Klohn Crippen Berger

June 25, 2015

Teck Highland Valley Copper Partnership
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Chris Fleming
Superintendent - Tailings and Water Management

Dear Mr. Fleming:

HVC Tailings Dams - Highmont Tailings Storage Facility
Response to MEM Memorandum - February 3, 2015

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 breach on January 30, 2015. Subsequent to the release of the Expert Panel report MEM issued a memorandum on February 3, 2015 (MEM memorandum), to all tailings dam owners in British Columbia to undertake a specific risk assessment of their tailing dams and report the results to MEM by June 30, 2015.

This report outlines KCB's assessment of conditions at the three dams forming the Highmont Tailings Storage Facility (TSF) 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. MEM items are shown in blue italicized text; KCB's response is shown in normal black text.

We consider this assessment to represent the knowledge of the facility available to KCB 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. Teck HVC has a very robust surveillance program as outlined in their Operations, Surveillance and Maintenance manual, involving regular inspections, weekly

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

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surveillances, instrumentation monitoring, full time engineering staff on site and a thorough reporting plan which includes dam safety inspections and annual performance reports.

1.1 Assessment Scope

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

1. Undrained shear failure of silt and clay foundations;
2. Water balance adequacy; and
3. Filter adequacy.

KCB reviewed available historical information on foundation characterization, design, construction, and operations records for the Highmont North, East and South Dams of the Highmont Tailings Storage Facility (TSF) to prepare responses for sub-items listed in the MEM memorandum. A summary of the documents reviewed is included in the reference list. Responses to the above three items are provided in Section 3, following the numbering system used in the MEM memorandum. Documents supporting this letter will be maintained on-site by Teck.

Our review included review of test pit and drill hole logs from the original investigation and design to the present, with particular consideration of whether silt and clay soils are present.

2 HIGHMONT TSF OVERVIEW

The Highmont TSF is shown on the attached Figures 1 and 2. The Highmont TSF includes a tailings pond retained by three main dams: North Dam, East Dam, and South Dam. The TSF has five perimeter seepage retention ponds and two decommissioned seepage ponds.

The construction of the Highmont starter dam and seepage dams are detailed in “Highmont Tailings Disposal System – 1980 Starter Dam Construction” (KL 1981). The design basis for the Highmont TSF is presented in a series of reports including (KL 1980a) and (KL 1980b).

Mining started at Highmont in 1979 and continued until the facility was shut down in 1984. Since then no tailings have been added to the Highmont TSF.

A spillway was constructed on the Highmont TSF in 2003 to 2004. It is located on the left abutment of the North Dam

The dams incorporate a compacted impervious glacial till starter dams of approximately 17 m height with an upstream random fill buttress. The dams were raised by centerline method with a downstream section of rockfill, an upstream section of spigotted tailings and two filter zones separating the two sections. The dams were raised progressively throughout the mine life until operations ceased at Highmont. The reported maximum dam heights range from 30 m to 47 m, significantly less than the maximum design height of 82 m. As a result, the existing dams are significantly wider than required by the design for the current heights.

The Highmont TSF retains tailings and a shallow water pond. The size of the pond was controlled by pumping after each spring runoff until the permanent spillway was constructed for both short-term operational and long-term decommissioning purposes.

There are ongoing investigations, monitoring and surveillance at the Highmont TSF. Where ongoing activities relate to the MEM questions, we refer to existing recommendations and tasks and their reference number.

3 HIGHMONT TAILINGS STORAGE FACILITY (TSF)

3.1 *Task 1 - Review of Foundation Conditions Risk of Undrained shear failure of silt and clay foundations*

There is low risk to dams at the Highmont TSF from undrained shear failure of silt and clay foundation conditions similar to those found at Mount Polley. Silt and clay foundation conditions are not noted in the foundations of the North Dam and East Dam. A lacustrine silt layer is noted at the South Dam which is 1.5 m to 3 m thick and about 23 m below original ground level. We have an adequate level of confidence in the available information. A stability analysis assuming a continuous weak layer has shown that even with the silt layer under the South Dam, the dam will meet stability criteria.

