Klohn Crippen Berger

Teck Highland Valley Copper Partnership

2018 Dam Safety Inspection Report

Highmont Tailings Storage Facility

CANADA'S BEST MANAGED COMPANIES Platinum member

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March 2019

March 26, 2019

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

Mr. Chris Anderson
Manager, Tailings and Water

Dear Mr. Anderson:

2018 Dam Safety Inspection Report
Highmont Tailings Storage Facility

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

Yours truly,

KLOHN CRIPPEN BERGER LTD.

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

RF/PU:cd

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2018 Dam Safety Inspection Report

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EXECUTIVE SUMMARY

Klohn Crippen Berger Ltd. (KCB) were engaged by Teck Highland Valley Copper Partnership (THVCP) to complete the 2018 Dam Safety Inspection (DSI) of the Highmont Tailings Storage Facility (TSF) on the Highland Valley Copper (HVC) mine site in accordance with the requirements of the Health, Safety and Reclamation Code for Mines in British Columbia (the Code). The visual inspection was completed by the Engineer of Record (EoR), Mr. Rick Friedel, P.Eng., and Mr. Pablo Urrutia, P.Eng., as representatives of KCB on September 19, 2018. Mr. Chris Anderson, P. Eng., THVCP Tailings and Water Superintendent, is the TSF Qualified Person (as defined by the Code) for Highmont TSF.

The DSI includes the North Dam, East Dam, and South Dam, which form the tailings impoundment, as well as five seepage recovery dams (S1, S2, S3, S5 and S8). Two other seepage recovery dams have been intentionally breached in a controlled manner by THVCP and are no longer capable of retaining water.

The HVC site is located near Logan Lake, approximately 45 km south of Kamloops, in the interior of British Columbia. The Highmont TSF is located 8 km southeast of the operating mill. The Highmont TSF is an inactive facility constructed in 1980 and operated from 1980 to 1984. The site has been reclaimed and is currently inactive. THVCP continue ongoing surveillance of the site including environmental sampling, visual inspections and maintenance activities. Under this level of site presence, the Highmont dams are considered to be in the active care closure phase as defined by the Canadian Dam Association (CDA) Mining Dam Technical Bulletin (CDA 2014).

Highmont TSF dams comprise glacial till starter dams which were raised by the centerline method with coarse and fine filter zones separating the upstream tailings spigotted from the crest from the downstream rockfill section. The seepage dams are constructed of compacted glacial till with a drainage blanket downstream of the seepage cut-off, and with a sand and gravel erosion blanket on the upstream and downstream faces.

The Highmont dams are assigned a “High” consequence category as defined by CDA (2013) based on a dam consequence review hosted by THVCP. Seepage Recovery Pond Dam S3 is also assigned a “High” consequence category. Seepage Recovery Pond Dams S1, S2 and S5 are assigned as “Significant”, while Seepage Recovery Pond Dam S8 is assigned as “Low”. There were no significant changes to the key geotechnical or hydrotechnical hazards during 2018. The most recent dam safety review (DSR) was completed by AMEC in 2013 (AMEC 2014a). The Code requires a DSR be undertaken every five years for tailings dams. THVCP commissioned a DSR in 2018 which is currently underway and is expected to be completed in 2019.

The tailings pond is located in the center of the impoundment. The water level varied seasonally by about 0.2 m in 2018 based on available data, with a peak in July and low in September, which is relatively consistent with the historic trend which shows no long-term trend of increasing pond volume. Note that no readings were conducted in April/May 2018 which are traditionally the months with higher pond levels.

The Highmont TSF Spillway, installed near the left abutment of the North Dam, is designed for a storm event with a return period greater than required by the Code. The S3 Pond Spillway is plugged with glacial till to prevent discharge of water that does not meet water quality regulatory requirements. The S5 Pond Spillway has been partially obstructed with sandbags since 2016 to increase the storage capacity before discharging to the environment. The S5 Pond crest must be raised to accommodate storing the IDF when the spillways are blocked and the pumping capacity should be confirmed to assess IDF routing assuming the system is operational.

The Emergency Preparedness and Response Plan (EPRP) was updated in 2016. The Operation, Maintenance and Surveillance (OMS) manual was also reviewed and issued as in December 2018 (THVCP 2018). The OMS manual and EPRP meets the intent of the Mining Association of Canada (MAC 2011) and CDA guidelines, is current and provides adequate coverage for existing conditions.

Visual inspections and instrument measurements were completed by THVCP at the prescribed frequencies during periods of the year when dams were accessible.

There were some threshold exceedances of piezometers in response to freshet, in each of these cases the readings dissipated to normal levels shortly after freshet passed. There was one threshold exceedance in response to piezometric level upward trends observed in instruments along the northeast corner of the impoundment (continuing trend that started in mid-2016). The current phreatic levels are not a dam safety concern, but identify a change in previous trends. A review of rising piezometric levels in the northeast corner of the impoundment is recommended to understand this trend. As part of that review, THVCP and KCB will review the need for additional instrumentation in the Highmont TSF.

One survey monument exceeded its horizontal movement threshold in 2018. The movement was in the northeast direction perpendicular to the dam orientation. This is not considered a dam safety concern based on no signs of distress being observed during site visit and no settlement being registered in the monument. The movement direction at the exceedance is consistent with variance in annual readings measured at this location and is roughly parallel to dam centerline, slightly in the upstream direction. Piezometric and movement thresholds have been set for 2019 to monitor deviation from established trends.

The Highmont TSF appears in good physical condition and the observed performance during the 2018 site inspections is consistent with the expected design conditions and past performance. The status of recommendations to address deficiencies and non-conformances identified during past DSIs are summarized in Table 1. Previous recommendations that are now closed are shown in *italics*. Recommendations to address deficiencies and non-conformances identified during the 2018 DSI are summarized in Table 2.

Table 1 Previous DSI Recommendations – Status Update

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority[2]	Recommended Deadline
Highmont Tailings Storage Facility					
HD-2016-02	*Monitoring*	*OMS*	*Complete a survey of monument P2, which was not surveyed in October 2016, to confirm whether the incremental horizontal movement is survey related.*	*3*	*Q2, 2017 (CLOSED)*
HD-2016-05	Signage	-	Signage should be added to the spillway gate controls indicating which turn direction to open and close the gate and identify which seepage pond water is being diverted to in each position.	4	Q1, 2018 (Open, THVCP to schedule for 2019)
HD-2017-01	Flood Management	Spillway	THVCP should modify the spillway channel in this area to pass the peak spillway design outflow beneath the access road (bridge or arch culvert) or regrade the road surface so that water that flows over the road will report to the downstream spillway channel. Suggested interim milestones: Design: 2019; Permit and Construction: 2020.	3	Q4, 2020 (Open)
S1 Pond / S2 Pond / S3 Pond / S8 Pond					
			No previous recommendations		
S5 Pond					
S5-2017-01	*Flood Management*	*Storage Capacity*	*THVCP should increase the storage capacity or attenuation within the S5 Pond system to reduce the reliance on pumping to prevent a spill and includes an emergency outflow that does not require a temporary plug.*	*3*	*Q2, 2019 (SUPERSEDED by S5-2018-01 and S5-2018-02)*

Notes:
1. Recommendation ID numbers from 2017 DSI have been revised as shown.
2. 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 2018 DSI Recommendations

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority[1]	Recommended Deadline
Highmont Tailings Storage Facility					
HD-2018-01	Monitoring	-	At completion of the DSR, THVCP and KCB will develop a workplan to investigate the cause of changing piezometric conditions, which will include a review of the need for additional instrumentation in the Highmont TSF.	2	Q3, 2019
HD-2018-02	Flood Routing	10.1.8	Update flood routing assessment for Highmont TSF and associated seepage ponds based on the most recent site wide hydrology information for consistency and to confirm compliance.	3	Q2, 2020
HD-2018-03	Monitoring	-	Survey monument P4 after snow has cleared to confirm interpretation that incremental movement is associated with survey error.	3	Q2, 2019

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority(1)	Recommended Deadline
S1 Pond; S3 Pond					
			No new recommendations from 2018.		
S5 Pond					
S5-2018-01	Flood Routing	10.1.8	Confirm the pumping capacity of the system at S5 Pond so that the ability to route the IDF (100-year return period, 24-hour duration) assuming the pumps are functioning as intended can be confirmed.	2	Q4, 2019
S5-2018-02	Flood Routing	10.1.8	To accommodate the temporary blocking of spillway during freshet, raise the dam crest so that the IDF (100-year 72-hour duration) can be stored within the impoundment, assuming no pumping is required. (Take into consideration, HD-2019-02)	2	Q3, 2021 (to be reviewed pending outcome of S5-2018-01)
S2 Pond					
S2-2018-01	Monitoring	OMS	Include monitoring of the inlet plug during high flow events in the 2019 OMS manual. When available, define the minimum till plug elevation necessary to prevent overtopping of flow from Highmont TSF Spillway channel during the S2 Pond IDF.	3	Q4, 2019
S2-2018-02	Flood Routing	10.1.8	To improve dam safety of S2 Pond, by reducing overtopping risks, KCB recommend the Highmont TSF spillway till plug be permanently relocated to the S2 Pond inlet channel and built to sufficient height such that the plug would not be overtopped during the Highmont TSF IDF.	2	Q4, 2019
S8 Pond					
S8-2018-01	Maintenance	OMS	A pipe was observed on the slope of the S8 Pond dam that did not appear to be connected to anything. This pipe should be removed.	4	Q4, 2019

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.

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1 INTRODUCTION

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Highland Valley Copper Partnership (THVCP) to complete the 2018 dam safety inspection (DSI) of the Highmont Tailings Storage Facility (TSF) on the Highland Valley Copper (HVC) mine site. The Highmont TSF is an inactive facility constructed in 1980 and operated from 1980 to 1984. The site has been reclaimed since tailings discharge ceased and THVCP continue ongoing surveillance. The DSI includes the North Dam, East Dam, and South Dam, which form the tailings impoundment, as well as five seepage recovery dams (S1, S2, S3, S5 and S8). Two other seepage recovery dams have been intentionally breached in a controlled manner by THVCP, are no longer capable of retaining water and not classified as dams. Therefore, the facilities are not included in the scope of this DSI.

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

The scope of work consisted of:

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

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

The inspection was completed by the Engineer of Record (EoR), Mr. Rick Friedel, P.Eng., and Pablo Urrutia, P.Eng., as representatives of KCB on September 19, 2018. During the inspection, the weather was sunny with some cloudy periods. Mr. Chris Anderson, P. Eng., THVCP Manager, Tailings and Water, is the TSF Qualified Person (as defined by the Code) for the Highmont TSF.

THVCP has three primary permits for the Highmont TSF, as listed below:

- Permit PE 376 (09) – Issued under the provisions of the Waste Management Act. British Columbia Ministry of Water, Land, and Air Protection, dated January 7, 1971 and last amended on May 29, 2003.

- Permit M11 – Approving Work Systems and Reclamation Program. Department of Mines and Petroleum Resources, dated January 20, 1970, last amended (regarding Highmont) on July 16, 1998.
- Permit No. M55 – Reclamation Permit. Department of Mines and Petroleum Resources dated July 17, 1979 and amalgamated with Permit M11 on July 16, 1998.

The Highmont dams are assigned a “High” consequence category as defined by CDA (2013) based on a dam consequence review hosted by THVCP. Seepage Recovery Pond Dam S3 is also assigned a “High” consequence category. Seepage Recovery Pond Dams S1, S2 and S5 are assigned as “Significant”, while Seepage Recovery Pond Dam S8 is assigned as “Low”.

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

2 FACILITY DESCRIPTION

The HVC site is located near Logan Lake, approximately 45 km south of Kamloops, in the interior of British Columbia. The Highmont TSF is located 8 km southeast of the operating mill; refer to Figure 1. The Highmont TSF comprises a tailings pond retained by three perimeter dams (North, East and South) and five active perimeter seepage recovery ponds; refer to Figure 2.

Highmont Dams

The layout of the Highmont dams is shown in Figure 3 through Figure 5, and the typical geometry and dimensions are summarized in Table 2.1. Refer to Appendix III for relevant design drawings.

General information regarding the dam is as follows:

- Construction record reports for the starter dams (KL 1981) and subsequent raises (HOC 1982, 1984a, 1984b and 1984c) were available.
- The Highmont dams are founded on granodiorite bedrock or shallow glacial till and glaciofluvial sand and gravel outwash overlying bedrock. Organics and soft ablation deposits were removed prior to the construction of the dam. A 2015 review of foundation conditions by KCB noted that silt and clay foundations were not encountered at the North Dam and East Dam, but a 1.5 m to 3 m lacustrine silt layer about 23 m below original ground was encountered at the South Dam (KCB 2015a).
- The dams incorporate a compacted glacial till starter dam approximately 17 m high, with an upstream random fill zone and a downstream sand and gravel drainage blanket. Construction materials came from local glacial till, local pockets of sand and gravel, and rockfill from Highmont Pit.
- The dams were raised by the centerline method with coarse and fine filter zones separating the upstream tailings spigotted from the crest from the downstream rockfill section. When required before a wide tailings beach had been established, glacial till facings were placed on the upstream face of the dam wherever water could accumulate against the dam.
- Seepage through the dams are collected by seepage collection ditches at their toe and directed to the perimeter seepage recovery ponds.
- An open channel spillway is located on the left[1] abutment of the North Dam. The spillway starts as a 640 m long approach channel excavated in tailings to a lock-block control sill, then crosses under the dam crest access road via twin HDPE culverts leading to a channel excavated through rock. A slide gate (the Highmont Spillway Flow Control Structure) regulates flow in the channel. Under normal operating conditions and smaller storm events, flows are typically diverted by an inlet structure via a HDPE pipe to S1 Pond. Larger flows continue along the spillway channel which discharges downstream of S2 Pond and eventually to Witches Brook.

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

Seepage Recovery Ponds

The layout of perimeter seepage dams is shown in Figures 2 and the typical geometry and dimensions are summarized in Table 2.1. Refer to Appendix III for relevant design drawings.

General information regarding the seepage recovery pond dams is as follows:

- A construction record report for ponds S1 and S2 (KL 1981) and a design report showing details for ponds S1 through S5 (KL 1980) are available. No records are available for ponds S8 and S9.
- Historically there have been seven seepage recovery ponds located around the perimeter of the Highmont TSF (S1, S2, S3, S4, S5, S8 and S9) which manage seepage from the TSF, and runoff from the TSF and local catchments. The dams at S4 and S9 have since been decommissioned by breaching, leaving five remaining seepage recovery pond dams (S1, S2, S3, S5 and S8).
- A 1980 design report shows preliminary locations for ponds S6 and S7 (KL 1980), which appear to be in the vicinity of S9 Pond (which was not in the design report). There are no records that indicate S6 Pond or S7 Pond were ever constructed.
- The dams are constructed of compacted glacial till with a drainage blanket downstream of the seepage cutoff, and with a sand and gravel erosion blanket on the upstream and downstream faces. The dams are founded on glacial till, except for the now breached S4 Pond dam which was founded on a deep sand and gravel outwash.
- In general, water from the seepage recovery ponds are ultimately pumped to the Highland Mill for reclaim via S1 Pond (refer to Figure 4.1). Details of pumping operations, pipelines and other water management structures in these ponds are discussed in Section 4.1.

Table 2.1 Summary of Approximate Dam Geometry

Dam	Crest Elevation (m)	Maximum Height (m)	Crest Length (m)	Minimum Crest Width (m)	Downstream Slope	Upstream Slope
Main Dams						
North Dam	1487	47	1200	30	2.5H:1V	n/a
East Dam	1487	30	1200	15	2.3H:1V	n/a
South Dam	1487	35	1300	9	2.3H:1V	n/a
Seepage Recovery Pond Dams						
S1 Dam	1445	9.1 (2015 DSI)	60	10	2H:1V [3]	3H:1V (1980 design report)
S2 Dam	1459	4	140	4	2.2H:1V [3]	3H:1V (1980 design report)
S3 Dam	1459	3.4	150	4	3H:1V	3H:1V (1980 design report)
S4 Dam	Decommissioned by breaching					
S5 Dam	1452.2	6.3 (2015 DSI)	340	3	1.7H:1V [3]	3H:1V (1980 design report)
S8 Dam	1452	5	120	9	2H:1V	Unknown
S9 Dam	Decommissioned by breaching					

Notes:
1. Dimensions are estimated from 2014 LiDAR data unless otherwise noted.
2. Height measured as the vertical distance between downstream toe and crest.
3. The downstream slope is steeper than the 2.5H:1V in the design report (KL 1980).

3 HISTORY AND RECENT ACTIVITY

3.1 History

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

- In 1980, the Highmont starter dams and Seepage Recovery Ponds S1 through S5 were completed. It is not known whether the ponds S8 and S9 were constructed at this time or at a later date. The 1980 design report by Klohn Leonoff does not mention ponds S8 or S9 (KL 1980).
- In 1984, the final crest elevations of the TSF dams (approximately 1487 m) was reached, well below the ultimate design elevation of 1524 m. There has been no tailings disposal since 1984.
- In 1996, a permit was received to release water from Seepage Recovery Ponds S4 and S9 as the quality of water in these ponds met the discharge criteria and THVCP breached these two dams in 1997 (AMEC 2014a).
- In 2003, the permanent spillway in the Highmont TSF was constructed (AMEC 2014a).
- In 2005, THVCP winterized the pumping systems for Seepage Recovery Ponds S1, S2, S3, S5 and S8 so that water could be pumped from these ponds throughout the year.
- In response to a flood event that overflowed S1 Pond in 2006 (KCB 2007), a 1.2 m high slide gate was installed at the Highmont spillway flow control structure in 2007, along with Highmont Distribution Box which allows flow from S3 Pond and S5 Pond to be stored in the Highmont tailings pond instead of to S1 Pond.
- The S3 Pond spillway was plugged to prevent discharge to Fowler Creek. The exact date of plugging is not known but was completed prior to 2010.
- In 2014, a 1.0 m raise was built on the S5 Pond dam crest (i.e. no change to the downstream toe). In 2015 the dam was raised by an additional 0.6 m, which included widening of the crest and downstream toe area.

3.2 2018 Activities

Maintenance activities as required by the OMS manual were conducted (e.g., clearing weirs of vegetation, pumping of seepage recovery ponds).

The Highmont TSF spillway channel design included a till plug across the channel, downstream of the dam, which diverts low flows into S2 Pond. In 2018, this plug was temporarily relocated from the Highmont TSF spillway channel to the S2 Pond inlet channel; see Figure 4.1. Fill material was locally sourced and placed using an excavator. No compaction efforts were applied. Refer to additional discussion in Section 4.4 regarding KCB's support of making this a temporarily relocation permanent.

4 WATER MANAGEMENT

4.1 Overview

Water management at each structure in upstream to downstream order and how they interact with each other is summarized below. The process flow diagram for Highmont TSF is shown in Figure 4.1. Decommissioned structures (S4 Pond and S9 Pond) are not discussed.

Highmont TSF

- The tailings pond is located in the centre of the impoundment as shown on Figure 2. The water level variation is discussed further in Section 5.3.
- Inflows include precipitation on the pond, surface runoff from upstream catchments, pumpback from S1 Pond, and pumpback from seepage recovery S3 Pond and S5 Pond via the Highmont Distribution Box.
- Outflows include seepage, evaporation and when necessary, flow through the spillway. Seepage is collected by five seepage recovery dams downstream of the TSF. Flow from the open channel spillway at the left abutment of the North Dam is diverted to S1 Pond under normal operations. Flows exceeding the capacity (>2,000 m^3/h) of the diversion to S1 Pond, flow along the Highmont TSF Spillway channel:
  - Freshet: till fuse plug built across channel to divert flow into S2 Pond.
  - Non-freshet: no till fuse plug, flows discharge to Fourier Creek.

Seepage Recovery Pond S3 (S3 Pond) downstream of the South Dam

- Inflows include seepage from the South Dam, precipitation on the pond, and surface runoff from upstream catchments.
- Outflows include seepage, pumpback to the TSF during winter or freshet, and pumping to S1 for the remainder of the year, controlled by the Highmont Distribution Box. The open channel spillway for S3 Pond was plugged with glacial till to prevent release into Fowler Creek.

Seepage Recovery Pond S5 (S5 Pond) downstream of the East Dam, between S1 and S3

- Inflows include seepage from the East Dam, precipitation on the pond, and surface runoff from upstream catchments.
- S5 is unique in that it is made up of three ponds, one of which is further subdivided into as many as five ponds depending on the water level (Figure 4). Surface water flows into the western “bow” shaped pond where it is stored and then flows to the southeast pond which has the pumping reclaim system, via two 8” dia. HDPE pipes. There is minimal (~270 m^3) retention capacity in the southeast (pumping) pond below the spillway; therefore, ability to prevent spilling is highly dependent on pump capacity and operability, as described below.

- Outflows typically include pumpback to the tailings pond during winter or freshet and pumping to S1 for the remainder of the year, controlled by the Highmont Distribution Box. The low-level outlet pipes at the north and south ends of the ponds are closed.
- Spillway pipes (2x 200 mm dia.) which are buried through the eastern retention berm in the southeast pond, were partially blocked by THVCP during freshet, to increase the storage capacity in the pond before discharging into Dupuis Creek. This action was driven by environmental requirements related to the water quality of the pond, not dam safety.

Seepage Recovery Pond S2 (S2 Pond) downstream of the North Dam and west of S8

- Inflows include seepage from the North Dam, precipitation on the pond, surface runoff from upstream catchments, and low flows from the Highmont TSF spillway during freshet. During non-freshet, the inlet channel from the Highmont TSF Spillway is blocked by a till plug. Refer to discussion in Section 4.4 regarding recommended permanent relocation of the till plug.
- Outflows include pumping to S8 Pond, an open channel spillway located at the dam's left abutment that discharges into the Highmont TSF spillway, and ultimately reports to Fourier Creek.

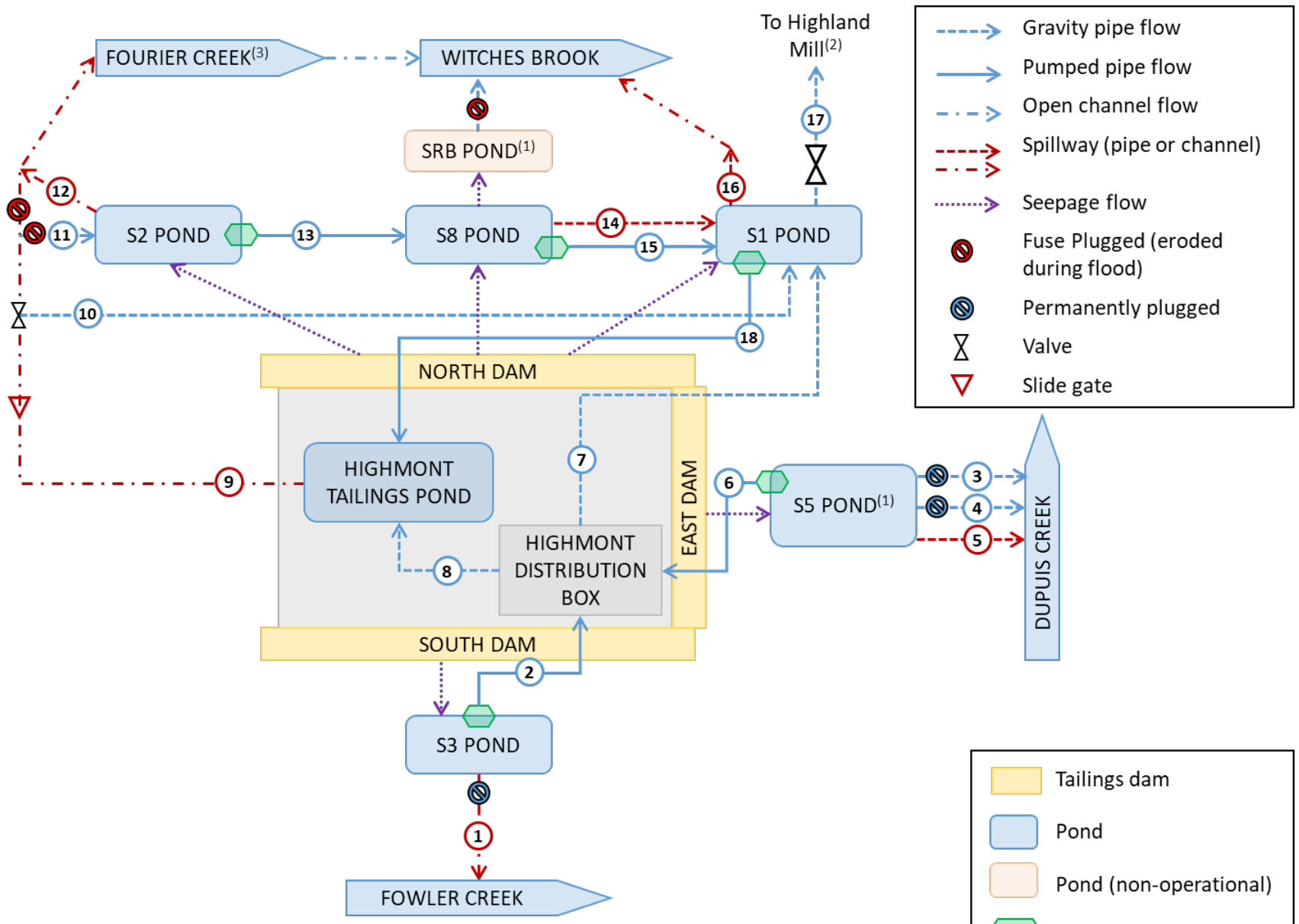
Seepage Recovery Pond S8 (S8 Pond) downstream of the North Dam, between S2 and S1

- Inflows include seepage from the North Dam, precipitation on the pond, surface runoff from upstream catchments, and pumping from S2 Pond.
- Outflows include seepage to the Sulfate Reduction Bacteria Pond (SRB), gravity flow through a 14" dia. pipeline to S1. Water can also be pumped to S1 Pond if required. When necessary, there is an emergency spillway pipe which discharges to S1 Pond.

Seepage Recovery Pond S1 (S1 Pond) downstream of the North Dam

- Inflows include seepage from the North Dam, precipitation on the pond, surface runoff from upstream catchments, diversion flows from the Highmont TSF spillway, gravity or pumped flow from S8 Pond, and pumping from S3 Pond and S5 Pond via the Highmont Distribution Box. This is the point of seepage and runoff collection convergence under normal flows at Highmont TSF.
- Outflows include discharge to the Highland Mill (conveyed via a 600 mm dia. gravity flow pipeline to a booster pumphouse then to the Mill), emergency pumpback to the Highmont tailings pond if water cannot be diverted to the mill, and when necessary, flow through the spillway. The spillway, located at the right abutment, is an open channel leading to a 900 mm dia. pipe that discharges onto a riprap apron downstream of the dam, then continues to an unnamed tributary which drains into Witches Brook.

Figure 4.1 Process Flow Diagram for Highmont TSF



Notes:
1. The Sulfate Reduction Bacteria (SRB) pond at S8 is downstream of the S8 Dam. The SRB pond at S5 consists of the five ponds in series in the centre of the facility. Water quality in both ponds do not meet discharge requirements at this time.
2. See the Gnawed Lake process flow diagram for detailed flow path from S1 to the Mill.
3. Subject to water license constraints. See Environment for details.

No.	Name	Description	Status
1	S3 Spillway	Open channel	Non-operational, plugged prior to 2010
2	S3 Reclaim	Seepage water pumped to the Highmont Distribution Box	Operational
3	S5 Outlet #1	2x 8”dia. HDPE pipes with control valves	Non-operational, metal plates placed at intake and pipes filled with till in 2015
4	S5 Outlet #2	2x 8”dia. HDPE pipes with control valves	
5	S5 Overflow	2x 200 mm dia. HDPE pipes	Operational, partially blocked at intake
6	S5 Reclaim	Pond water pumped to the Highmont Distribution Box	Operational
7	Distribution to S1	1x 18” dia. pipeline from the Highmont Distribution Box to S1	Operational
8	Highmont Distribution Box to Tailings Pond	1x 18” dia. pipeline from the Highmont Distribution Box to the tailings pond	Operational
9	Highmont Spillway	Open channel comprised of (U/S to D/S): i) Lock-block control sill; ii) Approach channel excavated in tailings; iii) Culvert crossings; iv) Channel excavated through rock; v) Flow control structure with 4’ high slide gate and diversion to S1; and vi) During freshet, till fuse plug located across Highmont TSF Spillway channel. During non-freshet, till fuse plug located across S2 Pond inlet channel.	Operational
10	Diversion to S1	18” dia. HDPE pipeline	Operational
11	Diversion to S2	Open channel with till fuse plug across S2 Pond inlet channel (except during freshet)	Operational
12	S2 Spillway	Open channel	Operational
13	S2 Outlet	1x 18” dia. HDPE pipeline carrying water pumped from S2 to S8	Operational
14	S8 Spillway	1x 18” dia. HDPE pipe with trash rack and headwall	Operational
15	S8 Outlet	1x 14” dia. HDPE pipeline carrying water pumped from S8 to S1	Operational
16	S1 Spillway	1x 900 mm dia. HDPE pipe discharging onto a riprap-lined apron	Operational
17	S1 Outlet	600 mm dia. HDPE pipe with manually operated valve	Operational
18	S1 Reclaim	Seepage water pumped back to the tailings pond	Operational

4.2 Climate

THVCP provided weather data from the L-L Dam climate station (El. 1186 m) which has historically been selected as most representative for the mine site. In 2018, some data logger issues in June, September and November led to some short data gaps as noted in Table 4.1. To support key precipitation trends and impacts on observed dam performance in 2018 data from Kamloops Airport (Environment Canada Station No. 1163781, El. 345 m) was reviewed for comparison that no major events were missed and general trends were consistent. Precipitation records from L-L Dam (corrected) and Kamloops Airport are tabulated and plotted with average monthly values or climate normals in Table 4.1 and Figure 4.2, respectively.

Seasonal snowpack depth is not measured at the L-L Dam weather station. Instead, monthly measurements at the Highland Valley snow survey station (Station No. 1C09A) near the Trojan TSF are used to track the changes in snowpack. The measurements are sorted by survey period (the first of January through May) to compare snowpack depths (in snow-water equivalent (SWE)) around the same time each year. Historical average and 2018 snowpack depths based on available records are summarized in Table 4.2.

The following observations were noted for 2018:

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

Table 4.1 Monthly Precipitation

Month	Precipitation (mm)			
	2018 at Highmont TSF[1]	Average Monthly at Highmont TSF[2]	2018 at Kamloops Airport[3]	1981-2010 Climate Normals at Kamloops Airport[3]
January	22.7	33.3	23.7	21.1
February	30.9	25.4	51.9	12.4
March	19.2	20.2	19.6	12.8
April	92.6	25.8	42.8	14.2
May	14.9	50.0	2.4	27.3
June	55.9[4]	58.0	36.8	37.4
July	42.5	52.6	35.7	31.4
August	47.8	38.4	19.2	23.7
September	62.3[5]	37.8	50.5	29.4
October	23.4	36.3	27.5	19.4
November	25.6	48.9	33.5	23.3
December	17.0	49.4	20.2	25.4
Annual Total	454.8	475.9	363.8	277.6

Notes:
1. Available data from L-L Dam climate station was adjusted by a L-L Dam-to-Highmont Area adjustment factor of 1.21 (Golder 2016).
2. Estimated by Golder (2016) using appropriate adjustment factors and average precipitation measured at Highland Valley Lornex climate station (Environment Canada ID No. 1123469 at El. 1268 m).
3. 2018 data from relocated station (ID No. 1163781); climate normals from data collected at previous station location (ID No. 1163780).
4. Data missing from June 6 to June 24 and June 26 to June 31, inclusive.
5. Data missing from September 21 to September 30, inclusive.

Figure 4.2 Monthly Precipitation

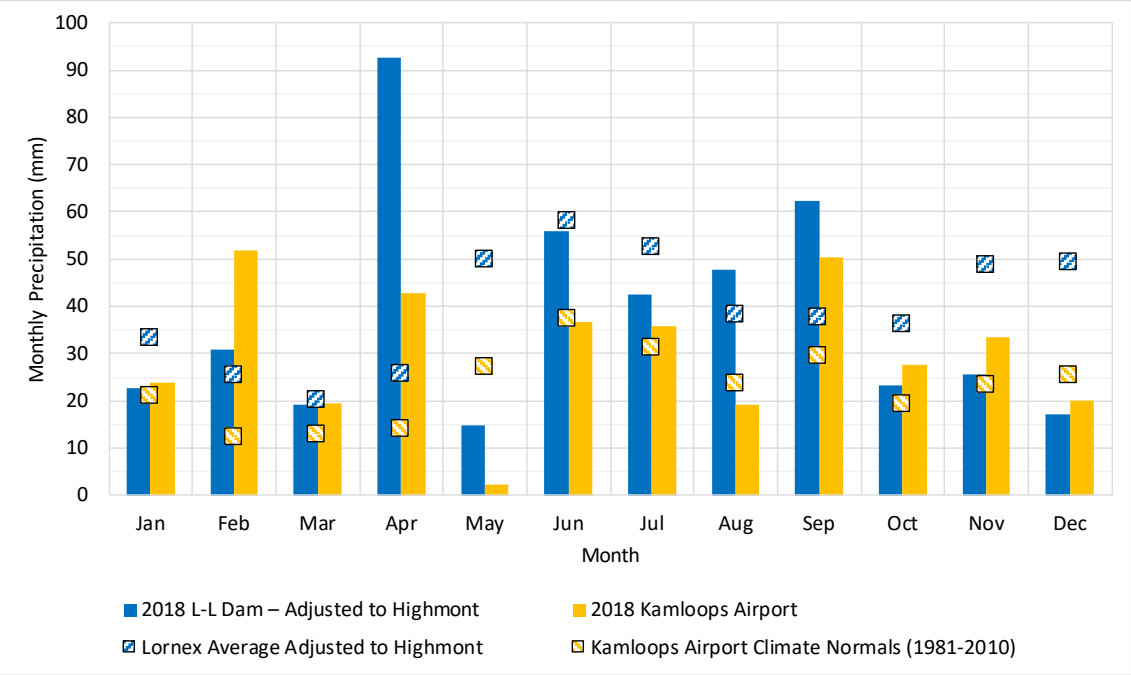


Table 4.2 Historical Average and 2018 Snowpack Depths

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

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

4.3 Water Balance

THVCP manages and tracks the annual water balance for the Highmont TSF. Table 4.3 is a summary of annual inflows and outflows, provided by THVCP. The water balance is based on simple model results and the values should be treated as indicative only.

Table 4.3 Annual Water Balance for Highmont TSF

Item	Volume in 2018 (m^3)
Inflows	
Direct precipitation and runoff	310
Groundwater	659,600
Total inflow:	*659,900*
Outflows	
Seepage	68,800
Evaporation[3]	588,600
Total outflow:	*657,400*
Balance	
Balance (inflow minus outflow)	2,500

Notes:
1. Values received from THVCP have been rounded to the closest 100 m^3.
2. Precipitation from the Shula Flats weather station adjusted to the Highmont area was used in the water balance.
3. Evaporation assumed for Highmont TSF: 540 mm/year.

