



**ALEXCO**

**Alexco Keno Hill Mining Corp.  
Bellekeno Mine Operations**

**Tailings Characterization Plan**

**Water Use Licence QZ09-092**

**December 2010**

**Prepared by:**



**ACCESS**  
CONSULTING GROUP

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## 1.0 INTRODUCTION

### 1.1 Purpose of Plan

This plan is submitted to fulfill the conditions set out in Part H, Clauses 67 and 68 of Water Licence QZ09-092 issued to Alexco Keno Hill Mining Corp (AHKM) on August 19<sup>th</sup> 2010

*67. As part of the Operations, Maintenance, and Surveillance Manual required for the DSTF under QML-0009, the Licensee shall develop and implement a Tailings Characterization Plan and submit the plan to the Board by December 31, 2010.*

*68. 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 tailings. Such tests shall be initiated for each new Mine and shall be continued until a steady-state has been established; and*

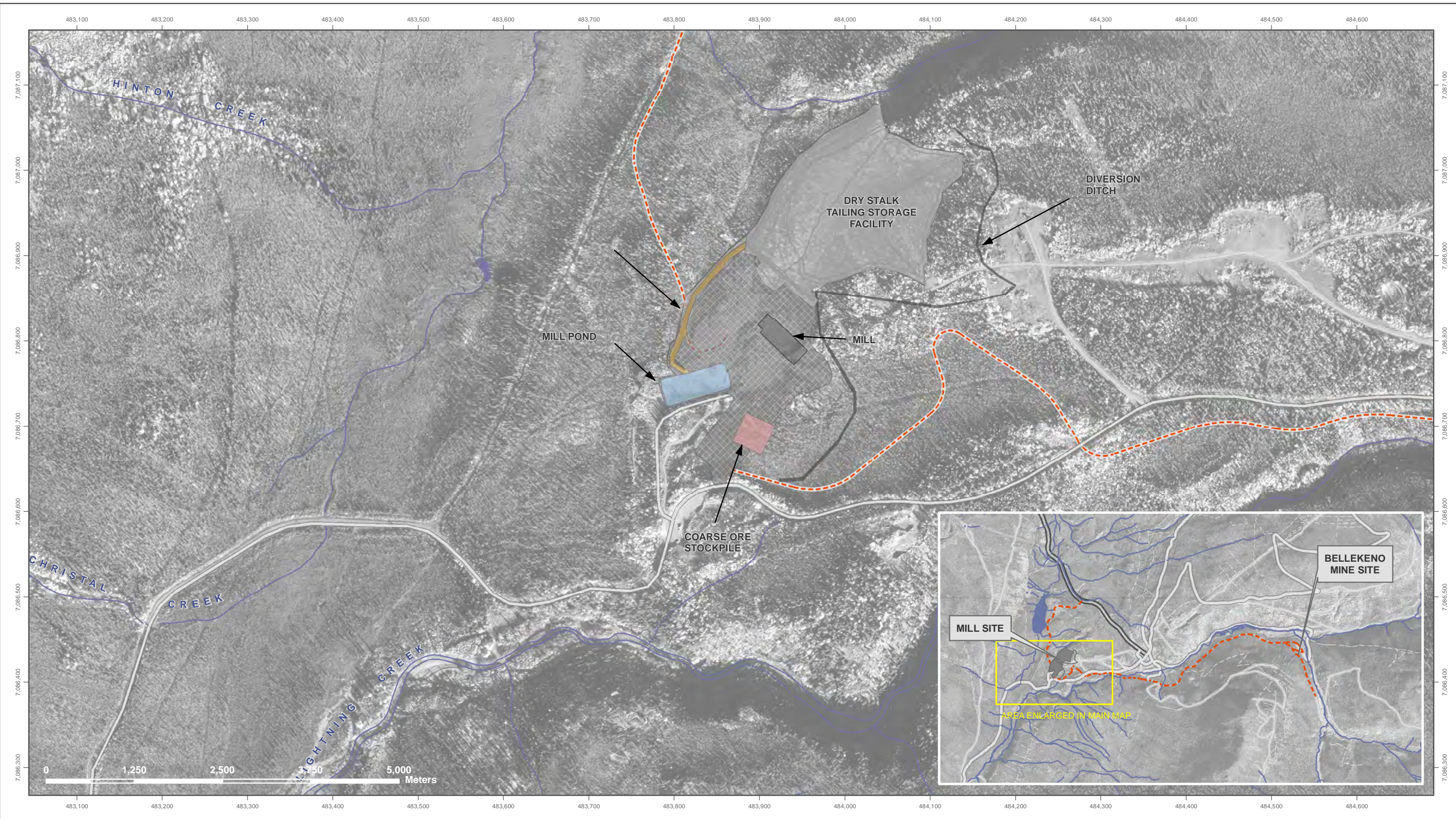
*c) sampling frequencies for confirming the properties of deposited tailings such that the assumed long term chemical and physical behaviour of the tailings stack can be progressively confirmed during operation of the Bellekeno Mine, and the rationale to support the recommended frequencies.*

This plan outlines the methodology that will be followed to comply with the requirements of these clauses at the Bellekeno Mine and Mill on Alexco's Keno Hill property.

