Alexco Keno Hill Mining Corp.

Bellekeno Mine Operations

Bellekeno Adaptive Management Plan

Water Use Licence QZ09-092

April 2011

Prepared by:

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1. INTRODUCTION

The Bellekeno Mine WUL QZ009-092 specifies the following licence conditions:

#90. Within six months of the effective date of this licence, the Licensee shall submit to the Board an AMP dealing specifically with Bellekeno Undertaking and shall implement that plan. The AMP should be based on the contents of the existing district-wide AMP submitted as exhibit 1.3.10, but customized for the specific activities and developments of the Bellekeno Undertaking.

#91. In addition to these relevant events already identified in the district wide AMP, the Bellekeno AMP should 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 Flame and Moth Site discharge area;*
d. *Transport of sediment from the Flame and Moth 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 Flame and Moth Site collection and sediment pond;*
g. *Exceedence of recommended water quality standards in the receiving environment occurring irrespective of compliance with effluent discharge standards;*
h. *Identification of groundwater quality impacts at the Flame and Moth or Bellekeno mill sites; and*
i. *Identification of water quality impacts to Keno City water wells.*

This report is submitted to fulfil these licence conditions.

2. UPDATE TO DISTRICT-WIDE AMP

The district-wide AMP has been updated several times to reflect the changing status of activities in the Keno Hills Silver District (KHSD). The March 2011 update is attached as Appendix 1 to this Bellekeno AMP.

2.1 Alexco Activities in the KHSD

Alexco and its subsidiary companies are undertaking care and maintenance, exploration and development, active mining and mill processing activities, and closure studies in the Keno Hill Silver District which includes various activities:

Principal activities Bellekeno Mine and Mill:

- Mining ore and waste rock from Bellekeno mine;
- Placement of potentially acidic/metal leachate (PAML) rock within engineered facilities;
- Placement of non-PAML rock in permitted waste rock storage areas;
- Construction of earthworks and erosion control protection;
- Crushing, grinding, flotation, thickening, filtration, and production of a lead concentrate, zinc concentrate, and two tailings streams related to the lead flotation circuit and the zinc flotation circuit;
- Placement of tailings in the engineered Dry Stack Tailings Facility;
- Placement of tailings and PAML rock in a cemented rock backfill within the former vein areas;
- Water treatment of water from Bellekeno mine and potentially from District Mill;
- Use of water for camp purposes and quartz mining undertakings;
- Use of water and wastewater for lime mixing operations;
- Use of water for milling operations; and
- Environmental monitoring, including dust, surface water, groundwater and treated mine water prior to discharge.

Principal activities Exploration, Development, Care and Maintenance and Closure:

- Surface drilling and advanced underground exploration with view to mine development;

- Direct use of water for camp purposes and quartz mining undertakings;
- Direct use of water and wastewater for lime mixing operations;
- Deposit of waste into water and receiving environment;
- Waste rock storage;
- Construction and upgrades to access roads;
- Operation and maintenance of existing four wastewater treatment facilities and
- associated settling ponds using lime treatment (Silver King 100, Galkeno 900, and Galkeno 300 and the Valley Tailings Area);
- Deposit of waste as lime treatment sludge;
- Construction of earthworks and erosion control protection;
- Storage of wastewater in the treatment settling ponds and Valley Tailings Area; and
- Maintenance of existing diversion channels (Porcupine Creek) and ditches.

Accessory activities:

- Maintenance and operation of site infrastructure related to water treatment systems and access roads;
- Site security and maintenance of site facilities and structures for public health and safety;
- Transport of milk of lime solutions to treatment sites;
- Periodic desludging of treatment settling ponds and transportation or pumping to sludge storage areas which are periodically decanted;
- Mine dewatering for care and maintenance purposes and to advance underground exploration or development;
- Water sampling (effluent and receiving waters);
- Waste rock analysis and classification;
- Environmental monitoring, inspections and sample programs, including monitoring and inspection of physical structures;
- Removal of blockages that have formed naturally or cofferdams that have been constructed as temporary structures to avoid uncontrolled discharge of mine pool water;

- Removal and clean up of infrastructure related to adits, adit structures and facilities;
- Wastewater treatment studies and test programs related to potential closure design options; and
- Operation, inspection and maintenance of the Valley Tailings Area.

2.2 Existing Plans

Alexco recognizes that the activities of Bellekeno Mine and the District Mill are being performed in a historic mining district which includes waters and physical workings at the Keno Hill Silver District that could potentially become an environmental risk or hazard that do not yet require immediate attention. The existing discharge from the Bellekeno mine of treated water, the potential future discharge of water from the DSTF mill area, and placement of water treatment sludge is being performed in watersheds that are impacted by historic mining operations. The development of a Keno Hill District Closure Plan is intended to address these water discharges and workings which require further intervention over the long term. As the closure work is implemented, it is expected that changes in the environmental status of the KHSD will be observed.

Several plans are currently in place pursuant to the existing licences and approvals and are referenced throughout this AMP. These plans have been prepared or will be prepared pursuant to Water Licences QZ09-092 and the Quartz Mining Licence QML-009 to guide the management of activities and monitoring associated with operation of the Bellekeno Mine and District Mill:

<u>QML Plans</u>

- Emergency Response Plan
- Hazardous Materials Management Plan
- Heritage Resources Protection Plan
- Monitoring and Surveillance Plan
- Noise Abatement Plan
- Spill Contingency Plan
- Traffic Management Plan
- Waste Management Plan
- Wildlife Protection Plan

WUL Plans

- Sludge Management Plan
- Groundwater Monitoring Plan
- Water Balance Report and Water Management Plans
- Tailings Characterization Plan
- Receiving Environment Study
- Physical Inspection and Reporting Plan
- Bellekeno 625 Water Treatment Systems Operations Manual
- Bellekeno Hydrogeology Plan
- Dry Stack Tailings Facility Design Report
- Dry Stack Tailings Facility Operation and Management Plan

This document builds on these plans and intended to summarize and augment the adaptive management activities already contained in the District-wide AMP and these plans.

3. ADAPTIVE MANAGEMENT PLAN OVERVIEW

3.1 Adaptive Management Plan Objectives

An adaptive management plan (AMP) is a management tool designed to guide responses to unforeseen or contingency events respecting for example, water quality and quantity and physical conditions of site workings and infrastructure. The adaptive management approach will provide for assessment of mitigation measures and their effectiveness, and guide the orderly implementation of responses. Since it is difficult to predict the specific environmental condition that may arise which requires a response from management, the AMP does not necessarily provide specific detailed descriptions of responses to a situation. The AMP provides a range of possible responses to use as a guide to respond to specific environmental conditions encountered. Management should use the information provided in the AMP and adapt the appropriate response from this guide, which is the sole purpose of an AMP.

The AMP framework encompassing Company management activities includes:

- routine inspection and environmental monitoring, maintenance and reclamation;
- routine assessment of monitoring and performance data;
- performance thresholds for implementation of appropriate levels of responses for planned contingency measures; and
- reporting of monitoring results and actions.

Results of the monitoring programs (Section 2.2 – Plans in Place), will be assessed on an ongoing basis to determine if any negative trends in water quality, quantity or other parameters are occurring. If the results indicate that there are no negative environmental impacts, then the frequency and length of monitoring and maintenance would continue as usual. Adaptive management will be implemented to respond to negative trends observed through the monitoring programs.

3.2 AMP Events Summary

The district-wide AMP identifies a number of "events" which represent potential environmental conditions that would require a management response, if they were to occur; these are the first 5 "events" listed below. The WUL clause 91 adds nine additional "events" which are in addition to the ones previously identified in the District-wide AMP, identified as "events" 6 through 14 listed below.