4.4 Flood Management

Flood management structures, the applicable design criteria, details for the six facilities and relevant discussion points are summarized below:

- The IDF events for each dam comply with requirements under the Code (refer to Table 4.4):

- The design flood for Highmont TSF (PMF) is greater than the minimum IDF required by the Code which further reduces overtopping risks. KCB supports this approach for this type of facility:
  - Temporary ponding at the North Dam toe (approximately 1 m high to El. 1463 m) due to flow restriction at the 2x culverts along the Highmont TSF spillway channel and under the lower toe access road would not compromise the structural stability of the dam in this area (KCB 2019). However, overtopping flows above the lower toe access road at El. 1463 m Highmont TSF spillway would flow into S2 Pond which is not a desirable condition and does not meet the design intent of the spillway or S2 Pond. In the 2017 DSI, KCB recommended THVCP modify the spillway channel in this area to pass the peak spillway design outflow beneath the access road (bridge or arch culvert) or regrade the road surface so that water that flows over the road will report to the downstream spillway channel. This recommendation remains open.
- At S3 the spillway is blocked and therefore the IDF is stored. To comply with the Code, the IDF duration was increased to 72-hours (KCB 2019).
- S2 Pond can manage the IDF assuming the local catchment but can not safely route the additional flow which could be diverted from the Highmont TSF spillway channel into S2 Pond by the till plug during the IDF:
  - As discussed in Section 3.2, in 2018 the till plug across the Highmont TSF spillway was temporarily relocated to the inlet channel from the spillway to S2 Pond. THVCP, intend to relocate the plug back to the Highmont TSF spillway prior to 2019 freshet, which will divert additional catchment into S2 Pond during a high flow period.
  - To improve dam safety of S2 Pond, by reducing overtopping risks, KCB recommend the till plug be permanently relocated to the S2 Pond inlet channel and built to sufficient height such that the plug would not be overtopped during the Highmont TSF IDF.
  - Whenever in place, plug performance and S2 Pond freeboard should be monitored during high flow events such that intervening measures (e.g. pumping) can be implemented, if needed. KCB recommend this be included in the next OMS manual update.
- To support this DSI, KCB reviewed S5 Pond flood routing of the IDF (100-year return period) assuming that the pumps are not working and that the spillway pipes are plugged (Section 4.1). Based on this review, S5 Pond cannot store the IDF (72-hour duration) under these conditions. KCB recommends THVCP complete the following:
  - confirm the pumping capacity of the system at S5 Pond so that the ability to route the IDF (100-year return period, 24-hour duration) assuming the pumps are functioning as intended can be confirmed; and
  - to accommodate the temporary blocking of spillway during freshet, raise the dam crest so that the IDF (100-year 72-hour duration) can be stored within the impoundment, assuming no pumping is required.

- Based on the preliminary review completed to support this DSI, this can be achieved, with 0.3 m of freeboard, by raising the southern portion of the crest (~125 m section) which is sloped to the south, up to the level of the horizontal section of crest (El. 1452.2 m). As part of this work the remainder of the crest should be surveyed to confirm there are no other low points. This should be reviewed based on the most appropriate hydrology.

- To support the 2017 DSI (KCB 2018), KCB reviewed flood routing at S8 Pond. The review indicates that the IDF could be routed through the overflow spillway pipe (24-hour duration) or stored (72-hour duration) if the pipe became plugged, assuming no flood is pumped from S2 Pond. This should be documented in a separate document. This will be completed as part of the recommended flood routing review based on the most recent hydrology.
- Flood routing assessments, including hydrologic modelling to estimate flood volumes and peak flow rates, for the Highmont impoundment and sediments have been completed over a long time period, during which climate data has changed. For completeness, KCB recommends all flood routing assessments be updated based on the most recent climate information.

Table 4.4 Inflow Design Flood Requirements for Highmont TSF and Seepage Ponds

Dam	Spillway Type	Consequence Classification	Inflow Design Flood[1]	Spillway Design Flood		Spillway Design Reference
				Design Event (IDF Depth, Peak Outflow)	Peak Flood Level	
Highmont TSF	Open channel	High	1/3 between 1000-year and PMF	PMF[2] 24-hour (260 mm[3], 9.8 m^3/s)	1482.4 m[4]	(KCB 2005)
S1 Pond	Open channel to pipe	Significant	Between 100-year and 1000-year	100-year 24-hour (59 mm, 0.6 m^3/s)	1444.1 m	(KCB 2015b)
S2 Pond	Open channel	Significant	Between 100-year and 1000-year	100-year 24-hour (59 mm, 0.1 m^3/s) [5]	1458.3 m	
S3 Pond	None (plugged)	High	1/3 between 1000-year and PMF	1/3 between 1000-year and PMF, 72-hour[6] (174 mm, Note 7)	1458.3 m	(KCB 2015b) (KCB 2019)
S5 Pond	Pipes (removable plug)	Significant	Between 100-year and 1000-year	100-year 24-hour[8] (59 mm, Note 9)	To be confirmed (Note 11)	(KCB 2019)
S8 Pond	Pipes	Low	100-year	100-year 72-hour (86 mm, Note 10)	1451.7 m	(Note 12)

Notes:
1. Per the Code.
2. The spillway channel has capacity for the PMF from a 24-hour PMP event, but the erosion protection was only designed for the 200-year 24-hour storm event. Damage during floods is expected and would require subsequent repair and maintenance.
3. Based on data from Atmospheric Environment Service (AES) climate stations at Kamloops Airport and Mamit Lake. A review of the spillway design was done in 2002 which concluded the 260 mm is comparable to the 230 mm estimated using the Highland Valley BCCL and Highland Valley Lornex climate stations and would accommodate a conservative snowmelt rate of 30 mm/day.
4. Assumes gate is in open position.
5. Does not include any additional flow from the Highland Spillway channel which may flow into S2 Pond via deflection berm.
6. As IDF is stored, duration increased from 24-hours to 72-hours to be consistent with the Code (KCB 2019).
7. The peak spillway discharge during the IDF was not reported as the spillway is plugged and the IDF is stored.
8. Although this assessment assumes the IDF is stored, flood routing is governed by pumping capacity and 24-hour duration storm event is a worse case scenario than 72-hour storm because the peak inflow is higher.

9. The peak spillway discharge during the IDF was not reported as the spillway was assumed to be completely blocked by the sandbags.
10. The S8 Pond overflow spillway pipe is operable but routing was checked for both a store (i.e. spillway blocked) or route (i.e. spillway open) the IDF and both conditions were satisfied.
11. Peak flood level during the IDF at S5 Pond requires additional flood routing and assessment of existing pumping capacity to be confirmed.
12. Review was completed as part of 2017 DSI (KCB 2018).

4.5 Freeboard

Where available, the minimum freeboard[2] measured during 2018 based on either the DSI site visit or regular surveys are estimated in Table 4.5. THVCP visually estimate freeboard as part of normal inspections. The key observations regarding freeboard compliance include:

- The minimum freeboard predicted during the IDF (or design spillway event for Highmont TSF) is greater than the minimum required under the Code for all ponds, except for S5 Pond which must be confirmed assuming pumping is operational (pump capacity currently not known). Refer to discussion in Section 4.4 recommendations to upgrade S5 Pond to store the IDF when the spillways are blocked.
- Freeboard for Highmont TSF is reported relative to the dam crest and the spillway channel at the spillway gate, assuming the spillway gate is fully open during the spillway design flood which is larger than require under the Code (Section 4.4). If flood levels were to crest out of the channel near the spillway gate, water can flow downstream, potentially eroding the North Dam.
- Freeboard refers to the difference between flood level and right bank at spillway gate which is below dam crest. Flow in the spillway channel is separated from the reservoir by culverts and not subject to the same wave or run-up conditions assumed in the Code freeboard calculations. The estimated available freeboard, during the spillway design flood (0.6 m), assuming the spillway gate is open, is appropriate for the spillway channel.
- As discussed in Section 4.4, flood routing in S5 Pond is reliant on the pumping system. Freeboard estimates assume pumps are operating throughout the IDF.
- Freeboard at S3 Pond is reported for the 72-hour duration IDF which meets requirements of the Code
- Freeboard at S8 Pond is greater than criteria if the IDF is routed through the spillway pipe or stored in the pond.

[2] The vertical distance between the peak flood level during a flood event and the low point of the dam crest.

Table 4.5 Freeboard at Time of Site Inspection

Dam	Required Freeboard During Inflow Design Flood [1]	Minimum Freeboard During Inflow Design Flood	Minimum Available Freeboard in 2018	2018 Freeboard Surveyed/Visually Estimated
Highmont TSF	0.9 m[2,3]	4.6 m[5] – dam crest 0.6 m[5] – spillway channel[9, 10]	6.6 m[5] – dam crest 1.2 m[5] – spillway channel[9]	Annual minimum from surveys, refer to App IV
S1 Pond	0.5 m[4]	1.0 m[4]	2.1 m	THVCP Inspections
S2 Pond	0.5 m[4]	0.7 m[4]	1.5 m	
S3 Pond	0.3 m[2]	1.1 m[2, 6]	1.3 m	
S5 Pond	0.5 m	To be confirmed (Note 7)	1.1 m	
S8 Pond	0.5 m[4]	0.5 m[2, 8]	1.8 m	

Notes:
1. As per the Code, refers to minimum vertical distance between dam crest and peak IDF level.
2. Based on KCB (2018).
3. Minimum required freeboard to accommodate wave run-up as per CDA (2013) is 0.4 m; however, minimum freeboard specified as 0.5 m to be consistent with other similar structures around the site.
4. Based on KCB (2015b).
5. Freeboard during PMF 24-hour duration spillway design flood which is larger than IDF required under the Code. Assumes spillway gate is open.
6. Freeboard reported for 72-hour duration IDF. Freeboard during operations storage condition (100-year 30-day + IDF 24-hour) is 0.4 m which still meets criteria.
7. Minimum freeboard during the IDF at S5 Pond to be confirmed assuming pumping is operational, refer to discussion in Section 4.4 recommendations to upgrade S5 Pond to store the IDF when the spillways are blocked.
8. Freeboard reported for the scenario where the IDF is stored in the pond.
9. Freeboard in spillway channel refers to difference between highest flood level and the spillway channel banks.
10. Freeboard in spillway channel during design flood is appropriate as discussed in Section 4.5.

5 REVIEW OF MONITORING RECORDS AND DOCUMENTS

5.1 Monitoring Plan

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

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

5.2 Inspections

The Highmont TSF monitoring program includes the following inspections:

- Annual DSI (this report) – completed by the EoR to comply with Section 10.5.3 of the Code and submitted to EMPR.
- Routine – monthly inspections of the Highmont dams (North, South and East), and monthly inspections of seepage recovery ponds are completed by THVCP staff during periods of the year when dams were accessible (typically April to November). The decommissioned S4 Pond and S9 Pond are not formally inspected:
  - As this system has reached an equilibrium or steady condition, reduced frequency of routine monitoring is considered appropriate. Event-driven inspections are of more value to confirm that the changed condition (i.e. flood, earthquake) did not have a significant impact on the structures. This change will be reflected in the next OMS manual update.
- Event-driven – these inspections are of more value than routine inspections to confirm that the changed condition (i.e. flood, earthquake) did not have a significant impact on the structures. THVCP are to complete an inspection in response to the following threshold exceedances:
  - Piezometric and dam movement instrumentation thresholds as discussed in Sections 5.4 to Section 5.5.
  - Earthquake greater than magnitude 5, within 100 km of the site or any earthquake felt at site.
  - Rainfall event greater than the 10-year, 24-hour duration storm; 41 mm (Golder 2016).

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

5.3 Reservoir Level

THVCP have a transducer installed at the Highmont TSF pond which collects frequent, automated readings which are uploaded to the site wide instrumentation management system. In addition, the Highmont TSF pond level was surveyed five times in 2018 (between July and November). This meets the minimum frequency prescribed for pond level surveys in the 2018 OMS manual (twice per year). The pond level is also visually checked during routine inspections but not recorded, and is monitored through an automatic water level. During winter, the pond is usually not accessible but is also the annual period with the sustained lowest levels.

Reservoir levels are shown in conjunction with piezometric levels and seepage rates in Appendix IV:

- Figure IV-1 to Figure IV-5 plots measured pond level and piezometric levels at the North Dam, South Dam, East Dam, Spillway, and Seepage Ponds.
- Figure IV-7 plots pond levels with measured weir flows from S1 Pond, S3 Pond, S5 Pond, and S8 Pond.

The pond level has remained relatively constant with the expected seasonal rise and fall associated with freshet. Pond levels were recorded more frequently than usual between 2015 and 2017 (15 to 25 measurements compared to less than 5 measurements in other years). The higher peak pond levels measured during 2016 and 2017 relative to previous may be associated with reading frequency rather than actual increased pond levels. The annual fluctuation in pond level measured since 2007 is less than 1 m and seepage flow measurements were similar.

5.4 Piezometers

There are 29 piezometers at the Highmont TSF and surrounding seepage collection ponds, 25 of which are active and 4 inoperative as shown on Figure 3 to Figure 5. Inoperative piezometers may be buried, plugged or otherwise damaged.

Piezometers are typically read monthly between March and November (when accessible) which meets the frequency prescribed in the 2018 OMS update. Piezometric readings from 2007 to 2018 are shown on Figure IV-1 to Figure IV-5. 2018 piezometer measurements typically show similar seasonal pattern as previous years which reflects fluctuation in the Highmont TSF pond level.

The following observations are noted:

- A groundwater mound between Highmont Pond and the North and East Dams where piezometric levels are higher in the middle of the beach, indicating radial drainage to the perimeter and some drainage towards the pond has been persistent for the instrumentation record and continued in 2018.
- The one set of nested piezometers (HM-PS-02 and HM-PS-03) indicate a modest upward gradient from the foundation glacial till into the tailings in the northeast corner of the facility.

- PW-H and PW-L around the East Dam temporarily exceeded their threshold value in 2018 in response to freshet. In each case the readings dissipated to normal levels shortly after freshet passed. PW-L has shown an upward trend since 2017 (~1 m rise). PW-H and PW-L had their Notification Level thresholds updated in 2017 because a 2017 freshet temporary exceedance.
- Instruments in the northeast corner of the impoundment (PW-A, HM-PS-01, HM-PS-02 and HM-PS-03) also exceeded threshold values in 2018 and have shown an upward trend since 2016 (about 1.5 m) which differs from the seasonal rise and fall trend observed in other instruments. The reason for this rise is unknown, in 2018 THVCP investigated to confirm these observations are not due to something other than rising piezometric levels (e.g. surveyed tip elevation or data entry). The current phreatic levels are near piezometric lines assumed in design analyses. However, the stability of the dam is not sensitive to small changes in the piezometric level upstream of the dam. Increasing seepage downstream of this area would be an indicator of increasing piezometric levels and gradient in the downstream portion of the dam and foundation. However, available weir flow data downstream of the North Dam and upstream of Seepage Pond 1 (HM-01-FS-02) show relatively stable seepage rates.
- S3-1 and P-M, around the southeast corner of the TSF, have shown an upward trend since 2016 but did not exceed their thresholds in 2018.

Starting in 2016, measured pore pressures at some instruments have deviated from the typical seasonal behavior observed during the prior years. Current levels at some of these instruments (HM-01-FS-01, 02 and 03) are below piezometric surfaces assumed in stability analysis, 1.4 m to 2.2 m (KC 1996, KCB 2015c). PW-l, S3-1 and P-M piezometric levels, on the other hand, are slightly higher (within 1 m) than the levels assumed in the stability analyzes. This is not considered a dam safety concern as these analyses resulted in factors of safety (FOS) that significantly exceeded their FOS criteria (KCB 2015c) and were found to be relatively insensitive to small changes in piezometric pressures. Regardless that this does not represent a current dam safety concern the cause for this behaviour should be investigated in 2019. At completion of the DSR, THVCP and KCB will develop a workplan to investigate the cause of changing piezometric conditions, which will include a review of the need for additional instrumentation in the Highmont TSF.

Piezometric level thresholds for the Highmont Dam are set to monitor deviation from the established trend. These thresholds reference a Notification Level (NL) response under the Trigger-Action-Response-Plan established on site and exceedance of this value is intended to notify THVCP of a change in behaviour, not a short-term dam safety concern. The threshold for piezometer showing a rising trend has been updated for 2019 to the elevation assumed in design. Other thresholds remain unchanged from 2018; refer to Table 5.1.

Table 5.1 Proposed 2019 Piezometric Level Thresholds

Instrument ID	2018 Piezometric Levels (m)		Notification Level (NL) Threshold	Comment
	Maximum	Minimum		
S1	1431.6	1431.2	1432.4	Same as 2018
S2	1451.7	1451.1	1452.5	Same as 2018
S2-1	1480.2	1480.1	1481.4	Same as 2018
S2-2	1481.1	1480.6	1482.0	Same as 2018
S2-3	1482.2	1481.7	1483.4	Same as 2018
S2-4	1481.8	1479.9	1482.9	Same as 2018
S3-1	1481.6	1481.3	1482.0	Same as 2018
S3-2	1482.3	1482.0	1483.0	Same as 2018
PW-A	1480.4	1480.1	*1480.5*	Showing upward trend. NL threshold: Same as 2018
PW-C (TALL)	1482.5	1480.7	1482.6	Same as 2018
P-D	1481.0	1479.6	1482.2	Same as 2018
P-E	1480.9	1480.8	1482.6	Same as 2018
P-G	1481.3	1480.3	1482.4	Same as 2018
PW-H	1481.1	1480.8	1481.1	Same as 2018
P-I	1481.1	1480.4	1482.7	Same as 2018
PW-J	1481.1	1479.9	1481.9	Same as 2018
P-K	1480.7	1479.5	1482.2	Same as 2018
PW-L	1481.5	1481.1	1481.5	Same as 2018
P-M	1482.7	1481.3	1483.5	Same as 2018
P-N	1481.4	1479.9	1481.9	Same as 2018
P-O	1479.8	1479.7	1482.4	Same as 2018
PW-P	1480.9	1479.9	1481.5	Same as 2018
HM-PS-01 (13-SRK-14)	1479.1	1478.8	*1480.5*	Showing upward trend. NL threshold updated for 2019 from 1479.3 m.
HM-PS-02 (13-SRK-13)	1478.3	1478.2	*1480.5*	Showing upward trend. NL threshold updated for 2019 from 1478.5 m.
HM-PS-03 (13-SRK-13)	1479.1	1478.8	*1480.5*	Showing upward trend. NL threshold updated for 2019 from 1479.0 m.

Notes:
1. *Italics* indicates revised threshold for 2019.

5.5 Survey Monuments

Survey monuments at the Highmont TSF are shown on Figure 3 to Figure 5. Monuments were surveyed once in 2018, in June. This meets the required frequency prescribed in the 2018 OMS manual (annual).

THVCP surveys since 2014 use a total station with an estimated accuracy of 25 mm for horizontal measurements, and a high precision digital level with an estimated accuracy of 10 mm for vertical measurements. Monument surveys, horizontal displacement and settlement since 2008 are plotted on Figure IV-6.

Table 5.2 2018 Survey Monument Incremental Displacement Summary

Monument	Incremental		Cumulative	
	Vector Horizontal Displacement[1] (mm)	Vertical Displacement[1] (mm)	Vector Horizontal Displacement[3] (mm)	Vertical Displacement[3] (mm)
P2	99.0, downstream	2.0	68.0, downstream	-4.8
P3	25.9, downstream	-1.2	36.8, downstream	-3.4
P4	87.7, parallel to dam crest and upstream	0.0	114.8, parallel to dam orientation	-31.5
P5	36.7, downstream	2.9	63.5, downstream	6.4
P6	37.2, parallel to dam crest downstream	2.4	64.3, downstream	-28.0
P7	Not measured[(4)]	1.1	Not measured[(4)]	-33.2

Notes:
1. June 2017 survey compared to June 2018 survey.
2. P2 was not surveyed in October 2016, or June 2017 because of vegetation growth has impeded line of site for surveyor. THVCP have actioned this issue be resolved and resume monitoring of P2 in spring 2018. Comparison of the most recent surveys indicates 138.7 cumulative movement in the downstream direction but reliability of measurement is uncertain.
3. All monuments earliest historic readings are in 2007. Cumulative displacements are calculated as difference from the June 2017 survey and earliest historical reading.
4. P7 is surveyed for elevation only and no horizontal vector displacements can be estimated.

From a review of the historic and 2018 data, the following observations are noted:

- P4 exceeded its horizontal movement threshold in 2018 (115 mm movement relative to 2007 original location; threshold set as 80 mm). The movement however was in the northeast direction perpendicular to the dam orientation, slightly in the upstream direction, which aligns with the variance observed at this location. No accompanying change in vertical settlement was observed. No significant indicators of distress in the dam observed in this area during site visit. Therefore, this is not considered a dam safety concern. KCB recommends reading P4 again in 2019 spring after snow clearing to confirm movements. 2018 survey of other monuments are consistent with previous surveys with no threshold exceedances.
- In general, no significant crest settlement or horizontal movement is noted based on 2018 survey. Apparent overall uplift at some locations is more likely a result of survey accuracy than dam movement.

Movement thresholds for 2019 remain unchanged from 2018; refer to Table 5.3.

Table 5.3 Proposed 2019 Survey Monument Displacement Thresholds

Instrument ID	Horizontal Vector Displacement from Original Position (mm)	Incremental Settlement Between Readings (mm)	Total Settlement (mm)
P2	80	20	50
P3			50
P4			75
P5			150
P6			75
P7	n/a		75

Notes:
1. There is no change from 2018 to 2019 threshold values for horizontal displacement from original position, incremental vertical displacement between readings, or total vertical displacement between readings.

5.6 Seepage

Seepage flows are monitored upstream of 4 seepage ponds at the instruments (weirs) and frequencies summarized in Table 5.4. Monitoring frequencies for all ponds are set primarily for environmental and water balance factors, not dam safety. Monthly data was reviewed by KCB as part of this DSI and it was considered adequate from a dam safety perspective. Instrument locations are shown in Figures 3 to 5 and 2018 flow measurements are plotted on Figure IV-7.

In general, flow rates peak in April/May during freshet. Although based on a lower number of readings, 2018 seepage measurements were generally similar to 2017 measurements during the same time period. The above average flows observed in all the seepage flow measurement instrumentation in 2017 was likely an early response to the freshet. This peak was not observed in 2018, possibly influenced by the reduced frequency of readings.

Table 5.4 Summary of Seepage Flow Measurement Instruments

Instrument ID	Location	Instrument Type	2018 Monitoring Frequency
HM-S1-FS-02	Upstream of S1 Pond	Weir – Datalogger and Manual Reading	15 min intervals Mar-Oct
HM-S3-FS-01	Upstream of S3 Pond	Weir – Datalogger and Manual Reading	15 min intervals Mar-Oct
HM-S5-FS-01	Upstream of S5 Pond	Pipe and Bucket – Manual Reading	Monthly, when accessible
HM-S8-FS-01	Upstream of S8 Pond	Pipe and Bucket – Manual Reading	Monthly, when accessible

5.7 Water Quality

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

- There are fourteen permitted surface water quality monitoring sites in the Highmont area, as shown on the site monitoring plan in Appendix V.
- There are two permitted performance targets in PE-376 for this site: Sites #264 (S5 Pond Outlet) and #279 (S8 Pond Outlet). There was no discharge from either S5 Pond or S8 Pond during 2018, therefore, no water samples were required to be collected and both sites are in compliance.
- All sampling sites were in compliance with the permit levels, required sampling frequencies and parameters.

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

6 VISUAL OBSERVATIONS AND PHOTOGRAPHS

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

Impoundment

- **Tailings Beach**: The tailings beach upstream of the downstream slope crest is well vegetated and the pond was well setback from the dam crest (>200 m) based on reservoir level, typical for this time of year.
- **Pond**: At the time of the inspection the pond was centrally located in the impoundment similar to the image on Figure 1 through Figure 3.

Dam

- **Crest**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking (Photo II-A-1 and Photo II-A-2).
- **Left and Right Abutments**: Good physical condition. No signs of erosion, deterioration, horizontal displacement, or cracking.
- **Downstream Slope**:
  - Good physical condition. Downstream slope well vegetated throughout, providing adequate erosion protection for future service life (Photo II-A-3 to Photo II-A-6).
  - The steepened lower portion of the North Dam downstream slope near the dam spillway is noticeably less vegetated. This portion was constructed with rockfill and a steeper grade. Aerial imagery from 2003, and contour records from 1994 indicate that in this more susceptible section no significant adverse change has been observed except for the increased erosion gullies in the shallow vegetated section of the dam slope (Photo II-A-7).
  - There is a local steeper lower portion of the North Dam downstream slope to the west of S8 Pond. The steeper slope appears to have been formed by excavation of a bench at the toe of the dam in the past. The area is well vegetated, and no visual signs of distress seepage or erosion were observed (Photo II-A-8).
- **Seepage**:
  - Observed seepage from western underdrains of the North Dam was clear and flowed to S2 Pond. The lower access road crosses the drainage channel for the underdrain which discharges to S2 Pond. No culvert is visible but seepage flows have not been observed to form a significant pond (i.e. to reach the dam toe) upstream of the road fill slope, indicating seepage through the road fill is sufficient to drain seepage rates. There are no signs of recent ponding or issues related to seepage flow through the road fill.
  - Some seepage is likely retained in local ponds along downstream toe of East Dam. Seepage flows from southern underdrains report to S5 Pond.

- Seepage from the main underdrains flow at the South Dam reports to seepage ponds downstream (S3 Pond and the decommissioned S4 Pond).

Spillway

- **Approach Channel**: Pooled water in local depressions of the channel but this was not connected to the main pond. No erosion noted and vegetation is established. Outlet of the spillway culverts that pass through the dam crest is obstructed by vegetation which should be cleared, as per OMS (Photo II-A-9 and Photo II-A-10).
- **Gate**: Water is ponded in local low points along the spillway channel (i.e. no current flow). Signage should be added to the gate controls indicating which turn direction to open and close the gate and identify which seepage pond water is being diverted to in each position. This was first noted in 2016 but has not been added. THVCP to action for 2019. A safety grate should also be placed over the opening in the floor of the catwalk that provides access to the gate control (Photo II-A-11 and Photo II-A-12).
- **Spillway Channel:**
  - The upstream segment of the spillway channel is in a near vertical walled bedrock excavation. No failures were observed along the channel walls. Water was ponded along the length of the channel upstream of a cascade drop chute in the channel (Photo II-A-13 to Photo II-A-14).
  - Downstream of the chute, the channel coverts to a trapezoidal ditch that is excavated in glacial till with exposed bedrock along the majority of the spillway invert and portions of the slopes. No evidence of significant scour was observed (Photos II-A-15 and II-A-17).
  - The culverts that allow flow to pass through the toe access road at the toe of the North Dam are damaged (Photo II-A-18 to Photo II-A-21).
  - During inspection, vegetation growth was observed at different locations of the spillway channel (e.g., upstream of the gate, near the culvert crossing the downstream road at the toe of the dam, etc.). Since then, THVCP reported having cleared tree-size vegetation. Grass and shrubs will be cleared in 2019 as part of routine maintenance in accordance with the OMS manual.
- **S2 Diversion Berm**: A diversion berm (i.e., plug) was observed across the S2 inlet channel that diverts water from the Highmont TSF spillway to S2 Pond. During large flood events, the plug will be overtopped and eroded, directing some of the flow to S2 Pond while the majority of flow will pass through the spillway channel. No signs of significant erosion, deterioration, or displacement (Photo II-B-13).

S1 Pond

- **Crest**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking (Photo II-B1 and Photo II-B-2).

- **Left and Right Abutment**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking.
- **Downstream Slope**: Good physical condition. Slope covered in gravel and moderately vegetated. This combination provides adequate erosion protection based on performance over the service life.
- **Pond**: At the time of inspection was about 1.6 m below the spillway invert (Photo II-B-3).
- **Spillway**: Good physical condition. Minor vegetation present downstream of spillway pipe and in riprap outfall. No immediate dam safety concern due to this, however should be monitored and removed during routine inspections (Photo II-B-4 and Photo II-B-5).
  - Since the inspection, THVCP reported having cleared tree-size vegetation. Grass and shrubs will be cleared in 2019 as part of routine maintenance in accordance with the OMS manual.
- **Low-level Outlet**: The outlet pipe trash rack was clear of large debris. Algae build-up on the trash rack is cleared as part of THVCP routine monitoring and maintenance.
- **Seepage**: None observed.

S2 Pond

- **Crest**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking (Photo II-B-6).
- **Left and Right Abutment**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking.
- **Downstream Slope**: Good physical condition. Well vegetated near left abutment, and sparsely vegetated throughout the rest of the downstream slope. Gravel and vegetation provides adequate erosion protection based on performance over the service life (Photo II-B-7).
- **Pond**: Pond level was about the same elevation at the time of inspection was observed during the 2017 site visit, approximately 2.7 m below the invert of the spillway (Photo II-B-8).
- **Spillway**: Good physical condition. The inlet is partially obstructed by vegetations. This does not pose an immediate dam safety concern but should be removed as part of maintenance in 2019. Vegetation along spillway should be monitored and removed if reduces the outlet capacity (Photo II-B-9 to Photo II-B-11).
  - Since the inspection, THVCP reported having cleared tree-size vegetation. Grass and shrubs will be cleared in 2019 as part of routine maintenance in accordance with the OMS manual.
- **S2 Inlet Channel – Highmont TSF Spillway Diversion**: A plug was in place across the inlet to S2 Pond so no flow is diverted from the Highmont TSF spillway into S2 Pond except under large flows (Photo II-B-12).

- **Seepage**: Seepage is not monitored downstream of the dam. However, a small pond of water at the downstream toe was observed. The pond is similar is size to the pond noted during the 2015, 2016 and 2017 DSI, and is likely to consist of surface runoff and seepage (Photo II-B-13).

S3 Pond

- **Crest**: Good physical condition. No indicators of significant concern observed (e.g. cracking, slumping, horizontal displacement) (Photo II-B-14).
- **Left and Right Abutment**: Good physical condition. No observations of significant scour or other indicators of potential concern (e.g. cracking, slumping, horizontal displacement).
- **Downstream Slope**: Good physical condition. Slope is sparsely vegetated over the layer of gravel which provides adequate erosion protection based on performance over the service life (Photo II-B-15).
- **Pond**: At the time of the inspection was approximately 2.1 m below the crest of the dam (Photo II-B-16 to Photo II-B-18).
- **Seepage**: Seepage is not monitored downstream of the dam. No pond was observed at the downstream toe in a low point.
- **Spillway**: Spillway intake is blocked with glacial till to prevent discharge of water that does not meet water quality regulatory requirements (Photo II-B-19 and Photo II-B-20).

S5 Pond

- **Crest**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking (Photo II-B-21).
- **Left and Right Abutment**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking.
- **Downstream Slope**: Good physical condition. Minor vegetation present throughout slope. No signs of erosion, deterioration, or animal activity (Photo II-B-22 to Photo II-B-26).
- **Pond**: During inspection pond observed to be approximately 11 m below crest of dam, which was a similar level compared to the 2017 inspection. Pond was highly vegetated during the site visit and requires dredging (Photo II-B-27 to Photo II-B-29).
- **Low-level Outlet and Spillway**: As observed during the 2016 and 2017 DSI, the Low-level Outlet valves were closed and the inlet of the spillway pipes were obstructed by sand bags (Photo II-B-30).
- **Seepage**: None observed.

S8 Pond

- **Crest**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking (Photo II-B-31).

- **Left and Right Abutment**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking.
- **Downstream Slope**: Good physical condition. Moderate vegetation throughout slope and large wood debris present. No observed signs of erosion, deterioration, or adverse displacement. A pipe was observed on the slope that did not appear to be connected to anything. This pipe should be removed (Photo II-B-32 and Photo II-B-33).
- **Pond**: At the time of inspection the pond appeared lower in elevation when compared to the 2017 inspection. Approximately 2 m below the crest of the dam (Photo II-B-34).
- **Spillway**: The outlet pipe was clear of debris (Photo II-B-35).
- **Seepage**: None observed.

7 ASSESSMENT OF DAM SAFETY

7.1 Dam Classification Review

The dam consequence classifications are summarized in Table 7.1. Based on the latest dam consequence review hosted by THVCP on January 23, 2019, no change in consequence classification was recommended for any of the Highmont TSF dams.

The consequence categories of the main tailings dams meet or exceed that recommended in the latest DSR (AMEC 2014a), the determination of which was based on the results of dam break and inundation studies (AMEC 2014b). A new DSR is currently underway and is schedule for completion in 2019, which will include a review of consequence classification.

Table 7.1 Summary of Highmont Dam Consequence Classifications

Name of Dam	Consequence Classification (CDA 2013)
Highmont TSF Dams	High [1]
S1	Significant
S2	Significant
S3	High
S4	N/A (Breached; no longer a dam structure)
S5	Significant
S8	Low
S9	N/A (Breached; no longer a dam structure)

Note:
1. The East Dam was assigned a "Significant" consequence classification in AMEC (2014a). However, THVCP has adopted an increased standard and is managing all Highmont dams as "High" consequence classification.

Failure Mode Review

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

7.1.1 Highmont Dams

Overtopping

The Highmont TSF has an open channel spillway designed (AMEC 2014a) to safely pass a flood (PMF due to24-hour duration PMP) that is greater than the minimum IDF recommended under the Code. Given the presence of the spillway and wide tailings beach that would be present between the pond and crest while discharging through the spillway (minimum 290 m from the East Dam during the PMF which is larger than the IDF), the likelihood of overtopping is considered very low.

Piping and Internal Erosion

Based on a 2015 review of filter adequacy (KCB 2015a), the likelihood of failure due to filter inadequacy issues (piping) is considered low. Seepage at the five remaining seepage ponds has been regularly measured and visually checked during regular site visits since the end of TSF operations. No sediment in seepage water has been noted in recent inspection reports reviewed for this DSI.

Slope Instability - Foundation Irregularities / Dam Fill

Previous slope stability analyses (KCB 2015c) indicate the minimum static Factor of Safety (FOS) for failure surfaces through the foundation ranges from 2.0 to 2.2 (under static conditions) at the design sections. The 2015 stability assessment (KCB 2015c) included a sensitivity case to assess potential failure surfaces through a lacustrine unit in the South Dam foundation, assuming the unit is continuous, indicated a FOS of 1.8. The FOS for all analyses are greater than the minimum (1.5) required by the Code. The FOS of failures through the dam fill are greater than the critical slip surfaces through the foundation. Therefore, the likelihood of a slope instability failure through the foundation developing is considered very low.

Surface Erosion

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

Earthquakes

Previous stability analyses (KC 1996, KCB 2015c) indicate the FOS under pseudo-static loading conditions are greater than the minimum values recommended by CDA (2013). Pseudo-static analyses are not intended to simulate limit equilibrium conditions but, rather, are considered to provide a preliminary seismic deformation screening analysis. A pseudo-static FOS below criterion does not indicate that the dam will fail, but that the seismic deformations could exceed those implied by the particular method used. In that case, a more rigorous seismic deformation analyses should be conducted. Based on this, and given that the pseudo-static FOS for the Highmont Dams are greater than 1.0 assuming 50% of EDGM value (KC 1996), more rigorous deformation analyses are not deemed necessary and the likelihood of an earthquake-induce slope instability failure developing through the foundation is considered low.

7.1.2 Seepage Recovery Pond Dams

Overtopping

Based the recent flood routing reviews:

- The spillways at ponds S1 and S2 are designed for storm events with return periods greater than or equal to the minimum IDF prescribed by the Code and meet minimum freeboard requirements. The likelihood of overtopping during the IDF is considered low:
  - Refer to discussion in Section 4.4 regarding impacts of diverting flow from Highmont TSF spillway into S2 Pond and KCB's recommendation to permanently relocate till plug.
- The spillway at S3 Pond has been plugged and the impoundment can store the 72-hour duration flood event with adequate freeboard. The likelihood of overtopping during the IDF is

considered low but is more reliant on monitoring and potential active intervention (e.g. breaching spillway plug) due to the absence of a functional spillway than other ponds.

- Refer to discussion in Section 4.4 regarding flood routing and storage of S5 Pond.
- Under the current configuration, the storage capacity of the pond is essentially equivalent to the capacity of the pumping system. Therefore, assuming the pumping system is operating, the pond can safely manage the IDF (KCB 2019). KCB recommends that THVCP increase the storage capacity or attenuation within the S5 Pond system to reduce the reliance on pumping.
- The IDF can either be stored within S8 Pond or routed through the existing overflow spillway pipe. The likelihood of overtopping during the IDF is considered low.

Piping and Internal Erosion

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

Dam Instability - Foundation Irregularities / Dam Fill

Previous stability analyses (KCB 2015d) indicate the FOS for slip surfaces through dam fill and foundation are greater than the minimum FOS (1.5) required by the Code. Therefore, the likelihood of a slope instability failure developing through the foundation is considered very low.

Surface Erosion

In general, the downstream slope of the seepage dams are moderately to well-vegetated, or faced with coarse rock with light vegetation. With the current routine and event-driven inspection program in place the likelihood of surface erosion over a dam slope resulting in a failure from a single event is considered low.

