WSP

CONFIDENTIAL

REPORT

2023 ANNUAL FACILITY PERFORMANCE REPORT - LOUVICOURT

TECK RESOURCES LTD.

Soumettre à:

Ms. Morgan Lypka, P.Eng

Tailings and Water Management Engineer
Teck Resources Ltd., Legacy Properties
375, avenue Centrale
Val-d'Or, QC J9P 1P4

Proposé par:

WSP Canada Inc.

7250, rue du Mile-End, Montréal (Québec) H2R 3A4 Canada

+1 514 383 0990

CA0005174.2774 RA-Rev0-TSF Inspection 2023

March 22, 2024

Distribution List

One electronic copy to Teck Resources Ltd.

One electronic copy to WSP Canada Inc.

Executive Summary

This document presents the 2023 annual facility performance report (AFPR) 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 on the basis of a site visit carried out on September 15 and 16, 2023, by Laurent Gareau and Nicolas Pepin of WSP Canada Inc., who were accompanied by Morgan Lypka, Jean Francois Lagueux, Jonathan Charland, and Luc Tellier of Teck Resources Ltd. (Teck, Owner), as well as on a review of available data representative of conditions over the period since the previous AFPR. Golder is the original designer of the facility and has been the provider of the Engineer of Record (EOR) since 2017. Laurent Gareau assumed the role of EOR for the Louvicourt TSF in 2018. The objective of the site-visit component of an AFPR for any such facility is to observe the physical condition of the structures of the facility and to look for any signs of changing geotechnical performance such as settlement, bulging, cracking, erosion, seepage, or piping. The review of monitoring data supplements the visual observations and provides a historic perspective on the annual performance of a facility.

The AFPR is supplemented by routine observations, instrumentation monitoring, and water quality monitoring carried out at the facility by Teck throughout the year.

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 kilometres (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 (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 at Dam 1E, at the northeast corner of the facility.

The polishing pond is bounded by Dams 4A and 4B and high ground 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, on the east end of Dam 4B.

The facility is inspected by Teck 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 AFPR, a review was completed of the instrumentation data and the September 2023 site observations relative to the potential hazards. There was no significant change to the key potential hazards based on the conditions observed in 2023 compared to previous reporting periods and no immediate safety concerns with the existing facilities were identified. Tailings facilities can have three broad areas of catastrophic geotechnical failure modes and those were reviewed as part of this annual summary – namely internal erosion, slope instability, and overtopping. The design basis relevant to each of the potential failure modes was reviewed. Presently, evaluations of two of the three broad areas of potential failure mechanisms are underway and these will inform WSP's recommendation on the status of credible failure modes for this facility. The following are updates on the status of that work for the end of the 2023 reporting period. The conclusion of this review is that the critical failure modes are considered to be highly unlikely for this facility and that they are being managed appropriately.

Internal Erosion

Flow rates at the V-notch weirs and seepage locations around the TSF are measured by Teck during monthly observations 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 September 15-16, 2023, site visit, the monitoring results from the previous year were reviewed. It was observed that measured flow rates were generally within normal historical operating ranges, with the exception of a series of measurements made during and after a heavy rainfall event in late April and early May, when v-notch flows exceeded historic maxima. Intermittently, heavy rainfall events result in limited amounts of sediment accumulating in the weirs from surficial washing. These high flows abated soon after the rainfall stopped, and water quality quickly reverted to clear flow. 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 under normal flow conditions. No zones of recent subsidence or sink holes, which could be indicative of internal erosion, were observed anywhere within the overall facility. In response to the observed high flow measurements, the TARPs for the v-notch weirs were reviewed and adjusted in 2023. In conclusion, no evidence of internal erosion was observed during the formal AFPR inspection nor indicated by the flow monitoring, and it is concluded that the risk due to internal erosion is appropriately low and is being managed diligently. This has been the case throughout operation and through the mine closure period.

A potential trigger for internal erosion may occur in conjunction with an extreme rainfall event, resulting in very high ponded water levels. High water levels occurring in the presence of a damaged dam core (either by settlement, such as at Dam 4B, or by frost-induced cracking of the core) could increase the potential for internal erosion, placing additional dependence on the graded chimney filter drain elements that are included in the construction of the dams.

Ongoing or planned studies to analyze this potential failure mode for the facility 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 include using appropriately placed instrumentation to supplement the regular visual assessment of dam performance relative to potential failure modes. For the Louvicourt TSF, piezometers, thermistors, and survey monuments comprise the instrumentation used for performance monitoring.

The groundwater monitoring network consists of eight standpipe piezometers and 11 vibrating wire piezometers (VWPs) installed on the berms of the three different dams (1, 2 and 4). These instruments indicate stable piezometric levels. Improvements in the remote data acquisition system are proposed in order to increase the confidence level in the measured water levels and to support early detection of changing conditions.

Survey monuments were surveyed between September 22 and 29, 2023 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. Where instruments 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:

- The maximum cumulative settlement of all the survey monuments is 41 mm, as measured SP-11-3 at the crest of Dam 4B with monitoring since 2011.
- Incremental settlements in the past year (2022 to 2023) were generally less than or equal to 3 mm. The exception is SP-11-3 with an incremental settlement of 5 mm.
- There is no sign of accelerating settlements.
- In general, the horizontal data show that the survey instruments exhibited horizontal movements within the range of annual precision and less than or equal to 10 mm from 2022 to 2023, and total horizontal movements since installation of less than or equal to 25 mm. There are two exceptions that will need validation from future surveys:
  - SP-11-6 on Dam 2B which had a measured displacement of 14 mm relative to 2022 but most of which was parallel to the dam crest (Appendix D).
  - SP-2 at Dam 1D crest showed 12 mm lateral movement relative to 2022, but in the upstream direction.
  - These two movements are of a similar order of magnitude as historic movements of the settlement plates and do not appear to be indicative of increasing lateral movements.
- The data suggest that no significant horizontal movements are occurring.

Based upon the monitoring results, deformation and potential instability did not constitute concerns for the facility in 2023. Studies to confirm that the risk from this failure mode is appropriately low are ongoing or planned and include:

- Site-specific seismic hazard assessment (complete) coupled with an update of seismic stability, including undrained loading, 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. *Dam Safety Guidelines* (CDA, 2007) provided updated guidance for freeboard allowance. Klohn Crippen Berger (KCB, 2011) reviewed the freeboard assessment for the tailings pond against the requirements of CDA (2007) in the 2010 independent Dam Safety Review (DSR) (KCB, 2011) and concluded that for a normal operating pond level of 316.15 m, freeboard was adequate to prevent overtopping in either normal or probable maximum flood (PMF) conditions. The polishing pond freeboard was judged to be more than adequate as the polishing pond level is currently maintained significantly lower than was intended in the original design, such that freeboard exceeds 3 m. In 2023, 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 (Golder, 2021b) determined that both the TSF pond and the polishing pond had adequate capacity to safely pass the PMF event, with significant contingency and without potential for overtopping, as long as the operational spillways are maintained free of obstructions. Teck has demonstrated diligence in the maintenance of the spillway structures. Under active closure care, it is concluded the risk of failure due to overtopping is appropriately low and is being managed diligently.

Consequence of Failure

Teck is committed to the safe and environmentally responsible management of tailings facilities throughout the mining life cycle to minimize harm to the environment and protect the health and safety of their people and surrounding Communities of Interest. This commitment includes the implementation of the Global Industry Standard on Tailings Management (GISTM) and industry-leading guidelines established by the International Council on Mining and Metals (ICMM), the Mining Association of Canada (MAC) and Canadian Dam Association (CDA).

In 2023, a new dam breach assessment has been completed for the Louvicourt TSF (WSP, 2024) to incorporate some changes in the state of practice in dam breach analysis. In this assessment, the consequence of failure assessment was reviewed. Notably, the environmental consequence classification used the new CDA guidance that was published in 2023 (CDA, 2023). As a result of this assessment, the TSF was considered to have a consequence classification of “High”. The polishing pond dams were not re-assessed according to CDA, 2023 and a ranking of “Significant” remains in force for this structure. Based on the nature and volume of storage in the Polishing Pond, it is reasonable to expect that the environmental consequence classification of the Polishing Pond Dams using CDA, 2023, would be lower than that of the TSF; however, Teck may elect to reanalyze the consequence classification of the Polishing Pond in the future.

As part of Teck’s commitment to the safety of tailings facilities, Teck has adopted evaluating their facilities against extreme loading criteria with a credible catastrophic flow failure mode, regardless of consequence classification. Risk assessments are performed for all tailings facilities, with the objective of reducing risks to As Low As Reasonably Practicable (ALARP). In some cases, this results in further risk reduction beyond applicable regulatory requirements and is consistent with the GISTM and industry-leading best practice.

Summary of Key Observations

Summary of Field Observations

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

- All embankments were in good condition without evidence of deteriorating geotechnical conditions.
- The facility spillways (Dams 4B and 1D) were in good condition and functional.
- 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. New seepage points were observed where the ground surface was disturbed by tree removal activities. 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 2022 to October 2023) was 1026 mm or 13% higher than the long-term average of 907 mm. Based on the consolidated hydrology study for the Louvicourt site (Golder, 2021b), this corresponds to a 1:25-year to 1:50-year wet precipitation year.

Based on a high-level water balance analysis, it was estimated that 510,000 cubic metres (m^3) of water were discharged to the polishing pond via the operational spillway. The annual discharge was transferred without any flow in either the primary or second emergency spillways and does not present a risk to the facility.

Summary of Significant Changes

No significant construction activities were undertaken at the Louvicourt TSF in 2023.

Summary of Review of OMS and ERP Manuals

The Operations, Maintenance and Surveillance (OMS) manual was updated in 2023. It is also reviewed annually. A further update is planned for 2024.

A Mine Emergency Response Plan (MERP) for the site was most recently updated on June 12, 2023. The MERP incorporates response procedures for the tailings and polishing pond components with input from the EOR and has replaced the previous emergency preparedness and response plan. The MERP was activated twice in 2023, once in response to forest fires that limited access to the site and once in response to high flows in the v-notch weirs due to heavy spring rains. In both cases, the MERP provided a good guide to manage risk through these events.

Status of Annual Facility Performance Inspection Key Recommended Actions

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

Table E1: Status of Annual Facility Performance Inspection Key Recommended Actions

Structure	ID	Deficiency or Non-conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline/Status
Previous Recommendations Closed / Superseded						
General	2022-01	Gaps in the rain gauge records	*CDA 2013 Section 3.2*	Download the rain gauge records monthly during the open-water season and verify the data for equipment errors. Verify the equipment calibration	4	OMS updated. Closed in 2023.
TSF Spillway	2021-02	Beaver access under trash rack leading to increased activity in spillway.	OMS Manual Section 6.2	Survey trash rack and re-assess the adequacy of design and the hydraulic capacity.	3	Closed in 2024
Previous Recommendations Ongoing						
All	2015-06	Perform a review of dam's seismic stability and undrained behaviour.	Directive 019 Section 2.9.3	Perform a review of dam's seismic stability and undrained behaviour of potentially contractive soils.	3	IN PROGRESS- Undrained stability analysis completed, and deformation analysis is in progress. Q1 2024.

Structure	ID	Deficiency or Non-conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline/Status
Dam 1C	2021-04	Irregular slope on toe berm of Dam 1C leading to preferential infiltration.	CDA 2013 Section 3.5.3	Engage a detailed survey of this area and use the data to refine facility integrity analyses.	3	Survey completed in 2021. Data analysis is ongoing. Integrate into stability analysis. Q1 2024.
2023 Recommendations						
All	2023-01	Finalize the implementation of the remote data collection system for site instruments.	*CDA 2013 Section 3.2*	Work with the equipment supplier to replace non-functioning dataloggers.	2	Discussions with supplier have been initiated. Work to be completed after spring runoff. Q2 2024.
Dam 4A	2023-02	Remove trees and shrubs greater than 50 mm in diameter from the embankment.	*OMS Manual Section 5.2*	Engage a tree removal contractor and remove vegetation, in conjunction with second emergency spillway clearing	3	Q3 2024.
Dam 4B	2023-03	Investigate the benefit of adding a trash rack at the polishing pond spillway.	*CDA 2013 Section 3.6.4*	Assess the pros and cons of a trash rack at the polishing pond spillway. If there is benefit, implement a plan to design and construct trash rack.	4	Determine whether a trash rack is required and pending this evaluation, plan the design of such a structure. Q4 2024.
Dam 1E	2023-04	Remove vegetation from outlet channel of operational and first emergency spillway at the main TSF.	*CDA 2013 Section 3.5.5*	Remove debris immediately at the spillway outlet and to clear vegetation in the entire outlet channel to the polishing pond.	4	Undertake at the same time as vegetation removal in the second emergency spillway channel. Q3 2024.
Dam 4B	2023-05	Dam crest settlement.	CDA 2013 Section 3.5.3	Resurvey dam profile to assess current condition and verify available freeboard.	3	Q2 2024.

CDA = Canadian Dam Association; OMS = Operations, Maintenance and Surveillance; TSF = tailings storage facility; QA/QC = quality assurance/quality control.

Table E2: 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.

Table of Contents

TABLES

FIGURES (after text)

APPENDICES

Definitions

Abbreviation	Definition
AFPR	Annual facility performance report
CDA	Canadian Dam Association
DSR	Dam Safety Review
EOR	Engineer of Record
Golder	Golder Associates Ltd.
GPS	Global Positioning System
MAC	Mining Association of Canada
MERP	Mine Emergency Response Plan
OMS	Operation, Maintenance and Surveillance
PGA	Peak Ground Accelerations
Teck	Teck Resources Ltd.
TSF	tailings storage facility
WSP	WSP Canada Inc.

Unit	Definition
%	percent
+/-	plus or minus
°C	degrees Celsius
cm	centimetre
ha	hectare
km	kilometre
kN/m^3	kilonewtons per cubic metre
kPa	kilopascal
L/s	litres per second
m	metre
m^2	square metre
m^3	cubic meter
t	tonne
tpd	tonnes per day

Term	Definition
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, pond or stored tailings.
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, pond or stored tailings.
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 Ltd. (Teck), WSP Canada Inc. (WSP) has completed the 2023 annual performance review inspection at the Louvicourt Mine tailings storage facility (TSF) 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 September 15 and 16, 2023, and the review of available surveillance data for the reporting period (September 2022 to September 2023) by the Engineer of Record (EOR), Laurent Gareau of WSP and Nicolas Pepin of WSP. The previous annual inspection for the tailings facility dams was carried out in September 2022, and is reported in the 2022 annual facility performance report (AFPR[1]) (Golder, 2023).

The 2023 inspection included the inspection of the polishing and tailings facilities and 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" or are not included in the report. The reader is encouraged to read the limitations and intended uses of the report, following the text, as they are an integral part of the report.

1.2 Regulatory Requirements and Guidelines

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

- *Guide de préparation du plan de réaménagement et de restauration des sites miniers au Québec*, MRNF[2] (Ministère de l'Énergie et des Ressources naturelles du Québec) and MELCCFP (Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques), 2022.
- Directive 019 sur l'industrie minière, MELCCFP, March 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 field inspection is a requirement of the certificate of authorization no. 7610-08-01-70141-52 issued by MELCCFP in October 2010.

[1] The annual performance report includes results of visual field inspection, instrumentation monitoring and assessment (ICMM, 2020).

[2] MRNF : ministère des Ressources naturelles et des Forêts since October 2022; previously named, ministère de l'Énergie et des Ressources naturelles (MERN, 2014 à 2022), ministère des Ressources naturelles (2012 à 2014), ministère des Ressources naturelles et de la Faune (2005 à 2012), ministère des Ressources naturelles, de la Faune et Parcs (MRNFP, de 2003 à 2005).

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.

The Louvicourt property surface lease is currently owned by Teck (55%) and Glencore Canada Corporation (45%). The site was managed with the support of and monitored by Golder from closure until the end of 2016. The site is managed by Teck.

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 linear segments separated by local bedrock outcrops located along the alignment of the dams as defined by the initial design (Golder, 1993), and shown in plan view in figure 1 after the text.

The polishing pond is contained by Dam 4 to the north, the tailings pond to the west (Dam 1D and 1E) 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. The total length of Dam 4 is 910 m, and 4A and 4B are separated by the Polishing Pond operational and emergency spill and the final effluent location. Dam 4A does not actively pond water under normal operating conditions.

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 a high sulphide content (30% to 45%) and are potentially acid generating. The tailings within the basin are covered with a water cover, approximately 1 m deep, 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 the elevation of 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 the elevation of 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 has performed annual inspections of the facilities since 2014. Laurent Gareau is the EOR for the site.

2.0 CONSTRUCTION, OPERATION, MAINTENANCE, AND SURVEILLANCE

The maintenance and surveillance activities performed in 2023 included the following:

- removal of beaver obstructions
- routine observations of the structures
- survey of monuments
- monitoring of piezometers, V-notch weirs and ponds water levels
- continuing integration of new instrumentation network (pond-level loggers and data acquisition system)
- removal of vegetation and debris in the tailings pond and polishing pond active spillway canals

3.0 CLIMATE DATA AND WATER BALANCE

3.1 Review and Summary of Climate Information

Table 2 and Figure 3 summarize the Val-d'Or total monthly precipitation data over the period from November 1, 2022, to October 31, 2023. The data originates from the Environment and Climate Change 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 1951-2023, 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 1951-2023 are also provided in Table 2.

Table 1: Information on the Selected Environment and Climate Change Canada Stations

Station Name, ID	Latitude, (degrees)	Longitude (degrees)	Station Elevation (m)	Available Data Record	Notes
VAL-D'OR A, 7098600	48°03'12'' N	77°46'58'' W	337.4	1951 – 2023	Main station since 1951
VAL-D'OR, 7098603	48°03'23'' N	77°47'11'' W	338.9	2008 – 2023	Used for missing data
VAL-D'OR A, 7098605	48°03'12'' N	77°46'58'' W	337.4	2011 – 2023	Used for missing data

The total precipitation over the hydrological year (November 2022 to October 2023) was 1026 mm or 13% higher than the long-term average of 907 mm[3]. Based on the consolidated hydrology study for the Louvicourt site (Golder, 2021b), this corresponds to a 1:25 to 1:50-year wet precipitation year. The months of April (99 mm vs. 60 mm long-term average), August (155 mm vs. 92 mm long-term average) and October (200 mm vs. 84 mm long-term average) were particularly wet. The months of January (27 mm vs. 58 mm long-term average) and June (13 mm vs. 89 mm long-term average) were particularly dry.

[3] Long-term average values were adjusted to account for the most recent records so they differ slightly from values presented in past documents.

Table 2: Monthly Precipitation Data from November 2022 to October 2023

Month – Year	Monthly Multi-Annual Average at Val-d'Or (mm) *	Total Precipitation Recorded at Val-d'Or (mm) between Nov. 2022 and Oct. 2023 *	Difference (%) **
November 2022	81	98	+21%↑
December 2022	68	69	+1%↑
January 2023	58	27	-53%↓
February 2023	48	56	+16%↑
March 2023	57	54	-5%↓
April 2023	60	99	+65%↑
May 2023	69	66	-5%↓
June 2023	89	13	-86%↓
July 2023	99	97	-2%↓
August 2023	92	155	+68%↑
September 2023	102	92	-10%↓
October 2023	84	200	+138%↑
Total over the hydrological year	**907**	**1026**	+13%↑

*: Values are based on records from Environment and Climate Change Canada climate stations ID 7098600, ID 7098603, ID and 7098605, from 1951 to 2023.

**: Difference between Val-d'Or current year precipitation and the multi-annual average precipitation: Difference = $(x-x_{ave}) / x_{ave}$

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

Since July 2021, Teck has operated a rain gauge at the Louvicourt site. Teck shared the collected data with WSP; there are around 200 days with valid rainfall data collected in 2023. As expected, there are differences in the daily intensities relative to the ECCC stations, but the cumulative rainfall depths are very well correlated. Over the 200 days, the local rain gauge recorded 22% less rainfall than the Val-d'Or A rain gauge. Over 107 days in 2021 and 2022 period, the similar comparison indicated that the local rain gauge recorded 15% less rainfall than the Val-d'Or A rain gauge. Before drawing any conclusions, WSP recommendations are the following:

- Continue to operate the local rain gauge and minimize data gaps.
- Verify the local rain gauge calibration.
- Continue to use Val-d'Or A climate statistics until a reliable conclusion is reached regarding the validity of the local rain gauge data.

3.2 Review and Summary Water Balance

A water balance of the Louvicourt TSF was compiled based on the recent climate data and the GoldSim model documented in WSP (2023). Table 3 summarizes the yearly flows resulting from the water balance for the considered year, namely from November 1, 2022, to October 31, 2023, and for a typical year (average climate conditions). Higher precipitation for the 2022-2023 year was compensated by higher evaporation such that the volume of water discharged at the spillway remained mostly constant.

Table 3: TSF Pond Water Balance for November 2022 to October 2023

Component	Typical Year Flows (Based on an average climate year) (m^3/year)	Current Year Flows* (m^3/year)	Difference to long-term average (%)
Total precipitation over the basin	912,000	1,031,000	**+13%**
Surface runoff over the external watershed area	573,000	591,000	**+3%**
Total of inflows	**1,485,000**	**1,622,000**	
Pond snow sublimation	72,000	74,000	+3%
Pond evaporation	530,000	595,000	12%
Seepage losses	363,000	363,000	0%
Spillway discharge to the polishing pond	520,000	510,000	-2%
Total of outflows	**1,485,000**	**1,542,000**	**+4%**
Increase in pond storage (increase in pond water level)		**80,000**	

* Current year extends from November 2022 to October 2023.

Water balance results extracted from available GoldSim water balance model. A model recalibration is upcoming, which will lead to changes to model estimates.

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 510,000 m^3 of water were 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 90 days after the start of each year to the *ministère de l'Environnement et de la Lutte contre les changements climatiques des Forêts et des Parcs du Québec* (MELCCFP[4]).

[4] MELCCFP : ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (du Québec) since October 2022; formerly known as the ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC, from 2018 to 2022), ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC, from 2014 to 2018), ministère du Développement durable, de l'Environnement de la Faune et des Parcs (MDDEFP, from 2012 to 2014), ministère du Développement durable, de l'Environnement et des Parcs (MDDEP, from 2005 to 2012), ministère de l'Environnement (MENV, de 1998 à 2005) and ministère de l'Environnement et de la Faune du Québec (MEF, from 1994 to 1998).

4.0 SITE OBSERVATIONS

A site inspection was carried out on September 15-16, 2023 by Nicolas Pepin, ing. and Laurent Gareau, ing. (EOR) from WSP. They were accompanied by Ms. Morgan Lypka (RTFE), Jonathan Charland, Jean Francois Lagueux and Luc Tellier of Teck Resources. The temperature during the visit was approximately 15 °C under sunny skies. During the previous two weeks, the ECCC Val-d'Or A station recorded 92.3 mm of precipitation, including 44.6 mm on September 12; for comparison, ECCC estimated the 1:2-year 24-hour rainfall to be 41.8 mm.

4.1 Visual Observations

The following observations were made during this inspection:

- The water level at the tailings pond was 316.00 m.
- The water level at the polishing pond was 307.19 m.

Dams 1A through 1E

- The riprap on the upstream berms of Dams 1A through 1D, which was repaired with new riprap in 2019 and 2022 (Photographs 1 and 2) was unchanged from the previous inspection.
- Ponding water was observed at the toe of Dams 1A to 1E generally at the same locations as last year. Ponded water with little to no observable flow was visible near the toe of Dams 1A to 1C and 2B (Photograph 3). Seepage volumes did not appear significantly different than that under typical conditions; however, disturbance from tree removal equipment during 2022 has resulted in some ponding areas that were not readily visible in the past (Photographs 4 and 5). The locations of current and historic seepage points are presented on Figure 1.
- The emergency spillway located between Dams 1D and 1E (denoted as the second emergency spillway of the TSF) was in good condition with limited vegetation growth. Vegetation in the downstream channel was cleared in 2022 (Photographs 6 and 7) and has historically been cleared every 2 years. This, it will likely require clearing again in 2024.
- The access bridge close to the TSF spillway was rehabilitated in 2018 and appears in good condition and unchanged from last year's inspection (Photograph 8).
- Crest erosion was nominal (Photograph 9), and evidence of crest erosion repair was observed (Photograph 10).
- Vegetation at the downstream toe of Dams 1A, 1B and 1C was removed in 2022, resulting in improved visibility for inspection purposes (Photograph 11).
- Gravel was added on the top of Dams 1A to 1C to improve the protection layer.

