APPENDIX A: GEOTECHNICAL REPORT

Tetra Tech Inc.

Lagimodiere Blvd Twin Overpass Rehabilitation Preliminary Design - (RFP No. 111-2022)

Prepared for:
Jeff Crang, P.Eng.
Tetra Tech Inc.
400-161 Portage Ave East
Winnipeg, Manitoba
R3B 0Y4

Project Number: 0002-130-00

Date: August 13, 2025

TREK
GEOTECHNICAL
Quality Engineering | Valued Relationships

August 13, 2025

Our File No. 0002-130-00

Jeff Crang, P.Eng.
Tetra Tech Inc.
400-161 Portage Ave East
Winnipeg, Manitoba
R3B 0Y4

RE: **Lagimodiere Blvd Twin Overpass Rehabilitation**
Preliminary Design - (RFP No. 111-2022)
Geotechnical Report

TREK Geotechnical Inc. is pleased to submit our Preliminary Design Geotechnical Report for the for the above noted project.

Please contact the undersigned should you have any questions.

Sincerely,

TREK Geotechnical Inc.
Per:

Kent Bannister, M.Sc., P.Eng.
Senior Geotechnical Engineer

Encl.

www.trekgeotechnical.ca
1712 St. James Street | Winnipeg, Manitoba R3H 0L3 | Tel 1.204.975.9433 | Fax 1.204.975.9435

Revision History

Revision No.	Author	Issue Date	Description
0	MK	August 25, 2023	Draft Report
1	MK	November 7, 2023	Revised Draft Report
2	MK	August 13, 2025	Revised Final Report

Authorization Signatures

Prepared By:

2025/08/13
M.D.
KLYMOCHKO
Member
37605

Matt Klymochko, P.Eng.
Geotechnical Engineer

ENGINEERS
GEOSCIENTISTS
MANITOBA
Certificate of Authorization
TREK GEOTECHNICAL INC.
No. 4877

Reviewed By:

Michael Van Helden, Ph.D., P.Eng.
Senior Geotechnical Engineer

Kent Bannister, M.Sc., P.Eng.
Senior Geotechnical Engineer

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 Introduction

This report provides geotechnical recommendations prepared by TREK Geotechnical Inc. (TREK) for Preliminary Design of Rehabilitation Works for the Lagimodiere Boulevard Twin Overpasses, which includes a Functional Design of future roadway widening to six lanes (three per direction). The terms of reference for this work are included in our contract with Tetra Tech Inc. (TT) dated April 29, 2022. TREK's scope of work for the project includes a review of existing information, site reconnaissance, sub-surface investigations and laboratory testing, slope stability analysis, provision of geotechnical design recommendations for the proposed bridge rehabilitation and functional roadway design.

2.0 Background Information and Site Conditions

The existing multi-span overpass consists of twin structures crossing Concordia Avenue and Canadian Pacific Rail (CPR) Keewatin along Lagimodiere Boulevard (PTH 59 / Route 20). The structures were constructed in 1967, with deck rehabilitation in 1978, and cantilever deck overhang modifications in 1987. The bridges are approximately 122 m long, with five approximately equal spans, and each structure conveys two lanes of traffic in the northbound and southbound directions. The bridge has a relatively high skew angle at 35 degrees. Based on record drawings and borehole logs provided on the structural drawings, the bridges are founded on 356 mm (14") precast prestressed concrete hexagonal (PPCH) piles driven to refusal in till. The foundation units consist of 17 piles per pier and 42 piles per abutment; abutment piles were spliced using steel plates cast into the tips of the piles and field welded.

The roadway embankments stand approximately 10 m tall, with head slope angles of 3.7H:1V (horizontal to vertical), and side slope geometries consisting of 3H:1V upper and lower slopes with a mid-slope bench that is up to 10 m wide (resulting in an overall slope that ranges from 3.5:1 to 5H:1V). The embankments consist of compacted clay fill overlying a 0.6 m thick sand blanket placed over the native clay subgrade. There is no information suggesting that the subgrade was crowned prior to placement of the sand blanket.

A total of nine shallow slope instabilities have occurred on the side and head slopes of both north and south approach embankments for the overpass, five of which occurred in 1993 and four occurred in 2007. These shallow slope instabilities were repaired using a combination of excavating existing materials, replacing with rockfill, constructing clay berms, filling in tension cracks and regrading at flatter slopes. Instabilities observed in 2007 on the lower east side of the south embankment have since re-activated, indicating ongoing movement in the areas where tension cracks were observed (Photos 01 and 02).

Adjacent to the west side of the south embankment is a City of Winnipeg storm retention pond (4-12). Retention pond 4-12 is approximately 6 m deep with 4H:1V original side slopes. A slope stability assessment by KGS Group in 2001 was performed in response to an 80 m long instability of the east side slope, and a 30 m long instability at the east end of the south side slope. The assessment concluded that the pond slopes should be regraded to 7H:1V (where already failed) and to at least 5.5H:1V (where un-failed). Record drawings from 2003 indicate that a 1 m thick riprap toe berm was added to all slopes (entire pond perimeter) and areas within the failed zones were flattened further by thickening the toe berm to 2 m; the south instability head scarp was infilled with granular fill. Trench drains were also installed along the crest (longitudinally) and perpendicular to the slope (transverse) on the east side slope. Since the repairs, active slope movements have been observed on the south slope immediately west of the area stabilized in 2001 (Photo 03), and the north-west slope of the pond (Photo 04). These movements appear to have similar geometry to the previously observed instabilities and appears to have occurred since 2015 based on aerial photography.

2.1 Project Description

The City of Winnipeg requires a preliminary design for bridge rehabilitation, as well as a functional design for future roadway widening, to confirm that the “near-term” (current) bridge rehabilitation design will not impede the future widening to 6 lanes of travel. The existing sub-structures may require foundation underpinning to support the increased loading from the new structure.

The project will include rehabilitation of the existing bridge structure on Lagimodiere Boulevard (PTH 59 / Route 20) crossing Concordia Avenue and the existing CPR tracks. Associated with the bridge work are increased embankment widths for new lanes and a wider bridge, and the construction of an active transport (AT) underpass in line with Ravelston Avenue and Callsbeck Avenue. Preliminary drawings prepared by TT are provided in Appendix A.

Bridge Embankment Widening

The widening of the bridge embankments will require additional fill to accommodate an extra lane in both directions and wider shoulders. The bridge embankments are anticipated to be raised by 270 mm and be widened by placing fill based on one of the following options:

- Option 1: Widening both northbound/southbound lanes outwards by placing fill on the upper slopes of both the west and east sides of the approach embankments.
- Option 2: Widening both northbound/southbound lanes westward by placing fill predominantly on the west side of the embankments and infilling the existing median ditch.
- Option 3: Widening both directions inwards by infilling the existing median ditch with limited outward widening.

Additionally, stabilization of the existing shallow slope instabilities along the lower east side of the south embankment is required. The observed instabilities are generally consistent with shallow, saturation induced instabilities which are commonly observed in cut or fill slopes during periods of high precipitation or water infiltration, in some cases several decades after construction. Further, record drawings from the 2007 slope repairs at other instability locations indicated the base of the slip surfaces coincided with the sand blanket that underlies the embankment fill. It is possible that the sand blanket has settled beneath the embankment and may not be properly draining. It may also be possible that the sand blanket has become blocked off and may not be able to drain water from beneath the embankment, concentrating excess porewater pressures in localized areas near the slope toe, where slope instabilities have been observed.

Active Transport Corridor and Retention Pond 4-12

The AT route will cross Lagimodiere via an underpass in line with Ravelston Avenue and Callsbeck Avenue which is anticipated to be consist of a 6 m wide by 3 m tall box culvert. The AT route will continue west from the underpass along Callsbeck Avenue and is planned to be constructed either along the top of slope on the south side of Pond 4-12 (Option 1), or on the shoulders of the existing roadway (Option 2). In either scenario stabilization of the existing slopes of Pond 4-12 are required to facilitate the AT route.

TREK understands that there may be advantages to completing repairs for the movements observed on the north-west slope at the same time as work is being completed to stabilize the south edge of the pond. Although the observed movements of the north-west slope do not impact the AT corridor, movements could retrogressively continue outside of City property limits and into the Canadian Pacific (CP) Rail right of way. In this regard the potential stabilization of the north-west instability was also evaluated, as requested by the City.

2.2 Existing Information

Available background information provided by the City of Winnipeg was reviewed. The available information includes reports, structure drawings, and record drawings of slope repair and remediation works. A summary of the remediation work previously completed on the embankments is provided in Table 01.

1. **Embankment Slope Failures Design and Construction of Remedial Work - KGS Group, 1994:** Contains information relative to instabilities observed at the Lagimodiere Overpass at Concordia on the head slope and the west and east sides of the south embankment. A slope stability assessment, test hole logs and proposed remedial works are provided.
2. **Upgrading of the 4-12 Storm Retention Pond – Supplementary Slope Stability Evaluation – KGS Group, 2001:** Contains information relative to instabilities observed at the retention pond on the south and east slopes. Slope stability assessments, test hole logs and proposed remedial works are provided.
3. **Stormwater Retentions Basin 4-12 Slope Regrading and Rockfill Berm As-Built Drawings – KGS Group, 2003:** Record drawings of the remediation works for stabilization of the east side of the pond and south east edge. Remediation included flattening slopes on the east side to 8H:1V, and placing granular fill and a rockfill toe berm on the south east slope instability.
4. **As-Built Drawings – Dillon Consulting / KGS Group, Various Dates**. Details of the as-built record drawings for embankment stabilization works on the north and south embankments. Details are summarised in Table 01.
5. **Record Drawings – Dillon Consulting / City of Winnipeg, 1978, 2004.** Record drawings and details of pavement repairs and asphalt resurfacing of approach embankments on both the north and south bound lanes. Record drawings display approach embankment profiles prior to resurfacing and repairs.

Table 01 - Summary of Previously Completed Embankment Stabilization Works

Year	Embankment / Slope	Location	Approx. Length	Ref. Dwg. / Treatment
1993	North, West Side, Lower Slope	25 m North of SB North Abutment	40 m	B123-1993: Excavate and replace with rockfill, 4H:1V regrading
	South, West Head Slope, Lower Slope	Immediately West of SB South Abutment	20 m	B123-93-02: Excavate and replace with rockfill, 5m wide toe berm.
	South, West Side, Upper Slope	25 m South of SB South Abutment	55 m	B123-93-03: Excavate and replace upper instability with rockfill (60 m long), lower toe clay berm (80 m long, 5H:1V slope)
	South, West Side, Lower Slope	55 m South of SB South Abutment	25 m	
	South, East Side, Upper Slope	10 m South of NB South Abutment	35 m	B123-93-03: Excavate and replace instability with rockfill (40 m long), use excavated soil to construction upper slope clay berm (45 m long, 4H:1V) to the south.
2007	North, East Side, Lower Slope	In-line with NB North Abutment (deck drain outlet)	28 m	B123-07-01/02: Fully-excavate instability, replace with clay base and rockfill for drainage. Install new CSP deck drain pipe. Regrade to 5H:1V.
	North, West Side, Lower Slope	In-line with SB North Abutment (deck drain outlet)	26 m	
	South, East Side, Lower Slope	± 150m South of abutment	48 m	B123-07-04: Excavate and recompact clay soils in tension crack (2 m deep, 4 m wide)
	South, East Side, Lower Slope	In-line with NB South Abutment	37 m	B123-07-03: Excavate and recompact clay soils in tension crack (2 m deep, 3 m wide)

3.0 Sub-surface Investigation

TREK drilled seventeen test holes as part of the preliminary design scope to evaluate soil conditions for the proposed embankment widening, existing foundation assessment, and retention pond stabilization. Test holes were drilled under the supervision of TREK personnel to determine the soil stratigraphy and groundwater conditions at the site. Details of the subsurface investigation are provided below:

- **TH22-01 to 06:** Test holes were drilled between September 12 to 15, 2022 by Paddock Drilling Ltd. using an Acker MP8 truck-mounted rig (TH22-01 to 05), and Acker MP5 track-mounted rig (TH22-06). A slope inclinometer (SI) was installed at 12.7 m depth, and two vibrating wire (VW) piezometers were installed at depths of 3.1 m and 7.6 m below ground surface in TH22-06.
- **TH22-07 to 14:** Test holes were drilled on October 14, 2022 by TREK using a 50 mm diameter hand auger. Standpipe piezometers (SP) were installed between 3.0 m and 3.4 m depth in each test hole. The SP's were also used to monitor for shear movements (if active).
- **TH23-15 to 17:** Test holes were drilled between April 4 and 5, 2023 by Paddock Drilling Ltd. using a Mobil B57 track-mounted rig. Slope inclinometers were installed in TH23-15, 16 and 17 at 14.6 m, 13.1 m, and 12.2 m depth, respectively. A SP was also installed in the till and two VW piezometers were installed in the clay 1.5 m east of TH23-15 at depths of 14.2 m, 4.6 m, and 10.7 m, respectively.

The test hole locations and elevations were surveyed by TREK using an RTK GPS. Test hole logs are attached describing the soil units encountered and other pertinent information such as test hole location, elevation (local), groundwater conditions and a summary of the laboratory testing results. Test hole locations from the preliminary investigations are shown on Figures 02, 04 and 07.

Sub-surface soils encountered during drilling were visually classified based on the Unified Soil Classification System (USCS). Disturbed (auger cutting and split spoon) samples were obtained at regular intervals and relatively undisturbed (Shelby tube) samples were collected at select depths. All samples retrieved during drilling were transported to TREK's testing laboratory in Winnipeg, Manitoba. Laboratory testing consisted of moisture content determination on all samples, Atterberg Limits and grain size analyses (hydrometer and sieve method) were determined on select samples. Bulk unit weight measurements, consolidation (oedometer) tests, direct shear, and unconfined compression tests were performed on select Shelby tube samples. Laboratory testing results are included in Appendix B.

3.1 Soil Stratigraphy

A brief description of the soil units encountered during drilling is provided below. All interpretations of soil stratigraphy for the purposes of design should refer to the detailed information provided on the attached test hole logs.

3.1.1 *Lagimodiere Blvd. Overpass and Pedestrian Underpass (TH22-01 to TH22-05)*

Test hole TH22-01 was drilled at the pedestrian underpass location, while test holes TH22-02 to 05 were drilled along the bridge crossing, as shown on Figure 02. The soil stratigraphy at the Lagimodiere Blvd. Overpass and Pedestrian Underpass structures generally consists of fill materials (asphalt, concrete, sand, clay) overlying silty clay, silt till, and limestone bedrock. A stratigraphic profile of the bridge crossing is shown on Figure 03. The existing fill is up to 10.5 m thick at the abutments for the bridge. Asphalt and gravel fill were encountered at the surface of TH22-01, 04 and 05. Clay fill was encountered at the surface of TH22-02 and 03, and below the asphalt/gravel fill in TH22-01, 04, and 05. The clay fill is up to 1.5 m thick in TH22-04 and 05, and up to 9.5 m thick (depending on where it was drilled in the embankment). The clay fill is silty, containing trace sand, trace gravel, is grey and brown, moist stiff to very stiff and of high plasticity. Sand fill was encountered at 1.5 m depth (1.5 to 1.8 m thick) and at the bottom of the clay fill at approximate El 231.0 m (1 m thick) in TH22-02 and 03 in the embankments. The sand fill layers contain trace to some gravel, are compact and consist of poorly graded medium sand to fine gravel.

Native silty clay was encountered below the fill soils in all test holes. The silty clay is brown and grey, moist, and of high plasticity, and stiff to very stiff, becoming firm with depth. A layer of silt ranging from 0.6 to 0.9 m thick was encountered within the silty clay between elevations of approximately 228 and 230 m. Silt till was encountered in all test holes at elevations ranging between 215.5 and 217.5 m. The till is a heterogenous mixture of clay, sand, and gravel within a predominately silt matrix and is known to contain cobbles and boulders. The till is light grey, moist, loose to compact and of no to low plasticity, becoming dense to very dense with depth. Dolomitic limestone bedrock was encountered in

TH22-04 and 05 at elevations of 214.8 and 214.5 m, respectively, extending to the maximum depth of exploration (El. 209.3 m).

3.1.2 South Embankment Lower East Slope Instabilities (TH22-07 to TH22-14)

Test holes TH22-07 to 14 were drilled within observed areas of active embankment instabilities lower east side of the south embankment at the locations shown on Figure 04. The soil stratigraphy consists of organic clay overlying clay fill, silty clay and silt, as shown on cross-sections on Figures 05 and 06. A veneer of organic clay (topsoil) was encountered at the surface of all test holes. The organic clay is silty, containing trace rootlets, is brown to black, moist, firm and of high plasticity. Clay fill was encountered beneath the organic clay (topsoil) ranging from 0.7 to 2 m in thickness. The clay fill is silty, contains trace sand, trace fine gravel, is brown and grey, moist, stiff and of high plasticity. Sand fill was encountered beneath the clay fill in TH22-13 and 14. The sand fill is brown, moist to wet, loose to compact and consists of poorly graded fine sand to fine gravel.

A layer of organic clay (topsoil) was encountered beneath the clay fill or sand fill in TH22-09 to 12 and TH22-14, ranging in thickness from 0.2 to 0.4 m. The organic clay is silty containing some rootlets, is black, moist, stiff to very stiff and of high plasticity. Silty clay was encountered beneath the clay fill or organic clay in all test holes. The silty clay is brown to grey, moist, of high plasticity and ranges from firm to very stiff. Silt, approximately 0.3 to 0.7 m thick, was encountered between elevations of 229 and 230 m in test holes TH22-07, 08 and 10 to 12. The silt contains some clay, trace sand, is brown, moist to wet, soft to firm and of low plasticity.

3.1.3 Retention Pond 4-12 (TH22-06, TH23-15 to 17)

Test holes 22-06 and 23-17 were drilled within the south slope instability of pond 4-12, while TH 23-15 and 16 were drilled on the north-west slope. The soil stratigraphy at retention Pond 4-12 generally consists of organic clay (topsoil) or riprap overlying silty clay and silt till. Organic clay (topsoil) was encountered at the surface of TH22-06 and TH23-15, located at the top bank of the retention pond. The organic clay is silty, contains some rootlets, is dark brown to black, moist, firm and is of high plasticity. Riprap was encountered at the surface of TH23-16 and 17 at the normal operating level of the pond shoreline. The riprap consists of approximately 350 mm down quarried limestone, based on a visual assessment of exposed riprap at ground surface. Silty clay was encountered beneath the organic clay or riprap in all test holes. The silty clay is brown and grey, moist, firm to stiff and of high plasticity, becoming grey and soft with depth. Silt till was encountered in all test holes at elevations ranging between 218 and 220.5 m. The till is a heterogenous mixture of clay, sand, and gravel within a predominately silt matrix. The till in the Winnipeg area commonly contains cobbles and boulders. The till is light grey, moist, loose to compact and of no to low plasticity, becoming dense to very dense with depth. The till became gravelly and dense to very dense in all test holes below El. 216 m, and became sandy below El. 214.5 m in TH23-16.

3.2 Power Auger Refusal

Power auger refusal was encountered in the silt till in test holes TH22-01 to 03, TH22-06 and TH23-15 and 16. Table 02 provides a summary of refusal depths encountered during the sub-surface investigation.

Table 02: Power Auger Refusal

Test Hole ID	Depth of Power Auger Refusal (m)	Power Auger Refusal Elevation (m)
TH22-01	21.4	214.2
TH22-02	25.7	215.1
TH22-03	25.2	215.0
TH22-06	12.7	218.1
TH23-15	15.5	214.8
TH23-16	13.7	214.0

3.3 Groundwater Conditions

Table 03 provides a summary of the seepage and sloughing conditions observed, and instrumentation installed during the sub-surface investigations. Vibrating wire piezometers were connected to data loggers following installation, and groundwater levels within the standpipe piezometers were measured on several occasions following the sub-surface investigation. The measured groundwater levels from VW and standpipe piezometers are summarized in Table 04. Plots summarizing the piezometer monitoring are included in Appendix C. This initial groundwater monitoring data based on the VW's installed around retention Pond 4-12 suggests that there is generally downward flow near the top of the slope in the retention pond. It is considered likely that the lower water elevations in SP 15 represent lag in the piezometer (i.e., the SP is not in equilibrium with till water levels).

Table 03: Depth of Observed Seepage and Sloughing

Test Hole ID	Depth of Observed Seepage (m)	Depth of Observed Sloughing (m)	Soil Unit	Instrumentation Installation and Depth (m)
TH22-01	6.4 to 7.3	6.4 to 7.3	Silt	-
TH22-02	9.7 to 10.7	9.7 to 10.7	Sand (Fill)	-
TH22-03	1.5 to 3.4 9.1 to 10.2	1.5 to 3.4 9.1 to 10.2	Sand (Fill)	-
TH22-04	2.6 to 3.1	2.6 to 3.1	Silt	-
TH22-05	2.1 to 3.1	2.1 to 3.1	Silt	-
TH22-06	-	-	-	SI 06 - 12.7 m VW 06A - 3.1 m VW 06B - 7.6 m
TH22-07	2.4 to 2.7	-	Silt	SP 07 - 3.0 m
TH22-08	2.4 to 3.2	-	Silt	SP 08 - 3.4 m
TH22-09	-	-	-	SP 09 - 3.0 m
TH22-10	Below 2.4	-	Organic Clay	SP 10 - 3.0 m
TH22-11	Below 2.6	-	Clay	SP 11 - 3.0 m
TH22-12	Below 2.9	-	Silt	SP 12 - 3.0 m
TH22-13	2.1 to 2.8	-	Sand (Fill)	SP 13 - 3.0 m
TH22-14	1.8 to 2.0	-	Sand (Fill)	SP 14 - 3.0 m
TH23-15	Below 12.2	Below 12.2	Silt (Till)	SI 15 - 14.6 m SP 15 - 14.2 m VW 15A - 4.6 m VW 15B - 10.7 m
TH23-16	Below 9.1	Below 9.1	Silt (Till)	SI 16 - 13.1 m
TH23-17	Below 9.1	-	Silt (Till)	SI17 - 12.2 m

Table 04: Piezometric Monitoring Data

Test Hole ID	Instrument ID, Tip Depth, and (Tip Elevation)	Ground Elevation (m)	Monitoring Dates				
			Oct. 14, 2022	Nov. 29, 2022	April 14, 2023	May 11, 2023	June 15, 2023
TH22-06	VW 06A - 3.1 m (El. 227.60 m)	230.70	229.98	229.32	229.39	229.89	229.59
	VW 06B - 7.6 m (El. 223.10 m)		228.76	229.06	228.86	229.19	228.95
TH22-07	SP 07 - 3.0 m (El. 229.85 m)	232.85	230.45	230.90	-	-	230.56
TH22-08	SP 08 - 3.4 m (El. 229.19 m)	232.59	229.36	230.83	-	-	230.57
TH22-09	SP 09 - 3.0 m (El. 230.21 m)	233.21	dry	230.87	-	-	230.72
TH22-10	SP 10 - 3.0 m (El. 229.77 m)	232.77	230.31	230.80	-	-	230.69
TH22-11	SP 11 - 3.0 m (El. 227.60 m)	232.91	230.34	230.84	-	-	230.76
TH22-12	SP 12 - 3.0 m (El. 230.04 m)	233.04	230.29	230.14	-	-	230.74
TH22-13	SP 13 - 3.0 m (El. 230.72 m)	233.72	231.11	231.07	-	-	231.06
TH22-14	SP 14 - 3.0 m (El. 230.18 m)	233.18	230.23	230.13	-	-	231.13
TH23-15	SP 15 - 14.2 m (El. 216.14m)	230.34	-	-	223.44	224.79	223.15
	VW 15A - 4.6 m (El. 225.74 m)		-	-	229.41	228.13	229.16
	VW 15B - 10.7 m (El. 219.64 m)		-	-	229.28	228.11	229.08

These observations are short-term and should not be considered reflective of (static) groundwater levels at the site which would require monitoring over an extended period of time to determine. It is important to recognize that groundwater conditions may vary seasonally, annually, or as a result of construction activities.

3.4 Slope Inclinometer Monitoring

The SI's installed in TH22-06 and TH23-15 are located at the top of the slope within the slide areas of the south and north-west sides of the pond, respectively. The SI's installed in TH23-16 and 17 are located in the mid-slope area at the top of riprap on the south and north-west sides of the pond, respectively. The tips of all inclinometer pipes are anchored approximately 2 to 4.5 m into silt till. The SI locations are shown on Figure 07.

Baseline readings of TH22-06 were taken on October 12, 2022 and were followed by five monitoring events between January and June 2023. Baseline readings on TH23-15 to 17 were taken on April 14, 2023 and were followed by three monitoring events between May and June, 2023. The baseline measurement establishes the initial shape of the SI pipe, and subsequent monitoring events are compared to the original baseline survey to identify changes in the pipe shape that may indicate slope movement. The cumulative and incremental horizontal displacement plots for the inclinometer is attached in Appendix D. Slope movements were observed in TH22-06 and TH23-15 at approximately 2-3 m below ground level (Elevation 227 to 228.5 m). Slope movements were not measured in either downslope SI (TH23-16 and 17) for any of the monitoring events.

In TH22-06 cumulative movements of 8 mm in the A+ (downslope) and 3 mm in the B+ (perpendicular to slope) directions at an elevation of approximately 228 to 229 m. Incremental movements of approximately 5 mm were measured at elevation 228.5 m between May and June 2023.

In TH23-15 cumulative movements of 3 mm in the A+ (downslope) and 1 mm in the B+ (perpendicular to slope) directions at an elevation of approximately 227 to 228 m. Incremental movements of approximately 1 mm were measured at elevation 227.5 m between May and June 2023.

It is important to note that the monitoring period was relatively short and a longer monitoring period that encompasses critical groundwater events (e.g. flood or drawdown events) may be required to confirm if any deep-seated movements (i.e. extending to the pond invert) are occurring.

3.4.1 *Slope Movement Monitoring – South Embankment Standpipe Piezometers*

The standpipes installed in TH22-07 to 22-14 were also used to monitor for shear movements. If differential shear movement develops within the depth of the standpipe, the relatively flexible PVC standpipe will deform with the surrounding soil at the shear plane, whereas a stiff steel pipe lowered within the standpipe will encounter resistance at the depth of movement, or may be impassable for larger movements.

A galvanized steel pipe (3.3 m long) was lowered into each standpipe to detect zones of differential shear movements. Following the installation in October 2022, monitoring events were completed in November 2022 and June 2023 to determine if any movement has occurred. In both events the steel pipe was lowered to the bottom of standpipe without resistance, suggesting that movement did not occur over the monitoring period.

An extended monitoring period that encompasses a period of elevated groundwater levels may detect movements triggered by such conditions.

4.0 Embankment Settlement

Consolidation settlement where new fill is placed to widen the lanes of the embankment (necessary to raise road grades) should be expected. One-dimensional consolidation settlement analysis was completed to estimate settlement remaining as a result of original embankment construction and additional settlement that should be anticipated based on a 2.2 m fill height (the maximum height of fill to be placed) and the geometries included in Appendix A.

4.1 Consolidation Parameters

Two oedometer tests were performed on clay samples in TH22-02 located at the centerline of the south abutment. A summary of the parameters established from the lab testing is presented in Table 05 and test results are provided in Appendix B.

Table 05: Consolidation Parameters

Sample ID	Sample Depth (m)	Sample Elevation (m)	Cc	Cr	σ'_{zc} (kPa)	OCR[1]
T30	15.5	225.25	0.607	0.218	270	1.2
T33	21.5	219.25	0.709	0.240	200	0.8

Note 1: Over Consolidation Ratio (OCR) is based on estimated pre-consolidation stresses and anticipated stresses resulting from fill placement.

An average coefficient of consolidation (c_v) of $1.0\text{x}10^{-8}$ m^2/s was selected by TREK to represent the range between an upper and lower bound established in the oedometer tests. The range of c_v values chosen is based on load increments from the oedometer that best represent the anticipated stress change in the clay associated with embankment fills. The selected values of c_v ranged between a lower bound of $7.0\text{x}10^{-9}$ m^2/s to an upper bound of $1.2\text{x}10^{-8}$ m^2/s.

4.2 Estimated Embankment Settlement

At the highest fill locations (10.7 m high fill), the total estimated settlement from original embankment construction is estimated to be approximately 1.0 m. Based on this fill height, the length of time the embankments have been in place (56 Years), and the average coefficient of consolidation, we estimate that 50 to 70 % of consolidation is complete, (0.5 to 0.7 m) of settlement has occurred within the fill embankments to date. The analysis was performed assuming 2-way drainage from the clay layer (into the till layer and the sand drainage layer). These results are comparable to TREK's experience with other projects in the Winnipeg area.

Based on previous record drawings of approach slab repairs and asphalt overlays, the approach embankments were raised between 0.2 and 0.3 m in 1978, and between 0.15 and 0.20 m in 2004, suggesting that a total of at least 0.3 to 0.5 m of embankment settlement had occurred in the 37 years following construction. These measurements are in good agreement with calculated settlement estimates of 0.4 to 0.6 m estimated to have been completed by 2004. It is estimated that an additional 0.3 to 0.5 m of settlement should be expected to occur over the next 30 to 40 years from fill placed to construct the existing embankment.

4.3 Future Embankment Settlement

The additional fill required for widening of embankments is estimated to result in an additional 0.1 to 0.2 m of settlement which would be differential with the remaining portions of the embankment where fill is not placed. It is anticipated that 10% of this settlement will occur in the first two years following fill placement, and 90% of settlement will be completed over several decades. Based on the increase in settlement from the fill placement (0.1 to 0.2 m) in addition to the overall settlement still estimated to occur in the embankment (0.3 to 0.5 m), the most cost-effective way to manage this is likely to plan for future maintenance as this settlement occurs, which may require re-surfacing approach slabs or road shoulders.

5.0 Foundation Recommendations

Based on record drawings and borehole logs provided on the structural drawings, the bridges are founded on 356 mm (14”) PPCH piles driven to refusal in till (17 piles per pier, 42 piles per abutment). The PPCH piles were supplied 19.2 m long at the piers, and 27.4 m long at the abutments; abutment piles consist of two 13.7 m long segments spliced together using steel plates cast into the tips of the piles and field welded. The maximum unfactored load per pile indicated on the drawings is 667 kN, which is slightly higher than traditionally used for 356 mm PPCH piles in Winnipeg (625 kN).

Foundation recommendations for existing PPCH piles, along with steel H-piles for potential underpinning are provided below in accordance with CHBDC guidelines.

5.1 Limit States Design (CHBDC)

Limit states design requires consideration of distinct loading scenarios comparing the structural loads to the foundation bearing capacity using resistance and load factors that are based on probabilistic reliability criteria. Two general design scenarios are evaluated corresponding to the serviceability and ultimate capacity requirements.

The **Ultimate Limit State (ULS)** is concerned with ensuring that the maximum structural loads do not exceed the nominal (ultimate) capacity of the foundation units. The ULS foundation bearing capacity is obtained by multiplying the nominal (ultimate) bearing capacity by a resistance factor (reduction factor), which is then compared to the factored (increased) structural loads. The ULS bearing capacity must be greater or equal to the maximum factored load. Table 06 summarizes the resistance factors that can be used for the design of foundations as per the CHBDC depending upon the method of analysis and verification testing completed during construction. The CHBDC also requires that the degree of understanding of soil conditions (which can be classified as either low, typical or high) be assessed in the selection of the resistance factors. Since driven pile refusal is anticipated to occur on bedrock (which is expected to be relatively uniform across the footprint of the structure based on test hole information) and given our extensive experience with the proposed pile types in similar geological conditions in Winnipeg, we consider the current level of understanding at the site to be high. CHBDC also requires that the resistance factor be modified by a consequence factor which ranges from 0.9 for high consequence structures to 1.15 for low consequence structures. The structures for this project are interpreted to be of typical consequence based on the CHBDC guidelines and as such the consequence factor is 1.0.

The **Service Limit State (SLS)** is concerned with limiting deformation or settlement of the foundation under service loading conditions such that the integrity of the structure will not be impacted. The SLS should generally be analysed by calculating the settlement resulting from applied service loads and comparing this to the settlement tolerance of the structure. However, the settlement tolerance of the structure is typically not defined at the preliminary design stage. As such, SLS bearing capacities (or unit resistances) provided are developed on the basis of limiting settlement to approximately 25 mm or less. A more detailed settlement analysis should be conducted to refine the estimated settlement and/or adjust the SLS vertical bearing resistance if a more stringent settlement tolerance is required.

Table 06: ULS Resistance Factors for Foundations (CHBDC, 2014)

Description	Resistance Factor for High Degree of Understanding of Soil Conditions
Shallow foundations with a typical degree of understanding of soil conditions and using empirical analysis	0.60
Deep foundations in compression based on static analysis	0.45
Deep foundations in compression based on dynamic testing	0.55
Deep foundations in tension based on static analysis	0.40

5.2 Existing PPCH Piles

Geotechnical resistances for existing PPCH piles driven to practical refusal within silt till for evaluation of both the ULS and SLS conditions are provided in Table 07.

Based on local experience and allowable stress design methods, 356 mm (14”) PPCH piles driven to refusal on bedrock (limestone) have an allowable axial capacity of 690 kN. As driving records of the existing piles are not available, TREK cannot confirm if existing piles were driven to bedrock or reached refusal in till. In this regard, TREK does not recommend an increase to the existing allowable pile capacity (i.e. SLS capacity). If additional foundation capacity is required for the new structure, underpinning should be completed.

Table 07: Recommended ULS and SLS Pile Capacities for Driven PPCH Piles

Pile Size (mm)	Refusal Criteria (Blows/ 25mm)	Factored ULS Axial Resistance			SLS Axial-Compressive Capacity (kN)
		Compression Capacity (kN)		Uplift Shaft Adhesion (kPa)	
		$\phi = 0.45$	$\phi = 0.55^1$	$\phi = 0.4$	
356	8	865	1,060	10	625

Note 1: Resistance factor of $\phi = 0.55$ requires dynamic pile testing (PDA testing) of existing and/or production piles.

5.3 Driven Steel H-Piles for Underpinning

Driven steel H-piles are likely to reach practical refusal in dolomitic limestone bedrock (at similar or greater depths than existing piles) and are considered suitable to underpin the existing structure or to support a replacement structure. This pile type will derive its resistance with both significant end bearing and shaft adhesion.

Piles driven to refusal on bedrock are commonly designed for the ULS based on the structural strength of the pile section, however due to the variability in rock strength and rock quality, reduced capacities are appropriate for this site based on regional dynamic pile load testing data. Also, while intact bedrock in the region is expected to be medium strong to strong, there is potential for pile damage during driving due to the presence of boulders within the overburden soils. Based on the above factors, we recommend limiting the factored SLS pile capacity to 0.30 F_y A_p, where F_y is the yield strength of the steel (350 MPa) and A_p is the cross-sectional area of the pile section. HP310 x 110 piles driven to practical refusal based on the hammer energy and criteria described below are expected to develop a nominal pile capacity of 3,500 kN, resulting in a factored ULS pile capacity of 1,575 kN (based on a resistance factor of $\phi = 0.45$) and an SLS pile capacity of 1,480 kN

A wave-equation analysis (WEAP) is recommended during detailed design to determine a termination criteria and driving energy such that the desired capacity can be reached without damage being done to the piles, and to aid in confirming the anticipated depth of refusal.

For calculation of pile settlement for the SLS, the pile head settlement under unfactored service loads can be calculated based on 10 mm or less of pile tip displacement plus elastic shortening of the pile.

Steel piles driven to refusal will derive their uplift resistance in skin friction within overburden deposits. For the purposes of uplift resistance calculations, an average ULS skin friction of 10 kPa should be used.

Design Recommendations

1. The weight of the embedded portion of the pile should be neglected in design.
2. Pile spacing should be a minimum of 2.5 pile diameters measured centre to centre. If a closer spacing is required, TREK should be contacted to provide an efficiency (reduction) factor to account for potential group effects.
3. The piles must be structurally designed to withstand the design loads, handling stresses, and driving stresses.

4. All piles should be fitted with driving tips (shoe) to help protect the pile tip during installation. The driving tip must be designed to withstand driving stresses and long-term design load cases.

Installation Recommendations

1. A pile driving system (i.e. pile-driving hammer) capable of delivering at least 350 J per square-centimetre of pile cross-sectional area should be specified for driving steel piles. Delivered energy is the energy transferred to the pile head and is typically less than the potential energy of the ram prior to impact (calculated as the stroke of the hammer times the weight of the ram). For example, the minimum delivered energy for HP310x110 steel H-piles should therefore be 49 kJ. The pile-driving hammer should have the capability of adjusting the fuel setting or stroke to deliver higher energy to the pile during driving if the energy is not sufficient to drive the pile to the required tip elevation. The driving system should also have the capability of adjusting the fuel setting or stroke to deliver lower energy to prevent pile damage upon sudden pile refusal.
2. The efficiency of the driving system (ratio of delivered to potential energy) depends on the type and condition of hammer used, as well as the properties of the soil and pile. The driving system efficiency is typically about 50 to 60% for single-acting diesel hammers and about 85 to 90% for hydraulic drop hammers, although it is not uncommon for values to fall outside this range. TREK can assist in developing specifications for piling hammers once the pile section to be used is known. The actual stroke (for hydraulic hammers) or blow rate (for open-ended diesel hammers) should be monitored during driving at refusal to confirm that the required potential energy is developed.
3. The Contractor should be required to submit a proposed driving system for approval a minimum of 7 days prior to the start of pile driving. The pile driving system should be capable of installing the piles to the required capacity within specified allowable driving stresses. Acceptance of the proposed driving system should be confirmed by driveability analysis (i.e. wave-equation analysis) prior to construction.
4. All piles driven within 5 pile diameters of one another should be monitored for pile heave. If heave is observed, all piles should be checked and piles exhibiting heave should be re-driven to one set of the specified refusal criteria.
5. Pile verticality (plumbness) should be measured on all piles after driving completion has been achieved to check if verticality is within the limits of the structural design. It is common local practice to specify a maximum acceptable percentage that the pile can be out of vertical plumbness (e.g. 2% out of plumb) or out of the specified batter.
6. Inspection of all driven H-piles should be performed by TREK personnel to confirm that the refusal criteria have been met and to record that pile installation has been completed according to the design.
7. Any piles damaged, out of plumb an excessive amount or reaching premature refusal may need to be replaced. The structural designer will have to assess non-conforming piles to determine if they are acceptable. PDA testing with CAPWAP analysis is recommended to verify pile capacity, installation stresses and pile integrity, in particular to any piles exhibiting unusual driving behaviour (e.g. relaxation) or those driven out of alignment, plumbness or not meeting the refusal criteria.

5.4 Downdrag (Negative Skin Friction)

Negative skin friction should only be applied in areas where fill placement has occurred (including fills for existing embankments which are still experiencing consolidation settlement). The existing embankments and underlying compressible clays are anticipated to undergo long-term consolidation settlement which will result in development of negative skin friction along the shafts of new piles and cause dragload on the piles. Dragload may result in excessive forces within driven H-piles.

When evaluating structural capacity of H-piles (not geotechnical capacity), a load combination of downdrag force and unfactored dead load (not live load) should be evaluated to calculate the total force developed within the pile. A unit negative skin friction of 35 kPa should be applied to the box perimeter of the pile within the fill and underlying clays for assessment of dragload.

5.5 Lateral Loads for Driven Piles

The soil response (sub-grade reaction) to lateral loads can be modeled in a simplified manner that assumes the soil around a pile can be simulated by a series of horizontal springs for preliminary design of pile foundations. The soil behaviour can be estimated using an equivalent spring constant referred to as the lateral subgrade reaction modulus (k_s). Table 08 provides the recommended subgrade reaction modulus for the lateral load analysis.

Table 08: Recommended Values for Lateral Sub-grade Reaction Modulus (K_s)

Soil	K_s (kN/m^3)	Approximate Elevation
Stiff Clay (Fill)	6,700 / d	Above 230 m
In-Situ Silty Clay	2,350 / d	230 m to 216 m
Silt Till / Dolomitic Limestone Bedrock	11,000 z/d	Below 216 m

Notes: d = pile diameter, z = depth below ground (road) surface

It should be understood that using the lateral sub-grade reaction modulus assumes a linear response to lateral loading and therefore is only appropriate under the following conditions:

- maximum pile deflections are small (less than 1% of the pile diameter),
- loading is static (no cycling), and
- pile material behaves linear elastically (does not reach yield conditions).

If one or more of these conditions are not met, a more rigorous analysis that includes non-linear behavior of the piles and surrounding soil is required. In this regard, as part of detailed design, a lateral pile analysis that incorporates the material and section properties of the piles, final lateral deflection criteria and a more realistic elastic-plastic model of the soil response to loading should be carried out by TREK to confirm the lateral load capacity of the piles.

5.6 Shallow Foundations – Active Transport Route Underpass

A shallow (mat) foundation founded on stiff silty clay at approximately El. 230 m is a suitable foundation alternative for box culvert proposed for the AT route underpass. Based on TH22-01 drilled at the location of the proposed crossing, the sub-surface soils will consist of approximately 3.3 m of fills overlying native silty clay. Provided that the mat is founded on undisturbed stiff silty clay, foundations can be sized based on a SLS bearing resistance of 100 kPa and a ULS bearing resistance of 150 kPa (based on a resistance factor of $\phi = 0.6$).

The weights of the culvert backfill, road pavement, and any paving materials placed within the culvert should be added to the structural loads in calculation of the applied bearing pressure.

Shallow foundations will be subject to seasonal movements resulting from moisture changes in underlying clay soils. Although difficult to predict these movements could be in the order of 50 mm or more.

Additional Mat Foundation Design Recommendations

1. Mat foundations should be installed on undisturbed stiff silty clay at a minimum depth of 2.4 m below final grade. Should a shallower foundation depth be required, insulation should be incorporated to provide an equivalent frost protection depth of 2.4 m. TREK should be contacted to review the final insulation detail.
2. The foundation should be designed by a qualified structural engineer to resist all applied loads from the proposed structures.
3. Lateral and eccentric loading on the foundation will result in the development of overturning and uplift forces and consequently a non-uniform applied pressure distribution under footings. In this regard, the maximum applied pressure should not exceed the ULS unit bearing resistance and the minimum applied pressure should not be less than 0 kPa. Sliding should be examined based on horizontal forces determined at the foundation level by the structural design engineer.

Additional Mat Foundation Installation Recommendations

1. Organics, silts, and any other deleterious materials should be stripped away such that the bearing surface consists of undisturbed native stiff silty clay.
2. The bearing surface should be protected from freezing, drying, inundation and disturbance at all times. If any of these conditions occur, the disturbed soils should be removed in their entirety such that the bearing surface consists of undisturbed stiff silty clay.
3. Excavations for foundations should be completed by an excavator equipped with a smooth bladed bucket operating from the edge of the excavation. The contractor should work carefully to minimize disturbance to the exposed bearing surface. Construction equipment should not be permitted to travel on the bearing surface.
4. The final bearing surface should be inspected and documented by TREK to verify the adequacy of the bearing surface and proper installation of the foundation.

5.7 Adfreeze

Piles and other buried structures subjected to freezing conditions should be designed to resist adfreeze and uplift forces related to frost action acting along the vertical face of the member within the depth of frost penetration (2.4 m). Adfreeze forces will be resisted by structural dead loads and uplift resistance provided by the length of the pile below the depth of frost penetration.

The following design recommendations apply to piles subject to adfreeze forces:

1. An adfreeze bond stress of 65 kPa for concrete or 100 kPa for steel should be used within the depth of frost penetration (2.4 m).
2. A load factor (α) of 1.2 may be used in the calculation of adfreezing forces.
3. A reduction factor of 0.8 may be used in calculation of the geotechnical resistance with an average nominal (unfactored) skin friction of 35 kPa.
4. The calculated geotechnical resistance plus the structural dead loads must be greater than the factored adfreezing forces.
5. Measures such as rigid polystyrene insulation could be considered to reduce frost penetration depths and thereby adfreezing and uplift forces.

6.0 Slope Stability Analysis

Slope stability analyses were performed to back-analyse the pre-instability geometry of slope instabilities along the south approach embankment side slopes and the retention Pond 4-12 slopes, and subsequently to evaluate changes to existing slope geometry and slope stabilization works required. Slope stability model methods, assumptions, parameters, results and recommendations are provided below. Cross-sections associated with AT pathway alignment alternatives, and proposed embankment side slopes are included in Appendix A.

The slope stability analyses were conducted using a 2-dimensional limit-equilibrium slope stability model (Slope/W) from the GeoStudio 2016 software package (Geo-Slope International Inc./Seequent Ltd.). The slope stability model used the Morgenstern-Price method of slices with a half-sine inter-slice force function to calculate factors of safety (FS) along potential slip surfaces. Groundwater conditions were represented using a static piezometric line.

6.1 Retention Pond 4-12 Numerical Model

Active movements were observed on the north-west and south slopes of retention Pond 4-12 since about 2015. The instability on the south slope is located immediately west of the area previously stabilized in 2001, and appears to have a similar geometry to the previous movements. The location and extents of head scarps in both areas are shown on Figure 07 along with the approximate extents of the stabilization work completed in 2001.

The observed movements were likely triggered by near-surface saturation and a loss of soil suction resulting from prolonged periods of high precipitation. The instabilities are generally consistent with shallow, saturation induced instabilities which are commonly observed in cut or fill slopes during periods of high precipitation or water infiltration. Using original (pre-instability) geometry, a zone of residual shear strength clay was defined based on the depth of the back-analysed critical slip surface. Analysis was completed to assess conditions in each area of observed slope movement.

The cross-sections analyzed are located through the approximate middle of each slide (Cross Section 8 and 9 on Figure 07) and were assumed to represent critical cross-sections for the observed movements. The soil stratigraphy and section geometry in the models are based on sub-surface conditions observed during the geotechnical investigation, topographical survey completed by TREK, and as built drawings of the pond provided by the City of Winnipeg. Design geometries for AT pathway alternatives are based on the cross-sections and profiles provided by TT (Appendix A).

Soil properties assumed in the analysis are summarized in Table 09; residual shear strength for the clay were derived from a back-analysis, as discussed below.

Table 09: Material Parameters used in Slope Stability Analysis

Material	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (degrees)
Silty Clay	17	5	17
Residual Strength Clay	17	3	12
Silt Till	Impenetrable (Bedrock)		
Riprap	19	0	40
Granular Fill	20	0	30
Light Weight Fill	5	30	0

6.1.1 *Slope Stability Analysis Results*

Slope stability analysis results for retention pond 4-12 are summarized in Tables 10 and 11 for the south and north-west slopes, respectively. Analysis results figures are included in Appendix E, as referenced in the tables. Discussion of the key analysis cases and results is provided in the following sections.

Table 10: Summary of Calculated Factors of Safety South Slope

Stability Case	Slip Surface Case	Factor of Safety	Figure No. (Appendix E)
Back-Analysis (Pre-Instability Geometry)	Critical	0.99	E01
Existing / Post-Instability Geometry	Critical	1.16	E02
AT Path Option 1: Alignment Over Existing Head Scarp			
Post-Instability Geometry + Lightweight Fill + AT Path	Critical (Short term)	1.30	E03
	Critical (Long term)	1.44	E04
Post-Instability Geometry + Mid Slope Berm+ AT Path	Critical (Short term)	1.27	E05
	Critical (Long term)	1.39	E06
AT Path Option 2: Alignment on Callsbeck Ave			
Post-Instability Geometry + Regrade	Critical (Short term)	1.30	E07
	Critical (Long term)	1.47	E08

Table 11: Summary of Calculated Factors of Safety North-west Slope

Stability Case	Slip Surface Case	Factor of Safety	Figure No. (Appendix E)
Back-Analysis (Pre- Instability Geometry)	Critical	1.03	E09
Existing / Post- Instability Geometry	Critical	1.16	E10
Stabilization			
Post- Instability Geometry + Regrade at 5H:1V	Critical (Short term)	1.35	E11
	Critical (Long term)	1.46	E12

Back-Analyses and Existing Conditions

Back-analyses were performed on Cross-sections 8 and 9 using as-built (pre-instability) geometry, with critical slip surfaces passing through zones of observed movement within the SI's, and approximately matching observed head scarp locations. Groundwater level (GWL) conditions assumed in the back-analysis consist of a short-term extreme groundwater level at Elev. 230.7 m in the upper bank and the normal pond operation level at 227.5 m. The calculated factor of safety along the critical slip surface within the zone of residual strength clay is 0.99 and 1.03 for pre-instability geometries of the south and north-west slopes, respectively (Figures 01 and 09). The critical factor of safety increases to 1.16 (Figures E2 and E10) for the existing geometries of both the south and north-west slope.

The material parameters assumed in the model for each soil unit are summarized in Table 09 and represent values based on local experience, and existing information. The residual shear strength clay parameters are based on the back analysis results for the pre-instability geometry and the strengths calculated are within a range of typical values for clays in the Winnipeg area. Preliminary sensitivity analyses were performed to examine the impact of deeper residual strength clay zones and it was determined that residual strength clay extending deeper would result in factors of safety less than unity and slip surfaces that do not match the geometry of the observed movements based on site observations and slope inclinometer data. This finding is supported by the inclinometer data which did not detect deep-seated shear movements at greater depths that could be attributed to a larger, global instability extending to the pond invert.

Proposed AT Pathways and Slope Stabilization Works

Target factors of safety of 1.3 and 1.5 were selected under short-term extreme (GWL at El. 230.7 m consistent with water levels used in the back analysis) and long-term normal (GWL at 229.4m) groundwater conditions, respectively, for the design of any active transportation alignments and associated slope stabilization works.

Two alternatives for the AT pathway alignment were developed by TT for consideration in the analysis. Option 1 is a 3.5 m wide off-street pathway that runs along the slope crest, offset approximately 3.4 m north shoulder of Callsbeck Ave. Option 1 involves placement of fill on the slope, in particular at, and downslope of the location of the head scarp on the south slope. Option 2 is a shared vehicular / AT facility that would be located within the extent of the existing gravel roadway. Option 2 would result in no net fill placement on the slope.

Preliminary analyses (not reported herein) indicated that slope stabilization works are required for both options, but to a greater degree for Option 1 due to the reduction in stability caused by fill placement on the instability head scarp. Further, satisfying long-term FS targets for Option 1 appeared excessively costly, therefore slope stabilization measures are presented that satisfy the short-term target but fall short of the long-term target. Slope stabilization alternatives included regrading, replacing existing soil with granular fill and installing drains, a rockfill shear key, and lightweight fill.

South Slope – Pathway Option 1

Based on preliminary analyses (not presented herein), drainage improvements and rockfill shear keys are not considered adequate for alignment Option 1 where the AT path is located at the top of the existing head scarp. Drainage improvements alone do not provide sufficient stability improvements to the section and may be subject to clogging and reduced performance in the long-term, whereas rockfill shear keys, granular ribs or material replacement (located in the mid slope) will not address the potential for shorter (upper-bank) translational slip surfaces from developing in the future, and would also require significant excavation.

Replacing approximately 10 m^2 (in cross-section) of the existing clay with lightweight fill (cellular concrete) below the proposed AT path achieves factors of safety of 1.30 and 1.43 for short-term and long-term conditions, respectively, with the Option 1 AT path (Figures E03 and E04).

Placement of additional riprap to enlarge the toe berm in the mid-slope was also considered, and achieves factors of safety of 1.27 and 1.39 for short-term and long-term conditions, respectively (Figures E05 and E06). The enlarged toe berm will result in additional 7.5 m^2 and 4.5 m^2 (in cross-section) of riprap within the active instability and the stabilized section to the east, respectively, and will reduce existing storage capacity of the pond by approximately 525 m^3 within the operating levels of the retention pond (Elev. 227.6 m to 229.4 m). It is anticipated that this capacity can be replaced through regrading of the north, west, and southwest slopes of the existing pond to a 5H:1V slope, which will also improve overall slope stability (as discussed in the following section). Based on conversation with the City of Winnipeg (Water and Waste Department) it is understood that an alteration in the operating volume of the pond between Elev. 227.6 m and 229.4 m should not occur unless a detailed hydraulic analysis of the pond and associated drainage system demonstrates that the change in the operating volume of the pond is acceptable from a drainage-system perspective. Stabilization of the north-west slope by slope regrading presents an opportunity to remove excess material within the operating volume, such that there is no net reduction in operating volume of the pond.

South Slope – Pathway Option 2

If the AT path is located within the existing extents of Callsbeck Ave (Option 2), regrading the pond slope at 5H:1V will satisfy the design FS targets of 1.30 and 1.50 for short and long term conditions (Figures E07 and E08).

North-west Slope

Regrading the north-west pond slope at 5H:1V will satisfy the design FS target of 1.30 for short term conditions and approach the target of 1.50 for long term conditions, achieving a FS of 1.46 (Figures

E11 and E12). Flattening the slope to 5.4H:1V will satisfy the long-term target FS of 1.50, however, the slope encroaches on the existing fence near the existing instability which may not be preferred by the City or CPR. In this regard, we consider regrading the slope to 5H:1V to be adequate. As shown on Figures 08 and 09, regrading of approximately 130 m length of the north pond slope provides additional storage capacity within the range of pond operating levels to offset the storage volume reduction associated with the south slope riprap berm. Additional riprap should be placed on the exposed toe of the regraded slopes on the north side of the pond to match the existing riprap extents which may require sub-excavation. Regrading extents and total quantities should be optimized during detailed design.

6.1.1 Stabilization Cost Estimate

Tables 12 to 15 summarize preliminary cost estimates for the stabilization of the pond slopes, including lightweight fill, or the use of a mid-slope berm, and regrading. Unit prices represent our estimate of current market prices based on recent projects. The cost estimate includes mobilization and demobilization and access development, temporary traffic control, but exclude taxes, engineering, administration costs and contingencies.

Table 12: South Pond Slope – Lightweight Fill Cost Estimate (Pathway Option 1)

Item	Units	Est. Qty	Unit Price	Subtotal
Mob/Demob	L.S.	1	$15,000	$15,000
Site Access (incl. traffic control, remove / re-install traffic barriers)	L.S.	1	$10,000	$10,000
Excavation for Lightweight Fill	m^3	700	$25	$17,500
Supply and Place Lightweight Fill	m^3	700	$750	$525,000
Erosion Control Blanket	m^2	1430	$10	$14,300
Topsoil and Seed	m^2	1430	$15	$21,450
Preliminary Cost Estimate (excluding Contingency, Engineering and Administration Costs)				$603,250

Table 13: South Pond Slope – Riprap Mid-Slope Toe Berm Cost Estimate (Pathway Option 1)

Item	Units	Est. Qty	Unit Price	Subtotal
Mob/Demob	L.S.	1	$15,000	$15,000
Site Access (incl. traffic control, remove / re-install traffic barriers)	L.S.	1	$10,000	$10,000
Supply and Place Riprap Berm	tonne	1100	$100	$110,000
Erosion Control Blanket	m^2	1000	$10	$10,000
Topsoil and Seed	m^2	1000	$15	$15,000
Preliminary Cost Estimate (excluding Contingency, Engineering and Administration Costs)				$160,000[1]

Note: Riprap toe berm will reduce the pond storage capacity by approximately 525 m^3 of between operating levels El. 227.6 m and 229.4 m..

Table 14: South Pond Slope – Regrade Cost Estimate (Pathway Option 2)

Item	Units	Est. Qty	Unit Price	Subtotal
Mob/Demob	L.S.	1	$15,000	$15,000
Site Access (incl. traffic control, remove / re-install traffic barriers)	L.S.	1	$10,000	$10,000
Excavation (Remove from Site)	m^3	700	$25	$17,500
Regrading to Final (incl. clay cap)	m^2	1730	$20	$34,600
Erosion Control Blanket	m^2	1730	$10	$17,300
Topsoil and Seed	m^2	1730	$15	$25,950
Preliminary Cost Estimate (excluding Contingency, Engineering and Administration Costs)				$120,350

Table 15: North-West Pond Slope – Regrade Cost Estimate

Item	Units	Est. Qty	Unit Price	Subtotal
Excavation (Remove from Site)	m^3	2100	$25	$52,500
Regrading to Final (incl. clay cap)	m^2	2900	$20	$58,000
Erosion Control Blanket	m^2	2900	$10	$29,000
Topsoil and Seed	m^2	2900	$15	$43,500
Supply and Place Riprap	Tonne	500	$100	50,000
Preliminary Cost Estimate (excluding Contingency, Engineering and Administration Costs)				$233,000[1]

Note:Mob/demob is excluded, assuming that the work is completed concurrently with south pond slope stabilization works.

6.2 Lagimodiere Boulevard at Concordia Avenue Embankments Numerical Model

The widening of the bridge embankments will require additional fill at the top of the embankment to accommodate an extra lane in both directions and wider shoulders. The bridge embankments are anticipated to be widened by placing up to 2.2 m of fill which will require stabilization on the lower east side of the south embankment where existing movement has been observed. Global stability of the embankment will also need to be assessed.

Groundwater conditions were represented in the model using two static piezometric lines to approximate the groundwater level elevations in the existing embankment and underlying in-situ clay. Table 16 summarizes the groundwater cases used for the analyses.

Table 16: Groundwater Levels Used in Embankment Slope Stability Analysis

	Piezometric Line 1		Piezometric Line 2	
	Embankment Fill and Sand Blanket		Native Clay	
Analysis Case	GWL Elevation (m)	Description	GWL Elevation (m) & B-Bar (New Fill)	Description
Back Analysis	233	Short-term extreme elevated levels in sand blanket	236 (No B-Bar)	2023 Conditions: Original B-Bar of 0.5 and 50% of excess porewater pressure dissipation
Existing Conditions	231	Based on current monitoring data		
2026 Proposed Embankments			236 (B-bar = 0.5)	
2045 Proposed Embankments			234 (B-bar = 0.4)	2045 Conditions: 60-70% excess porewater pressure dissipation + 0.4 B-Bar from New Fill

For the back-analysis of the instabilities observed on the lower east side of the south embankment, piezometric lines representative of a short-term extreme event in the embankment and drainage blanket, combined with an estimated groundwater level and excess porewater pressure (PWP) dissipation in the native clay reflective of consolidation complete to date (B-bar from original construction of 0.5 combined with 50% excess PWP dissipation to date). Note that the B-bar from the original construction was defined in the model using an elevated piezometric line, not using the B-bar function. The B-bar function was only used to represent the impact of additional fill for the proposed embankments.

For analysis of existing conditions, the piezometric line in the embankment and drainage blanket was lowered to represent conditions observed in the sub-surface investigation and monitoring. Groundwater levels in the native clay were held the same as the back-analysis case.

A zone of residual strength clay was included where instabilities have been observed on the lower toe of the embankment. The material parameters assumed in the model for each soil unit are summarized in Table 17 below and represent assumed values based on local experience, and existing information. The properties of the residual strength clay were adjusted along with the slight changes to the groundwater level to achieve a factor of safety of approximately 1.0 for a slip surface that closely matches the interpreted depth of movement, head scarp and toe bulge locations.

Table 17: Material Parameters used in Embankment Slope Stability Analysis

Material	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (degrees)
Existing Embankment Fill / Silty Clay / New Clay Fill	17	5	17
Residual Strength Clay Fill	17	2	10
Silt Till	Impenetrable (Bedrock)		
Sand Drain	19	0	30
Rockfill Ribs (3to1 Replacement)	17.75	1.5	15

2026 Bridge Embankment Widening

It is understood that widening of the existing approach embankments is required to facilitate construction of the new bridge, beginning in 2026. For analysis of the proposed embankment widening planned to be completed in 2026, the piezometric line in the embankment, drainage blanket, and underlying native clay was assumed consistent with existing conditions, in addition to the new excess porewater pressure from the new fill. When fill is expected to be placed to widen the existing embankments (2026), the original excess pore pressure is expected to be approximately 50% dissipated, consistent with existing conditions. A B-bar of 0.5 was applied to the underlying clay resulting from the new fill placement. For the design of embankment widening, a factor of safety target of 1.50 was selected, despite the groundwater conditions including B-bar effects typically considered only for short-term extreme conditions; in this regard, full dissipation of excess porewater pressures is expected to take decades beyond the planned fill placement. These groundwater conditions can be attributed to the “end of construction” case following completion of the embankment widening in 2026. Preliminary drawings provided by TT indicate that 2026 widening will be completed by widening both lanes outwards (i.e. Widening Option 1).

2045 Bridge Embankment Widening

For analysis of the proposed embankment widening planned to be completed between 2045 and 2055, the piezometric line in the embankment and drainage blanket was assumed consistent with existing conditions, while the groundwater level in the native clay was modified to reflect additional excess porewater pressure dissipation, and also add the new excess porewater pressure from the new fill. When fill is expected to be placed to widen the existing embankments (2045 to 2055), the original excess pore pressure is expected to be approximately 60 to 70% dissipated. A B-bar of 0.4 was applied to the underlying clay resulting from the new fill placement. For the design of embankment widening, a factor of safety target of 1.50 was selected, despite the groundwater conditions including B-bar effects typically considered only for short-term extreme conditions; in this regard, full dissipation of excess porewater pressures is expected to take decades beyond the planned fill placement. These groundwater conditions can be attributed to the “end of construction” case following completion of the embankment widening in 2045.

6.2.1 Slope Stability Analysis Results

The results of the analyses are summarized in Table 18, and are shown on Figures E13 to E23 which are included in Appendix E. Short term (extreme) conditions exceeded target FS and are not presented herein. The results are discussed in the following sections.

Table 18: Summary of Calculated Factors of Safety for Bridge Approach Embankments

Cross Section	Roadway Geometry	Embankment Side	Critical FS	Section Description and Stabilization	Figure No. (Appendix E)
Cross Section C	Existing - Back Analysis	East	1.08	Back analysis of section C through segment of observed instability	E13
	Existing	West	1.68	Existing Section - Lower east side of south embankment has 170 m of instabilities located at the embankment toe.	E14
		East	1.39		
	Option 1 2026	West	1.60	Grade fill on west and east sides at 4H:1V and 5H:1V, respectively. Construct rockfill ribs at 3:1 replacement on southeast quadrant.	E15
		East	1.52		
	Option 1 2045	West	1.50	Grade fill on west and east sides at 4H:1V and 4.4H:1V, respectively. Construct rockfill ribs at 3:1 replacement on southeast quadrant.	E16
		East	1.48		
	Option 2 2045	West	1.50	Regrade fill on west and east sides at 4H:1V. Construct rockfill ribs at 3:1 replacement on southeast quadrant.	E17
		East	1.54		
	Option 3 2045	West	1.69		E18
		East	1.51		
Cross Section D	Existing	West	1.67	Existing conditions	E19
		East	1.52		
	Option 1 2026	West	1.63	Grade fill on west and east sides at 4H:1V and 5H:1V, respectively.	E20
		East	1.55		
	Option 1 2045	West	1.61	Regrade fill on west and east sides at 4H:1V.	E21
		East	1.45		
	Option 2 2045	West	1.61		E22
		East	1.50		
	Option 3 2045	West	1.75		E23
		East	1.50		

Existing Embankments – Back Analysis

Shallow instabilities have been observed at numerous locations along the lower east side of the south embankment as shown in Figure 04. The observed instabilities consist of a head scarp initiating at or below the crest of the lower toe berm and exiting above the slope toe; this geometry is typical of shallow translational slides triggered by near-surface saturation and a loss of soil suction resulting from prolonged periods of high precipitation. This type of instability is often localized in extent and can be influenced by undetected pre-existing conditions (e.g. localized zones of pre-sheared or soft soils, or discontinuous layers of permeable soils with high piezometric levels). As shown in cross-section on Figures 05 and 06, several test holes had either soft silt, organic clay or sand fill just below the elevation of the toe bulge, which may be acting as a plane of weakness.

A back analysis was performed on the existing (post- instability) slope geometry of cross section C, with critical slip surfaces matching the observed head scarp and toe bulge locations. The calculated factor of safety along the critical slip surface within the zone of the lower toe instability is 1.09, whereas the global slip surface extending into the roadway has a factor of safety of 1.44 (Figure E13).

The instabilities at the toe of the embankment are localized, and based on the stability analysis, these movements are not anticipated to impact global stability of the existing embankment at the roadway. However, these instabilities may continue to move and may be exacerbated by the addition of fill placed on the upper and mid slopes of the embankment to widen the road. In this regard, the lower toe should be repaired and stabilized prior to adding fill to widen embankments as proposed.

Existing Embankments – 2023 Groundwater Conditions

The existing embankment geometry was analysed with current groundwater conditions based on the sub-surface investigation and estimated PWP dissipation to date. The calculated factor of safety along the critical slip surface within the zone of the lower toe instability is 1.392, whereas the critical global slip surface extending into the roadway has a FS of 1.68 on the west embankment (F13), and a FS of 1.46 on the east embankment. Based on these results, we find the existing factors of safety acceptable, although ongoing movements of lower toe instabilities can be expected to continue during periods of elevated groundwater levels in the drainage blanket.

Proposed Embankments

The embankments are proposed to be constructed at side slopes of 4 to 5H:1V on both the east and west sides for the three potential widening options. The cross-sections analyzed are located at cross sections C and D of the south and north approach embankments, respectively, where the embankments are tallest and the greatest fill thickness is expected (Appendix A). Slope stabilization works are required where any fill is placed over top of the lower toe instabilities.

Slope stabilization alternatives considered included (in order of increasing cost) drainage improvements (e.g. French drains), soil replacement and rockfill ribs. Based on preliminary analyses (not reported herein), drainage improvements and soil replacement are not considered adequate. Drainage improvements alone do not provide sufficient stability improvements and may be subject to clogging and reduced performance in the long-term, whereas full soil replacement would require significant excavation over the approximately 170 m of observed instabilities.

Rockfill ribs were considered for stabilization of the lower toe instabilities given that they improve stability lower bank areas, provide mechanical stabilization and provide drainage enhancement as a secondary benefit. Rockfill ribs installed at a 3:1 replacement ratio in plan view (e.g. 1.5 m wide with 4.5 m clear spacing between ribs) and a 16 m long base achieves a factor of safety that exceeds the design target of 1.50 in the lower bank, for all three embankment widening options (Figures E15 to E18).

For embankments constructed in 2026, in terms of global slope stability (extending into the roadway), side slopes of 4H:1V satisfy target factor of safety for widening on the west embankments, and side slopes of 5H:1V satisfy target factor of safety for widening on the east embankments As shown on Figures E15 and E20.

In terms of global slope stability (extending into the roadway), side slopes of 4.4H:1V satisfy target factor of safety for widening Option 1 (widen both lanes outwards) as shown in Figures E16 and E20, whereas 4H:1V slopes are expected to satisfy the factor of safety criteria for widening Options 2 and 3 (Figures E17-18, E22-23).

6.2.2 Stabilization Cost Estimate

Table 19 summarizes a preliminary cost estimate for the construction of rockfill ribs. Unit prices represent our estimate of current market prices based on recent projects. The cost estimate includes mobilization and demobilization and access development, temporary traffic control, but exclude taxes, engineering, administration costs and contingencies.

Table 19: Rockfill Rib Stabilization Cost Estimate

Item	Units	Est. Qty	Unit Price	Subtotal
Mob/Demob	L.S.	1	\$20,000	\$20,000
Site Access (incl. traffic control, remove / re-install traffic barriers)	L.S.	1	\$15,000	\$15,000
Excavation for Rockfill Ribs (Re-use for embankment widening)	m^3	1200	\$25	\$30,000
Supply and Compact Rockfill (Rockfill Ribs)	tonne	2600	\$70	\$182,000
Placement of Clay Cap - salvaged (200 mm thick)	m^3	470	\$20	\$9,400
Topsoil and Seed	m^2	2300	\$15	\$34,500
Preliminary Cost Estimate (excluding Contingency, Engineering and Administration Costs)				\$290,900

7.0 Embankment Construction

The additional roadway lanes require widening the existing embankment by up to 6.5 m constructed to the same elevation as the existing road. The embankment side slopes are recommended at 4H:1V to 4.4H:1V (depending upon the widening option) and the height of the embankment will vary along the alignment. Clay fill is expected to be used for embankment fill. Construction methods and embankment geometry will vary depending on the embankment height.

General recommendations for the construction of embankments are provided below:

1. Areas of existing lower toe instabilities must be stabilized prior to placement of fill on top of the slide area (Widening Option 1). For other widening options, existing lower toe instabilities are not anticipated to affect fill placement above the mid-slope bench, however stabilization is recommended to be completed regardless as the repairs would be most cost-effective when earthworks equipment are already on site.
2. To improve the bond between the existing fill and new fills, placement of new embankment fill should key into the existing embankment by excavating horizontal benches with a maximum vertical cut height of 0.6 m. Vertical cuts should not remain open overnight.
3. Organics, silts, soft or loose soils and any other deleterious materials should be stripped away such that the sub-grade consists of existing clay fill embankment material.
4. The clay fill subgrade should be scarified, moisture conditioned and compacted to 95% of Standard Proctor Maximum Dry Density (SPMDD). The clay fill subgrade should be left in a scarified condition to promote bonding between the existing embankment fill and newly placed clay fill.

8.0 Lateral Earth Pressure

Excavations for buried structures such as the box culvert AT underpass should be backfilled their full depth using granular fill. The magnitude of lateral earth pressures from retained soil against buried structures will depend on the backfill material type, method of placing and compacting the backfill and the magnitude of horizontal deflection of the retaining wall after the backfill is placed. Cohesive soils should not be used as backfill against buried walls as these soils could generate excessive lateral earth pressures from swelling. Table 20 below provides at rest earth pressures K_o values for calculation of lateral earth pressures developed from backfill acting on buried walls.

Table 20: Lateral Earth Pressure Parameters for Below Grade Wall Design

Design Parameter	Backfill
At-Rest Earth Pressure Coefficient (K_o)	0.5
Estimated Bulk Unit Weight, γ	18 kN/m³
Estimated Effective Unit Weight, γ´	8 kN/m³

Where backfill drainage is expected, such as a sub-drainage system at the base of the wall to prevent the build-up of hydrostatic pressures, the total lateral earth pressure force is the area of the triangular pressure distribution acting on a below grade wall which can be derived based on the following equation:

$$P = K_o \gamma D$$

where,

P = lateral earth pressure at depth D (kPa)
K_o = earth pressure coefficient (unitless)
γ = bulk unit weight of retained soil (20 kN/m^3)
D = depth below finished grade to where earth pressure is being calculated (m)

If drainage is not expected, the following equation should be used:

$$P = K_o \gamma' D + \gamma_w D$$

where,

P = lateral earth pressure at depth D (kPa)
K_o = earth pressure coefficient (unitless)
γ´ = effective unit weight of retained soil (8 kN/m^3)
D = depth below finished grade to where earth pressure is being calculated (m)
γ_w = unit weight of water (9.81 kN/m^3)

Backfill (retained soil) should not be placed and compacted until the walls can support lateral earth pressures. Over-compaction of the backfill soils adjacent to buried walls may result in earth pressures that are considerably higher than those predicted in design. Compaction of the granular fills within about 1.0 m of the vertical walls should be conducted with a light hand operated vibrating plate compactor and the number of compaction passes should be limited to achieve a maximum of 92% of Standard Proctor Maximum Dry Density (SPMDD). Compensation for any settlement can be made in the final grading by placing additional fill adjacent to the structure and to provide positive drainage away from the structure. Backfill compacted in this manner (lightly) will ultimately settle by a maximum of about 2 to 4% of the fill depth. Beyond the 1 m offset, the granular fill should be compacted to at least 95% SPMDD in an unfrozen state in lifts not exceeding 200 mm loose thickness.

9.0 Temporary Excavations

Excavations must be carried out in compliance with the appropriate regulations under the Manitoba Workplace Safety and Health Act. Any open-cut excavation greater than 3 m deep must be designed and sealed by a professional engineer and reviewed by the geotechnical engineer of record (TREK). If space is limited or the stability of adjacent structures may be endangered by an excavation, a shoring system may be required to prevent damage to, or movement of, any part of adjacent structures, and the creation of a hazard to workers and the public.

Excavation stability is the responsibility of the Contractor for the duration of construction. Excavations should be monitored regularly and flattened as necessary to maintain stability recognizing that excavation stability is time and weather dependent. Excavated slopes should be covered with polyethylene sheets to prevent wetting and drying.

Stockpiles of excavated material and heavy equipment should be kept away from the edge of any excavation by a distance equal to or greater than the depth of excavation. Dewatering measures should be completed as necessary to maintain a dry excavation and permit proper completion of the work. If seepage is encountered, it should be collected and pumped out of the excavation. If saturated silts or sands are encountered, shoring or slope flattening may be required. To prevent wet silts and sands from entering the excavation, gravel buttressing could be used in conjunction with sump pits for dewatering. Surface water should be diverted away from the excavation and the excavation should be backfilled as soon as possible following construction.

10.0 Site Drainage

Drainage adjacent to structures and exterior slabs should promote runoff away from the structures. A minimum gradient of about 2% should be used for both landscaped and paved areas and maintained throughout the life of the structures.

11.0 Inspection and Monitoring Requirements

In accordance with Section *4.2.2.3 Field Review* of the NBCC (2010), the designer or other suitably qualified person shall carry out a field review on:

1. a continuous basis during:
    i. the construction of all deep foundation units,
2. on an as-required basis for the construction of shallow foundation units and in excavating, dewatering and other related works.

In consideration of the above and relative to this project, we recommend that TREK, as the geotechnical engineer of record, be retained to inspect the installation of any foundation elements and to confirm soil conditions at the time of construction. TREK is most familiar with the geotechnical conditions present and the basis for our foundation recommendations and can provide any design modifications deemed to be necessary should altered sub-surface conditions be encountered. TREK recommends that, as a minimum, a qualified geotechnical inspector be present for installation of all piles for the project. It is also recommended that minimum of 1 pile be PDA tested at each of the structural units to validate design assumptions and allow for modifications to pile lengths and validation of final set criteria if underpinning is required.

12.0 Closure

The geotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation and laboratory testing). Soil conditions are natural deposits that can be highly variable across a site. If subsurface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work or standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

This report has been prepared by TREK Geotechnical Inc. (the Consultant) for the exclusive use of Tetra Tech Inc. (the Client) and their agents for the work product presented in the report. Any findings or recommendations provided in this report are not to be used or relied upon by any third parties, except as agreed to in writing by the Client and Consultant prior to use.

Site Photos

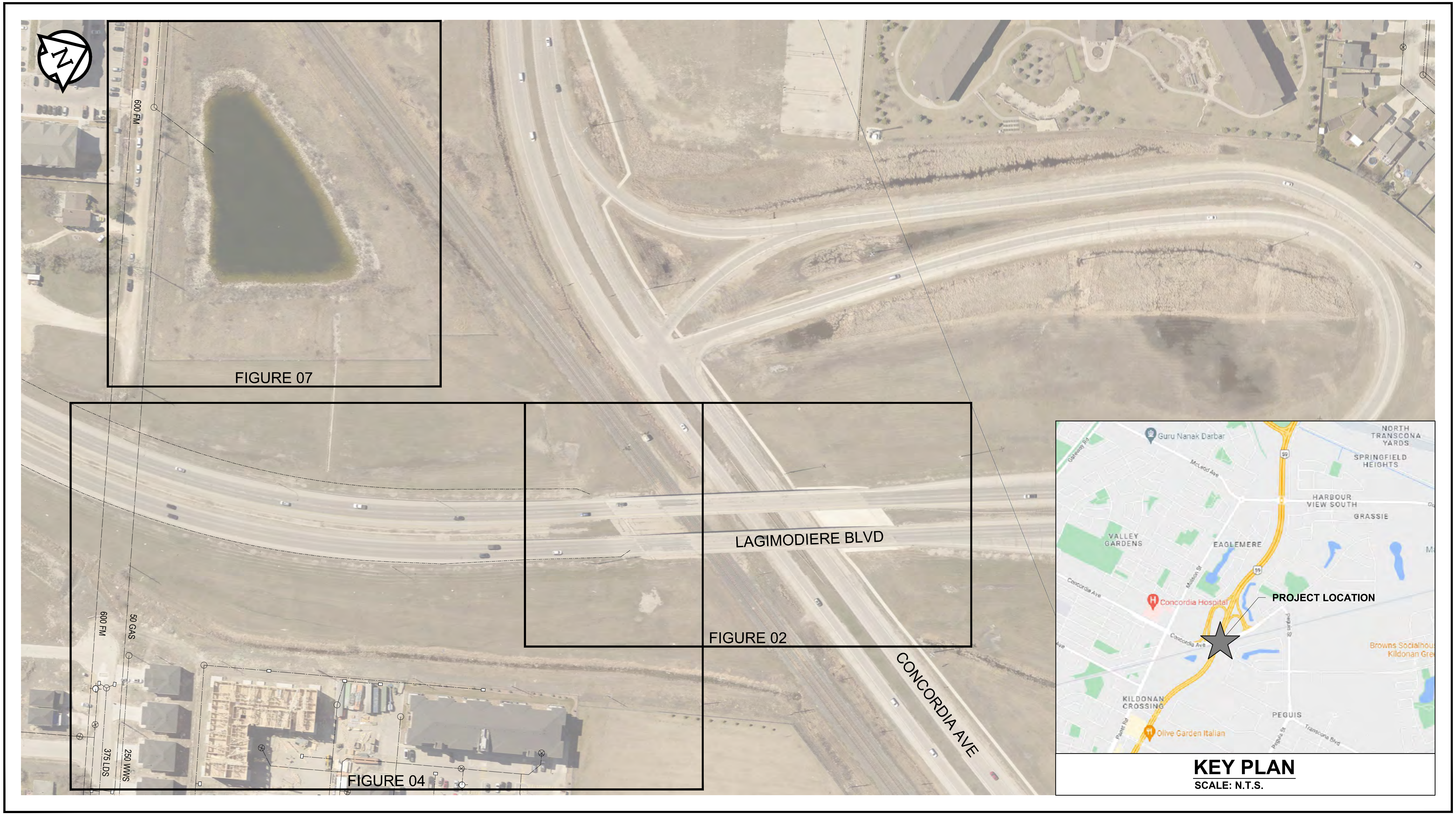
Photo 01: Shallow instabilities located on the lower east side of the south embankment.

Photo 02: Shallow instabilities located on the lower east side of the south embankment.

Photo 03: Instability located on the south side of Retention Pond 4-12, adjacent to Callsbeck Ave.

Photo 04: Instability located on the north-west side of Retention Pond 4-12, adjacent to CP Rail.

Figures



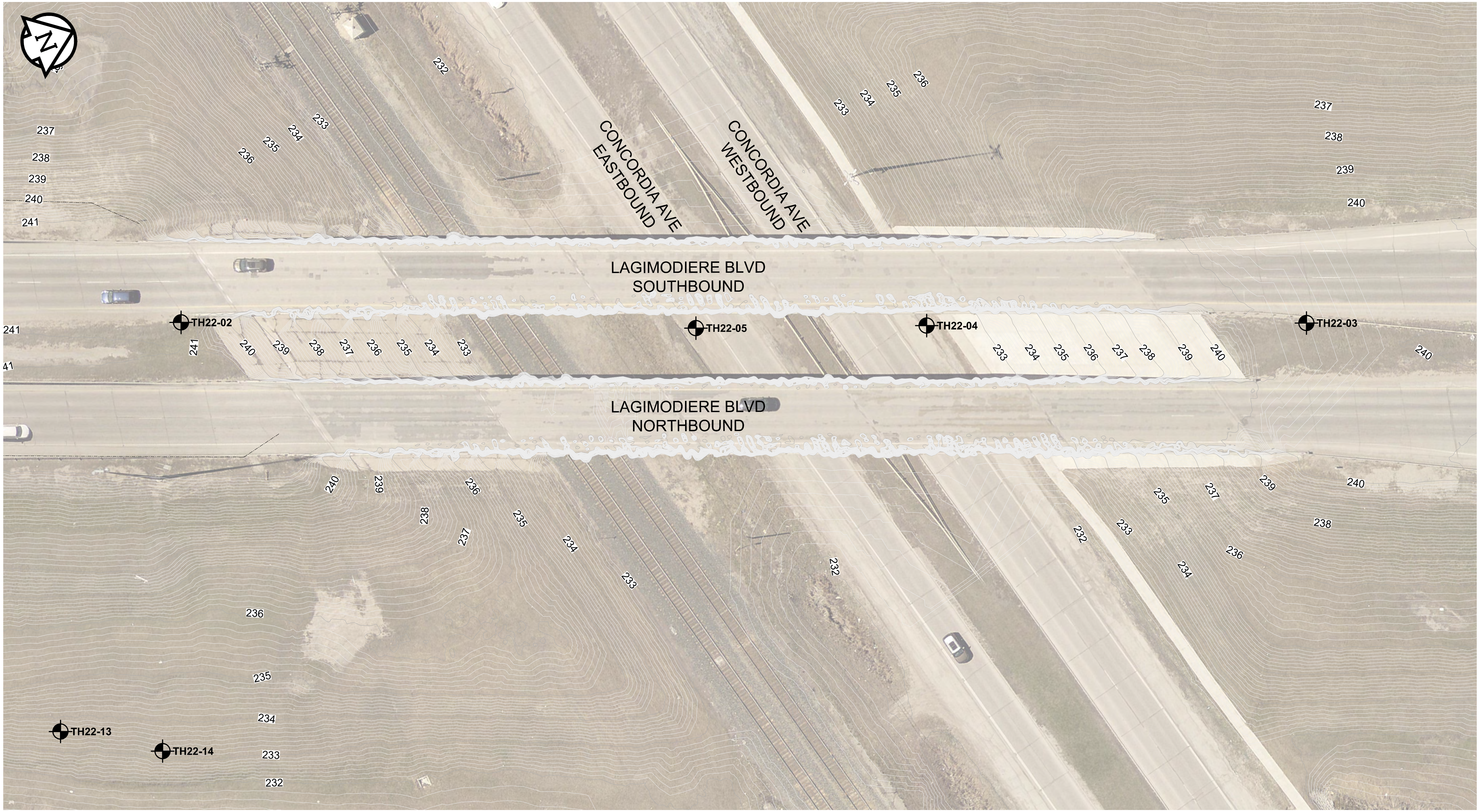
Z:\Projects\0002 Tetra Tech\0002 130 00 Lagimodiere Blvd Overpass Rehab\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Fig 01 2023-07-13 Lagimodiere Blvd Overpass Rehab 0_B 0002-130-00.dwg, 2023-07-13 1:23:04 PM

0 25 50 75 m
SCALE = 1 : 1 750 (279 mm x 432 mm)

NOTES:
1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2021).

