REPORT

Louvicourt Mine Tailings Storage Facility and Polishing Pond

Tailings Storage Facility Annual Inspection

Submitted to:

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Executive Summary

This report presents the 2020 tailings storage facility annual inspection (TSFAI) for the tailings storage facility (TSF) and polishing pond at the closed Louvicourt mine site located near Val-d'Or, Quebec. This report was prepared based on a site visit carried out on August 17, 2020 by Laurent Gareau and Nicolas Pepin of Golder Associates Ltd (Golder), Morgan Lypka and Jonathan Charland of Teck Resources Limited (Teck, Owner) as well as on a review of available data representative of conditions over the period since the previous annual TSFAI. Golder Associates are the original designer of the facility and have been the provider of the Engineer of Record (EOR) since 2017. Golder performed an inspection in 2009, and then has performed annual inspections of the facilities since 2014. Laurent Gareau assumed the role of EOR for the Louvicourt tailings facility in 2018. The objective of the site visit component of a TSFAI for any such facility is to observe the physical condition of the structures of the facility and look for any signs of changing geotechnical performance such as settlement, bulging, cracking, erosion, seepage and piping. The review of data supplements the visual observations and provides a historic perspective on the annual performance of a facility.

The annual TSFAI is supplemented by routine inspections, instrumentation monitoring, and water quality monitoring carried out at the facility by seconded external consultants throughout the year (from January to March, 2020, the seconded external consultant was a Glencore employee).

Summary of Facility Description

The Louvicourt Mine is a closed base metal mine (primarily copper and zinc, with some gold and silver) located approximately 20 km east of Val-d'Or, Quebec, north of Highway 117. The TSF is located some 8.5 km northwest of the former mine site. The Louvicourt property is currently owned by Teck Resources (55%) and Glencore Canada Corporation (45%). The TSF and polishing pond facilities are managed by Teck.

Infrastructure at the site comprises a tailings pond juxtaposed to a polishing pond. The polishing pond is located immediately downstream (east) of the tailings pond. The tailings pond is bounded by Dams 1A, 1B and 1C to the north and by Dams 1D and 1E to the east, Dams 2A and 2B to the west, and natural topography to the south. An operational spillway and two emergency spillways are located to the east of Dam 1E, at the northeast corner of the facility.

The polishing pond is bounded by Dam 4 to the north, Dam 1D (acting as a boundary between the polishing pond and the tailings pond) to the west and by high ground to the south and east. An operational spillway and an emergency spillway are located at the north end of the pond, to the east of Dam 4B.

The facility is inspected weekly during the summer period and monthly through the winter months.

Summary of Key Potential Hazards and Hypothetical Consequences

As a required component of the TSFAI, a review was completed of the facility safety implications of the instrumentation data and the August 2020 site observations relative to the potential hazards, to assess whether the observed performance suggests either the absence or presence of credible failure modes. Ongoing studies to assess potential failure modes are discussed. Tailings facilities can have three broad areas of failure modes and those were reviewed as part of this annual summary – namely overtopping, slope instability, and internal erosion. The design basis relevant to each of the potential failure modes was reviewed. There was no significant change to the key potential hazards based on the conditions observed in 2020 compared to previous reporting periods and no safety concerns with the existing facilities were identified. Golder understands that Teck's long-term goal for all tailings facilities is to reach landform status with all potential failure modes being reduced to non-credible, or where that is not possible, as low as reasonably practical (ALARP) without a clear trigger for failure under the redundant safety measures in place. Non-credible failure modes refers to a state where under the applicable extreme loading condition, there is negligible likelihood of triggering the given failure mode.

Internal Erosion

Flow rates at the V-notch weirs and seepage locations around the TSF are estimated or measured during monthly inspections in the snow-free seasons. The observable flow and/or water accumulation areas are observed for suspended solids, or cloudy discharge, which could be indicative of internal erosion. At the time of the site visit, the monitoring results from the previous year were reviewed and it was observed that measured flow rates were within normal historical operating ranges, and there was no evidence of suspended solids in the flows nor residues indicative of such solids in the flow during the past year. Although the V-notch weir flows fluctuate in response to rainfall and snowmelt events, the historical data does not suggest a trend of increasing seepage flows. The observed flows have consistently been noted to be clear and free of suspended sediments. No zones of recent subsidence or sink holes, which could be indicative of internal erosion, were observed anywhere within the overall facility. No evidence of internal erosion was therefore observed during the formal TSFAI inspection nor indicated by the flow monitoring. This has been the case throughout operation and through the mine closure period.

Studies to eliminate this hazard as a credible failure mode for the facility are ongoing or planned and include:

- Review of historic construction records to assess filter compatibility between natural soils and construction materials
- Piezometric monitoring to measure gradients across potential erosional transitions
- Seepage modelling to validate measured gradients
- Assessment of potential frost effects on core integrity

Instability

Best management practices for water retaining structures is to use instrumentation to supplement the regular visual assessment of dam performance relative to potential failure modes. For the Louvicourt TSF facility, piezometers, thermistors and survey monuments comprise the instrumentation used for performance monitoring.

The groundwater monitoring network consists of a total of eight standpipe piezometers (4 new, installed in 2020) and 11 vibrating wire piezometers (VWPs; all new, installed in 2020) installed on the berms of the three different dams (1, 2 and 4). These instruments indicate a stable piezometric level with no significant trend of increasing or decreasing levels.

Survey monuments were surveyed between September 10th and 11th, 2020 by Corriveau J.L. & Assoc. (Corriveau), a surveyor based in Val-d'Or. The data (Appendix C) indicates that in many cases, incremental vertical and horizontal movements are below the stated range of accuracy of the survey – this suggests that within the range of survey accuracy, these instruments are not undergoing any significant displacements. For instruments which show displacement greater than the stated survey accuracy, total displacements since installation are relatively low and some seasonal movements may be occurring. The following general observations were made:

- Total settlements for all the survey monuments do not exceed 31 mm in any case.
- Incremental settlements in the past year (2019 to 2020) were generally less than 2 mm (which is the stated survey accuracy). The maximal incremental settlement was 5 mm for one instrument (SP-11-4 at dam 4B).
- There is no sign of accelerating settlements.

- The horizontal data shows all of the survey instruments exhibited horizontal movements within the range of annual variability and in all cases less than 9 mm from 2019 to 2020, and total horizontal movements since installation of less than 17 mm. The data is within the accuracy of the monitoring instrument and suggests that no significant horizontal movements are occurring.

Based upon the monitoring results, deformation and potential instability was not a concern noted for the facility in 2020. Studies to eliminate this hazard as a credible failure mode for the facility are ongoing or planned and include:

- Site specific seismic hazard assessment coupled with an update of seismic stability and liquefaction susceptibility for a 1:10,000-year return period seismic event.

Overtopping

The dams of the tailings pond and polishing pond were originally designed with a 2.0 m freeboard and a 1.5 m freeboard respectively. Klohn Crippen Berger (2011) reviewed the freeboard assessment for the tailings pond against the requirements of CDA (2007) in the 2010 Independent Dam Safety Review (DSR) (Klohn, 2011). The report provides a summary of pond levels in both the tailings and polishing ponds. In 2020, the available freeboard was always greater than the minimum requirement of the CDA. These conditions do not present a concern with overtopping.

A consolidated hydrology study (draft version pending review) determined that both the TSF pond and the polishing pond had adequate capacity to safely pass the probable maximum flood (PMF) event, with significant contingency. Teck has demonstrated diligence in the maintenance of the spillway structures. Under active closure care, it is concluded that overtopping is not a credible failure mode.

Consequence Classification

A study by SNC-Lavalin (2012) concluded that the tailings dams should be classified as “very high” consequence dams, as per the criteria in CDA 2007. The classification of Dam 4B at the polishing pond was established as “high” in the 2010 DSR (Klohn Crippen Berger, 2011). The classification was governed by the environmental consequences of a dam breach that would produce impacts in the Bourlamaque River, which are impractical to restore.

Teck has directed Golder to assess the stability and physical performance of the various structures of the TSF and polishing pond against extreme loading conditions, those being a probable maximum flood event and a 1:10,000-year return period seismic event. These design basis loading conditions would be applicable to an extreme consequence classification – the highest consequence level considered in the CDA guidance. If the performance of the structures against extreme loading conditions is verified, Teck may opt to discontinue the periodic review of consequence classification. Future consequence classification may be required if the guidance for classification of structures evolves or if the magnitude of the extreme loading events changes.

Summary of Key Observations

Summary of Field Observations

The principal following observations were made at the time of the TSFAI inspection:

- All embankments were in good condition without evidence of deteriorating geotechnical condition.
- The spillways at Dams 4B and 1D were in good condition and functional.
- The trash rack upstream of the tailings pond spillway has been repaired.

- Ponding water or seepage with low flows was observed at the toe of several dams, generally at the locations indicated in previous years. In general, the ponding and seepage were similar to previous years. The seepage and ponding features do not represent any dam safety concerns.
- Minor erosion was observed on the dam crests from weather (freeze-thaw and wind activity). This should continue to be monitored, and maintenance efforts may be required in the future.

Climate and Water Balance Summary

The total precipitation over the hydrological year (November 2019 to October 2020) was 1,009.6 mm or 11% higher than the long-term average of 912.7 mm. Based on the draft consolidated hydrology study for the Louvicourt site (Golder, 2020b), this corresponds to an approximately 1:25-year wet precipitation year. The months of March (110.1 mm vs 55.3 mm long-term average), September (158.3 mm vs 101.3 mm long-term average) and October (120.8 mm vs 84 mm long-term average) were particularly wet.

Based on a high-level water balance analysis, it was estimated that 0.5 million m^3 of water was discharged to the polishing pond via the tailings pond operational spillway.

Summary of Significant Changes

In 2020, the trash rack in the tailings pond was replaced in Q4 2020. No other construction occurred in 2020.

Summary of Review of OMS and ERP Manuals

The Operations, Maintenance and Surveillance (OMS) manual was updated in 2017, with an interim update in 2019, and again in 2020. At the time of preparation of this report, a further update of the OMS is in progress to ensure the format is compliant with the Teck Tailings and Water Retaining Structures (TWRS) guideline (Teck, 2019), which is fully aligned with the Mining Association of Canada's (MAC) guidance on OMS manual best practices. Anticipated completion of the update is Q2 of 2021.

The emergency preparedness and response plan (EPRP) was last updated in March of 2019. The EPRP is appropriate for its intended purpose. Teck has also prepared a draft Mine Emergency Response Plan (MERP) which incorporates response procedures for the tailings and polishing pond components with input from the EOR, and once finalized, will replace the EPRP. The most recent MERP test for the facility was conducted on November 3, 2020.

Dam Safety Review

An independent DSR of the TSF and polishing pond was conducted in 2015 (SNC-Lavalin, 2015). Wood has been engaged for the next DSR. The next DSR was originally to occur in 2020, per Teck's guidance document but it was deemed appropriate to delay the originally scheduled 2020 DSR site inspection to 2021 due to the COVID-19 restrictions, given that the field review component is an intrinsic component of a DSR.

Status of Dam Safety Inspections Key Recommended Actions

The status of the deficiencies and non-conformances are presented in the following tables.

Structure	ID	Deficiency or Non-conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline/Status
Previous Recommendations Closed / Superseded						
Dam 1E	2018-02	Trash rack at inlet to the tailings pond operational spillway is damaged	OMS Manual Section 6.2	Repair trash rack.	3	COMPLETE. Trash rack replaced - Q4 2020
Dam 1D	2018-03	Access road at outlet of second emergency spillway is susceptible to erosion	CDA 2013 Section 3.5.5	Undertake erosion analysis to assess risk to embankment integrity. If required, install slope protection across the road and outlet channel, to route potential spillway flow away from the embankment.	3	Analysis completed and draft technical memo submitted for Teck review. No remedial measures are anticipated to be required to address this issue.
Previous Recommendations Ongoing						
All	2015-06	Perform a review of dam's seismic stability and liquefaction conditions	Directive 019 Section 2.9.3	Perform a review of dam's seismic stability and liquefaction conditions.	4	IN PROGRESS- Liquefaction analysis completed and deformation analysis is in progress. Q2 2021. Preliminary results suggest that seismic performance is adequate.
Dam 4B	2019-02	Granular fill has been placed east of the main spillway, in an area designed as an emergency spillway.	CDA 2013 Section 3.5.5	Assess whether the current configuration can pass the design storm. Preliminary indications are that the current configuration does not pose any flow restriction issues.	2	IN PROGRESS - Q2 2021 Analyses completed, draft report submitted. Pending review and finalization of hydrology study. No remedial measures are anticipated to be required to address this issue.
2020 Recommendations						
Dam 1A Dam 1C	2020-01	Replacement of riprap on the interior slopes of Dams 1A and 1C is required.	CDA 2013 Section 3.5.3	Place new rip rap as was done for Dams 1B and 1D.	3	Schedule progressively for 2021 and 2022.
Dam 1D	2020-02	Larger diameter (>4-inch trunk) vegetation exists on the downstream stability berm of Dam 1D	OMS Manual Section 6.2	Consider tree removal	4	To be considered as part of operation and maintenance activities.
Dam 4B	2020-03	Driftwood accumulated on the embankment in the polishing pond	OMS Manual Section 6.2	Consider removal of driftwood	4	To be considered as part of operation and maintenance activities.

Priority (defined by Teck Resources)	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
2	If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

Note: Priority description categories are consistent with Mining Association of Canada (MAC) guidelines.

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APPENDICES

Definitions

Abbreviation	Definition
CDA	Canadian Dam Association
DSI	Dam Safety Inspection
DSR	Dam Safety Review
ERP	Emergency Response Plan
OMS	Operation, Maintenance and Surveillance
TSFAI	Tailings Storage Facility Annual Inspection

Unit	Definition
kPa	Kilopascal
m	metre
m^3	Cubic meter
tpd	Ton per day

Term	Definition
Tailings Storage Facility Annual Inspection (TSFAI)	An annual report summarizing the results of an annual dam condition inspection.
Dam Safety Review (DSR)	A systematic review and evaluation of all aspects of design, construction, maintenance, operation, process, and system affecting a dam’s safety, including the dam safety management system (CDA 2013).
Downstream	The side of the embankment furthest away from the reservoir or pond.
Tailings	Fine-grained residual material remaining after the valuable resources have been separated.
Freeboard	The vertical distance between the still water surface elevation in the reservoir and the lowest elevation at the top of the containment structure (CDA 2013).
Upstream	The side of the embankment nearest to the reservoir or pond.
Waste Rock	Coarse-grained (gravel to boulder sized) mineral rockfill. Also referred to as rockfill.

1.0 INTRODUCTION

1.1 Purpose, Scope of Work and Methodology

At the request of Teck Resources Limited, Golder Associates Ltd. (Golder) has completed the 2020 Tailings Storage Facility Annual Inspection (TSFAI) at the Louvicourt Mine tailings storage facility and polishing pond located near Val-d'Or, Quebec. The facility includes the tailings pond and the polishing pond and associated appurtenant structures. The report is based on a site visit carried out on August 17, 2020, and the review of available surveillance data for the reporting period (September 2019 to September 2020) by the Engineer of Record, Laurent Gareau of Golder. The previous TSFAI for the tailings facility dams was carried out in September 2019, and is reported in the 2019 DSI report (Golder, 2020).

The 2020 inspection included the inspection of all of the polishing and tailings facility dams:

- Dams 1A through 1E
- Dams 2A and 2B
- Dams 4A and 4B

This report has been prepared in accordance with the Teck Guideline for Tailings and Water Retaining Structures (Teck, 2019). Sections that are no longer applicable due to the facility being closed or because of the particular nature of the Louvicourt tailings facility have been identified as "not applicable". The reader is encouraged to read the limitations and intended uses of the report, following the text, which is an integral part of the report.

1.2 Regulatory Requirements and Guidelines

In addition to Teck's requirements noted above, the dam safety inspection has also been performed in accordance with the following:

- *Guide de préparation du plan de réaménagement et de restauration des sites miniers au Québec*, MERN (Ministère de l'Énergie et des Ressources naturelles du Québec) et MDDELCC[1] (Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques), Novembre 2016.
- Directive 019 sur l'industrie minière, MELCC, Mars 2012.
- Canadian Dam Association *Dam Safety Guidelines*. Original dated 2007, Revised 2013.
- Canadian Dam Association Application of Dam Safety Guidelines to Mining Dams. Original dated 2014. Revised 2019.

The annual TSFAI is a requirement of the certificate of authorization no. 7610-08-01-70141-52 issued by MELCC in October 2010.

1.3 Facility Description

Louvicourt Mine is a closed base-metal mine (primarily copper and zinc, with some gold and silver) located approximately 20 km east of Val-d'Or, Quebec, north of Highway 117. A facility data sheet is included as Appendix A.

[1] MDDELCC refers to the Ministère du développement durable, de l'environnement et de la lutte contre le changement climatique, who is responsible for mining projects in Quebec. It is noted that the name of this ministry has evolved over time (previously MDDEP, currently MELCC) and where these acronyms are used in the document, it is intended to refer interchangeably to the current ministry or any of its predecessors.

The Louvicourt property is currently owned by Teck Resources (55%) and Glencore Canada Corporation (45%). The site was managed with the support of and monitored by Golder Associates from closure until the end of 2016. From 2017 to the end of 2018, the site was managed by Teck's Supervisor, Water Treatment & Maintenance, Eric Gingras. Since the beginning of 2019, the site has been managed by Kathleen Willman and Morgan Lypka of Teck Legacy Properties. Routine inspections of the facility are undertaken by staff of Teck (Jonathan Charland and Luc Tellier).

Dam infrastructure at the site comprises a tailings pond with a polishing pond located immediately downstream to the east of the tailings pond. The tailings pond is contained by Dam 1 to the north and east, Dam 2 to the west and natural topography to the south. For reference purposes, the main dams have been divided into several sub dams designated Dam 1A to Dam 1E and Dam 2A to Dam 2B, typically separated by local bedrock outcrops located along the alignment of the dams.

The polishing pond is contained by Dam 4 to the north, the tailings pond to the west and natural topography to south and east. For reference purposes, Dam 4 comprises two segments designated Dam 4A and Dam 4B, separated by a bedrock outcrop.

1.4 Background Information and History

The Louvicourt mine began operations around 1994 and had a nominal milling rate of 4,000 tpd, with a peak estimated rate of 5,000 tpd. Mining operations effectively ceased around July 2005.

Figure 1 shows a plan view of the Louvicourt TSF and polishing pond facilities. Figure 2 shows a typical dam cross-section of the facilities.

Approximately one third of the tailings from the milling process were pumped to the tailings facility, located approximately 8.5 km northwest of the mine/mill. The remainder of the tailings was used as paste backfill for the underground mine. Tailings generated from the milling process have high sulphide content (30% to 45%) and are acid generating. The tailings within the basin are covered with a water cover, approximately 1-m thick, to prevent oxidation and generation of acid rock drainage.

Tailings were deposited within the tailings facility using floating pipelines extending from the dams into the basin. The pipeline was moved laterally as required to keep the tailings solids below elevation 315 m. During operations, regular bathymetric surveys were performed to provide information to allow adjustment of the deposition plan to fill low spots and prevent overfilling in high areas. Local high tailings areas above elevation 315 m generated during deposition were generally spread using a barge-mounted dredge or a rotary harrow device.

The original design of the tailings dams and polishing pond dams was carried out by Golder in 1993. Golder performed an inspection in 2009, and then has performed annual inspections of the facilities since 2014. Mayana Kissiova of Golder became the Engineer of Record for the Tailings Facility in 2017 and Laurent Gareau succeeded Mayana Kissiova in 2018.

2.0 CONSTRUCTION, OPERATION, MAINTENANCE AND SURVEILLANCE

The broken trash rack in the tailings pond was replaced in Q4 2020. The maintenance and surveillance activities performed in 2020 included the following:

- Routine inspections
- Survey of monuments
- Removal of vegetation and debris in the tailings pond and polishing pond active spillway canals
- The use of stop logs at the polishing pond from January to March 2020 to increase retention time and control effluent pH.

3.0 CLIMATE DATA AND WATER BALANCE

3.1 Review and Summary of Climatic Information

Table 2 and Figure 3 summarize the Val-d’Or total monthly precipitation data over the period from November 1, 2019, to October 31, 2020. The data originates from the Environment Canada climate stations (Table 1), which are located about 15 km from the mine site. The available data from the stations presented in Table 1 were combined to form a continuous-time series over the period 1951-2020, which was used for the precipitation analysis and water balance presented in this section.

For comparative purposes, the monthly multi-annual averages calculated from the combined precipitation record over the period 1951-2020 are also provided in Table 1.

Table 1: Information of the Selected Environment Canada Climate Stations

Station Name, ID	Latitude, Longitude (degrees)	Station Elevation (m)	Available Data Record	Notes
VAL-D'OR A, 7098600	48.06, -77.79	337.4	1951 – 2020	Main station until 2011
VAL-D'OR, 7098603	48.06, -77.79	338.9	2008 – 2020	Main station since 2012
VAL-D'OR A, 7098605	48.05, -77.78	337.4	2011 - 2020	Used for missing data

The total precipitation over the hydrological year (November 2019 to October 2020) was 1,009.6 mm or 11% higher than the long-term average of 912.7 mm. Based on the consolidated hydrology study for the Louvicourt site (Golder, 2020b), this corresponds to an approximately 1:25-year wet precipitation year. The months of March (110.1 mm vs 55.3 mm long-term average), September (158.3 mm vs 101.3 mm long-term average) and October (120.8 mm vs 84 mm long-term average) were particularly wet.

Table 2: Monthly Precipitation Data from November 2019 to October 2020

Month - Year	Total Precipitation Recorded at Val-d'Or (mm) *	Monthly Multi-Annual Average at Val-d'Or (mm) **	Difference (%) ***
November 2019	99.9	82.2	22%↑
December 2019	64.4	67.6	-5%↓
January 2020	46.6	59.7	-28%↓
February 2020	61.7	47.8	29%↑
March 2020	110.1	55.3	99%↑
April 2020	64.8	60.4	7%↑
May 2020	41.5	70.6	-70%↓
June 2020	89.2	89.2	0%
July 2020	61.1	100.1	-64%↓
August 2020	91.2	94.3	-3%↓
September 2020	158.3	101.3	56%↑
October 2020	120.8	84.0	44%↑
Total over the hydrological year Nov 2019 - October 2020	**1009.6**	**912.7**	**11% ↑**

*: Values are based on records from Environment Canada climate stations ID 7098600, ID 7098603, ID and 7098605.

**: Values are based on records from Environment Canada climate stations ID 7098600, ID 7098603, ID and 7098605, from 1951 to 2020.

***: Difference between Val-d'Or current year precipitation and the multi-annual average precipitation.

↑ (↓): Current year precipitation higher (lower) than the multi-annual average precipitation.

3.2 Review and Summary Water Balance

A water balance of the Louvicourt tailings storage facility (TSF) was compiled based on the recent climate data:

- The runoff from the external watershed area was estimated using a constant, volumetric average annual runoff coefficient of 0.42 based on the approach proposed by Golder (2020b) draft hydrology study. The value is based on available regional hydrometric records, but has not been verified by local measurements. The runoff coefficient is smaller than the 0.6 used in the previous annual dam safety inspection reports. The change is justified by the analysis documented by Golder (2020b).
- The long-term mean pond evaporation was calculated using the Morton model (Morton, 1983), with historical climate data from climate stations at Val-d'Or (air temperature, dew point temperature, precipitation) and Rouyn-Noranda (solar radiation). The Rouyn-Noranda climate station stopped measuring solar radiation in October 2018; the average long-term (1969 to 2018) solar radiation was used for the 2019/2020 hydrological year.
- Constant seepage flow rates were predicted by finite element seepage analyses performed by Golder (1993) prior to construction. They have not been updated since the 1993 study.
- The spillway discharge is estimated based on a mass balance, assuming zero net flows for the facility and no volumes of water accumulating over time in the pond.

Table 3 summarizes the yearly flows resulting from the water balance for the considered year, namely from November 1, 2019, to October 31, 2020, and for a typical year (average climate conditions). Higher precipitation for the 2019/2020 year led to higher estimated volume of water discharged at the spillway.

Table 3: November 2019 to October 2020 Water Balance for the TSF

Component	Typical Year Flows (Based on an average climate year) (m^3/year)	Current Year Flows* (m^3/year)	Difference (%)	Comment/Source
Total precipitation over the basin	958,294	1,060,080	11% ↑	Basin area = 105 ha Mean annual precipitation = 912.7 mm Current year precipitation= 1,009.6 mm
Surface runoff over the external watershed area	400,950	443,537	11% ↑	Watershed area = 104.6 ha ** Runoff coefficient = 0.42 ***
Total of inflows	**1,359,244**	**1,503,617**	**11% ↑**	
Pond evaporation	655,835	639,251	3% ↓	Based on Morton (1983) Mean annual pond evaporation = 625 mm Current year pond evaporation = 609 mm
Seepage losses	362,664	362,664	0%	Based on analysis made prior to construction, Golder (1993) Seepage flow rates = 41.4 m^3/h
Spillway discharge to the polishing pond	340,745	501,703	47% ↑	Estimated based on mass balance
Total of outflows	**1,359,244**	**1,503,617**	**11% ↑**	

* Current year extends from November 2019 to October 2020.
** The watershed area has been updated in Louvicourt Consolidated Hydrological Report (in preparation)
*** Changed value relative to previous annual dam safety inspection reports. The change is justified by the analysis in Golder (2020b)
↑ (↓): Current year value higher (lower) than the long-term average value.

