TETRA TECH EBA

OQM | Organizational Quality Management Program

June 30, 2015

ISSUED FOR USE
FILE: V15103090-01-005
Via Email: drmattball@avino.com

Bralorne Gold Mines Ltd.
Suite 900, 570 Granville Street
Vancouver, BC V6C 3P1

Attention: Dr. Mathew Ball, P.Geo.

Subject: Tailings Dam Assessment as per MEM Requirements

1.0 INTRODUCTION

This letter report summarises our assessment of the Bralorne Gold Mines Ltd. (BGM) tailings storage facility (TSF). The report was prepared in response to a letter from the BC Ministry of Energy and Mines (MEM) to BGM on February 3, 2015 (Appendix A) that requested an assessment of the TSF related to foundation conditions, water balance adequacy and filter adequacy.

Tetra Tech EBA Inc. (Tetra Tech EBA) was retained by BGM to undertake this assessment via email approval on April 2, 2015. Terms of Reference for this study were provided in Tetra Tech EBA's proposal (Ref: PV15103090-01), dated February 27, 2015.

The mine is located approximately 160 km north of Vancouver, BC in the Cadwallader Creek Valley near Bridge River, BC. The TSF is located in a 300 m wide valley, and includes an 'L shaped' embankment retaining tailings and water. The embankment is approximately 10 m high at maximum.

BGM has suspended milling and tailings deposition pending an increase in freeboard via a raise of the existing TSF embankment. Tetra Tech has provided design of a 3 m raise to the TSF embankment that BGM plans to construct in 2015. Construction drawings showing the existing features of the facility and design drawings showing the proposed embankment raise are attached as Appendix B.

2.0 SCOPE

The following tasks were undertaken as part of this assessment:

- Review of the available borehole records in the area of the embankment footprint to assess the potential presence of silt and clay layers susceptible to undrained shear failure and review of the existing embankment geotechnical stability model to confirm the incorporated foundation conditions are adequate. The potential requirement for additional borehole information was assessed based on the availability and adequacy of borehole records and data provided by BGM.
- Review the adequacy of the TSF water balance based on information provided by BGM and the points under Item 2 in the MEM letter.
- Review the filter adequacy including an assessment of embankment materials filter compatibility based on the test results available in the construction reports. This assessment was based on the as-built drawings and reports prepared by others and provided by BGM.
- Provide a summary (letter report) of the assessment with response formatted to the numbered points as requested by MEM.

Tetra Tech EBA Inc.
150, 1715 Dickson Avenue
Kelowna, BC V1Y 9G6 CANADA
Tel 250.862.4832 Fax 250.862.2941

3.0 SOURCES OF INFORMATION

Tetra Tech EBA was not involved in the initial investigation, design or construction of the Bralorne TSF and as such, we are relying on data collected by others and provided by BGM to undertake this assessment. We have no way of verifying the accuracy or completeness of the information from others. Tetra Tech EBA has undertaken the design of a proposed dam raise and will be involved in monitoring the construction of these works. The following documents were reviewed by Tetra Tech EBA for this assessment:

- TSF operational and monitoring records provided by BGM, including pond water levels from 2008 to early 2015, piezometer water levels from 2011 to early 2015, and settlement monitoring pin coordinates from 2009 to early 2015.
- *Borrow Assessment at Bralorne Gold Mine Tailings Storage Facility,* Tetra Tech EBA, September 24, 2014.
- *Bralorne Tailings Storage Facility, 2014 Annual Inspection Update, Bralorne Gold Mine, BC*, Tetra Tech EBA File: V15103090-01, November 2014.
- *Bralorne Gold Mine Tailings Storage Facility Hydrotechnical Assessment*, Tetra Tech EBA File 704-V15103090, November 2014, Issued for Use.
- *Water Treatment 2013 Summary Report*, prepared by Bralorne Mines Ltd., July 2013;
- *Bralorne Gold Mine, Tailings Dam Annual Report 2009*, P.K. Read Engineering Ltd., March 2010.
- *Bralorne Mine Environmental Management Update*, Lorax Environmental, September 2008.
- *2004 Construction Report, Bralorne Tailings Impoundment*, Jacques Whitford and Associates Ltd., February 2005.
- *Tailings Dam Facilities: Design Verification and 2003 Construction Report Bralorne-Pioneer Gold Mine, Bralorne, B.C.,* Jacques Whitford and Associates Ltd., January 2004.
- *Bralorne Gold Project, Reclamation Permit Application,* Hallam Knight Piésold Ltd., August 1995, Report prepared for Avino Mines and Resources Ltd.

4.0 TAILINGS FACILITY ASSESSMENT

The assessment of the Bralorne Mine Tailings Storage Facility is presented with the response formatted to the numbered points as requested by MEM in their letter of February 3, 2015 (Appendix A).

