Klohn Crippen Berger

June 30, 2015

Barkerville Gold Mines Ltd.
11th Floor, 1111 Melville Street
Vancouver, British Columbia
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Kevin McMurren
Mine Manager

Dear Mr. McMurren:

QR Mine Tailings Storage Facility
Response to February 3, 2015 MEM Memorandum

1 INTRODUCTION

The Independent Expert Panel[1] (Panel) appointed by Ministry of Energy and Mines, British Columbia (MEM) released their report on the Mount Polley tailings dam failure on January 30th, 2015. Subsequent to the release of the Expert Panel report, MEM issued a memorandum on February 3rd, 2015 (MEM memorandum) to all tailing dam owners in British Columbia to undertake a specific risk assessment of their tailing dams and report the results to MEM by June 30th, 2015. A copy of the MEM memorandum is attached.

This report outlines KCB's assessment of conditions at the two dams forming the QR Mine Tailings Storage Facility relative to the specific aspects raised by the MEM memorandum, based on a review of available documents to prepare a "summary of knowledge". This assessment has been sealed by a qualified professional engineer and complies with generally-accepted professional practice common to the local area.

The report format is based on the MEM wording and numbering system, as requested by MEM. In Sections 3 to 5 MEM items are shown in blue italicized text; KCB's response is shown in normal black text.

We consider this assessment to represent the available knowledge of the facility at the time of writing. Operating, inactive and closed facilities are subject to physical and geochemical changes over time, including ongoing construction activities. It is essential that monitoring and assessment of the facilities continue through regular surveillance, dam safety inspections, dam safety reviews and other stewardship activities.

[1] Independent Expert Engineering Investigation and Review Panel, 2015. *Report on Mount Polley Tailings Storage Facility Breach*. January 30, 2015.

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1.1 Assessment Scope

The MEM memorandum asked that an assessment be undertaken to evaluate whether the dams may be at risk due to the following three conditions:

1. undrained shear failure of silt and clay foundation;
2. water balance adequacy; and
3. filter adequacy

KCB reviewed available historical information on foundation characterization, design, construction, and operations records for the QR Mine Tailings Storage Facility (TSF) dams to prepare responses for sub-items listed in the MEM memorandum. A register of the documents reviewed is included in Attachment II. The responses for the above three items are provided in Sections 2 to 4, respectively, following the numbering system used in the MEM memorandum.

1.2 QR Mine Tailings Storage Facility

The QR Mine is located approximately 73 km East of Quesnel, BC, on the North Side (right bank) of the Quesnel River, approximately 3 km West (downstream) of Maud Creek. Local terrain consists of rolling hill country typical of the interior plateau of central British Columbia.

The TSF impoundment spans a 300 m wide valley north of the main mill site and consists of two zoned earth embankments, the North Dam across the northern low end of the valley, and the Cross Dyke, situated on a saddle at the south end of the valley. In addition to the two earthfill embankment structures, notable features at the TSF include a Closure Spillway.

2 ITEM 1 - UNDRAINED SHEAR FAILURE OF SILT AND CLAY FOUNDATIONS

a. Including a determination with respect to whether or not similar foundation conditions exist below the dams on your site.

The available foundation characterization data reviewed for the QR Mine TSF did not indicate the presence of glacio-lacustrine deposits. The surface topography in the QR Mine site is primarily bedrock controlled and the surface geology is dominated by till deposits directly overlying bedrock. The subsurface foundation geology indicates that the bedrock at the location of the QR Mine TSF is relatively near surface(KC, 1994a), ranging from 0.45 m to 10 m below surface, and is generally overlain by silty sand till units. The sub-surface geology above the bedrock was primarily divided into four units for foundation characterization purposes (KC, 1994a):

1. Near surface, prior to construction, occasional soft organic deposits were observed, with thicknesses ranging from 0.15 m thick up to 2.5 m thick in the valley bottom. This unit was excavated prior to placement of dam fill materials, with the exception of the ground surface under the upstream rockfill zone for the tailings dam. Within this area, the rockfill was pushed upstream to displace the underlying peat and consolidate remaining material.

2. Deposits of silty sand or sandy silt, up to 0.5 m in thickness, were encountered below the surficial organic deposits across most of the site. These soils consist of weathered, compact, non-plastic, brown silty, sandy gravel. These post-glacial deposits of silt were stripped in the same areas as the peat.
3. Deposits classified as silty till were encountered in all test pits across the site. The thickness of the deposits typically ranged from 2 m to more than 3.6 m. The till consists of a brown, medium dense to dense, non to low plastic, sandy gravelly silt matrix which is interspersed with cobbles up to 200 mm in size, with occasional boulders up to 900 mm observed near the base of the deposit.
4. A very dense deposit of grey, basal clay till was encountered below the silty till in most of the test pits which penetrated below the overlying silty till. The basal clay till consists of a low plastic, clayey, silty sand with some gravel interspersed in the finer-grained matrix. This basal clay till was deposited at the base of the glacial ice sheet and was therefore heavily consolidated by the weight of the ice.

