KGHM AJAX MINE INC.



DAM SAFETY REVIEW
AFTON TAILINGS STORAGE FACILITY

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KGHM AJAX MINE INC.

DAM SAFETY REVIEW
AFTON TAILINGS STORAGE FACILITY
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1 – INTRODUCTION

1.1 FACILITY DESCRIPTION

The Afton Tailings Storage Facility (TSF) is located approximately 12 km west of the City of Kamloops as shown on Figure 1.1.

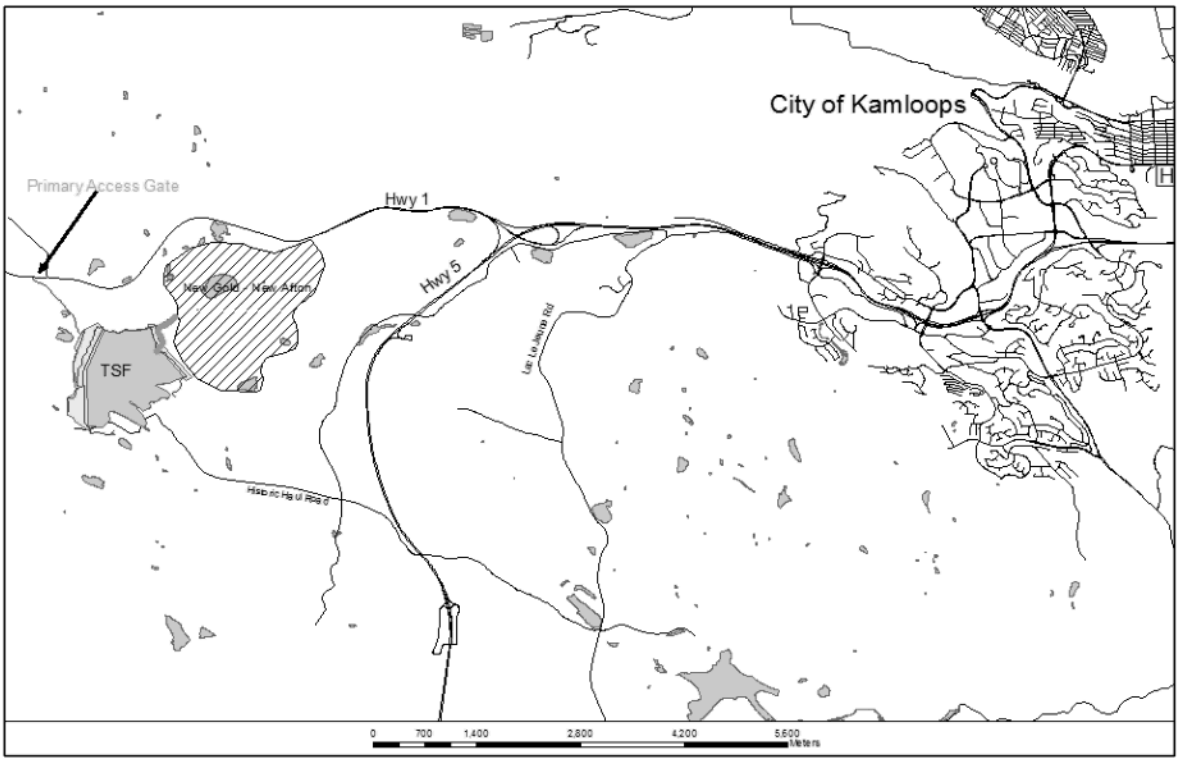

Figure 1.1 Afton TSF Location Map

The TSF was constructed in 1976/77 and was in operation until 1997. The TSF has been under care and maintenance since 1997. The current owner of the TSF is KGHM Ajax Mine, Inc.(KGHM) . The TSF consists of the following components:

- Two zoned earthfill/rockfill dams with engineered filters. The two dams are referred to as the West and East Dams.
- Two seepage collection ponds, the northwest and southwest seepage collection ponds, located downstream of the West Dam.
- An overflow spillway located at the north end of the East Dam.
- Diversion structures located south of the TSF to divert Alkali Creek to Cherry Creek, downstream of the TSF.

The general arrangement of the Afton TSF is shown on Figure 1.2.

Figure 1.2 Afton TSF – General Arrangement

The zoned dams were progressively raised using the downstream construction method during operations. The TSF dams were constructed to an approximate crest elevation of 706 m; the final height of the West Dam, the larger of the two dams, is approximately 75 m. The TSF was not constructed to its ultimate design elevation; however, the West Dam downstream rockfill zone was constructed to the ultimate width associated with the final dam height. This resulted in a wide dam, with a crest width in the order of 100 m wide at the current crest elevation of 706 m. The East Dam is buttressed by a waste dump on the downstream side. The crest length of the West Dam is approximately 1,300 m, and the crest length of the East Dam is approximately 860 m.

1.2 SCOPE OF DAM SAFETY REVIEW

This document presents the results of the Dam Safety Review (DSR) carried out by Knight Piésold Ltd. It has been completed in accordance with the "Dam Safety Guidelines" of the Canadian Dam Association (CDA), 2007. The DSR scope of work includes:

- Review of the existing Dam Classification (Consequence Classification) for the facility
- Review of available information, including instrumentation records and previous DSRs
- A site inspection
- Review of the dam performance, stability and operational safety
- Identification of potential deficiencies relating to dam safety
- Review of instrumentation monitoring
- Review of the Operation, Maintenance and Surveillance (OMS) manual, and
- Review of the Emergency Preparedness Plan (EPP) and Emergency Response Plan

The 2013 DSR is the third DSR for the Afton TSF. Previous DSRs were completed in 2004 and 2009. The 2009 DSR concluded the dams were in good condition with few deficiencies identified in the report. It is not the intent to duplicate the findings of the previous DSRs in this report. The 2013 DSR is therefore an audit of the previous DSR, including a review of the detailed stability assessment completed in 2011. The 2013 DSR also includes a review of the downstream conditions and the TSF dam classifications.

1.3 SITE INSPECTION

An inspection of the TSF was carried out on July 9, 2013 by Les Galbraith P.Eng. and Graham Greenaway P.Eng. of Knight Piésold Ltd. The weather was sunny and clear throughout the day. No water was discharging through the overflow spillway at the time of the inspection.

