REPORT

Beaverdell Tailings Storage Facilities

2020 Annual Facility Inspection Report

Submitted to:

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Distribution List

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Executive Summary

This report presents the 2020 annual inspection report for the embankments of the tailings storage facilities (TSFs) at the closed Beaverdell Mine. The facilities consist of the South TSF and North TSF.

This report was prepared by Golder Associates Ltd. (Golder) at the request of Teck Resources Limited (Teck), in consideration of the guidelines for annual facility inspection reporting provided in the Health, Safety, and Reclamation Code (HSRC) for Mines in British Columbia Guidance Document (Ministry of Energy and Mines 2016) and the requirements of the most recent version of Teck's Guideline for Tailings and Water Retaining Structures (Teck 2019a).

The annual inspection report is based on a site visit carried out on 21 July 2020 by the Engineer of Record team from Golder, and a review of data provided by Teck. The reporting period for the data review was 1 September 2019 through 31 August 2020 unless otherwise noted.

Activities completed during the reporting period were as follows:

- fall routine inspection on 24 September 2019, spring routine inspection on 12 April 2020, both by Teck, and annual inspection on 21 July 2020 by Teck and Golder
- placement of approximately 145 m of riprap in November/December 2019 to armour the riverbank adjacent to the South TSF
  - works were completed, outside of the reporting period, in November 2020
- stockpiling of additional riprap material at the toe of Cells 4 and 5 from January to April 2020 in preparation for the 2020 freshet
- completion of the Phase 1 geotechnical site investigation and laboratory testing program for the TSFs, including:
  - drilling of 8 boreholes with large penetration testing
  - installation of 12 vibrating wire piezometers in six boreholes and connection to a remote monitoring system
    - installation of 2 signal repeaters on 1 October 2020
  - excavation of 5 test pits along the toe of the Cell 3 embankment
- completion of a test pitting program, including 12 test pits in South TSF cells, 3 in North TSF cells, 8 in the former mill area, 1 downstream of Cell 3 and 6 downstream of Cell 5 in August 2020 (reporting in progress by others)
- development of a baseline hydrology study
- installation of a staff gauge at the West Kettle River (WKR) bridge
- four water quality sampling events in the WKR, including flow measurement in 2020, 2 groundwater sampling events, and quarterly/annual reporting

The latest topographic plan for the facilities was developed using LiDAR survey data collected 19 July 2018 with elevations referenced to the Canadian Geodetic Vertical Datum (CGVD2013). Elevations in this report are referenced to this datum, unless otherwise noted.

Summary of Facility Description

The TSFs are located within the valley of the WKR, at elevations between 777 and 800 m. The east side of Cranberry Ridge, including the area of the TSFs, is part of the drainage area of the WKR. There are two TSFs at the site, the South TSF and the North TSF. Both TSFs have been inactive for 29 years since the mine was permanently closed in 1991.

The South TSF includes five tailings storage cells (Cells 1 to 5) and the North TSF includes two cells (Cells 6 and 7). The South TSF Cell 5 embankment and the North TSF Cell 6 and 7 embankments were designed to be constructed of earthfill using the downstream construction method (Binnie 1973, 1980a,b 1988). No construction record reports are available for Cells 5, 6, and 7, however visual observations, including from site investigations, of the facilities appear to indicate that the construction of the Cell 5, 6 and 7 embankments are consistent with available design reports.

The South TSF Cell 4 embankment is assumed to have been constructed in a similar manner to Cells 5 to 7 using earthfill and the downstream construction method. External embankments forming Cells 3 to 5 were constructed downstream of Cells 1 and 2; however, a portion of Cell 1 is retained by an external embankment. Design and construction record reports for Cells 1 to 4 are not available.

Summary of Key Hazards

A required component of the annual inspection report is a review of the credible potential hazards and the associated failure modes, design basis, and observed dam performance. The facility dam safety assessment for the Beaverdell TSFs was completed based on site observations and a data review for each of the potentially credible hazards.

Golder understands and fully supports Teck’s long-term goal for all their tailings facilities to reach landform status with all potential failure modes that could result in the catastrophic release of tailings and/or water being reduced to non-credible, where possible. Teck is evaluating options for long-term management of the Beaverdell mine site and TSFs with an end goal of reducing all potential failure modes to be non-credible or close to non-credible based on Extreme consequence classification (CDA 2013) design criteria which is consistent with the Global Industry Standard on Tailings Management (GTR 2020). Golder understands Teck will be conforming to the Global Industry Standard on Tailings Management across all of its operating and legacy facilities by the end of 2023.

An annual review of the Beaverdell risk register was completed by Teck and the Engineer of Record on 22 July 2020, resulting in only minor edits related to the status and clarification of risks. The risk register was also updated, outside of the reporting period, in January 2021, following completion of WKR riprap works.

Internal Erosion

- The Beaverdell TSFs have been inactive without the deposition of waste materials or water for 29 years.
- Minor ponding was observed in Cells 3, 4 and Cell 6, due to snowmelt, during the 12 April 2020 routine inspection. No ponding was observed during the 24 September 2019 routine inspection or the 21 July 2020 annual inspection.

- No zones of subsidence or sinkholes were observed during the annual or routine inspections that would indicate voids due to either suffusion or piping.
- Inferred conditions from the 2018 CPT investigation and VWPs installed in the 2020 site investigation indicate typically insufficient hydraulic gradient to drive a potential piping failure.
- Filter compatibility between the coarse tailings and the sand and gravel material of the dam was assessed as part of the response to the Ministry of Energy and Mines order dated 3 February 2015 (Golder 2015a).
  - Based on a comparison of particle size distributions from samples used in the Golder (2015a) assessment and samples tested following the Phase 1 geotechnical site investigation (Golder 2020b) it is recommend that an update of the filter compatibility assessment and internal stability assessment be completed (Recommendation 2020-03).
- Based on available data internal erosion of the South TSF represents a credible failure mode with a rare likelihood and internal erosion of the North TSF represents a close to non-credible failure mode.

Overtopping

- The small, shallow, temporary ponding that occurs at the Beaverdell TSFs, under typical conditions, is not an overtopping risk.
  - Large non-typical storm events could generate surface ponding which would be managed by spillways.
- The North TSF Cell 7 has a spillway, and Cell 7 can contain the inflow design flood.
- The South TSF routes surface water to Cell 3 where it can exit the facility through a spillway, sized to convey the 24-hour probable maximum flood.
- Based on available data overtopping represents a close to non-credible failure mode for both the South and North TSFs.

Instability

- The visual inspection during the July 2020 annual inspection site visit did not identify any sign of stresses such as cracks, settling, or bulges on the North and South TSF dams.
  - Trees on the downstream slopes are generally vertical with diameters of 10 to 15 cm, and conditions generally suggest that there is no apparent movement or creep of the dam slopes. Removal of these trees was completed, outside of the reporting period, in November 2020, as part of riprap installation works (Recommendation 2019-02).
- No significant erosion was noted on the upstream or downstream slopes of either facility. The conditions of the dams have remained unchanged from previous site visits.
- Test pits completed at the toe of the Cell 3 embankment, as part of the 2020 site investigation, indicated the presence of tailings.
  - The South TSF dam may be founded on tailings in the area of Cell 3. It is recommended that additional investigations be planned to further delineate the extent of tailings downstream of the South TSF. Additional investigations were completed in August 2020 towards addressing this recommendation (reporting in progress by others).
- Based on available data the likelihood of instability for the North and South TSFs is considered to be close to non-credible (drained condition) to unlikely (seismic loading condition).

Erosion of Facility Toe from West Kettle River

- River levels in 2020 peaked below a 1-in-5-year return period maximum daily flow.
- A revised design for armouring of the Cell 4 and 5 riverbank for up to a 1-in-200-year flood event was completed in 2019 (Golder 2019f,g) and 145 m (56%) of the works installed in November and December 2019. Works were completed outside of the reporting period, in November 2020.
- At this time, there is a credible failure mode for river erosion of the South TSF for events above a 1-in-200-year flood event due to the WKR encroaching upon Cell 4 and 5 embankments.

Dam Consequence Classifications

Dam consequence classification is based on the potential consequences of a hypothetical dam failure irrespective of the potential for such an event to occur. At the time of this report, the consequence classifications for both the North and South TSFs remain Significant following the dam consequence classification guidelines from the HSRC Guidance Document Section 3.4 (Ministry of Energy and Mines 2016), which references the CDA (2013) Dam Safety Guidelines. This is the second lowest classification for a dam under these guidelines.

A report by Fisheries and Oceans Canada (DFO 2018) identified the area of the WKR immediately to the east of the South TSF as critical habitat for Speckled Dace (*Rhinichthys osculus*). The classification of this habitat as critical by others has the potential to increase the consequence classification of the North and South TSFs based on the consequence classification guidelines (CDA 2013) and a review of the consequence classifications is recommended (Golder 2019d), (Recommendation 2018-02).

Summary of Key Observations and Significant Changes

The Beaverdell TSFs were in good condition at the time of the 2020 site inspection.

Dam condition, maintenance, and surveillance of the facility were reviewed through site observation and discussion with Teck personnel.

No significant changes in visual monitoring records or dam stability were noted during the 2020 annual inspection for the South and North TSFs at the Beaverdell site. Quantifiable performance objectives have been established for surface water conditions (temporary ponding) and are presented in this report.

The South and North TSFs are trending to a state of having non credible failure modes.

Review of Operation, Maintenance, and Surveillance Manual

The operation, maintenance, and surveillance (OMS) manual for the TSF was updated in February 2018 (SP&P BEA-OMS-001.V002; Teck 2018a). This OMS manual was prepared to meet guidelines provided by the HSRC Guidance Document (Ministry of Energy and Mines 2016), the CDA (2013), the Mining Association of Canada (MAC 2011, 2017) and Teck (2014).

An update of the OMS manual is in progress at time of this report to reflect staff changes at the TSF and to meet revised guidelines provided by MAC (2019a,b) and Teck (2019a).

A draft flood monitoring and response protocol for the West Kettle River, including a trigger action response plan, was prepared in March 2020, prior to finalization of this document Teck developed a flood response procedure (Teck 2020), based on the draft flood monitoring and response protocol, which was implemented during the 2020 freshet.

The water management plan for the facility is out of date (Recommendation 2018-04), and an update was in progress at the time of this report based on the recent baseline hydrology study (Golder 2021).

Review of Emergency Preparedness and Response Plan

The emergency preparedness and response plan (EPRP) was updated in February 2018 (Teck 2018b) (SP&P BEA-EPRP-001.V002). This document was prepared to meet guidelines provided by the HSRC and HSRC Guidance Document (Ministry of Energy and Mines 2016, 2017), CDA (2013), MAC (2011, 2017), and Teck (2014).

An update of the EPRP was issued to Teck by Golder in July 2019, including incorporation of the TSF EPRP into a mine emergency response plan for the Beaverdell Mine (Teck 2019c), and is pending finalization at the time of this report. Updates reflect staff changes at the TSF and revised guidelines provided by MAC (2019a,b) and Teck (2019a).

The hypothetical failure of the Beaverdell TSFs is not considered to present a potential for loss of life, following the dam consequence classification guidelines from the HSRC Guidance Document Section 3.4 (Ministry of Energy and Mines 2016), which references the CDA (2013) *Dam Safety Guidelines*. The EPRP and dam consequence classification should be updated following the results of the hypothetical runout failure assessment (Recommendation 2017-02b).

Dam Safety Review

The last dam safety review for the Beaverdell TSFs was conducted in 2012 (Golder 2013). At that time it was recommended that the next dam safety review be completed within 10 years. However, based on the post-2016 requirement of the HSRC (Ministry of Energy and Mines 2017) the next dam safety review should be initiated in 2021.

Summary Table of Deficiencies and Non-conformances

Deficiencies / non-conformances and recommended actions are presented in Table E-1, which includes an update of the status, as of March 2021, of Recommended Actions from the 2019 dam safety inspection. Completed recommendations are shown in grey shading.

Table E-1: Table of Deficiencies and Non-conformances and Status Update of Previous Recommendations

<table>
<tr><th>Structure</th><th>ID Number</th><th>Deficiency or Non-conformance</th><th>Applicable Regulation or OMS Manual Reference</th><th>Recommended Action</th><th>Priority</th><th>Status, as of March 2021, and Recommended Deadline</th></tr>
<tr><td rowspan="8">South TSF</td><td>2016-01</td><td>The South TSF would discharge through the Cell 3 spillway during a 24-hour IDF event. The consequence of potential tailings migration due to flood transport is not quantified.</td><td>Permit PE-444</td><td>Collect tailings samples for geochemical testing and initiate the geochemical laboratory testing program in 2020.

Develop a contingency protocol (with TARP) to be implemented in the event that discharge through the spillway occurs.</td><td>3</td><td>Completed:
Tailings samples from the 2020 geotechnical site investigation were sent for geochemical analysis testing by Teck. Additional geochemical samples were collected in a test pit program by Teck in 2020.

In progress:
Teck to develop contingency protocol in the event of discharge through the spillway and include in the next OMS manual update.

End Q1 2021</td></tr>
<tr><td rowspan="2">2018-03 a,b</td><td rowspan="2">Existing riprap along the toe of Cell 4 and 5 may not be sufficient to prevent erosion of dam fill during a large river freshet flood event, based on observed changes in river alignment and adjacent riverbank conditions.</td><td rowspan="2">HSRC §10.1.8</td><td>Finalize flood response protocol for the WKR including the trigger action response plan prior to 2020 freshet.</td><td>2</td><td>Complete
Riprap stockpiles replenished between January and April 2020 in preparation for 2020 freshet.

Draft flood response protocol used to develop flood monitoring procedure for 2020 freshet, prior to finalization of the protocol document.</td></tr>
<tr><td>Assess short-term and long-term requirements for riprap based on changes in river hydrology and flood statistics.</td><td>3</td><td>In Progress
Design for WKR riprap up to a 1-in-200-year event and installation of 145 m of riprap completed in 2019. Construction to complete remaining riprap works completed in November 2020.

Document long-term plan for riprap along WKR, considering larger flood events, to mitigate risk of erosion along the toe of Cell 4 and 5

End Q2 2021</td></tr>
<tr><td>2019-01</td><td>The location and alignment of the Cell 5 decant pipe are unknown.</td><td>OMS manual §5.5</td><td>Determine the location and alignment of the outlet of the Cell 5 decant.</td><td>3</td><td>Not Started
End Q2 2023</td></tr>
<tr><td>2019-02</td><td>Dead trees along the toe of the Cell 5 dam.</td><td>OMS manual §5.5</td><td>Remove dead trees along the toe of the Cell 5 dam as part of clearance works for the installation of riprap in 2020 (see 2018-03b).</td><td>3</td><td>Complete:
Completed as part of riprap placement in 2020 (2018-03b)</td></tr>
<tr><td>2019-03</td><td>Reviewed data, including observed conditions during the removal of trees in 2019, could indicate the possibility of tailings in the foundation of the Cell 3 embankment. Foundations may be prone to liquefaction in a seismic event potentially leading to failure.</td><td>HSRC §10.1.4</td><td>Investigate the toe area and foundation of the Cell 3 dam for the presence of tailings or other soft, loose soils.</td><td>2</td><td>Completed:
Phase 1 site investigation completed in March 2020 including installation of vibrating wire piezometers. Baseline data collection and interpretation in progress.</td></tr>
<tr><td>2020-02</td><td>Results indicated the presence of tailings at the downstream toe of Cell 3. As such, the South TSF may be founded on tailings in the area of Cell 3.</td><td>HSRC §10.1.4</td><td>Additional investigation should be planned to further delineate the extent of tailings downstream of the South TSF.</td><td>3</td><td>New Recommendation
End 2021</td></tr>
<tr><td>2020-03</td><td>Results from the Phase 1 geotechnical site investigation indicate that tailings in Cell 4 are finer than the range used in the filter compatibility and internal stability assessment (Golder 2015a).</td><td>HSRC §10.1.4</td><td>Update filter compatibility and internal stability assessment for dam fill and foundations based on Phase 1 geotechnical investigation laboratory test results.</td><td>3</td><td>New Recommendation
End 2021</td></tr>
</table>

	2020-04	Flood monitoring and response protocol is out of date.	n/a	Update flood monitoring and response protocol, based on completion of 1-in-200-year riprap armouring along South TSF	3	New Recommendation – Updated in March 2021, requires finalization. End Q1 2021
North TSF	2019-04	The outlet structure of the Cell 6 decant accumulates a small quantity of water behind a metal weir, which may affect water chemistry when sampled.	OMS manual §5.5	Review collected water quality data to determine source of the accumulated water. Assess opportunity for maintaining the collection point to inform ongoing geochemistry studies. Consider upgrading to remove steel as a potential source of water contamination. Decommission the outlet structure if deemed of no value.	3	**In Progress:** Action plan to be developed for decommissioning and installation of standpipe for water quality monitoring. End Q2 2023
	2020-01	Excessive vegetation in the North TSF spillway and diversion channel may reduce flow capacity and impeded access.	OMS manual §5.5	Clear vegetation in the North TSF spillway and diversion channel.	4	New Recommendation End Q3 2021
South and North TSF	2016-03	Facility phreatic conditions not confirmed.	CDA 2013 §6.6 HSRC §10.1.4 (3)	Execute the planned drilling program to gather subsurface information and install piezometers.	3	**Completed:** ***Phase 1 Site investigation completed in March 2020 including installation of VWPs. Baseline data collection and interpretation in progress.***
	2016-05 a,b	Closure plan not updated	HSRC §10.4.1	Complete the planned Phase 1 geotechnical investigation to inform the development of an updated closure plan. Execute the planned geochemical site investigation and testing program. Teck should collect tailings samples for geochemical testing and initiate the geochemical laboratory testing program in 2020 (See 2016-01).	4	**Completed:** ***Tailings samples from the 2020 geotechnical site investigation were sent for geochemical analysis testing by Teck. Additional geochemical samples were collected in a test pit program by Teck in 2020.***
			HSRC §10.4.1	Update the closure plan.	4	**Not Started** End Q2 2023
	2017-02 a,b	No failure runout assessment completed.	HSRC §10.1.11	Complete the planned Phase 1 geotechnical investigation to inform the development of hypothetical failure runout evaluation	3	**Completed** ***Phase 1 geotechnical site investigation completed in March 2020.***
				Complete a hypothetical failure runout evaluation	3	**In Progress** ***End Q3 2021***
	2018-02	Dam consequence classification requires review due to changes in downstream conditions	HSRC §10.1.7	Review dam consequence classification as recommended in Golder (2019d).	3	**Not Started** ***End Q4 2021***
	2018-04	Water management plan is out of date.	HSRC §10.4.1 (3)	Update the existing water management plan.	4	**In Progress** ***Baseline hydrology study developed and issued in March 2021 and will inform surface water management plan update.*** ***End Q2 2021***

CDA = Canadian Dam Association; HSRC = Health, Safety and Reclamation Code; ID = identification; IDF = inflow design flood; OMS = operation, maintenance, and surveillance; TARP = trigger action response plan; TSF = tailings storage facility; VWP = vibrating wire piezometers; WKR = West Kettle River.

Priority	Description
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.
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.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

Source: HSRC Guidance Document, Section 4.2 (Ministry of Energy and Mines 2016).

Abbreviations

Abbreviation	Definition
BC	British Columbia
CDA	Canadian Dam Association
CGVD	Canadian Geodetic Vertical Datum
CPT	cone penetration testing
DFO	Fisheries and Oceans Canada
DSI	dam safety inspection
EoR	Engineer of Record
EPRP	emergency preparedness and response plan
ENV	Ministry of Environment and Climate Change Strategy
FAA	*Fisheries Act* authorization
Golder	Golder Associates Ltd.
HSRC	Health, Safety and Reclamation Code for Mines in British Columbia (Ministry of Energy and Mines 2017)
IDF	inflow design flood
LPT	large penetration test
MERP	mine emergency response plan
n/a	not applicable
OMS manual	operation, maintenance, and surveillance manual
QPO	quantifiable performance objective
PMF	probable maximum flood
TARP	trigger action response plan
Teck	Teck Resources Limited
TSF	tailings storage facility
WKR	West Kettle River
Wood	John Wood Group PLC
VWP	vibrating wire piezometer

Units of Measure

Unit	Definition
%	percent
cm	centimetre
km	kilometre
km^2	square kilometre
m	metre
m^3	cubic metre
mm	millimetre
t	tonne

Glossary

Term	Definition
Annual Facility Inspection	Tailings storage facilities and associated dams shall be inspected annually as required by Section 10.5.3 of the Health, Safety and Reclamation Code (HSRC) for Mines in British Columbia (Ministry of Energy and Mines 2017) and a report shall be prepared by the engineer of record in consideration of the HSRC Guidance Document (Ministry of Energy and Mines 2016), both available at http://www2.gov.bc.ca/gov/content/industry/mineral-exploration-mining/health-safety/health-safety-and-reclamation-code-for-mines-in-british-columbia.
Dam Safety Review	A systematic review and evaluation of all aspects of design, construction, maintenance, operation, process, and system affecting a dam's safety, including the dam safety management system (Ministry of Energy and Mines 2017).
Downstream	The side of the embankment farthest away from the reservoir or cell.
Downstream Construction	A dam raised by adding additional fill to the downstream side of the dam.
Earthfill Dam	An engineered barrier constructed of naturally occurring materials, including blasted or crushed rockfill and/or mineral soil fill, for the retention of water, water containing any other substance, fluid waste, or tailings.
Freeboard	The vertical distance between the still water surface elevation in the reservoir and the lowest elevation at the top of the containment structure (CDA 2013).
Inflow Design Flood (IDF)	The most severe inflow flood (peak volume, shape, duration, timing) for which a dam and its associated facilities are designed (CDA 2013).
Left Bank	Left bank of the West Kettle River while looking downstream from a fixed point.
Right Bank	Right bank of the West Kettle River while looking downstream from a fixed point.
Tailings	Fine-grained residual material remaining after the valuable resources have been separated.
Upstream	The side of the embankment nearest to the reservoir or cell.

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1.0 INTRODUCTION

1.1 Purpose, Scope of Work, and Methodology

As requested by Teck Resources Limited (Teck), Golder Associates Ltd. (Golder) prepared this 2020 annual facility inspection report for the tailings storage facilities (TSFs) at the closed Beaverdell Mine in British Columbia (BC). The facilities consist of the North TSF and South TSF.

This report has been prepared with consideration of Part 10 of the Health, Safety and Reclamation Code (HSRC) for Mines in British Columbia (Ministry of Energy and Mines 2017), which sets out the frequency for inspection of tailings storage facilities and associated dams. The guidelines for an annual facility inspection report provided in the HSRC Guidance Document (Ministry of Energy and Mines 2016) and the requirements of the most recent version of Teck's *Guideline for Tailings and Water Retaining Structures* (Teck 2019a) were followed, where applicable, during the preparation of this report. It is understood that this report will be submitted by Teck to the Chief Inspector of Mines for British Columbia.

This report is based on a site visit carried out by the Engineer of Record (EoR) on 21 July 2020, which included a walkover of the TSF areas with the Teck staff involved in the maintenance and surveillance of the dams. This report consists of the following key components:

- a summary of the site conditions and background information
- a summary of activities for the 2019/2020 reporting period
- dam consequence classification and required operational documents review
- site photographs and records of TSF inspection
- review of
  - climate data
  - dam safety relative to potential credible failure modes
- findings and recommended actions

A TSF data sheet for each facility is presented in Appendix A. Photographs of the TSF areas are presented in Appendix B. A summary of observations for each TSF during the 21 July 2020 site visit are included in the inspection reports presented in Appendix C.

The previous annual site visit for these facilities was carried out in July 2019 and is reported in the 2019 annual dam safety inspection (DSI) (Golder 2020a).

This report is to be read in conjunction with the Study Limitations, which follows the report text.

1.2 Regulatory Requirements

1.2.1 Health, Safety and Reclamation Code

The Beaverdell TSFs are regulated under the HSRC (Ministry of Energy and Mines 2017). Both the North TSF and South TSF dams meet the definition of a "dam" as defined in the HSRC. It is noted that the 2021 release of the HSRC will apply to the 2021 reporting period.

As required by the HSRC, the following personnel have been designated for the Beaverdell TSFs:

- Engineer of Record: John Cunning, P.Eng., an employee of Golder Associates Ltd.
  - Teck has informed Golder that the role of Engineer of Record will be transitioned to Wood in 2021. Transition planning was in progress at the time of this report.
- Tailings Storage Facility Qualified Person: Jason McBain, P.Eng., an employee of Teck Resources Limited

1.2.2 Permits and Licences

The Beaverdell Mine is regulated under the following permits:

- *Waste Management Act* – Permit No. PE-444, amended 12 December 2019
- *Mines Act* – Permit No. M-71, amended 4 October 2019

Additional permits are required for specific projects at Beaverdell, such as the West Kettle River (WKR) erosion protection installation downstream of Cell 4 and Cell 5 of the South TSF.

1.3 Facility Description

The Beaverdell Mine was an underground mine development adjacent to the community of Beaverdell, BC, which is located 87 km south of Kelowna via BC Highway 33 (Figure 1). Silver was the main ore extracted from the mine, with appreciable quantities of lead, zinc, gold, and cadmium. The Beaverdell Mine was closed in 1991 and is now under active care and maintenance, with no current or planned mining activities.

Golder understands that Teck's long-term goal for all their tailings facilities is to reach landform status with all potential failure modes being reduced to non-credible, where possible. Teck is evaluating options for long-term management of the Beaverdell mine site and TSFs with an end goal of reducing all potential failure modes to be close to non-credible based on Extreme consequence classification (CDA 2013) design criteria.

The latest topographic plan for the facilities was developed using LiDAR survey data collected 19 July 2018 based on the following datums:

- Horizontal: UTM Zone 11 NAD83
- Vertical: Canadian Geodetic Vertical Datum (CGVD2013)

Coordinates and elevations in this report are referenced to these datums, unless otherwise noted.

A general view of the topography and region surrounding the Beaverdell TSFs, which sit at the toe of the east side of Cranberry Ridge, is provided in Figure 2. The TSFs are located within the valley of the WKR, at elevations between 777 and 800 m. The TSFs have been inactive for 29 years since the mine was permanently closed in 1991.

The east side of Cranberry Ridge, including the area of the TSFs, is part of the drainage area of the WKR. Figure 2 illustrates the general view of the North and South TSFs. The South TSF includes five tailings deposition cells (Cells 1 to 5) and the North TSF includes two cells (Cells 6 and 7). Figure 3 shows the infrastructure related to the TSFs, along with locations of representative cross-sections. The cross-sections are presented in Figures 4 and 5.

The dams were classified as Low consequence structures by the BC Ministry of Energy and Mines in 2003 (Ministry of Energy and Mines 2003) and updated to Significant consequence structures as reported by Golder (2013). A review of the dam consequence classifications is provided in Section 5.1.

The Beaverdell Mine is an inactive facility under the closure – active phase of mine life (CDA 2019). No operational activities are required at the TSFs and they do not include any structures or mechanical components (e.g., pipes, pumps, spigots, gates, or valves) that require an operator. Drainage at the TSFs is solely by gravity (infiltration and spillways).

Golder's first involvement with the TSFs was the dam safety review, completed in 2012 (Golder 2013). Golder personnel have undertaken the EoR role for the Beaverdell TSFs since 2013.

1.3.1 South Tailings Storage Facility Description

The South TSF includes five tailings deposition cells (Cells 1 to 5). The South TSF area intersects the natural slope of the WKR valley, and as a result, no dam was required on the north and west sides of Cell 3, and the west side of Cell 2. The main perimeter dam of the South TSF is along the west side of Cell 1, south of Cell 1 and 5 and east of Cells 3, 4, and 5 (Figure 3).

The South TSF Cell 5 dam was designed to be constructed of earthfill using the downstream construction method (Binnie 1973, 1980c). No construction record reports are available for Cell 5, but visual observations, including site investigations, appear to indicate that the construction of the Cell 5 embankment is consistent with the available design report.

The South TSF Cell 4 dam is assumed to have been constructed in a similar manner to Cell 5 using earthfill and the downstream construction method. External embankments to form Cells 3 to 5 were constructed downstream of Cells 1 and 2; however, a portion of Cell 1 is retained by an external embankment. Design and construction record reports for Cells 1 to 4 are not available.

The downstream slopes of the Cell 4 and 5 dams are covered with trees.

A ditch along the road to the west of the South TSF area (Beaverdell Station Road, Figure 3) directs surface water runoff from Cranberry Ridge away from the facility (Golder 2019c). As a result, the catchment area of the South TSF consists of the surface area of the facility plus the area between the facility and the road. Surface water is observed to seasonally pool in a depression in Cell 4. During flood events, surface water can migrate through internal spillways to Cell 3, which has an external spillway. During normal precipitation events, water will collect in localized low spots on the tailings surface.

The South TSF contains a decant tower in Cell 5, which was understood to be used during operations. No decant tower has been observed in any of the other South TSF cells. The decant tower in Cell 5 is shown in Photograph 10, Appendix B, and its approximate location is shown in Figure 3. This decant tower was sealed with foam in 2016. The downstream end of the Cell 5 decant tower has not been located, and it is a recommended that the alignment and downstream outlet be located (Recommendation 2019-01).

A supernatant pond historically existed downstream of the southwest corner of Cell 5, where it is understood the decant tower outlet exited the cell during operations (Figure 3) (Binnie 1980c). The decant pipe outlet is not currently visible in the downstream area of Cell 5. During previous inspections, tailings were observed in the area downstream of Cell 5. These tailings could be related to the decant outlet. The area is a known low spot in the topography, and there has been ponding in this area during spring freshet and high river levels in the WKR.

1.3.1.1 Dimensions of South Tailings Storage Facility Dam

Based on observations made during annual site inspections and information from the latest topographic survey of the site, the South TSF dam has a maximum height of about 10 m and an approximate length of 1,010 m. The configuration of Cells 1, 2, and 3 dams is unknown on the upstream side of the embankments, but the downstream slopes can be determined from survey data. A portion of the tailings deposited in Cell 1, and all the tailings deposited in Cell 2 appear to be from deposition with limited control of runoff of solids and water (i.e., tailings solids and water was not contained behind a dam). This contrasts with Cells 4 and 5, where tailings and water were contained behind the South TSF dams. Tailings were observed in the foundation downstream of the Cell 3 embankment during test pit excavations undertaken as part of the Phase 1 geotechnical investigation (Section 2.6). Based on this, it is our opinion that the Cell 3 embankment is likely constructed over tailings.

The dimensions of each cell are shown in Table 1 and are approximate. The existing crest length excludes the divider dykes between cells; it is only the exterior dam length. Cross-sections are provided in Figures 4 and 5.

Table 1: Embankment Geometry and Storage for the South Tailings Storage Facility

Cell	Downstream Slopes	Upstream Slopes	Exterior Crest Length (m)	Crest Width (m)	Embankment Height (m)	Approximate Minimum Crest Elevation[a] (m)
1	2.0 to 4.0H:1V	unknown	110	1 to 3	3 to 10	785.5
2	n/a[b]	unknown	n/a[b]	n/a[b]	n/a[b]	n/a[b]
3	1.5 to 2.4H:1V	1.5 to 3H:1V	360	1 to 5[c]	2 to 3	781.1
4	1.2 to 1.4H:1V	1.5H:1V (assumed from original design)	240	3 to 3.5	7 to 8	785.0
5	1.3 to 2.5H:1V	1.5H:1V (assumed from original design)	300	3 to 6	7 to 8	785.0

(a) Elevation in CGVD2013.

(b) Tailings in Cell 2 appear to be from deposition of slurry with runoff of water from the deposited tailings (i.e., tailings and water were not contained).