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

Based on our review of the original design similar foundation conditions to Mount Polley are not present at the North Dam or East Dam. No silt or clay soil layers were encountered in the foundation of the North Dam or East Dam (RKL 1971; KL 1980c) and bedrock is near surface.

At the South Dam, a lacustrine silt layer 1.5 m to 3 m thick, about 23 m below the original ground surface was identified (RKL 1971; KL 1981). The material is described as stiff, lacustrine silt, interbedded with sand lenses. The design report indicates that the silt is not extensive and only present in a “pocket” at the bottom of the valley. The next nearest drill holes or test pits are 80 m upstream and 30 m downstream neither of which show the silt, implying a potential maximum extent of about 100 m. The available information indicates the layer is of limited extent but the soil properties are not available.

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

The original design report included 28 drill holes, 215 test pits, and 3 geologic cross sections. The average drill hole spacing was approximately 30 m to 60 m. Most of the drill holes extended to bedrock.

Considering the limited extent of silt identified under the South Dam, the general nature of the foundation soils (till over bedrock, with some ablation till deposits, removed), and that operations at

this facility ceased in 1984, we believe that sufficient site investigations have been conducted to have confidence in this determination.

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

At the South Dam, the presence of the lacustrine soil pocket in the foundation of the South Dam was acknowledged in the design report, with the following comment: "The silt is stiff and relatively incompressible and will provide good foundation support" (KL 1980c), and therefore the foundation was treated similarly to the North and East Dams. It is possible that the silt is now normally consolidated under the loading from the dam fill.

North Dam and East Dam design is appropriate for the foundation conditions identified. At all three dams (including the South Dam), soft material was stripped until competent glacial till was reached (HOC 1982).

Although the pocket of silt exists in the foundation, there are no further plans for construction or tailings deposition at the TSF so the only potential for undrained loading would be from a seismic event. As part of our review, we carried out a preliminary stability analysis assuming a continuous weak silt layer, using typical undrained residual strengths from similar silts elsewhere on site. This preliminary analysis, gave a minimum FoS of 1.2 which satisfies our criteria of 1.2 for undrained residual strength analysis.

The South Dam construction was completed in 1984 and there have been negligible movement or settlements since then. The dam is inspected annually in addition to weekly surveillance and is monitored through 7 survey monuments and 22 piezometers. Since 2006 the settlement recorded in survey monument P4 is less than 30 mm which is within the accuracy of the survey. In our opinion the design adequately considers the foundation conditions.

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

There are no identified gaps.

3.2 *Task 2 - Water Balance Adequacy*

The Highmont TSF is at low risk of failure due to water balance issues since it does not receive water from the mining operations and there is a closure spillway in place with adequate freeboard to manage the design flood.

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

The volume of free water behind the Highmont Dam as of October 7, 2014 was estimated at 51,300 m^3 with a pond elevation of 1480.2 m giving a freeboard (measured from pond level to the minimum dam crest) of 6.5 m. The spillway invert (El. 1480.2 m) is 6.5 m below the dam crest (El. 1486.7 m). Concrete gated structure with its sill at El. 1480.2 m was constructed to control the spillway discharge. The maximum annual pond elevation, volume, and freeboard for the past five years are:

Year	Pond Elevation	Volume[1]	Freeboard[2]
2014	1480.2 m	51,275 m^3	6.5 m
2013	Pond elevation not surveyed		
2012	1480.4 m	82,395 m^3	6.3 m
2011	1480.1 m	25,231 m^3	6.6 m
2010	Pond elevation not surveyed		

Note:
1. Pond volumes are estimated based on a stage-storage curve provided by Teck on May 26, 2015.
2. Pond level to minimum dam crest El. 1486.7 m (KCB 2014).
3. Pond elevations are based on survey water levels provided by Teck.

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

No surplus mine water has been added to the facility over the last five years. Inflows include: precipitation, runoff, pumpback water from seepage ponds (pond 3 and pond 5 only during spring if water levels are high in the seepage ponds). Outflows include: deep seepage, seepage that reports to the seepage ponds, evaporation, evapotranspiration, optional pumping from the TSF to seepage pond S1 (which receives water from all seepage ponds and flows by gravity to the mill) and is released via a spillway when applicable. The volume of outflows and inflows are approximately equal resulting in negligible net change since 2011.