A review of the test pit logs indicated that the foundation predominantly consists of sandy and gravelly silty till deposits. A basal clay till deposit was observed in some locations. The available laboratory test data indicates that the basal clay till contains low plasticity clay, while the silt till contains low to intermediate plasticity clay. Fines content of the overburden soils range from 33% to 46%, and with the remaining content generally consisting of sand and gravel.

The above characterization is consistent with the surficial geology maps reviewed, prepared by the British Columbia Geological Survey, and the Geological Survey of Canada (BCGS, 2003), (BCGS, 2007), (GSC, 2015).

In conclusion, the available foundation characterization data reviewed for the QR Mine TSF did not indicate the presence of glacio-lacustrine deposits.

b. Whether or not sufficient site investigation (drill holes, etc.) has been completed to have confidence in this determination.

Site investigations reviewed for the QR TSF consist of the following:

- 1988 site investigation conducted by SRK for the design of the QR TSF, including 14 test pits located within the tailings pond.
- 1990 site investigation conducted by SRK, including the advancement of 4 drill holes, and installation of piezometers in the vicinity of the TSF.
- 1994 site investigation conducted by KC in support of the design of the QR TSF. This site investigation included 4 test pits near the North Dam, 7 test pits in the tailings pond area, and 4 test pits near the Cross Dyke.
- A series of hydrogeologic and seepage investigations have also been conducted at the site including the 1995 KC site investigation, 2002 KC installation of four piezometers, 2010 Golder

north dam seepage investigation, 2011 KCB seepage investigation and the 2012 KCB Phase II seepage investigation.

- Site investigations to identify sources of borrow material have also been conducted.

Although the design of the dams appears to have been primarily based on test pit data, subsequent site investigations, including drill holes through the dams, underlying soils, and the bedrock confirm assumed design foundation conditions with respect to the stability of the dams.

Although no drill holes were noted for the eastern portion of the tailings dam, TP94-11, advanced in this area, encountered fractured bedrock at a depth of 0.45 m, and the test pit encountered refusal 1.05 m into the bedrock at a depth of 1.5 m. The test pit contained a surficial organic and silt layer, overlying silt till. Two other test pits in this area were both terminated in clay till or silt till. Based on the relatively shallow depth of bedrock in TP94-11 and the logs, glaciolacustrine clay is not believed to be present at the North Dam.

Likewise, no drill holes were noted for the east end and the west end of the abutments of the Cross Dyke, especially for the eastern portion of the dam. However, during the 1998 raise of the Cross Dyke, the dam was extended to the east and west. A key trench was excavated at the east end of the core raise and exposed moderately fractured bedrock on the downstream face and on the downstream third of the floor of the excavation. At the west abutment, bedrock was encountered within the abutment key trench at approximate elevation 1024.5 m (KC, 1998b).

Given the site investigation conducted to date, the depth, the spatial distribution of testing is believed to be adequate for sufficient confidence in the conclusions presented above.

c. If present, whether or not the dam design properly accounts for these materials.

The foundation characterization does not indicate the presence of a glaciolacustrine silt or clay layer that could behave in an undrained manner during construction loading.

Stability analyses conducted for the current design of the dams is believed to adequately account for the foundation materials present under the North Dam and the Cross Dyke. Although SPT and CPT data is not available, assumed soil strengths and densities used in design appear to be reasonable for the available field and laboratory test data.

Based on the foundation characterization, drained foundation conditions were used to develop the initial design and subsequent redesigns for the QR TSF. The design for the current configuration of the dams were assessed as part of the 2006 Tailings Dam and Cross Dyke Re-Design (KCB, 2006a) and found to have adequate factors of safety under static and seismic conditions.

It should be noted that allowable seepage rates for the purpose of maintaining a water cover over the tailings are exceeded at the North Dam. Seepage is understood to occur through a fractured bedrock zone, as identified during the Phase I (KCB, 2012a) and Phase II (KCB, 2014b) investigations. A trial grouting program was undertaken to address this issue, and completion of this work is recommended (KCB, 2014a). This is not believed to be an issue from a dam physical stability perspective.

d. If any gaps have been identified, a plan and schedule for additional sub-surface investigation.

No further subsurface investigation is recommended at this time to address the foundation soils. As previously recommended in the 2014 DSI, ongoing monitoring of the facility is recommended.

3 ITEM 2: WATER BALANCE

a. Including the total volume of surplus mine site water (if any) stored in the tailings storage facility.