3.3 Freeboard and Storage

Freeboard and storage are addressed in Section 5.2.3.

3.4 Water Discharge Volumes

Based on a high-level water balance analysis, it is estimated that 0.5 million m^3 of water was discharged to the polishing pond via the operational spillway.

3.5 Water Discharge Quality

Water discharge quality is presented in the Louvicourt annual environmental report (Suivi environnemental post-restauration) submitted by March 31 of each year to le Ministère de l’Environnement et de la Lutte contre les changements climatiques du Québec.

4.0 SITE OBSERVATIONS

A site inspection was carried out on August 17, 2020, by Mr. Nicolas Pepin, Eng. and Mr. Laurent Gareau, Eng., Engineer of Record, both from Golder. They were accompanied by Ms. Morgan Lypka, Tailings and Environment Engineer,and Mr. Jonathan Charland , both from Teck Resources. The temperature during the visit was approximately 15°C under overcast skies.

4.1 Visual Observations

The following observations were made during this TSFAI:

- The water level at the tailings pond was 316.09 m (water level from August 13, 2020).
- The water level at the polishing pond was 307.20 m (water level from August 13, 2020).

Dams 1A through 1E

- The riprap on the upstream berms of Dams 1B and 1D, which was repaired with new riprap in 2019 (photograph 1)was unchanged from the previous inspection.
- The riprap on Dams 1A and 1C was unchanged from last year (Photograph 2). Replacement of the riprap will be undertaken within a reasonable timeframe. Operational procedures, including a provision in the OMS for an event-driven inspection after extreme wind events, are used to manage risk in the interim.
- The trash rack located upstream of the entry to the spillway was damaged (Photograph 3) and should be repaired. It is noted that the trash rack was replaced in November, 2020 (Photograph 4).
- Very little ponding water was observed at the toe of Dams 1A to 1E at the same locations as last year. The water seems to be stagnant or exhibits very low flow. The location of current and historic seepage points is presented on Figure 1.
- The emergency spillway located between Dams 1D and 1E (denoted as the second emergency spillway) was in good condition. Vegetation in the downstream channel was cleared in 2020shortly before the inspection (Photographs 5 and 6). Historically, vegetation is cleared every other year, and clearing in 2022 is considered appropriate.
- The access bridge close to the spillway was rehabilitated in 2018 and appears in good condition, although the edge blocks appear to be suffering some scraping, presumably by snow removal equipment (photograph 7). If this issue worsens, it may be advisable to protect the timber blocks with metal covering to improve durability. WSP, 2020 observed these damaged features and indicated that they would require repair or replacement. (WSP, 2020)
- Several minor erosion points are visible at the crest of Dam 1E. These are not a concern but should continue to be observed.
- Vegetation is present at the downstream toe of Dams 1A, 1B and 1C (Photograph 8). This is not a stability concern.

Dams 2A and 2B

- Some stagnant water and slight seepage were observed at the toe of Dam 2B representing the seepage points labelled 10 thru 13, and reporting to V-notch 1 and V-notch 2, exhibiting very low flow (Photograph 9). The seepage water is clear.
- Stagnant water is observed at the toe of Dam 2A (Photograph 10). The extent of ponding appeared somewhat lower than in 2019; however, it is noted that this area represents a zone where the natural topography drains towards the tailings pond, such that some accumulation at this location is expected.
- The culverts located across the unnamed creek, just north and west of the tailings pond have been cleared since the 2019 inspection (Photograph 11) and drainage of this area was much improved. Limited new beaver activity was observed at this area.

Dams 4A, 4B and Final Effluent Point

- Dam 4A is a structure that is sited at higher ground and is no longer in contact with water. The structure was in good condition with no evidence of settlement, cracking, bulging or other deformation that would be indicative of geotechnical performance issues.
- Trees are continuing to encroach on the side slopes and crest of the 4A embankment (Photograph 12). These trees do not represent an issue of geotechnical concern, since the structure is not currently impounding water, and is not likely to impound water in the future.
- The main spillway at Dam 4B was in good condition although no flow was passing over the structure (Photograph 13).
- The north shoulder of the Dam 4B service spillway was inspected. Minor seepage and ponding exist at the contact between the rock and concrete structure (Photograph 14). Camera footage suggests that this seepage occurs year-round. The seepage quantity is small and there is no evidence of delamination or piping. No remedial measures are required. However this seepage area should be monitored regularly, similar to other seepage features on the dams.
- The outflow channel from the spillway to the Parshall flume contains significant vegetation (Photograph 15). This does not represent a performance issue for the channel; however, some vegetation removal may eventually be required in the future.
- Culverts at the final effluent point were clear although some limited vegetation is present upstream of these culverts. There was no significant flow through the outflow culverts.
- The Dam 4B crest was generally in good condition and unchanged from 2019. Survey monuments are visible. No noticeable changes were visually apparent (i.e., damage) to the survey monuments. Minor accumulation of deadwood on this embankment should be periodically removed to prevent its transport into the spillway structure.
- Ponding water was observed at the toe of Dam 4B at almost the same locations as last year (points 13 to 15 on Figure 1). The water appears to be stagnant.

4.2 Photographs

Key photographs of the inspection are presented in Appendix B.

4.3 Instrumentation and Data Review

The following information was available for this TSFAI:

- Yearly monitoring data of survey monuments.
- Records of weekly and monthly visual inspections.
- Measurement of flow at V-notches and groundwater elevations of existing piezometers since their installation to the end of autumn 2020.
- Measurements of the water levels for the tailings and polishing ponds.

4.3.1 Water Levels

Figure 4 presents groundwater levels for the polishing pond and tailings facility dams from a total of eight standpipe piezometers (4 new, installed in 2020) and 11 vibrating wire piezometers (VWPs; all new, installed in 2020) installed on the berms of the three different dams (1, 2 and 4).

The following piezometers are located on the berms of the TSF dams:

- LOU-D1B-VWP-2020-02A (LOWER VWP) and LOU-D1B-VWP-2020-02B (UPPER VWP)
- LOU-D1B-VWP-2020-03
- LOU-D1C-P-2020-04
- LOU-D1C-P-2020-05
- LOU-D1C-VWP-2020-07A (LOWER VWP) and LOU-D1C-VWP-2020-07B (UPPER VWP)
- LOU-D2B-P-2020-09
- LOU-D2B-P-2020-10
- LOU-D2B-VWP-2020-11A (LOWER VWP) and LOU-D2B-VWP-2020-11B (UPPER VWP)
- D2A
- D2B

The following piezometers are located on the berms of the polishing pond dams:

- LOU-D1D-VWP-2020-08A (LOWER VWP) and LOU-D1D-VWP-2020-08B (UPPER VWP)
- LOU-D4B-VWP-2020-12A (LOWER VWP) and LOU-D4B-VWP-2020-12B (UPPER VWP)
- PZ-02-04
- PZ-04-04

Six other standpipe piezometers (PBR-4, PBR-6, PBR-7, PBR-8, PO-06-30, PO-06-31) are located on natural ground, some distance away from the toe of the dams. The position of these piezometers is shown in Figure 1.

Data for 2020 was provided by Teck (Figure 4). It can be seen that recent values are quite stable for all standpipe piezometers and consistent with previous trends; historical trends for VWPs will be better defined in the coming years with more data collected.

Standpipe piezometer PZ-02-04 and VWPs LOU-D1D-VWP-2020-08A and B are located within Dam 1D downstream berm. Groundwater at this location corresponds to seepage through Dam 1D and drains toward the polishing pond. It is therefore normal that the trend line for this well is slightly higher than the level of the polishing pond.

4.3.2 Deformation/Settlement

A series of 15 movement monitoring monuments exists along the crest and berms of the tailings pond dams and four additional monuments are located along Dam 4B of the polishing pond. Some of these monuments were installed after the 1993 construction and are identified B-1 to B-11 in Appendix C and SP-1 to SP-11 in Figure 1. Other monuments, identified as SP-11-1 to SP-11-8 in Figure 1 and as 2011-1 to 2011-8 in Appendix C, were installed in September and October 2011. All monuments were surveyed between September 10th and 11th, 2020 by Corriveau J.L. & Assoc. (Corriveau), a surveyor based in Val-d'Or. The detailed report of Corriveau is presented in Appendix C. The annual survey includes a total station survey and a differential GPS survey of the monitoring points. Table 4 presents total settlement and horizontal displacement of all monuments based on total station survey. The stated precision of these results is 10 mm for horizontal movements and 2 mm for vertical movements (settlement).

Table 4: Settlement and Horizontal Displacement

Monument	Install Year	Horizontal Movements (total)		Settlement (Negative #s = upward)		
		Install to 2019	Install to 2020	Up to 2019	2019-2020	Up to present
Dam 1D (crest)						
B-1 (SP-1)	2008	6 mm	4 mm	1 mm	0 mm	1 mm
B-2 (SP-2)	2008	20 mm	16 mm	27 mm	1 mm	28 mm
B-3 (SP-3)	2008	4 mm	7 mm	2 mm	0 mm	2 mm
Dam 1D (berm)						
2011-2 (SP-11-2)	2011	15 mm	11 mm	14 mm	2 mm	16 mm
Dam 1C (crest)						
B-4 (SP-4)	2008	17 mm	14 mm	-1 mm	1 mm	0 mm
B-5 (SP-5)	2008	13 mm	11 mm	-3 mm	2 mm	-1 mm
Dam 1C (berm)						
2011-8 (SP-11-8)	2011	N/A*	10 mm	11 mm	0 mm	11 mm
Dam 1B (crest)						
B-6 (SP-6)	2008	15 mm	10 mm	0 mm	0 mm	0 mm
Dam 1A (crest)						
B-7 (SP-7)	2008	6 mm	6 mm	-22 mm	-1 mm	-23 mm
Dam 2B (crest)						
B-8 (SP-8)	2008	2 mm	4 mm	0 mm	1 mm	1 mm
B-9 (SP-9)	2008	7 mm	6 mm	1 mm	2 mm	3 mm
B-10 (SP-10)	2008	13 mm	12 mm	-9 mm	2 mm	-7 mm
Dam 2B (berm)						
B-11 (SP-11)	2011	4 mm	1 mm	13 mm	-1 mm	12 mm
2011-6 (SP-11-6)	2011	8 mm	8 mm	18 mm	0 mm	18 mm
2011-7 (SP-11-7)	2011	24 mm	17 mm	-11 mm	0 mm	-11 mm
Dam 4B (crest)						
2011-1 (SP-11-1)	2011	14 mm	13 mm	19 mm	3 mm	22 mm
2011-3 (SP-11-3)	2011	8 mm	8 mm	27 mm	4 mm	31 mm
2011-4 (SP-11-4)	2011	10 mm	10 mm	1 mm	5 mm	6 mm
Dam 4B (berm)						
2011-5 (SP-11-5)	2011	10 mm	1 mm	11 mm	4 mm	15 mm

* Measurement not taken.

The horizontal data (Appendix D) shows all of the survey instruments exhibited horizontal movements within the range of annual variability and in all cases less than 9 mm from 2019 to 2020. The instrument which showed 9 mm of incremental movement was towards the origin (i.e., survey point moving closer to its initial installation point). Total horizontal displacements since installation are less than 17 mm. The horizontal survey data is presented as point-of-origin plots in Appendix D. The observed movements are less than the accuracy of the survey which suggests that no measurable movements are discerned and the movement data are therefore not an issue of geotechnical concern. Continued monitoring is recommended. It is concluded that no significant horizontal displacements are occurring on these structures.

Since the previous year, the vertical data shows that 2 monuments indicated minor upward movements of 1 mm and 13 monuments (i.e., all monuments on Dams 1 and 2) had settlements of 2 mm or less (which is the stated survey accuracy). All four monuments on Dam 4B showed incremental settlements greater than 2 mm (3 to 5 mm). All monuments show total settlement since installation of 31 mm or less, although, the survey data record suggests a pattern of continuing, minor settlement. In order to better assess the settlement data, plots of historical settlement have been prepared as Figures 5 to 7.

From this data, the following general observations are made:

- SP-2 (crest), located in the center part of dam 1D, shows the maximum downward total displacement along dam 1, i.e., 28 mm. This settlement point shows consistent minor downward displacement.
- SP-11-6 (berm), located in the centre of the south half of dam 2B, shows the maximum downward total displacement along dam 2, i.e., 18 mm. This settlement point does not show a pattern of annual downward displacement.
- SP-11-3 (crest), located in the north-central part of dam 4B, shows the maximum downward total displacement along dam 4, i.e., 31 mm. This settlement point shows consistent minor downward displacement.
- Three of the four monitoring points on Dam 4 show similar rates of vertical movements in recent years. The rate and total movement is small, and is not accompanied by any significant horizontal movement.

4.3.3 Stability/Lateral Movement

Table 4 above presents total settlement and horizontal displacement for all monuments. The historic horizontal displacement data is presented as "point-of-origin" plots in Appendix D. Point-of-origin plots show the data points on a year-by-year basis, relative to the point of origin – that is the measured coordinates of the monuments at the time of installation. This type of plot allows the determination of the actual variability of the data and the visual assessment of trends that may be indicative of lateral deformation. The observed movements are low and do not indicate continuous lateral progression, which indicates there is no significant embankment movement.

The measured values of lateral displacement are very low and do not represent a dam safety concern, but annual monitoring should continue.

4.3.4 Discharge Flows

Seepage flows are measured through a series of 4 V-notch weirs that were installed at the toe of the dams between 1997 and 2003. **Table 5** presents measured flow rates at V-notch weirs as provided by Teck in 2020. The table also presents observations and visually estimated seepage rates during the tailings storage facility annual inspection, identified by locations 1 to 18 and shown in Figure 1.

Table 5: Measured Flow Rates at V-notch Weirs and Estimated Seepage Rates in 2020

Location	Dam	Flow (point measurements)
V-notch 1	2B	0.1 – 0.5 L/s (provided by Teck). Water was clear
V-notch 2	2B	0.3 – 1.8 L/s (provided by Teck). Water was clear
V-notch 3	1A	0.1 – 0.6 L/s (provided by Teck). Water was clear
V-notch 4	1C	0.6 – 3.3 L/s (provided by Teck). Water was clear
1	1B	Puddle, no flow
2	1B	Puddle, very low flow, clear
3	1B	Puddle, no flow
4	1A	Puddle, no flow
5	1A	Puddle, no flow
6	1A	Puddle, no flow
7	1A	Puddle, no flow
8	2B	Puddle, very low flow, clear, see V-notch 2
9	2B	Puddle, very low flow, clear
10	2B	Puddle, very low flow, clear, see V-notch 1
11	2A	Puddle, no flow
12	1E	Puddle, no flow
13	4B	Puddle, no flow
14	4B	Puddle, no flow
15	4B	Puddle, no flow
16	1C	Puddle, no flow
17	1C	Puddle, no flow
18	1C	Puddle, no flow

Figure 8 shows the historical trend of seepage flow measurements at these V-notch weirs since their installation. The figure indicates that seepage flows measured during 2020 were generally consistent with previous historical trends. Seepage flows measured during 2020 were also of the same order as those measured during 2019.

V-notch 4 presents a peak flow rate of 3.3 L/s in 2020. This peak corresponds to the period of the spring snowmelt and does not appear recurrently for previous years simply because there were no systematic readings during this same period (end of April) for the past years.

The sum of the measurable flows reflects both seepage from the dam and surface water runoff due to rainfall events. The peaks shown on Figure 8 likely reflect impacts of surface runoff, whereas the lower bound values more likely represent base flows derived primarily from seepage. The lower bound range (0 to 1.5 L/s) and upper bound range (1.5 to 3.3 L/s) are lower than the expected seepage rate from the 1993 design studies and as assumed in the water balance (11.5 L/s). The seepage rates are low and no pattern of increasing seepage flow is discernable. This is therefore considered to be within the expected range and does not indicate a dam safety concern.

4.4 Pond and Discharge Water Quality

Water discharge quality is presented in the Louvicourt annual environmental report (Suivi environnemental post-restauration) submitted by March 31 of each year to the Ministère de l'Environnement et Lutte contre les changements climatiques du Québec (MELCC).

4.5 Site Inspection Forms

The routine inspection forms completed by site reconnaissance staff were reviewed by the EoR. No significant performance issues were identified with the structures as part of the regular inspections.

5.0 DAM CONDITION ASSESSMENT

5.1 Design Basis Review

5.1.1 General

The Dams 1A through 1E, and 2A and 2B are comprised of a till core with rockfill/sand and gravel shoulders, a filter zone along the downstream face of the core and a drain along the base of the dam. Geotextile was placed beneath the shoulders and riprap protection layer. Dam height varies along the length of the alignment and ranges from a couple of metres near the abutments up to approximately 18 m in the deeper valleys of Dam 1 and Dam 2. The upper upstream and downstream faces are typically sloped at 2.5H to 1V and 2H to 1V respectively, with upstream and downstream stability berms constructed to approximately the mid height of the dams within the deeper valley sections. The stability berms reduce the overall slope to between about 3.5H:1 and 7H:1V.

The tailings pond level is controlled by a concrete overflow weir located at the south abutment of Dam 1E. Stoplogs were initially used during mine operations to control the pond level. These stoplogs were replaced after closure with mass concrete to form the weir at elevation 316.1 m, including an extra 0.1 m provided by a wood plank. Flood inflows into the tailings facility could be routed through a 5 m wide concrete spillway located adjacent to the overflow weir and set at elevation 316.3 m (referred to as the emergency spillway). In case of blockages of the weir and first emergency spillway, flood inflows would passively be routed through a second emergency spillway located approximately 170 m north of the concrete overflow weir spillway. The emergency spillway has a single 5 m wide trapezoidal shaped concrete sill at elevation 316.5 m with 2H:1V side slopes. All flows through the overflow weir and either of the spillways report to the downstream polishing pond.

The polishing pond was built in the fall of 1995 and completed in the spring of 1996. The design of Dam 4B is similar to Dams 1 and 2. Dam 4A is built on higher ground and currently does not retain any water. Outflow from the polishing pond passes over aluminium stoplogs embedded into a concrete structure. The water level is currently controlled at elevation 307.1 m.

Information concerning the geology, stratigraphy, and groundwater conditions is presented in Golder's report (Golder 1993). The tailings facility has not been raised since its original construction.

Routine inspections have been carried out since closure in 2005. Monthly inspections are performed by walking the crest of the dams, while weekly inspections are done by driving the dams at low speed and inspecting the spillways. Cameras have been installed at both spillways, and the photos are reviewed regularly by several qualified personnel.

Tailings Storage Facility Annual Inspections (TSFAI) are performed yearly and Dam Safety Reviews (DSR) are performed every 5 years in conformance with CDA recommendations and Teck corporate guidelines. The site inspection for the scheduled 2020 DSR was delayed to 2021 due to the COVID restrictions.

5.1.2 Tailings Pond Dams (Dams 1 and 2)

The combined length of all five segments of Dam 1 is 1,650 m. Dam 1 has an average height of 8 m and a maximum height of 18 m. The combined length of the two segments of Dam 2 is 880 m. Dam 2 has an average height of 10 m and a maximum height of 18 m. A typical cross-section of the dams is shown in Figure 2. Dam crests within the central portion of Dam 1D and part of Dam 2B were intentionally built 1 m higher than the design elevation to compensate for anticipated settlement at these locations.

Vibrating wire piezometers and an inclinometer were used to monitor dam behaviour during construction and shortly after. These instruments are no longer operational. Current instrumentation at the tailings pond dams consists of 4 piezometers, 4 V-notch weirs and 15 survey monuments. Other observation wells (5) are located further downstream from the dams and are used to monitor water quality. The locations of the instruments are shown in Figure 1. New instrumentation (vibrating wire piezometers, standpipe piezometers, thermistors and v-notch weirs) are being installed to supplement the monitoring network for the structures.

5.1.3 Polishing Pond Dam (Dam 4B)

The polishing pond was operated until 2011 at an elevation consistently lower than the design pond elevation of 309.0 m. The pond was then operated at elevation 306.54 m until 2018, and then at a spillway elevation of 307.1 m since. The design of Dam 4B is similar to that of Dams 1 and 2.

Current instrumentation at the polishing pond consists of 1 observation well and 4 survey monuments located on the crest and toe berm of the dam. The locations of the instruments are shown in Figure 1. New instrumentation (vibrating wire piezometers) are being installed to supplement the monitoring network for the structure.

5.1.4 Dam Design Parameters

The design geometry of the dams is summarized in Table 6.

Table 6: Design Geometry

Item	Design Value
Upstream Slope	2.5 H:1V
Crest Width	8 m
Downstream Slope	2.0 H:1V (inter bench, without considering downstream berms)
Minimum freeboard (from dam crest)	2.0 m at tailings pond 1.5 m at polishing pond
Maximum level of tailings (below dam crest)	3.0 m
Minimum crest elevation of Dams 1 and 2 at the tailings area	318.0 m with parts of Dams 1D and 2B at 319.0 m
Minimum crest elevation of Dam 4B at the polishing pond	310.5 m

5.1.5 Subsurface Conditions

The dams of the tailings facility are located in a valley between bedrock outcrops of relatively high elevation. The tailings pond dams were constructed between the local bedrock outcrops to reduce overall fill requirements.

Geotechnical investigations indicate that subsurface conditions at the site typically include the following layers:

- Surficial layer of topsoil/peat typically 100 mm to 300 mm thick.
- Overburden soils comprising layers of alluvial/lacustrine silty clay to clayey silt with consistencies ranging from soft to very stiff. A weathered upper crust of stiff clay was observed in most of the profiles, underneath which the consistency of the soils generally significantly decreases. Silty clay and clayey silt materials typically grade to a silt material with depth and in some cases to silty sand.
- A basal glacial till layer typically ranging from silt to silty/gravelly sand in a medium dense to dense state.
- Underlain by granodiorite bedrock.

5.1.6 Embankment Fill Materials

The tailings dams and polishing pond dam are zoned earth fill embankment structures, constructed of compacted till core with a filter zone along the downstream face of the core and a drain along the base of the dams and rockfill/sand and gravel shoulders, as shown in the typical section presented in Figure 2.

Updated material properties for the tailings, the embankment fill materials and subsurface materials were used in the 2005 DSR (SNC-Lavalin, 2005). These material properties are listed in Table 7.

Table 7: Updated Design Material Properties (SNC-Lavalin, 2005)

Material	Unit Weight (kN/m^3)	Total Stress Strength		Effective Stress Strength	
		Cohesion (kPa)	Friction Angle (degrees)	Cohesion (kPa)	Friction Angle (degrees)
Sand and gravel (Dams 1 and 2)	23 - 24*	-	-	0	35
Sand and gravel (Dam 4)	20.8 - 22.6*	-	-	0	35
Sand filter	20	-	-	0	35
Till (Core)	22 - 22.7*	-	-	0	35
Clay	15 – 16.5	30 – 85	0	0	26 – 29
Till (Foundation)	18.5 – 19	-	-	0	30 – 35
Tailings within the tailings pond	16	-	-	0	30

* Saturated Unit Weight.

Based on a reassessment of the tailings density (Golder 2018b), the saturated unit weight for the tailings was revised to 21.3 kN/m^3. Stability analyses confirmed that this change resulted in nominal reduction of the calculated factors of safety.

5.1.7 Seismicity

The seismicity values for the site were estimated by SNC-Lavalin in the 2005 DSR (SNC-Lavalin, 2005) and reviewed by Klohn Crippen Berger as part of the 2010 DSR (Klohn Crippen Berger, 2011). Both evaluations were based on the 2005 version of the National Building Code. The predicted peak ground accelerations (PGA) on very dense soils at the corresponding return period are summarized in the following table.

Table 8: Site Seismic Hazard Values from 2010 DSR (adapted from Klohn Crippen Berger, 2011)

Structure	Return Period (Years)	PGA[1] (g)
Tailings Pond Dams	1 in 10,000	0.23
Polishing Pond Dam	1 in 2,500	0.12

Note: [1] For ground site class '"C": very dense soil and soft rock foundation.

5.2 Hazards and Failure Modes Review (Assessment of Dam Safety Relative to Potential Failure Modes)

As a required component of the TSFAI, the key hazards and failure modes have been identified and assessed. This section reviews the dam safety implications of the instrumentation data and the September 24, 2019, site observations relative to potential failure modes. The design basis relevant to each of the typical potential failure modes is also presented.

5.2.1 Internal Erosion

Dam internal instability can be caused by materials migrating out of a dam via seepage, leaving voids. This generally happens with materials that do not have filter compatibility; that is, the fines fraction of one material can migrate into or through the voids of the adjacent material under a sufficient hydraulic gradient. Piping is caused by regressive erosion of particles towards an outside environment until a continuous pipe is formed.