(c) An earthfill berm, approximately 1 m wide, was constructed upstream of the Cell 3 dam as part of spillway remediation in 2019 to provide freeboard. This berm forms a portion of the Cell 3 dam.

n/a = not applicable.

1.3.1.2 Dimensions of South Tailings Storage Facility Spillways

Dimensions of the internal spillways through the cells have been determined based on the 2018 LiDAR survey data and observations made during site inspections. The spillway through the Cell 3/4 divider dyke has a base width of 3 m, a minimum depth of 1 m, lateral slopes of 2H:1V, and an invert elevation of approximately 784.5 m. It is trapezoidal in shape, partially riprap-armoured, and allows the conveyance of surface water from Cell 4 to Cell 3 (Photograph 14, Appendix B).

The small, partially riprap-armoured spillway through the Cell 4/5 divider dyke has a base width of 1 m and lateral slopes of about 1.5H:1V and allows conveyance of surface water from Cell 5 to Cell 4. The invert elevation of this spillway is approximately 785.0 m.

The Cell 3 external spillway, which conveys surface water from the South TSF, was upgraded on 4 July 2019. (Photograph 18, Appendix B). Based on the construction record (Golder 2019e) the Cell 3 spillway has a minimum base width of 13.6 m at the invert, a longitudinal slope of 5H:1V, and an invert elevation of 780.4 m. It is trapezoidal in shape and armoured with Class 50 riprap, minimum 0.66 m thick. The spillway is capable of conveying the 24-hour probable maximum flood (PMF).

1.3.1.3 Storage Capacity of South Tailings Storage Facility

The storage capacity of Cells 1, 2, 4, and 5 was calculated in AutoCAD Civil3D as part of the 2018 annual DSI (Golder 2019b) using topography from the July 2018 LiDAR survey. The storage capacity of Cell 3 was calculated in AutoCAD Civil3D using topography from the July 2018 LiDAR survey and 4 July 2019 spillway construction record survey. Storage was assumed to be available from the tailings surface elevation to the lowest spillway invert elevation of each cell.

From the 2018 cone penetration testing (CPT) investigation, it was estimated that the South TSF currently stores approximately 544,000 m^3 of tailings (Golder 2019a).

The cells in the South TSF area are connected by a system of spillways, resulting in overflow from upstream cells discharging to downstream cells, with excess runoff ultimately reporting to Cell 3 and discharging via the Cell 3 spillway. Cell 1 has no capacity, and its berms were raised in August 2016 to facilitate the movement of water from Cell 1 to Cell 5. Cell 2 has no capacity and runoff overflow reports to Cell 4. Cells 4 and 5 are estimated to be able to store approximately 7,400 and 14,500 m^3 of water, respectively. Excess runoff from Cell 5 reports to Cell 4, which in turn reports to Cell 3. With the spillway, Cell 3 has no storage capacity (other than in localized low spots) and excess runoff from Cell 3 would discharge via the spillway to the area downstream of the Cell 3 dam. The consequence of potential tailings migration due to flood transport is not quantified and a contingency protocol should be implemented (Recommendation 2016-01).

The calculated storage and tailings volumes, and the destinations of overflow discharge, are presented in Table 2.

Table 2: South Tailings Storage Facility Cell Storage Capacities

Cell	Storage Volume (m^3)	Storage to Elevation[(c)]	Overflow Discharged To	Estimated Volume of Stored Tailings (m^3)[(d)]
1[(a)]	0	n/a	Cell 5	27,000
2[(a)]	0	n/a	Cell 4	18,000
3[(b)]	0	n/a	downstream of Cell 3 (via spillway)	192,000
4[(a)]	7,400	784.5	Cell 3	165,000
5[(a)]	14,500	785.0	Cell 4	142,000
Total	**21,900**	n/a	n/a	**544,000**

(a) Based on 2018 LiDAR survey.

(b) Based on 2018 LiDAR survey and 2019 Cell 3 spillway construction record.

(c) Elevation in CGVD2013. Freeboard not considered.

(d) Golder (2019a).

n/a = not applicable.

1.3.2 North Tailings Storage Facility Description

The North TSF consists of two cells (Cells 6 and 7) contained by the North TSF dam and separated by a divider dyke (Figure 3). The North TSF area intersects the natural slope of the WKR valley. The main perimeter dam for the North TSF surrounds Cells 6 and 7, except for a portion of the west side of Cell 7 where the natural topography is higher in elevation than the dam.

The North TSF Cell 6 and 7 dam was designed to be constructed of earthfill using the downstream construction method (Binnie 1980a, 1988). No construction record reports are available for Cells 6 and 7; however, visual observations of the facilities appear to indicate that the construction of the Cell 6 and 7 embankments is consistent with available design reports.

The downstream slopes of the dam are covered with trees.

Cell 6 is contained by a dam on the north, east, and south sides and by an internal divider dyke (with Cell 7) on the west side. As a result, the catchment area of Cell 6 is limited to the surface area of the facility. Cell 6 has the capacity to store the inflow design flood (IDF) event (1/3 between the 1-in-975-year flood event and the PMF). In the event of flood flows larger than the IDF, water in Cell 6 is assumed to overflow the divider dyke between Cell 6 and 7 (which has a crest elevation approximately 0.5 m lower than the Cell 6 dam) and report to Cell 7.

A ditch along Cranberry Ridge to the west of the North TSF area (Figure 3) directs surface water runoff to the north and away from the facility (Golder 2019c). This ditch is divided into two reaches, as described in (Golder 2019c):

- Reach 1 – southernmost section of the diversion (approximately 115 m long)
  - cannot convey the IDF, and flows would enter Cell 7 during an IDF flood event
- Reach 2 – northernmost section of the diversion (approximately 110 m long)
  - capable of conveying the 24-hour PMF event, which exceeds the IDF

As a result, the catchment area of the North TSF, in an IDF event, consists of the surface area of the facility plus a 90,000 m^2 area of external catchment. Cell 7 has the storage capacity to store the IDF event. Water can also discharge via the Cell 7 spillway south of the TSF (Photographs 30, Appendix B).

The decant towers in the North TSF, which originally managed pond water, have been sealed (Golder 2014a; Photograph 27, Appendix B). The diameter of each of the decant tower pipes was estimated at 0.2 m (i.e., 8 inches). The locations of the decant towers in Cells 6 and 7 are shown in Figure 3.

1.3.2.1 Dimensions of North Tailings Storage Facility Dam

Based on observations made during annual site inspections and data from the 2018 LiDAR survey, the North TSF consists of an earthfill dam with a maximum height of about 12 m and an approximate length of 840 m. The approximate dimensions of each cell are shown in Table 3. The existing crest length excludes the divider dyke between the cells; it is only the dam length. Cross-sections are provided in Figure 5.

Table 3: Embankment Geometry and Storage for the North Tailings Storage Facility

Cell	Downstream Slopes	Upstream Slopes	Exterior Crest Length (m)	Crest Width (m)	Embankment Height (m)	Approximate Minimum Crest Elevation[(a)] (m)
6	1.4 to 1.9H:1V	1.5H:1V (assumed from original design)	510	3 to 4	10 to 12	797.5
7	1.6 to 2.6H:1V	1.5H:1V	330	3 to 4	8 to 10	798.0

(a) Elevation in CGVD2013 vertical datum.

Tailings within Cell 6 have settled to an elevation typically 1.5 m below the dam crest. Tailings in Cell 7 are between 6 and 7 m below the dam crest.

1.3.2.2 Dimensions of North Tailings Storage Facility Spillways

Dimensions of the spillway from Cell 7 have been determined based on the 2018 LiDAR data and observations made during site inspections. The spillway, built on the west side of Cell 7, is a trapezoidal outlet armoured with riprap, with a base width of approximately 2 m, a depth of approximately 2 m below the dam crest, side slopes of 4H:1V, and an invert elevation of approximately 797.0 m. There are no construction records for this spillway. There is no constructed channel in the divider dyke between Cells 6 and 7; however, survey data indicate the maximum elevation of the divider dyke (797.0 m) is 0.5 m lower than the minimum elevation of Cell 6 (797.5 m).

1.3.2.3 Storage Capacity of North Tailings Storage Facility Dam

The storage capacity of Cells 6 and 7 was calculated in AutoCAD Civil3D as part of the 2018 annual DSI (Golder 2019b) using topography from the July 2018 LiDAR survey. Storage was assumed to be available from the tailings surface elevation to the minimum elevation of the divider dyke and the Cell 7 spillway invert elevation (both at 797.0 m).

From the 2018 CPT investigation (Golder 2019a), it was estimated that the North TSF currently stores approximately 384,000 m^3 of tailings.

Calculated storage and tailings volumes, and the destination of overflow discharge, are presented in Table 4.

Table 4: North Tailings Storage Facility Cell Storage Capacities Based on 2018 LiDAR Survey

Cell	Storage Volume (m^3)	Storage to Elevation[(a)]	Overflow Discharged To	Estimated Volume of Tailings Stored (m^3)[(b)]
6	22,500	797.0	Cell 7	271,000
7	162,100	797.0	area downstream (south) of Cell 7 (via spillway)	113,000
Total	**184,600**	n/a	n/a	**384,000**

(a) Elevation in CGVD2013 vertical datum.

(b) Golder (2019a).

n/a = not applicable.

1.3.3 Subsurface Conditions

The foundation conditions for Cells 4, 5, 6, and 7 are reported to be sandy gravel alluvial deposits typical of river valleys in central BC (Binnie 1971, 1973, 1980a, 1988). The Phase 1 geotechnical site investigation in 2020 (Golder 2020b) encountered fine to coarse sandy gravel to gravelly sand with some silt foundation materials. In the South TSF 0.5 to 0.6 m thick layers of organic materials, including fine to coarse sandy peat or silty sand, darkly coloured and with wood fragments, were encountered in three boreholes below dam fill at approximately the same elevation, indicating legacy topsoil. Organic materials were not encountered in boreholes drilled in the North TSF dam.

Pore pressure readings from the 2018 CPT investigation (Golder 2019a) indicated low pore-water pressure within the inferred foundations, which may be indicative of vertical drainage occurring from the tailings to the foundation materials.

Test pits completed at the toe of the Cell 3 embankment in 2020 encountered tailings downstream of the embankment) and the Cell 3 embankment is likely constructed over tailings.

Soil units under the sand and gravel were not described in the design documents. CPT soundings in 2018 and boreholes in 2020 were terminated prior to reaching these strata. Bedrock outcrops are present west of Cell 7.

Laboratory index testing was completed on 58 samples recovered during the Phase 1 geotechnical site investigation. Strength testing was also completed on a sample of original ground from the northwest toe of Cell 5 (Golder 2016b). Groundwater levels are measured by:

- Six vibrating wire piezometers installed within foundation materials as part of the Phase 1 geotechnical investigation (Section 4.3.2).
  - four in the South TSF area and two in North TSF area
- Three water level dataloggers in monitoring wells installed by Wood in 2018 (Wood 2019) in the South TSF area and monitored by Golder in 2020 (Golder 2020c).

Data indicates:

- South TSF Area: Ground water table varies between approximately 775.5 and 777.5 m with the lowest elevations being recorded adjacent to the WKR at the south end of the site.
- North TSF Area: Ground water table varies between approximately 780.0 to 782.7 with the lowest elevations being recorded at the south end of the facility.

Data indicates groundwater levels vary throughout the year with the highest levels observed in spring freshet and the lowest levels observed in summer, similar to WKR levels.

1.3.4 Embankment Fill Materials

Based on the design documents, construction of Cells 5, 6, and 7 consisted of excavation of the centre of the cell area to source material for construction of the dams.

Dam fill and foundation materials recovered from boreholes during the 2020 Phase 1 geotechnical site investigation were found to be similar (fine to coarse sandy gravel to gravelly sand with some silt). This supports the theory that local borrowed foundation materials were used as dam fill for construction. Laboratory gradation test results were also similar with the largest variation being a 3.5% higher fines content in the dam fill, when compared to foundation materials. The dam fill and foundation were generally poorly graded, and gravels were subrounded to subangular. The specific gravity of solids measured in the laboratory was about 2.67 for both dam fill and foundation samples. The average water content from laboratory testing of the foundation material was approximately double that of dam fill. Large Penetration Testing (LPT) results were also similar for dam fill and foundation, which indicates similar densities.

Cells 4 and 5 have a waste rock or alluvial cobble protective layer on the downstream face (Binnie 1971, 1973). Based on the design drawings, this layer is approximately 1.8 m (6 ft) at the crest and 3.0 m (10 ft) at the base of the embankment (Binnie 1971, 1973).

Cells 1 and 2 appear to have been originally constructed without embankments. At some unknown time, waste rock spoil was placed to the south of Cell 1, and tailings appear to have been subsequently deposited using the waste rock spoil as an embankment.

1.4 Background Information and History

The Beaverdell Mine was an underground mine development. The main ore extracted was silver, with appreciable quantities of lead, zinc, gold, and cadmium. Records (BCGS 2018) indicate that mining commenced in the Beaverdell area in the late 1800s and milling ceased in 1991. Ore production records are available from 1913 to 1991 and indicate approximately 1.2 million tonnes of ore were mined and milled. Based on an estimated volume of tailings of 930,000 m^3, 2018 CPT investigation (Golder 2019a), the estimated average dry density of deposited tailings is 1.3 t/m^3.

A summary of the early history of the facilities, paraphrased from Verzosa and Goetting (1972), is provided in the paragraph below.

Available records indicated ongoing exploration activities in the Beaverdell area as early as 1898 by various companies, each exploring individual veins or vein systems. The first shipment of ore from the development was directed to the Hall Mines smelter at Nelson, BC, in 1900. In 1936, the Bell and the Highland Lass mines merged to form Highland Bell Limited, which soon added the Beaverdell mines to its holdings. Leith Gold Mines Limited acquired a controlling interest in Highland Bell Limited and the Sally mine property in 1946. This company continued shipping ore to the smelter at Trail, BC, and undertook an exploration and development program that led to new ore discoveries and the decision to build a mill at Beaverdell. The mill was operational in September 1950, with an initial capacity of 50 tons [45.4 tonnes] per day that was later increased to 85 tons [77.1 tonnes] per day in 1964 and 110 tons [99.8 tonnes] per day in 1967. The mill was located to the west of the community of Beaverdell, across the WKR.

The Beaverdell Mine was acquired by Teck Corporation Limited in 1971 and continued production until 1991, when the mining development was permanently closed (Teck 2012). The Beaverdell Mine is now a closed facility under active care and maintenance, with no current or planned mining activities. The primary remaining facilities include the TSFs west of Beaverdell and waste rock dumps and mine openings on Mount Wallace to the east of Beaverdell.

1.4.1 Site Investigations and Data

Known site investigations / data on ground conditions include:

- gradation testing on samples collected from existing dam fill at Cell 4 – Binnie (1971)
- gradation testing on samples collected from surface of natural soils at Cell 6 – Binnie (1980a)
- gradation testing on samples collected from test pits in natural soils at Cell 7 – Binnie (1988)
- 38 CPT of tailings in South and North TSF – Golder (2019a)
- 9 groundwater monitoring wells located outside of the North and South TSFs – (Wood 2019)
- Phase 1 Geotechnical Site Investigation of South and North TSF – Golder (2020b)
  - further details are provided in Section 2.6
- completion of a test pitting program, including 12 test pits in South TSF cells, 3 in North TSF cells, 8 in the former mill area, 1 downstream of Cell 3 and 6 downstream of Cell 5 in August 2020 (reporting in progress by others)

1.4.2 Original Design Dimensions

1.4.2.1 South Tailings Storage Facility Dam

A summary of the original design and references for the South TSF dam are shown in Table 5. Original design / assumed cross-sections are provided in Appendix D. There are no design reports for Cells 1 to 3, so the original design dimensions of these cells are unknown. Dimensions of Cell 4 are based on observations and discussions with mine staff, as presented in Binnie (1971, 1973).

Table 5: Original Design Dam Geometry for Cells in the South Tailings Storage Facility

Cell	Downstream Slopes	Upstream Slopes	Crest Width (m)	Embankment Height (m)	References	Figure
Cell 1	no known design					
Cell 2						
Cell 3						
Cell 4[(a)]	2H:1V	1.5H:1V (if drawn to scale)	3.2 to 5.1	3.8 to 4.6	Binnie 1971, 1973	Figure D-1
Cell 5	2H:1V	1.5H:1V	5.1	7	Binnie 1973, 1980c	Figure D-2

(a) Geometry based on observations and discussions with mine management (Binnie 1971, 1973).

1.4.2.2 North Tailings Storage Facility Dam

A summary of the original design and references for the North TSF dam are shown in Table 6. Original design cross-sections are provided in Appendix D.

Table 6: Original Design Dam Geometry for Cells in the North Tailings Storage Facility

Cell	Downstream Slopes	Upstream Slopes	Crest Width (m)	Embankment Height (m)	References	Figure
Cell 6	2H:1V	1.5H:1V	4	9.5	Binnie 1980a	Figure D-3
Cell 7	2H:1V	1.5H:1V	4	8	Binnie 1988	Figure D-4

1.4.3 Construction Summary

Initial construction of the South TSF was, presumably, concurrent with the opening of the Beaverdell mill in the 1950s. At the time, the site was owned by Highland Bell Limited and Leith Gold Mines Limited.

The South TSF (Cells 3, 4 and 5) and North TSF (Cell 6 and 7) dams are understood to have been constructed as earthfill dams using the downstream construction method.

1.4.3.1 South Tailings Storage Facility

No construction records are available for Cells 1 to 5.

Binnie (1971) indicates that Cell 4 experienced tailings migration through the dam section during the winter of 1970/1971. In response to this event, coarse rock was placed on the downstream slope of a section of the Cell 4 dam and operations were changed to spigot deposition to deposit coarse tailings against the upstream slope and push the slimes toward the centre of the facility (Binnie 1971). The tailings against the upstream face were found to contain less fines than the unsegregated tailings, which confirmed a wedge of coarse tailings was being successfully developed to act as a filter. The remedial measures directed in Binnie (1971) were determined to have been successful (Binnie 1973).

Cell 5 was constructed after Teck Corporation Limited obtained the property and was designed by Binnie (1973). Construction of Cell 5 consisted of excavation of the centre of the cell area to source material for construction of the dam.

Available design reports indicate that the design for Cell 5 required that operations create a wedge of coarse tailings against the upstream slope of the TSF dams to act as a filter for the slimes. Samples of the tailings were taken to confirm the coarse tailings wedge (beach) was being created, and spigot methods were observed (Binnie 1980a). Results of the 2018 CPT investigation (Golder 2019a) also indicated coarser material near the upstream face of the Cell 4 and 5 dam.

1.4.3.2 North Tailings Storage Facility

Cells 6 and 7 of the North TSF were constructed after Teck Corporation Limited obtained the property and were designed by Binnie (1980a,b, 1988). Construction of Cells 6 and 7 consisted of excavation of the centre of the cell area to source material for construction of the dam.

Design reports for Cells 6 and 7 specified that operations create a wedge of coarse tailings against the upstream slope of the TSF dam to act as a filter for the slimes. Samples of the tailings were taken to confirm the coarse tailings wedge (beach) was being created and spigot methods were observed (Binnie 1983, 1988). Results of the 2018 CPT investigation (Golder 2019a) also indicated coarser material near the upstream face of the North TSF dam.

Cell 7 of the North TSF is only partially filled with tailings.

1.4.3.3 Historic Piezometers

Installation details of historical piezometers are unknown, and the condition and usefulness of the piezometers are uncertain. As a result, historical piezometers at Beaverdell are considered non-functional.

During the 2020 Phase 1 geotechnical site investigation (Golder 2020b) 12 VWPs were installed, further details are provided in Section 4.3.2.

2.0 ACTIVITIES DURING 2019/2020 REPORTING PERIOD

2.1 Tailings Deposition and Storage

The Beaverdell Mine was not operational in 2020 and no new tailings or waste was deposited in either the North or South TSF.

The approximate volume of tailings stored in the South TSF is presented in Table 2. The approximate volume of tailings stored in the North TSF is presented in Table 4.

2.2 Inspections

The annual inspection by the EoR was conducted 21 July 2020 and was accompanied by Teck personnel.

The dams are also inspected twice per year (during spring freshet and in the fall) by Teck personnel. The fall 2019 (24 September 2019) routine inspection was completed by Gerry Murdoch and George Oulton, both representing Teck. The spring 2020 (12 April 2020) routine inspection was completed by Fernando Zarate, a seconded contractor of Teck.

2.3 Water Quality Testing

Water quality sampling in the WKR (upstream and downstream of the TSF) and groundwater sampling in seven groundwater monitoring wells surrounding the TSF was completed pursuant to provincial effluent Permit PE-444, *Environmental Management Act*. Four quarterly surface water WKR sampling events were completed by Golder in the 2019/2020 reporting period.

Two groundwater sampling events were completed during the 2019/2020 reporting period, by Wood in 2019 and Golder in 2020.

Surface water quality data are uploaded to the provincial environmental monitoring system, and quarterly reports summarizing surface and groundwater sampling results are sent to the BC Ministry of Environment and Climate Change Strategy (ENV) by Teck following each sampling event. The 2019 Annual Effluent Report was submitted by Teck to ENV in March 2020. The 2020 Annual Effluent Report will be submitted to ENV by Teck in March 2021.

2.4 Installation of West Kettle River Erosion Protection – South TSF

To address recommendation 2018-03 (Golder 2019b, updated Golder 2020a) construction of WKR erosion protection commenced on 20 November 2019. Work was suspended on 21 December due to winter conditions and restrictions of the *Fisheries Act* Authorization with respect to completion date (31 December 2019) and total footprint of works.

At the time of the shutdown approximately 145 m (56%) of the works had been installed (extent of installed works shown in Figure 3) with a plan to restart works in spring 2020, if possible, based on the expected timing of receipt of the *Fisheries Act* Authorization amendment. However, following a review of spring 2020 river flows and the requirement for in-river work, the risk to worker health and safety was considered too high due to working temperatures, and the potential for ice and river flow rate variability to be significantly above those expected during low flow (i.e., late summer, early autumn). It was therefore agreed that the remaining work would be deferred to fall 2020, pending *Fisheries Act* Authorization, during the low flow period and to coincide with the fisheries least risk timing window for the WKR (Ministry of Forests, Lands, Natural Resource Operations and Rural Development, 2018), to improve health and safety for workers and minimize impact on aquatic habitat/populations.

Work associated with *Fisheries Act* Authorization was ongoing throughout the 2019/2020 reporting period and Department of Fisheries and Oceans Canada notified Teck that the FAA amendment was approved 29 October 2020. The completion of WKR erosion protection works was completed in November 2020, outside of the 2019/2020 reporting period and will be reported in next years annual facility inspection report.

2.5 Stockpiling of Riprap

Following the cessation of WKR erosion protection works along the toe of Cell 4/5 (Section 2.4) additional riprap material was stockpiled between January and April 2020, in accordance with the requirements of the draft flood response protocol and TARP, at the locations shown in Figure 3. Riprap material was not required as an emergency protection measure during the 2020 freshet.

2.6 Phase 1 Geotechnical Site Investigation

The Phase 1 geotechnical site investigation was completed in March 2020 and included:

- a focus on issues related to TSF dam safety
- collection of geotechnical data on dam construction (fill) and foundation materials
- index testing of recovered materials
- installation of vibrating wire piezometers (VWPs) and remote monitoring system to record piezometric levels within the dam fill and dam foundation

Completed works included:

- 5 test pits at the toe of the Cell 3 embankment
- 8 boreholes
- installation of 12 vibrating wire piezometers including connection to a remote monitoring system
- LPT testing in 6 boreholes
- geotechnical laboratory testing on select samples of dam fill, tailings and foundation materials

Factual reporting of the Phase 1 geotechnical investigation is presented in Golder (2020b) and the following recommended actions from the 2019 dam safety inspection (Golder 2020b) are considered closed (Section 6.5):

- 2016-03 Install piezometers to confirm and monitor facility phreatic conditions
- 2019-03 Investigate the toe area downstream of Cell 3 embankment for the presence of tailings
- 2016-05a Complete the Phase 1 site investigation to collect data to inform development of an updated closure plan and collect tailings samples for initial geochemical testing
- 2017-02a Complete the Phase 1 site investigation to inform the development of a dam breach an inundation study / failure runout assessment

2.7 Installation of Staff Gauge

A staff gauge was installed on the east (town side) of the Beaverdell Station Road bridge (Photograph 33, Appendix B) on 29 May 2020 to allow visual assessment of conditions in the WKR by site personnel prior to crossing the river. In addition to the graduated measurements on the staff gauge, colour-coded tape was installed corresponding to the levels identified in the draft flood response protocol and TARP.

2.8 Baseline Hydrology Study

A baseline hydrological study for the Beaverdell site was developed in 2020 and finalized outside of the reporting period in March 2021 (Golder 2021). The baseline hydrological study summarizes existing climactic and hydrologic conditions and provides the basis for assessing potential impacts to surface hydrology and water flows for key infrastructure (e.g., TSFs). In addition, the report provides inputs for use in water balances, water quality modelling, sizing of hydraulic structures, and other works as required.

3.0 CLIMATE DATA AND WATER BALANCE

3.1 Review and Summary of Climate Data

The climate characteristics at the Beaverdell TSFs were reviewed for the reporting period (1 September 2019 to 31 August 2020, inclusive) with respect to total precipitation, the main contributor to the site water balance. There were no climate data available for the Beaverdell local area for the reporting period. Data from nearby active regional climate stations were analyzed for their relationship to concurrent historical data at the Beaverdell and Beaverdell North stations, which have been determined to be most representative of climate at the TSFs (Golder 2021). The stations considered are listed in Table 7, all of which are operated by Environment and Climate Change Canada (ECCC).

Table 7: Historical and Active Climate Station Data

Location	Period of Record	ECCC Station Number	Latitude; Longitude	Elevation[c] (m)	Distance to TSFs (km)
Beaverdell	1962 to 2004	1130770	49°25'; 119°06'	780	2
Beaverdell North	1975 to 2006	1130771	49°28'; 119°02'	838	6
Penticton A[a]	1944 to 2020	1126146	49°27'; 119°36'	344	37
Kelowna[b]	1968 to 2020	1123939	49°57'; 119°22'	430	62
Billings	1984 to 2020	1140876	49°01'; 118°13'	519	90

(a) Penticton A station changed World Meteorological Organization climate identifier from 1126150 to 1126146 on 10 May 2012.

(b) Kelowna data includes Kelowna A station from 1968 to 20 January 2005 (inclusive), Kelowna AWOS station from 2005 to 2 September 2009 and Kelowna station from 2009 to 2020. All three stations refer to the same climate station at Kelowna International Airport (YWL). Missing data are infilled with Kelowna UBCO station from 16 December 2013 to 31 August 2020.

(c) CGVD2013 vertical datum to nearest 1 m.

ECCC = Environment and Climate Change Canada; TSFs = tailings storage facilities; CGVD = Canadian Geodetic Vertical Datum.

The Beaverdell precipitation time series was compared to the nearby regional station data (Table 7) during concurrent time periods. The precipitation data were compared on a magnitude ranked basis. With the exception of data from the Beaverdell North station (which is approximately equivalent to the Beaverdell station data), the Kelowna station data were found to have the strongest correlation with the Beaverdell data and the most complete data set. A composite data set was created using the Beaverdell station, where data were available, and infilling with Beaverdell North where possible. Any missing days within this combined data set were infilled with location-adjusted (using a factor of 1.206) data from the Kelowna station. Furthermore, the location-adjusted precipitation data from Kelowna station were used to extend the combined Beaverdell data from 2004 to 2020. The resulting composite data set spans a period from 1962 to 2020 (Golder 2021).

The monthly total precipitation at Beaverdell during the 2019/2020 hydrologic year was estimated using the location-adjusted Kelowna precipitation data for the same period. Three days were not available from the Kelowna data set, although no notable gaps were observed. These data were infilled with data from the Kelowna UBCO (ID 1123996) station.

A comparison of the long-term average, maximum, and minimum total precipitation for each of the data sets (combined Beaverdell data set, location-adjusted Kelowna data set, and the Beaverdell Composite data set) are presented in Table 8 based on a hydrologic year (1 September to 31 August). Data indicates that the use of the Beaverdell composite data set represents a reasonable approach considering the lack of local climate data.

Table 8: Long-Term Annual Average, Minimum, and Maximum Total Precipitation for Considered Data Sets

Data Set	Minimum Annual Total Precipitation (mm)	Average Annual Total Precipitation (mm)	Maximum Annual Total Precipitation (mm)
Beaverdell Combined (1962-2004)	209	480	600
Kelowna Location-Adjusted (1969-2020)[a]	196	415	619
Beaverdell Composite (1962-2020)[b]	201	439	600

(a) Kelowna data was multiplied by a factor of 1.206.

(b) The 2004/2005 hydrologic year was excluded due to a large amount of missing data.

The estimated monthly and annual total precipitation at Beaverdell during the 2019/2020 hydrologic year as well as the long-term Beaverdell composite data set are shown in Table 9 and Chart 1.

Table 9: Comparison of Estimated Beaverdell (September 2019 to August 2020) and Long-Term Average Monthly and Annual Total Precipitation

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
2019/2020 scaled monthly total precipitation (mm)	49	29	30	59	29	11	13	11	98	69	26	14	437
1962-2020 composite average monthly total precipitation[a] (mm)	31	31	37	51	43	26	29	30	48	49	33	33	439
Percent Difference	56%	-6%	-20%	16%	-33%	-56%	-54%	-63%	105%	39%	-21%	-58%	-1%

Note: Values rounded for presentation purposes. This results in the total annual precipitation are not equal to the sum of the monthly values.

(a) The 2004/2005 hydrologic year was excluded due to a large amount of missing data.