Figure 01
Overall Plan

0002 130 00
Tetra Tech Inc.
Lagimodiere Boulevard Overpass Rehab



0 5 10 15 20 25 m
SCALE = 1 : 500 (279 mm x 432 mm)

LEGEND: ⊕ TEST HOLE (TREK, 2022)

NOTES:
1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2021).
2. TEST HOLE ELEVATIONS AND LOCATIONS SURVEYED BY TREK, (2022)

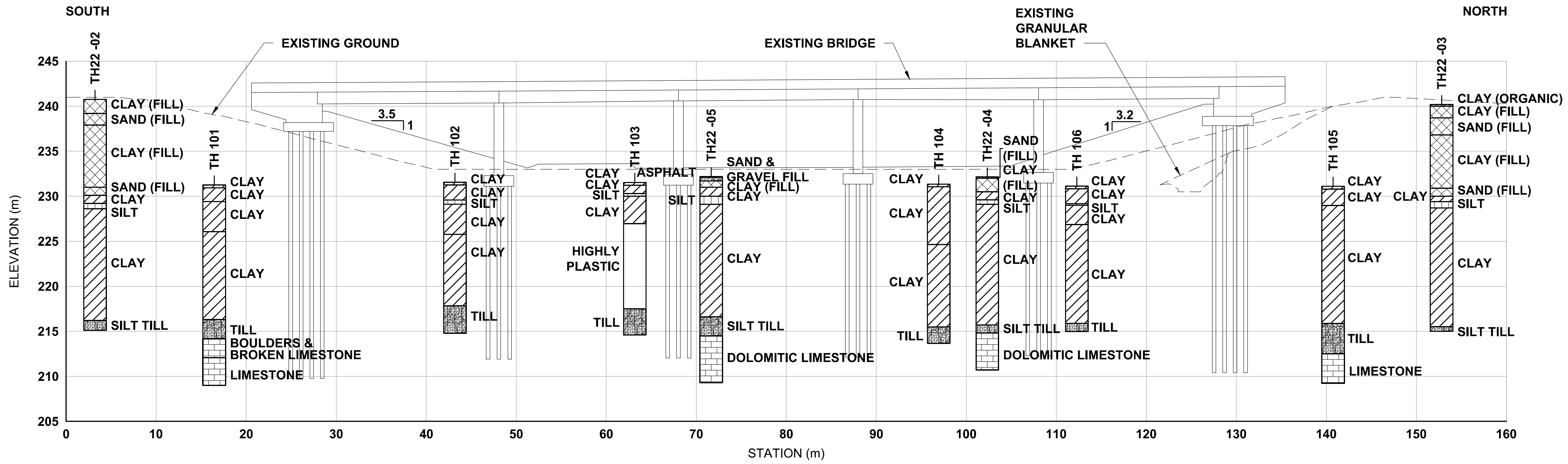
Figure 02
Bridge Plan

Z:\Projects\0002 Tetra Tech\0002 130 00 Lagimodiere Blvd Overpass Rehab\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Fig 02 & 03 2023-07-13 Lagimodiere Blvd Overpass Rehab 0_B 0002-130-00.dwg, 2023-07-13 1:24:38 PM

TREK GEOTECHNICAL

0002 130 00
Tetra Tech Inc.
Lagimodiere Boulevard Overpass Rehab

Z:\Projects\0002 130 00 Lagimodiere Blvd Overpass Rehab\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Fig 02 & 03 2023-07-13 Lagimodiere Blvd Overpass Rehab 0_B 0002-130-00.dwg, 2023-07-13 1:31:08 PM

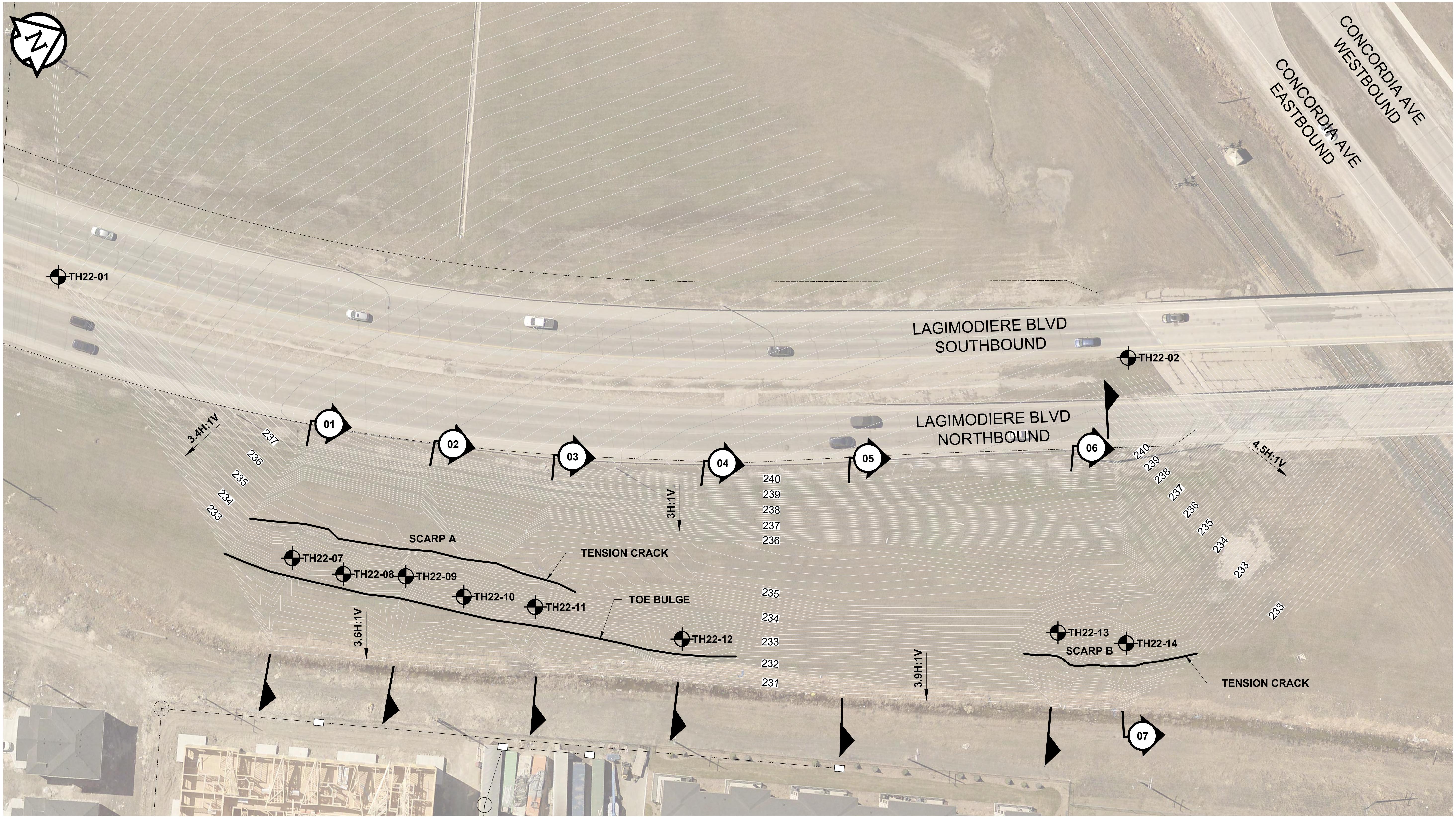


NORTHBOUND ELEVATION

0 5 10 15 20 25 m
SCALE = 1 : 500 (279 mm x 432 mm)

Figure 03
Bridge and
Stratigraphic Profile

0002 130 00
Tetra Tech Inc.
Lagimodiere Boulevard Overpass Rehab



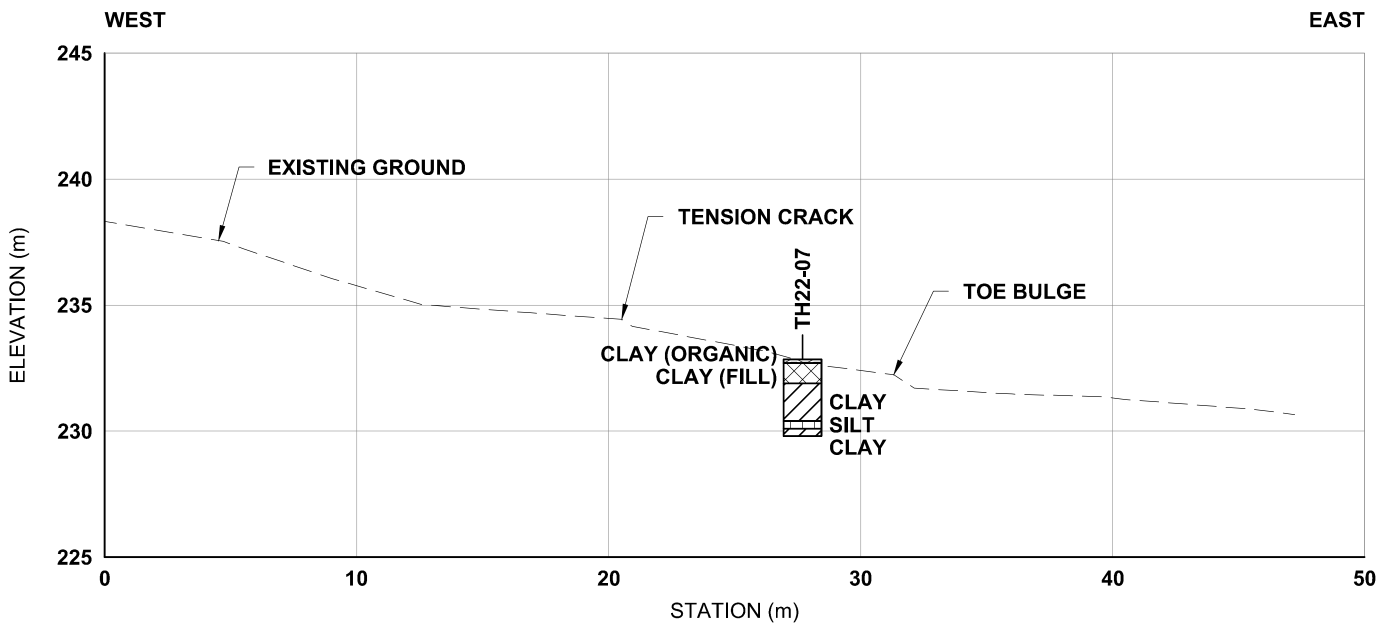
0 25 50 75 m
SCALE = 1 : 1 750 (279 mm x 432 mm)

LEGEND: ⊕ TEST HOLE (TREK, 2022)

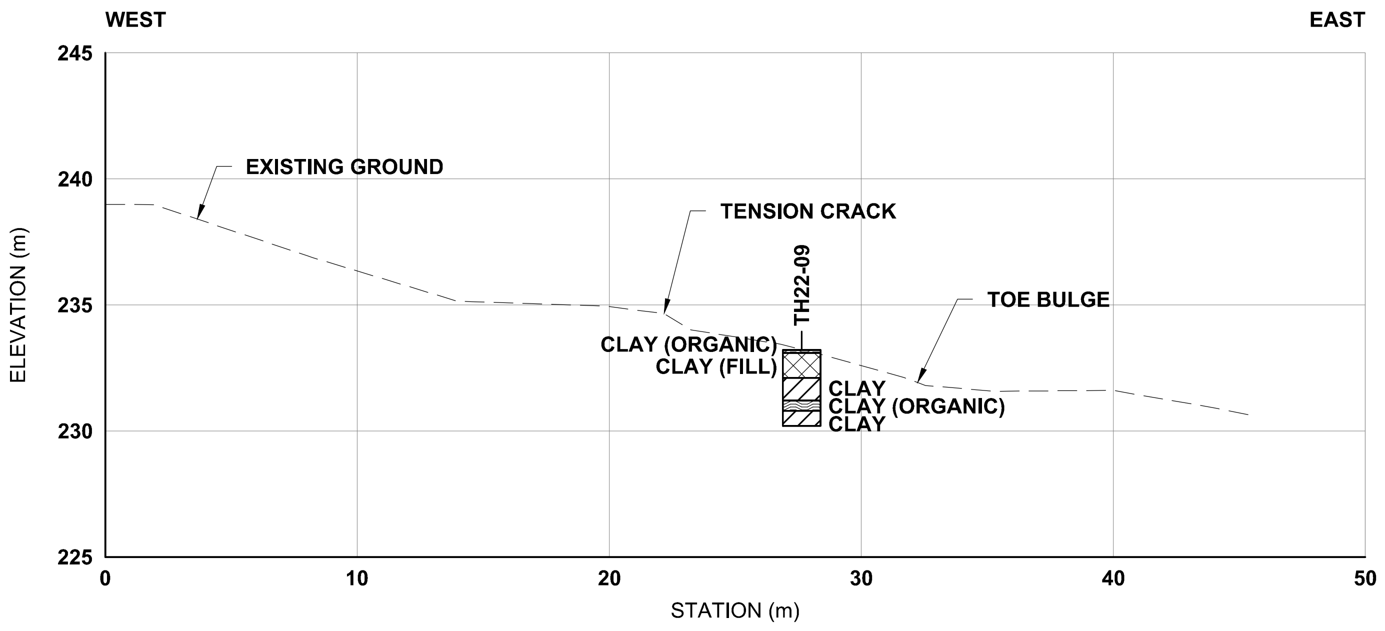
NOTES:
1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2021).
2. TEST HOLE ELEVATIONS AND LOCATIONS SURVEYED BY TREK, (2022)

Figure 04
South Embankment Plan

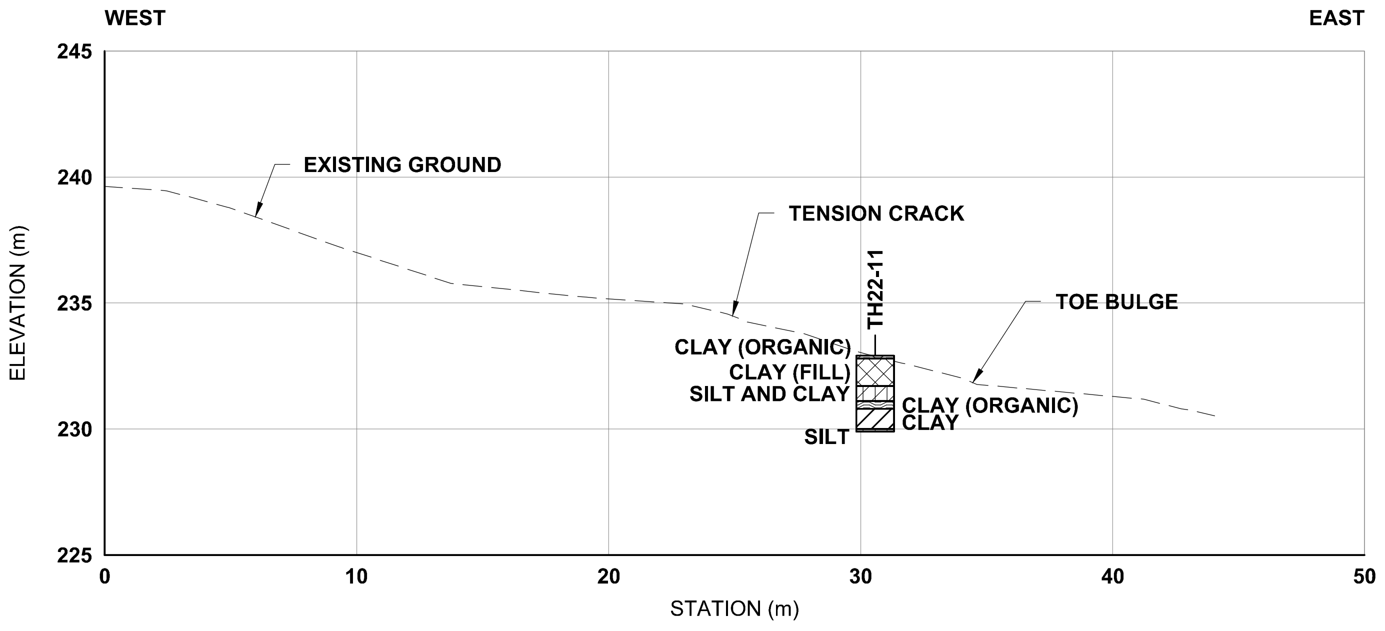
Z:\Projects\0002 130 00 Tetra Tech\0002 130 00 Lagimodiere Blvd Overpass Rehab\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Fig 04 to 06 2023-08-21 Lagimodiere Blvd Overpass Rehab 0_C 0002-130-00.dwg, 2023-08-21 2:47:30 PM



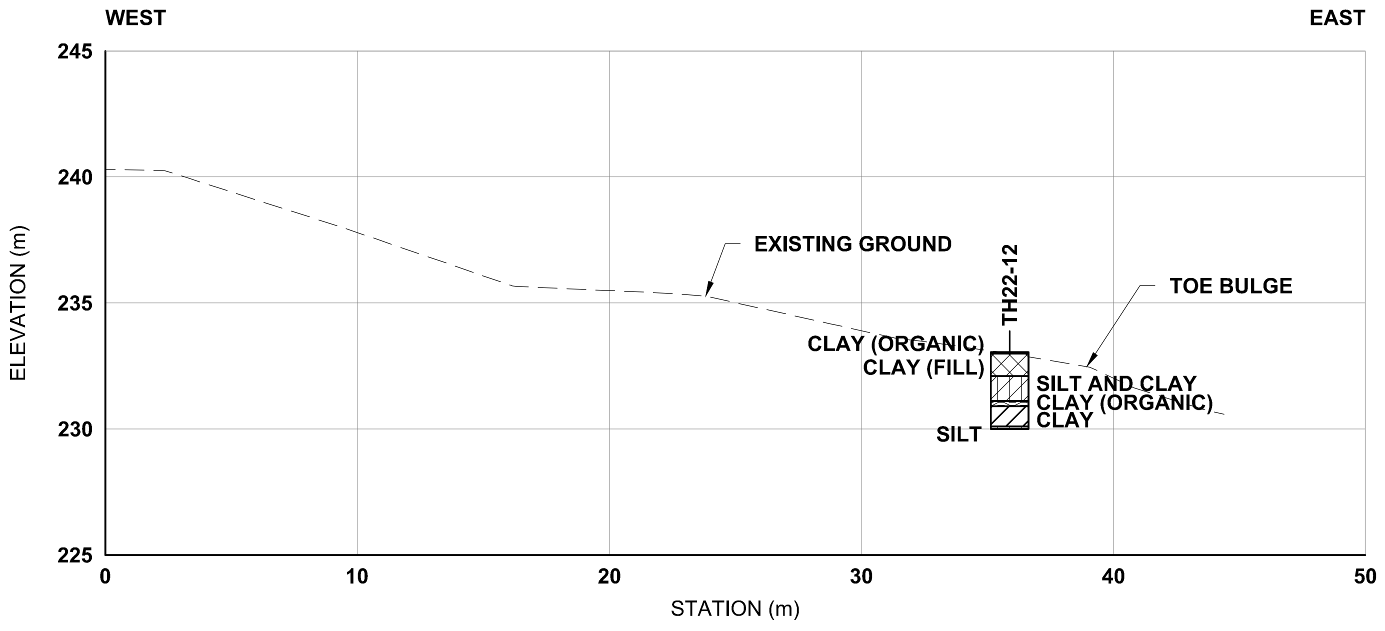
CROSS SECTION 01



CROSS SECTION 02



CROSS SECTION 03



CROSS SECTION 04

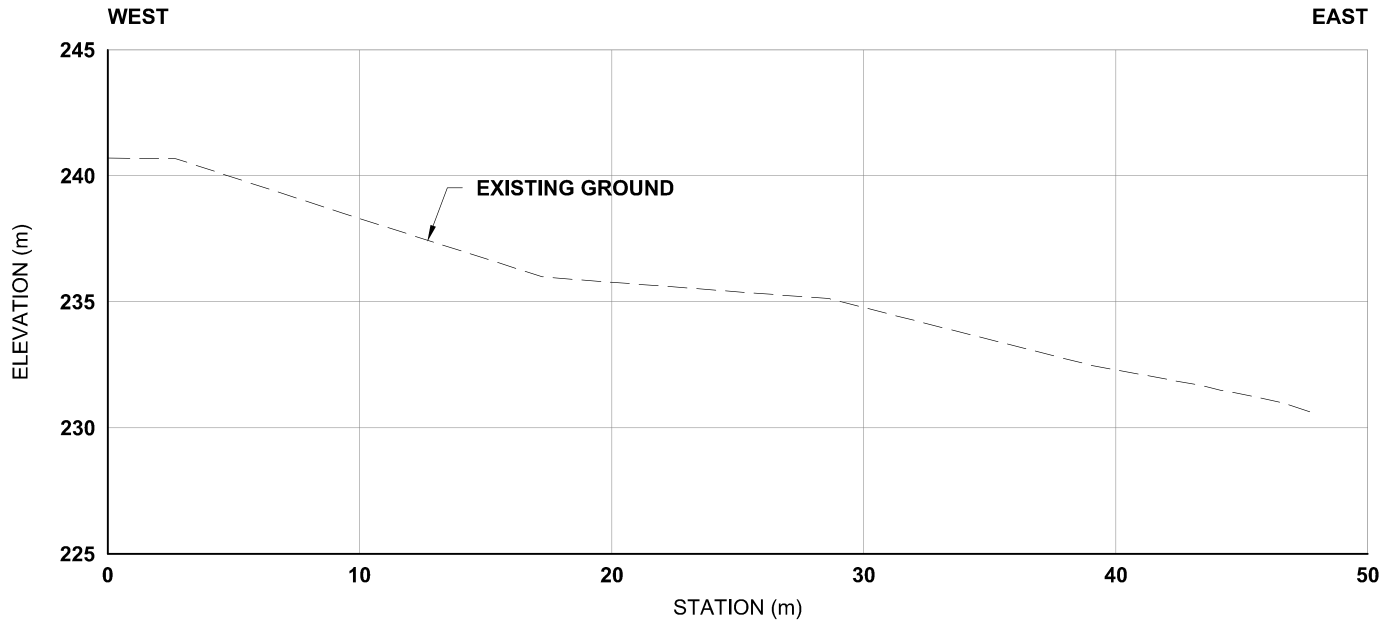
Z:\Projects\0002 Tetra Tech\0002 130 00 Lagimodiere Blvd Overpass Rehab\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Fig 04 to 06 2023-08-21 Lagimodiere Blvd Overpass Rehab 0_C 0002-130-00.dwg, 2023-08-21 2:47:14 PM

0 5 10 15 m
SCALE = 1 : 300 (279 mm x 432 mm)

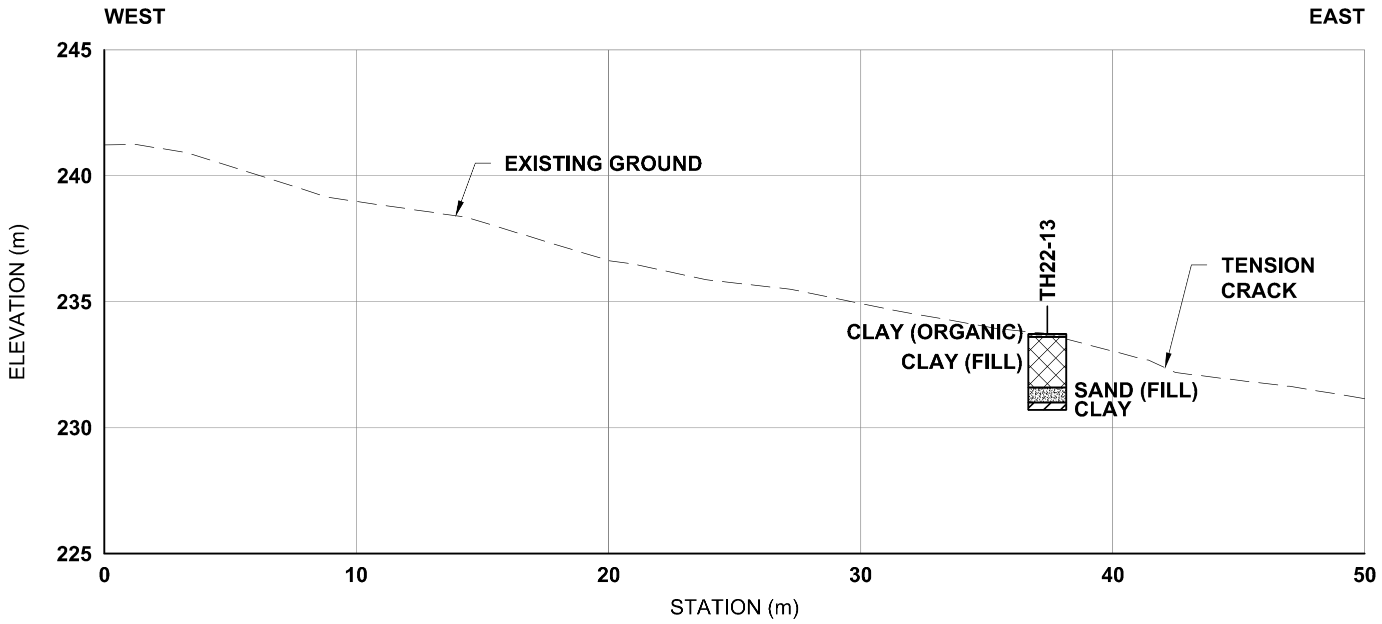
Figure 05
South Embankment
Cross Sections

TREK GEOTECHNICAL

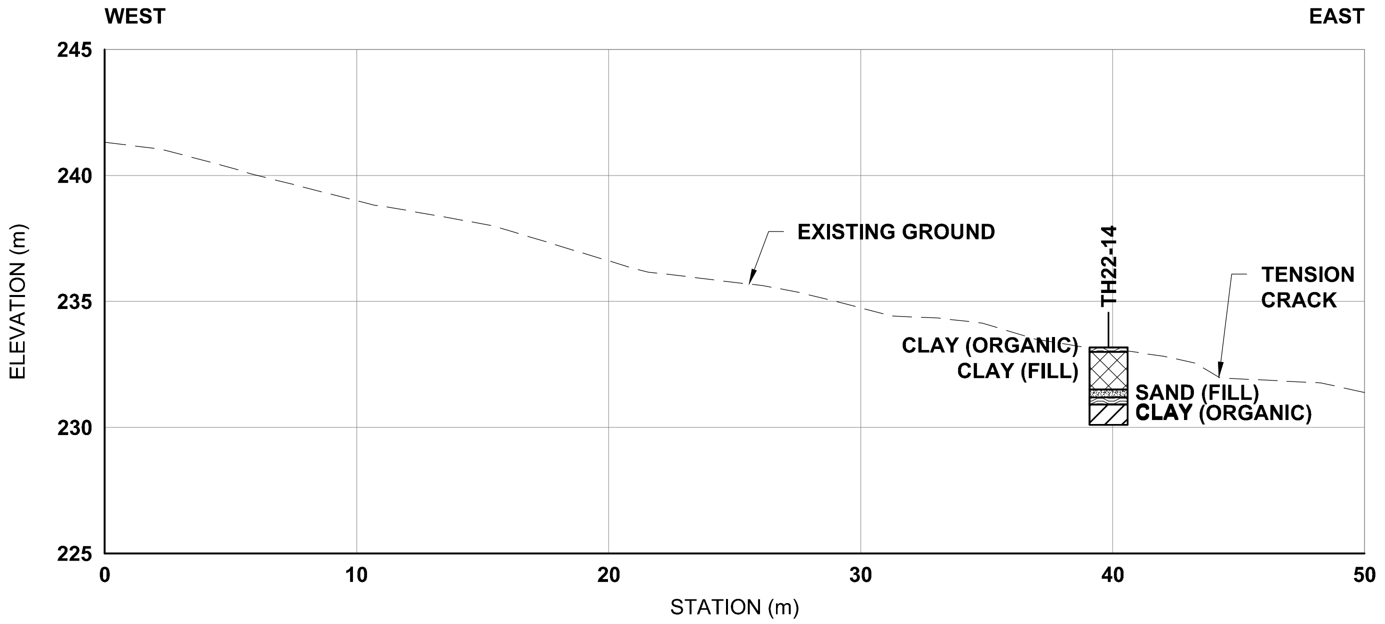
Z:\Projects\0002 Tetra Tech\0002 130 00 Lagimodiere Blvd Overpass Rehab\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Fig 04 to 06 2023-08-21 Lagimodiere Blvd Overpass Rehab 0_C 0002-130-00.dwg, 2023-08-21 2:46:58 PM



CROSS SECTION 05



CROSS SECTION 06



CROSS SECTION 07

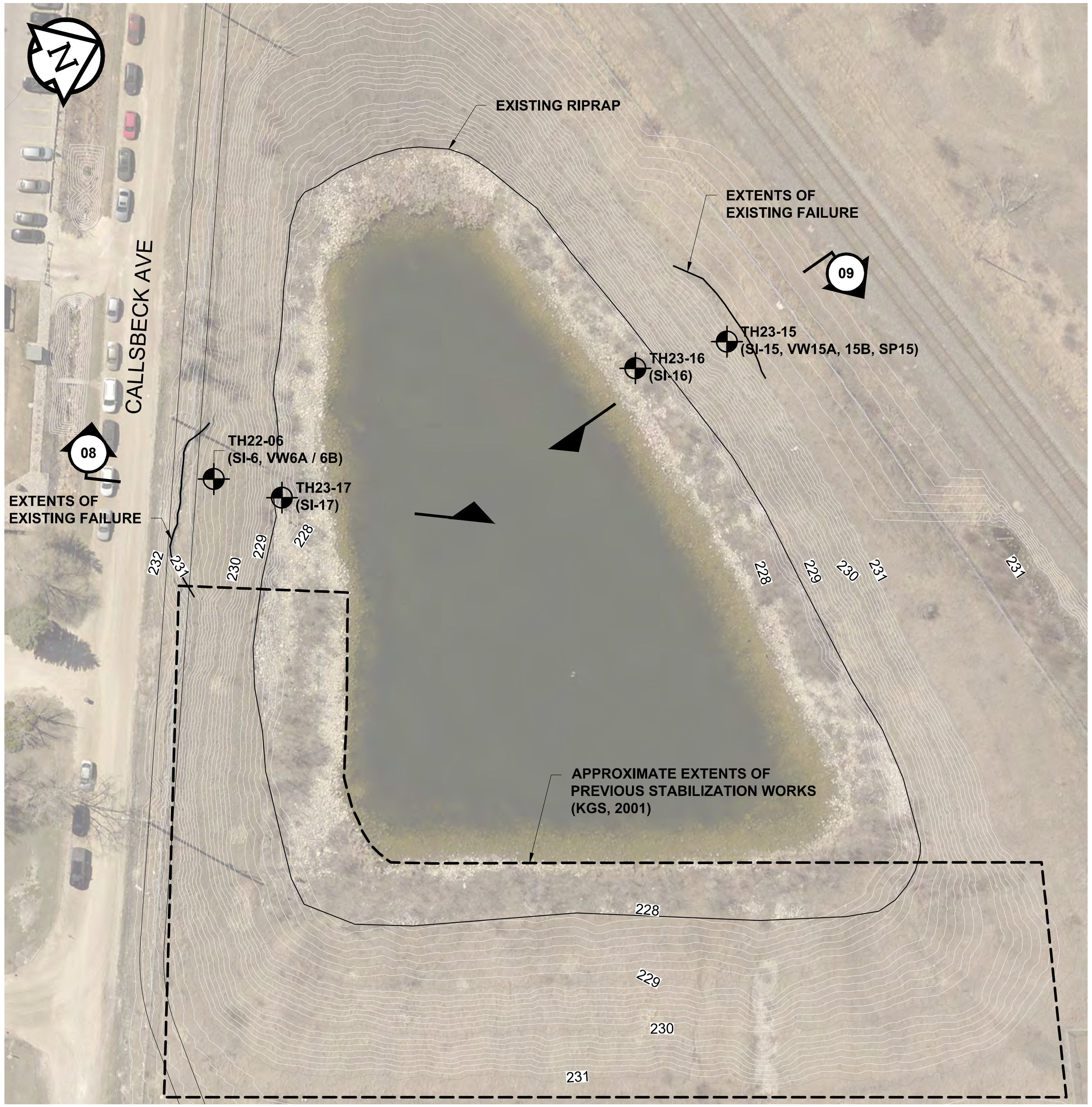
0 5 10 15 m
SCALE = 1 : 300 (279 mm x 432 mm)

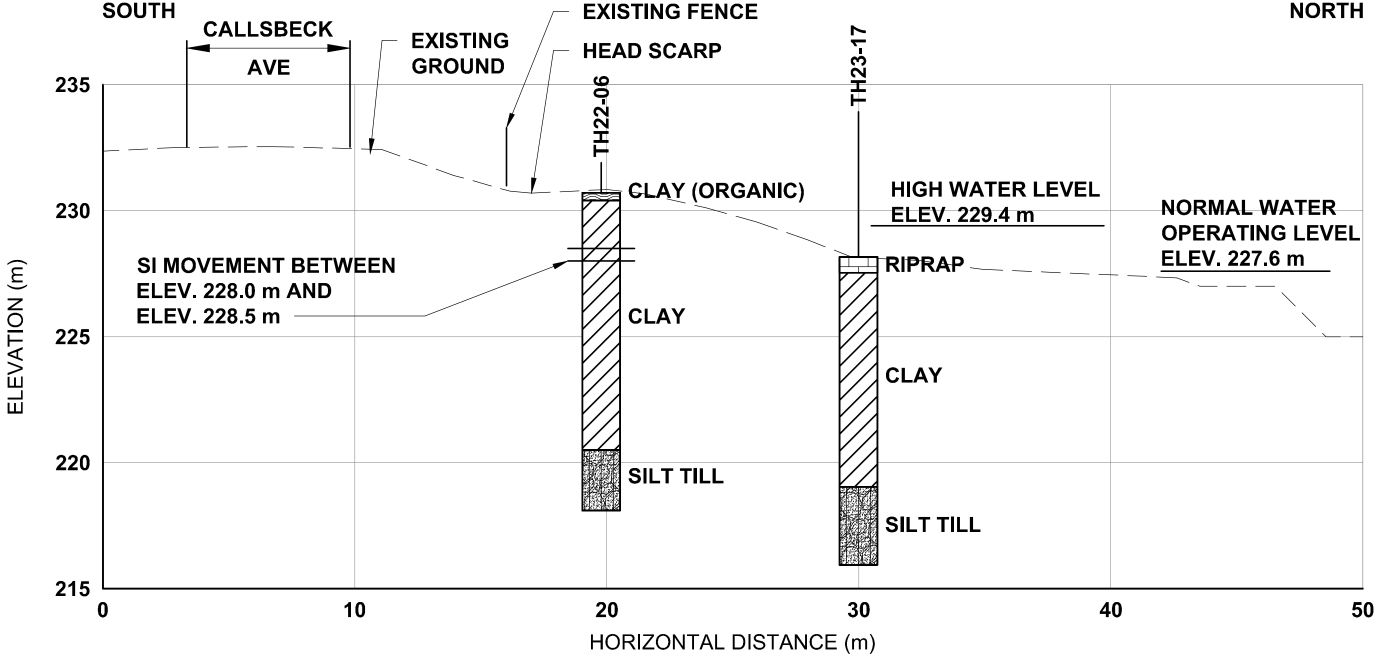
Figure 06

South Embankment
Cross Sections

0002 130 00
Tetra Tech Inc.
Lagimodiere Boulevard Overpass Rehab

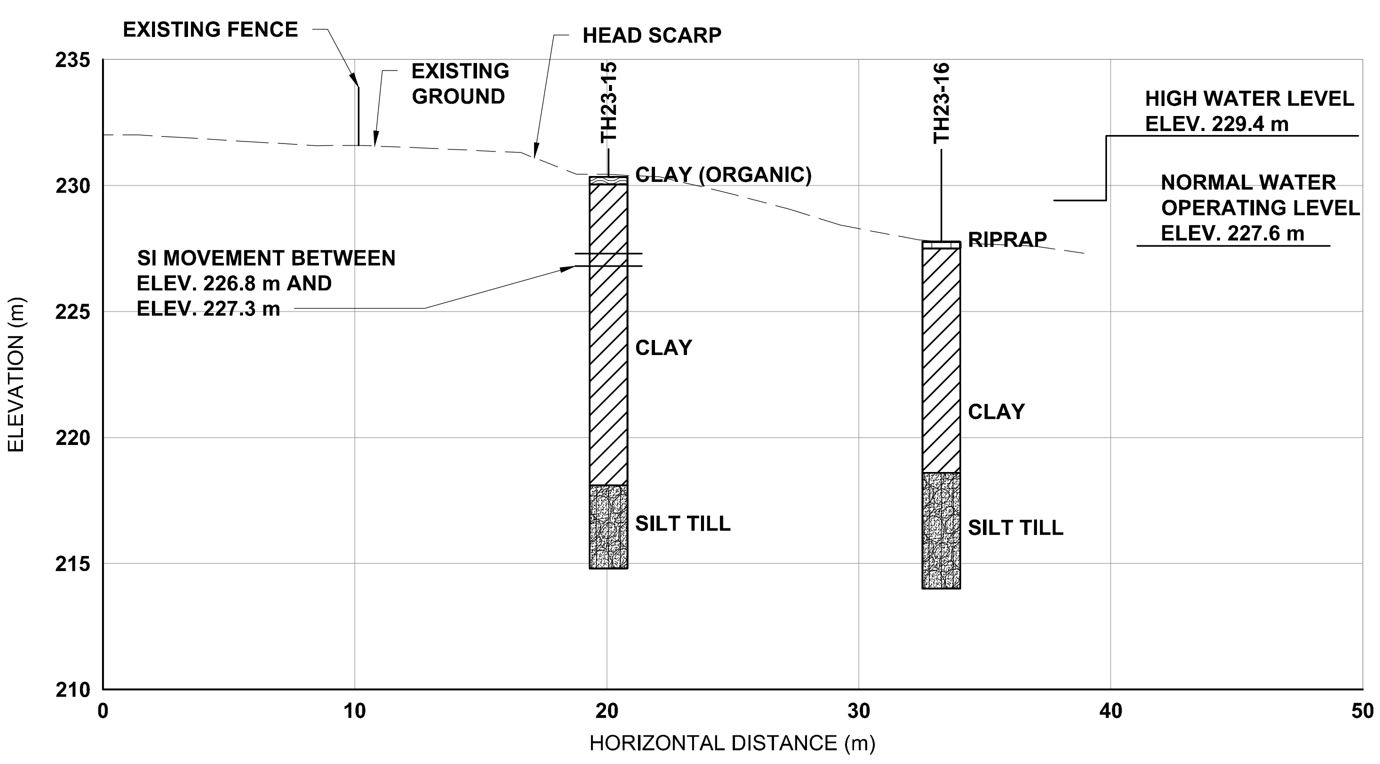
Z:\Projects\0002 Tetra Tech\0002 130 00 Lagimodiere Blvd Overpass Rehab\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Fig 07 2023-08-21 Lagimodiere Blvd Overpass Rehab 0_E 0002-130-00.dwg, 2023-08-21 2:45:40 PM





CROSS SECTION 08

0 5 10 15 m
SCALE = 1 : 300 (279 mm x 432 mm)



CROSS SECTION 09

0 5 10 15 m
SCALE = 1 : 300 (279 mm x 432 mm)

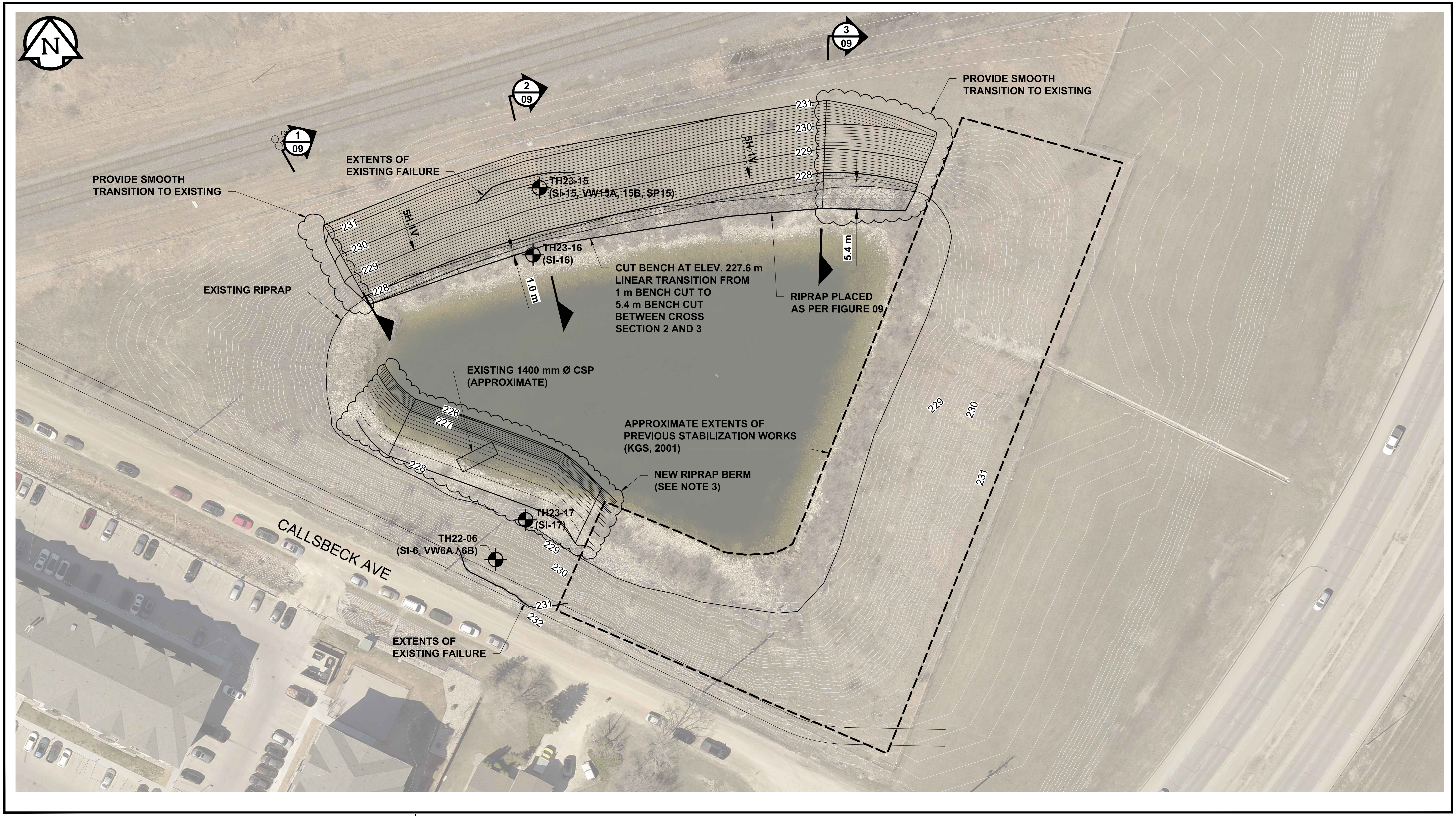
0 10 20 30 m
SCALE = 1 : 750 (279 mm x 432 mm)

LEGEND: ⌖ TEST HOLE (TREK, 2022)

NOTES:
1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2021).
2. TEST HOLE ELEVATIONS AND LOCATIONS SURVEYED BY TREK, (2022)
3. CROSS SECTIONS SURVEYED BY TREK (2022).

Figure 07
Retention Pond Plan
and Cross Section

Z:\Projects\0002 Tetra Tech\0002 130 00 Lagimodiere Blvd Overpass Rehab\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Figs 08 & 09 2023-11-06 Lagimodiere Blvd Overpass Rehab 0_D 0002-130-00.dwg, 2023-11-07 10:03:35 AM



0 10 20 30 m
SCALE = 1 : 750 (279 mm x 432 mm)

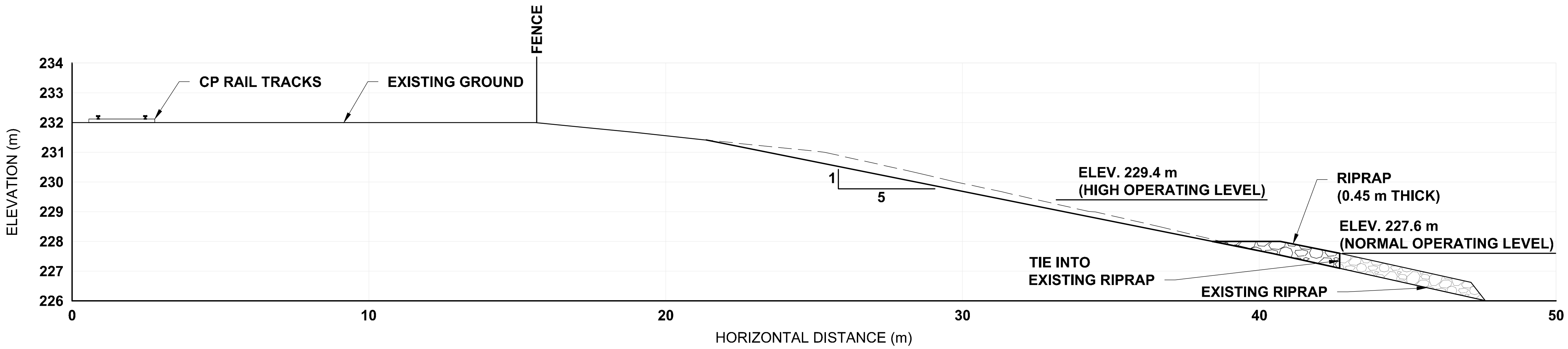
LEGEND:

- TEST HOLE (TREK, 2022)
- EXISTING MAJOR CONTOUR (1.0 m INTERVAL)
- EXISTING MINOR CONTOUR (0.125 m INTERVAL)
- PROPOSED MAJOR CONTOUR (1.0 m INTERVAL)
- PROPOSED MINOR CONTOUR (0.125 m INTERVAL)

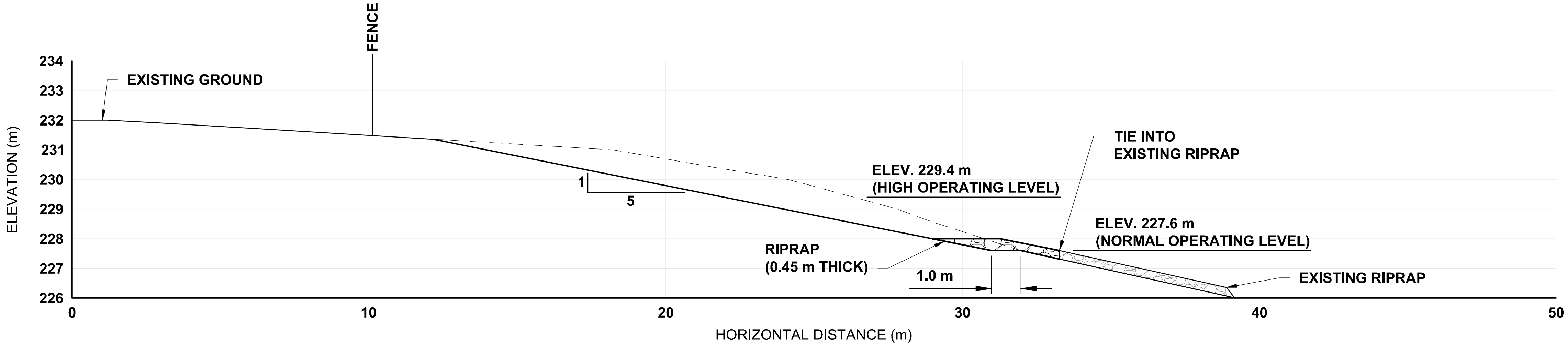
NOTES:

1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2021).
2. TEST HOLE ELEVATIONS AND LOCATIONS SURVEYED BY TREK, (2022).
3. RIPRAP EXTENTS AROUND EXISTING 1400 mm Ø CSP TO BE ADJUSTED DURING PLACEMENT.

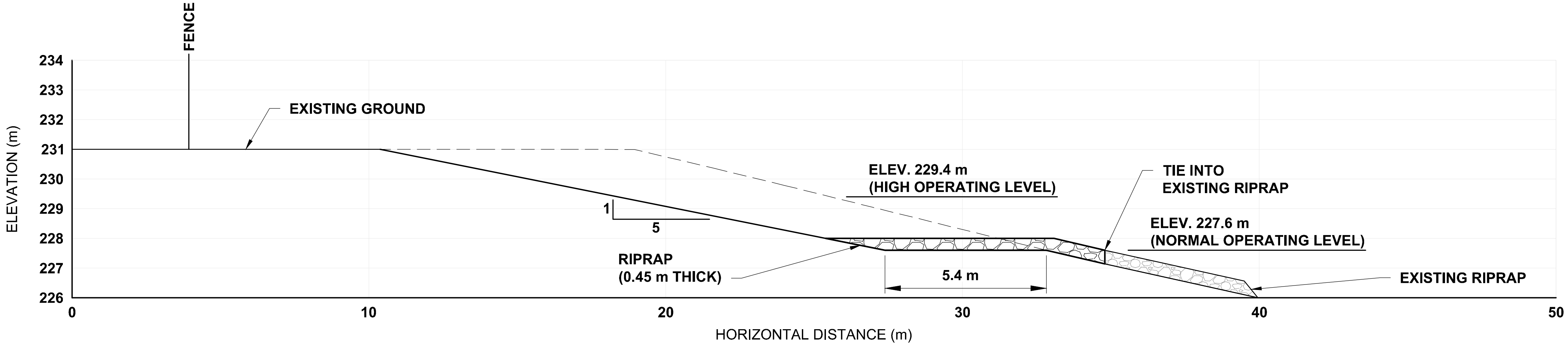
Figure 08
Proposed Retention Pond
Plan



CROSS SECTION 1



CROSS SECTION 2



CROSS SECTON 3

Z:\Projects\0002 Tetra Tech\0002 130 00 Lagimodiere Blvd Overpass Rehab\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Figs 08 & 09 2023-11-06 Lagimodiere Blvd Overpass Rehab 0_D 0002-130-00.dwg, 2023-11-07 10:04:32 AM

0.0 2.5 5.0 7.5 10.0 m
SCALE = 1 : 175 (279 mm x 432 mm)

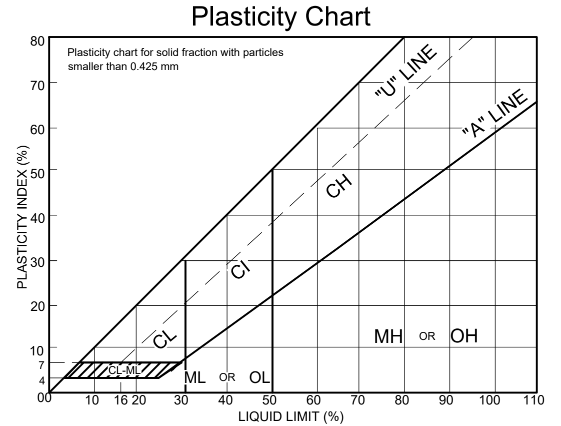
Figure 09
Proposed Retention Pond
Cross Sections

Test Hole Logs

EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the Unified Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
2. Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
3. When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

Major Divisions			USCS Classification	Symbols	Typical Names	Laboratory Classification Criteria			
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW	●	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve, depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows:	Less than 5 percent....... GW, GP, SW, SP More than 12 percent...... GM, GC, SM, SC 6 to 12 percent...... Borderline case4s requiring dual symbols*	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	○	Poorly-graded gravels, gravel-sand mixtures, little or no fines			Not meeting all gradation requirements for GW	
		Gravel with fines (Appreciable amount of fines)	GM	○	Silty gravels, gravel-sand-silt mixtures			Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols
			GC	▨	Clayey gravels, gravel-sand-silt mixtures			Atterberg limits above "A" line or P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	SW	⁘	Well-graded sands, gravelly sands, little or no fines			$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	∴	Poorly-graded sands, gravelly sands, little or no fines			Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	▥	Silty sands, sand-silt mixtures			Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols
			SC	▨	Clayey sands, sand-clay mixtures			Atterberg limits above "A" line or P.I. greater than 7	
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML	▥	Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity	Plasticity Chart 			
			CL	▨	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays				
			OL	▤	Organic silts and organic silty clays of low plasticity				
	Silts and Clays (Liquid limit greater than 50)		MH	▥	Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts				
			CH	▨	Inorganic clays of high plasticity, fat clays				
			OH	≋	Organic clays of medium to high plasticity, organic silts				
	Highly Organic Soils		Pt	⩊	Peat and other highly organic soils	Von Post Classification Limit		Strong colour or odour, and often fibrous texture	

Material		Particle Size mm	Particle Size ASTM Sieve sizes
Sand	Coarse	2.00 to 4.75	#10 to #4
	Medium	0.425 to 2.00	#40 to #10
	Fine	0.075 to 0.425	#200 to #40
Silt or Clay		< 0.075	< #200

Material		Particle Size mm	Particle Size ASTM Sieve Sizes
Boulders		> 300	> 12 in.
Cobbles		75 to 300	3 in. to 12 in.
Gravel	Coarse	19 to 75	3/4 in. to 3 in.
	Fine	4.75 to 19	#4 to 3/4 in.

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

■	Asphalt	▧	Bedrock (undifferentiated)	○	Cobbles
⁘	Concrete	⊞	Limestone Bedrock	●	Boulders and Cobbles
▩	Fill	☰	Cemented Shale	▥	Silt Till
		▤	Non-Cemented Shale	▨	Clay Till

EXPLANATION OF FIELD AND LABORATORY TESTING

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)
PL - Plastic Limit (%)
PI - Plasticity Index (%)
MC - Moisture Content (%)
SPT - Standard Penetration Test
RQD - Rock Quality Designation
Qu - Unconfined Compression
Su - Undrained Shear Strength

VW - Vibrating Wire Piezometer
SI - Slope Inclinometer

▽ Water Level at Time of Drilling
▼ Water Level at End of Drilling
▼ Water Level After Drilling as Indicated on Test Hole Logs

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent
with *	with silt, with sand	> 35 percent

* Used when the material is classified based on behaviour as a cohesive material

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	Undrained Shear Strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

EXPLANATION OF ROCK CLASSIFICATION

(Canadian Foundation Engineering Manual, 4th Edition, 2006)

Grade*	Term	Uniaxial Comp. Strength (MPa)	Point Load Index (MPa)	Field Estimate of Strength	Examples
R6	Extremely strong	>250	>10	Specimen can only be chipped with a geological hammer	Fresh basalt, chert, diabase, gneiss, granite, quartzite
R5	Very strong	100-250	4-10	Specimen requires many blows of a geological hammer to fracture it	Amphibolite, sandstone, basalt, gabbro, gneiss, granodiorite, peridotite, rhyolite, tuff
R4	Strong	50-100	2-4	Specimen requires more than one blow of a geological hammer to fracture it	Limestone, marble, sandstone, schist
R3	Medium Strong	25-50	1-2	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single blow from a geological hammer	Concrete, phyllite, schist, siltstone
R2	Weak	5-25	***	Can be peeled with a pocket knife with difficulty, shallow indentation made by a firm blow with the point of a geological hammer	Chalk, claystone, potash, marl, siltstone, shale, rocksalt
R1	Very weak	1-5	***	Crumbles under firm blows with point of a geological hammer, can be peeled with a pocket knife	Highly weathered or altered rock, shale
R0	Extremely weak	0.25-1	***	Indented by thumbnail	Stiff fault gouge

* Grade according to ISRM (1981).

** All rock types exhibit a broad range of uniaxial comprehensive strengths reflecting heterogeneity in composition and anisotropy in structure. Strong rocks are characterized by well-interlocked crystal fabric and few voids.

*** Rocks with a uniaxial compressive strength below 25 MPa are likely to yield highly ambiguous results under point load testing.

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH22-01

1 of 2

Client: Tetra Tech Inc

Project Number: 0002-130-00

Project Name: Lagimodiere / Concordia Overpass Rehabilitation

Location: UTM 14N: 5530270 N, 639424 E

Contractor: Paddock Drilling Ltd.

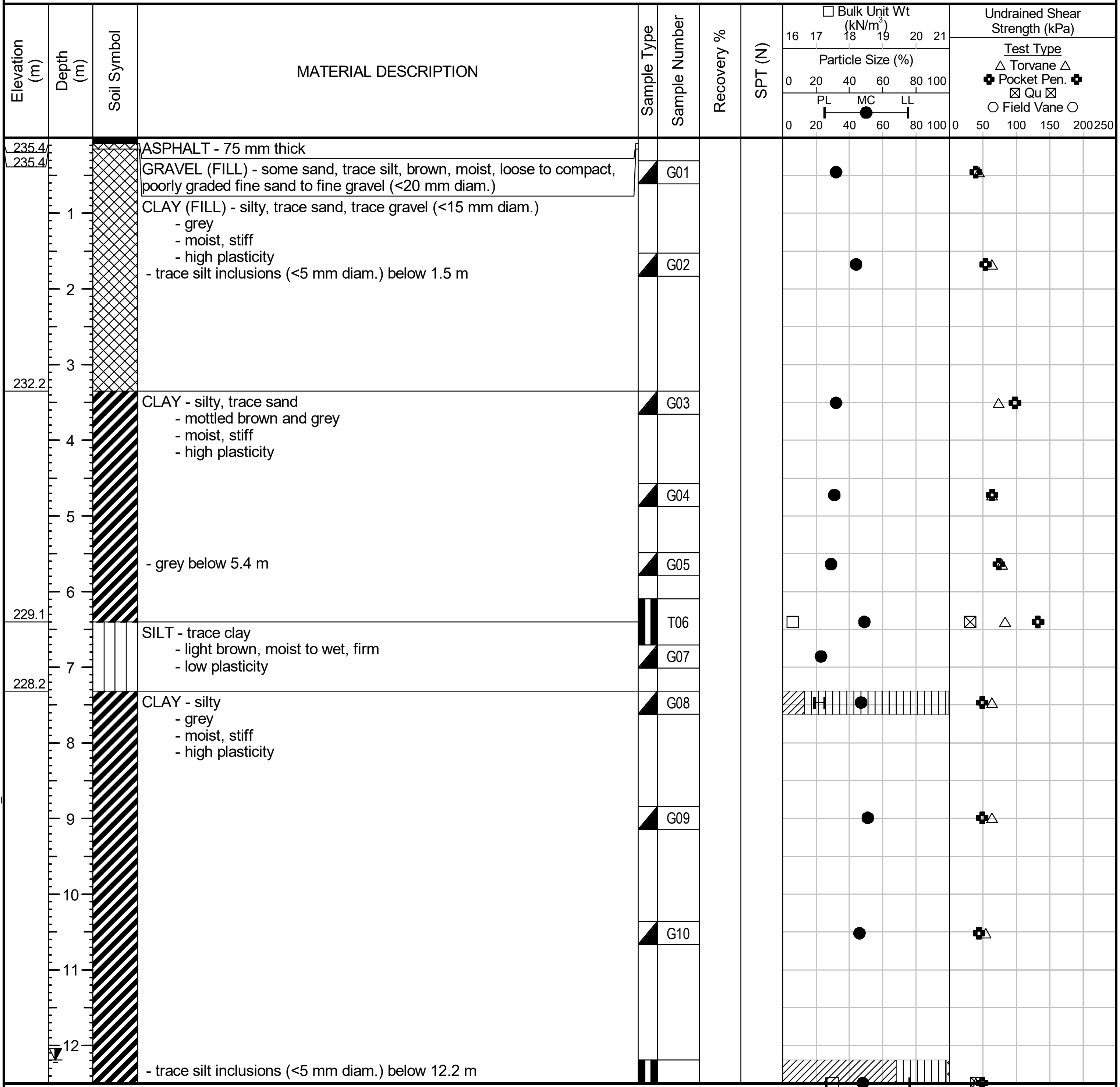
Ground Elevation: 235.52 m

Method: 125mm Solid Stem Auger, Acker MP8 Truck Mount

Date Drilled: September 12, 2022

Sample Type: ◪ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) / SPT ☒ Split Barrel (SB) / LPT ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand Gravel Cobbles Boulders



ASPHALT - 75 mm thick

GRAVEL (FILL) - some sand, trace silt, brown, moist, loose to compact, poorly graded fine sand to fine gravel (<20 mm diam.)

CLAY (FILL) - silty, trace sand, trace gravel (<15 mm diam.)
- grey
- moist, stiff
- high plasticity

- trace silt inclusions (<5 mm diam.) below 1.5 m

CLAY - silty, trace sand
- mottled brown and grey
- moist, stiff
- high plasticity

- grey below 5.4 m

SILT - trace clay
- light brown, moist to wet, firm
- low plasticity

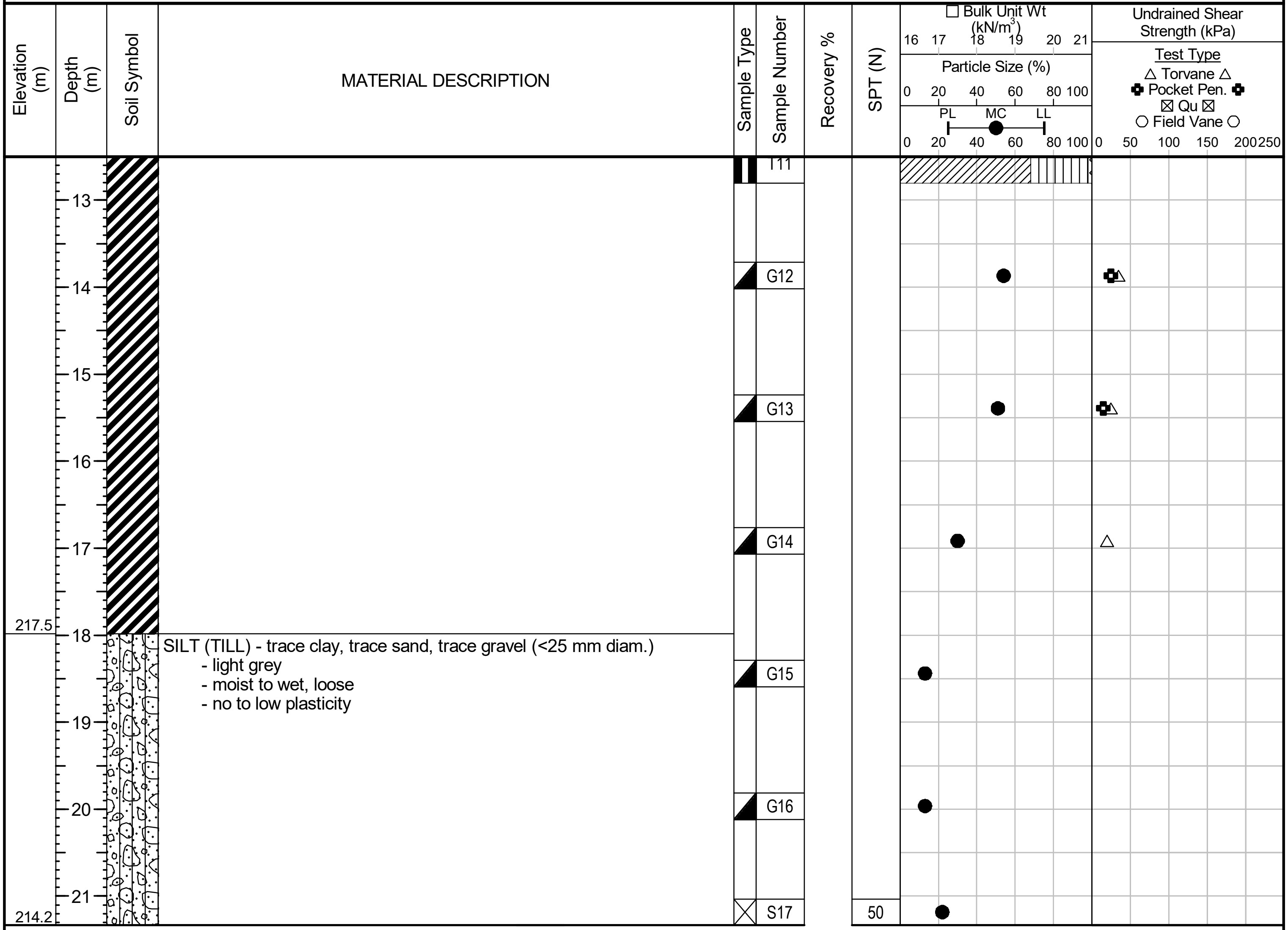
CLAY - silty
- grey
- moist, stiff
- high plasticity

- trace silt inclusions (<5 mm diam.) below 12.2 m

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

Sub-Surface Log

Test Hole TH22-01



SILT (TILL) - trace clay, trace sand, trace gravel (<25 mm diam.)
- light grey
- moist to wet, loose
- no to low plasticity

END OF TEST HOLE AT 21.4 m DEPTH IN SILT (TILL)

NOTES:

1) Power auger refusal encountered at 21.4 m depth.
2) Seepage and sloughing observed from 6.4 to 7.3 m depth.
3) Water level measured at 12.2 m depth after drilling.
4) Test hole open to 21.0 m depth after drilling.
5) Test hole backfilled with bentonite and auger cuttings to ground surface.

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

Sub-Surface Log

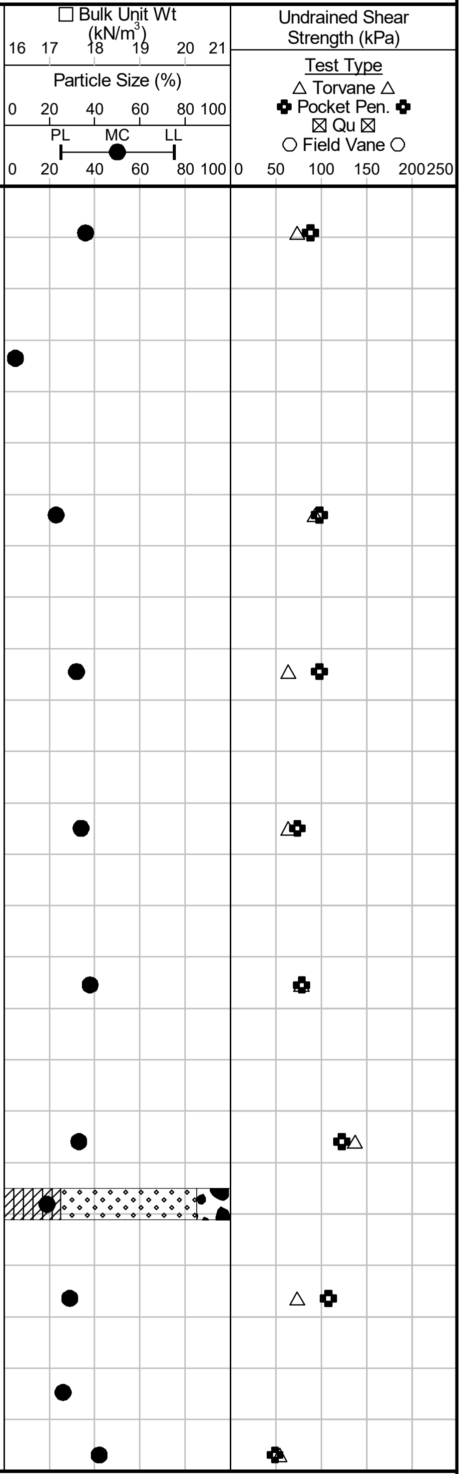
Test Hole TH22-02

Client:	Tetra Tech Inc	**Project Number:**	0002-130-00
Project Name:	Lagimodiere / Concordia Overpass Rehabilitation	**Location:**	UTM 14N:5530463 N, 639518 E
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	240.75 m
Method:	125mm Solid Stem Auger, Acker MP8 Truck Mount	**Date Drilled:**	September 12, 2022

Sample Type: ◩ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) / SPT ⧗ Split Barrel (SB) / LPT ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand ● Gravel ◌ Cobbles ■ Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	Recovery %	SPT (N)
		CLAY (FILL) - silty, trace sand, trace gravel (<10 mm diam.) - brown and grey - moist, stiff - high plasticity	◩	G18		
239.2		SAND (FILL) - trace to some gravel (<20 mm diam.) - brown - dry to moist, compact - poorly graded medium sand to fine gravel	◩	G19		
237.9		CLAY (FILL) - silty, trace sand, trace gravel (<10 mm diam.) - brown and grey - moist, stiff - high plasticity	◩ ◩ ◩ ◩	G20 G21 G22 G23		
		- very stiff below 9.2 m	◩	G24		
231.0		SAND (FILL) - some gravel (<20 mm diam.), trace clay, trace silt - brown, moist, compact - poorly graded medium sand to fine gravel	◩	G25		
230.1		CLAY - silty - mottled brown and grey, moist, stiff to very stiff - high plasticity	◩	G26		
229.2		SILT - trace clay, light brown - moist to wet, firm, low plasticity	◩	G27		
228.6		CLAY - silty, trace silt inclusions (<5 mm diam.)	◩	G28		



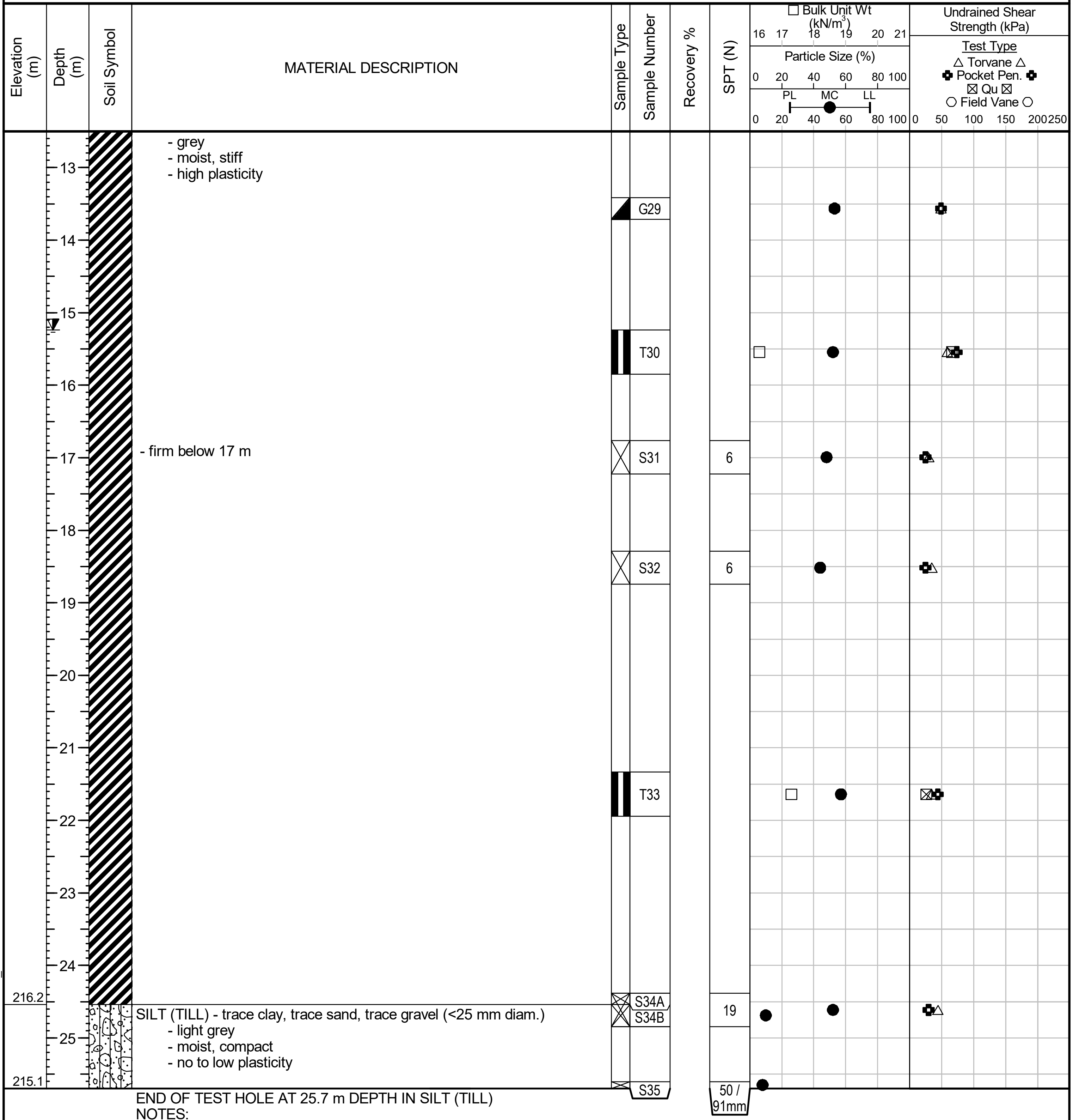
Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH22-02

2 of 2



- grey
- moist, stiff
- high plasticity

- firm below 17 m

SILT (TILL) - trace clay, trace sand, trace gravel (<25 mm diam.)
- light grey
- moist, compact
- no to low plasticity

Sample Number	SPT (N)
G29	
T30	
S31	6
S32	6
T33	
S34A	19
S34B	
S35	50 / 91mm

END OF TEST HOLE AT 25.7 m DEPTH IN SILT (TILL)

NOTES:

1) Power auger refusal encountered at 25.7 m depth.
2) Seepage and sloughing observed from to 9.7 to 10.7 m depth.
3) Switched to hollow stem augers below 13.7 m depth.
4) Water level measured at 15.2 m depth after drilling.
5) Test hole open to 10.7 m depth after removal of augers.
6) Test hole backfilled with bentonite and auger cuttings to ground surface.

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

Test Hole TH22-03

1 of 2

Sub-Surface Log

Client: Tetra Tech Inc

Project Number: 0002-130-00

Project Name: Lagimodiere / Concordia Overpass Rehabilitation

Location: UTM 14N:5530604 N, 639569 E

Contractor: Paddock Drilling Ltd.

Ground Elevation: 240.18 m

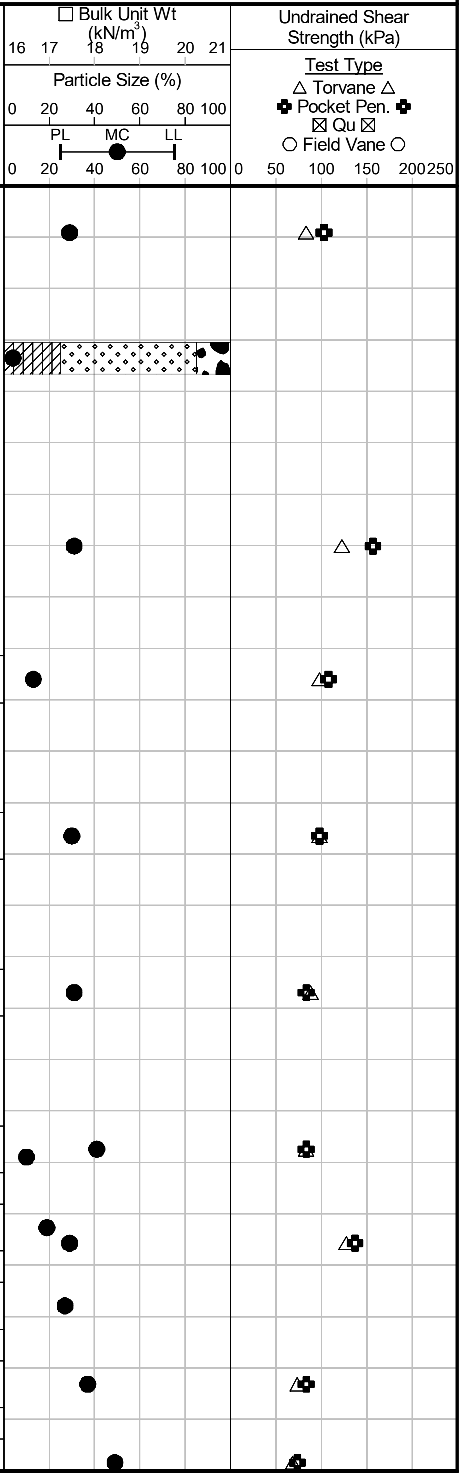
Method: 125mm Solid Stem Auger, Acker MP8 Truck Mount

Date Drilled: September 13, 2022

Sample Type: ◪ Grab (G) ◧ Shelby Tube (T) ☒ Split Spoon (SS) / SPT ☒ Split Barrel (SB) / LPT ◨ Core (C)

Particle Size Legend: ▥ Fines ▨ Clay ▥ Silt ⁘ Sand ● Gravel ◌ Cobbles ■ Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Recovery %	SPT (N)
240.0		▨	CLAY (ORGANIC) - silty, trace sand, trace gravel (<10 mm diam.), trace rootlets, black, moist, firm, high plasticity				
		▨	CLAY (FILL) - silty, trace sand, trace gravel (<15 mm diam.) - black and grey - moist, stiff - high plasticity	G	G36		
238.7		▨	SAND (FILL) - some gravel (<20 mm diam.), trace clay, trace silt - brown - dry to moist, compact - poorly graded medium sand to fine gravel	G	G37		
236.8		▨	CLAY (FILL) - silty, trace sand, trace gravel (<15 mm diam.) - brown and grey - moist, very stiff - high plasticity	G	G38		
		▨	- stiff below 4.6 m	SS	S39		16
		▨		SS	S40		16
		▨		SS	S41		12
	▼	▨		SS	S42A		21
230.9		▨	SAND (FILL) - trace gravel (<10 mm diam.) - brown, moist, compact - poorly graded medium sand to fine gravel	SS	S42B		
		▨		SS	S43A		13
230.0		▧	CLAY - silty, mottled brown and grey - moist, very stiff, high plasticity	SS	S43B		
229.4		▥	SILT - trace clay, light brown - moist, firm, low plasticity	SS	S44		7
228.7		▧	CLAY - silty - mottled brown and grey - moist, stiff - high plasticity	SS	S45		9
		▧		SS	S46		9

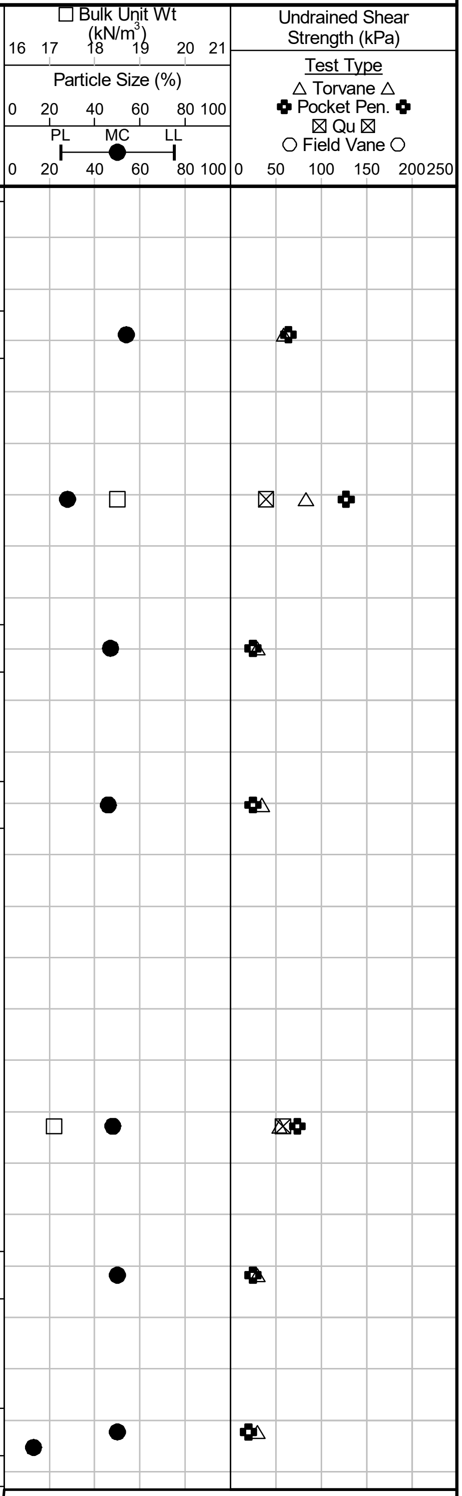


Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

Sub-Surface Log

Test Hole TH22-03

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Recovery %	SPT (N)
	12.2	▨	- trace silt inclusions (<10 mm diam.) below 12.2 m	☒			
	14	▨		☒	S47		8
	15.2	▨	- grey below 15.2 m		T48		
	17	▨	- firm below 17 m	☒	S49		7
	18.5	▨	- some till inclusions (<10 mm diam.), trace sand, trace gravel (<15 mm diam.)	☒	S50		6
	21.6	▨			T51		
	23.1	▨		☒	S52		8
215.5	24.6		SILT (TILL) - gravelly (<25 mm diam.), trace clay, trace sand, light grey - moist, dense, no to low plasticity	☒	S53A		30
				☒	S53B		
215.0	25.2				S54		50 / 30mm



END OF TEST HOLE AT 25.2 m DEPTH IN SILT (TILL)

NOTES:

1) Power auger refusal encountered at 25.2 m depth.
2) Seepage and sloughing observed from to 1.5 to 3.4 m and 9.1 to 10.2 m depth.
3) Switched to hollow stem augers below 4.6 m depth.
4) Water level measured at 9.1 m depth after removal of augers.
5) Test hole open to 11.6 m depth after removal of augers.
6) Test hole backfilled with bentonite and auger cuttings to ground surface.

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH22-04

1 of 2

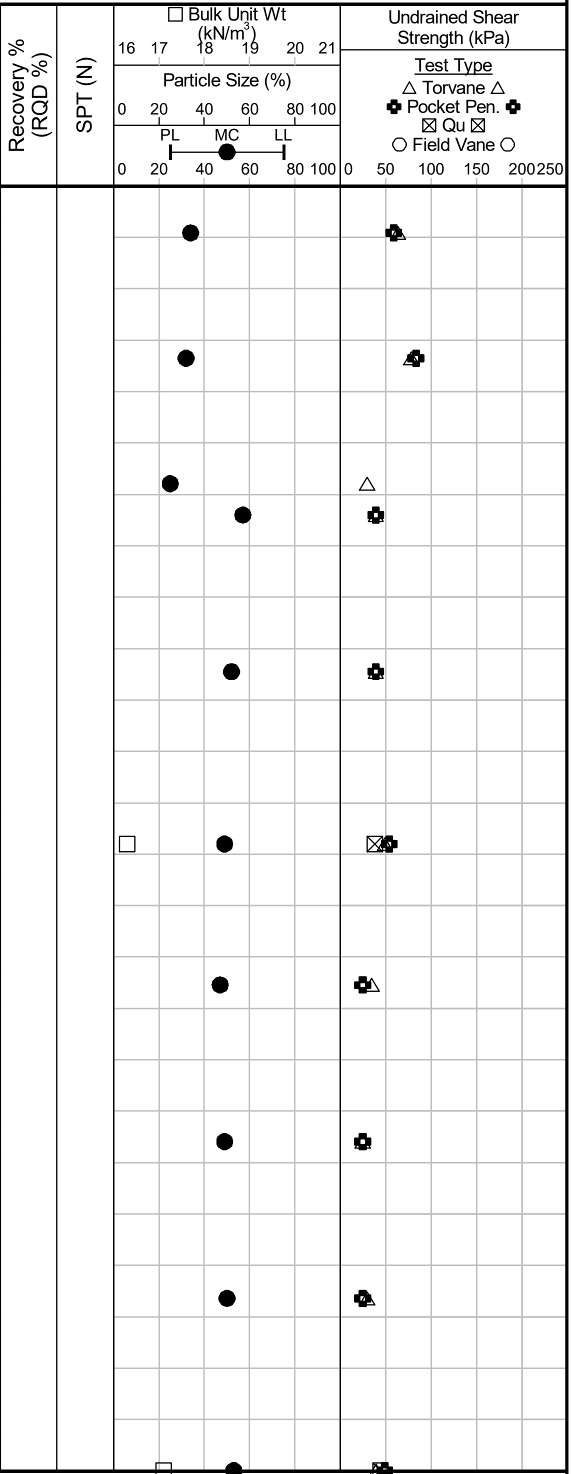
Client: Tetra Tech Inc
Project Name: Lagimodiere / Concordia Overpass Rehabilitation
Contractor: Paddock Drilling Ltd.
Method: 125mm Solid Stem Auger, Acker MP8 Truck Mount
Project Number: 0002-130-00
Location: UTM 14N:5530556 N, 639552 E
Ground Elevation: 232.15 m
Date Drilled: September 13, 2022

Sample Type: ◪ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) / SPT ☒ Split Barrel (SB) / LPT ▯ Core (C)

Particle Size Legend: ▥ Fines ▨ Clay ▥ Silt ⁙ Sand ● Gravel ○ Cobbles ■ Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
232.0			SAND (FILL) - some gravel (< 30 mm diam.), brown, dry, compact, poorly graded medium sand to coarse gravel		
			CLAY (FILL) - silty, trace sand, trace gravel (<20 mm diam.) - brown and dark grey - moist, stiff - high plasticity	Grab (G)	G55
230.6			CLAY - silty - mottled brown and grey - moist, stiff, high plasticity	Grab (G)	G56
229.6			SILT - trace clay, light grey and brown, moist, firm, no to low plasticity	Grab (G)	G57
229.1			CLAY - silty - mottled brown and grey - moist, firm - high plasticity	Grab (G)	G58
				Grab (G)	G59
			- grey, trace silt inclusions (<10 mm diam.) below 6.1 m	Shelby Tube (T)	T60
				Grab (G)	G61
				Grab (G)	G62
				Grab (G)	G63
				Shelby Tube (T)	

Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12



Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

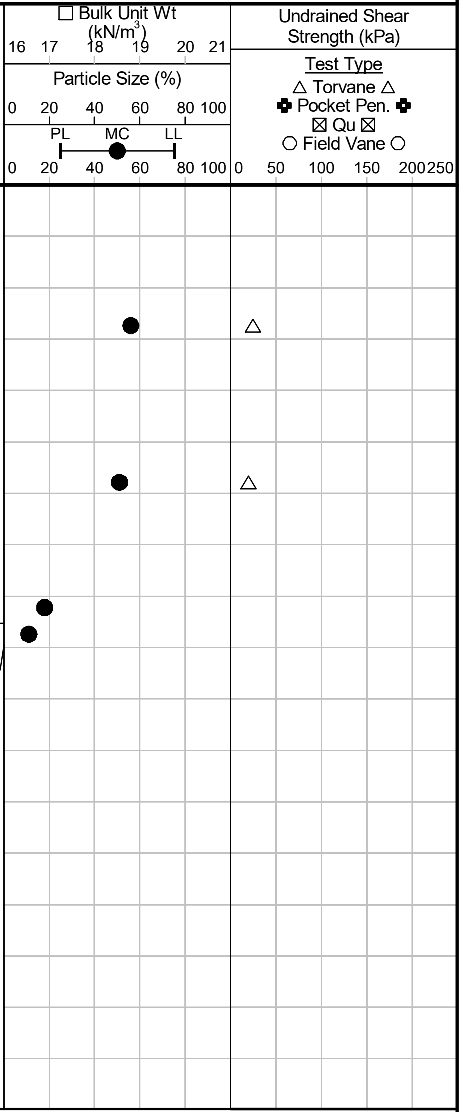
TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH22-04

2 of 2

Elevation (m)	Material Description	Sample Number	Recovery % (RQD %)	SPT (N)
		T64		
		G65		
		G66		
215.7	SILT (TILL) - gravelly, trace clay, trace sand, trace cobbles (<200 mm diam.) - light grey, moist, compact - no to low plasticity	G67		
		S68		50 / 61mm
214.8	DOLOMITIC LIMESTONE - (Red River Formation, Selkirk Member) - cream to light grey - mottled appearance - medium strong to strong (R3 to R4 strength) - massive to weakly bedded perpendicular to the core axis - locally vuggy, minor fracturing - intact bedrock below 18.0 m	C69A	0	
		C69B	75	
		C70	100 (90)	
		C71	100 (85)	
210.7				



END OF TEST HOLE AT 21.5 m DEPTH IN LIMESTONE (BEDROCK)

NOTES:

1) Seepage and sloughing observed from 2.6 to 3.1 m depth.
2) Drilling method switched to HQ core barrel with HW casing at 16.8 m depth .
3) Water level not measured due to drilling method used.
4) Test hole open to 18.0 m depth after removal of HW casing after rock coring.
5) Test hole backfilled with bentonite and auger cuttings to ground surface.

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

Sub-Surface Log

Test Hole TH22-05

1 of 2

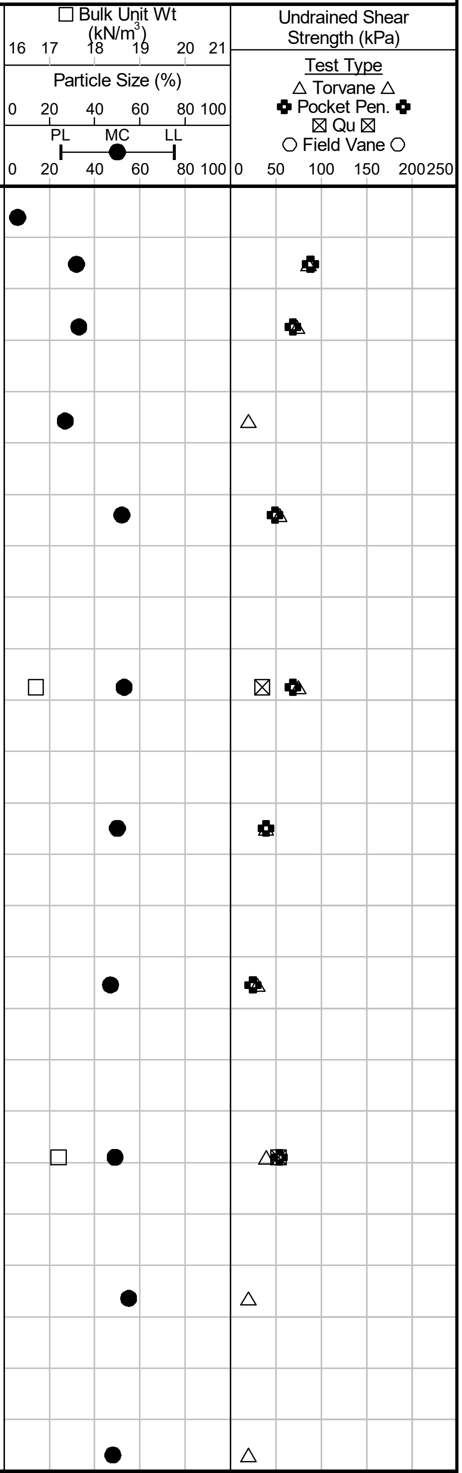
Client: Tetra Tech Inc
Project Name: Lagimodiere / Concordia Overpass Rehabilitation
Contractor: Paddock Drilling Ltd.
Method: 125mm Solid Stem Auger, Acker MP8 Truck Mount
Project Number: 0002-130-00
Location: UTM 14N:5530527 N, 639542 E
Ground Elevation: 232.18 m
Date Drilled: September 14, 2022

Sample Type: ◩ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) / SPT ☒ Split Barrel (SB) / LPT ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⛆ Sand Gravel Cobbles Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
232.1		ASPHALT - 75 mm thick		
231.7		SAND AND GRAVEL (FILL) - trace silt, trace clay, brown, moist, compact, well graded fine sand to fine gravel, (<20 mm diam.)	G	G72
231.0	1	CLAY (FILL) - silty, trace sand, dark grey and black, moist, stiff, high plasticity	G	G73
230.0	2	CLAY - silty - mottled brown and grey - moist, stiff, high plasticity	G	G74
229.1	3	SILT - some clay - brown, moist to wet, firm - low plasticity	G	G75
		CLAY - silty, trace silt inclusions (<5 mm diam.) - mottled brown and grey - moist, stiff - high plasticity	G	G76
	4			
	5	- firm below 4.6 m	T	T77
	6	- grey below 6.1 m	G	G78
	7			
	8		G	G79
	9		T	T80
	10			
	11		G	G81
	12		G	G82

Recovery % (RQD %) | SPT (N)



Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

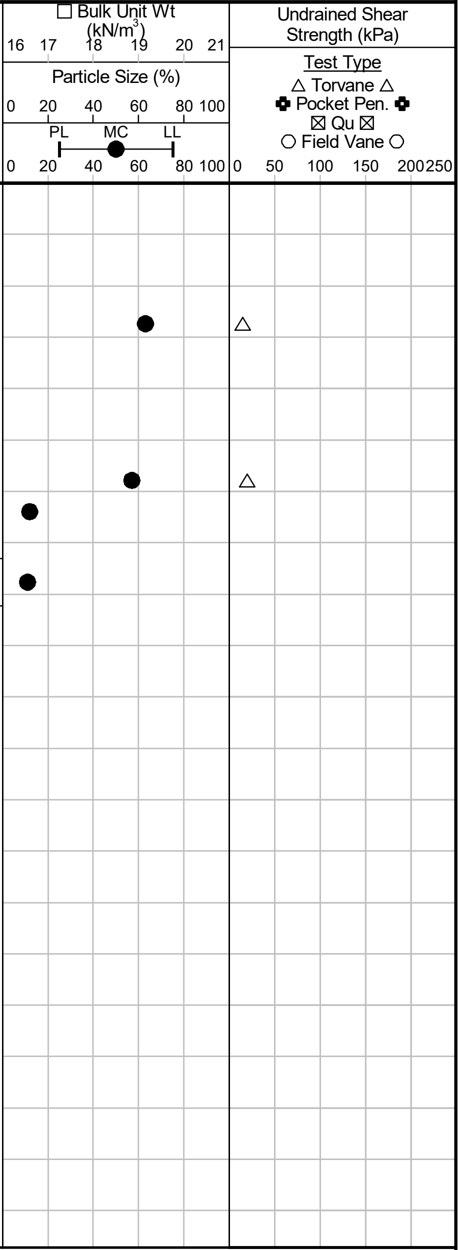
GEOTECHNICAL **TREK**

Sub-Surface Log

Test Hole TH22-05

2 of 2

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Recovery % (RQD %)	SPT (N)
	13.7		- soft to firm below 13.7 m	◣	G83		
	15.2		- trace till inclusions (<10 mm diam.), trace gravel (<20 mm diam.) below 15.2 m	◣	G84		
216.6			SILT (TILL) - trace clay, trace sand, trace gravel, trace cobbles (<200 mm diam.) - light grey - moist, compact - no to low plasticity	◣	G85		
				☒	S86		16
	16.7		- very dense below 16.7 m		C87	40 (20)	
214.5			DOLOMITIC LIMESTONE - (Red River Formation, Selkirk Member) - cream to light brown - calcareous, mottled in places - medium strong (R3 strength) - weak bedding perpendicular to the core axis - vuggy, minor fracturing		C88	20 (20)	
					C89	100 (40)	
	21.1		- Brecciated, fractures parallel and perpendicular to the core axis, some weathering along fractrures between 21.1 and 22.4 m		C90	94 (30)	
209.3							



END OF TEST HOLE AT 22.9 m DEPTH IN LIMESTONE (BEDROCK)
NOTES:
1) Seepage and sloughing observed from 2.1 to 3.1 m depth.
2) Drilling method switched to HQ core barrel with HW casing at 16.7 m depth .
3) Water level not measured due to drilling method used.
4) Test hole open to 18.0 m depth after removal of HW casing after rock coring.
5) Test hole backfilled with bentonite, auger cuttings, and cold patch asphalt to ground surface.