1. **Change in Water Quality or Quantity**
2. **Non-AML Waste Rock Disposal Area(s) Seepage Exhibits AML**
    a. Waste Rock Disposal Area(s) (including where used for road and general construction) runoff trending to AML conditions
3. **Sludge Storage Area Effectiveness Compromised**
    a. Seepage Observed Near Sludge Storage Area
    b. Sludge Storage Area Approaching Capacity
4. **Physical Instabilities**
    a. Area of Significant Subsidence is Observed
    b. Rock Fall or Landslide Occurs Within a Monitored Area
    c. Structure Failure or Portal Collapse
5. **Site Security Compromised**
    a. Gate, Fence or Sign Damaged
6. **Development of high pore pressures underneath the DSTF**
7. **Development of significant erosion of exposed DSTF surfaces**
8. **Development of erosion at the Flame and Moth Site discharge area**
9. **Transport of sediment from the Flame and Moth discharge area into Christal Creek**
10. **Development of large differential settlements at the DSTF**
11. **Development of large differential settlements along the conveyance flume from the DSTF to the Flame and Moth Site collection and sediment pond**
12. **Exceedence of recommended water quality standards in the receiving environment occurring irrespective of compliance with effluent discharge standards**
13. **Identification of groundwater quality impacts at the Flame and Moth or Bellekeno mill sites; and**
14. **Identification of water quality impacts to Keno City water wells.**

The AMP response for each of these events is described individually in subsequent sections while Table 3-1 at the end of this section provides a summary of the approach to AMP events. This table summarizes the narrative triggers, indicators and response thresholds, monitoring locations and parameters.

3.3 AMP Approach

For each AMP event a methodical approach is provided:

1. Description of the event and possible environmental consequences - Addresses issues or information that trigger the AMP;
2. Location of possible event occurrence – Identifies specific working site locations if applicable to event;
3. Monitoring requirements – Identifies the parameters to be monitored, frequency and means for monitoring each parameter;
4. Specific indicators and thresholds - Defines the conditions when management actions should be taken. There may be a series of indicators and staged thresholds for an individual event; and
5. Approach to responses –Description of the approach to responses including a simplified flow chart to guide the implementation process if any specific thresholds have been crossed.

Table 3.1 Overall AMP Summary

Event	Narrative Trigger	Indicators	Thresholds	Monitoring Locations	Monitoring Parameters
1. CHANGE IN WATER QUALITY OR QUANTITY					
a. Significant change in water quality of treatment plant discharge	Water Treatment Facilities Decline in effluent pH noted or effluent quality trending towards possible exceedence of standards or exceeds licenced standards.	pH, Total zinc, ammonia, TSS	Treated effluent: TSS>20 mg/L for three consecutive days; OR Effluent quality standards exceeded. Ammonia > 4.0 mg/L and pH > 9.0 for three consecutive days; OR Total Zinc > 0.40 mg/L and pH <6.5 for three consecutive days; OR	Water Treatment Facilities	Routine in-situ, on-site total zinc, external multi-element ICP, hardness, pH, conductivity, TSS, ammonia, LT50
b. Significant change in water quality of adit discharge	Significant decline in pH or increase in conductivity from mine adit discharge to treatment plant	pH, conductivity	Adit discharge pH more than 1 pH standard unit lower or conductivity 2X higher than historic average	KV-42 Bellekeno adit discharge	Same as indicators
b. Adit discharge quantity significantly increases	Observed or measured flows display a sustained and statistically significant increase over historical flow conditions	Flow	Increase of flow to greater than 95% Upper Confidence Level when compared to the average for the previous 24 months or 90% Licence flow discharge criteria exceeded	KV-43 Bellekeno treatment plant; KV-XX Mill sediment pond discharge treatment plant	same as indicators
2. WASTE ROCK SEEPAGE EXHIBITS AML					
a. Waste rock seepage or runoff trending to AML conditions	Seepages from waste rock disposal areas or from works constructed or upgraded with non AML material show significant decline in pH and/or an increase in conductivity OR approaching licenced discharge standards	pH, conductivity	Significant decline in pH between measurements or pH <6.0 and/or conductivity showing a significant increasing trend or >2000 mS/cm; OR indicators approaching licenced discharge standards	Waste rock disposal areas and works or features constructed from non-AML material	pH, conductivity, Routine multi-element ICP
3. SLUDGE STORAGE AREA EFFECTIVENESS COMPROMISED					
a. Seepage observed near sludge storage areas	Routine inspection of sludge storage area shows seepage	Total zinc, pH	pH >8.5 and total zinc > 1.0 mg/L	Valley Tailings sludge storage cell	Same as indicator
c. Sludge storage area approaching capacity	Sludge storage area approaching minimum freeboard of 1.0 meter below the decant point	Visual observation of freeboard	Freeboard is at 1.5 meter below decant point	Valley Tailings sludge storage cell	Same as indicator
4. PHYSICAL INSTABILITIES					
a. Area of significant surface subsidence has occurred	An observed subsidence has exposed an opening to surface or resulting in slope failure	Visible slope failure, ground subsidence or opening on surface	Opening to underground workings or area of subsidence effects public safety or down gradient environment	Bellekeno Mine Production Unit Area	same as indicators
b. Rock fall or landslide is observed that affects road right-of-way or intrudes into stream	An observed rock fall or landslide effects a road right-of-way, infrastructure or intrudes into stream	Mine source material movement	Source material effects road or stream	Bellekeno Mine Production Unit Area	same as indicators
5. SITE SECURITY COMPROMISED					
a. Security gate, fence, sign damaged	Public health and wildlife safety measure damaged or removed	Sign, fence, gates, locks	Security feature damaged, removed, or compromised	Bellekeno Mine Production Unit Area	same as indicators
6. Development of high pore pressures underneath the DSTF					
a. High porewater pressure within groundwater monitoring wells in the DSTF	Porewater pressure is observed in groundwater monitoring wells in the DSTF	Porewater pressure	Tip @1.0m or 1.7m depth – Porewater pressure parameter (Ru) exceeds 0.15	Groundwater monitoring wells in the DSTF	same as indicators
7.0 Development of significant erosion of exposed DSTF surfaces					
a. Area of significant erosion on exposed DSTF surface	An observed movement of tailings caused by erosion on surface	Visual inspection of tailings surface	Geotechnical engineer or operator inspection identifies adverse operating condition	DSTF	Same as indicators

Event	Narrative Trigger	Indicators	Thresholds	Monitoring Locations	Monitoring Parameters
8. Development of erosion at the Flame and Moth Site discharge area					
To be developed once discharge system is designed					
9. Transport of sediment from the Flame and Moth discharge area into Christal Creek					
To be developed once discharge system is designed					
10. Development of large differential settlements at the DSTF					
a. Significant differential settlements are observed in the DSTF	An observation of significant differential settlements are observed at the DSTF	Displacement of survey monitors and slope indicators	Displacements greater than 25 mm in any direction	Survey monuments and slope inclinometers	Same as indicators
11. Development of large differential settlements along the conveyance flume from the DSTF to the Flame and Moth Site collection and sediment pond					
a. Significant differential settlements are observed in along the conveyance flume	An observation of significant differential settlements are observed the conveyance flume	Displacement of survey monuments	Displacements greater than 25 mm in any direction	Survey monuments	Same as indicators
12. Exceedence of recommended water quality standards in the receiving environment occurring irrespective of compliance with effluent discharge standards					
a. Water quality standards are exceeded in the receiving environment even though authorized licenced discharges are within discharge limits	Receiving environment discharge standards exceed CCME and do not have a history of exceedence, and waste related to the Bellekeno undertaking are contributing greater than 10% of the mass load.	Licensed discharge parameters	Exceedence of CCME at a receiving environment monitoring station, no previous trend of exceedence, and Bellekeno undertaking contributes >10% of mass load	Receiving environment monitoring stations	Same as indicators
13. Identification of groundwater quality impacts at the Flame and Moth or Bellekeno mill sites					
a. A significant increasing trend is observed in groundwater near the Flame and Moth or Non-AML Waste Rock Disposal Area	Total zinc significantly exceeds baseline measurements for a given monitoring well, and exceeds licenced effluent discharge standards	Total Zn	Total zinc exceeds the highest baseline measurement by a factor of 2x, and exceeds licensed effluent discharge standards	Groundwater monitoring wells	Same as indicators
14. Identification of water quality impacts to Keno City water wells					
a. A significant increasing trend is observed in groundwater near the Flame and Moth or Non-AML Waste Rock Disposal Area	Total zinc significantly exceeds baseline measurements for a given monitoring well, and exceeds licenced effluent discharge standards	Total Zn	Total zinc exceeds the highest baseline measurement by a factor of 2x, and exceeds licensed effluent discharge standards	Groundwater monitoring wells	Same as indicators

4. DISTRICT AMP UPDATE FOR BELLEKENO PRODUCTION UNIT

4.1 Change in Water Quality or Quantity

Results of water quality and quantity monitoring are assessed on an ongoing basis to determine if significant changes are occurring and if an adaptive management response is required. The following sections describe what constitutes a significant change to water quality or quantity and associated responses that would be implemented.