Design Basis

Filter compatibility was established by Golder during the initial design phase of the structures (Golder, 1993). The initial design considered piping criteria based on grain size distributions of the till core and adjacent sand drain, and between the sand drain and the gravel located at the toe drain. Filter compatibility was briefly commented upon in section 3.4 of the SNC-Lavalin (2005) dam safety review and was described to have been set with "*conservative limits*".

Instrumentation and Observed Performance

The position of the V-notch weirs and seepage locations is shown on Figure 1. Table 5 presented measured flow rates and visually estimated seepage flows. Water flowing from the toe drains, the seepage points, and the V-notch weirs was clear and did not contain visible suspended particles. Flow rates were generally low and within the expected range. Additional v-notch weirs are being considered to augment the monitoring network.

No zones of subsidence or any sink holes were observed, the presence of which would indicate voids due to piping. No evidence of internal erosion was observed. It was concluded that no internal erosion was occurring that could threaten the integrity of the structures.

Planned and Ongoing Studies

Studies to eliminate this hazard as a credible failure mode for the facility are ongoing or planned and include:

- Review of historic construction records to assess filter compatibility between natural soils and construction materials
- Piezometric monitoring to measure gradients across potential erosional transitions
- Seepage modelling to validate measured gradients
- Assessment of potential frost effects on core integrity

5.2.2 Instability

Design Basis and Subsequent Reviews

Stability analyses were conducted during the original design phase of confinement dams (Golder, 1993). The original dam geometry was established to meet a minimum factor of safety of 1.5 under end of construction conditions and operational conditions. Seismic analysis of the dams was performed at that time using a 1:1,000-year seismic acceleration. The seismic value was modulated based on a one-dimensional soil response analysis of the soil column. The resulting horizontal ground acceleration was used in a pseudo-static stability analysis. Results showed factors of safety slightly greater than 1.1 for all dams. It is noted that the original stability analyses used Bishop's method of analysis, which was common at the time. Bishop's method is not as rigorous as currently used methods and it is therefore not valid to compare these results to modern compliance criteria.

Based on the results of the original 1992 field investigation, the 2005 DSR (SNC-Lavalin, 2005) confirmed a minimum factor of safety value of 1.3 for long-term operational conditions, except for Dam 1D. This led to the widening of Dam 1D downstream berm in 2005. The 1.3 factor of safety was considered adequate for the long-term operational condition. A post-closure target factor of safety of 1.5 was recommended. The seismic analysis contained in the 2005 DSR used seismic values for a 1:10,000-year seismic event and also performed a one-dimensional soil response analysis to account for the presence of a soil column. The resulting horizontal ground acceleration was used in a pseudo-static stability analysis. Results confirmed factors of safety slightly greater than unity for all dams. The liquefaction potential analysis indicated that localized zones of relatively low density till present in dam foundations could potentially be liquefiable in the case of the design earthquake. Post-liquefaction analyses have confirmed that if these zones should liquefy, the dams would remain stable.

The 2010 DSR (Klohn Crippen Berger 2011) included a preliminary liquefaction and cyclic softening screening assessment based on the results of the original 1992 field investigation. The 2010 DSR concluded a more extensive presence of potentially liquefiable materials than estimated previously by SNC-Lavalin in 2005. A preliminary stability assessment concluded that post-liquefaction factors of safety for a typical section of the tailings dam do not meet current recommended guidelines. Further field and laboratory studies were recommended.

Golder performed a supplemental liquefaction assessment and post-liquefaction stability analyses in 2013 (Golder 2013). Based on the 1992 geotechnical field data, the analysis indicated that there was a potential for the silt stratum below Dam 1C and Dam 2B to liquefy under the design seismic event. For a low-bound shear strength value of the liquefied silt layer, Dam 2B was predicted to have factors of safety below the target. However, these analyses did not account for consolidation that may have occurred subsequent to dam construction, and it was noted that the field investigation data did not include current techniques that did not exist in 1992. It was recommended that a focused geotechnical investigation program using current investigation methods be undertaken to update the analyses. The new field investigation was conducted in the fall of 2017 and subsequent analyses were underway while this report was being compiled. To support the stability analyses, a revised site-specific seismic hazard assessment has been completed (draft under review). Further, additional instrumentation was installed in 2020 to validate the piezometric assumptions for the analyses.

Movement Monitoring Instrumentation

Detailed analysis of monitoring data is included in Section 4.3.

The CDA Dam Safety Guidelines (CDA 2013) Section 3.6.3 recommends use of dam instrumentation to supplement the ongoing visual assessment of dam performance relative to potential failure modes. Section 4.3.2 presents a summary of settlement and horizontal movements measured and observed at the TSF.

Horizontal and vertical movements of the monuments listed in Table 4 remain relatively limited. Some trends and observations have been noticed and are commented on below:

- Monuments present movement with amplitudes similar to the survey of 2019.
- Incremental settlements (2019 to 2020) were generally less than 2 mm (which is the stated survey accuracy). The maximal incremental settlement was 5 mm for one instrument (SP-11-4) located on the crest of Dam 4B.
- SP-11-1 SP-11-3, SP-11-4 and SP-11-5 show patterns of annual settlement equal to a few millimetres per year. However, there is no sign of accelerating settlements. The other survey monuments present total settlements that have stabilized or are variable (minor up and down movements) through the years.
- The largest movement (settlement of 31 mm) occurs at SP-11-3 located on Dam 4B. The magnitude of deformations indicated by the monitoring instrumentation is within accepted ranges do not present a dam safety concern but do warrant continued monitoring as a best practice.
- None of the monitoring points show patterns of horizontal movement indicative of mass movement of the embankments.

Observed Performance

Longitudinal cracks were reported to develop along the crest of Dam 1 during the last few winter seasons. A general observation was that the severity of crest cracking in 2019 and 2020 was less pronounced than previous years. Golder (2015) inspected and analyzed the cracks and concluded that they were caused by frost action, exacerbated by eolian removal of snow on the upstream shoulder of the dam. No evidence to the contrary was observed at the time of the inspection.

It is likely that annual longitudinal cracking will continue. It may be necessary to undertake investigations to confirm that there is no associated risk to the integrity of the core. Continued monitoring of the cracks is required.

Planned and Ongoing Studies

Studies to eliminate this hazard as a credible failure mode for the facility are ongoing or planned and include:

- Site specific seismic hazard assessment coupled with an update of seismic stability and liquefaction susceptibility for a 1:10,000-year return period seismic event.

5.2.3 Overtopping

Design Basis

The dams of the tailings pond and polishing pond were originally designed with a 2.0 m freeboard and a 1.5 m freeboard respectively. During 2020, the freeboard varied between 1.75 and 2.05 m at the tailings area, and 3.15 to 3.39 m at the polishing pond. High water levels in both cases are associated with the spring freshet.

A review of freeboard was performed in the 2010 DSR (KCB, 2011) in accordance with CDA (2007) guidelines. Results indicated that wave run-up could reach an elevation less than or equal to 316.89 m in the TSF under normal and PMF conditions. Since this is below the existing crest elevation of nominally 318.0 m, it was concluded that protection against a wave overtopping condition was adequate for the tailings pond. For the polishing pond the current 3.15 m freeboard is considered to be more than adequate.

Flood routing was improved by the construction of a second emergency spillway at the tailings pond in 2005. SNC-Lavalin (2006) estimated that in the case where the operational spillway and the first emergency spillway were blocked by beaver activity, the second emergency spillway would be able to passively pass the 1:10,000-year storm event under a maximum pond elevation of 316.77 m. This level is close to the top of the till core but is at least 1.23 m below the dam crest elevation.

Instrumentation Data

The tailings pond water level was measured via staff gauge during the open water season in 2020. For the 2011-2020 period, the pond water elevations generally varied between a minimum value of 315.95 m in the fall months to a maximum value of 316.25 m (0.15 m head over the weir level) in springtime. The historical minimum levels were recorded in fall 2010 (315.17 m) and the maximum in spring 2019 (316.25 m). This may reflect higher than average spring rainfall and an increase in the frequency of measurement which was undertaken in 2019. The minimum CDA freeboard requirements were maintained in 2019-2020.

Observed Performance

The water level within the tailings pond was 316.09 m during the visit. The freeboard at the time of the site inspection was greater than the minimum CDA freeboard requirements (KCB, 2011) and therefore did not present a safety concern. The presence of three spillways at the tailings pond and two spillways at the polishing pond provides a significant mitigation against overtopping potential. Spillway cameras provide daily, or as triggered photos of the spillways.

Planned and Ongoing Studies

A consolidated hydrology study (draft version pending review) determined that both the TSF pond and the polishing pond had adequate capacity to safely pass the probable maximum flood (PMF) event, with significant contingency. Teck has demonstrated diligence in the maintenance of the spillway structures. Under active closure care, it is concluded that overtopping is not a credible failure mode. Results of this study will be used to update TARPs related to pond levels.

5.3 Review of Downstream and Upstream Conditions

No changes to the overall conditions downstream of the tailings and polishing ponds have been reported to Golder, and observations made in the toe regions of the embankments support this conclusion. Upstream conditions only report to a very limited watershed. No changes to the watershed conditions have been reported to Golder.

5.4 Dam Classification Review

5.4.1 Dam Consequence Classification

The dam consequence classification has evolved through time. The current dam consequence classification is “very high” for all dams except Dam 4B, which has a “high” classification.

Dam consequence classifications are based on the consequences of failure irrespective of the likelihood of a potential dam failure and should not be mistaken with the risk of failure, which is a combination of likelihood and consequence. Klohn Crippen Berger assessed the dam consequence classification as part of the 2010 DSR (Klohn Crippen Berger, 2011). Table 9 presents the dam classification criteria based on the CDA guidelines (CDA 2007). The classification of the dams at the tailings area (Dams 1 and 2) was established as “very high” to “extreme”. The classification of Dam 4B at the polishing pond was established as “high”. The tailings facility dams were classified in the “very high” to “extreme” consequence categories because the population at risk includes permanent residents in houses located within the floodway, for which the potential loss of life is estimated to be from 10 to in excess of 100. It is noted, however, that the population at risk was estimated without the benefit of a dam breach analysis, and therefore the classification must be considered qualitative.

Table 9: Dam Classification in Terms of Consequences of Failure Table (based on CDA 2007)

Dam Class	Population at Risk[(a)]	Incremental Losses		
		Loss of Life [(b)]	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	Minimal short-term loss. No long-term loss.	Low economic losses; area contains limited infrastructure or service.
Significant	Temporary Only	Unspecified	No significant loss or deterioration of fish or wildlife habitat. Loss of marginal habitat only. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes.
High	Permanent	10 of fewer	Significant loss or deterioration of important fish or wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transport, and commercial facilities.
Very High	Permanent	100 of fewer	Significant loss or deterioration of critical fish or wildlife habitat. Restoration or compensation in kind possible but impractical.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).
Extreme	Permanent	More than 100	Major loss of critical fish or wildlife habitat. Restoration or compensation in kind impossible.	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances).

Source: CDA (2007)

(a) Definition for population at risk:

None – There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventures.

Temporary – People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).

Permanent – The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

(b) Implications for loss of life:

Unspecified – The appropriate level of safety required a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

An inundation study for the tailings facility was subsequently completed by SNC-Lavalin (SNC-Lavalin, 2012) based on CDA 2007 guidelines. The study considered two potential failure scenarios and assessed the resulting impact on downstream receptors. The results indicated the consequence classification for the tailings pond dams was “very high”. The classification was governed by the environmental consequences of a dam breach that would produce impacts in the Bourlamaque River, which are impractical to restore. The reduction from “extreme” to “very high” was a result of the reduction of the estimated population at risk in the event of a dam breach to less than 100.

5.4.2 Review

No new elements are available to support dam classification modification; however, Teck has directed Golder to assess the stability and physical performance of the various structures of the TSF and polishing pond against extreme loading conditions, those being a probable maximum flood event and a 1:10,000-year return period seismic event. These design basis loading conditions would be applicable to an extreme consequence classification – the highest consequence level considered in the CDA guidance. If the performance of the structures against extreme loading conditions is verified, Teck may opt to discontinue the periodic review of consequence classification. Future consequence classification may be required if the guidance for classification of structures evolves or if the magnitude of the extreme loading events changes.

5.5 Physical Performance

The overall performance of the Louvicourt TSF and polishing pond is good. The observations made during the inspection are consistent with good geotechnical performance. The review of the instrumentation readings presented in Section 4.3 did not show displacement or settlement that could indicate a deterioration of physical stability.

Section 4.1 summarizes the observations made at the site and section 6.6 presents the identified recommended actions in view of supporting the facility performance in the longer term. It is to be considered that the outcome of the stability analyses at Dams 1C and 2B should be considered in the ongoing assessment of physical performance.

5.6 Operational Performance

The Louvicourt tailings facility is closed and there are no activities related to tailings disposal or regularly scheduled activities related to operation of the ponds. Stop logs are added and removed at the polishing pond spillway as needed to control effluent pH.

5.7 OMS Manual Review

The Operation, Maintenance and Surveillance (OMS) Manual for the tailings management facility was updated in March 2017 (Golder, 2017) with an interim update in 2019, and again in 2020. A new version following the 2019 Mining Association of Canada (MAC) OMS Guide is expected to be completed in Q2, 2021.

5.8 Emergency Preparedness and Response Review

An Emergency Preparedness and Response Plan (EPRP) for the tailings facility was finalized in 2017. Golder reviewed the version published on March 22, 2019. The EPRP is considered to be up to date and appropriate. Teck has also prepared a draft Mine Emergency Response Plan (MERP) which incorporates response procedures for the tailings and polishing pond components with input from the EOR, and once finalized, will replace the EPRP. The most recent MERP test for the facility was conducted on November 3, 2020.

6.0 SUMMARY AND RECOMMENDATIONS

6.1 Summary of Construction and Operation/Maintenance Activities

The trash rack at the tailings pond was replaced in 2020. Drilling and instrumentation programs were completed on the various structures in 2020. No other significant construction occurred. The maintenance and surveillance activities performed in 2019-2020 included the following:

- Routine inspections
- Survey of monuments
- Removal of vegetation in the emergency spillways
- Removal of debris in the polishing pond active spillway canal
- The use of stop logs at the polishing pond from January to March 2020 to increase retention time and control effluent pH

6.2 Summary of Climate and Water Balance

The total precipitation over the hydrological year (November 2019 to October 2020) was 1,009.6 mm or 11% higher than the long-term average of 912.7 mm. Based on the consolidated hydrology study for the Louvicourt site (Golder, 2020b), this corresponds to an approximately 1:25-year wet precipitation year. The months of March (110.1 mm vs 55.3 mm long-term average), September (158.3 mm vs 101.3 mm long-term average) and October (120.8 mm vs 84 mm long-term average) were particularly wet.

Based on a high-level water balance analysis, it was estimated that 0.50 million m^3 of water was discharged to the polishing pond via the operational spillway.

6.3 Summary of Performance

The overall performance of the Louvicourt TSF and polishing pond is good and does not require major works or corrections. Minor works to be considered are summarized in Section 6.6. All actions recommended in Sections 6.6 aim at obtaining a good long-term performance or improving the overall understanding of potential long-term stability issues.

6.4 Consequence Classification

No changes are recommended to the consequence classification of the facility. Since the stability of the structures is being assessed using criteria associated with the highest (Extreme) consequence classification, Teck may opt to discontinue the periodic review of consequence classification. Future consequence classification may be required if the guidance for classification of structures evolves or if the magnitude of the extreme loading events changes.

6.5 Table of Deficiencies and Non-Conformances

Review of Previous Deficiencies and Non-Conformances

The Dams at the tailings pond and polishing pond were observed to be in a good condition at the time of the 2019 site visit. No significant changes were noted in the condition of the dams since the 2019 DSI. Deficiencies and non-conformances noted during the TSFAI and their status are presented in Table 10. Table 11 provides a description of the priority levels referenced in Table 10.

Table 10: Status of Dam Safety Inspections Key Recommended Actions

Structure	ID	Deficiency or Non-conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline/Status
Previous Recommendations Closed / Superseded						
Dam 1E	2018-02	Trash rack at inlet to the tailings pond operational spillway is damaged	OMS Manual Section 6.2	Repair trash rack.	3	COMPLETE: Trash rack replaced - Q4 2020
Dam 1D	2018-03	Access road at outlet of second emergency spillway is susceptible to erosion	CDA 2013 Section 3.5.5	Undertake erosion analysis to assess risk to embankmen integrity. If required install slope protection across the road and outlet channel, to route potential spillway flow away from the embankment.	3	Analysis completed and draft technical memo submitted for Teck review. No remedial measures are anticipated to be required to address this issue.
Previous Recommendations Ongoing						
All	2015-06	Perform a review of dam's seismic stability and liquefaction conditions	Directive 019 Section 2.9.3	Perform a review of dam's seismic stability and liquefaction conditions.	4	IN PROGRESS- Liquefaction analysis completed and deformation analysis is in progress. Q2 2021. Preliminary results suggest that seismic performance is adequate.
Dam 4B	2019-02	Granular fill has been placed east of the main spillway, in an area designed as an emergency spillway.	CDA 2013 Section 3.5.5	Assess whether the current configuration can pass the design storm. Preliminary indications are that the current configuration does not pose any overtopping issues.	2	IN PROGRESS - Q2 2021 Analyses completed, draft report submitted. Pending review and finalization of hydrology study. No remedial measures are anticipated to be required to address this issue.
2020 Recommendations						
Dam 1A Dam 1C	2020-01	Replacement of riprap on the interior slopes of Dams 1A and 1C is required.	CDA 2013 Section 3.5.3	Place new rip rap as was done for Dams 1B and 1D.	3	Schedule progressively for 2021 and 2022.
Dam 1D	2020-02	Larger diameter (>4-inch trunk) vegetation exists on the downstream stability berm of Dam 1D	OMS Manual Section 6.2	Consider tree removal	4	To be considered as part of operation and maintenance activities..

Table 10: Status of Dam Safety Inspections Key Recommended Actions

Structure	ID	Deficiency or Non-conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline/Status
Dam 4B	2020-03	Driftwood accumulated on the embankment in the polishing pond	OMS Manual Section 6.2	Consider removal of driftwood	4	To be considered as part of operation and maintenance activities.

Table 11: Priorities and Level of risks

Priority (defined by Teck Resources)	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
2	If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

Note: Priority description categories are consistent with Mining Association of Canada (MAC) guidelines.

7.0 CLOSURE

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

Golder Associates Ltd.

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Associate, Senior Water Resources Engineer

LG/SC/IO/VD/cd

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9.0 STUDY LIMITATIONS

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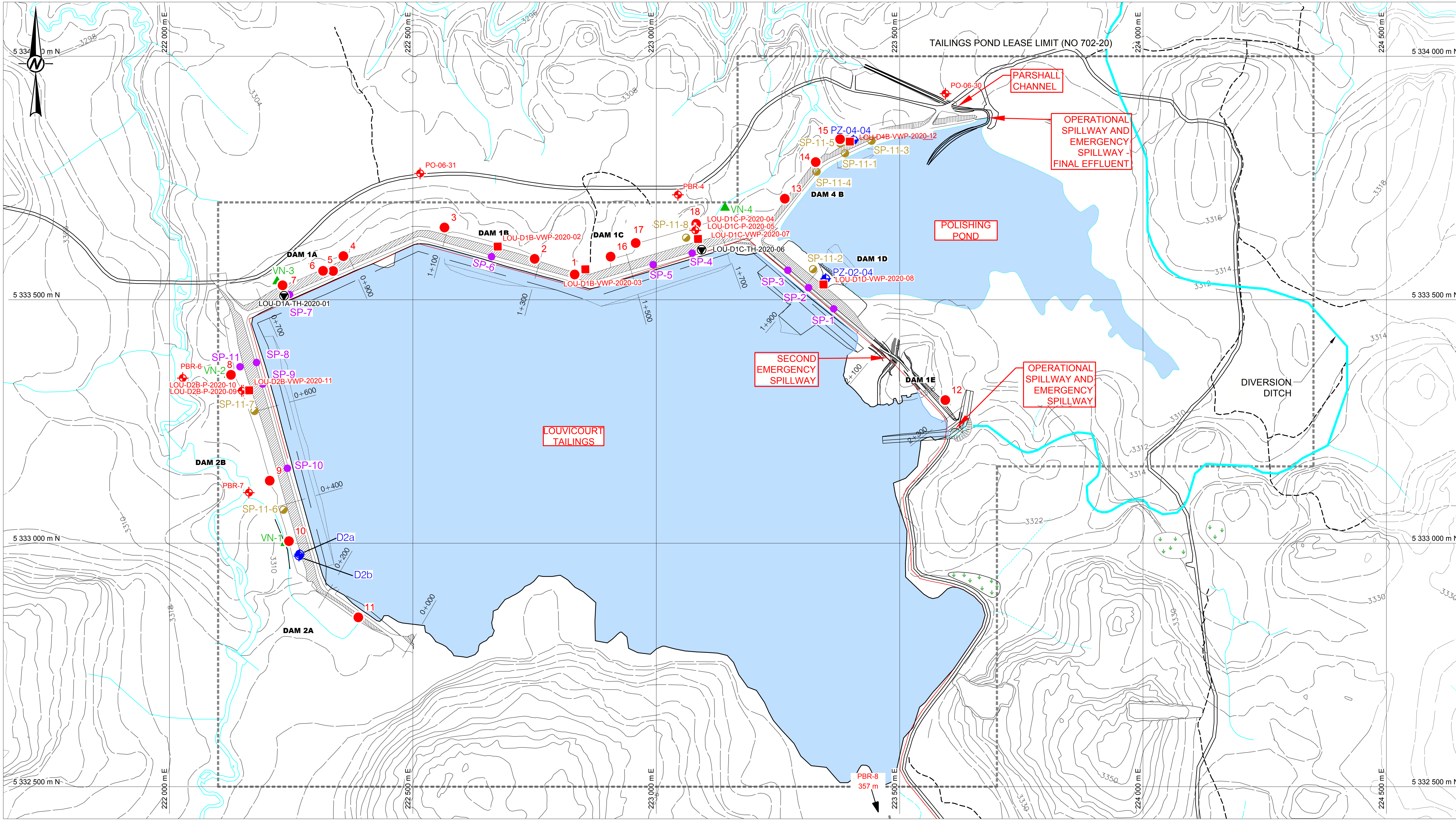
Figures



LEGEND

- PIEZOMETER
- V-NOTCH WEIR
- SEEPAGE AREA
- SETTLEMENT POINT
- SETTLEMENT POINT (GOLDER, 2011)
- OBSERVATION WELLS
- VIBRATING WIRE PIEZOMETER(S)
- THERMISTOR STRING

0 125 250
1:7 500 METRES

CLIENT
TECK
MINE LOUVICOURT

CONSULTANT

GOLDER

YYYY-MM-DD	2020-12-18
DESIGNED	I. Arroub
PREPARED	S. Chapuis
REVIEWED	L. Gareau
APPROVED	L. Gareau

PROJECT
LOUVICOURT MINE TAILING AND POLISHING PONDS 2020 DAM SAFETY INSPECTION

TITLE
GENERAL SITE PLAN

PROJECT NO.	PHASE	REV.	FIGURE
20145710	3000	0	1

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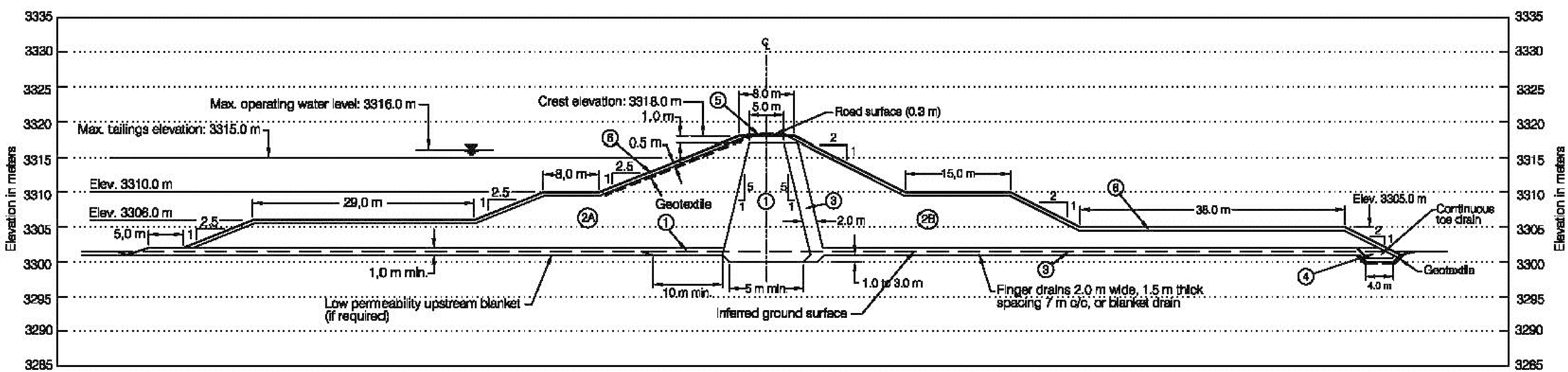


Legend:

