the 22 instruments under analysis, subject instrumentation is presented in Appendix B. Instrumentation within zones of interest (Figure 2a, 2b) should be monitored before and after each scheduled blast until no further change is noted. Zones of interest include boreholes; BH23, BH36, BH39, BH40, KV87, KV103, FM-MW-01, FM-MW-03.
- Instrumentation showing movement in measured data should continue to be monitored until the change in movement is not noted.

6.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Alexco Resource Company and their agents. Tetra Tech EBA Inc. does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Alexco Resource Company, or for any Project other than the blast monitoring program at the Keno Hill site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech EBA's Services Agreement. Tetra Tech EBA's General Conditions (Appendix C) are attached to this memo.

7.0 CLOSURE

We trust that this meets your current requirements. Should you have any further questions, please don't hesitate to contact the undersigned.

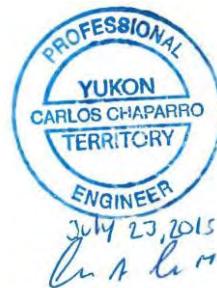
Respectfully submitted,
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FIGURES

Figure 1	Typical Round Loaded With Amex
Figure 2a	Amex Threshold Locations
Figure 2b	Packaged Explosive Threshold Locations

Typical Round loaded with Amex

Holes	Round length Meters	Total Meters	Load Density per meter of hole	Kg/meter	Totals	
38	4	152	1.14	42.5	169.8	63% Anfo
5	4	20	1.48	7.3	29.0	8% Geldyne
17	4	68	1.48	24.7	98.6	28% Xactex
60				74.4	297.4	

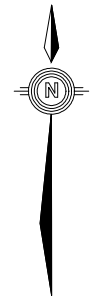
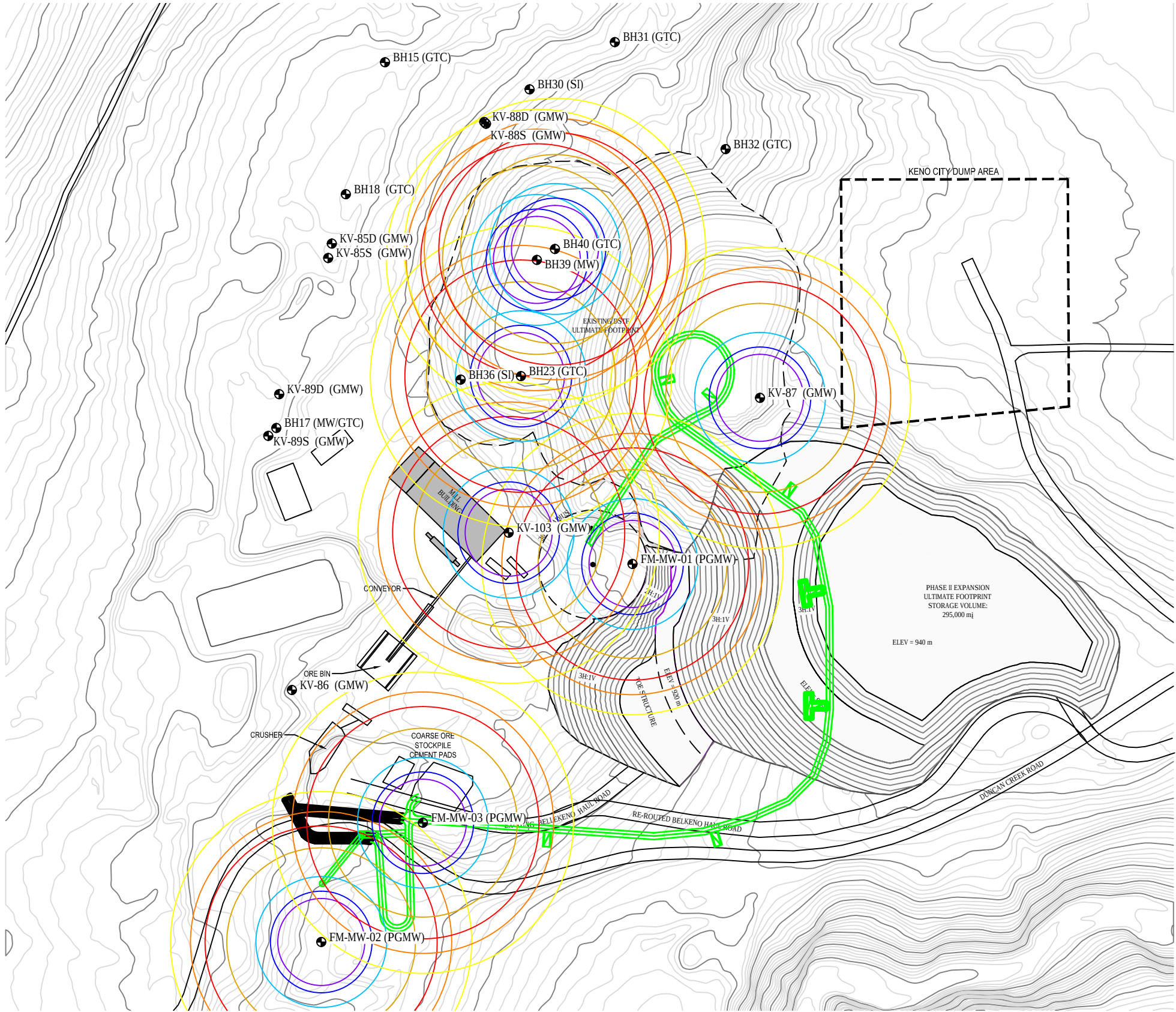
Typical Round loaded with Stick powder

43	4	172	1.48	62.4	249.5	72% Geldyne
17	4	68	1.48	24.7	98.6	28% Xactex
60				87.0	348.1	

Summary

A 4 x 4 x4 meter round with a combination of Anfo, Sitick powder will use 298 Kg of explosive per

A 4 x 4 x4 meter round with Sitick powder will use 298 Kg of explosive per round.



ISSUED FOR USE

LEGEND

● Instrumentation Location

AMEX

- 24 m minimum distance (2 decks per hole)
- 28 m minimum distance (1 deck hole)
- 36 m minimum distance
- 52 m minimum distance
- 64 m minimum distance
- 72 m minimum distance
- 83 m minimum distance

