Klohn Crippen Berger

Teck Highland Valley Copper Partnership

2018 Dam Safety Inspection Report

Trojan Tailings Storage Facility

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March 2019

March 26, 2019

Teck Highland Valley Copper Partnership
PO Box 1500
Logan Lake, British Columbia
V0K 1W0

Mr. Chris Anderson
Manager, Tailings and Water

Dear Mr. Anderson:

2018 Dam Safety Inspection Report
Trojan Tailings Storage Facility

We are pleased to submit the 2018 Dam Safety Inspection report for the Trojan Tailings Storage Facility. The inspection and this report were prepared to comply with Section 10.5.3 of the Health, Safety and Reclamation Code for Mines in British Columbia (the Code), Section 4.2 "Annual Tailings Facility and Dam Safety Inspection Report" of the Code Guidance Document.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Rick Friedel, P.Eng.
Engineer of Record
Senior Geotechnical Engineer, Principal

RF/PU:cd

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Teck Highland Valley Copper Partnership

2018 Dam Safety Inspection Report

Trojan Tailings Storage Facility

EXECUTIVE SUMMARY

Klohn Crippen Berger Ltd. (KCB) were engaged by Teck Highland Valley Copper Partnership (THVCP) to complete the 2018 Dam Safety Inspection (DSI) of the Trojan Tailings Storage Facility (TSF) on the Highland Valley Copper (HVC) mine site in accordance with the requirement of the Health, Safety and Reclamation Code for Mines in British Columbia (the Code). The DSI includes the Trojan Dam and two seepage dams (R4 Seepage Pond Dam and Lower Trojan Dam). The visual inspection was completed by the Engineer of Record (EoR), Mr. Rick Friedel, P.Eng. and Mr. Tyler Lappin, P.Eng., as representatives of KCB on August 7, 2018. Mr. Chris Anderson, P. Eng., THVCP Manager, Tailings and Water is the TSF Qualified Person (as defined by the Code) for the Trojan TSF.

The HVC site is located near Logan Lake, approximately 45 km south of Kamloops, in the interior of British Columbia. The Trojan TSF is located 4 km north of the operating mill. The Trojan TSF is a reclaimed, inactive facility constructed in 1973 and operated until 1989. THVCP continue ongoing surveillance of the site including environmental sampling, visual inspections and maintenance activities. Under this level of site presence, the Trojan Dam is considered to be in the active care closure phase as defined by the Canadian Dam Association (CDA) Mining Dam Technical Bulletin (CDA 2014).

The Trojan Dam comprises a rockfill starter dam which was raised in an upstream manner with cyclone sand. A sand and gravel filter zone separates the starter dam rockfill and the cycloned tailings sand. A pond is present in the impoundment continuously which is offset a minimum 200 m from the dam crest. The R4 Seepage Pond Dam, located downstream from Trojan Dam, collects seepage from the Trojan Dam toe. The Lower Trojan Dam, located downstream from R4 Seepage Pond, collects local runoff and flows from the R3 Reclaim Pond (from Bethlehem No. 1 TSF) and from R4 Seepage Pond.

Trojan Dam has been assigned a “Very High” consequence category as defined by CDA (2013). The downstream seepage dams have been assigned a “Low” consequence category as defined by CDA (2013). There were no significant changes to the key geotechnical or hydrotechnical hazards during 2018. The latest dam safety review (DSR) was completed by AMEC in 2013 (AMEC 2014a). The Code requires a DSR be undertaken every five years for tailings dams. THVCP commissioned a DSR in 2018 which is currently underway and is expected to be completed in 2019.

The free water pond, located in the center of the impoundment, varied seasonally in 2018 approximately 2.0 m which is consistent with recent years. THVCP manages and tracks the annual water balance for the Trojan TSF. Since 2011, the levels at Trojan Pond had been trending downwards (with the exception of seasonal rise during freshet) at an overall rate of about 0.3 m/year. This trend was not observed in 2017 and 2018, likely influenced by freshet events which were more pronounced than recent years. No water was discharged through the spillway in 2018.

Freeboard of each dam during the inflow design flood were reviewed in 2018 for compliance with the Code which included updated flood routing for the LTD. Based on the review, Trojan Dam and R4 Seepage Pond were in compliance, but upgrades are required for the LTD so it can safely pass the IDF with adequate freeboard. THVCP have planned this work to be completed in 2020. THVCP have

implemented additional measures to monitor and respond to elevated pond levels in LTD, if necessary, for the interim period while upgrades are complete.

The Emergency Preparedness and Response Plan (EPRP) was updated in 2016. The Operation, Maintenance and Surveillance (OMS) manual was also reviewed and issued as in December 2018 (THVCP 2018). The OMS manual and EPRP meets the intent of the Mining Association of Canada (MAC) and CDA guidelines, is current and provides adequate coverage for existing conditions.

Visual inspections and instrument measurements were completed by THVCP at the prescribed frequencies during periods of the year when dams were accessible. The frequency of routine visual inspections was increased during freshet by THVCP as a proactive measure. There were no event-driven inspections in 2018 triggered by precipitation or earthquake events as defined in the OMS manual.

There was one piezometer threshold exceedance (VW16-2A) in 2018. This is not considered a dam safety concern as the pattern of readings indicate that the instrument is still equilibrating after installation, the 2018 threshold was based on a short record history (resulting in the threshold not being appropriate), and the current piezometric levels being significantly lower than design assumptions.

Piezometric and movement thresholds which monitor deviation from the established trend were reviewed; one piezometer threshold revision (VW16-2A) is proposed for 2019. A threshold have been set for inclinometer IB16-2.

Water quality downstream of the Trojan TSF is monitored by HVC monthly to assess the effectiveness of the tailings facility in protecting the downstream receiving environment (ERM 2019). All permit sampling requirements and frequency were met in 2018, except for two instances when a subset of the required water quality parameters was not measured for specific samples. These parameters were tested in the previous and subsequent months.

The Trojan TSF appeared to be in good physical condition and the observed performance during the 2018 site inspections is consistent with the expected design conditions and past performance. Refer to Table 1 for status of outstanding recommendations from previous DSI reports. Recommendations that have been closed are shown in italics. Recommendations to address deficiencies and non-conformances identified during the 2018 DSI are summarized in Table 2.

Table 1 Previous Deficiencies and Non-Conformance Recommendations – Status Update

ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority[1]	Recommended Deadline (Status)
Trojan Dam					
TD-2017-01	*Surveillance*	*Inclinometer Monitoring*	*Establish a 2018 threshold limit for inclinometer IB16-2.*	*4*	*Q4, 2018 (CLOSED – see Section 5.6)*
TD-2017-02	Flood Routing	Freeboard	Raise the road in the designated area near the left abutment to El. 1440 m, either by fill placement or grading.	3	Q4, 2018 (deferred to 2019)
R4 Seepage Pond					
No previous recommendations (i.e. from 2017) requiring a status update.					
Lower Trojan Dam					
LTD-2017-01	Flood Routing	Inflow Design Flood	Complete appropriate upgrade works to allow LTD to safely pass IDF with adequate freeboard, including decommissioning of the spillway pipe.	2	Q4, 2020 (OPEN)

Notes:
1. Recommendation priority guidelines, specified by THVCP and assigned by KCB:
   Priority 1: A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
   Priority 2: If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
   Priority 3: Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
   Priority 4: Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

Table 2 2018 DSI Recommendations

ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority1	Recommended Deadline (Status)
Trojan Dam					
TD-2018-01	Erosion	-	Repair two rill erosions on the left bank of spillway channel (along riprap section), founded in tailings. Re-grade to divert water away from these areas, as feasible.	3	Q4, 2019 (OPEN)
TD-2018-02	Flood Routing	10.1.8 (the Code)	Update flood routing assessment for Trojan impoundment, R3 Seepage Pond and LTD based on the most recent site wide hydrology information for consistency and to confirm compliance.	3	Q2, 2020
TD-2018-03	Surveillance	Inclinometer Monitoring	Complete spiral correction on IB16-2 to resolve any measurement issues which may be impacting cumulative plots.	3	Q3, 2019 (before 2019 reading)
R4 Seepage Pond					
			No new recommendations.		
Lower Trojan Dam					
			No new recommendations.		

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1 INTRODUCTION

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Highland Valley Copper Partnership (THVCP) to complete the 2018 dam safety inspection (DSI) of the Trojan Tailings Storage Facility (TSF) on the Highland Valley Copper (HVC) mine site. The Trojan TSF is an inactive facility constructed in 1973 and operated until 1989. The site has been reclaimed since tailings discharge ceased and THVCP continue ongoing surveillance and maintenance. The DSI includes the Trojan Dam and two seepage dams downstream of the Trojan Dam (R4 Seepage Pond Dam and Lower Trojan Dam).

The reclaimed site is monitored and THVCP staff are onsite to support the ongoing operations at the site and regularly visit the Trojan TSF for environmental sampling, inspections and maintenance activities. Under this level of site presence, Trojan Dam is considered to be in the active care closure phase as defined by the Canadian Dam Association (CDA) Mining Dam Technical Bulletin (CDA 2014).

The scope of work consisted of:

- a visual inspection of the physical conditions of the various containment facilities;
- a review of updated piezometer, inclinometer and seepage monitoring data provided by THVCP;
- a review of climate and water balance data for the site;
- a review of other relevant dam safety management documents (e.g. Operations, Maintenance & Surveillance (OMS) manual); and
- a review of the past year's construction records, where applicable.

The inspection and this report were prepared to comply with Section 10.5.3 of the Health, Safety and Reclamation Code for Mines in British Columbia (the Code), Section 4.2 "Annual Tailings Facility and Dam Safety Inspection Report" of the Code Guidance Document (MEM 2016).

The visual inspection was completed by the Engineer of Record (EoR), Mr. Rick Friedel, P.Eng. and Mr. Tyler Lappin, P.Eng., as representatives of KCB on August 7, 2018. During the inspection, the weather was sunny with cloudy periods and did not impact the inspection. Mr. Chris Anderson, P. Eng., THVCP Manager, Tailings and Water is the TSF Qualified Person (as defined by the Code) for the Trojan TSF.

Water discharge quantity and quality from the Trojan TSF are regulated under Permit PE 376 (09), issued by the Ministry of Environment – Waste Management Branch, dated January 1, 1971 and last amended on May 29, 2003. Other permits include water licences C114183 and C068389, issued by the Ministry of Environment – Water Rights Branch.

Trojan Dam has been assigned a "Very High" consequence category as defined by CDA (2013). The downstream seepage dams have been assigned a "Low" consequence category as defined by CDA (2013).

The latest dam safety review (DSR) was completed by AMEC in 2013 (AMEC 2014a). The Code requires a DSR be undertaken every five years for tailings dams. THVCP commissioned a DSR in 2018 which is currently underway and is expected to be completed in 2019.

2 FACILITY DESCRIPTION

The HVC site is located near Logan Lake, approximately 45 km south of Kamloops, in the interior of British Columbia. The Trojan TSF is located 4 km north of the operating mill; refer to Figure 1. The Bethlehem No.1 TSF is immediately to the east of the facility; refer to Figure 2. A pond is continuously present in the impoundment which is offset approximately 240 m from the upstream dam crest by an elevated reclaimed tailings beach.

Two seepage ponds with associated dams are located downstream of Trojan Dam: R4 Seepage Pond Dam (Figure 4), 140 m downstream from Trojan Dam, collects seepage run-off from two collection ditches along the Trojan Dam toe; and Lower Trojan Dam (Figure 5), located approximately 1.1 km downstream from R4 Seepage Pond, collects local runoff and flows from the R3 Reclaim Pond (from Bethlehem No. 1 TSF) and from R4 Seepage Pond.

The Trojan Diversion runs around the northern perimeter of the facility (Figure 3), and intercepts runoff and diverts the flow away from the facility. The diversion ditch transitions to a pipeline near the right abutment and ultimately discharges into Witches Brook.

Trojan Dam

A layout of the Trojan Dam and associated structures is shown in Figure 3 and the typical geometry and dimensions of the dam are summarized in Table 2.1. Refer to Appendix III for relevant design drawings. The Trojan Dam left abutment[1] is in contact with Bethlehem Dam No. 1. Natural high ground forms the right abutment. A spillway near the right abutment was constructed following end of tailings discharge.

General information regarding the dam is as follows:

- Dam was constructed in 1973. Construction record reports are not available, but are referenced and form the basis of section drawings in two design reports (KL 1982, KL 1987) and in a stability assessment (KC 1996). A letter detailing the as-built condition of the spillway was available (KC 2002).
- The foundation is generally noted as dense glacial deposits over bedrock. The depth to bedrock increases from about 3 m at the right abutment to about 61 m in the mid-valley. A sandy silt layer with some clay is noted at 30 m to 36 m depth in the 1973 design report of the starter dam (Gepac 1973). A drill hole was completed in 2016 (KCB 2016b) which intercepted silt and clay layers, up to 150 mm thick, that were stratified within the glacial till. No distinctive laminated glaciolacustrine clay or silt was intersected by the drill hole.
- A shallow layer of forest mat and overburden was stripped from the starter dam foundation. Muskeg deposits were removed in the area of two creeks in the foundation footprint.
- The dam comprises a rockfill starter dam with coarse rock placed downstream of the dam axis and finer rockfill placed upstream. The starter dam was raised in an upstream manner with

[1] Left and right convention assumes point of view is in the downstream direction.

cyclone sand. A 25 ft to 30 ft wide sand and gravel filter zone separates the starter dam rockfill and cycloned tailings.

- Foundation drains direct seepage to the R4 Seepage Pond via two ditches that run along the toe of the dam, namely the West Seepage Collection Ditch and East Seepage Collection Ditch. Flow in both of these ditches are monitored using weirs (i.e. TB-R4-FS-01 and TB-R4-FS-02).
- During operations, tailings were discharged from the dam crest to form a beach between the pond and crest. The design minimum beach length was 152 m (500 ft) under normal conditions, and 92 m (300 ft) under temporary design flood conditions. The beach was also required to extend north a minimum distance of 500 m (1,640 ft) upstream of the crest along the west side of the pond. The existing minimum beach width under normal conditions is approximately 240 m. During the IDF peak pond elevation, 1438.5 m, the beach width remains greater than 100 m except for a 50 m wide area where the beach is approximately 90 m.
- The riprap lined spillway channel was originally constructed (in approximately 1996) from the right abutment to just past the toe of the Trojan Dam from which an excavated channel (without riprap erosion protection) conveyed flow through a wooded area and eventually to Witches Brook. To mitigate the risk of spillway flow from overtopping the channel and potentially eroding the toe of Trojan Dam, as noted in the 2013 DSR (AMEC 2014a), the lower portion of the spillway channel was upgraded in 2018. Works included raising an 80 m section of the left bank to design height and constructing a 300 m extension; refer to Section 3.2 for further discussion.

R4 Seepage Pond Dam

The R4 Seepage Pond is located in the mid-valley section at the old Trojan Creek bed with the right abutment in contact with a waste dump from the Trojan Dam construction. No details are available regarding the left abutment. A layout of the R4 Seepage Pond is shown in Figure 4 and the typical geometry and dimensions of the dam are summarized in Table 2.1. Refer to Appendix III for relevant design drawings.

General information regarding the dam is as follows:

- Dam was constructed in 1984. Construction record reports are not available. 1984 design drawings showing the dam section were appended in the *Trojan Creek Ponds – Long Term Options* design report (KCB 2005).
- The foundation was prepared with a 6 m wide cutoff trench with 1.5H:1V side slopes, excavated through the upper sand and gravel foundation layer and 0.3 m to 0.6 m into the underlying dense glacial till. The trench extends to the dam crest level at both abutments, and extends north into the waste dump tying into the till foundation soil.
- The dam is comprised of compacted glacial till fill borrowed from the Lake Zone open pit excavation, now part of the Valley Pit located approximately 4 km southwest of Trojan Dam. A 300 mm thick layer of waste rock riprap is present on the upstream slope.

- A 300 mm diameter Low Level Outlet, and a 100 mm diameter overflow pipe are embedded in the dam near the left abutment.
- An open channel spillway designed by AMEC is located near the right abutment. Record drawings of the spillway, which was constructed subsequent to the completion of dam construction, are available in Appendix III (AMEC 2014d).
- Water from R4 Seepage Pond is released through a 300 mm dia. low-level outlet pipe to an open channel that leads to Lower Trojan Pond and ultimately discharges into Witches Brook. A secondary outlet (intake west of the low-level outlet) diverts water to the Highland Mill when required.

Lower Trojan Dam

A layout of the Lower Trojan Pond is shown in Figure 5 and the typical geometry and dimensions of the dam are summarized in Table 2.1. Refer to Appendix III for relevant design drawings.

General information regarding the dam is as follows:

- Dam was constructed in 1989. Construction record reports are not available.
- A 2005 design drawing shows the existing pond and dam in plan and section (KC 2005). The section provided appears to be based on measurements taken in November 2004.
- Inflows, made up of discharge from R3 and R4 Seepage Ponds and surface runoff, are measured by THVCP upstream of the Lower Trojan Dam on the west side of the access road.
- Outflow from the pond is through a 460 mm dia. diversion pipeline with a control valve downstream of the dam. Flows join the Trojan Diversion downstream of the dam and are discharged to Witches Brook.
- A low-level outlet that discharged to Witches Brook via a 200 mm pipe with a control valve downstream of the dam has been decommissioned (the method and date of decommissioning are unknown). The outlet exited approximately 8 m downstream of the dam toe.
- A spillway near the right abutment comprises an 810 mm pipe through the dam. Spillway flows discharge to Witches Brook. An open channel spillway is also located near the right abutment.

Table 2.1 Summary of Approximate Dam Geometry

Dam	Trojan Dam	R4 Seepage Pond Dam	Lower Trojan Dam
Length (m)	1500	100	100
Crest Elevation (m)	1414 (starter rockfill dam design) 1440	1365	1297.5 to 1296
Minimum Crest Width (m)	39	5	5
Maximum Height[2] (m)	70	3	4
Upstream Slope	1.5H:1V (rockfill starter dam design)	unknown	2H:1V [3]
Downstream Slope	2.9H:1V (lower bench face) 3.5H:1V (upper bench face) [4] 3.7H:1V (overall)	2H:1V	2H:1V

1. Dimensions are estimated from 2014 LiDAR data unless otherwise noted.
2. Height measured as the vertical distance between downstream toe and crest.
3. A 2005 report indicates an upstream slope of 1.75H:1V based on a November 2004 measurement (KC 2005).
4. These slopes are shallower than those on 1987 design drawings showing cycloned sand slopes on the upper face of the dam at 3H:1V and steeper but unspecified slopes on the rockfill toe face. However, the design drawings also show raises which were never constructed.

3 HISTORY AND RECENT ACTIVITY

3.1 History

A brief history of the construction and operations of the Trojan TSF is summarized as follows:

- From 1973 to 1980, the Trojan rockfill starter dam, designed by Gepac Consultants Ltd. (Gepac), was constructed to El. 1414 m (KL 1987).
- In 1981/1982, Klohn Leonoff Ltd. reviewed the dam design and proposed an upstream raise using cycloned sand. The already placed rockfill would serve as a downstream buttress and toe drain (KL 1982).
- Between 1982 and 1984, (different reports provide different dates), the dam was raised upstream using cycloned sand. Initially cyclone overflow was pumped into Bethlehem No. 1 TSF. The dam was regularly raised until 1987 to a final El. of 1441.5 m (AMEC 2014a; KL 1987).
- In 1983, a 24-inch diameter corrugated steel culvert which provided drainage of Trojan Creek flows through the original rockfill dam in the natural channel was backfilled with concrete (AMEC 2014a).
- In 1984, the R4 Seepage Pond was constructed (KC 1996).
- During 1989 the Lower Trojan Pond was constructed and tailings deposition in the Trojan TSF was stopped (KC 1996).
- In 1995, the Fish Spawning Channel Pond Dam was constructed (KC 2005).
- In 1996, a permanent spillway was constructed at the right abutment of Trojan Dam (KC 2002).
- In 2004, a spillway was constructed at the right abutment of R4 Seepage Pond Dam (AMEC 2014d).
- In 2016, the Fish Spawning Channel Pond Dam was decommissioned as discussed.
- In 2016, two vibrating wire piezometers and an inclinometer were installed in one drill hole on the downstream face of Trojan Dam.
- In 2018, the Trojan spillway was upgraded (refer to Section 3.2).

3.2 2018 Activities

In addition to routine maintenance activities as required by the OMS manual (e.g., clearing weirs of vegetation), the only significant 2018 construction activity was the extension of the Trojan spillway.

To mitigate the risk of spillway flow from overtopping the channel and potentially eroding the toe of Trojan Dam, as noted in the 2013 DSR (AMEC 2014a), the lower portion of the spillway channel was upgraded in 2018. Amec Foster Wheeler (AmecFW) was commissioned by THVCP to provide IFC design (AmecFW 2017) and as-built documentation (Wood 2018) for these modifications, which were constructed between January and March 2018. KCB provided comments on the design of the spillway

extension prior to construction (KCB 2017b) and reviewed the 2018 as-built report on the modifications:

- **Modification #1:** Raise the left bank of the final (i.e. most downstream) 80 m of existing riprap lined spillway channel to meet the 2 m design depth (AmecFW 2017, KC 2002).
  - The Wood record drawing (Appendix III), labelled as Figure 1, shows the raise was completed to the design depth.
- **Modification #2:** Downstream extension of channel section with erosion protection (riprap).
  - Based on cross sections provided by THVCP and appended in the Wood as-built report, the left bank riprap thickness appears thinner than the 1.2 m required by design in the final 70 m of extension.
  - KCB recommend that THVCP confirm the thickness of riprap and information captured by the as-built survey.

The description and records of quality control (by THVCP) for placed riprap gradation are not available for review. If the riprap is undersized, the downstream section of the spillway channel would be damaged during extreme flood events which could include dislodging of some riprap and scouring of the channel base and sides. This, previously raised to THVCP, is considered acceptable from a dam safety perspective because if this damage were to occur there would still be sufficient capacity in the channel to carry the flow (KCB 2017b).

4 WATER MANAGEMENT

4.1 Overview

Water management at each structure in upstream to downstream order and how they interact with each other is summarized below. The process flow diagram for the nearby Bethlehem TSF and Trojan TSF is shown in Figure 4.1. Figure references for key operating water management structures are summarized in Table 4.1.

Trojan TSF

- The Trojan Diversion is a series of ditches, culverts and pipelines located upslope of the Trojan TSF. The direction of flow is east to west with the open channel terminating west of Trojan Dam's right abutment and spillway. The flow is then diverted into a pipeline which discharges downstream of Lower Trojan Pond into an open channel. This open channel, considered to be part of Trojan Diversion, transitions back into a pipeline approximately 1 km downstream of Lower Trojan Dam, and ultimately discharges into Witches Brook.
- Inflows include precipitation on the impoundment, surface runoff from upstream catchments, and flow from the breached Fish Spawning Channel Pond.
- The tailings free water pond is located in the center of the impoundment as shown on Figure 3. The water level varies seasonally up to 2.0 m based on historic records, typically with a peak in June and low in the winter months; refer to Figure IV-1.
- Outflows include seepage and when necessary, would discharge through the spillway (no discharge through spillway to date). Seepage reports to R4 Seepage Pond via the East and West Seepage Collection Ditches. The spillway, an open channel founded partially in tailings (upstream) and partially in natural ground (downstream) and lined with vegetation and riprap where needed, discharges into an existing tributary which drains into Witches Brook. As noted in Section 3.2, the lower spillway channel upgrade construction works were completed in March 2018.

R4 Seepage Pond Dam

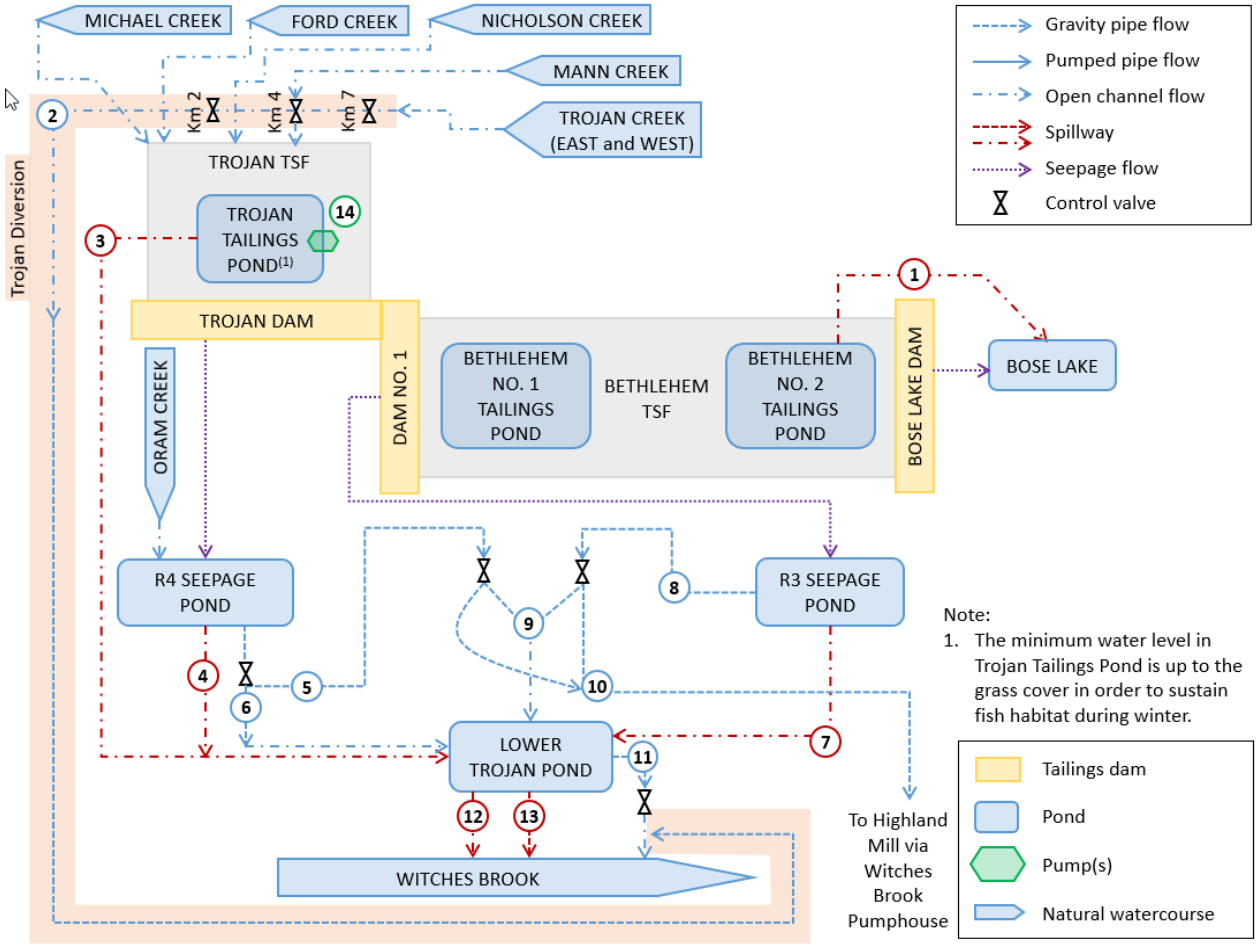
- Inflows include precipitation on the pond, surface runoff from upstream catchments, seepage from the Trojan Dam toe, and pumped flows from R3 Seepage Pond at the toe of Bethlehem Dam No. 1 (not part of regular operations). Inflows are measured monthly.
- The water level in the pond is not regularly surveyed by THVCP; however, visual estimates of available freeboard are included in the quarterly inspections by THVCP. These visual estimates of available freeboard ranged from 1.3 m to 1.7 m in 2018. The vertical distance between the pond and dam crest was approximately 1.5 m based on a visual estimate during the 2018 DSI site visit.
- Outflows include flow through a 300 mm dia. pipeline which leads to Lower Trojan Dam, seepage and when necessary, diversion via another pipeline to the Highland Mill or discharge

through the spillway. The pipeline flow to Lower Trojan Dam is controlled by a valve at the downstream toe of the dam. The spillway, a riprap-lined open channel with an energy dissipater, discharges into an existing tributary which drains into Witches Brook.

Lower Trojan Dam

- Inflows include precipitation on the pond, surface runoff from upstream catchments, outflow from R3 Seepage Pond at the toe of Dam No. 1, and outflow from R4 Seepage Pond. Flows from the Trojan Diversion bypass the Lower Trojan Dam. Inflows are measured weekly during freshet, and monthly for the remainder of the year.
- The water level in the pond is not regularly surveyed by THVCP; however, visual estimates of available freeboard are included in the quarterly inspections by THVCP. The visual estimate of available freeboard was 1.7 m in 2018. The vertical distance between the pond and dam crest was approximately 1.5 m based on a visual estimate during the 2018 DSI site visit. This is consistent with visual estimates during DSI site visits between 2014 and 2017 which observed the water level between 1.2 m and 2 m.
- Outflows include flow through the 460 mm dia. diversion pipeline which is the normal operating outlet. This outflow joins the Trojan Diversion and reports to Witches Brook. If necessary, water discharges through the 810 mm dia. spillway pipe and a 7 m wide channel spillway on the right abutment. Both outflows also report to Witches Brook, but no recent flow has been noted.

Figure 4.1 Process Flow Diagram for Bethlehem and Trojan TSFs



No.	Name	Description	Status
1	Bose Lake Spillway	3 m wide channel with concrete sill founded in tailings (3 m wide, vegetated) and natural ground (3 m, riprap-lined)	Operational
2	Trojan Diversion	6.5 km long series of channels, culverts, and pipelines	Operational
3	Trojan Spillway	1.3 km long open channel founded in tailings (5 m wide, vegetated), natural ground (3 m, riprap-lined) and bedrock (3 m).	Operational
4	R4 Spillway	2 m wide riprap-lined channel	Operational
5	R4 Low-Level Outlet	300 mm dia. HDPE pipe with U/S and D/S control valves and intake trash rack	Operational
6	R4 Overflow	100 mm dia. HDPE pipe with U/S control valve	Operational
7	R3 Spillway	2 m wide riprap-lined channel	Operational
8	R3 Low-Level Outlet	460 mm dia. HDPE pipeline with D/S control valve	Operational
9	Seepage to LTD	Buried pipeline	Operational
10	Northern Collection Line	Buried pipeline	Operational
11	LTD Low-Level Outlet	460 mm dia. HDPE pipe with control valve and intake trash rack	Operational
12	LTD Spillway	7 m wide channel	Operational
13	LTD Overflow	810 mm dia. HDPE pipe	Operational
14	Trojan Pump	Pump for Trojan Tailings Pond	Non-operational

Table 4.1 References for Operational Water Management Structures for Trojan Facility

Dam	Structure Name	Drawing or Figure Reference (Appendix III)
Trojan TSF	Trojan Diversion	None available, see Figure 2
	Trojan Spillway	114-808-202, C-001 to C-003, Figure 1
	East and West Seepage Collection Ditches	D-2916-13 The East Seepage Collection Ditch has since been regraded to flow west into R4 Seepage Pond.
R4 Seepage Pond	Outlet Pipeline	B-007
	Spillway	AB-2 to AB-6
Lower Trojan Dam	Diversion Pipeline	B-004
	Spillway Pipe	B-004

4.2 Climate

THVCP provided weather data from the L-L Dam climate station (El. 1186 m) which has historically been selected as most representative for the mine site. In 2018, some data logger issues in June, September and November led to some short data gaps as noted in Table 4.2. To support key precipitation trends and impacts on observed dam performance in 2018 data from Kamloops Airport (Environment Canada Station No. 1163781, El. 345 m) was reviewed for comparison that no major events were missed and general trends were consistent. Precipitation records at L-L Dam and Kamloops Airport are tabulated and plotted with average monthly values or climate normals in Table 4.2 and Figure 4.2, respectively.

Seasonal snowpack depth is not measured at the L-L Dam weather station. Instead, monthly measurements at the Highland Valley snow survey station (Station No. 1C09A) near the Trojan TSF are used to track the changes in snowpack. The measurements are sorted by survey period (the first of January through May) to compare snowpack depths (in snow-water equivalent (SWE)) around the same time each year. Historical average and 2018 snowpack depths based on available records are summarized in Table 4.3.

The following observations were noted for 2018:

- April was noticeably wetter than normal which appears to coincide with the peak pond level recorded in 2018 (see Section 5.3).
- Snowpack depths measured from March 1st to May 1st were significantly (up to +520%) deeper than average. The drier than normal month may have offset a portion of the melt-induced flows during freshet; however, impact of freshet could have also been less due to improvements made by THVCP following 2017 freshet.

Table 4.2 Monthly Precipitation

Month	Precipitation (mm)			
	2018 at Trojan TSF[1]	Average Monthly at Trojan TSF[2]	2018 at Kamloops Airport[3]	1981-2010 Climate Normals at Kamloops Airport[3]
January	20.8	30.5	23.7	21.1
February	28.2	23.3	51.9	12.4
March	17.5	18.5	19.6	12.8
April	84.5	23.6	42.8	14.2
May	13.6	45.8	2.4	27.3
June	51.0[4]	53.2	36.8	37.4
July	38.8	48.3	35.7	31.4
August	43.7	35.2	19.2	23.7
September	56.9[5]	34.6	50.5	29.4
October	21.3	33.3	27.5	19.4
November	23.4	44.8	33.5	23.3
December	15.6	45.3	20.2	25.4
Annual Total	415.3	436.4	363.8	277.6

Notes:
1. Available data from L-L Dam climate station was adjusted by a L-L Dam-to-Bethlehem/Trojan adjustment factor of 1.05 (Golder 2016).
2. Estimated by Golder (2016) using appropriate adjustment factors and average precipitation measured at Highland Valley Lornex climate station (Environment Canada ID No. 1123469 at El. 1268 m).
3. 2018 data from relocated station (ID No. 1163781); climate normals from data collected at previous station location (ID No. 1163780).
4. Data missing from June 6 to June 24 and June 26 to June 31, inclusive.
5. Data missing from September 21 to September 30, inclusive.

Figure 4.2 Monthly Precipitation

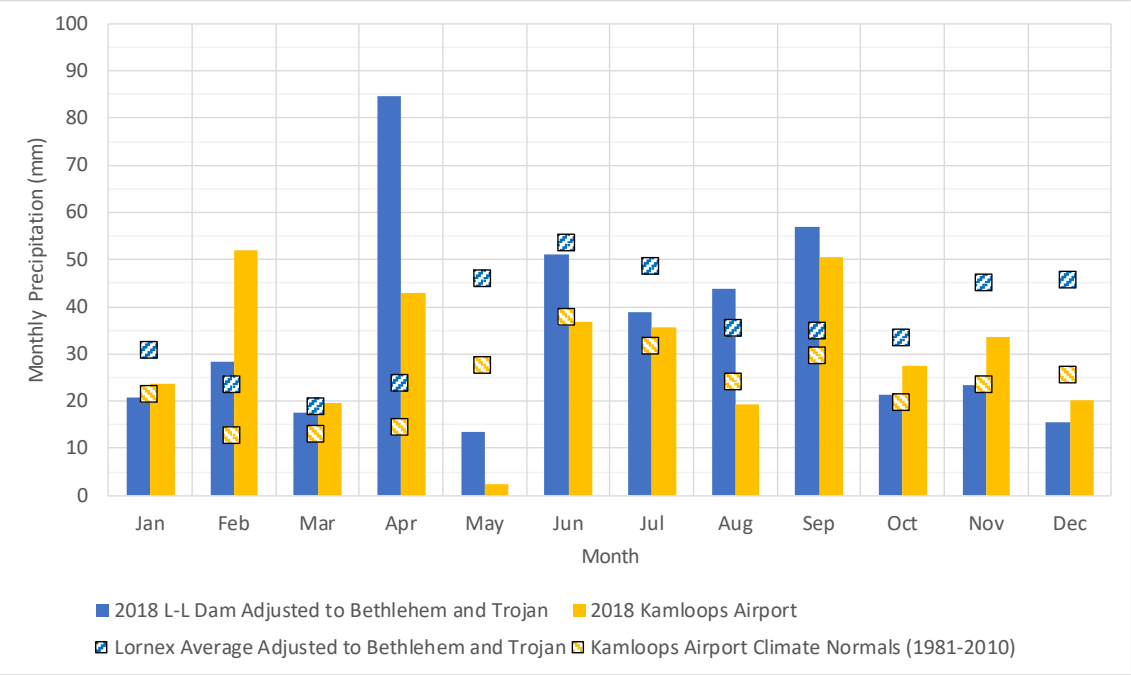


Table 4.3 Historical Average and 2018 Snowpack Depths

Survey Period	Years of Record[1]	Historic Average Snowpack Depth[2] (mm SWE[3])	2018 Snowpack Depth (mm SWE[3])	Percent Difference
January 1st	11	50.2	Not surveyed	N/A
February 1st	25	83.5	Not surveyed	N/A
March 1st	52	90.8	156	+72%
April 1st	51	101.7	166	+63%
May 1st	51	29.2	181	+520%
May 15th	25	2.4	Not surveyed	N/A

Notes:
1. At the Highland Valley snow survey station (Station No. 1C09A) near the Bethlehem TSF. Data prior to 1966 was not included as the station was moved to its current location in 1965.
2. Calculated based on available period on record.
3. SWE = snow water equivalent.
4. The March 1st survey was conducted on March 5, 2018. The April 1st survey was conducted on March 27, 2018. The May 1st survey was conducted on April 24, 2018.

4.3 Water Balance

THVCP manages and tracks the annual water balance for the Trojan TSF. Table 4.4 is a summary of annual inflows and outflows, provided by THVCP. The water balance is based on simplified modelling results and therefore the values should be treated as indicative only.

Table 4.4 Annual Water Balance for Trojan TSF

Item	Volume in 2018[1] (m^3)
Inflows	
Direct Precipitation[2]	*153,400*
Runoff	937,000
Groundwater	14,300
Outflow from Fish Spawning Channel Pond	0
Total Inflow:	*1,104,700*
Outflows	
Seepage	192,700
Evaporation[3]	839,500
Total Outflow:	*1,032,200*
Balance	
Balance (inflow minus outflow)	72,500

Notes:
1. Values received from THVCP have been rounded to the closest 100 m^3.
2. Precipitation from the Shula Flats weather station adjusted to the Trojan area was used in the water balance.
3. Runoff to Trojan Pond was calculated based on observed increase in pond volumes over 2018
4. Evaporation assumed for Trojan TSF: 540 mm/year.

4.4 Flood Management

The summary of flood management structures and the applicable design criteria and details for the three dams are given in Table 4.5 below with the following discussion points noted:

- The Trojan TSF and R4 spillways are designed for storm events with return periods greater than those required by the Code.
- The 24-hour probable maximum precipitation (PMP) depth is different between two recent assessments (AMEC 2014b, AMEC 2014c). The reason is unknown, but the difference is small and is unlikely to materially affect the results.
- To address recommendations from previous DSIs, flood routing for the Lower Trojan Dam was updated in 2018 to assess whether the facility can safely pass the IDF (100-year return period, 24-hour duration) with adequate freeboard (KCB 2019a). Based on the results of the assessment, the following was concluded:
  - The overflow pipe that is buried through the dam crest, near the right abutment, should be decommissioned because the pipe discharges at the dam toe and there is no erosion protection at the discharge or channel to convey flow away from the dam.
    - Flow did discharge through this pipe during 2017 freshet, during that time THVCP initiate twice daily inspections to monitor for potential scour or erosion downstream of the dam. No significant erosion was observed.
  - Assuming the spillway channel at the right abutment is unobstructed (i.e. cleared of vegetation), the dam cannot safely pass the IDF with adequate freeboard. The peak flood level (El. 1296.8 m) would overtop the dam crest at the left abutment.
- Flood routing assessments, including hydrologic modelling to estimate flood volumes and peak flow rates, for the Trojan impoundment, R4 Seepage Pond and LTD have been completed at various time periods, during which climate data has changed. For completeness, KCB recommends all flood routing assessments be updated based on the most appropriate climate information.
- Based on KCB (2018a), to bring the LTD in compliance with the Code, KCB recommended one of the following be undertaken (KCB 2018):
  - Option 1:
    - modify the alignment of the existing spillway channel so flow is directed away from the dam toe and cover with appropriately sized riprap to protect the channel from scour; and
    - raise the dam crest and left abutment area to provide containment up to El. 1297.3 m.