- ① Till core
- (2A) Pit-run sand or sand and gravel upstream shell
- (2B) Sand or sand and gravel downstream shell
- ③ Processed filter sand
- ④ Toe drain - processed gravel
- ⑤ Road surface
- ⑥ Quarried rock

CLIENT	TECK MINE LOUVICOURT
PROJECT	LOUVICOURT MINE TAILINGS AND POLISHING PONDS 2020 DAM SAFETY INSPECTION
CONSULTANT	GOLDER
YYYY-MM-DD	2020-12-18
DESIGNED	I. Arroub
PREPARED	S. Chapuis
REVIEWED	L. Gareau
APPROVED	L. Gareau
TITLE	TYPICAL DIKE CROSS-SECTION
PROJECT NO.	20145710
PHASE	3000
REV.	0
FIGURE	2

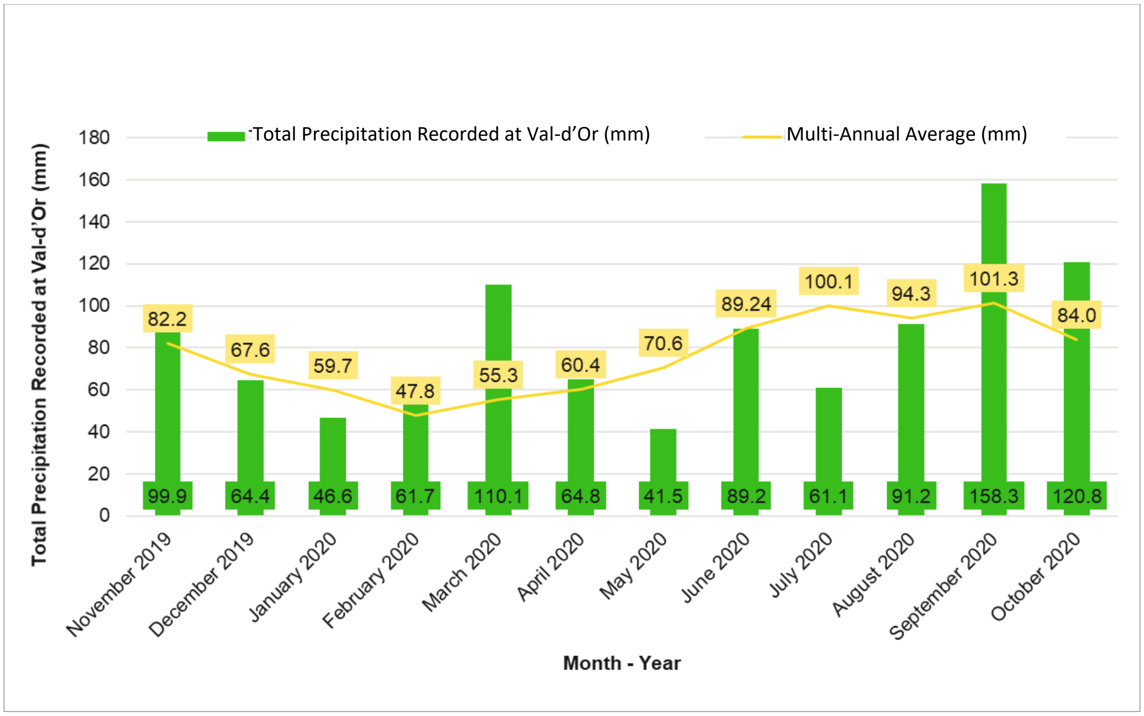
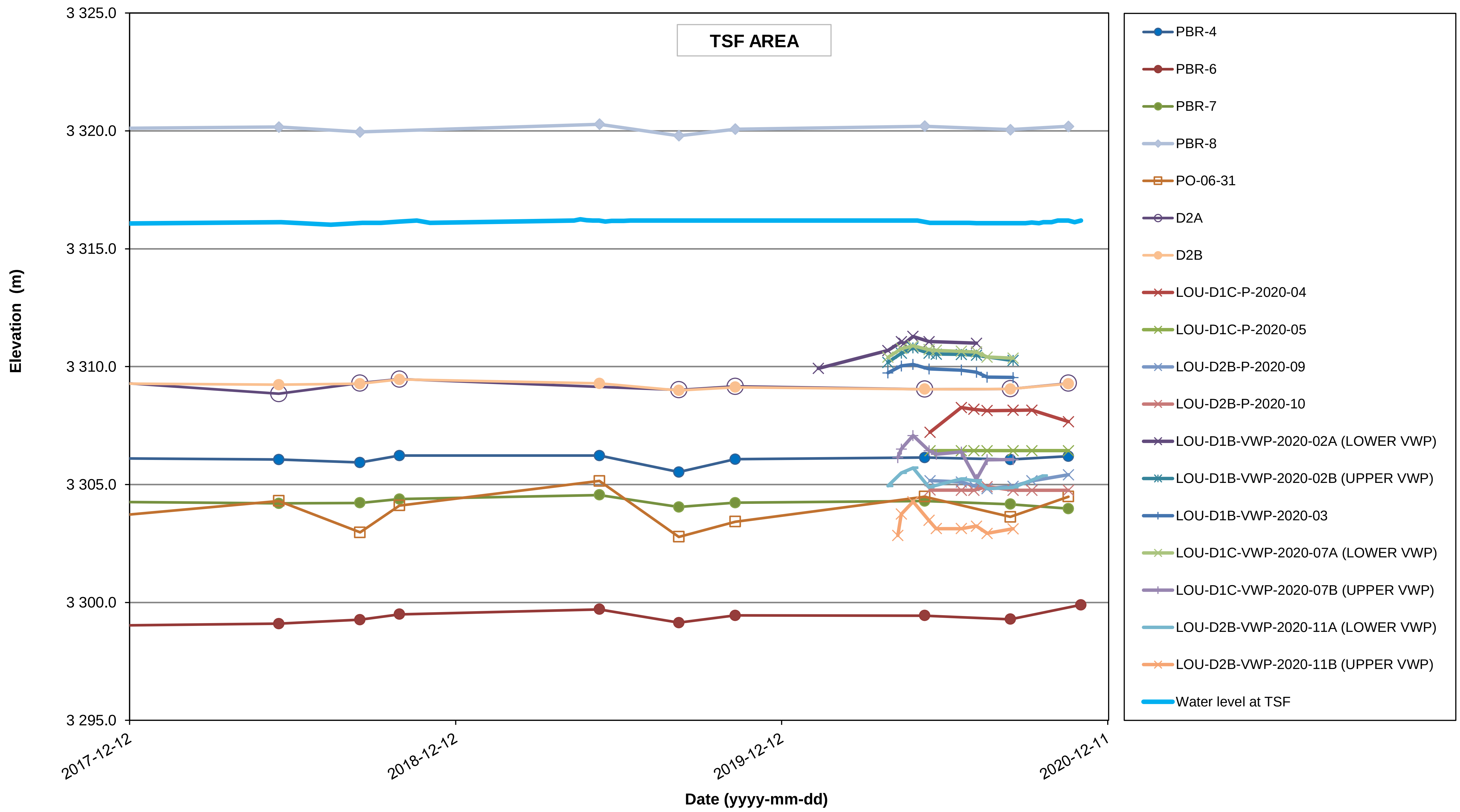
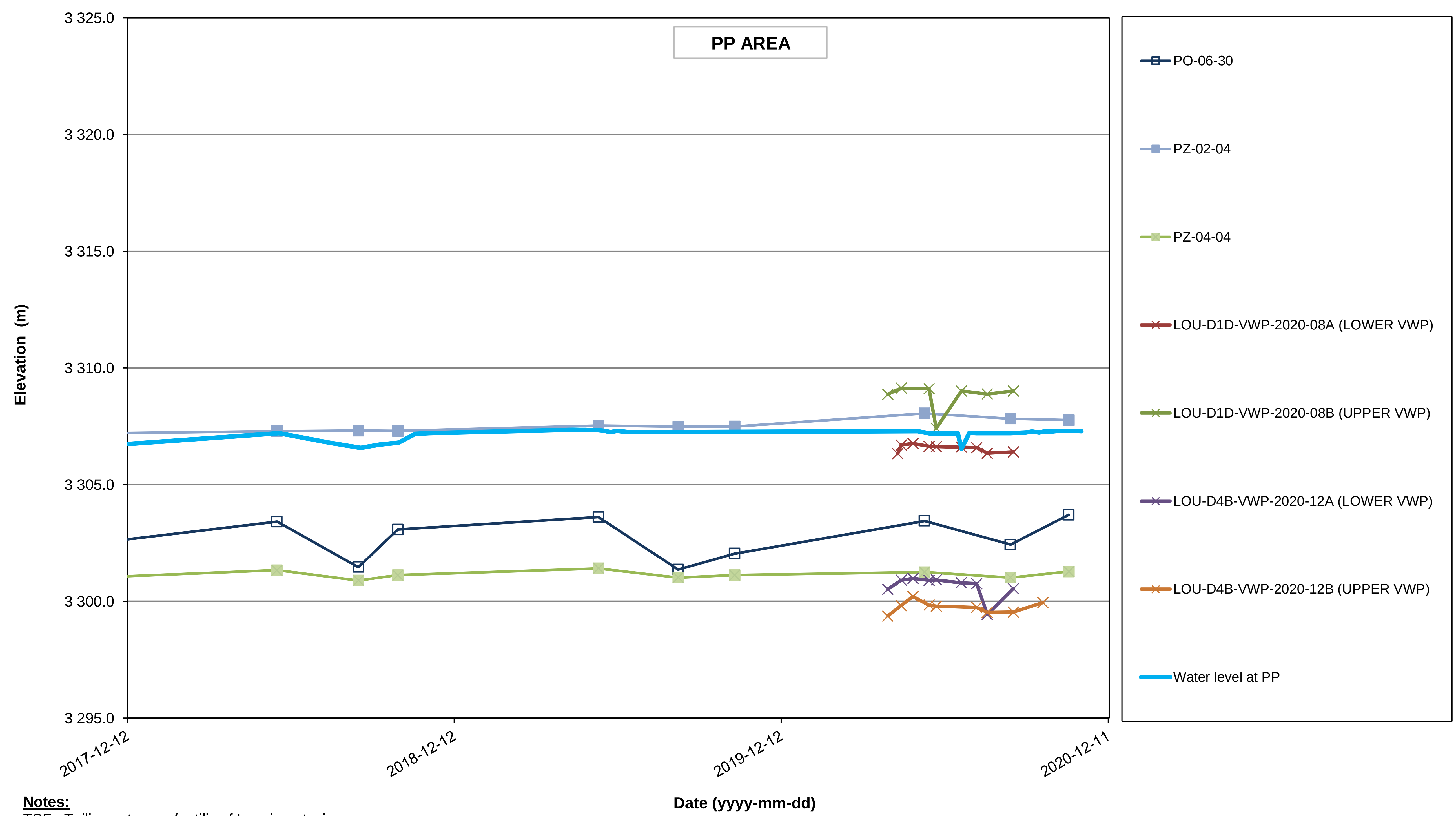


Figure 3: Monthly Precipitation Data from November 2019 to October 2020





Notes:
TSF : Tailings storage factiliy of Louvicourt mine
PP : Polishing pound of the Louvicour mine
PBR-8 : This well is located in the upstream of the TSF

DSI 2020	**Water level measurements - piezometers (provided by Teck)**	
Louvicourt TSF **Teck Resources Ltd**	PROJECT NO.	20145710-3000
	REV	0
	FIGURE	**4**

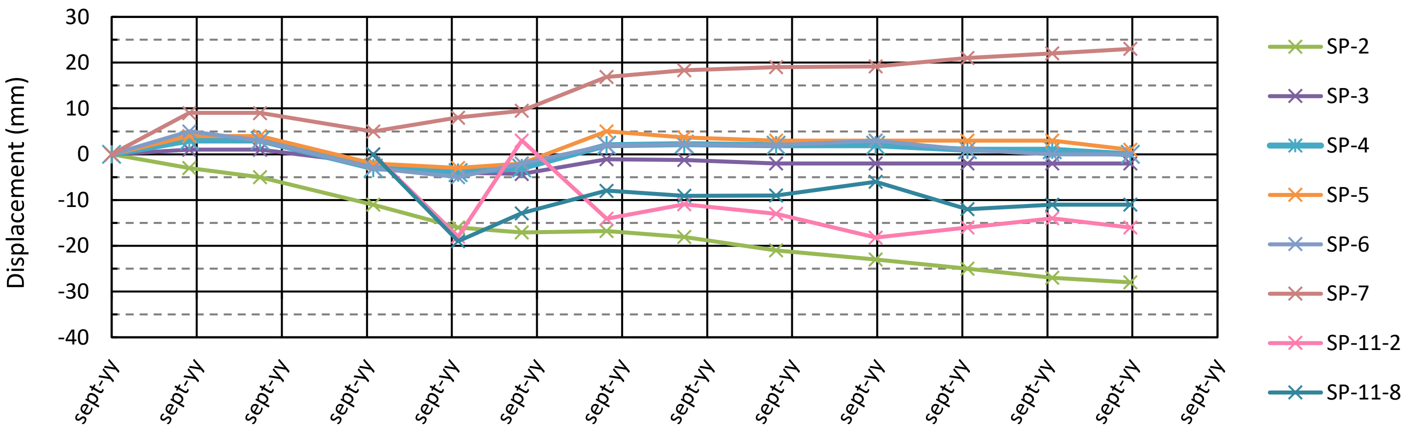


Figure 5 : Vertical Displacement of the Survey Monuments at Dam 1

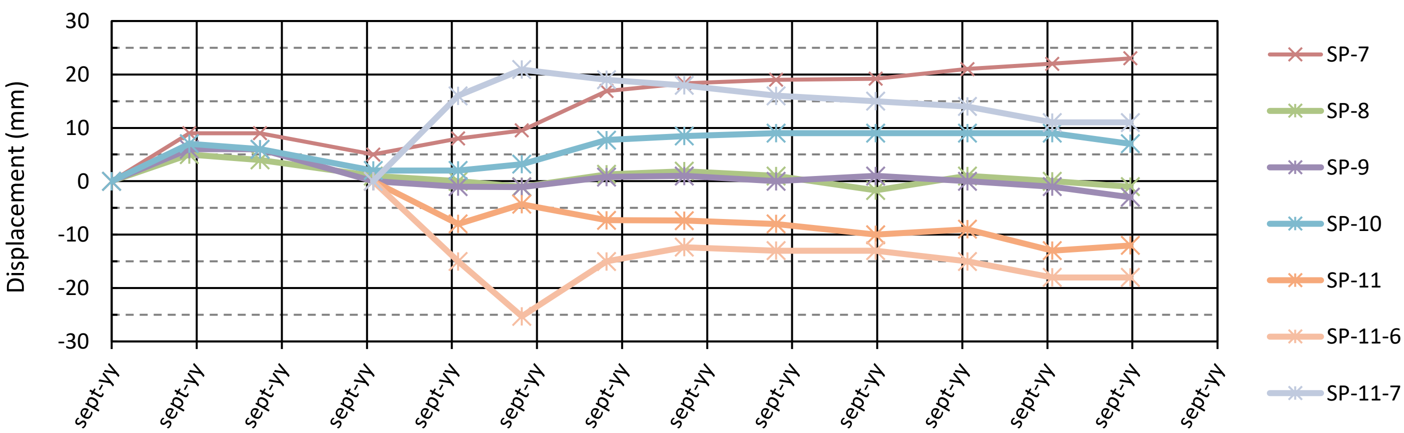


Figure 6 : Vertical Displacement of the Survey Monuments at Dam 2

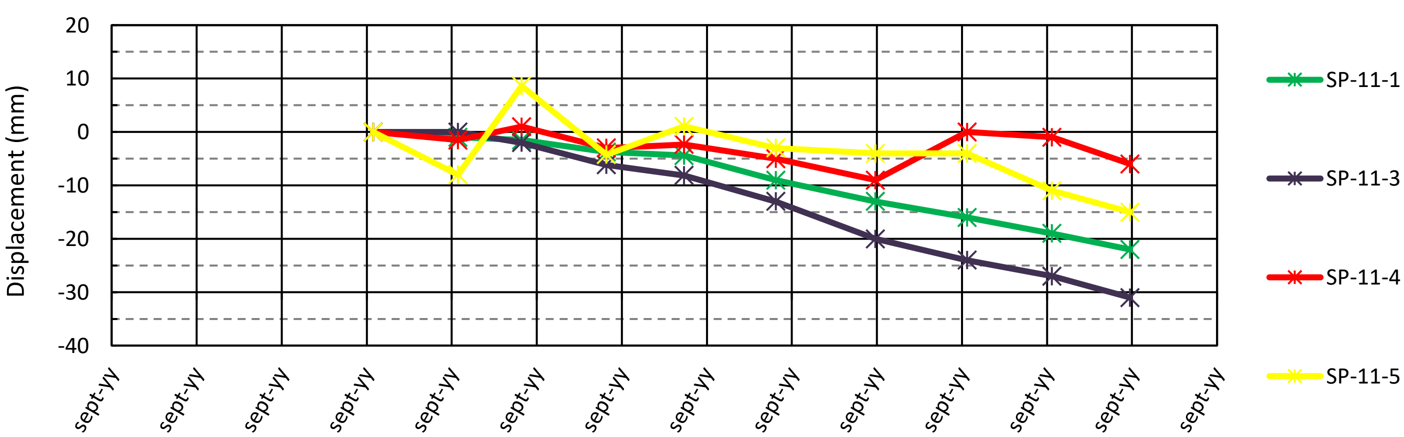
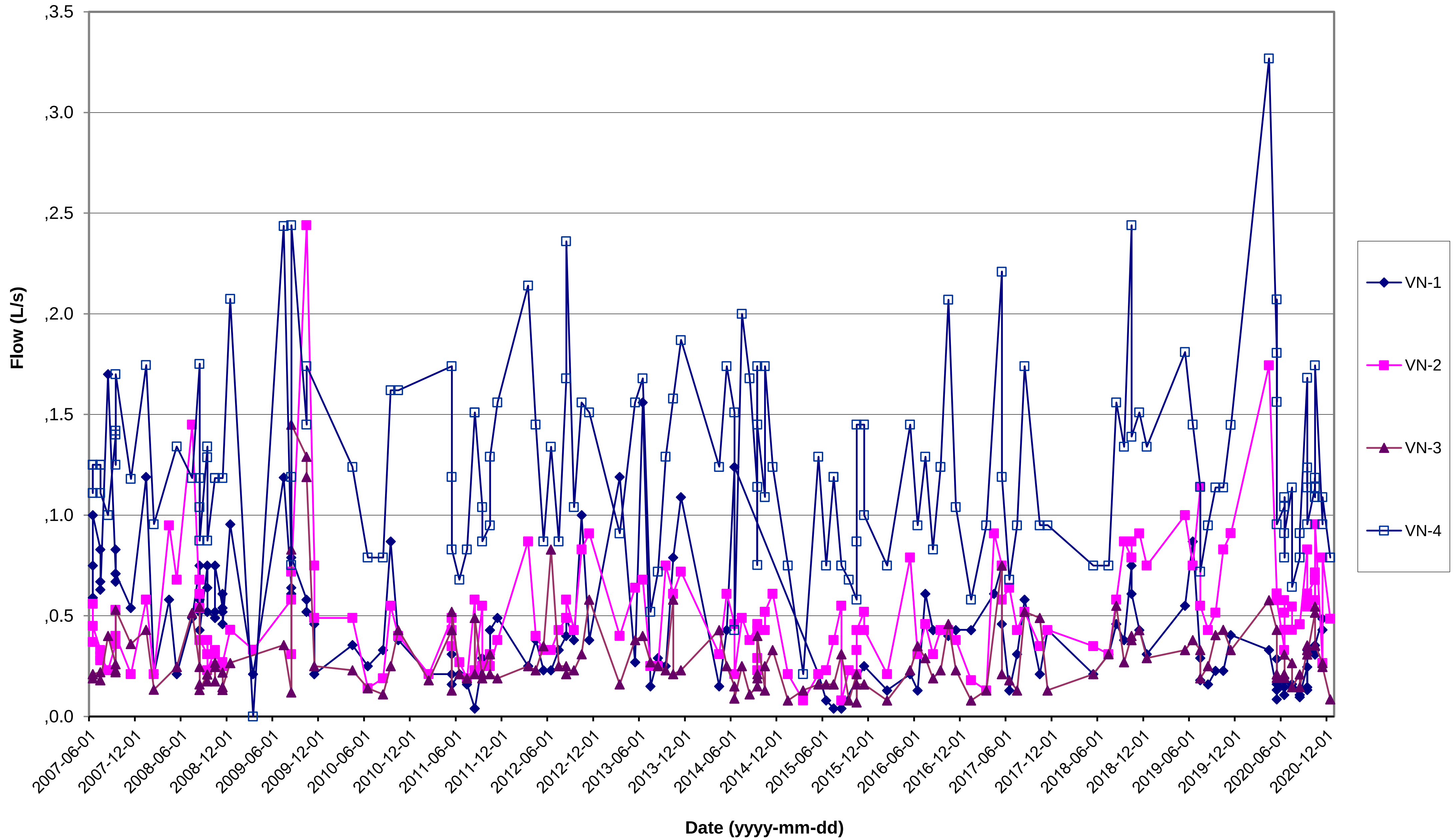


Figure 7 : Vertical Displacement of the Survey Monuments at Dam 4

Note: positive = upward displacement



DSI 2020	Louvicourt Mine Tailings Pond - historical trend of seepage flow measured at the V-notch weirs (provided by Teck)	
Louvicourt TSF Teck Resources Ltd	PROJECT NO.	20145710-3000
	REV	0
	FIGURE	**8**

APPENDIX A

Facility Data Sheet

Facility Data Sheet

Mine TSF and Polishing Pond Damne peux le faire cs

Dam 1

Dam Type	Till core, rock shell
Maximum Dam Height	13 m
Dam Crest Width	5 m
Impoundment Area	~1,000,000 m^2
Volume of Tailings	~6,500,000 t
Reservoir Capacity	~1,700,000 m^3 (to max spring pond elevation)
Consequence Classification	Very high
Inflow Design Flood (IDF)	PMF
Design Earthquake	1:10,000
Spillway Capacity	Combined 12.7 m^3/s at 317.0 m water level
Catchment Area	~2,100,000 m^2
Access to Dam	From crest of dam

Dam 2

Dam Type	Till core, rock shell
Maximum Dam Height	15 m
Dam Crest Width	5 m
Impoundment Area	~1,000,000 m^2
Volume of Tailings	~6,500,000 t
Reservoir Capacity	~1,700,000 m^3 (to max spring pond elevation)
Consequence Classification	Very high
Inflow Design Flood (IDF)	PMF
Design Earthquake	1:10,000
Spillway Capacity	N/A – See Dam 1
Catchment Area	~2,100,000 m^2
Access to Dam	From crest of dam

Dam 4 – Polishing Pond

Dam Type	Till core, rock shell
Maximum Dam Height	12.5 m
Dam Crest Width	5 m
Impoundment Area	150,000 m^2
Volume of Tailings	N/A
Reservoir Capacity	150,000 m^3 (to spillway crest elevation + 0.1 m)
Consequence Classification	Very high
Inflow Design Flood (IDF)	PMF
Design Earthquake	1:10,000
Spillway Capacity	Combined 22.0 m^3/s at 309.5 m water level
Catchment Area	1,150,000 m^2
Access to Dam	From crest of dam, or northeast access.

APPENDIX B

Photographs

Appendix B - Photographs

Photo 1 : Dam 1D - New rip rap placed in 2019 on upstream slope.
View looking South-East.

Photo 2 : Dam 1C – Degraded rip rap area on the upstream slope.
View looking West.

Appendix B - Photographs

Photo 3 : Dam 1E – Damaged trash rack structure upstream from the TSF operationnal spillway, before a new installation in November 2020.

Photo 4 : Dam 1E – New trash rack structure upstream from the TSF operationnal spillway, installed in November 2020.

Photo 5 : Dam 1D – Concrete sill and upstream spillway channel at the TSF emergency spillway. Vegetation was cleared in 2020.

Photo 6 : Dam 1D - Downstream spillway channel at the TSF emergency spillway. Vegetation was cleared in 2020.

Appendix B - Photographs

Photo 7 : Dam 1E – TSF operational spillway access bridge in good condition.

Photo 8 : Dam 1A – General view of vegetative growth at the toe of the embankment.

Photo 9 : Dam 2B – Water ponding at the downstream toe of the dam; seepage water is clear.

Photo 10 : Dam 2A - Stagnant water at the downstream toe of the dam. This area represents a zone where the natural topography drains towards the tailings pond; some accumulation at this location is expected.

Appendix B - Photographs

Photo 11 : Dam 2B - Culverts located northwest of the TSF - Drainage improved after clearing during last year.

Photo 12 : Dam 4A – Vegetation on the side slopes and crest of the embankment.

Photo 13 : Dam 4B – View of main spillway control structure and concrete outflow section adjacent to it.Good condition.

Photo 14 : Dam 4B – North shoulder of the service spillway. Minor seepage and ponding at the contact between the rock and the concrete structure.

