



**THURBER** ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT  
LARONDE CREEK BRIDGE REPLACEMENT  
HIGHWAY 17, 20.3 KM WEST OF HIGHWAY 11  
SITE NO. 43X-0065/B0**

**G.W.P. NO. 5198-13-00**

**Geocres Number: 31L-224**

**Report**

**to**

**McIntosh Perry Consulting Engineers**

**Latitude: 46.370246°  
Longitude: -79.710742°**

**August 2020**

**Thurber File No.: 23411**



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**PART 1: FACTUAL INFORMATION**

**1. INTRODUCTION**

This section of the report presents the factual findings obtained from a preliminary desktop study and subsequent foundation investigation for detailed design completed at the Highway 17 bridge crossing over Laronde Creek, which is located about 20.3 km west of Highway 11 near North Bay, Ontario.

The purpose of this investigation was to supplement the subsurface conditions identified in the desktop study 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. A model of the subsurface conditions influencing design and construction was developed in the course of the current investigation.

Thurber Engineering Ltd. (Thurber) was retained by McIntosh Perry Consulting Engineers (MPCE) to provide foundations engineering services for this project. This work is being carried out under assignment number 5018-E-0014.

**2. SITE DESCRIPTION**

The existing bridge was constructed in 1938 and is a two-lane single span structure. The overall open span and width of the structure are 13.7 and 10.2 m, respectively. The existing substructure consists of reinforced cast-in-place concrete abutments founded on timber piles. A sidewalk and gabion retaining wall were added to the south side of the structure in 2009.

The highway at this location has an east-west orientation and Laronde Creek has a north-south orientation, flowing to the south towards Lake Nipissing. Laronde Creek is about 12 m wide. The water level in the creek was reported to be about Elevation 195.7 m in October 2018. The road surface at the abutments is at about elevation 201.8 m based on the elevation of existing on-road boreholes (BH 4 and BH 6).

The embankment side slopes on the north side of the approaches are sloped at approximately 2H:1V. A perched gabion basket retaining wall, up to about 2.5 m in height, is present on the





south side of the approaches, with approximately 2H:1V sides slopes observed below the base of the retaining wall near the abutments.

A CN rail bridge crossing is located about 20 m south of the highway. To the north of the highway, the west creek bank has a shallow slope with an old asphalt paved access road to a boat launch and dock at the creek edge. On the east creek bank, the slope is steep and heavily vegetated with trees. An overhead power line is present about 15 m north of the highway. A ditch is also present on the north side of the highway at the toe of the approach embankments both on the east and west sides of the bridge.

Select photographs of the site are included in Appendix D.

### **3. DESKTOP STUDY**

#### **3.1 General**

A desktop study was completed at the preliminary design phase based on a site reconnaissance and a review of geotechnical data gathered from available sources; no borehole drilling or sampling was carried out for this phase of the work. Information on the existing surface and subsurface conditions relevant to the foundations of the existing structures and embankments are summarized in the sections below.

#### **3.2 MTO GEOCRES Files**

Thurber has reviewed the following Foundation Investigation and Design Reports (FIDR) available from the Geocres library.

- Report by Thurber Engineering Ltd. to Stantec Consulting Group Ltd., titled “Preliminary Foundation Investigation and Design Report for Proposed Bridge over Laronde Creek – Site 43-65, Highway 17 from North Bay to Sturgeon Falls, W.P. 812-76-00 & 398-91-00, District 54, Sudbury”, dated January 19, 1999 (File No. 19-2487-0A) [Geocres No. 31L-72].
- Report by Golder Associates Ltd. to McCormick Rankin Corporation, titled “Foundation Investigation and Design, Laronde Creek Bridge Replacement, Highway 17, Site 43-65, W.P. 812-76-02, District 54, Sudbury, G.W.P 812-76-01”, dated June 2000 (Report No. 991-1164-1) [Geocres No. 31L-70].
- Report by Trow Associates Inc. to Ministry of Transportation, titled “Foundation Investigation and Design Report, Gabion Wall Construction near Laronde Creek, Hwy 17, District 54, G.W.P. 5274-08-00”, dated October 15, 2009 (File No. SD000360624d) [Geocres No. 31L-137].

