



**THURBER** ENGINEERING LTD.

**PRELIMINARY  
FOUNDATION INVESTIGATION DESIGN REPORT  
HIGHWAY 17 TWINNING, RENFREW AREA  
CULVERTS 10 AND 10N  
STA. 19+200, HORTON TOWNSHIP  
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009**

Geocres No.: 31F07-005

Report to:

**Ministry of Transportation Ontario**

Latitude: 45.492056°  
Longitude: -76.667592°

December 2024  
Thurber File No.: 24726



## TABLE OF CONTENTS

### PART 1. FACTUAL INFORMATION

1	INTRODUCTION .....	1
2	SITE DESCRIPTION.....	1
2.1	General.....	1
2.2	Site Geology .....	2
3	SITE INVESTIGATION AND FIELD TESTING.....	3
4	LABORATORY TESTING .....	5
5	GENERAL DESCRIPTION OF SUBSURFACE CONDITIONS .....	5
5.1	Asphalt .....	5
5.2	Embankment Fill.....	6
5.2.1	Silty Sand, some Gravel Fill .....	6
5.2.2	Silty Clayey Sand with Gravel to Sandy Clayey Silt Fill .....	6
5.3	Clay to Silty Clay to Clayey Silt (CH to CI to CL/CL-ML) .....	7
5.4	Silty Sand with Gravel (Glacial Till) .....	8
5.5	Refusal .....	9
5.6	Groundwater.....	9
5.7	Analytical Testing .....	10
6	MISCELLANEOUS .....	10



## **APPENDICES**

- |             |   |
|-------------|---|
| Appendix A. | Borehole Location Plan and Stratigraphic Drawings |
| Appendix B. | Record of Borehole Sheets                         |
| Appendix C. | Laboratory Testing                                |
| Appendix D. | Site Photographs                                  |



**PRELIMINARY  
FOUNDATION INVESTIGATION DESIGN REPORT  
HIGHWAY 17 TWINNING, RENFREW AREA  
CULVERTS 10 AND 10N  
STA. 19+200, HORTON TOWNSHIP  
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009**

**Geocres No.: 31F07-005**

**PART 1. FACTUAL INFORMATION**

## **1 INTRODUCTION**

Thurber Engineering Ltd. (Thurber) has been engaged by the Ministry of Transportation Ontario (MTO) to carry out Foundation Investigations to support the design of the Highway 17 Twinning Project which extends from Scheel Drive westerly to 3 km west of Bruce Street within the County of Renfrew, Ontario. Thurber carried out the investigation under Ministry of Transportation (MTO) Assignment No. 4018-E-0009.

This report addresses the culvert crossing near Sta. 19+200 on Highway 17 in Horton Township within Renfrew County, Ontario. The existing Highway 17 alignment at this site will become the future Highway 17 westbound lanes and new eastbound lanes will be constructed to the south. The existing culvert will be replaced, and a new culvert is required to convey an unnamed tributary of the Bonnechere River below an embankment supporting the proposed Highway 17 eastbound lanes.

This section of the report presents the factual findings obtained from the foundation investigation conducted by Thurber as part of the current study.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions.

It should be noted that the use of and reliance on Part 1 of the Report is governed by and limited to the terms and conditions set out in the Report and a reliance letter. The Preferred Proponent remains responsible to assess the need for additional investigations and to complete that work.

## **2 SITE DESCRIPTION**

### **2.1 General**

For project purposes, Highway 17 is herein described as oriented east-west, and the culvert is described as oriented north-south. The site is located on Highway 17 approximately 600 m east of the Highway 17 intersection with Bruce St and Castleford Rd in Horton Township, Renfrew, Ontario.



In the area of the culvert, existing Highway 17 is an undivided highway with two travelled lanes, a partially paved/gravel shoulder on the eastbound side, an asphalt shoulder on the westbound side and a posted speed limit of 90 km/hr. The road surface near the culvert is at approximate elevation 137.3 m. Steel cable guide rail on wooden posts is present along both shoulders. The traffic volume for this section of Highway 17 is understood to have been 12,300 AADT in 2016.

The existing culvert is a 900 mm diameter, 37 m long, corrugated steel pipe (CSP) culvert oriented approximately perpendicular to the highway alignment. The culvert has an approximate gradient of approximately 4.8 % with the invert of the culvert near elevations 132.2 and 130.4 m at the inlet and outlet, respectively. The cover above the existing culvert is approximately 5 m at the highway centerline. The tributary flows through the culvert under the highway embankment from north to south. It is understood that the general drainage is near parallel to the south side of the highway alignment to the east of the culvert. The elevation of standing water near the outlet was measured as 130.8 m on July 25, 2024.

Embankment side slopes, in the vicinity of the culvert, are inclined at approximately 2.5H:1V on the north side and 1.7H:1V on the south side. The existing embankment side slopes at the culvert site did not show any visible signs of global instability at the time of the investigation.

The site is in a rural setting, and the terrain along the ditch line is relatively flat on the south side and sloped on the north side in the vicinity of the culvert site. The area directly adjacent to the culvert is mostly farmland with some deciduous trees and shrubs. Bedrock outcrops are present on both sides of the highway approximately 135 m to the west of the site. It is noted that a tile drain from the adjacent farm field is present near the toe of the slope near the culvert outlet. Furthermore, it is understood that there have been reported issues with drainage of the pavement structure 150 m west of the culvert; water has been observed seeping from the shoulders at this location.

Photographs of the project area are included in Appendix D. These photographs show the existing condition of the highway embankment and the culvert at the time of the field investigation.

## **2.2 Site Geology**

Under the same MTO Assignment, a foundation investigation was conducted by Thurber for several high fill locations within the Highway 17 twinning project boundaries. The available information was reviewed prior to this investigation and can be found in the Geocres Library under Geocres Number 31F-235. Borehole B-HF-03 and CPTu B-HF-02B from that investigation are relevant to the present report and have been included in Appendix B.

According to Crins et al. 2009<sup>1</sup>, the project area is described as Ecoregion 6E (Lake Simcoe-Rideau Ecoregion) within the Mixedwood Plains Ecozone. According to Wester et al. 2018<sup>2</sup>, the ecoregion is subdivided into Ecodistrict 6E-16 (Pembroke Ecodistrict). The area is characterized by glaciolacustrine dominated landscape overlying a mix of Paleozoic to Precambrian bedrock.

---

<sup>1</sup> <https://files.ontario.ca/mnrf-ecosystemspart1-accessible-july2018-en-2020-01-16.pdf>

<sup>2</sup> <https://files.ontario.ca/ecosystems-ontario-part2-03262019.pdf>



Based on published geological information in *The Physiography of Southern Ontario* by Chapman and Putnam (1984), the site lies within the physiographic region known as the Ottawa Valley Clay Plains. The Ottawa Valley Clay Plains are characterized primarily by clay plains deposited by the Champlain Sea (Leda Clay) interrupted by ridges of rock or sand.

Ontario Geological Survey Map P.2366<sup>3</sup> suggests for the site area marine deeper water deposits of clay, silty clay and clayey silt.

Ontario Geological Survey Map 2460<sup>4</sup> suggests the bedrock comprises calcitic carbonate metasedimentary bedrock including calcitic and siliceous marble.

### 3 SITE INVESTIGATION AND FIELD TESTING

Borehole B-HF-03 was drilled off-road in August 2021, using a CME 850 track mounted drill equipped with hollow stem augers and HQ casing. ConeTec Investigations Ltd. completed the CPT B-HF-02B test in August 2021; the hole was advanced with the support of a GTech GT6 track-mounted drill rig. Further details on the 2021 test holes can be found in Geocres Report Number 31F-235.

Additional foundation investigation and field-testing program was carried out between March 21 and April 15, 2024, and consisted of one on-road borehole identified as SC10-2 and four off-road boreholes identified as SC10-1, SC10-3, SC10-4 and SC10-5. Borehole SC10-2 was advanced with a CME 55 truck mounted drill rig utilizing hollow stem augers and NW casing. Boreholes SC10-4 and SC10-5 were advanced with a CME 75 track mounted drill rig utilizing hollow stem augers and NW casing. Boreholes SC10-1 and SC10-3 were advanced with portable drilling equipment. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

A summary of the borehole coordinates, elevations, and termination depths is provided in Table 3-1. The locations and elevations of the 2024 boreholes were surveyed by Thurber with a Trimble Catalyst DA1 antenna with centimeter accuracy and were measured relative to BM HCP 102 (Elevation 129.023 m) and HCP118 (Elevation 139.303 m). Horizontal locations were measured by Thurber relative to existing site features. The elevations and borehole coordinates were reviewed and referenced to the survey data provided by the MTO. The borehole coordinates and elevations are shown on the Borehole Location and Soil Strata drawing included in Appendix A and on the individual Record of Borehole sheets included in Appendix B. The borehole coordinates are referenced to MTM Zone 9.

---

<sup>3</sup> <https://www.geologyontario.mndm.gov.on.ca/mndmfiles/pub/data/imaging/P2366/P2366.pDf>

<sup>4</sup> [https://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm\\_dir.asp?type=pub&id=M2460](https://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm_dir.asp?type=pub&id=M2460)

**Table 3-1: Borehole Summary**

<b>Borehole No.</b>	<b>Drilled Location</b>	<b>Northing (Latitude)</b>	<b>Easting (Longitude)</b>	<b>Ground Surface Elevation (m)</b>	<b>Termination Depth (m)</b>
SC10-1	Existing Inlet	5 039 147.0 (45.492124)	291 720.0 (-76.667346)	132.6	10.4
SC10-2	On-road	5 039 148.7 (45.492139)	291 702.8 (-76.667566)	137.3	22.5
SC10-3	Existing Outlet	5 039 124.1 (45.491917)	291 683.2 (-76.667817)	132.2	12.0
SC10-4	Near Proposed Culvert Inlet	5 039 119.0 (45.491871)	291 663.2 (-76.668073)	130.2	13.6
SC10-5	Near Proposed Culvert Outlet	5 039 104.2 (45.491737)	291 646.7 (-76.668284)	129.7	13.6
B-HF-03	East of Proposed Culvert	5 039 087.7 (45.491591)	291 685.7 (-76.667784)	129.9	25.3
B-HF-02B (CPTu)	West of Proposed Culvert	5 039 153.7 (45.492183)	291 649.8 (-76.668245)	130.5	18.8

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in general accordance with ASTM D 1586. A full size hammer was used with the portable drill; thus, no hammer energy corrections were required. In-situ shear vane testing was carried out within the cohesive layers, where possible, using an MTO 'N' sized vane in general accordance with ASTM D 2573. A Thin-Walled (Shelby) Tube was pushed in Boreholes SC10-4 and SC10-5 to obtain relatively undisturbed cohesive soil samples for further laboratory testing.

Monitoring wells were installed in Boreholes SC10-1 (50 mm diameter), SC10-5 (50 mm diameter) and B-HF-03 (38 mm diameter) to allow for measurements of the groundwater level after drilling. The details for the well are illustrated on the respective Record of Borehole sheets provided in Appendix B. The monitoring wells installed as part of the current investigation will be decommissioned by Thurber, as outlined in the Hydrogeological Investigation and Design Report.

Boreholes SC10-2, SC10-3 and SC10-4 were backfilled in accordance with MOE requirements (O.Reg 903, as amended). Borehole SC10-2 was capped with cold patch asphalt to reinstate the pavement surface.

The drilling and sampling operations were supervised on a full-time basis by a member of Thurber's technical staff. The drilling supervisor logged the boreholes and processed the



recovered soil samples for transport to Thurber's Ottawa laboratory for further examination and testing.

#### **4 LABORATORY TESTING**

Laboratory testing on the 2024 samples was selected in accordance with the current MTO Guideline for Foundation Engineering Services, Section 5. Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all retained soil samples. At least 25% of the recovered soil samples were subjected to testing for grain size distribution analysis and, where appropriate, Atterberg Limits in accordance with MTO and ASTM standards.

One dimensional consolidation testing (ASTM D 2435) was completed on a selected Thin-Walled (Shelby) tube sample from borehole SC10-4.

Chemical analyses for determination of pH, conductivity, resistivity, sulphide, sulphate and chloride were carried out on two samples of the soil.

The results of the geotechnical tests are summarized on the Record of Borehole sheets included in Appendix B and all laboratory results are presented on the figures included in Appendix C.

#### **5 GENERAL DESCRIPTION OF SUBSURFACE CONDITIONS**

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and the Borehole Location and Soil Strata Drawing included in Appendix A. A general description of the stratigraphy based on the conditions encountered in the boreholes is given in the following sections. However, the factual data presented on the Borehole Records takes precedence over the Soil Strata Drawing and the general description. It must be recognized that the soil and groundwater conditions may vary between and beyond borehole locations. Soil descriptions are in accordance with the MTO Guideline for Foundation Engineering Services Manual (April 2022) and the 4<sup>th</sup> Edition of the Canadian Foundation Engineering Manual.

In general, the encountered stratigraphy consists of a gravel with sand to silty sand some gravel fill, overlying a weathered clay to silty clay crust overlying a deep silty clay to clayey silt deposit overlying glacial till. Bedrock was not proven with coring but was inferred in borehole B-HF-03. One CPT test, available from the online Geocres Library under Geocres Number 31F-235, was carried out in a location close to the culvert site. The results are summarized on figures presented in Appendix B.

##### **5.1 Asphalt**

Asphalt was encountered at the ground surface in Borehole SC10-2. The asphalt was measured to have a thickness of 50 mm.



## 5.2 Embankment Fill

### 5.2.1 Silty Sand, some Gravel Fill

A fill layer consisting of silty sand some gravel was encountered below the asphalt in on-road Borehole SC10-2. The thickness of the layer was 5.3 m (base elevation at 132.0 m). The SPT N values ranged from 2 to greater than 100 blows, indicating a very loose to very dense condition.

The moisture content of the samples tested ranged from 3% and 18%. The results of grain size analyses conducted on two samples of this fill material are summarized in the table below and are illustrated on Figure C1 in Appendix C.

#### Summary of Grain Size Distribution Testing – Gravel with Sand to Silty Sand, some Gravel Fill

Soil Particle	Percentage (%)
Gravel	11 – 12
Sand	70 – 72
Silt & Clay	16 – 19

### 5.2.2 Silty Clayey Sand with Gravel to Sandy Clayey Silt Fill

A fill layer consisting of silty clayey sand with gravel to sandy clayey silt containing some organics was encountered at ground surface in Boreholes SC10-1 and SC10-3. The thickness of the layer ranged from 0.9 to 1.5 m (base elevation at 131.7 to 130.7 m). The SPT N values ranged from 2 to 12 blows, indicating a very loose to compact relative density.

The moisture content of the samples tested ranged from 22% to 38%. The results of grain size analyses conducted on two samples of this fill material are summarized in the table below and are illustrated on Figure C2 in Appendix C.

#### Summary of Grain Size Distribution Testing – Silty Sand with Clay and Gravel Fill

Soil Particle	Percentage (%)
Gravel	0
Sand	25 – 30
Silt	41 – 44
Clay	26 – 34

The results of Atterberg Limits testing carried out on two samples of this fill material are summarized below and are illustrated on Figure C3 in Appendix C. The laboratory results indicate the fill is of low plasticity (CL).

