Klohn Crippen Berger

Teck Highland Valley Copper Partnership

2020 Annual Facility Performance Report

Bethlehem No.1 Tailings Storage Facility

CANADA BEST MANAGED COMPANIES Platinum member

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March 19, 2021

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

Mr. Bryan Bale, P.Eng.
Chief Engineer, Tailings

Dear Mr. Bale:

2020 Annual Facility Performance Report
Bethlehem No.1 Tailings Storage Facility

We are pleased to submit the 2020 Annual Facility Performance Report for the Bethlehem No.1 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) (MEM 2017), and Section 4.2 of the Guidance Document (MEM 2016).

Yours truly,

KLOHN CRIPPEN BERGER LTD.

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

RF/NS:cd

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2020 Annual Facility Performance Report

Bethlehem No.1 Tailings Storage Facility

EXECUTIVE SUMMARY

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Highland Valley Copper Partnership (THVCP) to complete the 2020 Annual Facility Performance Report[1] (AFPR) of the Bethlehem No.1 Tailings Storage Facility (TSF) for the period of October 2019 to September 2020. The Bethlehem No.1 TSF, located 4 km north of the operating mill, was constructed in 1963 and operated from 1964 to 1989. The Bethlehem No. 1 TSF is maintained by THVCP and considered to be in the active care closure phase as defined by the Canadian Dam Association (CDA 2019).

The review covers the following structures which comprise the Bethlehem No.1 TSF:

- Dam No. 1 – comprises a glacial till starter dam which was raised by centerline method with rockfill placed to form a downstream shell and spigotted or cycloned tailings hydraulically placed on the upstream beach. A downstream rockfill buttress was later added in the valley section. Consequence classification, as defined by CDA (2019), of "Very High."
- Bose Lake Dam – constructed of compacted glacial till with rockfill over the downstream slope for erosion protection, and a rockfill toe berm that includes a filter blanket and seepage collection system. Consequence classification of "High."
- R3 Seepage Pond Dam – located downstream from Dam No. 1, collects seepage from the Dam No. 1 underdrains. Consequence classification of "Low."

The facility has been inactive for more than 30 years and pond level has dropped during that period. During operations there were no significant dam safety incidents. Under the current configuration, the piezometric levels and gradients through the tailings and dam are lower than during operations which increase the factor of safety against slope failure and internal erosion.

The performance of Dam No. 1 and Bose Lake Dam is assessed based on the following:

- compliance with design criteria;
- comparison of actual conditions to design assumptions;
- consistency between measured response[2] and expected behaviour[3]; and
- presence or absence of potential dam safety concern indicators.

On this basis, the performance of the dams during the review period was acceptable.

Other than routine maintenance activities, as defined in the OMS manual, (e.g., clearing weirs of vegetation), there were no major repairs or construction activities completed during the review period.

During 2020, Mr. Bryan Bale, P.Eng. (THVCP Chief Engineer - Tailings), transitioned into the role of TSF Qualified Person, replacing Mr. Chris Anderson, P.Eng.

[1] Past Annual Facility Performance Reports were referred to as Dam Safety Inspections (DSI).
[2] "Measured response" refers to instrumentation readings and visual observations during inspections.
[3] "Expected behaviour" for an inactive facility is based on interpretation of the historic measured response.

The current Operation, Maintenance and Surveillance (OMS) Manual and the Emergency Preparedness and Response Plan (EPRP) (THVCP 2019) are suitable for the facility. As part of the routine update cycle both documents are being revised to align with the most recent industry guidance documents. A trial exercise of the EPRP was completed on December 9, 2020 in which THVCP and KCB representatives participated.

Due to the COVID 19 pandemic and to meet provincial health regulations THVCP implemented protocols limiting site resources. To support this change, the Engineer of Record (EoR) and THVCP agreed to modify the frequency of some routine surveillance activities which did not compromise the overall surveillance and management controls at the Bethlehem No. 1 TSF but helped ensure priority activities were maintained.

The Bethlehem No.1 TSF surveillance program is appropriate for an inactive tailings facility which includes visual inspection, measured behaviour and routine performance reviews and a Trigger-Action-Response-Plan (TARP). The TARP includes four levels which represent conditions of potentially increasing concern ranging from a routine engineering review, design assumption deviation up to initiation of the ERP. The adequacy of the instrumentation was reviewed as part of this AFPR and remains sufficient for the existing condition of the structure.

Information from routine surveillance activities was reported and reviewed once completed by THVCP during weekly dam safety meetings. This information is also shared with and reviewed by the EoR. An overall performance assessment is completed by the EoR as part of the AFPR. In addition, a routine engineering review can be triggered by the first level of the TARP in response to a localized deviation from historic behaviour.

The behaviour of the facility is expected to remain consistent with historic patterns. Variation in performance from year to year is primarily related to climate (i.e., freshet flows, water balance) or extreme events (e.g., seismic or flood), none of which occurred during the review period. Key observations from the 2020 performance review completed as part of the AFPR are:

- No issues of dam safety concern or unacceptable performance were identified.
- Pond No. 2 level was not measured during July or August. The pond level was visually checked during the July routine inspection. The absence of a pond level check in August is a minor non-conformance with the surveillance program, as August is typically the time of year when the pond level is receding from the freshet peak.
- There were no piezometric threshold exceedances at either dam and trends remained consistent with historic trends.
- A new method to survey monuments at either dam was implemented to monitor for potential movement trends. There are no downstream horizontal movement trends observed and settlement patterns for each dam remained consistent with historic behaviour.
- Visual inspections by the dam inspector, the EoR or others working in the area did not identify any indications of unacceptable behaviour at the dam.

- The reservoir levels and patterns were similar to historic trends but levels were higher during freshet compared to 2019, however, were similar in fall 2020.
- Minimum freeboard at the Bose Lake Dam during 2020 was 3 m, ~0.3 m below the invert of the spillway which is designed to pass the routed PMF with adequate freeboard.

As required by permit (PE-376), water quality downstream of the Bethlehem No.1 TSF is monitored by THVCP. Water quality monitoring data for the area is summarized and reported in 2020 Annual Water Quality Monitoring Report. A copy of the report was provided to KCB as part of the AFPR and no significant non-compliances were noted.

Refer to Table 1 for the status of outstanding recommendations from previous AFPRs, as of the issue date of this report. Recommendations that have been closed are shown in italics. Recommendations, related to facility performance, identified during the 2020 AFPR are summarized in Table 2. The deadline to complete the flood routing assessment and upgrade works were deferred to prioritize other flood routing activities at site which have a greater impact on risk reduction. Five of the recommendations from the most recent DSR (SRK 2019) have been addressed. Close out documentation for four of the recommendations are in progress as of the issue date for this report. The remaining six DSR recommendations have been scheduled for completion in 2021.

Table 1 Previous Recommendations Related to Facility Performance – Status Update

ID No.	Performance Area	Recommended Action	Priority(1)	Recommended Deadline (Status)
Bethlehem No.1 Tailings Storage Facility				
BTSF-2017-01	*Construction*	*Provide a completed summary of the construction work for the Seepage Pond 1 decommissioning project to KCB.* *Note: Summary is not available for the record but does not represent a dam safety concern.*	*4*	*Q1 2018 (Closed)*
Dam No. 1				
BTSF-2018-01	Flood Management	Update flood routing for Bethlehem No.1 TSF and R3 Seepage Pond based on the most recent site wide hydrology information for consistency and to confirm compliance.	3	Q2 2020 (Open – Revised Q4 2021)
BTSF-2019-01	*DSR*	*KCB and THVCP to develop a work plan to address 2018 DSR recommendations.*	*3*	*April 2020 (Closed)*
Bose Lake Dam and R3 Seepage Pond				
No Outstanding Previous 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.

Table 2 2020 Recommendations Related to Facility Performance

ID No.	Performance Area	Recommended Action	Priority(1)	Recommended Deadline (Status)
Bose Lake Dam				
BD-2020-01	Maintenance	Complete inspection of the downstream slope of exposed till fill (above ~El. 1440.1 m) for animal burrows and fill or obstruct them.	3	Q4 2021
Bethlehem No.1 Tailings Storage Facility, Dam No. 1 and R3 Seepage Pond				
No New Recommendations				

Notes:
1. Refer to notes for Table 1 for priority level definitions.

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1 INTRODUCTION

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Highland Valley Copper Partnership (THVCP) to complete the 2020 Annual Facility Performance Report (AFPR) of the Bethlehem No.1 Tailings Storage Facility (TSF) on the Highland Valley Copper (HVC) mine site. The Bethlehem No.1 TSF is an inactive facility constructed in 1963 and operated between 1964 and 1989. This AFPR includes the Bethlehem No.1 TSF retaining dams, Bethlehem Dam No. 1 (Dam No. 1) and Bose Lake Dam, as well as the R3 Seepage Pond for the review period from October 2019 through September 2020. Table 1.1 summarizes the dams' functions and consequence classes (CDA 2019). Refer to Figure 1 and Figure 2 for a layout of the facility.

Table 1.1 Bethlehem No. 1 TSF Structures

Facility	Structure	Function	Consequence Class[1]
Bethlehem No. 1 TSF	Dam No. 1	Retains tailings at western boundary of impoundment.	Very High
	Bose Lake Dam	Retains tailings at eastern boundary of impoundment.	Very High
	R3 Seepage Pond Dam	Retains R3 Seepage Pond, which stores seepage from Bethlehem No.1 TSF.	Low

Notes:
1. Consequence classes are based on Canadian Dam Association guidelines (CDA 2019).

The Bethlehem No.1 TSF has been reclaimed and THVCP continues ongoing management of the facility including instrumentation monitoring, environmental sampling, visual inspections and maintenance activities. Under this level of site presence, the Bethlehem No.1 TSF is considered to be in the active care closure phase as defined by the Canadian Dam Association (CDA) Mining Dam Technical Bulletin (CDA 2019).

The AFPR scope of work consisted of:

- visual inspection of the physical conditions of the various containment facilities;
- review of surveillance data for the review period provided by THVCP;
- review of climate and water balance data for the site;
- review of the Operations, Maintenance & Surveillance (OMS) manual to confirm it is appropriate for the existing facility; and
- review of additional activities completed at the site during the review period, if any.

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 (MEM 2017), herein referred to as the Code, and Section 4.2 of the Code Guidance Document (MEM 2016).

The visual inspection was completed by KCB representatives Mr. Rick Friedel, P.Eng. and Ms. Narges Solgi, EIT on July 15, 2020. During the inspection, the weather was sunny and did not impede the inspection. Designated roles related to tailings management, required under Part 10 of the Code, for the Bethlehem No.1 TSF at the end of the review period were filled by:

- Engineer or Record (EoR) - Mr. Friedel, P.Eng. (representative of KCB); and
- TSF Qualified Person - Mr. Bryan Bale, P. Eng. (THVCP Tailings Chief Engineer):
  - Mr. Bale, P.Eng. transitioned into the TSF Qualified Person role in September 2020, replacing Mr. Chris Anderson, P.Eng.

The Bethlehem Mine was operated under Permit M11 issued by the Ministry of Energy, Mines and Petroleum Resources (EMPR) in January 1970 and reclamation work was carried out under Permit M55 issued on October 27, 1989. In July 1998, the mining permits for the Highmont Mine, the Lornex Mine, and the Bethlehem Mine were amalgamated under M11 Permit (EMPR 2019).

In addition, the Bethlehem No.1 TSF is maintained under the following permits:

- British Columbia Ministry of Environment (MOE) Water Licences C114183 and C068389:
  - Conditional Water License 114183 authorizes the use of waters in Heustis, Jersey, and Iona (Pit) Lakes for fish culture.
  - Conditional Water License C131299 grants the rights to water use from Trojan (Northlodge) Mann, Nicholson, Michael, Ford, and Oram Creeks for use in mining and land improvement.
- British Columbia MOE Effluent Permit PE-376 – this permit contains discharge conditions and locations of permitted discharge of surface water to the environment, including: Bethlehem area; Bose Lake Saddle Dam Seepage (active) which flows into Bose Lake; Trojan Creek at End of the Trojan Diversion (active), which flows into Witches Brook.

2 FACILITY DESCRIPTION

The HVC mine site is located near Logan Lake, approximately 45 km south of Kamloops, in the interior of British Columbia. The Bethlehem No.1 TSF is located 4 km northeast of the operating mill and immediately east of the Trojan TSF; refer to Figure 1 and Figure 2. The facility was operated from 1963 to 1989 and stores an estimated 68 Mm^3 of tailings.

Dam No. 1 (Figure 3) retains tailings at the western boundary of the impoundment and Bose Lake Dam (Figure 4) retains tailings at its eastern boundary. The R3 Seepage Pond (Figure 5) is located approximately 200 m downstream of Dam No. 1. Bose Lake is a natural lake approximately 60 m downstream of the Bose Lake Dam toe. There are two free water ponds in the Bethlehem No.1 TSF that have formed in low points of the tailings surface and are present year-round (Figure 2): Pond No. 1 located centrally in the TSF; and Pond No. 2 located close to the Bose Lake Dam. Typical geometry and dimensions of the dams are summarized in Table 2.1. Figure 2.1, Figure 2.2, and Figure 2.3 show typical cross sections of Dam No.1, Bose Lake Dam and R3 Seepage Pond.

Bethlehem Dam No. 1

- Dam No. 1 comprises a glacial till starter dam (up to 20 m high), built in 1963. The dam foundation generally comprises competent glacial overburden up to 24 m thick overlying bedrock.
- The dam was raised by centreline method with mine waste (i.e. rockfill) placed to form a downstream shell that supports an upstream beach of spigotted or cycloned tailings. A rockfill toe buttress was added to the Dam No. 1 design in 1970 (Golder Brawner 1970).
- The design relies on the wide tailings beach, minimum of 122 m, between the tailings pond and dam rockfill. Under existing conditions, the minimum typical beach width is more than 800 m.
- Seepage from the underdrain system reports to R3 Seepage Pond. Prior to 2016, some of the flow which reports to R3 Seepage Pond was routed through Seepage Pond 1 before the retaining berm in Seepage Pond 1 was breached and replaced by a weir in 2016. This did not change the catchment or underdrain flow reporting to R3 Seepage Pond and eliminated potential failure modes related to the Seepage Pond 1 retaining embankment:
  - THVCP do not have a summary record of the Seepage Pond 1 decommissioning activities, completed in 2016, which had been requested by KCB (DSI recommendation BTSF-2017-01). As this facility is not longer functional, the absence of this for the record does not represent a concern. Maintaining records of all construction activities at a tailings facility is part of THVCP's current governance requirements.

Bose Lake Dam

- The dam is constructed of compacted glacial till with rockfill over a portion of the downstream slope for erosion protection, and a rockfill toe berm that includes a filter blanket and seepage collection system which drains, by gravity, to a pump well at the low point along the downstream toe.

- Concrete manholes along the downstream toe allow access to observe and sample seepage flow in the collection system.
- The dam was built in four stages, the first of which was done in 1972. The final stage was completed in 1981 (KC 1994).
- In 1995, a permanent open channel spillway (invert of inlet at El. 1469.3 m) for the Bethlehem TSF was constructed at the left abutment of Bose Lake Dam (KC 2002). The channel extends to the public access road at the toe of the dam, where it is diverted through two culverts (1 x 1380 mm dia., 1 x 600 mm dia.) and discharges into Bose Lake.

R3 Seepage Pond

- The pond is located approximately 170 m downstream of the Dam No.1. A dam retains the R3 reservoir along the west side.
- A spillway channel is constructed at the right (north) abutment and discharges flow to Lower Trojan Dam downstream of the dam toe. Water is typically discharged to Lower Trojan Dam via a buried pipeline at the left abutment, but flows can also be diverted to the Highland Mill.

Table 2.1 Summary of Approximate Dam Geometry

Dam	Construction Method	Nominal Crest Elevation (m)	Max. Dam Height (m)	Crest Length (m)	Min. Crest Width (m)	Upstream Slope	Overall Downstream Slope
TAILINGS DAMS							
Dam No. 1	Modified Centreline	1477 (top of sand fill) 1472 (top of rockfill)	91	2000	25	N/A	3H:1V (from sandfill crest) 2.2H:1V (from rockfill crest)
Bose Lake Dam	Saddle Dam Downstream	1475	31	600	9	2H:1V	2H:1V
SEEPAGE COLLECTION DAM							
R3 Seepage Pond	Unknown (believed single raise)	1371	2.6	60	6	N/A	2.3H:1V

Notes:
1. Dimensions are estimated from 2014 LiDAR data unless otherwise noted.
2. Height measured as the vertical distance between downstream toe and crest.

Figure 2.1 Typical Cross Section of Dam No. 1 (KC 1996)

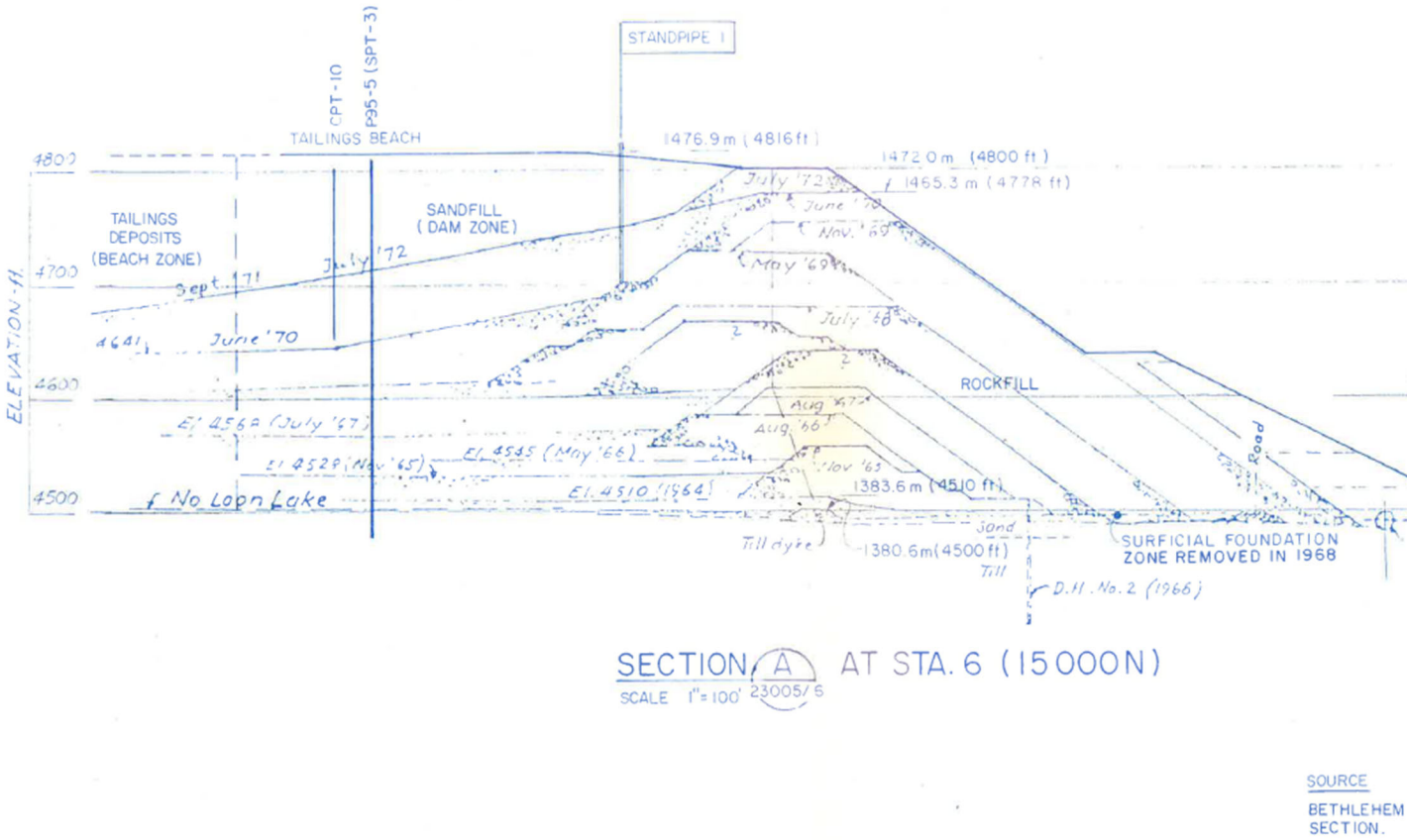


Figure 2.2 Typical Cross Section of Bose Lake Dam (Gepac 1972)

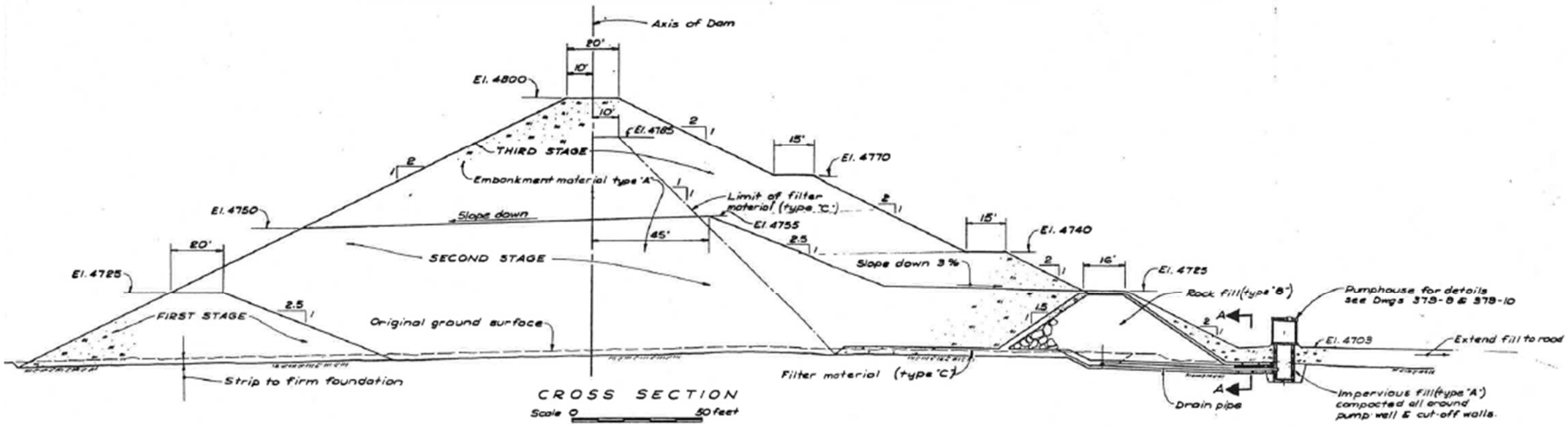
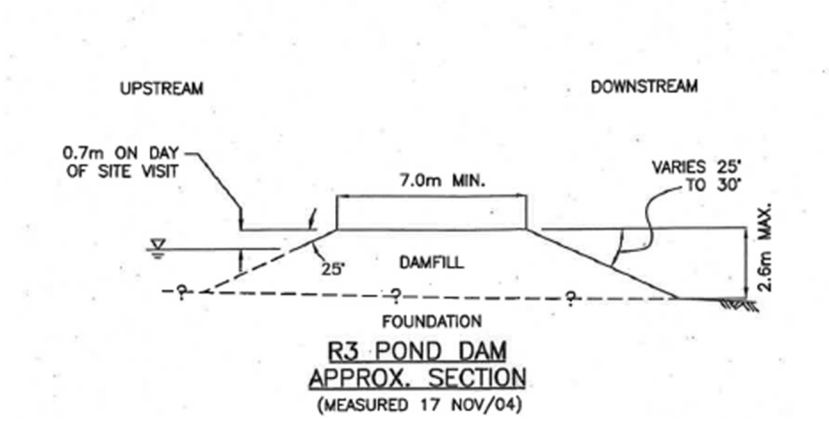


Figure 2.3 Typical Cross Section of R3 Seepage Pond Dam (KC 2005)



3 2020 ACTIVITIES

Other than routine maintenance activities, as defined in the OMS manual, (e.g., clearing weirs of vegetation), there were no major repairs or construction activities completed during 2020.

4 WATER MANAGEMENT

4.1 Overview

The flow schematic for the Bethlehem No.1 TSF and nearby Trojan TSF is shown in Figure 6.

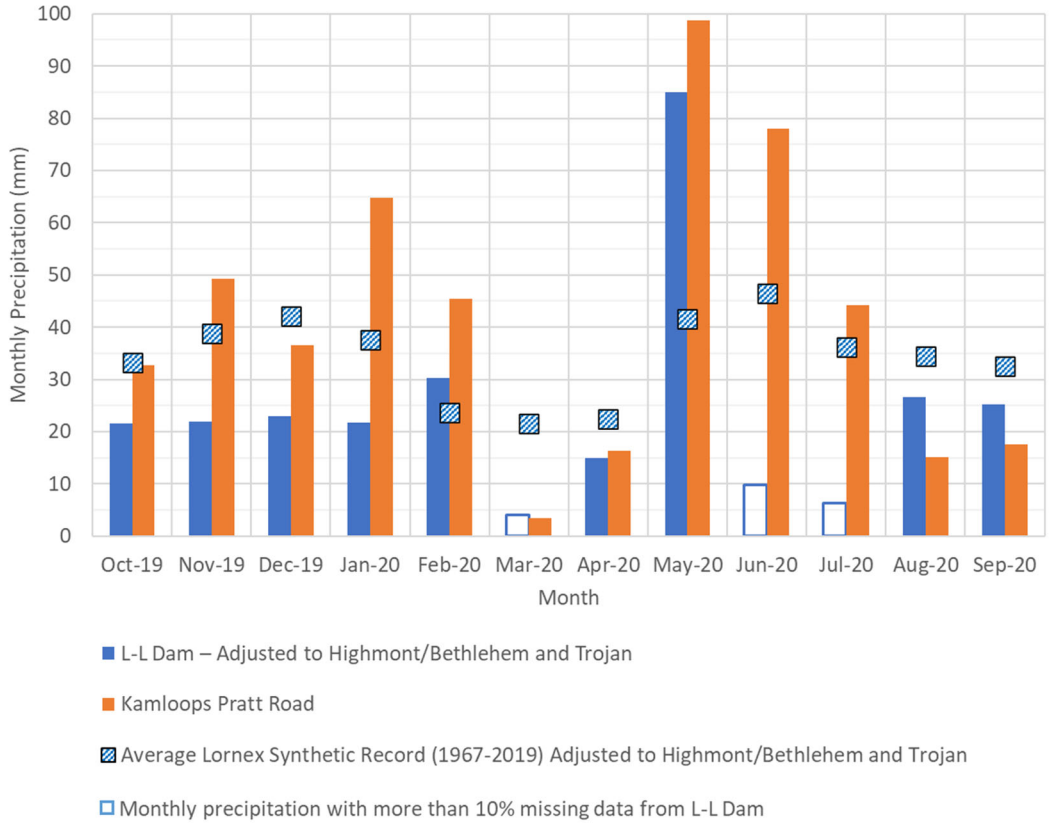
4.2 Climate

THVCP provided climate data from L-L Dam and Kamloops Pratt Road stations for 2020 AFPR reporting period to KCB for review. KCB applied the appropriate corrections to L-L Dam Weather Station data and Historical Average Lornex Synthetic Record, based on HVC site wide hydrology document (Golder 2019), and compared the climate data to typical values, refer to Appendix II-A.

