Klohn Crippen Berger

Teck Metals Ltd.

Sullivan Mine Tailings Facilities

2019 Dam Safety Inspection

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March 2020

Klohn Crippen Berger

March 27, 2020

Teck Metals Ltd.
Bag 2000
Kimberly, British Columbia
V1A 3E1

Kathleen Willman
Manager, Engineering and Remediation

Dear Ms. Willman:

Sullivan Mine Tailings Facilities
2019 Dam Safety Inspection

Klohn Crippen Berger is pleased to submit a copy of the 2019 Dam Safety Inspection Report for Teck Metal Ltd.'s Sullivan Mine located in Kimberley, British Columbia. This report documents our visual observations of the existing conditions of the Sullivan Mine tailings dikes and our review of the instrumentation data to August 31, 2019. The reporting period for the 2019 DSI is September 1, 2018 through August 31, 2019.

We appreciate the opportunity to continue to provide our services to Teck Metals. Please call the undersigned at 780-733-4592 if you have any questions.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Pamela Fines

Pamela Fines, M.A.Sc., P.Eng.
Associate / Manager, Edmonton

PF:kc

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Teck Metals Ltd.

Sullivan Mine Tailings Facilities

2019 Dam Safety Inspection

EXECUTIVE SUMMARY

This report presents the 2019 Annual Dam Safety Inspection (DSI) of the tailings dikes and dams at Sullivan Mine located in Kimberley, British Columbia. The 2019 DSI is the 28th consecutive annual inspection of the dikes and dams at the facility carried out by Klohn Crippen Berger Ltd. (KCB).

As per previous DSI reports by KCB, off-site water discharge quality, groundwater quality and monitoring, and geochemical assessment and monitoring are excluded from the scope of this report. These aspects are reviewed by others and are reported separately.

The report presents the findings from the site visit by the Engineer of Record (EoR), Mr. Bill Chin, P.Eng., and the approved EoR designate Ms. Pamela Fines, P.Eng. on May 22 and 23, 2019, as well as a review of the instrumentation data collected, and routine work performed at Sullivan Mine between September 1, 2018 and August 31, 2019.

Based on the visual inspection of the site during the DSI and a review of available instrument data, the dams/dikes appear to be in good physical condition, the observed performance has been consistent with historical performance and is satisfactory, and there was no evidence of any potential dam safety concerns.

Facility Description

After almost a century of operations, the Sullivan Mine was closed at the end of 2001. Reclamation work on the tailings area was formally initiated in 1990 and was essentially completed by 2008.

There is a total of 15 earthfill dam and dike structures that create seven separate storage facilities for tailings, ARD water, and water treatment sludge. The earthfill structures have a combined length of about 10.4 km, with maximum heights varying from 4.2 m to 29 m. A summary of the maximum height and crest lengths of the main embankments for each facility is shown in the table below.

While many of these facilities were initially designed and constructed through the 1970s and 1980s or earlier, field investigations and design reviews (stability and performance assessments) have been periodically completed since that time. Over the last 10 years prior to closure, a significant amount of work was conducted to enhance long-term stability; modifications to the structures included flattening of slopes and/or construction of toe berms such that the structures meet or exceed required factors of safety under static and dynamic loading, considering the Maximum Credible Earthquake and assuming all saturated tailings liquefy. In addition, a closure surface water management plan was put in place including construction of surface water diversions and spillways to safely handle flows from the respective Inflow Design Floods (IDF).

No modifications have been required for the Sludge Impoundment dikes to date. This is because the original design capacity of the facility far exceeded production requirements and there had been little accumulation of sludge immediately against the dikes. A design review of the Sludge Impoundment dikes is underway and the design will be updated as necessary based on projected storage requirements.

Failure Modes Review

As a required component of a dam safety inspection, the key potential hazards and failure modes must be identified. As the tailings and waste facilities are closed and have been reclaimed (except for the Sludge Impoundment, ARD Pond, and Iron Pond), the key hazards and potential failure modes of concern are overtopping during major flood events, internal erosion and piping, static and seismic stability, and surface erosion.

KCB understand, and fully support, that Teck's long-term goal for all of the tailings facilities is to reach landform status with all potential failure modes ultimately being reduced to non-credible. In the context of this DSI, the term "non-credible" represents a condition where the likelihood of failure is considered negligible. Ongoing work aimed at these long-term goals will indicate over subsequent annual reporting periods if the overall landform status has been achieved along with the elimination of any credible flow failure concerns.

Teck's long-term goal for the ARD Pond, as it is for all of Teck's tailings facilities that may not be able to achieve landform status, is for all potential failure modes to be non-credible based on maximum consequence loading conditions. Teck is also evaluating other long-term risk reduction strategies such as year-round treatment which would reduce storage requirements in the ARD Pond.

Overtopping failures are hypothetical and close to non-credible as the likelihood of overtopping failures is considered negligible considering closure measures already in place (e.g. drainage channels, spillways, etc. designed for PMF) for the tailings storage facilities. Spillways designed for the PMF are similarly in place for the ARD Pond and Iron Pond such that the likelihood of overtopping is also considered to be negligible. The likelihood of failure for overtopping of the Sludge Impoundment is low based on the review of the storage capacity completed in 2015. The design criteria for the facility is under review (started in 2018) and work is ongoing (see section 5.1.2) which is aimed towards eventually achieving Teck's long-term goal by removing overtopping as a credible failure mode.

The likelihood for piping failures is considered to be very low due to filter zones within the ARD Pond Dams and the low pond water levels and associated piezometric surfaces within the other tailings storage facilities. Internal drains were constructed in the Iron, Siliceous and Gypsum TSFs and had pipes that extended through the dams. A review of these structures is being completed as they represent a vulnerability to piping but the low phreatic surface results in low gradients. The likelihood of a piping failure for the Sludge Impoundment is considered to be very low to negligible due to the inclusion of filters in the dam and lack of permanent pond. The results of the current review will be used to assess if piping is a non-credible failure mode for these structures, or if not, what additional measures might be necessary to achieve this goal.

The likelihood of failure due to seismic instability (foundation and slope) is considered to be low to negligible. The low likelihood rating is currently assigned to the Gypsum and Siliceous TSFs where a site investigation was recently completed to better characterize the in-situ density and liquefaction susceptibility of the foundation sands and gravels. There are no liquefiable materials present in the foundation and dam fill of the ARD Pond Dams and, therefore, seismic instability due to seismic deformations is close to non-credible and seismic instability due to liquefaction failures is non-credible. Analysis of the ARD Pond dam structures is needed to confirm the magnitude of seismically-induced deformations that could be expected during an extreme seismic event. In addition, a due diligence review and update of the seismic stability of all structures is underway based on current phreatic surface levels and a revised seismic hazard assessment, which is aimed towards eventually achieving Teck's long-term goal of removing credible failure modes associated with instability due to seismic loading.

Static factors of safety are well above the minimum required values and the likelihood of failure is considered very low to negligible for all the TSF and ARD Pond dams. The likelihood of static failure of the sludge ponds is considered low. A review of the stability of the dams is currently underway, which is aimed towards eventually achieving Teck's long-term goal of removing credible failure modes associated with instability due to all loading conditions.

Summary of Storage Facilities at Sullivan Mine

Storage Facility	Embankments	Type	Approximate Embankment Length (m)	Approximate Maximum Embankment Height (m)	Starter Dike Constructed (Year)[1]	Year of Last Dike Raise (Year)
Iron TSF	Iron Dike	Iron Tailings	1500	29.0	1975	1999
Old Iron TSF	Old Iron Dike	Iron Tailings	520	7.6	Prior to 1948	Unknown
	Iron TSF Divider Dike	Iron Tailings	1190	3.6 [3]	Post 1948	Unknown
Siliceous TSF	No. 1 Siliceous Dike	Silica Tailings	2000	4.9 [3]	1923	1979
	No. 2 Siliceous Dike	Silica Tailings	730	9.5	1975	1982
	No. 3 Siliceous Dike	Silica Tailings	1540	12.5	1975	1984
Gypsum TSF	East Gypsum Dike	Gypsum	670	16.8	1969	1983
	West Gypsum Dike	Gypsum	640	22.9	1969	1986
	Northeast Dike	Gypsum, Seepage Water	120	10.0	1985	1985
	Recycle Dam	Seepage/ARD Water	90	6.0	1985	1985
Calcine TSF	Calcine Dike	Calcine	520	4.6 [3]	1972	1986
ARD Pond[2]	North Dam	ARD/Seepage Water	460	7.6	2001	2001
	South Dam	ARD/Seepage Water	330	16.8	1976	2001
Sludge Impoundment	North Dike	Sludge	120	4.3	1978	1978
	South Dike	Sludge	200	6.1	1978	1978

Notes:

[1] Starter dike information based on data from Annual Inspection Report by SRK-Robinson dated June 1991.

[2] The ARD Pond is established at the site of the old Cooling Pond.

[3] Tailings were placed downstream of both Iron TSF Divider Dike and No. 1 Siliceous Dike. The original height of the Iron TSF Divider and No. 1 Siliceous Dikes from original ground is 10.7 m and 16.8 m, respectively. A municipal landfill is downstream from the Calcine Dike. The height of the Calcine Dike from original ground is 15.2 m.

Consequence Classifications (CDA and HSRC)

Given that there have been no major changes to developments downstream of the tailings facilities at Sullivan Mine, no change to the consequence classifications was recommended.

The current consequence classifications of each of the dams/dikes at Sullivan Mine are summarized below.

Tailings Dikes and Consequence Classification

Facility	Embankment	Consequence Classification[1]
Iron TSF	Iron Dike	H
Old Iron TSF	Old Iron dike	L
	Iron TSF Divider Dike	L
Siliceous TSF	No. 1 Siliceous Dike	L
	No. 2 Siliceous Dike	L
	No. 3 Siliceous Dike	L
Gypsum TSF	East Gypsum Dike	H
	West Gypsum Dike	H
	Northeast Gypsum Dike	L
	Recycle Dam	L
Calcine TSF	Calcine Dike	L
Sludge Impoundment	North Dike	L
	South Dike	L
ARD Pond	North Dam	VH
	South Dam	VH

Note:
Consequence categories based on 2007 Canadian Dam Safety Guidelines (CDA, 2013): E=Extreme, VH=Very High, H=High, S=Significant, L=Low

However, it is important to highlight that, while all of these structures are currently considered “dams” from a regulatory perspective, few of the inactive facilities are retaining fluid tailings and could be considered equivalent to earthen landfills as noted above. This is evident through a review of the instrumentation data, which indicates piezometric surfaces for most which are very low (i.e. near or 1 m to 2 m above original ground), especially for the Old Iron, Siliceous, Calcine, and Gypsum TSFs. In addition, as previously discussed, aging effects may also be an important factor in reducing the mobility of the tailings over time. In such cases, their respective consequences classifications could be significantly lowered, and in the near future, it may be possible to declassify some of these dikes. Teck and KCB are continuing to develop a phased work plan to support lowering the consequence classifications for some of the inactive facilities and towards eventual declassification of the dikes where considered feasible and appropriate.

Key Observations (Instrumentation and Visual)

Notification levels have been established for all instruments. The current notification levels for piezometers are not intended to be indicative of a dam safety concern but rather to identify any measured change from historic or expected behaviour that warrants review by Teck and the Engineer of Record (or designate) to understand the likely cause of that change.

Alert levels tied to credible failure modes has been developed and will implemented in 2020. These alert levels are tied to seismic stability assumptions and internal erosion.

A facility by facility indication of condition and stability follows. A "safe" situation where no current indications of any dam safety issue exists is where the stability condition is "satisfactory".

Iron TSF

Based on the visual observations and instrumentation review, the Iron Dike is in good condition along with the emergency spillway. The stability of the Iron TSF is considered satisfactory.

Seepage has continued similarly to previous years near the downstream toe of the dike. Seepage near station 5+00 is monitored by Weir #3 – AIPWU and Weir #4 installed in the drainage ditch. Seepage near station 24+00 is collected in an existing low-lying area beyond the toe of the dike.

Of the 30 piezometers currently being monitored 22 of the 30 showed reduced piezometric readings compared to the previous monitoring period and all were below current notification levels.

Old Iron TSF

Based on the visual observations and instrumentation review, the stability of the Old Iron Dike and Iron TSF Divider Dike are considered satisfactory.

All five of the currently monitored piezometers in the Old Iron TSF showed a decrease in piezometric levels compared to the previous monitoring period.

Siliceous TSF

Based on the visual observations and instrumentation review, the stability of the Siliceous Dikes are considered satisfactory.

Of the 13 piezometers currently being read with established notification levels, 12 of 13 showed a stable or decreasing piezometric level compared to the previous monitoring period. One piezometer is reading near its notification level in Siliceous Dike No. 1. This is not a dam safety issue and the notification level will be reviewed.

Gypsum TSF

Based on the visual observations and instrumentation review, the stability of the East and West Gypsum Dikes, the Northeast Gypsum Dike, and the Recycle Dam are considered satisfactory. There are continued indications of rodent activity at the toe of the dikes, this is not considered a dam safety issue. Teck has worked to fill in the burrows, but new burrows were identified.

Visual observation of seepage indicates similar flows as previous years with no indication of sediment in the seepage flows.

The Sondex gauges in each dike indicate continued consolidation of the tailings consistent with previous readings. The settlement is expected to continue and is not a dam safety concern, the movements are consistent with the expected behaviour of gypsum tailings.

ARD Pond

Based on the visual observations and instrumentation review, the stability of the North and South Dams of the ARD Pond is considered satisfactory.

All of the 13 currently monitored piezometers in the ARD Pond dams indicated a lower or stable piezometric conditions compared to the previous monitoring period.

Calcine TSF

Based on the visual observations, the stability of the Calcine Dike is considered satisfactory. There were no changes observed from previous inspections.

Sludge Impoundment

Based on the visual observations, the stability of the North and South Dikes of the Sludge Impoundment is considered satisfactory. A design review and assessment of the storage capacity of the Sludge Impoundment is currently being planned to ensure the impoundment meets regulatory requirements.

Significant Changes

There are no significant changes to report in observed or monitored information with respect to dam stability for all dikes/dams. As the mine is closed facility and the ponds and dikes have undergone reclamation, there are no annual operation activities other than ongoing water seepage collection and treatment and care and maintenance.

OMS and MERP Manuals

The Operation, Maintenance and Surveillance Manual for the Sullivan Mine Tailings Facilities was updated to Revision 5 in August 2018. The document was reviewed in 2019 and an update to the new OMS manual template is planned for 2020.

The Emergency Preparedness and Response Procedures Manual was reviewed and converted to a Mine Emergency Response Plan (MERP) in January 2019.

Deficiencies and Non-conformances

Recommendations arising from the 2019 inspection are summarized in Table 6.1 along with completed recommendations from previous DSI summaries.

For this review, we have established definitions to describe deficiencies, potential deficiencies, non-conformances and items requiring updates to meet updated regulatory standards as follows:

- Deficiency (D): An unacceptable dam performance condition based on analysis results and/or site observations/instrumentation data with respect to criteria outlined in the 2007 CDA Guidelines, best practices, and/or applicable regulatory requirements.
- Potential Deficiency (PD): A dam performance condition that requires further evaluation to determine if the condition is a deficiency.
- Non-Conformance (NC): Defined as a deviation from established policies, procedures, operating instructions, maintenance requirements, or surveillance plans. A non-conformance is not an indication of unacceptable dam performance.
- Items Requiring Updates to Meet Updated Regulatory Standards (RS): Condition where regulatory requirements have changed and have become more stringent following initial design and/or construction.

None of the identified deficiencies or issues, closed/new/outstanding, are related to dam safety concerns. All of the recommendations pertain to the framework of continual improvements in the dam safety management program, such as documentation and maintenance/surveillance protocols. The recommendation for the Sludge Impoundment is part of the design review and update that is already being planned by Teck and KCB.

Summary of Outstanding Recommendations from Past DSIs and New Recommendations from Current DSI

Structure	ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Deficiency Type	Priority	Recommended Deadline/Status
Previous Recommendations Closed/Superseded							
ALL	2016-1	OMS Manual requires updates	EMPR HSRC (2017) & CDA Guidelines: Application to Mining Dams (2014)	Additional information to be added in 2017. EPRP Section to be removed once separate document completed.	RS	4	CLOSED – ongoing revisions being conducted
Previous Recommendations Ongoing							
Sludge Impoundment	2017-03	Changes to the HSRC design flood requirements indicate a review of the Sludge Impoundment hydrology is needed.	EMPR HSRC (2017) & CDA Guidelines: Application to Mining Dams (2014)	Review of the current design freeboard and design sludge levels is required for the new design flood event of 1/3 between 1:975 and PMF (HSRC, 2017). To facilitate the design update, the Sludge Impoundment surface should be surveyed to obtain average sludge deposition rates. Review of entire facility should be completed to address storage, life expectancy of the facility and regulatory requirements.	RS	3	Q4 2020
2019 Recommendations							
Iron TSF/ ARD Pond	2019-01	Frequent recordings of flow under or around all four weirs on site leads to inconsistent and unreliable readings.	OMS Section 4.0	Refurbish all four existing weirs with cut-off walls using low permeability material below and around the weir entrance to reduce bypass around/under weirs.	NC	3	Q2 2020
Siliceous TSF	2019-02	Flowing piezometer adjacent to Betcher's Slough	OMS Section 4.0	This piezometer should be added to the monitoring network and flow rates estimated monthly during the next monitoring period.	NC	3	Q2 2020
Siliceous TSF	2019-03	Flowing decant at toe of Siliceous 2 dike	OMS Section 4.0	The flow in the decants should be added to the inspections and changes in flow or sediment transport recorded.	NC	3	Q2 2020

Notes:

Priority ranking for outstanding recommendations is defined as follows:

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 occurrence 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.

Independent Dam Safety Review

The most recent Dam Safety Review (DSR) for the Sullivan Mine TSFs and dams was initiated by Haley Aldrich in 2018 and draft reporting developed issued in 2019. Finalizing the DSR documentation will occur in 2020. The previous DSR was completed by Golder Associates in 2013. This is consistent with the HSRC regulations (EMPR 2017) that mandate that a DSR be undertaken every five years regardless of consequence classification of the structures.

The next DSR is scheduled for 2023. At that time, we understand that Teck may have requested to remove some of the facilities from “dam” classification and, therefore, be exempt in scope from the HSRC regulation and instead be regulated as landforms.

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1 INTRODUCTION

1.1 Purpose, Scope of Work, and Methodology

This report presents the results of the 2019 Annual Dam Safety Inspection (DSI) of the tailings dikes and other dams at the Teck Metals Ltd. (Teck) former Sullivan Mine, located in Kimberly, British Columbia. The work was carried out in general accordance with our proposal letter dated March 4, 2019 and the Teck Guideline for Tailings and Water Retaining Structures (Teck 2019).

The scope of work consists of:

- a visual inspection of the physical condition of the various containment dikes and water retention dams during the site visit May 22 to May 24, 2019, which included:
  - reading of select piezometers at Siliceous Dikes No. 2 and No. 3; and
  - reading two Sondex settlement gauges and one inclinometer casing on the Gypsum Dikes.
- a review of the climate and water balance data for the site;
- a review of annual flow rates recorded from weirs for the Acid Rock Drainage (ARD) pond and Iron Tailings Storage Facility (TSF);
- a review of updated piezometer and settlement records provided by Teck in 2019; and
- a review of OMS and MERP Manuals for the storage facilities.

As in previous years, this report focuses on the geotechnical performance of the tailings dikes and water balance for the tailings facilities. Teck addresses and reports water discharge and water quality separately. The reporting period for this DSI is September 1, 2018 to August 31, 2019. Figures 1 and 2 show the project location and general layout of the tailings facilities.

This is the 28th consecutive annual inspection of the Sullivan Mine tailings dikes carried out by Klohn Crippen Berger Ltd. (KCB)Annual inspection reports for the periods preceding KCB's involvement were prepared by SRK-Robinson Inc. from 1989 to 1991 and by Robinson Dames and Moore from 1984 to 1988.

As per previous DSI reports by KCB, off-site water discharge quality, groundwater quality and monitoring, and geochemical assessment and monitoring are excluded from the scope of this report. These aspects are reviewed by others and are reported separately.

1.2 Regulatory Requirements

1.2.1 Mines Act and HSRC

This DSI addresses the performance of the tailings/sludge storage facilities and associated water management infrastructure in accordance with the most recent Health, Safety, and Reclamation Code for Mines in British Columbia (EMPR, 2016 & EMPR, 2017), which forms part of the Mines Act (RSBC, 1996).

As required by the HSRC, the following persons have been designated:

- Engineer of Record – Mr. Bill Chin, P.Eng. (KCB).
- Engineer of Record, Approved Designate[1] – Ms. Pamela Fines, P.Eng. (KCB).
- Tailings Storage Facility Qualified Person – Ms. Kathleen Willman, P.Eng. (Teck).

1.2.2 Water Act and BC Dam Safety Regulation

None of the tailings dikes or dams at Sullivan Mine required a water licence and are therefore not regulated by the BC Dam Safety Regulations. A conditional water licence (C050428) has been issued for the construction of the sludge pond dikes. The BC Dam Safety Regulation was referenced for guidance related to dam safety where appropriate

1.2.3 Permits and Licences

Sullivan Mine is regulated by the following permits:

- Reclamation Permit M-74 (February 22, 2019) issued by the Ministry of Mines. This permit is issued under the provision of the Mines Act (RSBC, 1996), and addresses reclamation and metal leaching and acid rock drainage requirements at Sullivan Mine. The requirements of the permit are:
  - monitoring programs of vegetation, surface water, and groundwater;
  - annual reporting as required under the HSRC (EMPR, 2017); and
  - informing the ministry of changes at the mine that might impact the amount of the reclamation security.
- Effluent Permit PE-00189 (October 24, 2016) issued by the Ministry of Environmental Protection & Sustainability: Waste Management. This permit is issued under the provision of the Environmental Management Act (SBC, 2003) and authorizes the discharge of effluent in Kimberley Creek and St. Mary River as well as sludge on land. Requirements under this permit include:
  - general requirements (Section 2 of the permit) which state the conditions under which the DWTP and Sludge Impoundment must be operated (i.e. maintaining the infrastructure in good working order, addressing emergencies, modification to infrastructure and processes, bypasses, and suspension); and
  - monitoring and reporting requirements (Sections 3 and 6 of the permit) which describe monitoring work to conduct on the discharges and receiving environment as well as the reporting frequency (i.e., spring and fall).

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[1] Engineer of Record – Approved Designate: the appointed alternate if the EoR is not available.

- Permit PR6742 (January 2, 2018) issued by the Ministry of Environmental Protection & Sustainability: Waste Management. This permit is issued under the provision of the Environmental Management Act (SBC 2003) and authorizes the discharge of refuse to a landfill. The landfill is located within the boundaries of the Old Iron TSF (northwest corner) and is denoted as E242184 and E310949 by the Ministry. Requirements under this permit include:
  - reporting of volumes of material placed within landfill; and
  - regular inspections and maintenance of the landfill works.

1.3 Facility Description

There is a total of 15 earthfill dam and dike structures that created seven separate storage facilities. A summary of the seven facilities and their associated dam/dike structures is provided in Table 1.1. The earthfill structures have a combined crest length of just over 10.4 km, with the maximum heights varying from 4.2 m to 29 m. A plan of the storage facilities and their retaining structures is provided in Figure 1.

The two water retaining dams[2], designated as the North Dam and South Dam, that form the ARD Pond are shown in Figure 20. This pond, located at the old Cooling Pond site, annually stores the water requiring treatment. The two sludge retention dikes, designated as the North and South Dikes, that form the Sludge Impoundment are shown in Figure 27. This impoundment is located south of the St. Mary River, and stores sludge produced from treatment of mine contact water at the Drainage Water Treatment Plant (DWTP).

Other than the above earthfill structures, the other dikes listed in Table 1.1 have been used primarily for tailings storage. Typically, these dikes consist of an initial earthfill starter section raised incrementally over the years using the upstream method of construction. The design and construction records for the original Old Iron TSF dikes and the No. 1 Siliceous Dike (which were constructed during the 1920’s to 1940’s), are not available, so it is unclear how these were originally constructed. In the 1990’s stability assessments for all of the tailings dikes were completed and, where required, slopes were flattened, and toe berms were constructed to meet required design criteria. A discussion of the design basis and criteria is provided in Section 5.1.

The Iron Pond, the ARD Pond, the West Gypsum Seepage Collection Pond, and the Northeast Gypsum and Recycle Dam seepage collection ponds are the only storage facilities that are still active as they are used as integral components of the overall surface water and groundwater management strategy at the Sullivan Mine. The Sludge Impoundment is also active but does not retain ponded water. The other tailings facilities have been decommissioned and surface reclamation is complete. The reclamation included draining and covering the TSF surfaces and the construction of surface water runoff conveyance channels and spillways.

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[2] In this report KCB refers to “dams” as water retaining earthfill structures engineered to limit seepage and refers to “dikes” as the earthfill structures that are constructed as part of the tailings storage and sludge storage facilities.

Water collected at Sullivan Mine through mine drainage, contaminated groundwater and seepage from TSFs and waste dumps is stored in the ARD Pond and then pumped to the DWTP. The ARD Pond serves as a flow equalization basin to facilitate seasonal operating campaigns at the DWTP. The treated water is released to the environment (St. Mary River) and the sludge is deposited in the Sludge Impoundment. The ARD Pond was designed with a spillway, which connects to the Iron Pond in the Iron TSF. The Iron TSF has an emergency spillway to safely convey excess water from flood events from the dikes/dams offsite. This spillway connects to Cow Creek, which in turn discharges into the St. Mary River.

Site location plans and typical dike/dam sections are provided in Figures 1 through 28.

Table 1.1 Summary of Storage Facilities at Sullivan Mine

Storage Facility	Embankments	Type	Approximate Embankment Length (m)	Approximate Maximum Embankment Height (m)	Starter Dike Constructed (Year)[1]	Year of Last Dike Raise (Year)
Iron TSF	Iron Dike	Iron Tailings	1500	29.0	1975	1999
Old Iron TSF	Old Iron Dike	Iron Tailings	520	7.6	Prior to 1948	Unknown
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	Recycle Dam	Seepage/ARD Water	90	6.0	1985	1985
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	South Dike	Sludge	200	6.1	1978	1978

Notes:

1. Starter dike information based on data from Annual Inspection Report by SRK-Robinson dated June 1991.
2. The ARD Pond is established at the site of the old Cooling Pond.
3. Tailings were placed downstream of both Iron TSF Divider Dike and No. 1 Siliceous Dike. The original height of the Iron TSF Divider and No. 1 Siliceous Dikes from original ground is 10.7 m and 16.8 m, respectively. A municipal landfill abuts the downstream slope of the Calcine Dike. The height of the Calcine Dike from original ground is 15.2 m.

1.4 Background Information and History

After almost a century of operations, the Sullivan Mine was closed at the end of 2001, with approximately 94,000,000 tonnes of tailings stored in the various TSFs and approximately 16,900,000 tonnes of mine waste stored at the former mine. Reclamation work on the tailings areas was formally initiated in 1990 and was essentially complete by 2008.

The mine had been mainly underground and operated on a near-continuous basis from the early 1900s to 2001. In the last decade prior to closure, the mine was processing primarily lead/zinc ore. For most of the mine's operating life, mill tailings were hydraulically transported to an area immediately southeast of the concentrator for disposal and storage. The historical development of the tailings areas is summarized in Table 1.2. Gypsum and circulation water from operation of the fertilizer plant have also been stored in the tailings area. These by-products from the fertilizer plant were produced and stored from about 1969 to 1987.

The DWTP, which began operating in 1979, continues to operate as part of the water management plan for the site. The DWTP treats acid rock drainage and other seepage produced from the underground mine and waste storage facilities. Sludge from the DWTP is located in an impoundment about 2 km south of Marysville near the DWTP. Figure 2 illustrates the relative locations of the DWTP, the tailings facilities, and the pipelines from the underground mine and highlights the primary seepage collection system.

Table 1.2 Historical Development

Date	Process	Storage Area	Comments
Prior to 1941	Milling/Flotation for lead and zinc recovery	One tailings stream to Old Iron TSF	
1941 to 1985	Tin Recovery Circuit	Iron Tailings to Old Iron TSF and Iron TSF Siliceous tailings to No. 1, 2, and 3 Siliceous Cells	
1953 to 1987	Fertilizer production including roasting of iron concentrate Waste products include iron oxide and gypsum	Iron oxide (known as calcine tailings) to Calcine TSF Gypsum tailings to East and West Gypsum Cells	Gypsum TSF not developed until 1968; prior to that gypsum tailings were stored and seasonally discharged to the St. Mary River during spring freshet
1975 to 1987	Fertilizer Plant effluent water	Stored and recycled from Cooling Ponds 1 and 2	
1987 to 2001	Fertilizer plant closed; single mill tailings stream	Single stream to Iron TSF	
1979 to present	Drainage Water Treatment Plant (DWTP) Sludge Impoundment	Sludge Impoundment	Located offsite, 1.5 km south of Marysville, 0.5 km south of DWTP
2001 to present	Water storage for feed to DWTP	Cooling Ponds 1 and 2 converted to ARD Pond	

1.4.1 Reference Reports

In 1991, Teck retained KCB to conduct forensic investigations to assess the failure of the (then) Active Iron Tailings Pond Dike. The work included the design of remedial measures to reinstate the Iron Dike, and then subsequently extended to include a review the existing and long-term stability of a number of other tailings dikes. These studies were part of Teck efforts toward decommissioning and eventual closure of the Sullivan Mine tailings facilities. Stability assessments, and the design and implementation of stabilization measures if required, were completed for the Iron Dike, the East and West Gypsum Dikes, the No. 1, No. 2, and No. 3 Siliceous Dikes, and the Old Iron Dike. The design and construction of two new dams for the ARD pond were also completed, including new spillways and a downstream flood impact study. Additional post-closure assessments have been performed as required based on performance. The main conclusions and recommendations from the studies are documented in the following KCB reports:

- Iron Dike Tailings Facility: 1991 Failure Assessment, February 20, 1992.
- Iron Dike Tailings Facility: Dike Stabilization, March 13, 1992.
- Stability Review of Gypsum Dikes, November 26, 1993.
- Stability Review of Southwest Limb of Old Iron Dike, June 21, 1994.
- Stability Review of Siliceous Dikes, June 24, 1994.
- 1993-1994 Annual Inspection of Tailings Dikes (Section 5.5, 9.4, 10.4, and 11.4, Typical Dike Cross-Section and Factors of Safety), October 21, 1994.
- Iron Dike: Geotechnical Design of 1995 Dike Raise, May 18, 1995.
- 1999 Annual Inspection of Tailings Dikes (Section 4.4 – Iron Pond Dike, Stability Review), September 16, 1999.
- Iron Pond Dike – Construction Recommendations for Float Rock Toe Berm, January 24, 2000.
- ARD Pond – Storage Pond No. 1 Design Report, February 29, 2000 and addendum letter, August 21, 2000.
- ARD Pond – Storage Pond No. 1 Construction Record Report, January 31, 2002.
- Geotechnical Design Basis for Tailings Dikes – Overview Summary Report, January 9, 2002.
- ARD Pond – Dam Breach and Inundation Study – Storage Pond No. 1, September 6, 2002.
- ARD and Emergency Storage Ponds – Potential Downstream Flood Impacts from Spillway Flows, November 14, 2002.
- Southwest Limb Stability Review, July 28, 2006.
- Geotechnical Stability Analysis of Sullivan Mine CPR Ballast Deposition Site, February 28, 2007.
- Sullivan Mine Tailings Area – Emergency Storage Pond (ESP) Spillway Design, September 28, 2007.
- Sullivan Mine Iron Pond Dike Stability, May 11, 2001.

- Sullivan Mine Emergency Storage Pond – Surface Water Management Plan Updated, December 8, 2011.
- TML Sullivan Mine Tailings Facility: Iron Pond Dike – Artesian Pressures in Confined Aquifer (Piezometers P92-H and P92-25), November 18, 2015.

The following report authored by others provided additional information:

- Dam Break Inundation Study for Three Containment Structures Sullivan Mine, BC – Final Report dated November 26, 2014. Prepared by AMEC Environment & Infrastructure, A Division of AMEC Americas Limited.

1.4.2 Reference As-Built Drawings

Teck has updated as-built drawings for the various facilities post reclamation. Table 1.3 provides a summary of these drawings, which were prepared for Teck by TM Tech Services. An updated LiDAR image created in December 2012 was used to update the figures attached to this report. There have been no significant construction/modifications to the as-built conditions since the drawings by TM Tech Services were issued.

Table 1.3 Summary of Drawings Prepared by TM Tech Services

Title	Drawing	Date
Site Plans		
TAILINGS SEEPAGE COLLECTION/DWT PLANT SYSTEM PIPING DETAILS	K100 A 3007	FEB 3/09
DAM SAFETY REVIEW KEY PLAN	K100 A 3010	MAR 23/09
Gypsum TSF		
WEST GYPSUM DIKE PLAN VIEW	K100 A 3230	JAN 29/07
WEST GYPSUM DIKE PROFILE / SECTIONS	K100 A 3231	JAN 29/07
EAST GYPSUM DIKE PLAN /PROFILE /SECTIONS	K100 A 3232	JAN 29/07
Iron TSF & Emergency Spillway (Iron Dike)		
EMERGENCY POND DIKE PLAN VIEW (FORMER IRON POND)	K100 A 3233	FEB 13/09
EMERGENCY POND DIKE PROFILE/SECTIONS (FORMER IRON POND)	K100 A 3234	FEB 13/09
EMERGENCY POND OVERFLOW SPILLWAY AS BUILT	K100 A 3235	FEB 13/09
West Gypsum Cell Ditching		
WEST GYPSUM POND DITCHING PLAN VIEW	K100 A 3236	JAN 14/09
WEST GYPSUM POND DITCH PROFILES	K100 A 3237	JAN 14/09
WEST GYPSUM POND DITCHING SECTIONS 1 TO 7	K100 A 3238	JAN 14/09
Calcine TSF		
CALCINE DIKE PLAN /PROFILE /SECTIONS	K100 A 3239	DEC 4/06
Old Iron Dike		
SW LIMB AS BUILT (OLD IRON POND)	K100 A 3240	JAN 16/09
Iron TSF Divider Dike		
SE LIMB AS BUILT	K100 A 3246	FEB/12/09
Siliceous TSF		
SILICEOUS PONDS 1/2/3 AS BUILT PLAN/PROFILE	K100 A 3241	JAN/26/09
SILICEOUS PONDS 1/2/3 AS BUILT SECTIONS	K100 A 3242	JAN/26/09
ARD Pond		
ARD POND, NORTH & SOUTH DIKE AS BUILT	K100 A 3243	FEB 4/08
ARD POND, NORTH & SOUTH DIKE AS BUILT	K100 A 3244	JAN 29/09
ARD POND OVERFLOW SPILLWAY AS BUILT	K100 A 3245	JAN 31/09
Iron TSF to Cow Creek		
SURFACE WATER CHANNELS D, E, F AND G PLAN VIEW	K100 A 3254	MAR 11/09
SURFACE WATER CHANNELS D, E, F AND G PROFILE AND SECTIONS	K100 A 3255	MAR 11/09
North of Siliceous TSF to Luke Creek		
SURFACE WATER CHANNELS M, P1, O, & P2 PLAN VIEW	K100 A 3310	MAR 4/09
SURFACE WATER CHANNELS M, P1, O, & P2 PROFILE /SECTIONS	K100 A 3311	MAR 4/09
Sludge Impoundment		
SLUDGE POND DIKE CREST AS BUILT	K101 A 2240	DEC 10/08
SLUDGE POND DIKE CREST AS BUILT	K101 A 2249	SEP 11/17
SLUDGE POND SURFACE AS-BUILT	K101 A 2243	SEP 9/15

1.4.3 Units of Measure and Coordinates

To facilitate the long-term monitoring of the site, this report has converted historical values, recorded in imperial units of measure in the Sullivan Mine Grid coordinate system, to metric units in UTM (NAD 83). Some figures still reference stationing along dikes in Imperial Units.

2 MAIN ACTIVITIES IN 2019

2.1 Tailings/Sludge Deposition and Available Storage

The Sullivan Mine closed in 2001 and, therefore, all of the tailings storage facilities are no longer active.

The Sludge Impoundment continues be active and provides storage of sludge generated from treatment of mine contact water through the DWTP. According to Teck, about 121,000 tonnes of sludge were deposited in the impoundment from October 1997 to December 2001, and about 55,841 tonnes of sludge were deposited from 2002 to 2018. An additional 1,228 tonnes of sludge was deposited during this reporting period. The average annual deposition rate since closure is 3,285 tonnes/year.

2.2 Main Construction Activities (September 2018 to August 2019)

Construction related activities that take place each year are primarily associated with ongoing care and maintenance, such as road grading, cleaning of ditches, rodent burrow infilling, removal of trees and shrubs from dike slopes as necessary, maintenance of the seepage collection system, maintenance of instrumentation and management of instrumentation data.

Specific key activities conducted over the current inspection period from September 1, 2018 to August 31, 2019 included:

- Trees were removed from the downstream slope and toe area of the Sludge Impoundment South Dike by cutting near ground surface.
- Rodent burrow infilling on the Gypsum Dikes and ARD dam slopes is ongoing due to active animal activities.
- New instruments installed have been automated and data is being uploaded directly into GeoExplorer.

2.3 Site Investigation

A Becker drilling program was planned in 2019 and executed in October 2019. Details of the investigation will be included with the 2020 DSI report.

2.4 Updates to Dam/Dike Cross-Sections

Typical cross-sections for each dike/dam have been previously updated using the 2012 LiDAR data and are shown in the figures included with this report.

A comparison of select cross-sections generated between the 2012 LiDAR surfaces and the 2019 LiDAR surfaces indicated no significant changes to the physical configuration of the dams and dikes on the site. The updated sludge surface from the 2019 LiDAR is provided in Figure 27.

2.5 2018 Dam Safety Review

The most recent Dam Safety Review (DSR) for the Sullivan Mine TSFs and dams was initiated by Haley Aldrich in 2018 and draft reporting developed issued in 2019. Finalizing the DSR documentation will occur in 2020. The previous DSR was completed by Golder Associates in 2013. This is consistent with the HSRC regulations (EMPR 2017) that mandate that a DSR be undertaken every five years regardless of consequence classification of the structures.

The next DSR is scheduled for 2023. At that time, we understand that Teck may have requested to remove some of the facilities from “dam” classification and, therefore, be exempt in scope from the HSRC regulation and instead be regulated as landforms.

3 CLIMATE REVIEW AND WATER MANAGEMENT – TAILINGS AREA

3.1 Overview

The water management system at Sullivan Mine involves the collection and treatment of mine drainage, contaminated groundwater, and seepage from TSFs and waste dumps. The only active storage facilities used as part of the water management system are the ARD Pond, Iron Pond and West Gypsum Seepage Collection Pond. Details of the system are included in the Kimberley Operations Seepage Collection Manual (Teck, 2017).

In general, water from the mine and tailings areas is collected and conveyed to the ARD Pond for storage to facilitate seasonal operating campaigns at the DWTP. The main sources of water include:

- Mine water from the old underground workings is pumped seasonally from the 3700 ft portal and from the 3900 ft mine level to the ARD Pond.
- Water from the waste dumps and the tailings seepage collection pumps and sumps, is pumped as required to the ARD Pond.

The main function of the Iron Pond is to provide storage of contaminated/contact water during spring runoff events. In addition, the system has the flexibility to by-pass the ARD Pond with temporary routing of mine and seepage water to the Iron Pond, where it can then be pumped to the ARD Pond or directly to the DWTP if required.

The ARD Pond has a storage capacity that allows for efficient operation of the DWTP for discrete periods of time and provides control over the time period when treated effluent is discharged to St. Mary River.

It should be noted that studies are underway to identify options and opportunities to improve the current water management system which, at the same time, can contribute to Teck’s overall objective of continual risk reduction for the Sullivan Mine.

3.2 Climate

3.2.1 Precipitation

Climate stations in the Environment Canada (EC) database relevant to the Sullivan Mine Tailings Facilities precipitation and active during the time period of this water balance assessment are Kimberley PCC (Station No. 1154203) located approximately 3 km southwest of the mine and Cranbrook A (Station No. 1152105) located about 13 km south east of the mine.

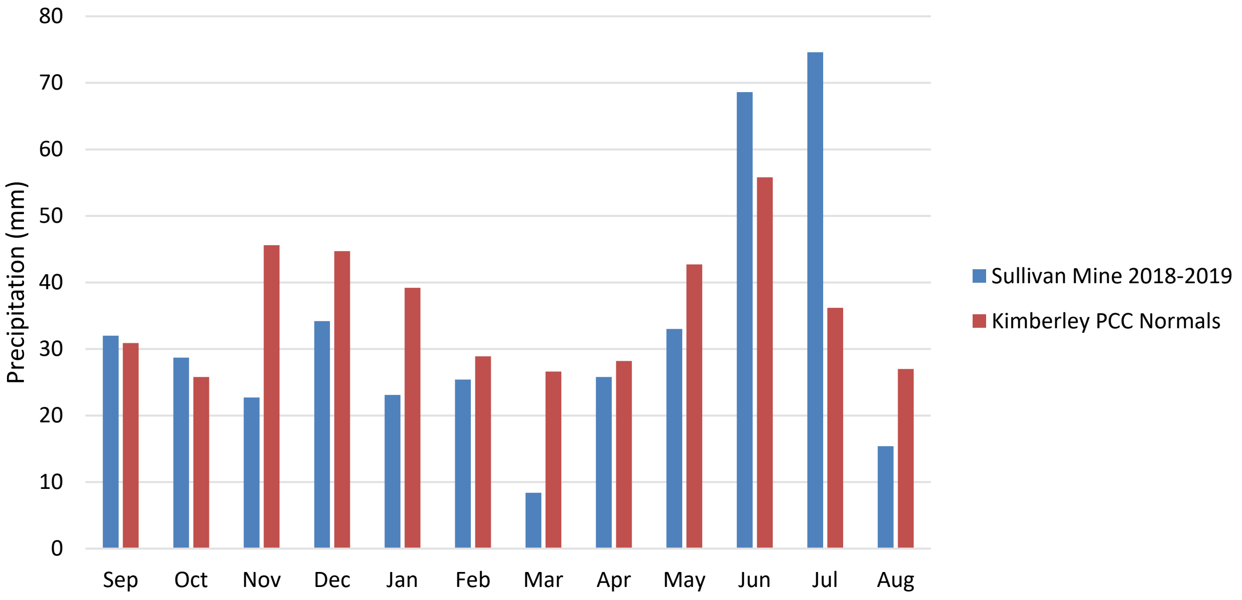
For the purpose of this assessment, site precipitation was estimated as the daily precipitation recorded at Kimberley PCC, with any missing data filled by precipitation recorded at the Cranbrook A station. Table 3.1 summarizes the total precipitation and snowpack estimated for the mine from September 1, 2018 to August 31, 2019 and provides a comparison with the corresponding climate normals for Kimberley calculated between 1981 – 2010 (EC 2019). The total precipitation for the current monitoring period and the climate normals are also graphically shown on Figure 3.1**Error! Reference source not found.**.

Overall, the data indicates that the conditions over the current monitoring period was drier than normal levels.

Table 3.1 Monthly Total Precipitation at Sullivan Mine 2018 – 2019 Compared to Normals

Month	2018-19 Total Precipitation (mm)	Normal Total Precipitation (mm)	2018 – 2019 Snow Depth (cm)	Normal Snow Depth (cm)
Sep 2018	32	30.9	1	0
Oct 2018	28.7	25.8	3	0
Nov 2018	22.7	45.6	15	6
Dec 2018	34.2	44.7	38	22
Jan 2019	23.1	39.2	28	34
Feb 2019	25.4	28.9	25	39
Mar 2019	8.4	26.6	8	19
Apr 2019	25.8	28.2	1	0
May 2019	33	42.7	0	0
Jun 2019	68.6	55.8	0	0
Jul 2019	74.6	36.2	0	0
Aug 2019	15.4	27.0	0	0
Total	**391.9**	**431.6**		

Figure 3.1 Monthly Total Precipitation at Sullivan Mine 2018-2019 Compared to Normals



The precipitation data collected for the water balance is for the ARD Pond and its surrounding catchment. All water collected in the mine and tailings areas is pumped to the ARD Pond, and these flows are measured and recorded by Teck.

3.2.2 Evaporation

Monthly lake evaporation data at the tailings area for the reporting period was estimated using the WREVAP model by SRK (2014). The WREVAP model uses the dew point temperature, average temperature, and global solar radiation to estimate the lake evaporation. The mean monthly lake evaporation depths modelled for data collected at Kimberley A station is shown in Table 3.2.

Table 3.2 Mean Monthly Evapotranspiration Rates at Kimberley A station

Month	Mean Evaporation (mm)
Sep 2018	65
Oct 2018	30
Nov 2018	5
Dec 2018	0
Jan 2019	0
Feb 2019	4
Mar 2019	36
Apr 2019	71
May 2019	117
Jun 2019	135
Jul 2019	163
Aug 2019	130
Total	**756**

3.3 Water Levels in ARD Pond and Iron Pond

The two key water storage ponds at the tailings area are the ARD Pond and Iron Pond. The area-volume curves and measured water elevations for these ponds are provided in the following sections.

3.3.1 Area-Volume Curves

ARD Pond

The ARD Pond is formed by the South and North Dams built in 2001. The dam crest elevation is at El. 1048.0 m and the pond's spillway crest elevation is at 1047.4 m. Discharges from the ARD Pond spillway reports to the Iron Pond. The Maximum Operating Level (MOL) for the pond is set at El. 1046.5 m (KCC, 2000). Figure XII.1 (Appendix XII) shows the pond area-volume curve used for the water balance assessment. Based on that curve, the pond surface area is approximately 10 ha and its storage volume is approximately 710 dam^3 at MOL.

Iron Pond

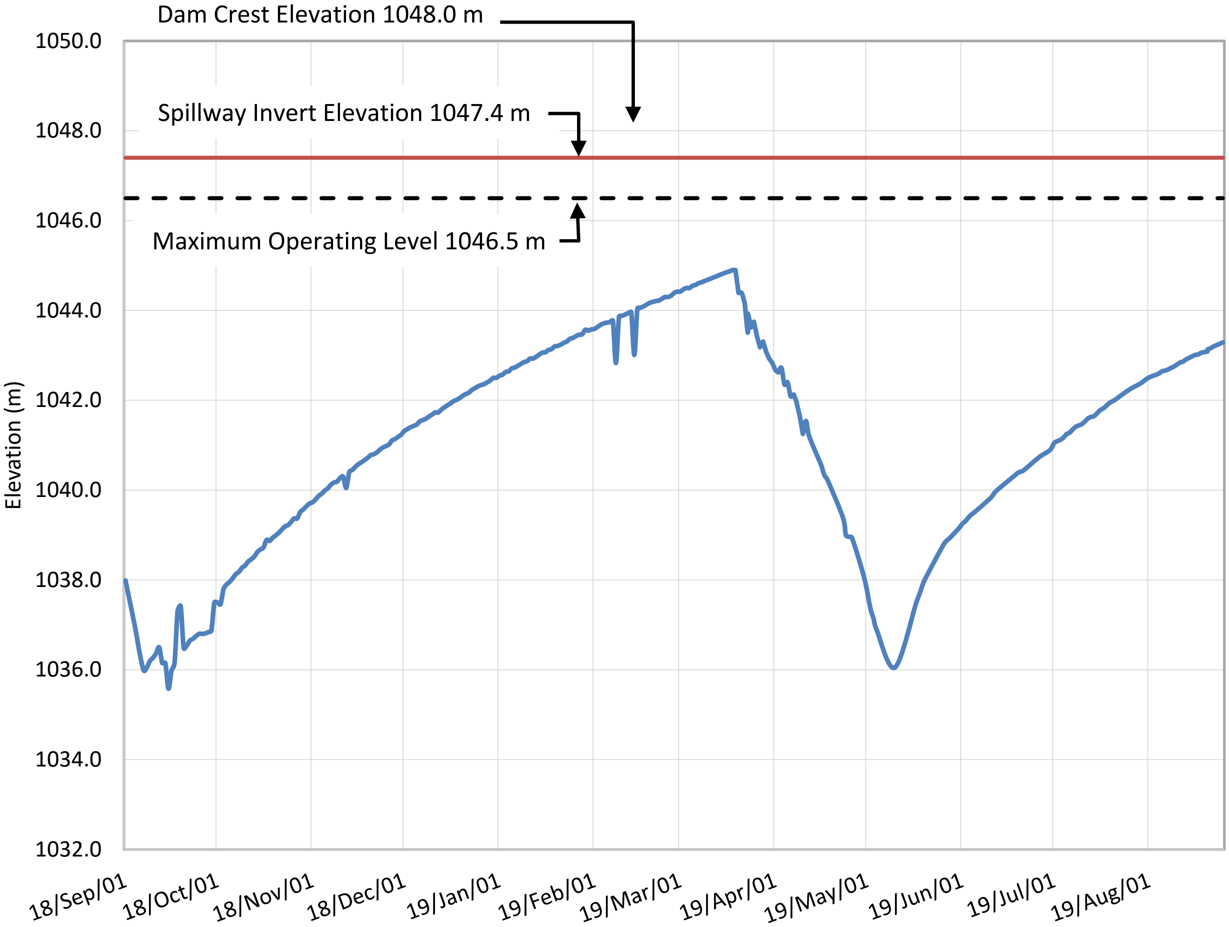
During normal operation, surface runoff from the Iron TSF and the upstream area is collected in the Iron Pond where it is then pumped to the ARD Pond or directly to the DWTP. In addition, the Iron Pond also provides emergency storage when the capacity of the ARD Pond is exceeded. The LiDAR survey from 2012, provided by Teck, shows the elevation of the top of the dike to be at 1042.0 m and the elevation of the emergency spillway crest at 1041.0 m, which is consistent with the original design. The stage–storage curve (KCB 2007) for the pond is shown on Figure XII.2 and indicates that the storage capacity of the Iron Pond at the emergency spillway crest elevation of 1041.0 m is about 380 dam^3.

3.3.2 Pond Water Levels

ARD Pond

Figure 3.2 shows the water levels measured by Teck in the ARD Pond from September 2018 to August 2019. The pond level was recorded daily.

Figure 3.2 ARD Pond Level 2018 – 2019



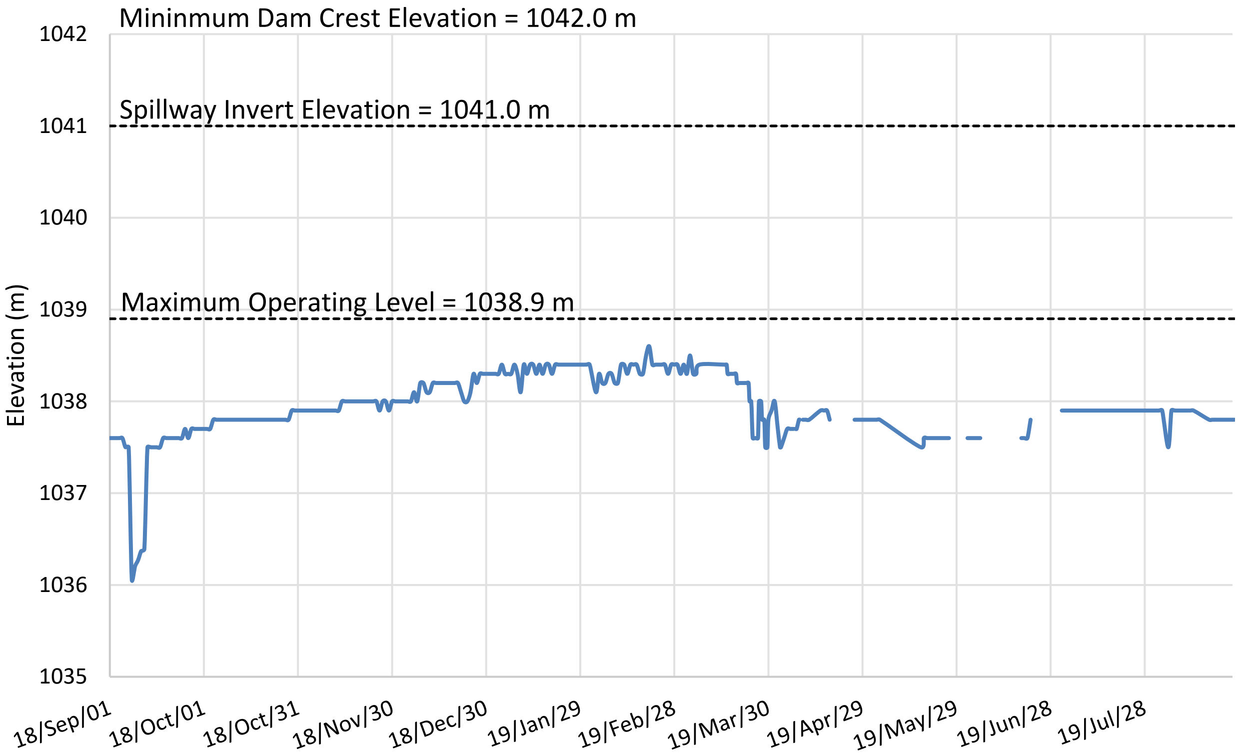
Based on the pond water levels, the maximum level observed during the reporting period was El. 1044.9 m, which occurred on March 18, 2019. This is 1.6 m lower than the maximum operating level (MOL) and is 2.5 m below the spillway crest elevation (spillway flows report to the Iron Pond). There was no water discharged from the ARD Pond spillway to the Iron Pond during the water balance time period.

Iron Pond

Figure 3.3 shows the measured water levels by Teck in the Iron Pond from September 2018 to August 2019. The pond level was recorded daily.

Based on pond water levels, the maximum level observed during the reporting period was El. 1038.6 m around February 20, 2019, which is 2.2 m below the spillway crest elevation (spillway flows discharge to the downstream creek). There was no water discharged from the Iron Pond spillway during the water balance period, and records show that water has never been discharged to the spillway since it was constructed after mine closure.

Figure 3.3 Iron Pond Level 2018 – 2019



3.4 Tailings Area Water Balance

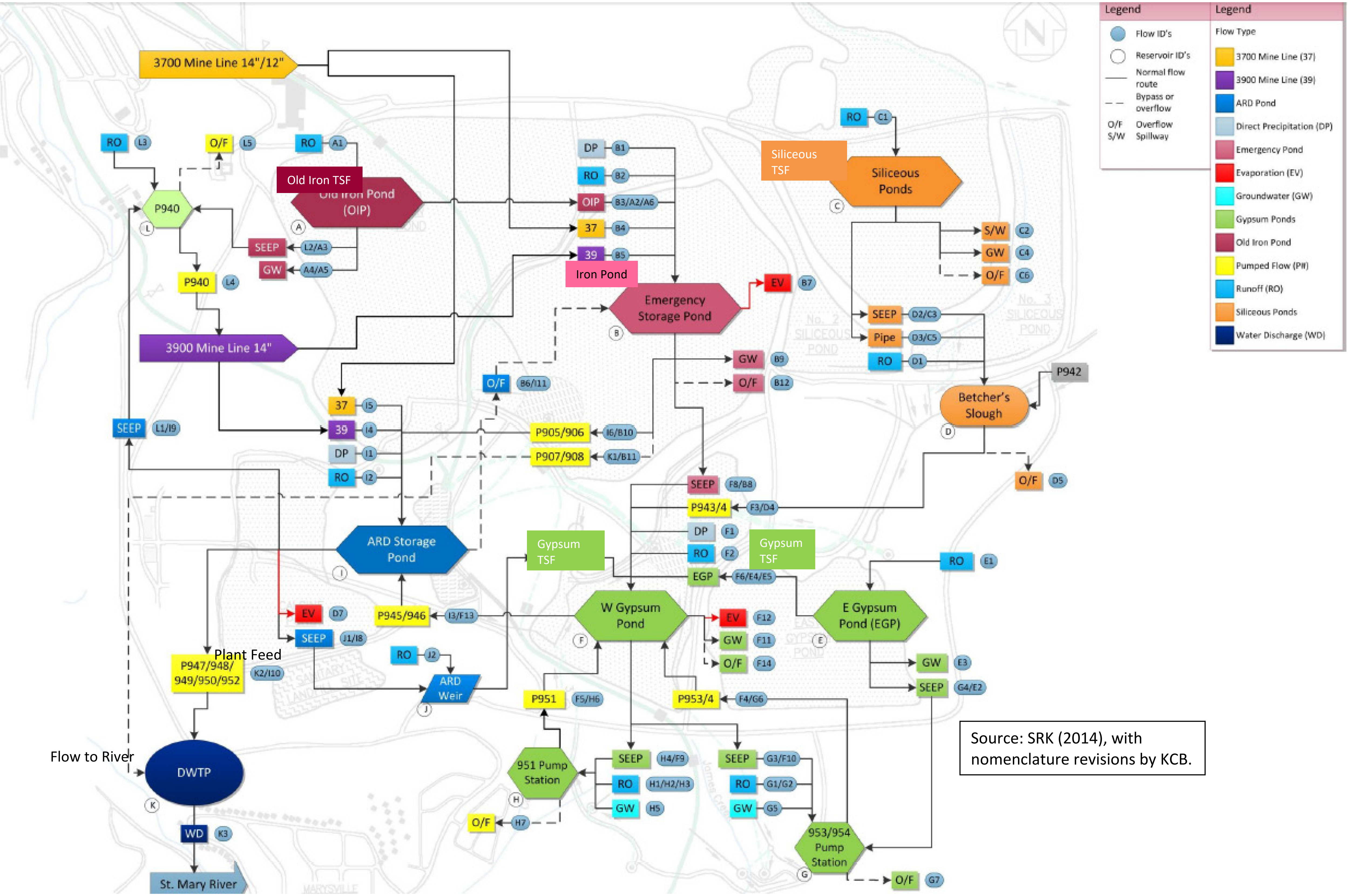
3.4.1 General

Teck manages and tracks the annual water balance for the Sullivan Mine. This section provides a review of the water balance for the current monitoring period from September 1, 2018 to August 31, 2019. The focus of the water balance is for the ARD Pond, as it is the central facility where all collected mine contact water is directed to for storage and then conveyed to the DWTP for treatment.

3.4.2 Water Balance Schematic

Figure 3.4 shows a schematic of the tailings area.

Figure 3.4 Tailings Area Water Balance Schematic



Source: SRK (2014), with nomenclature revisions by KCB.

3.4.3 Inflows

As shown on Figure 3.4, inflows to the ARD Storage Pond include the following:

- Seepage from the Iron Pond, Gypsum TSF, and Siliceous TSF, which is collected in the West Gypsum Seepage Collection Pond and directed to the ARD Pond through Pumps 945 and 946.
- Discharge from the mine through the 3700 and 3900 Mine Lines. The 3700 line carries water from the underground mine to the ARD Storage Pond. The 3900 line collects water from the waste dumps, aquifer dewatering wells, and Sullivan Creek as well as pump 940, which collects seepage from the Old Iron TSF, and carries the water to the ARD Pond.
- Pumped flows from the Iron Pond.
- Direct precipitation on the ARD Storage Pond surface and runoff from the surrounding catchment.

Pump data noted above was provided by Teck, rainfall data was obtained from Environment Canada weather stations and runoff was estimated using runoff parameters for the surrounding catchment.

Precipitation and runoff are calculated for the ARD Pond only. All other inflows are captured as measured pump flows to the ARD Pond, which already include precipitation and runoff from all other tailings areas. The ARD Pond catchment area is 0.179 km^2 (SRK 2014), including the pond and its surrounding catchment. Precipitation and runoff inflows were estimated based on the precipitation depths presented in Table 3.1, and estimated pond and catchment areas, which vary by pond level. The following inputs and assumptions were used for the precipitation and runoff estimates:

- monthly yield coefficients ranging from 0.15 to 0.30, as estimated by SRK (2014);
- precipitation accumulated as snow November through March; and
- 100% of accumulated snow melted in March, based on the snowpack data shown in Table 3.1.

3.4.4 Outflows

Outflows from the ARD Storage Pond include the following:

- Seepage through the South Dam (Weir #1 ARDWU), reporting to the West Gypsum Seepage Collection Pond. The weir also collects runoff from the dam face and upstream area.
- Water pumped from the ARD Pond to the DWTP.
- Evaporation from the pond surface.

Flows from Weir #1 were not collected during the reporting period. Water is pumped from the ARD Pond to the DWTP through pumps 947/948/949/950/952. The water is treated and then released to the St. Mary River.

Evaporation losses from the ARD Pond were estimated by multiplying the monthly evaporation depth shown in Table 3.2 by the estimated water surface area of the pond based on the measured pond elevation. Evaporation losses from other areas are reflected in the measured pump flows.

3.4.5 Water Balance Summary

A summary of the estimated monthly inflow and outflow volumes for the ARD Pond is provided in Table 3.3. The water storage in the ARD Storage Pond is calculated monthly based on the inflows and outflows and compared to the observed storage (calculated from the measured water elevation and stage-elevation curve), as summarized in Table 3.3. These volumes are based on the original capacity of the pond, so the accumulation of solids in the pond means that the actual water volume is somewhat less than the table indicates.

Agreement between the observed and calculated storage is variable on a monthly basis. The difference between the observed and calculated year-end storage volumes amounts to 17% of the annual inflow to the pond.

The calculated annual difference of 17% over the current monitoring period is greater than the calculated annual difference of 6% for the previous monitoring period. Several factors could have contributed to the greater difference, including uncertainties in pump flow readings and inaccuracies in capturing seepage flows at Weir #1. Improvements to the weirs to capture flows and automate the data recording are planned for the future to improve the water balance evaluation.-The variation in water balance is not a dam safety concern as pond levels are actively monitored and managed by Teck staff.

Table 3.3 ARD Pond Monthly Water Balance Summary

Description	Units	Sep 2018	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sept. 2017 – Aug. 2018
Beginning Water Level	(m)	1038.22	1037.50	1039.70	1041.24	1042.50	1043.58	1044.42	1042.83	1038.05	1039.16	1040.92	1042.47	1038.22
Beginning Storage	(dam^3)	90.32	59.30	167.31	263.89	355.43	443.09	515.30	381.44	82.27	137.32	242.66	353.16	90.3
Inflow:														
Pump 905/906/907/908	(dam^3)	0.8	0.0	0.0	0.0	0.0	0.0	42.9	9.1	3.3	0.0	0.0	0.0	56.0
Pump 945 / 946	(dam^3)	66.3	70.1	67.4	67.5	65.6	57.3	87.8	64.4	58.0	51.8	51.3	46.3	753.7
Mine Line 3700	(dam^3)	23.7	0.0	0.0	0.0	0.0	0.0	33.4	228.9	109.9	0.0	3.2	0.0	399.2
Mine Line 3900	(dam^3)	61.1	62.0	54.5	50.3	46.0	38.8	46.5	68.0	85.7	87.2	86.0	72.4	758.6
Precipitation and Runoff	(dam^3)	2.2	2.1	1.4	2.3	1.8	2.1	3.9	2.2	2.3	5.3	6.5	1.5	33.7
Total Inflow	**(dam^3)**	**154.2**	**134.3**	**123.3**	**120.2**	**113.4**	**98.2**	**214.5**	**372.7**	**259.2**	**144.4**	**147.0**	**120.1**	**2001.3**
Outflow:														
Pump 947/948/949/950/952	(dam^3)	152.7	0.0	0.0	0.0	0.0	0.0	285.2	676.7	166.1	0.0	0.0	0.0	1280.7
Weir 1 ARDWU	(dam^3)	Not Available												
Evaporation	(dam^3)	2.8	1.4	0.3	0.0	0.0	0.3	2.9	4.4	5.8	8.1	11.6	10.3	48.0
Total Outflow	**(dam^3)**	**155.5**	**1.4**	**0.3**	**0.0**	**0.0**	**0.3**	**288.1**	**681.1**	**171.9**	**8.1**	**11.6**	**10.3**	**1328.7**
Calculated Net Change in Storage	(dam^3)	-1.4	132.8	123.0	120.2	113.4	97.9	-73.6	-308.4	87.3	136.3	135.3	109.8	672.6
Calculated Month-End Storage	(dam^3)	89.0	192.1	290.3	384.1	468.8	541.0	441.7	73.1	169.6	273.6	378.0	462.9	762.9
Observed Month-End Storage	(dam^3)	59.3	167.3	263.9	355.4	443.1	515.3	381.4	82.3	137.3	242.7	353.2	419.0	419.0
Storage Difference (% of Inflow)	(%)	-19%	-18%	-21%	-24%	-23%	-26%	-28%	2%	-12%	-21%	-17%	-37%	-17%

Note:

Inflows to ARD pond from 3700 and 3900 lines include some flows diverted to Iron Pond when ARD Pond line maintenance is completed.

3.5 Flood Management

Reclamation work on the tailings areas commenced in 1990 and continued after mine closure in 2001 until it was completed in 2008. The reclamation work primarily comprised the development and construction of a multi-layer soil cover system of float rock and till over the tailings areas. A summary of the flood management structures and applicable design criteria is presented below.

- Surface water collection/diversion channels and spillways have been designed and constructed in the tailings areas for flood management. The main channels and spillways are Dobson's Draw diversion, Siliceous Spillway and outlet channel, ARD Pond spillway, Channel C within the Iron Pond and the Emergency spillway. They are designed to safely pass the Probable Maximum Flood (PMF) events. The channels are riprap lined and the spillways include stilling basins.
- As previously indicated, the Iron Pond is intended to provide storage of mine contact surface water during spring runoff events. The Iron Pond is designed to store the 100-year snowmelt event above the maximum operating level and controlled release of the 1000-year snowmelt event has also been provided for, if it cannot be stored. If the pond level at the start of the snowmelt event was below the maximum operating level then a larger than 100-year snowmelt event could be stored before discharge via the emergency spillway. The emergency spillway for the Iron Pond is designed to safely pass the PMF. Key characteristics of the Iron Pond are provided in Section 3.6.1.
- As previously indicated, the ARD Pond is the central water storage facility where all collected contaminated/contact water is directed to for storage and then subsequently conveyed to the DWTP for treatment. The ARD Pond has been designed to store the 48-hour PMF and also includes a spillway designed to safely pass a 24 hr PMF (after the 48-hour PMF has been stored). Note that, in essence, the ARD Pond is capable of safely handling two PMFs occurring in succession. Key characteristics of the ARD Pond are provided in Section 3.6.2.

