



**Foundation Investigation Report –
CNR Overhead – Highway 4
widening from Clinton Line to
New Talbotville Bypass and New
Talbotville Bypass from Highway 4
to Highway 3 at Ron McNeil Line**

Highway 3 Township of Southwold,
County of Elgin, ON
West Region

GWP 3042-22-00

Latitude 42.814091

Longitude -81.235023

Geocres No. 40114-224

Prepared for:

Ministry of Transportation, Ontario
(MTO), West Region

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FOUNDATION INVESTIGATION REPORT

For

G.W.P. 3042-22-00

CNR Overhead

Highway 4 widening from Clinton Line to New Talbotville Bypass and New Talbotville Bypass from Highway 4 to Highway 3 at Ron McNeil Line
West Region, Township of Southwold, County of Elgin, Ontario

1.0 INTRODUCTION

Stantec has been retained by the Ministry of Transportation Ontario (MTO) to provide preliminary and detailed design services for the Highway 4 widening from Clinton Line to the new Talbotville Bypass and for the new Talbotville Bypass from Highway 4 to Highway 3 at Ron McNeil Line (GWP 3042-22-00), and for the Highway 3 widening from Ron McNeil Line to Centennial Avenue (GWP 3041-22-00).

As part of the GWP 3042-22-00 new Talbotville Bypass from Highway 4 to Highway 3 at Ron McNeil Line, the following new structures are proposed:

- CNR Talbotville Overhead - Two (2) Single Span Bridges with about 300 m long approach embankment on both sides of bridges,
- Ron McNeil Line Interchange Overpass - Two Span Bridge with approach embankments, and
- Lindsay Creek Culvert (formerly Dodd's Creek Culvert).

As part of the GWP 3041-22-00 Highway 3 Twinning from Ron McNeil Line to Centennial Avenue, the following new structures, including two existing culverts replacement, are proposed:

- Wellington Road Interchange Underpass – New Two Span Bridge with approach embankments
- Kettle Creek WBL Bridge – New Three Span Bridge
- 05X-0266/C0 Underhill Drain Culvert – New Culvert Construction Under the proposed Highway Twinning
- 05X-0268/C0 – Existing CSP Culvert replacement & New Culvert Construction Under the proposed Highway Twinning
- Noise Walls (Station between 13+100 and 11+100, south side of the existing Highway 3 & between Station 12+400 and 13+600 on both sides of Highway 3)
- Deep Cuts (between Stations 13+650 and 15+050, north of the existing Highway 3)

Eighteen (18) Overhead Signs and three (3) Storm Water Management Ponds (SWMPs) were also planned at the early stage of the project. As per the preliminary design, three (3) Storm Water Management Ponds were eliminated, and four (4) structural culverts were added at the Ron McNeil Line interchange area.



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This Foundation Investigation Report has been prepared specifically and solely for the proposed CNR overhead structure. Other project foundations engineering components are reported under separate cover.

The terms of reference for the foundation investigation work scope were provided in the MTO's RFP (Request for Proposal) and addenda. The MTO Guideline for Foundation Engineering Services V.3.0 is also considered for the borehole termination depth based on the clarifications provided during the bid phase.

2.0 SITE DESCRIPTION AND GEOLOGY

2.1 SITE LOCATION

Talbotville bypass is planned to cross CNR tracks at approximately Station 12+020, about 700 m west of the proposed Ron McNeil underpass in the Township of Southwold, Elgin County, Ontario. The site location is shown on the Key Plan inset to Drawing Nos. 1 to 4 included in Appendix A.

2.2 GENERAL SITE DESCRIPTION

At the proposed location of CNR Overhead, the proposed Highway 3 Talbotville Bypass is planned to be a divided freeway, with two lanes (with paved shoulders) in each direction, divided by a grass median. The orientation of Talbotville Bypass is approximately northwest-southeast and the orientation of the CNR track is approximately north-south. For the purposes of this report, the orientation of Talbotville Bypass and the CNR track are taken as east-west and north-south, respectively.

At the project site, CN ROW is approximately 25 m wide and contains one track.

The area immediately adjacent to the proposed overhead structure and within most of embankment areas consists of heavily wooded area. There are agricultural fields further north and south of the wood area. The ground surface at the site generally slopes towards south and west.



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Photo 1. CNR Overhead North Embankment Site (looking North)

2.3 PROPOSED STRUCTURE AND EMBANKMENTS

Based on the General Arrangement (GA) drawing, a wide single-span, rigid-frame structure (a 27 m long span and 145 m width) will carry both the EB and WB lanes of the proposed Highway 3 Talbotville Bypass over the CNR ROW. The proposed width of the Highway 3 median is about 22.5 m. The GA drawing indicates that the overhead structure will be constructed at 61.3° skew angle to the CNR track alignment.

Based on the plan, ± 300 m long bridge approach embankments are proposed on either side of the overhead structure. Both the EB and WB lane will be constructed on a single embankment with a top width of approximately 50 m. The centreline profile of EB and WB lanes at the proposed overhead location are planned to be at approximately elevation 251 m, approximately 10 m higher than the surrounding lands. Concrete retaining walls are also proposed the end of embankments.

The GA drawing is included in Appendix A for reference.



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2.4 GEOLOGICAL INFORMATION

The site is located within the physiographic region of Mount Elgin Ridges, as delineated in the Physiography of Southern Ontario (Chapman and Putnam, 1983). According to the Ontario Department of Mines Preliminary Geological Maps 238 (Pleistocene Geology of The St. Thomas Area, West Half) and P.606 (Pleistocene Geology of The St. Thomas Area, East Half), the site subsurface conditions are generally characterized by lacustrine deposits of silt, silty sand and clay, Port Stanley silty clay to clayey silt till and modern alluvium deposits of gravel, sand, and silt along watercourses. As per the Ontario Geological Survey Map 2441 (Geological Highway Map Southern Ontario), the bedrock within the project area is described as grey limestone of the Dundee Formation. Based on the Ontario Department of Mines Preliminary Geological Map P. 482 (St. Thomas Sheet), the bedrock depths at the proposed CNR overhead site is estimated to be about 85 m below the original ground surface (o.g.).

2.5 EXISTING UTILITIES

A review of available information indicated that there are no existing utilities in the immediate area of the proposed overhead structure and embankments (within the wood lot). There is a gas main and watermain running along Wonderland Road to the east and a gas main crossing the farm field northwest of the proposed overhead structure and embankments.

3.0 REVIEW OF PREVIOUS INVESTIGATIONS

A review of MTO GEOCRES database identified the following report at the CNR overhead site:

GEOCRES Reference No. 40114-070

A foundation investigation report dated September 17, 1971, was available for the proposed crossing at CNR spur overhead and St. Thomas Expressway.

The report was referenced as follows:

Foundation Investigation Report
For Proposed Crossing at
CNR Spur Overheads and St. Thomas Expressway
Twps. Of Southwold; County of Elgin
W.O. 71-11068 - W.P. 89-69-05 & 06

The investigation included a total of eight (8) sampled boreholes (BH No. 1 to 8), advanced to depths ranging from approximately 10.4 m to 30.2 m below grade (corresponding to approximately elevations 229.8 m to 210.1 m) and eight (8) dynamic cone penetration tests carried out adjacent to each borehole advanced in July 1971.



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The boreholes encountered a deep stratum of stiff to hard clayey silt with some sand and trace gravel immediately below the topsoil. Except the top 2 m, the stratum had a moisture content that was at or below the Plastic Limit. The undrained shear strength of the stratum generally decreased with depth, being in excess of 240 kPa at approximate elevation 237.8 m and about 190 kPa at approximate elevation 213.4 m. The deposit appeared to be highly over-consolidated.

Groundwater levels were observed at elevations ranging from approximately 231 m to 218.1 m.

Following shifts in the alignment of the St. Thomas Expressway at the CNR overhead, five (5) additional borings (BH No.11 to 15) were advanced to a depth of approximately 5 m below grade at this site, which reported similar subsoil conditions as those indicated above.

For reference, copies of the Borehole Location Plan, stratigraphical profile, borehole records and laboratory test results are included in Appendix B.

4.0 INVESTIGATION PROCEDURES

4.1 FIELD INVESTIGATION

The geotechnical investigation for the detailed design of the proposed CNR overhead and embankments originally consisted of a total of 12 boreholes, designated as CNR-EMB01 to CNR-EMB12 for the proposed 600 m long embankments and four (4) boreholes, designated as CNR-OH1 to CNR-OH4 for the overhead structure abutments. As per discussions with the MTO, Boreholes CNR-EMB02, CNR-EMB08 and CNR-EMB10 were subsequently converted to seismic Cone Penetration Tests (sCPTs). The locations of the boreholes and sCPTs are shown on the Borehole Location Plan, Drawing Nos. 1 to 4 in Appendix A.

MTO cleared an alignment within the wooded area for the foundation investigation (along the bypass centreline). Prior to carrying out the investigation, Stantec contacted the public utility authorities, private locate and MTO to clear the borehole locations of private, public as well as and MTO-owned utilities.

The field drilling program was carried out from March 4, 2024, through to July 11, 2024. The approach embankment and overhead structure boreholes were advanced to depths of approximately 15.9 m and 44.8 m below grade, respectively. All boreholes were advanced using hollow-stem continuous-flight augers. Wash boring technique was used below a depth of 3 m in CNR-OH1 to CNR-OH4. Drilling was carried out with CME55 and D50 track-mounted rigs equipped for soil sampling.

The subsurface stratigraphy encountered in each borehole was recorded in the field by an experienced Stantec field technician. Standard Penetration Tests (SPT) were carried out in the drilled holes and split spoon samples were collected at regular intervals (0.75 m interval for the shallow depth / critical zone, 1.5 m interval to 20 m below grade and 3 m interval to the termination depths of the boreholes to meet the typical MTO subsurface investigation sampling requirements) in accordance with ASTM D1586. All recovered SPT and Shelby tube samples were returned to our Markham and Ottawa laboratories for



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detailed classification and testing. The undrained shear strength of cohesive soils was determined using an in-situ shear vane (MTO B-vane) in accordance with ASTM D2573 wherever applicable. A pocket penetrometer was also used to estimate the shear strength/consistency of clayey soil samples at the site. Shelby tube (thin-walled steel tube) samples were also obtained in several boreholes where lower N-values were obtained from the SPTs.

Three (3) CPT tests, designated as SCPT-CNREMB02, SCPT-CNREMB08 and SCPT-CNREMB10 were conducted by ConeTec at the site on May 9 and 10, 2024. The CPTs were advanced to depths of approximately 15.6 m, 20.1 m and 20.0 m below grade, respectively, where refusal to penetration of the cone was encountered. The CPTs included seismic measurements and pore dissipation tests. The ConeTec report dated May 24, 2024, is included in Appendix C.

Groundwater was observed in open boreholes during drilling. Following completion of drilling, a 50 mm diameter groundwater monitoring well, screened over a depth of 4.6 m to 7.6 m below ground surface, was installed in Borehole CNR-OH1. The borehole annulus surrounding the slotted pipe section was backfilled with sand. The remaining annulus was backfilled with bentonite up to the ground surface. A groundwater level measurement in the monitoring well was taken out on August 29, 2024.

After completion of drilling, the remaining boreholes were backfilled with a mix of bentonite and drill cuttings.

Multi-Channel Analysis of Surface Wave (MASW) measurements were carried out on both sides of CNR ROW to determine the seismic site class; the surveys consisted of a single a 69 m long array of geophones spaced at 3 m, at each site. The MASW report is included in Appendix F.

4.2 LOCATION AND ELEVATION SURVEY

The borehole locations and respective ground surface elevations were surveyed by Stantec Geomatics personnel using a Trimble R12i GPS with an elevation and spatial accuracy of ± 0.02 m vertically and ± 0.01 m horizontally to meet the survey accuracy requirements (vertical accuracy of 0.1 m and horizontal accuracy of 0.5 m) of the Guideline for MTO Foundation Engineering Services V2.

Table 4.1 below summarizes the borehole survey information and includes the drilling depth, end of borehole elevation and number of samples recovered for each borehole.

Table 4.1: Borehole and CPT Information Summary

Test Hole	MTM Zone 11 Coordinates		Ground surface elevation (m)	End of borehole depth (m)	End of borehole elevation (m)	Number of soil samples
	Northing	Easting				
CNR-EMB1	4742387.6	408194.1	241.4	15.9	225.5	14
SCPT-CNREMB-02	4742437.0	408134.9	241.0	15.6	225.4	-
CNR-EMB3	4742473.2	408075.1	241.8	15.9	225.9	15
CNR-EMB4	4742503.0	408026.1	241.4	15.9	225.6	15



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Test Hole	MTM Zone 11 Coordinates		Ground surface elevation (m)	End of borehole depth (m)	End of borehole elevation (m)	Number of soil samples
	Northing	Easting				
CNR-EMB5	4742528.0	407978.3	240.8	15.9	224.9	15
CNR-EMB6	4742559.1	407913.2	239.9	15.9	224.0	15
CNR-EMB7	4742291.1	408305.7	240.1	15.9	224.3	14
SCPT-CNREMB-08	4742299.9	408360.7	240.0	20.1	219.9	-
CNR-EMB9	4742180.0	408425.8	239.7	15.9	223.9	14
SCPT-CNREMB-10	4742135.9	408477.0	239.0	20.0	219.0	-
CNR-EMB11	4742091.9	408523.1	239.2	15.9	223.4	15
CNR-EMB12	4742048.1	408572.4	239.1	15.9	223.2	15
CNR-OH1	4742326.5	408283.1	240.2	44.8	195.4	26
CNR-OH2	4742271.9	408298.2	240.4	44.8	195.6	25
CNR-OH3	4742374.5	408227.3	240.7	44.8	195.9	26
CNR-OH4	4742319.5	408248.9	240.5	44.8	195.7	26

4.3 LABORATORY TESTING

All samples were taken to Stantec's Markham and Ottawa laboratories where they were subjected to a detailed visual and tactile examination by a Geotechnical Engineer.

The geotechnical laboratory testing program for the boreholes samples is summarized in the following table.

Table 4.2: Geotechnical Laboratory Testing Program

Laboratory Test Type	Number of Tests
Moisture Content	238
Gradation Analysis	54
Atterberg Limits	57
Consolidation (Oedometer)	4
Unconsolidated Undrained Triaxial Compression Test (UU)	1
Chemical Analysis	4

Four (4) soil samples from the boreholes advanced for the CNR overhead structure abutments were forwarded to AGAT Laboratories. The samples were tested for pH, soluble sulphate content, chloride content, and resistivity.

Samples remaining after testing will be placed in storage for a period of one year after issuance of the final report. After the storage period, the samples will be discarded unless we are directed otherwise by MTO.



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5.0 SUBSURFACE CONDITIONS

5.1 OVERVIEW

The detailed soil and groundwater conditions encountered in the boreholes and the results of the in-situ and laboratory testing are shown on the Borehole Records included in Appendix C. An explanation of the symbols and terms used to describe the Borehole Records is also provided in Appendix C. The results of the geotechnical laboratory testing are presented on Figures D1 to D6 included in Appendix D. It is noted that clay size particles include all particles smaller than 0.002 mm.

A borehole location plan and a stratigraphic section and profile of the soils encountered in the boreholes along the bridge alignment and embankments are provided on Drawing Nos.1 and 2 in Appendix A.

The stratigraphic boundaries on the borehole records and the strata plot are inferred from non-continuous sampling and therefore represent transitions between soil types rather than exact boundaries between geological units. The subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface stratigraphy encountered in the boreholes generally consisted of:

- Topsoil; underlain by,
- Fill comprising silty clayey sand in CNR-EMB03; underlain by,
- Stiff to hard clayey silt till; underlain interbedded with,
- Stiff to hard clayey silt in CNR-EMB1, CNR-EMB6, CNR-EMB9, CNR-EMB11 and CNR-EMB12.

Detailed descriptions of the subsurface conditions are provided below.

5.2 OVERBURDEN

5.2.1 Topsoil

Topsoil was encountered at all boreholes. The thickness of the topsoil varied from approximately 100 mm to 300 mm.

Laboratory tests conducted on samples from the topsoil yielded moisture contents of approximately 25% and 50%.

5.2.2 Fill

A layer of fill material comprising brown silty clayey sand was encountered below the topsoil in borehole CNR-EMB03. Samples obtained from the fill layer contained trace gravel.

The fill layer was approximately 1.3 m thick and extended to a depth of approximately 1.5 m below grade corresponding to approximately elevation 240.3 m.



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N-values of 2 and 10 blows per 0.3 m were obtained from the SPTs advanced in the fill layer, indicating a very loose to compact condition.

Laboratory tests conducted on the samples of the fill yielded natural moisture contents of approximately 22% and 15%.

Gradation analyses were carried out on a sample of the fill soils. The test results are illustrated on the borehole record in Appendix C and on the gradation curve on Figure No. D1 in Appendix D. The tests yielded the following results:

Gravel:	6%
Sand:	46%
Silt:	30%
Clay:	18%

Atterberg Limits tests were conducted on the sample referenced above. The tests yielded a Liquid Limit of approximately 18%, a Plastic Limit of approximately 11%, and a corresponding Plasticity Index of approximately 7%. The test results are illustrated on the borehole record in Appendix C and on the gradation curve on Figure No. D2 in Appendix D.

Based on the results of the laboratory tests, the sample tested can be classified as silty clayey sand with a group symbol of SC-SM based on the Unified Soil Classification System (USCS).

5.2.3 Clayey Silt Till

An extensive deposit of brown to grey clayey silt till was encountered below the topsoil and/or fill materials in all boreholes. The deposit typically contained various but minor amounts of sand and gravel. Samples obtained from the top portion of the till deposit were noted to have a slightly higher moisture content and plasticity in some boreholes. Localized seams/layers of soils with higher silt content and lower plasticity (described in the proceeding section) were noted within this deposit. Presence of cobbles and/or boulders was inferred at depth in the till deposit in borehole CNR-OH2 due to difficulties in drilling. Presence of cobbles and/or boulders should be anticipated in the till soils at other locations and depths.

All boreholes except CNR-EMB1, CNR-EMB6 and CNR-EMB9 were terminated in this deposit after penetrating 14.8 m to 44.8 m into the layer.

The N-values obtained from the SPTs advanced in the top 1 metre of the clayey silt till deposit ranged from 2 to 8 blows per 0.3 m penetration, indicating a soft to stiff consistency. Below this surficial zone, N-values ranging from 10 to 65 were obtained from the SPTs. N-values of greater than 30, indicating a hard consistency, were obtained below a depth of approximately 27 m below grade (approximately elevation 214 m) in boreholes CNR-OH2 and CNR-OH3 and below a depth of approximately 32 m below grade (approximately elevation 208 m) in boreholes CNR-OH1 and CNR-OH4.

An in-situ shear vane test (MTO B-vane) attempted at a depth of approximately 1.4 m below grade in borehole CNR-EMB07 encountered refusal, indicating an undrained shear strength greater than 200 kPa.



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An in-situ shear vane test (MTO B-vane) was conducted at a depth of approximately 19.2 m below grade, corresponding to approximate elevation 221 m in borehole CNR-OH1, which indicated undisturbed and remoulded undrained shear strengths of 160 kPa and 80 kPa, respectively corresponding to a sensitivity of 2.

Pocket penetrometer tests were also used to estimate the clayey silt till strength/consistency at the site. UCS, estimated by using the pocket penetrometer on recovered split-tube soil samples, were from 0.5 kgf/cm² to greater than 4.5 kgf/cm² and suggested an undrained shear strength of 50 kPa to greater than 220 kPa. Based on the results of these tests, the clayey silt till can be described as stiff to hard.

An Unconsolidated Undrained (UU) Triaxial test was conducted on a select Shelby tube sample retrieved at a depth of approximately 4.9 m below grade, corresponding to approximate elevation 235.8 m in borehole CNR-OH3. The test indicated a Compressive Strength of approximately 190 kPa corresponding to an undrained shear strength of approximately 95 kPa. The details of the test are included in the test sheets in Appendix D.

Laboratory tests conducted on samples of the clayey silt till deposit yielded natural moisture contents ranging from approximately 11% to 28%, averaging 16%. Higher moisture contents were obtained from the surficial samples of the clayey silt till deposit.

Gradation analyses were carried out on fifty samples of the clayey silt till soils. The test results are illustrated on the borehole records in Appendix C and on the gradation curve on Figure No. D3 in Appendix D. The tests yielded the following results:

Gravel:	0 to 17%
Sand:	0 to 19%
Silt:	32 to 68%
Clay:	29 to 48%

Atterberg Limits tests were conducted on the samples referenced above. The tests yielded Liquid Limits ranging from approximately 23% to 37%, Plastic Limits ranging from approximately 11% to 19%, and corresponding Plasticity Indices ranging from approximately 9% to 21%. The test results are illustrated on the borehole records in Appendix C and on the gradation curve on Figure No. D4 in Appendix D.

Based on the results of the laboratory tests, the samples tested can be classified as clayey silt with a group symbol of CL and silty clay with a group symbol of CI based on the Unified Soil Classification System (USCS).

One-dimensional oedometer consolidation tests were carried out on portions of selected Shelby tube samples. The results are provided below in Table 5.1 and the details of the tests, including the data plots, are provided on the laboratory test sheets in Appendix D.



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Table 5.1: One-Dimensional Oedometer Consolidation Test Results

Borehole/ Sample	Elevation (m)	Initial Void Ratio	Initial Unit Weight (kN/m ³)	Estimated Pre- consolidation Stress, P _c ' (kPa)	Recompression Index Cr / Compression Index Cc	Over Consolidation Ratio OCR	Coefficient of Consolidation C _v (cm ² /s)
CNR- EMB1/ ST1	235.7	0.51	21.19	500	0.11/0.013	6.1	4.3e ⁻³
CNR- EMB7/ ST1	236.0	0.55	20.78	500	0.141/0.015	10	2.5e ⁻³
CNR- EMB9/ ST2	233.3	0.41	21.99	650	0.11/0.01	8.3	4.6e ⁻³
CNR- EMB11/ ST2	224.1	0.51	20.98	500	0.125/0.012	3.0	4.2e ⁻³

5.2.4 Clayey Silt

Localized layers of clayey silt with higher silt content and lower plasticity than the clayey silt till described in the preceding section were noted interbedded in the clayey silt till described in the preceding section in boreholes CNR-EMB01, CNR-EMB06, CNR-EMB09, CNR-EMB11 and CNR-EMB12.

The clayey silt layer was approximately 1.6 m and 1.5 m thick and extended from depths of approximately 11.7 m and 10.2 m below grade, corresponding to approximately elevations 227.5 m and 223.2 m to depths of approximately 13.3 m and 11.7 m below grade, corresponding to approximate elevation 225.9 m and 221.7 m, respectively in boreholes CNR-EMB11 and CNR-EMB12. Boreholes CNR-EMB1, CNR-EMB06 and CNR-EMB09 were terminated in the clayey silt layer after penetrating 1.1 m, 0.2 m and 1.1 into the layer, respectively.

N-values obtained from the SPTs advanced in the clayey silt layer ranged from 17 to 51, indicating very stiff to hard consistency.

Two (2) pocket penetrometer tests were also conducted on samples obtained from this layer to estimate the clayey silt strength/consistency at the site. UCS, estimated by using the pocket penetrometer on recovered split-tube soil samples, were 2 kgf/cm² and greater than 4.5 kgf/cm² and suggested an undrained shear strength of 100 kPa and greater than 220 kPa. Based on the results of these tests, the clayey silt till can be described as very stiff to hard.

Laboratory tests conducted on samples of the clayey silt deposit yielded natural moisture contents ranging from approximately 9% to 19%, averaging 15%.



FOUNDATION INVESTIGATION REPORT – CNR OVERHEAD – HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

April 2025

Gradation analyses were carried out on three (3) samples of the clayey silt soils. The test results are illustrated on the borehole records in Appendix C and on the gradation curve on Figure No. D5 in Appendix D. The tests yielded the following results:

Gravel: 0 to 1%
 Sand: 0 to 2%
 Silt: 65 to 80%
 Clay: 30 to 32%

Atterberg Limits tests were conducted on the samples referenced above. The tests yielded Liquid Limits ranging of approximately 19%, 20% and 23%, Plastic Limits of approximately 14%, 15% and 14%, and corresponding Plasticity Indices of approximately 5%, 5% and 9%. The test results are illustrated on the borehole records in Appendix C and on the gradation curve on Figure No. D6 in Appendix D.

Based on the results of the laboratory tests, the samples tested can be classified as clayey silt with a group symbol of CL-ML and CL based on the Unified Soil Classification System (USCS).

5.2.5 Bedrock

No bedrock was encountered in any boreholes within the investigation depths.

5.2.6 Groundwater

A monitoring well was installed in Borehole CNR-OH1 to observe the long-term groundwater levels. In other boreholes, groundwater level observations were made during drilling operations, and in the open boreholes upon completion of drilling. Soil colour change from brown to grey was noted at approximate depths of 2.3 m to 3.8 m below grade, corresponding to approximately elevations 238.1 m to 236.1 m. Cave-in depths were also recorded. The groundwater level recorded in CNR-OH1 and inferred in the other boreholes are summarized in Table 5.1 below.

Table 5.2: Measured and Inferred Groundwater Levels

Borehole No	Date	Groundwater Level (m)		Remark
		Depth	Elevation	
CNR-EMB1	Upon Completion	Dry		Borehole Open
CNR-EMB3	Upon Completion	Dry		Borehole Open
CNR-EMB4	Upon Completion	Dry		Borehole Open
CNR-EMB5	Upon Completion	Dry		Borehole Open
CNR-EMB6	Upon Completion	Dry		Borehole Open
CNR-EMB7	Upon Completion	Dry		Borehole Open
CNR-EMB9	Upon Completion	Dry		Borehole Open
CNR-EMB11	Upon Completion	13.6	225.6	Cave-in at 14.5 m
CNR-EMB12	Upon Completion	Dry		Cave-in at 14.6 m



FOUNDATION INVESTIGATION REPORT – CNR OVERHEAD – HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

April 2025

Borehole No	Date	Groundwater Level (m)		Remark
		Depth	Elevation	
CNR-OH1	Well installed on June 6, 2024 Measured on August 29, 2024	0.5	239.7	Borehole was dry upon start of mud drilling (from 3 m bgs)
CNR-OH2	Borehole was dry upon the start of mud drilling (from 3 m bgs). Further groundwater monitoring was not possible due to the introduction of water during drilling.			
CNR-OH3	Borehole was dry upon the start of mud drilling (from 3.6 m bgs). Further groundwater monitoring was not possible due to the introduction of water during drilling .			
CNR-OH4	Borehole was dry upon start of mud drilling (from 3.6 m bgs) Further groundwater monitoring was not possible due to the introduction of water during drilling.			

The fact that the boreholes were observed to be dry at the time of drilling reflects the low permeability of the soils at this site rather than the depth to the water table.

Groundwater levels at the site will be subject to fluctuations due to seasonal changes, snowmelt and precipitation events. The water levels should be expected to be higher during the spring season and during and following periods of heavy precipitation or snow melt.

5.3 CHEMICAL TESTING

Four (4) representative samples from the soils at the site were tested for pH, water-soluble sulphate and chloride concentrations, and resistivity. The analysis results are provided in the following table.

Table 5.3: Results of Chemical Analysis

Borehole No	Sample No.	Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Resistivity (Ohm-cm)
CNR-OH1	SS8	5.6	8.48	6	194	3040
CNR-OH2	SS5	3.4	8.30	15	206	3370
CNR-OH3	SS4	2.6	8.35	16	185	2920
CNR-OH4	SS9	6.4	8.68	10	277	2430



FOUNDATION INVESTIGATION REPORT – CNR OVERHEAD – HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

April 2025

6.0 MISCELLANEOUS

The field work was carried out under the supervision of Mr. Muhammed Cuned and Mr. Harpreet Singh, under the direction of Mr. Gwangha Roh, P. Eng., Ph.D.

The wood lot was cleared for the foundations investigation by the Ministry of Transportation Ontario (MTO).

Both public and private utility locates were arranged by Stantec staff prior to initiation of drilling.

The drilling equipment was supplied and operated by London Soil Ltd. based in London, Ontario and DBW Drilling Ltd. based in North York, Ontario.

The CPT tests and MASW measurements were carried out by ConeTec based in Richmond Hill, Ontario.

The borehole locations and elevations were surveyed by Stantec's Geomatics division based in London.

Geotechnical laboratory testing was carried out at Stantec's laboratories in Markham and Ottawa, Ontario.

This report was prepared by Roshan Rashed, M.Sc., P.Eng., and reviewed by Gwangha Roh, P. Eng., Ph.D., and Raymond Haché, M.Sc., P.Eng., Designated Principal MTO Foundation Contact.



FOUNDATION INVESTIGATION REPORT – CNR OVERHEAD – HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

April 2025

7.0 CLOSURE

A subsurface investigation is a limited sampling of a site. The subsurface conditions given herein are based on information gathered at the specific borehole locations. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

Respectfully Submitted,

STANTEC CONSULTING LTD.



Roshan Rashed, M.Sc., P.Eng.
Geotechnical Engineer



Gwangha Roh, Ph.D., P.Eng.
Senior Geotechnical Engineer



Raymond Haché, M.Sc., P.Eng.
Designated Principal MTO Foundation Contact



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FOUNDATION INVESTIGATION REPORT – CNR OVERHEAD – HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

April 2025

APPENDIX A

A.1 DRAWING NOS. 1 TO 4 – BOREHOLE LOCATION PLAN AND SOIL STRATA PLOTS

A.2 GENERAL ARRANGEMENT DRAWING



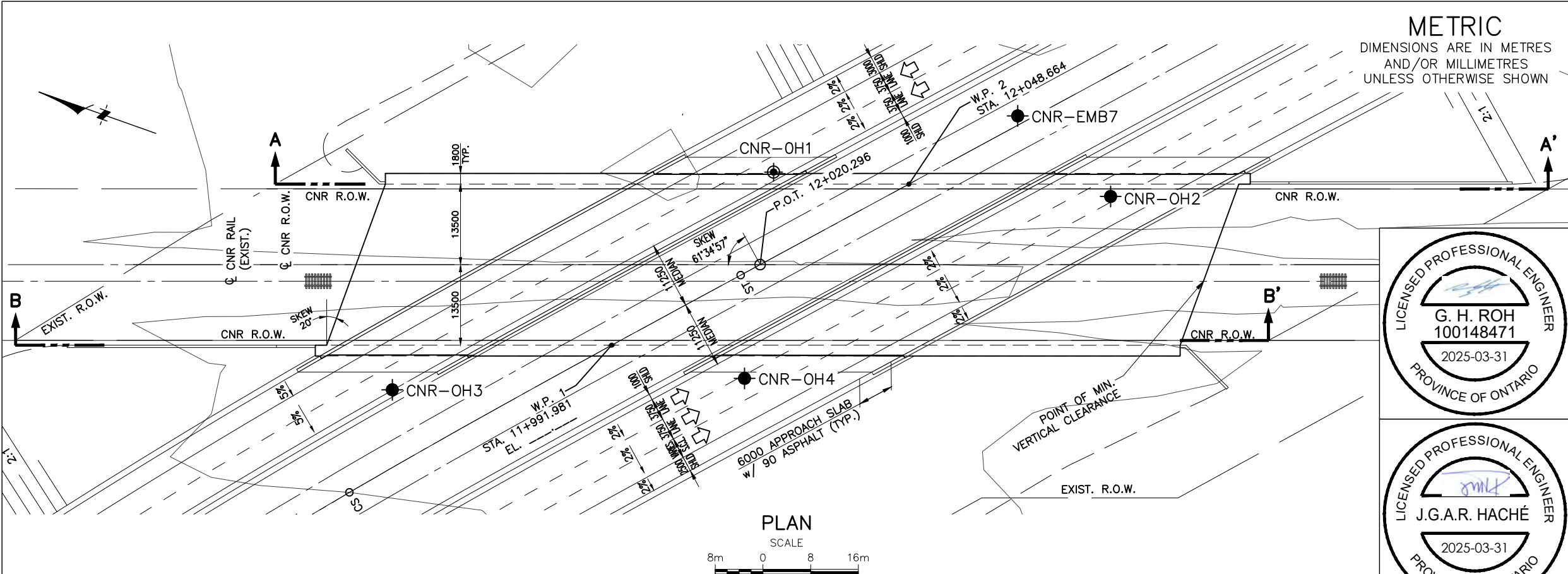
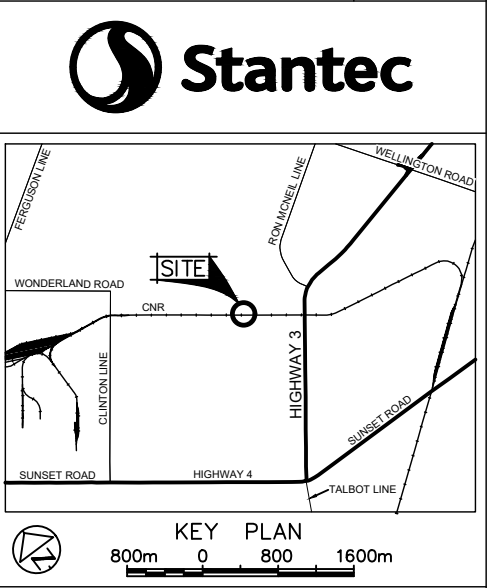


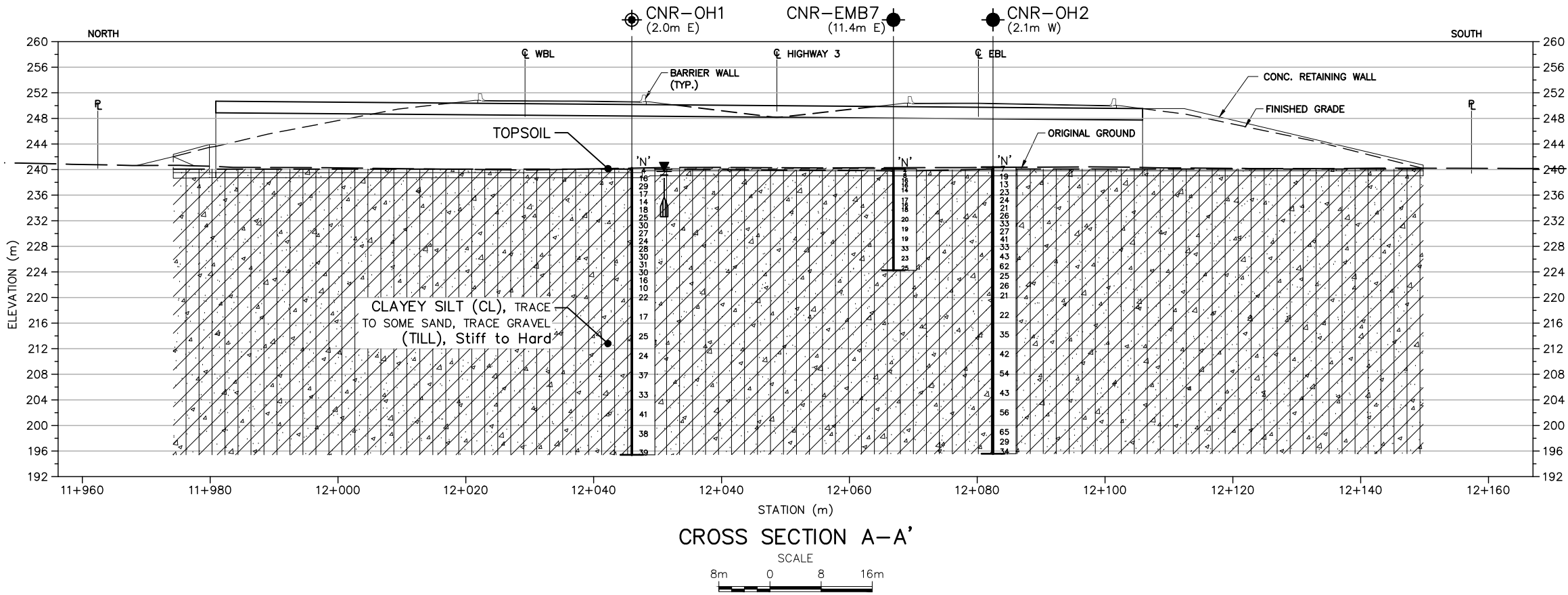
PLATE No
CONT
WP 3042-22-00

CNR TALBOTVILLE
OVERHEAD BRIDGE
BOREHOLE LOCATIONS & SOIL STRATA

SHEET
—



LEGEND			
	Borehole (Stantec, 2024)		
	Borehole with Monitoring Well (Stantec, 2024)		
(x.x m)	Offset from Cross Section Line		
N	Blows/0.3m (Std Pen Test, 475 J/blow)		
	WL Measured on August 2024		
	Piezometer		
No	ELEV	MTM ZONE 11 NORTH	COORDINATES EAST
CNR-EMB7	240.2	4 742 326.5	408 283.1
CNR-OH1	240.4	4 742 271.9	408 298.2
CNR-OH2	240.7	4 742 374.5	408 227.3
CNR-OH3	240.5	4 742 319.5	408 248.9
CNR-OH4	240.1	4 742 291.1	408 305.7



==NOTES==

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

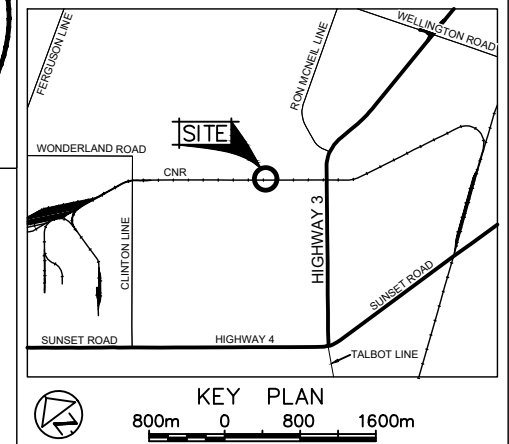
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	DATE	BY	DESCRIPTION
GEOCREs No 40114-224			
HWY No 3			DIST
SUBM'D RR	CHECKED	DATE 2025-03-31	SITE
DRAWN GBB	CHECKED	APPROVED	DWG 1

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



PLATE No
CONT
WP 3042-22-00



CNR TALBOTVILE OVERHEAD BRIDGE BOREHOLE LOCATIONS & SOIL STRATA



LEGEND

- | | |
|---|---|
|  | Borehole (Stantec, 2024) |
|  | Borehole with Monitoring Well (Stantec, 2024) |
| (x.x m) | Offset from Cross Section Line |
| N | Blows/0.3m (Std Pen Test,
475 J/blow) |

No	ELEV	MTM_ZONE 11 NORTH	COORDINATES EAST
CNR-EMB7	240.2	4 742 326.5	408 283.1
CNR-OH1	240.4	4 742 271.9	408 298.2
CNR-OH2	240.7	4 742 374.5	408 227.3
CNR-OH3	240.5	4 742 319.5	408 248.9
CNR-OH4	240.1	4 742 291.1	408 305.7

=NOTES=

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REVISIONS					
DATE	BY	DESCRIPTION			
GEOQUES No 40114-224					
HWY No 3				DIST	
SUBM'D	RR	CHECKED	DATE 2025-03-31		SITE
DRAWN	GRR	CHECKED	APPROVED	DWG	?

MINISTRY OF TRANSPORTATION, ONTARIO
PR-D-707 88-05
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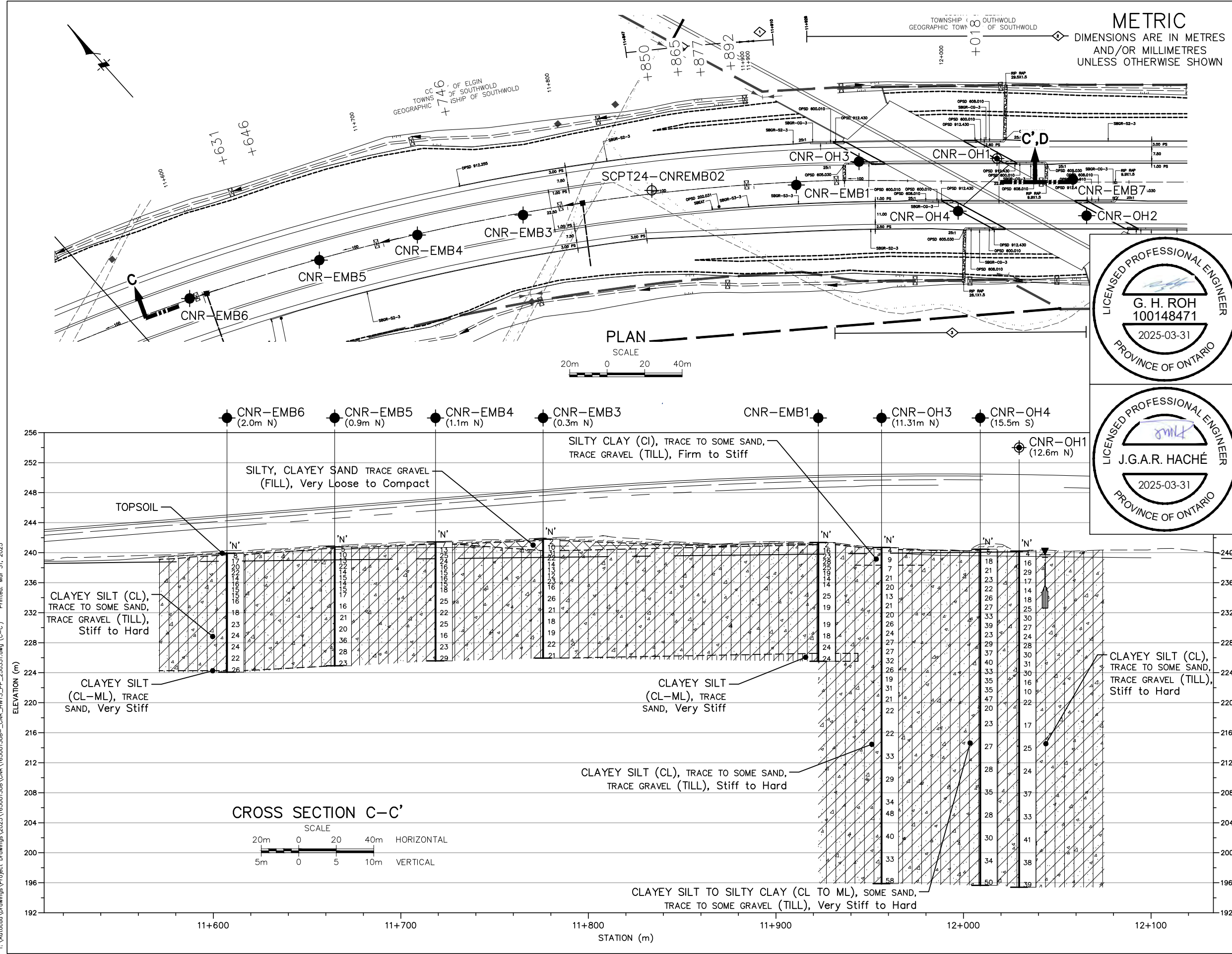


PLATE No
CONT
WP 3042-22-00

CNR TALBOTVILLE
OVERHEAD BRIDGE
BOREHOLE LOCATIONS & SOIL STRATA

SHEET
—

LEGEND

- Borehole (Stantec, 2024)
- Borehole with Monitoring Well (Stantec, 2024)
- Cone Penetration Test
- (x.x m) Offset from Cross Section Line
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- WL Measured on August 2024
- Piezometer

No	ELEV	MTM ZONE 11 NORTH	COORDINATES EAST
CNR-OH1	240.2	4 742 326.5	408 283.1
CNR-OH2	240.4	4 742 271.9	408 298.2
CNR-OH3	240.7	4 742 374.5	408 227.3
CNR-OH4	240.5	4 742 319.5	408 248.9
CNR-EMB1	240.1	4 742 387.6	408 194.1
CNR-EMB3	241.8	4 742 473.2	408 075.1
CNR-EMB4	241.4	4 742 503.0	408 026.1
CNR-EMB5	240.8	4 742 528.0	407 978.3
CNR-EMB6	239.9	4 742 559.1	407 913.2
CNR-EMB7	240.1	4 742 291.1	408 305.7
CNR-EMB9	239.7	4 742 180.1	408 425.8
CNR-EMB11	239.2	4 742 091.9	408 523.1
CNR-EMB12	239.1	4 742 048.1	408 572.4
SCPT24-CNREMB02	239.1	4 742 437.0	408 134.9
SCPT24-CNREMB08	239.1	4 742 229.9	408 360.7
SCPT24-CNREMB10	239.1	4 742 135.9	408 477.0

NOTES

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

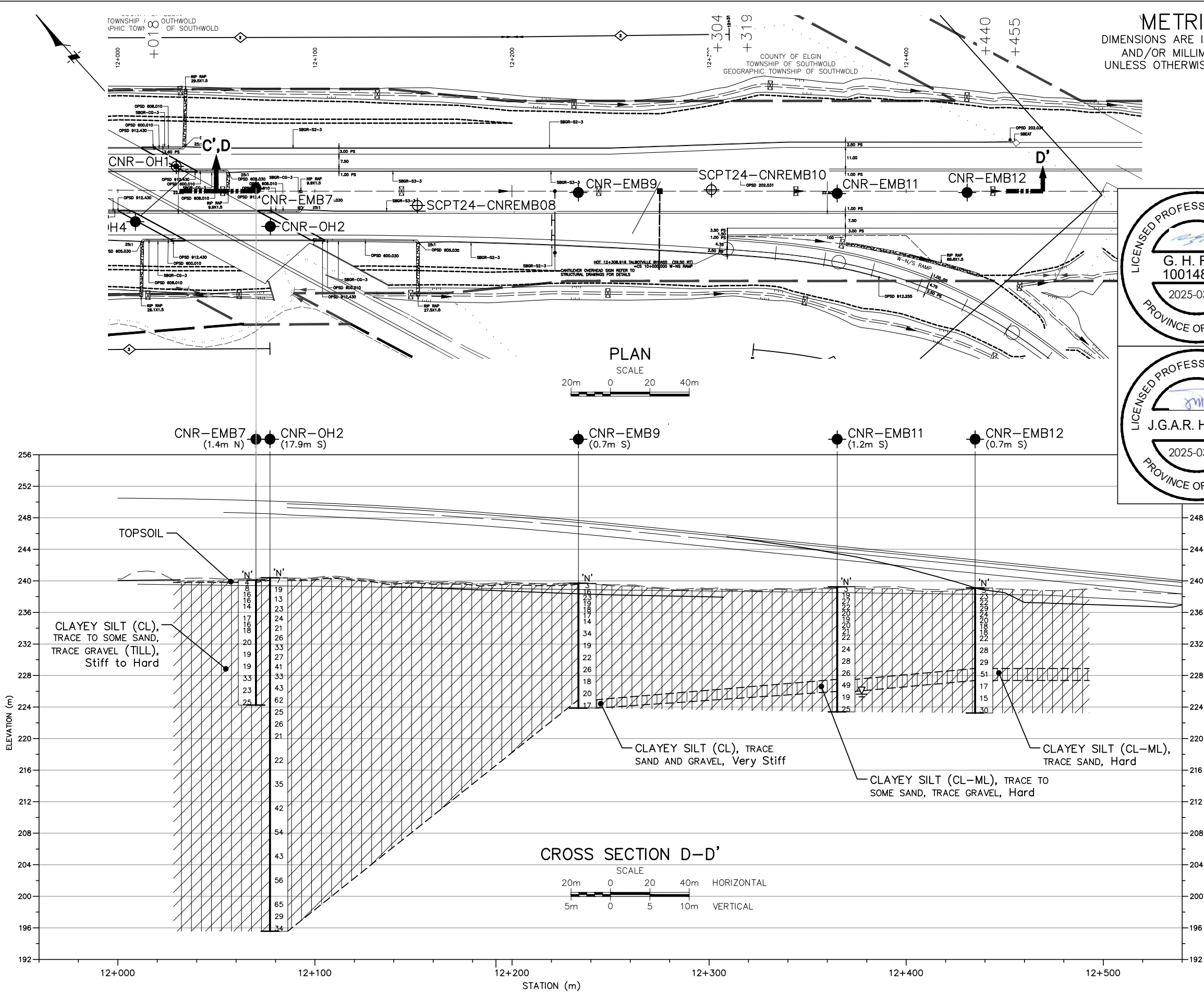
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

DATE	BY	DESCRIPTION

GEORES No 40114-224

HWY No 3	SUBM'D RR	CHECKED	DATE 2025-03-31	DIST

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Printed: Mar 31, 2025
PR-D-707
BB-05
MINISTRY OF TRANSPORTATION, ONTARIO



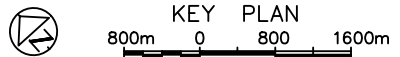
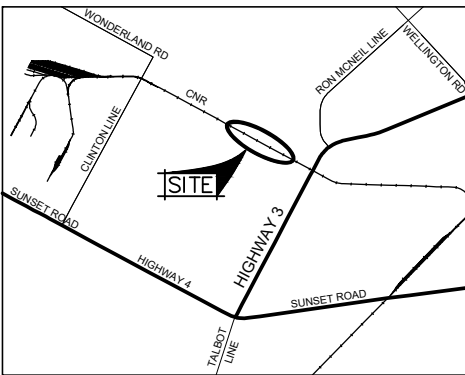
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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
CONT
WP 3042-22-00

CNR TALBOTVILLE
OVERHEAD BRIDGE
BOREHOLE LOCATIONS & SOIL STRATA



SHEET
—



LEGEND

- Borehole (Stantec, 2024)
- ⊕ Borehole with Monitoring Well (Stantec, 2024)
- ⊙ Cone Penetration Test
- (x.x m) Offset from Cross Section Line
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- WL Measured on August 2024
- ⊥ Piezometer

No	ELEV	MTM ZONE 11 NORTH	COORDINATES EAST
CNR-OH1	240.2	4 742 326.5	408 283.1
CNR-OH2	240.4	4 742 271.9	408 298.2
CNR-OH3	240.7	4 742 374.5	408 227.3
CNR-OH4	240.5	4 742 319.5	408 248.9
CNR-EMB1	240.1	4 742 387.6	408 194.1
CNR-EMB3	241.8	4 742 473.2	408 075.1
CNR-EMB4	241.4	4 742 503.0	408 026.1
CNR-EMB5	240.8	4 742 528.0	407 978.3
CNR-EMB6	239.9	4 742 559.1	407 913.2
CNR-EMB7	240.1	4 742 291.1	408 305.7
CNR-EMB9	239.7	4 742 180.1	408 425.8
CNR-EMB11	239.2	4 742 091.9	408 523.1
CNR-EMB12	239.1	4 742 048.1	408 572.4
SCPT24-CNREMB02		4 742 437.0	408 134.9
SCPT24-CNREMB08		4 742 229.9	408 360.7
SCPT24-CNREMB10		4 742 135.9	408 477.0

NOTES

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

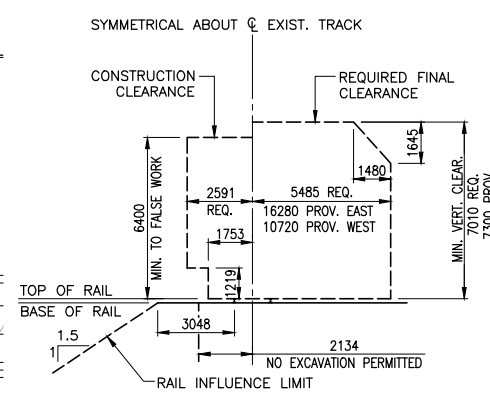
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REVISIONS	DATE	BY	DESCRIPTION

GEOCRES No 40114-224

HWY No 3			DIST
SUBM'D RR	CHECKED	DATE 2025-03-31	SITE
DRAWN GBB	CHECKED	APPROVED	DWG 4



FOUNDATION INVESTIGATION REPORT – CNR OVERHEAD – HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

April 2025

APPENDIX B

B.1 AVAILABLE GEOCRES INFORMATION



DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 40I14-70

DIST. 2 REGION

W.P. No. 89-69-05

CONT. No.

W. O. No.

STR. SITE No. 5-212

HWY. No. 3N

LOCATION PROPOSED CROSSING

AT CNR

No. of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 71-11068

LOCATION Co-Ord's 557,826 N. 339,591 E.

ORIGINATED BY P.P.

W.P. 89-69-05 & 06

BORING DATE July 22, 1971

COMPILED BY P.P.

DATUM Geodetic

BOREHOLE TYPE Continuous Flight Auger

CHECKED BY

SOIL PROFILE		SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_P WATER CONTENT ——— w			BULK DENSITY γ	REMARKS	
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w_o ——— w ——— w_L					
						SHEAR STRENGTH PS F					WATER CONTENT %					
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										
788.1	Ground level.					2000	4000				10	20	30	P.C.F.	GR.SA.SI.CL.	
0.0	Clayey silt, some sand, trace of gravel. Very stiff to hard.	1	SS	29												
		2	TW	PH	780										134	1 13 49 3
		3	SS	27												
		4	SS	70/6"	770											
		5	SS	34												
		6	TW	PH	760										140	
		7	SS	34												
		8	TW	PH	750										142	
		9	SS	40												
		10	TW	PH	740										136.5	
		11	SS	22												
					730											
		12	TW	PH											133	3 9 43 45
					720											
		13	SS	29												715.6'
				710												
	14	TW	PH											131		
				700												
		14A	SS	33												
689.1		15	TW	PH	690											
99.0	End of borehole.															

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 2

FOUNDATION SECTION

JOB 71-11068

LOCATION Co-Ord's 557,929 N. 339,505 E.

ORIGINATED BY P.P.

W.P. 89-69-05 & 06

BORING DATE July 23, 1971

COMPILED BY H.S.

DATUM Geodetic

BOREHOLE TYPE Continuous Flight Auger

CHECKED BY

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F. GR. SA. SI. CL.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		20	40	60	80	100	WATER CONTENT % w_p ——— w ——— w_L				
787.0	Ground level.														
	Clayey silt, some sand, trace of gravel.		1	SS	25										
			2	TW	PH										
	Very stiff to hard.		3	SS	20										
			4	TW	PH										
			5	SS	41										
			6	SS	65/6										
			7	TW	PH										
748.0			8	SS	53										
39.0	End of borehole.														

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 3

FOUNDATION SECTION

JOB 71-11068

LOCATION Co-Ord's 557,920 N. 339,456 E.

ORIGINATED BY P.P.

W.P. 89-69-05 & 06

BORING DATE July 26, 1971

COMPILED BY H.S.

DATUM Geodetic

BOREHOLE TYPE Continuous Flight Auger.

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT --- w _L PLASTIC LIMIT --- w _p WATER CONTENT --- w			BULK DENSITY γ	REMARKS			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w _p --- w --- w _L							
							SHEAR STRENGTH P.S.F.					WATER CONTENT %			P.C.F.	GR	SA	SL	CL
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE												
							2000 4000					10 20 30							
787.0	Ground level.		1	SS	34														
	Clayey silt, some sand, trace of gravel. Hard.		2	TW	PH	780												135.5	
			3	SS	32														
			4	TW	PH	770												140	
			5	SS	93/6"														
			6	SS	67	760													
			7	TW	PH														138
			8	SS	65	750													5 12 51 32
																			748.5
740.5	End of borehole.		9	SS	67	740													
46.5																			

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 71-11068 LOCATION Co-Ord's 558,019 N. 339,370 E. ORIGINATED BY P.P.

W.P. 89-69-05 & 06 BORING DATE July 27, 1971 COMPILED BY H.S.

DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger. CHECKED BY

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w _L PLASTIC LIMIT ——— w _p WATER CONTENT ——— w			BULK DENSITY γ	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	20	40	60	80	100	WATER CONTENT % 10 20 30				
787.9	Ground level.						SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
	Clayey silt, some sand, trace of gravel.		1	SS	17											
			2	SS	27											
			3	SS	35	780										
			4	SS	27											
			5	SS	25											
	Very stiff to hard.		6	SS	25											
			7	SS	27	770										
			8	SS	33											
			9	SS	24	760										
753.9			10	SS	40											
34.0	End of borehole.					750										

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 5

FOUNDATION SECTION

JOB 71-11068 LOCATION Co-Ord's 558,163 N. 339,320 E. ORIGINATED BY P.P.
W.P. 89-69-05 & 06 BORING DATE July 27, 1971 COMPILED BY H.S.
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger CHECKED BY

SOIL PROFILE		SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT --- w _L PLASTIC LIMIT --- w _p WATER CONTENT --- w			BULK DENSITY γ	REMARKS
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w _p	w	w _L		
788.3	Ground level.														
0.0															
	Clayey silt, some	1	SS	16											
	sand, trace of	2	TW	PH	780									136	
	gravel.	3	SS	47											
		4	TW	PH											
	Very stiff to	5	SS	55	770									135	
	hard.	6	TW	PH											
		7	SS	55	760									139	
		8	TW	PH											
		9	SS	40	750									140	2 13 51 34
		10	TW	PH											
		11	SS	69	740										
		12	TW	PH	730									133	
		13	SS	34	720										▼ 723.3
		14	SS	50	710										
706.8					700										
81.5	End of borehole.														0 9 41 50

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No.6

FOUNDATION SECTION

JOB 71-11068

LOCATION Co-Ord's 558,074 N. 339,402 E.

ORIGINATED BY P.P.

W.P. 89-69-05 & 06

BORING DATE July 26, 1971

COMPILED BY H.S.

DATUM Geodetic

BOREHOLE TYPE Continuous Flight Auger.

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT - w_L PLASTIC LIMIT - w_p WATER CONTENT - w			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w_p	w	w_L		
788.4	Ground level.															
0.0	Clayey silt, some sand, trace of gravel.		1	SS	26											
			2	SS	48											
			3	SS	51	780										
			4	TW	PH											
	Very stiff to hard.		5	SS	65											
			6	TW	PH	770										
			7	SS	55	760										
			8	TW	PH											
			9	SS	56	750										
746.9						740										
41.5	End of borehole.															

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 7

FOUNDATION SECTION

JOB 71-11068 LOCATION Co-Ord's 558,080 N, 339,453 E. ORIGINATED BY P.P.
 W.P. 89-69-05 & 06 BORING DATE July 26, 1971 COMPILED BY H.S.
 DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger. CHECKED BY

SOIL PROFILE		SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F. GR. SA. SI. CL.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		20	40	60	80	100	20	40	60		
787.8	Ground level.														
0.0			1	SS	12										
	Clayey silt, some sand, trace of gravel.		2	SS	34										
			3	SS	31	780									
			4	SS	31										
			5	SS	31										
			6	SS	29										
	Stiff to hard.		7	SS	35	770									
			8	SS	28										
			9	SS	34	760									
			10	SS	25										
748.8			11	SS	27	750									
39.0	End of borehole.														
						740									

End of cone test.

2 14 51 33

752.8

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No.8

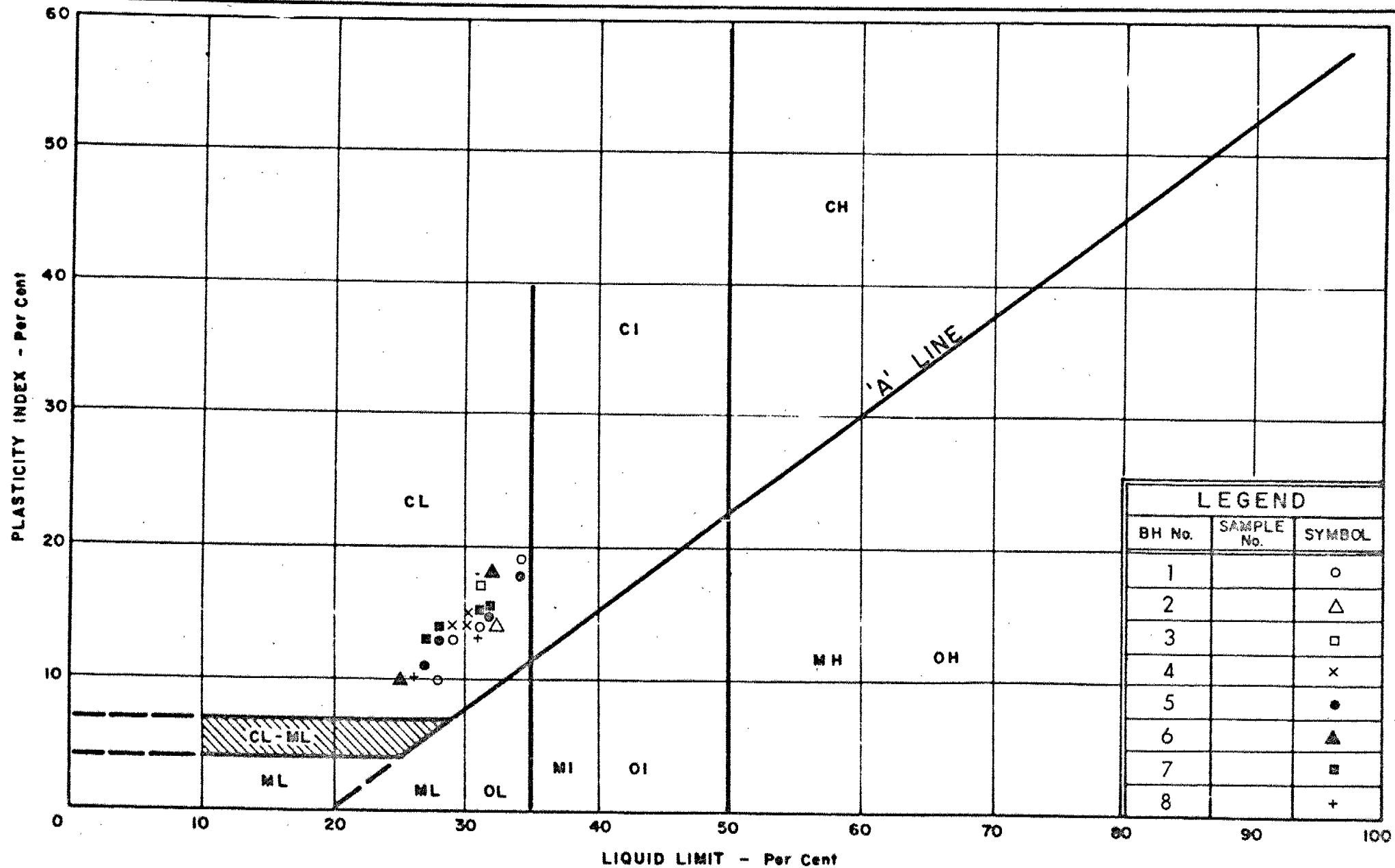
FOUNDATION SECTION

JOB 71-11068 LOCATION Co-Ord's 557, 988 N. 339, 33. E. ORIGINATED BY P.P.