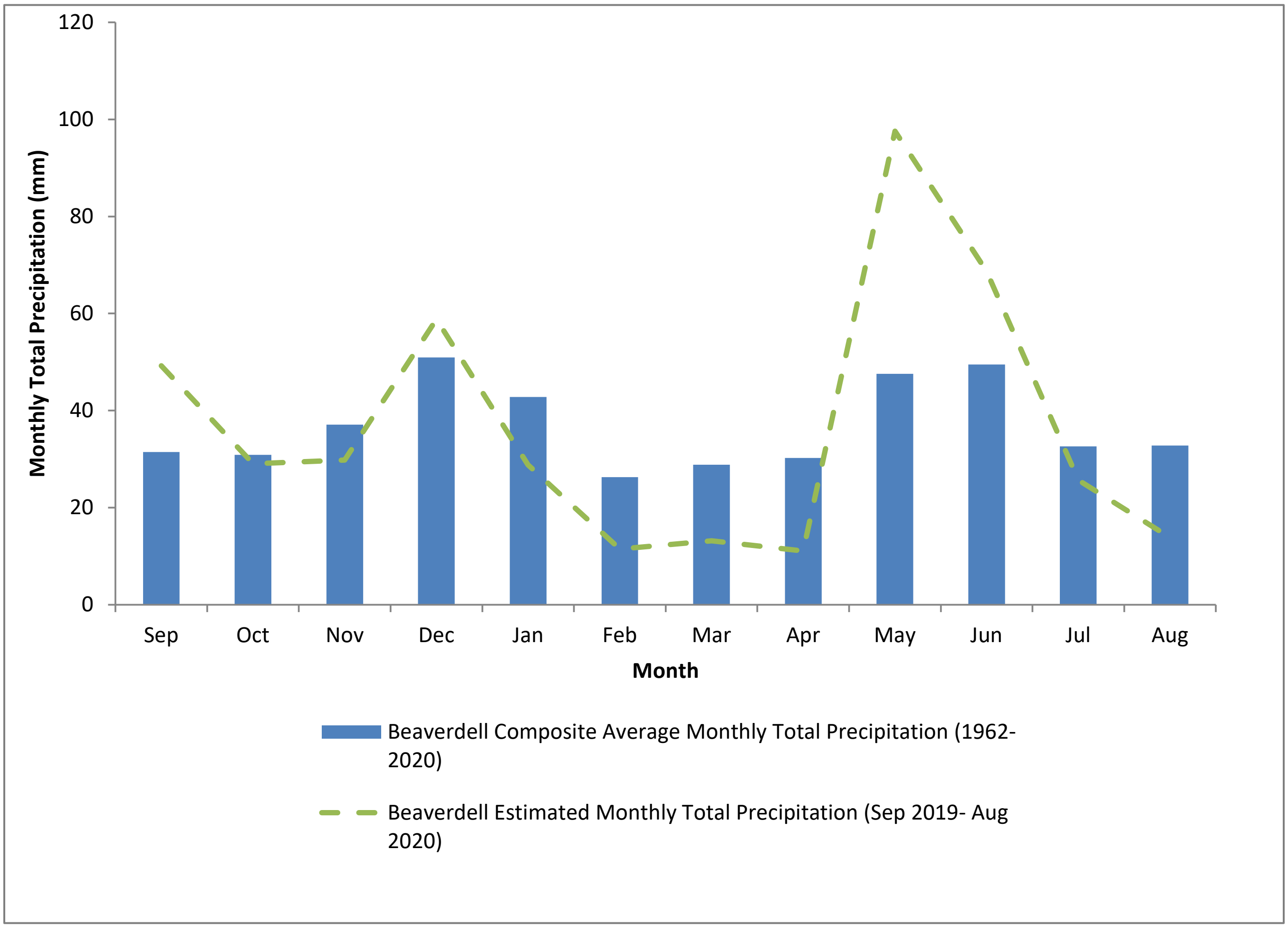

Chart 1: Average Monthly Precipitation Comparison of 2019/2020 Hydrologic Year and Long-Term Composite Data at Beaverdell TSF

Conclusions regarding precipitation at Beaverdell are:

- The estimated total precipitation in 2019/2020 was roughly equal to the average long-term total annual precipitation as shown in Table 9.
- The estimated distribution in 2019/2020 was generally more extreme than the long-term data set.
  - Estimated total precipitation at Beaverdell from January to April 2020 (inclusive), was approximately 50% less than the long-term average for the same time period.
  - Estimated total precipitation at Beaverdell in May and June 2020 (inclusive), was approximately 71% higher than the long-term average for the same period.

A baseline hydrology report, to establish baseline hydrologic conditions at the Beaverdell TSF, was developed in 2020/2021.

3.2 Review and Summary of Water Balance

The water balances for the South TSF and North TSF were based on the catchment areas summarized in Table 10. The total watershed of the South TSF area is limited by the South TSF dam and a diversion channel along Beaverdell Station Road which diverts runoff from Cranberry Ridge away from the TSF. The total watershed of the North TSF is limited to the areas of Cells 6 and 7. A diversion ditch to the west of the North TSF, including the spillway, diverts runoff from Cranberry Ridge away from the North TSF during normal climate conditions (as described in Section 1.3.2). For the purpose of the annual water balance, it is assumed that the facility did not experience an extreme flood event capable of overtopping Reach 1 of the North TSF diversion and runoff from the Cranberry Ridge catchment area did not enter the North TSF.

Table 10: North and South Tailings Storage Facility Catchment Areas

TSF	Cell	Cell Drainage Area[(a)] (km^2)	TSF Catchment Area (km^2)
South TSF	1	0.029	0.188
	2	0.020	
	3	0.086	
	4	0.027	
	5	0.026	
North TSF	6	0.031	0.081
	7	0.050	

Source: Golder 2017a.

(a) Areas downstream of diversion channels, assumes no runoff from Cranberry Ridge enters TSFs.

The water balance inflows are limited to surface water from total precipitation, as determined in Section 3.1. The annual evaporation at the site is estimated to be between 600 and 700 mm/year (Golder 2017a, 2021), which is higher than the long-term (1962-2020) average total precipitation (439 mm, Table 8, Section 3.1); hence the site has an overall water deficit. It is assumed that all inflows to the TSF are removed from the TSF and that there is no long-term accumulation of water in the cells. Only seasonal, temporary ponding is observed at the Beaverdell TSFs (refer to 3.3). Inflow volumes were calculated by multiplying the total annual precipitation for the reporting period (437 mm, Section 3.1) by the catchment areas, without accounting for losses (i.e., evaporation, transpiration, infiltration, sublimation, and seepage through dam). Predicted inflows were:

- 82,300 m^3 for the South TSF area
- 35,500 m^3 for the North TSF area

No surface discharge of water from the TSFs has been observed. The outflows from the TSFs are therefore assumed to be from the following processes:

- **Evaporation**—Loss of water to the atmosphere occurs from temporary water ponding and from surficial soil (wetting and drying sequence).
- **Transpiration**—A vegetation cover is partially present on the tailings surface and on the slopes of the dams. This cover traps water that is then released to the atmosphere in the form of transpiration.

- **Infiltration to ground**—Surface water drains through the tailings deposits and infiltrates the underlying ground.
- **Sublimation**—A fraction of the snow cover on the TSFs during the winter is lost to the atmosphere through sublimation (the transition from solid to water vapour).
- **Seepage**—Seepage occurs through the dam or dam foundation.

The distribution of inflows to outflows was not assessed. An update of the site water management plan (Recommendation 2018-04) based on the baseline hydrology report (Section 2.8) was in progress at the time of this report.

3.3 Freeboard and Storage

Freeboard is not measured directly at the Beaverdell TSFs as the tailings surface is generally dry. Temporary water ponding locations are recorded during regular inspections through estimating the distance from the upstream crest of the dam to any ponding, if observed.

A TARP and related quantifiable performance objectives (QPOs) for surface water conditions at the Beaverdell TSFs were developed and are summarized in Table 11.

Table 11: Trigger Action Response Plan for Surface Water Conditions for Beaverdell Tailings Storage Facilities

Item	Threshold Criteria		
	Acceptable	**Warning**	**Alarm**
QPO of ponding within the cell	Small central pond, edge of pond is located more than 10 m from upstream crest.	Edge of pond is less than 10 m but greater than 2 m from upstream crest.	Edge of pond is within 2 m of upstream crest or discharging through Cell 3 or Cell 7 spillways.
Action required	■ Document during biannual (twice per year) inspections. ■ This is normal operations.	■ Increase frequency of inspections to weekly until conditions meet acceptable criterion. ■ Document weekly inspections.	■ Increase frequency of inspections to daily until conditions meet warning criterion. ■ Sample downstream water quality. ■ Document daily inspections.
Personnel notified	■ Record and file with inspection reports. ■ EoR receives a copy of the inspections annually.	■ Jason McBain (TSF Qualified Person) ■ Kathleen Willman (Mine Manager) ■ EoR	■ British Columbia Ministry of Energy, Mines and Low Carbon Initiatives ■ Ministry of Environment and Climate Change Strategy ■ Jason McBain (TSF Qualified Person) ■ Kathleen Willman (Mine Manager) ■ Teck's Tailings Working Group ■ EoR ■ Communities of Interest

Source: Adapted from Teck 2018a.

Notes: The upstream crest is defined as the location where the tailings beach intersects the upstream face/toe of the dam or crest.

EoR = Engineer of Record; QPO = quantifiable performance objective; TSF = tailings storage facility.

Ponding conditions, as noted from inspections and observations during the 2019/2020 reporting period, are summarized in Table 12.

Table 12: Summary of Ponding Observations in Tailings Storage Facilities

Facility	Cell	24 September 219	12 April 2020	21 July 2020
South TSF	1	no pond	no pond	no pond
	2	no pond	no pond	no pond
	3	no pond	15 m from crest	no pond
	4	no pond	20+ m from crest	no pond
	5	no pond	no pond	no pond
North TSF	6	no pond	20+ m from crest	no pond
	7	no pond	no pond	no pond

TSF = tailings storage facility.

3.4 Water Discharge Volumes

There are no records of water discharge volumes for the facilities. No water was observed to be discharging from the North TSF or South TSF spillways at the time of the site inspections. Losses in the water balance are assumed to occur through processes listed in Section 3.2.

3.5 Water Quality

Water quality testing results are submitted to the ENV in accordance with Effluent Permit No. PE-444 (MOE 1990).

4.0 SITE OBSERVATIONS

4.1 Visual Observations and Photographs

A site inspection was carried out on 21 July 2020 by John Cunning, P.Eng., and Natasha Carrière, E.I.T., of Golder, accompanied by the TSF Qualified Person, Jason McBain, of Teck and Jeff Basarich, a Teck contractor.

The air temperature during the visit was approximately 32°C, and the weather was sunny.

Appendix B presents a summary of photographs from the site inspection and a summary of observations for each TSF are included in the inspection reports presented in Appendix C.

4.2 Water Levels in West Kettle River

As a response to high water flows in the WKR in spring 2017 and 2018, a draft flood response protocol and TARP were developed in March 2019 and included monitoring of developing conditions in the WKR and snowpack data at local stations. Prior to finalization of the protocol Teck developed a flood response procedure (Teck 2020), based on the draft protocol, which was implemented during the 2020 freshet. Based on flows measured at hydrometric stations at Westbridge (downstream of Beaverdell) and McCulloch (upstream of Beaverdell) there were no observed flooding events in the 2020 freshet period (1 April to 30 June 2020). The maximum flow during the 2020 freshet at Westbridge was 163 m^3/s, on 18 May 2020, which was below a 1-in-5-year return period event.

4.3 Instrument Review

4.3.1 Visual Assessment of Surface Water Ponding

QPOs have been established for ponding in the cells, as described in Section 3.3.

- No ponded water was observed in any cells during the 24 September 2019 routine inspection.
- Limited ponded water was observed in Cells 3,4 and 6 during the 12 April 2020 routine inspection.
  - ponds were within the acceptable range of the site QPOs
- No ponded water was observed in any cells during the 21 July 2020 annual inspection.

4.3.2 Vibrating Wire Piezometers

Twelve VWPs, at six locations, were installed as part of the Phase 1 geotechnical site investigation as shown in Table 13.

Table 13: Summary of Vibrating Wire Piezometer Installations

Borehole ID	Teck Instrumentation ID	Serial Number	Sensor Depth (m)	Sensor Elevation[a] (m)	Monitored Unit
BH20-01	BEA-VWP-2020-01A	VW65308	6.62	778.50	Tailings
	BEA-VWP-2020-01B	VW65315	10.25	774.87	Foundation
BH20-02	BEA-VWP-2020-02A	VW65307	6.16	778.42	Tailings
	BEA-VWP-2020-02B	VW65316	10.00	774.58	Foundation
BH20-03	BEA-VWP-2020-03A	VW65305	6.64	779.43	Dam fill
	BEA-VWP-2020-03B	VW65317	10.13	775.94	Foundation
BH20-04	BEA-VWP-2020-04A	VW65306	7.23	778.13	Dam Fill
	BEA-VWP-2020-04B	VW65318	9.89	775.47	Foundation
BH20-06	BEA-VWP-2020-06A	VW65310	9.36	788.92	Dam fill
	BEA-VWP-2020-06B	VW65314	19.90	778.38	Foundation
BH20-07	BEA-VWP-2020-07A	VW65311	6.32	791.82	Dam fill
	BEA-VWP-2020-07B	VW65312	16.61	781.53	Foundation

(a) Vertical datum: CVGD2013.

VWPs are connected to a remote monitoring system installed by NavStar Geomatics Ltd. (NavStar). During installation, the VWPs were connected to 8-channel VWP interfaces by cable. The interfaces act as dataloggers and collect data from the VWPs on a pre-determined frequency, then transmit data wirelessly to a Cellular Gateway. A total of six interfaces were installed. The Gateway (FLP100) uses a cellular uplink to transmit data from the site to a remote PC with GeoExplorer software (NavStar 2019). Two repeater stations were also installed in October 2020 to improve data acquisition from installed VWPs.

Available VWP data are presented in Appendix E, values of negative pressure head (corresponding to piezometric levels below the instrument tip) are not plotted. Data in Appendix E does not include atmospheric correction in the calculation of the recorded instruments, however as instruments are installed in grouted boreholes at depth, variation due to barometric pressure is expected to be negligible.

Interpretation and establishment of instrument baselines was in progress at the time of this report and no QPOs have been set. Interpretation of VWP data, used in the assessment of dam safety, is presented in Section 5.0.

4.4 Site Inspection Forms

A summary of observations from the 21 July 2020 inspection is presented for each TSF in Appendix C.

4.5 Facility Data Sheet

A TSF data sheet for the North and South TSFs is presented in Appendix A.

5.0 DAM SAFETY ASSESSMENT

5.1 Dam Classification Review

Guidelines for the classification of dams are presented in the HSRC Guidance Document, Section 3.4 (Ministry of Energy and Mines 2016), which references the Canadian Dam Association (CDA 2013) *Dam Safety Guidelines*. Table 14 presents the dam classification criteria. Dam consequence classification is based on incremental losses that a hypothetical failure of the dam may inflict on downstream or upstream areas, or at the dam location itself irrespective of the potential for such an event to occur. Incremental losses are those over and above losses that might have occurred in the same natural event or condition had the dam not failed. The consequences of a hypothetical dam failure are ranked as Low, Significant, High, Very High, or Extreme for each of four loss categories. The classification assigned to a dam is the highest rank determined among the four loss categories. A hypothetical failure runout assessment has not yet been completed for the Beaverdell TSFs (Recommendation 2017-02).

Table 14: Dam Classification in Terms of Consequences of Failure

Dam Class	Population at Risk	Incremental Losses		
		Loss of Life	Environmental and Cultural Values	Infrastructure and Economics
Low	None.	0	Minimal short term loss. No long term loss.	Low economic losses; area contains limited infrastructure or service.
Significant	Temporary only (e.g., seasonal cottage use, passing through on transportation routes, participating in recreation activities).	The appropriate level of safety required depends on the number of people, the exposure time, the nature of their activities, and other considerations.	No significant loss or deterioration of fish or wildlife habitat. Loss of marginal habitat only. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes.
High	Permanent– ordinarily located in the dam-breach inundation zone (e.g., as permanent residents).	10 or fewer	Significant loss or deterioration of important fish or wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transport, and commercial facilities.
Very High	Permanent– ordinarily located in the dam-breach inundation zone (e.g., as permanent residents).	100 or fewer	Significant loss or deterioration of critical fish or wildlife habitat. Restoration or compensation in kind possible but impractical.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).
Extreme	Permanent– ordinarily located in the dam-breach inundation zone (e.g., as permanent residents).	More than 100	Major loss of critical fish or wildlife habitat. Restoration or compensation in kind impossible.	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances).

Source: HSRC Guidance Document (Ministry of Energy and Mines 2016).

The HSRC Guidance Document (2016) and the CDA (2013) guidelines were used to assign a dam class to the Beaverdell TSF dams based on conditions during the 2019/2020 reporting period (Table 15).

Table 15: Dam Failure Consequence Classification for the South and North Tailings Storage Facilities

Dam	Dam Class	Population at Risk	Consequences of Failure		
			Loss of Life	Environment and Cultural Values	Infrastructure and Economics
South TSF dam	**Significant**	Significant	Low	Low to Significant	Low
North TSF dam	**Significant**	Significant	Low	Low	Low

Note: The class assigned to a dam is the highest rank determined among the four attributes (i.e., population at risk, loss of life, environmental and cultural values, and infrastructure and economics).
TSF = tailings storage facility.

The rationale for assigning the consequence level for each attribute of the South TSF is as follows:

- **Population at risk (Significant consequence)**—No permanent dwellings have been observed near the dam structures. However, recreational facilities (i.e., trails and a baseball field) are located near these structures and may be sporadically used by the residents of Beaverdell. A sporadic human presence qualifies as a temporary population.
- **Loss of life (Low consequence)**—The extent of the area impacted by a dam failure is expected to be small. Loss of life, if any, would be the result of unforeseeable misadventure.
- **Environmental and cultural values (Low to Significant consequence)**—A report by DFO has designated a 2.4 km section of the WKR, including a section of river adjacent to the South TSF as critical habitat, by others, for the Speckled Dace (*Rhinichthys osculus*; DFO 2018), which has the potential to change the consequence classification for incremental environmental and cultural losses. However, the extent of the area impacted and the impacts on Speckled Dace populations by a dam failure are unknown, and further studies are recommended to determine impact (Recommendation 2018-02).
- **Infrastructure and economics (Low consequence)**—Economic losses are expected to be limited to the owner of the South TSF (i.e., Teck).

The rationale for assigning the consequence level for each attribute for the North TSF area is as follows:

- **Population at risk (Significant consequence)**—One permanent dwelling is located approximately 150 m south of a portion of the Cell 7 dam. The limited volume of tailings in the cell is, however, not considered a risk to the dwelling or the residents. A temporary population should be considered as present near the North TSF.
- **Loss of life (Low consequence)**—The extent of the area impacted by a dam failure is expected to be small. Loss of life, if any, would be the result of unforeseeable misadventure.
- **Environmental and cultural values (Low consequence)**—Tailings from the North TSF are not expected to reach the WKR in the event of a failure. As such, no long-term loss or deterioration of valued components is expected. Short-term loss or deterioration of valued components is expected to be negligible.
- **Infrastructure and economics (Low consequence)**—Economic losses are expected to be limited to the owner of the North TSF (i.e., Teck).

Golder recommends a review of the dam consequence classification of both the North and South TSFs based on the changes in downstream conditions noted in this report and described in Golder 2019d (Recommendation 2018-02).

Beaverdell is currently considered to be in closure – active care (CDA 2019). The closure – active care phase is often referred to as “care and maintenance.” It involves the active care of a mining dam including monitoring, inspection, etc. The mine owner will typically have staff monitoring the site regularly, and the dam should achieve a steady state condition during this phase.

5.2 Review of Downstream and Upstream Conditions

No changes to conditions upstream or downstream of the North and South TSF were observed during the 21 July 2020 site visit. No further development of the land south the Teck property boundary was observed during the 21 July 2020 site visit.

5.3 Review of Potential Hazards and Failure Modes, Design Basis, and Dam Performance

A required component of the annual inspection report is a review of the credible potential hazards and the associated failure modes, design basis, and observed dam performance. The assessment of the Beaverdell TSFs was completed based on site observations and data review for each of credible hazards for the dams present at Beaverdell. Credible hazards for the South and North TSFs are described in the following sections.

An annual review of the Beaverdell risk register was completed by Teck and the EoR on 22 July 2020, resulting in only minor edits related to the status and clarification of risks. The risk register was updated, outside of the reporting period, in January 2021, following completion of WKR riprap works.

5.3.1 Internal Erosion (Suffusion and Piping)

Internal instability of a dam can be caused by materials migrating out of the dam, leaving voids. This happens with materials that do not have filter compatibility; that is, the fine-grained fraction of one material can migrate into or through the voids of the adjacent material under a sufficient hydraulic gradient. Piping is induced by regressive erosion of particles towards an outside environment until a continuous pipe is formed. Suffusion is the migration of soil particles through the soil matrix.

Design Basis and Design Assessment

Based on review of available data, as discussed in this report, and the results of the Phase 1 geotechnical site investigation it is understood that the dams were constructed of locally borrowed free-draining sand and gravel materials.

There are no known design or construction records for Cells 1, 2, 3, or 4. As described in Section 1.4.3.1, remedial measures were implemented under the direction of Binnie (1971) in response to observed tailings migration through a section of the Cell 4 dam during the winter of 1970/1971. Coarse rock was placed on the downstream slope of a section of the Cell 4 dam, and operations were changed to spigot deposition to place coarse tailings against the upstream slope and push the finer slimes toward the centre of the facility, creating a wedge of coarse tailings to act as a filter. The design reports for Cells 5, 6 and 7 included a coarse tailings beach adjacent to the sand and gravel dams to act as a filter for the slimes. Filter compatibility between the coarse tailings and the sand and gravel dam section was defined graphically by multiplying the gradation of the coarse tailings by a factor of five (Binnie 1973).

The filter compatibility between the coarse tailings and the sand and gravel material of the dam was reassessed as part of the response to the Ministry of Energy and Mines order dated 3 February 2015 (Golder 2015a).

The reassessment found that the available gradations of sand and gravel understood to be used for the dams are generally filter compatible with the coarse tailings based on Sherard et al. (1984) and Sherard and Dunnigan (1989); however, some gradations were found to not meet the criteria.

The internal stability of the filter was assessed based on the Li-Fannin criteria (Li et al. 2009), an update to the original Kenney-Lau criteria (Kenney and Lau 1985). The available gradations of sand and gravel understood to have been used for the embankments of Cells 4, 5, and 6 generally met the updated Li-Fannin criteria, although two samples from Cell 6 were assessed as being marginal. Three of four samples from Cell 7 did not meet the criteria.

A comparison of particle size distributions from samples used in the Golder (2015a) assessment and samples tested following the Phase 1 geotechnical site investigation indicate:

- 23 of 28 dam fill/foundation samples from the Phase 1 geotechnical investigation were within the limits of samples used in the Golder (2015a) assessment.
  - 5 samples were marginally coarser with up to approximately 70 to 80% gravel content compared to approximately 65% gravel content estimated in the Golder (2015a) assessment.
- 2 of 4 tailings samples recovered from within the TSFs during the Phase 1 geotechnical investigation were within the limits of samples used in the Golder (2015a) assessment.
  - 2 of 4 samples were finer with up to 100% fines content compared to the approximately 45% fines content assumed for tailings used in the Golder (2015a) assessment.

Based on the comparison it is recommend that an update of the filter compatibility assessment and internal stability assessment be completed (Recommendation 2020-03).

Observed Performance

The Beaverdell TSFs have been inactive without the deposition of waste materials or water for 29 years. Small, shallow ponds are occasionally present in Cell 3 and 4 and Cell 6. Minor ponding was observed in Cells 3, 4 and Cell 6, due to snowmelt, during the 12 April 2020 routine inspection. No ponding was observed during the 24 September 2019 routine inspection or the 21 July 2020 annual inspection.

Site visits from 2012 through 2020, including those used for this annual inspection, included a visual inspection of the toe of the North and South TSF dams. The inspection did not identify any seepage at the time of site visits, or any signs such as dampness, wetlands, or eroded zones that would be indicative of uncontrolled past seepage areas. Vegetation, including trees, is apparent on the downstream face and toe of the North and South TSF dams. However, water demand from that vegetation may assist in keeping the water table at a level that minimizes seepage (if any).

Data from 5 of the 6 VWP installed near the base of the tailings or dam fill indicated near zero pressure head between installation in March 2020 and 31 August 2020. This supports data collection in the 2018 CPT program and indicates the lack of a piezometric surface within the dams and as such insufficient hydraulic gradient to initiate internal erosion in these areas. A VWP installed in borehole 3 (BEA-VWP-2020-03A), located at the south side of Cell 5, has reported a small pressure head at the base of the tailings.

The decant pipes in the North TSF were sealed under the supervision of Teck, as noted in the 2013 annual DSI (Golder 2014a). The decant pipe in Cell 5 was sealed in 2016. It is unknown whether the pipes have seepage collars or similar structures to limit water flow adjacent to the pipe. It is possible that seepage flows may occur and thus that piping could develop around the decant pipes.

A supernatant pond historically existed downstream of the southwest corner of Cell 5, where it is understood the decant tower outlet exited the cell during operations (Figure 3) (Binnie 1980c). The decant pipe outlet is not currently visible in the downstream area of Cell 5. During previous inspections, tailings were observed in the area downstream of Cell 5. These tailings could be related to the decant outlet. A sufficient hydraulic gradient is not expected to develop, as evidenced by the limited or non-existent ponds in the TSFs, to pose a dam safety concern. However, the location and alignment of the Cell 5 decant should be determined (Recommendation 2019-01).

No seepage at the Cell 6 or Cell 7 pipe outlets was noted during the July 2020 inspection, although a small quantity of water was observed behind a metal weir, as in previous annual inspections, at the outlet structure of the Cell 6 decant. It is recommended that this outlet structure be decommissioned (Recommendation 2019-04).

No zones of subsidence or sinkholes were observed that would indicate voids due to either suffusion or piping.

The 2018 CPT investigation generally indicated unsaturated conditions with some limited zones of saturation in the tailings deposit. Data interpreted from CPT indicated low pore-water pressures within the inferred foundations, which may be indicative of vertical drainage occurring from the tailings to the foundation materials. Observed saturated zones corresponded with observed ponding areas. Inferred conditions indicate typically insufficient hydraulic gradient to drive a potential piping failure.

The likelihood of a dam failure of the North TSF through internal erosion is considered to be close to non-credible[1]. Due to the lack of tailings beach between areas of potential ponding within Cells 3 and 4 and the embankment, the likelihood of a dam failure of the South TSF through internal erosion is considered to be rare[2].

5.3.2 Overtopping

Design Basis and Design Confirmation

Golder (2017a) presents a water management plan for the Beaverdell TSFs (update in progress at the time of this report), which includes a summary of the site climate, a description of the water management for the TSFs, and a water balance.

The HSRC and the HSRC Guidance Document (Ministry of Energy and Mines 2016) require the following for a Significant consequence class dam:

- an IDF 1/3 between the 1-in-975-year flood event and the PMF
- a facility that stores the IDF, i.e., cannot pass the required IDF, shall use a storm duration of 72-hours

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[1] **Close to non-credible likelihood**—For a natural hazard (earthquake, flood, windstorm, etc.): the predicted return period for an event of this strength / magnitude is greater than 1 in 10,000 years. Also, for failure modes such as instability and internal erosion that are close to non-credible.

[2] **Rare likelihood**—For a natural hazard (earthquake, flood, windstorm, etc.): the predicted return period for an event of this strength / magnitude is 1 in 100 and 1,000 years. Also for failure modes such as instability and internal erosion that are rare.

The detailed design of an upgraded spillway for the South TSF was completed in March 2018 (Golder 2018b) and construction completed in July 2019 (Golder 2019e). The upgraded spillway can convey the 24-hour PMF (which exceeds the IDF requirements of the HSRC 2017) with allowance for freeboard.

A ditch along Cranberry Ridge to the west of the North TSF directs water runoff from the external catchment (Golder 2019c). A section of the diversion cannot convey the IDF and water from a 90,000 m^2 area of external catchment could enter the North TSF (Section 1.3.2). Cell 7 has the storage capacity to store the IDF event. In the event of flood flows larger than the IDF, water could discharge via the Cell 7 spillway south of the TSF.

The minimum freeboard is defined as the minimum vertical distance between the tailings pond level and the crest of the containing structure (CDA 2013). This distance needs to be maintained at all times (including during the IDF) to prevent overtopping of the containing structure by large waves resulting from the sum of wind, wave set-up, and wave run-up.

The North and South TSFs are dry, with occasional, temporary ponding away from the dam crests. As such, a minimum freeboard is not defined. Due to dry conditions, the freeboard is not measured directly; instead, the distance from the pond to the upstream edge of the dam is measured, as described in Section 3.3.

Observed Performance

Minor ponding was observed in Cells 3,4, and 6, due to snowmelt, during the 12 April 2020 routine inspection. No ponding was observed during the 24 September 2019 routine inspection or the 21 July 2020 annual inspection. There is no indication that surface water accumulation has reached the upstream face or crest of the dam.

Vegetation growth was observed in the North TSF spillway and diversion ditch (near Cell 7) which could impede conveyance of storm water and should be cleared (Recommendation 2020-01).

The likelihood of overtopping for the North TSF and South TSF is considered to be close to non-credible to very rare[3].

5.3.3 Instability

Design Basis and Design Confirmation

The HSRC Guidance Document (Ministry of Energy and Mines 2016) recommends a minimum factor of safety of 1.5 under normal (static) operating conditions, and the CDA (2013) recommends a minimum factor of safety of 1.0 under pseudo-static seismic loading conditions. The HSRC Guidance Document recommends a return period for seismic events of:

- 1-in-2,475-year probability of annual exceedance for Significant consequence structures

Seismic information from the seismic hazard maps developed by Natural Resources Canada was used to determine the peak horizontal ground acceleration for use in the stability reassessment. Earthquake ground motions calculated for the Beaverdell site (49.4423 north latitude and 119.0968 west longitude) from Natural Resources Canada (NRC 2015) are presented in Table 16. The 2015 seismic information is the most recent available from Natural Resources Canada.

3 **Very rare likelihood**—For a natural hazard (earthquake, flood, windstorm, etc.): the predicted return period for an event of this strength / magnitude is between 1 in 1,000 and 10,000 years. Also, for failure modes such as instability and internal erosion that are very rare.

Table 16: Peak Ground Acceleration by Return Period for the Beaverdell Site

Exceedance Probability	Return Period	Peak Ground Acceleration
40% in 50 years	100 years	0.0085 g
10% in 50 years	475 years	0.026 g
5% in 50 years	1,000 years	0.040 g
2% in 50 years	2,475 years	0.065 g

Note: Spectral and peak hazard values are determined for soil site Class C.

Return periods are not exact representations of annual exceedance probabilities; rounding per CDA is shown.

The HSRC (Ministry of Energy and Mines 2017) requires a 1-in-2,475-year return period for a seismic event for “Significant” consequence structures.

CDA = Canadian Dam Association; HSRC = Health, Safety and Reclamation Code.

A dam stability reassessment for the North and South TSFs was completed by Golder (2018a) in accordance with the HSRC Guidance Document (Ministry of Energy and Mines 2016), based on both facilities being Significant consequence structures. The 1-in-2,475-year earthquake event was selected (2% probability of exceedance in 50 years) for long-term stability analyses under pseudo-static seismic loading conditions as recommended by the HSRC Guidance Document. The reassessment found that the facilities are stable under static and pseudo-static conditions, and no analyses were required for post-earthquake conditions.

Data from the 2020 site investigation (Golder 2020b) and data from 3 of the 4 VWP installed in dam fill (Section 5.3) indicate the lack of a piezometric surface within the dams.

Ground water levels from the 6 VWP installed in the foundation (Golder 2020b), data from VWP installed by Wood (2019) and from the installation of groundwater wells in 2018 (Section 1.3.3) indicate groundwater levels at similar levels or below those adopted in the 2018 dam stability reassessment (Golder 2018a). The 2018 CPT investigation also indicated that the material within the TSFs is generally unsaturated, with low pore-water pressures within the inferred foundations (Golder 2019a). As such, factors of safety are expected to be similar, based on observed piezometric levels.

The HSRC requires justification for overall downstream dam slopes that are steeper than 2H:1V (Ministry of Energy and Mines 2017). The dam slopes range from 1.2H:1V to 4.0H:1V. Based on the current stability results, the dams are stable under static and pseudo-static conditions (Golder 2018a). Inspections from 2012 through 2020 have indicated that the slopes are performing adequately at a steeper slope angle than 2H:1V.

Observed Performance

The visual inspection during the July 2020 annual inspection site visit did not identify any sign of stresses such as cracks, settling, or bulges on the North and South TSF dams.

The downstream slopes of the South TSF Cell 4 and 5 dams are covered with trees. The trees are generally vertical with diameters of 10 to 15 cm, and conditions generally suggest that there is no apparent movement or creep of the dam slopes. Removal of these trees was completed in winter 2020, closing Recommendation 2019-02.

No significant erosion was noted on the upstream or downstream slopes of either facility. The conditions of the dams have remained unchanged from previous site visits (Golder 2013, 2014a,b, 2016a, 2017b, 2018c, 2019b, 2020a). No seepage was observed during the site visit. Some minor erosion was observed on the downstream slope of Cell 6 (Photograph 23, Appendix B) but is limited by armouring on the downstream face and is not considered to be a dam safety concern. The dam slopes were observed to be stable.