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

There are no plans to release water from the Highmont TSF Pond to the environment. Water released from the spillway is collected in Seepage Pond 1 and either pumped back to the Highmont TSF or carried by gravity to the Highland Mill.

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

During operations, a minimum beach width of 91 m was specified to prevent contact of pond water with the highly pervious dam (KL 1979a). These operating beach widths do not apply during the current inactive phase of the TSF life. The pond during this phase is much smaller than during the active operation of the facility.

The current beach widths in the North Dam, East Dam, and South Dam are about 310 m, 270 m, and 325 m, respectively. Under the routed design flood the beach widths for the North Dam, East Dam, and South Dam would be about 240 m, 200 m, and 175 m respectively. The mine has historically been able to maintain the beach.

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 Highmont TSF dams were designed for an ultimate height of 82 m, but were only built to a maximum height of 47 m (North Dam). The result is a much wider dam crest than required for its height.

Stability and deformation analyses on the existing section were completed in (KCC 1996) using Newmark and empirical methods to check performance for static and seismic conditions. The results confirmed adequate long-term static and pseudo-static safety factors with a predicted deformation of 0.3 m under the Maximum Credible Earthquake (MCE). Stability analysis resulted in static factor of safety of 2.5 and pseudo-static factor of safety of 1.8. In our updated review of the South Dam, we estimated the deformation under seismic loading to be 0.6 m assuming a continuous weak silt layer. This can be accommodated by the available freeboard.

The dams as observed since the end of construction have negligible movements and no instability.

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

The Highmont spillway will pass a 24-hr PMF event (KC 2005) while maintaining a 4.1 m - freeboard to minimum dam crest elevation.

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

There are no gaps identified.

3.3 *Task 3 - Filter Adequacy*

The Highmont TSF is at low risk of failure due to filter adequacy issues (piping). Filter design and construction records and performance records indicate the dams are adequately protected against piping.

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

The specified beach width during operations was 91 m and current beach widths are wider than this.

Filter specifications were adequately designed to prevent potential piping between dam fill zones. The primary fill zones include glacial till against fine filter, and two filter (fine and coarse) zones to separate the tailings from the rockfill zone.

The filter adequacy of all zones was checked using the US Army Corps filter design criteria (USACE 2004), for permeability, internal stability and retention of soil. All checked zones satisfied criteria for stability and soil retention.

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

During the construction, filter material gradations were checked for compliance with the design criteria and reported in the final construction reports (KL 1981; HOC 1982; HOC 1984a; HOC 1984b; HOC 1984c). The filter material that did not comply with the design was removed and used as random dam fill if suitable. The records indicate that the filters were constructed in accordance with the design.

Seepage at the five remaining seepage ponds has been regularly measured and visually checked during regular site visits since the end of TSF operations. No sediment in seepage water has been noted through the lifetime of the facility.

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

No gaps have been identified for all Highmont TSF dams. The dams were designed and built to appropriate filter criteria and observations since cessation of TSF operations have indicated the filters are functioning per design.

4 SUMMARY OF GAPS AND SCHEDULE TO ADDRESS

No gaps were identified that were specifically related to the questions in the MEM memorandum. The dams are performing satisfactorily in relation to foundation conditions, water balance, and filter adequacy.

5 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Teck Highland Valley Copper Partnership (Teck) for the specific application to the 2015 Highmont MEM Memorandum Response. 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 information at the time of writing. 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.

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AS/DW/NS:cd

Attachments: Figure 1 – Location Map for Tailings Dams and Water Retention Dams
Figure 2 – Highmont Dam Plan View

REFERENCES

Highmont Operating Corporation (HOC). 1982 "1981 Dam Construction Report".