W.P. 89-69-05 & 06 BORING DATE July 26, 1971 COMPILED BY P.P.

DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger. CHECKED BY

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w _L PLASTIC LIMIT ——— w _p WATER CONTENT ——— w			BULK DENSITY γ _s P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS/FOOT	20	40	60	80	100	w _p	w			w _L
						SHEAR STRENGTH P.S.F.					WATER CONTENT %					
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										
						2000 4000					10 20 30					
788.0	Ground level.															
0.0	Clayey silt, some sand, trace of gravel. Stiff to hard.		1	SS	13											
			2	TW	PE	780										
			3	SS	26											
			4	TW	PH	770										
			5	SS	36											
			6	TW	PH	760										
			7	SS	43											
			8	SS	57	750										
			9	SS	50	740										
			10	SS	35	730										
729.0																
59.0	End of borehole.															
						720										



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

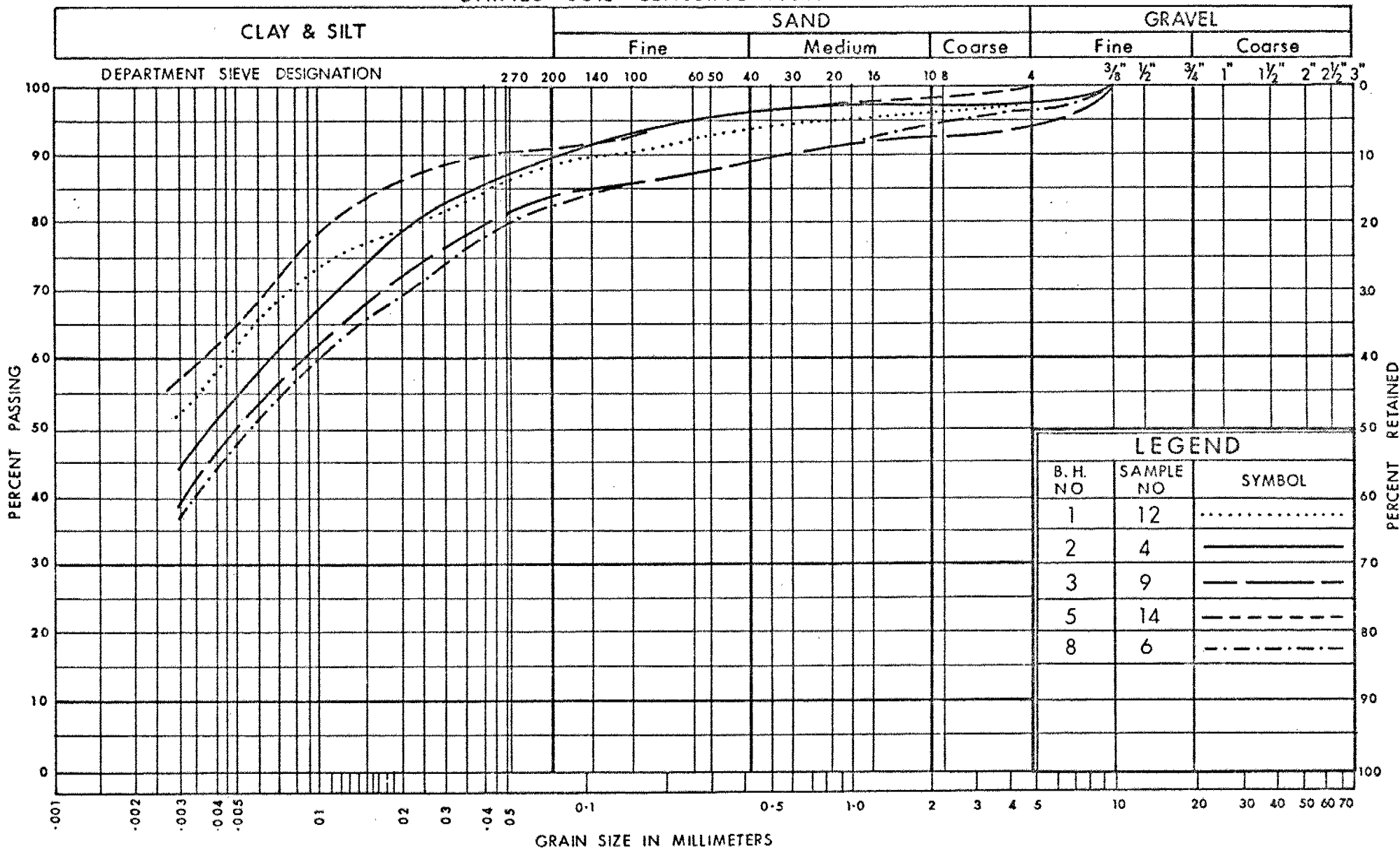
PLASTICITY CHART
CLAYEY SILT, SOME SAND, TRACE OF GRAVEL

WP No. 89-69-05 & 06

JOB No. 71-11068

FIG No 1

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT
OF
TRANSPORTATION AND COMMUNICATIONS



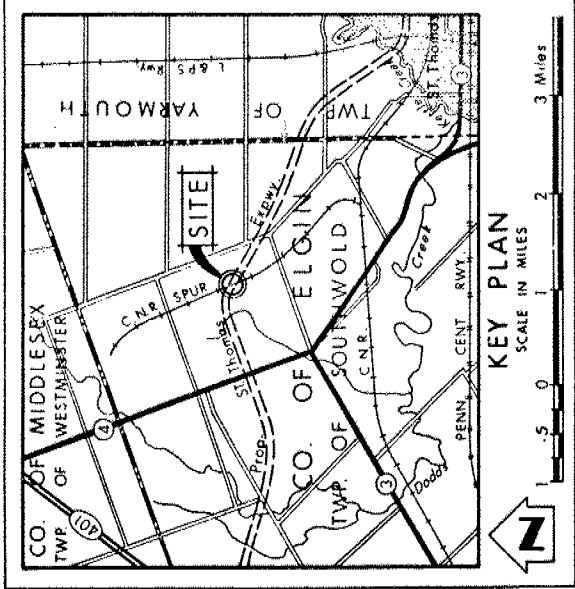
DESIGN SERVICES
BRANCH





GRAIN SIZE DISTRIBUTION
CLAYEY SILT, SOME SAND, TRACE OF GRAVEL

W.P. No. 89-69-05 & 06

JOB No. 71-11068

FIG. No 2



LEGEND			
	Bore Hole		
	Cone Penetration Test		
	Bore Hole & Cone Test		
	Water Levels established at time of field investigation. July 1971		
NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	788.1	557,826	339,591
2	787.0	557,929	339,505
3	787.0	557,920	339,456
4	787.9	558,019	339,370
5	788.3	558,163	339,320
6	788.4	558,074	339,402
7	787.8	558,080	339,453
8	788.0	557,988	339,533

— NOTE —
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISIONS		DESCRIPTION
DATE	BY	

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS
DESIGN SERVICES BRANCH — FOUNDATION OFFICE

C. N. R. SPUR LINE

HIGHWAY NO. 2 PROP. ST. THOMAS EXPWY. DIST. NO. 2
CO. ELGIN

TWP. SOUTHWOLD LOT 42 & 43 CON. E.S.T.R.

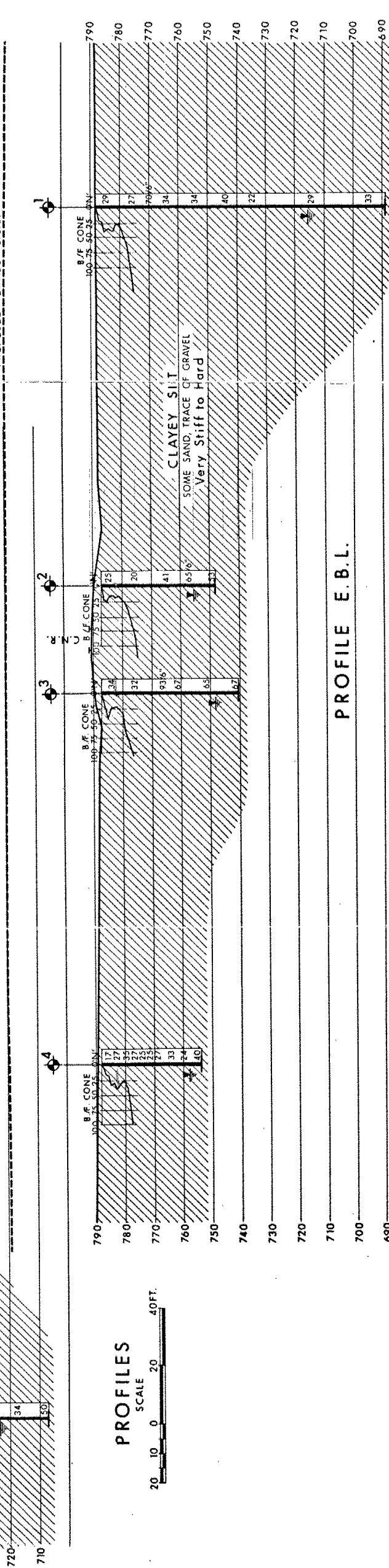
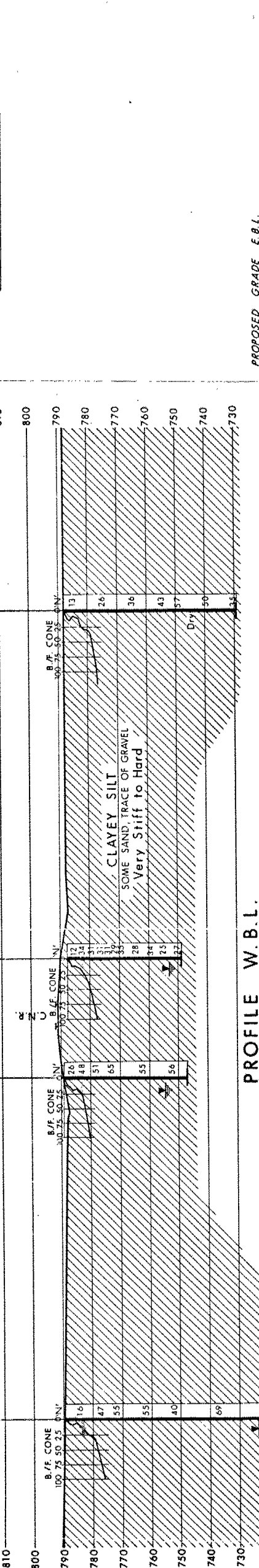
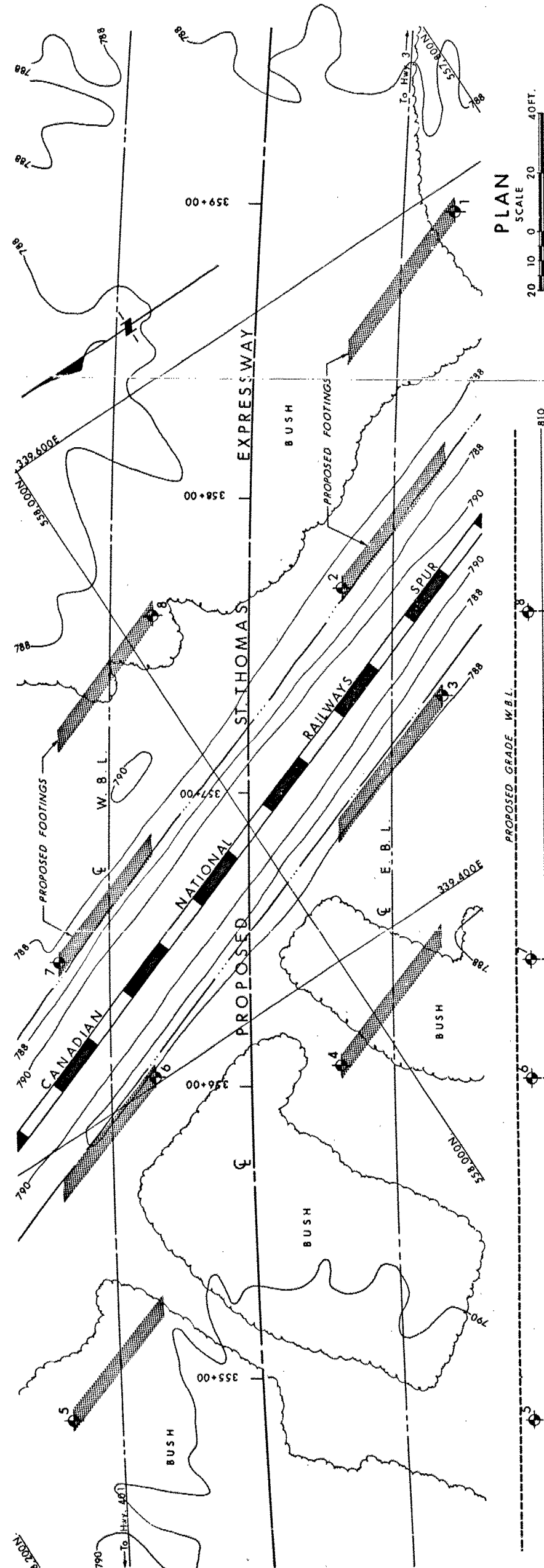
BORE HOLE LOCATIONS & SOIL STRATA

SUBNO. P.P. CHECKED W.P. NO. 89-69-053.06 DRAWING NO.

DRAWN BY CHECKED JOB NO. 71-110.68 71-11068A

DATE AUG. 31, 1971 SITE NO. BRIDGE DRAWING NO.

APPROVED: [Signature] CONT. NO.



PROFILES E.B.L.

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 11

JOB 71-11068

LOCATION Co-ords. 558,021 N; 339,473 E.

ORIGINATED BY LJH

W.P. 89-69-05/06

BORING DATE Nov. 7, 1973

COMPILED BY LJH

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — w_L		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT 20 40 60 80 100	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT — w_p	WATER CONTENT — w		
787.5	Ground Level											
0.0	Clayey silt, some sand, trace of gravel		1	SS	20	780						774
	Very Stiff		2	SS	19							
	Hard		3	SS	26							
771.0			4	SS	35							
16.5	End of Borehole					770						

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 12

JOB 71-11068

LOCATION Co-ords. 558,098 N; 339,398 E.

ORIGINATED BY L.J.H.

W.P. 89-69-05/06

BORING DATE Nov. 8, 1973

COMPILED BY L.J.H.

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W		BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE		WATER CONTENT %			
788.2	Ground Level											
0.0	Clayey silt, some sand traces of gravel. Very Stiff to Hard		1	SS	28	780						Hole Dry
			2	SS	54							
			3	SS	33							
771.7			4	SS	45							
16.5	End of Borehole					770						

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 13

JOB 71-11068

LOCATION Co-ords. 558,208 N; 339,405 E.

ORIGINATED BY LJH

W.P. 89-69-05/06


BORING DATE Nov. 7, 1973

COMPILED BY LJH

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT _____w _L PLASTIC LIMIT _____w _p WATER CONTENT _____w w _p _____w _____w _L WATER CONTENT %				BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
789.0	Ground Level															
0.0	Clayey silt, some sand, traces of gravel.		1	SS	11	780										 776.5
			2	SS	10											
	Stiff to Hard		3	SS	30											
772.5			4	SS	38											
16.5	End of Borehole					770										

776.5

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 14

JOB 71-11068

LOCATION Co-ords. 558,263 N; 339,337 E.

ORIGINATED BY LJH

W.P. 89-69-05/06

BORING DATE Nov. 8, 1973

COMPILED BY LJH

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT W_L PLASTIC LIMIT W_p WATER CONTENT W W_p — W — W_L WATER CONTENT %				BULK DENSITY γ P.C.F. GR. SA. SI. CL.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
789.4	Ground Level															
0.0	Clayey silt, some sand, traces of gravel.		1	SS	9	780									Hole Dry	
			2	SS	23											
	Very Stiff to Hard		3	SS	30											
772.9			4	SS	52											
16.5	End of Borehole					770										

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 15

JOB 71-11068

LOCATION Co-ords. 558,286 N; 339,400 E.

ORIGINATED BY WJH

W.P. 89-69-05/06

BORING DATE November 7, 1973

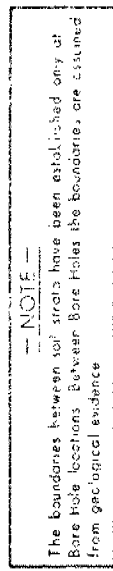
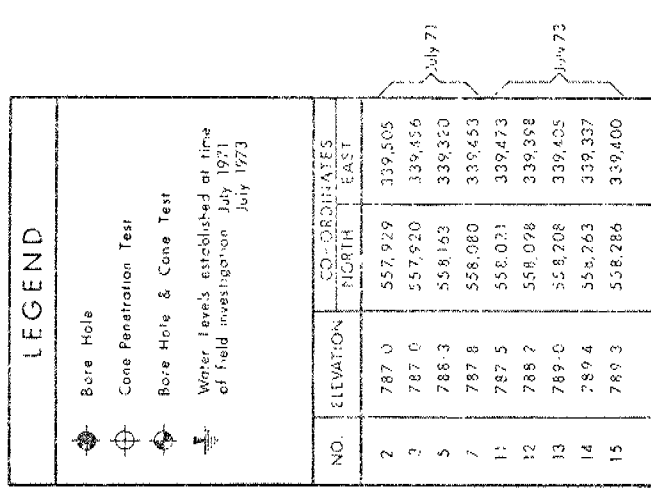
COMPILED BY LJH

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT W_L			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT	20	40	60	80	100	PLASTIC LIMIT W_P	WATER CONTENT W		
789.3	Ground Level															
0.0	Clayey silt, some sand, traces of gravel.		1	SS	16											
			2	SS	45											
			3	SS	24											
	Very Stiff to Hard		4	SS	27											
772.8			5	SS	54											
16.5	End of Borehole															



REVISIONS		DATE	BY
1	Initial design	10/1/77	J. L. S.
2	Revised design	10/1/77	J. L. S.
3	Final design	10/1/77	J. L. S.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
DESIGN SERVICES BRANCH—FOUNDATIONS OFFICE

C.N.R. SPUR LINE OVERPASS

HIGHWAY NO. PROP. ST. THOMAS EXPWY. DIST. NO. 2
CO. ELGIN

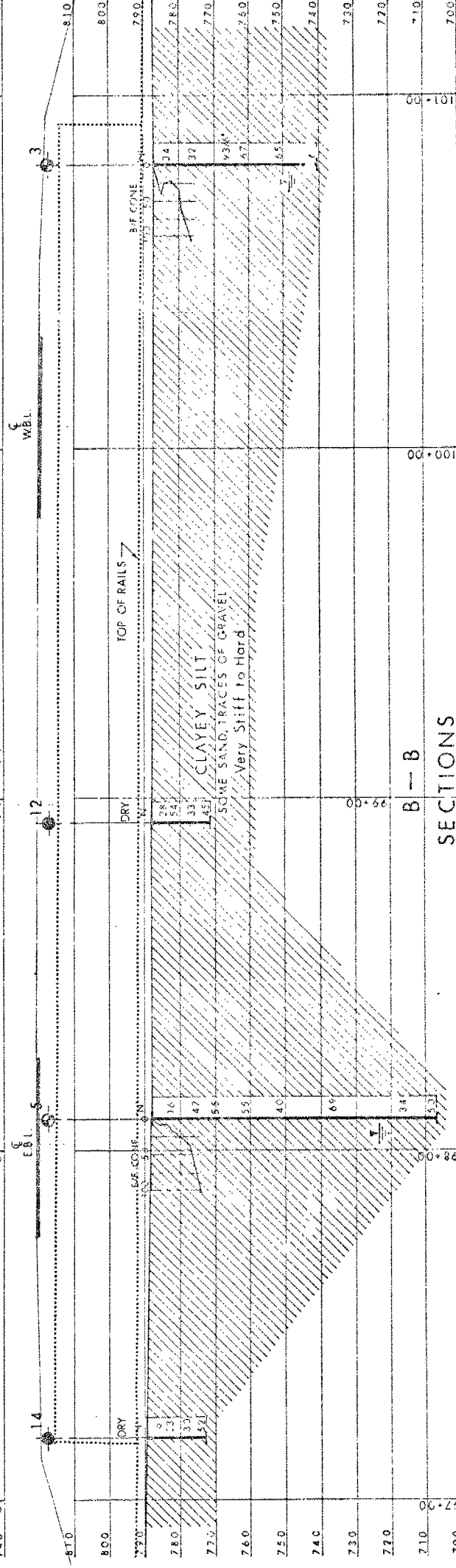
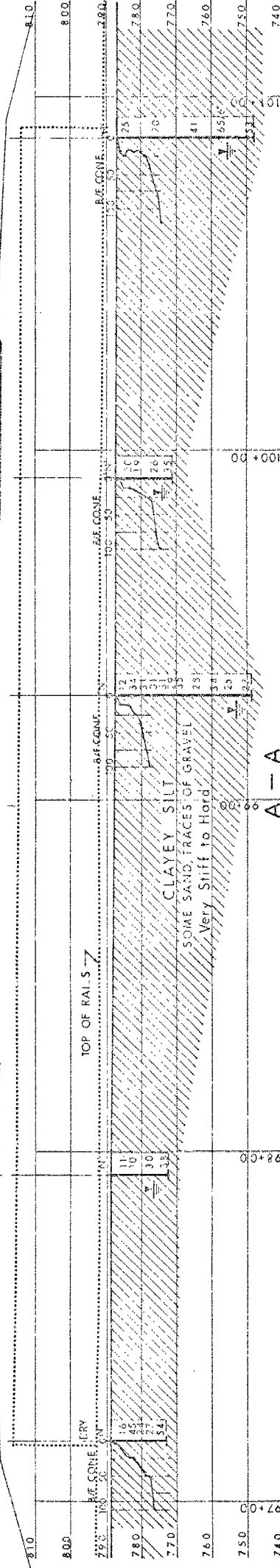
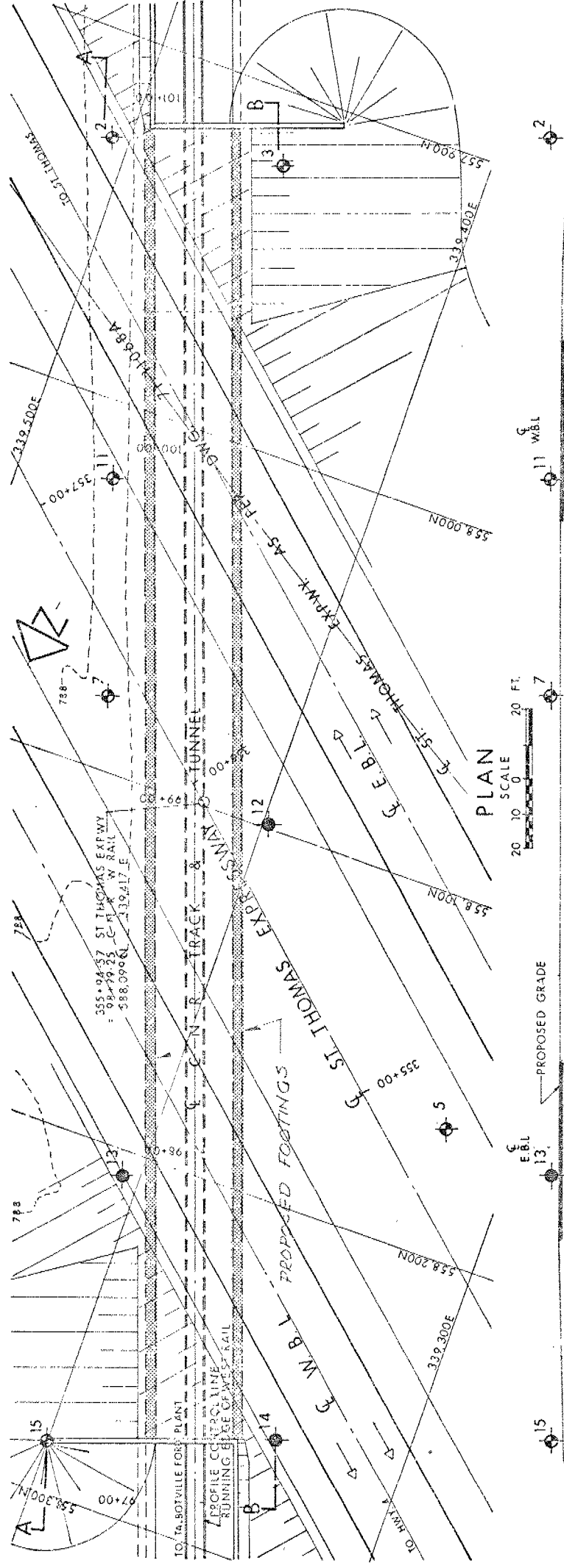
TWP SOUTHWOLD LOT 42 & 43 CON EST R

ROPE HOLES LOCATIONS & SOIL STRATA

ON 10/10/1968 ON 10/10/1968

CRANN O' ; CHS CRO ; W.C. NO 71-1169 71-110685

DATE 7: 20W 1973 1: 18 NO BRIDGE CREDIT'S NO



NOTE: The complete foundation investigation report for this structure may be examined at the Structural Office and Foundation Office, Downsview, and at the 1200 ONTARIO DISTRICT OFFICE.

REF ID: A5403803-97-109

FOUNDATION INVESTIGATION REPORT – CNR OVERHEAD – HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

April 2025

APPENDIX C

C.1 SYMBOLS AND TERMS USED ON BOREHOLE RECORDS

C.2 BOREHOLE RECORDS

C.3 CPT SOUNDING RECORDS



SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

<i>Rootmat</i>	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
<i>Topsoil</i>	- mixture of soil and humus capable of supporting vegetative growth
<i>Peat</i>	- mixture of visible and invisible fragments of decayed organic matter
<i>Till</i>	- unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

<i>Desiccated</i>	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
<i>Fissured</i>	- having cracks, and hence a blocky structure
<i>Varved</i>	- composed of regular alternating layers of silt and clay
<i>Stratified</i>	- composed of alternating successions of different soil types, e.g. silt and sand
<i>Layer</i>	- > 75 mm in thickness
<i>Seam</i>	- 2 mm to 75 mm in thickness
<i>Parting</i>	- < 2 mm in thickness

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%
<i>Frequent</i>	> 20%

Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
<i>Very Loose</i>	<4
<i>Loose</i>	4-10
<i>Compact</i>	10-30
<i>Dense</i>	30-50
<i>Very Dense</i>	>50

Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
<i>Very Soft</i>	<0.25	<12.5	<2
<i>Soft</i>	0.25 - 0.5	12.5 - 25	2-4
<i>Firm</i>	0.5 - 1.0	25 - 50	4-8
<i>Stiff</i>	1.0 - 2.0	50 - 100	8-15
<i>Very Stiff</i>	2.0 - 4.0	100 - 200	15-30
<i>Hard</i>	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	Very Poor Quality
25-50	Poor Quality
50-75	Fair Quality
75-90	Good Quality
90-100	Excellent Quality

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	Crushed
Severely Fractured	Shattered or Very Blocky
Fractured	Blocky
Moderately Jointed	Sound
Intact	Very Sound

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	Extremely Wide	-
2000-6000	Very Wide	Very Thick
600-2000	Wide	Thick
200-600	Moderate	Medium
60-200	Close	Thin
20-60	Very Close	Very Thin
<20	Extremely Close	Laminated
<6	-	Thinly Laminated

Terminology describing rock strength:

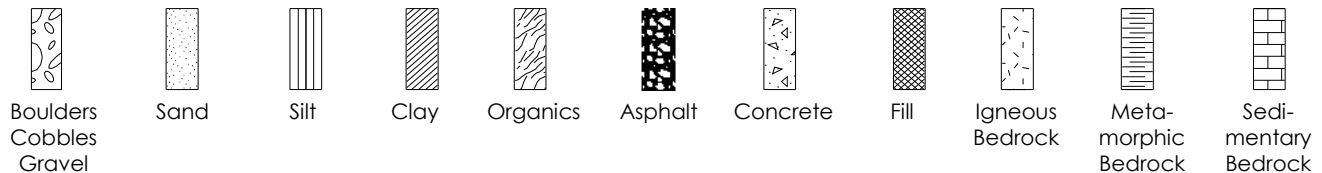
Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

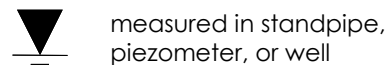
Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT



measured in standpipe, piezometer, or well



inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
y	Unit weight
G _s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q _u	Unconfined compression
I _p	Point Load Index (I _p on Borehole Record equals I _p (50) in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

RECORD OF BOREHOLE No CNR-EMB1

1 OF 1

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742387.6 E: 408194.1 ORIGINATED BY HS
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Auger COMPILED BY KL
DATUM Geodetic DATE 2024.05.16 - 2024.05.16 LATITUDE 42.81425905 LONGITUDE -81.23566536 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						× LAB VANE	WATER CONTENT (%)
241.4							20	40	60	80	100						
241.1	300 mm TOPSOIL		1	SS	2												
0.3	CLAYEY SILT (CL), trace to some sand, trace gravel (TILL) Stiff to very stiff (SS1 very soft) Brown to grey Moist Grey below 3.8 m		2	SS	16											2 13 48 37	
			3	SS	23												
			4	SS	28												
			5	SS	25												
			6	SS	19												0 12 41 47 PP = 3.5 TSF
			7	SS	14												PP = 3.5 TSF
			1	TW													Consolidation Test
			8	SS	14												2 9 42 47 PP = 3.5 TSF
			9	SS	25												PP = 4.0 TSF
			10	SS	19												PP = 4.5 TSF
			11	SS	19												PP = 4.5 TSF
226.6	CLAYEY SILT (CL-ML), trace sand Very stiff Grey Moist		12	SS	18											PP = 2.5 TSF	
			13	SS	24											4 14 48 34 PP = 3.0 TSF	
			14	SS	24												
14.8																	
225.5	END OF BOREHOLE																
15.9	Borehole open and dry on completion of drilling.																

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO GDT 9/26/24

RECORD OF BOREHOLE No CNR-EMB3

1 OF 1

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742473.2 E: 408075.1 ORIGINATED BY HS
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Auger COMPILED BY KL
DATUM Geodetic DATE 2024.03.04 - 2024.03.04 LATITUDE 42.81505 LONGITUDE -81.23712 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
								○ UNCONFINED	● QUICK TRIAXIAL	+ FIELD VANE						× LAB VANE	WATER CONTENT (%)	
241.8							20	40	60	80	100	20	40	60	GR	SA	SI	CL
240.6	180 mm TOPSOIL		1	SS	2													
0.2	SILTY, CLAYEY SAND (FILL), trace gravel Very loose to compact Brown Moist		2	SS	10													
240.3																		
1.5	CLAYEY SILT (CL), trace to some sand, trace gravel (TILL) Stiff to hard Brown to grey Moist		3	SS	31													
			4	SS	22													
			5	SS	14													
			6	SS	13													
	Grey below 3.8 m		7	SS	12													
			8	SS	23													
			9	SS	16													
			10	SS	26													
			11	SS	21													
			12	SS	18													
			13	SS	19													
			14	SS	22													
			15	SS	21													
225.9	END OF BOREHOLE																	
15.9	Borehole open and dry on completion of drilling.																	

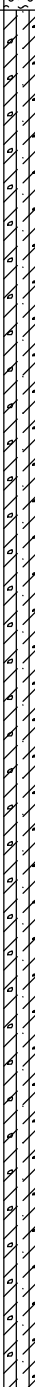
ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO GDT 9/26/24

RECORD OF BOREHOLE No CNR-EMB4

1 OF 1

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742503.0 E: 408026.1 ORIGINATED BY HS
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Auger COMPILED BY KL
DATUM Geodetic DATE 2024.03.04 - 2024.03.04 LATITUDE 42.81533 LONGITUDE -81.23771 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)			GR	SA	SI	CL	
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					w _p w w _L							
241.4							20	40	60	80	100	20	40	60						
241.4	280 mm TOPSOIL		1	SS	7													PP = 3.5 TSF		
0.3	CLAYEY SILT (CL), trace to some sand, trace gravel (TILL) Stiff to very stiff (SS1 firm) Brown to grey Moist Grey below 3.0 m		2	SS	13													PP = 4.0 TSF		
			3	SS	25														1 12 44 44	
			4	SS	24															
			5	SS	16														PP = 3.5 TSF	
			6	SS	15														PP = 4.0 TSF	
			7	SS	16														PP = 4.0 TSF	
			8	SS	15														PP = 4.5 TSF	
			9	SS	18														1 12 46 42 PP = 4.5 TSF	
			10	SS	25															PP > 4.5 TSF
			11	SS	22															PP > 4.5 TSF
			12	SS	25															PP > 4.5 TSF
13	SS	16															PP = 4.5 TSF			
14	SS	23															2 15 46 37 PP > 4.5 TSF			
15	SS	29															PP > 4.5 TSF			
225.6	END OF BOREHOLE																			
15.9	Borehole open and dry on completion of drilling.																			

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RECORD OF BOREHOLE No CNR-EMB5

1 OF 1

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742528.0 E: 407978.3 ORIGINATED BY HS
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Auger COMPILED BY KL
DATUM Geodetic DATE 2024.03.05 - 2024.03.05 LATITUDE 42.81556 LONGITUDE -81.23829 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	20					40	60	80	100				
240.8 240.6 0.2	150 mm TOPSOIL CLAYEY SILT (CL), trace to some sand, trace gravel (TILL) Stiff to hard (SS1 firm) Brown to grey Moist		1	SS	5		240							○				PP = 3.0 TSF						
																○					PP = 4.5 TSF			
																○					PP = 4.5 TSF			
																○					PP > 4.5 TSF			
																○					PP > 4.5 TSF			
																○					PP = 3.5 TSF			
																○					PP > 4.5 TSF			
																○					PP > 4.5 TSF			
																○					PP > 4.5 TSF			
																○					PP > 4.5 TSF			
																○					PP > 4.5 TSF			
																○					PP > 4.5 TSF			
																○					PP > 4.5 TSF			
																○					PP > 4.5 TSF			
																○					PP > 4.5 TSF			
													○			PP > 4.5 TSF								
224.9 15.9	END OF BOREHOLE Borehole open and dry on completion of drilling.						225							○			PP > 4.5 TSF							

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RECORD OF BOREHOLE No CNR-EMB6

1 OF 1

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742559.1 E: 407913.2 ORIGINATED BY HS
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Auger COMPILED BY KL
DATUM Geodetic DATE 2024.03.06 - 2024.03.06 LATITUDE 42.81585 LONGITUDE -81.23908 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							w _p w w _L				
239.9							20	40	60	80	100					GR	SA	SI	CL
239.0	200 mm TOPSOIL		1	SS	8														
0.2	CLAYEY SILT (CL), trace to some sand, trace gravel (TILL) Stiff to very stiff Brown to grey Moist		2	SS	17														
			3	SS	20														
			4	SS	22														
	Grey below 3.0 m		5	SS	14														
			6	SS	16														
			7	SS	15														
			8	SS	15														
			9	SS	16														
			10	SS	18														
			11	SS	23														
			12	SS	24														
			13	SS	24														
			14	SS	22														
			15	SS	26														
224.3																			
224.7	CLAYEY SILT (CL-ML), trace sand Very stiff Grey Moist to wet END OF BOREHOLE																		
15.9	Borehole open and dry on completion of drilling.																		

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO GDT 9/26/24

RECORD OF BOREHOLE No CNR-EMB7

1 OF 1

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742291.1 E: 408305.7 ORIGINATED BY HS
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Auger COMPILED BY KL
DATUM Geodetic DATE 2024.05.15 - 2024.05.15 LATITUDE 42.81338129 LONGITUDE -81.23433375 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								20 40 60 80 100						
240.1	300 mm TOPSOIL		1	SS	4									
239.8	CLAYEY SILT (CL), trace to some sand, trace gravel (TILL) Stiff to hard (SS1 soft) Brown to grey Moist Grey below 3.8 m		2	SS	8									
0.3			VANE											
			3	SS	16									
			4	SS	16									
			5	SS	14									
			1	TW										
			6	SS	17									
			7	SS	16									
			8	SS	18									
			9	SS	20									
			10	SS	19									
		11	SS	19										
		12	SS	33										
		13	SS	23										
		14	SS	25										
224.3	END OF BOREHOLE													
15.9	Borehole open and dry on completion of drilling.													

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO GDT 9/26/24

RECORD OF BOREHOLE No CNR-EMB9

1 OF 1

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742180.1 E: 408425.8 ORIGINATED BY HS
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Auger COMPILED BY KL
DATUM Geodetic DATE 2024.05.14 - 2024.05.15 LATITUDE 42.81236663 LONGITUDE -81.23288586 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa													
								○ UNCONFINED + FIELD VANE													
								● QUICK TRIAXIAL × LAB VANE													
							WATER CONTENT (%)														
							20 40 60 80 100	20 40 60													
239.7	150 mm TOPSOIL CLAYEY SILT (CL), trace to some sand, trace gravel (TILL) Stiff to very stiff (SS1 soft) Brown to grey Moist Grey below 3.0 m		1	SS	3		239											1 13 46 40			
239.6			2	SS	16																
0.2			1	TW																	
			3	SS	23																PP = 4.5 TSF
			4	SS	19																0 12 43 44 PP = 4.5 TSF
			5	SS	18																PP = 4.0 TSF
			6	SS	17																PP = 4.5 TSF
			7	SS	14																PP = 4.5 TSF
			2	TW																	Consolidation Test
			8	SS	34																PP = 4.5 TSF
			9	SS	19																2 17 47 34 PP = 3.5 TSF
					10			SS	22												
			11	SS	26																
			12	SS	18																
															</						

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RECORD OF BOREHOLE No CNR-EMB11 1 OF 1 METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742091.9 E: 408523.1 ORIGINATED BY HS
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Auger COMPILED BY KL
DATUM Geodetic DATE 2024.05.14 - 2024.05.14 LATITUDE 42.811559 LONGITUDE -81.231714 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w _p	w	w _L						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE													
239.2							20	40	60	80	100						GR	SA	SI	CL	
239.0	200 mm TOPSOIL		1	SS	3								○								
0.2	CLAYEY SILT (CL), trace to some sand, trace gravel (TILL) Very stiff (SS1 soft) Brown to grey Moist		2	SS	19								○	—				2	13	44	41
			3	SS	27								○								
			4	SS	22								○								
	Grey below 3.0 m		5	SS	20								○								
			6	SS	19								○	—				3	14	48	35
			7	SS	20								○								
			8	SS	21								○								
			9	SS	22								○								
			10	SS	24								○	—				6	11	46	36
			11	SS	28								○								
			12	SS	26								○								
227.5	CLAYEY SILT (CL-ML) Hard Grey Wet		13	SS	49								○	—				0	0	80	20
226.0	CLAYEY SILT (CL), trace to some sand, trace gravel (TILL) Very stiff Grey Moist		14	SS	19								○								
13.3			1	TW									○	—							
			15	SS	25								○								
223.4	END OF BOREHOLE																				
15.9	Groundwater and cave-in measured at 13.6 m and 14.5 m below grade on completion of drilling, respectively.																				

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO GDT 9/26/24

RECORD OF BOREHOLE No CNR-EMB12 1 OF 1 METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742048.1 E: 408572.4 ORIGINATED BY HS
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Auger COMPILED BY KL
DATUM Geodetic DATE 2024.05.13 - 2024.05.13 LATITUDE 42.811159 LONGITUDE -81.231118 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
239.1 239.0 0.1	100 mm TOPSOIL CLAYEY SILT (CL), trace to some sand, trace gravel (TILL) Very stiff (SS1 soft) Brown to grey Moist		1	SS	5									GR SA SI CL				
			2	SS	23													
			3	SS	22										3 13 45 39 PP = 4.5 TSF			
			4	SS	29										PP = 4.5 TSF			
	Grey below 3.0 m		5	SS	24										PP = 4.5 TSF			
			6	SS	20										PP = 3.5 TSF			
			7	SS	18										6 14 46 34 PP = 4.5 TSF			
			8	SS	18										PP = 4.5 TSF			
			9	SS	22										PP = 4.5 TSF			
			10	SS	28										PP = 4.5 TSF			
			11	SS	29										PP = 4.5 TSF			
228.9 10.2	CLAYEY SILT (CL-ML), trace sand Hard Grey Wet		12	SS	51										0 2 78 20			
227.4 11.7	CLAYEY SILT (CL), trace to some sand (TILL) Very stiff to hard Grey Moist	13	SS	17										PP = 3.0 TSF				
		14	SS	15										PP = 2.5 TSF				
		1	TW															
		15	SS	30														
223.2 15.9	END OF BOREHOLE Borehole dry and cave-in measured at 14.6 m below grade on completion of drilling.																	

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO GDT 9/26/24

RECORD OF BOREHOLE No CNR-OH1

1 OF 3

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742326.5 E: 408283.1 ORIGINATED BY MC
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Augers/ Wash Boring COMPILED BY KL
DATUM Geodetic DATE 2024.06.03 - 2024.06.06 LATITUDE 42.81370323 LONGITUDE -81.23460378 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)				
								○ UNCONFINED		+ FIELD VANE					● QUICK TRIAXIAL		× LAB VANE		
240.2							20	40	60	80	100	20	40	60	GR	SA	SI	CL	
240.0	150 mm TOPSOIL		1	SS	4								○						
0.2	CLAYEY SILT (CL), some sand, trace gravel (TILL) Stiff to hard (SS1 soft) Brown to grey Moist		2	SS	16														
			3	SS	29								⊕	—		1	12	42	45
	Grey below 2.3 m		4	SS	17								○						
			5	SS	14								○					Wash Boring below 3.0m	
			6	SS	18								⊕	—				PP = 2.0 TSF	
			7	TW												1	12	43	44
			8	SS	25								○					PP = 2.5 TSF	
			9	SS	30								○						
			10	SS	27								⊕	—		5	12	45	38
																		PP = 4.5 TSF	
			11	SS	24								○					PP = 4.0 TSF	
			12	SS	28								○					PP = 4.0 TSF	
			13	SS	30								○					PP = 2.5 TSF	
			14	SS	31								○					PP = 3.5 TSF	
			15	SS	30								○					PP = 3.0 TSF	
223.2																			

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO.GDT 10/11/24

METRIC[illegible]

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No CNR-OH1 3 OF 3 METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742326.5 E: 408283.1 ORIGINATED BY MC
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Augers/ Wash Boring COMPILED BY KL
DATUM Geodetic DATE 2024.06.03 - 2024.06.06 LATITUDE 42.81370323 LONGITUDE -81.23460378 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	W _P	W	W _L					
34.0	CLAYEY SILT (CL), some sand, trace gravel (TILL) Hard Grey Moist						206												
			23	SS	33		205						○						PP = 1.25 TSF
							204												
							203												
			24	SS	41		202						○						PP = 1.5 TSF
							201												
							200												
			25	SS	38		199						○						1 13 45 41 PP = 1.0 TSF
							198												
							197												
195.4 44.8	END OF BOREHOLE		26	SS	39	196						○						PP = 1.5 TSF	
	Borehole dry upon start of mud drilling at approximately 3 m below grade. Monitoring well installed in borehole, screened from approximately 4.6 m to 7.6 m below grade. Groundwater level recorded in monitoring well at approximately 0.5 m below grade on August 29, 2024.																		

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO GDT 10/11/24

RECORD OF BOREHOLE No CNR-OH2

1 OF 3

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742271.9 E: 408298.2 ORIGINATED BY MC
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Augers/ Wash Boring COMPILED BY KL
DATUM Geodetic DATE 2024.05.28 - 2024.06.03 LATITUDE 42.81321029 LONGITUDE -81.23442911 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							w _p — w — w _L			
240.4							20	40	60	80	100	20	40	60	GR	SA	SI	CL
240.0	300 mm TOPSOIL		1	SS	7							○						
240.1			2	SS	19							⦿	—	—	2	14	44	41
0.3	CLAYEY SILT (CL), some sand, trace gravel (TILL) Stiff to hard (SS1 firm) Brown to grey Moist		3	SS	13							○			PP = 4.5 TSF			
			4	SS	23							○			PP = 4.5 TSF Wash Boring below 3.0m			
	Grey below 3.0 m		5	SS	24							⦿	—	—	1	12	43	43
															PP = 4.5 TSF			
			6	SS	21							○			PP = 3.0 TSF			
			7	SS	26							○			PP = 4.5 TSF			
			8	SS	33							⦿	—	—	3	14	47	37
															PP = 4.5 TSF			
			9	SS	27							○			PP = 4.5 TSF			
			10	SS	41							○			PP = 4.5 TSF			
			11	SS	33							○			PP = 4.5 TSF			
			12	SS	43							○			PP = 4.5 TSF			
			13	SS	62							○			PP = 4.5 TSF			
223.4																		

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+ ³, X ³: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

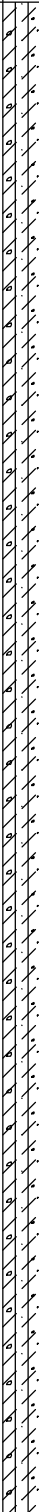
ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO.GDT 10/11/24

RECORD OF BOREHOLE No CNR-OH2

2 OF 3

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742271.9 E: 408298.2 ORIGINATED BY MC
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Augers/ Wash Boring COMPILED BY KL
DATUM Geodetic DATE 2024.05.28 - 2024.06.03 LATITUDE 42.81321029 LONGITUDE -81.23442911 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _P W W _L					WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE									
17.0	CLAYEY SILT (CL), some sand, trace to some gravel (TILL) Very stiff to hard Grey Moist		14	SS	25							○			PP = 2.25 TSF			
					15	SS	26							○				PP = 2.0 TSF
					16	SS	21							○		—		1 11 42 47 PP = 1.5 TSF
					17	SS	22									○		PP = 1.5 TSF

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO.GDT 10/11/24

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CNR-OH2

3 OF 3

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742271.9 E: 408298.2 ORIGINATED BY MC
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Augers/ Wash Boring COMPILED BY KL
DATUM Geodetic DATE 2024.05.28 - 2024.06.03 LATITUDE 42.81321029 LONGITUDE -81.23442911 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			w _p	w	w _L			
								○ UNCONFINED	+ FIELD VANE							
								● QUICK TRIAXIAL	× LAB VANE							
						20 40 60 80 100			20 40 60			WATER CONTENT (%)				
34.0	CLAYEY SILT (CL), some sand, trace gravel (TILL) Very stiff to hard Grey Moist						206								3 13 46 38 PP = 1.5 TSF	
			21	SS	43		205									
							204									
							203									
			22	SS	56		202									
							201									
							200									
	Inferred cobbles/boulder based on drilling difficulties between 39.9 m and 40.8 m			23	SS	65		199								
							198									
			24	SS	29		197									
	Frequent seams/layers of SILTY CLAY to CLAYEY SILT		25	SS	34		196									
195.6															0 2 49 48 PP = 1.5 TSF	
44.8	END OF BOREHOLE															
	Borehole dry upon start of mud drilling at approximately 3 m below grade.															

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO GDT 10/11/24

RECORD OF BOREHOLE No CNR-OH3

1 OF 3

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742374.5 E: 408227.3 ORIGINATED BY HS/MC
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Augers/ Wash Boring COMPILED BY KL
DATUM Geodetic DATE 2024.05.21 - 2024.06.11 LATITUDE 42.81414325 LONGITUDE -81.2352769 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
240.7 240.6 0.2	150 mm TOPSOIL SILTY CLAY (CI), trace to some sand, trace gravel (TILL) Firm to stiff (SS1 soft) Brown Moist		1	SS	4										
			2	SS	9										
			3	SS	7										
238.5 2.2	CLAYEY SILT (CL), some sand, trace gravel (TILL) Stiff to hard Brown to grey Moist Grey below 3.8 m		4	SS	21										
			5	SS	20										
			6	SS	13										
			1	TW											
			7	SS	21										
			8	SS	20										
			9	SS	26										
			10	SS	24										
			11	SS	27										
			12	SS	27										
			13	SS	32										
			14	SS	26										
223.7															

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+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO.GDT 10/11/24

RECORD OF BOREHOLE No CNR-OH3

2 OF 3

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742374.5 E: 408227.3 ORIGINATED BY HS/MC
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Augers/ Wash Boring COMPILED BY KL
DATUM Geodetic DATE 2024.05.21 - 2024.06.11 LATITUDE 42.81414325 LONGITUDE -81.2352769 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			w _p	w	w _L			
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						× LAB VANE
								20 40 60 80 100								
17.0	CLAYEY SILT (CL), trace to some sand, trace gravel (TILL) Very stiff to hard Grey Moist		15	SS	19										PP = 1.5 TSF	
								</								

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO.GDT 10/11/24

RECORD OF BOREHOLE No CNR-OH3

3 OF 3

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742374.5 E: 408227.3 ORIGINATED BY HS/MC
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Augers/ Wash Boring COMPILED BY KL
DATUM Geodetic DATE 2024.05.21 - 2024.06.11 LATITUDE 42.81414325 LONGITUDE -81.2352769 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
34.0	CLAYEY SILT (CL), some sand, trace gravel (TILL) Very stiff to hard Grey Moist																			
			23	SS	48										○				PP = 1.5 TSF	
				24	SS	40									○				PP = 1.5 TSF	
			25	SS	33									○				3 13 43 41 PP = 1.75 TSF		

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO.GDT 10/11/24

RECORD OF BOREHOLE No CNR-OH4

1 OF 3

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742319.5 E: 408248.9 ORIGINATED BY MC
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Augers/ Wash Boring COMPILED BY KL
DATUM Geodetic DATE 2024.07.04 - 2024.07.11 LATITUDE 42.81364502 LONGITUDE -81.23502322 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
240.5							20	40	60	80	100	20	40	60	GR	SA	SI	CL
240.4	100 mm TOPSOIL		1	SS	5													
	CLAYEY SILT to SILTY CLAY (CL to CI), some sand, trace to some gravel (TILL)																	
	Very stiff to hard (SS1 firm)		2	SS	18													
	Brown to grey																	
	Moist																	
			3	SS	21													
			4	SS	23													
			5	SS	22													
	Grey below 3.8 m		6	SS	26													
			7	SS	27													
			8	SS	33													
	Frequent layers of SILT with clay to CLAYEY SILT in SS9		9	SS	39													
			10	SS	23													
			11	SS	29													
			12	SS	37													
			13	SS	40													
			14	SS	33													
			15	SS	35													
223.5																		

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+ ³, × ³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO.GDT 10/11/24

RECORD OF BOREHOLE No CNR-OH4

2 OF 3

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742319.5 E: 408248.9 ORIGINATED BY MC
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Augers/ Wash Boring COMPILED BY KL
DATUM Geodetic DATE 2024.07.04 - 2024.07.11 LATITUDE 42.81364502 LONGITUDE -81.23502322 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			w _p	w	w _L							
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						× LAB VANE	WATER CONTENT (%)			
							20	40	60	80	100		20	40	60		GR	SA	SI	CL
17.0	CLAYEY SILT (CL), some sand, trace gravel (TILL) Very stiff to hard Grey Moist		16	SS	35								○							PP = 3.5 TSF
			17	SS	47								○							PP = 1.0 TSF
			18	SS	20								○							PP = 1.25 TSF
			19	SS	23								○							PP = 1.25 TSF
			20	SS	27								○	—						5 19 32 32 PP = 1.0 TSF
					</															

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO.GDT 10/11/24

Continued Next Page


+ ³, × ³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CNR-OH4

3 OF 3

METRIC

W.P. 3041-22-00 LOCATION CNR Overhead, Southwold, Ontario N: 4742319.5 E: 408248.9 ORIGINATED BY MC
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Augers/ Wash Boring COMPILED BY KL
DATUM Geodetic DATE 2024.07.04 - 2024.07.11 LATITUDE 42.81364502 LONGITUDE -81.23502322 CHECKED BY RR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			w _p	w	w _L					
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						× LAB VANE		
								20	40	60	80	100						
34.0	CLAYEY SILT (CL), some sand, trace gravel (TILL) Very stiff to hard Grey Moist						206											
			23	SS	28		205							○				PP = 1.75 TSF
							204											
							203											
			24	SS	30		202							○	—			2 13 45 40 PP = 1.25 TSF
							201											
							200											
			25	SS	34		199							○				
							198											
							197											
			26	SS	50		196											
195.7 44.8	END OF BOREHOLE Borehole dry upon start of mud drilling at approximately 3.6 m below grade.																	

ONTARIO MTO 165001308_MTO_CNR-BYPASS_20240926.GPJ ONTARIO MTO.GDT 10/11/24

PRESENTATION OF SITE INVESTIGATION RESULTS

HWY 3 St Thomas CPT

Prepared for:

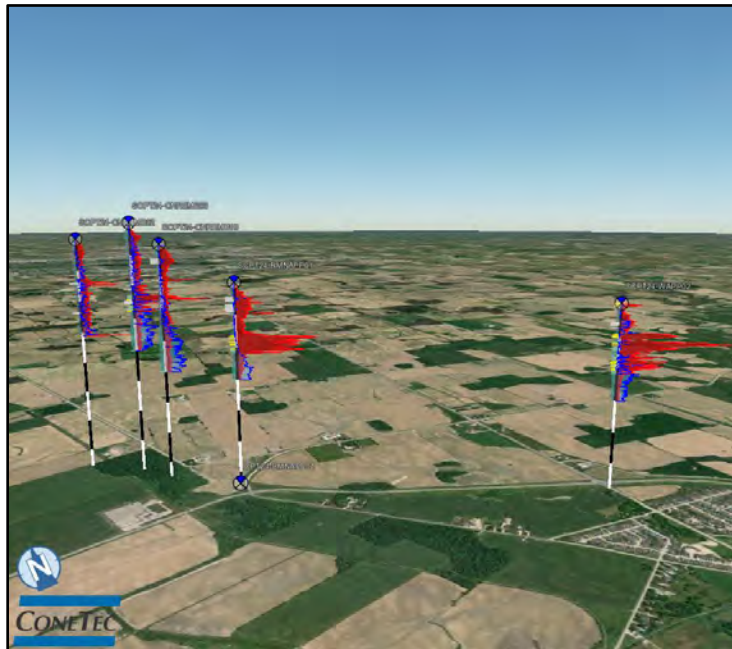
Stantec Consulting Ltd.

ConeTec Job No: 24-05-27609

Project Start Date: 2024-05-09

Project End Date: 2024-05-10

Report Date: 2024-05-24



Prepared by:

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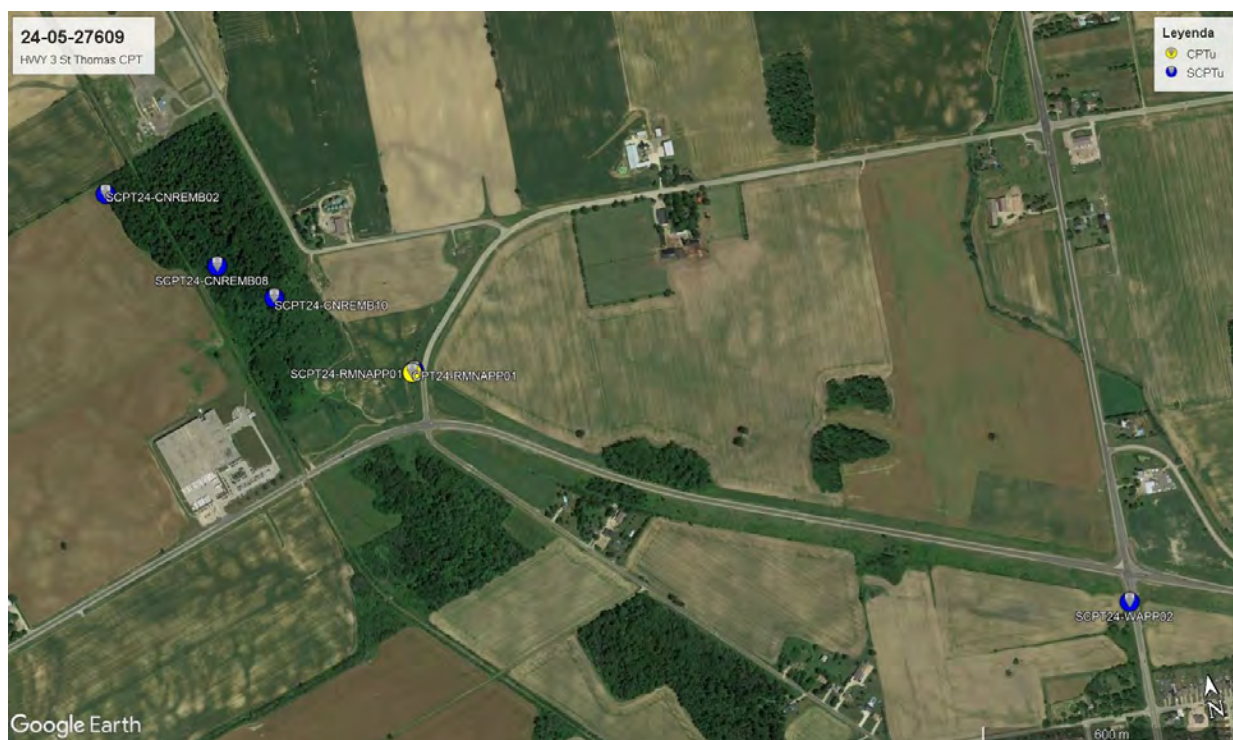
Introduction

The enclosed report presents the results of the site investigation program conducted by ConeTec Investigations Ltd. for Stantec Consulting Ltd. at HWY 3, St. Thomas, ON. The program consisted of 1 cone penetration test (CPTu) and 5 seismic cone penetration tests (SCPTu). Please note that this report, which also includes all accompanying data, are subject to the 3rd Party Disclaimer and Client Disclaimer that follow in the 'Limitations' section of this report.

Project Information

Project	
Client	Stantec Consulting Ltd.
Project	HWY 3 St Thomas CPT
ConeTec project number	24-05-27609

An aerial overview from Google Earth including the test locations is presented below.



Rig Description	Deployment System	Test Type
CPT track rig (TC23)	30 ton rig cylinder	CPTu, SCPTu

Coordinates		
Test Type	Collection Method	EPSG Number
CPTu, SCPTu	Consumer grade GPS	26917

Cone Penetrometers Used for this Project						
Cone Description	Cone Number	Cross Sectional Area (cm ²)	Sleeve Area (cm ²)	Tip Capacity (bar)	Sleeve Capacity (bar)	Pore Pressure Capacity (bar)
729:T1500F15U35	729	15	225	1500	15	35
Cone 729 was used for all CPTu soundings.						

Cone Penetration Test (CPTu)	
Depth reference	Depths are referenced to the existing ground surface at the time of each test.
Tip and sleeve data offset	0.1 meter This has been accounted for in the CPT data files.
Additional plots	<ul style="list-style-type: none"> Advanced plots with I_c, S_u, ϕ and $N1(60)I_c$ Seismic shear wave velocity plots Soil Behaviour Type (SBT) scatter plots

Calculated Geotechnical Parameter Tables	
Additional information	<p>The Normalized Soil Behaviour Type Chart based on Q_{tn} (SBT Q_{tn}) (Robertson, 2009) was used to classify the soil for this project. A detailed set of calculated CPTu parameters have been generated and are provided in Excel format files in the release folder. The CPTu parameter calculations are based on values of corrected tip resistance (q_t) sleeve friction (f_s) and pore pressure (u_2).</p> <p>Effective stresses are calculated based on unit weights that have been assigned to the individual soil behaviour type zones and hydrostatic conditions were assumed.</p> <p>Soils were classified as either drained or undrained based on the Q_{tn} Normalized Soil Behaviour Type Chart (Robertson, 2009). Calculations for both drained and undrained parameters were included for materials that classified as silt mixtures (zone 4).</p>

Limitations

3rd Party Disclaimer

This report titled “HWY 3 St Thomas CPT”, referred to as the (“Report”), was prepared by ConeTec for Stantec Consulting Ltd. The Report is confidential and may not be distributed to or relied upon by any third parties without the express written consent of ConeTec. Any third parties gaining access to the Report do not acquire any rights as a result of such access. Any use which a third party makes of the Report, or any reliance on or decisions made based on it, are the responsibility of such third parties. ConeTec accepts no responsibility for loss, damage and/or expense, if any, suffered by any third parties as a result of decisions made, or actions taken or not taken, which are in any way based on, or related to, the Report or any portion(s) thereof.

Client Disclaimer

ConeTec was retained by Stantec Consulting Ltd. to collect and provide the raw data (“Data”) which is included in this report titled “HWY 3 St Thomas CPT”, which is referred to as the (“Report”). ConeTec has collected and reported the Data in accordance with current industry standards. No other warranty, express or implied, with respect to the Data is made by ConeTec. In order to properly understand the Data included in the Report, reference must be made to the documents accompanying and other sources referenced in the Report in their entirety. Any analysis, interpretation, judgment, calculations and/or geotechnical parameters (collectively “Interpretations”) included in the Report, including those based on the Data, are outside the scope of ConeTec’s retainer and are included in the Report as a courtesy only. Other than the Data, the contents of the Report (including any Interpretations) should not be relied upon in any fashion without independent verification and ConeTec is in no way responsible for any loss, damage or expense resulting from the use of, and/or reliance on, such material by any party.

Cone penetration tests (CPTu) are conducted using an integrated electronic piezocone penetrometer and data acquisition system manufactured by Adara Systems Ltd., a subsidiary of ConeTec.

ConeTec's piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and two geophone sensors for recording seismic signals. All signals are amplified and measured with minimum sixteen-bit resolution down hole within the cone body, and the signals are sent to the surface using a high bandwidth, error corrected digital interface through a shielded cable.