The QR Mine TSF has not been filled to capacity and no further tailings are planned for deposition in the facility. The facility does not presently receive or hold water from mining operations. The current sources of inflow for the TSF comprise precipitation on the tailings surface and surface runoff from the natural surrounding catchment. The following provides additional information about water management within the facility:

- The facility is operated under Permit 12601, originally issued by March 3, 1994 and revised July 11, 2012, stipulates that discharge into the TSF is not authorized until plans to mitigate seepage losses from the tailings impoundment have been developed.
- Diversion ditches are currently being maintained along the east and west sides of the TSF to collect runoff and divert water around the TSF. Provided the ditches are properly maintained and cleared regularly, they will continue to divert water around the TSF.
- The only other source of outflow is via seepage and evaporation. Both the North Dam and Cross Dyke experience seepage; however, seepage is collected in a seepage collection pond and pumped back to the impoundment (KCB, 2014c).

According to the current Annual Reclamation Review Report provided by BGM (BGM, 2014a), water from the TSF is pumped to the mill as required to operate the mill. Reclaim water from the TSF makes up the majority of the water required to operate the mill (85%), with the remaining make-up water (15%) pumped from the Main Zone Pit. Mill reclaim rates provided by BGM for July 2014 to September 2014 indicate an average monthly reclaim rate of 14,000 m^3, of which roughly 11,900 m^3 would have been reclaimed from the TSF. We understand that this balance between water sourced from the Main Zone Pit and TSF is modified as needed by site requirements, and the reported balance noted in the Annual Reclamation Review Report may no longer be current.

In the event of an extreme flood event, excess flows will be discharged via the open-channel closure spillway.

b. The volume of surplus mine water that has been added to the facility over each of the past five years.

The water level has fluctuated over the past five years, but, in general, has increased approximately 2 m. The water level observed during the 2010 Annual Inspection was 1025.5 m (KCB, 2011) and was 1027.5 m during the most recent 2014 Dam Safety Inspection (DSI) (KCB, 2014a). Based on a bathymetry survey carried out in 2012, the 2 m increase in pond level amounts to approximately 314,000 m^3 of additional water storage at the facility over the past 5 years.

The volume of free water in the TSF as of November, 2014 was approximately 505,000 m^3. Approximate volumes over the past five years are presented in Table 3.1.

Table 3.1 Summary of Observed Water Level in QR Mine TSF (Last 5 Years)

Year	Water Level (m) (1)	Approximate Volume (m^3)
2010	1025.5	190,000
2011	1026.7	360,000
2012	1026.7	365,000
2013	1026.9	400,000
2014	1027.5	505,000

Note: (1) Water levels have been taken from available reports and represent a snapshot only. Seasonal water level fluctuations have been observed at the site.

c. Any plans that are in place or that are under development to release surplus mine water to the environment.

Tailings deposition into the QR TSF has ceased and the facility is primarily used as a source of water for mill reclaim. Other than continuing to supply the mill with reclaim water, there is no plan either in place or under development to release water to the environment. However plans are being developed to transfer some water from the QR TSF to the Main Zone Pit. These plans are preliminary at this time, and, once developed, would require approval by the Ministry of the Environment.

Based on the current TSF configuration, in the event of an extreme flood, the Closure Spillway will provide outflow capacity to release the additional inflow. The Closure Spillway, constructed in 2014, was sized to convey a PMF event without diversion ditches operating.

While seepage is currently collected, when the seepage return pumps are removed at closure the seepage has been calculated to exceed the maximum rate allowable to provide sufficient water cover over the impounded tailings after closure (KCB, 2010). The water cover is required to maintain saturation of the tailings to prevent oxidation and, ultimately, acid generation. There is, therefore, expected to be a net deficit and water inflows will likely be required from additional sources (e.g., removing diversions or diverting additional water into the facility) to maintain a water cover. A grouting trial was completed (KCB, 2014d) to evaluate the feasibility and best method of injection grouting the fractured bedrock zone as a seepage mitigation measure. Closure measures are still being evaluated.

d. Recommended beach width(s), and the ability of the mine to maintain these widths.

In the context of this report, beach width refers to the extent of the tailings that deposit above water upstream of the tailings dam. Tailings are no longer being deposited in TSF. When deposition was ongoing, tailings were deposited sub-aqueously by gravity feed and spigotting on a continuous basis (KCB, 2014b). Tailings discharge points were moved around different locations of the pond to achieve as flat a surface below the water as possible, and to aid in reducing the seepage flow in order to maintain the 1 m water cover over PAG material specified for final reclamation (KCB, 2014c).

The QR TSF is confined by the Cross Dyke which is generally a downstream configuration, and the North Dam which is a centreline configuration with the exception of the most recent upstream lifts. The upstream rockfill shell extends over 90 m to the upstream of the dam core zone. The stability of the two dams does not rely on a tailings beach, and no design beach width was specified for either the North Dam or the Cross Dyke.

e. The ability of the TSF embankments to undergo deformations without the release of water (i.e., the adequacy of the recommended beach width).