- Option 2:
  - modify the alignment of the existing spillway channel so flow is directed away from the dam toe and cover with appropriately sized riprap to protect the channel from scour; and
  - lower the inlet of the spillway to El. 1294.8 m which is 1.2 m[(2)] below the low point of the existing crest.

THVCP report that the recommended upgrades of LTD, is scheduled for 2020 pending completion of design and necessary permitting. To manage overtopping risks during the temporary period during which upgrades are being completed, THVCP implemented the following procedure:

- Remote monitoring system is used to monitor LTD pond level;
- If water reaches the invert of the outlet discharge pipe, THVCP initiate increased (twice daily, minimum) monitoring of the flow for signs of developing erosion downstream of the dam. If observed, remedial actions are taken.
- If flow through the outlet discharge pipe is not sufficient to maintain a stable pond level (i.e. pond continues to rise), THVCP would deploy a pump to the LTD to increase outflow capacity sufficiently to prevent overtopping. Pumping will keep the pond level below the overflow pipe and spillway intakes and discharge into the Trojan Diversion Channel.

This procedure shall be reflected in the next revision of the OMS manual.

Table 4.5 Inflow Design Flood for Trojan TSF and Seepage Ponds

Dam	Outfall Type	Consequence Classification	Inflow Design Flood	Spillway Design Flood (Precipitation Depth, Design Flow)		Spillway Design Reference
				Design Event	Peak Flood Level	
Trojan Dam	Open channel	Very High	2/3 between 1000-year and PMF[(1)]	24-hour PMF[(2)] (182.2 mm, 26.1 m^3/s)	1438.5 m	(AMEC 2014b)
R4 Seepage Pond Dam	Open channel	Low	100-year[(3)]	24-hour PMF[(4)] (180.7 mm, 1.57 m^3/s)	1364.6 m	(AMEC 2014c)
Lower Trojan Dam	Open channel and pipe	Low	100-year[(3)]	100-year 24-hour[(5)] (75.2 mm, 6.4 m^3/s)	1296.8 m	(KCB 2019a)

Notes:
1. Per the Code for tailings dams.
2. Based on data from Atmospheric Environment Service (AES) climate stations at Kamloops Airport and Mamit Lake. A review of the spillway design was done in 2002 which concluded the 260 mm is comparable to the 230 mm estimated using the Highland Valley BCCL and Highland Valley Lornex climate stations and would accommodate a conservative snowmelt rate of 30 mm/day.
3. Per the Code for water dams.
4. Based on data from the Environment Canada Highland Valley Lornex climate station (Station No. 1123469).
5. Based on data from the Environment Canada Highland Valley Lornex climate station (Station No. 1123469) and adjusted for orographic effects.

[2] 1.2 m based on 0.7 m peak flow depth during IDF and 0.5 m for freeboard (Section 4.5).

4.5 Freeboard

Where available, the minimum freeboard[3] measured during 2018, refer to Table 4.6, is based on either the DSI site visit observations and/or by the regular surveys completed by THVCP.

The Code specifies that an evaluation of available freeboard in excess of the design flood (i.e., account for wave setup and wave run-up) is required but defers to CDA (2013) for freeboard design standards. Consideration should be given to the mining dam specific factors highlighted in CDA (2014). Minimum required freeboard, as per the Code, for each dam and the freeboard during the IDF based on flood routing are listed in Table 4.6. These values were reviewed and updated in 2018 (KCB 2019a):

- Trojan Dam meets the freeboard requirement. A 2017 DSI recommendation was to raise the access road near the left abutment which forms part of the impoundment. The raise to El. 1440 m (allows for 0.9 m of buffer above minimum dam crest for grading as part of routine road maintenance) has been deferred to 2019.
- R4 Seepage Pond meets the freeboard requirement.
- As discussed in Section 4.4, upgrades are recommended for the LTD to safely pass the IDF with adequate freeboard.

Table 4.6 Minimum Required Freeboard

Dam	Code Required Freeboard During Inflow Design Flood (1)	Design Minimum Freeboard During Inflow Design Flood (1)	2018 Freeboard	2018 Freeboard Surveyed/Visually Estimated
Trojan Dam	0.6 m	>0.6 m	5.5 m (3)	Annual minimum from surveys, refer to App IV
R4 Seepage Pond Dam	0.5 m (2)	0.6 m	1.5 m	At the time of the 2018 DSI inspection
Lower Trojan Dam	0.5 m (2)	Note 4	1.5 m	At the time of the 2018 DSI inspection

Notes:
1. As per KCB (2018a).
2. Minimum required freeboard to accommodate wave run-up as per CDA (2013) is 0.2 m for R4, and 0.4 m for the Lower Trojan Dam; however, minimum freeboard specified as 0.5 m to be consistent with other similar structures around the site.
3. Based on a dam crest elevation of 1440 m. 2017 DSI recommendation to raise low point along the left abutment access road to El. `1440 m outstanding.
4. As discussed in Section 4.4, upgrades are recommended to safely pass the IDF with adequate freeboard.

[3] The vertical distance between the pond level and the low point of the dam crest during flood or normal operation.

5 REVIEW OF MONITORING RECORDS AND DOCUMENTS

5.1 Monitoring Plan

The Operation, Maintenance and Surveillance (OMS) manual, was reviewed and issued by THVCP in December 2018 (THVCP 2018). The 2018 update supersedes the versions submitted to Ministry of Energy, Mines and Petroleum Resources (EMPR) in December 2016 and was adopted on site.

The 2018 OMS manual meets the intent of the Mining Association of Canada (MAC 2011) and CDA (2014) guidelines and provides adequate coverage for existing conditions. A 2019 update to the OMS manual is planned to include additions referenced throughout this report and meet the recently updated guidance document by MAC (2019).

5.2 Inspections

The Trojan Dam monitoring program includes the following inspections:

- Annual DSI (this report) – completed by the EoR to comply with Section 10.5.3 of the Code and submitted to EMPR.
- Routine – monthly inspections of Trojan Dam and quarterly inspections of Lower Trojan Dam and Seepage Pond R4 are to be completed by THVCP, in accordance with the frequencies documented in the 2018 OMS update. All of the 2018 Trojan Dam monthly inspections of Trojan Dam occurred in 2018. Inspections of the Lower Trojan Dam and Seepage Pond R4 occurred in April and July:
  - As this system has reached an equilibrium or steady condition, reduced frequency of routine monitoring is considered appropriate. Event-driven inspections are of more value to confirm that the changed condition (i.e. flood, earthquake) did not have a significant impact on the structures. This change will be reflected in the next OMS manual update.
- Event-driven – these inspections are of more value at a closed facility than routine inspections as they confirm that the changed condition (i.e. flood, earthquake) did not have a significant impact on the structures. THVCP are to complete an inspection in response to the following threshold exceedances (included in the 2018 OMS manual update):
  - Piezometric and dam movement instrumentation thresholds as discussed in Section 5.4 to Section 5.6.
  - Earthquake greater than magnitude 5, within 100 km of the site or any earthquake felt at site.
  - Rainfall event greater than the 10-year, 24-hour duration storm; 41 mm (Golder 2016).

The frequency of routine visual inspections was increased during freshet by THVCP as a proactive measure. There were no event-driven inspections in 2018 triggered by precipitation or earthquake events as defined in the OMS manual.

5.3 Reservoir Level

The pond level is typically measured on a weekly basis, which is more frequent than prescribed in the 2018 OMS update (monthly). Reservoir levels are shown in conjunction with piezometric levels and seepage rates in Appendix IV:

- Figure IV-1 to Figure IV-3 plots measured pond level and Trojan Dam piezometric levels.
- Figure IV-6 and Figure IV-7 plots pond levels with measured weir flows at TB-R4-FS-01 and TB-R4-FS-02 collecting seepage flow from Trojan Dam, and at TB-LT-FS-01 and TB-LT-FS-02 collecting seepage flows from Seepage Ponds R3 and R4.

From 2011 to 2016, the Trojan pond levels appeared to be trending downwards (with the exception of seasonal rise during freshet) at an overall rate of about 0.3 m/year. This trend was not observed in 2017 and 2018, likely influenced by freshet events which were more pronounced than recent years.

5.4 Piezometers

There are 26 piezometers at the Trojan TSF, 11 of which are operational and being monitored, while 15 are inoperative as shown in Figure 3. Inoperative piezometers may be buried, plugged or otherwise damaged.

The reading frequency specified in the 2018 OMS update (monthly, when accessible) exceeds the recommendation from the 2016 DSI: quarterly for piezometers within the impoundment (Figure IV-1), monthly for all other piezometers, when accessible.

Refer to Appendix IV for plots of all piezometer results, 2018 and historic piezometric readings are shown in Figure IV-1 to Figure IV-3. Key observations for readings up to end of October 2018, are:

- Monitoring of piezometers in the crest and the downstream slope of the Trojan Dam in 2018 did not meet the minimum frequency specified in the OMS manual but readings do not indicate a deviation from historic trends:
  - Crest piezometers: read once a month between May and August, and once in October.
  - Downstream slope piezometers: read once per month between May and August.
- VW16-2A has shown a rising trend since installation in 2016 and exceeded the 2018 threshold value (El. 1363.0 m); refer to Figure IV-3. This, however, is not considered a dam safety concern as the pattern of readings indicate that the instrument is still equilibrating after installation. The 2018 threshold was based on a short record history, resulting in the threshold not being appropriate. Furthermore, current piezometric levels are approximately 15 m below the piezometric surface considered in the design (design assumes piezometric level at ground surface). The threshold for this instrument has been raised 2 m above the 2018 maximum to allow some buffer if the instrument continues to stabilize. The proposed 2019 threshold remains about 13 m below design levels.

- Piezometers within the tailings beach (between the pond and dam crest) showed a continued downward trend from approximately 2014 (~0.5 m/yr to 0.75 m/yr) to 2017 which is an indication that post-closure drain-down is ongoing. However, this trend has not been observed in 2017 and 2018 likely due to wetter than normal freshets.
- Current piezometer readings support the design assumption that the cycloned sand beach is unsaturated to a depth below the starter dam crest (El. 1414 m):
  - Piezometers in the tailings near the dam crest are measuring no head, referred to as “dry”, and have been over the past several years. These piezometers measured heads during operation which is an indication of the drain-down that has occurred post closure.
  - Instruments P95-4 is located about 40 m upstream of dam centreline and inferred to be to in cycloned sand based on tip elevation and design cross section from KC (1996). A sudden increase in water level was measured during the extended wet period in 2011. This same response was not observed in other instruments. Between 2011 and 2015, piezometric level declined by approximately 8.5 m to El. 1411,5 m. In 2015, P95-4 was slug tested as indicated by the spike in Figure IV-2. Since that test water level has shown a steady from a high of El. 1420 m to El. 1407.5 m. 2018 readings indicate draindown is ongoing but the current level is below the piezometric level assumed in design and the crest of the starter dam.
- Piezometers installed in the glacial till and sand and gravel fill zones of the starter dam at the upstream toe near to low point of the valley (TB-PS-04/P13-3 and TB-PS-03/P13-4) measure low piezometric heads which would further support a downward gradient and/or fully drained down condition is present in the cycloned sand tailings beach.

Piezometric level thresholds for the Trojan Dam are set to monitor deviation from the established trend. These thresholds reference a Notification Level (NL) response under the Trigger-Action-Response-Plan established on site and exceedance of this value is intended to notify THVCP of a change in behaviour, not a short-term dam safety concern. With the exception of VWP16-2A, piezometer readings have been fairly consistent over the past four years or more, showing a similar pattern of seasonal variability in the impoundment and relatively constant in the dam. The threshold for VW16-2A has been updated for 2019 as discussed. Other thresholds remain unchanged from 2018; refer to Table 5.1.

Table 5.1 2018 Piezometric Level and Proposed 2019 Thresholds

Instrument ID	Foundation Unit	2018 Piezometric Levels (m)		Proposed 2019 NL Threshold (m)[1]
		Minimum	Maximum	
P86-7	Sandfill	p/d	p/d	1419.8
P95-3	n/a	p/d	p/d	1415.0
P95-4	Sandfill	1407.7	1408.2	*Note 2*
P85-1A	Foundation	1396.6	1396.8	1399.2
TB-PS-02/P13-1	Cycloned Sand	1420.6	1423.1	1423.4
TB-PS-01/P13-2	Cycloned Sand	1416.7	1417.7	1418.6

Instrument ID	Foundation Unit	2018 Piezometric Levels (m)		Proposed 2019 NL Threshold (m)[1]
		Minimum	Maximum	
TB-PS-04/P13-3	Sand and Gravel	1383.6	1383.8	1385.4
TB-PS-03/P13-4	Glacial Till	1388.8	1388.9	1389.7
P86-1	Sandfill	p/d	p/d	1408.2
VW16-2A	Glacial Sediments / Debris	1364.6	1365.2	*1367.2*
VW16-2B	Glacial Till	1379.2	1379.3	1379.9

Notes:
1. *Italics* indicate revised threshold for 2019.
2. Piezometric level continues trending downward since 2015 falling head test; no threshold set until water level reaches steady state.

Based on the review of the available instrumentation data, the current suite of instruments is sufficient for the Trojan TSF. No follow up actions regarding any of the instrumentation is recommended.

5.5 Survey Monuments

Active and defunct survey monuments at the Trojan TSF are shown on Figure 3. Monuments were surveyed once in 2018, which is consistent with the frequency prescribed in the 2018 OMS manual (annual). Refer to Figure IV-4 (Appendix IV) for a plot of monument surveys. The incremental change between June 2017 and 2018 surveys, and the cumulative change, are summarized in Table 5.2. THVCP surveys since 2014 use a total station with an estimated accuracy of 10 mm to 25 mm for horizontal measurements, and a digital level with an estimated accuracy of 10 mm for vertical measurements.

Table 5.2 2017 Survey Monument Incremental Displacement Summary

Monument	Incremental		Cumulative	
	Vector Horizontal Displacement[1] (mm)	Vertical Displacement[1] (mm)	Vector Horizontal Displacement[1] (mm)	Vertical Displacement[2] (mm)
TD-1	2.2, upstream	-2.4	5.1, upstream	-8.9
TD-2A	12.6, upstream	-5.5	24.2, downstream	-5.5
TD-3	4.3, upstream	-3.3	8.4, downstream	-72.3
TD-4	1.3, upstream	-1.5	16.8, downstream	-74.4
TD-5	6.6, upstream	+1.15	11.1, upstream	-47.5
TD-6	2.5, upstream	+0.8	13.6, downstream	-28.9

Notes:
1. June 2017 survey compared to July 2018 survey.
2. Earliest historic reading is 2014 for TD-2A, all other monuments earliest historic readings are in 1998. Cumulative displacements are calculated as difference from June 2017 survey and earliest historical reading.

Movement thresholds (horizontal and settlement) have been established for the survey monuments; refer to Table 5.3. The thresholds were set based on the following criteria:

- Horizontal vector displacement threshold was set at 80 mm from the original location, based on the typical scatter in the available data which is most likely related to a survey or datum issue rather than movements.
- Incremental settlement between readings was set at 20 mm based on a review of the typical variation between readings (regardless of period between readings).
- Total settlement was set 50 mm greater than the most recent reading, based on the observed settlement trends.

Table 5.3 Survey Monument Displacement Thresholds

Instrument ID	Horizontal Vector Displacement from Original Position Threshold (mm)	Incremental Vertical Displacement Between Readings Threshold (mm)	Total Vertical Displacement Threshold (mm)
TD1	80	20	50
TD2A			50
TD3			100
TD4			100
TD5			75
TD6			75

Notes:
1. No change recommended to 2017 threshold values for 2018.

Consistent with recent years, the 2018 surveys do not indicate a trend of significant movements in the downstream or upstream direction, significant crest settlement or threshold exceedances.

5.6 Inclinometers

No inclinometers were installed in 2018. The one inclinometer at Trojan Dam (IB16-2) which was installed in 2016, is to be read monthly, when accessible, as defined in the 2018 OMS manual.

Cumulative displacements measured at IB16-2 are plotted on Figure IV-5. There are no significant movements in the downstream direction in the readings and no discrete zones of movement to date.

There is no planned construction at or significant change to the existing condition of the facility planned. Therefore, the development of significant movements in the foundation at this time are not expected. Based on measurements to date, KCB propose the following thresholds for ongoing monitoring:

- Notification Level: 1 mm/month over any 3 m vertical section.

5.7 Seepage

Seepage is recorded, typically between April and November when accessible, on a monthly basis from two weirs located at R4 Seepage Pond, and two weirs located at Lower Trojan Pond. This is consistent with the requirements in the 2018 OMS manual.

Weir TB-R4-FS-01 is a 60° V-notch weir installed on the west toe drain. Weir TB-R4-FS-02 is a 90° V-notch weir installed on the east toe drain. Weir flows from 2008 to the end of 2018 are plotted on Figure IV-6. 2018 seepage flows are generally consistent with historical trends (especially 2012-2015).

Weirs TB-LT-FS-01 and TB-LT-FS-02 are located downstream and upstream, respectively, of Lower Trojan Pond. Weir flows from 2016 to 2018 are plotted on Figure IV-7. Flows from previous years are not available. The TB-LT-FS-01 weir readings from late April/early May 2018 correlate with the significant precipitation reported in April 2018 (refer Table 4.2).

5.8 Water Quality

Water quality downstream of the Bethlehem TSF is monitored by THVCP monthly to assess the effectiveness of the tailings facility in protecting the downstream receiving environment. A copy of the 2018 Annual Water Quality Monitoring Report (ERM 2019) was provided to KCB for review as part of the DSI. Select observations and findings from the monitoring report are summarized as follows:

- There are twelve permitted surface water quality monitoring sites in the Trojan/Bethlehem area, as shown on the site monitoring plan in Appendix V.
- All permit sampling requirements and frequency were met in 2018, except for two instances when a subset of the required water quality parameters was not measured for specific samples. These parameters were tested in the previous and subsequent months.

The 2018 monitoring results were screened against applicable BC Water Quality Guidelines (WQG). Further discussion on specific WQG exceedances and water quality trends observed during 2018 can be found in the 2018 Annual Water Quality Monitoring Report (ERM 2019).

6 VISUAL OBSERVATIONS AND PHOTOGRAPHS

The visual observations made during the DSI site visit are summarized below. Copies of the filed inspection forms are included in Appendix I and the photographs of each site are included in Appendix II.

Trojan Dam

- **Crest**: No indication of erosion or deterioration, crest was observed to be in good physical condition. Local low points <1 m and "hummocky" surface observed and believed to be from differential settlement or formed for land reclamation. Freeboard is uncompromised by these features (Photo II-A-1 to Photo II-A-3, inclusive).
- **Left Abutment**: Good physical condition. Highpoint of the tailings beach is observed to be sloping towards the access road at the toe of Bethlehem Dam. The appears to have been graded or worked on in 2018; however, THVCP confirm that regrading of the access road near the left abutment to raise the road to El. 1440 m, per 2017 DSI recommendation, is scheduled for 2019 (Photo II-A-4).
- **Right Abutment**: Good physical condition. Spillway channel is excavated through bedrock and Glacial Till material, parallel to the dam abutment. No signs of abutment deterioration or erosion at the abutment; however, some erosion was observed along the spillway channel (additional details noted under spillway channel heading, below).
- **Downstream Slope**: Good physical condition. Downstream slope is well vegetated with grass and has no observed locations of concern or signs of adverse displacement (Photo II-A-5 and Photo II-A-6). Animal burrowing (extent unknown) noted in elevated till area between the downstream toe and the R4 seepage pond (Photo II-A-7). It is recommended that these features be backfilled.
- **Toe Collection Ditches:** Good physical condition. Extensive vegetation observed, which provides a measure of erosion protection. Seepage flow (clear, no turbidity observed) observed through ditches and weirs. Weirs in good condition, and no sign of obstructions in either toe collection ditch (Photo II-A-8 to Photo II-A-10, inclusive).
- **Seepage:** No seepage observed, except for seepage flow within the toe collection ditches (Photo II-A-7 to Photo II-A-9, inclusive).
- **Tailings Beach:** Good physical condition. No issues of concerns observed during inspection. Elevation of the vegetated portion of the beach is approximately 2 m above the reservoir level (Photo II-A-11).
- **Pond**: No indication of recent high-water event, at the time of inspection spillway invert was approximately 1.5 to 2 m above the pond elevation (Photo II-A-12).
- **Spillway Inlet**: Log booms secured in place, with no obstructions present besides minor vegetation. Spillway inlet in good condition with no signs of deterioration (Photo II-A-12).

- **Spillway Channel:**
  - **General**: Good physical condition. Initial section of channel is heavily vegetated with grass and slopes at minimal grade towards the first curve of the dam spillway. Following the first curve the vegetated Glacial Till channel transitions to a bedrock excavated channel at the right abutment of the dam. Along this segment water has accumulated in local depressions along the channel invert. Spillway channel riprap increases in size as the channel grade steepens towards the outfall. No major obstructions or deterioration was observed along the channel. (Photo II-A-13 and Photo II-A-14).
  - **Erosion features**:
    - At waypoint TRJ-2018-17 (riprap channel section) an erosion rill approximately 1 m wide by 1.5 m deep was observed. KCB recommends that this area be re-established and graded in 2019 so that surface water drains away from the slope (Photo II-A-15).
    - At waypoint TRJ-2018-18/19 (riprap channel section) an erosion rill approximately 2 m wide by 1.5 m deep was observed. KCB recommends that this area be re-established in 2019 (Photo II-A-16).
    - Neither erosion feature represents a dam safety concern at this time but should be remediated to prevent ongoing scour and washing of tailings into the spillway channel.
    - At waypoint TRJ-2018-20 cycloned sand is exposed (i.e. no vegetation cover) along the left bank. KCB recommends that a method of erosion protection (e.g. riprap) be implemented to prevent future toe erosion (Photo II-A-17).
  - **Spillway extension section**:
    - Riprap appears to be in good condition; however, it does not appear to be uniform (Photo II-A-18 and Photo II-A-19); refer to discussion in Section 3.2.

R4 Seepage Pond Dam

- **Crest**: Good physical condition. No observed signs of deterioration, lateral movement, or cracking (Photo II-B-1 and Photo II-B-2). The upstream slope is heavily vegetated, and KCB recommends that this vegetation be removed (Photo II-B-1).
- **Left and Right Abutments**: Good physical condition. Little vegetation at abutments, and no signs of deterioration observed.
- **Downstream Slope**: Good physical condition. Tall grass and vegetation present, no signs of deterioration or erosion (Photo II-B-2 to Photo II-B-4).
- **Pond**: During inspection, the pond water level was observed to be approximately 1 m below the spillway invert (Photo II-B-5 and Photo II-B-6).
- **Spillway**: Good physical condition through the whole spillway. No observed signs of recent flow, channel erosion, or deterioration. No obstructions present in spillway (Photo II-B-6 to Photo II-B-9).

- **Low-level Outlet**: Minor vegetation growth on log-boom, along with minor leaf obstruction on trash rack. Obstructions are monitored and cleared as part of THVCP ongoing monitoring and routine maintenance plan (Photo II-B-11).
- **Seepage**: No observed signs of seepage during inspection.

Lower Trojan Dam

- **Crest**: Good physical condition. Minor vegetation with no signs of erosion, deterioration, or cracking observed (Photo II-C-1).
- **Left and Right Abutment**: Good physical condition. Right abutment covered in tree debris (Photo II-C-3).
- **Downstream Slope**: Good physical condition. Minor vegetation present, no signs of erosion or deterioration (Photo II-C-1). Downstream outflow pipe shown on Photos II-C-2 does not have a defined channel or means of toe erosion protection. KCB recommends that a mitigation be advanced.
- **Pond**: Level at time of inspection consistent with level at 2017 inspection. Invert of spillway and pond approximately 0.5 m apart (Photo II-C-4 and Photo II-C-5).
- **Spillway**: Heavy vegetation present in front of pond overflow pipe resulting in potential for an obstruction. Spillway channel filled with tree debris, channel flow path is no longer visible. Spillway should be cleared of vegetation and debris and upgraded based on flood routing (Section 3.2) (Photo II-C-3).
- **Low-level Outlet**: Debris boom in good condition. Build up of leaves present on intake cage (Photo II-C-6).
- **Seepage**: None observed.

7 ASSESSMENT OF DAM SAFETY

7.1 Dam Classification Review

The latest published DSR (AMEC 2014a) a "Very High" consequence classification, as defined by CDA (2013), was recommended for the Trojan Dam. The R4 Seepage Pond and Lower Trojan Dam were both assigned a "Low" consequence classification as defined by CDA (2013). A new DSR is currently underway and scheduled for completion in 2019 which will include a review of consequence classification.

Based on the latest dam consequence review hosted by THVCP on January 23, 2019, no change in consequence classification was recommended for either of the three dam sites.

7.2 Failure Mode Review

7.2.1 Trojan Dam

Based on the DSI and review of available documents regarding Trojan Dam, the potential failure modes included in the Canadian Dam Safety Guidelines (CDA 2013) were reviewed:

Overtopping

The Trojan TSF has an open channel spillway designed (AMEC 2014a) to safely pass a flood (PMF, 24-hour duration) greater than the minimum IDF recommended under the Code. Given the presence of the spillway and wide tailings beach that would be present between the pond and crest while discharging the IDF through the spillway, the likelihood of overtopping during the IDF is considered very low.

Internal Erosion and Piping

Based on a 2015 review of filter adequacy (KCB 2015), the likelihood of piping related failure through the dam developing at this stage is very low.

A 24-inch diameter corrugated steel culvert provided drainage of Trojan Creek flows through the original rockfill dam in the natural channel until 1983 when tailings storage began and the pipe was backfilled with concrete (AMEC 2014a). No indicators of piping related failure (e.g., turbid water) have been observed in seepage from this area. The likelihood of a piping related failure developing around the culvert at this stage is considered very low.

Stability

The dam is founded on dense glacial till overlying bedrock with a downstream slope of 3.5H:1V for the upper cycloned sand raises and 2.9H:1V for the rockfill toe. Slope stability analyses (KL 1987, KCB 2019b) indicate the Factor of Safety (FOS) of a failure through the foundation is greater than required by the Code (1.5). The piezometric levels in the dam, cycloned sand beach and impoundment have reduced relative to those assumed in the 1996 analysis which would enhance stability since that time.

Therefore, the likelihood of a slope instability failure through the foundation developing is considered very low.

Surface Erosion

The downstream slope is well vegetated with grass with no significant erosion features. Progressive erosion that develops over time or multiple events are managed through routine monitoring and maintenance. The likelihood of surface erosion over the downstream slope resulting in a failure from a single event is considered negligible.

Earthquakes

Stability analyses (KC 1996, KCB 2019b) indicate the FOS under pseudo-static loading conditions are greater than the minimum values recommended by CDA (2013). Pseudo-static analyses are not intended to simulate limit equilibrium conditions but, rather, are considered to provide a preliminary seismic deformation screening analysis. A pseudo-static FOS below criterion does not indicate that the dam will fail, but that the seismic deformations could exceed those implied by the particular method used. In that case, a more rigorous seismic deformation analysis should be conducted. Based on this, and given that the pseudo-static FOS for the Trojan Dam is greater than 1.0 assuming up to 75% of EDGM value (KC 1996), more rigorous deformation analyses are not deemed necessary and the likelihood of an earthquake-induced slope instability failure developing through the foundation is considered low.

7.2.2 R4 Seepage Dam

Based on the DSI and review of available documents regarding Trojan Dam, the potential failure modes included in the Canadian Dam Safety Guidelines (CDA 2013) were reviewed:

Overtopping

The R4 Seepage Pond has an open channel spillway designed to safely pass a flood (PMF, 24-hour duration) significantly greater than the minimum IDF recommended under the Code (100-year flood). Given the presence of the spillway, the likelihood of overtopping during the IDF are considered very low.

Internal Erosion and Piping

The absence of suspended solids noted in observed seepage water during routine inspections over the service life of the dam suggests the likelihood failure by internal erosion under existing conditions is low.

Stability

Based on a stability analysis completed by KCB to support this DSI, the FOS of a deep-seated failure through the dam fill or foundation was greater than the minimum FOS (1.5) required by the Code.

Surface Erosion

The downstream slopes have some coarse rock and are lightly vegetated, combined with the short slope lengths and small catchment areas (restricted to primarily the slope area itself) the likelihood of surface erosion resulting in a failure is very low.

Earthquakes

The design seismic load of the dam used in previous stability analysis, which indicated satisfactory FOS, is greater than the minimum EDGM required by the Code, 100-year. Therefore, the likelihood of seismic related failure during the EDGM is considered low.

7.2.3 Lower Trojan Dam

Based on the DSI and review of available documents regarding Trojan Dam, the potential failure modes included in the Canadian Dam Safety Guidelines (CDA 2013) were reviewed:

Overtopping

Flood routing conducted for the Lower Trojan Dam in 2017 indicates that upgrades are required so the facility can safely pass the IDF event, as per the Code. KCB recommended upgrades are discussed in Section 4.4 and included in the recommendation summary (Table 8.2). In the interim period before upgrades are completed, THVCP have implemented a threshold values to increase monitoring periods during period of high flow and initiate pumping as discussed in Section 4.4.

Internal Erosion and Piping

The absence of suspended solids noted in observed seepage water during routine inspections over the service life of the dam suggests failure by internal erosion under existing conditions is low.

Stability

Slope stability analyses conducted in 2005 showed the FOS for downslope stability is greater than the minimum FOS (1.5) required by the Code. A shallow surficial (~2 m deep) failure surface within the upstream dam fill had a FOS of 1.3 (KC 2005); but there have been no incidents of instability or adverse displacement (e.g., sloughing) along the upstream slope observed in the available monitoring records nor observed during the 2017 DSI site inspection.

Surface Erosion

The downstream slopes have some coarse rock and are lightly vegetated, and therefore, combined with the short slope lengths and small catchment areas (restricted to primarily the slope area itself), the likelihood of surface erosion resulting in a failure is considered very low.

Earthquakes

The design seismic load is greater than the minimum EDGM required by the Code, 100-year. Therefore, the likelihood of seismic related failure during the EDGM is considered low.

7.3 Emergency Preparedness and Response

The emergency preparedness and response plan (EPRP) for the Trojan TSF was updated in 2016 and forms a part of the OMS manual.

Training of THVCP staff and contractors who work near the dams is provided by a video presentation which outlines dam safety warning signs that all staff should be aware of and report if any are observed during their work.

In the case of an emergency an incident command center would be established on site to coordinate with regional emergency response organizations and local authorities. The roles and responsibilities of key team members are well defined, along with reporting structures and who is responsible for declaring an emergency and starting the incident response. The EPRP also outlines strategies that could be implemented in the event of several types of dam emergencies. Additional systems are also being considered to further enhance the overall system.

Training and testing of the EPRP currently is done using desktop scenarios. Along with testing of the system, offsite emergency response resources are contacted regularly to ensure that contact information is still up to date. The emergency reporting contact list is also reviewed and updated as required. A table top exercise to review and update the EPRP for the HVC site was hosted by THVCP and attended by representatives of the KCB on site and the EoR on the phone on November 22, 2018.

8 SUMMARY

The Trojan TSF appears in good physical condition and the observed performance during the 2018 site inspections is consistent with the expected design conditions and past performance. The status of recommendations to address deficiencies and non-conformances identified during past DSIs are summarized in Table 8.1. Closed recommendations actions are shown in *italics*. Recommendations to address deficiencies and non-conformances identified during the 2018 DSI are summarized in Table 8.2.

Table 8.1 Previous Deficiencies and Non-Conformances – Status Update

ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority[1]	Recommended Deadline (Status)
Trojan Dam					
TD-2017-01	*Surveillance*	*Inclinometer Monitoring*	*Establish a 2018 threshold limit for inclinometer IB16-2.*	*4*	*Q4, 2018 (CLOSED – see Section 5.6)*
TD-2017-02	Flood Routing	Freeboard	Raise the road in the designated area near the left abutment to El. 1440 m, either by fill placement or grading.	3	Q4, 2018 (deferred to 2019)
R4 Seepage Pond					
No previous recommendations (i.e. from 2017) requiring a status update.					
Lower Trojan Dam					
LTD-2017-01	Flood Routing	Inflow Design Flood	Complete appropriate upgrade works to allow LTD to safely pass IDF with adequate freeboard, including decommissioning of the spillway pipe.	2	Q4, 2020 (OPEN)

Notes:
1. Recommendation priority guidelines, specified by THVCP and assigned by KCB:
   Priority 1: A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
   Priority 2: If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
   Priority 3: Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
   Priority 4: Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

Table 8.2 2018 DSI Recommendations

ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority1	Recommended Deadline (Status)
Trojan Dam					
TD-2018-01	Erosion	-	Repair two rill erosions on the left bank of spillway channel (along riprap section), founded in tailings. Re-grade to divert water away from these areas, as feasible.	3	Q4, 2019 (OPEN)
TD-2018-02	Flood Routing	10.1.8	Update flood routing assessment for Trojan impoundment, R3 Seepage Pond and LTD based on the most recent site wide hydrology information for consistency and to confirm compliance.	3	Q2, 2020
TD-2018-03	Surveillance	Inclinometer Monitoring	Complete spiral correction on IB16-2 to resolve any measurement issues which may be impacting cumulative plots.	3	Q3, 2019 (before 2019 reading)
R4 Seepage Pond					
			No new recommendations.		
Lower Trojan Dam					
			No new recommendations.		

Notes:

1. Recommendation priority guidelines, specified by Teck and assigned by KCB:
   Priority 1: A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
   Priority 2: If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
   Priority 3: Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
   Priority 4: Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

9 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 (Client). The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavored to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

KLOHN CRIPPEN BERGER LTD.

Rick Friedel, P.Eng.
Engineer of Record
Senior Geotechnical Engineer, Principal

Pablo Urrutia, P.Eng.
Senior Geotechnical Engineer

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FIGURES

VICINITY PLAN

Legend

- Creek / River
- Highway
- Ditch

0 5km

Notes:
1. Projection: HVC Mine Grid.
2. TSF = Tailings Storage Facility.
3. Base data provided by the Government.
4. Imagery provided by ESRI.

CLIENT	TECK HIGHLAND VALLEY COPPER PARTNERSHIP
	Klohn Crippen Berger
PROJECT	TROJAN TAILINGS STORAGE FACILITY 2018 DAM SAFETY INSPECTION
TITLE	MINE SITE PLAN
SCALE	1:100,000
PROJECT No.	M02341B43
FIG No.	1

Date: 2018-12-07
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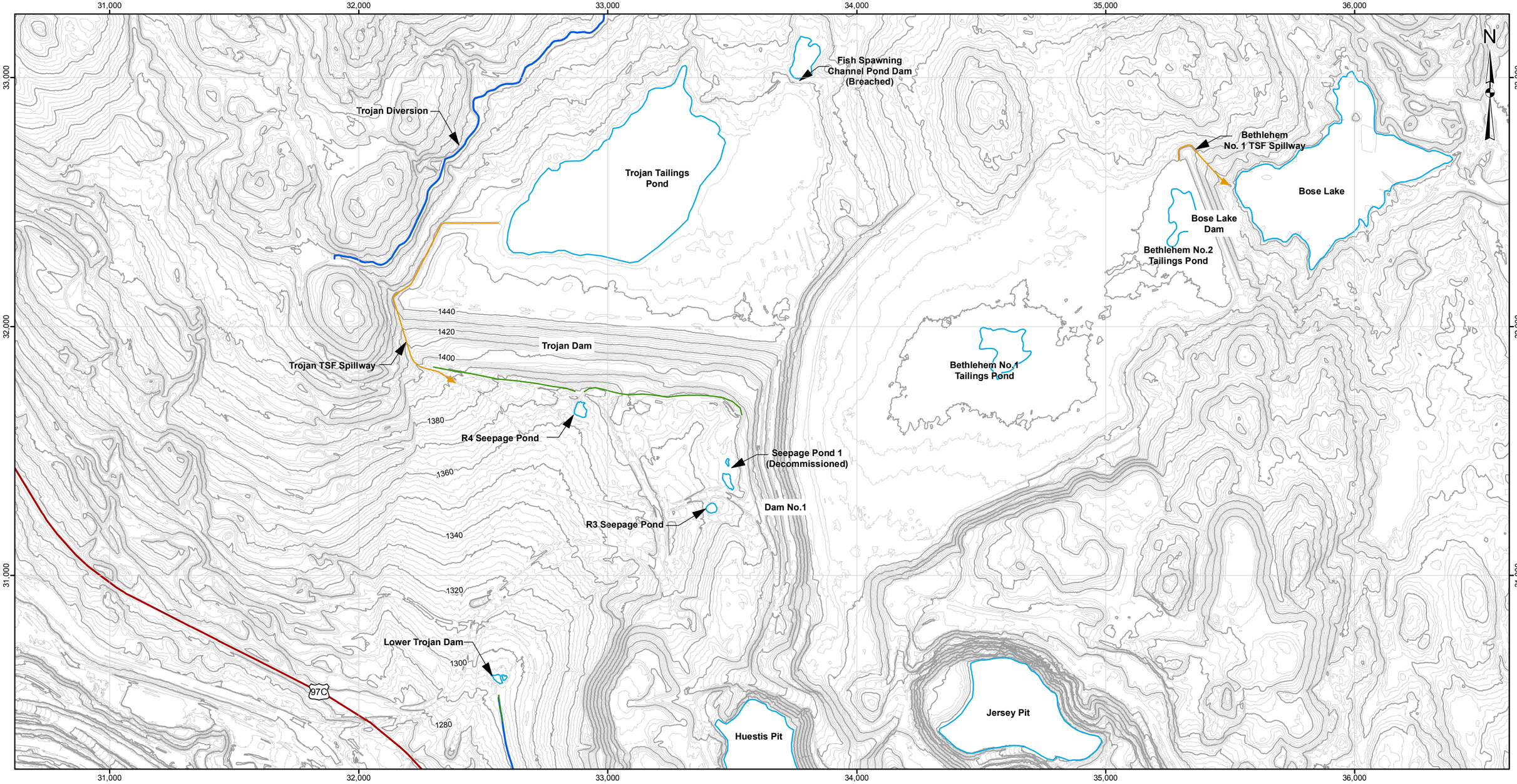

Legend

- Ditch
- Spillway
- Highway
- Index Contour (10 m)
- Intermediate Contour (2 m)
- Waterbody

0 0.5km

Notes:
1. Projection: HVC Mine Grid.
2. TSF = Tailings Storage Facility.
3. Topography from HVC, LiDAR flown on August 23rd, 2014.
4. Tailings and seepage pond extents based on imagery from September, 2016.

CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP	PROJECT: TROJAN TAILINGS STORAGE FACILITY 2018 DAM SAFETY INSPECTION		
Klohn Crippen Berger	TITLE: TROJAN TAILINGS STORAGE FACILITY OVERVIEW		
	SCALE: 1:15,000	PROJECT No.: M02341B43	FIG No.: 2

Date: 2018-12-07
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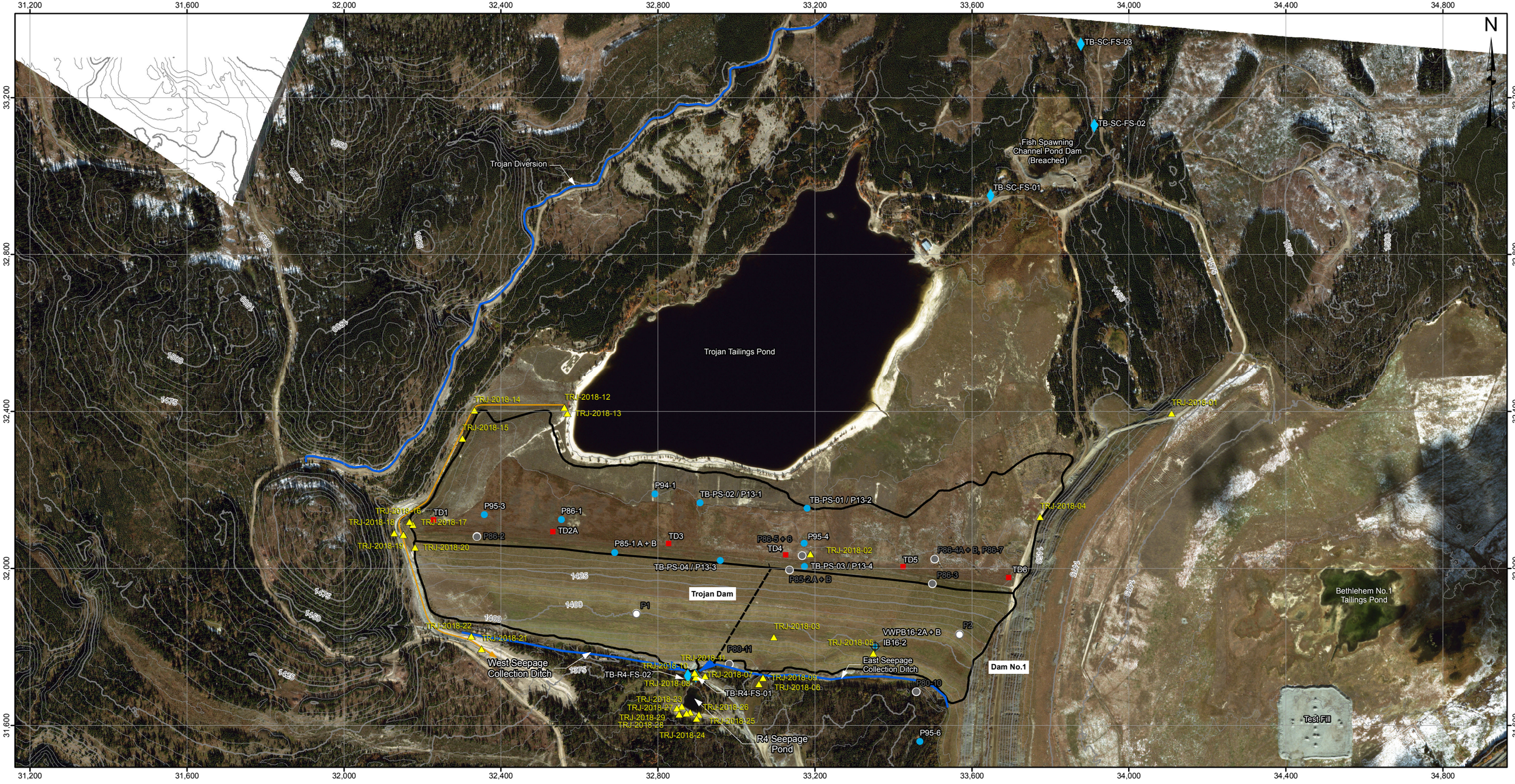


Legend

Instrument Type (Active)
- Standpipe Piezometer
- Vibrating Wire Piezometer
- Inclinometer
- Survey Monument
- Weir

Instrument Type (Defunct)
- Standpipe Piezometer
- Pneumatic Piezometer

- Waypoint (TRJ-2018-xx)
- Plugged Diversion Culvert
- Spillway
- Ditch
- Index Contour (25 m)
- Intermediate Contour (5 m)

0 250m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained October, 2018
3. Topography from HVC, LiDAR flown on August 23rd, 2014.

CLIENT
TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT
TROJAN TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

TITLE
TROJAN DAM
PLAN

SCALE	PROJECT No.	FIG No.
1:9,500	M02341B43	3

Date: 2019-03-22
Document Path: Z:\MVCR\M02341B43 - HVC 2018 Dam Safety Support\400 Drawings\GIS\02_Maps\Reports\DSI\Trojan\Fig3_Trojan_DamPlan.mxd

32,750 32,800 32,850 32,900 32,950 33,000 33,050 33,100

31,750 31,700 31,650 31,600

N

Trojan Dam

1380 1375 1370

F89-11

Flow from East Seepage Collection Ditch

Flow from West Seepage Collection Ditch

TRJ-2018-08

TRJ-2018-10

TB-R4-FS-01

TB-R4-FS-02

TRJ-2018-11

TRJ-2018-07

TRJ-2018-09

TRJ-2018-06

1370 1365

R4 Seepage Pond

TRJ-2018-27

TRJ-2018-28

TRJ-2018-23

TRJ-2018-29

TRJ-2018-24

R4 Seepage Pond Dam

Spillway Channel

TRJ-2018-26

TRJ-2018-25

Abandoned Pumphouse

1380

1375

1360

Original Outlet Pipe (See Note 4)

Valve Shed

100mm Dia. Pipe

300mm Dia. Pipeline

32,750 32,800 32,850 32,900 32,950 33,000 33,050 33,100

31,750 31,700 31,650 31,600

Legend

Instrument Type (Active)
- Weir

Instrument Type (Defunct)
- Standpipe Piezometer

- Waypoint (TRJ-2018-xx)
- Culvert
- Spillway
- Buried Pipeline

- Index Contour (5 m)
- Intermediate Contour (1 m)

0 50m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained October, 2018
3. Topography from HVC, LiDAR flown on August 23rd, 2014.
4. The status of the original outlet pipe is unknown.
5. Locations of buried pipes are approximate.

CLIENT
TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT
TROJAN TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

TITLE
R4 SEEPAGE POND DAM
PLAN

SCALE	PROJECT No.	FIG No.
1:1,000	M02341B43	4

Date: 2019-02-28
Document Path: \\int.klohn.com\Proj\Data\MVCR\M02341B43 - HVC 2018 Dam Safety Support\400 Drawings\GIS\02. Maps\Reports\DSI\Trojan\Fig4_Trojan_R4SeepagePond.mxd

Legend

Instrument Type (Active)
- Weir
- Waypoint (TRJ-2018-xx)
- Spillway
- Buried Pipeline
- Ditch
- Index Contour (5 m)
- Intermediate Contour (1 m)

0 50m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained October, 2018
3. Topography from HVC, LiDAR flown on August 23rd, 2014.
4. Locations of buried pipes are approximate.

CLIENT	TECK HIGHLAND VALLEY COPPER PARTNERSHIP
PROJECT	TROJAN TAILNGS STORAGE FACILITY 2018 DAM SAFETY INSPECTION
TITLE	LOWER TROJAN DAM PLAN
SCALE	1:1,000
PROJECT No.	M02341B43
FIG No.	5

Klohn Crippen Berger

Date: 2019-02-28
Document Path: \\int.klohn.com\Proj\Data\MVCR\M02341B43 - HVC 2018 Dam Safety Support\400 Drawings\GIS\02_Maps\Reports\DSI\TrojanFig5_Trojan_LowerTrojanDam.mxd

APPENDIX I

Dam Safety Inspection Checklist

APPENDIX I-A

Dam Safety Inspection Checklist – Trojan Dam

2018 ANNUAL DAM SAFETY INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Trojan Dam	**Inspection Date:**	7-Aug-18
Weather:	Sunny, partial cloud cover	**Inspector(s):**	Rick Friedel, Tyler Lappin
Pond Elevation:	1433.8 m (based on pond survey completed 6-Sept-18)		
Freeboard:	6.2 m (based on pond survey completed 2-Aug-18 and El. 1440 m crest elevation)		

Condition	Spillway
Was it flowing?	☐ Yes ☒ No
Flow rate:	N/A

Are the following components of your dam in *SATISFACTORY CONDITION*? (check one if applicable)

EMBANKMENT	Yes/No	SPILLWAY	Yes/No
U/S Beach	☒ Yes ☐ No	Debris Boom	☒ Yes ☐ No
Crest	☒ Yes ☐ No	Entrance	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No	Channel	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No	Channel Slopes	☒ Yes ☐ No
Drains	☒ Yes ☐ No		

Were any of the following *POTENTIAL PROBLEM INDICATORS* found?

INDICATOR	EMBANKMENT	SPILLWAY
Piping	☐ Yes ☒ No	☐ Yes ☒ No
Sinkholes	☐ Yes ☒ No	☐ Yes ☒ No
Seepage	☐ Yes ☒ No	☐ Yes ☒ No
External Erosion	☐ Yes ☒ No	☒ Yes ☐ No
Cracks	☐ Yes ☒ No	☐ Yes ☒ No
Settlement	☐ Yes ☒ No	☐ Yes ☒ No
Sloughing/Slides	☐ Yes ☒ No	☐ Yes ☒ No
Animal Activity	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Growth	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Debris	☐ Yes ☒ No	☐ Yes ☒ No

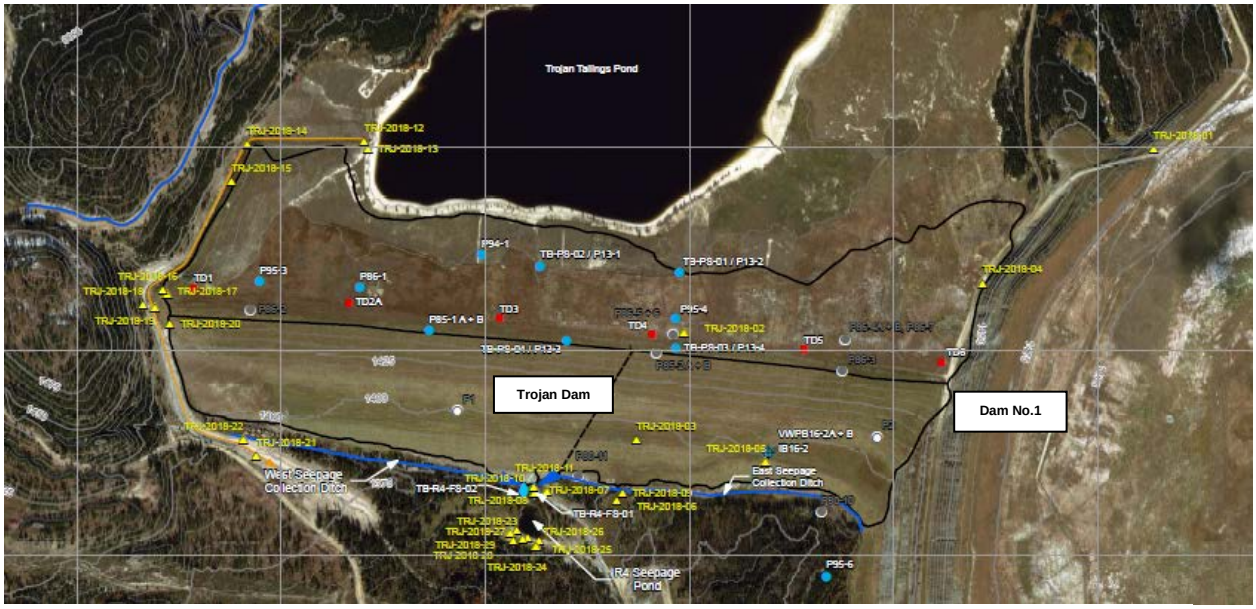
List and describe any deficiencies (all deficiencies require assessment and/or repair):

Two instances of rill erosion were observed along the left bank of the spillway channel (riprap section), which require regrading for repair and diversion of surface water, as feasible.

Comments / Notes:

Evidence of animal burrowing was observed at the downstream slope toe area near the R4 Seepage Pond. This appeared to be localized and not deemed as a "potential problem indicator" for the above checklist.

SITE PLAN



Legend

Instrument Type (Active)
- Standpipe Piezometer
- Vibrating Wire Piezometer
- Inclinometer
- Survey Monument
- Weir

Instrument Type (Defunct)
- Standpipe Piezometer
- Pneumatic Piezometer

- Waypoint (TRJ-2016-xx)
- Plugged Diversion Culvert

- Spillway
- Ditch
- Index Contour (25 m)
- Intermediate Contour (5 m)

APPENDIX I-B

Dam Safety Inspection Checklist – R4 Seepage Pond Dam

2018 ANNUAL DAM SAFETY INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	R4 Seepage Pond Dam	**Inspection Date:**	7-Sept-18
Weather:	Sunny, partial cloud cover	**Inspector(s):**	Rick Friedel, Tyler Lappin
Freeboard (pond level to dam crest):	1.5 m (visually estimated)		

Outlet Condition Survey

Description	Outlet Controls?	Was it flowing?	Flow rate	Visual Review?	Testing / Detailed Inspection?
Low Level Outlet	☒ Yes ☐ No	☒ Yes ☐ No	N/A	☒ Yes ☐ No	☐ Yes ☒ No
Spillway Channel	N/A	☐ Yes ☒ No	N/A	☒ Yes ☐ No	N/A
Original Outlet Pipe	☐ Yes ☐ No	☐ Yes ☐ No		☐ Yes ☒ No	☐ Yes ☒ No

Are the following components in *SATISFACTORY CONDITION*? (check one if applicable)

EMBANKMENT	Yes/No	LOW LEVEL OUTLET	Yes/No	SPILLWAY CHANNEL	Yes/No
U/S Slope	☒ Yes ☐ No	Outlet Pipe	☒ Yes ☐ No	Entrance	☒ Yes ☐ No
Crest	☒ Yes ☐ No	Outlet Channel	☒ Yes ☐ No	Channel	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No	Outlet Controls	☒ Yes ☐ No	Channel Slopes	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No				

ORIGINAL OUTLET PIPE	Yes/No
Entrance	☐ Yes ☐ No
Pipe	☐ Yes ☐ No

Were any of the following *POTENTIAL PROBLEM INDICATORS* found?

INDICATOR	EMBANKMENT	LOW LEVEL OUTLET	SPILLWAY CHANNEL
Piping	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Sinkholes	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Seepage	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Erosion	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Cracks	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Settlement	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Sloughing/Slides	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Animal Activity	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Growth	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Debris	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No

List and describe any deficiencies (all deficiencies require assessment and/or repair):

None.

Comments / Notes:

Minor vegetation present along the upstream slope and near the low-level outlet. Monitoring and clearing is part of THVCP routine dam inspection and maintenance.

SITE PLAN

APPENDIX I-C

Dam Safety Inspection Checklist – Lower Trojan

2018 ANNUAL DAM SAFETY INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Lower Trojan Dam	**Inspection Date:**	7-Aug-18
Weather:	Sunny, partial cloud cover	**Inspector(s):**	Rick Friedel, Tyler Lappin
Freeboard (pond level to dam crest):	1.5 m (visually estimated)		

Outlet Condition Survey

Description	Outlet Controls?	Was it flowing?	Flow rate	Visual Review?	Testing / Detailed Inspection?
460 mm HDPE Outlet to Weir	☒ Yes ☐ No	☒ Yes ☐ No	~1/3 full	☒ Yes ☐ No	☐ Yes ☒ No
200 mm HDPE Low Level Outlet	☐ Yes ☒ No	☐ Yes ☐ No	Decommissioned	☒ Yes ☐ No	☐ Yes ☒ No
810 mm HDPE Spillway Pipe	☐ Yes ☒ No	☐ Yes ☒ No	N/A	☒ Yes ☐ No	N/A
Spillway Channel	N/A	☐ Yes ☒ No	N/A	☒ Yes ☐ No	N/A

Are the following components in *SATISFACTORY CONDITION*?
(check one if applicable)

EMBANKMENT	Yes/No	OUTLET TO WEIR	Yes/No	LOW LEVEL OUTLET	Yes/No
U/S Slope	☒ Yes ☐ No	Outlet Pipe	☒ Yes ☐ No	Outlet Pipe	☒ Yes ☐ No
Crest	☒ Yes ☐ No	Outlet Channel	☒ Yes ☐ No	Outlet Channel	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No	Outlet Controls	☒ Yes ☐ No	Outlet Controls	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No				

SPILLWAY PIPE	Yes/No	SPILLWAY CHANNEL	Yes/No
Entrance	☒ Yes ☐ No	Entrance	☐ Yes ☒ No
Pipe	☒ Yes ☐ No	Channel	☐ Yes ☒ No
		Channel Slopes	☐ Yes ☒ No

Were any of the following *POTENTIAL PROBLEM INDICATORS* found?

INDICATOR	EMBANKMENT	LOW LEVEL OUTLET (Decommissioned)	OUTLET TO WEIR
Piping	☐ Yes ☒ No	☐ Yes ☐ No	☐ Yes ☒ No
Sinkholes	☐ Yes ☒ No	☐ Yes ☐ No	☐ Yes ☒ No
Seepage	☐ Yes ☒ No	☐ Yes ☐ No	☐ Yes ☒ No
Erosion	☐ Yes ☒ No	☐ Yes ☐ No	☐ Yes ☒ No
Cracks	☐ Yes ☒ No	☐ Yes ☐ No	☐ Yes ☒ No
Settlement	☐ Yes ☒ No	☐ Yes ☐ No	☐ Yes ☒ No
Sloughing/Slides	☐ Yes ☒ No	☐ Yes ☐ No	☐ Yes ☒ No
Animal Activity	☐ Yes ☒ No	☐ Yes ☐ No	☐ Yes ☒ No
Excessive Growth	☐ Yes ☒ No	☐ Yes ☐ No	☒ Yes ☐ No
Excessive Debris	☐ Yes ☒ No	☐ Yes ☐ No	☐ Yes ☒ No

INDICATOR	SPILLWAY PIPE	SPILLWAY CHANNEL
Piping	☐ Yes ☒ No	☐ Yes ☒ No
Sinkholes	☐ Yes ☒ No	☐ Yes ☒ No
Seepage	☐ Yes ☒ No	☐ Yes ☒ No
Erosion	☐ Yes ☒ No	☐ Yes ☒ No
Cracks	☐ Yes ☒ No	☐ Yes ☒ No
Settlement	☐ Yes ☒ No	☐ Yes ☒ No
Sloughing/Slides	☐ Yes ☒ No	☐ Yes ☒ No
Animal Activity	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Growth	☒ Yes ☐ No	☒ Yes ☐ No
Excessive Debris	☐ Yes ☒ No	☒ Yes ☐ No

List and describe any deficiencies (all deficiencies require assessment and/or repair):

1. The spillway pipe inlet and outlet areas were heavily vegetated and the outlet discharges at the downstream toe with no defined channel (or erosion protection). This vegetation should be removed as part of the routine maintenance program.
2. The spillway inlet and channel were partially blocked by heavy vegetation and tree debris. The spillway should be cleared of debris and vegetation.

The above items were documented in the 2017 DSI as TD-2017-02.

Comments / Notes:

1. The impoundment, upstream slope and low-level outlet intake areas were heavily vegetated and full of debris. This should be monitored and cleared as part of the routine maintenance program.

SITE PLAN


Spillway Channel
Lower Trojan Dam
TRJ-2018-32
Lower Trojan Pond
TRJ-2018-31
810 mm Dia Spillway Pipe
200 mm Dia Low-Level Outlet Pipe (Decommissioned)
TRJ-2018-33
TRJ-2018-30
TB-LT-FS-01
Control Valve
460 mm Dia Diversion Pipeline
TRJ-2018-34
Diversion Ditch
Legend
Instrument Type (Active)
Weir
Waypoint (TRJ-2016-xx)
Spillway
Buried Pipeline
Ditch
Index Contour (5 m)
Intermediate Contour (1 m)

APPENDIX II

Inspection Photographs

APPENDIX II-A

Inspection Photographs – Trojan Dam

Appendix II-A
Inspection Photographs - Trojan Dam

LEGEND:

- TRJ = Trojan Tailings Facility
- TRJ-2018-## refers to 2018 DSI waypoint shown on Figure 3
- All photographs taken during inspection on August 7, 2018

Photo II-A- 1 Overview of Trojan Tailings Storage Facility (TRJ-2018-01)

Photo II-A- 2 Trojan impoundment view from crest road (TRJ-2018-02)

Photo II-A- 3 Trojan Dam crest and starter dam crest (lower bench) (TRJ-2018-03)

Photo II-A- 4 Access road at Trojan TSF left abutment (TRJ-2018-04)

Photo II-A- 5 Trojan Dam downstream slopes (TRJ-2018-05 and TRJ-2018-06)

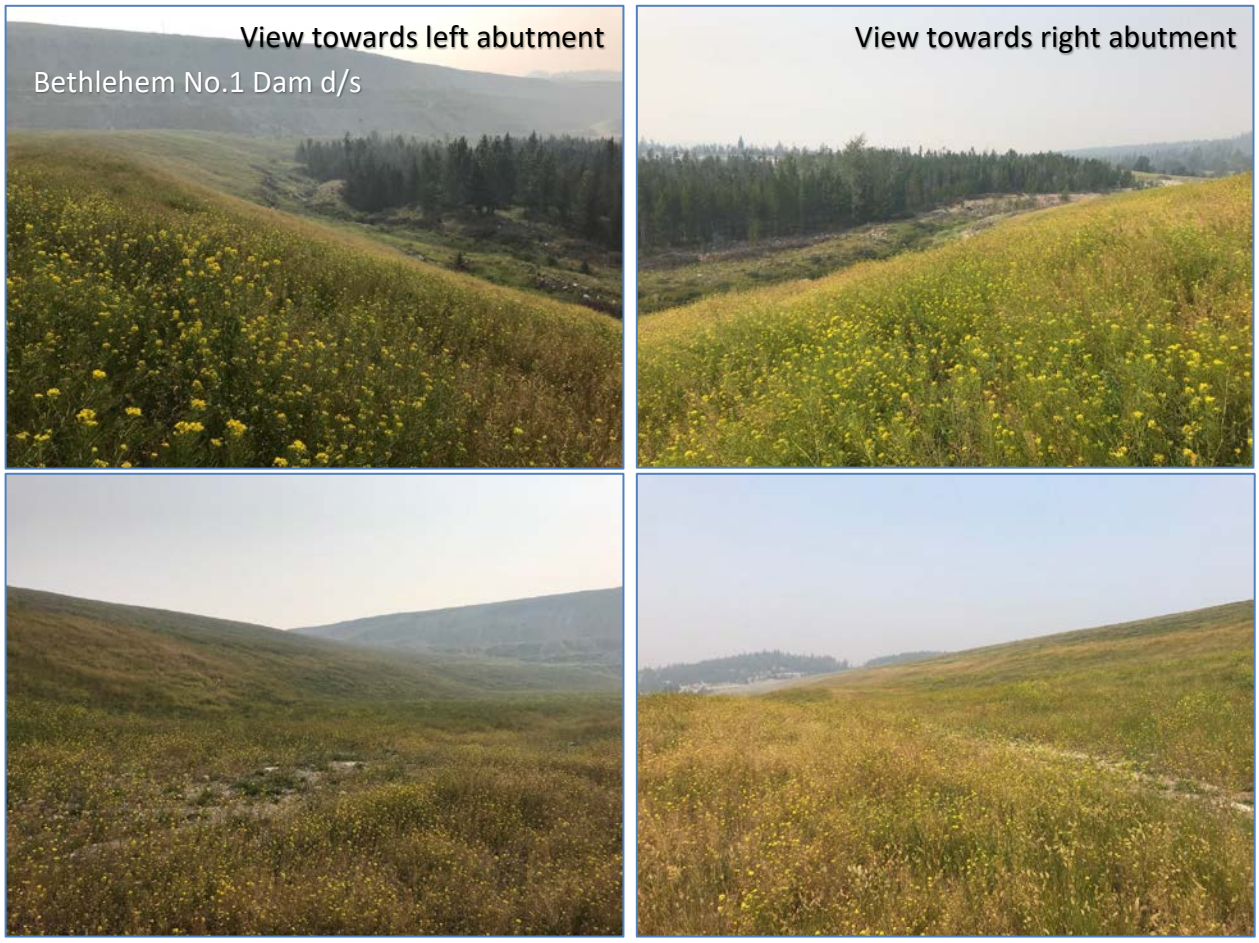


Photo II-A- 6 Trojan Dam downstream slopes (TRJ-2018-07)

Photo II-A- 7 Animal burrows observed at downstream slope toe area near the R4 Seepage pond (TRJ-2018-08)

Photo II-A- 8 West and East seepage collection ditches (TRJ-2018-09)

Photo II-A- 9 R4 Seepage Pond inlet at monitoring station TB-R4-FS-01 (TRJ-2018-10)

Photo II-A- 10 Immediately downstream of monitoring station TB-R4-FS-01, noted in Photo II-A-9 (TRJ-2018-11)

Photo II-A- 11 Trojan pond and beach adjacent to spillway inlet (TRJ-2018-12)

Photo II-A- 12 Trojan spillway inlet (TRJ-2018-13)

Photo II-A- 13 Spillway channel – rock cut section (TRJ-2018-14 & 15)

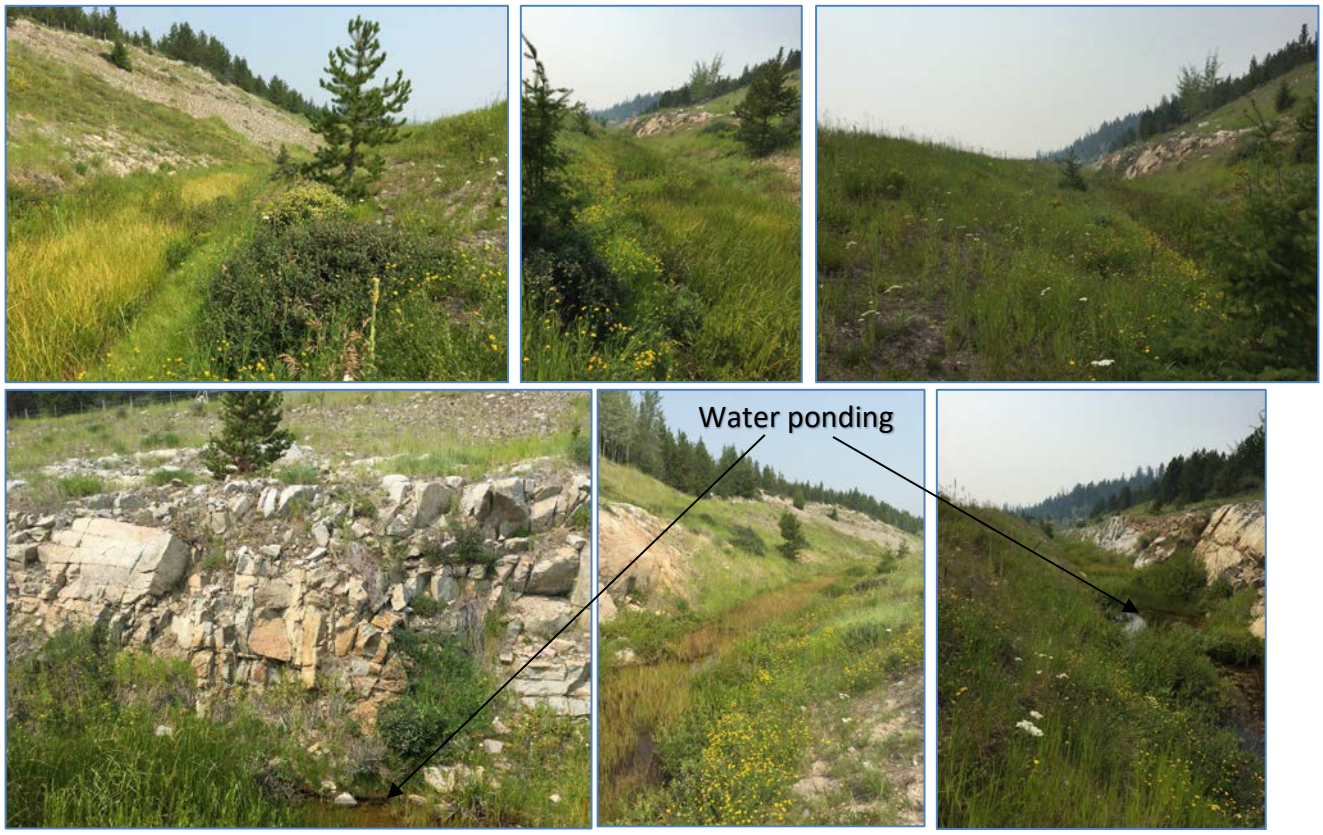


Photo II-A- 14 Spillway channel – transition to riprap lined section (TRJ-2018-16)

Photo II-A- 15 Spillway channel – left bank dam slope erosion feature (TRJ-2018-17)

Photo II-A- 16 Spillway channel – left bank erosion feature erosion (TRJ-2018-18 & 19)

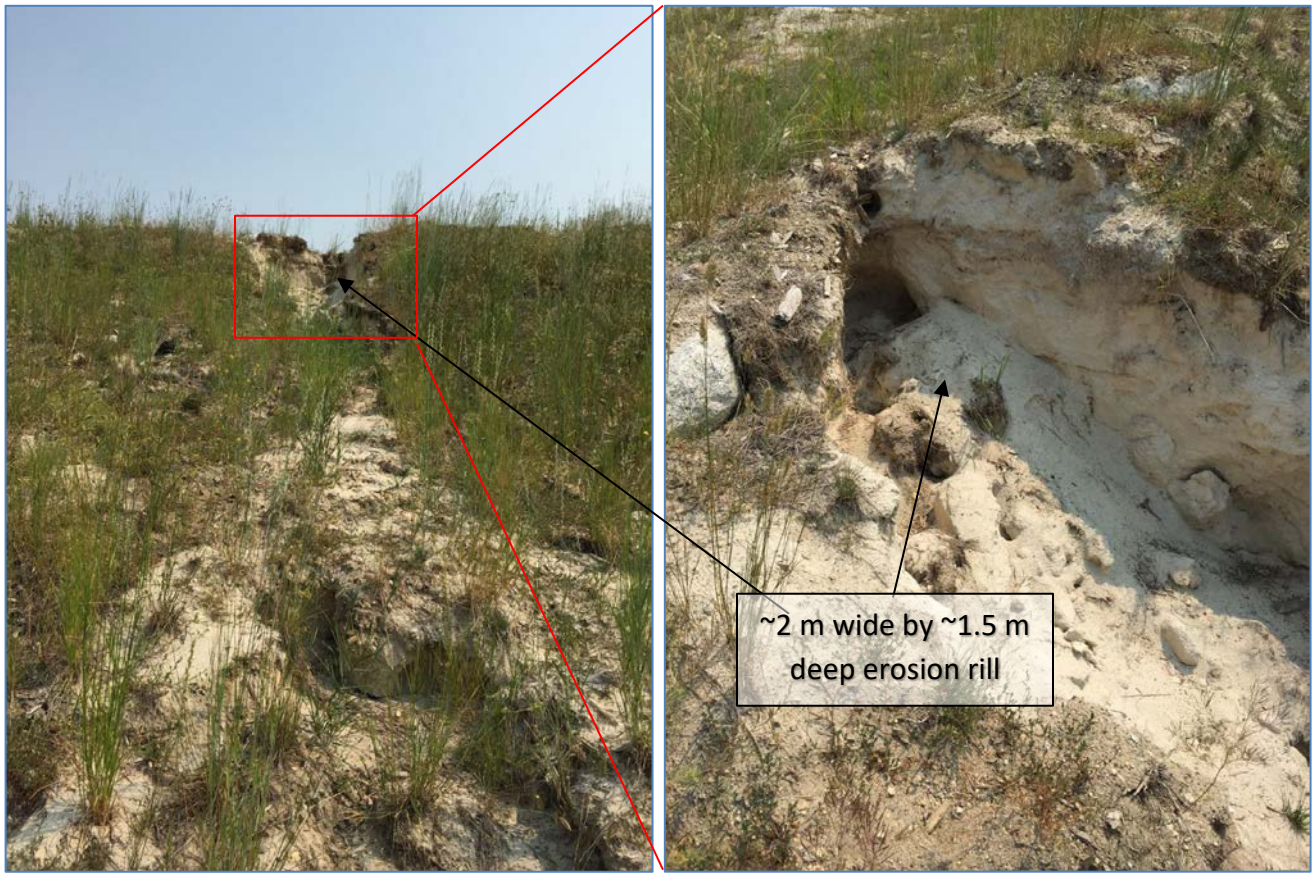


Photo II-A- 17 Spillway channel – extension of riprap section (TRJ-2018-20)

Photo II-A- 18 Spillway channel – extension of riprap section (TRJ-2018-21)

Photo II-A- 19 Spillway extension transition zone (TRJ-2018-22)

APPENDIX II-B

Inspection Photographs – R4 Seepage Pond Dam

Appendix II-B
Inspection Photographs - R4 Seepage Pond Dam

LEGEND:

- TRJ = Trojan Tailings Facility
- TRJ-2018-## refers to 2018 DSI waypoint shown on Figure 4.
- All photographs taken during inspection on August 7, 2018

Photo II-B- 1 Dam Crest and upstream slope (TRJ-2018-23)

Photo II-B- 2 Dam crest and downstream slope (TRJ-2018-23)

Photo II-B- 3 Downstream slope and toe (TRJ-2018-24)

Photo II-B- 4 Downstream slope (TRJ-2018-25)

Photo II-B- 5 R4 Dam Pond and Trojan toe drain inflow pipe (TRJ-2018-26)

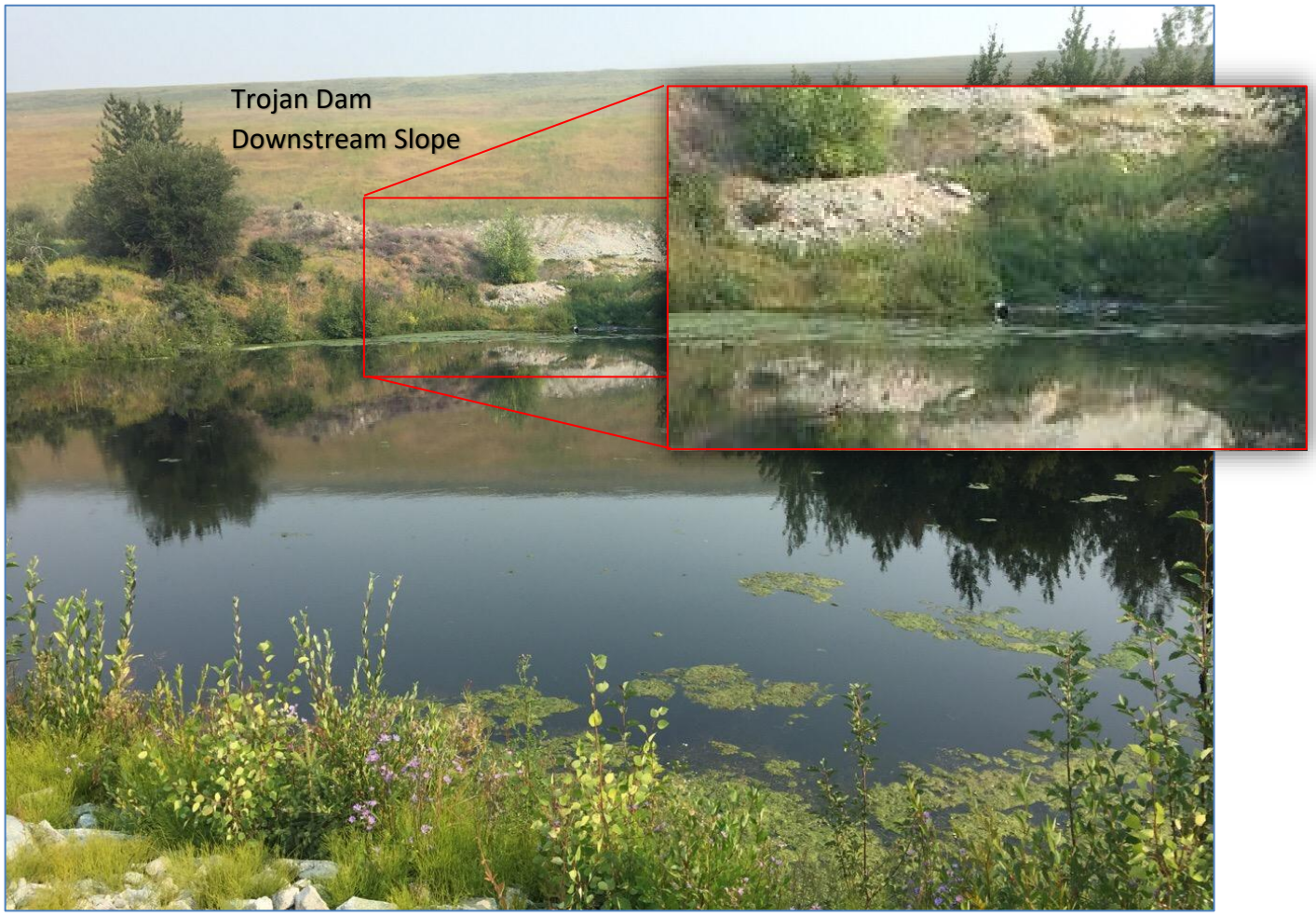


Photo II-B- 6 Spillway Inlet (TRJ-2018-27)

Photo II-B- 7 Spillway channel (TRJ-2018-27)

Photo II-B- 8 Spillway channel (TRJ-2018-28)

Photo II-B- 9 Spillway channel – transition to grass-lined channel (TRJ-2018-29)

Photo II-B- 10 Box enclosed valve for seepage pipe at downstream of the dam (TRJ-2018-25)

Photo II-B- 11 Low-level outlet to Witches Brook via Lower Trojan Dam (TRJ-2018-26)

APPENDIX II-C

Inspection Photographs – Lower Trojan Dam

Appendix II-C
Inspection Photographs - Lower Trojan Dam

LEGEND:

- TRJ = Trojan Tailings Facility.
- TRJ-2018-## refers to 2018 DSI waypoint shown on Figure 5.
- All photographs taken during inspection on August 7, 2018

Photo II-C-1 Dam crest and downstream slope (TRJ-2018-30)

Photo II-C-2 Downstream slope near right abutment with overflow pipe (TRJ-2018-31)

Photo II-C-3 Spillway near right abutment (TRJ-2018-32)

Photo II-C-4 Lower Trojan Dam Pond (TRJ-2018-32)

Photo II-C-5 Upstream crest with view of ramp to low level outlet intake (TRJ-2018-33)

Photo II-C-6 Low-level outlet intake and secured debris booms (TRJ-2018-33)

Photo II-C-7 Low-level outlet discharge pipe (TRJ-2018-34)

Photo II-C-8 Inflow culvert from Trojan Diversion Ditch (TRJ-2018-34)

Photo II-C-9 Discharge channel to weir TB-LT-FS-01 (TRJ-2018-34)