ConeTec penetrometers are manufactured with various tip, friction and pore pressure capacities in both 10 cm² and 15 cm² tip base area configurations in order to maximize signal resolution for various soil conditions. The specific piezocone used for each test is described in the CPT summary table presented in the first appendix. The 15 cm² penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 10 cm² piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross sectional area (typically 44 millimeters diameter over a length of 32 millimeters with tapered leading and trailing edges) located at a distance of 585 millimeters above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a 60 degree apex angle.

All ConeTec piezocones can record pore pressure at various locations. Unless otherwise noted, the pore pressure filter is located directly behind the cone tip in the "u₂" position ([ASTM Type 2](#)). The filter is six millimeters thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current [ASTM D5778](#) standard. ConeTec's calibration criteria also meets or exceeds those of the current [ASTM D5778](#) standard. An illustration of the piezocone penetrometer is presented in [Figure CPTu](#).

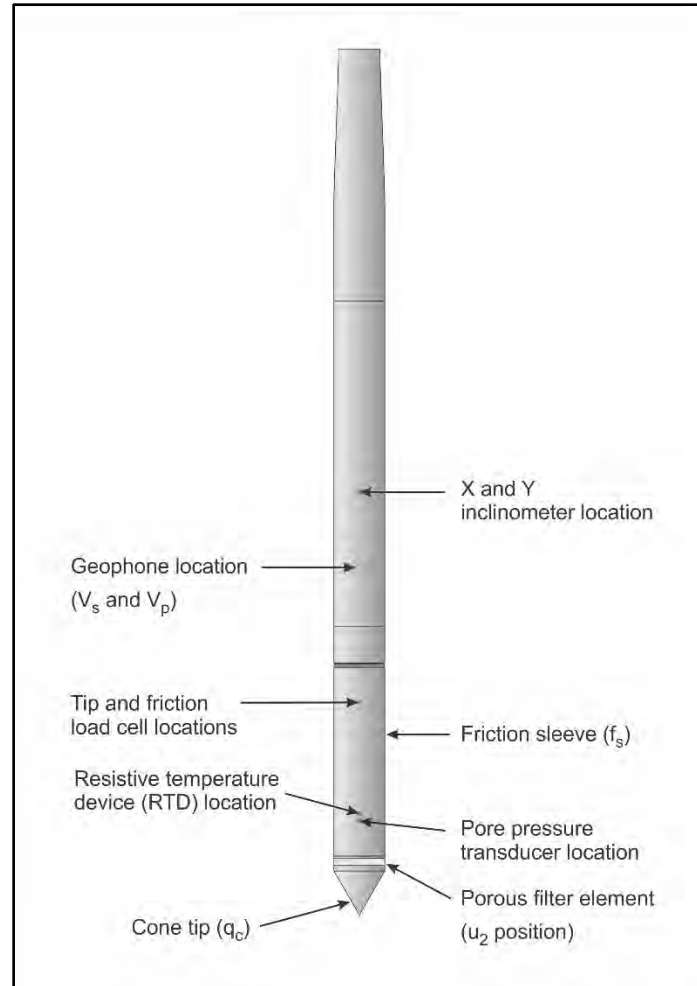


Figure CPTu. Piezocone Penetrometer (15 cm²)

The ConeTec data acquisition systems consist of a Windows based computer and a signal interface box and power supply. The signal interface combines depth increment signals, seismic trigger signals and the downhole digital data. This combined data is then sent to the Windows based computer for collection and presentation. The data is recorded at fixed depth increments using a depth wheel attached to the push cylinders or by using a spring loaded rubber depth wheel that is held against the cone rods. The typical recording interval is 2.5 centimeters; custom recording intervals are possible.

The system displays the CPTu data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected tip resistance (q_c)
- Sleeve friction (f_s)
- Dynamic pore pressure (u)
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

All testing is performed in accordance to ConeTec's CPTu operating procedures which are in general accordance with the current [ASTM D5778](#) standard.

Prior to the start of a CPTu sounding a suitable cone is selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with silicone oil and the baseline readings are recorded with the cone hanging freely in a vertical position.

The CPTu is conducted at a steady rate of two centimeters per second, within acceptable tolerances. Typically one meter length rods with an outer diameter of 38.1 millimeters are added to advance the cone to the sounding termination depth. After cone retraction final baselines are recorded.

Additional information pertaining to ConeTec's cone penetration testing procedures:

- Each filter is saturated in silicone oil under vacuum pressure prior to use
- Baseline readings are compared to previous readings
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs, excessive inclination occurs, equipment damage is likely to take place, or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with [ASTM](#) standards

The interpretation of piezocone data for this report is based on the corrected tip resistance (q_t), sleeve friction (f_s) and pore water pressure (u). The interpretation of soil type is based on the correlations developed by [Robertson et al. \(1986\)](#) and Robertson (1990, 2009). It should be noted that it is not always possible to accurately identify a soil behaviour type based on these parameters. In these situations, experience, judgment and an assessment of other parameters may be used to infer soil behaviour type.

The recorded tip resistance (q_c) is the total force acting on the piezocone tip divided by its base area. The tip resistance is corrected for pore pressure effects and termed corrected tip resistance (q_t) according to the following expression presented in [Robertson et al. \(1986\)](#):

$$q_t = q_c + (1-a) \cdot u_2$$

where: q_t is the corrected tip resistance

q_c is the recorded tip resistance

u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)

a is the Net Area Ratio for the piezocone (0.8 for ConeTec probes)

The sleeve friction (f_s) is the frictional force on the sleeve divided by its surface area. As all ConeTec piezocones have equal end area friction sleeves, pore pressure corrections to the sleeve data are not required.

The dynamic pore pressure (u) is a measure of the pore pressures generated during cone penetration. To record equilibrium pore pressure, the penetration must be stopped to allow the dynamic pore pressures to stabilize. The rate at which this occurs is predominantly a function of the permeability of the soil and the diameter of the cone.

The friction ratio (R_f) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

A summary of the CPTu soundings along with test details and individual plots are provided in the appendices. A set of files with calculated geotechnical parameters were generated for each sounding based on published correlations and are provided in Excel format in the data release folder. Information regarding the methods used is also included in the data release folder.

For additional information on CPTu interpretations and calculated geotechnical parameters, refer to [Robertson et al. \(1986\)](#), [Lunne et al. \(1997\)](#), [Robertson \(2009\)](#), Mayne (2013, 2014), [Mayne and Peuchen \(2012\)](#) and [Mayne et al. \(2023\)](#).

References

ASTM D5778-20, 2020, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils", ASTM International, West Conshohocken, PA. DOI: [10.1520/D5778-20](#).

Lunne, T., Robertson, P.K. and Powell, J. J. M., 1997, "Cone Penetration Testing in Geotechnical Practice", Blackie Academic and Professional.

Mayne, P.W., 2013, "Evaluating yield stress of soils from laboratory consolidation and in-situ cone penetration tests", Sound Geotechnical Research to Practice (Holtz Volume) GSP 230, ASCE, Reston/VA: 406-420. DOI: [10.1061/9780784412770.027](#).

Mayne, P.W. and Peuchen, J., 2012, "Unit weight trends with cone resistance in soft to firm clays", Geotechnical and Geophysical Site Characterization 4, Vol. 1 (Proc. ISC-4, Pernambuco), CRC Press, London: 903-910.

Mayne, P.W., 2014, "Interpretation of geotechnical parameters from seismic piezocone tests", CPT'14 Keynote Address, Las Vegas, NV, May 2014.

Mayne, P.W., Cargill, E. and Greig, J. (2023). The Cone Penetration Test: Better Information, Better Decisions. produced by ConeTec Group, Burnaby, B.C. www.conetec.com

Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, "Use of Piezometer Cone Data", Proceedings of In Situ 86, ASCE Specialty Conference, Blacksburg, Virginia.

Robertson, P.K., 1990, "Soil Classification Using the Cone Penetration Test", Canadian Geotechnical Journal, Volume 27: 151-158. DOI: [10.1139/T90-014](#).

Robertson, P.K., 2009, "Interpretation of cone penetration tests – a unified approach", Canadian Geotechnical Journal, Volume 46: 1337-1355. DOI: [10.1139/T09-065](#).

Shear wave velocity (V_s) testing is performed in conjunction with the piezocone penetration test (SCPTu) in order to collect interval velocities. For some projects seismic compression wave velocity (V_p) testing is also performed.

ConeTec's 15 cm² piezocone penetrometers are manufactured with one horizontally active geophone (28 hertz) and one vertically active geophone (28 hertz). Both geophones are rigidly mounted in the body of the cone penetrometer, 0.2 meters behind the cone tip. The vertically mounted geophone is more sensitive to compression waves; however, it is often affected by the compression wave travelling through the cone rods.

Shear waves are typically generated by using an impact hammer horizontally striking a beam that is held in place by a normal load. In some instances, an auger source or an imbedded impulsive source may be used for both shear waves and compression waves. The hammer and beam act as a contact trigger that initiates the recording of the seismic wave traces. For impulsive devices an accelerometer trigger may be used. The traces are recorded in the memory of the cone using a fast analog to digital converter. The seismic trace is then transmitted digitally uphole to a Windows based computer through a signal interface box for recording and analysis. An illustration of the shear wave testing configuration is presented in [Figure SCPTu-1](#).

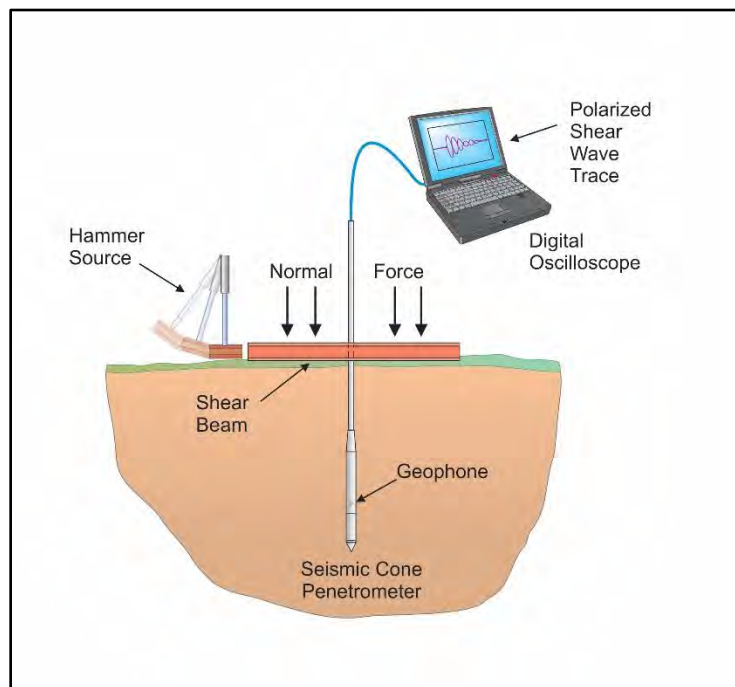


Figure SCPTu-1. Illustration of the SCPTu system

All testing is performed in accordance to ConeTec's SCPTu operating procedures which are in general accordance with the current [ASTM D5778](#) and [ASTM D7400](#) standards.

Prior to the start of a SCPTu sounding, the procedures described in the Cone Penetration Test section are followed. In addition, the active axis of the geophone is aligned parallel to the beam (or source) and the horizontal offset between the cone and the source is measured and recorded.

Prior to recording seismic waves at each test depth, cone penetration is stopped and the rods are decoupled from the rig to avoid transmission of rig energy down the rods. Typically, five wave traces for each orientation are recorded for quality control and uncertainty analysis purposes. After reviewing wave traces for consistency the cone is pushed to the next test depth (typically one meter intervals or as requested by the client). [Figure SCPTu-2](#) presents an illustration of a SCPTu test.

For additional information on seismic cone penetration testing refer to [Robertson et al. \(1986\)](#).

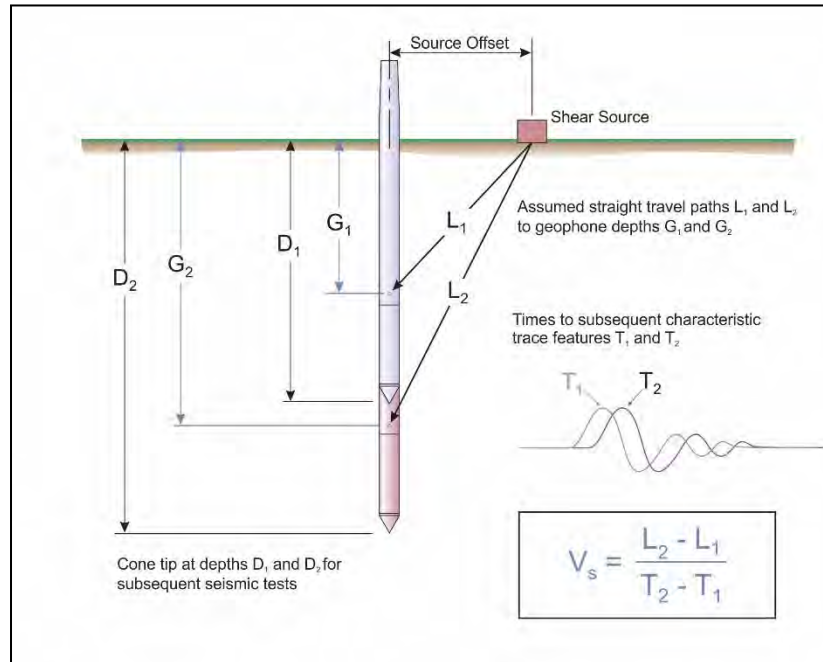


Figure SCPTu-2. Illustration of a seismic cone penetration test

For the determination of interval travel times the wave traces from all depths are displayed in analysis software. The results of the interval picks are supplied in the relevant appendix of this report. Standard practice for ConeTec is to record five wave traces for each source direction at each test depth. Outlier impacts are identified in the field and the impacts are repeated. For the final wave trace profile, the traces are stacked in the time domain to display a single average trace.

Determination of the shear wave interval velocities are performed by visually picking a common feature (e.g. the first characteristic peak, trough, or crossover) on all of the trace depths and taking the difference in ray path divided by the time difference between features at subsequent depths. The same process is used for compression waves, however the first break is most commonly used for selecting an arrival time. For velocity calculation, the ray path is defined as the straight-line distance from the seismic source to the geophone, accounting for beam offset, source depth and geophone offset from the cone tip.

In some cases, usually for shear wave velocity testing, more than one characteristic marker may be used. If there is an overlap between different sets of characteristic markers, then the average time value for those sets of interval times is applied to the determination of velocity.

Ideally, all depths are used for the determination of the velocity profile. However, an interval may be skipped if there is some ambiguity or quality concern with a particular depth, resulting in a larger interval.

Tabular results and SCPTu plots are presented in the relevant appendix.

The average shear wave velocity to a depth of thirty meters (V_{s30}) has been calculated and provided for all applicable soundings using an equation presented in [Crow et al. \(2012\)](#).

$$V_{s30} = \frac{\text{total thickness of all layers (30m)}}{\sum(\text{layer travel times})}$$

The layer travel times refers to the travel times propagating in the vertical direction, not the measured travel times from an offset source.

References

ASTM D5778-20, 2020, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils", ASTM International, West Conshohocken, PA. DOI: [10.1520/D5778-20](#).

ASTM D7400/D7400M-19, 2019, "Standard Test Methods for Downhole Seismic Testing", ASTM International, West Conshohocken, PA. DOI: [10.1520/D7400_D7400M-19](#).

Crow, H.L., Hunter, J.A., Bobrowsky, P.T., 2012, "National shear wave measurement guidelines for Canadian seismic site assessment", GeoManitoba 2012, Sept 30 to Oct 2, Winnipeg, Manitoba.

Robertson, P.K., Campanella, R.G., Gillespie D and Rice, A., 1986, "Seismic CPT to Measure In-Situ Shear Wave Velocity", Journal of Geotechnical Engineering ASCE, Vol. 112, No. 8: 791-803. DOI: [10.1061/\(ASCE\)0733-9410\(1986\)112:8\(791\)](#).

The cone penetration test is halted at specific depths to carry out pore pressure dissipation (PPD) tests, shown in Figure PPD-1. For each dissipation test the cone and rods are decoupled from the rig and the data acquisition system measures and records the variation of the pore pressure (u) with time (t).

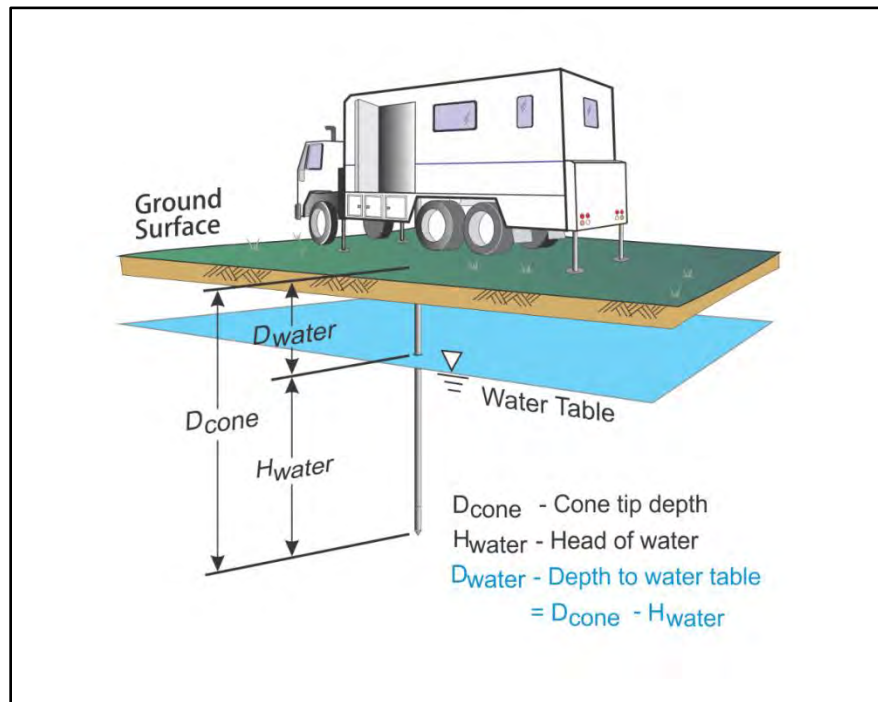


Figure PPD-1. Pore pressure dissipation test setup

Pore pressure dissipation data can be interpreted to provide estimates of ground water conditions, permeability, consolidation characteristics and soil behaviour.

The typical shapes of dissipation curves shown in Figure PPD-2 are very useful in assessing soil type, drainage, in situ pore pressure and soil properties. A flat curve that stabilizes quickly is typical of a freely draining sand. Undrained soils such as clays will typically show positive excess pore pressure and have long dissipation times. Dilative soils will often exhibit dynamic pore pressures below equilibrium that then rise over time. Overconsolidated fine-grained soils will often exhibit an initial dilatory response where there is an initial rise in pore pressure before reaching a peak and dissipating.

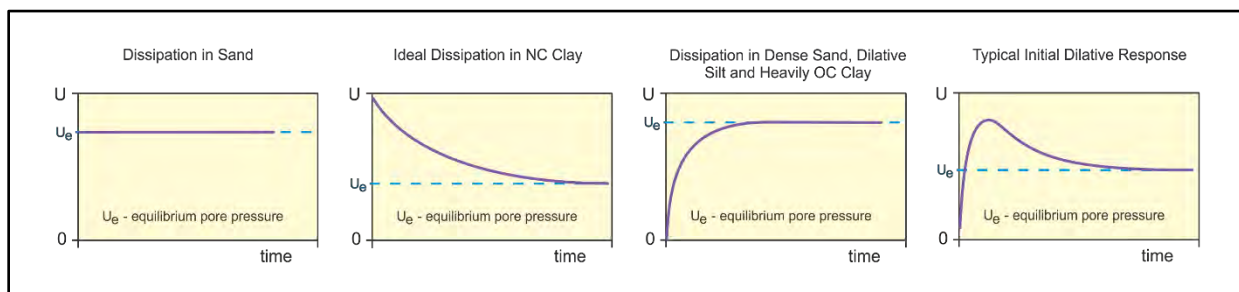


Figure PPD-2. Pore pressure dissipation curve examples

In order to interpret the equilibrium pore pressure (u_{eq}) and the apparent phreatic surface, the pore pressure should be monitored until such time as there is no variation in pore pressure with time as shown for each curve in Figure PPD-2.

In fine grained deposits the point at which 100% of the excess pore pressure has dissipated is known as t_{100} . In some cases this can take an excessive amount of time and it may be impractical to take the dissipation to t_{100} . A theoretical analysis of pore pressure dissipations by [Teh and Houlsby, 1991](#) showed that a single curve relating degree of dissipation versus theoretical time factor (T^*) may be used to calculate the coefficient of consolidation (c_h) at various degrees of dissipation resulting in the expression for c_h shown below.

$$c_h = \frac{T^* \cdot a^2 \cdot \sqrt{I_r}}{t}$$

Where:

T^* is the dimensionless time factor ([Table Time Factor](#))

a is the radius of the cone

I_r is the rigidity index

t is the time at the degree of consolidation

Table Time Factor. T^* versus degree of dissipation ([Teh and Houlsby, 1991](#))

Degree of Dissipation (%)	20	30	40	50	60	70	80
$T^* (u_2)$	0.038	0.078	0.142	0.245	0.439	0.804	1.60

The coefficient of consolidation is typically analyzed using the time (t_{50}) corresponding to a degree of dissipation of 50% (u_{50}). In order to determine t_{50} , dissipation tests must be taken to a pressure less than u_{50} . The u_{50} value is half way between the initial maximum pore pressure and the equilibrium pore pressure value, known as u_{100} . To estimate u_{50} , both the initial maximum pore pressure and u_{100} must be known or estimated. Other degrees of dissipations may be considered, particularly for extremely long dissipations.

At any specific degree of dissipation the equilibrium pore pressure (u at t_{100}) must be estimated at the depth of interest. The equilibrium value may be determined from one or more sources such as measuring the value directly (u_{100}), estimating it from other dissipations in the same profile, estimating the phreatic surface and assuming hydrostatic conditions, from nearby soundings, from client provided information, from site observations and/or past experience, or from other site instrumentation.

For calculations of c_h ([Teh and Houlsby, 1991](#)), t_{50} values are estimated from the corresponding pore pressure dissipation curve and a rigidity index (I_r) is assumed. For curves having an initial dilatatory response in which an initial rise in pore pressure occurs before reaching a peak, the relative time from the peak value is used in determining t_{50} . In cases where the time to peak is excessive, t_{50} values are not calculated.

A summary of the pore pressure dissipation tests and dissipation plots are presented in the relevant appendix.

References

Teh, C.I., and Houlsby, G.T., 1991, "An analytical study of the cone penetration test in clay", *Geotechnique*, 41(1): 17-34. DOI: [10.1680/geot.1991.41.1.17](https://doi.org/10.1680/geot.1991.41.1.17).

The appendices listed below are included in the report:

- Cone Penetration Test Summary and Standard Cone Penetration Test Plots
- Advanced Cone Penetration Test Plots
- Seismic Cone Penetration Test Plots
- Seismic Cone Penetration Test Shear Wave (V_s) Tabular Results
- Seismic Cone Penetration Test Shear Wave (V_s) Traces
- Soil Behaviour Type (SBT) Scatter Plots
- Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots
- Description of Methods for Calculated CPT Geotechnical Parameters

Cone Penetration Test Summary and Standard Cone Penetration Test Plots



Job No: 24-05-27609
Client: Stantec Consulting Ltd.
Project: HWY 3 St Thomas CPT
Start Date: 2024-05-09
End Date: 2024-05-10

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Cone Area (cm ²)	Assumed Phreatic Surface ¹ (m)	Final Depth (m)	Northing ² (m)	Easting ² (m)	Refer to Notation Number
CPT24-RMNAPP01	24-05-27609_CP-RM-01	2024-05-10	729:T1500F15U35	15	2.2	15.025	4739733	481289	
SCPT24-RMNAPP01	24-05-27609_SP-RM-01	2024-05-10	729:T1500F15U35	15	2.2	15.075	4739737	481294	
SCPT24-CNREMB02	24-05-27609_SP-CN-02	2024-05-09	729:T1500F15U35	15	2.0	15.575	4740267	480674	
SCPT24-WAPP02	24-05-27609_SP-WA-02	2024-05-10	729:T1500F15U35	15	1.8	15.000	4738905	482817	3
SCPT24-CNREMB08	24-05-27609_SP-CN-08	2024-05-09	729:T1500F15U35	15	1.5	20.100	4740056	480896	
SCPT24-CNREMB10	24-05-27609_SP-CN-10	2024-05-10	729:T1500F15U35	15	2.0	20.000	4739960	481010	

1. The assumed phreatic surface was based on the dynamic pore pressure response, unless otherwise noted. Hydrostatic conditions were assumed for the calculated parameters.
2. Coordinates were collected with a consumer grade GPS device with datum WGS84/UTM Zone 17 North.
3. The assumed phreatic surface was based on a pore pressure dissipation test.



Stantec

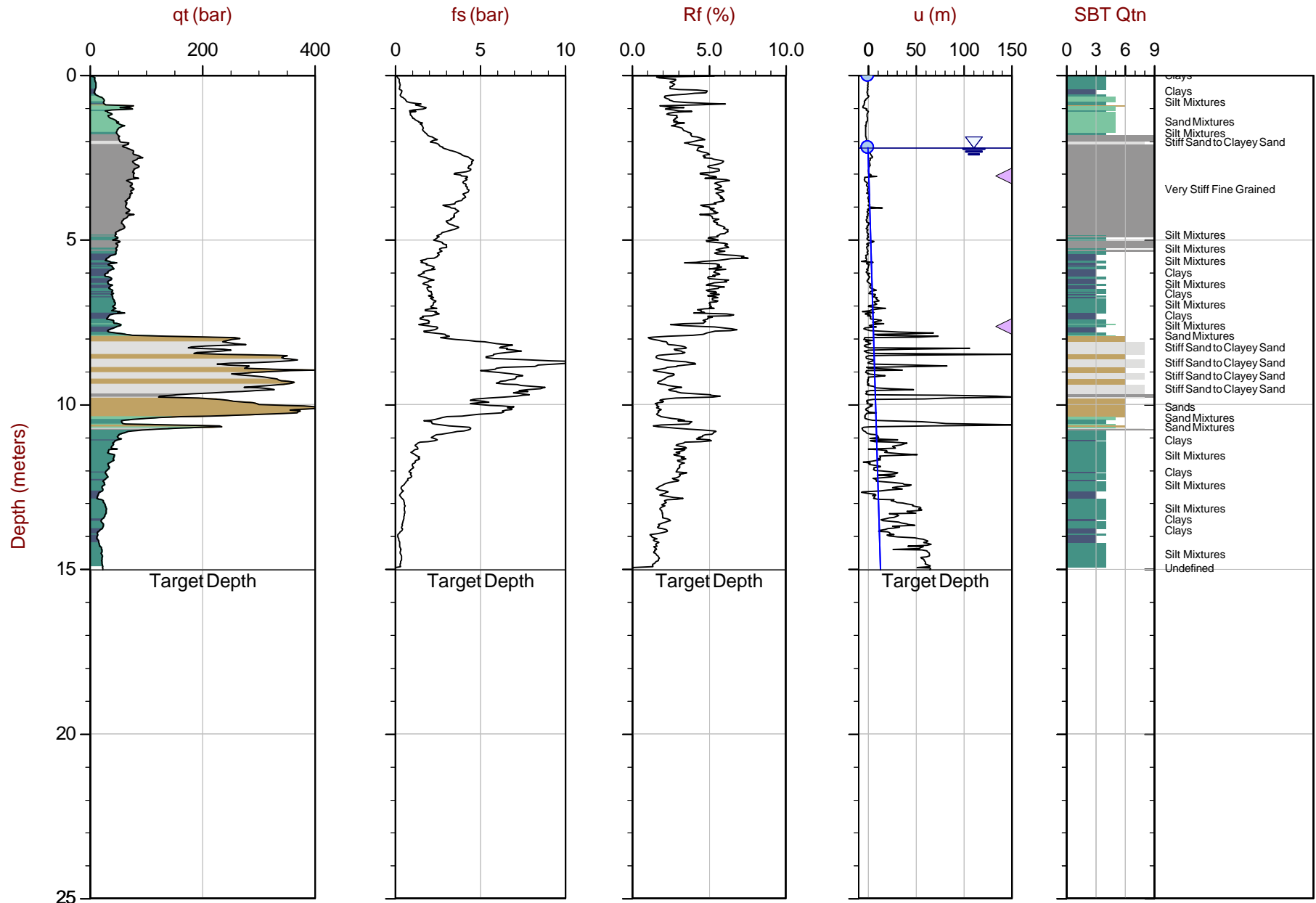
Job No: 24-05-27609

Date: 2024-05-10 12:15

Site: HWY 3, St.Thomas, ON

Sounding: CPT24-RMNAPP01

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 15.025 m / 49.29 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 24-05-27609_CP-RM-01.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM17N: 4739733m E: 481289m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Stantec

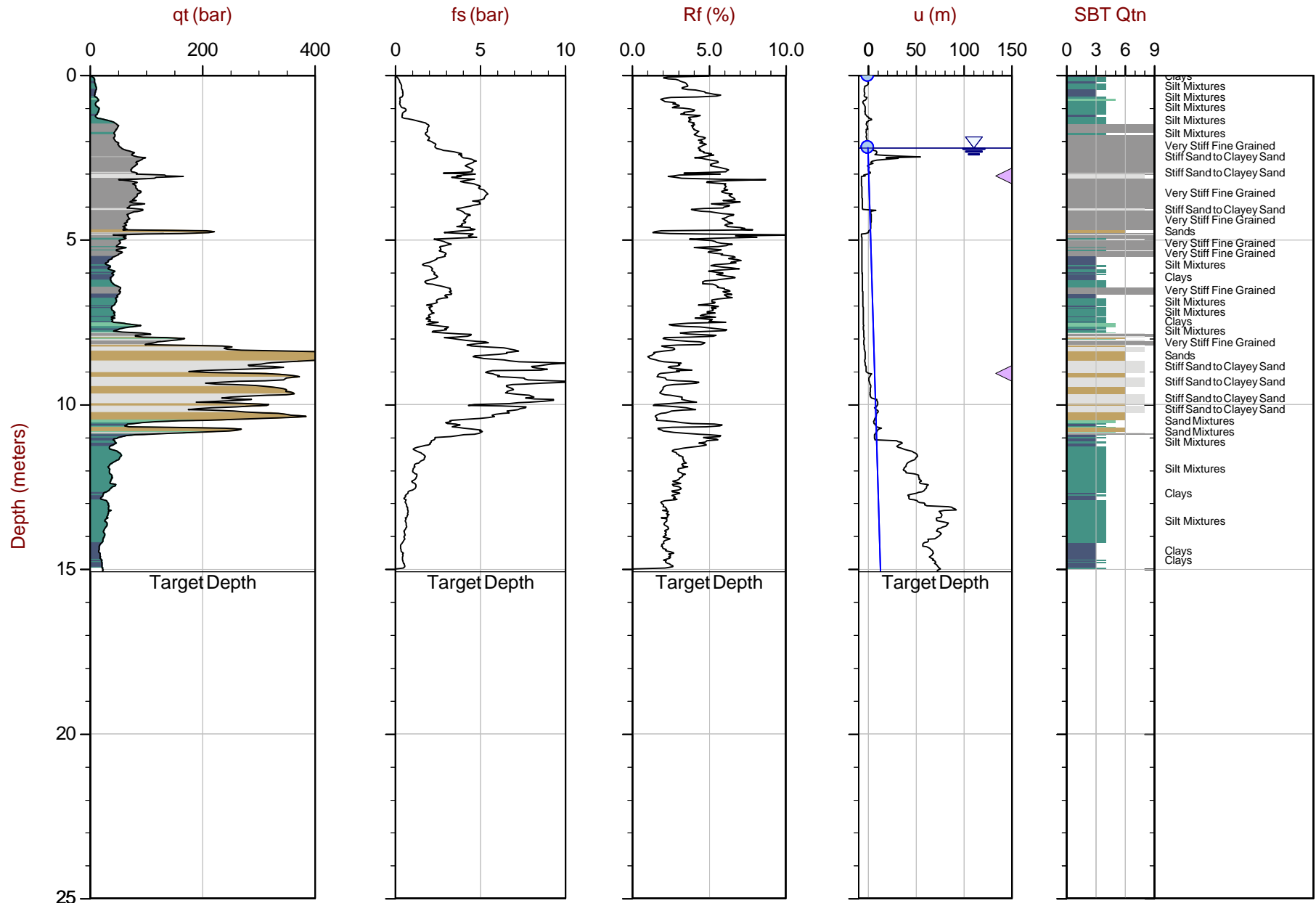
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Date: 2024-05-10 10:24

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-RMNAPP01

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 15.075 m / 49.46 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 24-05-27609_SP-RM-01.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM17N:4739737mE:481294m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Stantec

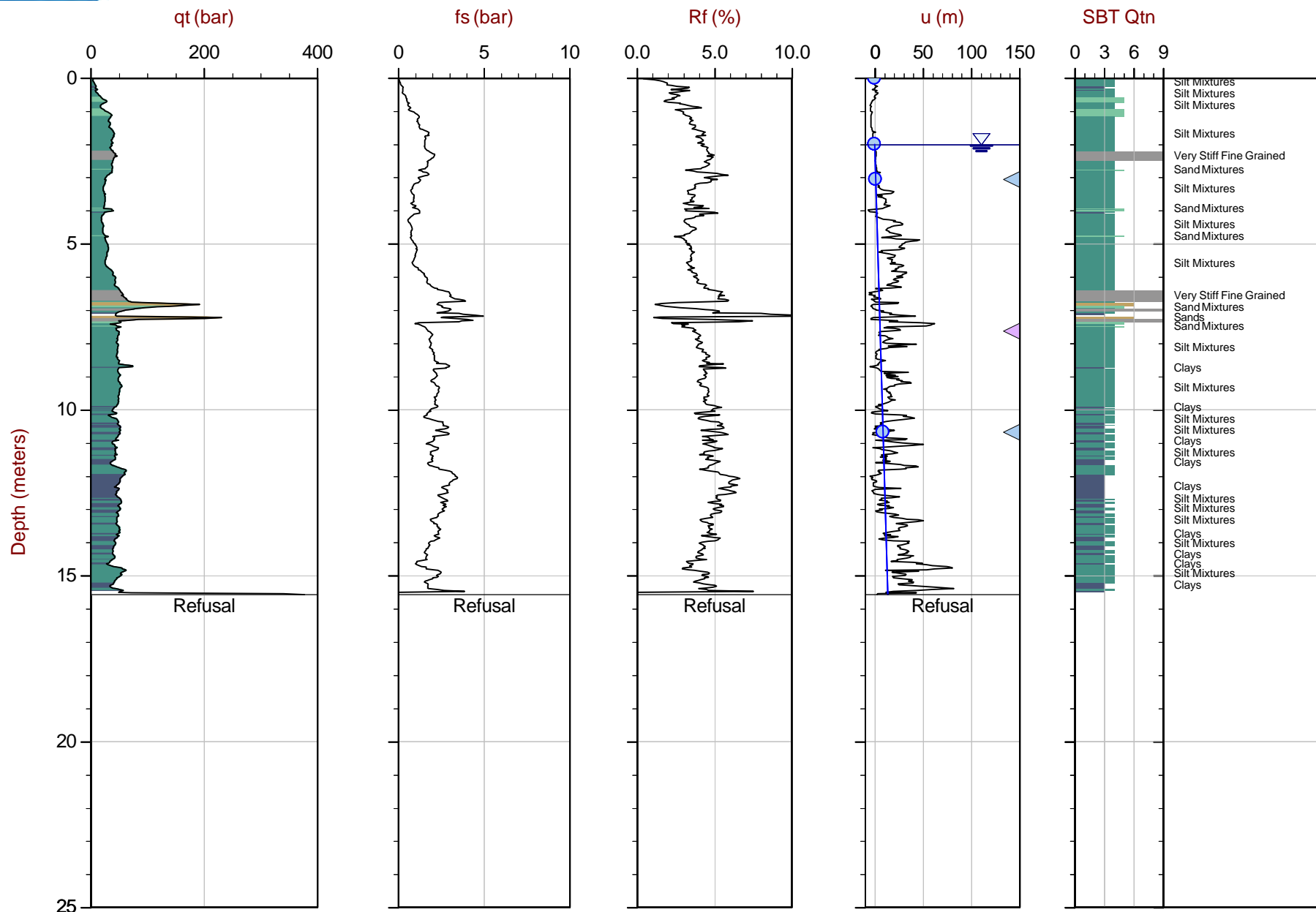
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Date: 2024-05-09 12:06

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB02

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 15.575 m / 51.10 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 24-05-27609_SP-CN-02.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM 17N N: 4740267m E: 480674m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Stantec

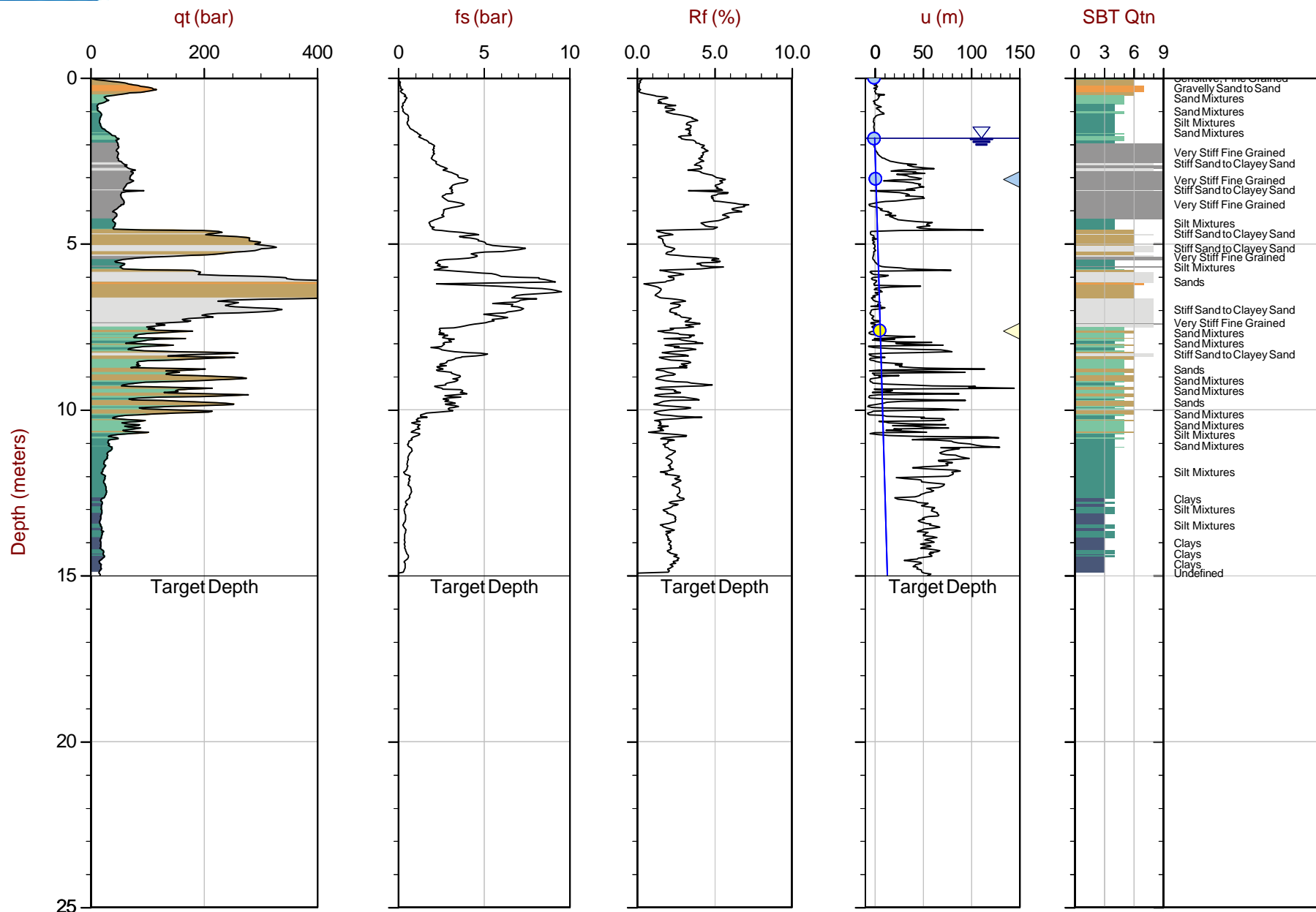
Job No: 24-05-27609

Date: 2024-05-10 14:49

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-WAPP02

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 15.000 m / 49.21 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 24-05-27609_SP-WA-02.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM17N: 4738905m E: 482817m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Stantec

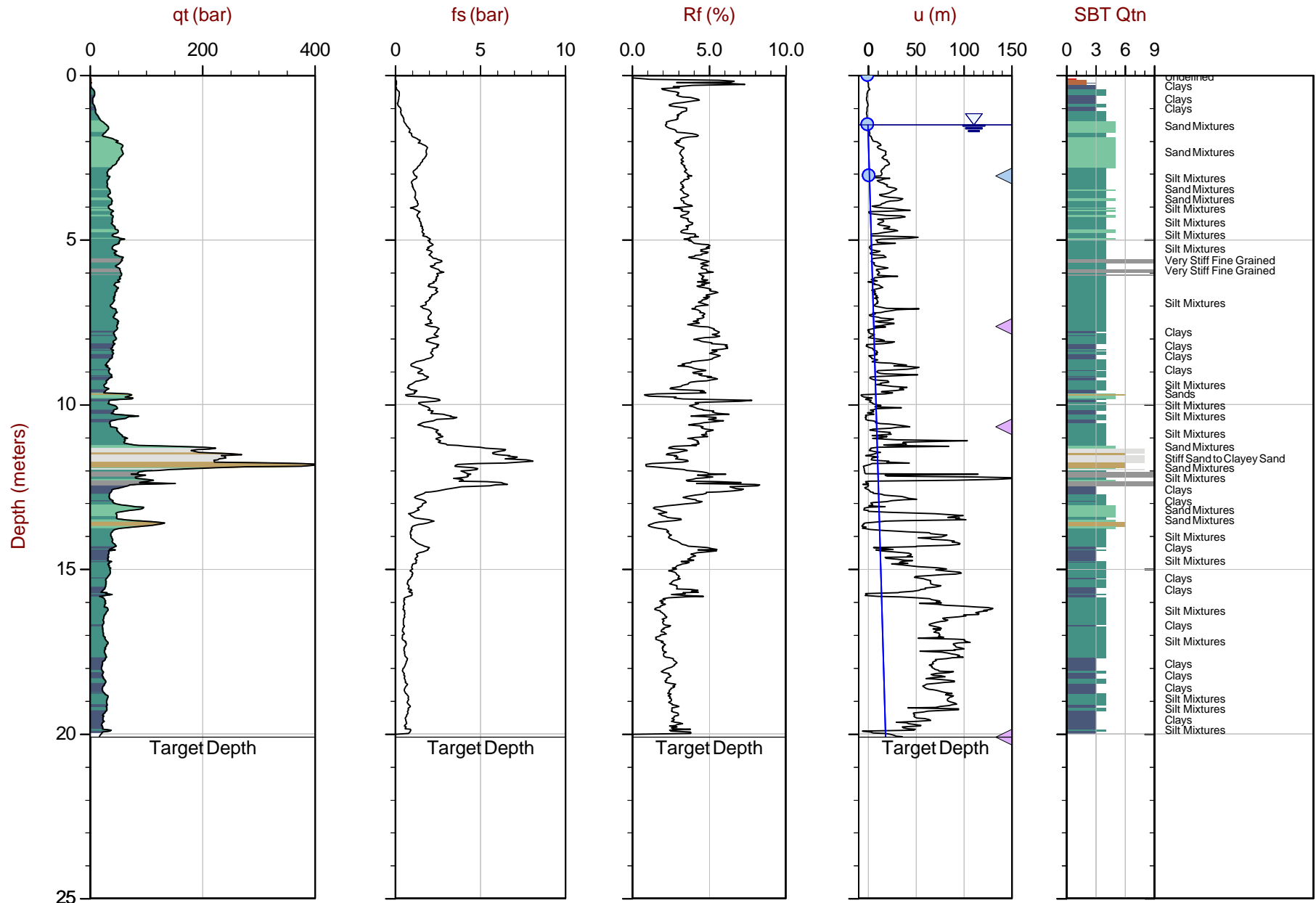
Job No: 24-05-27609

Date: 2024-05-09 16:43

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB08

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 20.100 m / 65.94 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 24-05-27609_SP-CN-08.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM 17N N: 4740056m E: 480896m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Stantec

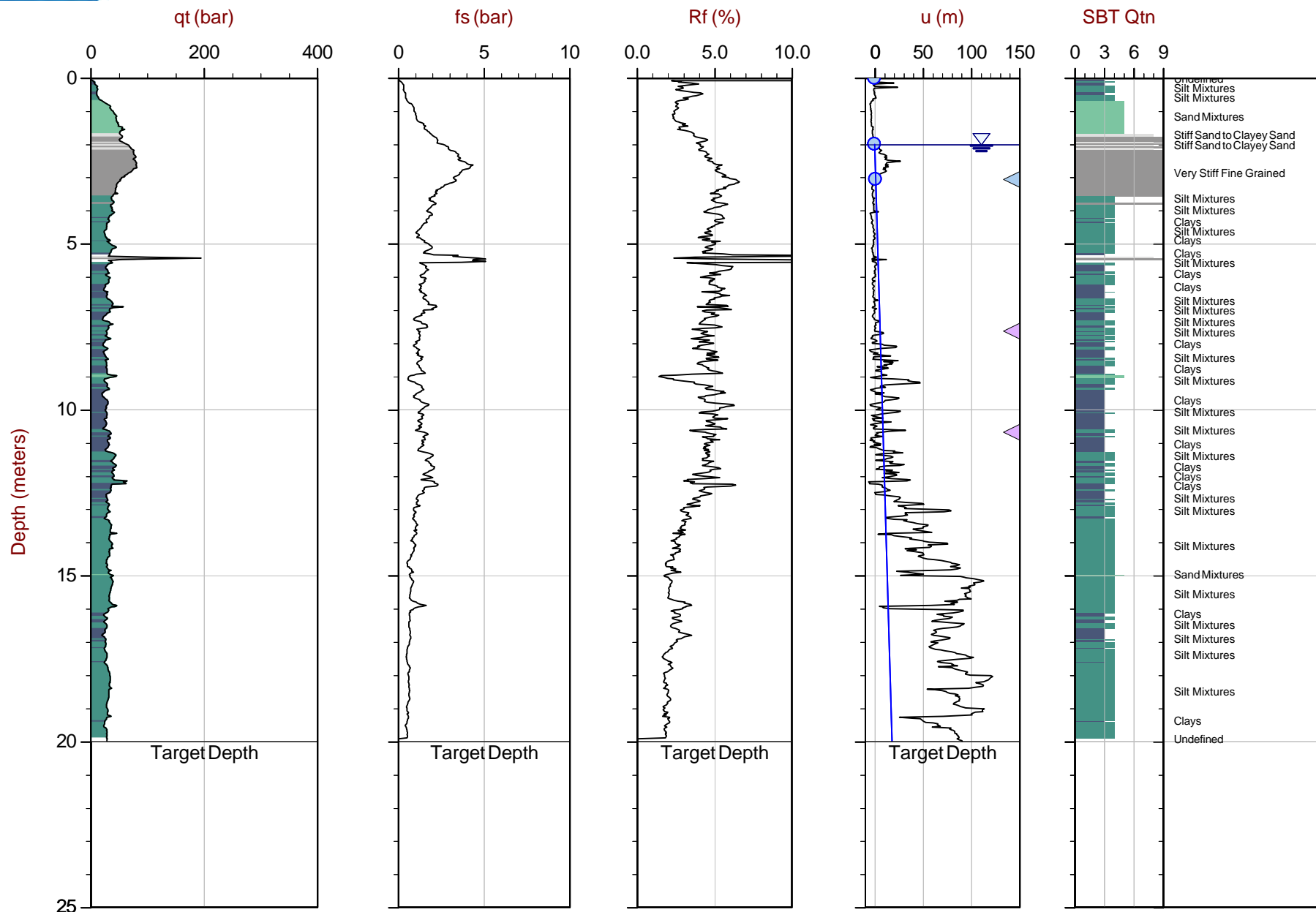
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Date: 2024-05-10 06:58

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Sounding: SCPT24-CNREMB10

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 20.000 m / 65.62 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 24-05-27609_SP-CN-10.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM17N: 4739960mE: 481010m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Advanced Cone Penetration Test Plots



Stantec

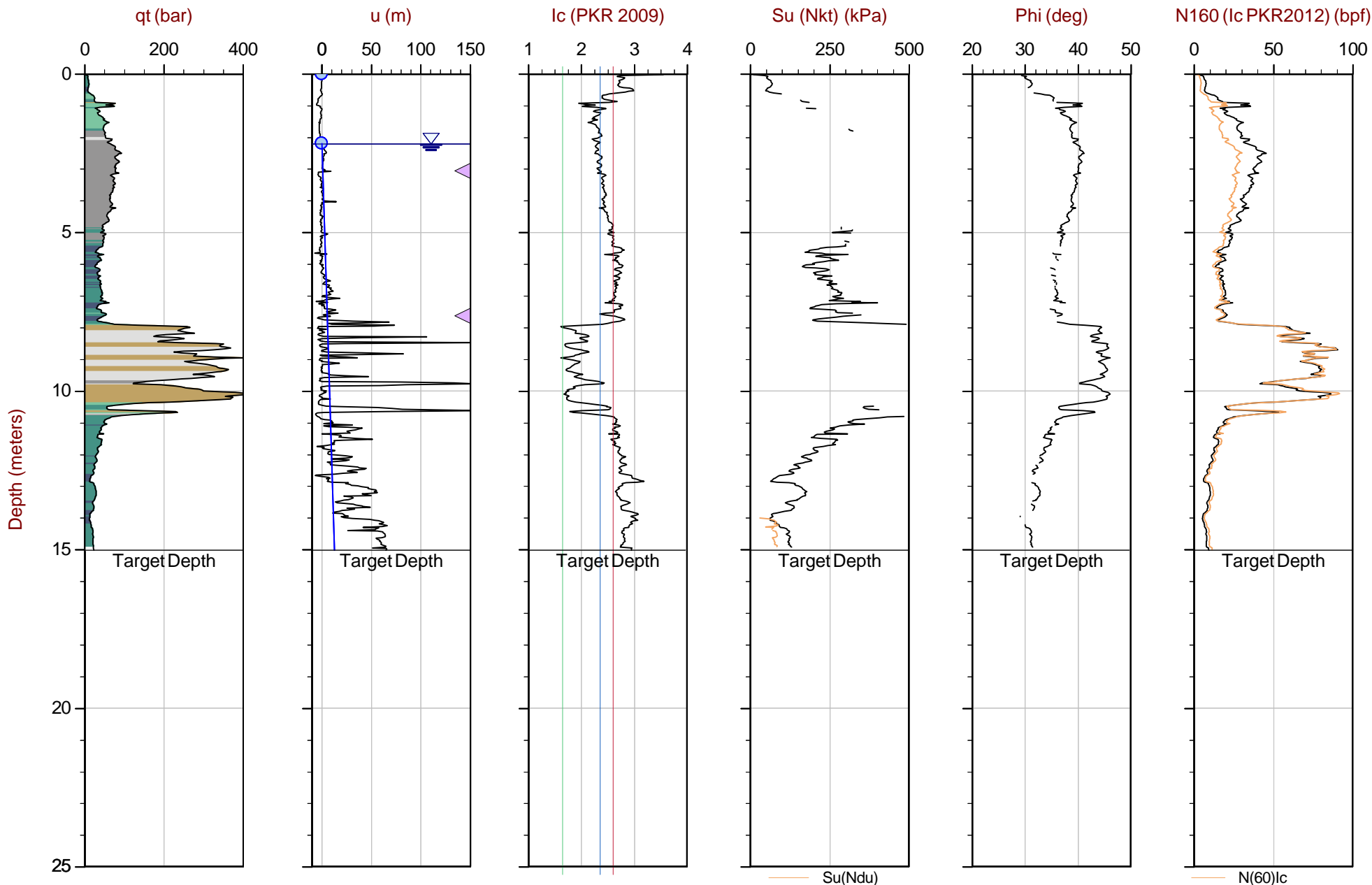
Job No: 24-05-27609

Date: 2024-05-10 12:15

Site: HWY 3, St.Thomas, ON

Sounding: CPT24-RMNAPP01

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 15.025 m / 49.29 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: EveryPoint

File: 24-05-27609_CP-RM-01.COR

Unit Wt: SBTQtn(PKR2009)

SuNkt/Ndu: 15.0 / 6.0

SBT: Robertson, 2009 and 2010

Coords: UTM17N: 4739733mE: 481289m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Stantec

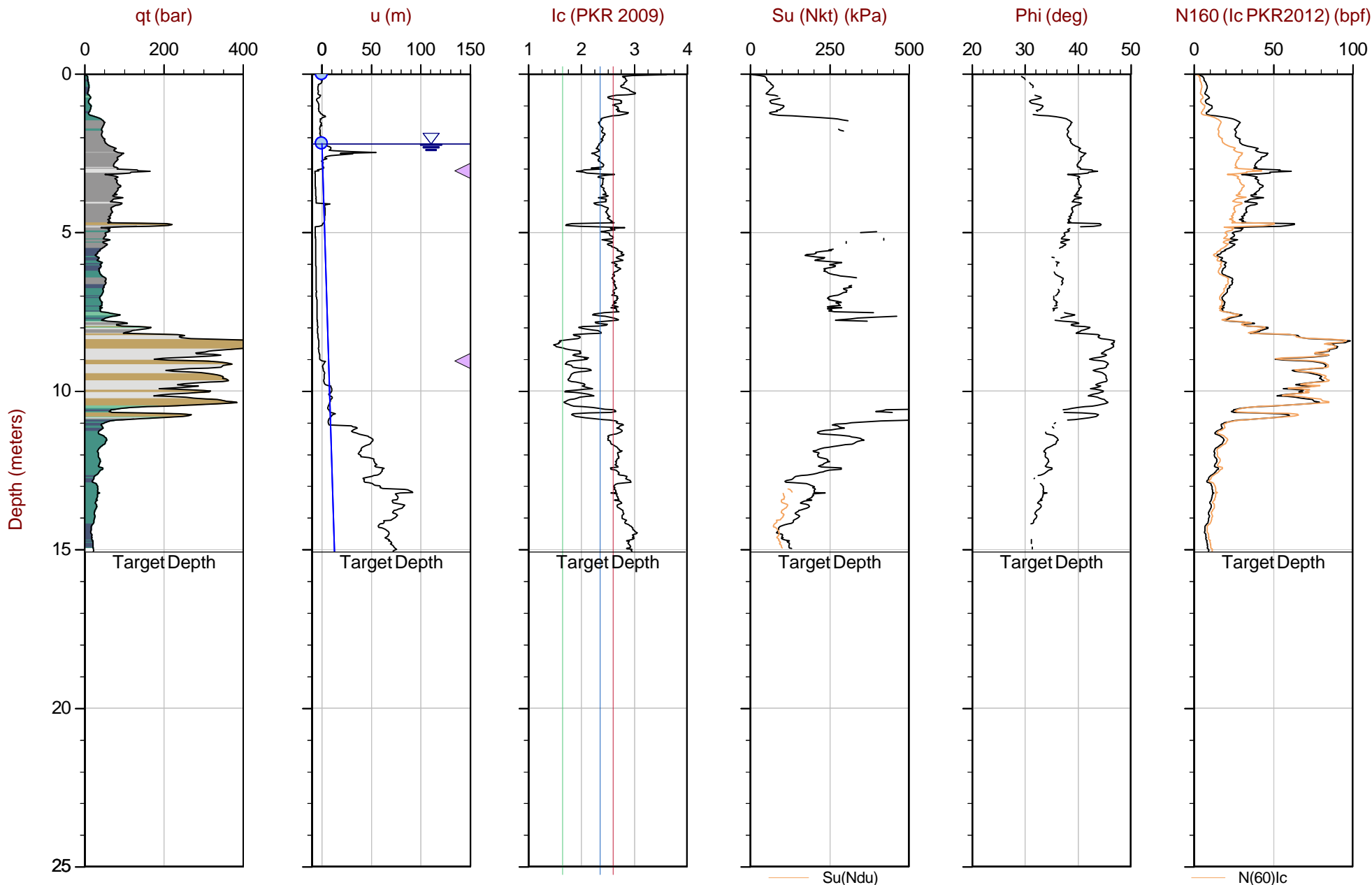
Job No: 24-05-27609

Date: 2024-05-10 10:24

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-RMNAPP01

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 15.075 m / 49.46 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 24-05-27609_SP-RM-01.COR

Unit Wt: SBTQtn(PKR2009)

Su Nkt/Ndu: 15.0 / 6.0

SBT: Robertson, 2009 and 2010

Coords: UTM17N: 4739737mE: 481294m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Stantec

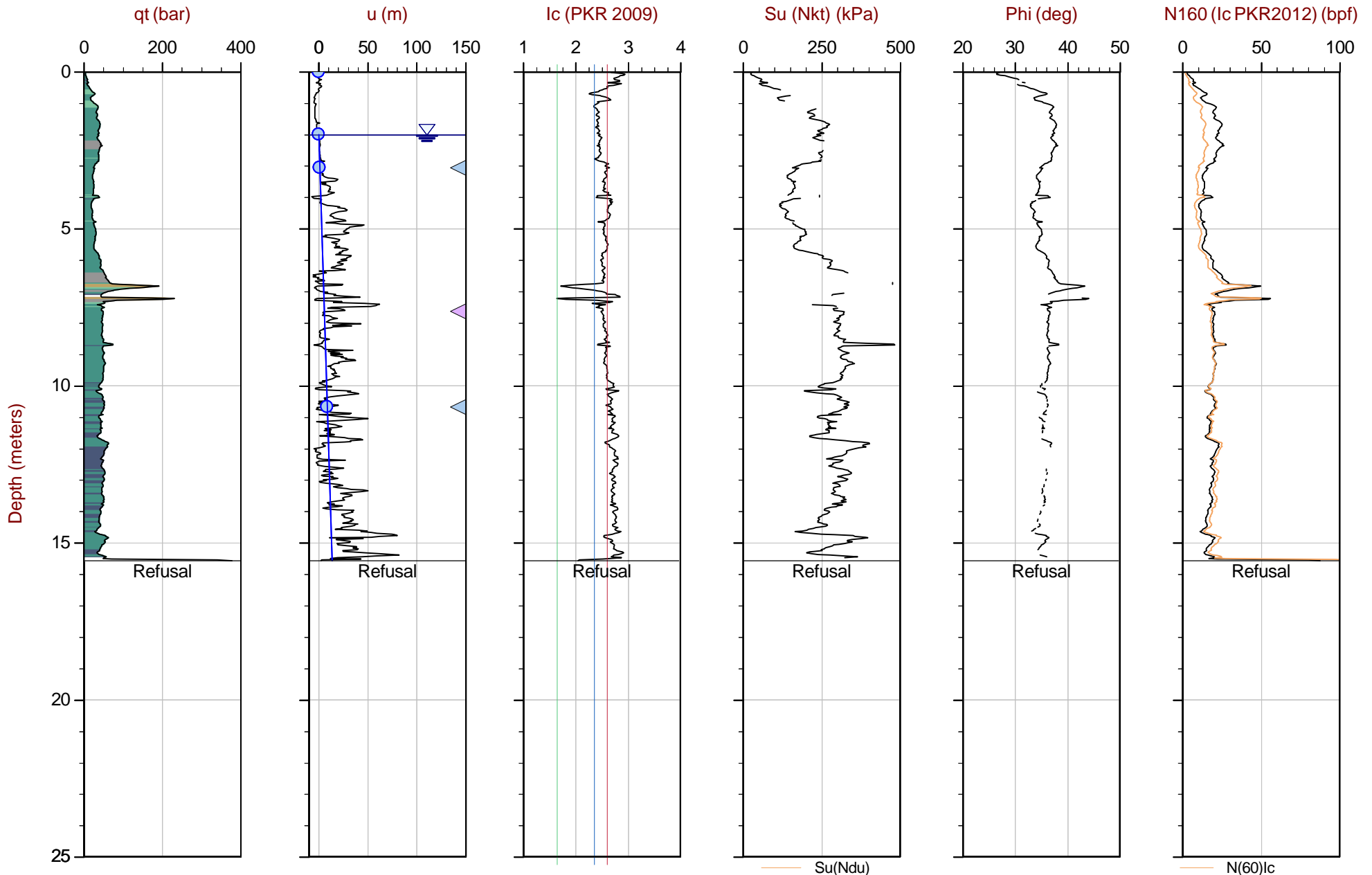
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Date: 2024-05-09 12:06

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB02

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 15.575 m / 51.10 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: EveryPoint

File: 24-05-27609_SP-CN-02.COR

Unit Wt: SBTQtn(PKR2009)

SuNkt/Ndu: 15.0 / 6.0

SBT: Robertson, 2009 and 2010

Coords: UTM17N: 4740267mE: 480674m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Stantec