The following observations were noted for the reporting period (refer to Figure 4.1):

- More than 10% of the L-L Dam weather station precipitation data were missing in March, June, and July. Due to these data gaps, the 2020 climate data from site was augmented with data from a regional weather station to support a comparison with historic normals.
- All storm events during 2020 were less than the 10-year return period rainfall event (40 mm in 24 hours). The largest 24-hour rainfall events measured at the L-L Dam Weather Station during the review period, were: 23.1 mm on May 30; 18.2 mm on May 17; and 12.9 mm on September 19.
- January through April precipitation was significantly less than historic normals except the precipitation in February which was higher than average.
- May precipitation was almost twice as much as the historic normals.
- Figure 4.1 indicates low precipitation at site during June and July; however, this is due to L-L Dam Weather Station data gaps during this period. THVCP inspection reports and regional climate station data indicate precipitation during this period was above historic normals.
- Snowpack depth measurements, from the Highland Valley station, indicate the snow had been melted by May 1, 2020.
- Seasonal rise and fall of pond levels is associated with freshet. The time of year when pond levels start to fall is associated with the end of freshet, in recent years this has started in April or May (Table 5.2 and Figure 5.2). In 2020, pond levels did not start to fall until mid to late June. This timing indicates that the 2020 response was driven primarily by precipitation, rather than snowmelt.

Figure 4.1 Monthly Precipitation



4.3 Water Balance

THVCP manages and tracks the annual water balance for the Bethlehem No.1 TSF. Table 4.1 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 4.1 Annual Water Balance for Bethlehem No.1 TSF

Item	Volume in 2020[1] (m^3)
Inflows	
Direct precipitation	34,000
Runoff	436,700
Total inflow:	470,700
Outflows	
Seepage	466,300
Evaporation	62,100
Total outflow:	528,400
Balance	
Balance (inflow minus outflow)	-57,700

Notes:
1. Values received from THVCP have been rounded to the closest 100 m^3.

4.4 Flood Management

The flood management structures at Bethlehem No.1 TSF are designed for storm events with return periods greater than the minimum required by the Code and thus exceeding IDF requirements, as summarized in Table 4.2.

Bethlehem No.1 TSF and R3 Seepage Pond flood routing updates are scheduled for 2021. These were recommended by KCB (2019a) and SRK (2019) so that all facilities were based on the most recent hydrology. In 2020, THVCP reviewed the outstanding activities required for the tailings and water storage facilities at the site and prioritized them to suit available resources and expected timelines. Based on this review the flood routing work at Bethlehem No. 1 TSF was deferred from 2020 to 2021. KCB agreed the deferral is the preferred approach in terms of prioritizing available resources because the Bethlehem No.1 TSF facilities have spillways and currently meet flood criteria.

Table 4.2 Inflow Design Flood for Bethlehem No.1 TSF and Seepage Pond

Dam	Outfall Type	Consequence Classification	Inflow Design Flood		Peak Design Flood El.	Spillway Design Reference
			Required[1,2]	Design Event		
Dam No. 1	Open channel spillway (near Bose Lake Dam left abutment)	Very High	2/3 between 1000-year and PMF	24-hour PMF (182.2 mm, 13.7 m^3/s)	1471.5 m	(AMEC 2014b)
Bose Lake Dam		High	1/3 between 1000-year and PMF			
R3 Seepage Pond Dam	Open channel	Low	100-year	100-year 24-hour[3] (54.3 mm, 0.16 m^3/s)	1371.2 m	(AMEC 2013)

Notes:
1. Per the Code (MEM 2017) for tailings and water retaining facilities.
2. The return period for the Bethlehem No.1 TSF IDF is governed by the highest consequence dam (Dam No. 1).
3. Code requires for a "Low" consequence dam that the spillway be able to route an IDF equivalent to the 100-year event rather than the PMF. IDF values are presented in the table.

4.5 Freeboard

Bose Lake Dam and R3 Seepage Pond design and operating conditions meet freeboard requirements as shown in Table 4.3 which summarizes minimum flood freeboard required, as per the Code, and minimum freeboard based on flood routing.

Where available, the minimum freeboards measured during the review period based on monitoring records are also listed in Table 4.3 and discussed further in Section 5.2. Other observations regarding freeboard:

- Seasonal rise and fall of pond levels is associated with freshet. The time of year when pond levels start to fall is associated with the end of freshet, in recent years this has started in April or May.
- Overtopping of the Dam No. 1 crest is not plausible because the Bose Lake Dam crest is 2 m lower (Table 2.1) and therefore, freeboard criteria is not applicable.

- The minimum required freeboard under normal (i.e. non-flood) conditions will be defined as part of the flood routing works scheduled for 2021 which were recommended by SRK (2019). Documenting normal freeboard requirements is considered a due diligence activity because the large freeboard (>6 m) available at Bose Lake Dam under the existing condition will be greater than the expected requirement.

Table 4.3 Freeboard for Bethlehem No.1 TSF and Seepage Pond

Dam	Freeboard (m)		
	Required During IDF[1]	Predicted During Peak Design Flood Level	Minimum Observed During the Review Period[6]
Bose Lake Dam	0.5 m[2]	3.5 m [4]	6.0 m
R3 Seepage Pond Dam	0.5 m[3]	0.6 m [5]	1.6 m

Notes:
1. As per the Code, refers to minimum vertical distance between dam crest and peak IDF level.
2. Calculated based on wave run-up using the method proposed by CDA (2013), as per the Code.
3. Freeboard target of 0.5 m has been adopted by THVCP which is greater than the minimum required freeboard to accommodate wave run-up (0.35 m) as per the method proposed by CDA (2013).
4. As per AMEC (2014b) based on KC (1994) spillway design flood (PMF), which is greater than the IDF for "High" consequence classification facility (1/3 between 1:1000 year and PMF) required by the Code.
5. As per KCB (2019b), freeboard reported is during the IDF.
6. Based on maximum recorded pond elevation during the review period.

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 2019 (THVCP 2019). As part of the routine update cycle the OMS Manual is being revised to align with the most recent industry guidance documents (MAC 2019). The update to the OMS Manual will include the recommended items from the DSR (SRK 2019).

Surveillance activities were completed as prescribed in the OMS manual or as agreed with the EoR (Table 5.1), with one exception discussed below. Starting in March 2020, THVCP were required to implement protocols to meet provincial health regulations related to reducing the spread of the COVID 19 pandemic. This included reducing the number of people on site to essential personnel only. Prior to reducing site personnel at the dams, THVCP requested KCB review the Bethlehem No.1 TSF surveillance program to identify site activities which could be completed at a reduced frequency, that would allow THVCP to reduce site personnel, but not compromise the overall surveillance controls at the facility. The modified frequency recommended by KCB is summarized in Table 5.1 and remain appropriate during 2021 while site personnel restrictions remain in place.

The Bethlehem TSF surveillance program is appropriate for an inactive, reclaimed tailings facility which includes visual inspection, measured behaviour, routine performance reviews, and a Trigger-Action-Response-Plan (TARP). The TARP includes four levels which represent conditions of potentially increasing concern ranging from a routine engineering review, design assumption deviation up to initiation of the ERP. At the Bethlehem TSF, there were no exceedances of any level of the TARP levels during the review period. Instrumentation triggers, which notify THVCP if a TARP level has been exceeded, were reviewed and updated by the EoR, where appropriate, as part of this AFPR.

Information from routine surveillance activities was reported and reviewed once completed by the THVCP Tailings Group, including the QP, during the weekly intra-departmental meeting. This information is also shared with and reviewed by the EoR. An assessment of performance is completed by the EoR as part of the AFPR based on the following:

- compliance with design criteria;
- comparison of actual conditions to design assumptions;
- consistency between measured response[4] and expected behaviour[5]; and
- presence or absence of potential dam safety concern indicators.

On this basis, the performance of the dams during the review period was acceptable.

[4] “Measured response” refers to instrumentation readings and visual observations during inspections.
[5] “Expected behaviour” for an inactive facility is based on interpretation of the historic measured response.

Pond No. 2 level was not measured during July or August. The pond level was visually checked during the July routine inspection. The absence of a pond level measurement in August is a minor non-conformance with the surveillance program as this is typically the time of year when the pond level is receding from the freshet peak (Figure 5.2) and the pond level during the freshet peak was still 0.3 m below the invert of the spillway, which manages flood routing risks.

The site visit for the most recent dam safety review (DSR) (SRK 2019) was completed in 2018. The Code requires a DSR be undertaken every five years for tailings dams; therefore, the next DSR should be scheduled for 2023. The status of recommendations from the most recent DSR (SRK 2019) are discussed further in Section 7.2.

Table 5.1 Monitoring Activities

TSF Monitoring	Facility	Minimum Frequency[1]	Responsible Party	Documentation	2020 Frequency Compliance[1]	Notes for the Review Period
Inspections						
Routine Visual Inspection[3]	Dam No.1 and Bose Lake Dam	Every 2 Months	THVCP	THVCP Inspection Report	Yes	-
	R3 Seepage Pond	Quarterly	THVCP	THVCP Inspection Report	Yes	-
Event-Driven Inspection	All	Event Driven[2]	THVCP	THVCP Inspection Report	N/A	No event-driven inspections were triggered during 2020.
Facility Performance Report	All	Annually	KCB	KCB Inspection Report	Yes	This report.
Dam Safety Review	All	Every 5 years	THVCP	Report	n/a	Next DSR is due in 2023.
Instrumentation Monitoring						
Piezometers	Dam No. 1 and Bose Lake Dam	Quarterly (excluding impoundment)	THVCP	Annual Facility Performance Report	Yes	KCB recommended impoundment be measured if resources allow but priority should be given to instruments nearer to the dams
Inclinometers	Dam No. 1	Quarterly	THVCP		Yes	Readings were taken monthly when the instrument was accessible.
Seepage flow instruments	R3 Seepage Pond	Quarterly	THVCP	THVCP Inspection Reports	Yes	-
Pond level	Pond No. 1	Every 2 Months[4]	THVCP		Yes	-
	Pond No. 2	Monthly[4]	THVCP		No	Pond level was not measured or visually inspected during August, refer to discussion in Section 5.1
Surveys						
Dam Crest	Dam No. 1 and Bose Lake Dam	Annually	THVCP	Annual Facility Performance Report	Yes	-
Survey monuments		Annually	THVCP		Yes	

Notes:
1. Frequency of routine surveillance activities were modified in 2020 related to site resources restrictions required to meet COVID 19 provincial health regulations, as discussed in Section 5.1.
2. THVCP staff are to complete an event-driven inspection in response to one of the following events:
   - 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; 39.9 mm (Golder 2020).
3. Visual inspections include pond level measurements and observations of unusual condition and/or dam safety concerns (e.g. settlement, sinkholes, slope sloughing, erosion, piping, etc.)
4. When accessible.

5.2 Pond Level

The Pond No. 1 and Pond No. 2 levels are measured and also visually checked during routine inspections for any unusual condition. Pond No. 1 and Pond No. 2 level observations during the review period are as follows:

Pond No.1:

- In general, 2020 levels were higher during freshet compared to 2019 levels, but the seasonal variations of pond rise and fall were consistent with historic observations which show no long-term trend of increasing pond volume (Figure 5.1 and Table 5.2).

Pond No.2:

- 2020 levels were the highest during freshet on the record dating back to 2015 (Figure 5.2 and Table 5.3). Since 2016, there has been a trend in rising pond levels (peak and end of year) which is associated with recent above average freshet events, most notably 2017. This trend is expected to reverse during drier periods as seepage and evaporation capacity exceeds inflows. Based on topography the volume of water which accumulated in the pond during 2020 was small (<5,000 m^3). The overall water balance for the facility (Section 4.3) indicates a water deficit during 2020 which does not agree with pond levels. This is not a dam safety concern but an observation for THVCP to consider in future water balance calibrations.
- There was no discharge through Bethlehem TSF spillway during 2020. The facility maintained adequate freeboard throughout the review period. Minimum freeboard exceeded requirements as discussed in Section 4.5.

Table 5.2 Change in Pond No.1 Water Elevations

Annual Change	Change in Pond Level 2019 to 2020	Range of Annual Pond Level Change 2015 to 2019
Peak Pond	0.3 m	-0.7 m to 0.3 m (avg. -0.1 m)
Pond at End of Review Period (1)	0.0 m	-0.1 m to 0.3 m (avg. 0.1 m)

Notes:
1. End of review periods, between 2015 and 2020, varied between September and November.

Table 5.3 Change in Pond No.2 Water Elevations

Annual Change	Change in Pond Level 2019 to 2020	Range of Annual Pond Level Change 2015 to 2019
Peak Pond	0.2 m	0.2 m to 0.7 m (avg. 0.3 m)
Pond at End of Review Period (1)	0.0 m	0.0 m to 0.7 m (avg. 0.4 m)

Notes:
1. End of review periods, between 2015 and 2020, varied between September and November.

Figure 5.1 Pond No.1 Water Elevations – 2015 to 2020

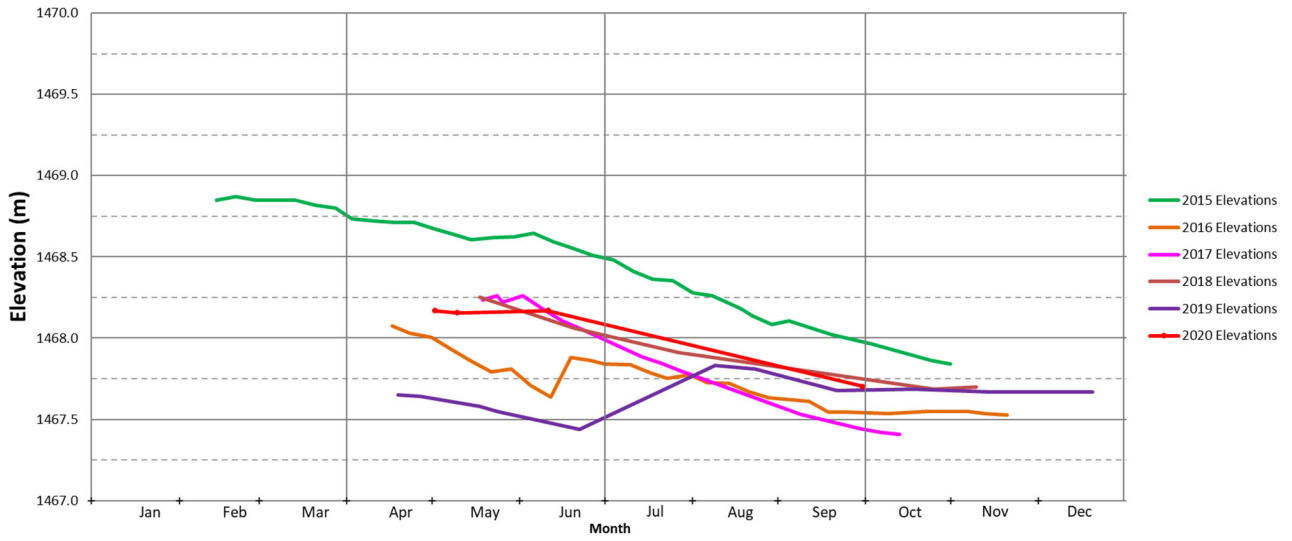
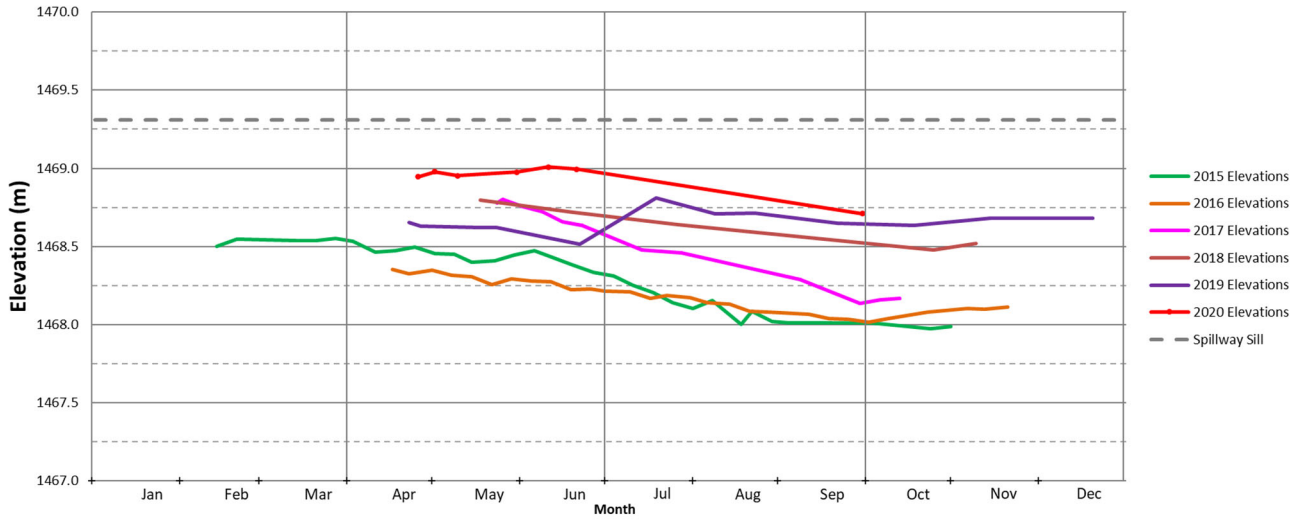


Figure 5.2 Pond No.2 Water Elevations – 2015 to 2020



5.3 Piezometers

The current suite of instruments is considered sufficient for the Bethlehem No.1 TSF, piezometric readings measured during 2020 for each dam are discussed below. Piezometers in the impoundment were not measured during 2020 as reduced site resources prioritized reading of instruments nearer to the dams, as discussed in Section 5.3. THVCP plan to collect four readings of the impoundment piezometers during 2021.

Dam No. 1

As of the end of September 2020, there are 34 piezometers being monitored at Dam No. 1 (Figure 3). Maximum and minimum piezometric levels, since 2013, instrument thresholds, as well as piezometric levels during the review period are reported in Appendix II-B. Piezometer readings collected since 2013 from instruments which are no longer functional are also shown on the summary plots included in Appendix II-B.

Piezometric readings at Dam No. 1 are plotted, with the Pond No. 1 level, on Figure II-B-1 to Figure II-B-3. A summary of key observations is as follows:

- There were no piezometric threshold exceedances during the review period.
- Dam No.1 Crest Area Piezometers: P13-5 continues to be the only piezometer near the dam crest which measures a piezometric head and the level was relatively constant through 2020, consistent with recent behaviour. The other piezometers in the area are installed at higher elevations (~El. 1440 m to 1460 m), above the interpreted existing piezometric surface.
- Dam No.1 Downstream Slope Area Piezometers: levels are consistent with previous years and continue to indicate a downward gradient towards the foundation. VWP16-1B water levels started rising but the pore pressures remain negative, indicating the piezometer is above water table or not fully saturated.

Bose Lake Dam

There are 11 operational piezometers at or near Bose Lake (Figure 4). Maximum and minimum piezometric levels, and instruments thresholds are provided in Appendix II-B. Piezometric readings at Bose Lake Dam are plotted, with the Pond No. 2 level, on Figure II-B-7 to Figure II-B-9. A summary of key observations is as follows:

- There were no piezometric threshold exceedances during the review period.
- Bose Lake Crest Area Piezometers: include three nested instruments installed in the dam fill and foundation. General rise in piezometric level (<1 m) since 2017, which is consistent with Pond No.2 level rise during that period. Instruments continue to suggest an upward gradient from the foundation (bedrock) into the dam fill. The rate of rise is also slightly greater in the foundation piezometers than in the fill piezometers, indicating the foundation piezometers are more greatly influenced by change in pond level.
- Bose Lake Toe Area Piezometers: Water levels at Standpipe No. 2 are now equal to those at Standpipe No. 1. In previous years, No. 2 was consistently ~0.2 m less than No. 1. This change is not significant to overall behaviour and piezometric levels have been relatively level for the existing condition of the dam.

5.4 Survey Monuments

The location of survey monuments at Dam No. 1 and Bose Lake Dam are shown on Figure 3 and Figure 4, respectively. Starting in November 2019 THVCP changed the method used to survey the displacement monuments on the TSF. Previously monuments were surveyed using a ground based total station with digital level and have changed to a GPS Real Time Kinematic (RTK) survey. Based on the survey data collected to date, the RTK method is suitable to monitor displacement. In comparison to the total station method, the 2020 RTK surveys show less variance (i.e. error) in the horizontal plane but increased variance in elevation.

Survey results using the RTK method are shown on Figure II-B-4 and Figure II-B-10. The baseline location for each monument using the RTK method is offset from the total station surveys. However, subsequent readings show this is related to the change in survey and not a movement trend. The horizontal surveys are plotted for the RTK method only, based on the new baseline location. However, KCB maintained a continuous record of settlement based on incremental change between RTK surveys.

During 2020, there were no threshold value exceedances and the surveys indicate dams are performing as expected and consistent with recent behaviour:

- Both Dams: No downstream horizontal movement trends;
- Dam No. 1: ongoing settlement (~4 mm/yr) related to compressible foundations and settling of downstream rockfill; and
- Bose Lake Dam: limited ongoing settlement as fill was compacted and a thinner, less compressible, glacial overburden is overlying bedrock, relative to Dam No. 1.

5.5 Inclinometers

One inclinometer (IB16-1) is installed in the downstream slope of Dam No. 1 (Figure 3). There are no significant movements and no discrete zones of movement observed in the downstream direction to date, including through the soft deposits (El. 1300 m to 1360 m) that are present in the foundation in the base of the natural valley (Section 2). This is consistent with measurements since the instrument was installed in 2016. Cumulative displacements are plotted on Figure II-B-5.

Based on measurements to date, a movement threshold was established (1 mm/month over any 3 m vertical section) to identify changes from typical behaviour that require review to confirm readings and assess response. This threshold was not exceeded along the inclinometer length based on the 2020 readings.

5.6 Seepage

Seepage is estimated based on inflow into R3 Seepage Pond measured at the weir installed at the outflow from the decommissioned Seepage Pond 1 (TB-R3-FS-01). During the review period, flow was measured/estimated monthly from October 2019 to May 2020 (Figure II-B-6) and flow rates were similar to recent years. Missing months are due to reduced site resources during COVID 19 as discussed in Section 5.1.

5.7 Water Quality

As required by permit (PE-376), water quality downstream of the Bethlehem No.1 TSF is monitored by THVCP. A summary of data to be included in the 2020 Annual Water Quality Monitoring Report was provided to KCB by THVCP for review as part of the AFPR. Select observations and findings from the monitoring data are summarized as follows:

- There are thirteen permitted surface water quality monitoring sites in the Trojan/Bethlehem area, as shown on the site monitoring plan in Appendix III.
- All sampling sites were in compliance with the permit levels, required sampling frequencies and parameters except for:
  - There were no dissolved organic carbon (DOC) data for HVC Site 220 in August. In addition, HVC sites 801, 802, and 805 were missing in situ pH measurements in September, June, and June.

The 2020 monitoring results were screened against applicable BC Water Quality Guidelines (WQG). Further discussion on specific WQG exceedances and water quality trends observed during 2020 are separately reported in the 2020 Annual Water Quality Monitoring Report which is submitted by THVCP to Ministry of Environment and EMPR.

6 INSPECTION OBSERVATIONS AND PHOTOGRAPHS

Copies of the field inspection forms, photographs and summary observations made during the AFPR site visit are included in Appendix I. No issue in terms of dam safety was observed. A summary of general observations and comments from the 2020 AFPR site visit is as follows:

- The lock-block barrier which had partially obstructed the R3 Seepage Pond spillway inlet was in place during the inspection but later removed as recommended by KCB and SRK (2019).
- Bose Lake Dam vegetation clearing (routine maintenance) is required of spillway inlet, approach channel and initial segment of riprap channel. THVCP have scheduled the clearing work for spring of 2021.
- Bose Lake Dam: multiple animal burrows observed along downstream slope near left abutment in the upper till section of the dam (above El. 1454 m, refer to Table 2.1). KCB recommend THVCP complete an inspection of the downstream slope of exposed till fill (above ~El. 1440.1 m) for animal burrows and, if present, fill or obstruct them before the end of 2021. The downstream slope of upper till is the closest (horizontal width) to the upstream face of the dam so openings have the greatest potential to act as preferential seepage pathways for pond water during routine or flood conditions.
- The downstream slope of Dam No. 1 is not showing signs of ongoing erosion or observations of concern. Existing erosion features typically have vegetation growth along the base indicating ongoing erosion rate, if any, is slow. Observations of erosion and shallow slumping of the downstream slope are local shallow features restricted to the waste rock slope and does not extend to the dam crest (Photo I-A-5).
- The sinkhole on the tailings beach, more than 340 m upstream of the Dam No. 1 crest, remains similar to 2019 observations. The feature first appeared in 1993 and was reviewed by the designers during operations (most recently in 1997). The designers concluded this is a potential safety hazard for people in the area but not a risk or concern for dam safety.

7 ASSESSMENT OF DAM SAFETY

7.1 Dam Classification Review

Based on the 2013 DSR (AMEC 2014a) a "Very High" consequence classification, as defined by CDA (2013), was recommended for Dam No. 1 and a "High" consequence classification was recommended for Bose Lake Dam. The R3 Seepage Pond was assigned a "Low" consequence classification as defined by CDA (2013). The dam consequence classifications were last reviewed by KCB and THVCP representatives during a workshop held on February 12, 2020 and remained unchanged.

7.2 Status of 2018 Dam Safety Review Recommendations

A DSR of the Bethlehem No.1 TSF was started in 2018 by SRK Consulting (SRK) with the final report issued in March 2019 (SRK 2019) which concluded the facility is well-managed with a high level of technical stewardship and appropriate operating procedures. The credible failure modes are understood and effectively controlled.

The DSR included 11 recommendations related to the Bethlehem No.1 TSF. All of the recommendations were assigned a Priority Level[6] of 3 or 4 which represent issues that should be resolved to meet compliance requirements or best practice but alone do not represent a dam safety concern.