Dams 2A and 2B

- Some stagnant water and low seepage were observed at the toe of Dam 2B representing the seepage points labelled 8 through 10, and reporting to V-notch 1 and V-notch 2 flow similar to previous years. The seepage water was clear.
- Stagnant water is observed at the toe of Dam 2B (Photograph 12). The extent of ponding appeared similar to that of 2022; it is noted that this area represents a zone where the natural topography drains towards the dam toe such that some accumulation at this location is expected.

- The culverts, which are located across Unnamed Creek, just north and west of the tailings pond, and which were cleared of debris in 2019, were blocked again during 2023, which caused the flow to breach the adjacent road/earth fill just to the north of the culverts (Photograph 13). This breach location is in turn subject to beaver activity. The partial beaver blockage represents a condition which could change/deteriorate quickly and further, which renders this local access road impassable. Whereas these conditions are not currently impacting the stability of the TSF dams, this area should continue to be monitored in the event that water ponding approaches the TSF infrastructure.

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 Dam 4A embankment (Photograph 14). These trees should be removed. A general rule is to remove any tree or shrub when the diameter of the trunk exceeds 50 mm. Given that Dam 4A does not impound water under normal operating conditions, clearing of the toe areas of this dam is not required.
- Significant debris in the main spillway at Dam 4B observed during the 2022 inspection has been removed (Photograph 15). Although some reeds and grasses are visible in the spillway, no evidence of significant beaver activity was found at the time of the inspection. This area continues to be susceptible to beaver blockage, however, and should be monitored closely.
- The seepage area on the north shoulder of the Dam 4B service spillway was unchanged from prior years' inspections. 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 16). 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 (Photograph 17). There was no significant flow through the outflow culverts at the time of the inspection.
- The Dam 4B crest was generally in good condition (Photograph 18) and essentially unchanged from 2022. Survey monuments are visible. No noticeable changes were visually apparent (i.e., damage) to the survey monuments. Some general maintenance should be applied to remove excess geotextile which is exposed to the west of the emergency spillway.
- Beaver activity historically observed at the toe of Dam 4B was not actively occurring (Photograph 19).

4.2 Photographs

Key photographs of the inspection are presented in Appendix B with many being referenced in Section 4.1 relating to specific observations from the field portion of the review.

4.3 Instrumentation and Data Review

The following information was available for this review:

- Yearly monitoring data of survey monuments.
- Records of weekly and monthly visual facility observations.
- Measurement of flow at V-notches and groundwater elevations of existing piezometers since their installation to November 2023.
- Measurements of the water levels for the tailings and polishing ponds.

Thermistor data is not currently available and will be integrated into the monitoring program in 2024.

The monitoring program is consistent with the site OMS manual, and it is concluded that the number of instruments, monitoring frequency, and threshold levels are appropriate for the observed performance of the facility. Additional instrumentation may be recommended as an outcome of the ongoing stability reassessment. The remote data collection via the GeoExplorer platform has proved largely unreliable. Teck has consulted with the instrument remote sensing equipment (Navstar), and a switch of data logger type is expected in mid-2024. In the interim, as agreed with the EoR, Teck is using manual readings to supplement any data gaps of the remote sensing Navstar system with more regular manual readings of added in the second half of 2023.

4.3.1 Water Levels

Figure 4 presents groundwater levels for the polishing pond and tailings facility embankments for a total of 8 standpipe piezometers and 11 vibrating wire piezometers installed on the berms of the three different embankments (1, 2 and 4). The vibrating wire piezometers installed in 2020 were grouted in place as described in the factual report (Golder 2023b), and any mention of manual readings indicates the use of a handheld wire connection.

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

- 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 2023 were provided by Teck (Figure 4) and include more frequent manual readings in late 2023. The values included in the WSP data review excluded remote telemetry data due to water-level inconsistencies and a lack of confidence. The reported values are manual reading, direct water levels of the open standpipes, or wire connection of the VWPs. 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. Certain instruments show variable readings in 2023, though the provided data includes manual readings that require validation. The data collection issues will be improved when the data acquisition system issues are resolved.

LOU-D1C-VWP-2020-07B is located within the sand drain of Dam 1C and has been increasing since 2020 and is now up approximately 2 meters since 2020, reaching a water elevation of 308.7 m on the manual reading of the piezometer wire on November 9, 2023. The open stand piper well LOU-D1C-P-2020-04 that is downstream of LOU-D1C-VWP-2020-07B and installed in the till has been largely level since 2020, with a reading of 308.1 m on August 7, 2023, the latest available reading. The rise of the water pressure within the sand drain must be closely monitored, though no visible water was observed at the downstream toe.

Standpipe piezometer PZ-02-04 and VWPs LOU-D1D-VWP-2020-08A and B are located within Dam 1D's 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 these two wells is slightly higher than the level of the polishing pond.

Teck measures TSF pond and polishing pond water levels on staff gauges installed near the operational spillways. The measurements are done weekly and are typically limited to the open-water season (it is more difficult to get accurate flow readings throughout the winter with ice buildup and ice cover). The data is also presented in Figure 4 and are described in Section 5.2.3.

4.3.2 Displacements

A series of 15 movement monitoring monuments exists along the crest and berms of the tailings pond dams and 4 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 22 and October 5, 2023, by Corriveau J. L. & Assoc. (Corriveau), a surveyor based in Val-d'Or. The Corriveau survey report is included in Appendix C. The annual survey includes a total station survey and a differential GPS survey of the monitoring points. Table 4 presents horizontal displacement and total settlement of all monuments based on differential GPS and total station survey, respectively. The stated precision of these results is 10 mm for horizontal movements and 2 mm for vertical movements (settlement). The overall precision of the survey data may be less than the stated precision, and for that reason, movements greater than the stated precision require multiple measurements over an extended period to establish patterns of movement.

The analysis of the displacement data is discussed in the following subsections.

Table 4: Settlement and Horizontal Displacement

Monument	Install Year	Horizontal Movements (total)		Settlement (Negative #s = upward movement)		
		Install to 2022	Install to 2023	Up to 2022	2022-2023	Total up to present
Dam 1D (crest)						
B-1 (SP-1)	2008	9 mm	3 mm	2 mm	0 mm	2 mm
B-2 (SP-2)	2008	31 mm	19 mm	31 mm	1 mm	33 mm
B-3 (SP-3)	2008	12 mm	12 mm	3 mm	1 mm	4 mm
Dam 1D (berm)						
2011-2 (SP-11-2)	2011	10 mm	8 mm	16 mm	1 mm	17 mm
Dam 1C (crest)						
B-4 (SP-4)	2008	16 mm	17 mm	-1 mm	1 mm	0 mm
B-5 (SP-5)	2008	11 mm	11 mm	-3 mm	1 mm	-2 mm
Dam 1C (berm)						
2011-8 (SP-11-8)	2011	9 mm	14 mm	11 mm	0 mm	11 mm
Dam 1B (crest)						
B-6 (SP-6)	2008	12 mm	7 mm	-2 mm	1 mm	-1 mm
Dam 1A (crest)						
B-7 (SP-7)	2008	6 mm	8 mm	-29 mm	-1 mm	-30 mm
Dam 2B (crest)						
B-8 (SP-8)	2008	4 mm	6 mm	-1 mm	0 mm	-1 mm
B-9 (SP-9)	2008	7 mm	0 mm	0 mm	0 mm	0 mm
B-10 (SP-10)	2008	10 mm	17 mm	-11 mm	0 mm	-11 mm
Dam 2B (berm)						
B-11 (SP-11)	2011	3 mm	6 mm	8 mm	2 mm	10 mm
2011-6 (SP-11-6)	2011	11 mm	25 mm	14 mm	2 mm	16 mm
2011-7 (SP-11-7)	2011	20 mm	23 mm	-15 mm	1 mm	-14 mm
Dam 4B (crest)						
2011-1 (SP-11-1)	2011	21 mm	22 mm	25 mm	-2 mm	23 mm
2011-3 (SP-11-3)	2011	9 mm	13 mm	36 mm	5 mm	41 mm
2011-4 (SP-11-4)	2011	18 mm	15 mm	1 mm	0 mm	1 mm
Dam 4B (berm)						
2011-5 (SP-11-5)	2011	11 mm	9 mm	11 mm	3 mm	14 mm

4.3.2.1 Settlements

Since the previous year, the vertical survey data of the 19 instruments on site shows that 14 monuments indicated minor vertical movements of ≤ 1 mm, 3 monuments had vertical movements > 1 mm and ≤ 3 mm (the stated survey accuracy is 2 mm) and 2 monuments had vertical movements > 3 mm and ≤ 5 mm. Here vertical movements indicate either positive (settlement), or negative (upward), to filter the movements that are below the survey stated precision of +/-2 mm. SP-11-3 and SP-11-5 at Dam 4B are the two instruments that show new settlement above the stated accuracy and require more careful monitoring for this period. All monuments show a total settlement since installation of 41 mm or less, although the survey data record suggests a pattern of continuing minor settlement in some instruments. To better assess the settlement data, plots of historical settlement have been prepared as Figures 5 to 7.

From the 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., 33 mm, and an incremental movement of 1.4 mm relative to 2022. This settlement point shows consistent minor downward displacement. This settlement point shows a pattern of annual downward displacement of about 2 to 3 mm per year since 2008. Historical data indicates that the total settlement since the installation of this settlement point in 1993 is in the order of 0.7 m and that the ongoing settlements are likely caused by secondary consolidation (KCB, 2011).
- SP-11-6 (berm), located in the center of the south half of Dam 2B, shows the maximum downward total displacement along Dam 2 (i.e., 16 mm). No historical data prior to 2011 exist for this monitoring point. The settlement point does not show a pattern of annual downward displacement, though 1.5 mm was observed since the 2022 survey, but this is within the stated accuracy.
- SP-11-3 (crest), located in the north-central part of Dam 4B, shows the maximum downward total displacement along Dam 4 (i.e., 41 mm), and a 5 mm increase since 2022. This settlement point shows a pattern of annual downward displacement of about 3 mm per year since 2011. No historical data exist for this monitoring point prior to 2011, the year it was installed.
- SP-7 at Dam 1A shows a pattern of year-over-year increase of elevation of the crest. This is inconsistent with the remainder of the instruments which show patterns of movement that are as expected, as shown on figure 5 after the text. This may suggest that SP-7 is subject to frost heave, which would in turn suggest that the installation is faulty. If frost heave is confirmed, that calls into question the reliability of all of the readings, since even a reading showing downward movement may actually be under-reporting the movement. If this trend continues, it may be required to replace this instrument. We note that SP-7 is located near the south end of Dam 1A where the embankment is very small and where the foundation conditions are either till or bedrock – so we would not expect ongoing movements.

The data suggest that minor consolidation settlement may be occurring in the foundations of embankments 1D and 4B. These embankments have the greatest thickness of foundation clays and silts, which are susceptible to secondary consolidation (creep). Consolidation settlements are normal under embankments. The measured values of settlement do not represent a dam safety concern, but annual monitoring should continue. It is noted that, whereas Dam 4B is experiencing minor settlements related to secondary compression, the overall settlement of the central part of this dam is in the order of 0.5 m, which means that the current crest elevation is less than the design intent. Hydrologic analysis (WSP, 2023) concludes that the remaining freeboard is greater than the expected high-water level in the event of an extreme rainfall event. Ongoing assessment of this settlement is being carried out to assess the potential impact of this settlement and to determine mitigation measures, if required.

4.3.2.2 Horizontal Movements

Table 4 above presents a summary of the total settlement and horizontal (lateral) 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. As recommended by the ITRB, a schematic downstream arrow has been added to the "point-of-origin" plots in Appendix D.

Point-of-origin plots in Appendix D show that the survey instruments exhibited horizontal movements within the range of annual variability and, in all cases, less than or equal to 14 mm from 2022 to 2023. The instrument which showed the largest incremental horizontal movement (14 mm) since 2022 was SP-11-6 at Dam 2B, but this was above the range of lateral displacements observed in the past years at that location and it is noted that the displacement is generally parallel to the crest of the dam – not specifically in a downstream direction. Such displacements have been recorded in the past at other locations and typically are corrected in the subsequent survey. For all monuments, the total horizontal displacements are less than or equal to 25 mm (SP-11-6 at Dam 2B).

Dam 1D, between the TSF and the polishing pond, presents the greatest total displacements (settlement, and horizontal towards the east), in its central part, compared to the other dams. However, displacements at Dam 1D remain low, with the exception of SP-2 that showed 12 mm movement relative to 2022, but in the upstream direction.

Overall, the observed movements are low and do not indicate continuous lateral progression, which suggests there is no significant embankment movement. The observed movements are not an issue of geotechnical concern.

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

4.3.3 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 2023 and includes the range and average over the 26 readings performed from April to September 2023.

Table 5: Measured Flow Rates at V-notch Weirs and Estimated Seepage Rates in 2023

Location	Dam	Flow (point measurements)
V-notch 1	2B	0.1 – 1.4 L/s (provided by Teck), average 0.22 L/s. Water was clear
V-notch 2	2B	0.4 – 1.8 L/s (provided by Teck), average 0.83 L/s. Water was clear
V-notch 3	1A	0.2 – 1.4 L/s (provided by Teck), average 0.39 L/s. Water was clear
V-notch 4	1C	0.6 – 4.8 L/s (provided by Teck), average 1.51 L/s. Water was clear

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 2023 were generally consistent with previous historical trends, except for the spring runoff. The seepage flows measured during 2023 from late April and May were above those measured during 2022. These high flows followed a heavy rainfall event that occurred over several days. These flows exceeded the TARP values and were equal to or greater than previous historic levels in the instruments.

The monitoring frequency was increased while the measurements were elevated, in accordance with the OMS guidance, and it was observed that the flows reduced back to normal or background levels within a few days of the rainfall event. While some sediments were mobilized during this event, the seepage water returned to a clear status quickly as the seepage rate reduced. After this rainfall event, the TARP values for these instruments were updated.

The sum of the measurable flows reflects both seepage from the dam and surface water runoff due to rainfall events and is likely affected by evaporation during the summer months. In order to better understand the variability of flows in the v-notch weirs, Figure 9 includes only data from September 2022 to September 2023 and is typical of an annual cycle of flow measurements. The spring freshet is noticeable between late April and late May. The months of July and August have the lowest recorded flows, and these likely underestimate seepage flows due to the contribution of evaporation. Flows during September, October and November are about 50% higher than summer flows, due to a combination of reduced evaporation and higher rainfall occurrence. Between December and March, the v-notch weirs are typically covered by snow and inaccessible. A few data points are registered when possible.

It is noted that some of the seepage flows from the embankments are not captured in the V-notch-weir network. Nonetheless, the seepage rates remain low and no pattern of increasing seepage flow is discernable (Figure 8). This is therefore considered to be within the expected range and does not indicate a dam safety concern. Two additional V-notch weirs are scheduled to be installed in 2024, one at Dam 2B and one at Dam 4B.

Other historic observation points of seepage noted during the TSF annual inspections over the years are identified by locations 1 to 18 and shown in Figure 1.

4.4 Pond and Discharge Water Quality

Water discharge quality is presented in the Louvicourt annual environmental report (*Suivi environnemental post-restauration*) submitted within 90 days of the start of each year to the *ministère de l'Environnement et Lutte contre les changements climatiques,* de la Faune et des Parcs *du Québec* (MELCCFP).

4.5 Site Observation Forms

The routine observation forms completed by the site field staff were reviewed by the EOR. Routine observation forms are provided to the RTFE and the EOR electronically and are regularly reviewed. Where issues are raised, they are noted and dealt with in a timely fashion. The quality and completeness of the routine observation forms are appropriate. No significant performance issues were identified with the structures as part of the regular observations.

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 the riprap protection layer. Dam height varies along the length of the alignment and ranges from zero (at outcrops) up to approximately 18 m in the deeper valleys of Dam 1 and 17 m for Dam 2. The upper upstream and downstream faces are typically sloped at 2.5H:1V and 2H: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 the elevation of 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 the elevation of 316.3 m (referred to as the first 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, between Dams 1D and 1E. The second emergency spillway has a single 5 m wide trapezoidal shaped concrete sill at the elevation of 316.5 m with 2H:1V side slopes. All of the flows through the overflow weir and either of the spillways report to the downstream polishing pond. It is noted that the second emergency spillway has never been put in service since its construction.

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 – it was designed to provide adequate freeboard during operations, when the polishing pond was operated at a much higher ponding elevation. Outflow from the polishing pond passes over aluminum stoplogs embedded into a concrete structure. The water level is currently controlled at a sill elevation of 307.2 m.

Information concerning the geology, stratigraphy, and groundwater conditions is presented in Golder’s design report (Golder, 1993). The tailings facility has not been raised since its original construction. More recently, in January 2020, a geotechnical instrumentation campaign including borehole drilling made it possible to collect additional information on the geotechnical conditions of the site (Golder, 2021a). Golder also prepared in 2020 a study on the characterization of the foundation materials at the TSF (Golder, 2020a) based on Golder’s design report (Golder 1993), to help consolidate the original design information and evaluate potential foundational failure modes and ongoing assessments for the TSF.

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

Inspection of the TSF is performed yearly as part of the facility performance report, and a Dam Safety Review (DSR) is performed every 5 years in conformance with CDA recommendations and Teck corporate guidelines. The site inspection for the 2020/2021 DSR was performed at the same time as the 2021 site inspection for the AFPR. The analysis and reporting for the 2021 DSR is currently being finalized.

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 17 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 17 piezometers, 2 thermistor strings, 4 V-notch weirs, and 19 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.

5.1.3 Polishing Pond Dam (Dam 4A and 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 the elevation of 306.54 m until 2018, and at a spillway elevation of 307.2 m since then. The total length of Dam 4 is 910 m, though this includes both Dams 4A and 4B, which are separated by the emergency spillway. Dam 4B is approximately 620 m in length, with a maximum height of 12.5 m.

Current instrumentation at the polishing pond consists of 6 piezometers, 1 observation well and 4 survey monuments located on the crest and toe berm of Dam 4B. No instruments exist in Dam 4A, which is a very low dike that only impounds water in extreme flood events. The locations of the instruments are shown in Figure 1.

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 (TSF), 6 m (Polishing Pond)
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 a 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, 2018), 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. Material parameters are being reviewed as part of the ongoing stability analysis.

5.1.7 Seismicity

The most recent assessment of the seismicity values for the site was performed by WSP in 2024 (WSP, 2024), and site-specific seismic shear wave velocity measurements were obtained in 2021. The evaluations were based on the 2020 version of the National Building Code of Canada and based on seismic source models developed for southeastern Canada by the Geological Survey of Canada for the 6th Generation Seismic Hazard Model of Canada (CanadaSHM6). The predicted peak ground accelerations (PGA) on hard rock (over 30 m below bedrock) at the corresponding return period are summarized in Table 8. Seismic design criteria are being reviewed in the ongoing update of the seismic hazard assessment for the site.

Table 8: Site Seismic Hazard Values from Site-Specific Seismic Hazard Assessment (WSP, 2024)

Structure	Return Period (Years)	PGA[1] (g)
Tailings Pond Dams	1 in 10,000	0.193
Polishing Pond Dam	1 in 2,475	0.099

Note: [1] For a bedrock V_{s30} of 1,853 m/s, the measured time average shear wave velocity on an outcrop downstream of Dam 1C.

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

As a required component of the AFPR, 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 15 and 16, 2023, 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. In granular materials, internal erosion can develop quickly, whereas in clayey materials, the process can be very slow.

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 presents measured flow rates. 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 at Dam 2B and 4B to augment the monitoring network and these are scheduled for installation in 2024.

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 that could threaten the integrity of the structures.

A potential trigger for internal erosion may occur in conjunction with an extreme rainfall event, resulting in very high ponded water levels. High water levels occurring in the presence of a damaged dam core (either by settlement, such as at Dam 4B, or by frost induced cracking of the core) could increase the potential for internal erosion, placing additional dependence on the graded chimney filter drain elements that are included in the construction of the dams. Dam 4A does not impound water; however, it could be subject to short-duration water ponding in a large rainfall event. Against such an eventuality, it is recommended that the removal of trees on this embankment be undertaken.

As with all structures at Louvicourt, the guidance is to remove any tree or shrub when the diameter of the trunk exceeds 50 mm.

Planned and Ongoing Studies

Ongoing or planned studies to analyze this potential failure mode for the facility 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 the 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 of 0.058 g 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's 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 of 0.20 g was used in a pseudo-static stability analysis. Results confirmed factors of safety slightly greater than unity for all dams when considering an effective stress approach. 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 (KCB, 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 did not meet current recommended guidelines in all areas. 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 contract and to have large portions liquefy under the 1:4,975-year 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. 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 and additional drilling was performed to validate foundation conditions in Dams 1D and 4B in 2022. There is also ongoing work to be concluded along with the revised site-specific seismic hazard work using stress-deformation modeling which is the state-of-practice for addressing undrained loadings and materials susceptible to liquefaction. This work is nearing completion.

Movement Monitoring Instrumentation

Detailed analysis of monitoring data is included in Section 4.3.

The *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 2022.
- Incremental settlements (2022 to 2023) were generally less than 3 mm (note the stated survey accuracy is 2 mm). The maximal incremental settlement was 5 mm for one instrument (SP-11-3) located on the crest of Dam 4B.
- SP-2 (crest), located in the center part of Dam 1D, shows the maximum downward total displacement along Dam 1, i.e., 33 mm, and an incremental movement of 1.4 mm relative to 2022. This settlement point shows a pattern of annual downward displacement of about 2 to 3 mm per year since 2008. Historical data indicates that the total settlement since installation of this settlement point in 1993 is in the order of 0.7 m and that the ongoing settlements are likely caused by secondary consolidation (KCB, 2011).
- SP-11-1, SP-11-3 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 largest total movement (settlement of 41 mm, since 2008) occurs at SP-11-3 located on Dam 4B. The magnitude of deformations indicated by the monitoring instrumentation is within accepted ranges and does not present a dam safety concern but does warrant continued monitoring as a best practice.
- SP-11-6 at Dam 2B’s berm showed a 14 mm horizontal shift in the 2023 survey. This movement is mostly parallel to the centreline of the dam (not downstream) and is similar to previous annual movements. This suggests that the movements are due to measurement error and will be validated in the next round of monitoring.
- SP-7 shows a pattern of year-over-year increase of elevation of the crest. This is inconsistent with the remainder of the instruments which show patterns of movement that are as expected. This may suggest that SP-7 is subject to frost heave, which would in turn suggest that the installation is faulty. If this trend continues, it may be required to replace this instrument.

- The other survey monuments present total settlements that have stabilized or are variable (minor up and down movements) through the years.
- None of the other 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 through 2023 was less pronounced than during previous years. No cracks were visible at the time of the 2023 annual inspection. 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 confirm that the risk from this failure mode is appropriately low are ongoing or planned and include:

- A reassessment of the stability of the TSF dams is ongoing.
- Thermistor data is being collected to assess frost penetration.

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. Both freeboards are relative to the crest of the dams; they are 1.0 m smaller when relative to the crest of the low permeability dam cores. Between November 2022 and September 2023, the minimum observed freeboard relative to the crest of the dams was 1.8 m for the tailings pond dams and 2.6 m for the polishing pond dams. It is noted that the polishing pond is operated at a significantly lower level than anticipated during the original design. Observed high water levels in both cases were 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 the wave run-up could reach an elevation less than or equal to 316.89 m in the TSF under normal and probable maximum flood (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 freeboard (> 3 m) was considered to be more than the guideline of CDA (2007) which is in the range of 2 m.