APPENDIX III

Reference Dam Design Drawings

APPENDIX III-A

Reference Dam Design Drawings – Trojan Dam

Normal Pond Level 1435 m 4678.5'

Spillway Invert El. 1435 m

Sand Dam 27.5 m high

137 m

El. 4610

Rockfill

Cycloned Sand Crest el 4695'

Piezometer

Existing Rockfill Section - Crest el 4610'

Berm el 4595'

Berm el 4585'

Max HT 27.4 m

Piezometer

Berm el. 4560'

Seepage interceptor ditch (excavated 1982)

Ditches for future seepage collection system

Temporary seepage collection ditches & sumps to collect seepage during 4th stage starter dam construction

Proposed location of future seepage recovery dam

Temporary Wing Dykes

Upstream toe of cycloned sand starter dam

Piezometer

Culverts

Culvert to be blocked

Piezometer

Piezometer

Berm el 4540'

el 4520'

Berm el 4513'

Seepage interceptor Ditch (excavated 1982)

Seepage Recovery Sump

Pumped into existing seepage collection system

Crest of Rockfill el 4800'

Operating Crest el 4820'

TAILINGS POND No. 1

18000 N

17000 N

16000 N

15000 N

2000 W

1000 W

0

1000 E

2000 E

3000 E

4000 E

REFERENCE

Base plan taken from Pencil manuscript supplied by Bethlehem Copper Corporation dwg 81-184, dated July 17, 1981

TO BE READ WITH KLOHN LEONOFF REPORT DATED NOV 22, 1982

SCALE: 200 0 400FT

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
S.R	E.D.P	NOV, 1982	AS SHOWN

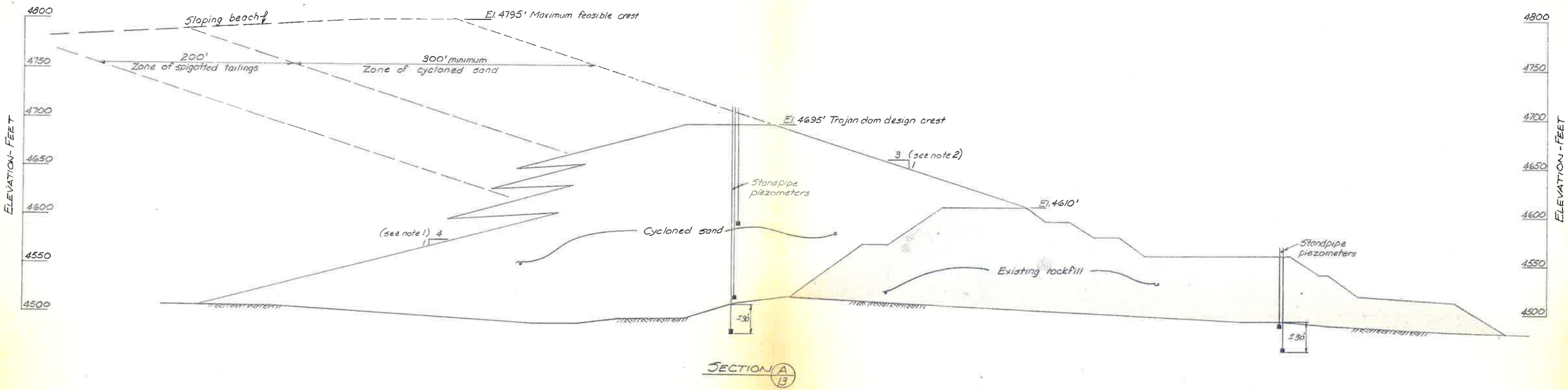
KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

PROJECT: TROJAN TAILINGS DAM

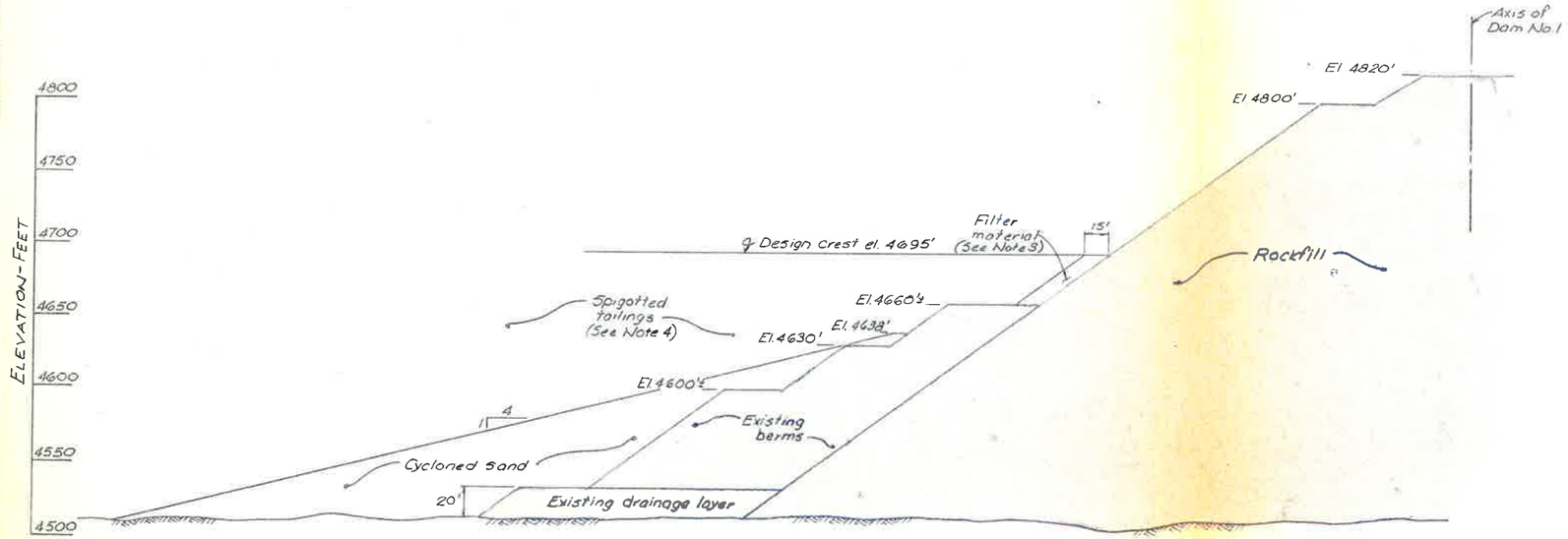
TITLE: PLAN OF TROJAN DAM

CLIENT: BETHLEHEM COPPER CORPORATION

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
APPROVED Steve Rice	VA2916	D-2916-13	



SECTION A 13



SECTION B 13

NOTES:

1. Upstream slopes of the cycloned sand dam should be no flatter than 4 horizontal to 1 vertical and can be steepened if placement procedures allow.
2. An average downstream slope of 3 horizontal to 1 vertical should be achieved by constructing a series of toe berms on the downstream edge of the dam to retain the cycloned sand.
3. Filter material to conform to the design gradation shown on figure 2, appendix I. Material should be placed in maximum 18 inch lifts, heavily watered and compacted.
4. Tailings will be hydraulically placed from spigot points along the dam crest to develop uniform beaches.
5. For construction schedule and sequencing see drawing D-2916-16
6. For location of standpipe piezometers see drawing D-2916-13.
7. The design presented in this report is for the dam constructed to elev. 4695 ft. The section above 4695 ft is presented to illustrate the feasibility of future dam raising.

TO BE READ WITH KLOHN LEONOFF REPORT DATED NOV. 22, 1982

SCALE: 50 0 50 100FT

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
S.R	E.D.P	NOV., 1982	AS SHOWN

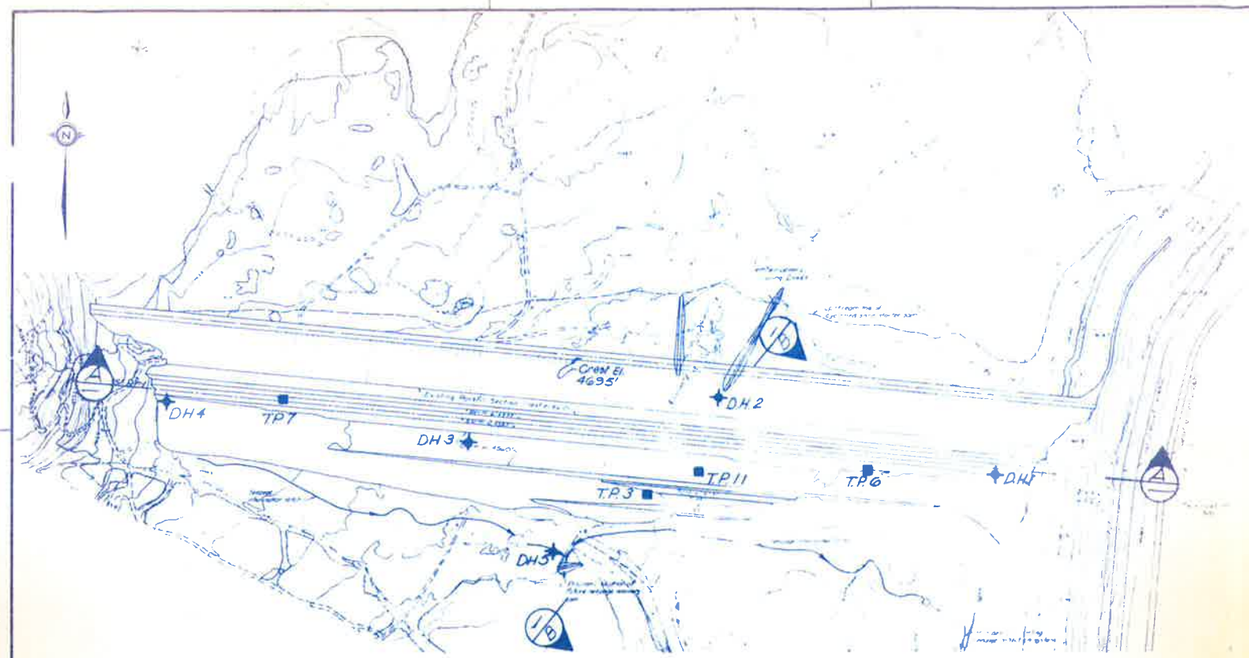
KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

PROJECT: TROJAN TAILINGS DAM

TITLE: TYPICAL DESIGN SECTIONS

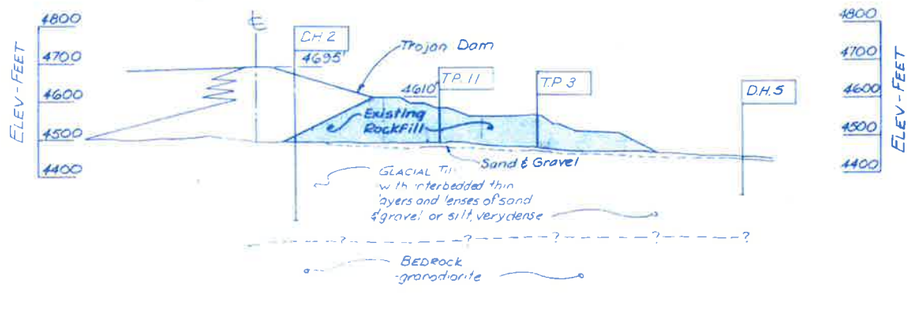
CLIENT: BETHLEHEM COPPER CORPORATION

DATE OF ISSUE	PROJECT NO	DWG. NO	REV.
APPROVED Steve Rice	VA2916	D-2916-14	

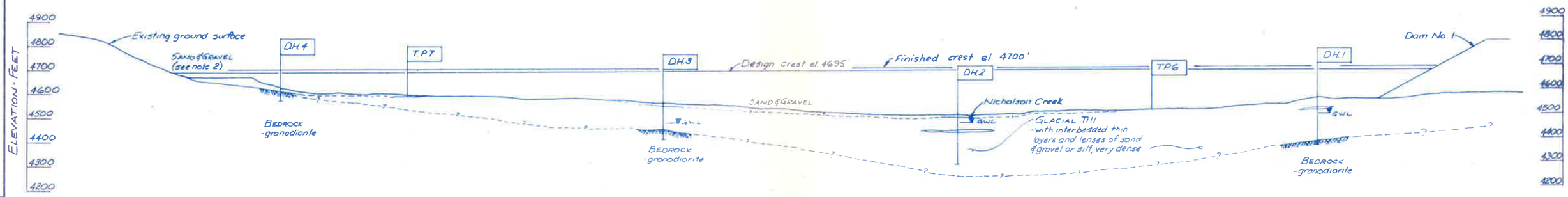


LOCATION PLAN

400' 0 800'



SECTION B



SECTION A

NOTES

1. Subsoil information based on site investigation carried out by Geopac Consultants Ltd in April & May, 1972.
2. Sand & gravel at west end of Trojan Dam used for filter on Trojan Dam.
3. Foundation conditions have been simplified and inferred between test holes.

SOURCE : KLOHN LEONOFF PROJECT VA 2916
DWG. No. D-2916-18, DATED NOV. 22, 1982.

TO BE READ WITH KLOHN - CRIPPEN REPORT DATED DEC. 9, 1996

SCALE: 200' 0 400'

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
S.R.	E.D.P.	NOV., 1982	AS SHOWN

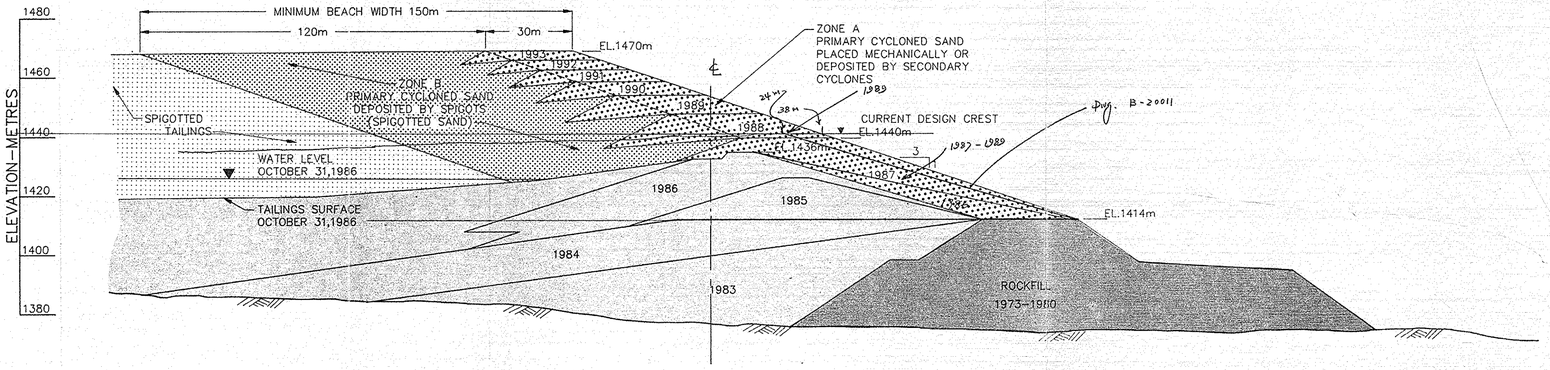
KLOHN-CRIPPEN

PROJECT: LONG-TERM STABILITY ASSESSMENT

TITLE: SUBSOIL DATA - TROJAN DAM

CLIENT: HIGHLAND VALLEY COPPER

DATE OF ISSUE	PROJECT No.	DWG. No.
DEC 9, 1996	FM2916 23	B-23018



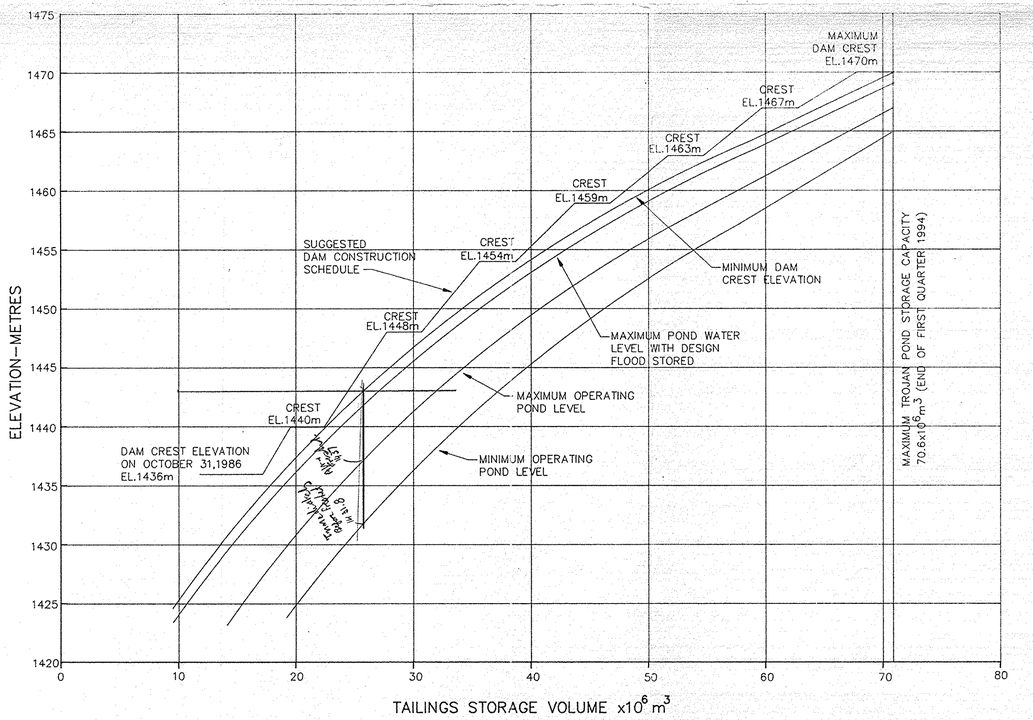
SECTION A (10008)

TYPICAL DESIGN SECTION AND CONSTRUCTION SCHEDULE

LEGEND

- ZONE A–PRIMARY CYCLONED SAND PLACED MECHANICALLY OR DEPOSITED BY SECONDARY CYCLONES
- ZONE B–PRIMARY CYCLONED SAND DEPOSITED BY SPIGOT
- SPIGOTTED TAILINGS
- EXISTING TAILINGS SAND EMBANKMENT
- ROCKFILL

TIME IN YEARS BASED ON MILL THROUGHPUT OF 27000 TONNES PER DAY								
1983–1986	1987	1988	1989	1990	1991	1992	1993	1994



TAILINGS POND STORAGE CURVES

YEAR	DESIGN CREST ELEVATION (m)	APPROXIMATE SAND VOLUME ZONE A (m^3)
1987	1440	0.98×10^6
1988	1448	0.78×10^6
1989	1454	0.54×10^6
1990	1459	0.39×10^6
1991	1463	0.31×10^6
1992	1467	0.27×10^6
1993	1470	0.22×10^6

APPROXIMATE ZONE A CONSTRUCTION SCHEDULE AND CYCLONED SAND VOLUMES

min – 4668
max – 4685
Nov. 2, 1987 4673.9

NOTES:

1. THE PRIMARY CYCLONED SAND DEPOSITED IN ZONES A AND B SHALL CONTAIN LESS THAN 10 PERCENT BY WEIGHT PASSING THE No. 200 SIEVE AND SHALL BE DEPOSITED WITH THE FOLLOWING MINIMUM AVERAGE IN-SITU DRY DENSITY:

ZONE	DRY DENSITY (kN/m^3)
A	14.4
B	14.9

2. THE MINIMUM DAM CREST ELEVATION REQUIRED AT ANY TIME DURING THE OPERATION OF TROJAN POND WILL PROVIDE THE FOLLOWING DESIGN STORAGE REQUIREMENTS, PLUS 1m OF FREEBOARD:
   a) THE TAILINGS PRODUCED BY THE MILL;
   b) A MINIMUM OPERATING POND CONTAINING $1.2 \times 10^6 m^3$ OF WATER;
   c) A MAXIMUM OPERATING POND CONTAINING $2.2 \times 10^6 m^3$ OF WATER FOLLOWING THE SPRING FRESHET; AND
   d) FLOOD STORAGE OF $3.4 \times 10^6 m^3$, ABOVE THE MAXIMUM OPERATING POND LEVEL, TO STORE THE PROBABLE MAXIMUM FLOOD.
3. THE SUGGESTED DAM CONSTRUCTION SCHEDULE IS BASED ON AN AVERAGE MILL THROUGHPUT RATE OF 27000 TONNES PER DAY(tpd) AND IS PRESENTED AS A GUIDE. THE ACTUAL DAM CONSTRUCTION SCHEDULE SHALL BE REVIEWED ANNUALLY AND ADJUSTED IN ACCORDANCE WITH OPERATING CONDITIONS.
4. TAILINGS STORAGE VOLUMES ARE BASED ON THE FOLLOWING ASSUMED IN-SITU DRY DENSITIES:

SLIMES	=	$9.4 kN/m^3$ ($0.96 t/m^3$)
SPIGOTTED TAILINGS	=	$13.0 kN/m^3$ ($1.33 t/m^3$)
ZONE A SAND	=	$14.4 kN/m^3$ ($1.47 t/m^3$)
ZONE B SAND	=	$14.9 kN/m^3$ ($1.52 t/m^3$)

DRAFT

TO BE READ WITH KLOHN LEONOFF REPORT DATED

SCALE: 20m 0 50m

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
S.R.	E.D.P.	MAY,1987	AS SHOWN

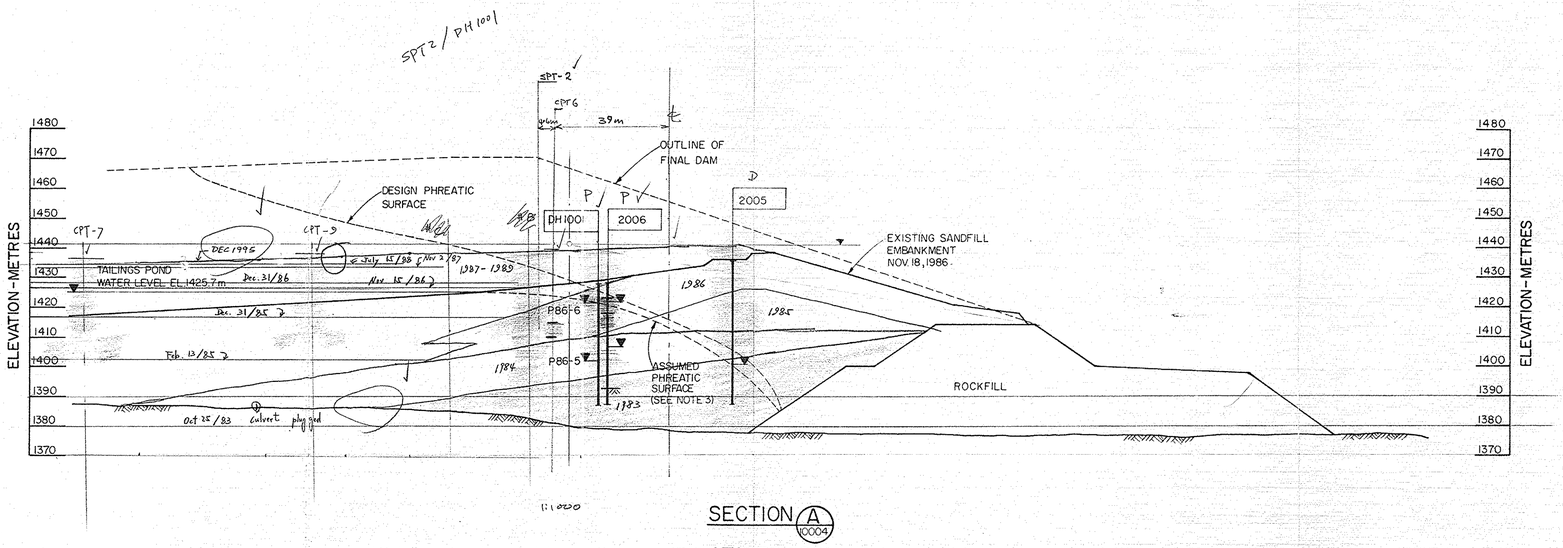
KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

PROJECT: TROJAN TAILINGS DAM

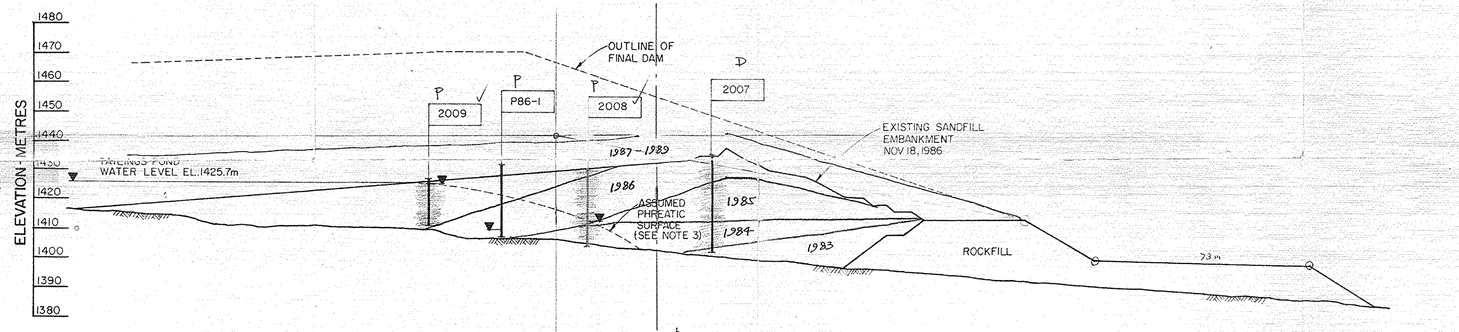
TITLE: TROJAN DAM DESIGN SECTION, CONSTRUCTION SCHEDULE AND POND STORAGE CURVES

CLIENT: HIGHLAND VALLEY COPPER

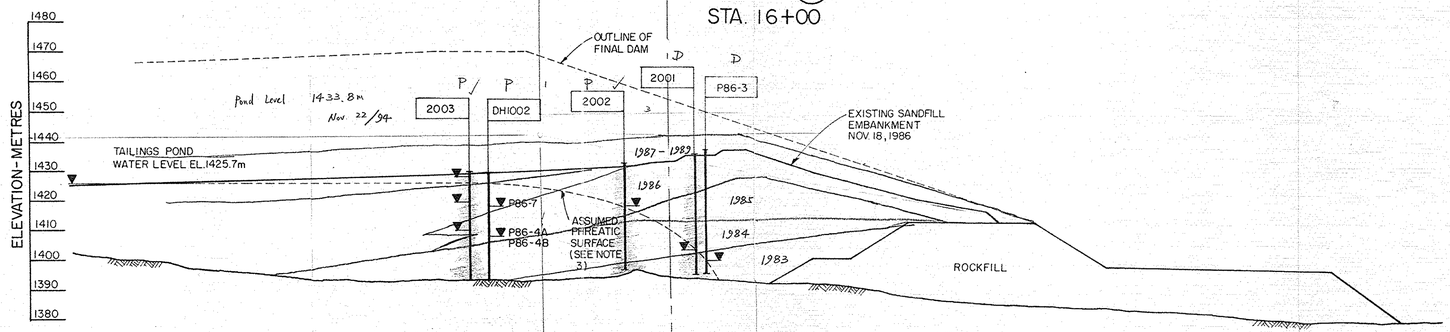
DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
APPROVED	PB291610	D-10009	



SECTION A (10004)
STA. 36+00



SECTION B (10004)
STA. 16+00



SECTION C (10004)
STA. 47+00

LEGEND

- 2003 — CONE PENETRATION TEST
- DH1001 — SAMPLED DRILLHOLE
- P86-1 — STANDPIPE PIEZOMETER
- ▼ — MEASURED WATER LEVEL OR WATER LEVEL INTERPRETED FROM CONE LOG
- ▼P86-6 — MEASURED WATER LEVEL IN STANDPIPE PIEZOMETER INSTALLED IN, OR ADJACENT TO, SAMPLED DRILLHOLE

NOTES

1. FOR TEST HOLE LOCATIONS SEE DRAWING D-10004.
2. WATER LEVELS IN THE CONE PENETRATION TEST HOLES WERE INTERPRETED FROM THE CONE LOGS (SEE APPENDIX II). WATER LEVELS IN STANDPIPE PIEZOMETERS WERE MEASURED APPROX. ONE MONTH AFTER THE FIELD INVESTIGATION.
3. THE ASSUMED PHREATIC SURFACE PLOTTED ON THE SECTIONS CORRESPONDS TO THE HIGHEST MEASURED WATER LEVEL.
4. SECTIONS BASED ON AS-BUILT SECTIONS PROVIDED BY HIGHLAND VALLEY COPPER.

1 : 100

DRAFT

TO BE READ WITH KLOHN LEONOFF REPORT DATED _____

SCALE: 20m 0 50m

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
S.R.	E.D.P.	AUG., 1987	AS SHOWN

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

PROJECT: TROJAN TAILINGS DAM

TITLE: SECTIONS

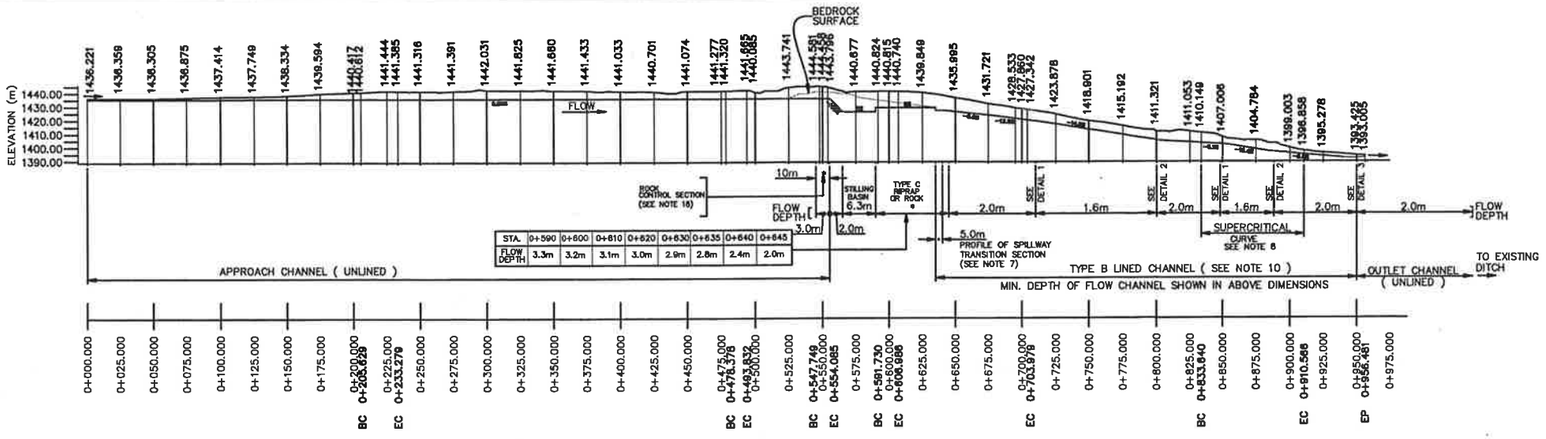
CLIENT: HIGHLAND VALLEY COPPER

DATE OF ISSUE: _____ APPROVED: _____

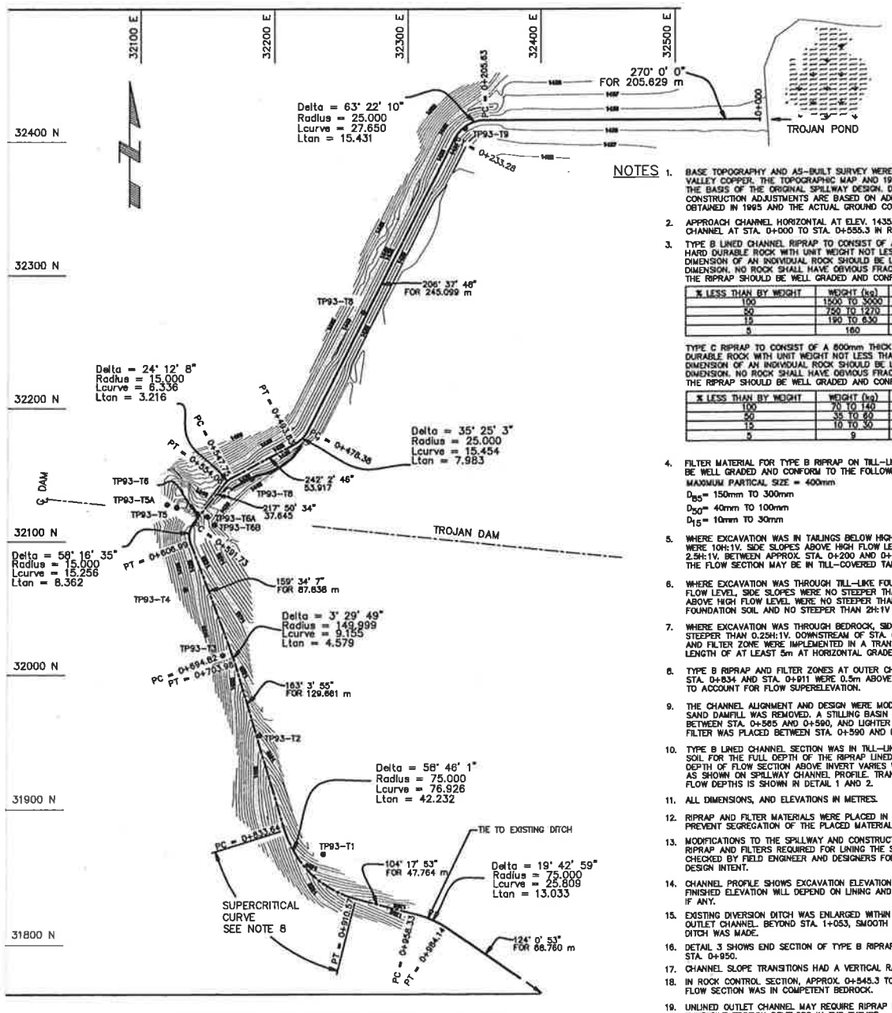
PROJECT No. PB2916-10

DWG. No. D-10005

REV.



PROFILE ALONG SPILLWAY CHANNEL
(SEE NOTE 14)



GENERAL ARRANGEMENT – PLAN

NOTES

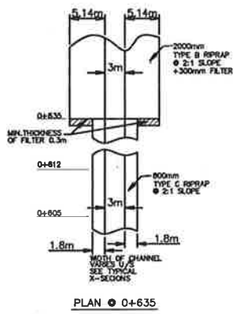
1. BASE TOPOGRAPHY AND AS-BUILT SURVEY WERE SUPPLIED BY HIGHLAND VALLEY COPPER. THE TOPOGRAPHIC MAP AND 1993 TEST PITTING DATA FORMED THE BASIS OF THE ORIGINAL SPILLWAY DESIGN. DESIGN MODIFICATIONS AND CONSTRUCTION ADJUSTMENTS ARE BASED ON ADDITIONAL TEST PITTING DATA OBTAINED IN 1995 AND THE ACTUAL GROUND CONDITIONS ENCOUNTERED.
2. APPROACH CHANNEL HORIZONTAL AT ELEV. 1435.5m FROM START OF TAILINGS CHANNEL AT STA. 0+000 TO STA. 0+555.3 IN ROCK CHANNEL.
3. TYPE B LINED CHANNEL RIPRAP TO CONSIST OF A 2000mm THICK LAYER OF HARD DURABLE ROCK WITH UNIT WEIGHT NOT LESS THAN 2400 kg/m³. NO DIMENSION OF AN INDIVIDUAL ROCK SHOULD BE LESS THAN 1/3 OF LARGEST DIMENSION. NO ROCK SHALL HAVE OBVIOUS FRACTURE PLANES OR FISSURES. THE RIPRAP SHOULD BE WELL GRADED AND CONFORM TO THE FOLLDWING:

% LESS THAN BY WEIGHT	WEIGHT (kg)	DIA. (mm)
100	1500 TO 3000	1050 TO 1340
50	750 TO 1270	840 TO 1000
15	190 TO 630	530 TO 800
5	160	500

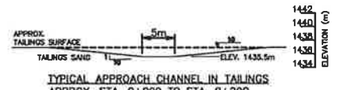
TYPE C RIPRAP TO CONSIST OF A 800mm THICK LAYER OF HARD DURABLE ROCK WITH UNIT WEIGHT NOT LESS THAN 2400 kg/m . NO DIMENSION OF AN INDIVIDUAL ROCK SHOULD BE LESS THAN 1/3 OF LARGEST DIMENSION. NO ROCK SHALL HAVE OBVIOUS FRACTURE PLANES OR FISSURES. THE RIPRAP SHOULD BE WELL GRADED AND CONFORM TO THE FOLLOWING:

% LESS THAN BY WEIGHT	WEIGHT (kg)	DIA. (mm)
100	70 TO 140	350 TO 450
50	35 TO 80	300 TO 370
15	10 TO 30	190 TO 260
5	9	150

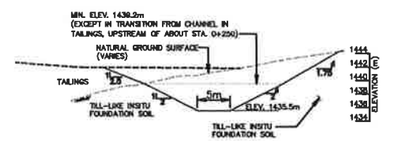
4. FILTER MATERIAL FOR TYPE B RIPRAP ON TILL-LIKE FOUNDATION SOIL SHOULD BE WELL GRADED AND CONFORM TO THE FOLLOWING:
   MAXIMUM PARTICAL SIZE = 400mm
   D_{85} = 150mm TO 300mm
   D_{50} = 40mm TO 100mm
   D_{15} = 10mm TO 30mm
5. WHERE EXCAVATION WAS IN TAILINGS BELOW HIGH FLOW LEVEL, SIDE SLOPES WERE 10H:1V. SIDE SLOPES ABOVE HIGH FLOW LEVEL WERE NO STEEPER THAN 2.5H:1V. BETWEEN APPROX. STA. 0+200 AND 0+525, THE UPPER PORTION OF THE FLOW SECTION MAY BE IN TILL-COVERED TAILINGS-SAND SLOPE LOCALLY.
6. WHERE EXCAVATION WAS THROUGH TILL-LIKE FOUNDATION SOIL BELOW HIGH FLOW LEVEL, SIDE SLOPES WERE NO STEEPER THAN 2H:1V. SIDE SLOPES ABOVE HIGH FLOW LEVEL WERE NO STEEPER THAN 1.75H:1V IN TILL-LIKE FOUNDATION SOIL AND NO STEEPER THAN 2H:1V IN SAND DAMFILL.
7. WHERE EXCAVATION WAS THROUGH BEDROCK, SIDE SLOPES WERE NO STEEPER THAN 0.25H:1V. DOWNSTREAM OF STA. 0+835, TYPE B RIPRAP AND FILTER ZONE WERE IMPLEMENTED IN A TRANSITION SECTION FOR A LENGTH OF AT LEAST 5m AT HORIZONTAL GRADE.
8. TYPE B RIPRAP AND FILTER ZONES AT OUTER CHANNEL SLOPE BETWEEN STA. 0+834 AND STA. 0+911 WERE 0.5m ABOVE THE HIGH FLOW LEVEL TO ACCOUNT FOR FLOW SUPERELEVATION.
9. THE CHANNEL ALIGNMENT AND DESIGN WERE MODIFIED AFTER OVERLYING SAND DAMFILL WAS REMOVED. A STILLING BASIN WAS IMPLEMENTED BETWEEN STA. 0+565 AND 0+590, AND LIGHTER TYPE C RIPRAP WITH NO FILTER WAS PLACED BETWEEN STA. 0+590 AND 0+635.
10. TYPE B LINED CHANNEL SECTION WAS IN TILL-LIKE FOUNDATION SOIL FOR THE FULL DEPTH OF THE RIPRAP LINED SECTION. MINIMUM DEPTH OF FLOW SECTION ABOVE INVERT VARIES WITH CHANNEL SLOPE AS SHOWN ON SPILLWAY CHANNEL PROFILE. TRANSITION DETAIL BETWEEN FLOW DEPTHS IS SHOWN IN DETAIL 1 AND 2.
11. ALL DIMENSIONS, AND ELEVATIONS IN METRES.
12. RIPRAP AND FILTER MATERIALS WERE PLACED IN A MANNER TO PREVENT SEGREGATION OF THE PLACED MATERIALS.
13. MODIFICATIONS TO THE SPILLWAY AND CONSTRUCTION MATERIALS FOR RIPRAP AND FILTERS REQUIRED FOR LINING THE SPILLWAY CHANNEL WERE CHECKED BY FIELD ENGINEER AND DESIGNERS FOR COMPLIANCE WITH THE DESIGN INTENT.
14. CHANNEL PROFILE SHOWS EXCAVATION ELEVATION ALONG CENTRELINE. FINISHED ELEVATION WILL DEPEND ON LINING AND FILTER THICKNESS, IF ANY.
15. EXISTING DIVERSION DITCH WAS ENLARGED WITHIN THE SEGMENT OF OUTLET CHANNEL. BEYOND STA. 1+053, SMOOTH TRANSITION TO EXISTING DITCH WAS MADE.
16. DETAIL 3 SHOWS END SECTION OF TYPE B RIPRAP AND FILTER AT STA. 0+950.
17. CHANNEL SLOPE TRANSITIONS HAD A VERTICAL RADIUS OF 5m.
18. IN ROCK CONTROL SECTION, APPROX. 0+545.3 TO 0+555.3, ENTIRE FLOW SECTION WAS IN COMPETENT BEDROCK.
19. UNLINED OUTLET CHANNEL MAY REQUIRE RIPRAP PROTECTION IF EXCESSIVE EROSION DEVELOPS IN THE FUTURE.