Soft ground was observed at the downstream toe of the Cell 3 embankment, north of the Cell 3 spillway, during the 2019 annual inspection and test pits were completed at this location as part of the 2020 Phase 1 site investigation. Tailings were observed in the foundation downstream of the Cell 3 embankment and the Cell 3 embankment is likely constructed over tailings. It is recommended that additional investigations be completed to further delineate the extent of tailings within dam foundation and downstream of the South TSF (Recommendation 2020-02).

The likelihood of instability for the North TSF and South is considered to be close to non-credible (drained condition) to unlikely[4] (seismic loading condition).

5.3.4 Erosion of Facility Toe from West Kettle River

The South TSF is adjacent to the WKR, and erosion of the South TSF toe due to flooding / high velocities could cause dam instability to the South TSF.

The toe of the North TSF dam is located approximately 9 m above the normal flow elevation of the WKR and approximately 100 m (horizontally) from the centreline of the WKR. Erosion of the North TSF toe is not considered to represent a risk to dam safety based on a very rare likelihood of occurrence.

Design Basis and Design Confirmation

Erosion protection was designed for the right bank of the WKR, adjacent to the South TSF, and installed between 2015 and 2016. The erosion protection comprised a trench of buried riprap that would “self-launch” to protect the South TSF in the event that the natural ground between the riprap and river was eroded. Such erosion occurred in 2018 over portions of the riprap downstream of Cell 5 as a result of high-water levels in the WKR near the Beaverdell TSFs. Further, including as a result of additional riprap placed upstream and on left bank by others, the river geomorphology was observed to have significantly varied, and the assumptions and parameters adopted in the 2015/2016 riprap design may no longer be valid. Erosion of the downstream toe of Cell 4 and 5 dams represents an ongoing risk to dam safety.

Observed Performance

River levels in 2020 peaked below a 1-in-5-year return period maximum daily flow (Section 4.2).

A revised design for armouring of the Cell 4 and 5 riverbank for up to a 1-in-200-year flood event was completed in 2019 (Golder 2019f,g) and 145 m (56%) of the works installed in November and December 2020. Riprap material stockpiled in freshet 2019 was used for the installation and additional riprap was stockpiled between January and April 2020 in preparation for the 2020 freshet. The FAA amendment was approved 29 October 2020. The completion of WKR erosion protection works was completed in November 2020, outside of the 2019/2020 reporting period and will be reported in the 2021 annual facility inspection report.

The likelihood of external erosion for the South TSF during the reporting period, prior to the completion of armouring, was considered to be possible[5] based on previous observed flooding of the WKR. Following the completion of armouring works along the toe of the South TSF, for an event up to and including the 1:200-year flood, the likelihood was reduced to rare.

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4 **Unlikely**—For a natural hazard (earthquake, flood, windstorm, etc.): the predicted return period for an event of this strength / magnitude is between 1 in 10 and 100 years.

5 **Possible**—For a natural hazard (earthquake, flood, windstorm, etc.): the predicted return period for an event of this strength / magnitude is between 1 in 5 and 10 years.

The draft flood monitoring and response protocol document was updated in February 2021 to reflect the completion of the WRK armouring (Recommendation 2020-04) and finalization was in progress at the time of this report.

5.4 Review of Operational Documents

5.4.1 Operation, Maintenance, and Surveillance Manual Review

The operation, maintenance, and surveillance (OMS) manual for the TSF was updated in February 2018 (SP&P BEA-OMS-001.V002; Teck 2018a). This OMS manual was prepared to meet guidelines provided by the HSRC Guidance Document (Ministry of Energy and Mines 2016), the CDA (2013), the Mining Association of Canada (MAC 2011, 2017) and Teck (2014).

An update of the OMS manual is in progress at time of this report to reflect staff changes at the TSF and to meet revised guidelines provided by MAC (2019a,b) and Teck (2019a).

A draft flood monitoring and response protocol for the West Kettle River, including a trigger action response plan, was prepared in March 2020, prior to finalization of this document Teck developed a flood response procedure (Teck 2020), based on the draft flood monitoring and response protocol, which was implemented during the 2020 freshet. The draft flood response protocol and TARP was updated in February 2021 to reflect the completion of the WRK armouring (Recommendation 2020-04). Finalization was in progress at the time of this report and this document should be included as part of the updated OMS manual, in accordance with the amended *Mines Act* Permit M-71, 4 October 2019 (Recommendation 2018-03b). The water management plan for the facility is out of date, and an update based on the baseline hydrology study (Section 2.8) was in progress at the time of this report.

5.4.2 Emergency Preparedness and Response Review

The emergency preparedness and response plan (EPRP) was updated in February 2018 (Teck 2018b) (SP&P BEA-EPRP-001.V002). This document was prepared to meet guidelines provided by the HSRC and HSRC Guidance Document (Ministry of Energy and Mines 2016, 2017), CDA (2013), MAC (2011, 2017), and Teck (2014).

An update of the EPRP was issued to Teck by Golder in July 2019, including incorporation of the TSF EPRP into a mine emergency response plan for the Beaverdell Mine (Teck 2019c), and is pending finalization by Teck at the time of this report. Updates will reflect staff changes at the TSF and revised guidelines provided by MAC (2019a,b) and Teck (2019a).

The last tabletop exercise to test the EPRP was conducted on 17 December 2019.

The hypothetical failure of the Beaverdell TSFs is not considered to present a potential for loss of life, following the dam consequence classification guidelines from the HSRC Guidance Document Section 3.4 (Ministry of Energy and Mines 2016), which references the CDA (2013) *Dam Safety Guidelines*.

5.4.3 Dam Safety Review

The last dam safety review for the Beaverdell TSFs was conducted in 2012 (Golder 2013). At that time it was recommended that the next dam safety review be completed within 10 years. However, based on the post-2016 requirement of the HSRC (Ministry of Energy and Mines 2017), the next dam safety review is to be undertaken in 2021.

6.0 SUMMARY AND RECOMMENDATIONS

6.1 Summary of Activities

Activities completed during the reporting period were as follows:

- fall routine inspection on 24 September 2019, spring routine inspection on 12 April 2020, both by Teck, and annual inspection on 21 July 2020 by Teck and Golder
- placement of approximately 145 m of riprap in November/December 2019 to armour the riverbank adjacent to the South TSF
  - remaining riprap was placed in November 2020, outside of the 2019/2020 reporting period, and completes the planned 1-in-200-year flood protection works
- stockpiling of additional riprap material at the toe of Cells 4 and 5 from January to April 2020 in preparation for the 2020 freshet
- completion of the Phase 1 geotechnical site investigation and laboratory testing program for the TSFs, including
  - drilling of 8 boreholes with large penetration testing
  - installation of 12 vibrating wire piezometers in six boreholes and connection to a remote monitoring system
    - installation of 2 signal repeaters on 1 October 2020
  - excavation of 5 test pits along the toe of the Cell 3 embankment
- completion of a test pitting program, including 12 test pits in South TSF cells, 3 in North TSF cells, 8 in the former mill area, 1 downstream of Cell 3 and 6 downstream of Cell 5 in August 2020 (reporting in progress by others)
- development of a baseline hydrology study
  - the study was finalized, outside of the reporting period, in March 2021 (Golder 2021)
- installation of a visual staff gauge at the WKR bridge
- four water quality sampling events in the WKR, including flow measurement in 2020, 2 groundwater sampling events, and quarterly/annual reporting

6.2 Summary of Climate and Water Balance

Adjusted Kelowna climate station data, based on a historical relationship between Beaverdell, Beaverdell North, and Kelowna stations, were used to estimate the total annual precipitation at the Beaverdell site during the reporting period (1 September 2019 through 31 August 2020). Results indicate:

- The estimated total precipitation in 2019/2020 was an approximately average year compared to the composite historical average, with a total annual precipitation just below the average annual precipitation recorded at the Beaverdell stations.

- Total precipitation at Beaverdell from January to April 2020 (inclusive), was estimated to be approximately 50% of the historical average for the same time period.
- Total precipitation at Beaverdell in May and June 2020 (inclusive), was estimated to be 171% of the historical average for the same period.

A review of the facility water balance was completed using the estimated precipitation at Beaverdell for the reporting period. The total inflow volumes are estimated to be:

- 82,300 m^3 for the South TSF area
- 35,500 m^3 for the North TSF area

Losses are assumed to equate to inflows and include evaporation, transpiration, sublimation, and infiltration to ground.

6.3 Summary of Performance and Changes

The Beaverdell TSF dams were observed to be in good condition at the time of the annual inspection site visit. No significant changes in condition were noted, based on visual monitoring records, dam stability, and surface water control.

The South and North TSFs are trending to a state of having non credible failure modes.

6.4 Consequence Classification

Following the consequence classification in Section 3.4 of the HSRC Guidance Document (Ministry of Energy and Mines 2016):

- The North and South TSF dams are Significant consequence class structures, which is unchanged from the 2019 annual DSI (Golder 2020a).

6.5 Table of Deficiencies and Non-Conformances

Deficiencies/non-conformances and recommended actions are presented in Table 17, which includes an update of the status, as of March 2021, of recommended actions from the 2019 annual DSI. Completed recommendations are shown in grey shading.

Table 17: Table of Deficiencies and Non-conformances and Status Update of Previous Recommendations

Structure	ID Number	Deficiency or Non-conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Status, as of March 2021, and Recommended Deadline
South TSF	2016-01	The South TSF would discharge through the Cell 3 spillway during a 24-hour IDF event. The consequence of potential tailings migration due to flood transport is not quantified.	Permit PE-444	Collect tailings samples for geochemical testing and initiate the geochemical laboratory testing program in 2020. Develop a contingency protocol (with TARP) to be implemented in the event that discharge through the spillway occurs.	3	**Completed:** ***Tailings samples from the 2020 geotechnical site investigation were sent for geochemical analysis testing by Teck. Additional geochemical samples were collected in a test pit program by Teck in 2020.*** **In progress:** Teck to develop contingency protocol in the event of discharge through the spillway and include in the next OMS manual update. End Q1 2021
	2018-03 a,b	Existing riprap along the toe of Cell 4 and 5 may not be sufficient to prevent erosion of dam fill during a large river freshet flood event, based on observed changes in river alignment and adjacent riverbank conditions.	HSRC §10.1.8	Finalize flood response protocol for the WKR including the trigger action response plan prior to 2020 freshet.	2	**Complete** ***Riprap stockpiles replenished between January and April 2020 in preparation for 2020 freshet.*** ***Draft flood response protocol used to develop flood monitoring procedure for 2020 freshet,* prior to finalization of the protocol document.**
				Assess short-term and long-term requirements for riprap based on changes in river hydrology and flood statistics.	3	**In Progress** ***Design for WKR riprap up to a 1-in-200-year event and installation of 145 m of riprap completed in 2019. Construction to complete remaining riprap works completed in November 2020.*** ***Document long-term plan for riprap along WKR, considering larger flood events, to mitigate risk of erosion along the toe of Cell 4 and 5*** ***End Q2 2021***
	2019-01	The location and alignment of the Cell 5 decant pipe are unknown.	OMS manual §5.5	Determine the location and alignment of the outlet of the Cell 5 decant.	3	**Not Started** End Q2 2023
	2019-02	Dead trees along the toe of the Cell 5 dam.	OMS manual §5.5	Remove dead trees along the toe of the Cell 5 dam as part of clearance works for the installation of riprap in 2020 (see 2018-03b).	3	**Complete:** ***Completed as part of riprap placement in 2020 (2018-03b)***
	2019-03	Reviewed data, including observed conditions during the removal of trees in 2019, could indicate the possibility of tailings in the foundation of the Cell 3 embankment. Foundations may be prone to liquefaction in a seismic event potentially leading to failure.	HSRC §10.1.4	Investigate the toe area and foundation of the Cell 3 dam for the presence of tailings or other soft, loose soils.	2	**Completed:** ***Phase 1 site investigation completed in March 2020 including installation of vibrating wire piezometers. Baseline data collection and interpretation in progress.***
	2020-02	Results indicated the presence of tailings at the downstream toe of Cell 3. As such, the South TSF may be founded on tailings in the area of Cell 3.	HSRC §10.1.4	Additional investigation should be planned to further delineate the extent of tailings downstream of the South TSF.	3	New Recommendation End 2021
	2020-03	Results from the Phase 1 geotechnical site investigation indicate that tailings in Cell 4 are finer than the range used in the filter compatibility and internal stability assessment (Golder 2015a).	HSRC §10.1.4	Update filter compatibility and internal stability assessment for dam fill and foundations based on Phase 1 geotechnical investigation laboratory test results.	3	New Recommendation End 2021

	2020-04	Flood monitoring and response protocol is out of date.	n/a	Update flood monitoring and response protocol, based on completion of 1-in-200-year riprap armouring along South TSF	3	New Recommendation – Updated in March 2021, requires finalization. End Q1 2021
North TSF	2019-04	The outlet structure of the Cell 6 decant accumulates a small quantity of water behind a metal weir, which may affect water chemistry when sampled.	OMS manual §5.5	Review collected water quality data to determine source of the accumulated water. Assess opportunity for maintaining the collection point to inform ongoing geochemistry studies. Consider upgrading to remove steel as a potential source of water contamination. Decommission the outlet structure if deemed of no value.	3	**In Progress:** Action plan to be developed for decommissioning and installation of standpipe for water quality monitoring. End Q2 2023
	2020-01	Excessive vegetation in the North TSF spillway and diversion channel may reduce flow capacity and impeded access.	OMS manual §5.5	Clear vegetation in the North TSF spillway and diversion channel.	4	New Recommendation End Q3 2021
South and North TSF	2016-03	Facility phreatic conditions not confirmed.	CDA 2013 §6.6 HSRC §10.1.4 (3)	Execute the planned drilling program to gather subsurface information and install piezometers.	3	**Completed:** ***Phase 1 Site investigation completed in March 2020 including installation of VWPs. Baseline data collection and interpretation in progress.***
	2016-05 a,b	Closure plan not updated	HSRC §10.4.1	Complete the planned Phase 1 geotechnical investigation to inform the development of an updated closure plan. Execute the planned geochemical site investigation and testing program. Teck should collect tailings samples for geochemical testing and initiate the geochemical laboratory testing program in 2020 (See 2016-01).	4	**Completed:** ***Tailings samples from the 2020 geotechnical site investigation were sent for geochemical analysis testing by Teck. Additional geochemical samples were collected in a test pit program by Teck in 2020.***
			HSRC §10.4.1	Update the closure plan.	4	**Not Started** End Q2 2023
	2017-02 a,b	No failure runout assessment completed.	HSRC §10.1.11	Complete the planned Phase 1 geotechnical investigation to inform the development of hypothetical failure runout evaluation	3	**Completed** ***Phase 1 geotechnical site investigation completed in March 2020.***
				Complete a hypothetical failure runout evaluation	3	**In Progress** ***End Q3 2021***
	2018-02	Dam consequence classification requires review due to changes in downstream conditions	HSRC §10.1.7	Review dam consequence classification as recommended in Golder (2019d).	3	**Not Started** ***End Q4 2021***
	2018-04	Water management plan is out of date.	HSRC §10.4.1 (3)	Update the existing water management plan.	4	**In Progress** ***Baseline hydrology study developed and issued in March 2021 and will inform surface water management plan update.*** ***End Q2 2021***

CDA = Canadian Dam Association; HSRC = Health, Safety and Reclamation Code; ID = identification; IDF = inflow design flood; OMS = operation, maintenance, and surveillance; TARP = trigger action response plan; TSF = tailings storage facility; VWP = vibrating wire piezometers; WKR = West Kettle River.

Priority	Description
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.
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.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

Source: HSRC Guidance Document, Section 4.2 (Ministry of Energy and Mines 2016).

7.0 CLOSURE

We trust that this report meets your present requirements. If you have any questions or further requirements, please contact the undersigned.

Golder Associates Ltd.

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https://golderassociates.sharepoint.com/sites/124047/project files/6 deliverables/issued/275-r-rev0-1000-2020 annual inspection/20140466-275-r-rev0-1000-bea tsf 2020 annual inspection report 30mar_21.docx

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STUDY LIMITATIONS

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LOCATION PLAN

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

25 mm

LEGEND

LIMITS OF 2018 ORTHO PHOTO

NOTE

1. COORDINATES ARE IN UTM ZONE 11 NAD83.

REFERENCES

1. 2013 ORTHOPHOTO RECEIVED FROM TECK RESOURCES LIMITED.
2. 2018 ORTHOPHOTO BY MCELHANNEY, RECEIVED 24 AUGUST 2018.

CLIENT

TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

CONSULTANT

GOLDER

YYYY-MM-DD	2021-03-19
DESIGNED	N. CARRIERE
PREPARED	A. KIM
REVIEWED	M. WILLAN
APPROVED	J. CUNNING

PROJECT

BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL INSPECTION REPORT

TITLE

BEAVERDELL SITE LOCATION PLAN

PROJECT NO.	PHASE/TASK/DOC	REV.	FIGURE
20140466	1000/1006/275	0	1

LEGEND

- 2018 TOPOGRAPHIC CONTOURS (SEE REFERENCE 1)
- EXTENT OF RIPRAP ARMOURING INSTALLED IN 2019 (SEE REFERENCE 4)
- APPROXIMATE EXTENT OF UPSTREAM ARMOURING
- # 2020 SITE VISIT PHOTOGRAPH LOCATION
- INDICATIVE LOCATION OF EMERGENCY RIPRAP STOCKPILES

NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES ARE IN UTM ZONE 11 NAD83.
3. VERTICAL DATUM IS CGVD2013.
4. CONTOURS SHOWN AT 0.5 m MINOR AND 2.5 m MAJOR INTERVAL.

REFERENCES

1. 2018 EXISTING GROUND LIDAR SURVEY AND ORTHOPHOTO BY MCELHANNEY 19 JULY 2018, PROVIDED BY MCELHANNEY, RECEIVED: 24 AUGUST 2018, FILE NAME: 358400VLIDARCONTOURS.DWG.
2. 2019 CONSTRUCTION: CELL 3 SPILLWAY AND BERM REPAIR WORKS SURVEY COMPLETED BY GOLDER; SURVEYED 3 JULY 2019, FILE: 1788497-1000-BEAVERDELL CELL 3 SPILLWAY 2019 CONSTRUCTION ASBUILT 2019-07-04.xml.
3. CELL 3 DAM SURVEY PROVIDED BY WSP. CAD FILE: 181-08185-00-000-00-SRWCA001-R0.dwg. DATE: 23 TO 28 JULY 2018
4. RECORD SURVEY PROVIDED BY LANDMARK SOLUTIONS, FILE NAME: "9062 - Jan 2020Combined asbuilt sent to Landmark 2020 01 23.dwg", RECEIVED: 24 JANUARY, 2020.

0 100 200

1:4,000 METRES

CLIENT

TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

CONSULTANT

GOLDER

YYYY-MM-DD	2021-03-19
DESIGNED	N. CARRIERE
PREPARED	A. KIM
REVIEWED	M. WILLAN
APPROVED	J. CUNNING

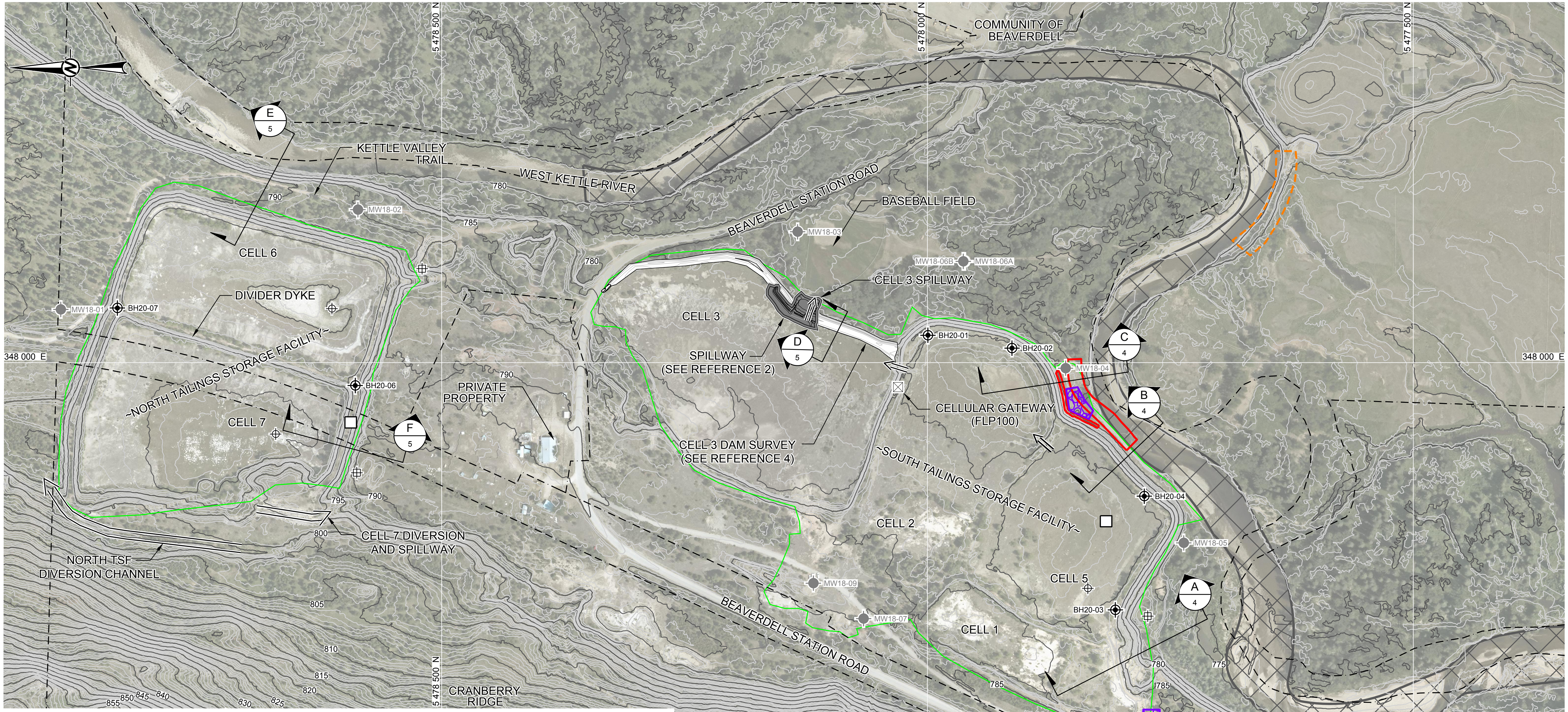
PROJECT

BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL INSPECTION REPORT

TITLE

2020 INSPECTION PHOTOGRAPH LOCATIONS

PROJECT NO.	PHASE/TASK/DOC	REV.	FIGURE
20140466	1000/1006/275	0	2



LEGEND

- 2018 TOPOGRAPHIC CONTOURS (SEE REFERENCE 1)
- EXTENT OF RIPRAP ARMOURING INSTALLED IN 2019 (SEE REFERENCE 5)
- APPROXIMATE EXTENT OF ARMOURING
- APPROXIMATE DECANT TOWER LOCATION
- APPROXIMATE DECANT OUTLET LOCATION
- APPROXIMATE SIGNAL REPEATER LOCATION (SEE NOTE 5)
- FLOW DIRECTION
- APPROXIMATE M-71 PERMIT BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY
- CRITICAL HABITAT OF SPECKLED DACE (SEE REFERENCE 2)
- GROUNDWATER MONITORING WELLS (BY WOOD PLC, COMPLETED JULY 2018)
- AS-BUILT BOREHOLE LOCATION WITH VIBRATING WIRE PIEZOMETERS
- INDICATIVE LOCATION OF EMERGENCY RIPRAP STOCKPILE

NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES ARE IN UTM ZONE 11 NAD83.
3. VERTICAL DATUM IS CGVD2013.
4. CONTOURS SHOWN AT 0.5 m MINOR AND 2.5 m MAJOR INTERVAL.
4. INTERFACES FOR BOREHOLES WITH VIBRATING WIRE PIEZOMETERS ARE WITHIN 2 m OF THE AS-BUILT LOCATION.
5. SIGNAL REPEATERS WERE INSTALLED IN OCTOBER 2020.

REFERENCES

1. 2018 EXISTING GROUND LIDAR SURVEY AND ORTHOPHOTO BY MCELHANNEY 19 JULY 2018, PROVIDED BY MCELHANNEY, RECEIVED: 24 AUGUST 2018, FILE NAME: 358400VLIDARCONTOURS.DWG.
2. FISHERIES AND OCEANS CANADA. 2018. RECOVERY STRATEGY FOR THE SPECKLED DACE (*RHINICHTHYS OSCULUS*) IN CANADA. SPECIES AT RISK ACT RECOVERY STRATEGY SERIES. FISHERIES AND OCEANS CANADA, OTTAWA. v + 31 pp.
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4. CELL 3 EAST DAM SURVEY PROVIDED BY WSP. CAD FILE: 181-08185-00-000-00-SRWCA001-R0.dwg. DATE: 23 TO 28 JULY 2018.
5. RECORD SURVEY PROVIDED BY LANDMARK SOLUTIONS, FILE NAME: "9062 - Jan 2020Combined asbuilt sent to Landmark 2020 01 23.dwg", RECEIVED: 24 JANUARY, 2020.

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1:4,000 METRES

CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-19
DESIGNED	N. CARRIERE
PREPARED	A. KIM
REVIEWED	M. WILLAN
APPROVED	J. CUNNING

PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL INSPECTION REPORT

TITLE
DETAIL PLAN

PROJECT NO.	PHASE/TASK/DOC	REV.	FIGURE
20140466	1000/1006/275	0	3

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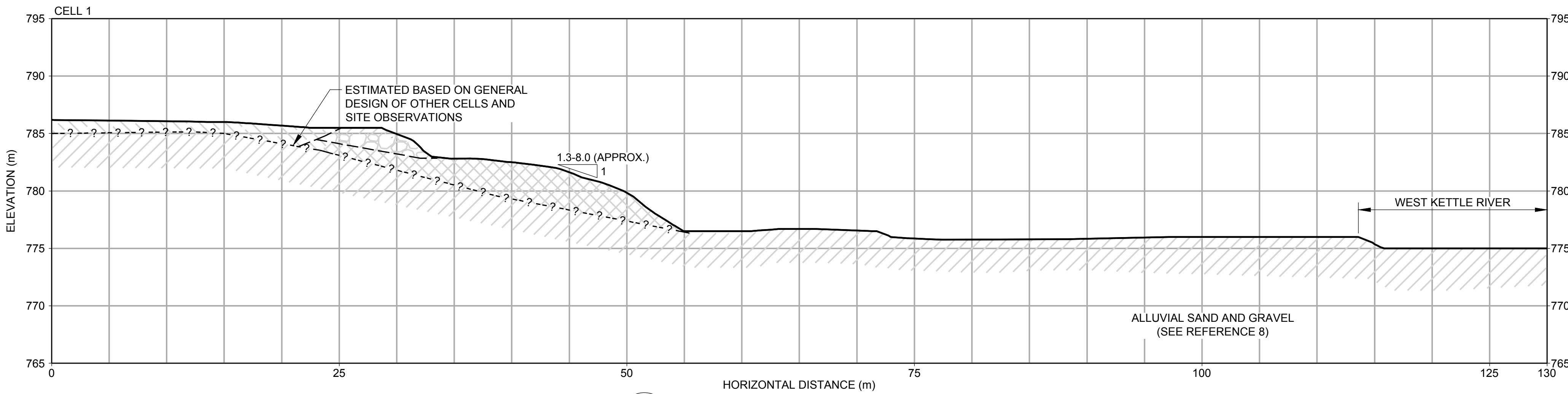

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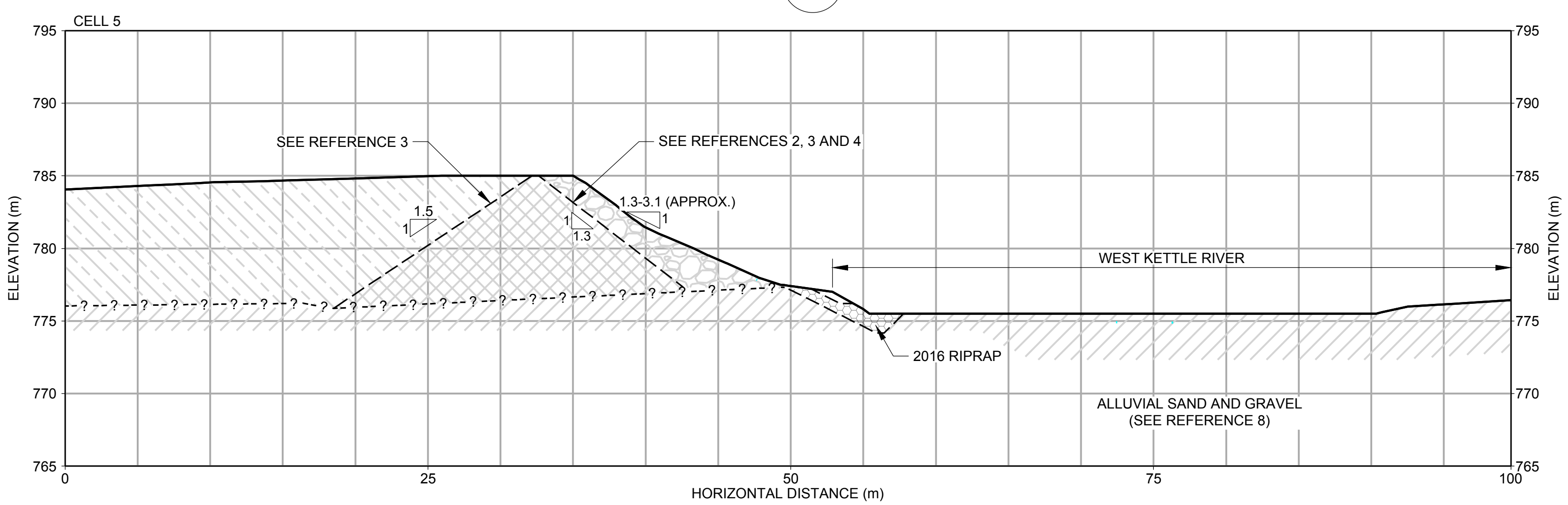

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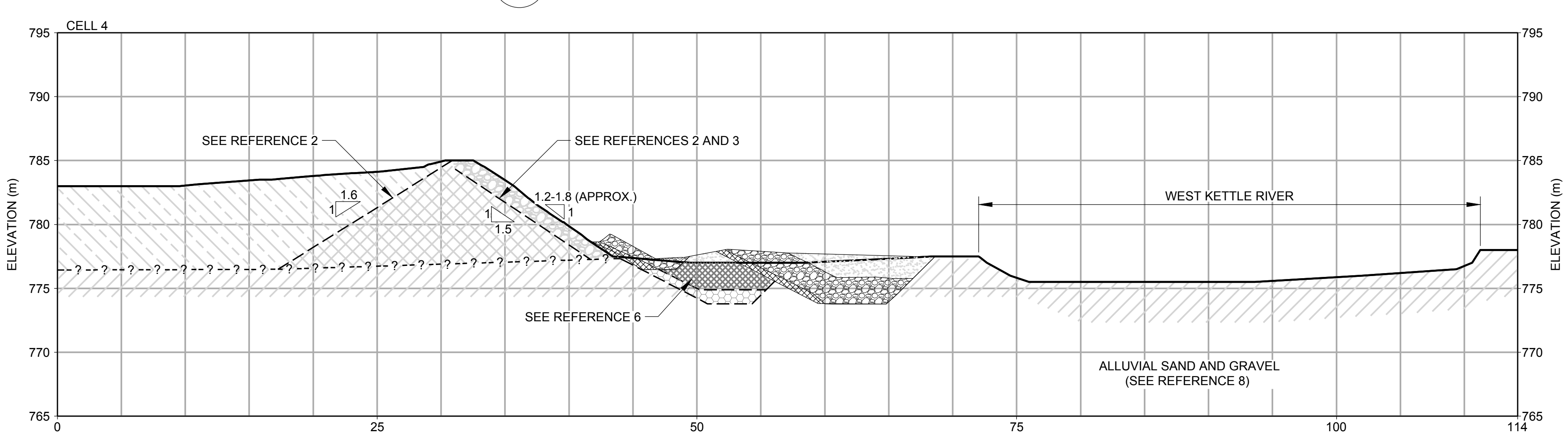

SCALE 1:500 m C/3 SECTION THROUGH CELL 4 EMBANKMENT

LEGEND

- EXISTING GROUND SURFACE (SEE REFERENCE 1)
- ESTIMATED ORIGINAL GROUND SURFACE
- INFERRED MATERIAL BOUNDARY
- TAILINGS
- EMBANKMENT FILL
- ALLUVIAL SAND AND GRAVEL
- ALLUVIAL COBBLE COVER
- WASTE ROCK/ALLUVIAL COBBLES
- 2016 RIPRAP MIXED WITH GRANULAR FILL
- BACKFILLED EXCAVATED MATERIAL
- 2019 RIPRAP (SEE REFERENCE 9)
- SALVAGED MATERIAL (ALLUVIAL SAND AND GRAVEL) (SEE REFERENCE 9)
- FILTER MATERIAL (SEE REFERENCE 9)

NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS OTHERWISE NOTED.
2. STRATIGRAPHY BENEATH ALLUVIAL SAND AND GRAVEL IS UNKNOWN.
3. GROUND SURFACE UNDER TAILINGS BASED ON 2018 CPT INVESTIGATION. (SEE REFERENCE 7)
4. VERTICAL DATUM IS CGVD2013.