4.2 Significant Change in Water Quality

4.2.1 Descriptions

All data for current water sample stations required in the Bellekeno Mine WUL QZ09-092 are stored in an EQWin database that allows water quality to be tracked at each site such that conditions can be identified at any point in the season. In this way parameters can be seen to be fluctuating from the normal, and reaching levels where management is required to respond. Set point triggers can be placed in the database so that response parameters are flagged for notification and action.

4.2.2 Locations

Water quality is monitored from the Bellekeno water treatment facilities for potential effects to the receiving environment including loading of down gradient waters. These sites are listed below and shown in Figure 3-1 of the Environmental Monitoring Program in Appendix A.

<u>Water Treatment Facilities:</u>

- KV-43 - Bellekeno 625 Treatment Pond Decant
- KV-XX - District Mill Treatment Decant, location not yet established

<u>Adits:</u>

- KV-42 - Bellekeno 625 Adit
- KV74 - Bellekeno East Adit

4.2.3 Monitoring Requirements

Specific parameters from the monitored areas will be compared to specific thresholds to determine if they have been exceeded. Monitoring requirements will change should one of the AMP thresholds be triggered. This could include more frequent monitoring

of grab samples at the station location as well as more frequent monitoring of the receiving environment below the site where the trigger was initiated.

4.2.4 Specific Thresholds

Specific thresholds for the different categories of monitoring stations that will initiate a response are provided in the following sections.

4.2.4.1 Water Treatment Facilities/ Licenced Effluent Discharges

Water quality data from treatment facilities and other potential effluent discharge from Bellekeno East decline will be assessed to determine if the following thresholds have been exceeded:

- Daily sampling result for pH less than 7.0 units at a water treatment facility decant for more than 3 consecutive days;
- Daily sampling result for zinc or ammonia trending toward possible exceedence of discharge standard:
    - Total zinc > 0.40 mg/l and pH < 7.0 units for three consecutive days; or
    - Ammonia > 4.0 mg/l and pH > 9.0 for three consecutive days; and
    - TSS > 20 mg/l for three consecutive days.
- Sample result exceeds effluent quality standard (Table 4-1 and Table 4-2).

Table 4.1 Bellekeno 625 Licenced Effluent Quality Standards

Parameter	Maximum Concentration in a Grab Sample (mg/L)
pH	6.5 to 9.5 pH Units
Suspended solids	25
Ammonia Nitrogen	5
Arsenic (Total)	0.5
Cadmium (Total)	0.01
Copper (Total)	0.1
Lead (Total)	0.2
Nickel (Total)	0.5
Silver (Total)	0.01
Zinc (Total)	0.5

Table 4.2 Flame and Moth Site Licenced Effluent Quality Standards

Parameter	Maximum Concentration in a Grab Sample (mg/L)
pH	6.5 to 9.5 pH Units
Suspended solids	25
Ammonia Nitrogen	5
Arsenic (Total)	0.5
Cadmium (Total)	0.01
Copper (Total)	0.1
Lead (Total)	0.2
Nickel (Total)	0.5
Radium 226	0.37 BQ/L
Silver (Total)	0.02

Zinc (Total)	0.5

4.2.4.2 Mine Water Quality Changes

The thresholds for Bellekeno adit discharges that would be applied in order to determine if mine water source quality had been significantly altered:

- A monitoring pH concentration trend, 1.0 standard pH unit below historic average. A trend would be established comparing the prior month average to the historic average.
- A monitoring trend whereby there is an increase of two-times (2X) or more in conductivity (measured externally by an accredited lab) when compared to the average conductivity for the previous 24-months' water quality data prior to dewatering.
- Specific metals trends will be evaluated if either pH or conductivity trend has been triggered. Due to the nature of mining activities high concentration of suspended solids and metals found in the suspended solids are periodically expected as sumps are cleaned out or during dewatering changes; consequently metals concentrations will not be a primary trigger.

4.2.4.3 Responses to Changes in Water Quality

Responses to changes in water quality from treatment plants and changes in adits will be different to account for the level of control over the results of water quality, where treatment plants are actively managed, while a mine water quality is dependent on the native groundwater associated with veins, host rock, recharge, and other factors not directly under the control of the mine operator.

4.2.4.4 Responses to changes in Treatment Plants

If an adaptive management trigger associated with the treatment plants is identified as being triggered, the following steps will be performed:

- Notification to the Water Inspector that the trigger has been triggered within three working days.
- Investigation of the root cause of the exceedence.
- If a root cause of exceedence can be readily identified and remedied, the remedy will be implemented in a timely manner, and the water inspector notified of the remedy implementation in a timely manner according to permit requirements.
- If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause.

- Water will be stored in underground sumps or the mill sediment pond to the extent practical to limit discharge until root causes have been identified and a solution implemented.

4.2.4.5 Responses to Changes in Mine Adit Chemistry

Monthly averages of pH and conductivity are considered good surrogate parameters to identify water quality changes that may affect the cost and feasibility of water treatment associated with the mine adits. If the trend analysis identifies specific changes then the following steps will be performed:

- Notification to the Water Inspector that the trigger has been triggered within three working days.
- Investigation of the root cause of the exceedence:
  - Due to the nature of underground mine workings, inflows to different areas of the mine may be different than other areas. A screening level water quality study will be implemented using field pH and conductivity equipment to identify mine areas that may be contributing to the change in water quality.
  - A review of recent mining practices and a study of specific rock lithologies in the area of recent mining activity will be performed to assess if the change is associated with specific rock types or if a mining practice could be associated with the change.
- If a root cause can be identified, plans will be implemented to manage the water quality, which may include modification of the water treatment plant design or operating approach.

4.2.5 Significant Changes in Water Quantity

The Bellekeno Hydrology Plan, and the Water Balance Report and Water Management Plans provide for a monitoring approach to identify water quantity and to determine if water quantity from the Bellekeno mine is showing long term trends that indicate sustained changes in water quantity. Short term temporary spikes in water quantity are to be expected as new mine areas with water transmissive features such as veins or fractures are encountered. However, experience from the advanced development and initial mining activities show that the amount of water associated with these initial drainage episodes is not significant, and in a short timeframe the water drains from the vein or fracture and the net contribution compared to the ongoing flow is minimal.

4.2.6 Monitoring Requirements and Specific Thresholds

The relevant flowmeter and totalizer that measures water quantity data from KV-42, the Bellekeno adit, is located just upstream of the rapid mix tank. The data from the flowmeter and totalizer will be downloaded on a frequent basis and analyzed monthly. The average daily totalized flow for each month will be compared with the trailing 24 months of water flow to establish trends and also to determine significant deviation from the trends.

Two thresholds for determining significantly increased water flow are:

1. If average flow from the adit for the month is significantly higher than the previous 24 months of flow data. This will be determined by comparing the current month flow with the 95% upper confidence level (UCL).
2. If the water discharge from KV-43, the water treatment plant discharge, is within 10% of 864m^3/day, which is the licence condition in WUL QZ09-092. KV-43 shows the net adit outflow, and will not be affected by changes in water recycle usage.

4.2.7 Responses to Changes in Water Quantity

If a significant increase in water quantity is determined by the statistical test or if 90% of the WUL water quantity discharge is observed, the following response actions will be taken:

- Notification to the Water Inspector that the trigger has been triggered within 3 working days.
- Investigation of the root cause of the exceedence:
    - Due to the nature of underground mine workings, inflows to different areas of the mine may be different than other areas. A screening level water quantity study will be implemented using portable flow meter equipment such as portable flumes or a standard time to fill the bucket test to identify mine areas that may be contributing to the change in water quantity.
- If a root cause can be identified, plans will be implemented to manage the change in water quantity, which may include modification of the water treatment plant design or changing the mine operating approach such as increasing water recycle usage.