#### Summary of Atterberg Limit Testing – Silty Sand with Clay and Gravel Fill

Parameter	Value
Liquid Limit	30 – 31
Plastic Limit	17 – 20
Plasticity Index	11 – 13

### 5.3 Clay to Silty Clay to Clayey Silt (CH to CI to CL/CL-ML)

A native deposit of clay to silty clay to clayey silt was encountered below the fill layer in Boreholes SC10-1, SC10-2 and SC10-3 and at ground surface in Boreholes B-HF-03, SC10-4 and SC10-5. Sand seams were encountered throughout the layer and were noted to be more frequent with depth. The layer was fully penetrated only in borehole B-HF-03 but was proven to be at least 9.5 to 22.3 m thick and extend to depths ranging from 10.4 to 22.3 m (base elev. 122.2 to 107.6 m). In boreholes B-HF-03, SC10-4 and SC10-5, the top portion of the layer was noted to be weathered crust ranging in thickness from 7.6 m to 7.8 m (base elevation 122.4 m to 122.1 m).

Where SPT were conducted within the layer, the N-values typically ranged from weight-of-hammer (WH) to 17 blows. N-values as high as 20 to 26 blows were noted in the layer in the portable Boreholes SC10-1, SC10-3. Field vane tests were performed within this layer where possible. Undrained shear strengths were obtained and ranged from 52 to greater than 100 kPa. Remolded vane tests recorded sensitivities typically ranging from 3 to 18, indicating that the clay is medium to high sensitive (CFEM, 2023). The layer is described as stiff to very stiff in consistency based on N-values, undrained shear strength measurements, and tactile evaluations of strength.

The moisture content of the samples tested ranged from 21 to 48%. The results of grain size analysis tests conducted on nineteen samples of this material are summarized in the table below and are illustrated on Figures C4 to C7 in Appendix C.

#### Summary of Grain Size Distribution Testing – Clay to Silty Clay to Clayey Silt

Soil Particle	Percentage (%)
Gravel	0
Sand	0 – 10
Silt	40 – 73
Clay	21 – 59

The results of Atterberg Limits testing carried out on nineteen samples of this material are summarized below and are illustrated on Figure C8 to C11 in Appendix C. The laboratory results indicate that the clay to silty clay to clayey silt generally exhibits low to high plasticity (CH to CI to CL-ML).

#### Summary of Atterberg Limit Testing – Clay to Silty Clay to Clayey Silt

Parameter	Value
Liquid Limit	22 – 51
Plastic Limit	15 – 27
Plasticity Index	7 – 30

One-dimensional consolidation testing (ASTM D 2435) was carried out on one relatively undisturbed cohesive sample from Borehole SC10-4. Load increments were maintained for 24 hours. Photographs of the extruded sample are provided in Appendix C. The testing results are presented in Appendix C and are summarized in Table 5-1. The preconsolidation stress summarized in the table was obtained from the end-of-increment void ratio. It should be expected that compressibility characteristics will vary with depth in accordance with the soil index parameters and stress history.

**Table 5-1: Advanced Laboratory Test Results**

Borehole	SC10-4
Sample	TW8
Sample Depth (m)	9.2 – 9.8
Sample Elevation (m)	120.7
Soil Layer	Clayey Silt (CL)
Moisture Content (%)	41
Liquidity Index ( - )	1
Initial Void Ratio ( - )	1.095
Moist Unit Weight (kN/m <sup>3</sup> )	17.9
In-situ Vertical Effective Stress (kPa)	76.9
Preconsolidation Stress (kPa)	247
Overconsolidation Ratio ( - )	3.2
Recompression Index ( - )	0.041
Compression Index ( - )	0.583
Coefficient of Reconsolidation (cm <sup>2</sup> /sec)	0.005
Coefficient of Consolidation (cm <sup>2</sup> /sec)	0.001
Load Increment Duration (hrs.)	24

#### 5.4 Silty Sand with Gravel (Glacial Till)

A native deposit of silty sand with gravel (glacial till), was encountered below the clay to silty clay to clayey silty layer in Borehole B-HF-03. The thickness of the layer was 3.0 m (base elevation at 104.6 m). The SPT N-value measured in this layer was greater than 100 blows, indicating a very dense relative density.

The moisture content of one sample tested was 8%.



## 5.5 Refusal

Borehole B-HF-03 was drilled to split spoon refusal on inferred bedrock, and a Dynamic Cone Penetration Test (DCPT) was carried out below the sampled depth in Borehole SC10-2. The refusal blow count was encountered at depths of 22.5 to 25.3 m (base elevation 114.8 m to 104.6 m).

The CPTu test (Borehole B-HF-02B) was advanced by ConeTec to a refusal depth of 18.8 m (elev. 111.7 m).

## 5.6 Groundwater

Monitoring wells with diameter of 50 mm were installed in Boreholes SC10-1 and SC10-5, and one monitoring well with diameter of 38 mm was installed in Borehole B-HF-03. Groundwater levels recorded in the wells are presented in Table 5-2.

**Table 5-2: Summary of Groundwater Levels**

Borehole No.	Bottom of Screen Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Date of Measurement
SC10-1	126.4	1.1	131.5	March 22, 2024
		0.5	132.1	April 09, 2024
		0.8	131.8	April 26, 2024
		1.1	131.5	June 26, 2024
		1.3	131.3	June 28, 2024
		2.5	130.1	August 30, 2024
SC10-5	120.6	0.9	128.8	April 09, 2024
		0.9	128.8	April 24, 2024
		1.1	128.6	June 26, 2024
		1.2	128.4	June 28, 2024
		1.2	128.4	July 16, 2024
		2.0	127.7	August 30, 2024
B-HF-03	120.2	3.5	126.4	September 21, 2021
		0.7	129.2	December 20, 2021
		2.4	127.5	January 11, 2022
		0.9 <sup>(a)</sup>	129.0	April 25, 2024
		2.8 <sup>(a)</sup>	127.1	August 30, 2024

Notes: (a) water level taken after borehole log was finalized

The elevation of standing water near the existing culvert outlet was measured as 130.8 m on July 25, 2024.

These observations are considered short term as they were recorded at discrete times, and it should be noted that the groundwater level at the time of construction may be different and seasonal fluctuations of the groundwater level are to be expected. In particular, the creek water



and groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation.

Groundwater levels were also observed during drilling in Boreholes SC10-2 and SC10-4, however, the groundwater level in the boreholes was not stabilized thus these readings are not considered reliable.

## 5.7 Analytical Testing

Two samples of the native clay to silty clay to clayey silt were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate, sulphide and chloride concentrations, resistivity, and conductivity. The analysis results are summarized in Table 5-3. Copies of the test results are provided in Appendix C.

**Table 5-3: Results of Chemical Analysis**

Borehole	Sample	Depth (m)	Chloride (µg/g)	Sulphate (µg/g)	Sulphide (%)	pH (-)	Resistivity (Ohm-cm)
SC10-1	SS2B	0.9 – 1.2	97	44	< 0.01	6.95	3,160
SC10-4	SS2	0.8 – 1.4	27	<10	< 0.01	6.84	4,050

## 6 MISCELLANEOUS

The borehole locations reflect existing site features and access constraints. The as-drilled locations and ground surface elevation were measured by Thurber following completion of the field program. George Downing Estate Drilling Ltd. of Hawkesbury, Ontario, supplied and operated the drill rigs used to drill, test, sample, and decommission the boreholes. Limitless Drilling Inc. of Renfrew, Ontario, supplied and operated the equipment used to drill, test, sample, and decommission the portable boreholes. Traffic control was performed in accordance with Ontario Book 7 and was provided by C&C Services of Renfrew, Ontario. The field investigation was supervised on a full-time basis by Mr. B. Coote, EIT, Mr. I. Khan, EIT, Mr. D. Amorim Pereira, Geotechnical Technician, and Mr. R. Howarth, Geotechnical Technician. Overall supervision of the field investigation program was provided by Mr. J. Gray, P.Eng.

Routine geotechnical laboratory testing were completed by Thurber's laboratory in Ottawa. Analytical testing was completed by Paracel Laboratories Ltd. in Ottawa.

Interpretation of the factual data and preparation of this report was completed by D. Amorim Pereira, Geotechnical Technician. The report was reviewed by Dr. F. Griffiths, P.Eng., and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundation Projects.



Thurber Engineering Ltd.  
Report Prepared By:

Darlan Amorim Pereira, M.Sc.  
Geotechnical Technician



Dr. Fred Griffiths, P.Eng.  
Principal, Senior Geotechnical Engineer



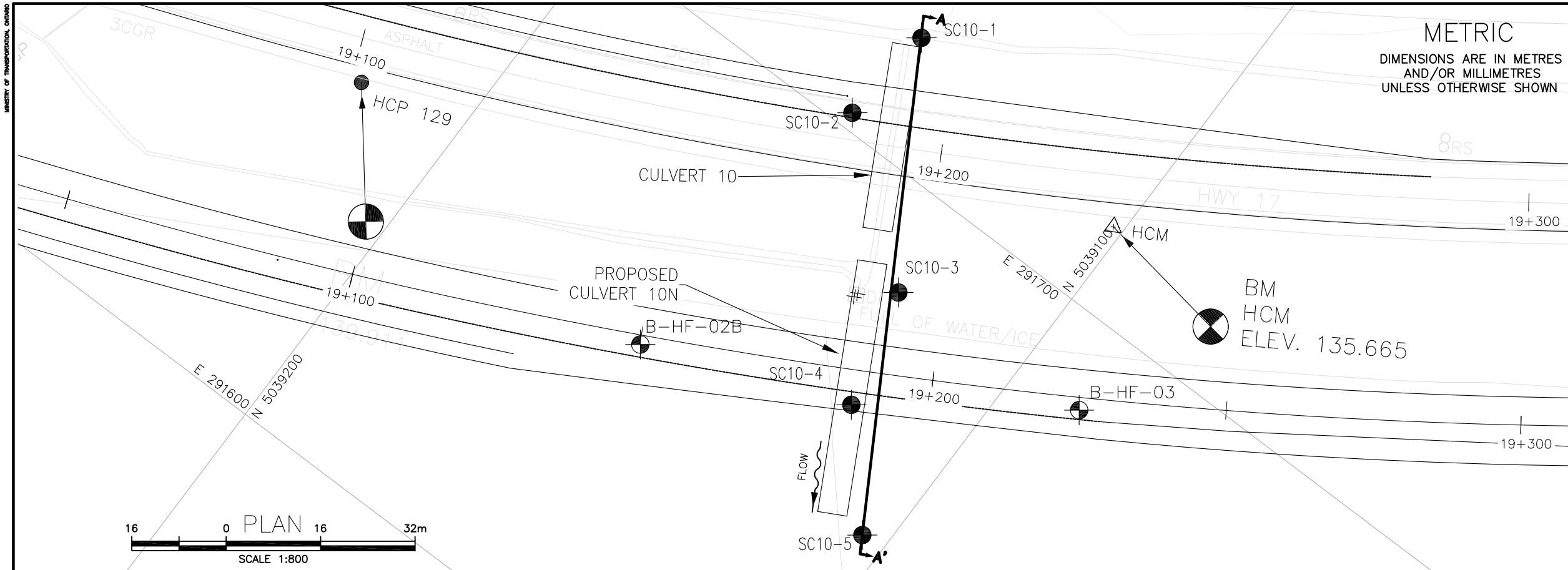
Dr. P.K. Chatterji, P.Eng.  
Designated Principal Contact,  
Principal, Senior Geotechnical Engineer



## **Appendix A.**

### **Borehole Location Plan and Stratigraphic Drawings**





PLAN  
SCALE 1:800

EXISTING EMBANKMENT

SILTY SAND FILL  
With Clay and Gravel  
Compact

CULVERT 10

PROPOSED EMBANKMENT

PROPOSED CULVERT 10N

SILTY CLAY (CI)  
Contains Sand Seams  
Very Stiff to Stiff

CLAYEY SILT (CL)  
Contains Sand Partings and Seams  
Very Stiff to Stiff



SECTION A-A'

SCALE 1:800  
SCALE 1:200

H 1:800

V 1:200

CONT No  
GWP No 4068-09-00

HIGHWAY 17 TWINNING  
STATION 19+200, HORTON TWP.  
CULVERT 10/10N  
BOREHOLE LOCATION PLAN AND SOIL STRATA

Ontario

THURBER



KEYPLAN

LEGEND

●	Borehole
⊕	Historic Borehole/Cone Penetration Test
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
—	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

(GEOCRES 31F-235)

(GEOCRES 31F-235)

NO	ELEVATION	NORTHING	EASTING
SC10-1	132.6	5 039 147.0	291 720.0
SC10-2	137.3	5 039 148.7	291 702.8
SC10-3	132.2	5 039 124.1	291 683.2
SC10-4	130.2	5 039 119.0	291 663.2
SC10-5	129.7	5 039 104.2	291 646.7
B-HF-03	129.9	5 039 087.7	291 685.7
B-HF-02B	130.5	5 039 153.7	291 649.8

-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.
- Coordinate system is MTM NAD 83 Zone 9.

GEOCRES No. 31F07-005

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	AO	CHK -	CODE
DRAWN	RH	CHK FG	SITE
LOAD	DATE	NOV 2024	
STRUCT	DWG	1	





## **Appendix B.**

### **Record of Borehole Sheets CPT Summary Sheets (ConeTec Investigations Ltd.)**



## SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

### TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

### TERMINOLOGY DESCRIBING SOIL STRUCTURE:

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

### RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

### N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

### DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "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 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.



### STRATA PLOT:

Strata plots symbolize the soil and 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.