The factual information from the GEOCRES reports (e.g., borehole plans, boreholes records and laboratory testing results) are provided in Appendix E.



It must be recognized that the service providers that produced the historical FIDR reports are solely responsible for the accuracy and quality of the subsurface information presented in their respective reports and that conditions, particularly near ground surface, may have changed subsequent to the investigations.

### **3.3 Archived Drawings**

Archived drawings from 1937 prepared by the Department of Highways Ontario (Contract 37-128) were reviewed as part of this assessment; two of the drawings are provided in Appendix F.

### **3.4 Inspection Reports**

A biannual inspection was completed by others in 2016 using the Ontario Bridge Management System (OBMS) to assess the condition of the existing structure through visual inspection. That report indicated deterioration of several elements of the Laronde Creek Bridge, including (but not limited to): light to severe scour at the base of the abutments, severe scaling and spalls of abutments and wing walls exposing corroded rebar, erosion of the northwest embankment, and settlement of the west approach wearing surface with corresponding ponding.

### **3.5 Site Reconnaissance Visit**

A site reconnaissance visit was carried out by a Thurber Geotechnical Engineer on October 26, 2018 as part of the preliminary foundation design assessment. The project site was visited and visible geological/geotechnical features were documented and assessed with respect to structure foundation and embankment performance.

Based on site observations, it is evident that the existing approach embankments have experienced settlement, as evidenced by tension cracks in the asphalt at the edges of the abutment, surface ponding, and the presence of newer asphalt placed only at the approaches (paved in 2007 per the OBMS 2016 inspection report). The settlement that was visible at the time of the site visit was estimated to be in the range of 50 to 100 mm; it is considered that it may be indicative of long-term consolidation settlement of the underlying clay deposit. Higher magnitudes of settlement were evident on the west embankment versus the east embankment.

On the embankment side slopes, some settlement (approximately 50 to 75 mm) has occurred near the eastern end of the gabion basket retaining wall. There was no evidence of global slope instability noted during the site reconnaissance. Some erosional channels have cut through the embankment fill in some areas, most notably along the northwest wing wall and at the two sidewalk wooden crib walls, which have been undermined.

A previously installed piezometer was observed to have active artesian flow at the time of the site visit. This well was subsequently sealed during the fieldwork that was carried out for the detailed design foundation investigation in August 2019 (discussed in Section 4 below).



#### 4. SITE INVESTIGATION AND FIELD TESTING

The investigation and field testing program was carried out between August 8th and 17th, 2019. The field investigation consisted of advancing five boreholes identified as 19-01, 19-02A, 19-02B, 19-03 and 19-04. Borehole 19-02A was advanced for the purpose of obtaining consecutive Shelby tube samples. One seismic cone penetration test (SCPT) identified as SCPT19-02 was pushed adjacent to Boreholes 19-02A and 19-02B.

Boreholes 19-01, 19-02A and 19-02B were advanced using a truck-mounted CME 55 drill rig off of the access roadway. Boreholes 19-03 and 19-04 were advanced using a portable Explo 220 drill rig. All boreholes were advancing using wash-boring techniques except for Borehole 19-02A which was advanced using mud-rotary techniques. SCPT19-02 was pushed from the truck-mounted CME 55 drill rig with portable cone penetration equipment. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

**Table 4-1: Summary of Boreholes – Current Investigation**

<b>Borehole / SCPT No.</b>	<b>Foundation Element</b>	<b>Northing (m)</b>	<b>Easting (m)</b>	<b>Ground Surface Elevation (m)</b>	<b>Termination Depth Below Ground Surface (m)</b>
19-01	West Approach	5136773.2	288543.8	199.8	11.9
19-02A	West Abutment	5136773.2	288554.2	198.4	16.6
19-02B		5136772.9	288556.8	198.3	5.2
SCPT19-02		5136772.5	288559.3	198.1	17.9
19-03	East Abutment	5136775.2	288596.7	197.8	20.0
19-04	East Approach	5136774.9	288616.4	202.8	11.9

In Boreholes 19-01, 19-02B, 19-03 and 19-04, soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) following ASTM D1586. Field vane testing was carried out in the cohesive deposits at selected depths using an MTO N vane. Borehole 19-03 was advanced into bedrock using rotary diamond drilling techniques while collecting NQ sized bedrock core. SCPT19-02 was advanced to refusal on very dense till or bedrock. Borehole 19-02A was advanced to Shelby tube refusal. Boreholes 19-01, 19-02B and 19-04 were advanced to their required termination depth.