The TSF, spillway, seepage collection ponds at the West Dam, and the Alkali Creek diversion system were inspected during the site visit. Details and findings of the site inspection are included in Section 3 of this report. Photographs taken during the site inspection are included as Appendix A.

1.4 REVIEW OF 2009 DAM SAFETY REVIEW

The 2013 DSR includes a review of the deficiencies and recommendations identified in the 2009 DSR, review of the downstream conditions, and review of the dam classifications. Recommendations from the previous DSR completed in 2009 included the following:

- Upgrade the Alkali Creek diversion system at the south end of the TSF to pass flows of 5 m^3/s, or review the pond elevation during routing of the Inflow Design Flood (IDF) assuming the diversion system is not able to pass the full 5 m^3/s. The IDF was estimated to be 182 m^3/s, and the design TSF spillway outflow capacity was 177 m^3/s.
- Install the training berms called for the initial spillway design to direct spillway flows to the New Gold pit. It was also recommended this be discussed with New Gold to evaluate the potential safety risks associated with this concept as New Gold further develops the resource using underground mining techniques in this area.
- Complete additional seismic stability analyses using higher seismic coefficients to be consistent with the CDA guidelines.
- Update and test the Emergency Preparedness Plan (EPP).
- Define trigger levels for the piezometers.
- Clear the sediment and vegetation blocking the plywood gate which is attached to the culvert inlet at the northwest seepage dam. Remove the plywood gate during a flood event.

The 2009 DSR comments are discussed in the body of the report.

1.5 REFERENCE DOCUMENTS

The following documents were provided by KGHM as part of the DSR:

- BGC, 2004, Dam Safety Review- East and West Dams, March 12, 2004
- BGC, 2009, Dam Safety Review - East and West Dams. Afton Mine, Kamloops. B.C. Final, Report, May 11, 2011
- Golder Associates, Annual Dam Inspection, September 1, 2011, and
- Klohn Crippen Berger, Afton tailings Impoundment, Seismic Hazard and Seismic Stability Assessment, May 27, 2011.

The following additional documents are also referenced in this report.

- Canadian Dam Association, 2007. Dam Safety Guidelines
- Canadian Dam Association, 2007. Dam Safety Guidelines. 2013 Revision
- Knight Piésold 2013a, Reduced Afton TSF Spillway Capacity Caused by Culverts, October 7, 2013, and
- Knight Piésold 2013b, Southeast Seepage Dam Repair, Construction Quality Assurance Report, November 21, 2013.

2 – DAM CLASSIFICATION

2.1 GENERAL

The dam classification for the West and East Dams has been reviewed by considering the potential incremental consequences of failure. The incremental consequences of failure are defined by the CDA guidelines as "*the total damage from an event with dam failure minus the damage that would have resulted from the same event had the dam not failed*." The consequences of failure considered potential loss of life, environmental and cultural impacts and losses, and economic loss. The dam classification scheme defined in the CDA guidelines considers five consequence classifications (Low, Significant, High, Very High and Extreme) and is reproduced in Table 2.1.

Table 2.1 Dam Classification (Reproduced from CDA "Dam Safety Guidelines," 2007)

Dam Class	Population at Risk[1]	Incremental Losses		
		Loss of Life[2]	Environmental and Cultural Values	Infrastructure and Economics
Low	None	Zero	Minimal short-term loss No long-term loss	Low economic losses; area contains limited infrastructure or services
Significant	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities; seasonal workplaces, and infrequently used for transportation services
High	Permanent	10 or fewer	Significant loss or deterioration of *important* fish or wildlife habitat Restoration or compensation in kind highly possible	High economic losses affecting infrastructure, public transportation, and commercial facilities
Very High	Permanent	100 or fewer	Significant loss or deterioration of *critical* fish or wildlife habitat Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances)
Extreme	Permanent	More than 100	Major loss of critical fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances)

NOTES:

1. Definitions for population risk:
   None - there is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.
   Temporary - people are only temporarily in the dam-breach inundation zone (e.g. Seasonal cottage use, passing through on transportation routes, participating in recreational activities).
   Permanent - the population at risk is ordinarily located in the dam-breach inundation zone (e.g. as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).
2. Implications for loss of life:
   Unspecified - the appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

2.2 DAM CLASSIFICATION

The dam classification defines the design parameters for the IDF and the Earthquake Design Ground Motion (EDGM). The dam classification also defines the frequency of inspections and DSRs. The West Dam and East Dam for the Afton TSF currently have different dam classifications. The West Dam has an "EXTREME" classification based on the 2007 CDA guidelines, and the East Dam has a "HIGH" classification.

The West Dam was given a higher classification due to the presence of a trailer park downstream of the dam that may be impacted by a hypothetical failure of the West Dam. The trailer park, located about 1.4 km downstream of the West Dam, was considered to have approximately 50 dwellings (BGC 2009). It is not known if a dam breach would inundate the trailer park; however, the 2009 classification conservatively assumed up to 150 fatalities could occur in the event of a failure of the West Dam (assuming three persons per residence). This resulted in an EXTREME classification based on the loss of life category. Although it is possible Highway 1 (Okanagan Highway) could be impacted from a catastrophic failure of the West Dam, this would only result in a VERY HIGH classification. Consequently, the classification of the West Dam was governed by the potential loss of life category, resulting in an "EXTREME" classification.

The East Dam currently has a HIGH classification. There is no permanent population at risk downstream of the East Dam and it was assumed the downstream New Gold pit would collect water and tailings in the event of a dam breach. However, the downstream conditions at the East Dam have changed since the 2009 DSR as New Gold is currently engaging in underground, block caving mining activities with the portal and decline located near the bottom of the New Gold pit. The 2009 DSR indicated there was a chance that water and/or debris could reach Highway 1 in the event of a failure of the East Damwhich would result in a dam classification of VERY HIGH. It is therefore recommended the classification of the East Dam be re-evaluated with this in mind.

2.3 DESIGN EARTHQUAKE

The CDA guidelines require a dam be designed to safely withstand the design earthquake without uncontrolled release of the reservoir. Suggested values for the EDGM are provided by the CDA guidelines and are based on the classification of the dam. The EDGM for dams with HIGH and EXTREME classifications corresponds to probabilistically derived events having an annual exceedance probability (AEP) of 1/2,475 for the HIGH classification and 1/10,000 for the EXTREME classification, as shown by Table 2.2.