Earthquakes

Previous stability analyses (KCB 2015d) indicate the FOS for slip surfaces under pseudo-static loading are greater than the minimum FOS (1.0) required by the Code. As discussed above for the Highmont Dams, pseudo-static analyses are not intended to simulate limit equilibrium conditions but, rather, are considered to provide a preliminary seismic deformation screening analysis. As a result, and given that the pseudo-static FOS for the Seepage Recovery Pond Dams is greater than unity, more rigorous deformation analyses are not deemed necessary and the likelihood of seismic related failure during the EDGM is considered very low.

7.2 Emergency Preparedness and Response

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

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

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

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

8 SUMMARY

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

Table 8.1 Previous DSI Recommendations – Status Update

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority (2)	Recommended Deadline
Highmont Tailings Storage Facility					
HD-2016-02	*Monitoring*	*OMS*	*Complete a survey of monument P2, which was not surveyed in October 2016, to confirm whether the incremental horizontal movement is survey related.*	*3*	*Q2, 2017 (CLOSED)*
HD-2016-05	Signage	-	Signage should be added to the spillway gate controls indicating which turn direction to open and close the gate and identify which seepage pond water is being diverted to in each position.	4	Q1, 2018 (Open, THVCP to schedule for 2019)
HD-2017-01	Flood Management	Spillway	THVCP should modify the spillway channel in this area to pass the peak spillway design outflow beneath the access road (bridge or arch culvert) or regrade the road surface so that water that flows over the road will report to the downstream spillway channel. Suggested interim milestones: Design: 2019; Permit and Construction: 2020.	3	Q4, 2020 (Open)
S1 Pond / S2 Pond / S3 Pond / S8 Pond					
			No previous recommendations		
S5 Pond					
S5-2017-01	*Flood Management*	*Storage Capacity*	*THVCP should increase the storage capacity or attenuation within the S5 Pond system to reduce the reliance on pumping to prevent a spill and includes an emergency outflow that does not require a temporary plug.*	*3*	*Q2, 2019 (SUPERSEDED by S5-2018-01 and S5-2018-02)*

Notes:
3. Recommendation ID numbers from 2017 DSI have been revised as shown.
4. 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 2018 DSI Recommendations

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority[1]	Recommended Deadline
Highmont Tailings Storage Facility					
HD-2018-01	Monitoring	-	At completion of the DSR, THVCP and KCB will develop a workplan to investigate the cause of changing piezometric conditions, which will include a review of the need for additional instrumentation in the Highmont TSF.	2	Q3, 2019
HD-2018-02	Flood Routing	10.1.8	Update flood routing assessment for Highmont TSF and associated seepage ponds based on the most recent site wide hydrology information for consistency and to confirm compliance.	3	Q2, 2020
HD-2018-03	Monitoring	-	Survey monument P4 after snow has cleared to confirm interpretation that incremental movement is associated with survey error.	3	Q2, 2019
S1 Pond; S3 Pond					
			No new recommendations from 2018.		
S5 Pond					
S5-2018-01	Flood Routing	10.1.8	Confirm the pumping capacity of the system at S5 Pond so that the ability to route the IDF (100-year return period, 24-hour duration) assuming the pumps are functioning as intended can be confirmed.	2	Q4, 2019
S5-2018-02	Flood Routing	10.1.8	To accommodate the temporary blocking of spillway during freshet, raise the dam crest so that the IDF (100-year 72-hour duration) can be stored within the impoundment, assuming no pumping is required. (Take into consideration, HD-2019-02)	2	Q3, 2021 (to be reviewed pending outcome of S5-2018-01)
S2 Pond					
S2-2018-01	Monitoring	OMS	Include monitoring of the inlet plug during high flow events in the 2019 OMS manual. When available, define the minimum till plug elevation necessary to prevent overtopping of flow from Highmont TSF Spillway channel during the S2 Pond IDF.	3	Q4, 2019
S2-2018-02	Flood Routing	10.1.8	To improve dam safety of S2 Pond, by reducing overtopping risks, KCB recommend the Highmont TSF spillway till plug be permanently relocated to the S2 Pond inlet channel and built to sufficient height such that the plug would not be overtopped during the Highmont TSF IDF.	2	Q4, 2019
S8 Pond					
S8-2018-01	Maintenance	OMS	A pipe was observed on the slope of the S8 Pond dam that did not appear to be connected to anything. This pipe should be removed.	4	Q4, 2019

Notes:

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

Priority 4: Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

9 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Teck Highland Valley Copper Partnership (Client). The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavoured to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

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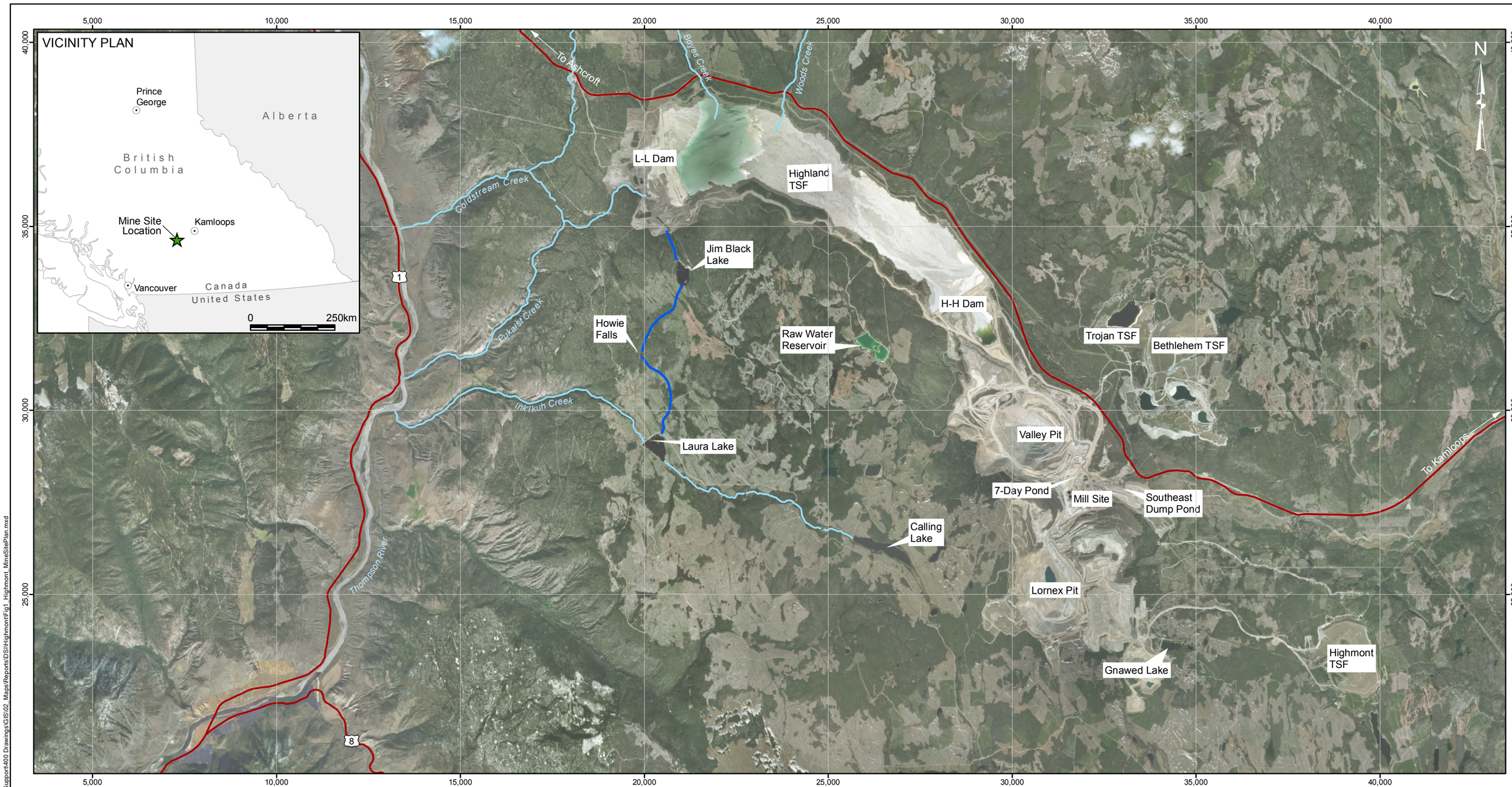
FIGURES



Legend

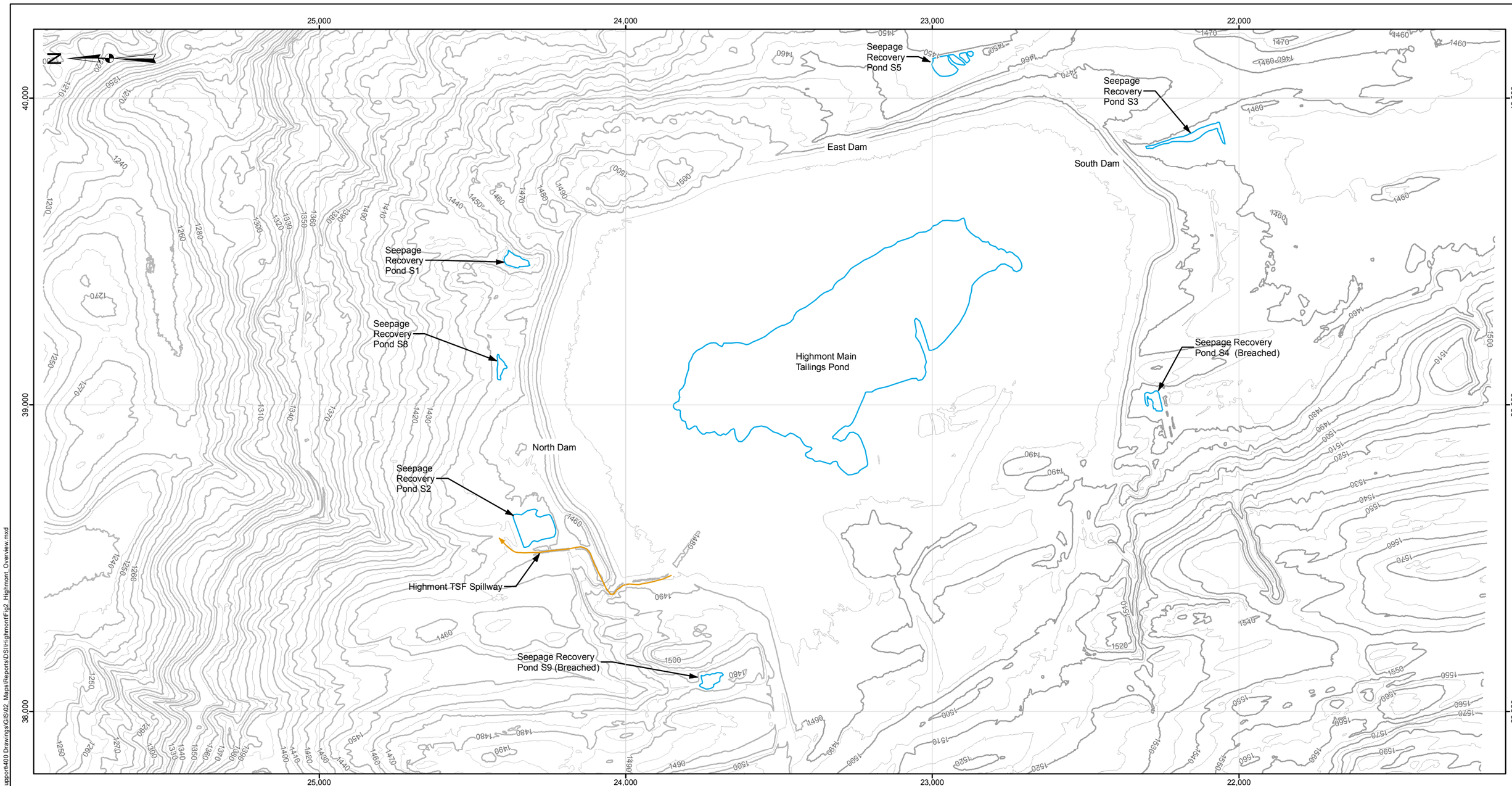
- Creek / River
- Highway
- Ditch

0 5km

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

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

Date: 2018-12-07
Document Path: Z:\MVCR\M02341B43 - HVC 2018 Dam Safety Support\400 Drawings\GIS\02_Maps\Reports\DSI\Highmont\Fig1_Highmont_MineSitePlan.mxd



Legend

- Spillway
- Index Contour (10 m)
- Intermediate Contour (5 m)
- Waterbody

0 500m

Notes:
1. Projection: HVC Mine Grid.
2. Topography from HVC, LiDAR flown on August 23rd, 2014.

CLIENT	TECK HIGHLAND VALLEY COPPER PARTNERSHIP
	Klohn Crippen Berger
PROJECT	HIGHMONT TAILINGS STORAGE FACILITY 2018 DAM SAFETY INSPECTION
TITLE	HIGHMONT TAILINGS STORAGE FACILITY OVERVIEW
SCALE	1:12,000
PROJECT No.	M02341B43
FIG No.	2

Date: 2018-12-07
Document Path: Z:\MVCR\M02341B43 - HVC 2018 Dam Safety Support\400 Drawings\GIS\02_Maps\Reports\DSI\Highmont\Fig2_Highmont_Overview.mxd

Legend

Instrument Type (Active)
- Standpipe Piezometer
- Survey Monument
- Pipe/Bucket Flow Reading
- Weir

Instrument Type (Defunct)
- Standpipe Piezometer

- Waypoint (HGH-2018-xx)
- Spillway
- Index Contour (5 m)
- Intermediate Contour (1 m)

0 250m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained July 1st, 2017
3. Topography from HVC, LiDAR flown on August 23rd, 2014.

CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP	PROJECT: HIGHMONT TAILINGS STORAGE FACILITY 2018 DAM SAFETY INSPECTION
Klohn Crippen Berger	TITLE: NORTH DAM PLAN
	SCALE: 1:5,000 | PROJECT No.: M02341B43 | FIG No.: 3

Date: 2019-03-01
Document Path: \\int.klohn.com\Proj\data\MVCR\M02341B43 - HVC 2018 Dam Safety Support\400 Drawings\GIS\02. Maps\Reports\DSI\HighmontFig3. Highmont_NorthDamPlan.mxd

Legend

Instrument Type (Active)
- Standpipe Piezometer
- Survey Monument
- Weir
- Pipe/Bucket Flow Reading

Instrument Type (Defunct)
- Standpipe Piezometer

- Waypoint (HGH-2018-xx)
- Spillway
- Index Contour (5 m)
- Intermediate Contour (1 m)

0 250m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained July 1st, 2017
3. Topography from HVC, LiDAR flown on August 23rd, 2014.

CLIENT
TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT
HIGHMONT TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

TITLE
EAST DAM
PLAN

SCALE	PROJECT No.	FIG No.
1:5,000	M02341B43	4

Date: 2019-03-01
Document Path: \\vt1.klohn.com\Proj\Data\MVCR\M02341B43 - HVC 2018 Dam Safety Support\400 Drawings\GIS\02. Maps\Reports\DSI\Highmont\Fig4_Highmont_EastDamPlan.mxd

Legend

Instrument Type (Active)
- Standpipe Piezometer
- Survey Monument
- Weir
- Waypoint (HGH-2018-xx)
- Spillway
- Spillway (Plugged)
- Index Contour (5 m)
- Intermediate Contour (1 m)

0 250m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained July 1st, 2017
3. Topography from HVC, LiDAR flown on August 23rd, 2014.

CLIENT	TECK HIGHLAND VALLEY COPPER PARTNERSHIP
	Klohn Crippen Berger
PROJECT	HIGHMONT TAILINGS STORAGE FACILITY 2018 DAM SAFETY INSPECTION
TITLE	SOUTH DAM PLAN
SCALE	1:5,000
PROJECT No.	M02341B43
FIG No.	5

Date: 2019-03-01
Document Path: \\vrt.klohn.com\Proj\Data\MVCR\M02341B43 - HVC 2018 Dam Safety Support\400 Drawings\GIS\02_Maps\Reports\DSI\Highmont\Fig5_Highmont_SouthDamPlan.mxd

APPENDIX I

Dam Safety Inspection Checklist

APPENDIX I-A

Dam Safety Inspection Checklist – North, East, and South Dams

2018 ANNUAL DAM SAFETY INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont North, East, and South Dam	**Inspection Date:**	September 19th, 2018
Weather:	Mostly sunny, with some cloudy periods	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng.

Condition	Spillway
Was it flowing?	☐ Yes ☒ No ☐ N/A
Flow rate:	N/A
Freeboard (from dam crest to current pond level):	6.75 m (based on HVC Dam Inspection Weekly Review – Week ending September 18)

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

EMBANKMENT	Yes/No	SPILLWAY	Yes/No
U/S Slope	☒ Yes ☐ No	Culverts crossing dam	☐ Yes ☒ No
Crest	☒ Yes ☐ No	Channel Invert	☐ Yes ☒ No
D/S Slope	☒ Yes ☐ No	Channel Slopes	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No	Culverts	☐ Yes ☒ No
PIPELINE DIVERSION	**Yes/No**		
Trash Rack	☒ Yes ☐ No		

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

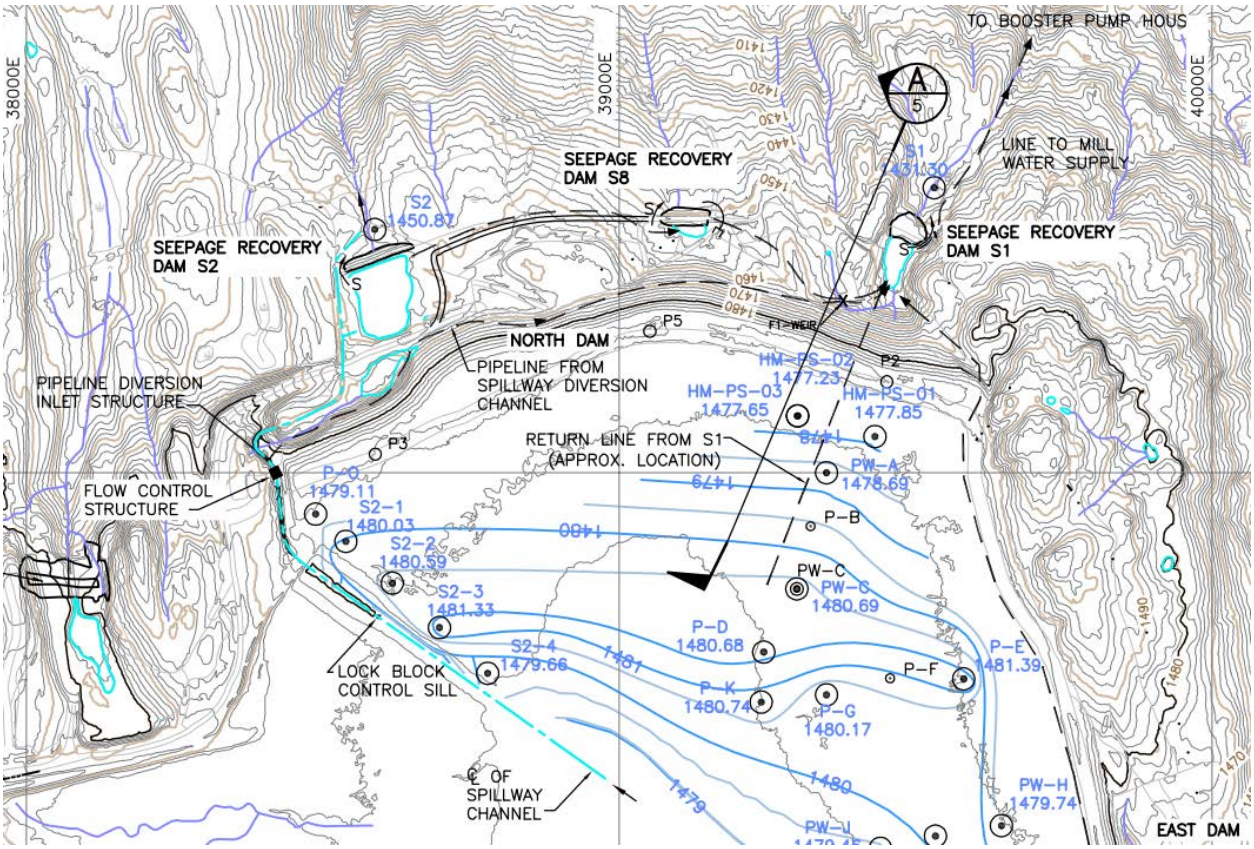
INDICATOR	EMBANKMENT	SPILLWAY
Piping	☐ Yes ☒ No	
Sinkholes	☐ Yes ☒ No	
Seepage	☐ Yes ☒ No	
External Erosion	☐ Yes ☒ No	☐ Yes ☒ No
Cracks	☐ Yes ☒ No	☐ Yes ☒ No
Settlement	☐ Yes ☒ No	☐ Yes ☒ No
Sloughing/Slides	☐ Yes ☒ No	☐ Yes ☒ No
Animal Activity	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Growth	☐ Yes ☒ No	☒ Yes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

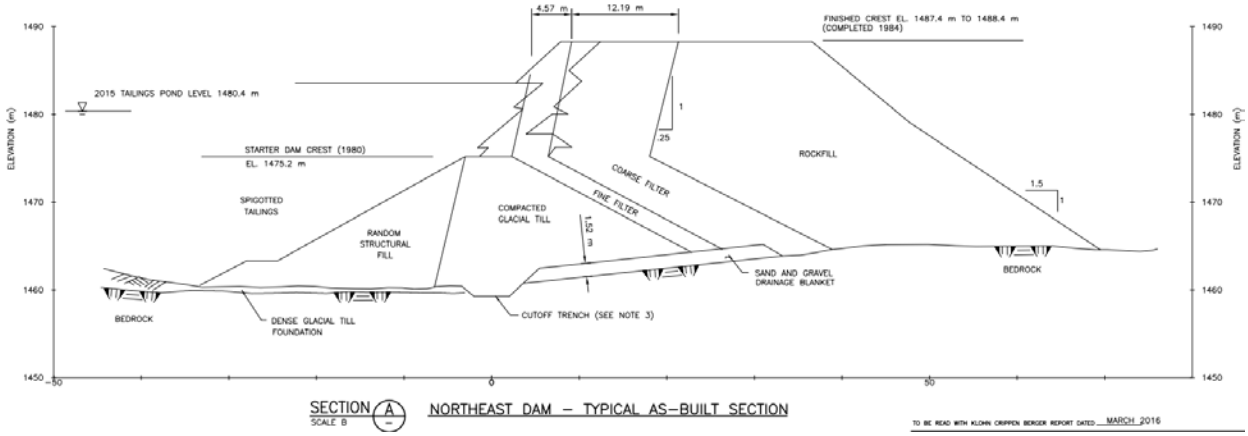
List and describe any deficiencies:

1) Tall vegetation is present in the spillway channel invert. This should be removed as part of routine maintenance to not impede flow and future inspections.
2) The inlet of the spillway culverts crossing the road downstream of the North Dam are partially blocked by debris. This should be removed to restore the intended flow capacity.

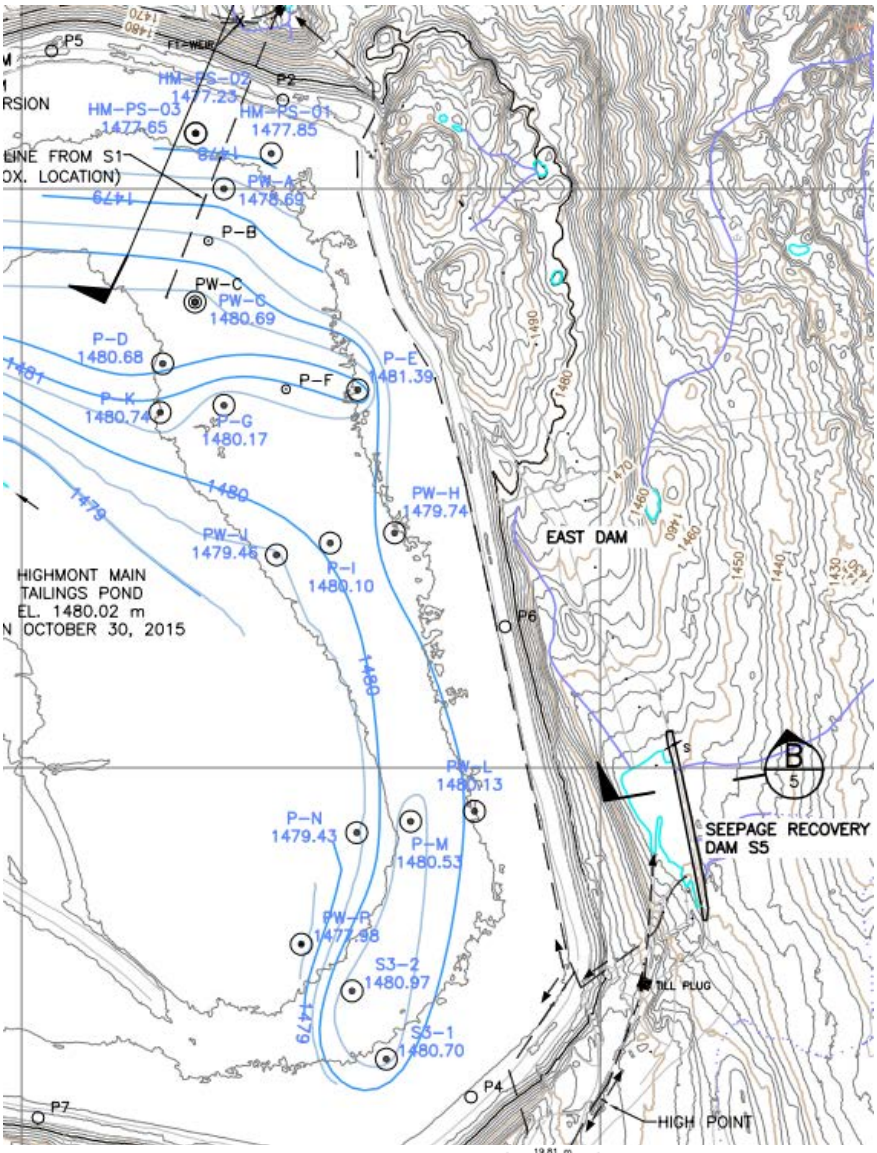
Comments: No additional comments.

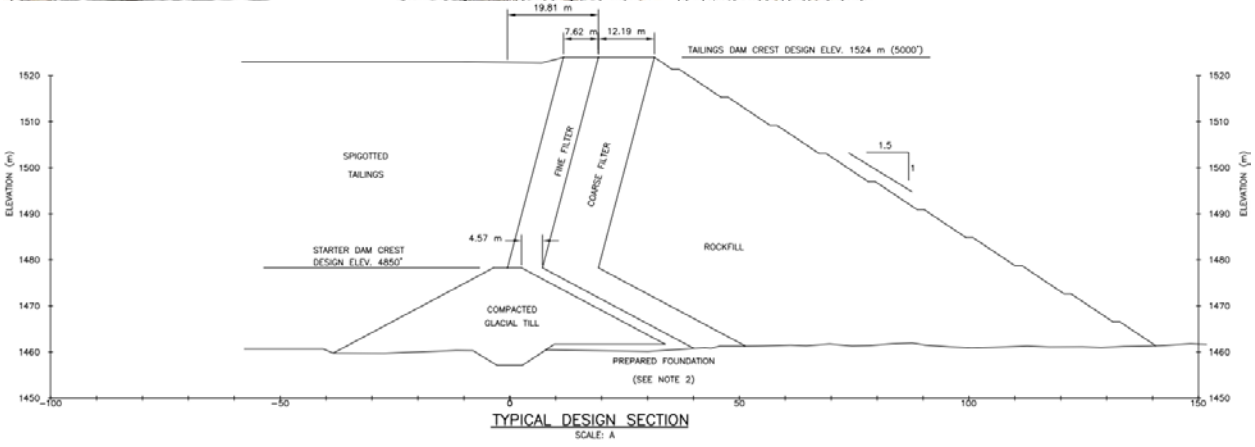
SITE PLAN (North Dam)



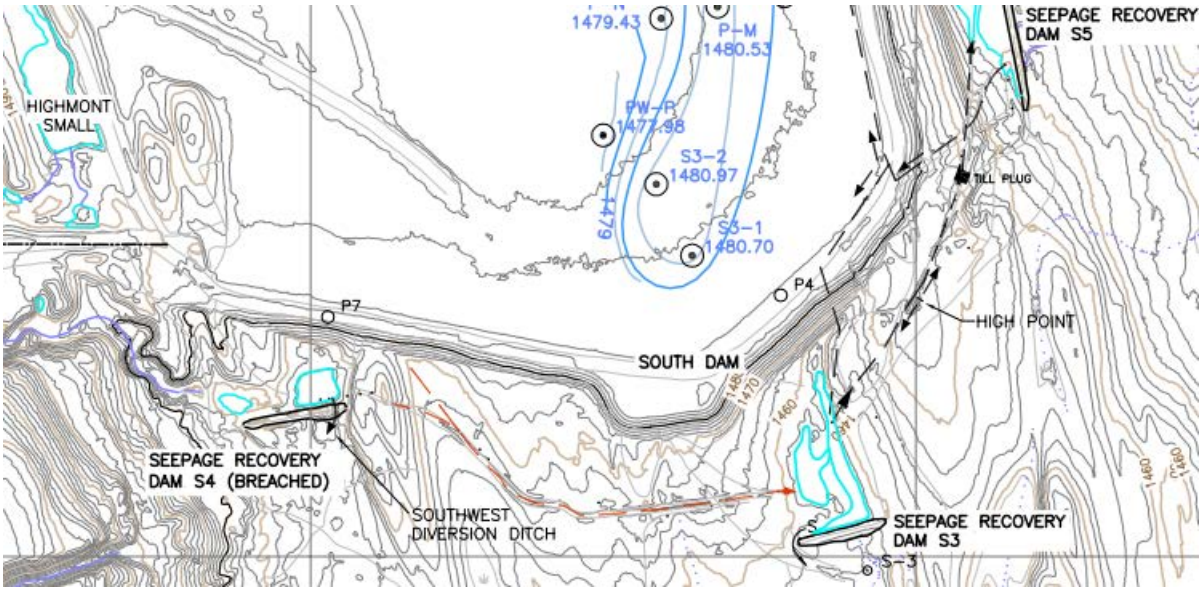


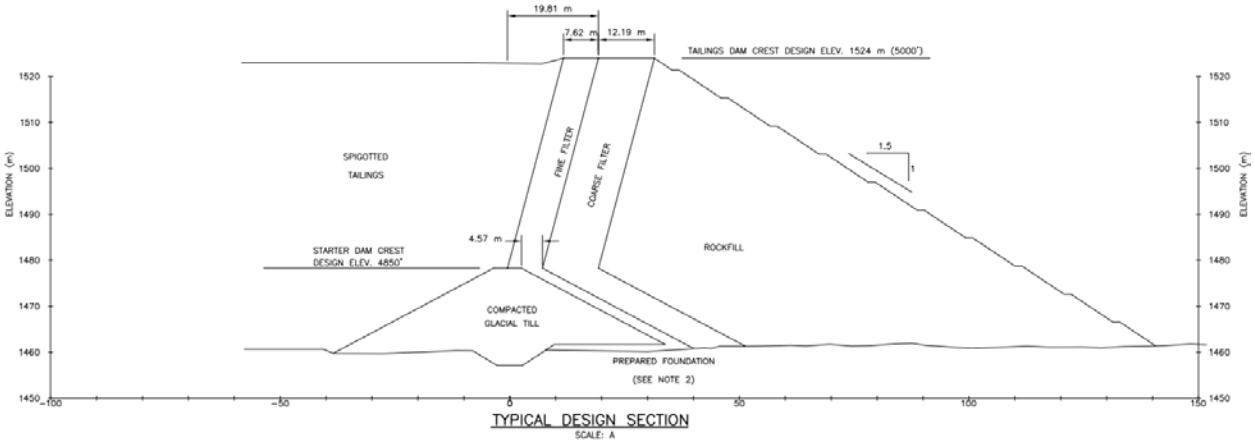
SITE PLAN (East Dam)





SITE PLAN (South Dam)





APPENDIX I-B

Dam Safety Inspection Checklist – Seepage Recovery Dams

2018 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S1	**Inspection Date:**	September 19th, 2018
Weather:	Mostly sunny, with some cloudy periods	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng.

Condition	Spillway
Was it flowing?	☐ Yes ☒ No ☐ N/A
Flow rate:	N/A
Freeboard (from dam crest to current pond level):	2.9 m (based on HVC pond inspection week ending 18-Sept-17)

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

EMBANKMENT	Yes/No	SPILLWAY	Yes/No
U/S Slope	☒ Yes ☐ No	Entrance	☒ Yes ☐ No
Crest	☒ Yes ☐ No	Walls	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No	Channel	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No	Channel Slopes	☒ Yes ☐ No

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

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

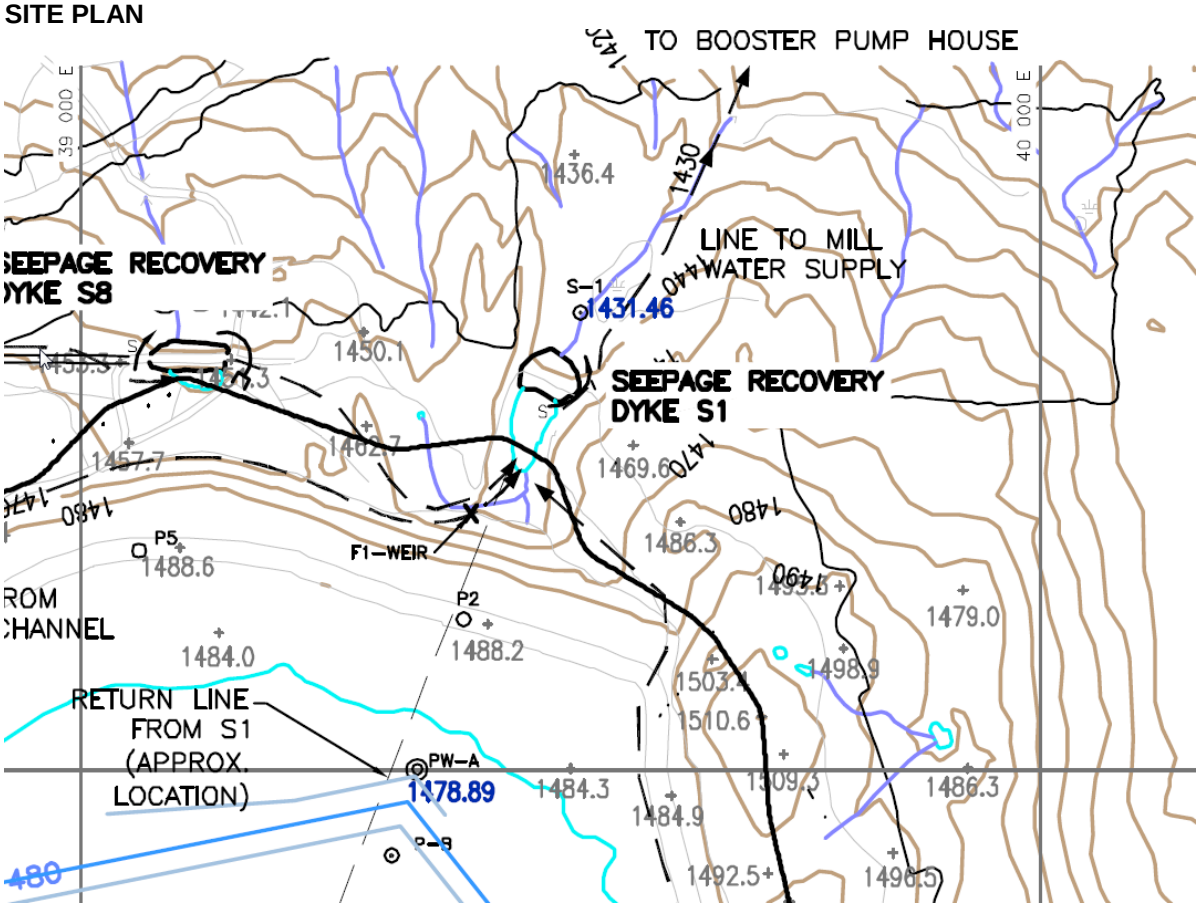
List and describe any deficiencies:

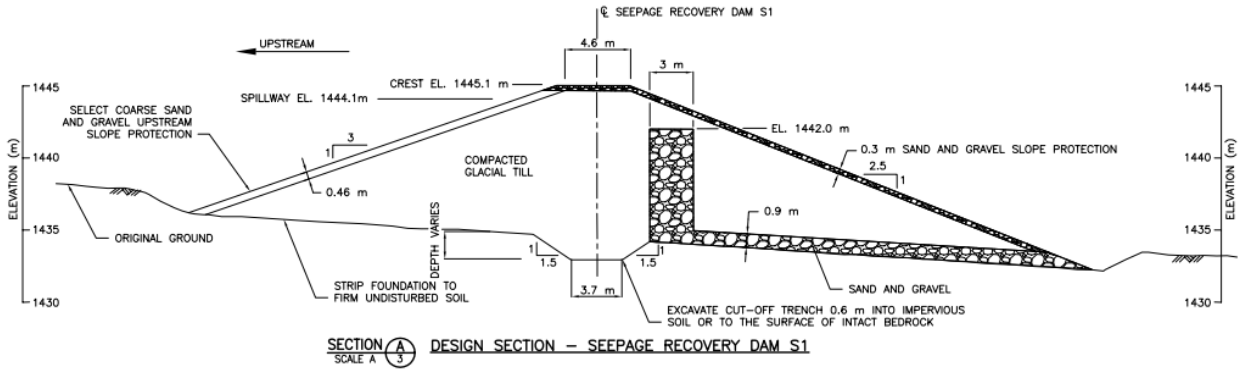
1) None.