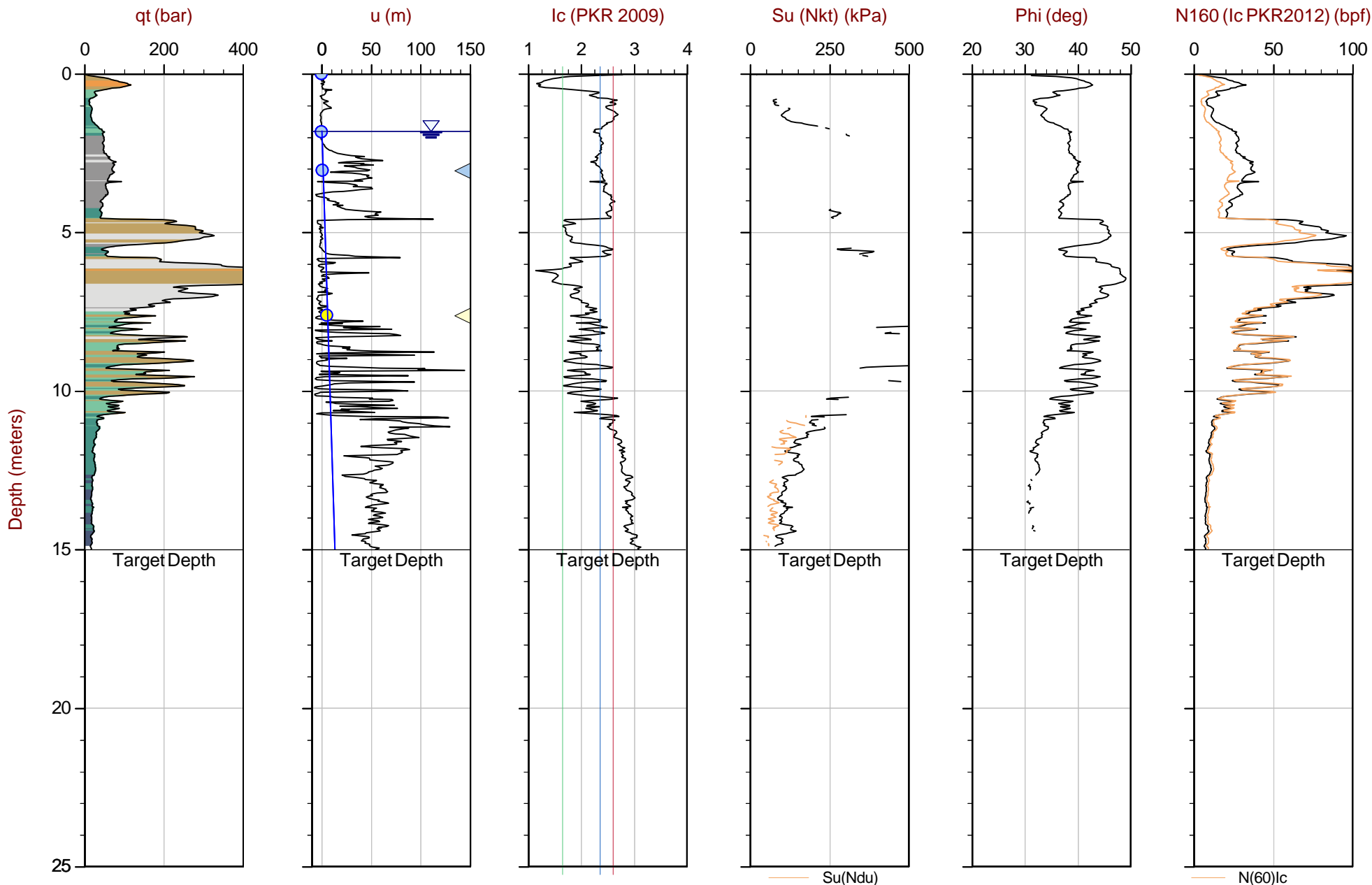
Job No: 24-05-27609

Date: 2024-05-10 14:49

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-WAPP02

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 15.000 m / 49.21 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: EveryPoint

File: 24-05-27609_SP-WA-02.COR

Unit Wt: SBTQtn(PKR2009)

SuNkt/Ndu: 15.0 / 6.0

SBT: Robertson, 2009 and 2010

Coords: UTM17N: 4738905mE: 482817m

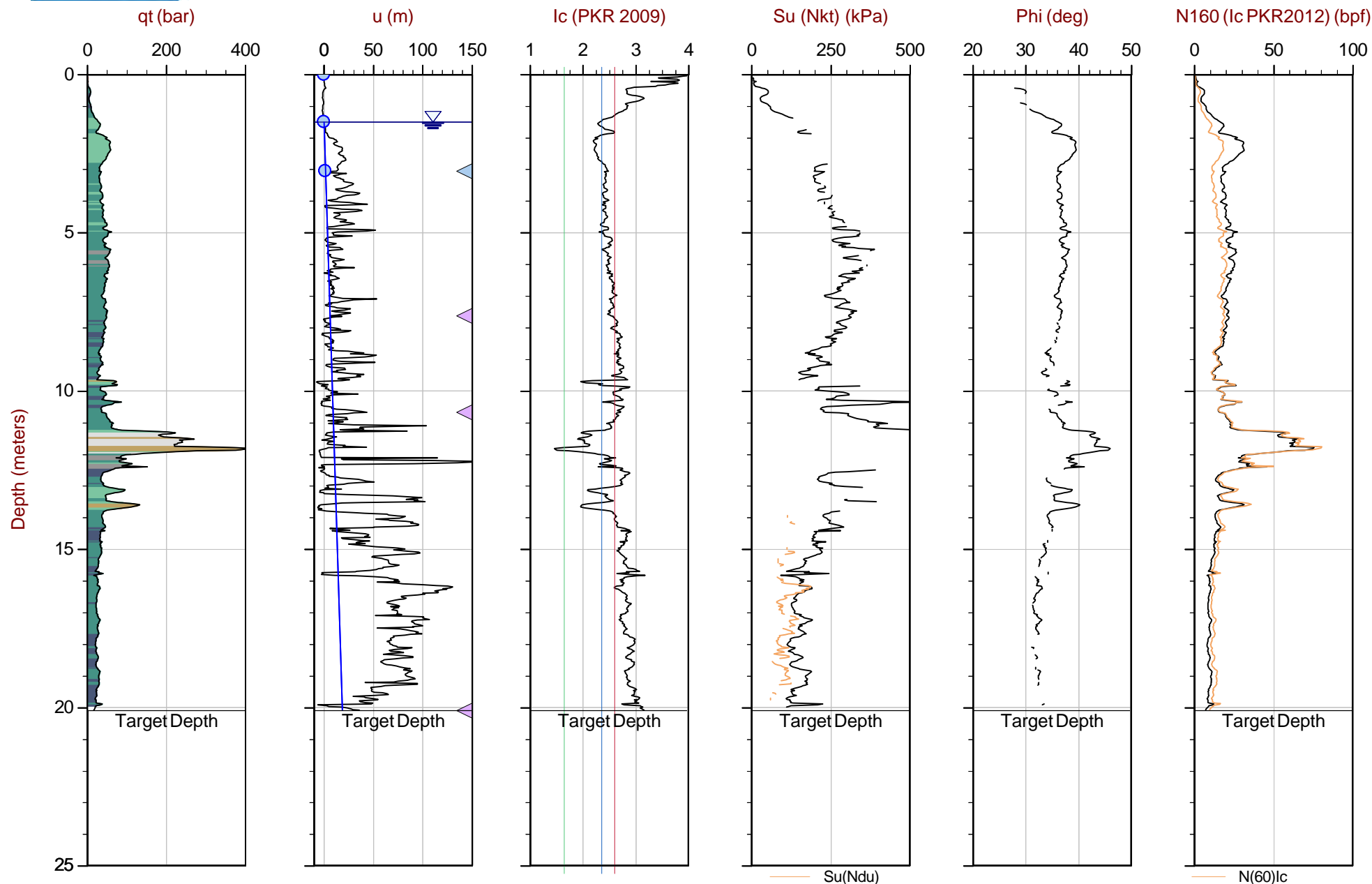
SheetNo: 1 of 1

OverplotItem: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

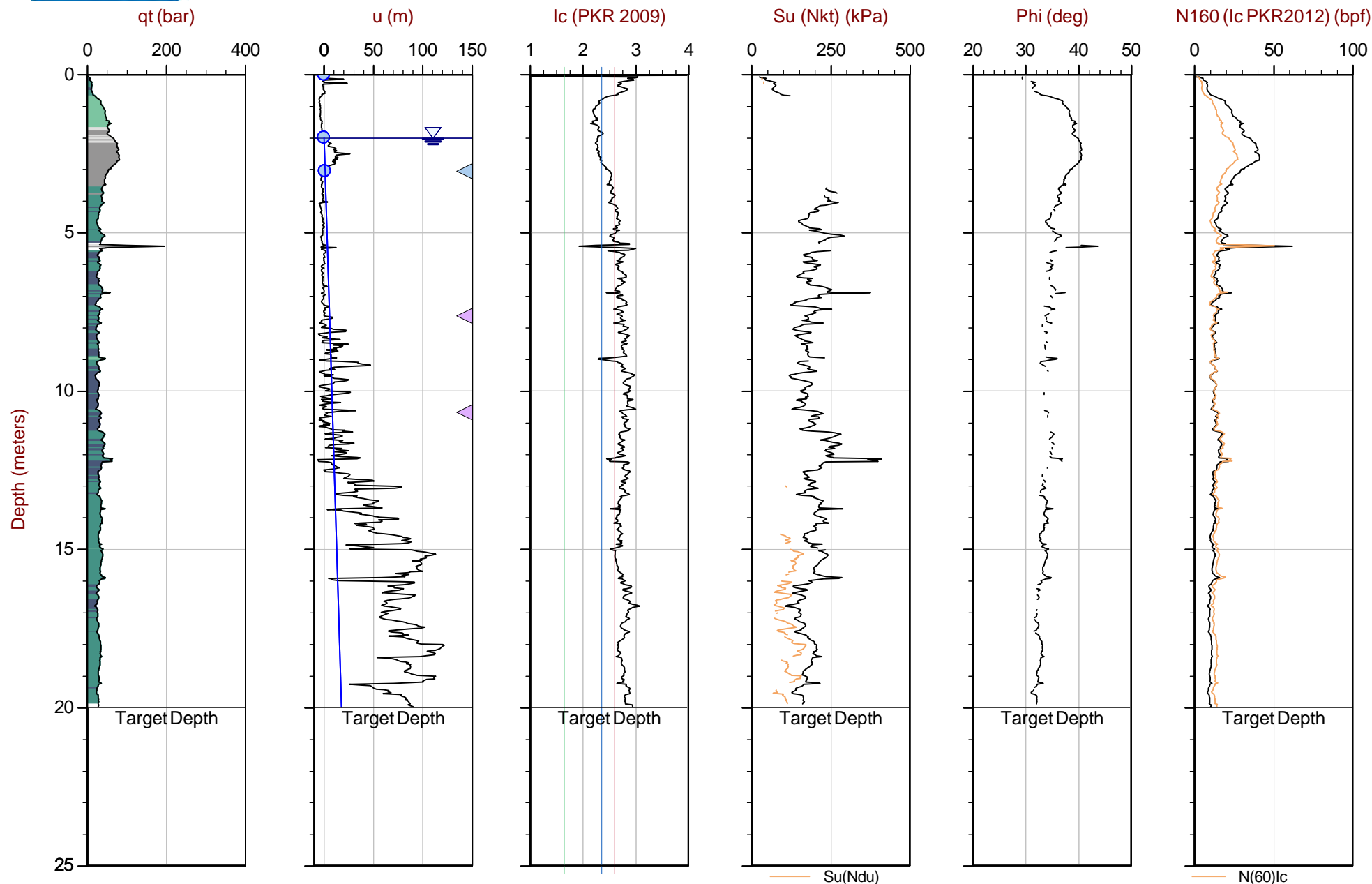
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Site: HWY 3, St.Thomas, ON



The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Legend: ● Ueq ● Assumed Ueq ◀ Dissipation, Ueq achieved ◀ Dissipation, Ueq not achieved ◀ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Seismic Cone Penetration Test Plots



Stantec

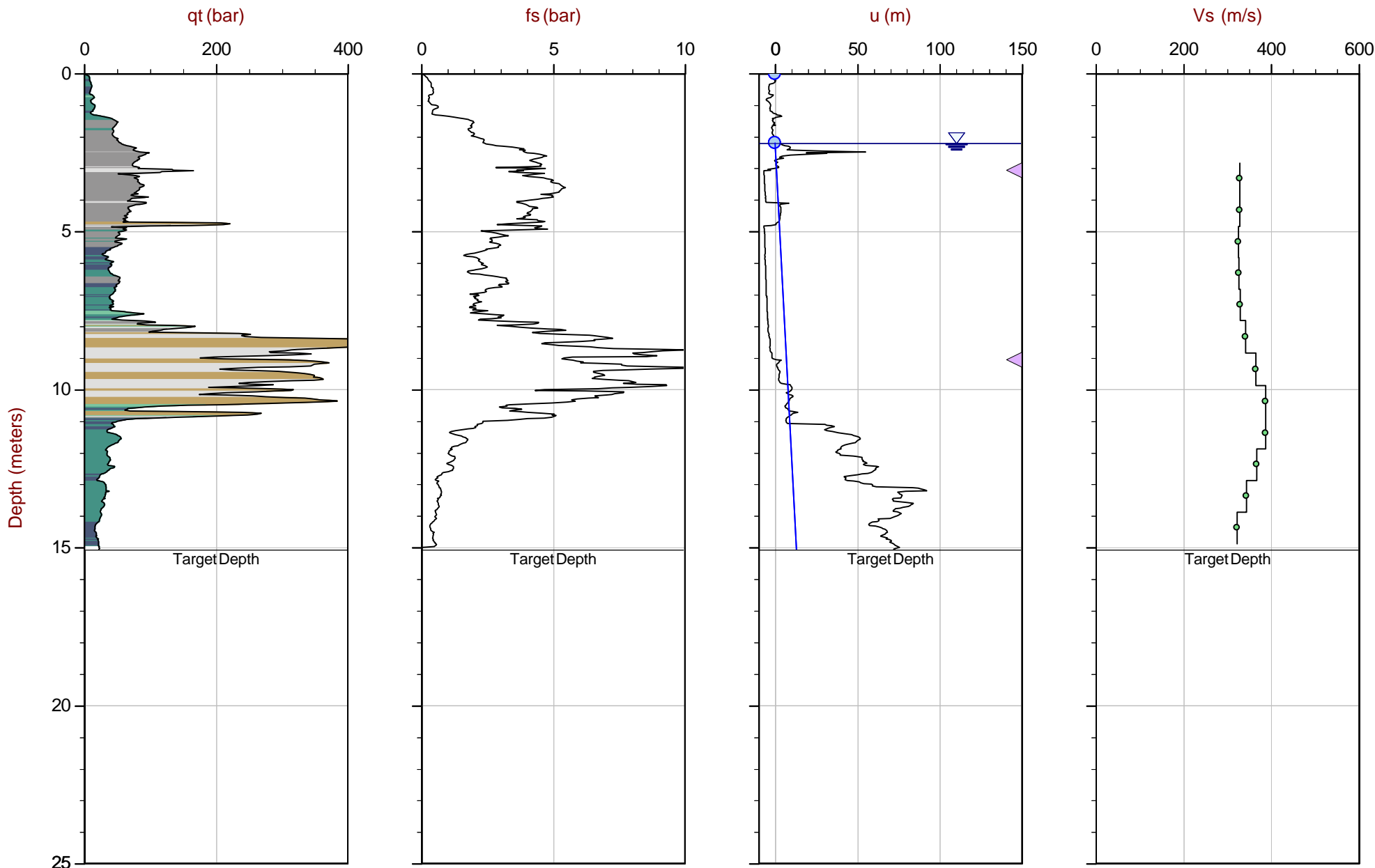
Job No: 24-05-27609

Date: 2024-05-10 10:24

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-RMNAPP01

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 15.075 m / 49.46 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 24-05-27609_SP-RM-01.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM17N: 4739737mE: 481294m

Sheet No: 1 of 1

OverplotItem: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Stantec

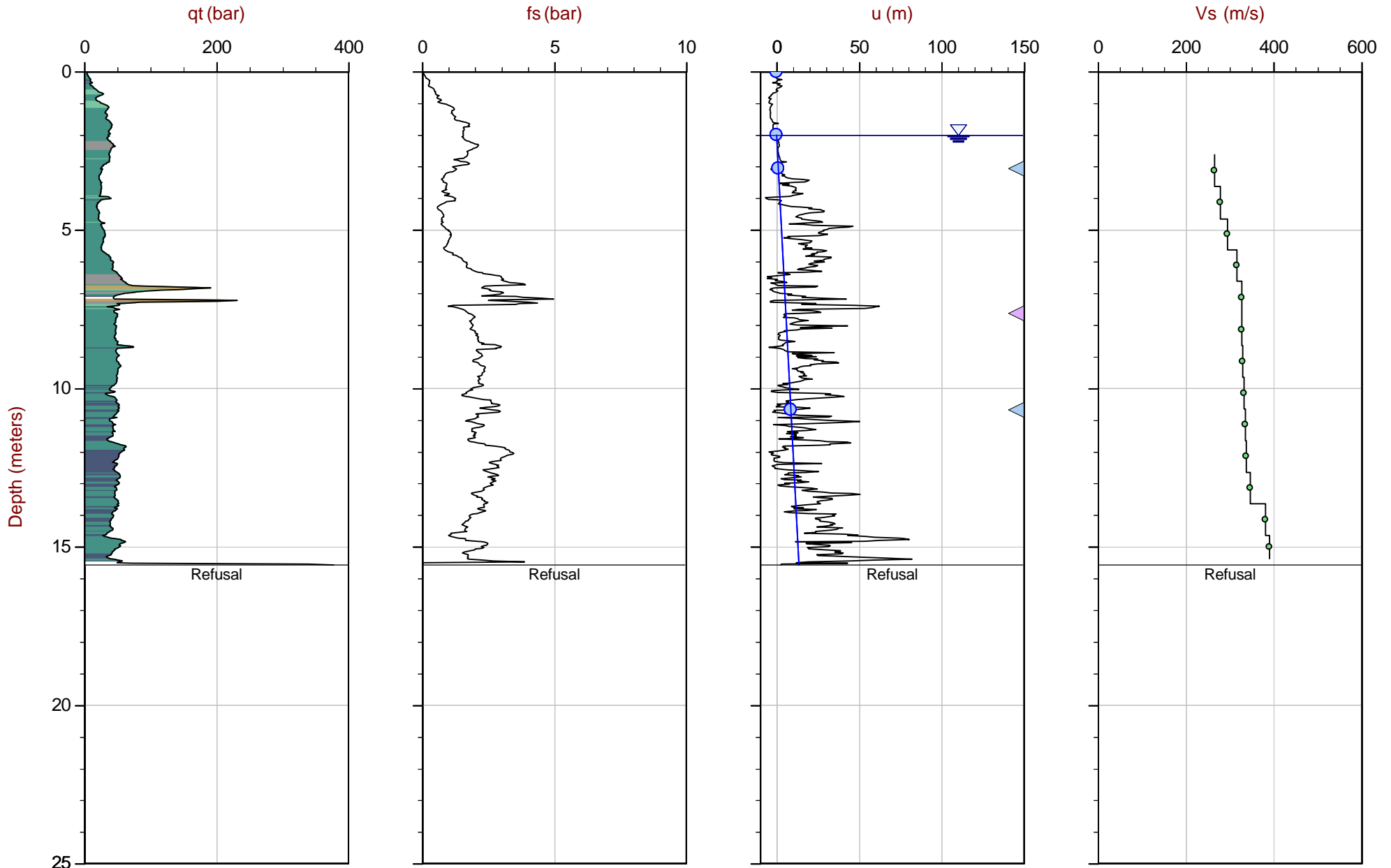
Job No: 24-05-27609

Date: 2024-05-09 12:06

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB02

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 15.575 m / 51.10 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 24-05-27609_SP-CN-02.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM17N N: 4740267m E: 480674m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Stantec

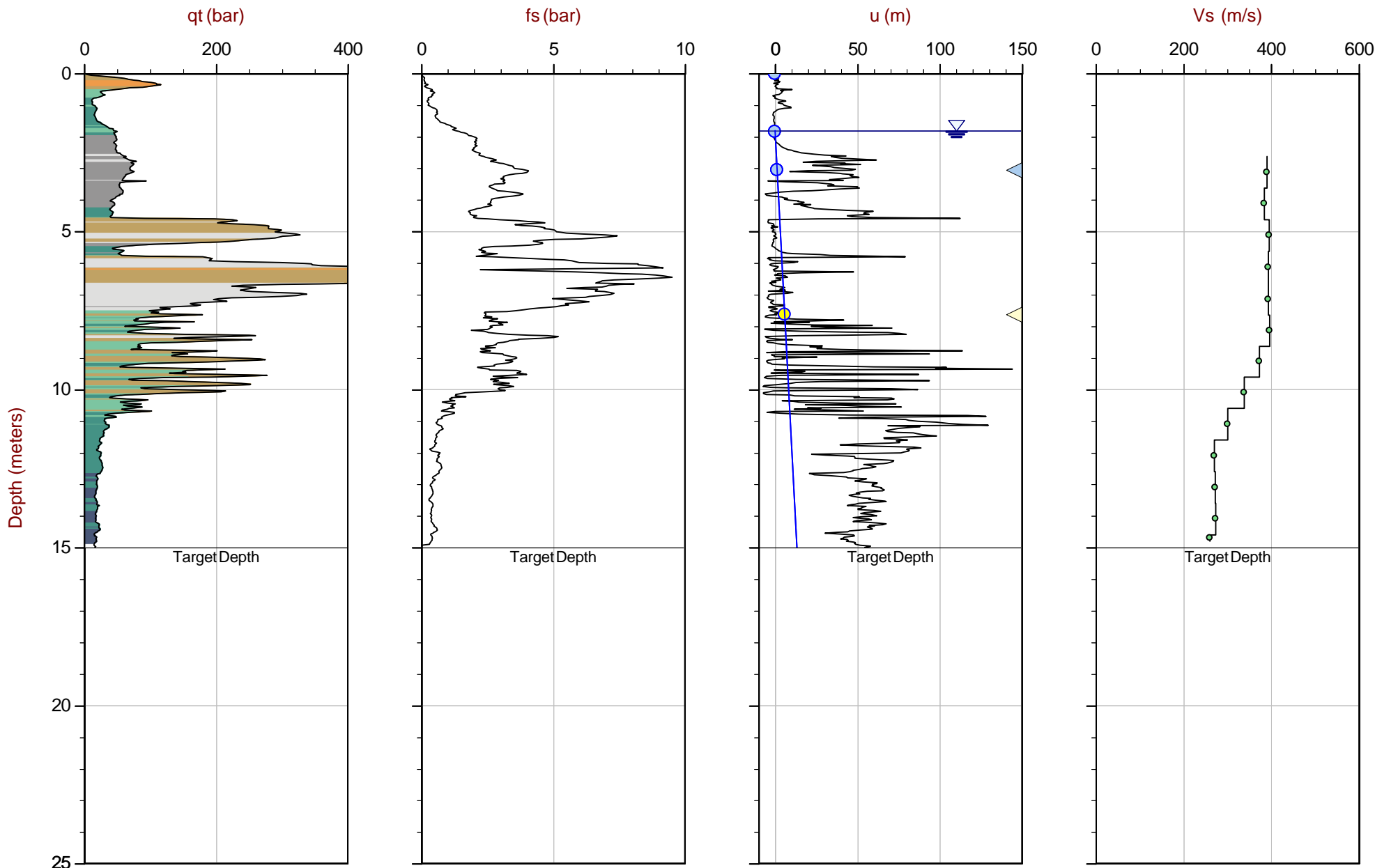
Job No: 24-05-27609

Date: 2024-05-10 14:49

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-WAPP02

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 15.000 m / 49.21 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 24-05-27609_SP-WA-02.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM17N N: 4738905m E: 482817m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▼ Dissipation, Ueq not achieved ◀ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Stantec

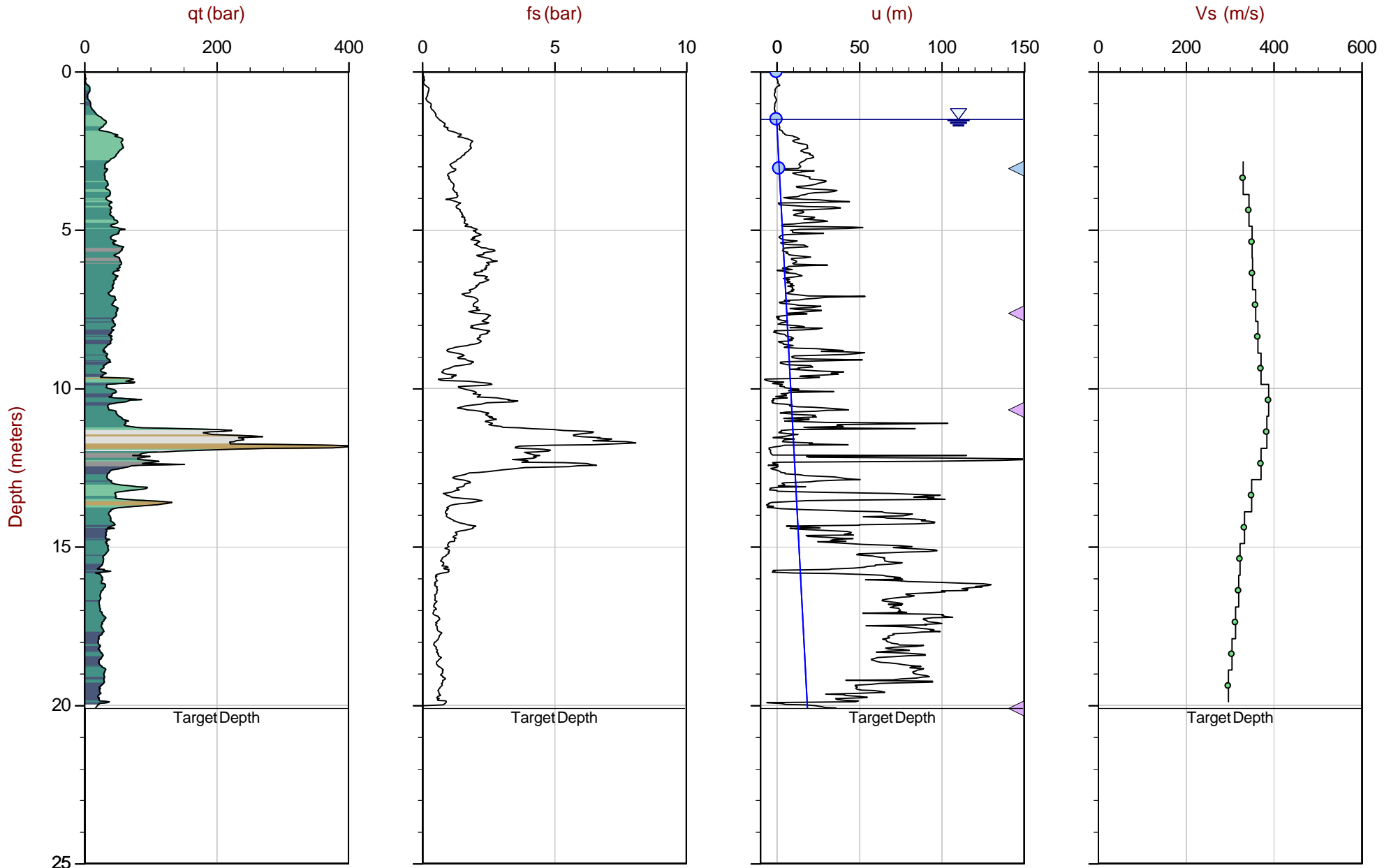
Job No: 24-05-27609

Date: 2024-05-09 16:43

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB08

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 20.100 m / 65.94 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: EveryPoint

File: 24-05-27609_SP-CN-08.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM17N: 4740056mE: 480896m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Stantec

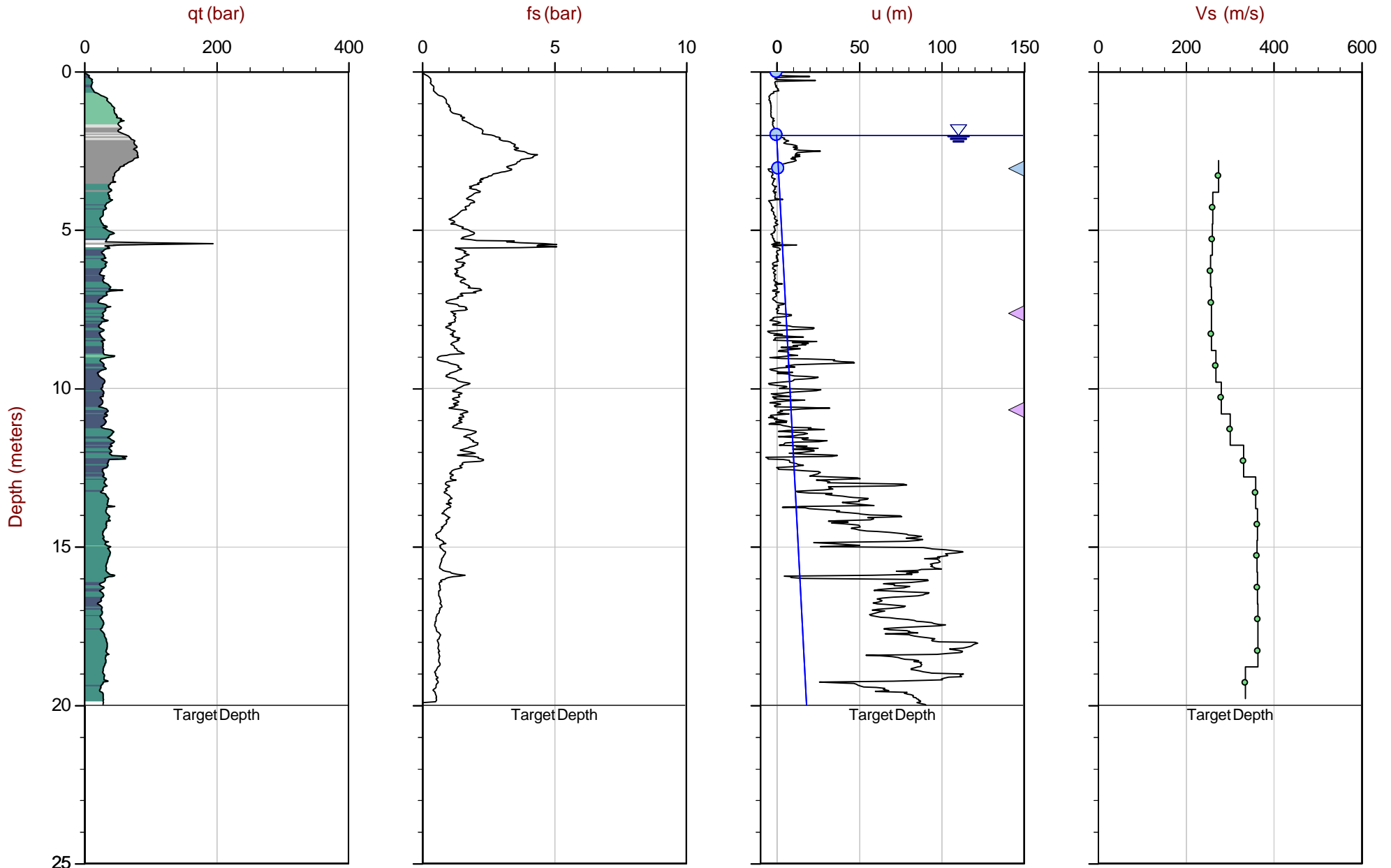
Job No: 24-05-27609

Date: 2024-05-10 06:58

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB10

Cone: 729:T1500F15U35 Area=15 cm²



Max Depth: 20.000 m / 65.62 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: EveryPoint

File: 24-05-27609_SP-CN-10.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM17N: 4739960mE: 481010m

Sheet No: 1 of 1

Overplot Item: ● Ueq ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved ▲ Dissipation, Ueq assumed — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Seismic Cone Penetration Test Shear Wave (V_s) Tabular Results



Job No: 24-05-27609
Client: Stantec
Project: HWY 3 St Thomas CPT
Sounding ID: SCPT24-RMNAPP01
Date: 2024-05-10

Seismic Source: Beam
Seismic Offset (m): 3.20
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPT_u SHEAR WAVE VELOCITY TEST RESULTS - V_s

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
3.03	2.83	4.27			
4.03	3.83	4.99	0.72	2.19	328
5.03	4.83	5.79	0.80	2.45	328
6.02	5.82	6.64	0.85	2.61	325
7.02	6.82	7.53	0.89	2.73	326
8.02	7.82	8.45	0.92	2.78	329
9.05	8.85	9.41	0.96	2.82	341
10.08	9.88	10.39	0.97	2.67	365
11.08	10.88	11.34	0.96	2.47	387
12.08	11.88	12.30	0.96	2.49	387
13.08	12.88	13.27	0.97	2.64	367
14.08	13.88	14.24	0.97	2.83	343
15.08	14.88	15.22	0.98	3.03	322



Job No: 24-05-27609
Client: Stantec
Project: HWY 3 St Thomas CPT
Sounding ID: SCPT24-CNREMB02
Date: 2024-05-09

Seismic Source: Beam
Seismic Offset (m): 3.20
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPT_u SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
2.82	2.62	4.14			
3.82	3.62	4.83	0.70	2.63	265
4.85	4.65	5.65	0.81	2.92	279
5.82	5.62	6.47	0.82	2.79	295
6.82	6.62	7.35	0.89	2.80	316
7.85	7.65	8.29	0.94	2.87	327
8.85	8.65	9.22	0.93	2.84	327
9.85	9.65	10.17	0.94	2.87	329
10.85	10.65	11.12	0.95	2.87	332
11.85	11.65	12.08	0.96	2.87	335
12.85	12.65	13.05	0.97	2.87	337
13.85	13.65	14.02	0.97	2.81	346
14.85	14.65	15.00	0.98	2.56	380
15.58	15.38	15.71	0.71	1.83	390



Job No: 24-05-27609
Client: Stantec
Project: HWY 3 St Thomas CPT
Sounding ID: SCPT24-WAPP02
Date: 2024-05-10

Seismic Source: Beam
Seismic Offset (m): 3.20
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPT_u SHEAR WAVE VELOCITY TEST RESULTS - V_s

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
2.82	2.62	4.14			
3.82	3.62	4.83	0.70	1.79	390
4.82	4.62	5.62	0.79	2.05	384
5.82	5.62	6.47	0.85	2.14	396
6.85	6.65	7.38	0.91	2.32	393
7.85	7.65	8.29	0.91	2.32	393
8.83	8.63	9.20	0.91	2.30	396
9.80	9.60	10.12	0.92	2.46	373
10.80	10.60	11.07	0.95	2.82	338
11.80	11.60	12.03	0.96	3.20	300
12.80	12.60	13.00	0.97	3.58	270
13.80	13.60	13.97	0.97	3.57	272
14.80	14.60	14.95	0.98	3.58	273
15.00	14.80	15.14	0.20	0.75	260



Job No: 24-05-27609
Client: Stantec
Project: HWY 3 St Thomas CPT
Sounding ID: SCPT24-CNREMB08
Date: 2024-05-09

Seismic Source: Beam
Seismic Offset (m): 3.20
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPT_u SHEAR WAVE VELOCITY TEST RESULTS - V_s

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
3.05	2.85	4.29			
4.08	3.88	5.03	0.74	2.26	330
5.08	4.88	5.84	0.81	2.35	343
6.08	5.88	6.69	0.86	2.45	351
7.08	6.88	7.59	0.89	2.55	351
8.08	7.88	8.51	0.92	2.56	358
9.08	8.88	9.44	0.93	2.57	363
10.08	9.88	10.39	0.95	2.56	370
11.08	10.88	11.34	0.96	2.46	388
12.10	11.90	12.32	0.98	2.56	384
13.08	12.88	13.27	0.95	2.56	371
14.10	13.90	14.26	0.99	2.84	349
15.10	14.90	15.24	0.98	2.93	333
16.10	15.90	16.22	0.98	3.03	323
17.10	16.90	17.20	0.98	3.07	319
18.10	17.90	18.18	0.98	3.15	313
19.10	18.90	19.17	0.99	3.23	305
20.10	19.90	20.16	0.99	3.32	297



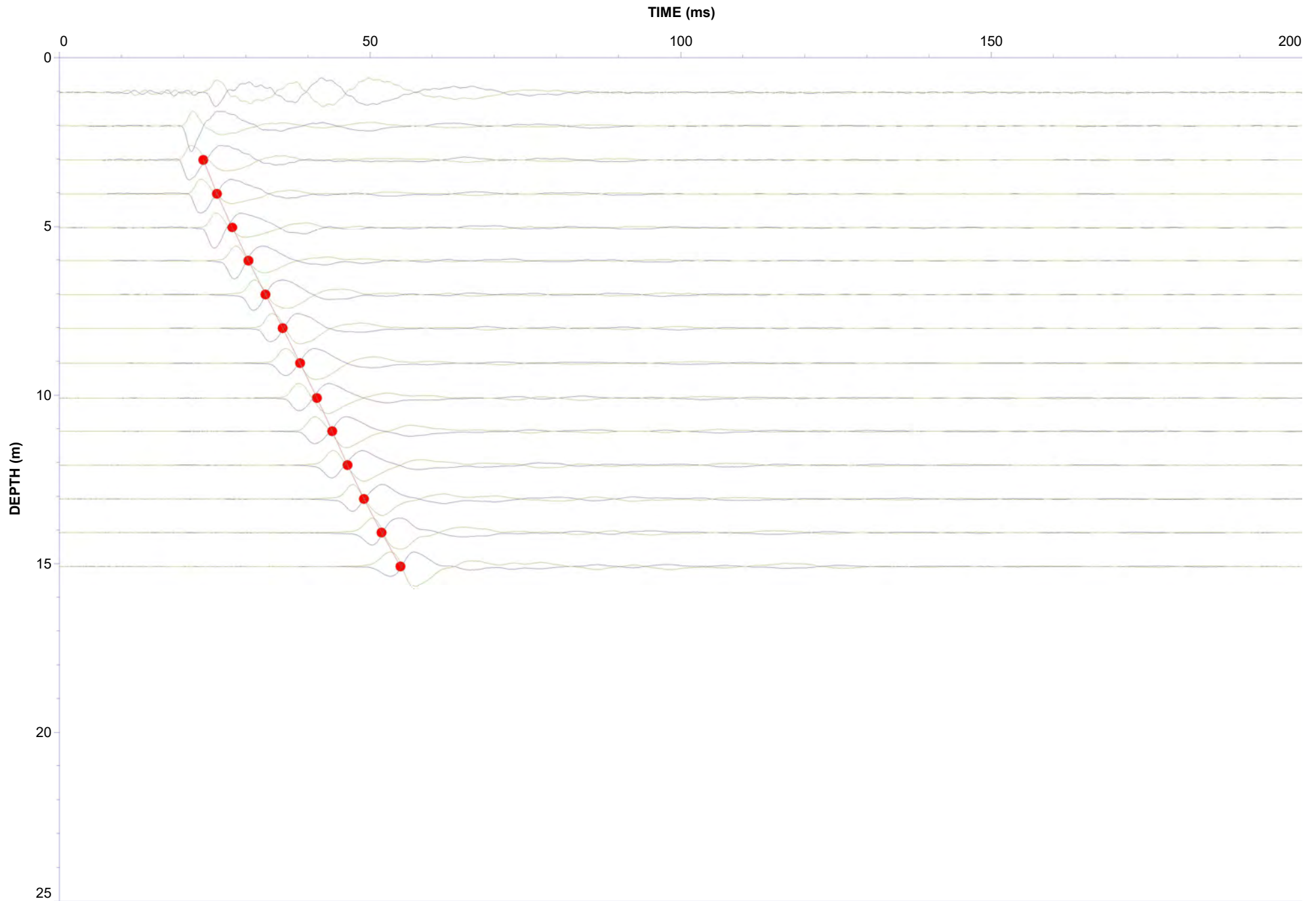
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Client: Stantec
Project: HWY 3 St Thomas CPT
Sounding ID: SCPT24-CNREMB10
Date: 2024-05-10

Seismic Source: Beam
Seismic Offset (m): 3.20
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPT_u SHEAR WAVE VELOCITY TEST RESULTS - V_s

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
3.00	2.80	4.25			
4.00	3.80	4.97	0.72	2.61	275
5.00	4.80	5.77	0.80	3.07	261
6.00	5.80	6.62	0.86	3.29	260
7.00	6.80	7.52	0.89	3.48	256
8.00	7.80	8.43	0.92	3.55	258
9.00	8.80	9.36	0.93	3.61	258
10.00	9.80	10.31	0.95	3.53	268
11.00	10.80	11.26	0.96	3.41	280
12.00	11.80	12.23	0.96	3.20	301
13.00	12.80	13.19	0.97	2.92	332
14.00	13.80	14.17	0.97	2.71	359
15.00	14.80	15.14	0.98	2.70	362
16.00	15.80	16.12	0.98	2.71	362
17.00	16.80	17.10	0.98	2.71	363
18.00	17.80	18.09	0.98	2.71	363
19.00	18.80	19.07	0.99	2.71	364
20.00	19.80	20.06	0.99	2.95	335

Seismic Cone Penetration Test Shear Wave (V_s) Traces





Job No: 24-05-27609
Analysis: S Wave - Geo X

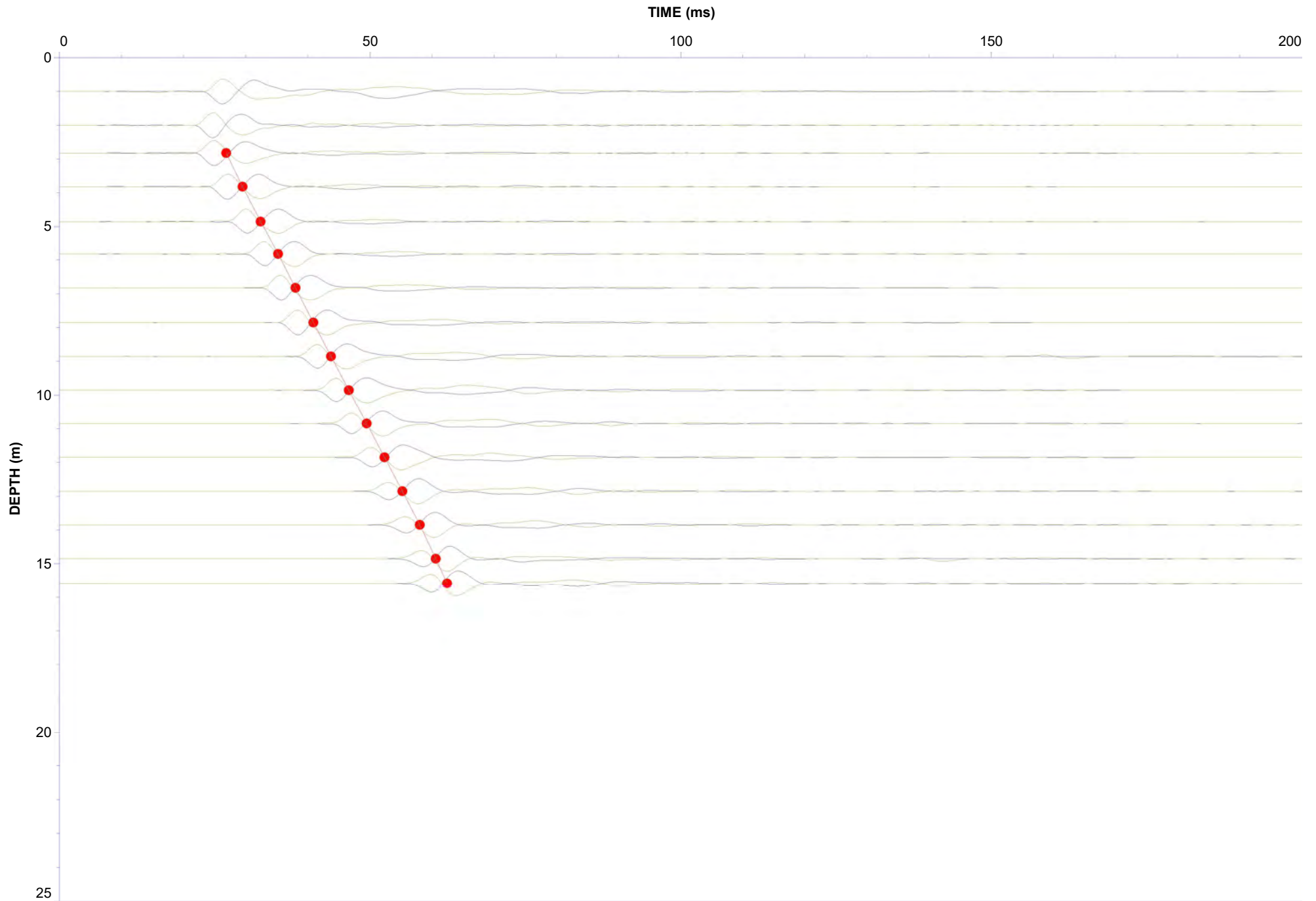
Client: Stantec

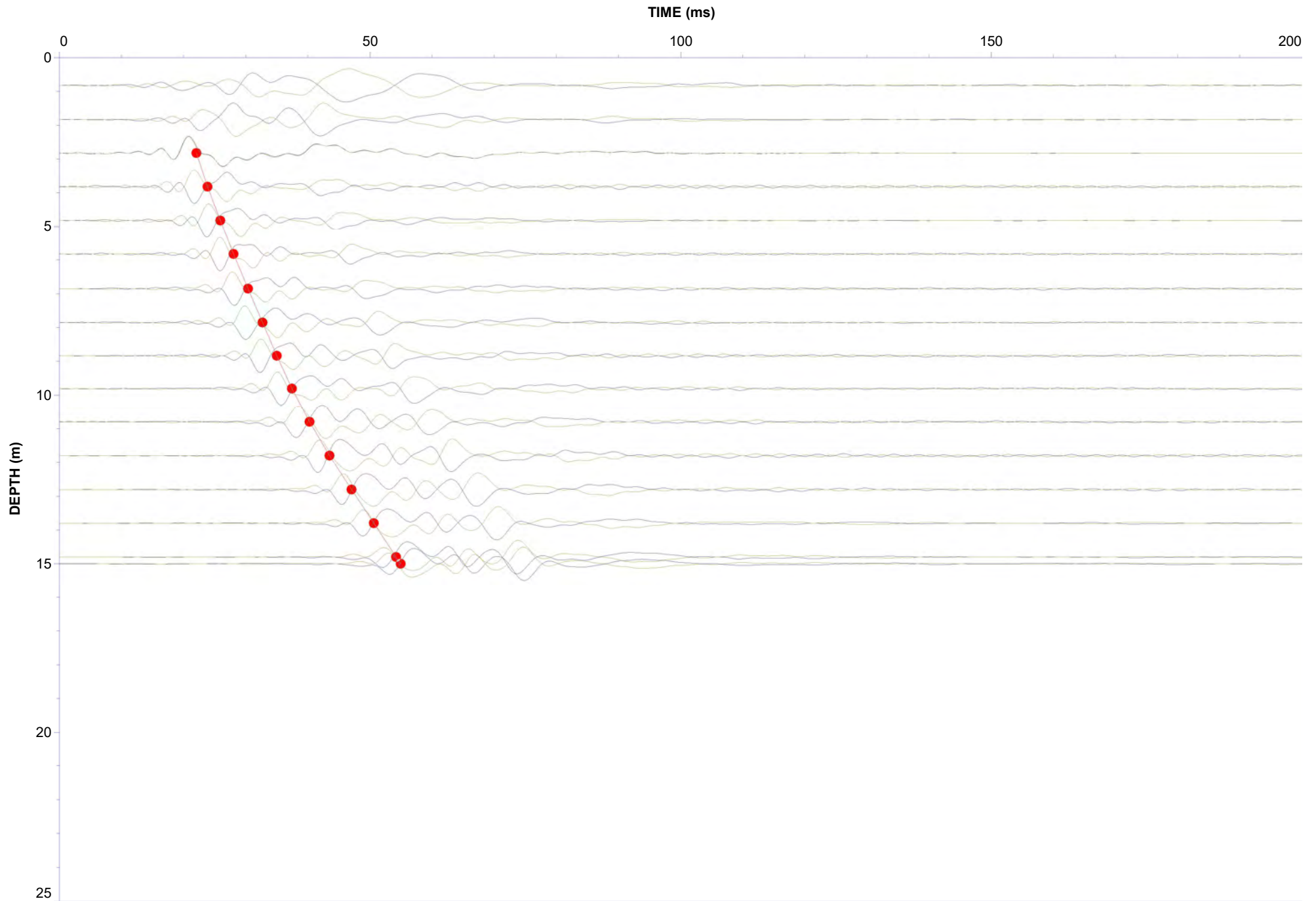
Project: HWY 3 St Thomas CPT

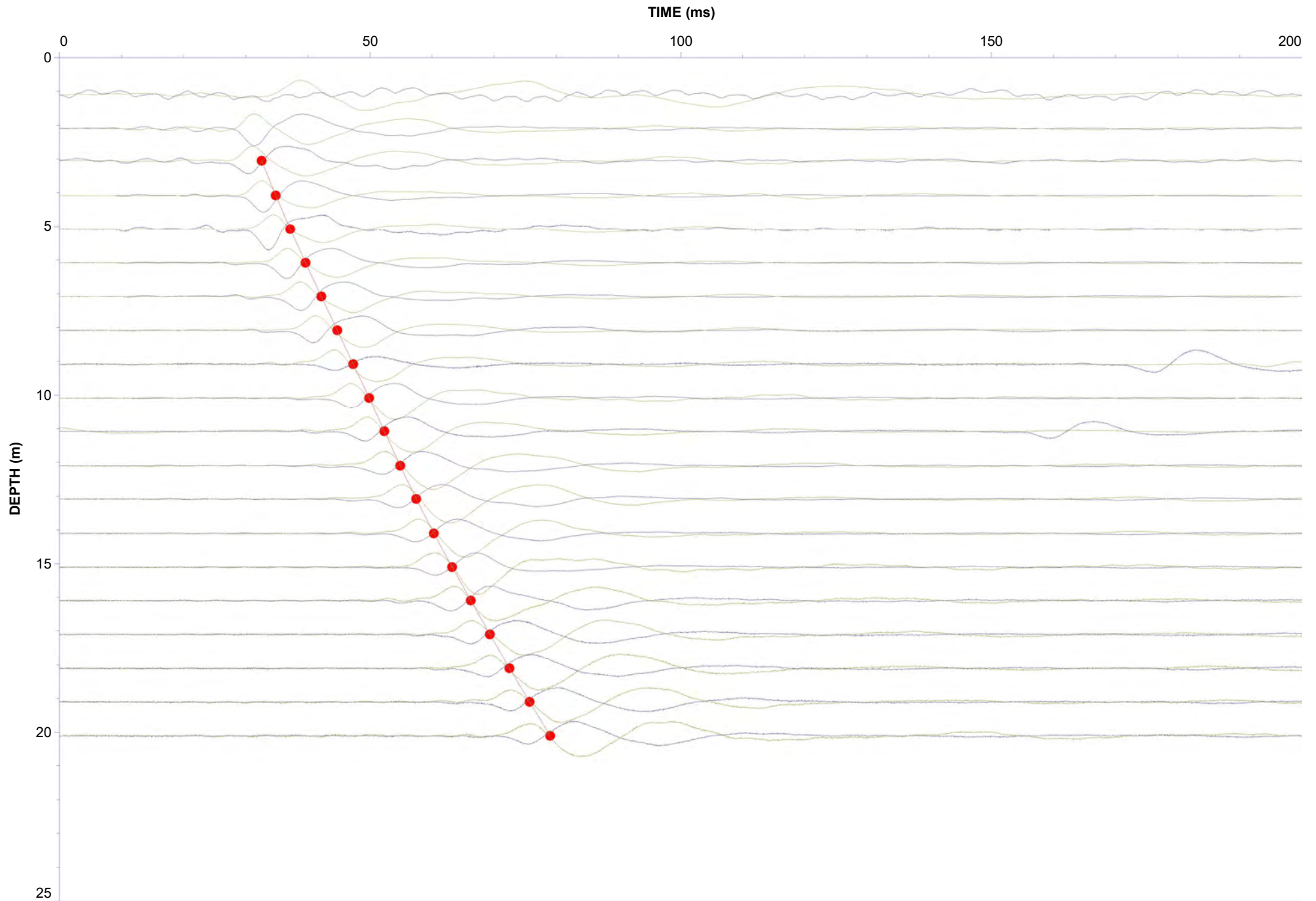
Sounding: SCPT24-CNREMB02

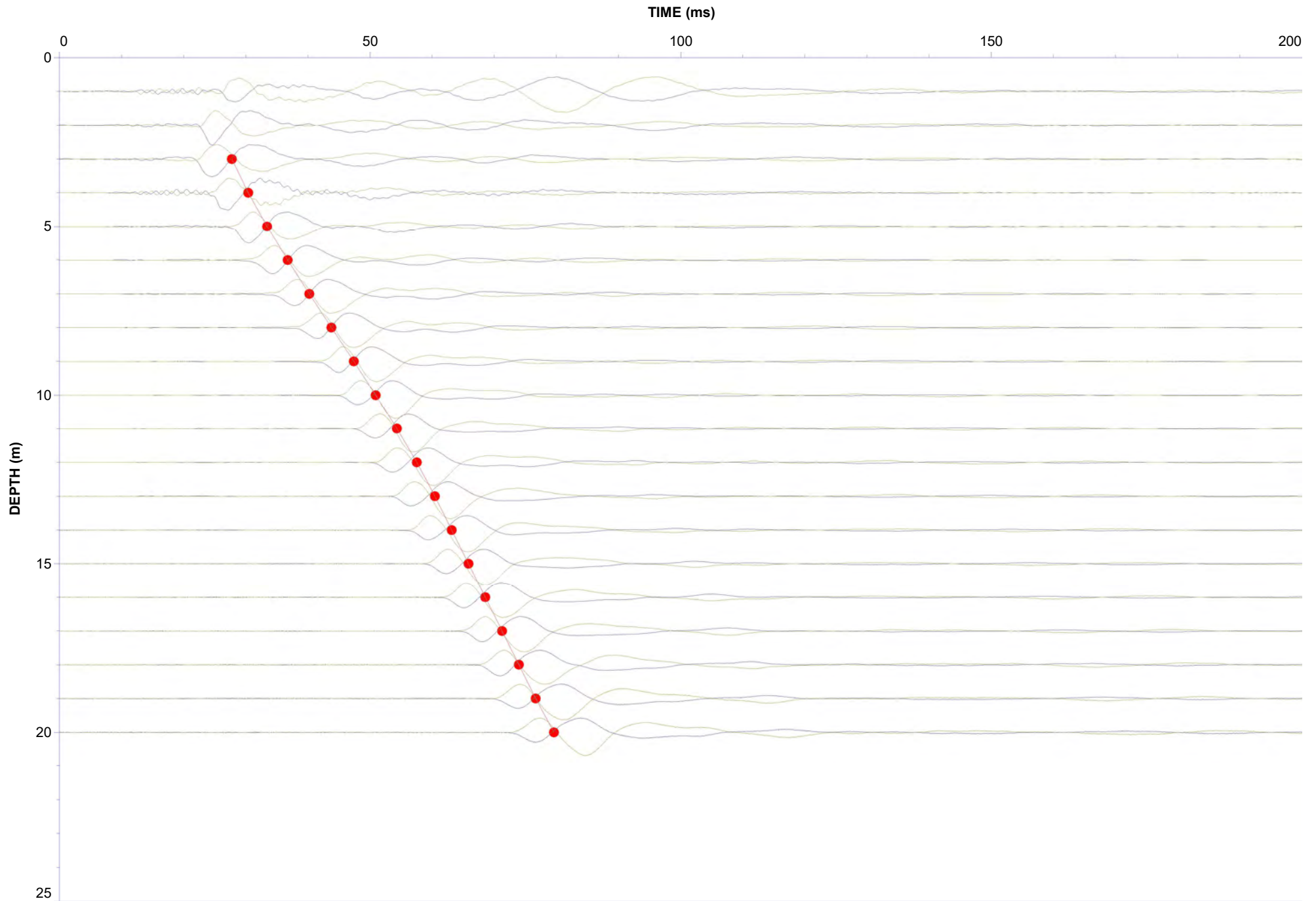
Filter: None

Date: 2024-05-09









Soil Behaviour Type (SBT) Scatter Plots



Stantec

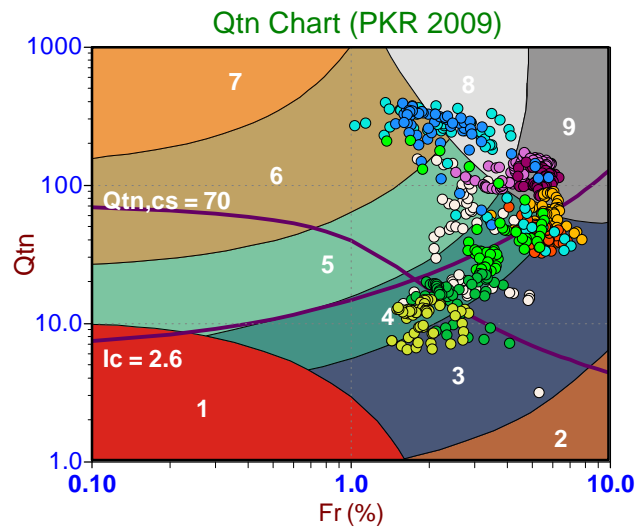
Job No: 24-05-27609

Date: 2024-05-10 12:15

Site: HWY 3, St.Thomas, ON

Sounding: CPT24-RMNAPP01

Cone: 729:T1500F15U35 Area=15 cm²

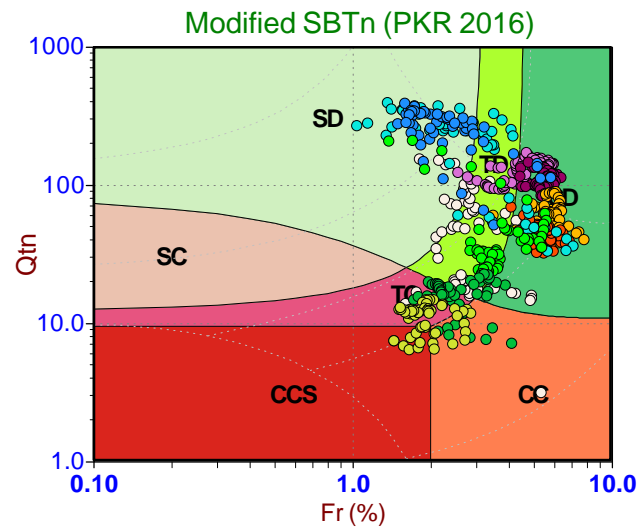


Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

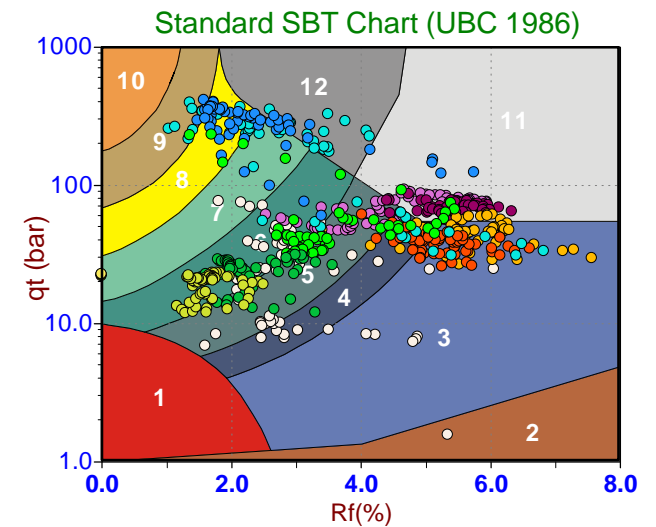
Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained



Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)



Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand



Stantec

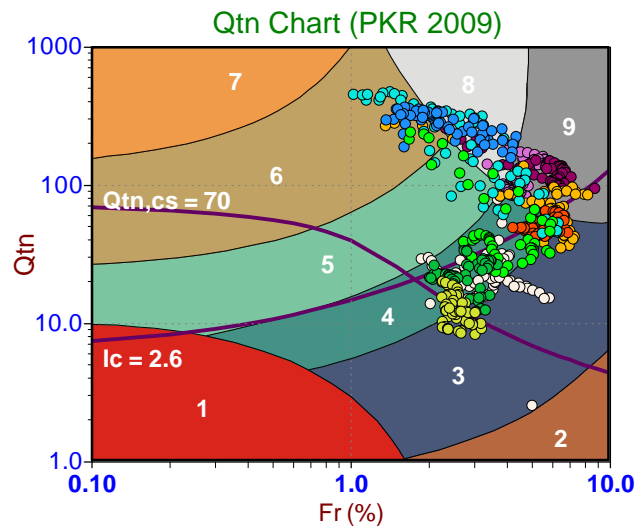
Job No: 24-05-27609

Date: 2024-05-10 10:24

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-RMNAPP01

Cone: 729:T1500F15U35 Area=15 cm²

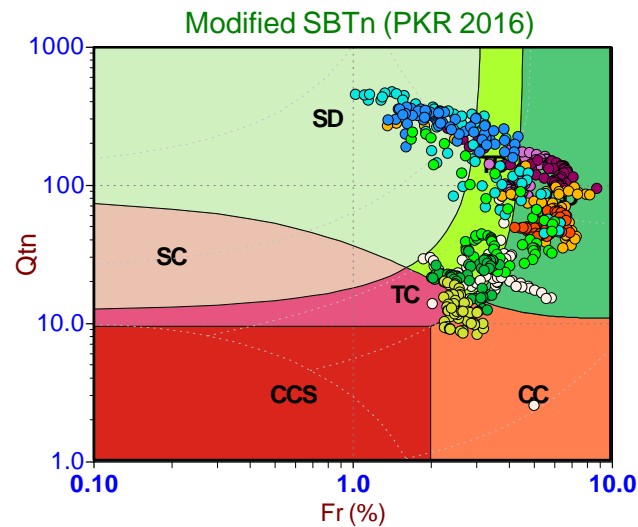


Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

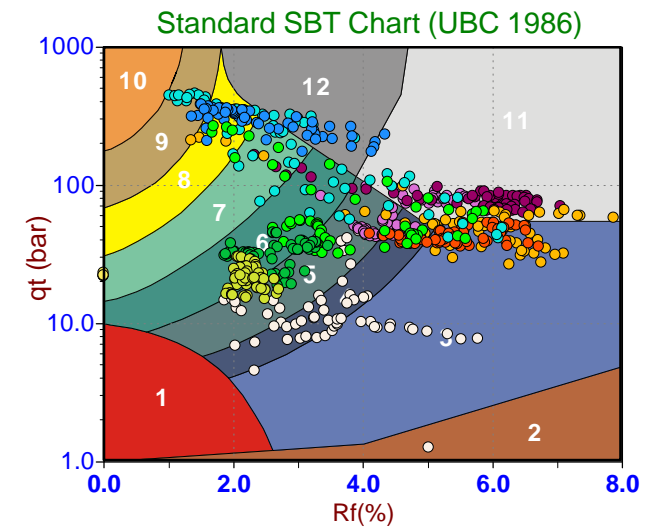
Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained



Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)



Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand



Stantec

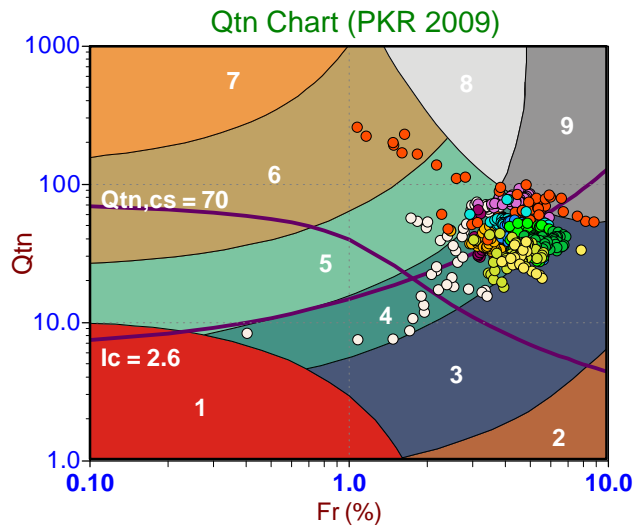
Job No: 24-05-27609

Date: 2024-05-09 12:06

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB02

Cone: 729:T1500F15U35 Area=15 cm²

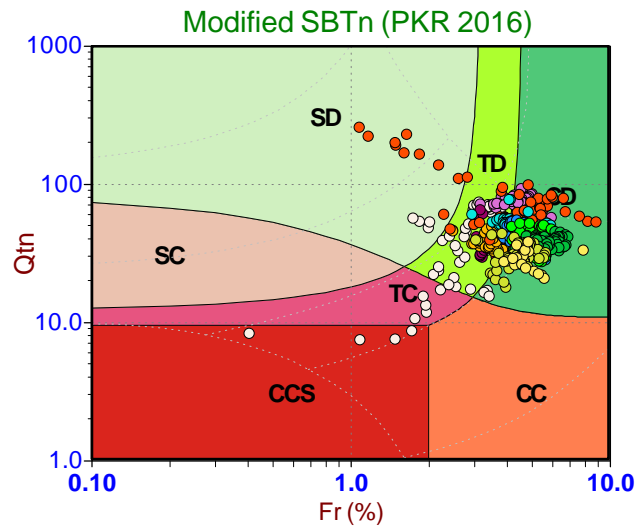


Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

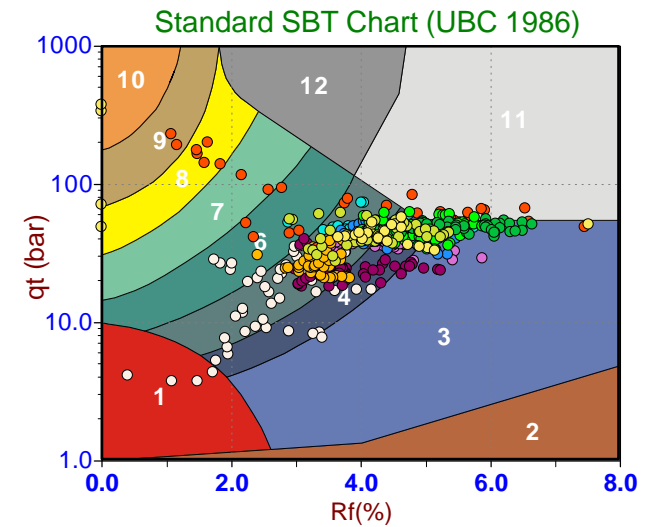
Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained



Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)



Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand



Stantec

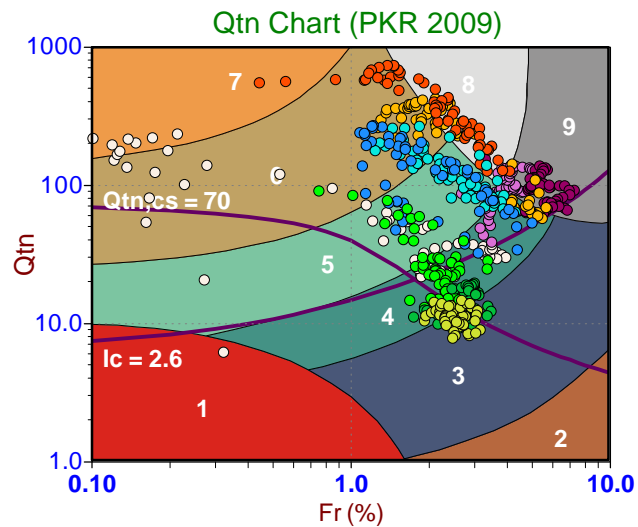
Job No: 24-05-27609

Date: 2024-05-10 14:49

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-WAPP02

Cone: 729:T1500F15U35 Area=15 cm²

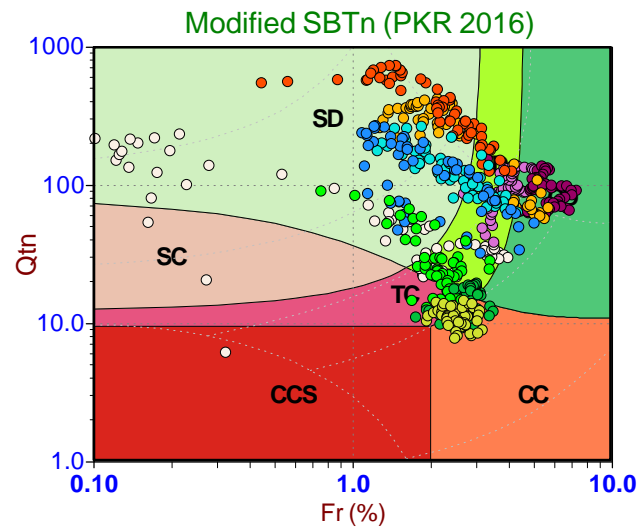


Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

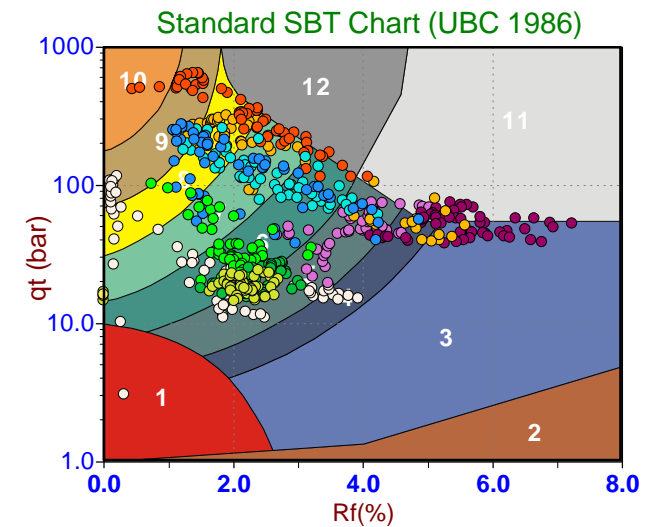
Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained



Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)



Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand



Stantec

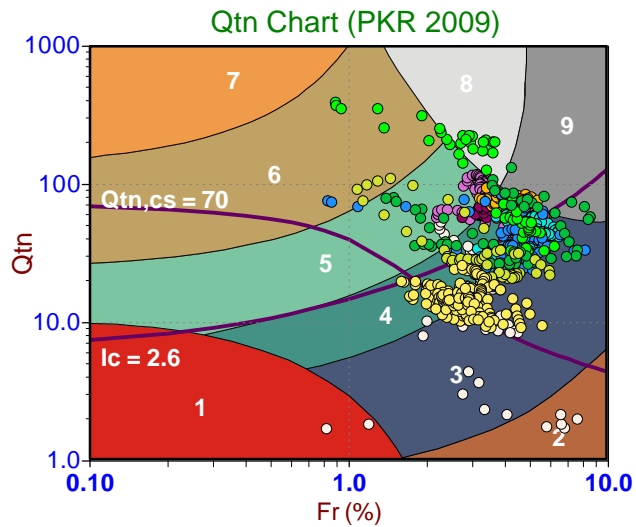
Job No: 24-05-27609

Date: 2024-05-09 16:43

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB08

Cone: 729:T1500F15U35 Area=15 cm²

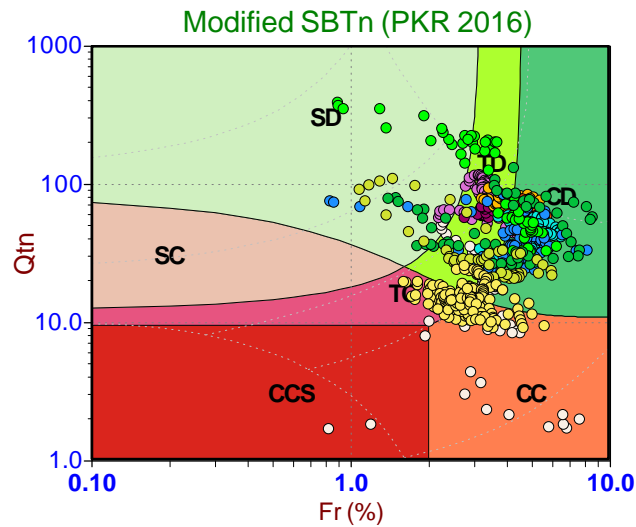


Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

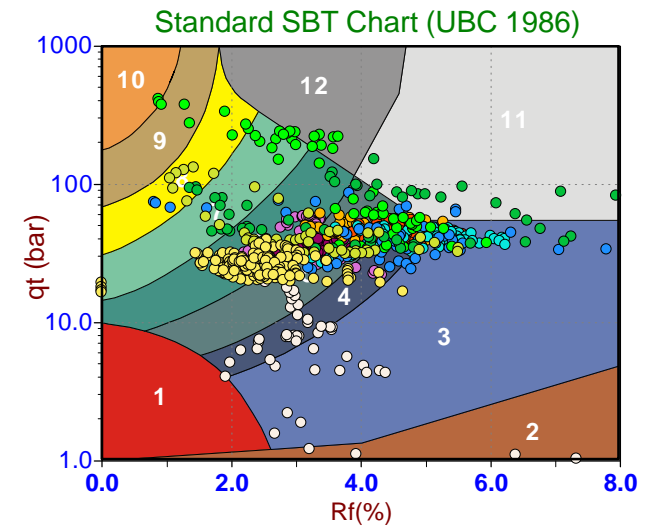
Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained



Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)



Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand



Stantec

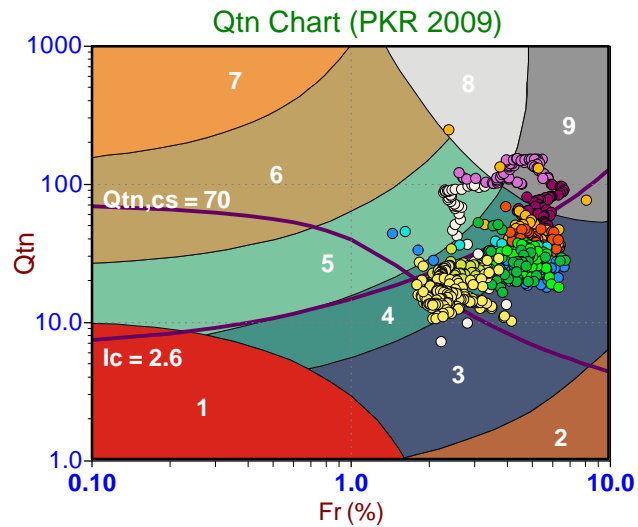
Job No: 24-05-27609

Date: 2024-05-10 06:58

Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB10

Cone: 729:T1500F15U35 Area=15 cm²

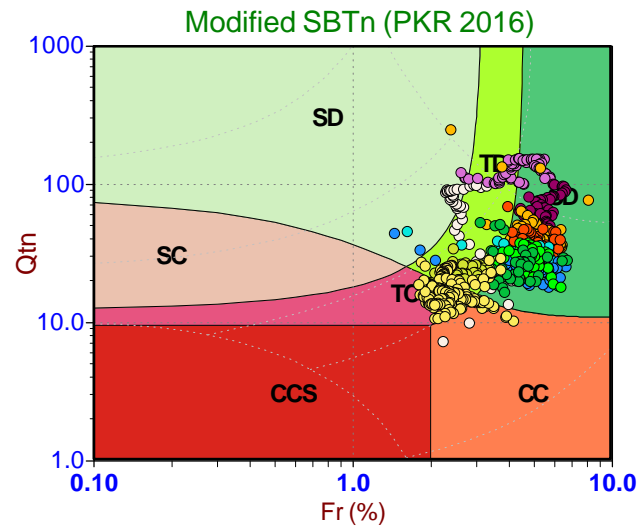


Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

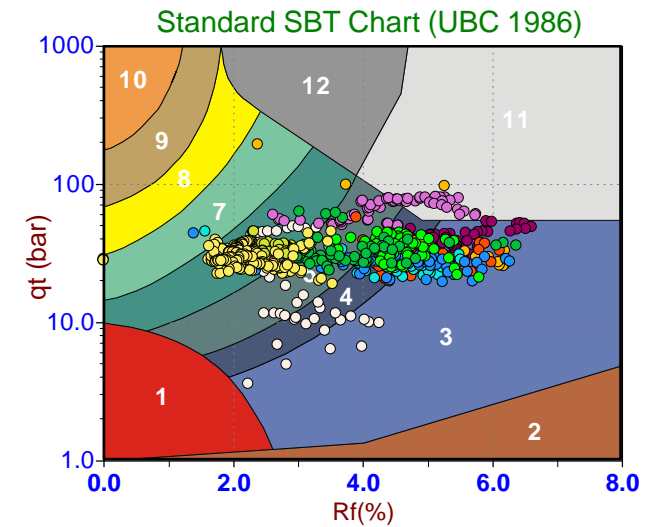
Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained



Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)



Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots



Job No: 24-05-27609
Client: Stantec Consulting Ltd.
Project: HWY 3 St Thomas CPT
Start Date: 2024-05-09
End Date: 2024-05-10

CPT_u PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm ²)	Duration (s)	Test Depth (m)	U _{initial} (m)	U _{max} (m)	U _{min} (m)	U _{final} (m)	Observed Equilibrium Pore Pressure U _{eq} (m)	Estimated Equilibrium Pore Pressure U _{eq} (m)	Assumed Phreatic Surface (m)	Percent Dissipation (%)	t ₅₀ (s) ₁	Assumed Rigidity Index (I _r)	c _h (cm ² /min) ₂	Refer to Notation Number
CPT24-RMNAPP01	24-05-27609_CP-RM-01	15	670	3.050	0.9	9.2	-2.2	9.2								
CPT24-RMNAPP01	24-05-27609_CP-RM-01	15	3090	7.625	0.4	44.6	0.4	26.4								
SCPT24-RMNAPP01	24-05-27609_SP-RM-01	15	790	3.050	1.4	1.4	-8.7	-7.3								
SCPT24-RMNAPP01	24-05-27609_SP-RM-01	15	1150	9.050	1.4	2.4	0.9	2.4								
SCPT24-CNREMB02	24-05-27609_SP-CN-02	15	3330	3.050	1.1	38.2	1.0	19.4		1.1	2.0	51	2923	100	0.2	3
SCPT24-CNREMB02	24-05-27609_SP-CN-02	15	1090	7.625	13.8	42.9	13.8	38.9								
SCPT24-CNREMB02	24-05-27609_SP-CN-02	15	2940	10.675	8.2	61.5	7.9	34.0		8.7	2.0	52	2423	100	0.3	3
SCPT24-WAPP02	24-05-27609_SP-WA-02	15	2010	3.050	31.5	99.6	31.5	49.9		1.2	1.8	51	1786	100	0.4	3
SCPT24-WAPP02	24-05-27609_SP-WA-02	15	1100	7.625	13.1	13.1	1.1	5.8	5.8		1.8	100				
SCPT24-CNREMB08	24-05-27609_SP-CN-08	15	3090	3.050	11.8	51.9	8.7	26.5		1.6	1.5	50	2773	100	0.3	3
SCPT24-CNREMB08	24-05-27609_SP-CN-08	15	1550	7.625	9.2	67.2	6.7	54.3								
SCPT24-CNREMB08	24-05-27609_SP-CN-08	15	2370	10.675	47.5	96.8	46.6	53.4								
SCPT24-CNREMB08	24-05-27609_SP-CN-08	15	470	20.100	40.1	70.1	40.1	66.8								
SCPT24-CNREMB10	24-05-27609_SP-CN-10	15	3030	3.050	-0.6	17.5	-0.6	9.2		1.1	2.0	50	2880	100	0.2	3
SCPT24-CNREMB10	24-05-27609_SP-CN-10	15	740	7.625	-0.6	30.1	-0.6	30.0								
SCPT24-CNREMB10	24-05-27609_SP-CN-10	15	3450	10.675	10.0	44.0	10.0	32.8								

1. Time for 50 percent dissipation was based on U_{max}, U_{min}, and the applied U_{eq}. Note the time is relative to where U_{max} occurred.

2. Teh and Houlsby, 1991.

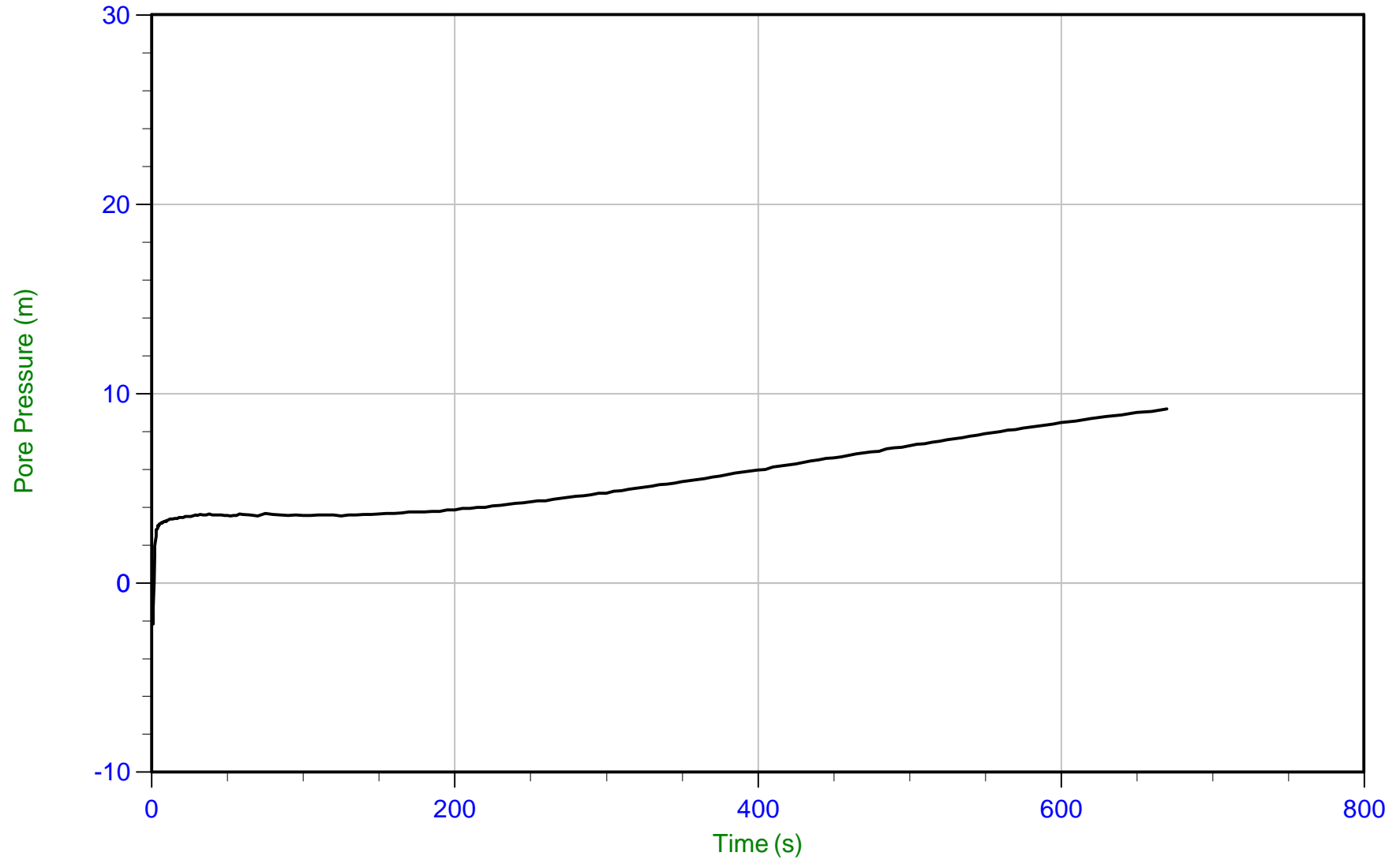
3. The estimated equilibrium pore pressure was based on a hydrostatic assumption from the assumed phreatic surface.



Stantec

Job No: 24-05-27609
Date: 2024-05-10 12:15
Site: HWY 3, St.Thomas, ON

Sounding: CPT24-RMNAPP01
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_CP-RM-01.PPF2
Depth: 3.050 m / 10.006 ft
Duration: 670.0 s

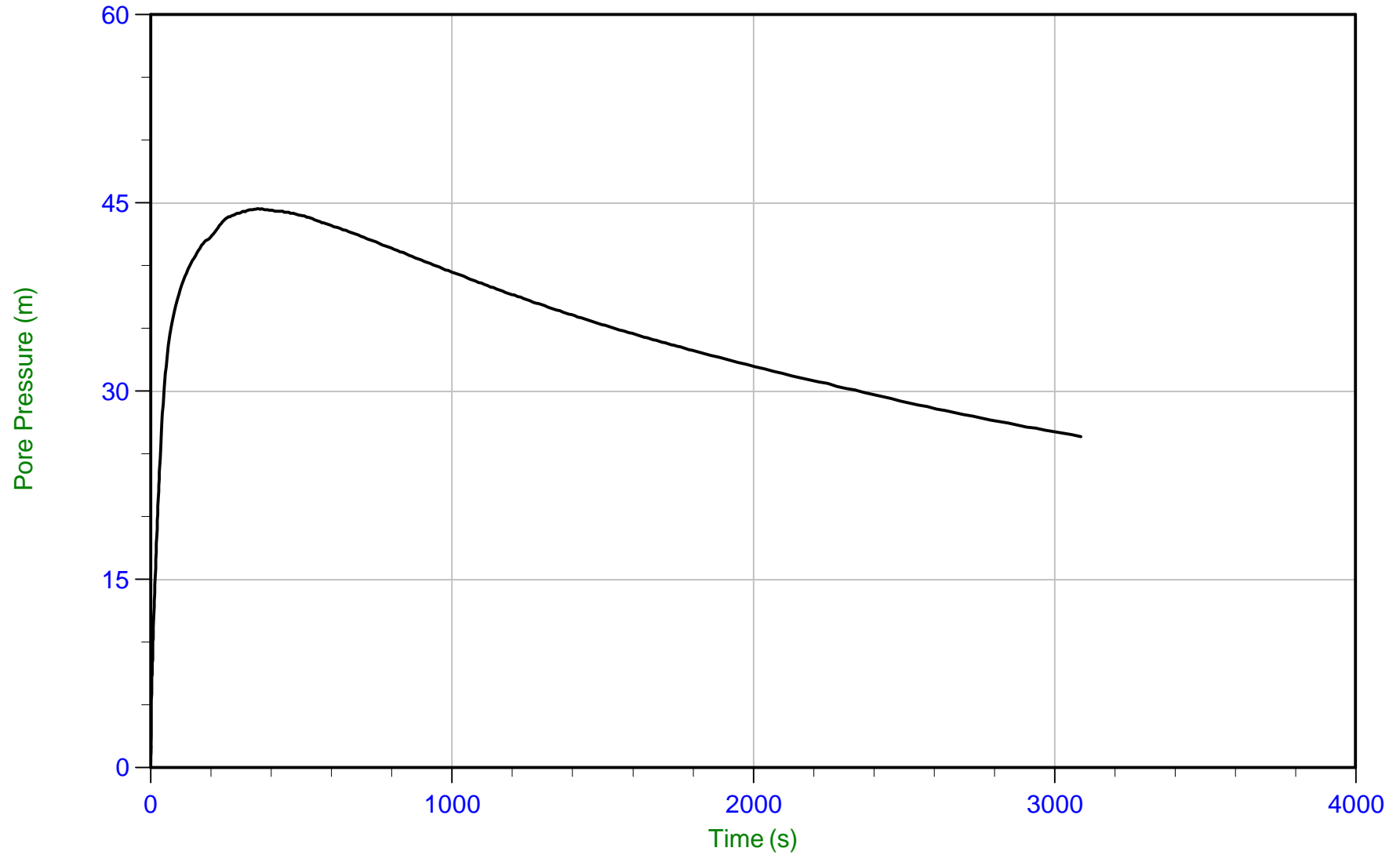
u Min: -2.2 m
u Max: 9.2 m
u Final: 9.2 m



Stantec

Job No: 24-05-27609
Date: 2024-05-10 12:15
Site: HWY 3, St.Thomas, ON

Sounding: CPT24-RMNAPP01
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_CP-RM-01.PPF2
Depth: 7.625 m / 25.016 ft
Duration: 3090.0 s

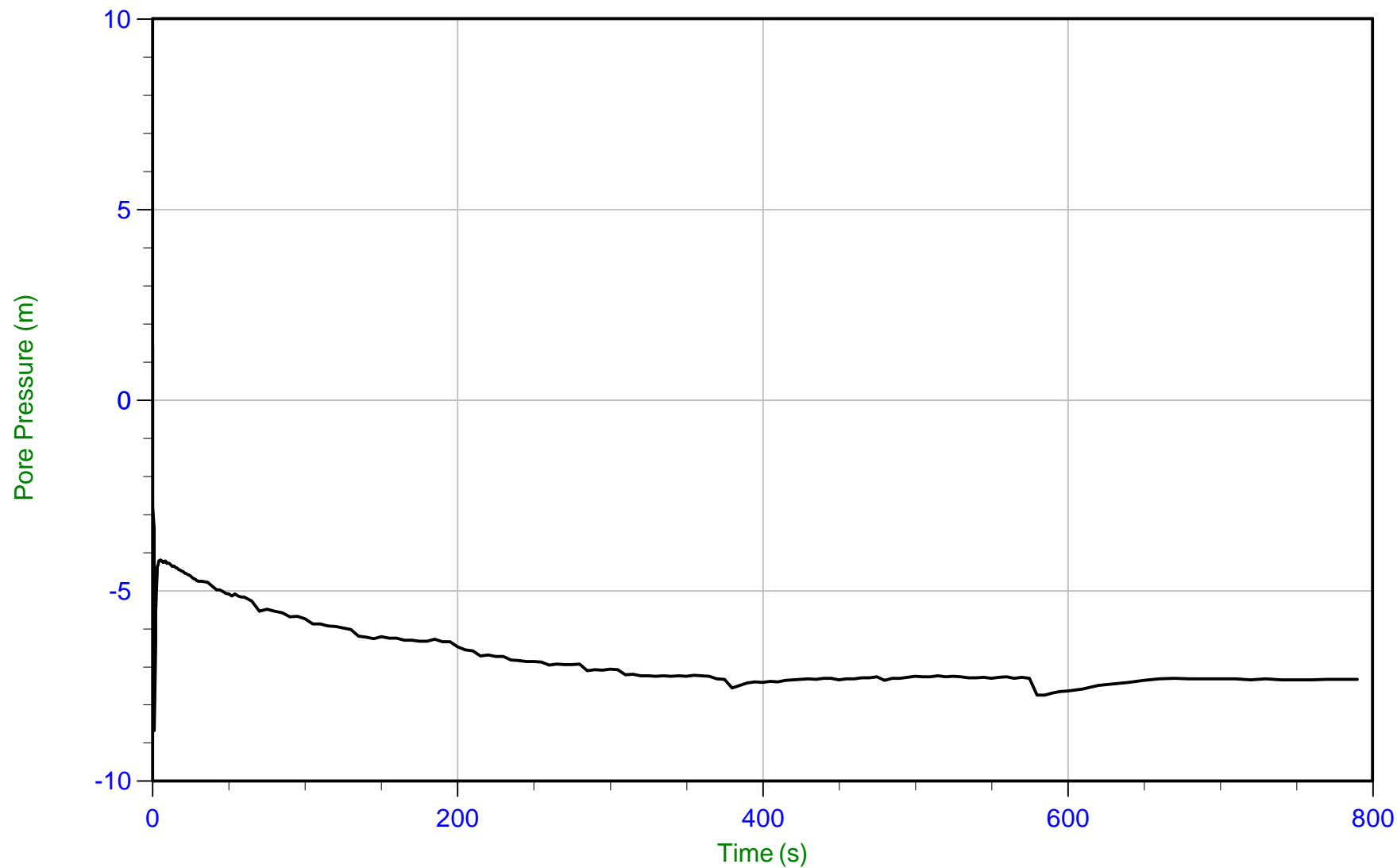
u Min: 0.4 m
u Max: 44.6 m
u Final: 26.4 m



Stantec

Job No: 24-05-27609
Date: 2024-05-10 10:24
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-RMNAPP01
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-RM-01.PPF2
Depth: 3.050 m / 10.006 ft
Duration: 790.0 s

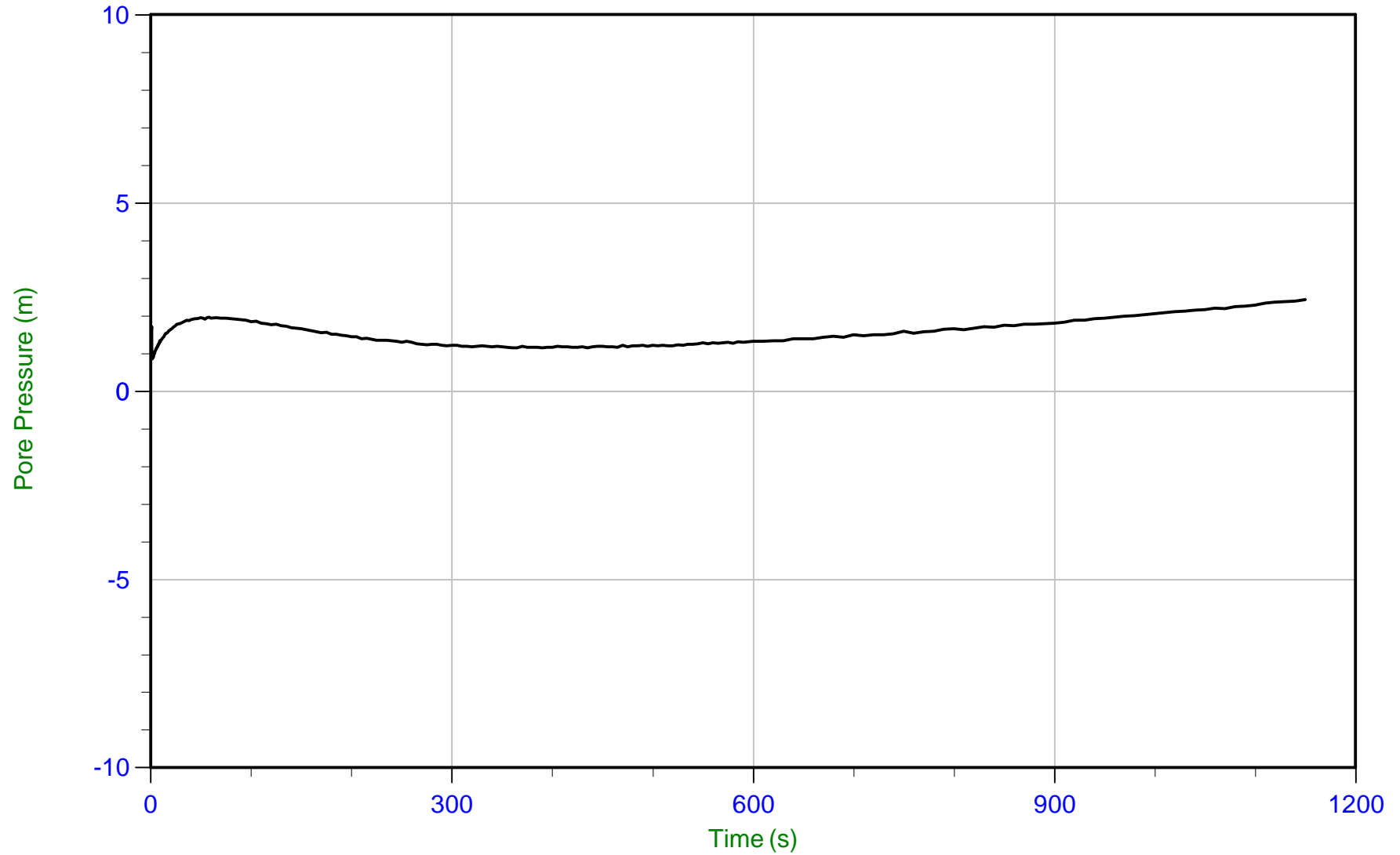
u Min: -8.7 m
u Max: 1.4 m
u Final: -7.3 m



Stantec

Job No: 24-05-27609
Date: 2024-05-10 10:24
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-RMNAPP01
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-RM-01.PPF2
Depth: 9.050 m / 29.691 ft
Duration: 1150.0 s

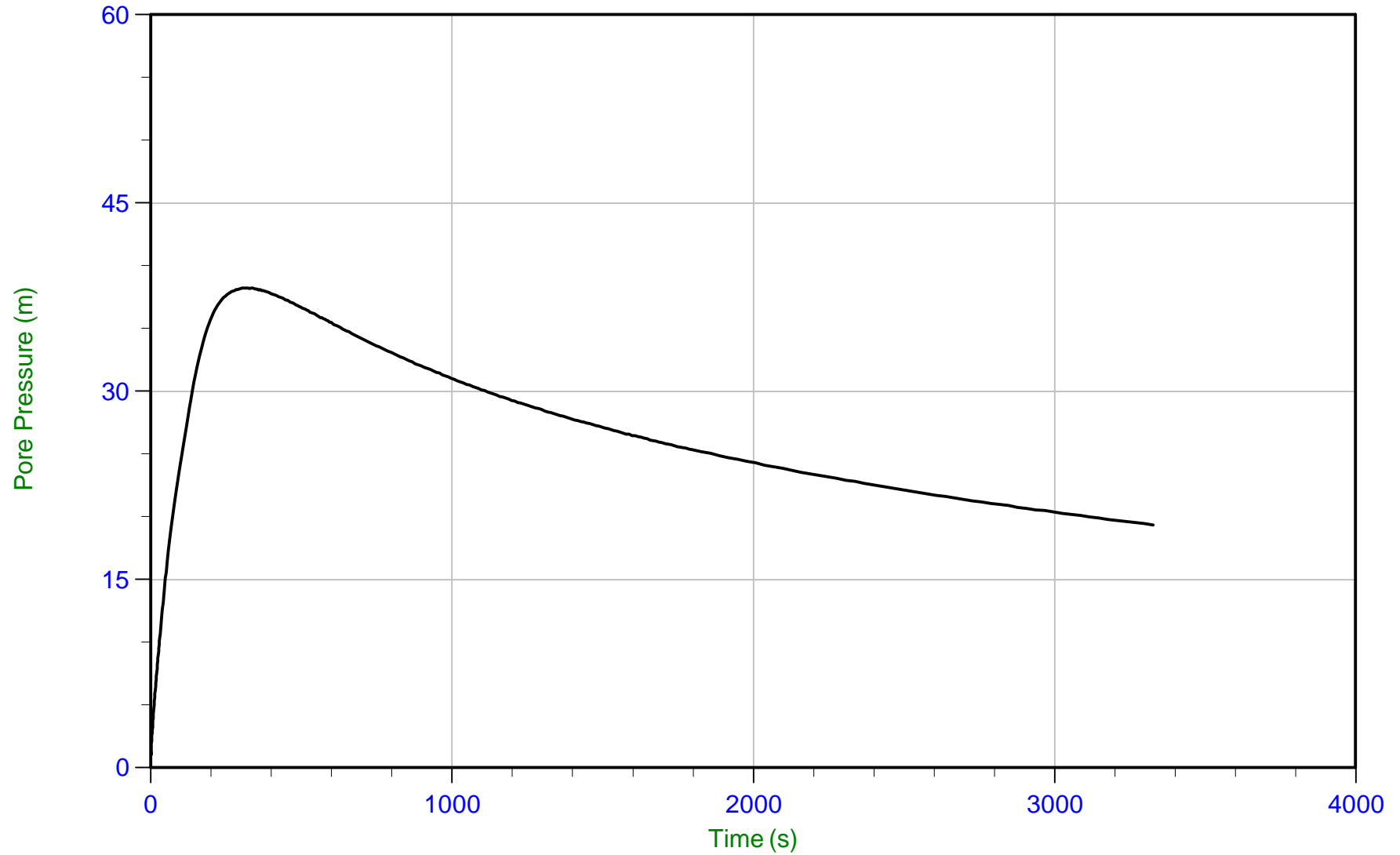
u Min: 0.9 m
u Max: 2.4 m
u Final: 2.4 m



Stantec

Job No: 24-05-27609
Date: 2024-05-09 12:06
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB02
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-CN-02.PPF2
Depth: 3.050 m / 10.006 ft
Duration: 3330.0 s

u Min: 1.0 m
u Max: 38.2 m
u Final: 19.4 m

WT: 2.0 m / 6.6 ft
Ueq: 1.1 m
U(50): 19.64 m

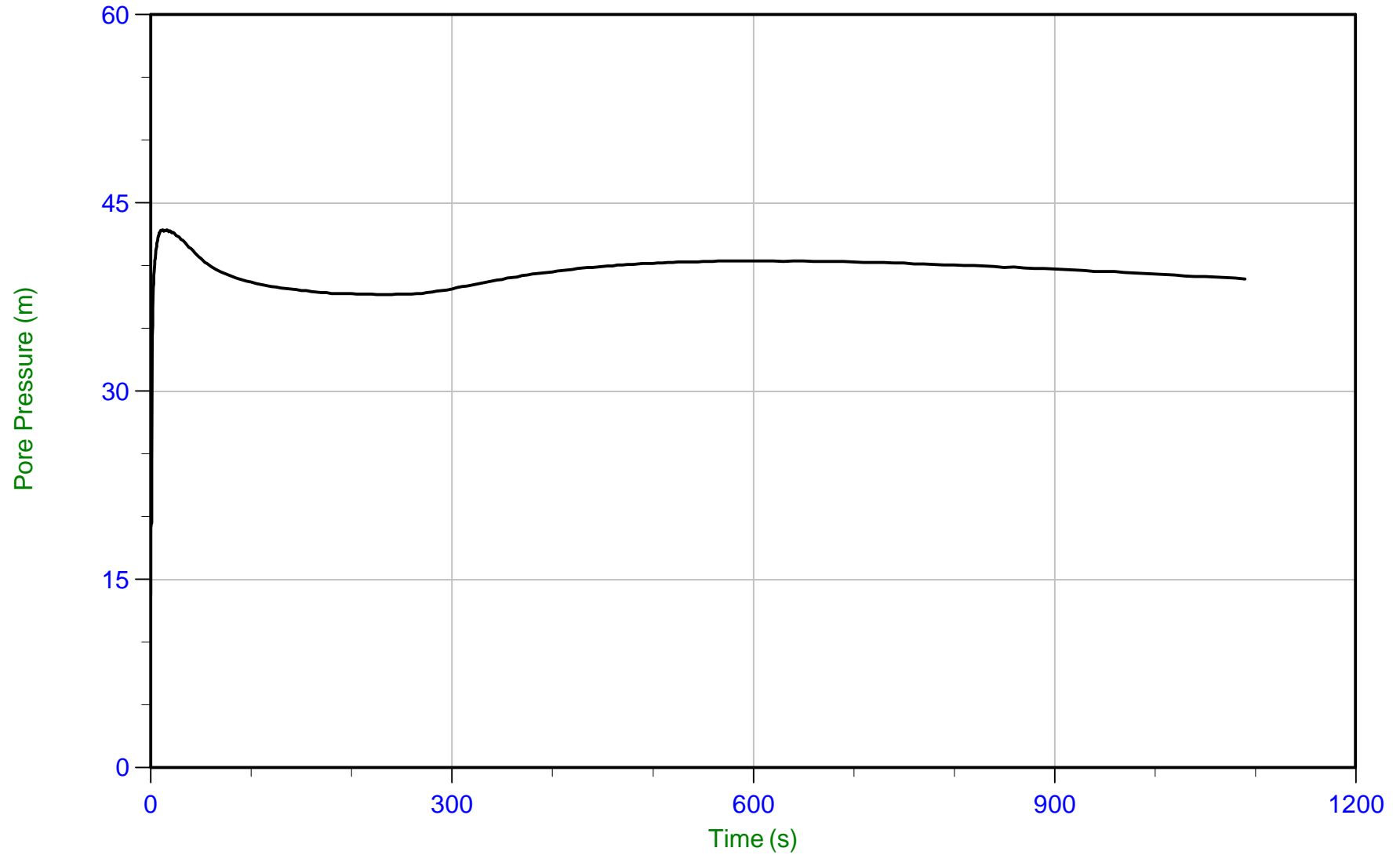
T(50): 2923.2 s
Ir: 100
Ch: 0.2 cm²/min



Stantec

Job No: 24-05-27609
Date: 2024-05-09 12:06
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB02
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-CN-02.PPF2
Depth: 7.625 m / 25.016 ft
Duration: 1090.0 s

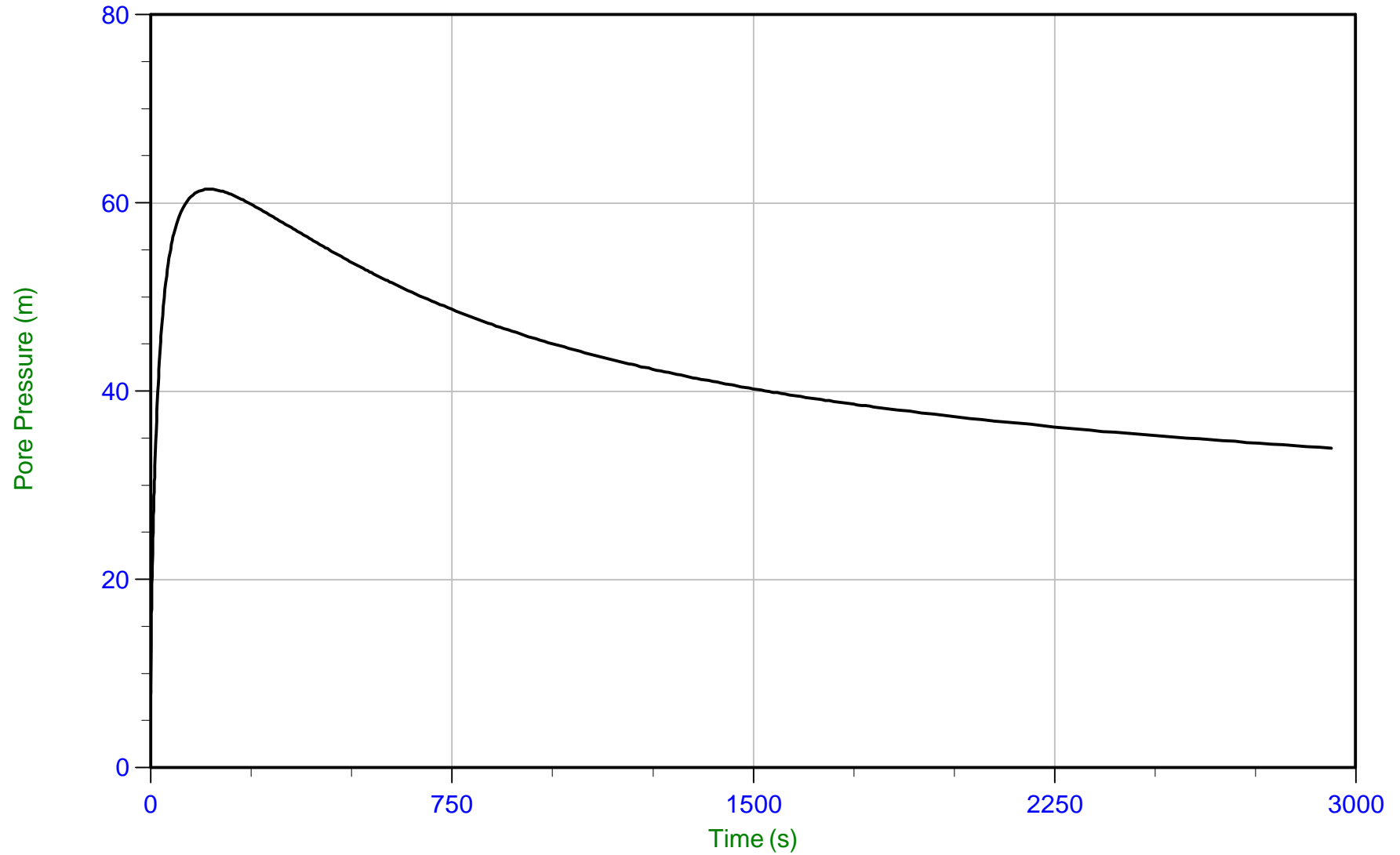
u Min: 13.8 m
u Max: 42.9 m
u Final: 38.9 m



Stantec

Job No: 24-05-27609
Date: 2024-05-09 12:06
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB02
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-CN-02.PPF2
Depth: 10.675 m / 35.023 ft
Duration: 2940.0 s

u Min: 7.9 m
u Max: 61.5 m
u Final: 34.0 m

WT: 2.0 m / 6.6 ft
Ueq: 8.7 m
U(50): 35.07 m

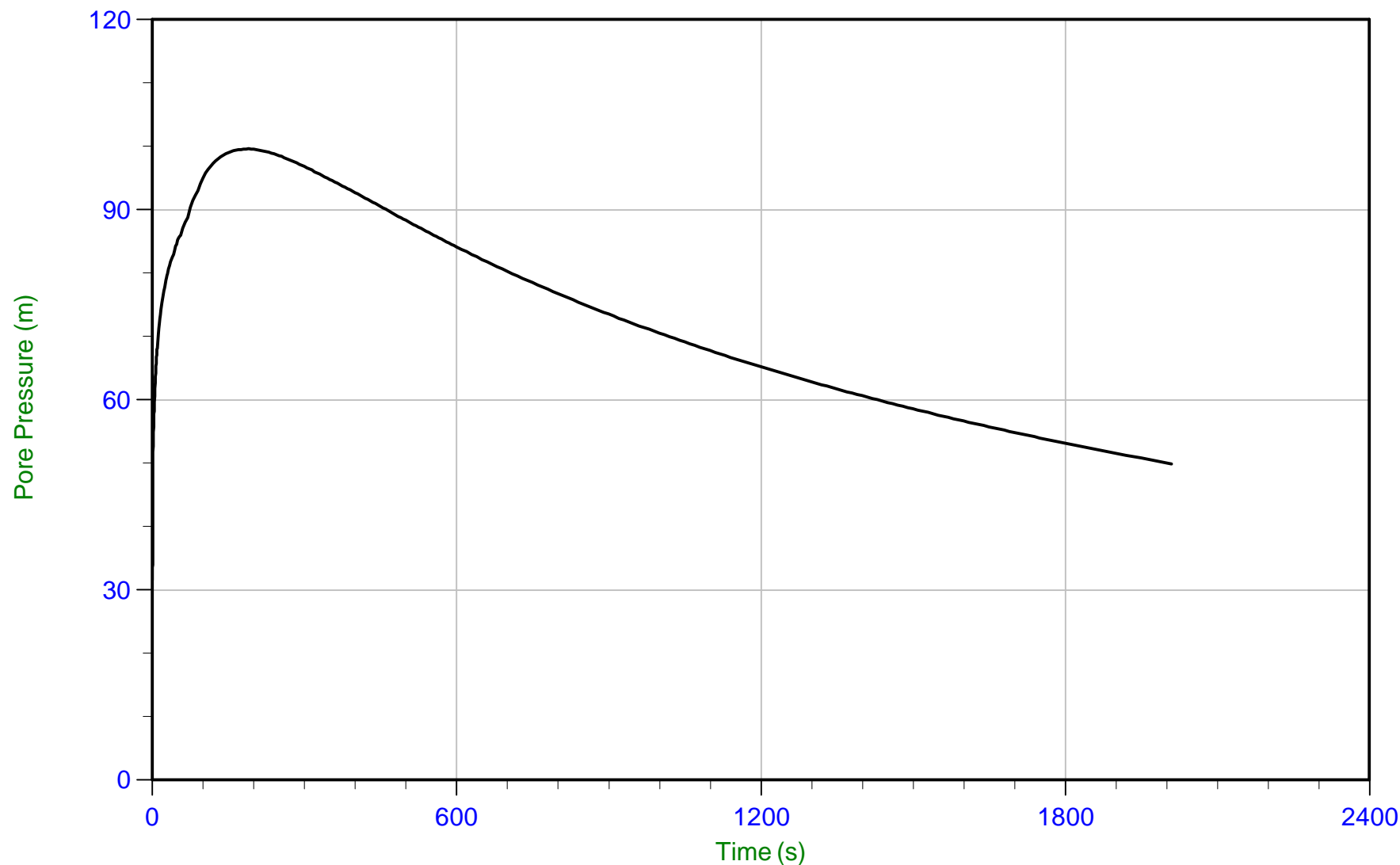
T(50): 2423.2 s
Ir: 100
Ch: 0.3 cm²/min



Stantec

Job No: 24-05-27609
Date: 2024-05-10 14:49
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-WAPP02
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-WA-02.PPF2
Depth: 3.050 m / 10.006 ft
Duration: 2010.0 s

u Min: 31.5 m
u Max: 99.6 m
u Final: 49.9 m

WT: 1.8 m / 6.0 ft
Ueq: 1.2 m
U(50): 50.41 m

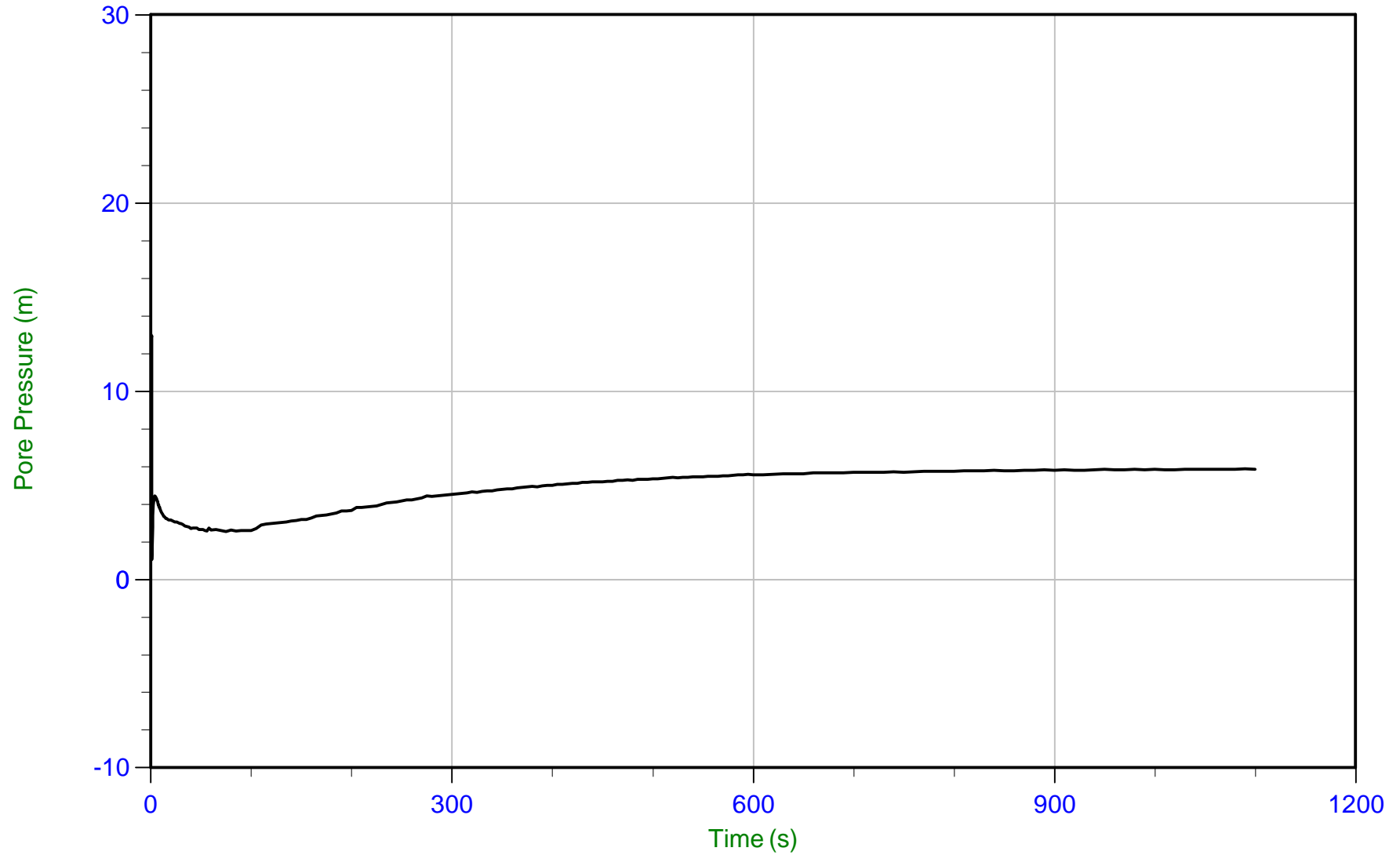
T(50): 1785.6 s
Ir: 100
Ch: 0.4 cm²/min



Stantec

Job No: 24-05-27609
Date: 2024-05-10 14:49
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-WAPP02
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-WA-02.PPF2
Depth: 7.625 m / 25.016 ft
Duration: 1100.0 s

u Min: 1.1 m
u Max: 13.1 m
u Final: 5.8 m

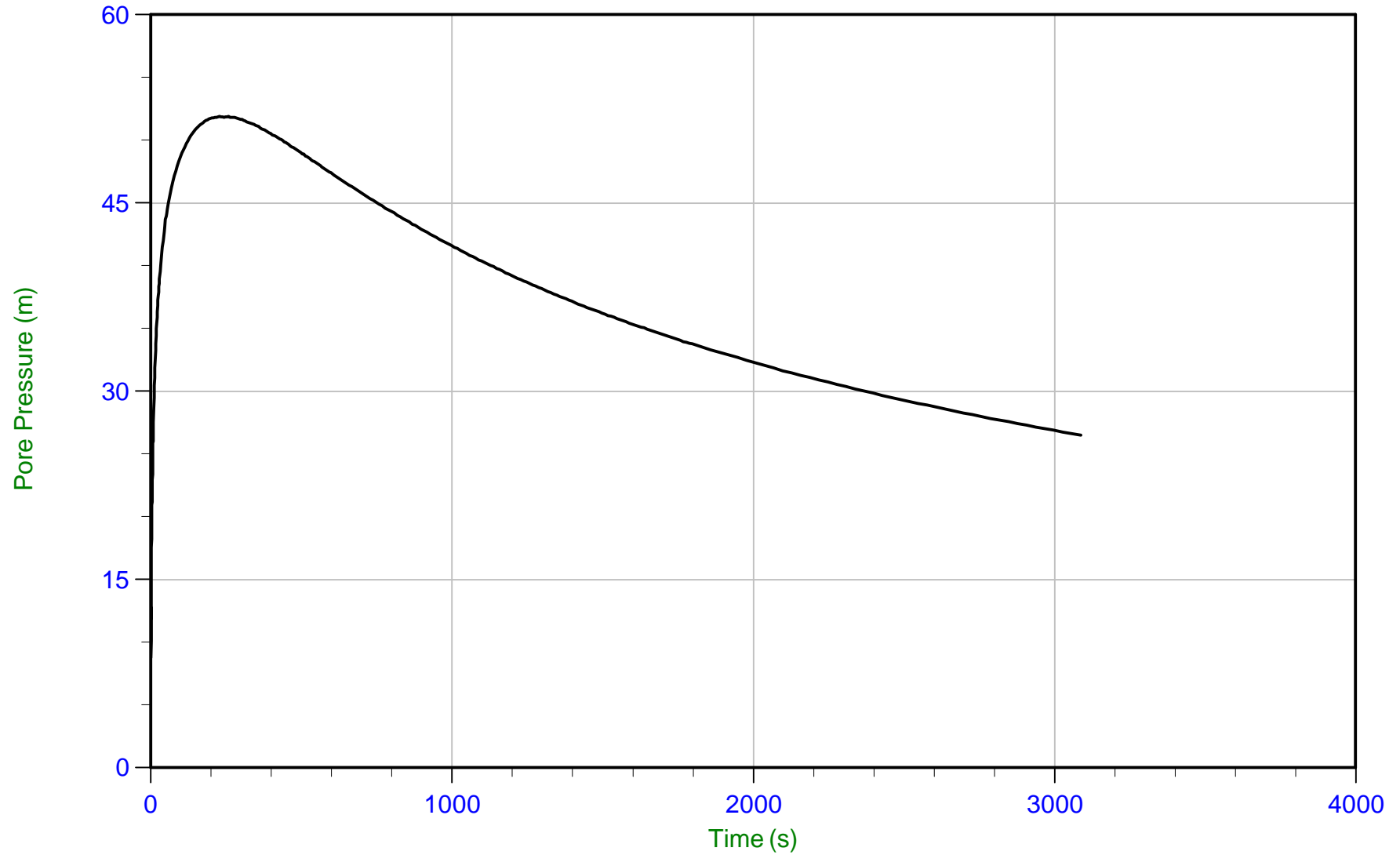
WT: 1.8 m / 6.0 ft
Ueq: 5.8 m



Stantec

Job No: 24-05-27609
Date: 2024-05-09 16:43
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB08
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-CN-08.PPF2
Depth: 3.050 m / 10.006 ft
Duration: 3090.0 s

u Min: 8.7 m
u Max: 51.9 m
u Final: 26.5 m

WT: 1.5 m / 4.9 ft
Ueq: 1.6 m
U(50): 26.72 m

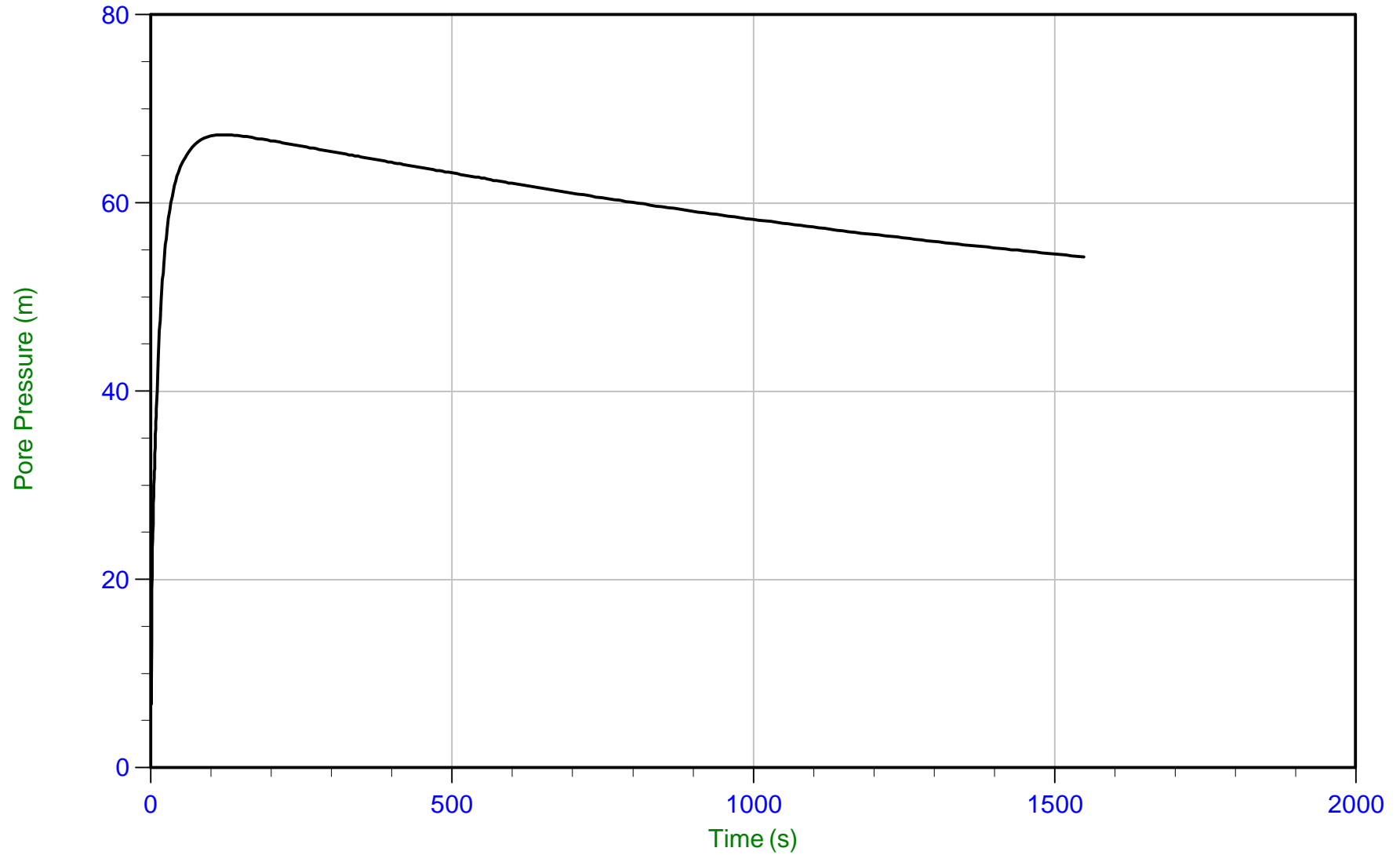
T(50): 2772.8 s
Ir: 100
Ch: 0.3 cm²/min



Stantec

Job No: 24-05-27609
Date: 2024-05-09 16:43
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB08
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-CN-08.PPF2
Depth: 7.625 m / 25.016 ft
Duration: 1550.0 s