Golder (2021b) updated the previous estimates and proposed extreme flood water levels combined with wave run-ups for three separate scenarios:

- Historical climate conditions and with non-obstructed spillways.
- 20% increased rainstorm intensities (for climate change impact, based on a site-specific assessment) and unobstructed spillways.
- 20% increased rainstorm intensities (for climate change impact) and obstructed operational spillways.

For the purpose of the current management philosophy for the facility, only the first two scenarios are relevant, as a complete obstruction of operation spillway is considered to have an extremely low likelihood under Teck's active maintenance. Flood events ranging from a 2-year event to the probable maximum flood (summer and two spring events, as per CDA (2007) were studied. The study concluded that (quotation from Golder, 2021b):

- *Under historical climate conditions and with non-obstructed spillways, the combination of the maximum flood water level, the wind set-up and the wave run-up would not overtop any of the TSF or Polishing Pond dams for any of the studied scenarios. The TSF dams core elevations would be exceeded by up to 0.19 m depending on the dam during the PMF events combined with 2-Year wind speed effects. These exceedances are smaller than the magnitude of the wind effects, which means that the peak pond water levels would remain, in the absence of the wind effects, below the dam core elevations.*
- *Climate change drive increases to the intensities of extreme rainstorms increased the maximum water level for the different flood events by 0.02 m to 0.13 m for the TSF Pond and by 0.04 to 0.29 m for the Polishing Pond. The largest increases occur during a summer PMF. These increases do not change the conclusions of the previous paragraph as the results indicate no dam overtopping. PMF exceedances of the TSF dams core elevation increase to a maximum of 0.31 m, still entirely due to the magnitude of the wind effects.*

Instrumentation Data

The tailings pond water level was measured weekly via staff gauge during the open water season. In 2023, the recorded pond water levels varied between 316.0 m (0.1 m below the spillway invert) at the end of August to 316.2 m (0.1 m above the spillway invert) during the freshet month. Higher water levels are likely to have occurred during the spring months, but they were not captured by the weekly measurements for various reasons, including limited accessibility to the weirs and the intermittent nature of the measurements.

The polishing pond water level was measured weekly via staff gauge during the open water season. In 2023, the recorded pond water levels varied between 307.10 m (0.10 m below the spillway invert) at the end of the August to 307.38 m (0.18 m above the spillway invert) during the freshet month. As for the tailings pond, higher water levels are likely to have occurred during the spring months, but they were not captured by the weekly measurements.

For both ponds, the 2023 water levels respected the minimum required freeboards (see KCB, 2011, and Golder, 2021b).

Observed Performance

The water level within the tailings pond was 316.0 m during the site visit on September 15-16, 2023. 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 available freeboard in the Polishing Pond was greater than 3 m 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. Settlement of the crest of Dam 4B will be assessed in 2024 to validate the freeboard in the event of a long return rainfall event.

Planned and Ongoing Studies

Golder (2021b) determined that both the TSF pond and the polishing pond had adequate capacity to safely pass the PMF event, with significant contingency as long as the spillways are maintained free of obstructions. Teck has demonstrated diligence in the maintenance of the spillway structures. Re-survey of the dam crests will be undertaken periodically to verify the available freeboard and future actions may be required.

5.3 Review of Downstream and Upstream Conditions

The unnamed creek to the west of Dam 2B was operating at a significantly higher flow than in previous years (flow is not measured, but visual observation of flow through culverts supports higher flows); nonetheless, the creek remained at a distance of about 30 m from the toe of the dam, not perceptibly closer than in previous years. It is noted that the roadway across the unnamed creek has been breached due to erosion – which in turn was caused by beaver blockage of the culverts at this location. The maintenance of this roadway and culverts is not the responsibility of Teck; however, conditions at this location should be monitored.

Under current conditions erosion of the TSF embankments due to high levels within unnamed creek is not realistic. Otherwise, no changes to the overall conditions downstream of the tailings and polishing ponds have been reported to WSP, and observations made in the toe regions of the embankments support this conclusion. No changes to the watershed conditions have been reported to WSP.

5.4 Consequence of Failure

5.4.1 Teck Corporate Policy

Teck is committed to the safe and environmentally responsible management of tailings facilities throughout the mining life cycle to minimize harm to the environment and protect the health and safety of our people and surrounding Communities of Interest. This commitment includes the implementation of the Global Industry Standard on Tailings Management (GISTM) and industry-leading guidelines established by the International Council on Mining and Metals (ICMM), the Mining Association of Canada (MAC) and the Canadian Dam Association (CDA).

For the purpose of assigning a dam classification, the consequences of potential failure modes are assessed as per the CDA guidelines and the requirements of the jurisdictions in which Teck operates. The GISTM bases consequence classification on credible failure modes only. As part of Teck's commitment to the safety of tailings facilities, Teck has adopted evaluating their facilities against extreme loading criteria with a credible catastrophic flow failure mode, regardless of consequence classification. Risk assessments are performed for all tailings facilities, with the objective of reducing risks to As Low As Reasonably Practicable (ALARP). In some cases, this results in further risk reduction beyond applicable regulatory requirements and is consistent with the GISTM and industry-leading best practice.

5.4.2 Consequence of Failure Assessment

Teck undertakes consequence of failure assessments of its facilities according to the CDA guidelines (CDA, 2013). The consequence of failure was assessed as part of the 2015 DSR (SNC, 2017). The TSF was considered to have a consequence ranking of "Very High", based on environmental and cultural impacts of a dam breach, whereas the polishing pond was assigned a ranking of "Significant", based on population at risk and on environmental and cultural impacts.

5.4.3 Review

A new dam breach assessment has been completed for the Louvicourt TSF (WSP, 2024) to incorporate some changes in the state of practice in dam breach analysis. In this assessment, the consequence of failure assessment was reviewed. Notably, the environmental consequence classification used the new CDA guidance that was published in 2023 (CDA, 2023). As a result of this assessment, the TSF was considered to have a consequence classification of "High". The polishing pond dams were not reassessed and a ranking of "Significant" remains in force for this structure.

Teck has directed WSP 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. Future consequence evaluation 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, regular monitoring, and periodic maintenance in conformance with the OMS manual for the site. 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 6.4 presents the identified recommended actions in view of supporting the facility’s performance in the longer term. It is recommended that the outcome of the stability analyses at the TSF Dams 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 the operation of the ponds. Stop logs are added and removed at the polishing pond spillway as needed to control effluent pH, and caustic soda is added at the TSF on an as-needed basis, to control effluent pH. Improvements to the polishing pond spillway access for maintenance are being considered. Neither of these measures were applied in 2023.

5.7 OMS Manual Review

The OMS manual was updated in 2023. It is also reviewed annually. A further update of the OMS manual was completed in 2023 in collaboration between Teck and WSP, which is fully aligned with the MAC guidance on OMS manual best practices. Anticipated completion of the next update is Q2 of 2024.

5.8 Emergency Preparedness and Response Review

A Mine Emergency Response Plan (MERP) for the site was most recently updated in June 2023 in collaboration between Teck and WSP. The MERP incorporates response procedures for the tailings and polishing pond components with input from the EOR and has replaced the previous emergency preparedness and response plan. The MERP was activated twice in 2023, once in response to forest fires that limited access to the site and once in response to high flows in the v-notch weirs due to heavy spring rains. In both cases, the MERP provided a good guide to manage risk through these events.

6.0 SUMMARY AND RECOMMENDATIONS

6.1 Summary of Construction and Operation/Maintenance Activities

Additional access gates were installed around the site in 2023. Other than that, no construction activities were undertaken at the TSF. The maintenance and surveillance activities performed in 2022-2023 included the following:

- routine observations.

- survey of monuments.
- removal of vegetation and debris (beaver activity) in the TSF and polishing pond active spillway canals.
- removal of beaver obstructions downstream of the embankments.
- monitoring of piezometers, V-notch weirs and ponds water levels.
- continuing integration of new instrumentation network (pond-level loggers and data acquisition system).

6.2 Summary of Climate and Water Balance

The total precipitation over the hydrological year (November 2022 to October 2023) was 1026 mm or 13% higher than the long-term average of 907 mm. Based on the consolidated hydrology study for the Louvicourt site (Golder, 2021b), this corresponds to a 1:25-year to 1:50-year wet precipitation year.

Based on a high-level water balance analysis, it was estimated that 510,000 m^3 of water were 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. Some works, including options assessment, design analyses, earthworks and/or additional instrumentation may be required as an outcome of the ongoing stability reassessment. Minor works to be considered are summarized in Section 6.4. All actions recommended in Section 6.4 aim at obtaining a good long-term performance or improving the overall understanding of potential long-term stability issues.

6.4 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 2022 site visit. No significant changes were noted in the condition of the dams since the 2021 AFPR. Deficiencies and non-conformances noted during the annual inspections and their status are presented in Table 9. Table 10 provides a description of the priority levels.

Table 9: Status of Annual Facility Performance Inspection Key Recommended Actions

Structure	ID	Deficiency or Non-conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline/Status
Previous Recommendations Closed / Superseded						
General	2022-01	Gaps in the rain gauge records	*CDA 2013 Section 3.2*	Download the rain gauge records monthly during the open-water season and verify the data for equipment errors. Verify the equipment calibration	4	OMS updated. Closed in 2023.
TSF Spillway	2021-02	Beaver access under trash rack leading to increased activity in	OMS Manual Section 6.2	Survey trash rack and re-assess the adequacy of design and	3	Closed in 2024

Structure	ID	Deficiency or Non-conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline/Status
		spillway.		the hydraulic capacity.		
Previous Recommendations Ongoing						
All	2015-06	Perform a review of dam's seismic stability and undrained behaviour.	Directive 019 Section 2.9.3	Perform a review of dam's seismic stability and undrained behaviour of potentially contractive soils.	3	IN PROGRESS- Undrained stability analysis completed, and deformation analysis is in progress. Q1 2024.
Dam 1C	2021-04	Irregular slope on toe berm of Dam 1C leading to preferential infiltration.	CDA 2013 Section 3.5.3	Engage a detailed survey of this area and use the data to refine facility integrity analyses.	3	Survey completed in 2021. Data analysis is ongoing. Integrate into stability analysis. Q1 2024.
2023 Recommendations						
All	2023-01	Finalize the implementation of the remote data collection system for site instruments.	*CDA 2013 Section 3.2*	Work with the equipment supplier to replace non-functioning dataloggers.	2	Discussions with supplier have been initiated. Work to be completed after spring runoff. Q2 2024.
Dam 4A	2023-02	Remove trees and shrubs greater than 50 mm in diameter from the embankment.	*OMS Manual Section 5.2*	Engage a tree removal contractor and remove vegetation, in conjunction with second emergency spillway clearing	3	Q3 2024.
Dam 4B	2023-03	Investigate the benefit of adding a trash rack at the polishing pond spillway.	*CDA 2013 Section 3.6.4*	Assess the pros and cons of a trash rack at the polishing pond spillway. If there is benefit, implement a plan to design and construct trash rack.	4	Determine whether a trash rack is required and pending this evaluation, plan the design of such a structure. Q4 2024.
Dam 1E	2023-04	Remove vegetation from outlet channel of operational and first emergency spillway at the main TSF.	*CDA 2013 Section 3.5.5*	Remove debris immediately at the spillway outlet and to clear vegetation in the entire outlet channel to the polishing pond.	4	Undertake at the same time as vegetation removal in the second emergency spillway channel. Q3 2024.

Structure	ID	Deficiency or Non-conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline/Status
Dam 4B	2023-05	Dam crest settlement.	CDA 2013 Section 3.5.3	Resurvey dam profile to assess current condition and verify available freeboard.	3	Q2 2024.

CDA = Canadian Dam Association; OMS = Operations, Maintenance and Surveillance; TSF = tailings storage facility; QA/QC = quality assurance/quality control.

Table 10: 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.

CLOSURE

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

WSP Canada Inc.

Nicolas Pepin, Eng., M.Sc.A.
Senior Geotechnical Engineer

Vlad Rojanschi, P.Eng., Ph.D.
Water Resource Engineer

Laurent Gareau, Eng.
Senior Geotechnical Engineer

LGA/LG/NP/mb

STUDY LIMITATIONS

WSP Canada Inc. (WSP; formerly Golder Associates Ltd.) has prepared this document in a manner consistent with the level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, has been prepared by WSP for the sole benefit of Teck Resources Ltd. It represents WSP's professional judgment based on the knowledge and information available at the time of completion. WSP is not responsible for any unauthorized use or modification of this document. All third parties relying on this document do so at their own risk.

The factual data, interpretations, suggestions, recommendations, and opinions expressed in this document pertain to the specific project, site conditions, design objective, development and purpose described to WSP by Teck Resources Ltd. and are not applicable to any other project or site location. In order to properly understand the factual data, interpretations, suggestions, recommendations, and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings, and other documents contained herein, as well as all electronic media prepared by WSP are considered its professional work product and shall remain the copyright property of WSP. Teck Resources Ltd. may make copies of the document in such quantities as are reasonably necessary for those parties conducting business specifically related to the subject of this document or in support of or in response to regulatory inquiries and proceedings. Electronic media is susceptible to unauthorized modification, deterioration, and incompatibility and therefore no party can rely solely on the electronic media versions of this document.

REFERENCES

CDA (Canadian Dam Association) 2007. *Dam Safety Guidelines*. Original dated 2007.

CDA (Canadian Dam Association) 2013. *Dam Safety Guidelines*. Original dated 2007, Revised 2013.

CDA (Canadian Dam Association) 2023. Revision to CDA Dam Safety Guidelines: Environmental Consequence Classification Procedures for Mining Dams. June 2023.

ICMM (International Council on Mining and Metals) 2020. *Global Industry Standard on Tailings Management* (GISTM). Published August 2020.

Golder Associés. 1993. *Rapport de conception, Parc à résidus, Project Louvicourt,* Volumes 1 et 2, projet 921-7025E, January 1993.

Golder (Golder Associates Ltd). 2013. *Liquefaction Potential Assessment for Louvicourt Mine Tailings Management Facility Dams, Val-d'Or,* Quebec, Canada, project 12-1118-0045, draft version issued on July 9, 2013.

Golder 2015. *Site Visit Summary – Louvicourt Tailings Facility, Technical Memo* 07-1227-3006-002-TM-Rev0-5200.

Golder 2018. *Update to tailings design criteria for the Louvicourt tailings storage facility (TSF),* project 18111951, November 2018.

Golder 2019. *Site-Specific Seismic Hazard Assessment,* project 18110953, draft version issued January 2019.

Golder 2020a. *DRAFT*. *Regional Geology Review & Foundation Characterization Report,* project 18111951, November 2020.

Golder 2021a. *DRAFT*. *Geotechnical Instrumentation - Tailings Storage Facility and Polishing Pond,* project 19123222, October 2021.

Golder 2021b. *Consolidated Hydrological Report. Louvicourt Site,* project 18108588, November 2021

Golder 2023. *Louvicourt Mine Tailings Storage Facility and Polishing Pond - Tailings Storage Facility Annual Facility Performance Assessment - 2021,* project 22521237, March 2023.

Golder 2023b. Geotechnical Instrumentaion – Tailings stoage facility and polishing pond. 001-19123222-Rev0. April 24, 2023.

KCB (Klohn Crippen Berger) 2011. *Louvicourt Tailings Facility 2010 Dam Safety Review, Report* M09682A01, Final report, January 2011.

MELCCFP (Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques), *Directive 019 sur l'industrie minière,* March 2012

MRNFand MELCCFP (Ministère des Ressources naturelles et des Forêts du Québec et Ministère de l'Environnement, de la Lutte contre les Changements climatiques, de la Faune et des Parcs), 2022. *Guide de préparation du plan de réaménagement et de restauration des sites miniers au Québec*. Available online only. Guide sur la restauration minière - Ministère des Ressources naturelles et des Forêts (gouv.qc.ca) , ISBN 978-2-550-92682-5 (PDF)

MAC (Mining Association of Canada), 2021. *Developing an Operation, Maintenance, and Surveillance Manual for Tailings and Water Management Facilities*. Version 2.1. March 2021.

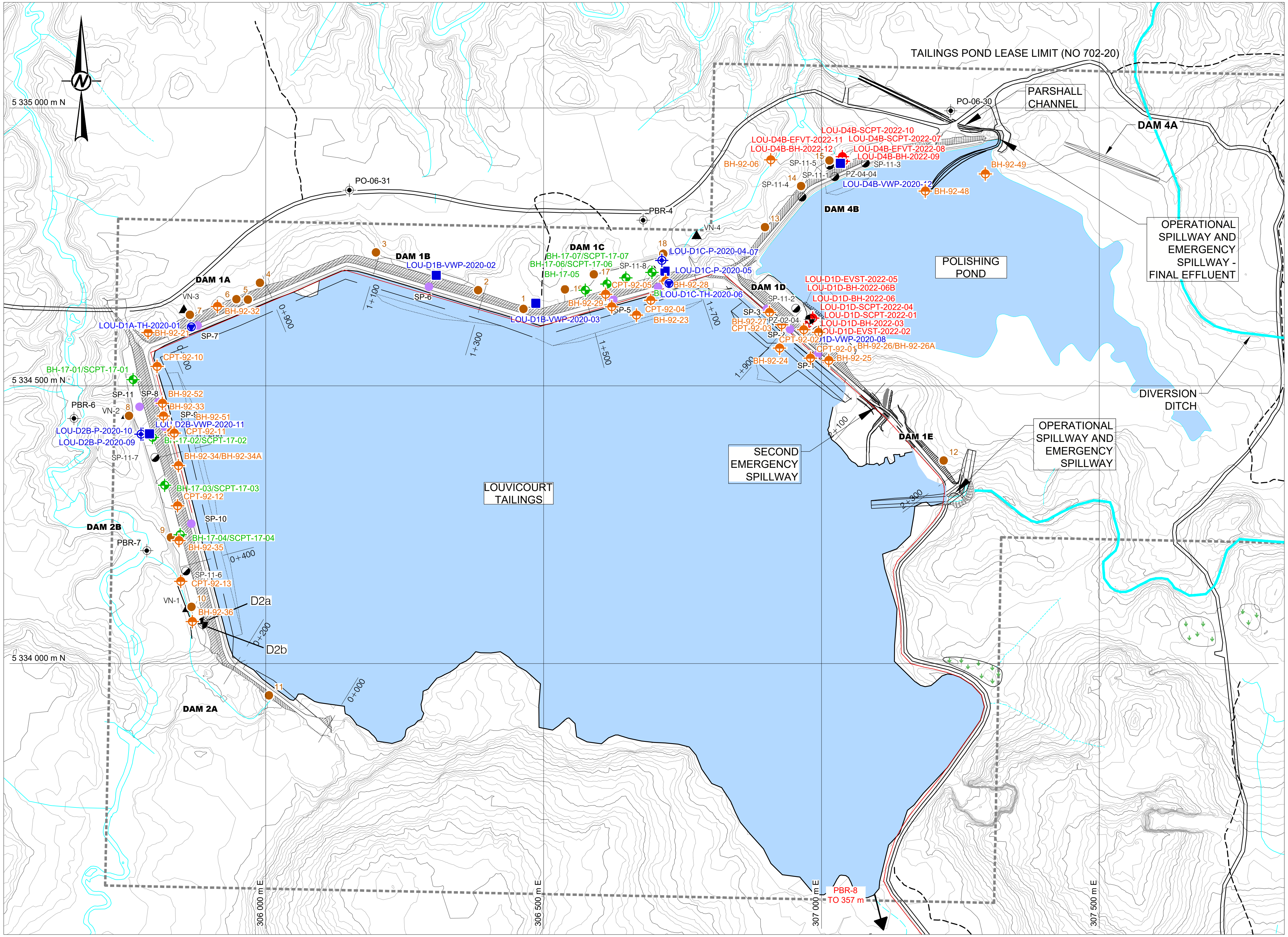
SNC-Lavalin 2005. *Dam Safety Review Louvicourt Tailings Facility*, File M-6837-1 (603562), January 2005.

Teck, 2019 Guideline for Tailings and Water Retaining Structures. Edition No.2, Teck Resources Ltd, January 2019.

WSP Canada inc. 2023. Louvicourt Tailings Storage Facility Water Balance Model. Teck Resources Ltd. Report no. 06-2140062-2023-RA-RevB. July 2023.

WSP 2024. Site-Specific Seismic Hazard Assessment, Louvicourt Mine Tailings Management Facility. 006-21494974.5000-Rev0, January 15, 2024 (Final report-Rev0).