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

TREK GEOTECHNICAL

Sub-Surface Log

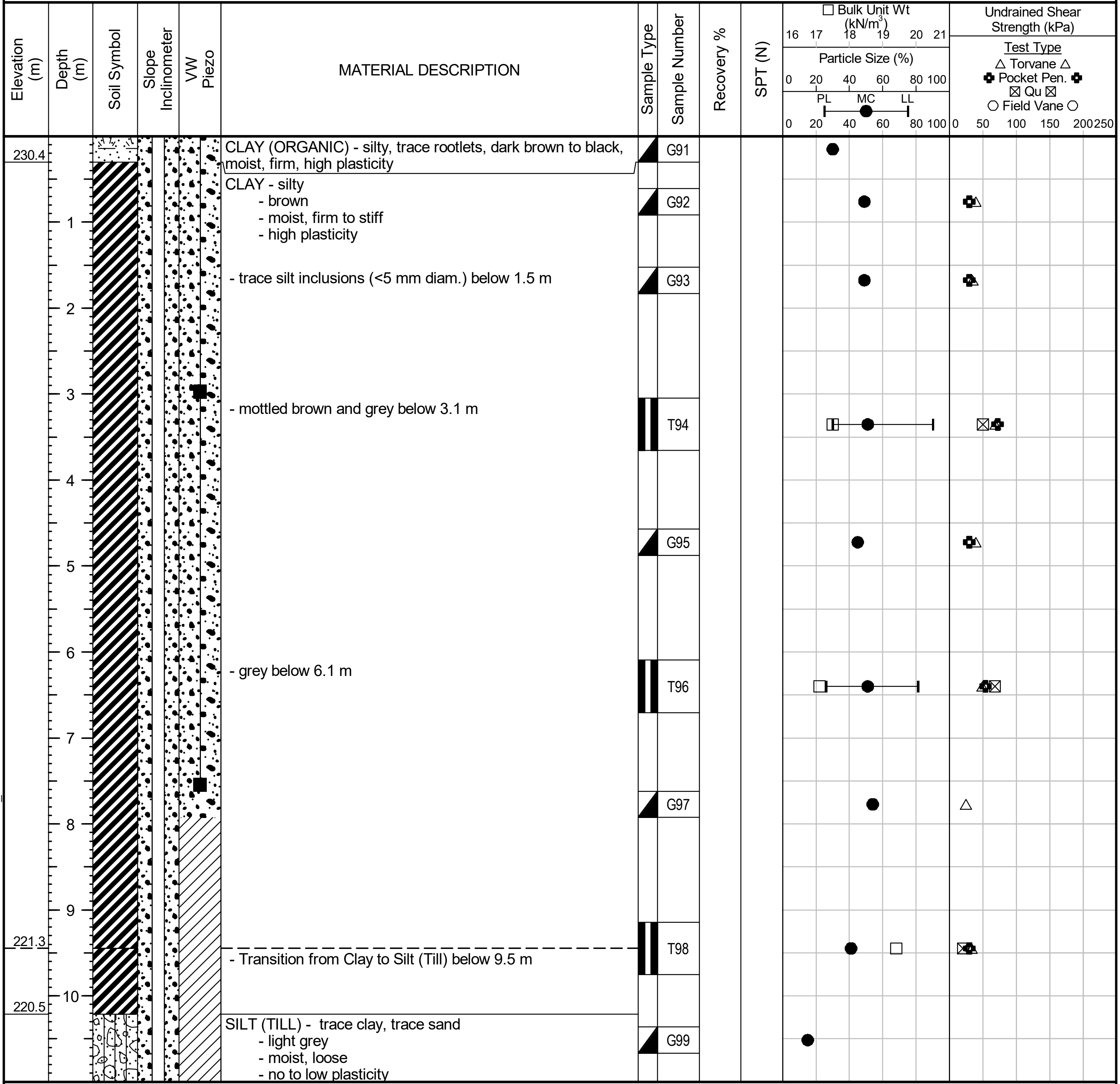
Test Hole TH22-06

Client: Tetra Tech Inc
Project Number: 0002-130-00
Project Name: Lagimodiere / Concordia Overpass Rehabilitation
Location: UTM 14N:5530332 N, 639282 E
Contractor: Paddock Drilling Ltd.
Ground Elevation: 230.70 m
Method: 125mm Solid Stem Auger, Acker MP8 Truck Mount
Date Drilled: September 15, 2022

Sample Type: ◣ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) / SPT ☒ Split Barrel (SB) / LPT ▯ Core (C)

Particle Size Legend: ▥ Fines ▨ Clay ▥ Silt ⁘ Sand ● Gravel ▱ Cobbles ■ Boulders

Backfill Legend: ■ Bentonite ▩ Cement ▨ Drill Cuttings ⁘ Filter Pack Sand ⁘ Grout ▩ Slough



CLAY (ORGANIC) - silty, trace rootlets, dark brown to black, moist, firm, high plasticity

CLAY - silty
- brown
- moist, firm to stiff
- high plasticity

- trace silt inclusions (<5 mm diam.) below 1.5 m

- mottled brown and grey below 3.1 m

- grey below 6.1 m

- Transition from Clay to Silt (Till) below 9.5 m

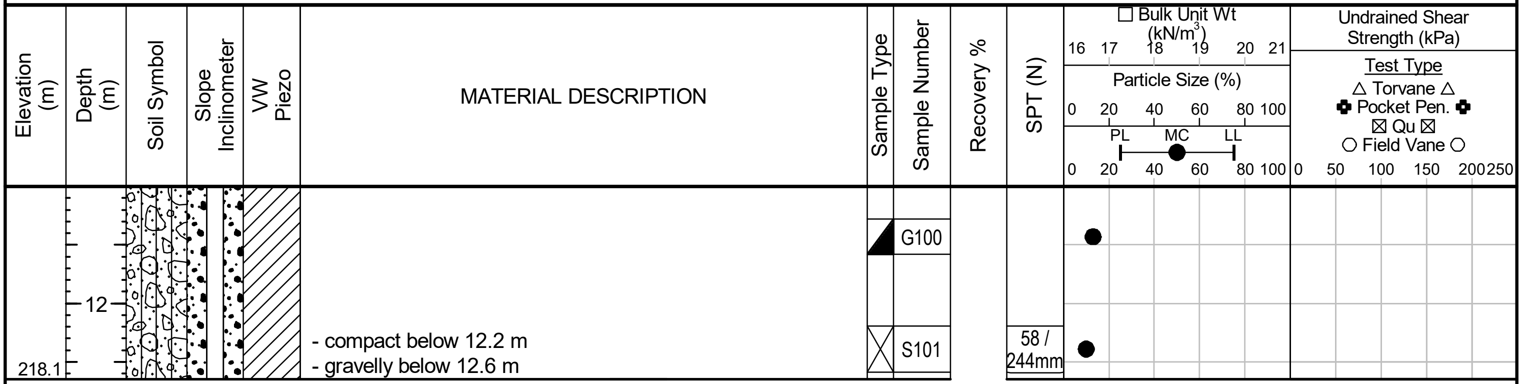
SILT (TILL) - trace clay, trace sand
- light grey
- moist, loose
- no to low plasticity

Logged By: Matt Klymochko
Reviewed By: Michael Van Helden
Project Engineer: Kent Bannister

Sub-Surface Log

Test Hole TH22-06

2 of 2



- compact below 12.2 m
- gravelly below 12.6 m

END OF TEST HOLE AT 12.7 m DEPTH IN SILT (TILL)

NOTES:

1) Power auger refusal encountered at 12.7 m depth.
2) Seepage and sloughing were not observed.
3) Test hole open to 12.7 m and dry immediately after drilling.
4) Slope Inclinometer installed to 12.7 m depth.
5) Vibrating Wire (VW 147959) and (VW 147960) installed at 3.1 and 7.6 m depth respectively in adjacent test hole 2 m west of Slope Inclinometer.
6) Test hole backfilled with bentonite grout mix to surface.

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

Sub-Surface Log

Test Hole TH22-07

1 of 1

Client: Tetra Tech Inc

Project Name: Lagimodiere / Concordia Overpass Rehabilitation

Contractor: TREK Geotechnical Inc.

Method: 50 mm Hand Auger

Project Number: 0002-130-00

Location: UTM 14N:5530293 N, 639494 E

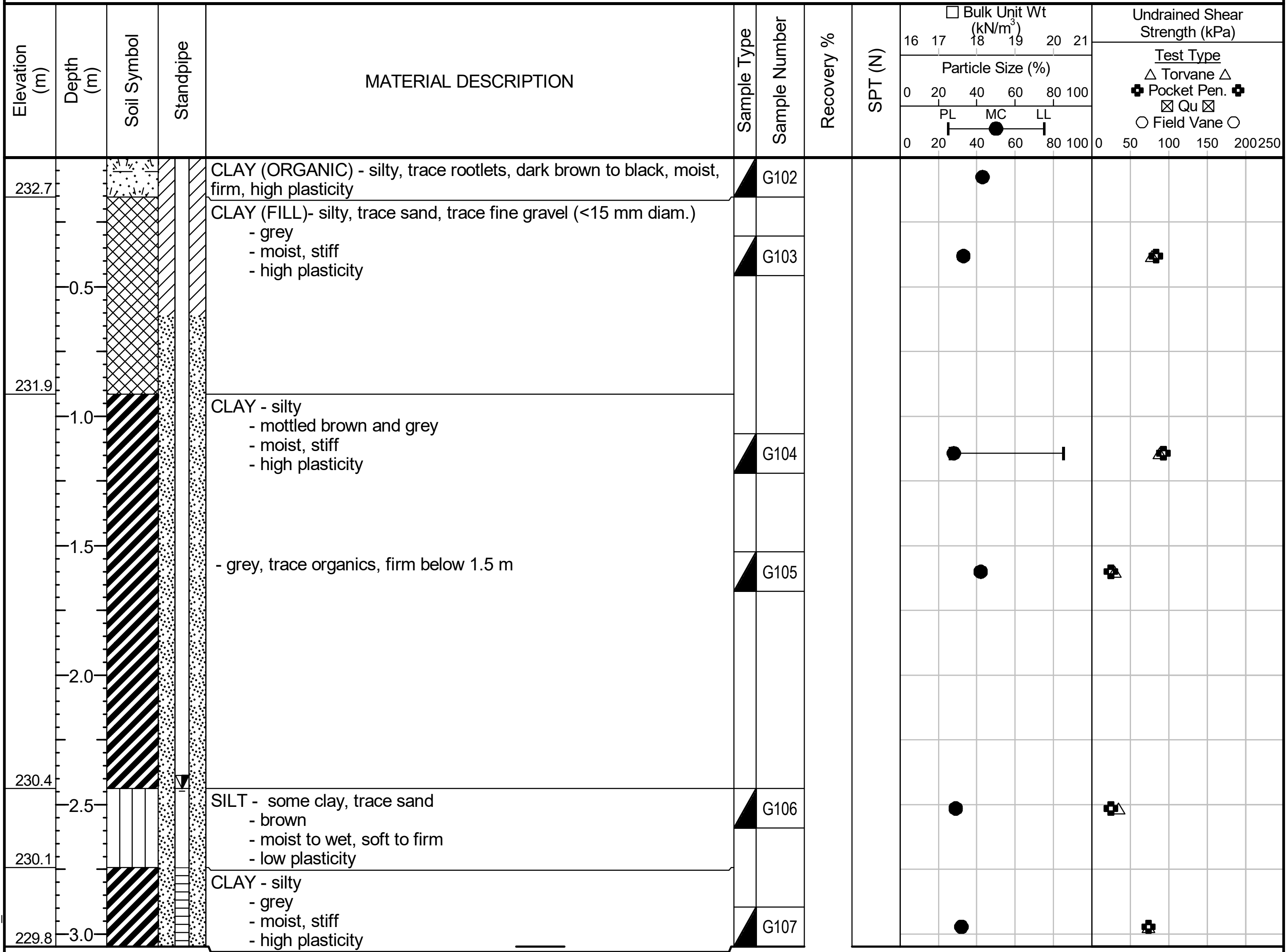
Ground Elevation: 232.85 m

Date Drilled: October 14, 2022

Sample Type: Grab (G) Shelby Tube (T) Split Spoon (SS) / SPT Split Barrel (SB) / LPT Core (C)

Particle Size Legend: Fines Clay Silt Sand Gravel Cobbles Boulders

Backfill Legend: Bentonite Cement Drill Cuttings Filter Pack Sand Grout Slough



CLAY (ORGANIC) - silty, trace rootlets, dark brown to black, moist, firm, high plasticity

CLAY (FILL)- silty, trace sand, trace fine gravel (<15 mm diam.)
- grey
- moist, stiff
- high plasticity

CLAY - silty
- mottled brown and grey
- moist, stiff
- high plasticity

- grey, trace organics, firm below 1.5 m

SILT - some clay, trace sand
- brown
- moist to wet, soft to firm
- low plasticity

CLAY - silty
- grey
- moist, stiff
- high plasticity

END OF TEST HOLE AT 3.0 m DEPTH IN CLAY

NOTES:

1) Seepage observed between 2.4 m to 2.7 m depth.

2)Sloughing not observed

3) Test hole open to 3.0 m immediately after drilling.

4) Standpipe installed to 3.0 m depth.

5) Water level measured at 2.4 m depth immediately after drilling.

6) Test hole backfilled with sand and auger cuttings to surface.

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

Sub-Surface Log

Test Hole TH22-08

1 of 1

Client: Tetra Tech Inc

Project Number: 0002-130-00

Project Name: Lagimodiere / Concordia Overpass Rehabilitation

Location: UTM 14N:5530301 N, 639500 E

Contractor: TREK Geotechnical Inc.

Ground Elevation: 232.59 m

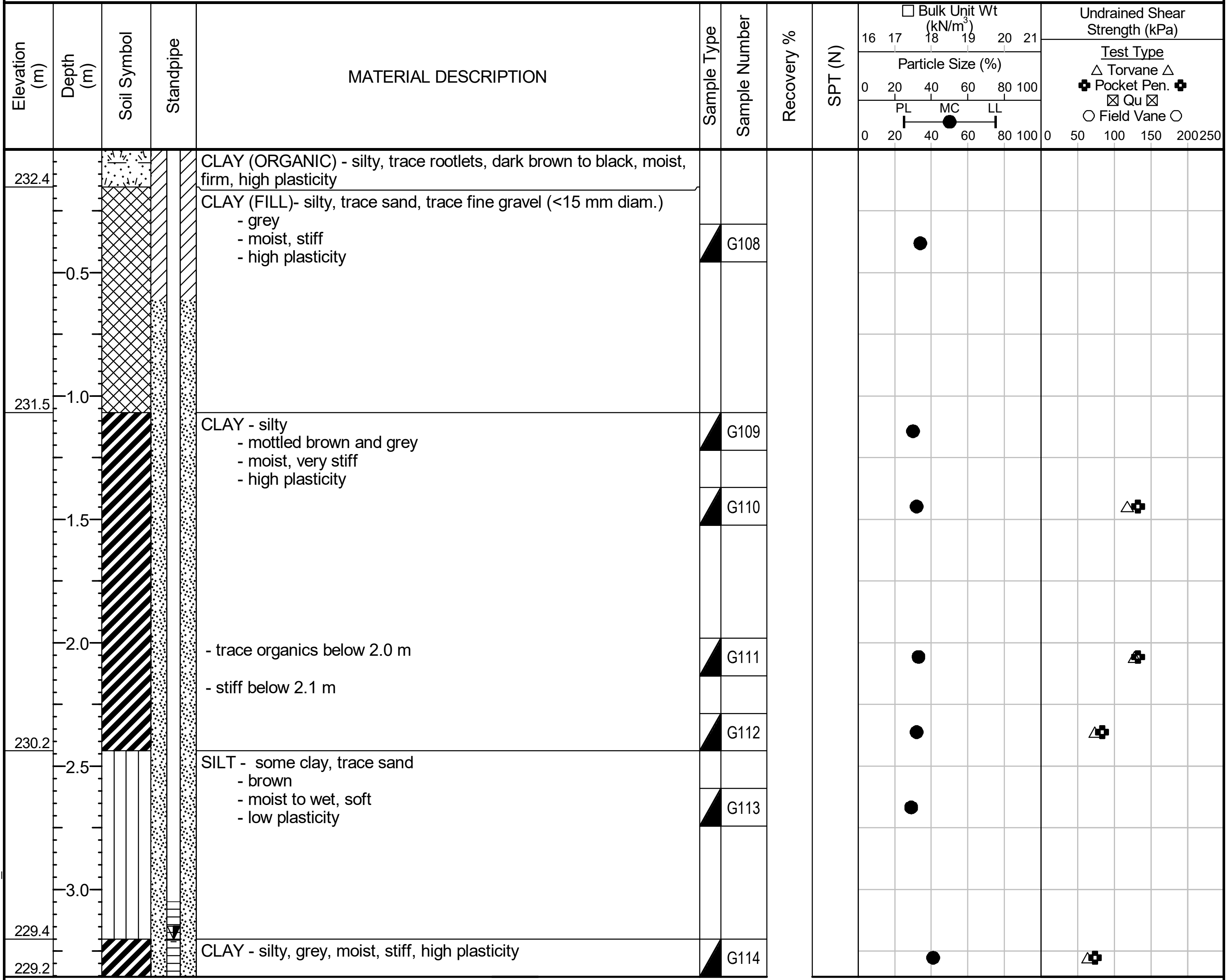
Method: 50 mm Hand Auger

Date Drilled: October 14, 2022

Sample Type: ◩ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) / SPT ⧗ Split Barrel (SB) / LPT ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand ● Gravel ○ Cobbles ■ Boulders

Backfill Legend: ■ Bentonite ▨ Cement ▨ Drill Cuttings ⁘ Filter Pack Sand ⁘ Grout ▩ Slough



CLAY (ORGANIC) - silty, trace rootlets, dark brown to black, moist, firm, high plasticity

CLAY (FILL)- silty, trace sand, trace fine gravel (<15 mm diam.)
- grey
- moist, stiff
- high plasticity

CLAY - silty
- mottled brown and grey
- moist, very stiff
- high plasticity

- trace organics below 2.0 m

- stiff below 2.1 m

SILT - some clay, trace sand
- brown
- moist to wet, soft
- low plasticity

CLAY - silty, grey, moist, stiff, high plasticity

END OF TEST HOLE AT 3.4 m DEPTH IN CLAY

NOTES:
1) Seepage observed between 2.4 m to 3.2 m depth.
2) Sloughing not observed.
3) Test hole open to 3.4 m immediately after drilling.
4) Standpipe installed to 3.4 m depth.
5) Water level measured at 3.2 m depth immediately after drilling.
6) Test hole backfilled with sand and auger cuttings to surface.

Logged By: Matt Klymochko

Reviewed By: Michael Van Helden

Project Engineer: Kent Bannister

Sub-Surface Log

Test Hole TH22-09

1 of 2

Client: Tetra Tech Inc

Project Number: 0002-130-00

Project Name: Lagimodiere / Concordia Overpass Rehabilitation

Location: UTM 14N:5530313 N, 639505 E

Contractor: TREK Geotechnical Inc.

Ground Elevation: 233.21 m

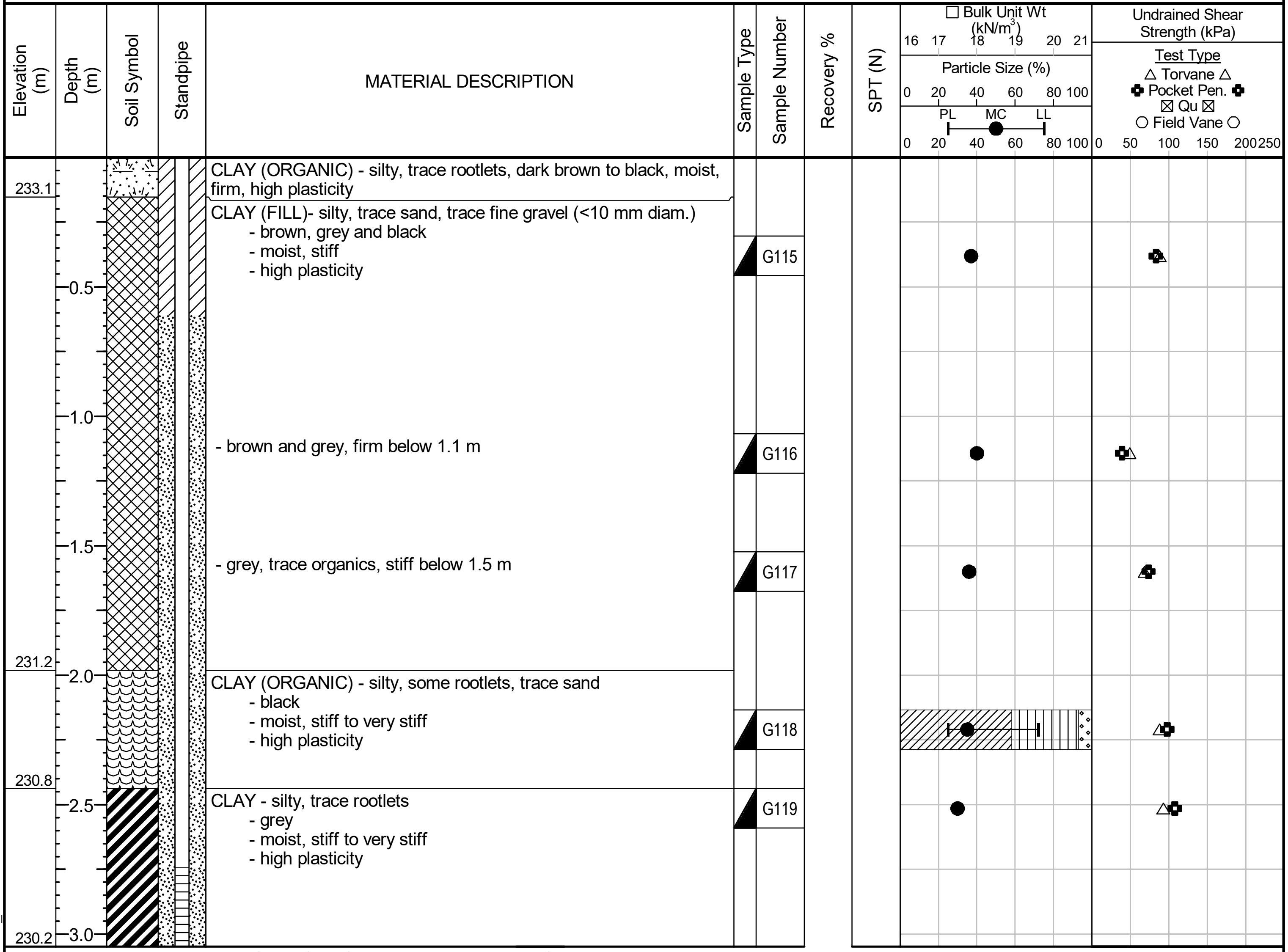
Method: 50 mm Hand Auger

Date Drilled: October 14, 2022

Sample Type: Grab (G), Shelby Tube (T), Split Spoon (SS) / SPT, Split Barrel (SB) / LPT, Core (C)

Particle Size Legend: Fines, Clay, Silt, Sand, Gravel, Cobbles, Boulders

Backfill Legend: Bentonite, Cement, Drill Cuttings, Filter Pack Sand, Grout, Slough



CLAY (ORGANIC) - silty, trace rootlets, dark brown to black, moist, firm, high plasticity

CLAY (FILL)- silty, trace sand, trace fine gravel (<10 mm diam.)
- brown, grey and black
- moist, stiff
- high plasticity

- brown and grey, firm below 1.1 m

- grey, trace organics, stiff below 1.5 m

CLAY (ORGANIC) - silty, some rootlets, trace sand
- black
- moist, stiff to very stiff
- high plasticity

CLAY - silty, trace rootlets
- grey
- moist, stiff to very stiff
- high plasticity

END OF TEST HOLE AT 3.0 m DEPTH IN CLAY

NOTES:
1) Seepage and sloughing not observed.
2) Test hole open to 3.0 m and dry immediately after drilling.
3) Standpipe installed to 3.0 m depth.
4) Test hole backfilled with sand and auger cuttings to surface.

Logged By: Matt Klymochko

Reviewed By: Michael Van Helden

Project Engineer: Kent Bannister

Sub-Surface Log

Elevation (m)	Depth (m)	Soil Symbol	Standpipe	MATERIAL DESCRIPTION	Sample Type	Sample Number	Recovery %	SPT (N)	☐ Bulk Unit Wt (kN/m^3) 16 17 18 19 20 21 Particle Size (%) 0 20 40 60 80 100 PL MC LL ├──●──┤ 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✚ Pocket Pen. ✚ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

Sub-Surface Log

Test Hole TH22-10

1 of 1

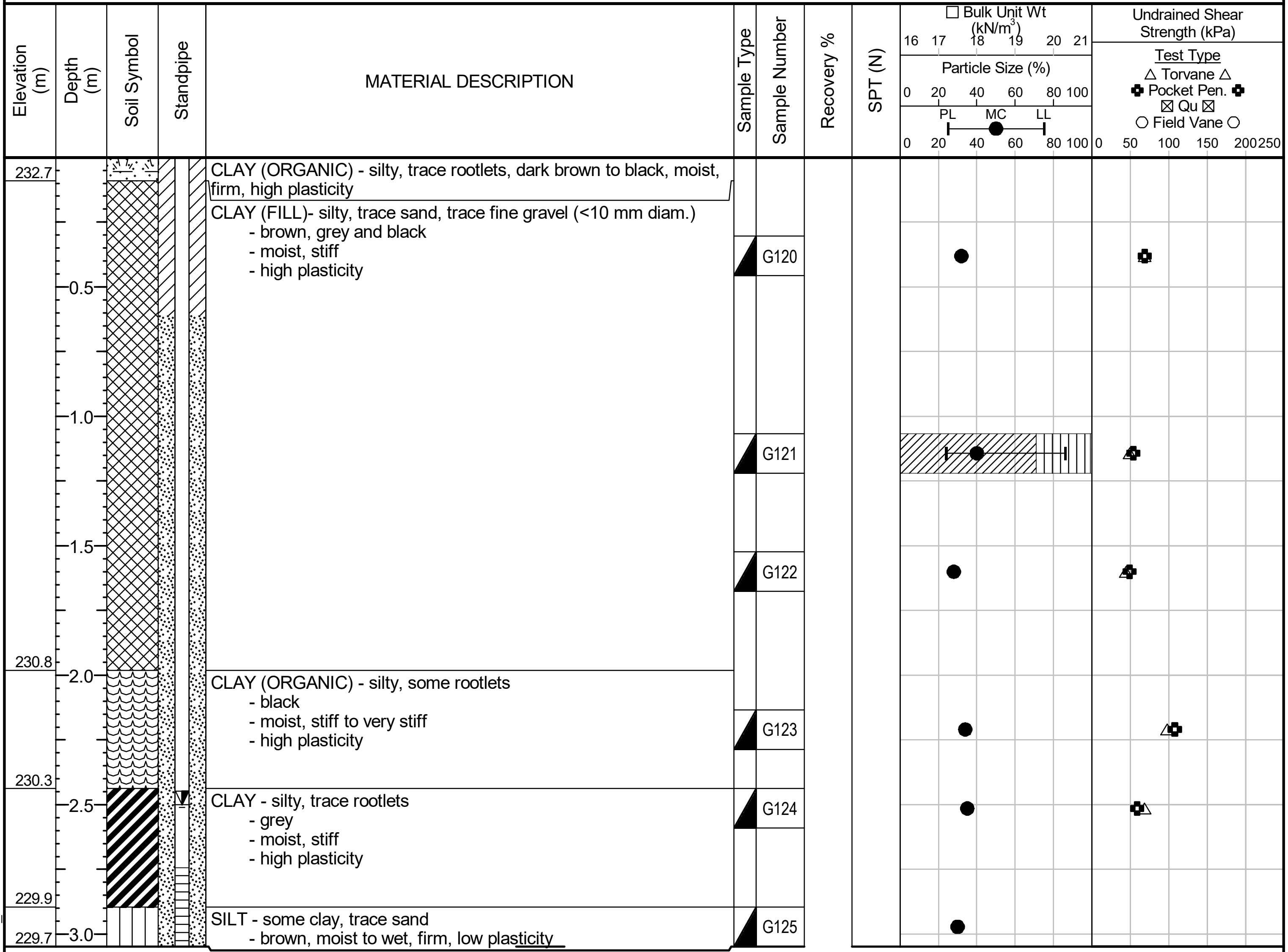
Client: Tetra Tech Inc
Project Name: Lagimodiere / Concordia Overpass Rehabilitation
Contractor: TREK Geotechnical Inc.
Method: 50 mm Hand Auger
Project Number: 0002-130-00
Location: UTM 14N:5530322 N, 639514 E
Ground Elevation: 232.77 m
Date Drilled: October 14, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Backfill Legend: Bentonite | Cement | Drill Cuttings | Filter Pack Sand | Grout | Slough

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
232.7		CLAY (ORGANIC) - silty, trace rootlets, dark brown to black, moist, firm, high plasticity		
		CLAY (FILL)- silty, trace sand, trace fine gravel (<10 mm diam.) - brown, grey and black - moist, stiff - high plasticity	G G G	G120 G121 G122
230.8	2.0	CLAY (ORGANIC) - silty, some rootlets - black - moist, stiff to very stiff - high plasticity	G	G123
230.3	2.5	CLAY - silty, trace rootlets - grey - moist, stiff - high plasticity	G	G124
229.9		SILT - some clay, trace sand - brown, moist to wet, firm, low plasticity	G	G125
229.7	3.0			



END OF TEST HOLE AT 3.0 m DEPTH IN SILT
NOTES:
1) Seepage observed below 2.4 m depth.
2) Sloughing not observed.
3) Test hole open to 3.0 m immediately after drilling.
4) Standpipe installed to 3.0 m depth.
5) Water level measured at 2.5 m depth.
6) Test hole backfilled with sand and auger cuttings to surface.

Logged By: Matt Klymochko
Reviewed By: Michael Van Helden
Project Engineer: Kent Bannister

Sub-Surface Log

Test Hole TH22-11

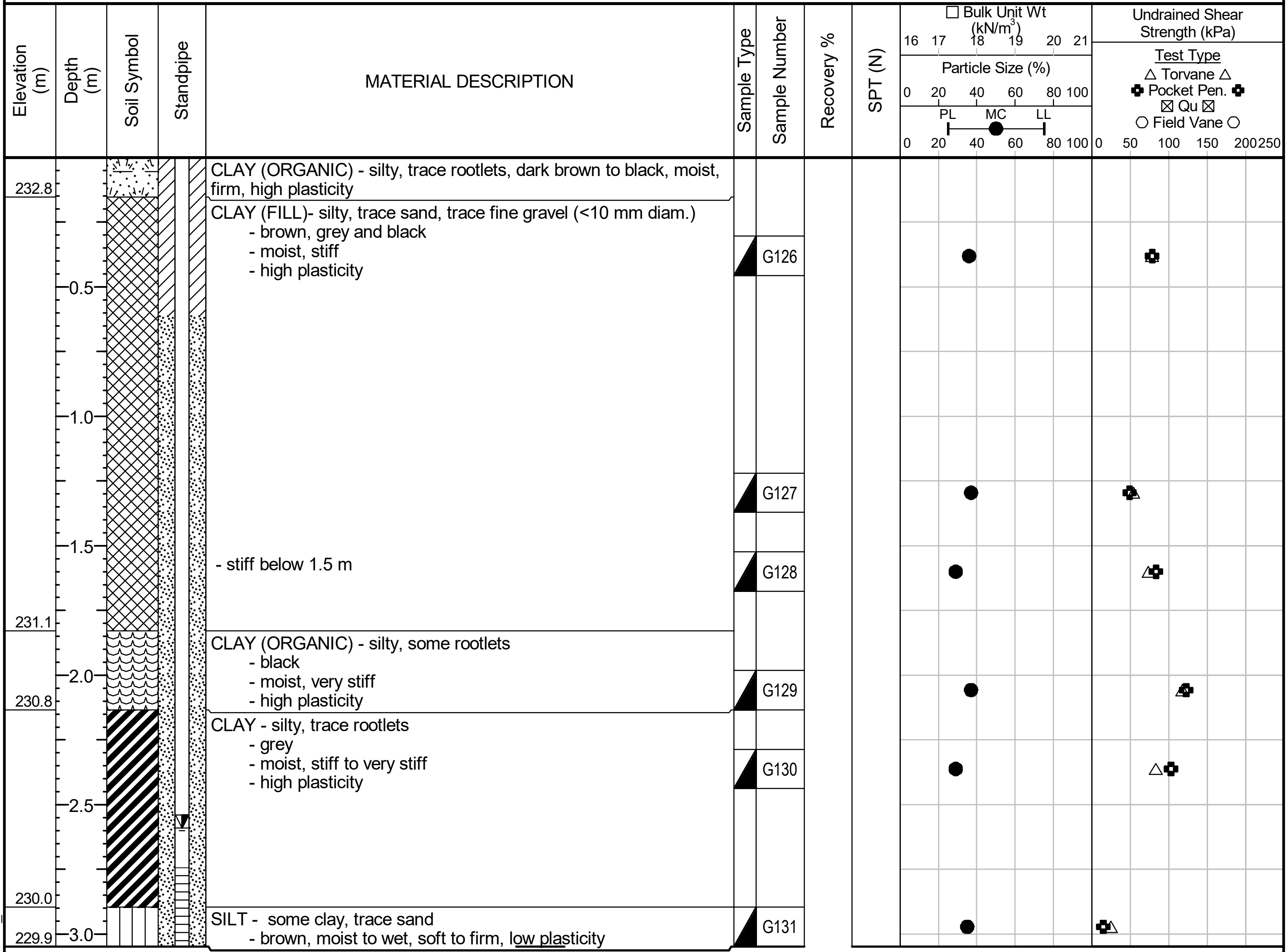
1 of 1

Client: Tetra Tech Inc
Project Number: 0002-130-00
Project Name: Lagimodiere / Concordia Overpass Rehabilitation
Location: UTM 14N:5530334 N, 639521 E
Contractor: TREK Geotechnical Inc.
Ground Elevation: 232.91 m
Method: 50 mm Hand Auger
Date Drilled: October 14, 2022

Sample Type: ◪ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) / SPT ☒ Split Barrel (SB) / LPT ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⛆ Sand ● Gravel ◌ Cobbles ■ Boulders

Backfill Legend: ■ Bentonite ▨ Cement ▨ Drill Cuttings ▩ Filter Pack Sand ⛆ Grout ▩ Slough



CLAY (ORGANIC) - silty, trace rootlets, dark brown to black, moist, firm, high plasticity

CLAY (FILL)- silty, trace sand, trace fine gravel (<10 mm diam.)
- brown, grey and black
- moist, stiff
- high plasticity

- stiff below 1.5 m

CLAY (ORGANIC) - silty, some rootlets
- black
- moist, very stiff
- high plasticity

CLAY - silty, trace rootlets
- grey
- moist, stiff to very stiff
- high plasticity

SILT - some clay, trace sand
- brown, moist to wet, soft to firm, low plasticity

END OF TEST HOLE AT 3.0 m DEPTH IN SILT
NOTES:
1) Seepage observed below 2.6 m depth.
2) Sloughing not observed.
3) Test hole open to 3.0 m immediately after drilling.
4) Standpipe installed to 3.0 m depth.
5) Water level measured at 2.6 m depth.
6) Test hole backfilled with sand and auger cuttings to surface.

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

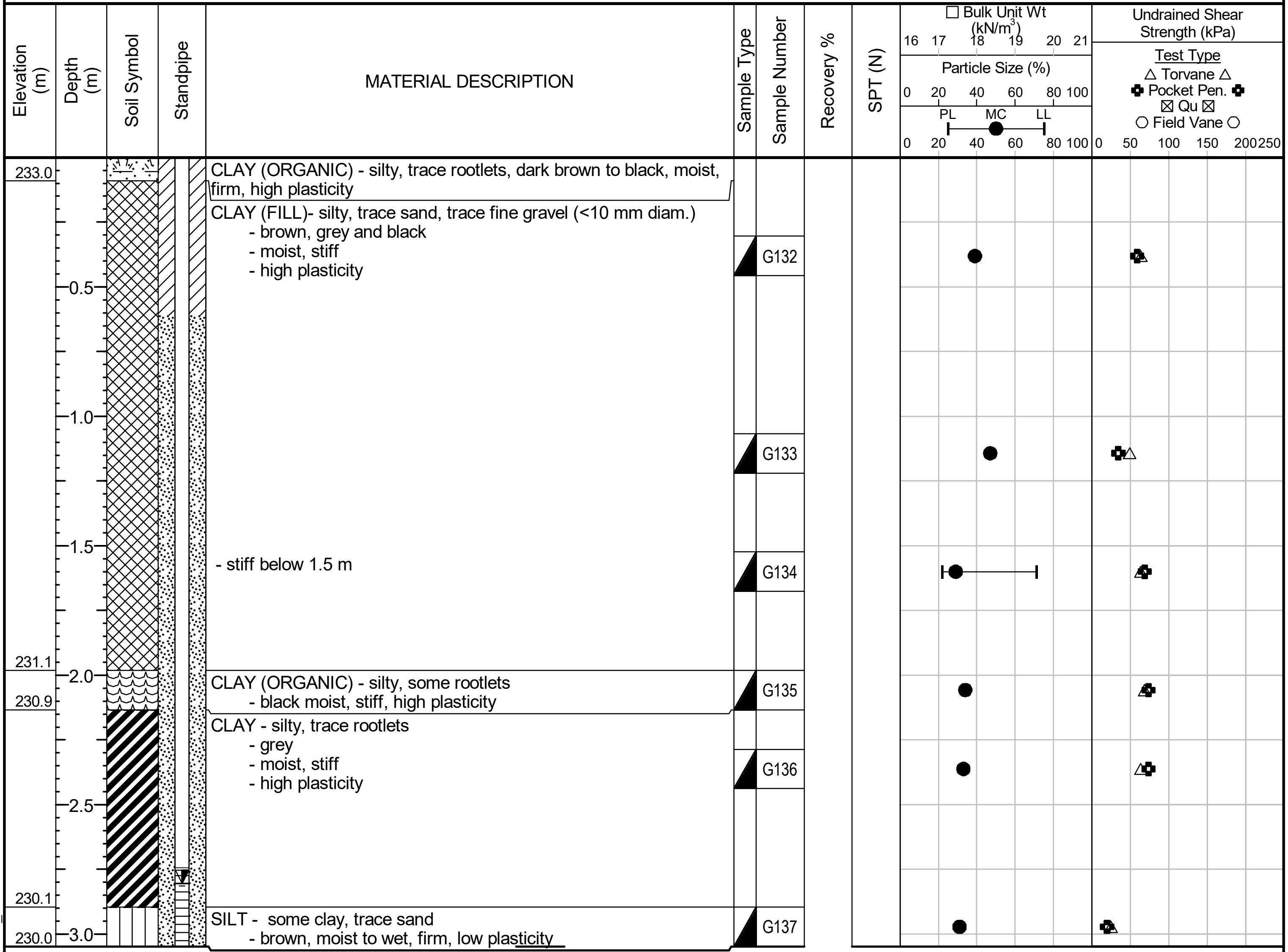
Sub-Surface Log

Client: Tetra Tech Inc
Project Number: 0002-130-00
Project Name: Lagimodiere / Concordia Overpass Rehabilitation
Location: UTM 14N:5530359 N, 639538 E
Contractor: TREK Geotechnical Inc.
Ground Elevation: 233.04 m
Method: 50 mm Hand Auger
Date Drilled: October 14, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Backfill Legend: Bentonite | Cement | Drill Cuttings | Filter Pack Sand | Grout | Slough



CLAY (ORGANIC) - silty, trace rootlets, dark brown to black, moist, firm, high plasticity

CLAY (FILL)- silty, trace sand, trace fine gravel (<10 mm diam.)
- brown, grey and black
- moist, stiff
- high plasticity

- stiff below 1.5 m

CLAY (ORGANIC) - silty, some rootlets
- black moist, stiff, high plasticity

CLAY - silty, trace rootlets
- grey
- moist, stiff
- high plasticity

SILT - some clay, trace sand
- brown, moist to wet, firm, low plasticity

END OF TEST HOLE AT 3.0 m DEPTH IN SILT
NOTES:
1) Seepage observed below 2.9 m depth.
2) Sloughing not observed.
3) Test hole open to 3.0 m immediately after drilling.
4) Standpipe installed to 3.0 m depth.
5) Water level measured at 2.8 m depth.
6) Test hole backfilled with sand and auger cuttings to surface.

Logged By: Matt Klymochko
Reviewed By: Michael Van Helden
Project Engineer: Kent Bannister

Sub-Surface Log

Test Hole TH22-13

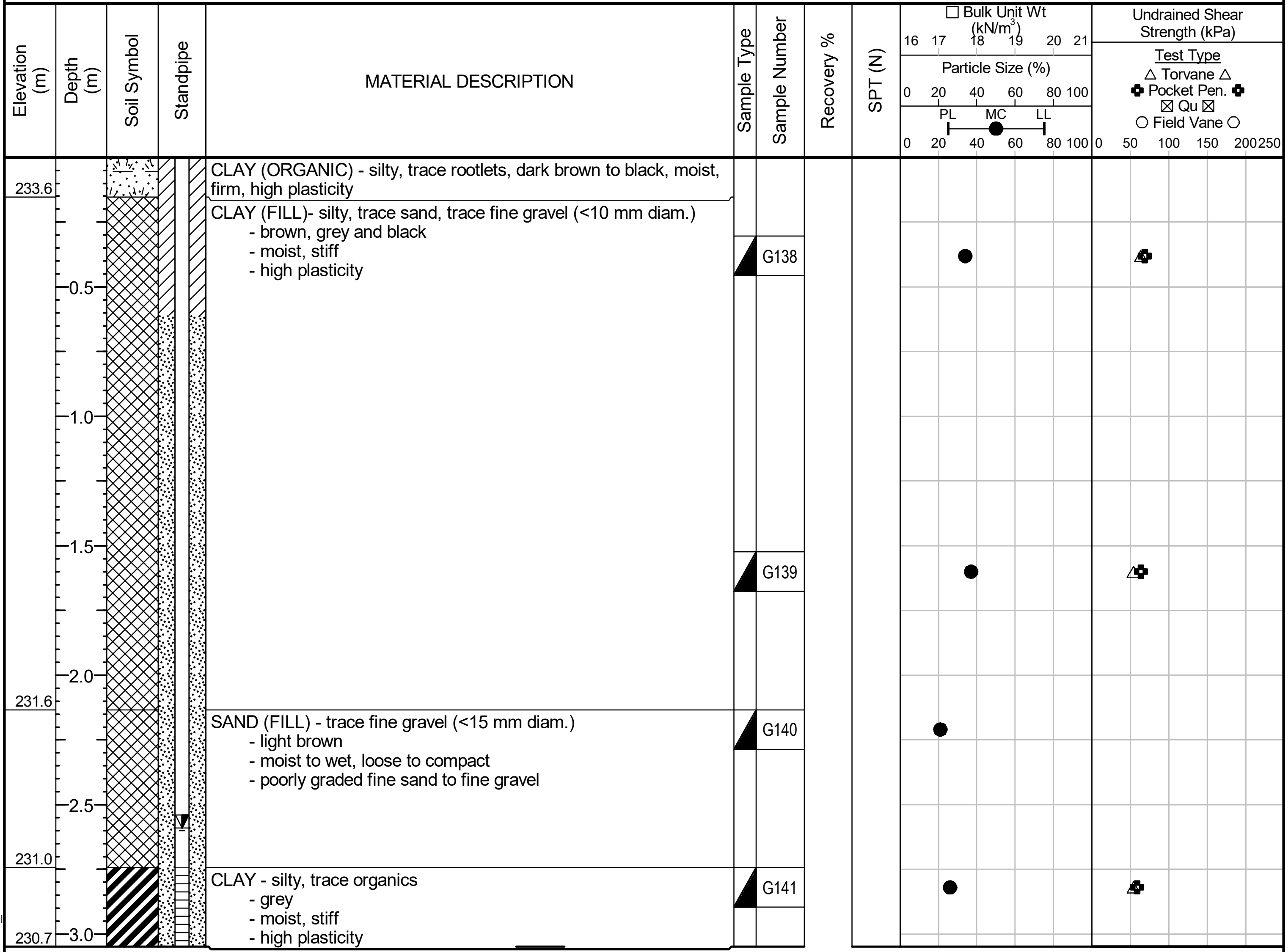
1 of 1

Client: Tetra Tech Inc
Project Number: 0002-130-00
Project Name: Lagimodiere / Concordia Overpass Rehabilitation
Location: UTM 14N:5530429 N, 639564 E
Contractor: TREK Geotechnical Inc.
Ground Elevation: 233.72 m
Method: 50 mm Hand Auger
Date Drilled: October 14, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Backfill Legend: Bentonite | Cement | Drill Cuttings | Filter Pack Sand | Grout | Slough



CLAY (ORGANIC) - silty, trace rootlets, dark brown to black, moist, firm, high plasticity

CLAY (FILL)- silty, trace sand, trace fine gravel (<10 mm diam.)
- brown, grey and black
- moist, stiff
- high plasticity

SAND (FILL) - trace fine gravel (<15 mm diam.)
- light brown
- moist to wet, loose to compact
- poorly graded fine sand to fine gravel

CLAY - silty, trace organics
- grey
- moist, stiff
- high plasticity

END OF TEST HOLE AT 3.0 m DEPTH IN CLAY
NOTES:
1) Seepage observed below 2.1 m depth.
2) Sloughing not observed.
3) Test hole open to 3.0 m immediately after drilling.
4) Standpipe installed to 3.0 m depth.
5) Water level measured at 2.6 m depth.
6) Test hole backfilled with sand and auger cuttings to surface.

Logged By: Matt Klymochko
Reviewed By: Michael Van Helden
Project Engineer: Kent Bannister

Sub-Surface Log

Test Hole TH22-14

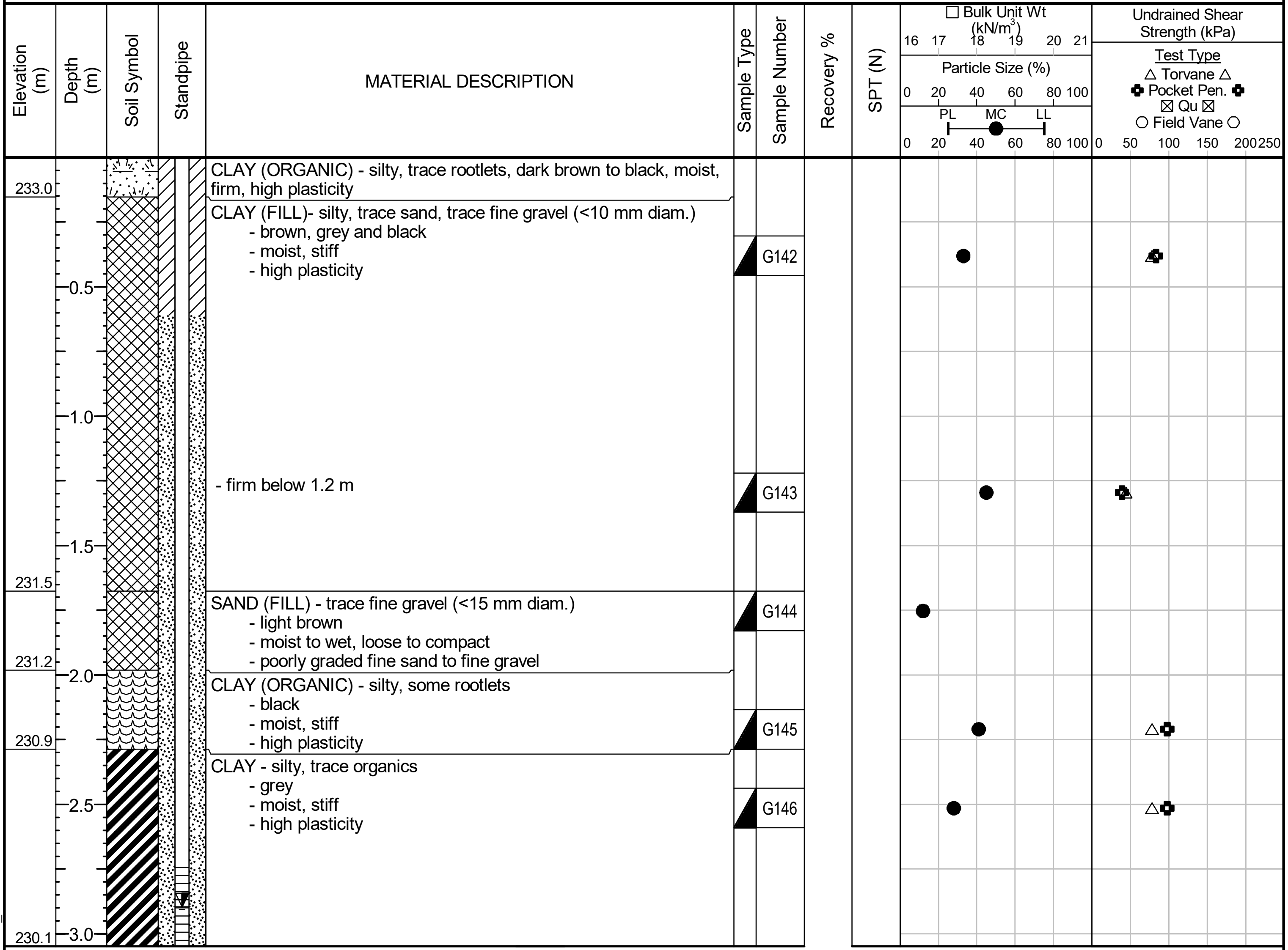
1 of 1

Client:	Tetra Tech Inc	**Project Number:**	0002-130-00
Project Name:	Lagimodiere / Concordia Overpass Rehabilitation	**Location:**	UTM 14N:5530441 N, 639571 E
Contractor:	TREK Geotechnical Inc.	**Ground Elevation:**	233.18 m
Method:	50 mm Hand Auger	**Date Drilled:**	October 14, 2022

Sample Type: ◪ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) / SPT ☒ Split Barrel (SB) / LPT ▯ Core (C)

Particle Size Legend: ▥ Fines ▨ Clay ▥ Silt ⁘ Sand ■ Gravel ▢ Cobbles ■ Boulders

Backfill Legend: ■ Bentonite ▩ Cement ▨ Drill Cuttings ⁘ Filter Pack Sand ⁘ Grout ▩ Slough



CLAY (ORGANIC) - silty, trace rootlets, dark brown to black, moist, firm, high plasticity

CLAY (FILL)- silty, trace sand, trace fine gravel (<10 mm diam.)
- brown, grey and black
- moist, stiff
- high plasticity

- firm below 1.2 m

SAND (FILL) - trace fine gravel (<15 mm diam.)
- light brown
- moist to wet, loose to compact
- poorly graded fine sand to fine gravel

CLAY (ORGANIC) - silty, some rootlets
- black
- moist, stiff
- high plasticity

CLAY - silty, trace organics
- grey
- moist, stiff
- high plasticity

END OF TEST HOLE AT 3.0 m DEPTH IN CLAY
NOTES:
1) Seepage observed below 1.8 m depth.
2) Sloughing not observed.
3) Test hole open to 3.0 m immediately after drilling.
4) Standpipe installed to 3.0 m depth.
5) Water level measured at 2.9 m depth.
6) Test hole backfilled with sand and auger cuttings to surface.

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

Sub-Surface Log

Test Hole TH23-15

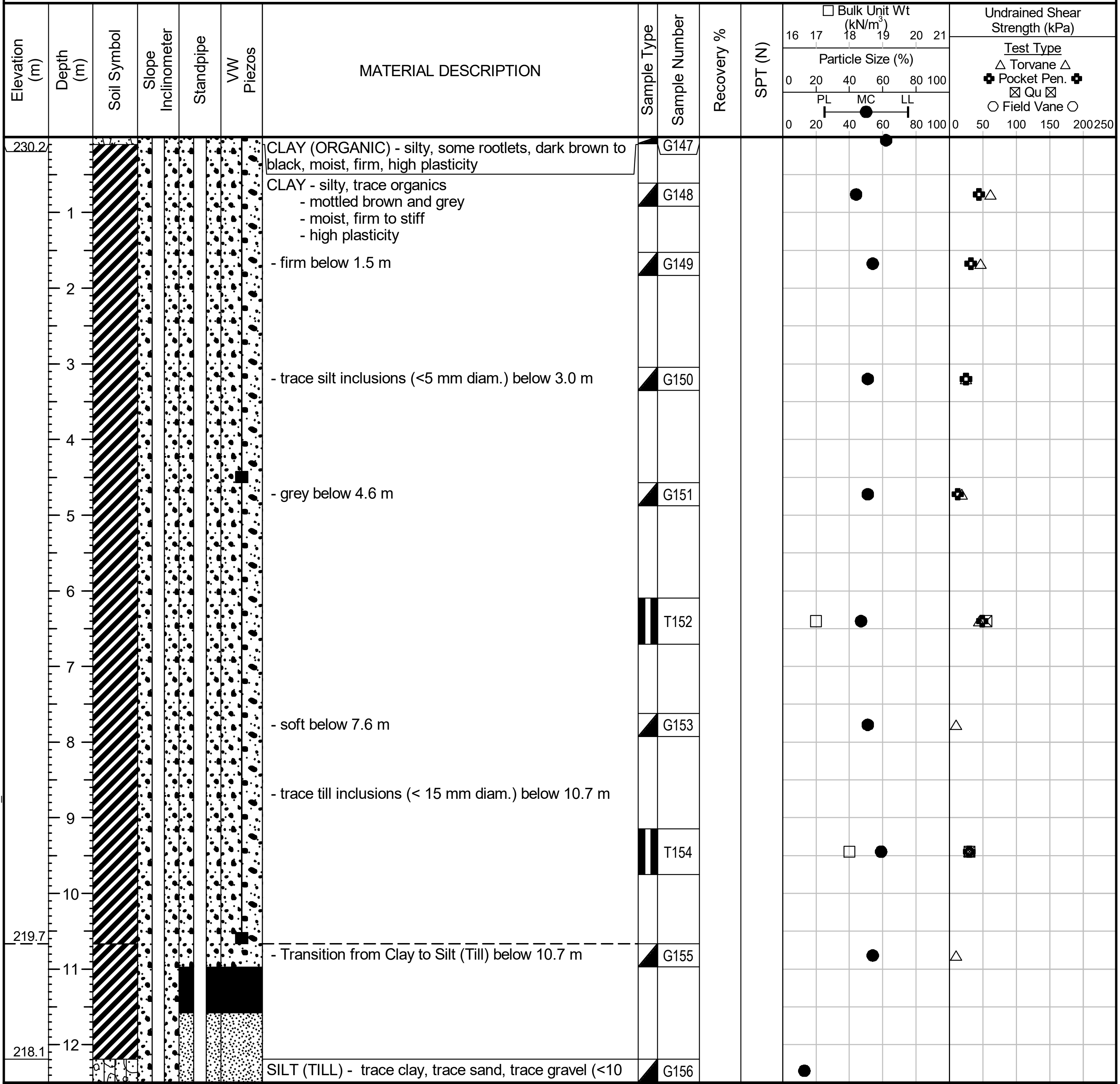
1 of 2

Client: Tetra Tech Inc
Project Number: 0002-130-00
Project Name: Lagimodiere / Concordia Overpass Rehabilitation
Location: UTM 14N: 5530409 N, 639291E
Contractor: Paddock Drilling Ltd.
Ground Elevation: 230.34 m
Method: 125 mm solid stem auger B-57 track mounted rig
Date Drilled: April 4, 2023

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Backfill Legend: Bentonite | Cement | Drill Cuttings | Filter Pack Sand | Grout | Slough

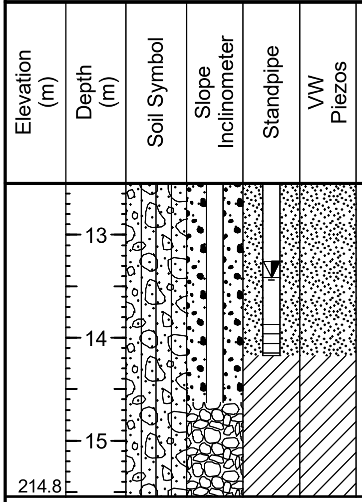


Material Description	Sample Number
CLAY (ORGANIC) - silty, some rootlets, dark brown to black, moist, firm, high plasticity	G147
CLAY - silty, trace organics - mottled brown and grey - moist, firm to stiff - high plasticity	G148
- firm below 1.5 m	G149
- trace silt inclusions (<5 mm diam.) below 3.0 m	G150
- grey below 4.6 m	G151
	T152
- soft below 7.6 m	G153
- trace till inclusions (< 15 mm diam.) below 10.7 m	
	T154
- Transition from Clay to Silt (Till) below 10.7 m	G155
SILT (TILL) - trace clay, trace sand, trace gravel (<10	G156

Logged By: Matt Klymochko
Reviewed By: Michael Van Helden
Project Engineer: Kent Bannister

Sub-Surface Log

Test Hole TH23-15

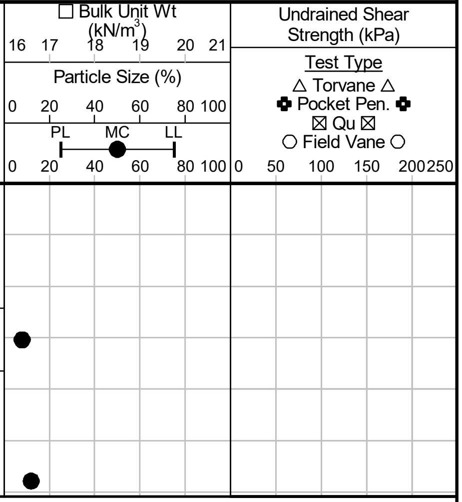


MATERIAL DESCRIPTION

mm diam.)
- light grey
- moist, loose
- no to low plasticity

- some gravel (<20 mm diam.), very dense below 13.7 m

Sample Type	Sample Number	Recovery %	SPT (N)
☒	S157		54
◪	G158		



END OF TEST HOLE AT 15.5 m DEPTH IN SILT (TILL)

NOTES:
1) Power auger refusal encountered at 15.5 m depth.
2) Seepage and sloughing observed below 12.2 m depth.
3) Water level measured at 13.4 m depth after drilling.
4) Test hole open to 14.6 m depth after drilling.
5) Slope Inclinometer installed to 14.6 m depth.
6) Standpipe (SP-15) installed at 14.2 m depthin adjacent test hole 1.5 m east of Slope Inclinometer.
7) Vibrating Wire (VW 160926) and (VW 160949) installed at 4.6 and 10.7 m depth respectively in adjacent test hole 1.5 m east of Slope Inclinometer.
8) Test hole backfilled with bentonite grout mix to surface.

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH23-16

1 of 2

Client: Tetra Tech Inc

Project Name: Lagimodiere / Concordia Overpass Rehabilitation

Contractor: Paddock Drilling Ltd.

Method: 125 mm SSA / 170 mm HSA, B-57 track mounted rig

Project Number: 0002-130-00

Location: UTM 14N: 5530395 N, 639290E

Ground Elevation: 227.76 m

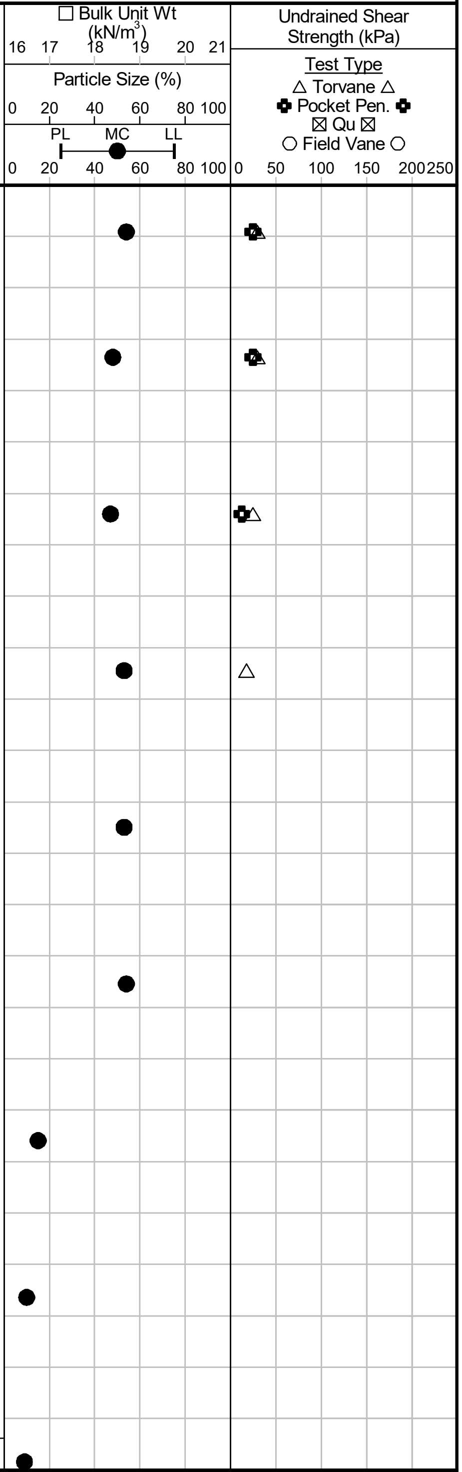
Date Drilled: April 4, 2023

Sample Type: ◪ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) / SPT ⧗ Split Barrel (SB) / LPT ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand ● Gravel ▱ Cobbles ■ Boulders

Backfill Legend: ■ Bentonite ▧ Cement ▨ Drill Cuttings ▩ Filter Pack Sand ⁘ Grout ▩ Slough

Elevation (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
227.5	RIPRAP (350 mm down Limestone)			
	CLAY - silty, trace silt inclusions (< 10 mm diam.) - mottled brown and grey - moist, firm - high plasticity	G	G159	
		G	G160	
	- grey below 2.7 m	G	G161	
	- soft to firm below 4.6 m	G	G162	
	- soft below 6.1 m	G	G163	
	- trace till inclusions (< 10 mm diam.) below 7.6 m	G	G164	
218.6	SILT (TILL) - trace clay, trace sand, trace gravel (<20 mm diam.) - light grey - moist, loose - no to low plasticity	G	G165	
		G	G166	
	- some gravel (<20 mm diam.), dense below 12.2 m	SS	S167	30



Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

Sub-Surface Log

Test Hole TH23-16

2 of 2

Elevation (m)	Depth (m)	Soil Symbol	Slope Inclinometer	MATERIAL DESCRIPTION	Sample Type	Sample Number	Recovery %	SPT (N)	☐ Bulk Unit Wt (kN/m^3) 16 17 18 19 20 21 Particle Size (%) 0 20 40 60 80 100 PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✚ Pocket Pen. ✚ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
	13			- sandy below 12.8 m	☒					
214.0										

END OF TEST HOLE AT 13.7 m DEPTH IN SILT (TILL)

NOTES:

1) Power auger refusal encountered at 13.7 m depth.
2) Seepage and sloughing observed below 9.1 m depth.
3) Water level measured at 7.6 m depth after drilling.
4) Test hole open to 13.1 m depth after drilling.
5) Slope Inclinometer installed to 13.1 m depth.
6) Test hole backfilled with bentonite grout mix to surface.

Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH23-17

1 of 1

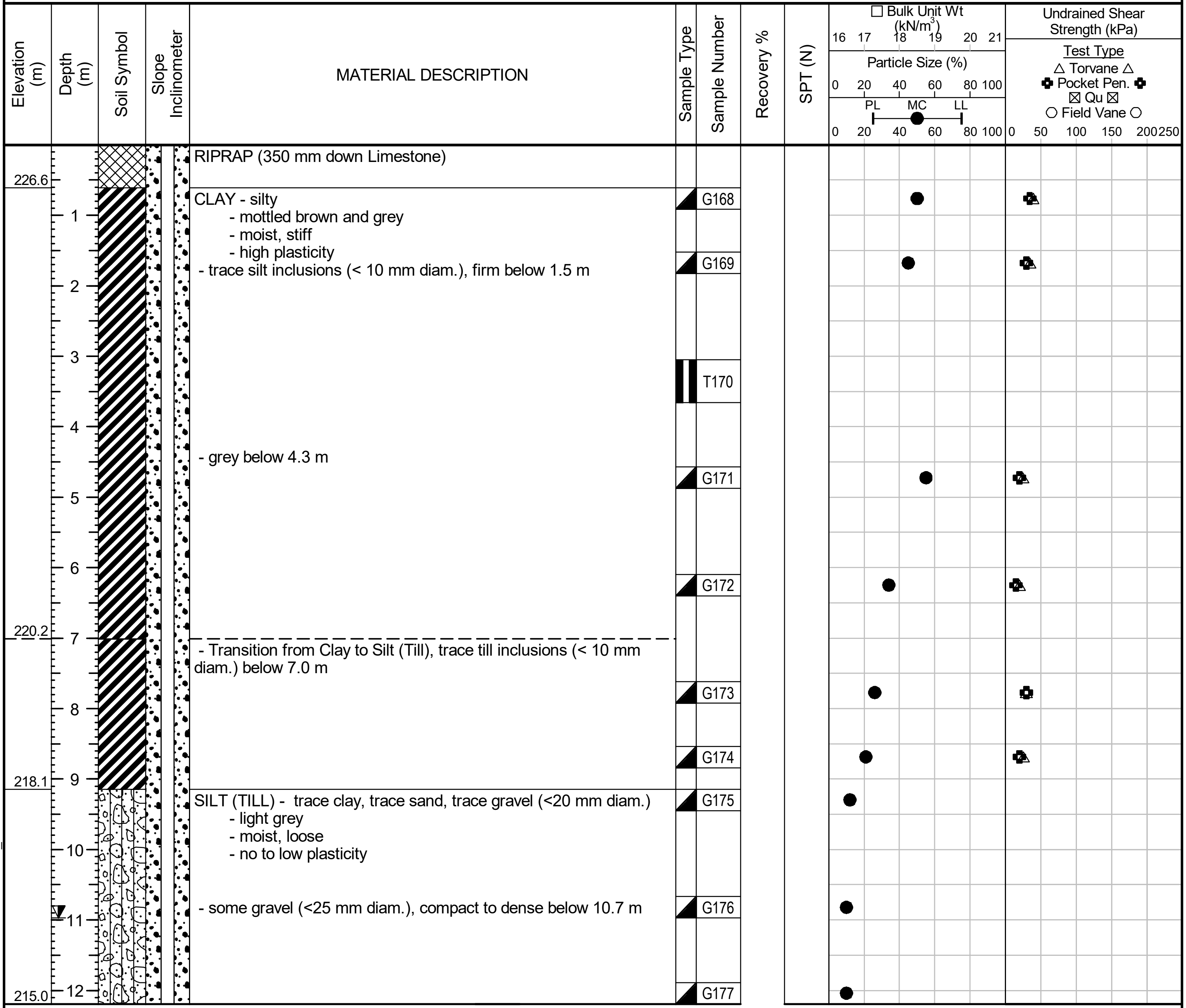
Client: Tetra Tech Inc
Project Name: Lagimodiere / Concordia Overpass Rehabilitation
Contractor: Paddock Drilling Ltd.
Method: 125 mm solid stem auger B-57 track mounted rig

Project Number: 0002-130-00
Location: UTM 14N: 5530338 N, 639287 E
Ground Elevation: 227.22 m
Date Drilled: April 5, 2023

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Backfill Legend: Bentonite | Cement | Drill Cuttings | Filter Pack Sand | Grout | Slough



RIPRAP (350 mm down Limestone)

CLAY - silty
- mottled brown and grey
- moist, stiff
- high plasticity
- trace silt inclusions (< 10 mm diam.), firm below 1.5 m

- grey below 4.3 m

- Transition from Clay to Silt (Till), trace till inclusions (< 10 mm diam.) below 7.0 m

SILT (TILL) - trace clay, trace sand, trace gravel (<20 mm diam.)
- light grey
- moist, loose
- no to low plasticity

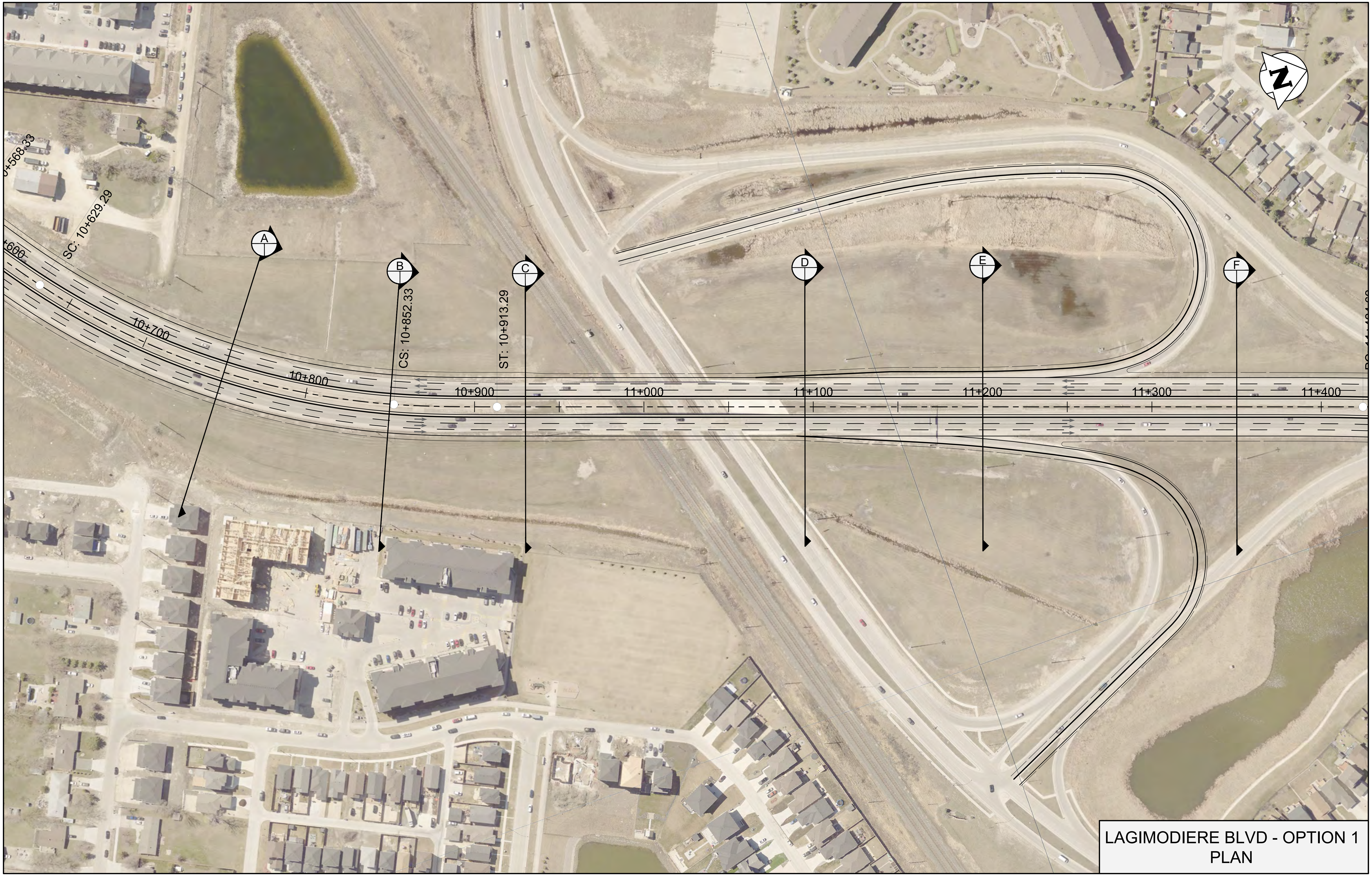
- some gravel (<25 mm diam.), compact to dense below 10.7 m

END OF TEST HOLE AT 12.2 m DEPTH IN SILT (TILL)
NOTES:
1) Seepage observed below 9.1 m depth.
2) Sloughing was not observed.
3) Water level measured at 11 m depth after drilling.
4) Test hole open to 12.2 m depth after drilling.
5) Slope inclinometer installed to 12.2 m depth.
6) Test hole backfilled with bentonite grout mix to surface.

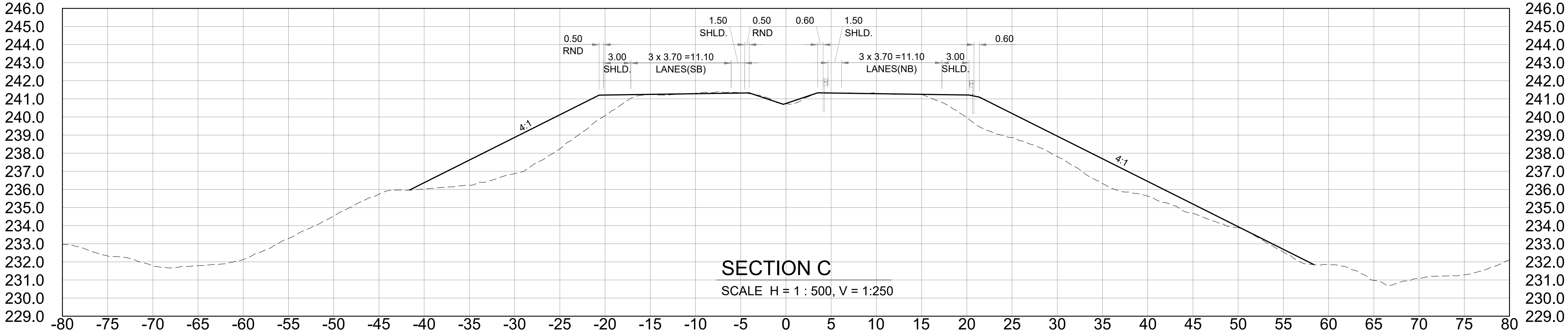
Logged By: Matt Klymochko **Reviewed By:** Michael Van Helden **Project Engineer:** Kent Bannister

Appendix A

Preliminary Drawings

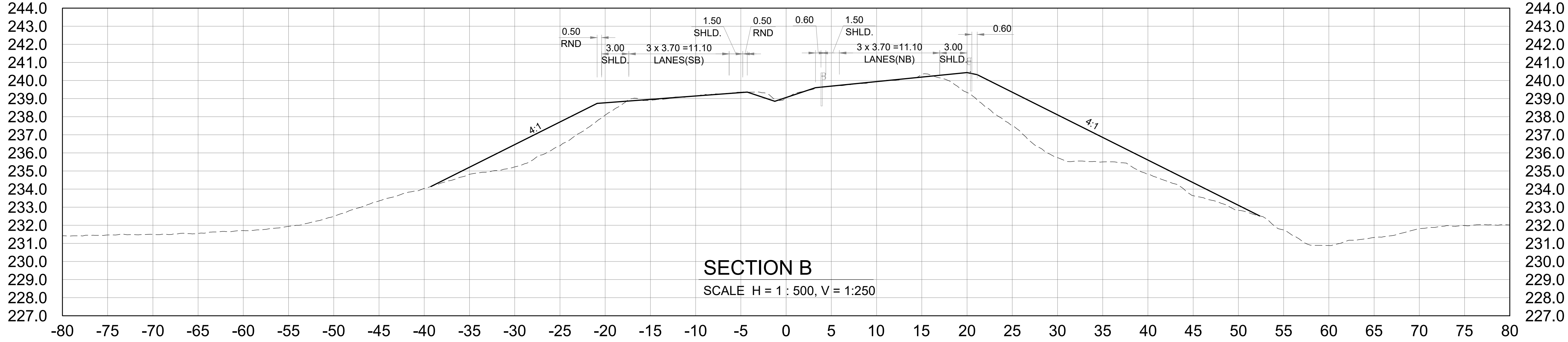


LAGIMODIERE BLVD - OPTION 1
PLAN



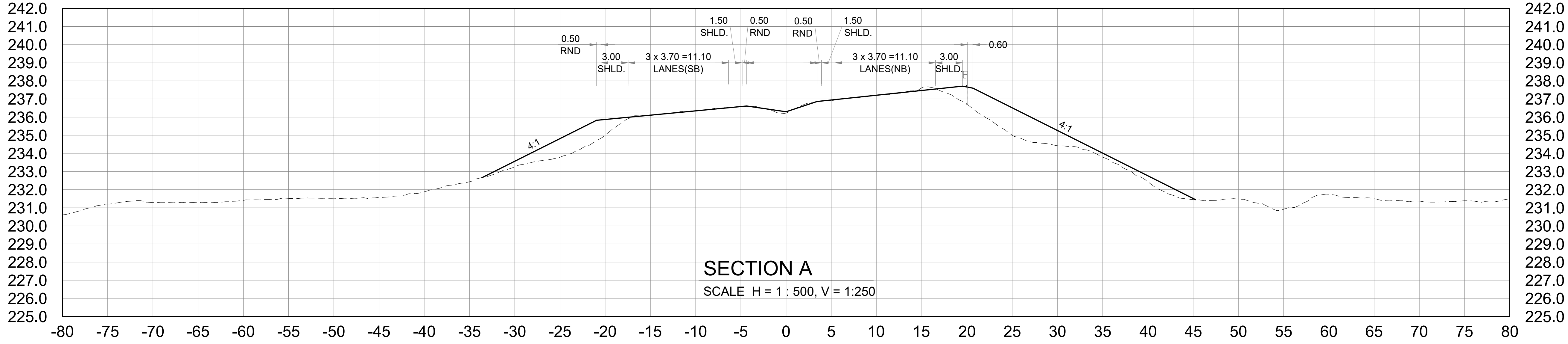
SECTION C

SCALE H = 1 : 500, V = 1:250



SECTION B

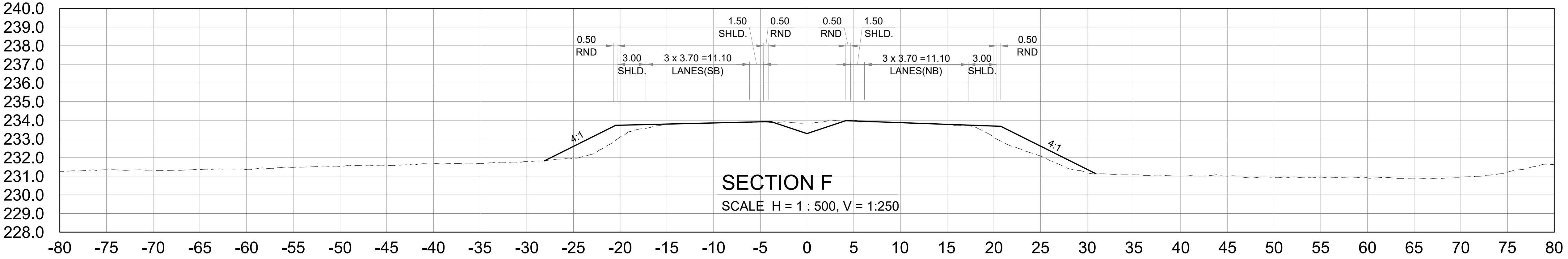
SCALE H = 1 : 500, V = 1:250



SECTION A

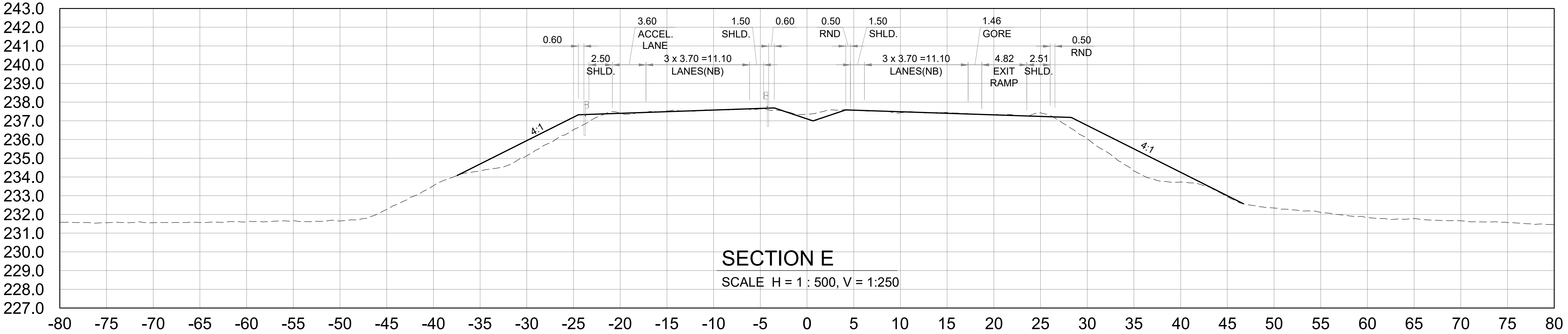
SCALE H = 1 : 500, V = 1:250

LAGIMODIERE BLVD - OPTION 1
CROSS SECTIONS - SHEET 1



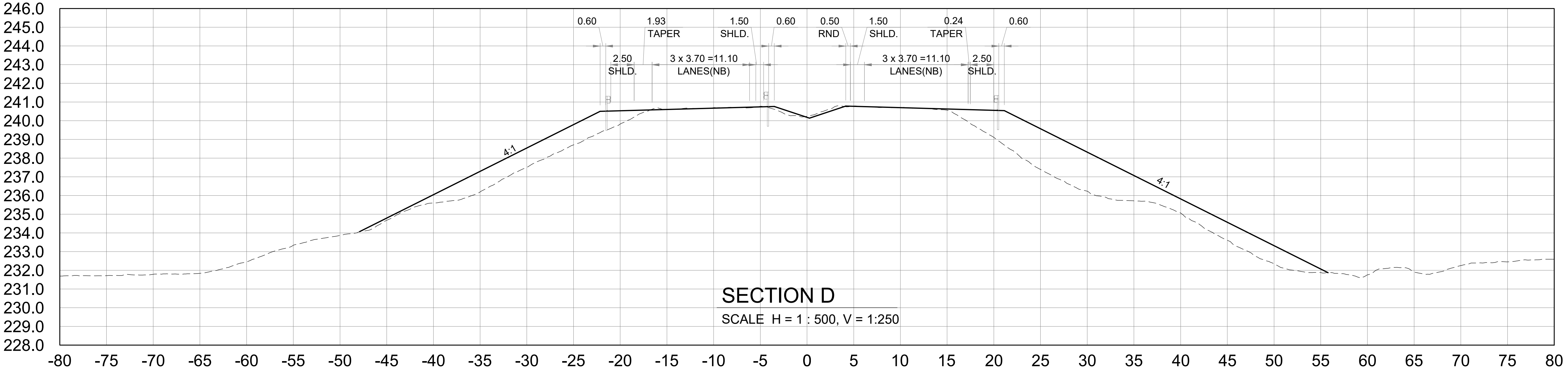
SECTION F

SCALE H = 1 : 500, V = 1:250



SECTION E

SCALE H = 1 : 500, V = 1:250

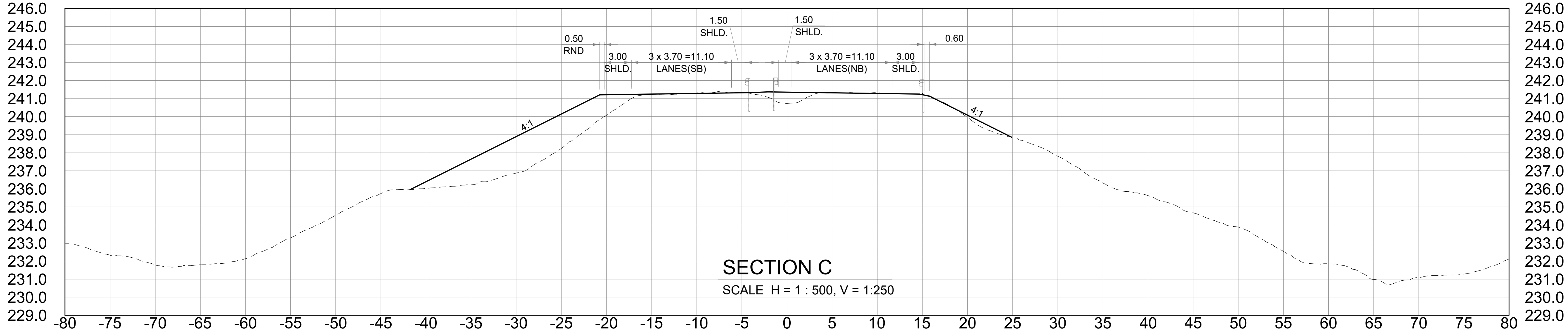


SECTION D

SCALE H = 1 : 500, V = 1:250

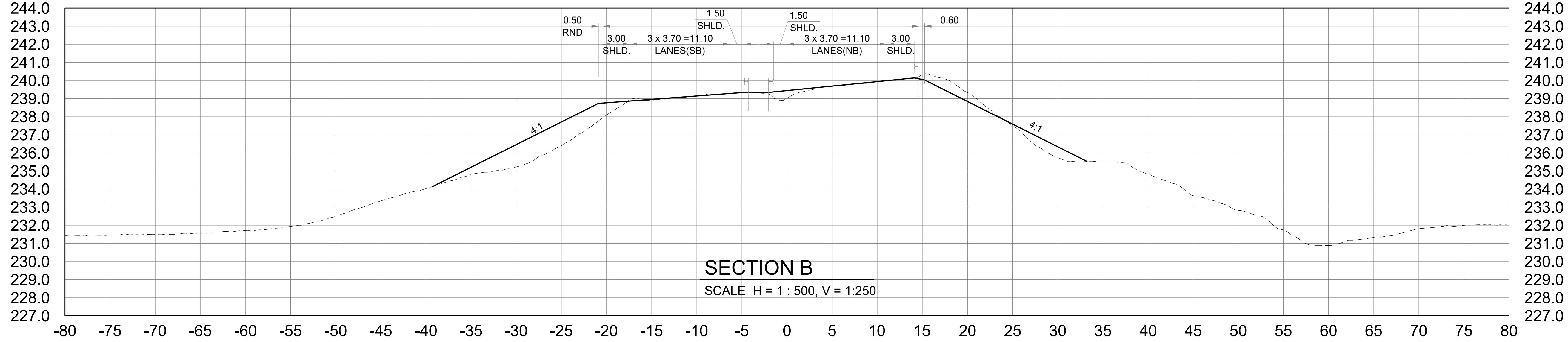
LAGIMODIERE BLVD - OPTION 1
CROSS SECTIONS - SHEET 2