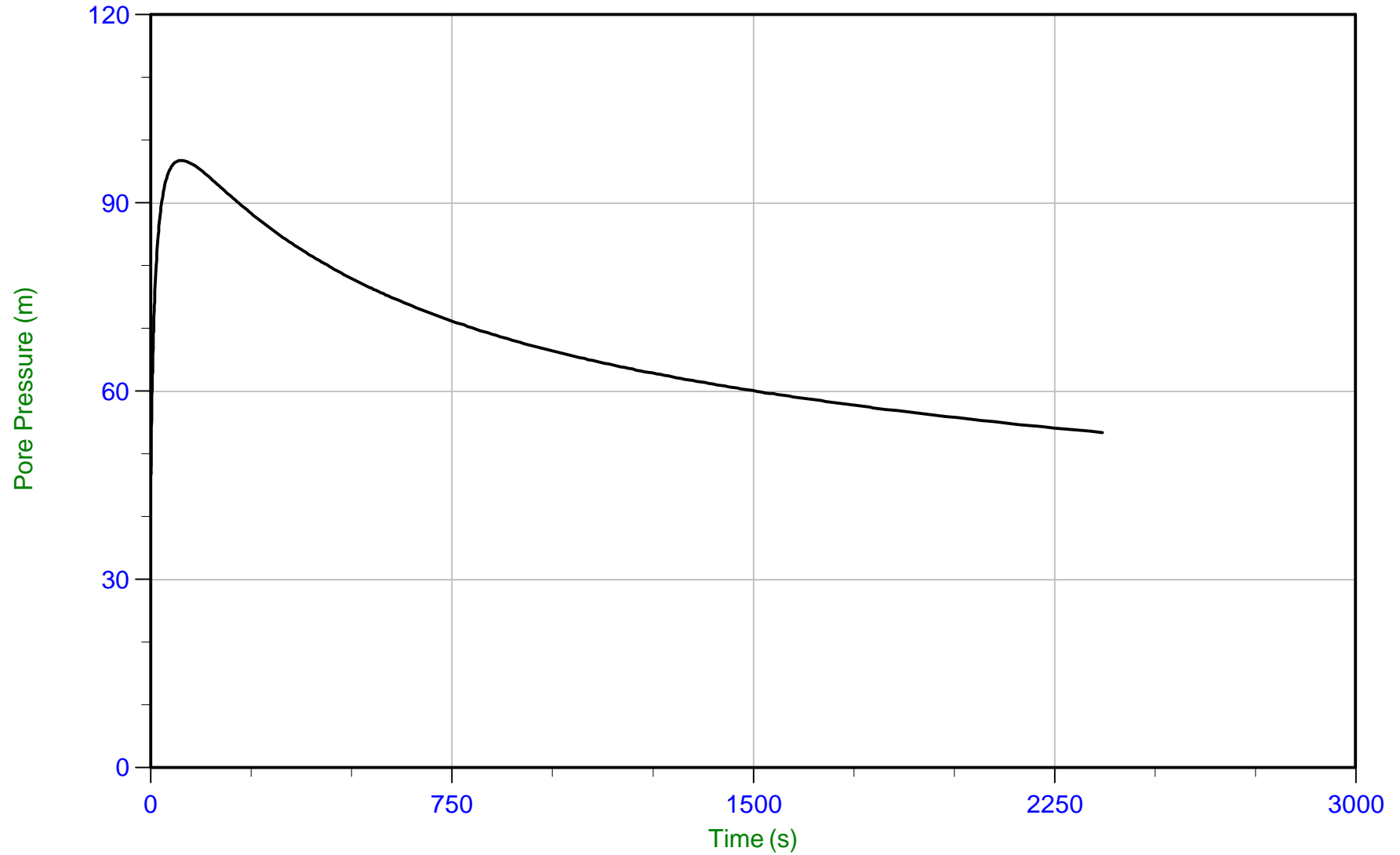
u Min: 6.7 m
u Max: 67.2 m
u Final: 54.3 m



Stantec

Job No: 24-05-27609
Date: 2024-05-09 16:43
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB08
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-CN-08.PPF2
Depth: 10.675 m / 35.023 ft
Duration: 2370.0 s

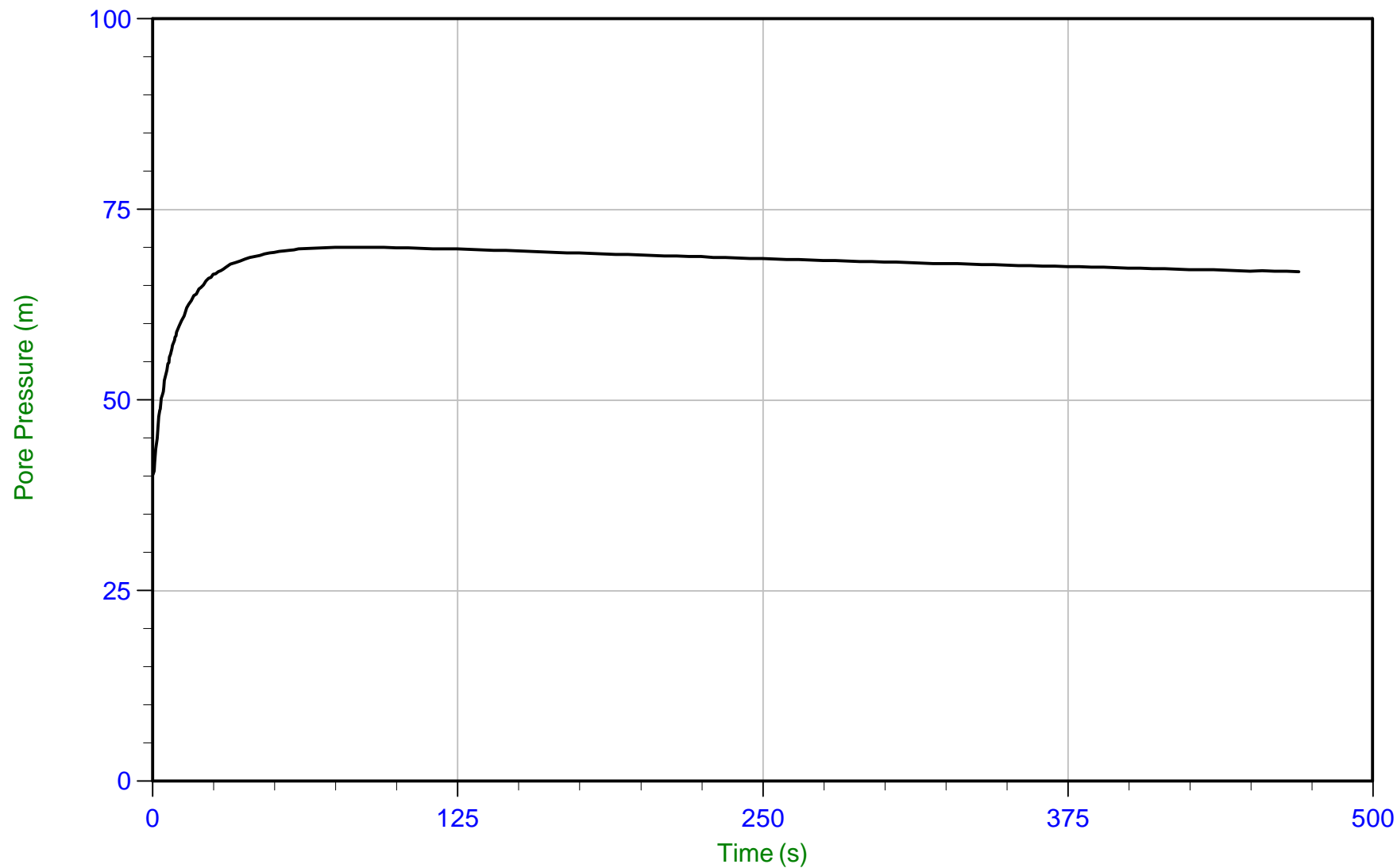
u Min: 46.6 m
u Max: 96.8 m
u Final: 53.4 m



Stantec

Job No: 24-05-27609
Date: 2024-05-09 16:43
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB08
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-CN-08.PPF2
Depth: 20.100 m / 65.944 ft
Duration: 470.0 s

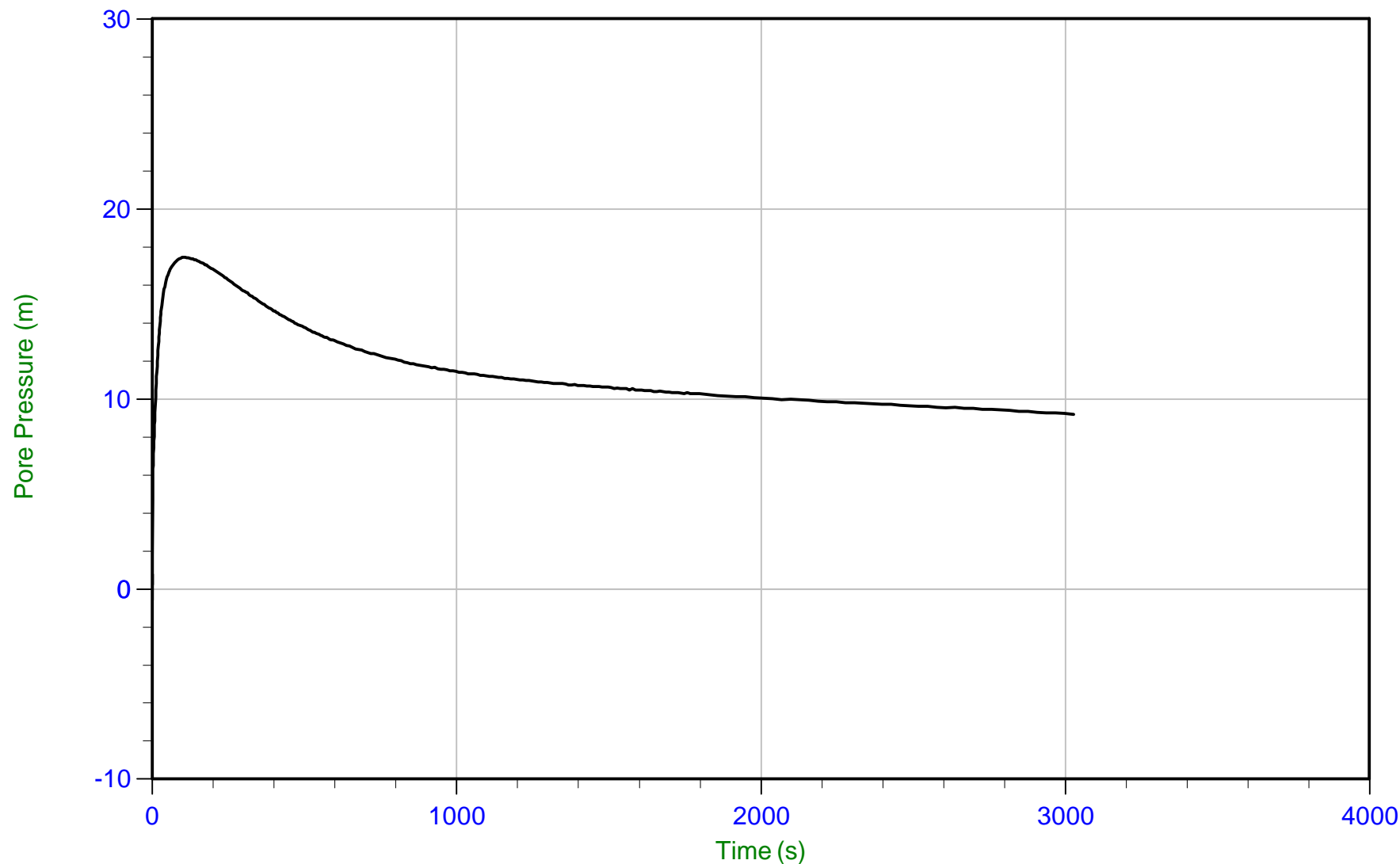
u Min: 40.1 m
u Max: 70.1 m
u Final: 66.8 m



Stantec

Job No: 24-05-27609
Date: 2024-05-10 06:58
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB10
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-CN-10.PPF2
Depth: 3.050 m / 10.006 ft
Duration: 3030.0 s

u Min: -0.6 m
u Max: 17.5 m
u Final: 9.2 m

WT: 2.0 m / 6.6 ft
Ueq: 1.1 m
U(50): 9.26 m

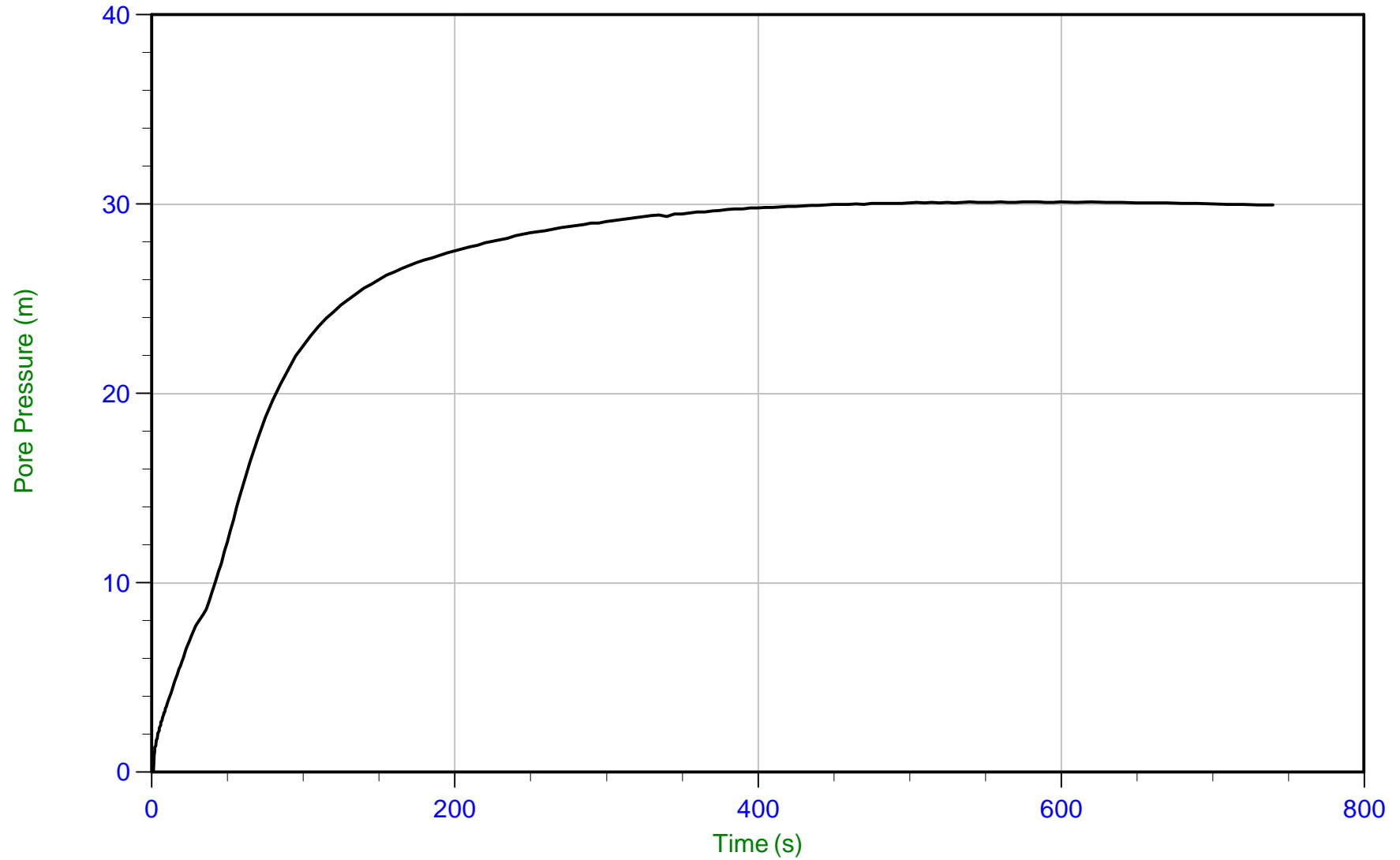
T(50): 2879.9 s
Ir: 100
Ch: 0.2 cm²/min



Stantec

Job No: 24-05-27609
Date: 2024-05-10 06:58
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB10
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-CN-10.PPF2
Depth: 7.625 m / 25.016 ft
Duration: 740.0 s

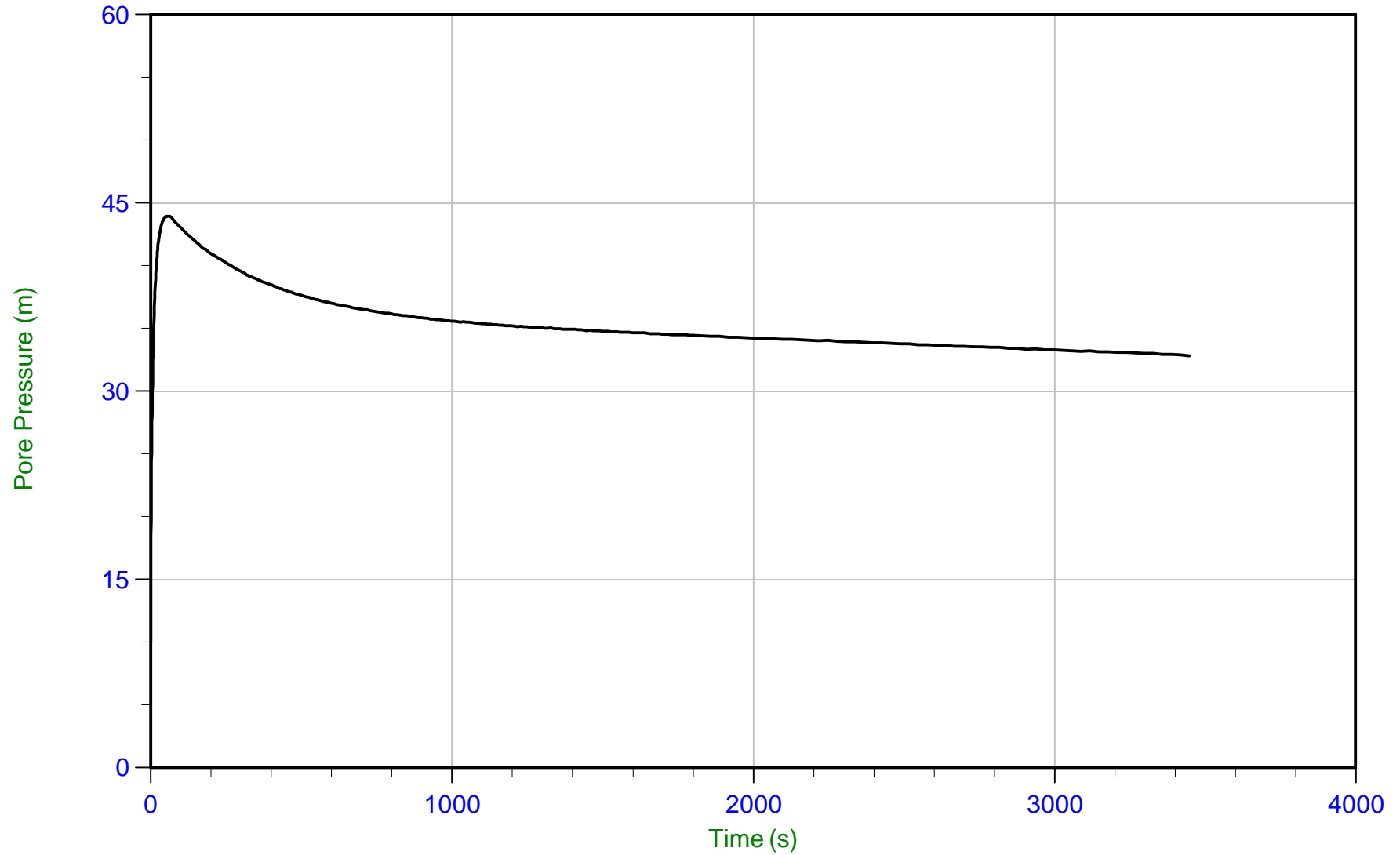
u Min: -0.6 m
u Max: 30.1 m
u Final: 30.0 m



Stantec

Job No: 24-05-27609
Date: 2024-05-10 06:58
Site: HWY 3, St.Thomas, ON

Sounding: SCPT24-CNREMB10
Cone: 729:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 24-05-27609_SP-CN-10.PPF2
Depth: 10.675 m / 35.023 ft
Duration: 3450.0 s

u Min: 10.0 m
u Max: 44.0 m
u Final: 32.8 m

Description of Methods for Calculated CPT Geotechnical Parameters

CALCULATED CPT GEOTECHNICAL PARAMETERS

A Detailed Description of the Methods Used in ConeTec's CPT Geotechnical Parameter Calculation and Plotting Software



Revision SZW-Rev 18

Revised February 10, 2023

Prepared by Jim Greig, M.A.Sc, P.Eng (BC, AB, ON)



Limitations

The geotechnical parameter output was prepared specifically for the site and project named in the accompanying report subject to objectives, site conditions and criteria provided to ConeTec by the client. The output may not be relied upon by any other party or for any other site without the express written permission of ConeTec Group (ConeTec) or any of its affiliates. For this project, ConeTec has provided site investigation services, prepared factual data reporting and produced geotechnical parameter calculations consistent with current best practices. No other warranty, expressed or implied, is made.

To understand the calculations that have been performed and to be able to reproduce the calculated parameters the user is directed to the basic descriptions for the methods in this document and the detailed descriptions and their associated limitations and appropriateness in the technical references cited for each parameter.

ConeTec's Calculated CPT Geotechnical Parameters as of February 10, 2023.

ConeTec's CPT parameter calculation and plotting routine provides a tabular output of geotechnical parameters based on current published CPT correlations and is subject to change to reflect the current state of practice. Due to drainage conditions and the basic assumptions and limitations of the correlations, not all geotechnical parameters provided are considered applicable for all soil types. The results are presented only as a guide for geotechnical use and should be carefully examined for consideration in any geotechnical design. Reference to current literature is strongly recommended. ConeTec does not warranty the correctness or the applicability of any of the geotechnical parameters calculated by the program and does not assume liability for any use of the results in any design or review. For verification purposes we recommend that representative hand calculations be done for any parameter that is critical for design purposes. The end user of the parameter output should also be fully aware of the techniques and the limitations of any method used by the program. The purpose of this document is to inform the user as to which methods were used and to direct the end user to the appropriate technical papers and/or publications for further reference.

The geotechnical parameter output was prepared specifically for the site and project named in the accompanying report subject to objectives, site conditions and criteria provided to ConeTec by the client. The output may not be relied upon by any other party or for any other site without the express written permission of ConeTec Group (ConeTec) or any of its affiliates.

The CPT calculations are based on values of tip resistance, sleeve friction and pore pressures considered at each data point or averaged over a user specified layer thickness (e.g., 0.20 m). Note that q_t is the tip resistance corrected for pore pressure effects and q_c is the recorded tip resistance. The corrected tip resistance (corrected using u_2 pore pressure values) is used for all calculations. Since all ConeTec cones have equal end area friction sleeves pore pressure corrections to sleeve friction, f_s , are not performed.

Corrected tip resistance: $q_t = q_c + (1-a) \cdot u_2$ (consistent units are required)

where: q_t is the corrected tip resistance

q_c is the recorded tip resistance

u_2 is the recorded dynamic pore pressure from behind the tip (u_2 position)

a is the Net Area Ratio for the cone (typically 0.80 for ConeTec cones)

The total stress calculations are based on soil unit weight values that have been assigned to the Soil Behavior Type (SBT) zones, from a user defined unit weight profile, by using a single uniform value throughout the profile, through unit weight estimation techniques described in various technical papers or from a combination of these methods. The parameter output files indicate the method(s) used.

Effective vertical overburden stresses are calculated using the total stress and equilibrium pore pressure (u_{eq} or u_o) values derived from an assumed hydrostatic distribution of pore pressures below the water table or from a user defined equilibrium pore pressure profile (typically obtained from CPT dissipation tests) or a combination of the two. For over water projects the stress effects of the column of water above the mudline are taken into account as is the appropriate unit weight of water. How this is done depends on where the instruments are zeroed (i.e. on deck or at the mudline). The parameter output files indicate the method(s) used.

A majority of parameter calculations are derived from or driven by results based on material types as determined by the various soil behavior type charts depicted in Figures 1 through 6. The parameter output files indicate the method(s) used.

The Soil Behavior Type classification chart shown in Figure 1 is the classic non-normalized SBT Chart developed at the University of British Columbia and reported in Robertson, Campanella, Gillespie and Greig (1986). Figure 2 shows the original normalized (linear method) SBTn chart developed by Robertson (1990). The Bq classification charts



shown in Figures 3a and 3b incorporate pore pressures into the SBT classification and are based on the methods described in Robertson (1990). Many of these charts have been summarized in Lunne, Robertson and Powell (1997). The Jefferies and Davies SBT chart shown in Figure 3c is based on the techniques discussed in Jefferies and Davies (1993) which introduced the concept of the Soil Behavior Type Index parameter, I_c . Take note that the I_c parameter developed by Robertson and Fear (1995) and Robertson and Wride (1998) is similar in concept but uses a slightly different calculation method than that defined by Jefferies and Davies (1993) as the latter incorporates pore pressure in their technique through the use of the B_q parameter. The normalized Q_{tn} SBT chart shown in Figure 4 is based on the work by Robertson (2009) utilizing a variable stress ratio exponent, n , for normalization based on a slightly modified redefinition and iterative approach for I_c . The boundary curves drawn on the chart are based on the work described in Robertson (2010).

Figure 5 shows a revised 1986 SBT Chart presented to CPT'10 by Robertson (2010b). It is known as the Updated non-normalized Soil Behavior Chart (also referred to as the Rev SBT Chart (PKR2010) in our output files). This chart was produced to be more in line with all post-1986 Robertson charts having the same 9 soil type zones, a \log_{10} axis for friction ratio, R_f in this case, and a unitless tip resistance axis.

Figure 6 shows a revised behavior based chart by Robertson (2016) depicting contractive-dilative zones. As the zones represent material behavior rather than soil gradation ConeTec has chosen a set of zone colors that are less likely to be confused with material type colors from previous SBT charts. These colors differ from those used by Dr. Robertson. A green palette was selected for the dilative (desirable) side of the chart and a red palette for the contractive side of the chart.

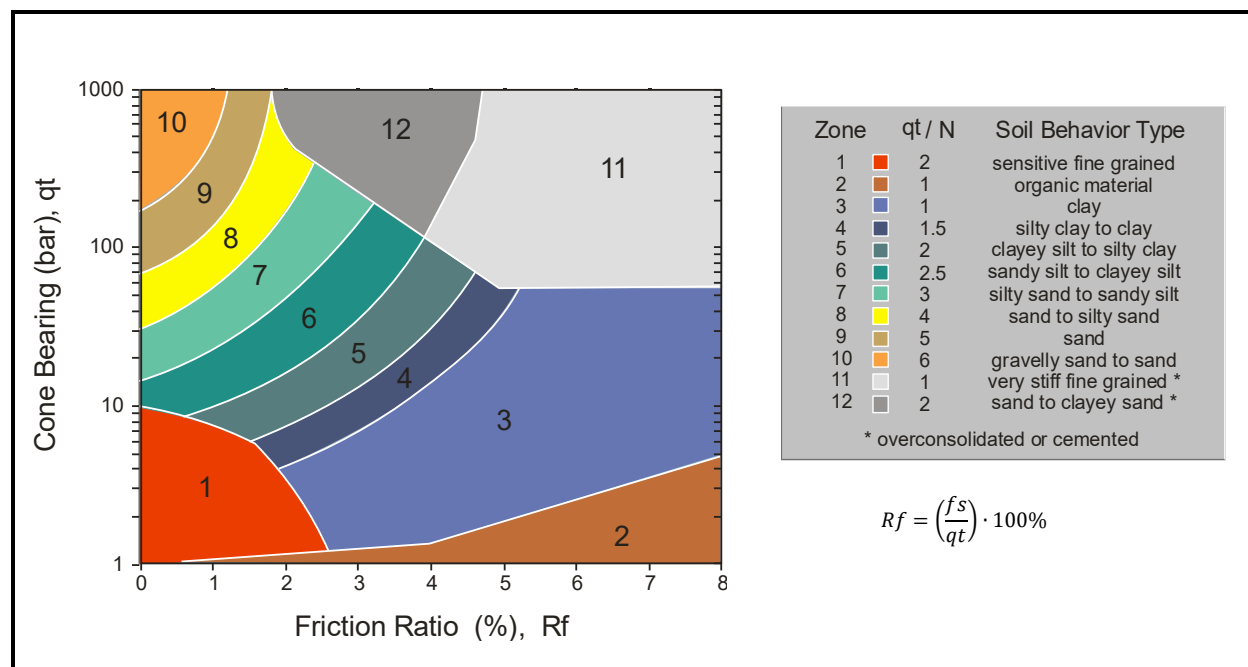


Figure 1. Non-normalized Soil Behavior Type Classification Chart (SBT)

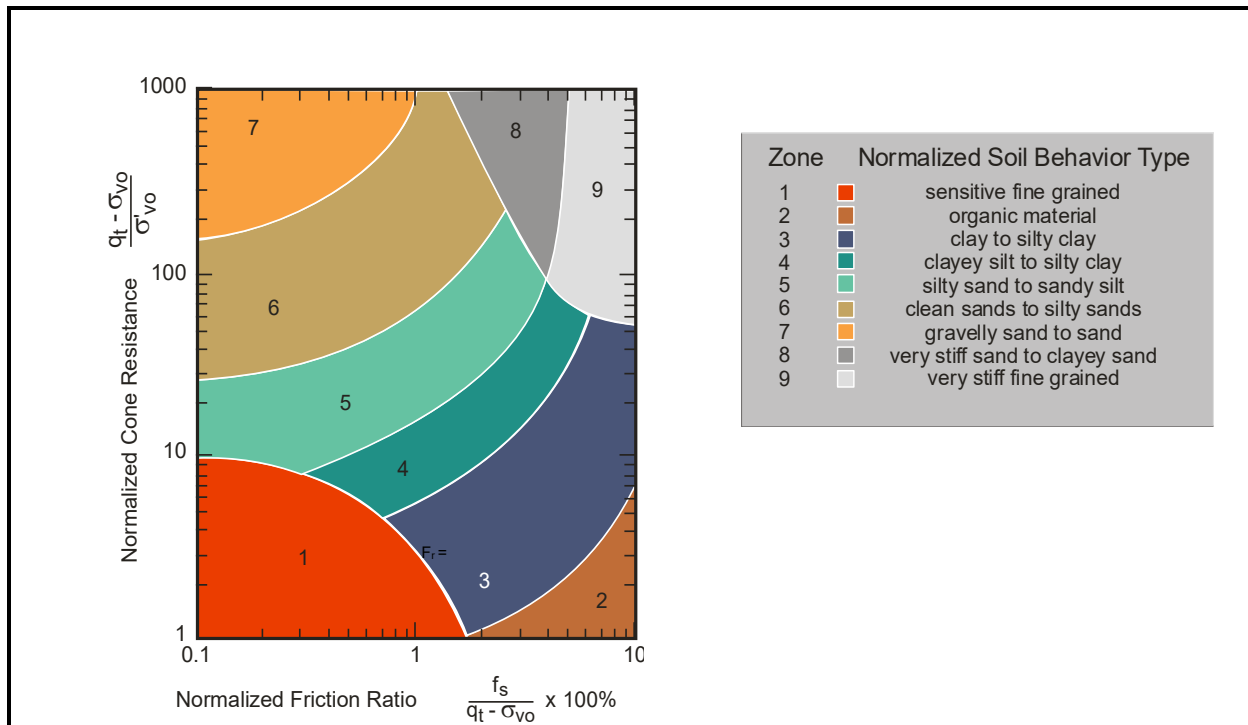
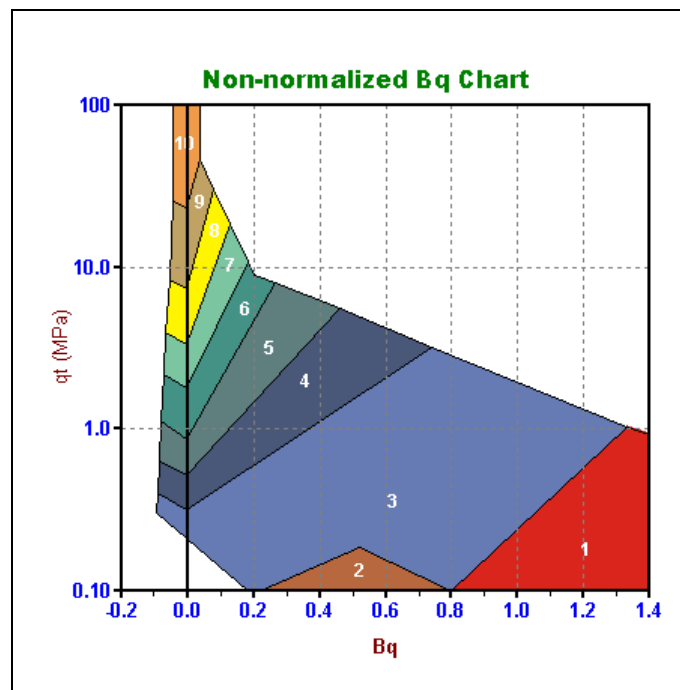
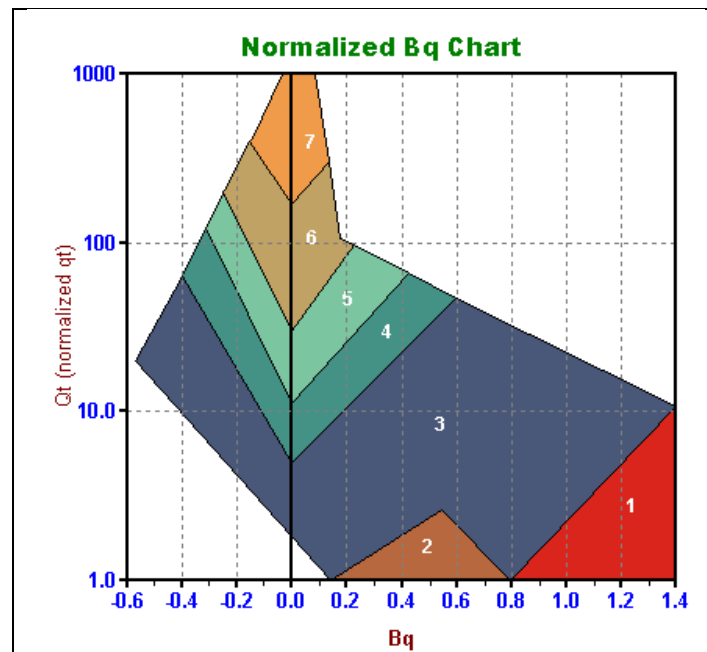
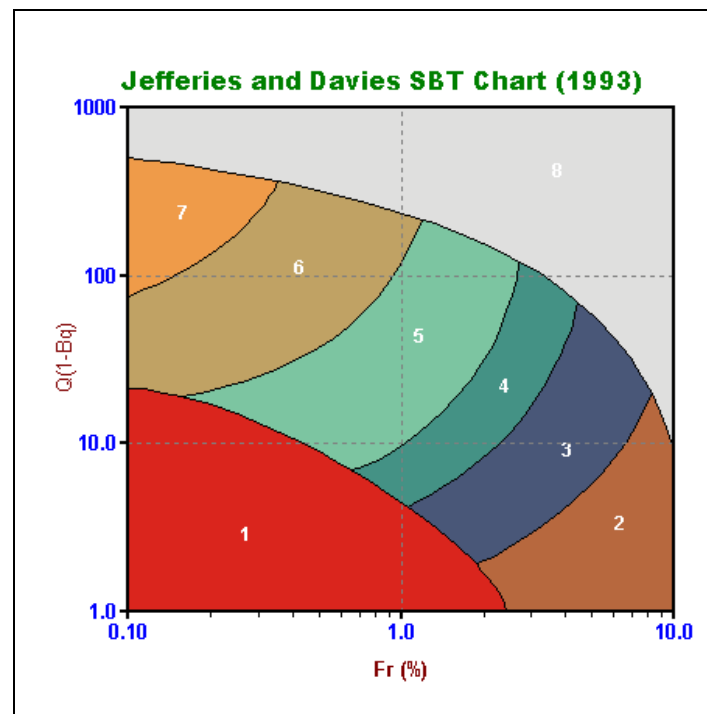


Figure 2. Normalized Soil Behavior Type Classification Chart (SBTn)

Figure 3a. Alternate Soil Behavior Type Chart (SBT Bq): $q_t - B_q$

Figure 3b. Alternate Soil Behavior Type Charts (SBT Bqn): Q_t - B_q Figure 3c. Alternate Soil Behavior Type Charts: $Q(1-B_q)$ - F_r

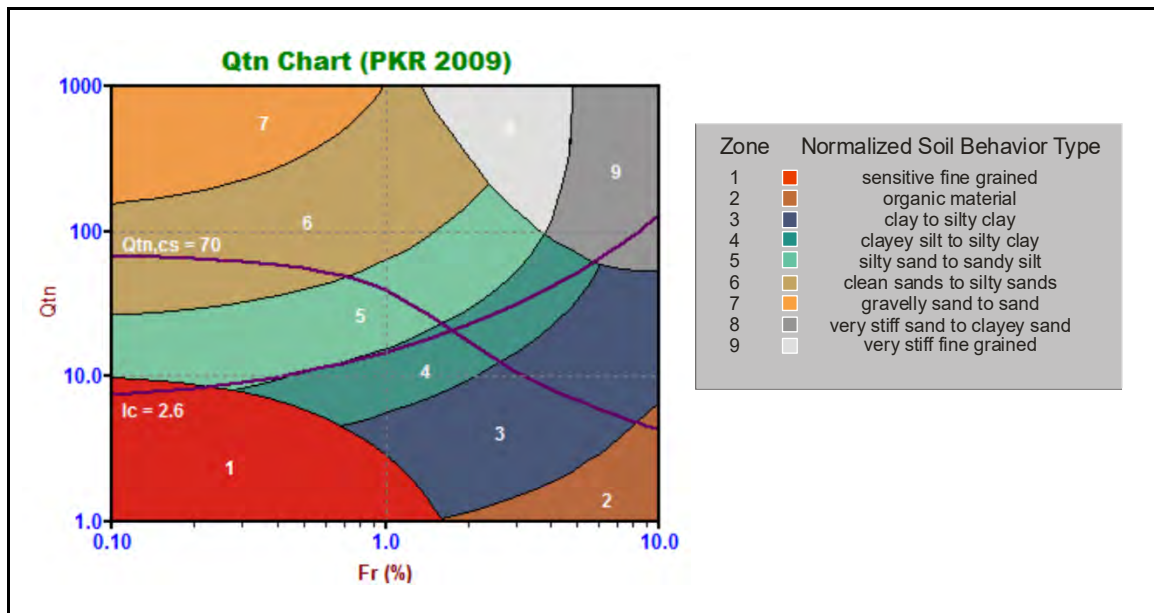
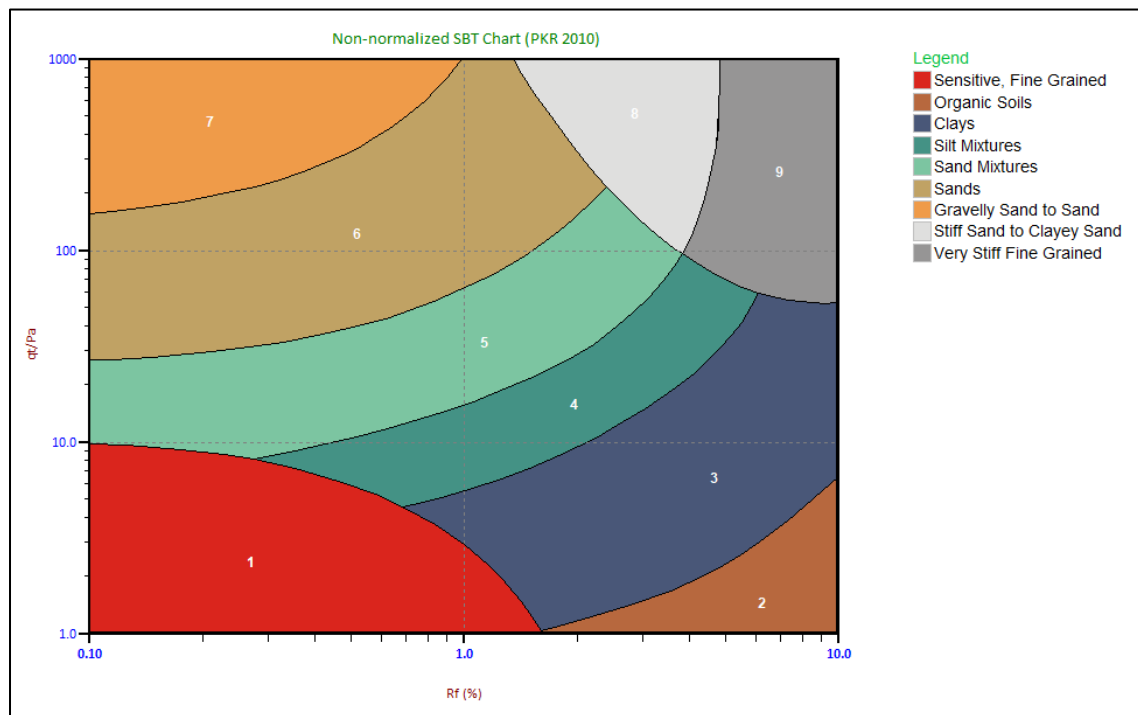
Figure 4. Normalized Soil Behavior Type Chart using Q_{tn} (SBT Q_{tn})

Figure 5. Non-normalized Soil Behavior Type Chart (2010)

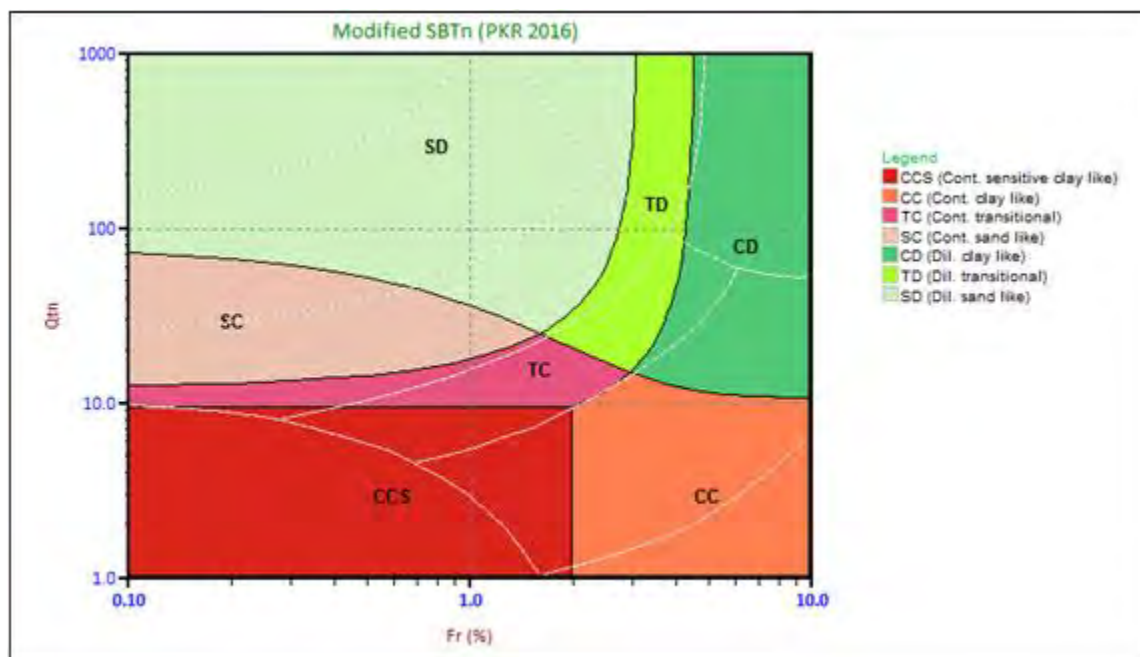


Figure 6. Modified SBTn Behavior Based Chart

Details regarding the geotechnical parameter calculations are provided in Tables 1a and 1b. The appropriate references cited are listed in Table 2. Non-liquefaction specific parameters are detailed in Table 1a and liquefaction specific parameters are detailed in Table 1b.

Where methods are based on charts or techniques that are too complex to describe in this summary, we recommend that the user refer to the cited material. Specific limitations for each method are described in the cited material.

Where the results of a calculation/correlation are deemed 'invalid' the value will be represented by the text strings "-9999", "-9999.0", the value 0.0 (Zero) or an empty cell. Invalid results will occur because of (and not limited to) one or a combination of:

1. Invalid or undefined CPT data (e.g., drilled out section or data gap).
2. Where the calculation method is inappropriate, for example, drained parameters in a material behaving in an undrained manner (and vice versa).
3. Where input values are beyond the range of the referenced charts or specified limitations of the correlation method.
4. Where pre-requisite or intermediate parameter calculations are invalid.

The parameters selected for output from the program are often specific to a particular project. As such, not all of the calculated parameters listed in Tables 1a and 1b may be included in the output files delivered with this report.

The output files are typically provided in Microsoft Excel XLS, XLSX or CSV format. The ConeTec software has several options for output depending on the number or types of calculated parameters desired or those specifically contracted for by the client. Each output file is named using the original file base name (from the .COR file) followed

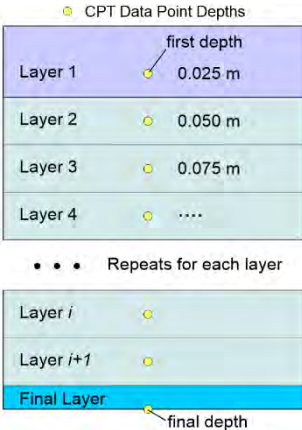
by a three or four character indicator of the output set selected (e.g. BSC, TBL, NLI, NL2, IFI, IFI2, IFI3) and possibly followed by an operator selected suffix identifying the characteristics of the particular calculation run.

Table 1a. CPT Parameter Calculation Methods – Non liquefaction Parameters

Reference Notes: CK* - Common Knowledge, U* - Unpublished

Calculated Parameter	Description	Equation	Ref
Depth	Mid Layer Depth <i>(where calculations are done at each point then Mid Layer Depth = Recorded Depth)</i>	$[Depth (Layer Top) + Depth (Layer Bottom)] / 2.0$	CK*
Elevation	Elevation of Mid Layer is based on the sounding collar elevation supplied by the client or through a site survey In Sweden a variation of elevation is used where the elevation increases with depth. We refer to this as inverse elevation.	Elevation = Collar Elevation – Depth InverseElevation = Collar Elevation + Depth	CK* N/A
Avg qc	Averaged recorded tip value (q_c)	$Avgqc = \frac{1}{n} \sum_{i=1}^n q_c$ <i>n=1 when calculations are done at each point</i>	CK*
Avg qt	Averaged corrected tip (q_t) where: $q_t = q_c + (1 - \alpha) \cdot u_2$ Averaged q_t is not calculated using the average q_c and averaged u values. Averaged q_t is based on the average of the q_t values calculated at each data point.	$Avgqt = \frac{1}{n} \sum_{i=1}^n q_t$ <i>n=1 when calculations are done at each point</i>	1
Avg fs	Averaged sleeve friction (f_s) No pore pressure corrections are applied to f_s .	$Avgfs = \frac{1}{n} \sum_{i=1}^n f_s$ <i>n=1 when calculations are done at each point</i>	CK*
Avg Rf	Averaged friction ratio (R_f) where friction ratio is defined as: $R_f = 100\% \cdot \frac{f_s}{q_t}$	$AvgRf = 100\% \cdot \frac{Avgfs}{Avgqt}$ <i>not an average of individual R_f values</i>	CK*
Avg u	Averaged dynamic pore pressure (u)	$Avgu = \frac{1}{n} \sum_{i=1}^n u_i$ <i>n=1 when calculations are done at each point</i>	CK*
Avg Res	Averaged Resistivity (this data is not always available since it is a specialized test requiring an additional module)	$AvgRes = \frac{1}{n} \sum_{i=1}^n Resistivity_i$ <i>n=1 when calculations are done at each point</i>	CK*
Avg UVIF	Averaged UVIF ultra-violet induced fluorescence (this data is not always available since it is a specialized test requiring an additional module)	$AvgUVIF = \frac{1}{n} \sum_{i=1}^n UVIF_i$ <i>n=1 when calculations are done at each point</i>	CK*
Avg Temp	Averaged Temperature (this data is not always available)	$AvgTemp = \frac{1}{n} \sum_{i=1}^n Temperature_i$ <i>n=1 when calculations are done at each point</i>	CK*
Avg Gamma	Averaged Gamma Counts (this data is not always available since it is a specialized test requiring an additional module)	$AvgGamma = \frac{1}{n} \sum_{i=1}^n Gamma_i$ <i>n=1 when calculations are done at each point</i>	CK*
SBT	Soil Behavior Type as defined by Robertson et al 1986 (often referred to as Robertson and Campanella, 1986)	See Figure 1	1, 5
SBTn	Normalized Soil Behavior Type as defined by Robertson 1990 (linear normalization using Q_t , now referred to as Q_{t1})	See Figure 2	2, 5

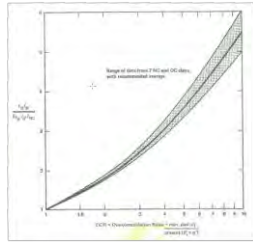
Calculated Parameter	Description	Equation	Ref
SBT-B _q	Non-normalized Soil Behavior type based on non-normalized tip resistance and the B _q parameter	See Figure 3a	1, 2, 5
SBT-B _{qn}	Normalized Soil Behavior type based on normalized tip resistance (Q _t , now called Q _{t1}) and the B _q parameter	See Figure 3b	2, 5
SBT-JandD	Soil Behavior Type as defined by Jeffries and Davies	See Figure 3c	7
SBT Q _{tn}	Soil Behavior Type as defined by Robertson (2009) using a variable stress ratio exponent for normalization based on I _c (PKR 2009)	See Figure 4	15
Modified Non-normalized SBT Chart SBT (PKR2010)	This is a revised version of the simple 1986 non-normalized SBT chart (presented at CPT '10). The revised version has been reduced from 12 zones to 9 zones to be similar to the normalized Robertson charts. Other updates include a dimensionless tip resistance normalized to atmospheric pressure, q _t /P _a , on the vertical axis and a log scale for non-normalized friction ratio, R _f , along the horizontal axis.	See Figure 5	33
Modified SBTn (contractive /dilative)	Modified SBTn chart as defined by Robertson (2016) indicating zones of contractive/dilative behavior. Note that ConeTec displays the chart with colors different from Robertson. ConeTec's colors were chosen to avoid confusion with soil type descriptions.	See Figure 6	30
Unit Wt.	<p>Unit Weight of soil determined from one of the following user selectable options:</p> <ol style="list-style-type: none"> 1) uniform value 2) value assigned to each SBT zone 3) value assigned to each SBTn zone 4) value assigned to SBTn zone as determined from Robertson and Wride (1998) based on q_{c1n} 5) values assigned to SBT Q_{tn} zones 6) values based on Robertson updated non-normalized Soil Behavior Type Chart (2010b) 6) Mayne f_s (sleeve friction) method 7) Robertson and Cabal 2010 method 8) user supplied unit weight profile <p>The last option may co-exist with any of the other options.</p>	See references	3, 5, 15, 21, 24, 29, 33

Calculated Parameter	Description	Equation	Ref
<p>TStress</p> <p>σ_v</p>	<p>Total vertical overburden stress at Mid Layer Depth</p> <p><i>A layer is defined as the averaging interval specified by the user where depths are reported at their respective mid-layer depth.</i></p> <p>For data calculated at each point layers are defined using the recorded depth as the mid-point of the layer. Thus, a layer starts half-way between the previous depth and the current depth unless this is the first point in which case the layer start is at zero depth. The layer bottom is half-way from the current depth to the next depth unless it is the last data point.</p> <p>Defining layers affects how stresses are calculated since the unit weight attributed to a data point is used throughout the entire layer. This means that to calculate the stresses the total stress at the top and bottom of a layer are required. The stress at mid layer is determined by adding the incremental stress from the layer top to the mid-layer depth. The stress at the layer bottom becomes the stress at the top of the subsequent layer. Stresses are NOT calculated from mid-point to mid-point.</p> <p>For over-water work the total stress due to the column of water above the mud line is taken into account where appropriate.</p>	<p>$TStress = \sum_{i=1}^n \gamma_i h_i$</p> <p>where γ_i is layer unit weight h_i is layer thickness</p> 	CK*
<p>EStress</p> <p>σ_v'</p>	<p>Effective vertical overburden stress at mid-layer depth.</p>	$\sigma_v' = \sigma_v - u_{eq}$	CK*
<p>Equil u</p> <p>u_{eq} or u_0</p>	<p>Equilibrium pore pressures are determined from one of the following user selectable options:</p> <ol style="list-style-type: none"> 1) hydrostatic below the water table 2) user supplied profile 3) combination of those above <p>When a user supplied profile is used/provided a linear interpolation is performed between equilibrium pore pressures defined at specific depths. If the profile values start below the water table then a linear transition from zero pressure at the water table to the first defined point is used.</p> <p>Equilibrium pore pressures may come from dissipation tests, adjacent piezometers or other sources. Occasionally, an extra equilibrium point ("assumed value") will be provided in the profile that does not come from a recorded value to smooth out any abrupt changes or to deal with material interfaces. These "assumed" values will be indicated on our plots and in tabular summaries.</p>	<p>For the hydrostatic option:</p> $u_{eq} = \gamma_w \cdot (D - D_{wt})$ <p>where u_{eq} is equilibrium pore pressure γ_w is the unit weight of water D is the current depth D_{wt} is the depth to the water table</p>	CK*
K_0	Coefficient of earth pressure at rest, K_0 .	$K_0 = (1 - \sin \Phi') OCR^{\sin \Phi'}$	17
C_n	Overburden stress correction factor used for $(N_1)_{60}$ and older CPT parameters.	$C_n = (P_a / \sigma_v')^{0.5}$ <p>where $0.0 < C_n < 2.0$ (user adjustable, typically ranging from 1.7 to 2.0) P_a is atmospheric pressure (100 kPa)</p>	4, 12

Calculated Parameter	Description	Equation	Ref
C_q	Overburden stress normalizing factor.	$C_q = 1.8 / [0.8 + (\sigma'_v/P_a)]$ where $0.0 < C_q < 2.0$ (user adjustable) P_a is atmospheric pressure (100 kPa) <i>Robertson and Wride define C_q to be the same as C_n. The Olson definition above is used in the program.</i>	3, 12
N_{60}	SPT N value at 60% energy calculated from q_t/N ratios assigned to each SBT zone. This method has abrupt N value changes at zone boundaries.	See Figure 1	5
$(N_1)_{60}$	SPT N_{60} value corrected for overburden pressure.	$(N_1)_{60} = C_n \cdot N_{60}$	4
$N_{60}I_c$	SPT N_{60} values based on the I_c parameter, as defined by Robertson and Wride 1998 (3), or by Robertson 2009 (15).	$(q_t/P_a)/N_{60} = 8.5 (1 - I_c/4.6)$ $(q_t/P_a)/N_{60} = 10^{(1.1268 - 0.2817I_c)}$ P_a being atmospheric pressure	3, 5 15, 31
$(N_1)_{60}I_c$	SPT N_{60} value corrected for overburden pressure (using $N_{60} I_c$). User has 3 options.	1) $(N_1)_{60}I_c = C_n \cdot (N_{60} I_c)$ 2) $q_{c1n}/(N_1)_{60}I_c = 8.5 (1 - I_c/4.6)$ 3) $(Q_{tn})/(N_1)_{60}I_c = 10^{(1.1268 - 0.2817I_c)}$	4 5 15, 31
S_u or $S_u (N_{kt})$	Undrained shear strength based on q_t S_u factor N_{kt} is user selectable.	$S_u = \frac{q_t - \sigma_v}{N_{kt}}$	1, 5
S_u or $S_u (N_{du})$ or $S_u (N_{\Delta u})$	Undrained shear strength based on pore pressure S_u factor $N_{\Delta u}$ is user selectable.	$S_u = \frac{u_2 - u_{eq}}{N_{\Delta u}}$	1, 5
D_r	Relative Density determined from one of the following user selectable options: 1) Ticino Sand 2) Høksund Sand 3) Schmertmann (1978) 4) Jamiolkowski (1985) - All Sands 5) Jamiolkowski et al (2003) (various compressibilities, K_o)	See reference (methods 1 through 4) Jamiolkowski et al (2003) reference	5 14
PHI ϕ	Friction Angle determined from one of the following user selectable options (methods 1 through 4 are for sands and method 5 is for silts and clays): 1) Campanella and Robertson 2) Durgunoglu and Mitchel 3) Janbu 4) Kulhawy and Mayne 5) NTH method (clays and silts)	See appropriate reference	5 5 5 11 23
Delta U/ q_t $\Delta u/q_t$ du/q_t	Differential pore pressure ratio (older parameter used before B_q was established)	$= \frac{\Delta u}{q_t}$ where: $\Delta u = u - u_{eq}$ and u = dynamic pore pressure u_{eq} = equilibrium pore pressure	39

Calculated Parameter	Description	Equation	Ref
B_q	Pore pressure parameter	$B_q = \frac{\Delta u}{q_t - \sigma_v}$ <p>where: $\Delta u = u - u_{eq}$ and u = dynamic pore pressure u_{eq} = equilibrium pore pressure</p>	1, 2, 5
Net q_t or qt_{Net}	Net tip resistance (used in many subsequent correlations)	$q_t - \sigma_v$	36
q_e or qE or qE	Effective tip resistance (using the dynamic pore pressure u_2 and not equilibrium pore pressure)	$q_t - u_2$	36
qe_{Norm}	Normalized effective tip resistance	$\frac{q_t - u_2}{\sigma_v}$	36
Q_t or Norm: Q_t or Q_{t1}	Normalized q_t for Soil Behavior Type classification as defined by Robertson (1990) using a linear stress normalization. Note this is different from Q_{tn} . This parameter was renamed to Q_{t1} in Robertson, 2009. Without normalization limits this parameter calculates to very high unrealistic values at low stresses.	$Q_t = \frac{q_t - \sigma_v}{\sigma_v}$	2, 5, 15
F_r or Norm: F_r	Normalized Friction Ratio for Soil Behavior Type classification as defined by Robertson (1990)	$F_r = 100\% \cdot \frac{fs}{q_t - \sigma_v}$	2, 5
$Q(1-B_q)$ $Q(1-B_q) + 1$	$Q(1-B_q)$ grouping as suggested by Jefferies and Davies for their classification chart and the establishment of their I_c parameter. Later papers added the +1 term to the equation.	$Q \cdot (1 - B_q)$ $Q \cdot (1 - B_q) + 1$ <i>where B_q is defined as above and Q is the same as the normalized tip resistance, Q_{t1}, defined above</i>	6, 7, 34
q_{c1}	Normalized tip resistance, q_{c1} , using a fixed stress ratio exponent, n (this method has stress units)	$q_{c1} = q_t \cdot (P_a / \sigma_v')^{0.5}$ where: P_a = atmospheric pressure	21
$q_{c1} (0.5)$	Normalized tip resistance, q_{c1} , using a fixed stress ratio exponent, n (this method is unit-less)	$q_{c1} (0.5) = (q_t / P_a) \cdot (P_a / \sigma_v')^{0.5}$ where: P_a = atmospheric pressure	5
$q_{c1} (C_n)$	Normalized tip resistance, q_{c1} , based on C_n (this method has stress units)	$q_{c1}(C_n) = C_n * q_t$	5, 12
$q_{c1} (C_q)$	Normalized tip resistance, q_{c1} , based on C_q (this method has stress units)	$q_{c1} (C_q) = C_q * q_t$ (some papers use q_c)	5, 12
q_{c1n}	normalized tip resistance, q_{c1n} , using a variable stress ratio exponent, n (where $n=0.0, 0.70$, or 1.0) (this method is unit-less)	$q_{c1n} = (q_t / P_a) (P_a / \sigma_v')^n$ where: P_a = atm. Pressure and n varies as described below	3