SCALE 1:2500



NOTES

1. Based on Figure 3-29, Flame and Moth Monitoring Locations

CLIENT



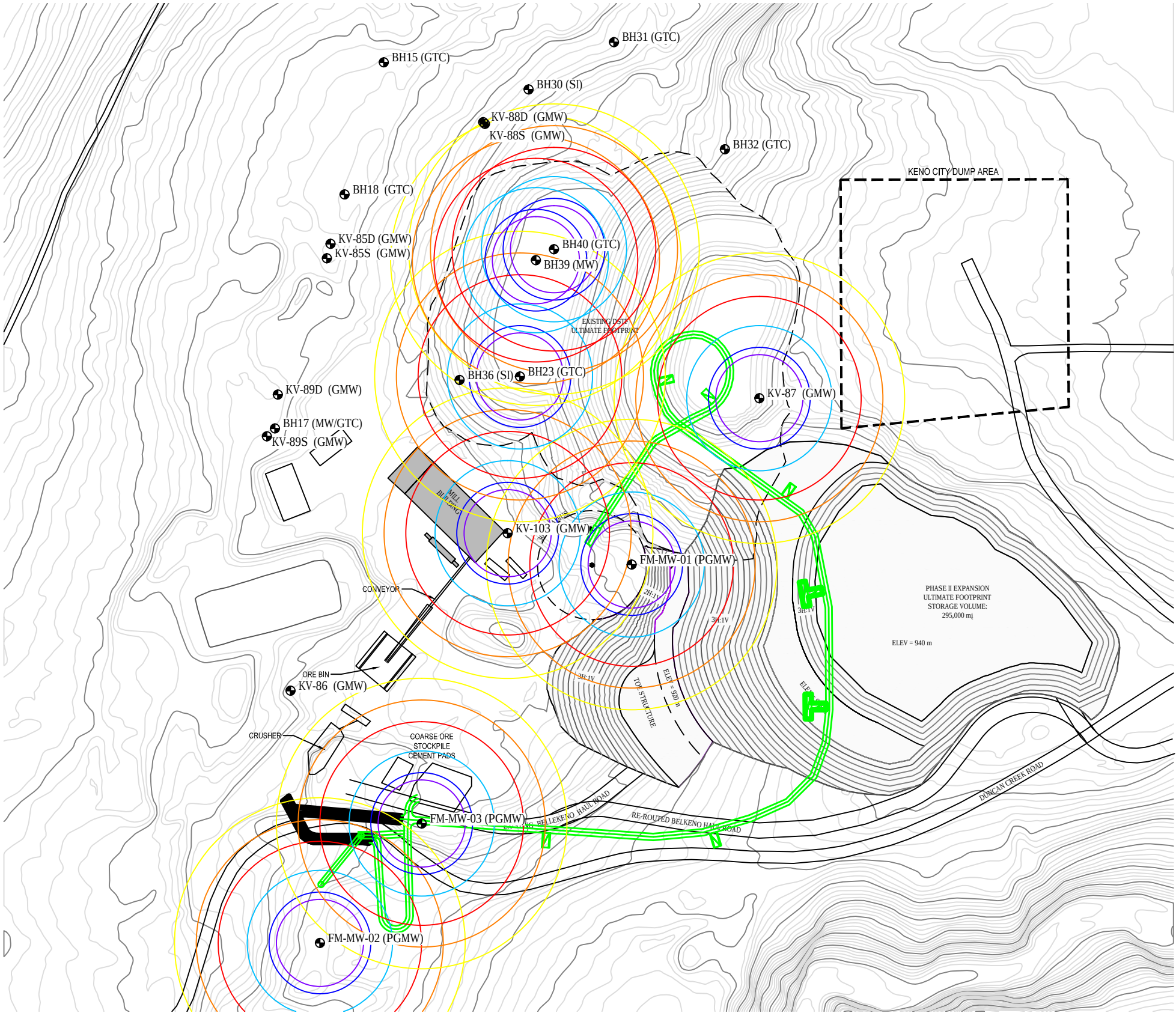
KENO HILL SILVER DISTRICT MINING OPERATIONS

"PPV THRESHOLD CONTOUR HOLES 1-5"
AMEX EXPLOSIVE

PROJECT NO. W14103303-01	DWN RH	CKD JK	REV 0
OFFICE EBA-VANC	DATE June 16, 2015		

Figure 2a

Q:\Vancouver\Drafting\Engineering\W141\W14103303-01\Site Plan - June 2015\W14103303-01 annex and sick powder R0a.dwg [FIGURE 2B] June 16, 2015 - 4:51:15 pm (BY: HALL, ROBERT J)



ISSUED FOR USE

LEGEND

● Instrumentation Location

PACKAGED EXPLOSIVE

- 24 m minimum distance (2 decks per hole)
- 28 m minimum distance (1 deck hole)
- 40 m minimum distance
- 56 m minimum distance
- 68 m minimum distance
- 80 m minimum distance

SCALE 1:2500



NOTES

1. Based on Figure 3-29, Flame and Moth Monitoring Locations

CLIENT



KENO HILL SILVER DISTRICT MINING OPERATIONS

"PPV THRESHOLD CONTOUR HOLES 1-4"
PACKAGED EXPLOSIVE

PROJECT NO. W14103303-01	DWN RH	CKD JK	REV 0
OFFICE EBA-VANC	DATE June 16, 2015		

Figure 2b

APPENDIX A

INTERNATIONAL SOCIETY OF EXPLOSIVES ENGINEERS BLAST VIBRATIONS AND SEISMOGRAPH SECTION

INTERNATIONAL SOCIETY OF EXPLOSIVES ENGINEERS

BLAST VIBRATIONS AND SEISMOGRAPH SECTION

ISEE Field Practice Guidelines for Blasting Seismographs

Disclaimer: These field practice recommendations are intended to serve as general guidelines, and cannot describe all types of field conditions. It is incumbent on the operator to evaluate these conditions and to obtain good coupling between monitoring instrument and the surface to be monitored. In all cases, the operator should describe the field conditions and setup procedures in the permanent record of each blast.

Preface: Seismographs are used to establish compliance with regulations and evaluate explosive performance. Laws and regulations have been established to prevent damage to property and injury to people. The disposition of the rules is strongly dependant on the reliability and accuracy of ground vibration and airblast data. In terms of explosive performance the same holds true. One goal of the ISEE Blast Vibrations and Seismograph Section is to ensure reliable and consistent recording of ground vibrations and air blasts between all blasting seismographs.

Part I. General Guidelines

Seismographs are deployed in the field to record the levels of blast-induced ground vibration and airblast. Accuracy of the recordings is essential. These guidelines define the user's responsibilities when deploying seismographs in the field.

1. Read the instruction manual. Every seismograph comes with an instruction manual. Users are responsible for reading the appropriate sections before monitoring a blast.
2. Seismograph calibration. Annual calibration of the seismograph is recommended.
3. Keep proper records. A seismograph user's log should note: the user's name, date, time, place and other pertinent data.
4. Record the blast. When seismographs are deployed in the field, the time spent deploying the unit justifies recording an event. As practical, set the trigger levels low enough to record each blast.
5. Record the full waveform. It is not recommended that the continuous recording option available on many seismographs be used for monitoring blast-generated vibrations.
6. Document the location of the seismograph. This includes the name of the structure and where the seismograph was placed on the property relative to the structure. Any person should be able to locate and identify the exact monitoring location at a future date.
7. Know and record the distance to the blast. The horizontal distance from the seismograph to the blast should be known to at least two significant digits. For example, a blast within 1000 feet would be measured to the nearest tens of feet and a blast within 10,000 feet would be measured to the nearest hundreds of feet. Where elevation changes exceed 2.5h:1v, slant distances or true distance should be used.
8. Know the data processing time of the seismograph. Some units take up to 5 minutes to process and print data. If another blast occurs within this time the second blast may be missed.
9. Know the memory or record capacity of the seismograph. Enough memory must be available to store the event. The full waveform should be saved for future reference in either digital or analog form.
10. Know the nature of the report that is required. For example, provide a hard copy in the field, keep digital data as a permanent record or both. If an event is to be printed in the field, a printer with paper is needed.
11. Allow ample time for proper setup of the seismograph. Many errors occur when seismographs are hurriedly set-up. Generally, more than 15 minutes for set-up should be allowed from the time the user arrives at the monitoring location until the blast.
12. Know the temperature. Seismographs have varying manufacturer specified operating temperatures.
13. Secure cable. Suspended or freely moving cables can produce false triggers from the wind or other extraneous sources.