It should be highlighted that the PMF, which was selected as the Inflow Design Flood (IDF) for the Sullivan Mine tailings facilities, exceeds the minimum criteria for their respective consequence classifications (see Table 5.1 in Section 5), as specified in CDA (2013, 2014) and EMPR (2017). Teck has adopted conservative IDF values.

3.6 Freeboard and Storage – Water Storage Ponds

3.6.1 Iron Pond

The maximum operating level of the Iron Pond is El. 1038.9 m. The stage – storage curve of the pond is shown on Figure XII.2, and its key design and performance characteristics are provided in Table 3.4.

Table 3.4 Relevant Iron Pond Characteristics

Item	Value
Top of the Dike Elevation (m)	1042.0
Spillway Crest Elevation (m)	1041.0
Maximum Operating Level (m)	1038.9
Storage Capacity at the MOL (dam^3)	76.9
Designed Storage Capacity up to the Spillway (dam^3)	614.2
Minimum Water Level in 2018-2019 (m)	1036.1
Maximum Water Level in 2018-2019 (m)	1038.8
Maximum Storage in 2018-2019 (dam^3)	66.1
Minimum Available Capacity Below MOL 2018-2019 (dam^3)	10.8

As previously discussed in Section 3.3.2, and shown on Figure 3.3, the maximum water level elevation recorded in the Iron Pond over this monitoring period was 1038.6 m, which is 2.2 m below the emergency spillway crest elevation and 3.2 m below the minimum Iron Dike crest elevation.

3.6.2 ARD Pond

The maximum operating level of the ARD Pond is set at El. 1046.5 m, which is 0.9 m lower than the spillway invert (El. 1047.4 m). It allows for a flood storage depth of 0.8 m for a 48-hour Probable Maximum Flood (PMF) plus 0.1 m freeboard to the spillway invert. The elevation of the top of the dam is set at 1048.0 m, providing a vertical distance of 0.6 m above the spillway invert. This vertical distance allows for a 0.3 m surcharge above the spillway crest and a dam freeboard of 0.3 m (KCB 2018) when routing the IDF (PMF) through the spillway to the Iron Pond.

The stage–storage curve of the pond is shown on Figure XII.1, and its key design and performance characteristics are provided in Table 3.5.

Table 3.5 Relevant ARD Pond Characteristics

Item	Value
Top of Dam Elevation (m)	1048.0
Spillway Crest Elevation (m)	1047.4
Maximum Operating Level (m)	1046.5
Storage Capacity at the MOL (dam^3)	710.7
Designed Storage Capacity for PMF (dam^3)	50.0
Designed Freeboard for PMF (m)	0.3
Minimum Water Level in 2018-2019 (m)	1035.6
Maximum Water Level in 2018-2019 (m)	1044.9
Maximum Storage in 2018-2019 (dam^3)	557.9
Minimum Available Capacity Below MOL 2018-2019 (dam^3)	152.8

As previously discussed in Section 3.3.2, and shown on Figure 3.2, the maximum water level elevation recorded in the ARD Pond over this monitoring period was 1044.9 m, which is 2.5 m below the spillway crest elevation and 3.1 m below the dam crest elevation.

3.7 Off-Site Surface Water Discharge Volumes

There were no off-site water discharges from the ARD Pond and Iron Pond spillways during the reporting period. These spillways have not operated since they were constructed in 2001 (ARD Pond) and Iron Pond (completed in 2007 with modifications in 2009).

The only discharge to the environment is treated water from the DWTP, which enters the St. Mary River. Table 3.6 provides a summary of the monthly discharge volumes, as provided by Teck. As shown, the total water discharge volume from the DWTP between September 2018 and August 2019 was 1263 dam^3.

Table 3.6 Summary of Treated Water Discharge to St. Mary River

Month	Total Volume (dam^3)	Average Discharge per Day (dam^3)
Sep 2018	176.7	5.9
Oct 2018	0.0	0.0
Nov 2018	0.0	0.0
Dec 2018	0.0	0.0
Jan 2019	0.0	0.0
Feb 2019	0.2	0.0
Mar 2019	200.8	7.2
Apr 2019	700.2	23.3
May 2019	184.7	6.0
Jun 2019	0.0	0.0
Jul 2019	0.0	0.0
Aug 2019	0.0	0.0
Total	**1263**	

The average daily discharge volumes over this monitoring period were less than the maximum daily limit of 28 dam^3 as compliant with the permit PE-00189.

3.8 Water Discharge Quality

Water discharge quality is not included in the scope of this report. Teck separately reports groundwater quality and discharge water quality to the BC Ministry of Environment as specified in Permit PE-00189.

4 SITE OBSERVATIONS AND INSTRUMENTATION REVIEW

4.1 Visual Observations

The on-site inspection of the dikes and dams was carried out by Ms. Pamela Fines, P.Eng. (Engineer of Record, Designated Alternate), Mr. Bill Chin, P.Eng. (Engineer of Record), and Mr. Patrick Beauchesne, P.Eng. (AB) of KCB from May 22 to May 23, 2019. The weather during the inspection was warm with mostly clear skies. The 2019 Dam Safety Inspection Forms that were completed for each dike/dam are included in Appendix I and selected photographs from the site visit are included in Appendix II. A summary of the visual observations of each dike/dam is below.

Selected photographs of the various embankments taken during the site visit are presented in Appendix II and are referenced throughout this report. Photographs have been grouped as follows:

ARD Pond, ARD Spillway, Weirs 1 and 2	II-1
Iron TSF, Iron Pond, Emergency Spillway (Upstream Portion), Weir 3	II-2
Siliceous TSF, Siliceous Spillway, Siliceous Decants	II-3
Gypsum TSF, Emergency Spillway (Downstream Portion), Weir 4	II-4
Sludge Impoundment	II-5
Calcine TSF	II-6
Old Iron TSF, Iron TSF Divider Dike	II-7

4.1.1 Iron TSF and Iron Dike

The visual inspection indicated that the Iron Dike was in good physical condition with no signs of structural distress. No cracking or other unusual physical conditions were noted along the crest or downstream slopes. Dikes slopes and crest were grassed with no significant areas observed with bare or loose soil (Photo 2.3 and 2.4).

Seepage continued similarly to previous years on the downstream side of the dike near station 5+00. Seepage is monitored by two weirs (Weir #3 – AIPWU and Weir #4) installed within the drainage ditch (Photo 2.6 and 2.7). Seepage was also occurring on the downstream side of the dike near station 24+00 and is being collected in the existing ditch and low-lying area, this seepage should continue to be monitored visually as part of routine inspections and collection of weir flow data.

The visual inspection of the Iron Pond (contained within Iron TSF) indicated that it was in good condition.

The Emergency Spillway Channel, which runs from the southwest corner of Iron TSF and down the west side of West Gypsum TSF. The visual inspection indicated the spillway was in good physical condition (Photo 4.6 and 4.7). Some grass, shrubs, and other vegetation were present in the lower portion of the spillway near the southwest corner of the West Gypsum TSF and the 951 Pump House. The rip rap appeared to be in good condition with no signs of movement or particle breakdown.

4.1.2 Old Iron Dike

The visual inspection indicated that the Old Iron Dike and Iron TSF Divider Dike were in good physical condition with no signs of structural distress. The downstream slope of the Old Iron Dike was grassed, with no significant areas of bare or loose soil (Photo 7.1). There were no signs of seepage. The Iron TSF Divider Dike is buttressed by the Iron TSF and is currently being used as an access road between the two TSFs (Photo 7.3). No physical changes were observed from the previous DSI. The Iron TSF Divider Dike is buttressed on both sides with tailings.

4.1.3 No. 1, 2, and 3 Siliceous TSFs

The visual inspection indicated that the No. 1, 2, and 3 Siliceous Dikes were in good physical condition with no signs of structural distress (Photo 3.1, 3.4, and 3.7). Seepage of variable amounts generally occurs from the toes of all Siliceous Dikes during the spring from runoff due to snowmelt water infiltration through the cover system. This seepage occurred during operations and has continued after mine closure. The observed seepage conditions appeared to be similar to those observed in previous DSI's. The seepage water is collected by drainage ditches. Inspection of seepage locations along the Siliceous dikes is performed by Teck on a regular basis. Signs of surface seepage emerging from the downstream slopes of the dikes were not evident during KCB's site visit which was carried out after freshet in late May.

A small trickle of flow observed from the historical decant pipes installed into the No. 3 Siliceous Dike (Photo 3.2). It is KCB's understanding that flow is relatively constant through these pipes during the entire year. A decant installed in 2000 within the No. 2 Siliceous Dike was dry and generally only sees flow during freshet. Flow from both decants should be monitored and recorded as part of the regular inspections by Teck and KCB. Any changes in flow rate or sediment in the flow should be reported to KCB.

The surface water runoff conveyance channel from No. 1 Siliceous Cell across No. 3 Siliceous Cell, the diversion channel to the north of No. 1 and No. 3 cells, and the emergency spillway channel constructed on the east slope of No. 3 Siliceous Dike were in good physical condition at the time of the site visit with no signs of movement or particle breakdown (Photo 3.4 to 3.6).

4.1.4 East and West Gypsum TSFs

The visual inspection indicated that the East Gypsum Dike was in good physical condition with no signs of structural distress (Photo 4.1 and 4.2). Dike slopes were well-grassed with no significant areas of bare or loose soil observed. Several large rodent burrows were observed along the lower dam slopes and toe (Photo 4.3) but are not considered to be a dam safety issue. However, the burrows are a safety hazard to personnel walking along the dam toe and slope. Rodent burrows should be infilled as they're identified. Seepage was observed in the ditch at the toe of the dike. The observed seepage condition was similar to previous DSI site visits.

The visual inspection indicated that the West Gypsum Dike was in good physical condition with no signs of structural distress. Dike slopes were well-grassed with no significant areas of bare or loose soil observed (Photo 4.4 and 4.5). Animal burrows were observed near the dike toe, the number of burrows on the West Gypsum Dike seemed to be less than observed in 2018. These burrows are not considered to be a dam safety issue; however, they are a safety hazard to personnel walking along the dam toe and slope and should be backfilled as they are identified. There is no public access to this area, so hazard is limited to Teck staff and authorized contractors.

4.1.5 Northeast Gypsum Dike and Recycle Dam

The visual inspection indicated that the Northeast Gypsum Dike and Recycle Dam were in good physical condition with no signs of structural distress. The slopes of both embankments were well-grassed (Photo 4.11). Animal tracks were observed along the downstream slope of the Northeast Gypsum Dike (Photo 4.10).

4.1.6 ARD Pond

The visual inspection indicated that the North and South Dams were in good physical condition with no signs of structural distress. The riprap on the upstream side of both dams was in good condition with no evidence of movements or damage (Photo 1.2 and 1.7). It was noted that there is sporadic vegetation growth on the upstream face of both dams but is not a dam safety concern at this time and should be managed as part of the vegetation management program on site.

An area of erosion was observed at an outlet pipe adjacent to the pumphouse located near the South Dam of the ARD Pond (Photo 1.3). This area should be monitored and repaired if it begins to encroach on the pumphouse. An erosion gully near the spillway was also observed. Teck reported that this gully had formed due to a high rainfall event just prior to the inspection and the area was flagged off for worker safety. The gully should be backfilled.

The downstream slope of the North Dam appeared to be in similar conditions to the previous years. The slope is well grassed with no significant patches of bare or loose soil observed (Photo 1.8). Localized depressions/steepened slopes along the toe of the North Dam have been noted during the annual inspections (Photo 1.9). These areas were purposely constructed by locally excavating into the dam slope to manage seepage exiting from the dam. Seepage collects in the toe ditch and flows to the seepage pond at the west end of the dam.

The downstream slope of the South Dam appeared to be in similar condition to past inspections (Photo 1.1). The slope is well grassed with no significant patches of bare or loose soil observed. Animal tracks were observed on the left abutment of the dam.

The ditch south of the South Dam that feeds into Weir #1 – ARDWU and Weir #2 are heavily vegetated with grass and other plants, which may impede flow (Photo 1.15). The ditches should be cleaned as part of the vegetation management program on site. The ditches and basins of the weirs were dry at the time of the inspection.

4.1.7 Calcine TSF

The visual inspection indicated that the Calcine Dike was in good physical condition with no signs of structural distress (Photo 6.1 and 6.2). The downstream slope of the dike was well vegetated and is buttressed by a municipal landfill.

The old beach surface is at crest level upstream of the dike and gently slopes downward towards the north (upstream). There was no free water observed during the inspection and vegetation has become established over the entire impoundment. Calcine removal from a pit developed at the northwest side of the lower cell ceased in 2011/2012 and this area was reclaimed (Photo 6.3). The pit is well drained, and no standing water was observed.

4.1.8 Sludge Impoundment

Both the North and South Dikes of the Sludge Impoundment were observed to be in good physical condition during the inspection. The sludge level in the impoundment adjacent to the dam is nearing the design levels of approximately one metre below the crest elevation at the North Dike and is approximately 1.5 m below design storage level near the South Dike. The depressions at the access ramps noted in last year's inspection have been repaired to level the crest.

A significant number of trees were removed from the toe and downstream area of South Dike. Vegetation removal was also completed at the North Dike.

4.2 Instrumentation Data Review

Based on the review of the instrumentation data and observations from the site inspection of May 23 and 24, 2019, there were no dam safety concerns identified. The current monitoring schedule for all instruments will be maintained for the 2020 DSI reporting period. The monitoring frequencies are reported in Table 4.1 below. Additional readings may be requested as required depending on trends observed during the 2020 reporting period.

All of the weirs on site had reported issues with water bypassing the weirs, leading to under-reporting of seepage flows. The weirs should be repaired/reconstructed to prevent flows from by-passing the weir boxes. Once the repairs are completed, automated flow measurements could be implemented.

Table 4.1 Monitoring Frequencies for 2020 Reporting Period

Dike/Dam		Monitoring Frequency (3x = three times per year, 3y = every 3 years, A = annually, AV = annual visual, M = monthly, W = weekly) Consult notes for conditional changes and special regimes.				
		Piezometers	Settlement	Inclinometers	Seepage(8)	Water Levels
Iron TSF	Iron Dike	3x(1)	A + 3y(5)	-	W(7)	Daily
Old Iron TSF	Old Iron Dike	3x(2)	-	-	-	-
	Iron TSF Divider Dike	A(3)	-	-	-	-
Siliceous TSF	No. 1, 2, and 3 Dikes	A	-	-	-	-
Gypsum TSF	West Gypsum Dike	3x(2)	A + 3y(6)	-	AV	-
	East Gypsum Dike	A	A + 3y(6)	3y	AV	-
	Northeast Gypsum Dike and Recycle Dam	-	3y	-	-	-
ARD Pond	North Dam	M(4)	3y	-	-	Daily
	South Dam	M(4)	3y	-	W(7)	Daily
Sludge Impoundment	North Dike	-	A	-	-	-
	South Dike	-	A	-	-	-

Notes:

[1] Three times per year (spring, summer, and fall) except P92-H which is recorded weekly by a datalogger and P92-02 and P92-25 which are read monthly.

[2] Three times per year (spring, summer, and fall).

[3] Annually in the spring if possible, to capture peak level.

[4] Read pneumatic piezometers weekly when pond is above 1045 m. Read standpipe piezometers weekly when ARD pond is about 1040 m and daily when ARD pond is about 1045 m.

[5] Survey of Iron Dike from Station 0+00 to 12+00 to be completed annually.

[6] Settlement plates to be surveyed annually, Sondex gauge to be read every three years.

[7] Weirs measured daily between March 1 and May 30. Read daily for three days following rainfall event > 10 mm in 24 hours.

[8] Record pond levels when weirs read. When reading weirs, provide visual observations of ditch flows, e.g. ice build-up, flows around or under weir, etc.

Quantifiable Performance Objectives (QPOs) have been established in terms of notification levels for the instrumentation installed within the dikes/dams, and notification levels relative to pond water elevations and corresponding freeboard for the ARD Pond and the Iron Pond. In addition, a check list of qualitative indicators (e.g. observations of cracking, slumping, erosion, etc.) for routine visual inspections, event-drive visual inspections and annual visual inspections have been developed. Additional details, including summary tables of instrumentation data and corresponding notification levels, are provided in Appendix III.

It is important to emphasize that the notification levels for the available instruments, including piezometers, seepage weirs, settlement systems and inclinometer, are not associated with any dam safety concerns. Rather, they are based on historical trends of readings in a particular instrument with the objective of highlighting readings that could be indicative of a potential change from historical norms in order to prompt a closer review as a matter of due diligence. The specified notification levels are well below the assumed levels for stability assessments.

A review is currently underway to link the threshold levels for Sullivan instrumentation to the key potential failure modes. The results will be discussed with Teck and is scheduled for implementation in 2020.

Teck contracts instrument reading and monitoring data collecting to Vast, who upload the data to GeoExplorer.

The precipitation data for the 2019 reporting period indicates that the Kimberley/Cranbrook area saw higher than average snowpack and rainfall precipitation in June and July 2019 and average to below average rainfall precipitation for the remainder of the monitoring period. The previous monitoring period received higher than average precipitation for much of the year. The observed trend of decreasing piezometric levels for most structures likely reflects the reduced precipitation in 2019 compared to the previous monitoring period.

4.2.1 Iron Dike

The locations of the existing instruments at the Iron Dike are shown on Figure 5. Typical sections showing geometry and pore pressure response are shown on Figures 6 and 7.

Piezometric Levels

Time plots of the piezometric readings received from Vast are presented on Figures 1 through 10 in Appendix IV. Peak values recorded over this period are reported in Table AIII.3.

Most of the Iron Dike piezometers (22 out of 30) show reduced peak pore water pressures during the 2019 reporting period compared to the previous year's readings. Readings generally remained below notification levels and are well below the assumed levels for stability assessments.

Settlements

The most recent survey of settlement plates and dike crest was carried out by Teck in October 2018, and the results were reported in the 2018 DSI report. The October 2018 survey confirmed that the dike crest is typically above the design elevation, and there has been no additional settlement since 2014. The surveys are scheduled to be conducted annually.

Seepage Flows

Two weirs (Weir #3 – AIPWU and Weir #4) exist to monitor seepage from the toe of the west portion of the Iron Dike. Weir #3 is located near the toe of the Dike and Weir #4 is located 300 m downstream.

Weir #3 – AIPWU measured peak flows of 22.4 m^3/day in August. The flow data indicates minimum flows through the weir of 0.1 m^3/day to 2.3 m^3/day. Several entries indicate that water was flowing under the weir, and therefore, the flows for Weir #3 associated with those entries are likely underreported. Historical data for Weir #3 is presented in Figure IV-11.

Weir #4 flow data shows a peak flow of 121.6 m^3/day in March during low elevation snowmelt. Minimum flows varied from 0.1 m^3/day to 10.4 m^3/day. Similar to Weir #3, entries in multiple months indicate that water was flowing under the weir, and therefore, the flows associated with those entries are likely underreported. Historic data for Weir #4 is presented in Figure IV-12. It should be noted that this weir is approximately 300 m downstream from the dike toe and flow measurements will include surface runoff from surrounding terrain as well as seepage flows.

The weirs are read at a minimum monthly, with daily or weekly readings performed during periods of higher flows and/or when the ARD Pond elevations is above 1145. Additional readings occur following heavy rainfall events.

4.2.2 Old Iron TSF

The locations of existing instruments at the Old Iron TSF (Old Iron Dike and Iron TSF Divider Dike) are shown on Figure 8. A typical section showing geometry is shown on Figure 9.

Piezometric Levels

Plots of piezometer readings for the Old Iron TSF are included as Appendix V. Peak values are reported in Table AIII.3. Four new vibrating wire piezometers were installed in 2018 to replace two malfunctioning pneumatic piezometers.

All five existing functioning piezometers showed a decrease in peak piezometric level compared to the previous monitoring period and were below the notification levels for the monitoring period.

4.2.3 Siliceous TSF

The locations of existing instruments in the Siliceous Cells are shown on Figure 10. Typical sections showing geometry are shown on Figures 11 and 12.

Piezometric Levels

No. 1 Siliceous Dike

Plots of piezometer readings for the No. 1 Siliceous Dike are shown in Figures VI-1 and VI-2. Peak values recorded over this period are reported in Table AIII.3.

There are currently four piezometers being read in the No. 1 Dike. All four piezometers recorded similar or lower maximum piezometric levels in this monitoring period compared to the previous monitoring period. P105, a standpipe piezometer installed in the dike adjacent to No. 3 Cell, has been reading near or above its notification level for several years including after an attempted flush in 2014. It is suspected that the piezometer may be plugged internally. The readings are still below the assumed phreatic surface in design, and adjacent and downstream piezometers continue to read below notification levels. The notification level for P105 is being reviewed and adjusted as deemed appropriate for 2020.

No. 2 Siliceous Dike

Plots of piezometer readings for the No. 2 Siliceous Dike are shown in Figures VI-3. Peak values recorded over this period are reported in Table AIII.3.

All three piezometers indicated lower peak readings compared to the previous monitoring period with all readings below the current notification levels.

During the site inspection, an existing standpipe piezometer was discovered downstream of No. 2 Siliceous Dike and along Betcher’s Slough, which was flowing. It is recommended that the flows from this standpipe piezometer should be measured on a monthly basis to start and reported as part of the overall instrumentation program.

No. 3 Siliceous Dike

Plots of piezometer readings for the No. 3 Siliceous Dike are shown in Figures VI-4 to VI-6. Peak values recorded over this period are reported in Table AIII.3.

Eight new piezometers were installed in 2018 to replace piezometers that were consistently reading as dry. Four piezometers were reinstated after not being read since 2004.

Of the nine existing standpipe piezometers read in the 2019 monitoring period, eight were dry or reading very near to tip depth. All were below notification level except three piezometers which were reinstated and have a current notification level at the tip depth of the instrument. Notification levels for the reinstated piezometers will be updated for the 2020 monitoring period. Notification levels for the new instruments will be established at the end of the 2020 once some historic readings have been established.

Seepage Flows

There are currently no flow measuring capabilities in the area of the Siliceous TSFs. During the site inspection, we inspected both the shallow decant and historical decant. We recommend that photos be taken of these decants when they are flowing and document any changed conditions.

4.2.4 Gypsum TSF

The locations of existing instruments in the Gypsum TSF are shown on Figures 13, 16, and 18. Typical sections showing geometry are shown on Figures 14, 15, 17, and 19.

Piezometric Levels

West Gypsum Dike

Plots of piezometer readings for the West Gypsum Dike are shown in Figures VII-2 and VII-3. Peak values recorded over this monitoring period are reported in Table AIII.3.

One new vibrating wire piezometer was installed in 2018. The borehole was drilled as part of a site investigation to confirm foundation conditions and a piezometer was installed as part of that investigation.

The majority (5 of 6) of piezometers indicated a relatively consistent or decreasing trend in the dike compared to the previous monitoring period. P93-2 had a slight increasing trend compared to the previous monitoring period. All piezometers are well below their current notification levels.

East Gypsum Dike

Plots of piezometer readings for the East Gypsum Dike are shown in Figures VIII-2 and VIII-3. Peak values recorded over this monitoring period are reported in Table AIII.3.

Two new vibrating wire piezometers was installed in 2018. The boreholes were drilled as part of a site investigation to confirm foundation conditions and piezometers were installed as part of that investigation.

Of the seven installed piezometers monitored, six indicated a relatively consistent or reduced piezometric trend compared to the previous monitoring period. The seventh piezometer (P93-14) was reported as blocked during the most recent reporting period. All piezometers are below their current notification levels.

Northeast Gypsum Dike and Recycle Dam

Standpipe piezometers in the Northeast Gypsum Dike and Recycle dam have not been monitored since 2004. Piezometric levels consistently matched pond elevations and were not providing information to assess Dike/Dam performance. The Dike/Dam have a long history of good performance, relatively low heights, and any impacts in the unlikely event of a failure would be wholly contained within the impoundment area and ongoing monitoring of the piezometric levels was considered not necessary.

Settlement

West Gypsum Dike

The most recent survey of settlement plates and dike crest was carried out by Teck in October 2018, and the results were reported in the 2018 DSI report. Settlement was reported as 0 mm/year to 25 mm/year with decreasing rates and this is consistent with the expected behaviour of the gypsum tailings.

Consolidation of the West Gypsum Cell tailings is monitored with a Sondex settlement gauge, S94-01, installed about 50 m upstream of the crest at Station 10+00 (Figure VII-1). A reading of the Sondex gauge was taken during the 2019 DSI. The Sondex readings indicated a settlement at the top ring of approximately 47 mm/year which is consistent with the readings of 30 mm/year to 70 mm/year measured over the last 10 years. The Sondex gauge has recorded total consolidation settlement of about 1.7 m since 1994. This is within the expected settlement for the facility. As indicated in KCB’s report Stability Review of Gypsum Dikes dated November 26, 1993, long term creep is a common characteristic of gypsum. Continued consolidation of the gypsum tailings is not considered a dike safety concern. Regular crest surveys are conducted to confirm that the dam crest remains at or above the design elevation. The next reading of this Sondex gauge is scheduled for 2022.

East Gypsum Dike

The most recent survey of settlement plates and dike crest was carried out by Teck in October 2018, and the results were reported in the 2018 DSI report. Settlement was reported as 15 mm/year to 30 mm/year and the rates of settlement were below threshold levels and consistent with the expected behaviour of the gypsum tailings.

Consolidation of the East Gypsum Cell tailings is monitored with a Sondex settlement gauge, S94-02, installed about 25 m upstream of the crest at Station 33+00 (Figure VIII-1). A reading of the Sondex gauge was taken during the 2019 DSI. The Sondex readings indicated a settlement at the top ring of approximately 28 mm/year which is consistent with the readings of 20 mm/year to 75 mm/year measured over the last 10 years. The Sondex gauge has recorded total consolidation settlement of about 1.0 m since 1994. This is within expected settlement for the facility. As indicated in KCB's report Stability Review of Gypsum Dikes dated November 26, 1993, long term creep is a common characteristic in gypsum. Continued consolidation of the gypsum tailings is to be expected and is not considered a dike safety concern. Regular crest surveys are conducted to confirm that the dam crest remains at or above the design elevation. The next reading of this Sondex gauge is scheduled for 2022.

Northeast Gypsum Dike and Recycle Dam

The most recent survey of settlement plates and dike crest was carried out by Teck in October 2018, and the results were reported in the 2018 DSI report.

Past surveys, presented in Appendix IX, indicated negligible settlements since 2007.

Lateral Movement

West Gypsum Dike

An inclinometer, BI94-01, installed at Station 10+00 has not been read completely since 2004 when it became blocked at a depth of 4.7 m below ground surface. Partial readings of the top 4.7 m of the casing were taken in 2007 through 2009. No further readings have been taken since 2009. Continued reading and/or replacement of this inclinometer was not considered necessary.

Figure VII-1 shows the historic readings and cumulative deflection of the inclinometer casing until 2004 when instrument readings were stopped.

East Gypsum Dike

There is one inclinometer, BI94-02, installed within the East Gypsum Dike at Station 33+00. A reading was conducted during the 2019 DSI site visit but errors in the data were discovered during processing. A re-reading was conducted in October 2019 and results indicate that the instrument is becoming difficult to read with indications from the data that the wheels may be leaving the grooves during readings. This could be a sign of joint separation or damage to the casing below ground surface. KCB will evaluate if the instrument should be replaced as part of an instrumentation review planned for 2020. The 2019 data is not included in Figure VIII-1.

Previous readings indicated less than 10 mm of cumulative horizontal movements between 2010 and 2016. Readings are shown on Figure VIII-1.

Northeast Gypsum Dike and Recycle Dam

The most recent survey of settlement plates and dike crest was carried out by Teck in October 2018, and the results were reported in the 2018 DSI report.

Past surveys, presented in Appendix IX, indicate less than 20 mm of lateral movement since 2007.

4.2.5 ARD Pond

The locations of existing instruments at the ARD Pond are shown on Figure 20. Typical sections showing geometry and piezometric levels are shown on Figures 21 through 24.

Piezometric Levels

South Dam

Plots of piezometer readings for the South Dam are shown in Figures X-1 and X-2. Peak values recorded over this monitoring period are reported in Table AIII.3.

Five piezometers in ARD South Dam are actively monitored, all of which showed relatively consistent or decreasing trends compared to the previous reporting period. One pneumatic piezometer, PP01-06, have been showing cyclic exceedances of its notification level since 2011 but the amount of exceedance has been relatively consistent to present. One pneumatic, PP01-05, and two standpipes, SD-02 and SD-03, have been showing cyclic peaks that approach their respective notification levels since about 2006. The notification levels for these piezometers are being reviewed and adjusted as deemed appropriate for 2020.

North Dam

Plots of piezometer readings for the South Dam are shown in Figures X-3 and X-4. Peak values recorded over this monitoring period are reported in Table AIII.3.

All eight piezometers being monitored in ARD North Dam indicated relatively consistent or decreasing piezometric levels compared to the previous monitoring period. One of the piezometers, ND-02S, has been showing cyclic exceedances of its notification level since about 2006, but the amount of exceedance is small and has been relatively consistent to present. The notification level for this piezometer is being reviewed and adjusted as deemed appropriate for 2020. Readings in all other piezometers are below their notification levels.

Settlement and Lateral Movement

South Dam

The most recent survey of settlement plates and dike crest was carried out by Teck in October 2018, and the results were reported in the 2018 DSI report.

Past data, included in Figure X-7, shows no notable settlement since 2001 and less than 25 mm of lateral movement since the end of construction.

North Dam

The most recent survey of settlement plates and dike crest was carried out by Teck in October 2018, and the results were reported in the 2018 DSI report.

Past data, included in Figure X-8, shows less than 20 mm of settlement since 2001 and less than 25 mm of lateral movement since the end of construction.

Seepage Flows

South Dam

There are currently two weirs installed to measure seepage at the South Dam toe, although runoff from the dikes and surrounding terrain is also captured. These include Weir #1 (ARDWU) installed in 2013 and Weir #2 approximately 50 m downstream installed in 2003. The 2019 monitoring period readings are included in Table AIII.5 and shown on Figures X-5 and X-6. Weir #1 and #2 showed maximum daily flows of 55.9 m^3/day and 36.2 m^3/day, respectively, and are both well below the notification levels. However, both weirs had a number of recordings, especially during freshet, that were flagged as “Flow Under Weir”. This contributes to the recommendation that the weirs need maintenance/improvements to collect more reliable data in future years.

4.2.6 Calcine TSF Dike

A plan view of the Calcine Dike is shown on Figure 25. Typical sections showing geometry and pore pressure response are shown on Figure 26.

Water Levels

Three standpipe piezometers are located on the dike crest, as shown on Figure 25. The piezometers were last read in 2004 and have been dry since 1986. Piezometer monitoring at the Calcine dike ceased in 2007. Given that the pit (where calcine was previously excavated) at the northwest side of the lower cell has always been dry and the Calcine Dike is buttressed on its downstream slope by the existing municipal landfill, continued reading of these piezometers was considered unnecessary.

4.2.7 Sludge Impoundment

A plan view of the Sludge Impoundment is shown on Figure 27. Typical sections showing geometry are shown on Figures 28.

Piezometric Levels

There is no piezometers installed to monitor water levels in the Sludge Impoundment Dikes. Water deposited during sludge deposition or due to precipitation drains through the embankment (which contains a filter zone) or into the foundation.

Settlement

2019 LiIDAR survey data was used to evaluate the dike crest elevation compared to design elevation. Dike crest elevation on the north and south dam was found to be above design elevation apart from the south side of the south dam briefly dipping below design. This was consistent with 2012 LiDAR data which indicates that there has been little to no settlement in the last 7 years.

5 DAM SAFETY ASSESSMENT

5.1 Dam/Dike Consequence Classifications

The consequence classifications of each of the dams/dikes at Sullivan Mine are summarized in Table 5.1. The consequence classifications are reviewed annually by Teck and KCB's EoR or designated representative at the time. Given that there have been no major changes to developments downstream of the tailings facilities at Sullivan Mine, no change to the consequence classifications was recommended.

Table 5.1 Consequence Classification

Facility	Embankment	Consequence Classification[1]
Iron TSF	Iron Dike	H
Old Iron TSF	Old Iron dike	L
	Iron TSF Divider Dike	L
Siliceous TSF	No. 1 Siliceous Dike	L
	No. 2 Siliceous Dike	L
	No. 3 Siliceous Dike	L
Gypsum TSF	East Gypsum Dike	H
	West Gypsum Dike	H
	Northeast Gypsum Dike	L
	Recycle Dam	L
Calcine TSF	Calcine Dike	L
Sludge Impoundment	North Dike	L
	South Dike	L
ARD Pond	North Dam	VH
	South Dam	VH

Note:

[1] Consequence categories based on 2007 Canadian Dam Safety Guidelines (CDA, 2013): E=Extreme, VH=Very High, H=High, S=Significant, L=Low

It is important to highlight that, while all of these structures are currently considered "dams" from a regulatory perspective, few of the inactive facilities are retaining large amounts of fluid tailings and could potentially be considered as being equivalent to earthen landfills. This is evident through a review of the instrumentation data, which indicates piezometric surfaces which are very low (i.e. near or 1 m to 2 m above original ground), especially for the Old Iron, Siliceous, Calcine, and Gypsum TSFs. In addition, as previously discussed, aging effects may also be an important factor in reducing the mobility of the tailings over time. In such cases, their respective consequences classifications could be significantly lowered, and in the near future, it may be possible to declassify some if not all of these dikes. Teck and KCB are continuing to develop a systematic and phased work plan to support lowering the consequence classifications for some of the inactive facilities and towards eventual declassification of the dikes where considered feasible and appropriate.

5.2 Design Basis Overview

5.2.1 Tailings Storage Facility Dikes

In 1991, a static liquefaction failure of the (then active) Iron Dike occurred (Davies et al, 1998). KCB was retained at that time by Cominco (predecessor to Teck) to conduct forensic investigations and develop remedial measures to reinstate the dike for operations. At the same time, the 1991 failure raised a concern regarding the seismic vulnerability of the other tailings storage dikes at the Sullivan Mine, which led to expanding the stability assessment work for the dikes associated with the Old Iron TSF, the No. 1, No. 2 and No. 3 Siliceous TSF and the Gypsum TSF. This work included the design and construction of required stabilization measures that were carried out from 1992 to 1995. The stabilization measures consisted of slope flattening, constructing downstream toe buttresses or a combination of both.

The Calcine TSF Dike was not included in the stability assessment since it was already buttressed on the downstream side by the large municipal landfill. In addition, the calcine tailings are high permeability and the TSF is essentially drained with a very low phreatic level.

A summary of the geotechnical design basis for the tailings dikes is provided in KCB (2002). Key aspects of the design basis for slope stability assessments conducted in the 1990’s were:

- It was recognized that loose contractive saturated tailings, such as those present in the tailings storage facilities at the Sullivan Mine, are susceptible to static and seismic liquefaction. Although a seismic hazard study was completed to estimate of the ground motions for the Maximum Credible Earthquake, the decision was made to assume that all saturated tailings would liquefy, irrespective of the earthquake ground motion. Therefore, all saturated tailings (i.e. all tailings below the phreatic surface prevailing at the time of the analyses) were assigned the liquefied residual undrained strength for stability calculations.
- The minimum target static factor of safety was 1.5 and the minimum target post-earthquake factor of safety was 1.1, which were consistent with the state of practice at that time. It is acknowledged that post-earthquake factor of safety of 1.1 adopted at the time is lower than the 1.2 that is currently specified in CDA (2013, 2014).

It is important to emphasize that the degree of stability of the dikes would have progressively increased since construction of the stabilization measures was completed and after mine closure, as the phreatic levels within the tailings facilities steadily decrease with time. This consideration is discussed further as part of the failure modes review in Section 5.3.

As previously discussed in Section 3.5, the design basis for all the flood management structures within tailings facilities is the PMF, which exceeds the minimum criterion specified by CDA (2013, 2014) and EMPR (2017) for the respective consequence classifications of each dike.

5.2.2 ARD Pond Dams

The North and South Dams of the ARD Pond were designed in 2000 and constructed in 2001. The geotechnical and hydrological design basis for the ARD Pond is documented in KCB (2000a and 2000b). Key aspects of the design basis for slope stability were:

- the minimum target factors of safety were:
    - static loading (downstream slope): factor of safety ≥ 1.5;
    - rapid drawdown (upstream slope): factor of safety ≥ 1.3; and
    - pseudo-static (seismic, upstream and downstream slopes): factor of safety ≥ 1.1.

Given that there are no liquefiable materials in the dams and their foundations, the pseudo-static method was considered appropriate to provide a screening level assessment of the seismic performance. The seismic coefficient applied for the pseudo-static analysis was taken as 0.225 g, which is 50% of the peak ground acceleration of 0.45 g associated with the Maximum Credible Earthquake.

The above factors of safety criteria adopted for the design in 2001 are consistent with today's acceptance criteria, as specified in CDA (2013, 2014) and EMPR (2017).

For reference, the factors of safety calculated for the North and South Dams during design were: 2.1 and 2.0, respectively, under static loading; 1.8 under rapid drawdown for both dams; and 1.3 and 1.1, respectively, under pseudo-static conditions. These factors of safety meet or exceed target criteria. Other design considerations included the addition of a two filter layers between the downstream slope of the glacial till core and the downstream float rock shell and a single filter layer between the upstream slope of the glacial till core and the upstream float rock shell. Typical cross-sections of the two dams are shown on Figures21, 22, 23, and 24.

Flood management criteria for the ARD Pond was previously discussed in Section 3.5.

5.2.3 Sludge Impoundment

The Sludge Impoundment and its containment dikes (North Dike and South Dike) were designed in 1978 by others. According to Dames and Moore (1978):

- the static factor of safety of the dikes is 1.4;
- the pseudo-static factor of safety of the dikes is 1.2; and
- a 1:200 return period flood event was adopted as the design criterion

As previously discussed, the North and South Dikes were not included in the 1992-1994 stability review work because there was minimal sludge retained at that time. In addition, unlike the tailings dikes which are constructed using the upstream-method-of-construction where each incremental dike raise is founded on top of deposited tailings, the North and South Dikes were constructed on competent foundation and comprised entirely of mechanically placed and compacted borrow fill.

Nevertheless, it was recommended at that time that a complete design review of the Sludge Impoundment and its dikes should be conducted once the impoundment becomes filled with more sludge.

In 2015, a review by KCB indicated that the Sludge Impoundment could accommodate another 15 to 20 years of operation at the current sludge production rate. In addition, it was considered prudent to assess whether the geotechnical and flood management aspects of the Sludge Impoundment are compliant with the recent changes/updates in regulatory requirements (e.g. MEPR, 2017).

The design review of the Sludge Impoundment and its dikes, including flood routing and handling, sludge deposition planning and embankment stability, is currently underway.

5.3 Failure Modes Review

5.3.1 Overview

KCB understand, and fully support, that Teck's long-term goal for all of the tailings facilities is to reach landform status with all potential failure modes ultimately being reduced to non-credible. In the context of this DSI, the term "non-credible" represents a condition where the likelihood of failure is considered negligible. Ongoing work aimed at these long-term goals will indicate over subsequent annual reporting periods if the overall landform status has been achieved along with the elimination of any credible flow failure concerns.

Teck's long-term goal for the ARD Pond, as it is for all of Teck's tailings facilities that may not be able to achieve landform status, is for all potential failure modes to be non-credible based on maximum consequence loading conditions. Teck is also evaluating other long-term risk reduction strategies such as year-round treatment which would reduce storage requirements in the ARD Pond.

Based on the DSI and review of available documents regarding the various earthfill dikes/dams, the potential geotechnical and hydrotechnical failure modes considered in the CDA Dam Safety Guidelines (CDA 2013) were reviewed and discussed below. Teck commissioned a Failure Modes and Effects Analysis (FMEA) risk assessment for the Sullivan Mine Tailings Facilities which was facilitated by the Wood Group and KCB also participated. The FMEA was completed over a series of workshop and follow up discussions in November 2017 and December 2017. The assessment included a review of design and operation controls for each of the dam safety failure modes. Based on the FMEA, the current failure mode risks were found to be well understood and well managed. No material changes to the risk classifications were necessary. The FMEA summary document has been issued in draft (Wood 2018).

5.3.2 Overtopping

Tailings Storage Facilities

The tailings facilities are no longer active, and the only facility currently being used for water storage as part of the site wide water management system is the Iron Pond.

As previously discussed in Section 3.5, surface water collection/diversion channels and spillways have been constructed in the tailings areas for flood management, which are designed to safely pass the Probable Maximum Flood (PMF) events. Therefore, the likelihood of a hypothetical overtopping is considered negligible which corresponds to close to non-credible overtopping modes of failure.

ARD Pond

The ARD Pond has been designed to store the 48-hour PMF and also includes a spillway designed to safely route a 24 hr PMF (after the 48-hour PMF has been stored) (see Section 3.5). Therefore, the likelihood of overtopping is considered to be negligible and is a close to non-credible failure mode.

Sludge Impoundment

According to Dames and Moore (1978), the 1:200-year return period flood event was adopted for design of the Sludge Impoundment. However, as the actual sludge production rate has been much lower than assumed in the original design by others, the impoundment currently has excessive flood storage capacity. A review by KCB in 2015 indicated that the available capacity is sufficient for another 15 to 20 years assuming the average annual sludge production rate remains unchanged.

As discussed in Section 5.2.3, a design review of the Sludge Impoundment and its dikes, including flood routing and handling, sludge deposition planning and embankment stability, is currently underway. The design of the facility will have a goal of driving all failure modes to close to non-credible. There is no population at risk downstream of the sludge pond and the sludge is drained which reduces the potential for a flow failure of the sludge in the event of a failure.

Based on the existing conditions and our understanding of the original design criteria, the likelihood of overtopping is considered to be low. The design criteria for the facility is under review (started in 2018) and work is ongoing (see section 5.1.2) which is aimed towards eventually achieving Teck’s long-term goal by removing overtopping as a credible failure mode.

5.3.3 Internal Erosion and Piping

Tailings Storage Facilities

The tailings storage facilities are no longer active, and since completion of the reclamation cover, the phreatic levels within the tailings have steadily decreased. As a result, the exit seepage gradients are correspondingly low, and therefore, the likelihood of piping related failure through the dikes and/or through their foundations is considered to be very low.

Notwithstanding the above, internal drains and decants are known to have been constructed within the Iron, Gypsum and Siliceous TSFs). Some of these have pipes that extend through the dikes. These drains and decants are constructed of brittle materials and, therefore, represents a vulnerability to potential piping. A review of these structures is being completed as they represent a vulnerability to piping but the low phreatic surface results in low gradients. The likelihood of a piping failure for the Sludge Impoundment is considered to be very low to negligible due to the inclusion of filters in the dam and lack of permanent pond. The results of the current review will be used to assess if piping is a non-credible failure mode for these structures, or if not, what additional measures might be necessary to achieve this goal.

ARD Pond

The ARD Pond North and South Dams are designed with filter layers on the downstream and upstream slopes of the glacial till core. Therefore, the likelihood of a piping related failure is considered to be very low to negligible.

One piezometer installed on the left abutment of the South Dam shows a close response to pond level fluctuations. A review of the borehole log for the piezometer installation indicate the presence of a gravel and cobble zone within the native till. The close response of the piezometer suggests that this layer may extend into the pond. Piping could be initiated if the seepage gradient is high enough and if the layer daylights at the surface so that the seepage is able to exit. To date, there range of response in the piezometer readings to pond level fluctuations has been consistent since first filling and there have been no indications of piping occurring. In addition, there has not been any evidence of outcrops of the gravel and cobble zone where seepage is exiting. Accordingly, the likelihood of a piping related failure is considered to be very low. A review of the ARD pond is currently underway and the results of the current review will be used to assess if piping is a non-credible failure mode, or if not, what additional measures might be necessary to achieve this goal.

Sludge Impoundment

The available design drawings show that a filter layer was included along the upstream slopes of the North and South Dikes. In addition, the impoundment surface is typically dry and there is no permanent water pond. Therefore, the likelihood of a piping related failure is considered to be very low to negligible.

5.3.4 Static Stability

Tailings Storage Facilities Dikes

An overview of the design basis for stability assessment of the tailings facilities dikes was previously presented in Section 5.2.1. As discussed, the static factors of safety computed for the dikes during design of the stabilization measures met or exceed the target factor of safety criteria of 1.5. Moreover, the static factors of safety for existing conditions are expected to be higher since the phreatic levels have steadily decreased over time since mine closure and completion of the reclamation cover.

Based on the above considerations, the likelihood of a dam instability is considered very low to negligible.

A review of the stability of the all the dams is currently underway, which is aimed towards eventually achieving Teck’s long-term goal of removing credible failure modes associated with instability due to all loading conditions.

ARD Pond Dams

An overview of the design basis for stability assessment of the North and South Dams of the ARD Pond was previously presented in Section 5.2.2. Given the relatively high static factors of safety, the likelihood of a dam instability is considered to be very low to negligible.

Sludge Impoundment Dikes

An overview of the design basis for stability assessment of the North and South Dikes of the Sludge Impoundment was previously presented in Section 5.2.3. The static factor of safety reported by the original designers is 1.4, which is below the specified criterion of 1.5 per the CDA (2013, 2014) and EMPR (2017). Nevertheless, there has been no reported signs of dike instability since completion of construction in 1978, some 40 years ago. Accordingly, the likelihood of a dike instability is considered to be low.

As previously discussed, a complete design review of this facility is currently underway.

5.3.5 Surface Erosion

The downstream slopes of the dams/dikes are well grassed and, although variable, are relatively flat. Progressive erosion that develops over time or multiple events are managed through routine and event-driven monitoring and ongoing maintenance. In terms of the overall size of the dams/dikes, such erosion features are typically small and the likelihood of surface erosion over the downstream slope resulting in a dam/dike failure from a single event is considered negligible and not a credible failure mode to induce a flow failure of the sludge.

5.3.6 Earthquakes

Tailings Storage Facilities Dikes

As discussed in Section 5.2.1, the post-earthquake factors of safety computed for the dikes during design of the stabilization measures met the criterion adopted at the time (i.e. factor of safety ≥ 1.1 assuming all saturated tailings liquefied). However, the adopted criterion was lower than the 1.2 that is currently specified in CDA (2013, 2014). In KCB’s view, this represents a regulatory non-compliance issue and is not a dam safety issue. Nevertheless, the current post-earthquake factors of safety representative of existing conditions are expected to be higher since the phreatic levels have steadily decreased over time since mine closure and completion of the reclamation cover.

Based on the above considerations, the likelihood of a seismically induced dike instability failure is considered to be low to negligible. Note that the “low” likelihood rating is currently assigned to the Gypsum and Siliceous TSFs where a site investigation program was recently completed to better characterize the in-situ density state of the foundation sands and gravels to evaluate the liquefaction potential of these deposits.

A due diligence review and update of the seismic stability of all structures is underway based on current phreatic surface levels and a revised seismic hazard assessment, which is aimed towards eventually achieving Teck's long-term goal of removing credible failure modes associated with instability due to seismic loading.

ARD Pond Dams

As discussed in Section 5.2.2, there are no liquefiable materials in the North and South Dams or in their respective foundations, and the computed pseudo-static factors of safety is 1.1 or greater. These values meet or exceed the current pseudo-static stability criterion of 1.0 per the CDA (2013, 2014). Therefore, the likelihood of a seismically induced dam instability failure is considered to be very low.

There are no liquefiable materials present in the foundation and dam fill of the ARD Pond Dams and, therefore, seismic instability due to seismic deformations is close to non-credible and seismic instability due to liquefaction failures is non-credible. Analysis of the ARD Pond dam structures is needed to confirm the magnitude of seismically-induced deformations that could be expected during an extreme seismic event.

Sludge Impoundment Dikes

As noted in Section 5.2.3, the pseudo-static factor of safety reported by the original designer for the North and South Dikes is 1.2, which exceeds the criterion of ≥ 1.0 as per CDA (2013, 2014). Therefore, the likelihood of a seismically induced dam instability failure is considered to be very low.

As previously discussed, a complete design review of this facility is currently underway, including an update of the seismic hazard for the site.

5.4 OMS Manual

The most recent version of the Operation, Maintenance, and Surveillance (OMS) Manual for the Sullivan Mine tailings facilities was completed in 2018 (V5, August 17, 2018) by Teck, which included changes as recommended in the 2016 DSI and a reorganization to meet Teck's internal guidelines. KCB annually reviews and updates the instrument reading frequencies and instrument notification levels, as input to the OMS Manual updates.

Teck will continue to review the manual annually and make revisions as necessary, with input from the EoR.

5.5 Mine Emergency Response Plan

The current version of the MERP was last updated in January 2019 when it was converted from the previous Emergency Preparedness and Response Plan (EPRP). The plan meets the regulatory requirements and guidance documents from CDA and the Mining Association of Canada. The plan includes identification of communities of interest, failure modes, and responses to various emergencies.

As required by HSRC (EMPR, 2017), the EPRP is tested annually using desk-top scenarios. A table-top exercise to review and update the Emergency Preparedness Response Plan for the HVC site was hosted by Teck and attended by the EoR Approved Alternate on December 2018.

The emergency reporting contact list is also reviewed and updated as required.

6 SUMMARY

The Sullivan Mine TSFs, ARD Pond and the Sludge Impoundment appear to be in good physical condition and the observed performance during the 2019 site inspections is consistent with the expected design conditions and historical performance.

Recommendations from the 2019 DSI, together with previous DSI recommendations that are still outstanding, are summarized in Table 6.1.

For this review, we have established definitions to describe deficiencies, potential deficiencies, non-conformances and items requiring updates to meet updated regulatory standards as follows:

- Deficiency (D): An unacceptable dam performance condition based on analysis results and/or site observations/instrumentation data with respect to criteria outlined in the 2007 CDA Guidelines, best practices, and/or applicable regulatory requirements.
- Potential Deficiency (PD): A dam performance condition that requires further evaluation to determine if the condition is a deficiency.
- Non-Conformance (NC): Defined as a deviation from established policies, procedures, operating instructions, maintenance requirements, or surveillance plans. A non-conformance is not an indication of unacceptable dam performance.
- Items Requiring Updates to Meet Updated Regulatory Standards (RS): Condition where regulatory requirements have changed and have become more stringent following initial design and/or construction.

None of the identified deficiencies or issues, closed/new/outstanding, are related to dam safety concerns. All of the recommendations pertain to the framework of continual improvements in the dam safety management program, such as documentation and maintenance/surveillance protocols. The recommendation for the Sludge Impoundment is part of the design review and updated that is already being planned by Teck and KCB.

Table 6.1 Summary of Outstanding Recommendations from Past DSIs and New Recommendations from Current DSI

Structure	ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Deficiency Type	Priority	Recommended Deadline/Status
Previous Recommendations Closed/Superseded							
ALL	2016-1	OMS Manual requires updates	EMPR HSRC (2017) & CDA Guidelines: Application to Mining Dams (2014)	Additional information to be added in 2017. EPRP Section to be removed once separate document completed.	RS	4	CLOSED – ongoing revisions being conducted
Previous Recommendations Ongoing							
Sludge Impoundment	2017-03	Changes to the HSRC design flood requirements indicate a review of the Sludge Impoundment hydrology is needed.	EMPR HSRC (2017) & CDA Guidelines: Application to Mining Dams (2014)	Review of the current design freeboard and design sludge levels is required for the new design flood event of 1/3 between 1:975 and PMF (HSRC, 2017). To facilitate the design update, the Sludge Impoundment surface should be surveyed to obtain average sludge deposition rates. Review of entire facility should be completed to address storage, life expectancy of the facility and regulatory requirements.	RS	3	Q4 2020
2019 Recommendations							
Iron TSF/ ARD Pond	2019-01	Frequent recordings of flow under or around all four weirs on site leads to inconsistent and unreliable readings.	OMS Section 4.0	Refurbish all four existing weirs with cut-off walls using low permeability material below and around the weir entrance to reduce bypass around/under weirs.	NC	3	Q2 2020
Siliceous TSF	2019-02	Flowing piezometer adjacent to Betcher's Slough	OMS Section 4.0	This piezometer should be added to the monitoring network and flow rates estimated monthly during the next monitoring period.	NC	3	Q2 2020
Siliceous TSF	2019-03	Flowing decant at toe of Siliceous 2 dike	OMS Section 4.0	The flow in the decants should be added to the inspections and changes in flow or sediment transport recorded.	NC	3	Q2 2020

Notes:

Priority ranking for outstanding recommendations is defined as follows:

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 occurrence 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.

7 CLOSING

This report is an instrument of service of Klohn Crippen Berger (KCB). The report has been prepared for the exclusive use of Teck Metals Ltd (Client) for the specific application to the 2019 Dam Safety Inspection, and it may not be relied upon by any other party without KCB's written consent.

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REFERENCES

Canadian Dam Association. 2013. Dam Safety Guidelines 2007 (Revised 2013).

Dames and Moore. 1978. Report on Final Design Studies Sludge Disposal Pond.

Davies, M.P., Dawson, B.B., and Chin, B.G. 1998. "Static Liquefaction of Mine Tailings – A Case History." Proceedings, 51st Canadian Geotechnical Conference.

EC (2019) Canadian Climate Normals 1981-2010 (Kimberley PCC). Retrieved from: https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnName&txtStationName=Kimberley+PCC&searchMethod=contains&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=1194&dispBack=1

Golder Associates. 2014. 2013 Dam Safety Review, Submitted to Teck Metals Ltd. September 11, 2014. Reference Number 1314270027-002-R-Rev 0-1000.

Klohn Crippen Berger, 2007. Sullivan Mine Tailings Area, Emergency Storage Pond (ESP) Spillway Design (ESP). Submitted September 28, 2007 to TeckCominco Metals Ltd. Project No. A05807A04.

Klohn Crippen Consultants, 2000. Sullivan Mine – Storage Pond No. 1 Design Report. Submitted March 20, 2000 to Cominco Ltd. Project No. PM5807.34.

Klohn Crippen Consultants, 2000b. Sullivan Mine – Storage Pond No. 1 Design Report Addendum. Submitted August 21, 2000 to Cominco Ltd. Project No. PM5807.34.

Ministry of Energy, Mines, and Petroleum Resources. 2016. "Guidance Document: Health, Safety and Reclamation Code for Mines in British Columbia. Version 1."

Ministry of Energy, Mines, and Petroleum Resources. 2017. "Health, Safety and Reclamation Code for Mines in British Columbia."

Revenue Services of British Columbia. 1996. Mines Act.

Service BC. 2003. Environmental Management Act.

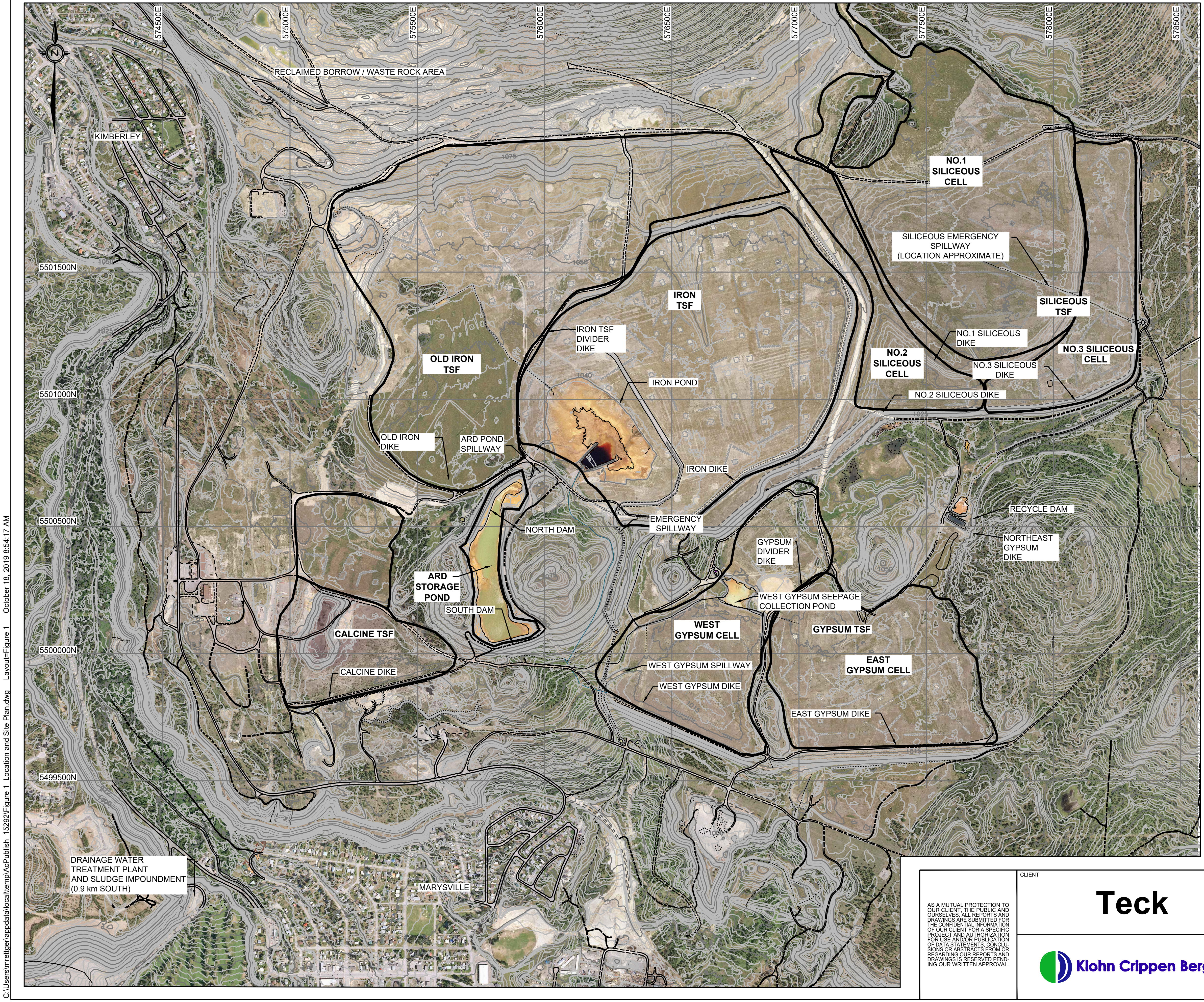
SRK. 2014 Sullivan Mine Post Closure Water Balance. A Report to Teck Metals Ltd.

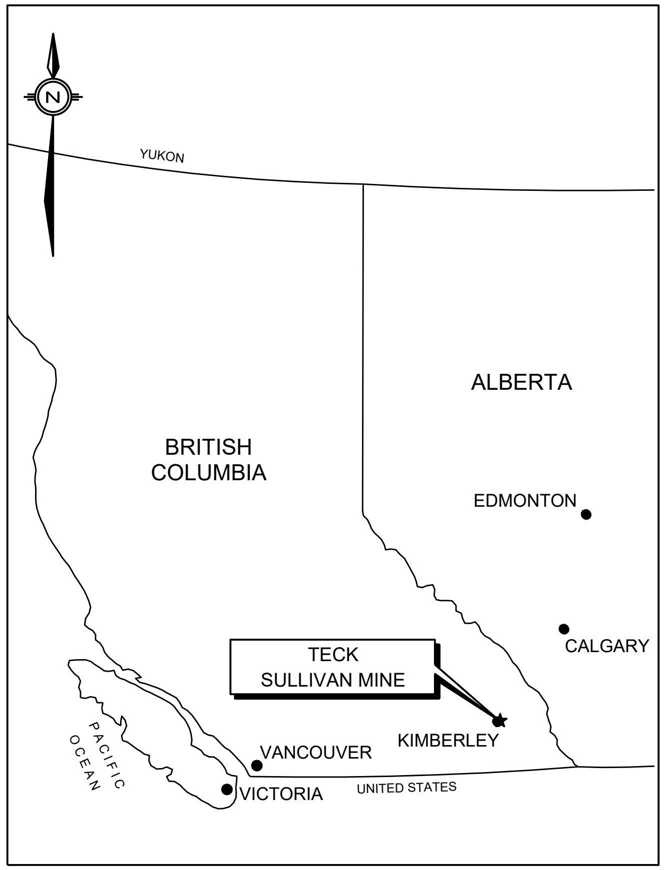
Teck Environmental Group. 2019. "Guideline for Tailings and Water Retaining Structures."

Teck Metals Ltd., 2017. Sullivan – Seepage Collection Manual. Version 005. September 25, 2017.

Wood. 2018. 2017 Draft Risk Assessment on Tailings Dams Classified as High or Higher. August 29, 2018

FIGURES





PROJECT LOCATION PLAN

N.T.S

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD 83). CONTOUR INTERVAL IS ONE METRE.
4. AERIAL PHOTO PROVIDED BY TECK METALS LTD. DATE: 2008.