Static loading due to dam raising is complete and the main source of additional potential deformation for the QR TSF is possible earthquake loading. The calculated seismic deformations (horizontal and vertical) for the QR TSF can be accommodated by the 2.0 m of available normal freeboard (i.e., between the spillway invert and the dam crest), and the embankment shell, to prevent the release of water or tailings.

Based on the 2014 DSI, there is 3.5 m of freeboard from the current pond elevation to dam crest elevation. Based on design calculations from the spillway, the pool rise associated with routing the design event is approximately 0.6 m. The minimum freeboard available (i.e., between the highest routed water level and the dam crest) is estimated to be 1.4 m, the normal freeboard available (i.e., between the spillway invert and the dam crest) is estimated to be 2.0 m.

The main potential source of additional deformation for QR TSF dams is possible earthquake loading. KC (1994a) reviewed regional historical earthquakes, as well as seismic studies by others, and noted that the Maximum Credible Earthquake expected at the site is estimated to have a peak ground acceleration of 0.17 g, with the maximum magnitude earthquake recorded for the region being a M5.4 earthquake. Swaisgood (2013) and Hynes-Griffin and Franklin (1984) methods were used to estimate potential vertical and lateral seismic deformations of the dams, respectively. Based on the available background information regarding expected design yield accelerations for the dams, the estimated seismic deformations can be accommodated by the available normal freeboard of 2.0 m at either dam, to prevent the release of water or tailings due to embankment deformation.

f. Provisions and contingencies that are in place to account for wet years.

A water balance review was undertaken in 2012 as part of the Dam Raise detail design (KCB, 2012b). The water balance for a 'wet year', assumed to be a 100-year return, was checked for the current status of the TSF. The water balance calculation indicates:

- That 50% of total inflows would be lost through evaporation.
- Release via seepage was assumed to be zero as it is collected and returned to the pond.
- The mill reclaim rates, provided by BGM and assumed to be typical rates, are enough to keep the pond in a neutral state and the expected rise in pond water level would be negligible.
- The total annual inflow into the impoundment (runoff and precipitation) during a wet year is estimated to be 210,000 m^3, compared to an average year of 158,000 m^3.

- Even if this yearly volume were to be stored in the impoundment without evaporation or mill reclaim, it would result in a 1.1 m rise in the pond level, which remains 0.5 m below the invert of the spillway.

The Operation, Maintenance and Surveillance Manual (BGM, 2014b), states that the level of the tailings pond should not exceed an elevation of 1028.3 m. If this level is exceeded, the Mine Manager will notify the facility designer (KCB) for appropriate action and ongoing monitoring frequency. This would provide approximately 145,000 m^3 of additional water storage at the current 2014 DSI water level of 1027.5 m.

g. If any gaps have been identified, a plan and schedule for addressing these issues.

- The Operation, Maintenance and Surveillance (OMS) Manual was updated in 2014 and is undergoing an additional update currently to support operations, maintenance and surveillance of the North Dam and Cross Dyke (BGM, 2014b). Once long-term planning regarding the facility is complete the water balance should be revised to reflect planned conditions.
- During the 2014 Dam Safety Inspection (KCB, 2014a), it was recommended that a trial grouting program be conducted and an overall seepage mitigation plan be developed. It was recommended that this be done by the end of 2015.

Barkerville Gold has indicated that they intend to address the above recommendations, once long-term planning regarding the facility is complete.

4 ITEM 3: FILTER ADEQUACY

a. Including the beach width and filter specifications necessary to prevent potential piping.

The QR TSF is confined by the Cross Dyke, which generally has a downstream configuration, and the North Dam, which has a centreline configuration, with the exception of the most recent upstream lifts. The upstream rockfill shell of the North Dam extends over 90 m upstream of the dam core zone.

The design of the TSF relies on low permeability dam cores of compacted till to restrict seepage and maintain a water cover over the tailings and waste rock (KC, 1994a). The stability of the dams does not rely on a tailings beach, and no design beach width was specified for either the North Dam or the Cross Dyke.

Seepage rates at the North Dam have been noted to be higher than preferred for the purposes of maintaining adequate water cover over the tailings within the TSF. This seepage appears to generally be through a fractured bedrock zone below the dam. Grouting of this bedrock zone has been partially completed, and completion of the grouting program is recommended (KCB, 2014c). Seepage is collected at the toe of the North Dam and pumped back into the facility and estimated at approximately 5 L/s.

At the Cross Dyke seepage would be collected at the toe and routed to the Main Zone Pit. Limited flow was observed along the right (west) abutment toe drain. This flow was noted as approximately

2 L/s however it is not certain whether this flow consists of seepage through the dam or natural spring flow. No visible seeps were observed on the east abutment (KCB, 2014c).