4.3 Waste Rock Seepage Exhibits AML

As mentioned previously in Section 2.2 (Plans in Place) a number of plans are in currently in place with respect to waste rock management and monitoring. The efficacy of these plans has been demonstrated through advanced exploration, development and production at the Bellekeno Mine. Although Alexco has a high level of confidence in the ability of these plans to accurately predict drainage chemistry and accurately designate waste rock appropriately, the following sections pertain to the possibility for acidic or metal leachate (AML) to occur as a result of seepage or runoff though waste rock disposal areas or areas where waste rock designated as non-AML has been used as a construction material. In addition, seeps from historic (unsegregated) waste rock piles are also considered.

4.3.1 Description

Waste rock seeps/runoff will be monitored to determine if water quality is trending to AML conditions and an adaptive management response is required.

4.3.2 Locations

- An observed seep has historically been monitored below Bellekeno 625 (KV-44).
- Any seepage from works constructed or upgraded with non-AML material, which currently includes Bellekeno East and Bellekeno powerline roads. Other Bellekeno East waste rock management areas as defined in the Waste Rock Management Plan are also monitored for drainage or seeps.
- Any other roads, facilities or structures built from non-AML material to be constructed under existing licenses.

4.3.3 Monitoring Requirements

Specific monitoring requirements for the Bellekeno 625 seep (KV-44) are outlined in the EMP (Appendix A). Monthly field measurements of pH, temperature and conductivity in will be taken between May and October, and flow at KV-44 will also be estimated. Samples will also be collected on an annual basis for KV-44 for the full suite of water quality analyses.

As per the Waste Rock Management Plan, any waste rock drainage or seeps observed between May and October will be monitored for estimated flow volume and basic field parameters of pH and conductivity. Evidence of sulphide oxidation such as snow melt areas or the presence of sulphide oxidations products will also be noted.

One geomembrane-lined lysimeter $\geq 5m^3$ will be installed in the non-AML storage areas (Bellekeno power line road). Drainage volume will be monitored, with field parameters (pH and conductivity) measured on a monthly basis from May to October. Providing there is sufficient quantity of drainage, a full suite of water quality analyses will be conducted at least twice per year.

4.3.4 Specific Thresholds

Field measurements of pH and conductivity will be monitored to determine if the following specific thresholds have been breached due to AML:

- pH significantly declining between measurements or dropping below 7.0; and/or
- conductivity showing a significant increasing trend or conductivity above 2,000 μS/cm.

4.3.5 Approach to Responses

Initial responses to an observed waste rock seep or runoff trending to AML conditions can include further inspection of the waste rock source material to ensure that the rock types used for construction are acceptable and mitigative measures such as ditching, berming, or pumping water, rock removal or whatever alternative is required to prevent degradation to the quality of water nearby. A full suite of water quality analysis will be performed by an external laboratory to verify the accuracy of field measurements.

The location of seepage or runoff will be documented with photos and GPS.

Downstream or down gradient locations will be monitored to ensure that AML runoff does not eventually reach fish bearing waters. If water quality analyses indicates runoff does deposit metal loading into a fish bearing stream or creek, the initial response of ditching, berming, pumping or selective waste rock removal to prevent this would be implemented. Once the seepage/runoff is diverted or removed, measures would be taken to prevent the AML from occurring. This may include removing the material responsible for producing the AML runoff and transporting it to a Potentially-AML Waste Rock Storage Facility, or installing a cover or water diversion system.

Weekly monitoring at the location trending to AML conditions would be implemented until seepage/runoff stops for two consecutive weeks or thresholds are not triggered for two consecutive months.

4.4 SLUDGE STORAGE AREA EFFECTIVENESS COMPROMISED

As mentioned previously in Section 2.2 (Plans in Place) a Sludge Management Plan is currently in place. The following sections pertain to the potential for the effectiveness of the Valley Tailings sludge storage area to become compromised. Sludge storage in the DSTF will be evaluated by DSTF monitoring programs.

4.5 Seepage Observed Near Sludge Storage Area

4.5.1 Description

Any seepage observed in the vicinity of the sludge storage areas will be monitored to determine if it is resulting from sludge deposition.

4.5.2 Locations

The Valley Tailings sludge storage areas will be routinely monitored for seepage.

4.5.3 Monitoring Requirements

Visual inspections will be conducted at the Valley Tailings Sludge Storage Cell when these facilities are in use. Any seepage will be documented and water quality assessed for pH and zinc.

4.5.4 Specific Thresholds

Any new identified seeps will be monitored and analyzed onsite for the pH and zinc thresholds:

- pH > 8.5 and zinc > 1.0 mg/L.

4.5.5 Approach to Responses

Seepage observed in the vicinity of the sludge storage areas will be documented with photos and monitored for flow, field pH and zinc. A full suite of water quality analysis will be performed by an external laboratory to verify the accuracy of field measurements. The flow path will be documented and an assessment of the down gradient environment conducted to determine if flow is reaching surface waters and whether or not they are fish bearing. If seepage is depositing a load into a fish bearing stream or creek, ditching, berming or pumping may be implemented to prevent this. Alternative sludge storage area would be assessed and use of the current one would cease.

The Sludge Management Plan would be revised to incorporate any new sludge storage areas and implemented.

4.6 Sludge Storage Area Approaching Capacity

4.6.1 Description

Sludge storage areas will be monitored daily during use to ensure sufficient capacity.

4.6.2 Locations

- The Valley Tailings Area Sludge Storage Cell.

4.6.3 Monitoring Requirements

Visual inspection of freeboard in Valley Tailings Sludge Storage Cell will be conducted when this facilities is in use.

4.6.4 Specific Thresholds

Freeboard is approaching capacity: 1.5 m. A minimum freeboard of 1.0 m below the decant point will be maintained.

4.6.5 Approach to Responses

Determine if there is seepage from the sludge storage area as per the visual inspection.

An investigation would be conducted of the ability to increase the facility capacity by increasing berm height for example.

Alternative sludge storage area would be assessed and use of the current one would cease.

The Sludge Management Plan would be revised to incorporate any new sludge storage areas and implemented.

4.7 PHYSICAL INSTABILITIES

The following sections pertain to potential physical instabilities that may be encountered in the Bellekeno Production Area, though specific DSTF triggers will be discussed separately.

4.7.1 Area of Significant Subsidence is Observed

Subsidence can be observed as a result of slope failure or erosion, which could potentially affect the down gradient environment, particularly surface water. Slope

failure could eventually result in a rock fall or landslide or lead to structure failure or portal collapse.

4.7.2 Locations

Throughout the Bellekeno Production Unit based on routine inspection throughout the property and as outlined in the Physical Inspection and Reporting Plan.

4.7.3 Monitoring Requirements

Maintenance personnel will routinely observe subsidence, slope failure, or erosion in the course of their daily site activities. Routine inspections will be performed in accordance with the Physical Inspection and Reporting Plan.

4.7.4 Specific Thresholds

The specific thresholds that will initiate an adaptive management response include:

- A depression with defined edges is noted in the ground with the potential to create a public safety concern;
- A cave-in has occurred allowing access to the underground workings of a mine site;
- Break in soil/ slope creep/ sediment transport observed from physical structure with perceived potential to effect nearby structures or down gradient surface water.

4.7.5 Approaches to Responses

As per the general approach to the adaptive management plan, a staged response to an observed area of subsidence, slope failure or erosion will be implemented if the threshold is triggered.

The initial response to observing an area of subsidence, slope failure or erosion will be to prevent a hazard to public health and safety and minimize sediment transport to surface waters. This could include installation of barriers such as dykes or silt fencing or construction of diversion ditches or berms.

If necessary, physical removal or physical repair of structure will be performed to remediate it to a safe status. Access to the area would be limited using fencing, barricades, or signage to alert the public and other maintenance personnel to the danger that may exist.

If there are no underground workings in the area, then it is possible that the subsidence, slope failure or erosion would be due to liquefaction of soil near the surface and may not be a cause for concern. The break or depression will be filled in with soil and monitored to see if the subsidence, slope failure or erosion continues. If the subsidence, slope failure or erosion continues to appear after repair, then further investigation by a mining engineer may be warranted, particularly if there is a risk to the stability of a nearby structure. Any physical repairs to slopes or embankments would involve an assessment in consultation with a mining engineer before implementation.

The final stage will be to implement the repair at the area of the subsidence, slope failure or erosion and to monitor the area to watch for signs of continued subsidence, slope failure or erosion at or around the previously identified area.