SCALE 1:15 000 0 150 300 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
LOCATION AND SITE PLAN

PROJECT No.
A05807A19

FIG No.
FIGURE 1

KCC-D-B

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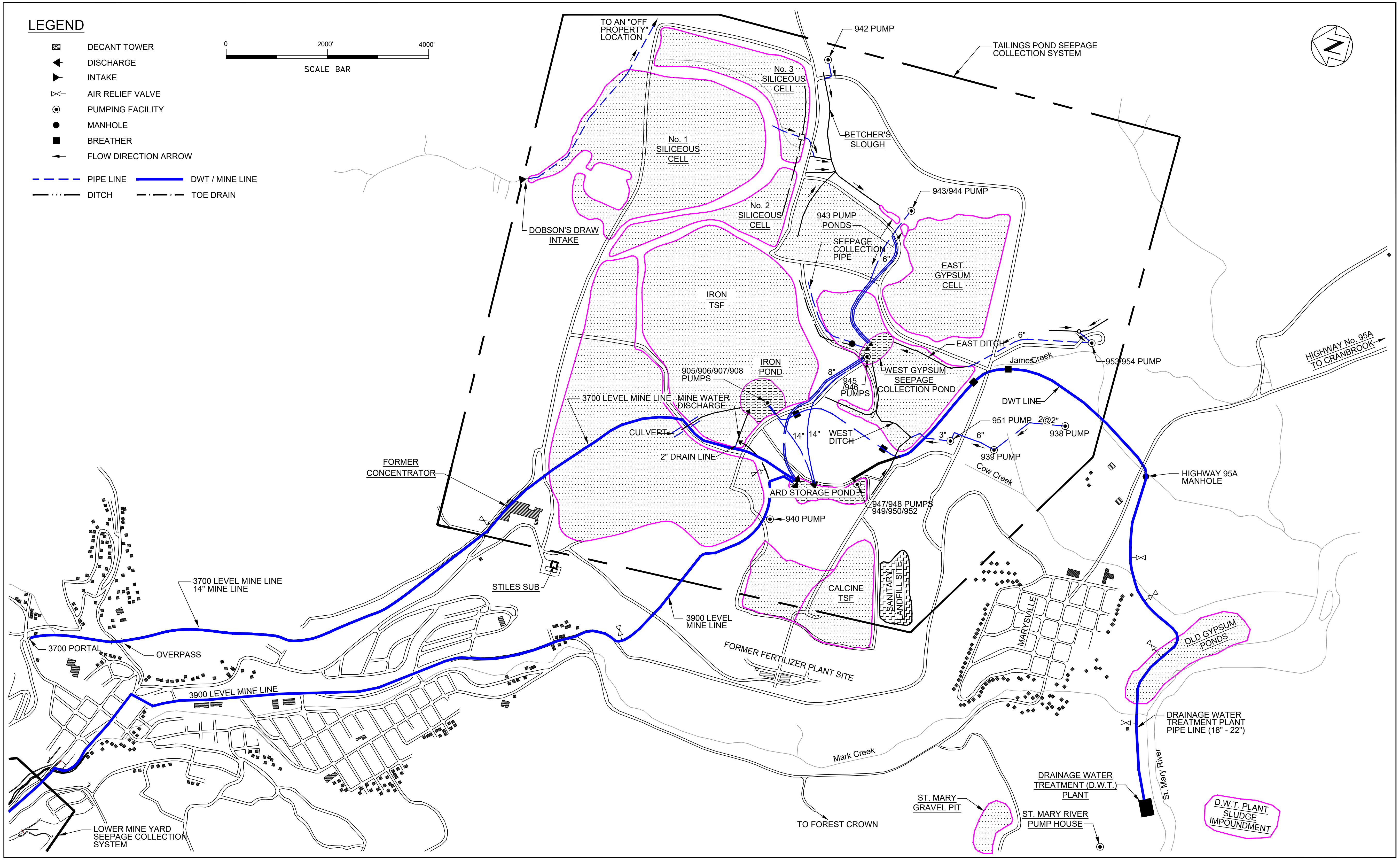

NOTES:

1. FROM TM Tech SERVICES DRAWING K100E3007 DATED FEB. 3, 2009, REV. 1.

SCALE 1:12 500 0 125 250 m

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SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE

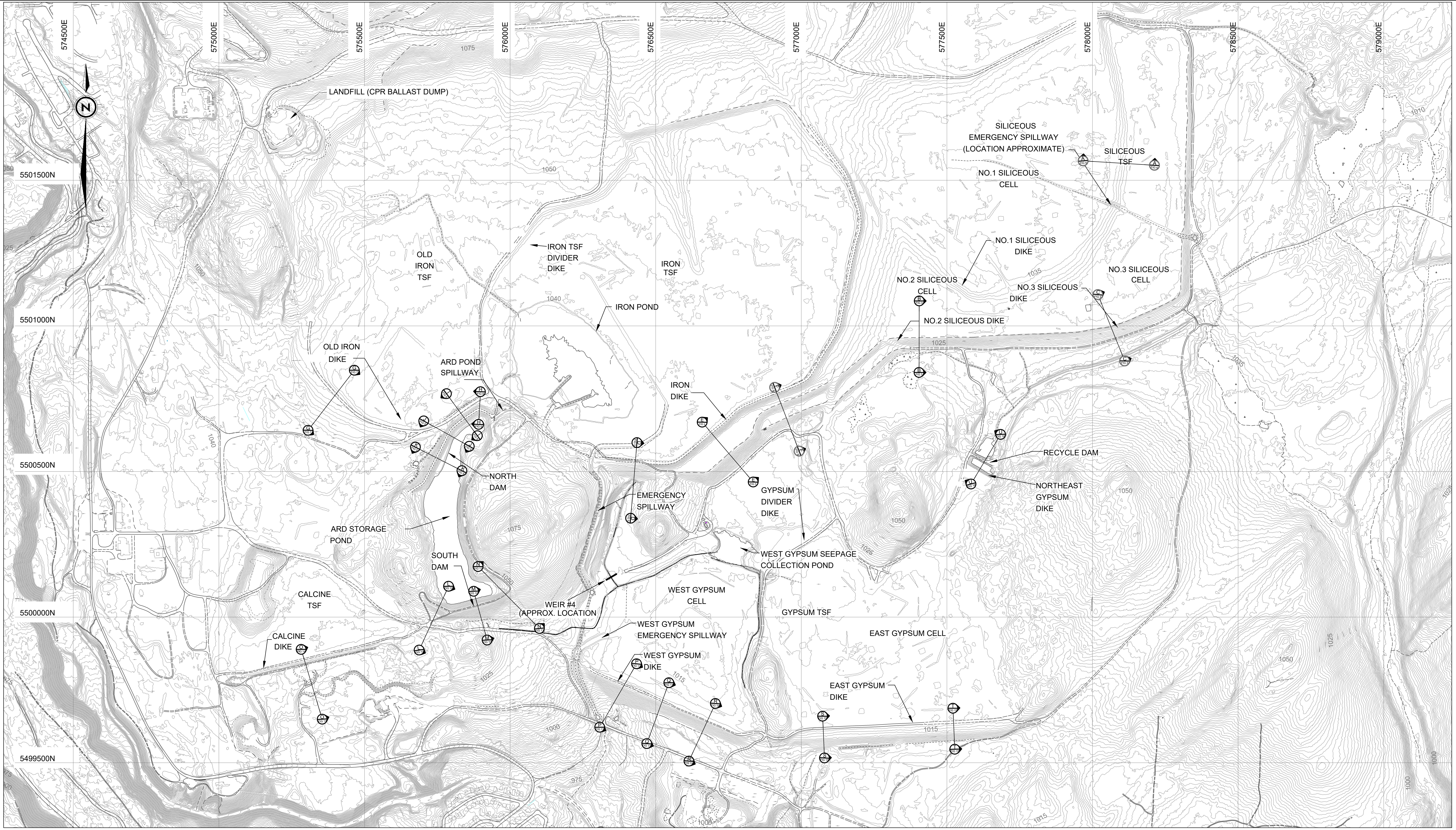
TAILINGS SEEPAGE COLLECTION
AND DWT PLANT LOCATION

PROJECT No.
A05807A19

FIG No.
FIGURE 2

KCC-D-B

C:\Users\mrettger\appdata\local\temp\AcPublish_7240\Figure 2.dwg Layout=Figure 2 September 16, 2019 1:16:15 PM



Z:\ACGY\Alberta\A05807A19 TML 2019 Sullivan Mine DSI\400 Drawings\DSI Report (Updated Sections)\Figure 3_Design Sections Arrangment.dwg Layout=2 November 4, 2019 8:48:08 AM

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD 83). CONTOUR INTERVAL IS ONE METRE.
4. LOCATIONS OF DESIGN SECTIONS ARE APPROXIMATE

SCALE 1:12 500 0 125 250 m

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

CLIENT
Teck

Klohn Crippen Berger

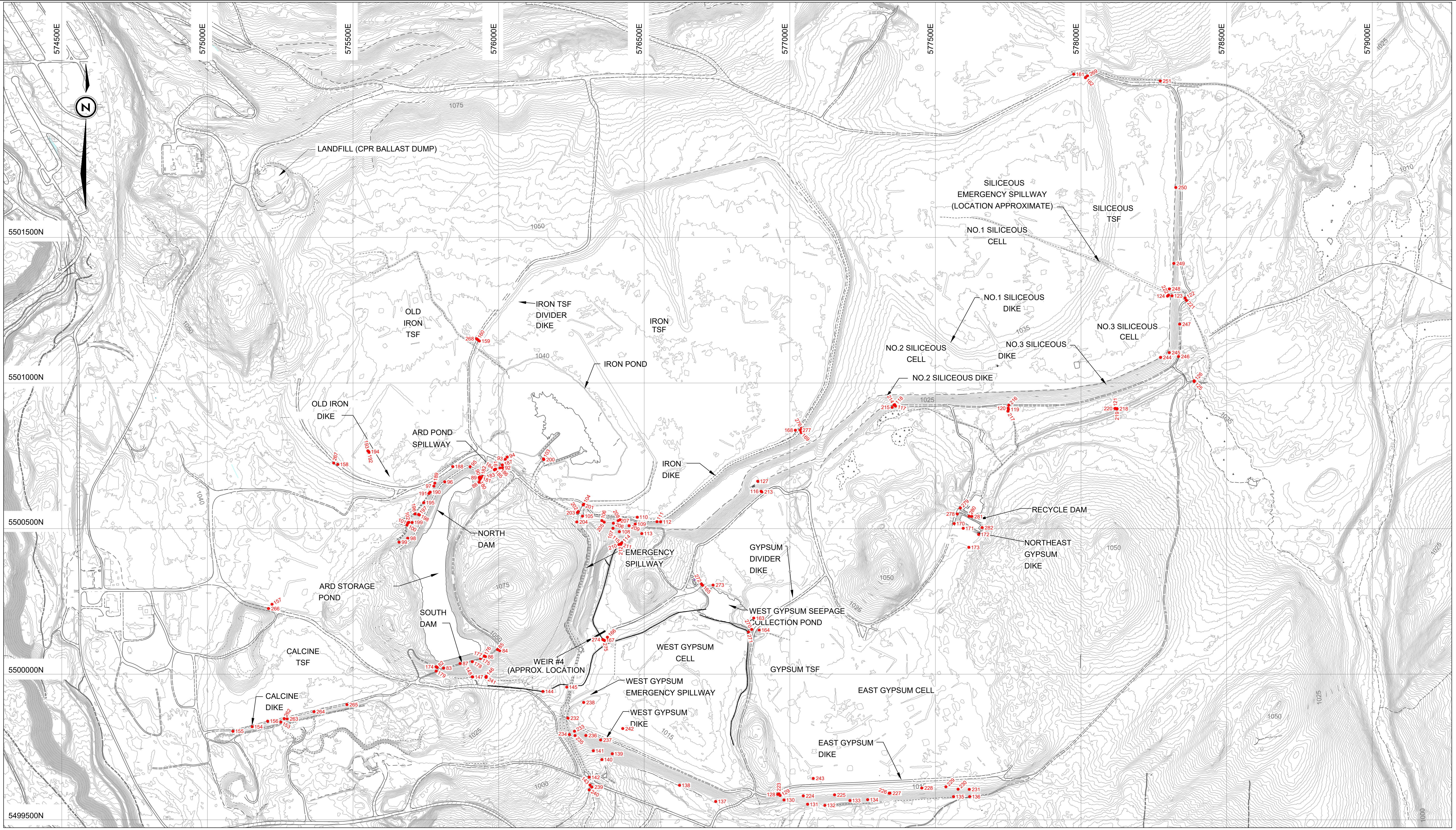
PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
GENERAL ARRANGEMENT
OF DESIGN SECTIONS

PROJECT No.
A05807A19

FIG No.
FIGURE 3

KCC-D-B



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD 83). CONTOUR INTERVAL IS ONE METRE.

LEGEND

LOCATION AND DIRECTION OF PHOTOGRAPHS
TAKEN DURING ANNUAL INSPECTION

104
PHOTO NUMBER
LOCATION WHERE PHOTO WAS TAKEN
DIRECTION OF VIEW
PANORAMA

SCALE 1:12 500 0 125 250 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

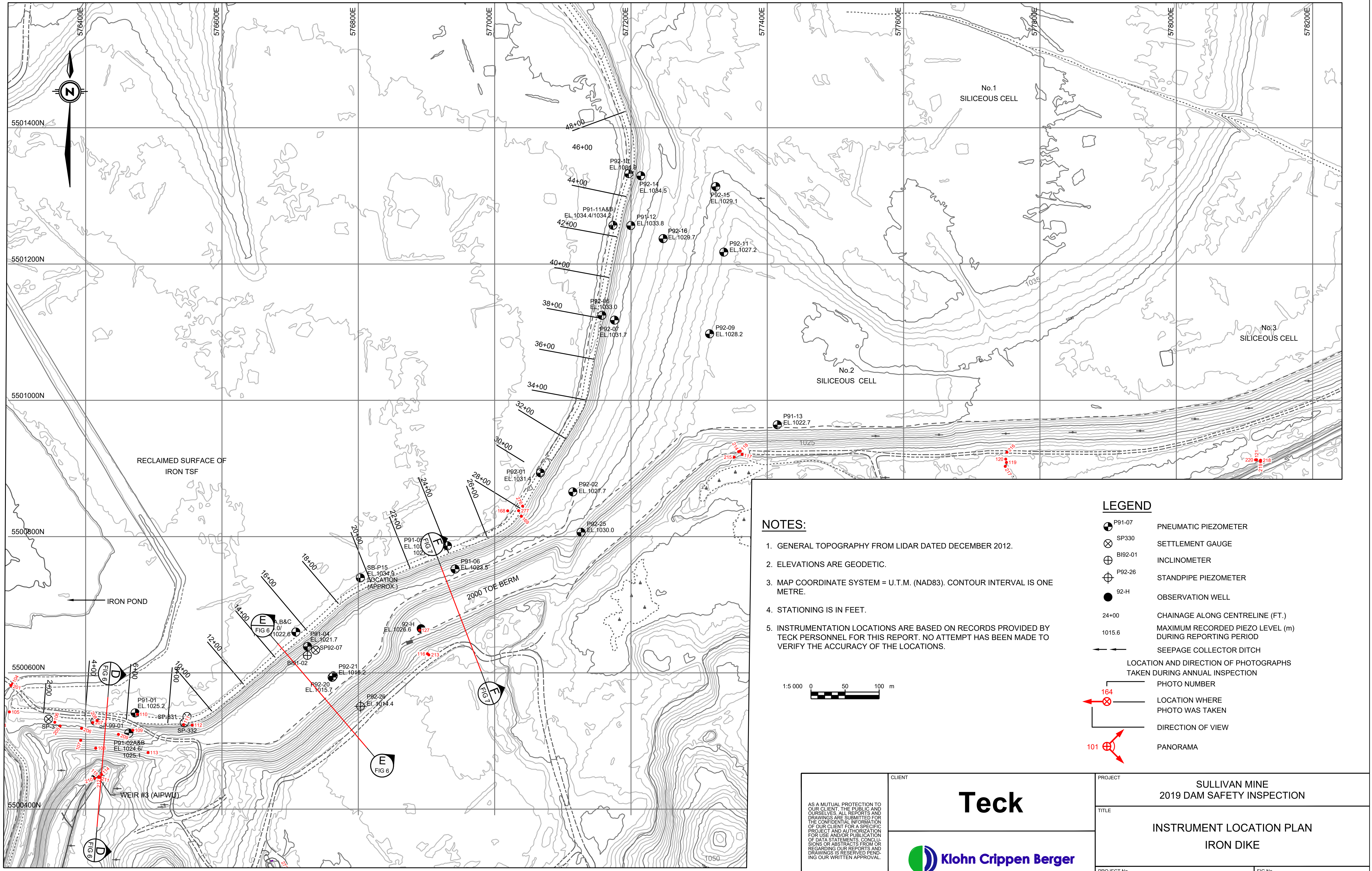
TITLE
GENERAL ARRANGEMENT
OF TAILINGS FACILITIES, PHOTO LOCATIONS

PROJECT No.
A05807A19

FIG No.
FIGURE 4

KCC-D-B

C:\Users\mrettger\appdata\local\temp\AcPublish_820\Figure 3_GenArg.dwg Layout=Figure 3 October 18, 2019 9:42:59 AM



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83). CONTOUR INTERVAL IS ONE METRE.
4. STATIONING IS IN FEET.
5. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK PERSONNEL FOR THIS REPORT. NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.

1:5 000 0 50 100 m

LEGEND

◕ P91-07	PNEUMATIC PIEZOMETER
⊗ SP330	SETTLEMENT GAUGE
⊕ BI92-01	INCLINOMETER
⌖ P92-26	STANDPIPE PIEZOMETER
● 92-H	OBSERVATION WELL
24+00	CHAINAGE ALONG CENTRELINE (FT.)
1015.6	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
← ←	SEEPAGE COLLECTOR DITCH

LOCATION AND DIRECTION OF PHOTOGRAPHS TAKEN DURING ANNUAL INSPECTION

164	PHOTO NUMBER
⊗	LOCATION WHERE PHOTO WAS TAKEN
←	DIRECTION OF VIEW
101 ⊕	PANORAMA

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

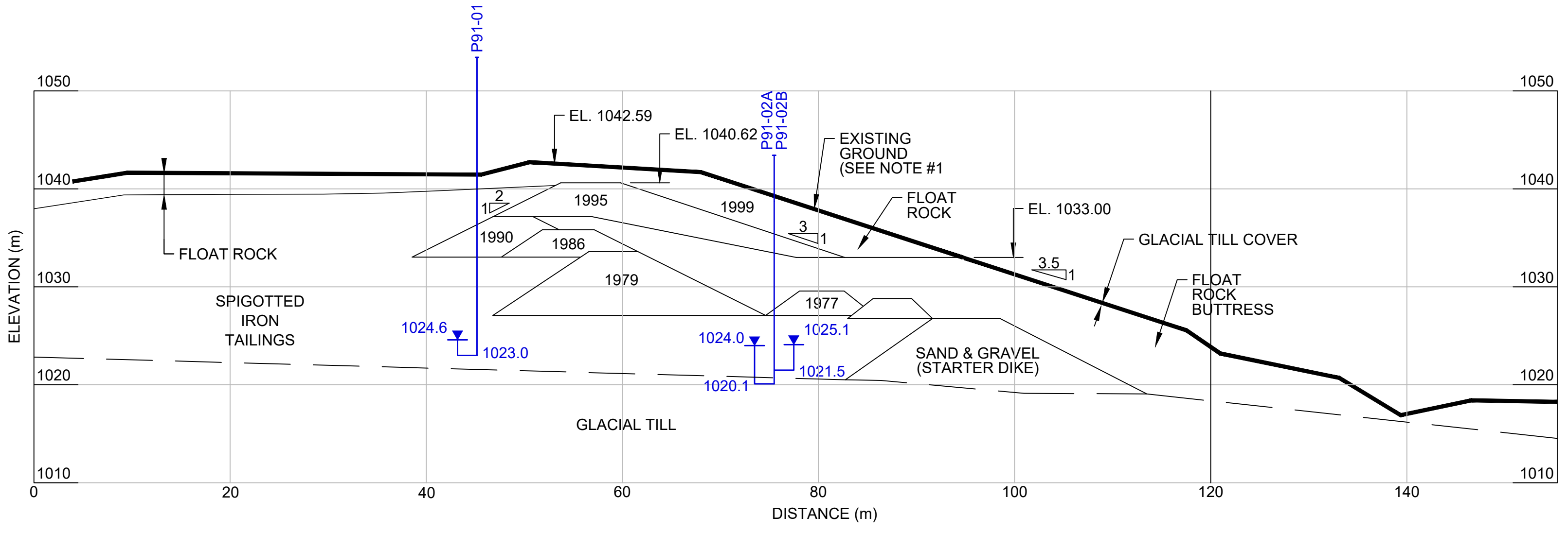
TITLE
INSTRUMENT LOCATION PLAN
IRON DIKE

PROJECT No.
A05807A19

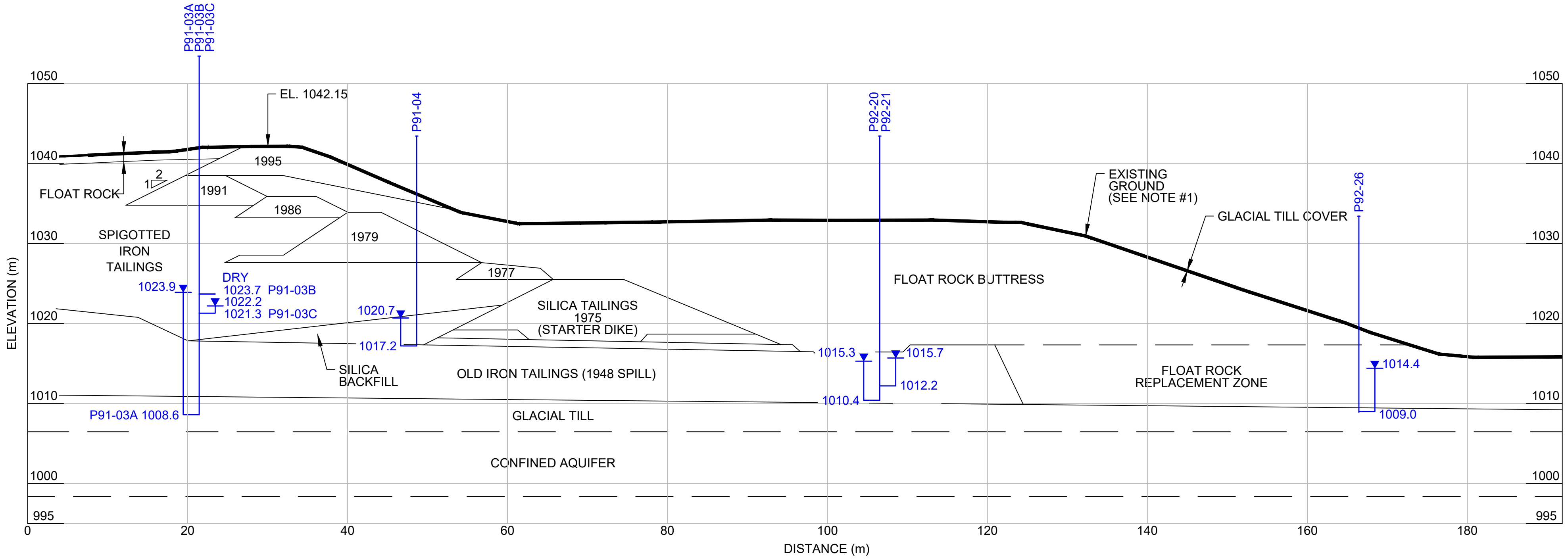
FIG No.
FIGURE 5

KCC-D-B

Z:\ACGY\Alberta\A05807A19 TML 2019 Sullivan Mine DSI\400 Drawings\DSI Report (Updated Sections)\Figure 5_IronPond.dwg Layout=Figure 4 October 18, 2019 12:09:12 PM



D SECTION
FIG 5 SCALE = 1:750



E SECTION
FIG 5 SCALE = 1:750

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 1995 ACTIVE IRON DIKE - GEOTECHNICAL DESIGN OF 1995 DIKE RAISE.

LEGEND:

P91-01	PIEZOMETER
1023.8	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1021.4	PIEZOMETER TIP

1:750 0 7.5 15 m

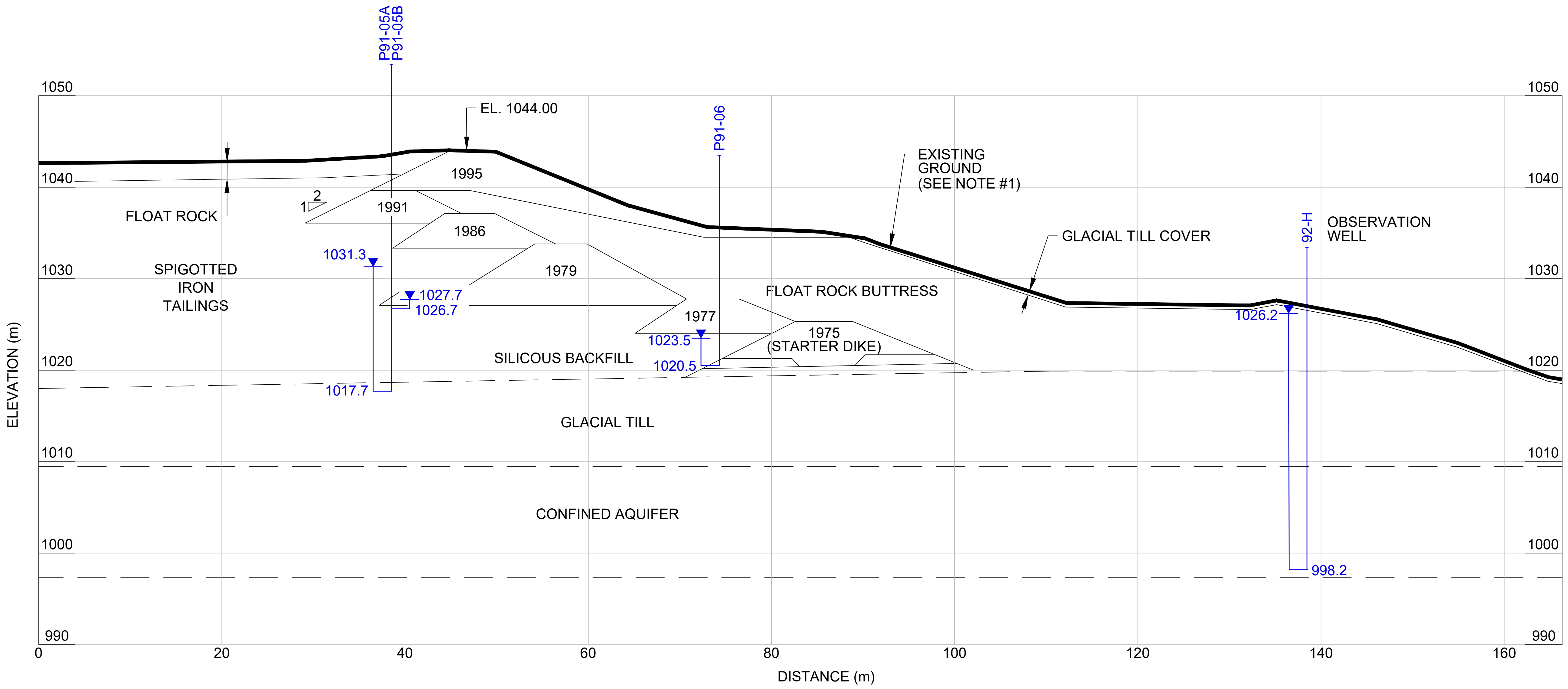
CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
IRON DIKE
SECTIONS D AND E

PROJECT No. A05807A19
FIG No. FIGURE 6



F
FIG 5
SECTION
SCALE = 1:500

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 1995 ACTIVE IRON DIKE - GEOTECHNICAL DESIGN OF 1995 DIKE RAISE.

LEGEND:

P91-01	PIEZOMETER
1023.8	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1021.4	PIEZOMETER TIP

1:750 0 7.5 15 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

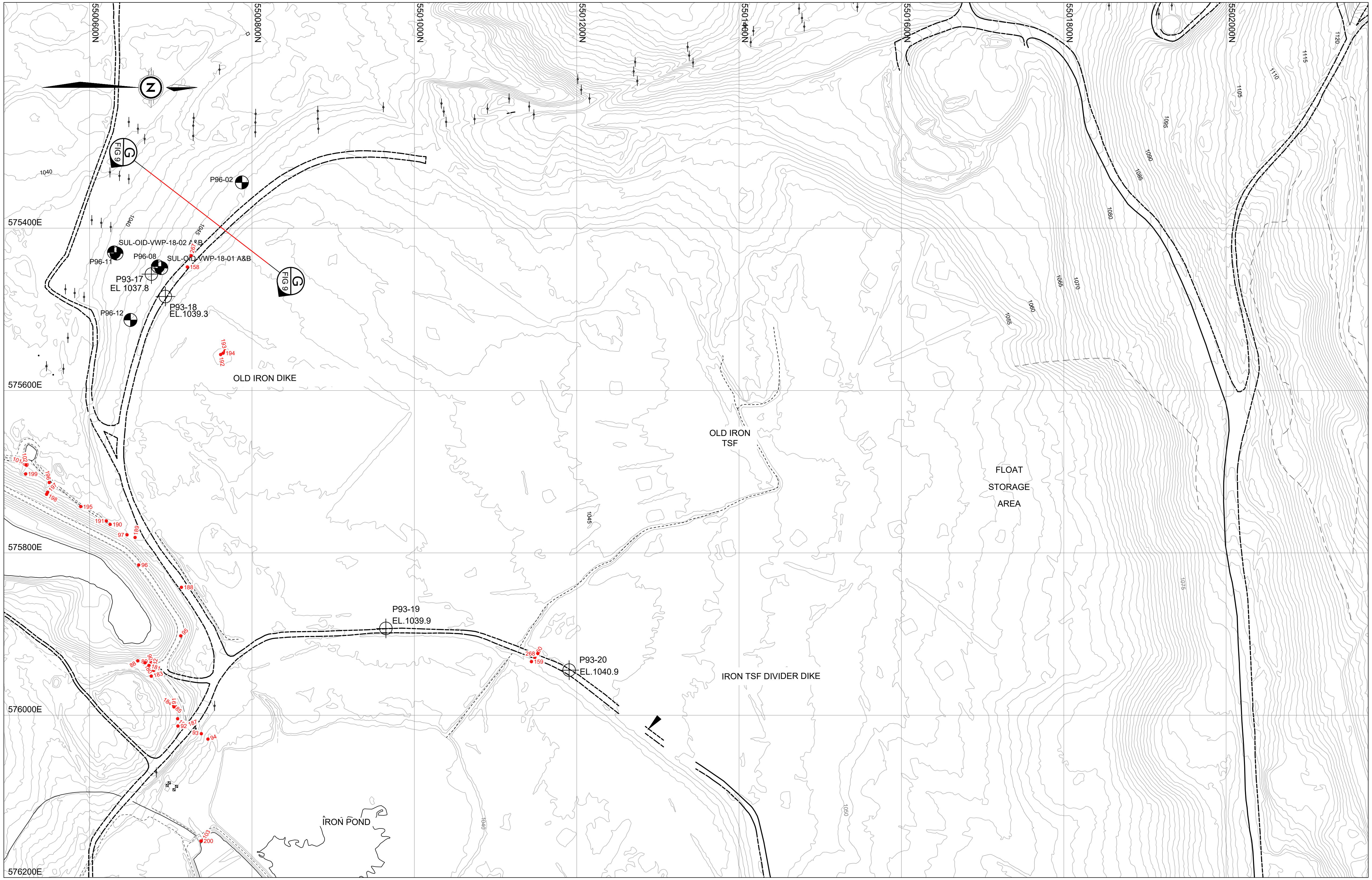
TITLE
IRON DIKE
SECTION F

PROJECT No.
A05807A19

FIG No.
FIGURE 7

KCC-D-B

Z:\A\CGY\Alberta\A05807A19 TML 2019 Sullivan Mine DSI\400 Drawings\DSI Report (Updated Sections)\Figure 6,7_Iron Dike Sections.dwg Layout=7 November 4, 2019 12:19:31 PM



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83).
4. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK PERSONNEL FOR THIS REPORT. NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.

1:5 000 0 50 100 m

LEGEND:

SUL-OID-VWP-18-01A&B
VIBRATING WIRE
PIEZOMETER

P205
STANDPIPE
PIEZOMETER

P91-07
PNEUMATIC
PIEZOMETER

EL.1032.1
MAXIMUM RECORDED
PIEZO LEVEL (m)
DURING REPORTING PERIOD

LOCATION AND DIRECTION OF PHOTOGRAPHS
TAKEN DURING ANNUAL INSPECTION

3.01
PHOTO NUMBER
LOCATION WHERE
PHOTO WAS TAKEN
DIRECTION OF VIEW

3.01
PANORAMA

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

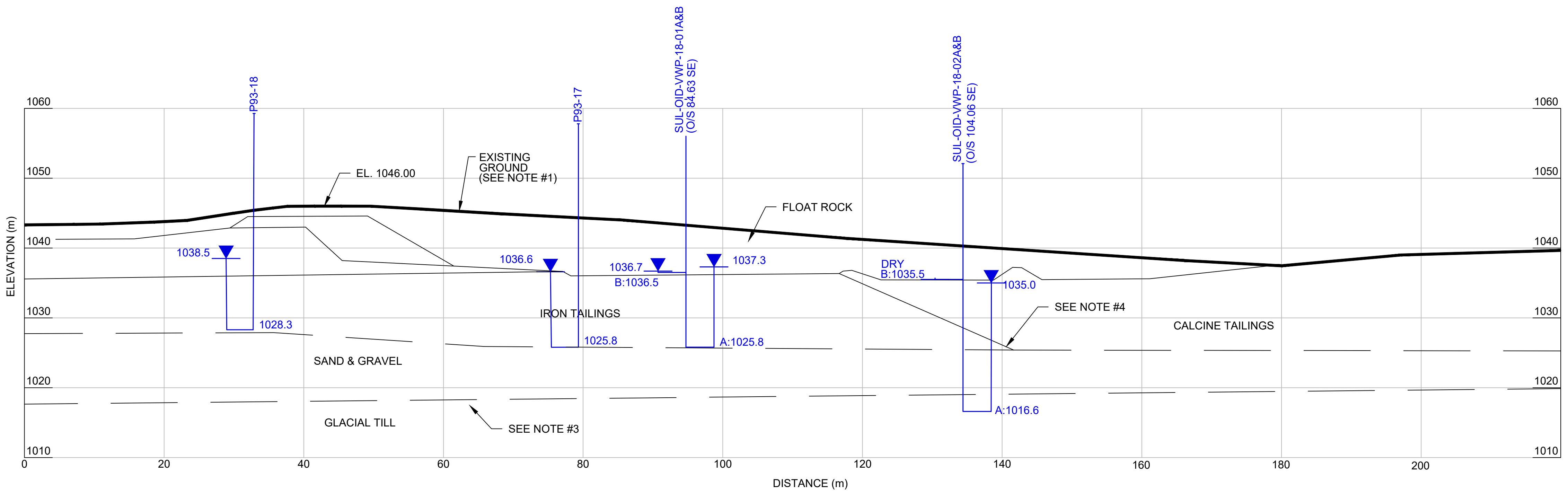
TITLE
INSTRUMENT LOCATION PLAN
OLD IRON & IRON TSF DIVIDER DIKES

PROJECT No.
A05807A19

FIG No.
FIGURE 8

KCC-D-B

C:\Users\mrettger\appdata\local\temp\AcPublish_820\Figure 8_OldIronPond.dwg Layout=Figure 8 October 18, 2019 12:49:21 PM



G SECTION
FIG 8 SCALE = 1:750

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 1994 SULLIVAN MINE STABILITY REVIEW OF SOUTHWEST LIMB.
3. APPROXIMATE ELEVATION OF GLACIAL TILL SURFACE FROM BOREHOLE 92-F (OFFSET 200 FT WEST).
4. APPROXIMATE LOCATION OF "SOUTH DAM", AN EARLY DYKE WHICH EXPERIENCED TWO FAILURES IN 1926 AND 1930, FROM 1964 TOPOGRAPHY. THE SOUTHWEST LIMB (WHICH INCLUDES SECTION G) OF THE IRON DYKE WAS PROBABLY THE FINAL INCREMENTAL RAISE OF THE "SOUTH DAM" ACCORDING TO THE 1994 SULLIVAN MINE STABILITY REVIEW OF SOUTHWEST LIMB.

LEGEND:

P91-01	PIEZOMETER
▼ 1023.8	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1021.4	PIEZOMETER TIP

1:750 0 7.5 15 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

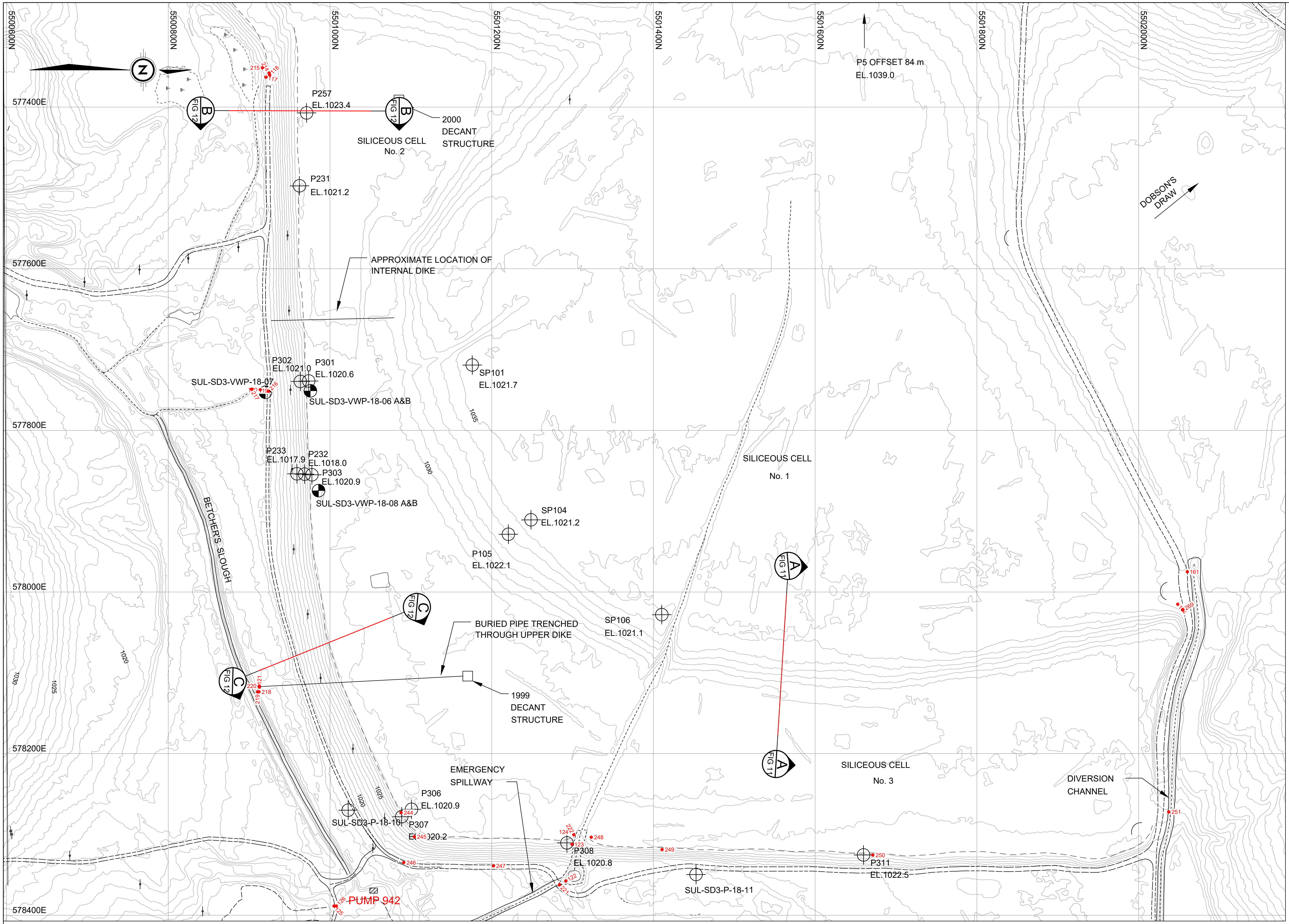
TITLE
OLD IRON DIKE
SECTION G

PROJECT No.
A05807A19

FIG No.
FIGURE 9

KCC-D-B

C:\Users\mrettger\appdata\local\temp\AcPublish_14024\Figure 9_Old Iron Dike Section.dwg Layout=9 October 18, 2019 3:03:17 PM



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83).
4. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK PERSONNEL FOR THIS REPORT. NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.
5. SPILLWAY LOCATIONS ARE APPROXIMATE.

LEGEND:

SUL-SD3-VWP-18-06A&B ◐	VIBRATING WIRE PIEZOMETER
P91-07 ◐	PNEUMATIC PIEZOMETER
P205 ⊕	STANDPIPE PIEZOMETER
SP206 ⊕	STANDPIPE PIEZOMETER AND SETTLEMENT PLATE
EL.1032.1	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

LOCATION AND DIRECTION OF PHOTOS TAKEN DURING ANNUAL INSPECTION

4.01	PHOTO NUMBER
⊗	LOCATION WHERE PHOTO WAS TAKEN
←	DIRECTION OF VIEW
4.01 ⊕	PANORAMA

1:5 000 0 50 100 m

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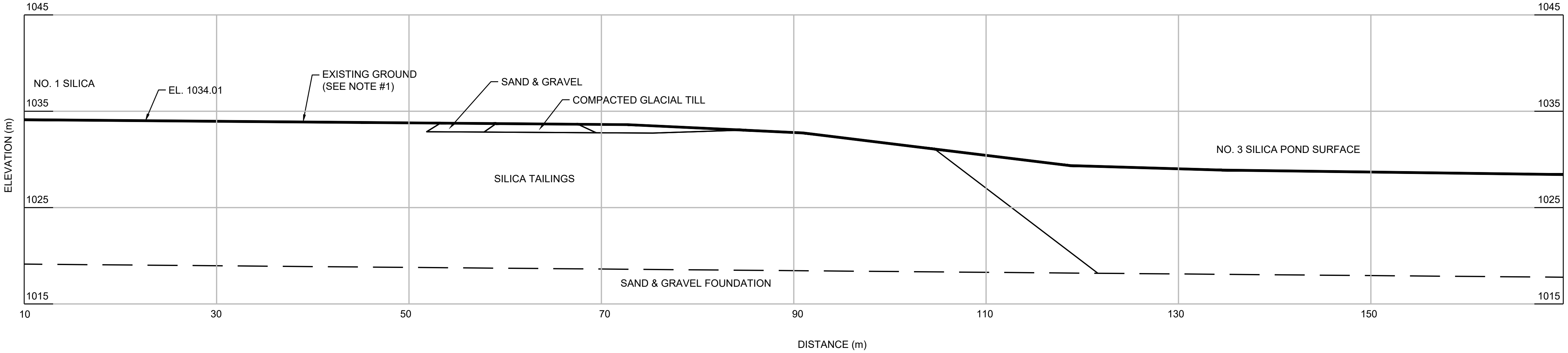
PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
INSTRUMENT LOCATION PLAN
NO. 1, 2 & 3
SILICEOUS DIKES

PROJECT No.
A05807A19

FIG No.
FIGURE 10

KCC-D-B



A
FIG 10
SECTION
SCALE = 1:500

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 1994 SULLIVAN MINE STABILITY REVIEW OF SILICA DYKES.

1:500 0 5 10 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

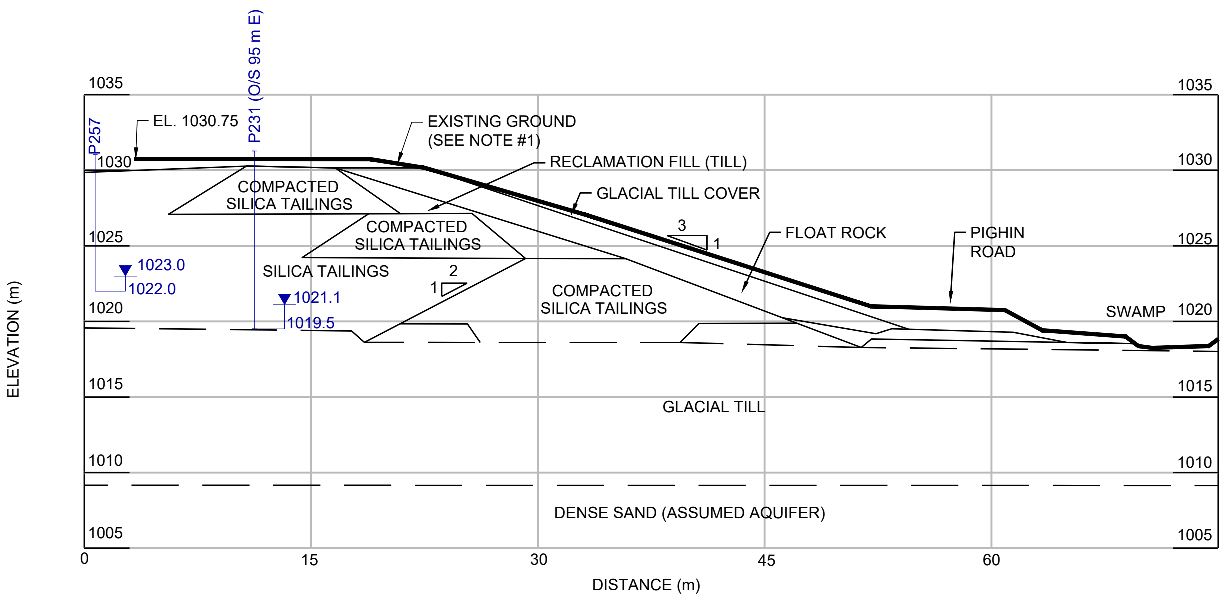
TITLE
NO. 1 SILICEOUS DIKE
SECTION A

PROJECT No.
A05807A19

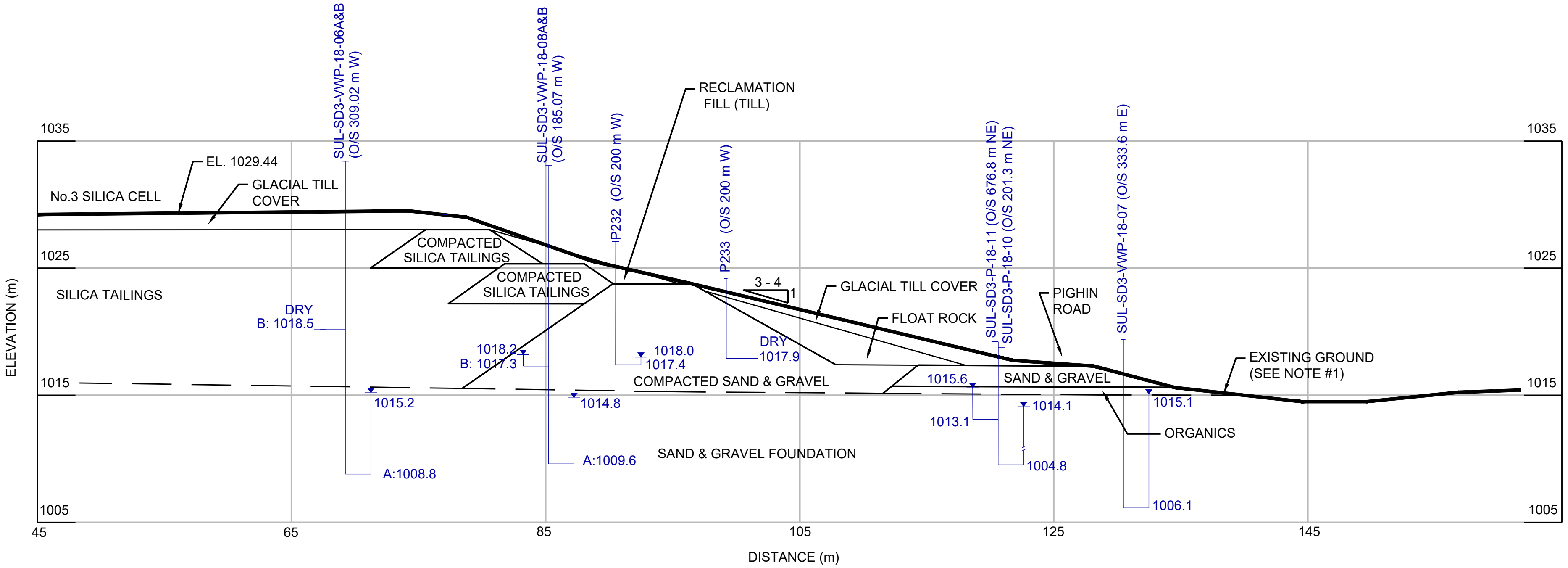
FIG No.
FIGURE 11

KCC-D-B

C:\Users\mrettger\appdata\local\temp\AcPublish_14024\Figure 11,12_Siliceous TSF Sections.dwg Layout=11 October 18, 2019 3:00:06 PM



B SECTION
FIG 10 SCALE = 1:500



C SECTION
FIG 10 SCALE = 1:500

NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 1994 SULLIVAN MINE STABILITY REVIEW OF SILICA DYKES.

LEGEND:

P91-01	PIEZOMETER
1023.8	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1021.4	PIEZOMETER TIP

1:500 0 5 10 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

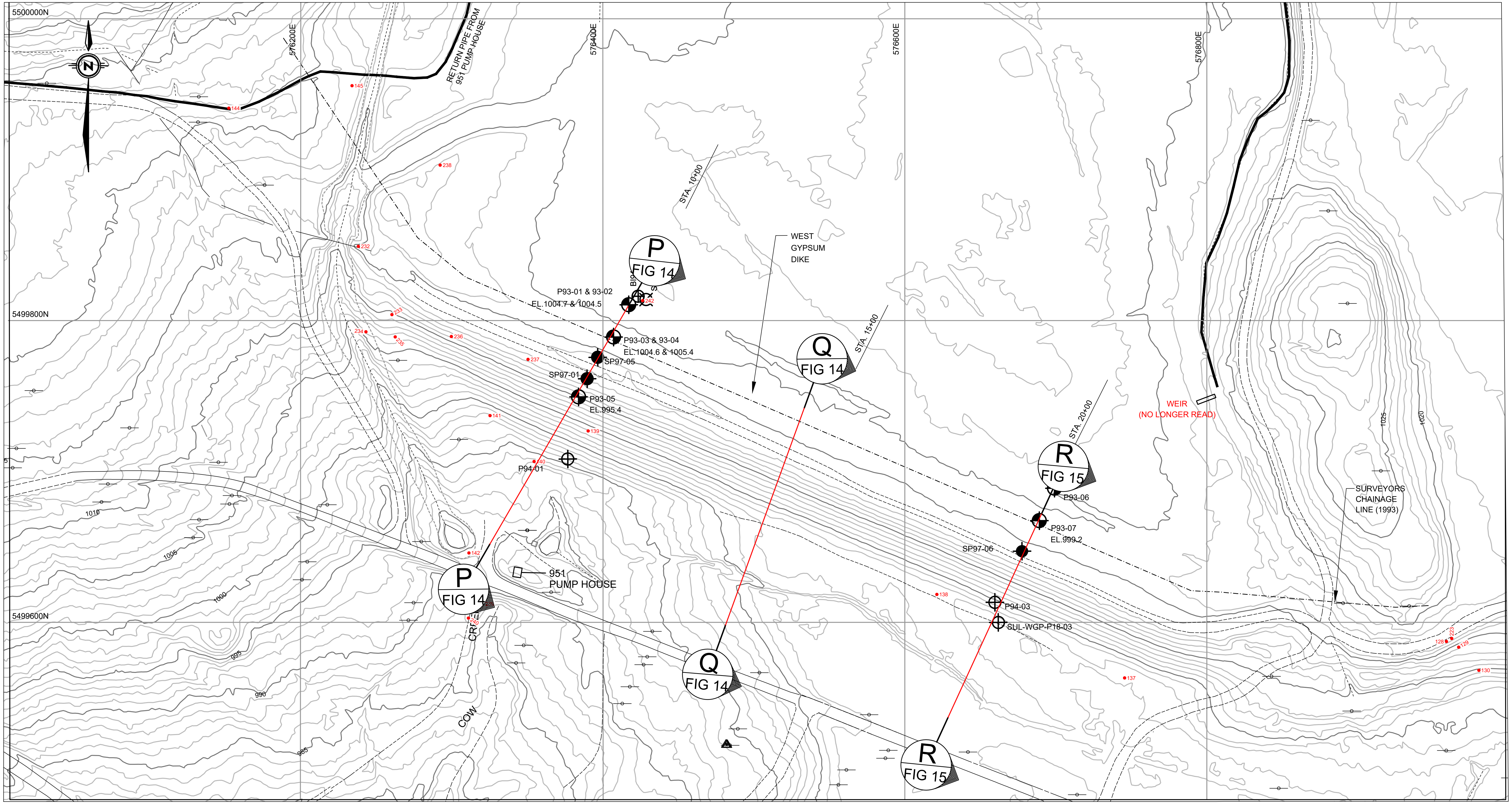
TITLE
NO. 2 AND NO. 3 SILICEOUS DIKES
SECTIONS B AND C

PROJECT No.
A05807A19

FIG No.
FIGURE 12

KCC-D-B

C:\Users\mrettger\appdata\local\temp\AcPublish_14024\Figure 11,12_Siliceous TSF Sections.dwg Layout=12 October 18, 2019 3:00:56 PM



1:2 500 0 25 50 m

NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83). CONTOUR INTERVAL IS ONE METRE.
4. STATIONING IS IN FEET.
5. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.

LEGEND:

⊕ P93-15	1993 STANDPIPE PIEZOMETER
⊕ P94-01	STANDPIPE PIEZOMETER
● SP97-01	SETTLEMENT PLATE
⊕ BI94-02	INCLINOMETER
⊗ S94-02	SONDEX SETTLEMENT GAUGE
EL.1032.1	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

LOCATION AND DIRECTION OF PHOTOGRAPHS
TAKEN DURING ANNUAL INSPECTION

PHOTO NUMBER

LOCATION WHERE
PHOTO WAS TAKEN

DIRECTION OF VIEW

PANORAMA

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

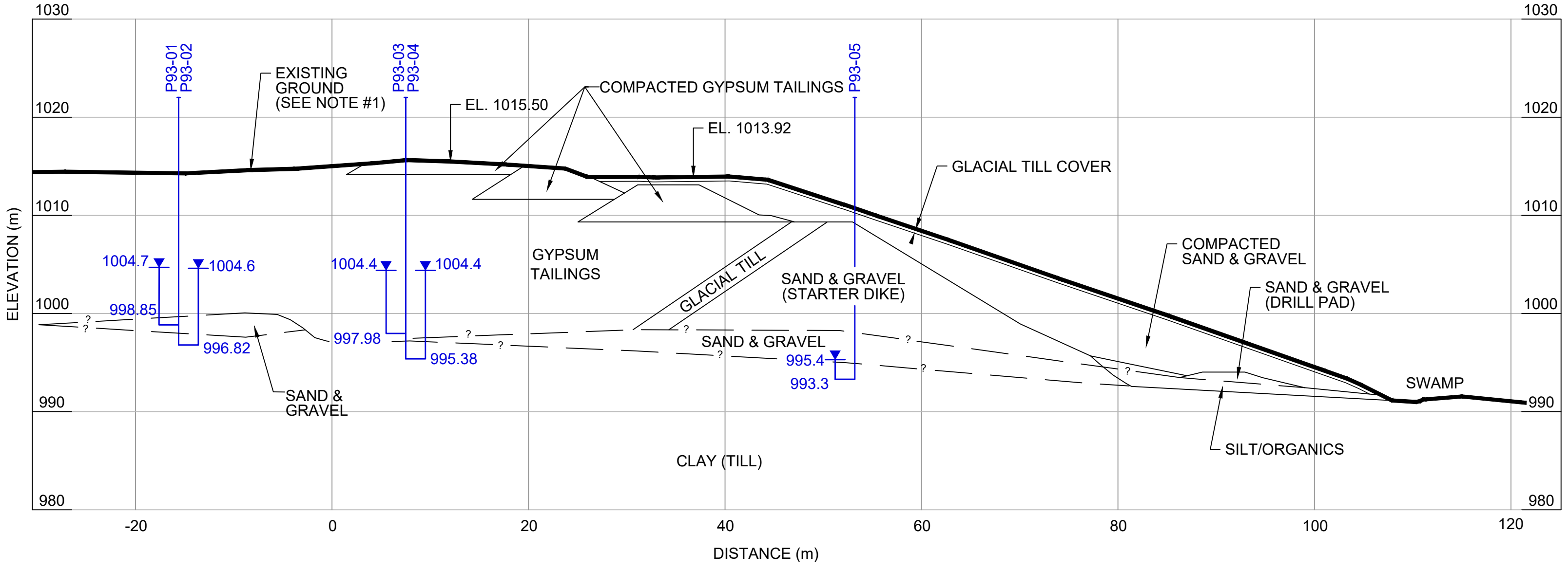
TITLE
INSTRUMENT LOCATION PLAN
WEST GYPSUM DIKE

PROJECT No.
A05807A19

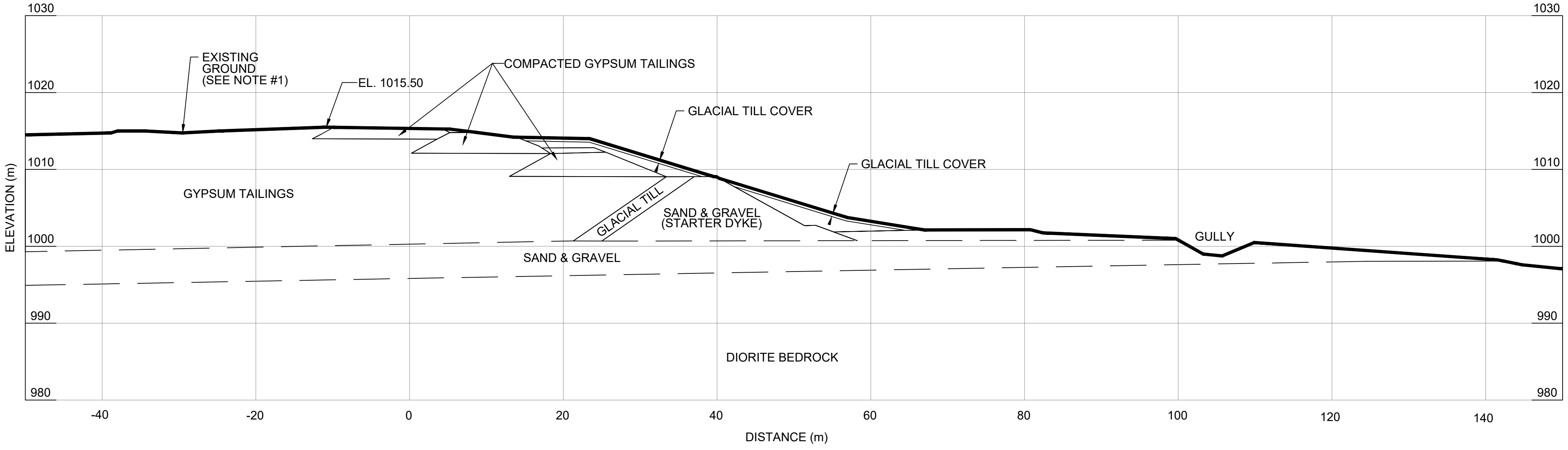
FIG No.
FIGURE 13

KCC-D-8

C:\Users\mrettger\appdata\local\temp\AcPublish_14024\Figure 13_WestGyp.dwg Layout=Figure 13 October 18, 2019 2:14:49 PM



P SECTION
FIG 13 SCALE = 1:750



Q SECTION
FIG 13 SCALE = 1:750

C:\Users\mrettger\appdata\local\temp\AcPublish_14024\Figure 14,15 West Gypsum Dike Sections.dwg Layout=14 October 18, 2019 3:11:40 PM

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 1993 SULLIVAN MINE STABILITY REVIEW OF GYPSUM DYKES.

LEGEND:

P93-01 PIEZOMETER
1006.30 MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1000.2 PIEZOMETER TIP

1:750 0 7.5 15 m

CLIENT
Teck

Klohn Crippen Berger

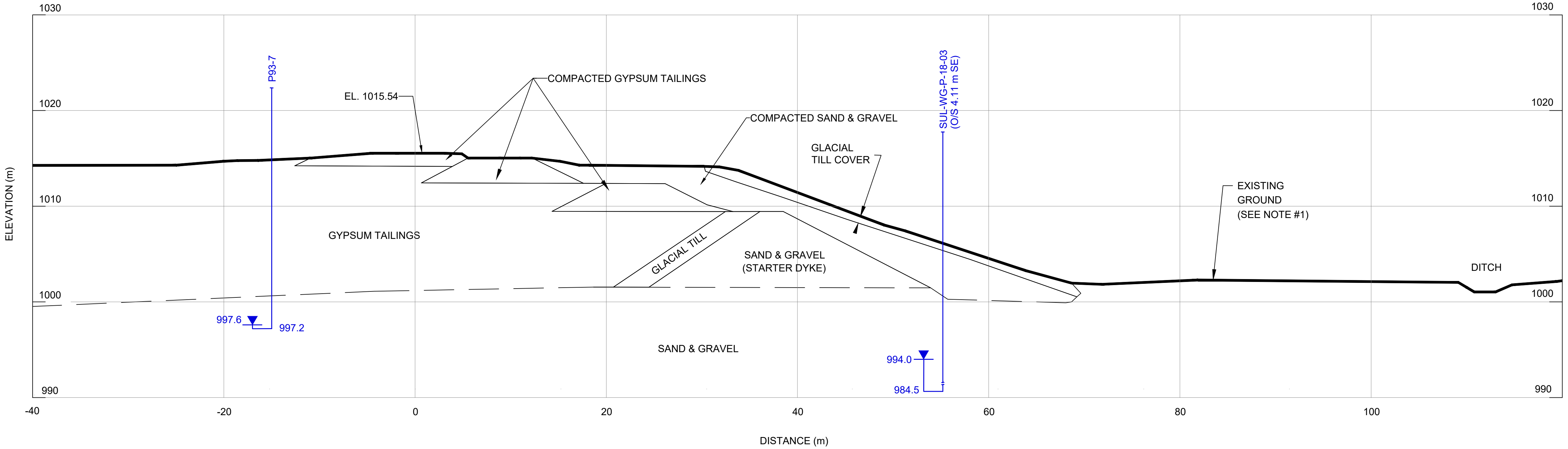
PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
WEST GYPSUM DIKE
SECTIONS P AND Q

PROJECT No.
A05807A19

FIG No.
FIGURE 14

KCC-D-B



R
FIG 13
SECTION
SCALE = 1:500

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 1993 SULLIVAN MINE STABILITY REVIEW OF GYPSUM DYKES.

LEGEND:

P93-01	PIEZOMETER
▼ 1006.30	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1000.2	PIEZOMETER TIP

1:500 0 5 10 m

CLIENT
Teck

Klohn Crippen Berger

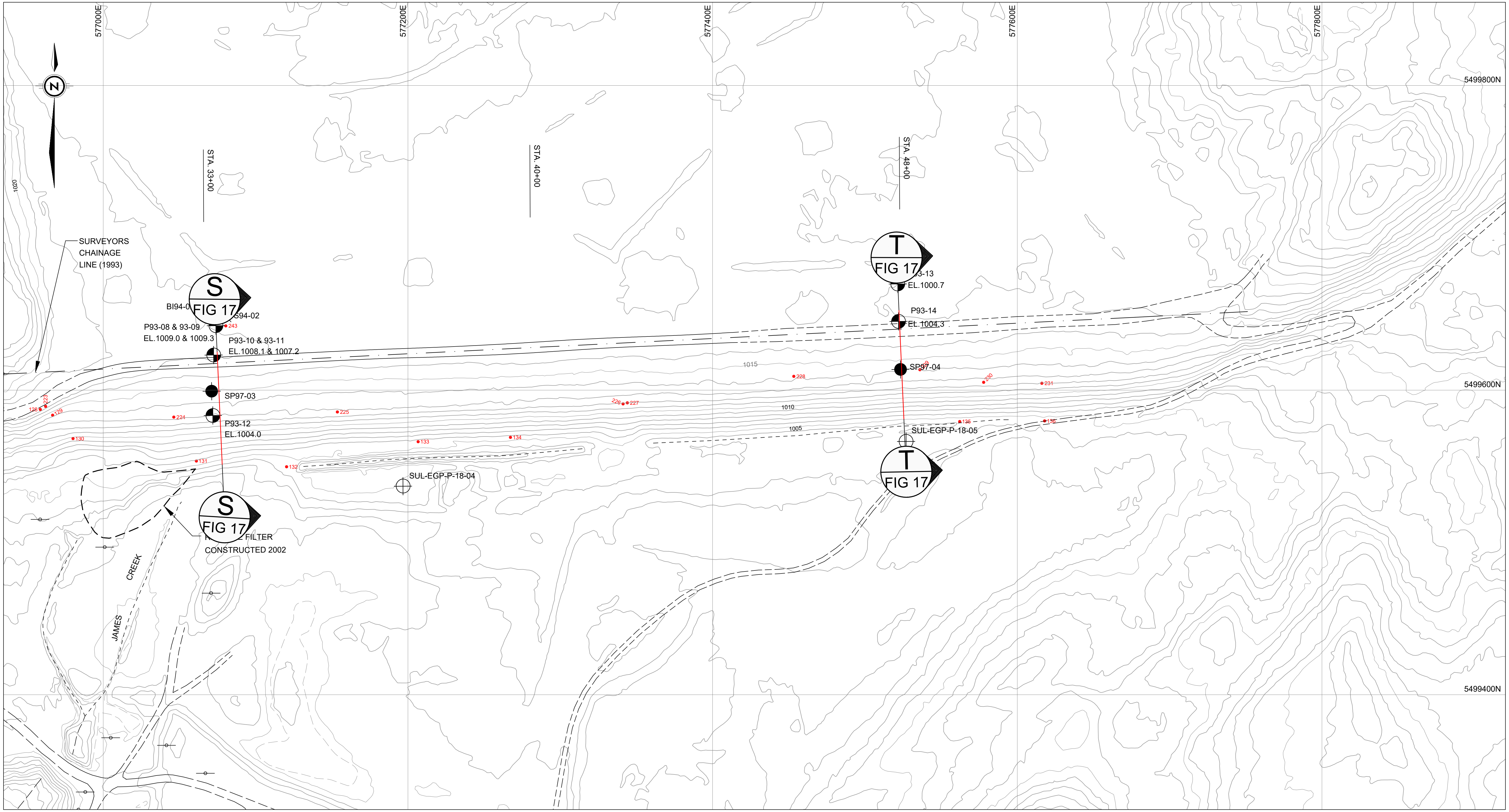
PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
WEST GYPSUM DIKE
SECTION R

PROJECT No.
A05807A19

FIG No.
FIGURE 15

KCC-D-B



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83). CONTOUR INTERVAL IS ONE METRE.
4. STATIONING IS IN FEET.
5. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.

LEGEND:

◐ P93-15	1993 STANDPIPE PIEZOMETER
⊕ P94-01	STANDPIPE PIEZOMETER
● SP97-01	SETTLEMENT PLATE
⊕ BI94-02	INCLINOMETER
⊗ S94-02	SONDEX SETTLEMENT GAUGE
EL.1032.1	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

LOCATION AND DIRECTION OF PHOTOGRAPHS TAKEN DURING ANNUAL INSPECTION

PHOTO NUMBER

LOCATION WHERE PHOTO WAS TAKEN

DIRECTION OF VIEW

PANORAMA

1:2 500 0 25 50 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

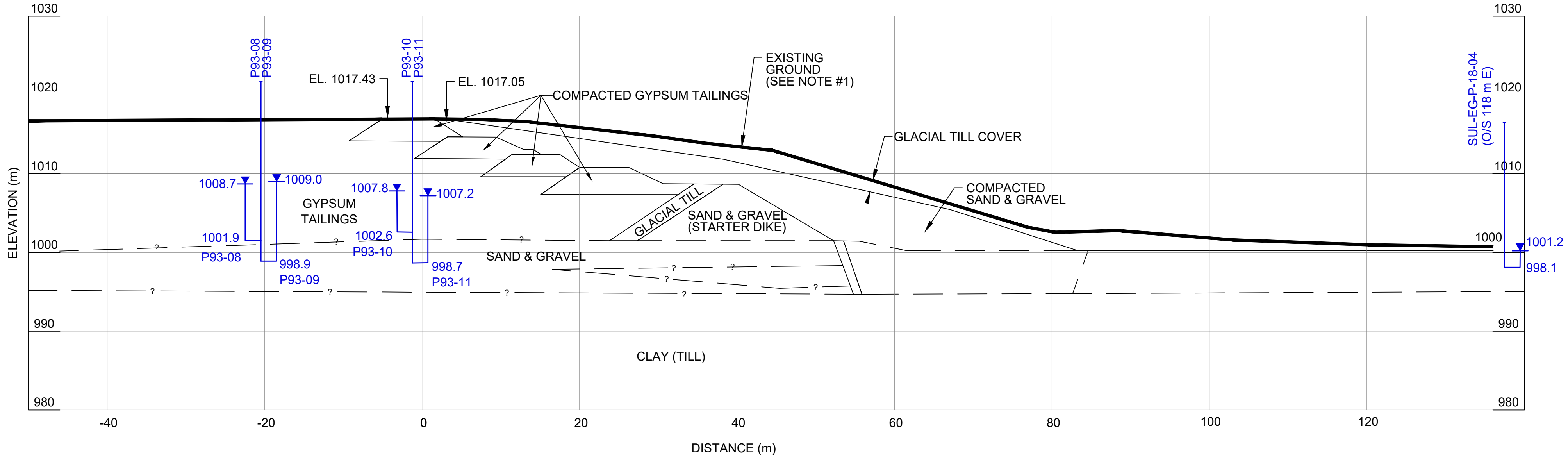
TITLE
INSTRUMENT LOCATION PLAN
EAST GYPSUM DIKE

PROJECT No.
A05807A19

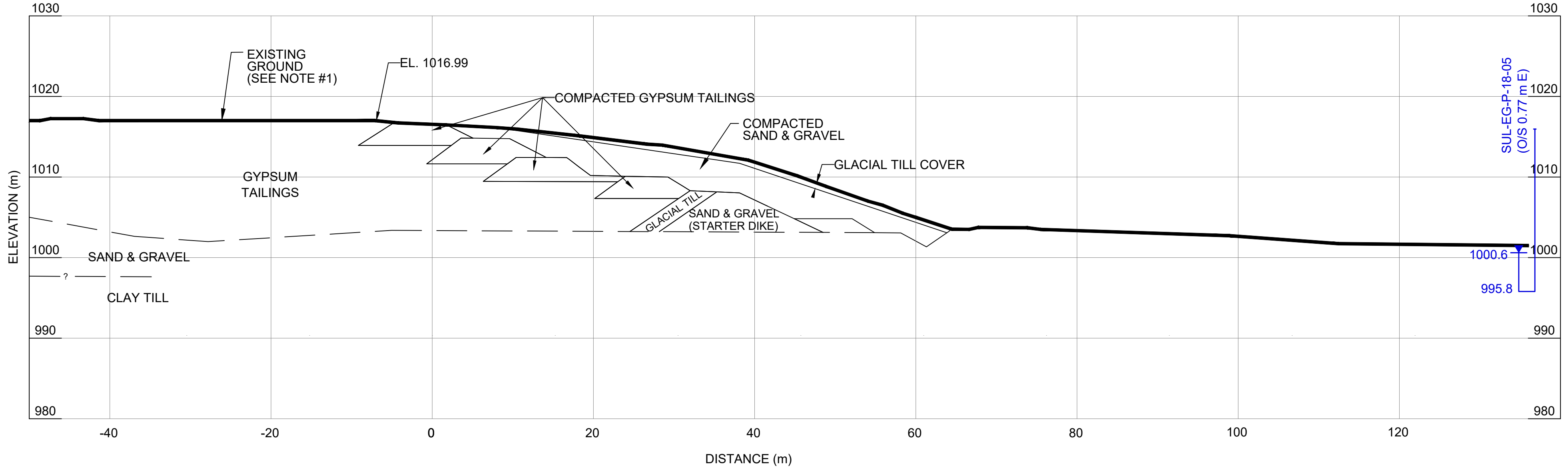
FIG No.
FIGURE 16

KCC-D-B

C:\Users\mrettger\appdata\local\temp\AcPublish_14024\Figure 16_EastGyp.dwg Layout=Figure 16 October 18, 2019 2:36:13 PM



S SECTION
FIG 16 SCALE = 1:750



T SECTION
FIG 16 SCALE = 1:750

C:\Users\mrettger\appdata\local\temp\AcPublish_15920\Figure 17_East Gypsum Dike Sections.dwg Layout=17 October 18, 2019 5:02:34 PM

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 1993 SULLIVAN MINE STABILITY REVIEW OF GYPSUM DYKES.