Table 2.2 Suggested Design Flood and Earthquake Levels (CDA 2013)

Dam Class[1]	Annual Exceedance Probability (AEP)	
	Inflow Design Flood (IDF)[2]	Earthquake Design Ground Motion (EDGM)[3]
Low	1/100	1/100
Significant	Between 1/100 and 1/1000 [note 4]	Between 1/100 and 1/1000
High	1/3 between 1/1000 and PMF [note 5]	1/2475 [note 6]
Very High	2/3 between 1/1000 and PMF [note 5]	1/2 between 1/2475 [note 6] and 1/10,000 or MCE [note 5]
Extreme	PMF [note 5]	1/10,000 or MCE [note 5]

NOTES:

- This table addresses two major natural hazards only, and does not consider the many other types of hazard that must be considered in dam safety assessments.
- Acronyms: PMF, probable maximum flood; AEP, annual exceedance probability; MCE, maximum credible earthquake

1. As defined in Table 2-1, Dam Classification (Section 2.5.4).
2. Simple extrapolation of flood statistics beyond 10-3 AEP is not acceptable.
3. Mean values of the estimated range in AEP levels for earthquakes should be used. Note 4. Selected on basis of incremental flood analysis, exposure, and consequences of failure.
5. The Probable Maximum Flood (PMF) and Maximum Design Earthquake (MCE) have no associated AEP.
6. This level has been selected for consistency with seismic design levels given in the National Building Code of Canada.

A site-specific seismic hazard assessment was carried out by Klohn Crippen Berger (KCB) in May 2011 to provide seismic ground motion parameters for the Afton TSF. The EDGMs were defined as peak ground accelerations of 0.20g for the East Dam and 0.34g for the West Dam, based on the different dam classifications. The KCB study also indicated a design earthquake magnitude of 7.3 was appropriate for the 2,475 and 10,000 year events.

Increasing the classification of the East Dam will increase the EDGM for this dam. This will likely have no impact on the stability of the East Dam as it is buttressed by a waste dump.

It is important to note that the CDA dam classifications are currently being re-evaluated with respect to the classification of tailings dams during the closure phase tailings dams have a very long design lives, which increases the likelihood of the tailings dams being subjected to extreme events. Consequently, the return periods for the IDF and EDGM for the different dam classifications are likely to be higher for the East Dam during the closure phase than those presented in Table 2.2.

2.4 INFLOW DESIGN FLOOD

The CDA guidelines require an evaluation be made of the ability of the dam to contain or pass the IDF without an uncontrolled release of the reservoir. This evaluation is made in terms of the discharge capacity and freeboard of a facility. Selection of an appropriate IDF is required to carry out a safety assessment of the dam and to determine storm storage requirements. The size of the IDF is dependent on the dam classification, as shown in Table 2.2. An appropriate IDF, based on the EXTREME dam classification, is the Probable Maximum Flood (PMF).

3 – TSF DAMS

3.1 GENERAL

The performance of the TSF dams was assessed using the observations and information provided by the visual inspection of the condition of the dams. Previous DSRs and inspections of the TSF were also reviewed to assess whether there have been any changes to the facility.

A visual inspection of the dams was made by walking along the crest, downstream slopes and abutments during the site visit of July 9, 2013. No signs of distress were identified on the dams. The dam slopes were approximately planar and there was no evidence of cracking, bulging or slumping in the fill materials. The dam crests appeared to be relatively level with no signs of differential settlement or distress. There was no evidence of animal burrowing. No evidence of seepage through the dams was observed during the site inspection. The downstream slope of the West Dam has been re-vegetated (Photo 1). There are a few small erosion gullies on the downstream slope of the West Dam (Photo 2). The West Dam is very wide as previously discussed and the erosion gullies are not a dam safety concern.

The tailings pond elevation was approximately 699.5 m at the time of the inspection, approximately 6 m below the crest of the dams. The area of the TSF was approximately 15 ha (Photo 3). The tailings beach has been re-vegetated in the vicinity of the East Dam (Photo 4).

Windblown dust was observed from the tailings beach during the inspection (Photo 5). Potential environmental impacts from fugitive dust are beyond the scope of this DSR.

The overall condition of the dams was found to be in satisfactory condition.

3.2 DAM STABILITY

A detailed seismic hazard and stability assessment of the TSF was completed by KCB in 2011. The stability assessment was completed in response to a recommendation from the 2009 DSR that additional seismic stability analyses be completed using higher seismic coefficients than previously used in the stability assessment to be consistent with the EXTREME classification of the dam. The 2009 DSR recommended ground motions with an annual exceedance probability of 1/10,000 be considered for the EDGM for the Afton TSF.

The 2011 stability assessment included a review of the seismic hazard and development of site specific ground motion parameters consistent with the dam classification. The seismic stability assessment was completed for the 1/10,000 year event with a peak ground acceleration (PGA) value of 0.34g and a corresponding earthquake magnitude of 7.3.

The stability assessment was also completed for the maximum section of the West Dam as the East Dam is buttressed by a waste dump, has similar foundation materials (generally consisting of dense glacial till deposits) and also has a lower EDGM due to the lower dam classification. The West Dam was therefore considered to be the critical section for the entire TSF. The section of the West Dam used in the stability analyses is included in Appendix B. The section illustrates the crest width of the dam which was overbuilt at the current elevation to facilitate construction of the upper section of the dam. The conclusions from the stability assessment were:

- The foundation soils were found to be unsusceptible to liquefaction
- The dam meet factor of safety targets for slope stability under static and seismic loading, and
- The predicted seismic deformation is within acceptable limits.

The East Dam was not analyzed for the reasons mentioned above. It is recommended a stability assessment be completed for the East Dam. It is also recommended that East Dam stability analyses consider EDGMs consistent with the 1/10,000 year event (same as the West Dam) as the CDA criteria which are currently being evaluated and modified for tailings dam closure conditions are likely to be in this order. The East Dam is buttressed by a waste dump and increasing the EDGM will likely have no impact on the stability of this dam.