## **2.0 MILL AND TAILINGS 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 mill site and Dry Stack Tailings Facility (hereinafter referred to as the “DSTF”) are located approximately 1 km west of Keno City on the Flame and Moth property, while the mine is located approximately 3 km to the east of Keno City (Figure 1). The mill and DSTF are located in the upper Christal Creek drainage.

The DSTF is located immediately to the west of the mill building and the infrastructure associated with these facilities occupies approximately 5.8 hectares. There are diversion ditches and berms located upgradient of these facilities in order to minimize the amount of run-on water. There are collection ditches that will collect water from the disturbed footprint of these facilities and route it to the mill pond for use in processing.

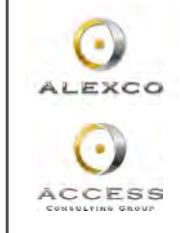


Main Map: 1:4,137 Inset Map: 1:50,000  
 (when printed on 11 x17 inch paper)

Aerial photography flight date: July 13th 2006. Ortho-rectification produced by Challenger Geomatics Ltd. Data obtained from EBA: Diversion Ditches and Conveyance flume: DSTF.dwg. Data obtained from Wardrop (mill site footprint:A0010002.dwg) Mill from YES Survey May 2010 (E10012.dwg); Mill pond from YES survey October 2010. DSTF area based on cleared surface surveyed by YES (TAILINGS.dwg) and A0010002.dwg (Wardrop).

Datum: NAD 83; Projection: UTM Zone 8N

- |                   |                             |                      |
|-------------------|-----------------------------|----------------------|
| <b>Road Types</b> | <b>Mill Site Footprints</b> |                      |
| Haul Road         | DSTSF                       | Coarse Ore Stockpile |
| Highway           | Diversion Structure         | Mill Site Footprint  |
| Local             | Mill                        | Mill Pond            |
| Track             | Conveyance Flume            |                      |



**BELLEKENO MINE**

**TAILINGS CHARACTERIZATION PLAN**

**FIGURE 1- SITE PLAN**

Drawn By MD	DECEMBER 2010	Verified by SD
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### 3.0 TAILINGS CHARACTERIZATION PLAN FRAMEWORK

The proposed tailings characterization plan is intended to provide a better understanding of the physical, chemical and mineralogical properties of tailings produced at the Bellekeno Mine. The Chief Assayer for AHKM will be responsible for preparing the representative monthly composite that will form the basis for the proposed test work; except where alternative or additional samples are being collected. Water sampling will be conducted by AHKM environmental personnel or contractors. Table 1 contains a summary of the analytical program described in this section of the plan.

Component	Testing Parameter	Sample Source	Frequency
Physical	Soil water characteristic curve	monthly composite	monthly
	Tailings gradation	monthly composite	monthly
	Tailings specific gravity	monthly composite	monthly
	Drained and undrained shear strength	quarterly composite	quarterly
Mineralogical	XRD and petrography	quarterly composite	quarterly
Chemical	Acid Base Accounting, ICP-MS	monthly composite	monthly
		daily grab sample (2 random)	monthly
		combined monthly composite (high and low pyrite tailings)	monthly
	Shake Flask	monthly composite	monthly
Seepage Chemistry	Dissolved metals, pH, alkalinity, sulphate, conductivity	grab sample from DSTF sump	monthly
Pore Water Chemistry	Dissolved metals, pH, alkalinity, sulphate, conductivity	Grab sample from lysimeter (following installation)	quarterly

#### 3.1 Definition of High Pyrite versus Low Pyrite Tailings

The separation of tailings is a requirement of QML-0009 and requires AHKM to place high pyrite tailings underground as cemented backfill in mined out areas. It is important to understand that the definition of tailings as high or low pyrite is an operational distinction based on the results of metallurgical testing and not geochemical characterization. The tailings output from the 1<sup>st</sup> zinc cleaner are identified as being pyrite tailings (ie. high pyrite tailings) while tailings output from the zinc rougher scavenger are considered as being bulk tailings (ie. low pyrite tailings). Acid base accounting results from the metallurgical testing program are shown in Table 2. The distribution of sulphides in the tailings from this testing showed that approximately 66% of the total sulphur in the tailings are concentrated in the high pyrite tailings. From the

results of the metallurgical testing it has been estimated that approximately 130 to 170 tonnes of tailings would be produced at the current permitted mill throughput of 250 tpd.