Part II. Ground Vibration Monitoring

Placement and coupling of the vibration sensor are the two most important factors to ensure accurate ground vibration recordings.

A. Sensor Placement

The sensor should be placed on or in the ground on the side of the structure towards the blast. A structure can be a house, pipeline, telephone pole, etc. Measurements on driveways, walkways, and slabs are to be avoided where possible.

1. Location relative to the structure. Sensor placement should ensure that the data obtained adequately represents the vibration levels received at the structure being protected. The sensor should be placed within 10 feet of the structure or less than 10% of the distance from the blast, whichever is less.
2. Soil density evaluation. The soil density should be greater than or equal to the sensor density. Fill material, sand, unconsolidated soils, flower-bed mulch or other unusual mediums may have an influence on the recording accuracy if not properly dealt with during geophone installation.
3. The sensor must be nearly level.
4. The longitudinal channel should be pointing directly at the blast and the bearing should be recorded.
5. Where access to the structure and/or property is not available, the sensor should be placed closer to the blast in undisturbed soil.

B. Sensor coupling

If the acceleration exceeds 0.2 g, slippage of the sensor may be a problem. Depending on the anticipated acceleration levels spiking, burial, or sandbagging of the geophone to the ground may be appropriate.

1. If the acceleration is expected to be:
 - a. less than 0.2 g, no burial or attachment is necessary
 - b. between 0.2 and 1.0 g, burial or attachment is preferred. Spiking may be acceptable.
 - c. greater than 1.0 g, burial or firm attachment is required (USBM RI 8506).

The following table exemplifies the particle velocities and frequencies where accelerations are 0.2 g and 1.0 g.

Frequency, Hz	4	10	15	20	25	30	40	50	100	200
Particle Velocity - in/s at 0.2 g	3.07	1.23	0.82	0.61	0.49	0.41	0.31	0.25	0.12	0.06
Particle Velocity - in/s at 1.0 g	15.4	6.15	4.10	3.05	2.45	2.05	1.55	1.25	0.60	0.30

2. Burial or attachment methods.
 - a. The preferred burial method is excavating a hole that is no less than three times the height of the sensor (ANSI S2.47-1990, R1997), spiking the sensor to the bottom of the hole, and firmly compacting soil around and over the sensor.
 - b. Attachment to bedrock is achieved by bolting, clamping or gluing the sensor to the rock surface.
 - c. The sensor may be attached to the foundation of the structure if it is located within ± 1.0 foot of ground level (USBM RI 8969). This should only be used if burial, spiking or sandbagging is not practical.
3. Other sensor placement methods.
 - a. Shallow burial is anything less than described at 2a above.
 - b. Spiking entails removing the sod, with minimal disturbance of the soil and firmly pressing the sensor with the attached spike(s) into the ground.
 - c. Sand bagging requires removing the sod with minimal disturbance to the soil and placing the sensor on the bare spot with a sand bag over top. Sand bags should be large and loosely filled with about 10 pounds

of sand. When placed over the sensor the sandbag profile should be as low and wide as possible with a maximum amount of firm contact with the ground.

d. A combination of both spiking and sandbagging gives even greater assurance that good coupling is obtained.

C. Programming considerations

Site conditions dictate certain actions when programming the seismograph.

1. Ground vibration trigger level. The trigger level should be programmed low enough to trigger the unit from blast vibrations and high enough to minimize the occurrence of false events. The level should be slightly above the expected background vibrations for the area. A good starting level is 0.05 in/s.
2. Dynamic range and resolution. If the seismograph is not equipped with an auto-range function, the user should estimate the expected vibration level and set the appropriate range. The resolution of the printed waveform should allow verification of whether or not the event was a blast.
3. Recording duration - Set the record time for 2 seconds longer than the blast duration plus 1 second for each 1100 feet from the blast.

Part III Airblast Monitoring

Placement of the microphone relative to the structure is the most important factor.

A. Microphone placement

The microphone should be placed along the side of the structure nearest the blast.

1. The microphone should be mounted near the geophone with the manufacturer's windscreen attached.
2. The preferred microphone height is 3 feet above the ground or within 1.2 inches of the ground. Other heights may be acceptable for practical reasons. (ANSI S12.18-1994, ANSI S12.9-1992/Part2) (USBM RI 8508)
3. If practical, the microphone should not be shielded from the blast by nearby buildings, vehicles or other large barriers. If such shielding cannot be avoided, the horizontal distance between the microphone and shielding object should be greater than the height of the shielding object above the microphone.
4. If placed too close to a structure, the airblast may reflect from the house surface and record higher amplitudes. Structure response noise may also be recorded. Reflections can be minimized by placing the microphone near a corner of the structure. (RI 8508)

B. Programming considerations

Site conditions dictate certain actions when programming the seismograph to record airblast.

1. Trigger level. When only an airblast measurement is desired, the trigger level should be low enough to trigger the unit from the airblast and high enough to minimize the occurrence of false events. The level should be slightly above the expected background noise for the area. A good starting level is 120 dB.
2. Recording duration. When only recording airblast, set the recording time for at least 2 seconds more than the blast duration. When ground vibrations and airblast measurements are desired on the same record, follow the guidelines for ground vibration programming (Part II C.3).

Approved December 1999

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APPENDIX B

INSTRUMENTATION LOCATION

Borehole ID	Easting	Northing	Elev (masl)	Depth (m)
FM-MW-01 (PGMW)	484025.71	7086770.45	911.72	183.5
FM-MW-02 (PGMW)	483854.14	7086562.16	911.41	244.4
FM-MW-03 (PGMW)	483910.16	7086627.86	904.96	195.7
BH15 (GTC)	483889.3	7087046.9	896.9	21.3
BH17 (MW/GTC)	483829.4	7086845.4	899.9	15.25
BH18 (GTC)	483867.7	7086974.2	898.9	8.5
BH23 (GTC)	483964.2	7086874	908.2	10.2
BH30 (SI)	483969	7087032	907.25	26
BH31 (GTC)	484016	7087058	907.79	24.4
BH32 (GTC)	484077	7086999	923.75	9
BH36 (SI)	483931	7086872	906.5	14
BH39 (MW)	483973	7086938	920	12.6
BH40 (GTC)	483983	7086944	920	13.7
KV-85D (GMW)	483860	7086947	898.5	41
KV-85S (GMW)	483858	7086939	897.5	4.6
KV-86 (GMW)	483838	7086701	900	36
KV-87 (GMW)	484096	7086862	937	56.4
KV-88D (GMW)	483944	7087014	906	50.1
KV-88S (GMW)	483945	7087013	906	4.1
KV-89D (GMW)	483831	7086864	898	38.3
KV-89S (GMW)	483825	7086841	899.9	15.25
KV-103 (GMW)	483957.4415	7086787.666	904	85.3

APPENDIX C

TETRA TECH EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEOTECHNICAL REPORT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of Tetra Tech EBA's Client. Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Tetra Tech EBA's Client unless otherwise authorized in writing by Tetra Tech EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Tetra Tech EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where Tetra Tech EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed Tetra Tech EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of Tetra Tech EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Tetra Tech EBA. Tetra Tech EBA's instruments of professional service will be used only and exactly as submitted by Tetra Tech EBA.