1. Tailings Storage Facility Foundation Conditions

    a. Potential Presence of Weak Silt and Clay Layer

    There is no indication of weak silt and/or clay layers in the TSF foundation based on existing information. The geomorphology of the Bridge River Valley and the Cadwallader Creek Valley tributary is typically characterized by sand and gravel plateaus, poorly sorted glacial till, and some outwash materials. The interpreted foundation geological conditions are as presented in the “Bralorne Gold Project, Reclamation Permit Application” by Hallam Knight Piésold, 1995. This report included reference to a TSF site investigation program that comprised 16 test pits, 6 boreholes with Standard Penetration Tests (SPT) and permeability testing, and laboratory characterisation of soil samples. Select borehole logs, a terrain map,

the test hole location plan, and a cross-section from Hallam Knight Piésold, 1995 are included in Appendix C. Borehole logs from two holes drilled immediately downstream of the embankment in 2008 were consistent with the previous findings and are also included in Appendix C. These records indicate that the foundation materials are comprised of silty till and sandy gravel deposits that were classified as dense to very dense based on SPT results with blow counts typically in the range of 30 and greater. Construction records indicate that the embankment footprint was stripped prior to construction and that a nominal 1.8 m deep by 4.5 m wide key trench of compacted silty till was constructed along the length of the embankment to intersect surficial material.

b. Site Investigation Adequacy

The historical site investigation scope is consistent with the standards of engineering practice at time of the project. Given the inherent variability in native soil deposits, there is always some uncertainty regarding the adequacy of a site investigation program and it is difficult to give assurances that all soil units have been encountered and the groundwater regime is fully understood. To confirm the previous findings and provide further data points, BGM has agreed to collect geotechnical data during the installation of new piezometers as part of the dam raise program planned for 2015.

c. If present, whether or not the dam design accounts for the presence of weak layers in the foundation

Weak layers have not been identified in the foundation of the dam. The subsurface material parameters and geometry applied in stability analyses of the proposed TSF embankment raise were determined based on test pit and borehole logs, and laboratory and field testing data. The stability analyses results indicated that the design embankment meets the requirements of the British Columbia Dam Safety Regulation and the Canadian Dam Association Dam Safety Guidelines.

It should also be noted that from a geotechnical stability perspective, the dam has performed as anticipated in the original design reports. This provides some level of assurance that the existing stability models, which do not include a soft/weak layer, are consistent with actual conditions.

d. Plan and schedule for additional sub-surface investigation

BGM plans to replace existing standpipe piezometers installed the TSF embankment in 2015. This will involve mobilisation of a drill rig capable of geotechnical sampling and testing, and provide an opportunity to confirm the ground conditions at select locations below the embankment.

2. Tailings Storage Facility Water Balance

a. Water balance adequacy including consideration of surplus mine site water stored in the TSF

Inflows to the Bralorne TSF include precipitation and surface water runoff, groundwater, tailings slurry water, and water pumped from the underground mine. Outflows from the Bralorne TSF include seepage, evaporation, and water retained in the tailings. The amount of water stored in the facility varies seasonally and also as a function of the amount of mine water pumped to the storage. As the volume of tailings stored in the facility has increased over time, the buffer capacity to handle seasonal variation and potential stormwater inflow has decreased. In addition, the seepage flows from the embankment have decreased over time, likely due to the low permeability tailings blanket deposited in the TSF basin.

The current system is not adequate with respect to water balance, and BGM has commenced planning for alternative management of mine water (see response 2c) and raising the tailings storage facility

embankment. The raised embankment will increase both tailings storage capacity and the buffer capacity for design storms and surplus water.

b. Volume of surplus mine water added to the TSF over each of the last five years

Mine water input to the Bralorne Mine TSF has included tailings slurry water and water pumped from the underground mine.

Year	Tailings Slurry Water m^3	Underground Mine Water m^3	Total Mine Water to TSF m^3	Comment
2010				Underground mine drainage pumped to TSF beginning in 2004. Records not available.
2011	38,969	52,031	91,000	Trial milling startup.
2012	81,471	14,894	96,365	
2013	85,249	250	85,499	
2014	99,497	200	99,697	
2015	N/A	- *	- *	Mill not operating.

* Note: 2015 is atypical with excess underground mine drainage pumped to TSF and water pumped out of the TSF periodically for emergency drawdown to maintain freeboard.

c. Any plans to release surplus mine water to the environment

BGM is currently permitted and advancing plans to treat and release excess water from the underground mine to Cadwallader Creek. This approach will reduce the amount of mine water input to the TSF. BGM pumps excess water from the underground mine to the TSF when unable to treat and release to Cadwallader Creek. Current water management initiatives include a study that involves an assessment of inflows to the underground and options to mitigate these flows. The proposed embankment raise will incorporate an emergency spillway, only to be used during an emergency release condition.