LEGEND:

P93-01	PIEZOMETER
▼ 1006.30	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1000.2	PIEZOMETER TIP

1:750 0 7.5 15 m

CLIENT
Teck

Klohn Crippen Berger

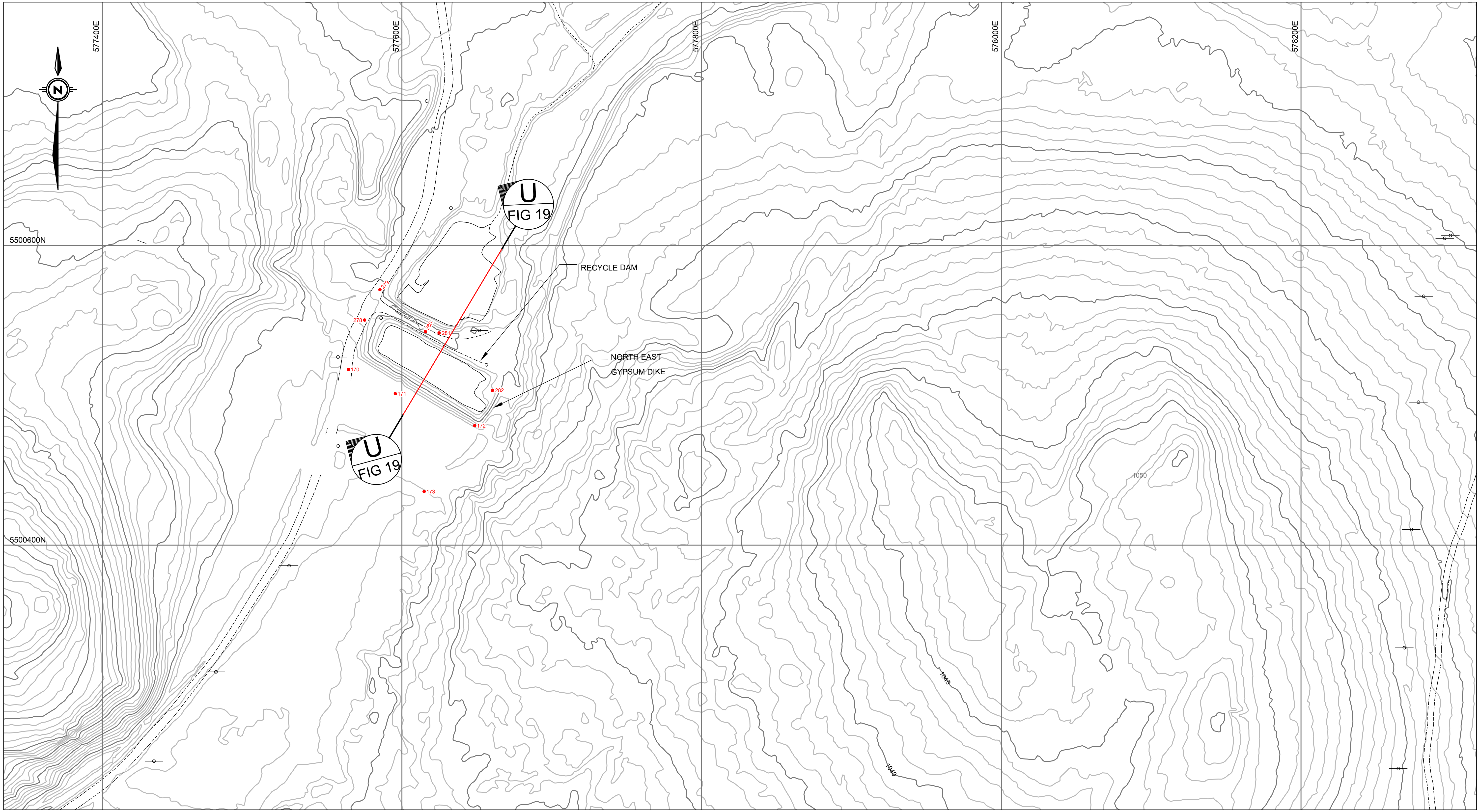
PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
EAST GYPSUM DIKE
SECTIONS S AND T

PROJECT No.
A05807A19

FIG No.
FIGURE 17

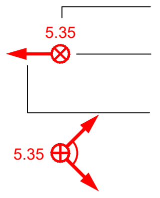
KCD-D-8



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83). CONTOUR INTERVAL IS ONE METRE.
4. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK PERSONNEL FOR THIS REPORT. NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.

LEGEND:



LOCATION AND DIRECTION OF PHOTOGRAPHS
TAKEN DURING ANNUAL INSPECTION

PHOTO NUMBER

LOCATION WHERE
PHOTO WAS TAKEN

DIRECTION OF VIEW

PANORAMA

1:2 500 0 25 50 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

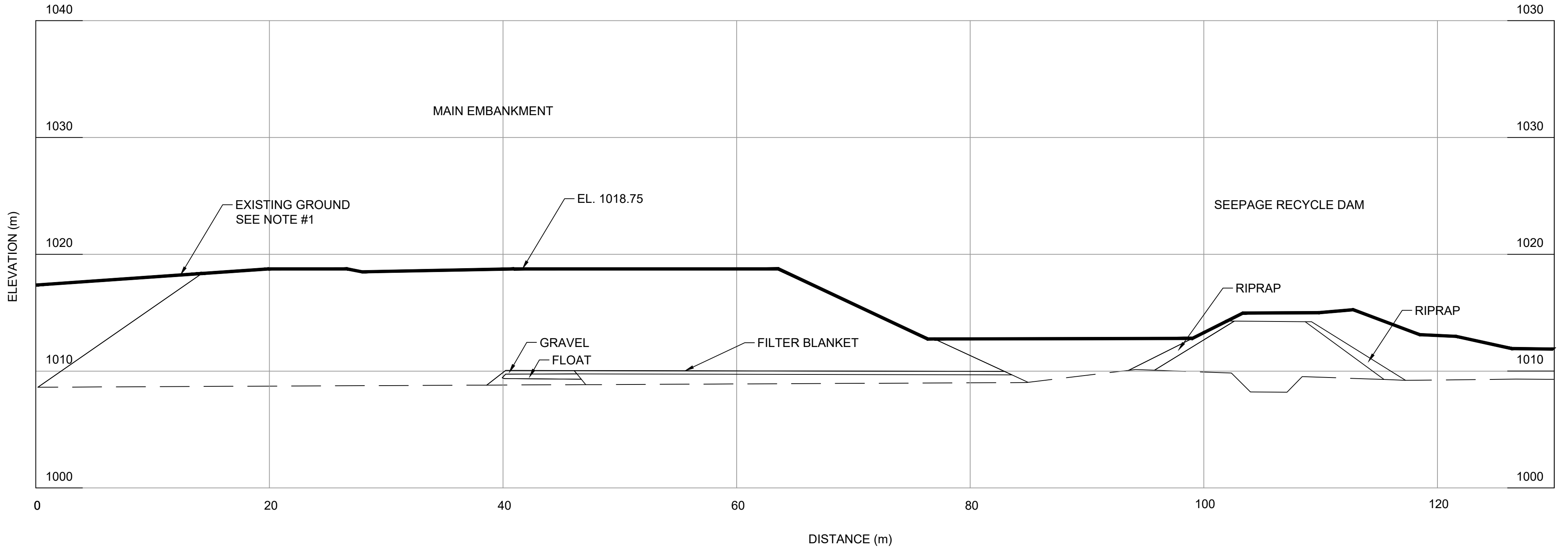
TITLE
INSTRUMENT LOCATION PLAN
NORTHEAST GYPSUM DIKE
AND RECYCLE DAM

PROJECT No.
A05807A19

FIG No.
FIGURE 18

C:\Users\mrettger\appdata\local\temp\AcPublish_14024\Figure 18_NEGyp.dwg Layout=Figure 18 October 18, 2019 3:18:01 PM

KCC-D-8



U SECTION
FIG 18 SCALE = 1:500.

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM REPORT ON 1985 CONSTRUCTION ACTIVITIES: NORTHEAST RETENTION EMBANKMENT GYPSUM PONDS.

1:500 0 5.0 10 m

CLIENT
Teck

Klohn Crippen Berger

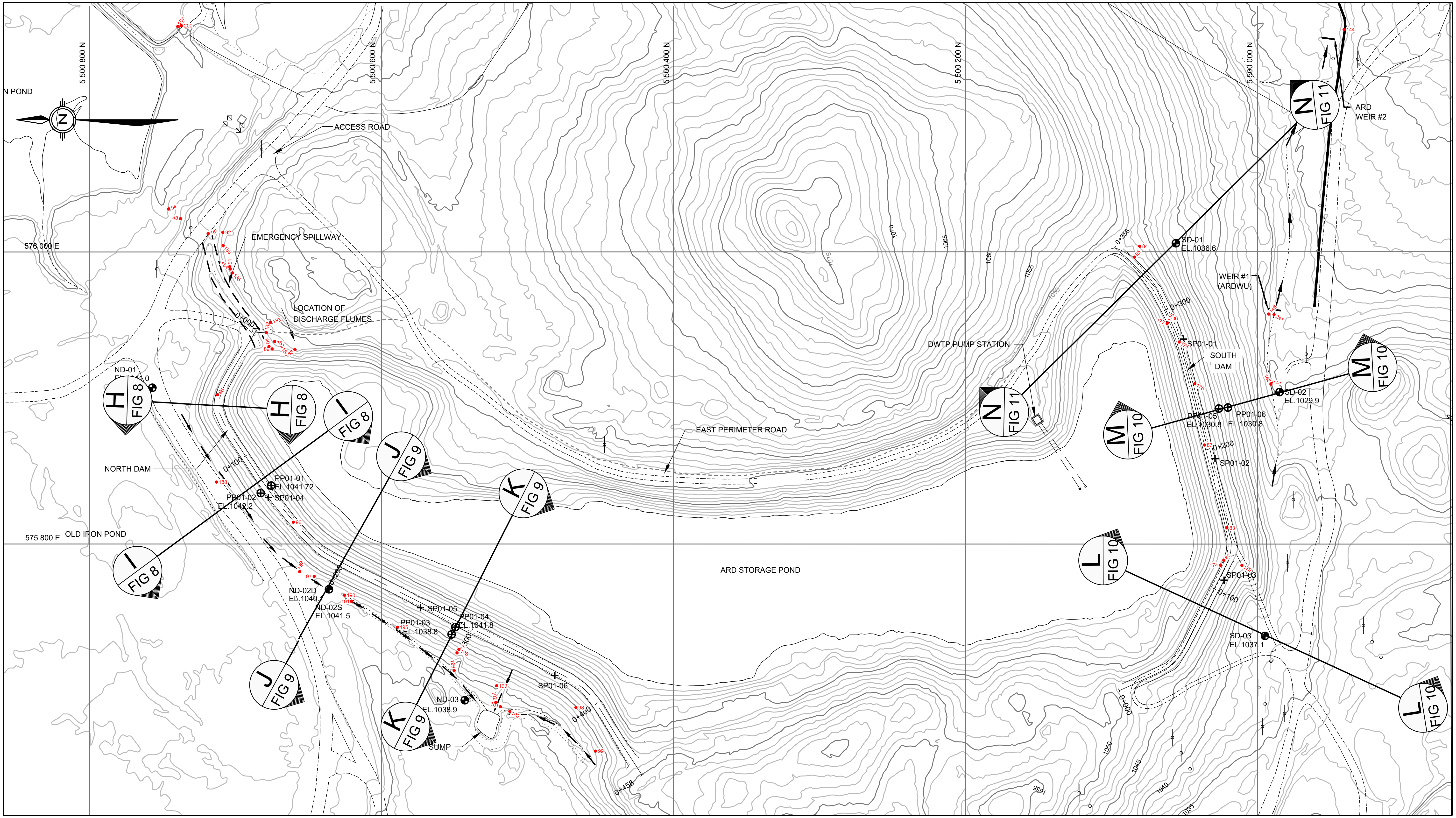
PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
NORTHEAST GYPSUM DIKE AND RECYCLE DAM
SECTION U

PROJECT No.
A05807A19

FIG No.
FIGURE 19

KCC-D-B



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD 83).

LEGEND:

⊕	PNEUMATIC PIEZOMETER
◕	STANDPIPE PIEZOMETER
+	SETTLEMENT PIN
➤ ➤	SEEPAGE COLLECTOR DITCH
EL.1032.1	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

LOCATION AND DIRECTION OF PHOTOGRAPHS TAKEN DURING ANNUAL INSPECTION

6.01	PHOTO NUMBER
⊗	LOCATION WHERE PHOTO WAS TAKEN
←	DIRECTION OF VIEW
6.01 ⊕	PANORAMA

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

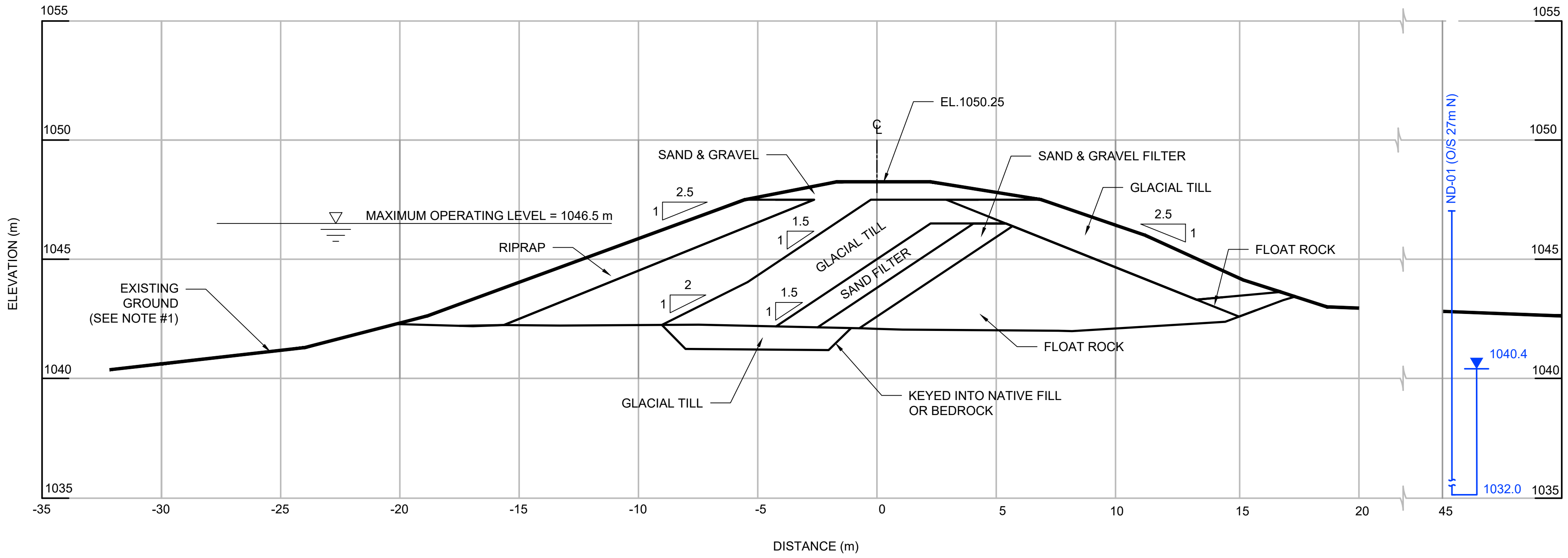
TITLE
ARD STORAGE POND
PLAN AND LAYOUT

PROJECT No.
A05807A19

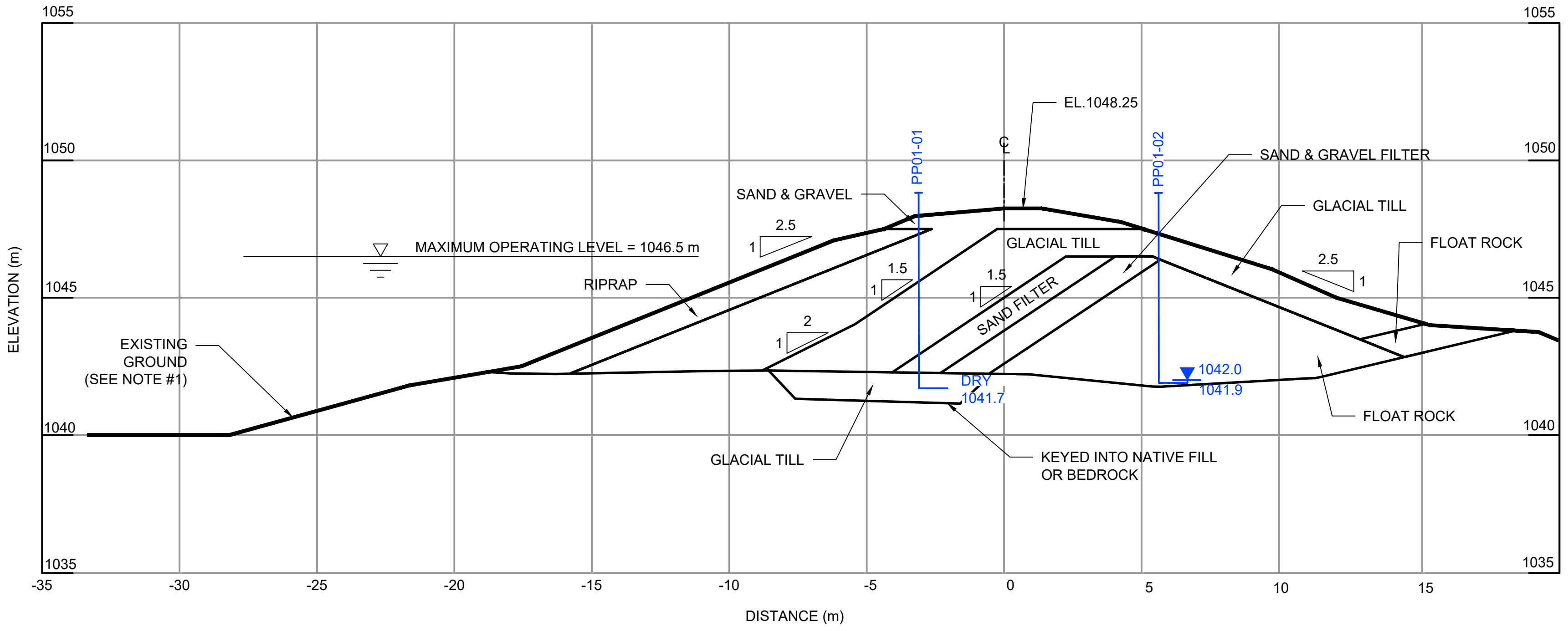
FIG No.
FIGURE 20

KCC-D-B

Z:\ACGY\Alberta\A05807A19 TML 2019 Sullivan Mine DSI\400 Drawings\DSI Report (Updated Sections)\Figure 20 ARD.dwg Layout=Figure 20 November 4, 2019 9:26:50 AM



H SECTION
FIG 20 SCALE = 1:250



I SECTION
FIG 20 SCALE = 1:250

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 2002 SULLIVAN MINE TAILINGS FACILITY STORAGE POND NO. 1 CONSTRUCTION RECORD REPORT.

LEGEND:

P91-01	PIEZOMETER
1023.8	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1021.4	PIEZOMETER TIP

1:250 0 2.5 5.0 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

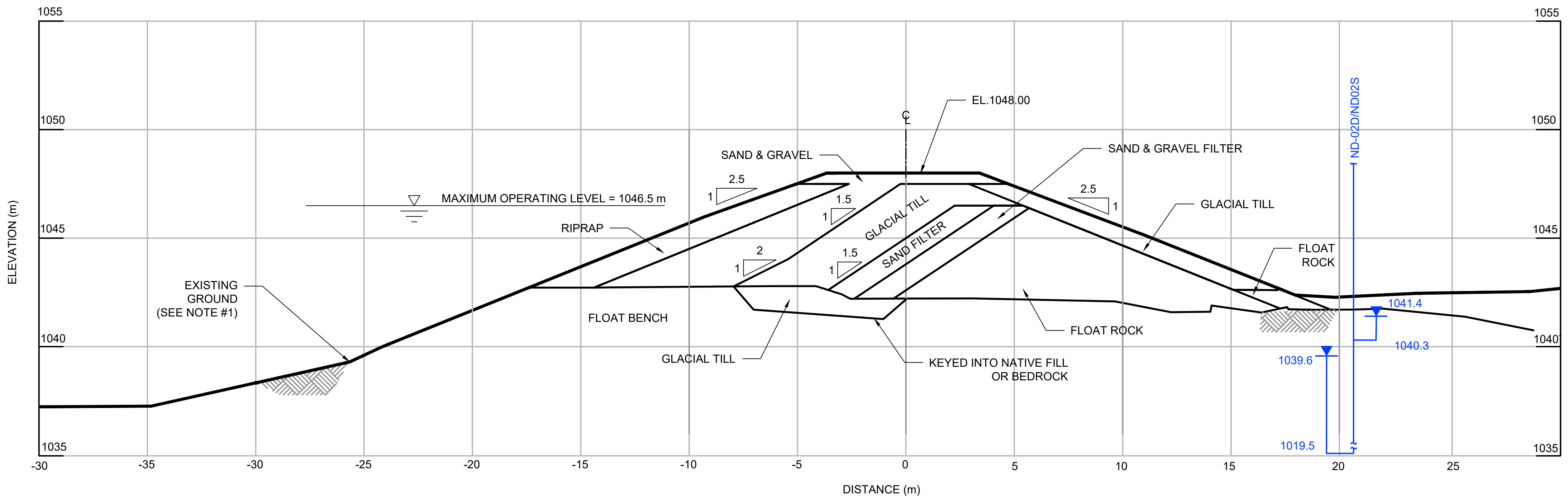
TITLE
ARD STORAGE POND
NORTH DAM SECTIONS H AND I

PROJECT No.
A05807A19

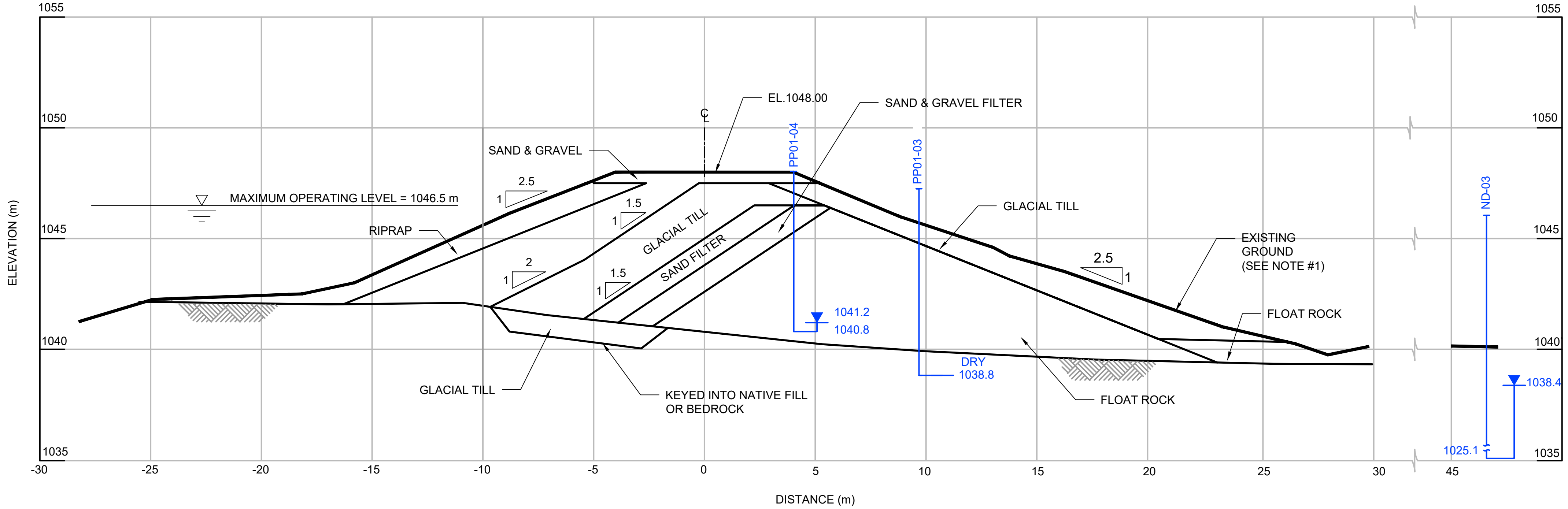
FIG No.
21

KCC-D-B

C:\Users\mrettger\appdata\local\temp\AcPublish_14024\Figure 21,22_ARD Storage Pond North Dam Sections.dwg Layout=21 October 18, 2019 3:49:15 PM



J SECTION
FIG 20 SCALE = 1:250



K SECTION
FIG 20 SCALE = 1:250

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 2002 SULLIVAN MINE TAILINGS FACILITY STORAGE POND NO. 1 CONSTRUCTION RECORD REPORT.

LEGEND:

P91-01	PIEZOMETER
1023.8	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1021.4	PIEZOMETER TIP

1:250 0 2.5 5.0 m

CLIENT
Teck

Klohn Crippen Berger

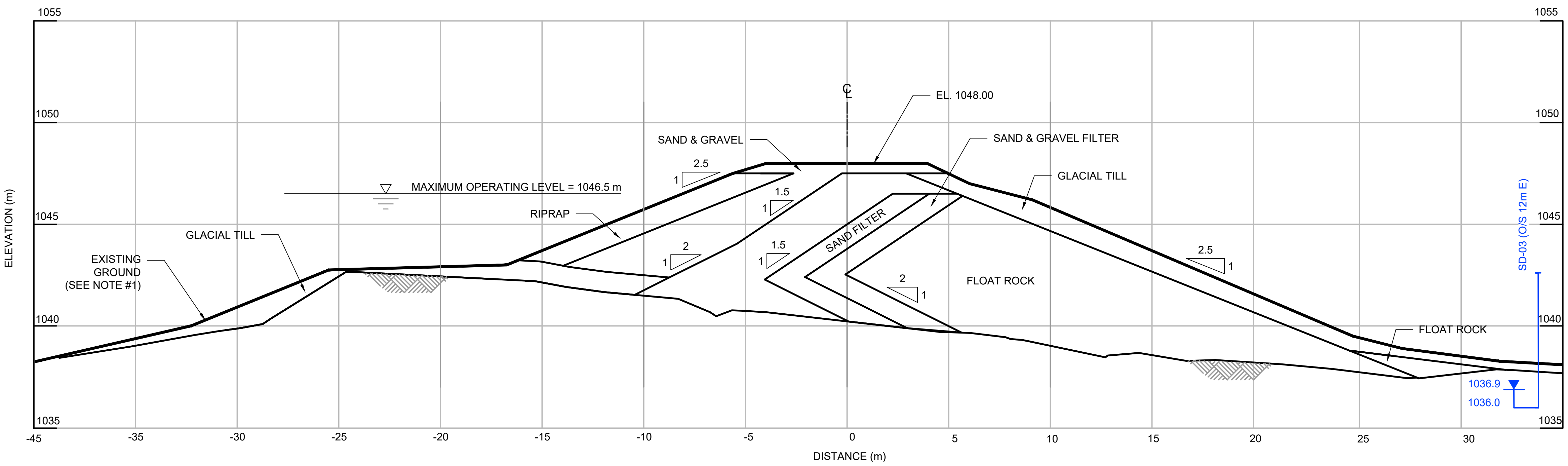
PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
ARD STORAGE POND
NORTH DAM SECTIONS J AND K

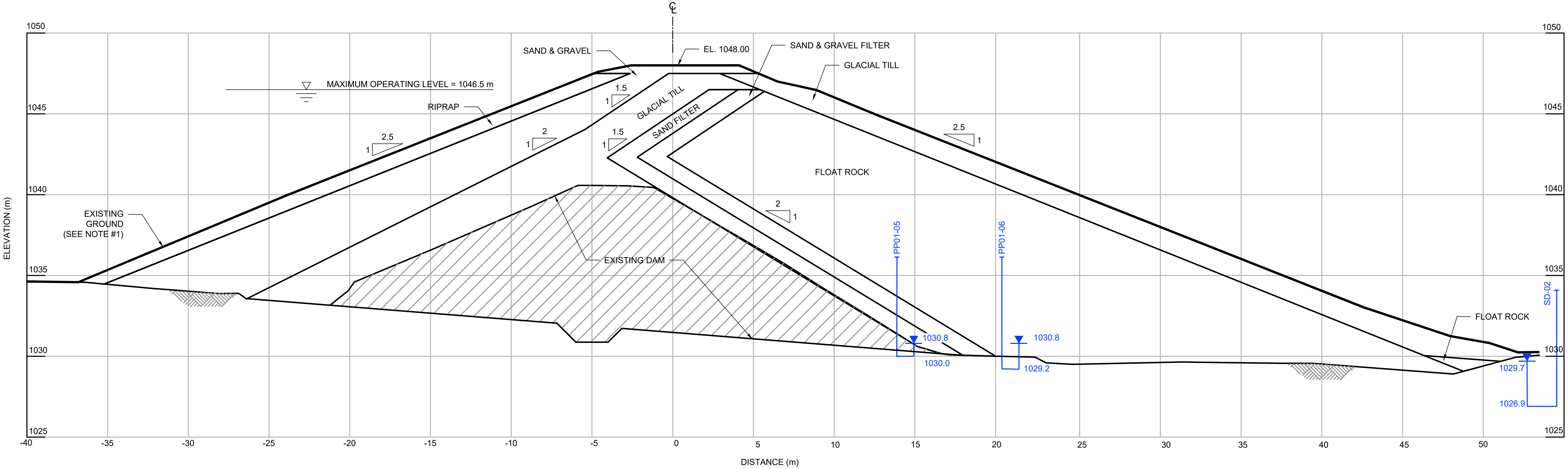
PROJECT No. A05807A19
FIG No. 22

KCD-D-B

C:\Users\mretger\appdata\local\temp\AcPublish_14024\Figure 21,22_ARD Storage Pond North Dam Sections.dwg Layout=22 October 18, 2019 3:50:34 PM



L SECTION
FIG 20 SCALE = 1:250



M SECTION
FIG 20 SCALE = 1:250

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 2002 SULLIVAN MINE TAILINGS FACILITY STORAGE POND NO. 1 CONSTRUCTION RECORD REPORT.

LEGEND:

P91-01	PIEZOMETER
1023.8	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1021.4	PIEZOMETER TIP

1:250 0 2.5 5.0 m

CLIENT
Teck

Klohn Crippen Berger

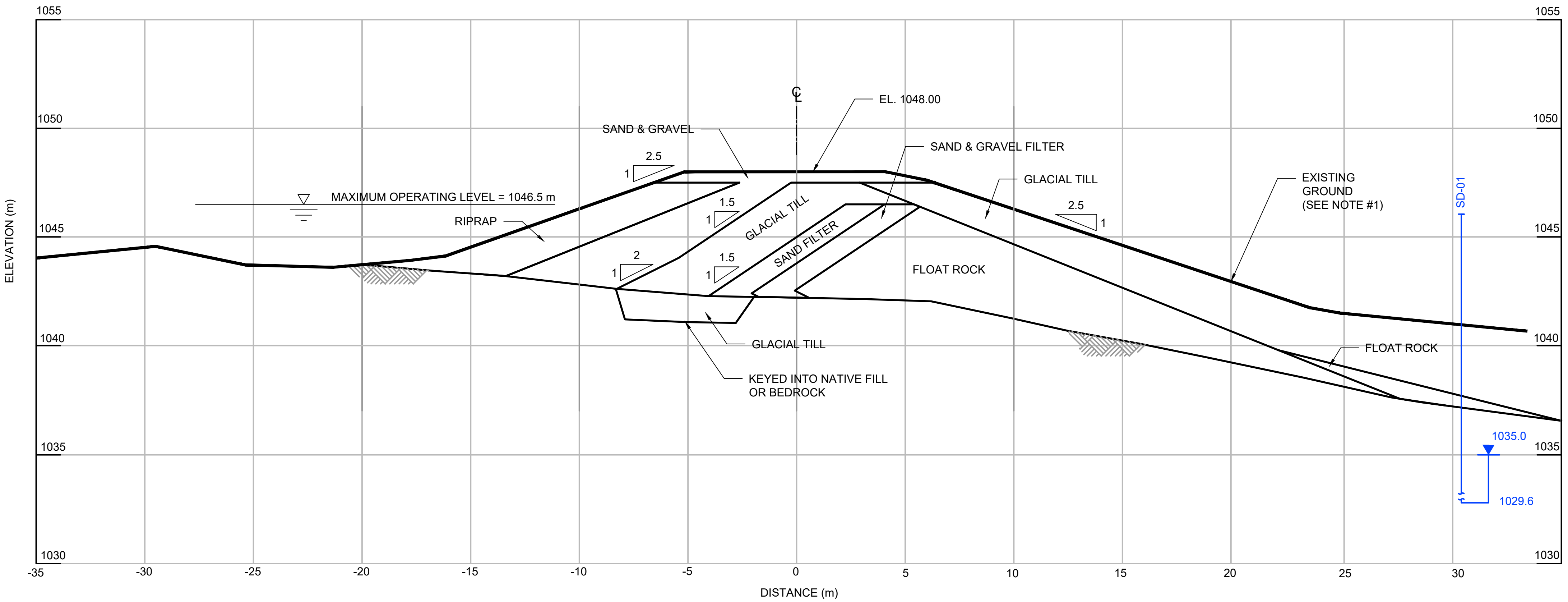
PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
ARD STORAGE POND
SOUTH DAM SECTIONS L AND M

PROJECT No.
A05807A19

FIG No.
23

C:\Users\mretger\appdata\local\temp\AcPublish_14024\Figure 23,24_ARD Storage Pond South Dam Sections.dwg Layout=23 October 18, 2019 3:59:26 PM



N SECTION
FIG 20
SCALE = 1:250

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 2002 SULLIVAN MINE TAILINGS FACILITY STORAGE POND NO. 1 CONSTRUCTION RECORD REPORT.

LEGEND:

P91-01	PIEZOMETER
1023.8	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1021.4	PIEZOMETER TIP

1:250 0 2.5 5.0 m

CLIENT
Teck
Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

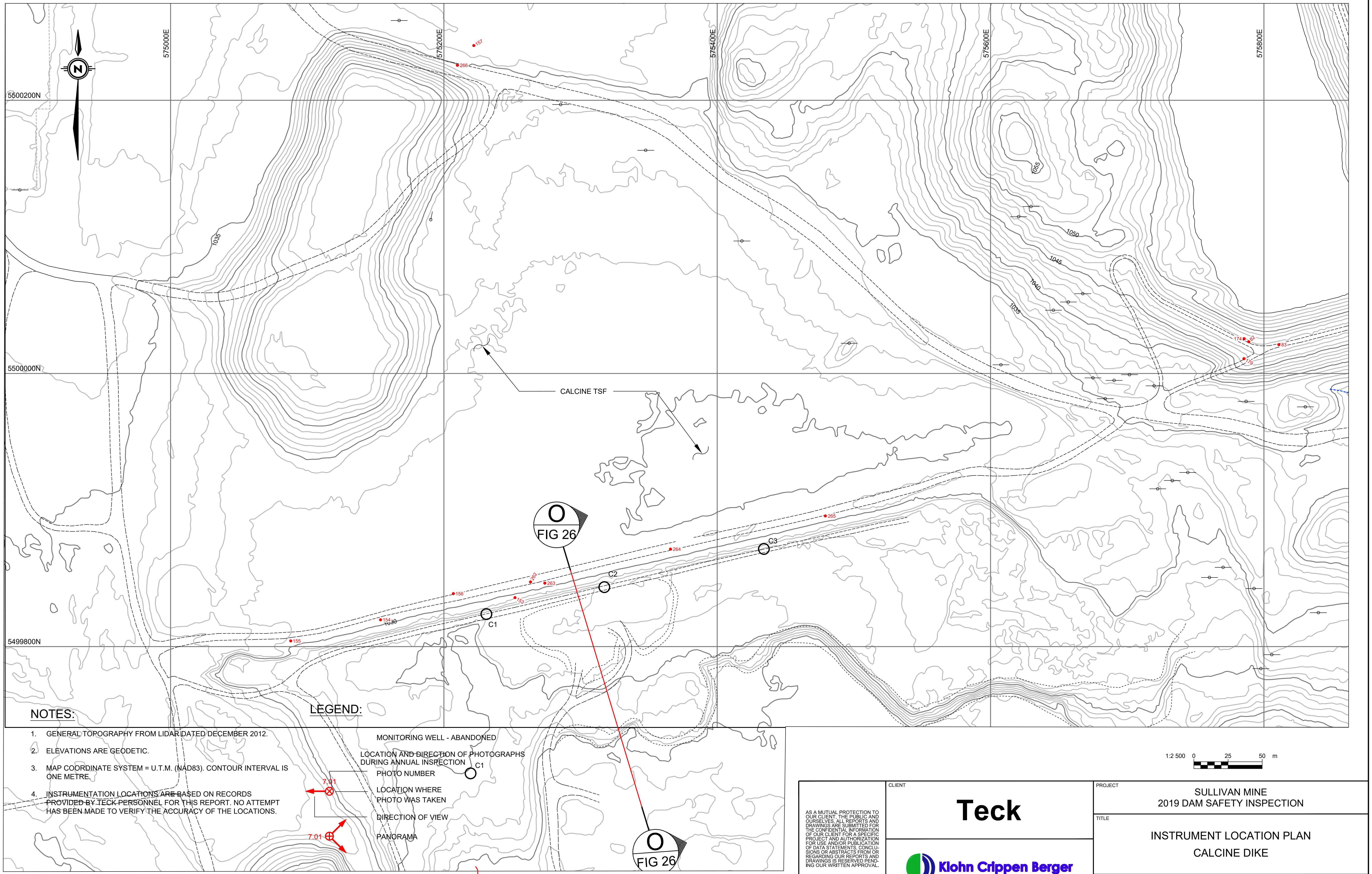
TITLE
ARD STORAGE POND
SOUTH DAM SECTION N

PROJECT No.
A05807A19

FIG No.
24

KCC-D-B

C:\Users\mrettger\appdata\local\temp\AcPublish_14024\Figure 23,24_ARD Storage Pond South Dam Sections.dwg Layout=24 October 18, 2019 4:00:43 PM



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83). CONTOUR INTERVAL IS ONE METRE.
4. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK PERSONNEL FOR THIS REPORT. NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.

LEGEND:

MONITORING WELL - ABANDONED

LOCATION AND DIRECTION OF PHOTOGRAPHS DURING ANNUAL INSPECTION

C1 PHOTO NUMBER

LOCATION WHERE PHOTO WAS TAKEN

7.01 DIRECTION OF VIEW

7.01 PANORAMA

CLIENT

Teck

Klohn Crippen Berger

PROJECT

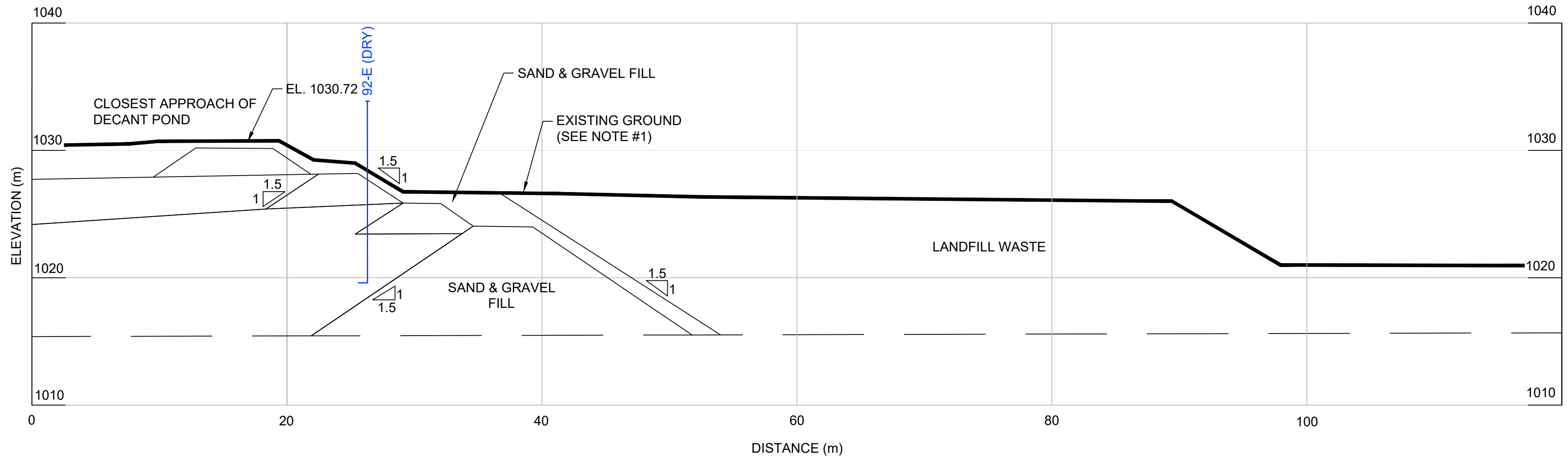
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE

INSTRUMENT LOCATION PLAN
CALCINE DIKE

PROJECT No.
A05807A19

FIG No.
FIGURE 25



O SECTION
FIG 25
SCALE = 1:500

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 1979 SOIL INVESTIGATION AND DESIGN SECOND DYKE EXTENSION CALCINE DYKE.

LEGEND:

P91-01	PIEZOMETER

1:500 0 5.0 10 m

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PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

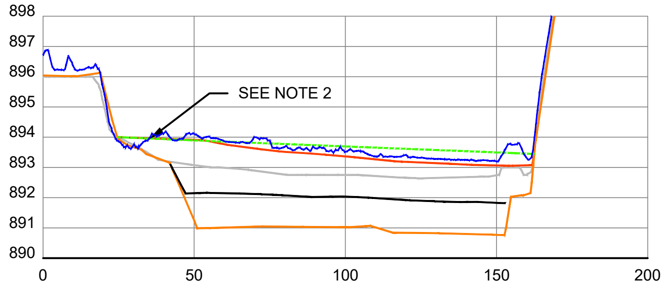
TITLE
CALCINE DIKE
SECTION O

PROJECT No.
A05807A19

FIG No.
FIGURE 26

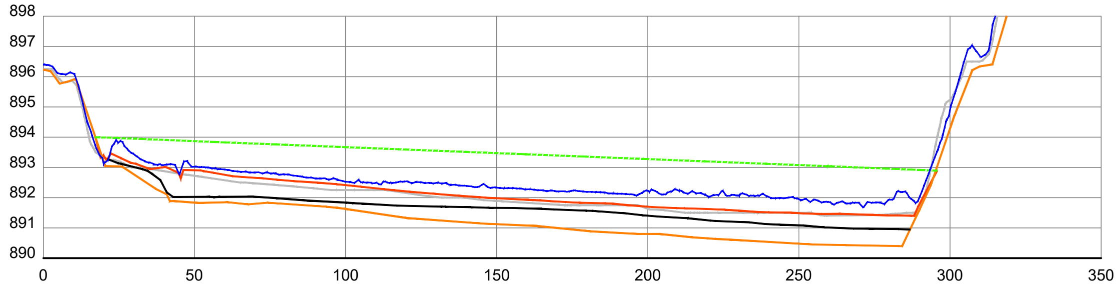
KCC-D-B

C:\Users\mrettger\appdata\local\temp\AcPublish_880\Figure 26_Calcine Dike Section.dwg Layout=26 October 18, 2019 4:43:57 PM

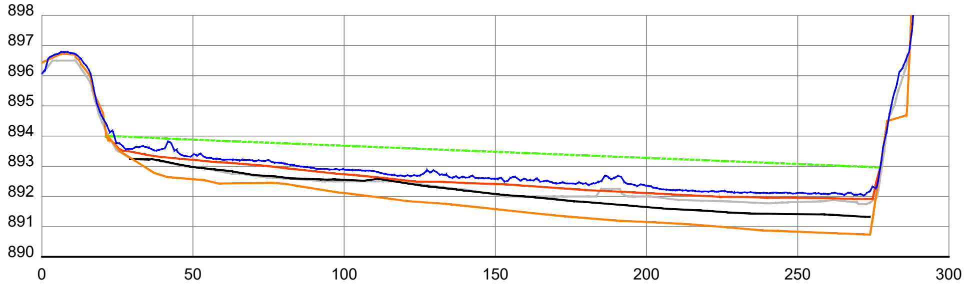


S SECTION
SCALE = 1:2500

NOTE:EXCESS SLUDGE DEPOSIT RELOCATED OCTOBER 2015



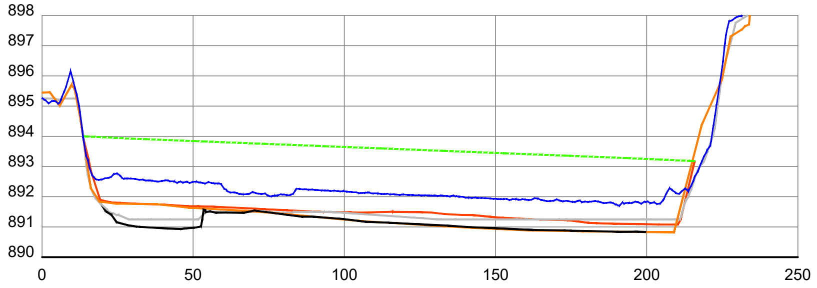
U SECTION
SCALE = 1:2500



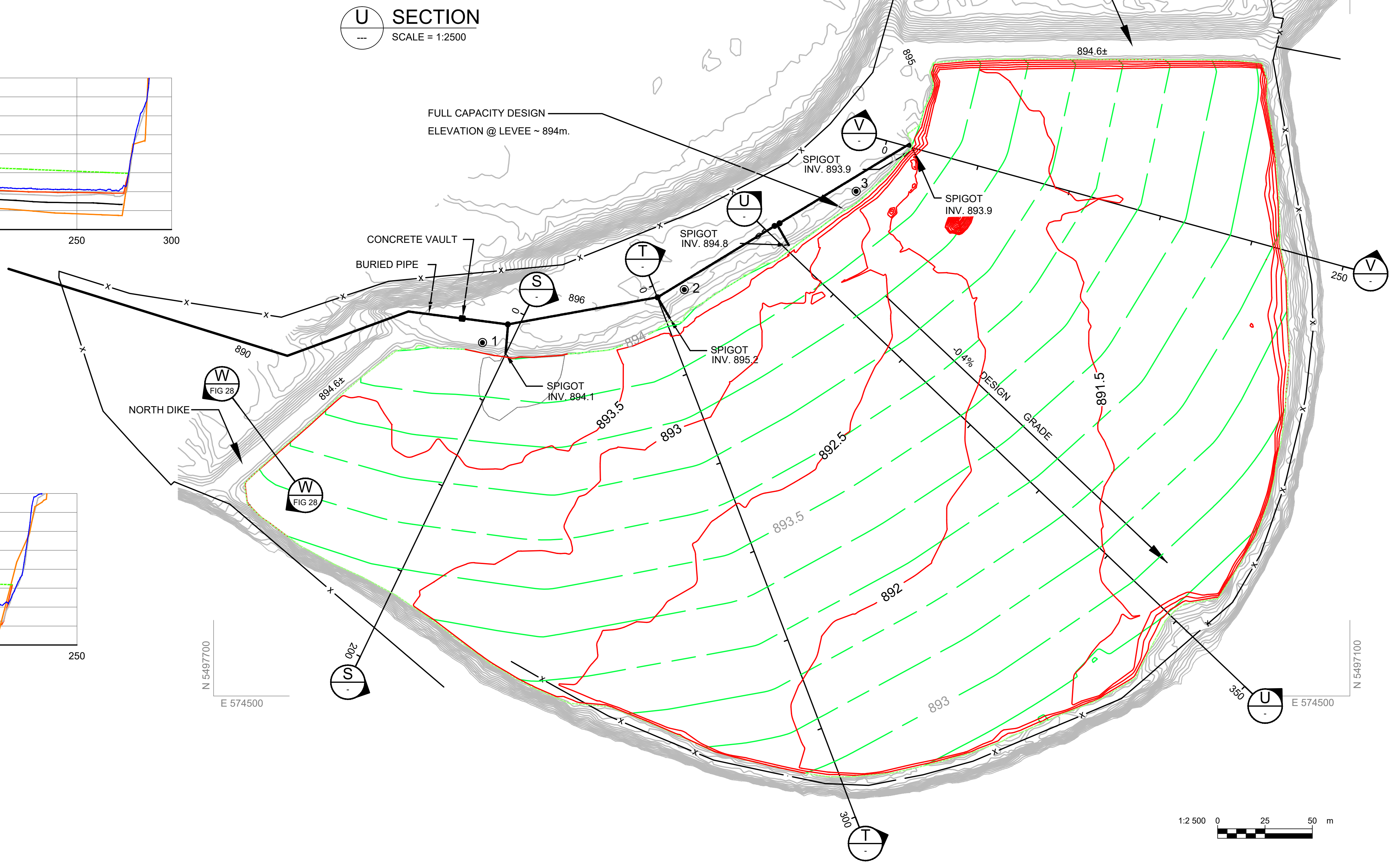
T SECTION
SCALE = 1:2500

VOLUME SUMMARY

2001 SURVEY TO FULL POOL @ 0.4% GRADIENT	~ 278,000 cu.m.
2001(MAY 8) SURVEY TO 2009(SEPT 18)	~ 52,430 cu.m.
2012 LIDAR SURFACE TO FULL POOL	~ 182,550 cu.m.
2015 SURFACE TO FULL POOL	~ 163,630 cu.m.



V SECTION
SCALE = 1:2500



LEGEND:

LOCATION AND DIRECTION OF PHOTOGRAPHS TAKEN DURING 2015 INSPECTION

PHOTO NUMBER

8.01

LOCATION WHERE PHOTO WAS TAKEN

DIRECTION OF VIEW

- 2001 SURFACE
- 2009 SURVEY
- 2012 LIDAR SURVEY
- 2015 SURVEY (INTERVAL 0.5m)
- 2019 LIDAR SURVEY
- FULL POOL DESIGN SURFACE (INTERVAL 0.25m)
- FULL POOL PERIMETER (128,500 sq.m.)
- ● DENOTES SHUT OFF STANDPIPE
- ◉ 1 CONTROL MONUMENT PLACED 2015

NOTES:

1. SLUDGE IMPOUNDMENT LAYOUT AND CROSS SECTIONS PROVIDED BY TM TECH SERVICES, DRAWING NO. K101A2243 DATED SEPTEMBER 9 2015.
2. EXCESS SLUDGE AT SPIGOT NO. 1 RELOCATED OCTOBER 27, 2015.

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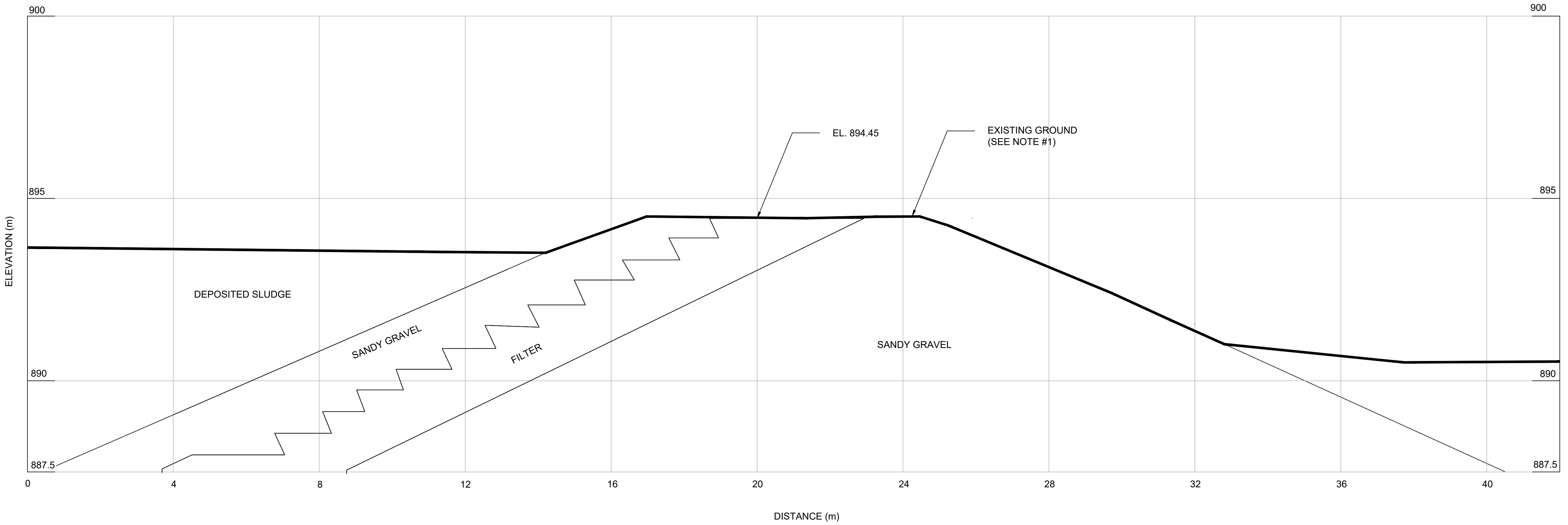
PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
SLUDGE IMPOUNDMENT DIKES PLAN

PROJECT No.
A05807A19

FIG No.
FIGURE 27

KCC-D-8



V - SECTION

SCALE = 1:125

NOTES:

1. SURFACE TOPOGRAPHY FROM LIDAR PROVIDED BY TECK METALS LTD. DATED DECEMBER 2012.
2. SUBSURFACE LITHOLOGY TRACED FROM 1978 CONSTRUCTION ACTIVITIES SLUDGE STORAGE POND - STAGE I DYKES.

1:125 0 1.25 2.5 m

CLIENT

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Klohn Crippen Berger

PROJECT

SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE

SLUDGE IMPOUNDMENT DIKES
SECTION V

PROJECT No.
A05807A19

FIG No.
FIGURE 28

Z:\ACGY\Alberta\A05807A19 TML 2019 Sullivan Mine DSI\400 Drawings\DSI Report (Updated Sections)\Figure 28_Sludge Impoundment Sections.dwg Layout=17 October 21, 2019 12:32:42 PM

KCC-D-B

APPENDIX I

2019 Dam Safety Inspection Forms

TML Sullivan Inpsection Checklist

ARD Pond - South Dam

Date: 2019-05-22

Inspected by: PF, BC, PB

Weather: Mostly sunny ~10°C

Pond Elevation:

Snow Cover? YES / [✓ NO]

Operational Limits: 1035 m to 1046.5 m

Inspection Item	Remarks
Dam Crest Surface	
Cracks	none
Erosion	none
Settlement/Depressions	none
Vegetation growth	~~well covered~~
Animal Activity (burrows)	~~none, animal trail on left abutment~~
Any unusual conditions	none
Ponding of water	none
Dam Upstream Slope	
Slope protection (riprap)	good
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	sporadic grass/weeds / shrubs
Animal Activity (burrows)	none
Any unusual conditions	none
Dam Downstream Slope and Toe	
Slope protection (grass)	well grassed
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	well grassed, sporadic weeds
Animal Activity (burrows)	animal trail on left abutment
Any unusual conditions	

TML Sullivan Inpsection Checklist

ARD Pond - North Dam

Date: 2015-05-22

Weather: Mostly Sunny 10+ °C

Snow Cover? YES / [✓ NO]

Inspected by: PF, DC, BB

Pond Elevation:

Operational Limits: 1035 m to 1046.5 m

Inspection Item	Remarks
Dam Crest Surface	
Cracks	none
Erosion	none
Settlement/Depressions	none
Vegetation growth	grassed / no trees
Animal Activity (burrows)	none
Any unusual conditions	none
Ponding of water	none
Dam Upstream Slope	
Slope protection (riprap)	good some woody debris
Surface erosion/gullying	minor
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	minor
Animal Activity (burrows)	none
Any unusual conditions	—
Dam Downstream Slope and Toe	
Slope protection (grass)	well grassed
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	grass, spur
Animal Activity (burrows)	some small burrowing
Any unusual conditions	

TML Sullivan Inpsection Checklist

No. 1 Siliceous

Date: 2019-05-22

Inspected by: PF, BC, PB

Weather: Mostly sunny, 15 °C

Pond Elevation: n/a

Snow Cover? YES / NO

Operational Limits: 1035 m to 1046.5 m

Inspection Item	Remarks
Dam Crest Surface	
Cracks	didn't observe, not accessibl
Erosion	
Settlement/Depressions	
Vegetation growth	
Animal Activity (burrows)	
Any unusual conditions	
Ponding of water	
Dam Upstream Slope	
Slope protection (riprap)	Same elevation as dam crest no ~~distinctt~~ distinct ~~sp~~ slope.
Surface erosion/gullying	
Slides or sloughing	
Settlement/Depressions	
Bulging	
Cracks	
Vegetation growth	
Animal Activity (burrows)	
Any unusual conditions	
Dam Downstream Slope and Toe	
Slope protection (grass)	good
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	none
Animal Activity (burrows)	none
Any unusual conditions	none

TML Sullivan Inpsection Checklist

No. 2 Siliceous

Date: 22-May-2019

Weather: Sunny +15°C

Snow Cover? YES / [✓ NO]

Inspected by: PF, BC, PB

Pond Elevation: n/a

Operational Limits: 1035 m to 1046.5 m

Inspection Item	Remarks
Dam Crest Surface	
Cracks	none
Erosion	none
Settlement/Depressions	none
Vegetation growth	grassed
Animal Activity (burrows)	none
Any unusual conditions	none
Ponding of water	none
Dam Upstream Slope	
Slope protection (riprap)	grass
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	none
Animal Activity (burrows)	none
Any unusual conditions	none
Dam Downstream Slope and Toe	
Slope protection (grass)	none
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	none
Animal Activity (burrows)	normal
Any unusual conditions	none.

TML Sullivan Inpsection Checklist

No. 3 Siliceous

Date: 22-May-2019

Inspected by: PF/BC/PB

Weather: sunny +15°C

Pond Elevation: —

Snow Cover? YES / NO

Operational Limits: 1035 m to 1046.5 m

Inspection Item	Remarks
Dam Crest Surface	
Cracks	none
Erosion	none
Settlement/Depressions	none
Vegetation growth	grassed
Animal Activity (burrows)	none
Any unusual conditions	none
Ponding of water	none
Dam Upstream Slope	
Slope protection (riprap)	grass
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	none
Animal Activity (burrows)	none
Any unusual conditions	none
Dam Downstream Slope and Toe	
Slope protection (grass)	heavy grass, minor shrubs
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	none
Animal Activity (burrows)	none
Any unusual conditions	two artesian wells found ~~[illegible]~~ along si/ 2/3

TML Sullivan Inpsection Checklist

East Gypsum

Date: 23-May-2019

Inspected by: PF/BC/PB

Weather: +19°C, mostly sunny

Pond Elevation: n/a

Snow Cover? YES / [✓ NO]

Operational Limits: 10~~35 m to 1046.5~~ m

Inspection Item	Remarks
Dam Crest Surface	
Cracks	none
Erosion	none
Settlement/Depressions	none
Vegetation growth	grassed / access road
Animal Activity (burrows)	none
Any unusual conditions	none
Ponding of water	none
Dam Upstream Slope	
Slope protection (riprap)	N/A
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/Depressions	N/A
Bulging	N/A
Cracks	N/A
Vegetation growth	reclaimed + grassed
Animal Activity (burrows)	none
Any unusual conditions	none
Dam Downstream Slope and Toe	
Slope protection (grass)	heavy grass
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	heavy grass, some shrubs, no trees
Animal Activity (burrows)	ground squirrels, badgers, large holes all along toe
Any unusual conditions	none.

TML Sullivan Inpsection Checklist

West Gypsum

Date: 22-May-2019

Inspected by: PF/BC/PB

Weather: +19°C, mostly sunny

Pond Elevation: n/a

Snow Cover? YES / [✓ NO]

Operational Limits: 10~~35 m to 1046.5~~ m

Inspection Item	Remarks
Dam Crest Surface	
Cracks	none
Erosion	none
Settlement/Depressions	none
Vegetation growth	grassed
Animal Activity (burrows)	none
Any unusual conditions	none
Ponding of water	none
Dam Upstream Slope	
Slope protection (riprap)	N/A
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/Depressions	N/A
Bulging	N/A
Cracks	N/A
Vegetation growth	reclaimed + grassed
Animal Activity (burrows)	none
Any unusual conditions	none
Dam Downstream Slope and Toe	
Slope protection (grass)	heavy grass, minor shrubs
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	heavy grass, no trees
Animal Activity (burrows)	some, less than 2018, backfilling seems to be working.
Any unusual conditions	none

TML Sullivan Inpsection Checklist

Northeast Gypsum Dike

Date: 23-May-2019

Weather: +25°C

Snow Cover? YES / [✓ NO]

Inspected by: PB/PF

Pond Elevation: —

Operational Limits: ~~1035 m to 1046.5 m~~

Inspection Item	Remarks
Dam Crest Surface	
Cracks	none
Erosion	minor, likely animals
Settlement/Depressions	none
Vegetation growth	grass, minor shrubs
Animal Activity (burrows)	none
Any unusual conditions	none
Ponding of water	none
Dam Upstream Slope	
Slope protection (riprap)	gravel, ok, some animal tracks
Surface erosion/gullying	→ from animal activity, minor
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	none
Animal Activity (burrows)	minor, grass, largely bare
Any unusual conditions	none
Dam Downstream Slope and Toe	
Slope protection (grass)	heavy grass
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	heavy grass
Animal Activity (burrows)	none, signs of wolf/coyote (tracks scat)
Any unusual conditions	none

TML Sullivan Inpsection Checklist

Iron Dike

Date: 2019-05-22

Inspected by: PF, BC, PB

Weather: Mostly Sunny, 10+°C

Pond Elevation:

Snow Cover? YES / NO

Operational Limits: 1035 m to 1046.5 m

Inspection Item	Remarks
Dam Crest Surface	
Cracks	none
Erosion	none
Settlement/Depressions	none
Vegetation growth	heavily grassed
Animal Activity (burrows)	none
Any unusual conditions	none
Ponding of water	none
Dam Upstream Slope	
Slope protection (riprap)	fine
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	none
Animal Activity (burrows)	none
Any unusual conditions	none
Dam Downstream Slope and Toe	
Slope protection (grass)	good, well grassed
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	good
Animal Activity (burrows)	none
Any unusual conditions	none

TML Sullivan Inpsection Checklist

Old Iron Dike

Date: 23-May-2019

Weather: +24°C, sunny

Snow Cover? YES / [✓ NO]

Inspected by: PF/PB

Pond Elevation: n/a

Operational Limits: ~~1035 m to 1046.5 m~~

Inspection Item	Remarks
Dam Crest Surface	
Cracks	none
Erosion	none
Settlement/Depressions	none
Vegetation growth	minor, gravelled road
Animal Activity (burrows)	none
Any unusual conditions	none
Ponding of water	none
Dam Upstream Slope	
Slope protection (riprap)	grass, ok
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	none
Animal Activity (burrows)	heavy grass, small shrubs
Any unusual conditions	none
Dam Downstream Slope and Toe	none
Slope protection (grass)	well grassed
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	heavy grass, small shrubs
Animal Activity (burrows)	none
Any unusual conditions	none

TML Sullivan Inpsection Checklist
Calcine

Date: 23-May-2019

Weather: +24°C, sunny

Snow Cover? YES / [✓ NO]

Inspected by: PF, PBI

Pond Elevation:

Operational Limits: ~~1035 m to 1046.5 m~~

Inspection Item	Remarks
Dam Crest Surface	
Cracks	none
Erosion	minor, may be animals
Settlement/Depressions	none
Vegetation growth	minor
Animal Activity (burrows)	minor, no burrows
Any unusual conditions	none
Ponding of water	none
Dam Upstream Slope	
Slope protection (riprap)	
Surface erosion/gullying	
Slides or sloughing	
Settlement/Depressions	
Bulging	no U/S slope
Cracks	same elevation
Vegetation growth	as dam crest
Animal Activity (burrows)	
Any unusual conditions	
Dam Downstream Slope and Toe	
Slope protection (grass)	bare gravel, minor shrubs
Surface erosion/gullying	minor, along trails
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	~~none~~ minor
Animal Activity (burrows)	trails only
Any unusual conditions	none

TML Sullivan Inpsection Checklist

Sludge Impoundment - South

Date: 23-May-2019
Weather: +23°C, sunny
Snow Cover? YES / [✓ NO]
Inspected by: PF/PB
Pond Elevation: n/a
Operational Limits: ~~1035 m to 1046.5~~ m

Inspection Item	Remarks
Dam Crest Surface	
Cracks	none
Erosion	none
Settlement/Depressions	right abutment is below dam crest from ramp
Vegetation growth	minor
Animal Activity (burrows)	9 small burrows on crest noted
Any unusual conditions	none
Ponding of water	none
Dam Upstream Slope	
Slope protection (riprap)	ok
Surface erosion/gullying	minor erosion gully
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	minor shrubs, clearing in 2018
Animal Activity (burrows)	none
Any unusual conditions	none
Dam Downstream Slope and Toe	
Slope protection (grass)	heavy grass, shrubs, stumps
Surface erosion/gullying	minor
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	heavy grassed, major clearing in 2018
Animal Activity (burrows)	none
Any unusual conditions	none

TML Sullivan Inpsection Checklist

Sludge Impoundment - North

Date: 23-May-2019

Weather: +24 °C Sunny

Snow Cover? YES / [✓ NO]

Inspected by: PF/PB

Pond Elevation: n/a

Operational Limits: ~~1035 m to 1046.5 m~~

Inspection Item	Remarks
Dam Crest Surface	
Cracks	—
Erosion	—
Settlement/Depressions	—
Vegetation growth	minor grass, clearing in 2018
Animal Activity (burrows)	—
Any unusual conditions	—
Ponding of water	—
Dam Upstream Slope	
Slope protection (riprap)	ok
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	grass, small shrubs
Animal Activity (burrows)	none
Any unusual conditions	none
Dam Downstream Slope and Toe	
Slope protection (grass)	grass, stumps, small shrubs
Surface erosion/gullying	none
Slides or sloughing	none
Settlement/Depressions	none
Bulging	none
Cracks	none
Vegetation growth	none
Animal Activity (burrows)	none
Any unusual conditions	Clearing in 2018 made slope much more visible.