Figures



LÉGENDE

- SOUNDING 2022 (BH, SCPT, eVST)
- SOUNDING 2020 (TH, PO, VWP)
- SOUNDING 2017 (BH, SCPT)
- SOUNDING 1992 (BH, CPT)
- SETTLEMENT POINT (GOLDER, 2011)
- SETTLEMENT POINT
- SEEPAGE AREA
- CPT, SCPT, eVST, BOREHOLE (BH)
- OBSERVATION WELLS (PO)
- PIEZOMETER
- VIBRATING WIRE PIEZOMETER (VWP)
- SEUIL DE MESURE EN V
- THERMISTOR STRING (TH)
- FORMER TAILINGS PIPELINE

NOTES

1. COORDINATE SYSTEM : UTM NAD83 ZONE 18.

REFERENCES

1. TOPOGRAPHY : LIDAR (24 JULY 2018) PROVIDED BY THE CLIENT.

CONFIDENTIAL

0 125 250
1:7 500 METRES

CLIENT
TECK
MINE LOUVICOURT

CONSULTANT

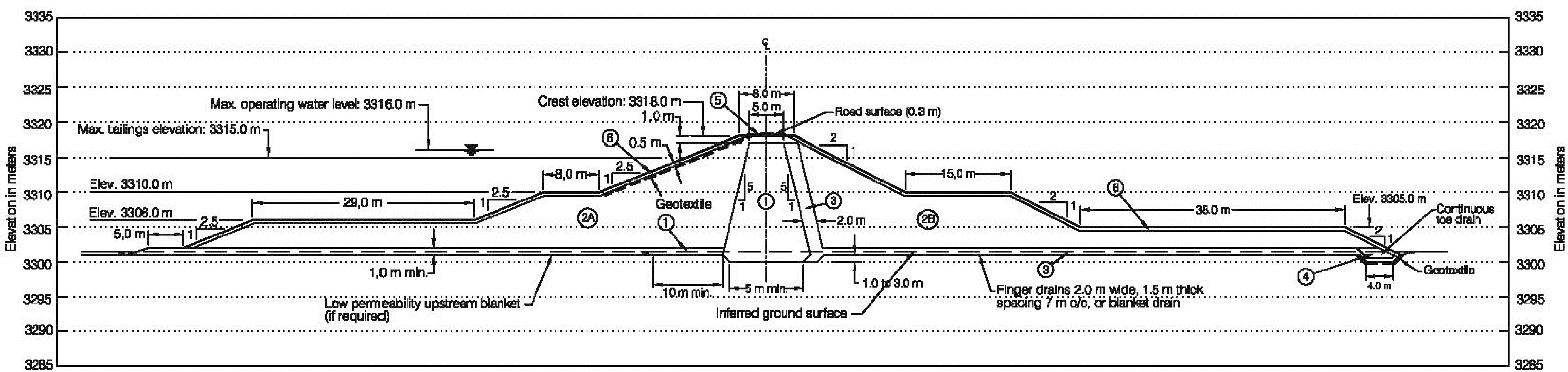
YYYY-MM-DD	2024-03-18
DESIGNED	C. Pachis
PREPARED	M. Brenner
REVIEWED	N. Pépin
APPROVED	L. Gareau

PROJECT
LOUVICOURT MINE TAILING AND POLISHING PONDS - TAILINGS STORAGE FACILITY ANNUAL INSPECTION 2023

TITLE
GENERAL SITE PLAN

PROJECT NO.	PHASE	REV.	FIGURE
CA0007154.2774	2005	0	1

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



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

CONFIDENTIAL

CLIENT
TECK
MINE LOUVICOURT

PROJECT
LOUVICOURT MINE TAILING AND POLISHING PONDS -
TAILINGS STORAGE FACILITY ANNUAL INSPECTION 2023

CONSULTANT

wsp

YYYY-MM-DD	2024-03-18
DESIGNED	C. Pachis
PREPARED	M. Brenner
REVIEWED	N. Pépin
APPROVED	L. Gareau

TITLE
TYPICAL DIKE CROSS-SECTION

PROJECT NO.	PHASE	REV.	FIGURE
CA0007154.2774	2005	0	2

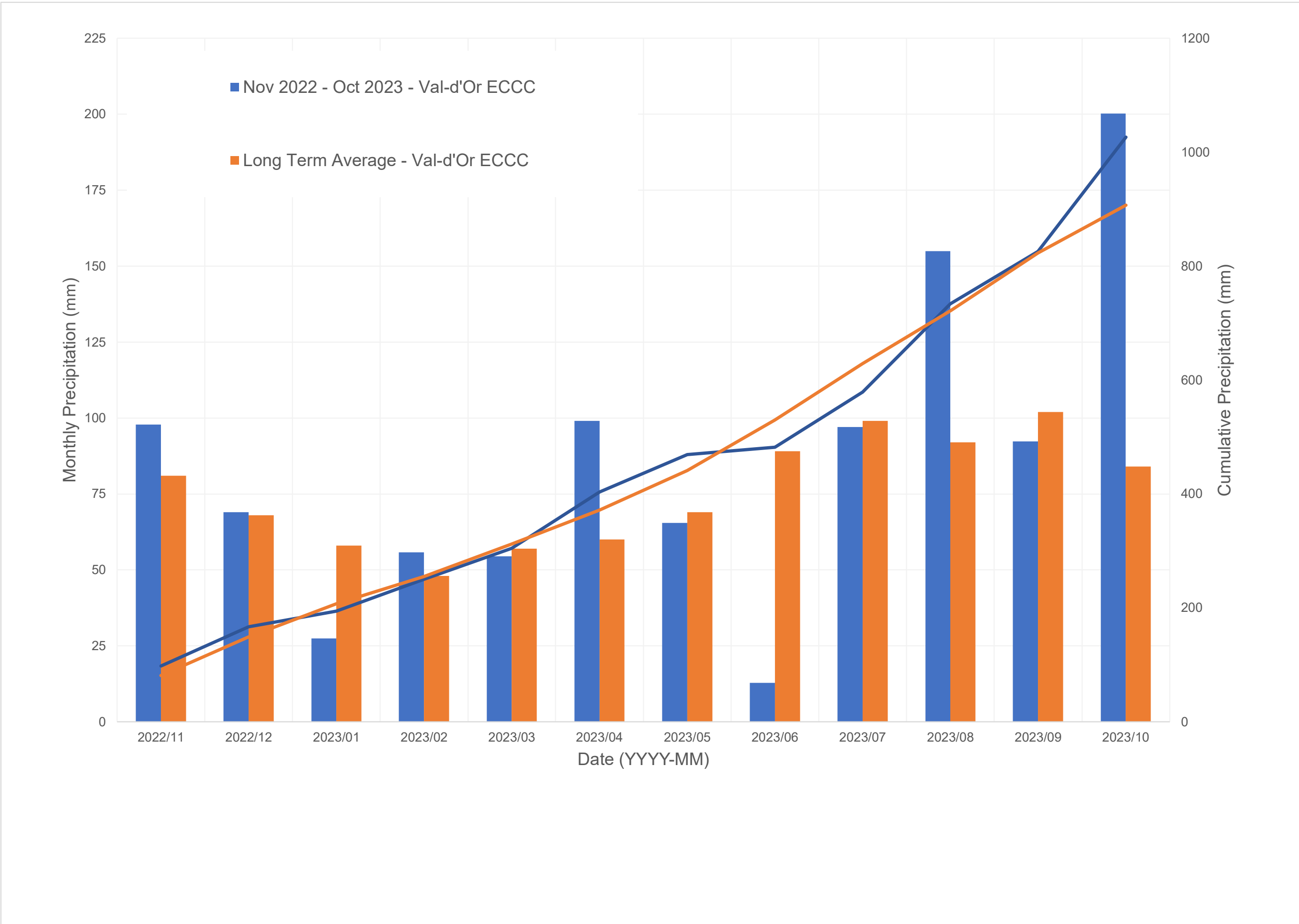
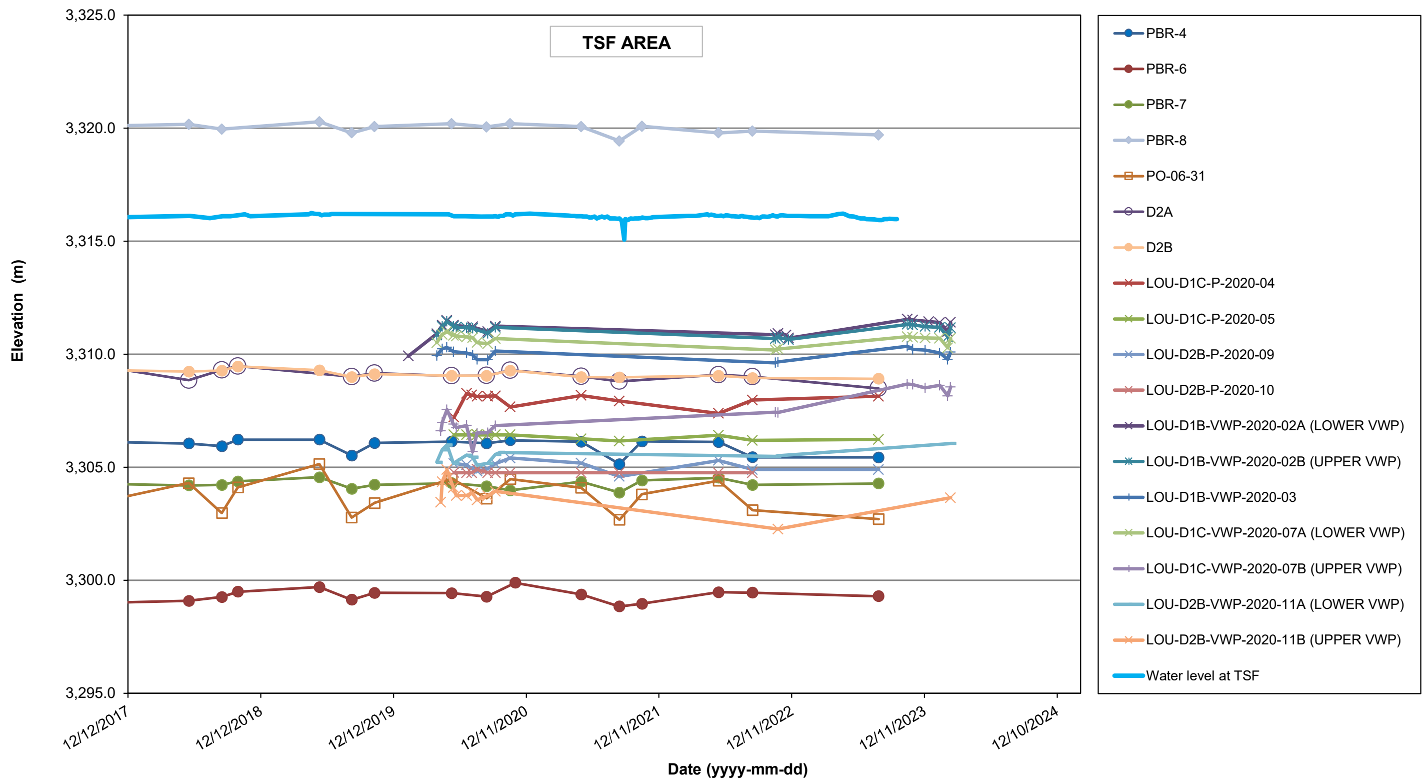
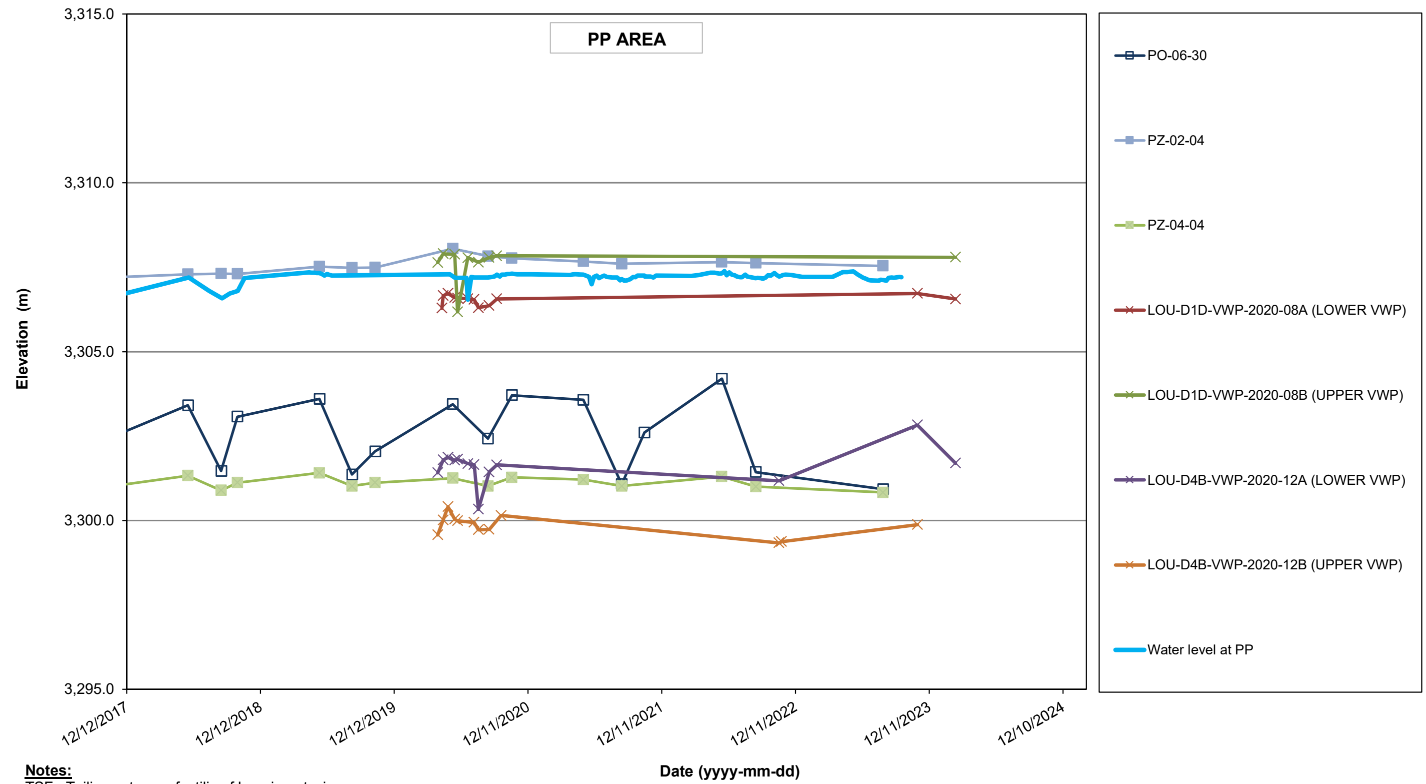


Figure 3: Monthly Precipitation Data from November 2022 to October 2023





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

Tailings Storage Facility Annual Facility Performance Assessment - 2023	**Water level measurements - piezometers (provided by Teck)**	
Louvicourt TSF **Teck Resources Ltd**	PROJECT NO.	CA0007154.2774-2000
	REV	0
	FIGURE	**4**

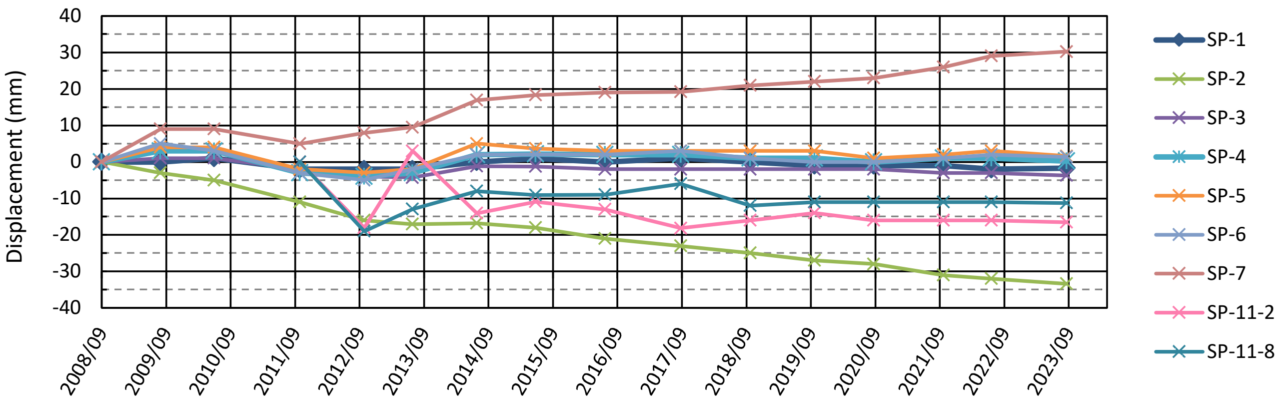


Figure 5 : Vertical Displacement of the Survey Monuments at Dam 1

0 Line indicates soil level at intial baseline survey

Negative displacements are settlement, positive are upward displacement

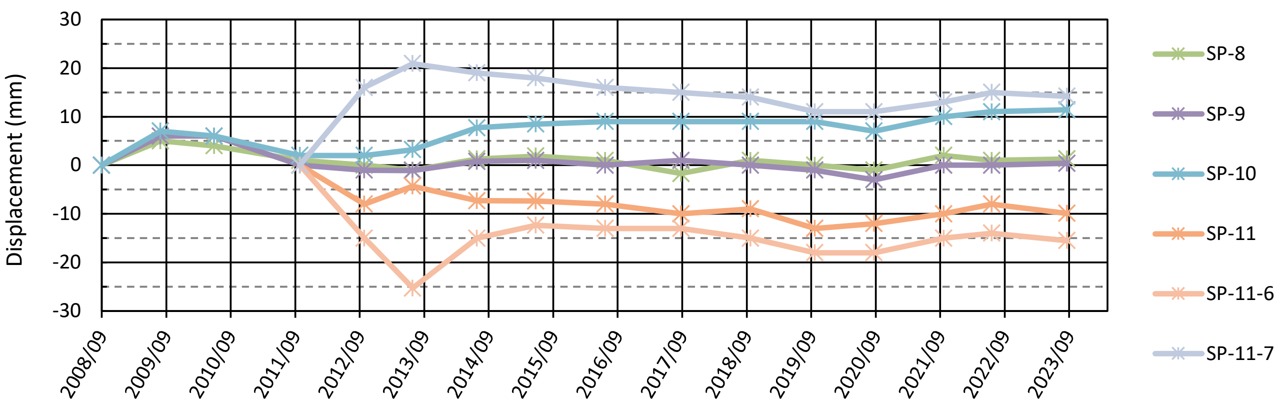


Figure 6 : Vertical Displacement of the Survey Monuments at Dam 2

0 Line indicates soil level at intial baseline survey

Negative displacements are settlement, positive are upward displacement

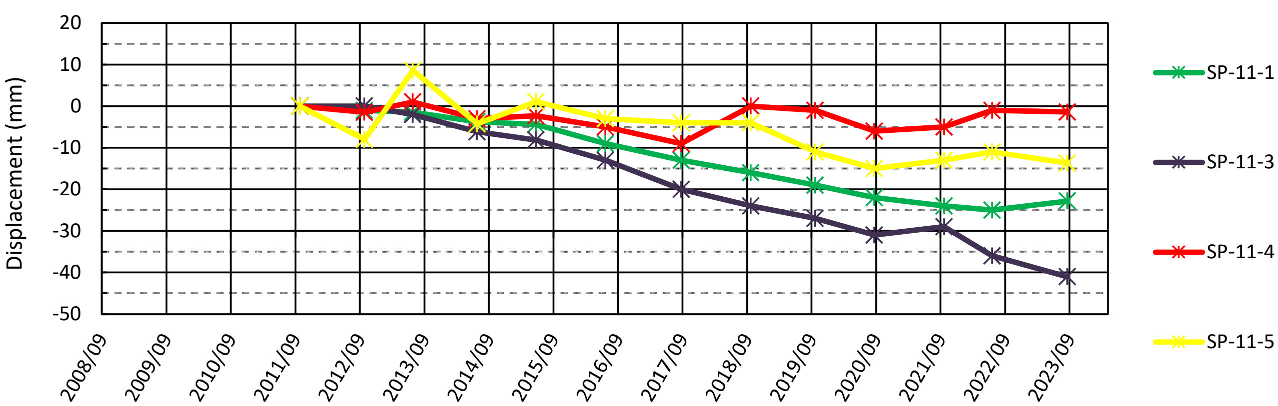
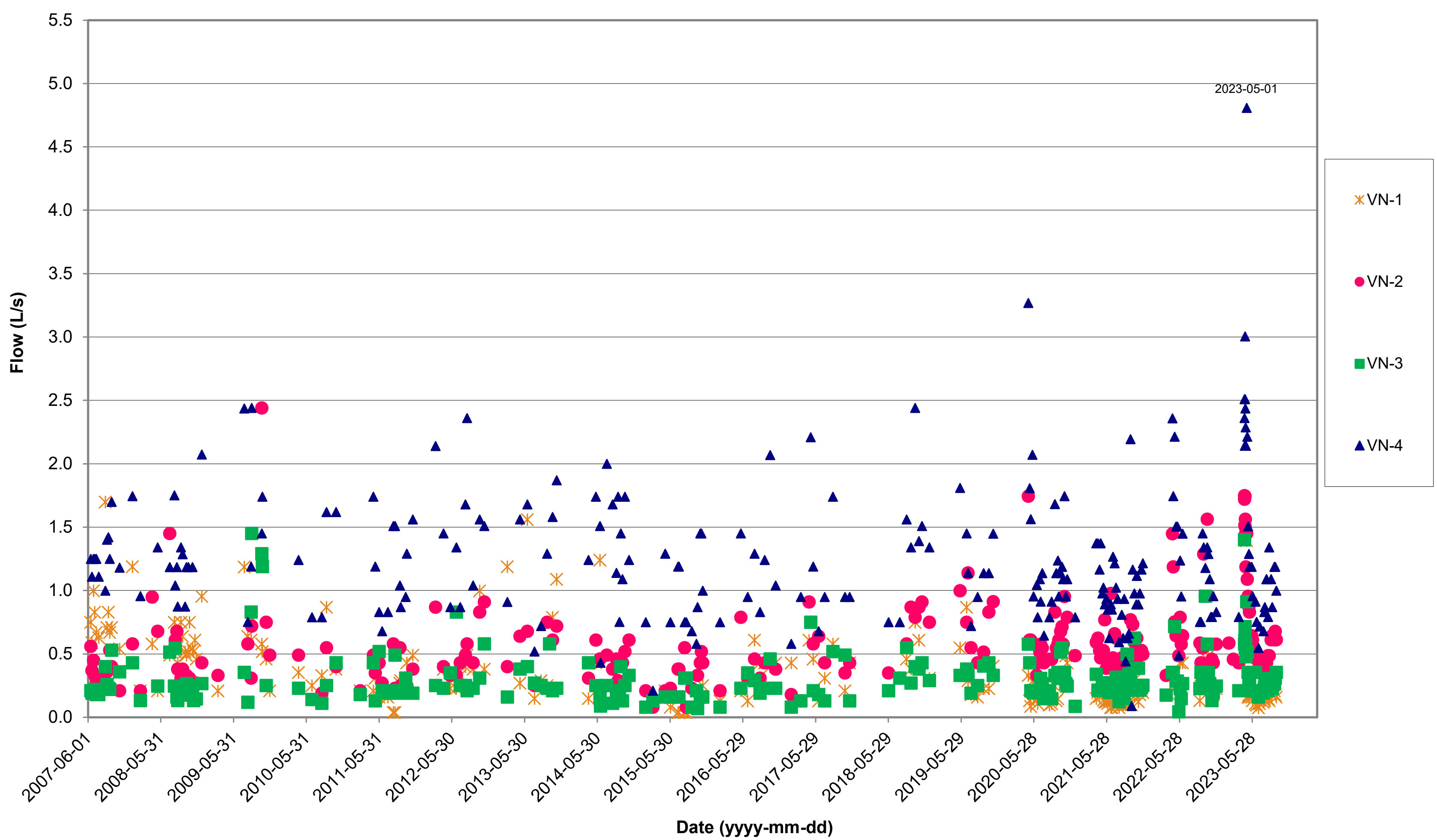


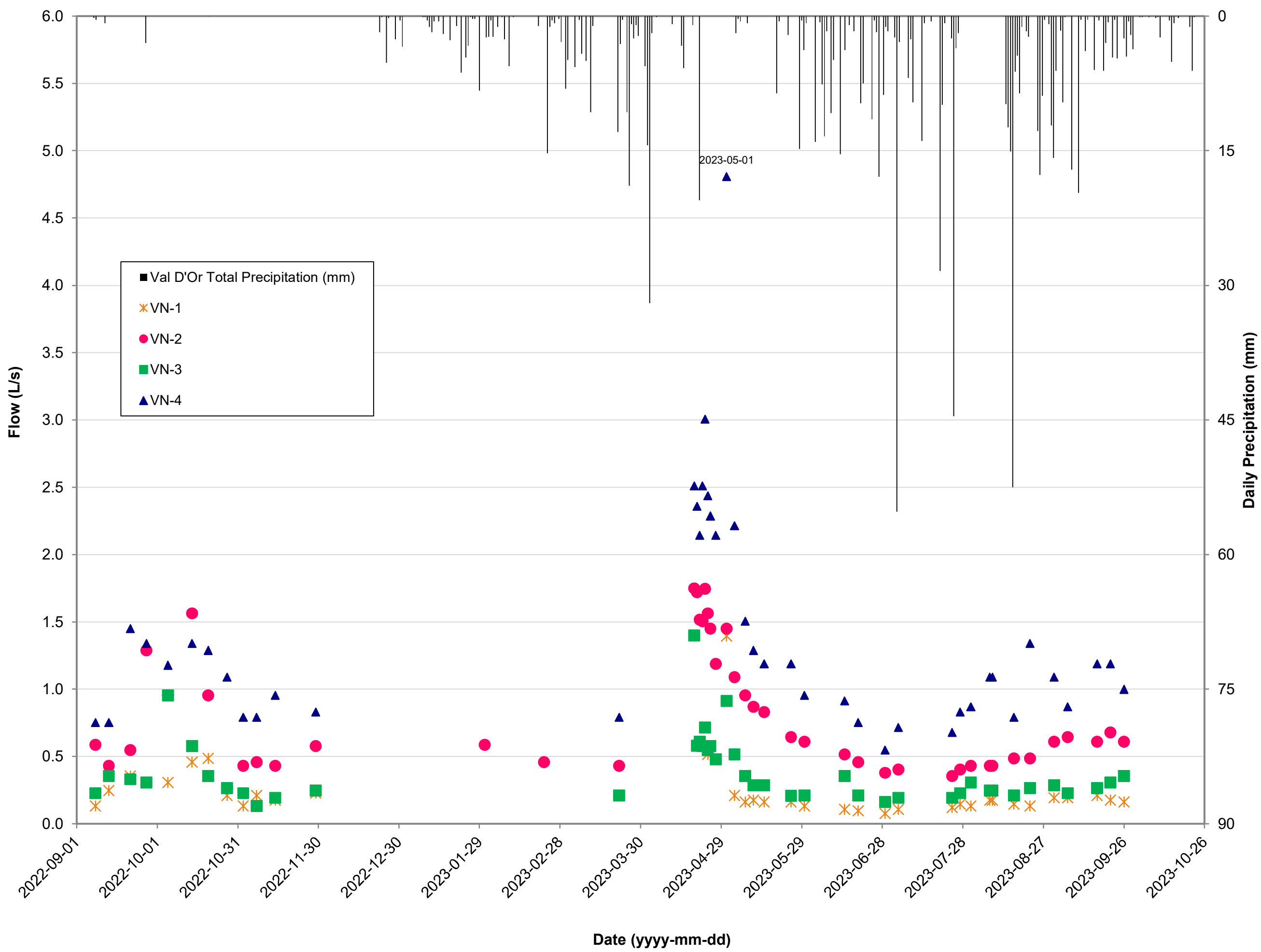
Figure 7 : Vertical Displacement of the Survey Monuments at Dam 4

0 Line indicates soil level at intial baseline survey

Negative disp positive = upward displacement, negative=settlement



Tailings Storage Facility Annual Facility Performance Assessment - 2023	Louvicourt Mine Tailings Pond - historical trend of seepage flow measured at the V-notch weirs (data provided by Teck)	
Louvicourt TSF Teck Resources Ltd	PROJECT NO.	CA0007154.2774
	REV	0
	FIGURE	8



Tailings Storage Facility Annual Facility Performance Assessment - 2023	**Louvicourt Mine Tailings Pond - 2022-2023 trend of seepage flow measured at the V-notch weirs (data provided by Teck), with Val D'Or station 7098605 daily precipitation**	
Louvicourt TSF Teck Resources Ltd	PROJECT NO.	CA0007154.2774
	REV	0
	FIGURE	**9**

APPENDIX A

Facility Data Sheet

FACILITY DATA SHEET
MINE TSF AND POLISHING POND DAMS

Dam 1

Dam Type	Till core, rock shell
Maximum Dam Height	18 m
Dam Crest Width	8 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)
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	17 m
Dam Crest Width	8 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)
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

Dam Type	Till core, rock shell
Maximum Dam Height	12.5 m
Dam Crest Width	6 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)
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

Photo 1 : Dams 1D – View of the upstream slope with riprap replaced.