Electronic files submitted by Tetra Tech EBA have been prepared and submitted using specific software and hardware systems. Tetra Tech EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, Tetra Tech EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. Tetra Tech EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of testholes and/or soil/rock exposures. Stratigraphy is known only at the locations of the testhole or exposure. Actual geology and stratigraphy between testholes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. Tetra Tech EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

7.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

8.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

9.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

10.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

11.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

12.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

13.0 SAMPLES

Tetra Tech EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

14.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS

During the performance of the work and the preparation of the report, Tetra Tech EBA may rely on information provided by persons other than the Client. While Tetra Tech EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX C

KENO HILL DISTRICT MILL SITE – BLAST PLAN ANALYSIS



To:	Brad Thrall, Kai Woloshyn	Date:	July 23, 2015
c:	Anders Frappell, P.Eng.; Aaron Nickoli; Justin Pigage	Memo No.:	1
From:	James Kidd	File:	W14103353-01
Subject:	Keno Hill District Mill Site – Blast Plan Analysis		

1.0 INTRODUCTION

Tetra Tech EBA Inc. (Tetra Tech EBA) has been commissioned by Alexco Resource Corp. (Alexco) to provide guidance with regards to blast vibrations and specifically to estimate and assess the potential effects blasting may have on instrumentation installed at the Flame and Moth site. The site is being developed as a new underground mine operation from a portal located in the vicinity of existing mine infrastructure such as the processing plant and dry stack tailings facility. In the development of the decline from the portal blasting will occur which will induce vibrations on existing infrastructure. Elements of the instrumentational infrastructure is considered sensitive to blast induce vibrations. It is understood that the instrumentation consists of 12 ground monitoring wells, 3 proposed ground monitoring wells, 5 ground temperature cells (GTC), and 2 slope inclinometers (SI) installed in the area of the proposed portal.

It is further understood that the blast analysis detailed within this memo will be used as the basis for development of a Peak Particle Velocity threshold limit, for which blasting can move ahead without producing permanent harmful effects on various geotechnical instruments.

1.1 Scope of Work

- Review of proposed blast report data – Tetra Tech EBA reviewed the following data:
 - AutoCAD site plan; containing 22 locations of known geotechnical instrumentation and existing structure.
 - Typical Blast Round Summary Sheet: Amex/Packaged Powder.
 - Grout-Well® – Product Information Sheet: Which contained information pertaining to the ground wells.
- Engineering Analysis and Evaluation - The information obtained from Alexco was analyzed and evaluated in order to establish recommendations for the proposed blast operations.
- Report – This report provides comments on the proposed blast plan and makes recommendations for attenuation. Figures 2a and 2b shows the location of the well sites and instrumentation.

2.0 BLAST VIBRATIONS

This section of the memo details how blast vibrations can be predicted and controlled if the charge weight per delay is known.

2.1 Simultaneous charge

The primary means of controlling vibrations is by controlling the explosive charge weight per delay during firing. A simultaneous charge is defined as anything less than 8 milliseconds per delay. The control of the explosive charge per delay can be obtained by reducing the drilled length per hole or providing more than one delay in each hole, known as decking. Decking is a method of creating unloaded zones within the borehole to enhance explosive performance or limit the charge weight initiated at any given time.

2.2 Scaled distance

Scaled distance is an equation that reduces two controllable variables in the blast to a single variable. The scaled distance is defined as:

$$SD = \left(\frac{D}{\sqrt{W}} \right)$$

Where;

D = Distance from the blast

W = Mass of the explosive per simultaneous charge

2.3 Peak Particle Velocity Predictions

To determine the Peak Particle Velocity (PPV but often referred to as the mean Peak Vector Sum or PVS) the following equation is used;

$$PPV = k \left(\frac{D}{\sqrt{W}} \right)^\beta$$

k and β are site specific constants developed through a scaled distance plot.

We are not aware of any site specific constants determined from previous blasts, therefore Tetra Tech EBA suggests using the following 'Upper Bound – High Confinement' site constants based on the findings of Blasters handbook 18th Edition for measurements of the proposed blasts. We note that these constants are conservative and are mainly dependent on the lithology, number, and nature of fractures plus other site specific conditions.

$$k = 4320$$

$$\beta = -1.6$$

By recording actual blast vibrations on site at known locations and distances from a planned blast, the site specific constants k and β can be determined for the Flame and Moth site and used to better predict future blast vibrations. To carry this out will require a blast monitoring program.

3.0 PROPOSED BLASTS

It is understood that Alexco proposes to develop the portal at the Flame and Moth site by conducting blasting with the utilization of two separately weighted blast plans. These are detailed in Figure 1.

3.1 Typical round loaded with Amex

297.4 kg of Amex explosive (63 % Anfo, 8 % Geldyne, 28 % Xactex) will be distributed over 60 holes. Assuming that the explosives are distributed evenly throughout the holes this gives 4.96 kg / hole.

3.2 Typical round loaded with packaged explosive

348.1 kg of packaged explosive (72 % Geldyne, 28 % Xactex) will distributed over 60 holes. Assuming that the explosives are distributed evenly throughout the holes this gives 5.8 kg / hole.

4.0 DISCUSSION

Due to the proximity of certain sensitive structures (including instrumentation) blast vibration levels should be controlled. Blasting at the specified site should follow either of the two proposed options detailed below. The first option is essentially a prescriptive basis for blast design and considered to have a low risk, the second option is a risk based approach using an observational methodology.

4.1 Option 1

We recommend a peak particle vibration threshold of 50 mm / second be adopted at each sensitive structure (geotechnical instrumentation). Sensitive instrumentation structures are listed in Appendix B.

The vibration threshold for this option is taken as a conservative approach to sensitive structures, and was determined using the following conservative constants.

$$k = 4320$$

$$\beta = - 1.6$$

The 50 mm / s PPV level has been estimated from case studies in which Tetra Tech monitored the effects of ground vibrations in close proximity to sensitive structures. Furthermore, case studies by Matheson (2000) on the blast vibration damage to water supply wells in the United States concluded similar PPV threshold limits at 50 mm / s. For this reason we recommend the blasts be designed to produce vibrations with a velocity less than 50 mm / s.

Figures 2a and 2b present locations of sensitive structures that might be affected by a blast that will produce vibrations greater than 50 mm / sec. Analysis was conducted on Option 1 PPV threshold, relative minimum distances were able to be determined based on the proposed charge weight per delay discussed in Section 3.0.

The minimum required distance for each blast / hole delay are detailed further in Table 1.

Table 1: Typical Blast Round Analysis

Holes per delay	Proposed minimum distance required from blast for estimate PPV ≤ 50 mm / sec (m)	
	Amex	Packaged Explosives
0.333 (2 decks per hole)	24	24
0.5 (1 deck hole)	28	28
1	36	40
2	52	56
3	64	68
4	72	80
5	83	

4.2 Blast Plan Option Two – Risk Based Approach

As an alternative to Option 1, Alexco may elect to take a risk based approach towards the blasting. In this case we recommend that a PPV of 75 mm / second for fully bentonite grouted Ground Monitoring Wells is used, and 100 mm / second for grouted inclinometers. It is understood the ground water monitoring wells are installed with Grout-Well bentonite grouting materials. The bentonite grouting material creates an effective measure for sealing the annular space between a well casing and the borehole wall.