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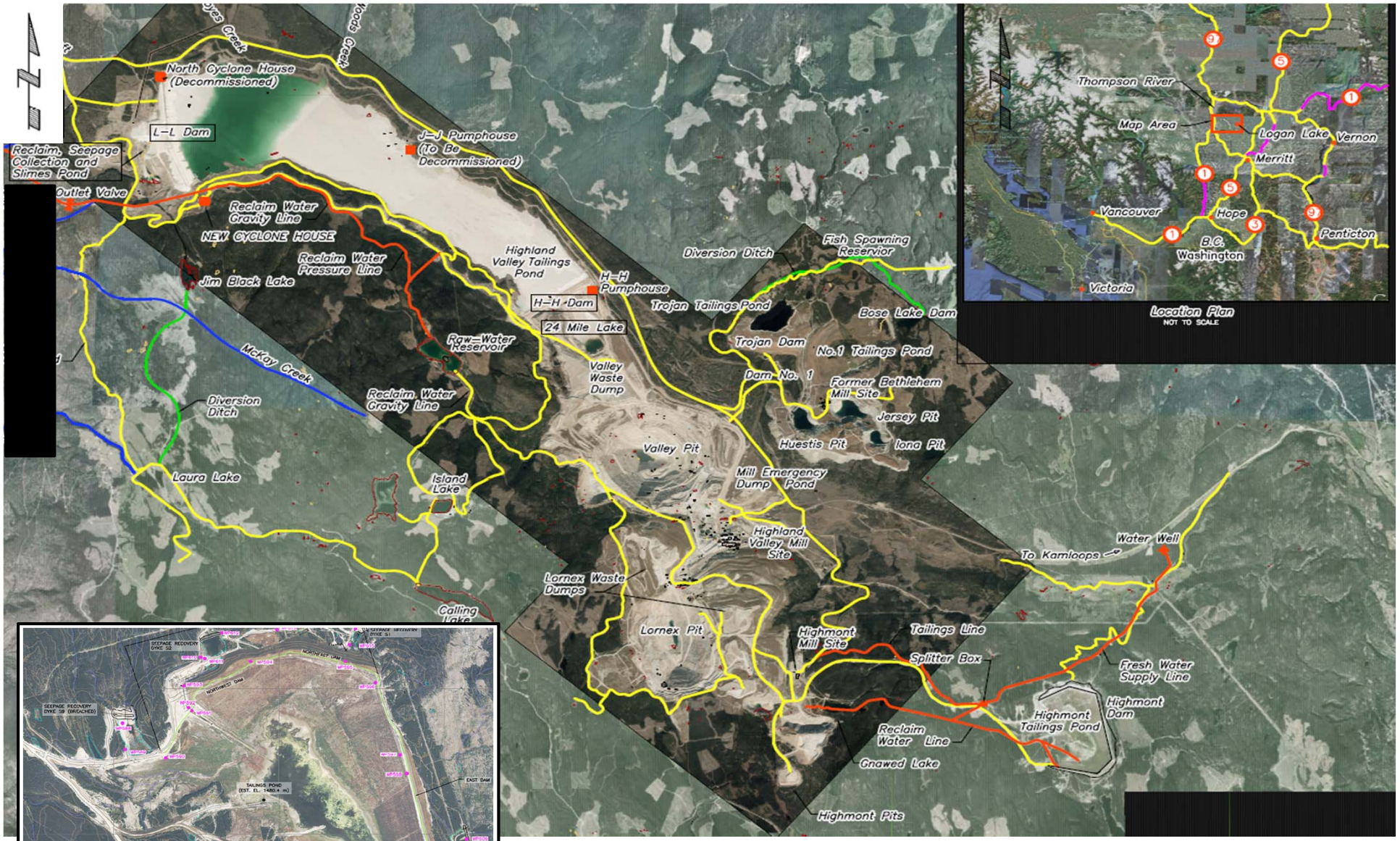
FIGURES