Photo 3 : Ponded water with little to now observable flow at toe of Dam 1C. Similar flows occur on Dams 1A and 1B.

Photo 2 : Dams 1D – View of the upstream slope with riprap replaced. traffic gravel was placed on the crest.

Photo 4 : Tree removal process resulting in ponded water at the toe of dam 1C

Photo 5 : Area of ponded water at the toe of Dam 1C, due to disturbance by tree removal equipment.

Photo 7 : View of downstream channel of second emergency spillway. Vegetation was controlled in 2022 and will require management in future.

Photo 6 : Concrete weir of the second emergency spillway between Dams 1D and 1E at the TSF with approach channel in background. Good condition.

Photo 8 : General view of the site access bridge. Unchanged from 2022.

Photo 9 : Dam 1B - Minor crest erosion features will require maintenance in future.

Photo 11 : Downstream slope of Dam 1B. Note trees have been removed for ease of access.

Photo 10 : Erosion features that have been infilled on the downstream shoulder of Dam 1E.

Photo 12 : Dam 2A - Stagnant water at toe of Dam 2B.

Photo 13 : Unnamed Creek to the west of Dam 2B. Access road fill has been breached due to beaver blockage of culverts immediately to the west.

Photo 15 : Main spillway at Dam 4B - Significant debris observed during the 2022 inspection has been removed

Photo 14 : Trees are continuing to encroach on the side slopes and crest of the Dam 4A embankment

Photo 16 : outflow channel from the spillway to the Parshall flume contains significant vegetation

Photo 17 : Culverts at the final effluent point were clear although some limited vegetation is present upstream

Photo 19 : Beaver activity historically observed at the toe of Dam 4B is not actively occurring. Continued monitoring is required.

Photo 18 : Dam 4B Crest unchanged from 2022.

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
EN 2023

MINE LOUVICOURT
TECK RESOURCES LIMITED

CANTON LOUVICOURT

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

CORRIVEAU J.L. & ASSOCIÉS. INC

C-16695/965

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 Fernando Zarate 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 cinq (5) autres points d'appui secondaires servent 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.

Cette année, en 2023, nous avons installé le nouveau point permanent **JLC2023-1**, un repère ancré dans le roc. Ce dernier, situer près du point existant 94-257, servira à la fois de point de contrôle et de sécurité en cas de dommage au point de référence principal.

La deuxième partie des travaux consistait à faire le cheminement vertical avec un niveau géométrique électronique de haute précision et une mire code-barres en fibre de verre 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 onze (11) cheminements en boucle obtenant des écarts de fermeture de 0.3mm, 0.1mm, 0.1mm, 0.5mm, 0.4mm, 0.7mm, 0.5mm, 0.1mm, 0.2mm, 0.5mm et 0.3mm.

Le premier cheminement en boucle s'étend sur une distance totale (incluant aller et retour) de 520m entre le repère **94-257** et le moniteur **B-1** avec une erreur de fermeture de 0.1mm. Le deuxième cheminement en boucle s'étend sur une distance de 672m totale (incluant aller et retour) entre le repère **94-257** et le moniteur **JLC-2011-3** avec une erreur de fermeture de 0.3mm. Le troisième cheminement en boucle s'étend sur une distance totale (incluant aller et retour) de 1114m entre le repère **94-257** et le moniteur **B-6** avec une erreur de fermeture de 0.7mm. Le quatrième cheminement en boucle s'étend sur une distance totale (incluant aller et retour) de 258m entre le point d'appui **94-257 et** le repère **JLC-2011-8** avec une erreur de fermeture globale de 0.3mm. Le cinquième cheminement liant le moniteur **B6** (départ) et le moniteur **B7** (arrivée) s'étend sur une distance totale (incluant aller et retour) de 889m avec une erreur de fermeture globale de 0.5mm. Le sixième cheminement liant le moniteur **B7** (départ) et le moniteur **B10** (arrivée) s'étend sur une distance totale (incluant aller et retour) de 849m avec une erreur de fermeture globale de 0.1mm. Le septième cheminement liant le moniteur **B10** (départ) et le point d'appui **94-263** (arrivée) s'étend sur une distance totale (incluant aller et retour) de 656m avec une erreur de fermeture globale de 0.2mm. Le huitième cheminement liant le point d'appui **94-262** (départ) et le moniteur **B11** (arrivée) s'étend sur une distance totale (incluant aller et retour) de 1001m avec une erreur de fermeture globale de 0.5mm. L'élévation de départ du point d'appui **94-262** est celle obtenue du nivellement d'octobre 2021, soit 3315.42m. Le neuvième cheminement liant le moniteur **B1** (départ) et le moniteur **JLC-2011-2** (arrivée) s'étend sur une distance totale (incluant aller et retour) de 752m avec une erreur de fermeture globale de 0.5mm. Le dixième 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 153m avec une erreur de fermeture globale de 0.1mm. Finalement, le dixième cheminement liant le moniteur **B1** (départ) et le moniteur **94-256** (arrivée) s'étend sur une distance totale (incluant aller et retour) de 442m avec une erreur de fermeture globale de 0.4mm. 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 a 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 la précision est d'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 des digues. Nous avons compensé les cheminements aller-retour même si l'erreur de fermeture des boucles n'était que de quelques fractions de millimètre et n'avait que peu d'incidence significative sur le résultat obtenu.

5) GÉNÉRALITÉS :

Les travaux ont été effectués les 22, 26, 27, 28 et 29 septembre 2023 et le 5 octobre 2023 par une équipe de trois hommes. Les travaux ont été supervisés par Jean-Luc Corriveau, arpenteur-géomètre.

Instruments utilisés :

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

- 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.

6) REMARQUES:

Positionnement GPS

Le levé par GPS des plaques de tassement montre que les positions de ces dernières sont stables dans le temps et que les écarts mesurés sont dans les limites de la tolérance de la méthode de mesure par GPS utilisée pour cette étude, soit une précision de 1 à 2 cm en planimétrie.

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

Nivellement

Suite au levé effectué en **2021**, on remarque que l'élévation de l'ensemble des plaques de tassement est stable hormis certaines dont **B-2**, **JLC-2011-1** et qui semblent s'enfoncer, alors que **B-7** s'élève légèrement confirmant la tendance déjà observée lors des années précédentes en ce point.

Suite au levé effectué en **2022**, on remarque que l'élévation de l'ensemble des plaques de tassement est stable hormis certaines dont **B-2**, **JLC-2011-1 et JLC-2011-3,** et qui semblent s'enfoncer, alors que **B-7** s'élève légèrement confirmant la tendance déjà observée lors des années précédentes en ces points. Cependant ces écarts sont très faibles, soit de l'ordre de quelques millimètres.

Suite au levé effectué en **2023**, on remarque que l'élévation de l'ensemble des plaques de tassement est stable hormis certaines dont **B-2** et de manière plus importante **JLC-2011-3** qui semblent lentement s'enfoncer, alors que **B-7** s'élève légèrement confirmant la tendance déjà observée lors des années précédentes en ces points. Cependant ces écarts restent faibles, soit de l'ordre de quelques millimètres.

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
Contrôle 1	Terrain 2010	5333567.016	222891.730	311.661
	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
	Terrain 2021	5333567.014	222891.729	311.680
	Terrain 2022	5333567.019	222891.733	311.672
	Terrain 2023	5333567.022	222891.726	311.680
	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
	Diff. Théo-2021	-0.060	0.000	-0.003
	Diff. Théo-2022	-0.065	-0.004	0.005
	Diff. Théo-2023	-0.068	0.003	-0.003
	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
	2021-2020	-0.006	-0.005	-0.008
	2022-2021	0.005	0.004	-0.008
	2023-2022	0.003	-0.007	0.008

94-256**	Théorique*	5333408.957	223515.007	317.777
Contrôle 2	Terrain 2010	5333408.888	223514.937	317.774
	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
	Terrain 2021	5333408.896	223514.934	317.788
	Terrain 2022	5333408.903	223514.928	317.788
	Terrain 2023	5333408.894	223514.930	317.802
	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
	Diff. Théo-2021	0.061	0.073	-0.011
	Diff. Théo-2022	0.054	0.080	-0.011
	Diff. Théo-2023	0.063	0.077	-0.025
	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
	2021-2020	-0.004	0.008	0.021
	2022-2021	0.008	-0.007	0.000
	2023-2022	-0.009	0.002	0.014

94-260**	Théorique*	5333495.201	222157.718	312.345
Contrôle 3	Terrain 2010	5333495.447	222157.739	312.333
	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
	Terrain 2021	5333495.440	222157.731	312.366
	Terrain 2022	5333495.455	222157.737	312.377
	Terrain 2023	5333495.439	222157.730	312.346
	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
	Diff. Théo-2021	-0.239	-0.013	-0.020
	Diff. Théo-2022	-0.254	-0.019	-0.032
	Diff. Théo-2023	-0.238	-0.012	-0.001
	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
	2021-2020	-0.008	-0.002	0.018
	2022-2021	0.015	0.005	0.011
	2023-2022	-0.016	-0.006	-0.031

Numéro		NORD (m)	EST (m)	ALTITUDE (m)***
94-262**	Théorique*	5332897.066	222292.513	315.842
Contrôle 4	Terrain 2010	5332897.303	222292.387	315.827
	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
	Terrain 2021	5332897.304	222292.392	315.852
	Terrain 2022	5332897.313	222292.392	315.868
	Terrain 2023	5332897.288	222292.379	315.868
	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
	Diff. Théo-2021	-0.238	0.121	-0.010
	Diff. Théo-2022	-0.247	0.121	-0.026
	Diff. Théo-2023	-0.222	0.134	-0.026
	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
	2021-2020	-0.006	0.007	-0.013
	2022-2021	0.009	0.000	0.016
	2023-2022	-0.025	-0.013	0.000

94-263**	Théorique*	5332858.918	222355.630	317.471
Contrôle 5	Terrain 2010	5332859.145	222355.493	317.465
	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
	Terrain 2021	5332859.138	222355.494	317.478
	Terrain 2022	5332859.116	222355.469	317.523
	Terrain 2023	5332859.159	222355.491	317.518
	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
	Diff. Théo-2021	-0.220	0.136	-0.007
	Diff. Théo-2022	-0.198	0.161	-0.052
	Diff. Théo-2023	-0.241	0.139	-0.047
	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
	2018-2017	-	-	-
	2019-2017	0.001	0.000	-0.047
	2020-2019	0.006	0.000	0.010
	2021-2020	-0.004	0.006	-0.009
	2022-2021	-0.021	-0.026	0.045
	2023-2022	0.043	0.022	-0.005

- **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 précision.

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 :	6.949 Km

Fait à Val d'Or, le 8 novembre 2023, sous le dossier C-16695/965 et le numéro C-16640 de mes minutes en référence aux dossiers : C-16117/817 (2022), C-15686/817 (2021), C-15304/817 (2020), 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 8 novembre 2023

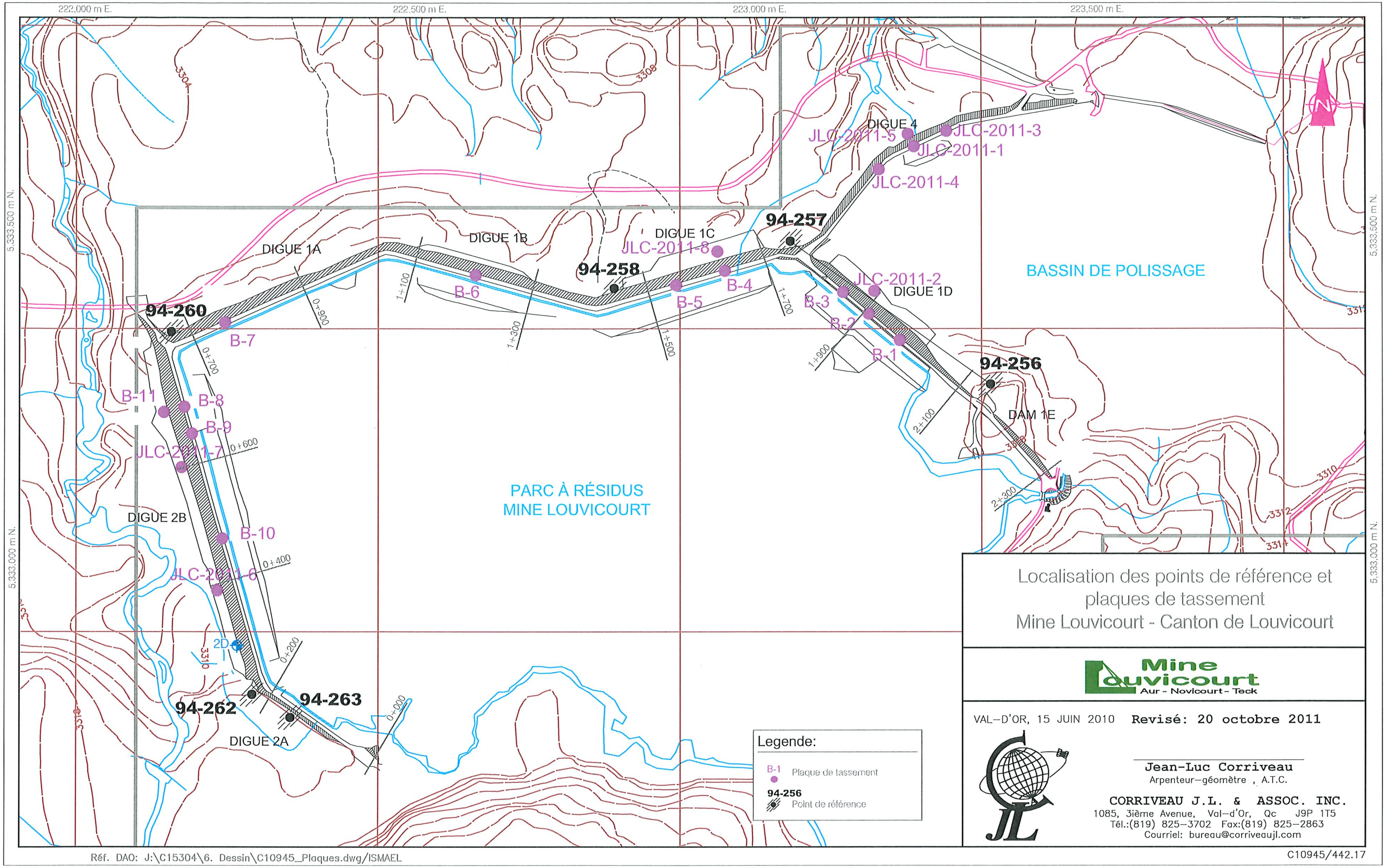
Jean-Luc Corriveau, A.-G., A.T.C.
CORRIVEAU J.L. & ASSOC. INC.

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.



222,000 m E.
222,500 m E.
223,000 m E.
223,500 m E.
5,333,500 m N.
5,333,000 m N.
3304
3308
3310
3312
3314
3318
DIGUE 4
JLC-2011-5
JLC-2011-3
JLC-2011-1
JLC-2011-4
94-257
DIGUE 1A
DIGUE 1B
DIGUE 1C
JLC-2011-8
94-258
B-4
B-5
B-6
JLC-2011-2
DIGUE 1D
B-3
B-2
B-1
BASSIN DE POLISSAGE
94-260
B-7
0+900
1+100
1+300
1+500
1+700
1+900
0+700
94-256
DAM 1E
2+100
2+300
B-11
B-8
B-9
JLC-2011-7
0+600
PARC À RÉSIDUS
MINE LOUVICOURT
DIGUE 2B
B-10
0+400
JLC-2011-6
2D
0+200
94-263
94-262
0+000
DIGUE 2A
Legende:
B-1 Plaque de tassement
94-256 Point de référence
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
Arpenteur-géomètre , A.T.C.
CORRIVEAU J.L. & ASSOC. INC.
1085, 3ième Avenue, Val-d'Or, Qc J9P 1T5
Tél.:(819) 825-3702 Fax:(819) 825-2863
Courriel: bureau@corriveaujl.com
Réf. DAO: J:\C15304\6. Dessin\C10945_Plaques.dwg/ISMAEL
C10945/442.17

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	
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
	Est	223364.365	223364.319	-0.046	O	223364.310	-0.009	O	223364.316	0.006	E	223364.317	0.001	E
	Elev.	319.120	319.085	-0.035	B	319.085	0.000	-	319.097	0.012	H	319.089	-0.008	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
	Est	223312.799	223312.758	-0.041	O	223312.754	-0.004	O	223312.766	0.012	E	223312.765	-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
B-3	Nord	5333560.718	5333560.716	-0.002	S	5333560.721	0.005	N	5333560.721	0.000	-	5333560.720	-0.001	S
	Est	223270.316	223270.298	-0.018	O	223270.294	-0.004	O	223270.298	0.004	E	223270.292	-0.006	O
	Elev.	319.122	319.090	-0.032	B	319.093	0.003	H	319.101	0.008	H	319.098	-0.003	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
	Est	223073.887	223073.882	-0.005	O	223073.899	0.017	E	223073.888	-0.011	O	223073.881	-0.007	O
	Elev.	318.136	318.111	-0.025	B	318.134	0.023	H	318.140	0.006	H	318.141	0.001	H
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
	Est	222993.640	222993.630	-0.010	O	222993.641	0.011	E	222993.631	-0.010	O	222993.632	0.001	E
	Elev.	318.157	318.151	-0.006	B	318.158	0.007	H	318.166	0.008	H	318.164	-0.002	B
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
	Est	222661.587	222661.604	0.017	E	222661.649	0.045	E	222661.613	-0.036	O	222661.609	-0.004	O
	Elev.	318.176	318.139	-0.037	B	318.141	0.002	H	318.150	0.009	H	318.139	-0.011	B
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
	Est	222246.790	222246.804	0.014	E	222246.868	0.064	E	222246.809	-0.059	O	222246.807	-0.003	O
	Elev.	318.176	318.185	0.009	H	318.190	0.005	H	318.203	0.013	H	318.186	-0.017	B
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
	Est	222178.864	222178.871	0.007	E	222178.944	0.073	E	222178.876	-0.068	O	222178.872	-0.004	O
	Elev.	319.031	319.022	-0.009	B	319.020	-0.002	B	319.035	0.015	B	319.031	-0.004	B
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
	Est	222191.523	222191.531	0.008	E	222191.610	0.079	E	222191.543	-0.067	O	222191.531	-0.012	O
	Elev.	319.181	319.161	-0.020	B	319.171	0.010	H	319.180	0.009	H	319.186	0.006	H
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
	Est	222242.232	222242.203	-0.029	O	222242.271	0.068	E	222242.254	-0.017	O	222242.192	-0.062	O
	Elev.	318.244	318.220	-0.024	B	318.226	0.006	H	318.234	0.008	H	318.233	-0.001	B
B-11	Nord								5333362.842	N/A		5333362.840	-0.002	S
	Est								222145.004	N/A		222145.006	0.002	E
	Elev.								307.277	N/A		307.241	-0.036	B
2011-1 L	Nord								5333800.878	N/A		5333800.873	-0.005	S
	Est								223387.811	N/A		223387.817	0.006	E
	Elev.								310.020	N/A		310.018	-0.002	B
2011-2 C	Nord								5333562.623	N/A		5333562.637	0.014	N
	Est								223322.116	N/A		223322.109	-0.007	O
	Elev.								309.270	N/A		309.252	-0.018	B
2011-3 L	Nord								5333826.347	N/A		5333826.349	0.002	N
	Est								223442.150	N/A		223442.150	0.000	-
	Elev.								310.354	N/A		310.345	-0.009	B
2011-4 L	Nord								5333763.037	N/A		5333763.041	0.004	N
	Est								223329.455	N/A		223329.455	0.000	-
	Elev.								310.371	N/A		310.359	-0.012	B
2011-5 C	Nord								5333821.228	N/A		5333821.227	-0.001	S
	Est								223378.028	N/A		223378.028	0.000	-
	Elev.								303.984	N/A		303.978	-0.006	B
2011-6 C	Nord								5333068.318	N/A		5333068.305	-0.013	S
	Est								222236.094	N/A		222236.095	0.001	E
	Elev.								309.338	N/A		309.334	-0.004	B
2011-7 C	Nord								5333271.670	N/A		5333271.658	-0.012	N
	Est								222174.469	N/A		222174.459	-0.010	O
	Elev.								309.156	N/A		309.159	0.003	H
2011-8 C	Nord								5333627.581	N/A		5333627.573	-0.008	S
	Est								223061.472	N/A		223061.471	-0.001	O
	Elev.								310.383	N/A		310.369	-0.014	B