4.8 Rock Fall or Landslide Occurs Within Monitored Area

4.8.1 Description

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

4.8.2 Locations

Monitoring locations are throughout the area of the Bellekeno Production Unit in accordance with the Physical Inspection and Reporting Plan.

4.8.3 Monitoring Requirements

At a minimum the locations identified in the Physical Inspection and Reporting Plan, and other areas as observed by site operators. Maintenance personnel will routinely observe soil or earth movement in the course of their daily site activities.

4.8.4 Specific Thresholds

The specific thresholds that will initiate an adaptive management response include:

- A rock fall or landslide has blocked access to a previously monitored site.
- A rock fall or landslide has blocked access to a roadway previously used by the public.

- A rock fall or landslide has blocked or re-directed the flow of water of a documented stream or watercourse.
- Liquefaction of a waste rock pile foundation has caused waste rock to migrate closer to a watercourse.

4.8.5 Approaches to Responses

As per the general approach to the adaptive management plan, a staged response to the presence of a rock fall or a landslide will be implemented if a threshold is breached.

The initial response to observing a rock fall or a landslide will be to determine if it impedes on a right-of-way or a water flow path. If the debris impedes on a right of way, access to the area will be limited using fencing, barricades, or signage to alert the public and other maintenance personnel to the debris' presence.

The next stage of the response will be to examine the area to assess the possibility of further erosion of the originating slope. This task may require the services of a registered engineer. If warranted, a plan will be developed to prevent future erosion in the area.

The final step in the response to debris from a rock fall or a landslide impeding on a right-of-way will be to remove the debris, likely with heavy machinery, and transporting it to an isolated waste pile where the debris will not affect any watercourse or physical stability.

If the rock fall or landslide debris enters a watercourse, then water quality testing will be implemented. This will be done to determine if the presence of the rock in the water is contributing any metal loading to the water. If the loading in the water is found to be effected by the source material, then a mitigation plan will be developed and implemented in consultation with ttechnical experts and regulatory agencies until such time as the debris can be removed from the watercourse, and water levels return to their historical norm.

If the metal loading is determined to be not affected by the source material, then no mitigation treatment plan will be necessary, and the debris can be removed from the watercourse.

The final stage will be to continue monitoring water quality at that location for a period of time until it is determined that the rock fall or landslide had no lingering effects on the water quality.

4.9 SITE SECURITY COMPROMISED

4.9.1 Gate, Fence or Sign Damaged

In the Bellekeno Production Unit hazards to public safety exist. In order to alleviate these hazards, depending on the type of hazard and its accessibility, structures, gates, fences, or signs have been erected to prevent the public from entering these areas or draw their attention to the hazard.

Over the course of time, some of these deterrents may suffer damage or may degrade which impedes on their ability to perform as a safety deterrent. The most likely scenario is for the item to have fallen down, however, the items performance may have been degraded by weather erosion or possibly at the hands of vandals.

4.9.2 Locations

Throughout the Bellekeno Production Unit.

4.9.3 Monitoring Requirements

Since it is almost impossible to predict when or where a gate, fence, or sign will be damaged, there can be no specific monitoring requirements to observe these circumstances prior to their existence. The monitoring information required is observations of damage to any of these safety features throughout the Bellekeno Production Unit. Maintenance personnel will be familiar with the placement of gates, signs, and fences around the property and thus, during their routine site activities will be able to observe when one of these features requires attention.

4.9.4 Specific Thresholds

The specific thresholds that will initiate the action plan will be as follows:

- A gate is found open outside of a scheduled visit by authorised site personnel.
- A gate post is found to be damaged such that the gate is sufficiently disabled to prevent access to the site by authorised site personnel.
- A gate post is found to be damaged such that the gate no longer prevents unauthorised access to a site of concern.
- A fence is found to be damaged such that it no longer prevents unauthorised access to a site of concern.
- A fence or structure is found to be damaged such that it no longer prevents unauthorised access to a site of concern.

- The placard of a sign has been damaged either by environmental conditions or by vandalism such that the sign is no longer effective in relaying the information intended.
- A sign post has been damaged to an extent where the sign is in a position which renders it ineffective in relaying the information intended.

4.9.5 Approaches to Responses

As per the general approach to the adaptive management plan, a staged response to any one of the above circumstances will be implemented if the threshold is triggered.

The initial response to a gate being found open or a fence being damaged and allowing access to the site will first trigger an examination of the area in question in order to ascertain whether trespassers are in the vicinity and may have initiated the condition of the gate or fence. If trespassers are found and do not appear to impose a risk to the site personnel, they will be cordially escorted off the property and the gate will be locked. If site personnel feel that there may be a risk in confronting the trespassers, then the appropriate authorities will be contacted immediately and requested to attend to the situation. If the lock on the gate has been damaged or tampered with, it will be replaced in a timely fashion.

If the gate is found to be damaged such that in no longer prevents unauthorised personnel from accessing a site, then the same measures above will be implemented. Once the trespassers have been escorted off site or the area is deemed to not contain any trespassers, the gate will be repaired or replaced in a timely fashion to ensure it will prevent access to the site by unauthorised personnel.

If the placard of a sign has been damaged either by environmental conditions or by vandalism, or the sign post is broken such that the sign is no longer effective in relaying the information intended, then maintenance personnel should note this at the time of observation and this information should be passed on to the project manager.

5. ADDITIONAL ADAPTIVE MANAGEMENT TRIGGERS FOR BELLEKENO PRODUCTION UNIT

EBA Engineering Consultants (EBA) designed the Dry Stack Tailings Facility for Alexco. In September 2010, EBA developed the Operation, Maintenance, and Surveillance Manual (OMSM) for the Dry Stack Tailings Facility at the direction of Alexco for the Keno Hill District Mill. This manual will be referenced in response to some triggers.

5.1 High Pore Pressure Underneath DSTF

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

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

The OMSM contains an adaptive management plan which can be triggered if the tailings handling and disposition is not meeting critical performance objectives according to specific conditions. Close monitoring of the DSTF is critical in determining if and when action is required. Section 9.0 of the OMSM contains a surveillance plan that provides for adequate monitoring to determine if and when adaptive management is required.

Specific to the development of high pore pressures identified underneath the DSTF, the OMSM presents the following table that lists triggers as well as response actions:

In the event that the above triggers occur, the Alexco staff will perform one or all of the listed actions to address the identified issue.

Table 5.1High pore pressure event

Taken from Table 14 of EBA's OMSM			
Provision	**Monitored Item**	**Triggers/Threshold**	**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 semiweekly 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.

5.2 Significant Erosion of Exposed DSTF Surfaces

The OMSM presents a management plan to ensure that the DSTF is managed to create compacted tailings, to limit run-on of surface water that could cause erosion, and also a plan to operate the DSTF in adverse conditions. The OMSM plan (pgs 22-23) states:

Potentially adverse conditions must be accounted for in the operation of the DSTF. These conditions, along with mitigative measures of dealing with them, are as follows.

- High Rainfall
- Erosion control – grade control and compaction of tailings stack during construction to seal lifts and prevent pooling of water.
- Compaction – may require drying out material prior to achieving compaction. At the discretion of the Geotechnical Engineer, material requiring additional compactive effort will be moved to less critical areas of the DSTF; i.e. south portion of the placement area away from the ultimate tailings slope, if required.

- High snow accumulation
- Removal prior to lift placements.
- Snow dumps will be sited to minimize any erosional impacts during thaw conditions.
- Freezing temperatures
- Location of placement – east portion of placement area away from the ultimate tailings slope as compaction prior to freezing problematic.
- Compaction – must be completed prior to the tailings freezing.
- Tailings Characteristics (higher moisture)
- Location of placement – south portion of placement area away from the ultimate tailings slope
- Compaction – may require drying out material prior to achieving compaction. At the discretion of the Geotechnical Engineer, material requiring additional compactive effort will be moved to less critical areas of the DSTF; i.e. south portion of the placement area away from the ultimate tailings slope, if required.

The OMSM surveillance plan includes key parameters to determine if failure modes are occurring. A visual observation list includes (Section 9.3, pgs 27-28)

- Surface—cracking, bulging, depression, sinkholes
- Seepage—new seepage areas, changes in seepage areas
- Turbid water in the natural drainages around or downstream the facility
- Water or tailings flowing down the stack indicating improper grading, and
- A failure or breach of a component of the facility.