3.3 INSTRUMENTATION

There are currently two piezometers located at the West Dam. The piezometers were read in March 2011 and the measured water levers were used to estimate the phreatic surface for the 2011 stability assessment. It is recommended the existing piezometers be located and read as per the frequency stated in the OMS manual. It is also recommended the OMS manual include trigger elevations for all piezometers. Consideration should also be given to installing additional piezometers in both dams, including the foundation materials, to provide sufficient information to properly assess the performance of the dams.

Surface monitors have been installed on the crest East Dam and buttressing waste dump by New Gold to evaluate whether the block caving is in any way impacting the performance of the East Dam (photo 6). Monitoring records from New Gold were not available for the DSR.

3.4 EMERGENCY PREPAREDNESS PLAN AND OPERATIONS, MAINTENANCE AND SURVEILLANCE

The Emergency Preparedness Plan (EPP) document, which includes Operations, Maintenance and Surveillance (OMS), was prepared and updated by KGHM in 2013. The document includes the following:

- Plan distribution and revision control
- Emergency contact information, including a response support contact list
- An Emergency Response Plan (ERP)
- Facility information
- OMS
- Hazard analysis of operation
- Conditions and responses, and
- Emergency stand down and follow-up procedures.

Additional information to be included in the EPP/OMS includes establishing trigger levels for the piezometers and developing and including an inundation map to show the potential impacted area in the event of a dam breach.

It is very important to keep this document up to date, especially when referencing specific individuals who may who may be contacted in the event of an emergency conditions at the TSF.

4 – DISCHARGE FACILITIES

4.1 GENERAL

The TSF has a spillway located at the East Dam. Stormwater flows passing through the spillway would discharge onto the New Gold property; the lower section of the spillway is also located on New Gold property. The spillway was designed to pass the PMF flow, which was estimated at 182 m^3/s. Knight Piésold reviewed the PMF value in 2013 and indicated the estimate of 182 m^3/s was generally appropriate for the large upstream catchment area.

A section of the spillway (approximately 300m downstream of the spillway inlet) was modified by New Gold in 2011, at which time five 2.7 m diameter culverts were installed to provide an overpass for vehicles and pipelines (Photo 7). The culvert installation reduced the spillway flow capacity at this location to approximately 78 m^3/s (Knight Piésold 2013a). However, the road across the culverts is at a lower elevation than the spillway invert elevation at the East Dam. The objective of the spillway is to provide a controlled release of stormwater from the TSF to prevent overtopping of the dams. The spillway modification does not reduce the efficacy of the spillway as the flows would overtop the road at the culverts before backing up into the TSF.

An identified deficiency/recommendation from the 2009 DSR was to upgrade the Alkali diversion system to pass flows of 5 m^3/s, or review the TSF pond elevation during routing of the IDF assuming the Alkali diversion system is not able to pass the full 5 m^3/s. The IDF was estimated to be 182 m^3/s, and the design TSF spillway outflow capacity was 177 m^3/s.

It is standard engineering practice to assume the failure of upstream diversion systems during extreme storm events when sizing critical dam safety components, such as emergency overflow spillways. The design of the spillway should have considered flows from the entire upstream catchment, estimated at 182 m^3/s. The key to this evaluation is the level of accuracy in defining PMF volumes and peak flows through the system. Estimated flood values are likely accurate to within 10-20%. The addition of 5 m^3/s from the Alkali Creek diversion system is therefore within the level of accuracy of the PMF estimate and spillway outflow capacity.

The 2009 DSR also recommended the training berms called for in the original design of the spillway be constructed. The apparent concept behind the training berms was to provide a means to direct flow or debris to the New Gold pit, but it is not understood if this was for flood conditions with water flowing through the spillway, or dam breach conditions. Exclusion of the training berms does not impact the safety of the TSF as their installation would not constrict flows through the spillway but rather redirect the flows to the New Gold pit. It is important to note that the lower section of the spillway is on New Gold property and any modifications to the spillway should be communicated with New Gold if it increases the likelihood of water entering their underground workings.

4.2 WEST DAM SEEPAGE PONDS

There are currently two seepage dams located downstream of the West Dam. These are referred to as the Northwest Seepage Dam and the Southwest Seepage Dam. The location of the dams is shown on Figure 4.1.

Figure 4.1 TSF Seepage Dams and Diversion Channel

The southwest seepage dam is a small dam located downstream of the southern end of the TSF West Dam. The southwest seepage dam has a very small upstream catchment and primarily collects surface runoff from the downstream face of the Afton TSF West Dam; the ponded area upstream of the dam is typically dry. The dam overtopped in May, 2011 following a storm event and subsequent failure of the upslope Alkali diversion channel which diverts surface flows from an upstream catchment area of approximately 53 km^2. This resulted in the erosion of a portion of the dam downstream slope (photo 8).

KGHM contracted Dawson Construction, a local contractor, to complete the repair work in October 2013. KGHM also contracted KP to provide construction Quality Assurance and to document the work. The dam was repaired (photo 9) and a construction quality assurance report was issued to KGHM (Knight Piésold 2013b).

The northwest seepage dam is a small dam located downstream of the northern section of the TSF West Dam. Unlike the southwest seepage dam, the northwest seepage dam ponds water throughout the year. The outlet of the northwest seepage dam is a culvert on the left side of the dam, however, the culvert inlet is blocked with sediment and vegetation, and has a piece of plywood nailed to the inlet to block any flow (photo 10). The plywood was apparently installed to prevent discharge of water downstream that may have not been of discharge quality. Water collecting in the pond is pumped into the TSF.

A recommendation from the 2009 DSR was to clean up the inlet such that the plywood barrier could be removed during a flood event. Removing the plywood barrier during a flood event may be difficult

(it is bolted on) and it is recommended KGHM explore alternative plans to safely pass flood events from the northwest seepage pond during storm events.

4.3 ALKALI DIVERSION SYSTEM

The Alkali diversion channel is located on the south side of the TSF and diverts flows from Alkali Creek downstream of the southeast seepage dam into Cherry Creek. The diversion channel is undercut in places (photo 11) and there is a risk the side slopes will slough into the channel during a high flow event in the channel as occurred in 2011. It is recommended the Alkali diversion channel be refurbished to safely pass the design flow. KGHM has plans to upgrade the Alkali diversion channel in spring of 2014. A hydrologic study and channel design have been completed for this work by Knight Piésold.