The threshold for Option 2 should be adopted as a risk based approach to blasting and was determined using the following constants.

$k(1) = 1730$ (Blast rounds 1 and 2; during initial open area blast conditions are present).

$k(2) = 4320$ (Blast rounds 3 onwards; Should be adopted after confinement has increased into tunneling conditions unless a monitoring program has developed a site specific constant).

$\beta = -1.6$.

Specific PPV data constants should be developed for the site in the first few blasts and refined accordingly as blasting progresses into full confinement conditions, where an appropriate k constant can be estimated from measured vibrations.

Aside from the initial blast of the portal, tunneling excavations for the proposed project will mostly have one free vertical face, which is also the drilling face, and for this reason relief of the blast is expected to be poor. This results in a high degree of confinement of the blast and therefore higher vibrations can be expected. This is reflected in the selection of 4320 for the k site constant in Options 1 and 2 in lieu of a site specific constant.

The $k(1)$ value was adopted as an upper bound blasting constant from the High Confinement site constants based on the findings of Blasters handbook 18th Edition for measurements of the proposed blasts.

4.3 Vibration Analysis:

Respective to Option Plan 1 (Section 4.1), provided five or less holes are not simultaneously detonated, damage to the monitoring wells and inclinometers outside of the minimum distance is unlikely to be caused from the proposed blasts. Blast vibrations inside the minimum distance (Figure 2a, 2b) may have an effect on the surrounding rock by opening and closing of discontinuities, which may affect the rate of discharge/recharge of monitoring wells.

Option 2 (Section 4.2) is designed with a greater risk approach to development of the heading with respect to the integrity of the instrumentation. Blasting using Option 2 should be undertaken accepting that unknown site constants in the blast analysis may result in alteration or damage to instrumentation which may require repair or replacement after blasting.

When an explosive charge is confined in the ground and detonated, the volume that is permanently deformed is ideally a conical solid with the open end of the cone along the ground surface, or free face. The radius of the open end of the cone is approximately equal to the depth of the borehole. According to Matheson (1997), outside of this conical volume, little permanent deformation takes place. Therefore, in theory instrumentation located outside the 'crater zone' should not sustain damage. Provided blast vibrations surrounding inclinometers do not affect the movement of the probe up and down the PVC piping, there should be no major issues blasting with PPV below the specified threshold limit.

5.0 RECOMMENDATIONS

5.1 Pre Blast evaluation of Instrumentation and Blast Review

- All blast monitoring should be undertaken as described by the International Society of Explosive Engineers Field Practice Guidelines for Blasting Seismographs (2009). This document can be found in Appendix A.
- Site specific constants (k and β) should be developed as blasting progresses.
- If Option 1 is adopted it is recommended that blasts not exceed the PPV threshold limit of 50 mm / second at each sensitive structure (Appendix B).
- An initial blast condition survey should be undertaken on all ground water monitoring wells, slope inclinometers; and ground temperature monitoring wells. This would entail taking a pre and post reading for each of the 22 instruments under analysis, subject instrumentation is presented in Appendix B. Instrumentation within zones of interest (Figure 2a, 2b) should be monitored before and after each scheduled blast until no further change is noted. Zones of interest include boreholes; BH23, BH36, BH39, BH40, KV87, KV103, FM-MW-01, FM-MW-03.
- Instrumentation showing movement in measured data should continue to be monitored until the change in movement is not noted.

6.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Alexco Resource Company and their agents. Tetra Tech EBA Inc. does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Alexco Resource Company, or for any Project other than the blast monitoring program at the Keno Hill site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech EBA's Services Agreement. Tetra Tech EBA's General Conditions (Appendix C) are attached to this memo.

7.0 CLOSURE

We trust that this meets your current requirements. Should you have any further questions, please don't hesitate to contact the undersigned.

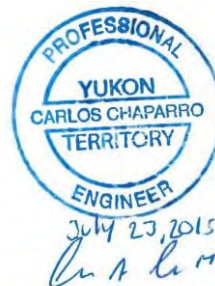
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FIGURES

Figure 1	Typical Round Loaded With Amex
Figure 2a	Amex Threshold Locations
Figure 2b	Packaged Explosive Threshold Locations

Typical Round loaded with Amex

Holes	Round length Meters	Total Meters	Load Density per meter of hole	Kg/meter	Totals	
38	4	152	1.14	42.5	169.8	63% Anfo
5	4	20	1.48	7.3	29.0	8% Geldyne
17	4	68	1.48	24.7	98.6	28% Xactex
60				74.4	297.4	

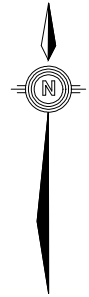
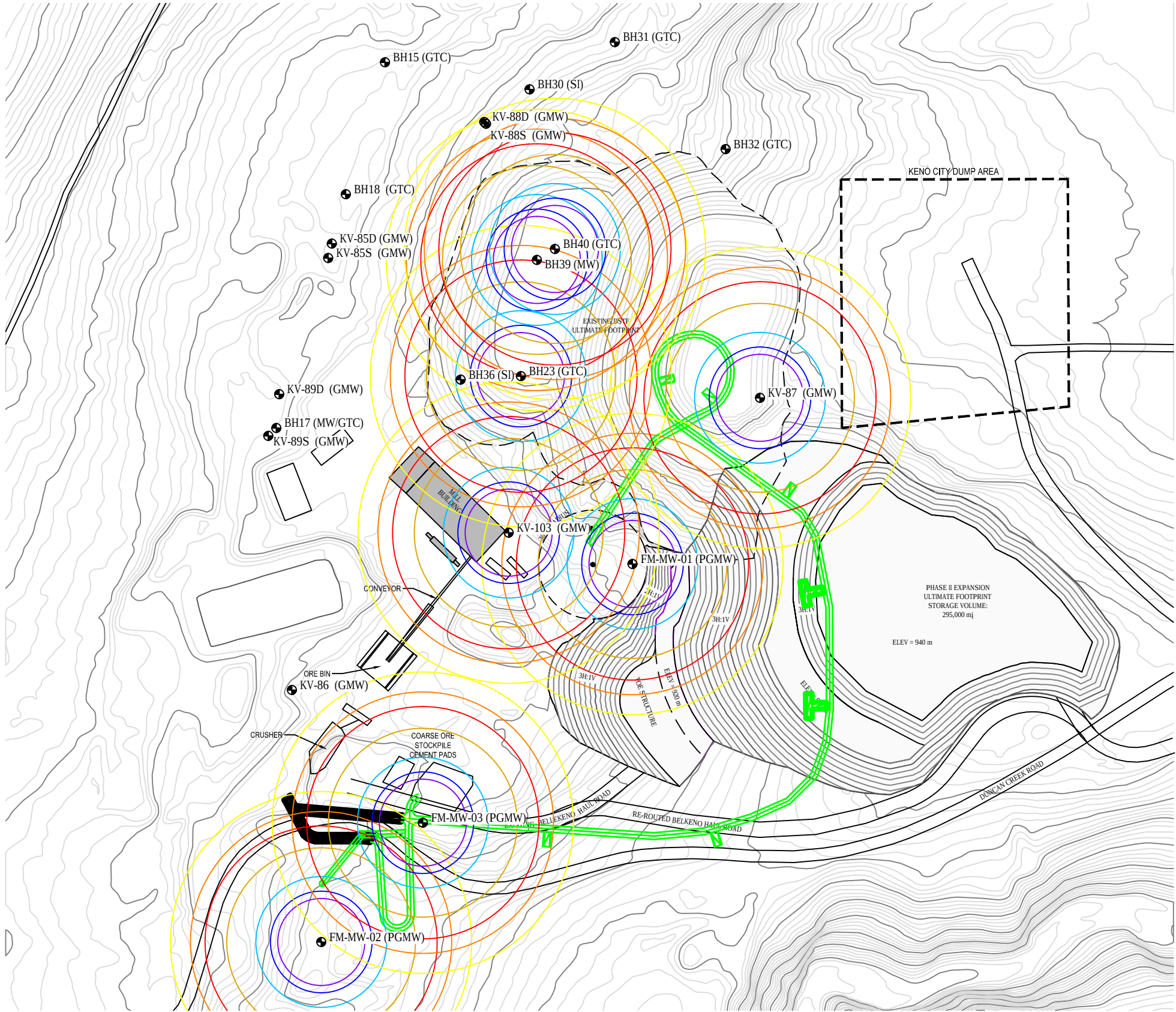
Typical Round loaded with Stick powder