LAGIMODIERE BLVD - OPTION 2
PLAN



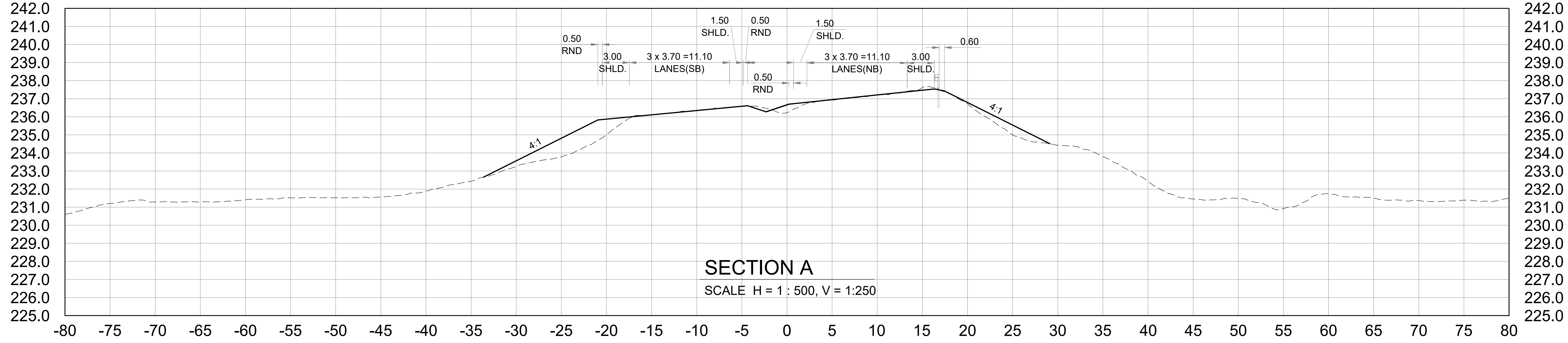
SECTION C

SCALE H = 1 : 500, V = 1:250



SECTION B

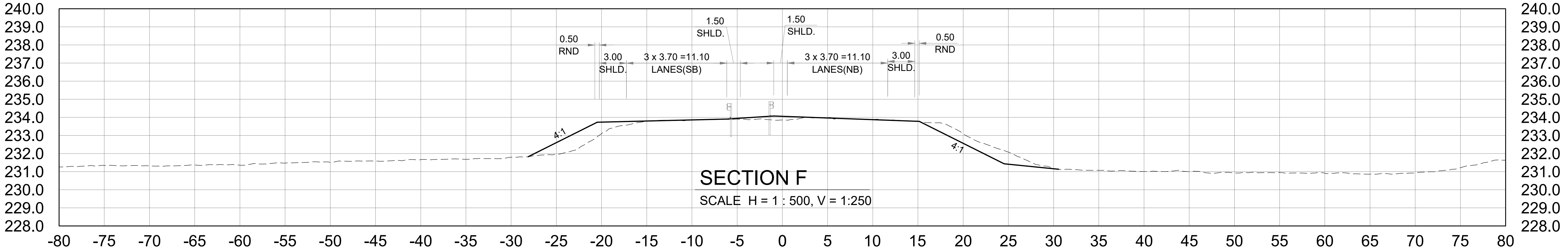
SCALE H = 1 : 500, V = 1:250



SECTION A

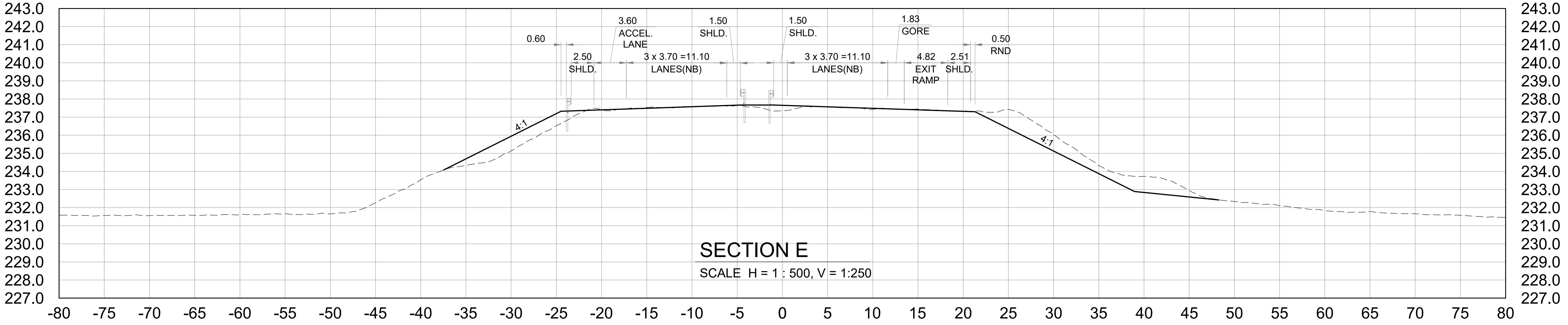
SCALE H = 1 : 500, V = 1:250

LAGIMODIERE BLVD - OPTION 2
CROSS SECTIONS - SHEET 1



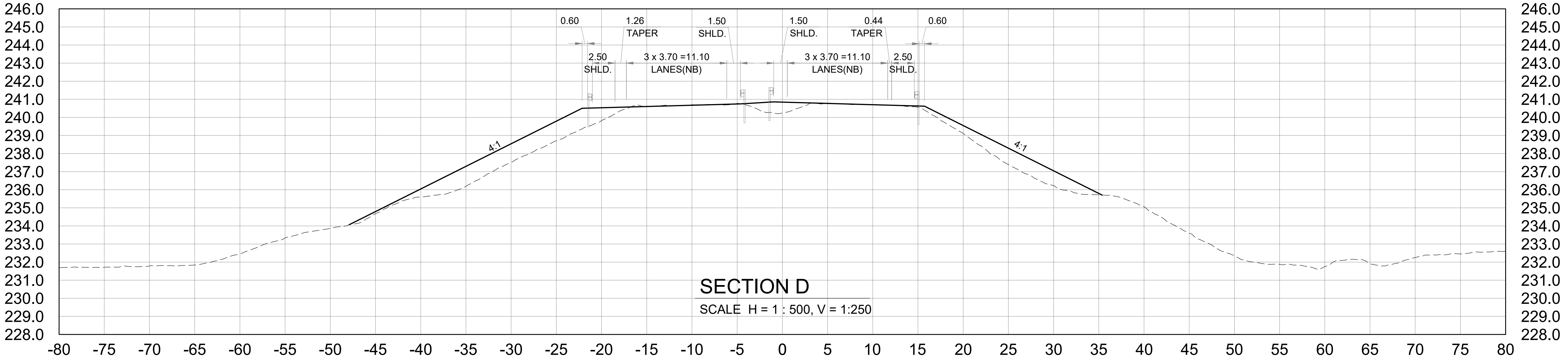
SECTION F

SCALE H = 1 : 500, V = 1:250



SECTION E

SCALE H = 1 : 500, V = 1:250

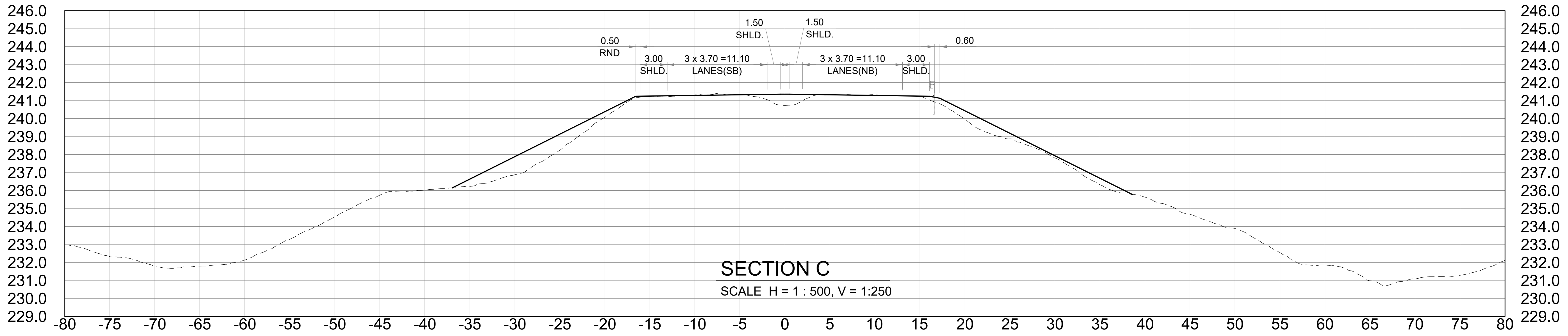


SECTION D

SCALE H = 1 : 500, V = 1:250

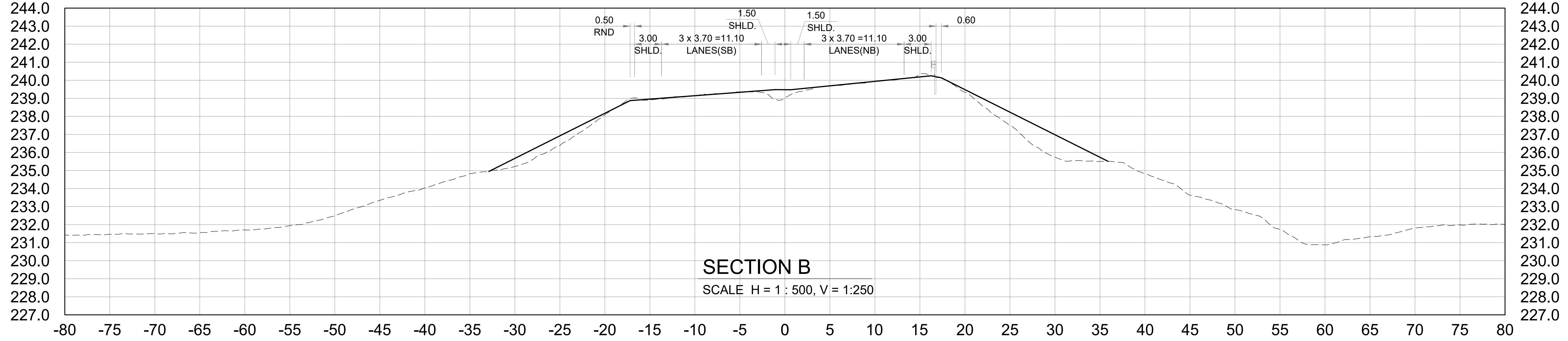
LAGIMODIERE BLVD - OPTION 2
CROSS SECTIONS - SHEET 2

LAGIMODIERE BLVD - OPTION 3
PLAN



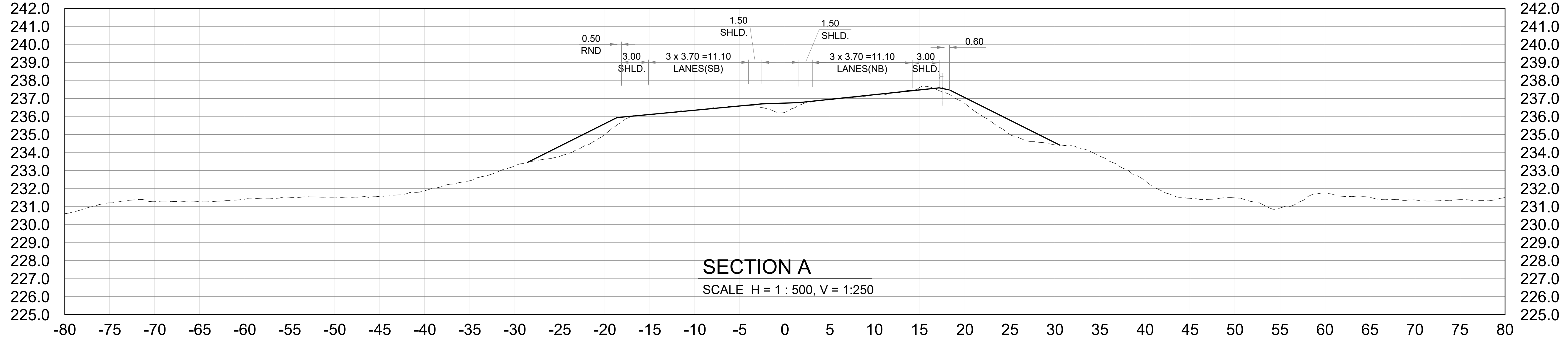
SECTION C

SCALE H = 1 : 500, V = 1:250



SECTION B

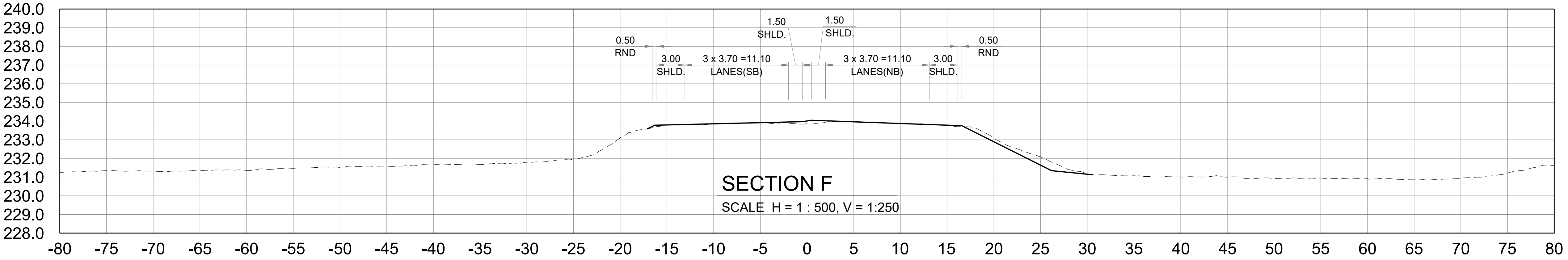
SCALE H = 1 : 500, V = 1:250



SECTION A

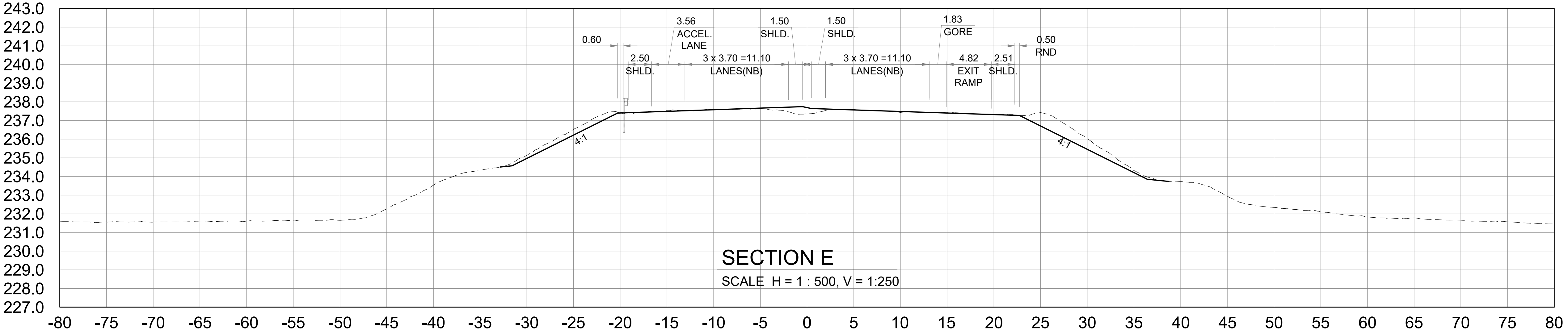
SCALE H = 1 : 500, V = 1:250

LAGIMODIERE BLVD - OPTION 3
CROSS SECTIONS - SHEET 1



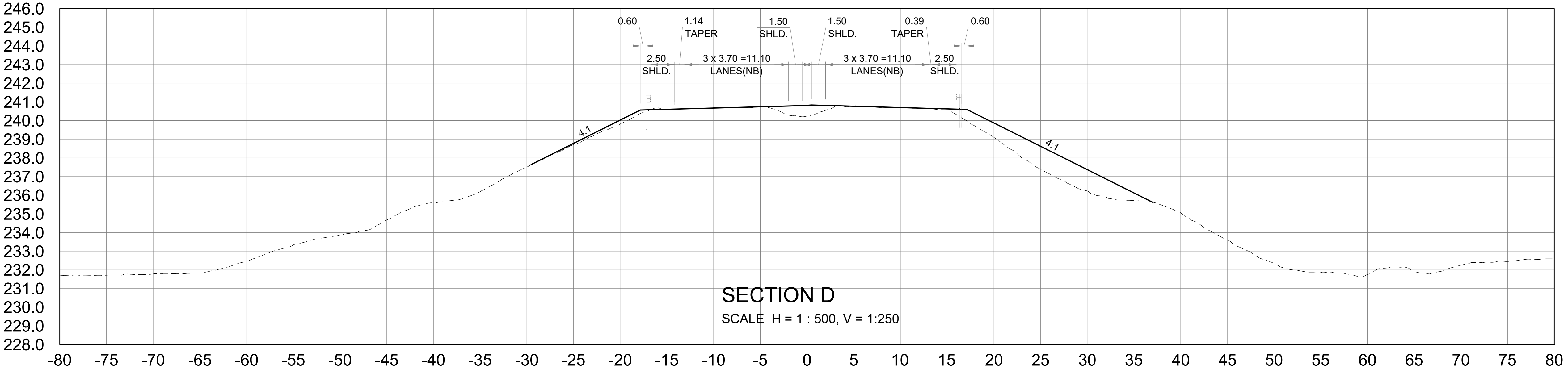
SECTION F

SCALE H = 1 : 500, V = 1:250



SECTION E

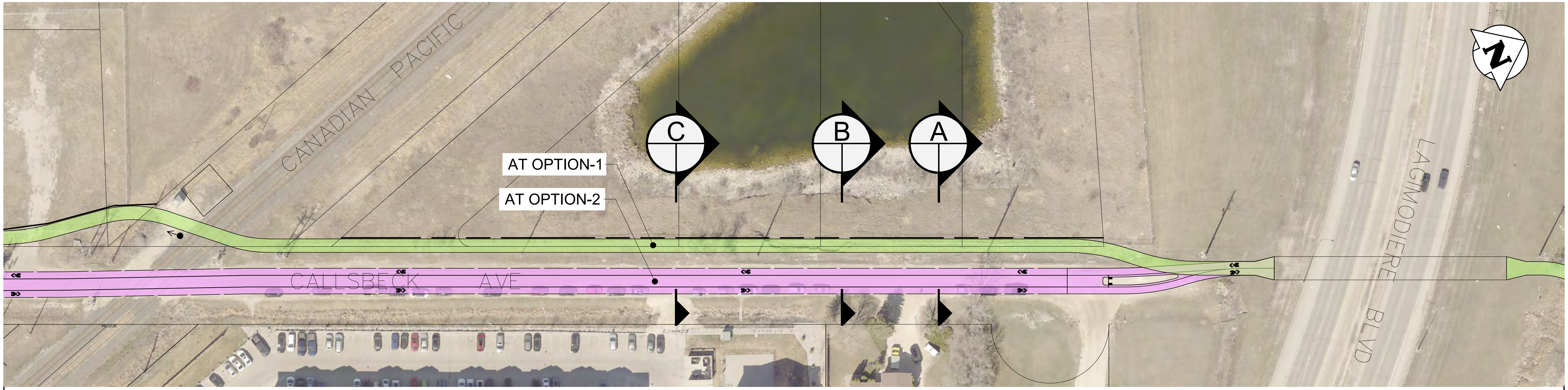
SCALE H = 1 : 500, V = 1:250

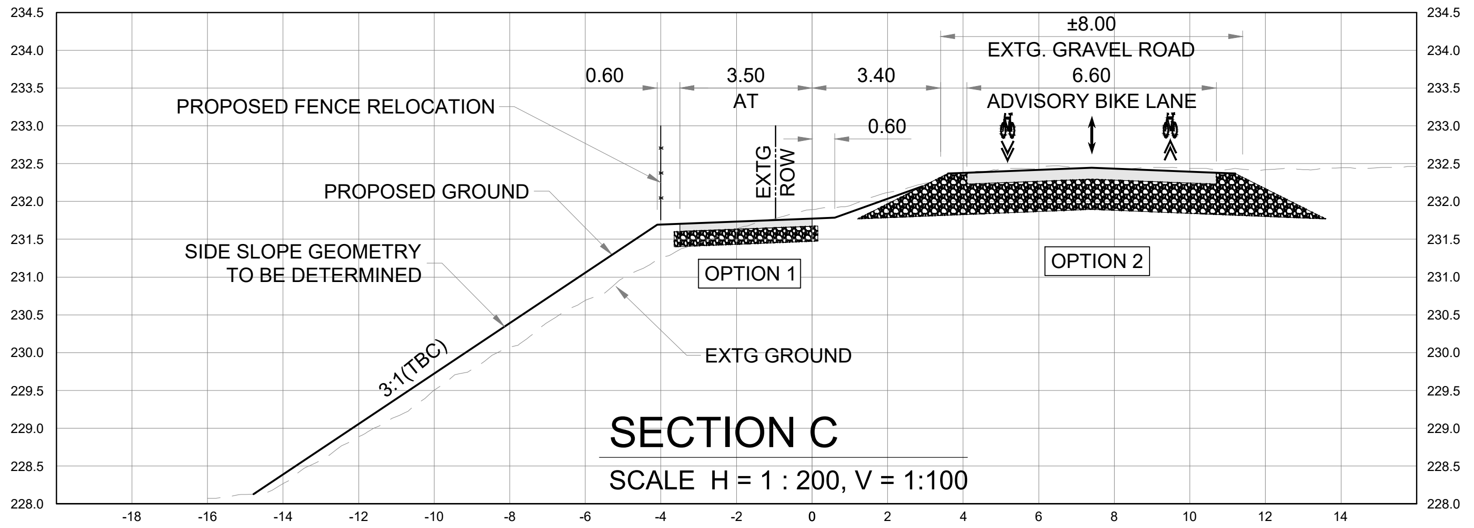


SECTION D

SCALE H = 1 : 500, V = 1:250

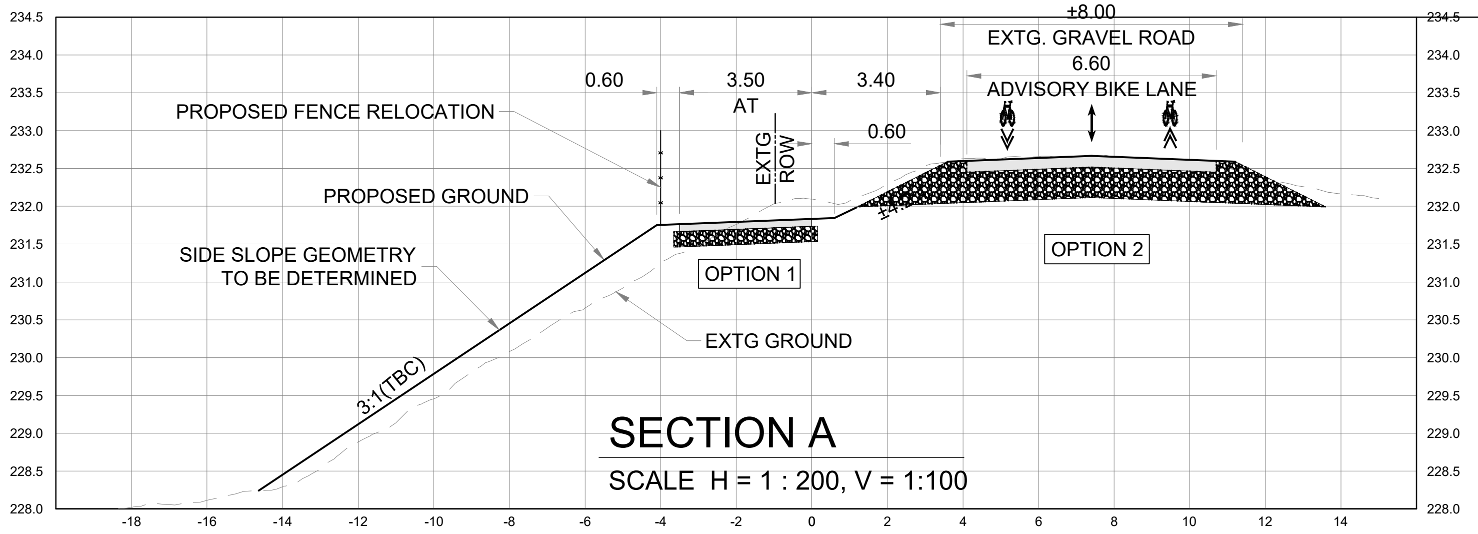
LAGIMODIERE BLVD - OPTION 3
CROSS SECTIONS - SHEET 2





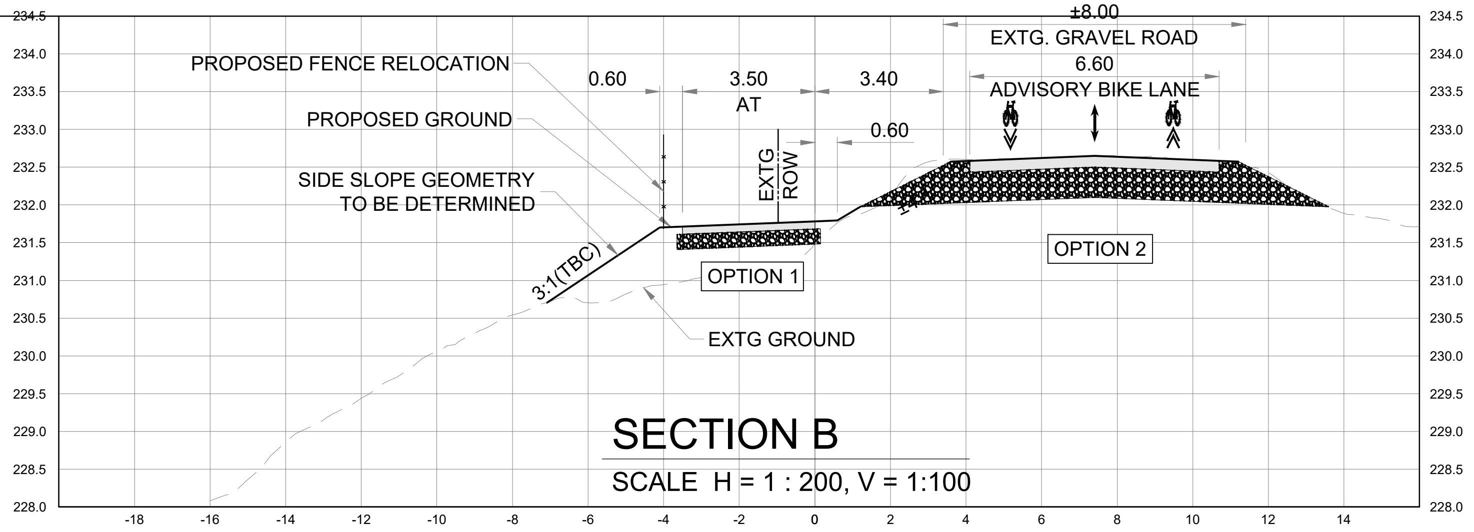
SECTION C

SCALE H = 1 : 200, V = 1:100



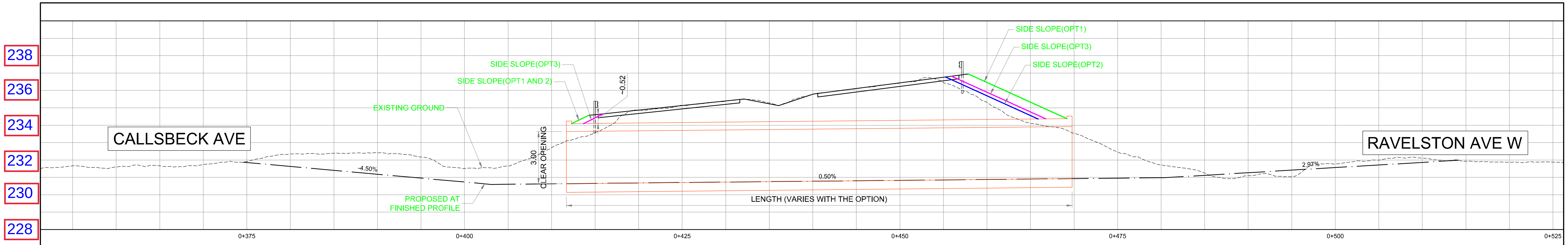
SECTION A

SCALE H = 1 : 200, V = 1:100

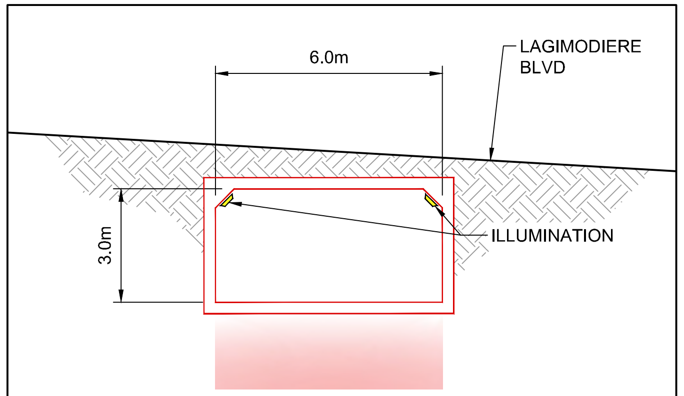


SECTION B

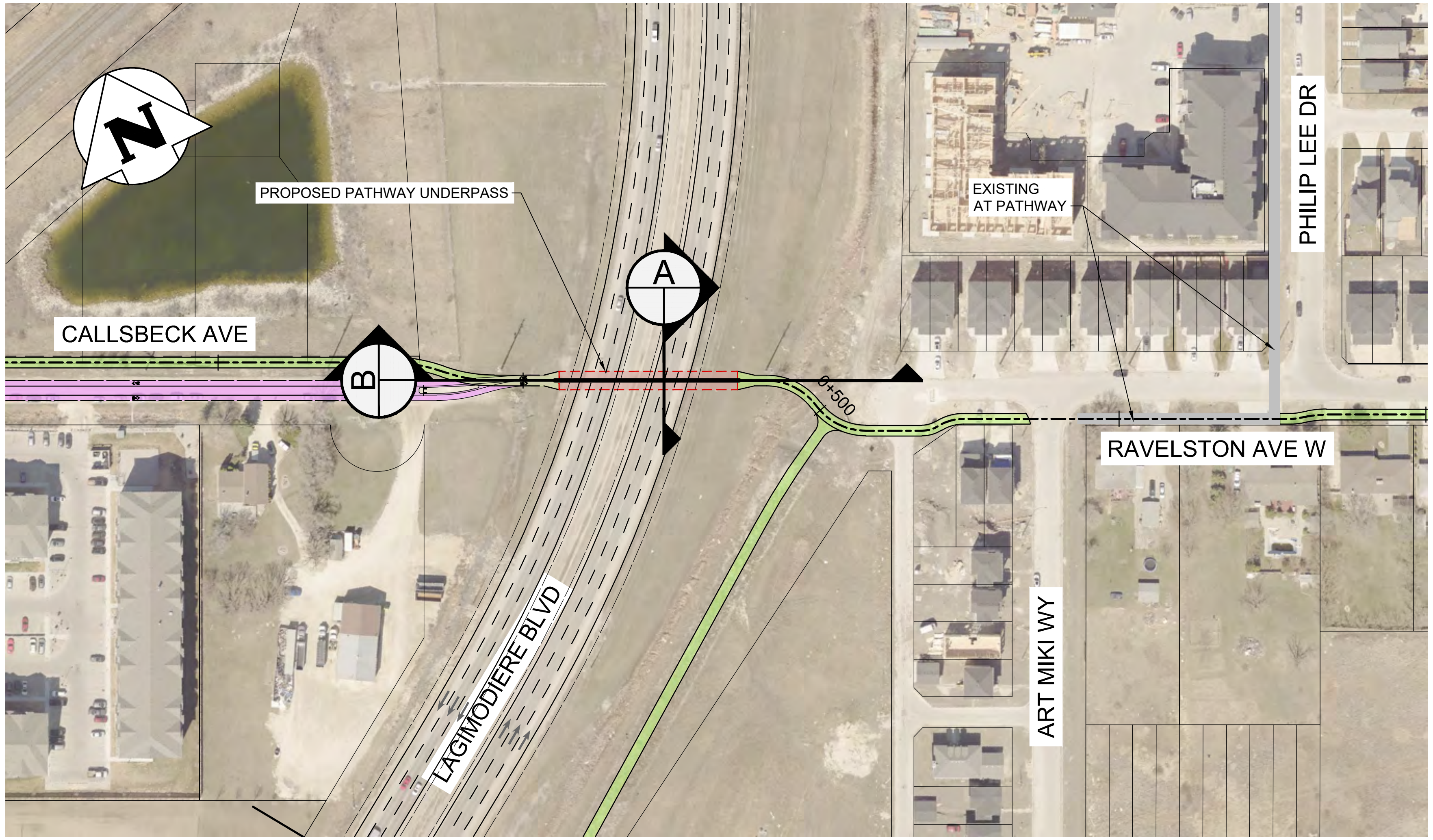
SCALE H = 1 : 200, V = 1:100



SECTION B (2x VERTICAL EXAGERRATION)



SECTION A



NO.	DATE	DESCRIPTION	DRAWN	REVIEWED	ISSUED	APPROVED
REVISIONS/ISSUE			DRAFTING		ENGINEERING	

3D MODEL REF No:

DESIGNED BY: BG
DRAWN BY: BG
REVIEWED BY: JT
APPROVED BY: JNC
DATE: 2023.02.24
SCALE: AS NOTED

CLIENT:
CITY OF WINNIPEG

TETRA TECH

PROJECT NAME:
LAGIMODIERE BOULEVARD TWIN OVERPASS REHABILITATION

DRAWING DESCRIPTION:
ACTIVE TRANSPORTATION
LAGIMODIERE BOULEVARD UNDERPASS
PLAN AND SECTION

PROJECT NO: 734-2200070600
SHEET NO: SKT-C034
REV: A

TT DOCUMENT I.D. No:

B (279 x 431)

Appendix B

Lab Testing Results

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

MEMORANDUM

Date	November 03, 2022
To	Matt Klymochko, TREK Geotechnical
From	Angela Fidler-Kliewer, TREK Geotechnical
Project No.	0002-130-00
Project	Concordia Overpass Rehab
Subject	Laboratory Testing Results – Lab Req. R22-559
Distribution	Michael Van Helden

Attached are the laboratory testing results for the above noted project. The testing included moisture content determinations, Atterberg limits, particle size analysis (Mechanical Sieve and Hydrometer method) and unconfined compression test with related testing on Shelby tube samples.

The unconfined compression test on cores, Direct Shear and Oedometers will be reported upon completion.

Regards,

Angela Fidler-Kliewer, C.Tech.,

Attach.

Review Control:

Prepared By: TN	*Reviewed By: AFK*	*Checked By: NJF*

DS/JC

TREK GEOTECHNICAL

LABORATORY REQUISITION

CLIENT Tetra Tech Inc
PROJECT NO: 0002-130-00
PROJECT NAME Lagimodiere / Concordia Overpass Rehabilitation
FIELD TECHNICIAN: Matt Klymochko

TEST HOLE NUMBER	SAMPLE NUMBER	DEPTH OF SAMPLE (ft)	TARE NUMBER (LAB USE ONLY)	MOISTURE	VISUAL CLASS.	ATTERBERG LIMITS	HYDROMETER	GRADATION	STD. PROCTOR	UNCONFINED AND AUXILLARY TESTS		Oedometer			Soil Description/Comments
TH22-01	G01	1.0 - 2.0		X											
TH22-01	G02	5.0 - 6.0		X											
TH22-01	G03	11.0 - 12.0		X											
TH22-01	G04	15.0 - 16.0		X											
TH22-01	G05	18.0 - 19.0		X											
TH22-01	T06	20.0 - 22.0								X					Might be silt
TH22-01	G07	22.0 - 23.0		X		X	X								
TH22-01	G08	24.0 - 25.0		X											
TH22-01	G09	29.0 - 30.0		X											
TH22-01	G10	34.0 - 35.0		X											
TH22-01	T11	40.0 - 42.0				X	X			X					
TH22-01	G12	45.0 - 46.0		X											
TH22-01	G13	50.0 - 51.0		X											
TH22-01	G14	55.0 - 56.0		X											
TH22-01	G15	60.0 - 61.0		X											
TH22-01	G16	65.0 - 66.0		X											
TH22-01	S17	69.0 - 70.0		X											
TH22-02	G18	1.0 - 2.0		X											
TH22-02	G19	5.0 - 6.0		X											
TH22-02	G20	10.0 - 11.0		X											
TH22-02	G21	15.0 - 16.0		X											
TH22-02	G22	20.0 - 21.0		X											
TH22-02	G23	25.0 - 26.0		X											
TH22-02	G24	30.0 - 31.0		X											
TH22-02	G25	32.0 - 33.0		X				X							Cow spec
TH22-02	G26	35.0 - 36.0		X											
TH22-02	G27	38.0 - 39.0		X											
TH22-02	G28	40.0 - 41.0		X											
TH22-02	G29	44.0 - 45.0		X											
TH22-02	T30	50.0 - 52.0								X		/			
TH22-02	S31	55.0 - 56.5		X											
TH22-02	S32	60.0 - 61.5		X											
TH22-02	T33	70.0 - 72.0								X		/			
TH22-02	S34A	80.0 - 80.5		X											
TH22-02	S34B	80.5 - 81.5		X											

REQUESTED BY: Matt Klymochko
REPORT TO: MK/MVH
REQUISITION DATE: Sept 19
DATE REQUIRED: Sept 30
COMMENTS:

REQUISITION NO. R22-559

TREK LABORATORY REQUISITION LOGS 2022-09-16 LAG OVERPASS_MK 0002-130-00.GPJ TREK GEOTECHNICAL.GDT 9/19/22

LABORATORY REQUISITION

CLIENT Tetra Tech Inc

PROJECT NO: 0002-130-00

PROJECT NAME Lagimodiere / Concordia Overpass Rehabilitation

FIELD TECHNICIAN: Matt Klymochko

TEST HOLE NUMBER	SAMPLE NUMBER	DEPTH OF SAMPLE (ft)	TARE NUMBER (LAB USE ONLY)	MOISTURE	VISUAL CLASS.	ATTERBERG LIMITS	HYDROMETER	GRADATION	STD. PROCTOR	UNCONFINED AND AUXILLARY TESTS					Soil Description/Comments
TH22-02	S35	84.0 - 84.3		X											
TH22-03	G36	1.0 - 2.0		X											
TH22-03	G37	5.0 - 6.0		X				X							cow spec
TH22-03	G38	11.0 - 12.0		X											
TH22-03	S39	15.0 - 16.5		X											
TH22-03	S40	20.0 - 21.5		X											
TH22-03	S41	25.0 - 26.5		X											
TH22-03	S42A	30.0 - 30.5		X											
TH22-03	S42B	30.5 - 31.5		X											
TH22-03	S43A	32.5 - 33.5		X											
TH22-03	S43B	33.5 - 34.0		X											
TH22-03	S44	35.0 - 36.5		X											
TH22-03	S45	37.5 - 39.0		X											
TH22-03	S46	40.0 - 41.5		X											
TH22-03	S47	45.0 - 46.5		X											
TH22-03	T48	50.0 - 52.0								X					
TH22-03	S49	55.0 - 56.5		X											
TH22-03	S50	60.0 - 61.5		X											
TH22-03	T51	70.0 - 72.0								X					
TH22-03	S52	75.0 - 76.5		X											
TH22-03	S53A	80.0 - 81.0		X											
TH22-03	S53B	81.0 - 81.5		X											
TH22-03	S54	82.5 - 82.6		X											missing sample
TH22-04	G55	1.0 - 2.0		X											
TH22-04	G56	5.0 - 6.0		X											
TH22-04	G57	9.0 - 10.0		X											
TH22-04	G58	10.0 - 11.0		X											
TH22-04	G59	15.0 - 16.0		X											
TH22-04	T60	20.0 - 22.0								X					
TH22-04	G61	25.0 - 26.0		X											
TH22-04	G62	30.0 - 31.0		X											
TH22-04	G63	35.0 - 36.0		X											
TH22-04	T64	40.0 - 42.0								X					
TH22-04	G65	45.0 - 46.0		X											
TH22-04	G66	50.0 - 51.0		X											

REQUESTED BY: Matt Klymochko

REPORT TO:

REQUISITION DATE:

DATE REQUIRED:

COMMENTS:

REQUISITION NO. R22-559

PAGE 2 OF 4

TREK GEOTECHNICAL

LABORATORY REQUISITION

CLIENT Tetra Tech Inc

PROJECT NAME Lagimodiere / Concordia Overpass Rehabilitation

PROJECT NO: 0002-130-00

FIELD TECHNICIAN: Matt Klymochko

TEST HOLE NUMBER	SAMPLE NUMBER	DEPTH OF SAMPLE (ft)	TARE NUMBER (LAB USE ONLY)	MOISTURE	VISUAL CLASS.	ATTERBERG LIMITS	HYDROMETER	GRADATION	STD. PROCTOR	UNCONFINED AND AUXILLARY TESTS	Direct Shear	~~[illegible]~~			Soil Description/Comments
TH22-04	G67	54.0 - 55.0		X											
TH22-04	S68	55.0 - 55.7		X											
TH22-04	C69A	55.7 - 58.0													Cobbles / Fractured Rock
TH22-04	C69B	58.0 - 60.0													" "
TH22-04	C70	60.5 - 65.5								⊘					Limestone Qu
TH22-04	C71	65.5 - 70.5													Limestone
TH22-05	G72	0.5 - 1.5		X											
TH22-05	G73	2.0 - 3.0		X											
TH22-05	G74	4.0 - 5.0		X											
TH22-05	G75	7.0 - 8.0		X											
TH22-05	G76	10.0 - 11.0		X											
TH22-05	T77	15.0 - 17.0								X					
TH22-05	G78	20.0 - 21.0		X											
TH22-05	G79	25.0 - 26.0		X											
TH22-05	T80	30.0 - 32.0								X					
TH22-05	G81	35.0 - 36.0		X											
TH22-05	G82	40.0 - 41.0		X											
TH22-05	G83	45.0 - 46.0		X											
TH22-05	G84	50.0 - 51.0		X											
TH22-05	G85	51.0 - 52.0		X											
TH22-05	S86	53.0 - 54.5		X											
TH22-05	C87	55.0 - 60.0													Cobbles / Fractured Rock
TH22-05	C88	60.0 - 65.0													" "
TH22-05	C89	65.0 - 70.0								⊘					Limestone Qu
TH22-05	C90	70.0 - 75.0													Limestone
TH22-06	G91	0.0 - 1.0		X											
TH22-06	G92	2.0 - 3.0		X											
TH22-06	G93	5.0 - 6.0		X											
TH22-06	T94	10.0 - 12.0				X				X	/				
TH22-06	G95	15.0 - 16.0		X											
TH22-06	T96	20.0 - 22.0				X				X					
TH22-06	G97	25.0 - 26.0		X											
TH22-06	T98	30.0 - 32.0		X						X					
TH22-06	G99	34.0 - 35.0		X											
TH22-06	G100	37.0 - 38.0		X											

REQUESTED BY: Matt Klymochko

REPORT TO:

REQUISITION DATE:

DATE REQUIRED:

COMMENTS:

REQUISITION NO. R22-559

PAGE 3 OF 4

TREK GEOTECHNICAL

LABORATORY REQUISITION

CLIENT Tetra Tech Inc

PROJECT NAME Lagimodiere / Concordia Overpass Rehabilitation

PROJECT NO: 0002-130-00

FIELD TECHNICIAN: Matt Klymochko

TEST HOLE NUMBER	SAMPLE NUMBER	DEPTH OF SAMPLE (ft)	TARE NUMBER (LAB USE ONLY)	MOISTURE	VISUAL CLASS.	ATTERBERG LIMITS	HYDROMETER	GRADATION	STD. PROCTOR	UNCONFINED AND AUXILLARY TESTS					Soil Description/Comments
TH22-06	S101	40.0 - 41.3		X											

Do Limestone Qu after Steve W has looked at sample. Matt will let you know when he has looked

REQUESTED BY: Matt Klymochko

REPORT TO:

REQUISITION DATE:

DATE REQUIRED:

COMMENTS:

REQUISITION NO. R22-559

PAGE 4 OF 4

TREK LABORATORY REQUISITION LOGS 2022-09-16 LAG OVERPASS_MK 0002-130-00.GPJ TREK GEOTECHNICAL.GDT 9/19/22

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere / Concordia Overpass Rehabilitation

Sample Date	12-Sep-22
Test Date	17-Oct-22
Technician	JC

Test Hole	TH22-01	TH22-01	TH22-01	TH22-01	TH22-01	TH22-01
Depth (m)	0.3 - 0.6	1.5 - 1.8	3.4 - 3.7	4.6 - 4.9	5.5 - 5.8	6.7 - 7.0
Sample #	G01	G02	G03	G04	G05	G07
Tare ID	F114	F34	Z94	A20	AB87	D40
Mass of tare	8.4	8.7	9.6	8.8	6.8	8.4
Mass wet + tare	241.5	252.8	262.7	284.8	250.5	410.3
Mass dry + tare	185.3	177.9	201.1	219.5	195.4	334.2
Mass water	56.2	74.9	61.6	65.3	55.1	76.1
Mass dry soil	176.9	169.2	191.5	210.7	188.6	325.8
Moisture %	31.8%	44.3%	32.2%	31.0%	29.2%	23.4%

Test Hole	TH22-01	TH22-01	TH22-01	TH22-01	TH22-01	TH22-01
Depth (m)	7.3 - 7.6	8.8 - 9.1	10.4 - 10.7	13.7 - 14.0	15.2 - 15.5	16.8 - 17.1
Sample #	G08	G09	G10	G12	G13	G14
Tare ID	Z74	AA22	F154	W65	E42	N48
Mass of tare	8.6	6.9	8.4	8.5	8.6	8.6
Mass wet + tare	235.5	201.7	228.1	208.1	208.4	212.3
Mass dry + tare	162.8	135.9	159.4	138.4	140.7	135.8
Mass water	72.7	65.8	68.7	69.7	67.7	76.5
Mass dry soil	154.2	129.0	151.0	129.9	132.1	127.2
Moisture %	47.1%	51.0%	45.5%	53.7%	51.2%	60.1%

Test Hole	TH22-01	TH22-01	TH22-01	TH22-02	TH22-02	TH22-02
Depth (m)	18.3 - 18.6	19.8 - 20.1	21.0 - 21.3	0.3 - 0.6	1.5 - 1.8	3.0 - 3.4
Sample #	G15	G16	S17	G18	G19	G20
Tare ID	Z104	W59	AC35	N02	W27	C13
Mass of tare	8.4	8.6	6.8	8.6	8.3	8.4
Mass wet + tare	262.0	244.9	221.3	233.3	221.5	286.7
Mass dry + tare	233.1	218.5	182.2	174.4	211.5	234.2
Mass water	28.9	26.4	39.1	58.9	10.0	52.5
Mass dry soil	224.7	209.9	175.4	165.8	203.2	225.8
Moisture %	12.9%	12.6%	22.3%	35.5%	4.9%	23.3%

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Lagimodiere / Concordia Overpass Rehabilitation

Sample Date 12-Sep-22
Test Date 17-Oct-22
Technician JC

Test Hole	TH22-02	TH22-02	TH22-02	TH22-02	TH22-02	TH22-02
Depth (m)	4.6 - 4.9	6.1 - 6.4	7.6 - 7.9	9.1 - 9.4	9.8 - 10.1	10.7 - 11.0
Sample #	G21	G22	G23	G24	G25	G26
Tare ID	Z68	K34	D32	Z21	DMEL	H80
Mass of tare	8.5	8.6	8.6	8.6	170.3	9.0
Mass wet + tare	313.6	237.7	281.0	252.5	1169.0	287.9
Mass dry + tare	240.1	179.0	206.7	192.7	1007.6	224.6
Mass water	73.5	58.7	74.3	59.8	161.4	63.3
Mass dry soil	231.6	170.4	198.1	184.1	837.3	215.6
Moisture %	31.7%	34.4%	37.5%	32.5%	19.3%	29.4%

Test Hole	TH22-02	TH22-02	TH22-02	TH22-02	TH22-02	TH22-02
Depth (m)	11.6 - 11.9	12.2 - 12.5	13.4 - 13.7	16.8 - 17.2	18.3 - 18.7	24.4 - 24.5
Sample #	G27	G28	G29	S31	S32	S34A
Tare ID	A101	N41	D34	F105	N16	F66
Mass of tare	8.6	8.5	8.8	8.5	8.9	8.7
Mass wet + tare	239.9	233.3	247.8	272.3	222.4	201.1
Mass dry + tare	191.9	166.6	165.3	186.3	156.8	135.3
Mass water	48.0	66.7	82.5	86.0	65.6	65.8
Mass dry soil	183.3	158.1	156.5	177.8	147.9	126.6
Moisture %	26.2%	42.2%	52.7%	48.4%	44.4%	52.0%

Test Hole	TH22-02	TH22-02	TH22-03	TH22-03	TH22-03	TH22-03
Depth (m)	24.5 - 24.8	25.6 - 25.7	0.3 - 0.6	1.5 - 1.8	3.4 - 3.7	4.6 - 5.0
Sample #	S34B	S35	G36	G37	G38	S39
Tare ID	AB95	Z140	F50	COSTCO	Z99	E20
Mass of tare	6.7	8.6	8.6	172.8	8.5	8.7
Mass wet + tare	234.6	91.4	209.9	846.8	203.3	98.2
Mass dry + tare	214.7	85.6	164.6	818.8	157.6	88.0
Mass water	19.9	5.8	45.3	28.0	45.7	10.2
Mass dry soil	208.0	77.0	156.0	646.0	149.1	79.3
Moisture %	9.6%	7.5%	29.0%	4.3%	30.7%	12.9%

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere / Concordia Overpass Rehabilitation

Sample Date	12-Sep-22
Test Date	17-Oct-22
Technician	JC

Test Hole	TH22-03	TH22-03	TH22-03	TH22-03	TH22-03	TH22-03
Depth (m)	6.1 - 6.6	7.6 - 8.1	9.1 - 9.3	9.3 - 9.6	9.9 - 10.2	10.2 - 10.4
Sample #	S40	S41	S42A	S42B	S43A	S43B
Tare ID	N32	N84	F37	AC40	W73	Z32
Mass of tare	8.6	8.6	8.5	6.8	8.8	8.8
Mass wet + tare	200.6	213.5	222.0	192.6	199.9	209.8
Mass dry + tare	156.9	165.0	160.3	175.9	169.4	165.1
Mass water	43.7	48.5	61.7	16.7	30.5	44.7
Mass dry soil	148.3	156.4	151.8	169.1	160.6	156.3
Moisture %	29.5%	31.0%	40.6%	9.9%	19.0%	28.6%

Test Hole	TH22-03	TH22-03	TH22-03	TH22-03	TH22-03	TH22-03
Depth (m)	10.7 - 11.1	11.4 - 11.9	12.2 - 12.6	13.7 - 14.2	16.8 - 17.2	18.3 - 18.7
Sample #	S44	S45	S46	S47	S49	S50
Tare ID	E3	P06	P85	C4	AB12	AA21
Mass of tare	8.4	8.6	8.6	8.5	7.0	6.9
Mass wet + tare	209.0	205.2	209.5	230.2	205.6	214.9
Mass dry + tare	166.6	152.4	143.6	152.1	141.9	149.4
Mass water	42.4	52.8	65.9	78.1	63.7	65.5
Mass dry soil	158.2	143.8	135.0	143.6	134.9	142.5
Moisture %	26.8%	36.7%	48.8%	54.4%	47.2%	46.0%

Test Hole	TH22-03	TH22-03	TH22-03	TH22-04	TH22-04	TH22-04
Depth (m)	22.9 - 23.3	24.4 - 24.7	24.7 - 24.8	0.3 - 0.6	1.5 - 1.8	2.7 - 3.0
Sample #	S52	S53A	S53B	G55	G56	G57
Tare ID	F17	Z34	F119	F17	Z75	A103
Mass of tare	8.6	8.5	8.5	8.6	8.6	8.7
Mass wet + tare	236.4	205.0	211.3	213.8	224.6	219.3
Mass dry + tare	160.5	139.9	187.4	161.4	172.9	176.6
Mass water	75.9	65.1	23.9	52.4	51.7	42.7
Mass dry soil	151.9	131.4	178.9	152.8	164.3	167.9
Moisture %	50.0%	49.5%	13.4%	34.3%	31.5%	25.4%

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Lagimodiere / Concordia Overpass Rehabilitation

Sample Date 12-Sep-22
Test Date 17-Oct-22
Technician JC

Test Hole	TH22-04	TH22-04	TH22-04	TH22-04	TH22-04	TH22-04
Depth (m)	3.0 - 3.4	4.6 - 4.9	7.6 - 7.9	9.1 - 9.4	10.7 - 11.0	13.7 - 14.0
Sample #	G58	G59	G61	G62	G63	G65
Tare ID	H50	N105	W98	F137	W57	N97
Mass of tare	8.6	8.9	8.7	8.9	8.9	8.4
Mass wet + tare	206.3	211.9	245.6	248.5	245.3	228.3
Mass dry + tare	134.2	142.3	169.5	169.9	166.4	149.8
Mass water	72.1	69.6	76.1	78.6	78.9	78.5
Mass dry soil	125.6	133.4	160.8	161.0	157.5	141.4
Moisture %	57.4%	52.2%	47.3%	48.8%	50.1%	55.5%

Test Hole	TH22-04	TH22-04	TH22-04	TH22-05	TH22-05	TH22-05
Depth (m)	15.2 - 15.5	16.5 - 16.8	16.8 - 17.0	0.2 - 0.5	0.6 - 0.9	1.2 - 1.5
Sample #	G66	G67	S68	G72	G73	G74
Tare ID	AC16	AB75	Z85	Z01	AC38	H49
Mass of tare	6.7	7.4	8.4	8.6	6.8	8.5
Mass wet + tare	235.2	226.9	131.8	233.7	275.8	248.8
Mass dry + tare	158.1	192.9	119.7	221.8	210.5	189.2
Mass water	77.1	34.0	12.1	11.9	65.3	59.6
Mass dry soil	151.4	185.5	111.3	213.2	203.7	180.7
Moisture %	50.9%	18.3%	10.9%	5.6%	32.1%	33.0%

Test Hole	TH22-05	TH22-05	TH22-05	TH22-05	TH22-05	TH22-05
Depth (m)	2.1 - 2.4	3.0 - 3.4	6.1 - 6.4	7.6 - 7.9	10.7 - 11.0	12.2 - 12.5
Sample #	G75	G76	G78	G79	G81	G82
Tare ID	A105	Z57	H13	K19	AA15	N28
Mass of tare	8.6	8.6	8.5	8.6	6.8	8.4
Mass wet + tare	255.8	218.3	250.8	246.0	213.2	212.0
Mass dry + tare	202.6	146.4	169.6	170.5	139.9	146.4
Mass water	53.2	71.9	81.2	75.5	73.3	65.6
Mass dry soil	194.0	137.8	161.1	161.9	133.1	138.0
Moisture %	27.4%	52.2%	50.4%	46.6%	55.1%	47.5%

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Lagimodiere / Concordia Overpass Rehabilitation

Sample Date 12-Sep-22
Test Date 17-Oct-22
Technician JC

Test Hole	TH22-05	TH22-05	TH22-05	TH22-05	TH22-06	TH22-06
Depth (m)	13.7 - 14.0	15.2 - 15.5	15.5 - 15.8	16.2 - 16.6	0.0 - 0.3	0.6 - 0.9
Sample #	G83	G84	G85	S86	G91	G92
Tare ID	Z59	D37	K20	W96	Z118	A51
Mass of tare	8.6	8.6	8.5	8.7	8.4	8.6
Mass wet + tare	200.1	226.0	281.7	330.0	154.0	210.3
Mass dry + tare	126.3	146.7	251.5	297.7	120.6	144.4
Mass water	73.8	79.3	30.2	32.3	33.4	65.9
Mass dry soil	117.7	138.1	243.0	289.0	112.2	135.8
Moisture %	62.7%	57.4%	12.4%	11.2%	29.8%	48.5%

Test Hole	TH22-06	TH22-06	TH22-06	TH22-06	TH22-06	TH22-06
Depth (m)	1.5 - 1.8	4.6 - 4.9	7.6 - 7.9	10.4 - 10.7	11.3 - 11.6	12.2 - 12.6
Sample #	G93	G95	G97	G99	G100	S101
Tare ID	AB65	K32	H43	AB74	H21	P03
Mass of tare	6.8	8.5	8.7	6.8	8.5	8.8
Mass wet + tare	242.2	238.2	229.4	281.1	224.2	227.0
Mass dry + tare	164.5	130.3	151.9	246.4	199.0	207.5
Mass water	77.7	107.9	77.5	34.7	25.2	19.5
Mass dry soil	157.7	121.8	143.2	239.6	190.5	198.7
Moisture %	49.3%	88.6%	54.1%	14.5%	13.2%	9.8%

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Atterberg Limits
ASTM D4318-10e1

CERTIFIED BY
CCIL
Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com

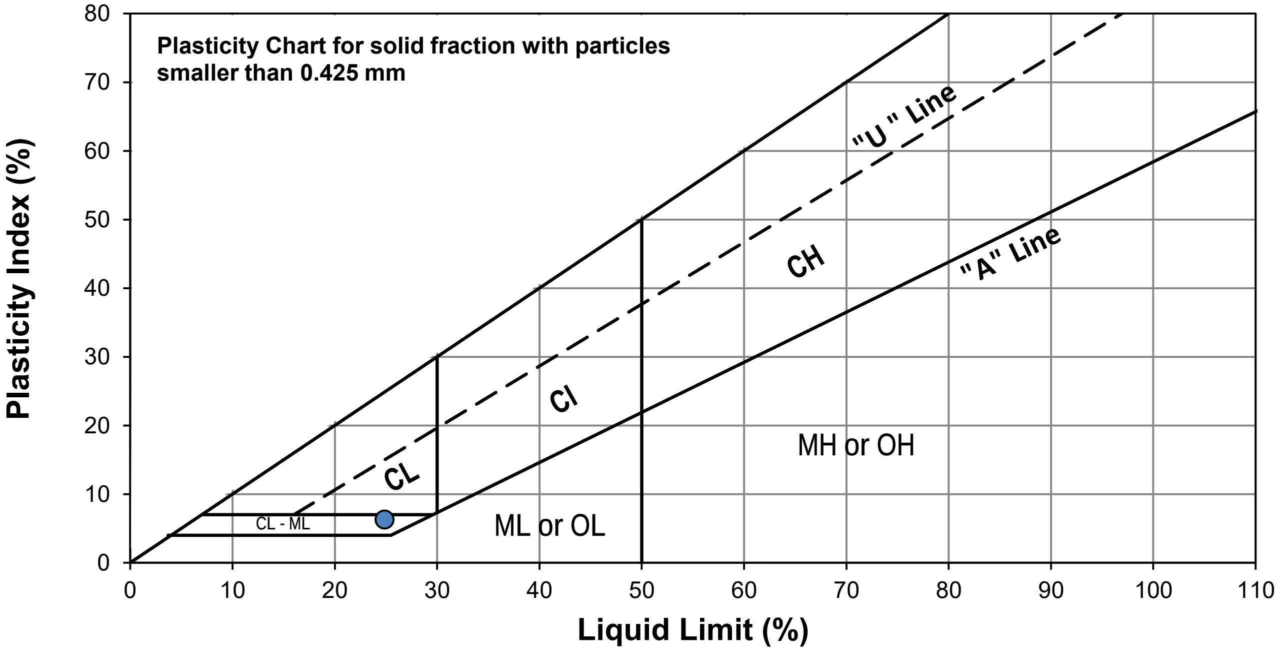
Project No. 0002-130-00
Client Tetra Tech Inc.
Project Lagimodiere / Concordia Overpass Rehabilitation

Test Hole TH22-01
Sample # G07
Depth (m) 6.7 - 7.0
Sample Date 12-Sep-22
Test Date 25-Oct-22
Technician DS

Liquid Limit	25
Plastic Limit	19
Plasticity Index	6

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	18	28	33		
Mass Tare (g)	13.914	13.936	14.314		
Mass Wet Soil + Tare (g)	24.309	24.580	25.343		
Mass Dry Soil + Tare (g)	22.152	22.481	23.241		
Mass Water (g)	2.157	2.099	2.102		
Mass Dry Soil (g)	8.238	8.545	8.927		
Moisture Content (%)	26.184	24.564	23.547		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	13.968	13.922			
Mass Wet Soil + Tare (g)	23.535	23.965			
Mass Dry Soil + Tare (g)	22.030	22.401			
Mass Water (g)	1.505	1.564			
Mass Dry Soil (g)	8.062	8.479			
Moisture Content (%)	18.668	18.446			

Note: Additional information recorded/measured for this test is available upon request.

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Atterberg Limits
ASTM D4318-10e1

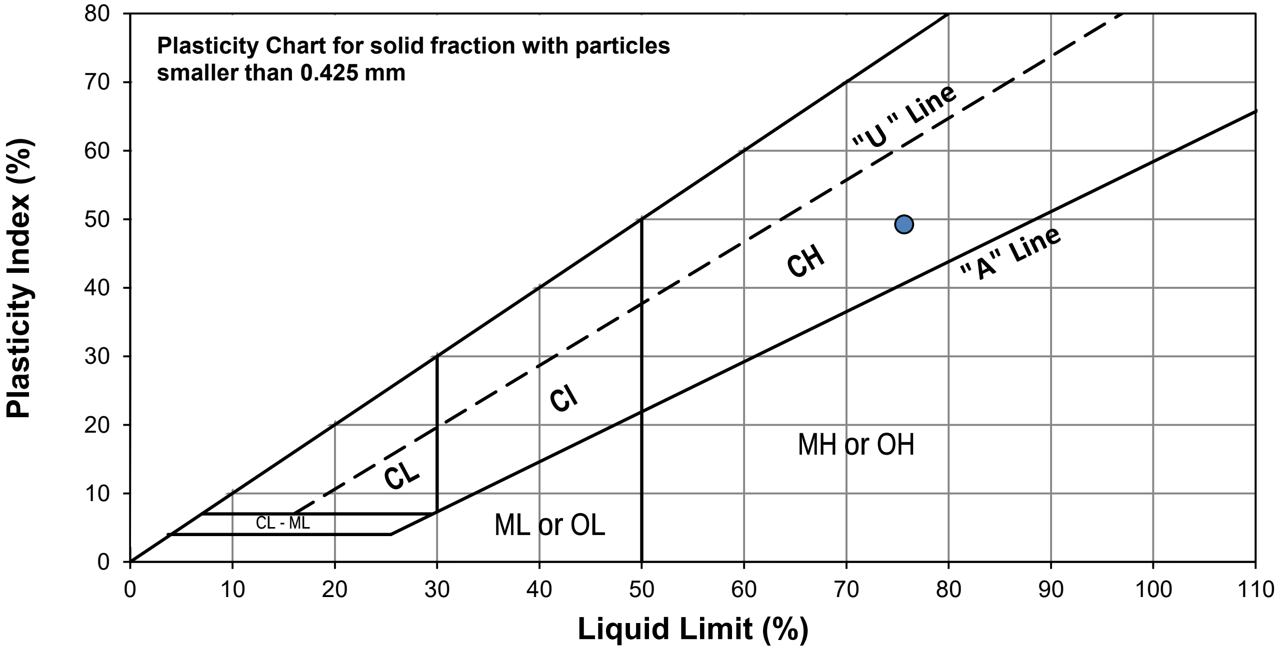
Project No. 0002-130-00
Client Tetra Tech Inc.
Project Lagimodiere/Concordia Overpass Rehabilitation

Test Hole TH22-01
Sample # T11
Depth (m) 12.2 - 12.8
Sample Date 12-Sep-22
Test Date 21-Oct-22
Technician TN

Liquid Limit	76
Plastic Limit	26
Plasticity Index	49

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	20	28	36		
Mass Tare (g)	14.117	13.895	14.182		
Mass Wet Soil + Tare (g)	29.893	25.900	25.808		
Mass Dry Soil + Tare (g)	23.001	20.758	20.937		
Mass Water (g)	6.892	5.142	4.871		
Mass Dry Soil (g)	8.884	6.863	6.755		
Moisture Content (%)	77.578	74.924	72.110		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	13.924	14.310			
Mass Wet Soil + Tare (g)	21.149	22.260			
Mass Dry Soil + Tare (g)	19.638	20.597			
Mass Water (g)	1.511	1.663			
Mass Dry Soil (g)	5.714	6.287			
Moisture Content (%)	26.444	26.451			

Note: Additional information recorded/measured for this test is available upon request.

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

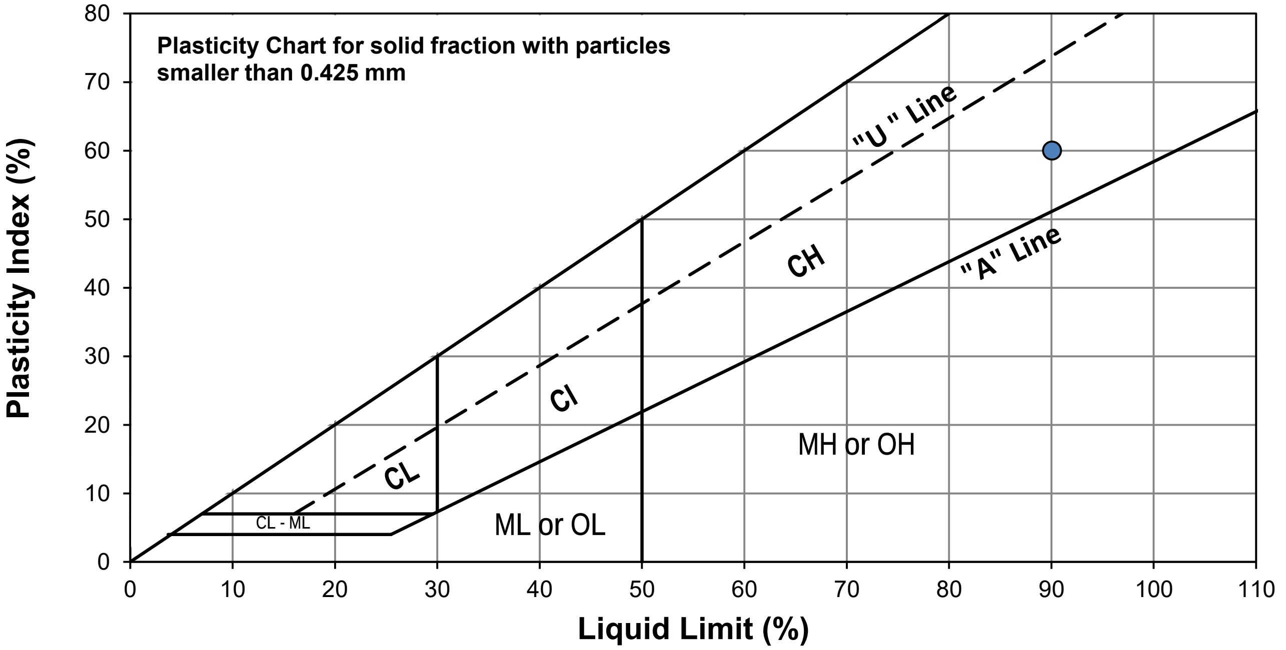
Atterberg Limits
ASTM D4318-10e1

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere / Concordia Overpass Rehabilitation
Test Hole	TH22-06
Sample #	T94
Depth (m)	3.0 - 3.7
Sample Date	19-Sep-22
Test Date	03-Nov-22
Technician	TN

Liquid Limit	90
Plastic Limit	30
Plasticity Index	60

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	15	22	30		
Mass Tare (g)	13.851	14.185	13.953		
Mass Wet Soil + Tare (g)	26.868	30.968	26.046		
Mass Dry Soil + Tare (g)	20.621	22.997	20.339		
Mass Water (g)	6.247	7.971	5.707		
Mass Dry Soil (g)	6.770	8.812	6.386		
Moisture Content (%)	92.275	90.456	89.367		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.046	13.909			
Mass Wet Soil + Tare (g)	23.156	25.502			
Mass Dry Soil + Tare (g)	21.036	22.837			
Mass Water (g)	2.120	2.665			
Mass Dry Soil (g)	6.990	8.928			
Moisture Content (%)	30.329	29.850			

Note: Additional information recorded/measured for this test is available upon request.

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

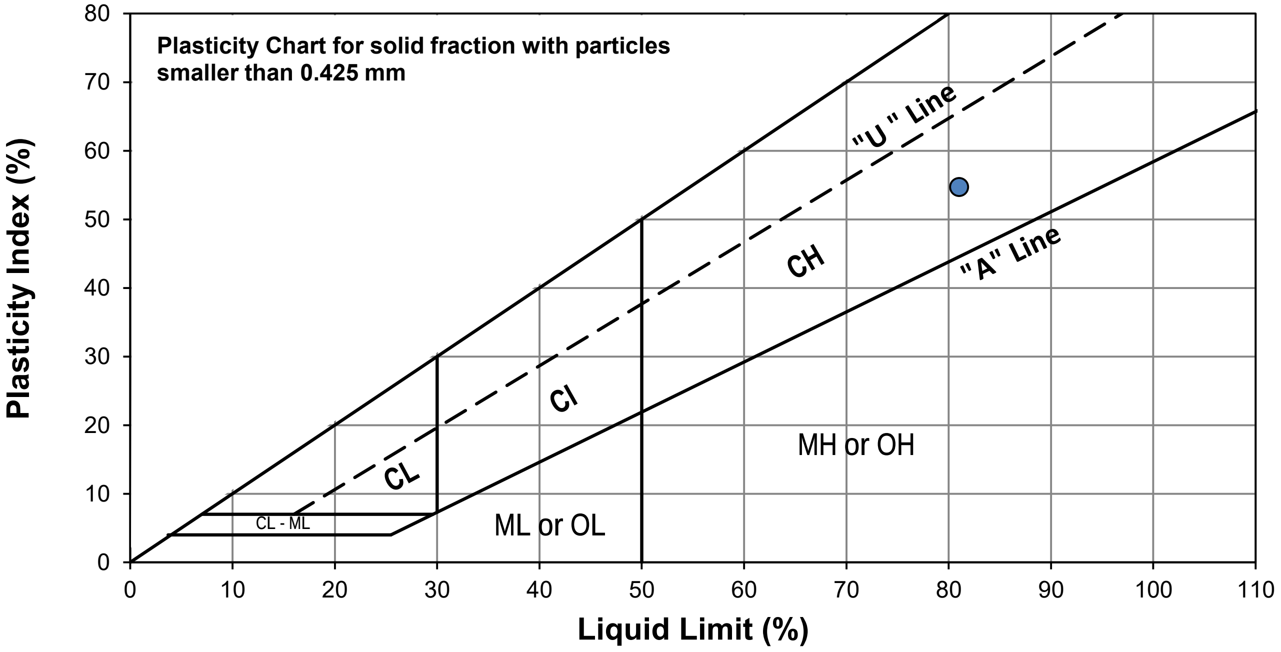
Atterberg Limits
ASTM D4318-10e1

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere/Concordia Overpass Rehabilitation
Test Hole	TH22-06
Sample #	T96
Depth (m)	6.1 - 6.7
Sample Date	12-Sep-22
Test Date	29-Oct-22
Technician	TN

Liquid Limit	81
Plastic Limit	26
Plasticity Index	55

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	15	21	27		
Mass Tare (g)	13.798	13.895	13.983		
Mass Wet Soil + Tare (g)	28.593	27.882	28.353		
Mass Dry Soil + Tare (g)	21.786	21.561	21.948		
Mass Water (g)	6.807	6.321	6.405		
Mass Dry Soil (g)	7.988	7.666	7.965		
Moisture Content (%)	85.215	82.455	80.414		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	14.198	13.908			
Mass Wet Soil + Tare (g)	23.715	24.225			
Mass Dry Soil + Tare (g)	21.710	22.096			
Mass Water (g)	2.005	2.129			
Mass Dry Soil (g)	7.512	8.188			
Moisture Content (%)	26.691	26.001			

Note: Additional information recorded/measured for this test is available upon request.

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

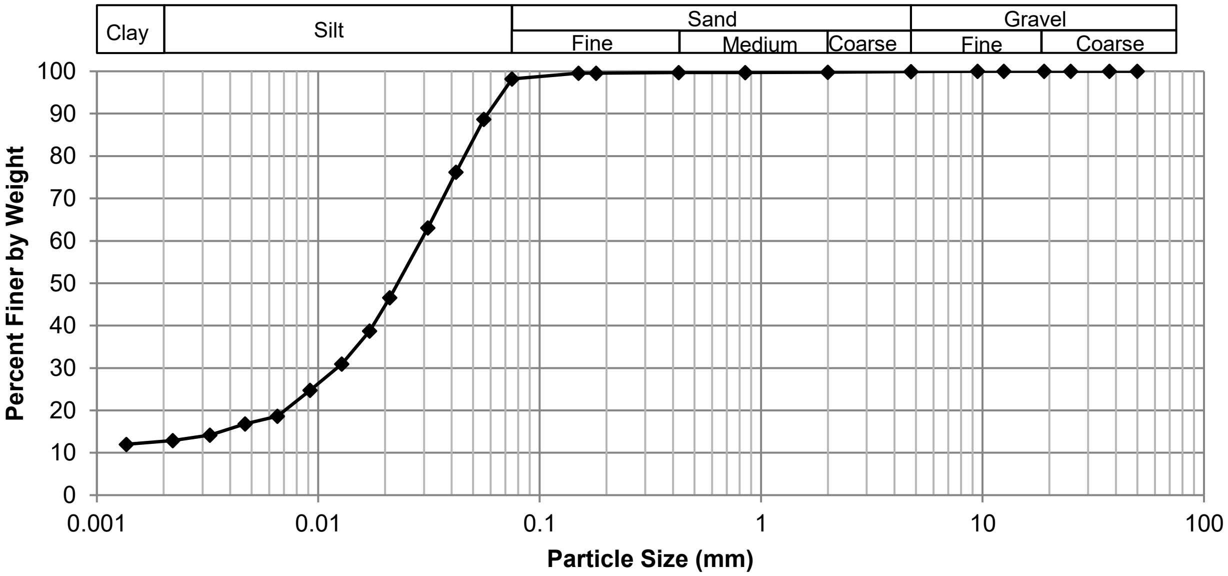
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere/Concordia Overpass Rehabilitation
Test Hole	TH22-01
Sample #	G07
Depth (m)	6.7 - 7.0
Sample Date	12-Sep-22
Test Date	21-Oct-22
Technician	AFK

Gravel	0.1%
Sand	1.7%
Silt	85.5%
Clay	12.7%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	99.92	0.0750	98.20
37.5	100.00	2.00	99.77	0.0560	88.68
25.0	100.00	0.850	99.74	0.0419	76.20
19.0	100.00	0.425	99.70	0.0313	63.10
12.5	100.00	0.180	99.59	0.0210	46.57
9.50	100.00	0.150	99.55	0.0171	38.77
4.75	99.92	0.075	98.20	0.0128	30.97
				0.0092	24.76
				0.0065	18.59
				0.0047	16.79
				0.0032	14.15
				0.0022	12.90
				0.0014	12.00

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

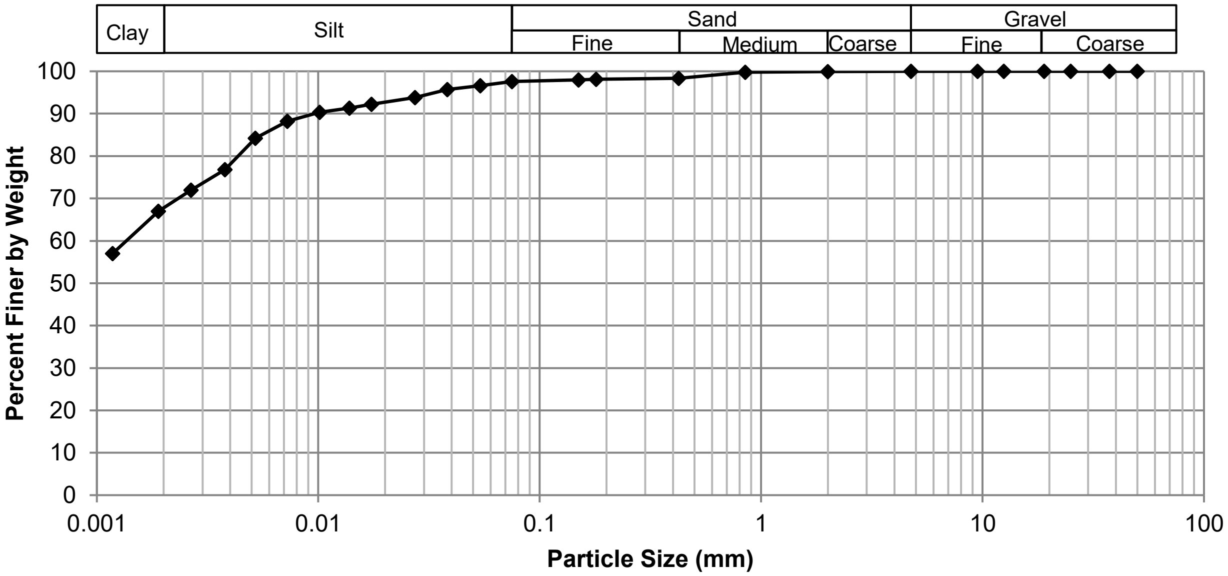
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere/Concordia Overpass Rehabilitation
Test Hole	TH22-01
Sample #	T11
Depth (m)	3.0 - 0.0
Sample Date	27-Sep-22
Test Date	19-Oct-22
Technician	AFK

Gravel	0.0%
Sand	2.4%
Silt	30.0%
Clay	67.6%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	97.60
37.5	100.00	2.00	99.91	0.0539	96.62
25.0	100.00	0.850	99.77	0.0383	95.68
19.0	100.00	0.425	98.37	0.0273	93.80
12.5	100.00	0.180	98.09	0.0174	92.24
9.50	100.00	0.150	97.99	0.0138	91.31
4.75	100.00	0.075	97.60	0.0102	90.37
				0.0072	88.22
				0.0052	84.22
				0.0038	76.79
				0.0027	71.96
				0.0019	66.96
				0.0012	57.00

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Grain Size Analysis (Sieve Method)

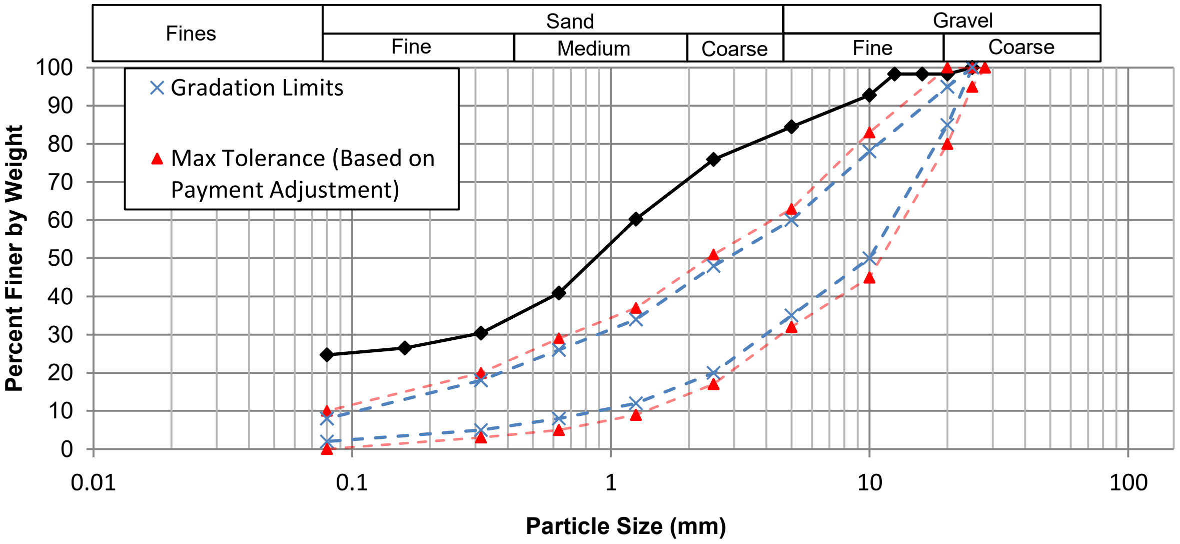
ASTM C136-14
ASTM C117-13

CERTIFIED BY CCIL Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere / Concordia Overpass Rehabilitation
Sample #	G25
Source	On-site
Soil Desc.	Sand and gravel
Date Sampled	12-Sep-22
Date Tested	20-Oct-22
Technician	JC

Total Weight (g)	837.3
Cobbles %	0.0
Gravel %	15.5
Sand %	59.8
Fines %	24.7

Particle Size Distribution Curve



Sieve Opening (mm)	Percent Passing	Specification (Min - Max)
		City of Winnipeg Specification
		Table CW3110-R21
		Granular A - Base Course
25.0	100	100-100
20.0	96	85-95
16.0	96	
12.5	96	
10.0	96	50-78
5.00	92	35-60
2.50	90	20-48
1.25	88	12-34
0.630	82	8-26
0.315	57	5-18
0.160	12	
0.080	7.8	2-8

Note: Additional information recorded/measured for this test is available upon request.

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Grain Size Analysis (Sieve Method)

ASTM C136-14

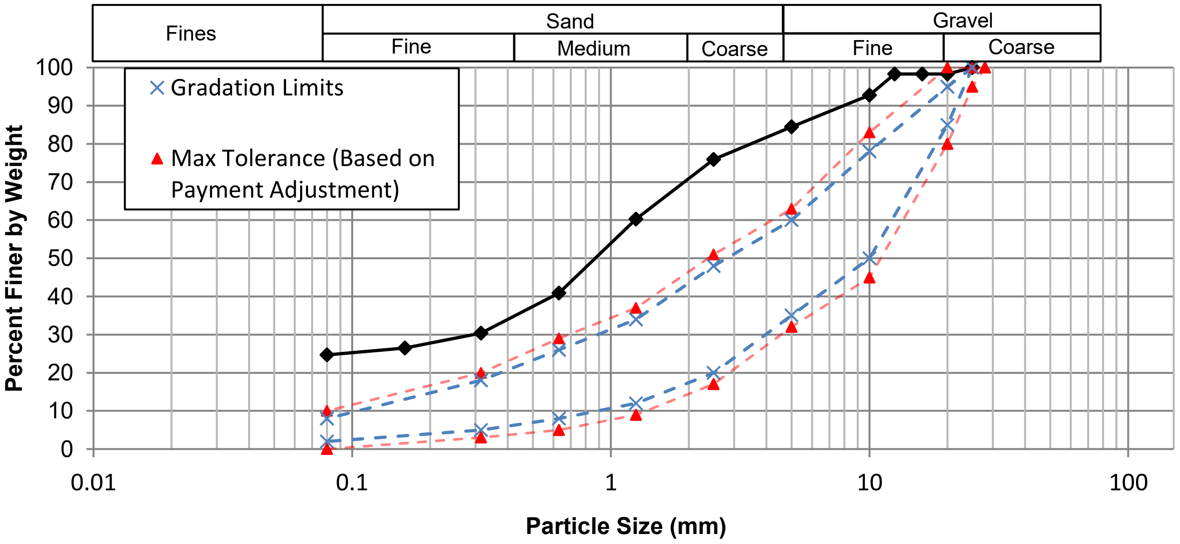
ASTM C117-13

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere / Concordia Overpass Rehabilitation
Sample #	G37
Source	On-site
Soil Desc.	Sand and gravel
Date Sampled	12-Sep-22
Date Tested	20-Oct-22
Technician	JC

Total Weight (g)	676.00
Cobbles %	0.0
Gravel %	15.5
Sand %	59.8
Fines %	24.7

Particle Size Distribution Curve



Sieve Opening (mm)	Percent Passing	Specification (Min - Max)
		City of Winnipeg Specification
		Table CW3110-R21
		Granular A - Base Course
25.0	100	100-100
20.0	98	85-95
16.0	98	
12.5	98	
10.0	93	50-78
5.00	86	35-60
2.50	76	20-48
1.25	58	12-34
0.630	36	8-26
0.315	24	5-18
0.160	20	
0.080	18	2-8

Note: Additional information recorded/measured for this test is available upon request.

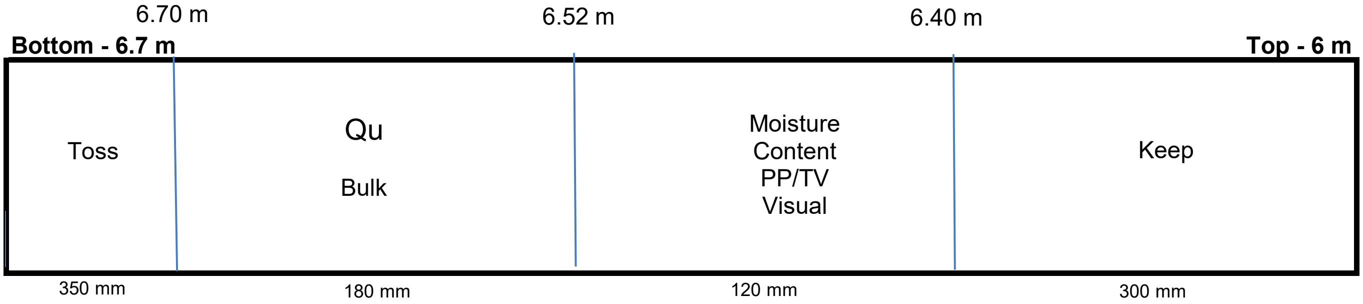
TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab
Test Hole	TH22-01
Sample #	T06
Depth (m)	6.1 - 6.7
Sample Date	12-Sep-22
Test Date	16-Oct-22
Technician	RSA

Tube Extraction

Recovery (mm) 665 (overpush)



Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<10 mm diam.)	
trace gravel (<20mm diam)	
some silt seams (<2mm thick)	
trace oxidation	
Color	brown
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.85
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	83.4

Pocket Penetrometer

Reading	**1**	2.60
	2	2.40
	3	3.00
	Average	2.67
Undrained Shear Strength (kPa)		130.8

Moisture Content

Tare ID	Z72
Mass tare (g)	8.6
Mass wet + tare (g)	332.7
Mass dry + tare (g)	225.7
Moisture %	49.3%

Unit Weight

Bulk Weight (g)		1062.8
Length (mm)	**1**	150.87
	2	150.57
	3	150.55
	4	151.30
Average Length (m)		0.151
Diam. (mm)	**1**	73.21
	2	73.40
	3	73.27
	4	73.60
Average Diameter (m)		0.073
Volume (m^3)		6.38E-04
Bulk Unit Weight (kN/m^3)		16.3
Bulk Unit Weight (pcf)		104.1
Dry Unit Weight (kN/m^3)		10.9
Dry Unit Weight (pcf)		69.7

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Test Hole TH22-01
Sample # T06
Depth (m) 6.1 - 6.7
Sample Date 12-Sep-22
Test Date 16-Oct-22
Technician RSA

Unconfined Strength

	kPa	ksf
Max q_u	62.5	1.3
Max S_u	31.3	0.7

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), trace gravel (<20mm diam), some silt seams (<2mm thick), trace oxidation, brown, moist, stiff, high plasticity

Length	150.8	(mm)
Diameter	73.4	(mm)
L/D Ratio	2.1	
Initial Area	0.00423	(m^2)
Load Rate	1.00	(%/min)

Moisture %	49%	
Bulk Unit Wt.	16.3	(kN/m^3)
Dry Unit Wt.	10.9	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.85	83.4	1.74
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	2.60	127.5	2.66
	2.40	117.7	2.46
	3.00	147.2	3.07
Average	**2.67**	**130.8**	**2.73**

Failure Geometry

Sketch:

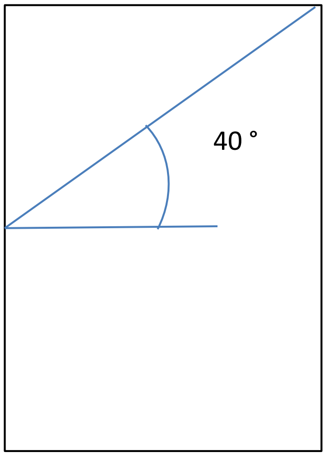
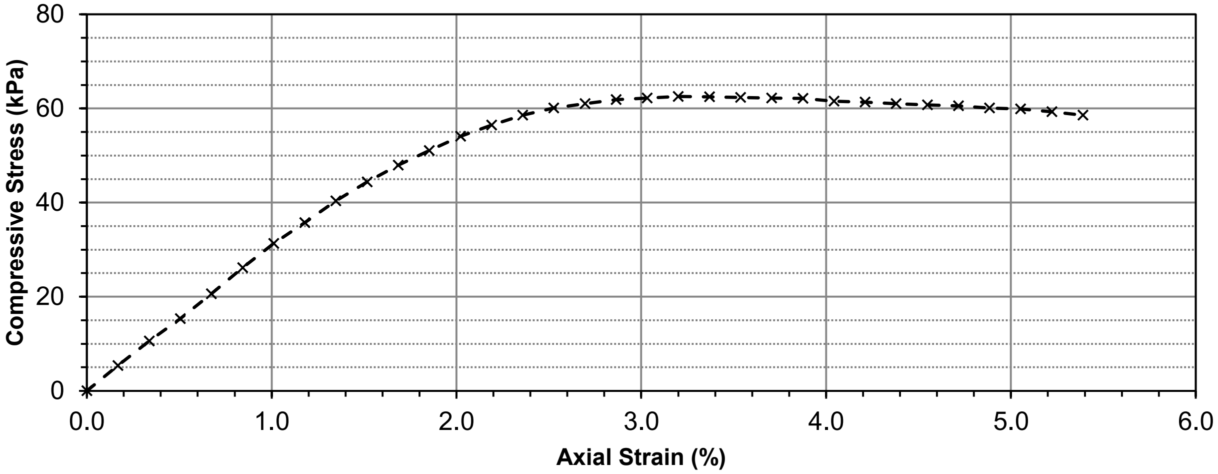


Photo:

Unconfined Compressive Strength
ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	1.52	0.0000	0.00	0.004228	0.0	0.00	0.00
10	1.97	0.2540	0.17	0.004235	22.7	5.36	2.68
20	2.41	0.5080	0.34	0.004242	44.9	10.57	5.29
30	2.81	0.7620	0.51	0.004249	65.0	15.30	7.65
40	3.26	1.0160	0.67	0.004257	87.7	20.60	10.30
50	3.73	1.2700	0.84	0.004264	111.4	26.12	13.06
60	4.17	1.5240	1.01	0.004271	133.6	31.27	15.64
70	4.55	1.7780	1.18	0.004278	152.7	35.70	17.85
80	4.95	2.0320	1.35	0.004286	172.9	40.34	20.17
90	5.30	2.2860	1.52	0.004293	190.5	44.38	22.19
100	5.61	2.5400	1.68	0.004300	206.1	47.94	23.97
110	5.88	2.7940	1.85	0.004308	219.8	51.01	25.51
120	6.15	3.0480	2.02	0.004315	233.4	54.08	27.04
130	6.36	3.3020	2.19	0.004323	244.0	56.44	28.22
140	6.55	3.5560	2.36	0.004330	253.5	58.55	29.28
150	6.69	3.8100	2.53	0.004337	260.6	60.08	30.04
160	6.78	4.0640	2.69	0.004345	265.1	61.02	30.51
170	6.86	4.3180	2.86	0.004353	269.2	61.84	30.92
180	6.90	4.5720	3.03	0.004360	271.2	62.19	31.10
190	6.94	4.8260	3.20	0.004368	273.2	62.55	31.27
200	6.94	5.0800	3.37	0.004375	273.2	62.44	31.22
210	6.94	5.3340	3.54	0.004383	273.2	62.33	31.16
220	6.94	5.5880	3.71	0.004391	273.2	62.22	31.11
230	6.94	5.8420	3.87	0.004398	273.2	62.11	31.06

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	6.90	6.0960	4.04	0.004406	271.2	61.55	30.77
250	6.89	6.3500	4.21	0.004414	270.7	61.32	30.66
260	6.87	6.6040	4.38	0.004422	269.7	60.99	30.49
270	6.86	6.8580	4.55	0.004429	269.2	60.77	30.38
280	6.85	7.1120	4.72	0.004437	268.6	60.55	30.27
290	6.82	7.3660	4.88	0.004445	267.1	60.10	30.05
300	6.81	7.6200	5.05	0.004453	266.6	59.88	29.94
310	6.77	7.8740	5.22	0.004461	264.6	59.32	29.66
320	6.71	8.1280	5.39	0.004469	261.6	58.54	29.27

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab
Test Hole	TH22-01
Sample #	T11
Depth (m)	12.2 - 12.8
Sample Date	13-Sep-22
Test Date	16-Oct-22
Technician	RSA

Tube Extraction

Recovery (mm) 670 (overpass)

6.60 m 6.55 m 6.39 m 6.35 m

Bottom - 12.8 m **Top - 12.1 m**

Toss	Keep	Moisture Content Atterberg and Hydrometer	Qu Bulk	PP/TV Visual	Toss
70 mm	180 mm	100 mm	170 mm	100 mm	50 mm

Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions (<10 mm diam.)