5 – CONCLUSIONS AND RECOMMENDATIONS

This 2013 DSR is the third DSR completed for the Afton TSF. This DSR is therefore an audit of the previous DSR, including a review of the detailed stability assessment completed in 2011. A site inspection was completed on July 9 by Graham Greenaway and Les Galbraith of Knight Piésold. The TSF was found to be in good condition with no major deficiencies noted. Table 5.1 provides a summary of DSR requirements and the findings of this DSR with regard to these requirements.

Significant findings and conclusions of the 2013 DSR include the following:

1. The dam classification for the East Dam is currently HIGH. The previous 2009 DSR indicated there is a chance that water and/or debris could reach Highway 1 in the event of a failure of the East Dam. This would result in an increase in the classification of the East Dam to at least VERY HIGH. It is recommended the classification be reviewed.
   The stability analyses completed in 2011 was completed for the West Dam only as it was considered to be the critical section for the TSF. One of the reasons for this was the EDGM for the East Dam was lower as it had a HIGH classification as compared to the EXTREME classification of the West Dam. It is recommended a stability analyses be completed for the East Dam and the EDGM associated with the 1/10,000 year event be adopted for the analyses, regardless of the dam classification, to be consistent with upcoming modifications to the CDA guidelines for tailings dams under closure conditions. The East Dam is buttressed by a waste dump and increasing the EDGM will likely have no impact on the dam stability.
2. Continue to monitor the surface monuments at the East Dam and develop a response plan should there be any impact to the East Dam resulting from the New Gold block caving mining operation.
3. Establish trigger levels for the piezometers.
4. There are currently only two piezometers installed in the dams, with both being located at the West Dam. It is recommended KGHM develop a plan to install additional piezometers in both dams to allow for ongoing monitoring of embankment fill and foundation pore pressures. Include the instrumentation monitoring schedule in the OMS manual.
5. The plywood gate blocking the outlet pipe for the northwest seepage dam should be cleared of debris and vegetation so that it can be removed in short-notice to release water downstream of the dam to prevent overtopping.
6. The section of the Alkali diversion channel to the west of the TSF is in need of repair as it has eroded down to bedrock in places and has over steepened side slopes. There is a risk the side slopes will slough into the ditch during a high flow event. This occurred in 2011 and the resultant discharge overtopped and eroded a section of the southeast seepage pond.
7. Keep the EPP and OMS up to date.
8. Develop an inundation map showing the potential impacted downstream areas in the event of a dam breach. Include inundation map in the EPP/OMS.

The CDA Dam Safety Guidelines recommend that a DSR be conducted every 5 years for an EXTREME Dam Classification (Consequence Classification). Therefore, it is recommended that the next DSR be carried out in 2018.