The drilling and sampling operations were supervised on a full-time basis by an experienced member of Thurber's geotechnical staff. The drilling supervisor logged the boreholes and processed the recovered soil and bedrock samples for transport to Thurber's Ottawa geotechnical laboratory for further examination and testing.



Vibrating wire piezometers (VWP) were installed in Boreholes 19-02A and 19-03 to allow for measurements of the porewater pressure after completion of drilling. The VWP installation details are illustrated on the Record of Borehole sheet provided in Appendix B. All other boreholes were backfilled with a low-permeability mixture of cuttings and bentonite pellets in accordance with Ontario MOE Regulation 903 as amended.

## **5. LABORATORY TESTING**

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all retained split-spoon soil samples. Grain size distribution and Atterberg limits testing was also carried out on selected samples to MTO and ASTM standards. All rock cores were photographed and their total core recovery (TCR), solid core recovery (SCR) and rock quality designation (RQD) were measured. Two samples of the bedrock core were submitted for unconfined compressive strength (UCS) testing. One-dimensional (incremental loading) consolidation testing was carried out on four samples. Two of those samples were subjected to long-term creep testing at a selected stress interval. Four samples were submitted for constant rate of strain (CRS) consolidation testing; a pair of samples were taken from two different elevations and subjected to different strain rates. One sample was submitted for triaxial testing (consolidated-undrained). Chemical analysis for determination of pH, conductivity, resistivity, sulphate, sulphide and chloride concentrations was carried out on four soil samples.

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.

## **6. SUBSURFACE CONDITIONS**

Details of the soil stratigraphy encountered during the current investigation are presented on the Record of Borehole sheets and SCPT log included in Appendix B and the Borehole Location and Soil Strata drawings included in Appendix A. Detailed descriptions of the previous field investigation methodologies and results are presented in the individual reports listed in Section 3.2. Details of the soil stratigraphy encountered during the previous investigations are presented on the Record of Borehole sheets and the Borehole Locations and Soil Strata drawings provided in Appendix E. The laboratory test results from the previous investigations are also provided in Appendix E.

A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets governs any interpretation of the site conditions. It must be recognized that the soil and groundwater conditions may vary between and beyond borehole locations.

Soil descriptions are in accordance with the Unified Soil Classification System, ASTM D2487, as modified by current MTO standards for cohesionless soils.

In general terms, subsurface conditions at the site consist of fill and/or surficial sands/silts overlying an approximately 19 m thick deposit of varved clayey silt to silty clay, which is underlain by a thin layer of sand till over granitic bedrock. A summary of the subsurface information from the current investigation is presented in the following sections. Information from previous investigations that is considered pertinent to the foundation design is also included in the discussion below.



## 6.1 Topsoil

Topsoil was encountered at the surface in Boreholes 99-43, 99-45, 3, 5 and 19-04. The topsoil ranged from 15 mm to 600 mm thick. One SPT N value of 6 was recorded in this layer indicating a loose relative density. One moisture content on a tested sample was 25%.

## 6.2 Asphalt & Concrete

Asphalt was encountered at surface in Boreholes 1, 2, 4 and 6 advanced from Highway 17 and in Boreholes 99-44, 19-01 and 19-02B advanced from the boat ramp access road to the north of the highway. The thickness of the asphalt ranged from 50 mm to 300 mm. A 100 mm thick layer of concrete was encountered below the asphalt in Borehole 19-01.