Calculated Parameter	Description	Equation	Ref
I_c or I_c (RW1998)	Soil Behavior Type Index as defined by Robertson and Wride (1997, 1998) for estimating grain size characteristics and providing smooth gradational changes across the SBTn chart. I_c (RW1998) is different from that of Jefferies and Davies (7) and is different from I_c (PKR2009).	$I_c = [(3.47 - \log_{10} Q)^2 + (\log_{10} Fr + 1.22)^2]^{0.5}$ <p>Where: $Q = \left(\frac{qt - \sigma_v}{P_a} \right) \left(\frac{P_a}{\sigma_v} \right)^n$</p> <p>Or $Q = q_{c1n} = \left(\frac{qt}{P_a} \right) \left(\frac{P_a}{\sigma_v} \right)^n$</p> <p>depending on the iteration in determining I_c</p> <p>And Fr is in percent P_a = atmospheric pressure</p> <p>n has the following distinct values: 0.5, 0.75 and 1.0 and is determined in an iterative manner based on the resulting I_c in each iteration</p> <p>Note that NCEER replaced 0.75 with 0.70</p>	3, 4, 5 10
I_c (PKR 2009)	Soil Behavior Type Index, I_c (PKR 2009) is based on a variable stress ratio exponent n , which itself is based on I_c (PKR 2009). An iterative calculation is required to determine I_c (PKR 2009) and its corresponding n (PKR 2009).	$I_c \text{ (PKR 2009)} = [(3.47 - \log_{10} Q_{tn})^2 + (1.22 + \log_{10} F_r)^2]^{0.5}$	15
n (PKR 2009)	Stress ratio exponent n , based on I_c (PKR 2009). An iterative calculation is required to determine n (PKR 2009) and its corresponding I_c (PKR 2009).	$n \text{ (PKR 2009)} = 0.381 (I_c) + 0.05 (\sigma'_v / P_a) - 0.15$	15
Q_{tn} (PKR 2009)	Normalized tip resistance using a variable stress ratio exponent based on I_c (PKR 2009) and n (PKR 2009). An iterative calculation is required to determine Q_{tn} (PKR 2009).	$Q_{tn} = [(qt - \sigma_v) / P_a] (P_a / \sigma'_v)^n$ <p>where P_a = atmospheric pressure (100 kPa) n = stress ratio exponent described above</p>	15
FC	Apparent fines content (%)	$FC = 1.75(I_c^{3.25}) - 3.7$ $FC = 100 \text{ for } I_c > 3.5$ $FC = 0 \text{ for } I_c < 1.26$ $FC = 5\% \text{ if } 1.64 < I_c < 2.6 \text{ AND } F_r < 0.5$	3
I_c Zone	This parameter is the Soil Behavior Type zone based on the I_c parameter (valid for zones 2 through 7 on SBTn or SBT Qtn charts)	$I_c < 1.31 \quad \text{Zone} = 7$ $1.31 < I_c < 2.05 \quad \text{Zone} = 6$ $2.05 < I_c < 2.60 \quad \text{Zone} = 5$ $2.60 < I_c < 2.95 \quad \text{Zone} = 4$ $2.95 < I_c < 3.60 \quad \text{Zone} = 3$ $I_c > 3.60 \quad \text{Zone} = 2$	3
CD	The contractive / dilative boundary on Robertson's Modified SBTn (contractive/dilative) Chart shown in Figure 6 above. The boundary is marked as CD = 70 on the chart in the relevant paper. Similar to the $Q_{tn,cs} = 70$ line in Figure 4.	$CD = 70 = (Q_{tn} - 11) (1 + 0.06F_r)^{17}$ <p>lower bound of CD = 60:</p> $CD = 60 = (Q_{tn} - 9.5) (1 + 0.06F_r)^{17}$	30

Calculated Parameter	Description	Equation	Ref
I_B	Hyperbolic fit defining the boundary between SBT soil types proposed by Schneider as a better fit than the I_c circles. $I_B = 32$ represents the boundary for most sand like soils. $I_B = 22$ represents the upper boundary for most clay like soils. The region between $I_B=22$ and $I_B=32$ is the “transitional soil” zone.	$I_B = 100 (Q_{tn} + 10) / (70 + Q_{tn} F_r)$	30
State Param or State Parameter or ψ	The state parameter index, ψ , is defined as the difference between the current void ratio, e , and the critical void ratio, e_c . Positive ψ - contractive soil Negative ψ - dilative soil This is based on the work by Been and Jefferies (1985) and Plewes, Davies and Jefferies (1992) This method uses mean normal stresses based on a uniform value of K_0 or a calculated K_0 using methods described elsewhere in this document	See reference	6, 8
Yield Stress σ_p'	Yield stress is calculated using the following methods 1) General method 2) 1 st order approximation using q_t Net (clays) 3) 1 st order approximation using Δu_2 (clays) 4) 1 st order approximation using q_e (clays) 5) Based on V_s	All stresses in kPa 1) $\sigma_p' = 0.33 \cdot (q_t - \sigma_v) m' (\sigma_{atm}/100)^{1-m'}$ where $m' = 1 - \frac{0.28}{1 + (I_c / 2.65)^{25}}$ 2) $\sigma_p' = 0.33 \cdot (q_t - \sigma_v)$ 3) $\sigma_p' = 0.54 \cdot (\Delta u_2)$ $\Delta u_2 = u_2 - u_0$ 4) $\sigma_p' = 0.60 \cdot (q_t - u_2)$ 5) $\sigma_p' = (V_s/4.59)^{1.47}$	19 20 20 20 18
OCR OCR(JS1978) YSR(Mayne2014) YSR (qtNet) YSR (deltaU) YSR (qe) YSR (Vs) OCR (PKR2015)	Over Consolidation Ratio based on 1) Schmertmann (1978) method involving a plot of $S_u/\sigma_v' / (S_u/\sigma_v')_{NC}$ and OCR  2) based on Yield stresses described above 3) approximate version based on qtNet 4) approximate version based on Δu 5) approximate version based on effective tip, q_e 6) approximate version based on shear wave velocity, V_s and σ_v' 7) based on Q_t	1) requires a user defined value for NC S_u/P_c' ratio 2 through 5) <i>based on yield stresses</i> 6) $YSR (Vs) = \sigma_p' (Vs) / \sigma_v'$ 7) $OCR = 0.25 \cdot (Q_t)^{1.25}$	9 19 20 20 20 18 32
E_s/q_t	Intermediate parameter for calculating Young's Modulus, E , in sands. It is the Y axis of the reference chart. Note that Figure 5.59 from reference 5, Lunne, Robertson and Powell, (LRP) has an error. The X axis values are too high by a factor of 10. The plot is based on Baldi's (not Bellotti as cited in	Based on Figure 5.59 in the reference	5, 37

Calculated Parameter	Description	Equation	Ref
	<p>LRP) original Figure 3 where the X axis is: $\frac{q_c}{\sqrt{\sigma'_v}}$ (both in kPa) with a range of 200 to 3000.</p> <p>Figure 5.59 from LRP shows a dimensionless form of the equation, q_{c1}, displaying the same range of values.</p> <p>Figure 5.59's X axis uses $q_{c1} = \left(\frac{q_c}{p_a}\right) \left(\frac{p_a}{\sigma'_v}\right)^{0.5}$</p> <p>The two expressions are not the same: they differ by a factor of $\frac{\sqrt{p_a}}{p_a}$. With p_a taken to be 100 kPa the factor is 1/10.</p> <p>Substituting typical values of 200 bar (20000 kPa) for q_c and 225 kPa for σ'_v one gets: $20000 / 15 = 1333.33$ for Bellotti's axis and $(200/1)(100/225)^{0.5} = 200 * (10/15) = 133.3$ for LRP's axis (noting that $p_a = 1$ bar) showing a factor of 10 difference.</p>		
Es or Es Young's Modulus E	<p>Young's Modulus based on the work done in Italy. There are three types of sands considered in this technique. The user selects the appropriate type for the site from:</p> <ul style="list-style-type: none"> a) OC Sands b) Aged NC Sands c) Recent NC Sands <p>Each sand type has a family of curves that depend on mean normal stress. The program calculates mean normal stress and linearly interpolates between the two extremes provided in the E_s/q_t chart. E_s is evaluated for an axial strain of 0.1%.</p>	<p>Mean normal stress is evaluated from:</p> $\sigma'_m = \frac{1}{3}(\sigma'_v + \sigma'_h + \sigma'_h)$ <p>where σ'_v = vertical effective stress σ'_h = horizontal effective stress</p> <p>and $\sigma'_h = K_o \cdot \sigma'_v$ with K_o assumed to be 0.5</p>	5
Delta U/TStress $\Delta u / \sigma_v$	Differential pore pressure ratio with respect to total stress	$= \frac{\Delta u}{\sigma_v}$ where: $\Delta u = u - u_{eq}$	39
Delta U/EStress, P Value, Excess Pore Pressure Ratio $\Delta u / \sigma'_v$	Differential pore pressure ratio with respect to effective stress. Key parameter (P, Normalized Pore Pressure Parameter, Excess Pore Pressure Ratio) in the Winckler et. al. static liquefaction method.	$= \frac{\Delta u}{\sigma'_v}$ where: $\Delta u = u - u_{eq}$	25, 25a
Su/EStress S_u / σ'_v	Undrained shear strength ratio with respect to vertical effective overburden stress using the $S_u (N_{kt})$ method	$= S_u (N_{kt}) / \sigma'_v$	9, 23
Vs or Vs	Recorded shear wave velocities (not estimated). The shear wave velocities are typically collected over 1 m depth intervals. Each data point over the relevant depth range is assigned the same V_s value.	recorded data	27
Vp or Vp	Recorded compression wave (or P wave) velocities (not estimated). The P wave velocities are typically collected over 1 m depth intervals. Each data point over the relevant depth range is assigned the same V_p value.	recorded data	27

Calculated Parameter	Description	Equation	Ref
V _{s30} V _{s100}	The average shear wave velocity of the near surface materials to a depth of 30 m (100 ft). It is based on the sum of all travel times through all layers in the top 30m (100 ft). V _{s100} is the same calculation as V _{s30} except down to a depth of 100 feet.	$V_{s30} = \frac{\text{total thickness of all layers to 30 m}}{\sum \left(\frac{\text{layer thickness}}{\text{layer shear wave velocity}} \right)}$ $V_{s30} = \frac{\text{total thickness of all layers to 30 m}}{\sum (\text{layer travel times})}$	38
G _{max}	G _{max} determined from SCPT shear wave velocities (not estimated values). Note that seismic data (V _s) is collected over set depth intervals (typically 1 meter). Each data point over the test segment is assigned the same V _s value. Since soil density changes with depth, slightly different G _{max} values may be calculated over the test depth interval.	$G_{\max} = \rho V_s^2$ where ρ is the mass density of the soil determined from the estimated unit weights at each test depth	27
qtNet/G _{max}	Net tip resistance ratio with respect to the small strain modulus G _{max} determined from SCPT shear wave velocities (not estimated values)	$= (q_t - \sigma_v) / G_{\max}$ where $G_{\max} = \rho V_s^2$ and ρ is the mass density of the soil determined from the estimated unit weights at each test depth	15, 28, 30
qUlt	A site specific and client specific parameter for estimating the limiting stress for “crane walk” accessibility	$q_{ult} = CraneWalkFactor \cdot S_u$ Where: CraneWalkFactor is client provided	U*
Estimated G _o	Estimated value for small strain shear modulus	$G_o = 0.0188[10^{(0.55I_c + 1.68)}](q_t - \sigma_v)$	15
Estimated E ₂₅	Estimated value for Young’s Modulus, E, at a 25% working load	$E_{25} = \alpha_E (qtNet)$ where $\alpha_E = 0.015[10^{(0.55I_c + 1.68)}]$	15
k _{SBT}	Estimated soil permeability derived from Soil Behavior Type (SBT) Chart I _c values.	For $1.0 < I_c \leq 3.27$: $k = 10^{(0.952 - 3.04I_c)}$ in m/s For $3.27 < I_c < 4.0$: $k = 10^{(-4.52 - 1.37I_c)}$ in m/s	35
M or D’ Constrained Modulus	Constrained Modulus based on 1) Robertson, M 2) Mayne, D’	1) Robertson $M = \alpha_M (q_t - \sigma_v)$ $I_c > 2.2$ (fine grained) $\alpha_M = Qt$ when $Qt < 14$ $\alpha_M = 14$ when $Qt > 14$ $I_c < 2.2$ (coarse grained) $\alpha_M = 0.0188 [10^{(0.55I_c + 1.68)}]$ $D' = \alpha_D (q_t - \sigma_v)$ where $\alpha_D = 5$	32 23

Table 1b. CPT Parameter Calculation Methods – Liquefaction Parameters

Calculated Parameter	Description	Equation	Ref
K_{SPT} or K_s	Equivalent clean sand factor for $(N_1)_{60}$	$K_{SPT} = 1 + ((0.75/30) \cdot (FC - 5))$	10
K_{CPT} or K_c (RW1998)	Equivalent clean sand correction for q_{c1N}	$K_{cpt} = 1.0$ for $l_c \leq 1.64$ $K_{cpt} = f(l_c)$ for $l_c > 1.64$ (see reference) $K_c = -0.403 l_c^4 + 5.581 l_c^3 - 21.63 l_c^2 + 33.75 l_c - 17.88$	3, 10
K_c (PKR 2010)	Clean sand equivalent factor to be applied to Q_{tn}	$K_c = 1.0$ for $l_c \leq 1.64$ $K_c = -0.403 l_c^4 + 5.581 l_c^3 - 21.63 l_c^2 + 33.75 l_c - 17.88$ for $l_c > 1.64$	16
$(N_1)_{60cs} l_c$	Clean sand equivalent SPT $(N_1)_{60} l_c$. User has 3 options.	1) $(N_1)_{60cs} l_c = \alpha + \beta((N_1)_{60} l_c)$ 2) $(N_1)_{60cs} l_c = K_{SPT} * ((N_1)_{60} l_c)$ 3) $(q_{c1ncs}) / (N_1)_{60cs} l_c = 8.5 (1 - l_c/4.6)$ FC \leq 5%: $\alpha = 0, \quad \beta = 1.0$ FC \geq 35%: $\alpha = 5.0, \quad \beta = 1.2$ 5% < FC < 35%: $\alpha = \exp[1.76 - (190/FC^2)]$ $\beta = [0.99 + (FC^{1.5}/1000)]$	10 10 5
q_{c1ncs}	Clean sand equivalent q_{c1n}	$q_{c1ncs} = q_{c1n} \cdot K_{cpt}$	3
$Q_{tn,cs}$ (PKR 2010)	Clean sand equivalent for Q_{tn} described above - Q_{tn} being the normalized tip resistance based on a variable stress exponent as defined by Robertson (2009)	$Q_{tn,cs} = Q_{tn} \cdot K_c$ (PKR 2016)	16
$S_u(Liq)/ES_v$ or $S_u(Liq)/\sigma_v'$	Liquefied shear strength ratio as defined by Olson and Stark	$\frac{S_u(Liq)}{\sigma_v'} = 0.03 + 0.0143(q_{c1})$ Note: σ_v' and s_v' are synonymous	13
$S_u(Liq)/ES_v$ or $S_u(Liq)/\sigma_v'$ (PKR 2010)	Liquefied shear strength ratio as defined by Robertson (2010)	$\frac{S_u(Liq)}{\sigma_v'}$ Based on a function involving $Q_{tn,cs}$	16
$S_u(Liq)$ (PKR 2010)	Liquefied shear strength derived from the liquefied shear strength ratio and effective overburden stress	$S_u(Liq) = \sigma_v' \cdot \left(\frac{S_u(Liq)}{\sigma_v'} \right)$	16
Cont/Dilat Tip	Contractive / Dilative q_{c1} Boundary based on $(N_1)_{60}$	$(\sigma_v')_{boundary} = 9.58 \times 10^{-4} [(N_1)_{60}]^{4.79}$ q_{c1} is calculated from specified q_t (MPa)/N ratio	13
CRR	Cyclic Resistance Ratio (for Magnitude 7.5)	$q_{c1ncs} < 50$: $CRR_{7.5} = 0.833 [q_{c1ncs}/1000] + 0.05$ $50 \leq q_{c1ncs} < 160$: $CRR_{7.5} = 93 [q_{c1ncs}/1000]^3 + 0.08$	10
K_g or K_g	Small strain Stiffness Ratio Factor, K_g	$[G_{max}/q_t]/[q_{c1n}^{-m}]$ m = empirical exponent, typically 0.75	26

Calculated Parameter	Description	Equation	Ref
K_g^*	Revised K_g factor extended to fine grained soils (Robertson).	$K_g^* = (G_o / q_n)(Q_{tn})^{0.75}$ where q_n is the net tip resistance = $q_t - \sigma_v$	30
SP Distance	State Parameter Distance, Winckler static liquefaction method	Perpendicular distance on Q_{tn} chart from plotted point to state parameter $\Psi = -0.05$ curve	25
URS NP Fr	Normalized friction ratio point on $\Psi = -0.05$ curve used in SP distance calculation		25
URS NP Q_{tn}	Normalized tip resistance (Q_{tn}) point on $\Psi = -0.05$ curve used in SP Distance calculation		25

Table 2. References

No.	Reference
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FOUNDATION INVESTIGATION REPORT – CNR OVERHEAD – HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

April 2025

APPENDIX D

D.1 SOIL LABORATORY TEST RESULTS

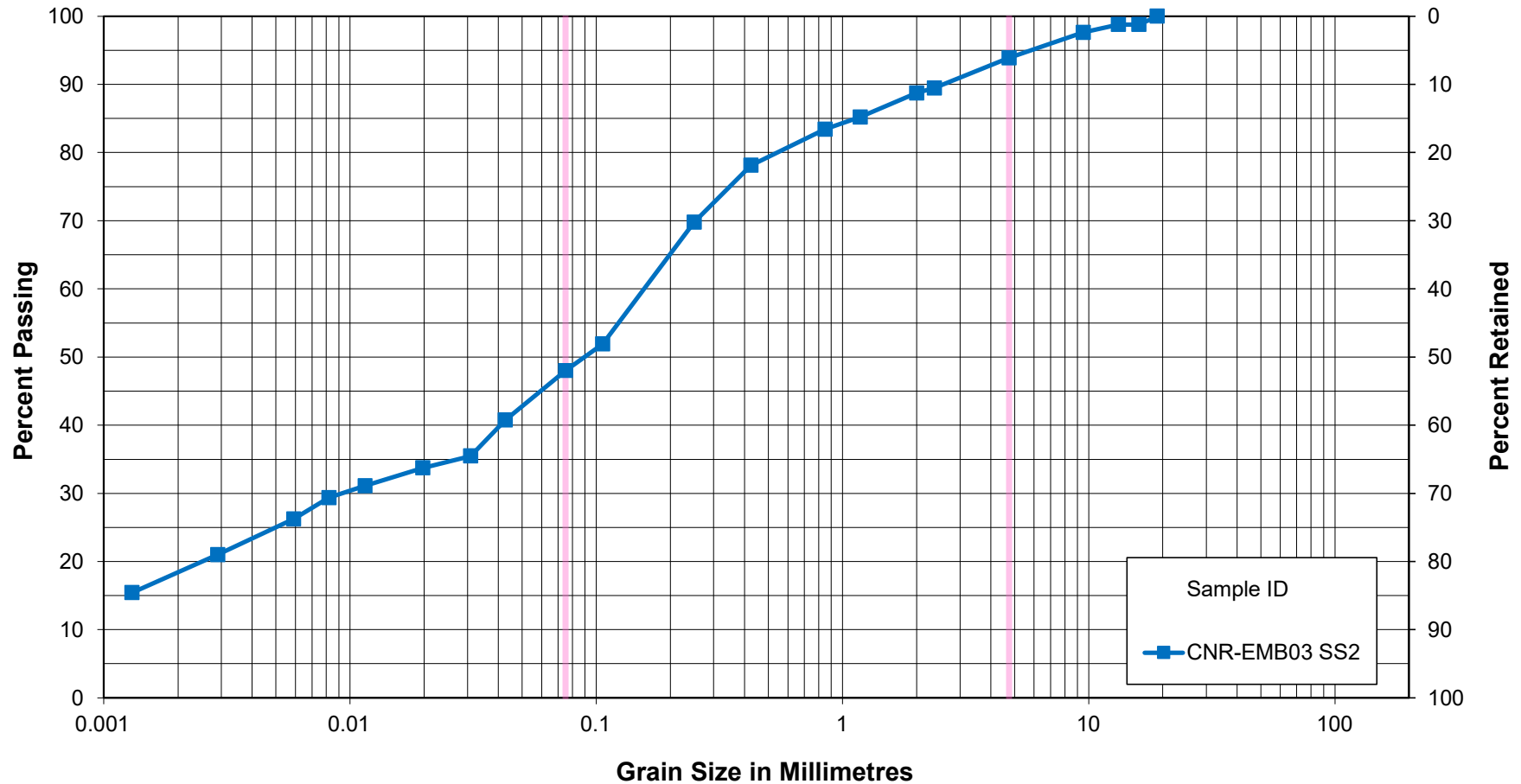


Unified Soil Classification System

CLAY & SILT	SAND			Gravel	
	Fine	Medium	Coarse	Fine	Coarse

U.S. Std. Sieve No.

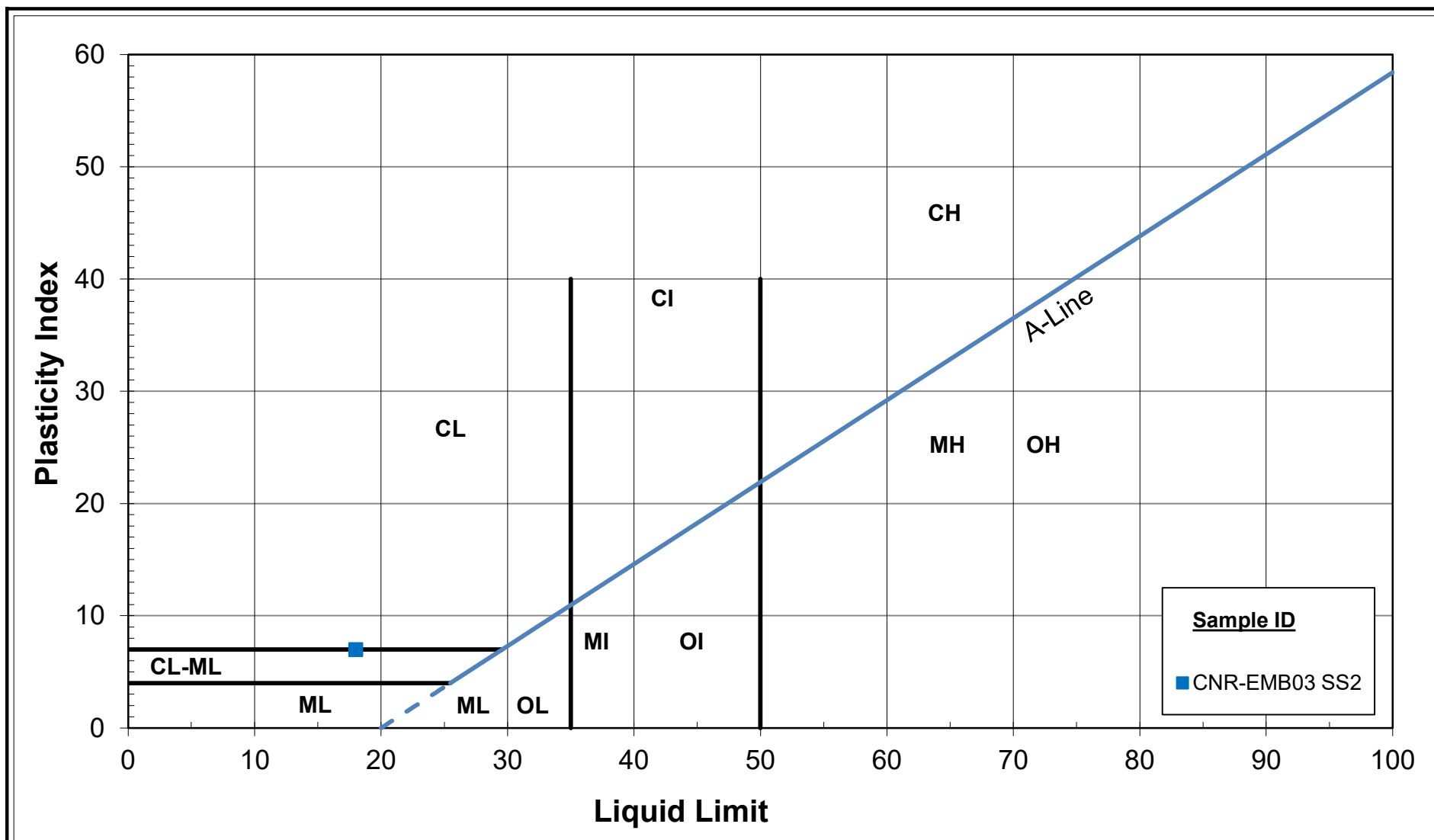
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FILL: Silty Clayey SAND (SC-SM)
 Ministry of Transportation (MTO)
 HWY 3 Twinning - CNR Overhead Bridge

Figure No. D1

Project No. 165001308

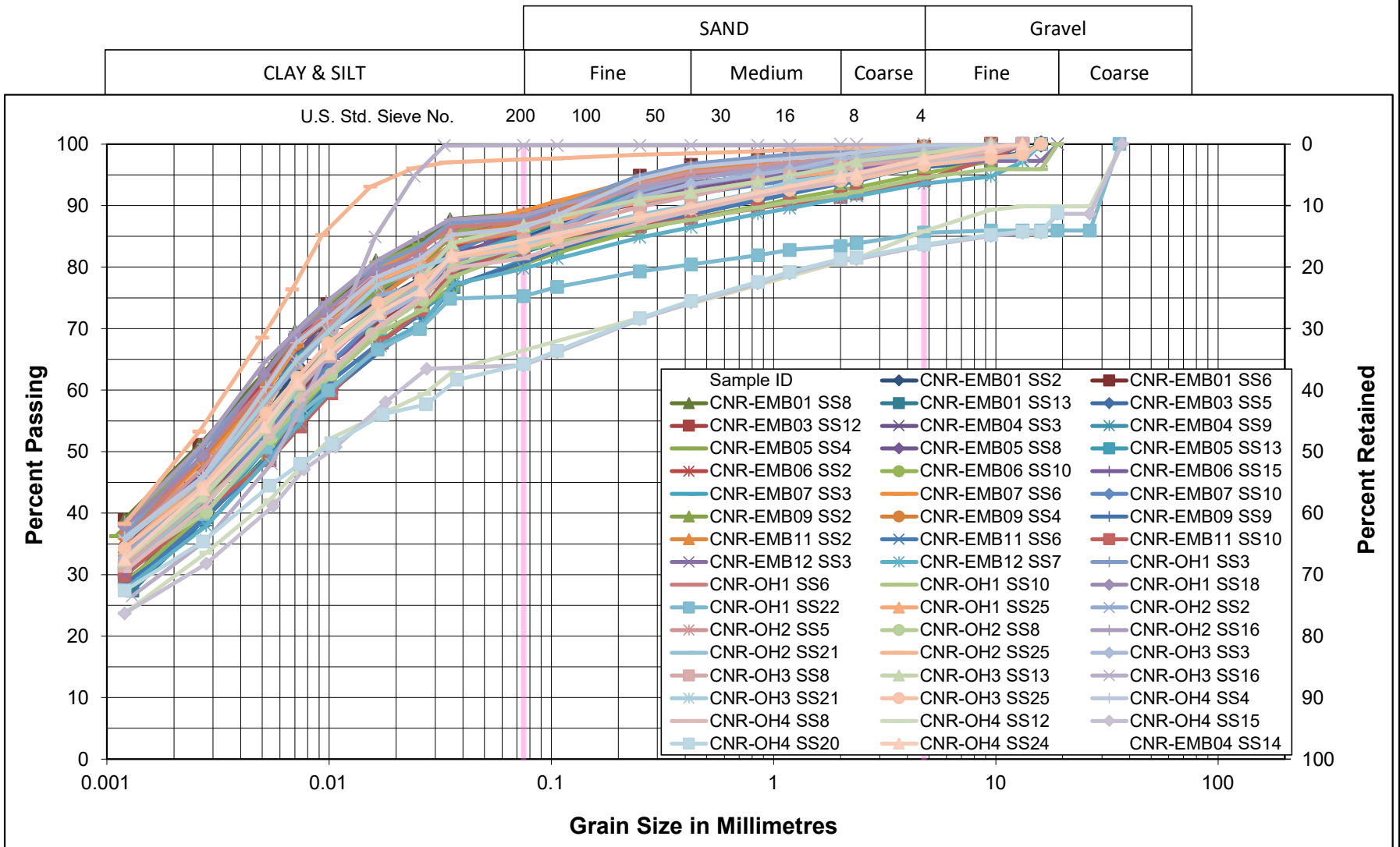


FILL: Silty Clayey SAND (SC-SM)
 Ministry of Transportation (MTO)
 HWY 3 Twinning - CNR Bridge

Figure No. D2

Project No. 165001308

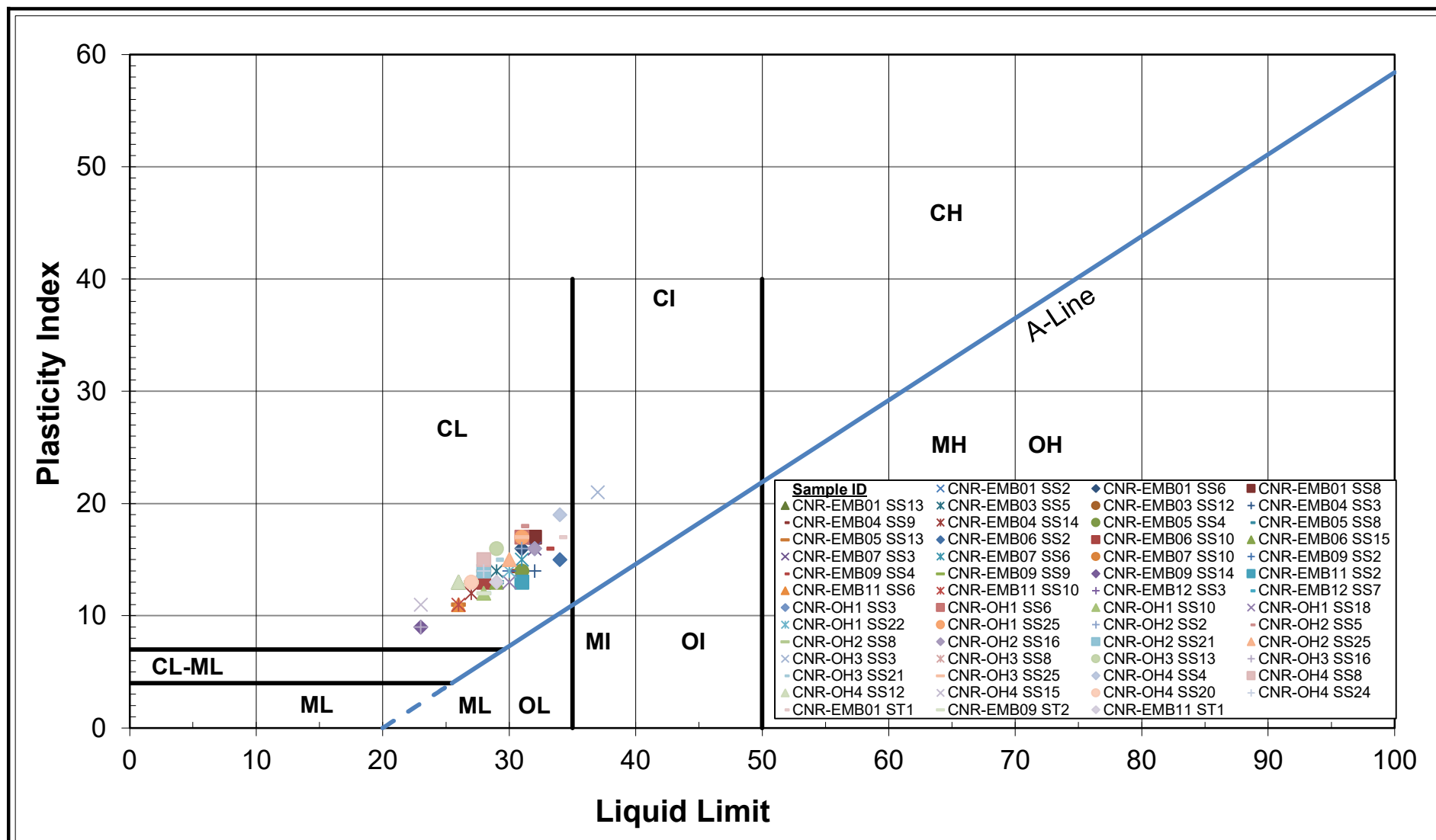
Unified Soil Classification System



TILL: CLAYEY SILT (CL) to SILTY CLAY (CI)
 Ministry of Transportation (MTO)
 HWY 3 Twinning - CNR Overhead Bridge

Figure No. D3

Project No. 165001308



TILL: CLAYEY SILT (CL) to SILTY CLAY (CI)

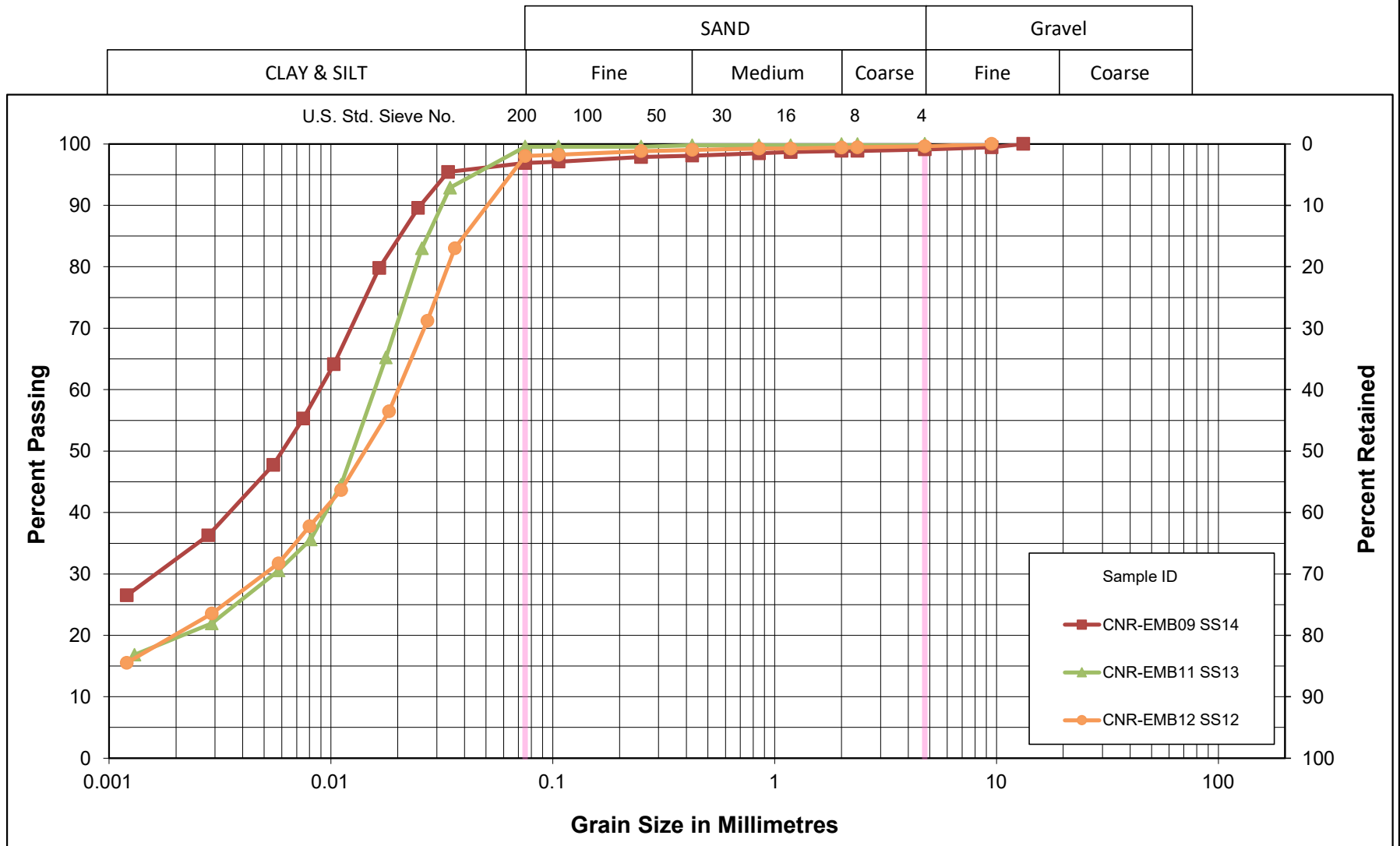
Ministry of Transportation (MTO)

HWY 3 Twinning - CNR Bridge

Figure No. D4

Project No. 165001308

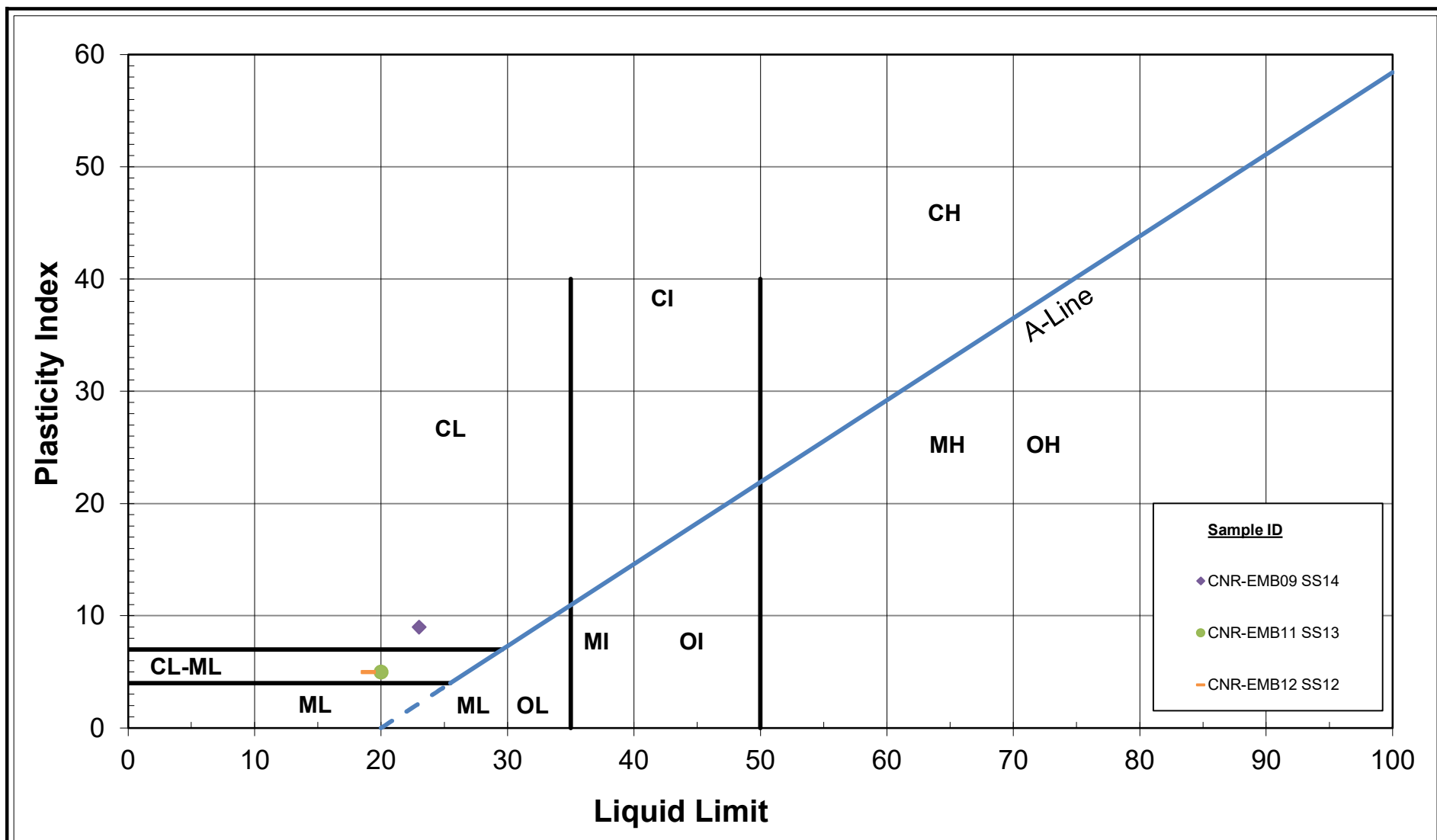
Unified Soil Classification System



CLAYEY SILT (CL-ML to CL)
Ministry of Transportation (MTO)
HWY 3 Twinning - CNR Overhead Bridge

Figure No. D5

Project No. 165001308



CLAYEY SILT (CL-ML to CL)
Ministry of Transportation (MTO)
HWY 3 Twinning - CNR Bridge

Figure No. D6

Project No. 165001308

CLIENT NAME: STANTEC CONSULTING LTD
300-675 Cochrane Drive
MARKHAM, ON L3R0B8
(905) 444-7777

ATTENTION TO: Bahram Siavash

PROJECT: 165001308.551.102

AGAT WORK ORDER: 24T167277

ROCK ANALYSIS REVIEWED BY: Jewel Shibu, Lab Supervisor

SOIL ANALYSIS REVIEWED BY: Sukhwinder Randhawa, Inorganic Team Lead

DATE REPORTED: Jul 05, 2024

PAGES (INCLUDING COVER): 7

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (403) 735-2005

*Notes

Disclaimer:

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
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- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
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- This document is signed by an authorized signatory who meets the requirements of the MELCCFP, CALA, CCN and NELAP.
- For environmental samples in the Province of Quebec: The analysis is performed on and results apply to samples as received. A temperature above 6°C upon receipt, as indicated in the Sample Reception Notification (SRN), could indicate the integrity of the samples has been compromised if the delay between sampling and submission to the laboratory could not be minimized.



Certificate of Analysis

AGAT WORK ORDER: 24T167277

PROJECT: 165001308.551.102

2910 12TH STREET NE
CALGARY, ALBERTA
CANADA T2E 7P7
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CLIENT NAME: STANTEC CONSULTING LTD

ATTENTION TO: Bahram Siavash

SAMPLING SITE:

SAMPLED BY:

(284-137) Sulfide (CGY)

DATE RECEIVED: 2024-06-27

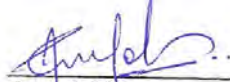
DATE REPORTED: 2024-07-05

		SAMPLE DESCRIPTION:		WR-UP3-SS7	RMN-UP3-SS8	CNR-OH1-SS8	CNR-OH2-SS5	CNR-OH3-SS4
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2024-06-26	2024-06-26	2024-06-26	2024-06-26	2024-06-26
Parameter	Unit	G / S	RDL	5964762	5964839	5964840	5964841	5964842
Sulfide	%	0.01	0.08	0.14	0.16	<0.01	<0.01	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Analysis performed at AGAT Calgary (unless marked by *)

Certified By:


Jewel Shibu

Certificate of Analysis

AGAT WORK ORDER: 24T167277

PROJECT: 165001308.551.102

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CLIENT NAME: STANTEC CONSULTING LTD

ATTENTION TO: Bahram Siavash

SAMPLING SITE:

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2024-06-27

DATE REPORTED: 2024-07-05

		SAMPLE DESCRIPTION:		WR-UP3-SS7	RMN-UP3-SS8	CNR-OH1-SS8	CNR-OH2-SS5	CNR-OH3-SS4
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2024-06-26	2024-06-26	2024-06-26	2024-06-26	2024-06-26
Parameter	Unit	G / S	RDL	5964762	5964839	5964840	5964841	5964842
Chloride (2:1)	µg/g	2	127	7	6	15	16	
Sulphate (2:1)	µg/g	2	154	174	194	206	185	
pH (2:1)	pH Units	NA	8.33	8.38	8.48	8.30	8.35	
Electrical Conductivity (2:1)	mS/cm	0.005	0.516	0.281	0.329	0.297	0.342	
Resistivity (2:1) (Calculated)	ohm.cm	1	1940	3560	3040	3370	2920	
Redox Potential 1	mV	NA	127	340	305	139	198	
Redox Potential 2	mV	NA	120	339	278	137	199	
Redox Potential 3	mV	NA	102	318	288	131	199	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

5964762-5964842 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.

Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.

Redox potential measurement in soil is quite variable and non reproducible due in part, to the general heterogeneity of a given soil. It is also related to the introduction of increased oxygen into the sample after extraction. The interpretation of soil redox potential should be considered in terms of its general range rather than as an absolute measurement.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



Quality Assurance

CLIENT NAME: STANTEC CONSULTING LTD

PROJECT: 165001308.551.102

SAMPLING SITE:

AGAT WORK ORDER: 24T167277

ATTENTION TO: Bahram Siavash

SAMPLED BY:

Rock Analysis

RPT Date: Jul 05, 2024			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE	
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper

(284-137) Sulfide (CGY)

Total Sulfur 5964762 5964762 0.10 0.09 11.4% < 0.01 108% 80% 120%

Sulfate 5950778 5950778 0.04 0.04 0.6% < 0.01 87% 80% 120%

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Duplicate/ Replicate NA: Results are less than 10X the RDL and RPD will not be calculated

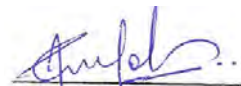
(284-137) Sulfide (CGY)

Sulfate 5964762 5964762 0.02 0.02 2% < 0.01 80% 120%

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Duplicate/ Replicate NA: Results are less than 10X the RDL and RPD will not be calculated

Certified By:


Jewel Shibu

Quality Assurance

CLIENT NAME: STANTEC CONSULTING LTD

PROJECT: 165001308.551.102

SAMPLING SITE:

AGAT WORK ORDER: 24T167277

ATTENTION TO: Bahram Siavash

SAMPLED BY:

Soil Analysis

RPT Date: Jul 05, 2024			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE	
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper

Corrosivity Package

Chloride (2:1)	5961472		21	21	0.0%	< 2	101%	70%	130%	96%	80%	120%	95%	70%	130%
Sulphate (2:1)	5961472		77	77	0.0%	< 2	101%	70%	130%	96%	80%	120%	92%	70%	130%
pH (2:1)	5962742		7.86	7.56	3.9%	NA	97%	80%	120%						
Electrical Conductivity (2:1)	5962742		1.67	1.69	1.2%	< 0.005	103%	80%	120%						
Redox Potential 1	5964762					NA	100%	90%	110%						

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Corrosivity Package

pH (2:1)	5964762	5964762	8.33	8.00	4.0%	NA	98%	80%	120%
Electrical Conductivity (2:1)	5964762	5964762	0.516	0.509	1.4%	< 0.005	102%	80%	120%

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Certified By:



Method Summary

CLIENT NAME: STANTEC CONSULTING LTD

AGAT WORK ORDER: 24T167277

PROJECT: 165001308.551.102

ATTENTION TO: Bahram Siavash

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	modified from EPA 9045D and MCKEAGUE 3.11	PH METER
Electrical Conductivity (2:1)	INOR-93-6075	modified from MSA PART 3, CH 14 and SM 2510 B	PC TITRATE
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B, SSA #5 Part 3	CALCULATION
Redox Potential 1	INOR-93-6066	G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	ASTM G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	ASTM G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE

CLIENT NAME: STANTEC CONSULTING LTD
300-675 Cochrane Drive
MARKHAM, ON L3R0B8
(905) 444-7777

ATTENTION TO: Bahram Siavash

PROJECT: 165001308.551.102

AGAT WORK ORDER: 24T187247

ROCK ANALYSIS REVIEWED BY: Jewel Shibu, Lab Supervisor

SOIL ANALYSIS REVIEWED BY: Sukhwinder Randhawa, Inorganic Team Lead

DATE REPORTED: Aug 28, 2024

PAGES (INCLUDING COVER): 7

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (403) 735-2005

*Notes

Disclaimer:

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
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- The test results reported herewith relate only to the samples as received by the laboratory.
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- All reportable information is available on request from AGAT Laboratories, in accordance with ISO/IEC 17025:2017, ISO/IEC 17025:2005 (Quebec), DR-12-PALA and/or NELAP Standards.
- This document is signed by an authorized signatory who meets the requirements of the MELCCFP, CALA, CCN and NELAP.
- For environmental samples in the Province of Quebec: The analysis is performed on and results apply to samples as received. A temperature above 6°C upon receipt, as indicated in the Sample Reception Notification (SRN), could indicate the integrity of the samples has been compromised if the delay between sampling and submission to the laboratory could not be minimized.



Certificate of Analysis

AGAT WORK ORDER: 24T187247

PROJECT: 165001308.551.102

2910 12TH STREET NE
CALGARY, ALBERTA
CANADA T2E 7P7
TEL (403)735-2005
FAX (403)735-2771
<http://www.agatlabs.com>

CLIENT NAME: STANTEC CONSULTING LTD

SAMPLING SITE:

ATTENTION TO: Bahram Siavash

SAMPLED BY:

(284-137) Sulfide (CGY)

DATE RECEIVED: 2024-08-20

DATE REPORTED: 2024-08-28

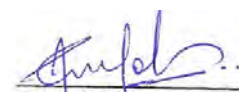
		SAMPLE DESCRIPTION: CNR-OH4 - SS9		RMN-UP2 - SS7		RMN-UP1 - SS10
		SAMPLE TYPE: Soil		Soil		Soil
		DATE SAMPLED: 2024-08-20		2024-08-20		2024-08-20
Parameter	Unit	G / S	RDL	6087931	6087963	6087966
Sulfide	%	0.01	0.09	0.14	0.13	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

6087931-6087966 Sulfide is a calculated parameter and is non-accredited. The parameters that are components of the calculation are accredited.

Analysis performed at AGAT Calgary (unless marked by *)

Certified By:


Jewel Shibu

Certificate of Analysis

AGAT WORK ORDER: 24T187247

PROJECT: 165001308.551.102

2910 12TH STREET NE
CALGARY, ALBERTA
CANADA T2E 7P7
TEL (403)735-2005
FAX (403)735-2771
<http://www.agatlabs.com>

CLIENT NAME: STANTEC CONSULTING LTD

ATTENTION TO: Bahram Siavash

SAMPLING SITE:

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2024-08-20

DATE REPORTED: 2024-08-28

Parameter	Unit	SAMPLE DESCRIPTION: CNR-OH4 - SS9 RMN-UP2 - SS7 RMN-UP1 - SS10				
		SAMPLE TYPE: Soil		Soil		Soil
		DATE SAMPLED: 2024-08-20		2024-08-20		2024-08-20
		G / S	RDL	6087931	6087963	6087966
Chloride (2:1)	µg/g	2	10	5	6	
Sulphate (2:1)	µg/g	2	277	318	272	
pH (2:1)	pH Units	NA	8.68	8.46	8.79	
Electrical Conductivity (2:1)	mS/cm	0.005	0.412	0.397	0.366	
Resistivity (2:1) (Calculated)	ohm.cm	1	2430	2520	2730	
Redox Potential 1	mV	NA	201	199	196	
Redox Potential 2	mV	NA	186	205	216	
Redox Potential 3	mV	NA	195	221	229	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

6087931-6087966 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.

Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.

Redox potential measurement in soil is quite variable and non reproducible due in part, to the general heterogeneity of a given soil. It is also related to the introduction of increased oxygen into the sample after extraction. The interpretation of soil redox potential should be considered in terms of its general range rather than as an absolute measurement.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



Quality Assurance

CLIENT NAME: STANTEC CONSULTING LTD

PROJECT: 165001308.551.102

SAMPLING SITE:

AGAT WORK ORDER: 24T187247

ATTENTION TO: Bahram Siavash

SAMPLED BY:

Rock Analysis

RPT Date: Aug 28, 2024			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE	
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper

(284-137) Sulfide (CGY)

Total Sulfur 6087931 6087931 0.11 0.13 16.8% < 0.01 105% 80% 120%

Sulfate 6074983 6074983 <0.01 <0.01 NA < 0.01 99% 80% 120%

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Duplicate/ Replicate NA: Results are less than 10X the RDL and RPD will not be calculated

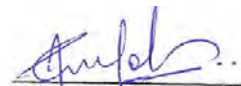
(284-137) Sulfide (CGY)

Sulfate 6087931 6087931 0.02 0.02 0.2% < 0.01 80% 120%

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Duplicate/ Replicate NA: Results are less than 10X the RDL and RPD will not be calculated

Certified By:


Jewel Shibu

Quality Assurance

CLIENT NAME: STANTEC CONSULTING LTD

PROJECT: 165001308.551.102

SAMPLING SITE:

AGAT WORK ORDER: 24T187247

ATTENTION TO: Bahram Siavash

SAMPLED BY:

Soil Analysis

RPT Date: Aug 28, 2024			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE	
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper

Corrosivity Package

Chloride (2:1)	6089108		40	40	0.0%	< 2	94%	70%	130%	98%	80%	120%	95%	70%	130%
Sulphate (2:1)	6089108		171	172	0.6%	< 2	98%	70%	130%	101%	80%	120%	100%	70%	130%
pH (2:1)	6089108		8.52	8.34	2.1%	NA	96%	80%	120%						
Electrical Conductivity (2:1)	6089108		0.353	0.364	3.1%	< 0.005	102%	80%	120%						
Redox Potential 1	6087931					NA	100%	90%	110%						

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Certified By:



Method Summary

CLIENT NAME: STANTEC CONSULTING LTD

AGAT WORK ORDER: 24T187247

PROJECT: 165001308.551.102

ATTENTION TO: Bahram Siavash

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	modified from EPA 9045D and MCKEAGUE 3.11	PH METER
Electrical Conductivity (2:1)	INOR-93-6075	modified from MSA PART 3, CH 14 and SM 2510 B	PC TITRATE
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential 1	INOR-93-6066	G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	ASTM G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	ASTM G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE

**UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
(ASTM D2850)**

Tables 1-4

***MTO Hwy 3 Talbotville Bypass*
SPECIMEN IDENTIFICATION**

Borehole/Sample No.:	BH CNR OH3, ST1	Sample Type:	Intact
Sample Depth (ft):	13-15	Soil Classification:	CL
Liquid Limit:	31.0%	Specific Gravity:	2.761
Plastic limit:	16.8%		
Soil Description & Classification:	<i>Lean clay of low plasticity, stiff, brown, moist, CL</i>		

INITIAL SPECIMEN DIMENSIONS AND PROPERTIES

Test No	1	2
Specimen Height, (mm)	152	152
Specimen Diameter, (mm)	70	70
Natural Water Content (Cuttings), (%)	19.2	16.9
Void Ratio	0.57	0.52
Degree of Saturation, (%)	93.1	89.9
Dry Unit Weight (kN/m ³)	17.26	17.75

SHEARING/FAILURE

Max. Deviator Stress, ($\sigma_1 - \sigma_3$), (kPa)	179.7	189.6
Axial Strain At Maximum ($\sigma_1 - \sigma_3$), (%)	12.23	11.79
Compressive Strength, Max, (kN)	0.8	0.8
Max Total Principal Stress Ratio, (σ_1 / σ_3)	2.8	1.9
Deviator Stress At (σ_1 / σ_3) Max, (kPa)	179.7	189.6
Total Major Principal Stress At Failure, σ_1 , (kPa)	278.3	389.5
Total Minor Principal Stress At Failure, σ_3 , (kPa)	98.6	200.0
Average Rate of Strain, (%/min)	1.00	1.00

Test Notes:

Specimen Saturation Method	N/A	N/A
Failure Criterion	Max. $\sigma_1 - \sigma_3$	Max. $\sigma_1 - \sigma_3$
Membrane Thickness Correction Applied, Y/N	Y	Y

Project No.: 165001308.451.200

Date: August 19, 2024



Prepared By : DB

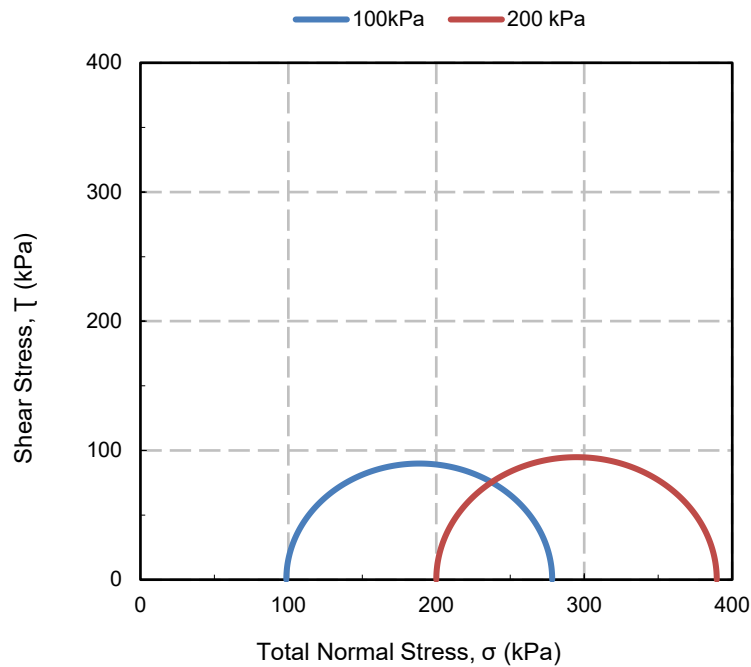
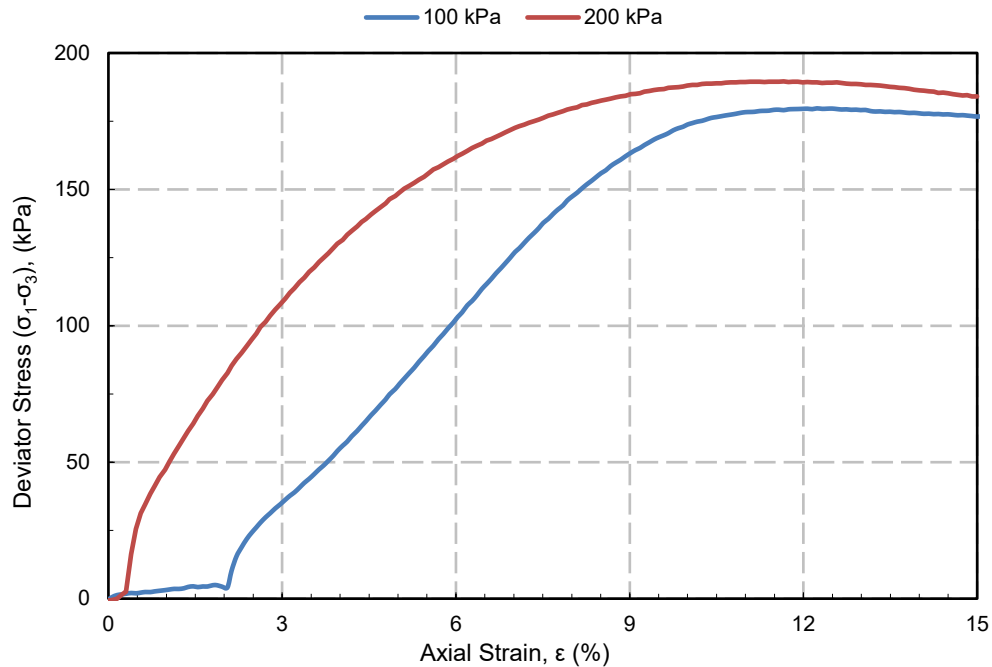
Checked By : RG

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST (ASTM D2850)

Figures 1-2

MTO Hwy 3 Talbotville Bypass

BH CNR OH3, ST1



Project No.: 165001308.451.200
Date: August 19, 2024

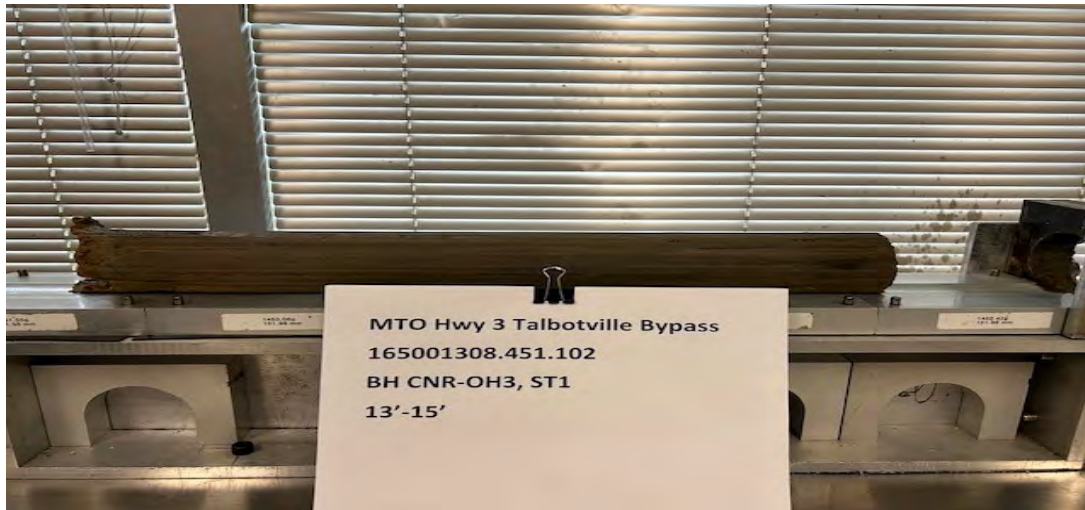


Prepared By : DB
Checked By : RG

MTO Hwy 3 Talbotville Bypass

Lean clay of low plasticity, stiff, brown, moist, CL

BH CNR OH3, ST1



Project No. : 165001308.451.200

Date : August 19, 2024



Prepared by : DB

Checked by : RG

MTO Hwy 3 Talbotville Bypass

Lean clay of low plasticity, stiff, brown, moist, CL

BH CNR OH3, ST1



100 kPa Shearing



200 kPa Shearing


Project No. : 165001308.451.200

Date : August 19, 2024



Prepared by : DB

Checked by : RG

CONSOLIDATION TEST SUMMARY								
SAMPLE IDENTIFICATION								
Borehole No. :	BH CNR EMB1				Sample No. :	ST1		
					Sample Depth (ft) :	17.5-19.5		
TEST CONDITIONS								
Test Type :	ASTM D2435/D2435M				Date Started :	19-Aug-24		
Load Duration (hr) :	Method B				Date Completed :	21-Aug-24		
SAMPLE DIMENSIONS AND PROPERTIES _ INITIAL								
Sample Height (mm) :	20.50				Unit Weight (kN/m ³) :	21.19		
Sample Diameter (mm) :	50.00				Dry Unit Weight (kN/m ³) :	17.95		
Area (cm ²) :	19.63				Specific Gravity : (Assumed)	2.761		
Volume (cm ³) :	40.25				Solid Height (mm) :	13.59		
Water Content (%) :	18.08				Volume of Solids (cm ³) :	26.68		
Wet Mass (g) :	86.98				Volume of Voids (cm ³) :	13.57		
Dry Mass (g) :	73.66				Degree of Saturation (%) :	98.14		
TEST COMPUTATIONS								
		Corrected	Axial	Void Ratio	t ₉₀	C _v	m _v	k
Axial Stress	Height (H)	Deformation (ΔH)	Strain (ε _a)	e	(sec)	(cm ² /s)	(m ² /kN)	(m/s)
(kPa)	(mm)	(mm)	(%)					
0	20.5000			0.509				
10	20.4213	0.0787	0.51	0.501	129.14	6.85E-03	5.06E-04	3.40E-09
20	20.3335	0.1665	0.87	0.496	1117.35	7.86E-04	3.68E-04	2.84E-10
40	20.2334	0.2666	1.49	0.486	585.65	1.49E-03	3.07E-04	4.47E-10
80	20.0674	0.4326	2.36	0.473	603.68	1.42E-03	2.17E-04	3.02E-10
160	19.8192	0.6808	3.51	0.456	807.31	1.04E-03	1.45E-04	1.47E-10
320	19.5457	0.9543	4.88	0.435	613.86	1.33E-03	8.55E-05	1.12E-10
160			4.68	0.438				
80			4.38	0.443				
160	19.5716	0.9284	4.56	0.440	229.99	3.53E-03	2.24E-05	7.78E-11
320	19.4896	1.0104	5.03	0.433	287.02	2.81E-03	2.94E-05	8.11E-11
480	19.3550	1.1450	5.73	0.422	563.37	1.42E-03	4.41E-05	6.13E-11
640	19.2231	1.2769	6.36	0.413	652.87	1.21E-03	3.95E-05	4.67E-11
1280	18.8632	1.6368	8.22	0.385	445.05	1.72E-03	2.90E-05	4.89E-11
2560	18.4444	2.0556	10.30	0.353	389.94	1.88E-03	1.62E-05	3.00E-11
4800	18.0496	2.4504	12.32	0.323	291.57	2.41E-03	9.01E-06	2.13E-11
2560			12.12	0.326				
640			11.15	0.341				
160			9.60	0.364				
40			8.15	0.386				
10			6.74	0.407				
SAMPLE DIMENSIONS AND PROPERTIES _ FINAL								
Sample Height (mm) :	19.12				Unit Weight (kN/m ³) :	22.19		
Sample Diameter (mm) :	50.00				Dry Unit Weight (kN/m ³) :	19.24		
Area (cm ²) :	19.63				Specific Gravity (Assumed) :	2.761		
Volume (cm ³) :	37.54				Solid Height (mm) :	13.59		
Water Content (%) :	15.30				Volume of Solids (cm ³) :	26.68		
Wet Mass (g) :	84.93				Volume of Voids (cm ³) :	10.86		
Dry Mass (g) :	73.66							
<div style="display: flex; justify-content: space-between; align-items: flex-end;"> <div> Project No. : 165001308.451.102 Date : 24-Aug-24 </div> <div style="text-align: center;">  </div> <div> Prepared By : DB Checked By : RG </div> </div>								