In 2020, THVCP and KCB developed a workplan to address the DSR recommendations (Appendix IV). Five of the recommendations have been addressed, close out documentation for four of the recommendations are in progress as of the date or report issue. The remaining six recommendations have been scheduled for completion in 2021.

7.3 Failure Mode Review

KCB understands that Teck's long-term goal for all tailings facilities is to reach landform status with all potential failure modes that could result in catastrophic release of tailings and/or water being reduced to non-credible. The long-term goal for the Bethlehem No.1 TSF is for all potential failure modes to be non-credible based on Extreme consequence loading conditions. Evaluation of failure modes with respect to this goal is ongoing.

Management and status of failure modes, and related controls, which have the greatest influence on design and performance are summarized herein. All potential failure modes are reviewed and characterized in the facility risk assessment (AMEC 2019) which remains appropriate for the current structure

[6] Refer to Table 8.1 for summary of Priority Levels.

Dam No. 1

- Slope Stability:
  - The existing condition of the dam meets design FOS criteria for global slip surfaces which would result in an uncontrolled release of tailings under static ($\geq$ 1.5) and post-earthquake ($\geq$ 1.2) loading (KCB 2020a). The key design controls related to dam stability are the downstream rockfill shell and toe buttress as well as a low piezometric level in the upstream cycloned sand beach which is supported by piezometer readings. Under the current configuration, the piezometric levels and gradients through the tailings and dam are lower than during operations, which increase the factor of safety against slope failure.
  - The slope stability review (KCB 2020a) identified a potential hazard to mine roads and downstream infrastructure (e.g., seepage ponds) related to slumping of the rockfill toe buttress under an extreme earthquake load. The toe buttress would most likely slump to a shallower slope but would not result in a flow failure and/or uncontrolled release of the contained materials.

Bose Lake Dam

- Overtopping: the open channel spillway is designed to safely pass a flood (PMF, 24-hour duration) significantly greater than the minimum IDF recommended under the Code (1/3 between 1000-year and PMF) and is an effective control to manage overtopping risks. In addition, the Bethlehem TSF spillway design assumes the pond level is at the invert of the spillway at the onset of the storm. Under normal conditions the pond level is >6 m below the invert, which provides additional flood attenuation that is not accounted for in the design and significantly reduces the potential for overtopping.

R3 Seepage Pond Dam

- Overtopping: the open channel spillway is designed to safely pass the IDF with adequate freeboard which is an effective control to manage overtopping risks.
- Slope Stability: A slope stability review was completed by KCB, as recommended by SRK (2019), concluded that the dam meets design criteria (FOS $\geq$ 1.5). The documentation of this review for the record is in progress as of the issue date for this report.

7.4 Emergency Preparedness and Response

The emergency preparedness and response plan (EPRP) for the Bethlehem No.1 TSF forms a part of the 2019 OMS manual and is appropriate for the current structure. The EPRP is being reviewed as part of the ongoing OMS manual updates to ensure it remains consistent with changes made to the OMS manual and site emergency response procedures.

Training and testing of the EPRP was completed on December 9, 2020. The training consisted of a trial of the EPRP using hypothetical scenario at the L-L Dam. Participants included members of THVCP's operation team (including site management), THVCP QP and EoR. Along with testing of the system, THVCP contacts offsite emergency response resources to ensure that contact information is current.

8 SUMMARY

The observed performance of the Bethlehem No.1 TSF is consistent with expected performance and within design requirements. There have been no significant changes to the condition of the structure during 2020.

The status of recommendations identified during past Annual Facility Performance Reports are summarized in Table 8.1. Closed recommended actions are shown in *italics*. Recommendations, related to facility performance, identified during the 2020 AFPR are summarized in Table 8.2

Table 8.1 Previous Recommendations Related to Facility Performance – Status Update

ID No.	Performance Area	Recommended Action	Priority[1]	Recommended Deadline (Status)
Bethlehem No.1 Tailings Storage Facility				
BTSF-2017-01	*Construction*	*Provide a completed summary of the construction work for the Seepage Pond 1 decommissioning project to KCB. Note: Summary is not available for the record but does not represent a dam safety concern.*	*4*	*Q1 2018 (Closed)*
Dam No. 1				
BTSF-2018-01	Flood Management	Update flood routing for Bethlehem No.1 TSF and R3 Seepage Pond based on the most recent site wide hydrology information for consistency and to confirm compliance.	3	Q2 2020 (Open – Revised Q4 2021)
BTSF-2019-01	*DSR*	*KCB and THVCP to develop a work plan to address 2018 DSR recommendations.*	*3*	*April 2020 (Closed)*
Bose Lake Dam and R3 Seepage Pond				
No Outstanding Previous 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.

Table 8.2 2020 Recommendations Related to Facility Performance

ID No.	Performance Area	Recommended Action	Priority[1]	Recommended Deadline (Status)
Bose Lake Dam				
BD-2020-01	Maintenance	Complete inspection of the downstream slope of exposed till fill (above ~El. 1440.1 m) for animal burrows and fill or obstruct them.	3	Q4 2021
Bethlehem No.1 Tailings Storage Facility, Dam No. 1 and R3 Seepage Pond				
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 (KCB). The report has been prepared for the exclusive use of Teck Highland Valley Copper Partnership (Client) for the specific application to the 2020 Annual Facility Performance Report Project, and it may not be relied upon by any other party without KCB's written consent.

KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

Use of or reliance upon this instrument of service by the Client is subject to the following conditions:

1. The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report.
2. The Executive Summary is a selection of key elements of the report. It does not include details needed for the proper application of the findings and recommendations in the report.
3. The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to precisely represent conditions at any other time.
4. The report is based on information provided to KCB by the Client or by other parties on behalf of the client (Client-supplied information). KCB has not verified the correctness or accuracy of such information and makes no representations regarding its correctness or accuracy. KCB shall not be responsible to the Client for the consequences of any error or omission contained in Client-supplied information.
5. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.

KLOHN CRIPPEN BERGER LTD.

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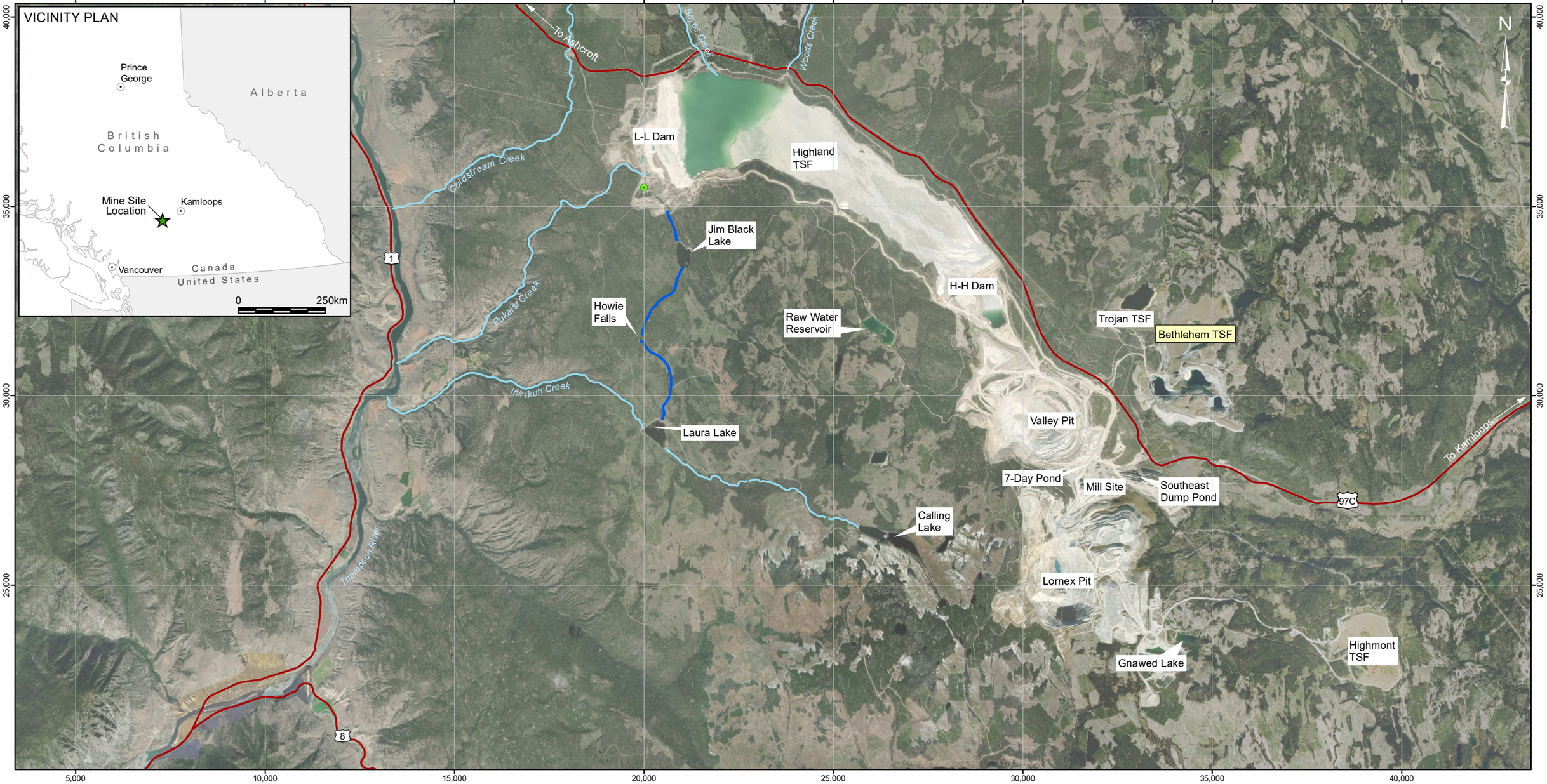
FIGURES



Legend

- L-L Dam Climate Station
- 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: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: MINE SITE PLAN

SCALE	PROJECT No.	FIG No.
1:100,000	M02341B83	1

Date: 2021-01-14
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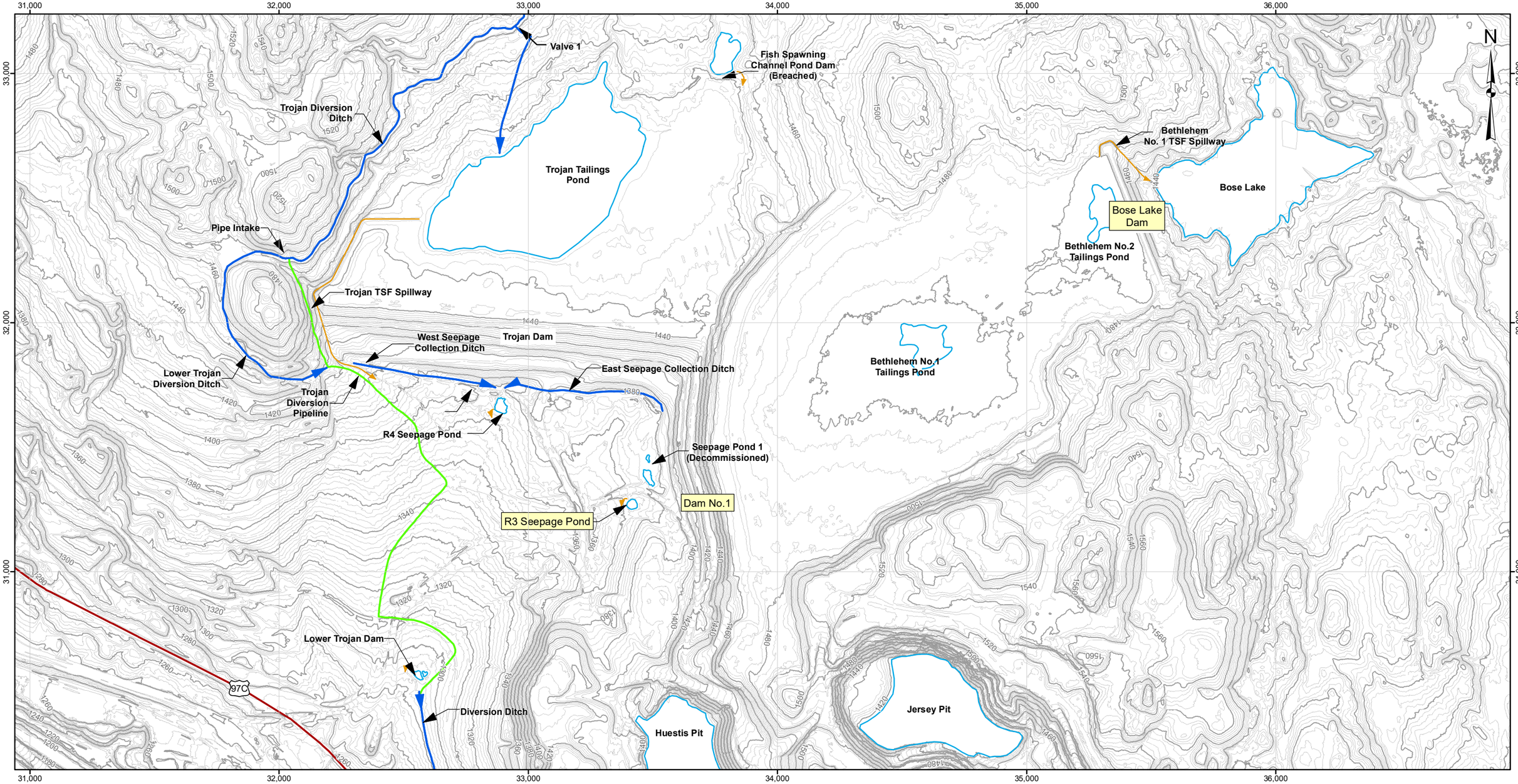

Legend

- Spillway
- Ditch
- Above Ground Pipeline
- 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	Highland Valley Copper / Teck
	Klohn Crippen Berger
PROJECT	BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY 2020 ANNUAL FACILITY PERFORMANCE REPORT
TITLE	BETHLEHEM OVERVIEW
SCALE	1:15,000
PROJECT No.	M02341B83
FIG No.	2

Date: 2021-03-18
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Legend

Instrument Type (Active)
- Standpipe Piezometer
- Vibrating Wire Piezometer
- Inclinometer
- Weir
- Survey Monument
- Waypoint (BTH-2020-xx)

Instrument Type (Defunct)
- Standpipe Piezometer
- Index Contour (25 m)
- Intermediate Contour (5 m)

0 250m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained September, 2020.
3. Topography from HVC, LiDAR flown on August 23rd, 2014.

Date: 2021-01-18
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CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: DAM No.1 PLAN

SCALE	PROJECT No.	FIG No.
1:6,000	M02341B83	3

Legend

Instrument Type (Active)

- Standpipe Piezometer
- Vibrating Wire Piezometer
- Survey Monument
- Waypoint (BTH-2020-xx)
- Spillway

0 100m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained September, 2020.
3. Topography from HVC, LiDAR flown on August 23rd, 2014.

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CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: BOSE LAKE DAM
PLAN

SCALE	PROJECT No.	FIG No.
1:2,000	M02341B83	4

Legend

Instrument Type (Active)
- Standpipe Piezometer
- Weir

Instrument Type (Defunct)
- Standpipe Piezometer

- Waypoint (BTH-2020-xx)
- Spillway
- Buried Pipeline
- Index Contour (5 m)
- Intermediate Contour (1 m)

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained September, 2020.
3. Topography from HVC, LiDAR flown on August 23rd, 2014.
4. Location of buried pipes are approximate.

0 25m

CLIENT
Highland Valley Copper / Teck

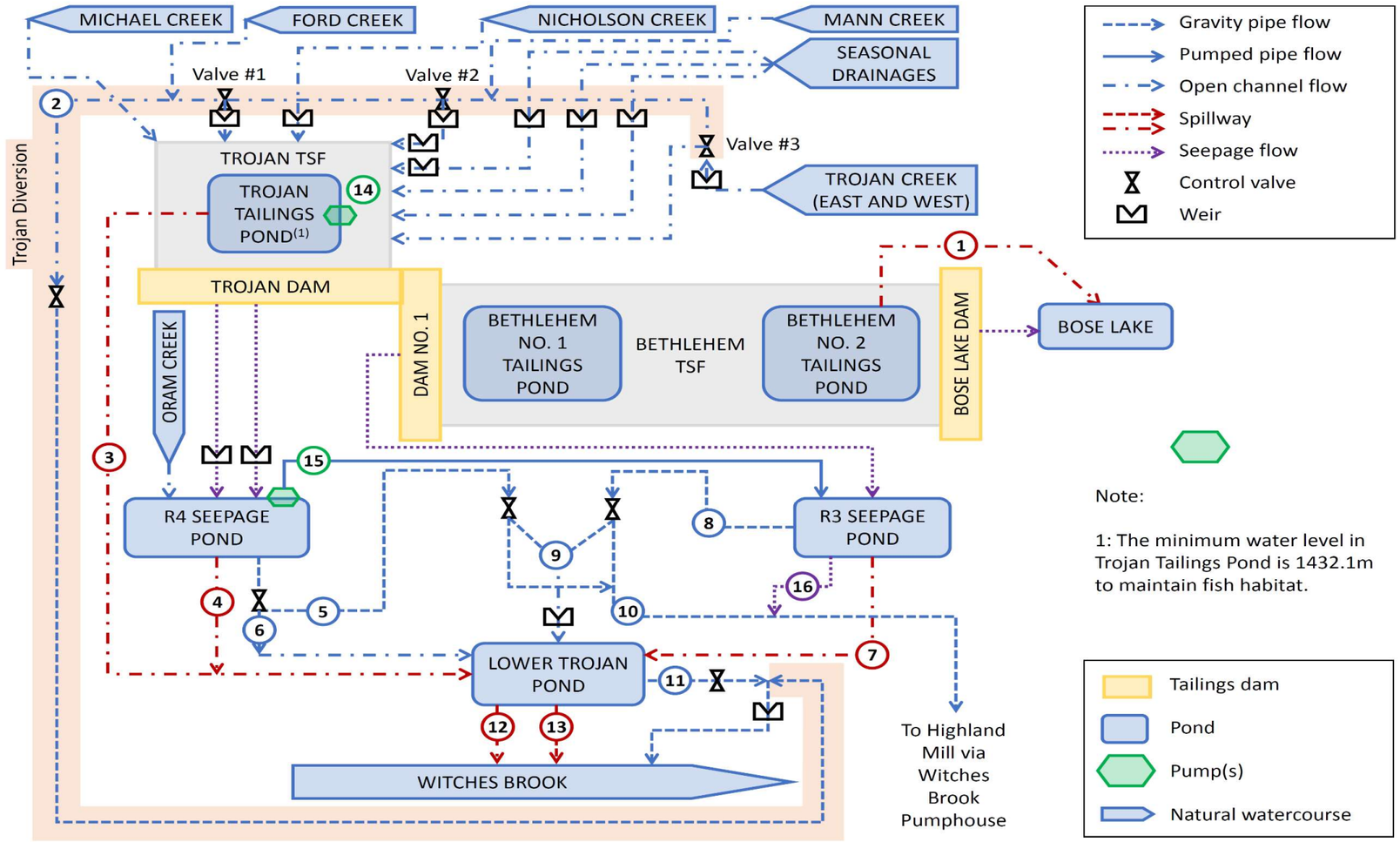
Klohn Crippen Berger

PROJECT
BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

TITLE
R3 SEEPAGE POND DAM
PLAN

SCALE	PROJECT No.	FIG No.
1:750	M02341B83	5

Date: 2020-11-27
Document Path: Z:\MV\CRM\02341B83 - HVC 2020 Dam Safety Support\400 Drawings\GIS\Reports\DS\BethFig5_Bethlehem_R3Seepage_Plan.mxd



Gravity pipe flow
Pumped pipe flow
Open channel flow
Spillway
Seepage flow
Control valve
Weir

Note:

1: The minimum water level in Trojan Tailings Pond is 1432.1m to maintain fish habitat.

Tailings dam
Pond
Pump(s)
Natural watercourse

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	957 m 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	R3/R4 Seepage to Lower Trojan Pond	Open channel from Valve Box to Lower Trojan Pond	Operational
10	R3/R4 Seepage to Northern Collection Line	10" dia. buried steel pipeline	Operational
11	LTP Low-Level Outlet	460 mm dia. HDPE pipe with valve and intake trash rack	Operational
12	LTP Spillway	7 m wide channel	Operational
13	LTP Overflow	810 mm dia. HDPE pipe	Operational
14	Trojan Pump	Pump for Trojan Tailings Pond	Non-operational
15	R4 Pump to R3 Pond	Steel pipe from R4 Pumphouse discharge to R3 Pond	Non-operational
16	R3 Overland Collector	8"-12" HDPE pipe collecting surface water	Operational

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CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: FLOW SCHEMATIC FOR BETHLEHEM NO. 1 AND TROJAN TAILINGS STORAGE FACILITIES

SCALE	PROJECT No.	FIG. No.
NTS	M02341B83	6

FILE PATH: Z:\MV\CRM\02341B83 - HVC 2020 DAM SAFETY SUPPORT\700 DELIVERABLES\720 WORKING\2020 DS\[G5 BETHLEHEM\FIGURES\FOR PFD (FIGG)\FIG 6- PFD.XLSX - 2021-01-12 14:47

APPENDIX I

Annual Facility Performance Report Inspection Checklist, Observations and Photographs

APPENDIX I-A

Annual Facility Performance Report
Inspection Checklist, Observations and Photographs
Dam No. 1

Appendix I-A
Annual Facility Performance Report Inspection Checklist, Observations and Photographs
Dam No. 1

INSPECTION CHECKLIST

Facility:	Bethlehem Dam No.1	**Inspection Date:**	July 15, 2020
Consequence Classification:	Very High		
Weather:	Sunny	**Inspector(s):**	Rick Friedel, P.Eng. Narges Solgi, EIT
Freeboard (pond level to dam crest):	8.8 m based on the June 9th pond survey.		

Are the following components of the facility in ***SATISFACTORY CONDITION***?

EMBANKMENT	Yes/No
U/S Slope	☒ Yes ☐ No
Crest	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No
Drains	☒ Yes ☐ No

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

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

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

- No dam safety deficiencies observed.

Comments / Notes:

- Sinkhole on upstream beach which has been present since 1993 remains but does not represent a potential problem indicator based on a review by dam designers in 1997.
- Cracks are present in the downstream rockfill zone but they are related to shallow sloughing of the rockfill slope and are not related to global or overall stability of the dam.
- Refer to Inspection Observations Section.

INSPECTION OBSERVATIONS

Crest and Tailings Beach

Good physical condition. The highpoint between the pond and the downstream slope is upstream of the slope crest. The tailings beach is well vegetated. There was no significant visual change of the sinkhole on the tailings beach (Photo I-A-3). No observations of concern were noted (Photo I-A-1 to Photo I-A-3).

The sinkhole on the beach, more than 340 m upstream of the crest, remains similar to 2019 observations. Feature first appeared in 1993 and was reviewed by the designers during operations (most recently in 1997). The designers concluded this is a potential safety hazard for people in the area but not a risk or concern for dam safety.

Left and Right Abutments

Good physical condition. The location of the left abutment is not visible due to the blending of dam fill and waste rock from a previously used waste dump. No signs of significant erosion, deterioration, or cracking at either abutment.

Downstream Slope

The remediated erosion gullies are in good physical condition and not showing signs of ongoing erosion. No significant change of the remediated or existing erosion features compared to recent Annual Facility Performance Reports (AFPRs). Existing erosion features typically have vegetation growth along the base indicating ongoing erosion rate, if any, is slow. Observations of erosion and shallow slumping of the downstream slope are local features restricted to the waste rock fill benches. Cracking is present within the rockfill that was pushed over the downstream slope to fill the erosion gullies. This is related to shallow localized sloughing of the rockfill slope and does not extend to the dam crest (Photo I-A-5).

Pond

No visual indicators along tailings beach (i.e. change in vegetation or wave scour) of a recent high-water event (Photo I-A-9 and Photo I-A-10).

Seepage

No signs of unexpected seepage in addition to flow from the underdrains which discharge to the R3 Seepage Pond.

INSPECTION PHOTOGRAPHS

LEGEND:

- BTH = Bethlehem Tailings Facility.
- BTH-2020-## refers to 2020 AFPR waypoint shown on Figure 3.
- All photographs taken during inspection on July 15, 2020.