Color	brown
Moisture	moist
Consistency	firm to stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.40
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	39.2

Pocket Penetrometer

Reading	**1**	1.00
	2	0.90
	3	1.20
	Average	1.03
Undrained Shear Strength (kPa)		50.7

Moisture Content

Tare ID	AC22
Mass tare (g)	8.8
Mass wet + tare (g)	379.3
Mass dry + tare (g)	259.8
Moisture %	47.6%

Unit Weight

Bulk Weight (g)		1100.8
Length (mm)	**1**	148.84
	2	148.87
	3	148.33
	4	147.40
Average Length (m)		0.148
Diam. (mm)	**1**	72.78
	2	72.30
	3	72.43
	4	73.61
Average Diameter (m)		0.073
Volume (m^3)		6.17E-04
Bulk Unit Weight (kN/m^3)		17.5
Bulk Unit Weight (pcf)		111.3
Dry Unit Weight (kN/m^3)		11.8
Dry Unit Weight (pcf)		75.4

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength
ASTM D2166

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Test Hole	TH22-01
Sample #	T11
Depth (m)	12.2 - 12.8
Sample Date	2022-09-13
Test Date	2022-10-16
Technician	RSA

Unconfined Strength

	kPa	ksf
Max q_u	79.2	1.7
Max S_u	39.6	0.8

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), brown, moist, firm to stiff, high plasticity

Length	148.4	(mm)	**Moisture %**	48%	
Diameter	72.8	(mm)	**Bulk Unit Wt.**	17.5	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	11.8	(kN/m^3)
Initial Area	0.00416	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.40	39.2	0.82
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.00	49.1	1.02
	0.90	44.1	0.92
	1.20	58.9	1.23
Average	**1.03**	**50.7**	**1.06**

Failure Geometry

Sketch:

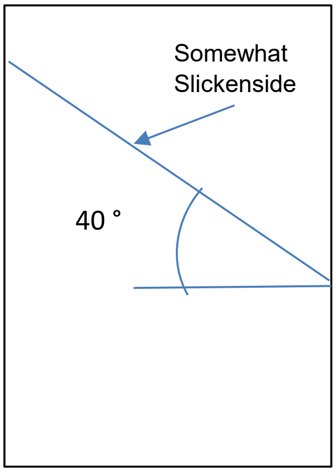


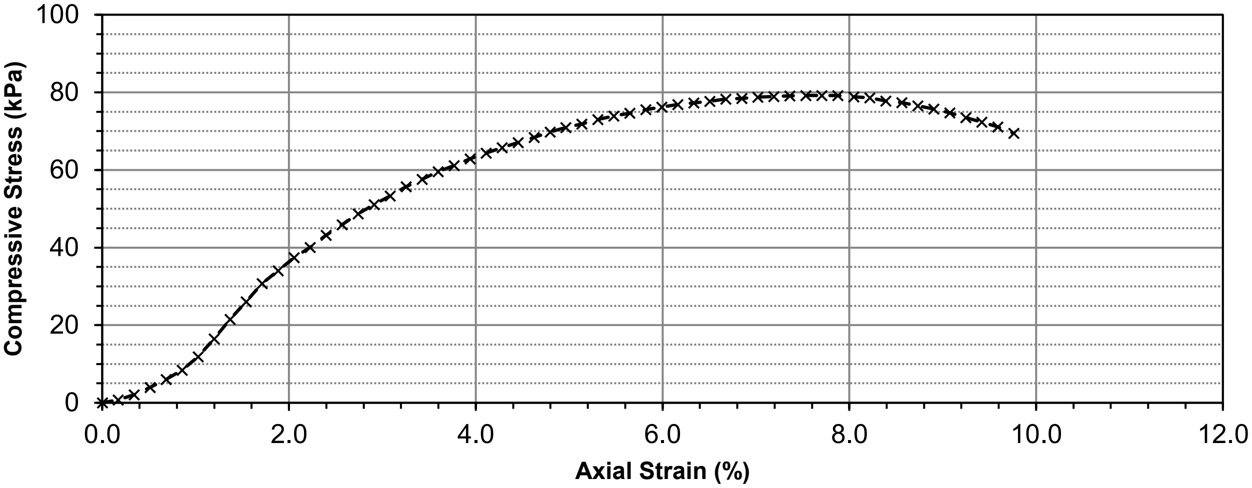
Photo:

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.29	0.0000	0.00	0.004160	0.0	0.00	0.00
10	0.35	0.2540	0.17	0.004167	3.0	0.73	0.36
20	0.46	0.5080	0.34	0.004174	8.6	2.05	1.03
30	0.62	0.7620	0.51	0.004182	16.6	3.98	1.99
40	0.79	1.0160	0.68	0.004189	25.2	6.02	3.01
50	0.99	1.2700	0.86	0.004196	35.3	8.41	4.20
60	1.28	1.5240	1.03	0.004203	49.9	11.87	5.94
70	1.67	1.7780	1.20	0.004211	69.6	16.52	8.26
80	2.09	2.0320	1.37	0.004218	90.7	21.51	10.75
90	2.47	2.2860	1.54	0.004225	109.9	26.00	13.00
100	2.87	2.5400	1.71	0.004233	130.0	30.72	15.36
110	3.15	2.7940	1.88	0.004240	144.2	34.00	17.00
120	3.44	3.0480	2.05	0.004247	158.8	37.38	18.69
130	3.67	3.3020	2.23	0.004255	170.4	40.04	20.02
140	3.94	3.5560	2.40	0.004262	184.0	43.16	21.58
150	4.18	3.8100	2.57	0.004270	196.1	45.92	22.96
160	4.42	4.0640	2.74	0.004277	208.2	48.67	24.33
170	4.63	4.3180	2.91	0.004285	218.7	51.05	25.53
180	4.83	4.5720	3.08	0.004292	228.8	53.31	26.65
190	5.04	4.8260	3.25	0.004300	239.4	55.68	27.84
200	5.21	5.0800	3.42	0.004308	248.0	57.57	28.78
210	5.39	5.3340	3.60	0.004315	257.1	59.57	29.78
220	5.53	5.5880	3.77	0.004323	264.1	61.09	30.55
230	5.69	5.8420	3.94	0.004331	272.2	62.85	31.42

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	5.83	6.0960	4.11	0.004338	279.2	64.36	32.18
250	5.96	6.3500	4.28	0.004346	285.8	65.75	32.88
260	6.08	6.6040	4.45	0.004354	291.8	67.03	33.51
270	6.21	6.8580	4.62	0.004362	298.4	68.41	34.20
280	6.34	7.1120	4.79	0.004370	304.9	69.79	34.89
290	6.45	7.3660	4.96	0.004378	310.5	70.93	35.46
300	6.54	7.6200	5.14	0.004385	315.0	71.83	35.92
310	6.65	7.8740	5.31	0.004393	320.6	72.97	36.48
320	6.74	8.1280	5.48	0.004401	325.1	73.86	36.93
330	6.82	8.3820	5.65	0.004409	329.1	74.64	37.32
340	6.91	8.6360	5.82	0.004417	333.7	75.54	37.77
350	6.98	8.8900	5.99	0.004425	337.2	76.20	38.10
360	7.05	9.1440	6.16	0.004433	340.7	76.85	38.43
370	7.10	9.3980	6.33	0.004442	343.2	77.28	38.64
380	7.15	9.6520	6.51	0.004450	345.8	77.71	38.85
390	7.21	9.9060	6.68	0.004458	348.8	78.24	39.12
400	7.24	10.1600	6.85	0.004466	350.3	78.44	39.22
410	7.28	10.4140	7.02	0.004474	352.3	78.74	39.37
420	7.31	10.6680	7.19	0.004483	353.8	78.94	39.47
430	7.34	10.9220	7.36	0.004491	355.3	79.13	39.56
440	7.36	11.1760	7.53	0.004499	356.3	79.20	39.60
450	7.37	11.4300	7.70	0.004507	356.9	79.17	39.58
460	7.38	11.6840	7.88	0.004516	357.4	79.13	39.57
470	7.37	11.9380	8.05	0.004524	356.9	78.88	39.44
480	7.36	12.1920	8.22	0.004533	356.3	78.62	39.31
490	7.30	12.4460	8.39	0.004541	353.3	77.81	38.90
500	7.27	12.7000	8.56	0.004550	351.8	77.33	38.66
510	7.21	12.9540	8.73	0.004558	348.8	76.52	38.26
520	7.15	13.2080	8.90	0.004567	345.8	75.71	37.86
530	7.07	13.4620	9.07	0.004575	341.7	74.69	37.34
540	6.97	13.7160	9.25	0.004584	336.7	73.45	36.72
550	6.88	13.9700	9.42	0.004593	332.2	72.32	36.16
560	6.78	14.2240	9.59	0.004601	327.1	71.09	35.55
570	6.64	14.4780	9.76	0.004610	320.1	69.43	34.71

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab
Test Hole	TH22-02
Sample #	T30
Depth (m)	15.2 - 15.8
Sample Date	13-Sep-22
Test Date	16-Oct-22
Technician	RSA

Tube Extraction

Recovery (mm) 550

15.75 m 15.59 m 15.49 m 15.39 m

Bottom - 15.8 m **Top - 15.3 m**

Toss	Qu Bulk	Oedometer	PP/TV Visual Moisture	Keep
40 mm	160 mm	100 mm	100 mm	150 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<10 mm diam.)	
Color	brown
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.60
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	58.8

Pocket Penetrometer

Reading	**1**	1.50
	2	1.50
	3	1.60
	Average	1.53
Undrained Shear Strength (kPa)		75.2

Moisture Content

Tare ID	D11
Mass tare (g)	9.1
Mass wet + tare (g)	362.6
Mass dry + tare (g)	242.2
Moisture %	51.7%

Unit Weight

Bulk Weight (g)		1028.7
Length (mm)	**1**	146.30
	2	147.73
	3	147.55
	4	146.70
Average Length (m)		0.147
Diam. (mm)	**1**	73.19
	2	73.19
	3	73.10
	4	73.14
Average Diameter (m)		0.073
Volume (m^3)		6.18E-04
Bulk Unit Weight (kN/m^3)		16.3
Bulk Unit Weight (pcf)		103.9
Dry Unit Weight (kN/m^3)		10.8
Dry Unit Weight (pcf)		68.5

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Test Hole	TH22-02
Sample #	T30
Depth (m)	15.2 - 15.8
Sample Date	2022-09-13
Test Date	2022-10-16
Technician	RSA

Unconfined Strength

	kPa	ksf
Max q_u	132.8	2.8
Max S_u	66.4	1.4

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), brown, moist, stiff, high plasticity

Length	147.1	(mm)
Diameter	73.2	(mm)
L/D Ratio	2.0	
Initial Area	0.00420	(m^2)
Load Rate	1.00	(%/min)

Moisture %	52%	
Bulk Unit Wt.	16.3	(kN/m^3)
Dry Unit Wt.	10.8	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	kPa	ksf
0.60	58.8	1.23
Vane Size		
m		

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	kPa	ksf
	1.50	73.6	1.54
	1.50	73.6	1.54
	1.60	78.5	1.64
Average	**1.53**	**75.2**	**1.57**

Failure Geometry

Sketch:

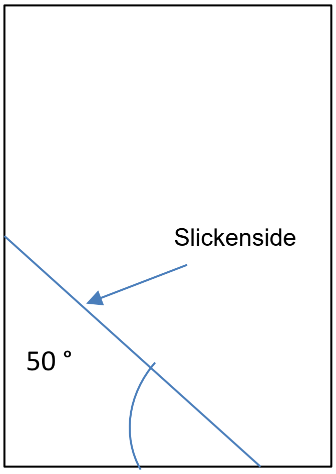
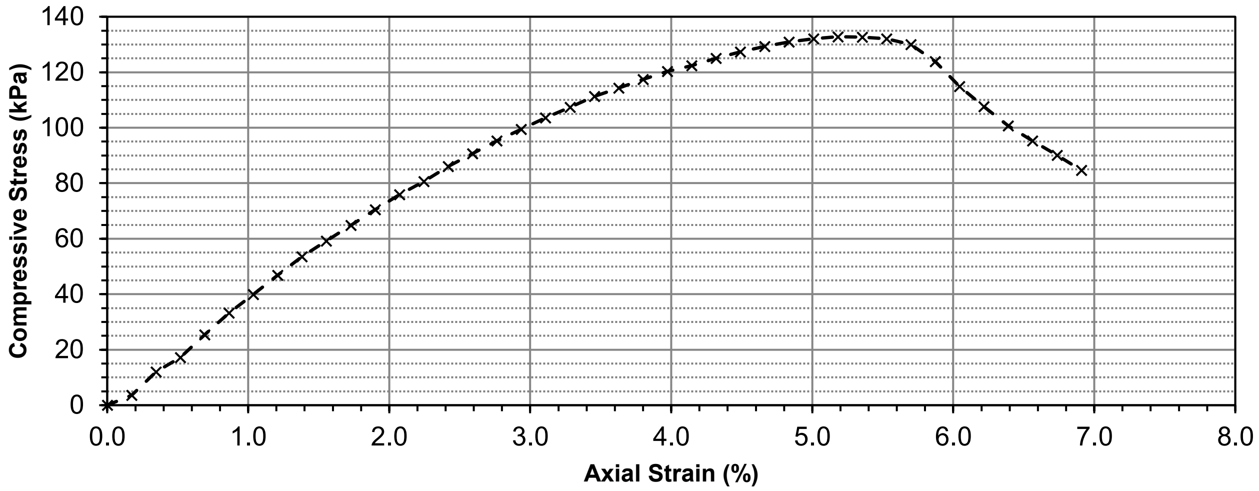


Photo:

Unconfined Compressive Strength
ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.29	0.0000	0.00	0.004203	0.0	0.00	0.00
10	0.59	0.2540	0.17	0.004210	15.1	3.59	1.80
20	1.30	0.5080	0.35	0.004218	50.9	12.07	6.03
30	1.73	0.7620	0.52	0.004225	72.6	17.18	8.59
40	2.42	1.0160	0.69	0.004232	107.4	25.37	12.68
50	3.09	1.2700	0.86	0.004240	141.1	33.29	16.64
60	3.65	1.5240	1.04	0.004247	169.4	39.87	19.94
70	4.24	1.7780	1.21	0.004255	199.1	46.79	23.40
80	4.82	2.0320	1.38	0.004262	228.3	53.57	26.79
90	5.30	2.2860	1.55	0.004270	252.5	59.14	29.57
100	5.79	2.5400	1.73	0.004277	277.2	64.81	32.41
110	6.28	2.7940	1.90	0.004285	301.9	70.47	35.23
120	6.75	3.0480	2.07	0.004292	325.6	75.86	37.93
130	7.17	3.3020	2.25	0.004300	346.8	80.65	40.33
140	7.64	3.5560	2.42	0.004307	370.5	86.01	43.00
150	8.05	3.8100	2.59	0.004315	391.1	90.64	45.32
160	8.46	4.0640	2.76	0.004323	411.8	95.26	47.63
170	8.83	4.3180	2.94	0.004330	430.4	99.40	49.70
180	9.20	4.5720	3.11	0.004338	449.1	103.52	51.76
190	9.55	4.8260	3.28	0.004346	466.7	107.40	53.70
200	9.90	5.0800	3.45	0.004354	484.4	111.26	55.63
210	10.18	5.3340	3.63	0.004361	498.5	114.30	57.15
220	10.47	5.5880	3.80	0.004369	513.1	117.44	58.72
230	10.74	5.8420	3.97	0.004377	526.7	120.33	60.17

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	10.94	6.0960	4.14	0.004385	536.8	122.42	61.21
250	11.19	6.3500	4.32	0.004393	549.4	125.07	62.53
260	11.41	6.6040	4.49	0.004401	560.5	127.36	63.68
270	11.60	6.8580	4.66	0.004409	570.1	129.30	64.65
280	11.76	7.1120	4.84	0.004417	578.1	130.89	65.45
290	11.88	7.3660	5.01	0.004425	584.2	132.02	66.01
300	11.97	7.6200	5.18	0.004433	588.7	132.81	66.40
310	11.98	7.8740	5.35	0.004441	589.2	132.68	66.34
320	11.95	8.1280	5.53	0.004449	587.7	132.10	66.05
330	11.78	8.3820	5.70	0.004457	579.1	129.93	64.97
340	11.26	8.6360	5.87	0.004465	552.9	123.82	61.91
350	10.49	8.8900	6.04	0.004474	514.1	114.92	57.46
360	9.86	9.1440	6.22	0.004482	482.4	107.62	53.81
370	9.26	9.3980	6.39	0.004490	452.1	100.69	50.35
380	8.79	9.6520	6.56	0.004498	428.4	95.24	47.62
390	8.34	9.9060	6.74	0.004507	405.7	90.03	45.02
400	7.87	10.1600	6.91	0.004515	382.1	84.62	42.31

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab
Test Hole	TH22-02
Sample #	T33
Depth (m)	9.1 - 9.8
Sample Date	12-Sep-22
Test Date	26-Sep-22
Technician	RSA

Tube Extraction

Recovery (mm) 535

Bottom - 9.8 m | 9.68 m | 9.54 m | 9.44 m | 9.26 m | **Top - 9.2 m**

Keep	PP/TV Visual/MC	Qu Bulk	Oedometer	Toss
135 mm	100 mm	185 mm	95 mm	20 mm

Visual Classification

Material	CLAY
Composition	silty
trace sand	
trace gravel (<20 mm diam.)	
trace silt inclusions (<5mm diam.)	
Color	dark brown
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.35
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	34.3

Pocket Penetrometer

Reading	**1**	0.90
	2	0.90
	3	1.00
	Average	0.93
Undrained Shear Strength (kPa)		45.8

Moisture Content

Tare ID	PC9
Mass tare (g)	8.6
Mass wet + tare (g)	370.6
Mass dry + tare (g)	239.8
Moisture %	56.6%

Unit Weight

Bulk Weight (g)		1111.2
Length (mm)	**1**	151.70
	2	151.80
	3	151.93
	4	152.44
Average Length (m)		0.152
Diam. (mm)	**1**	72.83
	2	72.65
	3	72.64
	4	72.61
Average Diameter (m)		0.073
Volume (m^3)		6.31E-04
Bulk Unit Weight (kN/m^3)		17.3
Bulk Unit Weight (pcf)		110.0
Dry Unit Weight (kN/m^3)		11.0
Dry Unit Weight (pcf)		70.3

Unconfined Compressive Strength

ASTM D2166

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Test Hole	TH22-02
Sample #	T33
Depth (m)	9.1 - 9.8
Sample Date	2022-09-12
Test Date	2022-11-01
Technician	RSA

Unconfined Strength

	kPa	ksf
Max q_u	52.4	1.1
Max S_u	26.2	0.5

Specimen Data

Description CLAY - silty, trace sand, trace gravel (<20 mm diam.), trace silt inclusions (<5mm diam.), dark brown, moist, firm, high plasticity

Length	152.0	(mm)	**Moisture %**	57%	
Diameter	72.7	(mm)	**Bulk Unit Wt.**	17.3	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	11.0	(kN/m^3)
Initial Area	0.00415	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	kPa	ksf
0.35	34.3	0.72
Vane Size		
m		

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	kPa	ksf
	0.90	44.1	0.92
	0.90	44.1	0.92
	1.00	49.1	1.02
Average	**0.93**	**45.8**	**0.96**

Failure Geometry

Sketch:

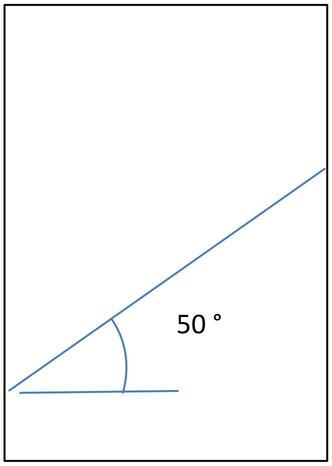


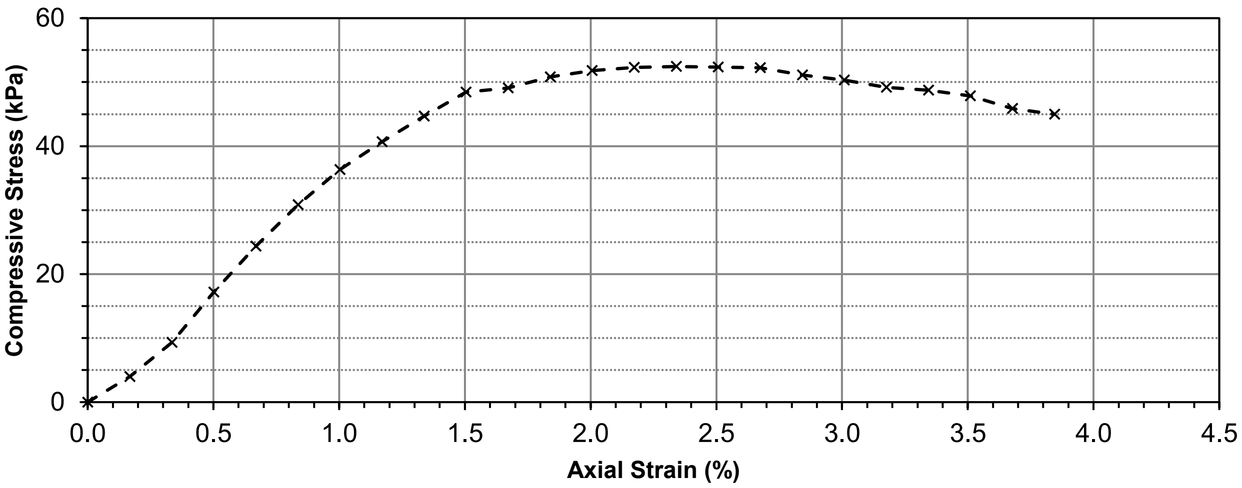
Photo:

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.24	0.0000	0.00	0.004149	0.0	0.00	0.00
10	0.57	0.2540	0.17	0.004156	16.6	4.00	2.00
20	1.01	0.5080	0.33	0.004163	38.8	9.32	4.66
30	1.66	0.7620	0.50	0.004170	71.6	17.16	8.58
40	2.26	1.0160	0.67	0.004177	101.8	24.38	12.19
50	2.80	1.2700	0.84	0.004184	129.0	30.84	15.42
60	3.26	1.5240	1.00	0.004191	152.2	36.32	18.16
70	3.63	1.7780	1.17	0.004198	170.9	40.70	20.35
80	3.97	2.0320	1.34	0.004205	188.0	44.71	22.35
90	4.29	2.2860	1.50	0.004212	204.1	48.46	24.23
100	4.35	2.5400	1.67	0.004220	207.2	49.09	24.55
110	4.50	2.7940	1.84	0.004227	214.7	50.80	25.40
120	4.59	3.0480	2.01	0.004234	219.3	51.78	25.89
130	4.64	3.3020	2.17	0.004241	221.8	52.29	26.15
140	4.66	3.5560	2.34	0.004248	222.8	52.44	26.22
150	4.66	3.8100	2.51	0.004256	222.8	52.35	26.17
160	4.66	4.0640	2.67	0.004263	222.8	52.26	26.13
170	4.57	4.3180	2.84	0.004270	218.2	51.11	25.55
180	4.51	4.5720	3.01	0.004278	215.2	50.31	25.16
190	4.42	4.8260	3.18	0.004285	210.7	49.17	24.58
200	4.39	5.0800	3.34	0.004293	209.2	48.73	24.36
210	4.32	5.3340	3.51	0.004300	205.6	47.82	23.91
220	4.16	5.5880	3.68	0.004307	197.6	45.87	22.93
230	4.09	5.8420	3.84	0.004315	194.1	44.97	22.49

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

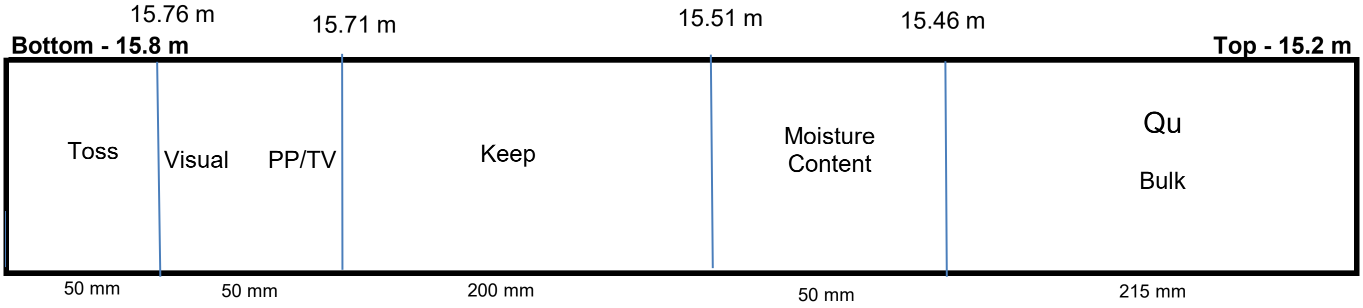
Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Test Hole	TH22-03
Sample #	T48
Depth (m)	15.2 - 15.8
Sample Date	12-Sep-22
Test Date	16-Oct-22
Technician	RSA

Tube Extraction

Recovery (mm) 635



Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions (<10 mm diam.)

Color	brown
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.85
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	83.4

Pocket Penetrometer

Reading	**1**	2.60
	2	2.40
	3	3.00
	Average	2.67
Undrained Shear Strength (kPa)		130.8

Moisture Content

Tare ID	Z72
Mass tare (g)	6.7
Mass wet + tare (g)	223.9
Mass dry + tare (g)	175.9
Moisture %	28.4%

Unit Weight

Bulk Weight (g)		1178.4
Length (mm)	**1**	150.11
	2	149.76
	3	149.76
	4	150.17
Average Length (m)		0.150
Diam. (mm)	**1**	73.12
	2	72.91
	3	73.04
	4	72.06
Average Diameter (m)		0.073
Volume (m^3)		6.24E-04
Bulk Unit Weight (kN/m^3)		18.5
Bulk Unit Weight (pcf)		117.9
Dry Unit Weight (kN/m^3)		14.4
Dry Unit Weight (pcf)		91.9

Unconfined Compressive Strength

ASTM D2166

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Test Hole	TH22-03
Sample #	T48
Depth (m)	15.2 - 15.8
Sample Date	12-Sep-22
Test Date	16-Oct-22
Technician	RSA

Unconfined Strength

	kPa	ksf
Max q_u	78.0	1.6
Max S_u	39.0	0.8

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), brown, moist, stiff, high plasticity

Length	150.0	(mm)
Diameter	72.8	(mm)
L/D Ratio	2.1	
Initial Area	0.00416	(m^2)
Load Rate	1.00	(%/min)

Moisture %	28%	
Bulk Unit Wt.	18.5	(kN/m^3)
Dry Unit Wt.	14.4	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.85	83.4	1.74
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	2.60	127.5	2.66
	2.40	117.7	2.46
	3.00	147.2	3.07
Average	**2.67**	**130.8**	**2.73**

Failure Geometry

Sketch:

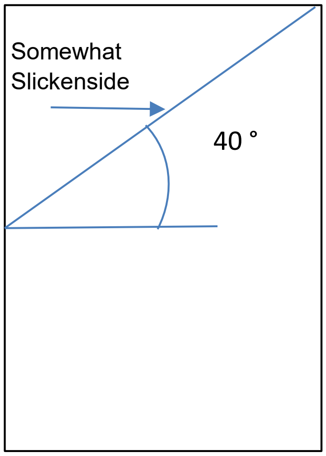


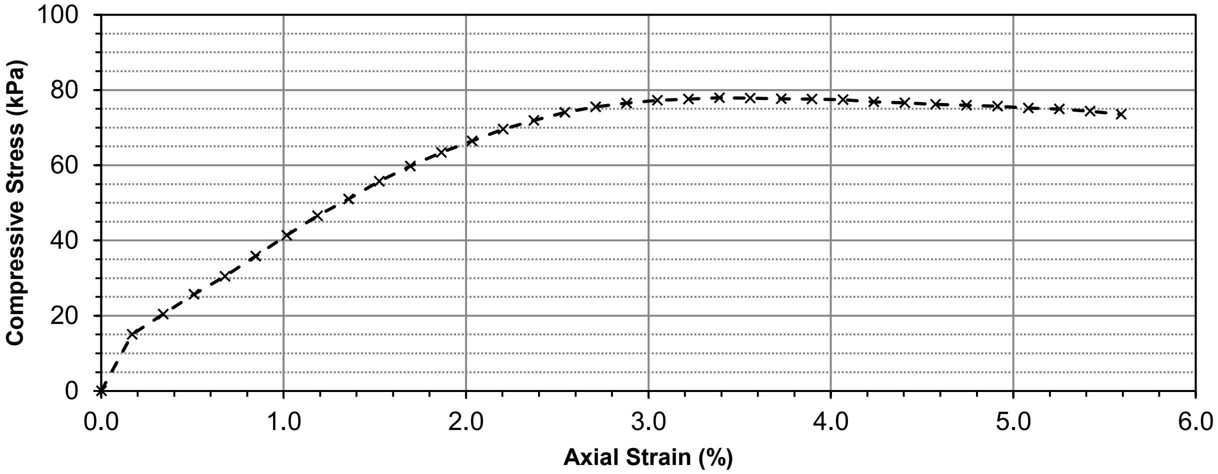
Photo:

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.28	0.0000	0.00	0.004160	0.0	0.00	0.00
10	1.52	0.2540	0.17	0.004168	62.5	15.00	7.50
20	1.97	0.5080	0.34	0.004175	85.2	20.40	10.20
30	2.41	0.7620	0.51	0.004182	107.4	25.67	12.84
40	2.81	1.0160	0.68	0.004189	127.5	30.44	15.22
50	3.26	1.2700	0.85	0.004196	150.2	35.80	17.90
60	3.73	1.5240	1.02	0.004203	173.9	41.37	20.69
70	4.17	1.7780	1.19	0.004210	196.1	46.57	23.28
80	4.55	2.0320	1.36	0.004218	215.2	51.03	25.51
90	4.95	2.2860	1.52	0.004225	235.4	55.71	27.86
100	5.30	2.5400	1.69	0.004232	253.0	59.79	29.89
110	5.61	2.7940	1.86	0.004239	268.6	63.37	31.68
120	5.88	3.0480	2.03	0.004247	282.3	66.46	33.23
130	6.15	3.3020	2.20	0.004254	295.9	69.55	34.77
140	6.36	3.5560	2.37	0.004262	306.5	71.91	35.96
150	6.55	3.8100	2.54	0.004269	316.0	74.03	37.01
160	6.69	4.0640	2.71	0.004276	323.1	75.55	37.78
170	6.78	4.3180	2.88	0.004284	327.6	76.48	38.24
180	6.86	4.5720	3.05	0.004291	331.7	77.28	38.64
190	6.90	4.8260	3.22	0.004299	333.7	77.62	38.81
200	6.94	5.0800	3.39	0.004306	335.7	77.95	38.98
210	6.94	5.3340	3.56	0.004314	335.7	77.81	38.91
220	6.94	5.5880	3.73	0.004322	335.7	77.68	38.84
230	6.94	5.8420	3.90	0.004329	335.7	77.54	38.77

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	6.94	6.0960	4.07	0.004337	335.7	77.40	38.70
250	6.90	6.3500	4.23	0.004344	333.7	76.80	38.40
260	6.89	6.6040	4.40	0.004352	333.2	76.55	38.28
270	6.87	6.8580	4.57	0.004360	332.2	76.18	38.09
280	6.86	7.1120	4.74	0.004368	331.7	75.93	37.97
290	6.85	7.3660	4.91	0.004375	331.1	75.68	37.84
300	6.82	7.6200	5.08	0.004383	329.6	75.20	37.60
310	6.81	7.8740	5.25	0.004391	329.1	74.95	37.48
320	6.77	8.1280	5.42	0.004399	327.1	74.36	37.18
330	6.71	8.3820	5.59	0.004407	324.1	73.54	36.77

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB   R3H 0L3
Tel: 204.975.9433   Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Test Hole	TH22-03
Sample #	T51
Depth (m)	15.2 - 15.8
Sample Date	13-Sep-22
Test Date	16-Oct-22
Technician	RSA

Tube Extraction

Recovery (mm) 565

Bottom - 15.8 m	15.76 m	15.71 m	15.51 m	15.46 m	**Top - 15.3 m**
Toss	Visual PP/TV	Keep	Moisture Content	Qu Bulk	
50 mm	50 mm	200 mm	50 mm	215 mm	

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<10 mm diam.)	
Color	dark brown
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.55
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	53.9

Pocket Penetrometer

Reading	**1**	1.50
	2	1.50
	3	1.60
	Average	1.53
Undrained Shear Strength (kPa)		75.2

Moisture Content

Tare ID	P13
Mass tare (g)	8.4
Mass wet + tare (g)	200.1
Mass dry + tare (g)	138.2
Moisture %	47.7%

Unit Weight

Bulk Weight (g)		1104.1
Length (mm)	**1**	148.85
	2	149.33
	3	149.49
	4	149.23
Average Length (m)		0.149
Diam. (mm)	**1**	73.74
	2	73.46
	3	73.36
	4	73.49
Average Diameter (m)		0.074
Volume (m^3)		6.33E-04
Bulk Unit Weight (kN/m^3)		17.1
Bulk Unit Weight (pcf)		108.8
Dry Unit Weight (kN/m^3)		11.6
Dry Unit Weight (pcf)		73.7

Unconfined Compressive Strength

ASTM D2166

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Test Hole	TH22-03
Sample #	T51
Depth (m)	15.2 - 15.8
Sample Date	2022-09-13
Test Date	2022-10-16
Technician	RSA

Unconfined Strength

	kPa	**ksf**
Max q_u	116.6	2.4
Max S_u	58.3	1.2

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), dark brown, moist, stiff, high plasticity

Length	149.2	(mm)	**Moisture %**	48%	
Diameter	73.5	(mm)	**Bulk Unit Wt.**	17.1	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	11.6	(kN/m^3)
Initial Area	0.00424	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.55	53.9	1.13
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.50	73.6	1.54
	1.50	73.6	1.54
	1.60	78.5	1.64
Average	**1.53**	**75.2**	**1.57**

Failure Geometry

Sketch:

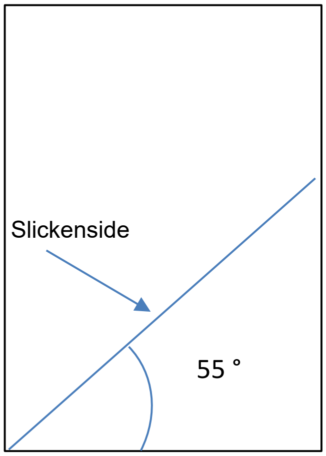
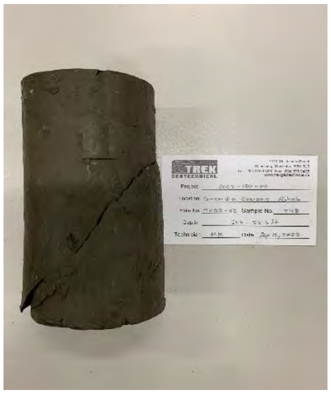


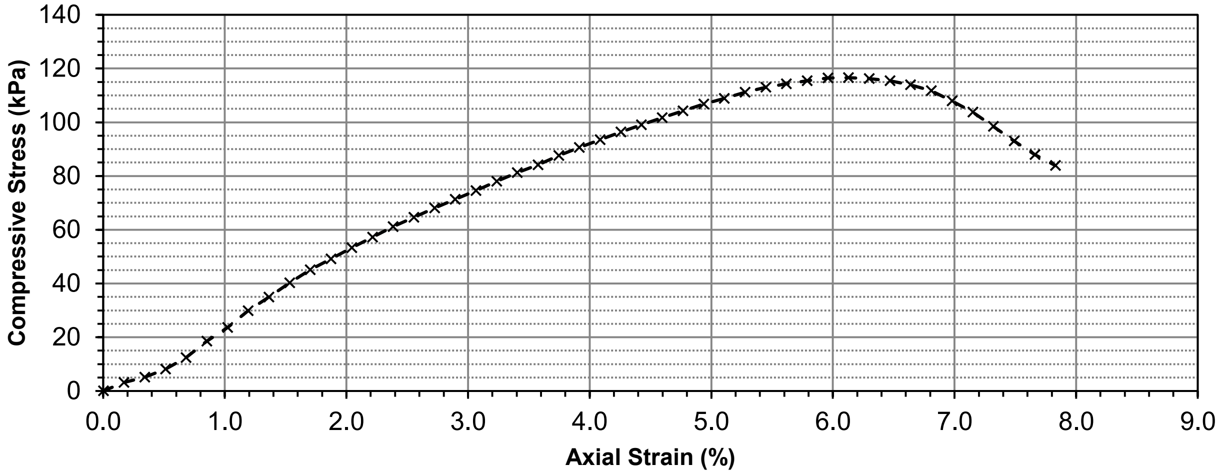
Photo:



Unconfined Compressive Strength
ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.29	0.0000	0.00	0.004244	0.0	0.00	0.00
10	0.56	0.2540	0.17	0.004252	13.6	3.20	1.60
20	0.72	0.5080	0.34	0.004259	21.7	5.09	2.54
30	0.98	0.7620	0.51	0.004266	34.8	8.15	4.08
40	1.34	1.0160	0.68	0.004273	52.9	12.38	6.19
50	1.86	1.2700	0.85	0.004281	79.1	18.49	9.24
60	2.30	1.5240	1.02	0.004288	101.3	23.63	11.81
70	2.83	1.7780	1.19	0.004296	128.0	29.80	14.90
80	3.27	2.0320	1.36	0.004303	150.2	34.91	17.45
90	3.73	2.2860	1.53	0.004310	173.4	40.23	20.11
100	4.15	2.5400	1.70	0.004318	194.6	45.06	22.53
110	4.51	2.7940	1.87	0.004325	212.7	49.18	24.59
120	4.87	3.0480	2.04	0.004333	230.8	53.28	26.64
130	5.22	3.3020	2.21	0.004340	248.5	57.25	28.62
140	5.56	3.5560	2.38	0.004348	265.6	61.09	30.55
150	5.87	3.8100	2.55	0.004356	281.2	64.57	32.29
160	6.18	4.0640	2.72	0.004363	296.9	68.04	34.02
170	6.47	4.3180	2.89	0.004371	311.5	71.27	35.63
180	6.76	4.5720	3.06	0.004379	326.1	74.48	37.24
190	7.08	4.8260	3.23	0.004386	342.2	78.03	39.01
200	7.37	5.0800	3.40	0.004394	356.9	81.21	40.61
210	7.64	5.3340	3.57	0.004402	370.5	84.16	42.08
220	7.95	5.5880	3.74	0.004409	386.1	87.56	43.78
230	8.23	5.8420	3.91	0.004417	400.2	90.60	45.30

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	8.50	6.0960	4.09	0.004425	413.8	93.51	46.76
250	8.77	6.3500	4.26	0.004433	427.4	96.42	48.21
260	9.01	6.6040	4.43	0.004441	439.5	98.97	49.48
270	9.27	6.8580	4.60	0.004449	452.6	101.74	50.87
280	9.51	7.1120	4.77	0.004457	464.7	104.27	52.14
290	9.75	7.3660	4.94	0.004465	476.8	106.79	53.40
300	9.95	7.6200	5.11	0.004473	486.9	108.86	54.43
310	10.17	7.8740	5.28	0.004481	498.0	111.14	55.57
320	10.35	8.1280	5.45	0.004489	507.1	112.96	56.48
330	10.49	8.3820	5.62	0.004497	514.1	114.32	57.16
340	10.61	8.6360	5.79	0.004505	520.2	115.46	57.73
350	10.72	8.8900	5.96	0.004513	525.7	116.48	58.24
360	10.75	9.1440	6.13	0.004521	527.2	116.60	58.30
370	10.74	9.3980	6.30	0.004530	526.7	116.28	58.14
380	10.68	9.6520	6.47	0.004538	523.7	115.40	57.70
390	10.57	9.9060	6.64	0.004546	518.1	113.97	56.99
400	10.39	10.1600	6.81	0.004554	509.1	111.77	55.89
410	10.06	10.4140	6.98	0.004563	492.4	107.92	53.96
420	9.70	10.6680	7.15	0.004571	474.3	103.76	51.88
430	9.24	10.9220	7.32	0.004580	451.1	98.50	49.25
440	8.76	11.1760	7.49	0.004588	426.9	93.05	46.53
450	8.31	11.4300	7.66	0.004596	404.2	87.94	43.97
460	7.95	11.6840	7.83	0.004605	386.1	83.84	41.92

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Test Hole	TH22-04
Sample #	T60
Depth (m)	6.1 - 6.7
Sample Date	13-Sep-22
Test Date	16-Oct-22
Technician	RSA

Tube Extraction

Recovery (mm) 625 (overpush)

Bottom - 6.7 m	6.62 m	6.48 m	6.32 m **Top - 6.1 m**
Moisture Content	PP/TV Visual	Qu Bulk	Keep
100 mm	140 mm	160 mm	225 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<5 mm diam.)	
trace gravel (<10 mm)	
Color	dark brown
Moisture	moist
Consistency	firm to stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.50
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	49.0

Pocket Penetrometer

Reading	**1**	1.00
	2	1.30
	3	1.10
	Average	1.13
Undrained Shear Strength (kPa)		55.6

Moisture Content

Tare ID	H12
Mass tare (g)	8.6
Mass wet + tare (g)	332.7
Mass dry + tare (g)	225.7
Moisture %	49.3%

Unit Weight

Bulk Weight (g)		1062.8
Length (mm)	**1**	150.87
	2	150.57
	3	150.55
	4	151.30
Average Length (m)		0.151
Diam. (mm)	**1**	73.21
	2	73.40
	3	73.27
	4	73.60
Average Diameter (m)		0.073
Volume (m^3)		6.38E-04
Bulk Unit Weight (kN/m^3)		16.3
Bulk Unit Weight (pcf)		104.1
Dry Unit Weight (kN/m^3)		10.9
Dry Unit Weight (pcf)		69.7

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Test Hole TH22-04
Sample # T60
Depth (m) 6.1 - 6.7
Sample Date 2022-09-13
Test Date 2022-10-16
Technician RSA

Unconfined Strength

	kPa	ksf
Max q_u	76.2	1.6
Max S_u	38.1	0.8

Specimen Data

Description CLAY - silty, trace silt inclusions (<5 mm diam.), trace gravel (<10 mm), dark brown, moist, firm to stiff, high plasticity

Length	150.8	(mm)
Diameter	73.4	(mm)
L/D Ratio	2.1	
Initial Area	0.00423	(m^2)
Load Rate	1.00	(%/min)

Moisture %	49%	
Bulk Unit Wt.	16.3	(kN/m^3)
Dry Unit Wt.	10.9	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.50	49.0	1.02

Vane Size
m

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.00	49.1	1.02
	1.30	63.8	1.33
	1.10	54.0	1.13
Average	**1.13**	**55.6**	**1.16**

Failure Geometry

Sketch:

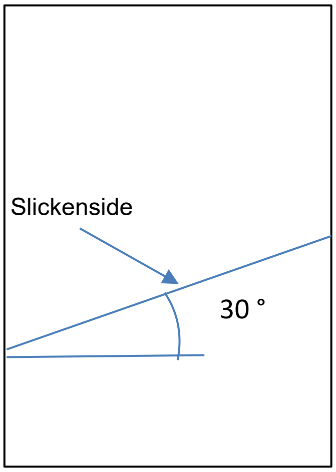


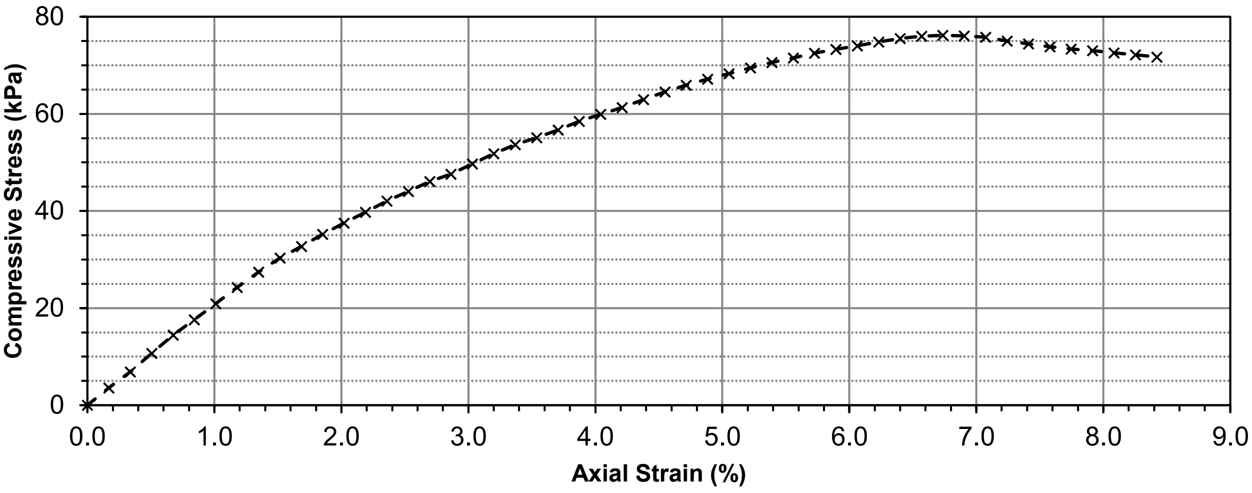
Photo:

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.29	0.0000	0.00	0.004228	0.0	0.00	0.00
10	0.59	0.2540	0.17	0.004235	15.1	3.57	1.79
20	0.87	0.5080	0.34	0.004242	29.2	6.89	3.45
30	1.19	0.7620	0.51	0.004249	45.4	10.68	5.34
40	1.51	1.0160	0.67	0.004257	61.5	14.45	7.22
50	1.78	1.2700	0.84	0.004264	75.1	17.61	8.81
60	2.06	1.5240	1.01	0.004271	89.2	20.89	10.44
70	2.35	1.7780	1.18	0.004278	103.8	24.27	12.13
80	2.62	2.0320	1.35	0.004286	117.4	27.40	13.70
90	2.87	2.2860	1.52	0.004293	130.0	30.29	15.15
100	3.08	2.5400	1.68	0.004300	140.6	32.70	16.35
110	3.30	2.7940	1.85	0.004308	151.7	35.22	17.61
120	3.50	3.0480	2.02	0.004315	161.8	37.49	18.75
130	3.70	3.3020	2.19	0.004323	171.9	39.76	19.88
140	3.90	3.5560	2.36	0.004330	182.0	42.02	21.01
150	4.08	3.8100	2.53	0.004337	191.0	44.04	22.02
160	4.26	4.0640	2.69	0.004345	200.1	46.05	23.03
170	4.40	4.3180	2.86	0.004353	207.2	47.59	23.80
180	4.59	4.5720	3.03	0.004360	216.7	49.71	24.85
190	4.78	4.8260	3.20	0.004368	226.3	51.81	25.91
200	4.95	5.0800	3.37	0.004375	234.9	53.68	26.84
210	5.08	5.3340	3.54	0.004383	241.4	55.08	27.54
220	5.23	5.5880	3.71	0.004391	249.0	56.71	28.36
230	5.39	5.8420	3.87	0.004398	257.1	58.44	29.22

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	5.53	6.0960	4.04	0.004406	264.1	59.94	29.97
250	5.66	6.3500	4.21	0.004414	270.7	61.32	30.66
260	5.81	6.6040	4.38	0.004422	278.2	62.93	31.46
270	5.96	6.8580	4.55	0.004429	285.8	64.52	32.26
280	6.09	7.1120	4.72	0.004437	292.3	65.88	32.94
290	6.21	7.3660	4.88	0.004445	298.4	67.13	33.56
300	6.32	7.6200	5.05	0.004453	303.9	68.25	34.13
310	6.44	7.8740	5.22	0.004461	310.0	69.49	34.74
320	6.55	8.1280	5.39	0.004469	315.5	70.61	35.30
330	6.64	8.3820	5.56	0.004477	320.1	71.49	35.75
340	6.74	8.6360	5.73	0.004485	325.1	72.49	36.25
350	6.82	8.8900	5.89	0.004493	329.1	73.26	36.63
360	6.90	9.1440	6.06	0.004501	333.2	74.02	37.01
370	6.98	9.3980	6.23	0.004509	337.2	74.78	37.39
380	7.06	9.6520	6.40	0.004517	341.2	75.54	37.77
390	7.11	9.9060	6.57	0.004525	343.7	75.96	37.98
400	7.14	10.1600	6.74	0.004533	345.3	76.16	38.08
410	7.14	10.4140	6.90	0.004542	345.3	76.02	38.01
420	7.13	10.6680	7.07	0.004550	344.8	75.78	37.89
430	7.07	10.9220	7.24	0.004558	341.7	74.97	37.49
440	7.03	11.1760	7.41	0.004566	339.7	74.40	37.20
450	6.99	11.4300	7.58	0.004575	337.7	73.82	36.91
460	6.96	11.6840	7.75	0.004583	336.2	73.36	36.68
470	6.94	11.9380	7.92	0.004591	335.2	73.00	36.50
480	6.91	12.1920	8.08	0.004600	333.7	72.54	36.27
490	6.89	12.4460	8.25	0.004608	332.7	72.19	36.09
500	6.86	12.7000	8.42	0.004617	331.1	71.73	35.86

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Test Hole	TH22-04
Sample #	T64
Depth (m)	12.2 - 12.8
Sample Date	13-Sep-22
Test Date	01-Nov-22
Technician	RSA

Tube Extraction

Recovery (mm) 580

Bottom - 12.8 m	12.62 m	12.52 m	12.35 m	**Top - 12.2 m**
Toss	PP/TV Visual/MC	Qu Bulk	Keep	
150 mm	100 mm	170 mm	160 mm	

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<10 mm diam.)	
Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.39
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	38.3

Pocket Penetrometer

Reading	**1**	0.90
	2	1.10
	3	1.00
	Average	1.00
Undrained Shear Strength (kPa)		49.0

Moisture Content

Tare ID	H14
Mass tare (g)	8.4
Mass wet + tare (g)	301.8
Mass dry + tare (g)	200.6
Moisture %	52.7%

Unit Weight

Bulk Weight (g)		1118.2
Length (mm)	**1**	152.25
	2	152.09
	3	152.22
	4	152.40
Average Length (m)		0.152
Diam. (mm)	**1**	73.35
	2	73.19
	3	73.30
	4	73.20
Average Diameter (m)		0.073
Volume (m^3)		6.42E-04
Bulk Unit Weight (kN/m^3)		17.1
Bulk Unit Weight (pcf)		108.8
Dry Unit Weight (kN/m^3)		11.2
Dry Unit Weight (pcf)		71.3

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength
ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Test Hole TH22-04
Sample # T64
Depth (m) 12.2 - 12.8
Sample Date 2022-09-13
Test Date 2022-11-01
Technician RSA

Unconfined Strength

	kPa	ksf
Max q_u	87.7	1.8
Max S_u	43.8	0.9

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), grey, moist, firm, high plasticity

Length	152.2	(mm)	**Moisture %**	53%	
Diameter	73.3	(mm)	**Bulk Unit Wt.**	17.1	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	11.2	(kN/m^3)
Initial Area	0.00422	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	kPa	ksf
0.39	38.3	0.80
Vane Size		
m		

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	kPa	ksf
	0.90	44.1	0.92
	1.10	54.0	1.13
	1.00	49.1	1.02
Average	**1.00**	**49.1**	**1.02**

Failure Geometry

Sketch:

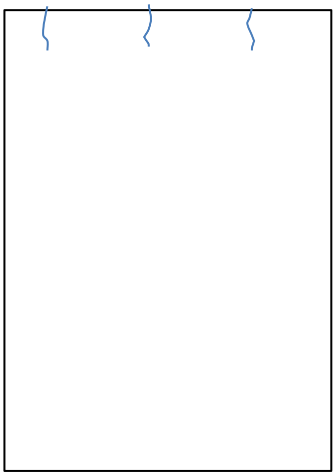


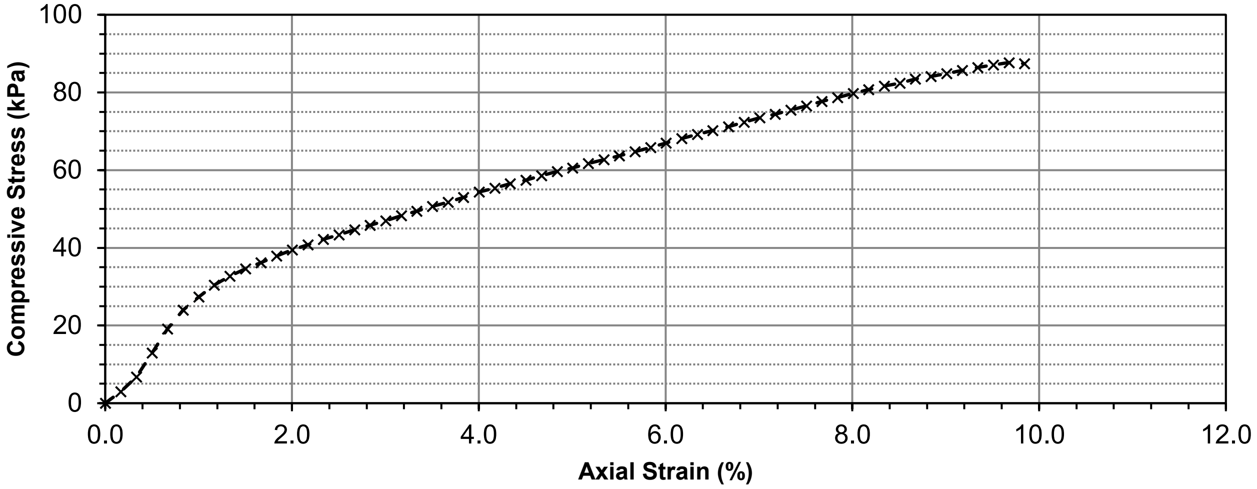
Photo:

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.39	0.0000	0.00	0.004215	0.0	0.00	0.00
10	0.64	0.2540	0.17	0.004222	12.6	2.98	1.49
20	0.96	0.5080	0.33	0.004229	28.7	6.79	3.40
30	1.48	0.7620	0.50	0.004236	54.9	12.97	6.48
40	2.00	1.0160	0.67	0.004244	81.1	19.12	9.56
50	2.41	1.2700	0.83	0.004251	101.8	23.95	11.98
60	2.70	1.5240	1.00	0.004258	116.4	27.34	13.67
70	2.96	1.7780	1.17	0.004265	129.5	30.37	15.19
80	3.16	2.0320	1.33	0.004272	139.6	32.68	16.34
90	3.33	2.2860	1.50	0.004280	148.2	34.63	17.31
100	3.47	2.5400	1.67	0.004287	155.2	36.21	18.11
110	3.62	2.7940	1.84	0.004294	162.8	37.91	18.96
120	3.76	3.0480	2.00	0.004301	169.9	39.49	19.74
130	3.88	3.3020	2.17	0.004309	175.9	40.83	20.41
140	4.00	3.5560	2.34	0.004316	182.0	42.16	21.08
150	4.11	3.8100	2.50	0.004323	187.5	43.37	21.68
160	4.23	4.0640	2.67	0.004331	193.5	44.69	22.35
170	4.33	4.3180	2.84	0.004338	198.6	45.78	22.89
180	4.44	4.5720	3.00	0.004346	204.1	46.97	23.49
190	4.56	4.8260	3.17	0.004353	210.2	48.28	24.14
200	4.67	5.0800	3.34	0.004361	215.7	49.47	24.73
210	4.78	5.3340	3.50	0.004368	221.3	50.65	25.33
220	4.88	5.5880	3.67	0.004376	226.3	51.72	25.86
230	5.00	5.8420	3.84	0.004383	232.4	53.01	26.50

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	5.13	6.0960	4.00	0.004391	238.9	54.41	27.20
250	5.22	6.3500	4.17	0.004399	243.4	55.34	27.67
260	5.33	6.6040	4.34	0.004406	249.0	56.51	28.25
270	5.42	6.8580	4.50	0.004414	253.5	57.44	28.72
280	5.53	7.1120	4.67	0.004422	259.1	58.59	29.29
290	5.63	7.3660	4.84	0.004430	264.1	59.62	29.81
300	5.72	7.6200	5.01	0.004437	268.6	60.54	30.27
310	5.83	7.8740	5.17	0.004445	274.2	61.68	30.84
320	5.93	8.1280	5.34	0.004453	279.2	62.71	31.35
330	6.03	8.3820	5.51	0.004461	284.3	63.73	31.86
340	6.13	8.6360	5.67	0.004469	289.3	64.74	32.37
350	6.24	8.8900	5.84	0.004477	294.9	65.87	32.93
360	6.35	9.1440	6.01	0.004485	300.4	66.99	33.49
370	6.46	9.3980	6.17	0.004493	305.9	68.10	34.05
380	6.57	9.6520	6.34	0.004501	311.5	69.21	34.61
390	6.67	9.9060	6.51	0.004509	316.5	70.21	35.10
400	6.77	10.1600	6.67	0.004517	321.6	71.20	35.60
410	6.88	10.4140	6.84	0.004525	327.1	72.29	36.15
420	7.00	10.6680	7.01	0.004533	333.2	73.50	36.75
430	7.09	10.9220	7.17	0.004541	337.7	74.37	37.18
440	7.20	11.1760	7.34	0.004549	343.2	75.45	37.73
450	7.31	11.4300	7.51	0.004557	348.8	76.53	38.27
460	7.43	11.6840	7.67	0.004566	354.8	77.72	38.86
470	7.53	11.9380	7.84	0.004574	359.9	78.68	39.34
480	7.64	12.1920	8.01	0.004582	365.4	79.75	39.87
490	7.74	12.4460	8.18	0.004591	370.5	80.70	40.35
500	7.84	12.7000	8.34	0.004599	375.5	81.65	40.83
510	7.92	12.9540	8.51	0.004607	379.5	82.38	41.19
520	8.03	13.2080	8.68	0.004616	385.1	83.43	41.71
530	8.11	13.4620	8.84	0.004624	389.1	84.15	42.07
540	8.19	13.7160	9.01	0.004633	393.1	84.86	42.43
550	8.28	13.9700	9.18	0.004641	397.7	85.69	42.84
560	8.36	14.2240	9.34	0.004650	401.7	86.40	43.20
570	8.44	14.4780	9.51	0.004658	405.7	87.10	43.55
580	8.51	14.7320	9.68	0.004667	409.3	87.70	43.85
590	8.50	14.9860	9.84	0.004675	408.8	87.43	43.71

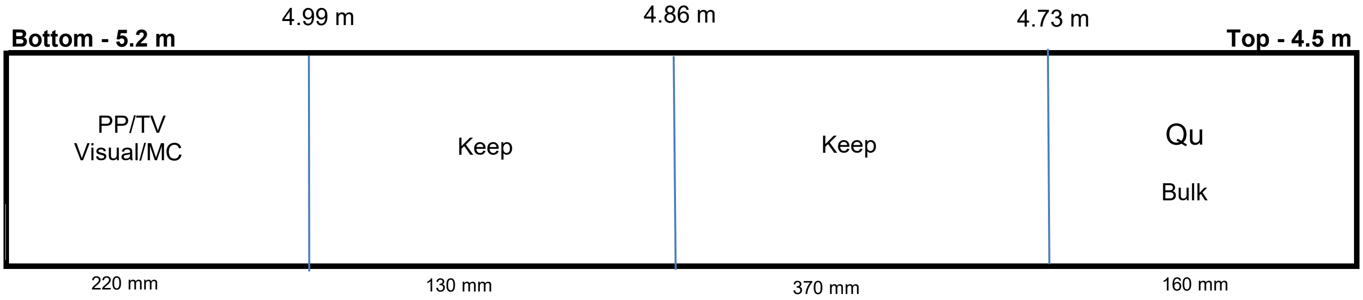
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab
Test Hole	TH22-05
Sample #	T77
Depth (m)	4.6 - 5.2
Sample Date	13-Sep-22
Test Date	01-Nov-22
Technician	AD

Tube Extraction

Recovery (mm) 640 (overpush)



Visual Classification

Material	CLAY
Composition	silty
trace precipitates (gypsum seam 5mm thick)	
Color	grey
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.76
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	74.5

Pocket Penetrometer

Reading	**1**	1.40
	2	1.40
	3	1.50
	Average	1.43
Undrained Shear Strength (kPa)		70.3

Moisture Content

Tare ID	H14
Mass tare (g)	7
Mass wet + tare (g)	318.4
Mass dry + tare (g)	211
Moisture %	52.6%

Unit Weight

Bulk Weight (g)		1085.2
Length (mm)	**1**	151.97
	2	151.73
	3	151.78
	4	151.61
Average Length (m)		0.152
Diam. (mm)	**1**	73.04
	2	73.65
	3	72.53
	4	73.58
Average Diameter (m)		0.073
Volume (m^3)		6.39E-04
Bulk Unit Weight (kN/m^3)		16.7
Bulk Unit Weight (pcf)		106.1
Dry Unit Weight (kN/m^3)		10.9
Dry Unit Weight (pcf)		69.5

Unconfined Compressive Strength

ASTM D2166

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Test Hole	TH22-05
Sample #	T77
Depth (m)	4.6 - 5.2
Sample Date	2022-09-13
Test Date	2022-11-01
Technician	AD

Unconfined Strength

	kPa	**ksf**
Max q_u	70.9	1.5
Max S_u	35.4	0.7

Specimen Data

Description CLAY - silty, trace precipitates (gypsum seam 5mm thick), grey, moist, stiff, high plasticity

Length	151.8	(mm)
Diameter	73.2	(mm)
L/D Ratio	2.1	
Initial Area	0.00421	(m^2)
Load Rate	1.00	(%/min)

Moisture %	53%	
Bulk Unit Wt.	16.7	(kN/m^3)
Dry Unit Wt.	10.9	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.76	74.5	1.56
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.40	68.7	1.43
	1.40	68.7	1.43
	1.50	73.6	1.54
Average	**1.43**	**70.3**	**1.47**

Failure Geometry

Sketch:

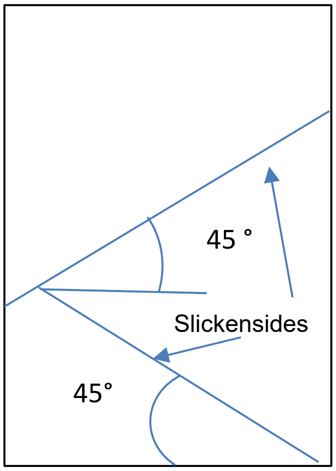


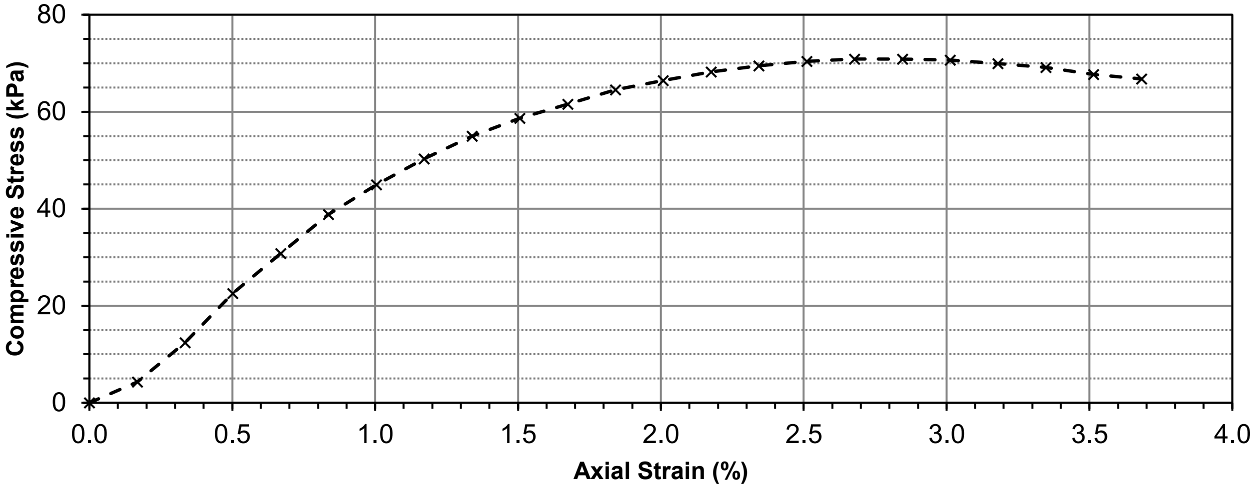
Photo:

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength
ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.34	0.0000	0.00	0.004208	0.0	0.00	0.00
10	0.70	0.2540	0.17	0.004215	18.1	4.30	2.15
20	1.38	0.5080	0.33	0.004222	52.4	12.41	6.21
30	2.23	0.7620	0.50	0.004230	95.3	22.52	11.26
40	2.93	1.0160	0.67	0.004237	130.5	30.81	15.41
50	3.61	1.2700	0.84	0.004244	164.8	38.84	19.42
60	4.13	1.5240	1.00	0.004251	191.0	44.94	22.47
70	4.59	1.7780	1.17	0.004258	214.2	50.31	25.15
80	4.99	2.0320	1.34	0.004265	234.4	54.95	27.47
90	5.31	2.2860	1.51	0.004273	250.5	58.63	29.31
100	5.57	2.5400	1.67	0.004280	263.6	61.59	30.80
110	5.83	2.7940	1.84	0.004287	276.7	64.54	32.27
120	6.00	3.0480	2.01	0.004295	285.3	66.43	33.21
130	6.16	3.3020	2.18	0.004302	293.3	68.19	34.09
140	6.28	3.5560	2.34	0.004309	299.4	69.48	34.74
150	6.37	3.8100	2.51	0.004317	303.9	70.41	35.20
160	6.42	4.0640	2.68	0.004324	306.5	70.87	35.43
170	6.43	4.3180	2.85	0.004332	307.0	70.86	35.43
180	6.42	4.5720	3.01	0.004339	306.5	70.63	35.31
190	6.37	4.8260	3.18	0.004347	303.9	69.92	34.96
200	6.31	5.0800	3.35	0.004354	300.9	69.11	34.55
210	6.20	5.3340	3.51	0.004362	295.4	67.72	33.86
220	6.13	5.5880	3.68	0.004369	291.8	66.79	33.40

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab
Test Hole	TH22-05
Sample #	T80
Depth (m)	9.1 - 9.8
Sample Date	13-Sep-22
Test Date	01-Nov-22
Technician	RSA

Tube Extraction

Recovery (mm) 625

Bottom - 9.8 m
9.6 m
9.43 m
9.24 m
Top - 9.1 m

PP/TV Visual/MC	Keep	Qu Bulk	Toss
160 mm	130 mm	190 mm	100 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<10 mm diam.)	
trace gravel (<20 mm)	
Color	grey
Moisture	moist
Consistency	firm to stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.40
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	39.2

Pocket Penetrometer

Reading	**1**	1.10
	2	1.20
	3	1.10
	Average	1.13
Undrained Shear Strength (kPa)		55.6

Moisture Content

Tare ID	D19
Mass tare (g)	8.5
Mass wet + tare (g)	330.5
Mass dry + tare (g)	225.2
Moisture %	48.6%

Unit Weight

Bulk Weight (g)		1129.6
Length (mm)	**1**	151.34
	2	151.32
	3	151.39
	4	151.40
Average Length (m)		0.151
Diam. (mm)	**1**	73.30
	2	73.57
	3	73.82
	4	73.50
Average Diameter (m)		0.074
Volume (m^3)		6.43E-04
Bulk Unit Weight (kN/m^3)		17.2
Bulk Unit Weight (pcf)		109.7
Dry Unit Weight (kN/m^3)		11.6
Dry Unit Weight (pcf)		73.8

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength
ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Test Hole TH22-05
Sample # T80
Depth (m) 9.1 - 9.8
Sample Date 2022-09-13
Test Date 2022-11-01
Technician RSA

Unconfined Strength

	kPa	ksf
Max q_u	105.8	2.2
Max S_u	52.9	1.1

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), trace gravel (<20 mm), grey, moist, firm to stiff, high plasticity

Length	151.4	(mm)	**Moisture %**	49%	
Diameter	73.5	(mm)	**Bulk Unit Wt.**	17.2	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	11.6	(kN/m^3)
Initial Area	0.00425	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.40	39.2	0.82

Vane Size
m

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.10	54.0	1.13
	1.20	58.9	1.23
	1.10	54.0	1.13
Average	**1.13**	**55.6**	**1.16**

Failure Geometry

Sketch:

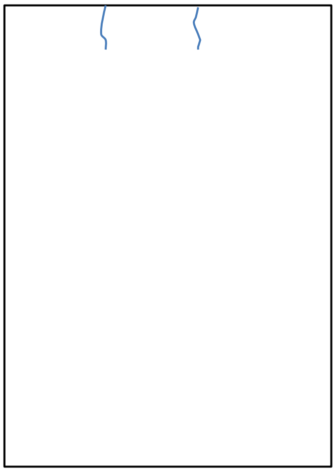


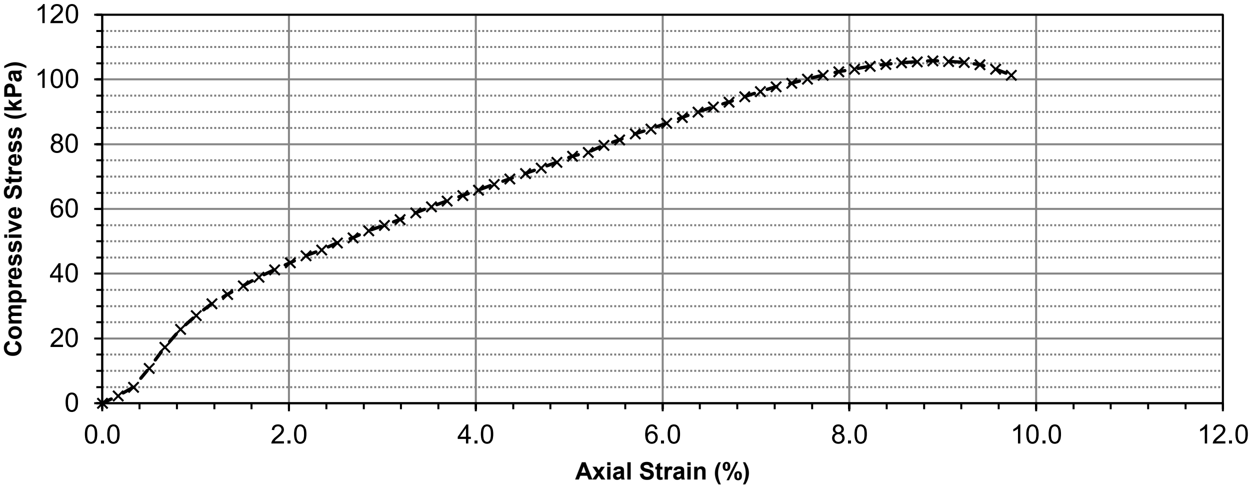
Photo:

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.36	0.0000	0.00	0.004248	0.0	0.00	0.00
10	0.55	0.2540	0.17	0.004256	9.6	2.25	1.13
20	0.78	0.5080	0.34	0.004263	21.2	4.97	2.48
30	1.27	0.7620	0.50	0.004270	45.9	10.74	5.37
40	1.83	1.0160	0.67	0.004277	74.1	17.32	8.66
50	2.30	1.2700	0.84	0.004284	97.8	22.82	11.41
60	2.67	1.5240	1.01	0.004292	116.4	27.13	13.56
70	2.98	1.7780	1.17	0.004299	132.1	30.72	15.36
80	3.23	2.0320	1.34	0.004306	144.7	33.59	16.80
90	3.47	2.2860	1.51	0.004314	156.8	36.34	18.17
100	3.70	2.5400	1.68	0.004321	168.3	38.96	19.48
110	3.90	2.7940	1.85	0.004328	178.4	41.22	20.61
120	4.09	3.0480	2.01	0.004336	188.0	43.36	21.68
130	4.29	3.3020	2.18	0.004343	198.1	45.61	22.80
140	4.45	3.5560	2.35	0.004351	206.1	47.38	23.69
150	4.64	3.8100	2.52	0.004358	215.7	49.50	24.75
160	4.79	4.0640	2.68	0.004366	223.3	51.15	25.57
170	4.98	4.3180	2.85	0.004373	232.9	53.25	26.62
180	5.14	4.5720	3.02	0.004381	240.9	55.00	27.50
190	5.30	4.8260	3.19	0.004388	249.0	56.74	28.37
200	5.49	5.0800	3.36	0.004396	258.6	58.82	29.41
210	5.66	5.3340	3.52	0.004404	267.1	60.66	30.33
220	5.83	5.5880	3.69	0.004411	275.7	62.50	31.25
230	5.99	5.8420	3.86	0.004419	283.8	64.22	32.11

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	6.14	6.0960	4.03	0.004427	291.3	65.81	32.91
250	6.31	6.3500	4.20	0.004434	299.9	67.63	33.81
260	6.47	6.6040	4.36	0.004442	308.0	69.33	34.66
270	6.63	6.8580	4.53	0.004450	316.0	71.02	35.51
280	6.79	7.1120	4.70	0.004458	324.1	72.70	36.35
290	6.96	7.3660	4.87	0.004466	332.7	74.49	37.25
300	7.13	7.6200	5.03	0.004474	341.2	76.28	38.14
310	7.25	7.8740	5.20	0.004482	347.3	77.49	38.75
320	7.46	8.1280	5.37	0.004489	357.9	79.71	39.86
330	7.62	8.3820	5.54	0.004497	365.9	81.36	40.68
340	7.80	8.6360	5.71	0.004505	375.0	83.23	41.62
350	7.95	8.8900	5.87	0.004513	382.6	84.76	42.38
360	8.12	9.1440	6.04	0.004522	391.1	86.50	43.25
370	8.29	9.3980	6.21	0.004530	399.7	88.24	44.12
380	8.46	9.6520	6.38	0.004538	408.3	89.97	44.99
390	8.62	9.9060	6.54	0.004546	416.3	91.58	45.79
400	8.77	10.1600	6.71	0.004554	423.9	93.08	46.54
410	8.93	10.4140	6.88	0.004562	432.0	94.68	47.34
420	9.09	10.6680	7.05	0.004571	440.0	96.27	48.14
430	9.24	10.9220	7.22	0.004579	447.6	97.75	48.88
440	9.36	11.1760	7.38	0.004587	453.6	98.89	49.45
450	9.49	11.4300	7.55	0.004595	460.2	100.14	50.07
460	9.62	11.6840	7.72	0.004604	466.7	101.38	50.69
470	9.73	11.9380	7.89	0.004612	472.3	102.40	51.20
480	9.82	12.1920	8.05	0.004621	476.8	103.19	51.60
490	9.92	12.4460	8.22	0.004629	481.9	104.09	52.05
500	9.99	12.7000	8.39	0.004638	485.4	104.66	52.33
510	10.06	12.9540	8.56	0.004646	488.9	105.23	52.62
520	10.10	13.2080	8.73	0.004655	490.9	105.47	52.74
530	10.15	13.4620	8.89	0.004663	493.4	105.82	52.91
540	10.15	13.7160	9.06	0.004672	493.4	105.62	52.81
550	10.14	13.9700	9.23	0.004680	492.9	105.32	52.66
560	10.09	14.2240	9.40	0.004689	490.4	104.59	52.29
570	9.98	14.4780	9.57	0.004698	484.9	103.21	51.61
580	9.82	14.7320	9.73	0.004706	476.8	101.31	50.65

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab
Test Hole	TH22-06
Sample #	T94
Depth (m)	3.0 - 3.7
Sample Date	13-Sep-22
Test Date	01-Nov-22
Technician	AD

Tube Extraction

Recovery (mm) 510

Bottom - 3.7 m	3.50 m	3.33 m	3.13 m Top - 3.1 m
Toss	Qu Bulk	Direct Shear	PP/TV Visual/MC Atterberg
60 mm	170 mm	200 mm	80 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<10mm diam.)	
Color	grey
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.72
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	70.6

Pocket Penetrometer

Reading	**1**	1.50
	2	1.50
	3	1.40
	Average	1.47
Undrained Shear Strength (kPa)		71.9

Moisture Content

Tare ID	F121
Mass tare (g)	8.6
Mass wet + tare (g)	445.6
Mass dry + tare (g)	298.8
Moisture %	50.6%

Unit Weight

Bulk Weight (g)		1142.6
Length (mm)	**1**	152.91
	2	153.15
	3	152.99
	4	152.98
Average Length (m)		0.153
Diam. (mm)	**1**	73.65
	2	72.75
	3	72.65
	4	73.25
Average Diameter (m)		0.073
Volume (m^3)		6.42E-04
Bulk Unit Weight (kN/m^3)		17.5
Bulk Unit Weight (pcf)		111.2
Dry Unit Weight (kN/m^3)		11.6
Dry Unit Weight (pcf)		73.8

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Test Hole TH22-06
Sample # T94
Depth (m) 3.0 - 3.7
Sample Date 2022-09-13
Test Date 2022-11-01
Technician AD

Unconfined Strength

	kPa	ksf
Max q_u	99.2	2.1
Max S_u	49.6	1.0

Specimen Data

Description CLAY - silty, trace silt inclusions (<10mm diam.), grey, moist, stiff, high plasticity

Length	153.0	(mm)	**Moisture %**	51%	
Diameter	73.1	(mm)	**Bulk Unit Wt.**	17.5	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	11.6	(kN/m^3)
Initial Area	0.00419	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.72	70.6	1.47
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.50	73.6	1.54
	1.50	73.6	1.54
	1.40	68.7	1.43
Average	**1.47**	**71.9**	**1.50**

Failure Geometry

Sketch:

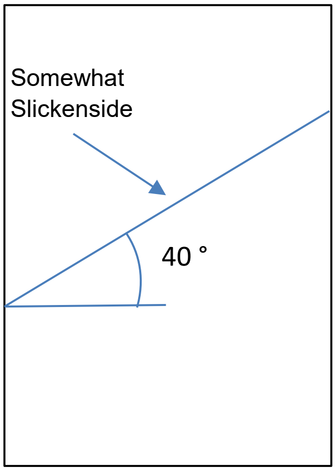


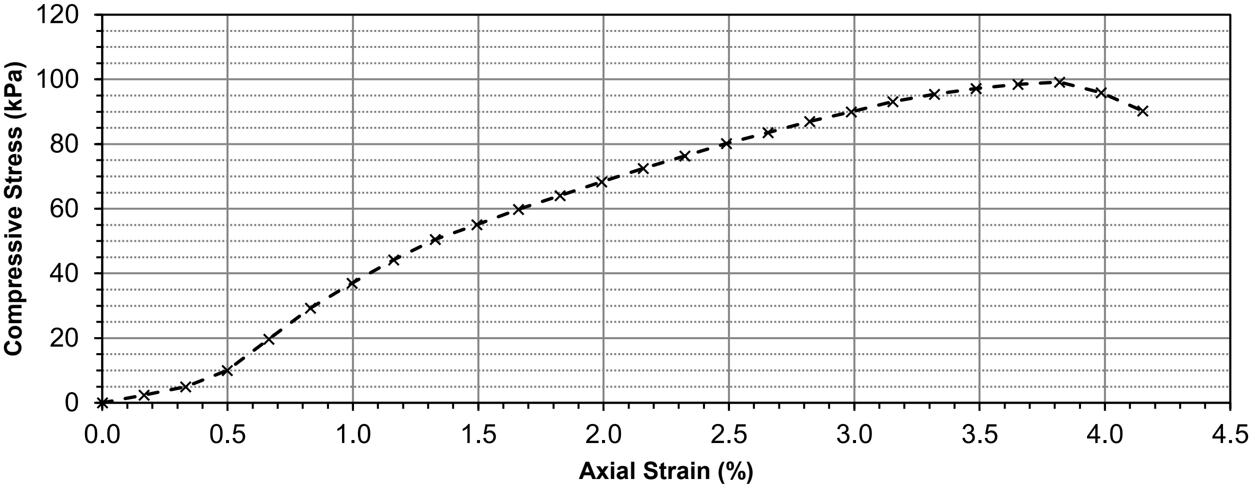
Photo:

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength
ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.42	0.0000	0.00	0.004194	0.0	0.00	0.00
10	0.62	0.2540	0.17	0.004201	10.1	2.40	1.20
20	0.83	0.5080	0.33	0.004208	20.7	4.91	2.46
30	1.26	0.7620	0.50	0.004215	42.3	10.04	5.02
40	2.07	1.0160	0.66	0.004222	83.2	19.70	9.85
50	2.88	1.2700	0.83	0.004229	124.0	29.32	14.66
60	3.53	1.5240	1.00	0.004236	156.8	37.00	18.50
70	4.14	1.7780	1.16	0.004243	187.5	44.19	22.09
80	4.68	2.0320	1.33	0.004250	214.7	50.52	25.26
90	5.07	2.2860	1.49	0.004258	234.4	55.05	27.52
100	5.48	2.5400	1.66	0.004265	255.0	59.80	29.90
110	5.85	2.7940	1.83	0.004272	273.7	64.07	32.03
120	6.22	3.0480	1.99	0.004279	292.3	68.32	34.16
130	6.58	3.3020	2.16	0.004286	310.5	72.43	36.22
140	6.92	3.5560	2.32	0.004294	327.6	76.30	38.15
150	7.26	3.8100	2.49	0.004301	344.8	80.16	40.08
160	7.56	4.0640	2.66	0.004308	359.9	83.53	41.76
170	7.87	4.3180	2.82	0.004316	375.5	87.01	43.50
180	8.14	4.5720	2.99	0.004323	389.1	90.01	45.00
190	8.42	4.8260	3.15	0.004331	403.2	93.11	46.56
200	8.63	5.0800	3.32	0.004338	413.8	95.39	47.70
210	8.80	5.3340	3.49	0.004345	422.4	97.20	48.60
220	8.92	5.5880	3.65	0.004353	428.4	98.42	49.21
230	9.00	5.8420	3.82	0.004360	432.5	99.18	49.59

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	8.73	6.0960	3.98	0.004368	418.8	95.89	47.94
250	8.26	6.3500	4.15	0.004376	395.2	90.31	45.16

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab
Test Hole	TH22-06
Sample #	T96
Depth (m)	6.1 - 6.7
Sample Date	13-Sep-22
Test Date	16-Oct-22
Technician	RSA

Tube Extraction

Recovery (mm) 555

Bottom - 6.7 m | 6.60 m | 6.55 m | 6.39 m | 6.35 m | **Top - 6.2 m**

Toss	Moisture Content Atterberg	Qu Bulk	PP/TV Visual	Keep
50 mm	50 mm	150 mm	40 mm	255 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<30 mm diam.)	
trace gravel (<20 mm)	
Color	dark brown
Moisture	moist
Consistency	firm to stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.50
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	49.0

Pocket Penetrometer

Reading	**1**	1.20
	2	1.10
	3	1.10
	Average	1.13
Undrained Shear Strength (kPa)		55.6

Moisture Content

Tare ID	AC22
Mass tare (g)	7.1
Mass wet + tare (g)	369.4
Mass dry + tare (g)	247.4
Moisture %	50.8%

Unit Weight

Bulk Weight (g)		1104.7
Length (mm)	**1**	151.51
	2	152.03
	3	152.25
	4	151.29
Average Length (m)		0.152
Diam. (mm)	**1**	72.94
	2	73.14
	3	72.66
	4	72.74
Average Diameter (m)		0.073
Volume (m^3)		6.33E-04
Bulk Unit Weight (kN/m^3)		17.1
Bulk Unit Weight (pcf)		109.0
Dry Unit Weight (kN/m^3)		11.4
Dry Unit Weight (pcf)		72.3

Unconfined Compressive Strength

ASTM D2166

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Test Hole	TH22-06
Sample #	T96
Depth (m)	6.1 - 6.7
Sample Date	2022-09-13
Test Date	2022-10-16
Technician	RSA

Unconfined Strength

	kPa	**ksf**
Max q_u	136.4	2.8
Max S_u	68.2	1.4

Specimen Data

Description CLAY - silty, trace silt inclusions (<30 mm diam.), trace gravel (<20 mm), dark brown, moist, firm to stiff, high plasticity

Length	151.8	(mm)
Diameter	72.9	(mm)
L/D Ratio	2.1	
Initial Area	0.00417	(m^2)
Load Rate	1.00	(%/min)

Moisture %	51%	
Bulk Unit Wt.	17.1	(kN/m^3)
Dry Unit Wt.	11.4	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.50	49.0	1.02

Vane Size
m

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.20	58.9	1.23
	1.10	54.0	1.13
	1.10	54.0	1.13
Average	**1.13**	**55.6**	**1.16**

Failure Geometry

Sketch:

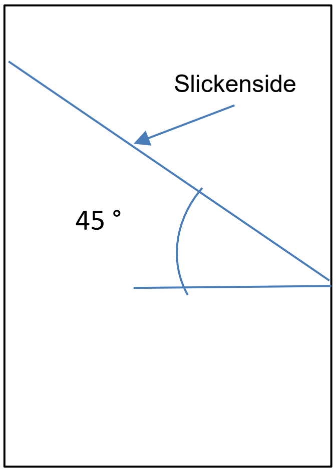
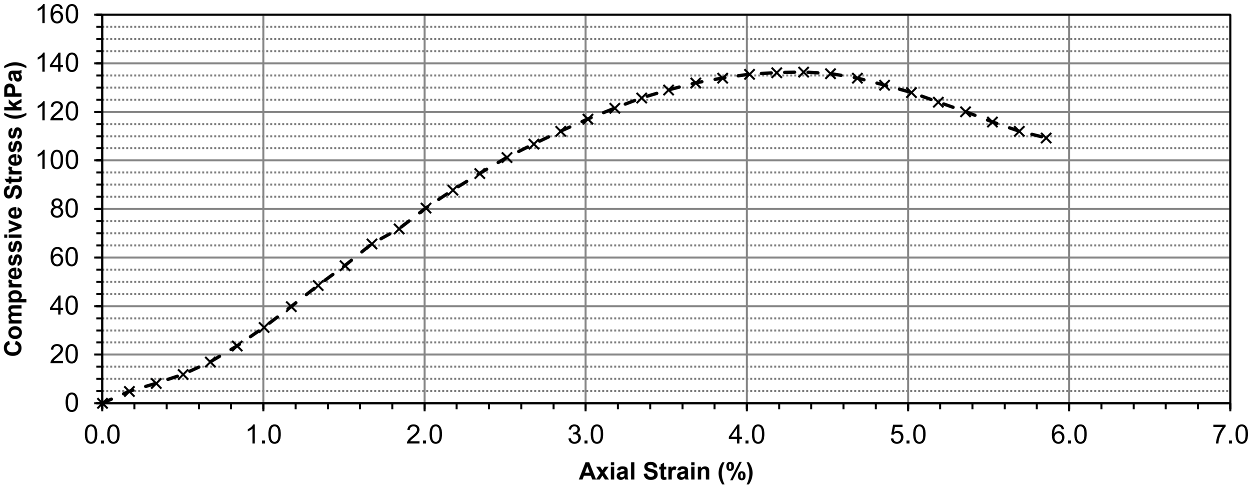


Photo:

Unconfined Compressive Strength
ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.29	0.0000	0.00	0.004170	0.0	0.00	0.00
10	0.70	0.2540	0.17	0.004177	20.7	4.95	2.47
20	0.97	0.5080	0.33	0.004184	34.3	8.19	4.10
30	1.28	0.7620	0.50	0.004192	49.9	11.90	5.95
40	1.71	1.0160	0.67	0.004199	71.6	17.05	8.52
50	2.26	1.2700	0.84	0.004206	99.3	23.61	11.80
60	2.90	1.5240	1.00	0.004213	131.6	31.23	15.61
70	3.62	1.7780	1.17	0.004220	167.8	39.77	19.89
80	4.36	2.0320	1.34	0.004227	205.1	48.53	24.26
90	5.05	2.2860	1.51	0.004234	239.9	56.66	28.33
100	5.82	2.5400	1.67	0.004241	278.7	65.71	32.86
110	6.35	2.7940	1.84	0.004249	305.4	71.89	35.95
120	7.08	3.0480	2.01	0.004256	342.2	80.41	40.21
130	7.72	3.3020	2.18	0.004263	374.5	87.84	43.92
140	8.31	3.5560	2.34	0.004271	404.2	94.66	47.33
150	8.88	3.8100	2.51	0.004278	433.0	101.21	50.60
160	9.37	4.0640	2.68	0.004285	457.7	106.80	53.40
170	9.83	4.3180	2.85	0.004293	480.8	112.02	56.01
180	10.28	4.5720	3.01	0.004300	503.5	117.10	58.55
190	10.68	4.8260	3.18	0.004307	523.7	121.58	60.79
200	11.05	5.0800	3.35	0.004315	542.3	125.69	62.84
210	11.36	5.3340	3.51	0.004322	558.0	129.09	64.54
220	11.62	5.5880	3.68	0.004330	571.1	131.89	65.94
230	11.82	5.8420	3.85	0.004337	581.1	133.98	66.99

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	11.97	6.0960	4.02	0.004345	588.7	135.49	67.75
250	12.05	6.3500	4.18	0.004353	592.7	136.18	68.09
260	12.09	6.6040	4.35	0.004360	594.8	136.40	68.20
270	12.05	6.8580	4.52	0.004368	592.7	135.70	67.85
280	11.92	7.1120	4.69	0.004376	586.2	133.97	66.98
290	11.69	7.3660	4.85	0.004383	574.6	131.09	65.54
300	11.44	7.6200	5.02	0.004391	562.0	127.99	63.99
310	11.11	7.8740	5.19	0.004399	545.4	123.98	61.99
320	10.79	8.1280	5.36	0.004406	529.2	120.10	60.05
330	10.44	8.3820	5.52	0.004414	511.6	115.89	57.95
340	10.12	8.6360	5.69	0.004422	495.5	112.04	56.02
350	9.89	8.8900	5.86	0.004430	483.9	109.23	54.61

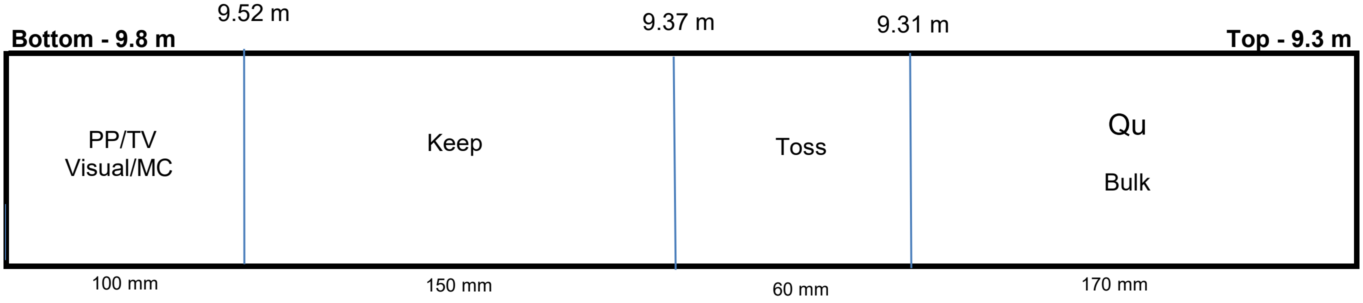
TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab
Test Hole	TH22-06
Sample #	T98
Depth (m)	9.1 - 9.8
Sample Date	13-Sep-22
Test Date	01-Nov-22
Technician	AD

Tube Extraction

Recovery (mm) 480



Visual Classification

Material	CLAY (TILL)
Composition	silty
trace sand	
trace gravel (<25 mm diam.)	
trace silty sand pockets	
Color	grey
Moisture	moist
Consistency	soft to firm
Plasticity	intermediate to high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.34
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	33.3

Pocket Penetrometer

Reading	**1**	0.60
	2	0.60
	3	0.70
	Average	0.63
Undrained Shear Strength (kPa)		31.1

Moisture Content

Tare ID	Z120
Mass tare (g)	8.8
Mass wet + tare (g)	313.1
Mass dry + tare (g)	225
Moisture %	40.7%

Unit Weight

Bulk Weight (g)		1208.2
Length (mm)	**1**	150.50
	2	149.90
	3	149.77
	4	150.44
Average Length (m)		0.150
Diam. (mm)	**1**	72.63
	2	72.34
	3	71.70
	4	71.03
Average Diameter (m)		0.072
Volume (m^3)		6.10E-04
Bulk Unit Weight (kN/m^3)		19.4
Bulk Unit Weight (pcf)		123.6
Dry Unit Weight (kN/m^3)		13.8
Dry Unit Weight (pcf)		87.8

Unconfined Compressive Strength
ASTM D2166

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Test Hole	TH22-06
Sample #	T98
Depth (m)	9.1 - 9.8
Sample Date	2022-09-13
Test Date	2022-11-01
Technician	AD

Unconfined Strength

	kPa	ksf
Max q_u	39.5	0.8
Max S_u	19.7	0.4

Specimen Data

Description CLAY (TILL) - silty, trace sand, trace gravel (<25 mm diam.), trace silty sand pockets, grey, moist, soft to firm, intermediate to high plasticity

Length	150.2	(mm)	**Moisture %**	41%	
Diameter	71.9	(mm)	**Bulk Unit Wt.**	19.4	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	13.8	(kN/m^3)
Initial Area	0.00406	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.34	33.3	0.70
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	0.60	29.4	0.61
	0.60	29.4	0.61
	0.70	34.3	0.72
Average	**0.63**	**31.1**	**0.65**

Failure Geometry

Sketch:

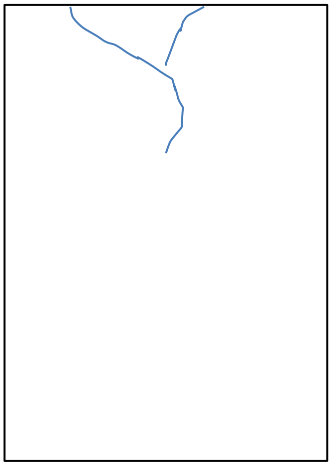


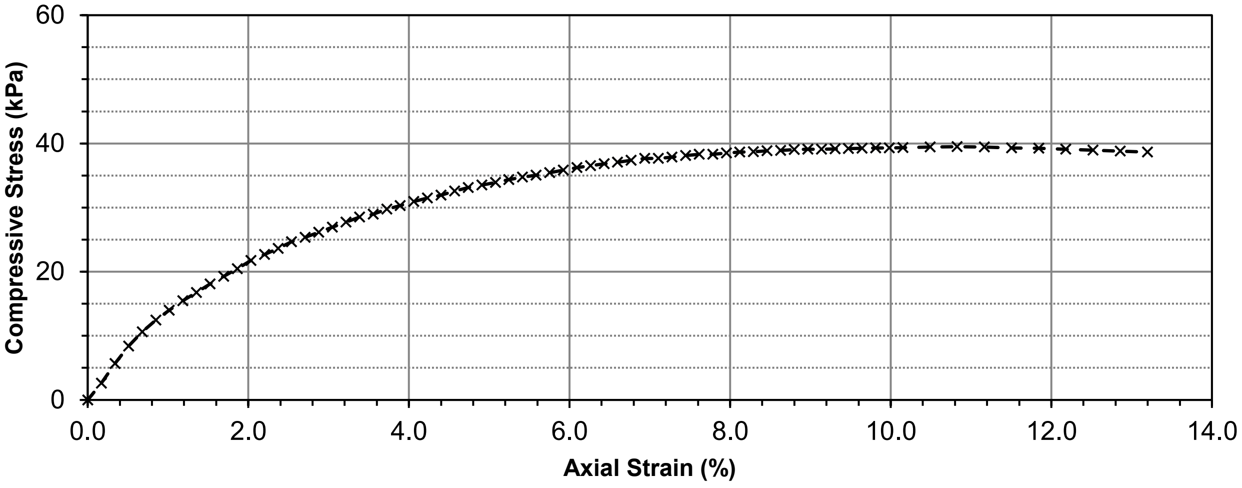
Photo:

Unconfined Compressive Strength

ASTM D2166

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Concordia Overpass Rehab

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.35	0.0000	0.00	0.004063	0.0	0.00	0.00
10	0.56	0.2540	0.17	0.004070	10.6	2.60	1.30
20	0.81	0.5080	0.34	0.004077	23.2	5.69	2.84
30	1.03	0.7620	0.51	0.004084	34.3	8.39	4.20
40	1.21	1.0160	0.68	0.004091	43.3	10.60	5.30
50	1.36	1.2700	0.85	0.004098	50.9	12.42	6.21
60	1.49	1.5240	1.01	0.004105	57.5	14.00	7.00
70	1.61	1.7780	1.18	0.004112	63.5	15.45	7.72
80	1.72	2.0320	1.35	0.004119	69.1	16.77	8.38
90	1.83	2.2860	1.52	0.004126	74.6	18.08	9.04
100	1.93	2.5400	1.69	0.004133	79.6	19.27	9.63
110	2.03	2.7940	1.86	0.004140	84.7	20.45	10.23
120	2.14	3.0480	2.03	0.004147	90.2	21.75	10.88
130	2.22	3.3020	2.20	0.004154	94.3	22.69	11.34
140	2.30	3.5560	2.37	0.004162	98.3	23.62	11.81
150	2.39	3.8100	2.54	0.004169	102.8	24.66	12.33
160	2.45	4.0640	2.71	0.004176	105.8	25.35	12.67
170	2.52	4.3180	2.88	0.004183	109.4	26.15	13.07
180	2.59	4.5720	3.04	0.004191	112.9	26.94	13.47
190	2.66	4.8260	3.21	0.004198	116.4	27.74	13.87
200	2.73	5.0800	3.38	0.004205	120.0	28.53	14.26
210	2.77	5.3340	3.55	0.004213	122.0	28.95	14.48
220	2.84	5.5880	3.72	0.004220	125.5	29.74	14.87
230	2.89	5.8420	3.89	0.004228	128.0	30.28	15.14

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Concordia Overpass Rehab

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	2.95	6.0960	4.06	0.004235	131.0	30.94	15.47
250	3.00	6.3500	4.23	0.004242	133.6	31.48	15.74
260	3.04	6.6040	4.40	0.004250	135.6	31.90	15.95
270	3.10	6.8580	4.57	0.004257	138.6	32.56	16.28
280	3.15	7.1120	4.74	0.004265	141.1	33.09	16.54
290	3.19	7.3660	4.91	0.004273	143.1	33.50	16.75
300	3.23	7.6200	5.07	0.004280	145.2	33.91	16.96
310	3.27	7.8740	5.24	0.004288	147.2	34.32	17.16
320	3.31	8.1280	5.41	0.004296	149.2	34.73	17.37
330	3.34	8.3820	5.58	0.004303	150.7	35.02	17.51
340	3.38	8.6360	5.75	0.004311	152.7	35.43	17.71
350	3.42	8.8900	5.92	0.004319	154.7	35.83	17.91
360	3.46	9.1440	6.09	0.004327	156.8	36.23	18.12
370	3.49	9.3980	6.26	0.004334	158.3	36.51	18.26
380	3.52	9.6520	6.43	0.004342	159.8	36.80	18.40
390	3.55	9.9060	6.60	0.004350	161.3	37.08	18.54
400	3.58	10.1600	6.77	0.004358	162.8	37.36	18.68
410	3.61	10.4140	6.94	0.004366	164.3	37.64	18.82
420	3.62	10.6680	7.10	0.004374	164.8	37.68	18.84
430	3.64	10.9220	7.27	0.004382	165.8	37.84	18.92
440	3.67	11.1760	7.44	0.004390	167.3	38.12	19.06
450	3.69	11.4300	7.61	0.004398	168.3	38.28	19.14
460	3.70	11.6840	7.78	0.004406	168.9	38.32	19.16
470	3.72	11.9380	7.95	0.004414	169.9	38.48	19.24
480	3.74	12.1920	8.12	0.004422	170.9	38.64	19.32
490	3.75	12.4460	8.29	0.004430	171.4	38.68	19.34
500	3.77	12.7000	8.46	0.004438	172.4	38.84	19.42
510	3.78	12.9540	8.63	0.004447	172.9	38.88	19.44
520	3.80	13.2080	8.80	0.004455	173.9	39.03	19.52
530	3.81	13.4620	8.97	0.004463	174.4	39.07	19.54
540	3.82	13.7160	9.13	0.004471	174.9	39.11	19.56
550	3.83	13.9700	9.30	0.004480	175.4	39.15	19.58
560	3.84	14.2240	9.47	0.004488	175.9	39.19	19.60
570	3.85	14.4780	9.64	0.004497	176.4	39.23	19.62
580	3.86	14.7320	9.81	0.004505	176.9	39.27	19.64
590	3.87	14.9860	9.98	0.004513	177.4	39.31	19.65
600	3.88	15.2400	10.15	0.004522	177.9	39.35	19.67
620	3.9	15.7480	10.49	0.004539	178.9	39.42	19.71
640	3.92	16.2560	10.83	0.004556	179.9	39.49	19.75
660	3.93	16.7640	11.16	0.004574	180.4	39.45	19.73
680	3.93	17.2720	11.50	0.004591	180.4	39.30	19.65
700	3.94	17.7800	11.84	0.004609	180.9	39.26	19.63
720	3.94	18.2880	12.18	0.004627	180.9	39.11	19.56
740	3.94	18.7960	12.52	0.004644	180.9	38.96	19.48
760	3.94	19.3040	12.86	0.004662	180.9	38.81	19.40

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

MEMORANDUM

Date	November 04, 2022
To	Matt Klymochko, TREK Geotechnical
From	Angela Fidler-Kliewer, TREK Geotechnical
Project No.	0002-130-00
Project	Concordia Overpass Rehab
Subject	Laboratory Testing Results – Lab Req. R22-559
Distribution	Michael Van Helden

Attached are the laboratory testing results for the above noted project. The testing included unconfined compression test on rock core.