43	4	172	1.48	62.4	249.5	72% Geldyne
17	4	68	1.48	24.7	98.6	28% Xactex
60				87.0	348.1	

Summary

A 4 x 4 x4 meter round with a combination of Anfo, Sitick powder will use 298 Kg of explosive per

A 4 x 4 x4 meter round with Sitick powder will use 298 Kg of explosive per round.



ISSUED FOR USE

LEGEND

● Instrumentation Location

AMEX

- 24 m minimum distance (2 decks per hole)
- 28 m minimum distance (1 deck hole)
- 36 m minimum distance
- 52 m minimum distance
- 64 m minimum distance
- 72 m minimum distance
- 83 m minimum distance

SCALE 1:2500



NOTES

1. Based on Figure 3-29, Flame and Moth Monitoring Locations

CLIENT



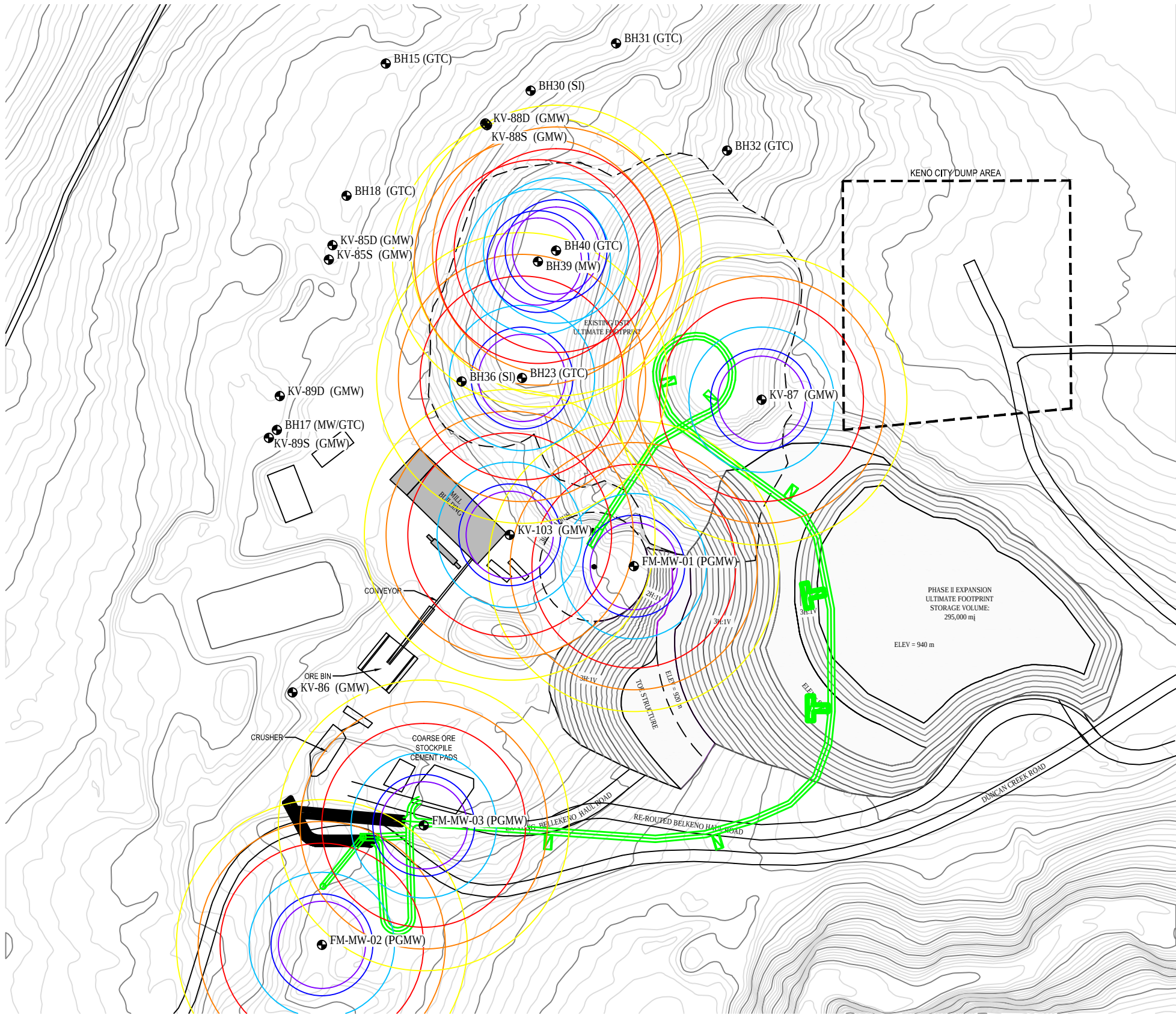
KENO HILL SILVER DISTRICT MINING OPERATIONS

"PPV THRESHOLD CONTOUR HOLES 1-5"
AMEX EXPLOSIVE

PROJECT NO. W14103303-01	DWN RH	CKD JK	REV 0
OFFICE EBA-VANC	DATE June 16, 2015		

Figure 2a

Q:\Vancouver\Drafting\Engineering\W141W14103303-01\Site Plan - June 2015\W14103303-01 annex and sick powder R0a.dwg [FIGURE 2B] June 16, 2015 - 4:51:15 pm (BY: HALL, ROBERT J)



ISSUED FOR USE

LEGEND

● Instrumentation Location

PACKAGED EXPLOSIVE

- 24 m minimum distance (2 decks per hole)
- 28 m minimum distance (1 deck hole)
- 40 m minimum distance
- 56 m minimum distance
- 68 m minimum distance
- 80 m minimum distance

SCALE 1:2500



NOTES

1. Based on Figure 3-29, Flame and Moth Monitoring Locations

CLIENT



KENO HILL SILVER DISTRICT MINING OPERATIONS

"PPV THRESHOLD CONTOUR HOLES 1-4"
PACKAGED EXPLOSIVE

PROJECT NO. W14103303-01	DWN RH	CKD JK	REV 0
OFFICE EBA-VANC	DATE June 16, 2015		

Figure 2b

APPENDIX A

INTERNATIONAL SOCIETY OF EXPLOSIVES ENGINEERS BLAST VIBRATIONS AND SEISMOGRAPH SECTION

INTERNATIONAL SOCIETY OF EXPLOSIVES ENGINEERS

BLAST VIBRATIONS AND SEISMOGRAPH SECTION

ISEE Field Practice Guidelines for Blasting Seismographs

Disclaimer: These field practice recommendations are intended to serve as general guidelines, and cannot describe all types of field conditions. It is incumbent on the operator to evaluate these conditions and to obtain good coupling between monitoring instrument and the surface to be monitored. In all cases, the operator should describe the field conditions and setup procedures in the permanent record of each blast.