Photo I-A-1 Dam No. 1 crest road. No evidence of erosion or depression was observed (BTH-2020-01)

Photo I-A-2 Overview of Dam No.1 beach (BTH-2020-02)

Photo I-A-3 Bethlehem sinkhole on tailings beach, no visual change from 2019 visual observations (BTH-2020-03)

Photo I-A-4 View of downstream slope of Dam No.1 from Trojan Dam and toe area (BTH-2020-04)

Photo I-A-5 Local cracking of rockfill pushed over downstream slope to fill erosion scour. Previously observed cracking has been filled, indicating area has been inactive (BTH-2020-05)

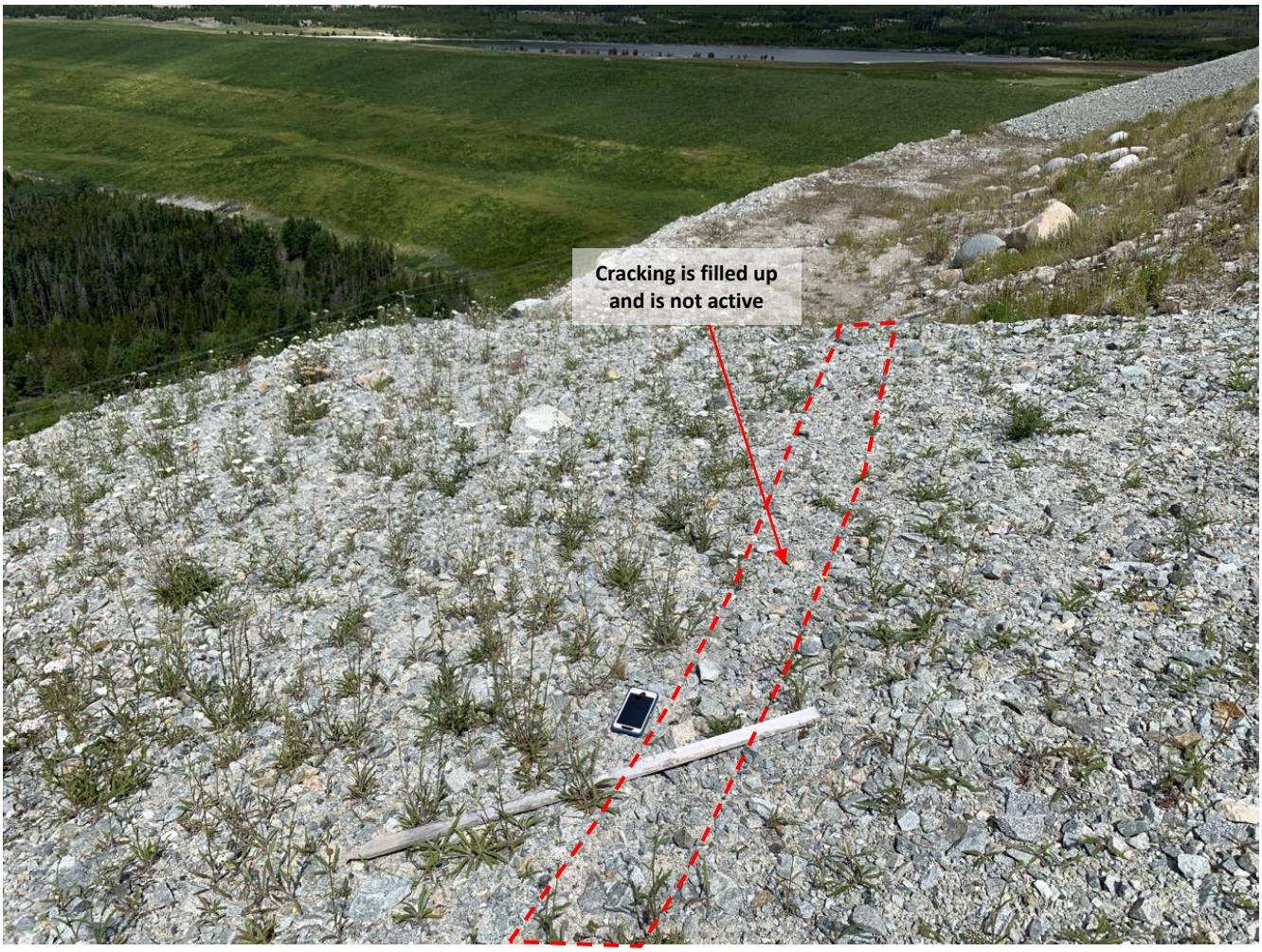


Photo I-A-6 Overview of downstream slope and toe area (BTH-2020-05)

Photo I-A-7 Overview of downstream slope and toe from crest road, looking south. No major erosion areas were observed. (BTH-2020-01)

Photo I-A-8 Overview of downstream slope and toe from Trojan Dam. No major erosion areas were observed (BTH-2020-06)

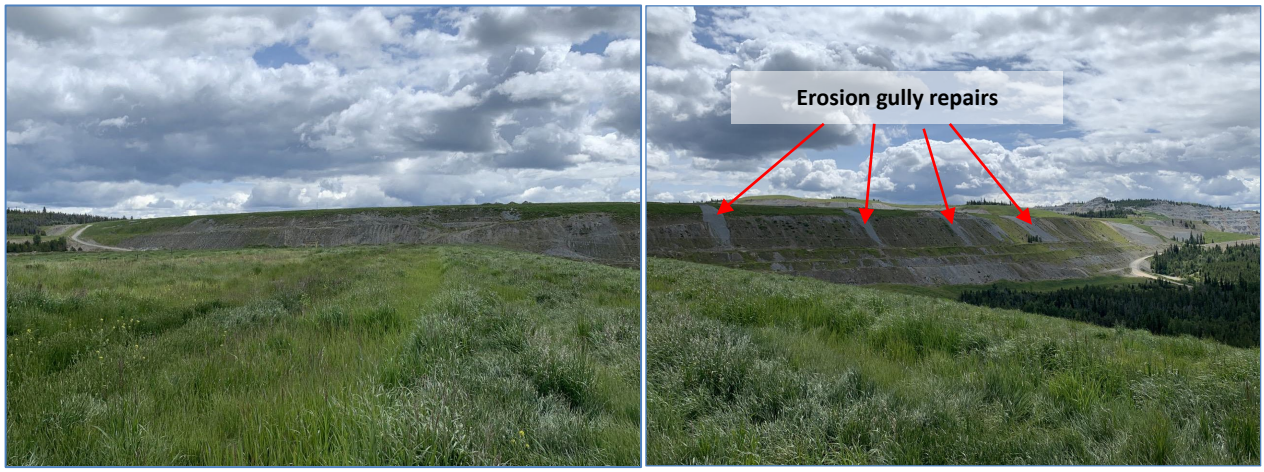


Photo I-A-9 Overview of impoundment and Bethlehem Pond No.1 (BTH-2020-07)

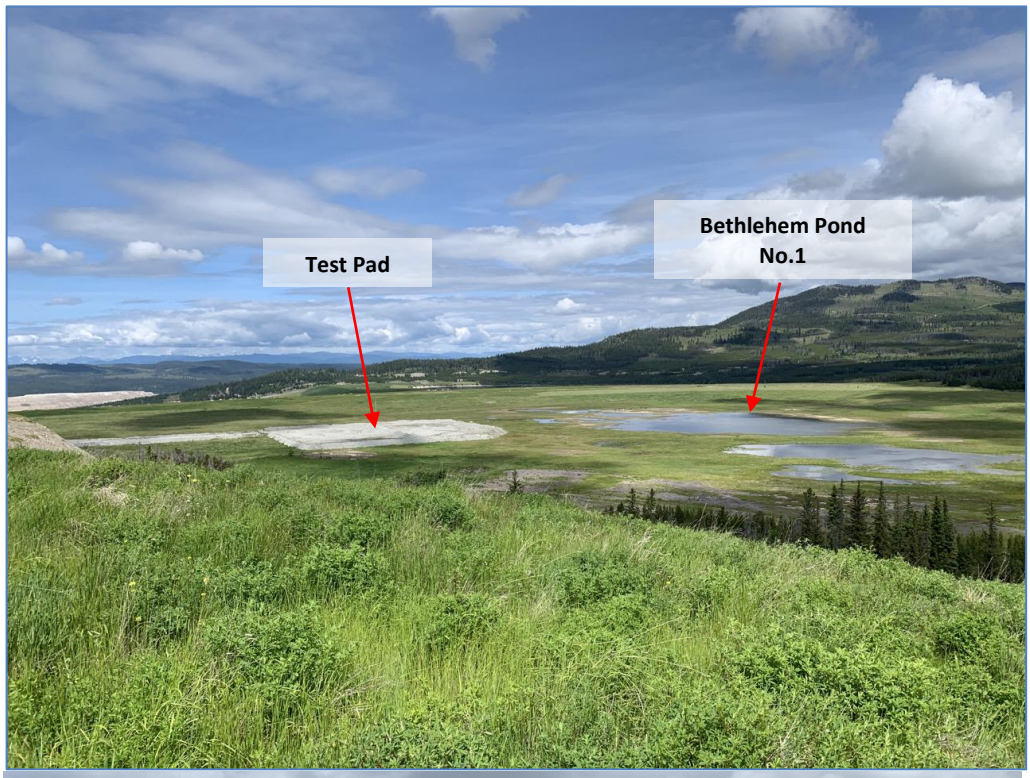


Photo I-A-10 Overview of Bethlehem Pond No.1 and the test pad (BTH-2020-02)

APPENDIX I-B

Annual Facility Performance Report
Inspection Checklist, Observations and Photographs
Bose Lake Dam

Appendix I-B
Annual Facility Performance Report Inspection Checklist, Observations and Photographs
Bose Lake Dam

INSPECTION CHECKLIST

Facility:	Bose Lake Dam	**Inspection Date:**	July 15, 2020
Consequence Classification:	Very High		
Weather:	Partly cloudy	**Inspector(s):**	Rick Friedel, P.Eng. Narges Solgi, EIT
Freeboard (pond level to dam crest):	6.0 m based on the June 19th pond survey.		

Outlet Condition Survey

Description	Outlet Controls?	Was it flowing?	Flow rate
Spillway Channel	N/A	☐ Yes ☒ No	N/A

Are the following components of the facility in ***SATISFACTORY CONDITION***?

EMBANKMENT	Yes/No	SPILLWAY	Yes/No
U/S Slope	☒ Yes ☐ No	Debris Boom	☒ Yes ☐ No
Crest	☒ Yes ☐ No	Entrance	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No	Sill	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No	Road Culvert	☒ Yes ☐ No
Drains	☒ Yes ☐ No	Channel Invert	☒ Yes ☐ No
		Channel Slopes	☒ 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 (See Notes)	☐ 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):

- No dam safety deficiencies observed.

Comments/ Notes:

- Refer to Inspection Observations Section.

INSPECTION OBSERVATIONS

Crest

Good physical condition. No indications of major lateral movement, depressions, or cracking (Photo I-B-1 to Photo I-B-3). Access road at downstream toe should be graded as part of THVCP routine maintenance. The existing road could make the access to the left abutment and spillway difficult during flood events.

Left and Right Abutments

Good physical condition. An access road runs along the abutments which connects the crest and toe roads. No sign of seepage, excessive scour or displacement (Photo I-B-4 and Photo I-B-5).

Multiple animal burrows observed at downstream slope near left abutment. THVCP should conduct an inspection before 2021 freshet and fill animal burrows where horizontal width between tailings and downstream slope is narrowest (Photo I-B-6).

Downstream Slope

Good physical condition. No signs of adverse displacement or cracking. The majority of the slope is protected from erosion by coarse rockfill. The slope at the toe of the dam is well vegetated (Photo I-B-7 to Photo I-B-11).

Local sand piles are present on the downstream slope of the dam. No change to 2019 Annual Facility Performance Report (AFPR) observation. There was no sign of flow from the area which is well above nearest water level measurement. They are not interpreted as active seepage features or dam safety concerns (Photo I-B-12 and Photo I-B-13).

Upstream Slope and Tailings Beach

Good physical condition. The beach immediately upstream of the dam is well vegetated with no visual issues of concern or indication of recent flooding (Photo I-B-14 and Photo I-B-15).

Pond

During inspection, the pond appears typical for the time of year. The pond remains approximately 40 m upstream of the crest in a localized depression on the tailings beach (Photo I-B-16).

Spillway Inlet

Good physical condition and consistent trapezoidal shape. Vegetation throughout channel but no major obstructions or signs of deterioration. The debris boom is secured in place with no sign of damage. The vegetation at the spillway inlet should be cleared as part of THVCP routine monitoring and maintenance (Photo I-B-17).

Spillway Channel and Outlet

Good physical condition. Initial segment of channel is vegetated with no or very modest grade. As the channel crosses the dam centerline, the spillway channel transitions to a riprap lined trapezoidal channel which continues downslope parallel to the dam abutment. The vegetation at the approach channel and the initial segment of the riprap channel should be cleared as part of THVCP routine monitoring and maintenance. There was no visible sign of significant degradation of the riprap, compared to KC (2002), or blockage of the culverts (Photo I-B-18 to Photo I-B-20).

Seepage Collection System

The seepage relief wells were locked and could not be inspected. The outer casings showed no signs of damage. Water could be heard flowing within the culverts. At the gauge-house, water was observed flowing (< 1 L/s) out of the outflow pipe and into the riprap lined basin. No surface outflow from the basin was observed; therefore, water is lost through seepage and/or evaporation (Photo I-B-21).

INSPECTION PHOTOGRAPHS

LEGEND:

- BTH = Bethlehem Tailings Facility.
- BTH-2020-## refers to 2020 AFPR waypoint shown on Figure 4.
- All photographs taken during inspection on July 15, 2020.

Photo I-B-1 Overview of dam crest from right abutment (BTH-2020-08)

Photo I-B-2 Overview of dam crest and downstream slope from mid dam (BTH-2020-09)

Photo I-B-3 Overview of dam crest, looking towards left abutment (top photos) and right abutment (bottom photos). No sign of erosion or depression was observed (BTH-2020-10 and BTH-2020-11)

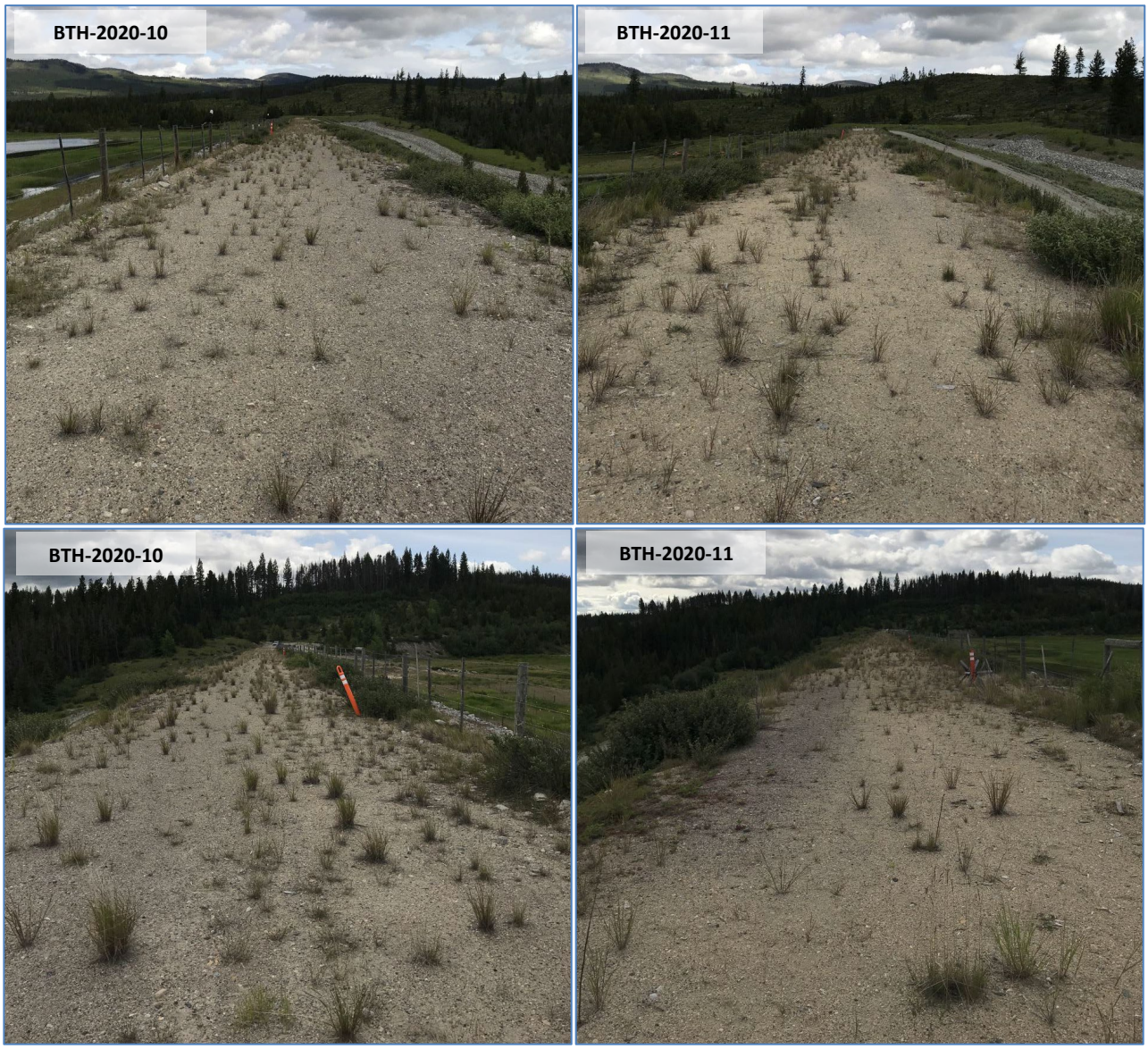


Photo I-B-4 View of right abutment (BTH-2020-12)

Photo I-B-5 View of left abutment. No sign of erosion or unusual condition (BTH-2020-13 and BTH-2020-14)

Photo I-B-6 **Multiple animal burrows observed at downstream slope near left abutment. Before 2021 freshet, THVCP should conduct an inspection of the upper downstream slope of till, where horizontal width between tailings and downstream slope is narrowest, and fill animal burrows (BTH-2020-15)**

Photo I-B-7 View of downstream slope and toe area from crest looking towards left abutment (top photo) and right abutment (bottom photo) (BTH-2020-10)

Photo I-B-8 Overview of downstream slope from right abutment. No ongoing erosion, road in good condition, and no seepage or wet sections observed in area (BTH-2020-16)

Photo I-B-9 Upslope extent of toe drain along abutment. Toe drain access point is visible. Cap is sealed (BTH-2020-17)

Photo I-B-10 View of downstream slope. Vegetation cover over lower portion of slope, comprised of till fill. No erosion of slope (rock of till) was observed (BTH-2020-18)

Photo I-B-11 Downstream slope and lower part of left abutment. No sign of unusual condition or erosion (BTH-2020-19)

Photo I-B-12 Pile of sand (not tailings) on upper part of starter dam slope. Appears to have been dumped there rather than related to seepage. No change from 2019 visual observations. Well above water level and no sign of flow in the area (BTH-2020-20 and BTH-2020-21)

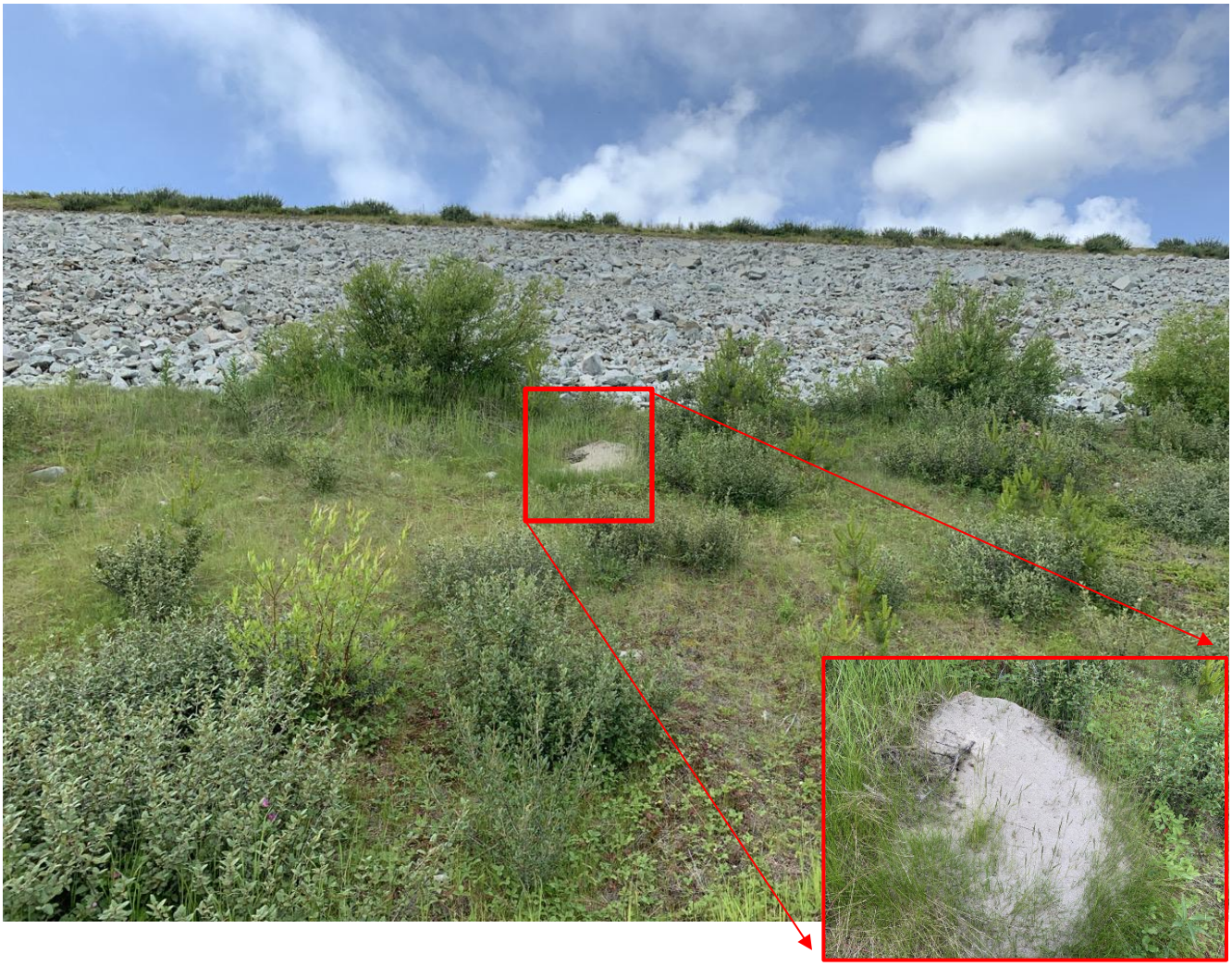


Photo I-B-13 Sand pile similar to the one observed in Photo I-B-12 and at a similar elevation. No change from 2019 visual observations (BTH-2020-22)

Photo I-B-14 Overview of upstream riprap and tailings beach from right abutment (BTH-2020-23)

Photo I-B-15 Overview of upstream riprap and tailings beach from left abutment (BTH-2020-13)

Photo I-B-16 Overview of Bethlehem No.2 Tailings Pond and tailings beach (BTH-2020-24)

Photo I-B-17 Spillway inlet and approach channel. Vegetation to be cleared from flow channel as part of routine maintenance (BTH-2020-25)

Photo I-B-18 Spillway channel at transition point between inlet and riprap-lined segment, looking towards north (BTH-2020-25)

Photo I-B-19 Spillway channel shallow area (top photo) and transition to steep sections (bottom photo) (BTH-2020-26)

Photo I-B-20 **Spillway channel and outlet to Bose Lake. Downstream spillway culverts are unobstructed. Sign of water pooling upstream of culverts in channel but no sign of flow through spillway. Likely pooled runoff (BTH-2020-09 and BTH-2020-27)**

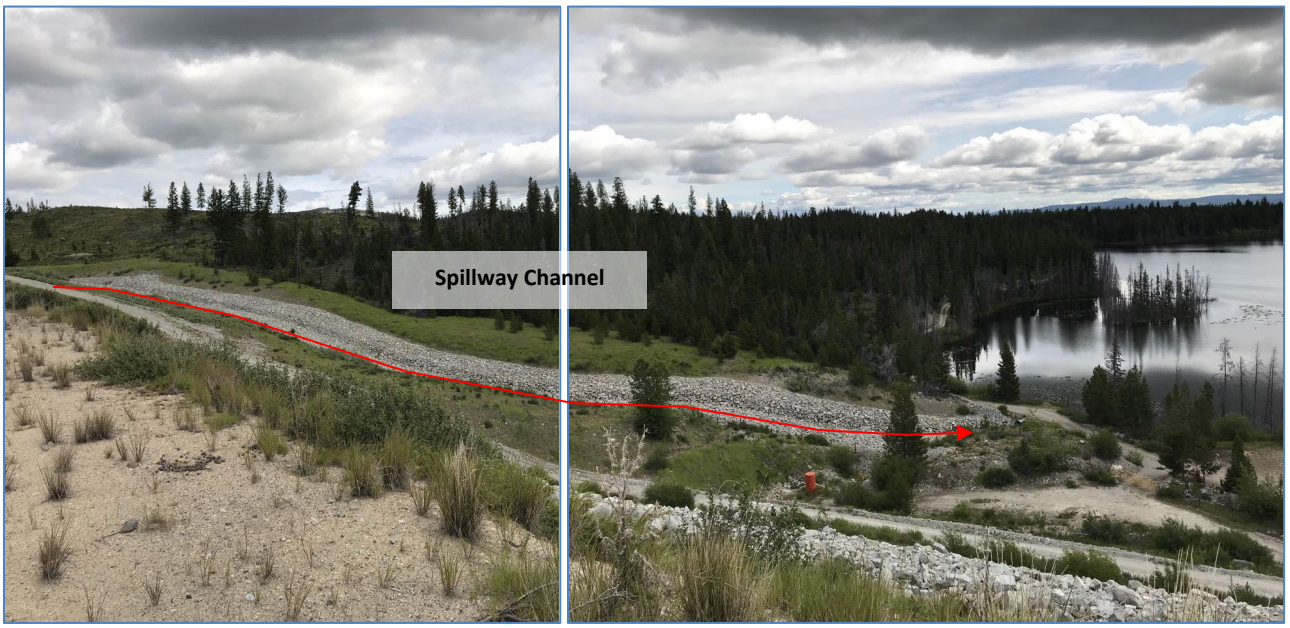


Photo I-B-21 Seepage flow from toe drain is clear. Pond drainage conditions unchanged from 2019 observations (BTH-2020-27)

APPENDIX I-C

Annual Facility Performance Report
Inspection Checklist, Observations and Photographs
R3 Seepage Pond Dam

Appendix I-C
Annual Facility Performance Report Inspection Checklist, Observations and Photographs
R3 Seepage Pond Dam

INSPECTION CHECKLIST

Facility:	R3 Seepage Reclaim Pond Dam	**Inspection Date:**	July 15, 2020
Weather:	Mostly cloudy	**Inspector(s):**	Rick Friedel, P.Eng. Narges Solgi, EIT
Freeboard (pond level to dam crest):		1.6 m on July 9th (as per THVCP Weekly Inspection Report of Week 28, ending July 14, 2020)	

Outlet Condition Survey

Description	Outlet Controls?	Was it Flowing?	Flow rate	Visual Review?	Testing / Detailed Inspection?
Low Level Outlet (LLO)	No outlet control was seen	☒ Yes ☐ No	Not estimated	☒ Yes ☐ No	☐ Yes ☒ No
Spillway Channel	N/A	☐ Yes ☒ No	N/A	☒ Yes ☐ No	N/A

Are the following in ***SATISFACTORY CONDITION***?

DAM	Yes/No	LOW LEVEL OUTLET	Yes/No	SPILLWAY CHANNEL	Yes/No
U/S Slope	☒ Yes ☐ No	Outlet Pipe	Inlet visible (clear), pipeline buried.	Invert	☐ Yes ☒ No (See Notes)
Crest	☒ Yes ☐ No	Outlet Controls	☐ Yes ☒ No (See Notes)	Side Slopes	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No			Erosion Protection	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No				

Were ***POTENTIAL PROBLEM INDICATORS*** found?

INDICATOR	DAM	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

Deficiencies:

- No dam safety deficiencies observed.
- Lock block safety barrier at spillway inlet should be replaced with an alternate barrier that does not obstruct flow or flood routing revised to confirm suitable performance with lock-block in place.

Comments:

- Low Level Outlet intake trash rack is clogged and required cleaning (not related to flood routing).
- Excessive growth on upstream slope and spillway inlet should be cleared as part of THVCP routine maintenance.

INSPECTION OBSERVATIONS

Crest

Good physical condition. No indication of adverse lateral movement, depressions or cracking (Photo I-C-2).

Left and Right Abutment

Good physical condition. No signs of significant erosion, deterioration, or cracking.