Boulders  
Cobbles  
Gravel      Sand      Silt      Clay      Organics      Asphalt      Concrete      Fill      Bedrock

### TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

### TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

### SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

### TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT "N" Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

### MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note -  $W_L$  = Liquid Limit



## EXPLANATION OF ROCK LOGGING TERMS

### ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structures are preserved.

### TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

### DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 to 2 m
Medium bedded	0.2 to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 to 60 mm
Laminated	6 to 20 mm
Thinly laminated	Less than 6 mm

### STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

# RECORD OF BOREHOLE No SC10-1

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.492124°, Long: -76.667346° Culvert 10/10N; Horton Township; MTM z9: N 5 039 147.0 E 291 720.0 ORIGINATED BY IK  
 HWY 17 BOREHOLE TYPE Portable Drilling / Tricone / NW Casing / NQ Coring COMPILED BY IK  
 DATUM Geodetic DATE 2024.03.21 - 2024.03.21 CHECKED BY JG


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	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							
132.6	Ground Surface							20 40 60 80 100		20 40 60					
0.0	SILTY CLAYEY SAND with gravel contains organics compact dark brown to brown FILL		1	SS	10		132					○			0 30 44 26
131.7			2	SS	12							●			
0.9	SILTY CLAY (CI), trace sand very stiff brown						131			6.9		○			
			3	SS	14										
			4	SS	17		130					○			
			5	SS	10		129					○			
										18.0					
										10.3					
			6	SS	4		128					●			0 1 44 55
							127			6.4					
										7.0					
			7	SS	5		126					○			
										> 118 kPa					
										> 118 kPa					
			8	SS	7		125					○			
							124			6.3					
										3.7					
			9	SS	5		123					○			
122.8															
9.8	CLAYEY SILT (CL), trace sand														

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SC10-1 2 OF 2 METRIC

WP# 4068-09-00 LOCATION Lat: 45.492124°, Long: -76.667346° Culvert 10/10N; Horton Township; MTM z9: N 5 039 147.0 E 291 720.0 ORIGINATED BY IK  
HWY 17 BOREHOLE TYPE Portable Drilling / Tricone / NW Casing / NQ Coring COMPILED BY IK  
DATUM Geodetic DATE 2024.03.21 - 2024.03.21 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT  W <sub>P</sub>	NATURAL MOISTURE CONTENT  W	LIQUID LIMIT  W <sub>L</sub>	UNIT WEIGHT  γ	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																											
	Continued From Previous Page							20	40	60	80	100																										
122.2	CLAYEY SILT (CL), trace sand very stiff brown		10	SS	26									14			GR SA SI CL 0 6 73 21																					
10.4	<b>End of Borehole</b> <b>Monitoring Well installed:</b> Schedule 40 PVC standpipe with 50-mm diameter and 3.0-m slotted screen. Stick-up cover installed at ground surface.  <b>Water Level Readings:</b> <table><tr><th>DATE</th><th>DEPTH (m)</th><th>ELEV. (m)</th></tr><tr><td>2024/03/22</td><td>1.1</td><td>131.5</td></tr><tr><td>2024/04/09</td><td>0.5</td><td>132.1</td></tr><tr><td>2024/04/26</td><td>0.8</td><td>131.8</td></tr><tr><td>2024/06/26</td><td>1.1</td><td>131.5</td></tr><tr><td>2024/06/28</td><td>1.3</td><td>131.3</td></tr><tr><td>2024/08/30</td><td>2.5</td><td>130.1</td></tr></table> <b>Note:</b> Full-weight hammer was used to advance the split-spoons.	DATE	DEPTH (m)	ELEV. (m)	2024/03/22	1.1	131.5	2024/04/09	0.5	132.1	2024/04/26	0.8	131.8	2024/06/26	1.1	131.5	2024/06/28	1.3	131.3	2024/08/30	2.5	130.1																
DATE	DEPTH (m)	ELEV. (m)																																				
2024/03/22	1.1	131.5																																				
2024/04/09	0.5	132.1																																				
2024/04/26	0.8	131.8																																				
2024/06/26	1.1	131.5																																				
2024/06/28	1.3	131.3																																				
2024/08/30	2.5	130.1																																				

RECORD OF BOREHOLE No SC10-2

1 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.492139°, Long: -76.667566°  
Culvert 10/10N; Horton Township; MTM z9: N 5 039 148.7 E 291 702.8 ORIGINATED BY DAP  
HWY 17 BOREHOLE TYPE CME 55 Truckmount / HSA / NW Casing COMPILED BY IK  
DATUM Geodetic DATE 2024.03.21 - 2024.03.21 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE							w <sub>p</sub> w      w <sub>L</sub>		
137.3	Asphalt Surface						20	40	60	80	100	20	40	60			
0.0	ASPHALT (50 mm)																
	SILTY SAND, some gravel very dense to very loose yellowish brown to grey FILL		1	SS	56							○					
			2	SS	45							○					
			3	SS	43							○				12 72 16 (SI+CL)	
			4	SS	100/ 75 mm							○					
			5	SS	17							○					
			6	SS	19							○					
			7	SS	2							○				11 70 19 (SI+CL)	
132.0	SILTY CLAY (CI) very stiff brown		8	SS	8								○				
5.3																	
			9	SS	11								○			0 1 42 57	
			10	SS	9								○				
			11	SS	9								○				
			12	SS	7								○				
			13	SS	5								○			0 1 48 51	

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity  
20  
15  
10  
(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No SC10-2

2 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.492139°, Long: -76.667566°  
Culvert 10/10N; Horton Township; MTM z9: N 5 039 148.7 E 291 702.8 ORIGINATED BY DAP  
HWY 17 BOREHOLE TYPE CME 55 Truckmount / HSA / NW Casing COMPILED BY IK  
DATUM Geodetic DATE 2024.03.21 - 2024.03.21 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>		
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)				
	SILTY CLAY (CI) very stiff brown		14	SS	5		127	> 118 kPa					
							126	> 118 kPa					
			15	SS	3		125	> 118 kPa					
			16	SS	6		124	> 118 kPa					
			17	SS	7		123						
			18	SS	6		122						
			19	SS	7		121						
120.5							120						
16.8	CLAYEY SILT (CL) very stiff brown						119						
							118						

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity 20  
15 10 5 0  
(%) STRAIN AT FAILURE

## METRIC

[illegible]

DOUBLE LINE CULVERT 10 GINT LOGS.GPJ 2012TEMPLATE(MTO).GDT 12-17-24

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

RECORD OF BOREHOLE No SC10-3

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.491917°, Long: -76.667817°  
Culvert 10/10N; Horton Township; MTM z9: N 5 039 124.1 E 291 683.2 ORIGINATED BY RH  
HWY 17 BOREHOLE TYPE Portable Drilling / Tricone / NW Casing / NQ Coring COMPILED BY RH  
DATUM Geodetic DATE 2024.04.15 - 2024.04.15 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
132.2	Ground Surface						20 40 60 80 100	20 40 60	W <sub>P</sub> W W <sub>L</sub>				GR SA SI CL	
0.0	SILT CLAYEY SAND very loose brown FILL		1	SS	2									
131.4														
0.8	SANDY CLAYEY SILT stiff grey FILL		2	SS	8									0 25 41 34
130.7														
1.5	SILTY CLAY (CI) very stiff to stiff grey		3	SS	20									
			4	SS	16									
			5	SS	12									
			6	SS	8									0 1 43 56
			7	SS	11									
			8	SS	15									
			9	SS	6									
			10	SS	4									0 0 48 52

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

## METRIC

[illegible]

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

RECORD OF BOREHOLE No SC10-4

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.491871°, Long: -76.668073°  
Culvert 10/10N; Horton Township; MTM z9: N 5 039 119.0 E 291 663.2 ORIGINATED BY BC  
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA / NW Casing COMPILED BY IK  
DATUM Geodetic DATE 2024.04.04 - 2024.04.04 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
130.2	Ground Surface							20 40 60 80 100				
0.0	<b>SILTY CLAY (CI)</b> contains sand partings very stiff brown <b>WEATHERED CRUST</b>		1	SS	10		130	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
			2	SS	8		129	20 40 60 80 100				
			3	SS	8		128	WATER CONTENT (%)				
			4	SS	7		127	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				
			5	SS	4		126	W P W W L				
			6	SS	4		125	20 40 60				
			7	SS	WH		124	> 118 kPa				
			8	TW	-		123	> 118 kPa				
122.4							122	12.0				
7.8	<b>CLAYEY SILT (CL)</b> contains sand partings and seams stiff to very stiff grey						121	6.0				

OED:  
 $e_0 = 1.10$   
 $C_c = 0.58$   
 $C_u = 0.04$   
 $P'_{c0} = 247 \text{ kPa}$   
0 1 49 50

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
20  
15  
10  
(%) STRAIN AT FAILURE


DOUBLE LINE CULVERT 10 GINT LOGS.GPJ 2012TEMPLATE(MTO).GDT 12-17-24

RECORD OF BOREHOLE No SC10-4

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.491871°, Long: -76.668073°  
Culvert 10/10N; Horton Township; MTM z9: N 5 039 119.0 E 291 663.2 ORIGINATED BY BC  
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA / NW Casing COMPILED BY IK  
DATUM Geodetic DATE 2024.04.04 - 2024.04.04 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  γ kN/m <sup>3</sup>	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	20	40	60	80		
	Continued From Previous Page																
	CLAYEY SILT (CL) contains sand partings and seams stiff to very stiff grey						120										
			9	SS	WH		119										
							118										
			10	SS	WH		117										
116.6																	
13.6	End of Borehole																

RECORD OF BOREHOLE No SC10-5

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.491737°, Long: -76.668284°  
Culvert 10/10N; Horton Township; MTM z9: N 5 039 104.2 E 291 646.7 ORIGINATED BY BC  
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA / NW Casing COMPILED BY IK  
DATUM Geodetic DATE 2024.04.05 - 2024.04.08 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
129.7	Ground Surface							20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>		
0.0	<b>SILTY CLAY (CI)</b> , trace sand very stiff brown not varved to varved <b>WEATHERED CRUST</b>		1	SS	10			○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)				GR SA SI CL
								20 40 60 80 100	20 40 60				
			2	SS	10		129						0 8 49 43
			3	SS	8		128						
								> 118 kPa +					
							127	> 118 kPa +					
			4	SS	5								
							126	> 118 kPa + > 118 kPa +					
			5	SS	4		125						0 1 45 54
								> 118 kPa +					
							124	> 118 kPa +					
			6	SS	1								
							123	> 118 kPa +					
								> 118 kPa +					
122.1							122						0 0 52 48
7.6	<b>CLAYEY SILT (CL)</b> contains sand partings and seams stiff to very stiff grey		7	SS	WH								
							121	5.0 +					
								5.0 +					
			8	TW	-		120						

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SC10-5

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.491737°, Long: -76.668284°  
Culvert 10/10N; Horton Township; MTM z9: N 5 039 104.2 E 291 646.7 ORIGINATED BY BC  
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA / NW Casing COMPILED BY IK  
DATUM Geodetic DATE 2024.04.05 - 2024.04.08 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	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 (%)	
	Continued From Previous Page							20	40	60	80	100		20	40	60			
116.1 13.6	CLAYEY SILT (CL) contains sand partings and seams stiff to very stiff grey						119						> 118 kPa +						
			9	SS	WH													○	
			10	SS	WH		118						> 118 kPa +						
													> 118 kPa +						
							117								○				
													> 118 kPa +						
													> 118 kPa +						
	End of Borehole																		
	Monitoring Well installed: Schedule 40 PVC standpipe with 50-mm diameter and 3.0-m slotted screen. Stick-up cover installed at ground surface.																		
	Water Level Readings:																		
	DATE      DEPTH (m)      ELEV. (m)																		
	2024/04/09      0.9      128.8																		
	2024/04/24      0.9      128.8																		
	2024/06/28      1.2      128.5																		
	2024/07/16      1.2      128.5																		
	2024/08/30      2.0      127.7																		



# RECORD OF BOREHOLE No B-HF-03

1 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.491591°, Long: -76.667784°  
High Falls; MTM Zone 9: N 5 039 087.7 E 291 685.7 ORIGINATED BY RH/BC  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / HSA / HQ Casing COMPILED BY AO  
DATUM Geodetic DATE 2021.08.30 - 2021.08.31 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
129.9	Ground Surface							20 40 60 80 100	20 40 60	W <sub>P</sub> W   W <sub>L</sub>	kN/m <sup>3</sup>	GR   SA   SI   CL		
0.0	CLAY (CH) very stiff brown to grey-brown WEATHERED CRUST		1	SS	9			○ UNCONFINED   + FIELD VANE						
			2	SS	11		129	● QUICK TRIAXIAL   × LAB VANE				CH	0   1   41   58	
			3	SS	11		128							
			4	SS	8		127							
			5	SS	10		126					CH	0   1   45   54	
			6	SS	7		125							
			7	SS	8		124							
			8	SS	7		123							
			9	SS	5		122					CI	0   1   46   53	
			10	SS	6		121							
122.3			11	SS	6		120							
7.6	SILTY CLAY (CI) to CLAYEY SILT (CL-ML) occasional interbedded sand layers very stiff to stiff grey		12	SS	6									

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity 20  
15 10 5  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No B-HF-03

2 OF 3

METRIC




WP# 4068-09-00 LOCATION Lat: 45.491591°, Long: -76.667784°  
High Fills; MTM Zone 9: N 5 039 087.7 E 291 685.7 ORIGINATED BY RH/BC  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / HSA / HQ Casing COMPILED BY AO  
DATUM Geodetic DATE 2021.08.30 - 2021.08.31 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL	
	Continued From Previous Page							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>					
	SILTY CLAY (CI) to CLAYEY SILT (CL-ML) occasional interbedded sand layers very stiff to stiff grey  -Su > 118 kPa     -Su > 118 kPa          -Su > 118 kPa																			
			13	SS	7		119													
				14	SS	2														
							117													
				15	SS	3		116												
							115													
				16	SS	2		114												
			17	SS	2															
						113														
			18	SS	3		112													
							111													
110.7																				
19.2	CLAYEY SILT (CL), some sand very stiff grey		19	SS	6															
							110													

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
20  
15  
10  
(%) STRAIN AT FAILURE

## METRIC

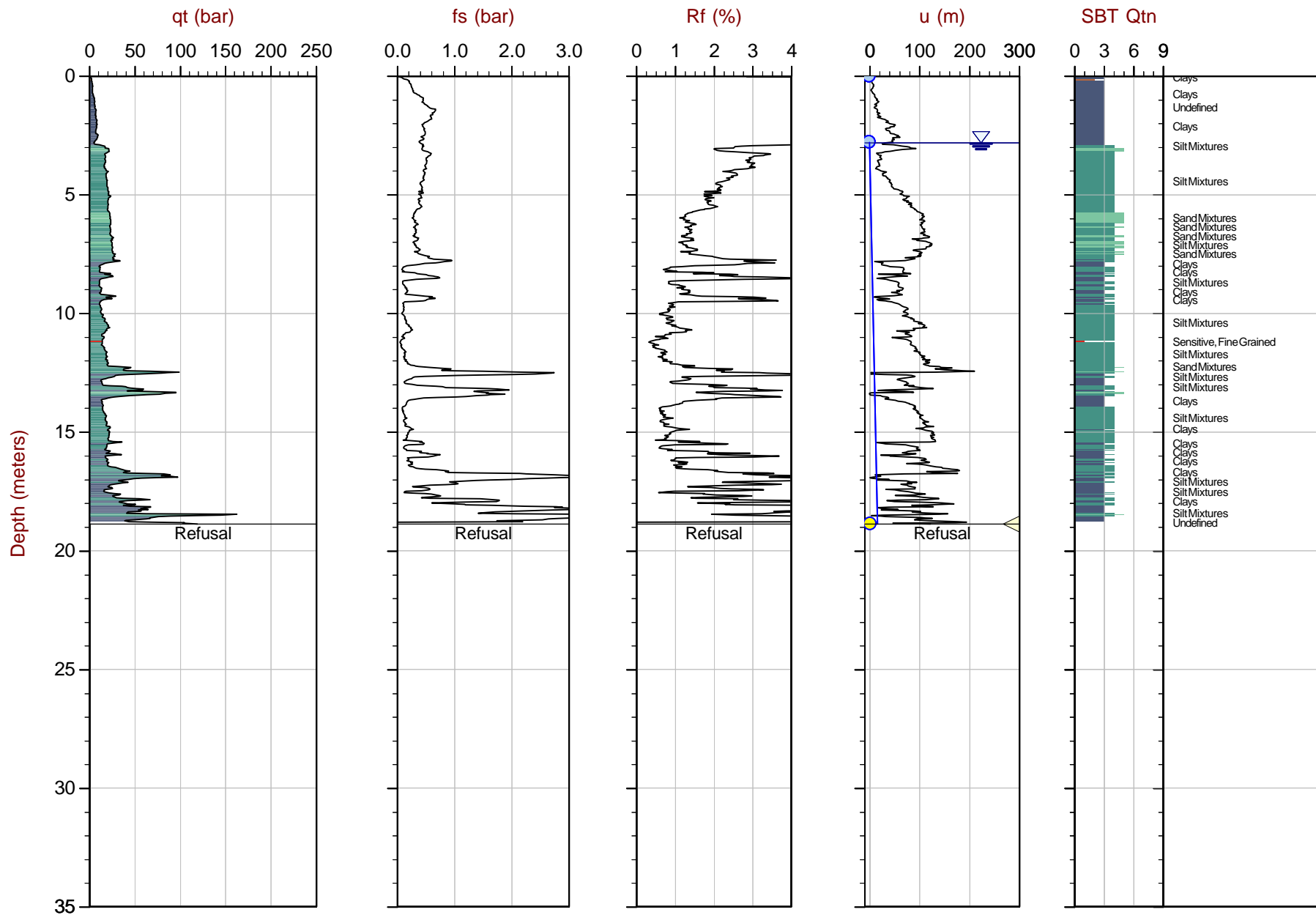
ELEV. DEPTH	SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT  W <sub>P</sub>	NATURAL MOISTURE CONTENT  W	LIQUID LIMIT  W <sub>L</sub>	UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
								SHEAR STRENGTH kPa ○ UNCONFINED     + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					
	Continued From Previous Page						 20      40      60      80      100						
							 20      40      60						