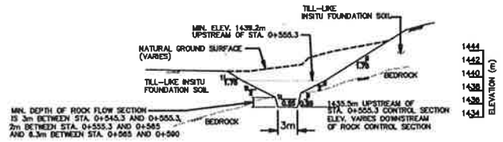
PLAN @ 0+635



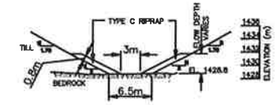
TYPICAL APPROACH CHANNEL IN TAILINGS
APPROX. STA. 0+000 TO STA. 0+200
(SEE NOTE 5)



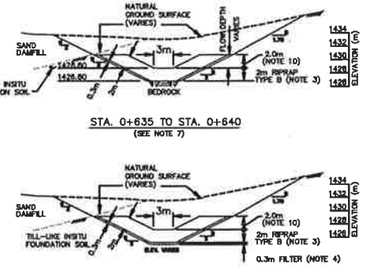
TYPICAL UNLINED CHANNEL
APPROX. STA. 0+200 TO STA. 0+525
(EXCEPT A ROCK SECTION AT APPROX. STA. 0+300)
(SEE NOTES 8, 9)



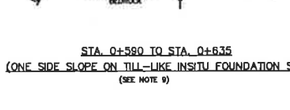
TYPICAL ROCK CHANNEL
APPROX. STA. 0+300 AND
BETWEEN STA. 0+525 AND STA. 0+590
(SEE NOTES 8, 7 AND 9)



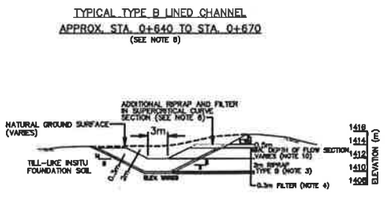
STA. 0+590 TO STA. 0+635
(BOTH SIDE SLOPES ON TILL-LIKE INSITU FOUNDATION SOIL)
(SEE NOTE 9)



STA. 0+635 TO STA. 0+640
(SEE NOTE 7)

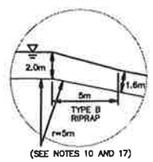


STA. 0+590 TO STA. 0+635
(ONE SIDE SLOPE ON TILL-LIKE INSITU FOUNDATION SOIL)
(SEE NOTE 9)



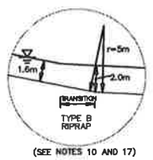
TYPICAL TYPE B LINED CHANNEL
APPROX. STA. 0+640 TO STA. 0+670
(SEE NOTE 8)

TYPICAL TYPE B LINED CHANNEL
APPROX. STA. 0+670 TO STA. 0+950
(SEE NOTE 10)



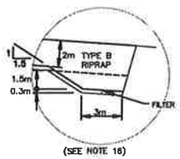
(SEE NOTES 10 AND 17)

DETAIL 1
1:200



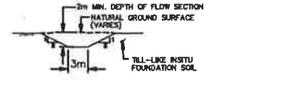
(SEE NOTES 10 AND 17)

DETAIL 2
1:200



(SEE NOTE 16)

DETAIL 3
1:200



TYPICAL UNLINED OUTLET CHANNEL
APPROX. STA. 0+950 TO STA. 1+053
(SEE NOTE 15)

TO BE READ WITH KLOHN CRIPPEN REPORT DATED JANUARY 18, 2002

NO.	DATE	ISSUE / REVISION	DRAWN	APPROVED
	JANUARY 18, 2002	ISSUED WITH REPORT	CYW	RJS

CAD File: 114-808-202-1

No.	Revision	Date	By	Ch'd	App'd	No.	Reference Drawings
1	ADDED KLOHN-CRIPPEN DESIGN SECTIONS & NOTES	mm/dd	R.B.				

KLOHN CRIPPEN

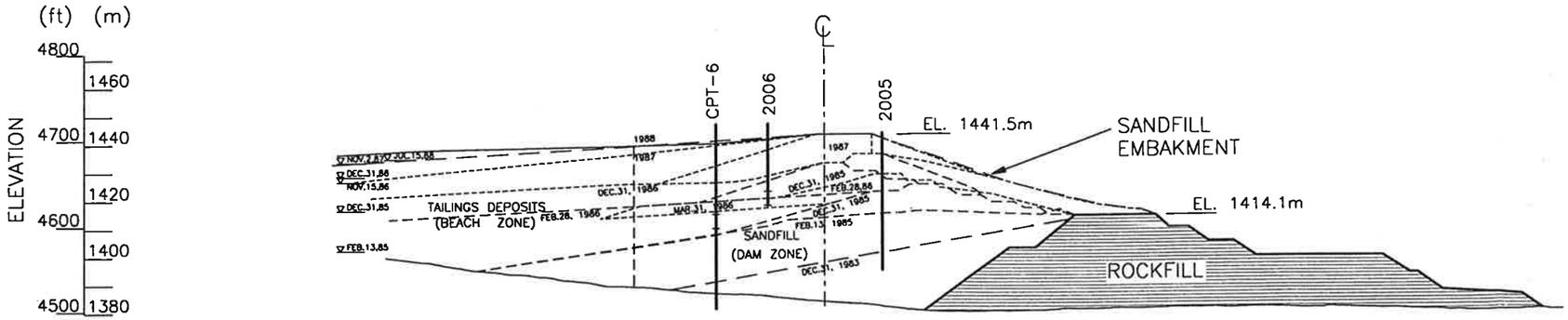
PROJECT No. PM 2916 29 | DWG. No. D-29002

Highland Valley Copper

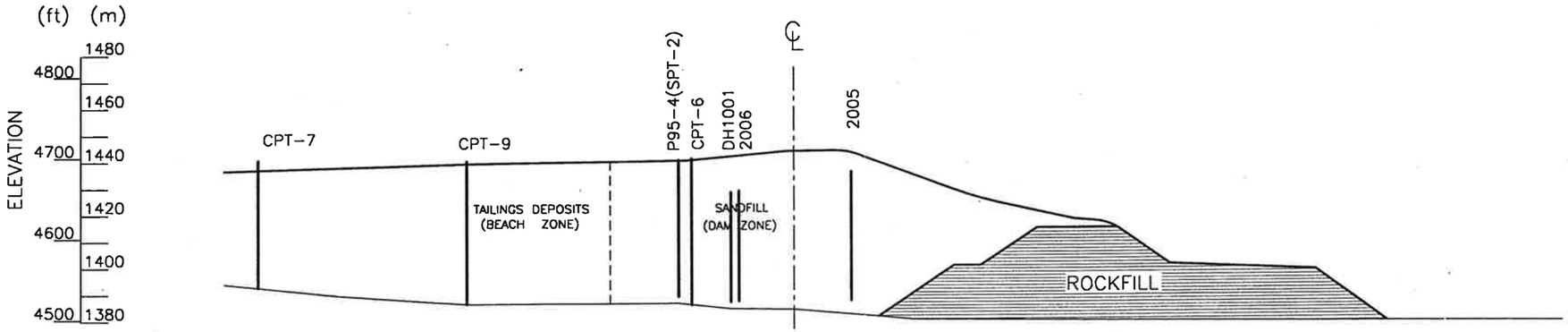
AS-BUILT TROJAN DAM SPILLWAY PLAN, PROFILE & SECTIONS

DRAWN H.P. | CHECKED

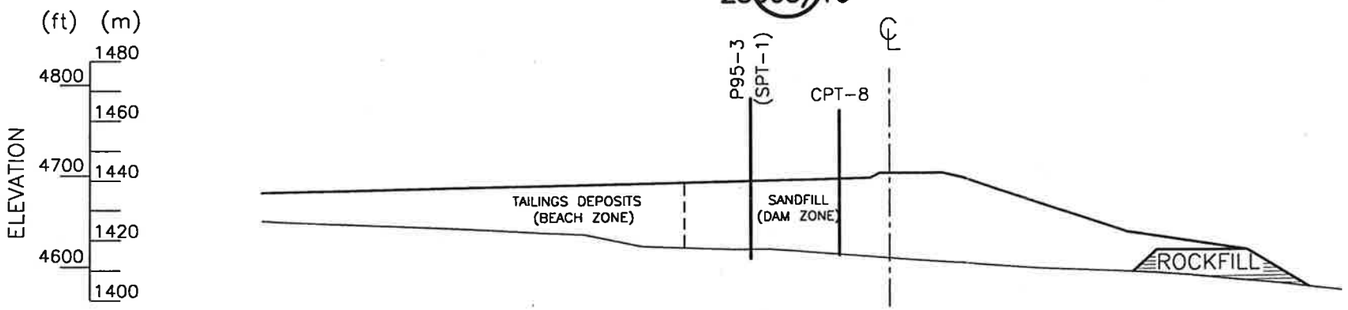
DATE 99 03 08 | SCALE 1:2000 | DWG No. 114-808-202 | REV. 1



TYPICAL CONSTRUCTION SEQUENCE



SECTION A 23005/16 VALLEY SECTION



SECTION B 23005/16 ABUTMENT SECTION

100 0 200ft

40 0 100m

SCALE

TO BE READ WITH KLOHN-CRIPPEN REPORT DATED DEC. 9, 1996

KLOHN-CRIPPEN		DATE
DESIGNED		
DRAWN		
CHECKED		
RECOMMENDED		
APPROVED	RJB	DEC 96

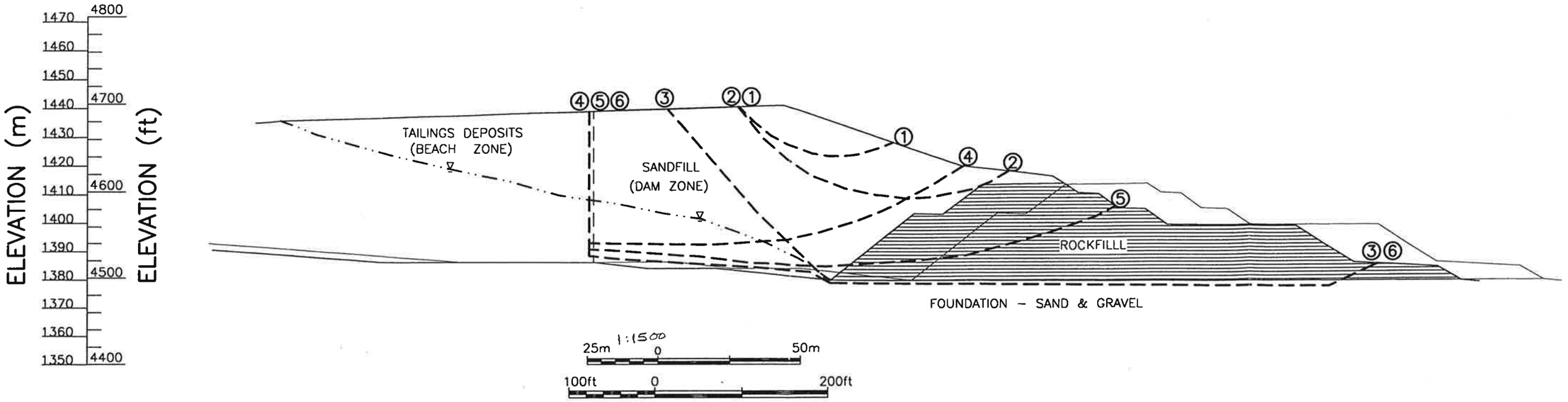
KLOHN-CRIPPEN

CLIENT: HIGHLAND VALLEY COPPER

PROJECT: LONG-TERM STABILITY ASSESSMENT

TITLE: TYPICAL SECTIONS TROJAN DAM

DATE OF ISSUE	PROJECT No.	DWG. No.	REV
DEC. 9, 1996	PM2916 23	B-23017	



STATIC AND PSEUDO-STATIC STABILITY ANALYSES
SUMMARY OF SAFETY FACTOR AND YIELD ACCELERATION

FAILURE SURFACE NUMBER	FACTOR OF SAFETY (1)		YIELD ACCELERATION (g)
	STATIC	PSEUDO-STATIC (a=0.1g)	
①	3.22	2.24	0.45
②	2.85	2.05	0.42

(1) FACTOR OF SAFETY OBTAINED FROM SIMPLIFIED JANBU METHOD OF SLICES WITH NO CORRECTION FOR SIDE FORCES BETWEEN SLICES, USING SLOPE-W COMPUTER PROGRAM.

MATERIAL PROPERTIES

TYPE OF MATERIAL	UNIT WEIGHT		EFFECTIVE SHEAR STRENGTH(1) FRICTION ANGLE ø' (degree)
	γ_{moist} (kN/m³)	γ_{sat} (kN/m³)	
SANDFILL (DAM ZONE)	18	–	35
TAILINGS DEPOSITS (BEACH ZONE)	–	19	25
ROCKFILL	18.9	–	37
SAND AND GRAVEL (FOUNDATION)	–	22.8	35

(1) EFFECTIVE SHEAR STRENGTH – COHESION C' = 0 kN/m²

POST-EARTHQUAKE STABILITY ANALYSIS
SUMMARY OF SAFETY FACTOR

FAILURE SURFACE NUMBER	FACTOR OF SAFETY (1)
①	1.26
②	1.21
③	2.72
④	2.72
⑤	1.68
⑥	2.86

(1) FACTOR OF SAFETY OBTAINED FROM SIMPLIFIED JANBU METHOD OF SLICES WITH NO CORRECTION FOR SIDE FORCES BETWEEN SLICES, USING SLOPE-W COMPUTER PROGRAM.

LEGEND

④- - - -④ FAILURE SURFACE No.4

– · · ▽ · · – PIEZOMETRIC SURFACE

NOTES

1. ELEVATION IN METRES REFERS TO HIGHLAND VALLEY COPPER DATUM.
2. ELEVATION IN FEET REFERS TO BETHLEHEM COPPER DATUM.

TO BE READ WITH KLOHN-CRIPPEN REPORT DATED DEC. 9, 1996

SCALE

KLOHN-CRIPPEN		DATE
DESIGNED	PH	JUNE 96
DRAWN	CYW	
CHECKED		
RECOMMENDED		
APPROVED		DEC.96

KLOHN-CRIPPEN

CLIENT: HIGHLAND VALLEY COPPER

PROJECT: LONG-TERM STABILITY ASSESSMENT

TITLE: STABILITY ANALYSES
TROJAN DAM SECTION A-A
– VALLEY SECTION

DATE OF ISSUE	PROJECT No.	DWG. No.	REV
DEC. 9, 1996	PM2916 23	B-23020	

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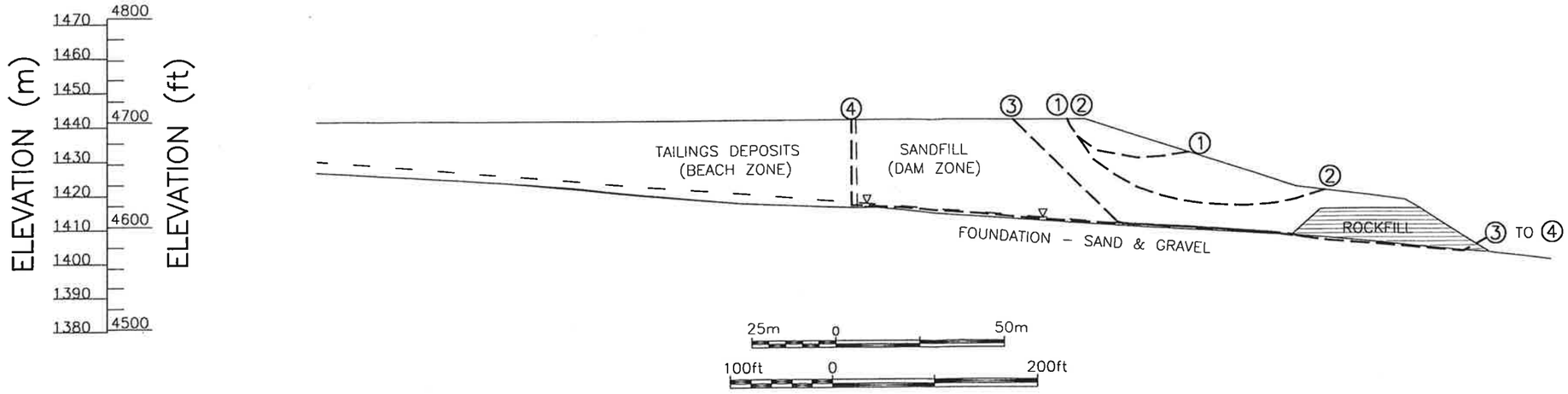
10/08/96 TIME:2:40



STATIC AND PSEUDO–STATIC STABILITY ANALYSES SUMMARY OF SAFETY FACTOR AND YIELD ACCELERATION

FAILURE SURFACE NUMBER	FACTOR OF SAFETY (1)		YIELD ACCELERATION (g)
	STATIC	PSEUDO–STATIC (a=0.1g)	
①	2.72	1.97	0.42
③	3.05	2.02	0.43

(1) FACTOR OF SAFETY OBTAINED FROM SIMPLIFIED JANBU METHOD OF SLICES WITH NO CORRECTION FOR SIDE FORCES BETWEEN SLICES, USING SLOPE–W COMPUTER PROGRAM.

MATERIAL PROPERTIES

TYPE OF MATERIAL	UNIT WEIGHT		EFFECTIVE SHEAR STRENGTH(1) FRICTION ANGLE ø' (degree)
	γ_{moist} (kN/m^3)	γ_{sat} (kN/m^3)	
SANDFILL (DAM ZONE)	18	–	35
TAILINGS DEPOSITS (BEACH ZONE)	–	19	25
TAILINGS DEPOSITS (POND ZONE)	–	19	25
ROCKFILL	18.9	–	37
SAND AND GRAVEL (FOUNDATION)	–	22.8	35

(1) EFFECTIVE SHEAR STRENGTH – COHESION C' = 0 kN/m^2

POST–EARTHQUAKE STABILITY ANALYSIS SUMMARY OF SAFETY FACTOR

FAILURE SURFACE NUMBER	FACTOR OF SAFETY (1)
①	1.17
②	1.18
③	1.75
④	2.52

(1) FACTOR OF SAFETY OBTAINED FROM SIMPLIFIED JANBU METHOD OF SLICES WITH NO CORRECTION FOR SIDE FORCES BETWEEN SLICES, USING SLOPE–W COMPUTER PROGRAM.

LEGEND

④– – –④ FAILURE SURFACE No.4

– ▽ – PIEZOMETRIC SURFACE

NOTES

1. ELEVATION IN METRES REFERS TO HIGHLAND VALLEY COPPER DATUM.
2. ELEVATION IN FEET REFERS TO BETHLEHEM COPPER DATUM.

TO BE READ WITH KLOHN–CRIPPEN REPORT DATED DEC. 9, 1996

KLOHN–CRIPPEN		DATE
DESIGNED	PH	JUNE 96
DRAWN	CYW	
CHECKED		
RECOMMENDED		
APPROVED	RPO	DEC.96

KLOHN-CRIPPEN

CLIENT: HIGHLAND VALLEY COPPER

SCALE

PROJECT: LONG–TERM STABILITY ASSESSMENT

TITLE: STABILITY ANALYSES TROJAN DAM SECTION B–B – WEST ABUTMENT SECTION

DATE OF ISSUE	PROJECT No.	DWG. No.	REV
DEC. 9, 1996	PM2916 23	B–23021	

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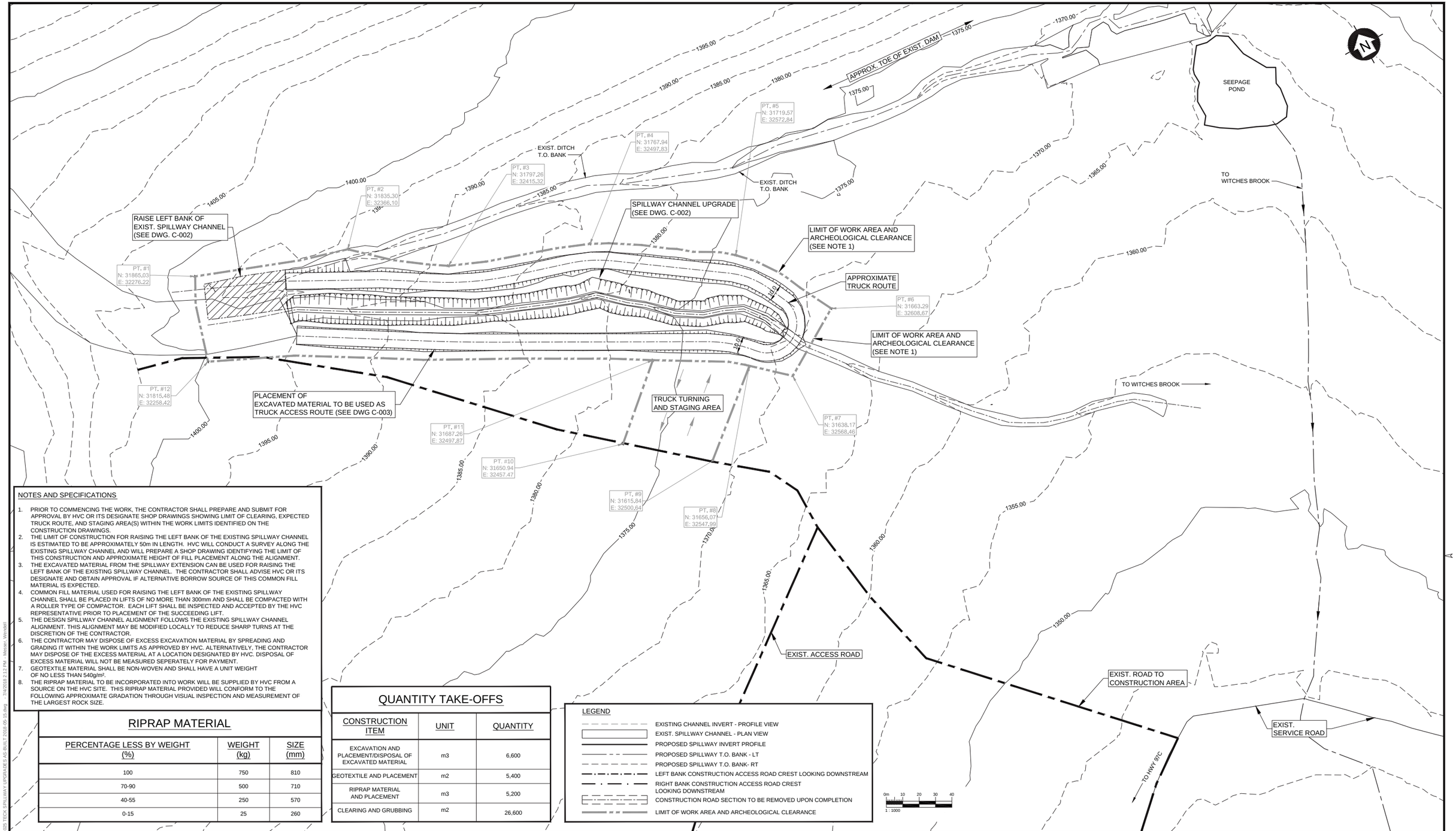
10/09/96 TIME: 3:10



NOTES AND SPECIFICATIONS

1. PRIOR TO COMMENCING THE WORK, THE CONTRACTOR SHALL PREPARE AND SUBMIT FOR APPROVAL BY HVC OR ITS DESIGNATE SHOP DRAWINGS SHOWING LIMIT OF CLEARING, EXPECTED TRUCK ROUTE, AND STAGING AREA(S) WITHIN THE WORK LIMITS IDENTIFIED ON THE CONSTRUCTION DRAWINGS.
2. THE LIMIT OF CONSTRUCTION FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL IS ESTIMATED TO BE APPROXIMATELY 50m IN LENGTH. HVC WILL CONDUCT A SURVEY ALONG THE EXISTING SPILLWAY CHANNEL AND WILL PREPARE A SHOP DRAWING IDENTIFYING THE LIMIT OF THIS CONSTRUCTION AND APPROXIMATE HEIGHT OF FILL PLACEMENT ALONG THE ALIGNMENT.
3. THE EXCAVATED MATERIAL FROM THE SPILLWAY EXTENSION CAN BE USED FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL. THE CONTRACTOR SHALL ADVISE HVC OR ITS DESIGNATE AND OBTAIN APPROVAL IF ALTERNATIVE BORROW SOURCE OF THIS COMMON FILL MATERIAL IS EXPECTED.
4. COMMON FILL MATERIAL USED FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL SHALL BE PLACED IN LIFTS OF NO MORE THAN 300mm AND SHALL BE COMPACTED WITH A ROLLER TYPE OF COMPACTOR. EACH LIFT SHALL BE INSPECTED AND ACCEPTED BY THE HVC REPRESENTATIVE PRIOR TO PLACEMENT OF THE SUCCEEDING LIFT.
5. THE DESIGN SPILLWAY CHANNEL ALIGNMENT FOLLOWS THE EXISTING SPILLWAY CHANNEL ALIGNMENT. THIS ALIGNMENT MAY BE MODIFIED LOCALLY TO REDUCE SHARP TURNS AT THE DISCRETION OF THE CONTRACTOR.
6. THE CONTRACTOR MAY DISPOSE OF EXCESS EXCAVATION MATERIAL BY SPREADING AND GRADING IT WITHIN THE WORK LIMITS AS APPROVED BY HVC. ALTERNATIVELY, THE CONTRACTOR MAY DISPOSE OF THE EXCESS MATERIAL AT A LOCATION DESIGNATED BY HVC. DISPOSAL OF EXCESS MATERIAL WILL NOT BE MEASURED SEPERATELY FOR PAYMENT.
7. GEOTEXTILE MATERIAL SHALL BE NON-WOVEN AND SHALL HAVE A UNIT WEIGHT OF NO LESS THAN 540g/m².
8. THE RIPRAP MATERIAL TO BE INCORPORATED INTO WORK WILL BE SUPPLIED BY HVC FROM A SOURCE ON THE HVC SITE. THIS RIPRAP MATERIAL PROVIDED WILL CONFORM TO THE FOLLOWING APPROXIMATE GRADATION THROUGH VISUAL INSPECTION AND MEASUREMENT OF THE LARGEST ROCK SIZE.

RIPRAP MATERIAL

PERCENTAGE LESS BY WEIGHT (%)	WEIGHT (kg)	SIZE (mm)
100	750	810
70-90	500	710
40-55	250	570
0-15	25	260

QUANTITY TAKE-OFFS

CONSTRUCTION ITEM	UNIT	QUANTITY
EXCAVATION AND PLACEMENT/DISPOSAL OF EXCAVATED MATERIAL	m3	6,600
GEOTEXTILE AND PLACEMENT	m2	5,400
RIPRAP MATERIAL AND PLACEMENT	m3	5,200
CLEARING AND GRUBBING	m2	26,600

LEGEND

- EXISTING CHANNEL INVERT - PROFILE VIEW
- EXIST. SPILLWAY CHANNEL - PLAN VIEW
- PROPOSED SPILLWAY INVERT PROFILE
- PROPOSED SPILLWAY T.O. BANK - LT
- PROPOSED SPILLWAY T.O. BANK- RT
- LEFT BANK CONSTRUCTION ACCESS ROAD CREST LOOKING DOWNSTREAM
- RIGHT BANK CONSTRUCTION ACCESS ROAD CREST LOOKING DOWNSTREAM
- CONSTRUCTION ROAD SECTION TO BE REMOVED UPON COMPLETION
- LIMIT OF WORK AREA AND ARCHEOLOGICAL CLEARANCE

NOTES:

1. ALL DIMENSIONS ARE IN METRES (m) UNLESS OTHERWISE NOTED.

RECORD DRAWING

NO.	DESCRIPTION	NO.	DATE	DESCRIPTION
REFERENCE DRAWINGS		REVISIONS		
		5		
		4		
		3		
		2		
		0	2018 07/04	ISSUE FOR RECORD DRAWING

STAMP:

CLIENT: Highland Valley Copper Teck

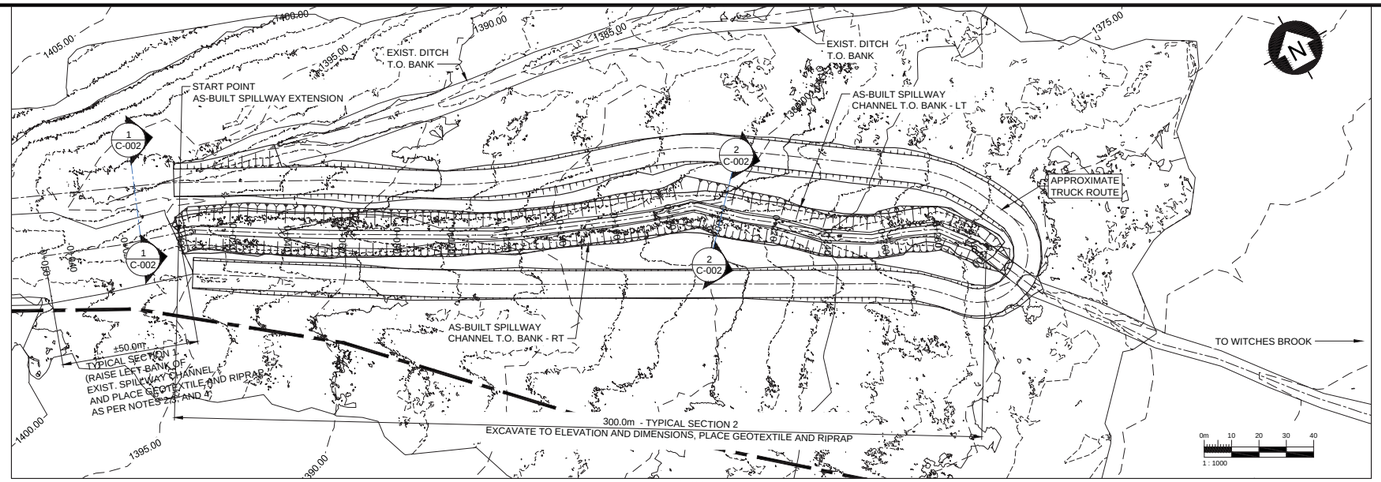
amec foster wheeler

DRAWN BY:	WM
DESIGNED BY:	HX
CHECKED BY :	
SCALE :	1:1000
DATE :	2017-04-07

PROJECT: TROJAN SPILLWAY EXTENSION

TITLE: RECORD DRAWING TROJAN DAM SPILLWAY SITE LOCATION, AND WORK LIMITS

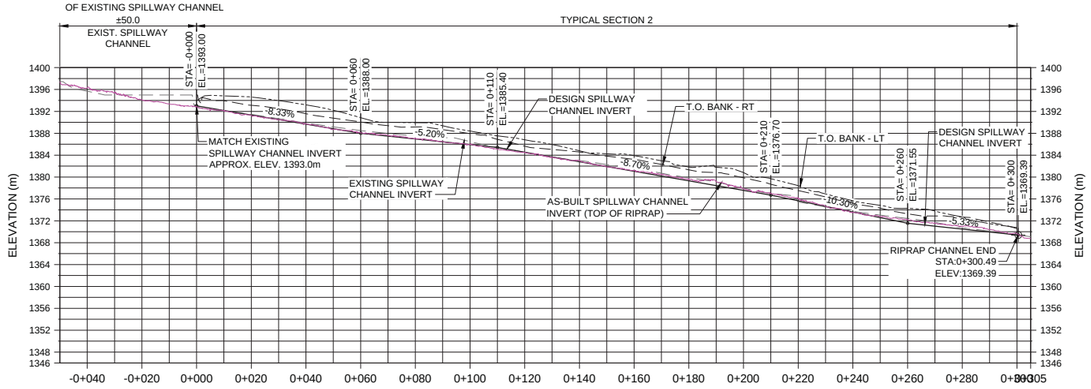
DATUM :	MINE GRID
PROJECTION :	
PROJECT NO. :	TE154025
REV. :	0
DRAWING NO. :	C-001



PLAN

1:1000

TYPICAL SECTION 1
SEE NOTES 2, 3 AND 4
FOR RAISING LEFT BANK
OF EXISTING SPILLWAY CHANNEL



PROFILE

SCALE: H=1:1000
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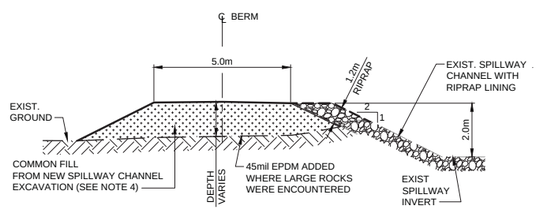
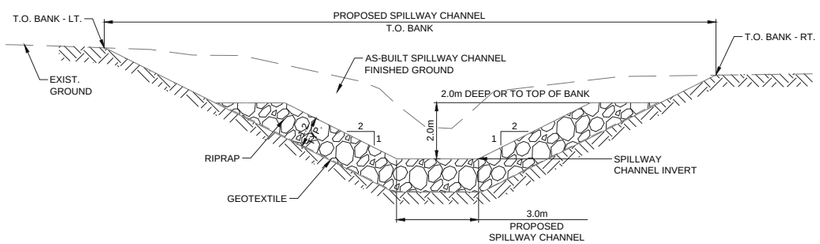


1 C-002 TYPICAL SECTION 1 - RAISE LEFT BANK OF EXISTING SPILLWAY CHANNEL (SEE NOTES 2, 3 AND 4)

SCALE: 1:100



2 C002 TYPICAL SECTION 2 - SPILLWAY CHANNEL WITH RIPRAP

SCALE: 1:100

LEGEND

- EXISTING CHANNEL INVERT - PROFILE VIEW
- EXIST. SPILLWAY CHANNEL - PLAN VIEW
- PROPOSED SPILLWAY INVERT PROFILE
- PROPOSED SPILLWAY T.O. BANK - LT
- PROPOSED SPILLWAY T.O. BANK- RT
- LEFT BANK CONSTRUCTION ACCESS ROAD CREST LOOKING DOWNSTREAM
- RIGHT BANK CONSTRUCTION ACCESS ROAD CREST LOOKING DOWNSTREAM
- CONSTRUCTION ROAD SECTION TO BE REMOVED UPON COMPLETION
- LIMIT OF WORK AREA AND ARCHEOLOGICAL CLEARANCE

NOTES AND SPECIFICATIONS

1. PRIOR TO COMMENCING THE WORK, THE CONTRACTOR SHALL PREPARE AND SUBMIT FOR APPROVAL BY HVC OR ITS DESIGNATE SHOP DRAWINGS SHOWING LIMIT OF CLEARING, EXPECTED TRUCK ROUTE, AND STAGING AREA(S) WITHIN THE WORK LIMITS IDENTIFIED ON THE CONSTRUCTION DRAWINGS.
2. THE LIMIT OF CONSTRUCTION FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL IS ESTIMATED TO BE APPROXIMATELY 50m IN LENGTH. HVC WILL CONDUCT A SURVEY ALONG THE EXISTING SPILLWAY CHANNEL AND WILL PREPARE A SHOP DRAWING IDENTIFYING THE LIMIT OF THIS CONSTRUCTION AND APPROXIMATE HEIGHT OF FILL PLACEMENT ALONG THE ALIGNMENT.
3. THE EXCAVATED MATERIAL FROM THE SPILLWAY EXTENSION CAN BE USED FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL. THE CONTRACTOR SHALL ADVISE HVC OR ITS DESIGNATE AND OBTAIN APPROVAL IF ALTERNATIVE BORROW SOURCE OF THIS COMMON FILL MATERIAL IS EXPECTED.
4. COMMON FILL MATERIAL USED FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL SHALL BE PLACED IN LIFTS OF NO MORE THAN 300mm AND SHALL BE COMPACTED WITH A ROLLER TYPE OF COMPACTOR. EACH LIFT SHALL BE INSPECTED AND ACCEPTED BY THE HVC REPRESENTATIVE PRIOR TO PLACEMENT OF THE SUCCEEDING LIFT.
5. THE DESIGN SPILLWAY CHANNEL ALIGNMENT FOLLOWS THE EXISTING SPILLWAY CHANNEL ALIGNMENT. THIS ALIGNMENT MAY BE MODIFIED LOCALLY TO REDUCE SHARP TURNS AT THE DISCRETION OF THE CONTRACTOR.
6. THE CONTRACTOR MAY DISPOSE OF EXCESS EXCAVATION MATERIAL BY SPREADING AND GRADING IT WITHIN THE WORK LIMITS AS APPROVED BY HVC. ALTERNATIVELY, THE CONTRACTOR MAY DISPOSE OF THE EXCESS MATERIAL AT A LOCATION DESIGNATED BY HVC. DISPOSAL OF EXCESS MATERIAL WILL NOT BE MEASURED SEPERATELY FOR PAYMENT.
7. GEOTEXTILE MATERIAL SHALL BE NON-WOVEN AND SHALL HAVE A UNIT WEIGHT OF NO LESS THAN 540g/m².
8. THE RIPRAP MATERIAL TO BE INCORPORATED INTO WORK WILL BE SUPPLIED BY HVC FROM A SOURCE ON THE HVC SITE. THIS RIPRAP MATERIAL PROVIDED WILL CONFORM TO THE FOLLOWING APPROXIMATE GRADATION THROUGH VISUAL INSPECTION AND MEASUREMENT OF THE LARGEST ROCK SIZE.