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TABLE 5.1

KGHM AJAX MINING INC.
DAM SAFETY REVIEW
AFTON TAILINGS STORAGE FACILITY

SUMMARY OF DAM SAFETY REVIEW REQUIREMENTS AND FINDINGS

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CDA Section	Title and Brief Description of Requirement	Meets CDA	Insufficient Information	Fails CDA	Remarks
1.0	**GENERAL**				
1.1	**Responsibility for Dam Safety**				
	Clearly defined responsibility for dam safety	X			
1.2	**Dam Classification (Consequence Classification)**				
	The West Dam shall be classified by consideration of the consequences of failure.	X			The West Dam has an EXTREME dam classification
	The East Dam shall be classified by consideration of the consequences of failure.	X			The East Dam currently has a HIGH dam classification
1.3	**Design Earthquake (EDGM)**				
	Selection of the EDGM based on Dam Classification.	X			
	Dam shall withstand EDGM without release of reservoir.	X			
1.4	**Design Flood (IDF)**				
	Selection of the IDF based on Dam Classification.	X			IDF based on EXTREME dam classification
	Dam shall safely pass the IDF without release of the reservoir.	X			
	Confirm adequacy of the existing statistical flood analysis.	X			
2.0	**DAM SAFETY REVIEW**				
2.1	**General**				
	Dam Safety Reviews (DSR's) shall be performed regularly.	X			Previous DSR completed in 2009.
2.2	**Details of Review**				
2.2.1	**Dam Classification**				
	The DSR shall include review of Dam Classification (Consequence Classification)	X			Recommendation to review the Dam Classification for the East Dam
2.2.2	**Site Inspection**				
	The DSR shall include an appropriate site inspection.	X			Conducted July 9th, 2013.
2.2.3	**Design and Construction**				
	Design and Construction shall meet current standards.	X			
2.2.4	**Operation and Testing**				
	The dam operation shall be reviewed.	X			Operation procedures in updated EPP and OMS manual
2.2.5	**Maintenance**				
	Maintenance procedures shall be reviewed	X			Maintenance procedures in updated EPP and OMS manual
2.2.6	**Surveillance and Monitoring of Dam Performance**				
	Surveillance and Monitoring shall be reviewed.	X			Surveillance or monitoring procedures updated in EPP and OMS manual.
2.2.7	**Emergency Preparedness**				
	The emergency preparedness shall be reviewed.	X			
2.2.8	**Compliance with Previous Reviews**				
	Previous dam safety reports shall be reviewed	X			
3.0	**OPERATION, MAINTENANCE AND SURVEILLANCE**				
3.1	**General**				
	OMS shall be provided to ensure adequate dam safety.	X			The EPP and OMS manual updated in 2013.
	OMS manual shall be routinely updated.	X			The EPP and OMS manual updated in 2013.
	Qualified personnel shall be used for OMS of the dam.	X			The EPP and OMS manual updated in 2013.
	Adequate records shall be maintained.	X			The EPP and OMS manual updated in 2013.
3.2	**Operation**				
3.2.1	**Design Information**				
	Dam operation shall not violate important design assumptions.	X			Included in updated EPP and OMS manual
3.2.2	**Flood Operating Procedures**				
	Facilities shall be available to discharge IDF.	X			Discharge through spillway.
3.2.3	**Emergency Operating Procedures**				
	Established procedures for reservoir control during emergencies.	X			Reservoir control through spillway
3.2.4	**Ice and Debris Handling**				
	Established procedures to handle ice and debris.		X		Procedures to be included in the EPP/OMS manual.
3.3	**Maintenance**				
	Established maintenance procedures to maintain safe condition.	X			Tier 1 and 2 Conditions and Responses included in updated OMS manual.
3.4	**Surveillance**				
3.4.1	**Standards**				
	Established inspection and testing standards.	X			Included in updated EPP and OMS manual
3.4.2	**Regular Inspections**				
	Inspect condition of dam and appurtenant structures.	X			
3.4.3	**Special Inspections**				
	Perform special inspection following potentially damaging events.	X			Included in updated EPP and OMS manual
3.4.4	**Instrumentation**				
	Evaluate and maintain dam safety instrumentation			X	No piezometeric records available for review.
4.0	**EMERGENCY PREPAREDNESS**				
4.1	**General**				
	Identify and evaluate potential emergencies at a dam	X			Included in updated EPP and OMS manual
	An emergency Preparedness Plan (EPP) shall be prepared.	X			Included in updated EPP and OMS manual
	EPP shall have notification procedure for potential dam breach.	X			Included in updated EPP and OMS manual
	EPP shall notify either officials or inhabitants directly.	X			Included in updated EPP and OMS manual
	EPP shall initiate actions to prevent failure or reduce damage.	X			Included in updated EPP and OMS manual
4.2	**Emergency Preparedness Plan (EPP)**				
4.2.1	**Development of an EPP**				
	EPP shall describe actions and assign responsibilities.	X			Notification flow charts included in EPP and OMS manual.
	EPP shall be provided to those responsible.	X			Distribution list included.
4.2.2	**Contents of an EPP**				
	EPP shall have standard contents (see CDA).	X			
4.2.3	**Maintenance and Testing of an EPP**				
	The EPP shall be issued to those affected and updated.	X			
	The EPP shall be tested.		X		Unknown if tested.
4.2.4	**Training**				
	Dam personnel shall be familiar with EPP responsibilities.	X			
4.3	**Inundation Studies**				
	An inundation study is required for some dams (see CDA)			X	Not included in EPP/OMS manual. High level study recommended.
	Inundation study shall use reasonable worst-case assumptions.			X	Not included in EPP/OMS manual. High level study recommended.
5.0	**DISCHARGE FACILITIES**				
5.1	**Flow Capacity of Hydraulic Structures**				
	Discharge facilities must pass routed IDF with freeboard.	X			Spillway channel has been modified since constructed with the addition of five culverts. However, the PMF flow will overtop the culverts prior to backing up into the TSF.
5.2	**Freeboard**				
	Freeboard must be sufficient under all operating conditions.	X			
5.3	**Operation During Floods**				
	Develop operating rules to pass floods up to IDF.	X			Discharge through spillway.
5.4	**Operation of Flow Control Equipment**				
	Determine site-specific discharge facility operation and automation.				NA
	Determine required service conditions for discharge equipment.				NA
5.5	**Instrumentation and Control**				
	Local/Remote monitoring of hydraulic structures for High, V.High, Extreme dams.				NA
5.6	**Emergency Equipment**				
	Emergency power shall be available for High, V.High and Extreme dams.				NA
	Controls shall be operable during blackouts for High, V.High and Extreme dams.				NA

Knight Piésold CONSULTING

TABLE 5.1

KGHM AJAX MINING INC.
DAM SAFETY REVIEW
AFTON TAILINGS STORAGE FACILITY

SUMMARY OF DAM SAFETY REVIEW REQUIREMENTS AND FINDINGS

Print Mar/28/2014 14:58:31

CDA Section	Title and Brief Description of Requirement	Meets CDA	Insufficient Information	Fails CDA	Remarks
6.0	**GEOTECHNICAL CONSIDERATIONS**				
6.1	**Geotechnical Investigations**				
	Adequate geotechnical investigations at dam site.	X			Review of geotechnical investigations completed by Klohn Crippen in 2011 for stability assessment.
6.2	**Embankment Dams and Soil Foundations**				
6.2.1	**Monitoring and Instrumentation**				
	Sufficient instrumentation shall be available for High, V.High and Extreme dams.			X	Only two piezometers installed in dams. Piezometers not read since March 2011.
6.2.2	**Stability and Deformation**				
	Dam & abutment slopes shall be stable under all operating conditions.	X			Review of geotechnical investigations completed by Klohn Crippen in 2011 for stability assessment.
	Loads shall not cause excessive dam or foundation deformation.	X			Review of geotechnical investigations completed by Klohn Crippen in 2011 for stability assessment.
	Reservoir slopes shall be stable if failure threatens dam or public safety.	X			Review of geotechnical investigations completed by Klohn Crippen in 2011 for stability assessment.
6.2.3	**Seepage and Drainage Control**				
	Erosion of soil particles shall be prevented by adequate filters.	X			Dam has engineered filter between till and rockfill materials.
	Filter provisions adequate to accommodate seismic induced movements	X			Deformation analyses completed by Klohn Crippen in 2011 for stability assessment.
	Hydraulic gradients shall be low to prevent piping and heave.		X		Insufficient information available to assess.
	Flow capacity of drains and filters shall not be exceeded.		X		Insufficient information available to assess.
6.2.4	**Cracking**				
	Settlement or hydraulic fracturing shall not cause loss of the reservoir.	X			No observed evidence of settlement/cracking.
6.2.5	**Surface Erosion**				
	Upstream slopes shall be protected from wave induced erosion.	X			No riprap erosion protection provided. However, there is minimal pond cover on TSF and pond is not
	Downstream slopes shall be protected against runoff, seepage, etc.	X			Some erosion gullies on downstream slope of West Dam which is overbuilt. Not a stability concern.
	Outlet channels shall be protected from erosion.			X	No erosion protection on spillway channel downstream of East Dam.
6.2.6	**Liquefaction**				
	Identify all embankment and foundation materials that could liquefy.	X			Completed by Klohn Crippen in 2011 for stability assessment.
	Evaluate post-liquefaction stability of the dam.	X			Completed by Klohn Crippen in 2011 for stability assessment.
6.2.7	**Earthquake Resistance**				
	The dam and reservoir rim shall be capable of resisting the EDGM.	X			Completed by Klohn Crippen in 2011 for stability assessment.
6.3	**Appurtenant Structures - Spillway**				
6.3.1	**Foundation Movement**				
	Foundations shall not deform and prevent structure operation.				NA
	Foundations shall not deform to cause leakage or cracking.				NA
6.3.2	**Slope Stability**				
	Slope instability shall not block approach or exit channels.	X			Spillway channel satisfactory, but no erosion protection.
6.3.3	**Seepage**				
	Prevent piping under appurtenant structures.				NA
7.0	**RESERVOIR AND ENVIRONMENT**				
7.1	**Reservoir Debris and Ice**				
	Shall be managed so as not to threaten dam safety	X			Minimal pond volume. Pond not adjacent to dams.
7.2	**Reservoir Rim**				
	Reservoir slopes shall not threaten dam safety.	X			Terrain comprises shallow slopes around reservoir rim
7.3	**Sedimentation and Silting**				
	Silt buildup shall not interfere with flood routing through spillway	X			No evidence of silt buildup in spillway.
7.4	**Ecology**				
	Monitor and protect against animal or other organism damage.	X			No evidence of damage observed during site inspection.