Other routine monitoring required by the OMSM plan includes:

- 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—displacement of survey monuments
- Measuring slope inclinometers located in the foundation soils
- Water sampling of Christal Creek, and
- Recording Weather conditions.

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

Specific to these conditions, EBA has developed the following table that lists triggers as well as response actions:

Table 5.2 Significant Erosion

Taken from Table 13 of EBA's OMSM			
Provision	**Monitored Item**	**Triggers/Threshold**	**Action**
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

In the event that the above triggers occur, the Alexco staff will perform one or all of the listed actions to address the identified issue.

5.3 Erosion at the Flame and Moth Discharge Site

Discharge from the Flame and Moth facility is not anticipated to occur in the near future, as the size of the stormwater runoff pond has been oversized to provide for operational flexibility. When the discharge from the facility is designed, an adaptive management approach will be developed to account for erosion from this site. Specific elements of the design will allow for flexibility to spread out the discharge such that erosion can be prevented, or discharge will be adjusted to prevent continuous saturation of soils in the area of discharge.

5.4 Transport of Sediments from Mill Facility to Christal Lake

Discharge from the Flame and Moth facility is not anticipated to occur in the near future, as the size of the stormwater runoff pond has been oversized to provide for operational flexibility. When the discharge from the facility is designed, an adaptive management approach will be developed to account for erosion from this site. Specific elements of the design will allow for flexibility to spread out the discharge such that erosion can be prevented, or discharge will be adjusted to prevent continuous saturation of soils in the area of discharge.

5.5 Large Differential Settlements at DSTF

Included in EBA's OMSM is an adaptive management plan which can be triggered if differential settlements within the DSTF surfaces occur. Close monitoring of the DSTF as outlined in Section 5.2 will be implemented to determine if and when action is required.

Specific to these conditions, EBA has developed the following table that lists triggers as well as response actions:

Table 5.3 Large Differential Settlements

Taken from Table 14 of EBA's OMSM			
Provision	**Monitored Item**	**Triggers/Threshold**	**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 semiweekly 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

In the event that the above triggers occur, the Alexco staff will perform one or all of the listed actions to address the identified issue.

5.6 Large Differential Settlements from DSTF to Stormwater Collection Pond

The development of large differential settlements along the conveyance flume from the DSTF to the Flame and Moth Site collection and sediment pond will be identified and addressed through the same actions listed in Table 5-3 above.

5.7 Exceedence of Water Quality Standard in Receiving Environment

Sitewide monitoring of the entire KHSD, and specific monitoring of the Bellekeno Production Unit is being performed in accordance with WUL QZ06-074 and WUL QZ09-092 and the plans referenced in Section 2.2.

In addition to the historic impacts of mining in the KHSD and the Bellekeno undertaking, placer mining on Lightning creek, deposition of waste in the Keno City municipal dump facility, and other non-mining activities has the potential to impact the receiving environment.

5.7.1 Descriptions

With respect to the Bellekeno undertaking, it is imperative to identify the impact of the discharges authorized under this licence with the existing discharges occurring in the KHSD and other human activities in the area. Consequently, site-wide monitoring information must be compared with water quality information collected and compiled for the Bellekeno undertaking to assess the relative impacts of these various activities.

All data for current water sample stations required in the KHSD WUL QZ06-074 and Bellekeno Mine WUL QZ09-092 and are stored in an EQWin database that allows water quality to be tracked at each site such that conditions can be identified at any point in the season. In this way parameters can be seen to be fluctuating from the normal, and reaching levels where management is required to respond. Set point triggers can be placed in the database so that response parameters are flagged for notification and action.

Comparison of all water quality information is routinely done and a variance report is generated on at least a quarterly basis for site wide information that could identify site wide trends.

5.7.2 Locations

Water quality is monitored from the Bellekeno water treatment facilities for potential effects to the receiving environment including loading of down gradient waters. These sites are shown in Figure 3-1 of the Environmental Monitoring Program in Appendix A. The district-wide AMP also identifies all other monitoring locations in the district.

5.7.3 Monitoring Requirements

All water quality information in the KHSD and the Bellekeno undertaking is analyzed for exceedences of CCME criteria, as well as variances with the previous 6 months of data at

that location, which can assist in the determination of causes of water quality changes over time. All exceedences of water quality for licenced parameters will be compared with historic exceedences.

5.7.4 Specific Thresholds

Three cases to determine if a threshold has been exceeded:

Case 1: Sites that have a CCME exceedence will be flagged for additional analysis. If there is a long trend of exceedence at that site and the exceedence is within the 95% UCL for the last two years of data at that site, then no further action will be taken and it is assumed that the district-wide closure plan implementation will be the primary mechanism to improve the water quality at that site.

Case 2: If a new exceedence is detected in either the Lightning Creek or Christal Creek drainages, which are the two drainages where the Bellekeno undertaking is authorized to deposit waste, and the mass loading from the Bellekeno undertaking is contributing less than 10% of the mass load for the constituent causing the exceedence, then no further action will be taken and it is assumed that the district-wide closure plan implementation will be the primary mechanism to improve the water quality at that site.

Case 3: If a new exceedence is detected in either the Lightning Creek or Christal Creek drainages, which are the two drainages where the Bellekeno undertaking is authorized to deposit waste, and the mass loading from the Bellekeno undertaking is contributing to greater than 10% of the mass load for the constituent causing the exceedence, then further responses will be undertaken.

5.7.5 Responses to Changes in Receiving Environment Water Quality

Potential responses to Case 3 exceedences include the following:

- Notification to the Water Inspector that the trigger has been triggered within three working days.
- Increased sampling frequency may be required around the area of the exceedence will be implemented to help determine potential causes.
- Investigation of the root cause of the exceedence.
- If a root cause of exceedence can be readily identified and remedied, the remedy will be implemented in a timely manner, and the water inspector notified of the remedy implementation in a timely manner according to permit requirements.

- If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause.

5.8 Identification of Groundwater Quality Impact at F&M or BK

The Groundwater Monitoring Plan provides data that can be utilized to assess groundwater quality impacts associated with mining and milling activities. The Groundwater Monitoring Plan identifies two areas of the Bellekeno undertaking where groundwater monitoring will be carried out.

5.8.1 Description

Groundwater in the vicinity of Keno City and the mill site flows in a north-westerly towards the Christal Creek. A network of shallow and deep groundwater monitoring wells is specified for the Flame and Moth mill site in order to determine if there are any impacts to groundwater as a result of deposition of waste authorized by the Licence and also to determine if upgradient users may be influencing groundwater which flows toward the site (i.e. the Keno City dump). The Flame and Moth site is located upgradient of Christal Creek, so understanding any impacts to groundwater as a result of the undertaking is important to help determine any risk to Christal Creek. Although groundwater flow direction has been demonstrated to flow away Keno City towards the northwest, a well in Keno City is also being monitored (See Section 5.9)

The second groundwater monitoring location specified by the Groundwater Monitoring Plan is downgradient of the proposed Non-AML Waste Rock Disposal Area along the north flank of Sourdough Hill to the west of the Bellekeno 625 adit. It is assumed that groundwater flow in this area follows surface topography and flows down slope towards Lightning Creek. Groundwater wells located below the toe of the Non-AML Waste Rock Disposal Area will be used to determine if seepage from Non-AML waste rock is having any impacts to downgradient groundwater quality, which might in turn, impact water quality in Lightning Creek.

5.8.2 Locations of Groundwater Monitoring Wells

Groundwater monitoring wells at the Flame and Moth Mill Site are shown on Figure 1 of the Groundwater Monitoring Plan. Conceptual monitoring well locations below the Non-AML Waste Rock Disposal Area are shown on Figure 2 of the Groundwater Monitoring Plan.

5.8.3 Monitoring Requirements

Monitoring requirements for groundwater monitoring are described in the Groundwater Monitoring Plan. Quarterly measurement field parameters including water level and measurement by an external laboratory of suite of standard parameters including total ICP metals, dissolved ICP metals, ammonia, phosphorous, sulphate, DOC, and hardness is specified by the Licence.