## 6.3 Fill

Fill associated with the existing highway embankment and the old asphalt paved boat launch was encountered in Boreholes 98-3 to 98-6, 99-44, 1 to 7, 19-01 and 19-02B. Where present, the fill ranges in thickness from 0.6 to 3.0 m with the underside of the layer at elevations ranging from 194.4 m to 201.0 m. The fill generally consists of sandy gravel, to sand, to sand with silt, to silty sand, to sandy silt. SPT N values in this material ranged from 2 to 25 blows, indicating a very loose to compact relative density. The moisture content on tested samples typically ranged from 2% to 34%. One moisture content of 86% was recorded.

Gradation analyses were completed on five samples in the fill (one from the current investigation). The grain size distribution curve for the sample from the current investigation is included in Figure C1 in Appendix C. The results from all five tests are summarized in Table 4-1 below and the results are presented on the corresponding Record of Borehole sheets in Appendix B and Appendix E for the current and previous investigations, respectively.

**Table 4-1: Summary of Gradation Test Results – Fill**

Soil Particle	Percentage (%)
Gravel	0 to 64
Sand	3 to 70
Silt and Clay	6 to 97

## 6.4 Surficial Sand and Silt

A thin discontinuous surficial deposit of sand and silt was encountered in Boreholes 98-1, 98-2, 99-45, 3, 4, 6, 19-03 and 19-04. Where encountered, the surficial sand and silt is 0.8 to 4.4 m thick with the underside of the layer at elevations ranging from 195.7 m to 200.1 m. SPT N values in this material ranged from 2 to 12 blows, indicating a very loose to compact relative density. The moisture content on tested samples typically ranged from 11% to 31%. One moisture content of 61% was recorded.



Gradation analyses were completed on six samples of this deposit (three from the current investigation). The grain size distribution curves for the samples from the current investigation are included in Figure C2 in Appendix C. The results from all six tests are summarized in Table 4-2 below and the results are presented on the corresponding Record of Borehole sheets in Appendix B and Appendix E for the current and previous investigations, respectively.

**Table 4-2: Summary of Gradation Test Results – Surficial Sand and Silt**

Soil Particle	Percentage (%)
Gravel	0 to 10
Sand	0 to 56
Silt	31 to 93
Clay	3 to 13

Atterberg Limits tests were completed on four samples (three from the current investigation and one from the previous investigations). The results from the current investigation indicated that the sand and silt samples were non-plastic, and the test result from the previous investigation gave a liquid limit of 25 and plastic limit of 23, indicating a low plastic silt (ML). It is noted that this soil had a high susceptibility to erosion.

## **6.5 Clayey Silt (CL-ML to CL) to Clay (CI to CH)**

A thick layer of compressible glaciolacustrine varved clay was encountered beneath the surficial deposits described above in all boreholes. The upper portion of the deposit is weathered and is generally described as clayey silt with trace sand. The upper clayey silt ranges in thickness from 0.8 to 3.8 m with bottom elevation ranging from 194.1 to 199.9 m. The lower clayey silt to clay is generally described as being varved with layers of silty clay and clayey silt. Occasional sand seams are also noted within the deposit. Where fully penetrated, the lower clay deposit ranges in thickness from 13.1 m to 19.1 m with bottom elevations ranging from 178.5 m to 181.1 m.

SPT 'N' values in the upper clayey silt deposit ranged from weight-of-hammer to 19 blows. One field vane test gave an undrained shear strength ( $s_u$ ) of 39 kPa. These in situ test results indicate a firm to very stiff consistency for the upper clayey silt. Field vane testing conducted in the lower clayey clay deposit indicate that the  $s_u$  generally ranges from about 17 kPa (soft) at the top of the deposit to 100 kPa (stiff) at the bottom of the deposit, with a generally linear increase with depth. It is noted that there is variation in the vane results ( $\pm 20$  kPa) between the three firms that carried out the testing. Remolded vane testing indicates that the sensitivity of the deposit generally ranges from 2 to 4 (medium sensitivity).

Eight dissipation tests were carried out during the advancement of the SCPT19-02. The results of that testing are summarized in Appendix B and indicate that the coefficient of consolidation in the horizontal direction,  $C_h$ , ranges from  $1.4E-2$  to  $8.6E-1$   $\text{cm}^2/\text{s}$ . Shear wave velocity measurements were also taken during advancement of the SCPT, with the measured shear wave velocities in the clay deposit ranging from 81 to 206 m/s. Further details on the shear wave velocity testing results are provided in Appendix B.