APPENDIX II

Photographs

Appendix II
Photographs

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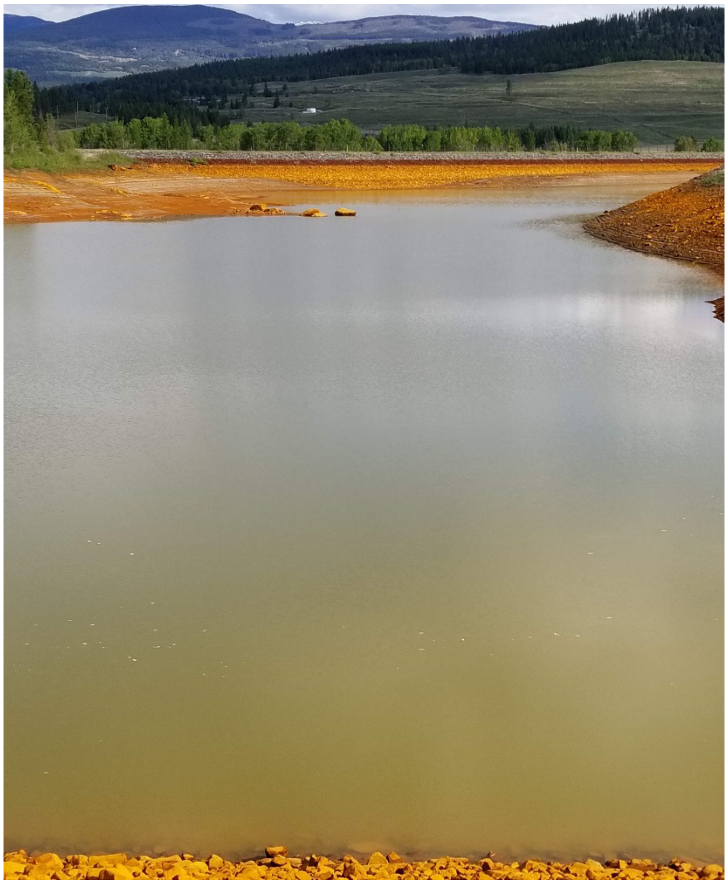

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APPENDIX III

2019 Instrumentation Monitoring

Appendix III

Quantifiable Performance Objectives and 2019 Instrumentation Monitoring

III.1 QUANTIFIABLE PERFORMANCE OBJECTIVES

Quantifiable Performance Objectives (QPOs) have been established for all of the instrumentation and for the freeboard under normal operating conditions for those tailings facilities which have ponds, i.e., ARD Pond and Iron Pond. The QPOs are discussed below.

III.1.1 Piezometric

Pneumatic, standpipe and vibrating wire piezometers are all used at site to monitor phreatic surfaces within the tailings facilities and foundations. The notification levels established for the piezometers, required monitoring frequency and current readings are summarized in Section III.2 Table AIII.3

The following is required when a notification level is reached for a single instrument:

- Data, data reductions, and calculations are checked for accuracy and correctness.
- If no errors are found in the calculations, the Mine Manager is notified that an anomalous reading has been observed and that further assessment must be conducted. The EOR is notified at this time. The EOR will evaluate data for reliability, review data within the general vicinity of the individual instrument. The EOR may require the following:
    - Check of readout equipment to verify that it is functioning correctly and to verify calibration.
    - Re-read instrument and other nearby instruments for confirmation.
    - Adjust on-going monitoring frequency as required.
- If it is observed that an instrument or piece of readout equipment has stopped functioning, the Mine Manager and subsequently the EOR should be notified immediately. If considered critical, a replacement instrument should be installed.

If several instruments within an area of the dikes or dams are observed to exceed the notification levels then the following is required:

- The Mine Manager and EOR should be notified within 24 hours.
- Monitoring frequency will be increased as needed based on assessment of common trend.
- EOR to assess the dam integrity and may recommend analyses, site visit or implementation of remedial actions as required.

III.1.2 Settlement

There are several methods used to monitor settlement at the Sullivan Mine tailings facilities. These include settlement plates, Sondex settlement gauges, and surveys.

Notification levels have been established for the various settlement measurements. These are summarized along with survey results and required monitoring frequency in Section III.2 Table AIII.4.

The following response is required when the notification level is exceeded at one instrument:

- Notify EoR within 24 hours upon verification of reading exceedance.
- EoR to evaluate data for reliability, and review survey data within the general vicinity of the individual survey monument in question. EoR may recommend repeat measurement and increased on-going monitoring frequency.

If more than one instrument within the facility indicates exceedance of the notification level then the following is required:

- Notify EoR within 24 hours upon verification of reading exceedance.
- Repeat reading within 1 week.
- EoR to assess dam integrity and may recommend analyses, site visit or other action.

III.1.3 Lateral Movement

There is one inclinometer installed in the East Gypsum Dike to monitor lateral movements. A notification level has been established for the inclinometer and is provided along with the required monitoring frequency in Section III.2 Table AIII.4.

The following response is required when the notification level is exceeded:

- Data reductions are checked for accuracy and correctness.
- EoR to evaluate data for reliability, and review other instrumentation in vicinity of the slope inclinometer. Repeat measurement and/or measurement of other instruments may be recommended.
- EoR to assess dam integrity and may recommend analyses, site visit or other action.

III.1.4 Seepage

There are 4 weirs installed to measure seepage from the ARD Pond South Dam and the Iron Dike. Notification levels have been established and are provided along with the required monitoring frequency in Section III.2 Table AIII.5.

The following response is required when the notification level is exceeded:

- Data and data reductions are checked for accuracy and correctness.
- EoR to evaluate data for reliability and review other instrumentation in the vicinity. Repeat measurement and/or measurement of other instruments may be recommended.
- EoR to assess dam integrity and may recommend analyses, site visit or other action.

III.1.5 Freeboard

There are three notification levels which have been set for the ARD Pond and the Iron Pond, which are provided in Section III.2 Table AIII.6.

Notification Level 1 indicates when the pumps should be started to transfer water to either the Drainage Water Treatment Plant (ARD Pond) or to the ARD Pond (Iron Pond).

Notification Level 2 indicates when water levels are approaching maximum operating levels. When Notification Level 2 is met or exceeded, transfer of water should continue as well as notifying the EOR and minimizing inflows. For the ARD Pond this could include diverting 3700/39000 to the Iron Pond and for the Iron Pond, stop pumping to the Iron Pond and divert runoff if possible.

Notification Level 3 indicates when water levels are within 0.5 m of the spillway inverts. When Notification Level 3 is met or exceeded, continue with transfer of water, minimizing inflows, notification of the EOR and notify MEMPR/MOE of potential spill as well as enacting Emergency Preparedness and Response Plan (EPRP).

III.1.6 Visual Inspections

As part of the QPOs, a series of regularly scheduled inspections is required to ensure that the tailings facilities are operating as intended and to identify problems and issues so that necessary corrective actions may be implemented in a timely manner. The main types of inspections are as follows:

- routine inspections (performed by Teck staff);
- event driven inspections (performed by Teck staff, and the Engineer of Record depending on the event);
- annual Inspection (performed by the Engineer of Record); and
- dam safety review (performed by an independent and qualified professional engineer).

Routine Visual Inspections

Routine visual inspections are performed by Teck staff and documented using one of the standard inspection forms, which are included in Appendix E of the OMS Manual. Two types of forms are provided: one for Weekly/Bi-weekly inspections and forms for Monthly/Annual inspections.

The minimum visual inspection frequency for each of the structures can be found in Table III.1.

Table III.1 Visual Inspection Requirements for the Dikes and Dams at Sullivan Mine

Dike		CDA Classification	Pond Elevation	Visual Inspection Requirements
ARD Pond Dikes		Very High	< 1040 m	Monthly
			>1040 m	Weekly (a Monthly Inspection form must be filled in once per week if pond is high for an extended period of time, i.e. greater than one month)
Iron Dike (STA 0+00 to 10+00)		High	N/A	Monthly
Iron Dike (STA 10+00 to end of dam)		High	N/A^{*1}	Annually
Old Iron TSF	Old Iron Dike	Low	N/A^{*1}	Annually
	Iron TSF Divider Dike	Low		
Siliceous Cell Dikes #1, #2 and #3		Low		Annually
Gypsum TSF	West Gypsum Dike	High		Annually
	East Gypsum Dike	High		
Northeast Gypsum Dike and Recycle Dam		Low		Annually
Calcine Dike		Low		Annually
Sludge Pond		Low	N/A	Bi-Weekly during DWTP operations otherwise Annually

The following is a list of general information that should be recorded (monthly and annual inspections):

- signs of depressions and/or movements of the downstream dam/dike slope;
- general condition of the dam/dike crest, toe, and faces, looking for settlement, erosion, seepage, cracking, animal burrows, vegetation growth or other abnormal conditions;
- water levels in active ponds;
- depth of flow in spillways (record zero flow in spillway as 0.0 m^3);
- issues related to blockage and inadequate capacity of spillway channels; and
- seepage noting change in flow rate and visual cloudiness and any new seepage.

Documentation of the routine inspections should be submitted to the Mine Manager following each inspection. If any maintenance requirements or anomalies are identified during the inspection, these must be identified to the mine manager.

The annual routine inspection by Teck staff should be planned such that it does not coincide with the annual inspection performed by the Engineer of Record. The annual routine inspection should include photographs of key features and any potential dam/dike safety concerns.

The completed inspection forms are stored in an electronic data base system, and hard copies of the inspection forms are catalogued and stored at Sullivan Mine.

Event Driven Inspections

In addition to routine inspections, special inspections may be required for significant seismic or climatic events, or anomalous instrumentation readings. Table III.2 presents the specific inspections to be carried out following specified events. All events involve immediate inspection by Teck staff, followed if required by notification to or inspection by the Engineer of Record.

Table III.2 Event Driven Inspections

Item	Event	Action	Comment
Embankments	Earthquake M5 or bigger within 100 km	Immediate inspection by Teck staff	Call the Engineer of Record if damage is noted
		Read all instruments within one week	Send instrument data to the Engineer of Record
	Earthquake M6 or bigger within 100 km	Inspection by the Engineer of Record Read all instruments	
	Rainfall (50 year event): 6 hour > 40 mm 24 hour > 56 mm Snowpack (50 year event): Accumulated snow water equivalent > 360 mm	Check and record water ponding Check dam toe seepage daily Drawdown water level if necessary	
	DWTP water delivery system fails	Check water level in the ARD Pond and Iron Pond daily Check rainfall daily Prepare standby pumps if required	Call the Engineer of Record if one pond is more than 75% full
	Instability or noticeable deformation, displacement of riprap.	Inspection by the Engineer of Record	
Surface Water Conveyance System	Rainfall (50 year event): 6 hour > 40 mm 24 hour > 56 mm Snowpack (50 year event): Accumulated snow water equivalent > 360 mm	Check and record water flow and ponding Check channels for debris Check channels for damage to riprap lining	

Annual Inspections

Annual inspections shall be carried out by the Engineer of Record for the tailings facilities for Sullivan Mine. The objective of the annual inspection is to confirm the routine inspections carried out, and to carry out a review of the conditions of the facilities and facility operation. The site water balance is reviewed to confirm the inputs and assumptions are still valid according to the current conditions.

The Engineer of Record issues an annual inspection report to the Mine Manager containing observations and recommendations. This report provides information to be used to revise the operation, maintenance and surveillance programs as necessary and to assist in planning for future operation of the facility. The annual inspection reports are issued to the British Columbia Ministry of Environment (BC MOE) by March 31 each year (as stated in Permit No. 74). Copies of the annual inspection report are to be stored at Sullivan Mine.

III.2 INSTRUMENT DATA SUMMARY

The lists of active instruments and measurement points, along with alarm notification levels and maximum readings from the 2019 DSI reporting period, are shown in Tables AIII.3, AIII.4, AIII.5, and AIII.6. Updated instrument readings were provided to KCB by Vast Resources (Vast), WSP and Teck staff on several occasions from September 2018 to August 2019. Daily, then weekly readings of several selected instruments were taken during the year to better identify potential trends. Vast of Cranbrook, British Columbia is contracted by Teck to read the pneumatic and standpipe piezometers, and WSP to survey the settlement plates and dike crests. The daily/weekly readings for the weirs and ARD Pond standpipes were performed by Teck staff. KCB also selectively read several standpipes during the DSI site visit. Copies of the plots that were produced for each impoundment area are included in Appendix IV through Appendix X.

Table AIII.3 Active Piezometers – Iron TSF

Group Designation	Piezometer No.	Northing	Easting	Elevation Ground (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing (m)	General Location	Instrument Type	Recommended Reading Frequency	Notification Level (m)	Max Measured Piezometer Level In 2019^1 (m)	Max 2019 Level Relative To 2018	Comment
Iron TSF													
Line 6+00	P91 – 1	5500541.5	576470.5	1037.3	N/A	1023.0	Dike	Pneumatic	Three times a year (spring, summer and fall)	1028.4	1024.6 (31 October 2018)	↓	
	P91 – 2A	5500512.5	576459.9	1029.7	N/A	1020.1	Road	Pneumatic		1026.9	1024.0 (11-Dec-2018)	↓	
	P91 – 2B	5500511.9	576462.4	1029.3	N/A	1021.5	Road	Pneumatic		1026.9	1024.1 (31-Oct-2018)	↓	
Line 16+00	SB – P15	5500739.4	576803.0	1033.9	N/A	1029.0	Iron TSF	Pneumatic		1036.2	1033.6 (31-Oct-2018)	↓	
	P91 – 3A	5500660.4	576707.5	1038.4	N/A	1008.6	Dike	Pneumatic		1024.8	1023.9 (31-Oct-2018)	↓	
	P91 – 3B	5500661.3	576708.4	1038.3	N/A	1023.7	Dike	Pneumatic		1025.8	1023.7 (31-Oct-2018)	↓	Dry
	P91 – 3C	5500660.4	576709.0	1038.9	N/A	1021.3	Dike	Pneumatic		1025.8	1022.2 (31-Oct-2018)	↓	
	P91 – 4	5500630.6	576730.8	1031.5	N/A	1017.2	Bench	Pneumatic		1022.0	1020.7 (31-Oct-2018)	↓	
	P92 – 20	5500593.9	576760.7	1033.0	N/A	1010.4	Bench	Pneumatic		1015.9	1015.3 (31-Oct-2018)	↓	Near Notification level. Recent reading lower.
	P92 – 21	5500595.8	576762.3	1033.0	N/A	1012.2	Bench	Pneumatic		1015.9	1015.7 (31-Oct-2018)	↓	Near Notification level. Recent reading lower.
Line 24+00	P91 – 5A	5500482.1	576931.7	1039.7	N/A	1017.7	2400 Bench at Dike	Pneumatic		1031.8	1031.3 (31-Oct-2018)	↓	Near Notification level. Recent reading lower.
	P91 – 5B	5500786.8	576930.2	1039.7	N/A	1026.7	2400 Bench at Dike	Pneumatic		1030.0	1027.7 (31-Oct-2018)	↔	
	P91 - 6	5500752.7	576941.0	1031.5	N/A	1020.5	2400 Bench at Dike	Pneumatic		1023.6	1023.5 (31-Oct-2018)	↔	Near Notification level. Recent reading lower.
Line 30+00	P92 – 1	5500893.9	577066.3	1035.1	N/A	1021.1	91 Dike	Pneumatic		1033.0	1031.9 (4-Apr-2019)	↑	
	P92 – 2	5500865.9	577113.8	1028.6	N/A	1024.0	Slope	Pneumatic	Monthly	1027.8	1026.9 (26-Nov-2018)	↓	
Line 38+00	P92 – 6	5501125.1	577156.5	1042.1	N/A	1024.2	91 Dike	Pneumatic	Three times a year (spring, summer and fall)	1033.6	1032.4 (31-Oct-2018)	↓	
	P92 – 7	5501118.0	577174.9	1040.2	N/A	1029.6	Slope	Pneumatic		1032.7	1030.9 (31-Oct-2018)	↓	
	P92 – 9	5501097.9	577314.6	1029.9	N/A	1025.3	Toe	Pneumatic		1028.4	1027.9 (4-Apr-2019)	↓	Near Notification level. Recent reading lower.
Line 42+00	P92 – 11	5501217.8	577335.4	1031.5	N/A	1025.0	Toe	Pneumatic		1028.4	1026.3 (31-Oct-2018)	↓	
	P91 – 11A	5501258.1	577172.2	1042.4	N/A	1027.0	91 Dike	Pneumatic		1036.7	1034.5 (31-Oct-2018)	↑	
	P91 – 11B	5501258.1	577172.2	1042.3	N/A	1029.9	91 Dike	Pneumatic		1036.7	1033.9 (4-Apr-2019)	↓	
	P91 – 12	5501209.4	577418.1	1040.9	N/A	1029.7	Slope	Pneumatic		1034.5	1033.8 (31-Oct-2018)	↔	
	P92 - 16	5501237.6	577246.4	1037.3	N/A	1027.6	Slope	Pneumatic		1030.6	1029.9 (8-Jul-2019)	↑	

Group Designation	Piezometer No.	Northing	Easting	Elevation Ground (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing (m)	General Location	Instrument Type	Recommended Reading Frequency	Notification Level (m)	Max Measured Piezometer Level In 2019[1] (m)	Max 2019 Level Relative To 2018	Comment
Iron TSF													
Line 45+00	P92 - 13	5504074.8	577182.3	1040.5	N/A	1031.3	91 Dike	Pneumatic		1037.3	1034.6 (31-Oct-2018)	↓	
	P92 - 14	5504071.7	577199.9	1037.4	N/A	1029.6	Slope	Pneumatic		1036.8	1034.5 (31-Oct-2018)	↔	
	P92 - 15	5501320.2	577314.9	1030.3	N/A	1029.0	Toe	Pneumatic		1030.3	1029.0 (31-Oct-2018)	↓	
Line 54+00	P5	5501660.5	577228.4	1039.1	1041.6	1037.4	Toe at Siliceous Cell #1	Standpipe	Annually	1039.5	1038.9 (4-Apr-2019)	↓	
Toe Piezometers	P92 – H	5500665.1	576891.7	1025.6	N/A	998.1	21+00	VWP	Remotely monitored (hourly readings). Review data monthly.	1032.0	1026.2 (12-Nov-2018)	↓	
	P92 – 25	5500806.7	577125.8	1022.9	N/A	999.0	28+00	Pneumatic	Monthly	1032.0	1029.5 (4-Apr-2019)	↓	
	P92 – 26	5500550.3	576802.5		1019.8	1009.1	16+00	Standpipe	Three times a year (spring, summer and fall)	1015.0	1014.4 (4-Apr-2019)	↔	

Notes:

1. Water levels are considered equal if differences are smaller than 0.1 m., 2. 2018 reporting period runs from October 1, 2018 to August 31, 2019.

Table AIII.3 Active Piezometers – Old Iron TSF

Group Designation	Piezometer No.	Northing	Easting	Ground Elevation (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing (m)	General Location	Instrument Type	Recommended Reading Frequency	Notification Level	Max Measured Piezometer Level In 2019[1]	Max 2019 Level Relative To 2018	Comment
Old Iron TSF													
Old Iron Dike	P93 – 17	5500680.3	575451.9	1043.0	1043.0	1025.8	Dike	Standpipe	Three times a year (spring, summer and fall)	1037.3	1036.6 (31-Oct-2018)	↓	Near Notification level. Recent reading lower.
	P93 – 18	5500701.7	575475.6	1044.4	1044.7	1028.3	Dike	Standpipe		1039.0	1038.5 (31-Oct-2018)	↓	Near Notification level. Recent reading lower.
	~~P96 – 08~~	-	-	-	~~N/A~~	~~Unknown~~	~~MCE Buttress~~	~~Pneumatic~~		~~2.6[2]~~	-	-	Replaced with new vibrating wire piezometer in 2018.
	~~P96 – 11~~	~~Not available~~	~~Not available~~	~~Not available~~	~~Not available~~	~~Not available~~	~~MCE Buttress~~	~~Pneumatic~~		~~-1.5~~	-	-	Slow leak, erratic data, replaced with new vibrating wire piezometer in 2018.
	P96 – 12				N/A	Unknown	MCE Buttress	Pneumatic		0.9[2]	0.2 m (4-Apr-2019)	↓	
	SUL-OID-VWP-18-01 A&B	5500688.4	575449.2	1043.4	Tip A:	1025.8	MCE Buttress	VWP	Remotely monitored (hourly readings). Review data monthly.	Pending review	1037.3 (12-Nov-2018)	N/A	August 2018 install, replaced P96-08
					Tip B:	1036.5		VWP		Pending review	1036.7 (12-Nov-2018)	N/A	
	SUL-OID-VWP-18-02 A&B	5500633.2	575431.2	1040.1	Tip A:	1016.6	MCE Buttress	VWP		Pending review	1035.0 (12-Nov-2018)	N/A	August 2018 install, replaced P96-11
					Tip B:	1035.5		VWP		Pending review	1035.5 (8-Dec-2018)	N/A	
Iron TSF Divider Dike	P93 – 19	5500962.3	575892.0	1042.6	1043.6	1025.6	Dike	Standpipe	Annual	1040.15	1039.8 (4-Apr-2019)	↓	Dike is fully buttressed. P93-19 (near Notification level) and P93-20 are read to provide U/S info for Old Iron Dike.
	P93 – 20	5501191.4	575943.2	1044.1	1045.3	1026.4	Dike	Standpipe		1041.25	1040.6 (4-Apr-2019)	↓	

Notes:

1. Water levels are considered equal if differences are smaller than 0.1 m., 2. 2018 reporting period runs from October 1, 2018 to August 31, 2019.
2. Installation elevation not known.

Table AIII.3 Active Piezometers – Siliceous TSF

Group Designation	Piezometer No.	Northing	Easting	Ground Elevation (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing (m)	General Location	Instrument Type	Recommended Reading Frequency	Notification Level	Max Measured Piezometer Level In 2019[1]	Max 2019 Level Relative To 2018	Comment
Siliceous Dikes													
West Side Siliceous Dike #1	P5	5501660.5	577228.4	1039.1	1041.6	1037.4	Cell #1	Standpipe	P105 and P5 annually unless change > 0.5 m or at notification levels then read all Piezometers	1039.5	1038.9 (4-Apr-2019)	↓	
	SP101	5501176.3	577719.3	1035.4	1036.4	1021.6	Cell #1	Standpipe		1023.9	1021.7 (9-Jul-2019)	↔	
Middle Siliceous Dike #1	P105	5501220.6	577927.9	1033.0	1033.2	1021.3	Cell #1	Standpipe		1022.0	1022.2 (5-Apr-2019)	↑	Max. 2019 reading above notification level. Recent reading also above notification level.
	SP104	5501248.9	577910.8	1035.4	1035.1	1021.1	Cell #1	Standpipe		1022.0	N/A		Blocked at 1031.3
East Side Siliceous Dike #1	SP106	5501410.5	578028.7	1034.1	1034.7	1020.9	Cell #1	Standpipe		1021.4	1021.1 (6-Jun-2019)	↔	Near Notification level
Crest Siliceous Dike #2	P231	5500962.2	577497.5	1031.2	1031.2	1019.5	Cell #2	Standpipe	Annual (Spring)	1022.3	1021.1 (5-Apr-2019)	↓	
	P257	5500971.0	577407.3	1031.3	1030.4	1022.0	Cell #2	Standpipe		1025.0	1023.0 (5-Apr-2019)	↓	
	P91 – 13	5500964.5	577413.7	1029.7	N/A	1020.0	Cell #2	Pneumatic	Three times a year (spring, summer and fall)	1025.0	1022.4 (31-Oct-2018)	↓	
Lines 3+00/7+00 Siliceous Dike #3	P303	5500977.6	577855.0	1029.1	1029.3	1020.9	7+00 Crest	Standpipe	P232, P301 and P303 annually unless change > 0.5 m then read all Piezometers	1022.3	1020.9 (5-Apr-2019)	↔	Dry
	P301	5500973.6	577739.0	1028.1	1029.4	1020.6	3+00 Crest	Standpipe		1022.3	1020.6 (9-Jul-2019)	↔	Dry
	P302	5500963.3	577739.5	1025.7	1027.2	1021.0	3+00 Slope	Standpipe		1021.2	1021.1 (5-Apr-2019)	↑	
	P232	5500968.5	577854.3	1026.7	1027.3	1017.4	7+00 Slope	Standpipe		1019.3	1018.0 (9-Jul-2019)	↔	
	P233	5500959.1	577853.8	1023.6	1024.3	1017.9	7+00 Slope	Standpipe		1019.3	Dry	↔	Dry
	SUL-SD3-VWP-18-06 A&B	5500975.7	577751.2	1029.2	Tip A:	1008.8	3+00 Crest	VWP	Remotely monitored (hourly readings). Review data monthly.	Pending review	1015.2 (12-Nov-2018)	N/A	August 2018 install, replaced P301
					Tip B:	1018.5		VWP		Pending review	Dry	N/A	
	SUL-SD3-VWP-18-07	5500920.1	577753.0	1017.1	Tip A:	1006.1	3+00 Toe	VWP		Pending review	1015.1 (12-Nov-2018)	N/A	August 2018 install, replaced P302
	SUL-SD3-VWP-18-08 A&B	5500985.8	577874.7	1029.6	Tip A:	1009.6	7+00 Crest	VWP		Pending review	1014.8 (12-Nov-2018)	N/A	August 2018 install, replaced P303
					Tip B:	1017.3		VWP		Pending review	1018.2 (12-Nov-2018)	N/A	
	SUL-SD3-VWP-18-09	5500919.4	577852.5	1016.8	Tip A:	1013.4	7+00 Toe	VWP		Pending review	1146.1 (20-Mar-2019)	N/A	Non-functioning
Siliceous Dike #3 East Side	P306	5501100.8	578268.9	1028.4	1029.6	1020.9	Crest	Standpipe	Monthly first 12 months then annual (in Spring)	1028.9	Dry	N/A	Stopped reading in 2004 as dry since 1985. Reinstated 2019. Top of casing to be re-surveyed.
	P307	5501088.7	578278.1	1026.1	1027.0	1020.2	Crest	Standpipe		1020.2	1020.5 (6-Jun-2019)	N/A	Stopped reading in 2004 as dry since 1985. Reinstated 2019. Above notification level. Top of casing to be re-surveyed.
	P308	5501293.0	578310.5	1028.8	1030.0	1020.8	Crest	Standpipe		1020.8	Dry	N/A	Stopped reading in 2004 as dry since 1985. Reinstated 2019. Near notification level. Top of casing to be re-surveyed.
	P311	5501659.8	578325.4	1028.8	1030.0	1022.5	Crest	Standpipe		1022.5	1022.8 (8-Aug-2019)	N/A	Stopped reading in 2004 as dry since 1985. Reinstated 2019. Above notification level.

Group Designation	Piezometer No.	Northing	Easting	Ground Elevation (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing (m)	General Location	Instrument Type	Recommended Reading Frequency	Notification Level	Max Measured Piezometer Level In 2019[1]	Max 2019 Level Relative To 2018	Comment
Siliceous Dike #3	SUL-SD3-P-18-10	5501022.5	578270.0	1018.1	1019.4	1004.8	Toe	Standpipe	Monthly	Pending review	1014.1 (31-Oct-2018)	N/A	August 2018 install
	SUL-SD3-P-18-11	5501452.7	578349.6	1022.1	1023.5	1013.1	Toe	Standpipe		Pending review	1015.6 (1-Apr-2019)	N/A	August 2018 install

Notes:

1. No settlement plate or other instruments are required for long term monitoring of the Siliceous TSF Dikes.
2. Water levels are considered equal if differences are smaller than 0.1 m.
3. 2018 reporting period runs from October 1, 2018 to August 31, 2019.

Table AIII.3 Active Piezometers – Gypsum TSF

Group Designation	Piezometer No.	Northing	Easting	Ground Elevation (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing Elevation (m)	General Location	Instrument Type	Recommended Reading Frequency	Notification Level	Max Measured Piezometer Level In 2019[1]	Max 2019 Level Relative To 2018	Comment
Gypsum TSF													
West Gypsum Dike Line 10+00	P93 – 1	5499811.6	576419.4	1013.8	1014.9	1000.0	Upstream	Standpipe	Three times a year (spring, summer and fall)	1008.0	1004.7 (11-Dec-2018)	↔	
	P93 – 2	5499811.0	576420.9	1014.4	1014.4	996.8	Upstream	Standpipe		1008.0	1004.6 (11-Dec-2018)	↑	
	P93 – 3	5499789.6	576411.6	1017.5	1016.1	998.0	Crest	Standpipe		1008.0	1004.4 (11-Dec-2018)	↓	
	P93 – 4	5499790.2	576409.5	1017.5	1016.4	995.4	Crest	Standpipe		1008.0	1004.4 (11-Dec-2018)	↓	
	P93 – 5	5499751.1	576388.7	1011.1	1011.9	993.3	Downstream	Standpipe		1008.0	995.4 (31-Oct-2018)	↔	
West Gypsum Dike Line 20+00	~~P93 – 6~~	~~5499691.8~~	~~576696.5~~	~~1014.4~~	~~1014.9~~	~~997.9~~	~~Upstream~~	~~Standpipe~~	Three times a year (spring, summer and fall)	~~1008.0~~	-	-	Standpipe blocked at ~ 10.4 m
	P93 – 7	5499670.8	576688.2	1015.3	1016.6	997.2	Crest	Standpipe		1008.0	997.6 (9-Jul-2019)	↓	
	SUL-WG-P-18-03	5499599.9	576662.0	1001.5	1002.9	984.5	Toe	Standpipe	Monthly	Pending review	994.0 (8-Aug-2019)	N/A	August 2018 install
East Gypsum Dike Line 33+00	P93 – 8	5499642.3	577074.1	1017.2	1017.7	1001.9	Upstream	Standpipe	Annual	1010.1	1008.7 (5-Apr-2019)	↓	
	P93 – 9	5499642.6	577072.6	1017.2	1017.8	998.9	Upstream	Standpipe		1010.1	1009.0 (5-Apr-2019)	↓	
	P93 – 10	5499640.6	580423.8	1017.5	1018.0	1002.6	Crest	Standpipe		1009.5	1007.8 (5-Apr-2019)	↓	
	P93 – 11	5499622.5	577071.1	1017.5	1018.0	998.7	Crest	Standpipe		1008.6	1007.2 (9-Jul-2019)	↔	
	P93 – 12	5499583.8	577073.5	1013.5	1013.0	1000.8	Toe	Standpipe		1004.7	1003.9 (5-Apr-2019)	↓	
	SUL-EG-P-18-04	5499537.0	577196.9	1004.6	1005.9	998.1	Toe	Standpipe	Monthly	Pending review	1001.2 (9-May-2019)	N/A	August 2018 install
East Gypsum Dike Line 48+00	P93 – 13	5499669.6	577521.5	1016.8	1017.6	1000.3	Upstream	Standpipe	Annual	1002.5	1000.4 (5-Apr-2019)	↓	
	P93 – 14	5499645.3	577521.9	1017.2	1017.7	1004.3	Crest	Standpipe		1005.6	1004.6 (5-Apr-2019)	↑	Dry, blocked at 13.3 m
	SUL-EG-P-18-05	5499566.3	577527.0	1003.1	1004.5	995.8	Toe	Standpipe	Monthly	Pending review	1000.6 (31-Oct-2018)	N/A	August 2018 install

Notes:

1. Water levels are considered equal if differences are smaller than 0.1 m.
2. 2018 reporting period runs from October 1, 2018 to August 31, 2019.

Table AIII.3 Active Piezometers – ARD Storage Pond

Group Designation	Piezometer No.	Northing	Easting	Ground Elevation (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing Elevation (m)	General Location	Instrument Type	Recommended Reading Frequency	Notification Level	Max Measured Piezometer Level In 2018[1]	Max 2018 Level Relative To 2017	Comment
ARD Storage Pond													
North Dam	PP01-01	5500675.6	575840.0	N/A	N/A	1041.7	North Dam	Pneumatic	Monthly, with additional readings taken weekly when the Pond level is above 1040 masl, or daily when the Pond level is above 1045 masl. The pneumatic piezometers are to be read monthly.	1042.7	Dry	↔	
	PP01-02	5500682.7	575834.9	N/A	N/A	1041.9	North Dam	Pneumatic		1042.7	1042.0 (5-Apr-2019)	↓	Near Notification level. Recent reading lower.
	PP01-03	5500552.0	575738.1	N/A	N/A	1038.8	North Dam	Pneumatic		1039.8	Dry	↔	
	PP01-04	5500549.5	575743.1	N/A	N/A	1040.8	North Dam	Pneumatic		1041.8	1041.2 (5-Apr-2019)	↓	Near Notification level. Recent reading lower.
	ND-01	5500756.6	575907.3	1042.2	1042.7	1032.0	North Abutment	Standpipe		1042.2	1040.4 (5-Apr-2019)	↓	
	ND-02D	5500636.4	575769.0	1042.2	1042.7	1019.5	Toe	Standpipe		1041.5	1039.6 (5-Apr-2019)	↓	
	ND-02S	5500636.3	575768.9	1042.2	1042.7	1040.3	Toe	Standpipe		1041.5	1041.4 (29-Mar-2019)	↓	Near Notification level. Recent reading lower.
	ND-03	5500542.8	575693.1	1038.4	1039.2	1025.1	Toe	Standpipe		1039.2	1038.4 (5-Apr-2019)	↓	
South Dam	PP01-05	5500026.7	575892.8	N/A	N/A	1030.0	South Dam	Pneumatic		1031.0	1030.8 (5-Apr-2019)	↔	Near Notification level.
	PP01-06	5500020.4	575893.4	N/A	N/A	1029.2	South Dam	Pneumatic		1030.5	1030.8 (5-Apr-2019)	↔	Max. 2019 reading above Notification level. Recent reading also above notification level.
	SD-01	5500056.6	576006.3	1041.0	1041.6	1029.6	South Abutment	Standpipe		1041.0	1035.0 (22-Mar-2019)	↓	
	SD-02	5499985.4	575904.0	1029.9	1030.5	1026.9	Toe	Standpipe		1029.9	1029.7 (29-Mar-2019)	↓	Near Notification level.
	SD-03	5499995.4	575737.2	1037.0	1038.1	1036.0	South Abutment	Standpipe		1037.0	1036.9 (22-Mar-2019)	↓	Near Notification level.

Notes:

1. Water levels are considered equal if differences are smaller than 0.1 m.
2. 2018 reporting period runs from October 1, 2018 to August 31, 2019.

Table AIII.4 Active Settlement and Inclinometer Measuring Instruments

Type	Instrument Number	Initial Elevation (m)	Location	Notification Level	Recommended Reading Frequency	Measured Level in 2019 (m)	Comment
Iron Dike							
Settlement plates	SP330[1]	1037.40	2+00	>25 mm over 3 years	Every 3 Years	N/A	Surveyed in 2018. Less than 40 mm of settlement since 2007. Next survey 2021.
	SP331[1]	1042.44	9+00			N/A	Surveyed in 2018. Less than 65 mm of settlement since 2007. Next survey 2021.
	SP332[2]	1041.79	9+00			N/A	Surveyed in 2018. Less than 45 mm of settlement since 2007. Next survey 2021.
	SP 92 – 07	1034.91	16+00			N/A	Surveyed in 2018. Less than 35 mm of settlement since 2007. Next survey 2021.
	SP 99 – 01[3]	1042.07	4+00			N/A	Surveyed in 2018. Less than 45 mm of settlement since 2007. Next survey 2021.
Dike Crest Survey	-	-	0+00 to 12+00 centerline, U/S, D/S dike crest	1042 m	Annually	1042	Recent survey shows elevations greater than or equal to design crest elevation.
Gypsum TSF Dikes							
Settlement plates at West Gypsum Dike	SP97 – 01	1014.592	Line 10+00 Slope	>60 mm over 3 years	Annually	1014.317	Settled 0 mm since 2017. Was not read in 2019.
	SP97 – 05	1015.568	Line 10+00 Crest			1014.599	Settled 23 mm since 2017. Was not read in 2019.
	SP97 – 06	1015.936	Line 20+00 Slope			1015.339	Settled 22 mm since 2017. Was not read in 2019.
Sondex gauge and Inclinometer at West Gypsum Dike	S94 – 01	N/A	Line10+00 Upstream	>90 mm over 3 years	Every 3 Years	N/A	Reading taken in 2019. Cumulative change since 1994 of 1.720, incremental change since 2016 of 0.14. Next reading scheduled for 2022.
	~~BI94-01~~	~~N/A~~	~~Line10+00 Upstream~~	~~N/A~~	~~Inactive~~	~~N/A~~	Inclinometer blocked since 2006 (last read in 2004). Do not replace unless other instruments indicate signs of movement.
Settlement plates at East Gypsum Dike	SP97 – 03	1017.676	Line 33+00	>60 mm over 3 years	Annually	1017.060	Settled 17 mm since 2017. Was not read in 2019.
	SP97 – 04	1017.457	Line 48+00		Annually	1016.924	Settled 28 mm since 2017. Was not read in 2019.
Sondex gauge and Inclinometer at East Gypsum Dike	S94 – 02	N/A	Line 33+00 Upstream	>60 mm over 3 years	Every 3 Years	N/A	Reading taken in 2019. Cumulative change since 1994 of 1.02, incremental change since 2016 of 0.08.
	BI94 – 02	N/A	Line 33+00 Upstream	>25 mm horizontal movement over 3 years	Every 3 Years	N/A	Reading taken in 2016. <5 mm movement parallel to dike and no change perpendicular to dike. To be read in October 2019.
Settlement plates at N.E. Gypsum Dike	SW (S1)	1019.264	Main Dike	>5 mm over 3 years	Every 3 Years	N/A	Surveyed in 2018. Less than 2 mm of settlement since 2007. Next survey 2021.
	SE (S2)	1019.073	Main Dike		Every 3 Years	N/A	Surveyed in 2018. Essentially 0 mm of settlement since 2007. Next survey 2021.
ARD Storage Pond							
Settlement Plates	SP01-01	1048.009	North Dam	>25 mm over 3 years	Every 3 Years	N/A	Surveyed in 2018. Less than 7 mm of settlement since 2001 Next survey 2021.
	SP01-02	1048.224	North Dam			N/A	Surveyed in 2018. Less than 15 mm of settlement since 2001. Next survey 2021.
	SP01-03	1048.113	North Dam			N/A	Surveyed in 2018. Less than 19 mm of settlement since 2001. Next survey 2021.
	SP01-04	1048.311	South Dam			N/A	Surveyed in 2018. Less than 8 mm of settlement since 2001. Next survey 2021.
	SP01-05	1048.310	South Dam			N/A	Surveyed in 2018. Essentially 0 mm of settlement since 2001. Next survey 2021.
	SP01-06	1048.351	South Dam			N/A	Surveyed in 2018. Less than 9 mm of settlement since 2001. Next survey 2021.
Sludge Impoundment Dikes							
Dike Crest Survey	-	-	North Dike centerline, U/S, D/S dike crest	894.6	Annually	894.6	Recent survey shows elevations greater than or equal to design crest elevation.
			South Dike centerline, U/S, D/S dike crest	894.6	Annually	894.6	Recent survey shows elevations greater than or equal to design crest elevation. Exception: southern most portion of the South Dike crest is currently below design elevation by approximately 0.5 m due to access ramp.

Notes: (1) SP330 and 331 lowered in 2006. (2) SP332 raised in 2004. (3) SP99-01 lowered in 2006.

Table AIII.5 Active Seepage Measurements October 1, 2018 – August 31, 2019

Structure/ Weir	Min. Current Reading Frequency	Notification Level	Weir Readings and Observations – October 1, 2018 to August 31, 2019																					
			October		November		December		January		February		March		April		May		June		July		August	
			Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow
			m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day
ARD Pond/Weir #1 (ARDWU)	Weekly with daily readings between March 1 and May 30. Daily readings when the pond level is > 1045 m. Read for 3 days following rainfall event >10 mm.	150 m^3/day	Dry	Dry	Dry	Dry	Dry	Flow under weir[3]	Flow under weir[3]	36.4[4]	Flow under weir[3]	36.4[4]	Flow under weir	Flow under weir	Flow under weir	Flow under weir	Dry	Flow under weir	Dry	Dry	Flow under weir	Flow under weir	Flow under weir	55.9[4]
ARD Pond/Weir #2		175 m^3/day	Dry	Dry	Dry	Dry	Dry	36.2[4]	Flow under weir[3]	Flow under weir[3]	Flow under weir[3]	Flow under weir	Flow under weir[3]	Flow under weir	Flow under weir	Flow under weir	Dry	Flow under weir	Dry	Dry	Dry	Flow under weir	Dry	Flow under weir
AIP[1] Dike/Weir #3 (AIPWU)	Weekly with daily readings between March 1 and May 30. Read for 3 days following rainfall event >10 mm.	50 m^3/day	2.3	22.4	Flow under weir[3]	12.9	Flow under weir[3]	2.3	Flow under weir[3]	6.3	Flow under weir[3]	6.3	Flow under weir[3]	10.2	0.1	24.9	0.7	5.5	0.7	2.5	0.7	10.2	0.7	5.5
AIP[1] Dike/Weir #4		500 m^3/day	2.6	36.6	Flow under weir[3]	18.2	Flow under weir[3]	18.2	0.5	23.5	Flow under weir[3]	10.0	Flow under weir[3]	121.6	2.5	79.7	0.1	47.9	10.4	35.4	7.4	25.1	2.5	10.4
West Gypsum Cell/Toe of Gravel Buttress at Cow Creek (STA. 11+00)	Visual Reading Annually	Cloudy flow	Flow is clear (observed as part of May 2018 site visit)																					
East Gypsum Cell/Toe of Dike Adjacent to James Creek	Visual Reading Annually	Cloudy flow	Flow is clear (observed as part of May 2018 site visit)																					

Notes:

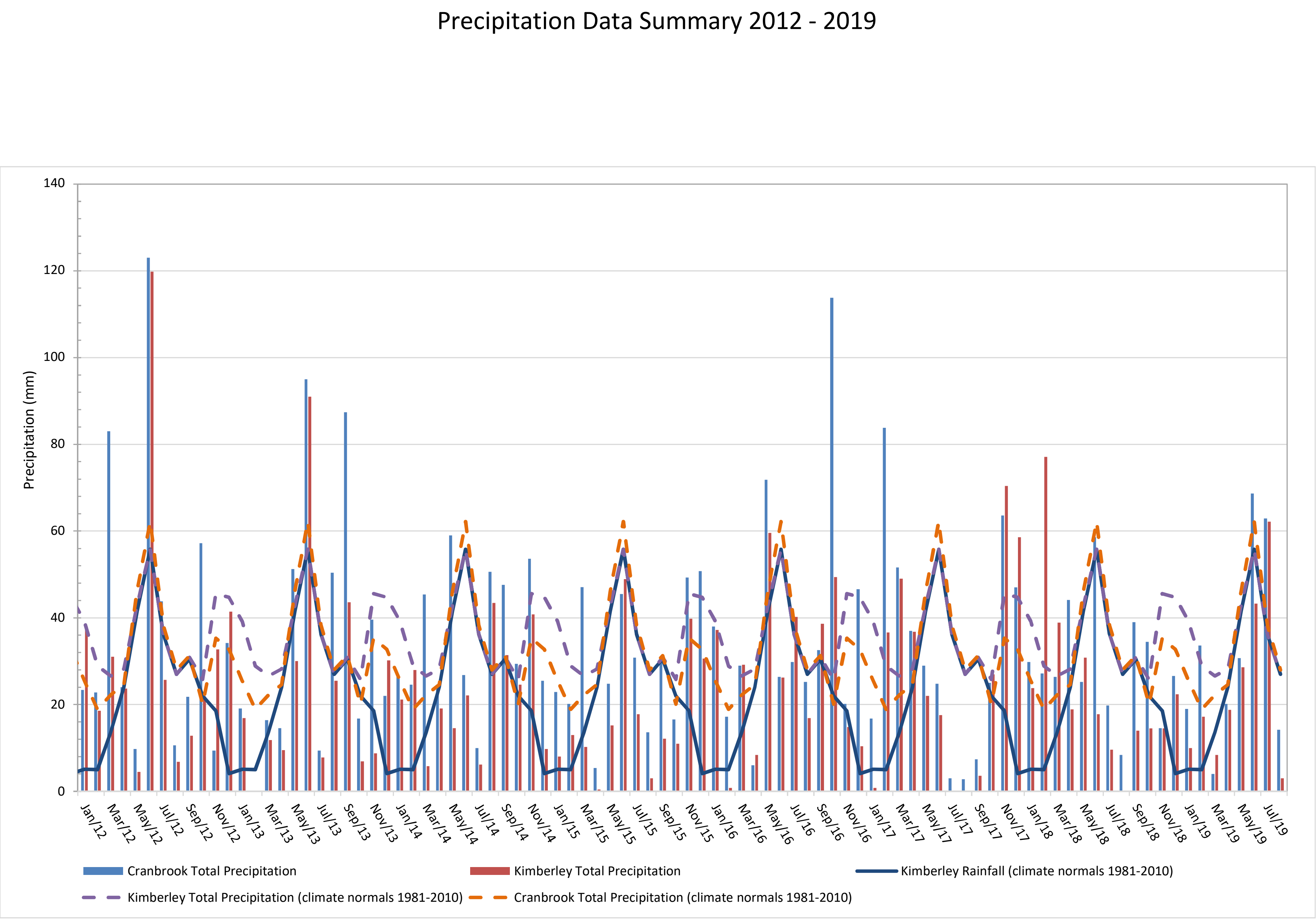
1. AIP = Iron Pond
2. N/A – Flow could not be measured as it was by-passing weir.
3. One or several readings were reported as “frozen”
4. Flows are likely underreported due to a portion of the water flowing under the weir.

Table AIII.6 Active Pond Water Level Monitoring Locations

Type	Description	Location	Primary Purpose	Reading Frequency	Notification Level 1	Notification Level 2	Notification Level 3	General Water Level Information (m)
Iron Pond Water Level	Electronic readout unit.	Iron Dike Pump Station	Overtopping	Daily	1038.5 (Pump to ARD Pond)	1038.9 (As for Level 1 and notify EOR, minimize inflows, consider pumping to DWTP)	1040.5 (As for Level 2 and notify MEMPR/MOE, enact EPRP)	1036.5 (Measured low water) 1038.8 (Measured high water) 1041.0[1] (Spillway invert) 1042.0 (Top of dike)
Pond Water Level	Electronic readout unit with pressure transducer in bottom of wet well at el. 1034 m.	Pump wet well, data transmitted to DWT control room through the PLC system	Dam Stability	Daily	1045.5 (Pump to DWTP)	1046.5 (As for Level 1 and notify EOR, minimize inflows (e.g. divert 3700/3900 to Iron Pond))	1046.9 (As for Level 2 and notify MEMPR/MOE, enact EPRP)	1034.7 (Measured low water) 1044.6 (Measured high water) 1046.5 9 Maximum operating level) 1047.4 (Spillway invert) 1048.0 (Top of dam)

Notes:

1. The surveyed as-constructed invert elevations for the Iron Pond/Emergency Spillway varied from 1040.8 m to 1041.4 m, with the design elevation being 1041.0 m.



Note: The Kimberley Station is most likely under-reported as there are generally two days a week that are not reported. Precipitation information is provided to indicate general trends.

Figure AIII-1

APPENDIX IV

Iron Dyke Instrumentation

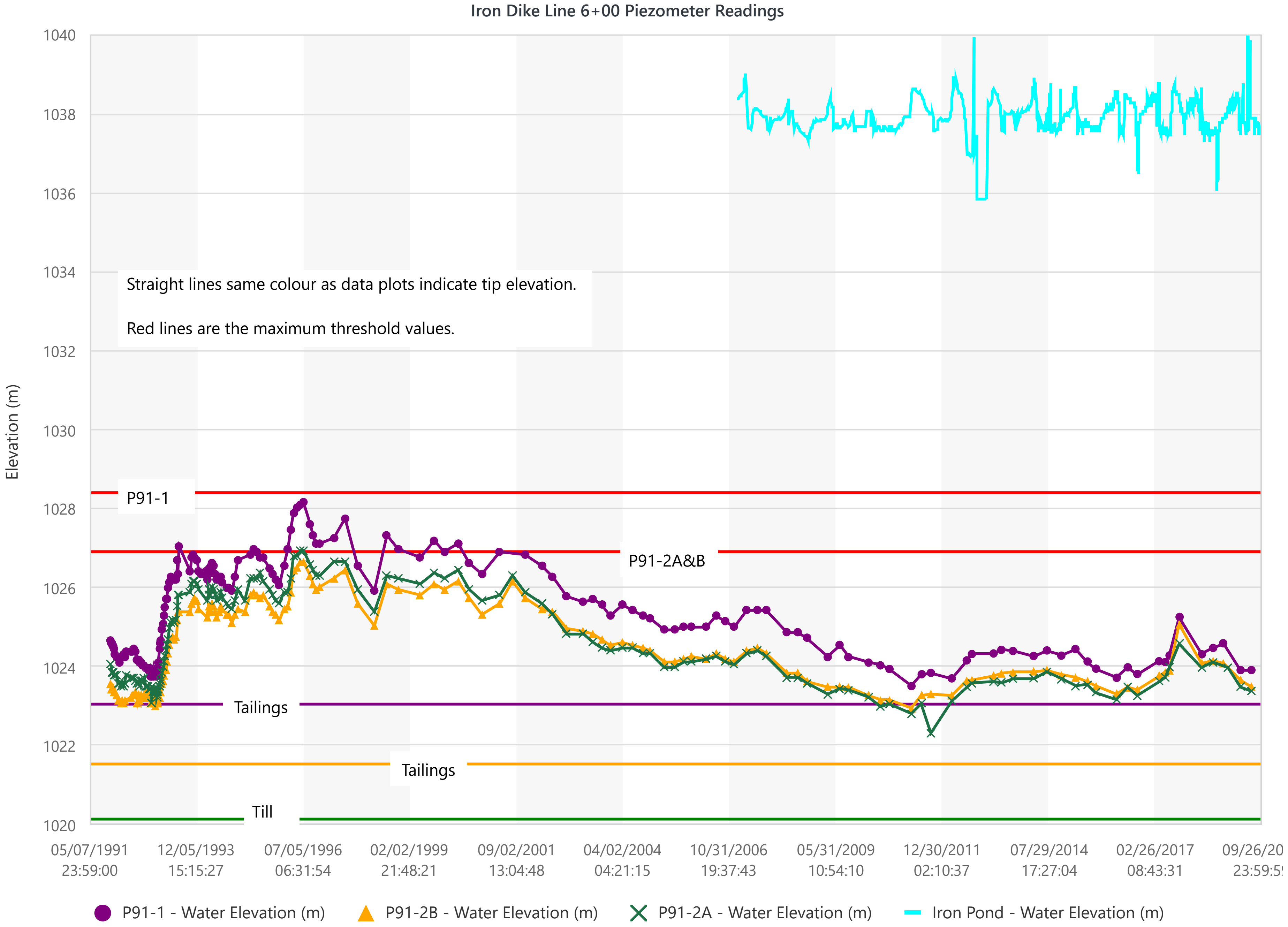
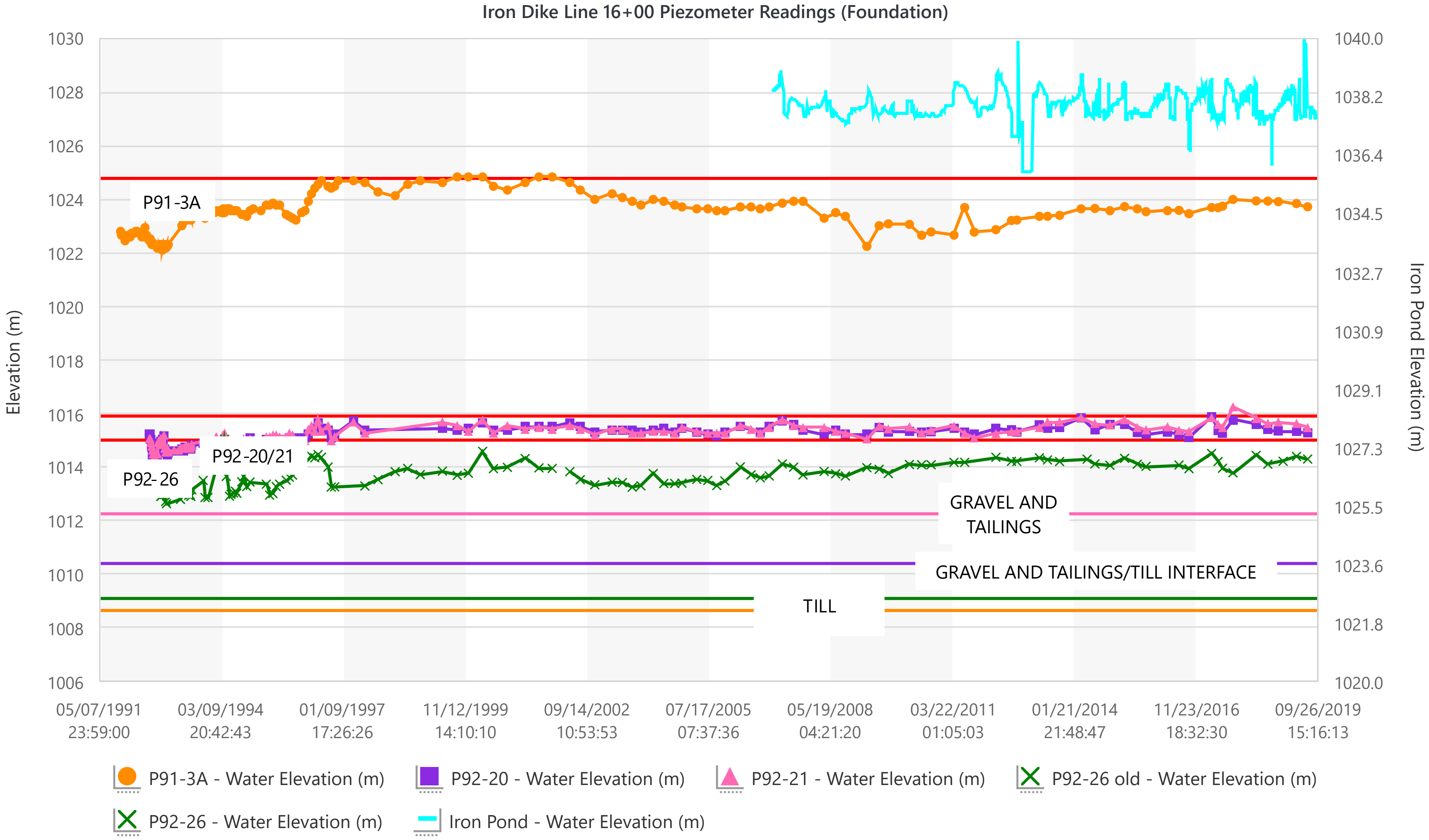


Figure IV-1 STN 6+00



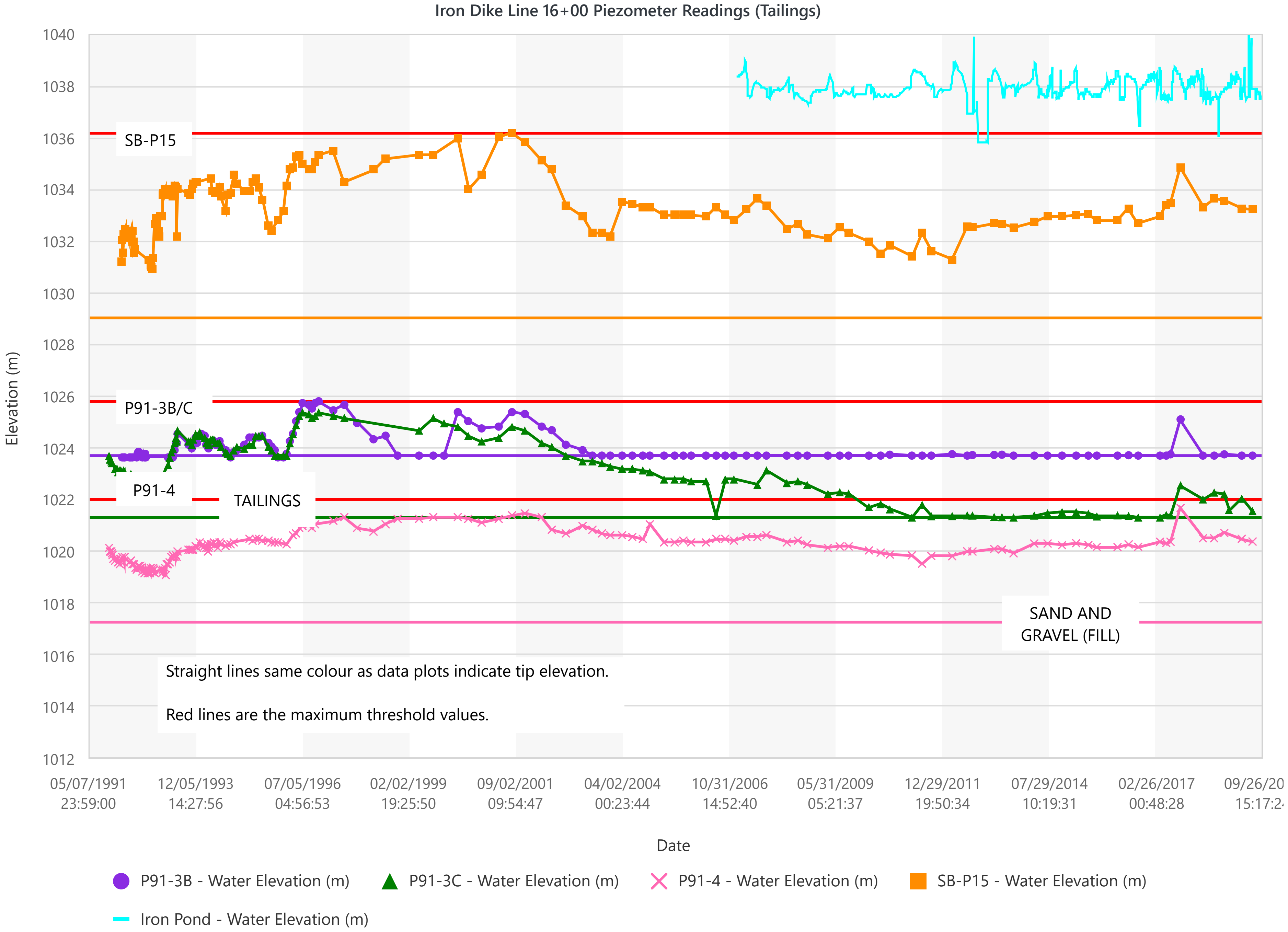
Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure IV-2 STN 16+00 Foundation



Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Figure IV-3 STN 16+00 Tailings