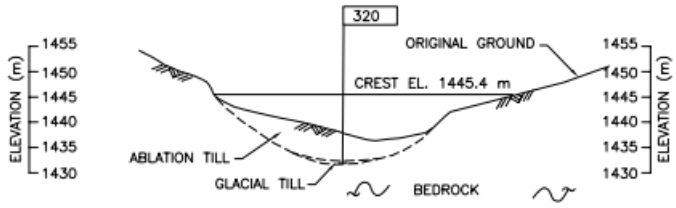
Comments:

1) The outlet of the spillway pipe is partially obstructed by vegetation which has started to grow in the riprap outfall apron. This does not pose an immediate dam safety concern but should be removed as part of regular maintenance by THVCP to facilitate future inspections.

SITE PLAN







PROFILE OF SEEPAGE RECOVERY DAM S1
SCALE B

2018 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S2	**Inspection Date:**	September 19th, 2018
Weather:	Mostly sunny, with some cloudy periods	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng.

Condition	Spillway
Was it flowing?	☐ Yes ☒ No ☐ N/A
Flow rate:	N/A
Freeboard (from dam crest to current pond level):	3.45 m (based on HVC pond inspection week ending 18-Sept-2018)

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

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

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

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

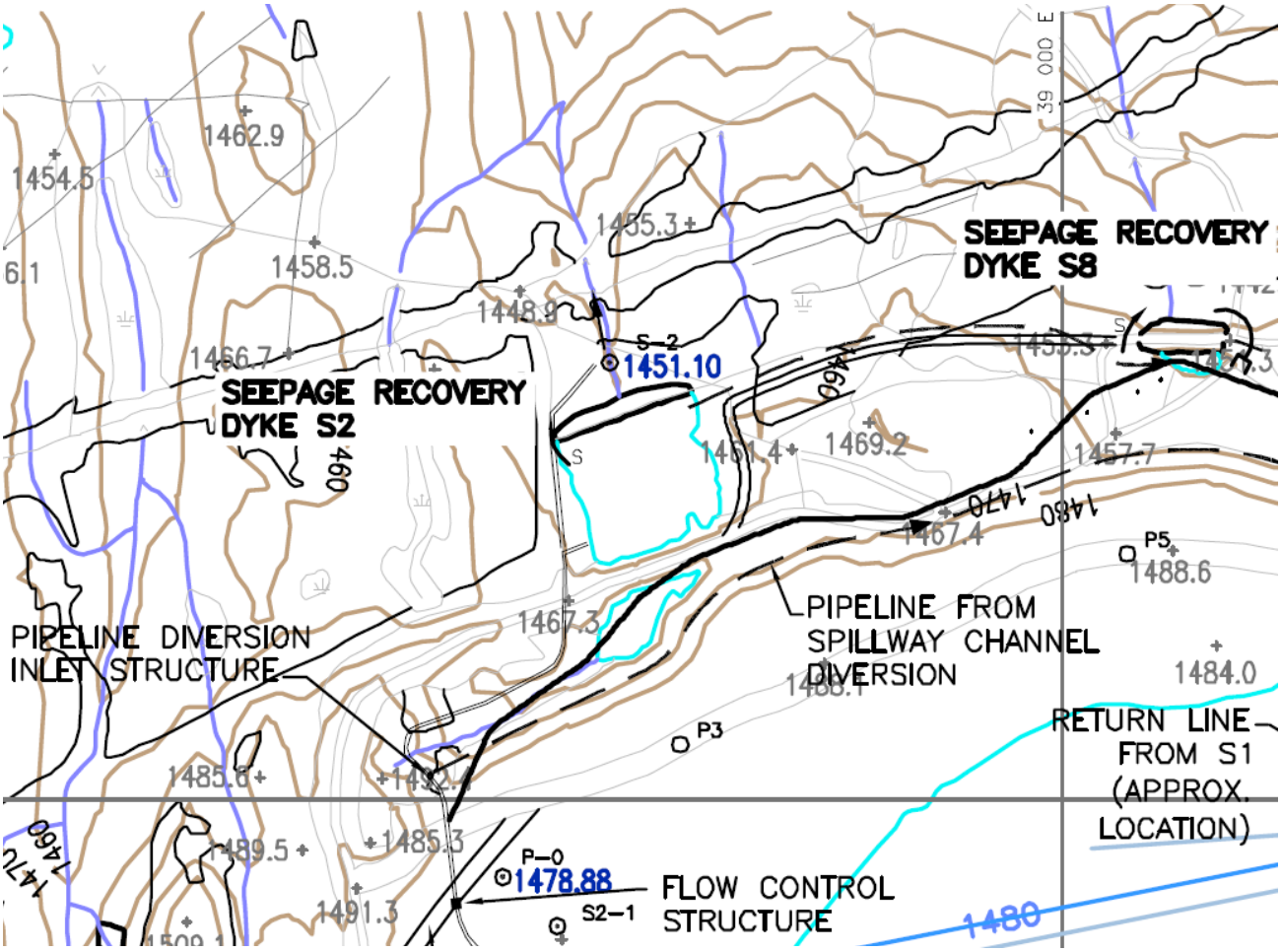
List and describe any deficiencies:

1) None.

Comments:

1) The spillway inlet is partially obstructed by vegetation. This does not pose an immediate dam safety concern but should be removed as part of regular maintenance by THVCP. Vegetation along spillway should be monitored and removed if reduces the outlet capacity.

SITE PLAN



PROFILE OF SEEPAGE RECOVERY DAM S2
SCALE B

2018 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S3	**Inspection Date:**	September 19th, 2018
Weather:	Mostly sunny, with some cloudy periods	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng.

Condition	Spillway
Was it flowing?	☐ Yes ☒ No ☐ N/A
Flow rate:	N/A
Freeboard (from dam crest to current pond level):	2.1 m (based on HVC pond inspection week ending 18-Sept-2018)

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

EMBANKMENT	Yes/No	SPILLWAY	Yes/No
U/S Slope	☒ Yes ☐ No	Entrance	☐ Yes ☐ No ☒ N/A
Crest	☒ Yes ☐ No	Walls	☐ Yes ☐ No ☒ N/A
D/S Slope	☒ Yes ☐ No	Channel	☐ Yes ☐ No ☒ N/A
D/S Toe	☒ Yes ☐ No	Channel Slopes	☐ Yes ☐ No ☒ N/A

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

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

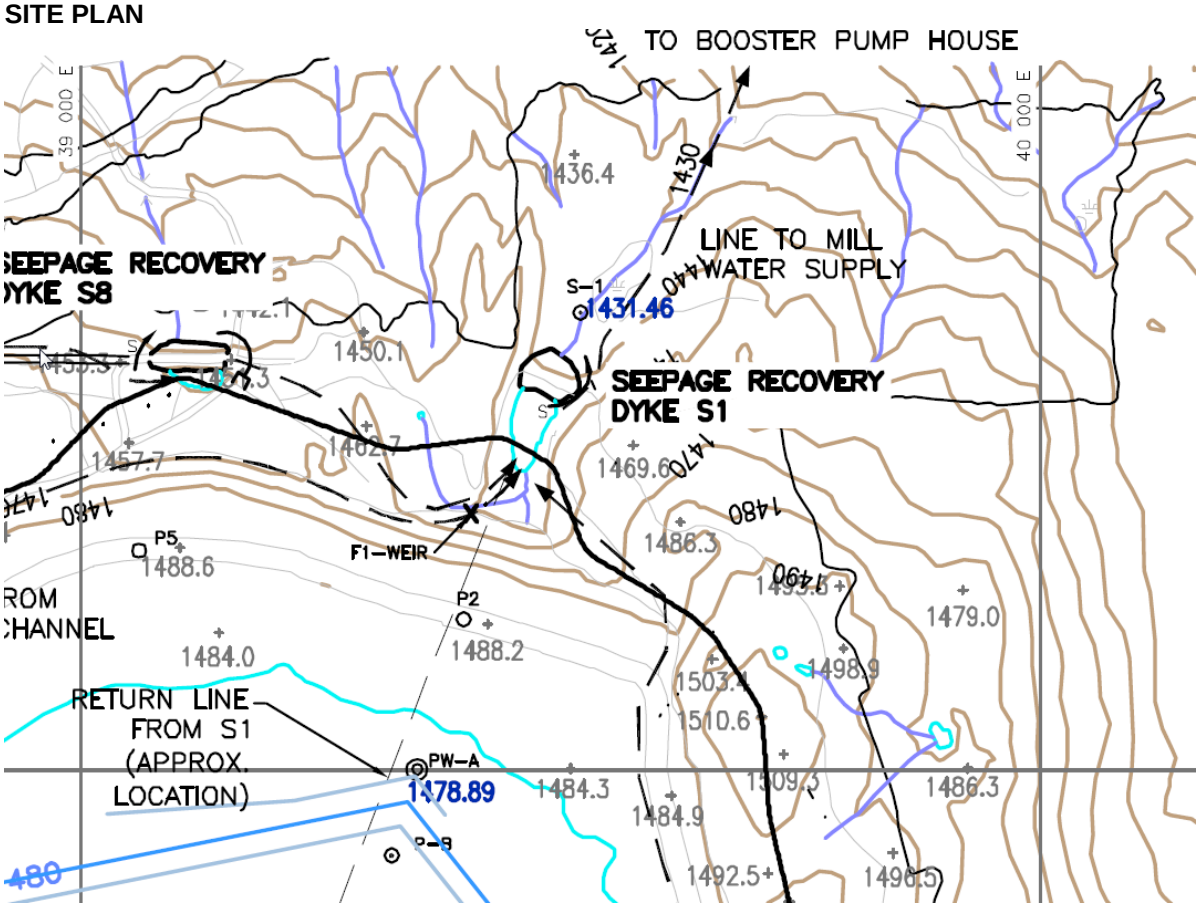
List and describe any deficiencies:

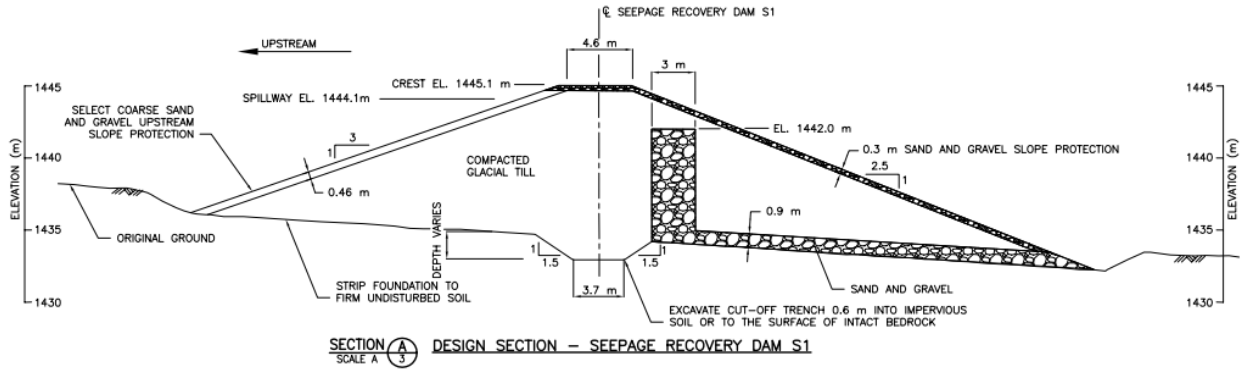
1) None.

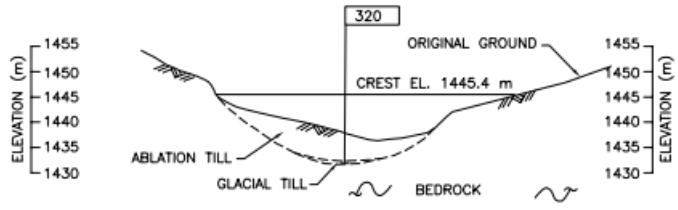
Comments:

1) Spillway intake is blocked with glacial till to prevent discharge of water that does not meet water quality regulatory requirements.

SITE PLAN







PROFILE OF SEEPAGE RECOVERY DAM S1
SCALE B

2018 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S5	**Inspection Date:**	September 19th, 2018
Weather:	Mostly sunny, with some cloudy periods	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng.

Condition	Spillway
Was it flowing?	☐ Yes ☒ No ☐ N/A
Flow rate:	N/A
Freeboard (from dam crest to current pond level):	1.1 m (based on HVC pond inspection week ending 18-Sept-2018)

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

EMBANKMENT	Yes/No	OUTLET - north	Yes/No	OUTLET - south	Yes/No
U/S slope	☒ Yes ☐ No	Outlet Pipe	☒ Yes ☐ No	Outlet Pipe	☒ Yes ☐ No
Crest	☒ Yes ☐ No				
D/S Slope	☒ Yes ☐ No				
D/S Toe	☒ Yes ☐ No				

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

INDICATOR	EMBANKMENT	OUTLET - north	OUTLET - south
Seepage	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
External Erosion	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Cracks	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Settlement	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Sloughing/Slides	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Animal Activity	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Growth	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Debris	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No

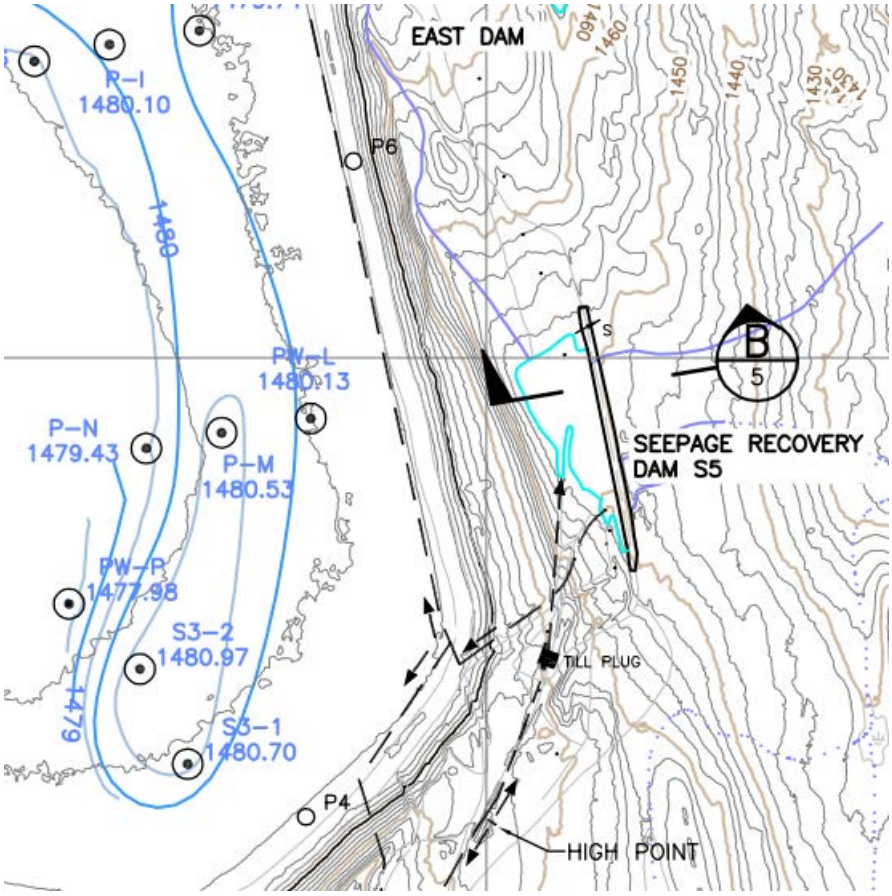
List and describe any deficiencies:

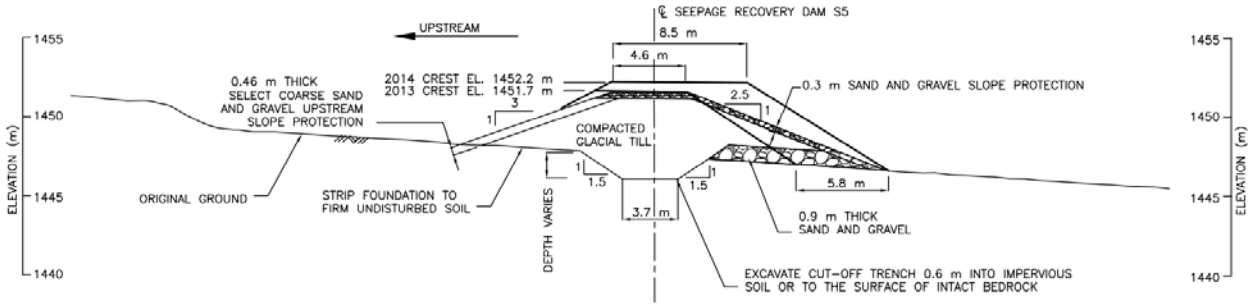
1) None.

Notes:

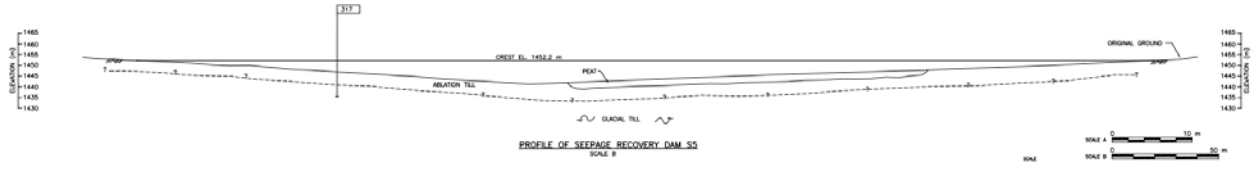
1) Spillway obstructed by sandbags at time of inspection.

SITE PLAN





SECTION B / 3 SCALE A — DESIGN SECTION – SEEPAGE RECOVERY DAM S5



2018 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S8	**Inspection Date:**	September 19th, 2018
Weather:	Mostly sunny, with some cloudy periods	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng.

Condition	Spillway
Was it flowing?	☐ Yes ☒ No ☐ N/A
Flow rate:	N/A
Freeboard (from dam crest to current pond level):	~2 m (based on KCB DSI inspection and HVC pond inspection on weeks ending 18-Jul-24 and 18-Oct-2018)

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

EMBANKMENT	Yes/No	OUTLET	Yes/No
U/S Slope	☒ Yes ☐ No	Outlet Pipe	☒ Yes ☐ No
Crest	☒ Yes ☐ No	Outlet Controls	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No		
D/S Toe	☒ Yes ☐ No		

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

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

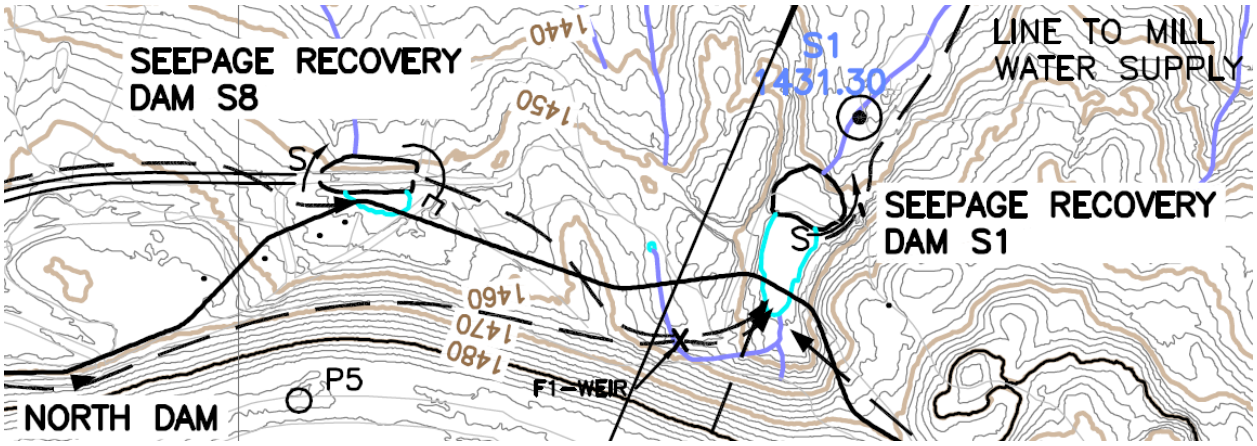
List and describe any deficiencies:

1) None.

Notes:

1) None.

SITE PLAN


SEEPAGE RECOVERY
DAM S8
1440
1450
S1
1431.30
LINE TO MILL
WATER SUPPLY
SEEPAGE RECOVERY
DAM S1
1460
1470
1480
P5
F1-WEIR
NORTH DAM

APPENDIX II

Inspection Photographs

APPENDIX II-A

Inspection Photographs – North, East, and South Dams

Appendix II-A
Inspection Photographs – North, East, and South Dams

LEGEND:

- HGH= Highmont Tailings Facility.
- HGH-2018-## refers to 2018 DSI waypoint shown on Figure 3, Figure 4, and Figure 5.
- Photographs taken during inspection on September 19

Photo II-A-1 Overview of North Dam Crest road looking East. There are some low points on the crest but there is no sign of distress (HGH-2018-1)

Photo II-A-2 Overview of North Dam Crest road and impoundment beach looking West. (HGH-2018-1)

Photo II-A-3 East Dam downstream overview looking North. Slope covered by vegetation. (HGH-2018-2)

Photo II-A-4 East Dam downstream overview looking South. Slope covered by vegetation. (HGH-2018-2)

Photo II-A- 5 Downstream slope of the road at the toe of the South Dam looking West. Slope is in good condition. (HGH-2018-3)

Photo II-A-6 South Dam toe and HM-S3-FS-01 weir. S3 upstrem slopes are in good condition (HGH-2018-4)

Photo II-A-7 Steepened section of downstream slope and underdrain flow channel. Underdrain discharge seems similar to 2017 DSI. There is no evidence of excessive ponding or high-water level on dam toe. (HGH-2018-5)

Photo II-A-8 North Dam: local excavation. Appears to be an old pipeline bench excavated at the dam toe. (HGH-2018-6)

Photo II-A-9 Spillway approach channel, concrete lock-block control sill (HGH-2018-7)

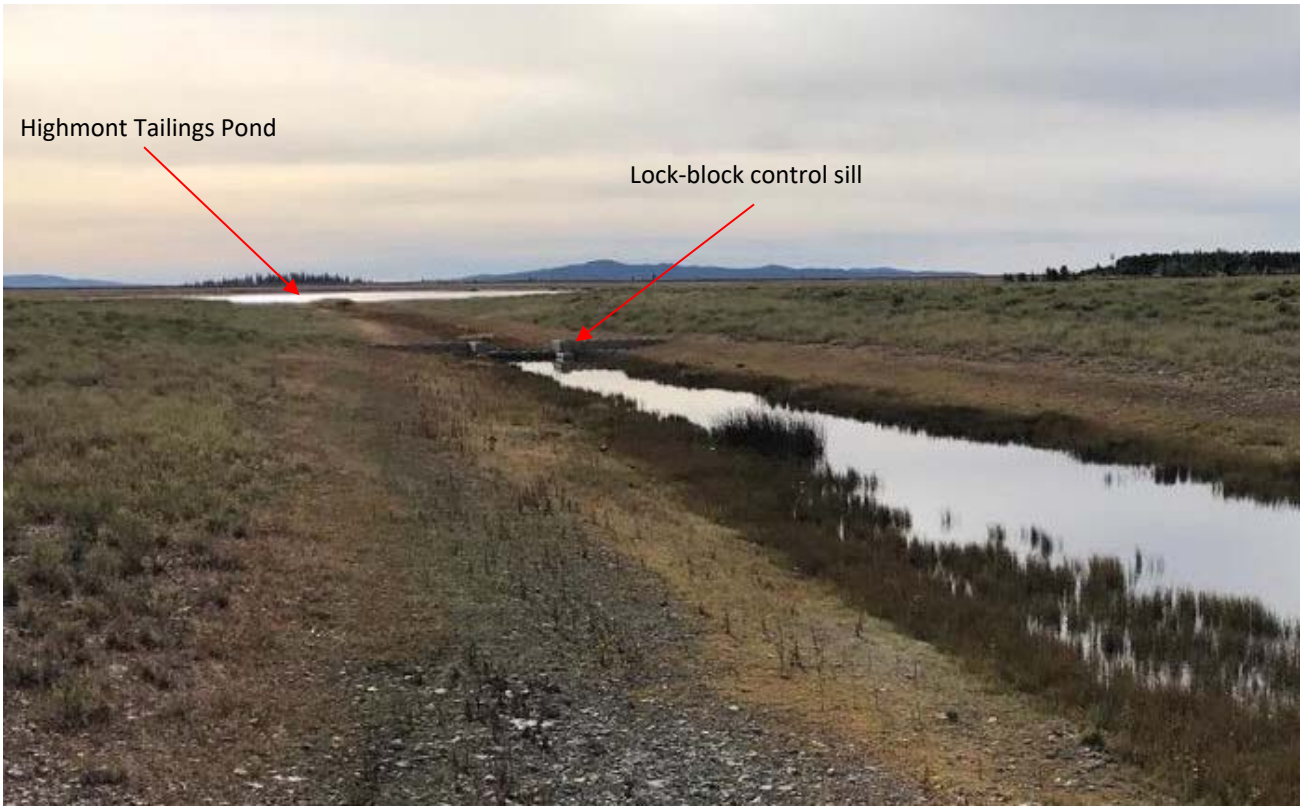


Photo II-A-10 Spillway upstream of road crest. Road is in good condition. Spillway culverts are partially submerged (HGH-2018-7)

Photo II-A-11 Spillway channel looking upstream from the flow control gate. (HGH-2018-8)

Photo II-A- 12 Spillway flow control gate (HGH-2018-8)

Photo II-A-13 Spillway channel looking downstream from the flow control gate. Channel is highly vegetated. Water elevation has not changed compared to inspection in 2017(HGH-2018-8)

Photo II-A-14 Spillway channel looking downstream at inlet to Seepage Recovery Pond S1 pipeline division, showing trashrack on invert (HGH-2018-9)

Photo II-A-15 Overview of spillway channel and rock chute. (HGH-2018-5)

Photo II-A-16 Overview of spillway channel looking downstream towards S2 Seepage Recovery Pond (HGH-2018-9)

Photo II-A-17 Overview of spillway area from the road crest looking south. (HGH-2018-10)

Photo II-A-18 Inlet of 33" ID spillway road culverts, showing vegetation (HGH-2018-11)

Photo II-A-19 Highmont road-crossing spillway culverts, downstream side of the road, less vegetation observed compared to 2017DSI (HGH-2018-12)

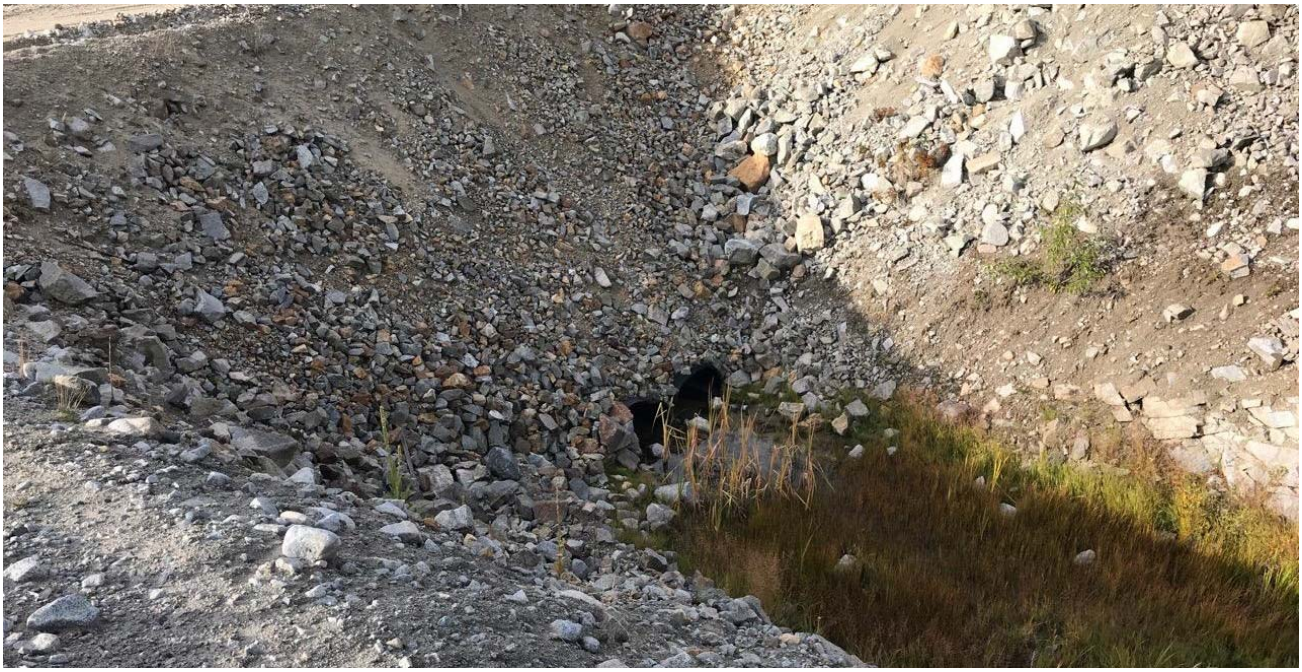


Photo II-A-20 S2: Highmont spillway; looking south. North dam toe and the road-crossing culverts are visible. There is vegetation growth which will be cleared as part of routine maintenance (HGH-2018-13).