M:\1\01\00246\16\A\Report\Afton TSF\Rev 0\Tables\[Table 5.1 - Afton TSF - Summary of DSR Requirements & Findings - Rev 0 March 25.xls]Rev. A

NOTES:

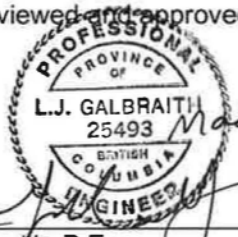
1) EDGM is the Earthquake Design Ground Motion.

2) IDF is the Inflow Design Flood.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	28MAR'14	ISSUED WITH REPORT	LJG	GRG	KJB

6 – CERTIFICATION

This report was prepared, reviewed and approved by the undersigned.



March 28/14

Prepared: _____

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Reviewed: _____

Graham R. Greenaway, P.Eng.
Specialist Geotechnical Engineer

Approved: _____

Ken Brouwer, P.Eng.
President

APPENDIX A

PHOTOGRAPHS OF JULY 9, 2013 SITE INSPECTION

(Pages A-1 to A-6)

PHOTO 1 – Re-vegetated downstream slope near crest of West Dam.

PHOTO 2 – Downstream toe of West Dam showing small erosion gullies.

PHOTO 3 – TSF pond and beach.

PHOTO 4 – Re-vegetated tailings beach near East Dam.

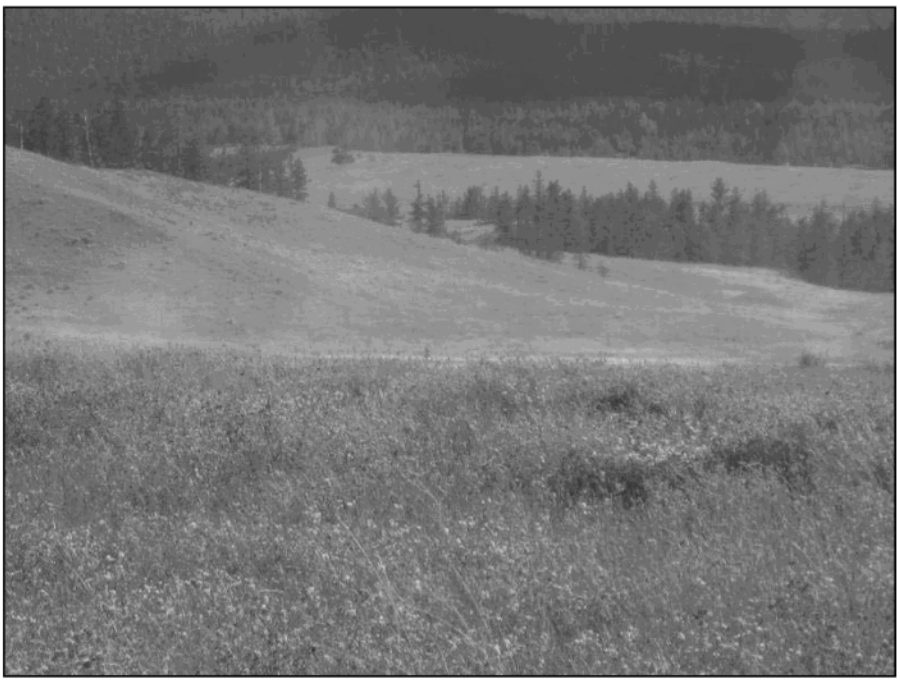


PHOTO 5 – Wind blown dust from tailings beach.

PHOTO 6 – Surface monitors at East Dam.

PHOTO 7 – Culverts installed in spillway channel. Culverts installed in 2011 by New Gold.

PHOTO 8 – Eroded section of the southwest seepage dam.

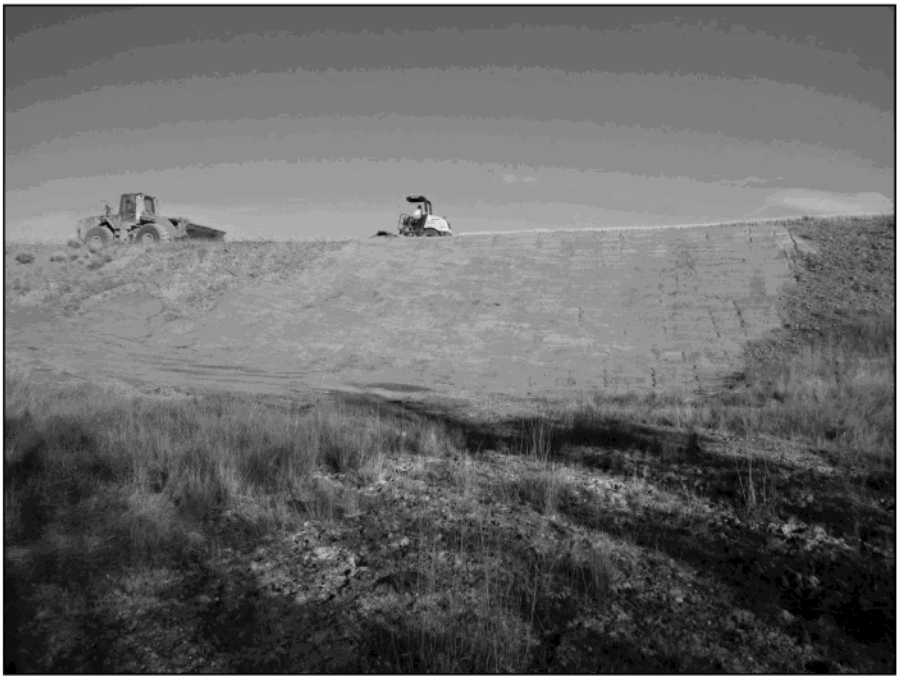


PHOTO 9 – Eroded section of the southwest seepage dam repaired in October 2013.