Photo 15 : Dam 4B – Vegetation at the outflow channel from the spillway to the Parshall flume.

APPENDIX C

Movement Monitoring Survey

LEVÉ EN XYZ
DE DIX-NEUF (19) REPÈRES DE TASSEMENT
EXISTANTS

PAR MÉTHODE GPS TEMPS RÉEL,
NIVELLEMENT GÉOMÉTRIQUE
ET
TRIGONOMÉTRIQUE

MINE LOUVICOURT
TECK RESOURCES LIMITED

CANTON LOUVICOURT

Corriveau J.L. & Assoc. inc.
1085, 3e Avenue Ouest
Val d'Or (Québec) J9P 1T5

LEVÉ EN XYZ DE DIX-NEUF (19) REPÈRES (PLAQUES) DE TASSEMENT EXISTANTS PAR MÉTHODE GPS TEMPS RÉEL, NIVELLEMENT GÉOMÉTRIQUE ET TRIGONOMÉTRIQUE

RAPPORT D'OPÉRATION

1) INTRODUCTION :

À la demande de monsieur Morgan Lypka de la compagnie Teck Resources, nous nous sommes rendus sur le site du parc à résidus de la Mine Louvicourt situé dans le canton de Louvicourt pour y effectuer le levé de dix-neuf (19) plaques de tassement en XYZ afin de contrôler leur déplacement en horizontal et en vertical, à l'aide de la méthode GPS temps réel, les méthodes de nivellement géométrique et trigonométrique.

2) TRAVAUX TERRAIN EXÉCUTÉS :

Description des travaux :

En premier lieu, les travaux consistaient à lever par GPS temps réel haute précision (± 1cm) la position XYZ de toutes les plaques de tassement. Nous avons utilisé un jalon calé avec un trépied « tripode » pour maintenir l'antenne GPS en stabilité parfaite et ainsi obtenir une meilleure précision de nos observations. De plus, chacune des plaques de tassement a fait l'objet de trois (3) séquences d'observation différentes à environ quinze (15) minutes d'intervalle ou plus pour avoir des géométries différentes de la position des satellites. Chaque séquence d'observation comptait trois (3) moyennes de dix (10) lectures chacune avec une rotation de 120° du jalon à chaque moyenne pour une plus grande justesse et annuler l'erreur de verticalité du jalon porteur du récepteur GPS. Tous les travaux ont été réalisés dans le système SCOPQ (projection MTM) fuseau 9, NAD83, mais appuyés ou comparés sur les points du *« tableau des Points d'appui et de contrôle levés au GPS Temps réel – Système SCOPQ Fuseau 9 NAD83 »* (voir le point 6 du rapport), soit les mêmes points de référence ancrés dans le roc que les années précédentes.

Comme à chaque année, nous avons gardé le point **94-257** comme point de référence principal, alors que trois (3) autres points d'appui secondaires servaient de validation du point d'appui principal ainsi que de témoin de la bonne opération et de la justesse de nos méthodes de levé au GPS RTK. Notez que deux (2) points de référence (**94-256** et **94-260**) n'ont pas été observés en raison de la trop forte densité du boisé qui influence négativement la qualité des observations GPS.

La deuxième partie des travaux consistait à faire le cheminement vertical avec un niveau géométrique électronique de haute précision et une mire code-barres Invar pour obtenir une précision verticale de quelques millimètres de toutes les plaques de tassement placées sur le sommet des digues. Le point de départ du cheminement est le repère **94-257** (ancré dans le roc) d'une élévation fixe de **3316.707m (Mine)** ou **316.707m (altitude N.M.M)**. Nous avons effectué huit (8) cheminements en boucle obtenant des écarts de fermeture de 1mm, 1mm, 1mm, 0.8mm, 0.4mm, 1mm, 0.3mm et 1.3mm. Le premier cheminement en boucle s'étend sur une distance totale (incluant aller et retour) de 512m entre le repère **94-257** et le moniteur **B-1** avec une erreur de fermeture de 1mm. Le deuxième cheminement en boucle s'étend sur une distance de 668m totale (incluant aller et retour) entre le repère **94-257** et le moniteur **JLC-2011-3** avec une erreur de fermeture de 1mm. Le troisième cheminement en boucle s'étend sur une distance totale (incluant aller et retour) de 1986m entre le repère **94-257** et le moniteur **B-7** avec une erreur de fermeture de 0.8mm. Le quatrième cheminement liant le moniteur **JLC-2011-8** (départ) et le point d'appui **94-257** (arrivée) s'étend sur une distance totale (incluant aller et retour) de 250m avec une erreur de fermeture globale de 0.4mm. Le cinquième cheminement liant le moniteur **B7** (départ) et le moniteur **94-263** (arrivée) s'étend sur une distance totale (incluant aller et retour) de 1488m avec une erreur de fermeture globale de 1mm. Le sixième cheminement liant le point d'appui **94-263** (départ) et le moniteur **B11** (arrivée) s'étend sur une distance totale (incluant aller et retour) de 1175m avec une erreur de fermeture globale de 0.5mm. Enfin, le septième cheminement liant le moniteur **B2** (départ) et le moniteur **JLC-2011-2** (arrivée) s'étend sur une distance totale (incluant aller et retour) de 850m avec une erreur de fermeture globale de 0.5mm. Finalement, le huitième cheminement liant le moniteur **JLC-2011-4** (départ) et le moniteur **JLC-2011-5** (arrivée) s'étend sur une distance totale (incluant aller et retour) de 150m avec une erreur de fermeture globale de 1.3mm. Les plaques de tassement ont été mesurées à l'aller et au retour, soit deux (2) déterminations différentes utilisant chacune des plaques comme des « points tournant ». Nous avons ensuite fait la moyenne de ces deux (2) déterminations pour obtenir les valeurs du « *tableau des Élévations précises des plaques de tassement* » (voir le point 8 du rapport).

La troisième partie des travaux consistait à lever les plaques de tassement placées sur les bermes. La méthode consistant à stationner une station totale sur le sommet des digues, à été abandonnée au profit du nivellement géométrique, ce dernier étant plus précis en élévation. Les cheminements permettant la mesure des plaques sur les bernes ont été décrits au paragraphe précédent.

3) COMMENTAIRES SUR LES OBSERVATIONS DE 2008 :

Comme déjà mentionné dans les rapports des années passées, il est possible qu'il y ait un cassé en déplacement entre les données de 2008 et les années précédentes qui ne soit pas nécessairement dû au déplacement des plaques de tassement, mais plutôt à un choix différent des points d'origine et l'incohérence des repères d'appui ou de référence. De plus, il y a sûrement une différence entre la procédure que nous utilisons pour faire les levés et celle qu'utilisait la compagnie minière, laquelle procédure ne nous a pas été indiquée, on aurait pu alors assurer une continuité plus rigoureuse dans les résultats par une même méthodologie de levé.

4) TRAVAUX BUREAU EXÉCUTÉS :

Nous avons calculé les coordonnées des points mesurés en XYZ par GPS temps réel en faisant les moyennes des répétitions, avons complété le « *tableau des Différences des coordonnées XYZ* » et avons calculé les déplacements (voir le point 7 du rapport). Il est à noter que les coordonnées XYZ obtenues par méthode GPS temps réel sont estimées avoir une précision de ± 1cm avec 1 sigma en horizontal, tandis qu'en élévation par GPS la précision n'est qu'environ 2cm.

Nous avons fait la moyenne des deux (2) lectures d'élévation obtenues par nivellement géométrique (aller et retour) de toutes les plaques de tassement des sommets de digues. Nous avons compensé les cheminements aller-retour même si l'erreur de fermeture des boucles n'était que de quelques fractions de millimètres et n'avait que peu d'incidence significative sur le résultat obtenu.

5) GÉNÉRALITÉS :

Les travaux ont été effectués le 10 et 11 septembre 2020 par une équipe de trois hommes. Les travaux ont été supervisés par Jean-Luc Corriveau, arpenteur-géomètre.

Instruments utilisés :

- Un (1) système GNSS comprenant :

  deux (2) récepteurs GNSS modèle GS14 et GS15 de la compagnie Leica la précision du système GNSS ou GPS est de ± 0,01m horizontalement et ± 0,02m verticalement à un niveau de confiance de 1σ, selon les spécifications du fabricant; cependant, par la répétition, la proximité des points d'appui et la méthodologie, ces précisions ont pu être largement améliorées.

- Un (1) niveau électronique DNA 3 compagnie Leica avec deux mires à code-barres précision en nivellement double de 1 mm/km.

6) REMARQUE POINT 2011-3 :

Contrairement aux mesures de nivellement géométrique, les mesures GNSS temps réel au point 2011-3 montrent un écart de 30 mm par rapport aux mesures de 2018 qui semble anormal, bien que les mesures aient été prises parfaitement selon les normes (3 mesures prises à une quinzaine de minutes d'espacement donc 3 installations indépendantes) ayant chacune d'excellentes statistiques et que de plus les autres points pris dans la même période ne présentent pas de biais. Ces données GPS pour le vertical sont à plus ou moins 1 à 2 cm de précision, d'où le 30 mm s'expliquerait par des inexactitudes normales de 1 à 2 cm s'additionnant sur les 2 ans au lieu de s'annuler ou se soustraire.

Ces données verticales du GPS ne sont qu'à titre indicatif et ne saurait remplacer les altitudes obtenues par nivellement géométrique.

Suite au levé effectué en 2020, on remarque que l'élévation de l'ensemble des plaques de tassements est stable hormis certaines (**B-2, JLC-2011-1 à -6 et -8**) qui semblent s'enfoncer légèrement, alors que B-1 et 2011-7 s'élèvent légèrement confirmant la tendance déjà observée lors des années précédentes en ces points.

JLC

7) TABLEAU DES POINTS D'APPUI ET DE CONTRÔLE LEVÉS AU GPS TEMPS RÉEL SYSTÈME SCOPQ FUSEAU 9 NAD83

Numéro		NORD (m)	EST (m)	ALTITUDE (m)***
94-257**	Théorique*	5333644.982	223183.100	316.707
Point de base	Terrain	5333644.982	223183.100	316.707
	Différence	0.000	0.000	0.000

94-258**	Théorique*	5333566.954	222891.729	311.677
	Terrain 2010	5333567.016	222891.730	311.661
Contrôle 1	Terrain 2011	5333567.027	222891.729	311.682
	Terrain 2012	5333567.011	222891.724	311.681
	Terrain 2013	5333567.022	222891.723	311.685
	Terrain 2014	5333567.020	222891.730	311.676
	Terrain 2015	5333567.019	222891.728	311.680
	Terrain 2016	5333567.028	222891.729	311.699
	Terrain 2017	5333567.015	222891.735	311.688
	Terrain 2018	5333567.020	222891.726	311.674
	Terrain 2019	5333567.021	222891.727	311.681
	Terrain 2020	5333567.021	222891.734	311.688
	Diff. Théo-2010.	-0.062	-0.001	0.016
	Diff. Théo-2011.	-0.073	0.000	-0.005
	Diff. Théo-2012.	-0.057	0.005	-0.004
	Diff. Théo-2013	-0.068	0.006	-0.008
	Diff. Théo-2014	-0.066	-0.001	0.001
	Diff. Théo-2015	-0.065	0.001	-0.003
	Diff. Théo-2016	-0.074	0.000	-0.022
	Diff. Théo-2017	-0.061	-0.006	-0.011
	Diff. Théo-2018	-0.066	0.003	0.003
	Diff. Théo-2019	-0.067	0.002	-0.004
	Diff. Théo-2020	-0.067	-0.005	-0.011
	2011-2010	0.011	-0.001	0.021
	2012-2011	-0.016	-0.005	-0.001
	2013-2012	0.011	-0.001	0.004
	2014-2013	-0.002	0.007	-0.009
	2015-2014	-0.001	-0.002	0.004
	2016-2015	0.009	0.001	0.019
	2017-2016	-0.013	0.006	-0.011
	2018-2017	0.005	-0.009	-0.014
	2019-2018	0.001	0.001	0.007
	2020-2019	0.000	0.007	0.008

94-256**	Théorique*	5333408.957	223515.007	317.777
	Terrain 2010	5333408.888	223514.937	317.774
Contrôle 2	Terrain 2011	5333408.896	223514.929	317.784
	Terrain 2012	5333408.900	223514.927	317.782
	Terrain 2013	5333408.899	223514.929	317.786
	Terrain 2014	5333408.887	223514.932	317.772
	Terrain 2015	5333408.894	223514.932	317.773
	Terrain 2016	5333408.899	223514.929	317.792
	Terrain 2017	5333408.907	223514.939	317.801
	Terrain 2018	Trop boisé pour observation		
-	Terrain 2019	Trop boisé pour observation		
	Terrain 2020	5333408.900	223514.926	317.767
	Diff. Théo-2010.	0.069	0.070	0.003
	Diff. Théo-2011.	0.061	0.078	-0.007
	Diff. Théo-2012.	0.057	0.080	-0.005
	Diff. Théo-2013	0.058	0.078	-0.009
	Diff. Théo-2014	0.070	0.075	0.005
	Diff. Théo-2015	0.063	0.076	0.004
	Diff. Théo-2016	0.059	0.079	-0.015
	Diff. Théo-2017	0.050	0.068	-0.024
	Diff. Théo-2020	0.057	0.081	0.010
	2011-2010	0.008	-0.008	0.010
	2012-2011	0.004	-0.002	-0.002
	2013-2012	-0.001	0.002	0.005
	2014-2013	-0.012	0.003	-0.014
	2015-2014	0.007	0.000	0.001
	2016-2015	0.004	-0.003	0.019
	2017-2016	0.008	0.010	0.010
	2020-2017	-0.007	-0.013	-0.034

94-260**	Théorique*	5333495.201	222157.718	312.345
	Terrain 2010	5333495.447	222157.739	312.333
Contrôle 3	Terrain 2011	5333495.453	222157.733	312.360
	Terrain 2012	5333495.443	222157.735	312.350
	Terrain 2013	5333495.453	222157.735	312.369
	Terrain 2014	5333495.451	222157.737	312.345
	Terrain 2015	5333495.447	222157.738	312.354
	Terrain 2016	5333495.453	222157.731	312.368
	Terrain 2017	5333495.435	222157.742	312.385
	Terrain 2018	5333495.441	222157.743	312.371
	Terrain 2020	5333495.449	222157.734	312.347
	Diff. Théo-2010	-0.246	-0.021	0.012
	Diff. Théo-2011	-0.252	-0.015	-0.015
	Diff. Théo-2012	-0.242	-0.017	-0.005
	Diff. Théo-2013	-0.252	-0.017	-0.024
	Diff. Théo-2014	-0.250	-0.019	0.000
	Diff. Théo-2015	-0.246	-0.020	-0.009
	Diff. Théo-2016	-0.252	-0.013	-0.023
	Diff. Théo-2017	-0.234	-0.024	-0.040
	Diff. Théo-2018	-0.240	-0.025	-0.026
	Diff. Théo-2020	-0.248	-0.016	-0.002
	2011-2010	0.006	-0.006	0.027
	2012-2011	-0.010	0.002	-0.010
	2013-2012	0.010	0.000	0.019
	2014-2013	-0.002	0.002	-0.024
	2015-2014	-0.004	0.001	0.009
	2016-2015	0.006	-0.007	0.014
	2017-2016	-0.018	0.011	0.017
	2018-2017	0.006	0.001	-0.014
	2020-2018	0.007	-0.009	-0.023

Numéro		NORD (m)	EST (m)	ALTITUDE (m)***
94-262**	Théorique*	5332897.066	222292.513	315.842
	Terrain 2010	5332897.303	222292.387	315.827
Contrôle 4	Terrain 2011	5332897.306	222292.381	315.840
	Terrain 2012	5332897.307	222292.382	315.856
	Terrain 2013	5332897.304	222292.381	315.859
	Terrain 2014	5332897.311	222292.390	315.840
	Terrain 2015	5332897.313	222292.386	315.851
	Terrain 2016	5332897.325	222292.386	315.870
	Terrain 2017	5332897.307	222292.386	315.878
	Terrain 2018	5332897.311	222292.388	315.861
	Terrain 2019	5332897.302	222292.385	315.835
	Terrain 2020	5332897.310	222292.384	315.865
	Diff. Théo-2010.	-0.237	0.126	0.015
	Diff. Théo-2011.	-0.240	0.132	0.002
	Diff. Théo-2012.	-0.241	0.131	-0.014
	Diff. Théo-2013	-0.238	0.132	-0.017
	Diff. Théo-2014	-0.245	0.123	0.002
	Diff. Théo-2015	-0.247	0.127	-0.009
	Diff. Théo-2016	-0.259	0.128	-0.028
	Diff. Théo-2017	-0.241	0.127	-0.036
	Diff. Théo-2018	-0.245	0.125	-0.019
	Diff. Théo-2019	-0.236	0.128	0.007
	Diff. Théo-2020	-0.244	0.129	-0.023
	2011-2010	0.003	-0.006	0.013
	2012-2011	0.001	0.001	0.016
	2013-2012	-0.003	-0.001	0.003
	2014-2013	0.007	0.009	-0.019
	2015-2014	0.002	-0.004	0.011
	2016-2015	0.012	0.000	0.019
	2017-2016	-0.018	0.000	0.008
	2018-2017	0.004	0.002	-0.017
	2019-2018	-0.009	-0.004	-0.026
	2020-2019	0.008	0.000	0.030

94-263**	Théorique*	5332858.918	222355.630	317.471
	Terrain 2010	5332859.145	222355.493	317.465
Contrôle 5	Terrain 2011	5332859.147	222355.487	317.467
	Terrain 2012	5332859.140	222355.487	317.485
	Terrain 2013	5332859.142	222355.485	317.488
	Terrain 2014	5332859.139	222355.491	317.468
	Terrain 2015	5332859.140	222355.492	317.478
	Terrain 2016	5332859.138	222355.487	317.495
	Terrain 2017	5332859.135	222355.488	317.524
	Terrain 2018	Trop boisé pour observation		
	Terrain 2019	5332859.136	222355.488	317.477
	Terrain 2020	5332859.141	222355.489	317.487
	Diff. Théo-2010.	-0.227	0.137	0.006
	Diff. Théo-2011.	-0.229	0.143	0.004
	Diff. Théo-2012.	-0.222	0.143	-0.014
	Diff. Théo-2013	-0.224	0.145	-0.017
	Diff. Théo-2014	-0.221	0.139	0.003
	Diff. Théo-2015	-0.222	0.138	-0.007
	Diff. Théo-2016	-0.220	0.143	-0.024
	Diff. Théo-2017	-0.217	0.142	-0.053
	Diff. Théo-2018	-	-	-
	Diff. Théo-2019	-0.218	0.142	-0.006
	Diff. Théo-2020	-0.223	0.141	-0.016
	2011-2010	0.002	-0.006	0.002
	2012-2011	-0.007	0.000	0.018
	2013-2012	0.002	-0.002	0.003
	2014-2013	-0.003	0.006	-0.020
	2015-2014	0.001	0.001	0.010
	2016-2015	-0.002	-0.005	0.017
	2017-2016	-0.003	0.001	0.029
	2017-2016	-	-	-
	2019-2017	0.001	0.000	-0.047
	2020-2018	0.006	0.000	0.010

■ **SCOPQ (MTM) NAD83 FUSEAU 9 MÉRIDIEN CENTRAL : 76°30' OUEST**

* Coordonnées théoriques fournies par la mine dont on a ajouté 5 300 000m en Nord et 200 000m en Est et soustrait 3 000m en élévation

Note : On doit considérer les inscriptions au mm significatives qu'au 10mm près en horizontal et qu'au 2 cm près en vertical pour les données venant des levés GPS ou GNSS.

Légende :

** Point existant ancré dans le roc avec trépied témoin.

*** Précision insuffisante en vertical, se référer au nivellement géométrique pour une meilleure

8) TABLEAU DES DIFFÉRENCES DES COORDONNÉES XYZ DES PLAQUES DE TASSEMENT OBTENUES PAR MÉTHODE GPS TEMPS RÉEL (voir annexe 1)

9) TABLEAU DES ÉLÉVATIONS PRÉCISES DES PLAQUES DE TASSEMENT (voir annexe 2)

10) RÉSUMÉ :

En résumé, notre travail contient :

Nombre de plaques de tassement levées par GPS (±1cm) :	19
Nombre de plaques de tassement nivelées (± 2mm) :	19
Nombre de plaques levées par st. totale pour le vertical :	0
Nombre de plaques nivelées à partir du niveau géométrique :	19
Nombre de points d'appui localisés/contrôlés en horizontal :	5
Nombre de points d'appui en vertical (cheminement géométrique) :	2
Longueur totale des cheminements altimétriques :	7.079 Km

Fait à Val d'Or, le 8 novembre 2019, sous le dossier C-15304/817 et le numéro **15206** de mes minutes en référence aux dossiers : C-14891/442.18-19 (2019), C-14421/442.18-19 (2018), C-13907/442.18-19 (2017), C-13282/442.18 (2016), C-12762/442.18 (2015), C-12486/442.17 (2014), C-12102/442.17 (2013), C-11735/442.17 (2012), C-11471/442.17 (2011), C-10945/442.17 (2010), C-10558/442.16 (2009) et C-10178/442.15 (2008) du soussigné.

Val-d'Or, le 29 octobre 2020

Jean-Luc Corriveau
CORRIVEAU J.L. & ASSOC. INC.

Copie conforme à l'original

12/12/2020

Jean-Luc Corriveau
A.-G., A.T.C.

Annexes

Annexe 1 Tableau des différences des coordonnées xyz des plaques de tassement obtenues par méthode GPS temps réel.

Annexe 2 Tableau des élévations précises des plaques de tassement.

Annexe 3 Plan de localisation des plaques de tassement révision du 20/10/2011 minute C-10945/442.17 du soussigné.