Downstream Slope

Good physical condition. No indication of adverse displacement. No signs of erosion, deterioration, or seepage.

Pond

At the time of inspection, the pond was more than 1 m below the spillway invert (Photo I-C-3).

Low-level Outlet

At the time of inspection, the outlet pipe trash rack was partially obstructed with vegetation. This should be cleared as part of THVCP routine monitoring and maintenance. The upstream debris fence was also obstructed, which may be cleared or replaced as part of routine maintenance but not required for dam safety (Photo I-C-4). THVCP cleared the outlet pipe trash rack and upstream debris fence in December 2020.

Spillway

Good physical condition. No indicators of recent flow through the channel. No visual signs of riprap degradation.

At the time of inspection, heavy vegetation and a lock block were obstructing the spillway inlet (Photo I-C-5). Vegetation should be cleared as part of THVCP routine monitoring and maintenance. THVCP removed the lock block from the spillway channel in December 2020.

Seepage

None observed.

INSPECTION PHOTOGRAPHS

LEGEND:

- BTH = Bethlehem Tailings Facility.
- BTH-2020-## refers to 2020 Annual Facility Performance Report waypoint shown on Figure 5.
- All photographs taken during inspection on July 15, 2020.

Photo I-C-1 Overview of R3 Seepage Pond (BTH-2020-28)

Photo I-C-2 R3 Seepage Pond dam crest. No cracking or no sign of distress was observed (BTH-2020-29)

Photo I-C-3 R3 Seepage Pond upstream slope heavily vegetated. Vegetation should be removed as part of routine maintenance (BTH-2020-30)

Photo I-C-4 **View of R3 Seepage Pond and debris mesh for Low-Level Outlet (LLO). Clear water was flowing at the time of inspection. The debris mesh is clogged below and above water. This does not impact flood routing but could be part of routine maintenance. (BTH-2020-30)**

Photo I-C-5 View of spillway inlet. Lock-block and vegetation to be cleared from inlet (BTH-2020-31)

Photo I-C-6 Spillway channel and road crossing at right abutment, looking downstream (BTH-2020-31)

APPENDIX II

APPENDIX II-A

Climate Data

Appendix II-A
Climate Data

THVCP provided weather data from the L-L Dam climate station (El. 1186 m) which is the nearest climate station to the site but is at a lower elevation than Bethlehem No.1 TSF catchment (>El. 1477 m, i.e. dam crest). Climate data was adjusted for elevation, using the recommended adjustment factors from L-L Dam to Highmont/Bethlehem and Trojan Area (Average El. 1550 m), from Golder (2019). To support key precipitation trends and impacts on observed dam performance, data from Kamloops Pratt Road (Environment Canada Station No. 116C8P0, El. 729.0 m) was reviewed for comparison. Previous Annual Facility Performance Reports (AFPRs) compared the Bethlehem No.1 TSF data with Kamloops Airport (Environment Canada Station No. 1163781, El. 345 m) data, but this station was missing too much data in 2020. Precipitation records from L-L Dam (adjusted) and Kamloops Pratt Road between October 2019 and September 2020 are tabulated and plotted in Table II-A.1 and Figure II-A.1, respectively. Precipitation normals, reported in Table II-A.1, are based on the Highland Valley Lornex Synthetic Record, adjusted for elevation to Highmont/Bethlehem and Trojan Area using Golder (2019).

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 by THVCP to monitor snowpack. The measurements are sorted by survey period (the first of January through May) to compare snowpack depths, in snow-water equivalent (SWE), for the same period each year. Historical average and 2020 snowpack depths based on available records are summarized in Table II-A.2.

The following observations were noted for the reporting period (refer to Figure II-A.1):

- More than 10% of the L-L Dam weather station precipitation data were missing in March, June, and July. Due to these data gaps, the 2020 climate data from site was augmented with data from a regional weather station to support a comparison with historic normals.
- All storm events during 2020 were less than the 10-year return period rainfall event (40 mm in 24 hours). The largest 24-hour rainfall events measured at the L-L Dam Weather Station during the review period, were: 23.1 mm on May 30; 18.2 mm on May 17; and 12.9 mm on September 19.
- January through April precipitation was significantly less than historic normals except the precipitation in February which was higher than average.
- May precipitation was almost twice as much as the historic normals.
- Figure II-A.1 indicates low precipitation at site during June and July; however, this is due to L-L Dam Weather Station data gaps during this period. THVCP inspection reports and regional climate station data indicate precipitation during this period was above historic normals.
- Snowpack depth measurements, from the Highland Valley station, indicate the snow had been melted by May 1, 2020.

- Seasonal rise and fall of pond levels is associated with freshet. The time of year when pond levels start to fall is associated with the end of freshet, in recent years this has started in April or May (Figure 5.1 and Figure 5.2 in the main text). In 2020, pond levels did not start to fall until mid to late June. This timing indicates that the 2020 response was driven primarily by precipitation, rather than snowmelt.

Table II-A.1 Monthly Precipitation

Month	Availability of Data (%)	Precipitation (mm)		
	L-L Dam Weather Station	L-L Dam Weather Station Data Adjusted to Highmont/Bethlehem and Trojan Area [1]	Average Lornex Synthetic Record Adjusted to Highmont/Bethlehem and Trojan Area [2]	Kamloops Pratt Road Weather Station
Oct 2019	100	21.5	33.3	32.8
Nov 2019	100	21.9	38.9	49.2
Dec 2019	97	22.9	42.1	36.6
Jan 2020	100	21.8	37.5	64.8
Feb 2020	100	30.3	23.7	45.4
Mar 2020	89	4.1 [4]	21.5	3.4
Apr 2020	100	15.0	22.4	16.4
May 2020	100	85.1	41.7	98.8
Jun 2020	32	9.8 [4]	46.5	78.0
Jul 2020	11	6.3 [4]	36.3	44.2
Aug 2020	100	26.6	34.4	15.2
Sep 2020	100	25.2	32.6	17.6
Annual Total	-	-	410.8	502.4

Notes:
1. Available data from L-L Dam climate station was adjusted by a L-L Dam-to-Highmont/Bethlehem and Trojan Area adjustment factor of 1.02 (Golder 2019).
2. Estimated by Golder (2019) using appropriate adjustment factors and average precipitation measured at Highland Valley Lornex climate station (Environment Canada ID No. 1123469 at El. 1268 m from 1976 to 2011). Golder (2019) infilled the data gaps prior to November 2011 and created a long-term synthetic precipitation record. Monthly average of the synthetic record adjusted to Highmont/Bethlehem and Trojan Area by a Lornex-to-Highmont/Bethlehem and Trojan Area adjustment factor of 1.12 are shown herein, refer to Golder (2019) for detailed information.
3. Review period for the Bethlehem No. 1 TSF Annual Facility Performance Report is from October 2019 through September 2020.
4. Monthly precipitation with more than 10% missing data.

Figure II-A.1 Monthly Precipitation

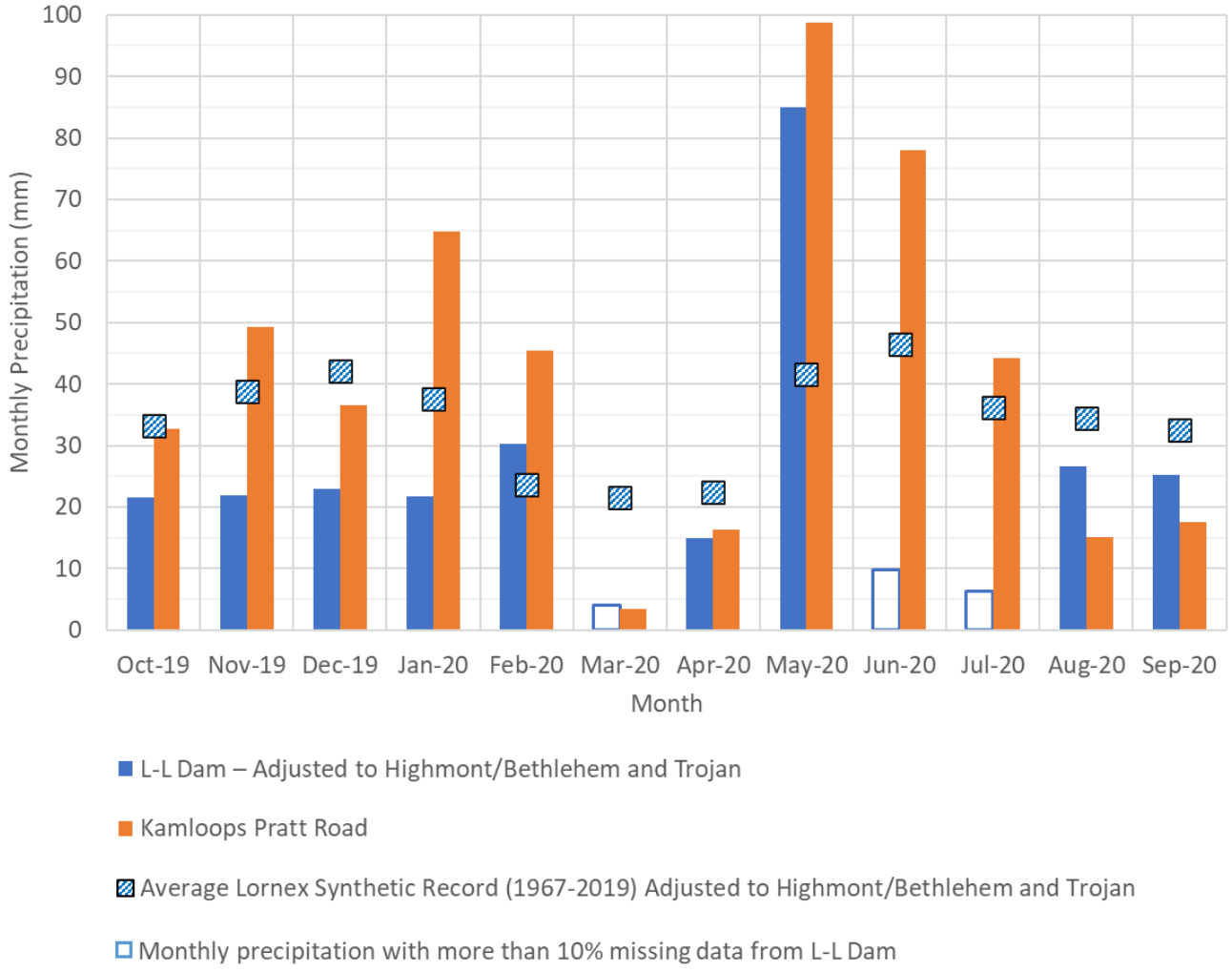


Table II-A.2 Historical Average and 2020 Snowpack Depths

Survey Period	Years of Record[1]	Historic Average Snowpack Depth[2] (mm SWE[3])	2020 Snowpack Depth (mm SWE[3])	Percent Change Relative to Historic Average
January 1st	11	50.2	Not surveyed	N/A
February 1st	25	83.5	Not surveyed	N/A
March 1st	54	91.2	100	10%
April 1st	52	100.8	Not surveyed	N/A
May 1st	53	28.1	0	-100%
May 15th	25	2.4	Not surveyed	N/A
June 1st	8	0	Not surveyed	N/A

Notes:
1. At the Highland Valley snow survey station (Station No. 1C09A) near the Bethlehem TSF. Data prior to 1966 were 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.

APPENDIX II-B

Instrumentation Summary and Plots

Appendix II-B
Instrumentation Summary and Plots

II-B-1 PIEZOMETERS

Piezometric readings at Dam No. 1 and Bose Lake Dam are plotted on Figure II-B-1 to Figure II-B-3 and Figure II-B-7 to Figure II-B-9, respectively.

Thresholds for piezometers were updated and reported in the 2016 Annual Facility Performance Report (AFPR) (KCB 2017b). The thresholds were set at 0.5 m above the maximum elevation head to identify any deviations from established trends. Questionable readings (e.g., where there was a spike that has not been repeated) were not used when defining thresholds. Maximum and minimum water levels during this review period and instrument thresholds were reviewed as part of 2020 AFPR. Threshold values remain unchanged for 2021 except for two piezometers (Refer to Table II-B-1).

Table II-B-1 Piezometric Levels during the review period and 2021 Thresholds

Instrument ID	Dam Zone or Foundation Unit	Status of Piezometer	Piezometric Levels during the review period[1] (m)		Proposed 2021 Threshold Value[2] (m)
			Maximum	Minimum	
Dam No. 1					
STANDPIPE No. 1B	Dam Fill	Plugged	Reported plugged in 2019		1440.4
STANDPIPE No. 1A	Dam Fill	Plugged	Reported plugged in 2019		1457.9
STANDPIPE No. 3	Dam Fill	Plugged/Dry	Reported dry in 2019		***1443.1***
STANDPIPE No. 4	Dam Fill	Plugged/Dry	Reported dry in 2019		1453.6
STANDPIPE No. 6	Upstream Dam Fill	Defunct	n/a		n/a
STANDPIPE No. 7	Dam Fill	Plugged/Dry	Reported dry in 2019		1440.5
P95-1	Downstream Foundation	Active	1378.0	1376.2	1379.0
P95-2	Downstream Foundation	Destroyed	n/a		n/a
P95-5	Dam Foundation	Destroyed	n/a		n/a
P95-6	Downstream Foundation	Active	1372.1	1371.6	1373.6
13-SRK-09/P13-5	Tailings	Active	1409.8	1409.7	1411.0
13-SRK-12B/P13-6	Glacial Till	Active	1377.2	1377.2	1377.9
VWPB16 - 1A	Glacial Till	Active	1349.9	1349.8	1351.7
VWPB16 - 1B	Glacial Till	Active	1359.3	1359.3	1369.8
BP3A	Glacial Till	Active	1452.6 [3]		1454.8
BP3B	Tailings	Active	1453.9 [3]		1455.9
BP3C	Tailings	Active	1461.0 [3]		1466.6
BP4A	Glacial Till	Active	1465.0 [3]		1466.7
BP4B	Tailings	Active	1450.8 [3]		1454.6
BP5A	Glacial Till	Active	1461.0 [3]		1461.6
BP5B	Tailings	Active	1463.7 [3]		1465.3
BP9A	Tailings	Active	1402.7 [3]		1403.4
BP9B	Tailings	Active	1424.3 [3]		1424.9
BP9C	Tailings	Active	1449.1 [3]		1449.6
BP10A	Tailings	Active	1463.9 [3]		1465.2
BP10B	Tailings	Active	-[4]		1466.8
BP12A	Tailings	Active	-[5]		1420.8
BP12B	Tailings	Active	-[5]		1441.8

Instrument ID	Dam Zone or Foundation Unit	Status of Piezometer	Piezometric Levels during the review period[1] (m)		Proposed 2021 Threshold Value[2] (m)
			Maximum	Minimum	
BP12C	Tailings	Active	-[5]		1463.9
BP13A	Glacial Till	Active	1440.1 [3]		1441.5
BP13B	Tailings	Active	1445.3 [3]		1446.0
BP14A	Glacial Till	Active	1424.5 [3]		1425.0
BP-14B	Tailings	Active	1425.2 [3]		1425.7
BP14C	Tailings	Active	1446.9 [3]		1447.9
BP15A	Glacial Till	Active	-[5]		1447.7
BP15B	Tailings	Active	-[5]		1451.0
BP15C	Tailings	Active	-[5]		1458.6
Bose Lake Dam					
No.1	Overburden / Bedrock Contact	Active	1444.8	1444.7	1445.3
No.2	Overburden / Bedrock Contact	Active	1444.8	1444.7	1445.2
BD-VWP14-1A	Bedrock	Active	1451.5	1451.3	1452.0
BD-VWP14-1B	Overburden	Active	1451.3	1451.2	***1451.8***
BD-VWP14-1C	Dam Fill	Active	1448.7	1448.6	1449.9
BP6A	Glacial Till	Active	-[5]		1462.8
BP6B	Tailings	Active	-[5]		1466.0
BP6C	Tailings	Active	-[5]		1467.3
BP7A	Glacial Till	Active	-[5]		1469.1
BP7B	Tailings	Active	-[5]		1469.1
BP7C	Tailings	Active	-[5]		1468.3

Notes:
1. October 2019 through September 2020.
2. ***Bold Italics*** indicate revised threshold for 2021.
3. Based on single reading taken in December 2019.
4. BP10B wire is cut and no reading has been taken for this piezometer since December 2019.
5. No readings were taken during the review period.

II-B-2 SURVEY MONUMENTS

Survey monuments at Dam No. 1 and Bose Lake Dam are shown on Figure 3 and Figure 4, respectively. Starting in November 2019, THVCP changed the method used to survey the displacement monuments on the TSF. Previously, monuments were surveyed using a ground based total station with digital level. This has changed to a GPS Real Time Kinematic (RTK) survey. Based on the survey data collected to date, the RTK method is suitable to monitor displacement. In comparison to the total station method, the RTK surveys show less variance (i.e. error) in the horizontal plane but increased variance in elevation.

Survey results using the RTK method are shown on Figure II-B-4 and Figure II-B-10. The baseline location for each monument using the RTK method is offset from the total station surveys. However, subsequent readings show this is related to the change in survey and not a movement trend. The horizontal surveys are plotted for the RTK method only, based on the new baseline location. However, KCB maintained a continuous record of settlement based on incremental change between RTK surveys.

Table II-B-2 summarizes incremental and cumulative displacement during the 2020 AFPR review period. Incremental displacements are relative to the November 2019 RTK baseline. Change from initial survey for horizontal displacement is reported relative to the November 2019 RTK baseline.

KCB estimated change from initial survey for vertical displacement by adding the incremental vertical displacement over the reporting period to the cumulative vertical displacement from the last total station survey. This assumes no vertical displacement occurred between the last total station survey with elevation data (July 2019) and the date of the GPS RTK baseline survey (November 2019).

Table II-B-2 2020 Survey Monument Displacement Summary

Monument ID	Incremental[1]		Change from Initial Survey	
	Vector Horizontal Displacement (mm)	Vertical Displacement (mm)	Vector Horizontal Displacement[2] (mm)	Vertical Displacement[3] (mm)
Dam No. 1				
MON 1-73	4, downstream (toward northeast)	-17	4, downstream (toward northeast)	-216
DM-2	4, downstream (toward northeast)	-23	4, downstream (toward northeast)	-169
DM-3	3, downstream (toward northeast)	-17	3, downstream (toward northeast)	-108
PIN-2	5, downstream (toward northeast)	-25	5, downstream (toward northeast)	-104
Bose Lake Dam				
BD-1	1, parallel to dam crest (toward south)	+18	1, parallel to dam crest (toward south)	-5
BD-2	5, downstream (toward east)	+6	5, downstream (toward east)	-6
BD-3	8, downstream (toward south)	0	8, downstream (toward south)	+3
BD-4	10, downstream (toward south)	+2	10, downstream (toward south)	-4
BD-5	7, downstream (toward south)	-7	7, downstream (toward south)	-9
BD-6	0	-14	0	-11
BD-7	13, parallel (toward south)	-22	13, parallel (toward south)	-19

Notes:
1. Incremental displacements are calculated between the November 2019 and September 2020 surveys.
2. Cumulative horizontal displacements calculated relative to the RTK November 2019 baseline.
3. Cumulative vertical displacements calculated by adding 2020 incremental displacement to displacement between July/October 2019 surveys and earliest historic readings:
   - 2008 for BD-7;
   - 2013 for BD-3 (shift pre- and post-2013 possibly attributed to damage or change to datum; no observations this was an indicator of dam safety issue);
   - 1983 for all other monuments.

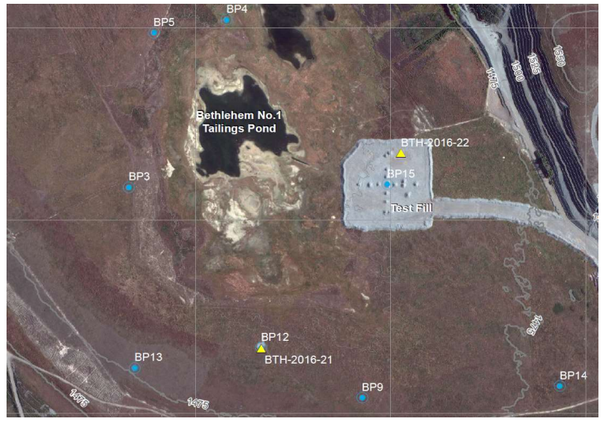
The current survey movement thresholds were set during the 2016 AFPR (KCB 2017b) based on typical variance and error using the total station method; refer to Table II-B-3. These thresholds are being revised by KCB and THVCP for 2021 based on the RTK survey method. The survey readings for this review period do not indicate any increased displacement and horizontal movement trends and settlement rate was consistent with recent behaviour.

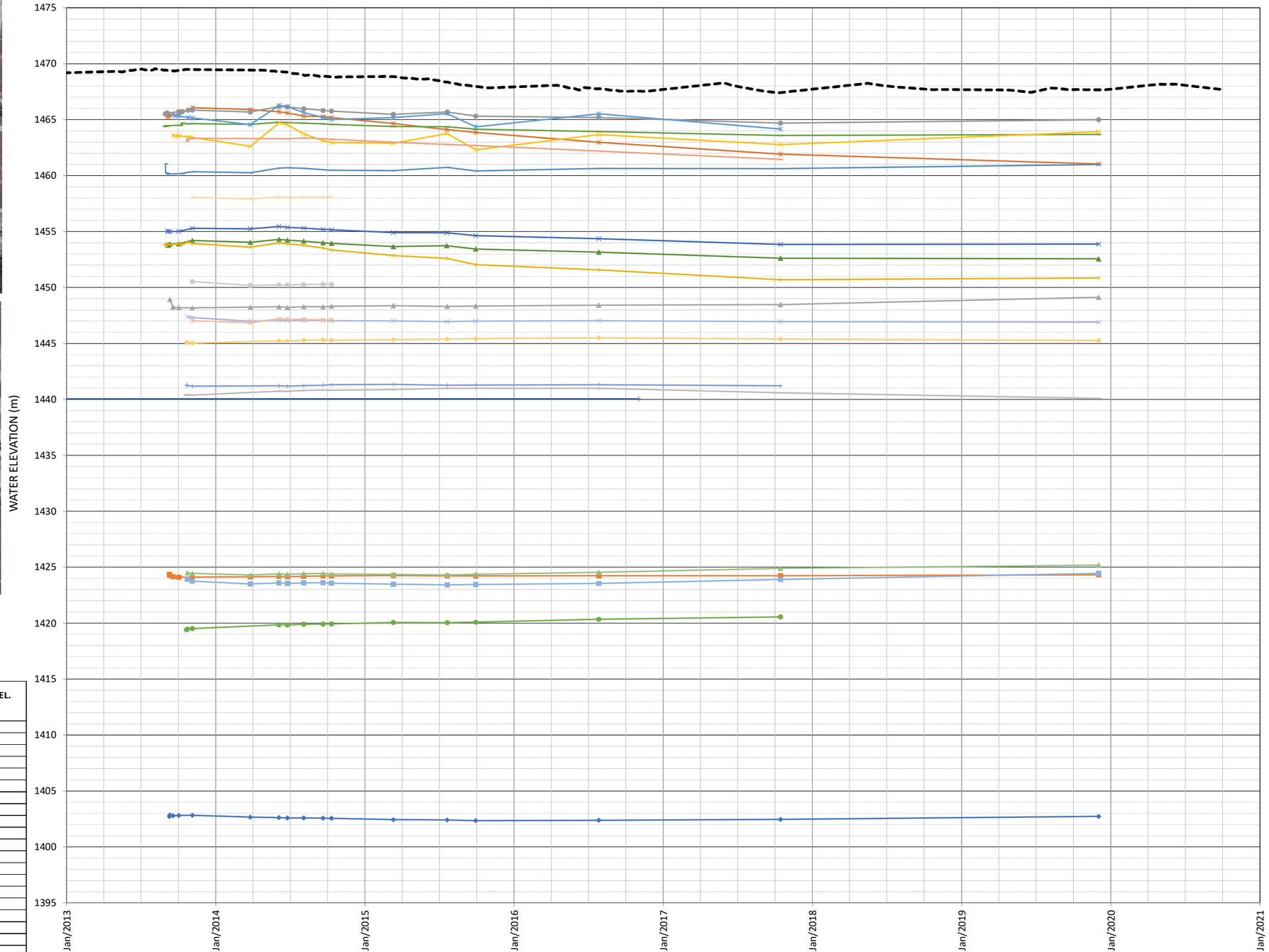
Table II-B-3 Total Station Survey Monument Displacement Thresholds

Instrument ID	Instrument Threshold (mm)		
	Total Horizontal Vector Displacement from Original Position	Incremental Vertical Displacement Between Readings	Total Vertical Displacement
DAM NO. 1			
MON 1-73	80	20	240
DM-2			170
DM-3			125
PIN-2			125
BOSE LAKE DAM			
BD-1	80	20	75
BD-2			50
BD-3			75
BD-4			50
BD-5			50
BD-6			50
BD-7			50

Notes:
1. Thresholds are being revised by KCB and THVCP based on the GPS Real Time Kinematics (RTK) method. The presented thresholds are not applicable to the GPS RTK survey data from the 2020 AFPR review period.

INSTRUMENTATION PLOTS





LEGEND:

- STANDPIPE NO. 7 (Tip El. 1439.8706 m, Upstream Dam Fill, dry elevation)
- BP3A (Tip El. 1439.4 m, Glacial Till)
- BP3B (Tip El. 1444 m, Tailings)
- BP3C (Tip El. 1457.7 m, Tailings)
- BP4A (Tip El. 1421.9 m, Glacial Till)
- BP4B (Tip El. 1449.4 m, Tailings)
- BP5A (Tip El. 1450 m, Glacial Till)
- BP5B (Tip El. 1459.1 m, Tailings)
- BP9A (Tip El. 1371.8 m, Tailings)
- BP9B (Tip El. 1411.5 m, Tailings)
- BP9C (Tip El. 1441.9 m, Tailings)
- BP10A (Tip El. 1452.8 m, Tailings)
- BP10B (Tip El. 1462 m, Tailings)
- BP12A (Tip El. 1404 m, Tailings)
- BP12B (Tip El. 1426.1 m, Tailings)
- BP12C (Tip El. 1456.6 m, Tailings)
- BP13A (Tip El. 1431.6 m, Glacial Till)
- BP13B (Tip El. 1442.9 m, Tailings)
- BP14A (Tip El. 1417.8 m, Glacial Till)
- BP-14B (Tip El. 1423.9 m, Tailings)
- BP14C (Tip El. 1447 m, Tailings)
- BP15A (Tip El. 1394.9 m, Glacial Till)
- BP15B (Tip El. 1411.7 m, Tailings)
- BP15C (Tip El. 1440.6 m, Tailings)
- Bethlehem No.1 Pond Level

PIEZOMETER ID	2020 THRESHOLD EL. (m)
BP3A	1454.8
BP3B	1455.9
BP3C	1466.6
BP4A	1466.7
BP4B	1454.6
BP5A	1461.6
BP5B	1465.3
BP9A	1403.4
BP9B	1424.9
BP9C	1449.6
BP10A	1465.2
BP10B	1466.8
BP12A	1420.8
BP12B	1441.8
BP12C	1463.9
BP13A	1441.5
BP13B	1446.0
BP14A	1425.0
BP-14B	1425.7
BP14C	1447.9
BP15A	1447.7
BP15B	1451.0
BP15C	1458.6

NOTES:

1. ONE READING WAS TAKEN FOR EACH PIEZOMETER IN DECEMBER 2019. NO READINGS WERE COLLECTED THEREAFTER.
2. NO READING WAS TAKEN IN DECEMBER 2019 FOR BP10B AS THE WIRE WAS CUT.
3. NO READINGS WERE COLLECTED FOR BP12 OR B15 SERIES IN DECEMBER 2019.