Photo II-A-21 S2: Highmont spillway; looking north. There is vegetation growth which will be cleared as part of routine maintenance (HGH-2018-13)

APPENDIX II-B

Inspection Photographs – Seepage Recovery Dams

Appendix II-B
Inspection Photographs - Seepage Recovery Dams

LEGEND:

- HGH = Highmont Tailings Facility.
- HGH-2018-## refers to 2018 DSI waypoint shown on Figure 3, Figure 4, and Figure 5.
- All photographs taken during inspection on September 19

II-B-I Seepage Recovery Pond S1

Photo II-B-1 S1: Overview of pond and upstream slope of dam from Highmont Dam crest. (HGH-2018-1)

Photo II-B-2 S1: Dam crest looking West towards left abutment. (HGH-2018-14)

Photo II-B-3 S1: Overview of pond and upstream slope of dam, looking North. (HGH-2018-15)

Photo II-B-4 S1: Spillway inlet (HGH-2018-14)

Photo II-B-5 S1: Spillway channel and pipe intake looking downstream. Pipe intake is clear with no sign of vegetation or any other obstructions. (HGH-2018-14)

II-B-II Seepage Recovery Pond S2

Photo II-B-6 S2: Dam crest, view from right abutment. Crest in good condition; no sign of differential movement or distress was observed (HGH-2018-16)

Photo II-B-7 S2: Downstream slope looking from right abutment. The slope is in good condition; no erosion was observed (HGH-2018-16)

Photo II-B-8 S2: Overview of the pond and upstream slope from right abutment. The slope is in good condition; no erosion was observed. Highmont North Dam downstream toe is visible in the background to the left. (HGH-2018-16)

Photo II-B-9 S2: Spillway invert and channel. Looking downstream to tie-in with Highmont spillway. (HGH-2018-17)

Photo II-B-10 S2: Spillway invert and channel. (HGH-2018-17)

Photo II-B-11 S2: Spillway outlet. Outlet is vegetated; vegetation should be monitored and removed if reduces the outlet capacity. (HGH-2018-17)

Photo II-B-12 S2: Plug across inlet S2 channel to direct flow to spillway channel. View looking downstream (HGH-2018-13)

Photo II-B-13 S2: Ponded water at downstream toe, similar in size to the pond noted during the 2015, 2016, and 2017 DSI. (HGH-2018-18)

II-B-III Seepage Recovery Pond S3

Photo II-B-14 S3: Dam crest view from left abutment. Crest is in good condition; no sign of erosion or any differential movement is observed (HGH-2018-19)

Photo II-B-15 S3: Downstream slope; no sign of erosion is observed (HGH-2018-19)

Photo II-B-16 S3: Overview of the pond and upstream slopes, looking South. Slopes are in good condition. (HGH-2018-4)

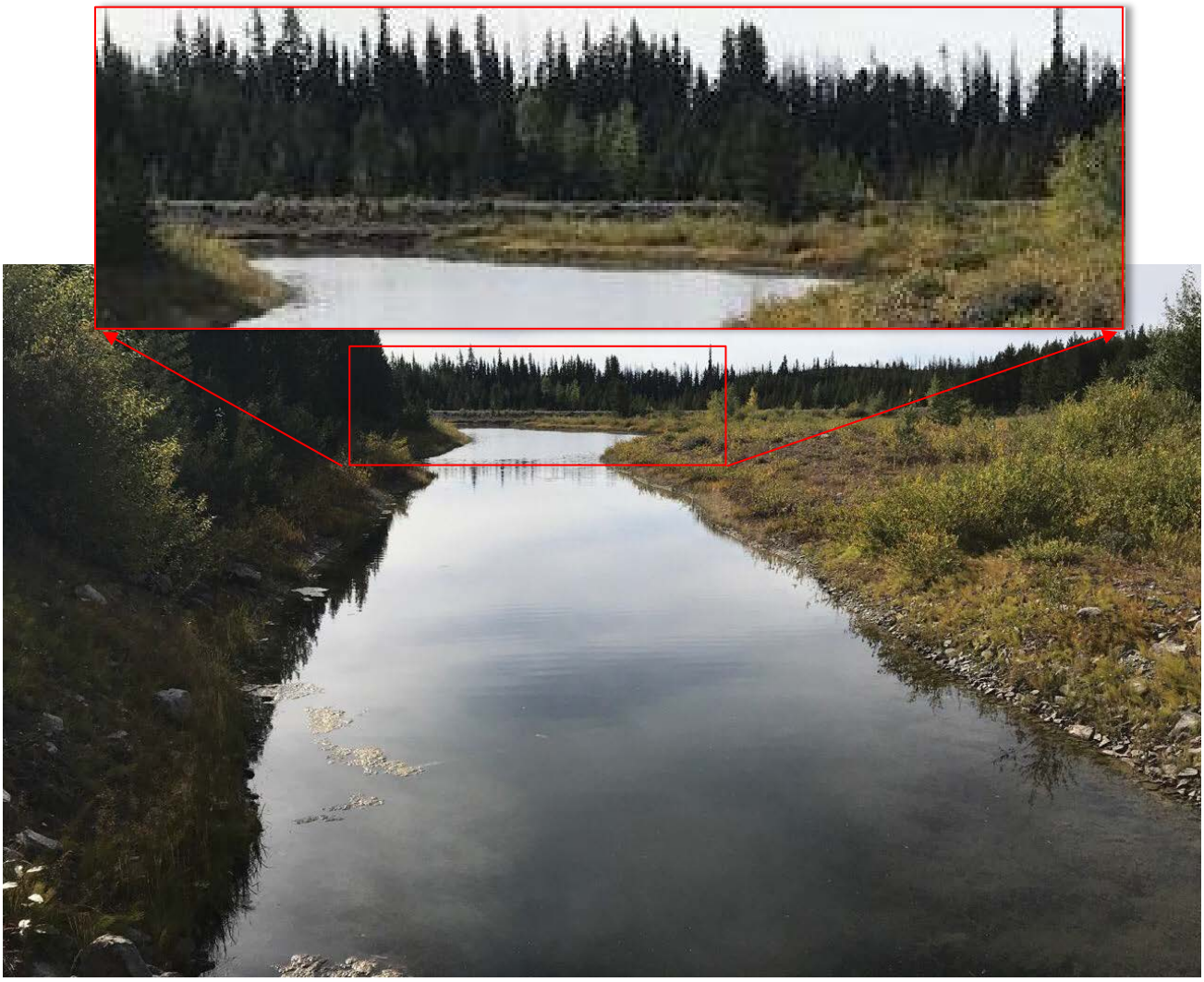


Photo II-B-17 S3: Catwalk; personal flotation devices are in place. (HGH-2018-4)

Photo II-B-18 S3: Pond and South Dam toe view from left abutment, looking Northwest (HGH-2018-19)

Photo II-B-19 S3: Spillway intake is blocked (HGH-2018-20)

Photo II-B-20 S3: spillway channel downstream of blockade. (HGH-2018-20)

II-B-IV Seepage Recovery Pond S5

Photo II-B-21 S5: dam crest is in good condition; no evidence of erosion or distress (HGH-2018-21)

Photo II-B-22 S5: Downstream slope looking North from right abutment. Slope is in good condition; no sign of erosion is observed (HGH-2018-21)

Photo II-B-23 S5: Downstream slope of central pond looking south towards right abutment. Slope is in good condition (HGH-2018-22)

Photo II-B-24 S5: Downstream slope of left abutment. Slope is in good condition (HGH-2018-22)

Photo II-B-25 S5: Upstream slope of central pond looking south towards right abutment. Slope is in good condition (HGH-2018-22)

Photo II-B-26 S5: Upstream slope looking South. Slope is in good condition; no sign of erosion is observed (HGH-2018-23)

Photo II-B-27 S5: Inflow pond; intake of pipe connecting perimeter pond to pumping cell is visible. Pond is highly vegetated and requires dredging. (HGH-2018-24)

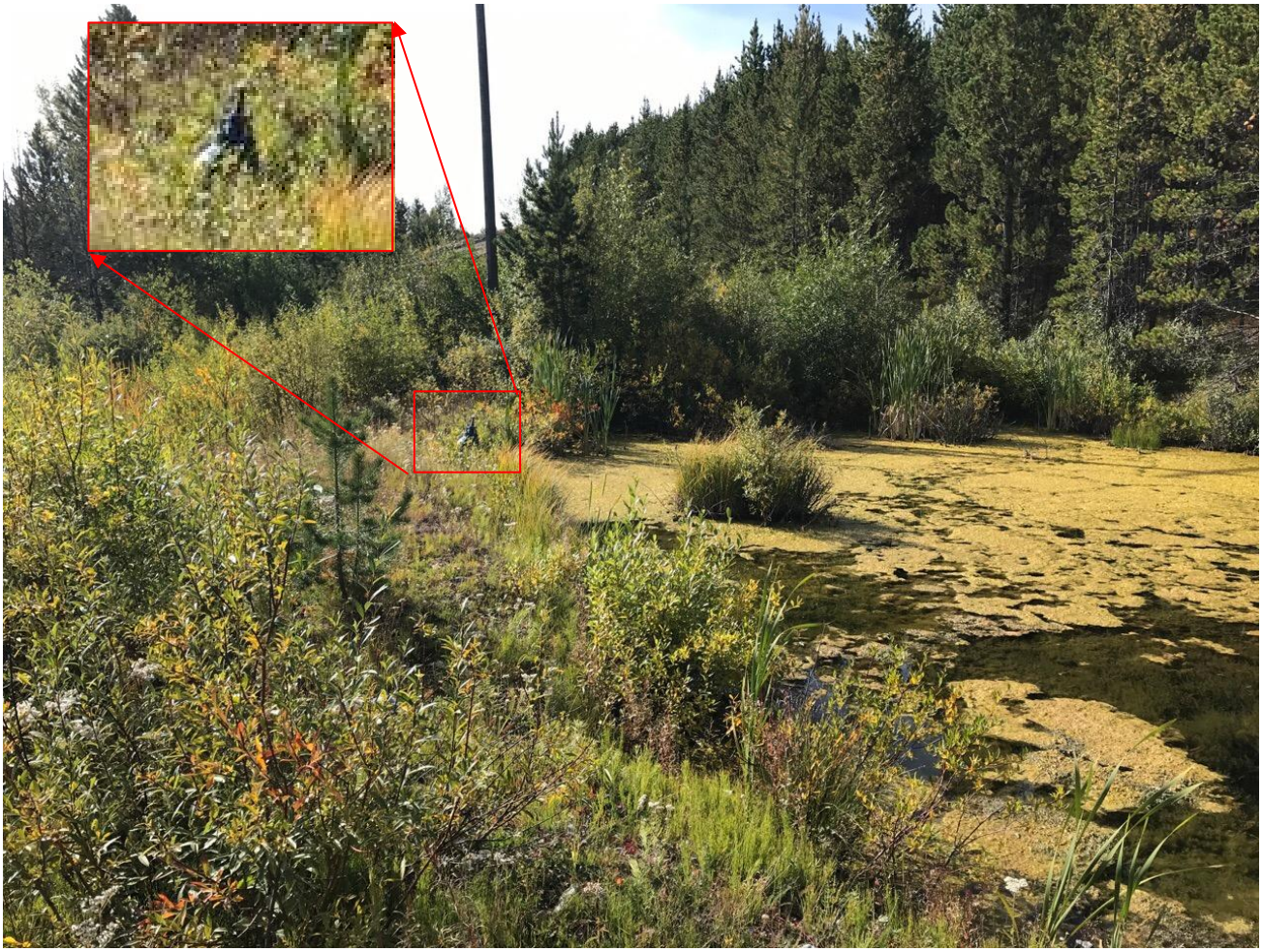


Photo II-B-28 S5: Inflow pond, looking North. Pond is highly vegetated (HGH-2018-24)

Photo II-B-29 S5: Pumping cell with outlet pump to S1 pond. (HGH-2018-23)

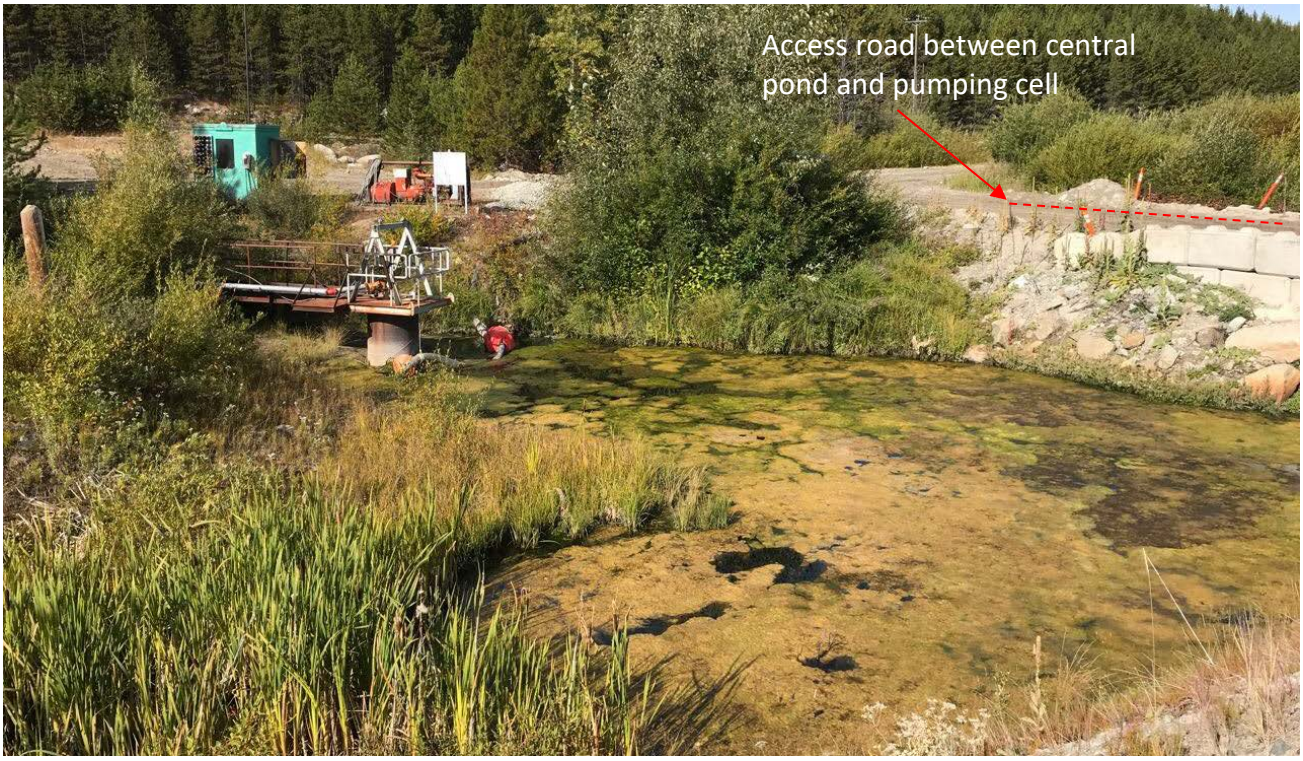


Photo II-B-30 S5: Spillway pipes (2x), inlet blocked with sand bags. (HGH-2018-25)

II-B-V Seepage Recovery Pond S8

Photo II-B-31 S8: Overview of crest and upstream slope. u/s slope is in good condition. Crest has low points but there is no major distress. (HGH-2018-26)

Photo II-B-32 S8: Downstream slope looking East from left abutment. Slope is in good condition, pipe on slope is not connected to anything. (HGH-2018-26)

Photo II-B-33 S8: Downstream slope looking West from right abutment. (HGH-2018-27)

Photo II-B-34 S8: Pond overview with pumphouse to S1 pond (right of photo) and North Dam downstream slope on left. (HGH-2018-27)

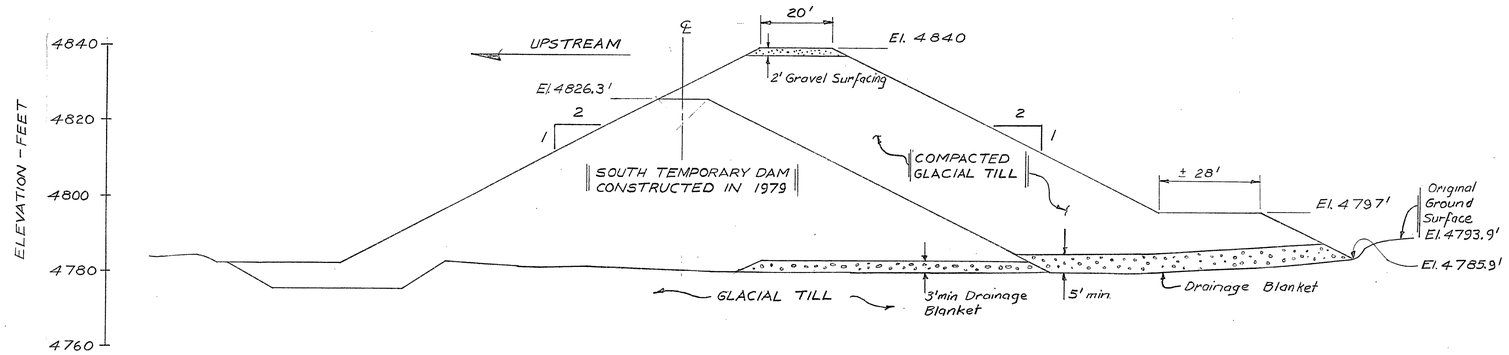
Photo II-B-35 S8: Trash rack for overflow pipe is clear of debris. (HGH-2018-27)

APPENDIX III

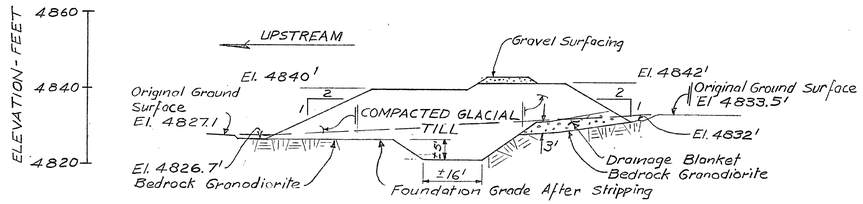
Reference Dam Design Drawings

APPENDIX III-A

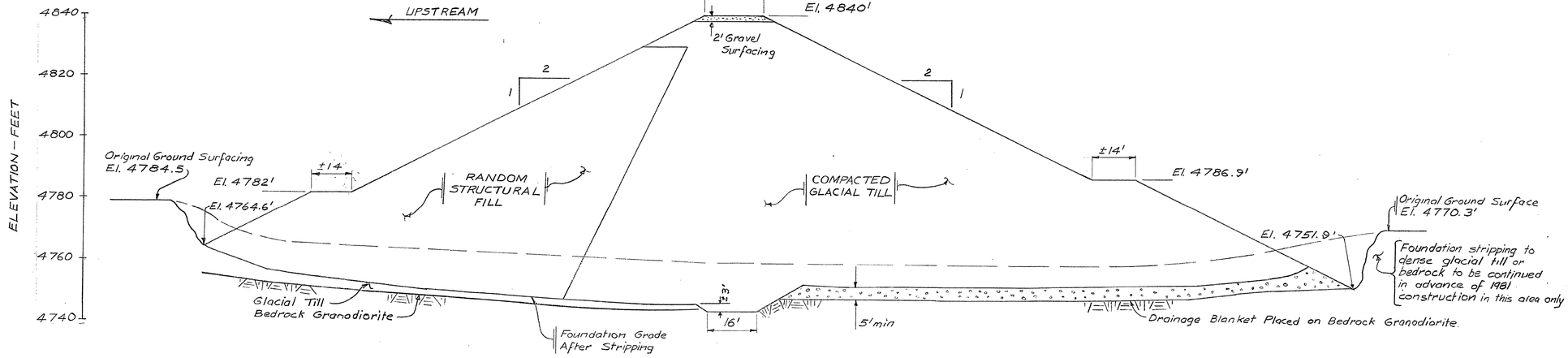
Reference Dam Design Drawings – Highmont TSF



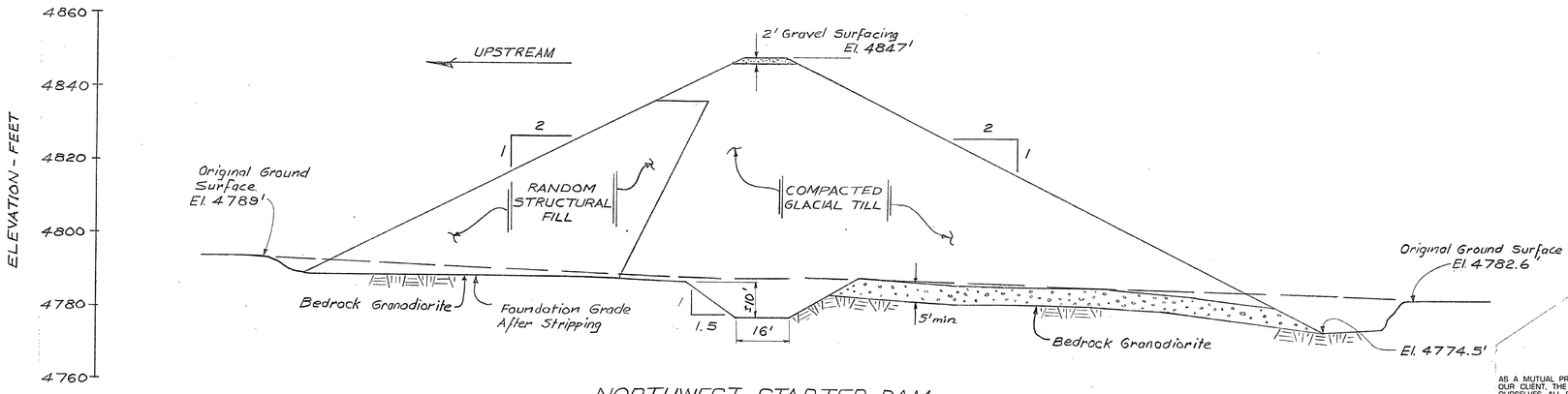
SOUTH STARTER DAM
STATION 104+00



EAST STARTER DAM
STATION 67+30



NORTHEAST STARTER DAM
STATION 39+00



NORTHWEST STARTER DAM
STATION 11+00

NOTES

1. All dam foundations stripped to firm undisturbed soil or bedrock.
2. Cutoff trenches excavated a minimum of 2' into dense impervious soil or to the surface of intact bedrock, except for the east dam where the excavation was a maximum of 5' deep. Cutoff trenches in bedrock were hand cleaned.
3. Berms on the northeast and south dams resulted from a reduction in starter dam elevation from 4847' to 4840'. The berm on the upstream side of the east dam was cut, to maintain the tailings pipeline at elevation 4840'.
4. For general arrangement and location of sections see drawing E-1526-45.

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TO BE READ WITH KLOHN LEONOFF REPORT DATED MAR. 27, 1981

SCALE: 20 0 20 40 ft.

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
S.R.	C.P.V	MAR. 1981	AS SHOWN

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

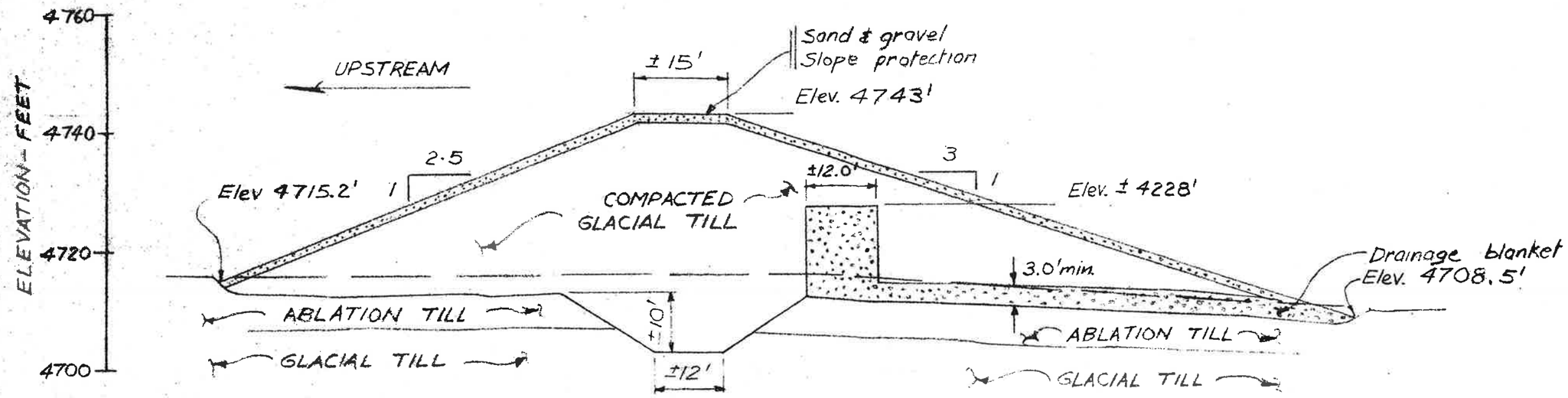
PROJECT: TAILINGS DISPOSAL DAMS

TITLE: STARTER DAM AS-BUILT SECTIONS

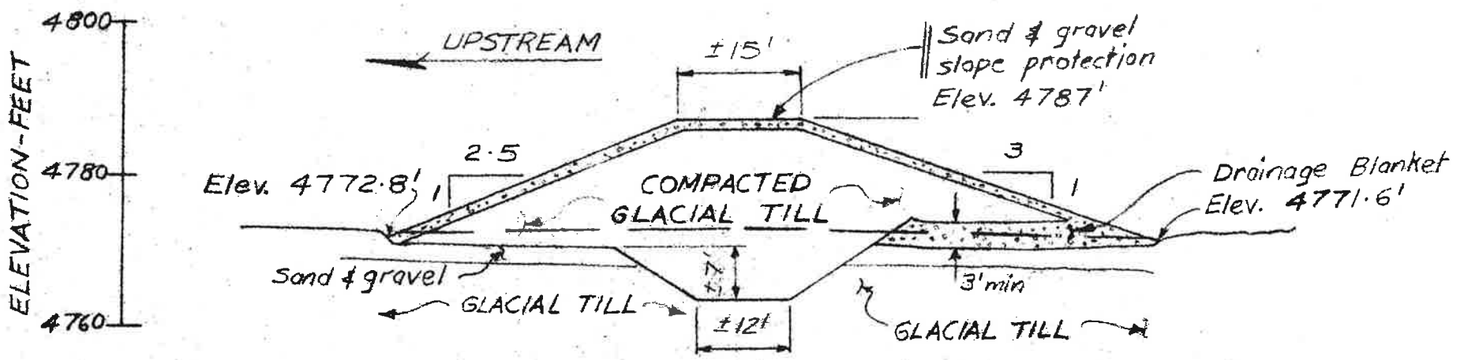
CLIENT: HIGHMONT OPERATING CORP.

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
MAR. 27, 1981	VA1526	D-1526-46	

APPROVED



SEEPAGE RECOVERY DAM S1
STATION 2+00



TYPICAL SECTION SEEPAGE
RECOVERY DAMS S2 & S3
(Section on S3, ST. 1+38)

REFERENCE

1. For notes see drawing D-1526-46
2. For location of dams see drawing D1526 - 45

20 0 20 40 ft.
SCALE

TO BE READ WITH KLOHN LEONOFF REPORT DATED MAR. 27, 1981

SCALE As Shown.

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KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

CLIENT: HIGHMONT OPERATING CORP.

PROJECT: TAILINGS DISPOSAL DAMS

TITLE: SEEPAGE RECOVERY DAMS AS-BUILT SECTIONS

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA S. LIGHTHALL

DATE OF ISSUE: MAR 1981

APPROVED

PROJECT No.: VA1526

DWG. No.: B-1526-47

REV.

NCI-456-K.L

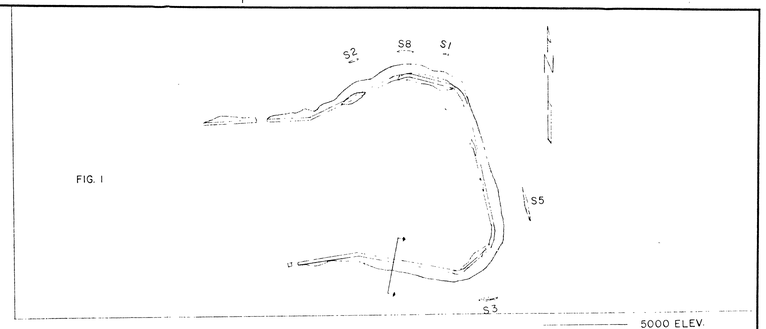
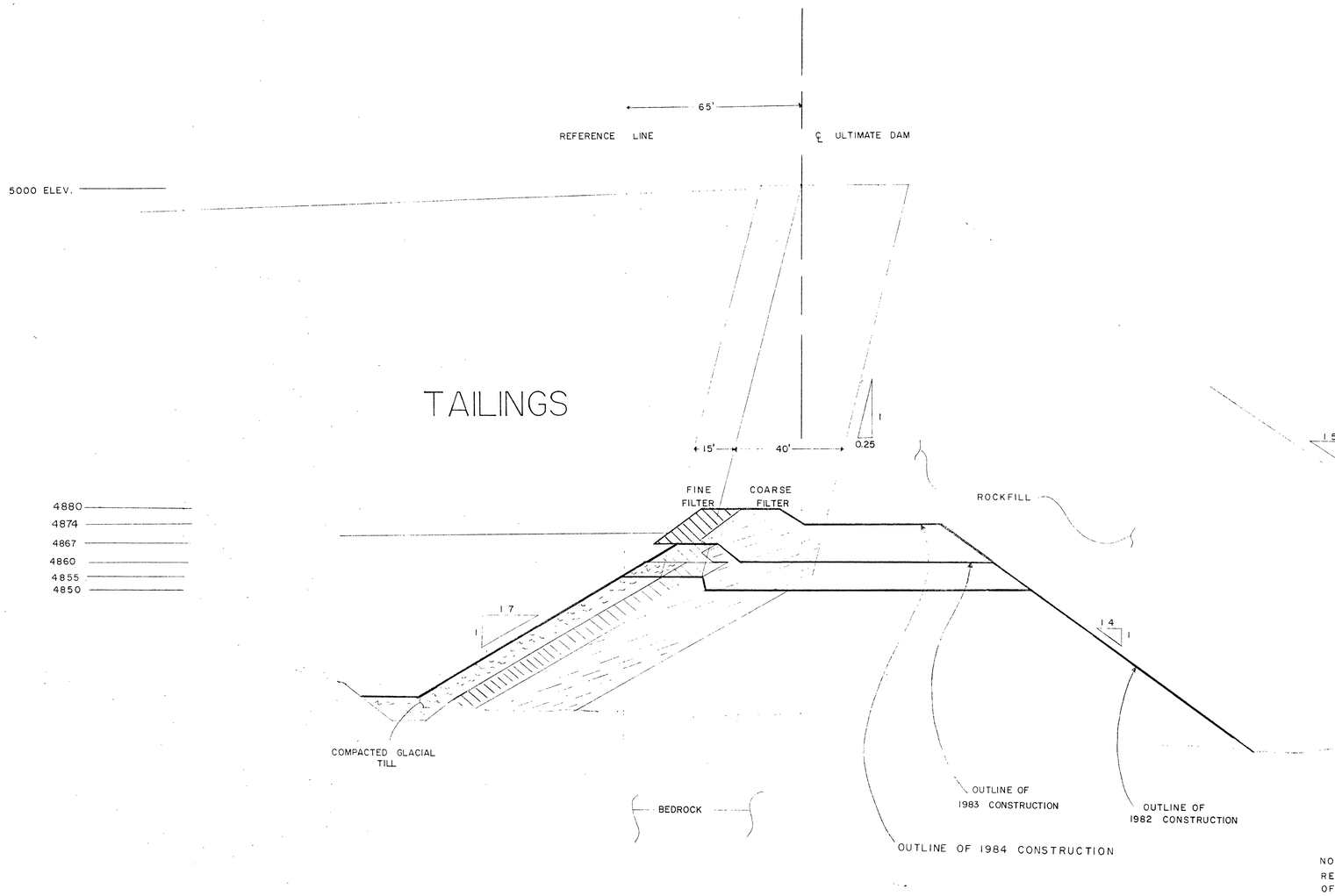


FIG. 1



NOTE,
REFER TO FIG 1 FOR LOCATION OF SECTION

LEGEND
FINE FILTER
COARSE FILTER
COMPACTED GLACIAL TILL

SCALE,
VERTICAL 1"=20'
HORIZONTAL 1"=20'

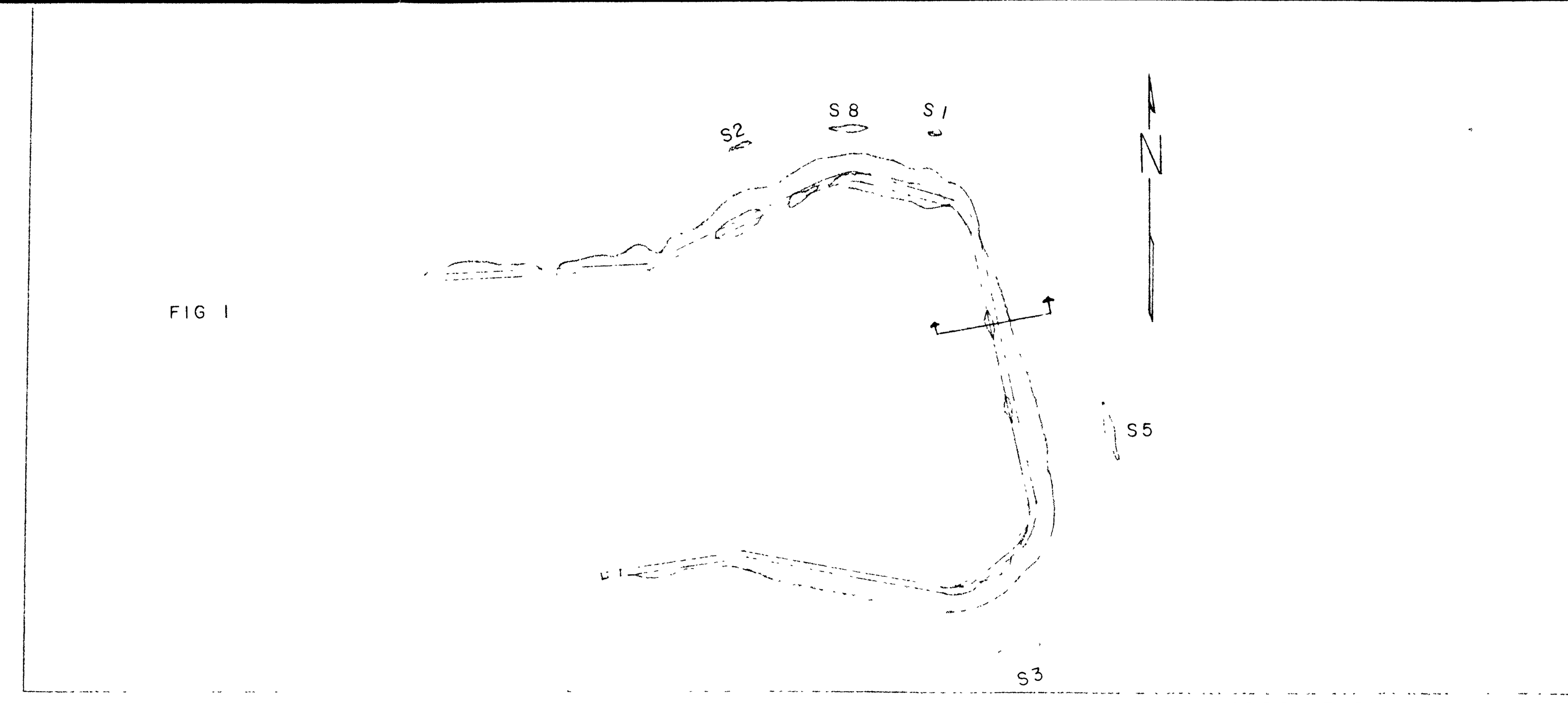
A ISSUED FOR CONSTRUCTION

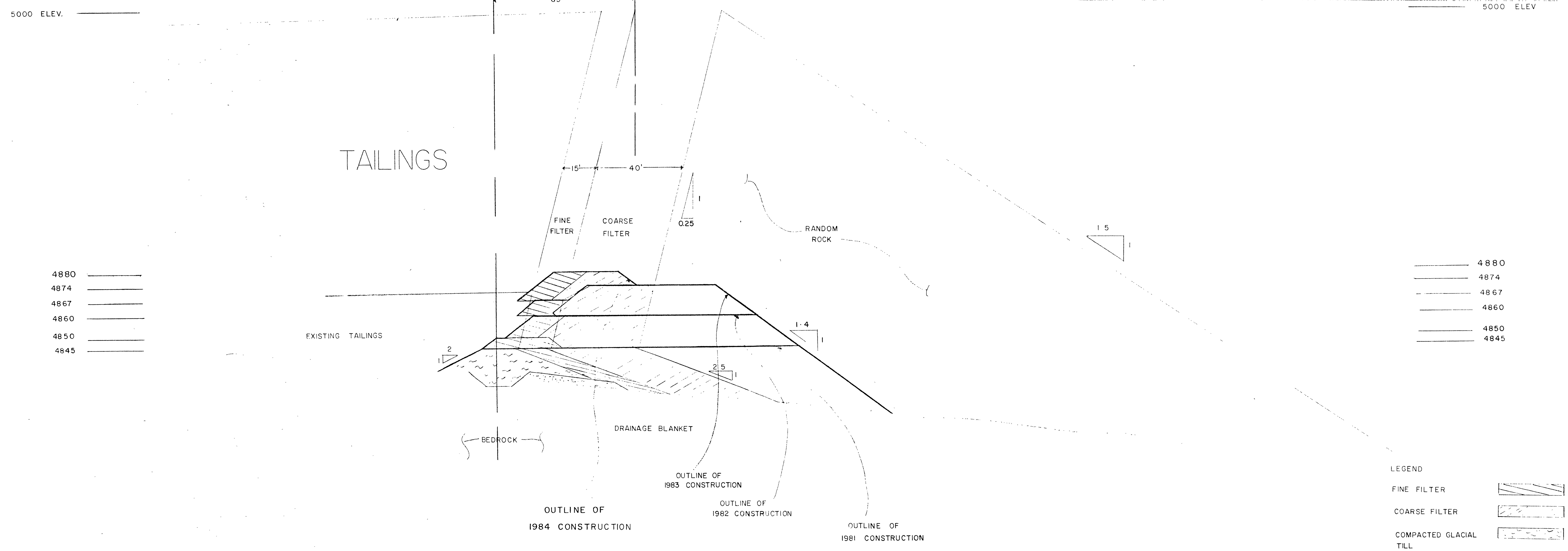
HIGHMONT OPERATING CORP.
LOGAN LAKE, B.C.

TYPICAL SECTION
OF SOUTHWEST DAM

SCALE AS SHOWN	DESIGNED	DAY	MO	YR
	DRAWN			
	CHECKED			
	APPROVED			
DRAWING NO. TD-23-5				ISSUE A

BCEL-7931-A60





NOTE

REFER TO FIG I FOR LOCATION OF SECTION

SCALE

HORIZONTAL 1" = 20'

VERTICAL 1" = 20'

REVISION

HIGHMONT OPERATING CORP.
LOGAN LAKE, B.C.