[illegible]

DOUBLE LINE CULVERT 10 GINT LOGS.GPJ 2012TEMPLATE(MTO).GDT 11-20-24

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

# Cone Penetration Test Summary and Standard Cone Penetration Test Plots

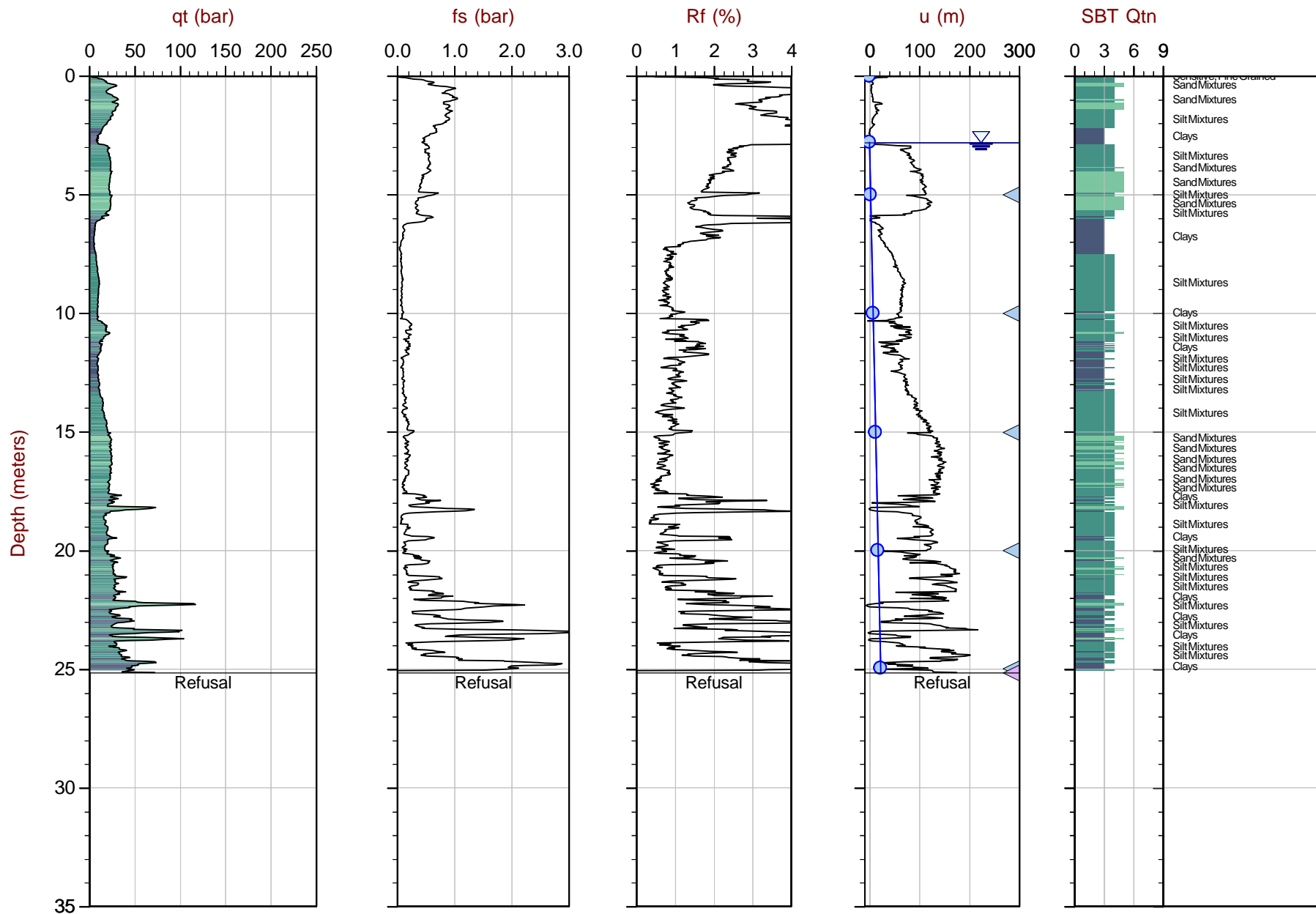


Max Depth: 18.875 m / 61.93 ft  
Depth Inc: 0.025 m / 0.082 ft  
Avg Int: Every Point

File: 21-05-22576\_CP-B-HF-2B.COR  
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010  
Coords: UTM Zone 18 N: 5038985m E: 369648m  
Page No: 1 of 1

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

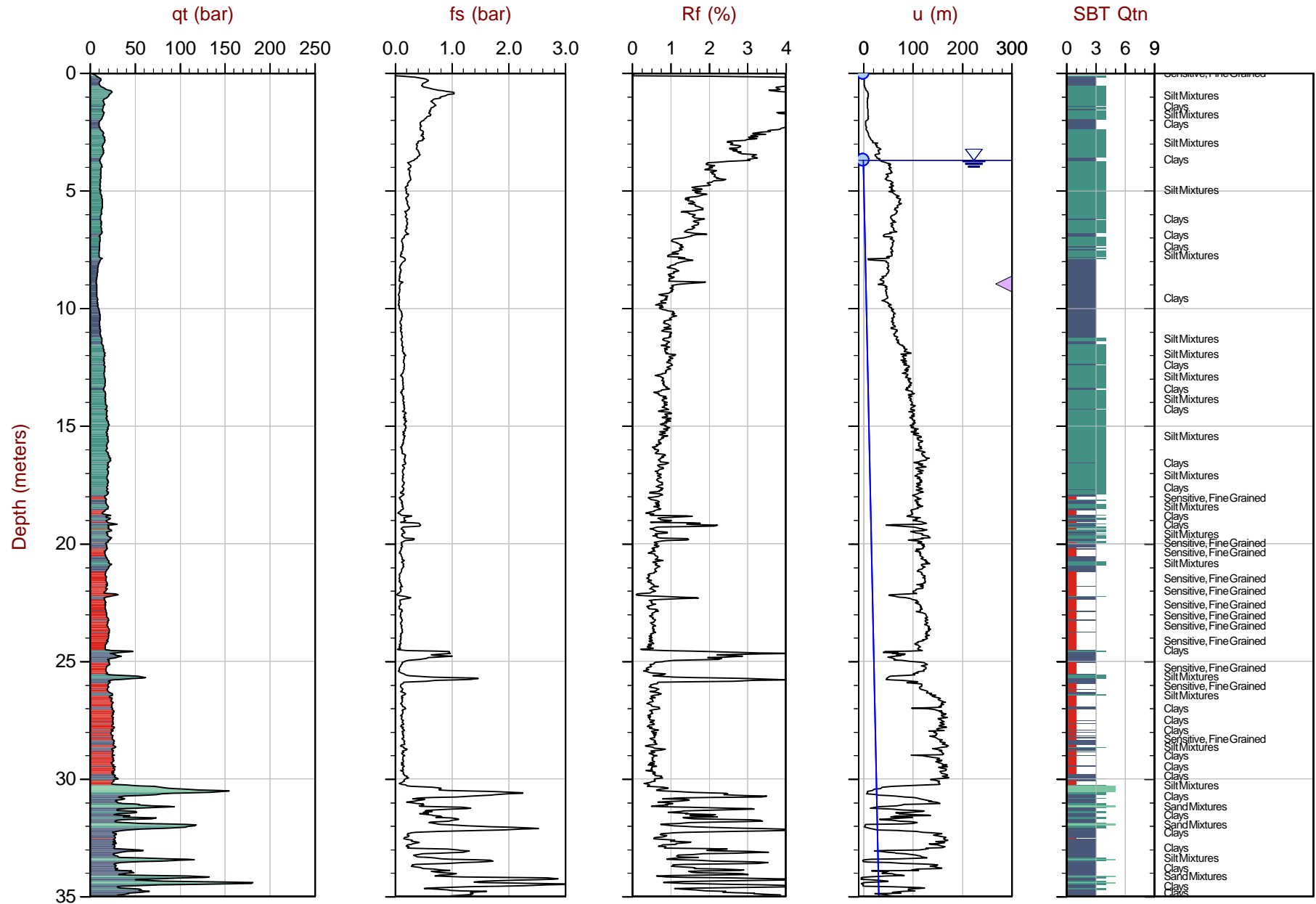


Max Depth: 25.150 m / 82.51 ft  
Depth Inc: 0.025 m / 0.082 ft  
Avg Int: Every Point

File: 21-05-22576\_SP-B-HF-5.COR  
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010  
Coords: UTM Zone 18 N: 5038790m E: 369766m  
Page No: 1 of 1

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



Max Depth: 35.575 m / 116.71 ft  
Depth Inc: 0.025 m / 0.082 ft  
Avg Int: Every Point

File: 21-05-22576\_CP-B-HF-8.COR  
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010  
 Coords: UTM Zone 18 N: 5038619m E: 369949m  
 Page No: 1 of 2

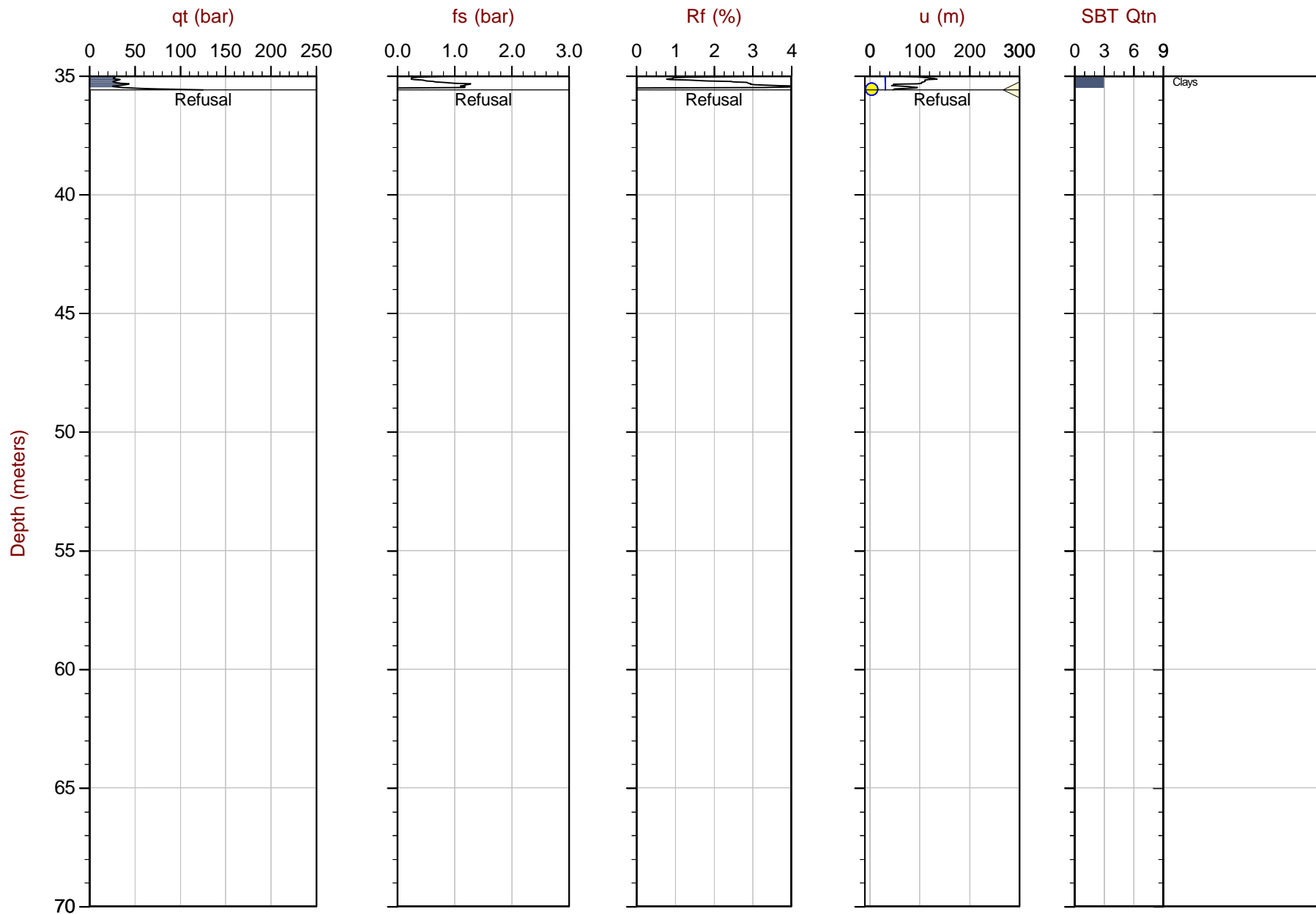
Overplot Item:

- Assumed Ueq
- Ueq

- ◀ Dissipation, equilibrium achieved
- ◀ Dissipation, equilibrium assumed

Hydrostatic Line  
Dissipation, equilibrium not achieved

- Equilibrium Profile



Max Depth: 35.575 m / 116.71 ft  
Depth Inc: 0.025 m / 0.082 ft  
Avg Int: Every Point

File: 21-05-22576\_CP-B-HF-8.COR  
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010  
Coords: UTM Zone 18 N: 5038619m E: 369949m  
Page No: 2 of 2

Overplot Item:

Assumed Ueq  
Ueq

Dissipation, equilibrium achieved  
Dissipation, equilibrium assumed

Hydrostatic Line  
Dissipation, equilibrium not achieved

Equilibrium Profile



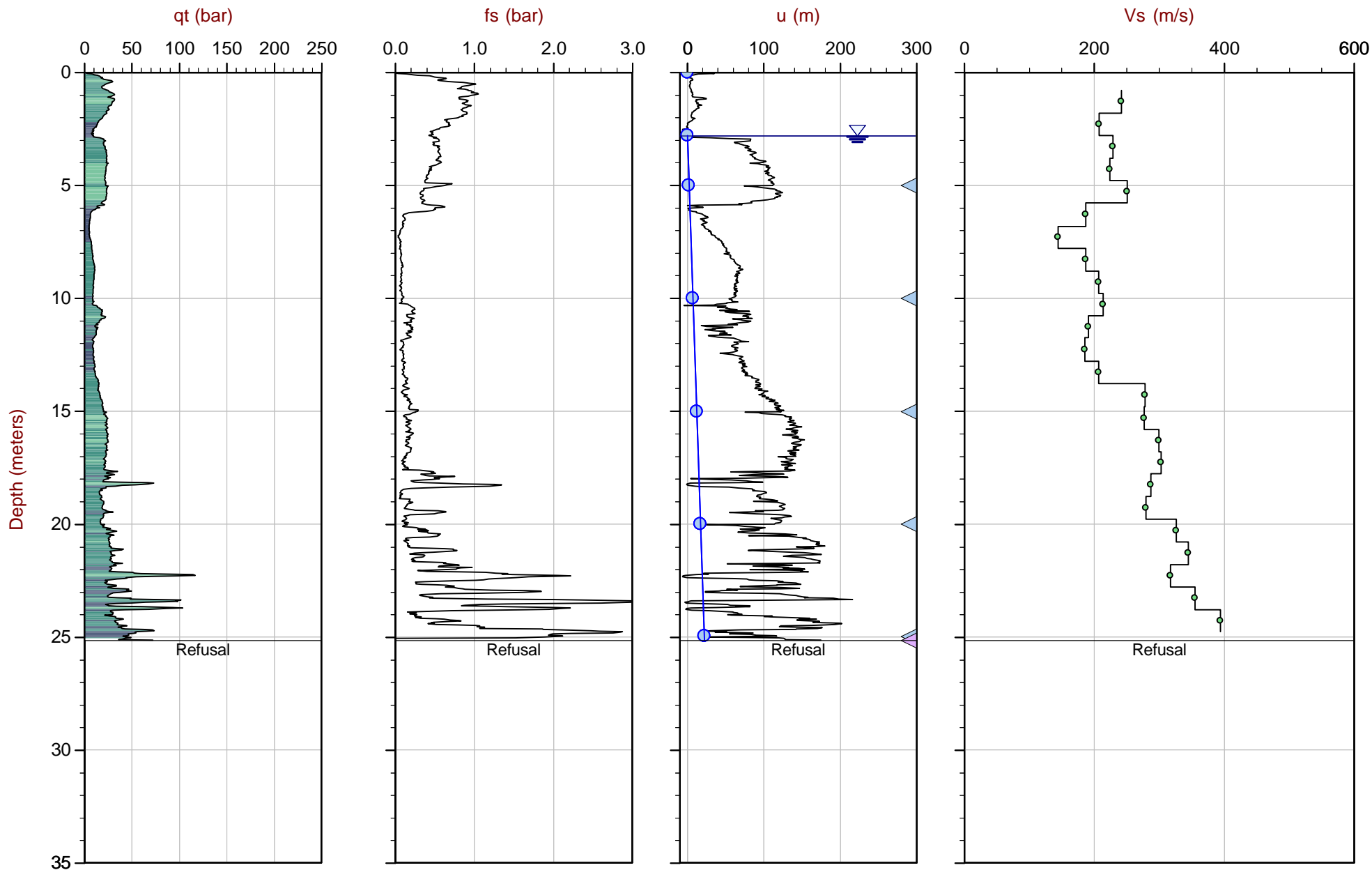
## Seismic Cone Penetration Test Plots



# Thurber Engineering

Job No: 21-05-22576  
Date: 2021-08-05 09:15  
Site: Renfrew Ontario

Sounding: B-HF-5  
Cone: 609:T1500F15U35



Max Depth: 25.150 m / 82.51 ft  
Depth Inc: 0.025 m / 0.082 ft  
Avg Int: Every Point

File: 21-05-22576\_SP-B-HF-5.COR  
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010  
Coords: UTM Zone 18 N: 5038790m E: 369766m  
Page No: 1 of 1

Overplot Item:

Assumed Ueq  
Ueq

Dissipation, equilibrium achieved  
Dissipation, equilibrium assumed

Hydrostatic Line  
Dissipation, equilibrium not achieved

Equilibrium Profile



## **Appendix C.**

### **Laboratory Testing**



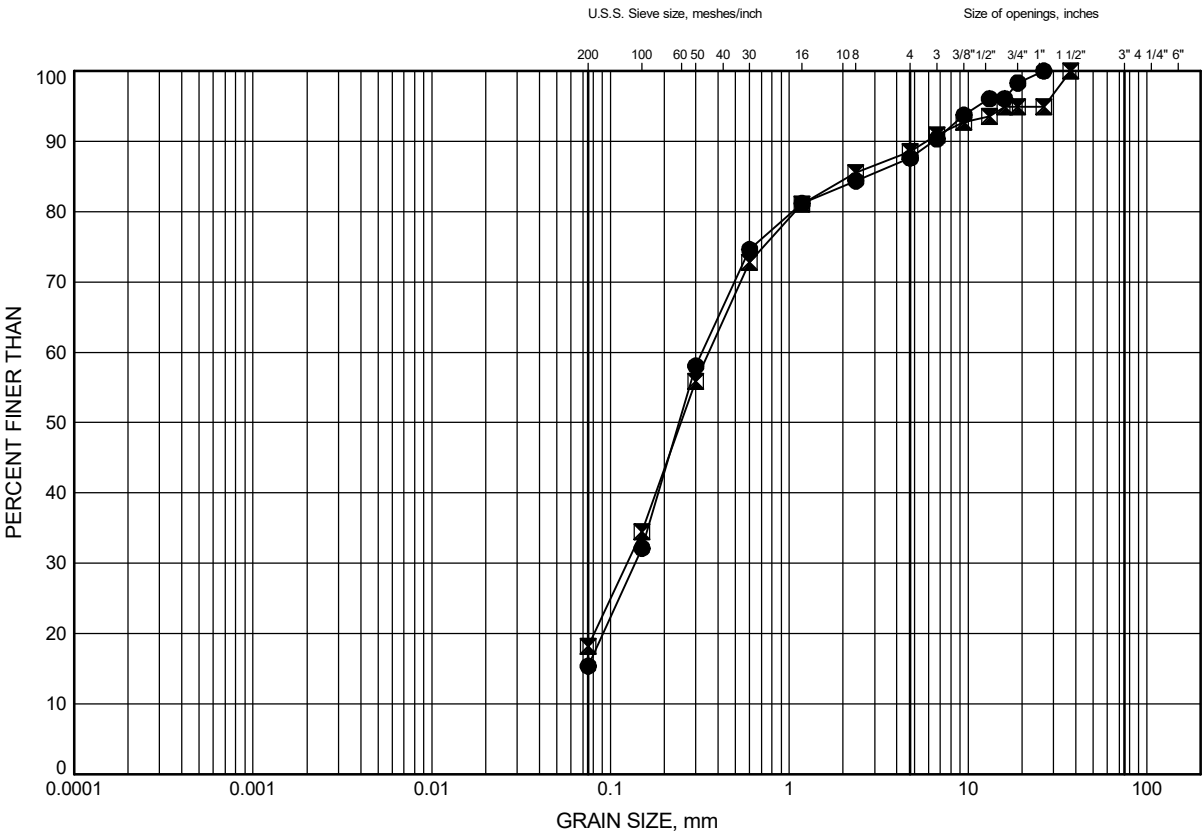
**Appendix C.1**  
**Particle Size Analysis Figures**  
**Atterberg Limit Test Results**  
**Consolidation Testing Results**

Hwys 17

# GRAIN SIZE DISTRIBUTION

FIGURE C1

FILL: Silty Sand some Gravel



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC10-2	1.8	135.5
⊠	SC10-2	4.9	132.4

GRAIN SIZE DISTRIBUTION - THURBER CULVERT 10 GINT LOGS.GPJ 9-5-24

Date September 2024  
GWP# 4018-E-0009



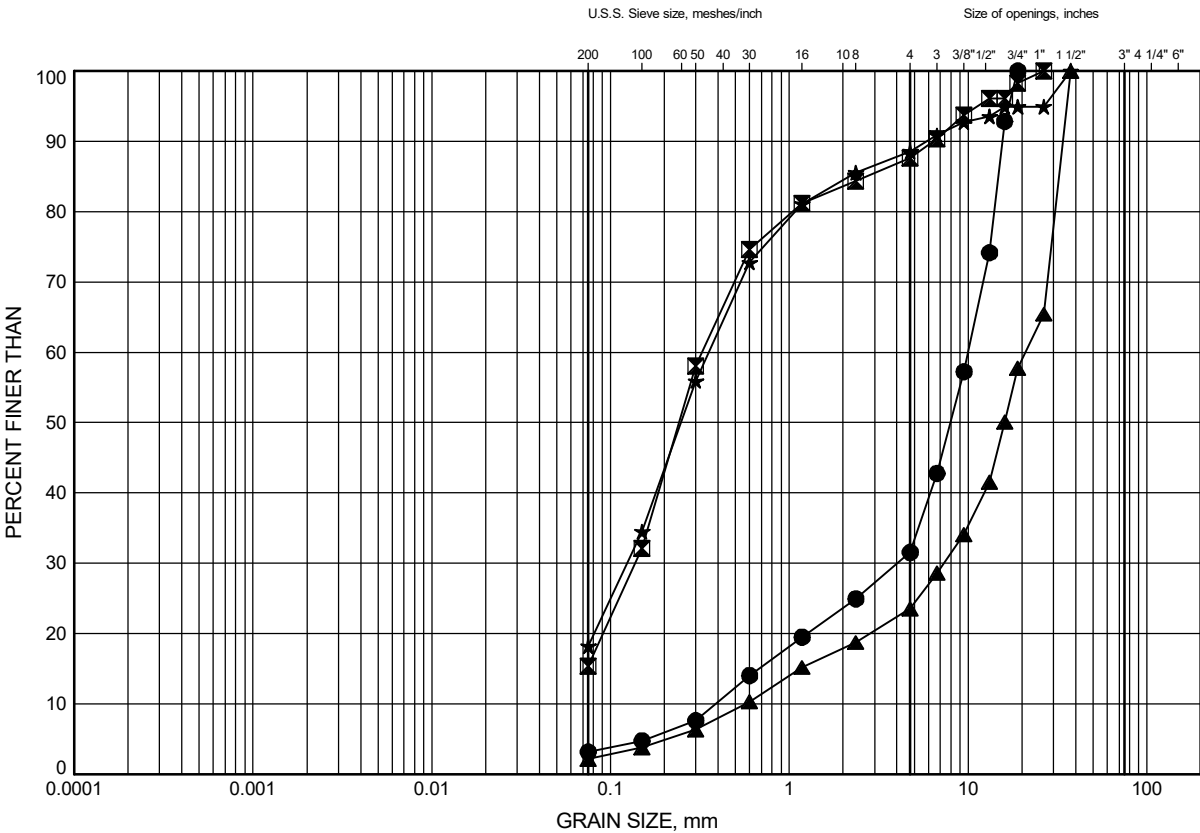
Prep'd RH  
Chkd. MJK

Hwys 17

# GRAIN SIZE DISTRIBUTION

FIGURE C1

FILL: Gravel with Sand to Silty Sand some Gravel



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC 10-2	0.1	137.2
⊠	SC 10-2	1.8	135.5
▲	SC 10-2	3.5	133.8
★	SC 10-2	4.9	132.4

Date August 2024  
GWP# 4018-E-0009



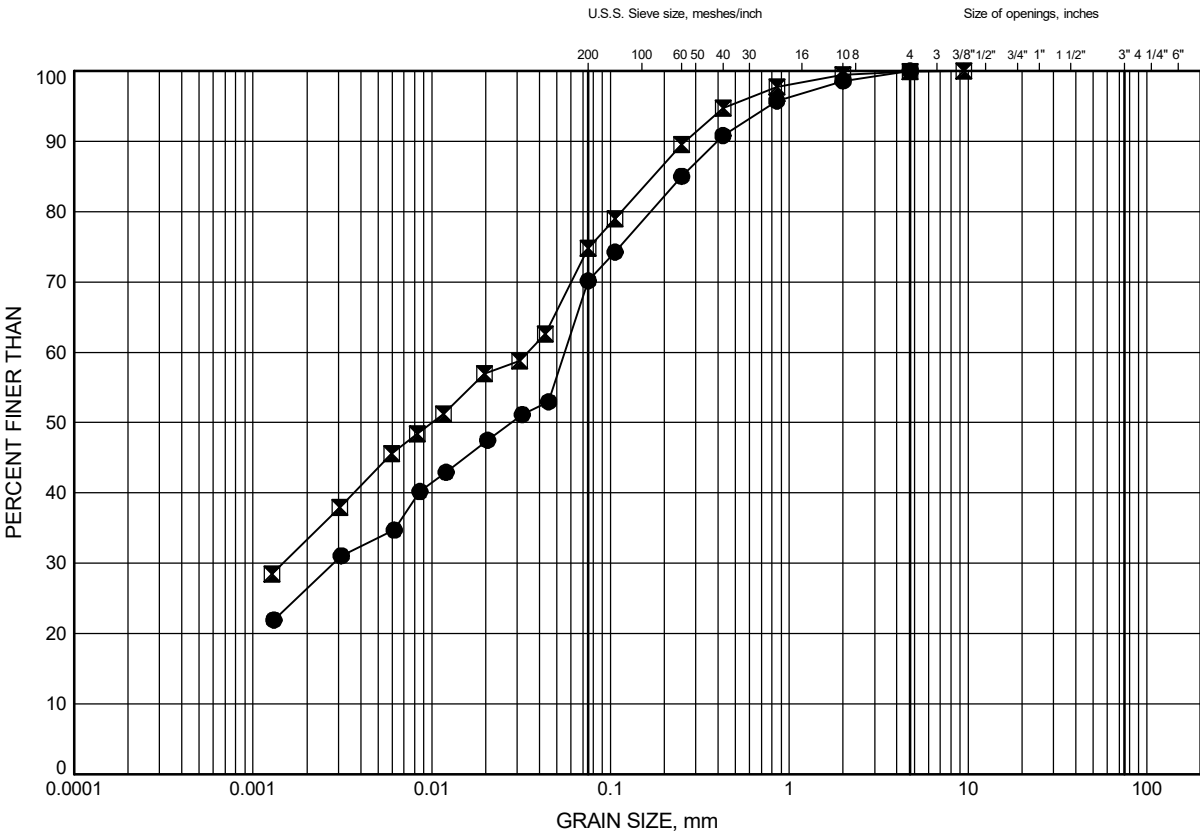
Prep'd RH  
Chkd. JG

Hwys 17

# GRAIN SIZE DISTRIBUTION

FIGURE C2

FILL: Silty Sand with Clay and Gravel



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC 10-1	0.8	131.8
⊠	SC 10-3	0.9	131.3