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CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: DAM No. 1 PIEZOMETRIC DATA
2013-2020

IMPOUNDMENT

PROJECT No. M02341B83

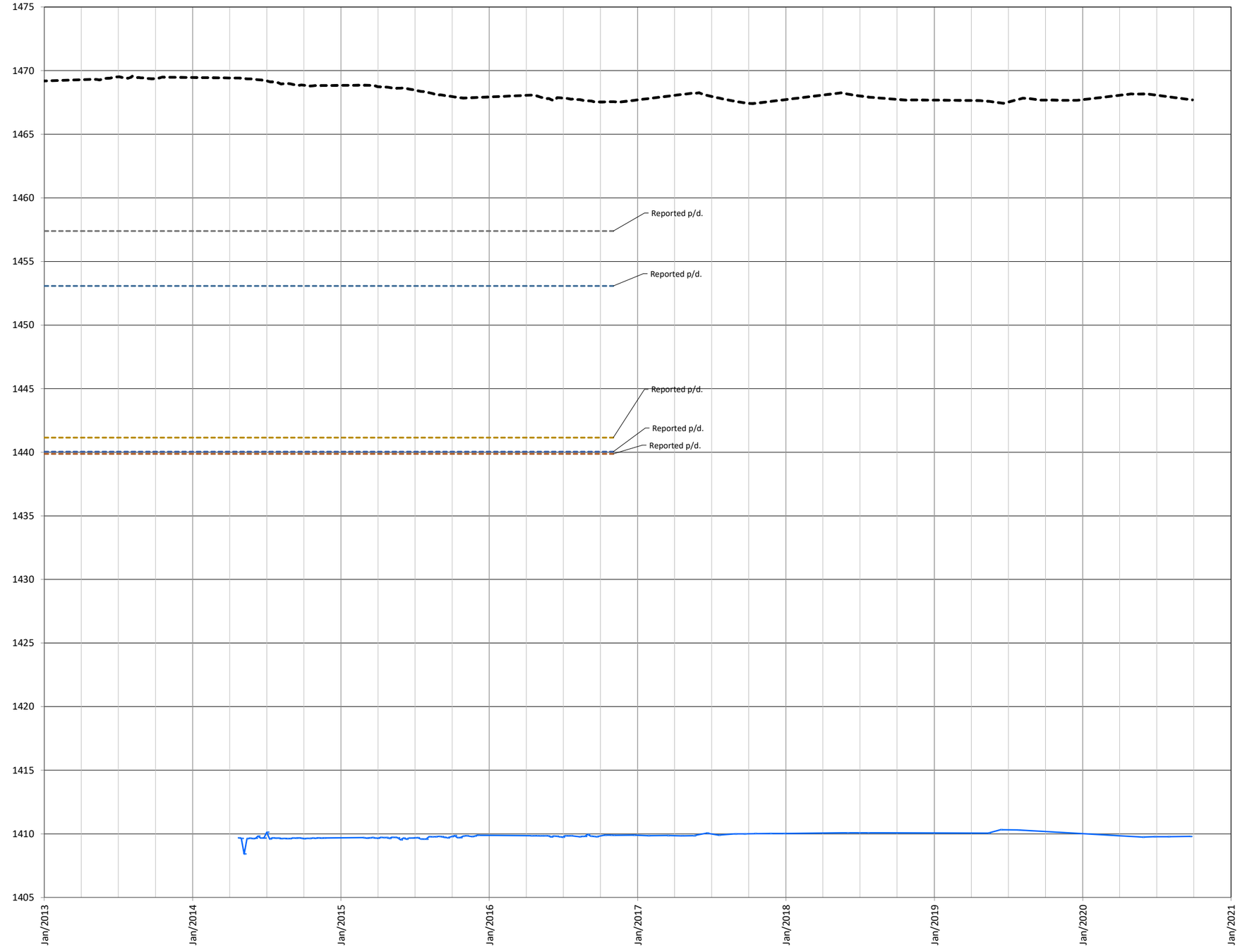
FIG No. II-B-1

November 25, 2020
Z:\MV\CR\M02341B83 - HVC 2020 Dam Safety Support\300 Design\320 Piezometer Data\Bethlehem\[201123 Bethlehem Piezo.xlsx]Piezo Data Entry No.1

LEGEND:

- STANDPIPE NO. 1B (Tip El. 1440.26684 m, Upstream Dam Fill, plugged elevation)
- STANDPIPE NO. 1A (Tip El. 1446.60668 m, Upstream Dam Fill, plugged elevation)
- STANDPIPE NO. 3 (Tip El. 1442.7662 m, Upstream Dam Fill, dry elevation (note 1))
- STANDPIPE NO. 4 (Tip El. 1451.7578 m, Upstream Dam Fill, dry elevation)
- STANDPIPE NO. 7 (Tip El. 1439.8706 m, Upstream Dam Fill, dry elevation)
- 13-SRK-09/P13-5 (Tip El. 1391.2 m, Tailings)
- Bethlehem No.1 Pond Level

PIEZOMETER ID	2020 THRESHOLD EL. (m)
STANDPIPE No. 1A	1457.9
STANDPIPE No. 1B	1440.4
STANDPIPE No. 3	1441.6
STANDPIPE No. 4	1453.6
STANDPIPE No. 7	1440.5
13-SRK-09/P13-5	1411.0



NOTES:

1. STANDPIPE NO. 3 HAS BEEN NOTED AS DRY/PLUGGED IN THE RECORDS AND LIKELY EXPLAINS THE ERRATIC JUMPS IN MEASUREMENTS. HOWEVER A FALLING HEAD TEST CONDUCTED IN 2015 INDICATED THE PIEZOMETER WAS STILL RESPONDING.
2. STANDPIPE NO. 6 WAS TESTED IN 2015 AND FOUND TO BE DEFUNCT.

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Klohn Crippen Berger

PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

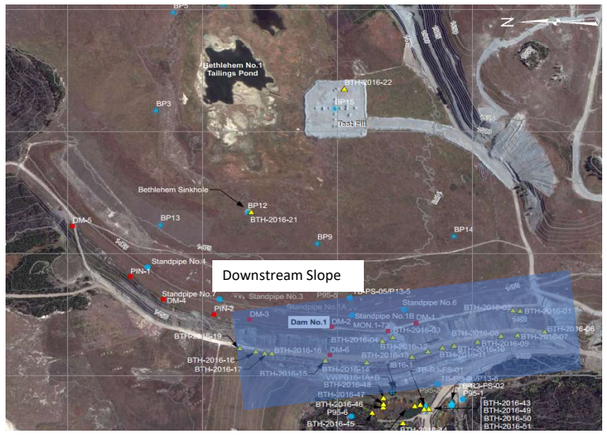
TITLE: DAM No. 1 PIEZOMETRIC DATA
2013-2020

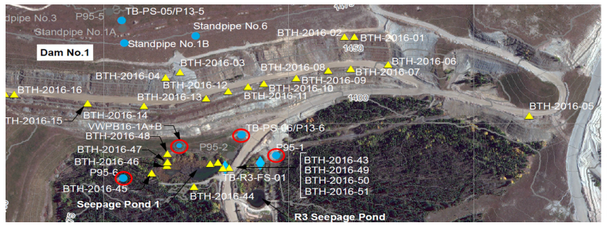
CREST

PROJECT No. M02341B83

FIG No. II-B-2

November 25, 2020
Z:\MV\CR\M02341B83 - HVC 2020 Dam Safety Support\300 Design\320 Piezometer Data\Bethlehem\[201123 Bethlehem Piezo.xlsx]Piezo Data Entry No.1

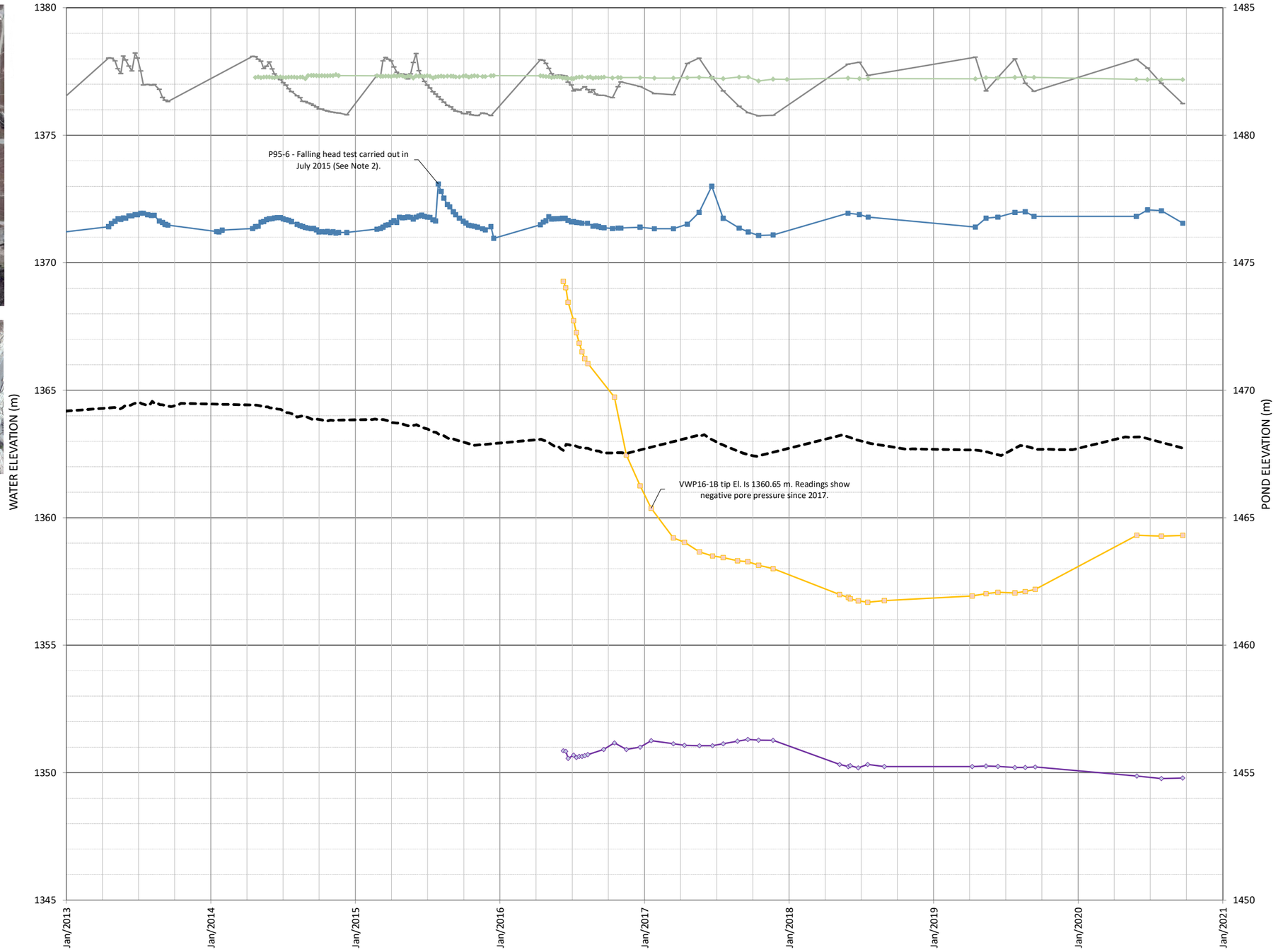




LEGEND:

- VWP16-1B (Tip El. 1360.65 m, Glacial Till)
- P95-1 (Tip El. 1373.7 m, Downstream Foundation)
- P95-6 (Tip El. 1368.190784 m, Downstream Foundation)
- 13-SRK-12B/P13-6 (Tip El. 1357.2 m, Glacial Till)
- VWP16-1A (Tip El. 1346.15 m, Glacial Till)
- Bethlehem No.1 Pond Level

PIEZOMETER ID	2020 THRESHOLD EL. (m)
P95-1	1379.0
P95-6	1373.6
13-SRK-12B/P13-6	1377.9
VWP16-1A	1351.7
VWP16-1B	1369.8



NOTES:

1. PIEZOMETER WATER ELEVATIONS PLOTTED ON PRIMARY (LEFT) AXIS, POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.
2. FALLING HEAD TEST CARRIED OUT ON P95-6 DURING JULY 2015 - CAUSE OF SPIKE IN PIEZOMETRIC LEVELS.
3. JUNE 25, 2020 WATER LEVELS AT VWP16-1A AND VWP16-1B ARE NOT MEASURED AND PLOTTED BECAUSE THE BAROMETRIC PRESSUER READINGS WERE NOT TAKEN.

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CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

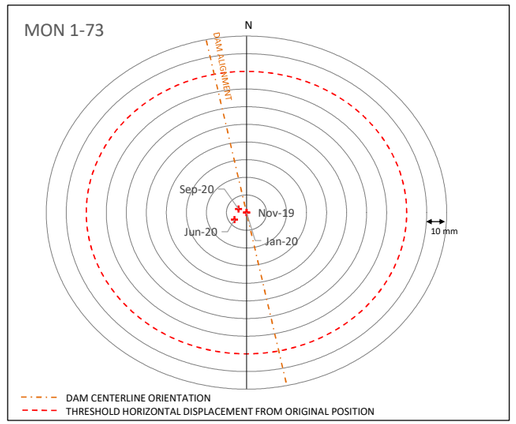
TITLE: DAM No. 1 PIEZOMETRIC DATA
2013-2020

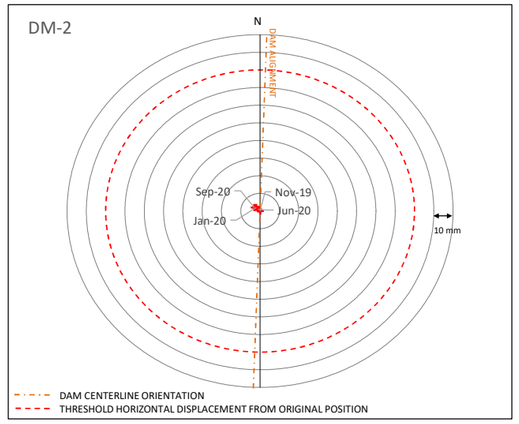
DOWNSTREAM SLOPE

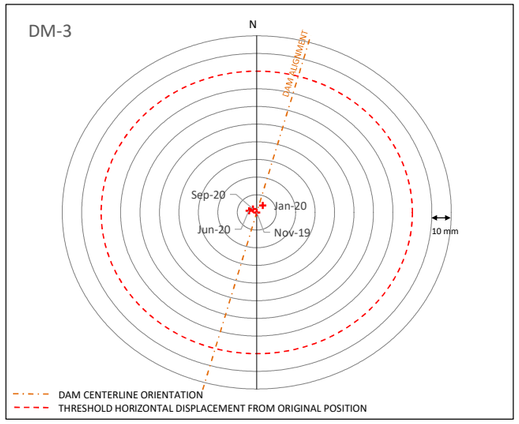
PROJECT No. M02341B83

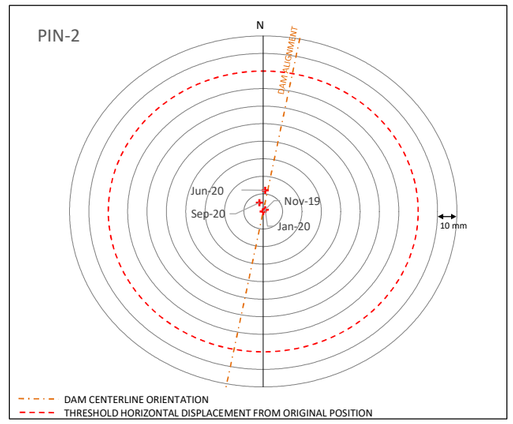
FIG No. II-B-3

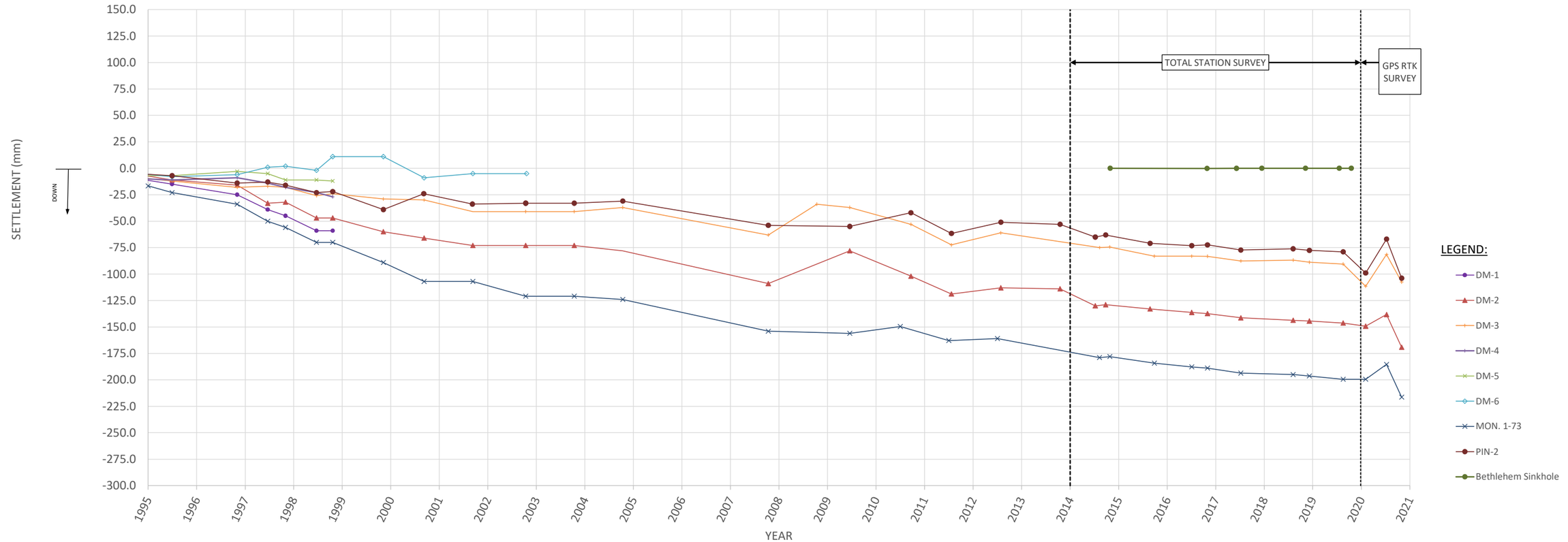
November 25, 2020
Z:\MVCR\M02341B83 - HVC 2020 Dam Safety Support\300 Design\320 Piezometer Data\Bethlehem\[201123 Bethlehem Piezo.xlsx]Piezo Data Entry No.1











NOTES:

1. SURVEY METHOD SWITCHED FROM TOTAL STATION TO GPS RTK ON NOVEMBER 26, 2019.
2. HORIZONTAL DISPLACEMENT PRIOR TO NOVEMBER 2019 NOT SHOWN. HORIZONTAL DISPLACEMENT BASELINES SET TO NOVEMBER 26, 2019 GPS RTK SURVEY READINGS.
3. DAM No. 1 MOVEMENT MONITORING DATA PRIOR TO 1995 NOT SHOWN.
4. REFER TO FIGURE 3 FOR MONUMENT LOCATIONS IN PLAN VIEW.
5. DM-1, DM-4 AND DM-5 DESTROYED IN 1999.
6. DM-6 DESTROYED IN 2002.
7. 2008 SETTLEMENT DATA OF DM-2, MON. 1-73, AND PIN-2 WERE OUTLIERS AND NOT PLOTTED.
8. 2020 SETTLEMENT PLOTTED BY ADDING INCREMENTAL DISPLACEMENT BETWEEN GPS RTK SURVEY READINGS TO CUMULATIVE TOTAL DISPLACEMENT ON JULY 16, 2019. THIS ASSUMES NO SETTLEMENT OCCURED BETWEEN JULY 16 AND NOVEMBER 26, 2019.

MONUMENT ID	TOTAL STATION SURVEY METHOD THRESHOLDS		
	HORIZONTAL DISPLACEMENT FROM ORIGINAL POSITION (mm)	INCREMENTAL SETTLEMENT BETWEEN READINGS (mm)	TOTAL SETTLEMENT (mm)
MON 1-73	80	20	240
DM-2			170
DM-3			125
PIN-2			125
Bethlehem Sinkhole			250

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CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

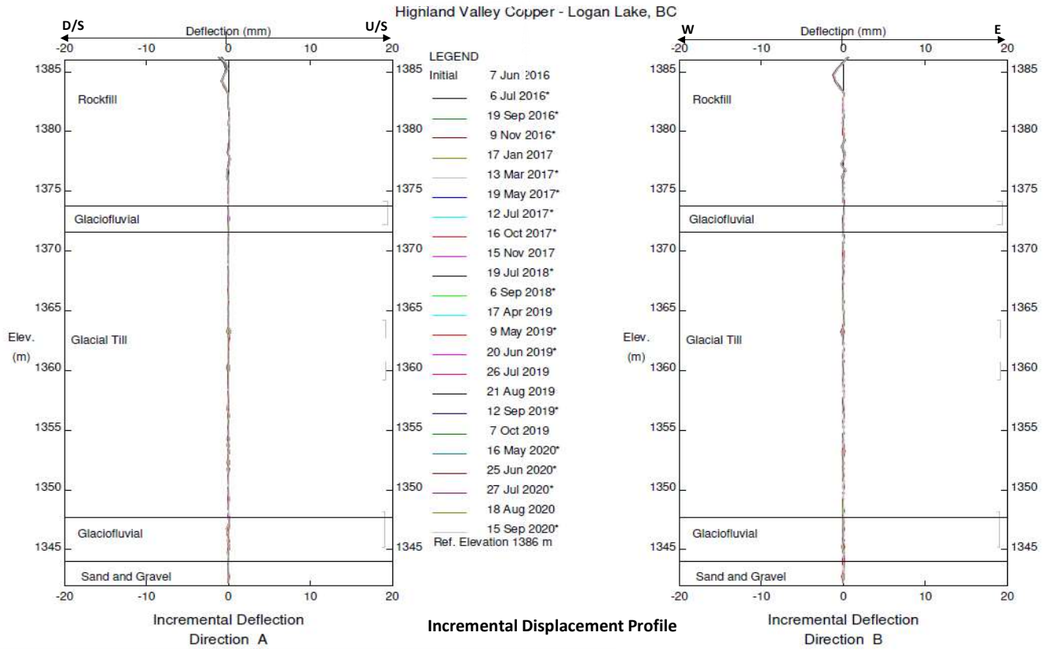
PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: DAM NO. 1
SURVEY MONUMENT READINGS

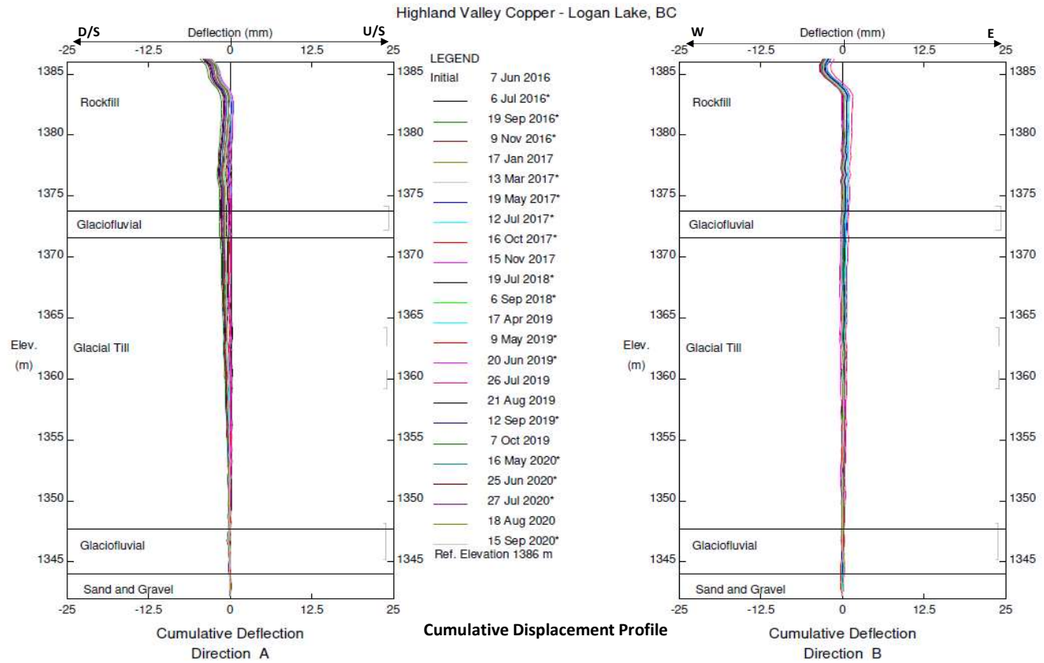
PROJECT No. M02341B83

FIG No. II-B-4

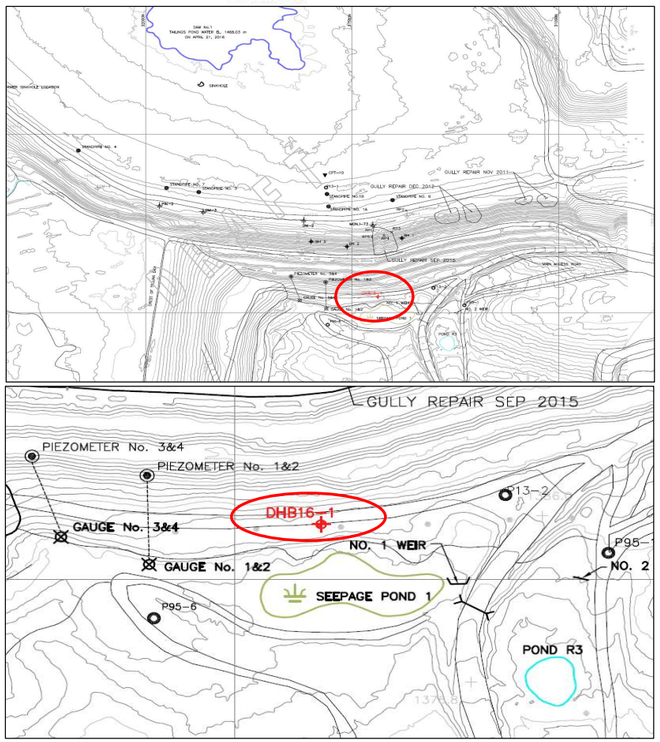
November 25, 2020
Z:\MV\CR\M02341B83 - HVC 2020 Dam Safety Support\300 Design\340 Dam Movement Monitoring\347 Survey Monuments\Bethlehem\[201123 BethMainDamMonitoring.xlsm]Fig V-B-4

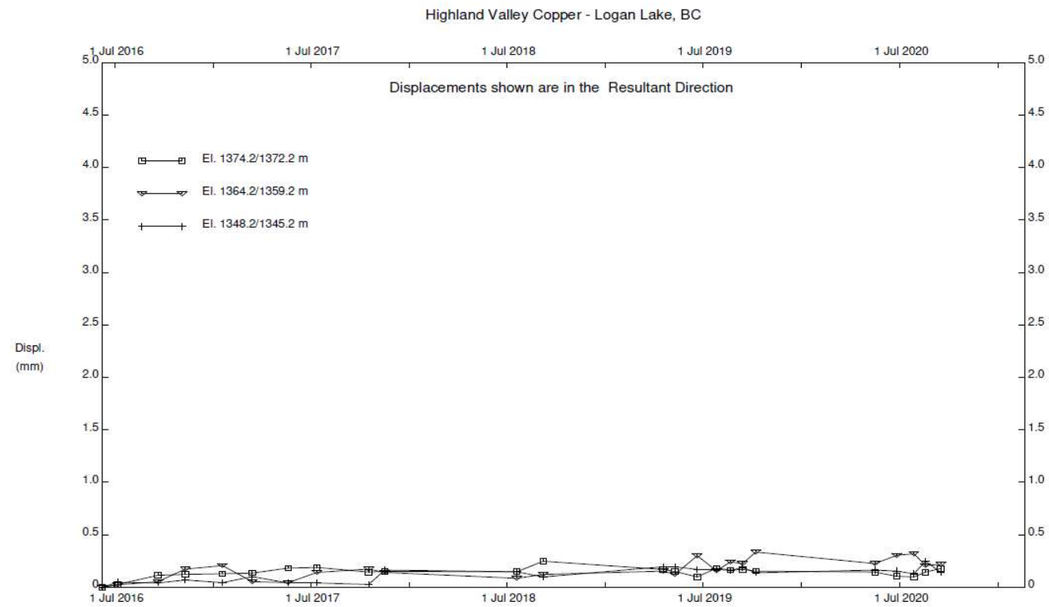


Incremental Displacement Profile



Cumulative Displacement Profile





Cumulative Displacement Profile vs. Time

NOTES:

1) IB16-1 was installed on April 20, 2016.
2) IB16-1 was initialized on June 07, 2016.
3) Reel/Probe Serial Number for the initial reading: DR15020000/DP06580000.