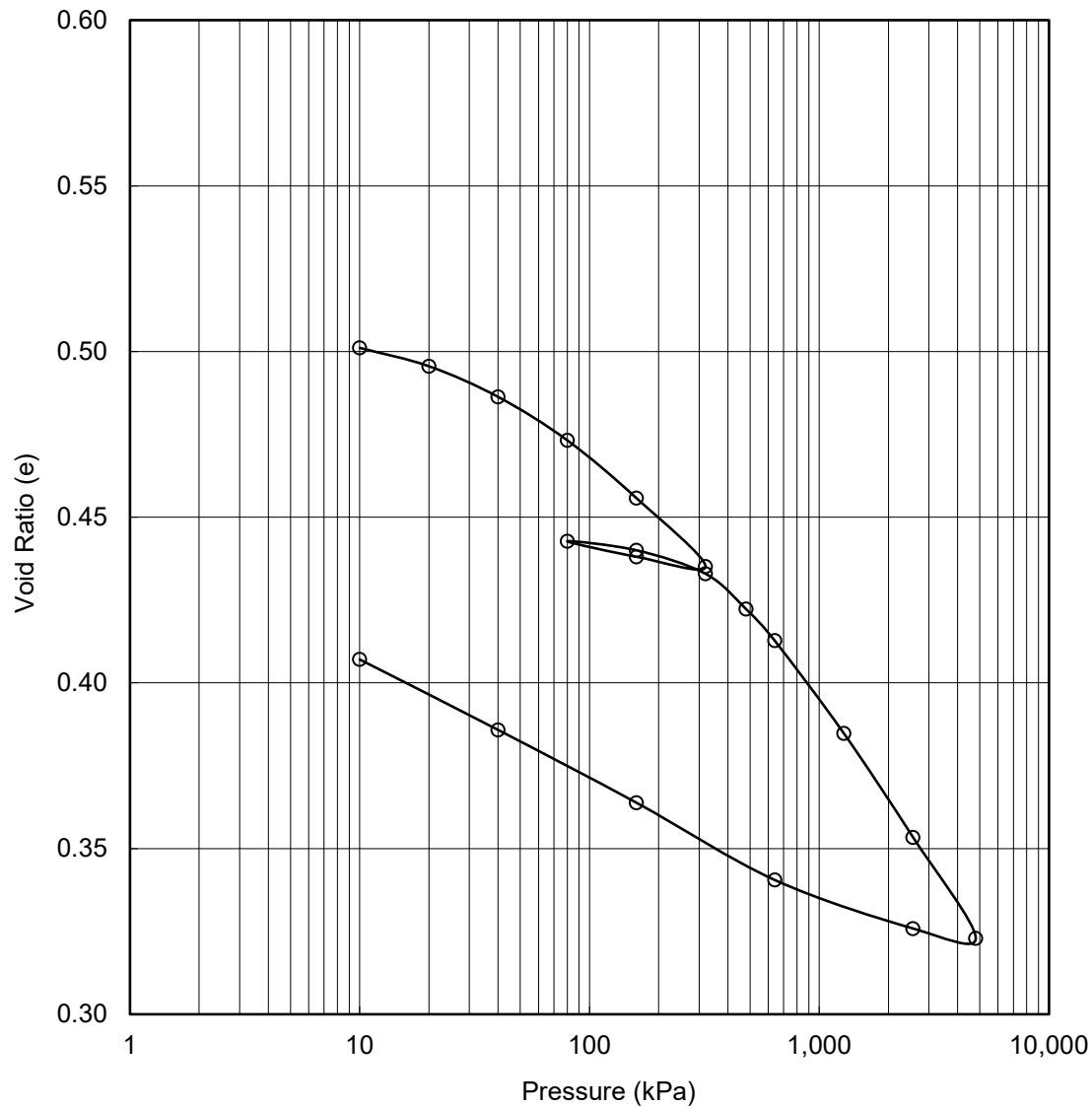
CONSOLIDATION TEST

FIGURE 1

MTO Hwy 3 Talbotville Bypass

BH CNR EMB1, ST1

Void Ratio vs Pressure



Soil Type : Overconsolidated Lean clay of low plasticity, very stiff, brown, moist, CL

$e_o =$	0.509	$w_L =$	33.7%	$\sigma_{v0}' =$	kPa
$w =$	18.1%	$w_p =$	17.3%	$\sigma_p' =$	kPa
$\gamma =$	21.2 kN/m ³	$PI =$	16.4%		
$G_s =$	2.761				

Project No. : 165001308.451.102
Date : 24-Aug-24



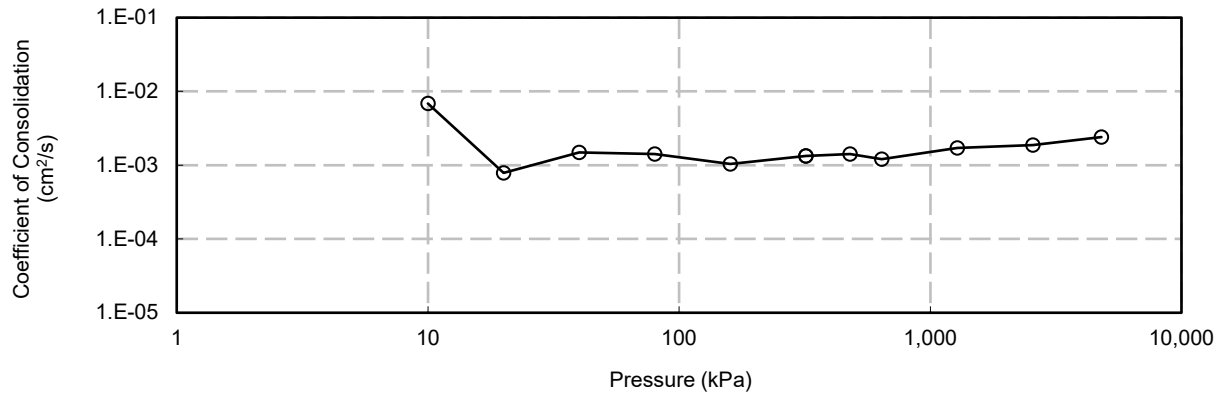
Prepared By : DB
Checked By : RG

CONSOLIDATION TEST

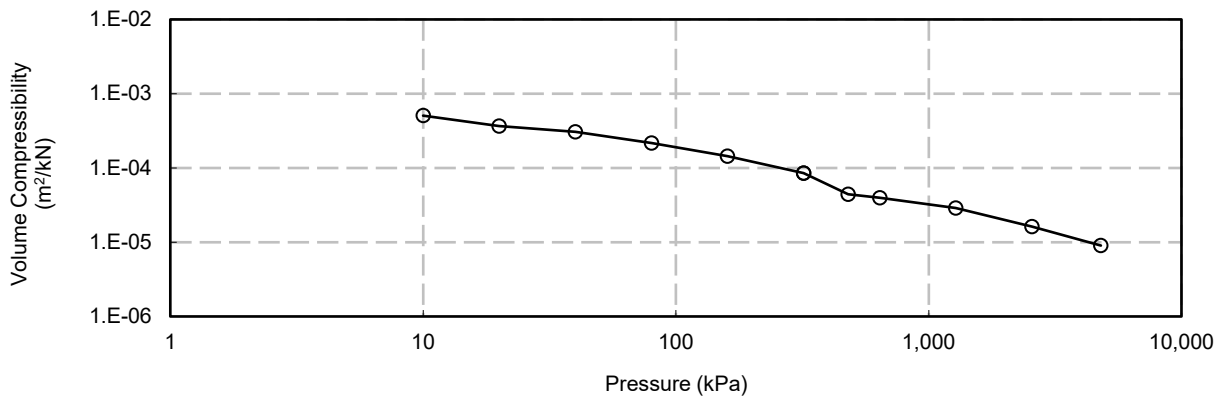
FIGURES 2, 3 & 4

MTO Hwy 3 Talbotville Bypass
BH CNR EMB1, ST1

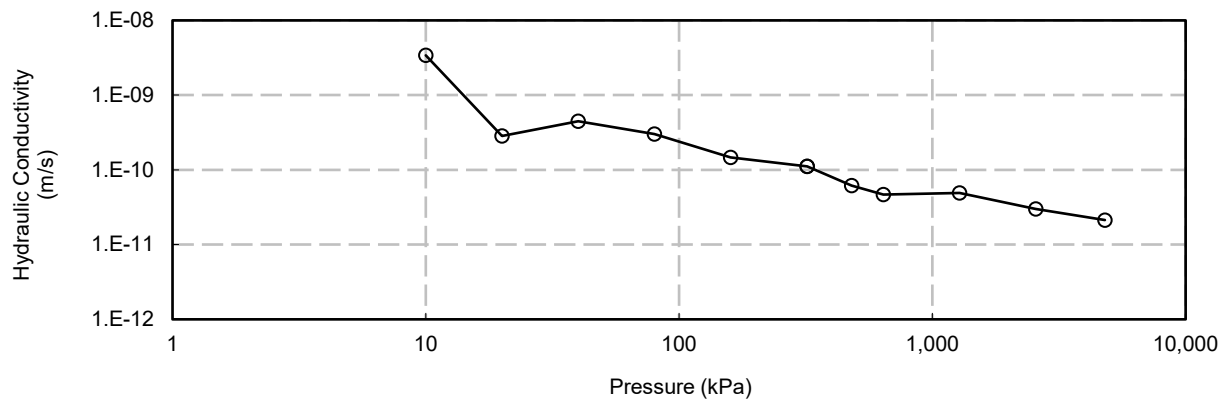
Cv vs Pressure



mv vs Pressure



k vs Pressure



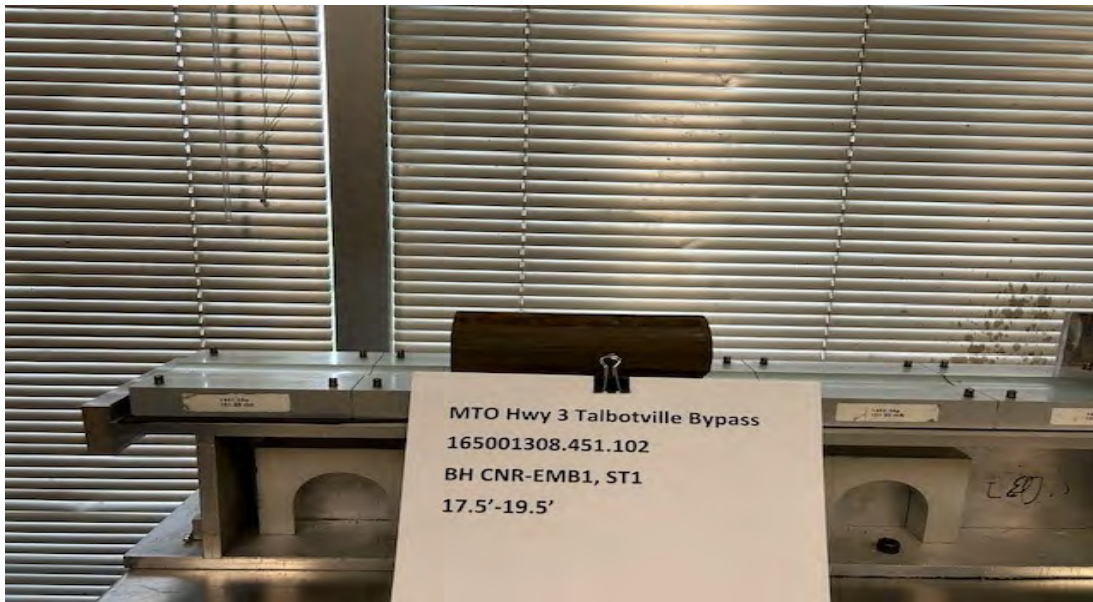
Project No. : 165001308.451.102
Date : 24-Aug-24



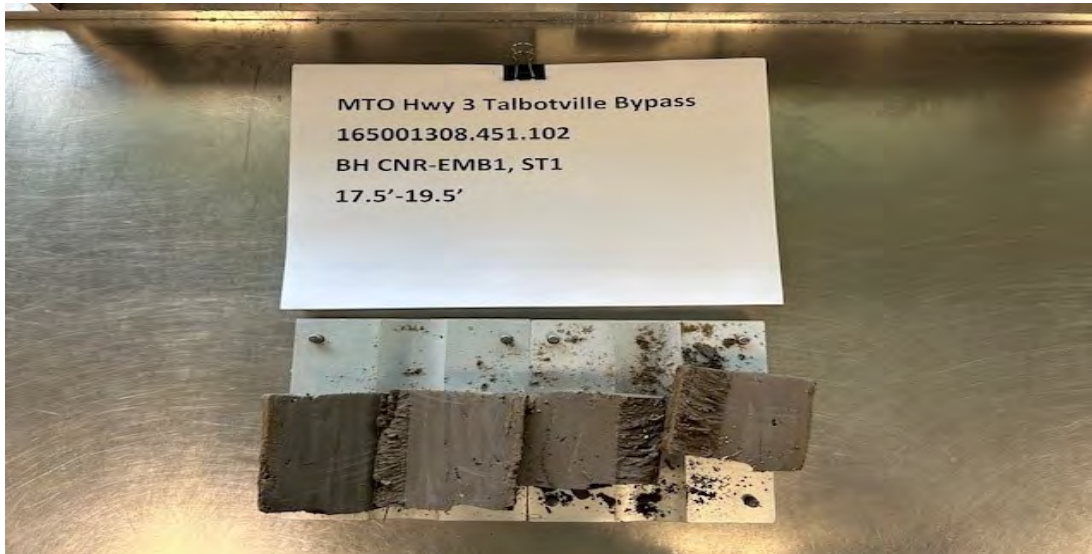
Prepared By : DB
Checked By : RG

MTO Hwy 3 Talbotville Bypass

Overconsolidated Lean clay of low plasticity, very stiff, brown, moist, CL



BH CNR EMB1, ST1



BH CNR EMB1, ST1


Project No. : 165001308.451.102

Date : 24-Aug-2024



Prepared by : DB

Checked by : RG

CONSOLIDATION TEST SUMMARY									
SAMPLE IDENTIFICATION									
Borehole No. :		BH CNR EMB7				Sample No. :		ST1	
						Sample Depth (ft) :		12.5-14.5	
TEST CONDITIONS									
Test Type :		ASTM D2435/D2435M				Date Started :		13-Aug-24	
Load Duration (hr) :		Method B				Date Completed :		15-Aug-24	
SAMPLE DIMENSIONS AND PROPERTIES _ INITIAL									
Sample Height (mm) :		20.50				Unit Weight (kN/m ³) :		20.78	
Sample Diameter (mm) :		50.00				Dry Unit Weight (kN/m ³) :		17.43	
Area (cm ²) :		19.63				Specific Gravity : (Assumed)		2.757	
Volume (cm ³) :		40.25				Solid Height (mm) :		13.21	
Water Content (%) :		19.24				Volume of Solids (cm ³) :		25.94	
Wet Mass (g) :		85.29				Volume of Voids (cm ³) :		14.31	
Dry Mass (g) :		71.53				Degree of Saturation (%) :		96.18	
TEST COMPUTATIONS									
		Corrected	Axial	Void Ratio	t ₉₀	C _v	m _v	k	
Axial Stress	Height (H)	Deformation (ΔH)	Strain (ε _a)	e	(sec)	(cm ² /s)	(m ² /kN)	(m/s)	
(kPa)	(mm)	(mm)	(%)						
0	20.5000	0.0000	0.00	0.551					
10	20.2257	0.2743	1.51	0.528	94.84	9.16E-03	1.51E-03	1.35E-08	
20	20.1224	0.3776	2.02	0.520	192.49	4.47E-03	5.19E-04	2.27E-09	
40	19.9786	0.5214	2.82	0.508	233.92	3.63E-03	3.97E-04	1.41E-09	
80	19.7848	0.7152	3.84	0.492	258.97	3.22E-03	2.56E-04	8.08E-10	
160	19.5429	0.9571	5.17	0.471	213.09	3.82E-03	1.66E-04	6.21E-10	
320	19.2069	1.2931	6.78	0.446	341.23	2.31E-03	1.01E-04	2.28E-10	
160			6.58	0.449					
80			6.23	0.455					
160	19.1877	1.3123	6.44	0.452	314.04	2.49E-03	2.70E-05	6.58E-11	
320	19.0989	1.4011	6.97	0.443	300.85	2.58E-03	3.33E-05	8.42E-11	
480	18.9467	1.5533	7.81	0.430	508.69	1.50E-03	5.20E-05	7.68E-11	
640	18.7787	1.7213	8.55	0.419	805.35	9.33E-04	4.67E-05	4.28E-11	
1280	18.3603	2.1397	10.85	0.383	458.48	1.58E-03	3.59E-05	5.57E-11	
2560	17.8597	2.6403	13.44	0.343	347.12	1.98E-03	2.03E-05	3.94E-11	
4800	17.3326	3.1674	16.05	0.302	338.94	1.92E-03	1.16E-05	2.19E-11	
2560			15.74	0.307					
640			14.46	0.327					
160			12.81	0.353					
40			10.92	0.382					
10			9.53	0.404					
SAMPLE DIMENSIONS AND PROPERTIES _ FINAL									
Sample Height (mm) :		18.55				Unit Weight (kN/m ³) :		22.34	
Sample Diameter (mm) :		50.00				Dry Unit Weight (kN/m ³) :		19.26	
Area (cm ²) :		19.63				Specific Gravity (Assumed) :		2.757	
Volume (cm ³) :		36.42				Solid Height (mm) :		13.21	
Water Content (%) :		15.95				Volume of Solids (cm ³) :		25.94	
Wet Mass (g) :		82.94				Volume of Voids (cm ³) :		10.47	
Dry Mass (g) :		71.53							
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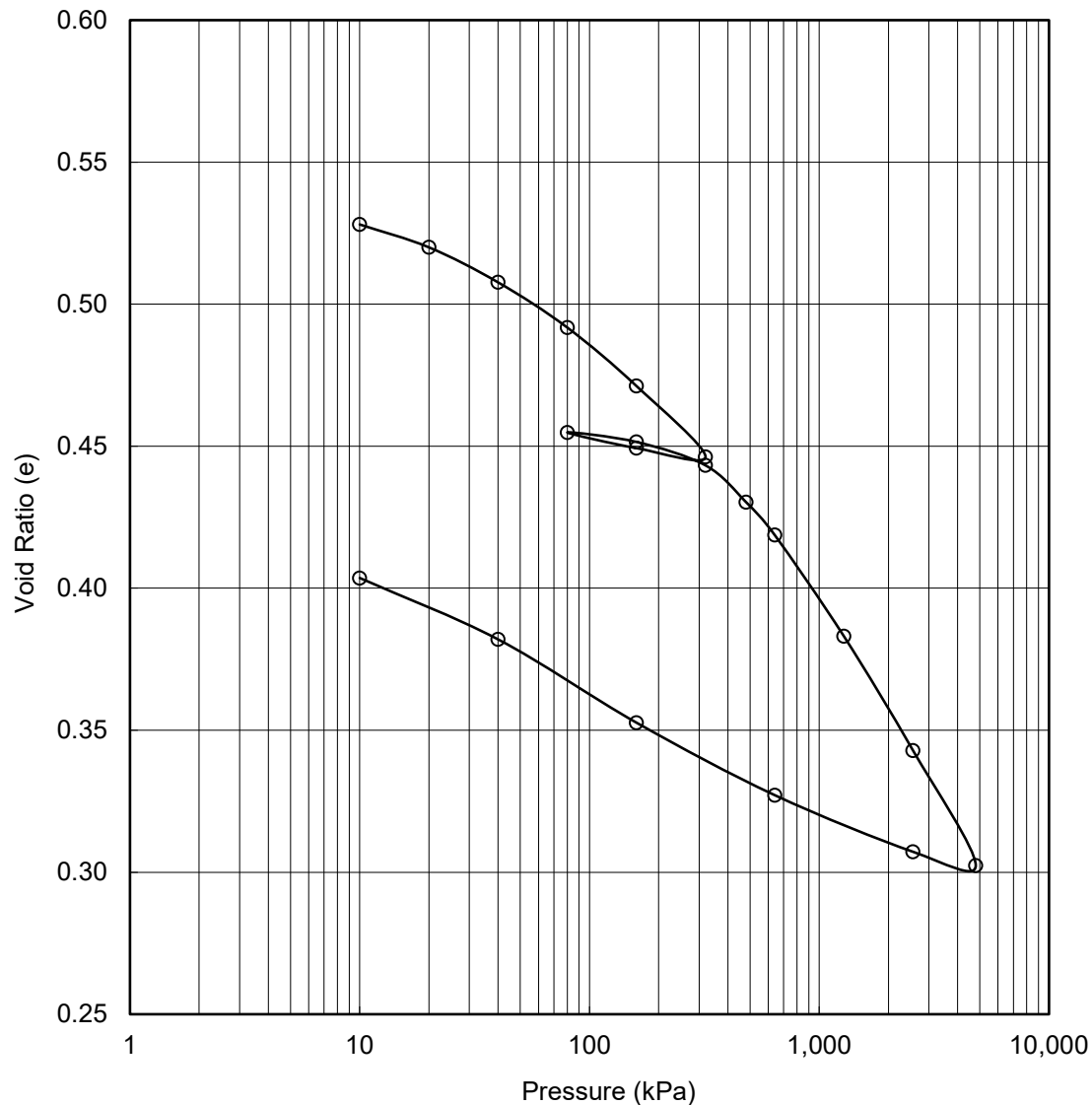
CONSOLIDATION TEST

FIGURE 1

MTO Hwy 3 Talbotville Bypass

BH CNR EMB7, ST1

Void Ratio vs Pressure



NB: Not enough sample available for Atterberg Limits Testing

Soil Type : Overconsolidated silty clay , hard, brown, moist

$e_o =$	0.551	$w_L =$	N/A	$\sigma_{v0}' =$	kPa
$w =$	19.2%	$w_p =$	N/A	$\sigma_p' =$	kPa
$\gamma =$	20.8 kN/m ³	$PI =$	N/A		
$G_s =$	2.757				

Project No. : 165001308.451.102
Date : 16-Aug-24



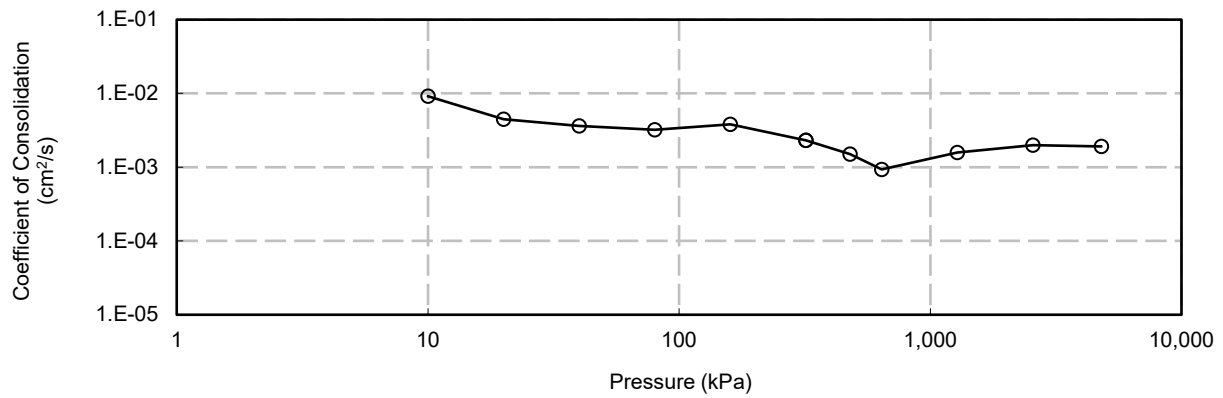
Prepared By : DB
Checked By : RG

CONSOLIDATION TEST

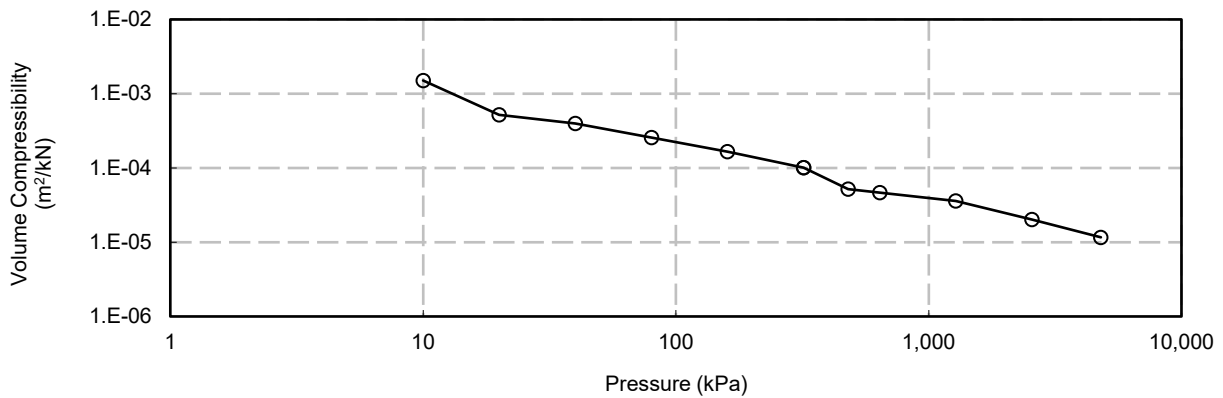
FIGURES 2, 3 & 4

*MTO Hwy 3 Talbotville Bypass
BH CNR EMB7, ST1*

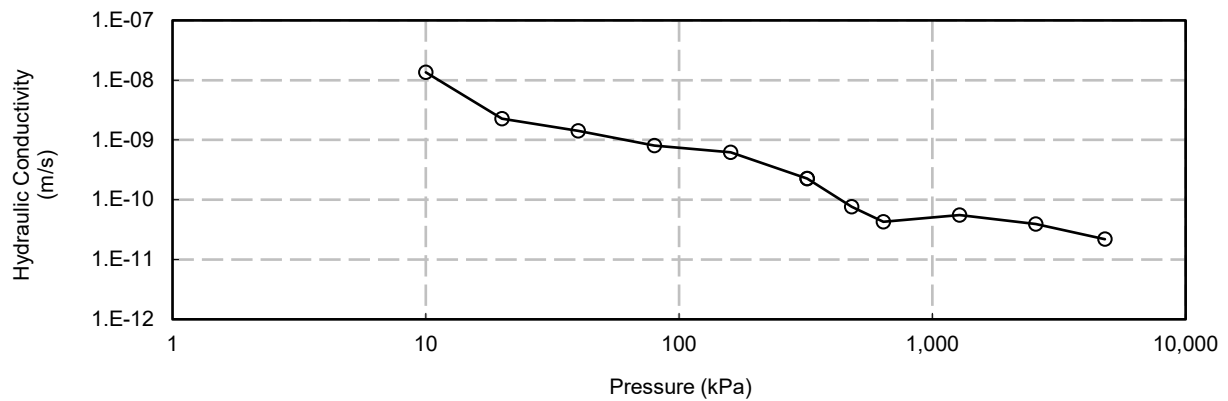
Cv vs Pressure



mv vs Pressure



k vs Pressure



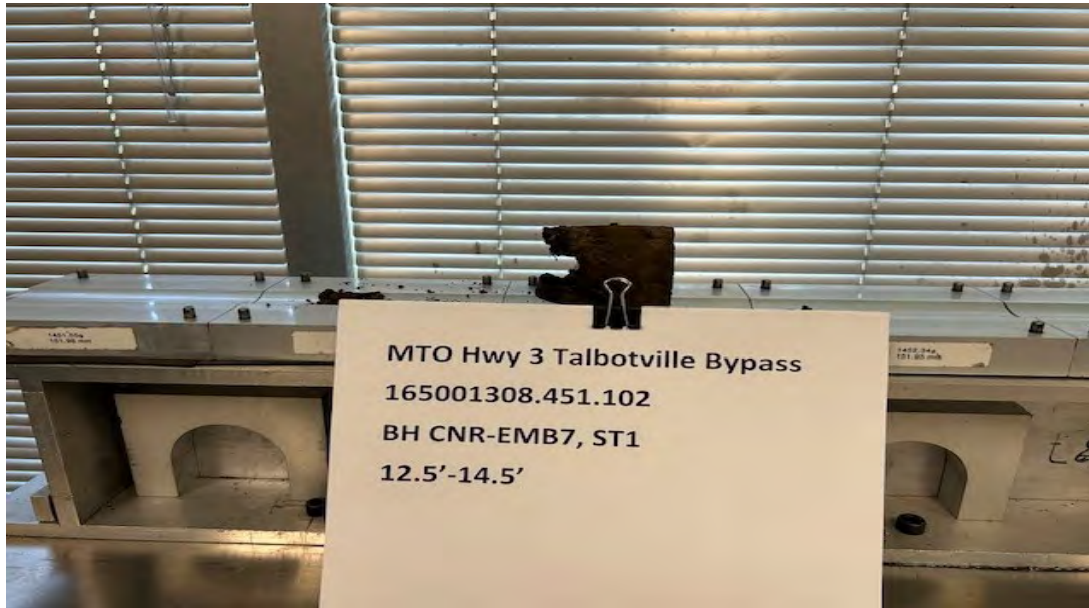
Project No. : 165001308.451.102
Date : 16-Aug-24



Prepared By : DB
Checked By : RG

MTO Hwy 3 Talbotville Bypass

Overconsolidated silty clay , hard, brown, moist



BH CNR EMB7, ST1



BH CNR EMB7, ST1

Project No. : 165001308.451.102

Date : 16-Aug-2024



Prepared by : DB

Checked by : RG

CONSOLIDATION TEST SUMMARY									
SAMPLE IDENTIFICATION									
Borehole No. :	BH CNR EMB9				Sample No. :	ST2			
					Sample Depth (ft) :	20-22			
TEST CONDITIONS									
Test Type :	ASTM D2435/D2435M				Date Started :	19-Aug-24			
Load Duration (hr) :	Method B				Date Completed :	21-Aug-24			
SAMPLE DIMENSIONS AND PROPERTIES _ INITIAL									
Sample Height (mm) :	20.50				Unit Weight (kN/m ³) :	21.99			
Sample Diameter (mm) :	50.00				Dry Unit Weight (kN/m ³) :	19.24			
Area (cm ²) :	19.63				Specific Gravity : (Assumed)	2.764			
Volume (cm ³) :	40.25				Solid Height (mm) :	14.55			
Water Content (%) :	14.32				Volume of Solids (cm ³) :	28.57			
Wet Mass (g) :	90.27				Volume of Voids (cm ³) :	11.68			
Dry Mass (g) :	78.96				Degree of Saturation (%) :	96.80			
TEST COMPUTATIONS									
		Corrected	Axial	Void Ratio	t ₉₀	C _v	m _v	k	
Axial Stress	Height (H)	Deformation (ΔH)	Strain (ε _a)	e	(sec)	(cm ² /s)	(m ² /kN)	(m/s)	
(kPa)	(mm)	(mm)	(%)						
0	20.5000			0.409					
10	20.3219	0.1781	0.94	0.396	122.98	7.13E-03	9.44E-04	6.61E-09	
20	20.2445	0.2555	1.37	0.390	211.15	4.12E-03	4.24E-04	1.72E-09	
40	20.1241	0.3759	2.00	0.381	279.16	3.08E-03	3.18E-04	9.62E-10	
80	19.9689	0.5311	2.79	0.370	311.81	2.72E-03	1.97E-04	5.27E-10	
160	19.7773	0.7227	3.73	0.356	368.09	2.26E-03	1.17E-04	2.59E-10	
320	19.5546	0.9454	4.80	0.341	353.68	2.31E-03	6.73E-05	1.52E-10	
160	0.0000	0.0000	4.64	0.344	0.00	0.00E+00	1.04E-05	0.00E+00	
80	0.0000	0.0000	4.37	0.347	0.00	0.00E+00	3.40E-05	0.00E+00	
160	19.5767	0.9233	4.53	0.345	196.60	4.14E-03	2.04E-05	8.26E-11	
320	19.5086	0.9914	4.93	0.340	162.42	4.98E-03	2.52E-05	1.23E-10	
480	19.4042	1.0958	5.50	0.332	278.89	2.87E-03	3.52E-05	9.91E-11	
640	19.3047	1.1953	5.99	0.325	281.65	2.81E-03	3.09E-05	8.52E-11	
1280	19.0038	1.4962	7.56	0.303	220.48	3.50E-03	2.45E-05	8.41E-11	
2560	18.6238	1.8762	9.48	0.275	181.68	4.10E-03	1.50E-05	6.04E-11	
4800	18.2038	2.2962	11.64	0.245	127.16	5.61E-03	9.64E-06	5.30E-11	
2560			11.38	0.249					
640			10.22	0.265					
160			8.68	0.287					
40			7.21	0.307					
10			6.05	0.324					
SAMPLE DIMENSIONS AND PROPERTIES _ FINAL									
Sample Height (mm) :	19.26				Unit Weight (kN/m ³) :	23.07			
Sample Diameter (mm) :	50.00				Dry Unit Weight (kN/m ³) :	20.48			
Area (cm ²) :	19.63				Specific Gravity (Assumed) :	2.764			
Volume (cm ³) :	37.82				Solid Height (mm) :	14.55			
Water Content (%) :	12.68				Volume of Solids (cm ³) :	28.57			
Wet Mass (g) :	88.97				Volume of Voids (cm ³) :	9.25			
Dry Mass (g) :	78.96								
Project No. : 165001308.451.102					Prepared By : DB				
Date : 24-Aug-24					Checked By : RG				



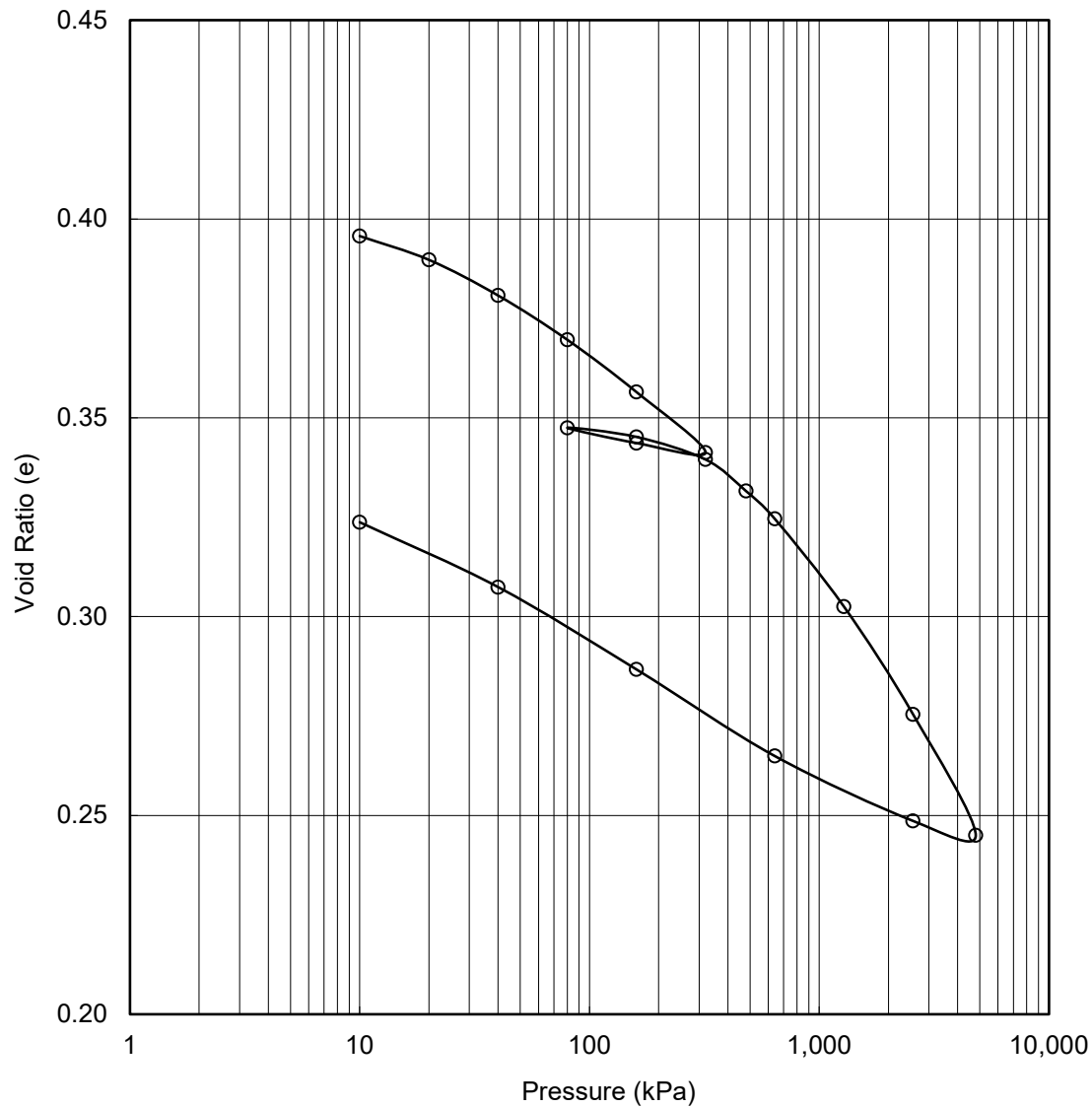
CONSOLIDATION TEST

FIGURE 1

MTO Hwy 3 Talbotville Bypass

BH CNR EMB9, ST2

Void Ratio vs Pressure



Soil Type : Overconsolidated Lean clay till of low plasticity, very stiff, brown, moist, CL

$e_o =$	0.409	$w_L =$	28.4%	$\sigma_{v0}' =$	kPa
$w =$	14.3%	$w_p =$	15.6%	$\sigma_p' =$	kPa
$\gamma =$	22.0 kN/m ³	$PI =$	12.8%		
$G_s =$	2.764				

Project No. : 165001308.451.102
Date : 24-Aug-24



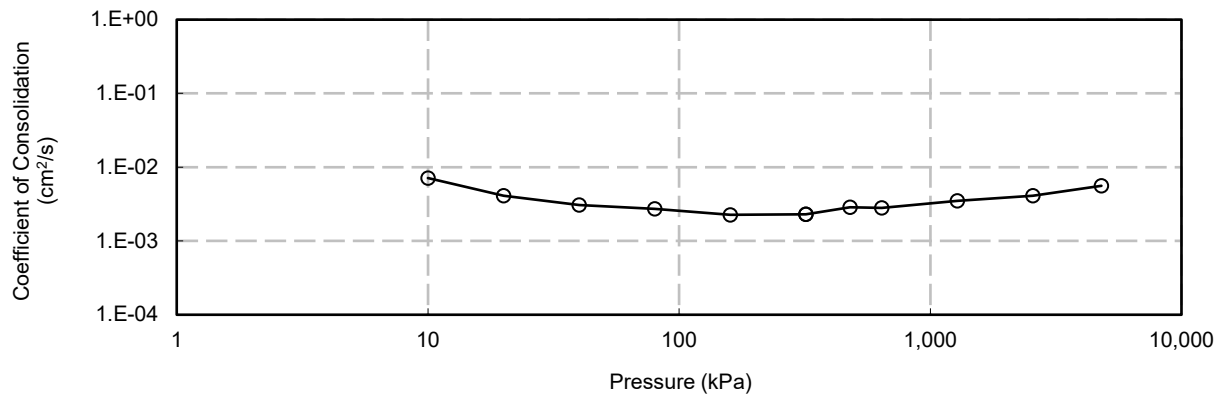
Prepared By : DB
Checked By : RG

CONSOLIDATION TEST

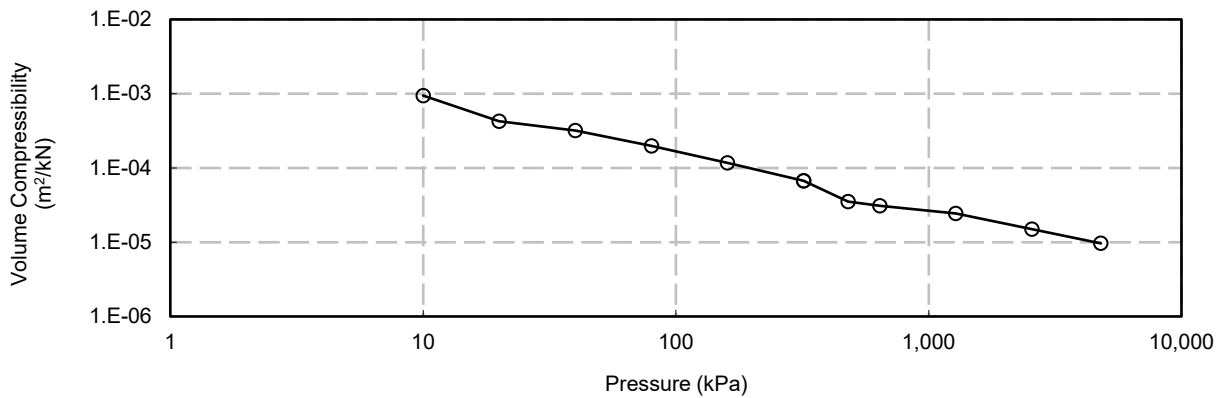
FIGURES 2, 3 & 4

*MTO Hwy 3 Talbotville Bypass
BH CNR EMB9, ST2*

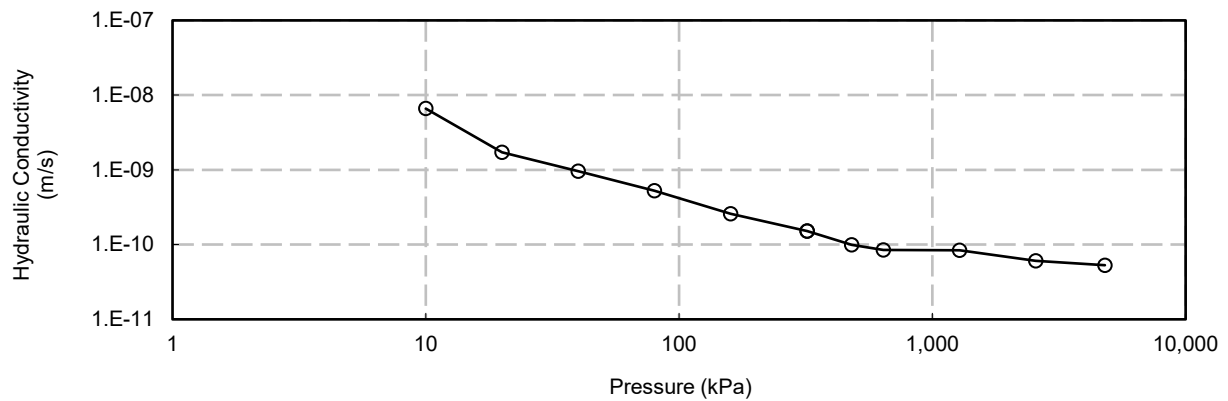
Cv vs Pressure



mv vs Pressure



k vs Pressure



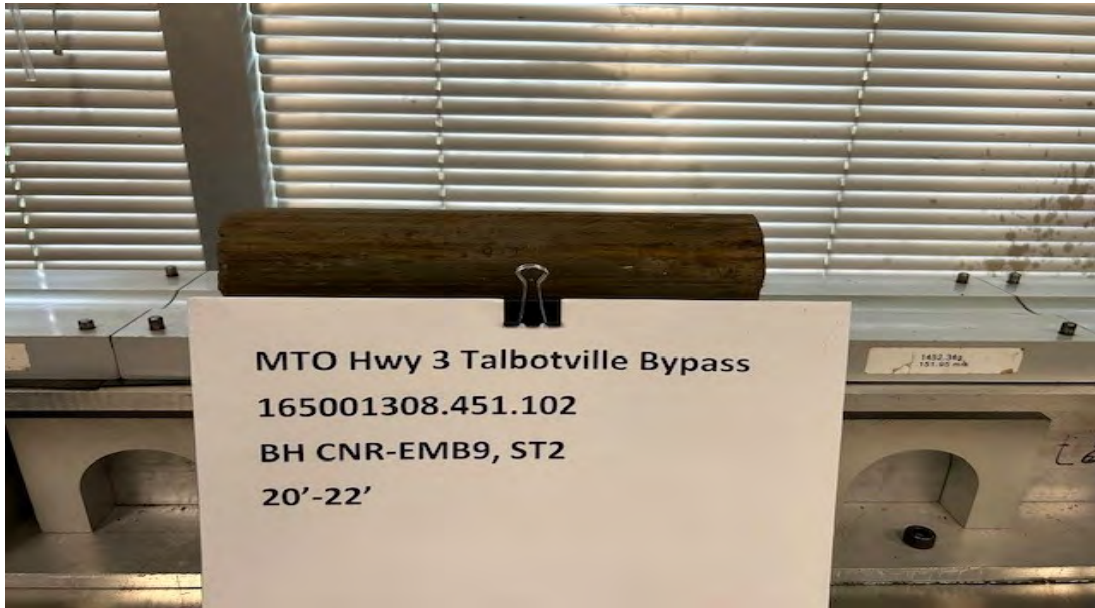
Project No. : 165001308.451.102
Date : 24-Aug-24



Prepared By : DB
Checked By : RG

MTO Hwy 3 Talbotville Bypass

Overconsolidated Lean clay till of low plasticity, very stiff, brown, moist, CL



BH CNR EMB9, ST2



BH CNR EMB9, ST2

Project No. : 165001308.451.102

Date : 24-Aug-2024



Prepared by : DB

Checked by : RG

CONSOLIDATION TEST SUMMARY									
SAMPLE IDENTIFICATION									
Borehole No. :		BH CNR EMB11				Sample No. :		ST1	
						Sample Depth (ft) :		48-50	
TEST CONDITIONS									
Test Type :		ASTM D2435/D2435M				Date Started :		9-Aug-24	
Load Duration (hr) :		Method B				Date Completed :		11-Aug-24	
SAMPLE DIMENSIONS AND PROPERTIES _ INITIAL									
Sample Height (mm) :		20.50				Unit Weight (kN/m ³) :		20.98	
Sample Diameter (mm) :		50.00				Dry Unit Weight (kN/m ³) :		17.91	
Area (cm ²) :		19.63				Specific Gravity :		2.757	
Volume (cm ³) :		40.25				Solid Height (mm) :		13.58	
Water Content (%) :		17.12				Volume of Solids (cm ³) :		26.67	
Wet Mass (g) :		86.11				Volume of Voids (cm ³) :		13.58	
Dry Mass (g) :		73.52				Degree of Saturation (%) :		92.68	
TEST COMPUTATIONS									
		Corrected	Axial	Void Ratio	t ₉₀	C _v	m _v	k	
Axial Stress	Height (H)	Deformation (ΔH)	Strain (ε _a)	e	(sec)	(cm ² /s)	(m ² /kN)	(m/s)	
(kPa)	(mm)	(mm)	(%)						
0	20.5000	0.0000	0.00	0.509					
10	20.1934	0.3066	1.72	0.483	95.62	9.07E-03	1.72E-03	1.53E-08	
20	20.0857	0.4143	2.18	0.476	304.66	2.81E-03	4.64E-04	1.28E-09	
40	19.9713	0.5287	2.82	0.467	195.22	4.34E-03	3.17E-04	1.35E-09	
80	19.8170	0.6830	3.61	0.455	188.88	4.42E-03	1.99E-04	8.62E-10	
160	19.6054	0.8946	4.60	0.440	287.64	2.85E-03	1.23E-04	3.44E-10	
320	19.3592	1.1408	5.84	0.421	266.12	3.01E-03	7.73E-05	2.28E-10	
160			5.66	0.424					
80			5.37	0.428					
160	19.3683	1.1317	5.55	0.426	184.13	4.32E-03	2.16E-05	9.18E-11	
320	19.2941	1.2059	5.97	0.419	189.33	4.18E-03	2.68E-05	1.10E-10	
480	19.1928	1.3072	6.64	0.409	149.89	5.23E-03	4.17E-05	2.14E-10	
640	19.0478	1.4522	7.28	0.399	312.30	2.47E-03	4.02E-05	9.74E-11	
1280	18.6872	1.8128	9.27	0.370	201.36	3.72E-03	3.10E-05	1.13E-10	
2560	18.2258	2.2742	11.58	0.335	175.57	4.08E-03	1.81E-05	7.24E-11	
4800	17.7164	2.7836	13.98	0.298	191.37	3.54E-03	1.07E-05	3.71E-11	
2560			13.74	0.302					
640			12.65	0.319					
160			11.15	0.341					
40			9.55	0.365					
10			7.99	0.389					
SAMPLE DIMENSIONS AND PROPERTIES _ FINAL									
Sample Height (mm) :		18.86				Unit Weight (kN/m ³) :		22.27	
Sample Diameter (mm) :		50.00				Dry Unit Weight (kN/m ³) :		19.47	
Area (cm ²) :		19.63				Specific Gravity :		2.757	
Volume (cm ³) :		37.03				Solid Height (mm) :		13.58	
Water Content (%) :		14.42				Volume of Solids (cm ³) :		26.67	
Wet Mass (g) :		84.12				Volume of Voids (cm ³) :		10.37	
Dry Mass (g) :		73.52							
Project No. :		165001308.451.102				Prepared By :		DB	
Date :		16-Aug-24				Checked By :		RG	



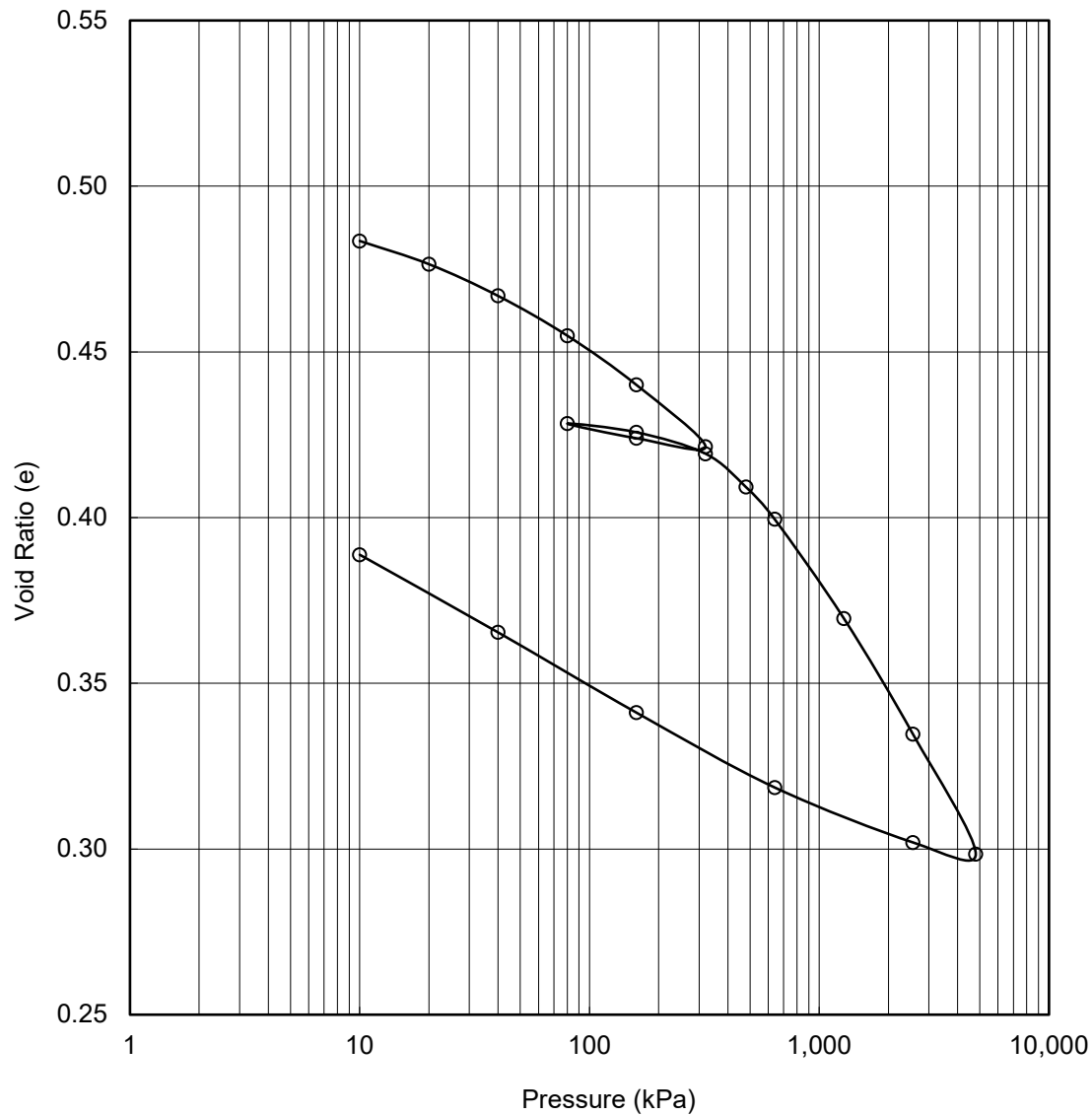
CONSOLIDATION TEST

FIGURE 1

MTO Hwy 3 Talbotville Bypass

BH CNR EMB11, ST1

Void Ratio vs Pressure



Soil Type : *Overconsolidated Lean clay of low plasticity , hard, brown, moist, -CL*

$e_o =$	0.509	$w_L =$	28.9%	$\sigma_{v0}' =$	kPa
$w =$	17.1%	$w_p =$	16.2%	$\sigma_p' =$	kPa
$\gamma =$	21.0 kN/m ³	$PI =$	12.7%		
$G_s =$	2.757				

Project No. : 165001308.451.102
Date : 16-Aug-24



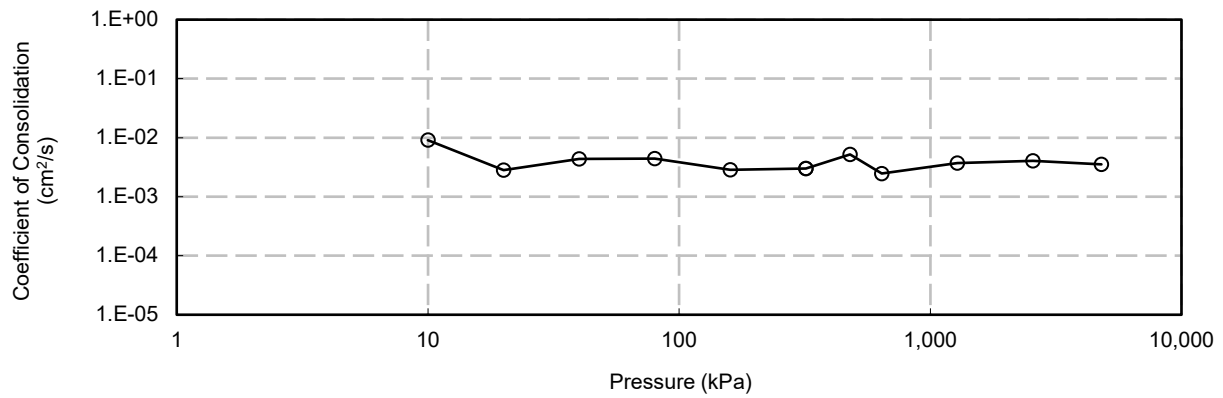
Prepared By : DB
Checked By : RG

CONSOLIDATION TEST

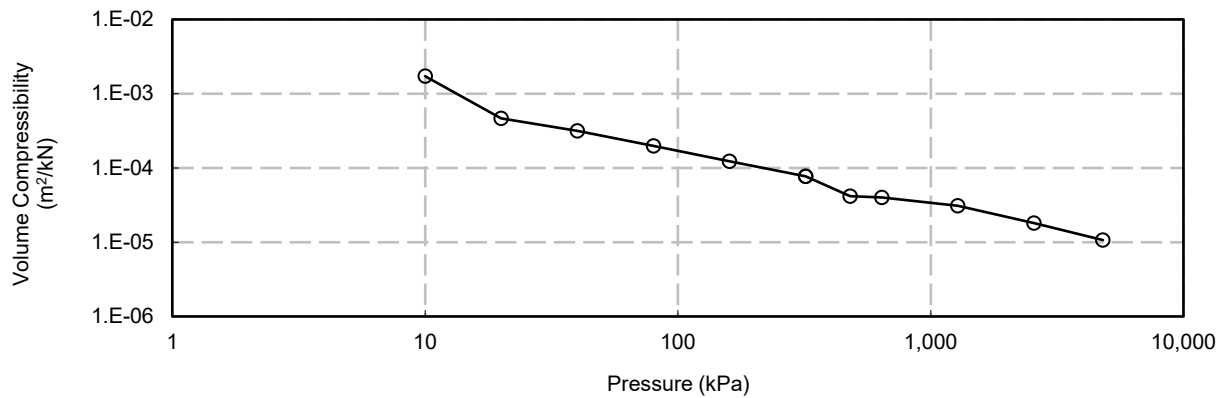
FIGURES 2, 3 & 4

MTO Hwy 3 Talbotville Bypass
BH CNR EMB11, ST1

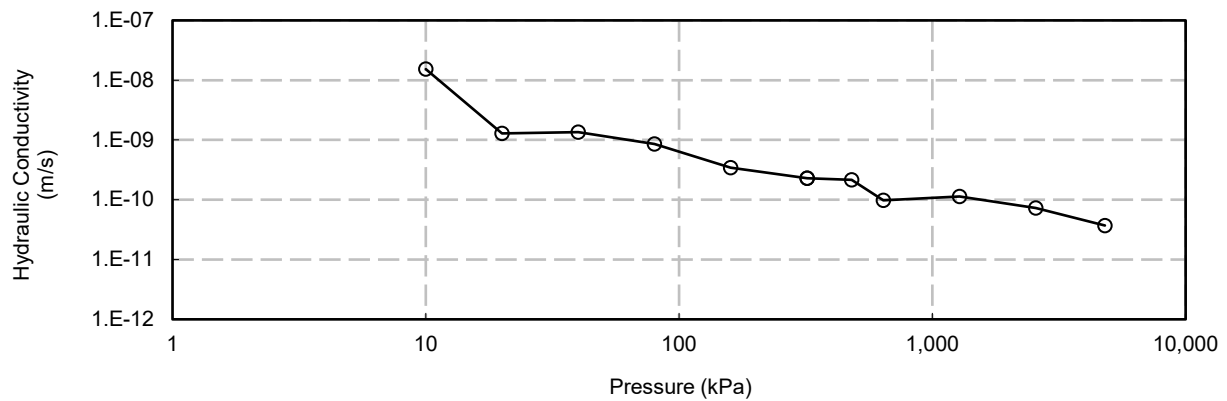
Cv vs Pressure



mv vs Pressure



k vs Pressure



Project No. : 165001308.451.102
 Date : 16-Aug-24



Prepared By : DB
 Checked By : RG

MTO Hwy 3 Talbotville Bypass

Overconsolidated Lean clay of low plasticity , hard, brown, moist, -CL



BH CNR EMB11, ST1



BH CNR EMB11, ST1

Project No. : 165001308.451.102

Date : 16-Aug-2024



Prepared by : DB

Checked by : RG