



**AKHM**  
ALEXCO KENO HILL  
MINING CORP.

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**DUST ABATEMENT AND MONITORING PLAN**

**KENO HILL SILVER DISTRICT MINING OPERATIONS**

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June 2015

**ALEXCO KENO HILL MINING CORP.**



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## 1 INTRODUCTION

Alexco Keno Hill Mining Corp (AKHM) operates the Bellekeno Mine and Keno District Mill in the vicinity of Keno City, Yukon. In addition to the Bellekeno Mine, the Lucky Queen and Onek 990 Mines are permitted and additional mines including Flame and Moth will be put into production as the Keno Hill Silver District is developed and advanced. All related mining activities in the foreseeable future will occur in the eastern end of the Keno Hill Silver District and therefore around the vicinity of Keno City and as such, a Dust Abatement and Monitoring Plan has been developed to address any potential air quality effects that may occur with the operations of the Mines and Keno District Mill.

Part of the Dust Abatement and Monitoring Plan is based on results of an air dispersion model completed by Access Consulting Group in June 2014 during the *Yukon Environmental and Socio-Economic Assessment Act* (YESAA) process for the Flame & Moth Development and Production Program (Project 2013-0161). The model identified the potential dust sources from the Bellekeno, Lucky Queen/Onek 990 and Flame & Moth mining-related activities, as well as sensitive receptors, and predicted the anticipated ambient concentrations under different operation scenarios. Scenario 1 modeled the operation of the Bellekeno mine only, which represents the existing conditions at site. Scenario 2 was for the operation of the Bellekeno and the Flame & Moth Mines concurrently, which, according to the mine plan, would occur in 2016 and 2017. Scenario 3 was for the operation of the Flame & Moth Mine concurrently with Onek 990/Lucky Queen, which is scheduled to occur from 2018 to 2021.

## 2 YUKON AMBIENT AIR QUALITY STANDARDS

Dust, or particulate matter, can be divided into fractions of different sizes. PM<sub>10</sub> (aerodynamic diameter of less than 10 µm) is the fraction of TSP (total suspended particulate) that is inhalable, and therefore have the potential to cause adverse health effects. Fine particles (aerodynamic diameter of less than 2.5 µm) are able to penetrate deeper into the lungs and are generally considered a stronger risk factor than the coarse fraction of PM<sub>10</sub> (particles in the 2.5-10 µm range) (WHO, 2013).

Environment Yukon implemented Ambient Air Quality Standards for TSP and PM<sub>2.5</sub> in 2010, and more recently for PM<sub>10</sub>. Those standards and averaging periods are presented in Table 1.

**Table 1 Yukon Ambient Air Quality Standards (µg/m<sup>3</sup>)**

Parameter	24-hour	Annual
TSP	120	60
PM <sub>10</sub>	50	n/a
PM <sub>2.5</sub>	30	n/a

### **3 AIR DISPERSION MODEL SUMMARY**

#### **3.1 POTENTIAL DUST SOURCES**

The main dust sources considered in the air dispersion model include the dry stack tailings facility (DSTF), mineral processing and the traffic on unpaved roads (see Figure 1).

##### **3.1.1 DSTF**

The DSTF is subject to wind erosion and as such, represents a potential source of airborne dust. The existing DSTF footprint was used for modeling the existing conditions (Scenario 1), while for Scenarios 2 and 3, it was assumed that the existing DSTF would be fully reclaimed and that no more than 50% of the area of the proposed expanded DSTF (corresponding to about 13 ha) would be exposed at any given time, due to progressive reclamation.