Annexe 1

Tableau des différences des coordonnées XYZ des plaques de tassement obtenues par méthode GPS Temps réel

PLAQUE DE TASSEMENT		Coordonnées théoriques	Arpentage Sept. 2008	Différence 2008-Théo		Arpentage Juin 2010	Différence 2010-2008		Arpentage Octobre 2011	Différence 2011-2010		Arpentage Octobre 2012	Différence 2012-2011		Arpentage Juillet 2013	Différence 2013-2012	
B-1	Nord	5333481.600	5333481.572	-0.028	S	5333481.588	0.016	N	5333481.573	-0.015	S	5333481.567	-0.006	S	5333481.574	0.007	N
	Est	223364.365	223364.319	-0.046	O	223364.310	-0.009	O	223364.316	0.006	E	223364.317	0.001	E	223364.319	0.002	E
	Elev.	319.120	319.085	-0.035	B	319.085	0.000	-	319.097	0.012	H	319.089	-0.008	B	319.087	-0.002	B
B-2	Nord	5333524.849	5333524.834	-0.015	S	5333524.840	0.006	N	5333524.842	0.002	N	5333524.839	-0.003	S	5333524.843	0.004	N
	Est	223312.799	223312.758	-0.041	O	223312.754	-0.004	O	223312.766	0.012	E	223312.765	-0.001	O	223312.764	-0.001	O
	Elev.	318.489	318.450	-0.039	B	318.452	0.002	H	318.454	0.002	H	318.448	-0.006	B	318.439	-0.009	B
B-3	Nord	5333560.718	5333560.716	-0.002	S	5333560.721	0.005	N	5333560.721	0.000	-	5333560.720	-0.001	S	5333560.718	-0.002	S
	Est	223270.316	223270.298	-0.018	O	223270.294	-0.004	O	223270.298	0.004	E	223270.292	-0.006	O	223270.294	0.002	E
	Elev.	319.122	319.090	-0.032	B	319.093	0.003	H	319.101	0.008	H	319.098	-0.003	B	319.096	-0.002	B
B-4	Nord	5333595.764	5333595.789	0.025	N	5333595.793	0.004	N	5333595.798	0.005	N	5333595.802	0.004	N	5333595.802	0.000	N/A
	Est	223073.887	223073.882	-0.005	O	223073.899	0.017	E	223073.888	-0.011	O	223073.881	-0.007	O	223073.879	-0.002	O
	Elev.	318.136	318.111	-0.025	B	318.134	0.023	H	318.140	0.006	H	318.141	0.001	H	318.141	0.000	N/A
B-5	Nord	5333572.172	5333572.224	0.052	N	5333572.230	0.006	N	5333572.233	0.003	N	5333572.227	-0.006	S	5333572.231	0.004	N
	Est	222993.640	222993.630	-0.010	O	222993.641	0.011	E	222993.631	-0.010	O	222993.632	0.001	E	222993.625	-0.007	O
	Elev.	318.157	318.151	-0.006	B	318.158	0.007	H	318.166	0.008	H	318.164	-0.002	B	318.165	0.001	H
B-6	Nord	5333588.639	5333588.744	0.105	N	5333588.757	0.013	N	5333588.748	-0.009	S	5333588.747	-0.001	S	5333588.753	0.006	N
	Est	222661.587	222661.604	0.017	E	222661.649	0.045	E	222661.613	-0.036	O	222661.609	-0.004	O	222661.604	-0.005	O
	Elev.	318.176	318.139	-0.037	B	318.141	0.002	H	318.150	0.009	H	318.139	-0.011	B	318.143	0.004	H
B-7	Nord	5333510.829	5333511.090	0.261	N	5333511.091	0.001	N	5333511.093	0.002	N	5333511.087	-0.007	S	5333511.096	0.009	N
	Est	222246.790	222246.804	0.014	E	222246.868	0.064	E	222246.809	-0.059	O	222246.807	-0.003	O	222246.802	-0.005	O
	Elev.	318.176	318.185	0.009	H	318.190	0.005	H	318.203	0.013	H	318.186	-0.017	B	318.203	0.018	H
B-8	Nord	5333371.342	5333371.603	0.261	N	5333371.609	0.006	N	5333371.606	-0.003	S	5333371.607	0.001	N	5333371.610	0.003	N
	Est	222178.864	222178.871	0.007	E	222178.944	0.073	E	222178.876	-0.068	O	222178.872	-0.004	O	222178.867	-0.005	O
	Elev.	319.031	319.022	-0.009	B	319.020	-0.002	B	319.035	0.015	B	319.031	-0.004	B	319.035	0.004	H
B-9	Nord	5333326.921	5333327.178	0.257	N	5333327.189	0.011	N	5333327.187	-0.002	S	5333327.193	0.006	N	5333327.189	-0.004	S
	Est	222191.523	222191.531	0.008	E	222191.610	0.079	E	222191.543	-0.067	O	222191.531	-0.012	O	222191.528	-0.003	O
	Elev.	319.181	319.161	-0.020	B	319.171	0.010	H	319.180	0.009	H	319.186	0.006	H	319.177	-0.009	B
B-10	Nord	5333154.032	5333154.277	0.245	N	5333154.279	0.002	N	5333154.282	0.003	N	5333154.278	-0.004	S	5333154.275	-0.003	S
	Est	222242.232	222242.203	-0.029	O	222242.271	0.068	E	222242.254	-0.017	O	222242.192	-0.062	O	222242.189	-0.003	O
	Elev.	318.244	318.220	-0.024	B	318.226	0.006	H	318.234	0.008	H	318.233	-0.001	B	318.231	-0.002	B
B-11	Nord								5333362.842	N/A		5333362.840	-0.002	S	5333362.842	0.002	N
	Est								222145.004	N/A		222145.006	0.002	E	222145.000	-0.006	O
	Elev.								307.277	N/A		307.241	-0.036	B	307.266	0.025	H
2011-1 L	Nord								5333800.878	N/A		5333800.873	-0.005	S	5333800.871	-0.002	S
	Est								223387.811	N/A		223387.817	0.006	E	223387.815	-0.002	O
	Elev.								310.020	N/A		310.018	-0.002	B	310.018	0.000	N/A
2011-2 C	Nord								5333562.623	N/A		5333562.637	0.014	N	5333562.632	-0.005	S
	Est								223322.116	N/A		223322.109	-0.007	O	223322.107	-0.002	O
	Elev.								309.270	N/A		309.252	-0.018	B	309.242	-0.010	B
2011-3 L	Nord								5333826.347	N/A		5333826.349	0.002	N	5333826.347	-0.002	S
	Est								223442.150	N/A		223442.150	0.000	-	223442.153	0.003	E
	Elev.								310.354	N/A		310.345	-0.009	B	310.344	-0.001	B
2011-4 L	Nord								5333763.037	N/A		5333763.041	0.004	N	5333763.040	-0.001	S
	Est								223329.455	N/A		223329.455	0.000	-	223329.456	0.001	E
	Elev.								310.371	N/A		310.359	-0.012	B	310.365	0.006	H
2011-5 C	Nord								5333821.228	N/A		5333821.227	-0.001	S	5333821.221	-0.006	S
	Est								223378.028	N/A		223378.028	0.000	-	223378.028	0.000	-
	Elev.								303.984	N/A		303.978	-0.006	B	303.980	0.001	H
2011-6 C	Nord								5333068.318	N/A		5333068.305	-0.013	S	5333068.308	0.003	N
	Est								222236.094	N/A		222236.095	0.001	E	222236.096	0.001	E
	Elev.								309.338	N/A		309.334	-0.004	B	309.337	0.003	H
2011-7 C	Nord								5333271.670	N/A		5333271.658	-0.012	N	5333271.660	0.002	N
	Est								222174.469	N/A		222174.459	-0.010	O	222174.458	-0.001	O
	Elev.								309.156	N/A		309.159	0.003	H	309.161	0.001	H
2011-8 C	Nord								5333627.581	N/A		5333627.573	-0.008	S	5333627.577	0.004	N
	Est								223061.472	N/A		223061.471	-0.001	O	223061.467	-0.004	O
	Elev.								310.383	N/A		310.369	-0.014	B	310.370	0.001	H

PLAQUE DE TASSEMENT		Arpentage Juin 2014	Différence 2014-2013		Arpentage Juin 2015	Différence 2015-2014		Arpentage Juin 2016	Différence 2016-2015		Arpentage Septembre 2017	Différence 2017-2016		Arpentage Octobre 2018	Différence 2018-2017		Arpentage Octobre 2019	Différence 2019-2018		Arpentage Septembre 2020	Différence 2020-2019	
B-1	Nord	5333481.565	-0.009	S	5333481.569	0.004	N	5333481.576	0.007	N	5333481.586	0.010	N	5333481.575	-0.011	S	5333481.568	-0.007	S	5333481.571	0.003	N
	Est	223364.324	0.005	E	223364.321	-0.003	O	223364.317	-0.004	O	223364.321	0.004	O	223364.321	0.000	O	223364.323	0.002	O	223364.323	-0.001	E
	Elev.	319.082	-0.005	B	319.080	-0.002	B	319.098	0.018	H	319.094	-0.004	B	319.086	-0.007	B	319.083	-0.004	B	319.062	-0.020	B
B-2	Nord	5333524.841	-0.002	S	5333524.836	-0.005	S	5333524.846	0.010	N	5333524.853	0.007	N	5333524.839	-0.014	S	5333524.841	0.002	N	5333524.841	0.000	-
	Est	223312.774	0.010	E	223312.774	0.000	-	223312.771	-0.003	O	223312.773	0.002	E	223312.775	0.002	E	223312.776	0.001	E	223312.772	-0.004	O
	Elev.	318.430	-0.009	B	318.428	-0.002	B	318.441	0.013	H	318.436	-0.005	B	318.425	-0.010	B	318.424	-0.001	B	318.397	-0.027	B
B-3	Nord	5333560.713	-0.005	S	5333560.717	0.004	N	5333560.730	0.014	N	5333560.720	-0.010	S	5333560.722	0.002	N	5333560.716	-0.005	S	5333560.722	0.006	N
	Est	223270.302	0.008	E	223270.297	-0.005	O	223270.295	-0.002	O	223270.299	0.004	E	223270.301	0.002	E	223270.302	0.001	E	223270.301	-0.001	O
	Elev.	319.086	-0.010	B	319.087	0.001	H	319.099	0.001	H	319.092	-0.007	B	319.084	-0.008	B	319.083	-0.001	B	319.091	0.008	H
B-4	Nord	5333595.797	-0.005	S	5333595.803	0.006	N	5333595.808	0.005	N	5333595.807	-0.001	S	5333595.803	-0.004	S	5333595.806	0.003	N	5333595.803	-0.003	S
	Est	223073.885	0.006	E	223073.879	-0.006	O	223073.877	-0.002	O	223073.879	0.002	E	223073.890	0.011	E	223073.878	-0.012	O	223073.880	0.002	E
	Elev.	318.127	-0.014	B	318.134	0.007	H	318.146	0.012	H	318.137	-0.009	B	318.136	-0.002	B	318.143	0.007	H	318.122	-0.021	H
B-5	Nord	5333572.233	0.002	N	5333572.232	-0.001	S	5333572.233	0.001	N	5333572.234	0.001	N	5333572.226	-0.008	S	5333572.237	0.010	N	5333572.234	-0.003	S
	Est	222993.633	0.008	E	222993.633	0.000	-	222993.626	-0.007	O	222993.629	0.003	E	222993.639	0.010	E	222993.628	-0.010	O	222993.633	0.004	E
	Elev.	318.160	-0.005	B	318.163	0.003	H	318.172	0.009	H	318.160	-0.012	B	318.158	-0.003	B	318.168	0.010	H	318.151	-0.017	B
B-6	Nord	5333588.751	-0.002	S	5333588.753	0.002	N	5333588.754	0.001	N	5333588.759	0.005	N	5333588.749	-0.010	S	5333588.759	0.010	N	5333588.754	-0.005	S
	Est	222661.610	0.006	E	222661.608	-0.002	O	222661.609	0.001	E	222661.607	-0.002	O	222661.620	0.012	E	222661.608	-0.011	O	222661.607	-0.001	O
	Elev.	318.132	-0.011	B	318.148	0.016	H	318.160	0.012	H	318.146	-0.014	B	318.144	-0.001	B	318.155	0.010	H	318.145	-0.010	B
B-7	Nord	5333511.093	-0.003	S	5333511.096	0.003	N	5333511.098	0.002	N	5333511.101	0.003	N	5333511.092	-0.009	S	5333511.096	0.004	N	5333511.096	0.000	-
	Est	222246.805	0.003	E	222246.803	-0.002	O	222246.804	0.001	E	222246.797	-0.007	O	222246.812	0.014	E	222246.802	-0.010	O	222246.806	0.004	E
	Elev.	318.196	-0.007	B	318.204	0.008	H	318.221	0.017	H	318.217	-0.004	B	318.222	0.005	H	318.223	0.001	H	318.219	-0.004	B
B-8	Nord	5333371.606	-0.004	S	5333371.607	0.001	N	5333371.610	0.003	N	5333371.607	-0.003	S	5333371.606	-0.001	S	5333371.603	-0.003	S	5333371.607	0.004	N
	Est	222178.872	0.005	E	222178.876	0.004	E	222178.866	-0.010	O	222178.868	0.001	E	222178.881	0.014	E	222178.869	-0.012	O	222178.872	0.003	E
	Elev.	319.012	-0.023	B	319.033	0.021	H	319.028	-0.005	B	319.032	0.004	H	319.027	-0.005	B	319.030	0.003	H	319.033	0.003	H
B-9	Nord	5333327.179	-0.010	S	5333327.182	0.003	N	5333327.191	0.009	N	5333327.186	-0.005	S	5333327.181	-0.005	S	5333327.185	0.003	N	5333327.183	-0.001	S
	Est	222191.533	0.005	E	222191.536	0.003	E	222191.524	-0.012	O	222191.528	0.004	E	222191.542	0.014	E	222191.532	-0.010	O	222191.534	0.002	E
	Elev.	319.154	-0.023	B	319.173	0.019	H	319.175	0.002	H	319.173	-0.002	B	319.172	-0.001	B	319.175	0.003	H	319.174	-0.001	B
B-10	Nord	5333154.276	0.001	N	5333154.268	-0.008	S	5333154.280	0.012	S	5333154.274	-0.006	S	5333154.274	0.000	S	5333154.272	-0.002	S	5333154.271	-0.001	S
	Est	222242.196	0.007	E	222242.196	0.000	-	222242.186	-0.010	O	222242.185	-0.001	O	222242.207	0.022	E	222242.191	-0.016	O	222242.193	0.001	E
	Elev.	318.226	-0.005	B	318.232	0.006	H	318.243	0.011	H	318.243	0.000	N/A	318.237	-0.005	B	318.234	-0.003	B	318.232	-0.003	B
B-11	Nord	5333362.843	0.001	N	5333362.849	0.006	N	5333362.854	0.005	N	5333362.834	-0.020	S	5333362.849	0.015	N	5333362.845	-0.004	S	5333362.842	-0.003	S
	Est	222145.004	0.004	E	222145.004	0.000	-	222144.996	-0.008	O	222144.997	0.001	E	222145.015	0.018	E	222145.002	-0.013	O	222145.005	0.003	E
	Elev.	307.251	-0.015	B	307.255	0.004	H	307.273	0.018	H	307.258	-0.015	B	307.269	0.011	H	307.266	-0.003	B	307.256	-0.010	B
2011-1 L	Nord	5333800.866	-0.005	S	5333800.873	0.007	N	5333800.859	-0.014	S	5333800.872	0.013	N	5333800.863	-0.009	S	5333800.865	0.002	N	5333800.866	0.000	-
	Est	223387.819	0.004	E	223387.817	-0.002	O	223387.818	0.001	E	223387.812	-0.006	O	223387.813	0.000	-	223387.816	0.004	E	223387.816	0.000	-
	Elev.	310.001	-0.017	B	310.003	0.002	H	309.987	-0.016	B	309.999	0.012	H	309.986	-0.013	B	309.986	0.000	-	309.992	0.006	H
2011-2 C	Nord	5333562.627	-0.005	S	5333562.627	0.000	-	5333562.629	0.002	N	5333562.632	0.003	N	5333562.636	0.004	N	5333562.638	0.002	N	5333562.634	-0.004	S
	Est	223322.116	0.009	E	223322.110	-0.006	O	223322.107	-0.003	O	223322.099	-0.008	O	223322.112	0.013	E	223322.117	0.005	E	223322.115	-0.003	O
	Elev.	309.240	-0.002	B	309.235	-0.005	B	309.247	0.012	H	309.252	0.005	H	309.240	-0.012	B	309.249	0.009	H	309.218	-0.031	B
2011-3 L	Nord	5333826.343	-0.004	S	5333826.350	0.007	N	5333826.338	-0.012	S	5333826.351	0.013	N	5333826.344	-0.007	S	5333826.344	0.000	-	5333826.347	0.003	N
	Est	223442.157	0.004	E	223442.154	-0.003	O	223442.161	0.007	E	223442.151	-0.010	O	223442.151	0.000	-	223442.157	0.006	E	223442.158	0.001	E
	Elev.	310.332	-0.012	B	310.333	0.001	H	310.307	-0.026	H	310.323	0.016	H	310.309	-0.014	B	310.279	-0.030	B	310.313	0.035	H
2011-4 L	Nord	5333763.036	-0.004	S	5333763.040	0.004	N	5333763.033	-0.007	S	5333763.039	0.006	N	5333763.037	-0.002	S	5333763.030	-0.007	S	5333763.034	0.004	S
	Est	223329.465	0.009	E	223329.460	-0.005	O	223329.458	-0.002	O	223329.458	0.000	-	223329.458	0.000	-	223329.462	0.004	E	223329.465	0.003	E
	Elev.	310.349	-0.016	B	310.353	0.004	H	310.341	-0.012	B	310.347	0.006	H	310.347	0.000	-	310.343	-0.004	B	310.343	0.000	B
2011-5 C	Nord	5333821.222	0.001	N	5333821.227	0.005	N	5333821.220	-0.007	S	5333821.222	0.002	N	5333821.221	-0.001	S	5333821.223	0.002	N	5333821.227	0.004	N
	Est	223378.034	0.006	E	223378.031	-0.003	O	223378.030	-0.001	O	223378.030	0.000	E	223378.025	-0.005	O	223378.037	0.012	E	223378.029	-0.008	E
	Elev.	303.967	-0.013	B	303.970	0.003	H	303.963	-0.007	B	303.973	0.010	H	303.965	-0.008	B	303.958	-0.006	B	303.968	0.010	B
2011-6 C	Nord	5333068.307	-0.001	S	5333068.308	0.001	N	5333068.313	0.005	N	5333068.302	-0.011	S	5333068.314	0.012	N	5333068.310	-0.003	S	5333068.311	0.001	S
	Est	222236.100	0.004	E	222236.096	-0.004	O	222236.093	-0.003	O	222236.094	0.001	E	222236.113	0.020	E	222236.095	-0.018	O	222236.098	0.003	O
	Elev.	309.324	-0.013	B	309.334	0.010	H	309.349	0.015	H	309.347	-0.002	B	309.346	-0.001	B	309.334	-0.012	B	309.338	0.003	B
2011-7 C	Nord	5333271.666	0.006	N	5333271.661	-0.005	S	5333271.669	0.008	N	5333271.658	-0.011	S	5333271.661	0.003	N	5333271.653	-0.008	S	5333271.661	0.009	S
	Est	222174.459	0.001	E	222174.457	-0.002	O	222174.447	-0.010	O	222174.452		E	222174.472	0.020	E	222174.452	-0.020	O	222174.455	0.003	O
	Elev.	309.149	-0.012	B	309.172	0.023	H	309.170	-0.002	B	309.171	0.001	H	309.164	-0.007	B	309.171	0.007	H	309.169	-0.002	H
2011-8 C	Nord	5333627.571	-0.006	S	5333627.574	0.003	N	5333627.574	0.000	-	5333627.568	-0.006	S	5333627.571	0.003	N	pas levé		-	5333627.572	0.002	N
	Est	223061.476	0.009	E	223061.475	-0.001	O	223061.469	-0.006	O	223061.470	0.001	E	223061.473	0.004	E	pas levé		-	223061.477	0.004	E
	Elev.	310.355	-0.015	B	310.368	0.013	H	310.383	0.015	H	310.369	-0.014	B	310.373	0.004	H	pas levé		-	310.366	-0.007	B

N.B. Valeurs des différences en "Z" significatives qu'à 2cm près; pour plus de précision, se référer au tableau des élévations prises au niveau électronique.
B-1 à B-11 Tiges existantes avec regard protecteur en métal et tige témoin.

Note: On doit considérer les inscriptions au mm significative qu'aux 5 mm près

N = déplacement vers le Nord
S = déplacement vers le Sud
O = déplacement vers l'Ouest
H = déplacement vers le Haut
E = déplacement vers l'Est
B = déplacement vers le Bas

Légende
L= Repère médaillon sur longs tuyaux 2.35m x 0.33m extérieur avec 3 ailettes et bout vrillé, regard protecteur et tige témoin 2m
C= Repère médaillon sur tige d'armature de ¾ x 0.9m, regard protecteur et tige témoin de 2m.

CORRIVEAU J.L. & ASSOCIÉS. INC

C-15304/817

Annexe 2

<u>TABLEAU DES *ÉLÉVATIONS PRÉCISES DES PLAQUES DE TASSEMENT*</u>

(Obtenues par nivellement géométrique-électronique et trigonométrique)

Plaque de tassement	Élévation Théorique selon mine	Année Sept. 2008	Diff. (m) 2008-Théo.	Élévation Août 2009	Diff. (m) 2009-2008	Élévation Juin 2010	Diff. (m) 2010-2009	Élévation Oct. 2011	Diff. (m) 2011-2010	Diff. (m) 2011-2008	Élévation Oct. 2012	Diff. (m) 2012-2011	Diff. (m) 2012-2008
94-257	3316.707	3316.707	-	3316.707	-	3316.707	-	3316.707	-	-	3316.707	-	-
94-262	3315.842	-	-	-	-	-	-	3315.840	-	-	3315.839	-0.001	-0.001
B1	3319.120	3319.099	-0.021	3319.099	0.000	3319.100	0.001	3319.097	-0.003	-0.002	3319.097	0.000	-0.002
B2	3318.489	3318.465	-0.024	3318.462	-0.003	3318.460	-0.002	3318.454	-0.006	-0.011	3318.449	-0.005	-0.016
B3	3319.122	3319.103	-0.019	3319.104	0.001	3319.104	0.000	3319.101	-0.003	-0.002	3319.099	-0.002	-0.004
B4	3318.136	3318.143	0.007	3318.146	0.003	3318.146	0.000	3318.140	-0.006	-0.003	3318.139	-0.001	-0.004
B5	3318.157	3318.168	0.011	3318.172	0.004	3318.172	0.000	3318.166	-0.006	-0.002	3318.165	-0.001	-0.003
B6	3318.176	3318.153	-0.023	3318.158	0.005	3318.156	-0.002	3318.150	-0.006	-0.003	3318.148	-0.002	-0.005
B7	3318.176	3318.198	0.022	3318.207	0.009	3318.207	0.000	3318.203	-0.004	0.005	3318.206	0.003	0.008
B8	3319.031	3319.034	0.003	3319.039	0.005	3319.038	-0.001	3319.035	-0.003	0.001	3319.034	-0.001	0.000
B9	3319.181	3319.180	-0.001	3319.186	0.006	3319.186	0.000	3319.180	-0.006	0.000	3319.179	-0.001	-0.001
B10	3318.244	3318.232	-0.012	3318.239	0.007	3318.238	-0.001	3318.234	-0.004	0.002	3318.234	0.000	0.002
**B11	3307.253	-	-	-	-	-	-	3307.277	-	-	3307.269	-0.008	-
*2011-1	-	-	-	-	-	-	-	3310.020	-	-	3310.019	-0.001	-
**2011-2	-	-	-	-	-	-	-	3309.270	-	-	3309.252	-0.018	-
*2011-3	-	-	-	-	-	-	-	3310.354	-	-	3310.354	0.000	-
*2011-4	-	-	-	-	-	-	-	3310.371	-	-	3310.370	-0.002	-
**2011-5	-	-	-	-	-	-	-	3303.984	-	-	3303.976	-0.008	-
**2011-6	-	-	-	-	-	-	-	3309.357	-	-	3309.342	-0.015	-
**2011-7	-	-	-	-	-	-	-	3309.156	-	-	3309.172	0.016	-
**2011-8	-	-	-	-	-	-	-	3310.383	-	-	3310.364	-0.019	-

Plaque de tassement	Élévation Juil. 2013	Diff. (m) 2013-2012	Diff. (m) 2013-2008 / 2013-2011	Élévation Juil. 2014	Diff. (m) 2014-2013	Diff. (m) 2014-2008 / 2014-2011	Élévation juin-15	Diff. (m) 2015-2014	Diff. (m) 2015-2008 / 2015-2011	Élévation juin-16	Diff. (m) 2016-2015	Diff. (m) 2016-2008 / 2017-2011
94-257	3316.707	-	-	3316.707	-	-	3316.707	-	-	3316.707	-	-
94-262	3315.859	0.020	0.019	3315.841	-0.018	0.001	3315.842	0.001	0.002	3315.842	0.000	0.002
B1	3319.097	0.000	-0.002	3319.099	0.002	0.000	3319.100	0.001	0.001	3319.099	-0.001	0.000
B2	3318.448	-0.001	-0.017	3318.448	0.000	-0.017	3318.447	-0.001	-0.018	3318.444	-0.003	-0.021
B3	3319.099	0.000	-0.004	3319.102	0.003	-0.001	3319.102	0.000	-0.001	3319.101	-0.001	-0.002
B4	3318.140	0.001	-0.003	3318.145	0.005	0.002	3318.145	0.000	0.002	3318.145	0.000	0.002
B5	3318.166	0.001	-0.002	3318.173	0.007	0.005	3318.172	-0.001	0.004	3318.171	-0.001	0.003
B6	3318.151	0.003	-0.002	3318.155	0.004	0.002	3318.155	0.000	0.002	3318.155	0.000	0.002
B7	3318.208	0.002	0.010	3318.215	0.007	0.017	3318.216	0.001	0.018	3318.217	0.001	0.019
B8	3319.033	-0.001	-0.001	3319.035	0.002	0.001	3319.036	0.001	0.002	3319.035	-0.001	0.001
B9	3319.179	0.000	-0.001	3319.181	0.002	0.001	3319.181	0.000	0.001	3319.180	-0.001	0.000
B10	3318.235	0.001	0.003	3318.240	0.005	0.008	3318.240	0.000	0.008	3318.241	0.001	0.009
**B11	3307.273	0.004	-0.004	3307.270	-0.003	-0.007	3307.270	0.000	-0.007	3307.269	-0.001	-0.008
*2011-1	3310.019	0.000	-0.001	3310.016	-0.002	-0.004	3310.016	-0.001	-0.004	3310.011	-0.005	-0.009
**2011-2	3309.273	0.021	0.003	3309.256	-0.017	-0.014	3309.259	0.003	-0.011	3309.257	-0.002	-0.013
*2011-3	3310.352	-0.002	-0.002	3310.348	-0.004	-0.006	3310.346	-0.002	-0.008	3310.341	-0.005	-0.013
*2011-4	3310.372	0.003	0.001	3310.368	-0.004	-0.003	3310.369	0.001	-0.002	3310.366	-0.003	-0.005
**2011-5	3303.993	0.017	0.009	3303.980	-0.013	-0.004	3303.985	0.005	0.001	3303.981	-0.004	-0.003
**2011-6	3309.332	-0.010	-0.025	3309.342	0.010	-0.015	3309.345	0.003	-0.012	3309.344	-0.001	-0.013
**2011-7	3309.177	0.005	0.021	3309.175	-0.002	0.019	3309.174	-0.001	0.018	3309.172	-0.002	0.016
**2011-8	3310.370	0.006	-0.013	3310.375	0.005	-0.008	3310.374	-0.001	-0.009	3310.374	0.000	-0.009