5.8.4 Thresholds

A trend based approach using a minimum of 5 data points for each monitoring well will be used to determine thresholds and triggers for adaptive management. This approach is deemed to be necessary because of the high degree of local variability in local aquifers due to mineralization.

Monthly sampling will be undertaken for each new monitoring well until a minimum of 5 data points are available to provide a baseline for each monitoring well. After these data points are collected, for each well, sampling will revert to quarterly sampling as per the groundwater monitoring plan. The trigger for adaptive management would be:

- Exceedence of the highest baseline measurement for Zn for any parameter by a factor of 2x and;
- Sample result exceeds effluent quality standard for wells located within each drainage (Table 4-1 for Lightning Creek, Table 4-2 for Christal Creek).

5.8.5 Responses

- Notification to the Water Inspector that the trigger has been triggered within three working days.
- Increased sampling frequency may be required around the area of the exceedence will be implemented to help determine potential causes.
- Investigation of the root cause of the exceedence.
- If a root cause of exceedence can be readily identified and remedied, the remedy will be implemented in a timely manner, and the water inspector notified of the remedy implementation in a timely manner according to permit requirements.
- If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause.

5.9 Water Quality Impact to Keno City Water Wells

The Groundwater Monitoring Plan provides data that can be utilized to assess groundwater quality impacts associated with mining and milling activities. In addition to addressing groundwater monitoring in the immediate vicinity of the mill site and the Bellekeno Waste Rock Disposal Area, the Groundwater Monitoring Plan identifies groundwater sampling which will be undertaken within the townsite area of Keno City.

5.9.1 Description

Groundwater in the vicinity of Keno City and the mill site flows in a north-westerly towards the Christal Creek. Although groundwater flow direction has been demonstrated to flow away Keno City towards the northwest, a well in Keno City is also being monitored (KV-84).

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 Licence in order to fulfill monitoring requirements for KV-84, but because of difficulties coordinating sampling, this is not viewed as a satisfactory solution for the duration of the Licence. Alexco, through part of the District Closure Planning, has installed several wells around Keno City for a hydrogeology study as part of a hydrogeologic study of the Keno City area. These wells have just recently been installed; the final selection for KV-84 has not yet been made. A notification will be submitted to the YWB and Water Resources in order to provide notification to regulators of the final sampling location of the Keno City well.

5.9.2 Location of Groundwater Monitoring Well

Groundwater monitoring wells in the vicinity of Keno City are shown on Figure 3 of the Groundwater Monitoring Plan, including approximate location of the final location for the monitoring well which will be used as KV-84.

5.9.3 Monitoring Requirements

Monitoring requirements for groundwater monitoring are described in the Groundwater Monitoring Plan. Quarterly measurement field parameters including water level and measurement by an external laboratory of suite of standard parameters including total ICP metals, dissolved ICP metals, ammonia, phosphorous, sulphate, DOC, and hardness is specified by the Licence.

5.9.4 Thresholds

A trend based approach using a minimum of 5 data points for the Keno City monitoring well will be used to determine thresholds and triggers for adaptive management. This approach is deemed to be necessary because of the high degree of local variability in local aquifers due to mineralization.

Monthly sampling will be undertaken for KV-84 until a minimum of 5 data points are available to provide a baseline for each monitoring well. After these data points are collected, for each well, sampling will and sampling will revert to quarterly sampling as per the groundwater monitoring plan. The trigger for adaptive management would be:

- Exceedence of the highest baseline measurement for Zn by a factor of 2x and;
- Sample result exceeds effluent quality standard (Table 4-1).

5.9.5 Responses

- Notification to the Water Inspector that the trigger has been triggered within three working days.
- Increased sampling frequency may be required around the area of the exceedence will be implemented to help determine potential causes.
- Investigation of the root cause of the exceedence.
- If a root cause of exceedence can be readily identified and remedied, the remedy will be implemented in a timely manner, and the water inspector notified of the remedy implementation in a timely manner according to permit requirements.
- If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause.

6. REVIEW OF EXISTING MONITORING AND MANAGEMENT PLANS

A review of existing monitoring and management plans was performed to identify the effects of these plans on the adaptive management framework, and to identify the commitments for adaptive management already made. The following summarizes this review:

6.1 QML and WUL Plans

1. Emergency Response Plan—No adaptive management plan elements.
2. Hazardous Materials Management Plan—No adaptive management plan elements.
3. Heritage Resources Protection Plan—No adaptive management plan elements.
4. Monitoring and Surveillance Plan—Provides monitoring information for AMP, but only summarizes site-wide AMP.
5. Noise Abatement Plan—No adaptive management plan elements.
6. Spill Contingency Plan—No AMP elements.
7. Traffic Management Plan—No AMP elements.
8. Waste Management Plan—No AMP elements.
9. Wildlife Protection Plan—No AMP elements.
10. Sludge Management Plan—No adaptive management plan elements.
11. Groundwater Monitoring Plan—Provides monitoring information for AMP, but no specific AMP commitments.
12. Tailings Characterization Plan—No adaptive management plan elements.
13. Dry Stack Tailings Facility Design Report—no adaptive management plan elements.

6.2 Physical Inspection and Reporting Plan

In section 5.2, pgs 5-6 of the Physical Inspection and Reporting Plan, the following commitments were made:

6.2.1 Inspection Checklists

Inspection checklists will be filled out on a weekly basis to ensure structural integrity of mine components and that runoff and discharge is being appropriately managed (see

Appendix I). The following rating system will be used in the field reporting to evaluate the structural integrity of the areas to be physically inspected:

- Excellent “As New” Condition.
- Good System or element is sound and performing its function; although it shows signs of use and may require some minor repairs, mostly routine.
- Fair System or element is still performing adequately at this time, but needs “priority” and/or “routine” repair to prevent future deterioration and to restore it to good condition. A fair rating will be reported to site manager after the inspection.
- Poor System or element cannot be relied upon to continue to perform its original function without “immediate” and/or “priority” repairs. A poor rating will be reported to site manager after the inspection. The site manager will then be responsible to immediately re-ascertain whether or not the system or element is safe for use for the next 24 hours.

If issues are identified during the weekly inspections of structures, works and installations (e.g. waste rock storage area, overburden stockpiles, embankments, diversion ditches, sediment ponds, and pipelines) 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 also need to be implemented as required. If fair or poor conditions are noted during an inspection, NND will be notified of the details and of any planned mitigative action.

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.

6.3 Bellekeno 625 Water Treatment Systems Operations Manual

In Section 8 of the Water Treatment Systems Operations Manual, the following selection identifies the contingency plans and system flexibility associated with the treatment operation.

6.3.1 Future Improvements

One of the challenging aspects of processing water from inflows to the Bellekeno underground mine is that TSS and ammonia / ammonium spikes in the discharged water can occur based on variable underground conditions.

To address these issues, AKHMC is currently researching additional modifications to improve the water treatment system's responsiveness and flexibility to address potential spikes in detrimental water quality parameters. An example of these improvements is a pilot study evaluating the use of an inorganic resin specifically designed to remove ammonia / ammonium from water.

6.3.2 Ion Exchange System – Ammonia Reduction Pilot Study

In October 2010, AKHMC placed a portable treatment system at the Bellekeno 625 consisting of a small shed near the sea containers containing two tanks filled with an inorganic resin and gravel. These tanks were plumbed for water to flow between the tanks in series before final discharge back into the pond. This system is similar to the MMF system except that instead of a multi-layered media bed used to capture fine solids, the media bed is replaced with an ion exchange resin that preferentially removes ammonium, potassium, and cesium. Like the MMF system, water enters at the top of a tank and then flows downward through the resin. As water passes through this resin, ions (especially ammonium) are sorbed onto the resin thereby removing them from the water.

Once the resin has been in service for a certain amount of time (typically a few days), breakthrough can occur where the resin becomes saturated and ammonium ions are no longer collected. When this happens, the ion exchange system must complete a regeneration cycle during which all filtration is suspended and a brine consisting of 10% sodium chloride in water is pumped into the resin tank being regenerated.