Regards,

Angela Fidler-Kliewer, C.Tech.,

Attach.

Review Control:

Prepared By: IA	*Reviewed By: AFK*	*Checked By: NJF*

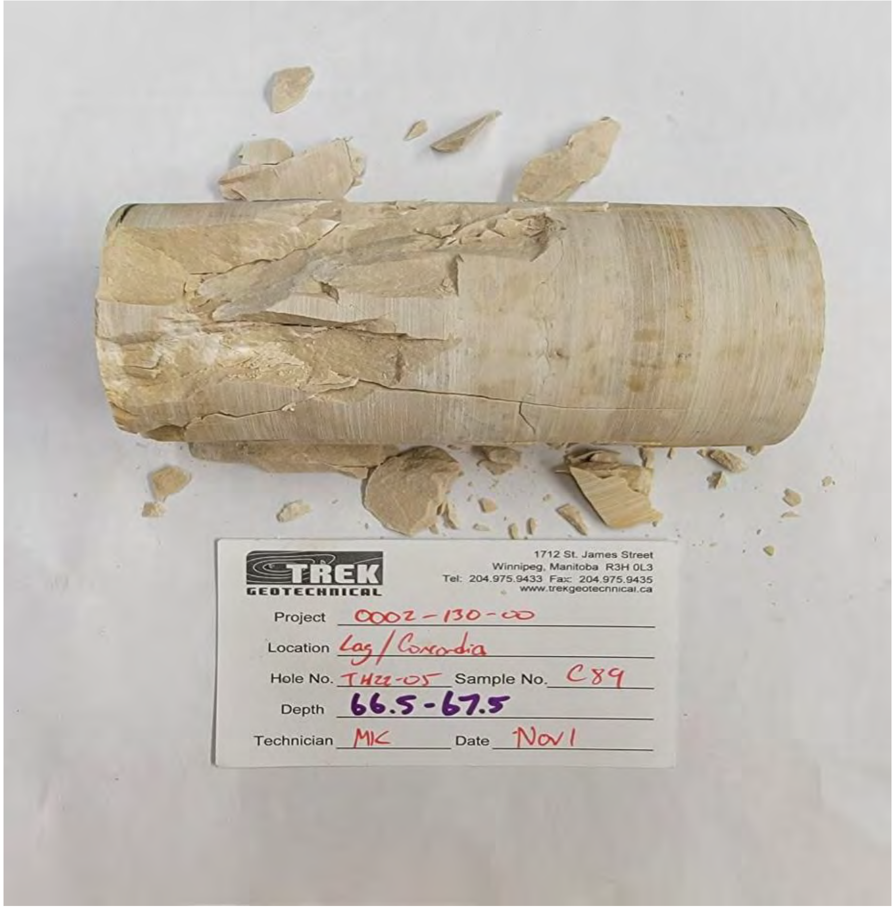
TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Rock Core Unconfined Compressive Strength Report

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS (ASTM D 7012)

Project No. 0002-130-00
Project Lagimodiere/Concordia Overpass Rehabilitation
Client Tetra Tech Inc
Date Received 01-Nov-22
Sampled by MK
Requested by MK
Test Date 04-Nov-22
Report No. R22-559
Technician IA

Core No.	Core Length as Received (mm)	Core Diameter (mm)	Core Length (mm)	Core Weight (g)	Density (g/mm³)	Area (sq.mm)	Core Load (kN)	Core Strength (Mpa)	Notes
TH22-05 (C89)	220	63	132	1063.7	2.585 X10^{-3}	3117	244.64	78.5	



TREK GEOTECHNICAL
1712 St. James Street
Winnipeg, Manitoba R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435
www.trekgeotechnical.ca

Project 0002-130-00
Location Lag/Concordia
Hole No. TH22-05 Sample No. C89
Depth 66.5-67.5
Technician MK Date Nov 1

Comments:

GEOTECHNICAL Quality Engineering | Valued Relationships

MEMORANDUM

Date	November 24, 2022
To	Matt Klymochko, TREK Geotechnical
From	Angela Fidler-Kliewer, TREK Geotechnical
Project No.	0002-130-00
Project	Concordia Overpass Rehab
Subject	Laboratory Testing Results – Lab Req. R22-559
Distribution	Michael Van Helden

Attached are the laboratory testing results for the above noted project. The testing included Oedometer test results on sample T33 using Pneumatic Loading frame.

Regards,

Angela Fidler-Kliewer, C.Tech.,

Attach.

Review Control:

Prepared By: RSA	*Reviewed By: AFK*	*Checked By: NJF*

TREK GEOTECHNICAL
1712 St.James Street
Winnipeg, Manitoba R3H 0L3
tel 204. 975.9433 fax 204.975.9435

Summary of Consolidation Results

Client: Tetra Tech
Job No: 0002-130-00
Project: Lagimodiere / Concordia Overpass Rehab.

Test Dates : September 26, 2022 to November 01, 2022

Test Hole No.: TH22-02
Sample No.: T33
Sample Depth: 21.3 m - 21.9 m
Sample Description: Clay, silty
Liquid Limit: -
Plasticity Index: -

Ring Size: 63.4325 mm ϕ
Specimen Height (Initial): 24.4 mm
Avg. Moisture Content of Trimmings (%): 49.3

Specific Gravity: 2.8 (Not Measured)

Test Apparatus: Pneumatic Loading Frame 1
Cap Load: 0.471 kg
Arm Factor: N/A
Cap Pressure: 1.46 kPa

Test Specimen Data:

Moisture Content	Intial	Final
% Moisture	56.5	45.5
Hs (mm)	9.3	9.3
e (void Ratio)	1.62	1.21

Density	Intial	Final
Bulk Density (kN/m^3)	16.7	18.5
Dry Density (kN/m3)	10.7	11.8
Saturation (%)	97.9	105.6

Preconsolidation Presure (Casagrande's Method): 222.38 kPa

Compression Index (Cc): 0.786
Un-load Re-compression Index (Cr): 0.240
Re-load Re-compression Index (Cr): -

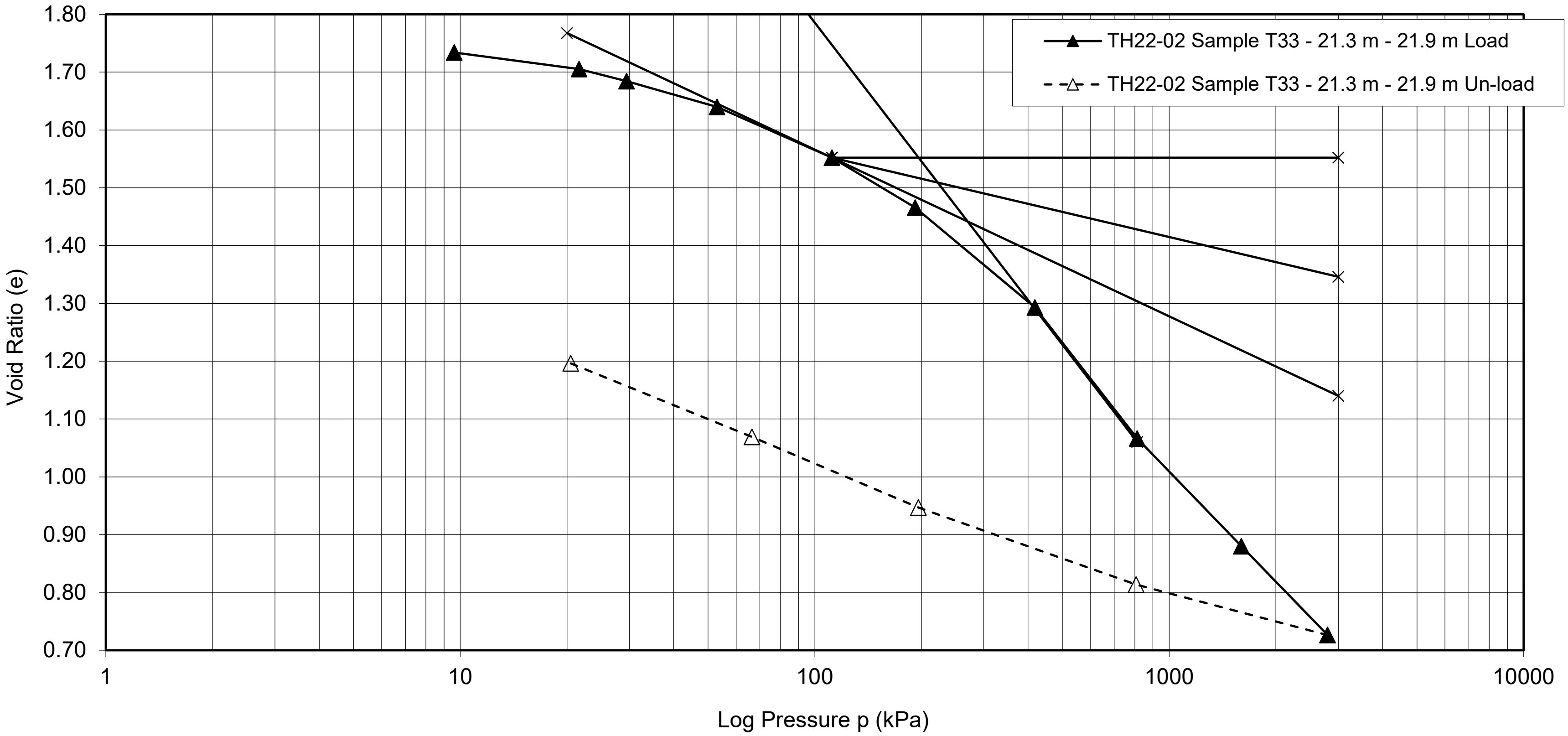
Load (kN)	P (kPa)	ΔP (kPa)	H_0 (mm)	H_{100} (mm)	H_{50} (mm)	t_{100} (s)	t_{50} (s)	c_v (mm^2/s)	e_{start}	e_{finish}	Δe	m_v (kPa^{-1})	k (mm/s)
0.068	21.7	12.0	25.455	25.261	25.358	17060.6	1956.7	1.61E-02	1.758	1.702	-0.056	1.69E-03	2.66E-07
0.093	29.5	7.8	25.230	25.069	25.149	15313.2	1941.8	1.60E-02	1.702	1.681	-0.021	1.00E-03	1.57E-07
0.168	53.1	23.6	25.040	24.650	24.845	19722.7	2459.5	1.23E-02	1.681	1.634	-0.048	7.53E-04	9.08E-08
0.353	111.9	58.8	24.535	23.831	24.183	17204.8	2822.5	1.02E-02	1.634	1.544	-0.090	5.80E-04	5.78E-08
0.607	192.0	80.2	23.709	23.025	23.367	16421.1	2611.1	1.02E-02	1.544	1.460	-0.084	4.10E-04	4.12E-08
1.322	418.5	226.4	22.935	21.411	22.173	20558.8	3434.8	7.01E-03	1.460	1.276	-0.184	3.31E-04	2.28E-08
2.569	812.9	394.5	21.265	19.293	20.279	33025.1	5575.0	3.61E-03	1.276	1.048	-0.228	2.53E-04	8.98E-09
5.049	1597.7	784.8	19.128	17.558	18.343	29144.4	4401.2	3.75E-03	1.048	0.867	-0.181	1.13E-04	4.13E-09
8.851	2800.9	1203.2	17.321	16.119	16.720	29267.2	3837.9	3.57E-03	0.867	0.715	-0.152	6.78E-05	2.37E-09

Notes: 1. Specimen was trimmed using a cutting shoe and tested as per ASTM D2435 Method A. Specimen was allowed to swell under a normal stress of 9.6 kPa after inundation.

Consolidation Results

Client:	Tetra Tech	Test Dates :	September 26, 2022 to November 01, 2022	Test Hole No.:	TH22-02
Job No:	0002-130-00			Sample No.:	T33
Project:	Lagimodiere / Concordia Overpass Rehab.			Sample Depth:	21.3 m - 21.9 m
				Sample Description:	Clay, silty
				Liquid Limit:	-
				Plasticity Index:	-

Void Ratio versus Log Pressure



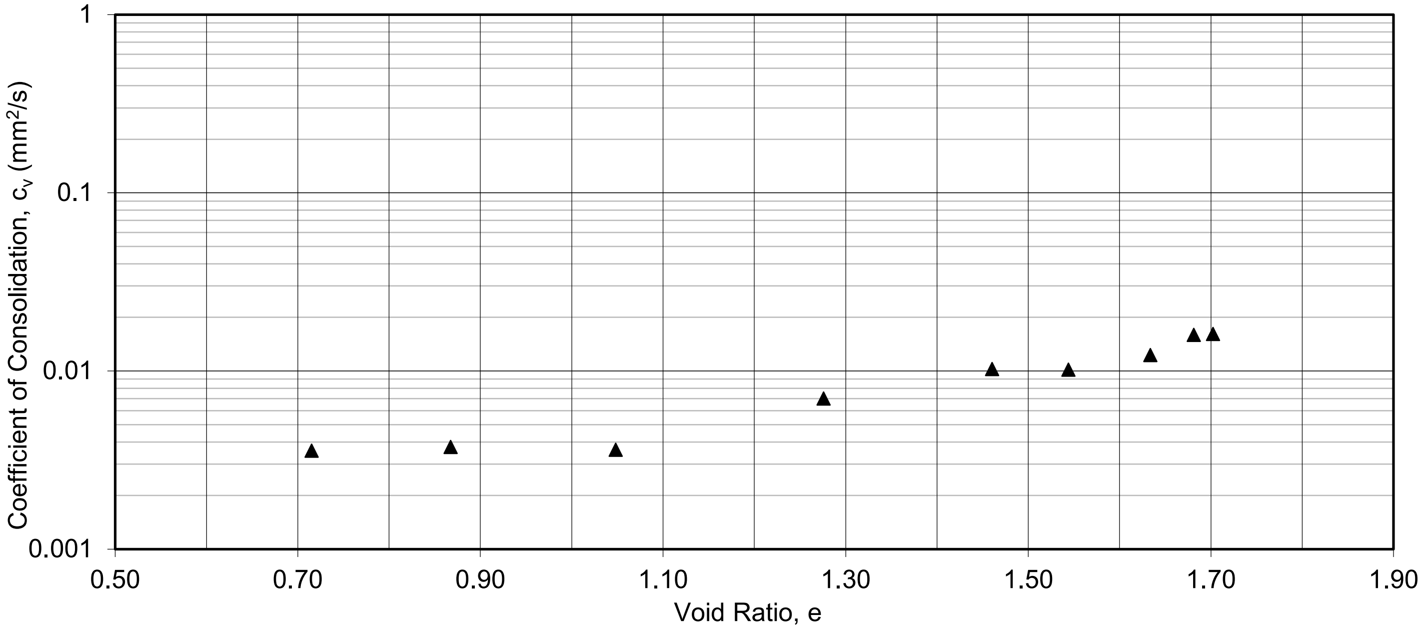
Notes: 1. Specimen was trimmed using a cutting shoe and tested as per ASTM D2435 Method A. Specimen was allowed to swell under a normal stress of 9.6 kPa after inundation.

TREK GEOTECHNICAL
1712 St.James Street
Winnipeg, Manitoba R3H 0L3
tel 204. 975.9433 fax 204.975.9435

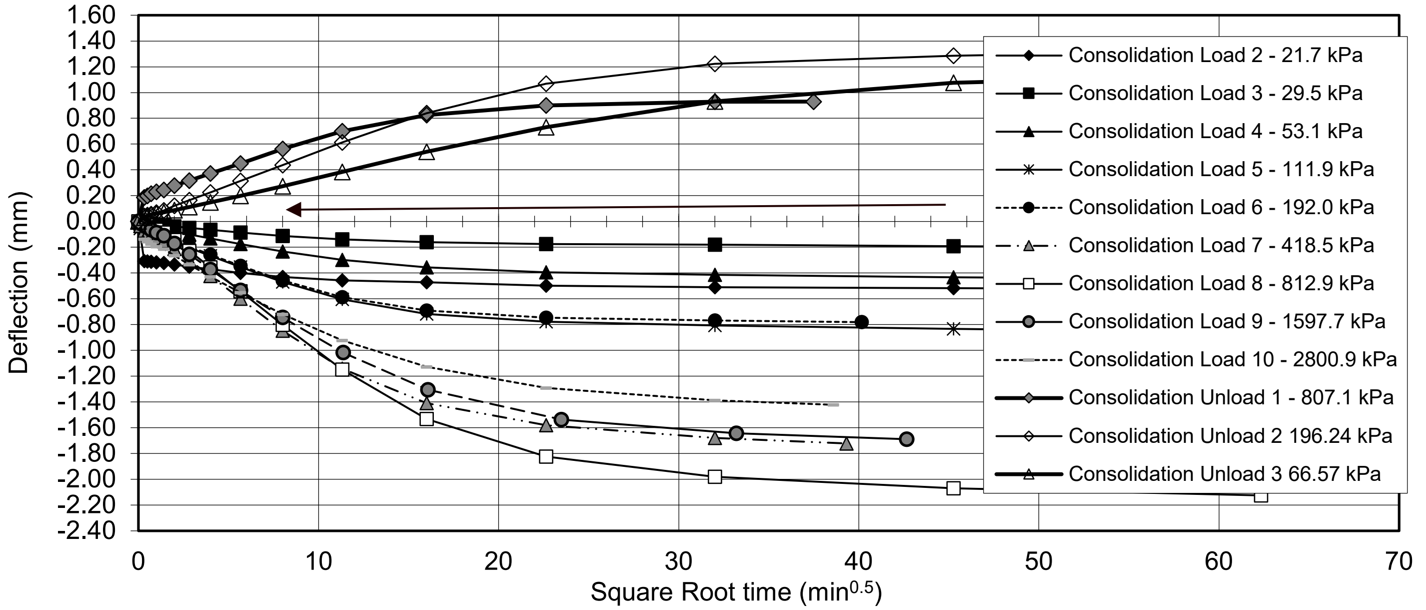
Consolidation Results

Client:	Tetra Tech	Test Dates :	September 26, 2022 to November 01, 2022
Job No:	0002-130-00	Test Hole No.:	TH22-02
Project:	Lagimodiere / Concordia Overpass Rehab.	Sample No.:	T33
		Sample Depth:	21.3 m - 21.9 m
		Sample Description:	Clay, silty
		Test Apparatus:	Pneumatic Loading Frame 1

Coefficient of Conolidation versus Void Ratio



Deflection versus Square Root Time



Notes:

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

MEMORANDUM

Date	January 5th, 2023
To	Matt Klymochko, TREK Geotechnical
From	Angela Fidler-Kliewer, TREK Geotechnical
Project No.	0002-130-00
Project	Concordia Overpass Rehab
Subject	Laboratory Testing Results – Lab Req. R22-559
Distribution	Michael Van Helden

Attached are the laboratory testing results for the above noted project. The testing included Oedometer test results on sample T30 using the Free Weight Loading frame.

Regards,

Angela Fidler-Kliewer, C.Tech.,

Attach.

Review Control:

Prepared By: KRM	*Reviewed By: AFK*	*Checked By: NJF*

TREK GEOTECHNICAL
1712 St.James Street
Winnipeg, Manitoba R3H 0L3
tel 204. 975.9433 fax 204.975.9435

Summary of Consolidation Results

Client: Tetra Tech
Job No: 0002-130-00
Project: Lagimodiere/Concordia Overpass Rehab

Test Dates : November 23, 2022 to December 26, 2022

Test Hole No.: TH22-02
Sample No.: T30
Sample Depth: 15.3 - 15.8 m
Sample Description: Clay, silty

Liquid Limit: -
Plasticity Index: -

Ring Size: 63.3 mm ϕ
Specimen Height (Initial): 24.5 mm
Avg. Moisture Content of Trimmings (%): 48.7
Specific Gravity: 2.7 (Not Measured)

Test Apparatus: Free-Weight Loading Frame
Cap Load: 0.359 kg
Arm Factor: 11
Cap Pressure: 1.12 kPa

Test Specimen Data:

Moisture Content	Intial	Final
% Moisture	51.7	49.9
Hs (mm)	10.3	10.3
e (void Ratio)	1.39	1.28

Density	Intial	Final
Bulk Density (kN/m^3)	17.2	17.7
Dry Density (kN/m^3)	11.3	11.7
Saturation (%)	100.8	105.2

Preconsolidation Pressure (Casagrande's Method): 132.54 kPa

Compression Index (Cc): 0.66
Un-load Re-compression Index (Cr): 0.24

Load (kN)	P (kPa)	ΔP (kPa)	H_0 (mm)	H_{100} (mm)	H_{50} (mm)	t_{100} (s)	t_{50} (s)	c_v (mm^2/s)	e_{start}	e_{finish}	Δe	m_v (kPa^{-1})	k (mm/s)
0.052	16.7	11.4	25.669	25.576	25.622	17323.5	2039.0	1.58E-02	1.506	1.493	-0.013	4.52E-04	6.99E-08
0.101	32.3	15.6	25.561	25.387	25.474	22298.2	3017.4	1.05E-02	1.493	1.474	-0.019	4.98E-04	5.14E-08
0.150	47.8	15.6	25.352	25.191	25.271	23716.1	3700.7	8.46E-03	1.474	1.455	-0.019	5.01E-04	4.16E-08
0.297	94.5	46.7	25.127	24.726	24.926	21918.2	3405.9	8.94E-03	1.455	1.407	-0.048	4.18E-04	3.66E-08
0.591	187.9	93.4	24.659	24.146	24.402	16307.9	2361.6	1.24E-02	1.407	1.351	-0.056	2.48E-04	3.01E-08
1.227	390.3	202.4	24.088	23.250	23.669	20556.0	2481.6	1.11E-02	1.351	1.259	-0.092	1.93E-04	2.09E-08
2.450	779.5	389.2	23.147	21.542	22.344	39942.3	4336.4	5.64E-03	1.259	1.085	-0.174	1.98E-04	1.09E-08
4.896	1557.9	778.4	21.455	19.509	20.482	38626.3	4705.3	4.37E-03	1.085	0.890	-0.195	1.20E-04	5.15E-09
9.789	3114.6	1556.7	19.385	17.799	18.592	40127.1	5214.6	3.25E-03	0.890	0.726	-0.164	5.59E-05	1.78E-09

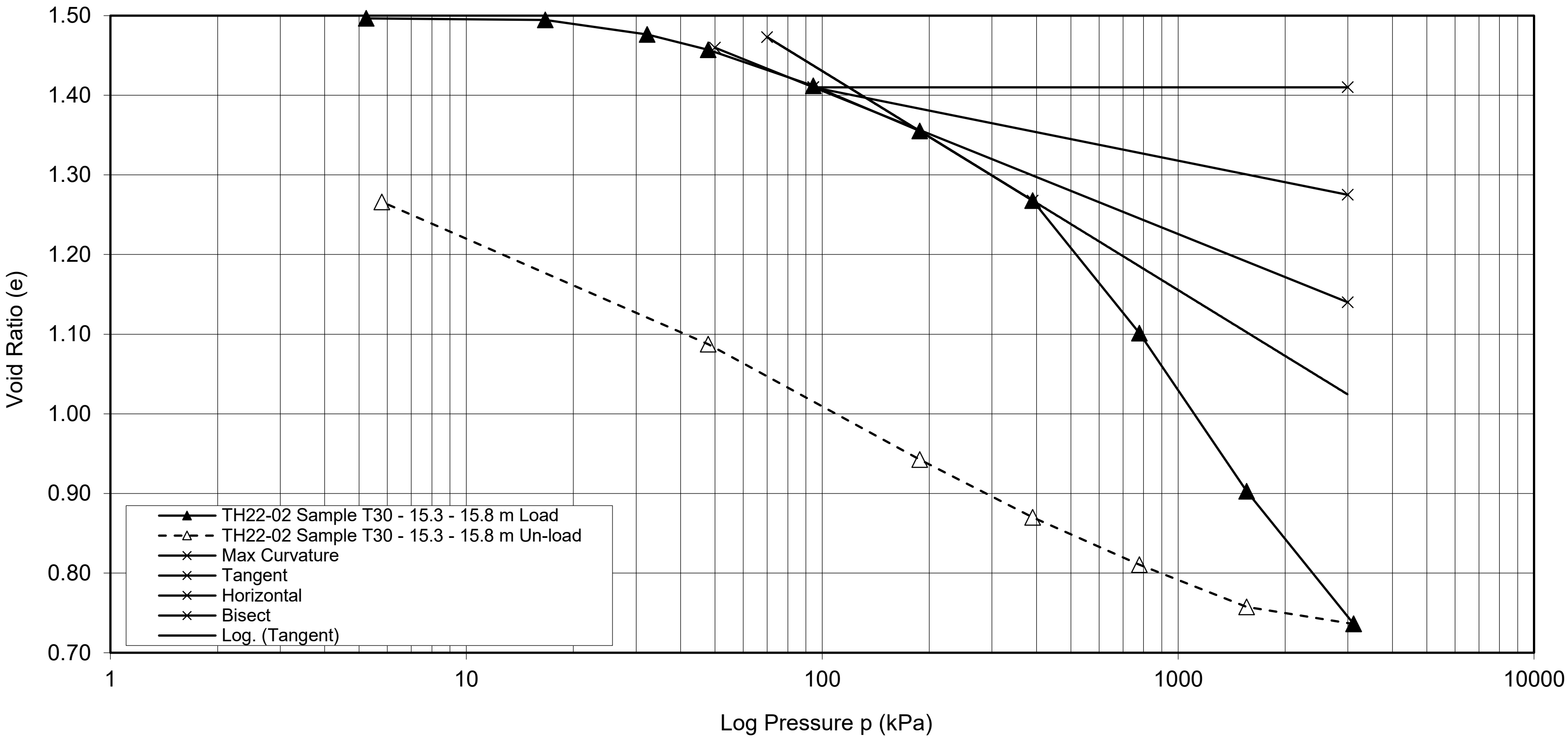
Notes: 1. Specimen was trimmed using a cutting shoe and tested as per ASTM D2435 Method A. Specimen was allowed to swell under a normal stress of 5.2 kPa after inundation.

TREK GEOTECHNICAL
1712 St.James Street
Winnipeg, Manitoba R3H 0L3
tel 204. 975.9433 fax 204.975.9435

Consolidation Results

Client:	Tetra Tech	Test Dates :	November 23, 2022 to December 26, 2022	Test Hole No.:	TH22-02
Job No:	0002-130-00			Sample No.:	T30
Project:	Lagimodiere/Concordia Overpass Rehab			Sample Depth:	15.3 - 15.8 m
				Sample Description:	Clay, silty
				Liquid Limit:	-
				Plasticity Index:	-

Void Ratio versus Log Pressure



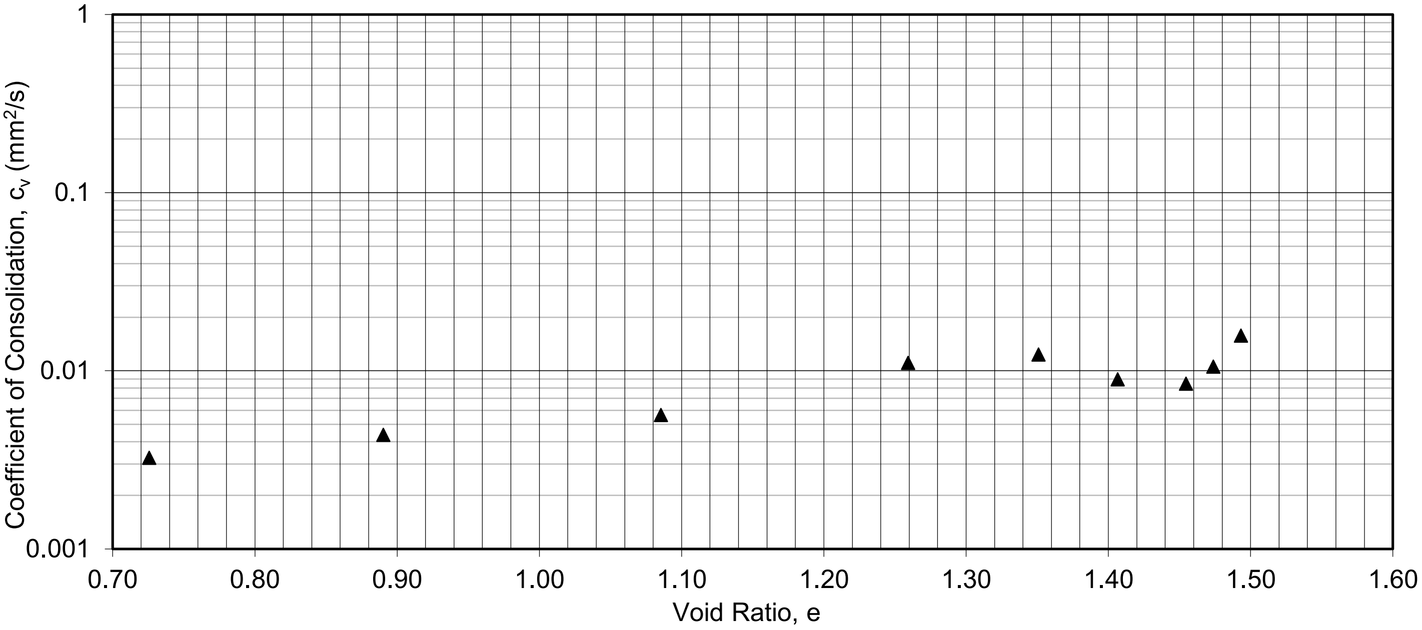
Notes: 1. Specimen was trimmed using a cutting shoe and tested as per ASTM D2435 Method A. Specimen was allowed to swell under a normal stress of 5.2 kPa after inundation.

Consolidation Results

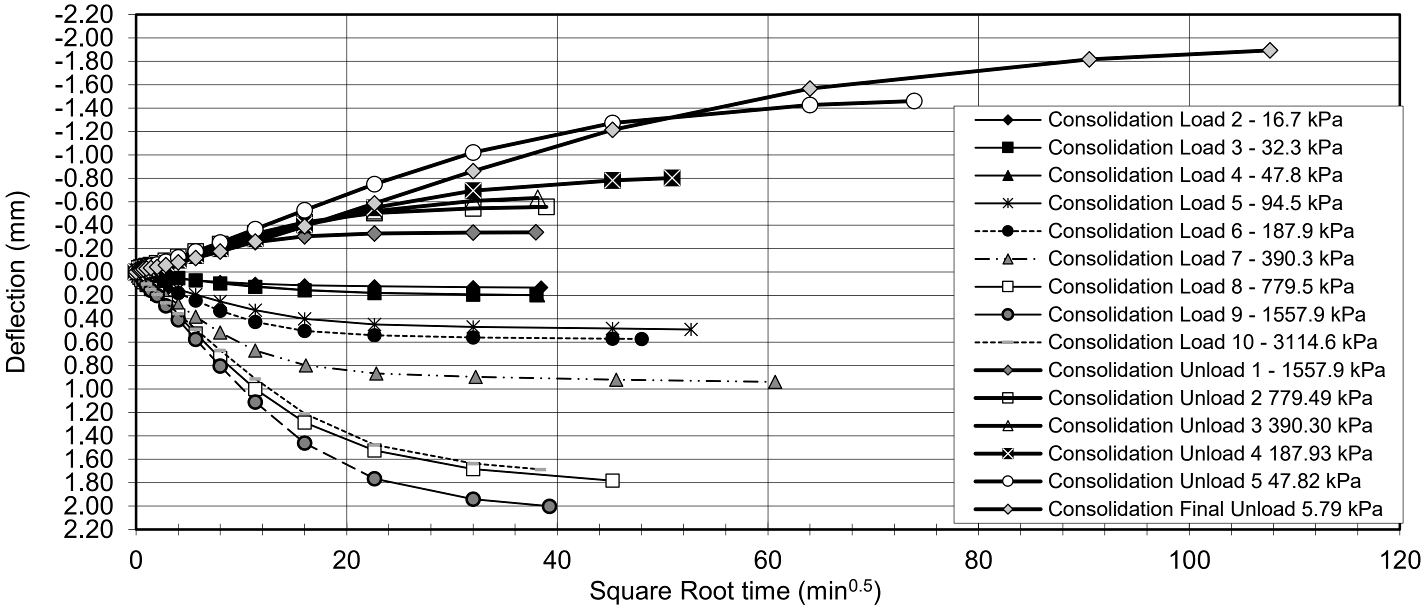
Client: Tetra Tech
Job No: 0002-130-00
Project: Lagimodiere/Concordia Overpass Rehab

Test Dates : November 23, 2022 to December 26, 2022
Test Hole No.: TH22-02
Sample No.: T30
Sample Depth: 15.3 - 15.8 m
Sample Description: Clay, silty
Test Apparatus: Free-Weight Loading Frame

Coefficient of Conolidation versus Void Ratio



Deflection versus Square Root Time



Notes:

Quality Engineering | Valued Relationships

MEMORANDUM

Date	November 18, 2022
To	Matt Klymochko, TREK Geotechnical
From	Angela Fidler-Kliewer, TREK Geotechnical
Project No.	0002-130-00
Project	Concordia Overpass Rehab
Subject	Laboratory Testing Results – Lab Req. R22-627
Distribution	Michael Van Helden

Attached are the laboratory testing results for the above noted project. The testing included moisture content determinations, Atterberg limits, and particle size analysis (Hydrometer method).

Regards,

Angela Fidler-Kliewer, C.Tech.,

Attach.

Review Control:

Prepared By: MT	*Reviewed By: AFK*	*Checked By: NJF*

TREK GEOTECHNICAL

LABORATORY REQUISITION

CLIENT Tetra Tech Inc

PROJECT NO: 0002-130-00

PROJECT NAME Lagimodiere / Concordia Overpass Rehabilitation

FIELD TECHNICIAN: Matt Klymochko

TEST HOLE NUMBER	SAMPLE NUMBER	DEPTH OF SAMPLE (ft)	TARE NUMBER (LAB USE ONLY)	MOISTURE	VISUAL CLASS.	ATTERBERG LIMITS	HYDROMETER	GRADATION	STD. PROCTOR	UNCONFINED AND AUXILARY TESTS					Soil Description/Comments
TH22-07	G102	0.0 - 0.5		X											
TH22-07	G103	1.0 - 1.5		X											
TH22-07	G104	3.5 - 4.0		X											
TH22-07	G105	5.0 - 5.5		X		X									
TH22-07	G106	8.0 - 8.5		X											
TH22-07	G107	9.5 - 10.0		X											
TH22-08	G108	1.0 - 1.5		X											
TH22-08	G109	3.5 - 4.0		X											
TH22-08	G110	4.5 - 5.0		X											
TH22-08	G111	6.5 - 7.0		X											
TH22-08	G112	7.5 - 8.0		X											
TH22-08	G113	8.5 - 9.0		X											
TH22-08	G114	10.5 - 11.0		X											
TH22-09	G115	1.0 - 1.5		X											
TH22-09	G116	3.5 - 4.0		X											
TH22-09	G117	5.0 - 5.5		X											
TH22-09	G118	7.0 - 7.5		X		X	X								
TH22-09	G119	8.0 - 8.5		X											
TH22-10	G120	1.0 - 1.5		X											
TH22-10	G121	3.5 - 4.0		X		X	X								
TH22-10	G122	5.0 - 5.5		X											
TH22-10	G123	7.0 - 7.5		X											
TH22-10	G124	8.0 - 8.5		X											
TH22-10	G125	9.5 - 10.0		X											
TH22-11	G126	1.0 - 1.5		X											
TH22-11	G127	4.0 - 4.5		X											
TH22-11	G128	5.0 - 5.5		X											
TH22-11	G129	6.5 - 7.0		X											
TH22-11	G130	7.5 - 8.0		X											
TH22-11	G131	9.5 - 10.0		X											
TH22-12	G132	1.0 - 1.5		X											
TH22-12	G133	3.5 - 4.0		X											
TH22-12	G134	5.0 - 5.5		X		X									
TH22-12	G135	6.5 - 7.0		X											
TH22-12	G136	7.5 - 8.0		X											

REQUESTED BY: Matt Klymochko

REPORT TO: MK / MVH

REQUISITION DATE: Nov 2

DATE REQUIRED: Nov 18

COMMENTS:

REQUISITION NO. R22-627

PAGE 1 OF 2

TREK LABORATORY REQUISITION LOGS 2022-09-16 LAG OVERPASS_MK 0002-130-00.GPJ TREK GEOTECHNICAL.GDT 11/2/22

LABORATORY REQUISITION

CLIENT Tetra Tech Inc

PROJECT NO: 0002-130-00

PROJECT NAME Lagimodiere / Concordia Overpass Rehabilitation

FIELD TECHNICIAN: Matt Klymochko

TEST HOLE NUMBER	SAMPLE NUMBER	DEPTH OF SAMPLE (ft)	TARE NUMBER (LAB USE ONLY)	MOISTURE	VISUAL CLASS.	ATTERBERG LIMITS	HYDROMETER	GRADATION	STD. PROCTOR	UNCONFINED AND AUXILLARY TESTS					Soil Description/Comments
TH22-12	G137	9.5 - 10.0		☒											
TH22-13	G138	1.0 - 1.5		☒											
TH22-13	G139	5.0 - 5.5		☒											
TH22-13	G140	7.0 - 7.5		☒											
TH22-13	G141	9.0 - 9.5		☒											
TH22-14	G142	1.0 - 1.5		☒											
TH22-14	G143	4.0 - 4.5		☒											
TH22-14	G144	5.5 - 6.0		☒											
TH22-14	G145	7.0 - 7.5		☒											
TH22-14	G146	8.0 - 8.5		☒											

REQUESTED BY: Matt Klymochko

REPORT TO:

REQUISITION DATE:

DATE REQUIRED:

COMMENTS:

REQUISITION NO.
R22621

PAGE 2 OF 2

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere / Concordia Overpass Rehabiliation

Sample Date	14-Oct-22
Test Date	14-Nov-22
Technician	JC

Test Hole	TH22-07	TH22-07	TH22-07	TH22-07	TH22-07	TH22-07
Depth (m)	0.0 - 0.2	0.3 - 0.5	1.1 - 1.2	1.5 - 1.7	2.4 - 2.6	2.9 - 3.0
Sample #	G102	G103	G104	G105	G106	G107
Tare ID	W23	E15	E67	F145	AB69	F62
Mass of tare	8.6	8.7	8.7	8.9	6.8	8.5
Mass wet + tare	193.3	254.6	211.4	349.9	272.6	239.5
Mass dry + tare	137.8	193.6	167.6	248.8	213.3	183.3
Mass water	55.5	61.0	43.8	101.1	59.3	56.2
Mass dry soil	129.2	184.9	158.9	239.9	206.5	174.8
Moisture %	43.0%	33.0%	27.6%	42.1%	28.7%	32.2%

Test Hole	TH22-08	TH22-08	TH22-08	TH22-08	TH22-08	TH22-08
Depth (m)	0.3 - 0.5	1.1 - 1.2	1.4 - 1.5	2.0 - 2.1	2.3 - 2.4	2.6 - 2.7
Sample #	G108	G109	G110	G111	G112	G113
Tare ID	W106	E110	AB63	W100	F49	Z37
Mass of tare	8.5	8.7	7.0	8.5	8.6	8.3
Mass wet + tare	209.6	231.0	222.5	229.1	237.1	231.8
Mass dry + tare	158.2	179.7	169.9	174.2	182.0	181.6
Mass water	51.4	51.3	52.6	54.9	55.1	50.2
Mass dry soil	149.7	171.0	162.9	165.7	173.4	173.3
Moisture %	34.3%	30.0%	32.3%	33.1%	31.8%	29.0%

Test Hole	TH22-08	TH22-09	TH22-09	TH22-09	TH22-09	TH22-09
Depth (m)	3.2 - 3.4	0.3 - 0.5	1.1 - 1.2	1.5 - 1.7	2.1 - 2.3	2.4 - 2.6
Sample #	G114	G115	G116	G117	G118	G119
Tare ID	E75	Z11	N42	P33	D48	A37
Mass of tare	8.7	8.3	8.5	8.6	8.6	8.5
Mass wet + tare	213.3	200.2	214.6	252.0	424.6	261.7
Mass dry + tare	154.1	147.9	155.4	187.6	316.4	203.3
Mass water	59.2	52.3	59.2	64.4	108.2	58.4
Mass dry soil	145.4	139.6	146.9	179.0	307.8	194.8
Moisture %	40.7%	37.5%	40.3%	36.0%	35.2%	30.0%

Moisture Content Report
ASTM D2216-10

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere / Concordia Overpass Rehabiliation

Sample Date	14-Oct-22
Test Date	14-Nov-22
Technician	JC

Test Hole	TH22-10	TH22-10	TH22-10	TH22-10	TH22-10	TH22-10
Depth (m)	0.3 - 0.5	1.1 - 1.2	1.5 - 1.7	2.1 - 2.3	2.4 - 2.6	2.9 - 3.0
Sample #	G120	G121	G122	G123	G124	G125
Tare ID	F14	W69	Z127	F114	F109	P36
Mass of tare	8.6	8.5	8.5	8.6	8.5	8.7
Mass wet + tare	217.5	400.0	265.0	221.5	218.1	270.6
Mass dry + tare	166.6	288.7	209.4	167.9	163.5	209.8
Mass water	50.9	111.3	55.6	53.6	54.6	60.8
Mass dry soil	158.0	280.2	200.9	159.3	155.0	201.1
Moisture %	32.2%	39.7%	27.7%	33.6%	35.2%	30.2%

Test Hole	TH22-11	TH22-11	TH22-11	TH22-11	TH22-11	TH22-11
Depth (m)	0.3 - 0.5	1.2 - 1.4	1.5 - 1.7	2.0 - 2.1	2.3 - 2.4	2.9 - 3.0
Sample #	G126	G127	G128	G129	G130	G131
Tare ID	K16	H36	W10	E33	F881	Z07
Mass of tare	8.5	8.6	8.5	8.5	8.5	8.8
Mass wet + tare	200.9	238.9	231.6	224.6	227.5	216.5
Mass dry + tare	149.9	177.1	180.9	166.7	178.1	162.3
Mass water	51.0	61.8	50.7	57.9	49.4	54.2
Mass dry soil	141.4	168.5	172.4	158.2	169.6	153.5
Moisture %	36.1%	36.7%	29.4%	36.6%	29.1%	35.3%

Test Hole	TH22-12	TH22-12	TH22-12	TH22-12	TH22-12	TH22-12
Depth (m)	0.3 - 0.5	1.1 - 1.2	1.5 - 1.7	2.0 - 2.1	2.3 - 2.4	2.9 - 3.0
Sample #	G132	G133	G134	G135	G136	G137
Tare ID	F154	Z185	W91	E100	F112	F150
Mass of tare	8.6	8.4	8.6	8.7	8.3	8.3
Mass wet + tare	249.2	250.5	346.6	221.8	247.9	255.2
Mass dry + tare	181.5	172.5	270.2	168.0	188.9	196.1
Mass water	67.7	78.0	76.4	53.8	59.0	59.1
Mass dry soil	172.9	164.1	261.6	159.3	180.6	187.8
Moisture %	39.2%	47.5%	29.2%	33.8%	32.7%	31.5%

Moisture Content Report
ASTM D2216-10

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere / Concordia Overpass Rehabiliation
Sample Date	14-Oct-22
Test Date	14-Nov-22
Technician	JC

Test Hole	TH22-13	TH22-13	TH22-13	TH22-13	TH22-14	TH22-14
Depth (m)	0.3 - 0.5	1.5 - 1.7	2.1 - 2.3	2.7 - 2.9	0.3 - 0.5	1.2 - 1.4
Sample #	G138	G139	G140	G141	G142	G143
Tare ID	AB96	W13	H22	N92	N107	H64
Mass of tare	6.9	8.6	8.6	8.7	8.6	8.7
Mass wet + tare	208.2	209.0	222.3	211.3	204.3	211.4
Mass dry + tare	157.4	154.7	184.8	169.4	155.7	148.3
Mass water	50.8	54.3	37.5	41.9	48.6	63.1
Mass dry soil	150.5	146.1	176.2	160.7	147.1	139.6
Moisture %	33.8%	37.2%	21.3%	26.1%	33.0%	45.2%

Test Hole	TH22-14	TH22-14	TH22-14			
Depth (m)	1.7 - 1.8	2.1 - 2.3	2.4 - 2.6			
Sample #	G144	G145	G146			
Tare ID	H2	AC26	P40			
Mass of tare	8.6	6.8	8.8			
Mass wet + tare	268.1	207.7	218.1			
Mass dry + tare	239.8	149.5	171.9			
Mass water	28.3	58.2	46.2			
Mass dry soil	231.2	142.7	163.1			
Moisture %	12.2%	40.8%	28.3%			

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Atterberg Limits
ASTM D4318-10e1

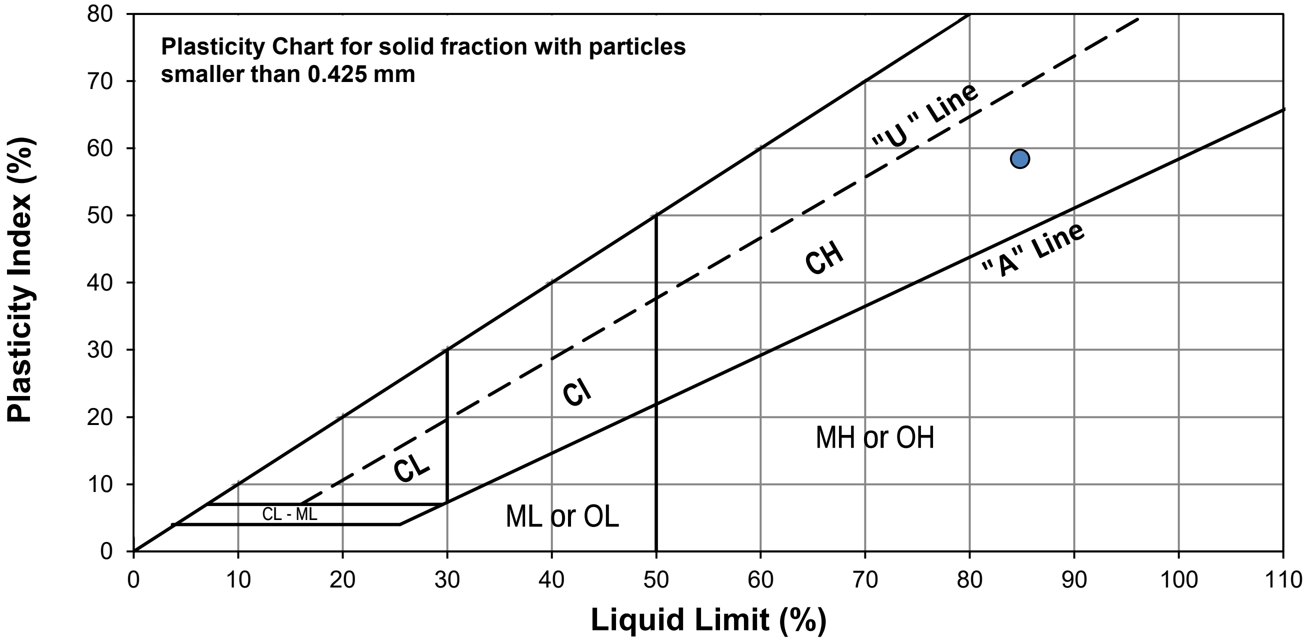
CERTIFIED BY CCIL Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com

Project No.	0002-130-00
Client	Tetra Tech Inc
Project	Lagimodiere / Concordia Overpass Rehabilitation
Test Hole	TH22-07
Sample #	G105
Depth (m)	1.5 - 1.7
Sample Date	14-Oct-22
Test Date	16-Nov-22
Technician	MT

Liquid Limit	85
Plastic Limit	26
Plasticity Index	58

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	18	20	34		
Mass Tare (g)	14.104	13.934	13.839		
Mass Wet Soil + Tare (g)	25.053	23.494	23.570		
Mass Dry Soil + Tare (g)	19.886	19.021	19.229		
Mass Water (g)	5.167	4.473	4.341		
Mass Dry Soil (g)	5.782	5.087	5.390		
Moisture Content (%)	89.364	87.930	80.538		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.171	14.218			
Mass Wet Soil + Tare (g)	22.936	21.057			
Mass Dry Soil + Tare (g)	21.122	19.616			
Mass Water (g)	1.814	1.441			
Mass Dry Soil (g)	6.951	5.398			
Moisture Content (%)	26.097	26.695			

Note: Additional information recorded/measured for this test is available upon request.

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

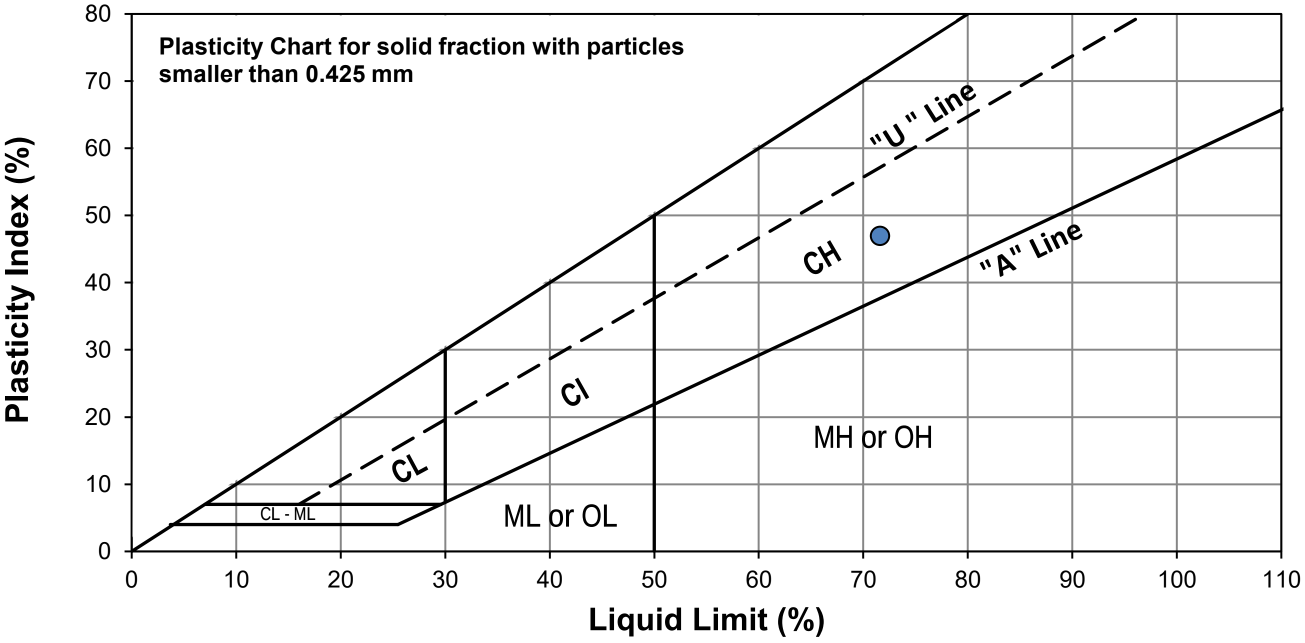
Atterberg Limits
ASTM D4318-10e1

Project No.	0002-130-00
Client	Tetra Tech Inc
Project	Lagimodiere / Concordia Overpass Rehabilitation
Test Hole	TH22-09
Sample #	G118
Depth (m)	2.1 - 2.3
Sample Date	14-Oct-22
Test Date	15-Nov-22
Technician	SL

Liquid Limit	72
Plastic Limit	25
Plasticity Index	47

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	16	27	30		
Mass Tare (g)	13.947	13.831	14.110		
Mass Wet Soil + Tare (g)	19.909	20.640	19.954		
Mass Dry Soil + Tare (g)	17.364	17.810	17.540		
Mass Water (g)	2.545	2.830	2.414		
Mass Dry Soil (g)	3.417	3.979	3.430		
Moisture Content (%)	74.481	71.123	70.379		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	13.908	14.097			
Mass Wet Soil + Tare (g)	20.513	20.966			
Mass Dry Soil + Tare (g)	19.202	19.613			
Mass Water (g)	1.311	1.353			
Mass Dry Soil (g)	5.294	5.516			
Moisture Content (%)	24.764	24.529			

Note: Additional information recorded/measured for this test is available upon request.

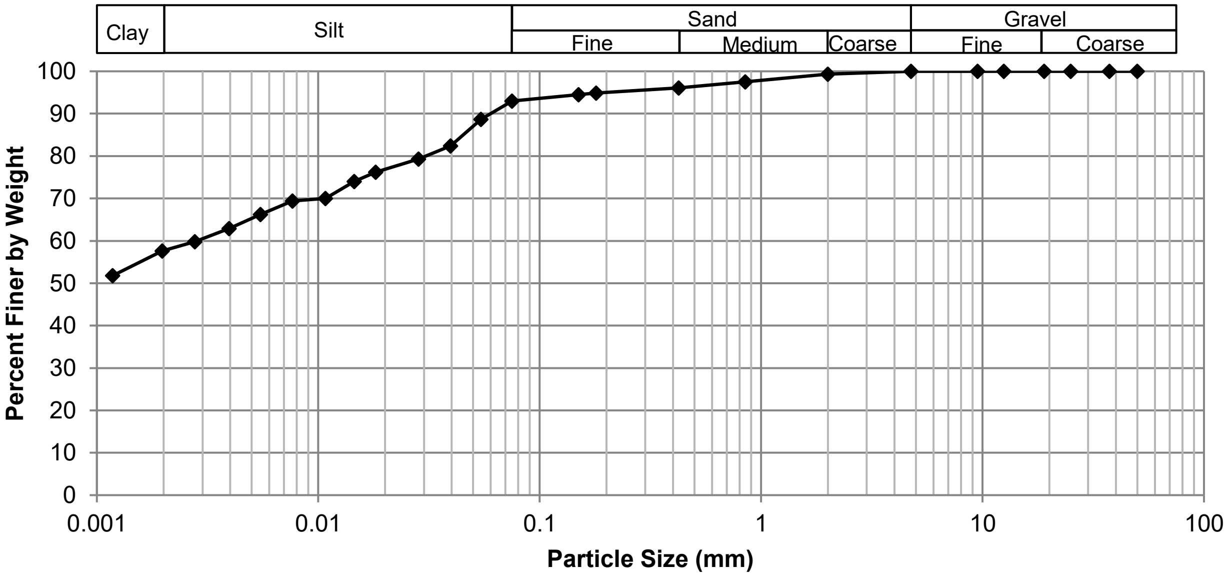
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere/Concordia Overpass Rehabilitation
Test Hole	TH22-09
Sample #	G118
Depth (m)	2.1 - 2.3
Sample Date	27-Sep-22
Test Date	17-Nov-22
Technician	AFK

Gravel	0.0%
Sand	7.0%
Silt	35.3%
Clay	57.7%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	92.98
37.5	100.00	2.00	99.32	0.0544	88.65
25.0	100.00	0.850	97.53	0.0396	82.44
19.0	100.00	0.425	96.11	0.0284	79.33
12.5	100.00	0.180	94.85	0.0182	76.23
9.50	100.00	0.150	94.49	0.0145	74.05
4.75	100.00	0.075	92.98	0.0108	70.02
				0.0076	69.39
				0.0055	66.24
				0.0040	62.91
				0.0028	59.81
				0.0020	57.59
				0.0012	51.78

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Atterberg Limits
ASTM D4318-10e1

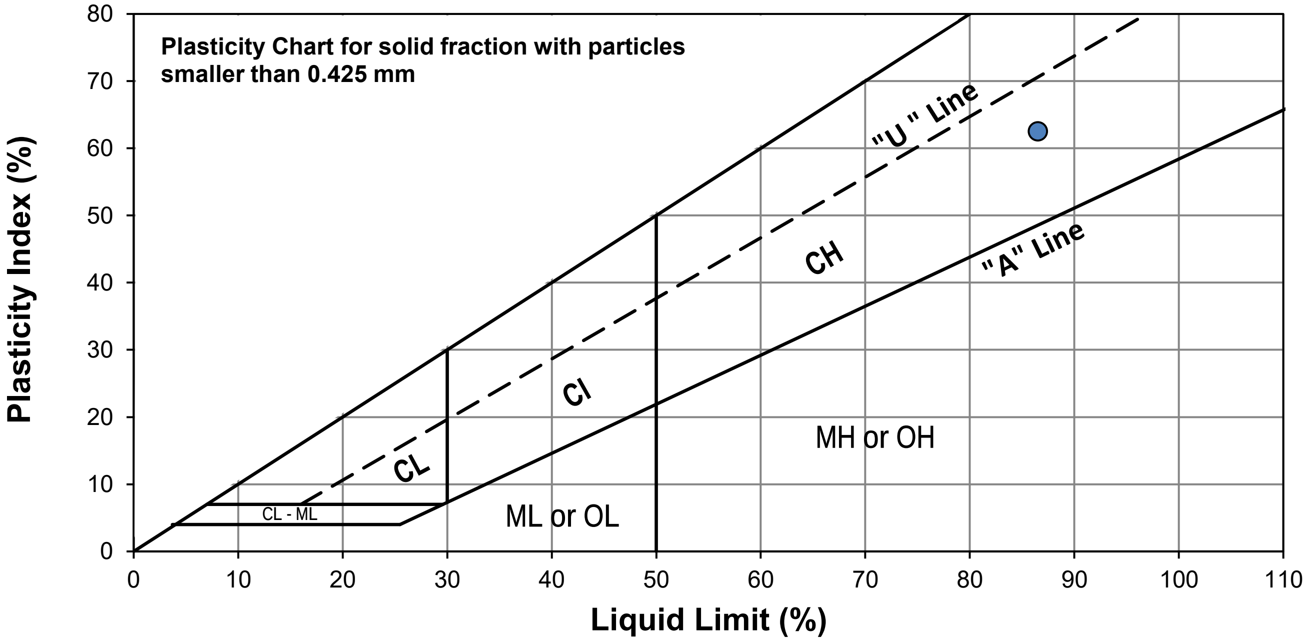
CERTIFIED BY CCIL Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com

Project No.	0002-130-00
Client	Tetra Tech Inc
Project	Lagimodiere / Concordia Overpass Rehabilitation
Test Hole	TH22-10
Sample #	G121
Depth (m)	1.1 - 1.2
Sample Date	14-Oct-22
Test Date	17-Nov-22
Technician	MT

Liquid Limit	86
Plastic Limit	24
Plasticity Index	63

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	17	27	33		
Mass Tare (g)	13.952	14.167	14.407		
Mass Wet Soil + Tare (g)	24.007	24.536	23.414		
Mass Dry Soil + Tare (g)	19.248	19.724	19.320		
Mass Water (g)	4.759	4.812	4.094		
Mass Dry Soil (g)	5.296	5.557	4.913		
Moisture Content (%)	89.860	86.593	83.330		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	14.043	14.221			
Mass Wet Soil + Tare (g)	21.033	20.931			
Mass Dry Soil + Tare (g)	19.677	19.638			
Mass Water (g)	1.356	1.293			
Mass Dry Soil (g)	5.634	5.417			
Moisture Content (%)	24.068	23.869			

Note: Additional information recorded/measured for this test is available upon request.

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

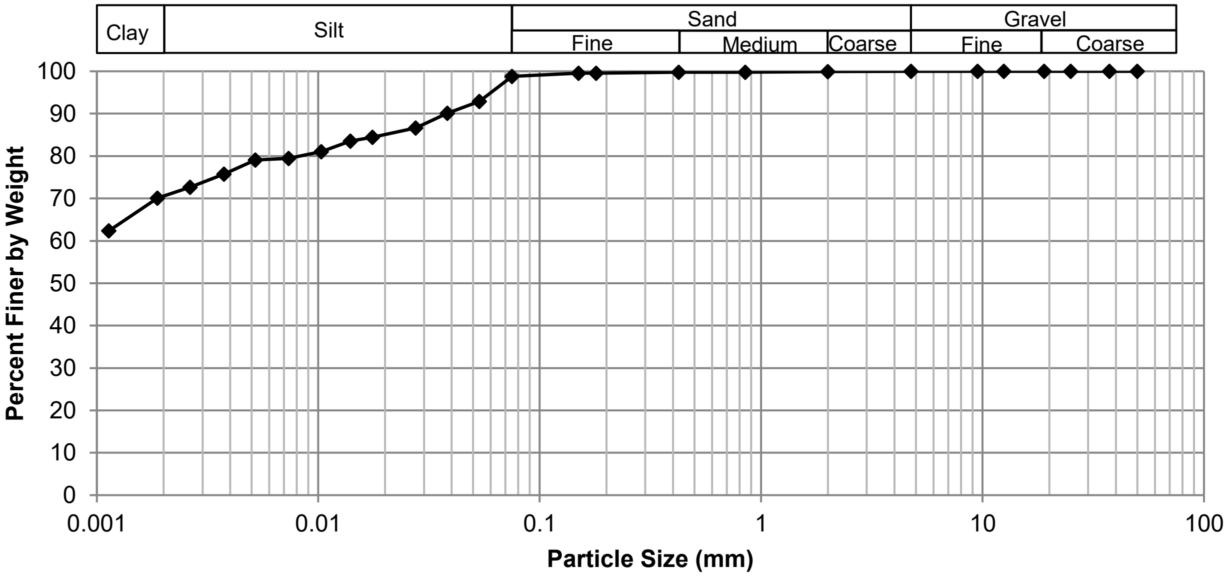
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere/Concordia Overpass Rehabilitation
Test Hole	TH22-10
Sample #	G121
Depth (m)	1.1 - 1.2
Sample Date	27-Sep-22
Test Date	17-Nov-22
Technician	AFK

Gravel	0.0%
Sand	1.2%
Silt	28.3%
Clay	70.5%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	98.81
37.5	100.00	2.00	99.93	0.0534	92.91
25.0	100.00	0.850	99.75	0.0383	90.09
19.0	100.00	0.425	99.75	0.0275	86.66
12.5	100.00	0.180	99.54	0.0176	84.47
9.50	100.00	0.150	99.54	0.0140	83.53
4.75	100.00	0.075	98.81	0.0103	81.03
				0.0073	79.47
				0.0052	79.11
				0.0038	75.76
				0.0026	72.64
				0.0019	70.09
				0.0011	62.38

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Atterberg Limits
ASTM D4318-10e1

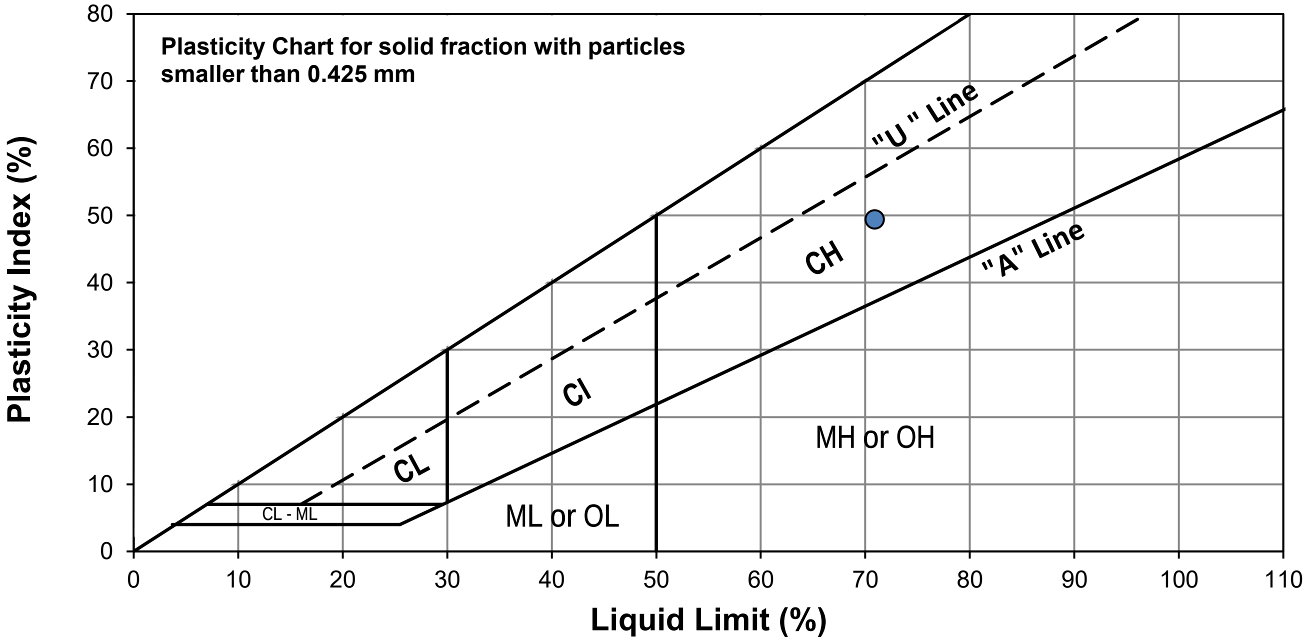
Project No. 0002-130-00
Client Tetra Tech Inc
Project Lagimodiere / Concordia Overpass Rehabilitation

Test Hole TH22-12
Sample # G134
Depth (m) 1.5 - 1.7
Sample Date 14-Oct-22
Test Date 17-Nov-22
Technician MT

Liquid Limit	71
Plastic Limit	22
Plasticity Index	49

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	15	21	31		
Mass Tare (g)	14.207	13.979	14.216		
Mass Wet Soil + Tare (g)	23.968	25.041	24.729		
Mass Dry Soil + Tare (g)	19.781	20.405	20.428		
Mass Water (g)	4.187	4.636	4.301		
Mass Dry Soil (g)	5.574	6.426	6.212		
Moisture Content (%)	75.117	72.144	69.237		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	14.120	14.287			
Mass Wet Soil + Tare (g)	22.572	24.247			
Mass Dry Soil + Tare (g)	21.070	22.490			
Mass Water (g)	1.502	1.757			
Mass Dry Soil (g)	6.950	8.203			
Moisture Content (%)	21.612	21.419			

Note: Additional information recorded/measured for this test is available upon request.

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

MEMORANDUM

Date April 13, 2023

To Matt Klymochko, TREK Geotechnical

From Angela Fidler-Kliewer, TREK Geotechnical

Project No. 0002-130-00

Project Concordia Overpass Rehab

Subject Laboratory Testing Results – Lab Req. R23-097

Distribution Michael Van Helden, Kent Bannister

Attached are the laboratory testing results for the above noted project. The testing included moisture content determinations and unconfined compression test with related testing on Shelby tube samples. Triaxials will be reported upon completion.

Regards,

Angela Fidler-Kliewer, C.Tech.,

Attach.