Sample ID	% S (% of total S)	Acid Potential	Neutralization Potential		
			Actual	Ratio	Net
Low Pyrite (Bulk) Tailings	0.8 (4.8)	22.2	43.3	2.0	21.1
High Pyrite Tailings	10.9 (9.5)	146.9	65.9	0.4	-81.0

### 3.2 *Physical Property Characterization*

Physical parameters of the placed tailings will be verified through a combination of physical monitoring results and laboratory testing programs. The following physical properties will be determined as part of the ongoing characterization of physical parameters:

- soil water characteristic curve;
- tailings gradation
- tailings specific gravity; and,
- drained and undrained shear strength

The soil water characteristic curve (SWCC) is a function of the grain-size and in-situ density of the placed tailings. The SWCC will be calculated monthly for the tailings based on the averaged results of field monitoring of in-situ density and the reported gradation for the tailings.

The tailings grain-size distribution will be determined using ASTM approved methods for measuring coarse and fine-grained granular materials. A split of the monthly composite sample will be submitted for determination of the average monthly gradation.

Tailings specific gravity will be determined using a split from the monthly tailings composite. The testing procedure will be conducted using ASTM approved methods.

Testing to determine the drained and undrained shear strength of the placed tailings will be conducted quarterly using a quarterly composite sample created from the monthly composites. The use of a quarterly sampling frequency for this parameter is based on the size of sample required for conducting this testwork and consideration of an anticipated tailings production rate of approximately 250 tonnes per day.

### **3.3 Mineralogical Testing**

Mineralogical testing of the tailings will be conducted quarterly. A split of quarterly composite will be submitted for Reitveld-XRD analysis to determine the major constituents of the tailings.

### **3.4 Chemical Testing – Static Testwork**

An evaluation of the tailings pore water chemistry will be determined through monthly monitoring of the Dry Stack Tailings Facility (DSTF) collection sump. The DSTF is underlain by a GCL liner in order to ensure collection of all seepage waters from the facility into the collection sump. This sump is located at the toe of the DSTF and seepage waters will be representative of water draining from the facility and provide an indication of pore water chemistry.

Chemical testing to characterize the placed tailings materials will be conducted in accordance with sampling guidance contained in MEND 2009. A split of the monthly composite will be submitted for acid-base accounting (ABA), shake flask testing and determination of the total metals content using the 4-acid “near total” digestion method. Two additional samples of daily tailings will be collected and submitted on a monthly basis in addition to the ABA analysis conducted on the monthly composite. The submission of these two additional samples is intended to provide information on the variability of chemical characteristics of the tailings from the monthly composite.

A tailings composite sample will also be tested by the same procedures that is representative of all tailings produced, i.e., without the separation of high and low sulfur

tailings streams. This will be used to determine the environmental benefits of separating pyrite tailings from the remaining tailings.

### **3.5 Chemical Testing – Kinetic Testwork**

Humidity cell testing is an accepted method for identification of potential long term effects from geologic materials disturbed by mining activities. A humidity cell for geochemical characterization of the placed tailings will be initiated within 16 months of the start of commercial production. The humidity cell will be a composite comprised of splits collected from representative monthly composites. The humidity cell composite will be comprised of at least 10 splits collected during the first 16 months of operation. The use of monthly composites for an operational tailings characterization kinetic testing program is consistent with those implemented as part of an operational geochemistry program for the Cantung Mine in the Northwest Territories.

AHKM will also install a field lysimeter into the DSTF in order to collect samples of pore water from within the facility. The lysimeter will be sampled quarterly in order to determine trends in pore water chemistry and will be compared with the results of the monthly seepage collection sump sampling. The design of the field lysimeter will be tied to the construction of the DSTF and a detailed design will be submitted prior to construction. The field lysimeter will be installed within 12 months of the beginning of commercial production.

## **4.0 IMPLEMENTATION SCHEDULE**

AHKM will begin to assemble the monthly composites once commercial production has begun. Testing of the monthly and quarterly composites will begin immediately. The humidity cell testing requires that the mill be in commercial operation for more than a year which would mean that the testing would commence in early 2012. The field lysimeter would be constructed during the summer of 2011.

## 5.0 REPORTING

The results of the tailings characterization program will be included with the annual report for Water Licence QZ09-092. Further to the identified reporting requirements previously identified in clause 83 additional reporting requirements are outlined in clause 54 of Water Licence QZ09-092:

*Unless otherwise specified in this licence, all monitoring data, reports, plans, studies, study results, designs or manual shall be submitted to the Board in the following format:*

- a) All reports required to be submitted to the Board will be unbound and reproducible by standard photocopier, accompanied by one electronic copy on a CD/DVD.*
- b) The Licensee shall provide to the Board 5 additional copies of all reports. The additional copies may be either 5 bound paper copies or 5 electronic copies on individual CDs/DVDs.*
- c) Electronic copies shall be IBM compatible in one of the following formats: Word 97-2003, Excel 97-2003 workbooks, or Adobe .pdf format. Water quality results must be presented in Excel 97-2003 .xls format.*