RIPRAP MATERIAL

PERCENTAGE LESS BY WEIGHT (%)	WEIGHT (kg)	SIZE (mm)
100	750	810
70-90	500	710
40-55	250	570
0-15	25	260

NOTES:

1. ALL DIMENSIONS ARE IN METRES (m) UNLESS OTHERWISE NOTED.

RECORD DRAWING

NO.	DESCRIPTION	NO.	DATE	DESCRIPTION
		5		
		4		
		3		
		2		
		0	2018 07/17	ISSUE FOR RECORD DRAWING

REFERENCE DRAWINGS | REVISIONS

STAMP:

CLIENT: Highland Valley Copper / Teck

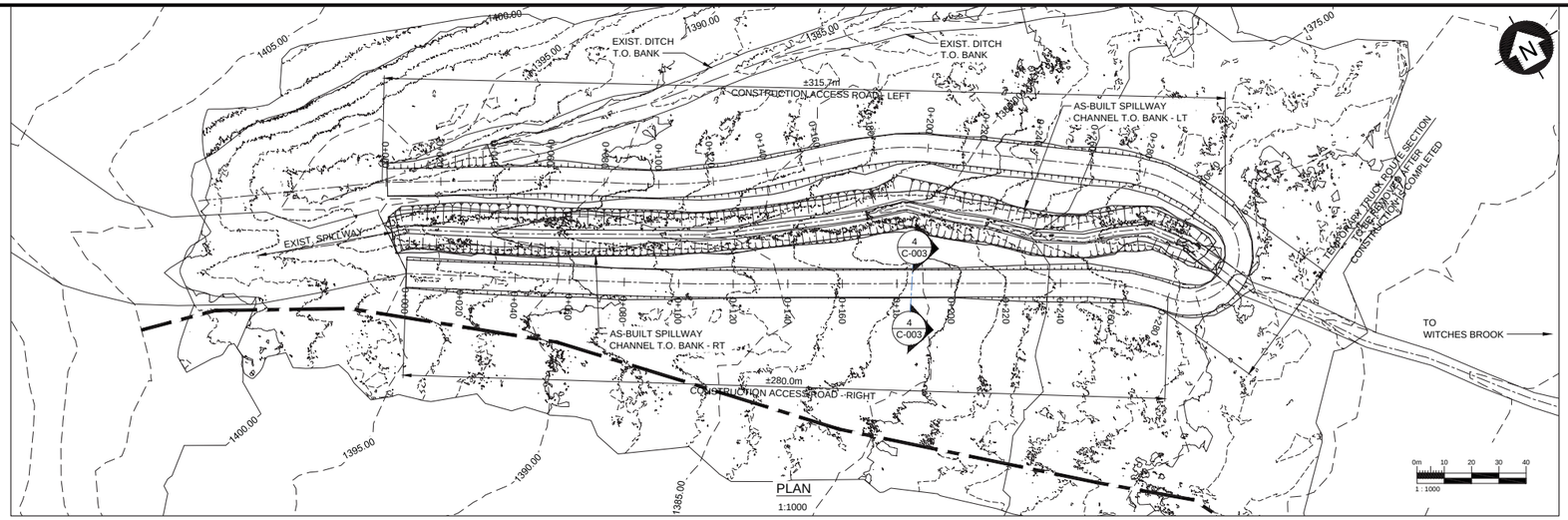
amec foster wheeler

DRAWN BY: DM/WM
DESIGNED BY: HX
CHECKED BY :
SCALE : AS SHOWN
DATE : 2016-11-24

PROJECT: TROJAN SPILLWAY EXTENSION

TITLE: RECORD DRAWING SPILLWAY CHANNEL PLAN - PROFILE AND SECTIONS

DATUM : MINE GRID
PROJECTION :
PROJECT NO. : TE154025
REV. : 0
DRAWING NO. : C-002



PLAN
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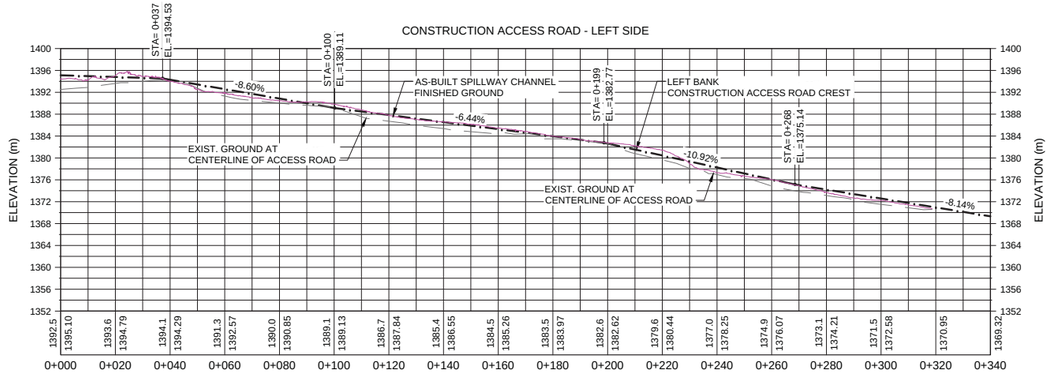

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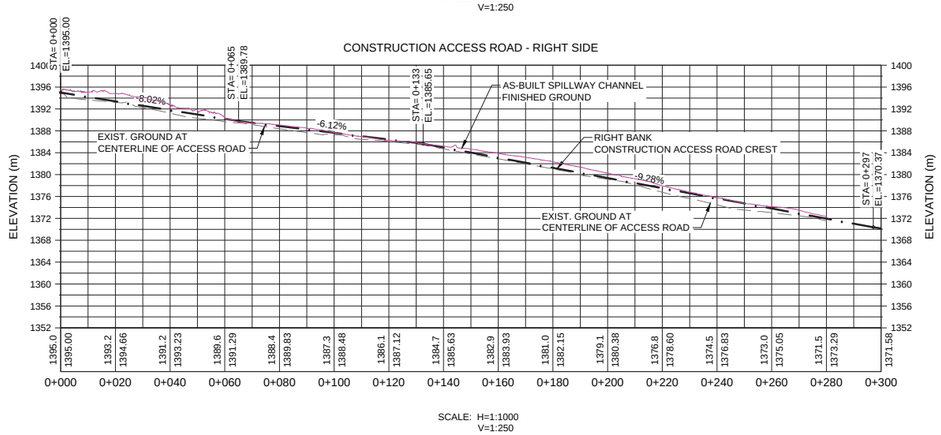

SCALE: H=1:1000
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LEGEND

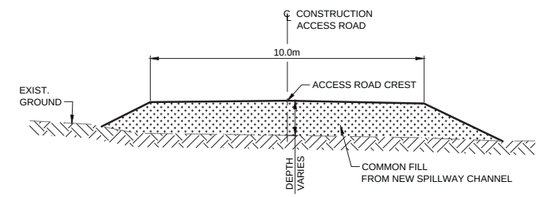
- EXISTING CHANNEL INVERT - PROFILE VIEW
- EXIST. SPILLWAY CHANNEL - PLAN VIEW
- PROPOSED SPILLWAY INVERT PROFILE
- PROPOSED SPILLWAY T.O. BANK - LT
- PROPOSED SPILLWAY T.O. BANK- RT
- LEFT BANK CONSTRUCTION ACCESS ROAD CREST LOOKING DOWNSTREAM
- RIGHT BANK CONSTRUCTION ACCESS ROAD CREST LOOKING DOWNSTREAM
- CONSTRUCTION ROAD SECTION TO BE REMOVED UPON COMPLETION
- LIMIT OF WORK AREA AND ARCHEOLOGICAL CLEARANCE

NOTES AND SPECIFICATIONS

1. PRIOR TO COMMENCING THE WORK, THE CONTRACTOR SHALL PREPARE AND SUBMIT FOR APPROVAL BY HVC OR ITS DESIGNATE SHOP DRAWINGS SHOWING LIMIT OF CLEARING, EXPECTED TRUCK ROUTE, AND STAGING AREA(S) WITHIN THE WORK LIMITS IDENTIFIED ON THE CONSTRUCTION DRAWINGS.
2. THE LIMIT OF CONSTRUCTION FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL IS ESTIMATED TO BE APPROXIMATELY 50m IN LENGTH. HVC WILL CONDUCT A SURVEY ALONG THE EXISTING SPILLWAY CHANNEL AND WILL PREPARE A SHOP DRAWING IDENTIFYING THE LIMIT OF THIS CONSTRUCTION AND APPROXIMATE HEIGHT OF FILL PLACEMENT ALONG THE ALIGNMENT.
3. THE EXCAVATED MATERIAL FROM THE SPILLWAY EXTENSION CAN BE USED FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL. THE CONTRACTOR SHALL ADVISE HVC OR ITS DESIGNATE AND OBTAIN APPROVAL IF ALTERNATIVE BORROW SOURCE OF THIS COMMON FILL MATERIAL IS EXPECTED.
4. COMMON FILL MATERIAL USED FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL SHALL BE PLACED IN LIFTS OF NO MORE THAN 300mm AND SHALL BE COMPACTED WITH A ROLLER TYPE OF COMPACTOR. EACH LIFT SHALL BE INSPECTED AND ACCEPTED BY THE HVC REPRESENTATIVE PRIOR TO PLACEMENT OF THE SUCCEEDING LIFT.
5. THE DESIGN SPILLWAY CHANNEL ALIGNMENT FOLLOWS THE EXISTING SPILLWAY CHANNEL ALIGNMENT. THIS ALIGNMENT MAY BE MODIFIED LOCALLY TO REDUCE SHARP TURNS AT THE DISCRETION OF THE CONTRACTOR.
6. THE CONTRACTOR MAY DISPOSE OF EXCESS EXCAVATION MATERIAL BY SPREADING AND GRADING IT WITHIN THE WORK LIMITS AS APPROVED BY HVC. ALTERNATIVELY, THE CONTRACTOR MAY DISPOSE OF THE EXCESS MATERIAL AT A LOCATION DESIGNATED BY HVC. DISPOSAL OF EXCESS MATERIAL WILL NOT BE MEASURED SEPERATELY FOR PAYMENT.
7. GEOTEXTILE MATERIAL SHALL BE NON-WOVEN AND SHALL HAVE A UNIT WEIGHT OF NO LESS THAN 540g/m².
8. THE RIPRAP MATERIAL TO BE INCORPORATED INTO WORK WILL BE SUPPLIED BY HVC FROM A SOURCE ON THE HVC SITE. THIS RIPRAP MATERIAL PROVIDED WILL CONFORM TO THE FOLLOWING APPROXIMATE GRADATION THROUGH VISUAL INSPECTION AND MEASUREMENT OF THE LARGEST ROCK SIZE.

RIPRAP MATERIAL

PERCENTAGE LESS BY WEIGHT (%)	WEIGHT (kg)	SIZE (mm)
100	750	810
70-90	500	710
40-55	250	570
0-15	25	260



4 C-003 TYPICAL 10m CONSTRUCTION ACCESS ROAD SECTION AT NEW SPILLWAY (RIGHT AND LEFT SIDES)

SCALE: 1:100

NOTES:

1. ALL DIMENSIONS ARE IN METRES (m) UNLESS OTHERWISE NOTED.

RECORD DRAWING

NO.	DESCRIPTION	NO.	DATE	DESCRIPTION
		5		
		4		
		3		
		2		
		0	2018 07/04	ISSUE FOR RECORD DRAWING

REFERENCE DRAWINGS | REVISIONS

STAMP:

CLIENT: Highland Valley Copper Teck

amec foster wheeler

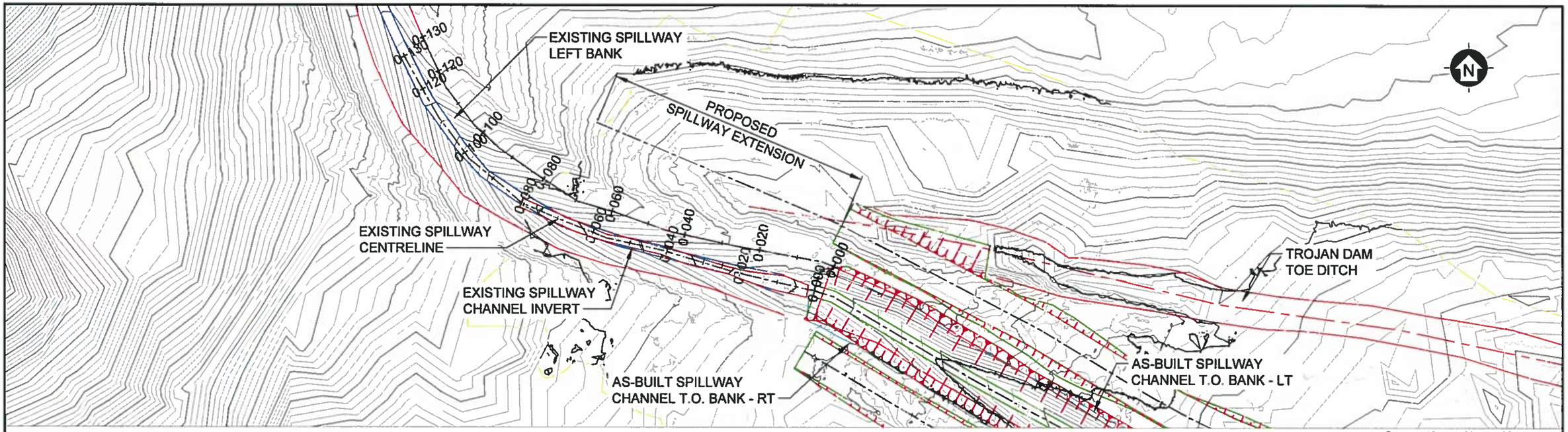
DRAWN BY:	DM/WM
DESIGNED BY:	HX
CHECKED BY :	
SCALE :	AS SHOWN
DATE :	2016-11-24

PROJECT: TROJAN SPILLWAY EXTENSION

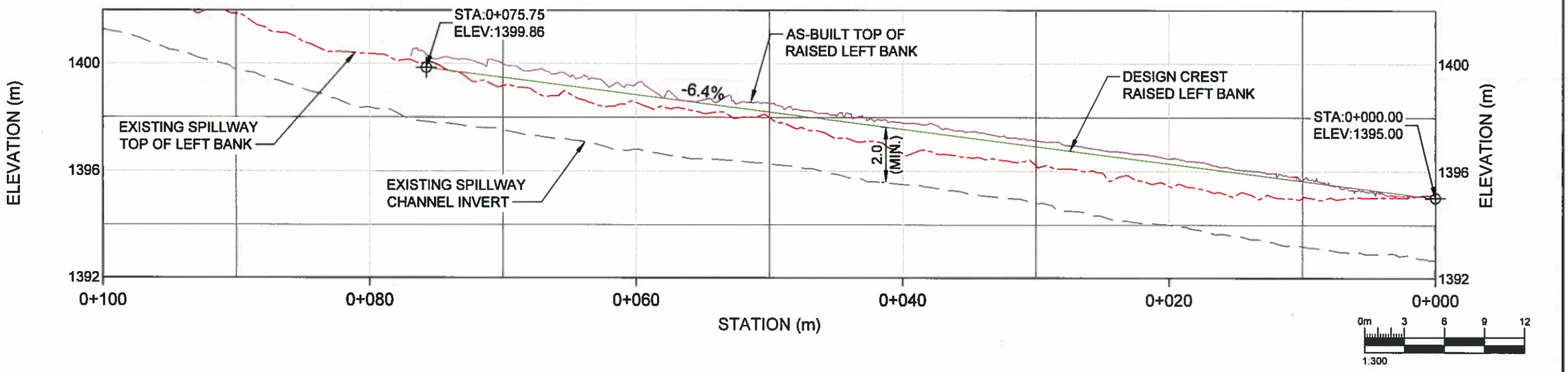
TITLE: RECORD DRAWING CONSTRUCTION ACCESS ROAD PLAN, PROFILES AND DETAIL

DATUM :	MINE GRID
PROJECTION :	
PROJECT NO. :	TE154025
REV. :	0
DRAWING NO. :	C-003

H:\PROJECTS\TE154025_Teck_HVC\DRAWINGS\154025 TECK SPILLWAY UPGRADE 0 AS BUILT 2018-06-15.dwg 7/4/2018 2:12 PM Hasan Vahidi



PLAN VIEW



NOTES:

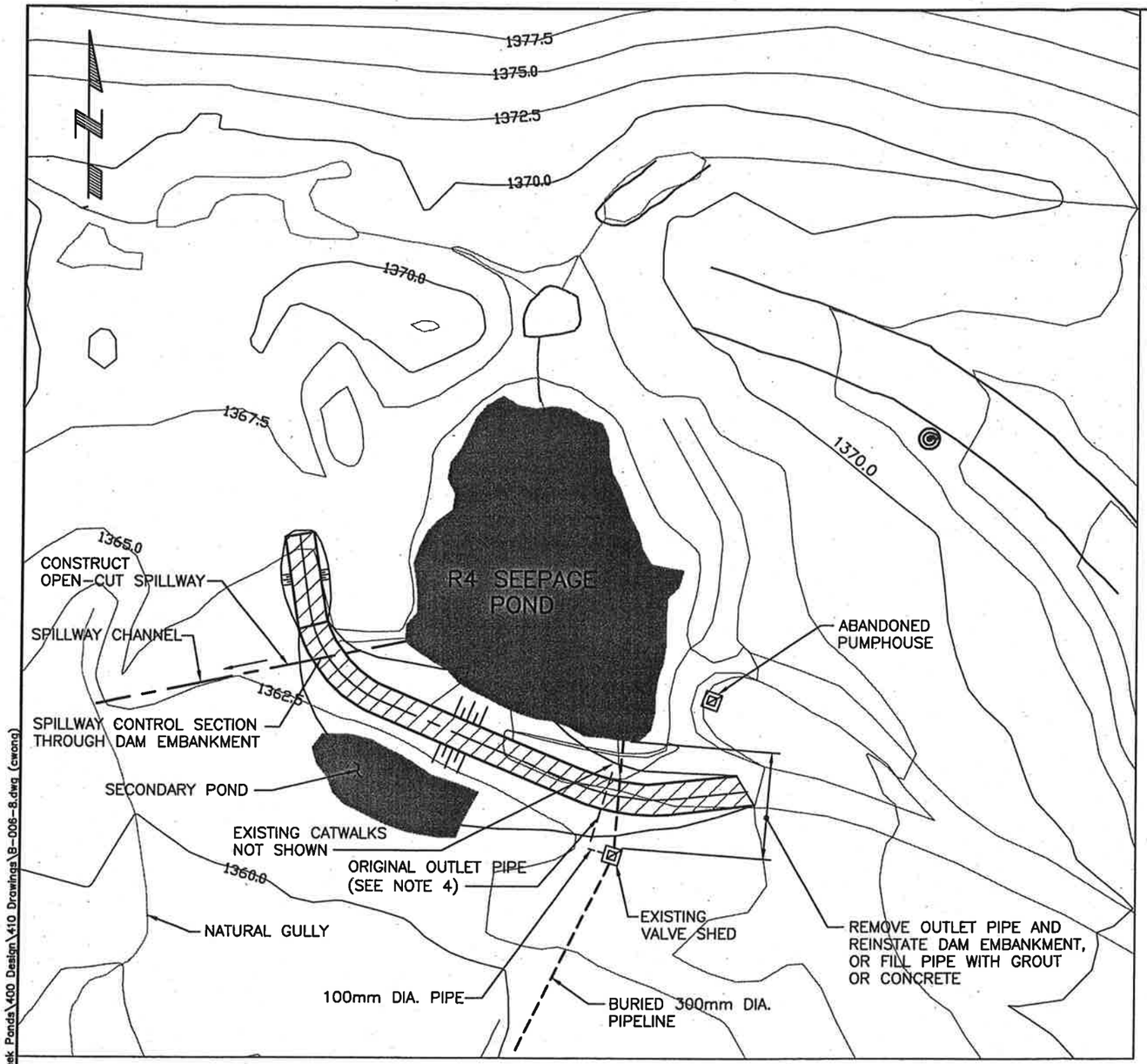
1. EXISTING FEATURES BASED ON COMPILATION OF 2014 LIDAR DATA, 2015 LIDAR DATA AND SURVEY DATA PROVIDED BY HVC.

CLIENT: Highland Valley Copper Teck	SCALE: AS SHOWN	PROJECT: TROJAN SPILLWAY EXTENSION	DWN BY: DM/WM; DSGN'D BY: HX
amec foster wheeler	DATUM: MINE GRID	TITLE: RECORD DRAWING TROJAN SPILLWAY LEFT BANK RAISE	CHK'D BY: -; CHK'D BY (LEAD): -
	PROJECTION:		PROJECT NO: TE154025
			REV. DATE: 2018-07-04; REV. NO: 0
			FIGURE NO: FIG. 1

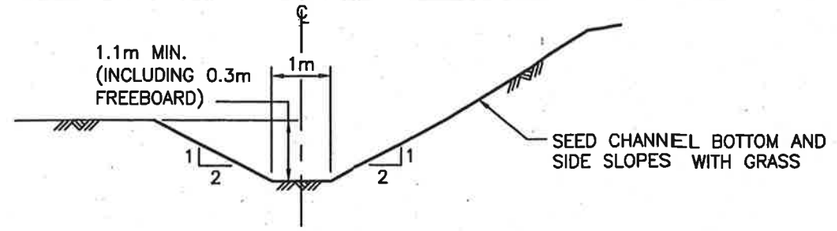
H:\PROJECTS\TE154025_Teck_HVC\DRAWINGS\154025 TECK SPILLWAY UPGRADES_FIG 1 AS-BUILT 2018-05-17.dwg - 1/23/2019 8:39 AM - Messer, Wendell

APPENDIX III-B

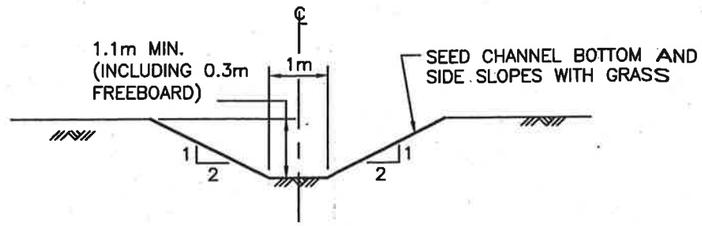
Reference Dam Design Drawings - R4 Seepage Pond Dam



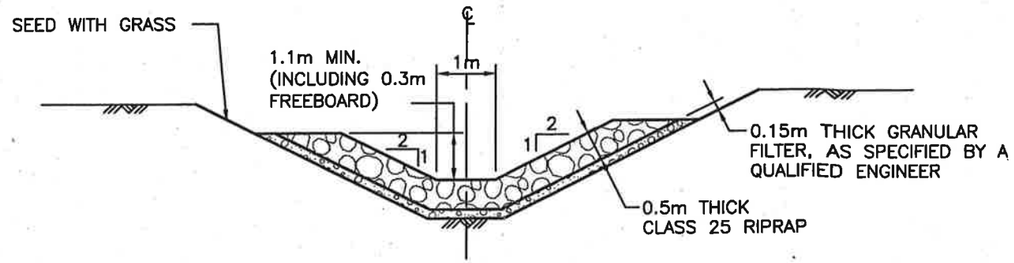
PLAN
SCALE A



SPILLWAY CONTROL SECTION THROUGH DAM
SCALE B



SPILLWAY CHANNEL SECTION FOR 0.5% OR FLATTER BED SLOPE
SCALE B



SPILLWAY CHANNEL SECTION FOR 0.6% TO 10% BED SLOPE
SCALE B

NOTES:

1. FOR LOCATION OF POND SEE FIG. B-001.
2. FOR RIPRAP GRADATION SEE FIG. B-006.
3. LOCATIONS OF BURIED PIPELINES ARE APPROXIMATE.
4. STATUS OF THE ORIGINAL OUTLET PIPE AND DECOMMISSIONING REQUIREMENTS, IF ANY, ARE TO BE DETERMINED.

SCALE B 0 5m

SCALE A 0 50m

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN REPORT DATED JUNE 10, 2005

CLIENT: HIGHLAND VALLEY COPPER

KLOHN CRIPPEN

PROJECT: TROJAN CREEK PONDS

TITLE: R4 SEEPAGE POND PROPOSED DECOMMISSIONING WORK PLAN AND SECTIONS

PROJECT No. M 02341 A3105

FIG. No. B-007

Time: 9:25:18
Date: 6/10/2005
Scale: 1=10(PS)
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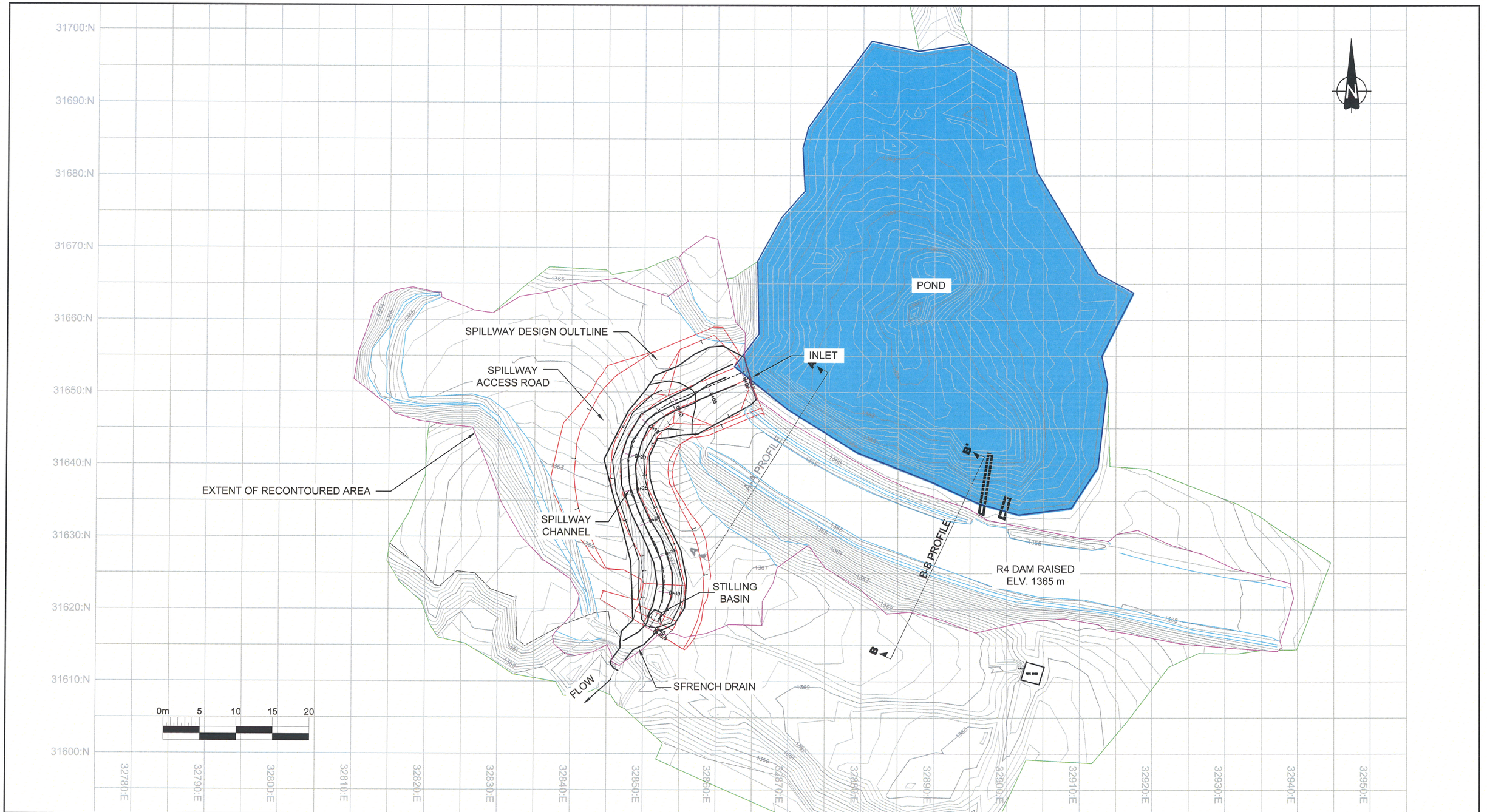


NOTE:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE LETTER (FILE No. VW1035) DATED NOVEMBER 2014.

RECORD DRAWINGS

CLIENT: Highland Valley Copper — Teck

AMEC Environment & Infrastructure
Suite 600 - 4445 Lougheed Highway
Burnaby, BC V5C 0E4
Tel. 604-294-3811 Fax 604-294-4664

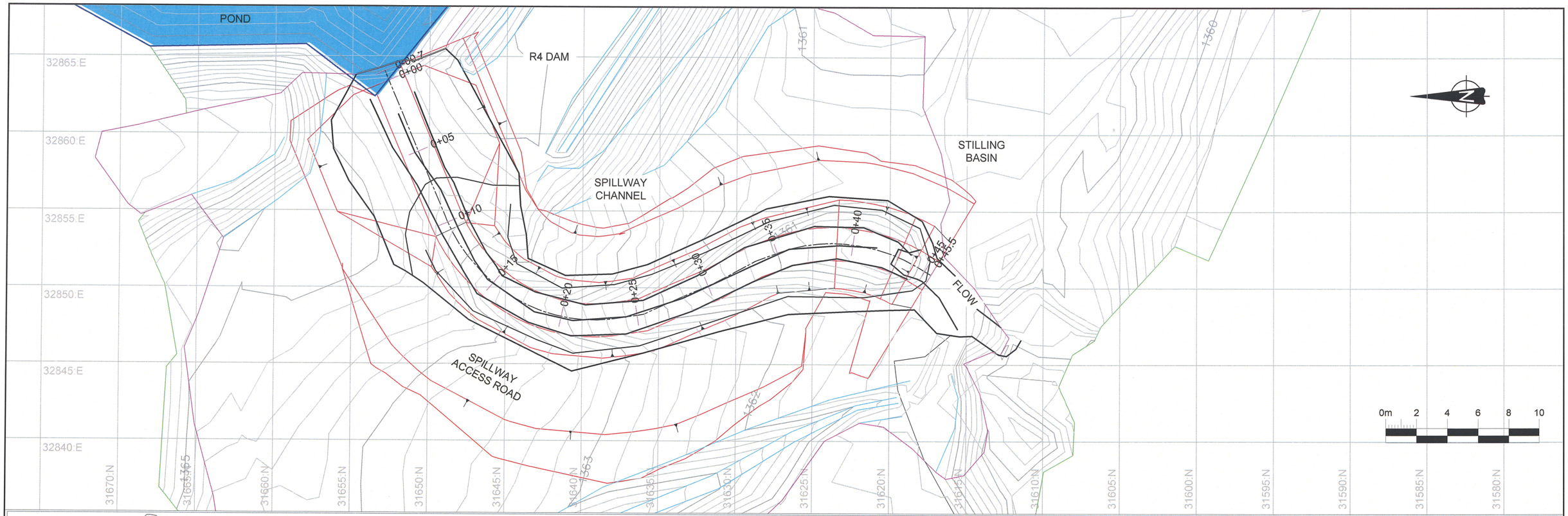
DWN BY:	YC/HY
CHK'D BY:	AF
DATUM:	MINE
PROJECTION:	MINE
SCALE:	AS SHOWN

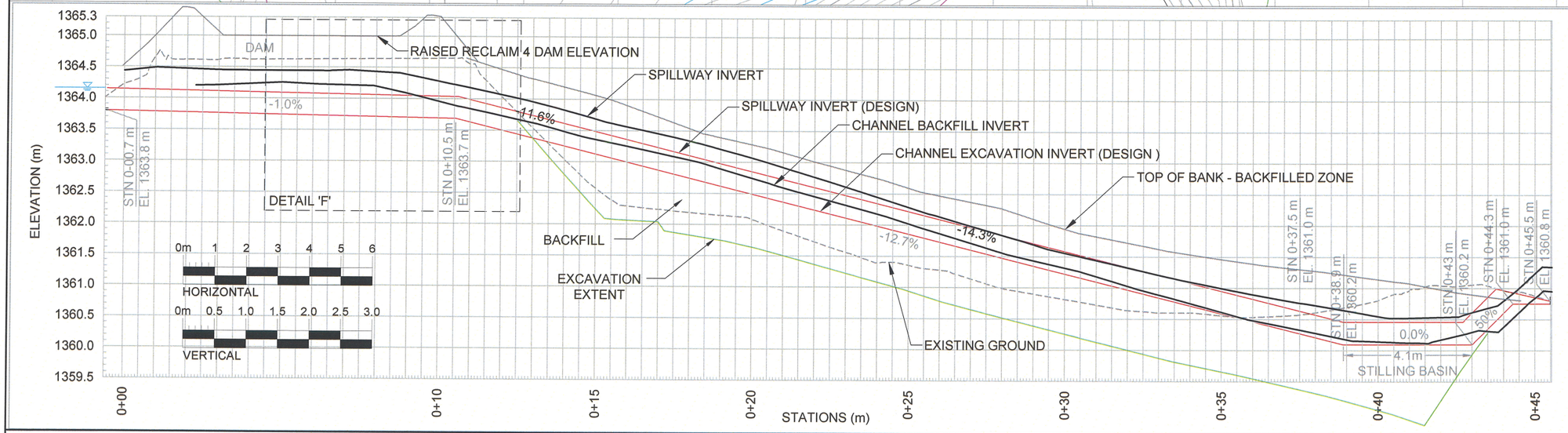
PROJECT: SPILLWAY DESIGN - TROJAN RECLAIM DAM 4

TITLE: GENERAL LAYOUT

DATE:	NOVEMBER 2014
PROJECT NO:	VW1035
REV. NO:	A
FIGURE NO:	AB - 2

W:\Projects\VW1035 – HVC R4 Spillway\Drawings\As-Built Drawings\FINAL\R4-Spillway-Figures-002-007 Oct. 2014.FINAL.dwg – AB-2 Plan – Nov. 26, 2014 4:32pm – hamid.yousefbeigi





Station (m)	Excavation Elevation (m)	X	Y
0+00.4	1364.3	32863.1	31652.5
0+05.0	1364.2	32858.9	31650.7
0+09.0	1364.2	32855.2	31649.2
0+10.0	1364.1	32854.2	31648.8
0+15.0	1363.4	32850.3	31645.8
0+20.0	1362.7	32848.1	31641.4
0+25.0	1362.0	32848.2	31636.4
0+30.0	1361.3	32850.1	31631.8
0+35.0	1360.6	32852.3	31627.3
0+38.9	1360.1	32852.9	31624.3
0+40.0	1360.1	32852.8	31622.4
0+43.0	1360.1	32852.3	31620.3
0+45.0	1360.9	32851.1	31617.7
0+45.5	1360.8	32850.9	31617.3

NOTE: FIELD MODIFIED DESIGN COORDINATES AND ELEVATION

NOTE:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE LETTER (FILE No. VW1035) DATED NOVEMBER 2014.

RECORD DRAWINGS

CLIENT: Highland Valley Copper — Teck

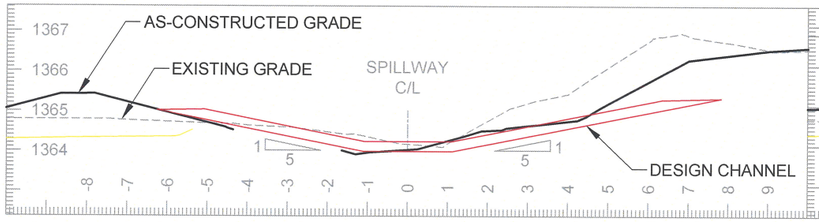
AMEC Environment & Infrastructure
Suite 600 - 4445 Lougheed Highway
Burnaby, BC V5C 0E4
Tel. 604-294-3811 Fax 604-294-4664

DWN BY:	HY
CHK'D BY:	AF
DATUM:	MINE
PROJECTION:	MINE
SCALE:	AS SHOWN

PROJECT: SPILLWAY DESIGN - TROJAN RECLAIM DAM 4

TITLE: PLAN AND PROFILE

DATE:	NOVEMBER 2014
PROJECT NO:	VW1035
REV. NO:	A
FIGURE NO:	AB - 3



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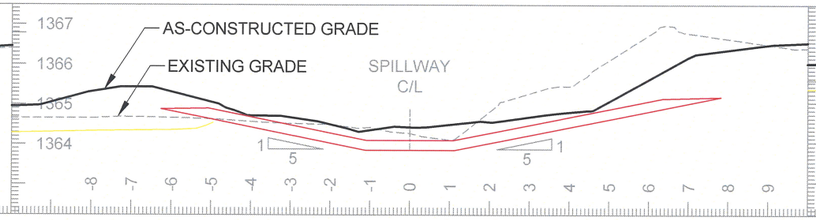

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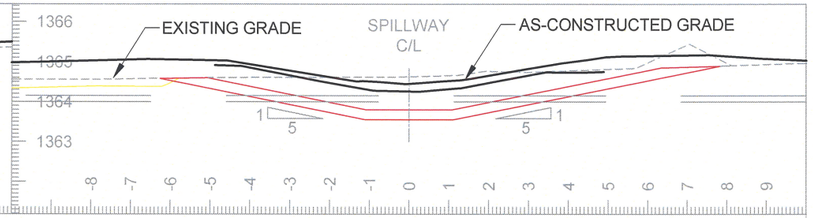

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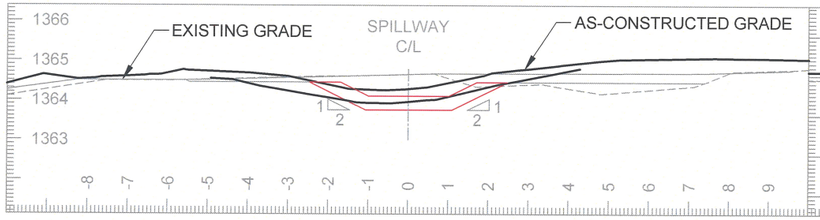

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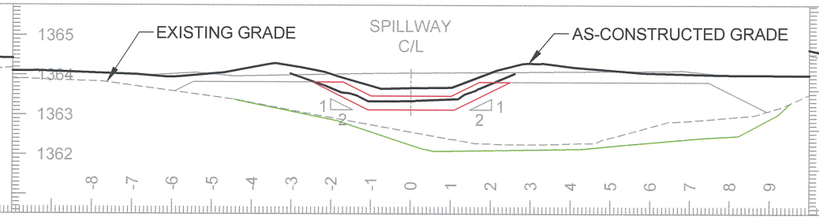

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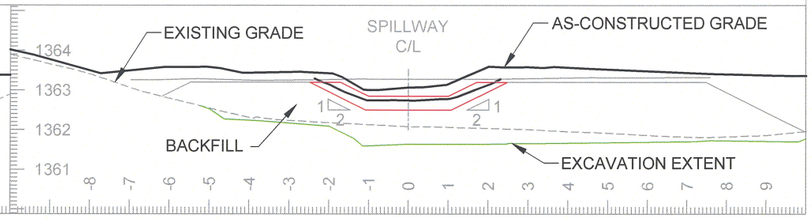

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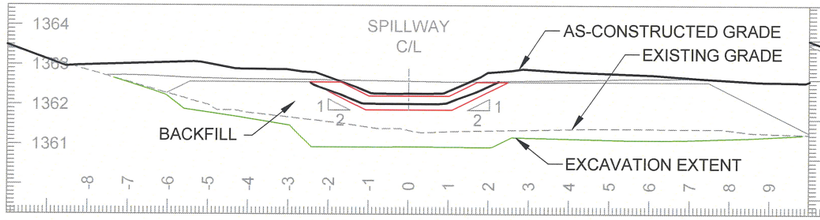

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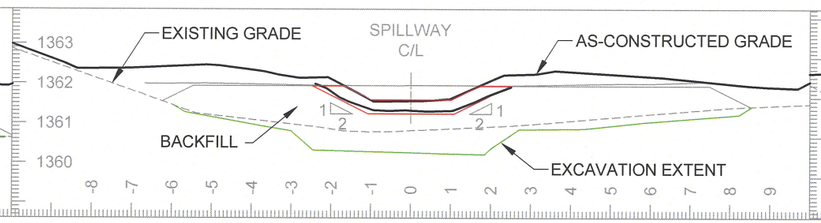

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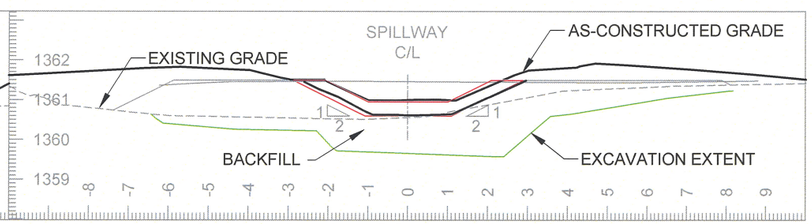

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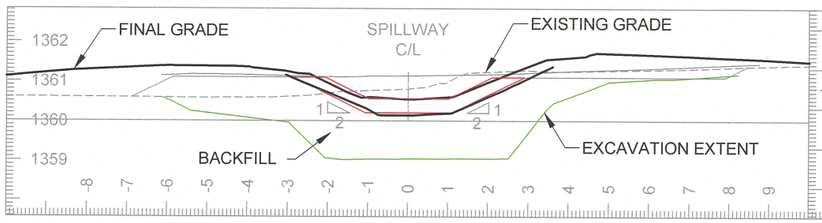

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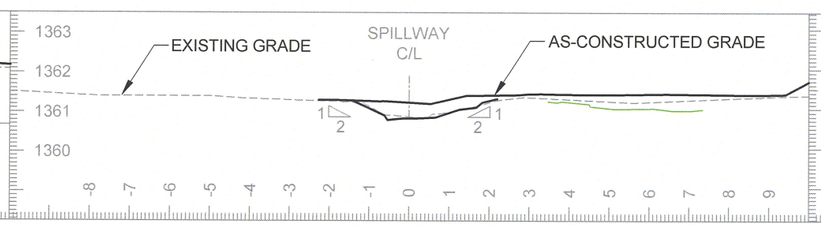

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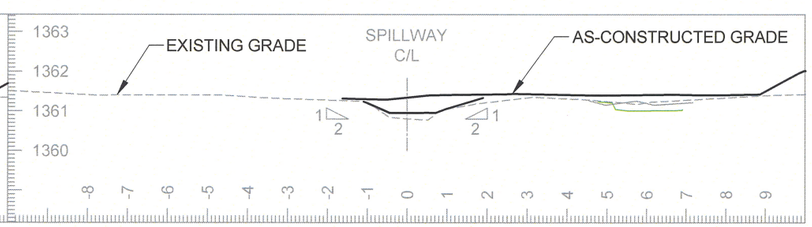

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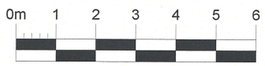
SPILLWAY CROSS SECTIONS AT 5.0 m STATION INTERVALS



NOTE: CROSS SECTIONS CUT LOOKING DOWNSTREAM

NOTE:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE LETTER (FILE No. VW1035) DATED NOVEMBER 2014.