GRAIN SIZE DISTRIBUTION - THURBER CULVERT 10 GINT LOGS.GPJ 8-19-24

Date August 2024  
GWP# 4018-E-0009



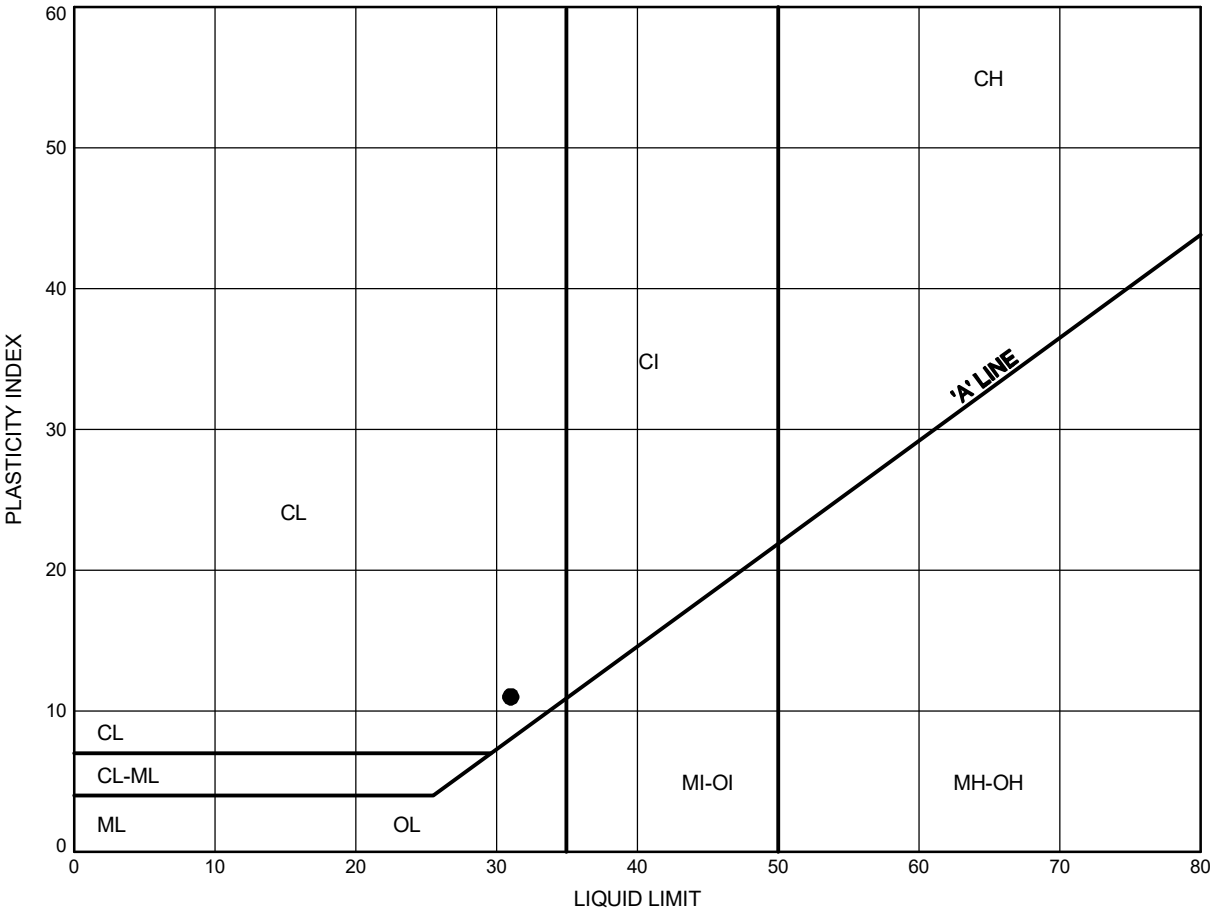
Prep'd RH  
Chkd. JG

Hwys 17

# ATTERBERG LIMITS TEST RESULTS

FIGURE C3

FILL: Silty Sand with Clay and Gravel



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC 10-1	0.8	131.8

Date August 2024  
GWP# 4018-E-0009



Prep'd RH  
Chkd. JG

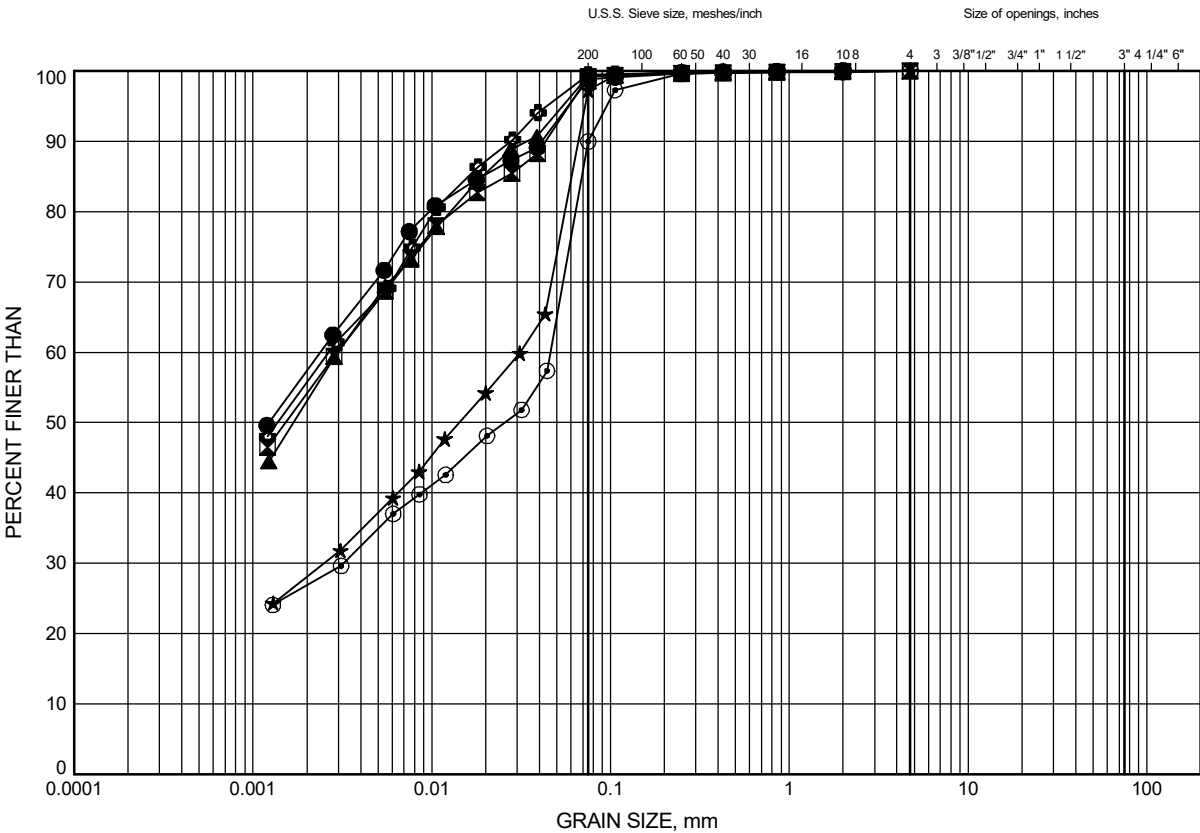


Hwys 17

# GRAIN SIZE DISTRIBUTION

FIGURE C4

Clay to Silty Clay to Clayey Silt (CH to CI to CL/CL-ML)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	B-HF-03	1.1	128.8
⊠	B-HF-03	4.1	125.8
▲	B-HF-03	7.9	122.0
★	B-HF-03	14.0	115.9
⊙	B-HF-03	19.5	110.4
⊕	SC 10-1	4.9	127.7

GRAIN SIZE DISTRIBUTION - THURBER CULVERT 10 GINT LOGS.GPJ 8-19-24

Date August 2024  
GWP# 4018-E-0009



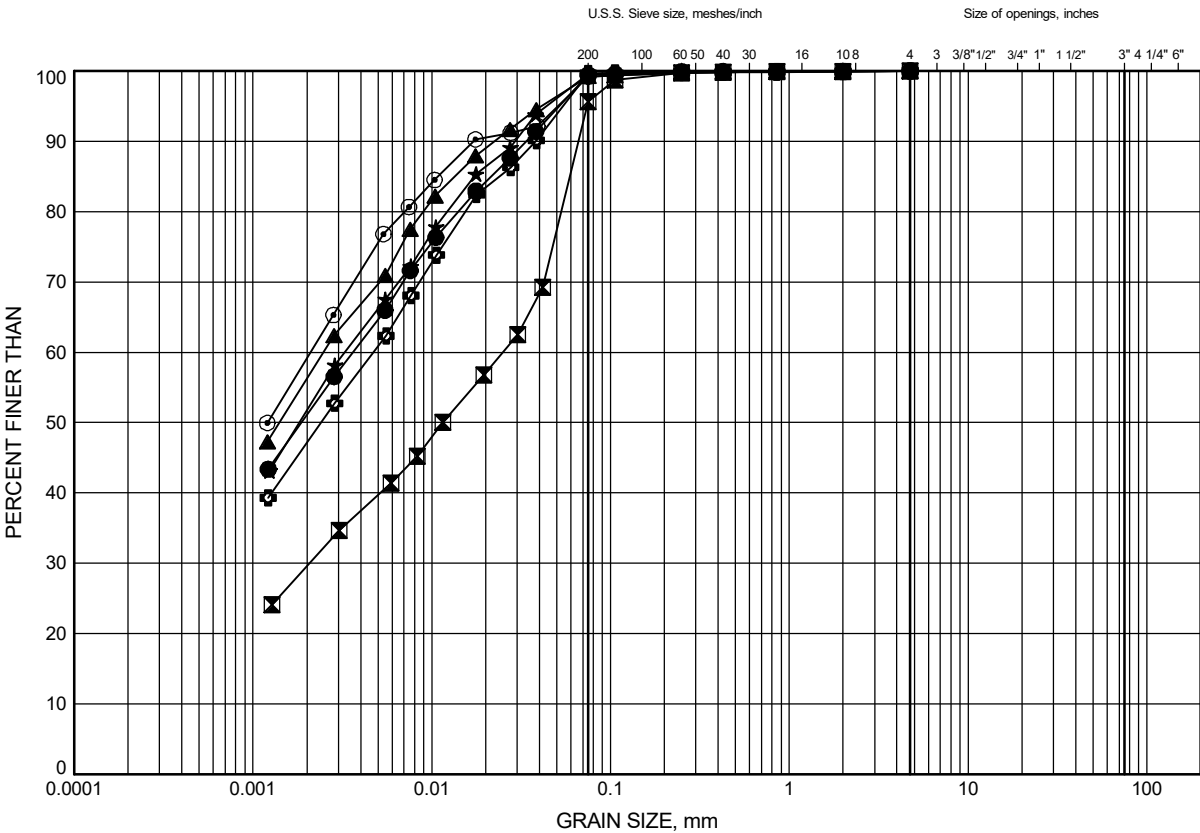
Prep'd RH  
Chkd. JG

Hwys 17

# GRAIN SIZE DISTRIBUTION

FIGURE C5

Clay to Silty Clay to Clayey Silt (CH to CI to CL/CL-ML)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC 10-2	9.4	127.9
⊠	SC 10-2	17.1	120.2
▲	SC 10-3	4.1	128.1
★	SC 10-3	8.7	123.5
⊙	SC 10-4	1.8	128.4
⊕	SC 10-4	6.4	123.8

Date August 2024  
GWP# 4018-E-0009



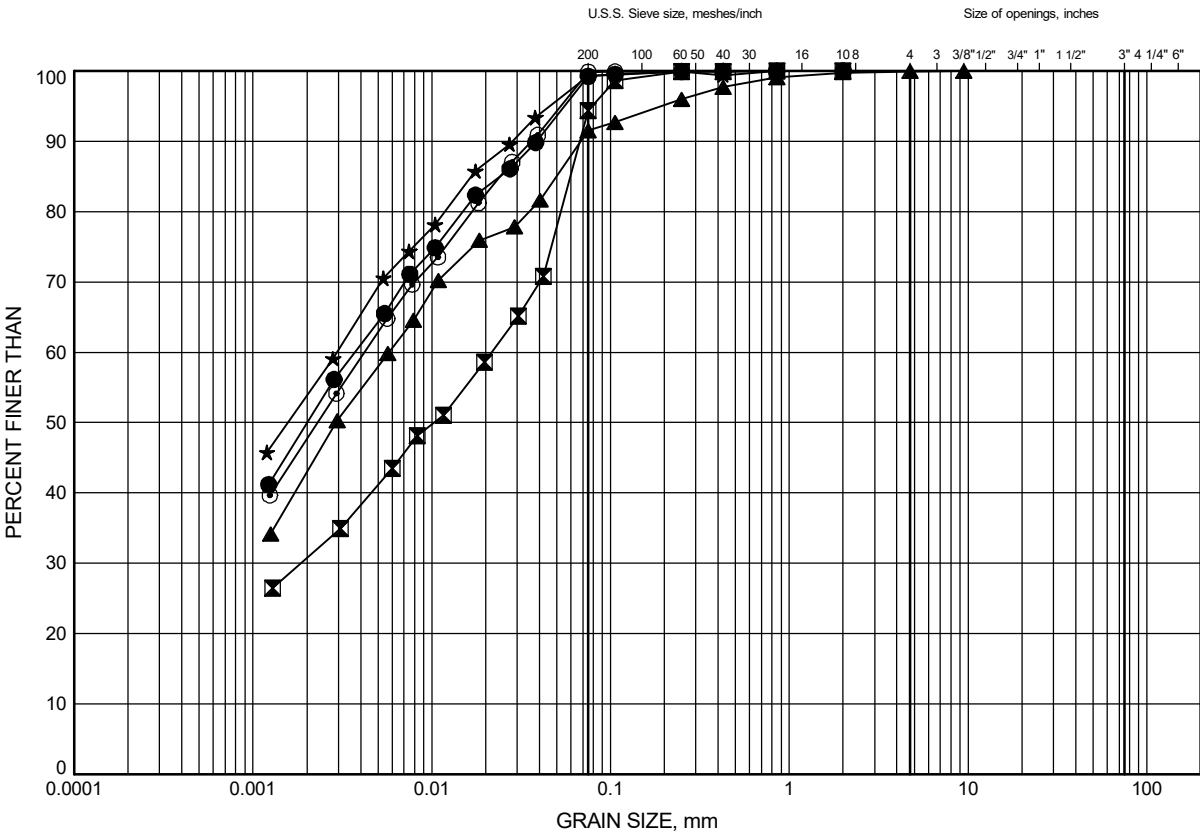
Prep'd RH  
Chkd. JG

Hwys 17

# GRAIN SIZE DISTRIBUTION

FIGURE C6

Clay to Silty Clay to Clayey Silt (CH to CI to CL/CL-ML)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC 10-4	9.4	120.8
⊠	SC 10-4	12.5	117.7
▲	SC 10-5	0.3	129.4
★	SC 10-5	4.9	124.8
⊙	SC 10-5	7.9	121.8