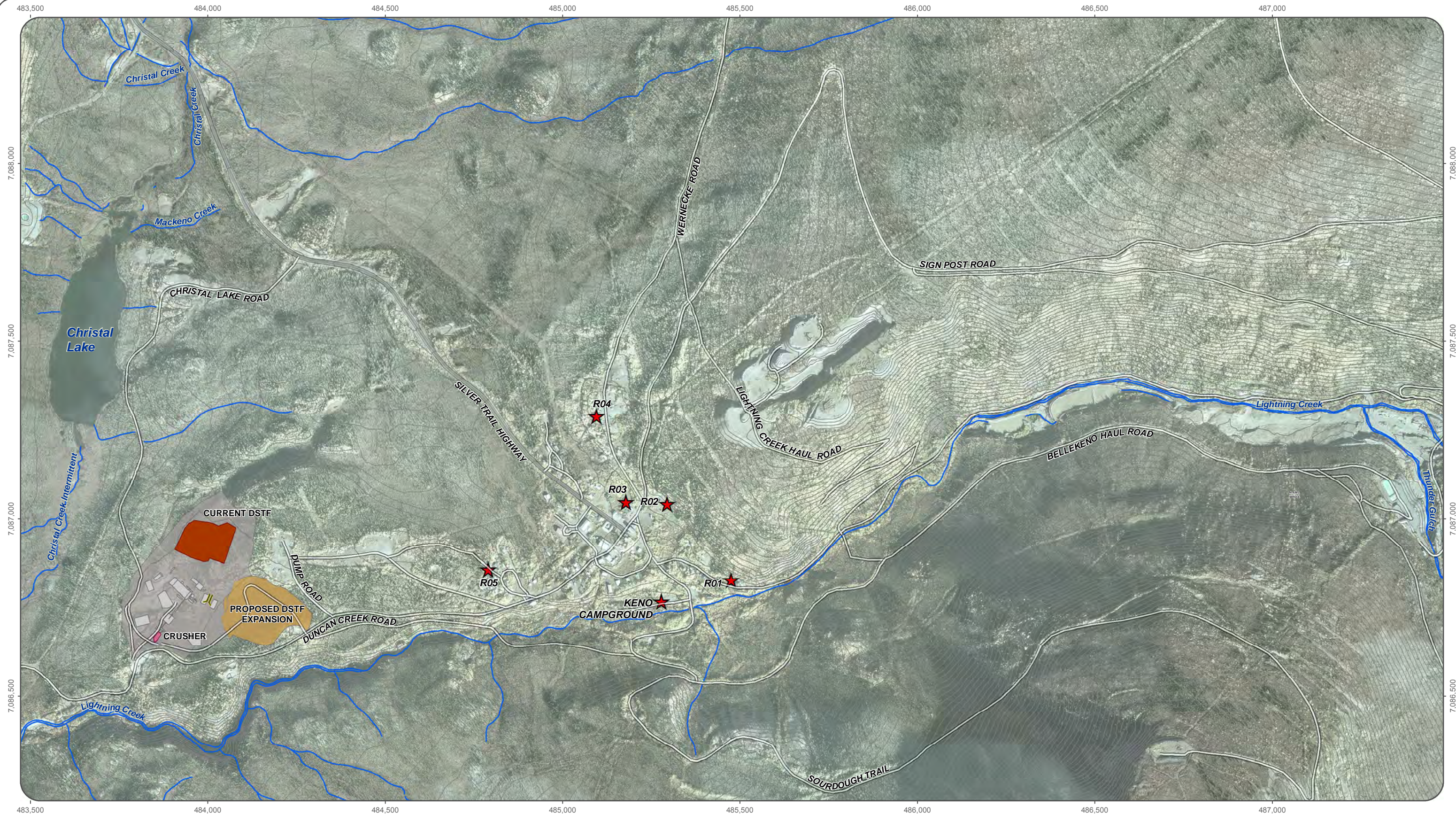
##### **3.1.2 Mineral Processing**

The main processes taking place at the mill and crusher include primary and secondary crushing, wet grinding and various material transfers and handling. Fugitive emissions can be reduced by enclosing the crusher in a ventilated building, which was assumed to be the case in the model.

##### **3.1.3 Unpaved Roads**

Estimated mine-related traffic volumes on unpaved roads for Bellekeno, Onek 990/Lucky Queen as well as Flame & Moth are presented in the Traffic Management Plan, and includes Christal Lake Road, Bellekeno Haul Road, the road between the F&M adit and the crusher, Wernecke Road, Keno City Bypass Road and the Silver Trail Highway between Christal Lake Road and Keno City.

Fugitive dust emissions from unpaved roads are naturally mitigated by precipitation and can also be controlled with the use of chemical suppressants or road watering. Both types of mitigations were assumed in the model.



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 x 17 inch paper)

- Potential Dust Sources**
- Highway
  - Secondary Road
  - Crusher
  - Current DSTF
  - Proposed DSTF

- Other Features**
- ★ Dust Receptors
  - ⌋ Flame and Moth Adit
  - Waterbody
  - Watercourse
  - Contours (5m)



KENO HILL SILVER DISTRICT MINING OPERATIONS

**FIGURE 1**

**DUST SOURCES AND RECEPTORS**

JUNE 2014

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### 3.2 DUST RECEPTORS

In order to assess potential effects of particulate matter, discrete receptors in Keno City were used. Table 2 presents the coordinates and description of the six receptors, which are shown on Figure 1. Those same receptors were used in the Noise Impact Assessment and are part of the Noise Monitoring Plan.

**Table 2 Discrete Receptors in Keno City**

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

### 3.3 PREDICTED AMBIENT CONCENTRATIONS

Predicted maximum 24-hr and annual concentrations at the six Keno City receptors, under the three modelled scenarios, are presented in Tables 3 to 5 below. No exceedences of the applicable Yukon Ambient Air Quality Standards (YAAQS) are predicted at any of the six discrete receptors located in Keno City, however, some exceedences of the YAAQS are possible for TSP and PM<sub>10</sub> in a very localised area near the sources.

