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27 November 2014

Province of British Columbia
Ministry of Forests, Lands and Natural Resource Operations
2nd floor, 441 Columbia Street
Kamloops BC, V2C 2T3

Attn: Dave McBeth, RPF
A/Director, Resource Management
Thompson-Okanagan Region

Re: Alwin Tailings Dam
Independent Third Party Review of Dam Safety Inspection

1. INTRODUCTION

This letter presents the observations and conclusions of a third party review of the dam safety inspection (DSI) of the Alwin tailings dam. The review was carried out in accordance with Klohn Crippen Berger (KCB) Subconsultant Agreement dated November 24, 2014. The third party review was mandated by the British Columbia Ministry of Energy and Mines (MEM), Chief Inspector's Orders, dated August 18, 2014, which stipulated that a DSI be carried out to cover all dam structures for all tailings storage facilities in British Columbia, and that the DSI must be reviewed by an independent qualified engineer from a firm that has not been associated with the tailings dam. The Independent Third Party Review must include a review of the dam consequence classification.

The DSI of the Alwin tailings dam was carried out by KCB, dated November 2014 (Klohn Crippen Berger, 2014). This third party review is based on that DSI. No site visit was made for the third party review.

2. BACKGROUND

Alwin Mine is located about 18 km west of Logan Lake, BC, and just west of the Highland Valley Copper operations. The mine operated in 1972, milling about 77,000t and in 1981, milling about 155,000t (Kerr 2006). Tailings from these operations were disposed in the tailings storage facility (TSF), formed by construction of the dam. No mining or milling have been done on the property since 1981.

The dam was constructed in 1971 under the direction of CBA Engineering. The initial tailings dam was about 10 ft. high, with a crest elevation of 5060 ft. The dam was raised by downstream construction in 1980 to its current crest elevation of 5081 ft., with the raise design prepared by Herman Fellhauer, P.Eng. The maximum height of the dam, from crest to downstream toe, is about 35 ft. The crest length is about 1000 ft. (305m). In 1982 a spillway was constructed in the north abutment of the dam, with the invert at elevation 5076 ft. The spillway was also designed by Herman Fellhauer.

The TSF is currently filled with water to about the level of the spillway. The tailings surface is reported to be about 20 ft. below the water surface. The TSF pond is now referred to as Little OK Lake. The lake

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is used as a recreational fishery. Island Lake, also known as Big OK Lake, is downstream of Little OK Lake. Island Lake is known as a trophy fishery for large trout.

The Alwin tailings dam was previously assigned a consequence classification of "LOW" by MEM personnel. KCB suggests that classification should be reviewed, since the facility has undergone a change of use from a tailings facility to a recreational fishing lake.

3. **2014 DAM SAFETY INSPECTION**

Neil Singh, P.Eng. and Emma Hill of KCB visited the site on October 29, 2014 to undertake the Dam Safety Inspection. They provided a good photographic record of the dam.

Significant findings of the 2014 DSI included:

- The embankment slopes and crest appeared in good condition, with no signs of significant deformation or erosion
- Minor seepage was noted downstream of the dam. The seepage reports to the seepage recovery pond which was reported to be in satisfactory condition. Oil barrels and other debris were noted in the area of the seepage pond.
- The spillway was noted to have been partly infilled with road surfacing material that has raised the spillway invert above its design level
- An open adit was noted near the old mill, representing a public safety hazard.

Recommendations of the 2014 DSI were as follows:

- Geotechnical inspector to discuss abandonment and responsibility for this impoundment with colleagues at MEMPR and MELP. At this time, the bond on the defaulted permit should be retained.
- Clean up oil barrels and debris near the seepage pond
- Remove excess road surfacing in spillway and confirm spillway invert is at 5076 ft. elevation, or demonstrate that dam has sufficient freeboard and spillway has sufficient capacity
- Prepare an OMS manual for the facility or demonstrate that it is not required
- Locate as-built drawings or prepare new ones using an updated survey
- Confirm if geotechnical review by C.O. Brawner exists and if so, locate it and review
- Carry out a DSR to review the dam classification
- Confirm if there are functional instruments and if so, locate them and obtain readings
- Define monitoring and instrument readings frequency for Alwin Dam and include in OMS
- Define monitoring frequency of flow rates and water quality measurements
- Remove trees and bushes in spillway channel

- Remove logs and debris from spillway channel, extend cobbles in upper section of spillway to full depth of road crossing
- Adjust spillway invert to design elevation and resize spillway excavation to accommodate cobbles and road crush
- Inspect and repair identified erosion areas in lower portion of spillway
- Close off access to underground workings. Reclaim old mill site.

4. CONCLUSIONS AND RECOMMENDATIONS OF 3RD PARTY REVIEW

4.1 The 2014 DSI provides a good summary of the status of the Alwin tailings dam and to have addressed the key issues as per the Ministry of Energy and Mines Guidelines for Annual Dam Safety Inspection Reports. Recommendations provided in the 2014 DSI are considered appropriate and should be followed.

4.2 The Alwin Dam is currently assigned a CDA consequence category of Low. Given that the lake supports fish, and is upstream of another fishery lake, a consequence classification of Significant or High, depending on the value of the fishery, would be more appropriate. The writer recommends, in agreement with KCB, that a DSR be carried out to re-assess the consequence classification.

4.3 The embankment as described by KCB is apparently in good condition and there appears to be a low risk of any mode of failure.

4.4 While not a dam safety issue, the open mine adit near the old mill foundations appears to pose a public safety hazard, and should be securely closed.

5. CLOSURE

Thank you for the opportunity to undertake this 3rd party review of the Alwin Mine tailings dam DSI. I would be pleased to provide any additional information or clarification you may require.

Yours truly,

November 27, 2014

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c. Diane Howe, P.Geo. (Ministry of Energy and Mines)
Neil Singh, P.Eng. (Klohn Crippen Berger)

REFERENCES

British Columbia Ministry of Energy and Mines, August 2013. Guidelines for Annual Dam Safety Inspection Reports.

Canadian Dam Association, 2007. Dam Safety Guidelines.

Canadian Dam Association, 2014. Mining Dams Technical Bulletin.

Kerr, John R., P.Eng. 2006. Summary Report on the Alwin Property, Kamloops Mining Division, British Columbia, report prepared for Max Investments Inc., on behalf of San Marco Resources Inc., November 15, 2006.

Klohn Crippen Berger, 2014. Alwin Tailings Dam, 2014 Dam Safety Inspection, report prepared for Province of British Columbia Ministry of Energy and Mines, November 2014.