REFERENCES

1. 2018 EXISTING GROUND LIDAR SURVEY AND ORTHOPHOTO BY MCELHANNEY 19 JULY 2018, PROVIDED BY MCELHANNEY, RECEIVED: 24 AUGUST 2018, FILE NAME: 358400VLidarContours.dwg.
2. BINNIE (ROBERT F. BINNIE LTD.). 1971. *REPORT ON STABILITY OF TAILINGS DAM*. REPORT PREPARED FOR TECK CORPORATION LTD., BEAVERDELL, BC. SUBMITTED 8 JUNE 1971.
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5. BINNIE. 1980C. *REPORT ON STABILITY OF ABANDONED POND NO. 5*. REPORT PREPARED FOR TECK CORPORATION LTD., BEAVERDELL, BC. SUBMITTED 9 DECEMBER 1980.
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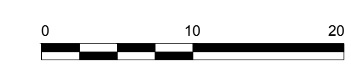
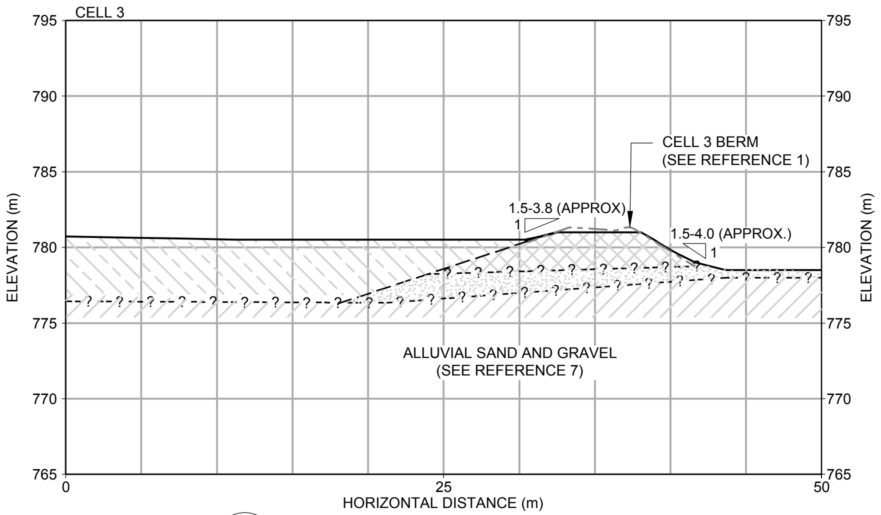
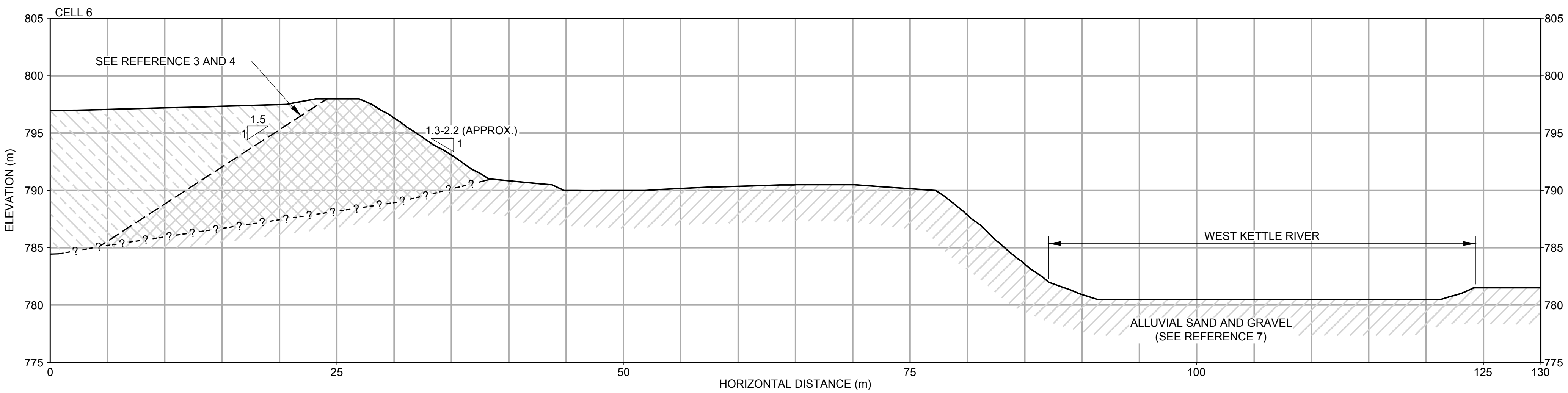
7. GOLDER. 2019. *INTERIM CONE PENETRATION TESTING SITE INVESTIGATION FACTUAL REPORT FOR BEAVERDELL TAILINGS STORAGE FACILITIES*. REFERENCE NO. 18104486-115-TM-REV1-2000. SUBMITTED 25 MARCH 2019.
8. GOLDER 2020b. BEAVERDELL TAILINGS STORAGE FACILITIES PHASE 1 SITE INVESTIGATION FACTUAL REPORT. REFERENCE NO.1811487-255-R-REV0-2000. SUBMITTED 15 OCTOBER 2020.
9. RECORD SURVEY PROVIDED BY LANDMARK SOLUTIONS, FILE NAME: "9062 asbuild.dwg", RECEIVED: 22 DECEMBER, 2019.



CLIENT	TECK RESOURCES LIMITED BEAVERDELL MINE BEAVERDELL, B.C.
CONSULTANT	GOLDER
YYYY-MM-DD	2021-03-19
DESIGNED	N. CARRIERE
PREPARED	A. KIM
REVIEWED	M. WILLAN
APPROVED	J. CUNNING
PROJECT	BEAVERDELL TAILINGS STORAGE FACILITIES 2020 ANNUAL INSPECTION REPORT
TITLE	**CROSS SECTIONS (1 OF 2)**
PROJECT NO.	20140466
PHASE/TASK/DOC	1000/1006/275
REV.	0
FIGURE	4



SCALE 1:500 m D 3 SECTION THROUGH CELL 3 EMBANKMENT



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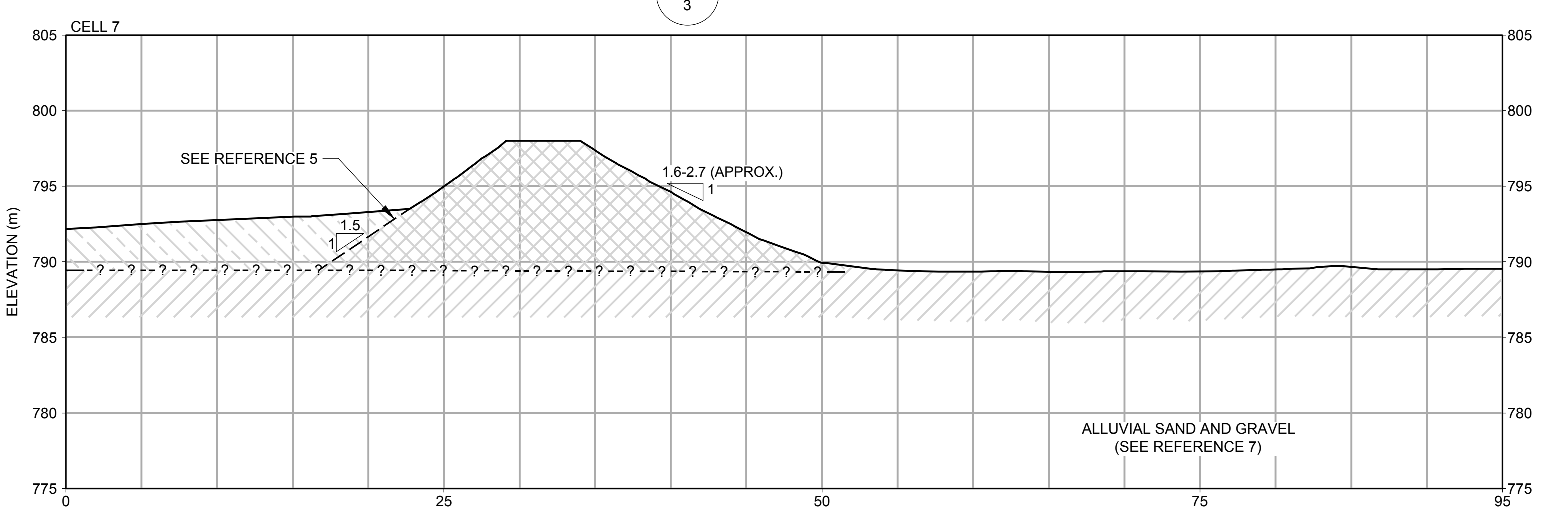


SCALE 1:500 m F 3 SECTION THROUGH CELL 7 EMBANKMENT

LEGEND

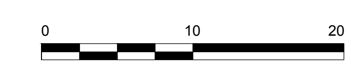
- EXISTING GROUND SURFACE (SEE REFERENCE 2)
- --?--?--?--?- ESTIMATED SURFACE
- INFERRED MATERIAL BOUNDARY
- CELL 3 BERM (SEE REFERENCE 1)
- TAILINGS
- EMBANKMENT FILL
- ALLUVIAL SAND AND GRAVEL
- TAILINGS AND ALLUVIAL SAND AND GRAVEL (EXTENT TO BE DEFINED) (SEE REFERENCE 5)

NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS OTHERWISE NOTED.
2. STRATIGRAPHY BENEATH ALLUVIAL SAND AND GRAVEL IS UNKNOWN.
3. GROUND SURFACE UNDER TAILINGS BASED ON 2018 CPT INVESTIGATION. (SEE REFERENCE 6)
4. VERTICAL DATUM IS CGVD2013.

REFERENCES

1. CELL 3 EAST DAM SURVEY PROVIDED BY WSP. CAD FILE: 181-08185-00-000-00-SRWCA001-R0.dwg. DATE: 23 TO 28 JULY 2018
2. 2018 EXISTING GROUND LIDAR SURVEY AND ORTHOPHOTO BY MCELHANNEY 19 JULY 2018, PROVIDED BY MCELHANNEY, RECEIVED: 24 AUGUST 2018, FILE NAME: 358400VLIDARCONTOURS.DWG.
3. BINNIE. 1980A. *REPORT ON TAILINGS DISPOSAL POND NO. 5 AND PROPOSED POND NO. 6.* REPORT PREPARED FOR TECK CORPORATION LTD., BEAVERDELL, BC. SUBMITTED 20 FEBRUARY 1980.
4. BINNIE. 1980B. *SUPPLEMENTARY REPORT ON PROPOSED POND NO. 6.* REPORT PREPARED FOR TECK CORPORATION LTD., BEAVERDELL, BC. SUBMITTED 31 MARCH 1980.
5. BINNIE (R.F. BINNIE & ASSOCIATES LTD.). 1988. *REPORT ON PROPOSED POND NO. 7.* REPORT PREPARED FOR TECK CORPORATION, BEAVERDELL, BC. SUBMITTED APRIL 1988.
6. GOLDER. 2019. *INTERIM CONE PENETRATION TESTING SITE INVESTIGATION FACTUAL REPORT FOR BEAVERDELL TAILINGS STORAGE FACILITIES.* REFERENCE NO.18104486-115-TM-REV1-2000. SUBMITTED 25 MARCH 2019.
7. GOLDER 2020b. BEAVERDELL TAILINGS STORAGE FACILITIES PHASE 1 SITE INVESTIGATION FACTUAL REPORT. REFERENCE NO.1811487-255-R-REV0-2000. SUBMITTED 15 OCTOBER 2020.



CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

CONSULTANT

GOLDER

YYYY-MM-DD	2021-03-19
DESIGNED	N. CARRIERE
PREPARED	A. KIM
REVIEWED	M. WILLAN
APPROVED	J. CUNNING

PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL INSPECTION REPORT

TITLE
CROSS SECTIONS (2 OF 2)

PROJECT NO.	PHASE/TASK/DOC	REV.	FIGURE
20140466	1000/1006/275	0	5

APPENDIX A

2020 TSF Data Sheets

CLIENT:	Teck Resources Limited	**PROJECT:**	Beaverdell Tailings Storage Facilities
LOCATION:	Beaverdell Mine	**REVIEWED:**	M. Willan

SOUTH TSF – FACILITY DATA SHEET

Impoundment Area (tailings and dam footprint area)	150,000 m^2	Measured from 2018 LiDAR Survey Data
Volume of Stored Tailings	544,000 m^3	Estimated Golder (2019a)
Reservoir Capacity	21,900 m^3 (in Cell 4 and 5 to internal spillway invert levels)	Calculated 2018 LiDAR Survey Data and 2019 Cell 3 spillway as-built survey
Consequence Classification	Significant	Ministry of Energy and Mines (2016) and CDA (2013)
Inflow Design Flood (IDF)	1/3 between the 1-in-975-year flood event and the PMF.	Ministry of Energy and Mines (2016)
Design Earthquake	1/2,475-year event	Ministry of Energy and Mines (2016)
Spillway Capacity	4.8 m^3/s considering a design storm calculated based on 24-hour probable maximum precipitation plus snow melt plus 10% climate change factor. Includes 0.3 m of freeboard.	Calculated Golder (2019e)
Catchment Area	188,000 m^2	Calculated Golder (2017a)
Dam Type	Earthfill Dam	Assumed from Binnie (1980a, 1988). No construction record reports available.
Maximum Dam Height	2 to 10 m	Estimated from 2018 LiDAR Survey Data
Dam Crest Width	1 to 5 m	Estimated from 2018 LiDAR Survey Data and 2019 spillway as-built survey
Access to Facility	Permanent wire fence installed around South TSF. Access via gate located on access road from west side of Cell 3, adjacent to Cell 2. Vehicle access to dam crest not generally available.	-

NORTH TSF – FACILITY DATA SHEET

Impoundment Area (tailings and dam footprint area)	90,000 m^2	Measured from 2018 LiDAR Survey Data
Volume of Stored Tailings	384,000 m^3	Estimated Golder (2019a)
Reservoir Capacity	184,600 m^3 (to Cell 7 spillway invert elevation of 797.0 m)	Calculated 2018 LiDAR Survey Data
Consequence Classification	Significant	Ministry of Energy and Mines (2016) and CDA (2013)
Inflow Design Flood (IDF)	1/3 between the 1-in-975-year flood event and the PMF. Available capacity to store the IDF with a duration of 72 hours.	Ministry of Energy and Mines (2016)
Design Earthquake	1-in-2,475-year event.	Ministry of Energy and Mines (2016)
Spillway Capacity	2 m^3/s considering a design storm calculated based on 24-hour probable maximum precipitation plus snow melt plus 10% climate change factor.	Calculated Golder (2019c)
Catchment Area	Internal catchment of Cell 6 and 7 during normal precipitation events: 81,000 m^2 Internal and external catchment of Cell 6 and 7 during IDF event: 171,000 m^2	Calculated Golder (2017a)
Dam Type	Earthfill Dam	Assumed from Binnie (1980a, 1988). No construction record reports available.
Maximum Dam Height	8 to 12 m	Measured from 2018 LiDAR Survey Data
Dam Crest Width	3 to 4 m	Measured from 2018 LiDAR Survey Data
Access to Facility	Permanent wire fence installed around North TSF. Access via gate located on access road from downstream toe area at southeast corner of facility to crest of Cell 6 dam. Continuous narrow road around crest of North TSF perimeter, Accessible by all terrain vehicle	-

APPENDIX B

2020 Site Inspection Photographs

Photograph 1: South TSF Cell 1, tailings surface, looking northeast. 21 July 2020.

Photograph 2: South TSF, Cell 1, west side downstream toe area with animal burrows, looking east. 21 July 2019.

Photograph 3: South TSF, Cell 1, crest and upstream ditch, looking southwest. 21 July 2020.

Photograph 4: South TSF, Cell 1, downstream slope, looking northeast. 21 July 2020.

TSF = Tailings Storage Facility

CLIENT	TECK RESOURCES LIMITED BEAVERDELL MINE BEAVERDELL, B.C.
PROJECT	BEAVERDELL TAILINGS STORAGE FACILITIES 2020 ANNUAL FACILITY INSPECTION REPORT
CONSULTANT	GOLDER
YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGN	NEC
REVIEW	MBW
APPROVED	JCC
TITLE	SOUTH TSF PHOTOGRAPHS 1 to 4
PROJECT No.	20140466
PHASE No.	1000-1006-275
REV.	0
SHEET	B-1

Photograph 5: South TSF, Cell 5, downstream slope waste rock, looking east. 21 July 2020.

Photograph 6: South TSF, Cell 5, tailings surface, looking northeast. 21 July 2020.

Photograph 7: South TSF, Cell 5, downstream slope, minor erosion, looking northwest. 21 July 2020.

Photograph 8: South TSF, Cell 5, downstream dam slope, looking northeast. 21 July 2020.

TSF = Tailings Storage Facility

CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

CONSULTANT

GOLDER

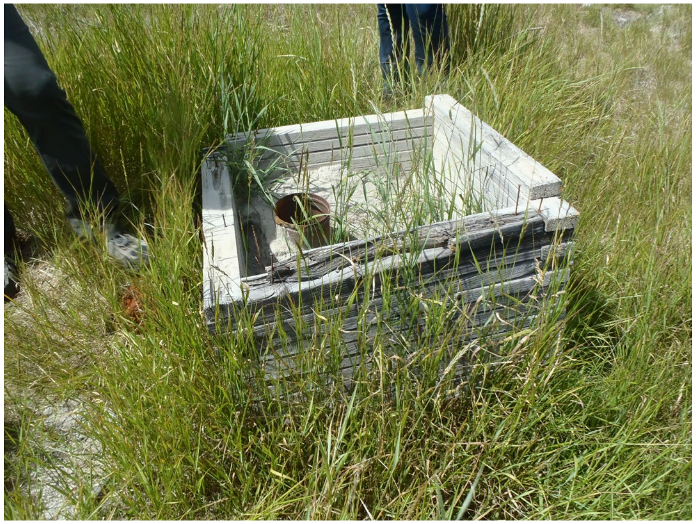
YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGN	NEC
REVIEW	MBW
APPROVED	JCC

PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL FACILITY INSPECTION REPORT

TITLE
SOUTH TSF
PHOTOGRAPHS 5 to 8

PROJECT No.	PHASE No.	REV.	SHEET
20140466	1000-1006-275	0	B-2

Photograph 9: South TSF, Cell 4/5 downstream toe with recently installed riprap along West Kettle River, looking south. 21 July 2020.



Photograph 10: South TSF, Cell 5, backfilled decant tower, looking northeast
21 July 2020.

Photograph 11: South TSF, Cell 4, tailings surface, looking northwest.
21 July 2020.

TSF = Tailings Storage Facility

CLIENT **TECK RESOURCES LIMITED** **BEAVERDELL MINE** **BEAVERDELL, B.C.**	PROJECT **BEAVERDELL TAILINGS STORAGE FACILITIES** **2020 ANNUAL FACILITY INSPECTION REPORT**
CONSULTANT GOLDER YYYY-MM-DD 2021-03-24 PREPARED NEC DESIGN NEC REVIEW MBW APPROVED JCC	TITLE **SOUTH TSF** **PHOTOGRAPHS 9 to 11** PROJECT No. **20140466** PHASE No. **1000-1006-275** REV. **0** SHEET **B-3**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
0 1 in

Photograph 12: South TSF, Cell 4, downstream slope and emergency riprap stockpile, looking northwest. 21 July 2020.

Photograph 13: South TSF, Cell 4, downstream slope and emergency riprap stockpile, looking northeast. 21 July 2020.

Photograph 14: South TSF, spillway between Cell 4 and Cell 3, looking northwest. 21 July 2020.

Photograph 15: South TSF, Cell 3, tailings surface and instrumentation gateway, looking west. 21 July 2020.

TSF = Tailings Storage Facility

CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

CONSULTANT

GOLDER

YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGN	NEC
REVIEW	MBW
APPROVED	JCC

PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL FACILITY INSPECTION REPORT

TITLE
SOUTH TSF
PHOTOGRAPHS 12 to 15

PROJECT No.	PHASE No.	REV.	SHEET
20140466	1000-1006-275	0	B-4

Photograph 16: South TSF, Cell 4, tailings surface and crest, looking southeast. 21 July 2020.

Photograph 17: South TSF, Cell 3, crest, downstream slope and toe, looking northeast. 21 July 2020.

Photograph 18: South TSF, Cell 3, spillway downstream, looking southeast. 21 July 2020.

TSF = Tailings Storage Facility

CLIENT **TECK RESOURCES LIMITED BEAVERDELL MINE BEAVERDELL, B.C.**		PROJECT **BEAVERDELL TAILINGS STORAGE FACILITIES 2020 ANNUAL FACILITY INSPECTION REPORT**	
CONSULTANT GOLDER	YYYY-MM-DD	2021-03-24	TITLE **SOUTH TSF PHOTOGRAPHS 16 to 18**
	PREPARED	NEC	
	DESIGN	NEC	
	REVIEW	MBW	
	APPROVED	JCC	PROJECT No. **20140466** · PHASE No. **1000-1006-275** · REV. **0** · SHEET **B-5**

Photograph 19: South TSF, Cell 3, tailings surface, looking south. 21 July 2020.

Photograph 20: South TSF, Cell 3, felled trees at toe, looking south. 21 July 2020.

TSF = Tailings Storage Facility

CLIENT **TECK RESOURCES LIMITED BEAVERDELL MINE BEAVERDELL, B.C.**		PROJECT **BEAVERDELL TAILINGS STORAGE FACILITIES 2020 ANNUAL FACILITY INSPECTION REPORT**	
CONSULTANT GOLDER	YYYY-MM-DD: 2021-03-24 PREPARED: NEC DESIGN: NEC REVIEW: MBW APPROVED: JCC	TITLE **SOUTH TSF PHOTOGRAPHS 19 and 20**	
		PROJECT No. **20140466**	PHASE No. **1000-1006-275** REV. **0** SHEET **B-6**

Photograph 21: North TSF, Cell 6, tailings surface, looking west. 21 July 2020.

Photograph 22: North TSF, Cell 6, east crest, looking north. 21 July 2020.

Photograph 23: North TSF, Cell 6, erosion on north downstream slope, looking east. 21 July 2020.

Photograph 24: North TSF, Cell 6, tailings surface from divider dyke between Cell 6 and Cell 7, looking southeast. 21 July 2020.

TSF = Tailings Storage Facility

CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGN	NEC
REVIEW	MBW
APPROVED	JCC

PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL FACILITY INSPECTION REPORT

TITLE
NORTH TSF
PHOTOGRAPHS 21 to 24

PROJECT No.	PHASE No.	REV.	SHEET
20140466	1000-1006-275	0	B-7

Photograph 25: North TSF, Cell 6, east downstream slope, looking west. 21 July 2020.

Photograph 26: North TSF, Cell 6, decant outlet, looking north. 21 July 2020.

Photograph 27: North TSF, Cell 6, tailings surface and plugged decant tower looking northwest. 21 July 2020.

Photograph 28: North TSF, Cell 6/7 divider dyke looking south. 21 July 2020.

TSF = Tailings Storage Facility

CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

CONSULTANT

GOLDER

YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGN	NEC
REVIEW	MBW
APPROVED	JCC

PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL FACILITY INSPECTION REPORT

TITLE
NORTH TSF
PHOTOGRAPHS 25 to 28

PROJECT No.	PHASE No.	REV.	SHEET
20140466	1000-1006-275	0	B-8

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

Photograph 29: North TSF, Cell 7 decant outlet, looking north. 21 July 2020.

Photograph 30: North TSF, Cell 7, spillway at southwest corner, looking northeast. 21 July 2020.

Photograph 31: North TSF, Cell 7, tailings surface looking north. 21 July 2020.

Photograph 32: North TSF, Cell 7 crest, looking west. 21 July 2020.

TSF = Tailings Storage Facility

CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

CONSULTANT

GOLDER

YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGN	NEC
REVIEW	MBW
APPROVED	JCC

PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL FACILITY INSPECTION REPORT

TITLE
NORTH TSF
PHOTOGRAPHS 29 to 32

PROJECT No.	PHASE No.	REV.	SHEET
20140466	1000-1006-275	0	B-9

Photograph 33: West Kettle River bridge crossing with staff gauge looking west.
21 July 2020.

TSF = Tailings Storage Facility

CLIENT **TECK RESOURCES LIMITED BEAVERDELL MINE BEAVERDELL, B.C.**		PROJECT **BEAVERDELL TAILINGS STORAGE FACILITIES 2020 ANNUAL FACILITY INSPECTION REPORT**	
CONSULTANT GOLDER	YYYY-MM-DD 2021-03-24 PREPARED NEC DESIGN NEC REVIEW MBW APPROVED JCC	TITLE **NORTH TSF PHOTOGRAPH 33**	
		PROJECT No. **20140466** · PHASE No. **1000-1006-275** · REV. **0**	SHEET **B-10**

APPENDIX C

2020 Site Inspection Reports

CLIENT:	Teck Resources Limited	**BY:**	Natasha Carriere, E.I.T.
PROJECT:	Beaverdell Mine	**DATE:**	21 July 2020
LOCATION:	South TSF (Cells 1 through 5)	**REVIEWED:**	John Cunning, P.Eng.

GENERAL INFORMATION

Dam Type: Earthfill

WEATHER CONDITIONS:	Sunny	**AIR TEMPERATURE:**	32°C

INSPECTION ITEM	OBSERVATIONS / DATA	PHOTO	COMMENTS & OTHER DATA
1. DAM CREST		3,16,17,18	
1.1 Crest Elevation	Low Point of Embankment: Cell 1: elev. 785.5 m Cell 5: elev. 785.0 m Cell 4: elev. 785.0 m Cell 3: elev. 781.1 m		2018 LiDAR Survey and 2019 Spillway as-built survey
1.2 Reservoir Level / Freeboard	Dry	1,6,11,14,16,19	No ponding observed during site inspection
1.3 Distance to Tailings Pond (if applicable)	N/A		
1.4 Surface Cracking	None		
1.5 Unexpected Settlement	None		
1.6 Lateral Movement	None		
1.7 Other Unusual Conditions	Variable crest width: Cell 1: 1 to 3 m Cell 5: 3 to 6 m Cell 4: 3 to 3.5 m Cell 3: 1 to 5 m		2018 LiDAR Survey and 2019 Spillway as-built survey
2. UPSTREAM SLOPE		16	
2.1 Slope Angle	Cells 1 & 2: unknown Cell 5: 1.5H:1V Cell 4: 1.5H:1V Cell 3: 1.5 to 3H:1V		Assumed from original design (Cell 4 and 5) Estimated for Cell 3
2.2 Signs of Erosion	None		
2.3 Signs of Movement (Deformation)	None		
2.4 Cracks	None		
2.5 Face Liner Condition (if applicable)	N/A		
2.6 Other Unusual Conditions	None		

INSPECTION ITEM	OBSERVATIONS / DATA	PHOTO	COMMENTS & OTHER DATA
3. DOWNSTREAM SLOPE		4,5,7,9,12,13,17	
3.1 Slope Angle	Cell 1: 2.0 to 4.0H:1V Cell 5: 1.3 to 2.5H:1V Cell 4: 1.2 to 1.4H:1V Cell 3: 1.5 to 2.4H:1V		2018 LiDAR Survey
3.2 Signs of Erosion	Minor erosion gullies	7	Erosion gullies along southeast corner of Cell 5
3.3 Signs of Movement (Deformation)	None	13	Small slough along Cell 4 downstream slope adjacent to placed riprap
3.4 Cracks	None		
3.5 Seepage or Wet Areas	Dry		
3.6 Vegetation Growth	Mature trees	4,5,7,8,9,15,	Some dead trees removed during riprap placement in 2019.
3.7 Other Unusual Conditions	None		
4. DOWNSTREAM TOE AREA		4,8,9,12,17,18,20	
4.1 Seepage from Dam	None		
4.2 Signs of Erosion	Riprap placed along toe of Cell 4 & 5	9,12,13	2019 Riprap placed along toe of Cell 4 and 5 along the WKR bank
4.3 Signs of Turbidity in Seepage Water	N/A		
4.4 Discoloration / Staining	N/A		
4.5 Outlet Operating Problem (if applicable)	N/A		
4.6 Other Unusual Conditions	Soft ground encountered along south toe of Cell 5 Animal burrows on west side of Cell 1	20 2	
5. ABUTMENTS			
5.1 Seepage at Contact Zone (Abutment / Embankment)	None		
5.2 Signs of Erosion	None		
5.3 Vegetation	Mature Trees		
5.4 Presence of Rodent Burrows	N/A		
5.5 Other Unusual Conditions	None		
6. RESERVOIR		1,3,6,11,14,16,19	No ponding observed at time of inspection.
6.1 Stability of Slopes	N/A		
6.2 Distance to Nearest Slide (if applicable)	N/A		
6.3 Estimate of Slide Volume (if applicable)	N/A		

INSPECTION ITEM	OBSERVATIONS / DATA	PHOTO	COMMENTS & OTHER DATA
6.4 Floating Debris	N/A		
6.5 Other Unusual Conditions	Plugged decant tower inlet in Cell 5	10	Tower inlet filled in 2016, downstream outlet not found
7. EMERGENCY SPILLWAY / OUTLET STRUCTURE	From Cell 3 to environment	18	Can pass 24-hour Probable Maximum Flood event
7.1 Surface Condition	Class 50 riprap		
7.2 Signs of Erosion	N/A		
7.3 Signs of Movement (Deformation)	N/A		
7.4 Cracks	N/A		
7.5 Settlement	N/A		
7.6 Presence of Debris or Blockage	None		
7.7 Closure Mechanism Operational	N/A		
7.8 Slope Protection	None		
7.9 Instability of Side Slopes	None		
7.10 Other Unusual Conditions	Interior spillways: - From Cell 5 to 4 - From Cell 4 to 3	None 14	Small amount of vegetation in spillway channel
8. INSTRUMENTATION			
8.1 Piezometers	VWPs installed in 2020	16	Vibrating wire piezometers installed in 2020 and connected to remote monitoring system
8.2 Settlement Cells	None		
8.3 Thermistors	None		
8.4 Settlement Monuments	None		
8.5 Accelerograph	None		
8.6 Inclinometer	None		
8.7 Weirs and Flow Monitors	None		
8.8 Data Logger(s)	Installed in 2020		
8.9 Other	Monitoring wells		Monitoring wells along perimeter of facilities
9. DOCUMENTATION			
9.1 Operation, Maintenance and Surveillance (OMS) Manual 9.1.1 OMS Manual Exists	Yes		SP&P BEA-OMS-001.V002
9.1.2 OMS Manual Reflects Current Dam Conditions	No		Update planned for Q4 2020 / Q1 2021
9.1.3 Date of Last Revision	16 February 2018		
9.2 Emergency Preparedness Plan (EPP) 9.2.1 EPP Exists	Yes		SP&P BEA-EPRP-001.V0002

INSPECTION ITEM	OBSERVATIONS / DATA	PHOTO	COMMENTS & OTHER DATA
9.2.2 EPP Reflects Current Conditions	No		Update in progress
9.2.3 Date of Last Revision	22 February 2018		

10. NOTES
2020 site investigation completed in March 2020, including installation of vibrating wire piezometers and test pits along the toe of Cell 3. 2019 riprap was in good condition and 2020 riprap works was completed by 30 November 2020 Required work based on inspection: ■ Remove remaining dead trees along downstream toe of Cell 5 dam during completion of riprap placement. ■ Locate outlet from Cell 5 decant pipe to confirm location and alignment. ■ Install signal repeater(s) to convey the signal from BEA-VWP-2020-04A/B to the gateway at Cell 4 (installed on 1 October 2020)

CLIENT:	Teck Resources Limited	**BY:**	Natasha Carriere, E.I.T.
PROJECT:	Beaverdell Mine	**DATE:**	21 July 2020
LOCATION:	North TSF (Cells 6 and 7)	**REVIEWED:**	John Cunning, P.Eng.