**Table 3 Predicted TSP, PM<sub>10</sub> and PM<sub>2.5</sub> Concentrations (µg/m<sup>3</sup>) under Scenario 1**

Receptor	TSP		PM <sub>10</sub>		PM <sub>2.5</sub>	
	Max 24-hr Concentration	Annual Concentration	Max 24-hr Concentration	Annual Concentration	Max 24-hr Concentration	Annual Concentration
R01	44.59	7.38	12.77	2.10	1.32	0.22
R02	39.73	6.25	11.47	1.79	1.21	0.18
R03	45.49	6.68	13.18	1.91	1.39	0.20
R04	30.04	4.15	8.82	1.20	0.96	0.13
R05	71.60	11.76	21.39	3.39	2.41	0.36
Cmpgrnd	56.13	9.61	16.05	2.73	1.66	0.28
<b>YAAQS</b>	<b>120</b>	<b>60</b>	<b>50</b>	<b>n/a</b>	<b>30</b>	<b>n/a</b>

**Table 4 Predicted TSP, PM<sub>10</sub> and PM<sub>2.5</sub> Concentrations (µg/m<sup>3</sup>) under Scenario 2**

Receptor	TSP		PM <sub>10</sub>		PM <sub>2.5</sub>	
	Max 24-hr Concentration	Annual Concentration	Max 24-hr Concentration	Annual Concentration	Max 24-hr Concentration	Annual Concentration
R01	47.90	7.73	13.77	2.21	1.43	0.226
R02	43.98	6.66	12.77	1.91	1.35	0.198
R03	50.83	7.18	14.82	2.07	1.57	0.215
R04	36.72	4.74	10.84	1.38	1.18	0.147
R05	87.67	13.04	26.83	3.82	3.06	0.406

Receptor	TSP		PM <sub>10</sub>		PM <sub>2.5</sub>	
	Max 24-hr Concentration	Annual Concentration	Max 24-hr Concentration	Annual Concentration	Max 24-hr Concentration	Annual Concentration
Cmpgrnd	59.91	10.03	17.21	2.87	1.78	0.294
<b>YAAQS</b>	<b>120</b>	<b>60</b>	<b>50</b>	<b>n/a</b>	<b>30</b>	<b>n/a</b>

**Table 5 Predicted TSP, PM<sub>10</sub> and PM<sub>2.5</sub> Concentrations (µg/m<sup>3</sup>) under Scenario 3**

Receptor	TSP		PM <sub>10</sub>		PM <sub>2.5</sub>	
	Max 24-hr Concentration	Annual Concentration	Max 24-hr Concentration	Annual Concentration	Max 24-hr Concentration	Annual Concentration
R01	26.63	4.92	7.76	1.42	0.83	0.15
R02	23.00	3.98	6.78	1.16	0.74	0.12
R03	22.13	4.83	6.72	1.41	0.76	0.15
R04	18.49	3.68	5.69	1.08	0.66	0.12
R05	38.95	4.76	13.08	1.48	1.68	0.17
Cmpgrnd	24.37	4.27	7.18	1.24	0.78	0.13
<b>YAAQS</b>	<b>120</b>	<b>60</b>	<b>50</b>	<b>n/a</b>	<b>30</b>	<b>n/a</b>

The highest ambient concentrations are expected to occur under scenario 2, when the Flame & Moth and Bellekeno Mines are operated concurrently. Maximum 24-hr concentrations are predicted to be higher than under Scenario 1 (existing conditions) by 7.4%, while still well below the YAAQS.

#### 4 DUST MITIGATION MEASURES

AKHM has committed to the following measures which were incorporated into the air dispersion model:

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

Additional mitigation measures that could further reduce fugitive dust emissions include:

- Dust suppressant could be applied to the DSTF. Including the application of a tackifier product to the exposed tailings surfaces (as final slopes or benches are completed), to reduce potential wind erosion prior to progressive reclamation.

AKHM will notify Keno City residents regarding traffic increases, operation schedules and potential dust-generating events.

## 5 AIR QUALITY MONITORING

### 5.1 BACKGROUND

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. The locations are shown on Figure 2. The BGI Omni samplers are set up with Total Suspended Particulates (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 (see Table 1). 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 6 below.