Plaque de tassement		Arpentage Juillet 2013	Différence 2013-2012		Arpentage Juin 2014	Différence 2014-2013		Arpentage Juin 2015	Différence 2015-2014		Arpentage Juin 2016	Différence 2016-2015		Arpentage Septembre 2017	Différence 2017-2016	
B-1	Nord	5333481.574	0.007	N	5333481.565	-0.009	S	5333481.569	0.004	N	5333481.576	0.007	N	5333481.586	0.010	N
	Est	223364.319	0.002	E	223364.324	0.005	E	223364.321	-0.003	O	223364.317	-0.004	O	223364.321	0.004	O
	Elev.	319.087	-0.002	B	319.082	-0.005	B	319.080	-0.002	B	319.098	0.018	H	319.094	-0.004	B
B-2	Nord	5333524.843	0.004	N	5333524.841	-0.002	S	5333524.836	-0.005	S	5333524.846	0.010	N	5333524.853	0.007	N
	Est	223312.764	-0.001	O	223312.774	0.010	E	223312.774	0.000	-	223312.771	-0.003	O	223312.773	0.002	E
	Elev.	318.439	-0.009	B	318.430	-0.009	B	318.428	-0.002	B	318.441	0.013	H	318.436	-0.005	B
B-3	Nord	5333560.718	-0.002	S	5333560.713	-0.005	S	5333560.717	0.004	N	5333560.730	0.014	N	5333560.720	-0.010	S
	Est	223270.294	0.002	E	223270.302	0.008	E	223270.297	-0.005	O	223270.295	-0.002	O	223270.299	0.004	E
	Elev.	319.096	-0.002	B	319.086	-0.010	B	319.087	0.001	H	319.099	0.001	H	319.092	-0.007	B
B-4	Nord	5333595.802	0.000	N/A	5333595.797	-0.005	S	5333595.803	0.006	N	5333595.808	0.005	N	5333595.807	-0.001	S
	Est	223073.879	-0.002	O	223073.885	0.006	E	223073.879	-0.006	O	223073.877	-0.002	O	223073.879	0.002	E
	Elev.	318.141	0.000	N/A	318.127	-0.014	B	318.134	0.007	H	318.146	0.012	H	318.137	-0.009	B
B-5	Nord	5333572.231	0.004	N	5333572.233	0.002	N	5333572.232	-0.001	S	5333572.233	0.001	N	5333572.234	0.001	N
	Est	222993.625	-0.007	O	222993.633	0.008	E	222993.633	0.000	-	222993.626	-0.007	O	222993.629	0.003	E
	Elev.	318.165	0.001	H	318.160	-0.005	B	318.163	0.003	H	318.172	0.009	H	318.160	-0.012	B
B-6	Nord	5333588.753	0.006	N	5333588.751	-0.002	S	5333588.753	0.002	N	5333588.754	0.001	N	5333588.759	0.005	N
	Est	222661.604	-0.005	O	222661.610	0.006	E	222661.608	-0.002	O	222661.609	0.001	E	222661.607	-0.002	O
	Elev.	318.143	0.004	H	318.132	-0.011	B	318.148	0.016	H	318.160	0.012	H	318.146	-0.014	B
B-7	Nord	5333511.096	0.009	N	5333511.093	-0.003	S	5333511.096	0.003	N	5333511.098	0.002	N	5333511.101	0.003	N
	Est	222246.802	-0.005	O	222246.805	0.003	E	222246.803	-0.002	O	222246.804	0.001	E	222246.797	-0.007	O
	Elev.	318.203	0.018	H	318.196	-0.007	B	318.204	0.008	H	318.221	0.017	H	318.217	-0.004	B
B-8	Nord	5333371.610	0.003	N	5333371.606	-0.004	S	5333371.607	0.001	N	5333371.610	0.003	N	5333371.607	-0.003	S
	Est	222178.867	-0.005	O	222178.872	0.005	E	222178.876	0.004	E	222178.866	-0.010	O	222178.868	0.001	E
	Elev.	319.035	0.004	H	319.012	-0.023	B	319.033	0.021	H	319.028	-0.005	B	319.032	0.004	H
B-9	Nord	5333327.169	-0.004	S	5333327.179	-0.010	S	5333327.182	0.003	N	5333327.191	0.009	N	5333327.186	-0.005	S
	Est	222191.528	-0.003	O	222191.533	0.005	E	222191.536	0.003	E	222191.524	-0.012	O	222191.528	0.004	E
	Elev.	319.177	-0.009	B	319.154	-0.023	B	319.173	0.019	H	319.175	0.002	H	319.173	-0.002	B
B-10	Nord	5333154.275	-0.003	S	5333154.276	0.001	N	5333154.268	-0.008	S	5333154.280	0.012	S	5333154.274	-0.006	S
	Est	222242.189	-0.003	O	222242.196	0.007	E	222242.196	0.000	-	222242.186	-0.010	O	222242.185	-0.001	O
	Elev.	318.231	-0.002	B	318.226	-0.005	B	318.232	0.006	H	318.243	0.011	H	318.243	0.000	N/A
B-11	Nord	5333362.842	0.002	N	5333362.843	0.001	N	5333362.849	0.006	N	5333362.854	0.005	N	5333362.834	-0.020	S
	Est	222145.000	-0.006	O	222145.004	0.004	E	222145.004	0.000	-	222144.996	-0.008	O	222144.997	0.001	E
	Elev.	307.266	0.025	H	307.251	-0.015	B	307.255	0.004	H	307.273	0.018	H	307.258	-0.015	B
2011-1 L	Nord	5333800.871	-0.002	S	5333800.866	-0.005	S	5333800.873	0.007	N	5333800.859	-0.014	S	5333800.872	0.013	N
	Est	223387.815	-0.002	O	223387.819	0.004	E	223387.817	-0.002	O	223387.818	0.001	E	223387.812	-0.006	O
	Elev.	310.018	0.000	N/A	310.001	-0.017	B	310.003	0.002	H	309.987	-0.016	B	309.999	0.012	H
2011-2 C	Nord	5333562.632	-0.005	S	5333562.627	-0.005	S	5333562.627	0.000	-	5333562.629	0.002	N	5333562.632	0.003	N
	Est	223322.107	-0.002	O	223322.116	0.009	E	223322.110	-0.006	O	223322.107	-0.003	O	223322.099	-0.008	O
	Elev.	309.242	-0.010	B	309.240	-0.002	B	309.235	-0.005	B	309.247	0.012	H	309.252	0.005	H
2011-3 L	Nord	5333826.347	-0.002	S	5333826.343	-0.004	S	5333826.350	0.007	N	5333826.338	-0.012	S	5333826.351	0.013	N
	Est	223442.153	0.003	E	223442.157	0.004	E	223442.154	-0.003	O	223442.161	0.007	E	223442.151	-0.010	O
	Elev.	310.344	-0.001	B	310.332	-0.012	B	310.333	0.001	H	310.307	-0.026	H	310.323	0.016	H
2011-4 L	Nord	5333763.040	-0.001	S	5333763.036	-0.004	S	5333763.040	0.004	N	5333763.033	-0.007	S	5333763.039	0.006	N
	Est	223329.456	0.001	E	223329.465	0.009	E	223329.460	-0.005	O	223329.458	-0.002	O	223329.458	0.000	-
	Elev.	310.365	0.006	H	310.349	-0.016	B	310.353	0.004	H	310.341	-0.012	B	310.347	0.006	H
2011-5 C	Nord	5333821.221	-0.006	S	5333821.222	0.001	N	5333821.227	0.005	N	5333821.220	-0.007	S	5333821.222	0.002	N
	Est	223378.028	0.000	-	223378.034	0.006	E	223378.031	-0.003	O	223378.030	-0.001	O	223378.030	0.000	E
	Elev.	303.980	0.001	H	303.967	-0.013	B	303.970	0.003	H	303.963	-0.007	B	303.973	0.010	H
2011-6 C	Nord	5333068.308	0.003	N	5333068.307	-0.001	S	5333068.308	0.001	N	5333068.313	0.005	N	5333068.302	-0.011	S
	Est	222236.096	0.001	E	222236.100	0.004	E	222236.096	-0.004	O	222236.093	-0.003	O	222236.094	0.001	E
	Elev.	309.337	0.003	H	309.324	-0.013	B	309.334	0.010	H	309.349	0.015	H	309.347	-0.002	B
2011-7 C	Nord	5333271.660	0.002	N	5333271.666	0.006	N	5333271.661	-0.005	S	5333271.669	0.008	N	5333271.658	-0.011	S
	Est	222174.458	-0.001	O	222174.459	0.001	E	222174.457	-0.002	O	222174.447	-0.010	O	222174.452		E
	Elev.	309.161	0.001	H	309.149	-0.012	B	309.172	0.023	H	309.170	-0.002	B	309.171	0.001	H
2011-8 C	Nord	5333627.577	0.004	N	5333627.571	-0.006	S	5333627.574	0.003	N	5333627.574	0.000	-	5333627.568	-0.006	S
	Est	223061.467	-0.004	O	223061.476	0.009	E	223061.475	-0.001	O	223061.469	-0.006	O	223061.470	0.001	E
	Elev.	310.370	0.001	H	310.355	-0.015	B	310.368	0.013	H	310.383	0.015	H	310.369	-0.014	B

Plaque de tassement		Arpentage Octobre 2018	Différence 2018-2017		Arpentage Octobre 2019	Différence 2019-2018		Arpentage Septembre 2020	Différence 2020-2019		Arpentage Octobre 2021	Différence 2021-2020		Arpentage Juillet 2022	Différence 2022-2021		Arpentage Septembre 2023	Différence 2023-2022	
B-1	Nord	5333481.575	-0.011	S	5333481.568	-0.007	S	5333481.571	0.003	N	5333481.569	-0.002	S	5333481.573	0.004	N	5333481.569	-0.004	S
	Est	223364.321	0.000	O	223364.323	0.002	E	223364.323	-0.001	O	223364.325	0.002	E	223364.328	0.003	E	223364.320	-0.008	O
	Elev.	319.086	-0.007	B	319.083	-0.004	B	319.062	-0.020	B	319.089	0.026	H	319.068	-0.021	B	319.092	0.024	H
B-2	Nord	5333524.839	-0.014	S	5333524.841	0.002	N	5333524.841	0.000	-	5333524.835	-0.006	S	5333524.848	0.013	N	5333524.840	-0.008	S
	Est	223312.775	0.002	E	223312.776	0.001	E	223312.772	-0.004	O	223312.779	0.007	E	223312.785	0.006	E	223312.775	-0.010	O
	Elev.	318.425	-0.010	B	318.424	-0.001	B	318.397	-0.027	B	318.423	0.025	H	318.409	-0.014	B	318.428	0.020	H
B-3	Nord	5333560.722	0.002	N	5333560.716	-0.005	S	5333560.722	0.006	N	5333560.712	-0.010	S	5333560.722	0.010	N	5333560.713	-0.010	S
	Est	223270.301	0.002	E	223270.302	0.001	E	223270.301	-0.001	O	223270.304	0.003	E	223270.308	0.004	E	223270.293	-0.014	O
	Elev.	319.084	-0.008	B	319.083	-0.001	B	319.091	0.008	H	319.091	0.000	-	319.070	-0.021	B	319.094	0.024	H
B-4	Nord	5333595.803	-0.004	S	5333595.806	0.003	N	5333595.803	-0.003	S	5333595.797	-0.006	S	5333595.805	0.008	N	5333595.796	-0.009	S
	Est	223073.890	0.011	E	223073.878	-0.012	O	223073.880	0.002	E	223073.882	0.002	E	223073.882	0.001	-	223073.879	-0.003	O
	Elev.	318.136	-0.002	B	318.143	0.007	H	318.122	-0.021	B	318.138	0.016	H	318.119	-0.018	B	318.136	0.017	H
B-5	Nord	5333572.226	-0.008	S	5333572.237	0.010	N	5333572.234	-0.003	S	5333572.229	-0.005	S	5333572.234	0.005	N	5333572.226	-0.008	S
	Est	222993.639	0.010	E	222993.628	-0.010	O	222993.633	0.004	E	222993.634	0.001	E	222993.633	-0.001	O	222993.631	-0.002	O
	Elev.	318.158	-0.003	B	318.168	0.010	H	318.151	-0.017	B	318.165	0.014	H	318.143	-0.022	B	318.163	0.020	H
B-6	Nord	5333588.749	-0.010	S	5333588.759	0.010	N	5333588.754	-0.005	S	5333588.747	-0.007	S	5333588.755	0.009	N	5333588.746	-0.009	S
	Est	222661.620	0.012	E	222661.608	-0.011	O	222661.607	-0.001	O	222661.609	0.002	E	222661.610	0.001	E	222661.611	0.001	E
	Elev.	318.144	-0.001	B	318.155	0.010	H	318.145	-0.010	B	318.147	0.002	H	318.123	-0.023	B	318.148	0.025	H
B-7	Nord	5333511.092	-0.009	S	5333511.096	0.004	N	5333511.096	0.000	-	5333511.091	-0.006	S	5333511.096	0.006	N	5333511.083	-0.013	S
	Est	222246.812	0.014	E	222246.802	-0.010	O	222246.806	0.004	E	222246.805	-0.001	O	222246.802	-0.003	O	222246.802	0.000	-
	Elev.	318.222	0.005	H	318.223	0.001	H	318.219	-0.004	B	318.214	-0.005	B	318.213	-0.001	B	318.222	0.009	H
B-8	Nord	5333371.606	-0.001	S	5333371.603	-0.003	S	5333371.607	0.004	N	5333371.600	-0.007	S	5333371.605	0.005	N	5333371.597	-0.008	S
	Est	222178.881	0.014	E	222178.869	-0.012	O	222178.872	0.003	E	222178.877	0.005	E	222178.867	-0.011	O	222178.871	0.004	E
	Elev.	319.027	-0.005	B	319.030	0.003	H	319.033	0.003	H	319.025	-0.007	B	319.025	0.000	-	319.037	0.012	H
B-9	Nord	5333327.181	-0.005	S	5333327.185	0.003	N	5333327.183	-0.001	S	5333327.178	-0.005	S	5333327.185	0.008	N	5333327.177	-0.008	S
	Est	222191.542	0.014	E	222191.532	-0.010	O	222191.534	0.002	E	222191.539	0.004	E	222191.531	-0.008	O	222191.531	0.000	-
	Elev.	319.172	-0.001	B	319.175	0.003	H	319.174	-0.001	B	319.171	-0.003	B	319.170	-0.001	B	319.181	0.011	H
B-10	Nord	5333154.274	0.000	S	5333154.272	-0.002	S	5333154.271	-0.001	S	5333154.261	-0.011	S	5333154.277	0.016	N	5333154.266	-0.011	S
	Est	222242.207	0.022	E	222242.191	-0.016	O	222242.193	0.001	E	222242.194	0.001	E	222242.193	-0.001	O	222242.191	-0.003	O
	Elev.	318.237	-0.005	B	318.234	-0.003	B	318.232	-0.003	B	318.236	0.004	H	318.227	-0.008	B	318.249	0.022	B
B-11	Nord	5333362.849	0.015	N	5333362.845	-0.004	S	5333362.842	-0.003	S	5333362.845	0.003	N	5333362.839	-0.006	S	5333362.837	-0.002	S
	Est	222145.015	0.018	E	222145.002	-0.013	O	222145.005	0.003	E	222145.006	0.001	E	222145.003	-0.002	O	222145.001	-0.003	O
	Elev.	307.269	0.011	H	307.266	-0.003	B	307.256	-0.010	B	307.267	0.011	H	307.269	0.002	H	307.264	-0.005	B
2011-1 L	Nord	5333800.863	-0.009	S	5333800.865	0.002	N	5333800.866	0.000	-	5333800.859	-0.007	S	5333800.861	0.002	N	5333800.856	-0.005	S
	Est	223387.813	0.000	-	223387.816	0.004	E	223387.816	0.000	-	223387.817	0.001	E	223387.823	0.006	E	223387.814	-0.008	O
	Elev.	309.986	-0.013	B	309.986	0.000	-	309.992	0.006	H	309.992	0.000	-	309.971	-0.021	B	309.998	0.027	H
2011-2 C	Nord	5333562.636	0.004	N	5333562.638	0.002	N	5333562.634	-0.004	S	5333562.624	-0.010	S	5333562.633	0.009	N	5333562.631	-0.002	S
	Est	223322.112	0.013	E	223322.117	0.005	E	223322.115	-0.003	O	223322.118	0.003	E	223322.117	-0.001	O	223322.114	-0.003	O
	Elev.	309.240	-0.012	B	309.249	0.009	H	309.218	-0.031	B	309.251	0.033	H	309.235	-0.017	B	309.247	0.012	H
2011-3 L	Nord	5333826.344	-0.007	S	5333826.344	0.000	-	5333826.347	0.003	N	5333826.341	-0.006	S	5333826.345	0.004	N	5333826.336	-0.009	S
	Est	223442.151	0.000	-	223442.157	0.006	E	223442.158	0.001	E	223442.158	0.000	-	223442.159	0.001	E	223442.157	-0.003	O
	Elev.	310.309	-0.014	B	310.279	-0.030	B	310.313	0.035	H	310.326	0.013	H	310.257	-0.069	B	310.316	0.059	H
2011-4 L	Nord	5333763.037	-0.002	S	5333763.030	-0.007	S	5333763.034	0.004	S	5333763.031	-0.003	S	5333763.033	0.001	N	5333763.028	-0.005	N
	Est	223329.458	0.000	-	223329.462	0.004	E	223329.465	0.003	E	223329.467	0.001	E	223329.473	0.006	E	223329.467	-0.006	O
	Elev.	310.347	0.000	-	310.343	-0.004	B	310.343	0.000	B	310.347	0.005	H	310.337	-0.010	B	310.339	0.003	H
2011-5 C	Nord	5333821.221	-0.001	S	5333821.223	0.002	N	5333821.227	0.004	N	5333821.220	-0.007	S	5333821.222	0.002	N	5333821.220	-0.002	S
	Est	223378.025	-0.005	O	223378.037	0.012	E	223378.029	-0.008	E	223378.036	0.006	E	223378.037	0.002	E	223378.032	-0.006	O
	Elev.	303.965	-0.008	B	303.958	-0.006	B	303.968	0.010	B	303.974	0.006	H	303.957	-0.017	B	303.971	0.014	H
2011-6 C	Nord	5333068.314	0.012	N	5333068.310	-0.003	S	5333068.311	0.001	S	5333068.307	-0.005	S	5333068.313	0.006	N	5333068.293	-0.020	S
	Est	222236.113	0.020	E	222236.095	-0.018	O	222236.098	0.003	O	222236.096	-0.002	O	222236.104	0.008	E	222236.094	-0.010	O
	Elev.	309.346	-0.001	B	309.334	-0.012	B	309.338	0.003	B	309.337	-0.001	B	309.321	-0.016	B	309.339	0.017	H
2011-7 C	Nord	5333271.661	0.003	N	5333271.653	-0.008	S	5333271.661	0.009	S	5333271.667	0.005	N	5333271.655	-0.012	S	5333271.648	-0.007	S
	Est	222174.472	0.020	E	222174.452	-0.020	O	222174.455	0.003	O	222174.461	0.005	E	222174.456	-0.005	O	222174.461	0.005	E
	Elev.	309.164	-0.007	B	309.171	0.007	H	309.169	-0.002	H	309.167	-0.003	B	309.164	-0.003	B	309.172	0.008	H
2011-8 C	Nord	5333627.571	0.003	N	pas levé		-	5333627.572	0.002	N	5333627.569	-0.004	S	5333627.574	0.005	N	5333627.568	-0.006	S
	Est	223061.473	0.004	E	pas levé		-	223061.477	0.004	E	223061.475	-0.002	O	223061.477	0.003	E	223061.468	-0.010	O
	Elev.	310.373	0.004	H	pas levé		-	310.366	-0.007	B	310.373	0.007	H	310.365	-0.008	B	310.361	-0.003	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.

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.

Annexe 2

TABLEAU DES *ÉLÉVATIONS PRÉCISES DES PLAQUES DE TASSEMENT*

(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 Sept. 2020	Diff. (m) 2020-2019	Diff. (m) 2020-2008 2020-2011	Élévation Oct. 2021	Diff. (m) 2021-2020	Diff. (m) 2021-2008 2021-2011	Élévation Juil. 2022	Diff. (m) 2022-2021	Diff. (m) 2022-2008 2022-2011	Élévation Sep. 2023	Diff. (m) 2023-2022	Diff. (m) 2023-2008 2023-2011	Plaque de tassement
94-257	3316.707	3316.707	-	3316.707	-	3316.707	-	3316.707	-	-	3316.707	-	-	3316.707	-	-	3316.707	-	-	3316.707	-	-	94-257
94-262	3315.842	-	-	-	-	-	-	3315.840	-	-	3315.840	-0.001	0.000	3315.842	0.002	0.002	3315.843	0.001	0.003	3315.842	-0.001	0.002	94-262
B1	3319.120	3319.099	-0.021	3319.099	0.000	3319.100	0.001	3319.097	-0.003	-0.002	3319.098	0.001	-0.001	3319.098	-0.001	-0.002	3319.097	0.000	-0.002	3319.097	0.000	-0.002	B1
B2	3318.489	3318.465	-0.024	3318.462	-0.003	3318.460	-0.002	3318.454	-0.006	-0.011	3318.437	-0.001	-0.028	3318.434	-0.003	-0.031	3318.433	-0.001	-0.032	3318.432	-0.002	-0.033	B2
B3	3319.122	3319.103	-0.019	3319.104	0.001	3319.104	0.000	3319.101	-0.003	-0.002	3319.101	0.000	-0.002	3319.100	-0.001	-0.003	3319.100	0.000	-0.003	3319.099	0.000	-0.004	B3
B4	3318.136	3318.143	0.007	3318.146	0.003	3318.146	0.000	3318.140	-0.006	-0.003	3318.143	-0.001	0.000	3318.144	0.000	0.001	3318.144	0.001	0.001	3318.143	-0.001	0.000	B4
B5	3318.157	3318.168	0.011	3318.172	0.004	3318.172	0.000	3318.166	-0.006	-0.002	3318.169	-0.002	0.001	3318.170	0.001	0.002	3318.171	0.001	0.003	3318.170	-0.001	0.002	B5
B6	3318.176	3318.153	-0.023	3318.158	0.005	3318.156	-0.002	3318.150	-0.006	-0.003	3318.153	-0.001	0.000	3318.154	0.002	0.001	3318.155	0.001	0.002	3318.154	-0.001	0.001	B6
B7	3318.176	3318.198	0.022	3318.207	0.009	3318.207	0.000	3318.203	-0.004	0.005	3318.221	0.000	0.023	3318.224	0.004	0.026	3318.227	0.003	0.029	3318.228	0.002	0.030	B7
B8	3319.031	3319.034	0.003	3319.039	0.005	3319.038	-0.001	3319.035	-0.003	0.001	3319.033	-0.002	-0.002	3319.036	0.003	0.002	3319.035	0.000	0.001	3319.035	0.000	0.001	B8
B9	3319.181	3319.180	-0.001	3319.186	0.006	3319.186	0.000	3319.180	-0.006	0.000	3319.177	-0.002	-0.003	3319.180	0.003	0.000	3319.180	0.000	0.000	3319.180	0.000	0.000	B9
B10	3318.244	3318.232	-0.012	3318.239	0.007	3318.238	-0.001	3318.234	-0.004	0.002	3318.239	-0.002	0.007	3318.242	0.002	0.010	3318.243	0.002	0.011	3318.243	0.000	0.011	B10
**B11	3307.253	-	-	-	-	-	-	3307.277	-	-	3307.265	0.000	-0.012	3307.267	0.002	-0.010	3307.269	0.002	-0.008	3307.267	-0.001	-0.010	**B11
*2011-1	-	-	-	-	-	-	-	3310.020	-	-	3309.998	-0.004	-0.022	3309.996	-0.002	-0.024	3309.995	0.000	-0.025	3309.997	0.002	-0.023	*2011-1
**2011-2	-	-	-	-	-	-	-	3309.270	-	-	3309.254	-0.002	-0.016	3309.254	0.000	-0.016	3309.254	0.000	-0.017	3309.254	0.000	-0.017	**2011-2
*2011-3	-	-	-	-	-	-	-	3310.354	-	-	3310.323	-0.004	-0.031	3310.325	0.002	-0.029	3310.318	-0.007	-0.036	3310.313	-0.005	-0.041	*2011-3
*2011-4	-	-	-	-	-	-	-	3310.371	-	-	3310.365	-0.005	-0.006	3310.366	0.001	-0.005	3310.370	0.005	-0.001	3310.370	-0.001	-0.001	*2011-4
**2011-5	-	-	-	-	-	-	-	3303.984	-	-	3303.969	-0.004	-0.015	3303.971	0.002	-0.013	3303.973	0.002	-0.011	3303.970	-0.003	-0.014	**2011-5
**2011-6	-	-	-	-	-	-	-	3309.357	-	-	3309.339	0.000	-0.018	3309.342	0.002	-0.015	3309.343	0.001	-0.014	3309.342	-0.001	-0.015	**2011-6
**2011-7	-	-	-	-	-	-	-	3309.156	-	-	3309.167	0.000	0.011	3309.169	0.002	0.013	3309.171	0.002	0.015	3309.170	-0.001	0.014	**2011-7
**2011-8	-	-	-	-	-	-	-	3310.383	-	-	3310.372	0.000	-0.011	3310.372	0.000	-0.011	3310.372	0.000	-0.011	3310.372	0.000	-0.011	**2011-8