GRAIN SIZE DISTRIBUTION - THURBER CULVERT 10 GINT LOGS.GPJ 8-19-24

Date August 2024  
GWP# 4018-E-0009



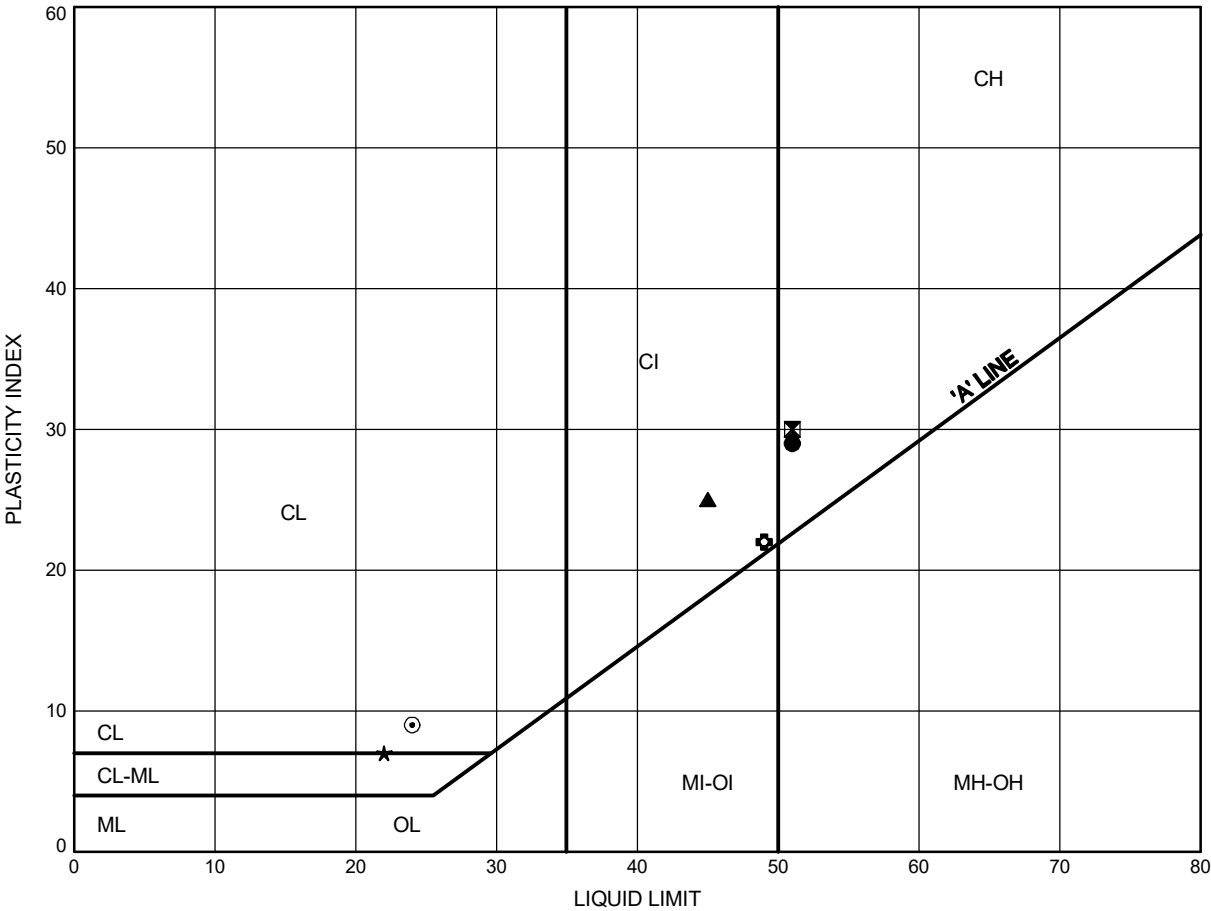
Prep'd RH  
Chkd. JG

Hwys 17

# ATTERBERG LIMITS TEST RESULTS

FIGURE C8

Clay to Silty Clay to Clayey Silt (CH to CI to CL/CL-ML)



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	B-HF-03	1.1	128.8
⊠	B-HF-03	4.1	125.8
▲	B-HF-03	7.9	122.0
★	B-HF-03	14.0	115.9
⊙	B-HF-03	19.5	110.4
⊕	SC 10-1	4.9	127.7

Date August 2024  
GWP# 4018-E-0009



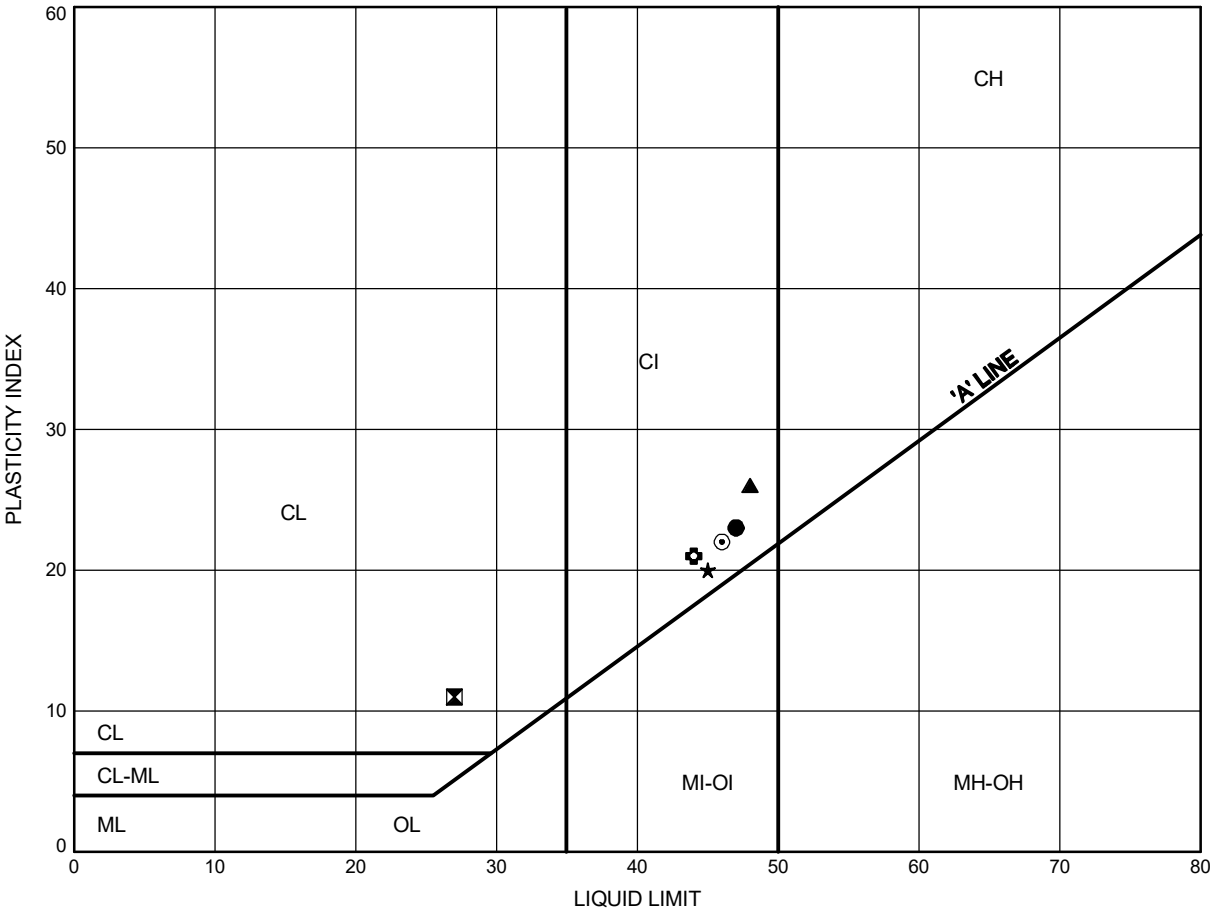
Prep'd RH  
Chkd. JG

Hwys 17

# ATTERBERG LIMITS TEST RESULTS

FIGURE C9

Clay to Silty Clay to Clayey Silt (CH to CI to CL/CL-ML)



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC 10-2	9.4	127.9
⊠	SC 10-2	17.1	120.2
▲	SC 10-3	4.1	128.1
★	SC 10-3	8.7	123.5
⊙	SC 10-4	1.8	128.4
⊕	SC 10-4	6.4	123.8

Date August 2024  
GWP# 4018-E-0009



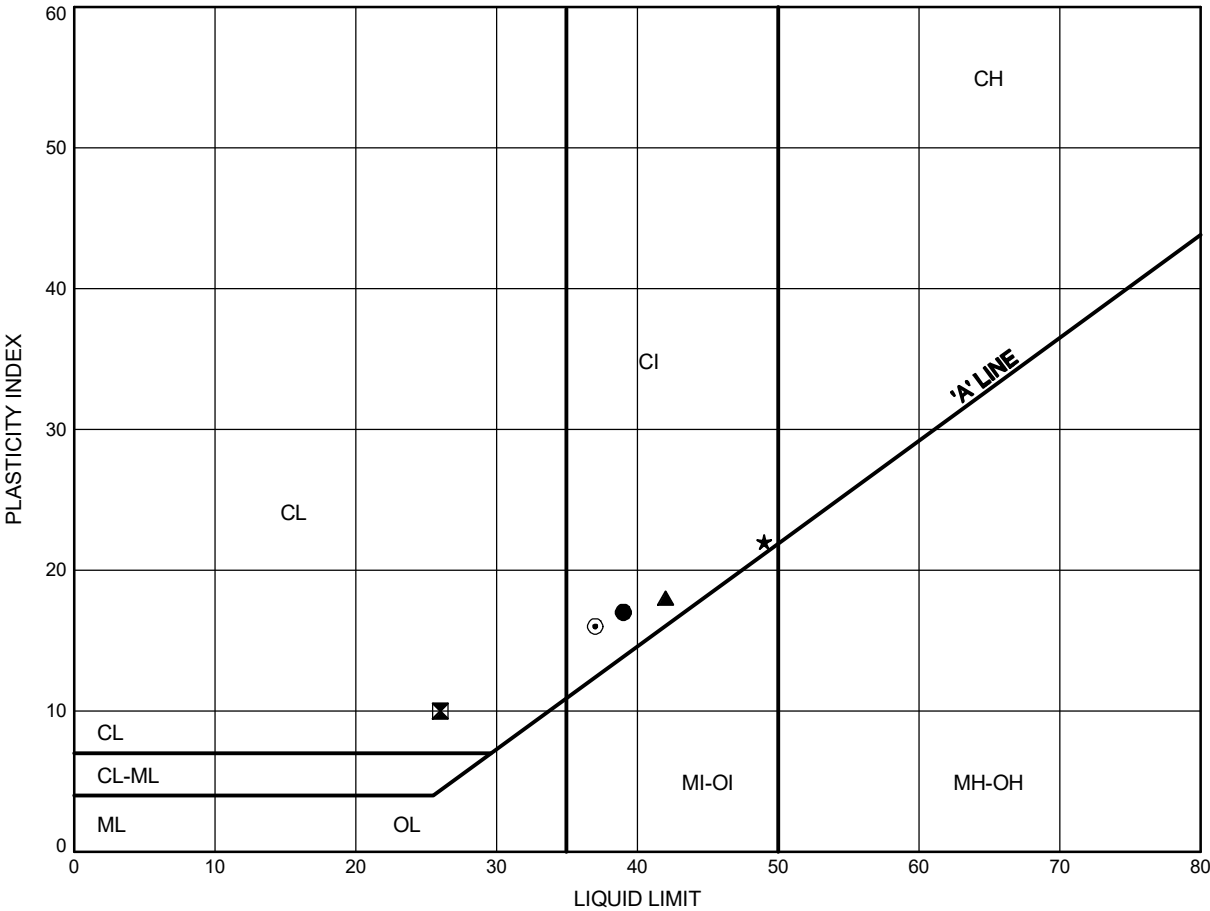
Prep'd RH  
Chkd. JG

Hwys 17

# ATTERBERG LIMITS TEST RESULTS

FIGURE C10

Clay to Silty Clay to Clayey Silt (CH to CI to CL/CL-ML)



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC 10-4	9.4	120.8
⊠	SC 10-4	12.5	117.7
▲	SC 10-5	0.3	129.4
★	SC 10-5	4.9	124.8
⊙	SC 10-5	7.9	121.8

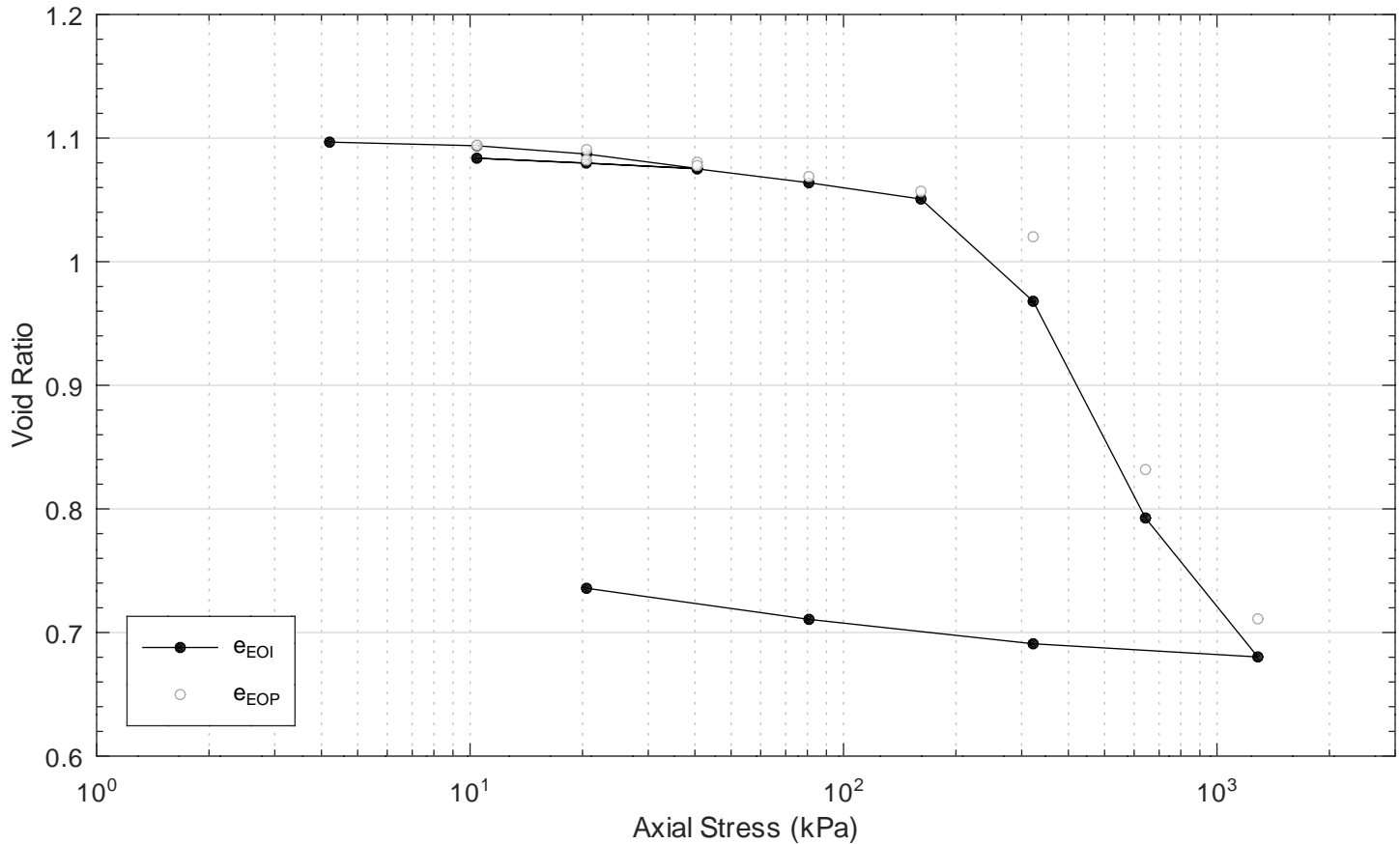
Date August 2024  
GWP# 4018-E-0009



Prep'd RH  
Chkd. JG



Project: 24726  
 Hwy 17 Twinning  
 Borehole: SC10-4  
 Sample: TW8  
 Depth: 9.5m  
 Client: Ministry of Transportation