**Table 6 Ontario Ambient Air Quality Criteria ( $\mu\text{g}/\text{m}^3$ )**

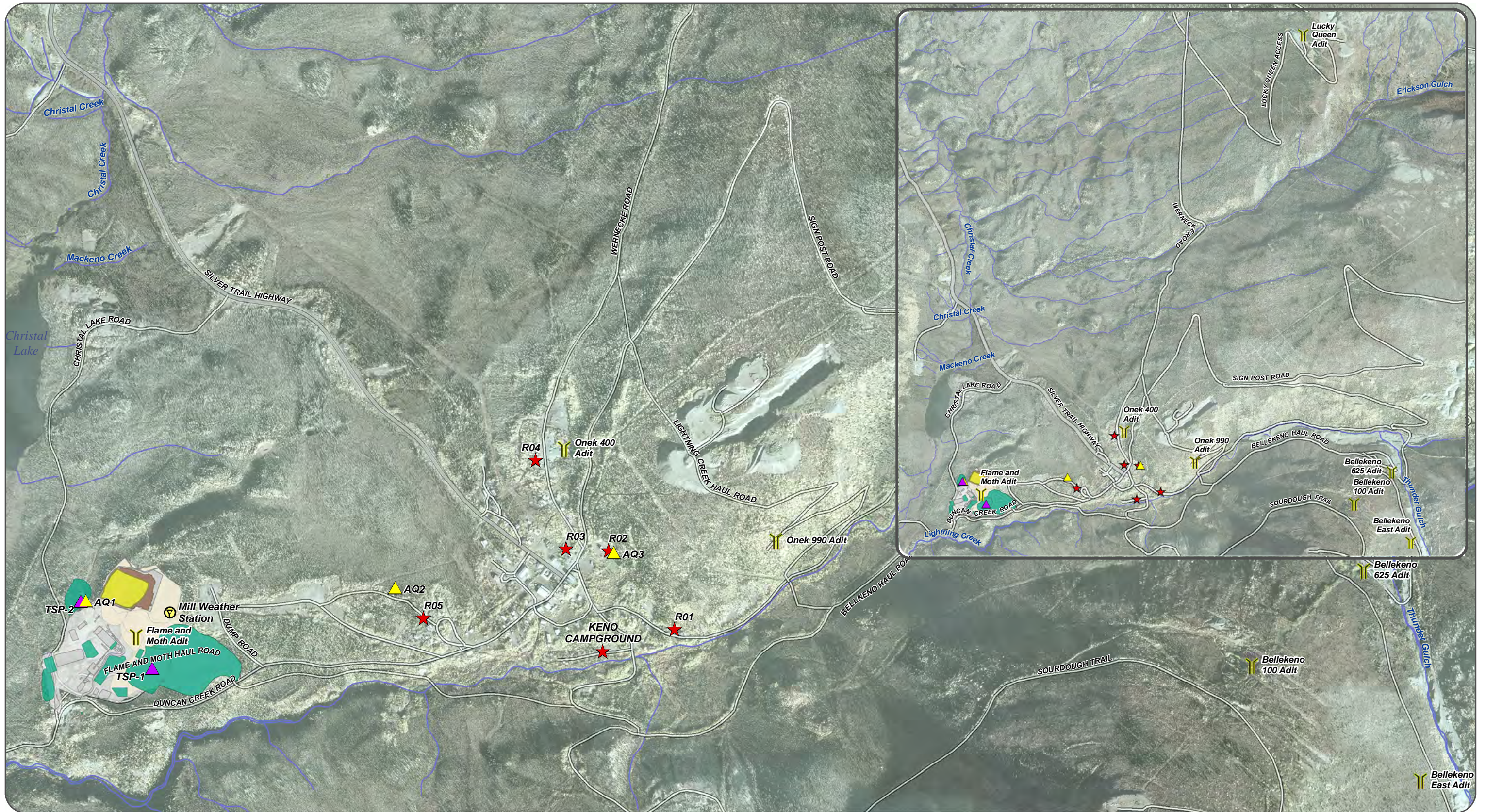
Parameter	Criteria
Antimony	25
Arsenic	0.3
Barium	10
Beryllium	0.01
Boron	120
Cadmium	0.025
Chromium	0.5
Cobalt	0.1
Copper	50
Iron	4
Lead	0.5
Manganese	0.4
Molybdenum	120

Parameter	Criteria
Nickel	2
Selenium	10
Silver	1
Strontium	120
Tin	10
Titanium	120
Vanadium	2
Zinc	120

## 5.2 UPDATED MONITORING PLAN

In response to concerns raised during the YESAA process for Flame & Moth and considering the results of the air dispersion model, AKHM has made 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 PM<sub>10</sub> and PM<sub>2.5</sub> is 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 are collected from each location, for TSP, PM<sub>10</sub> and for PM<sub>2.5</sub>.
- 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.



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  
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- Proposed Features
- DSTF Cover and Revegetation Phase I-II
- Building/Structures
- DSTF 322k Tonnes Design
- Current DSTF
- Mill Site Footprint

- Highway
- Secondary Road

- Dust Receptors
- Air Quality Monitoring Stations
- Former Dust Monitoring Stations
- Weather Station



KENO HILL SILVER DISTRICT MINING OPERATIONS

**FIGURE 2**  
**AIR QUALITY MONITORING STATION LOCATIONS**

NOVEMBER 2014

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