The original design for the filter zones was developed based on the following design criteria for the retention of base soils:

- D15 of the filter / d85 of the protected soil < 5, where d85 of the base soil is based on the finer fraction passing the No. 4 sieve.
- Maximum particle size of the filter D100 = 75 mm.

Notes on the design filter zones for the North Dam and Cross Dyke follow.

North Dam

- The North Dam is generally broken into 8 major fill zones. However, seepage flow is expected to generally occur below elevation 1,025 m in the dam and, as such, only fill zones below elevation 1,025 m (corresponding to the 2002 construction period and earlier) were assessed for filter compatibility.
- Below elevation 1,025 m, there are 6 zones consisting of: the Upstream Shell, a Till Transition Zone, a Till Core, a Fine Filter, a Coarse Filter, and the Downstream Shell.
- The width of the dam core was designed to be at least 10 m, providing a minimum ratio of core width to hydrostatic head of approximately 0.67. (KC, 1997c). The width of the dam was designed to be at least 50% of the reservoir head against the core. This is twice the ratio of 0.25 to 0.3 often used for water storage dams.
- The till transition zone comprises a silty sandy till to protect the upstream side of the core and act as a crack filler in the event of a crack in the core.
- The design for the filter zones were developed based on engineering standards at the time. As filter design recommendations have changed since the development of the design recommendations for the filter gradations at the QR Mine, KCB has compared the available design information to current design recommendations as per the US Army Corps of Engineers (2004), and Kenney and Lau (1986). In general, although the filters were designed according to generally accepted standards typical at the time of design development, the design of the filter zones the North Dam does not meet modern filter design criteria. The filter designs meet permeability criteria, but do not meet filter retention criteria (USACE, 2004), and also do not meet gradation requirements to prevent segregation of filters during construction (USACE, 2004). The design gradations may also be susceptible to internal erosion (Kenny and Lau, 1986).

Cross Dyke

- The Cross Dyke is generally broken into 6 major fill zones: the Silty Till Core, Clay Core, the Upstream Silty Sand Shell, the Downstream Silty Sand Shell, and the Fine Filter Toe Drain.

- Similar to the North Dam, seepage through the structure is generally expected to occur below elevation 1,025 m in the dam.
- KCB has compared the available design information to current design recommendations as per the US Army Corps of Engineers (2004), and Kenney and Lau (1986). In general, although the filters were designed according to generally accepted standards typical at the time of design development, the design of the filter zones for the Cross Dyke does not meet modern filter design criteria. The filter designs meet permeability criteria, but do not meet filter retention criteria (USACE, 2004), and also do not meet gradation requirements to prevent segregation of filters during construction (USACE, 2004). The design gradations may also be susceptible to internal erosion (Kenny and Lau, 1986).

b. Whether or not the filter has been constructed in accordance with the design.

Generally, where available, the as-built records for both the North Dam and Cross Dyke construction materials adhere to the design specifications. Some limited exceptions are presented below.

North Dam

As noted, the as-built records of the North Dam construction materials generally adhere to the design specifications, with the following exceptions (KC, 1995a), (KC, 1996), (KC, 1997a):

- Most samples of the Till Core were within the specified limits, with some limited samples somewhat finer or coarser than the specified limits. During construction, Till Core materials varied by borrow source from a silty till to a clayey till, with fines content ranging from 8% to 58%
- The Fine Filter samples generally plotted near or along the coarse design limit. Some limited samples were coarser than specified.
- One Coarse Filter sample was coarser than the specified design limits.

KCB has also compared the relevant as-built design information to current design recommendations as per the US Army Corps of Engineers (2004), Kenney and Lau (1986), and the recommendations of Foster and Fell (2001). Based on the assessment conducted, the available gradations for the as-constructed dam materials indicate that permeability design criteria (USACE, 2004) are met. Some of the filter zones do not meet soil retention criteria (USACE, 2004) and most do not meet maximum particle size criterion (USACE, 2004). The assessment also indicates that the as-constructed filters may be susceptible to internal erosion (Kenney and Lau, 1986), and gradation requirements to prevent segregation during construction are not met (USACE, 2004).

Although the soils do not meet the criteria outlined above, on the basis of the generally clear seepage, there has been no evidence of widespread migration of the base soil or the impounded tailings through the North Dam. The 2014 DSI also notes that "if the internal filters do not perform as designed, tailings fines that migrated through the dam would not result in a structural failure of the dam given the high shear strength of the coarse rockfill. Migration of tailings into the downstream

shell could impact environmental containment performance but there is no evidence this has occurred" (KCB, 2014).

Cross Dyke

The as-built records of the Cross Dyke construction materials generally adhere to the design specifications, with the exception of the following:

- The Blanket Drain constructed in 2012-2013 is coarser than the design limits specified, which were the same gradation limits, as specified for the Fine Filter Toe Drain. However, the construction records indicate that filter compatibility with the Downstream Shell was found acceptable according to the design criteria of D15/d85<5 (KCB, 2014a).