Highmont Tailings Storage Facility

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED JUNE 25, 2015

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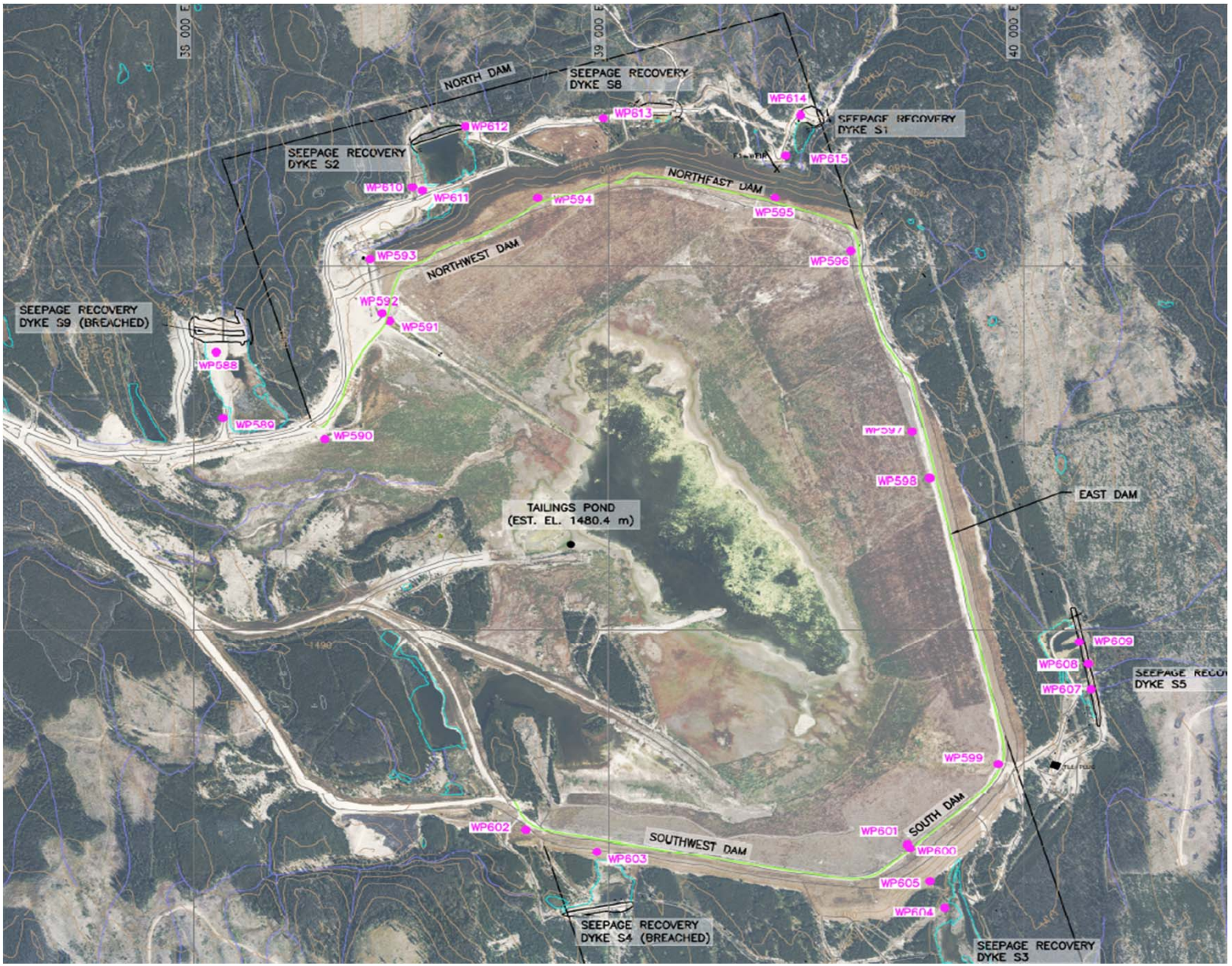
PROJECT: HVC TAILINGS DAMS
RESPONSE TO MEM MEMORANDUM

TITLE: LOCATION MAP FOR TAILINGS DAMS AND WATER RETENTION DAMS

PROJECT No. M02341A87

No. 1

Date & Time: 25/06/2015 12:02



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PROJECT: HVC TAILINGS DAMS
RESPONSE TO MEM MEMORANDUM

TITLE: HIGHMONT TSF

PROJECT No.: M02341A87

No.: 2

Date & Time: 25/06/2015 12:02