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Klohn Crippen Berger

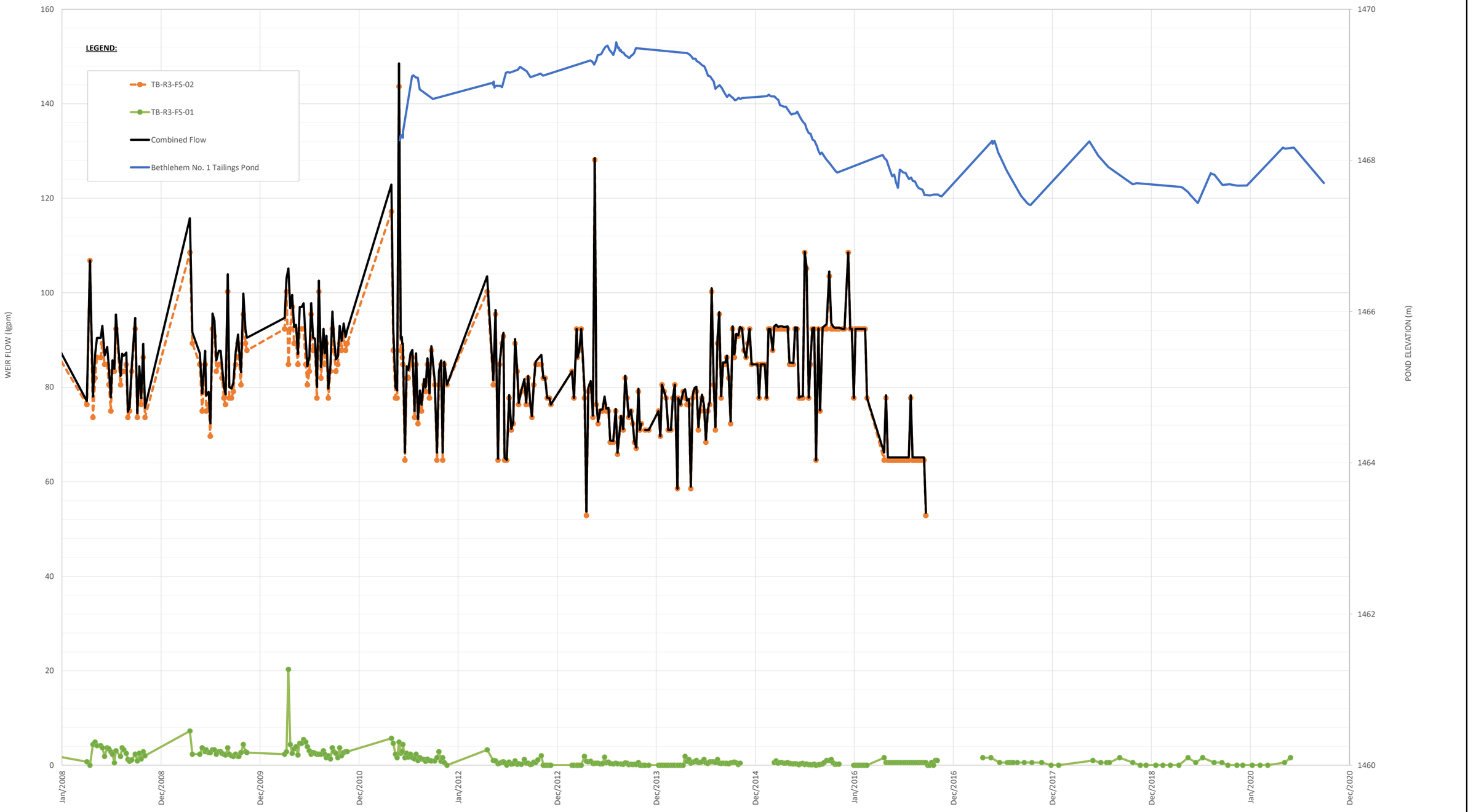
PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: INCLINOMETER DISPLACEMENT PROFILE
IB16-1

PROJECT No. M02341B83

FIG No. II-B-5

November 23, 2020
\\int.klohn.com\busdata\MVCR\600 QMS & PM\620 PM\623 Staff Planning\[Staff Planning Detailed.xlsx]Name Summary



NOTES:

1. WEIR FLOW PLOTTED ON PRIMARY (LEFT) AXIS, BETHLEHEM NO. 1 TAILINGS POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.
2. TB-R3-FS-02 (WEIR 1) REMOVED OCTOBER 2016, COMBINDED FLOW ONLY PLOTTED UNTIL THAT DATE.

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CLIENT: Highland Valley Copper / Teck

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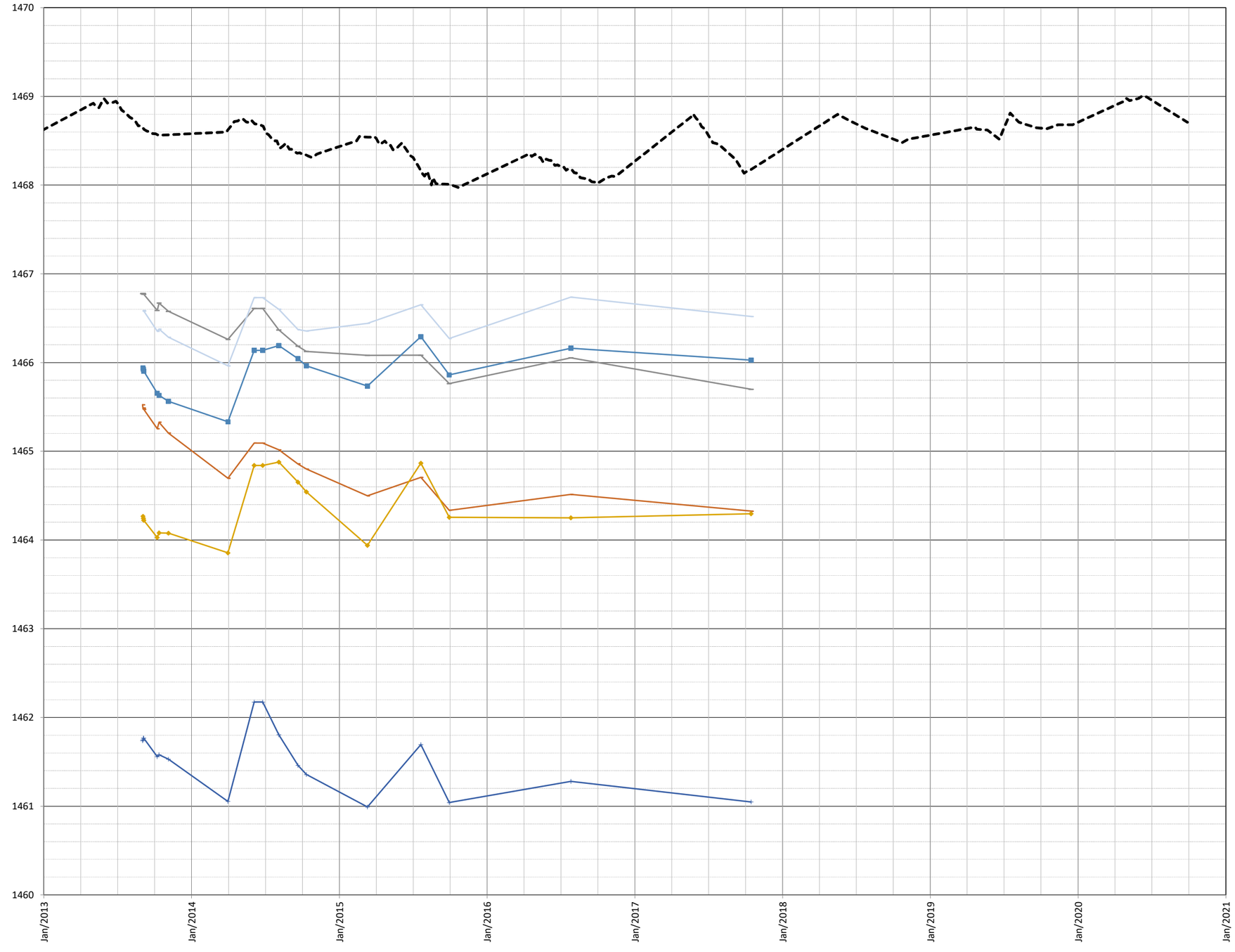
PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: DAM NO. 1
WEIR FLOWS

PROJECT No.: M02341B83

FIG No.: II-B-6

November 25, 2020
Z:\MV\CRM\02341B83 - HVC 2020 Dam Safety Support\500 Design\350 Seepage Data\Bethlehem\[20110S0 Beth Weir x ls x]II-B-6 Seepage



LEGEND:

- BP6A (Tip El. 1431.1 m, Glacial Till)
- BP6B (Tip El. 1441.8 m, Tailings)
- BP6C (Tip El. 1455.5 m, Tailings)
- BP7A (Tip El. 1439.6 m, Glacial Till)
- BP7B (Tip El. 1448.7 m, Tailings)
- BP7C (Tip El. 1459.4 m, Tailings)
- Bethlehem No.2 Pond Level

PIEZOMETER ID	2020 THRESHOLD EL. (m)
BP6A	1462.8
BP6B	1466.0
BP6C	1467.3
BP7A	1469.1
BP7B	1469.1
BP7C	1468.3

NOTES:

1. NO READINGS WERE TAKEN IN 2019 or 2020.

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CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

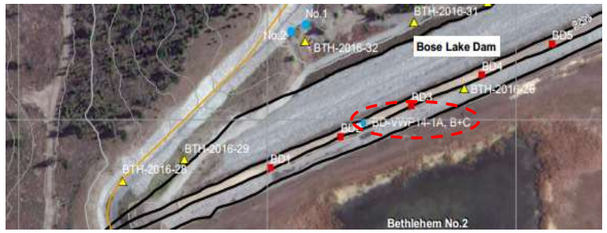
TITLE: BOSE LAKE DAM PIEZOMETRIC DATA
2013-2020

IMPOUNDMENT

PROJECT No. M02341B83

FIG No. II-B-7

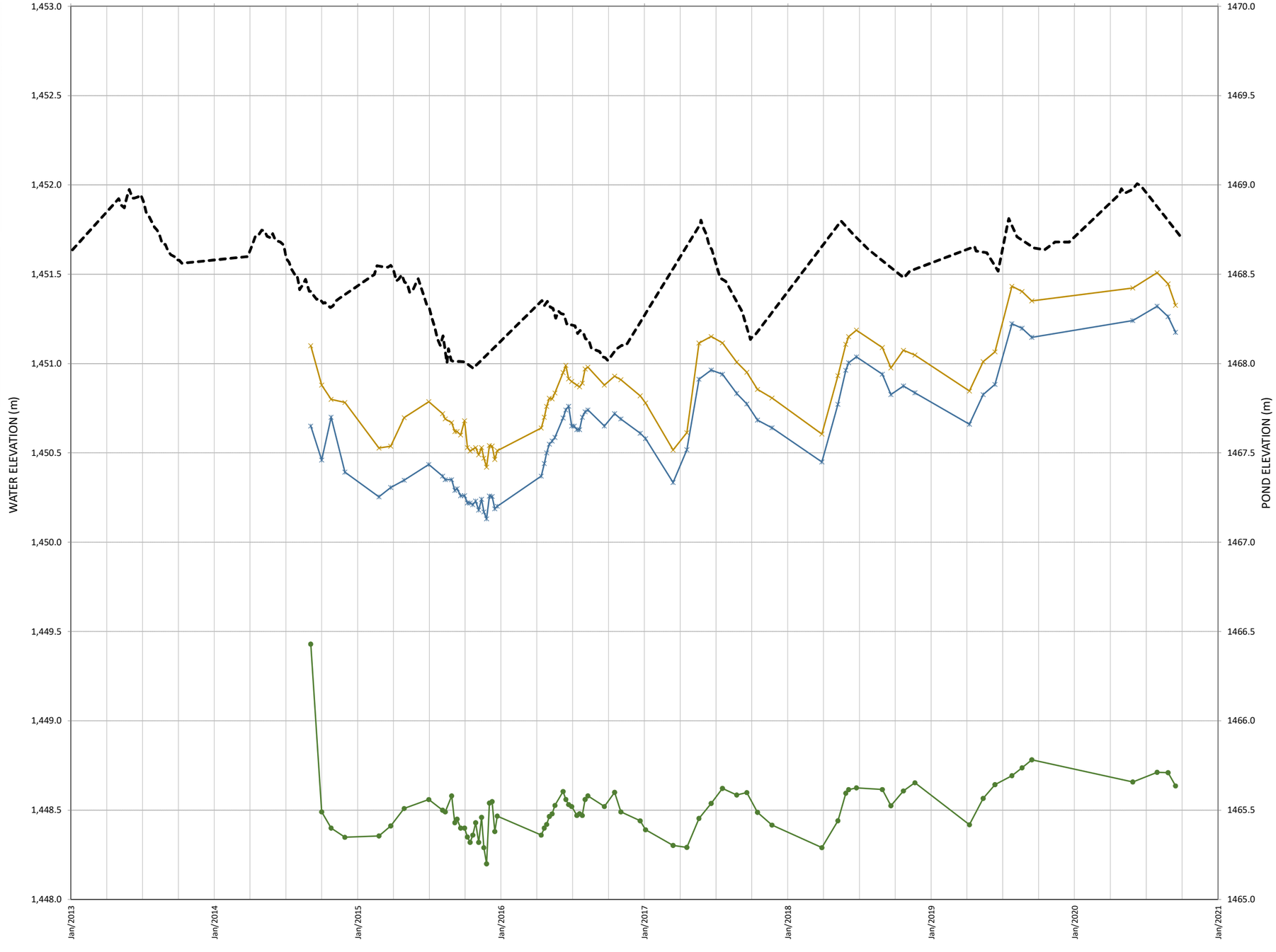
January 12, 2021
Z:\MVCR\M02341B83 - HVC 2020 Dam Safety Support\300 Design\320 Piezometer Data\Bethlehem\[201215 Bethlehem Piezo.xlsx]II-B-9 BLD DOWNSTREAM TOE



LEGEND:

- Bethlehem No.2 Pond Level
- BD-VWP14-1A (Tip El. 1425.1 m, Bedrock)
- BD-VWP14-1B (Tip El. 1435.1 m, Overburden)
- BD-VWP14-1C (Tip El. 1448.1 m, Dam Fill)

PIEZOMETER ID	2020 THRESHOLD EL. (m)
BD-VWP14-1A	1452.0
BD-VWP14-1B	1451.7
BD-VWP14-1C	1449.9



NOTES:

1. PIEZOMETER WATER ELEVATIONS PLOTTED ON PRIMARY (LEFT) AXIS, POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.
2. JUNE 25, 2020 WATER LEVELS ARE NOT MEASURED AND PLOTTED BECAUSE THE BAROMETRIC PRESSURE READINGS WERE NOT TAKEN.

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CLIENT: Highland Valley Copper / Teck

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PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: BOSE LAKE DAM PIEZOMETRIC DATA
2013-2020

CREST

PROJECT No. M02341B83

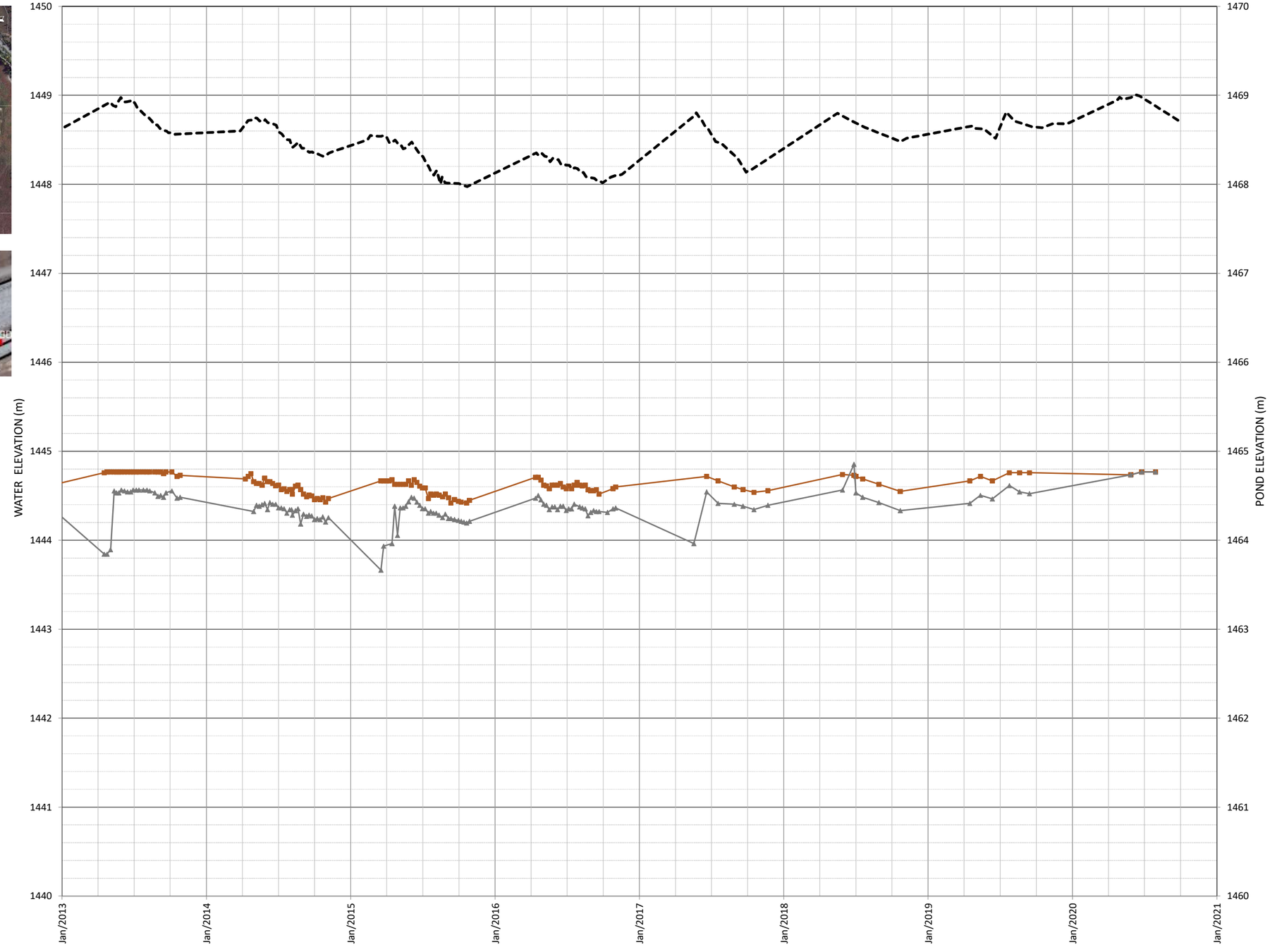
FIG No. II-B-8

January 12, 2021
Z:\MVCR\M02341B83 - HVC 2020 Dam Safety Support\300 Design\320 Piezometer Data\Bethlehem\[201215 Bethlehem Piezo.xlsx]II-B-9 BLD DOWNSTREAM TOE

LEGEND:

- No. 1 (Tip El. 1433.0126 m, Overburden / Bedrock)
- No. 2 (Tip El. 1434.2318 m, Overburden / Bedrock)
- Bethlehem No.2 Pond Level

PIEZOMETER ID	2020 THRESHOLD EL. (m)
No. 1	1445.3
No. 2	1445.2



NOTES:

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

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CLIENT: Highland Valley Copper / Teck

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PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

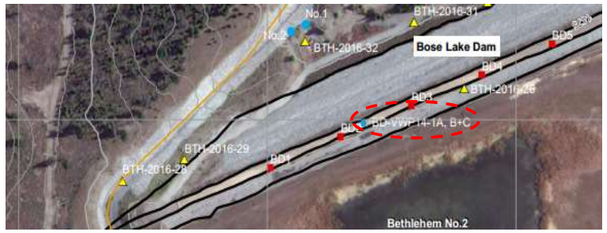
TITLE: BOSE LAKE DAM PIEZOMETRIC DATA
2013-2020

DOWNSTREAM TOE

PROJECT No. M02341B83

FIG No. II-B-9

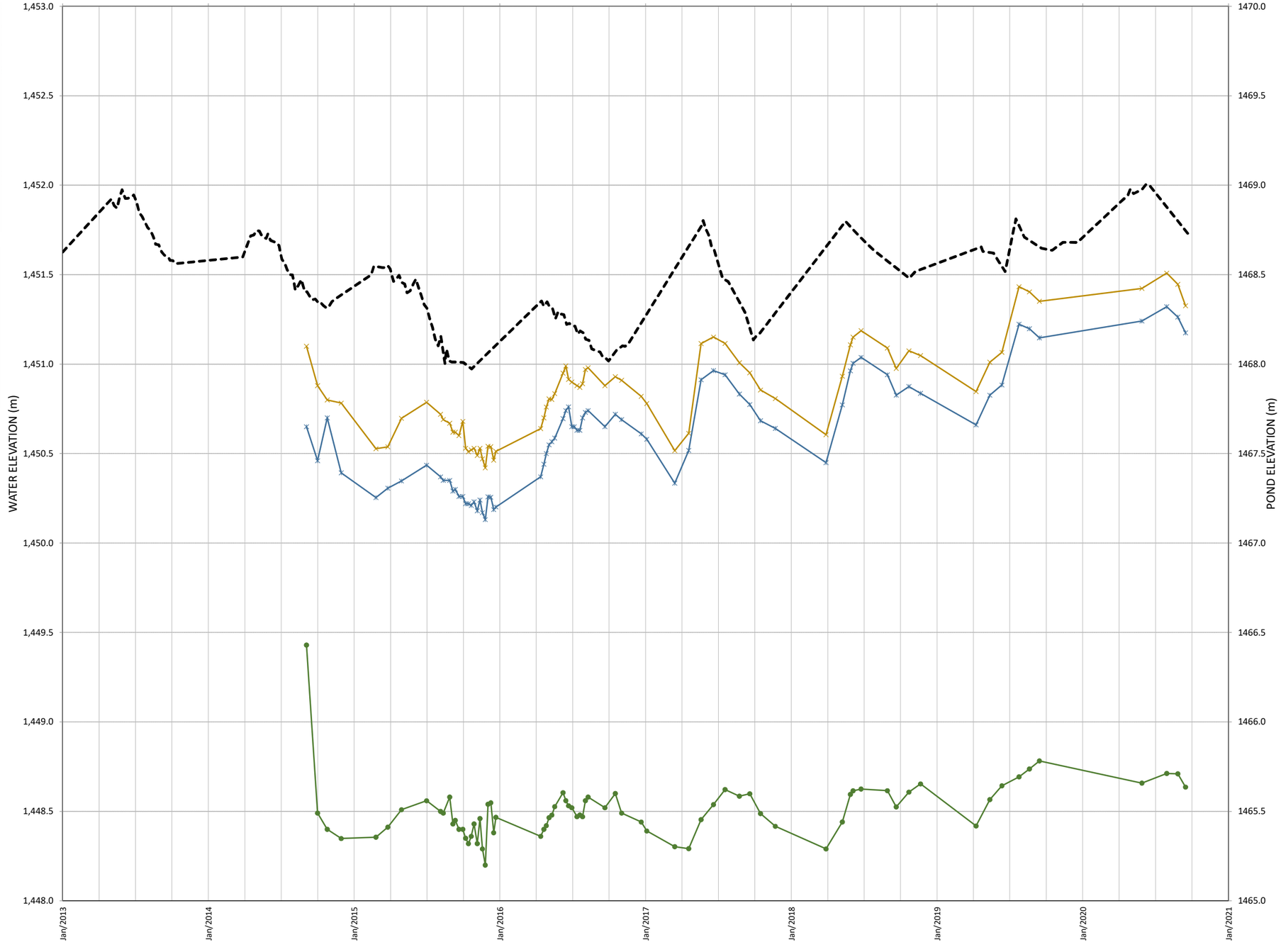
January 12, 2021
Z:\MV\CRM\M02341B83 - HVC 2020 Dam Safety Support\300 Design\320 Piezometer Data\Bethlehem\[201215 Bethlehem Piezo.xlsx]II-B-9 BLD DOWNSTREAM TOE



LEGEND:

- Bethlehem No.2 Pond Level
- BD-VWP14-1A (Tip El. 1425.1 m, Bedrock)
- BD-VWP14-1B (Tip El. 1435.1 m, Overburden)
- BD-VWP14-1C (Tip El. 1448.1 m, Dam Fill)

PIEZOMETER ID	2020 THRESHOLD EL. (m)
BD-VWP14-1A	1452.0
BD-VWP14-1B	1451.7
BD-VWP14-1C	1449.9



NOTES:

1. PIEZOMETER WATER ELEVATIONS PLOTTED ON PRIMARY (LEFT) AXIS, POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.
2. JUNE 25, 2020 WATER LEVELS ARE NOT MEASURED AND PLOTTED BECAUSE THE BAROMETRIC PRESSUER READINGS WERE NOT TAKEN.