KCB has also compared the relevant as-built design information to current design recommendations as per the US Army Corps of Engineers (2004), Kenney and Lau (1986), and the recommendations of Foster and Fell (2001). The assessment conducted on the available gradations for the as-constructed dam materials for the Cross Dyke indicated the following:

- The fine filter toe drain meets gradation requirements for permeability, maximum gradation size, and prevention of segregation during construction (USACE, 2004). It does not meet particle retention criteria for all of the assessed zones (USACE, 2004). This filter zone may also be susceptible to internal erosion (Kenney and Lau, 1986).
- The blanket drain does not meet gradation requirements for permeability, particle retention, and prevention of segregation during construction (USACE, 2004). This filter zone may also be susceptible to internal erosion (Kenney and Lau, 1986).

Although the soils do not meet the criteria outlined above, on the basis of the generally clear seepage, there has been no evidence of widespread migration of the base soil or the impounded tailings through the Cross Dyke.

c. If any gaps have been identified, a plan and schedule for addressing these issues.

As noted, gaps exist within the as-built records of the dam fill zones. In addition, the design and the as-built gradations of the filters do not meet one or more of the assessed filter criteria (USACE, 2004), Kenney and Lau (1986), and Foster and Fell (2001).

No immediate further assessment of the filters is deemed necessary in order to evaluate filter adequacy, based on the following:

- No documentation or observations of local deformations / washouts, voids, or piping are indicated.
- Filter performance has been demonstrated by clear seepage and retention of tailings in the impoundment.
- The low permeability core zones are wide in relation to the dam height and the upstream transition zones offer additional protection.

There is, however, a requirement for ongoing monitoring of the seepage to check for continuing filter adequacy, based upon the following:

- The gradations of the filter and base soils are such that they are susceptible to segregation and internal stability, and are within the range of gradations where filter performance has often been poor (Foster and Fell, 2001).
- The facility continues to retain water, including water ponded directly against the upstream face of the dams.

The above requirement for continued monitoring of the performance of the dam was also recommended in the 2014 DSI (KCB, 2014c). As part of this assessment, the following specific recommendation is provided with respect to filter adequacy:

- Given the potential for filter inadequacy, seepage should be monitored for both dams on at least a monthly basis. The seepage should also be monitored for suspended solids.

Barkerville Gold has indicated that ongoing monitoring of the seepage at the dams will continue, and recommendations regarding slope monitoring equipment will be requested as part of the 2015 DSI. It is expected that the 2015 DSI will be complete prior to the end of the third quarter of 2015.

5 SUMMARY OF GAPS AND SCHEDULE TO ADDRESS

MEM Letter		Schedule to Address
Item No.	Gap Identified	
1.	**Undrained shear failure of silt and clay foundation**	
	▪ No further subsurface investigation is recommended at this time to address the foundation soils. Ongoing monitoring of the facility is recommended.	
2.	**Water balance adequacy**	
	▪ Water balance should be revised to reflect planned conditions. ▪ Trial grouting program should be conducted and an overall seepage mitigation plan should be developed.	▪ To be completed once long-term planning regarding the facility is complete. ▪ To be completed once long-term planning regarding the facility is complete.
3.	**Filter adequacy**	
	▪ The need for slope monitoring equipment should be assessed. ▪ Continued monitoring of seepage from the facility is recommended, including for presence of suspended solids.	▪ Slope monitoring needs to be developed during 2015 DSI (expected by end of Q3 2015). ▪ Ongoing monitoring to continue.

In addition to the three major scope items summarized above, the MEM also requested the following information in their memorandum:

- *Is your mine implementing the "Toward Sustainable Mining" initiative of the Mining Association of Canada? Are there any plans to do so?*
- *Does your mine have an Independent Tailings Dam Review Board (ITRB) in place? Is one planned?*

These items have not been addressed by KCB; further information will be provided by BGM.

6 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Barkerville Gold Mines Limited (Client) for the specific application to the QR Tailings Storage Facility. The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. The review is based on available design and as-constructed documentation. In this report, Klohn Crippen Berger has endeavoured to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

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Project Manager and Geotechnical Engineer

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MO/JC/RAC/eeb

Attachments:

Attachment I – MEM Letter to Barkerville Gold Mines Ltd.
Attachment II – Referenced Reports Reviewed

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KC. (1997c). Tailings Dam and Fresh Water Dam Re-Design Report. Prepared for Kinross Gold Corp., dated June 3, 1997.

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KC. (1998b). QR Project Tailings Facility - 1998 Construction Activities. Prepared for Kinross Gold Corp., dated August 10, 1998.

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KC. (2002). Confirmation of Design Details from October 25 to 30, 2002 Site Visit (Letter). Prepared for Kinross Gold Corp., dated November 4, 2002.