GENERAL INFORMATION

Dam Type: Earthfill

WEATHER CONDITIONS:	Sunny	**AIR TEMPERATURE:**	32°C

INSPECTION ITEM	OBSERVATIONS / DATA	PHOTO	COMMENTS & OTHER DATA
1. DAM CREST		22	
1.1 Crest Elevation	Low Point in Embankment: Cell 6: elev. 797.5 m Cell 7: elev. 798.0 m		2018 LiDAR Survey
1.2 Reservoir Level / Freeboard	Dry	21,24,27,28, 31	No ponding observed during site inspection.
1.3 Distance to Tailings Pond (if applicable)	N/A		
1.4 Surface Cracking	None		
1.5 Unexpected Settlement	None		
1.6 Lateral Movement	None		
1.7 Other Unusual Conditions	Variable crest width: 3 to 4 m		2018 LiDAR Survey
2. UPSTREAM SLOPE		28	
2.1 Slope Angle	1.5H:1V		2018 LiDAR Survey
2.2 Signs of Erosion	Minor	-	Minor surficial erosion noted
2.3 Signs of Movement (Deformation)	None		
2.4 Cracks	None		
2.5 Face Liner Condition (if applicable)	N/A		
2.6 Other Unusual Conditions	Mature trees	28	
3. DOWNSTREAM SLOPE		22,25	
3.1 Slope Angle	Cell 6: 1.4 to 1.9H:1V Cell 7: 1.6 to 2.6H:1V		2018 LiDAR Survey

INSPECTION ITEM	OBSERVATIONS / DATA	PHOTO	COMMENTS & OTHER DATA
3.2 Signs of Erosion	Minor	23	Minor surficial erosion noted at north section of Cell 6
3.3 Signs of Movement (Deformation)	None		
3.4 Cracks	None		
3.5 Seepage or Wet Areas	Dry		
3.6 Vegetation Growth	Mature trees	22,23,25,32	
3.7 Other Unusual Conditions	Equipment tracks	21	Equipment tracks on tailings surface in Cell 6
4. DOWNSTREAM TOE AREA		25,26,29	
4.1 Seepage from Dam	None		
4.2 Signs of Erosion	None		
4.3 Signs of Turbidity in Seepage Water	N/A		
4.4 Discoloration / Staining	N/A		
4.5 Outlet Operating Problem (if applicable)	N/A		
4.6 Other Unusual Conditions	Decant outlets	26,29	Ponded water in metal sump below Cell 6 outlet
5. ABUTMENTS			
5.1 Seepage at Contact Zone (Abutment / Embankment)	None		
5.2 Signs of Erosion	None		
5.3 Vegetation	Immature trees		
5.4 Presence of Rodent Burrows	None		
5.5 Other Unusual Conditions	None		
6. RESERVOIR		21,24,27,28, 31	
6.1 Stability of Slopes	N/A		
6.2 Distance to Nearest Slide (if applicable)	N/A		
6.3 Estimate of Slide Volume (if applicable)	N/A		
6.4 Floating Debris	N/A		
6.5 Other Unusual Conditions	Decant tower inlets	27	Tower inlet filled

INSPECTION ITEM	OBSERVATIONS / DATA	PHOTO	COMMENTS & OTHER DATA
7. EMERGENCY SPILLWAY / OUTLET STRUCTURE	From Cell 7 to environment	30	
7.1 Surface Condition	Alluvial cobbles, original ground		
7.2 Signs of Erosion	None		
7.3 Signs of Movement (Deformation)	None		
7.4 Cracks	None		
7.5 Settlement	None		
7.6 Presence of Debris or Blockage	Small trees within diversion and spillway channels	30	
7.7 Closure Mechanism Operational	N/A		
7.8 Slope Protection	N/A		
7.9 Instability of Side Slopes	None		
7.10 Other Unusual Conditions	N/A		
8. INSTRUMENTATION			
8.1 Piezometers	VWPs installed in 2020		Vibrating wire piezometers installed in 2020
8.2 Settlement Cells	None		
8.3 Thermistors	None		
8.4 Settlement Monuments	None		
8.5 Accelerograph	None		
8.6 Inclinometer	None		
8.7 Weirs and Flow Monitors	None		
8.8 Data Logger(s)	Installed in 2020		
8.9 Other	Monitoring wells		Monitoring wells along perimeter of facilities
9. DOCUMENTATION			
9.1 Operation, Maintenance and Surveillance (OMS) Manual 9.1.1 OMS Manual Exists	Yes		SP&P BEA-OMS-001.V002
9.1.2 OMS Manual Reflects Current Dam Conditions	No		Update planned for Q4 2020 / Q1 2021
9.1.3 Date of Last Revision	16 February 2018		
9.2 Emergency Preparedness Plan (EPP) 9.2.1 EPP Exists	Yes		SP&P BEA-EPRP-001.V0002
9.2.2 EPP Reflects Current Conditions	No		Update in progress
9.2.3 Date of Last Revision	22 February 2018		

10. NOTES
2020 site investigation completed in March 2020, including installation of vibrating wire piezometers. Signal not consistently received at gateway at Cell 4. Required work based on inspection: ■ Clear vegetation from the spillway ■ Install signal repeater(s) to convey the signal from the dataloggers to the gateway at Cell 4 (installed on 1 October 2020)

https://golderassociates.sharepoint.com/sites/124047/project files/6 deliverables/issued/275-r-rev0-1000-2020 annual inspection/appendices/appendix c - inspection reports/appendix c2 - north tsf inspection report.docx

APPENDIX D

Available Design and As-Built Cross-Sections

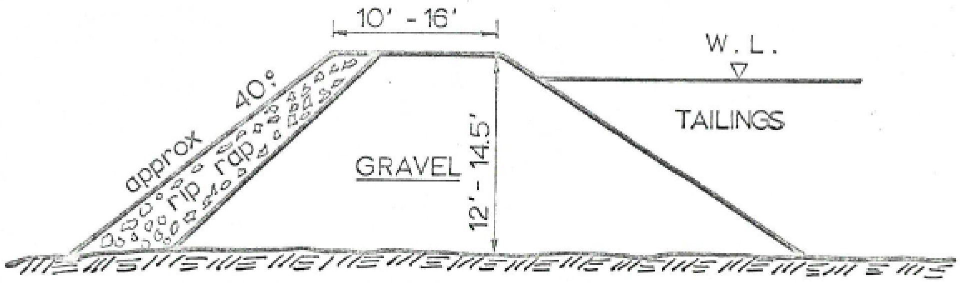
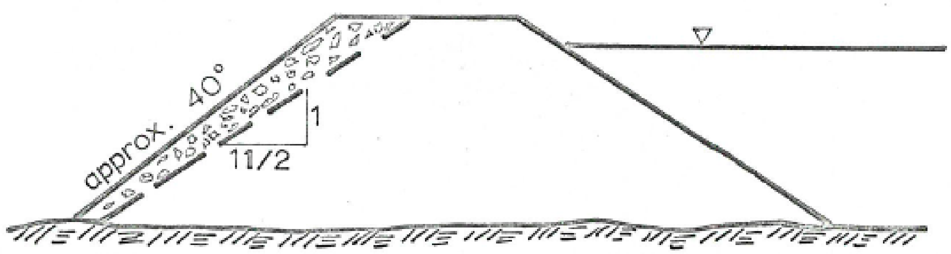


FIG. A



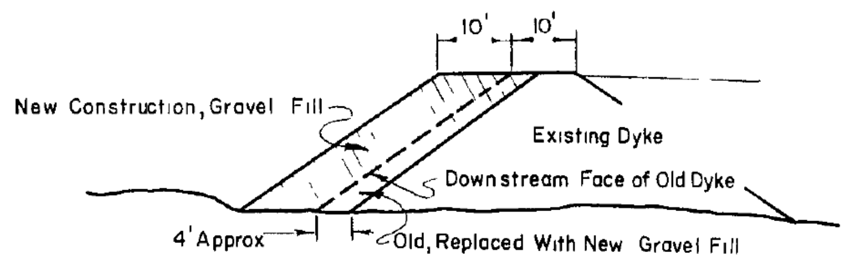
Assumed actual crossection

FIG. B

REFERENCE: BINNIE (ROBERT F. BINNIE LTD.). 1971. REPORT ON STABILITY OF TAILINGS DAM. REPORT PREPARED FOR TECK CORPORATION LTD., BEAVERDELL, BC. SUBMITTED 8 JUNE 1971.

TYPICAL SECTION Y-Y

SCALE 1"= 20' Approx



REFERENCE: BINNIE (ROBERT F. BINNIE LTD.). 1973. REPORT ON PROPOSED NEW TAILINGS CELL. REPORT PREPARED FOR TECK CORPORATION LTD., BEAVERDELL

CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGN	NEC
REVIEW	MBW
APPROVED	JCC

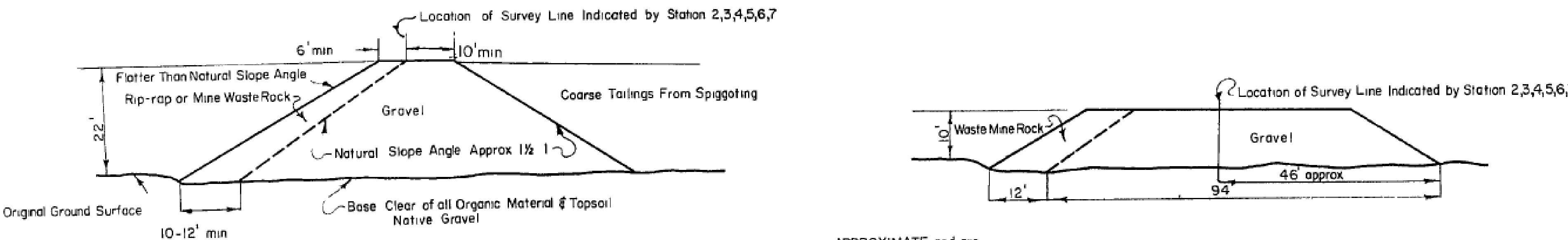
PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL FACILITY INSPECTION REPORT

TITLE
CELL 4 CROSS SECTIONS

PROJECT No.	Phase No.	Rev.	Sheet
20140466	1000-1006-275	0	D-1

TYPICAL SECTION X-X AT FINAL HEIGHT & INITIAL CONSTRUCTION STAGE

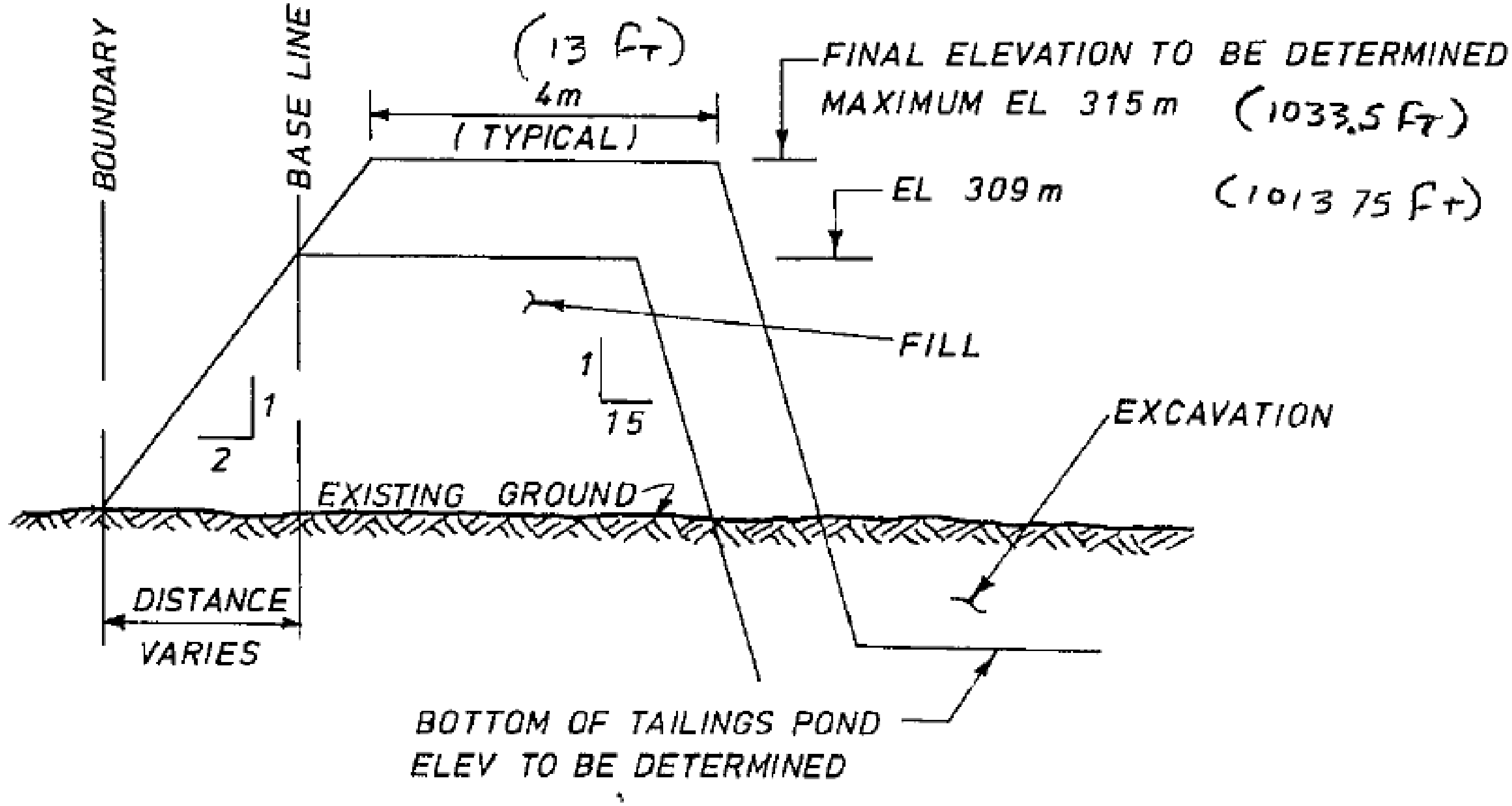
FINAL HEIGHT SCALE 1" = 20' Approx INITIAL STAGE



NOTE Dimensions are APPROXIMATE and are only for the highest section. Dimensions should be decreased accordingly where the ultimate height will be less. Slopes remain constant.

REFERENCE: BINNIE (ROBERT F. BINNIE LTD.). 1973. REPORT ON PROPOSED NEW TAILINGS CELL. REPORT PREPARED FOR TECK CORPORATION LTD., BEAVERDELL

CLIENT	TECK RESOURCES LIMITED BEAVERDELL MINE BEAVERDELL, B.C.	PROJECT	BEAVERDELL TAILINGS STORAGE FACILITIES 2020 ANNUAL FACILITY INSPECTION REPORT
CONSULTANT	GOLDER	TITLE	DAM DESIGN FOR CELL 5 CROSS SECTIONS
YYYY-MM-DD	2021-03-24	PROJECT No.	20140466
PREPARED	NEC	Phase No.	1000-1006-275
DESIGN	NEC	Rev.	0
REVIEW	MBW	Sheet	D-2
APPROVED	JCC		



TYPICAL DAM CROSS-SECTION

NOT TO SCALE

REFERENCE: BINNIE (ROBERT F. BINNIE LTD.). 1980A. REPORT ON TAILINGS DISPOSAL POND NO. 5 AND PROPOSED POND NO. 6. REPORT PREPARED FOR TECK CORPORATION LTD., BEAVERDELL, BC. SUBMITTED 20 FEBRUARY 1980.

CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

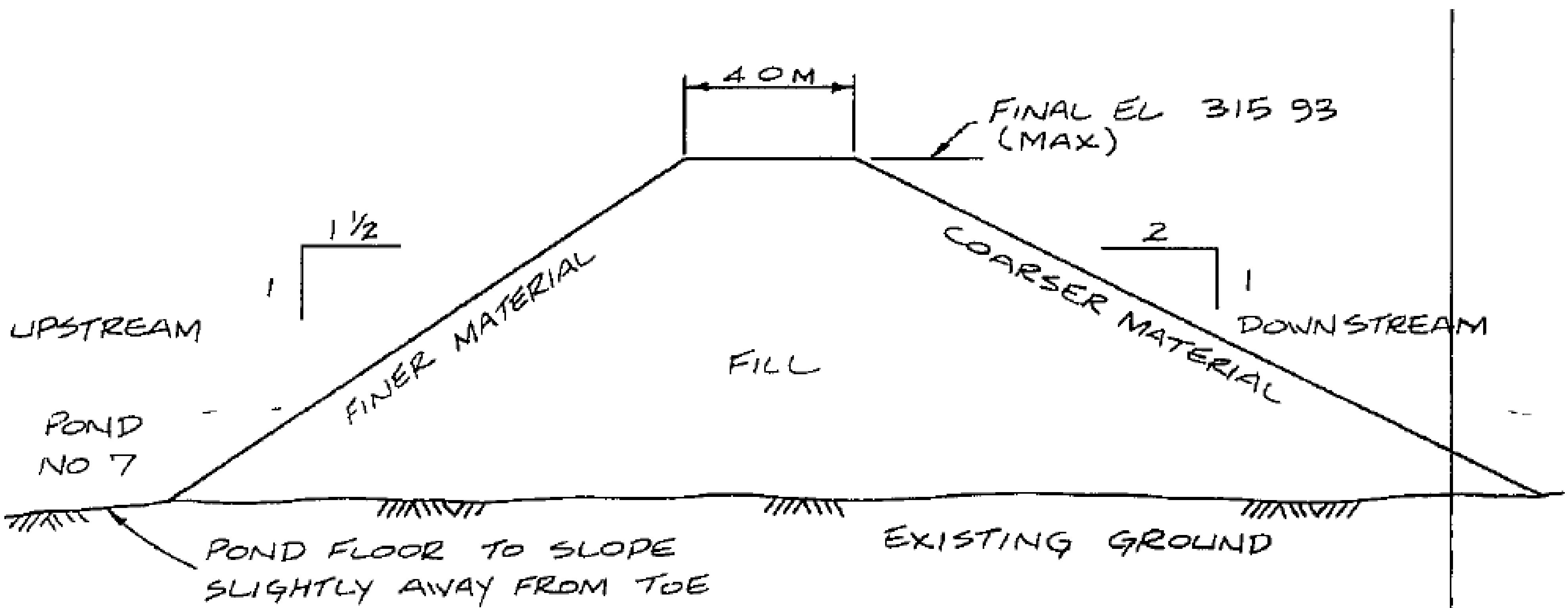
CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGN	NEC
REVIEW	MBW
APPROVED	JCC

PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL FACILITY INSPECTION REPORT

TITLE
DAM DESIGN FOR CELL 6
CROSS SECTIONS

PROJECT No.	Phase No.	Rev.	Sheet
20140466	1000-1006-275	0	D-3



REFERENCE: BINNIE (R.F. BINNIE & ASSOCIATES LTD). 1988. REPORT ON PROPOSED POND NO. 7. REPORT PREPARED FOR TECK CORPORATION, BEAVERDELL, BC. SUBMITTED APRIL 1988.

CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGN	NEC
REVIEW	MBW
APPROVED	JCC

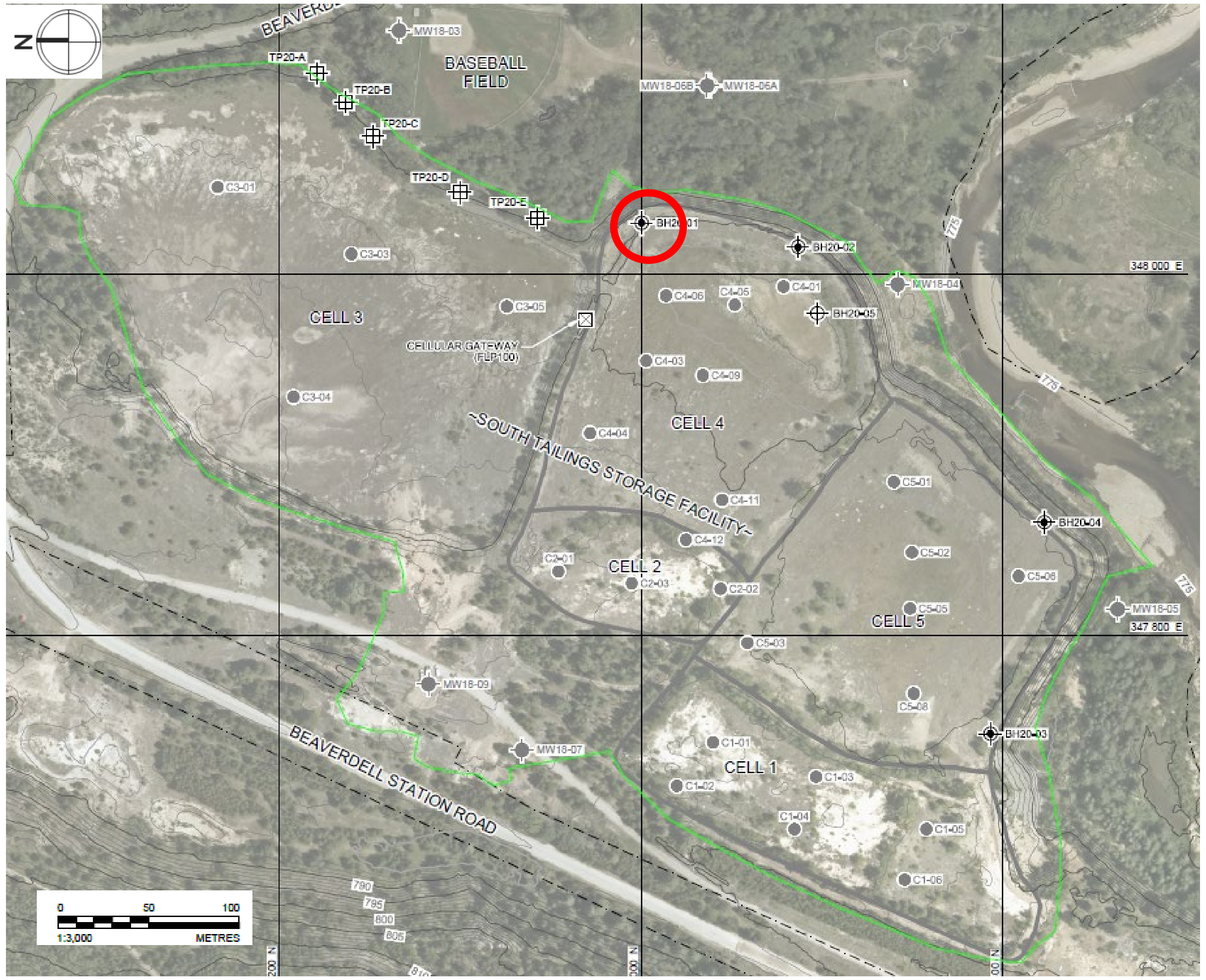
PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL FACILITY INSPECTION REPORT

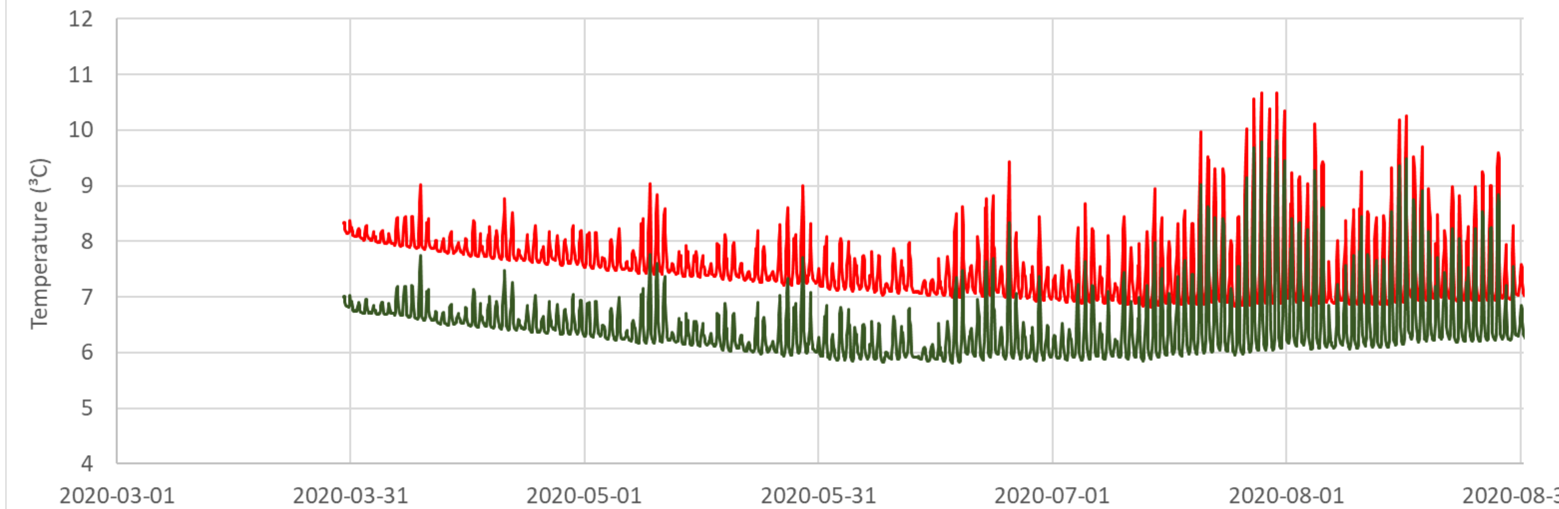
TITLE
DAM DESIGN FOR CELL 7
CROSS SECTIONS

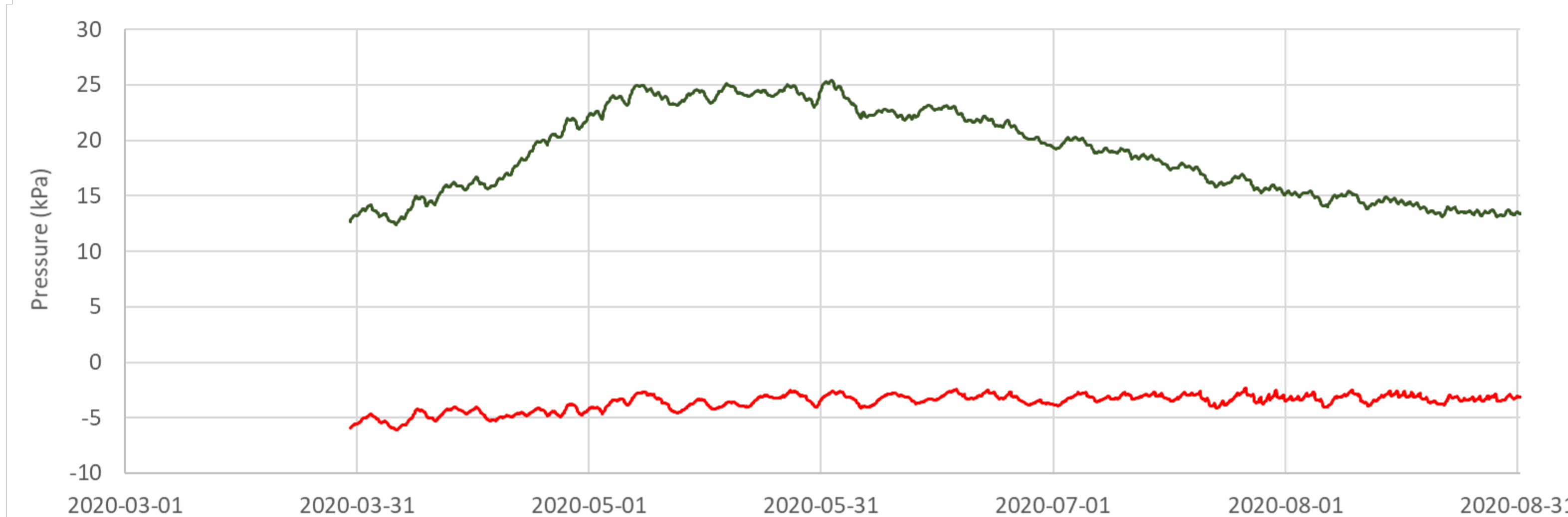
PROJECT No.	Phase No.	Rev.	Sheet
20140466	1000-1006-275	0	D-4

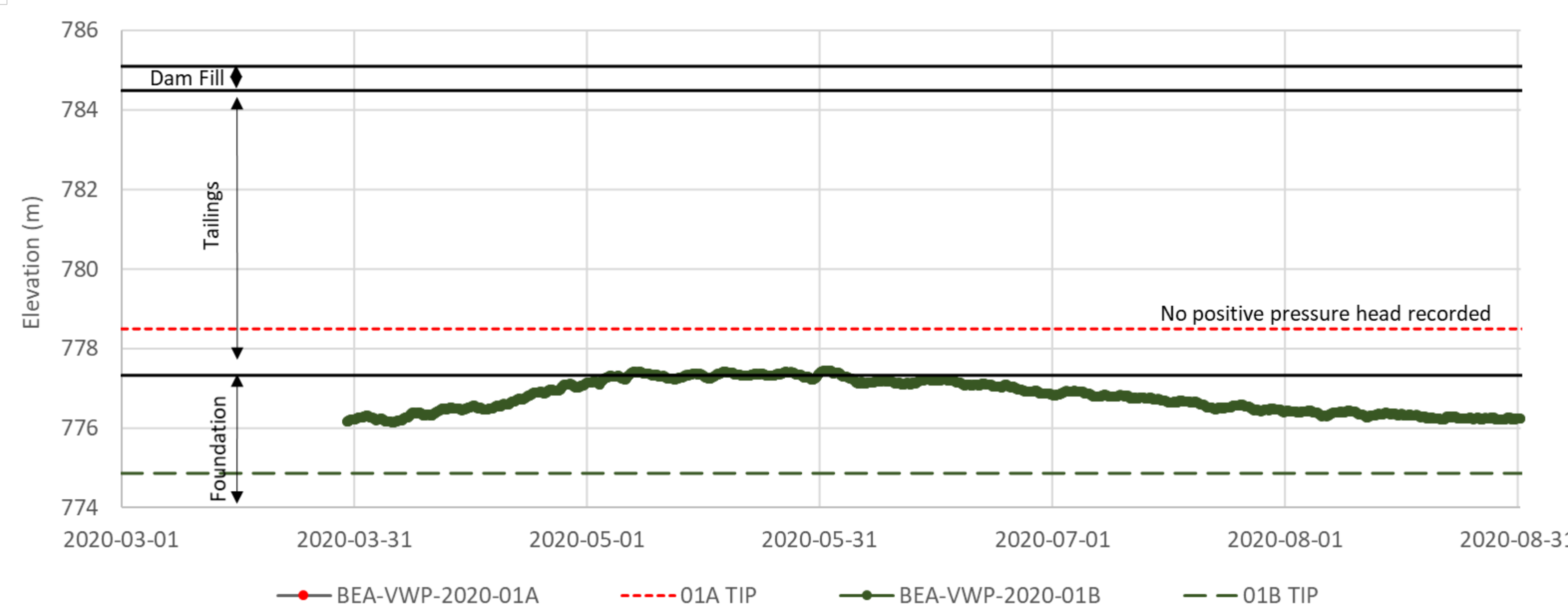
APPENDIX E

2020 Reporting Period Piezometer Data









LEGEND

- AS-BUILT TEST PIT LOCATION
- AS-BUILT BOREHOLE LOCATION WITH LARGE PENETRATION TESTING AND VIBRATING WIRE PIEZOMETERS
- AS-BUILT BOREHOLE LOCATION - TAILINGS SAMPLE
- APPROXIMATE PROPERTY BOUNDARY
- 820 EXISTING GROUND CONTOURS (SEE REFERENCE 1)
- GROUNDWATER MONITORING WELLS (BY WOOD PLC, COMPLETED JULY 2018)
- 2018 CONE PENETRATION TEST LOCATION (GOLDER 2019)
- APPROXIMATE M-71 PERMIT BOUNDARY
- PIEZOMETER LOCATION

NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES ARE IN UTM, NAD83, ZONE 11 VERTICAL DATUM CGVD 2013.
3. 2018 CONTOURS SHOWN AT 1.0 m MINOR AND 5.0 m MAJOR INTERVAL.
4. INTERFACES FOR BOREHOLES WITH VIBRATING WIRE PIEZOMETERS INSTALLED ARE WITHIN 2 m OF THE AS-BUILT LOCATION.

