November 24, 2014

INDEPENDENT REVIEW OF 2014 DAM SAFETY INSPECTION REPORT

Highmont Tailings Dams

Submitted to:
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REPORT

Golder Associates

Executive Summary

Golder Associates Ltd. (Golder) was engaged by Teck Highland Valley Copper Partnership (HVC) to perform an independent review of the 2014 Dam Safety Inspection report produced by Klohn Crippen Berger Ltd. (KCB).

The independent review was required based on the *Notification of Chief Inspector's Orders – Tailings Dams – Independent Review of Dam Safety and Consequence Classification* from the British Columbia Ministry of Energy and Mines (BC MEM) dated August 18, 2014 (BC MEM 2014).

The scope of the review included the following:

- Site visit by Mr. Terry Eldridge, P. Eng., on September 16, 2014, as part of a Tailings Review Board meeting at the HVC site, to visually observe the status and condition of the Highmont tailings dams; and
- Review of the 2014 Annual Dam Safety Inspection and Review (DSI) report produced by KCB, reference 141107R-Highmont DSI, dated November 21, 2014 (KCB 2014).

The findings of Golder's review are as follows:

- The DSI report prepared by KCB addresses the elements required by the BC MEM (2012).
- The dam consequence classifications are appropriate.
- The report provides a comprehensive documentation of the status and performance of the tailings dams.
- The report provides a thorough description of the responses of the instrumentation over time.
- The report provides a list of recommended actions assigning priority and a timeline for implementation. None of the recommendations relate to high priority issues concerning dam safety that require immediate action.

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was engaged by Teck Highland Valley Copper Partnership (HVC) to perform an independent review of the 2014 Dam Safety Inspection report produced by Klohn Crippen Berger Ltd. (KCB).

The independent review was required based on the *Notification of Chief Inspector's Orders – Tailings Dams – Independent Review of Dam Safety and Consequence Classification* from the British Columbia Ministry of Energy and Mines (BC MEM) dated August 18, 2014 (BC MEM 2014). This order states:

> *The mine manager must have the DSI reviewed by an independent qualified third party professional engineer from a firm that has not been associated with the tailings dam. The Independent Third Party Review of the DSI must also include a review of the dam consequence classification.*

The scope of the review included the following:

- site visit by Mr. Terry Eldridge, P. Eng., on September 16, 2014, as part of the Tailings Review Board meeting at the HVC site, to visually observe the status and condition of the Highmont tailings dams; and
- review of the 2014 Annual Dam Safety Inspection and Review (DSI) report produced by KCB, reference 141107R-Highmont DSI, dated November 21, 2014 (KCB 2014).

The KCB DSI report includes discussion of the performance of the seepage collection ponds associated with the Highmont tailings dams (KCB 2014). As tailings dams are the focus of the BC MEM (2014) order, this independent review is restricted to the Highmont tailings dams.

The independent review is not a Dam Safety Review as defined in the *Dam Safety Review Guidelines* produced by the BC Dam Safety Section (BC MEM 2012), Section 5 of the Canadian Dam Safety Guidelines (CDA 2013) and in the *Professional Practice Guidelines – Legislated Dam Safety Reviews in BC* produced by the Association of Professional Engineers BC (APEGBC 2014).

2.0 BACKGROUND

2.1 Project and Site Description

The Highland Valley Copper Mine is owned and operated by Teck Highland Valley Copper Partnership (HVC). The mine is located near Logan Lake, about 45 kilometres south of Kamloops, British Columbia. The Highmont TSF starter dam was completed in 1980, and the facility received tailings until 1984. Tailings have not been deposited in the TSF since the end of 1984, and the facility has only undergone routine maintenance and upgrade of the water management components to date.

The Highmont tailings facility comprises three dams that create a three sided ring dyke against the valley side. Natural ground completes the containment. The dams are zoned rockfill with central low permeability till core. The TSF was designed to a crest elevation of 1524 m, however due to the stoppage of the operation in 1984 the finished crest elevation is 1487.4 m. Design features include filter zones downstream of the core, a downstream rockfill shell and a wide tailings beach above water at the tailings pond. The dams have a nominal height of 30 m. A spillway was constructed on the west abutment in 2003 and a slide gate was installed in 2007 in the spillway to control flows into downstream pond S1.

2.2 Design Engineer

The design engineers for the Highmont tailings dams include Ripley, Klohn Leonoff International and Klohn Leonoff Consultants, both predecessors of Klohn Crippen Berger Ltd. KCB has maintained involvement with these dams since the initial design and is the current Engineer of Record for the Highmont tailings dams.

The preparation of this report by Golder does not impact the Engineer of Record role held by KCB.

3.0 INDEPENDENT REVIEW OF DAM SAFETY INSPECTION REPORT

3.1 Compliance with Ministry of Energy and Mines Requirements

The requirements for DSIs are presented in *Guidelines For Annual Dam Safety Inspection Reports* (BC MEM 2012). Table 1 summarizes the compliance or otherwise of the KCB DSI report with the BC MEM requirements.