Preface: Seismographs are used to establish compliance with regulations and evaluate explosive performance. Laws and regulations have been established to prevent damage to property and injury to people. The disposition of the rules is strongly dependant on the reliability and accuracy of ground vibration and airblast data. In terms of explosive performance the same holds true. One goal of the ISEE Blast Vibrations and Seismograph Section is to ensure reliable and consistent recording of ground vibrations and air blasts between all blasting seismographs.

Part I. General Guidelines

Seismographs are deployed in the field to record the levels of blast-induced ground vibration and airblast. Accuracy of the recordings is essential. These guidelines define the user's responsibilities when deploying seismographs in the field.

1. Read the instruction manual. Every seismograph comes with an instruction manual. Users are responsible for reading the appropriate sections before monitoring a blast.
2. Seismograph calibration. Annual calibration of the seismograph is recommended.
3. Keep proper records. A seismograph user's log should note: the user's name, date, time, place and other pertinent data.
4. Record the blast. When seismographs are deployed in the field, the time spent deploying the unit justifies recording an event. As practical, set the trigger levels low enough to record each blast.
5. Record the full waveform. It is not recommended that the continuous recording option available on many seismographs be used for monitoring blast-generated vibrations.
6. Document the location of the seismograph. This includes the name of the structure and where the seismograph was placed on the property relative to the structure. Any person should be able to locate and identify the exact monitoring location at a future date.
7. Know and record the distance to the blast. The horizontal distance from the seismograph to the blast should be known to at least two significant digits. For example, a blast within 1000 feet would be measured to the nearest tens of feet and a blast within 10,000 feet would be measured to the nearest hundreds of feet. Where elevation changes exceed 2.5h:1v, slant distances or true distance should be used.
8. Know the data processing time of the seismograph. Some units take up to 5 minutes to process and print data. If another blast occurs within this time the second blast may be missed.
9. Know the memory or record capacity of the seismograph. Enough memory must be available to store the event. The full waveform should be saved for future reference in either digital or analog form.
10. Know the nature of the report that is required. For example, provide a hard copy in the field, keep digital data as a permanent record or both. If an event is to be printed in the field, a printer with paper is needed.
11. Allow ample time for proper setup of the seismograph. Many errors occur when seismographs are hurriedly set-up. Generally, more than 15 minutes for set-up should be allowed from the time the user arrives at the monitoring location until the blast.
12. Know the temperature. Seismographs have varying manufacturer specified operating temperatures.
13. Secure cable. Suspended or freely moving cables can produce false triggers from the wind or other extraneous sources.

Part II. Ground Vibration Monitoring

Placement and coupling of the vibration sensor are the two most important factors to ensure accurate ground vibration recordings.

A. Sensor Placement

The sensor should be placed on or in the ground on the side of the structure towards the blast. A structure can be a house, pipeline, telephone pole, etc. Measurements on driveways, walkways, and slabs are to be avoided where possible.

1. Location relative to the structure. Sensor placement should ensure that the data obtained adequately represents the vibration levels received at the structure being protected. The sensor should be placed within 10 feet of the structure or less than 10% of the distance from the blast, whichever is less.
2. Soil density evaluation. The soil density should be greater than or equal to the sensor density. Fill material, sand, unconsolidated soils, flower-bed mulch or other unusual mediums may have an influence on the recording accuracy if not properly dealt with during geophone installation.
3. The sensor must be nearly level.
4. The longitudinal channel should be pointing directly at the blast and the bearing should be recorded.
5. Where access to the structure and/or property is not available, the sensor should be placed closer to the blast in undisturbed soil.

B. Sensor coupling

If the acceleration exceeds 0.2 g, slippage of the sensor may be a problem. Depending on the anticipated acceleration levels spiking, burial, or sandbagging of the geophone to the ground may be appropriate.

1. If the acceleration is expected to be:
 - a. less than 0.2 g, no burial or attachment is necessary
 - b. between 0.2 and 1.0 g, burial or attachment is preferred. Spiking may be acceptable.
 - c. greater than 1.0 g, burial or firm attachment is required (USBM RI 8506).

The following table exemplifies the particle velocities and frequencies where accelerations are 0.2 g and 1.0 g.

Frequency, Hz	4	10	15	20	25	30	40	50	100	200
Particle Velocity - in/s at 0.2 g	3.07	1.23	0.82	0.61	0.49	0.41	0.31	0.25	0.12	0.06
Particle Velocity - in/s at 1.0 g	15.4	6.15	4.10	3.05	2.45	2.05	1.55	1.25	0.60	0.30

2. Burial or attachment methods.
 - a. The preferred burial method is excavating a hole that is no less than three times the height of the sensor (ANSI S2.47-1990, R1997), spiking the sensor to the bottom of the hole, and firmly compacting soil around and over the sensor.
 - b. Attachment to bedrock is achieved by bolting, clamping or gluing the sensor to the rock surface.
 - c. The sensor may be attached to the foundation of the structure if it is located within ± 1.0 foot of ground level (USBM RI 8969). This should only be used if burial, spiking or sandbagging is not practical.
3. Other sensor placement methods.
 - a. Shallow burial is anything less than described at 2a above.
 - b. Spiking entails removing the sod, with minimal disturbance of the soil and firmly pressing the sensor with the attached spike(s) into the ground.
 - c. Sand bagging requires removing the sod with minimal disturbance to the soil and placing the sensor on the bare spot with a sand bag over top. Sand bags should be large and loosely filled with about 10 pounds

of sand. When placed over the sensor the sandbag profile should be as low and wide as possible with a maximum amount of firm contact with the ground.

d. A combination of both spiking and sandbagging gives even greater assurance that good coupling is obtained.

C. Programming considerations

Site conditions dictate certain actions when programming the seismograph.

1. Ground vibration trigger level. The trigger level should be programmed low enough to trigger the unit from blast vibrations and high enough to minimize the occurrence of false events. The level should be slightly above the expected background vibrations for the area. A good starting level is 0.05 in/s.
2. Dynamic range and resolution. If the seismograph is not equipped with an auto-range function, the user should estimate the expected vibration level and set the appropriate range. The resolution of the printed waveform should allow verification of whether or not the event was a blast.
3. Recording duration - Set the record time for 2 seconds longer than the blast duration plus 1 second for each 1100 feet from the blast.

Part III Airblast Monitoring

Placement of the microphone relative to the structure is the most important factor.