KC. (2003). QR Mine, 2002 Permanent Closure Construction Summary. Prepared for Kinross Gold Corp., dated March 31, 2003.

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KCB. (2009). QR Mine - 2007 Construction Summary Report. Prepared for Cross Lake Minerals Ltd., dated March 2, 2009.

KCB. (2010). QR Mine 2010 Tailings and Water Management Study. Prepared for Barkerville Gold Mines Ltd., dated May 21, 2010.

KCB. (2011). QR Mine - Tailings Impoundment and Surface Water Management Structures, 2010 Annual Geotechnical Review. Prepared for Barkerville Gold Mines, dated March 31, 2011.

KCB. (2012a). Tailings Storage Facility 2011 Tailings Dam Seepage Assessment. Prepared for Barkerville Gold Mines, dated January 12, 2012.

KCB. (2012b). QR Mine Water Balance for Potential Tailings Deposition Scenarios. Prepared for Barkerville Gold Mines Ltd., dated August 29, 2012.

KCB. (2014a). QR Mine Tailings Storage Facility, Interim Status Construction Summary, Rev.1. Prepared for Barkerville Gold Mines, dated May 15, 2014.

KCB. (2014b). QR Mine Tailings Storage Facility, 2014 Construction Summary Report. Prepared for Barkerville Gold Mines, dated November 6, 2014.

KCB. (2014c). QR Mine Tailings Storage Facility 2014 Dam Safety Inspection Report (Rev. 3). Prepared for Barkerville Gold Mines Ltd., dated November 27, 2014.

KCB. (2014d). QR Mine TSF Phase II Seepage Assessment - Report on Site Investigation and Trial Grouting Program (DRAFT). Prepared for Barkerville Gold Mines, dated March 21, 2014.

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USACE. (2004). General Design and Construction Considerations for Earth and Rock-Fill Dams (EM 1110-2-2300).

USBR. (1987). Design of Small Dams, 3rd Ed.

ATTACHMENT I

MEM February 3, 2015 Memorandum

February 3, 2015

To: Kevin McMurren, Mine Manager - QR Mine - Barkerville Gold Mines Ltd

As you know, the Expert Panel that was convened to examine the Mount Polley tailings dam breach has issued a report on their findings. This report has been made public and you may already be familiar with the conclusions of this report. Chief among these was the determination that the failure at Mount Polley was related to the presence of weak glacio-lacustrine soils in the dam foundation. The Panel also indicated that the severity of the consequence of failure was in large part owing to the quantity of stored water and the proximity of this water to the dam embankment (i.e. lack of beach). The Ministry of Energy and Mines (MEM) requires confirmation that the conditions that lead to the incident at Mount Polley are not present at other mines in B.C.

More specifically, you are required to undertake an assessment to determine if the dam(s) associated with your tailings storage facility/facilities may be at risk due to:

1. Undrained shear failure of silt and clay foundations;
    a. Including a determination with respect to whether or not similar foundation conditions exist below the dams on your site,
    b. Whether or not sufficient site investigation (drill holes, etc.) has been completed to have confidence in this determination,
    c. If present, whether or not the dam design properly accounts for these materials, and
    d. If any gaps have been identified, a plan and schedule for additional sub-surface investigation.

2. Water balance adequacy;
    a. Including the total volume of surplus mine site water (if any) stored in the tailings storage facility,
    b. The volume of surplus mine water that has been added to the facility over each of the past five years,
    c. Any plans that are in place or that are under development to release surplus mine water to the environment,
    d. Recommended beach width(s), and the ability of the mine to maintain these widths,
    e. The ability of the TSF embankments to undergo deformation without the release of water (i.e. the adequacy of the recommended beach width),
    f. Provisions and contingencies that are in place to account for wet years, and
    g. If any gaps have been identified, a plan and schedule for addressing these issues.

3. Filter adequacy;
    a. Including the beach width and filter specifications necessary to prevent potential piping,
    b. Whether or not the filter has been constructed in accordance with the design, and
    c. If any gaps have been identified, a plan and schedule for addressing these issues.

The Ministry is cognizant of the demands that were placed on your company by the Chief Inspector's Orders of August 18, 2014, and does not wish to place any additional undue burdens on your company. However, the previous Orders were issued before the mechanism of failure was known. Consequently, you are asked to provide a letter of assurance to respond to the items listed above. The letter is to be prepared and sealed by a qualified professional engineer, and is to be submitted to the Chief Inspector of Mines by June 30, 2015. To facilitate MEM's review, you are asked to maintain the above numbering system in your response to each item.

It is envisioned that the above items would best be addressed through a fulsome review of existing information. Where this information has not been compiled, it will be necessary to conduct a review of historical information to determine if any gaps remain in the understanding of the relevant conditions for the tailings storage facility dams on your site. Where appropriate, follow-up actions shall be identified that will be taken to address any opportunities for improvement.