This brine must contact the resin for a minimum of 30 minutes in order to desorb the ammonium that has sorbed onto the resin, thereby recharging the resin for future use. Once the brine solution has contacted the resin for the required time, it is pumped from the ion exchange tanks into a large holding tank and the system can be used again for treatment. The brine holding tank requires the addition of small amounts of sodium hydroxide as well as injected air that is bubbled through the solution. This injected air removes the collected ammonium through the process of off-gassing and recharges the brine for future use.

To date, the results of the ion exchange pilot study have been promising and a final report summarizing the results of this pilot study will be prepared once the pilot study has been completed. AHKMC may implement this system in the future if the performance of the resin in the pilot study is effective.

6.3.3 Clarifier

AKHMC is also considering the addition of a clarifier at the Bellekeno 625 water treatment facility. Clarifiers are currently in use at other adits within the Keno Hill Silver District that require active treatment and to date they have been very successful. Water passing through a clarifier is typically processed with the following steps:

Static Mixing- Chemicals (polymer and lime solution) may be added upstream of a static mixer, after which water flows into the flocculation tank.

Flocculation – The water passes sequentially through a two stage mechanical flocculator. Variable-speed drives on each paddle permit a wide variation in energy input and allow tapered flocculation to optimize floc formation.

Settling - The settling clarifiers currently under consideration are an up-flow solids contact unit complete with 60° settling tubes. The flow enters the bottom of the settler through a full length distribution manifold, and then passes upward as laminar flow. Heavier floc particles settle to the floor of the tank and lighter particles are retained within the tube settlers, coalesce into larger floc, and then settle to the floor. Clarified water is collected from the surface of the tank through two, full length collection launders. The tube settlers are fabricated out of light resistant polystyrene. The tube cell size and angle ensure self cleaning under normal operation. A sludge blanket is maintained in the lower portion of the clarifier and its position can be monitored through sampling valves installed in the cell wall. The lower portion of the tank has a sloped, "V" section to encourage sludge thickening and collection in the central hopper. Periodically, this sludge must be removed hydraulically through a full length, perforated sludge collector located at the foot of the "V". The desludging operation may be controlled automatically by timer controlled operation of an actuated valve programmed into the plant Process Logic Controller (PLC).

It is this formation of heavier floc particles and coalescence of lighter flocs into larger heavier flocs described above, that differentiates the clarifier from an open pond. Although additional retention time in ponds would provide increased settling, the mechanics of floc formation do not occur in an open pond as efficiently as the clarification provided in the tube settlers of a clarifier. It is for this reason that the installation of a clarifier at Bellekeno 625 is under consideration.

6.3.4 Organic Polymer

In the future, ERDC may consider the addition of an organic polymer at the rapid mix tank to aid in flocculation. The polymer would be injected after the pH has been adjusted with the expectation that it would attach to the metal hydroxide particles and

improve settling. When the polymer is added, the hydroxide particles become entangled in the long chains of the polymer, causing the particles to increase in size and form flocs. As the flocs increase in size they become heavier and settle more quickly to the bottom of the pond. This floc formation is illustrated in the figure 6-1 below (University of Maryland, Engineering Research Center Report):

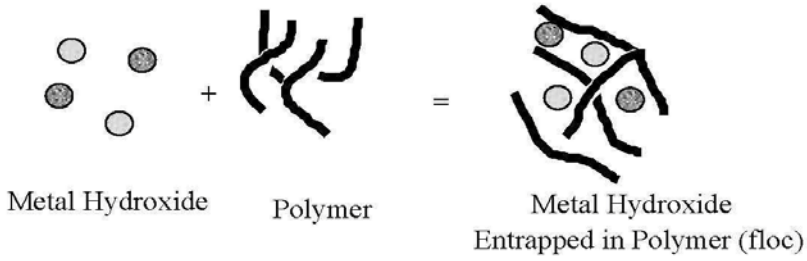

Figure 6-1. Floc Formation

If an organic polymer is used in the future, it would be stored in the treatment shed and added into the rapid mix tank via a small metering pump.

6.4 Water Management Plan and Water Balance Report

The water management plan and water balance report provides the following with respect to adaptive management of the Bellekeno Mine. Quote from Water Management Plan and Water Balance Report, pgs. 23-25:

Contingency Plans

Contingency plans for flood or drought conditions have been considered to ensure unexpected climatic conditions do not adversely affect mine/mill operations or result in significant environmental impact.

6.4.1 Drought Conditions

The current make-up water requirements at the mill are approximately 30,000 liters/day (0.35 L/s). This makeup water requirement is less than 5% of the combined flow emanating from Galkeno 900 and Bellekeno 625. The makeup water requirements at the mill also represent a very small portion of the Christal Creek drainage which has its headwaters near the mill site location. Given the relatively small volume of make-up water compared to current source levels, a reduction in make-up water available for mill operations due to a drought condition does not represent a concern from an

operational standpoint and therefore no unique contingency plans are in place for a drought scenario.

The Bellekeno Mine produces excess water that must be collected and treated. Although the Bellekeno Mine produces approximately 4 L/s of constant discharge, only about 50% of the mine recharge volume is required for mine development and operations (equipment, paste backfill). The amount of water required to sustain mine operations is a small portion (1-2%) of the flow at Lightning Creek where mine makeup water is currently permitted for withdrawal. Similar to the mill makeup water requirements, a drought scenario does not represent a current operational concern for the Bellekeno Mine and a contingency plan is currently not in effect.

6.4.2 Flood Conditions

High flow or flood conditions at the mill do not necessarily pose an extreme case from an operational perspective as the mill site water management design already incorporates ditching and pond volumes based on extreme precipitation events (design capacity in excess of 1:100 year event). In addition, the mill site location is situated with a very small, headwater drainage basin (<3 km^2), effectively minimizing the potential for flooding conditions. In the case of a flood event, active milling operations may be temporarily suspended to ensure operations personnel and equipment are appropriately allocated to managing and maintaining ditches and conveyance structures until the peak flows have decreased to normal levels.

6.4.3 High Mine Inflow Conditions

Contingency and response plans for high or unexpected underground mine flows fall under the protocols of the company's emergency response plan.

The first priority in a high mine inflow condition is the safety and protection of the employees and contractors working underground at Bellekeno. If the water in-rush was of a nature that required immediate evacuation, the specific protocols for mine evacuation would be initiated by the Mine Manager or his designate (Section 8, Keno Hill Emergency Response Plan).

Once the safety of underground employees and contractors have been established, the nature of the water in-rush would be immediately investigated by the General Manager or his designate. Securing underground facilities and infrastructure would become the next priority after employee safety. Depending on the nature and level of the mine flow in-rush or high flow condition, a determination would be made if mobile equipment needed to be removed from certain levels and locations in the mine and brought to surface or to the central decline. Electrical utilities and infrastructure would be assessed

to determine if areas of the mine needed to be isolated or removed from electrical power distribution.

The cause and extent of the high mine water flow condition would then be assessed by the General Manager, Mine Manager and other specialist positions on the site (i.e. Chief Engineer) to determine if the extent of the high mine flow was expected to continue or if flow conditions are expected to recede. Based on the level of high mine flow, the rate of dewatering would be increased to the maximum levels permitted in order to reduce the volume of mine pool. Standby pumps would be established if necessary to increase the volume of water being pumped from the underground mine. The Bellekeno 625 water treatment plant is permitted and capable of treating 10 L/s which is approximately double the current steady state flow conditions of the Bellekeno Mine. If the volume required for dewatering were to exceed permitted levels or if the Bellekeno 625 water treatment plant was not meeting discharge standards due to high sustained flows, the appropriate regulatory agencies would be contacted and consulted. If necessary, consideration would be given to applying for an Emergency Amendment under QZ09-092 to manage the high inflow conditions if all other measures were not effective.

6.5 Groundwater Monitoring Plan

Section 7, page 17 states the following:

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 44, 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 Fire Hall well have been sampled since issuance of the Licence in order to fulfill monitoring requirements for KV-84, but because of difficulties coordinating sampling, this is not viewed as a satisfactory solution for the duration of the Licence.

Alexco, through part of the District Closure Planning, is currently planning installation of several wells around Keno City for a hydrogeology study as part of a hydrogeologic study of the Keno City area. It is anticipated that this work will be carried out during February 2011, and that once installed, one of these wells will be selected for reporting for KV-84. A notification will be submitted to the YWB and Water Resources in order to provide notification to regulators of the final sampling location of the Keno City well.