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CLIENT: Highland Valley Copper / Teck

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PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

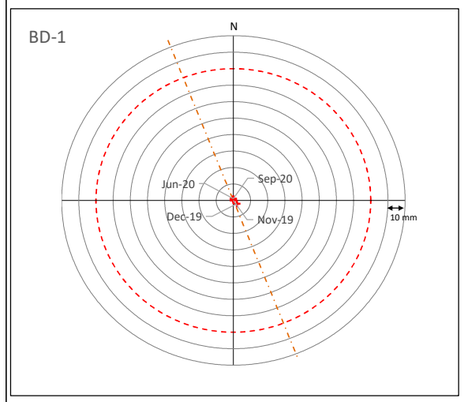
TITLE: BOSE LAKE DAM PIEZOMETRIC DATA
2013-2020

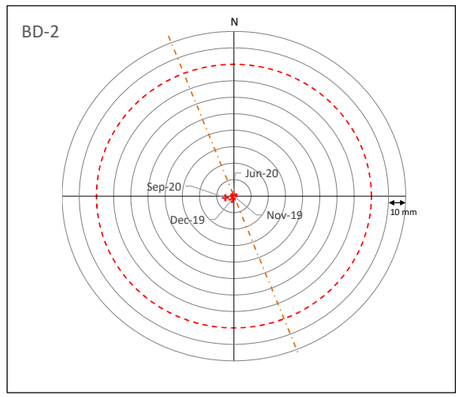
CREST

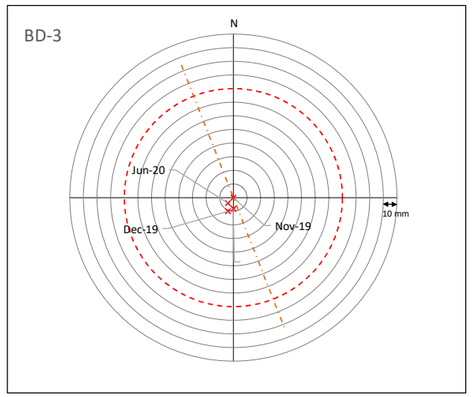
PROJECT No. M02341B83

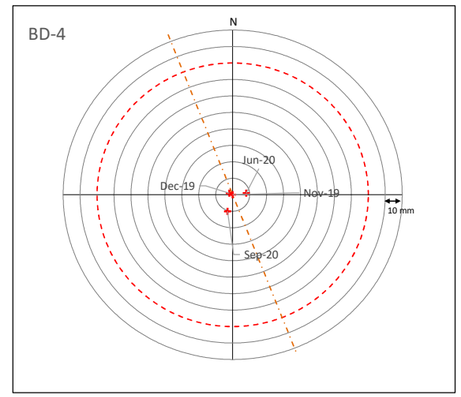
FIG No. II-B-8

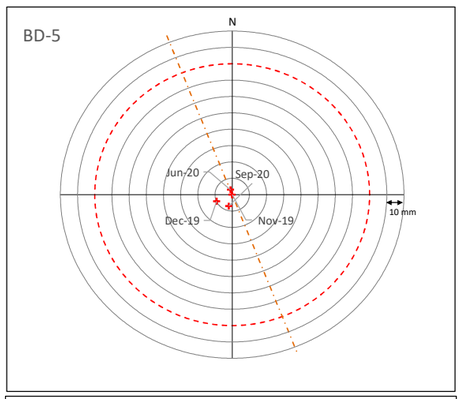
January 6, 2021
Z:\MVCR\M02341B83 - HVC 2020 Dam Safety Support\300 Design\320 Piezometer Data\Bethlehem\[201215 Bethlehem Piezo.xlsx]II-B-8 BLD CREST (2)

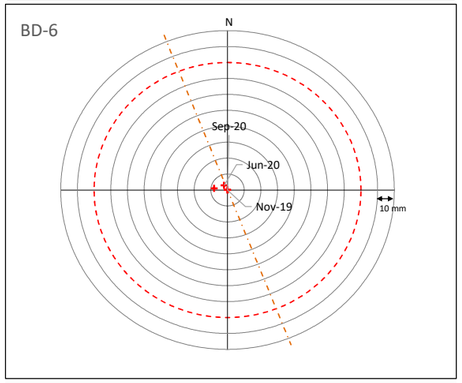


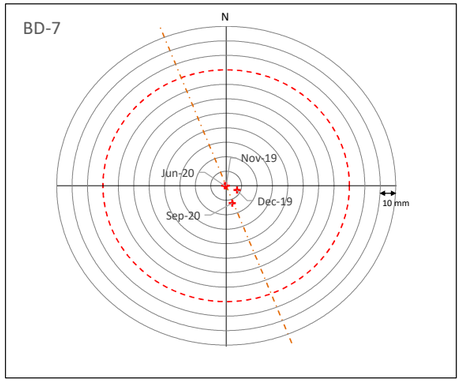


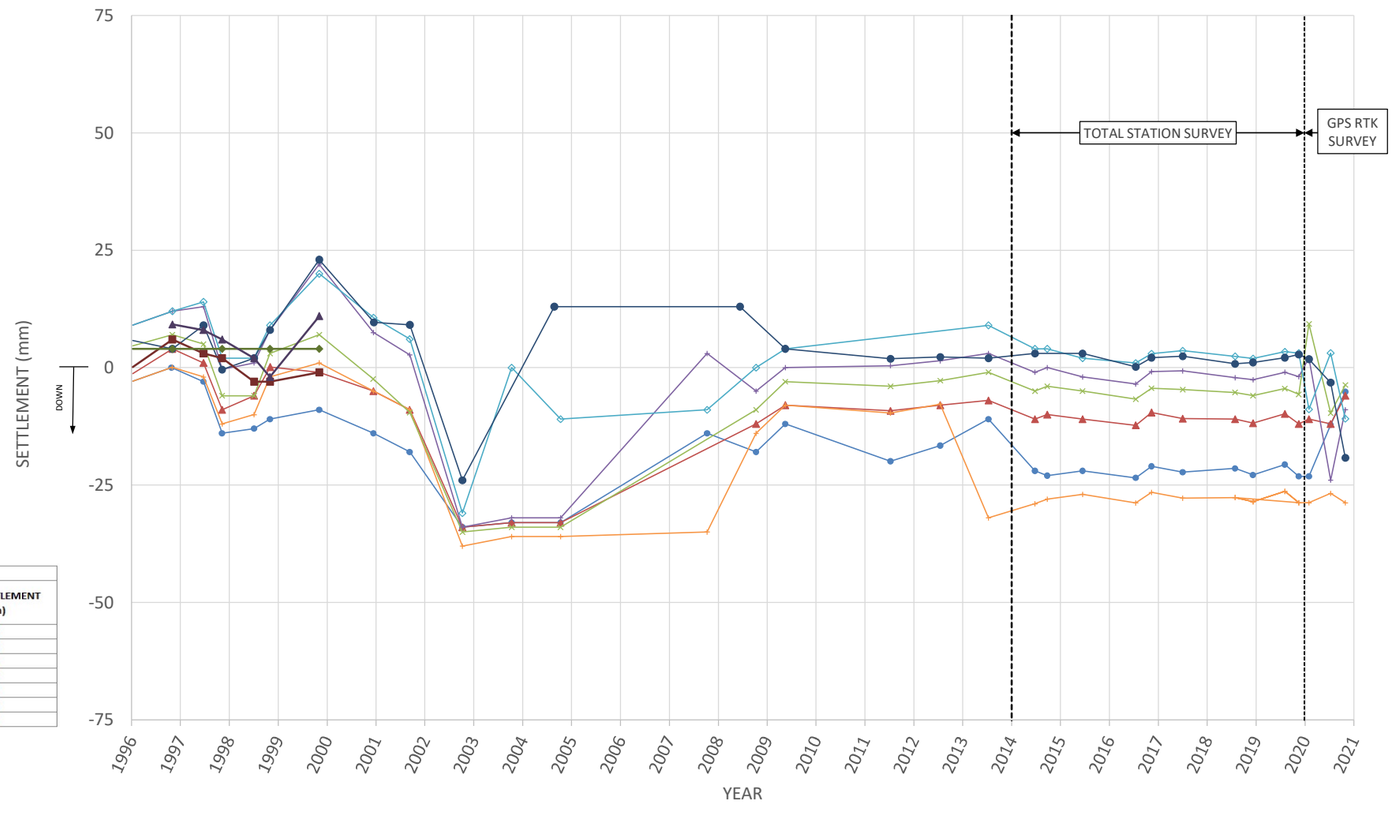












MONUMENT ID	TOTAL STATION SURVEY METHOD THRESHOLDS		
	HORIZONTAL DISPLACEMENT FROM ORIGINAL POSITION (mm)	INCREMENTAL SETTLEMENT BETWEEN READINGS (mm)	TOTAL SETTLEMENT (mm)
BD-1	80	20	75
BD-2			50
BD-3			75
BD-4			50
BD-5			50
BD-6			50
BD-7			50

DAM CENTERLINE ORIENTATION

THRESHOLD HORIZONTAL DISPLACEMENT FROM ORIGINAL POSITION

NOTES:

1. SURVEY METHOD SWITCHED FROM TOTAL STATION TO GPS RTK ON NOVEMBER 12, 2019.
2. HORIZONTAL DISPLACEMENT PRIOR TO NOVEMBER 2019 NOT SHOWN. HORIZONTAL DISPLACEMENT BASELINES SET TO NOVEMBER 12, 2019 GPS RTK SURVEY READINGS.
3. BOSE LAKE DAM CREST MOVEMENT MONITORING DATA PRIOR TO 1996 NOT SHOWN.
4. REFER TO FIGURE 4 FOR MONUMENT LOCATIONS IN PLAN VIEW.
5. BD-8, BD-9 AND BD-10 DESTROYED IN 1999 OR 2000.
6. BD-1 2010 READING (NOT SHOWN IN PLAN PLOT) LOCATED 1505 mm FROM INITIAL 1993 READING. READING WAS REVIEWED AND FOUND MORE LIKELY RELATED TO SURVEY ERROR THAN DISPLACEMENT.
7. BD-5 2010 READING (NOT SHOWN IN PLAN PLOT) LOCATED 294 mm FROM INITIAL 1993 READING. READING WAS REVIEWED AND FOUND MORE LIKELY RELATED TO SURVEY ERROR THAN DISPLACEMENT.
8. BD-3 SHIFT BETWEEN PRE AND POST 2013 SURVEYS WHICH COULD BE THE RESULT OF DAMAGE OR SURVEY DATUM. NOT AN INDICATOR OF DAM SAFETY ISSUE.
9. BD-7 2003 SETTLEMENT DATA WAS OUTLIER AND NOT PLOTTED.
10. 2007 SETTLEMENT DATA OF BD-4, AND BD-2 WERE OUTLIERS AND NOT PLOTTED.
11. 2020 SETTLEMENT PLOTTED BY ADDING INCREMENTAL DISPLACEMENT BETWEEN GPS RTK SURVEY READINGS TO CUMULATIVE TOTAL DISPLACEMENT ON JULY 2, 2019. THIS ASSUMES NO SETTLEMENT OCCURED BETWEEN JULY 2 AND NOVEMBER 12, 2019.

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CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: BETHLEHEM NO. 1 TAILINGS STORAGE FACILITY
2020 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: BOSE LAKE DAM
SURVEY MONUMENT READINGS

PROJECT No. M02341B83

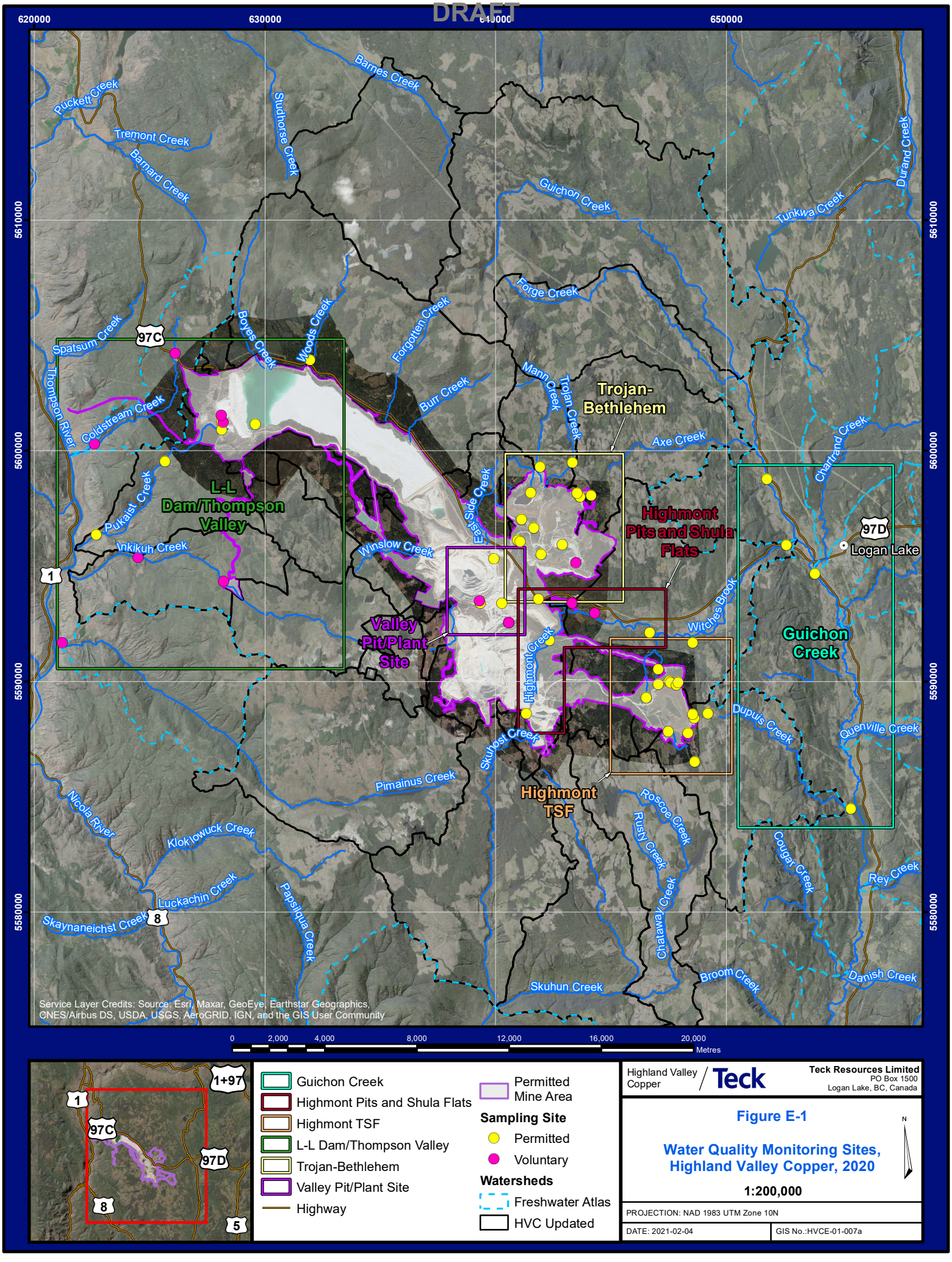
FIG No. II-B-10

November 25, 2020
Z:\MV\CR\M02341B83 - HVC 2020 Dam Safety Support\300 Design\340 Dam Movement Monitoring\347 Survey Monuments\Bethlehem\[201123 BoseLakeDamMonitoring.xlsm]Fig V-B-10

APPENDIX III

Map of Water Quality Monitoring Points

DRAFT



- Guichon Creek
- Highmont Pits and Shula Flats
- Highmont TSF
- L-L Dam/Thompson Valley
- Trojan-Bethlehem
- Valley Pit/Plant Site
- Highway
- Permitted Mine Area

Sampling Site
- Permitted
- Voluntary

Watersheds
- Freshwater Atlas
- HVC Updated

Highland Valley Copper / Teck

Teck Resources Limited
PO Box 1500
Logan Lake, BC, Canada

Figure E-1

Water Quality Monitoring Sites, Highland Valley Copper, 2020

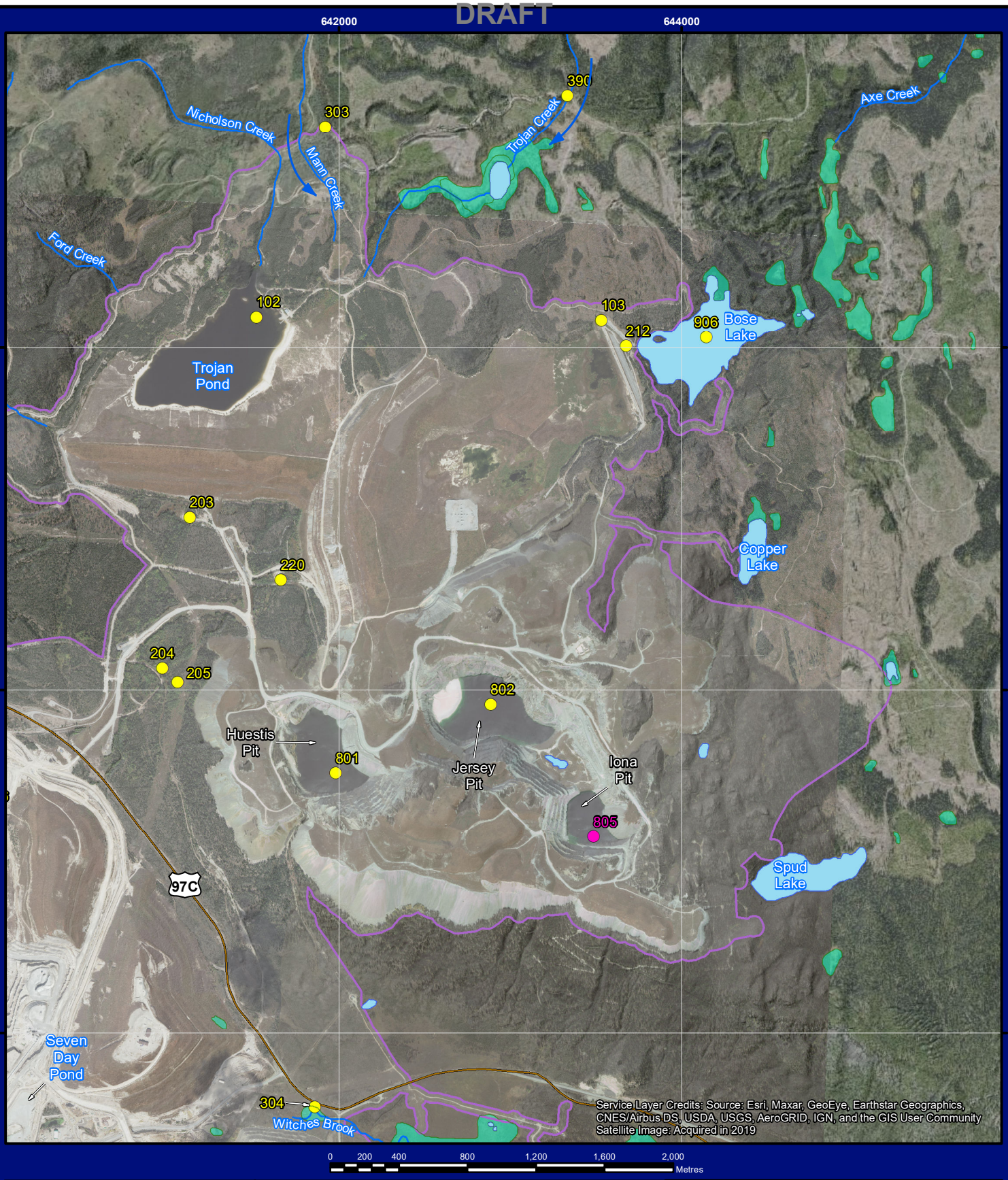
1:200,000

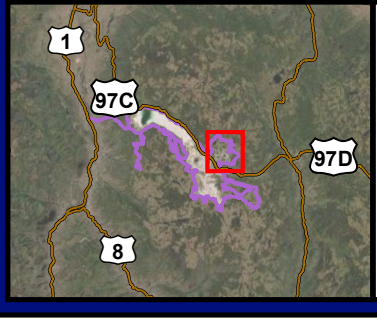
PROJECTION: NAD 1983 UTM Zone 10N

DATE: 2021-02-04

GIS No.:HVCE-01-007a

DRAFT





Sampling Site

- Permitted
- Voluntary
- Permitted Mine Area
- Wetland
- Highland Valley Copper
- Highway
- Flow Direction

Highland Valley Copper / Teck

Teck Resources Limited
PO Box 1500
Logan Lake, BC, Canada

Figure 3.2-30
Water Quality Monitoring Sites in the Trojan-Bethlehem Area, Highland Valley Copper, 2020

1:30,000

N

PROJECTION: NAD 1983 UTM Zone 10N

DATE: 2021-02-05 | GIS No.:HVCE-01-007d

APPENDIX IV

DSR Recommendations – THVCP Work Plan

Appendix IV
Annual Facility Performance Report and DSR Recommendations – THVCP Workplan

Table IV-1 Bethlehem TSF: 2018 SRK DSR Recommendations for Deficiencies and Non-Conformances

ID No.	Recommended Action	DSR Assigned Priority[1]	Status (Scheduled completion)	Workplan To Complete
Bethlehem No. 1 Tailings Storage Facility				
SRK19-BD-01	THVCP have installed public safety signs as recommended by AMEC in the previous DSR (AMEC 2014a). However, these signs do not identify hazards specifically. Include identification and description of hazards in the public safety signs near the Bose Lake Dam.	4	OPEN (2021)	The AMEC DSR is specific to public safety signs bystanders for hazards near dams, specifically the site gates near Bose Lake Dam and Trojan Pond. THVCP is to review signage requirements and take actions as appropriate.
SRK19-BD-02	*Update stability analyses to include sensitivities to the phreatic surface. If phreatic levels are shown to be critical to stability, re-define thresholds based on the results of stability and/or other appropriate engineering analyses.*	*4*	*CLOSED*	*Piezometric sensitivity analysis was completed as part of updated slope stability assessment finalized by KCB in 2020 (KCB 2020a).*
SRK19-BD-03	*The earthquake used in the 1996 stability assessment (KCC 1996) does not meet the current criterion for annual exceedance probability. Utilize the appropriate earthquake in the stability assessment.*	*3*	*CLOSED*	*Appropriate Earthquake Design Ground Motion, based on most recent seismic hazard study, was used for the updated slope stability assessment finalized by KCB in 2020 (KCB 2020a).*
SRK19-BD-04	The PMF design flood was not evaluated in accordance with CDA (2013) Evaluate the spring and summer/autumn PMF as per CDA (2013) and update the flood routing analysis.	3	OPEN (2021)	Refer to Annual Facility Performance Report recommendation BTSF-2018-01.
SRK19-BD-05	Determine normal operating water level if different than spillway invert and evaluate the required normal freeboard as per CDA (2013).	3	OPEN (2021)	Will be completed as part of planned flood routing review, refer to Annual Facility Performance Report recommendation BTSF-2018-01.
SRK19-BD-06	*Include maintenance requirements for the log boom in the OMS manual.*	*3*	*CLOSED*	*Add as part of the OMS Manual update started in 2020.*
R3 Seepage Pond				
SRK19-R3-01	*The dam crest elevation is reported as 1371 m in the current OMS manual (THVCP 2016) and the latest DSI (KCB 2018). It is reported as 1371.8 m in the latest freeboard evaluation report (KCB 2018). Reconcile the dam crest elevation and include in the final OMS currently being finalised.*	*4*	*CLOSED*	*Clarified in the OMS Manual update started in 2020.*
SRK19-R3-02	The 100-year inflow design flood is not based on the most recent hydrology. Update the inflow design flood and flood routing with the most recent hydrology.	4	OPEN (2021)	Will be completed as part of planned flood routing review which includes the R3 Pond, refer to Annual Facility Performance Report recommendation BTSF-2018-01.
SRK19-R3-03	The required normal freeboard as per CDA (2013) was not evaluated. Determine maximum normal operating water level if different than spillway invert and evaluate the required normal freeboard as per CDA (2013).	3	OPEN (2021)	Will be completed as part of planned flood routing review which includes R3 Pond, refer to Annual Facility Performance Report recommendation BTSF-2018-01.
SRK19-R3-04	*The emergency spillway channel has a large concrete block in the inlet which would affect flood capacity. Remove the concrete block in the spillway channel.*	*3*	*CLOSED*	*THVCP removed the concrete block from the spillway channel in December 2020.*
SRK19-R3-05	*KCB (2017) reports that a stability analysis carried out to support the DSI indicated that the FOS for a deep-seated failure was compliant with the Code (MEM, 2017), but there is no reference for such analysis. Include the references for the stability assessments of R3 Reclaim Pond in the OMS manual.*	*3*	*CLOSED*	*KCB completed stability analysis which concluded structure met slope stability design criteria for static and seismic loading conditions.*

Notes:
1. Recommendation priority guidelines, specified by Teck and assigned by DSR author:
   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.