Élévation septembre.17	Diff. (m) 2017-2016	Diff. (m) 2017-2008 / 2017-2011	Élévation octobre.18	Diff. (m) 2018-2017	Diff. (m) 2018-2008 / 2018-2011	Élévation octobre.19	Diff. (m) 2019-2018	Diff. (m) 2019-2008 / 2019-2011	Élévation Sept. 2020	Diff. (m) 2020-2019	Diff. (m) 2020-2008 / 2020-2011	Plaque de tassement
3316.707	-	-	3316.707	-	-	3316.707	-	-	3316.707	-	-	94-257
3315.878	0.036	0.038	3315.842	-0.036	0.002	3315.841	-0.001	0.001	3315.840	-0.001	0.000	94-262
3319.100	0.001	0.001	3319.099	-0.001	0.000	3319.098	-0.002	-0.002	3319.098	0.001	-0.001	B1
3318.442	-0.002	-0.023	3318.440	-0.002	-0.025	3318.438	-0.002	-0.027	3318.437	-0.001	-0.028	B2
3319.101	0.000	-0.002	3319.101	0.000	-0.002	3319.101	-0.001	-0.003	3319.101	0.000	-0.002	B3
3318.145	0.000	0.002	3318.144	-0.001	0.001	3318.144	0.000	0.001	3318.143	-0.001	0.000	B4
3318.171	0.000	0.003	3318.171	0.000	0.003	3318.171	0.000	0.003	3318.169	-0.002	0.001	B5
3318.156	0.001	0.003	3318.154	-0.002	0.001	3318.153	-0.001	0.000	3318.153	-0.001	0.000	B6
3318.217	0.000	0.019	3318.219	0.002	0.021	3318.220	0.001	0.022	3318.221	0.000	0.023	B7
3319.032	-0.003	-0.002	3319.035	0.003	0.001	3319.034	-0.001	0.000	3319.033	-0.002	-0.002	B8
3319.181	0.001	0.001	3319.180	-0.001	0.000	3319.179	-0.001	-0.001	3319.177	-0.002	-0.003	B9
3318.241	0.000	0.009	3318.241	0.000	0.009	3318.241	0.000	0.009	3318.239	-0.002	0.007	B10
3307.267	-0.002	-0.010	3307.268	0.001	-0.009	3307.264	-0.004	-0.013	3307.265	0.000	-0.012	**B11
3310.007	-0.004	-0.013	3310.004	-0.003	-0.016	3310.001	-0.003	-0.019	3309.998	-0.004	-0.022	*2011-1
3309.252	-0.005	-0.018	3309.254	0.002	-0.016	3309.256	0.002	-0.014	3309.254	-0.002	-0.016	**2011-2
3310.334	-0.007	-0.020	3310.330	-0.004	-0.024	3310.327	-0.003	-0.027	3310.323	-0.004	-0.031	*2011-3
3310.362	-0.004	-0.009	Tige non atteignable avec la règle			3310.370	0.008	-0.001	3310.365	-0.005	-0.006	*2011-4
3303.980	-0.001	-0.004	3303.980	0.000	-0.004	3303.973	-0.007	-0.011	3303.969	-0.004	-0.015	**2011-5
3309.344	0.000	-0.013	3309.342	-0.002	-0.015	3309.339	-0.003	-0.018	3309.339	0.000	-0.018	**2011-6
3309.171	-0.001	0.015	3309.170	-0.001	0.014	3309.167	-0.003	0.011	3309.167	0.000	0.011	**2011-7
3310.377	0.003	-0.006	3310.371	-0.006	-0.012	3310.372	0.001	-0.011	3310.372	0.000	-0.011	**2011-8

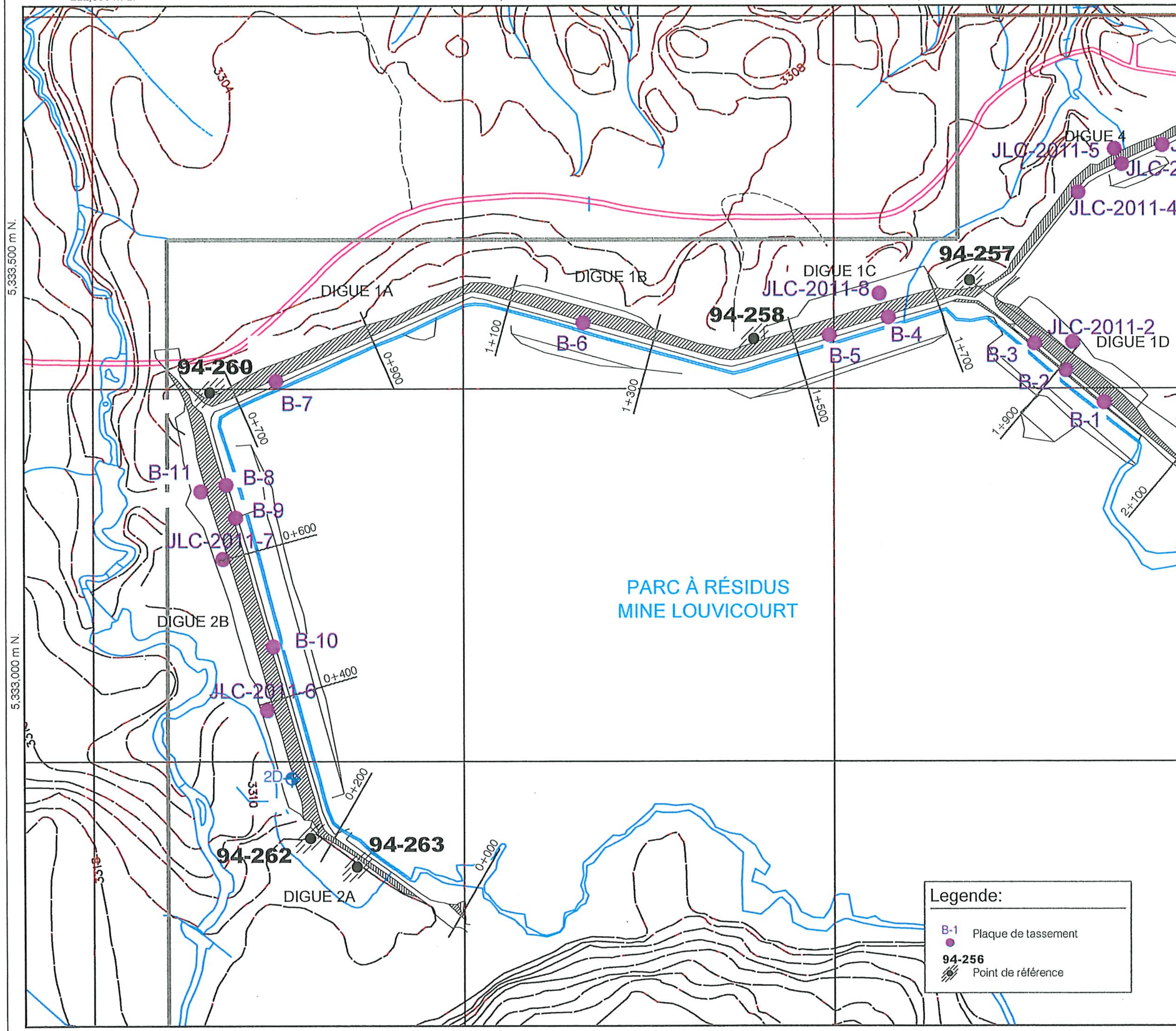
*Trait jaune = Repères implantés en 2011

**Nivellement trigonométrique (précision estimé à +/- 5 mm

Note : seul le nivellement géométrique à été utilisé lors du levé des plaques de tassement en octobre 2019.

Légende des écarts : pas de signe s'élève, signe négatif (-) s'enfonce

Annexe 3



Localisation des points de référence et plaques de tassement
Mine Louvicourt - Canton de Louvicourt

Mine Louvicourt
Aur - Novicourt - Teck

VAL-D'OR, 15 JUIN 2010 **Revisé: 20 octobre 2011**

Jean-Luc Corriveau
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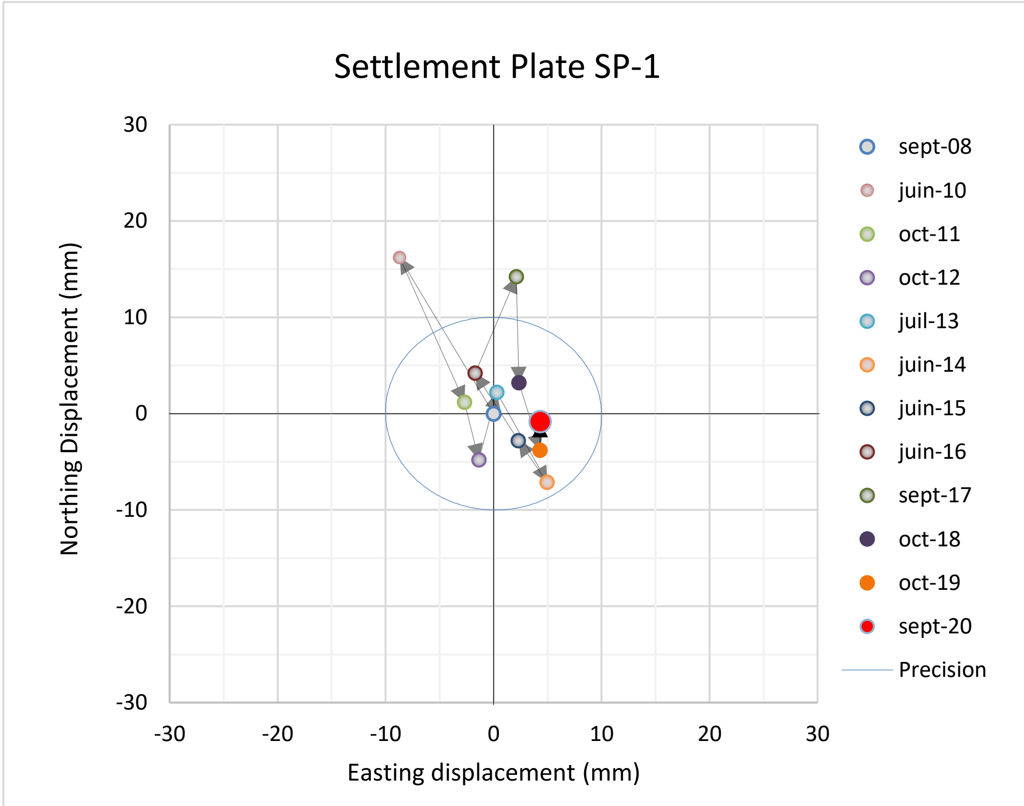
Tél.:(819) 825-3702 Fax:(819) 825-2863
Courriel: bureau@corriveaujl.com

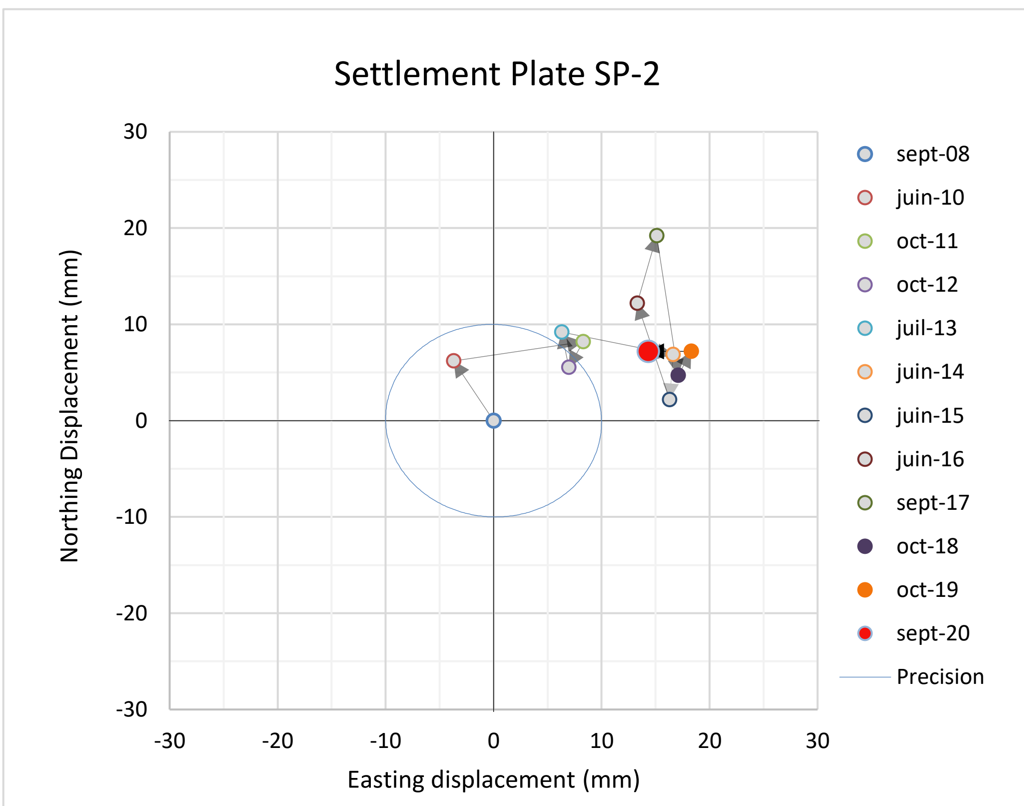
Réf. DAO: J:\C10945\6. Dessin\1. Preliminaire\C10945_Plaques.dwg/ISMAEL