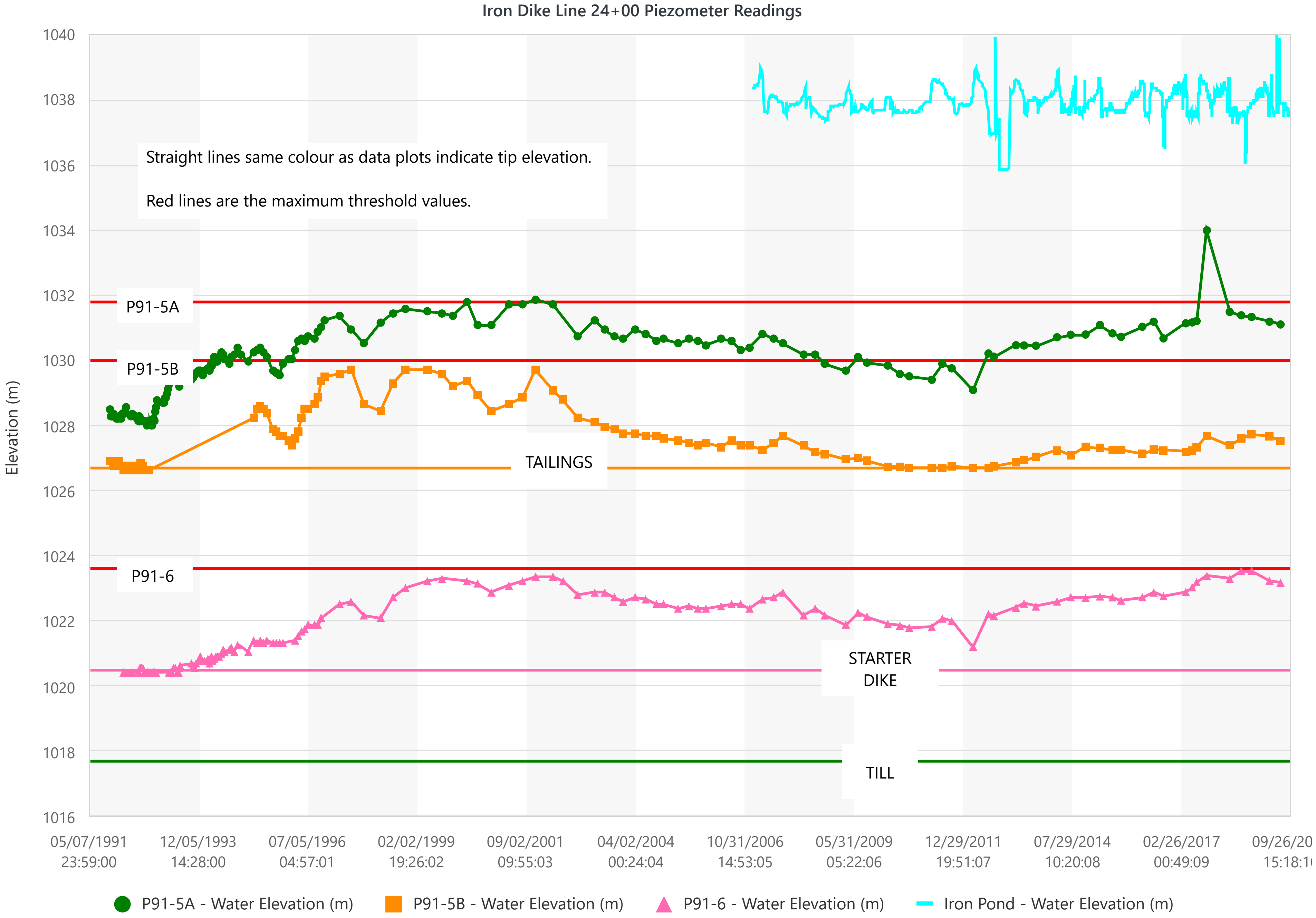


Figure IV-4 STN 24+00

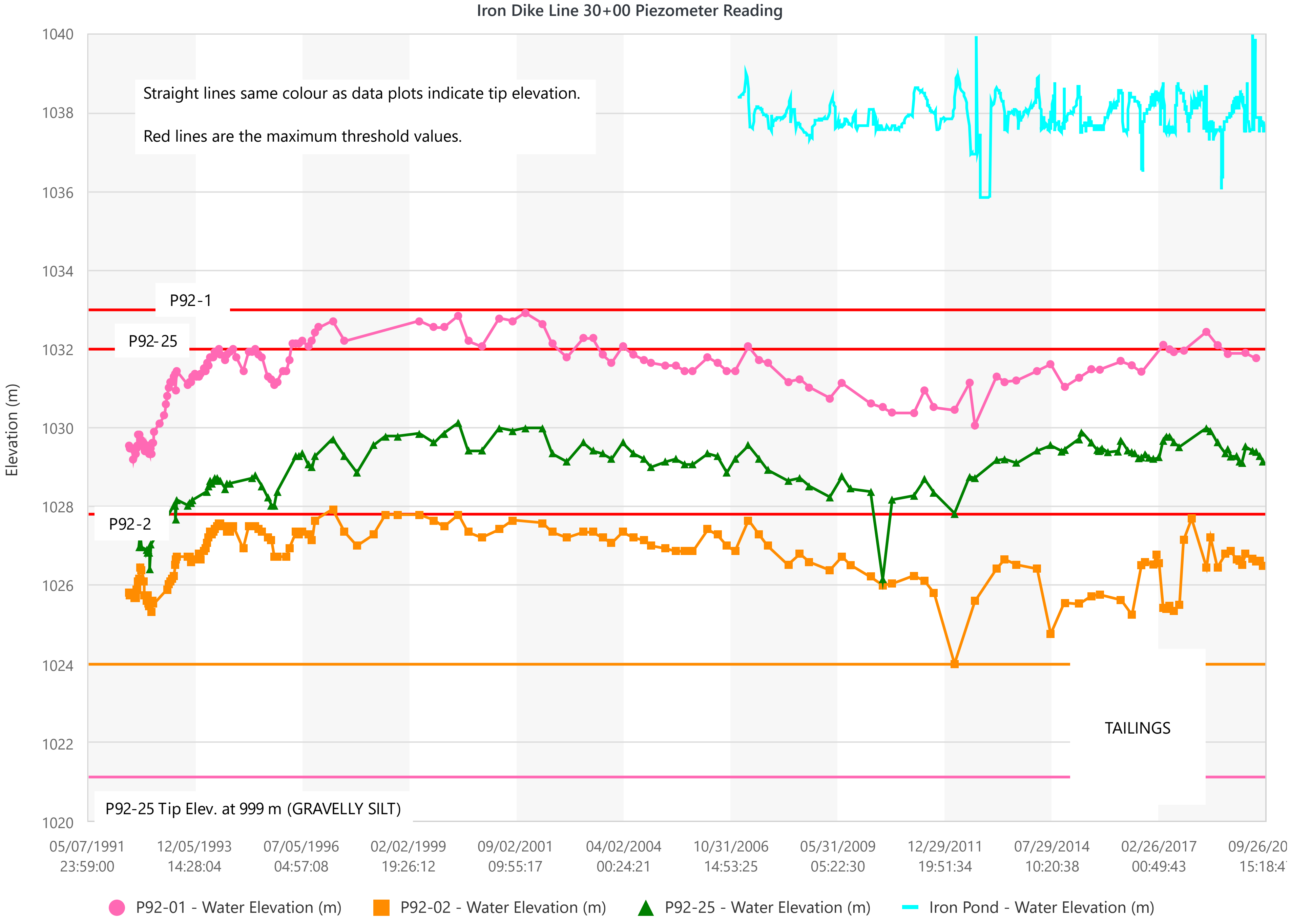


Figure IV-5 STN 30+00

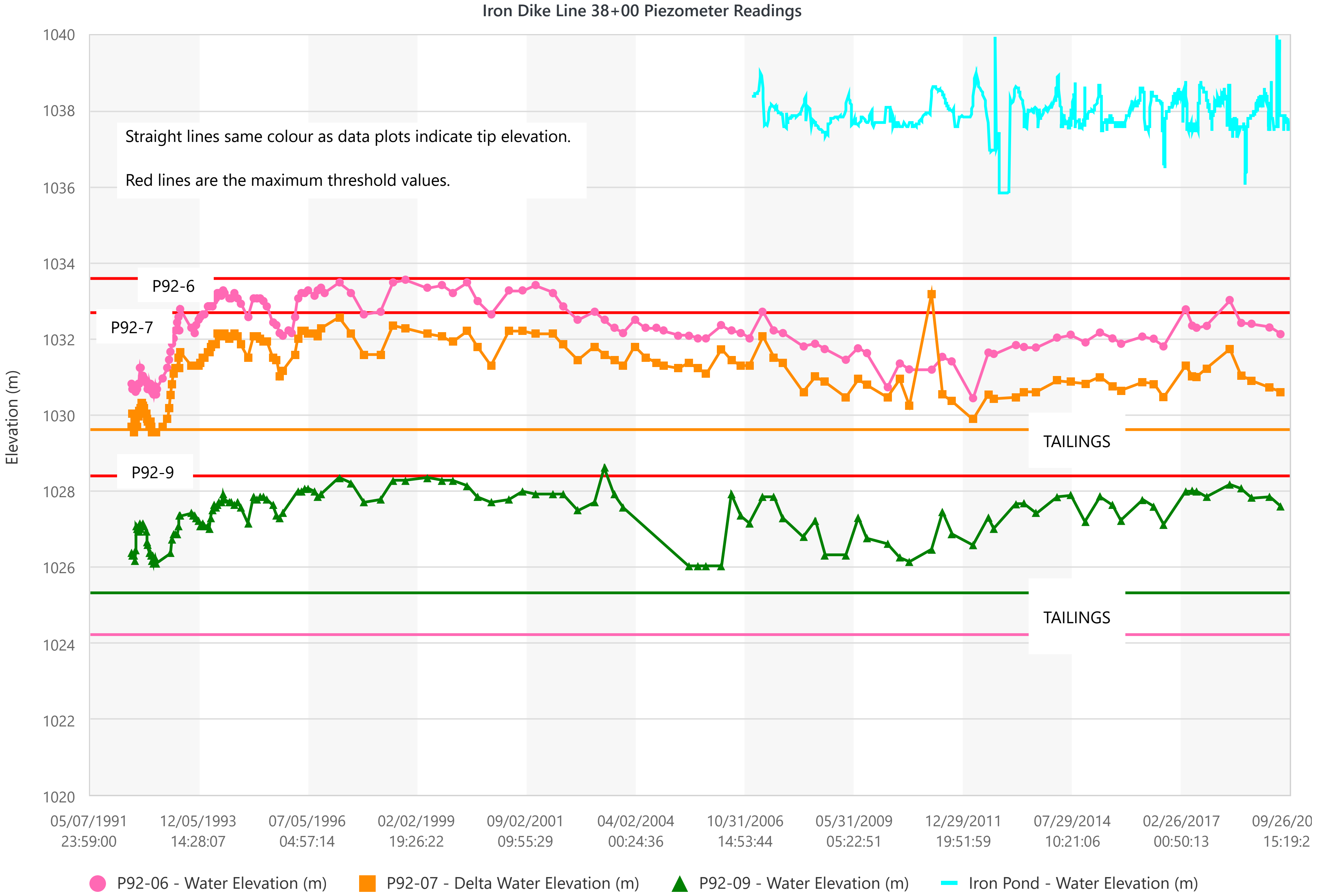
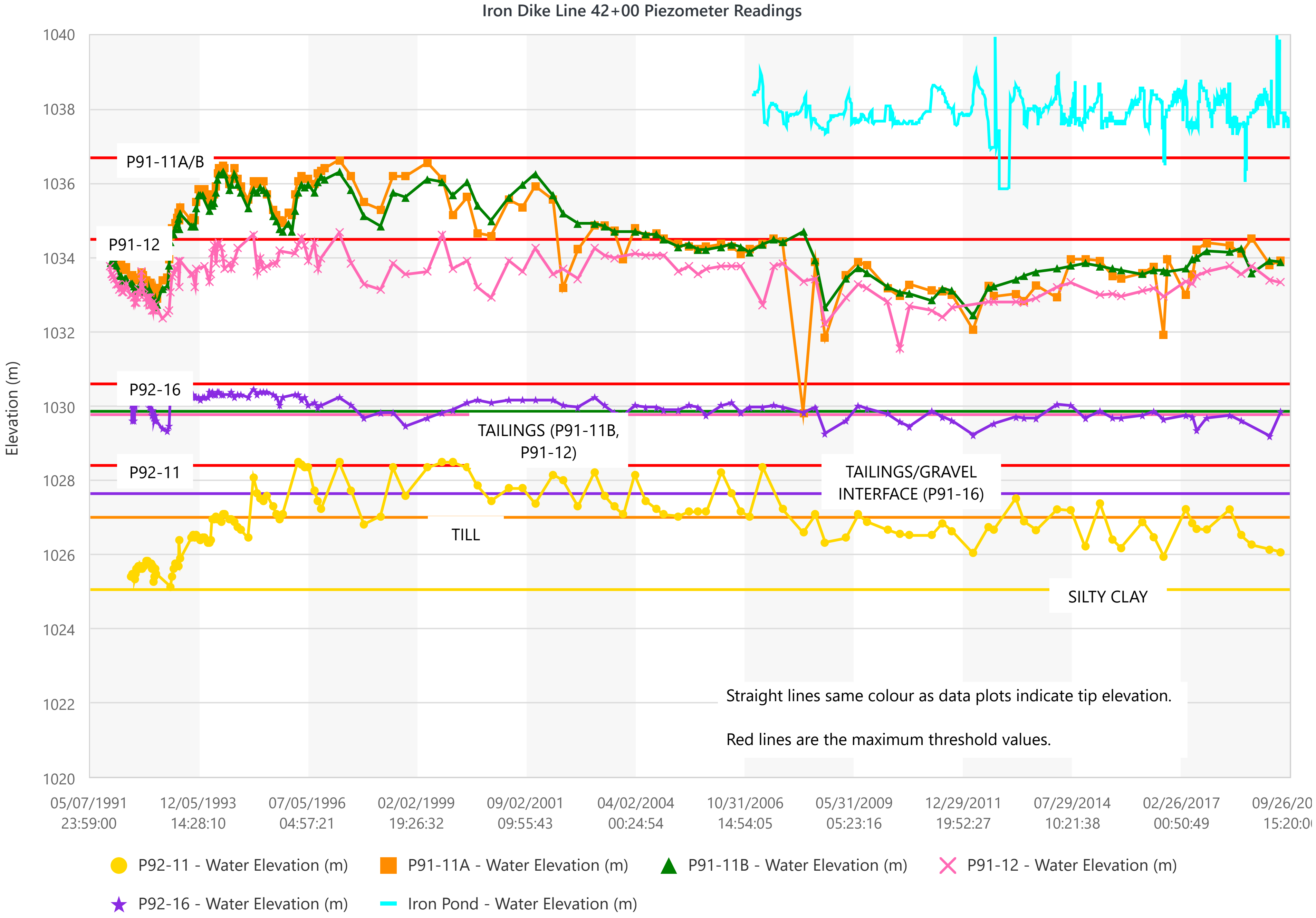


Figure IV-6 STN 38+00

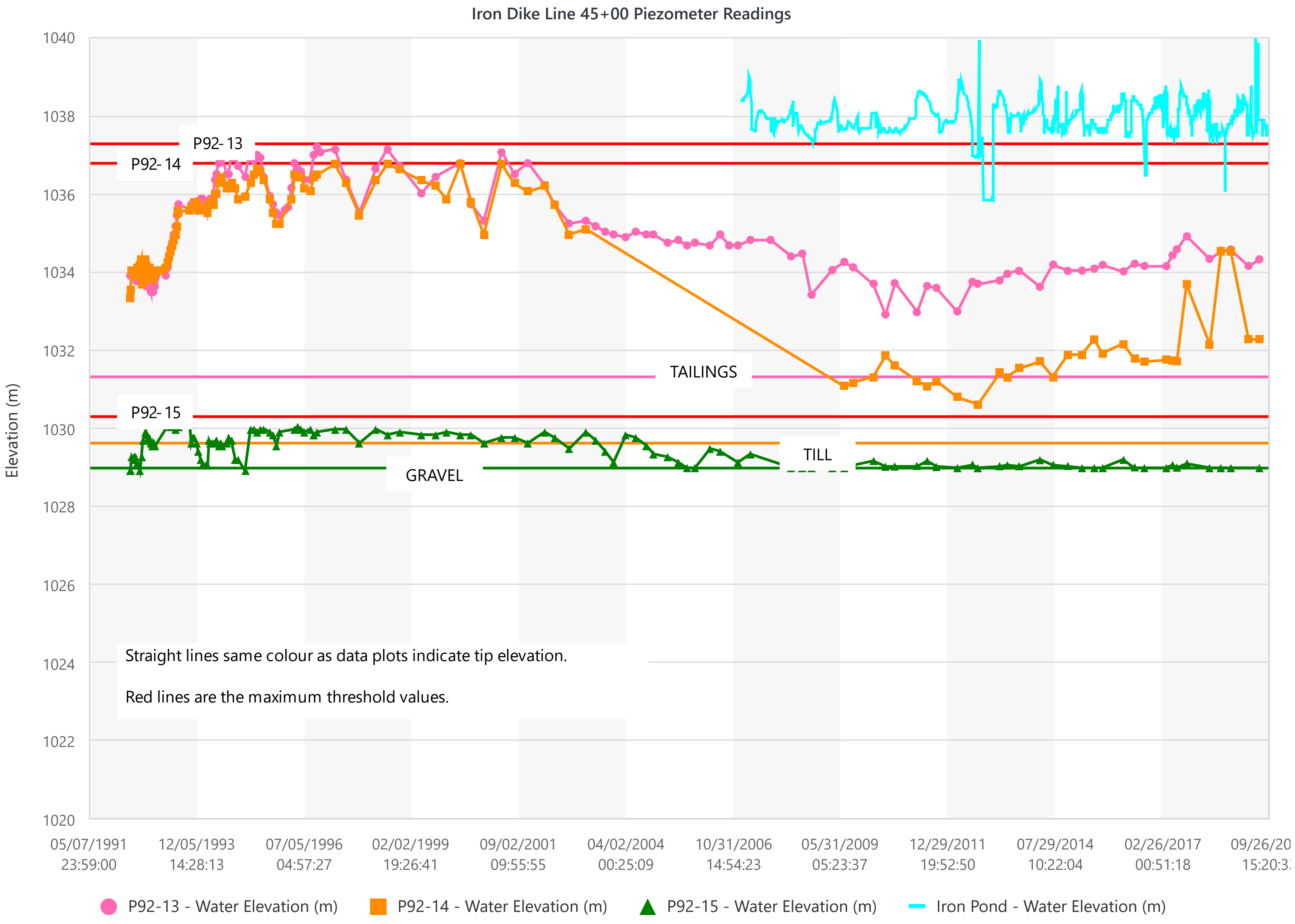


Iron Dike Line 42+00 Piezometer Readings

Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

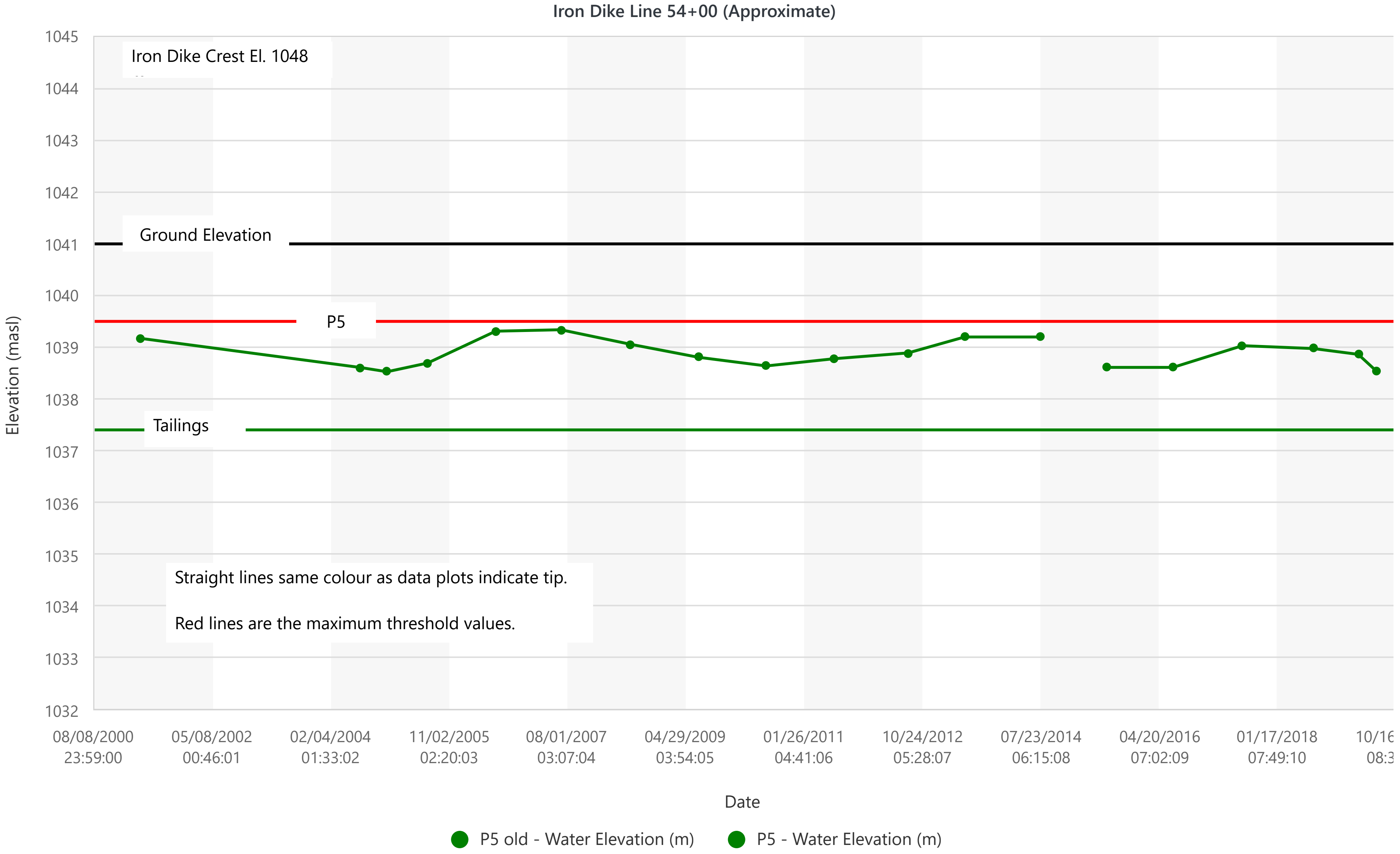
Figure IV-7 STN 42+00



Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

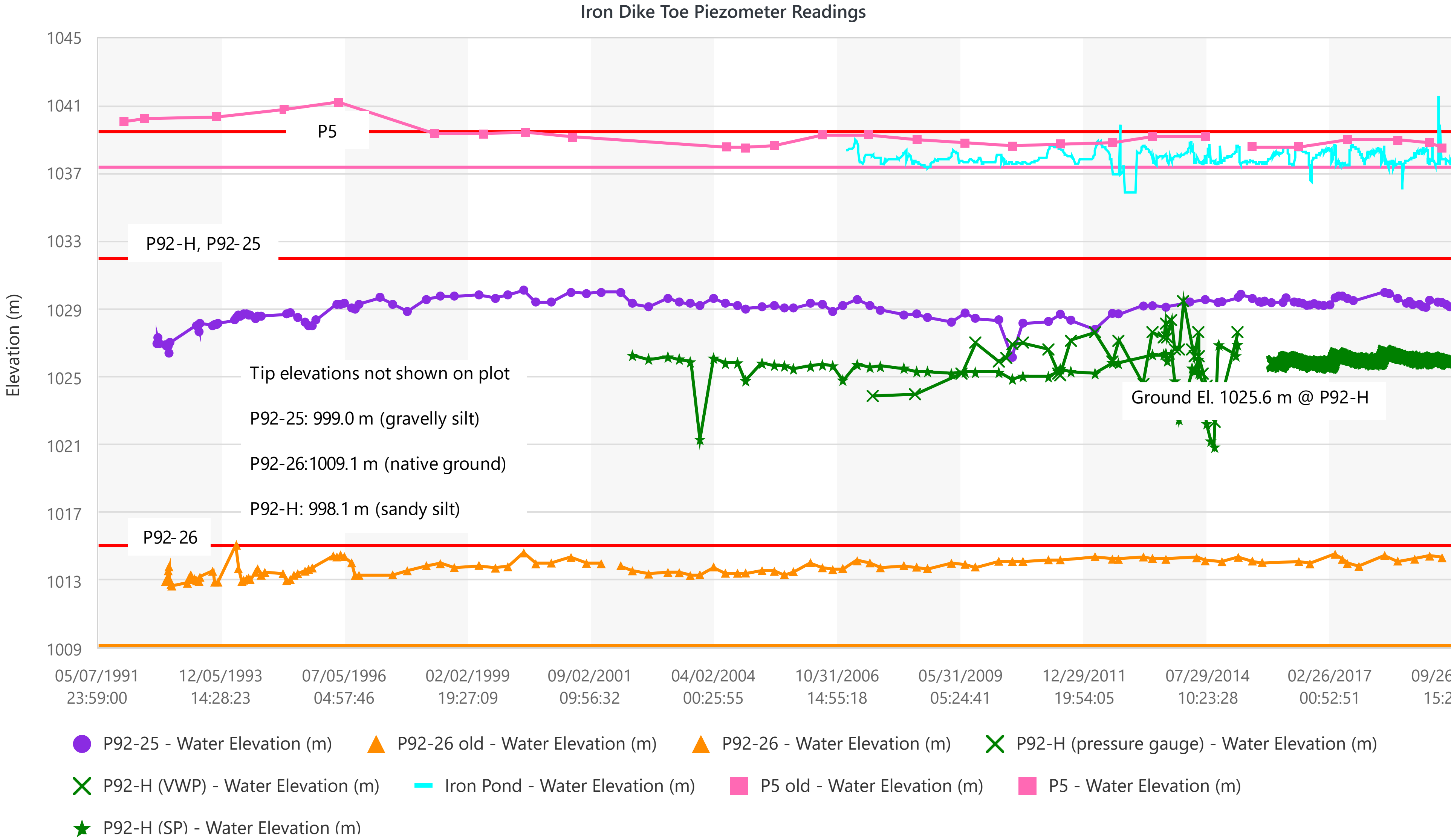
Figure IV-8 STN 45+00



Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure IV-9 Line 54+00



Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure IV-10 Toe Piezometers

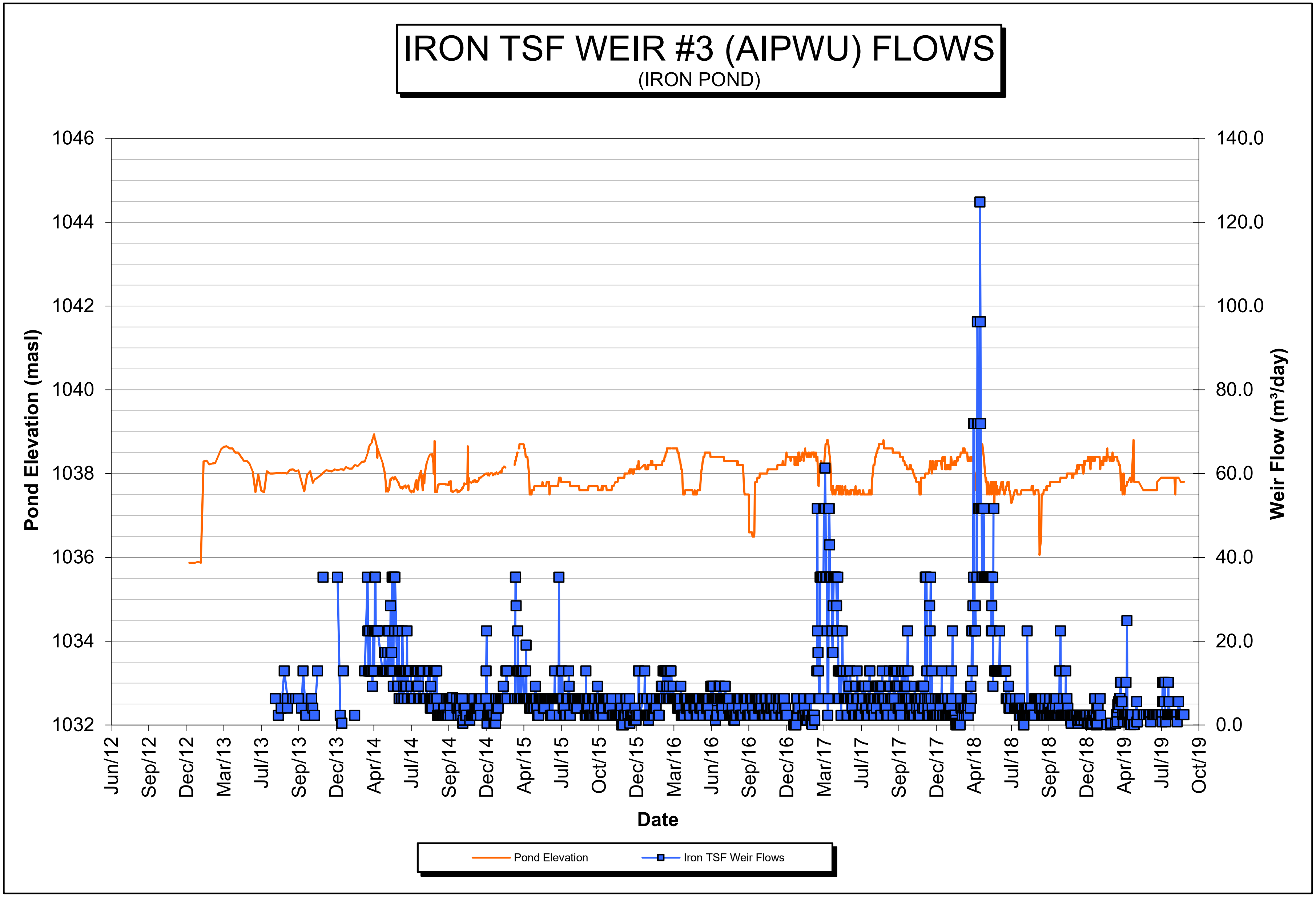


Figure IV-11 Weir #3 - AIP (AIPWU) time plot

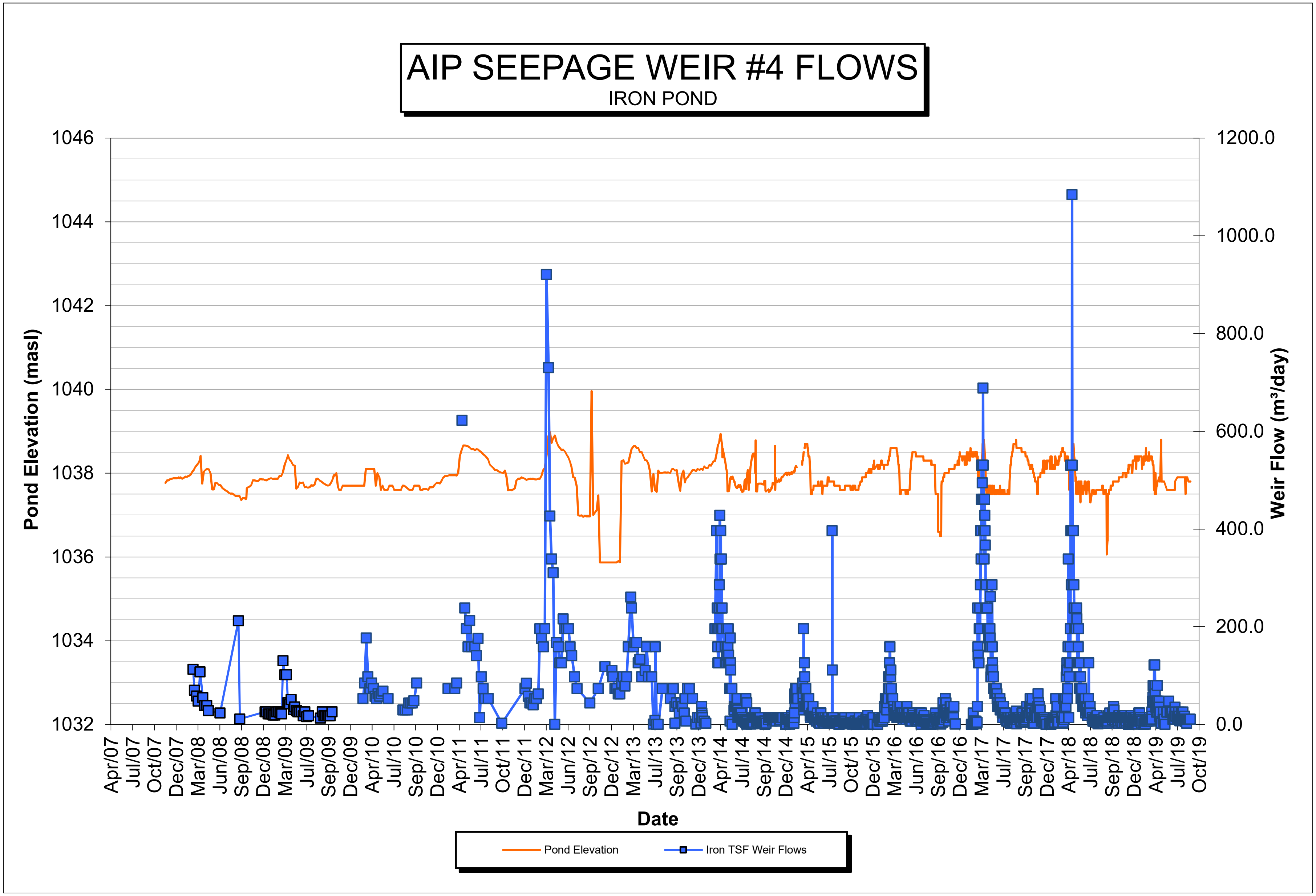


Figure IV-12 Weir #4 - AIP_time plot

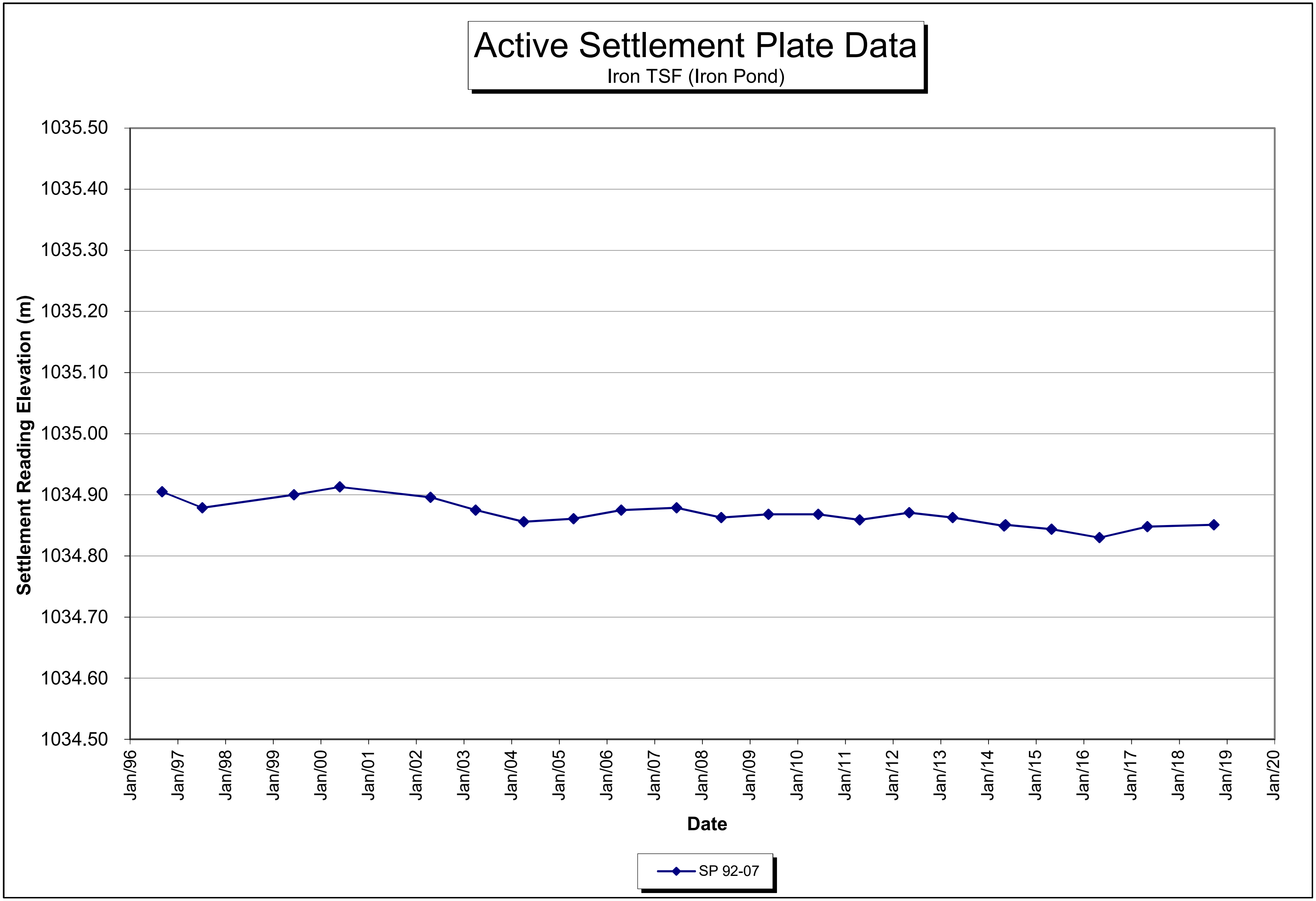


Figure IV-13 SP 92-07

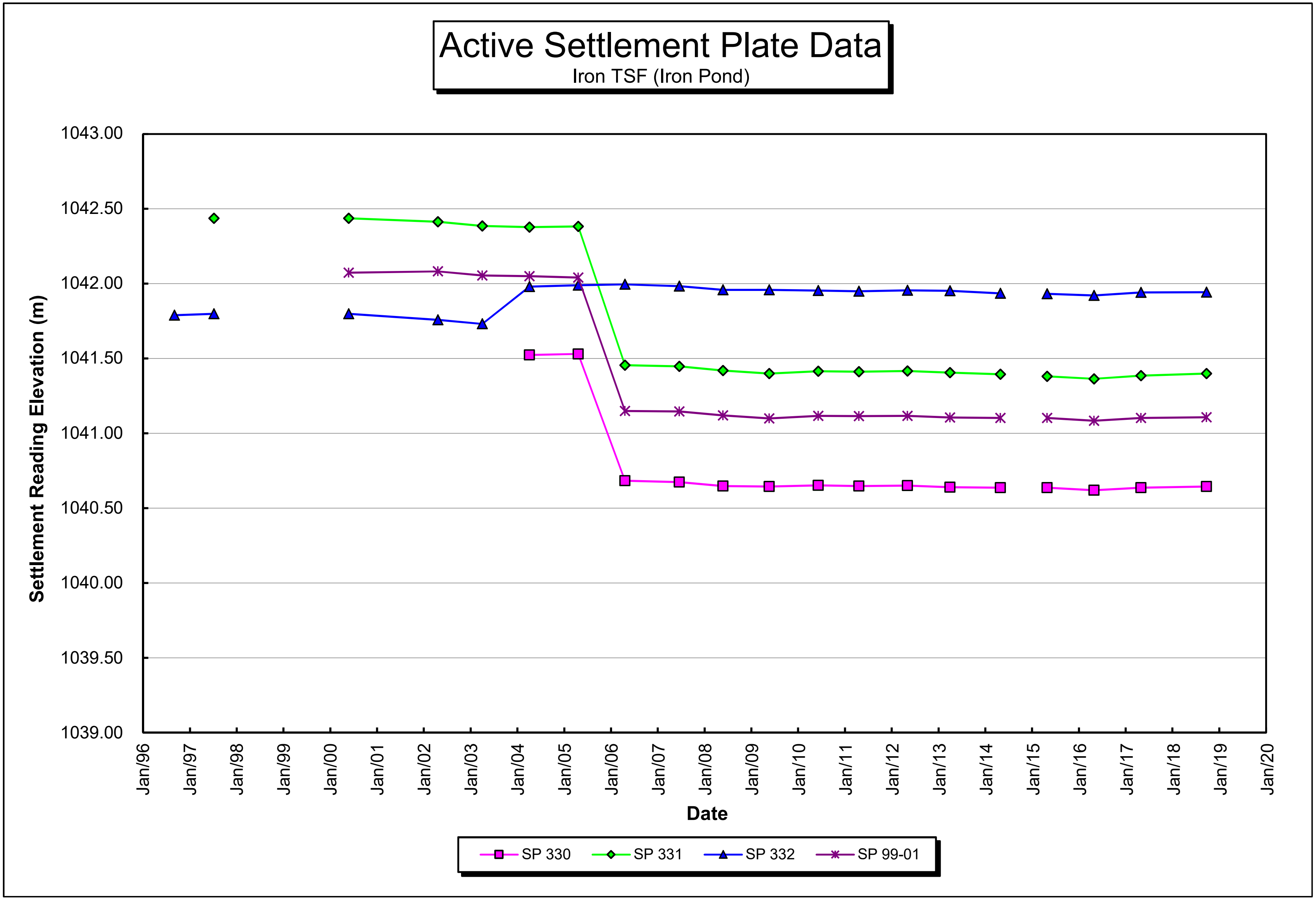
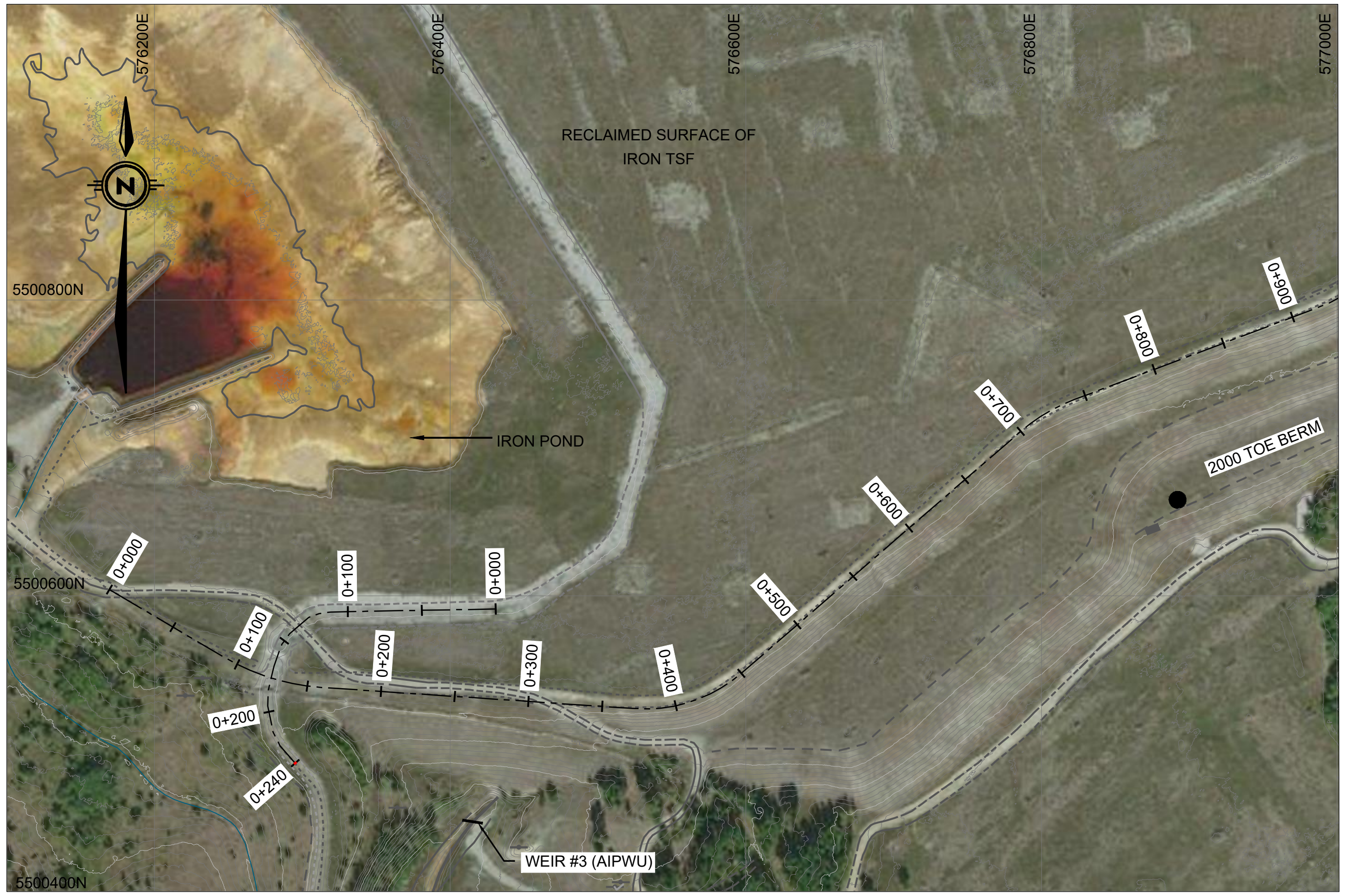
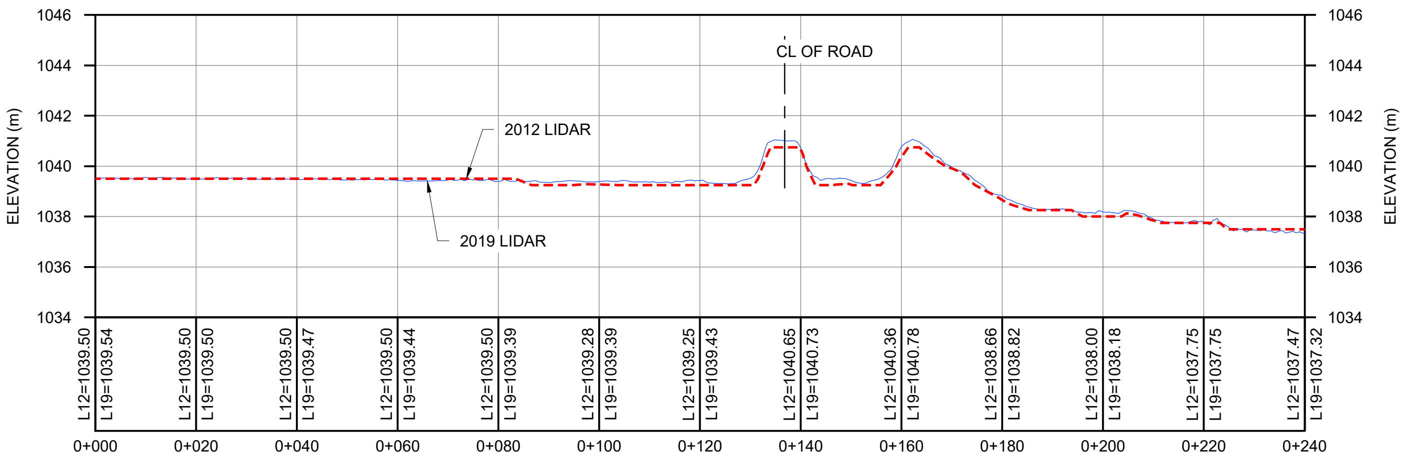


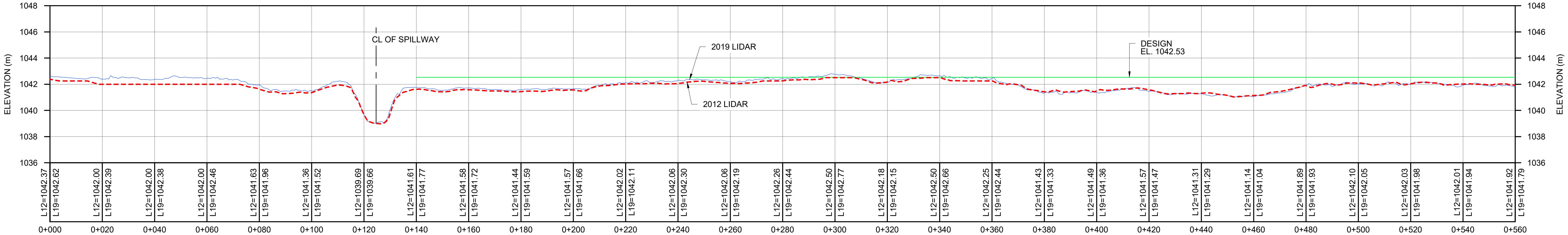
Figure IV-14 SP 330 - 332 and SP 99-01





SPILLWAY

HOR: 1:1500
VER: 1:300



IRON DYKE CREST

HOR: 1:1500
VER: 1:300

1:5 000 0 50 100 m

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PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
IRON DIKE CREST
AND SPILLWAY PROFILE

PROJECT No.
A05807A19

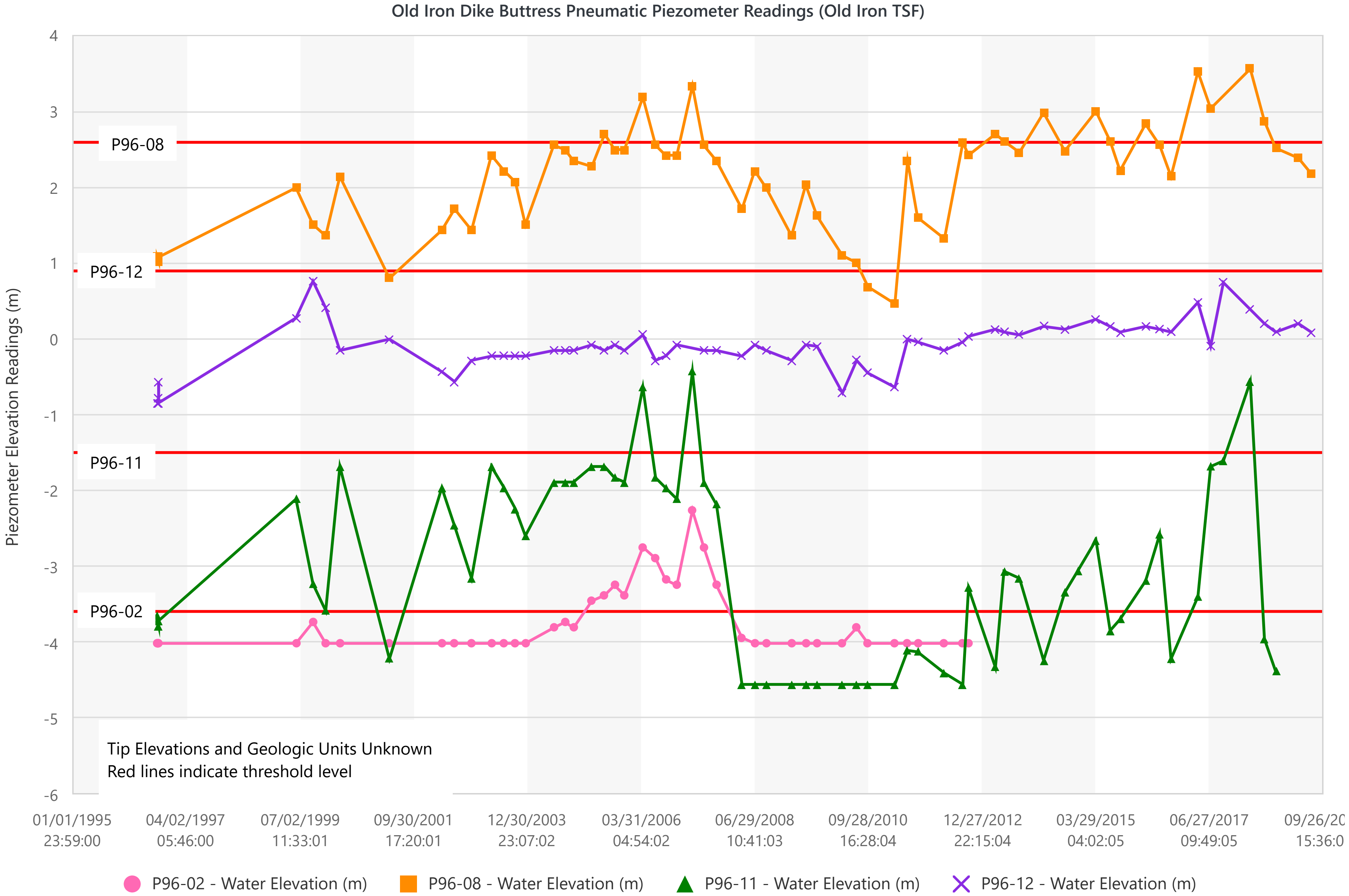
FIG No.
FIGURE IV-15

KCC-D-B

\\int.klohn.com\ProjData\ACGY\Alberta\A05807A19 TML 2019 Sullivan Mine DSI\400 Drawings\DSI RPT\Figure IV-15.dwg Layout=Figure 4 October 4, 2019 3:01:15 PM

APPENDIX V

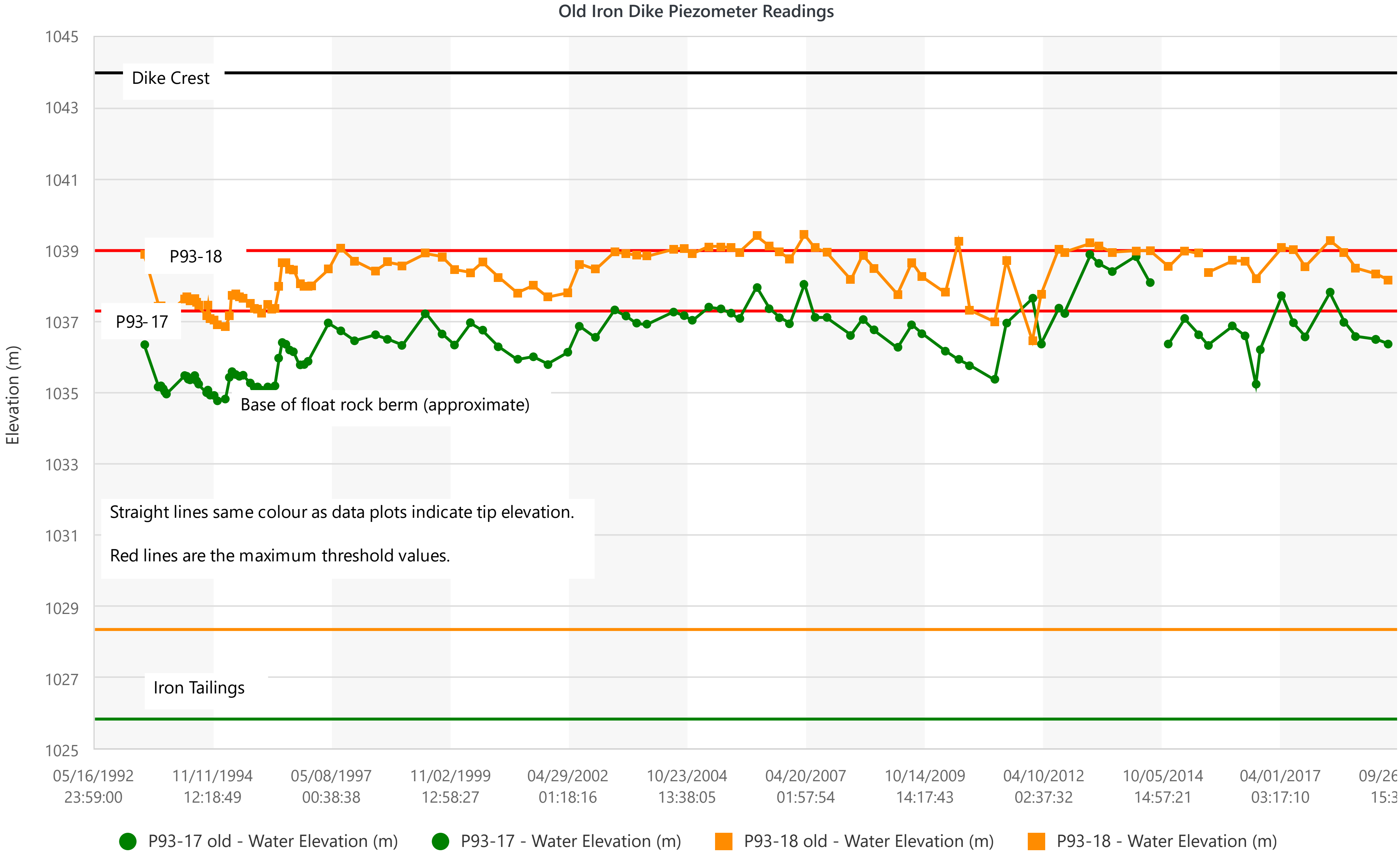
Old Iron Dyke Instrumentation



Elevations are relative to elevation of top of tailings or original ground prior to construction of the toe berm in 1996, i.e. m of head measured - difference between top of berm in 1996 and estimated top of ground prior to berm construction.

P96-02: Destroyed
P96-11: Slow leak 2008 unable to get reading until 2011, erratic data since 2012, replaced in 2018

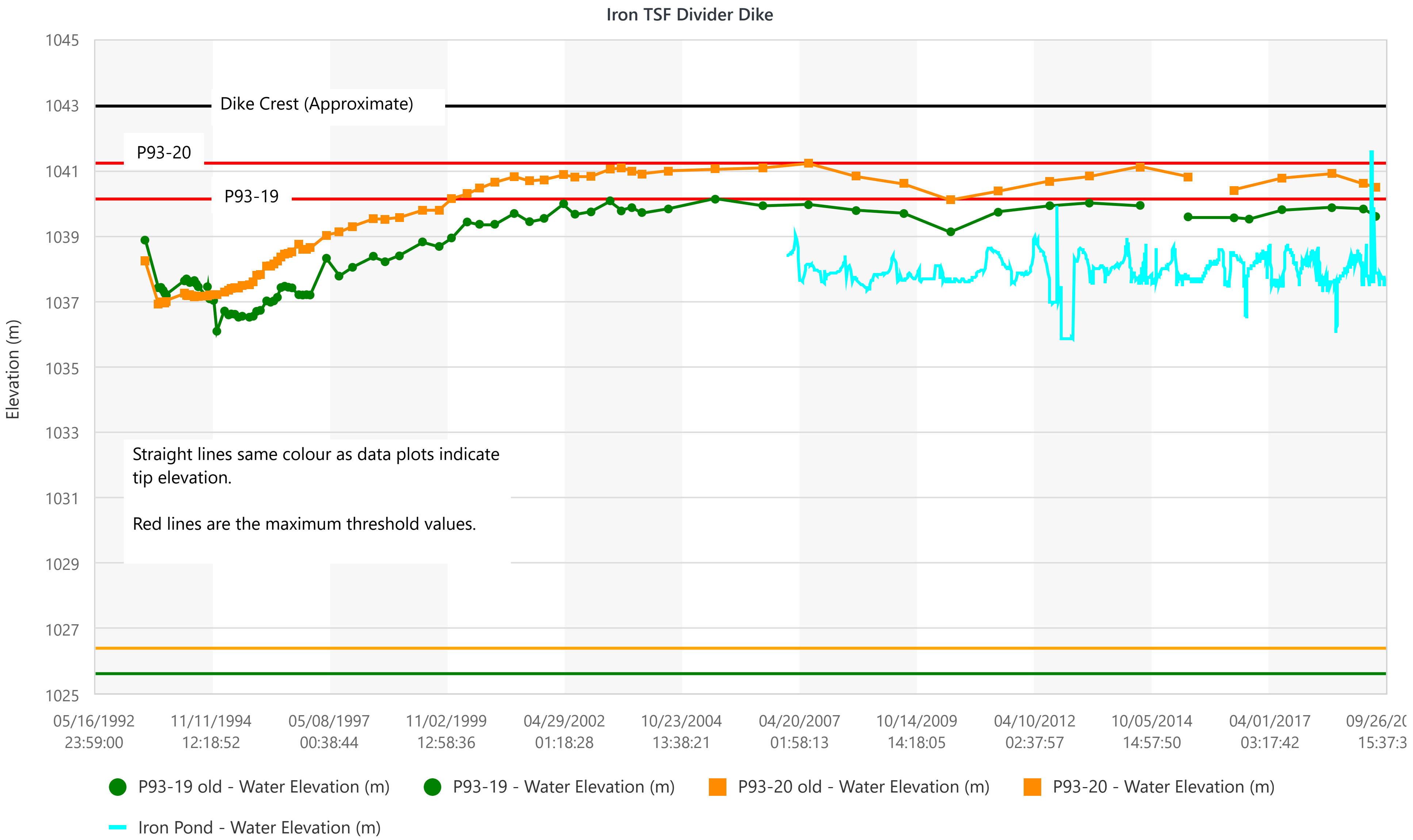
Figure V-1 Old Iron Dike Buttress



Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

P-xxx old represents readings to point of flushing. P-xxx represents readings post flushing. If no "old" plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure V-2 Old Iron Dike



Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

P-xxx old represents readings to point of flushing. P-xxx represents readings post flushing. If no "old" plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure V-3 Iron TSF Divider Dike

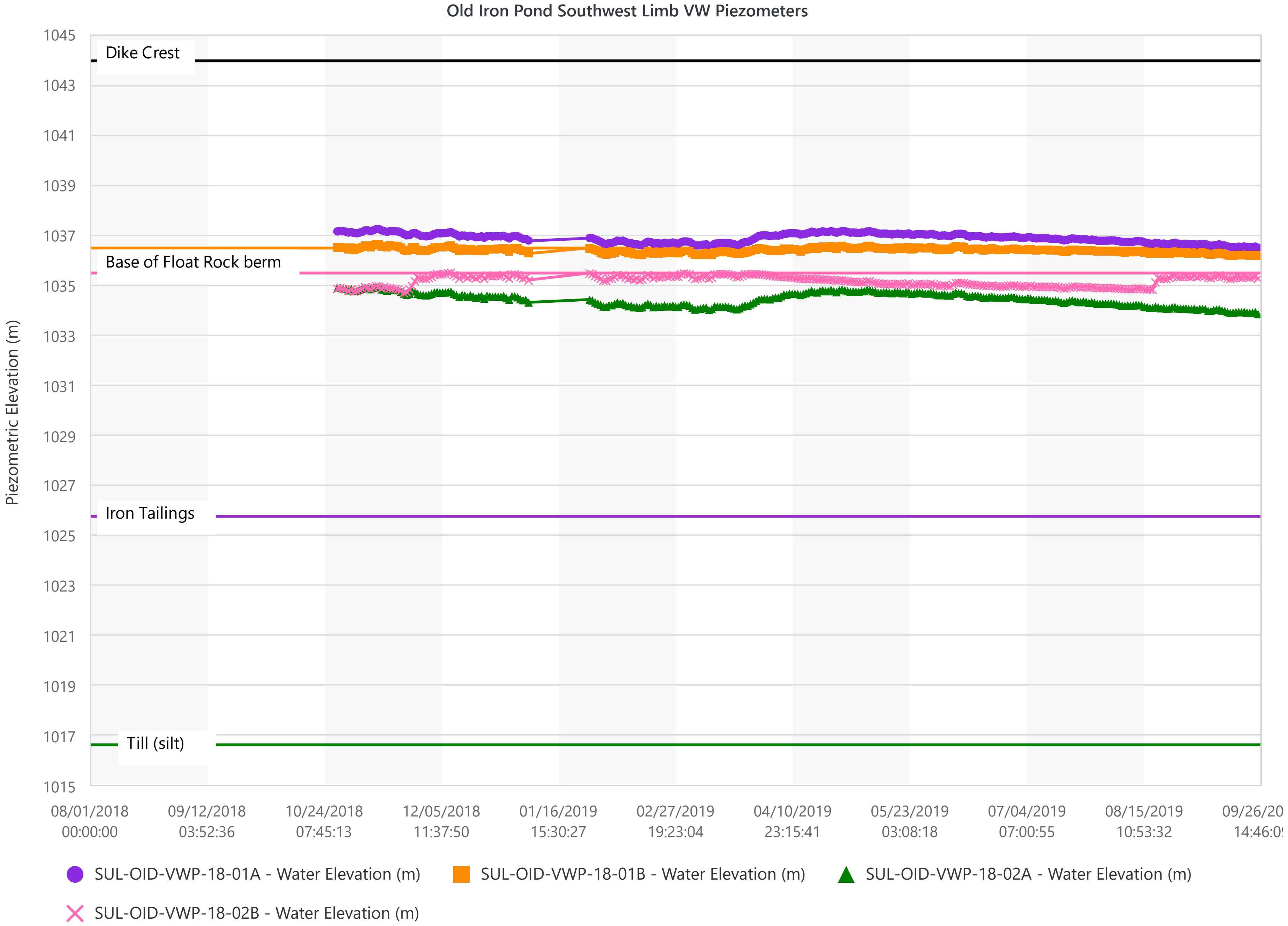
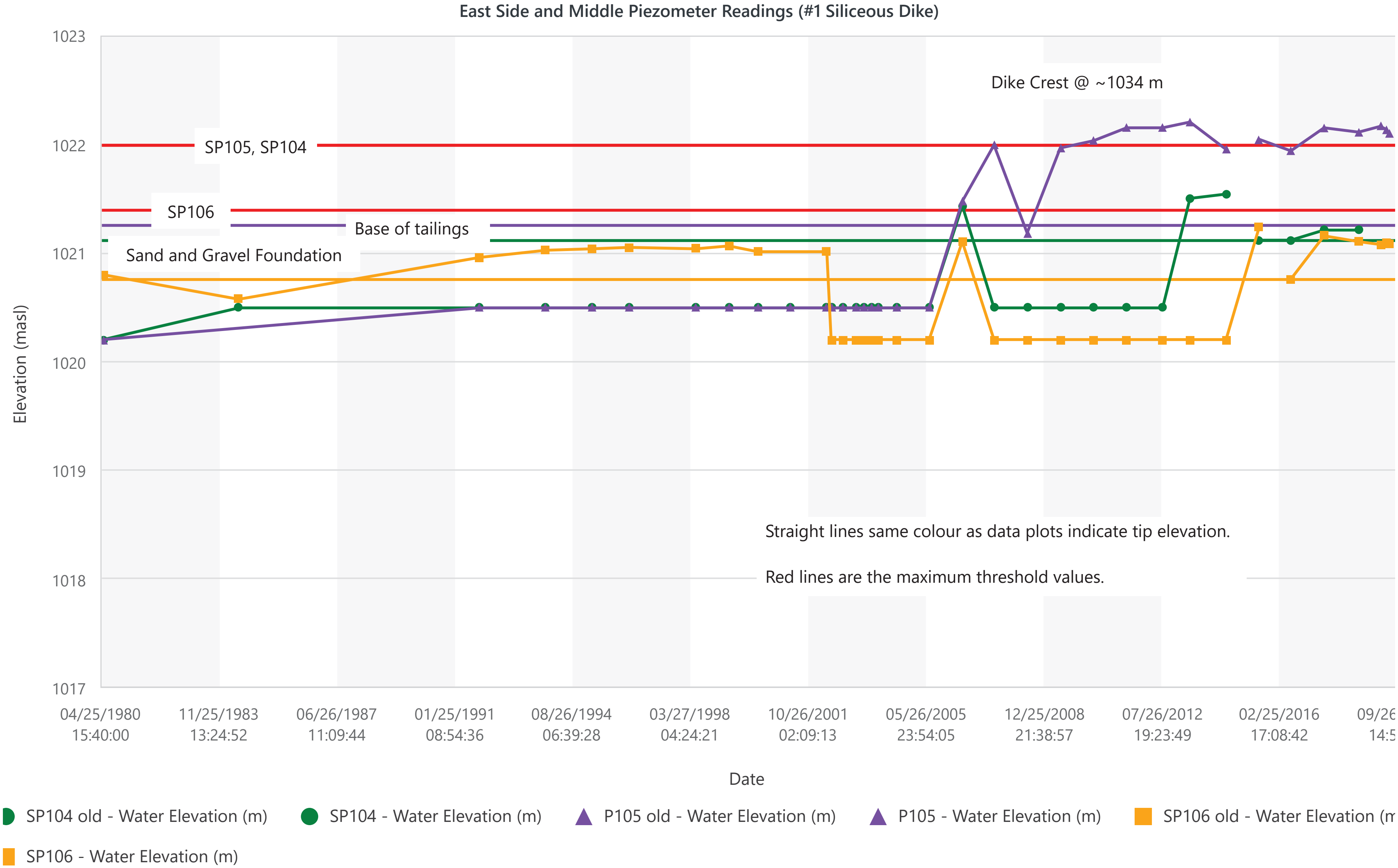


Figure V-4 Old Iron Dike VWP

APPENDIX VI

Siliceous Dyke Instrumentation



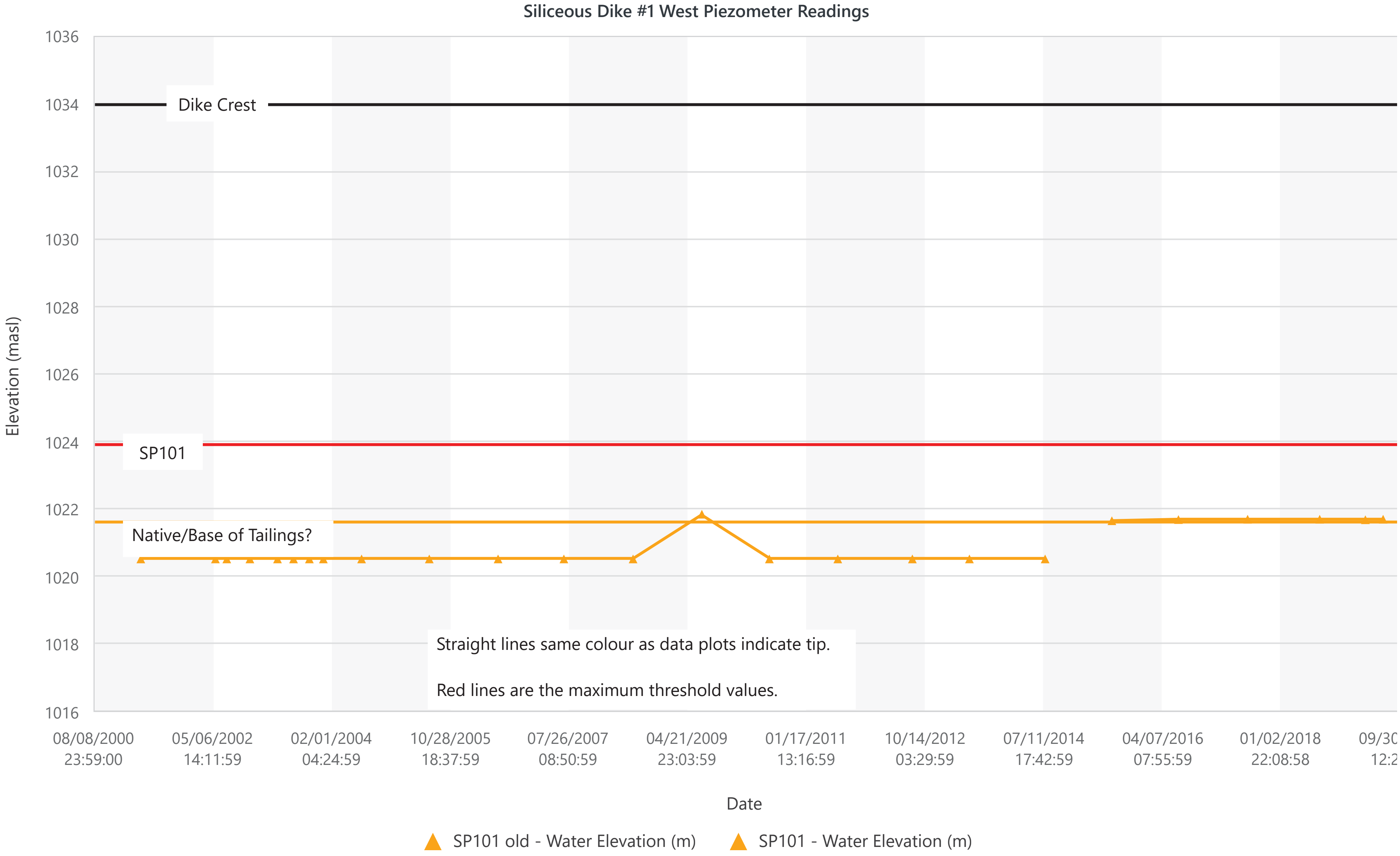
Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx old represents readings to point of flushing. SPxxx represents readings post flushing. If no "old" plot then no change to top of casing elevation or depth to bottom of standpipe.