RECORD DRAWINGS

CLIENT: Highland Valley Copper — Teck

AMEC Environment & Infrastructure
Suite 600 - 4445 Lougheed Highway
Burnaby, BC V5C 0E4
Tel. 604-294-3811 Fax 604-294-4664

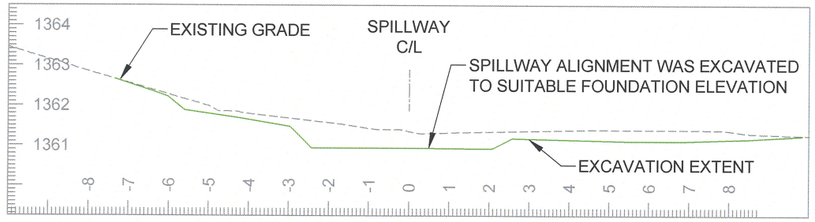
DWN BY:	HY
CHK'D BY:	AF
DATUM:	MINE
PROJECTION:	MINE
SCALE:	AS SHOWN

PROJECT: SPILLWAY DESIGN - TROJAN RECLAIM DAM 4

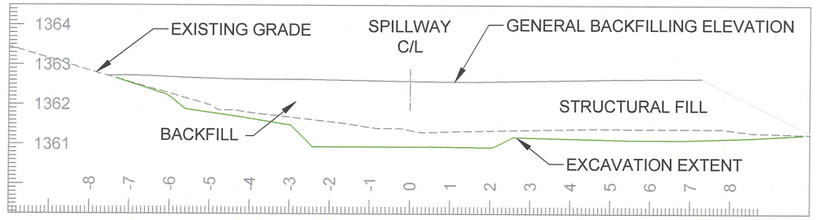
TITLE: CROSS SECTIONS

DATE:	NOVEMBER 2014
PROJECT NO:	VW1035
REV. NO:	A
FIGURE NO:	AB - 4

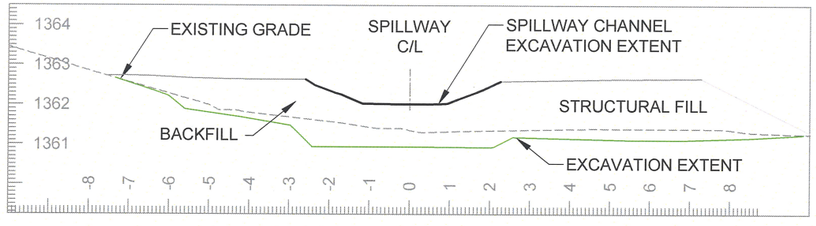
CONSTRUCTION SEQUENCING AND STAGING SHOWN AT STATION 0+25



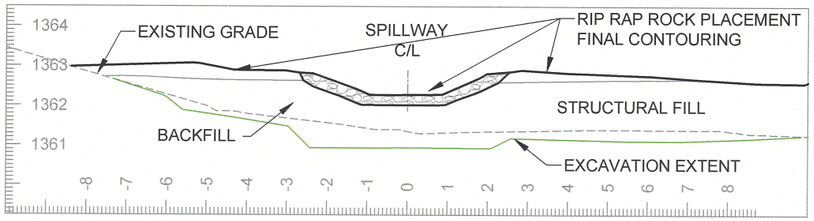
STAGE 1 - FOUNDATION EXCAVATION



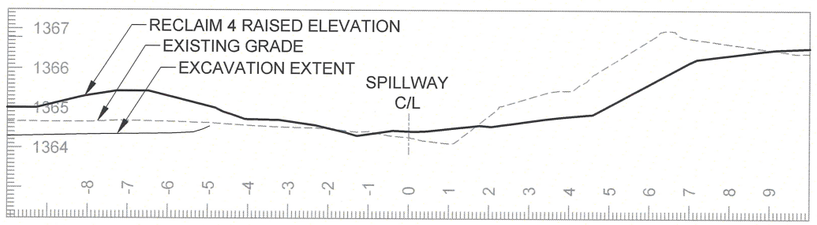
STAGE 2 - GENERAL BACKFILLING OF THE SPILLWYA AND ACCESS ROAD



STAGE 3 - SPILLWYA CHANNEL WAS EXCAVATED TO THE DESIGN ALIGNMENT

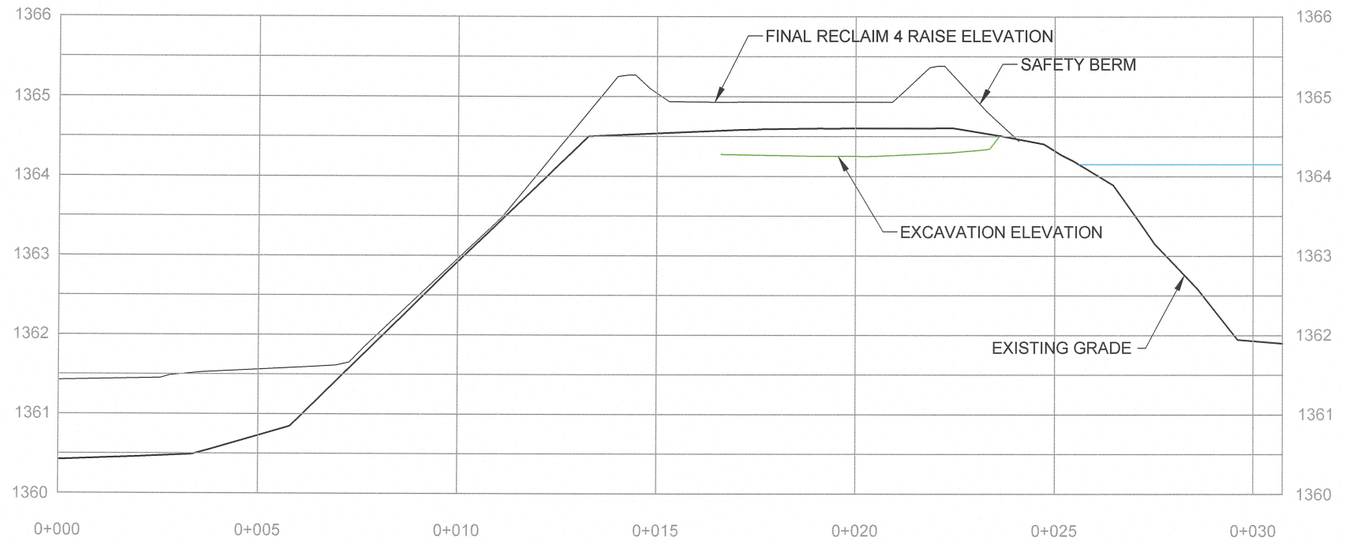


STAGE 4 - RIP RAP ROCK PLACEMENT IN THE CHANNEL AND CONTOURING

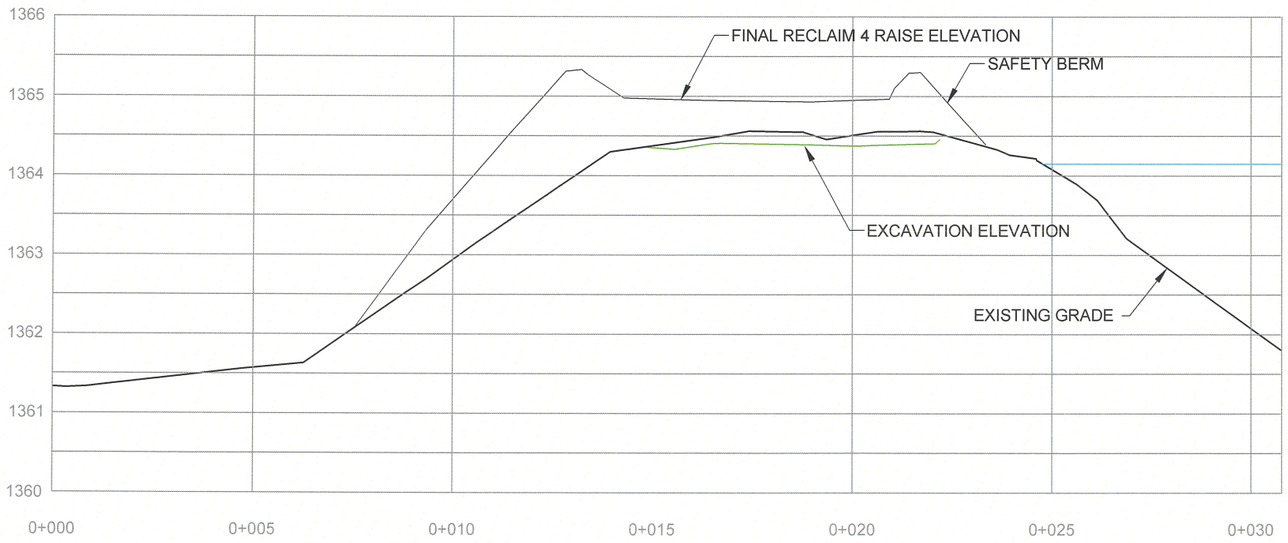


STN: 0+00.0 - DAM RAISE SECTION

A-A PROFILE



B-B SECTION



NOTE:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE LETTER (FILE No. VW1035) DATED NOVEMBER 2014.

RECORD DRAWINGS

CLIENT: Highland Valley Copper Teck

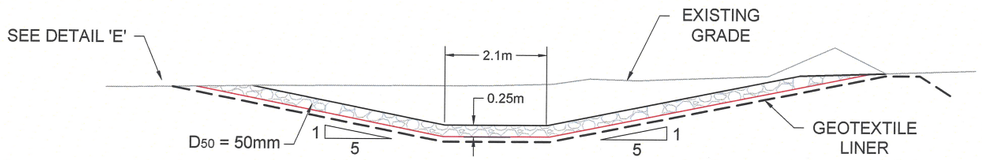
AMEC Environment & Infrastructure
Suite 600 - 4445 Lougheed Highway
Burnaby, BC V5C 0E4
Tel. 604-294-3811 Fax 604-294-4664

DWN BY:	HY
CHK'D BY:	AF
DATUM:	MINE
PROJECTION:	MINE
SCALE:	AS SHOWN

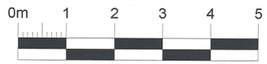
PROJECT: SPILLWAY DESIGN - TROJAN RECLAIM DAM 4

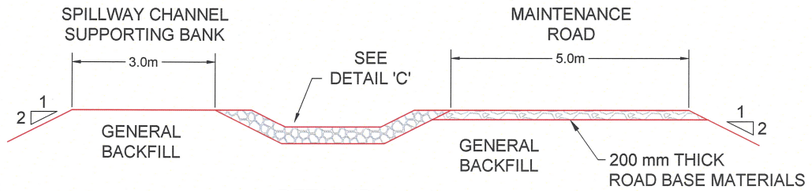
TITLE: DETAILS AND DETAIL SECTIONS

DATE:	NOVEMBER 2014
PROJECT NO:	VW1035
REV. NO:	A
FIGURE NO:	AB - 5

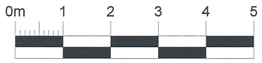


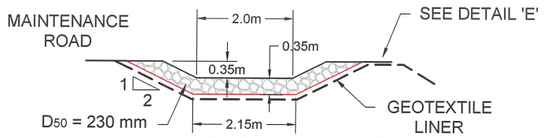
DETAIL 'A'
SECTION - SPILLWAY CHANNEL - 1% GRADE
STATION 0+05.0m



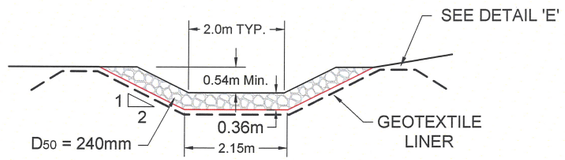


DETAIL 'B'
TYPICAL BACKFILL ZONE AND SPILLWAY CHANNEL
(LOOKING DOWNSTREAM)

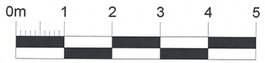


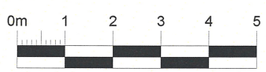


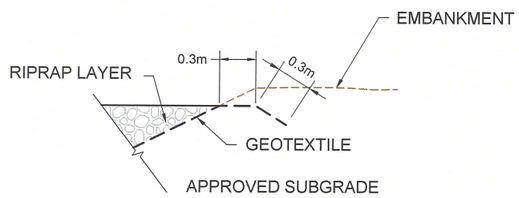
DETAIL 'C'
TYPICAL SECTION - SPILLWAY CHANNEL -12.7% GRADE



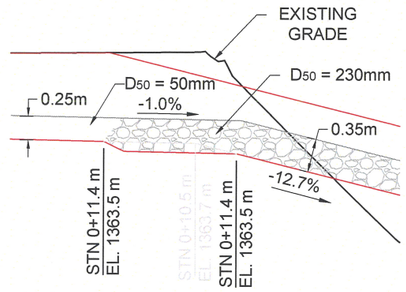
DETAIL 'D'
SECTION - STILLING BASIN
STATION 0+40.0m







DETAIL 'E'
TYPICAL SECTION - ANCHOR DETAIL
(NTS)



DETAIL 'F'
SLOPE TRANSITION
NTS

NOTE:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE LETTER (FILE No. VW1035) DATED NOVEMBER 2014.

RECORD DRAWINGS

CLIENT: Highland Valley Copper Teck

AMEC Environment & Infrastructure
Suite 600 - 4445 Lougheed Highway
Burnaby, BC V5C 0E4
Tel. 604-294-3811 Fax 604-294-4664

DWN BY:	HY
CHK'D BY:	AF
DATUM:	MINE
PROJECTION:	MINE
SCALE:	AS SHOWN

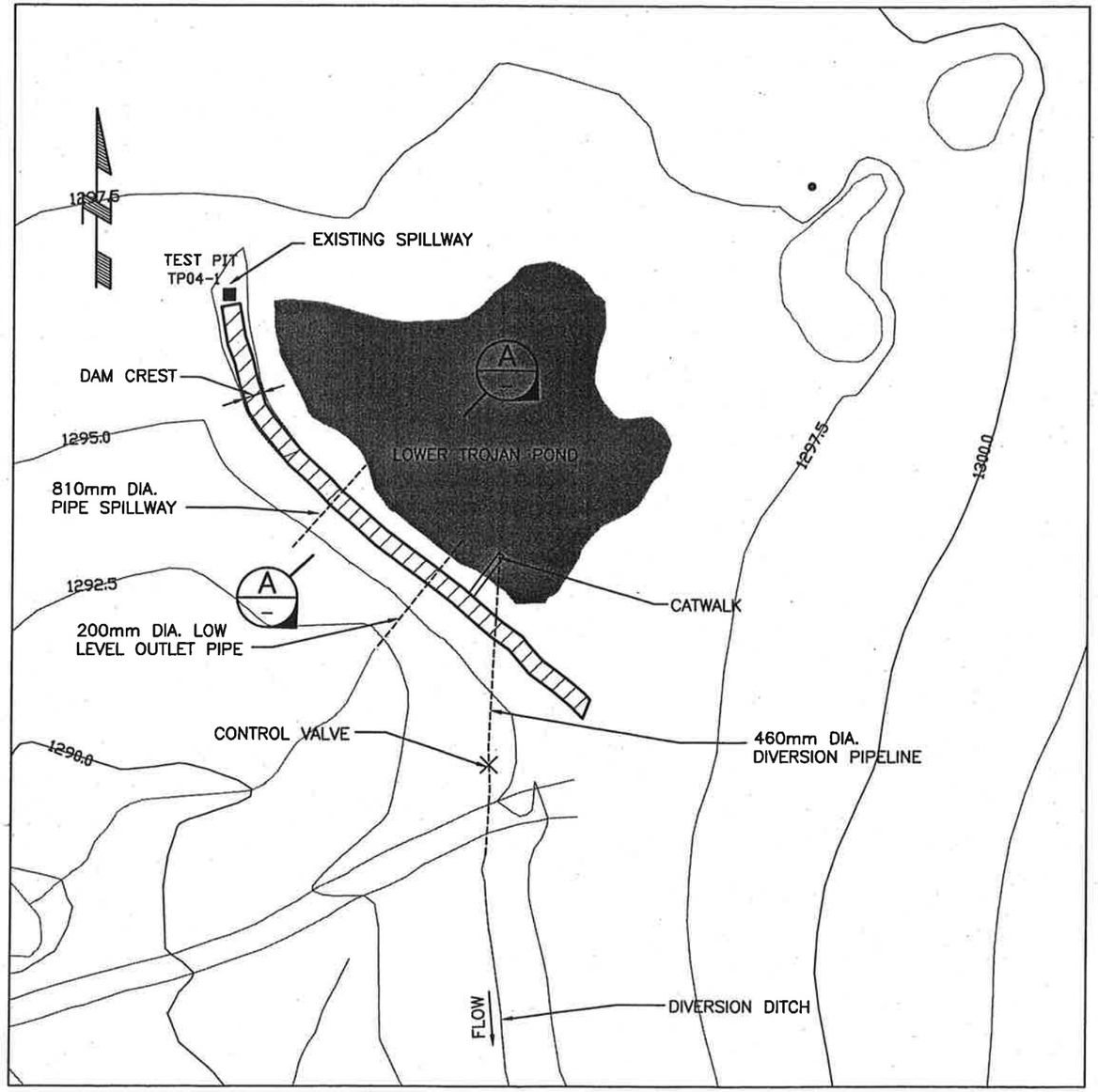
PROJECT: SPILLWAY DESIGN - TROJAN RECLAIM DAM 4

TITLE: DESIGN DETAILS AND SECTIONS

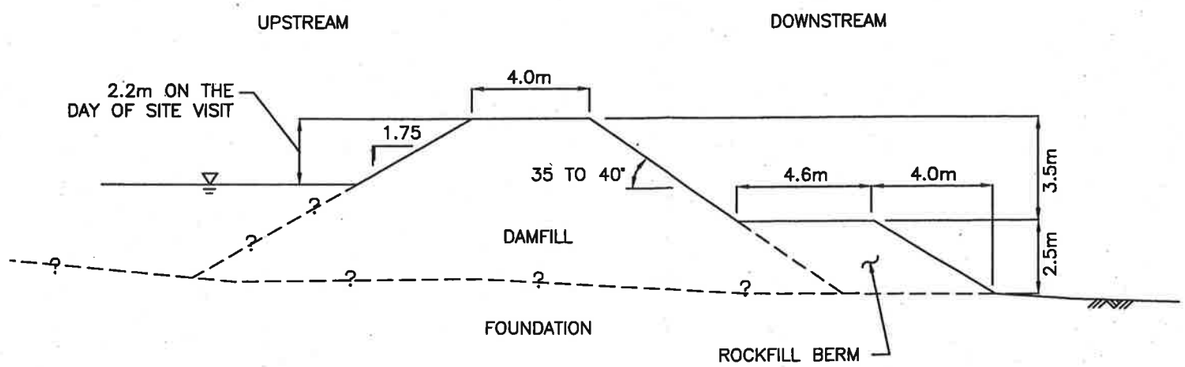
DATE:	NOVEMBER 2014
PROJECT NO:	VW1035
REV. NO:	A
FIGURE NO:	AB - 6

APPENDIX III-C

Reference Dam Design Drawings – Lower Trojan



PLAN
SCALE A



LOWER TRAJAN POND DAM
APPROX. SECTION AT HIGHEST POINT IN DAM
(MEASURED 17 NOV/04)
SCALE B

NOTES:
1. FOR LOCATION OF POND SEE FIGURE B-001.
2. LOCATION OF BURIED PIPES ARE APPROXIMATE.

SCALE B 0 10m
SCALE A 0 50m
SCALE

NOT FOR CONSTRUCTION
TO BE READ WITH KLOHN CRIPPEN REPORT DATED JUNE 10, 2005

CLIENT: HIGHLAND VALLEY COPPER

KLOHN CRIPPEN

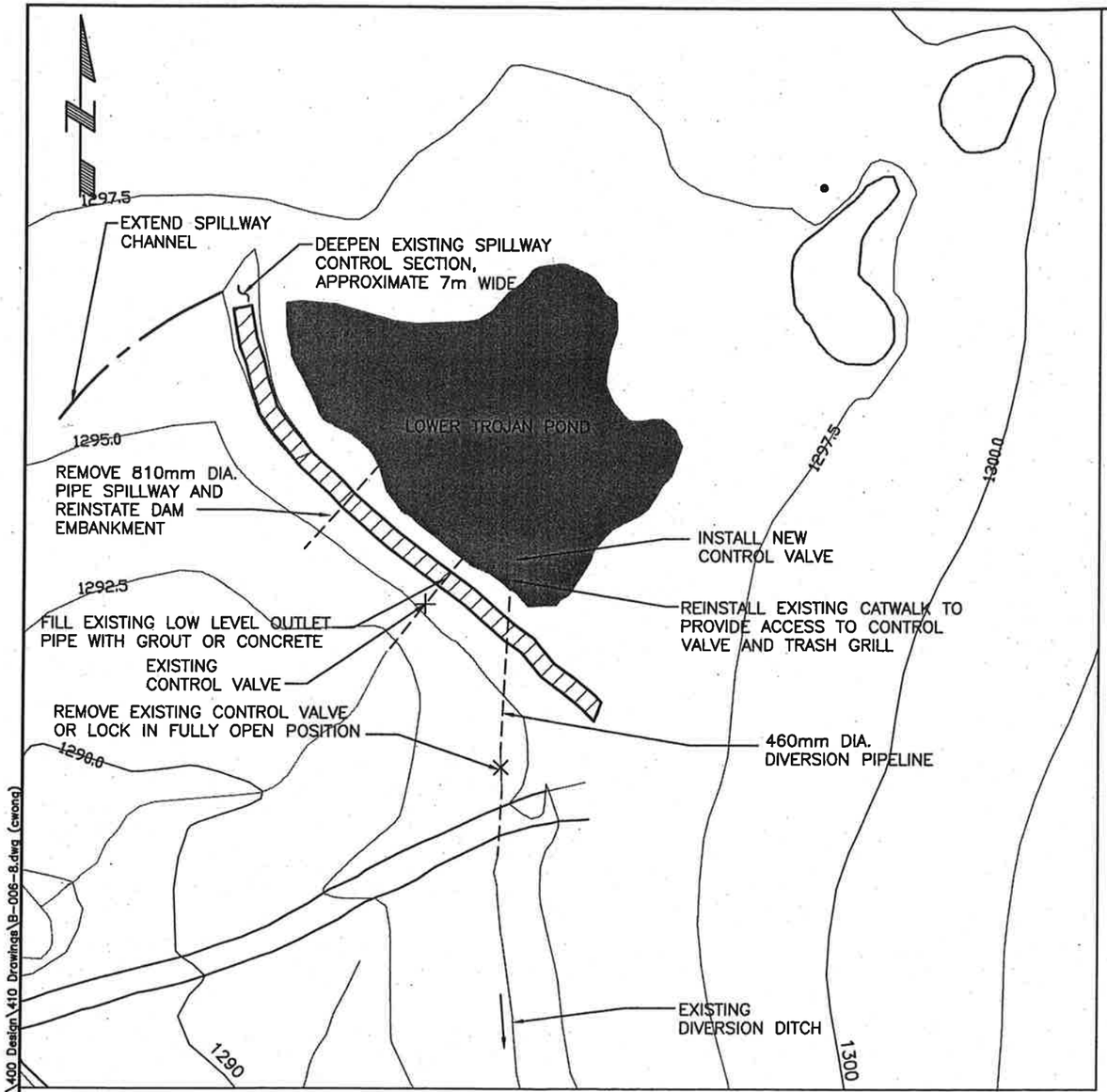
PROJECT: TROJAN CREEK PONDS

TITLE: LOWER TROJAN POND
PLAN AND DAM SECTION

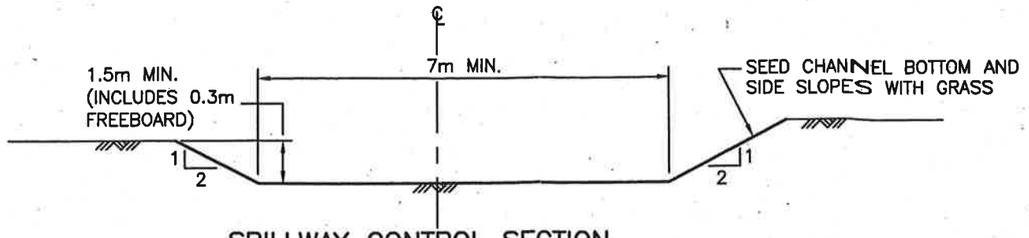
PROJECT No. M 02341 A3105

FIG. No. B-004

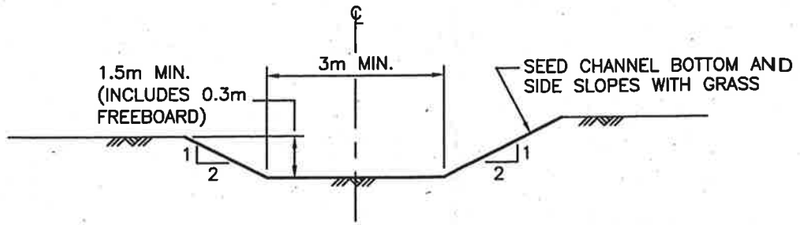
Time: 13:21:53
Date: 3/9/2005
Scale: 1=5(PS)
Drawing File: M:\M02341\A3105 - Trojan Creek Ponds\400 Design\410 Drawings\B-001-5.dwg (cwong)
Xrefs: FIG-BASE



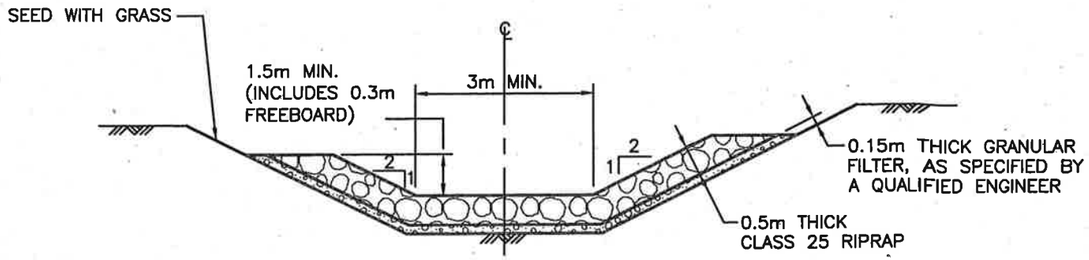
PLAN
SCALE A



SPILLWAY CONTROL SECTION
SCALE B



SPILLWAY CHANNEL SECTION DOWNSTREAM OF DAM FOR 0.5% OR FLATTER BED SLOPE
SCALE B



SPILLWAY CHANNEL SECTION DOWNSTREAM OF DAM FOR 0.6% TO 10% BED SLOPE
SCALE B

NOTES:

1. FOR LOCATION OF POND SEE FIG. B-001.
2. FOR RIPRAP GRADATION SEE FIG. B-006.
3. LOCATIONS OF BURIED PIPELINES ARE APPROXIMATE.

SCALE B 0 5m

SCALE A 0 50m

SCALE

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN REPORT DATED JUNE 10, 2005

CLIENT: HIGHLAND VALLEY COPPER

KLOHN CRIPPEN

PROJECT: TROJAN CREEK PONDS

TITLE: LOWER TROJAN POND
PROPOSED DECOMMISSIONING WORK
PLAN AND SECTIONS

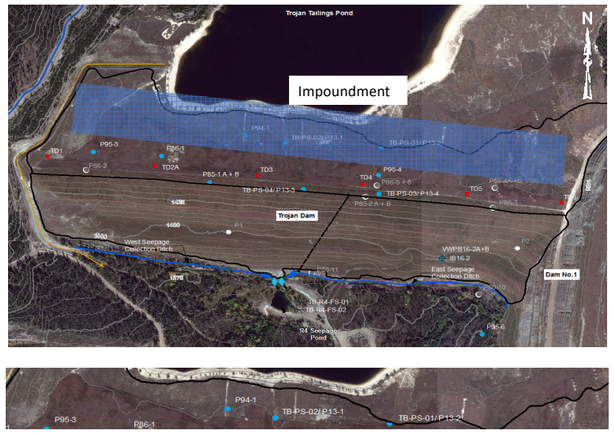
PROJECT No. M 02341 A3105

FIG. No. B-008

Time: 2:2:18
Date: 6/10/2005
Scale: 1=10(PS)
Drawing File: M:\M02341A3105 - Trojan Creek Ponds\400 Design\410 Drawings\B-006-8.dwg (awong)

APPENDIX IV

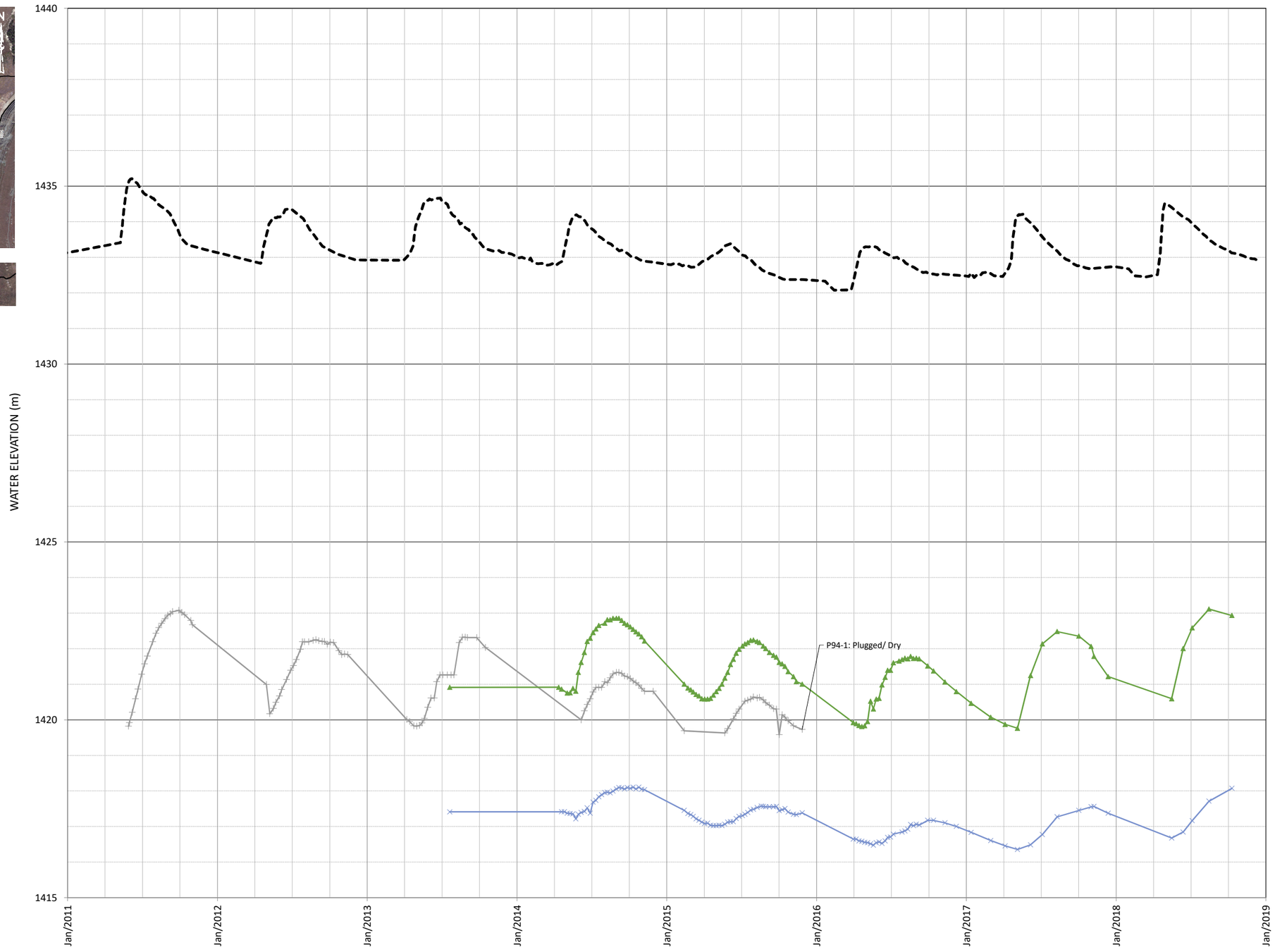
Instrumentation Plots



LEGEND:

- P94-1 (Tip El. unknkown m, Sandfill)
- TB-PS-02/P13-1 (Tip El. 1409.5 m, Cycloned Sand)
- TB-PS-01/P13-2 (Tip El. 1413 m, Cycloned Sand)
- Trojan Pond Level

PIEZOMETER ID	2018 THRESHOLD EL. (m)
TB-PS-02/P13-1	1423.4
TB-PS-01/P13-2	1418.6



CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT: TROJAN TAILINGS STORAGE FACILITY 2018 DAM SAFETY INSPECTION

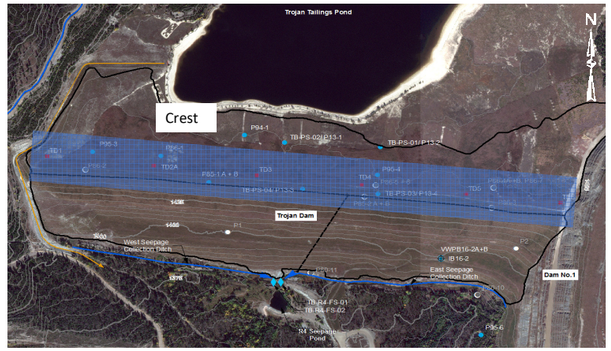
TITLE: TROJAN DAM PIEZOMETRIC DATA 2011-2018

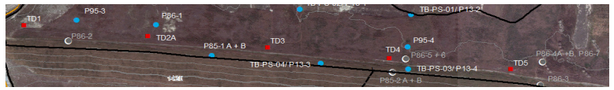
IMPOUNDMENT

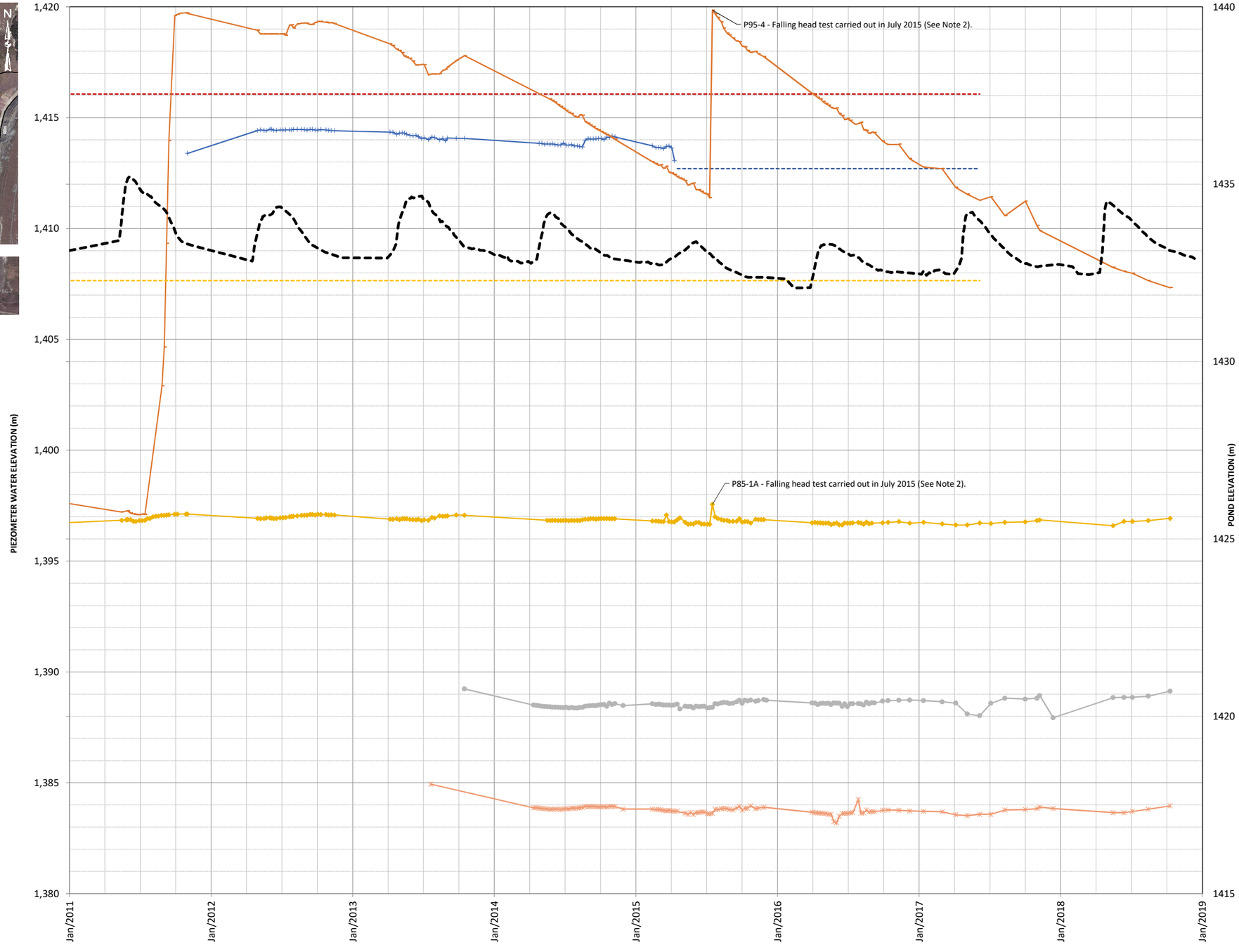
PROJECT No. M02341B43

FIG No. IV-1

March 25, 2019
Z:\M\VC\RM\02341B43 - HVC 2018 Dam Safety Support\300 Design\Piezometer Data\Piezo Data\Trojan\[190322 Trojan Piezo.xlsx]IMPOUNDMENT







LEGEND:

- P86-7 dry elevation
- P95-3 (Tip El. 1412.7 m, Foundation)
- P95-3 dry elevation
- P95-4 (Tip El. 1389.09 m, Unknown)
- P85-1A (Tip El. 1388.12 m, Foundation)
- TB-PS-04/P13-3 (Tip El. 1376.2 m, Sand and Gravel)
- TB-PS-03/P13-4 (Tip El. 1376.6 m, Till)
- P86-1 dry elevation
- Trojan Pond Level

PIEZOMETER ID	2018 THRESHOLD EL. (m)
P85-1A	1399.2
P86-1	1408.2
P86-7	1419.8
P95-3	1415.0
TB-PS-04/P13-3	1385.4
TB-PS-03/P13-4	1389.7

NOTES:

1. PIEZOMETER WATER ELEVATIONS PLOTTED ON PRIMARY (LEFT) AXIS, POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.
2. FALLING HEAD TESTS WERE CONDUCTED IN P85-1A (JULY 23, 2015), P95-4 (JULY 24, 2015) AND P85-1B (JULY 23, 2015, DEFUNCT). THE ELEVATED READINGS FOR P85-1A DURING THIS TIME WERE NOT USED TO DETERMINE THE REVISED PIEZOMETRIC LEVEL THRESHOLD.
3. THE FOLLOWING PIEZOMETERS WERE FUNCTIONING BUT DRY IN 2017: P86-1, P86-7, P95-3.
4. THE FOLLOW PIEZOMETERS ARE PLUGGED AND NOT SHOWN ON THIS FIGURE: P86-3 IS PLUGGED AT ~6 m DEPTH; P86-4A, P86-4B AND P85-2A ARE PLUGGED AT BETWEEN 15 m AND 30 m DEPTH; P85-1B IS PLUGGED AT 43 m DEPTH AND WAS HISTORICALLY DRY.

CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT: TROJAN TAILINGS STORAGE FACILITY 2018 DAM SAFETY INSPECTION

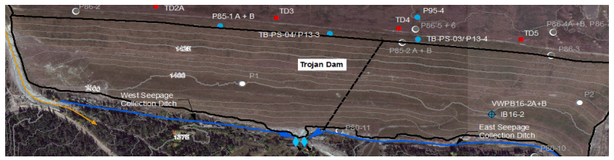
TITLE: TROJAN DAM PIEZOMETRIC DATA 2011-2018

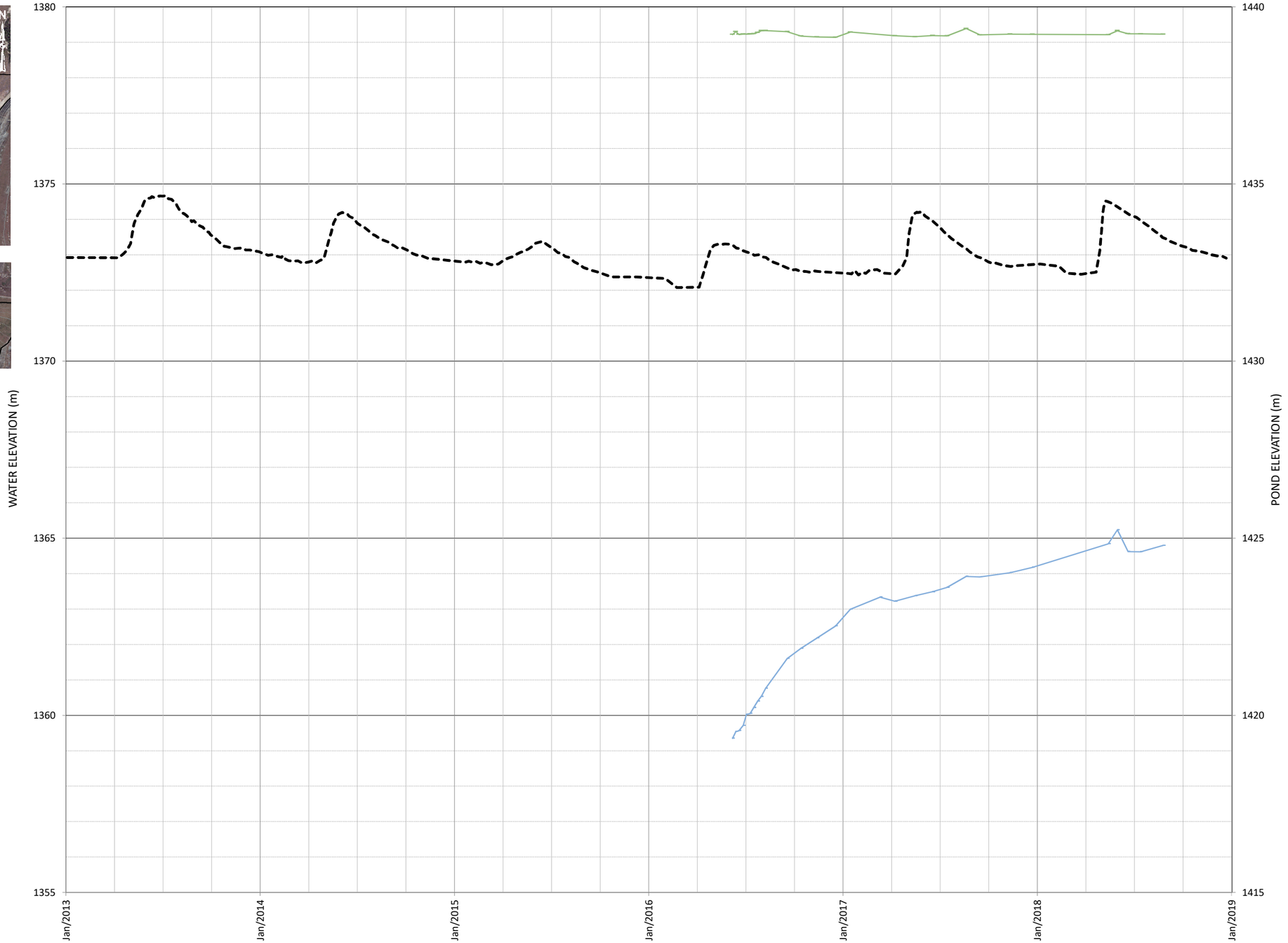
CREST

PROJECT No. M02341B43

FIG No. IV-2

March 25, 2019
Z:\MVCFRM\02341B43 - HVC 2018 Dam Safety Support\300 Design\Piezometer Data\Piezo Data\Trojan\[190322 Trojan Piezo.xlsx]IMPOUNDMENT





LEGEND:

- VW16-2A (Tip El. 1321.85 m, Glacial Sediments / Debris)
- VW16-2B (Tip El. 1373.35 m, Glacial Till)
- Trojan Pond Level

PIEZOMETER ID	2018 THRESHOLD EL. (m)
VW16-2A	1363.0
VW16-2B	1379.8

NOTES:

1. PIEZOMETER WATER ELEVATIONS PLOTTED ON PRIMARY (LEFT) AXIS, POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.

CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT: TROJAN TAILINGS STORAGE FACILITY 2018 DAM SAFETY INSPECTION

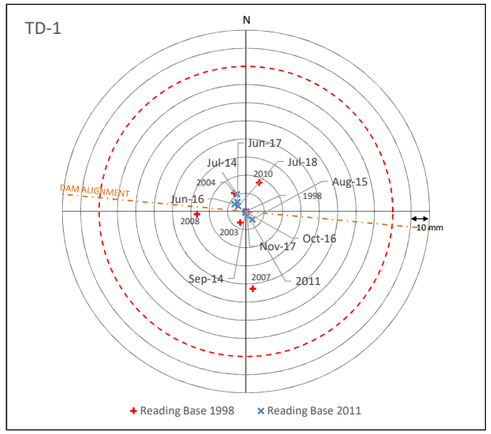
TITLE: TROJAN DAM PIEZOMETRIC DATA 20013-2018

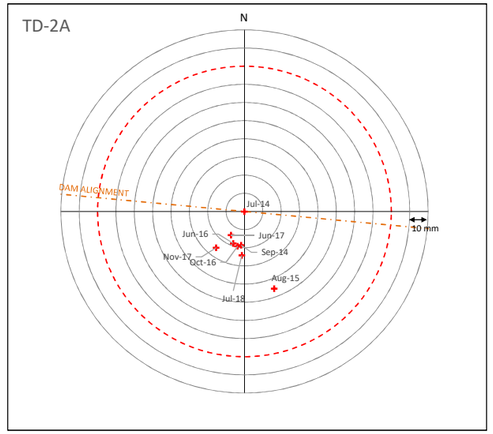
DOWNSTREAM SLOPE

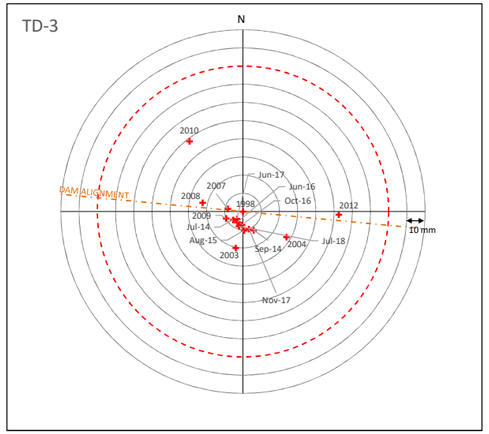
PROJECT No. M02341B43

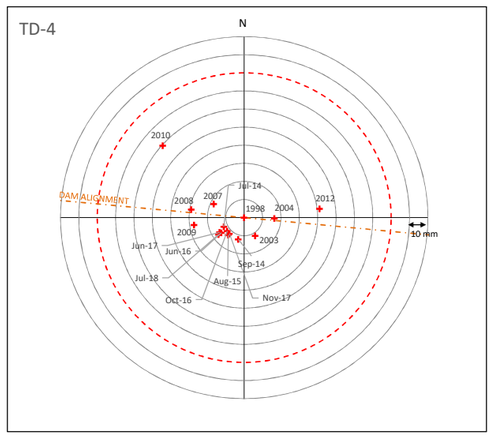
FIG No. IV-3

March 25, 2019
Z:\MVCR\M02341B43 - HVC 2018 Dam Safety Support\300 Design\Piezometer Data\Piezo Data\Trojan\[190322 Trojan Piezo.xlsx]IMPOUNDMENT



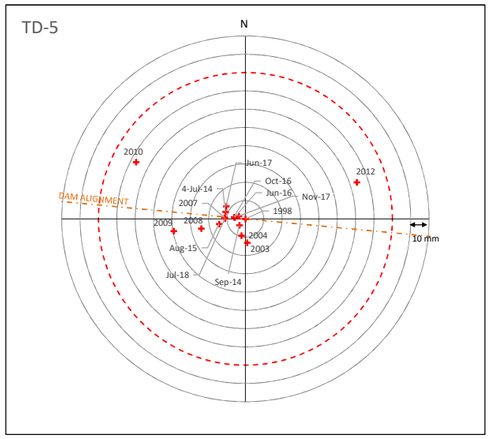


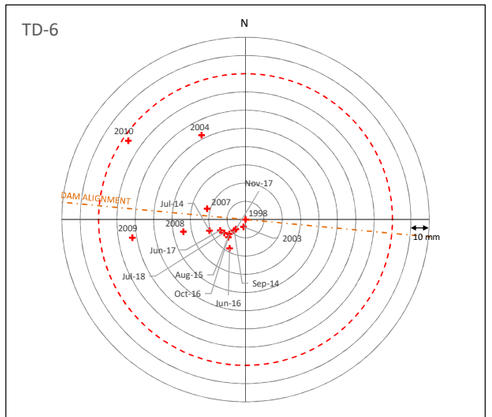


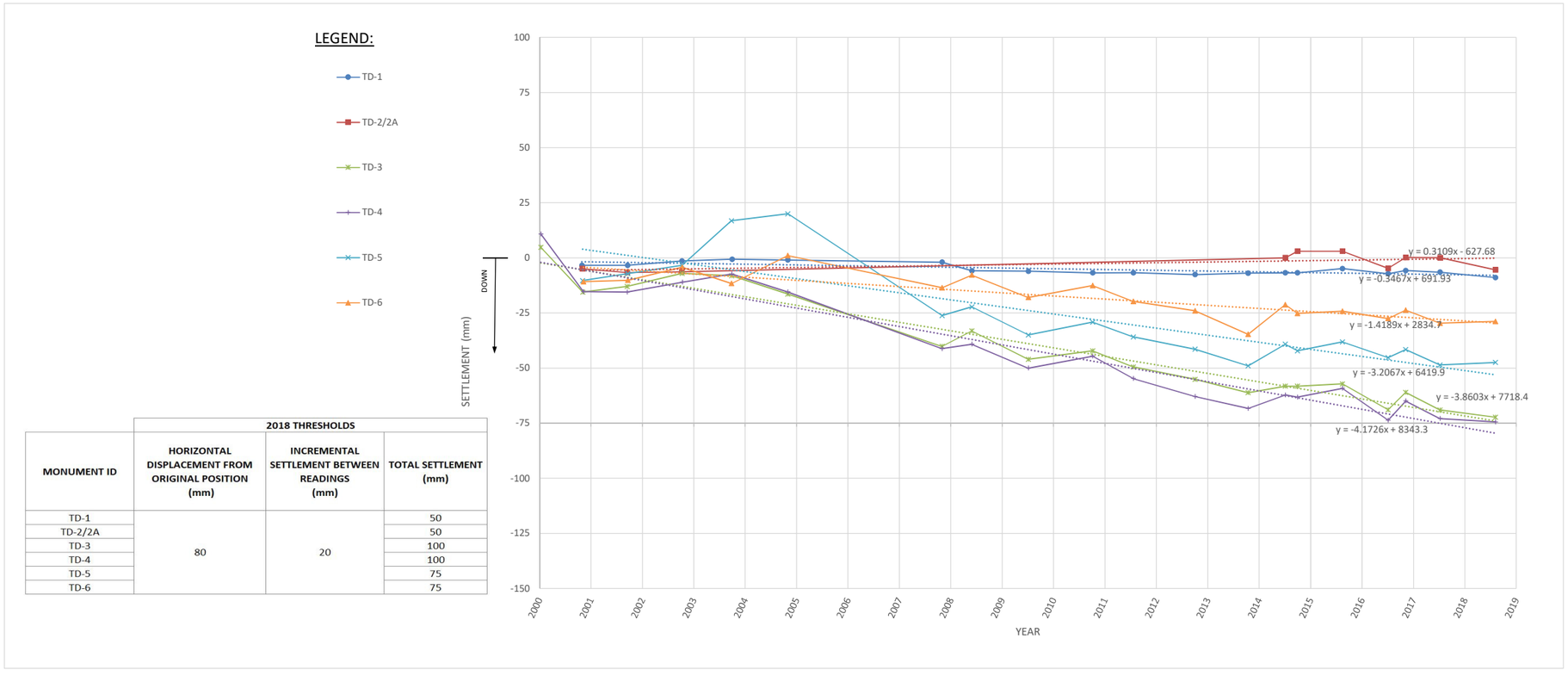


DAM CENTERLINE ORIENTATION

THRESHOLD HORIZONTAL DISPLACEMENT FROM ORIGINAL POSITION







MONUMENT ID	2018 THRESHOLDS		
	HORIZONTAL DISPLACEMENT FROM ORIGINAL POSITION (mm)	INCREMENTAL SETTLEMENT BETWEEN READINGS (mm)	TOTAL SETTLEMENT (mm)
TD-1	80	20	50
TD-2/2A			50
TD-3			100
TD-4			100
TD-5			75
TD-6			75

NOTES:

1. TROJAN DAM MOVEMENT MONITORING DATA PRIOR TO 2000 NOT SHOWN.
2. REFER TO FIGURE 3 FOR MONUMENT LOCATIONS IN PLAN VIEW.
3. TD-1 RELOCATED AFTER OCT 2001.
4. TD-1 2009 READING (NOT SHOWN IN PLAN PLOT) LOCATED 297 mm FROM INITIAL 1998 READING . READING WAS REVIEWED AND FOUND MORE LIKELY RELATED TO SURVEY ERROR THAN DISPLACEMENT.

CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

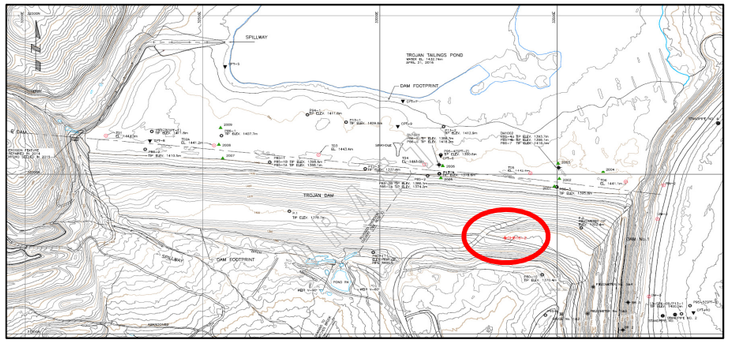
PROJECT: TROJAN TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

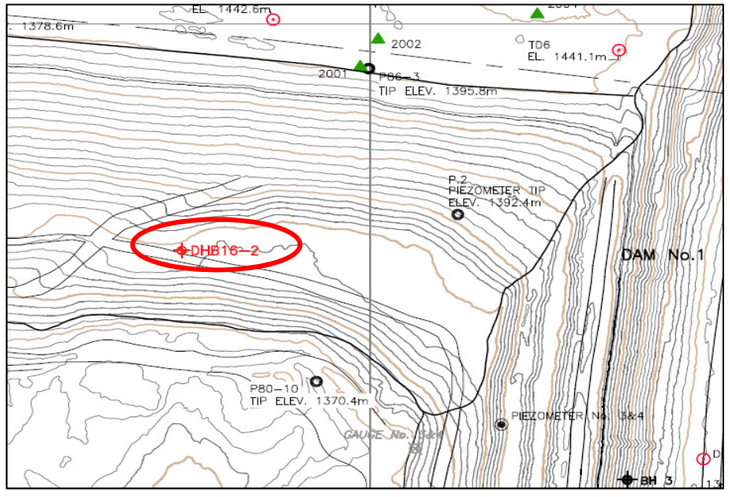
TITLE: TROJAN DAM
SURVEY MONUMENT READINGS

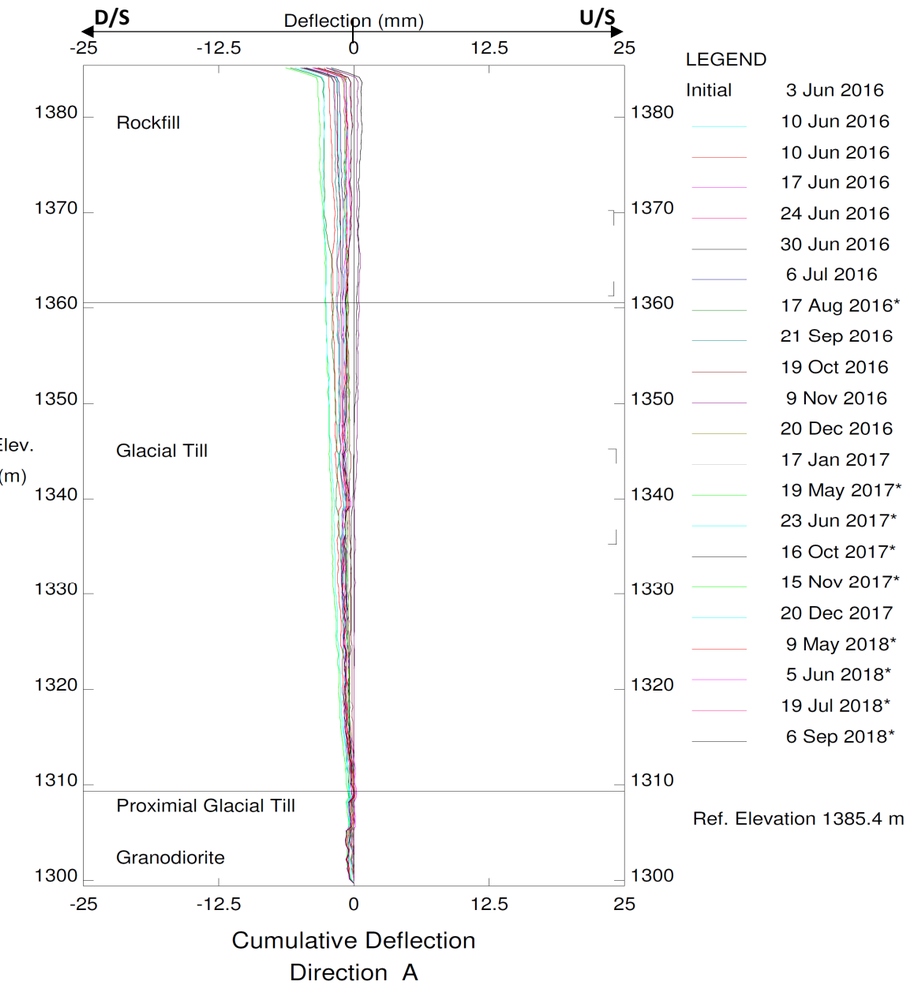
PROJECT No. M02341B43

FIG No. IV-4

January 8, 2019
Z:\MV\CH\M02341B43 - HVC 2018 Dam Safety Support\300 Design\Monument Data\Trojan\[181205 TrojanDamMonitoring.xlsm]Fig V-4



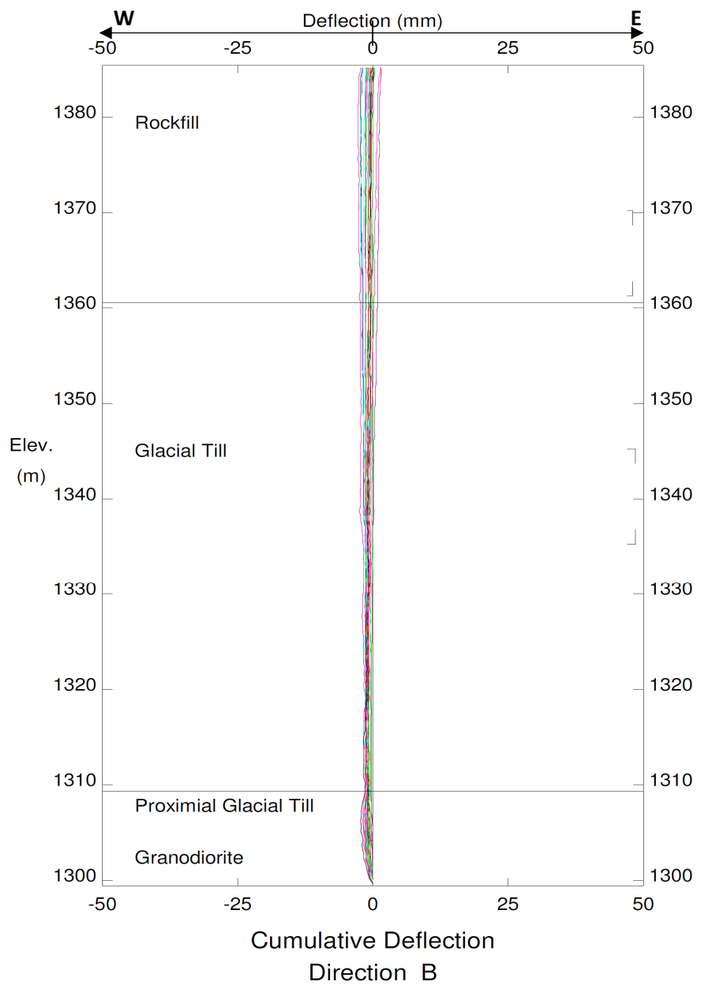




LEGEND

Initial	3 Jun 2016
	10 Jun 2016
	10 Jun 2016
	17 Jun 2016
	24 Jun 2016
	30 Jun 2016
	6 Jul 2016
	17 Aug 2016*
	21 Sep 2016
	19 Oct 2016
	9 Nov 2016
	20 Dec 2016
	17 Jan 2017
	19 May 2017*
	23 Jun 2017*
	16 Oct 2017*
	15 Nov 2017*
	20 Dec 2017
	9 May 2018*
	5 Jun 2018*
	19 Jul 2018*
	6 Sep 2018*

Ref. Elevation 1385.4 m



NOTES:

1) IB16-2 was installed on April 29, 2016.
2) IB16-2 was initialized on June 10, 2016.
3) Reel/Probe Serial Number for the initial reading: DR15020000/DP06580000.
4) Not all readings are plotted.

CLIENT
TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

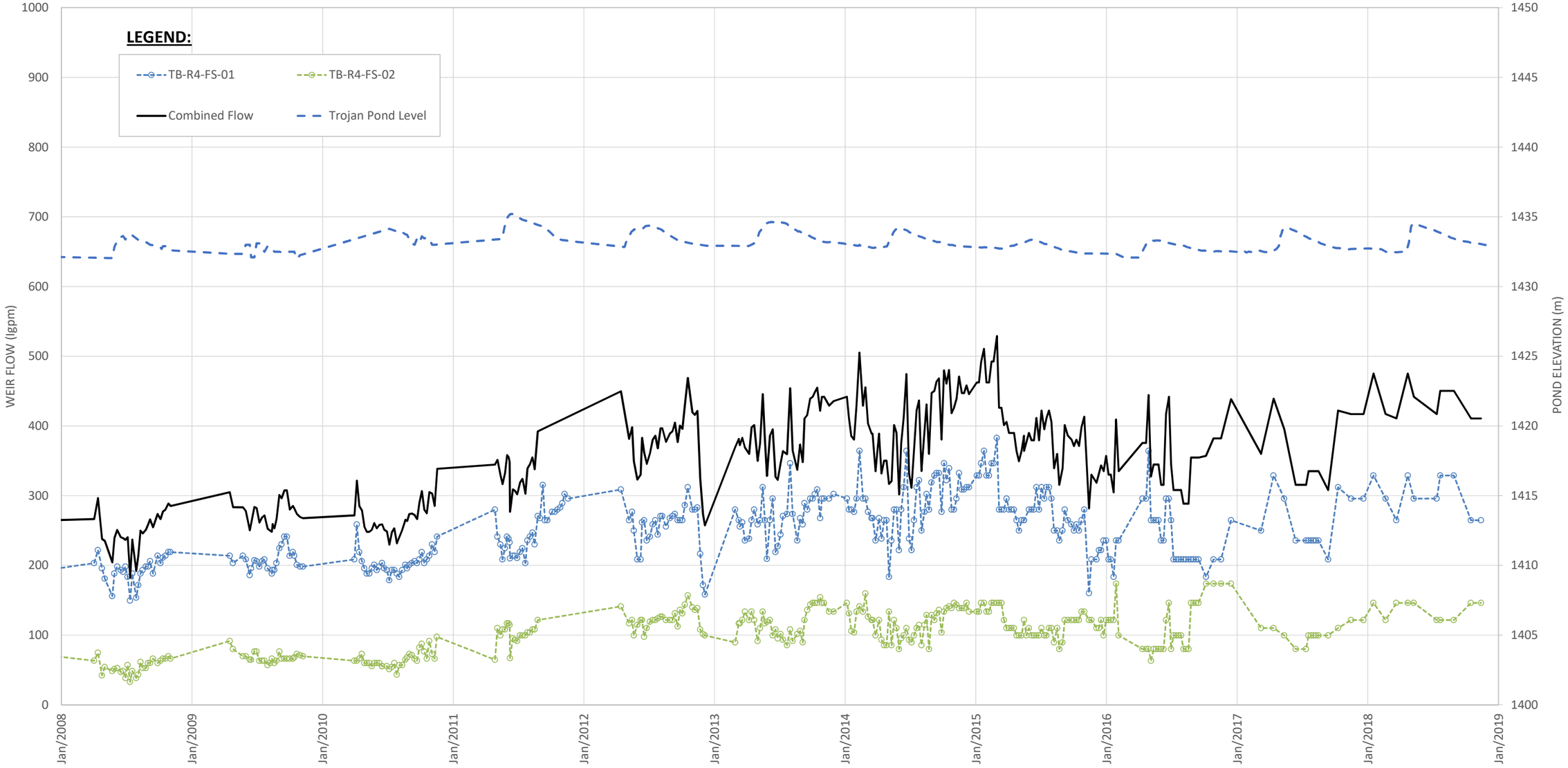
PROJECT
TROJAN DAM TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

TITLE
INCLINOMETER CUMULATIVE DISPLACEMENT PROFILE
IB16-2

PROJECT No. M02341B43

FIG. No. IV-5

Date & Time: 2019-03-26 17:46
Figure File: \\VCR-FS-V\Projects\M\M02341B43 - HVC 2018 Dam Safety Support\300 Design\Inclinometer Data\Inclinometer processing\Beth\Fig. IV-5 (IB16-2) (2).xlsx



NOTES:

1. WEIR FLOW PLOTTED ON PRIMARY (LEFT) AXIS, TROJAN POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.
2. POND WATER LEVEL RECORDED ON NOVEMBER 8, 2009 HAD A 10 m JUMP AND IS NOT PLOTTED AS IT IS ALMOST CERTAINLY A MEASUREMENT OR DATA ENTRY ERROR.

CLIENT
TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

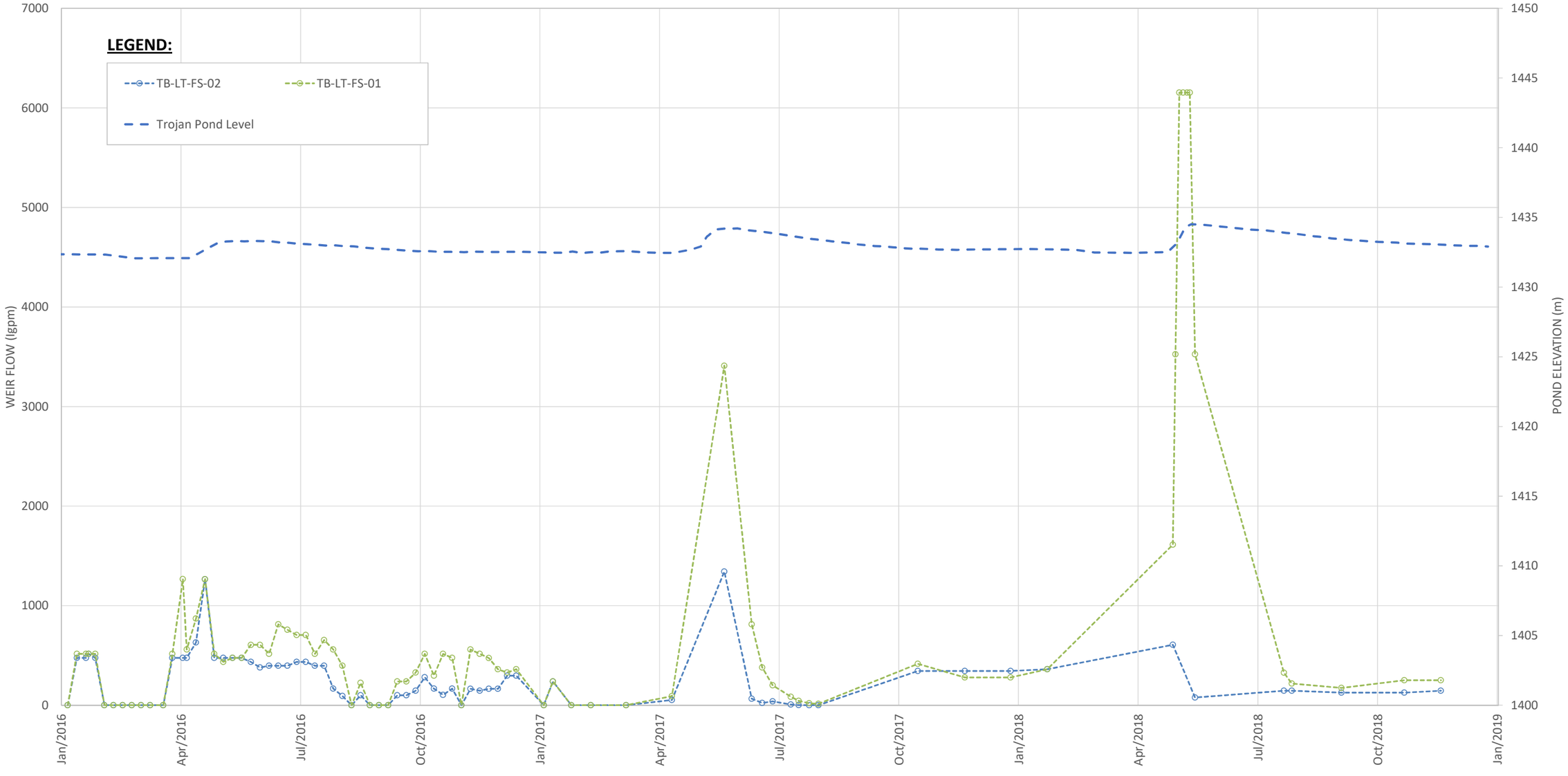
PROJECT
TROJAN TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

TITLE
TROJAN DAM
WEIR FLOWS

PROJECT No. M02341B43

FIG No. IV-6

March 22, 2019
Z:\M\VCR\M02341B43 - HVC 2018 Dam Safety Support\300 Design\Seepage Data\Trojan\[190322 Trojan Weir.xlsx]Fig. V-6 R4 Weir



March 22, 2019
Z:\M\VCR\M02341B43 - HVC 2018 Dam Safety Support\300 Design\Seepage Data\Trojan\[1903222 Trojan Weir.xlsx]Fig. V-6 R4 Weir

CLIENT
TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT
TROJAN TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

TITLE
LOWER TROJAN POND
WEIR FLOWS

PROJECT No. M02341B43

FIG No. IV-7

APPENDIX V

Map of Water Quality Monitoring Points

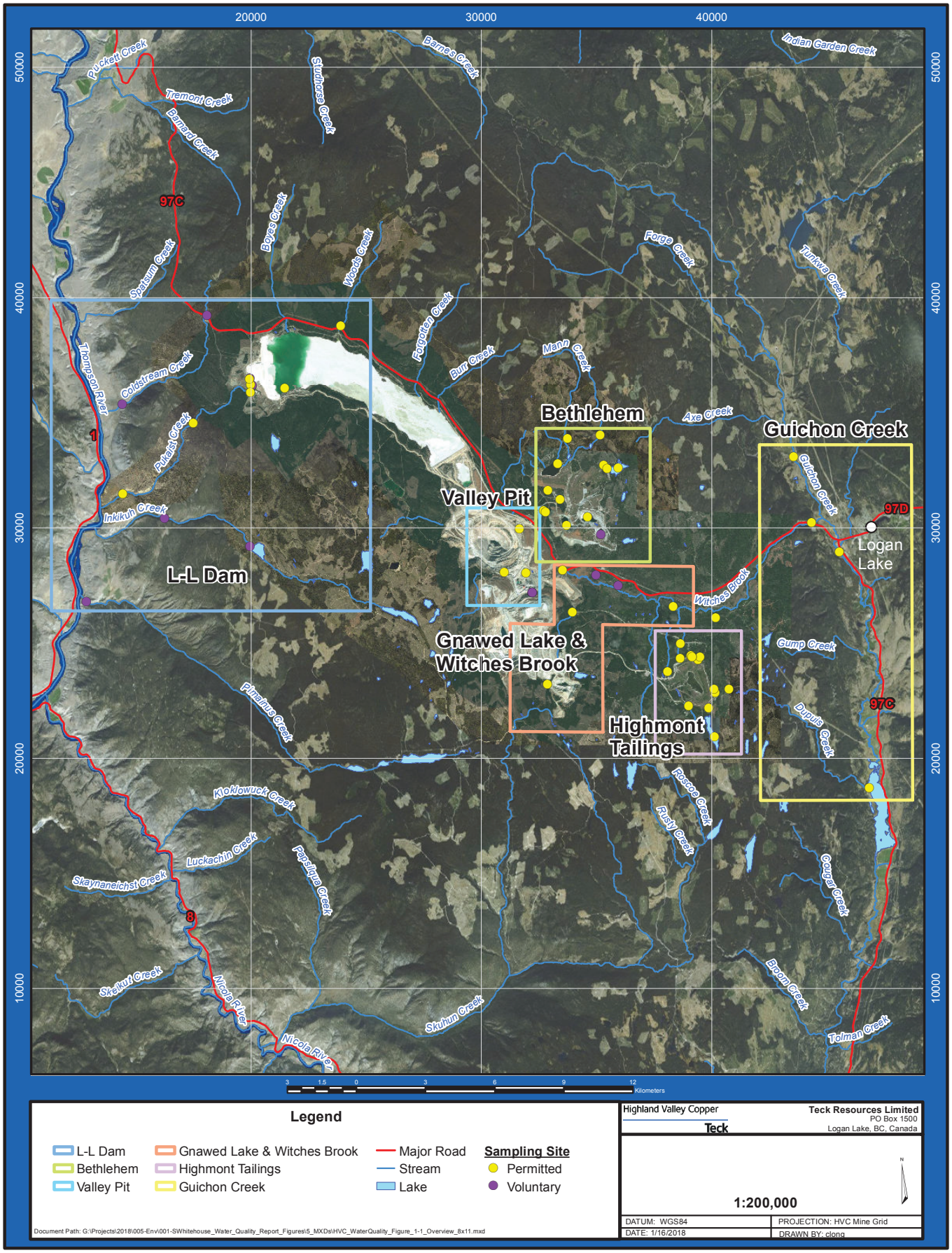


Figure E-1 Water Quality Monitoring Sites, Highland Valley Copper, 2018

Figure 3.2-17 Water Quality Monitoring Sites in the Bethlehem Area, Highland Valley Copper, 2018

Figure 3.2-26 Water Quality Monitoring Sites in the Witches Brook and Gnawed Lake Area, Highland Valley Copper, 2018