A. Microphone placement

The microphone should be placed along the side of the structure nearest the blast.

1. The microphone should be mounted near the geophone with the manufacturer's windscreen attached.
2. The preferred microphone height is 3 feet above the ground or within 1.2 inches of the ground. Other heights may be acceptable for practical reasons. (ANSI S12.18-1994, ANSI S12.9-1992/Part2) (USBM RI 8508)
3. If practical, the microphone should not be shielded from the blast by nearby buildings, vehicles or other large barriers. If such shielding cannot be avoided, the horizontal distance between the microphone and shielding object should be greater than the height of the shielding object above the microphone.
4. If placed too close to a structure, the airblast may reflect from the house surface and record higher amplitudes. Structure response noise may also be recorded. Reflections can be minimized by placing the microphone near a corner of the structure. (RI 8508)

B. Programming considerations

Site conditions dictate certain actions when programming the seismograph to record airblast.

1. Trigger level. When only an airblast measurement is desired, the trigger level should be low enough to trigger the unit from the airblast and high enough to minimize the occurrence of false events. The level should be slightly above the expected background noise for the area. A good starting level is 120 dB.
2. Recording duration. When only recording airblast, set the recording time for at least 2 seconds more than the blast duration. When ground vibrations and airblast measurements are desired on the same record, follow the guidelines for ground vibration programming (Part II C.3).

Approved December 1999

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APPENDIX B

INSTRUMENTATION LOCATION

Borehole ID	Easting	Northing	Elev (masl)	Depth (m)
FM-MW-01 (PGMW)	484025.71	7086770.45	911.72	183.5
FM-MW-02 (PGMW)	483854.14	7086562.16	911.41	244.4
FM-MW-03 (PGMW)	483910.16	7086627.86	904.96	195.7
BH15 (GTC)	483889.3	7087046.9	896.9	21.3
BH17 (MW/GTC)	483829.4	7086845.4	899.9	15.25
BH18 (GTC)	483867.7	7086974.2	898.9	8.5
BH23 (GTC)	483964.2	7086874	908.2	10.2
BH30 (SI)	483969	7087032	907.25	26
BH31 (GTC)	484016	7087058	907.79	24.4
BH32 (GTC)	484077	7086999	923.75	9
BH36 (SI)	483931	7086872	906.5	14
BH39 (MW)	483973	7086938	920	12.6
BH40 (GTC)	483983	7086944	920	13.7
KV-85D (GMW)	483860	7086947	898.5	41
KV-85S (GMW)	483858	7086939	897.5	4.6
KV-86 (GMW)	483838	7086701	900	36
KV-87 (GMW)	484096	7086862	937	56.4
KV-88D (GMW)	483944	7087014	906	50.1
KV-88S (GMW)	483945	7087013	906	4.1
KV-89D (GMW)	483831	7086864	898	38.3
KV-89S (GMW)	483825	7086841	899.9	15.25
KV-103 (GMW)	483957.4415	7086787.666	904	85.3

APPENDIX C

TETRA TECH EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEOTECHNICAL REPORT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of Tetra Tech EBA's Client. Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Tetra Tech EBA's Client unless otherwise authorized in writing by Tetra Tech EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Tetra Tech EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where Tetra Tech EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed Tetra Tech EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of Tetra Tech EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Tetra Tech EBA. Tetra Tech EBA's instruments of professional service will be used only and exactly as submitted by Tetra Tech EBA.

Electronic files submitted by Tetra Tech EBA have been prepared and submitted using specific software and hardware systems. Tetra Tech EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, Tetra Tech EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. Tetra Tech EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of testholes and/or soil/rock exposures. Stratigraphy is known only at the locations of the testhole or exposure. Actual geology and stratigraphy between testholes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. Tetra Tech EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

7.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

8.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

9.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

10.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

11.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

12.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

13.0 SAMPLES

Tetra Tech EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

14.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS

During the performance of the work and the preparation of the report, Tetra Tech EBA may rely on information provided by persons other than the Client. While Tetra Tech EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX D

PHYSICAL INSPECTION AND REPORTING PLAN (JUNE 2013), WATER LICENCE QZ12-053



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

Physical Inspection and Reporting Plan

Water Use Licence QZ12-053-1

June 2013

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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 103 to 105 of Water Licence QZ12-053-1 issued to Alexco Keno Hill Mining Corp. on May 15th, 2013:

103. Within 90 days of the effective date of this licence, the Licensee shall submit to the Board an amended plan titled, "Physical Inspection and Reporting Plan" for all water retaining structures, water conveying structures, and mine Waste structures in the Keno Hill Silver District and shall implement that plan.
104. 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.
105. The Physical Inspection and Reporting Plan shall include the Bellekeno 625 settling ponds, the Lucky Queen and Onek water storage ponds, all N-AML Waste Rock disposal areas and all P-AML Waste Rock storage facilities, the access roads, DSTF, and Mill Site and DSTF collection and sedimentation 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 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.

3.0 PHYSICAL INSPECTION LOCATIONS

As per Part G, Clause 105 of Water Licence QZ12-053-1, the areas to be inspected include:

- Bellekeno 625 settling ponds;
- Lucky Queen settling ponds
- Onek 990 water storage 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;
- Mill site & DSTF collection and sedimentation pond; and
- Dry stack tailings facility (DSTF).

4.0 PHYSICAL INSPECTION SCHEDULE

The physical inspection for the all water retaining structures will be conducted on a weekly basis. These include the Bellekeno 625 settling ponds, the Lucky Queen ponds, Onek 990 pond, the P-AML Waste Rock Storage Facilities at Bellekeno East, Onek and Lucky Queen (once constructed), and the Mill site & DSTF collection and sedimentation pond. 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 site & DSTF collection and sedimentation 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
Bellekeno N-AML waste rock disposal area	x
Lucky Queen N-AML waste rock disposal area	x
Access roads	x

DSTF	x
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*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 and 2
11	Mill Site collection and sedimentation pond (from E corner, in front of crusher)
12	DSTF runoff collection sump (on road, facing NW)

13	Lightning Creek Bridge #1(BKR2)
14	Lightning Creek Bridge #2 (Onek)

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 A). 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 26 and 27 of Water Licence QZ12-053-1:

26. 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.
27. The Licensee shall upload electronic copies of all reports required by this licence to the Yukon Water 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. Water quality results uploaded to the WATERLINE must be presented in Excel 97-2003.xls 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.

Alexco Keno Hill Mining Corp.

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Appendix A

Physical Inspections Checklist

Physical Monitoring Program
Inspection Checklist

	MINE							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	Collection 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?																				
Photo(s) taken?																				
Checked after storm event?																				
Soil / Rock Structures																				
Materials being disposed of properly?																				
Check for movement?																				
Crest checked?																				
Toe checked?																				
No tension cracks?																				
No creep?																				
No failure?																				
Safe for use next 24 hrs?																				
Water Conveyance Structures																				
No loose material or exposed liner?																				
Spillway clear?																				
Good runoff management?																				
Diversion clear?																				
No seepage?																				
No failure?																				
Safe for use next 24 hrs?																				
Limits adhered to?																				
Piping																				
No leaks?																				
No sags or deformation?																				
Comments (recommendations / corrective actions required):																				

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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 Inclinometers	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.