Moisture contents in the upper clayey silt ranged from 18 to 41% and the moisture contents in the lower clay ranged from 21 to 68%.

Gradation analyses were completed on forty-two samples of this deposit (14 from the current investigation). The grain size distribution curves for the samples from the current investigation are included in Figures C3 to C6 in Appendix C. Previous lab test results are presented in Appendix E. The results from all of the tests are summarized in Table 4-3 below and the results are presented on the corresponding Record of Borehole sheets in Appendix B and Appendix E for the current and previous investigations, respectively.

**Table 4-3: Summary of Gradation Test Results – Clay**

Soil Particle	Percentage (%)		
	Upper Clayey Silt	Cohesive Lower Varved Clay	Non-Cohesive Silt Layer/Varve (19-02A, TW-15)
Gravel	0	0	0
Sand	0 to 1	0 to 2	4
Silt	63 to 80	25 to 71	82
Clay	20 to 37	27 to 73	14

Atterberg limits testing was completed on fifty-one samples (19 from the current investigation). All of the results are summarized in Table 4-4 below and the tests from the current investigation are summarized on Figures C8 to C11 in Appendix C.

**Table 4-4: Summary of Atterberg Limits Test Results – Clay**

Parameter	Value		
	Upper Clayey Silt	Cohesive Lower Varved Clay	Non-Cohesive Silt Layer/Varve (19-02A, TW-15)
Plastic Limit	19 to 24	14 to 25	Non-plastic
Liquid Limit	24 to 32	19 to 57	

The results of the testing indicates that the upper portion of the deposit is low plasticity (CL-ML) and the lower portion of the deposit ranges from low (CL) to high plasticity (CH).

One-dimensional (incremental loading) consolidation testing and constant rate of strain (CRS) testing was carried out on selected samples from Borehole 19-02A. One-dimensional consolidation testing was also completed on two samples from Borehole 99-45 during one of the previous investigations, although only one of those tests was considered reliable (SA9). The results of the testing are provided in Appendix C and Appendix E, and are summarized in Table 4-5 below.





**Table 4-5: Consolidation Test Parameters**

<b>Borehole</b>	<b>19-02A</b>							
<b>Parameter</b>	<b>TW1</b>	<b>TW5</b>	<b>TW8</b>	<b>TW15</b>	<b>TW4 / SA1</b>	<b>TW4 / SA2</b>	<b>TW6 / SA3</b>	<b>TW6 / SA4</b>
Sample Depth (m)	3.4	5.8	7.6	12.5	5.2	5.2	6.4	6.4
Sample Elevation (m)	195.0	192.6	190.8	185.9	193.2	193.2	192.0	192.0
Strain Rate (%/hr) for CRS	-	-	-	-	3.0%	0.10%	1.0%	0.30%
Natural Moisture Content, $w_n$ (%)	46.0	51.2	47.2	26.5	64.3	57.4	46.5	42.9
Initial Void Ratio, $e_o$ (-)	1.27	1.45	1.43	1.01	1.81	1.68	1.18	1.14
Unit Weight ( $kN/m^3$ )	17.1	16.5	16.2	16.9	15.9	16.0	18.3	18.2
In-situ Vertical Effective Stress, $p_o'$ (kPa)	45	60	71	110	54	54	73	73
Preconsolidation Pressure, $p_c'$ (kPa)	137	150	140	185	210	157	175	165
Overconsolidation Ratio, OCR (-)	3.0	2.5	2.0	1.7	3.9	2.9	2.4	2.3
Recompression Index, $C_r$	0.052	0.063	0.075	0.072	0.102	0.100	0.107	0.089
Coefficient of Consolidation, $c_{vr}$ ( $m^2/yr$ )	28.0 - 53.2	17.5 - 32.2	21.1 - 56.6	26.4 - 44.6	-	-	-	-
Compression Index, $C_c$	0.67	1.01	1.06	0.61	0.96	1.48	0.53	0.48
Coefficient of Consolidation, $c_v$ ( $m^2/yr$ )	2.0 - 5.7	0.7 - 3.5	1.5 - 5.0	1.5 - 4.4	-	-	-	-
Secondary Compression Index, $C_{\alpha}(-)$	0.015	0.015	-	-	-	-	-	-





Triaxial testing (consolidated-undrained) was also carried out on one sample (TW3 from Borehole 19-02A). The results of the triaxial testing are presented in Appendix C.