TYPICAL SECTION
OF EAST DAM

SCALE	DESIGNED	
AS SHOWN	DRAWN	06 09 84
	CHECKED	
	APPROVED	
DRAWING NO TD-23-4		ISSUE A

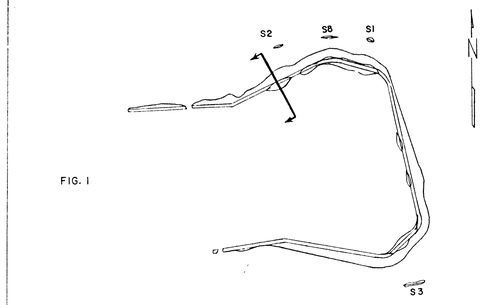


FIG. 1

NOTE:

REFER TO FIG.1 FOR LOCATION OF SECTION

LEGEND:

- FINE FILTER
- COARSE FILTER
- COMPACTED GLACIAL TILL
- RANDOM STRUCTURAL FILL

SCALE:

VERTICAL - 1" = 20'

HORIZONTAL - 1" = 20'

QTY	PART	ITEM	DESCRIPTION

ISSUE	D/M/Y	REVISION	DR	CH	APP
B	7/8/84	1983 CONSTRUCTION	GW	KJ	
A	7/8/84	1982 CONSTRUCTION			

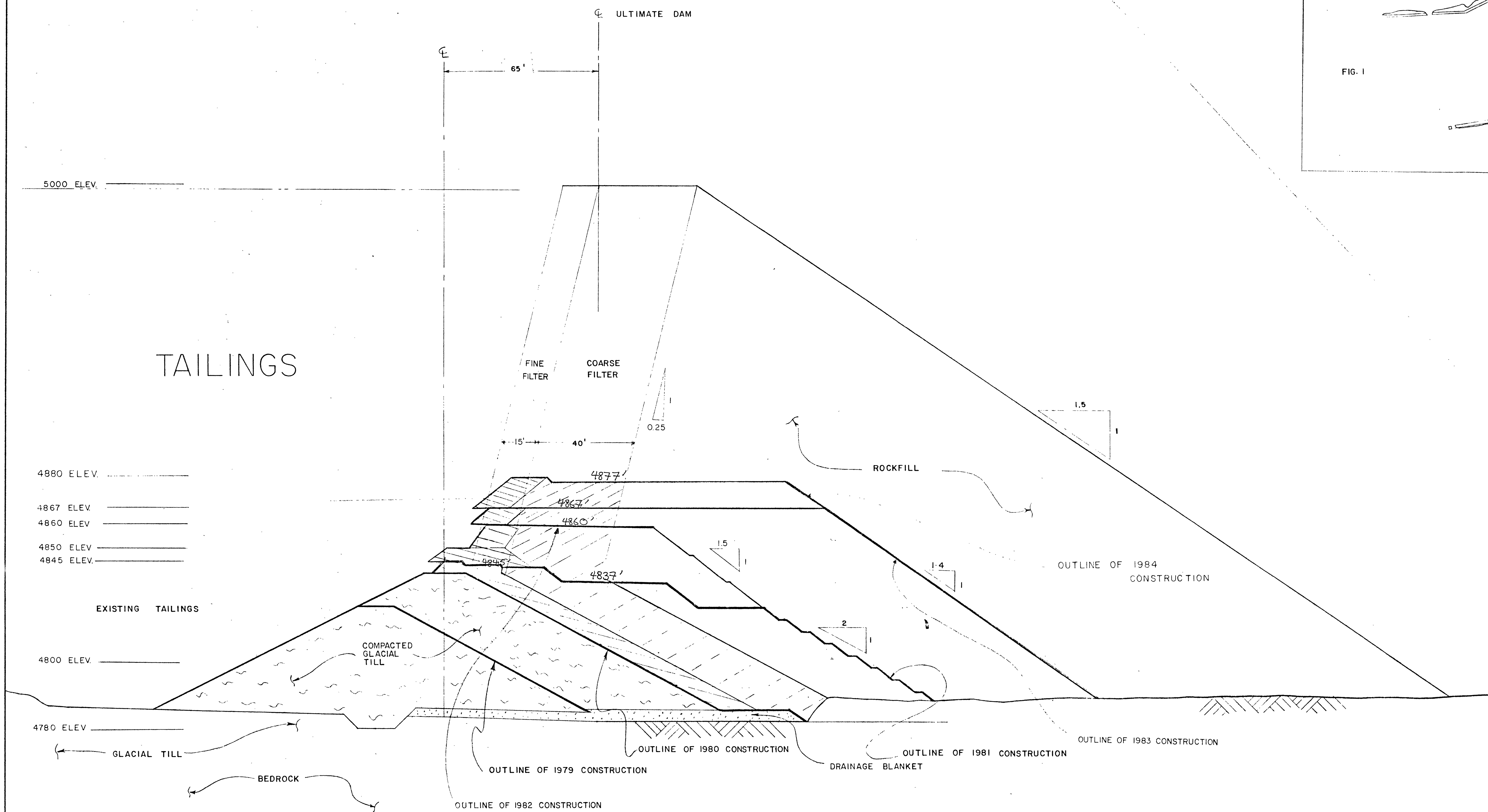
HIGHMONT OPERATING CORP.

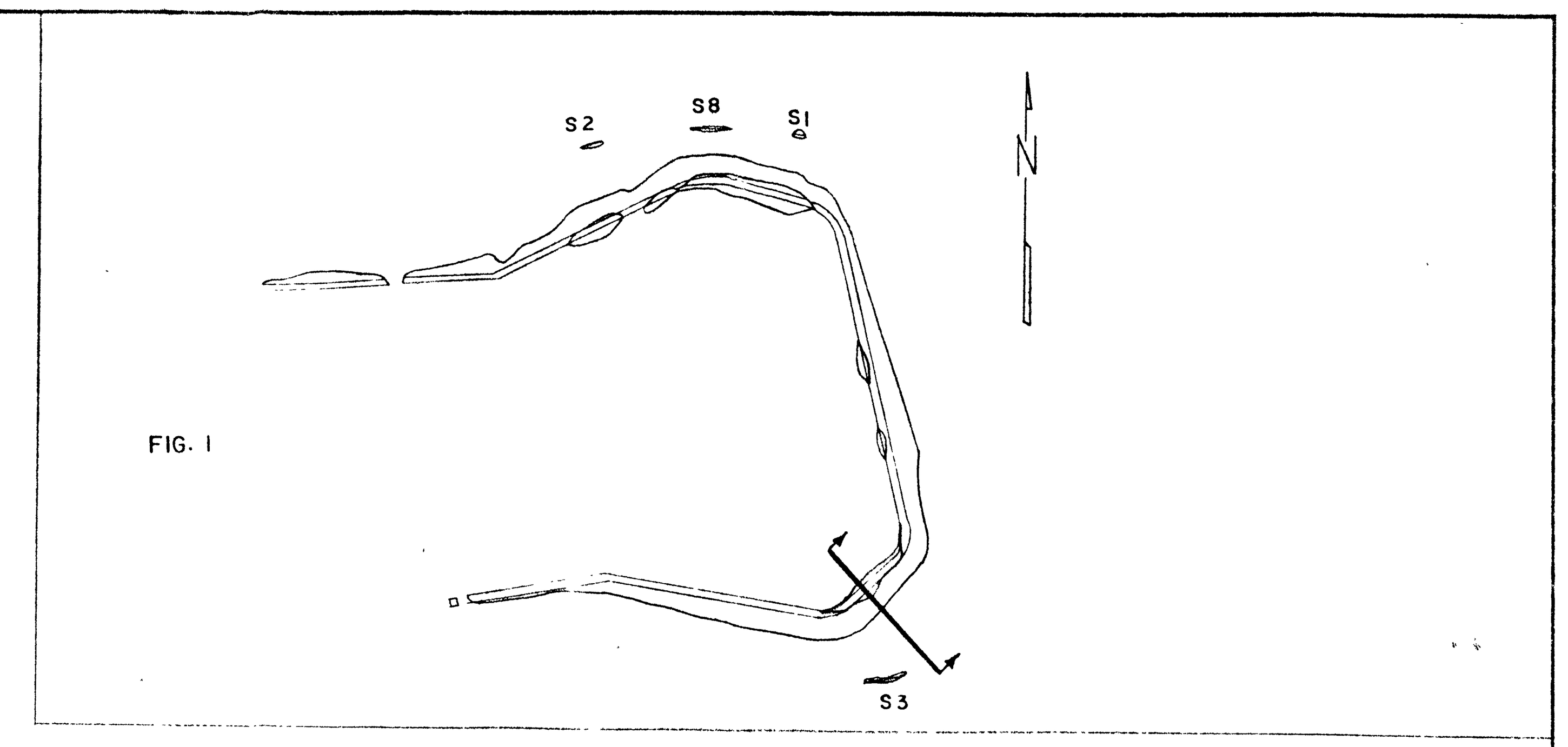
LOGAN LAKE, B.C.

TYPICAL SECTION OF NORTHWEST DAM

SCALE	DESIGNED	DAY	MO	YR
AS SHOWN	DRAWN G.W. KJ	10	03	82
	CHECKED			
DRAWING NO	APPROVED			ISSUE
TD-23-3				B

RCG-7181-HE





NOTE:

REFER TO FIG. 1 FOR LOCATION OF SECTION

LEGEND:

- FINE FILTER
- COARSE FILTER
- COMPACTED GLACIAL TILL
- ROCKFILL

SCALE:

VERTICAL - 1" = 20'

HORIZONTAL - 1" = 20'

QTY	PART	ITEM	DESCRIPTION

ISSUE	D.M.Y.	REVISION	DR	CH	APP
A	[illegible]	[illegible]			

HIGHMONT OPERATING CORP.
LOGAN LAKE, B.C.

TYPICAL SECTION OF SOUTH DAM

SCALE: AS SHOWN	DRAWN: G.W.	10.03.82
DRAWING NO. TD-23-2		ISSUE: B

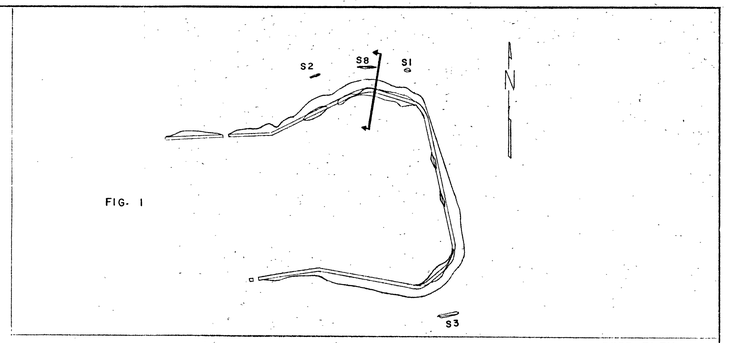


FIG. 1

NOTE:

REFER TO FIG: 1 FOR LOCATION OF SECTION

LEGEND:

- FINE FILTER
- COARSE FILTER
- COMPACTED GLACIAL TILL
- RANDOM STRUCTURAL FILL

SCALE:

VERTICAL - 1" = 20'
HORIZONTAL- 1" = 20'

QTY	PART	ITEM	DESCRIPTION

ISSUE	D/M	REVISION	DR	CH	APP
B	12	1984 CONSTRUCTION	MK		
A	16/11	82 CONSTRUCTION	MS		

HIGHMONT OPERATING CORP.

LOGAN LAKE, B.C.

TYPICAL SECTION
OF NORTHEAST DAM

SCALE	DESIGNED	DAY	MO	YR
AS SHOWN	DRAWN G.W.	10	03	82
	CHECKED			
DRAWING NO. TD - 23 - 1	APPROVED			ISSUE B

BCIL 7931HE

LEGEND

- TAILINGS PIPELINE
- DITCHES
- CREST LINE
- TOE
- SEEPAGE DAM AND SPILLWAY
- BEACH-WATER CONTACT (1994)
- SEEPAGE RETURN PIPELINE
- INSTRUMENTATION LINE
- POWER POLE

NOTES

1. DRAWING TAKEN FROM TECK CORPORATION DRAWING No TP-E3C.
2. TAILINGS BEACH-WATER CONTACT SHOWN IS THAT WHICH EXISTED IN 1994, WITH THE TAILINGS POND LEVEL AT 4867.4 m

SOURCE

KLOHN LEONOFF PROJECT No PB 2916 18, DWG No. E-16001 REV A, DATED NOV 13, 1992.

400 0 800m

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

SCALE

KLOHN-CRIPPEN		DATE
DESIGNED		
DRAWN		
CHECKED		
RECOMMENDED		
APPROVED	RJT	DEC. 96

KLOHN-CRIPPEN

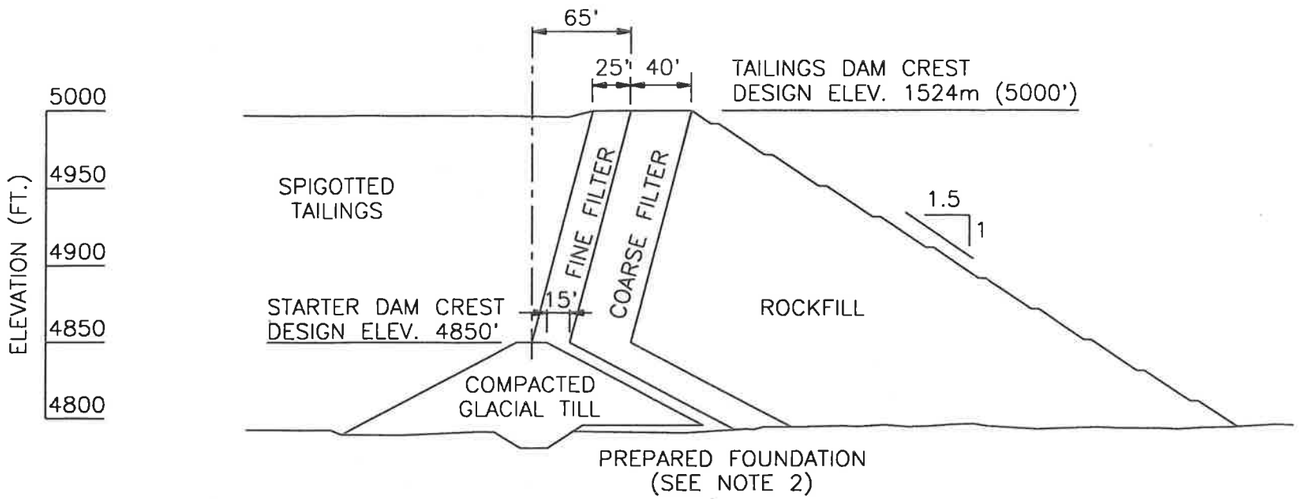
CLIENT: HIGHLAND VALLEY COPPER

PROJECT: LONG-TERM STABILITY ASSESSMENT

TITLE: GENERAL ARRANGEMENT HIGHMONT DAM

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
DEC. 9, 1996	PM2916 23	B-23 022	

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.



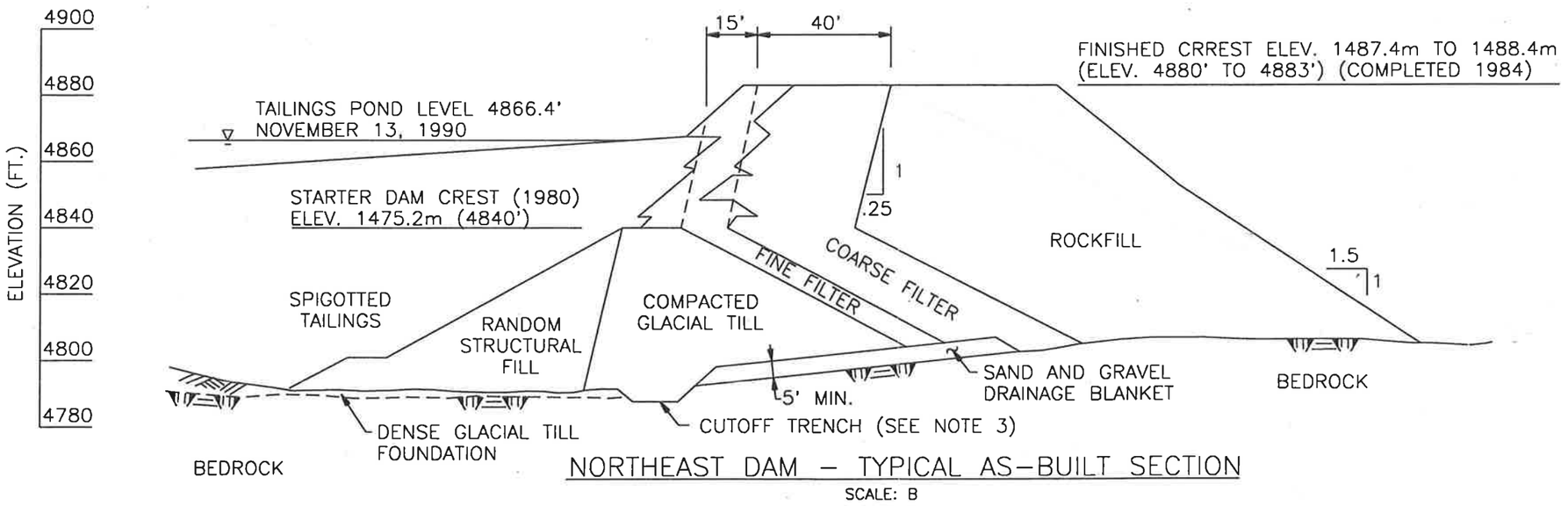
TYPICAL DESIGN SECTION

SCALE: A

NOTES:

1. AS-BUILT SECTION TAKEN FROM DWG. TD-23-1, PERPARED BY TECK CORPORATION, 1984.
2. ALL DAM FOUNDATIONS EXCAVATED TO DENSE UNDISTRURBED SOIL OR TO BEDROCK.
3. CUTOOF TRENCHES EXCAVATED TO A MINIMUM OF 2 FT. INTO DENSE, IMPERVIOUS SOIL OR TO THE SURFACE OF INTACT BEDROCK, EXCEPT FOR THE EAST DAM WHERER THE EXCAVATION DEPTH WAS 5 FT. MAXIMUM. CUTOFF TRENCHES IN BEDROCK WERE HAND-CLEANED.
4. FOR GENERAL ARRANGEMENT OF DAMS AND LOCATION OF NORTHEAST DAM AS-BUILT, SEE DWG. E-16001.

SOURCE
KLOHN LEONOFF PROJECT No.PB2916 16,
DWG No.B-16002, DATED JULY 2, 1992.



NORTHEAST DAM – TYPICAL AS-BUILT SECTION

SCALE: B

SCALE: B 0 40 FT.

SCALE: A 0 100 FT.

SCALE

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

KLOHN-CRIPPEN		DATE
DESIGNED		
DRAWN		
CHECKED		
RECOMMENDED		
APPROVED	RFO	DEC.96

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

KLOHN-CRIPPEN

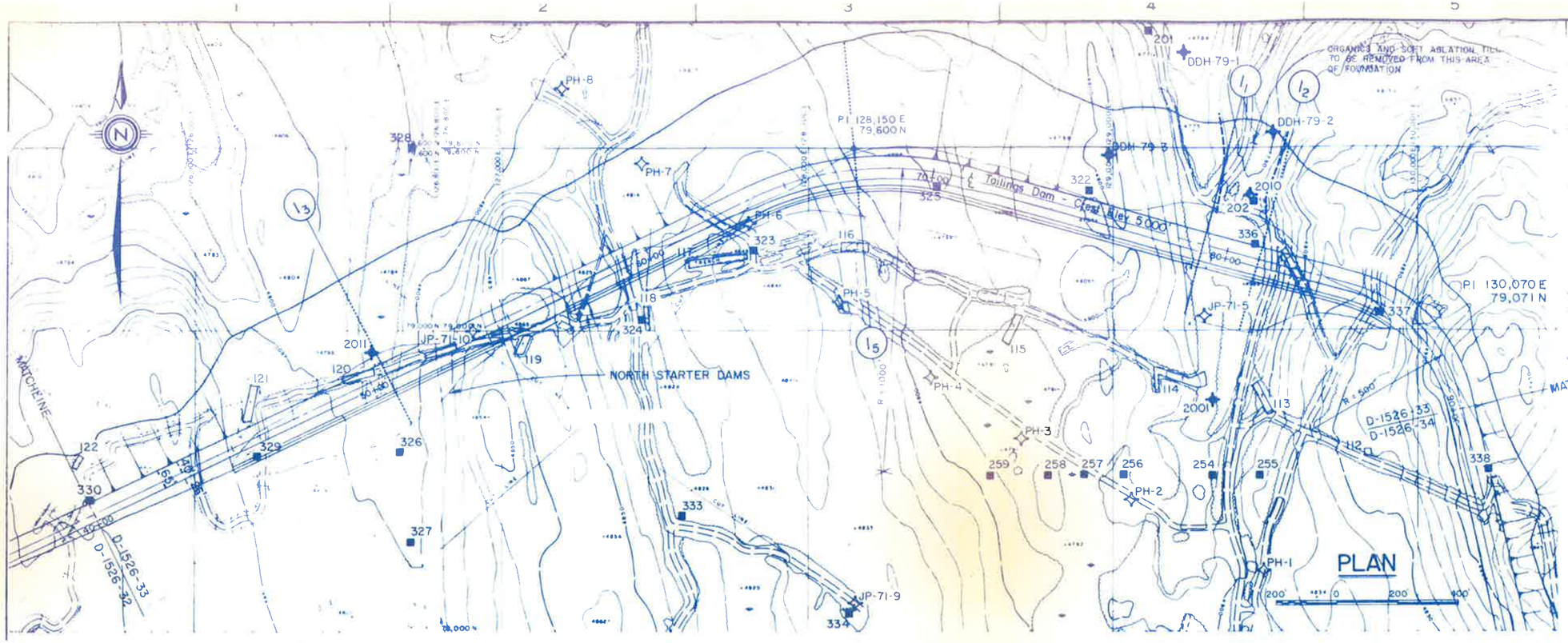
CLIENT
HIGHLAND VALLEY COPPER

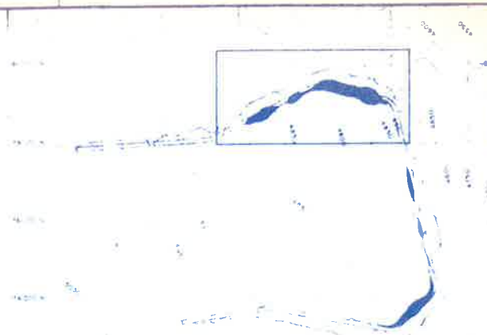
PROJECT
LONG-TERM STABILITY ASSESSMENT

TITLE
TYPICAL SECTION
HIGHMONT DAM

DATE OF ISSUE	PROJECT No.	DWG. No.	REV
DEC. 9, 1996	PM2916 23	B-23023	

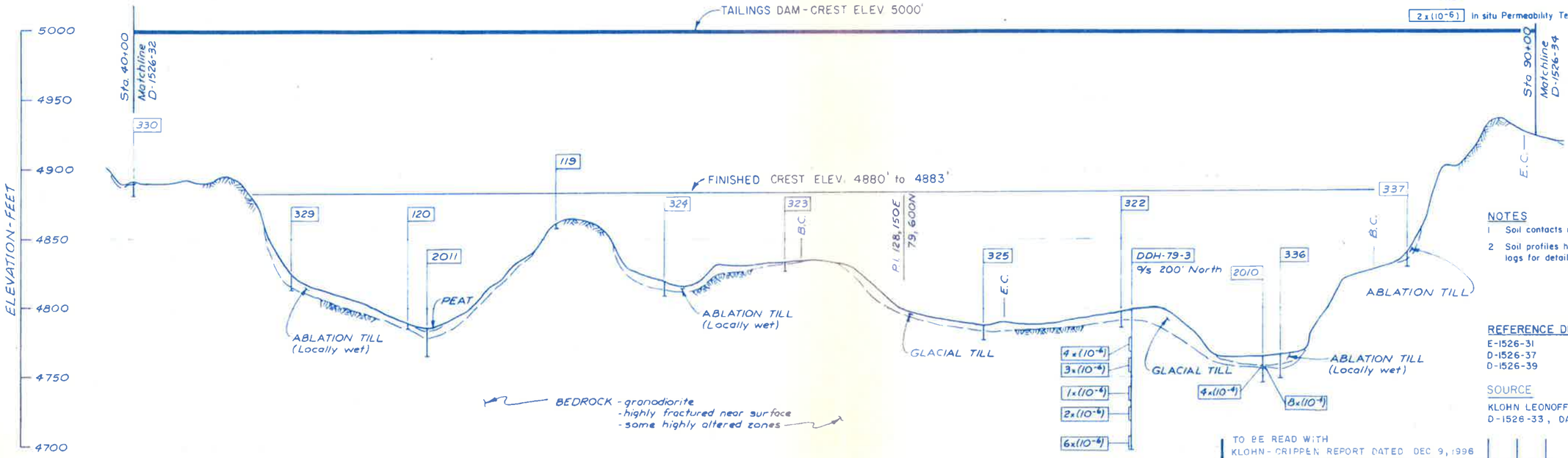
N:\M\M2916\CADD\23
B-23023.DWG





LEGEND

- 124 — 1971 Ripley, Klohn & Leonoff International Ltd. Test Pit
- 1001 — " " " " " " Test Hole
- PH — Percussion Drill Hole by Others
- JP — 1971 Diamond Drill Hole by Others
- 202 — 1979 Klohn Leonoff Consultants Ltd. Test Pit
- 2001 — " " " " " " Test Hole
- DDH — " " " " " " Diamond Drill Hole
- I_1 — Instrumentation Location
- 2 x (10⁻⁶) — In situ Permeability Test. Coefficient of Permeability k in cm/sec.



NOTES

1. Soil contacts inferred between test holes.
2. Soil profiles have been simplified. Refer to test hole logs for detailed descriptions of subsoil conditions

REFERENCE DRAWINGS

E-1526-31	General Arrangement
D-1526-37	Typical Dam Design Sections
D-1526-39	Instrumentation Layout, Schedule and Details

SOURCE

KLOHN LEONOFF PROJECT No. VA1526, DWG. No. D-1526-33, DATED NOV. 7, 1980.

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

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REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
P.C.L.	J.K.	April, 1980	As Shown

KLOHN-CRIPPEN

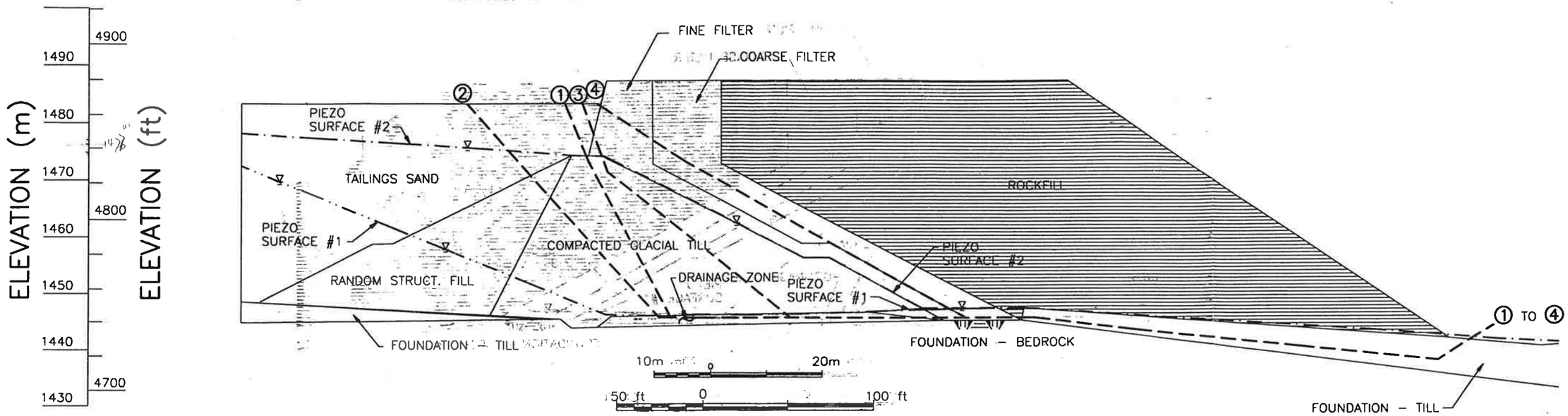
PROJECT: LONG-TERM STABILITY ASSESSMENT

TITLE: REPRESENTATIVE SUBSOIL DATA HIGHMONT DAM

CLIENT: HIGHLAND VALLEY COPPER

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
DEC. 9, 1996	PM2916 23	B-23024	

APPROVED



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

FAILURE SURFACE NUMBER	FACTOR OF SAFETY (1)		YIELD ACCELERATION (g)
	STATIC	PSEUDO-STATIC (a=0.1g)	
①	3.63	2.36	0.45 – 0.5
②	3.70	2.34	0.45
③	3.15	2.11	0.4 – 0.45
④	2.50	1.78	0.35

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

MATERIAL PROPERTIES

TYPE OF MATERIAL	UNIT WEIGHT γ_{moist} (kN/m³)	UNIT WEIGHT γ_{sat} (kN/m³)	EFFECTIVE SHEAR STRENGTH(1) FRICTION ANGLE ø' (degree)
TAILINGS SAND	–	18.9	33
COMPACTED GLACIAL TILL	–	21.5	35
FOUNDATION TILL	–	22.8	35
FINE FILTER	18.9	–	32
COARSE FILTER	18.9	–	32
ROCKFILL	18.9	–	37
DRAINAGE ZONE	18.9	–	32
RANDOM STRUCTURAL FILL	18.9	–	32

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

LEGEND

④ – – – ④ FAILURE SURFACE No.4

– · ▽ · – PIEZOMETRIC SURFACE #1

— · ▽ · — PIEZOMETRIC SURFACE #2

NOTES

1. ELEVATION IN METRES AND FEET REFERS TO HIGHLAND VALLEY COPPER DATUM.
2. PIEZOMETRIC SURFACE #1 APPLIED TO FOUNDATION TILL AND DRAINAGE ZONE.
3. PIEZOMETRIC SURFACE #2 APPLIED TO TAILINGS SAND, RANDOM STRUCTURAL FILL AND COMPACTED GLACIAL TILL.

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

SCALE

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

KLOHN-CRIPPEN

CLIENT: HIGHLAND COPPER VALLEY

PROJECT: LONG-TERM STABILITY ASSESSMENT

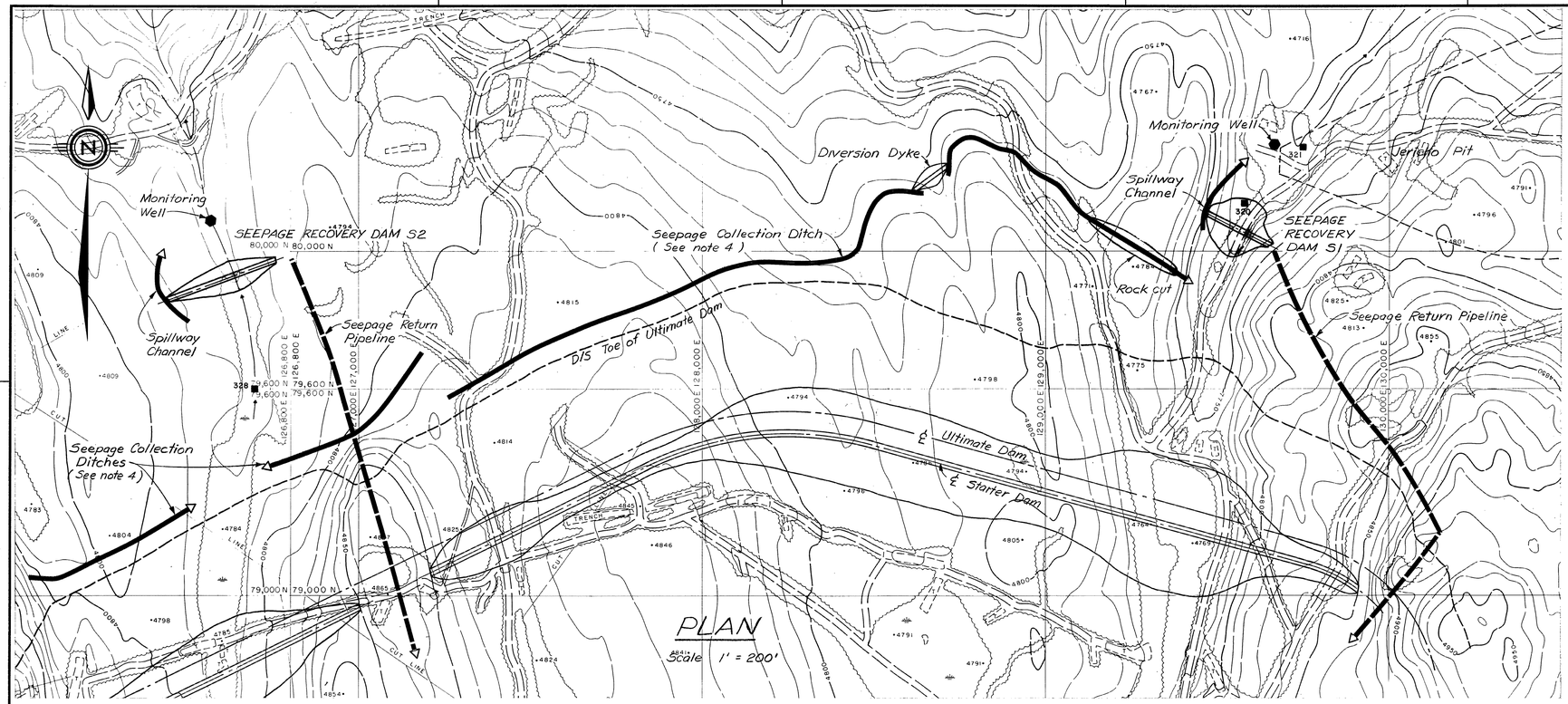
TITLE: STABILITY ANALYSES – HIGHMONT DAM

DATE OF ISSUE	PROJECT No.	DWG. No.	REV
DEC. 9, 1996	PM2916 23	B-23025	

N:\M\M2916\CDD\23\B-23025.DWG
08/23/96 TIME: 4:35

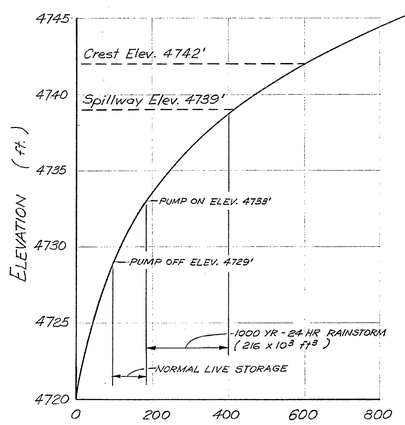
APPENDIX III-B

Reference Dam Design Drawings – Seepage Dams

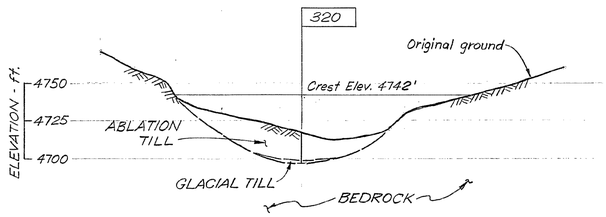


PLAN

Scale 1" = 200'

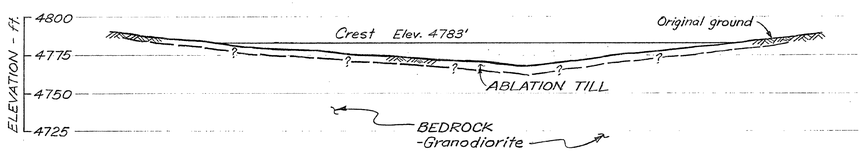


VOLUME ELEVATION CURVE
SEEPAGE RESERVOIR S1



PROFILE OF SEEPAGE RECOVERY DAM S1

Scale 1" = 50'

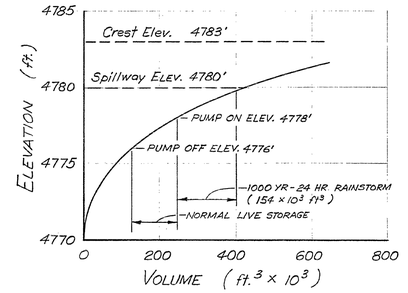


PROFILE OF SEEPAGE RECOVERY DAM S2

Scale 1" = 50'

NOTES:

1. Refer to Drawing E-1526-25 for General Arrangement of Seepage Network.
2. Refer to Drawings D-1526-29 and -30 for typical design sections of dams, ditches and spillways.
3. Subsurface profiles are inferred from preliminary test hole information. More detailed investigation will be performed prior to construction.
4. Small dumped rockfill check dams may be required for erosion protection where glacial deposits are exposed in seepage collection ditches.
5. Location of seepage return pipelines are included for illustration only. Final design of pipelines by others.



VOLUME ELEVATION CURVE
SEEPAGE RESERVOIR S2

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DESIGN	DRAWN	DATE	SCALES
P.C.L., S.R.	F.C.	MAR., 1980	As shown

Klohn Leonoff Consultants Ltd.

CIVIL • GEOTECHNICAL • HYDRAULIC

VANCOUVER - CALGARY - WINNIPEG - DENVER

PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

TITLE: SEEPAGE RECOVERY DAMS S1 & S2 PLAN, PROFILES & STORAGE CURVES

CLIENT: HIGHMONT OPERATING CORP.