Review Control:

Prepared By: KM	*Reviewed By: AFK*	*Checked By: NJF*

KM

TREK GEOTECHNICAL

LABORATORY REQUISITION

CLIENT Tetra Tech Inc

PROJECT NAME Lagimodiere / Concordia Overpass Rehabilitation

PROJECT NO: 0002-130-00

FIELD TECHNICIAN: Matt Klymochko

TEST HOLE NUMBER	SAMPLE NUMBER	DEPTH OF SAMPLE (ft)	TARE NUMBER (LAB USE ONLY)	MOISTURE	VISUAL CLASS.	ATTERBERG LIMITS	HYDROMETER	GRADATION	STD. PROCTOR	UNCONFINED AND AUXILIARY TESTS	Triaxial / (practice)			Soil Description/Comments
TH23-15	G147	0.0 - 0.3		X										
TH23-15	G148	2.0 - 3.0		X										
TH23-15	G149	5.0 - 6.0		X										
TH23-15	G150	10.0 - 11.0		X										
TH23-15	G151	15.0 - 16.0		X										
TH23-15	T152	20.0 - 22.0								X				
TH23-15	G153	25.0 - 26.0		X										
TH23-15	T154	30.0 - 32.0								X				
TH23-15	G155	35.0 - 36.0		X										
TH23-15	G156	40.0 - 41.0		X										
TH23-15	S157	45.0 - 47.0		X										
TH23-15	G158	50.0 - 51.0		X										
TH23-16	G159	1.0 - 2.0		X										
TH23-16	G160	5.0 - 6.0		X										
TH23-16	G161	10.0 - 11.0		X										
TH23-16	G162	15.0 - 16.0		X										
TH23-16	G163	20.0 - 21.0		X										
TH23-16	G164	25.0 - 26.0		X										
TH23-16	G165	30.0 - 31.0		X										
TH23-16	G166	35.0 - 36.0		X										
TH23-16	S167	40.0 - 41.5		X										
TH23-17	G168	2.0 - 3.0		X										
TH23-17	G169	5.0 - 6.0		X										
TH23-17	T170	10.0 - 12.0									/			100, 150, 200 kPa. Get 3 samples from tube
TH23-17	G171	15.0 - 16.0		X										
TH23-17	G172	20.0 - 21.0		X										
TH23-17	G173	25.0 - 26.0		X										
TH23-17	G174	28.0 - 29.0		X										
TH23-17	G175	30.0 - 31.0		X										
TH23-17	G176	35.0 - 36.0		X										
TH23-17	G177	39.0 - 40.0		X										

REQUESTED BY: Matt Klymochko

REQUISITION DATE: April 12

COMMENTS:

REPORT TO: MK/MVH/ KB

DATE REQUIRED:

REQUISITION NO. R23-097

PAGE 1 OF 1

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere / Concordia Overpass Rehabiliation
Sample Date	04-Apr-23
Test Date	12-Apr-23
Technician	KM

Test Hole	TH23-15	TH23-15	TH23-15	TH23-15	TH23-15	TH23-15
Depth (m)	0.0 - 0.1	0.6 - 0.9	1.5 - 1.8	3.0 - 3.4	4.6 - 4.9	7.6 - 7.9
Sample #	G147	G148	G149	G150	G151	G153
Tare ID	W15	NP8	N111	K35	AA22	W76
Mass of tare	8.6	8.6	8.8	8.4	6.8	8.6
Mass wet + tare	86.4	73.2	124.1	136.0	118.8	144.9
Mass dry + tare	56.7	53.5	83.8	92.8	81.2	98.6
Mass water	29.7	19.7	40.3	43.2	37.6	46.3
Mass dry soil	48.1	44.9	75.0	84.4	74.4	90.0
Moisture %	61.7%	43.9%	53.7%	51.2%	50.5%	51.4%

Test Hole	TH23-15	TH23-15	TH23-15	TH23-15	TH23-16	TH23-16
Depth (m)	10.7 - 11.0	12.2 - 12.5	13.7 - 14.3	15.2 - 15.5	0.3 - 0.6	1.5 - 1.8
Sample #	G155	G156	S157	G158	G159	G160
Tare ID	F131	Z05	P21	W94	G75	E61
Mass of tare	8.6	8.4	8.5	8.5	8.6	8.7
Mass wet + tare	154.3	147.1	91.6	114.1	83.5	90.2
Mass dry + tare	103.5	131.6	85.3	102.5	57.4	63.7
Mass water	50.8	15.5	6.3	11.6	26.1	26.5
Mass dry soil	94.9	123.2	76.8	94.0	48.8	55.0
Moisture %	53.5%	12.6%	8.2%	12.3%	53.5%	48.2%

Test Hole	TH23-16	TH23-16	TH23-16	TH23-16	TH23-16	TH23-16
Depth (m)	3.0 - 3.4	4.6 - 4.9	6.1 - 6.4	7.6 - 7.9	9.1 - 9.4	10.7 - 11.0
Sample #	G161	G162	G163	G164	G165	G166
Tare ID	F52	C3	N85	P37	Z71	AC24
Mass of tare	8.5	8.5	8.5	8.4	8.5	6.8
Mass wet + tare	90.2	89.6	92.9	92.7	136.7	152.4
Mass dry + tare	64.2	61.6	63.6	63.2	120.1	139.2
Mass water	26.0	28.0	29.3	29.5	16.6	13.2
Mass dry soil	55.7	53.1	55.1	54.8	111.6	132.4
Moisture %	46.7%	52.7%	53.2%	53.8%	14.9%	10.0%

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere / Concordia Overpass Rehabiliation

Sample Date	04-Apr-23
Test Date	12-Apr-23
Technician	KM

Test Hole	TH23-16	TH23-17	TH23-17	TH23-17	TH23-17	TH23-17
Depth (m)	12.2 - 12.6	0.6 - 0.9	1.5 - 1.8	4.6 - 4.9	6.1 - 6.4	7.6 - 7.9
Sample #	S167	G168	G169	G171	G172	G173
Tare ID	F112	AC03	AB33	N12	E56	A106
Mass of tare	8.3	6.7	6.9	8.6	8.6	8.4
Mass wet + tare	108.1	98.7	147.7	99.6	135.2	122.2
Mass dry + tare	100.3	68.1	104.0	67.3	103.1	98.8
Mass water	7.8	30.6	43.7	32.3	32.1	23.4
Mass dry soil	92.0	61.4	97.1	58.7	94.5	90.4
Moisture %	8.5%	49.8%	45.0%	55.0%	34.0%	25.9%

Test Hole	TH23-17	TH23-17	TH23-17	TH23-17		
Depth (m)	8.5 - 8.8	9.1 - 9.4	10.7 - 11.0	11.9 - 12.2		
Sample #	G174	G175	G176	G177		
Tare ID	H36	E133	P04	A23		
Mass of tare	8.9	8.5	8.6	8.6		
Mass wet + tare	147.1	155.9	122.4	144.7		
Mass dry + tare	123.1	140.5	112.4	132.1		
Mass water	24.0	15.4	10.0	12.6		
Mass dry soil	114.2	132.0	103.8	123.5		
Moisture %	21.0%	11.7%	9.6%	10.2%		

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere/Concordia Overpass Rehabilitation
Test Hole	TH23-15
Sample #	T152
Depth (m)	6.1 - 6.7
Sample Date	04-Apr-23
Test Date	12-Apr-23
Technician	KM

Tube Extraction

Recovery (mm) 610

Bottom - 6.7 m	6.66 m	6.55 m	6.37 m	6.19 m **Top - 6.1 m**
Toss	Moisture Content PP/TV Visual	Keep	Qu Bulk	Toss
50 mm	110 mm	180 mm	180 mm	90 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<5mm diam.)	
trace gravel (<5mm diam.)	
Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.45
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	44.1

Pocket Penetrometer

Reading	**1**	1.00
	2	1.00
	3	1.00
	Average	1.00
Undrained Shear Strength (kPa)		49.0

Moisture Content

Tare ID	M57
Mass tare (g)	6.8
Mass wet + tare (g)	353
Mass dry + tare (g)	241.7
Moisture %	47.4%

Unit Weight

Bulk Weight (g)		1045.0
Length (mm)	**1**	147.23
	2	147.32
	3	147.49
	4	147.44
Average Length (m)		0.147
Diam. (mm)	**1**	72.12
	2	72.11
	3	72.20
	4	72.18
Average Diameter (m)		0.072
Volume (m^3)		6.03E-04
Bulk Unit Weight (kN/m^3)		17.0
Bulk Unit Weight (pcf)		108.3
Dry Unit Weight (kN/m^3)		11.5
Dry Unit Weight (pcf)		73.5

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Lagimodiere/Concordia Overpass Rehabilitation

Test Hole TH23-15
Sample # T152
Depth (m) 6.1 - 6.7
Sample Date 4-Apr-23
Test Date 12-Apr-23
Technician KM

Unconfined Strength

	kPa	ksf
Max q_u	110.2	2.3
Max S_u	55.1	1.2

Specimen Data

Description CLAY - silty, trace silt inclusions (<5mm diam.), trace gravel (<5mm diam.), grey, moist, firm, high plasticity

Length	147.4	(mm)
Diameter	72.2	(mm)
L/D Ratio	2.0	
Initial Area	0.00409	(m^2)
Load Rate	1.00	(%/min)

Moisture %	47%	
Bulk Unit Wt.	17.0	(kN/m^3)
Dry Unit Wt.	11.5	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

trace silt inclu		
trace gravel (<5mm diam.)		**ksf**
0.45	44.1	0.92
Vane Size		
m		

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	kPa	ksf
	1.00	49.1	1.02
	1.00	49.1	1.02
	1.00	49.1	1.02
Average	**1.00**	**49.1**	**1.02**

Failure Geometry

Sketch:

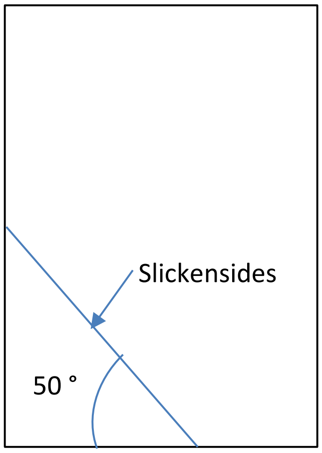
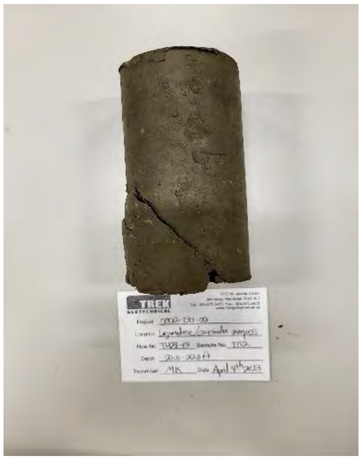


Photo:

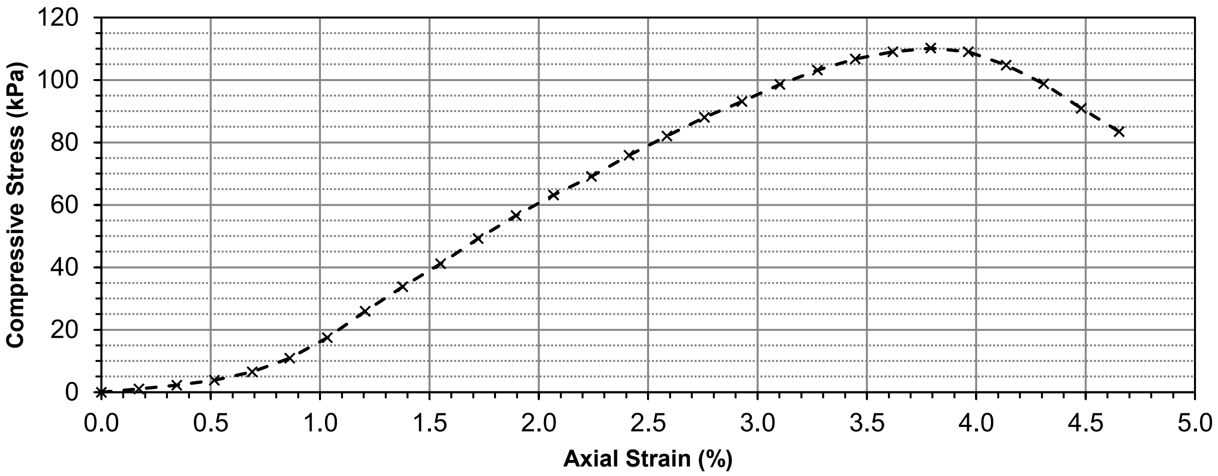


Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Lagimodiere/Concordia Overpass Rehabilitation

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.38	0.0000	0.00	0.004089	0.0	0.00	0.00
10	0.47	0.2540	0.17	0.004096	4.5	1.11	0.55
20	0.56	0.5080	0.34	0.004103	9.1	2.21	1.11
30	0.69	0.7620	0.52	0.004110	15.6	3.80	1.90
40	0.91	1.0160	0.69	0.004117	26.7	6.49	3.24
50	1.27	1.2700	0.86	0.004124	44.9	10.88	5.44
60	1.81	1.5240	1.03	0.004131	72.1	17.45	8.72
70	2.51	1.7780	1.21	0.004139	107.4	25.94	12.97
80	3.16	2.0320	1.38	0.004146	140.1	33.80	16.90
90	3.77	2.2860	1.55	0.004153	170.9	41.14	20.57
100	4.44	2.5400	1.72	0.004160	204.6	49.19	24.59
110	5.06	2.7940	1.90	0.004168	235.9	56.60	28.30
120	5.61	3.0480	2.07	0.004175	263.6	63.14	31.57
130	6.12	3.3020	2.24	0.004182	289.3	69.17	34.59
140	6.69	3.5560	2.41	0.004190	318.0	75.91	37.95
150	7.21	3.8100	2.59	0.004197	344.3	82.02	41.01
160	7.72	4.0640	2.76	0.004205	370.0	87.99	43.99
170	8.16	4.3180	2.93	0.004212	392.1	93.10	46.55
180	8.63	4.5720	3.10	0.004220	415.8	98.54	49.27
190	9.03	4.8260	3.27	0.004227	436.0	103.14	51.57
200	9.35	5.0800	3.45	0.004235	452.1	106.76	53.38
210	9.56	5.3340	3.62	0.004242	462.7	109.07	54.53
220	9.67	5.5880	3.79	0.004250	468.2	110.18	55.09
230	9.59	5.8420	3.96	0.004258	464.2	109.03	54.52

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Lagimodiere/Concordia Overpass Rehabilitation

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	9.24	6.0960	4.14	0.004265	446.6	104.70	52.35
250	8.75	6.3500	4.31	0.004273	421.9	98.73	49.37
260	8.10	6.6040	4.48	0.004281	389.1	90.90	45.45
270	7.48	6.8580	4.65	0.004288	357.9	83.45	41.73

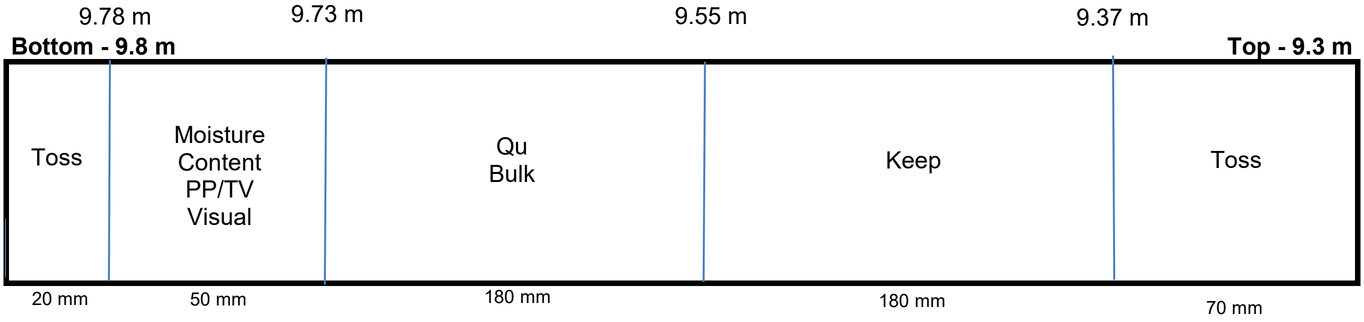
TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere/Concordia Overpass Rehabilitation
Test Hole	TH23-15
Sample #	T154
Depth (m)	9.3 - 9.8
Sample Date	04-Apr-23
Test Date	12-Apr-23
Technician	KM

Tube Extraction

Recovery (mm) 500



Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<5mm diam.)	
trace gravel (<15mm diam.)	
Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.30
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	29.4

Pocket Penetrometer

Reading	**1**	0.60
	2	0.60
	3	0.50
	Average	0.57
Undrained Shear Strength (kPa)		27.8

Moisture Content

Tare ID	Z64
Mass tare (g)	8.5
Mass wet + tare (g)	316.6
Mass dry + tare (g)	201.8
Moisture %	59.4%

Unit Weight

Bulk Weight (g)		1010.3
Length (mm)	**1**	145.20
	2	145.19
	3	144.98
	4	144.99
Average Length (m)		0.145
Diam. (mm)	**1**	66.42
	2	66.21
	3	72.50
	4	72.44
Average Diameter (m)		0.069
Volume (m^3)		5.49E-04
Bulk Unit Weight (kN/m^3)		18.1
Bulk Unit Weight (pcf)		114.9
Dry Unit Weight (kN/m^3)		11.3
Dry Unit Weight (pcf)		72.1

Unconfined Compressive Strength

ASTM D2166

Project No.	0002-130-00
Client	Tetra Tech Inc.
Project	Lagimodiere/Concordia Overpass Rehabilitation

Test Hole	TH23-15
Sample #	T154
Depth (m)	9.3 - 9.8
Sample Date	4-Apr-23
Test Date	12-Apr-23
Technician	KM

Unconfined Strength

	kPa	**ksf**
Max q_u	60.5	1.3
Max S_u	30.2	0.6

Specimen Data

Description CLAY - silty, trace silt inclusions (<5mm diam.), trace gravel (<15mm diam.), grey, moist, firm, high plasticity

Length	145.1	(mm)
Diameter	69.4	(mm)
L/D Ratio	2.1	
Initial Area	0.00378	(m^2)
Load Rate	1.00	(%/min)

Moisture %	59%	
Bulk Unit Wt.	18.1	(kN/m^3)
Dry Unit Wt.	11.3	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

trace silt inclu	**Undrained Shear Strength**	
trace gravel (<15mm diam.)		**ksf**
0.30	29.4	0.61
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	0.60	29.4	0.61
	0.60	29.4	0.61
	0.50	24.5	0.51
Average	**0.57**	**27.8**	**0.58**

Failure Geometry

Sketch:

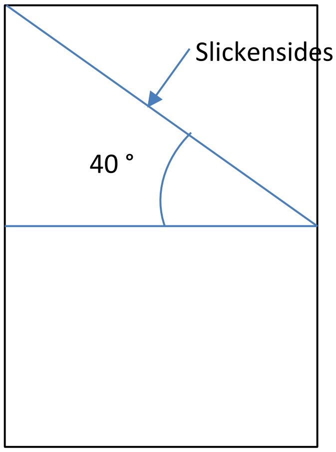


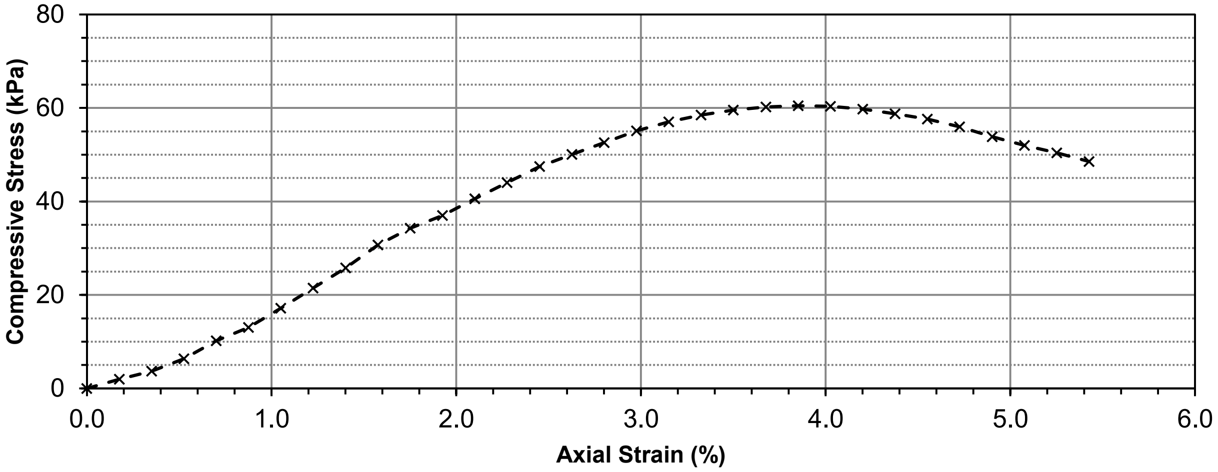
Photo:

Unconfined Compressive Strength

ASTM D2166

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Lagimodiere/Concordia Overpass Rehabilitation

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.38	0.0000	0.00	0.003782	0.0	0.00	0.00
10	0.53	0.2540	0.18	0.003789	7.6	2.00	1.00
20	0.66	0.5080	0.35	0.003795	14.1	3.72	1.86
30	0.86	0.7620	0.53	0.003802	24.2	6.36	3.18
40	1.15	1.0160	0.70	0.003809	38.8	10.19	5.10
50	1.37	1.2700	0.88	0.003815	49.9	13.08	6.54
60	1.68	1.5240	1.05	0.003822	65.5	17.14	8.57
70	2.01	1.7780	1.23	0.003829	82.2	21.46	10.73
80	2.34	2.0320	1.40	0.003836	98.8	25.76	12.88
90	2.72	2.2860	1.58	0.003842	117.9	30.69	15.35
100	3.00	2.5400	1.75	0.003849	132.1	34.31	17.15
110	3.21	2.7940	1.93	0.003856	142.6	36.99	18.49
120	3.49	3.0480	2.10	0.003863	156.8	40.58	20.29
130	3.76	3.3020	2.28	0.003870	170.4	44.02	22.01
140	4.03	3.5560	2.45	0.003877	184.0	47.45	23.73
150	4.24	3.8100	2.63	0.003884	194.6	50.09	25.05
160	4.44	4.0640	2.80	0.003891	204.6	52.59	26.30
170	4.64	4.3180	2.98	0.003898	214.7	55.08	27.54
180	4.80	4.5720	3.15	0.003905	222.8	57.05	28.53
190	4.92	4.8260	3.33	0.003912	228.8	58.49	29.25
200	5.01	5.0800	3.50	0.003919	233.4	59.54	29.77
210	5.07	5.3340	3.68	0.003926	236.4	60.21	30.10
220	5.10	5.5880	3.85	0.003933	237.9	60.48	30.24
230	5.10	5.8420	4.03	0.003941	237.9	60.37	30.19

Project No. 0002-130-00
Client Tetra Tech Inc.
Project Lagimodiere/Concordia Overpass Rehabilitation

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	5.06	6.0960	4.20	0.003948	235.9	59.75	29.88
250	4.99	6.3500	4.38	0.003955	232.4	58.75	29.37
260	4.91	6.6040	4.55	0.003962	228.3	57.62	28.81
270	4.79	6.8580	4.73	0.003970	222.3	56.00	28.00
280	4.63	7.1120	4.90	0.003977	214.2	53.86	26.93
290	4.49	7.3660	5.08	0.003984	207.2	51.99	26.00
300	4.37	7.6200	5.25	0.003992	201.1	50.38	25.19
310	4.23	7.8740	5.43	0.003999	194.1	48.53	24.26

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

MEMORANDUM

Date	December 8, 2022
To	Matt Klymochko, TREK Geotechnical
From	Angela Fidler-Kliewer, TREK Geotechnical
Project No.	0002-130-00
Project	Concordia Overpass Rehab
Subject	Laboratory Testing Results – Lab Req. R22-559
Distribution	Michael Van Helden

Attached are the laboratory testing results for the above noted project. The testing includes Direct Shear test results on a sample sent to Thurber Engineering Ltd.

Regards,

Angela Fidler-Kliewer, C.Tech.,

Attach.

Review Control:

Prepared By: AFK	*Reviewed By: AFK*	*Checked By: NJF*

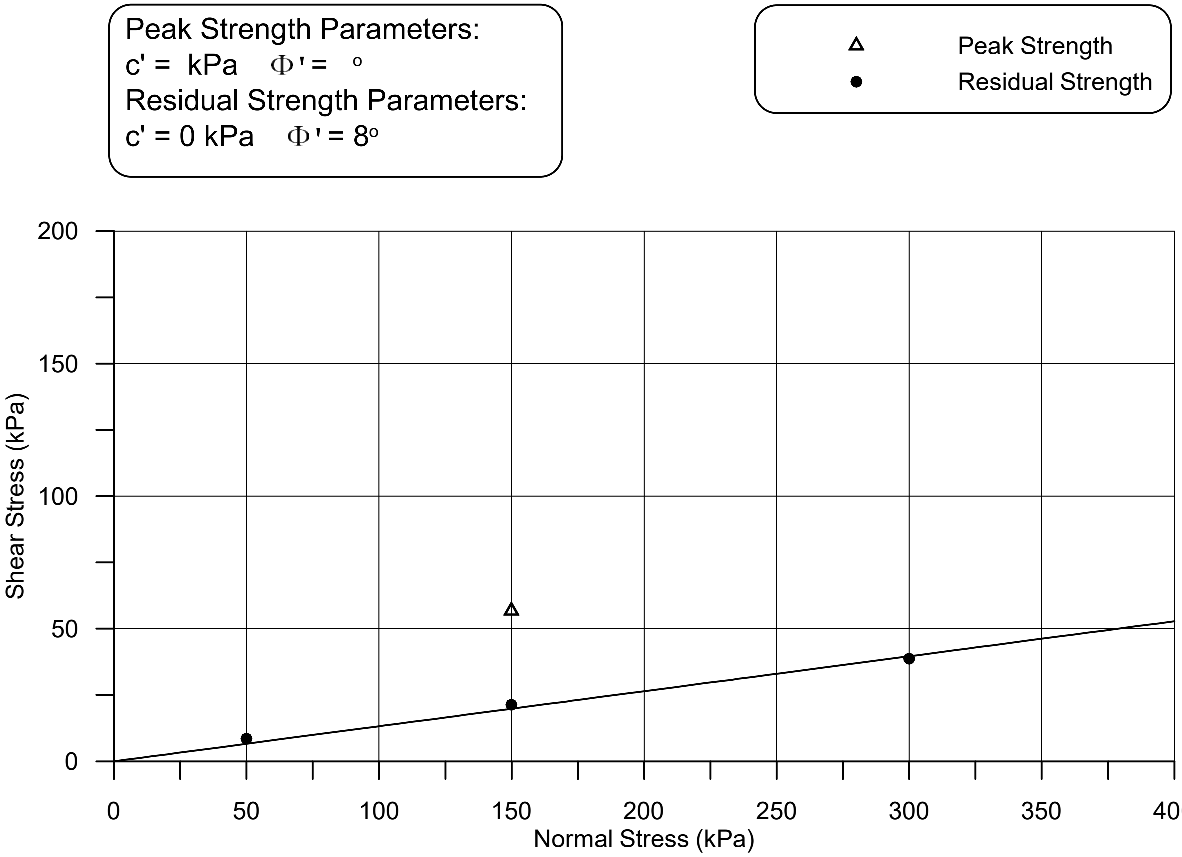
THURBER ENGINEERING LTD.

Direct Shear Test Results

Client: Trek Geotechnical Inc.
Project: Lagimodiere/Concordia Overpass (0002-130-00)
Job No.: 36019

Test Hole: TH22-06
Sample: Clay (CH), silty, brown and grey.
Depth: 10'6" - 11'2"
Date: Dec 5/22

Peak Strength Parameters:
c' = kPa Φ' = °
Residual Strength Parameters:
c' = 0 kPa Φ' = 8°



Remarks:

DIRECT SHEAR TEST - CONSOLIDATED DRAINED
SUMMARY OF TEST RESULTS

Trek Geotechnical Inc.
FILE NUMBER: 36019

REPORT DATE: Dec 6/22
REPORT NUMBER: DS22-1a (Stage I)

Lagimodiere/Concordia Overpass (0002-130-00)

Test Date: Nov 9/22
Sample: TH22-06, T94, 10'6" - 11'2"
Description: Clay (CH), silty, trace silt lenses, coal, oxides, brown and grey.

	Start of Test	End of Consolidation
Wet Density (kg/m^3):	1721	N/A
Dry Density (kg/m^3):	1150	N/A
Water Content (%):	49.7	N/A
Void Ratio:	1.39	N/A
Saturation (%):	98	N/A
Rate of Shear (mm/min)	0.0006	0.0160
Est. specific gravity:	2.75	

Index Properties	
Sand (%):	-
Silt (%):	-
Clay (%):	-
Liquid Limit (%):	-
Plastic Limit (%):	-
Plastic. Index (%):	-

AFTER TEST NOTES

NORMAL STRESS (kPa)	PEAK SHEAR STRESS (kPa)	PEAK PHI (0 cohesion)* (degrees)	RESIDUAL SHEAR STRESS (kPa)	RESIDUAL PHI (0 cohesion) (degrees)
150	56.8	20.7	21	8.0

*For the purpose of estimating the peak friction angle of this single specimen the cohesion was assumed equal to zero. The material friction angle should be estimated based on a Mohr-Coulomb envelope with at least three points.

Water content taken within 1mm of shear surfaces = n/a

TEST PROCEDURE

As requested by the client, the test was performed as described below:

- The specien was consolidated in two stages to 150 kPa, after primary consolidation was complete the specimen was sheared.
- after the peak or initial cycle the rate of displacement was increased to 0.016 mm/min and reversing switches allowed the machine to continuously cycle backwards and forwards until the shear stress reached a constant value.
- after the residual value was determined the test continued to the second stage with 50 kPa normal stress.

DIRECT SHEAR TEST - CONSOLIDATED DRAINED
SUMMARY OF TEST PLOTS

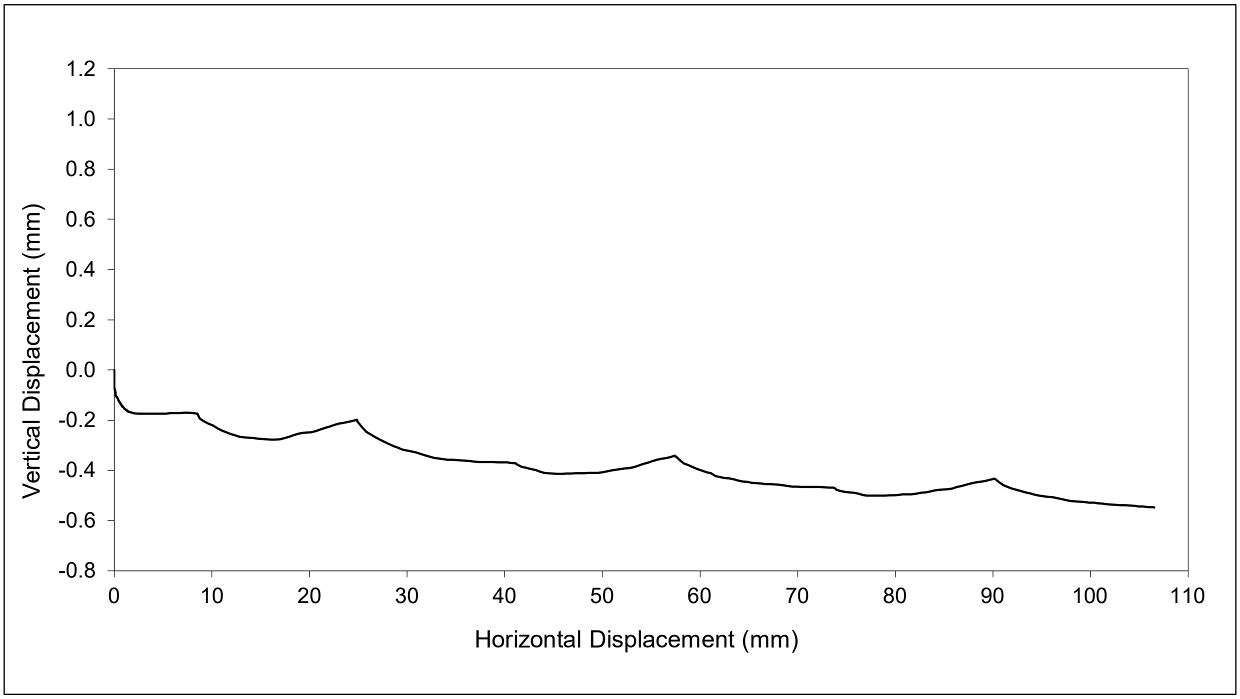
Trek Geotechnical Inc.
FILE NUMBER: 36019

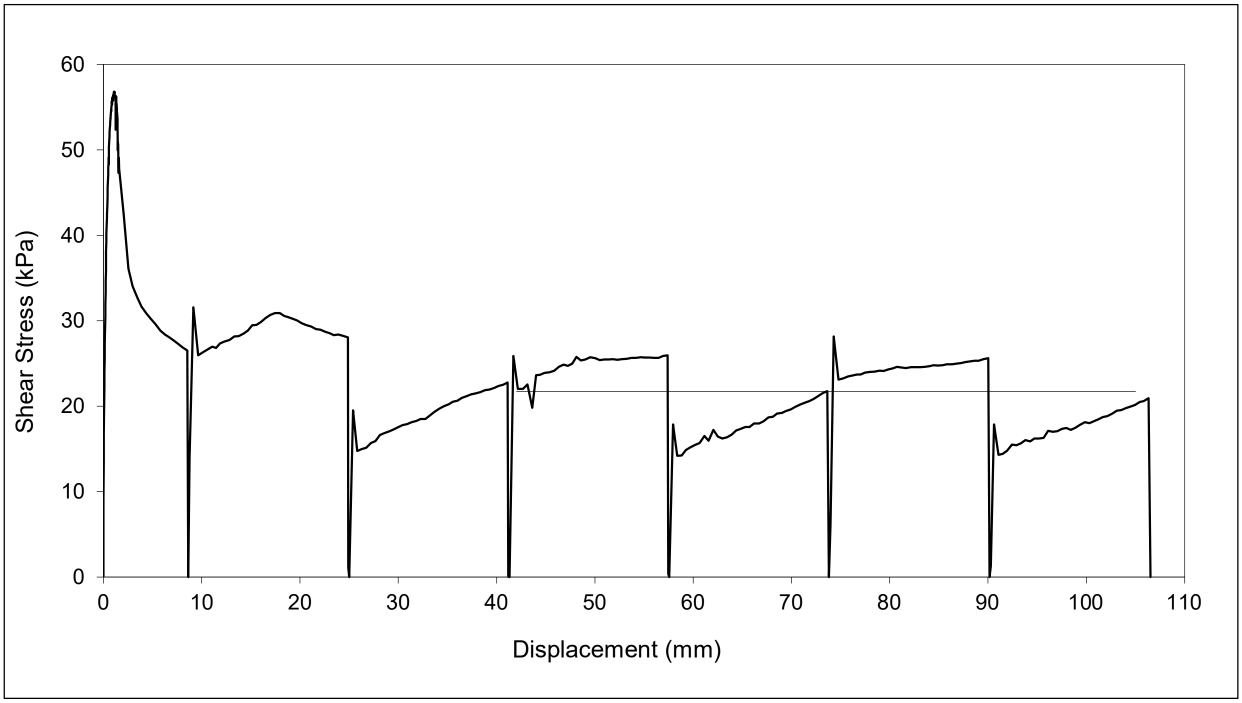
REPORT DATE: Dec 6/22
REPORT NUMBER: DS22-1a

Lagimodiere/Concordia Overpass (0002-130-00)

Sample: TH22-06, T94, 10'6" - 11'2"

Normal Stress: 150 kPa





DIRECT SHEAR TEST - CONSOLIDATED DRAINED
SUMMARY OF TEST RESULTS

Trek Geotechnical Inc.		REPORT DATE:	Dec 6/22
FILE NUMBER:	36019	REPORT NUMBER:	DS22-1b (Stage II)

Lagimodiere/Concordia Overpass (0002-130-00)

Test Date: Nov 17/22
Sample: TH22-06, T94, 10'6" - 11'2"
Description: Clay (CH), silty, trace silt lenses, coal, oxides, brown and grey.

	Start of Test	End of Consolidation	Index Properties	
Wet Density (kg/m^3):	N/A	N/A	Sand (%):	-
Dry Density (kg/m^3):	N/A	N/A	Silt (%):	-
Water Content (%):	N/A	N/A	Clay (%):	-
Void Ratio:	N/A	N/A		
Saturation (%):	N/A	N/A	Liquid Limit (%):	-
Rate of Shear (mm/min)	0.0064	0.0160	Plastic Limit (%):	-
Est. specific gravity:	2.75		Plastic. Index (%):	-

AFTER TEST NOTES

NORMAL STRESS (kPa)	PEAK SHEAR STRESS (kPa)	PEAK PHI (0 cohesion)* (degrees)	RESIDUAL SHEAR STRESS (kPa)	RESIDUAL PHI (0 cohesion) (degrees)
50	11.8	13.3	9	9.6

*For the purpose of estimating the peak friction angle of this single specimen the cohesion was assumed equal to zero. The material friction angle should be estimated based on a Mohr-Coulomb envelope with at least three points.

Water content taken within 1mm of shear surfaces = n/a

TEST PROCEDURE

As requested by the client, the test was performed as described below:
- The specimen was unloaded to 50 kPa normal stress and was allowed to swell untill primary swelling was complete, followed by the shearing stage.
- after the peak or initial cycle the rate of displacement was increased to 0.016 mm/min and reversing switches allowed the machine to continuously cycle backwards and forwards until the shear stress reached a constant value.
- after the residual value was determined the test contiuned to the third and final stage with 300 kPa normal stress.

DIRECT SHEAR TEST - CONSOLIDATED DRAINED
SUMMARY OF TEST PLOTS

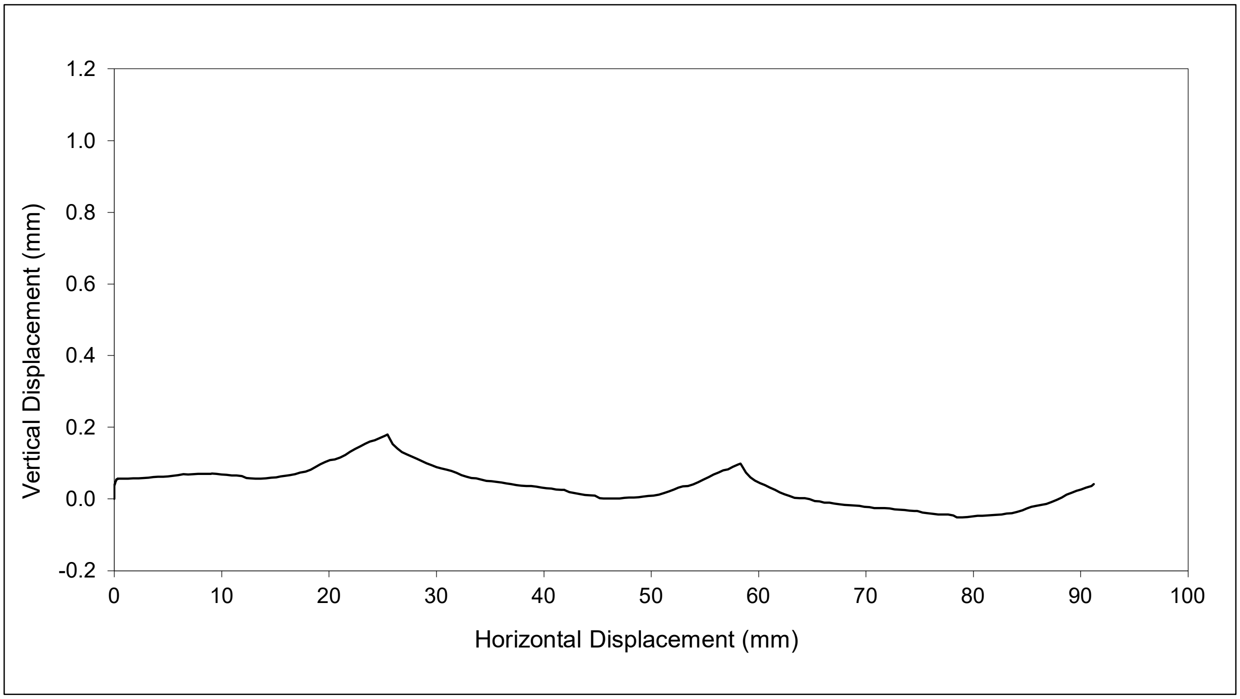
Trek Geotechnical Inc.
FILE NUMBER: 36019

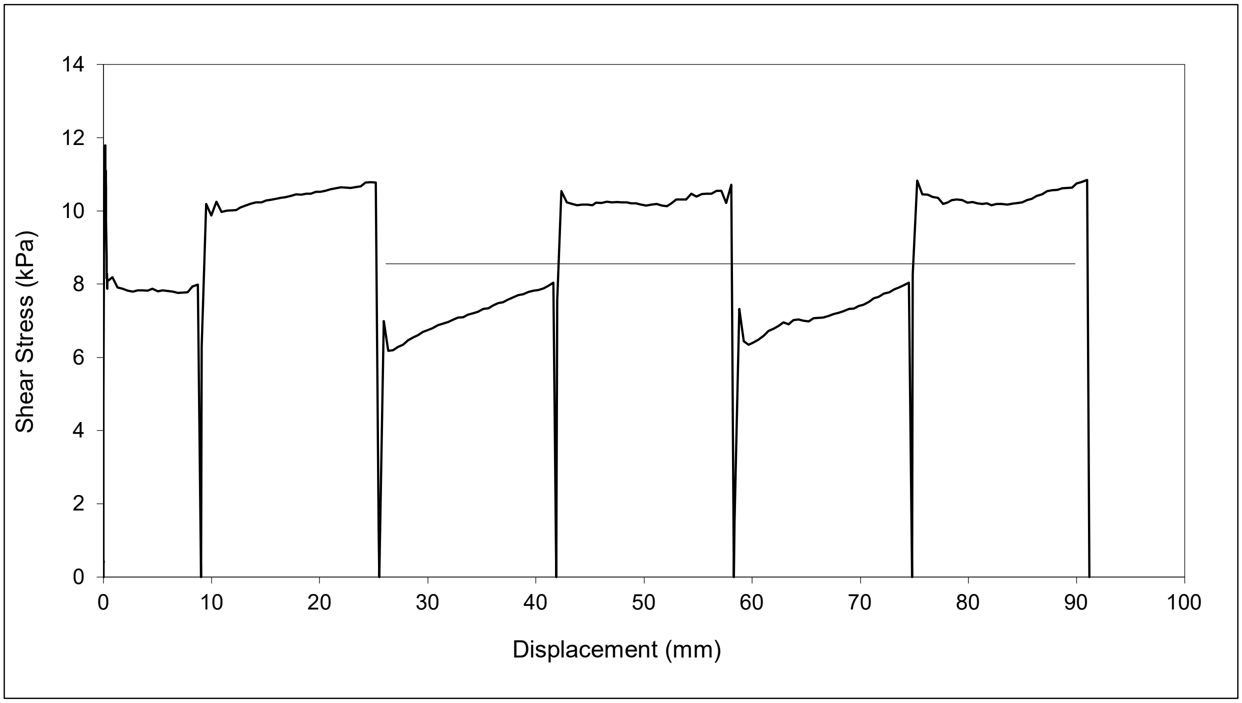
REPORT DATE: Dec 6/22
REPORT NUMBER: DS22-1b

Lagimodiere/Concordia Overpass (0002-130-00)

Sample: TH22-06, T94, 10'6" - 11'2"

Normal Stress: 50 kPa





THURBER ENGINEERING LTD.

DIRECT SHEAR TEST - CONSOLIDATED DRAINED
SUMMARY OF TEST RESULTS

Trek Geotechnical Inc.		REPORT DATE:	Dec 6/22
FILE NUMBER:	36019	REPORT NUMBER:	DS22-1c (Stage III)

Lagimodiere/Concordia Overpass (0002-130-00)

Test Date: Nov 25/22
Sample: TH22-06, T94, 10'6" - 11'2"
Description: Clay (CH), silty, trace silt lenses, coal, oxides, brown and grey.

	Start of Test	End of Consolidation	Index Properties	
Wet Density (kg/m^3):	N/A	N/A	Sand (%):	-
Dry Density (kg/m^3):	N/A	N/A	Silt (%):	-
Water Content (%):	N/A	47.5	Clay (%):	-
Void Ratio:	N/A	N/A		
Saturation (%):	N/A	N/A	Liquid Limit (%):	-
Rate of Shear (mm/min)	0.0006	0.0160	Plastic Limit (%):	-
Est. specific gravity:	2.75		Plastic. Index (%):	-

AFTER TEST NOTES

NORMAL STRESS (kPa)	PEAK SHEAR STRESS (kPa)	PEAK PHI (0 cohesion)* (degrees)	RESIDUAL SHEAR STRESS (kPa)	RESIDUAL PHI (0 cohesion) (degrees)
300	45.3	8.6	39	7.3

*For the purpose of estimating the peak friction angle of this single specimen the cohesion was assumed equal to zero. The material friction angle should be estimated based on a Mohr-Coulomb envelope with at least three points.

Water content taken within 1mm of shear surfaces = 47.6%

1) Extrusion was light and the reservoir water was clear.
   Extruded material was silt and clay.

2) Top Cap was level.

3) Top Shear Plane: Smooth with polished areas and slight undulations. Plane was raised towards on side and lower on the other side with a 2mm relief. The surace was softened.

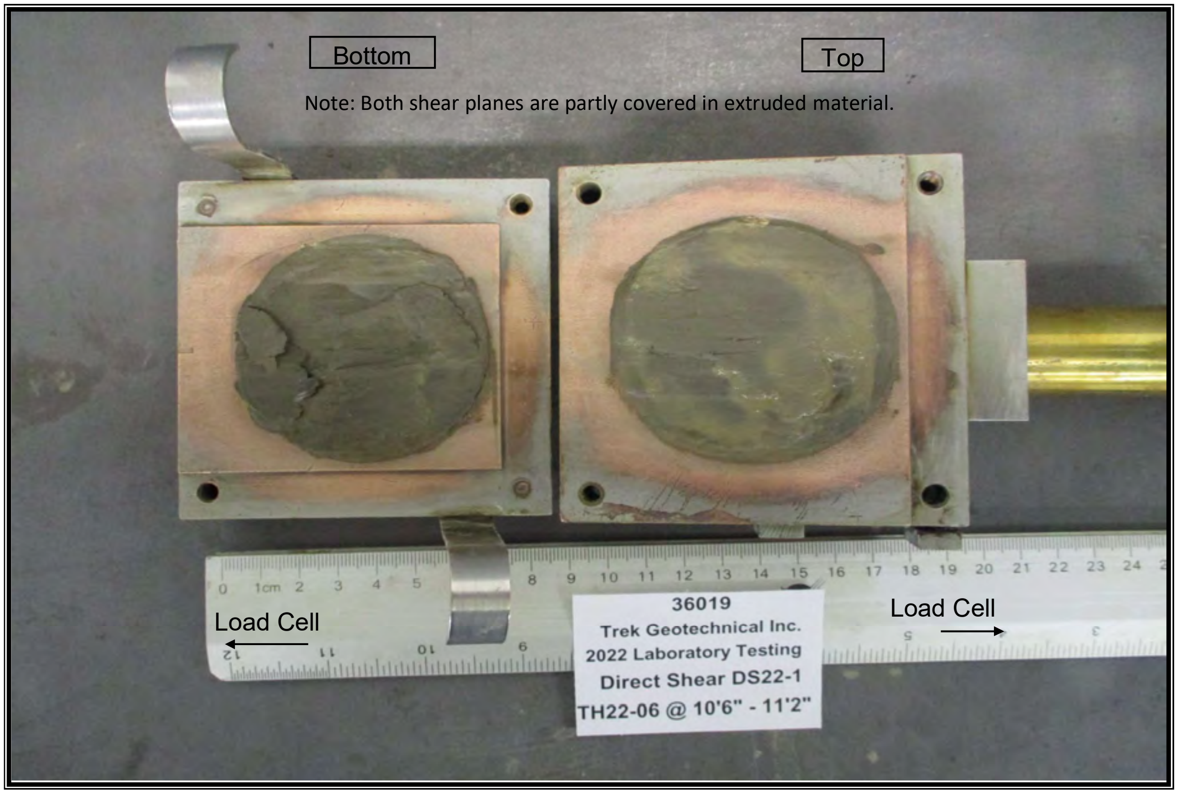
4) Bottom Shear Plane: Smooth with polshed areas and undulated. Plane was depressed through the plane towards on side and slightly raised on the other side with a 2mm relief.
   The surface was softened.

DIRECT SHEAR TEST - CONSOLIDATED DRAINED
SUMMARY OF TEST RESULTS

Trek Geotechnical Inc.		REPORT DATE:	Dec 6/22
FILE NUMBER:	36019	REPORT NUMBER:	DS22-1c

Lagimodiere/Concordia Overpass (0002-130-00)

Sample: TH22-06, T94, 10'6" - 11'2"



Note: Both shear planes are partly covered in extruded material.

PHOTO OF SHEAR PLANE AFTER DISMANTLE

TEST MACHINE

Wykeham Farrance direct test apparatus with a 60 mm diameter round shear box. Vertical and horizontal strains were measured by electronic displacement transducer. The normal force was applied by dead weights on a 10:1 lever loading loading yoke. The shear stress was measured with an electronic load cell.

TEST PROCEDURE

As requested by the client, the test was performed as described below.

-the specimen was consolidated in two stages until primary consolidation was complete followed by the shearing stage.

- after the peak or initial cycle the rate of displacement was increased to 0.016 mm/min and reversing switches allowed the machine to continuously cycle backwards and forwards until the shear stress reached a constant value.

DIRECT SHEAR TEST - CONSOLIDATED DRAINED
SUMMARY OF TEST PLOTS

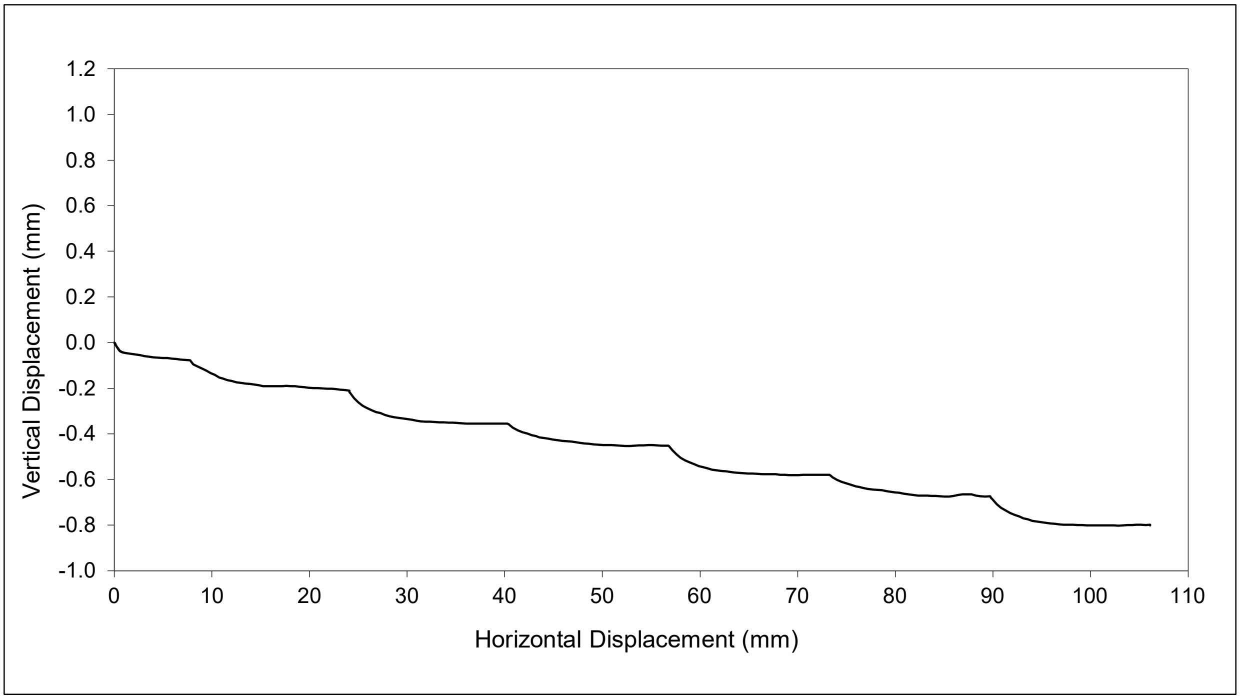
Trek Geotechnical Inc.
FILE NUMBER: 36019

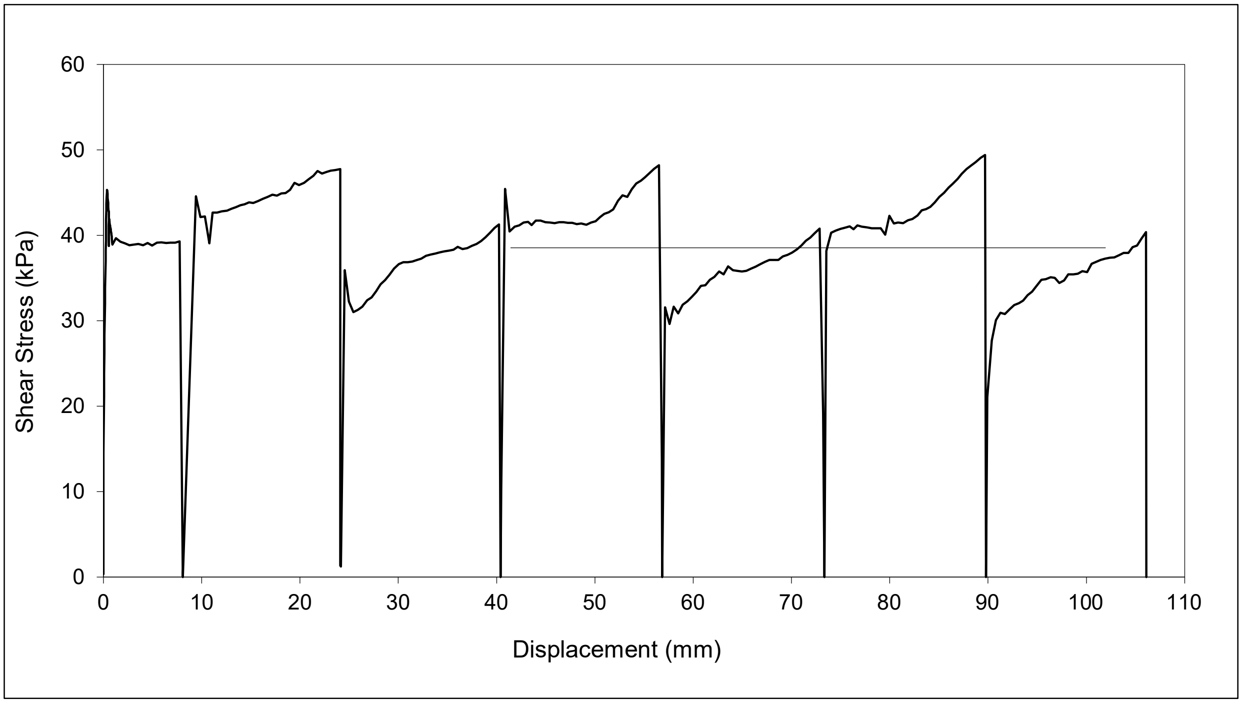
REPORT DATE: Dec 6/22
REPORT NUMBER: DS22-1c

Lagimodiere/Concordia Overpass (0002-130-00)

Sample: TH22-06, T94, 10'6" - 11'2"

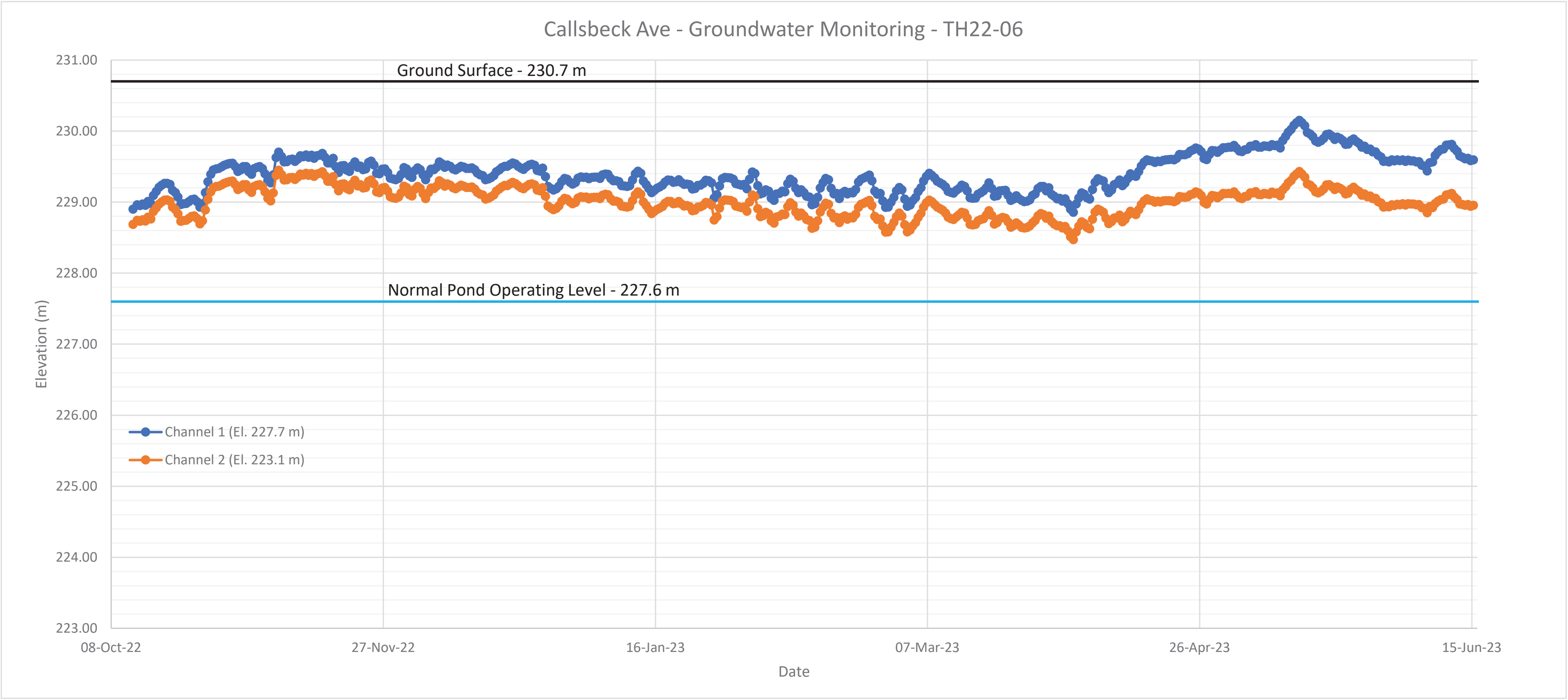
Normal Stress: 300 kPa





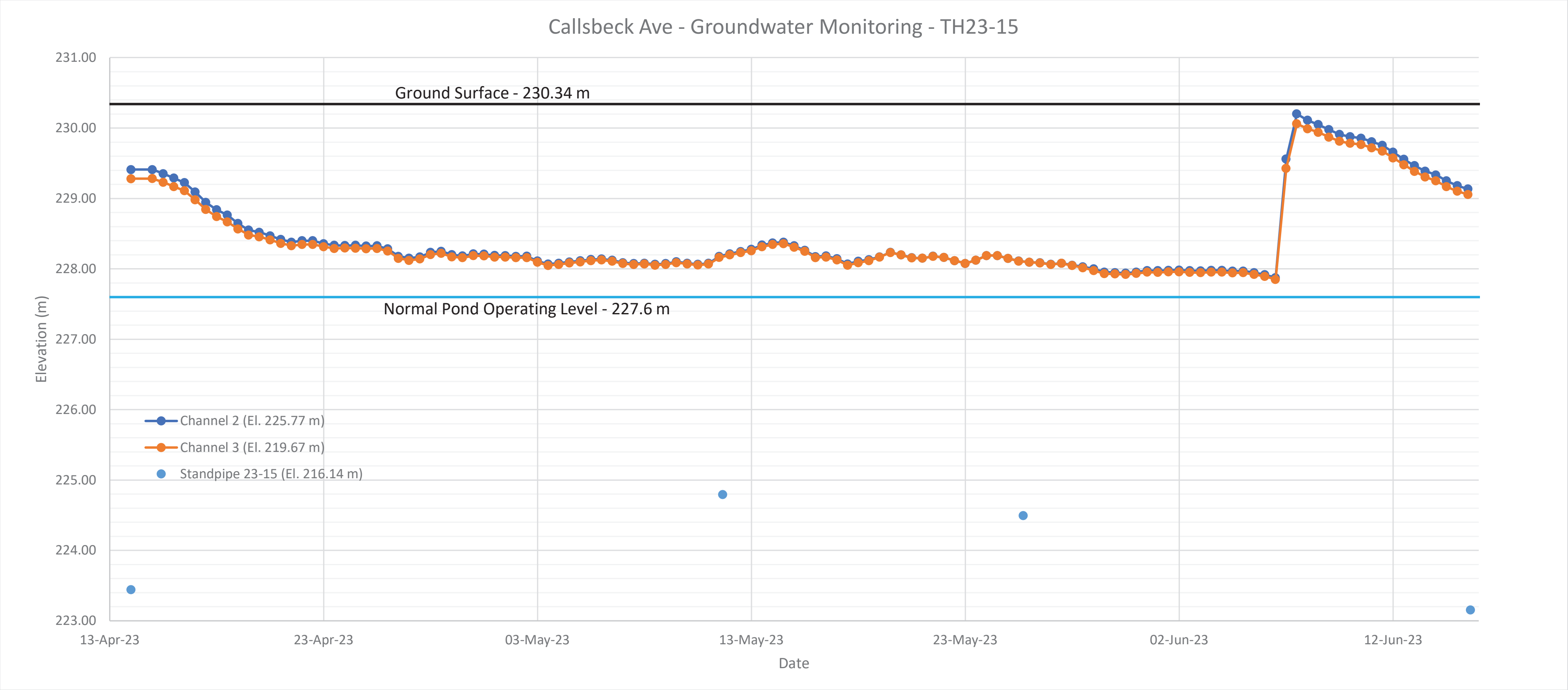
Appendix C

Retention Pond 4-12 Groundwater Monitoring



D1

Retention Pond 4-12 Groundwater Level Monitoring TH22-06



D2

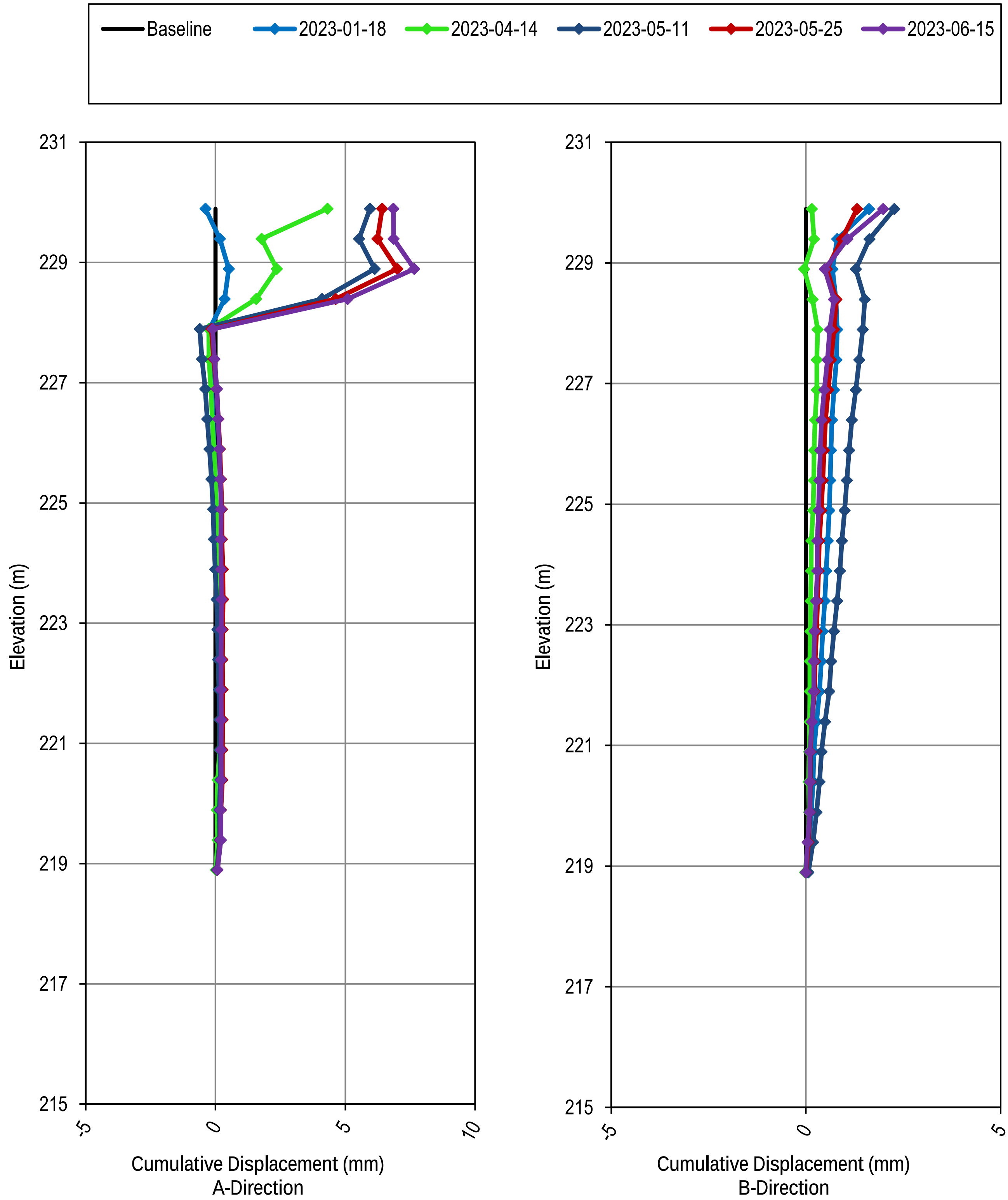
Retention Pond 4-12 Groundwater Level Monitoring TH22-06

Appendix D

Slope Inclinometer Monitoring

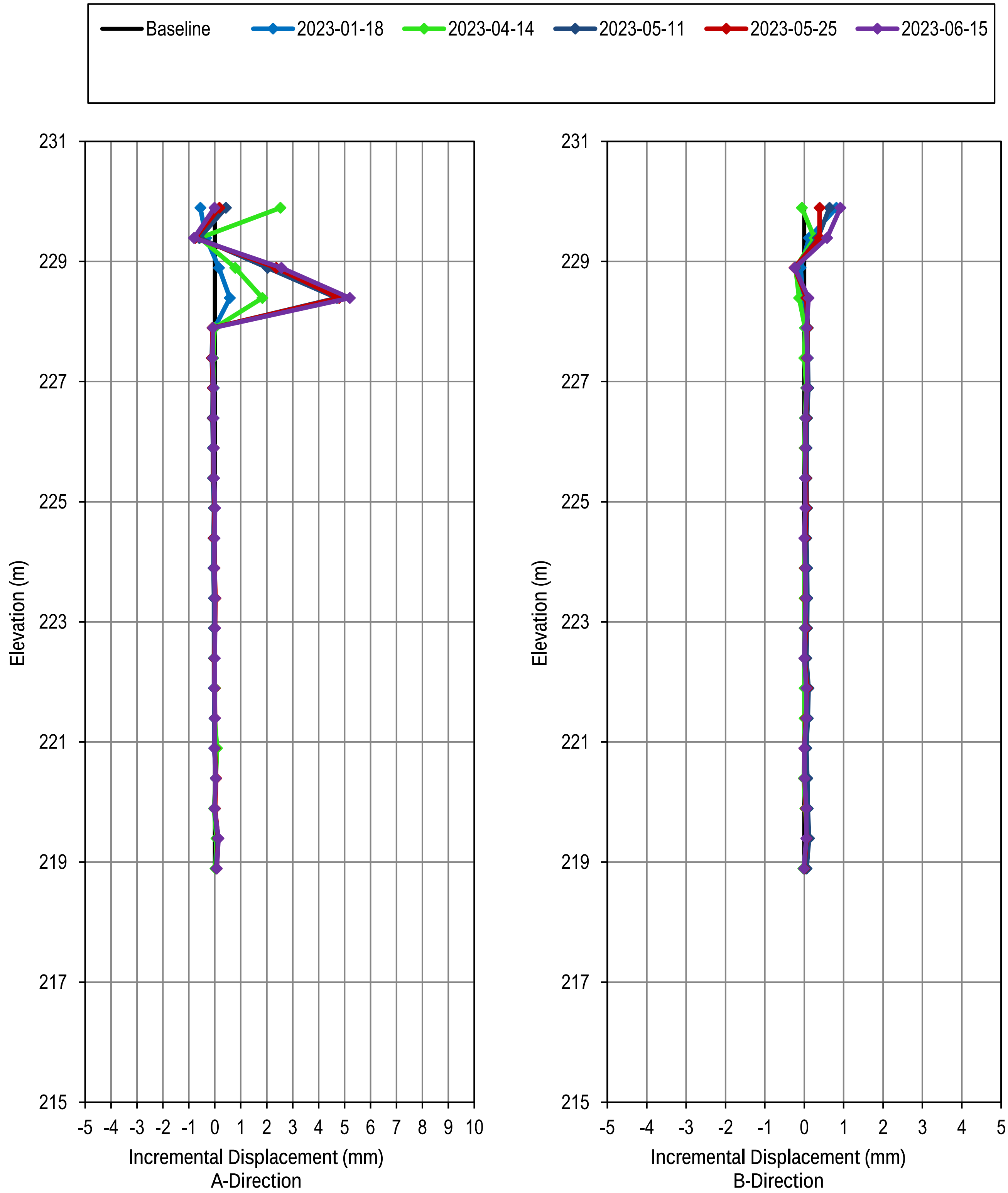
SLOPE INCLINOMETER DATA PLOTS

TH22-06



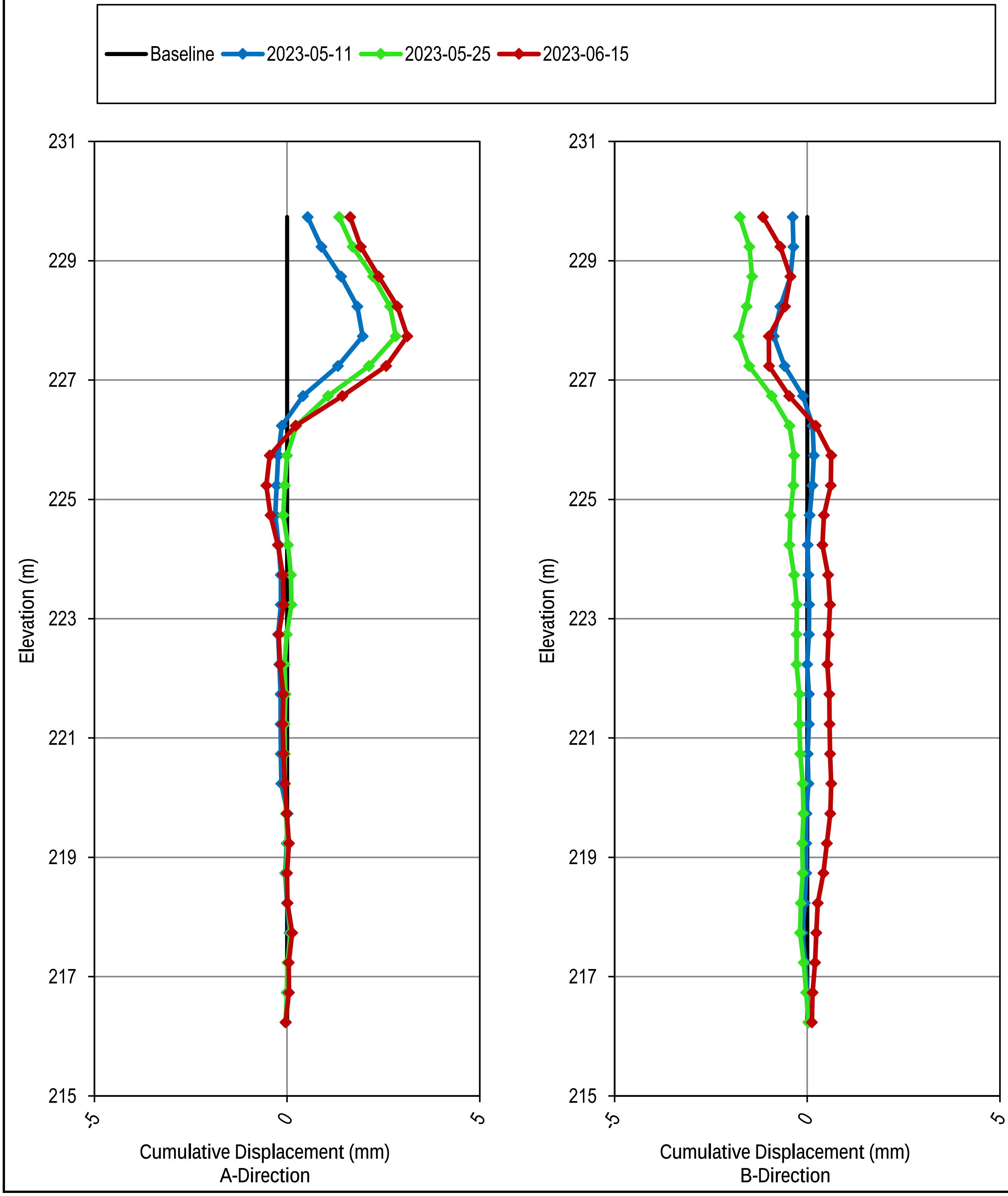
SLOPE INCLINOMETER DATA PLOTS

TH22-06



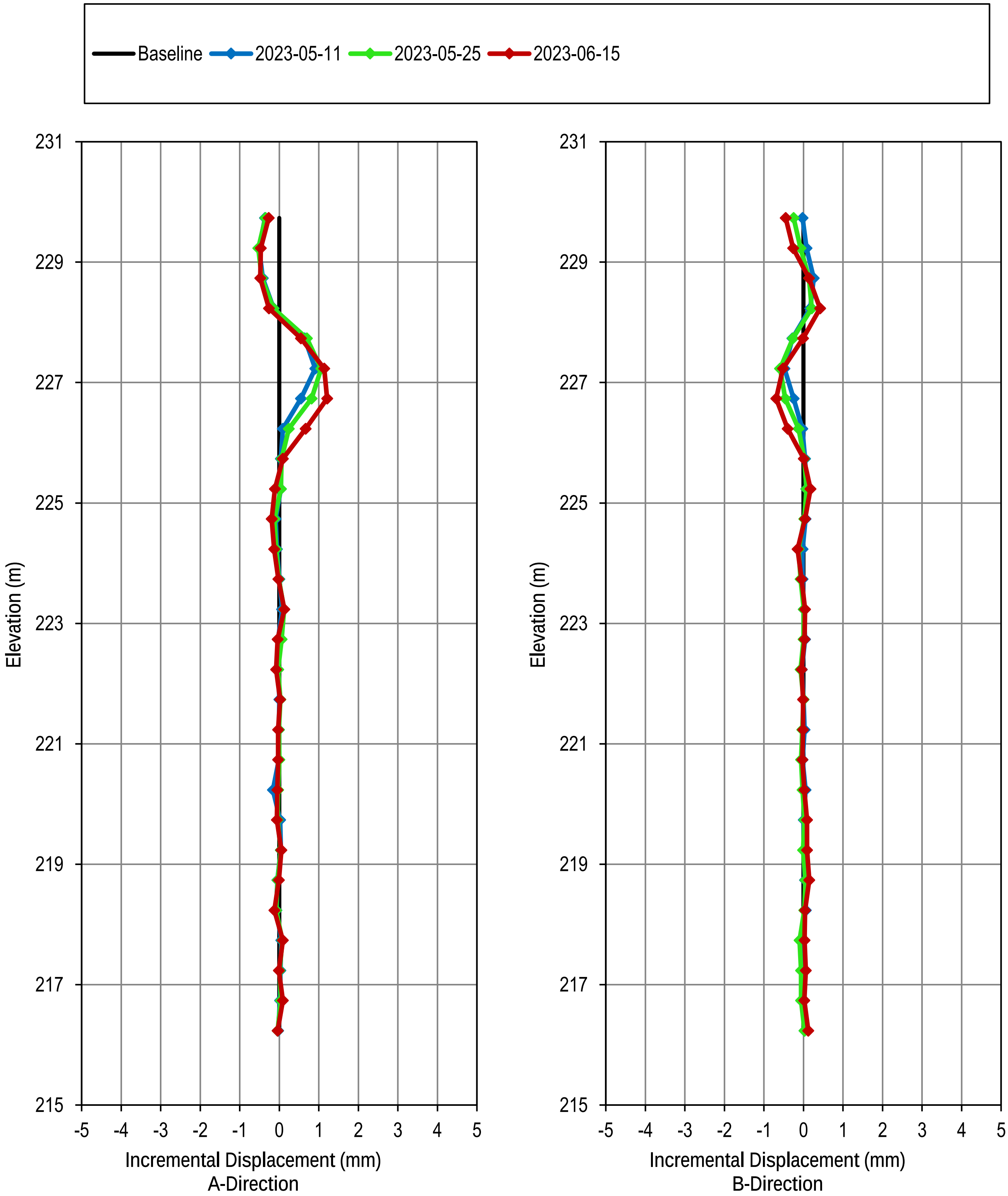
SLOPE INCLINOMETER DATA PLOTS

TH23-15



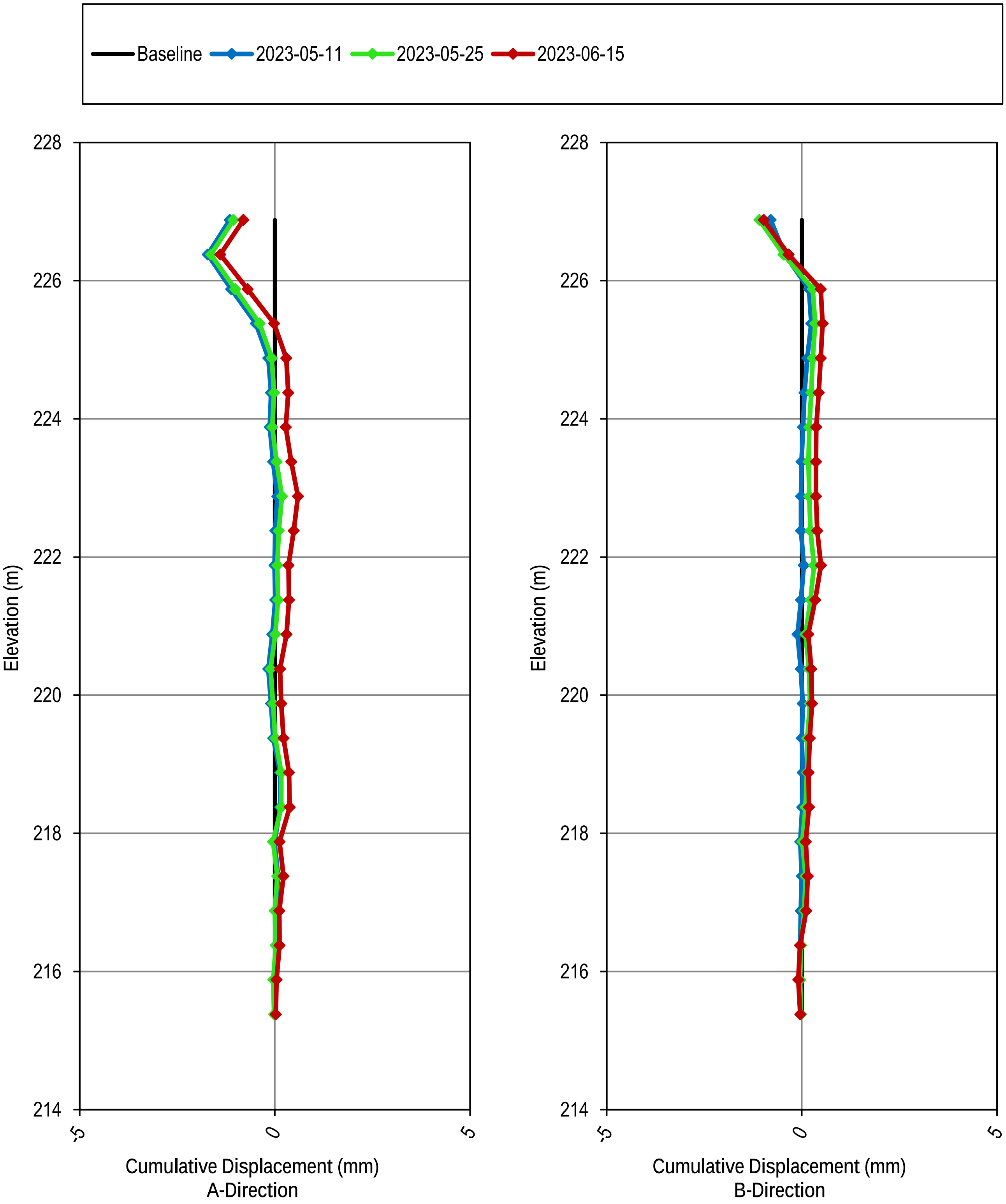
SLOPE INCLINOMETER DATA PLOTS

TH23-15



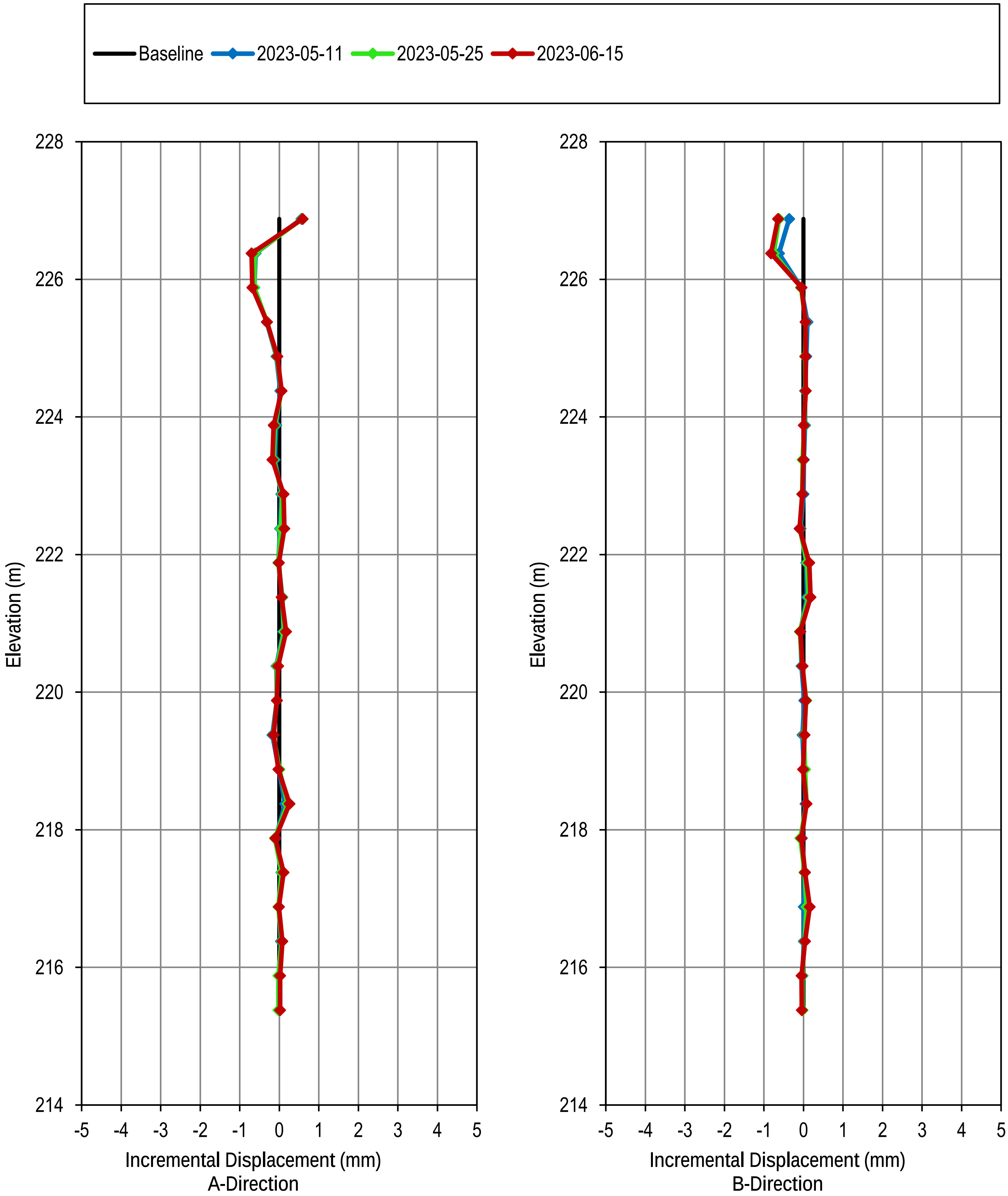
SLOPE INCLINOMETER DATA PLOTS

TH23-16



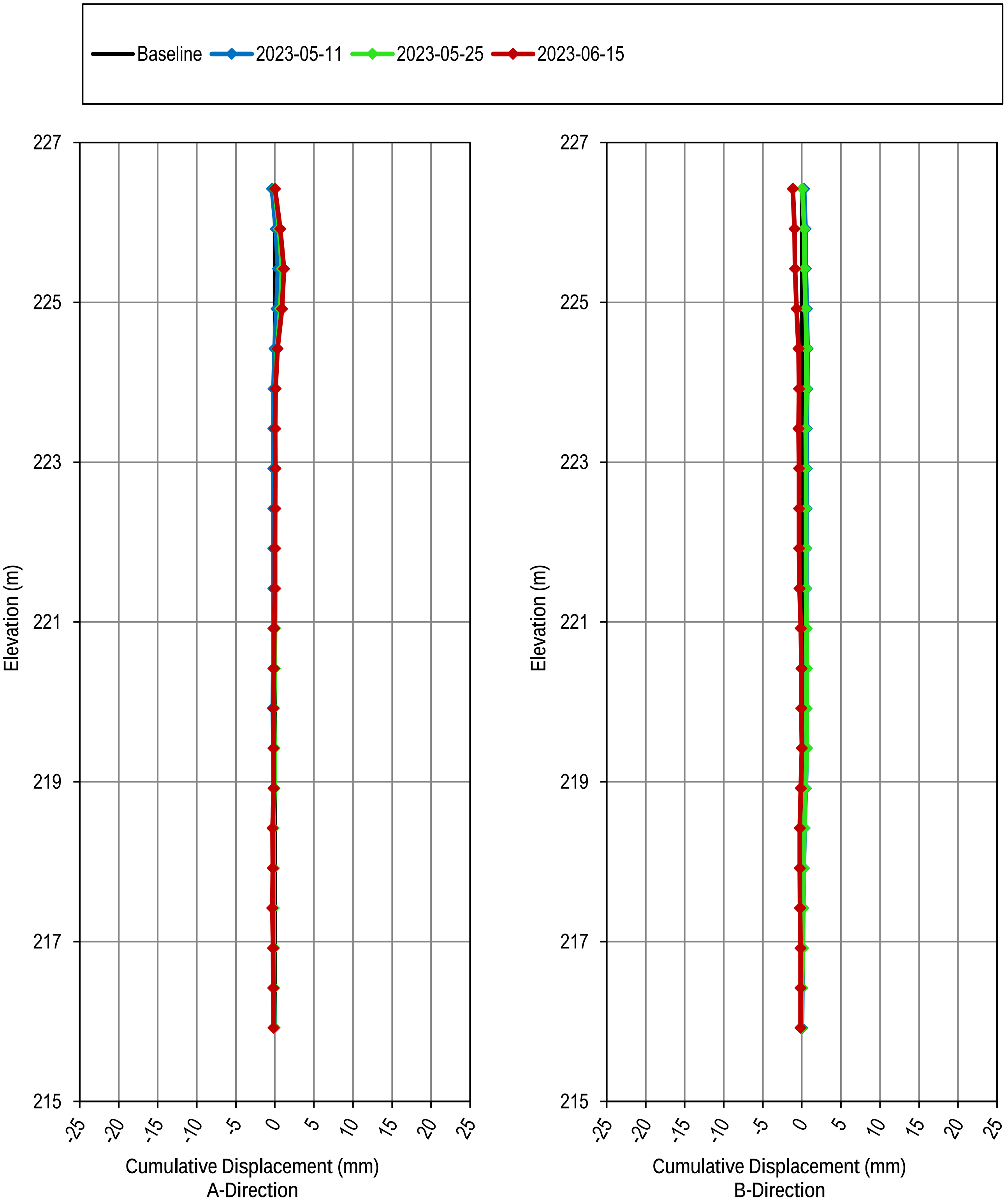
SLOPE INCLINOMETER DATA PLOTS

TH23-16



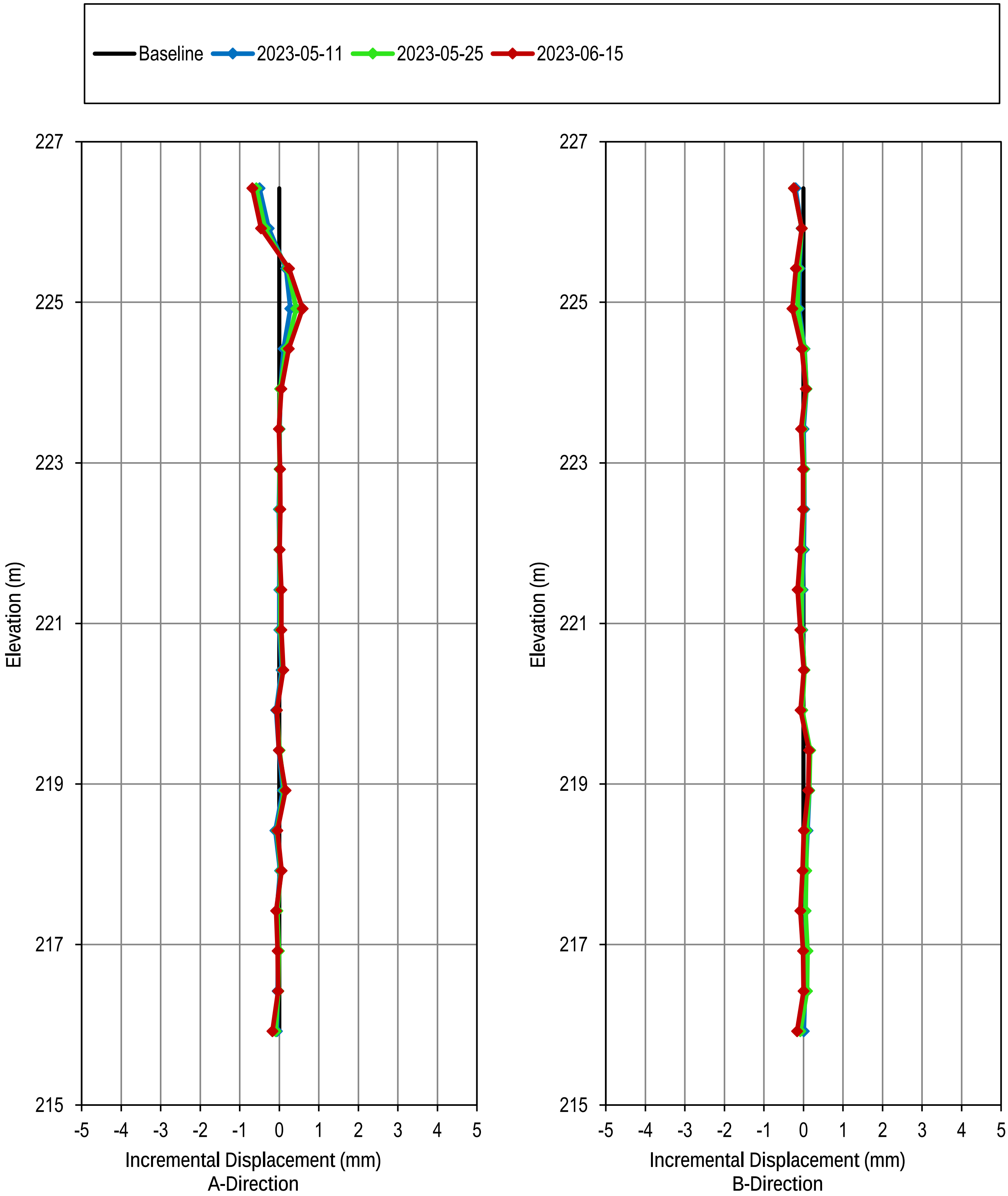
SLOPE INCLINOMETER DATA PLOTS

TH23-17



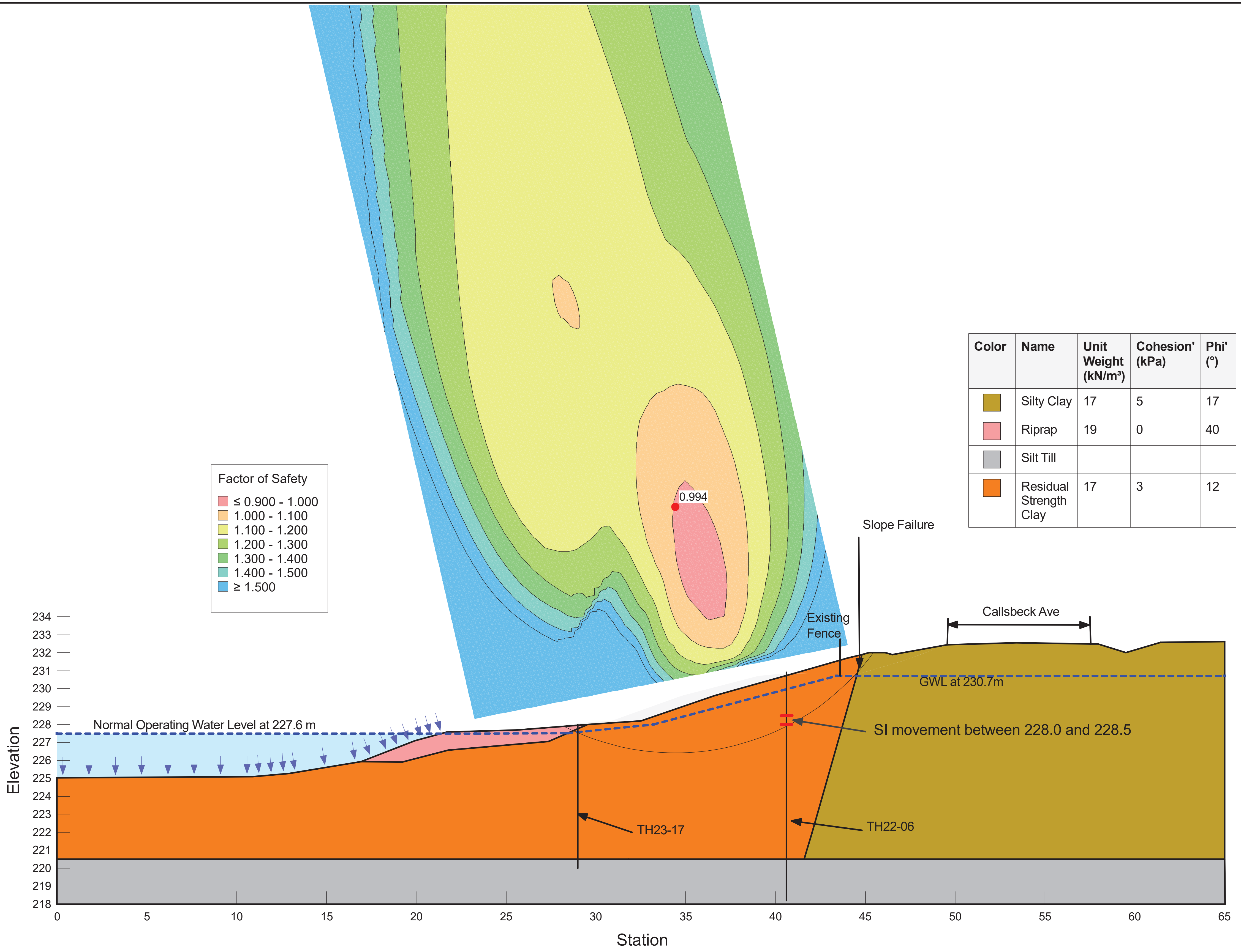
SLOPE INCLINOMETER DATA PLOTS

TH23-17



Appendix E

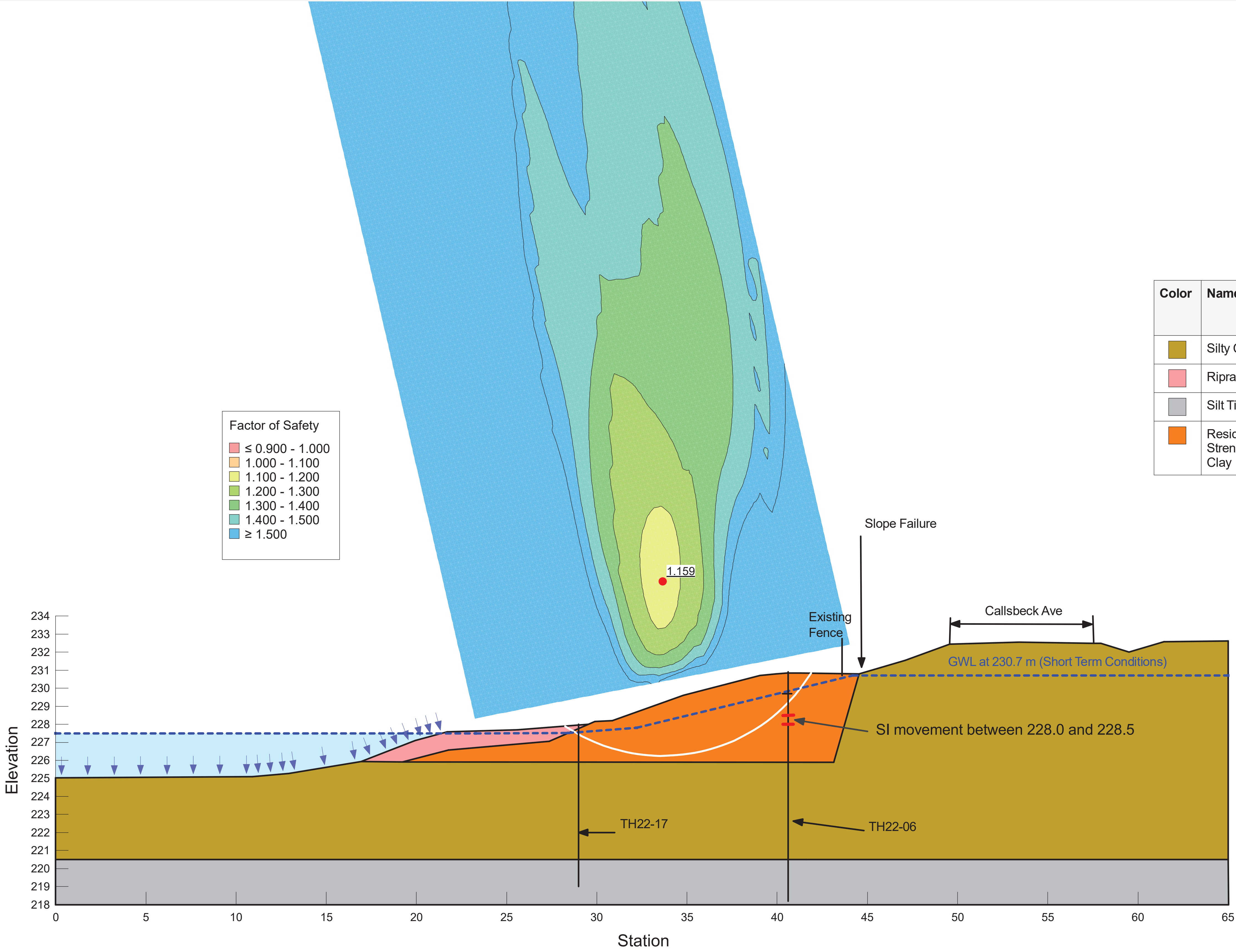
Slope Stability Analysis Outputs



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟫	Silty Clay	17	5	17
🟥	Riprap	19	0	40
⬜	Silt Till			
🟧	Residual Strength Clay	17	3	12