C10945/442.17

APPENDIX D

Point of Origin Plots


Settlement Plate SP-1
Northing Displacement (mm)
Easting displacement (mm)
30
20
10
0
-10
-20
-30
-30
-20
-10
0
10
20
30
sept-08
juin-10
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-2
Northing Displacement (mm)
Easting displacement (mm)
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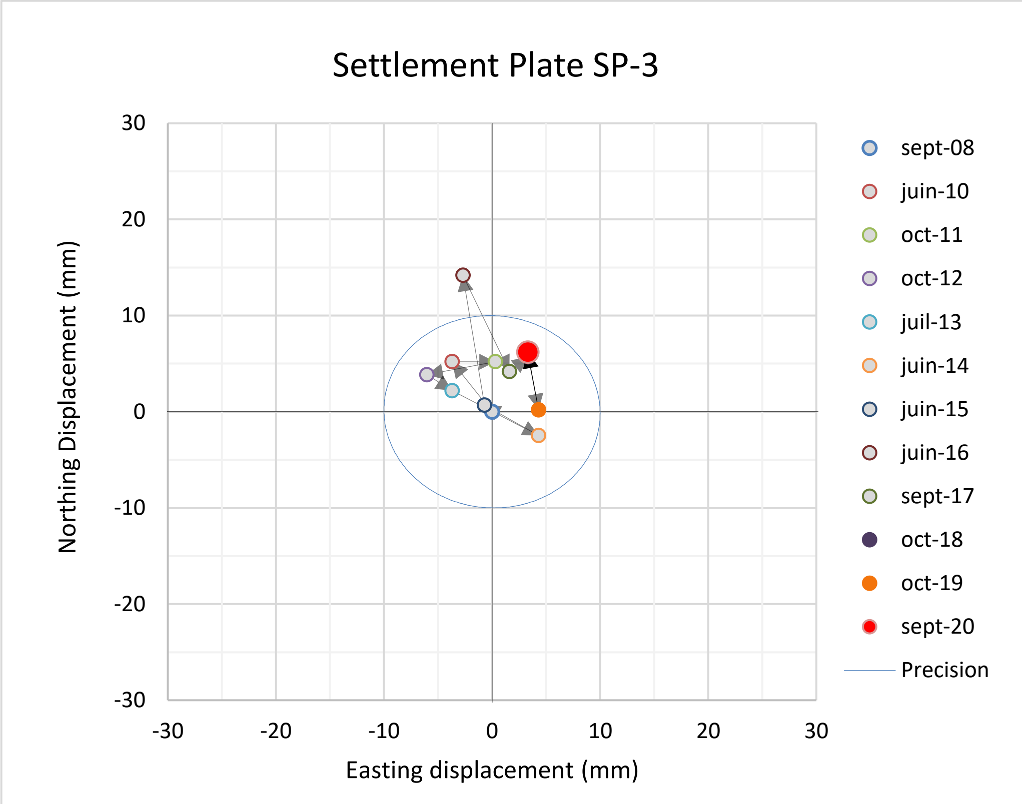
0
-10
-20
-30
-30
-20
-10
0
10
20
30
sept-08
juin-10
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-3
Northing Displacement (mm)
Easting displacement (mm)
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20
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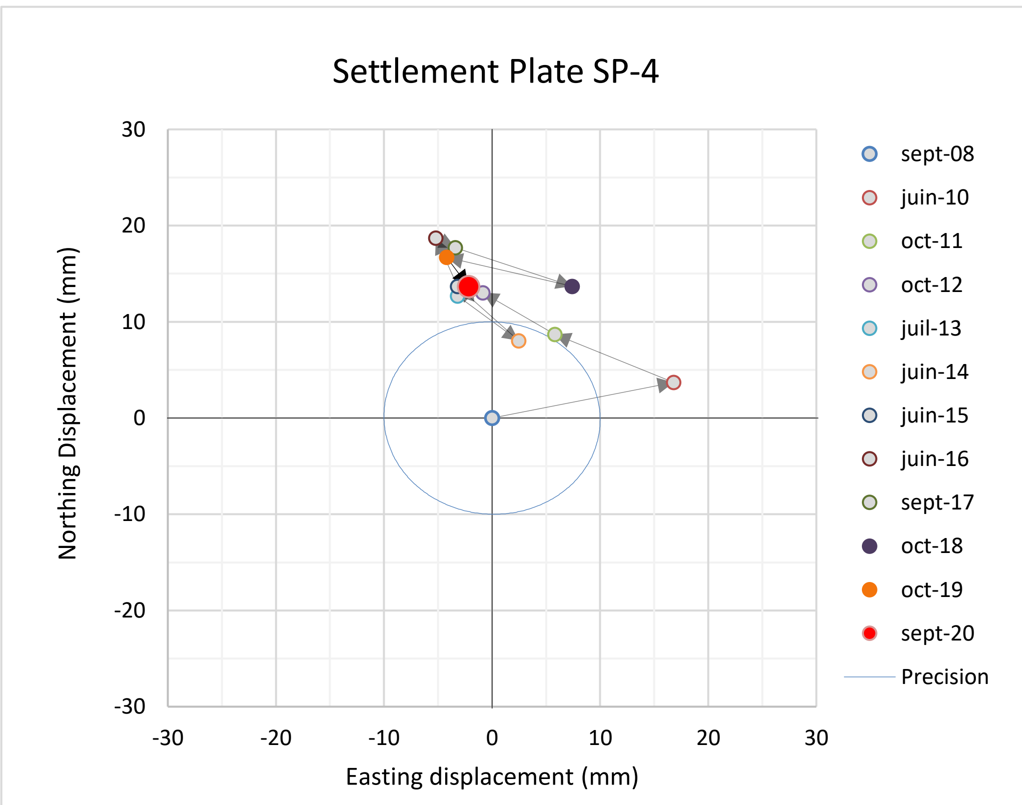
0
-10
-20
-30
-30
-20
-10
0
10
20
30
sept-08
juin-10
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-4
Northing Displacement (mm)
Easting displacement (mm)
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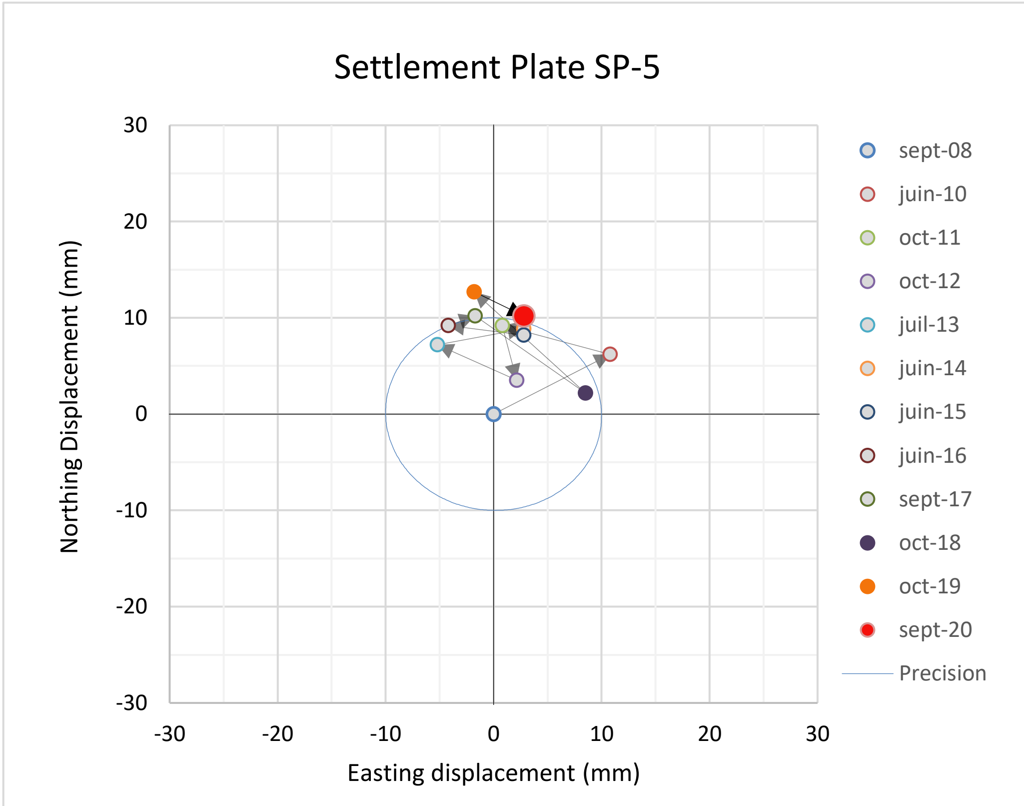
20
10
0
-10
-20
-30
-30
-20
-10
0
10
20
30
sept-08
juin-10
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-5
Northing Displacement (mm)
Easting displacement (mm)
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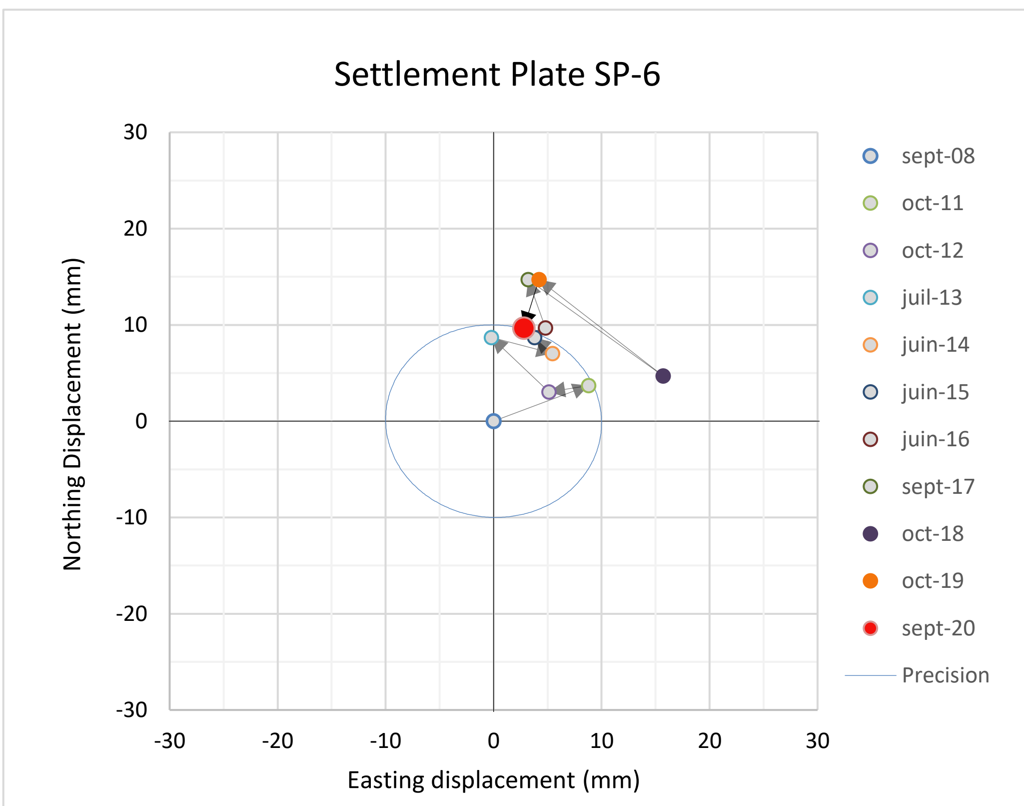
20
10
0
-10
-20
-30
sept-08
juin-10
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-6
Northing Displacement (mm)
Easting displacement (mm)
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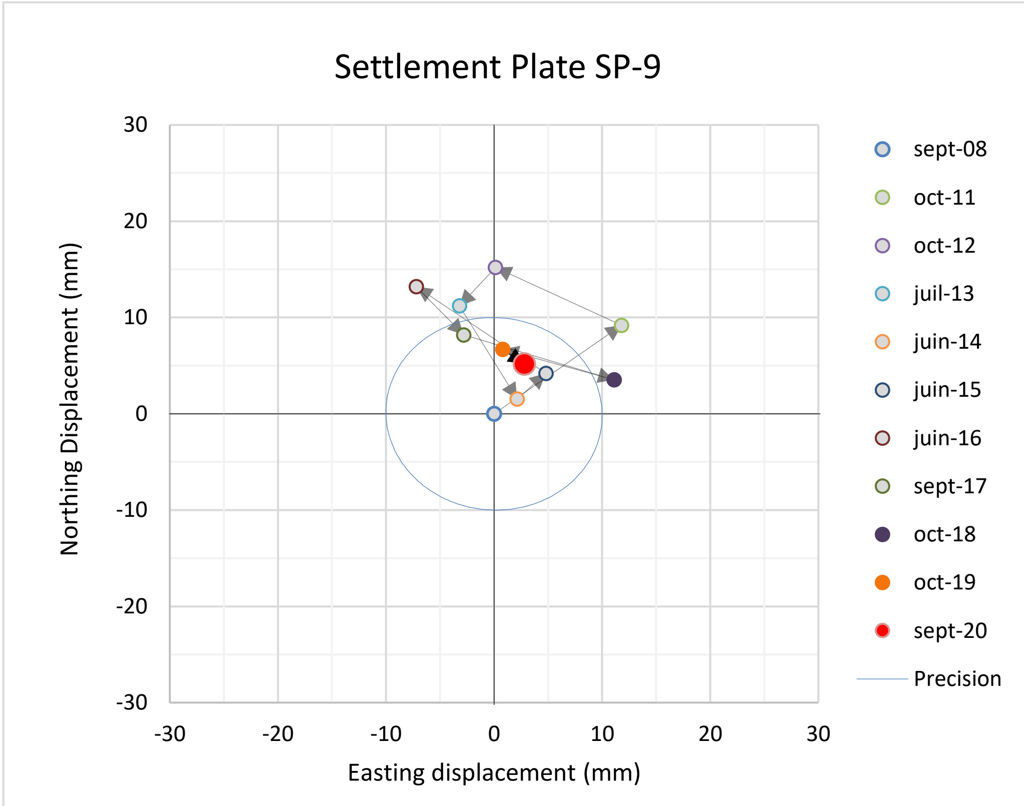
20
10
0
-10
-20
-30
sept-08
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-7
Northing Displacement (mm)
30
20
10
0
-10
-20
-30
-30
-20
-10
0
10
20
30
Easting displacement (mm)
sept-08
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-8
Northing Displacement (mm)
30
20
10
0
-10
-20
-30
-30
-20
-10
0
10
20
30
Easting displacement (mm)
sept-08
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-9
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20
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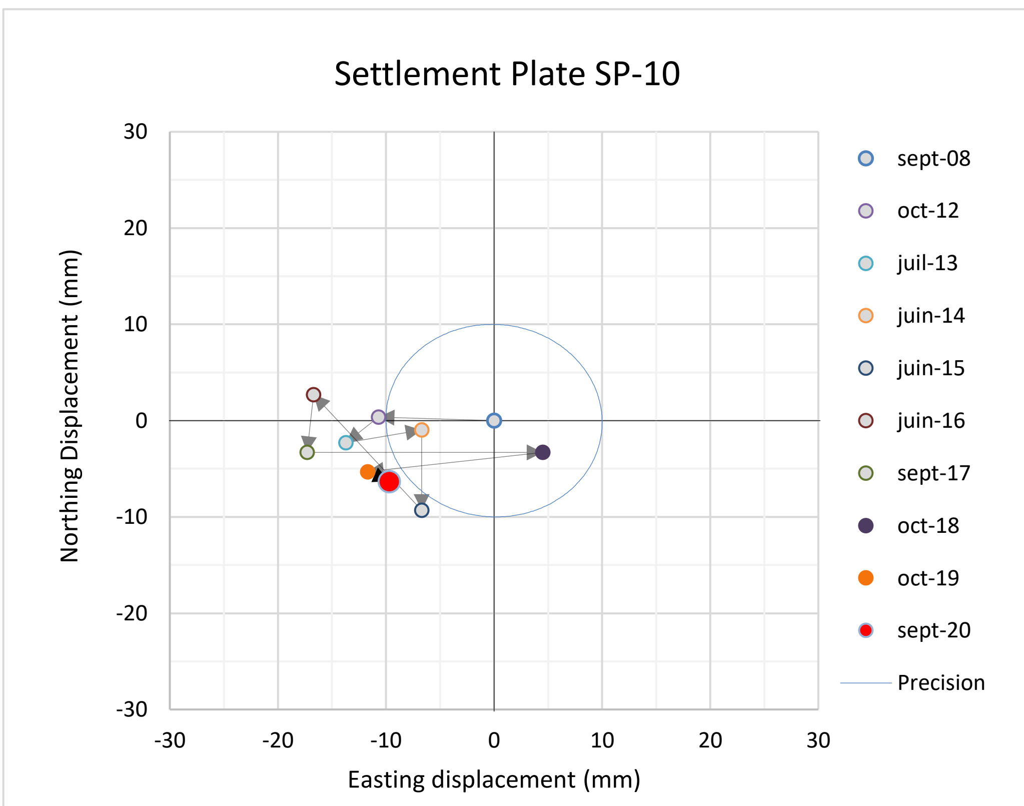
0
-10
-20
-30
Northing Displacement (mm)
-30
-20
-10
0
10
20
30
Easting displacement (mm)
sept-08
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-10
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20
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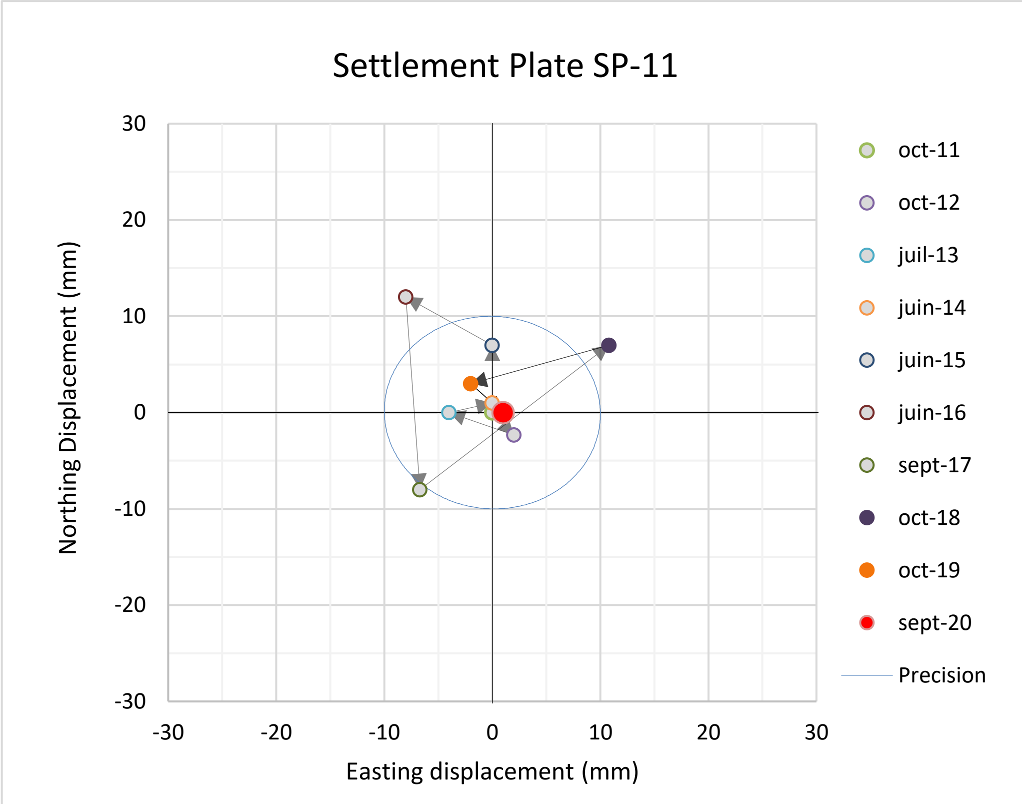
0
-10
-20
-30
Northing Displacement (mm)
-30
-20
-10
0
10
20
30
Easting displacement (mm)
sept-08
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision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Northing Displacement (mm)
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20
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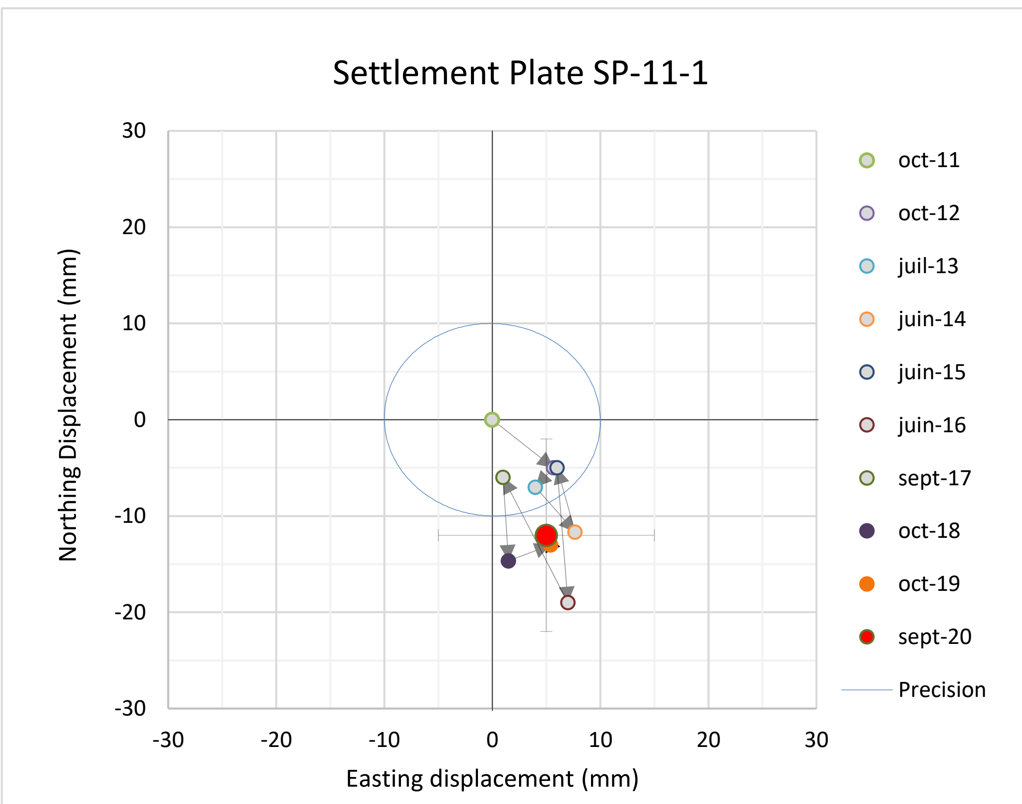
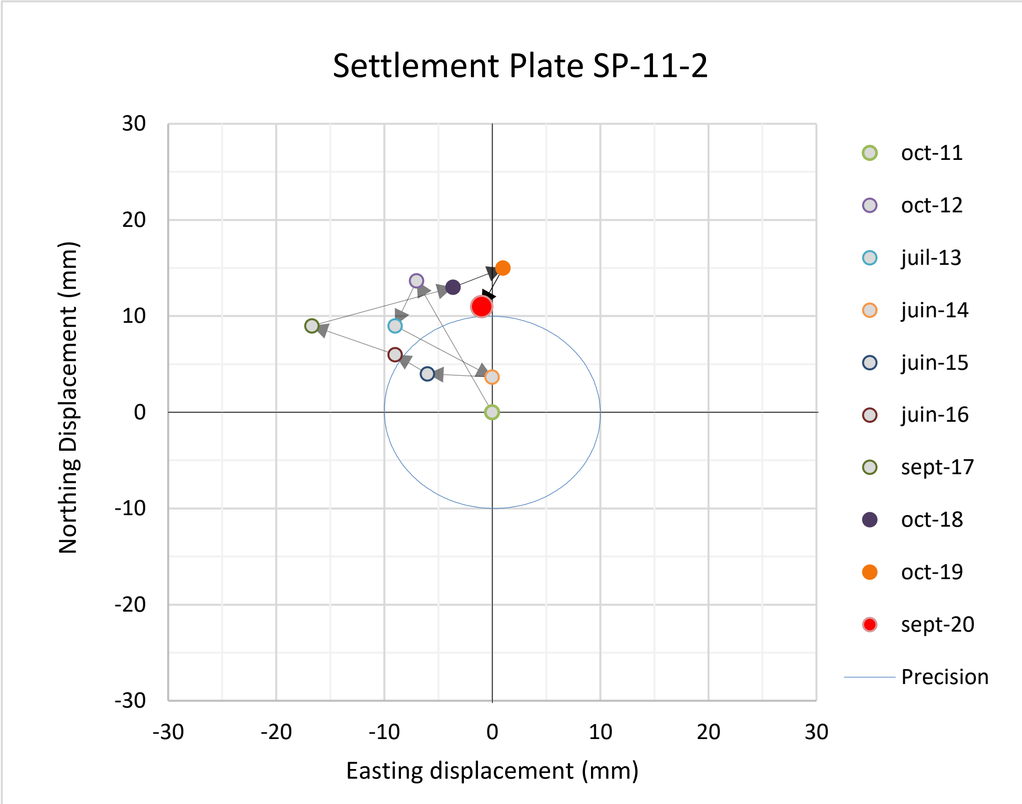
0
-10
-20
-30
-30
-20
-10
0
10
20
30
Easting displacement (mm)
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-11-1
Northing Displacement (mm)
30
20
10
0
-10
-20
-30
-30
-20
-10
0
10
20
30
Easting displacement (mm)
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-11-2
Northing Displacement (mm)
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20
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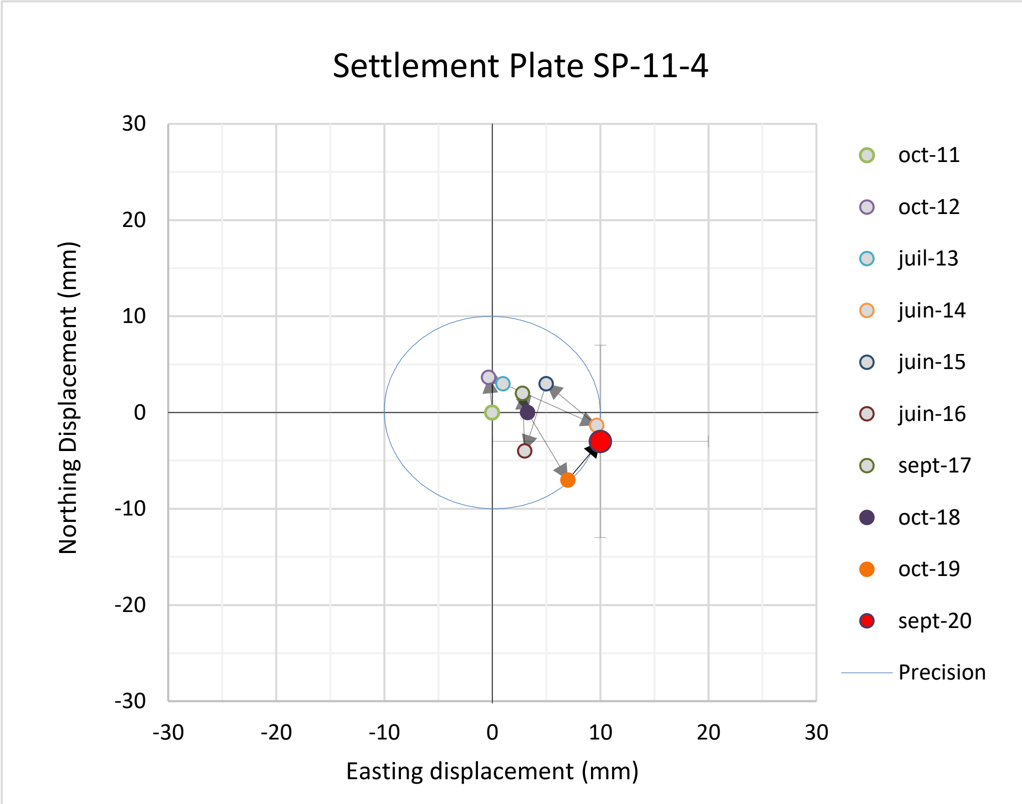
0
-10
-20
-30
-30
-20
-10
0
10
20
30
Easting displacement (mm)
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-11-3
Northing Displacement (mm)
30
20
10
0
-10
-20
-30
-30
-20
-10
0
10
20
30
Easting displacement (mm)
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision
SP-11-3


Settlement Plate SP-11-4
Northing Displacement (mm)
Easting displacement (mm)
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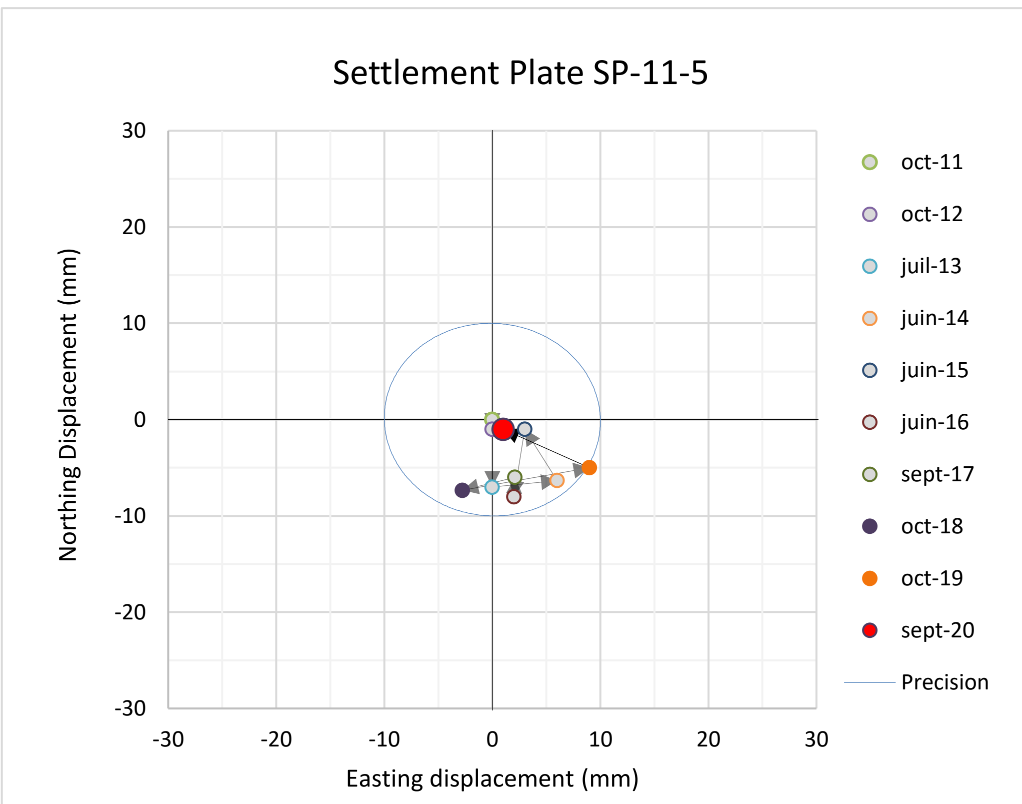
0
-10
-20
-30
-30
-20
-10
0
10
20
30
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-11-5
Northing Displacement (mm)
Easting displacement (mm)
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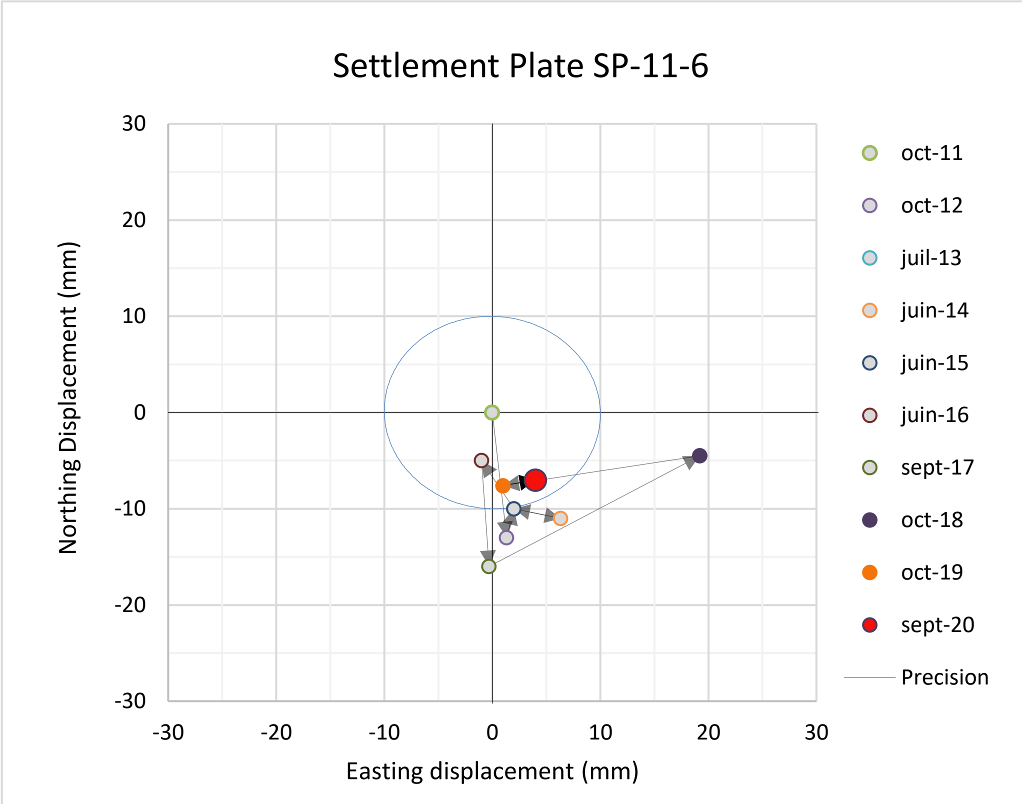
0
-10
-20
-30
-30
-20
-10
0
10
20
30
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-11-6
Northing Displacement (mm)
Easting displacement (mm)
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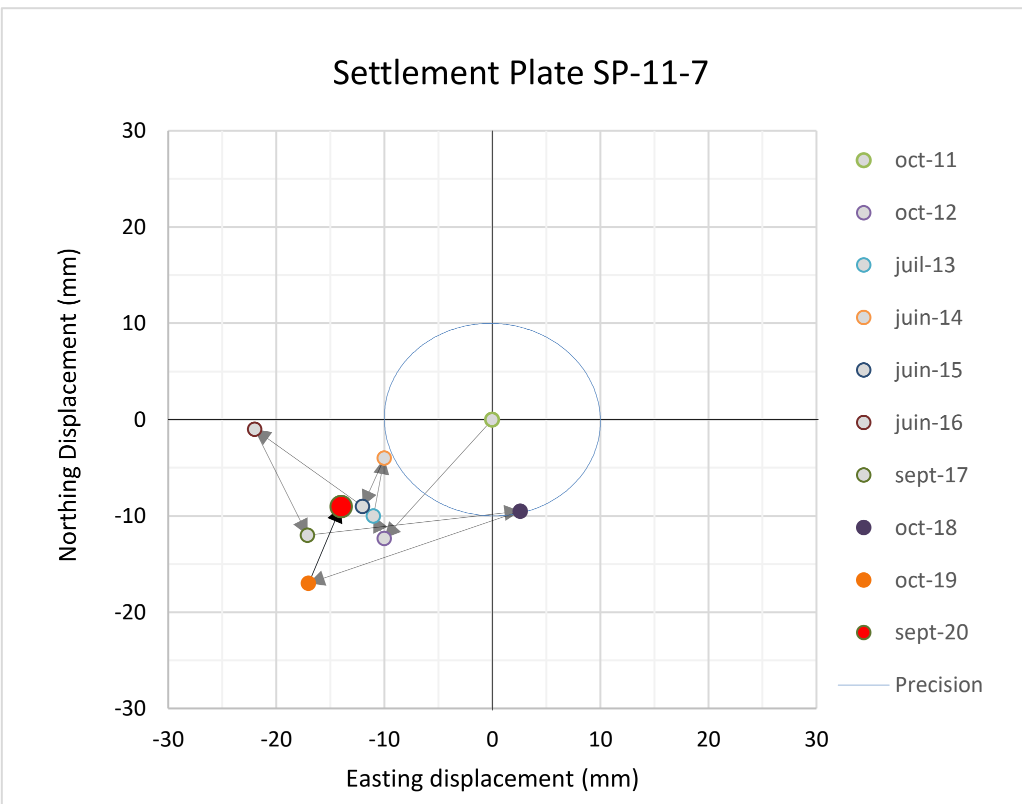
0
-10
-20
-30
-30
-20
-10
0
10
20
30
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-11-7
Northing Displacement (mm)
Easting displacement (mm)
30
20
10
0
-10
-20
-30
-30
-20
-10
0
10
20
30
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
oct-19
sept-20
Precision


Settlement Plate SP-11-8
Northing Displacement (mm)
Easting displacement (mm)
30
20
10
0
-10
-20
-30
-30
-20
-10
0
10
20
30
*2019 - Unsurveyed
oct-11
oct-12
juil-13
juin-14
juin-15
juin-16
sept-17
oct-18
sept-20
Precision

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