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
Apr. 3, 1980	VA 1526	D-1526-26	

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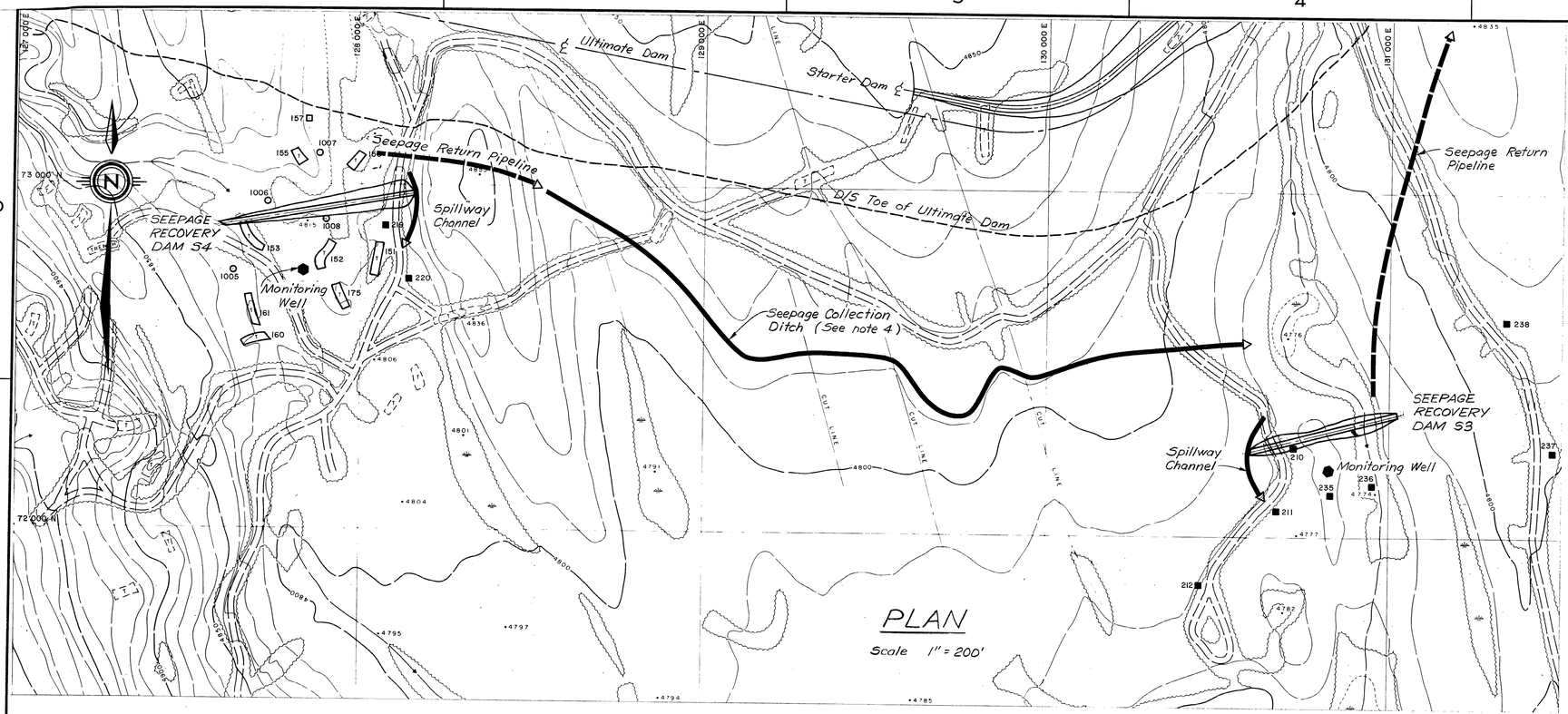
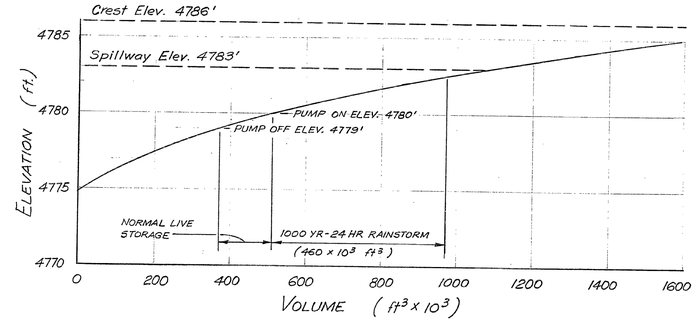
NCI 317 — K.L.C.L.

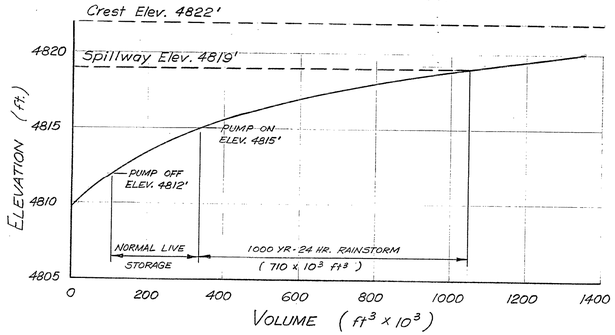


PLAN

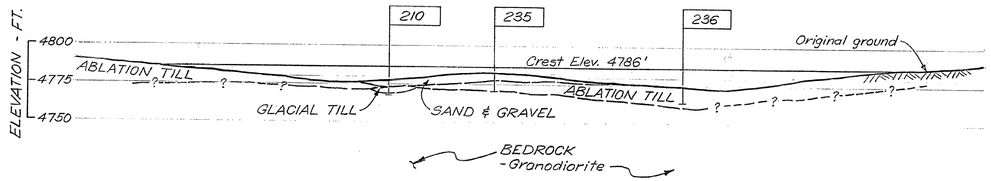
Scale 1" = 200'



VOLUME ELEVATION CURVE
SEEPAGE RESERVOIR S3

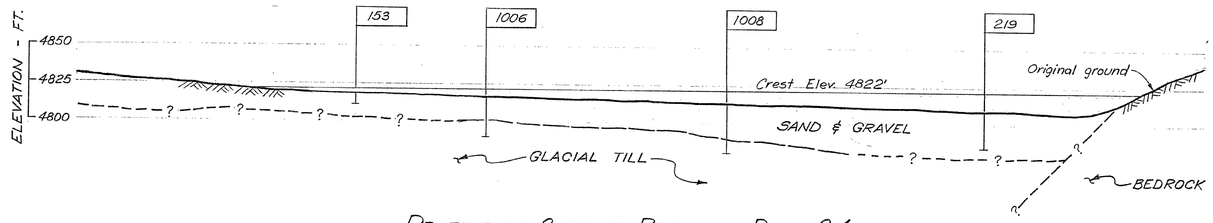


VOLUME ELEVATION CURVE
SEEPAGE RESERVOIR S4



PROFILE OF SEEPAGE RECOVERY DAM S3

Scale 1" = 50'



PROFILE OF SEEPAGE RECOVERY DAM S4

Scale 1" = 50'

NOTES:

1. Refer to Drawing E-1526-25 for General Arrangement of Seepage Network.
2. Refer to Drawings D-1526-29 and -30 for typical design sections of dams, ditches and spillways.
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4. Small dumped rockfill check dams may be required for erosion protection where glacial deposits are exposed in seepage collection ditches.
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PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

TITLE: SEEPAGE RECOVERY DAMS S3 & S4 PLAN, PROFILES & STORAGE CURVES

CLIENT: HIGHMONT OPERATING CORP.

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
Apr. 3, 1980	VA 1526	D-1526-27	

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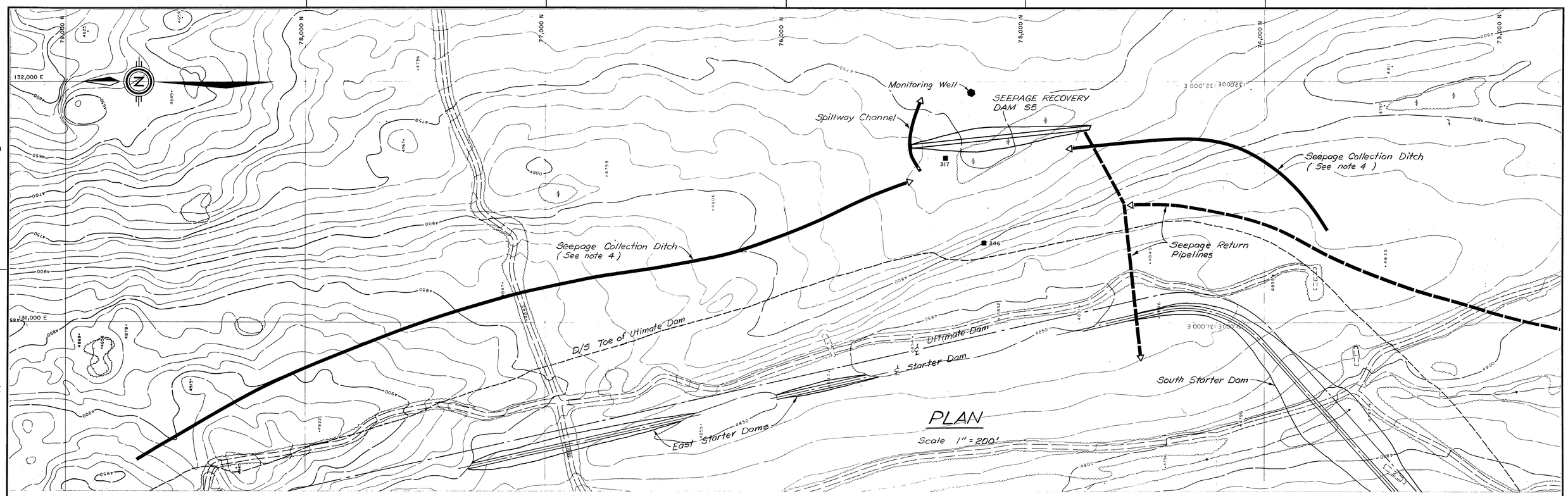
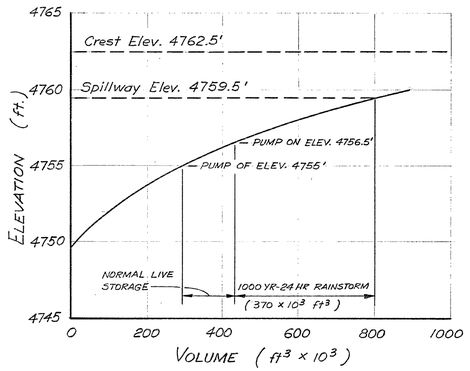
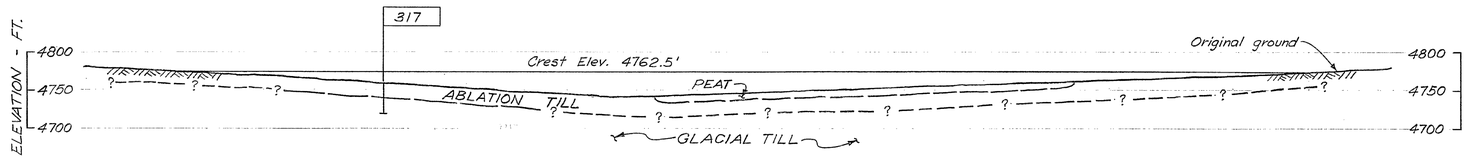


PLAN

Scale 1" = 200'



VOLUME ELEVATION CURVE
SEEPAGE RECOVERY S5



PROFILE OF SEEPAGE RECOVERY DAM S5

Scale 1" = 50'

NOTES:

1. Refer to Drawing E-1526-25 for General Arrangement of Seepage Network.
2. Refer to Drawings D-1526-29 and -30 for typical design sections of dams, ditches and spillways.
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VANCOUVER - CALGARY - WINNIPEG - DENVER

PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

TITLE: SEEPAGE RECOVERY DAM S5
PLAN, PROFILE & STORAGE CURVE

CLIENT: HIGHMONT OPERATING CORP.

DATE OF ISSUE Apr. 3, 1980

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PROJECT No. VA 1526

DWG. No. D-1526-28

REV.

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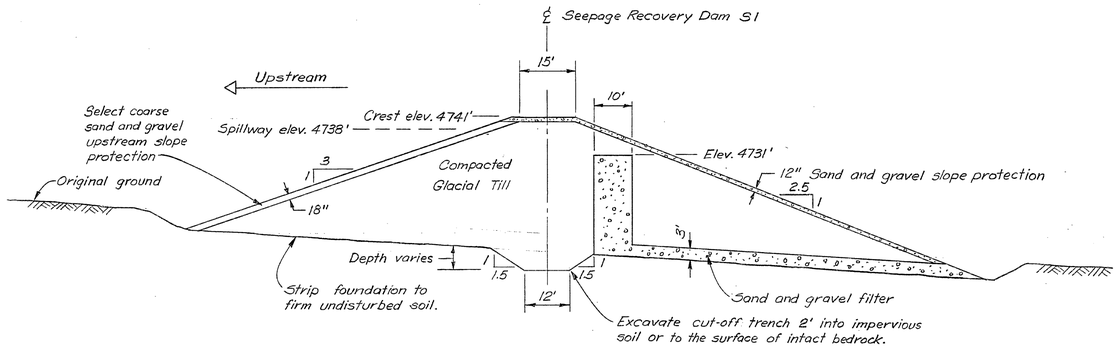
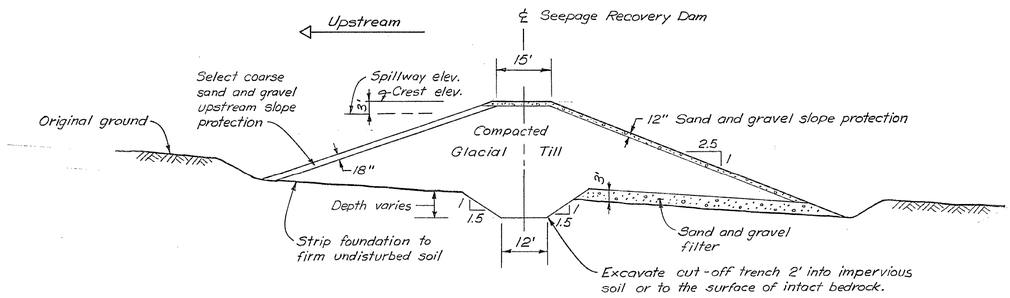


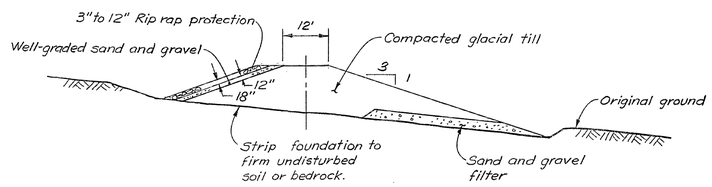
Design Section - Seepage Recovery Dam S1

Scale 1" = 20'



Typical Section - Seepage Recovery Dams S2 to S7

Scale 1" = 20'

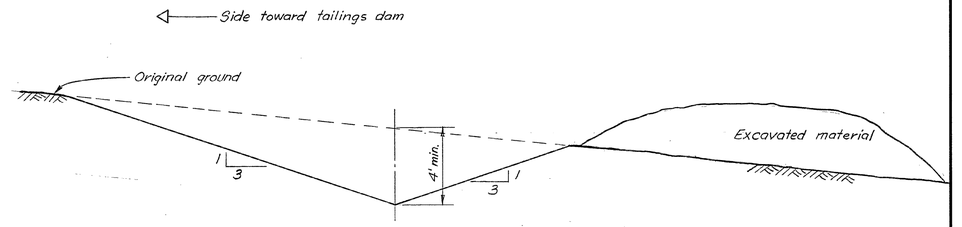


Typical Section - Diversion Dyke

Scale 1" = 20'

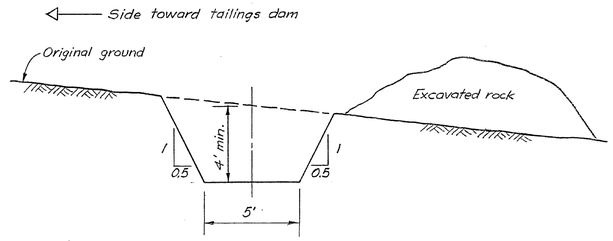
Gradation Requirements For Upstream Slope Protection

U.S. Standard Sieve Size	Percent Passing By Weight
8"	70 - 100
3"	55 - 80
3/4"	25 - 55
# 4	10 - 35
#40	0 - 15
#200	0 - 3



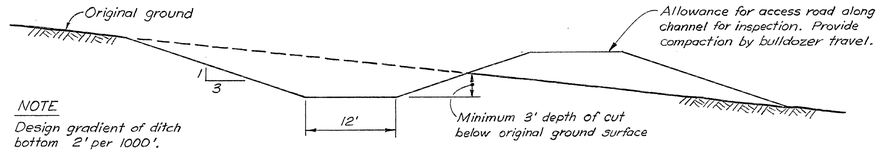
Seepage Collection Ditch Excavated In Soil

Scale 1/4" = 1'-0"



Seepage Collection Ditch Excavated In Bedrock

Scale 1/4" = 1'-0"



NOTE
Design gradient of ditch bottom 2' per 1000'.

Run-off Diversion Ditch

Scale 1" = 10'

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CIVIL • GEOTECHNICAL • HYDRAULIC
VANCOUVER - CALGARY - WINNIPEG - DENVER

CLIENT: HIGHMONT OPERATING CORP.

PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

TITLE: TYPICAL DESIGN SECTIONS

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
Apr. 3, 1980	VA 1526	D-1526-29	

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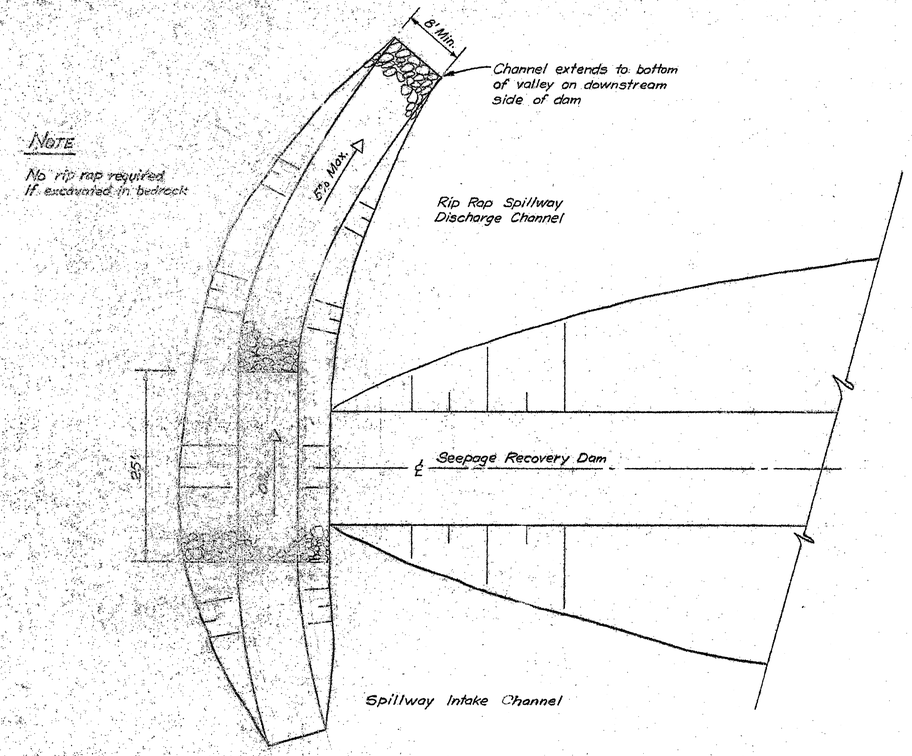
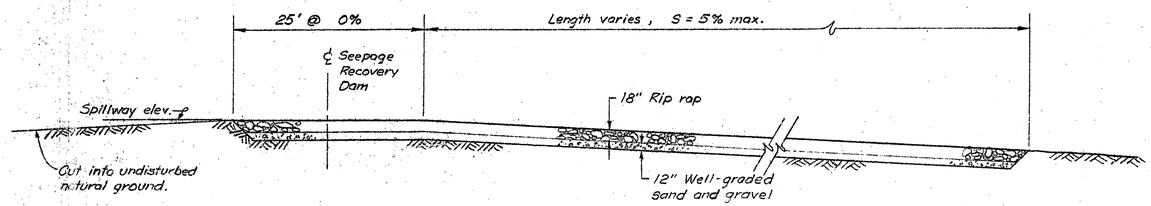


NOTE

No rip rap required if excavated in bedrock.

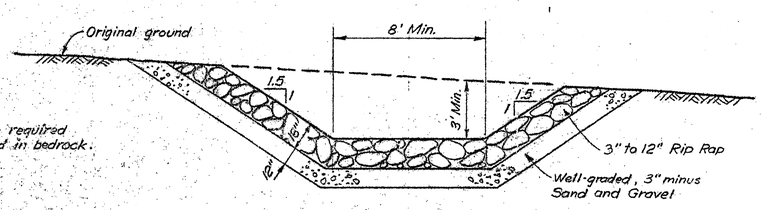
TYPICAL PLAN OF SPILLWAYS FOR SEEPAGE RECOVERY DAMS

Scale 1" = 10'



LONGITUDINAL PROFILE OF SPILLWAY CHANNEL

Scale 1" = 10'



NOTE

No rip rap required if excavated in bedrock.

TYPICAL SPILLWAY DISCHARGE CHANNEL

Scale 1/4" = 1'0"

TO BE READ WITH KLOHN LEONOFF CONSULTANTS REPORT DATED Apr. 3, 1980.

SCALE:

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
P.C.L., S.R.	F.C.	MAR., 1980.	As shown

Klohn Leonoff Consultants Ltd.

CIVIL • GEOTECHNICAL • HYDRAULIC

VANCOUVER - CALGARY - WINNIPEG - DENVER

PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

TITLE: TYPICAL SPILLWAY DETAILS

CLIENT: HIGHMONT OPERATING CORP.

DATE BY ISSUED FOR APPROVED: Apr. 3, 1980 P.C.L.

PROJECT NO. VA 1528

DWG. NO. D-1526-30

REV.

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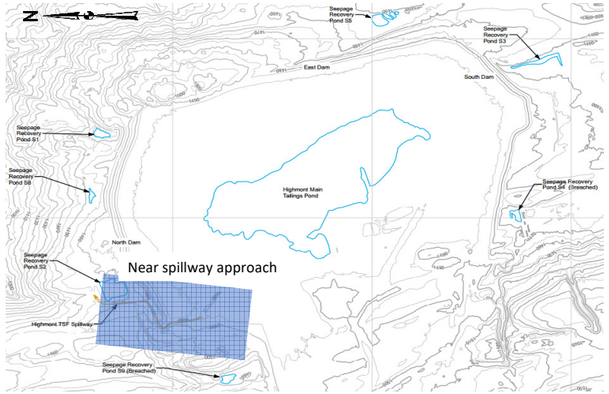
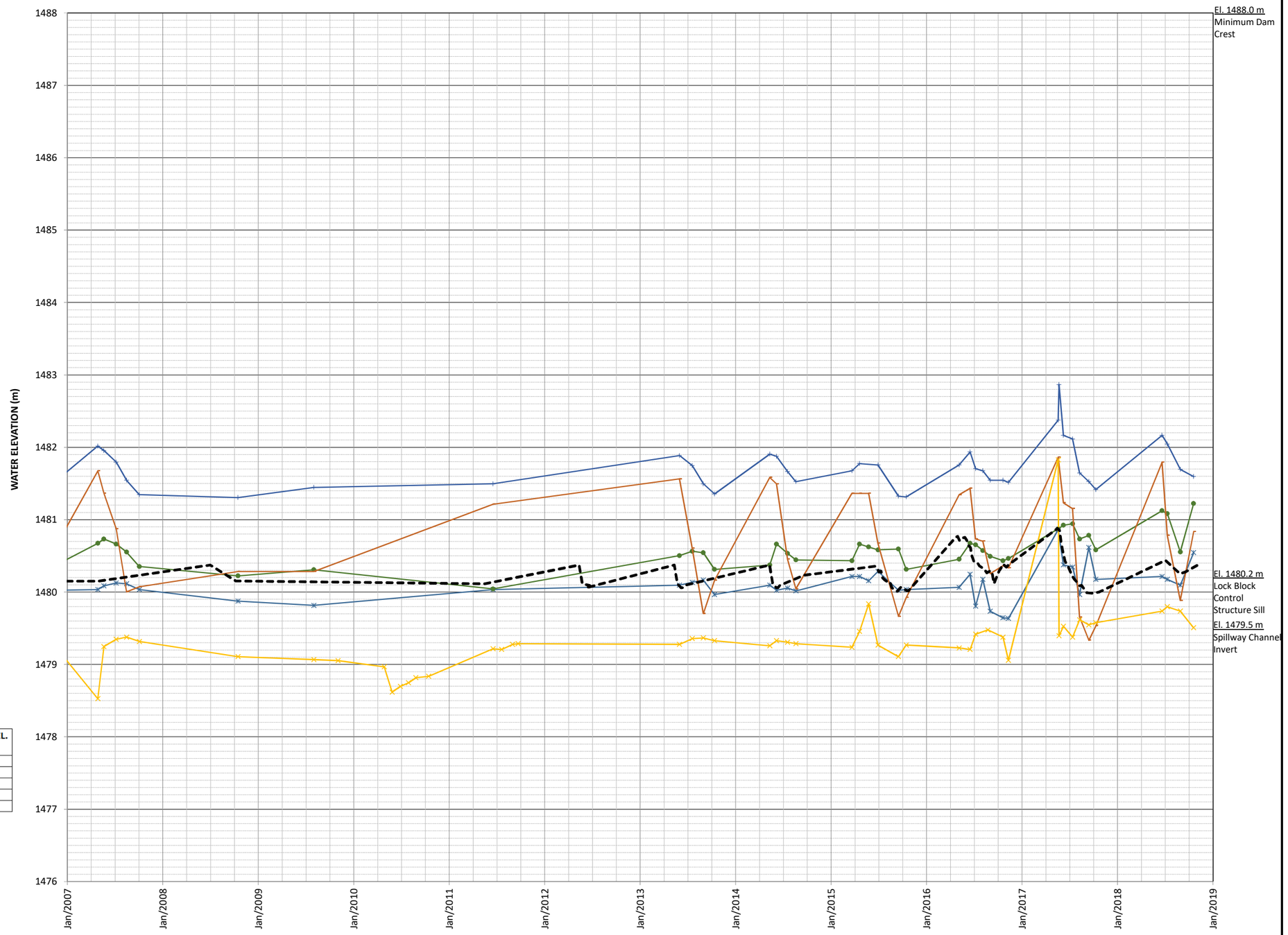
NCI 317 - K.L.C.L.

APPENDIX IV

Instrumentation Plots





LEGEND:

- S2-1 (Tip El. 1477.5 m,)
- S2-2 (Tip El. 1479.2 m,)
- S2-3 (Tip El. 1476.7 m,)
- S2-4 (Tip El. 1477.8 m,)
- P-O (Tip El. 1478.8 m,)
- Highmont Pond Level

PIEZOMETER ID	2018 THRESHOLD EL. (m)
P-O	1480.8
S2-1	1482.8
S2-2	1483.1
S2-3	1483.9
S2-4	1483.2

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CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

TITLE: HIGHMONT TSF PIEZOMETRIC DATA 2007-2018

NEAR SPILLWAY APPROACH

PROJECT No. M02341B43

FIG No. IV-1

March 22, 2019
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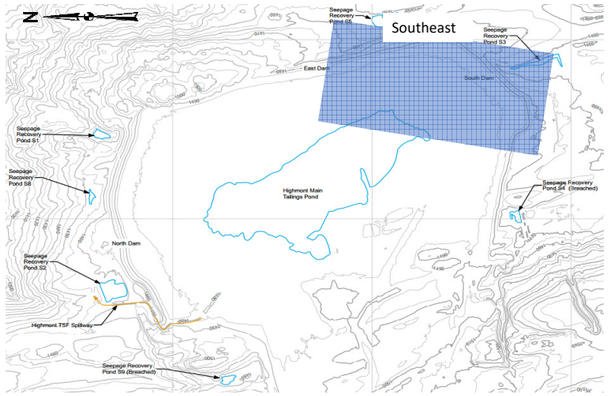

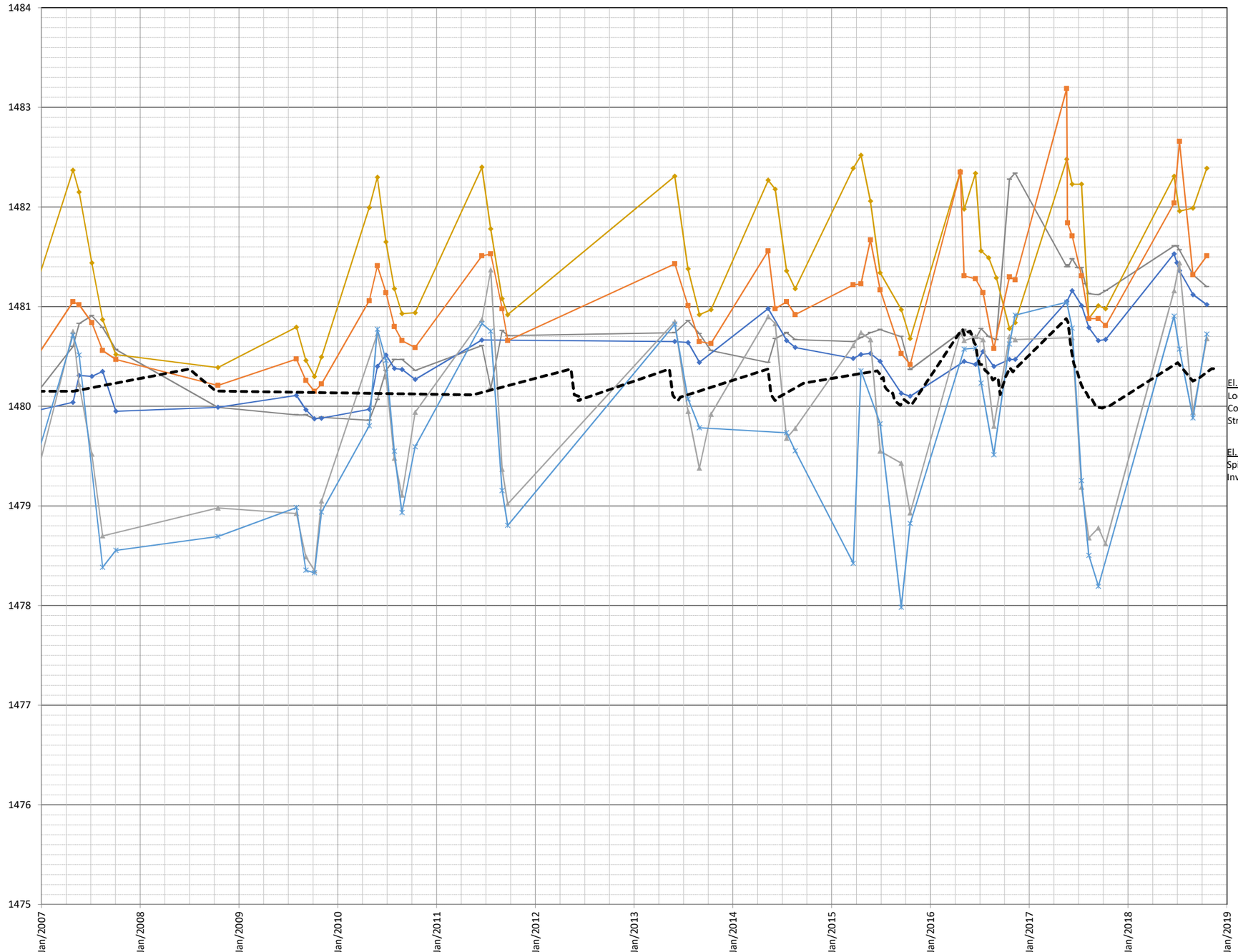

LEGEND:

- S3-1 (Tip El. 1476.3 m,)
- S3-2 (Tip El. 1477.4 m,)
- PW-L (Tip El. 1473.5 m,)
- P-M (Tip El. 1474.3 m,)
- P-N (Tip El. 1473.6 m,)
- PW-P (Tip El. 1473.5 m,)
- Highmont Pond Level

PIEZOMETER ID	2018 THRESHOLD EL. (m)
PW-L	1481.5
P-M	1482.8
P-N	1481.9
S3-1	1482.0
S3-2	1483.0
PW-P	1482.2

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE USE OF OUR CLIENT IN ACCORDANCE WITH OUR AGREEMENT WITH OUR CLIENT. IT IS SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

TITLE: HIGHMONT TSF PIEZOMETRIC DATA
2007-2018

SOUTH EAST

PROJECT No. M02341B43

FIG No. IV-2

March 22, 2019
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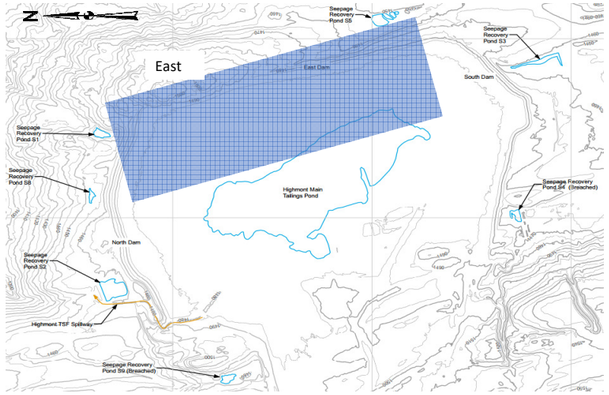

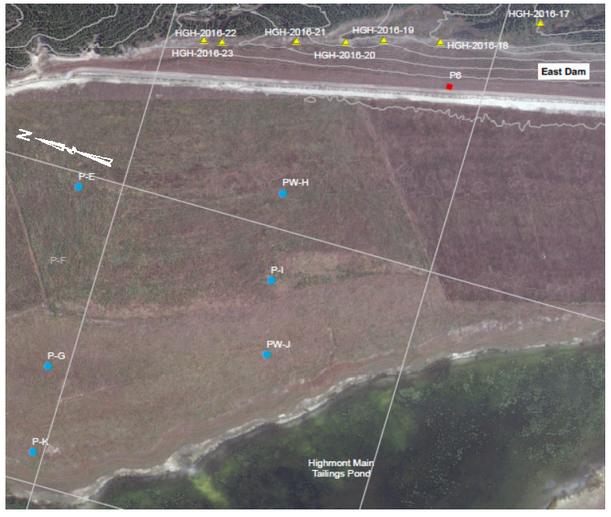

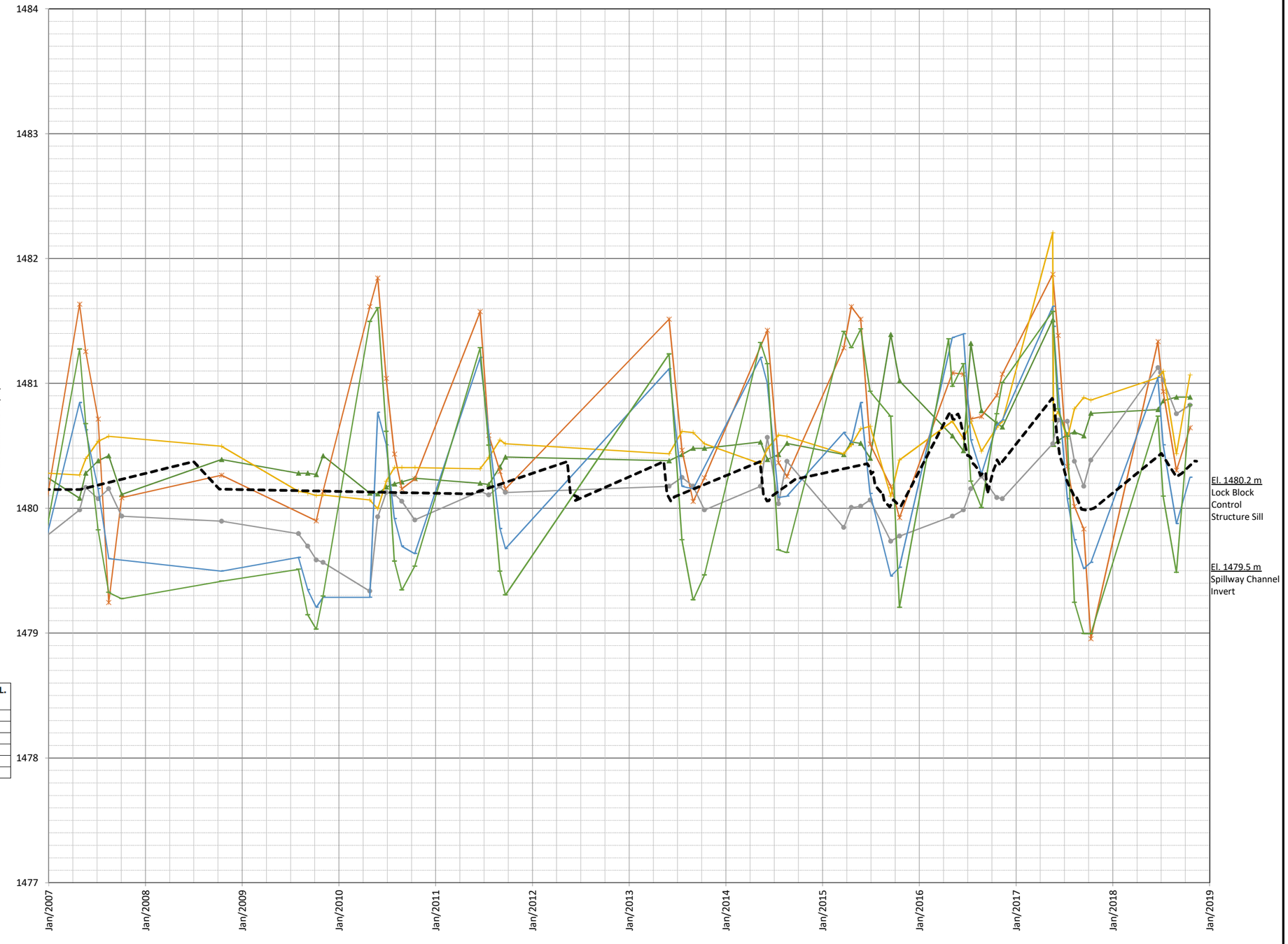

LEGEND:

- P-E (Tip El. 1473.4 m,)
- P-G (Tip El. 1475 m,)
- PW-H (Tip El. 1473.4 m,)
- P-I (Tip El. 1474.6 m,)
- PW-J (Tip El. 1475.4 m,)
- P-K (Tip El. 1474.9 m,)
- Highmont Pond Level

PIEZOMETER ID	2018 THRESHOLD EL. (m)
P-E	1483.6
P-G	1482.4
P-K	1482.2
PW-H	1481.1
P-I	1481.5
PW-J	1481.9

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CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

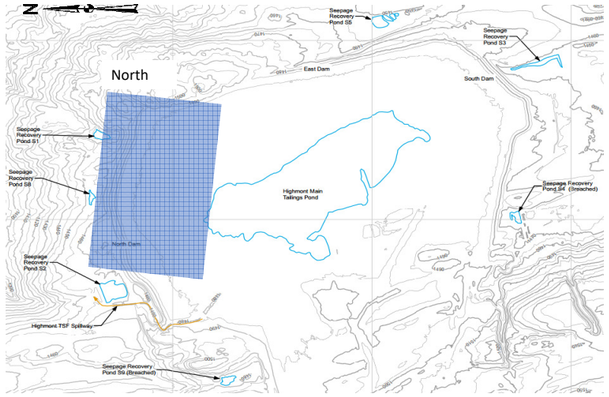
TITLE: HIGHMONT TSF PIEZOMETRIC DATA
2007-2018

EAST

PROJECT No. M02341B43

FIG No. IV-3

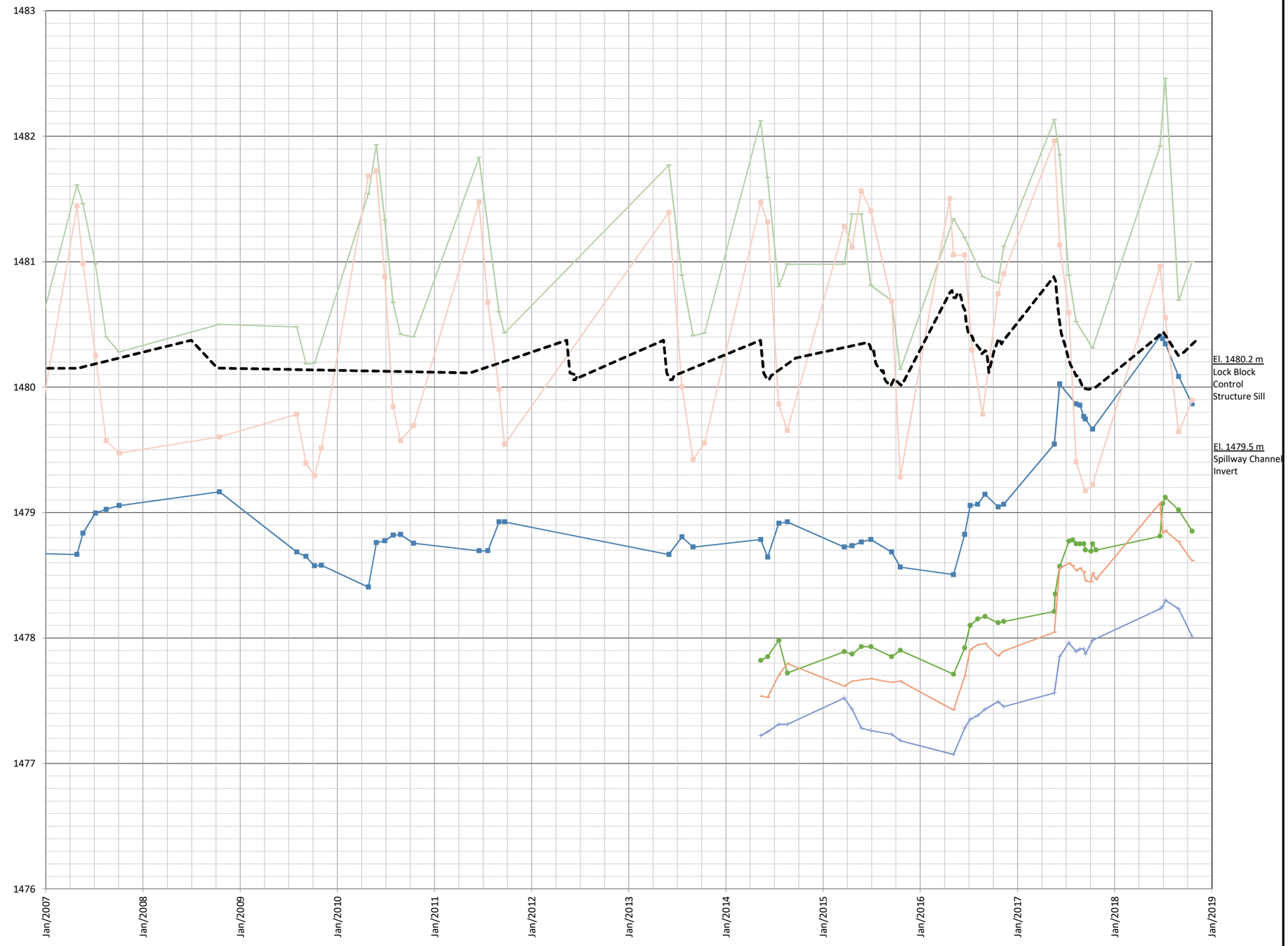
March 22, 2019
Z:\MV\CP\M02341B43 - HVC 2018 Dam Safety Support\300 Design\Piezometer Data\Piezo Data\Highmont\[190322 Highmont Piezo.xlsx]Piezo Data Entry



LEGEND:

- PW-A (Tip El. 1473.3 m,)
- PW-C (TALL) (Tip El. 1475.8 m,)
- P-D (Tip El. 1476.6 m,)
- HM-PS-01 (13-SRK-14) (Tip El. 1466.8 m,)
- HM-PS-02 (13-SRK-14) (Tip El. 1456.55 m,)
- HM-PS-03 (13-SRK-13) (Tip El. 1456.9 m,)
- Highmont Pond Level

PIEZOMETER ID	2018 THRESHOLD EL. (m)
PW-A	1480.5
PW-C (TALL)	1482.6
P-D	1482.2
HM-PS-01 (13-SRK-14)	1478.7
HM-PS-02 (13-SRK-14)	1478.0
HM-PS-03 (13-SRK-13)	1478.5



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PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

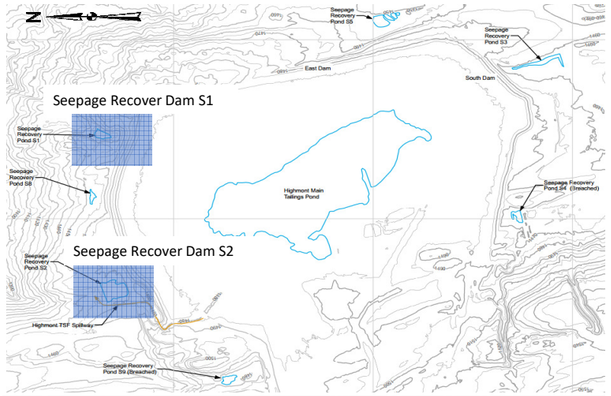
TITLE: HIGHMONT TSF PIEZOMETRIC DATA
2007-2018

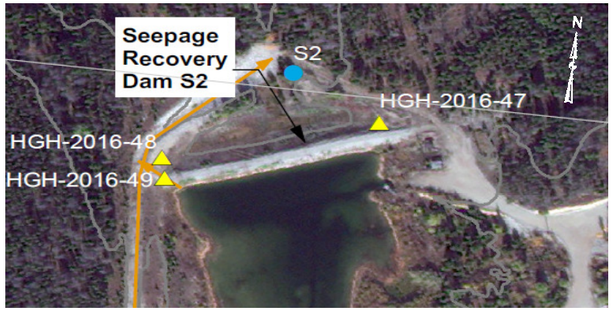
NORTH

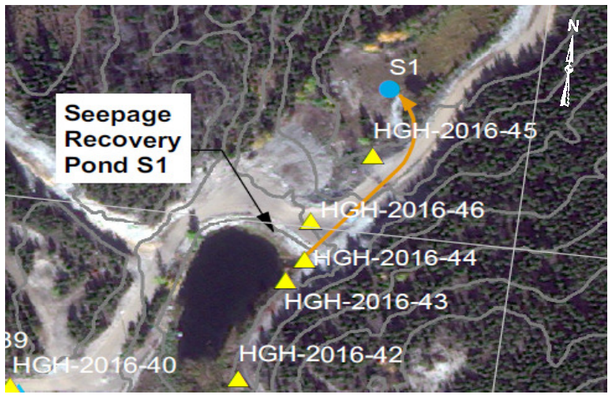
PROJECT No. M02341B43

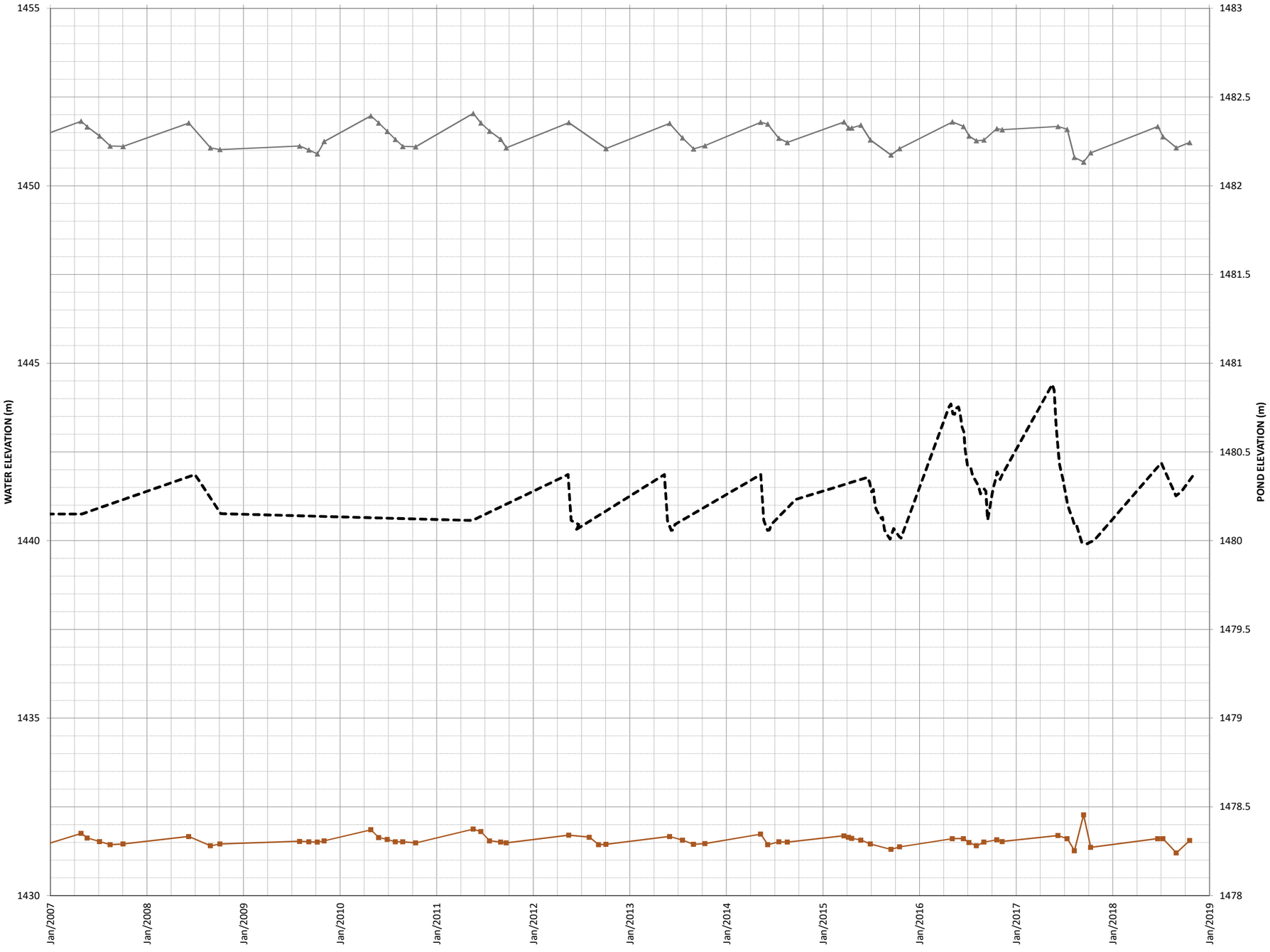
FIG No. IV-4

March 22, 2019
Z:\M.VCR\M02341B43 - HVC 2018 Dam Safety Support\300 Design\Piezometer Data\Piezo Data\Highmont\190322 Highmont Piezo.xlsx|Piezo Data Entry









LEGEND:

- Highmont Pond Level
- S1 (Tip El. unknown m,)
- S2 (Tip El. unknown m,)

PIEZOMETER ID	2018 THRESHOLD EL. (m)
S1	1432.4
S2	1452.5

NOTES:

1. PIEZOMETER WATER ELEVATIONS PLOTTED ON PRIMARY (LEFT) AXIS, POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.
2. TIP ELEVATIONS FOR S-1 AND S-2 ARE UNAVAILABLE.

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CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

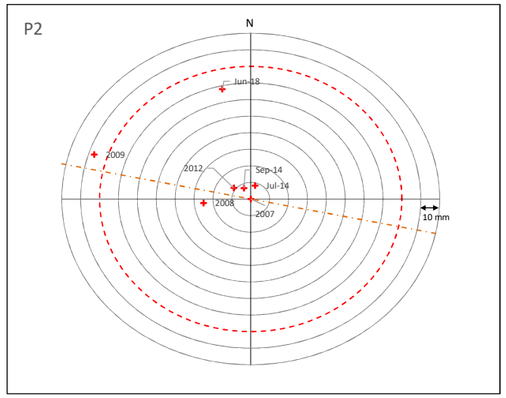
TITLE: HIGHMONT TSF PIEZOMETRIC DATA
2007-2018

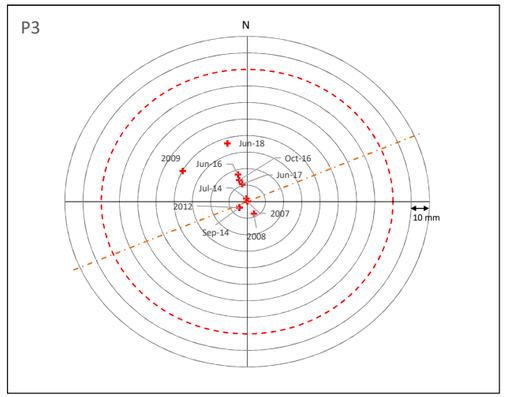
SEEPAGE PONDS

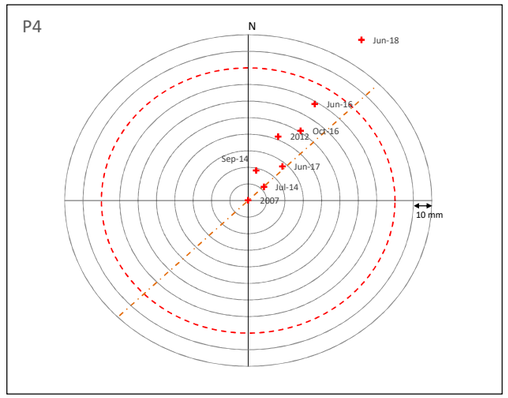
PROJECT No. M02341B43

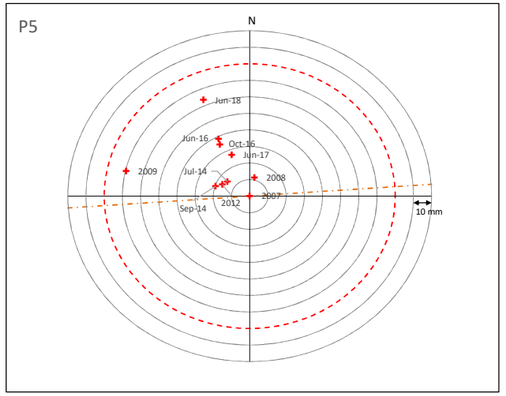
FIG No. IV-5

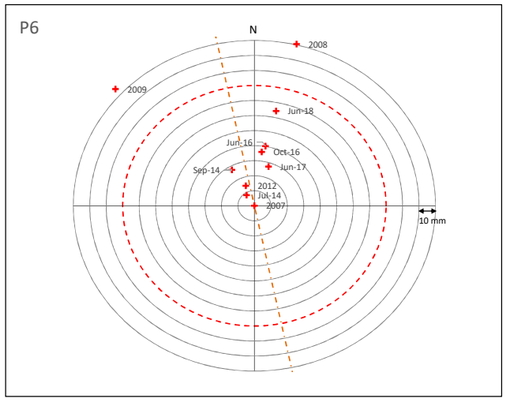
March 22, 2019
Z:\MVCR\M02341B43 - HVC 2018 Dam Safety Support\300 Design\Piezometer Data\Piezo Data\Highmont\[190322 Highmont Piezo.xlsx]Piezo Data Entry

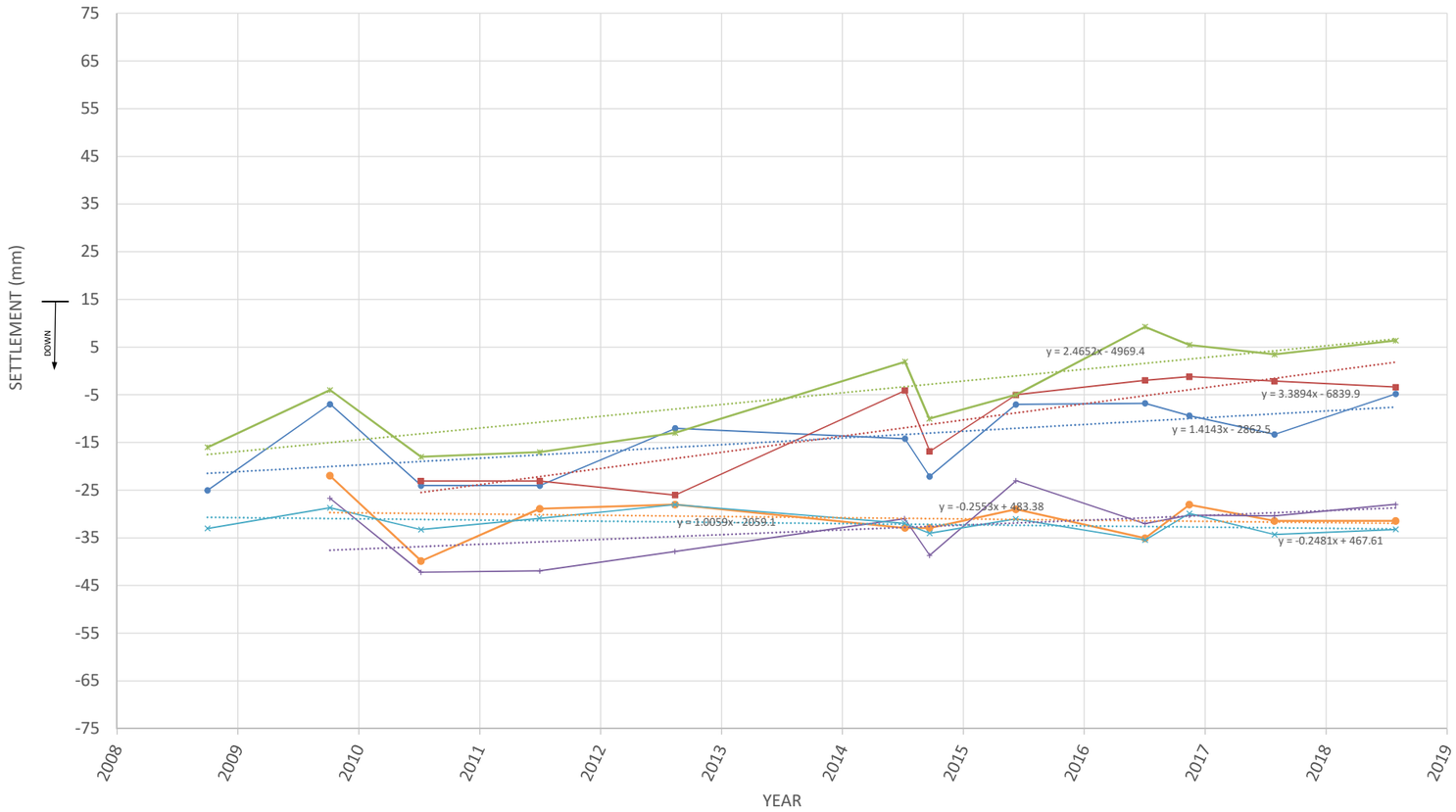












DAM CENTERLINE ORIENTATION

THRESHOLD HORIZONTAL DISPLACEMENT FROM ORIGINAL POSITION

LEGEND:

- P2
- P3
- P4
- P5
- P6
- P7

MONUMENT ID	2018 THRESHOLDS		
	HORIZONTAL DISPLACEMENT FROM ORIGINAL POSITION (mm)	INCREMENTAL SETTLEMENT BETWEEN READINGS (mm)	TOTAL SETTLEMENT (mm)
P2	80	20	50
P3			50
P4			75
P5			50
P6			75
P7			75

NOTES:

1. HIGHMONT DAM CREST MOVEMENT MONITORING DATA PRIOR TO 2007 NOT SHOWN.
2. P2 JUNE 2016 READING (NOT SHOWN IN PLAN PLOT) LOCATED 139 MM FROM INITIAL 2007 READING. READING WAS REVIEWED AND FOUND MORE LIKELY RELATED TO SURVEY ERROR THAN DISPLACEMENT. DISPLACEMENT WAS MOSTLY IN A NORTHWEST DIRECTION PERPENDICULAR TO THE DAM ORIENTATION, BUT SLIGHTLY IN THE DOWNSTREAM DIRECTION.
3. P4 2008, AND 2009 READINGS (NOT SHOWN IN PLAN PLOT) LOCATED 240 mm and 167 mm FROM INITIAL 2007 READING, RESPECTIVELY. READING WAS REVIEWED AND FOUND MORE LIKELY RELATED TO SURVEY ERROR THAN DISPLACEMENT.

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CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

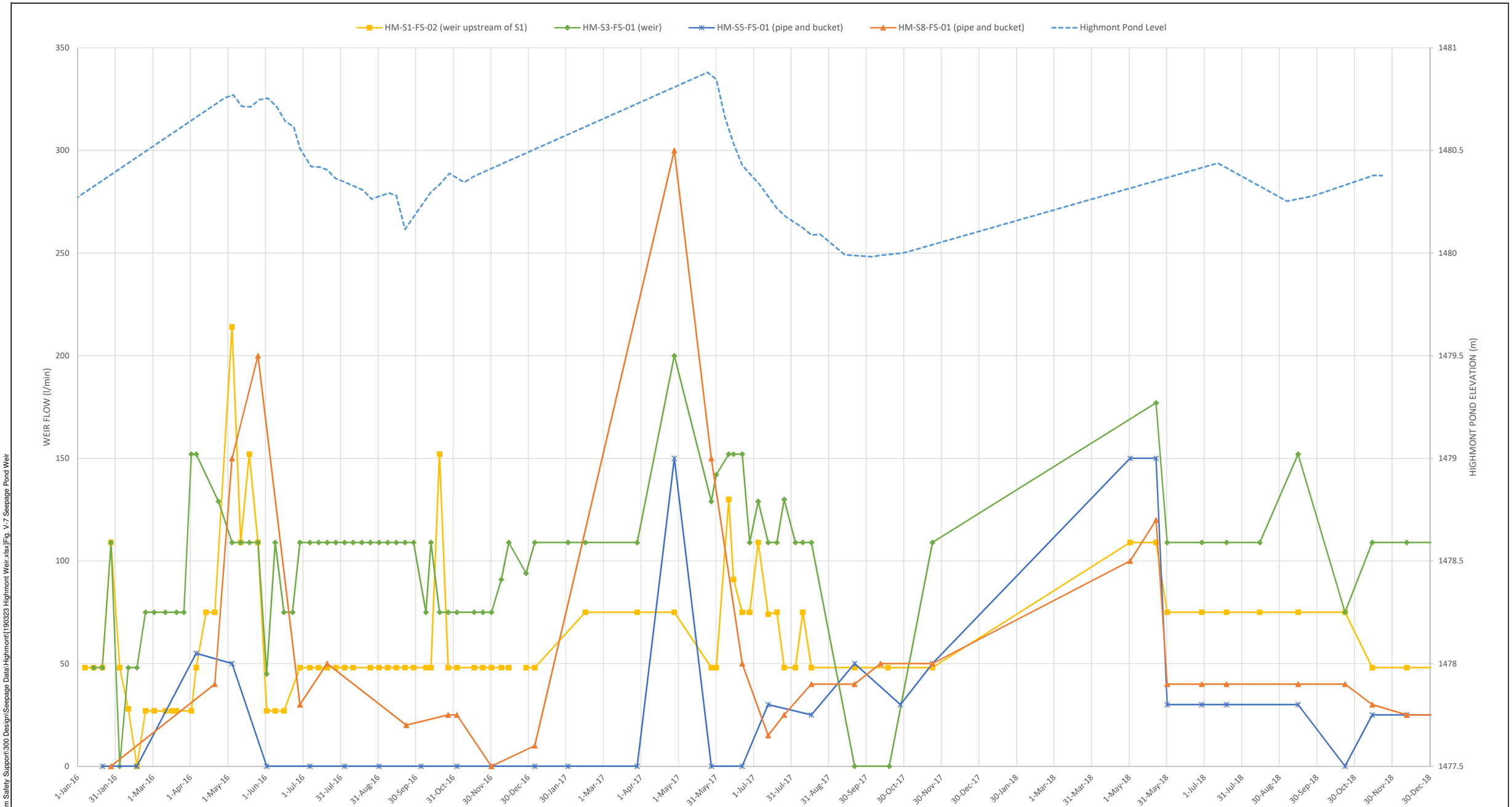
PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

TITLE: HIGHMONT DAM
SURVEY MONUMENT READINGS

PROJECT No. M02341B43

FIG No. IV-6

March 26, 2019
Z:\MVCR\M02341B43 - HVC 2018 Dam Safety Support\300 Design\Monument Data\Highmont\[190326 HighmontDamMonitoring.xlsm]Historic Data



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CLIENT
TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT
HIGHMONT TAILINGS STORAGE FACILITY
2018 DAM SAFETY INSPECTION

TITLE
SEEPAGE PONDS
WEIR FLOWS

PROJECT No. M02341B43

FIG No. IV-7

March 23, 2019
Z:\M\VCR\M02341B43 - HVC 2018 Dam Safety Support\300 Design\Seepage Data\Highmont\[190323 Highmont Weir.xlsx]Fig. V-7 Seepage Pond Weir

APPENDIX V

Map of Water Quality Monitoring Points

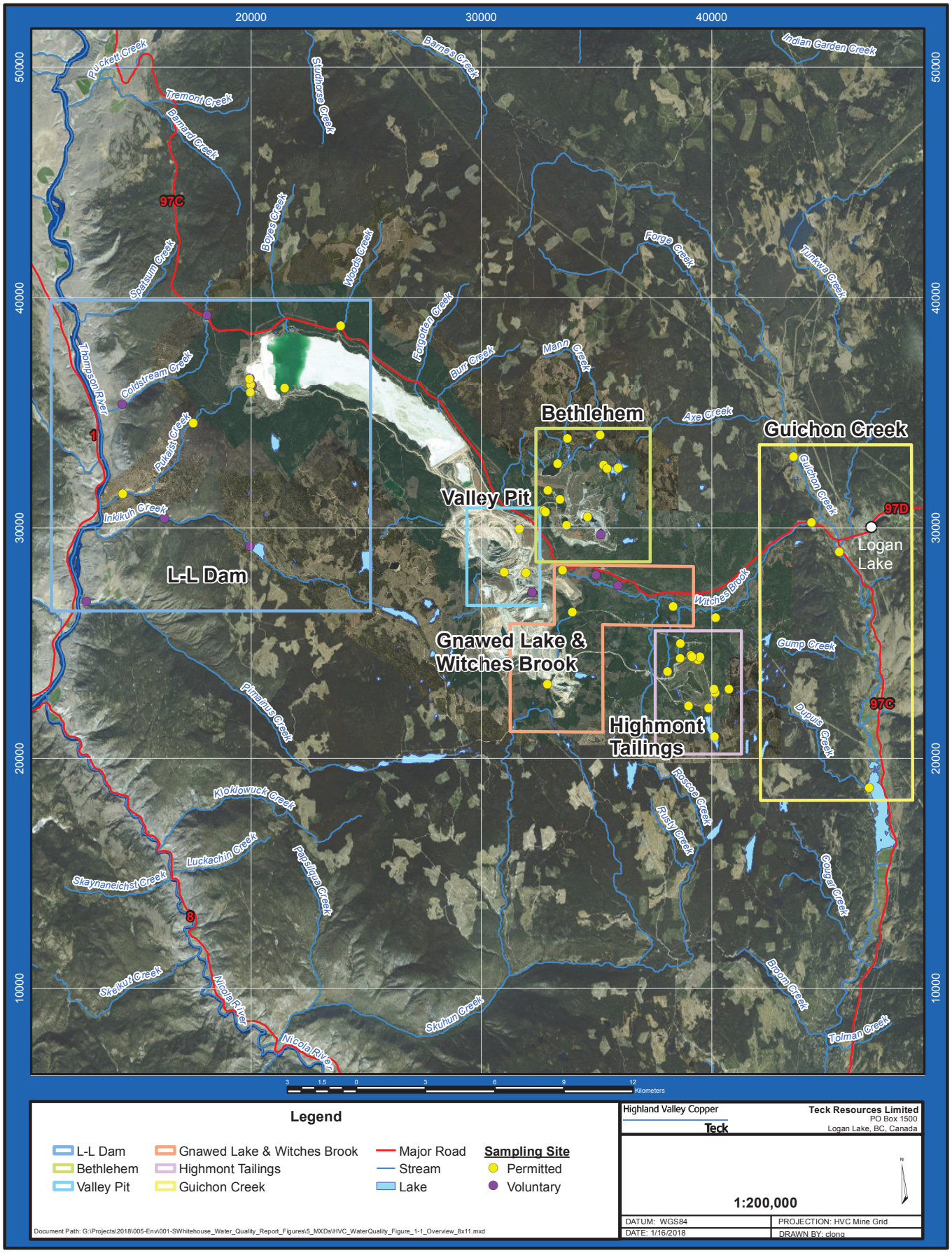

Figure E-1 Water Quality Monitoring Sites, Highland Valley Copper, 2018

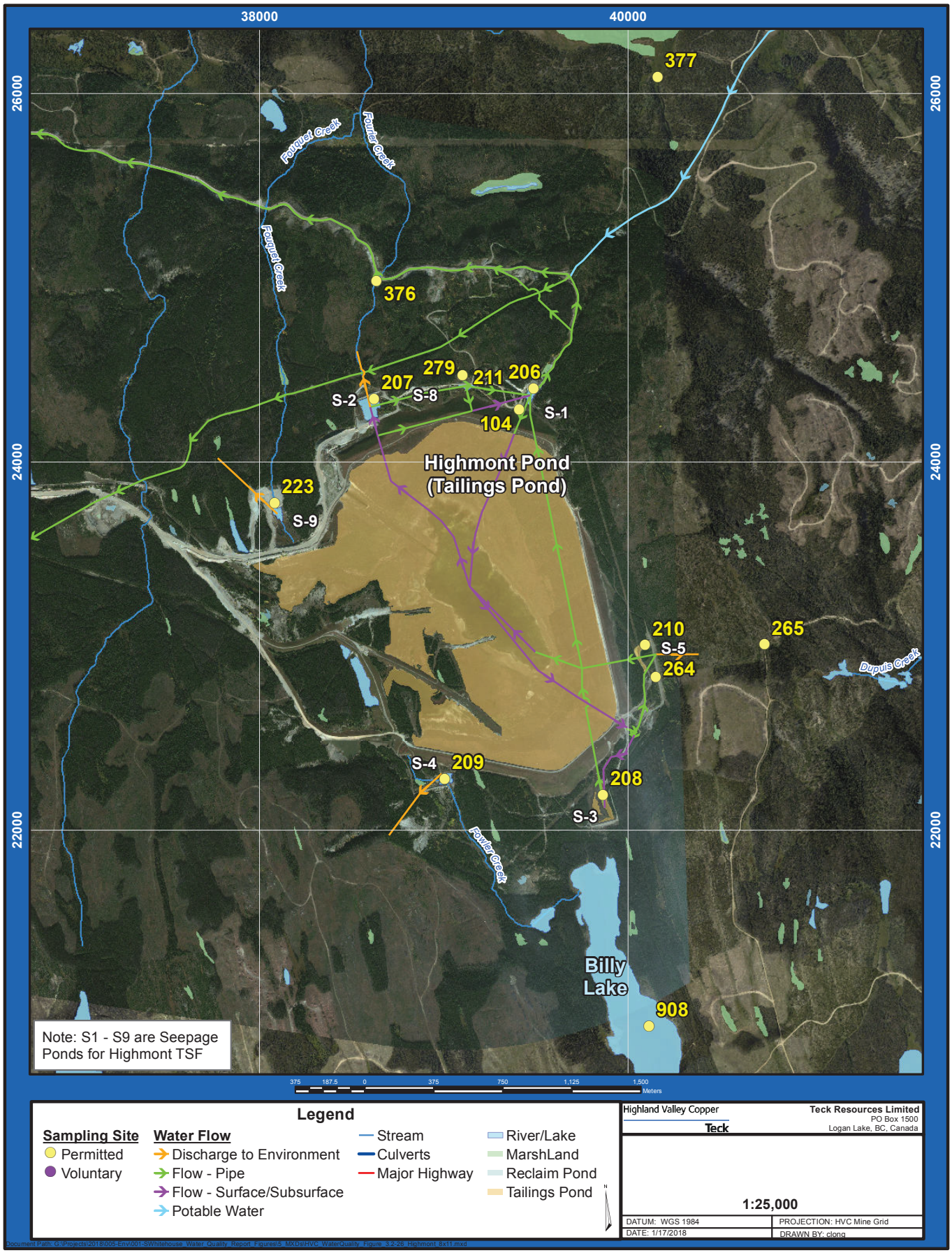

Figure 3.2-37 Water Quality Monitoring Sites in the Highmont Area, Highland Valley Copper, 2018