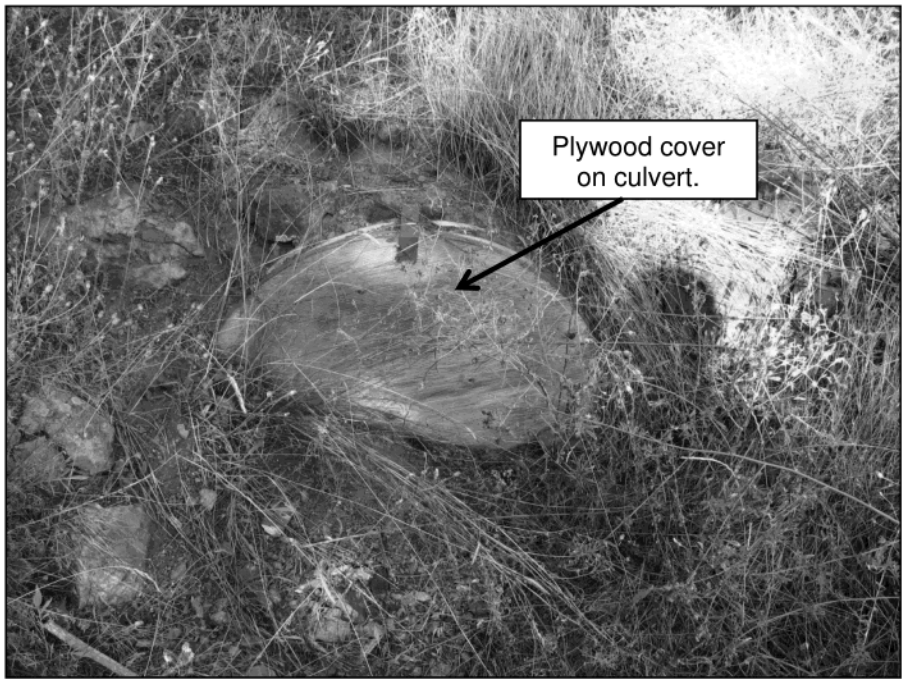


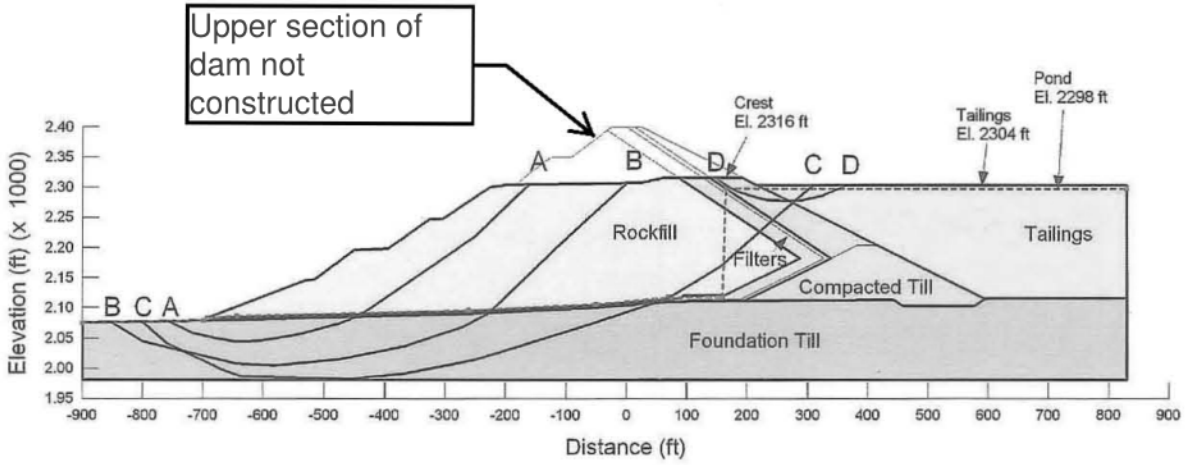
PHOTO 10 – Plywood gate and debris blocking outlet at northwest seepage dam.

PHOTO 11 – Alkali diversion channel, undercut section. Diversion channel modifications/repair planned for 2014.

APPENDIX B

DAM SECTION FROM 2011 STABILITY ASSESSMENT

(Page B-1)



Material Properties

Material Type	Unit Weight (pcf)	Effective Friction Angle, ϕ' (degrees)	Post-Liquefaction Strength
Tailings	110	30	$S_u / \sigma_v' = 0.15$
Compacted Till	143 saturated, 140 unsaturated	32	-
Foundation Till	143	30	-
Filters	125	32	-
Rockfill	125	37	-

Calculated Factor of Safety

		Factor of Safety		
Failure Surface		Static	Pseudo-static (0.17 g)	Post-liquefaction (Tailings)
Downstream	A	1.61	1.07	-
	B	1.86	1.19	-
	C	2.36	1.35	2.32
Upstream	D	5.21	1.83	3.96

NOT FOR CONSTRUCTION
TO BE READ WITH KLOHN CRIPPEN REPORT DATED MAY 27, 2011

SCALE: 0 300 FT

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL USE OF OUR CLIENT FOR A SPECIFIC PROJECT AND NOT FOR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT: AFTON OPERATING CORPORATION

Klohn Crippen Berger

PROJECT: AFTON TAILINGS IMPOUNDMENT
SEISMIC HAZARD AND SEISMIC STABILITY ASSESSMENT

TITLE: WEST DAM STABILITY ANALYSIS

PROJECT No. M09713A01

FIG. No. 3.13