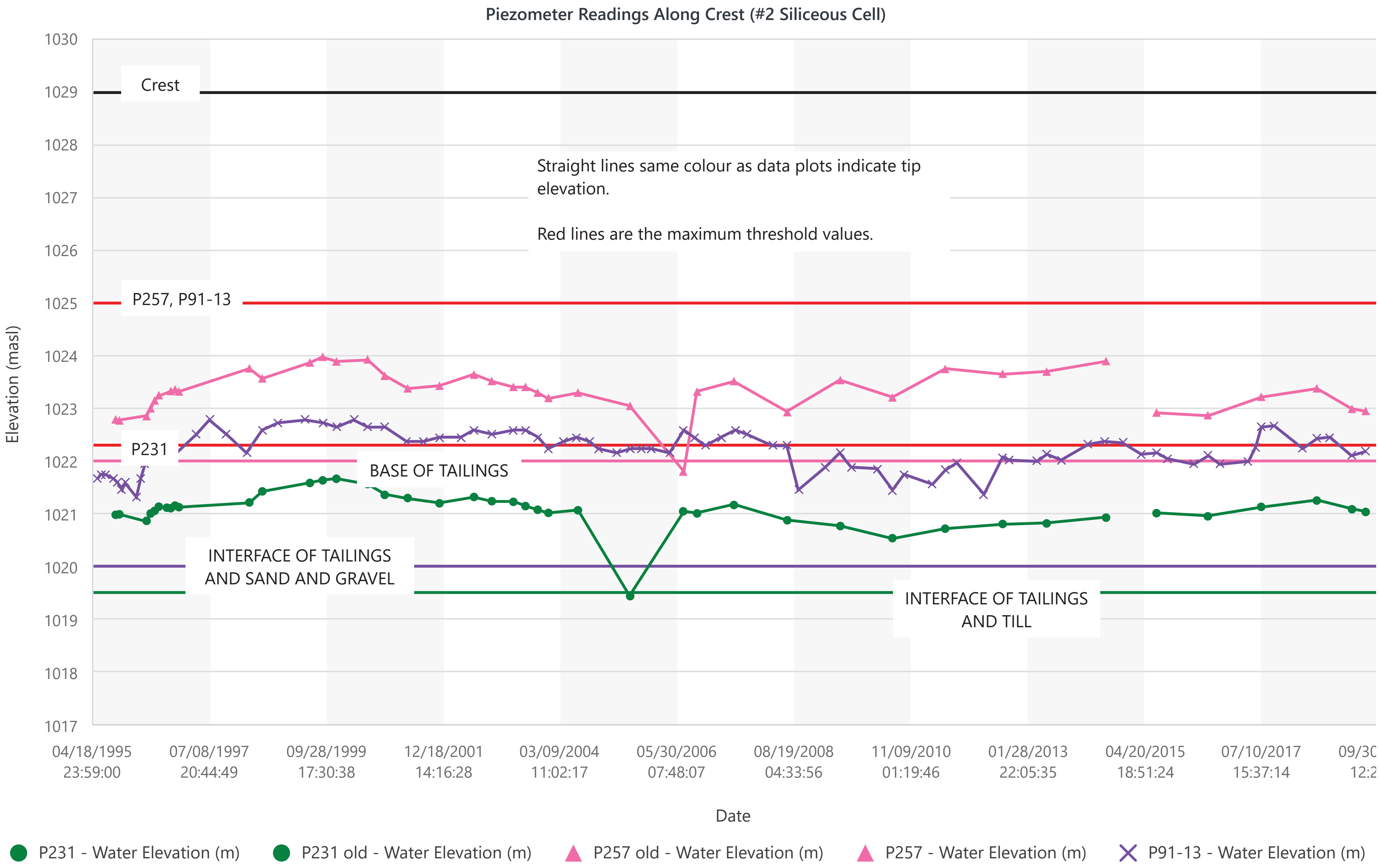
Figure VI-1 East and Middle



Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx old represents readings to point of flushing. SPxxx represents readings post flushing. If no "old" plot then no change to top of casing elevation or depth to bottom of standpipe.

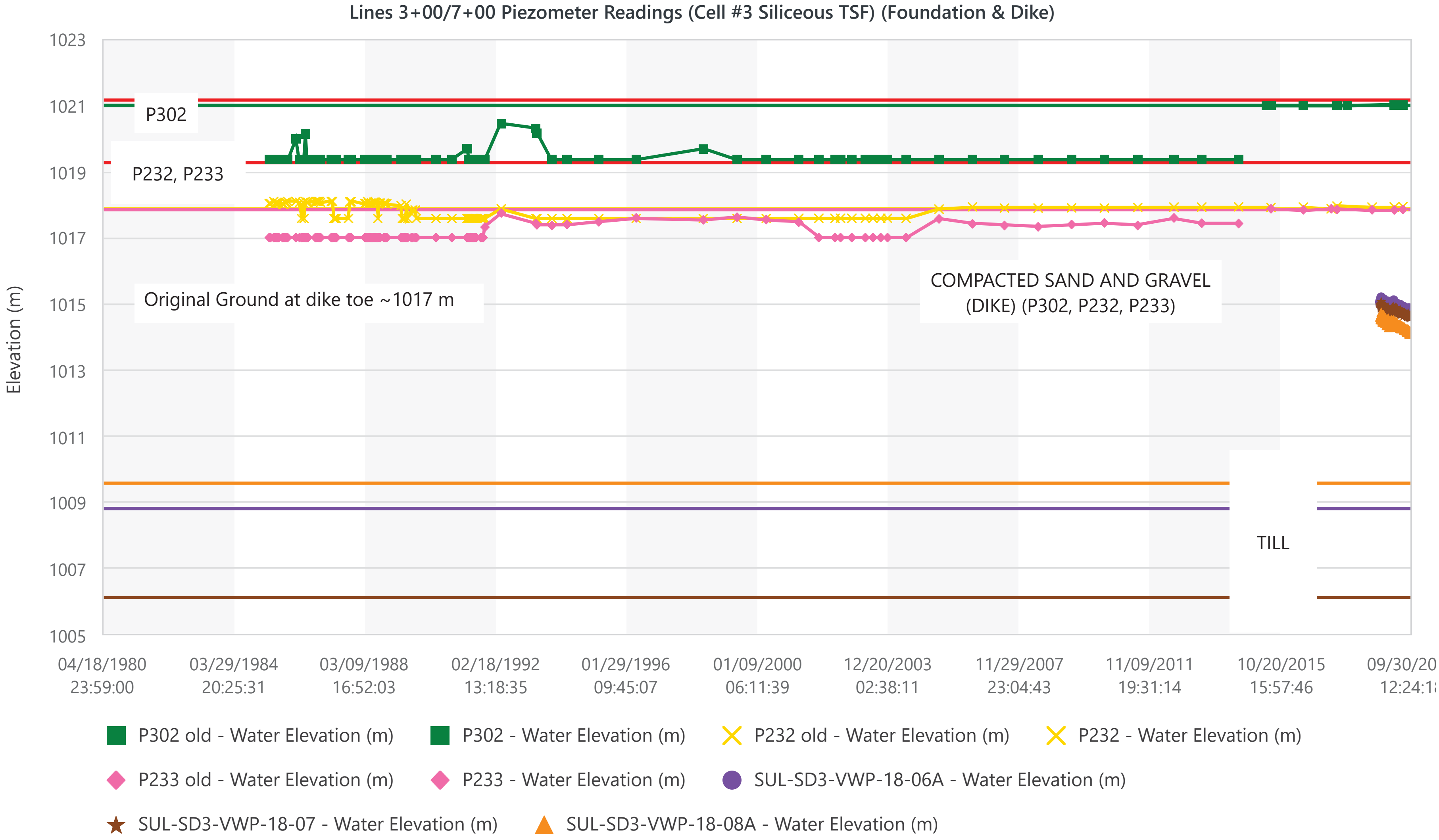
Figure VI-2 West



Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

Pxxx old represents readings to point of flushing. Pxxx represents readings post flushing. If no "old" plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure VI-3 Sil2 Crest



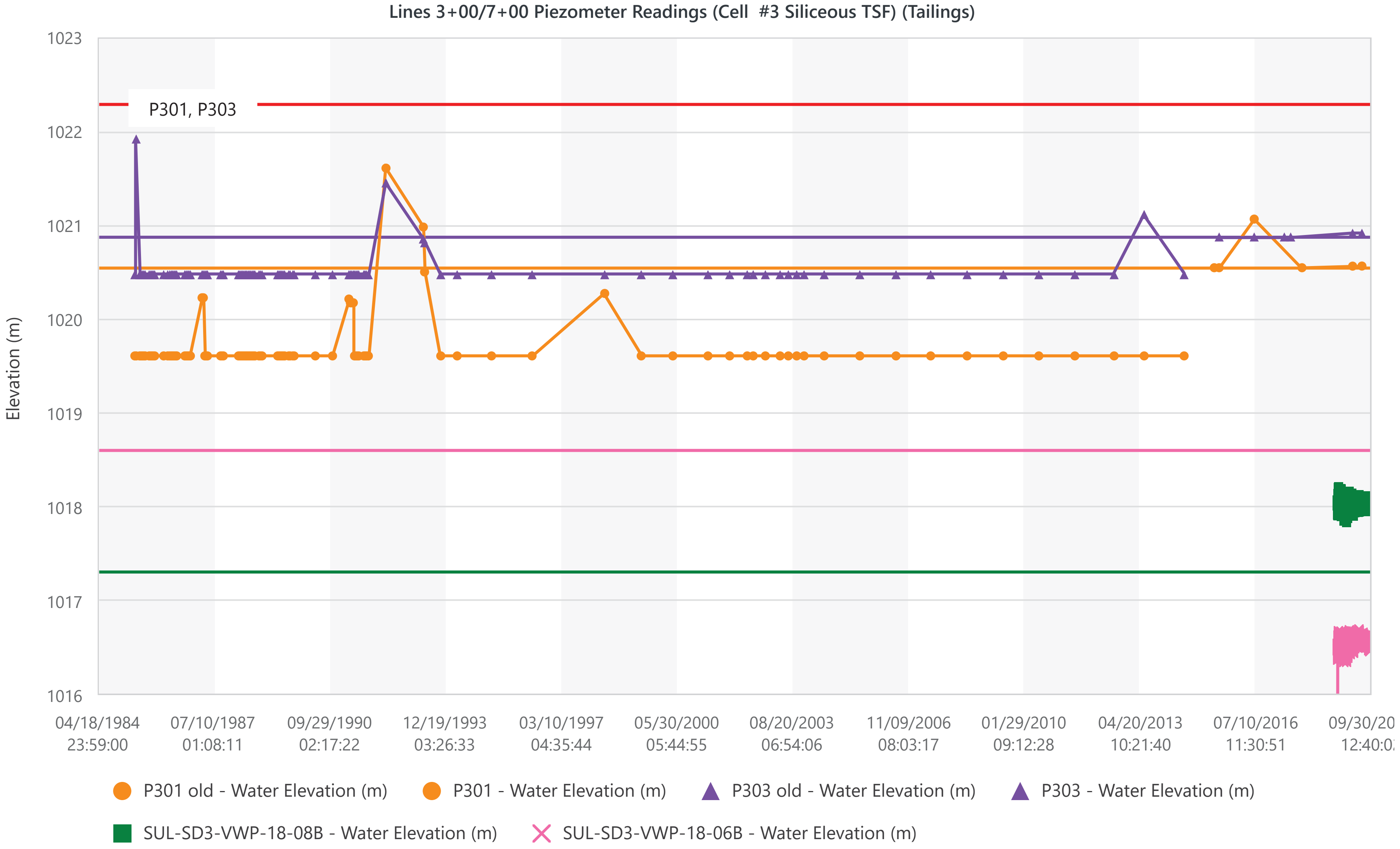
Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

Pxxx old represents readings to point of flushing. Pxxx represents readings post flushing. If no "old" plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure VI-4 Siliceous Cell #3 TSF Line 3 +00/7+00 (Foundation and Dike)



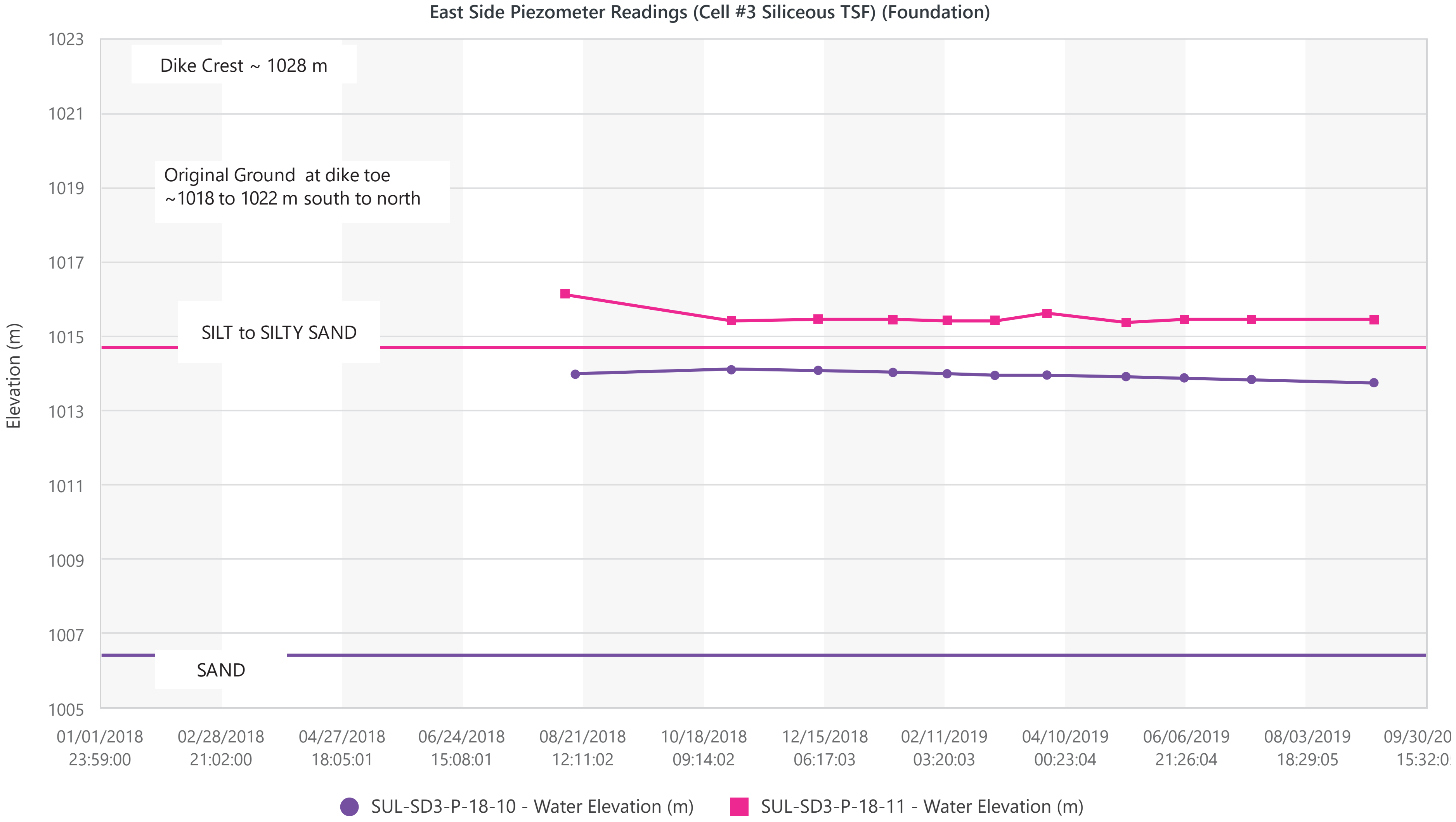
Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

Pxxx old represents readings to point of flushing. Pxxx represents readings post flushing. If no "old" plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure VI-5 Silceous Cell #3 TSF Line 3+00/7+00 (Tailings)



Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

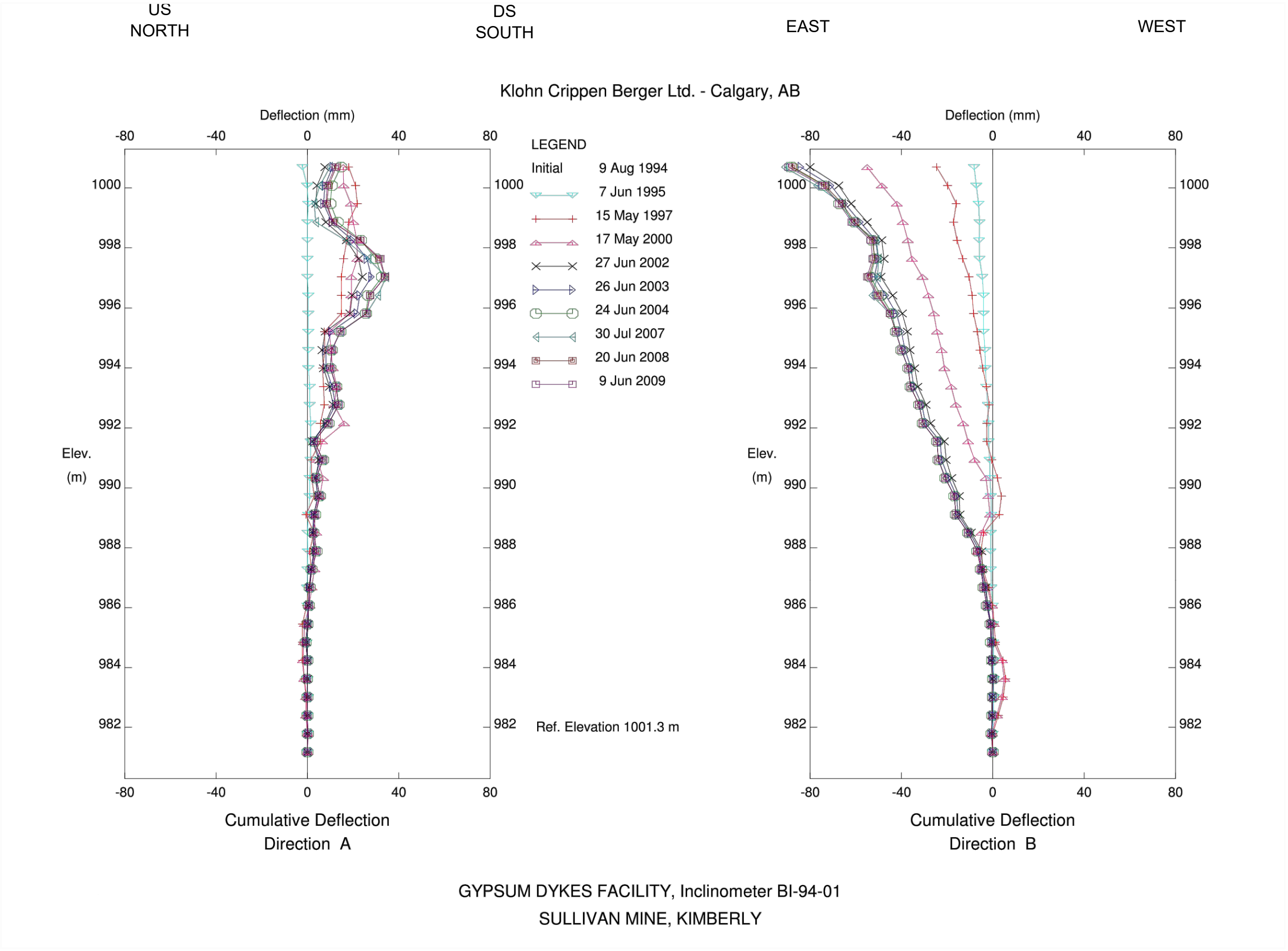
Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

Pxxx old represents readings to point of flushing. Pxxx represents readings post flushing. If no "old" plot then no change to top of casing elevation or depth to bottom of standpipe.

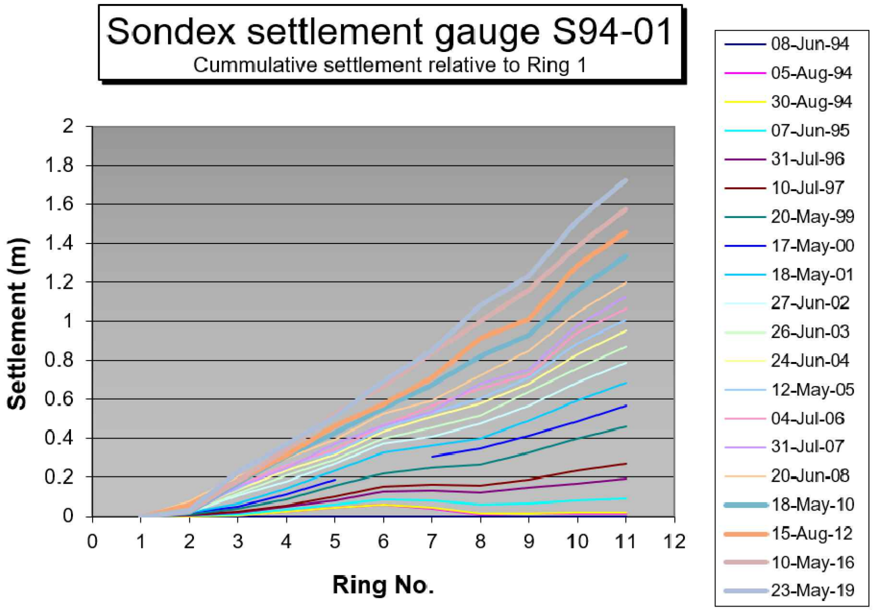
Figure VI-6 Siliceous Cell #3
TSF East (Foundation)

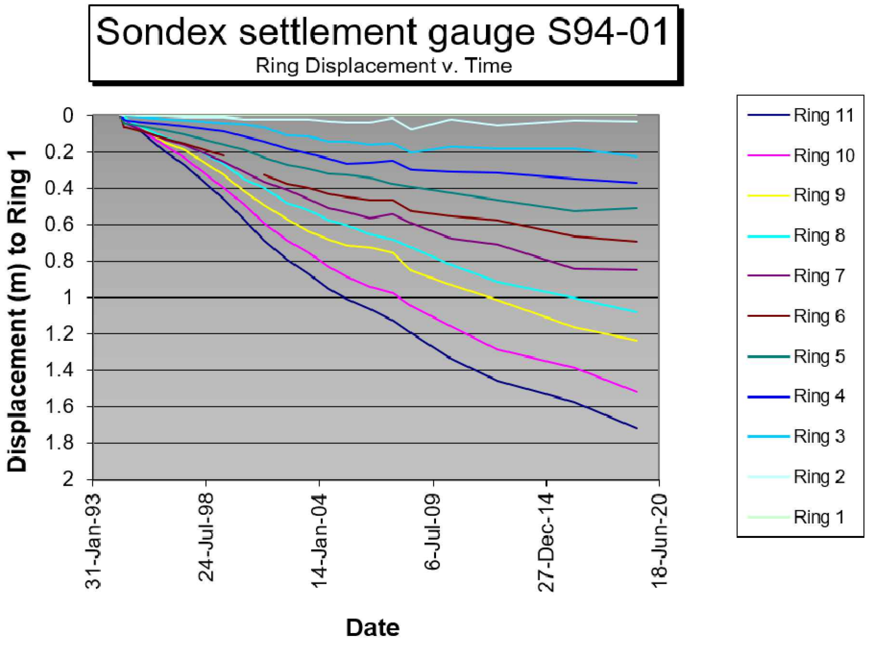
APPENDIX VII

West Gypsum Dyke Instrumentation



(CAN NO LONGER READ. BLOCKED AT 4.7 m BELOW THE GROUND SURFACE)





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PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

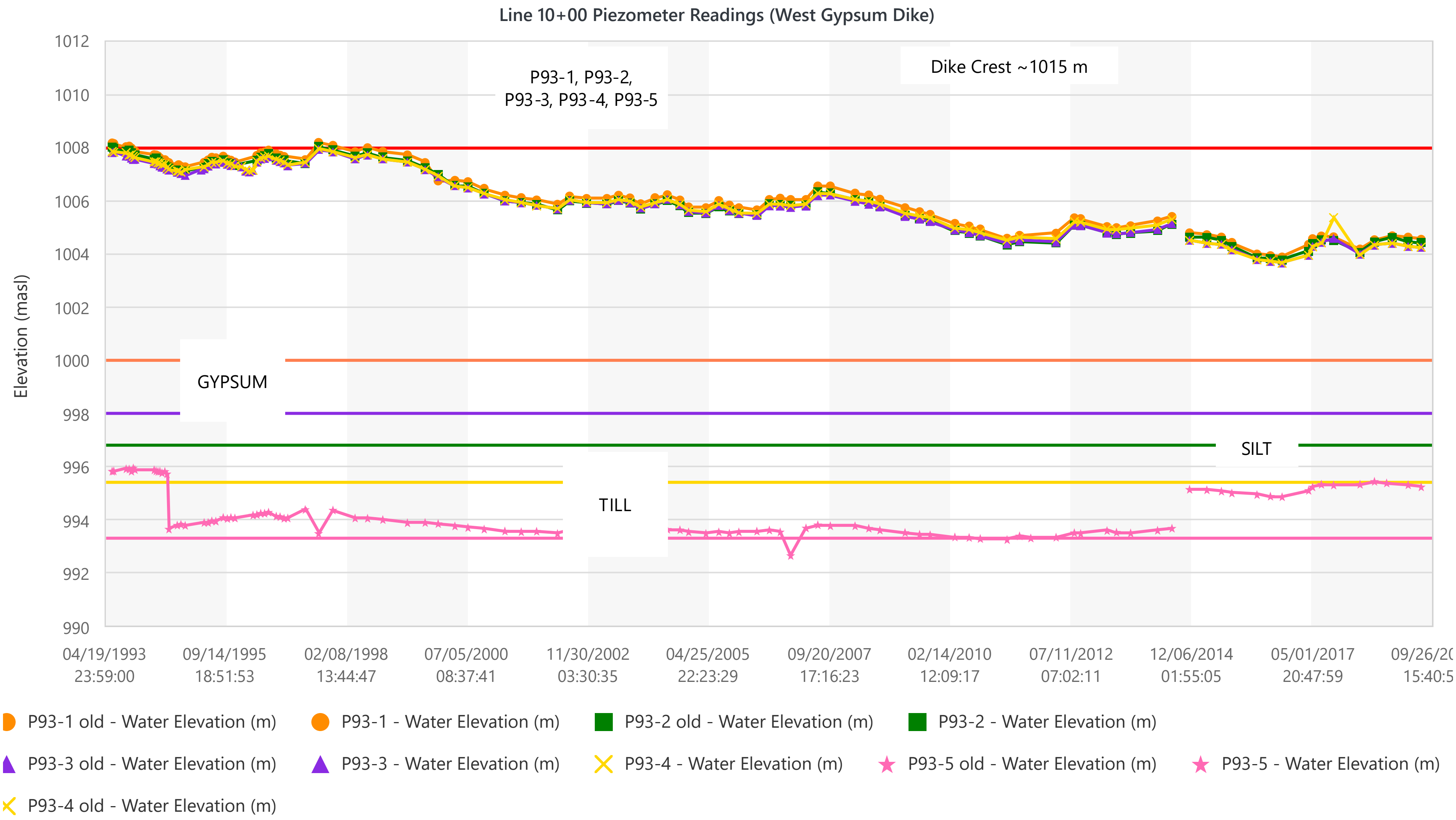
TITLE
WEST GYPSUM DIKE
SONDEX AND
INCLINOMETER PLOTS

PROJECT No.
A05807A19

FIG. No.
FIGURE VII-1

A05807A14 FIGure VI-1.dwg

KCC-F-B-M



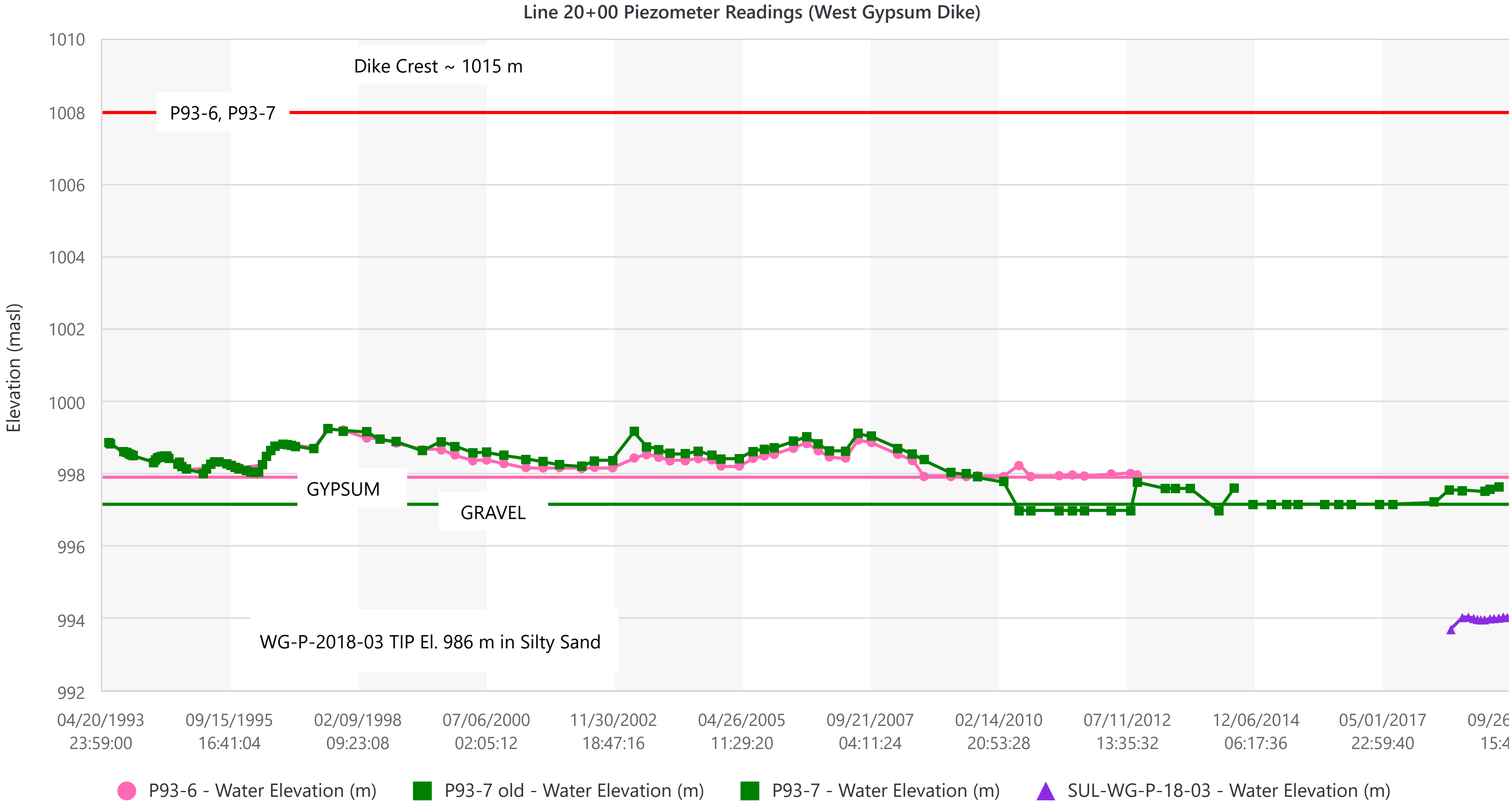
Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx old represents readings to point of flushing. SPxxx represents readings post flushing. If no "old" plot then no change to top of casing elevation or depth to bottom of standpipe

Figure VII-2 Line 10+00



Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

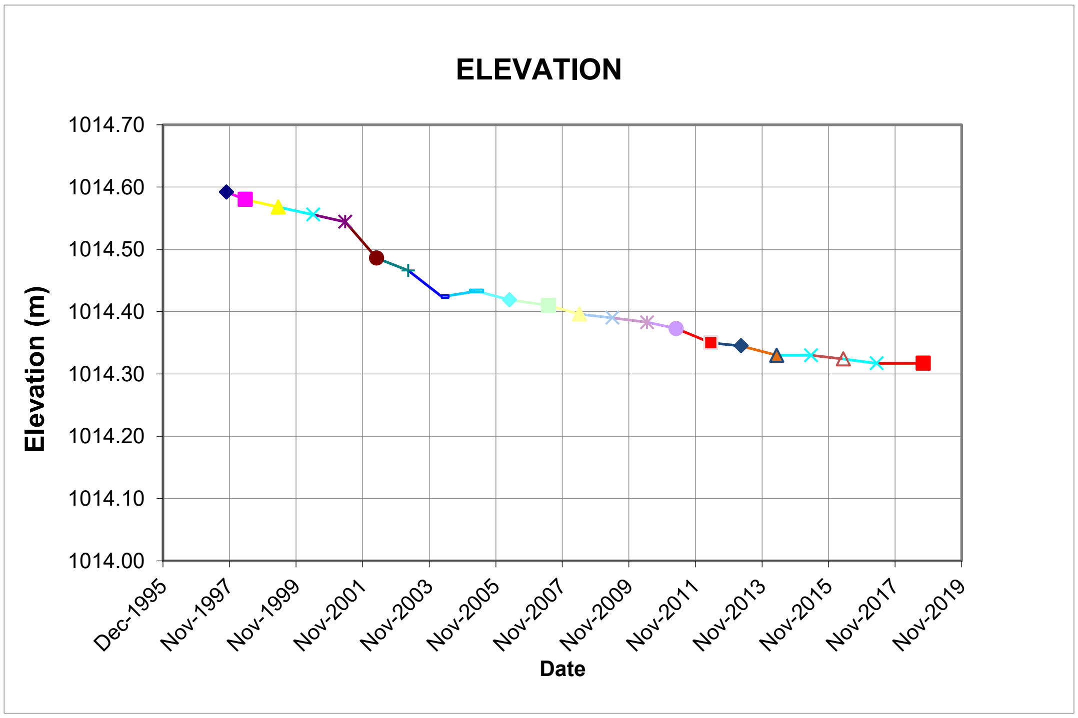
Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx old represents readings to point of flushing. SPxxx represents readings post flushing. If no "old" plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure VII-3 Line 20+00

SP97-01 Line 10+00

SETTLEMENT PLATES - WEST GYPSUM DIKE



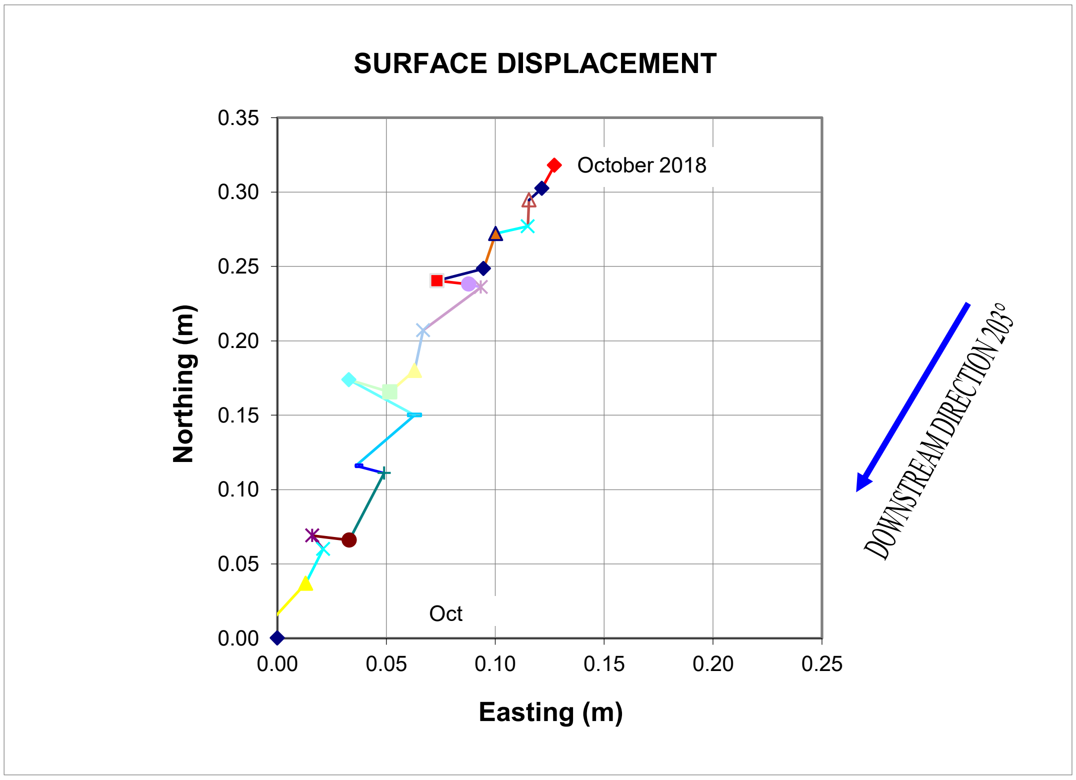
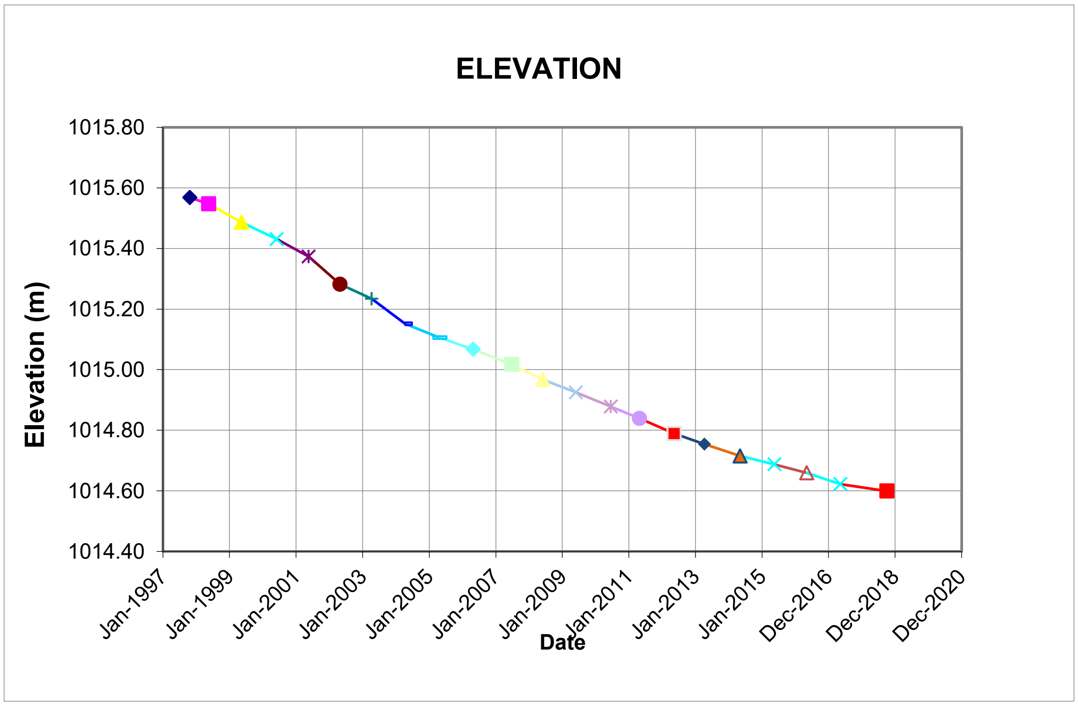


Figure VII-4-SP97-01

SP97-05 Line 10+00

SETTLEMENT PLATES - WEST GYPSUM DIKE



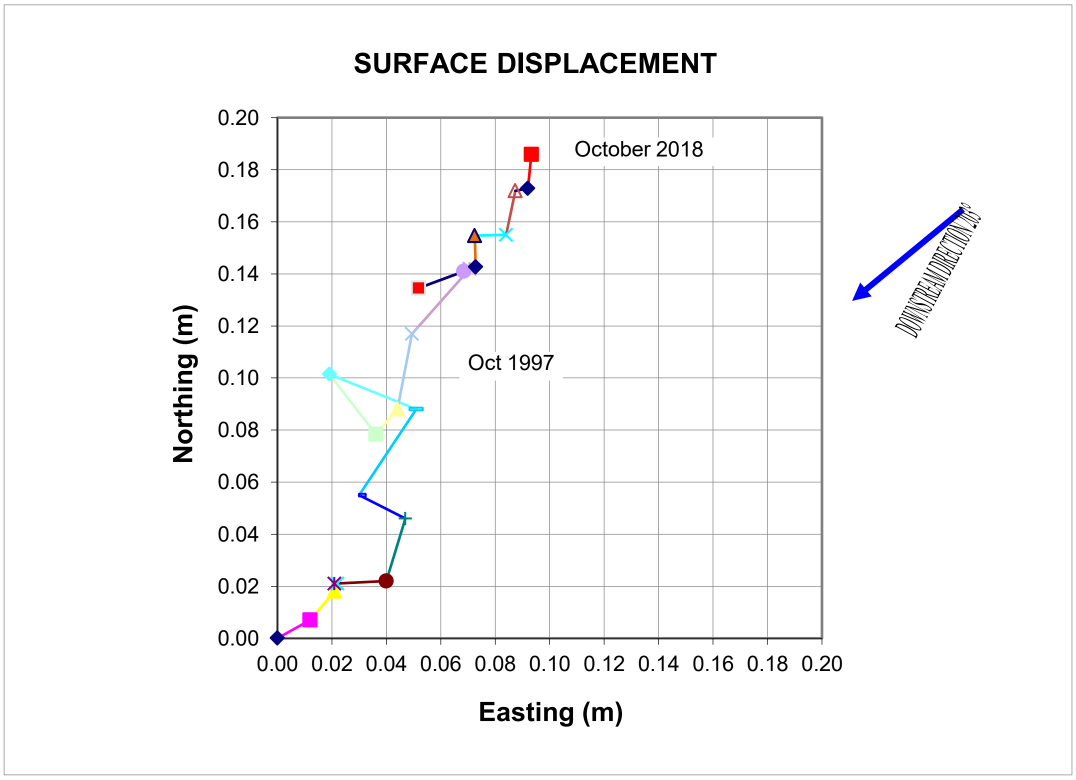
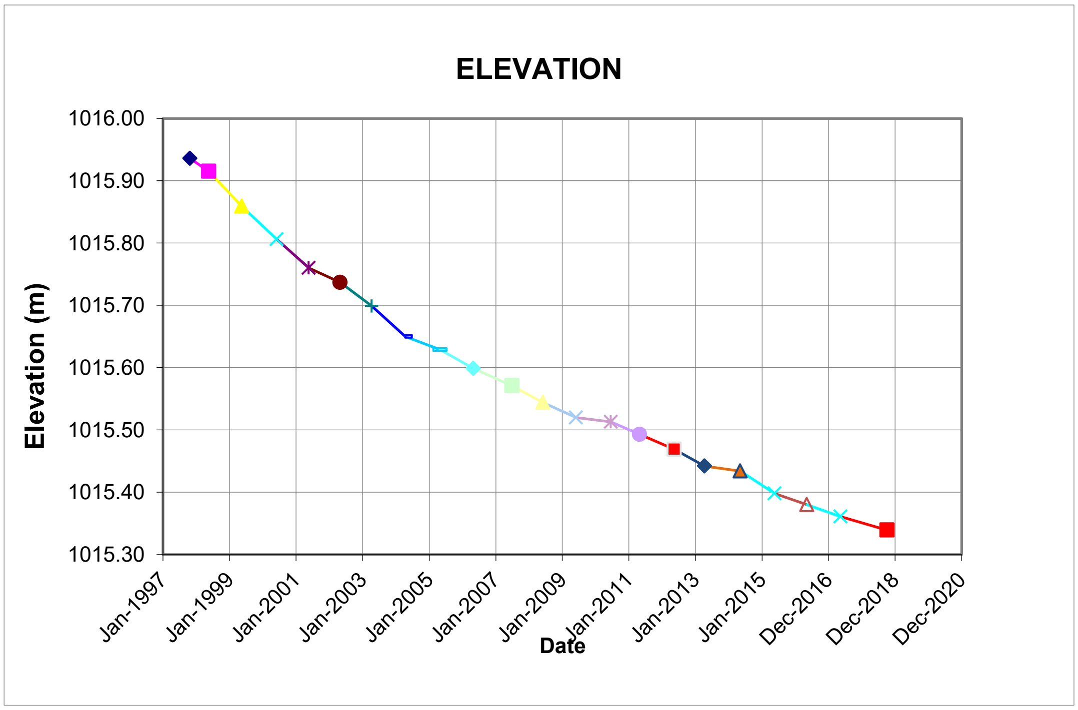
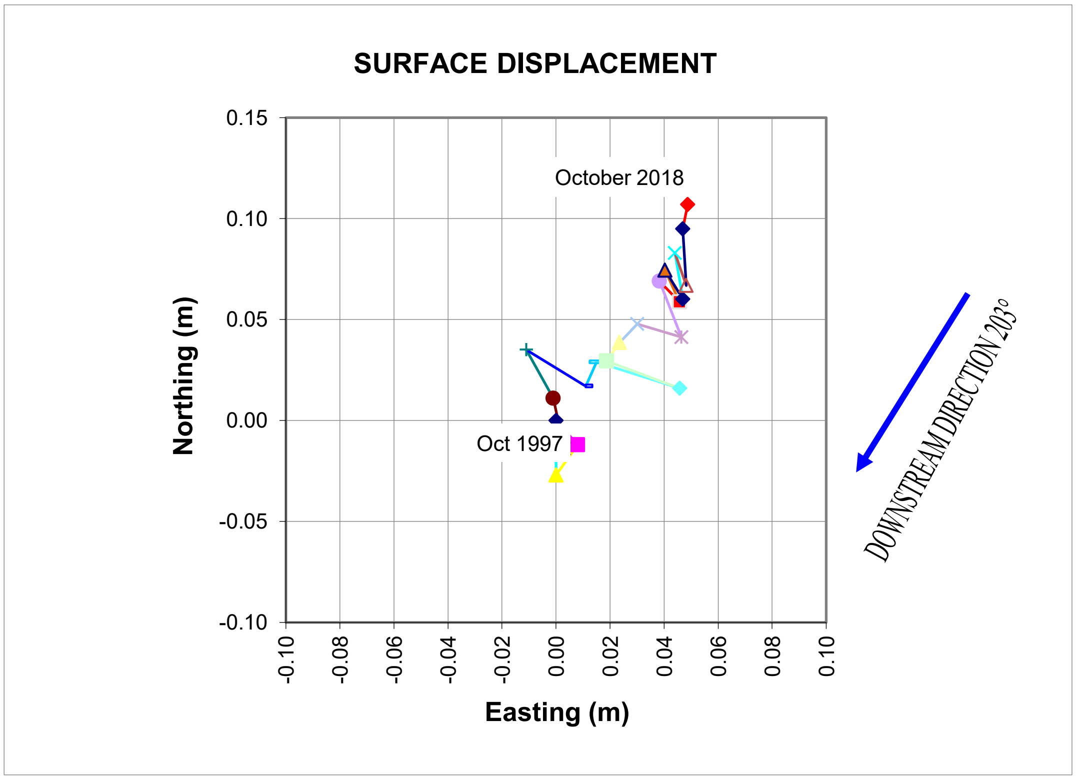


Figure VII-5-SP97-05

SP97-06 Line 20+00

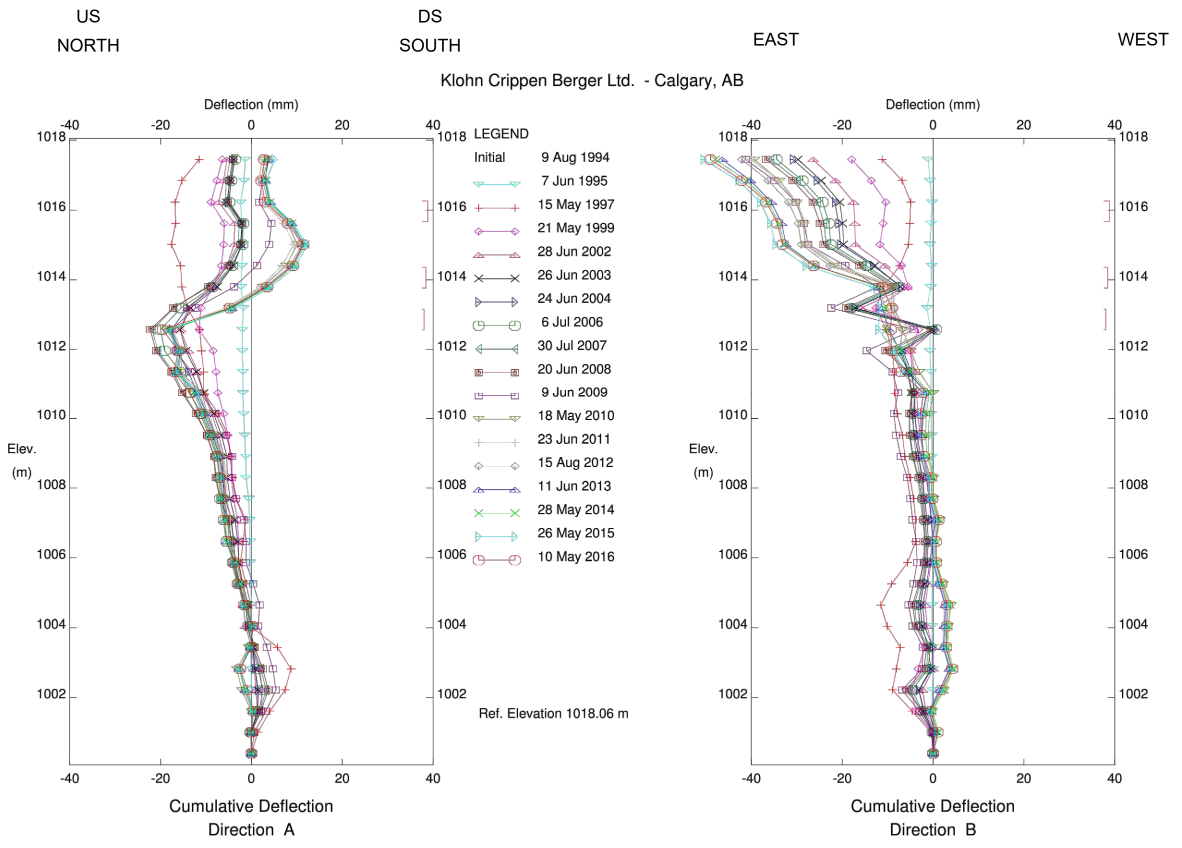
SETTLEMENT PLATES - WEST GYPSUM DIKE



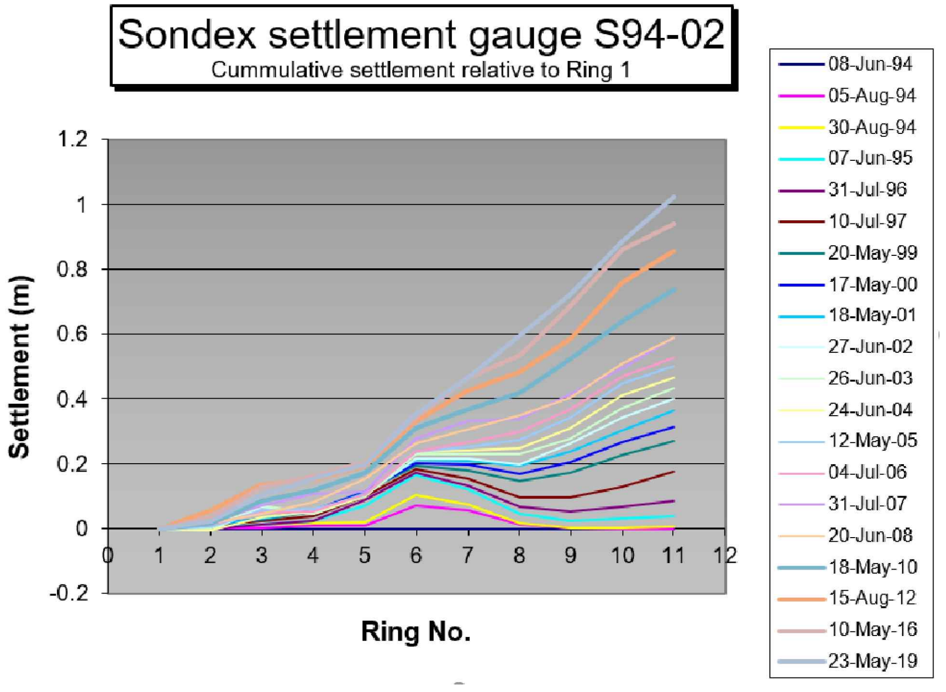


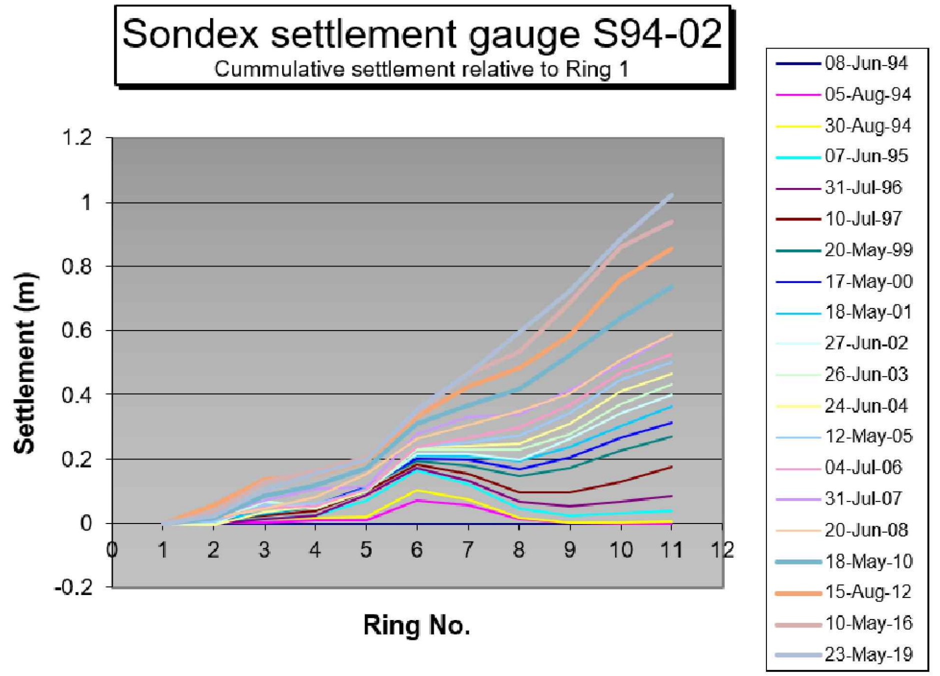
APPENDIX VIII

East Gypsum Dyke Instrumentation



GYPSUM DYKES FACILITY, Inclinometer BI-94-02
SULLIVAN MINE, KIMBERLEY





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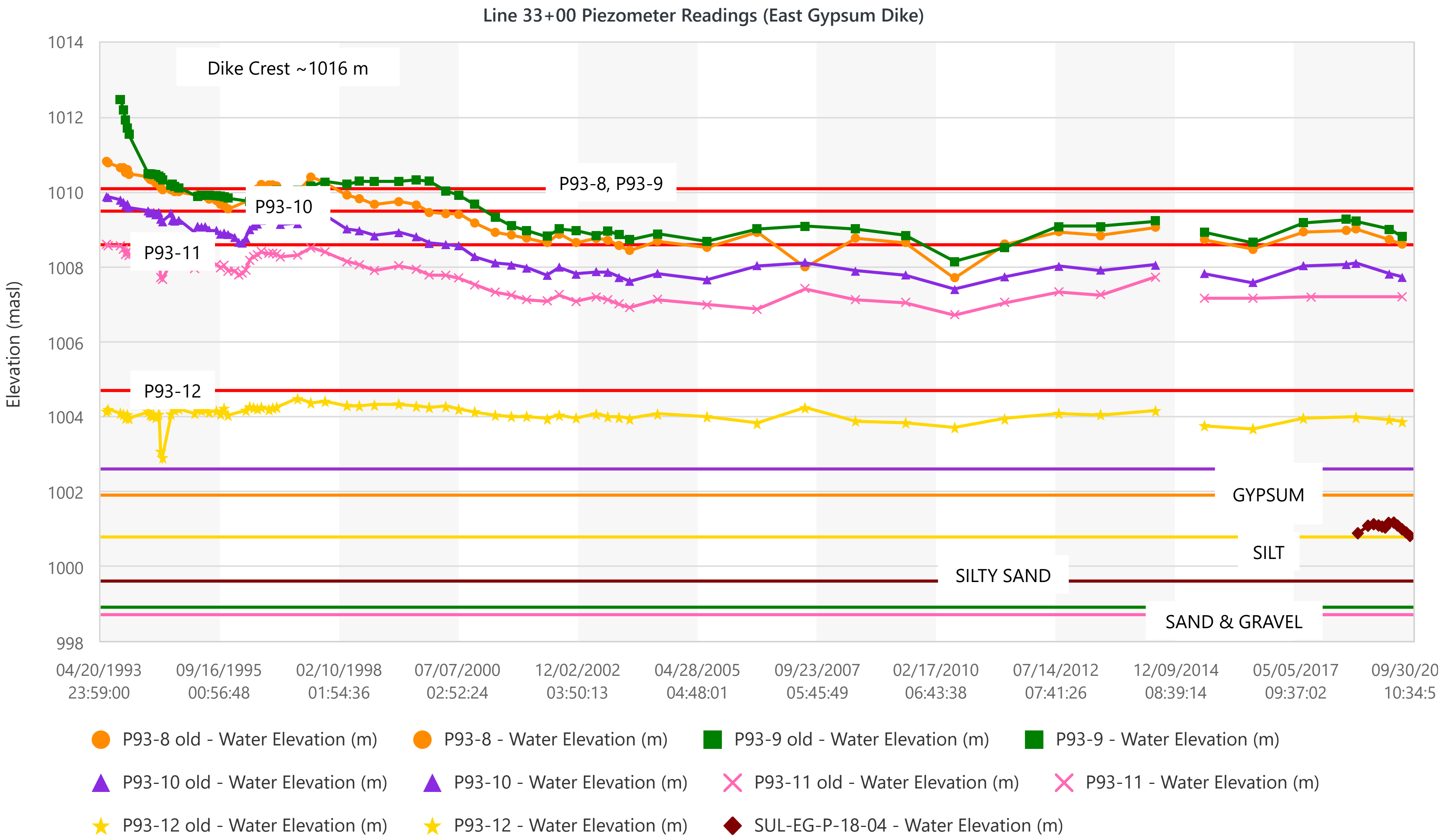
PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
EAST GYPSUM DIKE
SONDEX AND
INCLINOMETER PLOTS

PROJECT No.
A05807A19

FIG. No.
FIGURE VIII-1



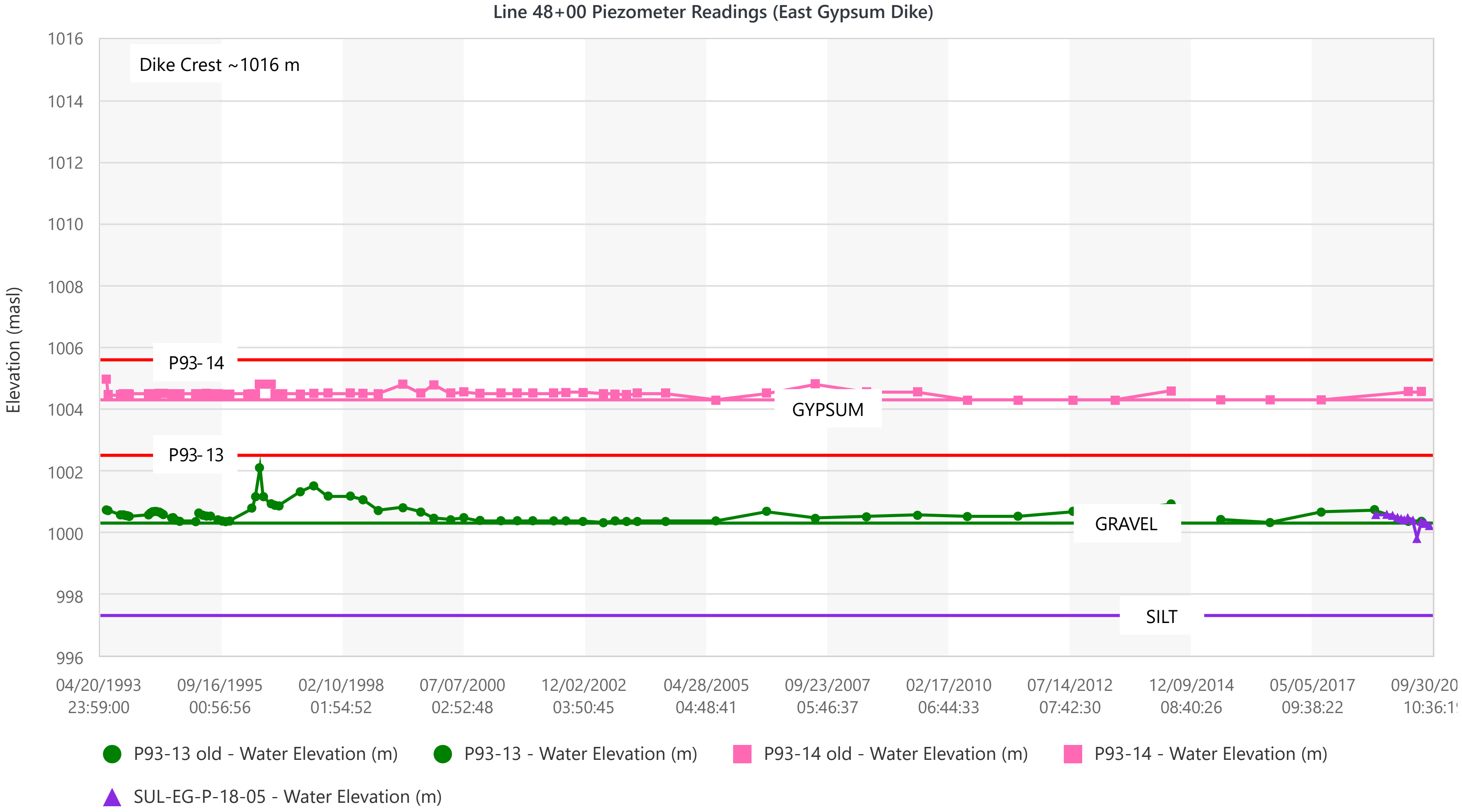
Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure VIII-2 Line 33+00



Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

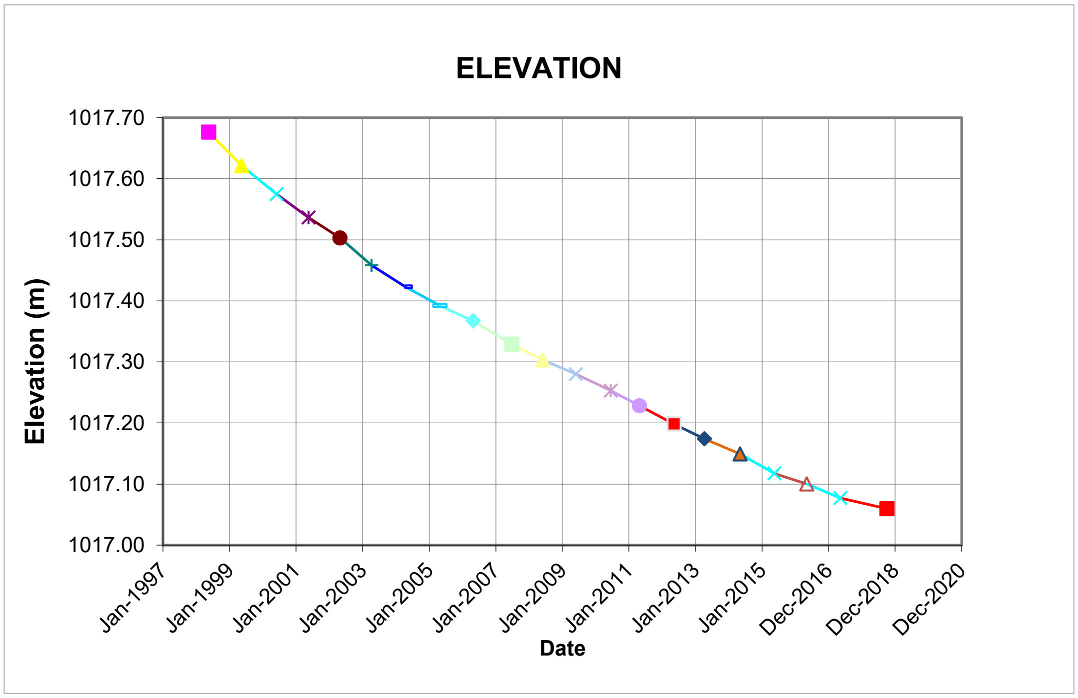
Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

Pxxx old represents readings to point of flushing. Pxxx represents readings post flushing. If no "old" plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure VIII-3 Line 48+00