*Trait jaune = Repères implantés en 2011

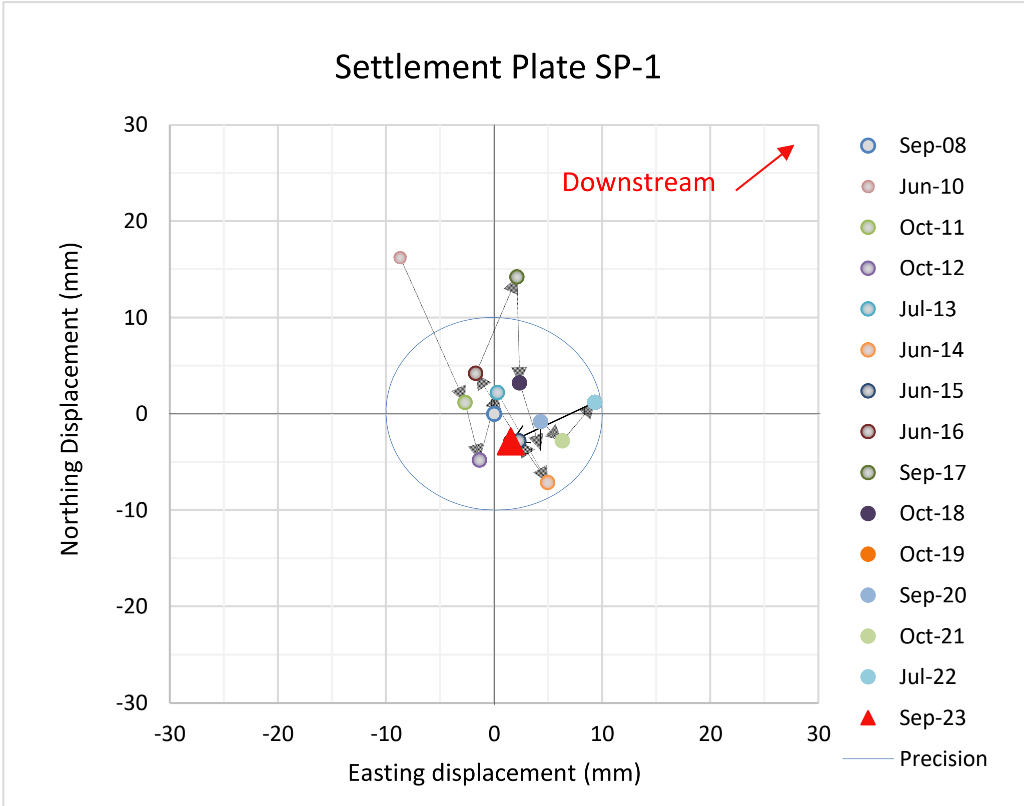
**Nivellement trigonométrique (précision estimé à +/- 5 mm

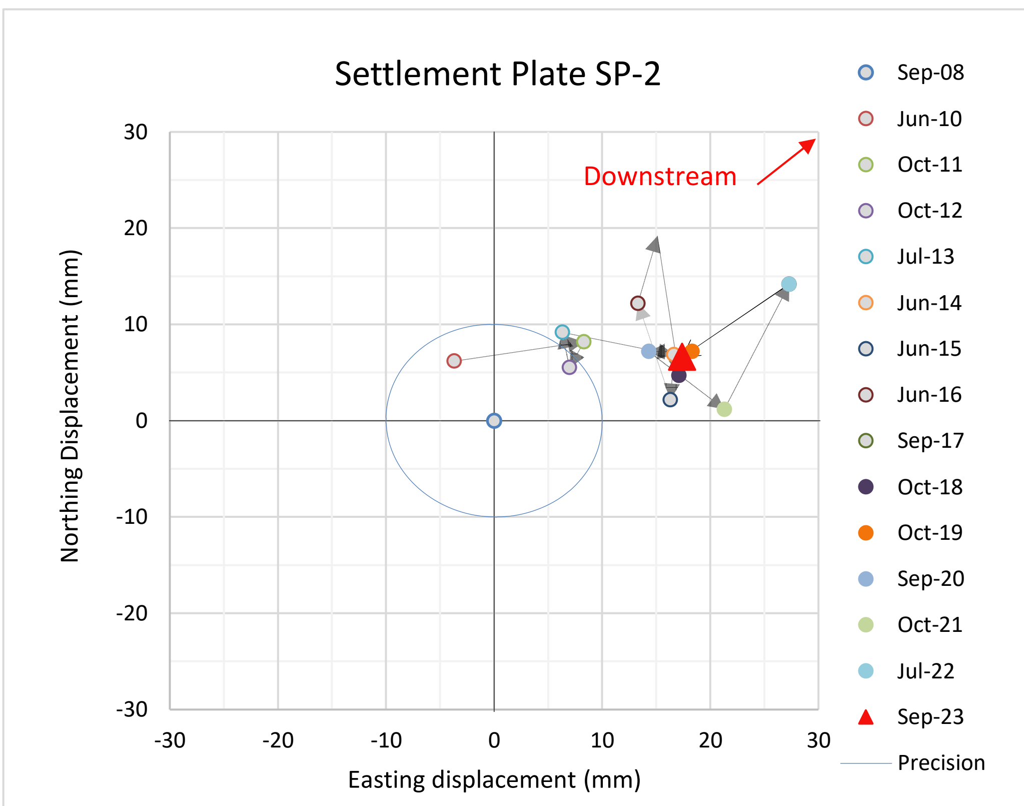
Note : seul le nivellement géométrique à été utilisé lors du levé des plaques de tassement en octobre 2019.

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

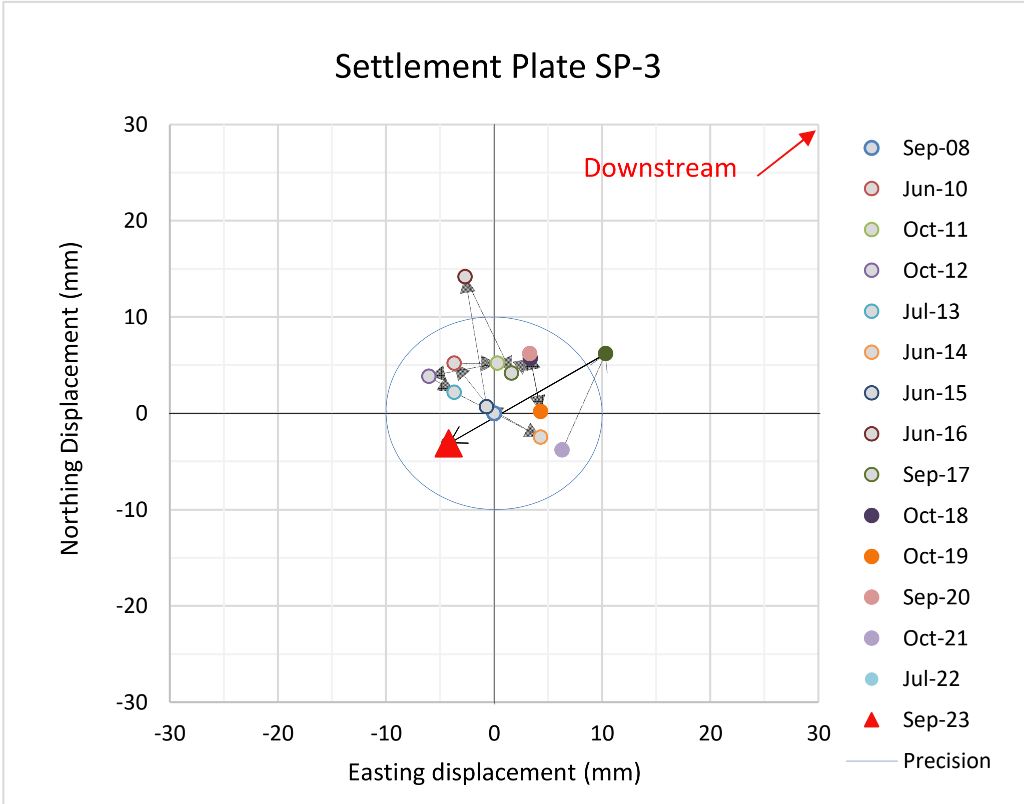
APPENDIX D

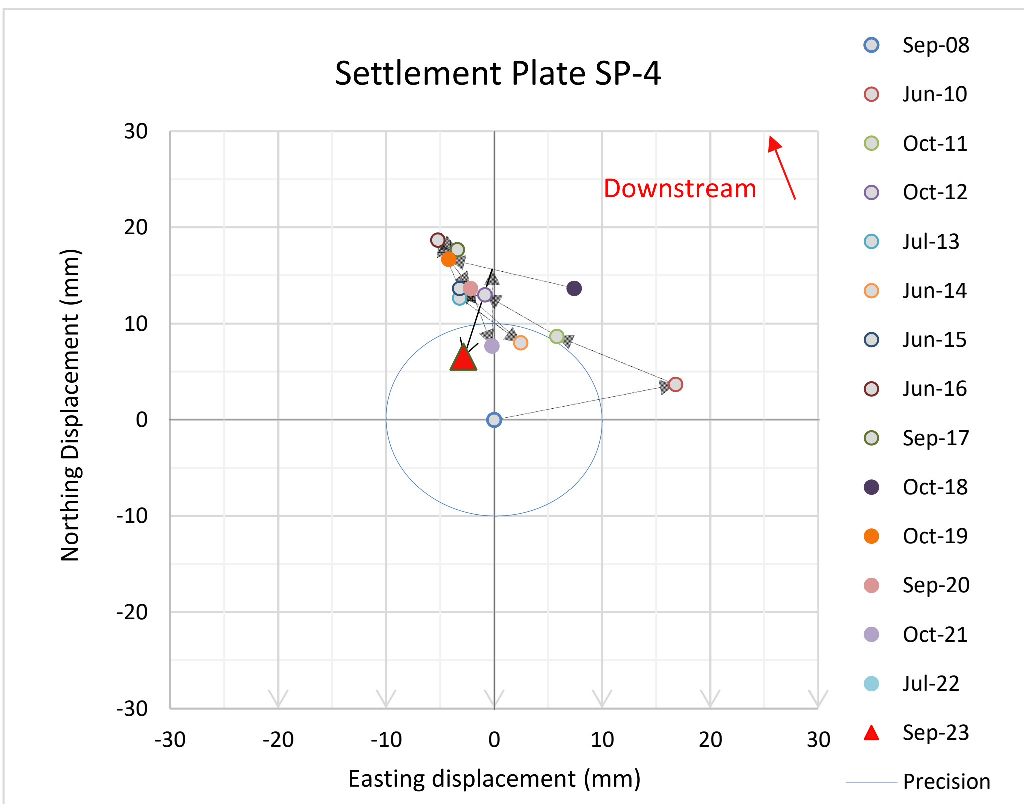
Point of Origin Plot



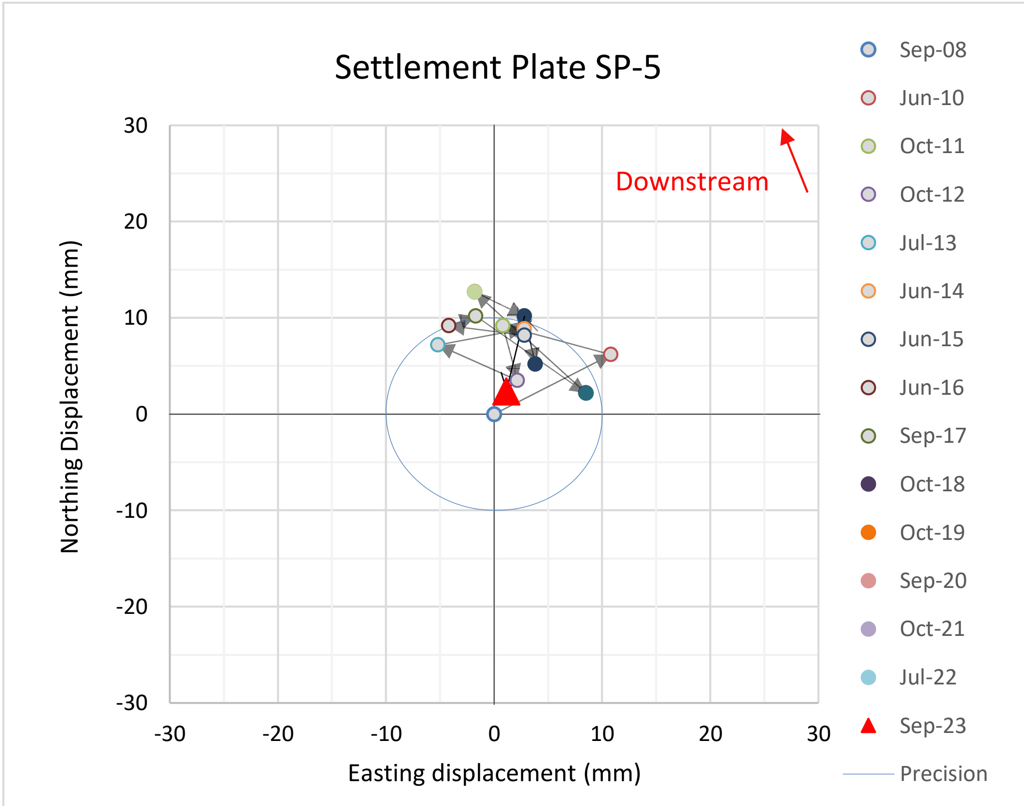


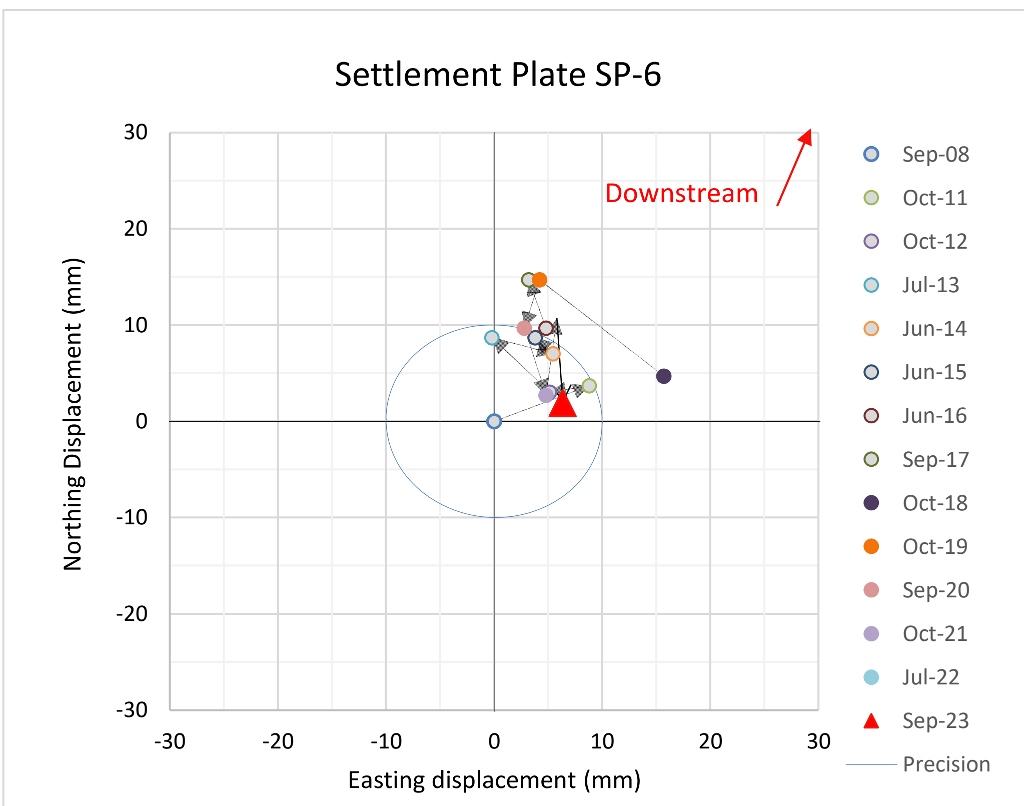
→ Schematic Vector of Downstream Direction



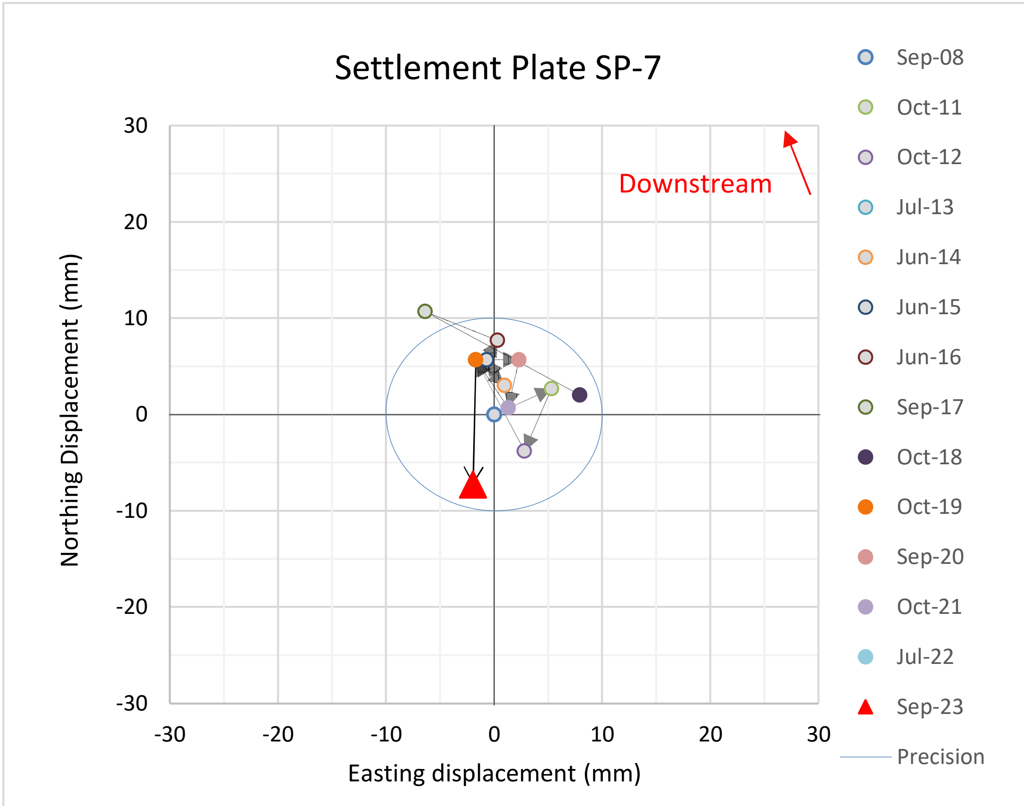


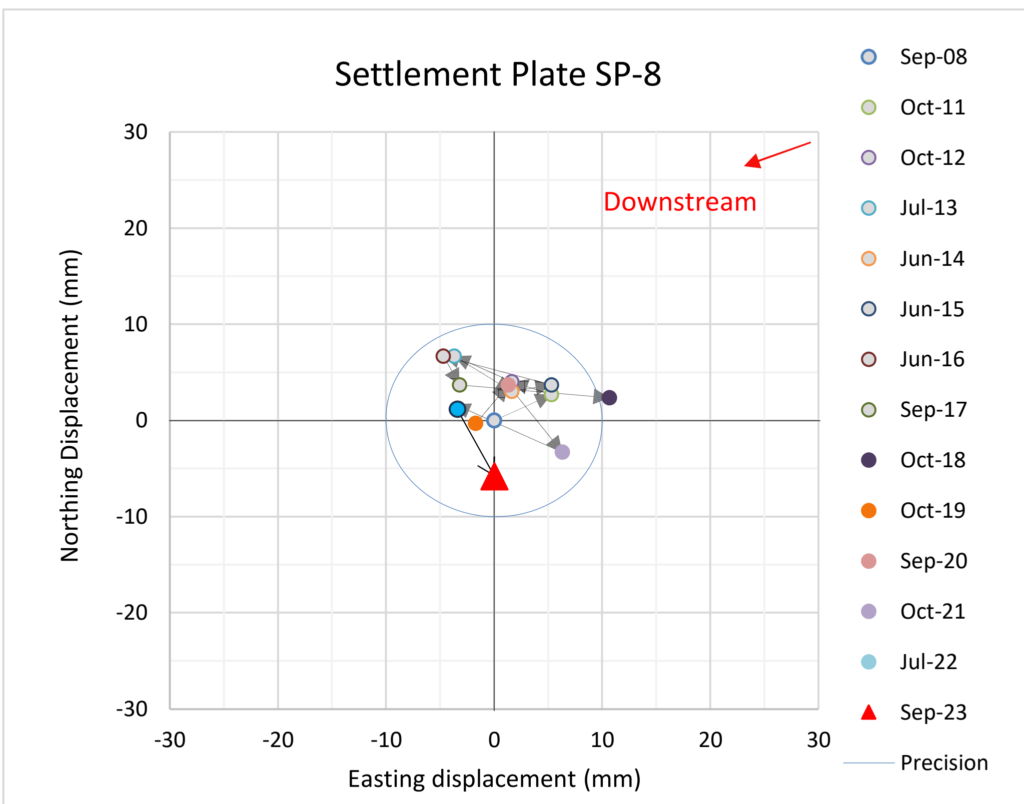
Schematic Vector of Downstream Direction