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

There is no specified minimum tailings beach width at the TSF. Historically, the beach was submerged as the facility was operated with greater water input than tailings. Since starting milling operations in 2011, BGM managed tailings deposition to create beaches adjacent to the embankment and a subaerial tailings deposition environment. The beaches were between 25 m and 50 m wide when surveyed in September 2013.

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

The likelihood of the TSF embankment undergoing significant deformation was assessed to be low due to the dense to very dense foundation conditions and the embankment design.

The maintenance of adequate freeboard is essential to mitigate the risk of embankment overtopping and release of water from the storage facility. The construction of the dam raise in 2015 will re-instate sufficient freeboard to mitigate any risk of water release due to deformation.

f. Provisions in place to account for wet years

The freeboard associated with the TSF embankment raise design was assessed to ensure containment of the inflow design flood. The inflow design storm event was determined to be 62,500 m^3 using a rainfall runoff approach that was based on site specific conditions such as soil type and local climate data. When a shallow tailings beach is not present adjacent to the embankment, a freeboard of 0.29 m in addition to the storm storage is required to protect the embankment against wind and wave run-up.

BGM are currently maintaining the 1 m minimum freeboard specified in the operating permit by emergency drawdown measures.

g. A plan and schedule to address any gaps or issues identified

BGM plans to raise the TSF embankment by approximately 3 m in the summer/fall of 2015 and incorporate an emergency spillway into the design. This earthwork is expected to generate over 100,000 cubic metres of additional storage capacity for tailings and water.

3. Filter Assessment

a. Beach width and filter specifications necessary to present potential piping

The Bralorne TSF embankment was assessed to have a low vulnerability to internal erosion as part of the embankment raise design assessment (Tetra Tech EBA, 2014). The Bralorne TSF tailings beach width is not specified in the context of filter requirements.

b. Filter construction in accordance with the design

The compatibility between the embankments till core, blanket drain, and outer shell material was assessed by the method outlined in Sherard and Dunnigan, 1985. Sherard and Dunnigan (1985) state that for different impervious soil types that different assessment criteria be utilized. Based on the sieve analyses of the embankment materials (JW, 2004), the base materials have been classified as follows:

- Dam Shell: Impervious Soil Group 3, sand and sandy gravels with small content of fines. $D_{15F} \leq 4D_{85B}$
- Till Core: Impervious Soil Group 2, sandy silts. $D_{15F} \leq 0.7mm$

Based on this criteria the dam shell and till core material was analyzed for compatibility with the blanket drain. The material property parameters used for the analyses are summarized in Table 1 and the results of the analysis are presented in the Table 2.

Table 1: Summary of Parameters Used for the Compatibility Analysis

Material	D15	D85	4D85
Blanket Drain	0.363	25.90	103.6
Till Core	N/A	6.47	25.88
Shell Material	0.833	34.50	138

Table 2: Results of Compatibility Analyses

Material	Blanket Drain
Dam Shell $D_{15F} \leq 4D_{85B}$	0.363 < 25.88 Pass
Till Core $D_{15F} \leq 0.7mm$	0.363 < 0.7 Pass

Based on the analyses, the dam shell material and the till core are compatible with the blanket drain material. This means there is a reduced likelihood of piping due to fines loss through the drain as well as a decreased chance that the drain material will undergo clogging from fines from the till core or dam shell.

c. A plan and schedule to address any gaps or issues identified

The proposed embankment raise specification incorporates a requirement that the raised embankment is keyed into competent material and inspected during construction to mitigate the risk of excessive seepage and piping at the abutments.

5.0 LIMITATIONS OF REPORT

The assessment was based on boreholes and data undertaken by others and Tetra Tech EBA assumes that the data is complete and accurate. The responsibility for the accuracy of the provided information remains with the company(s) originally retained to gather the geotechnical data.

This report and its contents are intended for the sole use of Bralorne Gold Mines Ltd. and their agents. Tetra Tech EBA Inc. (Tetra Tech EBA) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Bralorne Gold Mines Ltd., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech EBA's Services Agreement. Tetra Tech EBA's General Conditions are provided in Appendix D of this report.

6.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech EBA Inc.

Prepared by:
Chris Johns, P.Eng.
Geological Engineer
Phone: 250.862.3026
chris.johns@tetratech.com

Review by:
Scott Martin, P.Eng.
Vice President, Pacific Engineering
Phone: 250.862.3026
scott.martin@tetratech.com

Attachments:

	Appendix A	BC Ministry of Energy and Mines Letter to BGM, February 3, 2015
	Appendix B	Construction Drawings (JW, 2004)
		Embankment Raise Design Drawings
	Appendix C	Borehole Plan and Logs from Site Investigations by Others
	Appendix D	Tetra Tech EBA's General Conditions – Geotechnical Report

REFERENCES

Sherard, J.L, and Lorn P. Dunnigan (1985). “Critical Filters for Impervious Soils” ASCE, Journal of the Geotechnical Engineering Division, No. 115(7), July 1989, pp. 927-947.