SP97-03 Line 33+00

SETTLEMENT PLATES - EAST GYPSUM DIKE



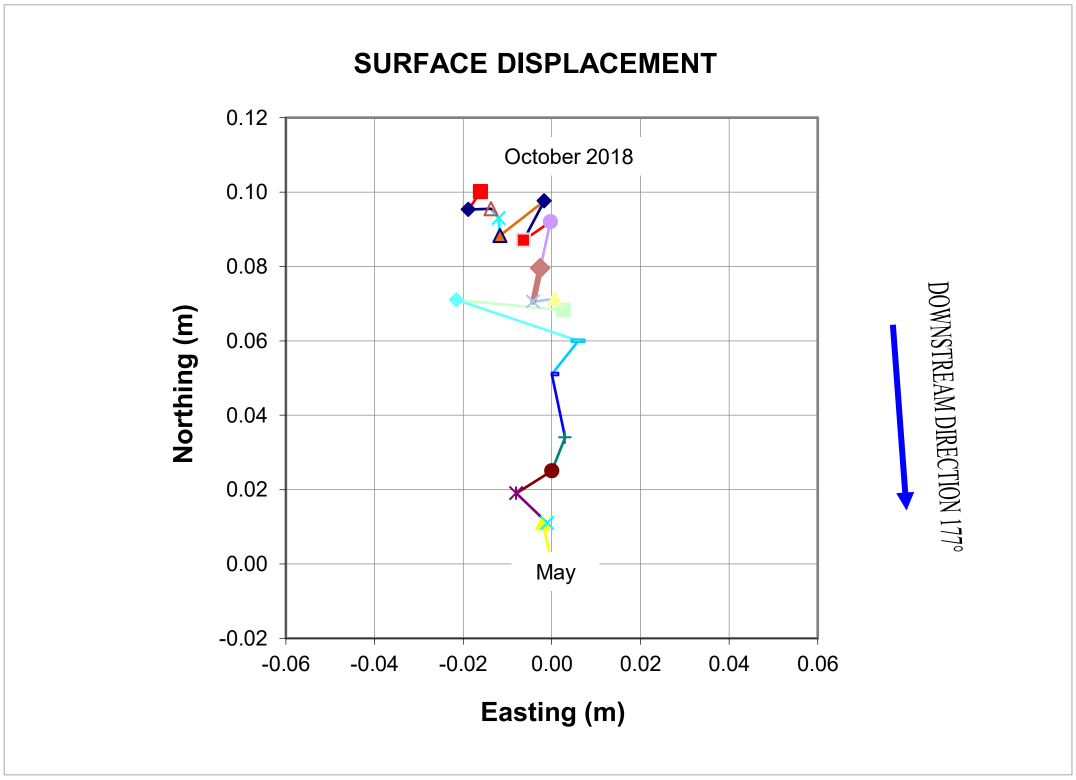
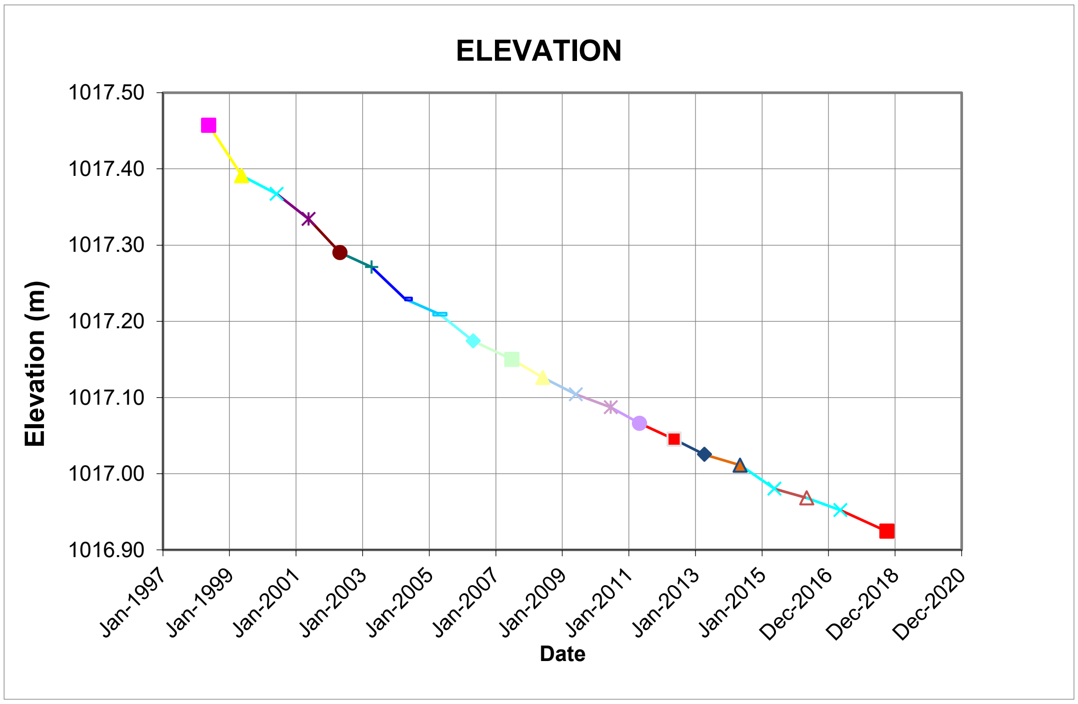
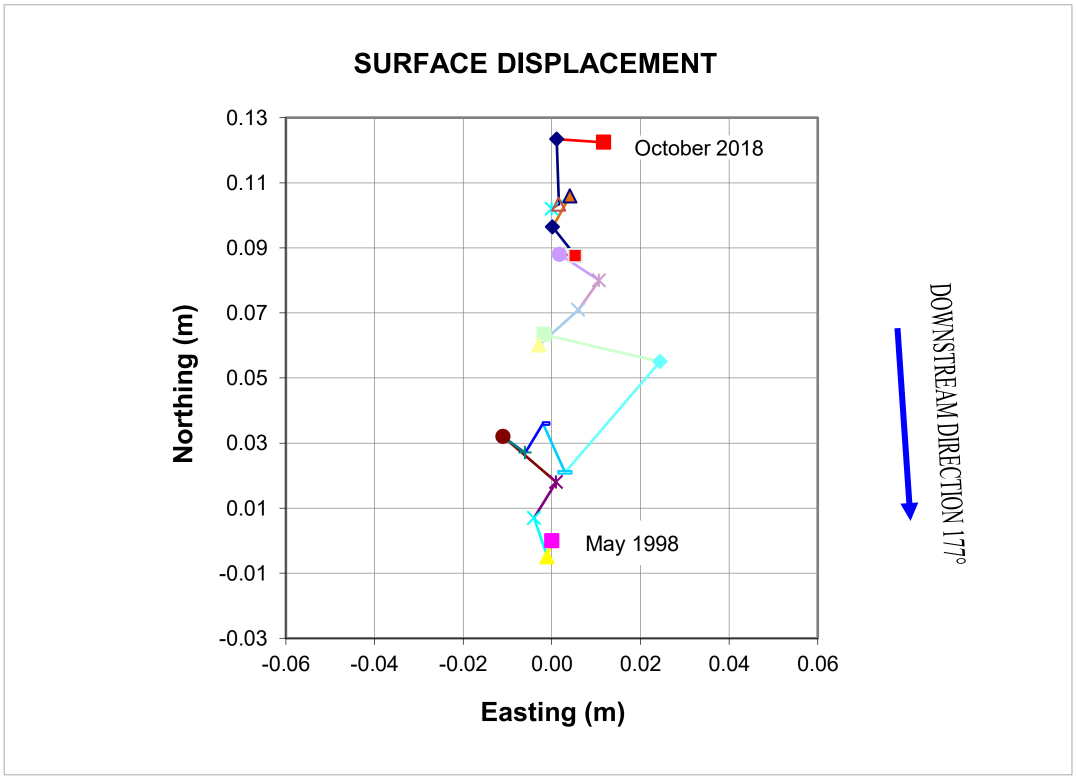


Figure VIII-4-SP97-03

SP97-04 Line 48+00

SETTLEMENT PLATES - EAST GYPSUM DIKE



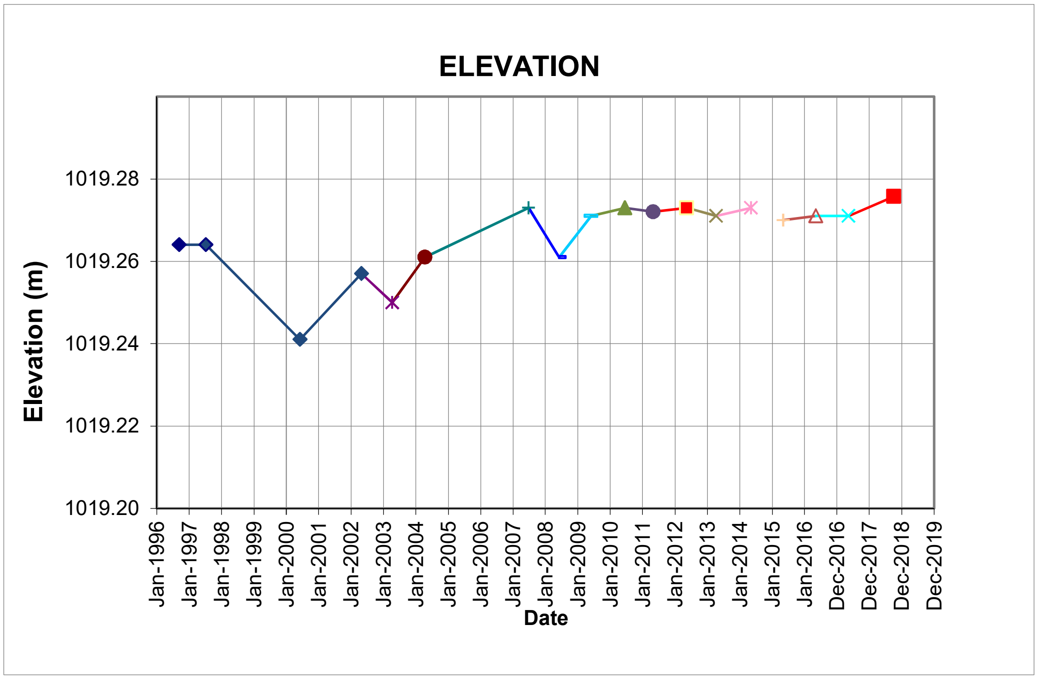


APPENDIX IX

Northeast Gypsum Dyke Instrumentation

W Pipe

NE Gypsum Dike



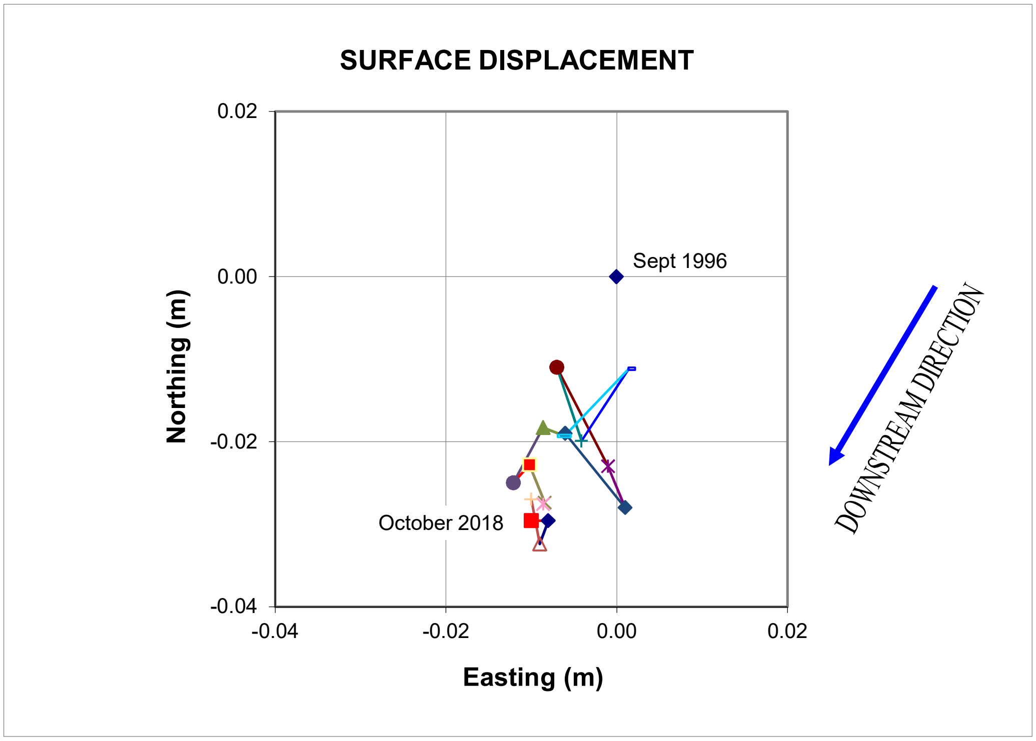
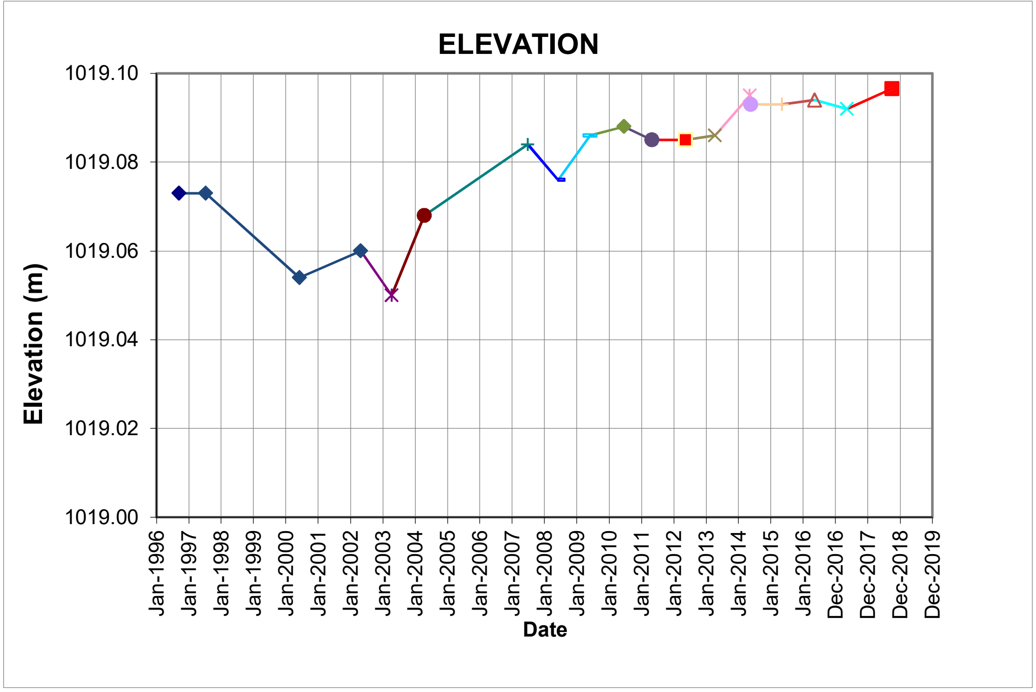


Figure IX-1 NE Gypsum Dike W pipe

E Pipe

NE Gypsum Dike



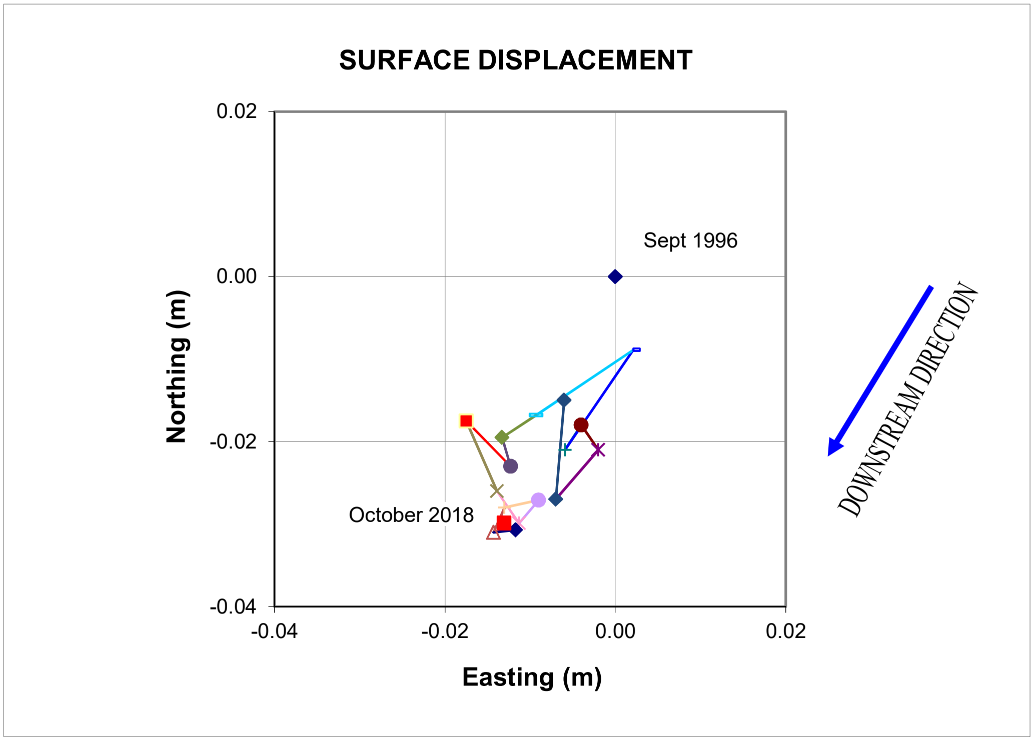


Figure IX-2 NE Gypsum Dike E pipe

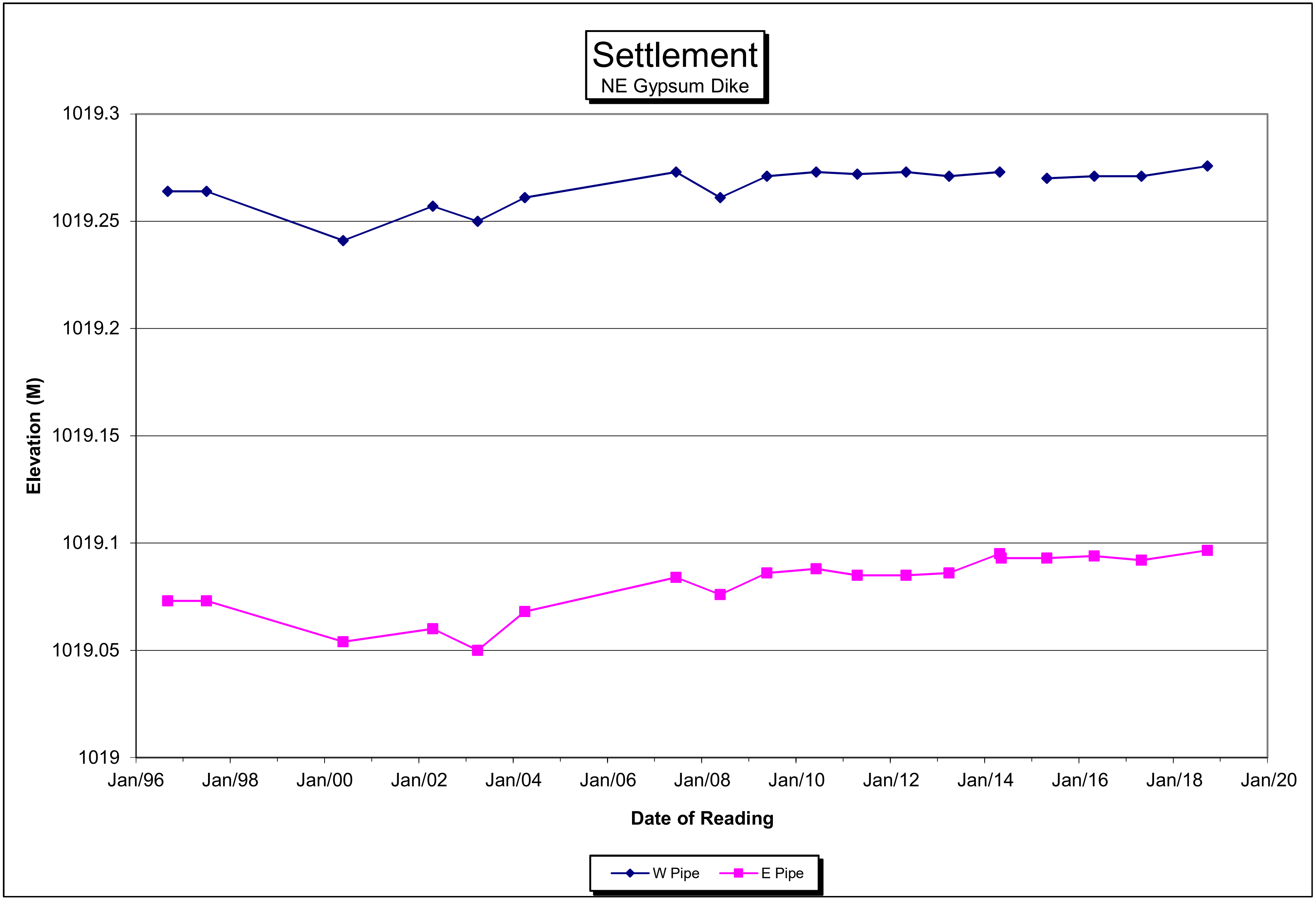

Settlement
NE Gypsum Dike
1019.3
1019.25
1019.2
1019.15
1019.1
1019.05
1019
Elevation (M)
Jan/96
Jan/98
Jan/00
Jan/02
Jan/04
Jan/06
Jan/08
Jan/10
Jan/12
Jan/14
Jan/16
Jan/18
Jan/20
Date of Reading
W Pipe
E Pipe

Figure IX-3

APPENDIX X

ARD Instrumentation

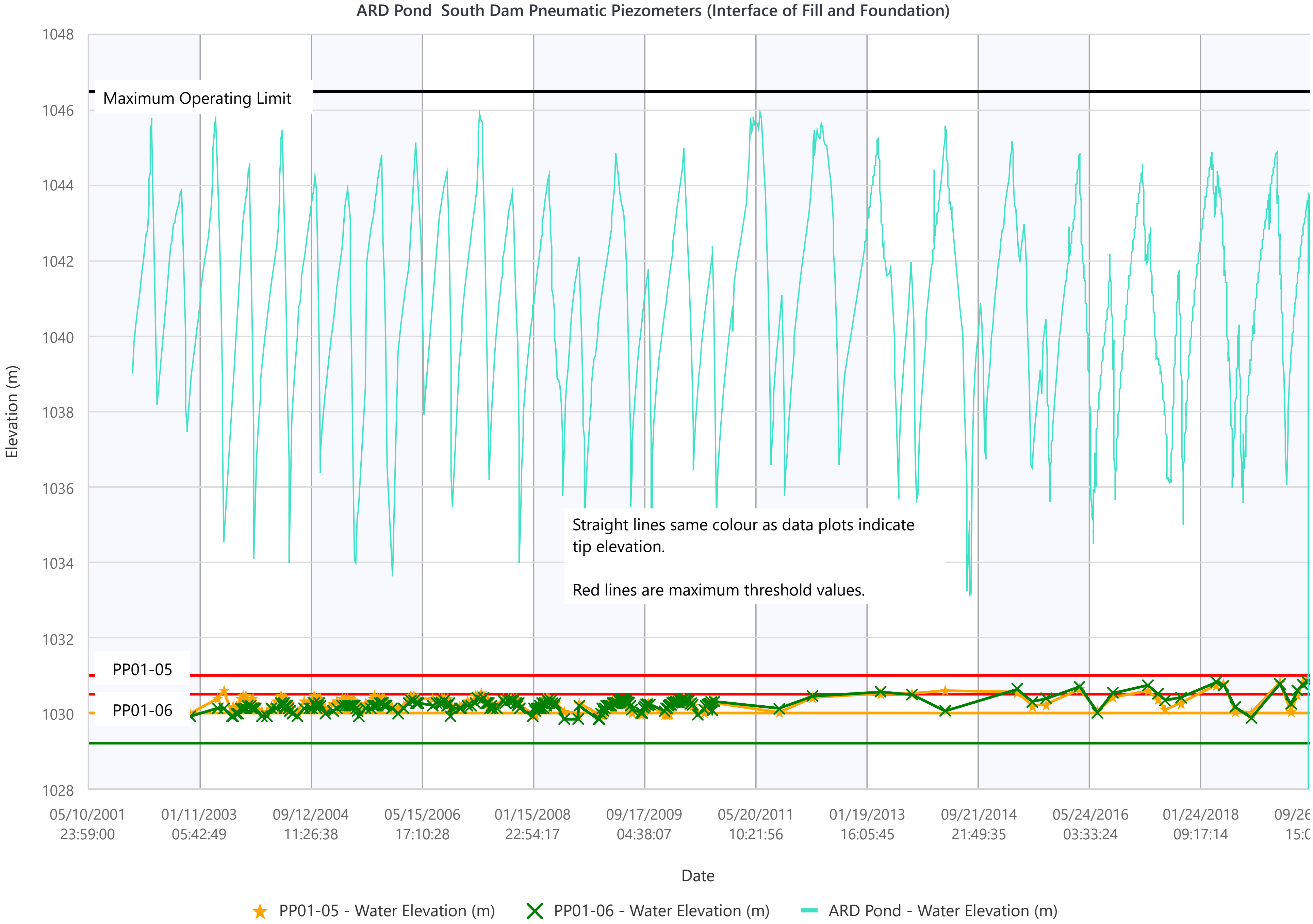
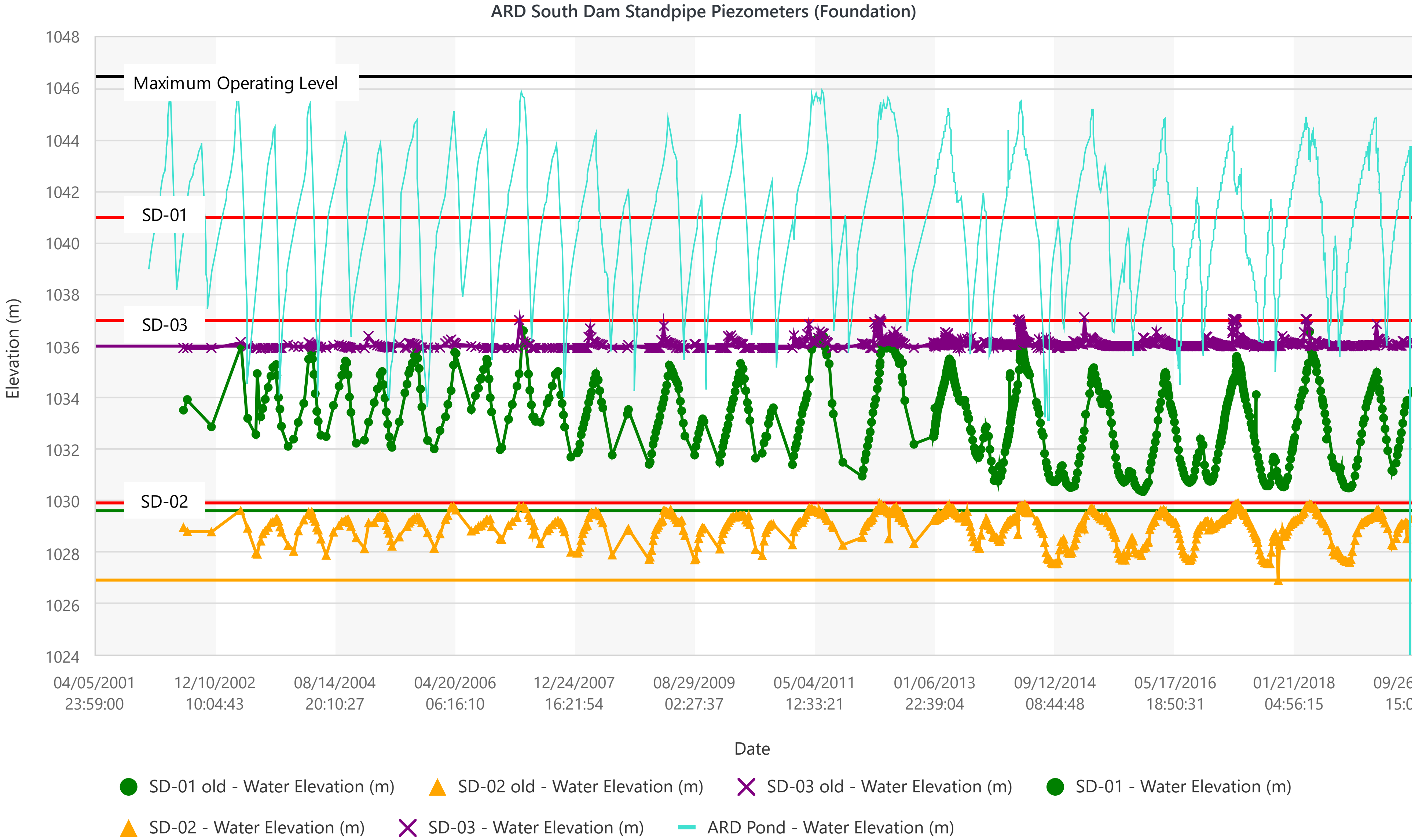


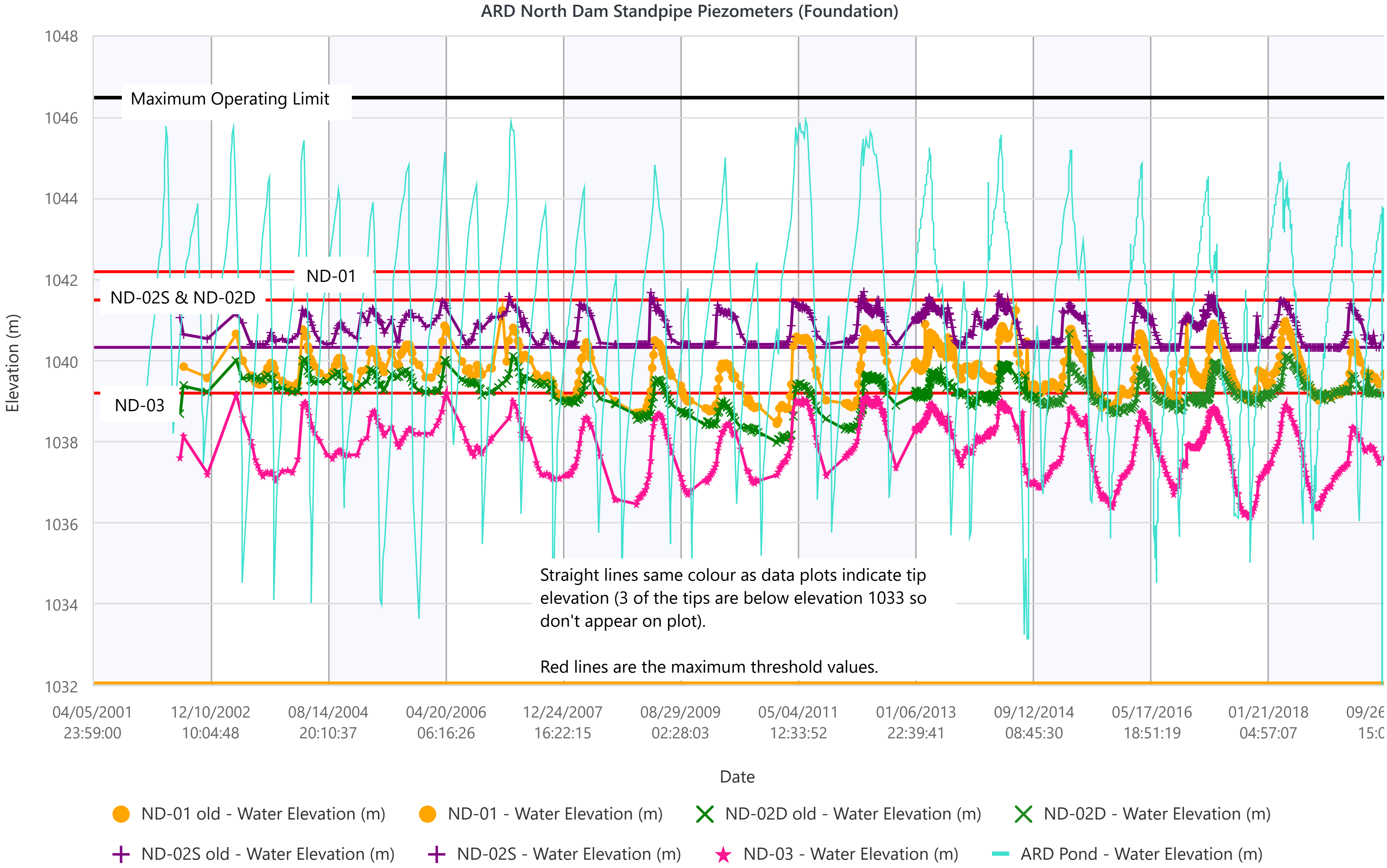
Figure X-1 South Dam



Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Only noticeable for those instruments which record "dry" or if previous top of casing elevation was incorrect due to damage.

SD-xx represents readings to point of flushing. SD-xx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure X-2 South Dam Standpipe



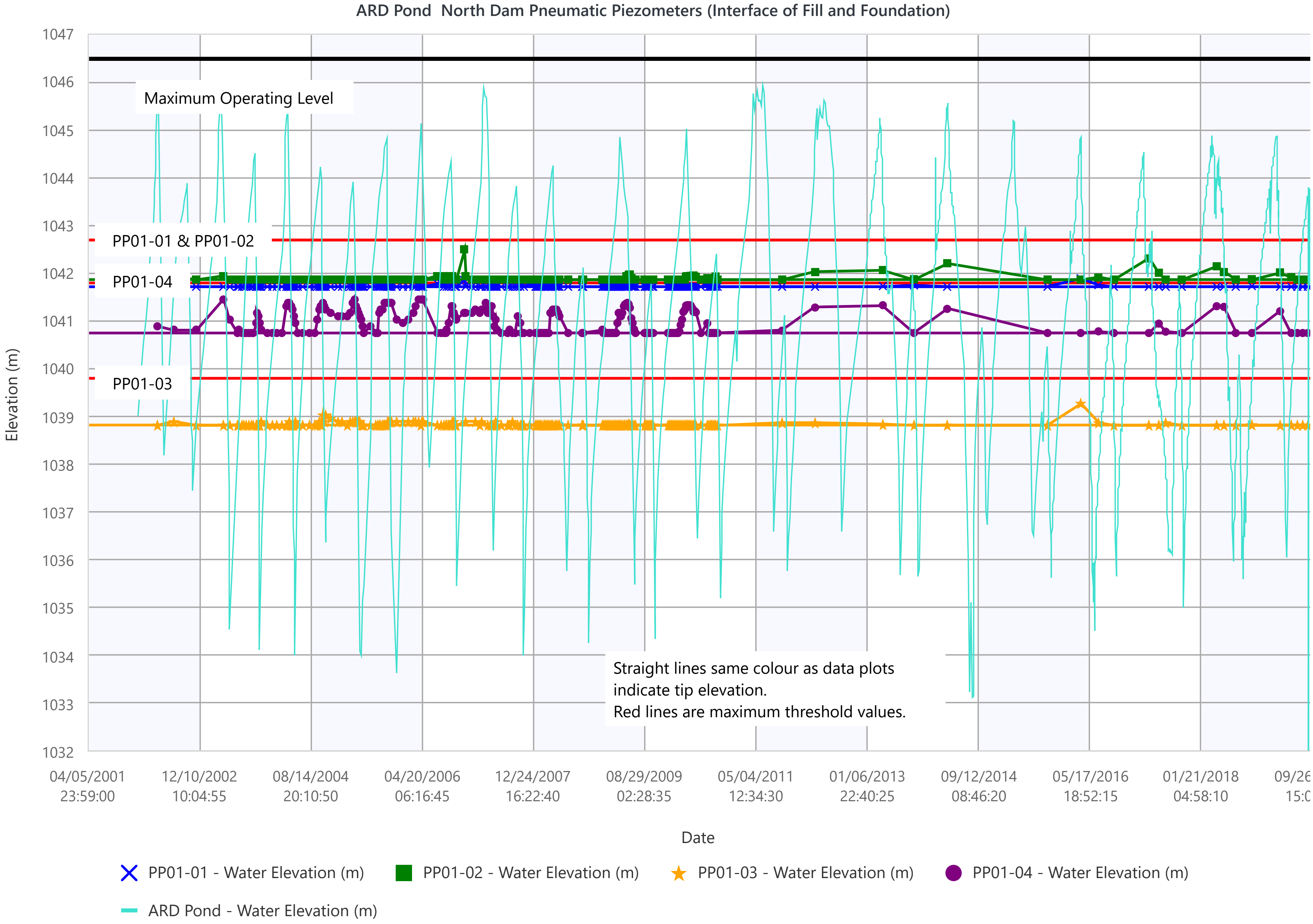
Straight lines same colour as data plots indicate tip elevation (3 of the tips are below elevation 1033 so don't appear on plot).

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Only noticeable for those instruments which record "dry" or if previous top of casing elevation was incorrect due to damage.

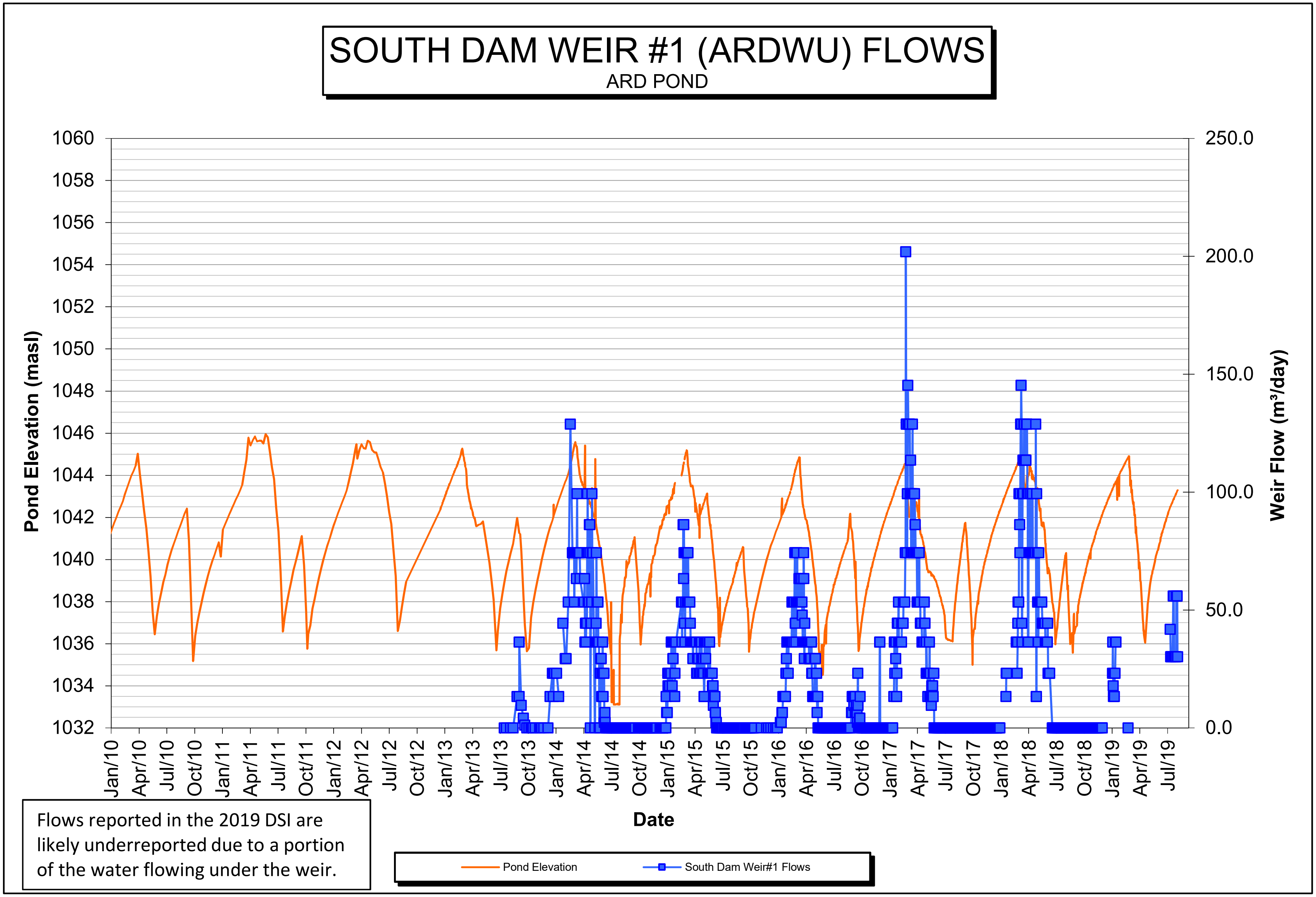
ND-xx represents readings to point of flushing. ND-xx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure X-3 North Dam Standpipes



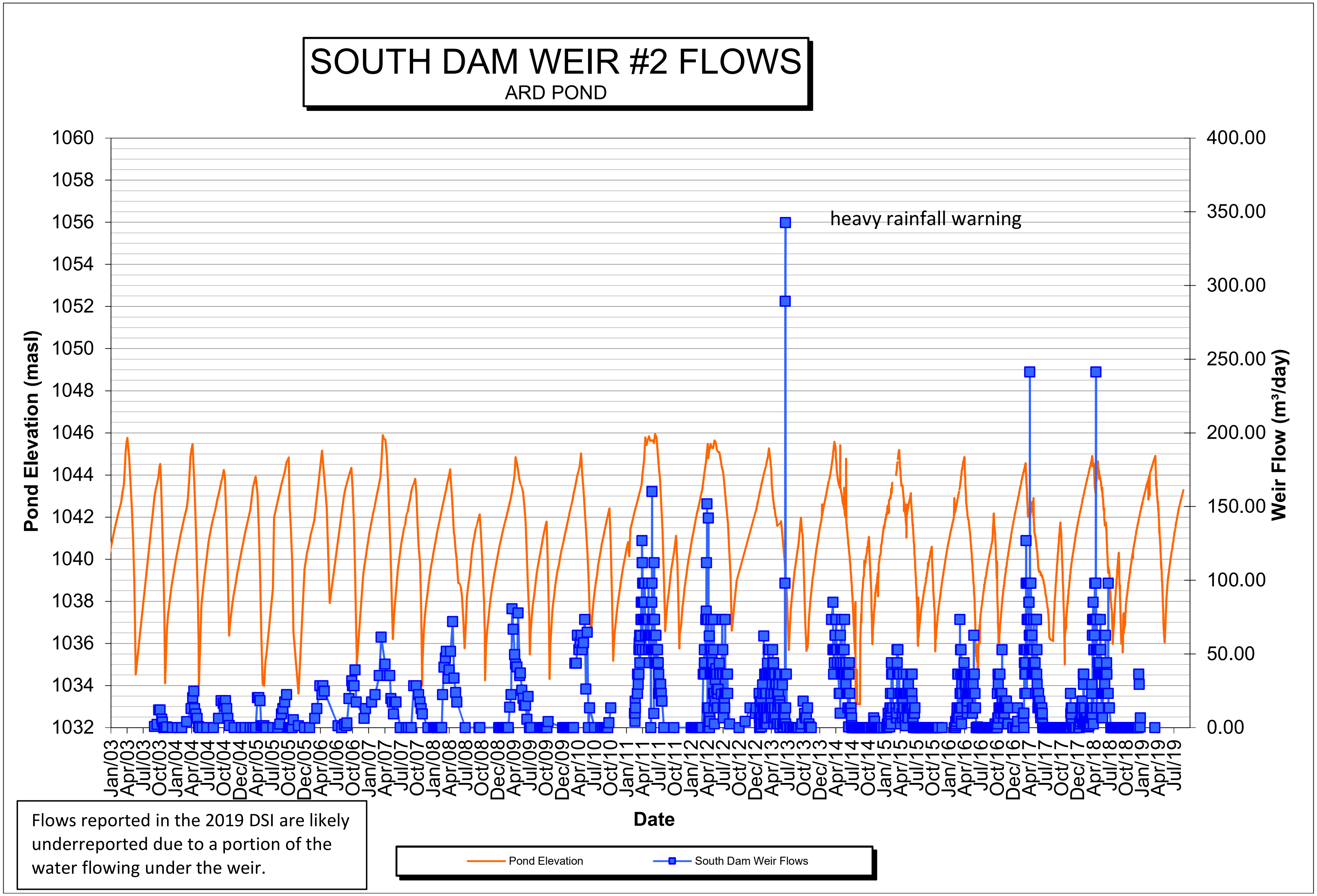
Straight lines same colour as data plots indicate tip elevation.
Red lines are maximum threshold values.

Figure X-4 North Dam Piezometers



Flows reported in the 2019 DSI are likely underreported due to a portion of the water flowing under the weir.

Figure X-5 ARD Weir #1 (ARDWU) time plot



Flows reported in the 2019 DSI are likely underreported due to a portion of the water flowing under the weir.

Figure X-6 ARD Weir #2 time plot

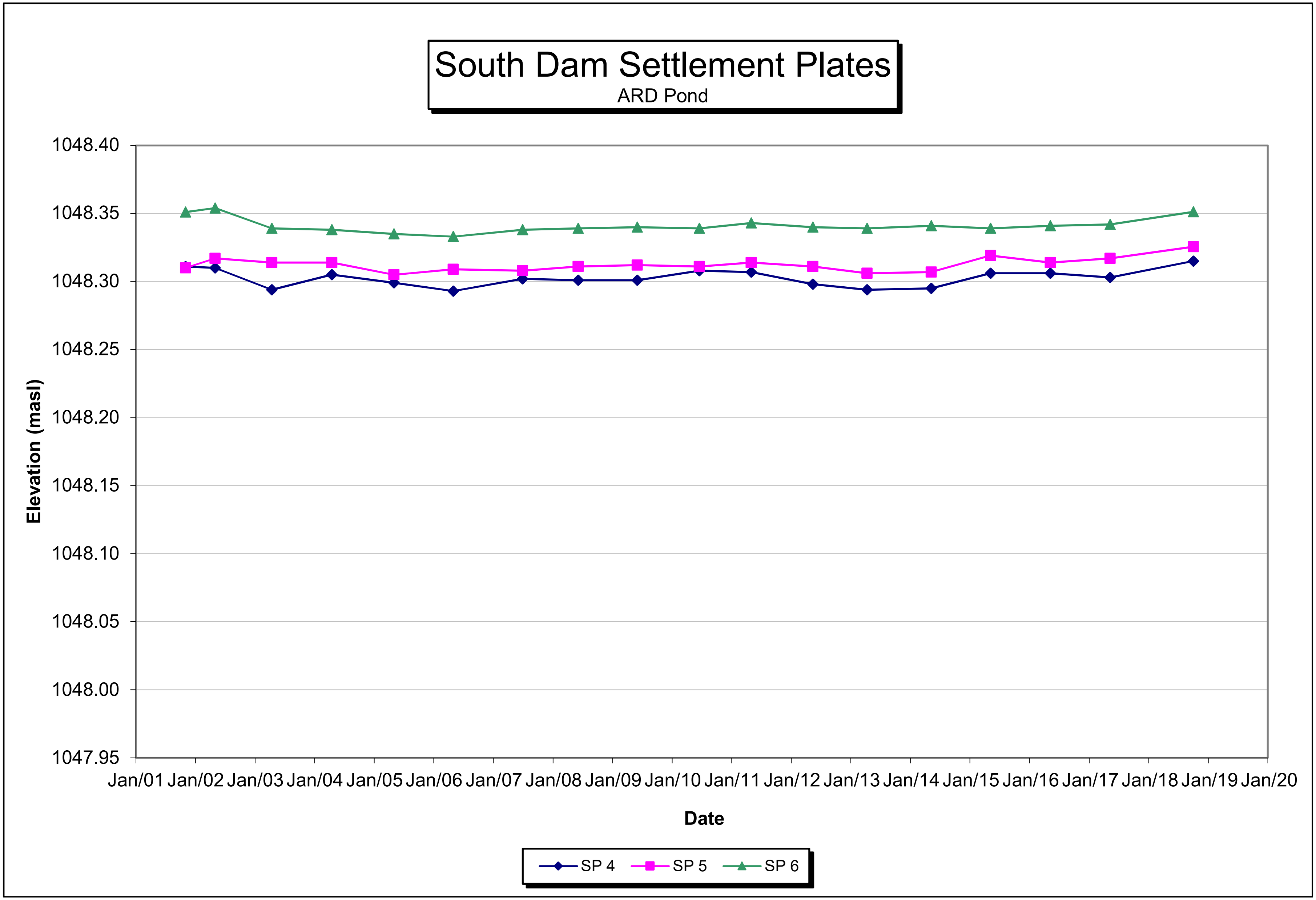


Figure X-7 SD Settlement

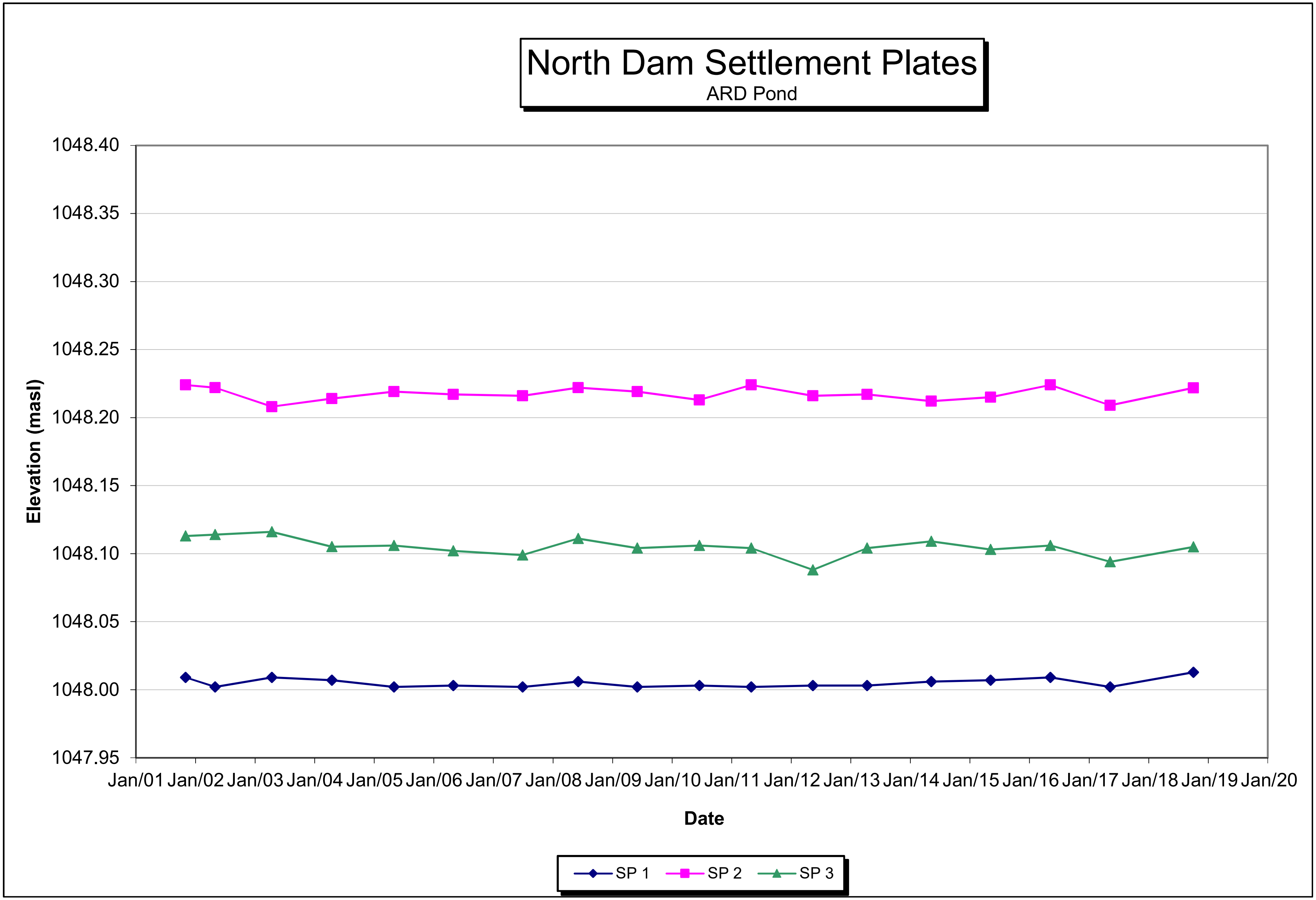
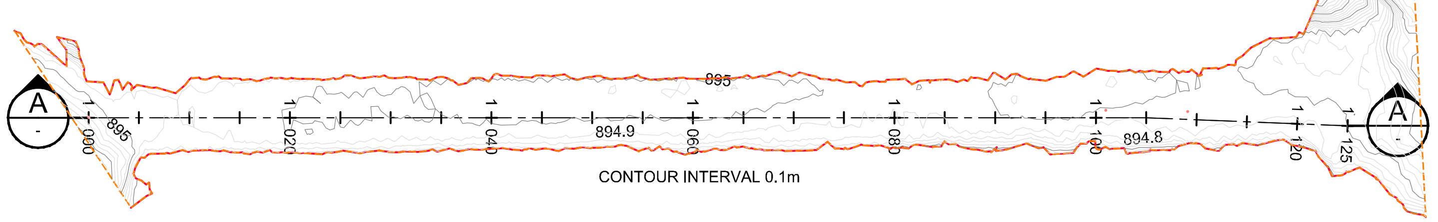


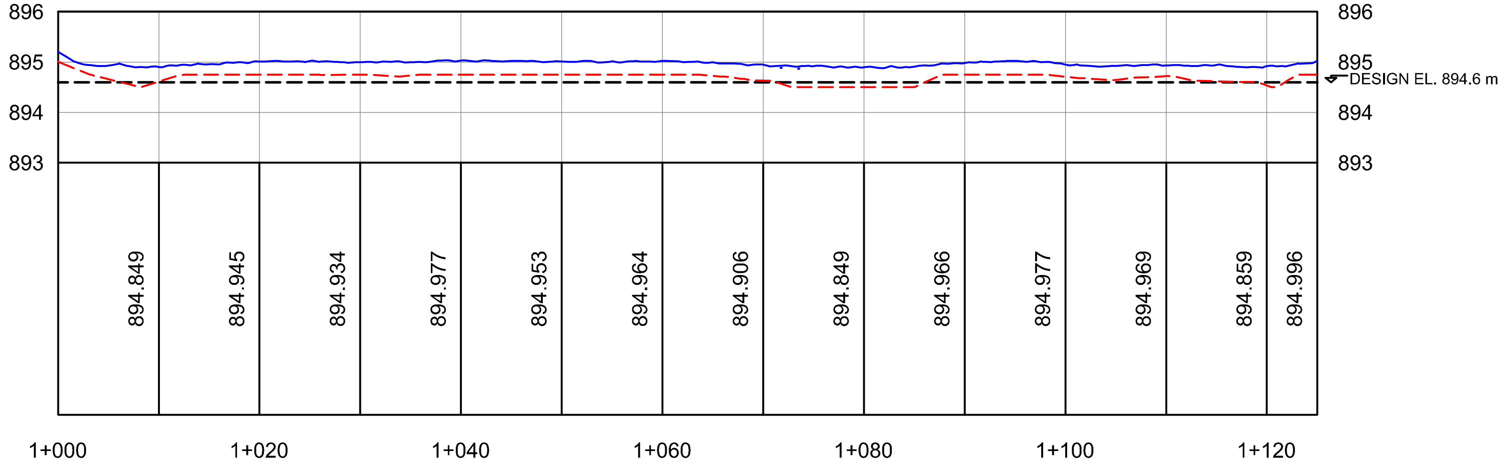
Figure X-8 ND Settlement

APPENDIX XI

Sludge Pond Dyke Crest Profiles

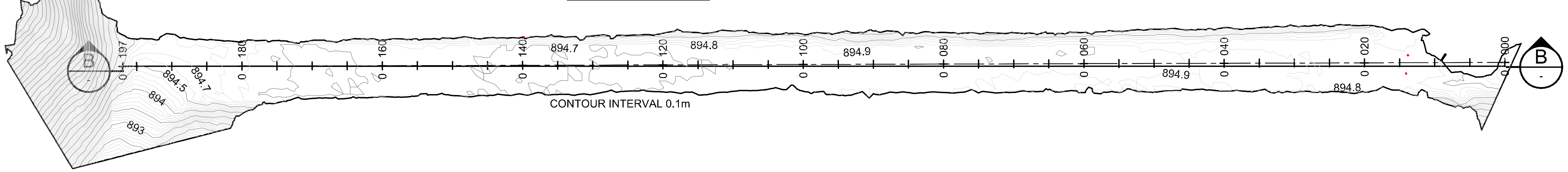
NORTH DAM CREST

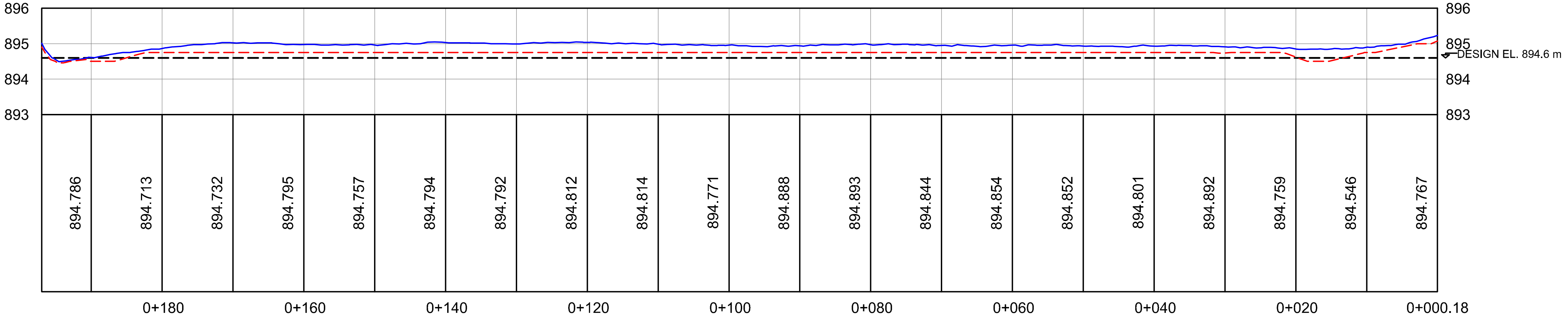




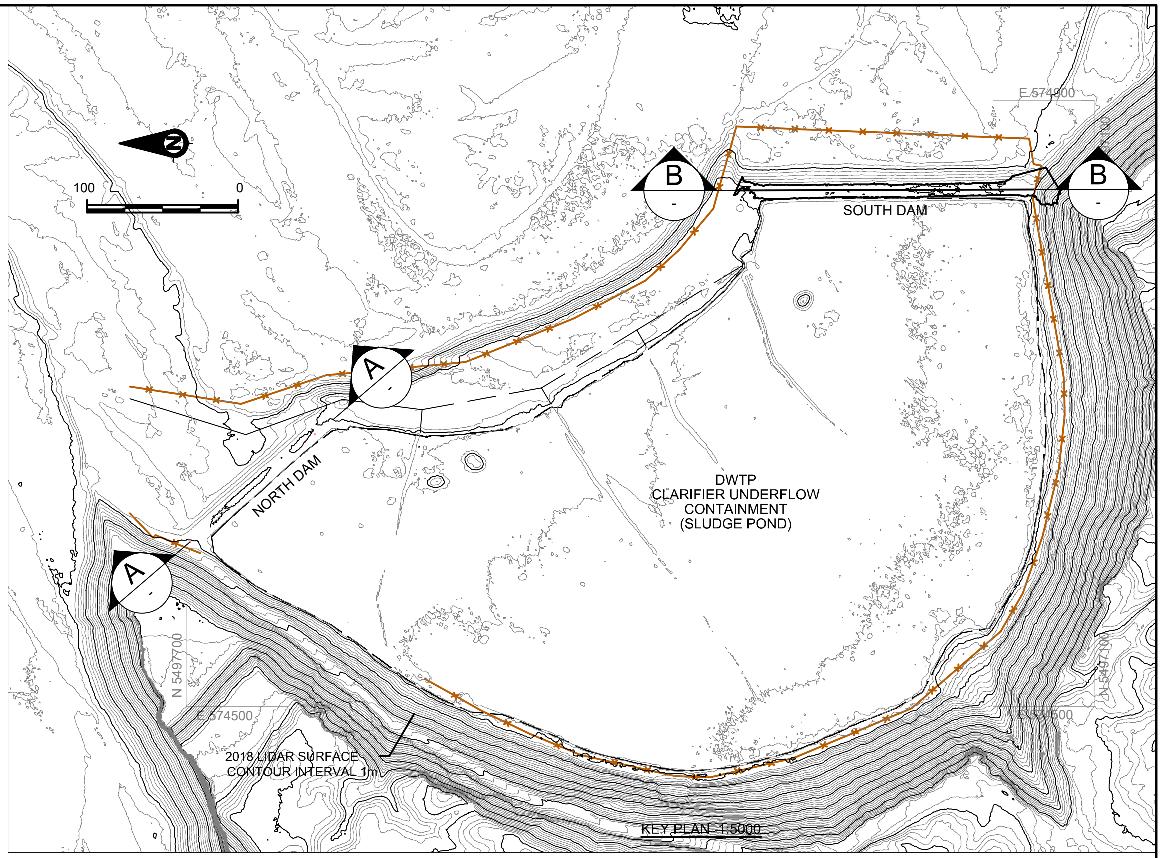
A PROFILE
SCALE 1:750 HORZ.
1:150 VERT.

SOUTH DAM CREST





B PROFILE
SCALE 1:750 HORZ.
1:150 VERT.



LEGEND

- - - 2012 LIDAR
— 2019 LIDAR

1:150 0 1.5 3 m
1:750 0 7.5 15 m

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CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2019 DAM SAFETY INSPECTION

TITLE
SLUDGE POND
DIKE CREST PROFILES

PROJECT No.
A05807A19

FIG No.
FIGURE XI-1

KCC-D-B

\\int.klohn.com\Proj\Data\CGY\Alberta\A05807A19 TML 2019 Sullivan Mine DSI\400 Drawings\DSI RPT\Figure XI-1.dwg Layout=FIGURE IX-1 October 17, 2019 11:48:20 AM

APPENDIX XII

Pond Storage Curves

Appendix XII
Pond Storage Curves

Figure XII.1 ARD Storage Pond Area-Volume Curve

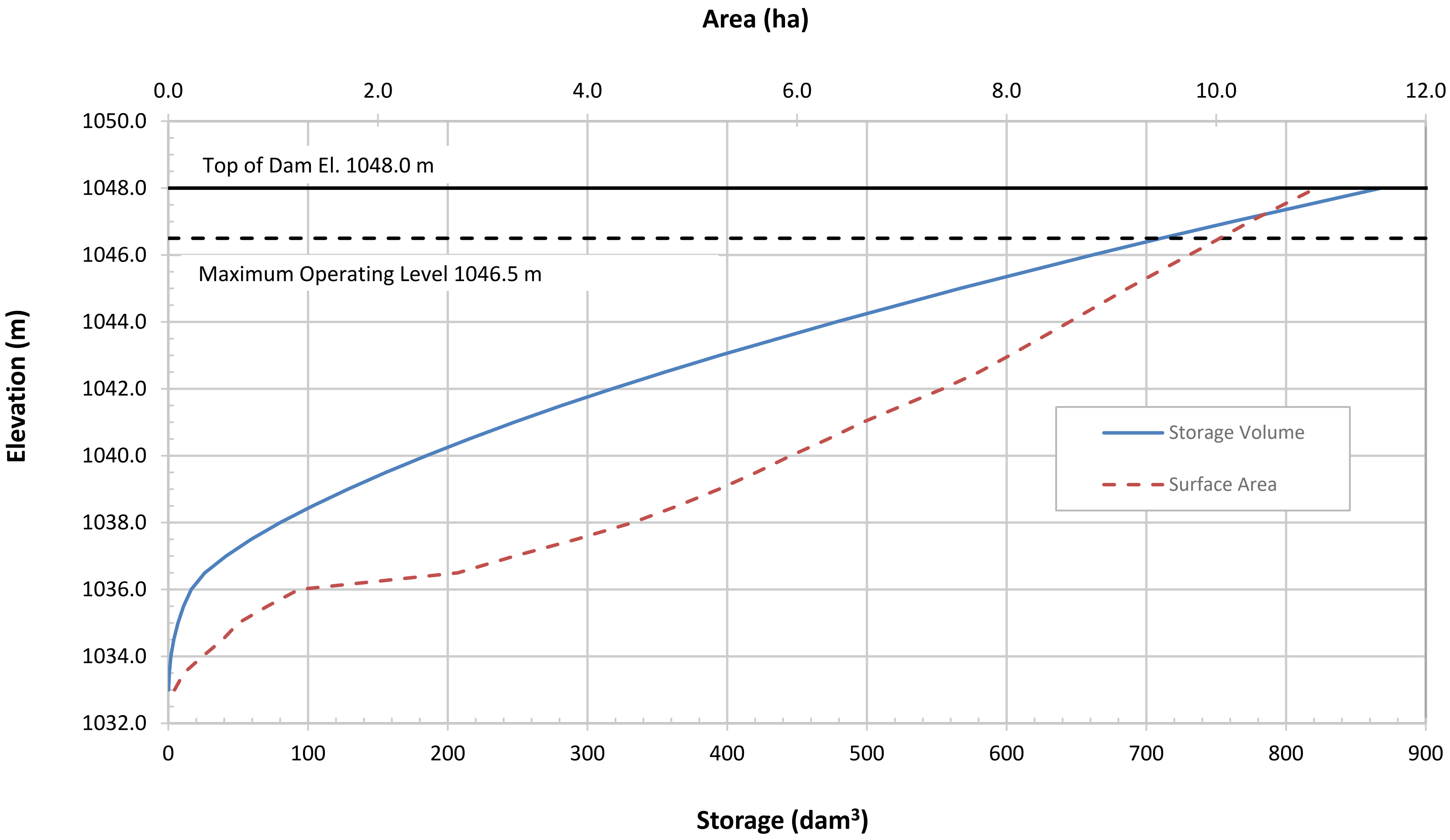

Figure XII.2 Iron Pond Stage-Volume Curve