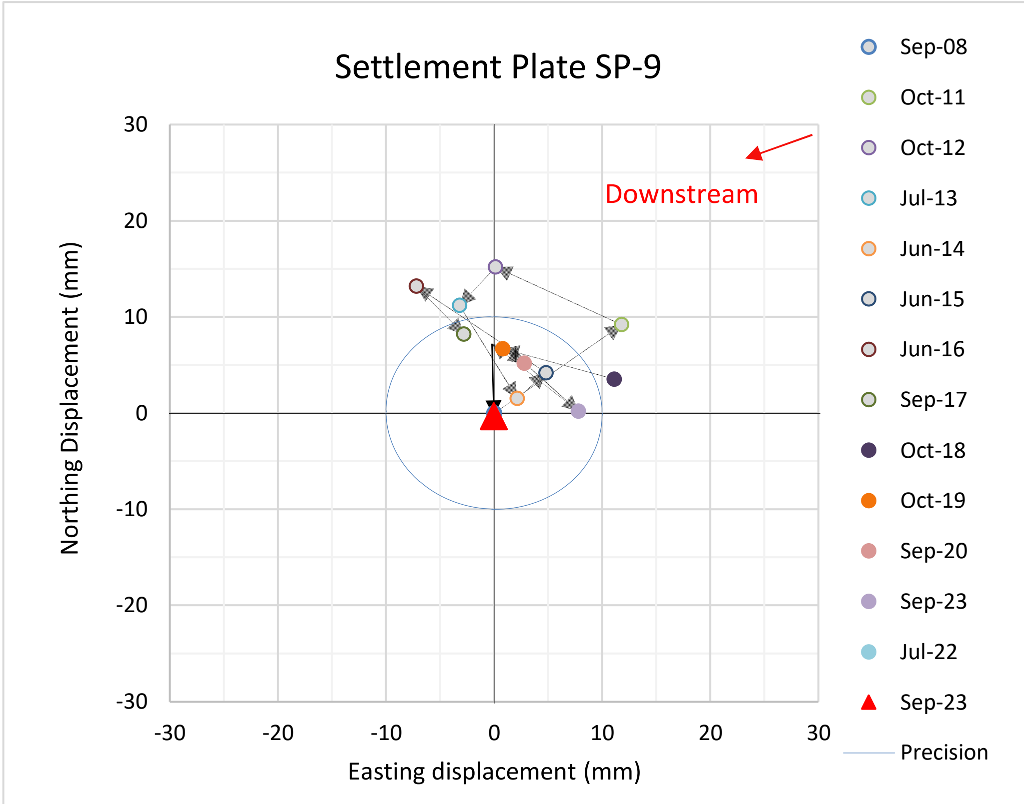


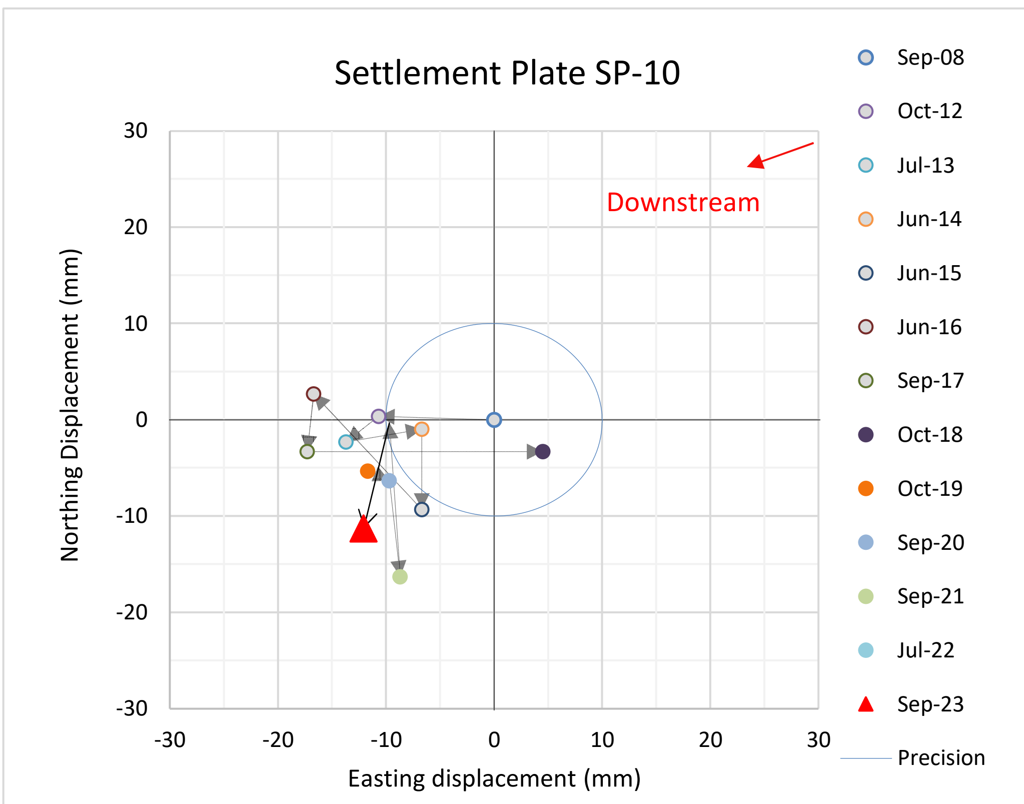
Schematic Vector of Downstream Direction



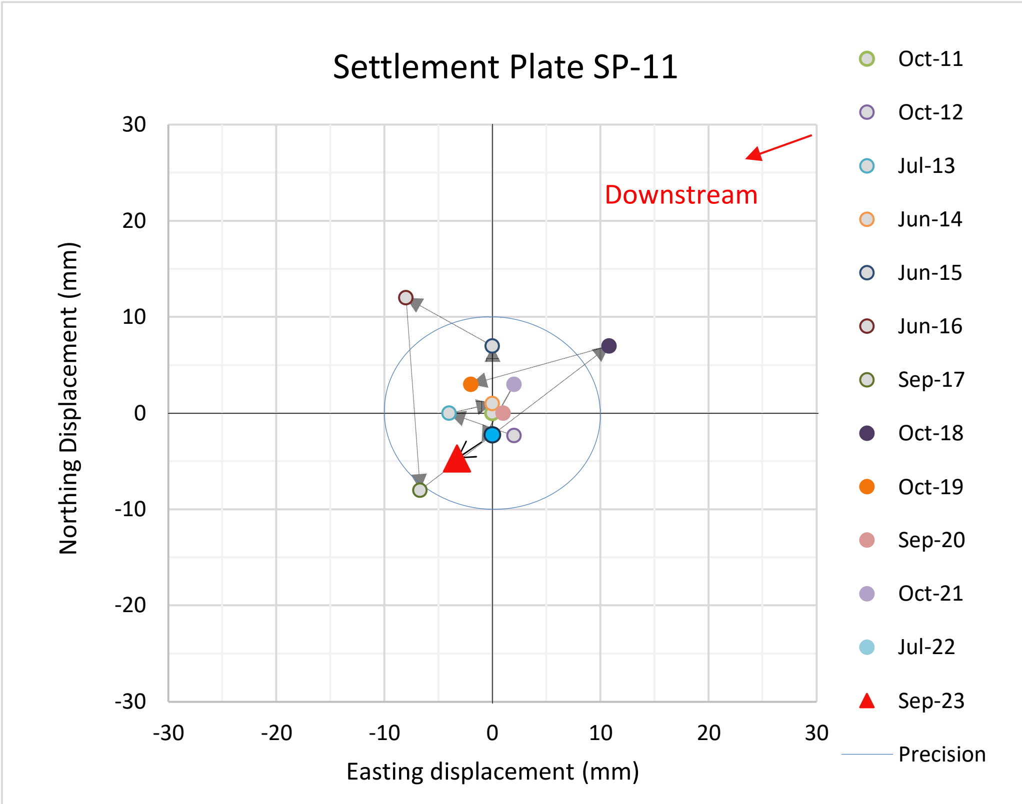


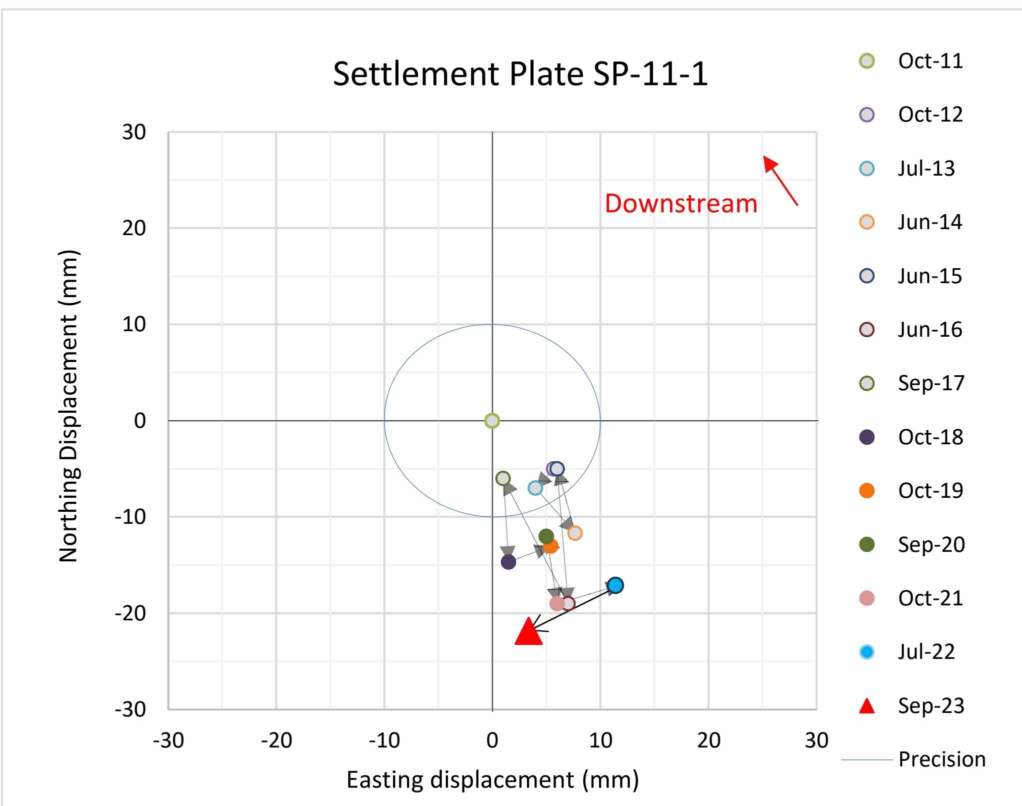
Schematic Vector of Downstream Direction



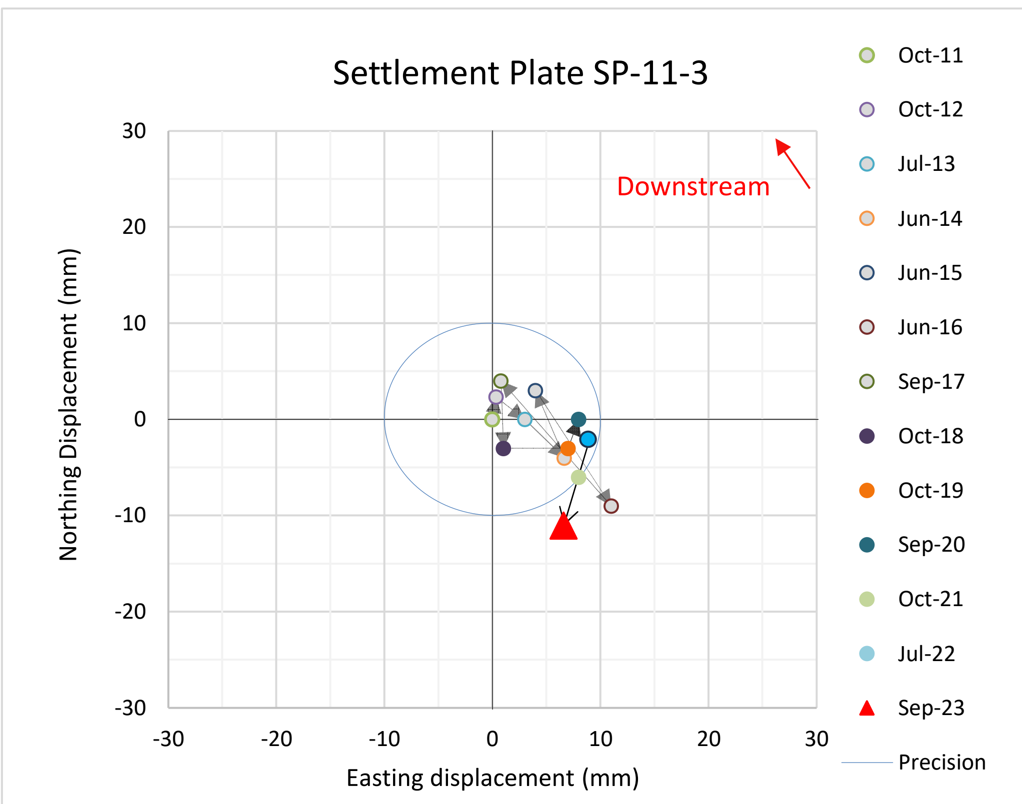


Schematic Vector of Downstream Direction

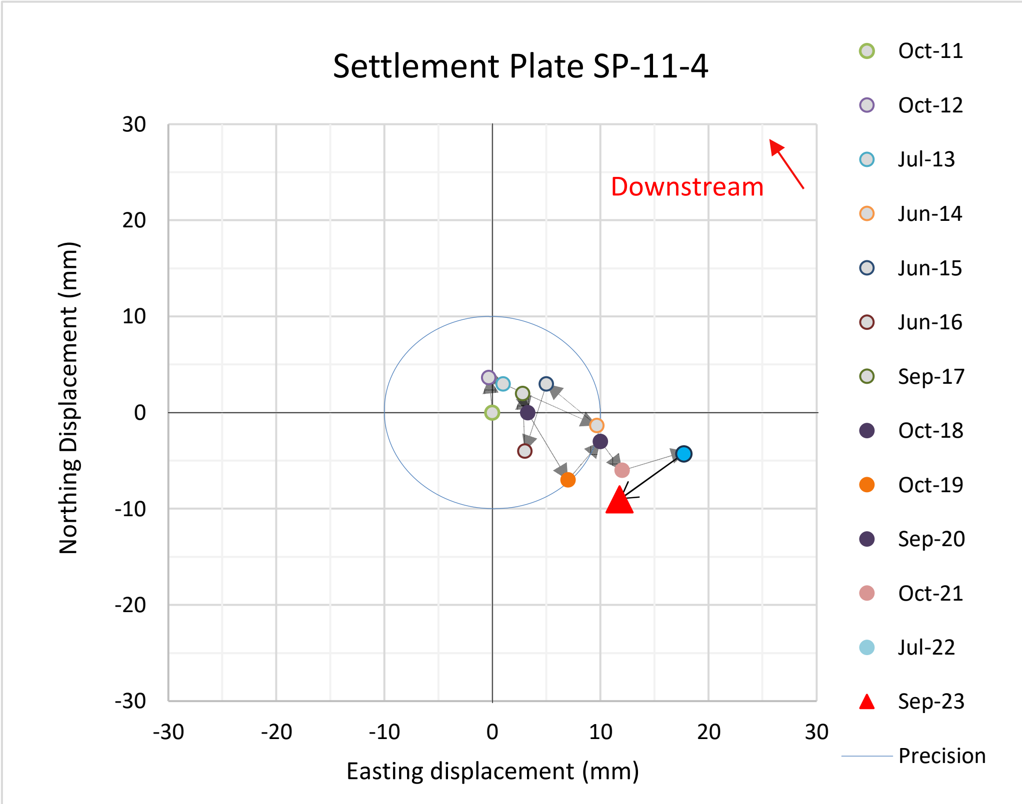


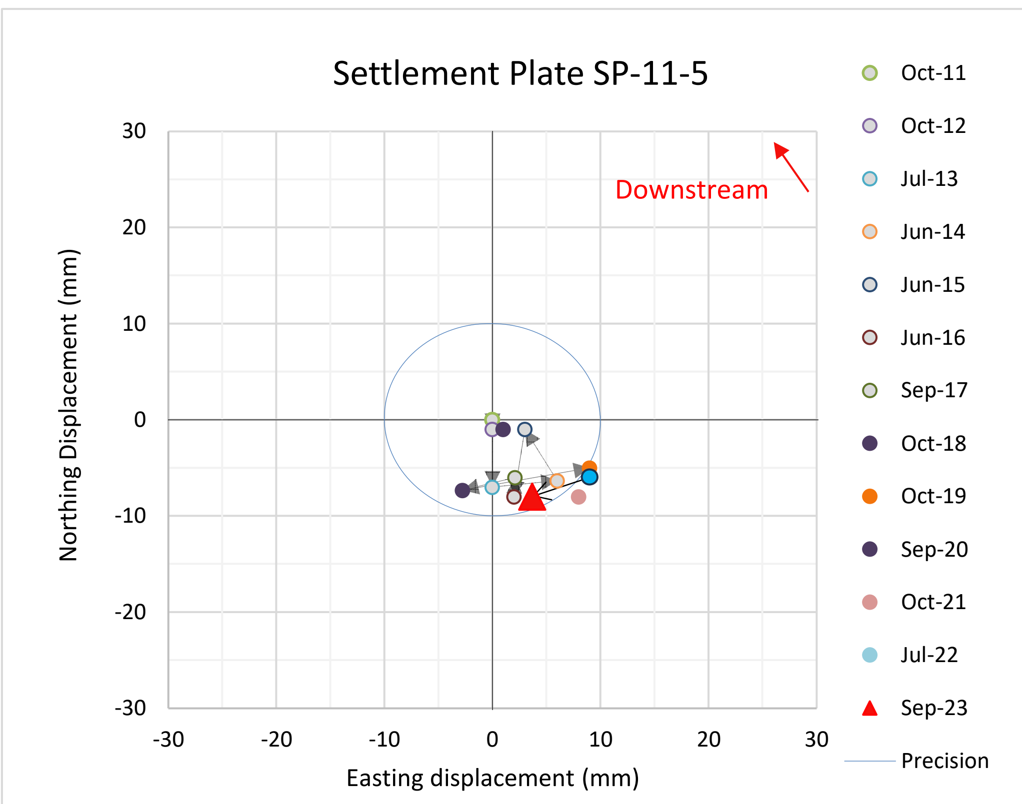


Schematic Vector of Downstream Direction

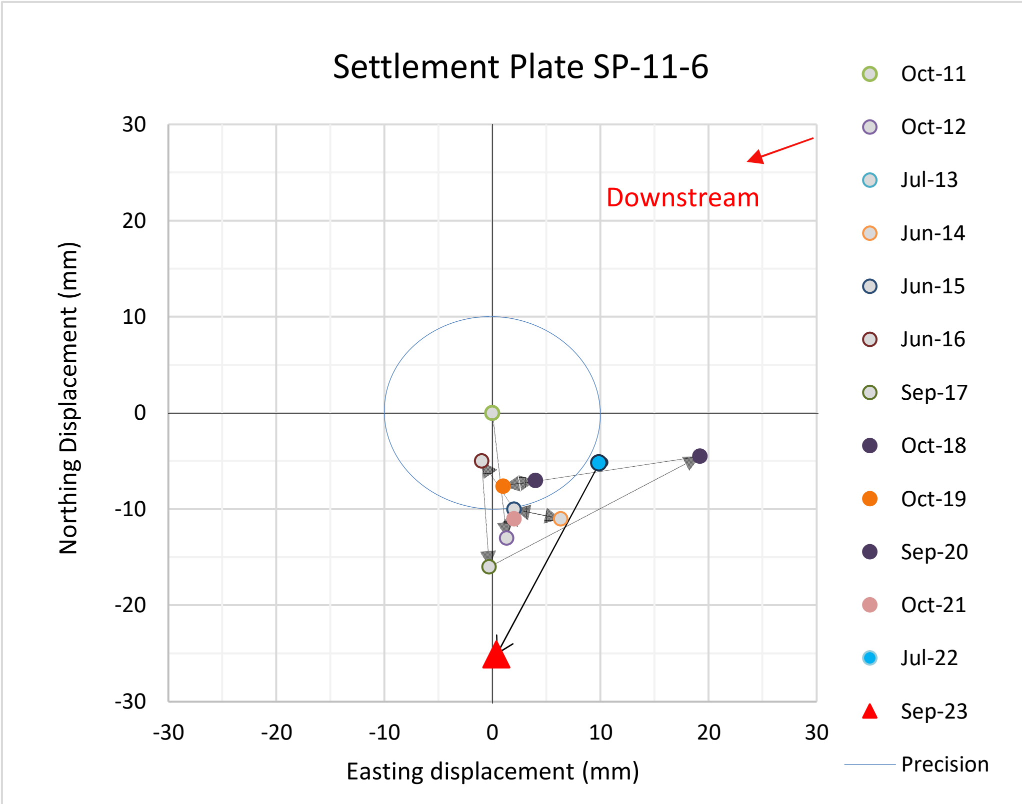


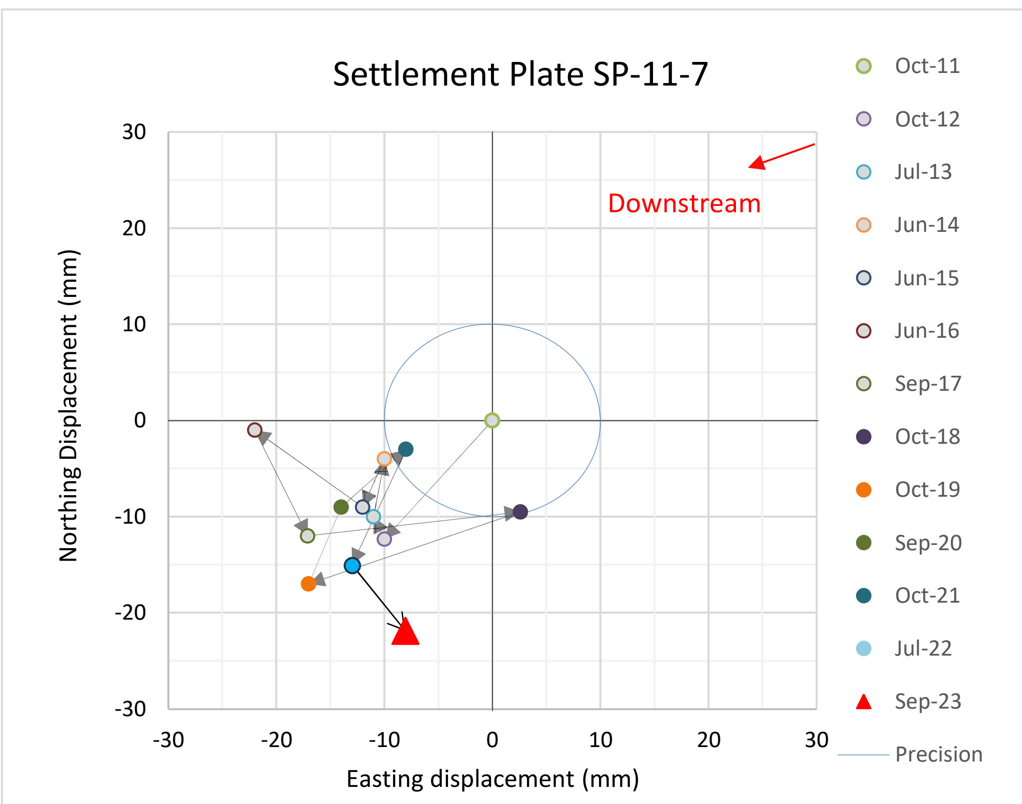
Schematic Vector of Downstream Direction



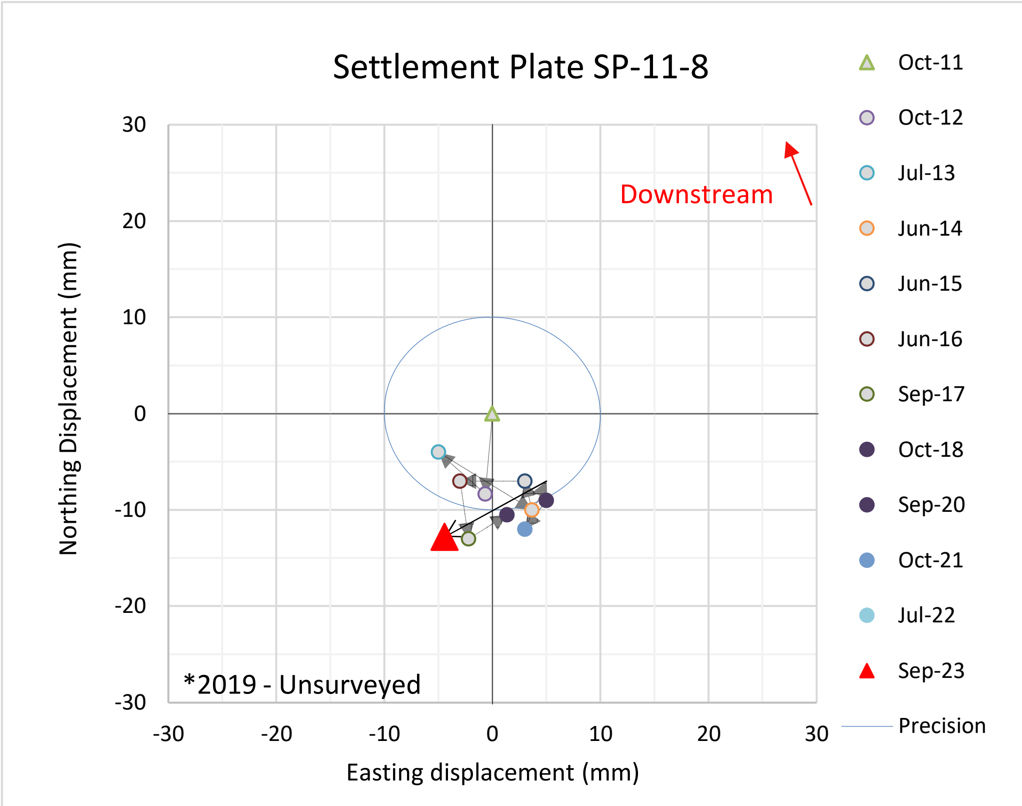


Schematic Vector of Downstream Direction





Schematic Vector of Downstream Direction



Schematic Vector of Downstream Direction

WSP Canada Inc.