Documents supporting the letter of assurance shall be maintained on-site and shall be made available to any Inspector of Mines upon request.

It should be noted that the Panel made a number of additional recommendations in Chapters 9 and 11 of their January 30, 2015 *Report on Mount Polley Tailings Storage Facility Breach.* MEM is in general agreement with all of the recommendations, and will be examining each of them to determine how they can be implemented over the coming weeks and months. You are asked to do the same.

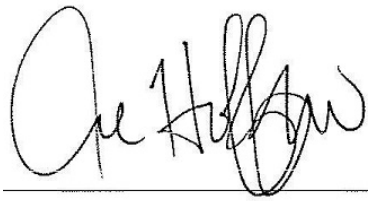
Specifically, in your response, please also provide the following information in order to inform an Action Plan on implementation of other Panel Recommendations:

- Is your mine implementing the "Toward Sustainable Mining" initiative of the Mining Association of Canada? Are there any plans to do so?

- Does your mine have an Independent Tailings Dam Review Board (ITRB) in place? Is one planned?

Thank you for your prompt attention to these matters,

Regards,



Al Hoffman, P. Eng.
Chief Inspector of Mines
Ministry of Energy and Mines

Cc: Diane Howe, Deputy Chief Inspector, Reclamation and Permitting, MEM
George Warnock, Manager, Geotechnical Engineering, MEM
Heather Narynski, Sr. Geotechnical Inspector, MEM

ATTACHMENT II

Referenced Reports Reviewed

Appendix II
Referenced Reports Reviewed

Document Tile	Author	Date of Issue
Goldstream Project - Tailings Dam (Feasibility Report -Draft)	Rescan	Apr-1990
QR Gold Project Tailings Impoundment and Fresh Water Pond Final Design of Operating Facilities	Klohn Crippen (KC)	Aug-1994
QR Gold Project Tailings Impoundment and Fresh Water Pond Technical Specifications for Construction	KC	Aug-1994
QR Gold Project Tailings Impoundment and Fresh Water Pond Stage 1 As-Built Report	KC	Feb-1995
Tailings Dam Re-Design Report	KC	Jun-1995
Tailings Facilities - 1995 Annual Review and As-Built Report	KC	Apr-1996
QR Project - Tailings Impoundment and Freshwater Pond 1996 Annual Review and As-Built Report	KC	Jun-1997
QR Project Tailings Facility - 1997 Raise of Cross-Dyke (Letter)	KC	May-1997
Tailings Dam and Fresh Water Dam Re-Design Report	KC	Jun-1997
QR Project Tailings Facility - 1998 Construction Activities	KC	Aug-1998
Water Management Plan for Temporary and Permanent Closure	KC	May-1998
QR Project - Tailings Impoundment and Freshwater Pond 1999 Annual Review	KC	Mar-2000
QR Mine Tailings Facility - Design for Permanent Closure Final Report	KC	Jul-2001
QR Project – Tailings Impoundment and Freshwater Pond 2000 / 2001 Review (Draft)	KC	May-2002
QR Mine 2002 Permanent Closure Construction Summary	Klohn Crippen Berger (KCB)	Mar-2003
QR Mine 2006 Technical Specifications - Tailings Dam and Cross Dyke	KCB	Jul-2006
QR Mine - Tailings Dam and Cross Dyke Re-Design Report	KCB	May-2006
QR Mine - Tailings Impoundment and Surface Water Management Structures 2007 Annual Geotechnical Review	KCB	Aug-2008
QR Mine - 2007 Construction Summary Report	KCB	May-2009
QR Mine - Tailings Impoundment and Surface Water Management Structures 2008 Annual Geotechnical Review	KCB	Feb-2009
QR Mine - Tailings Impoundment and Surface Water Management Structures 2009 Annual Geotechnical Review	KCB	Mar-2010
QR Mine - Tailings Impoundment and Surface Water Management Structures, 2010 Annual Geotechnical Review	KCB	Mar-2011
QR Mine Water Balance for Potential Tailings Deposition Scenarios	KCB	Aug-2012
Tailings Storage Facility 2011 Tailings Dam Seepage Assessment	KCB	Jan-2012
QR Mine Tailings Storage Facility Interim Status Construction Summary - Rev 1	KCB	May-2014
QR Mine 2012 TSF Phase II Seepage Assessment Report on Site Investigation and Trial Grouting Program – Draft	KCB	Mar-2014
QR Mine Tailings Storage Facility Trial Grouting Program – Draft	KCB	Mar-2014
QR Mine Tailings Storage facility - Tailings Storage Facility 2014 Dam Safety Inspection Report - Rev 3	KCB	Nov-2014
QR Mine Tailings Storage Facility, 2014 Construction Summary Report	KCB	Nov-2014