Figure E01

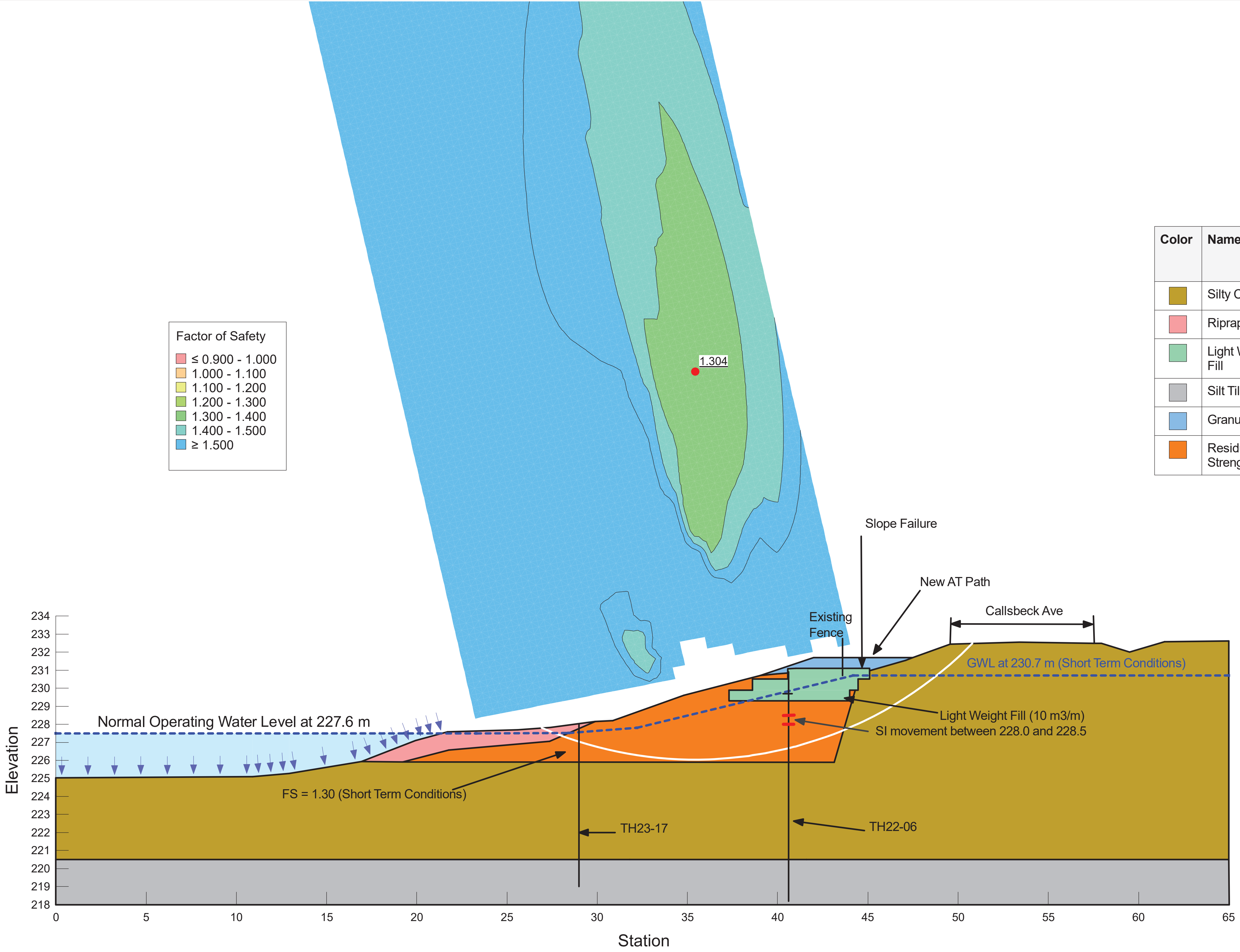
Retention Pond 4-12 South Slope
Back-Analysis (Pre-Failure Geometry)



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟫	Silty Clay	17	5	17
🟥	Riprap	19	0	40
⬜	Silt Till			
🟧	Residual Strength Clay	17	3	12

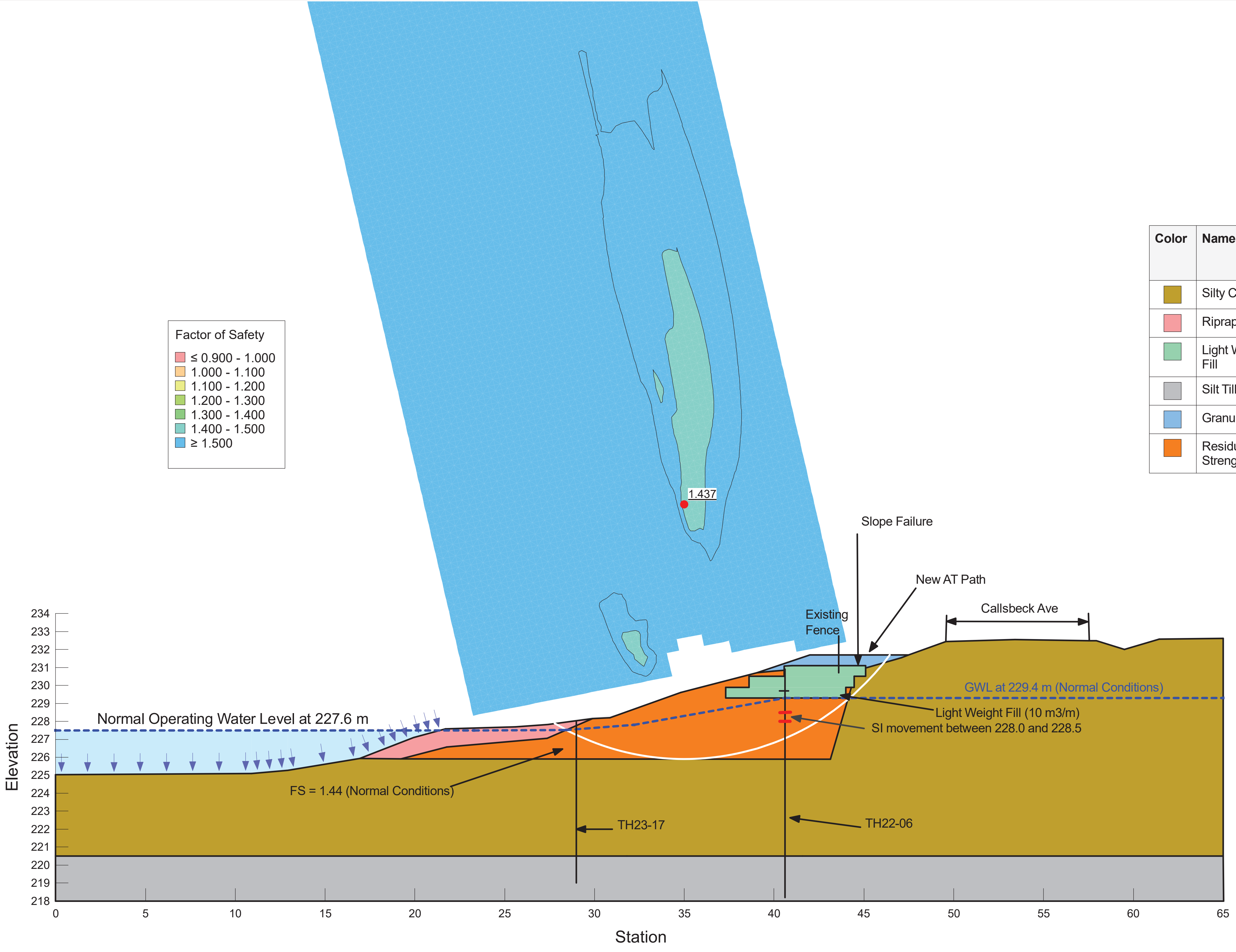
Figure E02

Retention Pond 4-12 South Slope
Existing / Post-Failure Geometry



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟨	Silty Clay	17	5	17
🟥	Riprap	19	0	40
🟩	Light Weight Fill	5	30	0
⬜	Silt Till			
🟦	Granular Fill	20	0	30
🟧	Residual Strength Clay	17	3	12

Figure E03
Retention Pond 4-12 South Slope - Short Term
AT Path Option 1 Post Failure Geometry + Lightweight Fill + AT Path

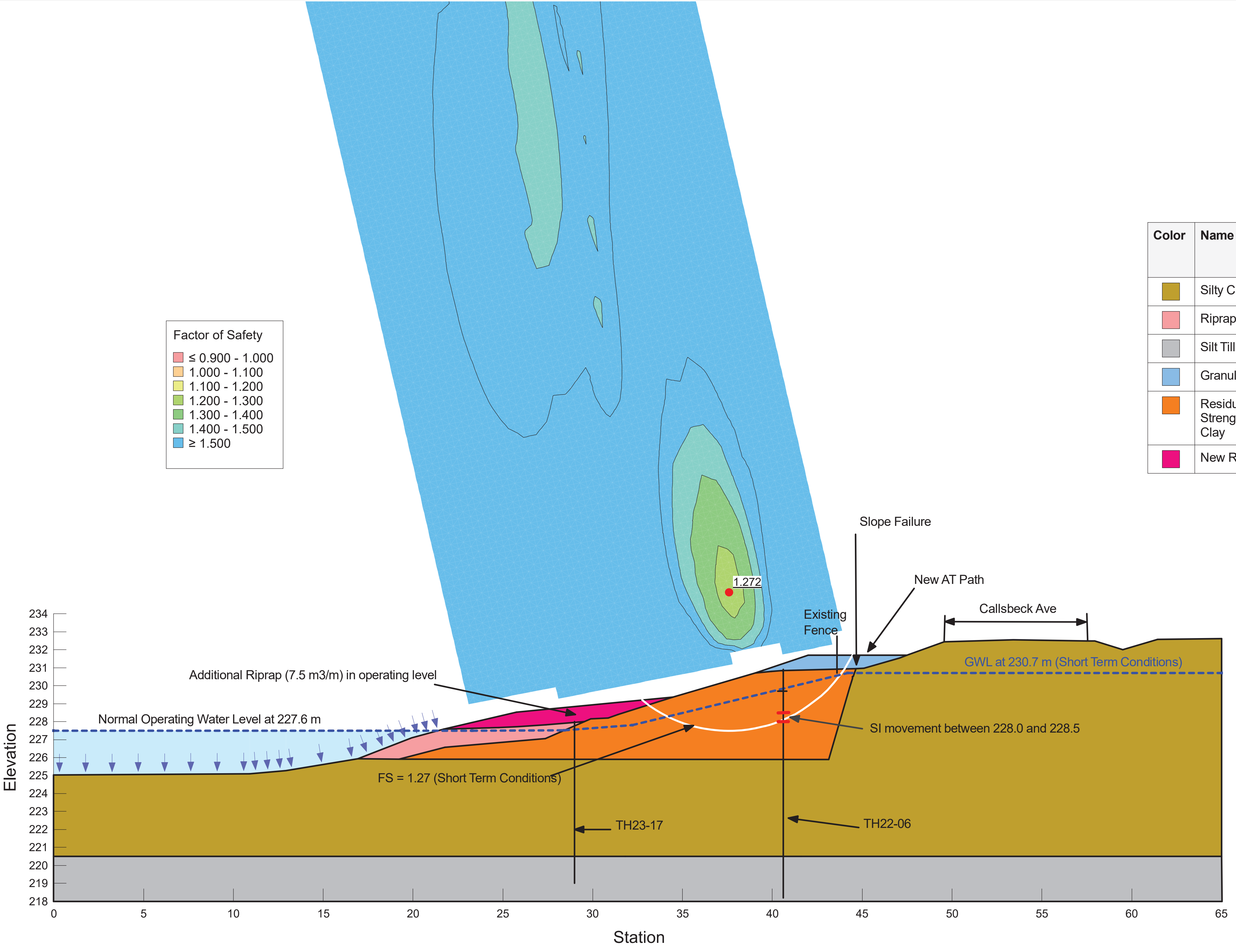


Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟫	Silty Clay	17	5	17
🟥	Riprap	19	0	40
🟩	Light Weight Fill	5	30	0
⬜	Silt Till			
🟦	Granular Fill	20	0	30
🟧	Residual Strength Clay	17	3	12

Figure E04

Retention Pond 4-12 South Slope - Long Term

AT Path Option 1 Post Failure Geometry + Lightweight Fill + AT Path



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟫	Silty Clay	17	5	17
🟥	Riprap	19	0	40
⬜	Silt Till			
🟦	Granular Fill	20	0	30
🟧	Residual Strength Clay	17	3	12
🟪	New Riprap	19	0	40

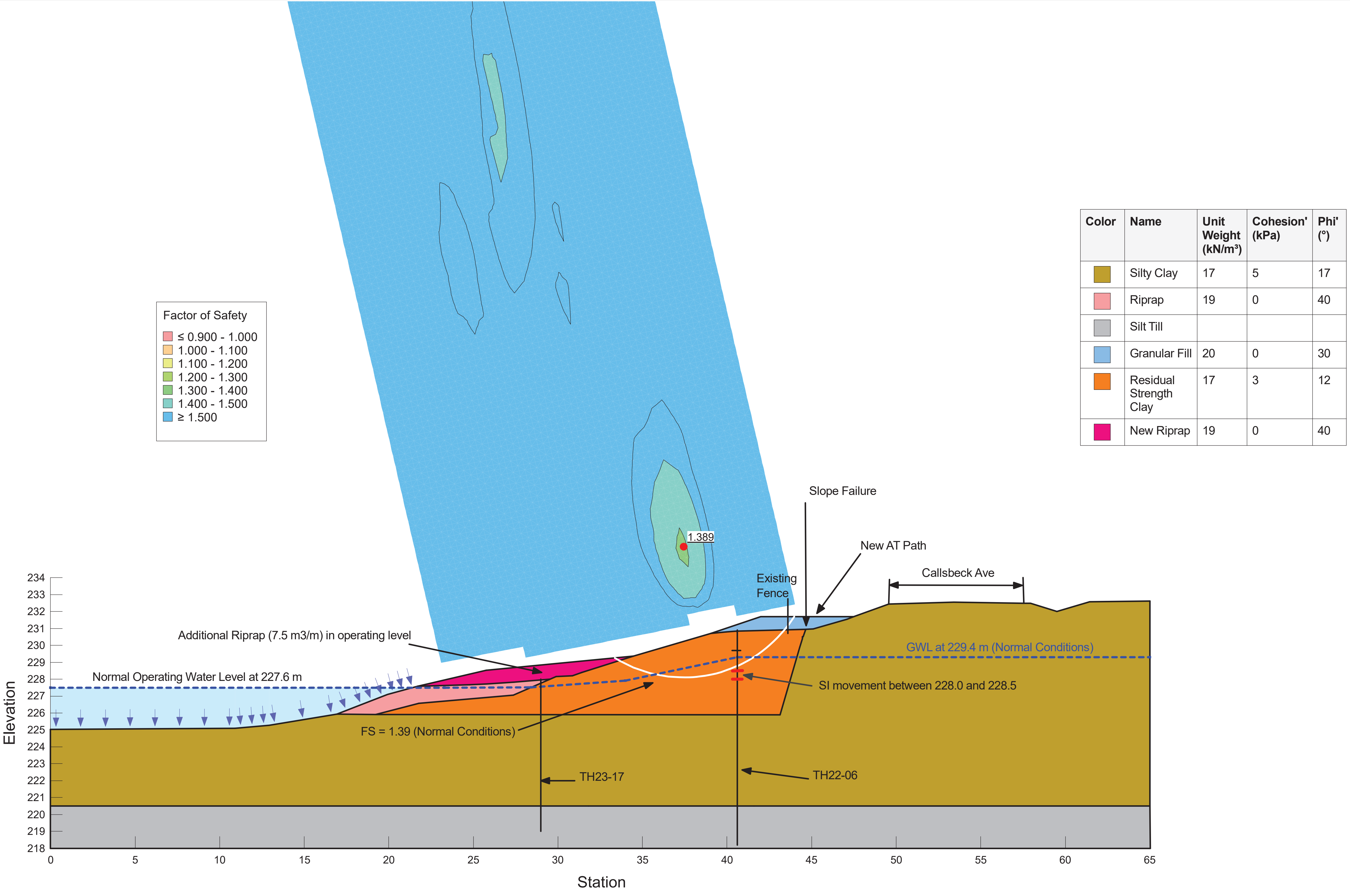
Figure E05

Retention Pond 4-12 South Slope - Short Term
AT Path Option 1 Post Failure Geometry + Mid Slope Berm+ AT Path

0002 130 00

Lagimodiere Blvd Twin Overpass Rehabilitation Preliminary Design - (RFP No. 111-2022)

Tetra Tech Inc.

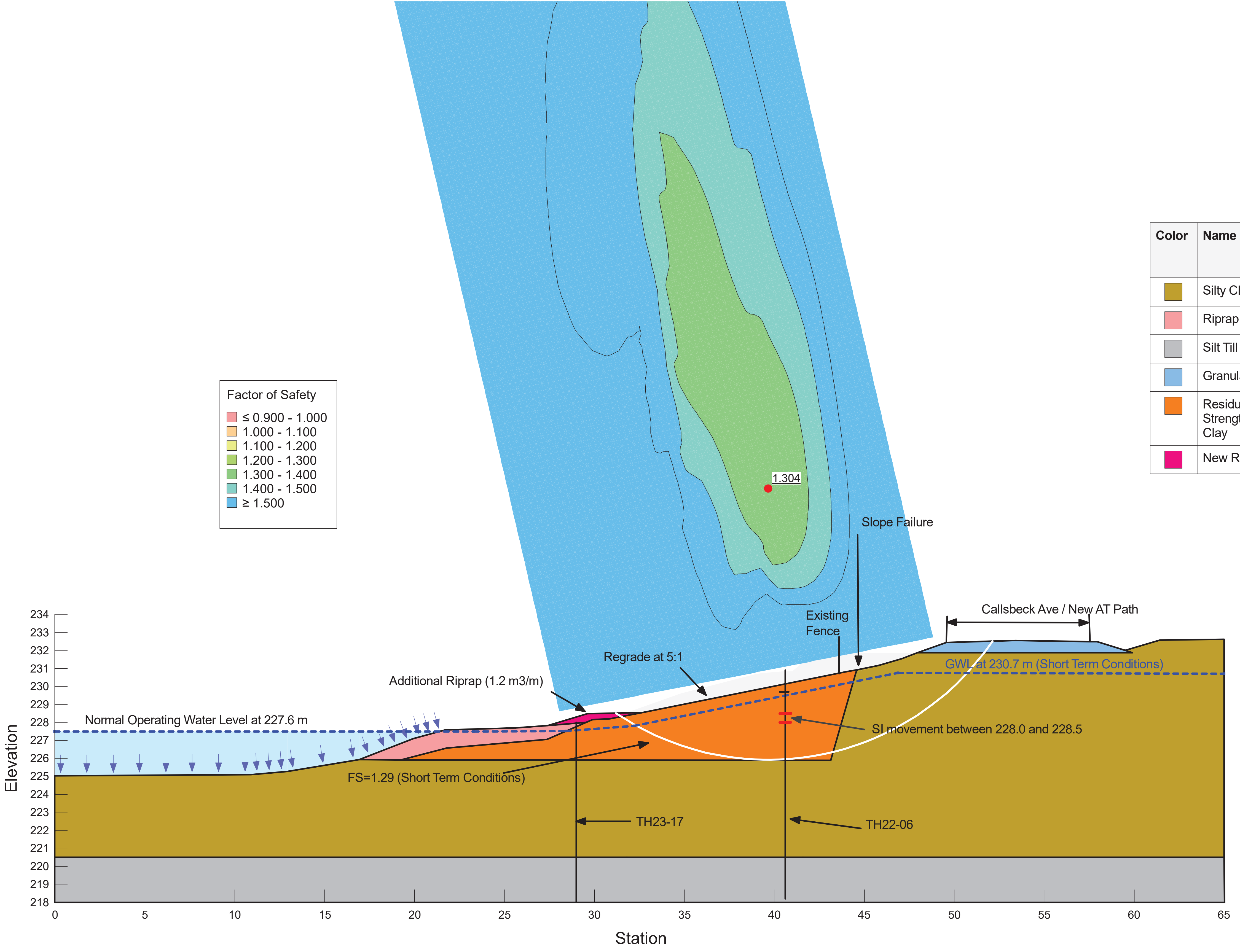


Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟫	Silty Clay	17	5	17
🟥	Riprap	19	0	40
⬜	Silt Till			
🟦	Granular Fill	20	0	30
🟧	Residual Strength Clay	17	3	12
🟪	New Riprap	19	0	40

Figure E06

Retention Pond 4-12 South Slope - Long Term

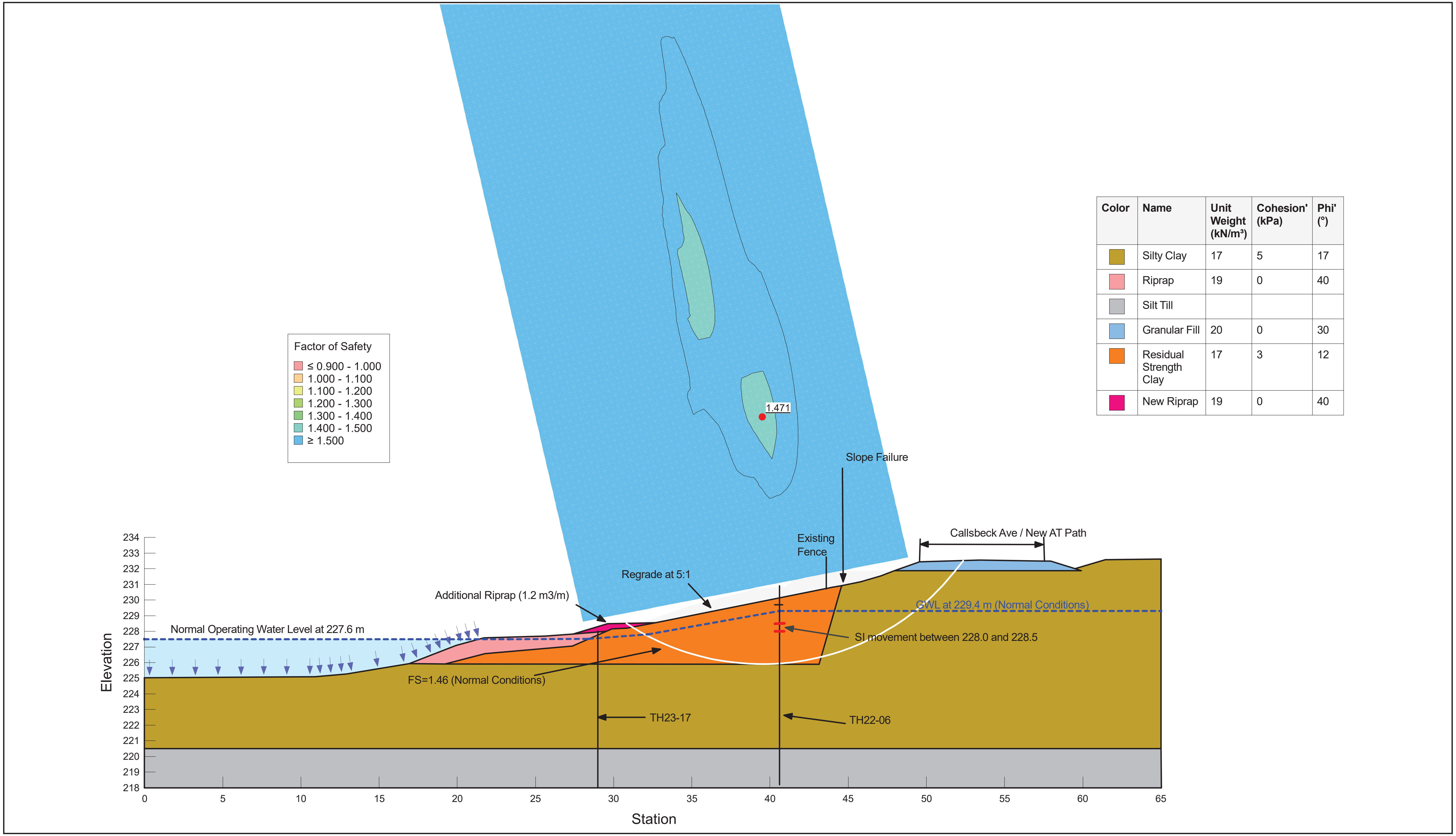
AT Path Option 1 Post Failure Geometry + Mid Slope Berm+ AT Path



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟫	Silty Clay	17	5	17
🟥	Riprap	19	0	40
⬜	Silt Till			
🟦	Granular Fill	20	0	30
🟧	Residual Strength Clay	17	3	12
🟪	New Riprap	19	0	40

Figure E07

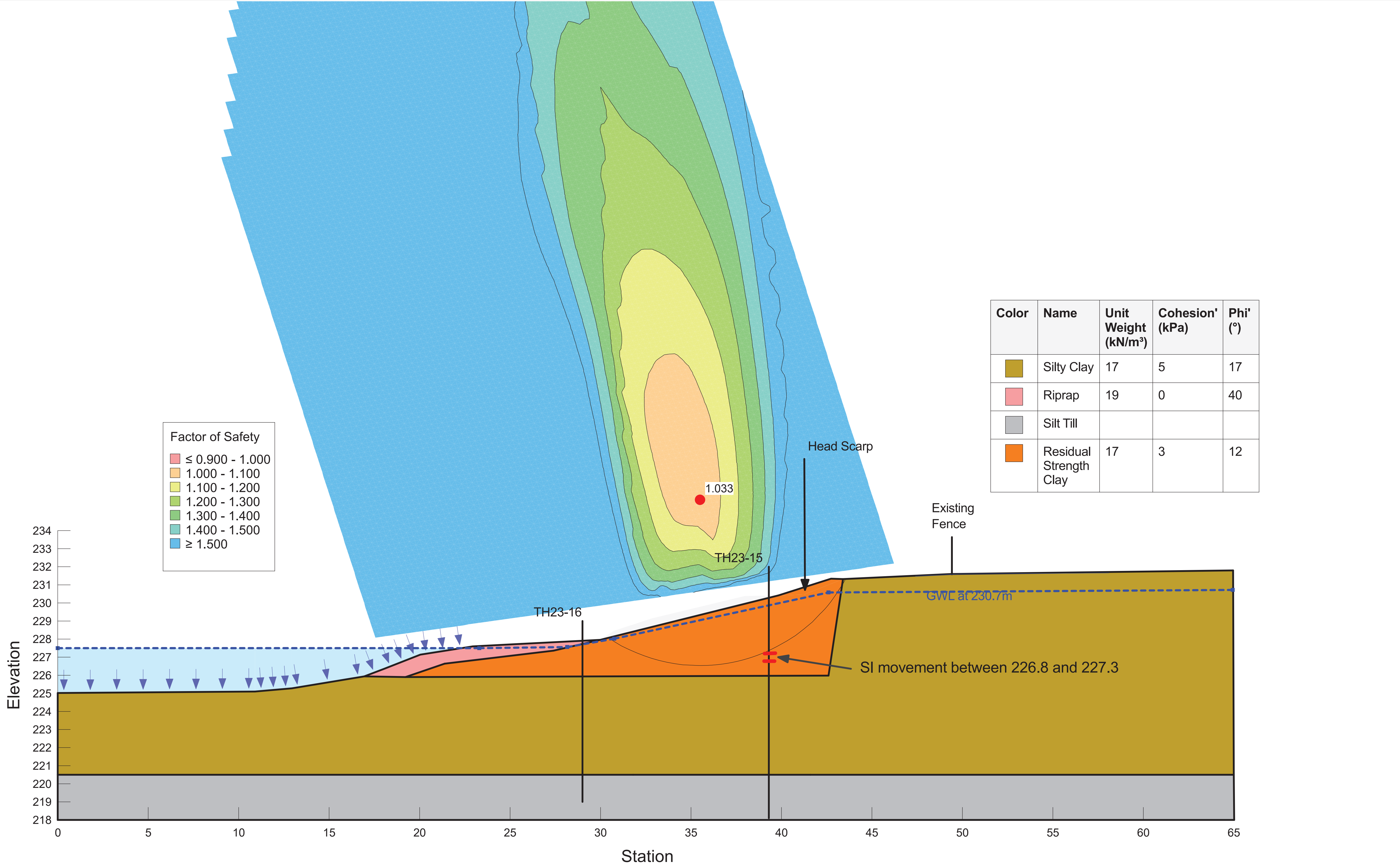
Retention Pond 4-12 South Slope - Short Term
AT Path Option 2 Post Failure Geometry + Re-grade



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟫	Silty Clay	17	5	17
🟥	Riprap	19	0	40
⬜	Silt Till			
🟦	Granular Fill	20	0	30
🟧	Residual Strength Clay	17	3	12
🟪	New Riprap	19	0	40

Figure E08

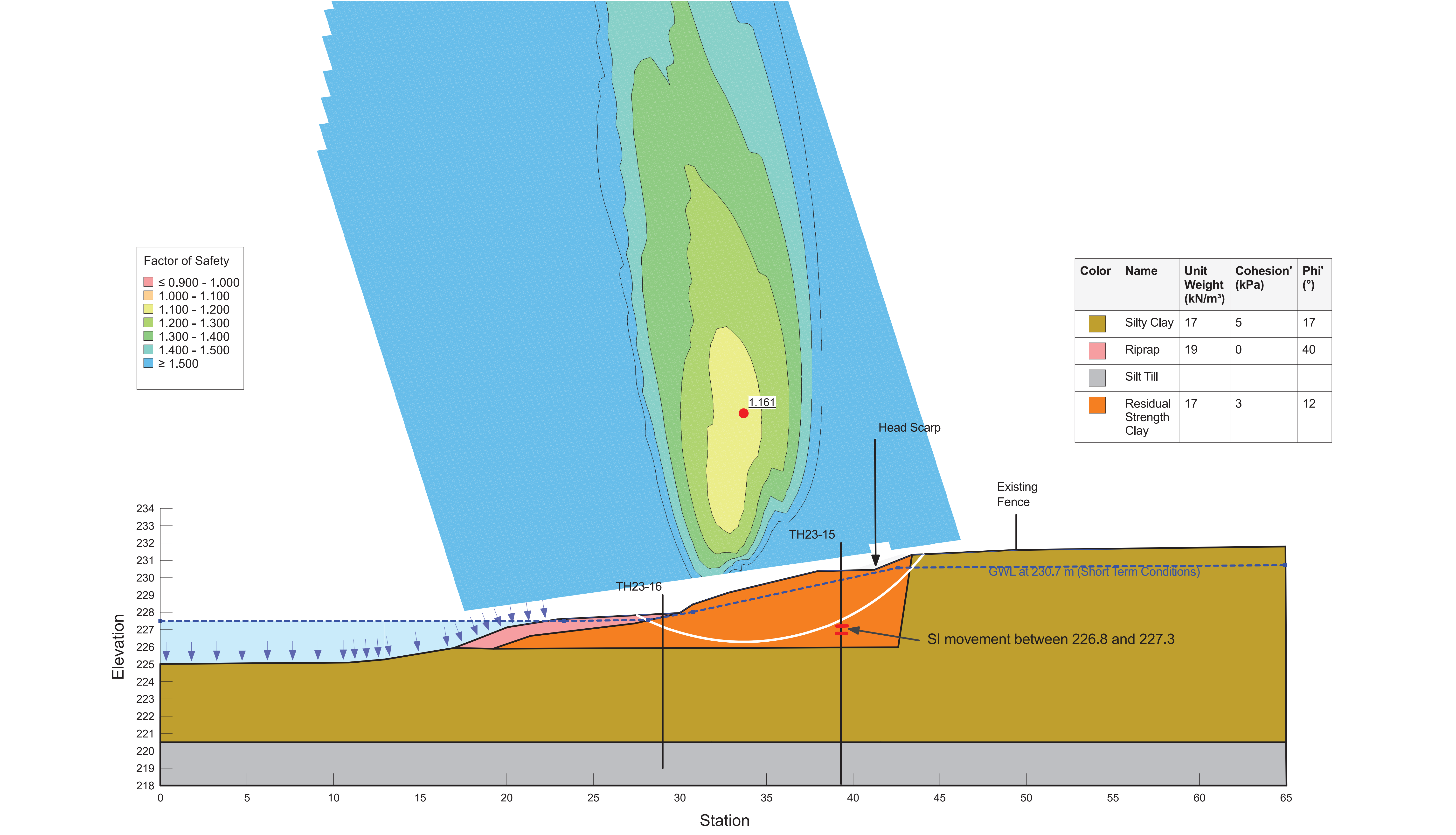
Retention Pond 4-12 South Slope - Long Term
AT Path Option 2 Post Failure Geometry + Re-grade



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟫	Silty Clay	17	5	17
🟥	Riprap	19	0	40
⬜	Silt Till			
🟧	Residual Strength Clay	17	3	12

Figure E09

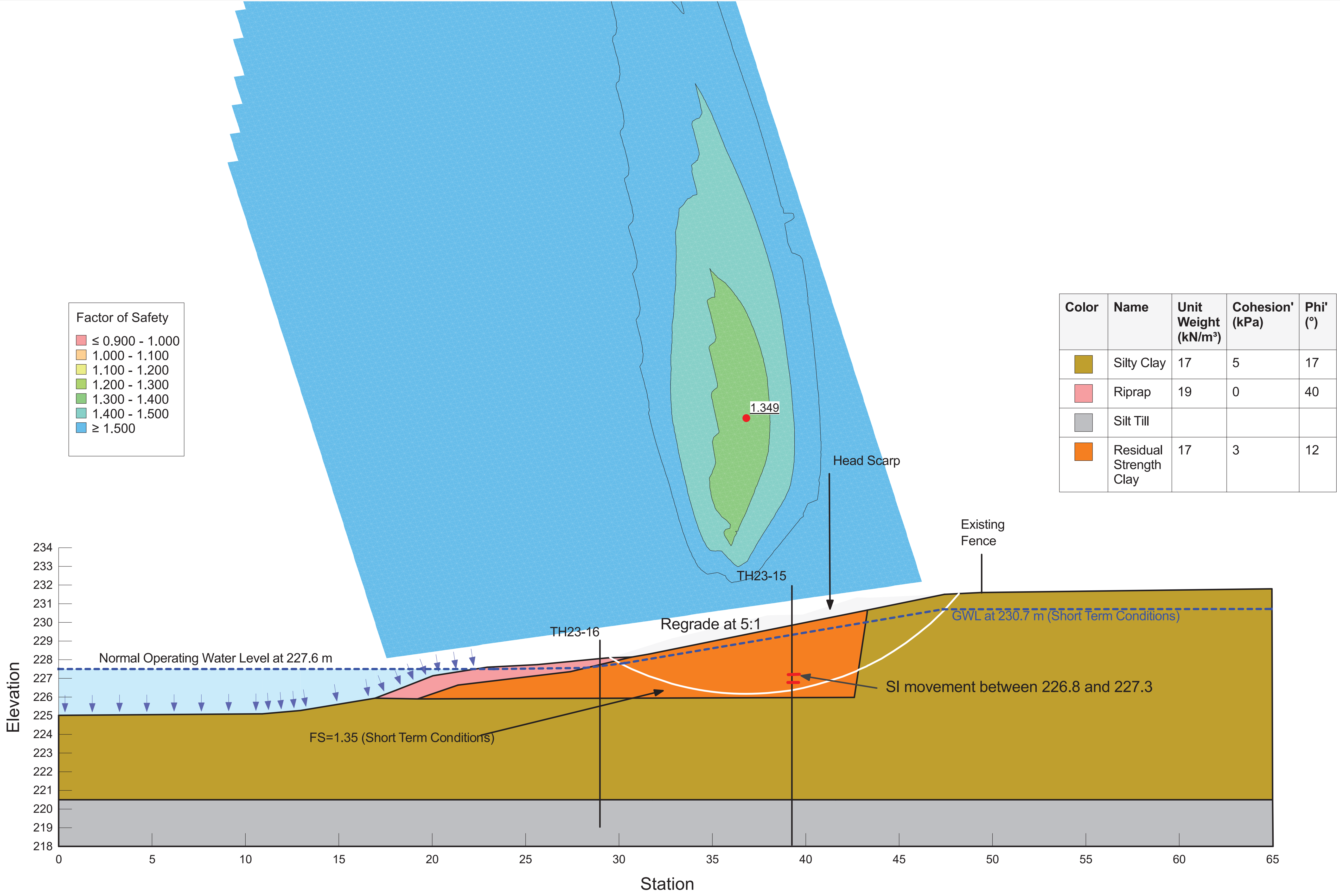
Retention Pond 4-12 Northwest Slope
Back-Analysis (Pre-Failure Geometry)



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟫	Silty Clay	17	5	17
🟥	Riprap	19	0	40
⬜	Silt Till			
🟧	Residual Strength Clay	17	3	12

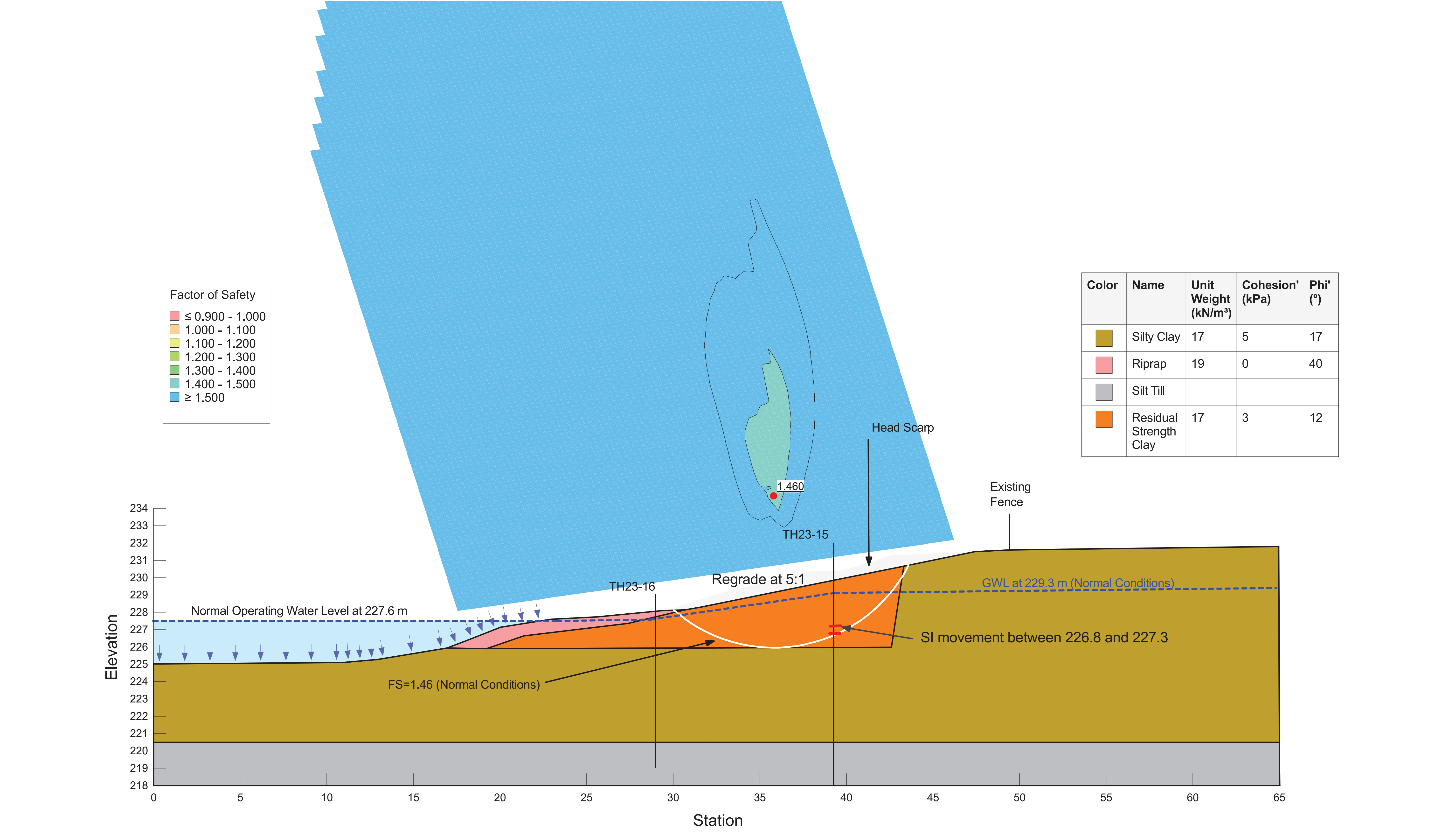
Figure E10

Retention Pond 4-12 Northwest Slope
Existing / Post-Failure Geometry



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟫	Silty Clay	17	5	17
🟥	Riprap	19	0	40
⬜	Silt Till			
🟧	Residual Strength Clay	17	3	12

Figure E11
Retention Pond 4-12 Northwest Slope - Short Term
Re-grade at 5H:1V

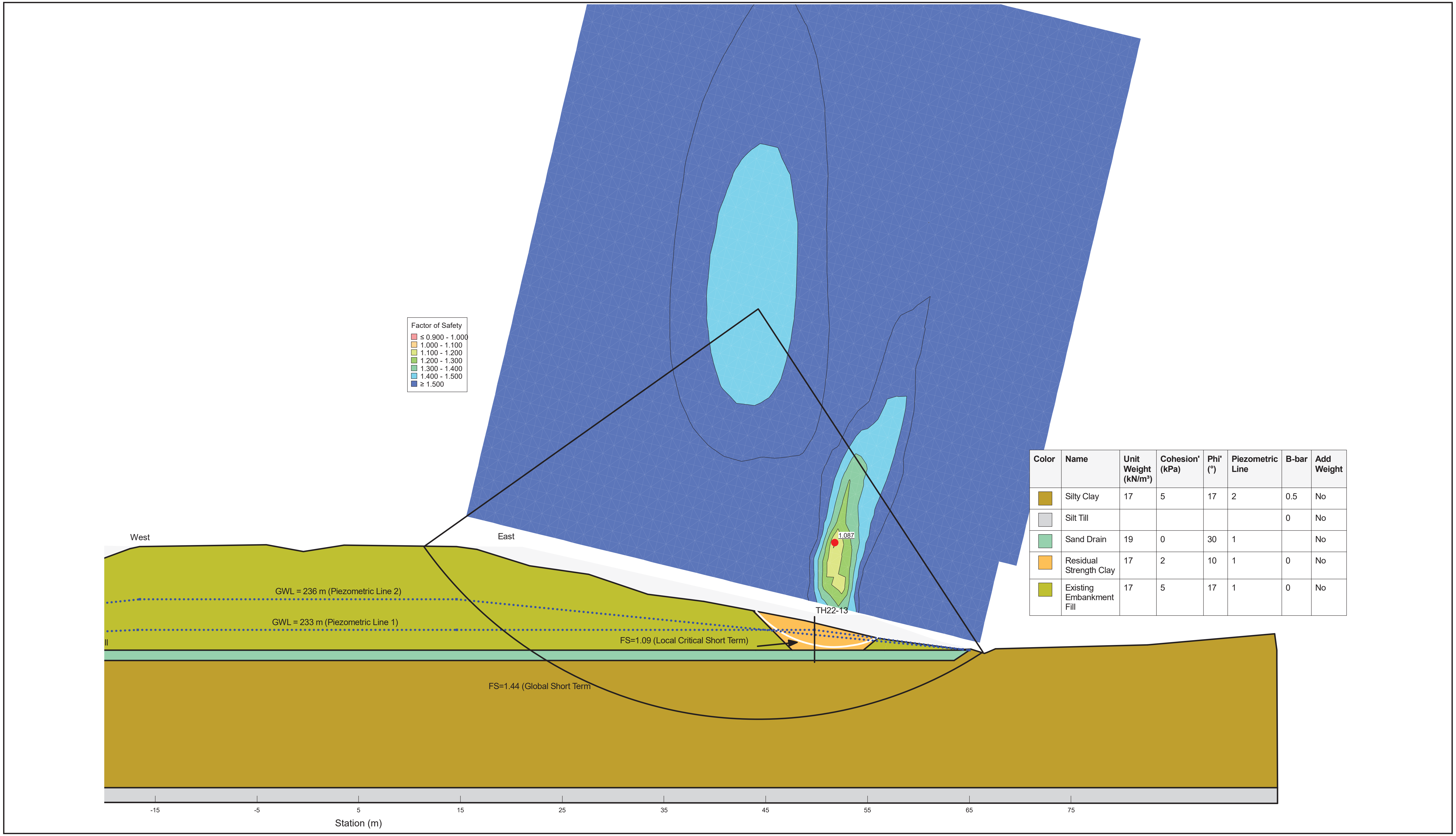


Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟫	Silty Clay	17	5	17
🟥	Riprap	19	0	40
⬜	Silt Till			
🟧	Residual Strength Clay	17	3	12

Figure E12

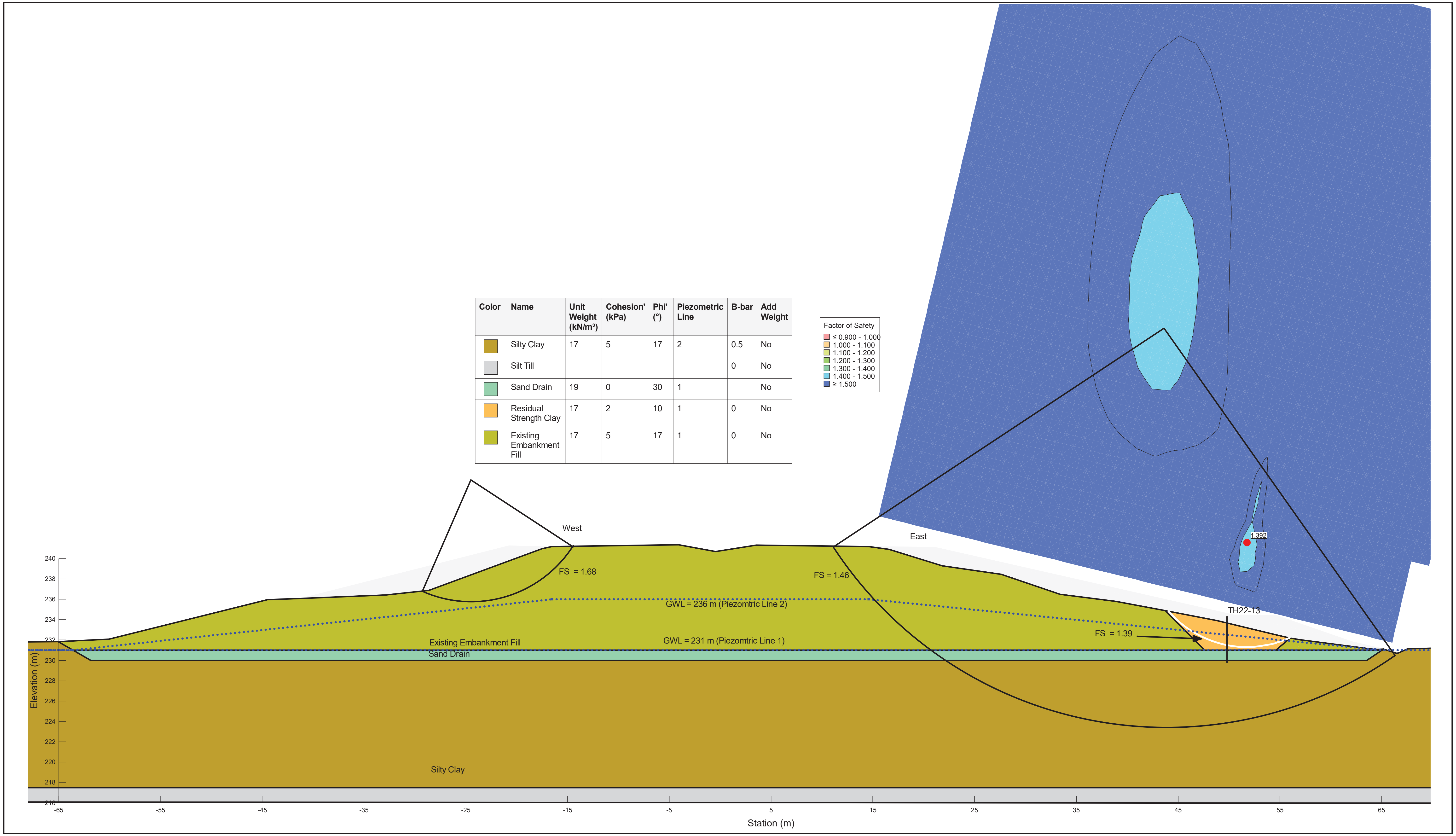
Retention Pond 4-12 Northwest Slope - Long Term

Re-grade at 5H:1V



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line	B-bar	Add Weight
🟫	Silty Clay	17	5	17	2	0.5	No
⬜	Silt Till					0	No
🟩	Sand Drain	19	0	30	1		No
🟧	Residual Strength Clay	17	2	10	1	0	No
🟨	Existing Embankment Fill	17	5	17	1	0	No

Figure E13
South Approach Embankment
Cross Section C - Back Analysis



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line	B-bar	Add Weight
🟫	Silty Clay	17	5	17	2	0.5	No
⬜	Silt Till					0	No
🟩	Sand Drain	19	0	30	1		No
🟧	Residual Strength Clay	17	2	10	1	0	No
🟩	Existing Embankment Fill	17	5	17	1	0	No

Figure E14

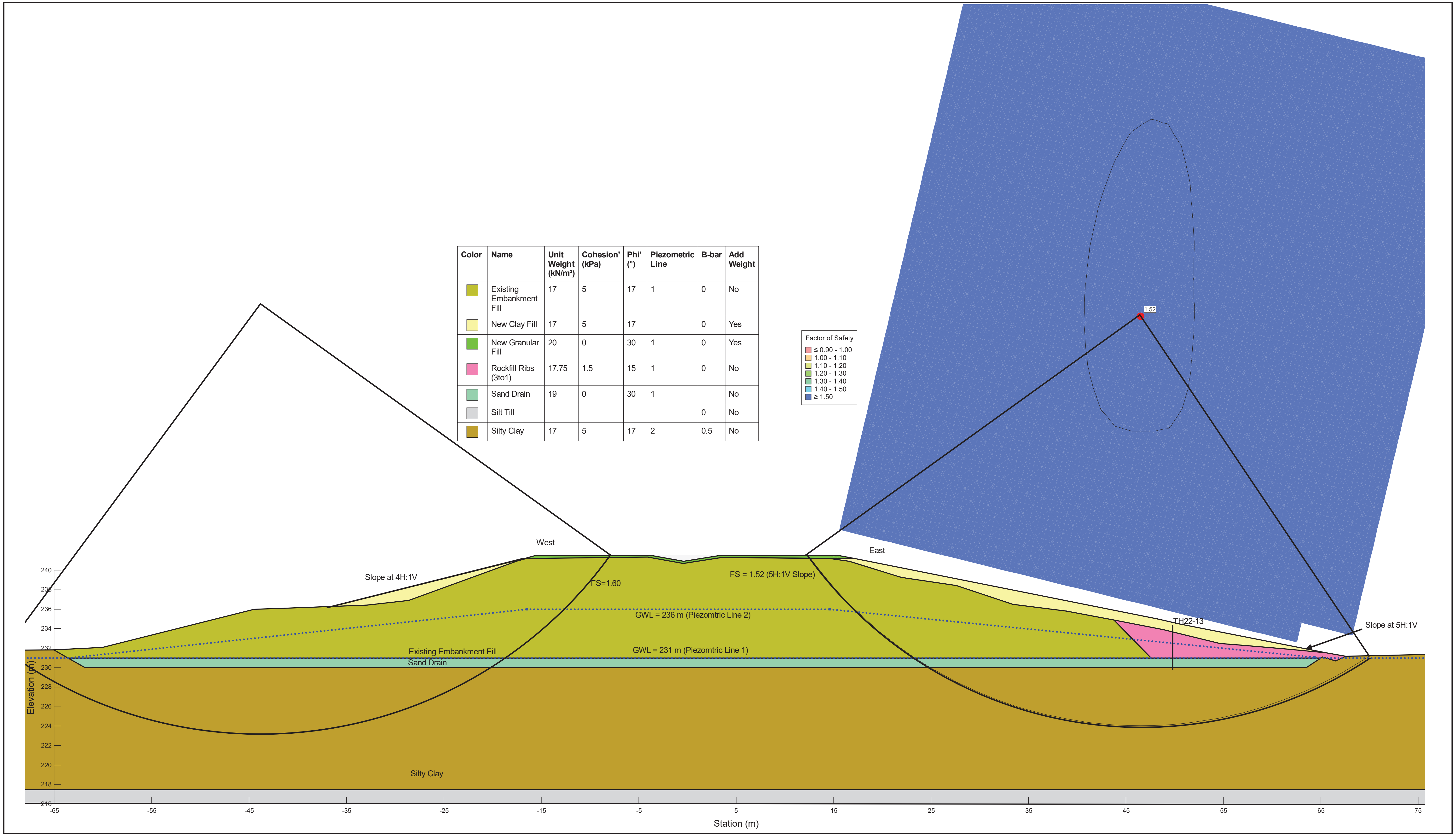
South Approach Embankment

Cross Section C - Existing Geometry

0002 130 00

Lagimodiere Blvd Twin Overpass Rehabilitation Preliminary Design - (RFP No. 111-2022)

Tetra Tech Inc.



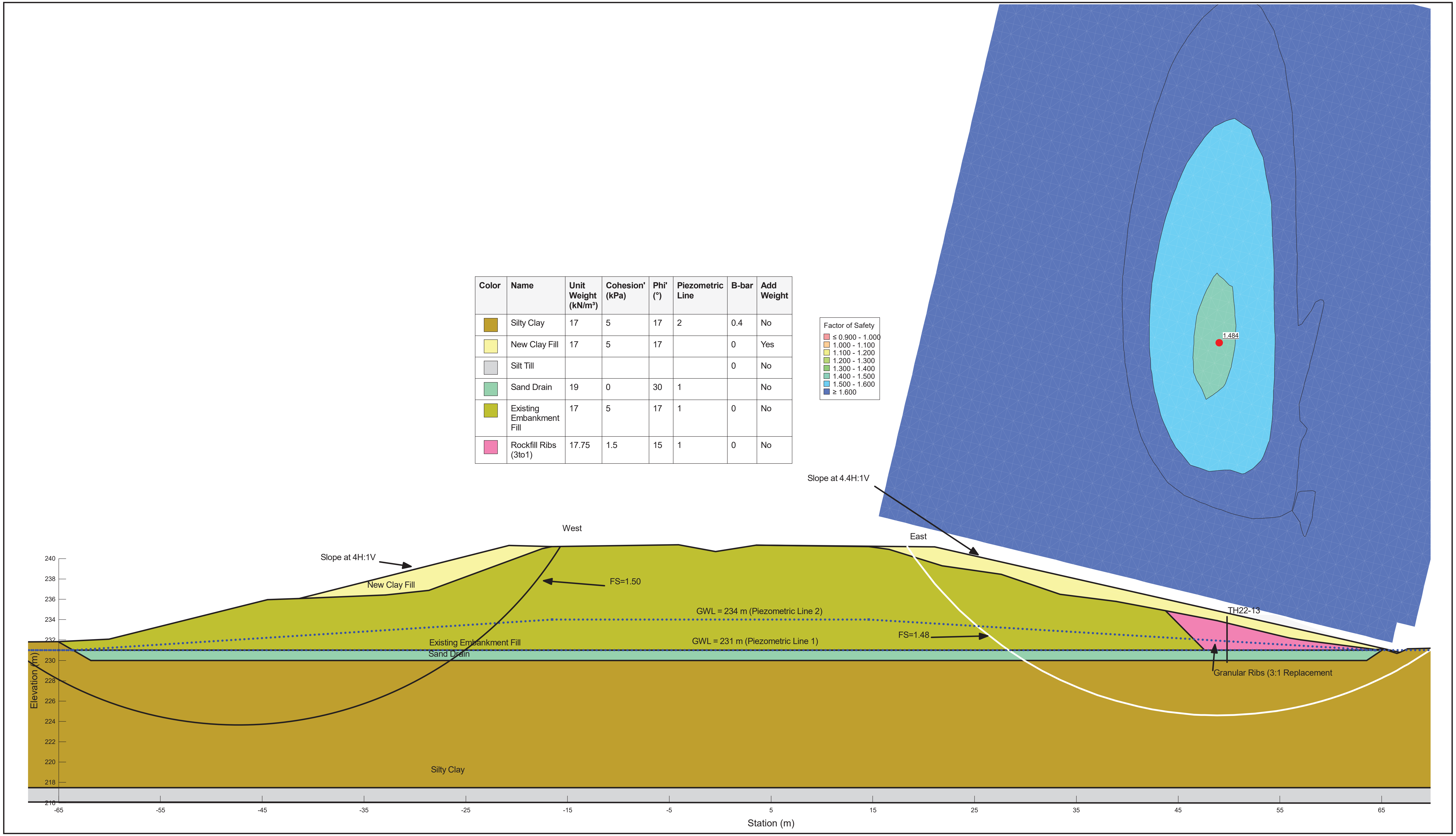
Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line	B-bar	Add Weight
🟨	Existing Embankment Fill	17	5	17	1	0	No
🟨	New Clay Fill	17	5	17		0	Yes
🟩	New Granular Fill	20	0	30	1	0	Yes
🟪	Rockfill Ribs (3to1)	17.75	1.5	15	1	0	No
🟩	Sand Drain	19	0	30	1		No
⬜	Silt Till					0	No
🟫	Silty Clay	17	5	17	2	0.5	No

Factor of Safety
- 🟥 ≤ 0.90 - 1.00
- 🟧 1.00 - 1.10
- 🟨 1.10 - 1.20
- 🟩 1.20 - 1.30
- 🟩 1.30 - 1.40
- 🟦 1.40 - 1.50
- 🟦 ≥ 1.50

Figure E15

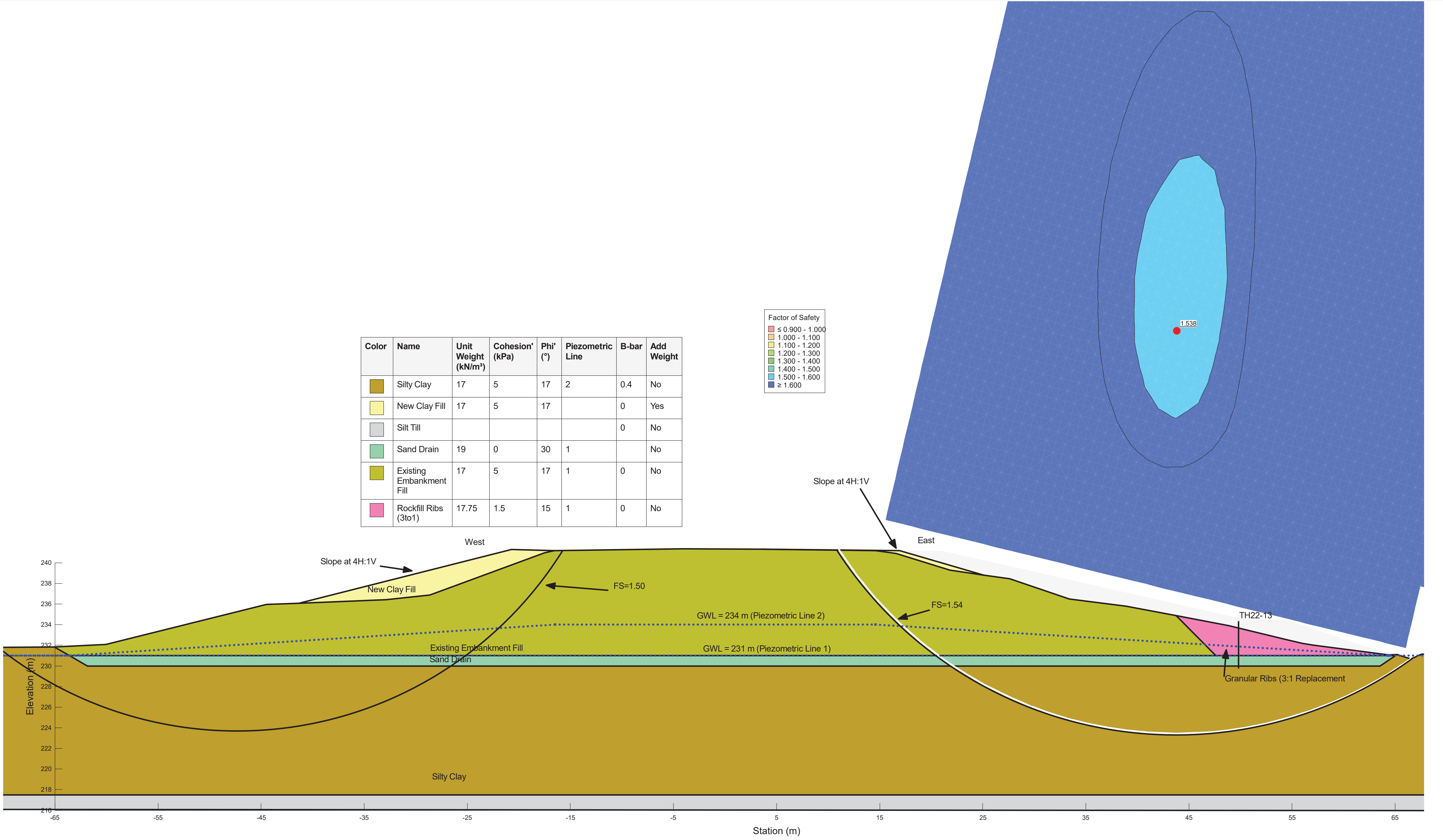
2026 South Approach Embankment

Cross Section C - Option 1 Widening Geometry



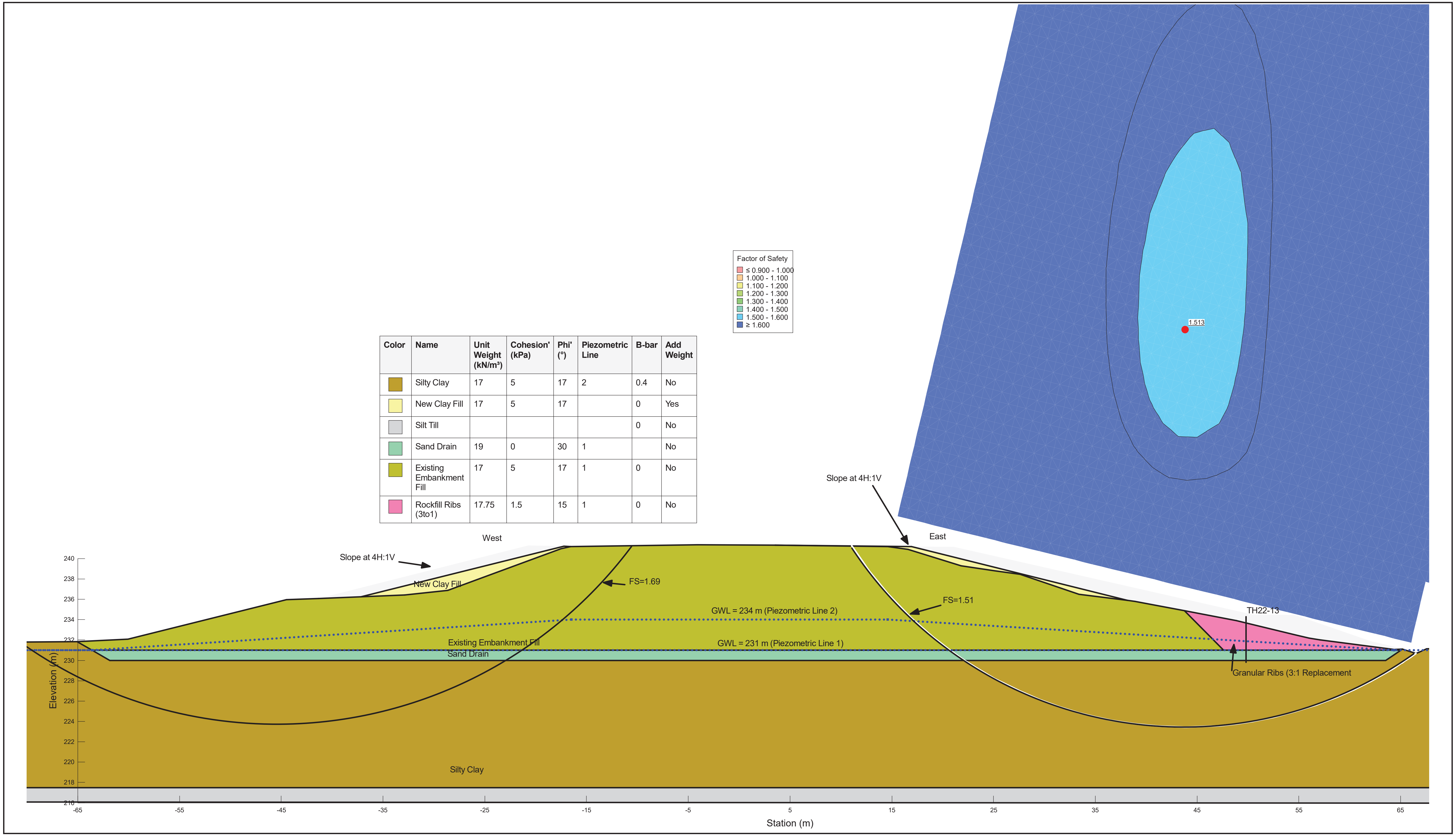
Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line	B-bar	Add Weight
🟫	Silty Clay	17	5	17	2	0.4	No
🟨	New Clay Fill	17	5	17		0	Yes
⬜	Silt Till					0	No
🟩	Sand Drain	19	0	30	1		No
🟩	Existing Embankment Fill	17	5	17	1	0	No
🟪	Rockfill Ribs (3to1)	17.75	1.5	15	1	0	No

Figure E16
South Approach Embankment
Cross Section C - Option 1 Widening Geometry



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line	B-bar	Add Weight
🟫	Silty Clay	17	5	17	2	0.4	No
🟨	New Clay Fill	17	5	17		0	Yes
⬜	Silt Till					0	No
🟩	Sand Drain	19	0	30	1		No
🟩	Existing Embankment Fill	17	5	17	1	0	No
🟪	Rockfill Ribs (3to1)	17.75	1.5	15	1	0	No

Figure E17
South Approach Embankment
Cross Section C - Option 2 Widening Geometry



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line	B-bar	Add Weight
🟫	Silty Clay	17	5	17	2	0.4	No
🟨	New Clay Fill	17	5	17		0	Yes
⬜	Silt Till					0	No
🟩	Sand Drain	19	0	30	1		No
🟩	Existing Embankment Fill	17	5	17	1	0	No
🟪	Rockfill Ribs (3to1)	17.75	1.5	15	1	0	No

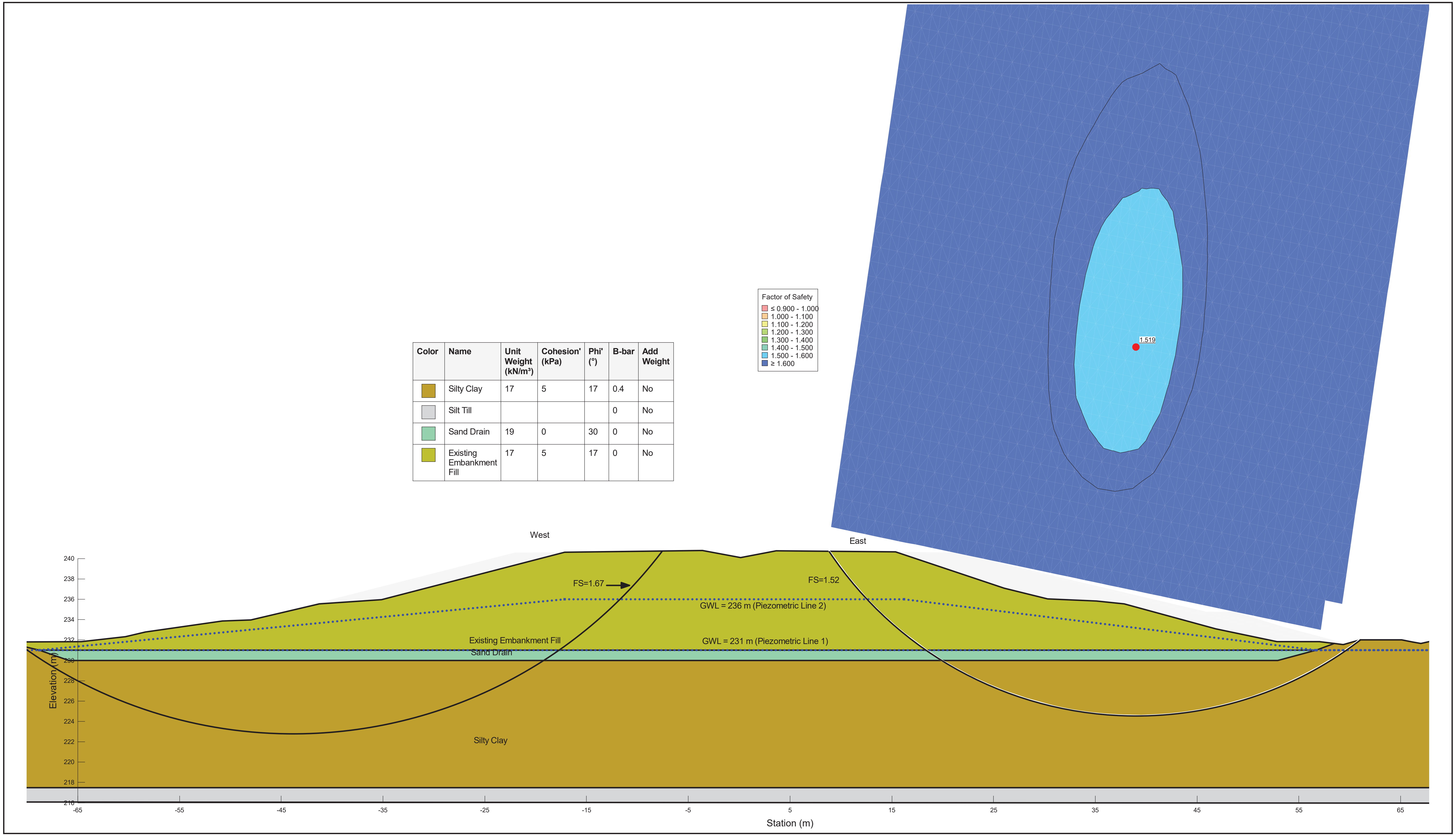
Figure E18

South Approach Embankment
Cross Section C - Option 3 Widening Geometry

0002 130 00

Lagimodiere Blvd Twin Overpass Rehabilitation Preliminary Design - (RFP No. 111-2022)

Tetra Tech Inc.

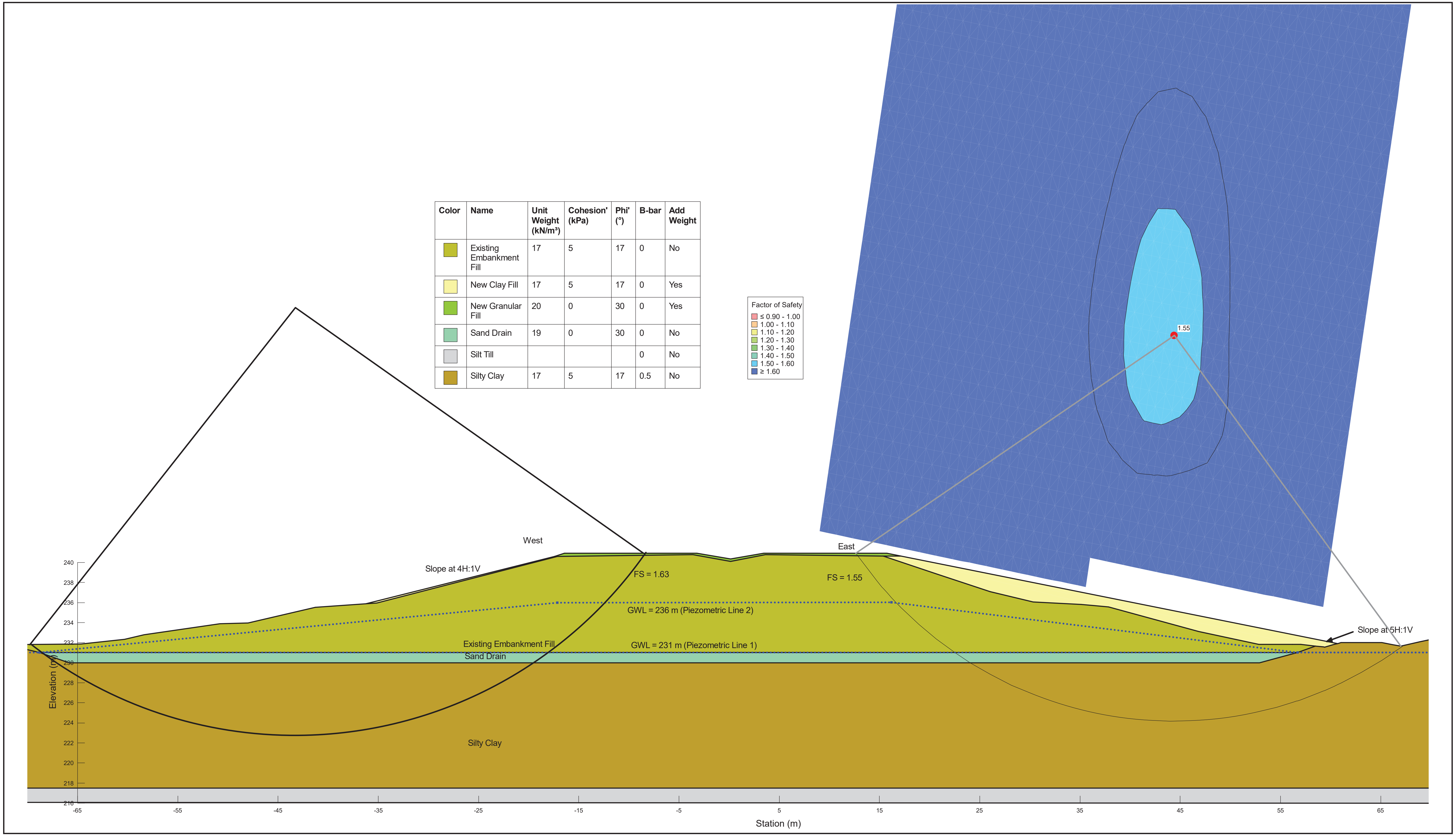


Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	B-bar	Add Weight
🟫	Silty Clay	17	5	17	0.4	No
⬜	Silt Till				0	No
🟩	Sand Drain	19	0	30	0	No
🟨	Existing Embankment Fill	17	5	17	0	No

Figure E19

North Approach Embankment

Cross Section D - Existing Geometry

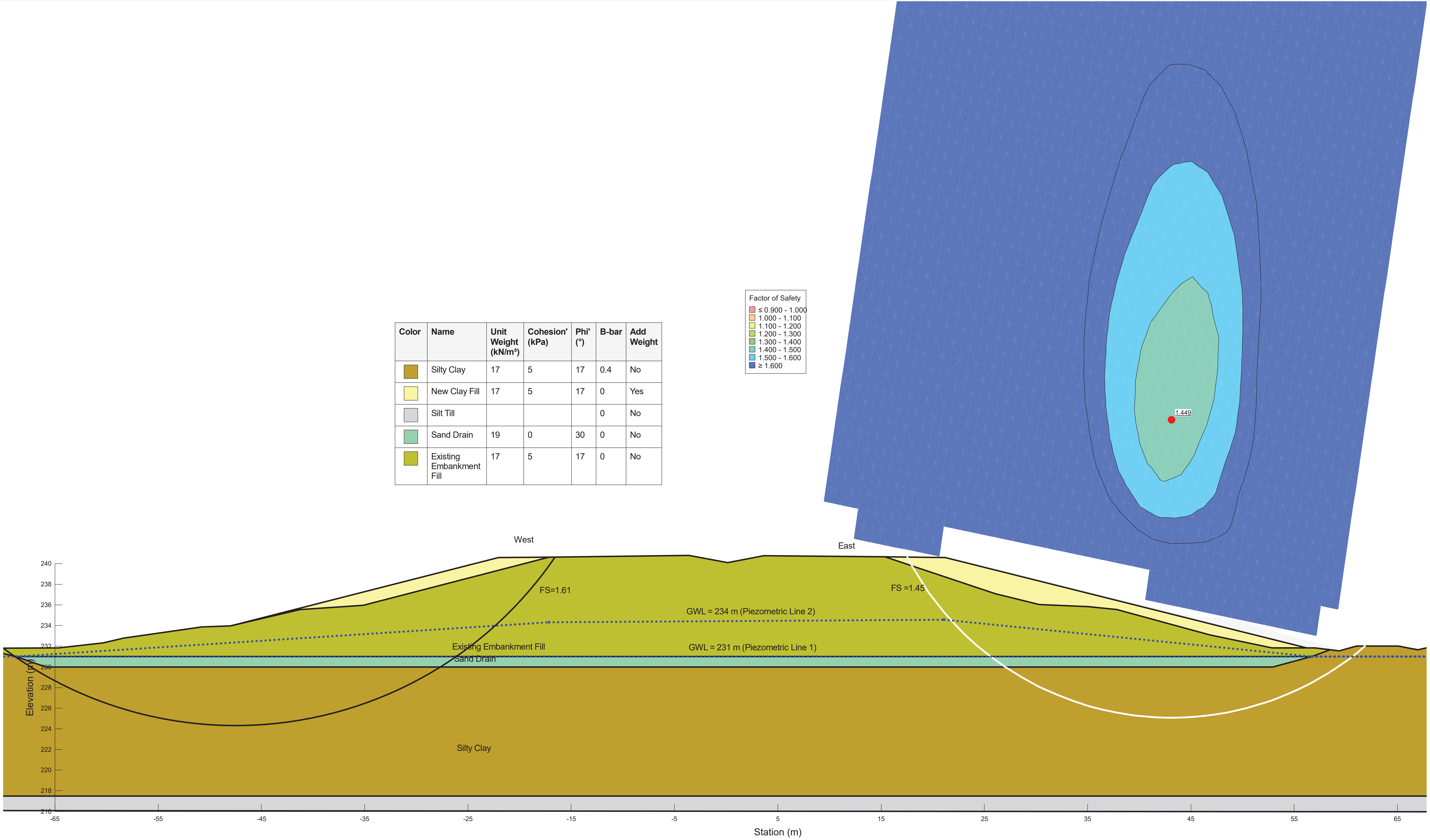


Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	B-bar	Add Weight
🟨	Existing Embankment Fill	17	5	17	0	No
🟨	New Clay Fill	17	5	17	0	Yes
🟩	New Granular Fill	20	0	30	0	Yes
🟩	Sand Drain	19	0	30	0	No
⬜	Silt Till				0	No
🟫	Silty Clay	17	5	17	0.5	No

Figure E20

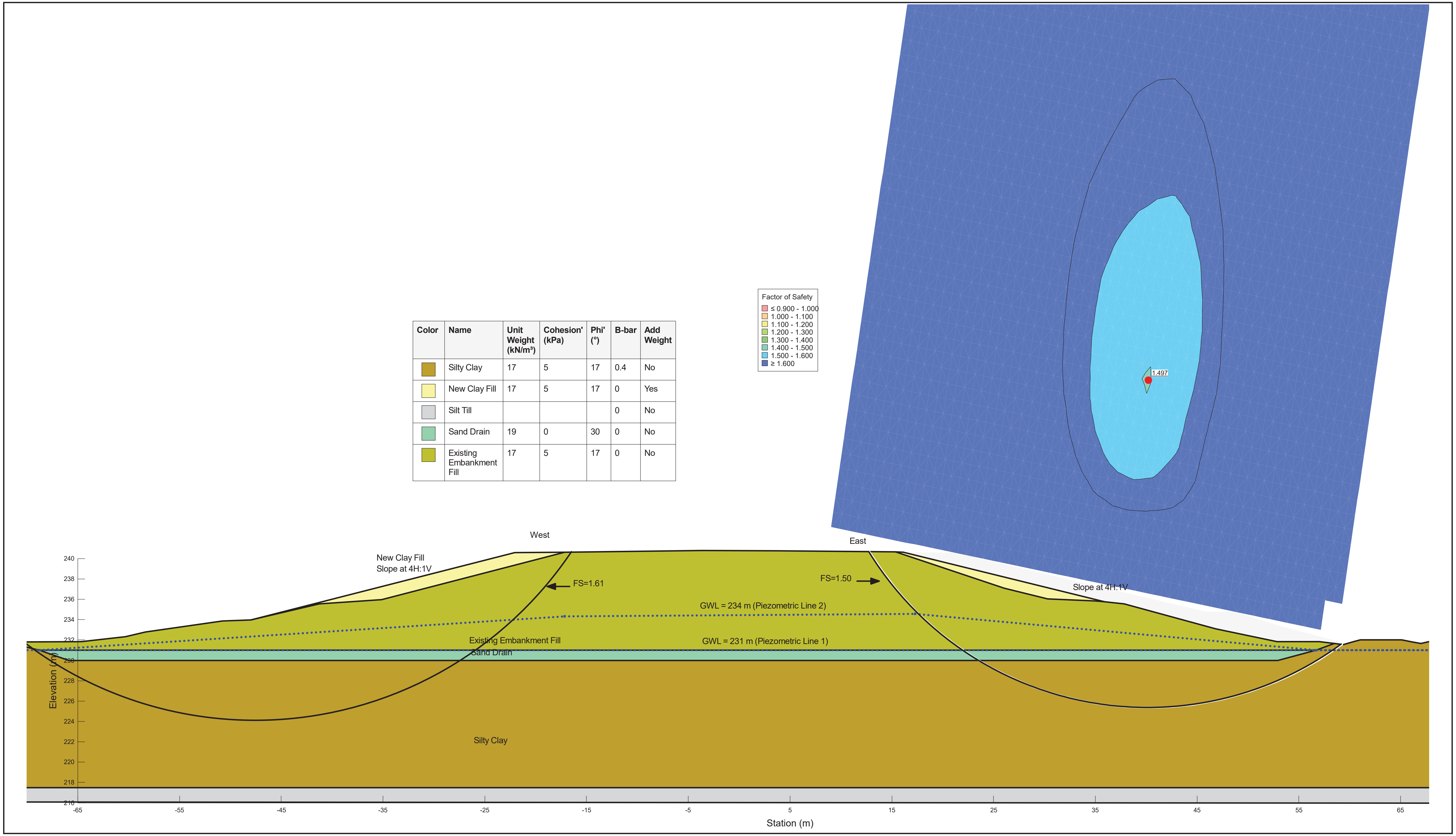
2026 South Approach Embankment

Cross Section D - Option 1 Widening Geometry



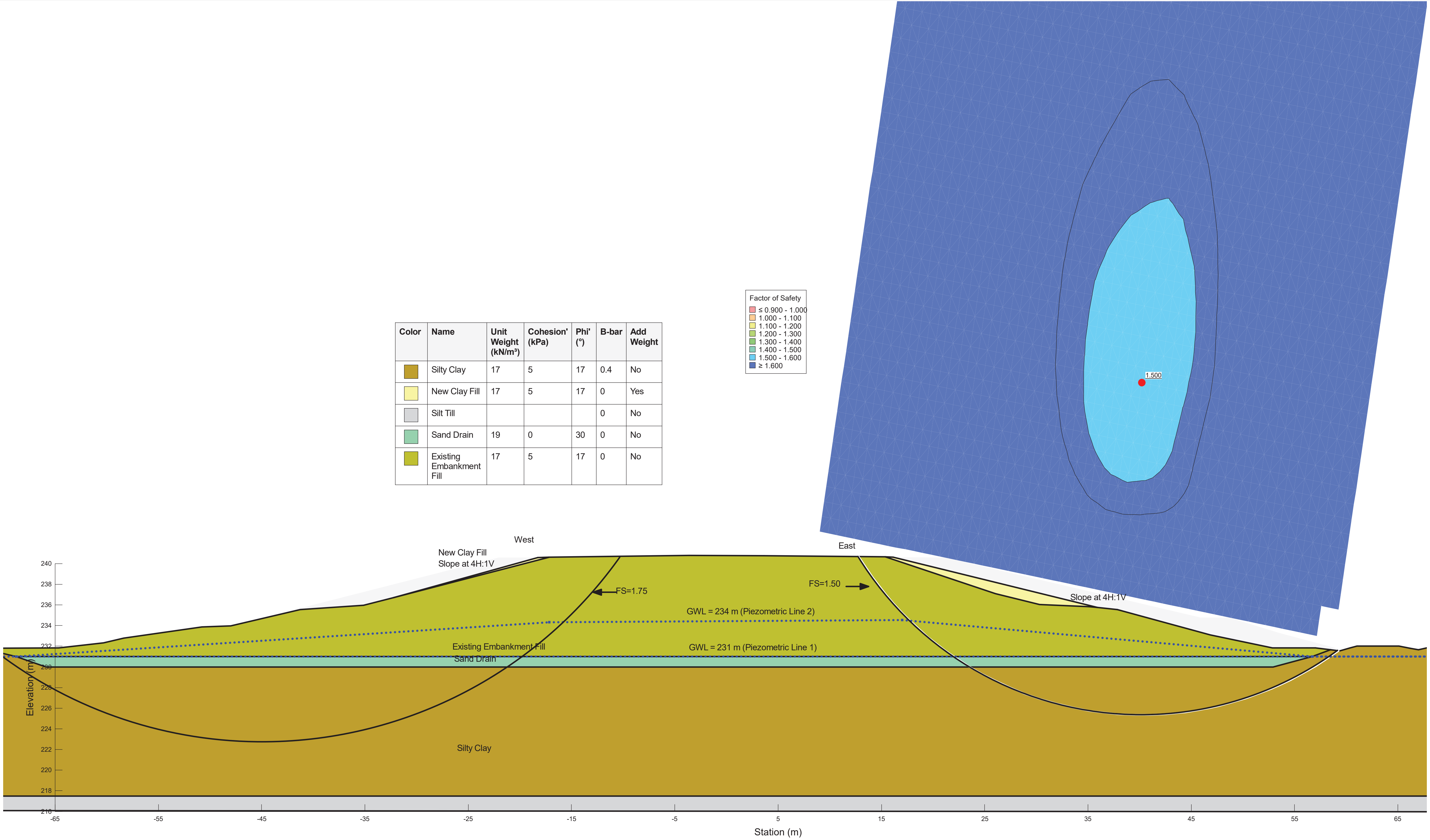
Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	B-bar	Add Weight
🟫	Silty Clay	17	5	17	0.4	No
🟨	New Clay Fill	17	5	17	0	Yes
⬜	Silt Till				0	No
🟩	Sand Drain	19	0	30	0	No
🟩	Existing Embankment Fill	17	5	17	0	No

Figure E21
North Approach Embankment
Cross Section D - Option 1 Widening Geometry



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	B-bar	Add Weight
🟫	Silty Clay	17	5	17	0.4	No
🟨	New Clay Fill	17	5	17	0	Yes
⬜	Silt Till				0	No
🟩	Sand Drain	19	0	30	0	No
🟩	Existing Embankment Fill	17	5	17	0	No

Figure E22
North Approach Embankment
Cross Section D - Option 2 Widening Geometry



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	B-bar	Add Weight
🟫	Silty Clay	17	5	17	0.4	No
🟨	New Clay Fill	17	5	17	0	Yes
⬜	Silt Till				0	No
🟩	Sand Drain	19	0	30	0	No
🟨	Existing Embankment Fill	17	5	17	0	No

Figure E23

North Approach Embankment
Cross Section D - Option 3 Widening Geometry