REFERENCE

1. 2018 EXISTING GROUND LIDAR SURVEY AND ORTHOPHOTO BY MCELHANNEY 19 JULY 2018, PROVIDED BY MCELHANNEY, RECEIVED: 24 AUGUST 2018, FILE NAME: 358400VLIDARCONTOURS.dwg.

NOTES:

(a) PLOTTED DATA DOES NOT INCLUDE ATMOSPHERIC PRESSURE CORRECTION.

(b) PIEZOMETRIC LEVELS BELOW TIP ELEVATION INDICATE NEGATIVE PRESSURES. NEGATIVE PRESSURES NOT INDICATIVE OF PIEZOMETRIC LEVEL

CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL FACILITY INSPECTION REPORT

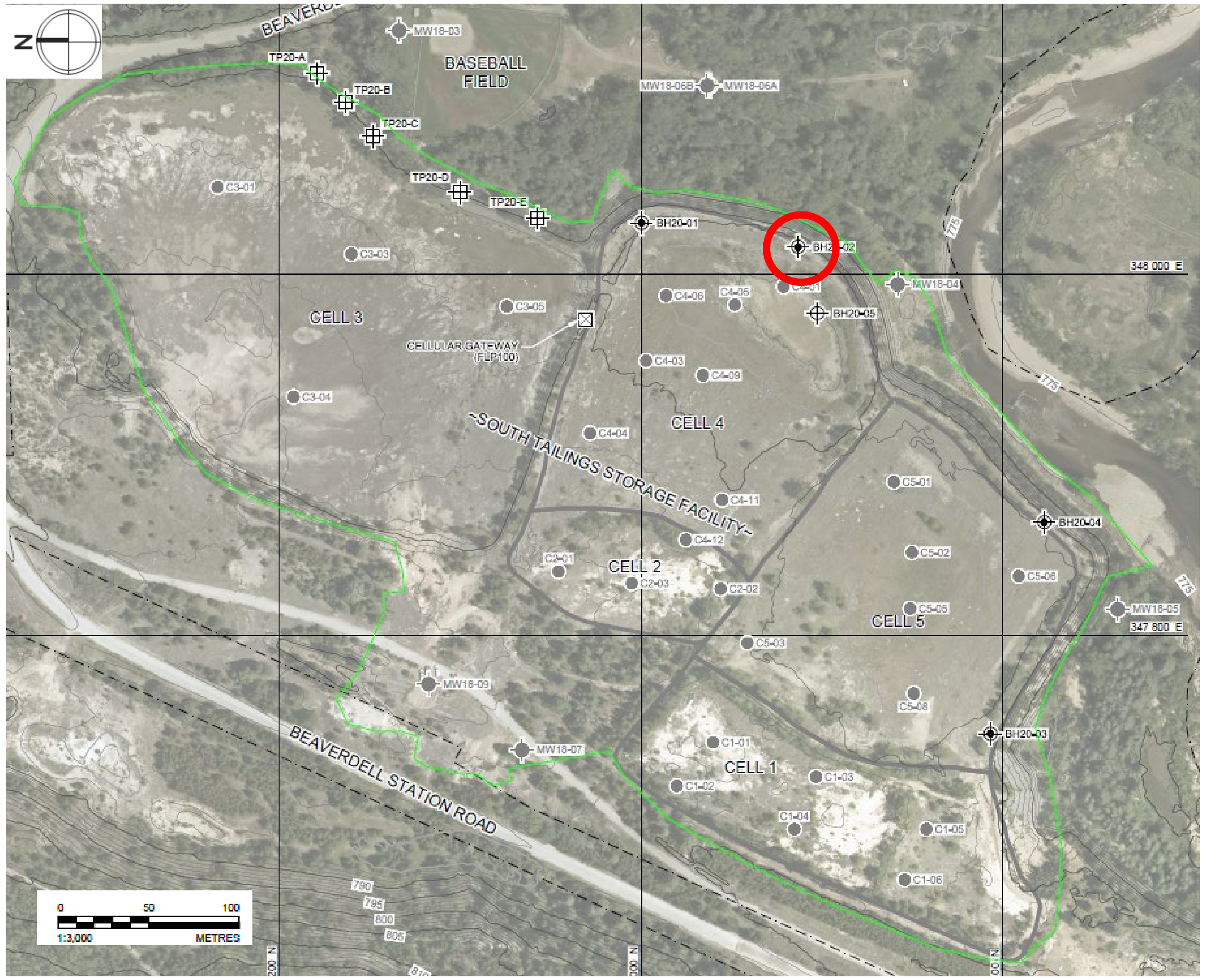
CONSULTANT

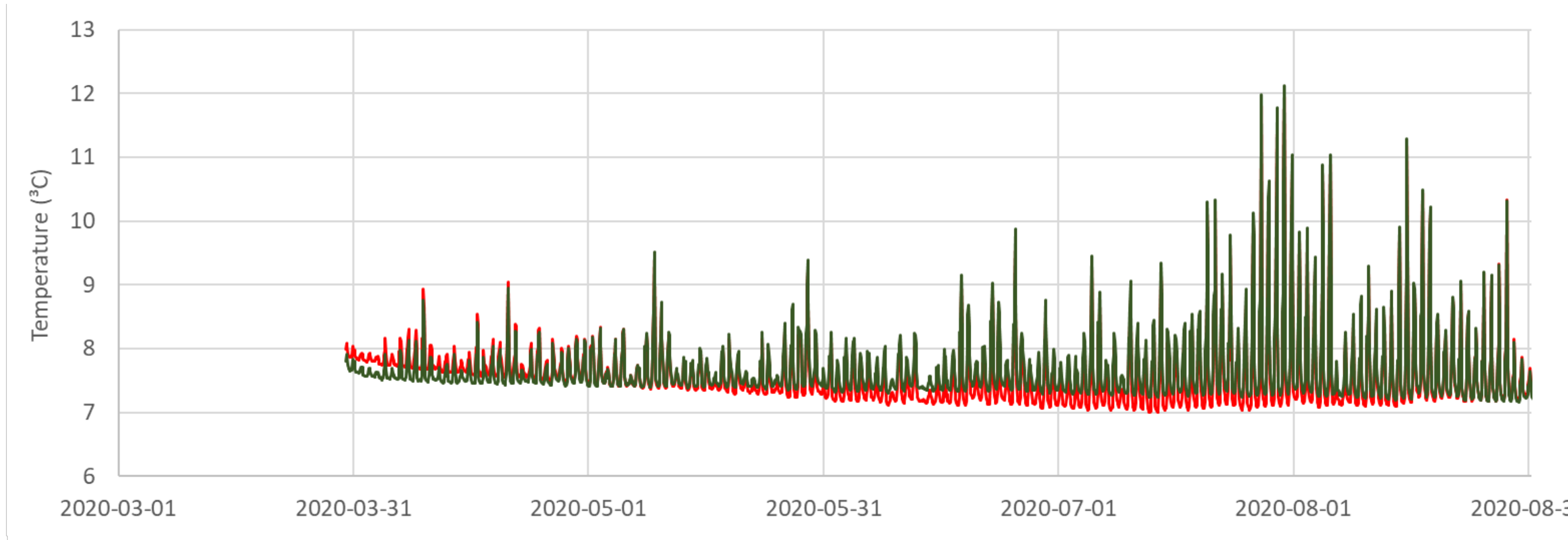
GOLDER

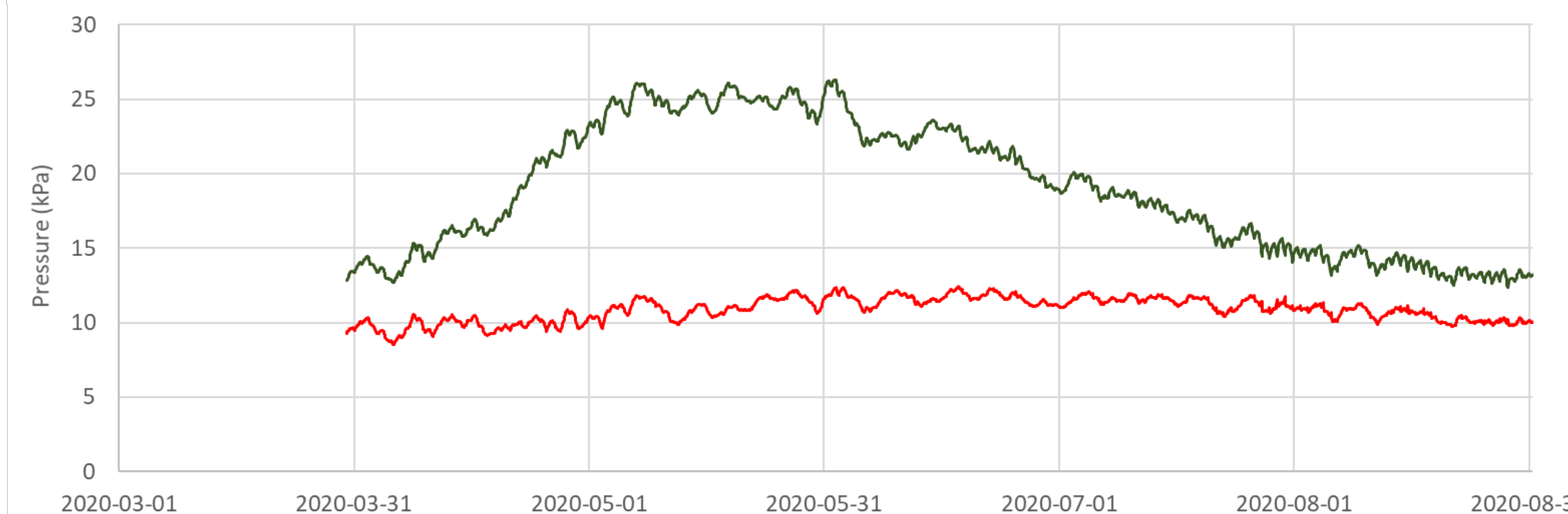
YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGNED	NEC
REVIEWED	MBW
APPROVED	JCC

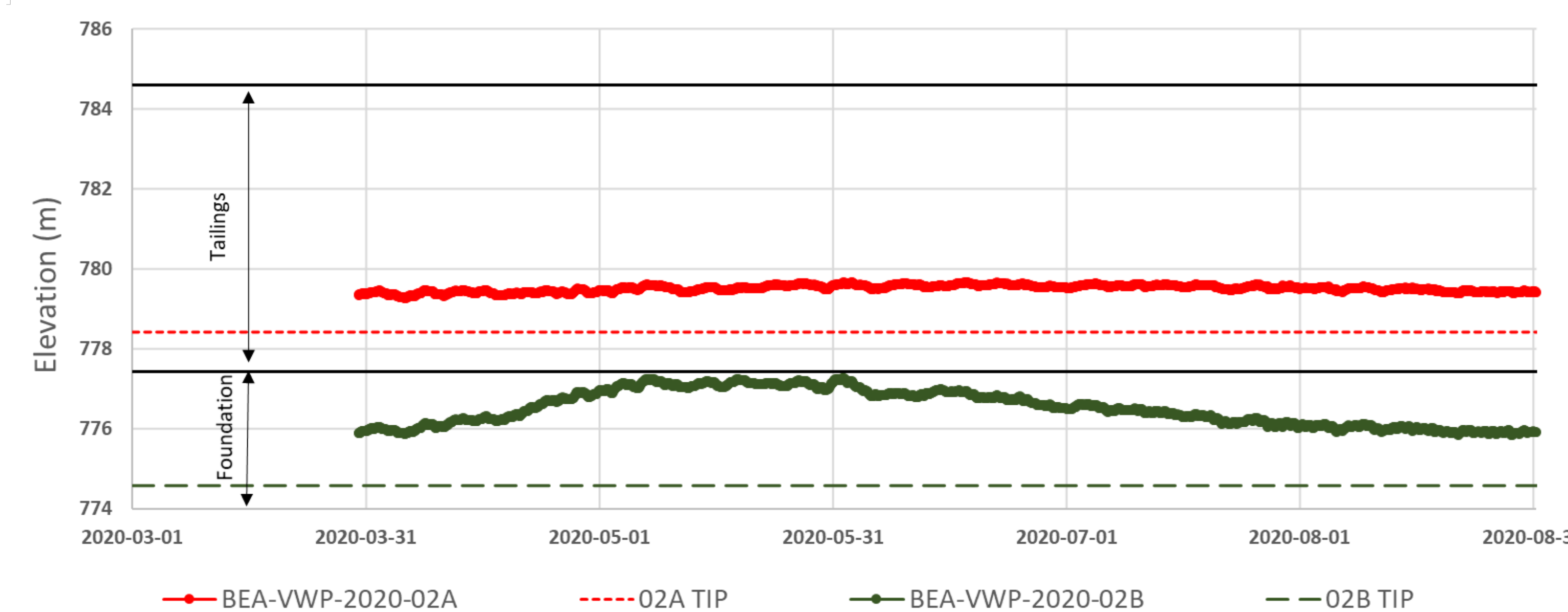
TITLE
BOREHOLE BH20-01
VIBRATING WIRE PIEZOMETER BEA-VWP-2020-01A/B

PROJECT NO.	PHASE/TASK/DOC	REV.	FIGURE
20140466	1000-1006-275	0	E-1









LEGEND

- AS-BUILT TEST PIT LOCATION
- AS-BUILT BOREHOLE LOCATION WITH LARGE PENETRATION TESTING AND VIBRATING WIRE PIEZOMETERS
- AS-BUILT BOREHOLE LOCATION - TAILINGS SAMPLE
- APPROXIMATE PROPERTY BOUNDARY
- 820 EXISTING GROUND CONTOURS (SEE REFERENCE 1)
- GROUNDWATER MONITORING WELLS (BY WOOD PLC, COMPLETED JULY 2018)
- 2018 CONE PENETRATION TEST LOCATION (GOLDER 2019)
- APPROXIMATE M-71 PERMIT BOUNDARY
- PIEZOMETER LOCATION

NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES ARE IN UTM, NAD83, ZONE 11 VERTICAL DATUM CGVD 2013.
3. 2018 CONTOURS SHOWN AT 1.0 m MINOR AND 5.0 m MAJOR INTERVAL.
4. INTERFACES FOR BOREHOLES WITH VIBRATING WIRE PIEZOMETERS INSTALLED ARE WITHIN 2 m OF THE AS-BUILT LOCATION.

REFERENCE

1. 2018 EXISTING GROUND LIDAR SURVEY AND ORTHOPHOTO BY MCELHANNEY 19 JULY 2018, PROVIDED BY MCELHANNEY, RECEIVED: 24 AUGUST 2018, FILE NAME: 358400VLIDARCONTOURS.dwg.

NOTES:
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CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL FACILITY INSPECTION REPORT

CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGNED	NEC
REVIEWED	MBW
APPROVED	JCC

TITLE
BOREHOLE BH20-02
VIBRATING WIRE PIEZOMETER BEA-VWP-2020-02A/B

PROJECT NO.	PHASE/TASK/DOC	REV.	FIGURE
20140466	1000-1006-275	0	E-2

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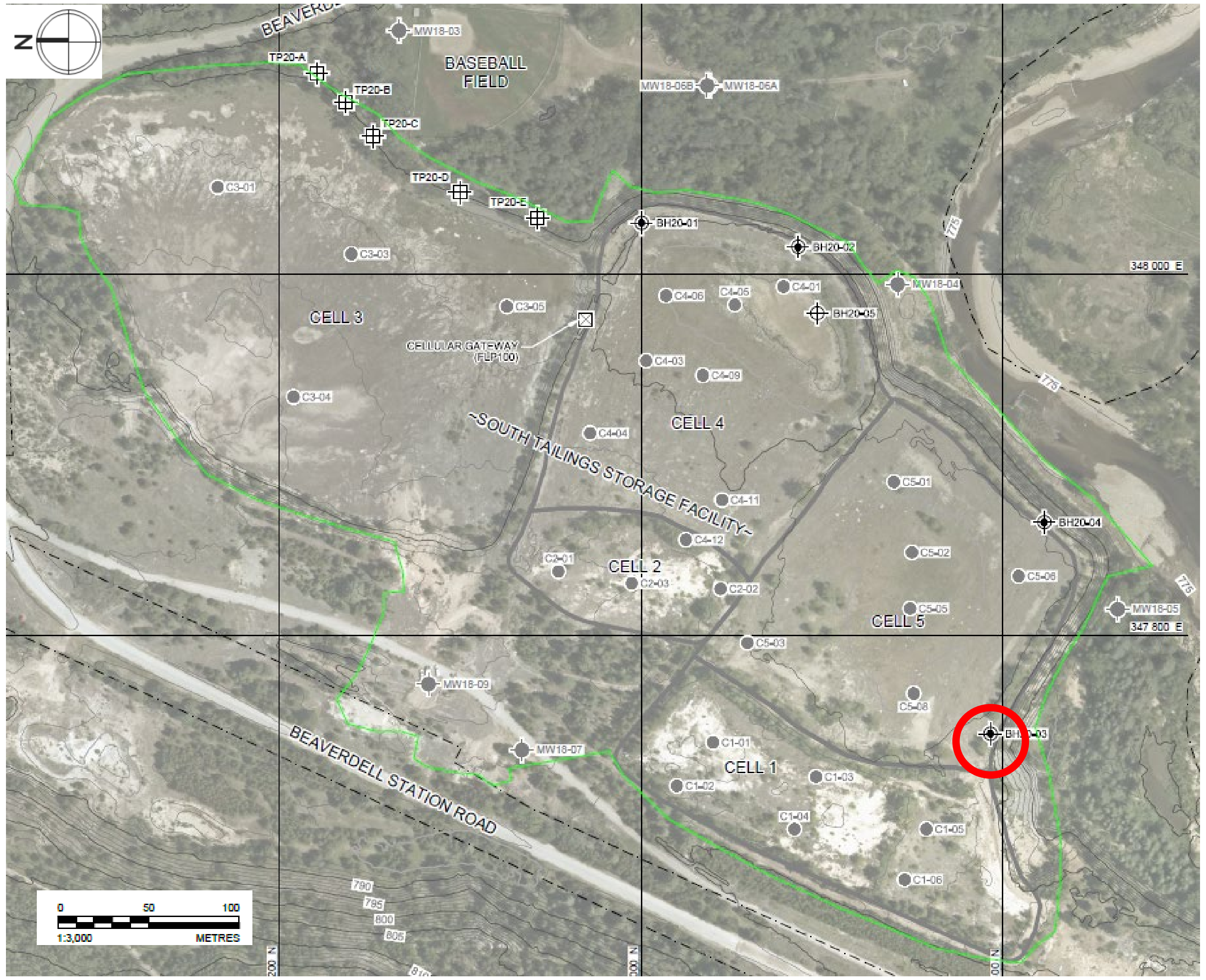

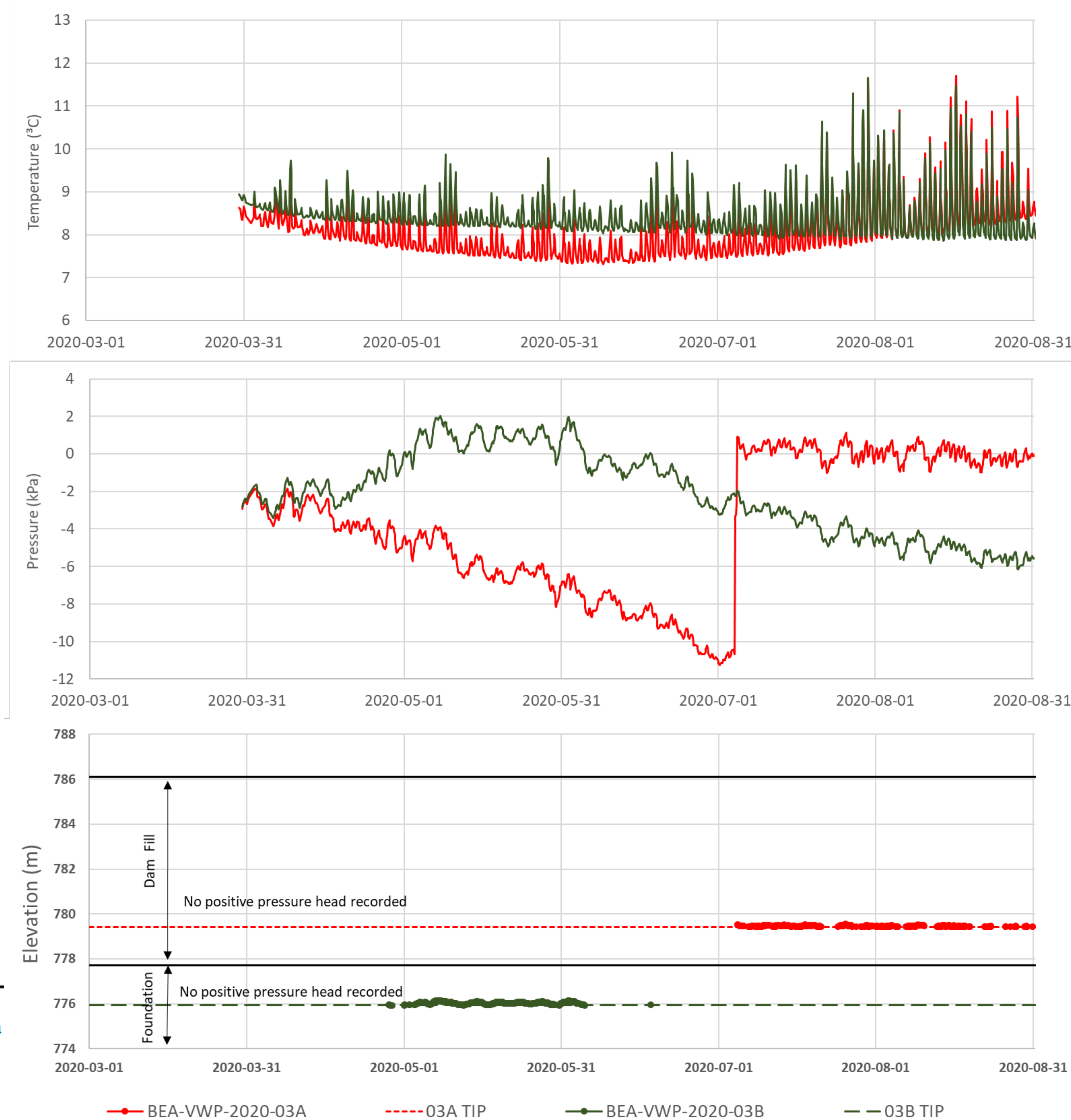

LEGEND

- AS-BUILT TEST PIT LOCATION
- AS-BUILT BOREHOLE LOCATION WITH LARGE PENETRATION TESTING AND VIBRATING WIRE PIEZOMETERS
- AS-BUILT BOREHOLE LOCATION - TAILINGS SAMPLE
- APPROXIMATE PROPERTY BOUNDARY
- 820 EXISTING GROUND CONTOURS (SEE REFERENCE 1)
- GROUNDWATER MONITORING WELLS (BY WOOD PLC, COMPLETED JULY 2018)
- 2018 CONE PENETRATION TEST LOCATION (GOLDER 2019)
- APPROXIMATE M-71 PERMIT BOUNDARY
- PIEZOMETER LOCATION

NOTES

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4. INTERFACES FOR BOREHOLES WITH VIBRATING WIRE PIEZOMETERS INSTALLED ARE WITHIN 2 m OF THE AS-BUILT LOCATION.

REFERENCE

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NOTES:
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CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL FACILITY INSPECTION REPORT

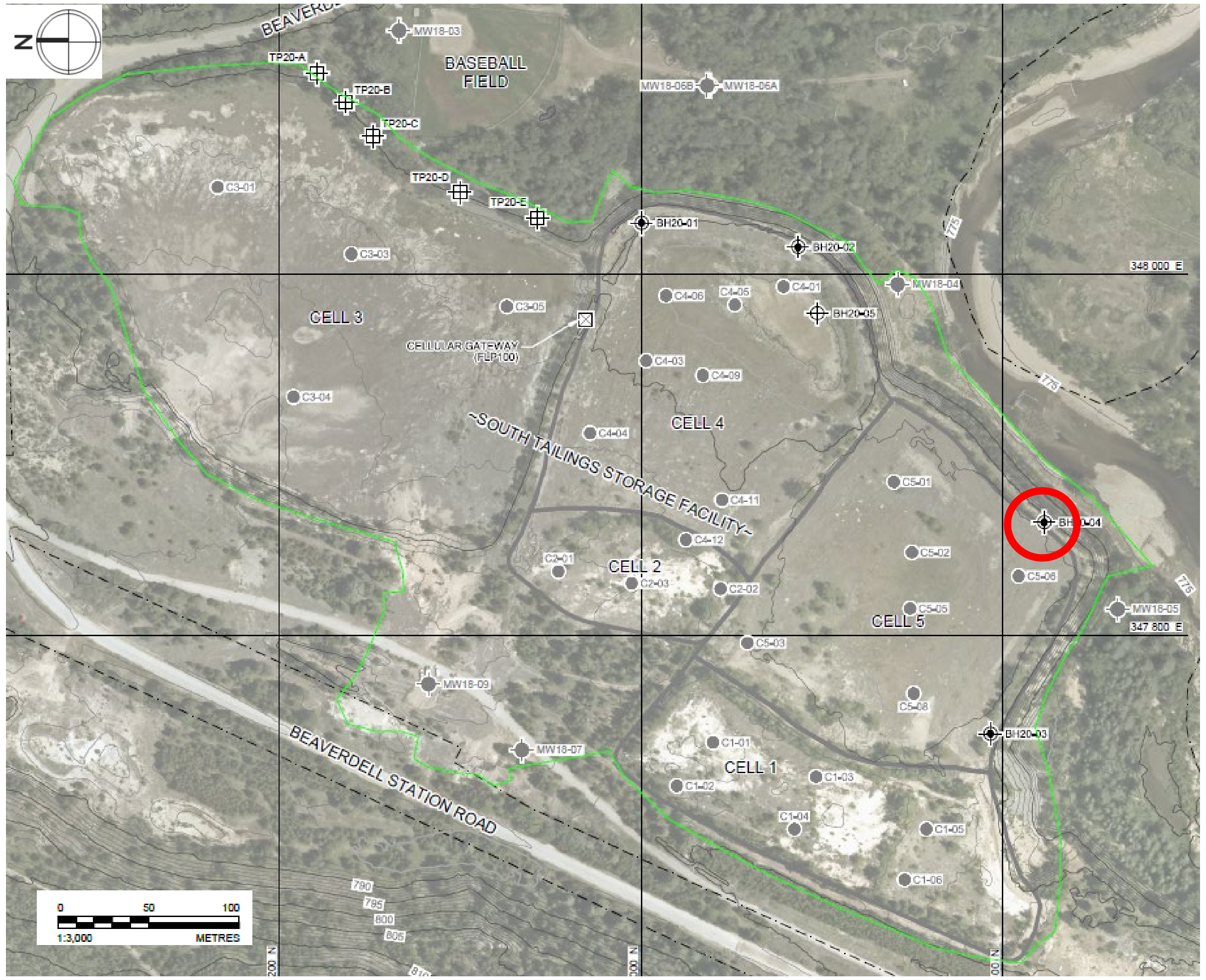
CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGNED	NEC
REVIEWED	MBW
APPROVED	JCC

TITLE
BOREHOLE BH20-03
VIBRATING WIRE PIEZOMETER BEA-VWP-2020-03A/B

PROJECT NO.	PHASE/TASK/DOC	REV.	FIGURE
20140466	1000-1006-275	0	E-3

https://golderassociates.sharepoint.com/:x:/r/sites/124047/Project%20Files/5%20Technical%20Work/VWP%20Conversions%20%26%20Plots/BEA%20VWP%20Plots_2020DSI.xlsx?d=weff05e5b5bed460faa58dbf17546ed14&csf=1&web=1&e=QnaE4M



LEGEND

- AS-BUILT TEST PIT LOCATION
- AS-BUILT BOREHOLE LOCATION WITH LARGE PENETRATION TESTING AND VIBRATING WIRE PIEZOMETERS
- AS-BUILT BOREHOLE LOCATION - TAILINGS SAMPLE
- APPROXIMATE PROPERTY BOUNDARY
- 820 EXISTING GROUND CONTOURS (SEE REFERENCE 1)
- GROUNDWATER MONITORING WELLS (BY WOOD PLC, COMPLETED JULY 2018)
- 2018 CONE PENETRATION TEST LOCATION (GOLDER 2019)
- APPROXIMATE M-71 PERMIT BOUNDARY
- PIEZOMETER LOCATION