Table 1: Compliance of Dam Safety Inspection Report with British Columbia Ministry of Energy and Mines Dam Safety Inspection Requirements

Requirement	Included	Comment
Executive Summary Classification of the dam(s) in terms of Consequence of Failure in accordance with Table 2-1 of the CDA Dam Safety Guidelines (2013).	✓	North and South – High. East - Significant
a. Significant changes in instrumentation and/or visual monitoring records.	✓	
b. Significant changes to dam stability and/or surface water control.	✓	
c. For major impoundments, as defined in Part 10 of the Code, a current Operation, Maintenance and Surveillance (OMS) Manual is required. The annual report shall indicate the latest revision date of the OMS manual.	✓	Dec 2013 OMS update
d. For tailings dams classified as High, Very High, or Extreme Consequence, an Emergency Preparedness Plan (EPP) is required. The annual report shall indicate the latest revision date of the EPP document.	✓	2013 EPRP update
e. Scheduled date for the next formal Dam Safety Review in accordance with Table 5-1 of the CDA Dam Safety Guidelines (2013). Formal Dam Safety Reviews are required every 5 to 10 years (depending on consequence classification) and differ from annual dam safety inspections. The requirements for Dam Safety Reviews are included in Section 5 of the CDA Dam Safety Guidelines. Dam Safety Reviews may be conducted by the Engineer of Record with third party review, or by an independent third party with involvement of the Engineer of Record.	✓	2020 Dam Safety Review
Summary of past years' construction (if any) with a description of any problems and stabilization	✓	No tailings deposition since 1984. Last construction in 2007 (gate valve in spillway)
Plan and representative cross-sections	✓	
Site photographs	✓	
Review of climate data	✓	
Water balance review	✓	
Freeboard and storage availability (in excess of the design flood)	✓	
Water discharge system, volumes, and quality	✓	Indicates water quality reported by HVC
Seepage occurrence and water quality	✓	Indicates water quality reported by HVC
Surface water control and surface erosion	✓	
Instrumentation review including: (a) Phreatic surfaces and piezometric data (b) Settlement (c) Lateral movement	 ✓ ✓ ✓	

3.2 Dam Consequence Classification

Tailings dams in British Columbia are regulated under the Health, Safety and Reclamation Code for Mines in British Columbia 2008, which references Canadian Dam Association (CDA) Dam Safety Guidelines (CDA 2013).

Consequence categories are based on the incremental losses that a failure of the dam might inflict on downstream or upstream areas, or at the dam location itself. Incremental losses are those over and above losses that might have occurred in the same natural event or condition had the dam not failed. The classification assigned to a dam is the highest rank determined among the loss categories.

Table 2 presents the dam classification criteria by CDA (2013).

Table 2: Dam Classification in Terms of Consequences of Failure

Dam Class	Population at Risk[(a)]	Incremental Losses		
		Loss of life[(b)]	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	Minimal short term loss. No long term loss.	Low economic losses; area contains limited infrastructure or service.
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 transport routes.
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 transport, 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).

Source: CDA (2013).

a) Definition for population at 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).

b) 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.

A dam breach and inundation study was carried out by AMEC in 2014 and the results were reviewed as part of this DSI review to identify downstream losses in the event of a dam breach and to assign a dam consequence classification as shown in Table 3.

Table 3: Dam Consequence Classification – Golder Interpretation

Dam	Population at Risk	Incremental Losses			Dam Consequence Classification
		Loss of Life	Environmental and Cultural Values	Infrastructure and Economics	
North	Temporary Only	Unspecified	Loss of marginal habitat only. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transport routes.	Significant
East	Temporary Only	Unspecified	Loss of marginal habitat only. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transport routes.	Significant
South	Temporary Only	Unspecified	Loss of marginal habitat only. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transport routes.	Significant

KCB has assigned dam consequence classifications of High for the North and South Dams and Significant for the East Dam. The Highmont tailings dams were designed with a spillway to pass the PMF and for an earthquake generating a peak ground acceleration of 0.5 g, which is greater than the peak ground acceleration generated by the 10,000 year return period event. Both design criteria exceed the requirements for Significant and High consequence classification dams.

4.0 FINDINGS AND RECOMMENDATIONS

4.1 General Findings

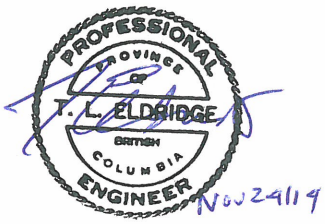
The general findings of Golder's review are as follows:

- The DSI report prepared by KCB addresses the elements required by the BC MEM (2012).
- The dam consequence classifications are appropriate.
- The report provides a comprehensive documentation of the status and performance of the tailings dams.
- The report provides a thorough description of the responses of the instrumentation over time.
  - Piezometers installed within the tailings indicate a groundwater mound exists about 300 m upstream of the East dam. The measured water level is about 4 metres higher than the pond water level. The groundwater level at the East dam does not show this groundwater mounding, and is therefore not an issue for dam stability. KCB consider that this elevated water level within the tailings may be due to ongoing long-term consolidation of the tailings. However, tailings have not been deposited in this facility for 30 years and consolidation of the nominal 20 m thickness of tailings is likely to be complete. KCB has recommended that the reason for the measured piezometric level being elevated in this area be investigated.
- The report provides a list of recommended actions assigning priority and a timeline for implementation. A number of actions recommended by KCB are to bring the documentation of the dams to a level consistent with the dam consequence classification. None of the recommendations relate to high priority issues concerning dam safety that require immediate action.

5.0 REPORT CLOSURE

We trust that this Independent Review of the 2014 Dam Safety Inspection Report of the Highmont Mines tailings dams (KCB 2014) meets your requirements. Please contact the undersigned if you require additional information regarding this review.

GOLDER ASSOCIATES LTD.



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Principal, Senior Engineer

TLE/AJH/rs/it

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