## 6.6 Till – Sand to Silty Sand to Sandy Silt with Gravel

A thin deposit of till consisting of sand, to silty sand, to sandy silt, and containing gravel, cobbles and boulders is was encountered below the clay in Boreholes 98-2, 98-3, 98-4, 99-43, 99-44, 99-45, 1, 2 and 19-03. Where encountered, the till is 0.2 to 4.2 m thick with an underside elevation ranging from 174.5 m to 180.7 m. SPT N values in this material were generally 27 to greater than 50 blows per 50 mm penetration, indicating a compact to very dense relative density. The moisture content on the tested samples ranged from 10% to 28%.

Gradation analyses were completed on two samples of this deposit (one from the current investigation). The grain size distribution curve for the sample from the current investigation is included in Figure C7 in Appendix C. Both of the test results are summarized in Table 4-6 below and the results are presented on the corresponding Record of Borehole sheets in Appendix B and Appendix E for the current investigation and previous investigation, respectively.

**Table 4-6: Summary of Gradation Test Results – Till**

Soil Particle	Percentage (%)
Gravel	6 to 16
Sand	18 to 84
Silt	8 to 54
Clay	2 to 12

Atterberg limits testing was completed on one sample from the current investigation. The plastic and liquid limits were 16 and 18, respectively, indicating a low plasticity silt (ML). The test result is summarized on Figure C12 in Appendix C.

## 6.7 Bedrock

Eight boreholes were cored into the bedrock and two others were terminated upon auger refusal on the assumed bedrock surface. Borehole 19-03 from the current investigation was advanced into bedrock by coring. The bedrock is generally described as fresh, very strong to extremely strong, undifferentiated Precambrian granite of the Canadian Shield. Two unconfined compressive strength (UCS) tests completed on the rock yielded strengths of 147 and 162 MPa, indicating very strong rock. The UCS test results are presented in Appendix C. Rock Quality Designation (RQD) values generally range between 50 and 80%, indicating fair to good quality rock; however, the upper 3 m of bedrock at Borehole 99-43 was weathered and contained significantly more fractures (RQD 0 to 5%), indicating very poor rock at that location. The upper bedrock was also fractured in Borehole 19-03 (RQD 0 to 25%). Photographs of the bedrock core are presented in Appendix C.



The bedrock surface depths and elevations encountered in the current and previous boreholes are summarized in the following table.

**Table 4-7: Summary of Bedrock Surface Depths/Elevations**

Borehole	Bedrock Surface	
	Depth (mbgs)	Elevation (m)
98-1	18.3*	178.5
98-2	20.9*	178.7
98-3	21.0*	176.5
98-4	26.9*	174.5
99-43	21.3*	179.5
99-44	17.1*	180.0
99-45	20.9*	180.7
1	22.3**	179.9
2	22.3**	179.6
19-03	17.9*	179.9

Notes: \*Bedrock proven by coring

\*\*Suspected bedrock surface based on auger refusal

Based on the bedrock surface elevations encountered in the boreholes, it appears that the bedrock surface gently slopes towards the river from both the east and west (i.e., in a trough shape), as well as to the south.

## 6.8 Groundwater

The groundwater levels measured in the VWP's installed during the current investigation and the wells/piezometers installed during the previous investigations are summarized in Table 4-8 below. A downward hydraulic gradient is evident in the multi-level installations of Boreholes 99-43 and 99-45. Artesian conditions were encountered during drilling in Boreholes 98-1 and 19-03, which are located close to the creek bank, and the VWP installed in Borehole 19-02A indicates a slight artesian condition.

These groundwater observations are considered short term 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 groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation.