NOTES

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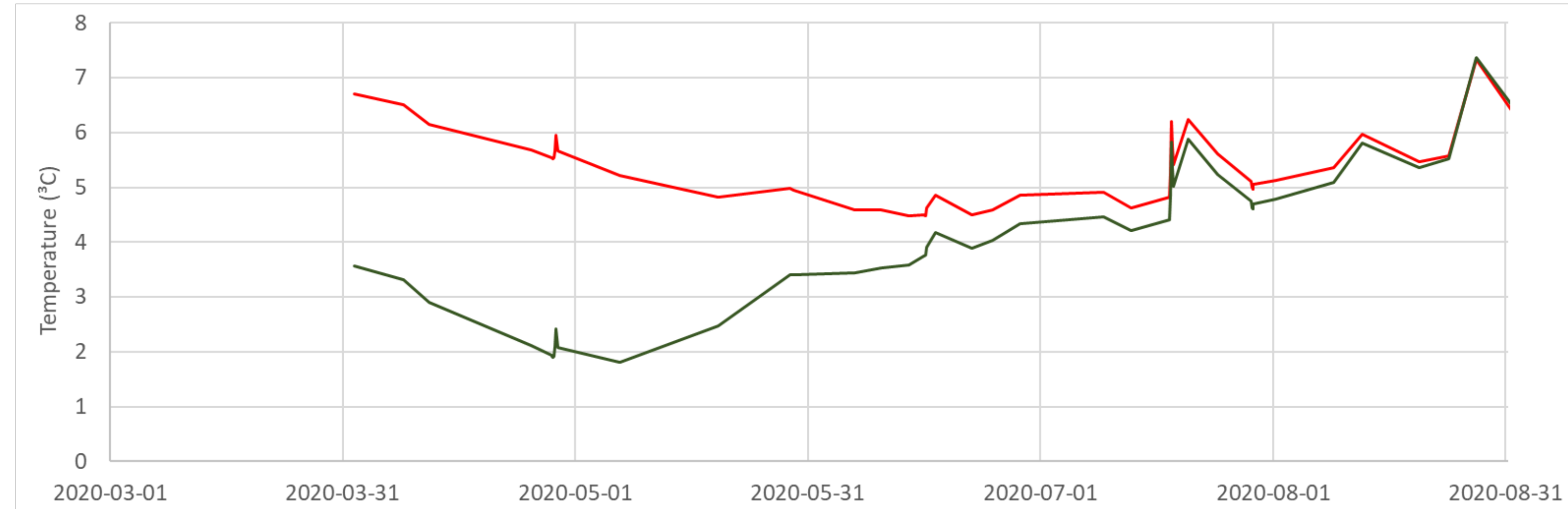
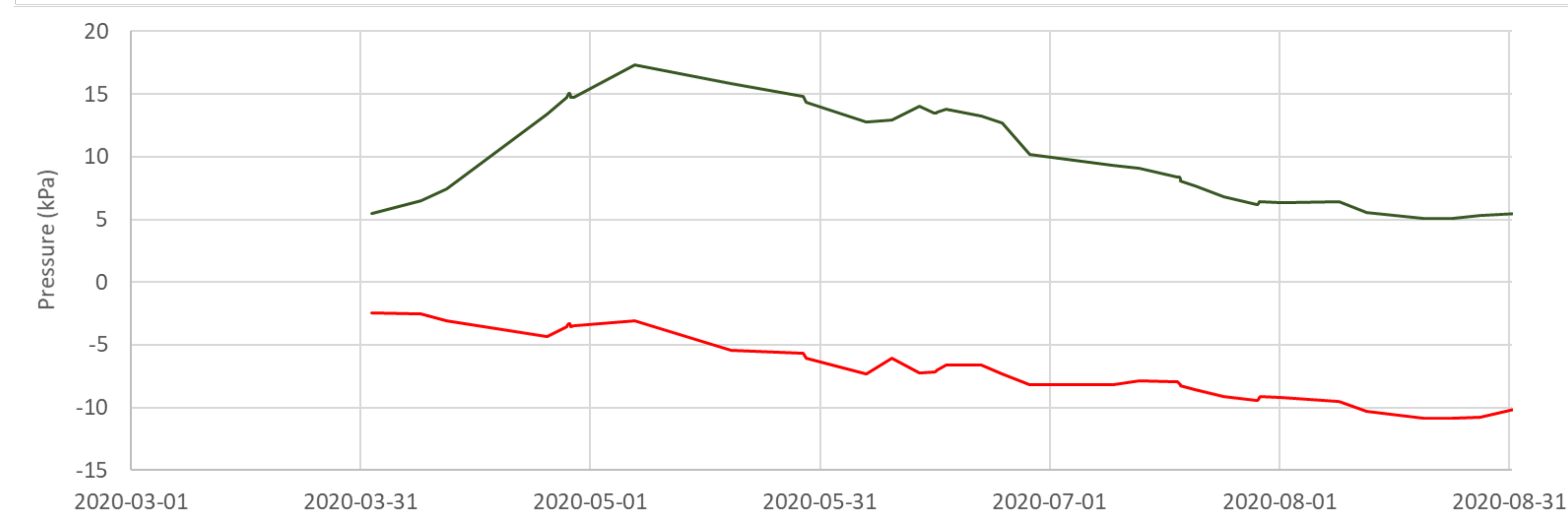
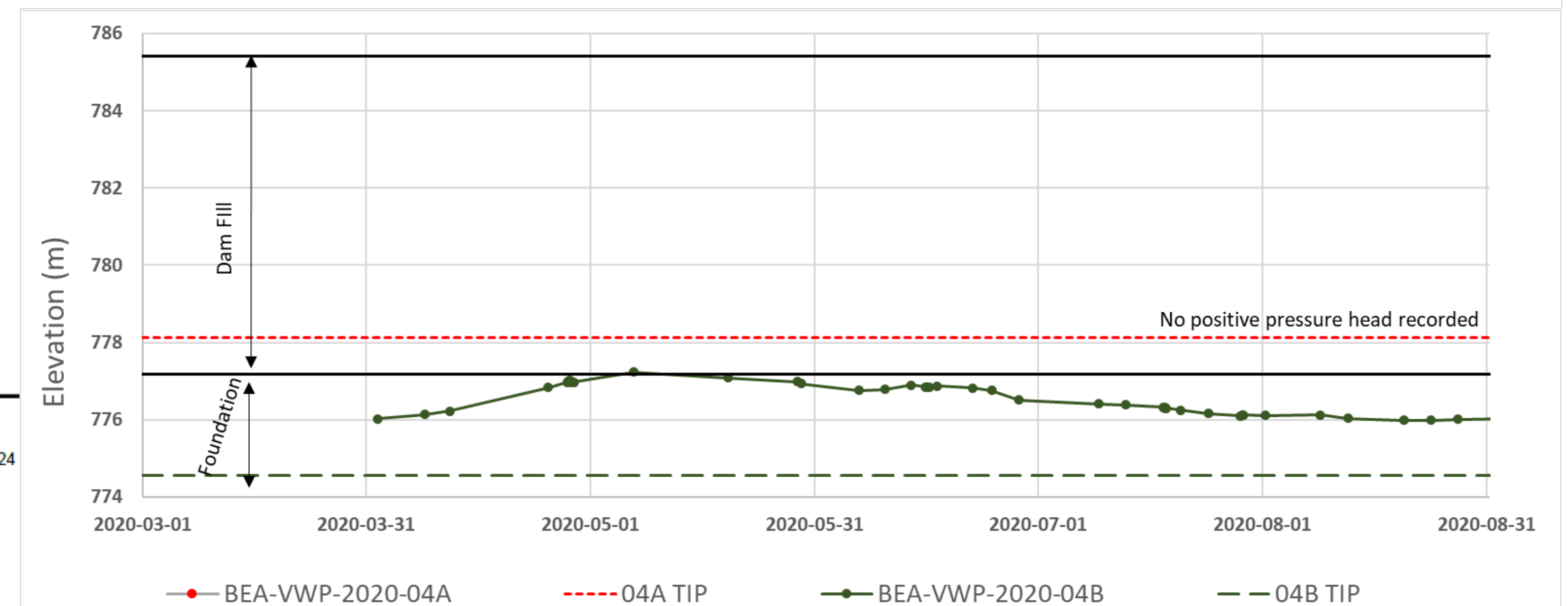
REFERENCE

1. 2018 EXISTING GROUND LIDAR SURVEY AND ORTHOPHOTO BY MCELHANNEY 19 JULY 2018, PROVIDED BY MCELHANNEY, RECEIVED: 24 AUGUST 2018, FILE NAME: 358400VLIDARCONTOURS.dwg.







NOTES:

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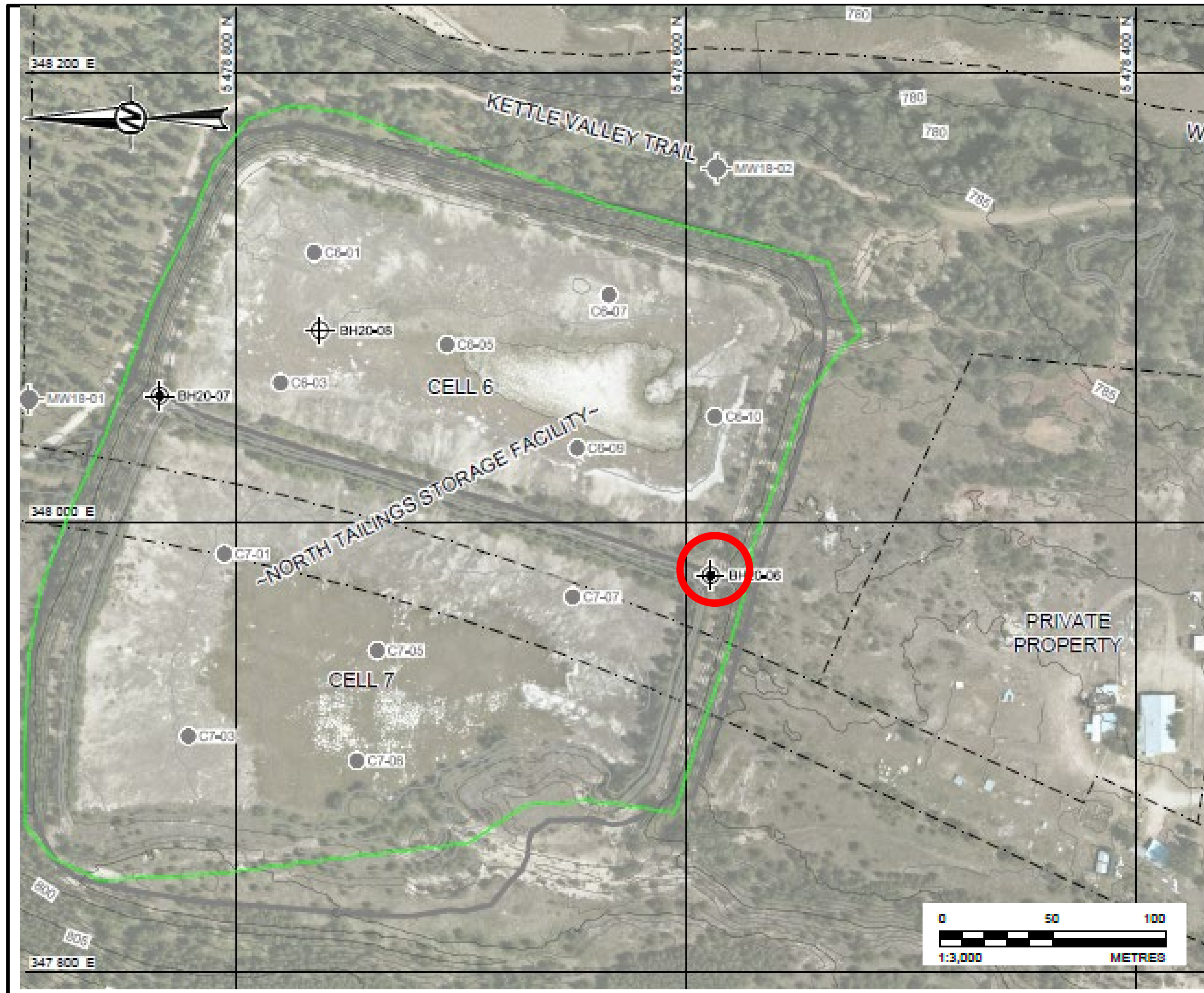
PROJECT	BEAVERDELL TAILINGS STORAGE FACILITIES 2020 ANNUAL FACILITY INSPECTION REPORT
CONSULTANT	GOLDER
YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGNED	NEC
REVIEWED	MBW
APPROVED	JCC
TITLE	BOREHOLE BH20-04 VIBRATING WIRE PIEZOMETER BEA-VWP-2020-04A/B
PROJECT NO.	20140466
PHASE/TASK/DOC	1000-1006-275
REV.	0
FIGURE	E-4



LEGEND

- AS-BUILT TEST PIT LOCATION
- AS-BUILT BOREHOLE LOCATION WITH LARGE PENETRATION TESTING AND VIBRATING WIRE PIEZOMETERS
- AS-BUILT BOREHOLE LOCATION - TAILINGS SAMPLE
- APPROXIMATE PROPERTY BOUNDARY
- 820 EXISTING GROUND CONTOURS (SEE REFERENCE 1)
- GROUNDWATER MONITORING WELLS (BY WOOD PLC, COMPLETED JULY 2018)
- 2018 CONE PENETRATION TEST LOCATION (GOLDER 2019)
- APPROXIMATE M-71 PERMIT BOUNDARY
- PIEZOMETER LOCATION

NOTES

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REFERENCE

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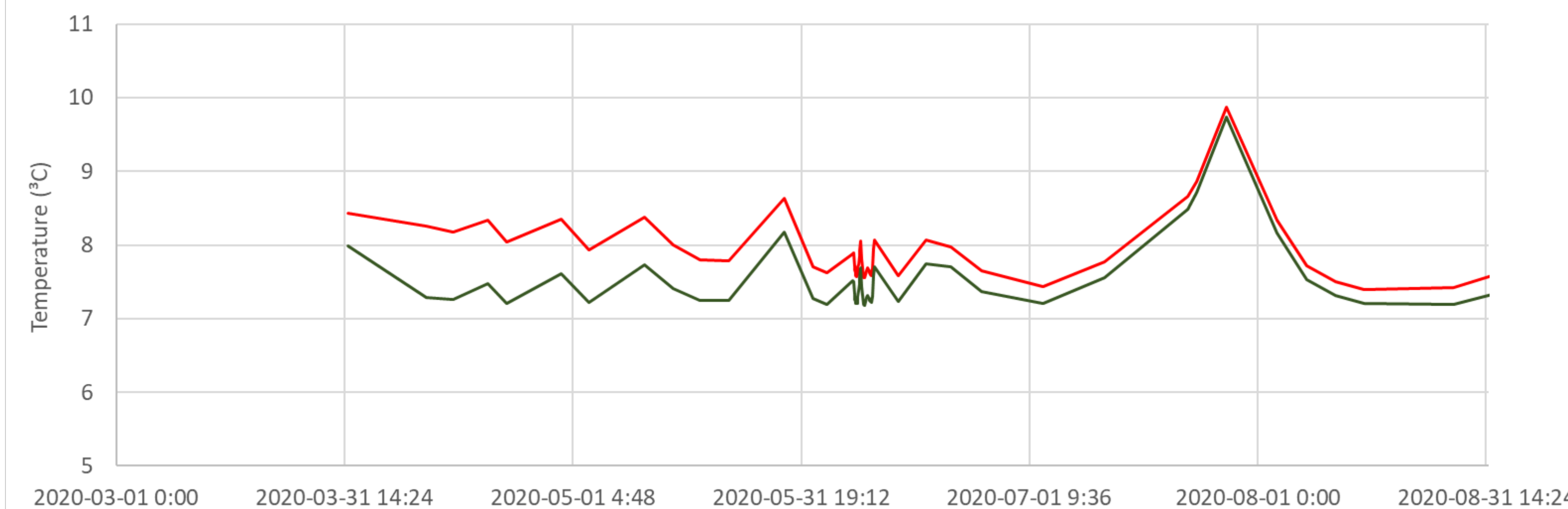

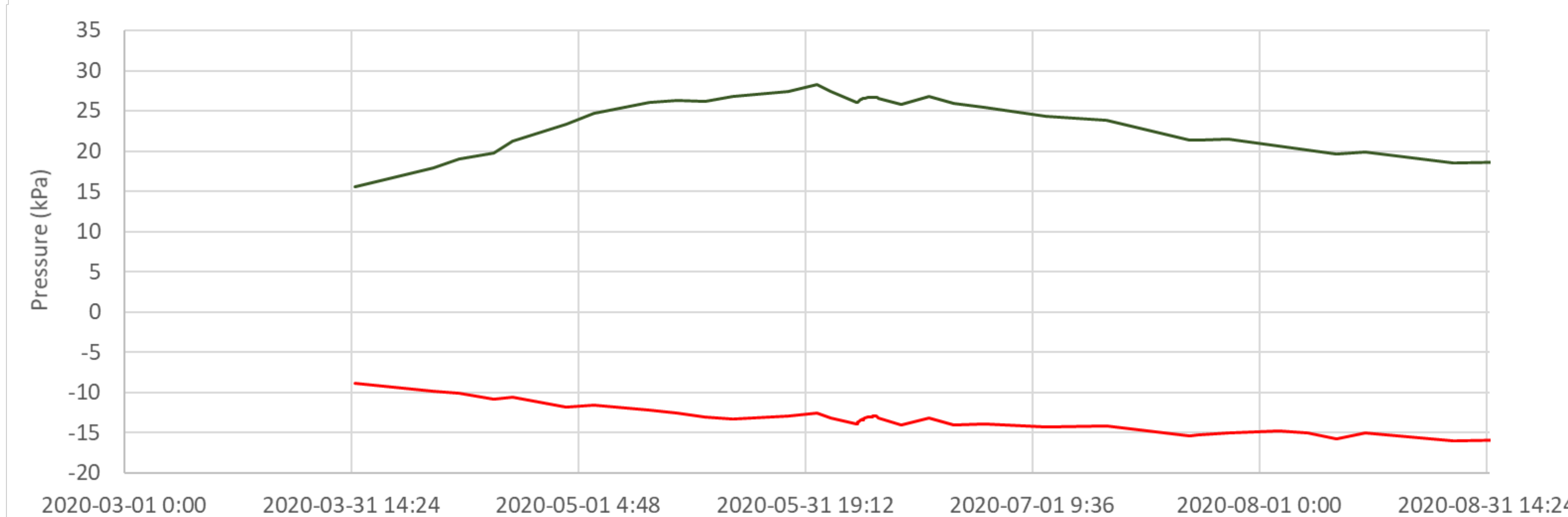

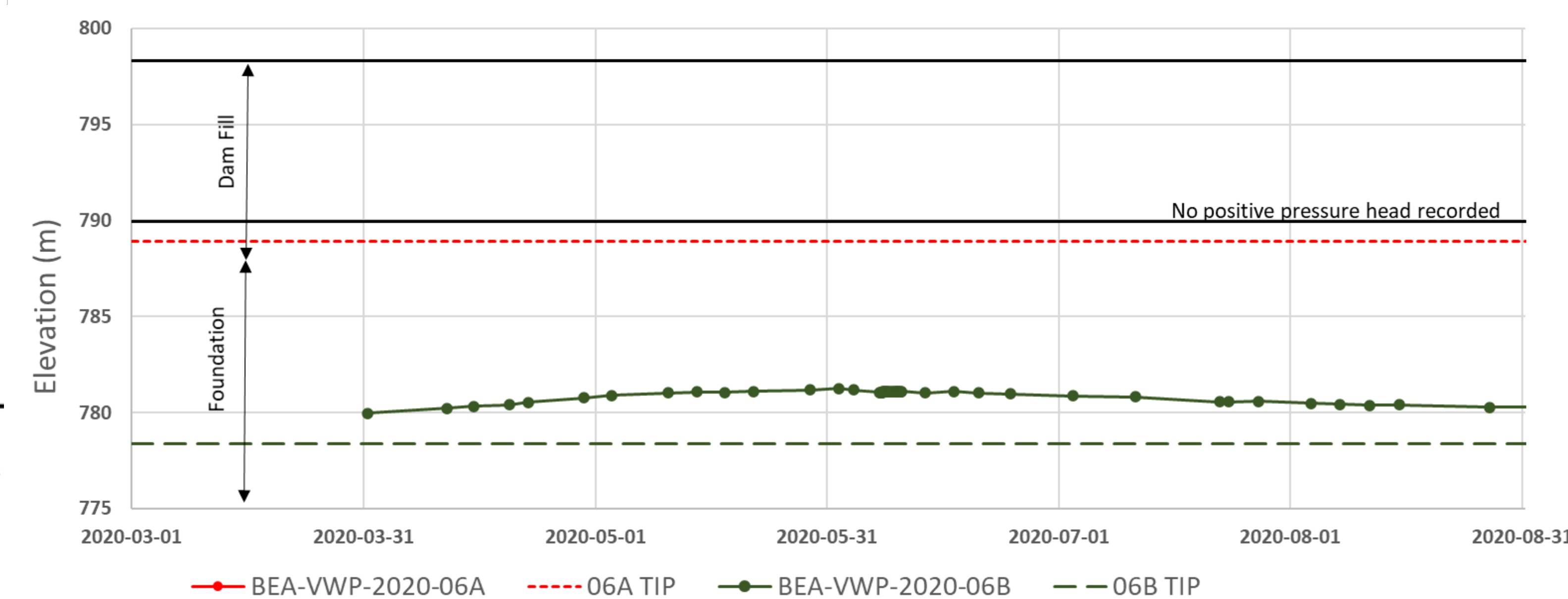

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CLIENT
TECK RESOURCES LIMITED
BEAVERDELL MINE
BEAVERDELL, B.C.

CONSULTANT

GOLDER

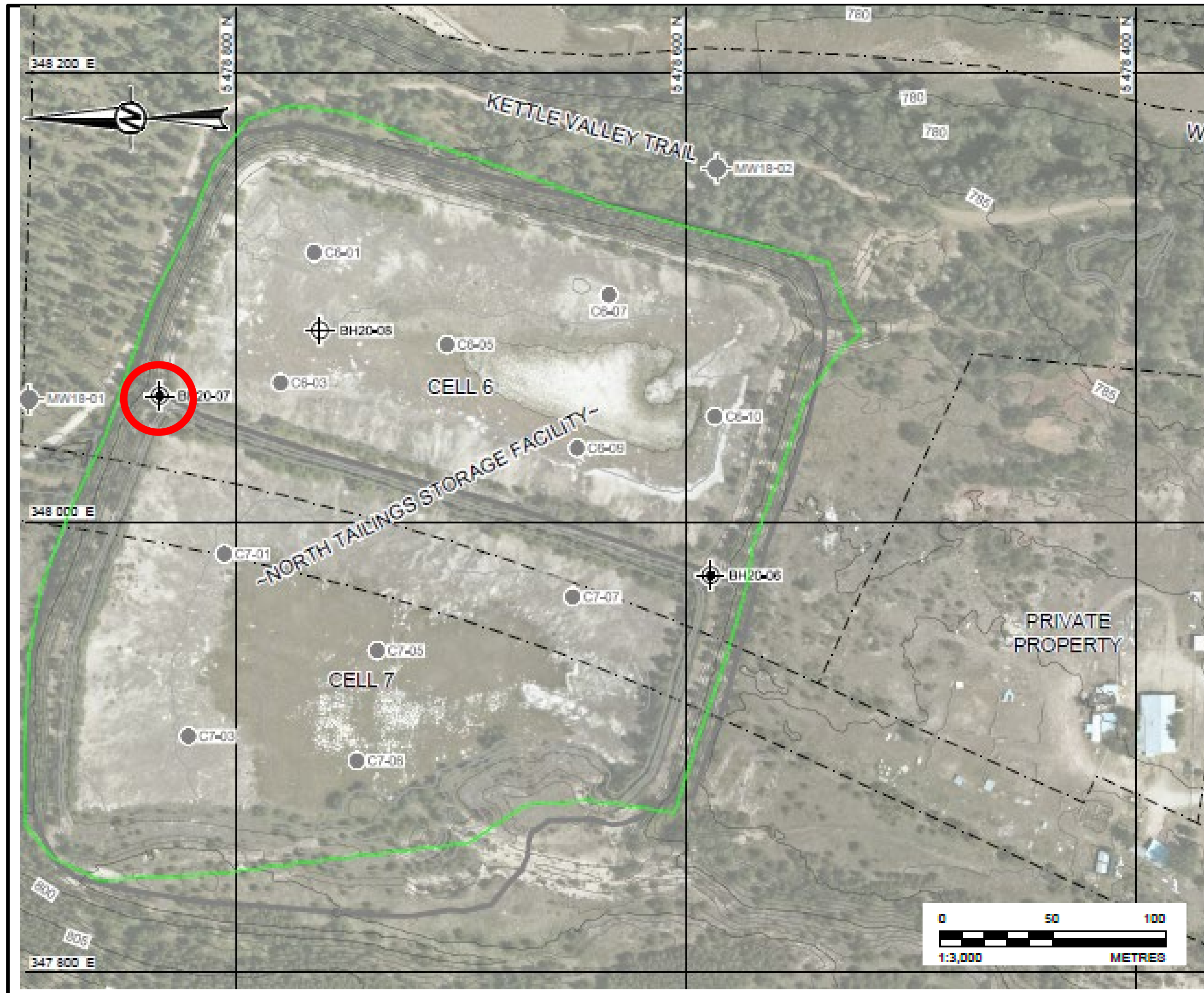
YYYY-MM-DD	2021-03-24
PREPARED	NEC
DESIGNED	NEC
REVIEWED	MBW
APPROVED	JCC

PROJECT
BEAVERDELL TAILINGS STORAGE FACILITIES
2020 ANNUAL FACILITY INSPECTION REPORT

TITLE
BOREHOLE BH20-06
VIBRATING WIRE PIEZOMETER BEA-VWP-2020-06A/B

PROJECT NO.	PHASE/TASK/DOC	REV.	FIGURE
20140466	1000-1006-275	0	E-5

https://golderassociates.sharepoint.com/:x:/r/sites/124047/Project%20Files/5%20Technical%20Work/VWP%20Conversions%20%26%20Plots/BEA%20VWP%20Plots_2020DSI.xlsx?d=weff05e5b5bed460faa58dbf17546ed14&csf=1&web=1&e=QnaE4M



LEGEND

- AS-BUILT TEST PIT LOCATION
- AS-BUILT BOREHOLE LOCATION WITH LARGE PENETRATION TESTING AND VIBRATING WIRE PIEZOMETERS
- AS-BUILT BOREHOLE LOCATION - TAILINGS SAMPLE
- APPROXIMATE PROPERTY BOUNDARY
- 820 EXISTING GROUND CONTOURS (SEE REFERENCE 1)
- GROUNDWATER MONITORING WELLS (BY WOOD PLC, COMPLETED JULY 2018)
- 2018 CONE PENETRATION TEST LOCATION (GOLDER 2019)
- APPROXIMATE M-71 PERMIT BOUNDARY
- PIEZOMETER LOCATION

NOTES

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REFERENCE

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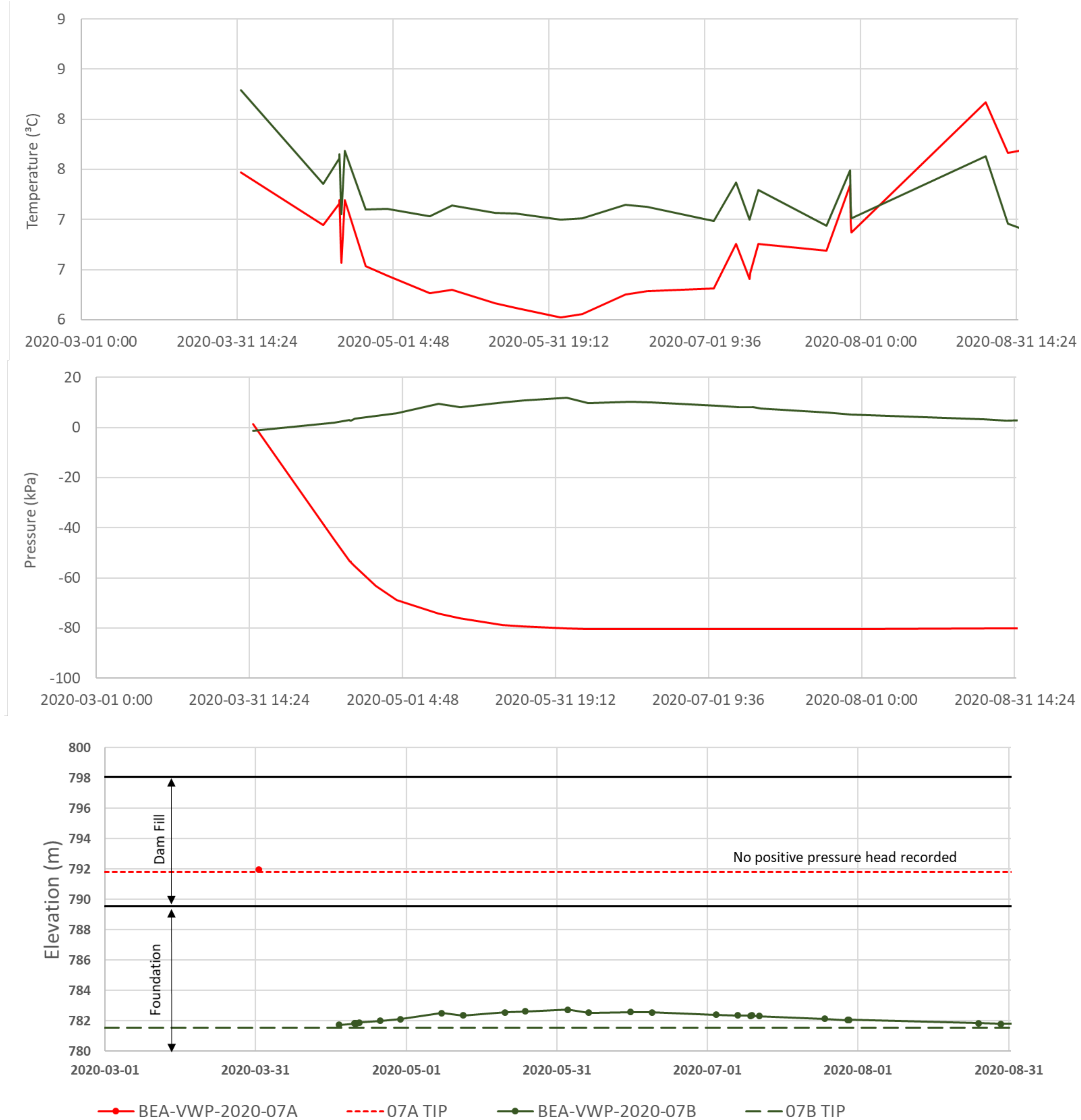

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CONSULTANT	GOLDER	YYYY-MM-DD	2021-03-24
		PREPARED	NEC
		DESIGNED	NEC
		REVIEWED	MBW
		APPROVED	JCC
TITLE	BOREHOLE BH20-07 VIBRATING WIRE PIEZOMETER BEA-VWP-2020-07A/B		
PROJECT NO.	20140466	PHASE/TASK/DOC	1000-1006-275
REV.	0	FIGURE	E-6

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