Start of Test		2024-06-28	
Diameter of Sample	cm	D	6.335
Height of Sample	cm	H <sub>o</sub>	2.542
Height of Solids	cm	H <sub>s</sub>	1.213
Water Content	%	w <sub>o</sub>	40.57
Dry Density	g/cm <sup>3</sup>	ρ <sub>d</sub>	1.30
Moist Unit Weight	kN/m <sup>3</sup>	γ	17.9
Void Ratio	-	e <sub>o</sub>	1.095
Degree of Saturation	-	S <sub>ro</sub>	1.01
Specific Gravity	-	G <sub>s</sub>	2.718
End of Test		2024-07-13	
Height of Sample	cm	H <sub>f</sub>	2.106
Water Content	%	w <sub>f</sub>	27.92
Void Ratio	-	e <sub>f</sub>	0.736

TRIMMING: the specimen was manually trimmed to the size of the consolidation ring, then mounted in a fixed ring consolidometer

LOADING: the consolidometer was flooded with water with the seating load adjusted to limit swelling

CALCULATIONS: coefficients of consolidation were calculated by the square root time method, secondary consolidation was calculated based on the available duration of the time step

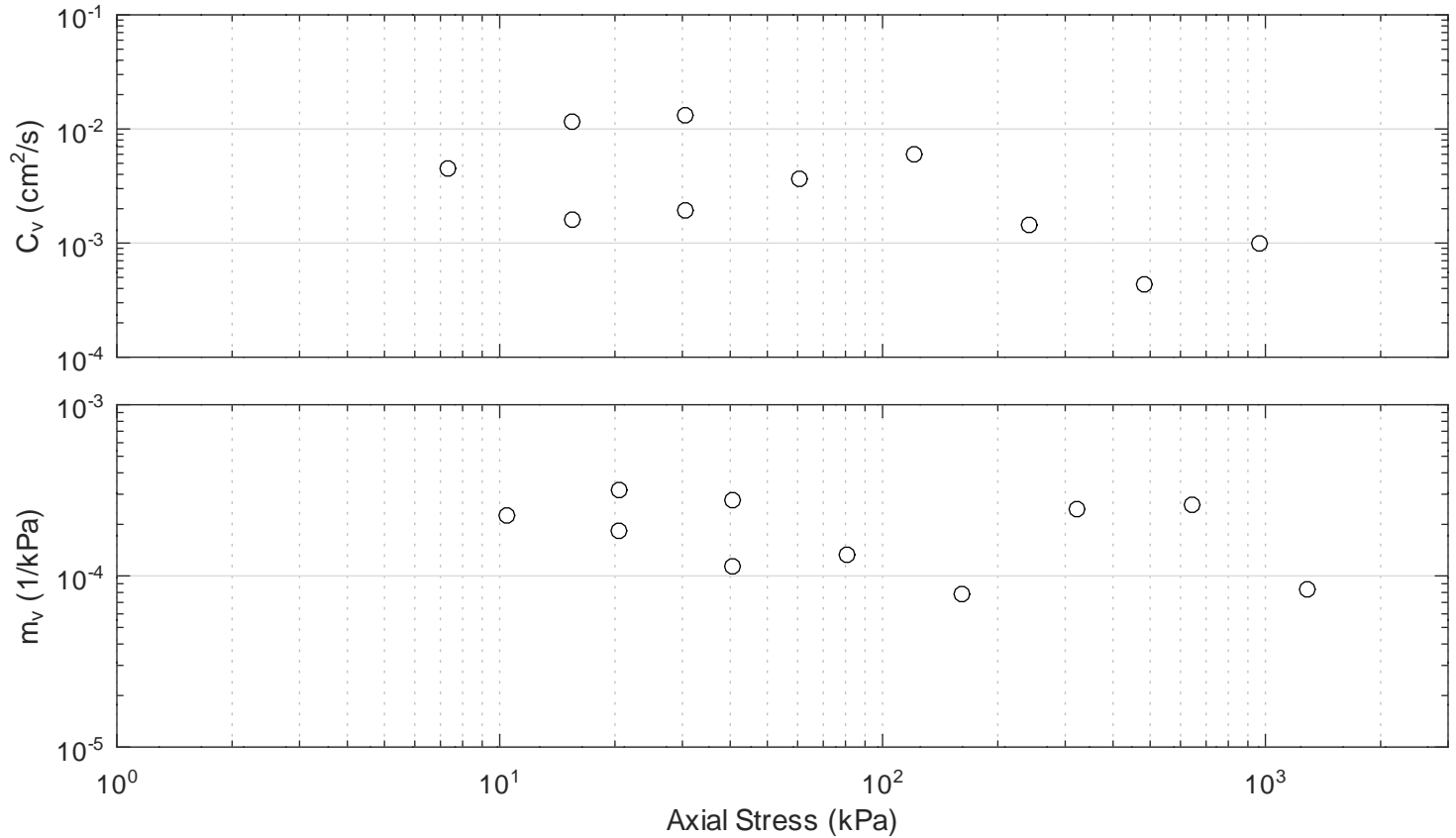
#### Interpreted Results

Recompression Index (reloading)	-	C <sub>r</sub>	0.041
Compression Index	-	C <sub>c</sub>	0.583
Recompression Index (unloading)	-	C <sub>r</sub>	0.033
Probable Preconsolidation Pressure	kPa	p' <sub>c</sub>	247

Check: AO/SP Review: KS



Project: 24726  
 Hwy 17 Twinning  
 Borehole: SC10-4  
 Sample: TW8  
 Depth: 9.5m  
 Client: Ministry of Transportation

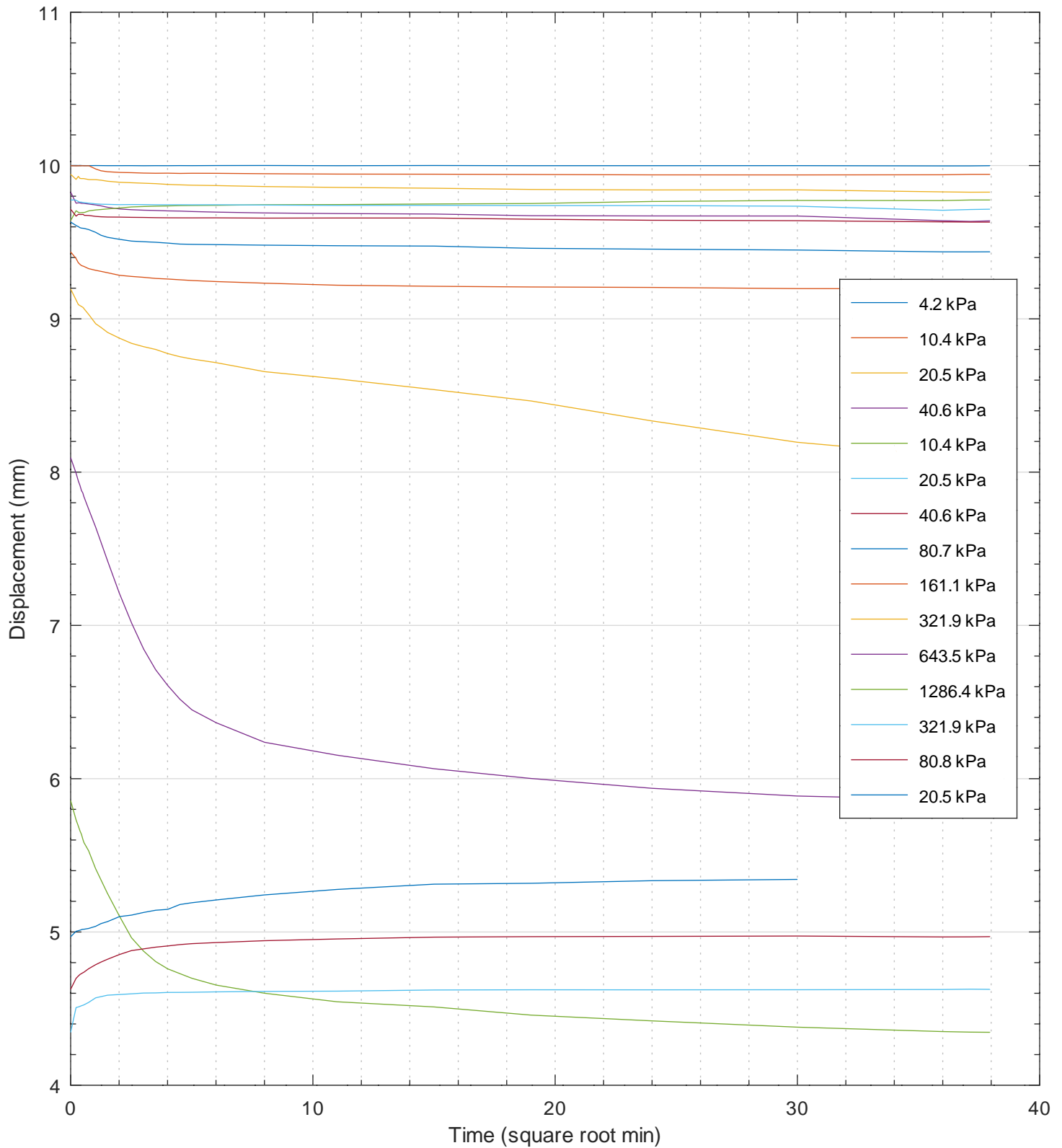


Load No.	Axial Stress	Load Duration	System Deflec.	Dial	Sample Height	Axial Strain	Void Ratio	Void Ratio	Time U(0.99)	$C_v$	$k_v$	$C_{ae}$
	kPa	min	mm	mm	cm	%	(EOI)	(EOP)	min	cm <sup>2</sup> /s	cm/s	-
0				10.000	2.542	0.00	1.095					
1	4.2	1440.2	0.021	9.998	2.544	-0.08	1.097					
2	10.4	1440.1	0.041	9.944	2.541	0.06	1.094	1.094	10.5	4.50e-03	9.96e-08	0.0002
3	20.5	1440.1	0.076	9.826	2.533	0.38	1.087	1.091	29.3	1.60e-03	5.00e-08	0.0010
4	40.6	1440.4	0.122	9.639	2.518	0.94	1.075	1.080	24.0	1.93e-03	5.26e-08	0.0014
5	10.4	1440.5	0.088	9.775	2.529	0.54	1.084					
6	20.5	1440.5	0.102	9.715	2.524	0.73	1.080	1.082	4.1	1.16e-02	2.08e-07	0.0005
7	40.6	1440.1	0.128	9.631	2.518	0.96	1.075	1.078	3.5	1.32e-02	1.47e-07	0.0005
8	80.7	1440.4	0.186	9.438	2.504	1.49	1.064	1.069	12.3	3.66e-03	4.77e-08	0.0011
9	161.1	1440.5	0.266	9.196	2.488	2.12	1.051	1.057	7.5	6.00e-03	4.61e-08	0.0013
10	321.9	1440.4	0.362	8.095	2.388	6.07	0.968	1.020	27.7	1.44e-03	3.47e-08	0.0170
11	643.5	1440.1	0.474	5.855	2.175	14.44	0.793	0.832	39.3	4.35e-04	1.11e-08	0.0127
12	1286.4	1440.1	0.622	4.345	2.039	19.80	0.680	0.711	20.1	9.93e-04	8.13e-09	0.0095
13	321.9	1440.1	0.470	4.626	2.052	19.29	0.691					
14	80.8	1440.4	0.367	4.969	2.076	18.35	0.711					
15	20.5	900.1	0.298	5.343	2.106	17.15	0.736					





Project: 24726  
 Hwy 17 Twinning  
 Borehole: SC10-4  
 Sample: TW8  
 Depth: 9.5m  
 Client: Ministry of Transportation







## **Appendix C.2**

### **Analytical Testing Results**

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

Client ID:	BON24-2 SS4 10'-12'	NSC20-2 SS2A 2'6"-3'3"	SC10-1 SS2B 3'-4'	SC10-4 SS2 2'6"-4'6"	
Sample Date:	09-Apr-24 09:00	02-Apr-24 09:00	21-Mar-24 09:00	04-Apr-24 09:00	-
Sample ID:	2415421-05	2415421-06	2415421-07	2415421-08	-
Matrix:	Soil	Soil	Soil	Soil	
MDL/Units					

#### Physical Characteristics

% Solids	0.1 % by Wt.	72.6	69.1	73.2	77.5	-	-
----------	--------------	------	------	------	------	---	---

#### General Inorganics

Conductivity	5 uS/cm	286	203	316	247	-	-
pH	0.05 pH Units	6.79	6.65	6.95	6.84	-	-
Resistivity	0.1 Ohm.m	35.0	49.2	31.6	40.5	-	-

#### Anions

Chloride	10 ug/g	12	37	97	27	-	-
Sulphate	10 ug/g	24	21	44	<10	-	-

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.  
Lakefield - Ontario - K0L 2H0  
Phone: 705-652-2000 FAX: 705-652-6365

**Paracel Laboratories**

Attn : Dale Robertson

300-2319 St.Laurent Blvd.  
Ottawa, ON  
K1G 4K6, Canada

Phone: 613-731-9577  
Fax:613-731-9064

19-April-2024

**Date Rec. :** 16 April 2024  
**LR Report:** CA12714-APR24  
**Reference:** Project#: 2415421

**Copy:** #1

## CERTIFICATE OF ANALYSIS

### Final Report

Sample ID	Sample Date & Time	Sulphide (Na <sub>2</sub> CO <sub>3</sub> ) %
1: Analysis Start Date		19-Apr-24
2: Analysis Start Time		13:06
3: Analysis Completed Date		19-Apr-24
4: Analysis Completed Time		13:12
5: RL		0.01
<del>6: SC48-3 SC3A 5' 6"3"</del>	<del>11 Mar 24</del>	<del>&lt; 0.01</del>
<del>7: SC23-2 SS5 10' 12"</del>	<del>13 Mar 24</del>	<del>0.83</del>
<del>8: DOC23-1 SS7, 15' 17"</del>	<del>11 Mar 24</del>	<del>0.01</del>
<del>9: OBR23-1 SC10 40' 50"</del>	<del>27 Mar 24</del>	<del>&lt; 0.01</del>
<del>10: BON24-2 SS4 10' 12"</del>	<del>09-Apr-24</del>	<del>&lt; 0.01</del>
<del>11: NSC20-2 SS2A 2'0"-3'3"</del>	<del>02-Apr-24</del>	<del>&lt; 0.01</del>
12: SC10-1 SS2B 3'-4"	21-Mar-24	< 0.01
13: SC10-4 SS2 2'6"- 4'6"	04-Apr-24	< 0.01

RL - SGS Reporting Limit

Note: Samples taken March 11 and 13th were past the 28 day holding time for sulphide analysis when received; result may be unreliable. Processed past holding time as per client's instructions.

Kimberley Didsbury  
Project Specialist,  
Environment, Health & Safety



## **Appendix D.**

### **Site Photographs**





**Photo 1. Looking southeast along existing westbound embankment (March 21, 2024)**



**Photo 2. Looking northwest at existing culvert inlet (March 21, 2024)**





**Photo 3. Looking northwest along the existing eastbound embankment (July 25, 2024)**



**Photo 4. Looking southeast along the existing eastbound embankment (July 25, 2024)**





**Photo 5. Looking south from Highway 17 alignment (July 25, 2024)**



**Photo 6. Existing culvert outlet (July 25, 2024)**