The water level in the creek was reported by others to be at 195.37 m in October 2018.

**Table 4-8: Summary of Groundwater Level Measurements**

Borehole	Strata and Elevation within Screened Interval	Ground Surface Elevation (m)	Groundwater Level		
			Depth (mbgs)	Elevation (m)	Date of Measurement
98-1	Clay (181.5 – 183.0)	196.8	-2.4*	199.2	October 21, 1998
			-2.4*	199.2	October 22, 1998
			-2.3*	199.1	October 23, 1998
			-2.3*	199.1	October 24, 1998
			-2.3*	199.1	October 25, 1998
			-2.3*	199.1	October 26, 1998
			-2.3*	199.1	October 27, 1998
98-4	Sand till (176.5 – 178.0)	201.4	4.1	197.3	October 24, 1998
			4.1	197.3	October 25, 1998
			4.3	197.1	October 26, 1998
			4.2	197.2	October 27, 1998
99-43 (shallow)	Clay (188.6 – 190.1)	200.8	2.0	198.8	October 3, 1999
99-43 (deep)	Granitic bedrock (175.0 – 176.5)		2.8	198.0	October 3, 1999
99-45 (shallow)	Clay (191.0 – 192.5)	201.6	1.0	200.6	October 3, 1999
99-45 (deep)	Granitic bedrock (177.6 – 179.1)		3.2	198.4	October 3, 1999
1	Clay (190.0 – 191.5)	202.2	0.9	201.3	September 11, 2009
2	Clay (189.7 – 190.2)	201.9	1.5	200.4	September 11, 2009
4	Clay (189.6 – 191.1)	201.8	3.1	198.7	September 11, 2009
5	Clay (185.6 – 187.1)	196.8	0.2	196.6	September 11, 2009
6	Clay (189.6 – 191.1)	201.8	0.9	200.9	September 11, 2009
19-02A	Clay (182.1 – 182.4) Tip Elev. 182.5	198.4	-0.3*	198.7	August 19, 2019
			-0.3*	198.7	August 20, 2019
			-0.5*	198.9	August 26, 2019
			-0.4*	198.8	August 27, 2019
19-03	Clay (192.9 – 194.1) Tip Elev. 193.0	197.8	1.7	196.1	August 27, 2019

\*Note – Artesian conditions



## 6.9 Analytical Testing

Four samples of the native soils were submitted for analysis of pH, water soluble sulphate, sulphide, chloride, conductivity and resistivity. The analysis results are summarized in Table 4-9 below and a copy of the test results is provided in Appendix C.

**Table 4-9: Results of Chemical Analysis**

<b>Borehole (Sample)</b>	<b>Depth (mbgs)</b>	<b>Sulphate (µg/g)</b>	<b>pH ( - )</b>	<b>Resistivity (Ohm-cm)</b>	<b>Conductivity (uS/cm)</b>	<b>Chloride (µg/g)</b>	<b>Sulphide (%)</b>
19-02B (SS2)	0.8 – 1.4	<5	7.68	15300	62	9	0.02
19-02B (SS4)	2.3 – 2.9	14	7.70	1570	637	231	0.02
19-03 (SS5)	2.4 – 3.0	28	7.77	4390	228	9	0.02
19-03 (SS8)	6.1 – 6.7	24	8.09	4390	228	5	<0.02



## 7. MISCELLANEOUS

Borehole locations were selected in consultation with the Ministry of Transportation and were located in the field by Thurber relative to existing site features. The as-drilled locations and ground surface elevation of the boreholes were surveyed by Thurber following completion of the field program. Survey elevation benchmarks were provided by MPCE. Marathon Drilling Ltd. of Greely, Ontario supplied and operated the drilling equipment to conduct the drilling, soil sampling, in-situ testing, VWP installation and borehole decommissioning. ConeTec Investigations Ltd. supplied and operated the CPT equipment. The field investigation was supervised on a full-time basis by Michel Johnston, E.I.T. and Sean O'Bryan, C.E.T. of Thurber. Overall supervision of the investigation program was provided by Stephen Dunlop, P.Eng.

Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. UCS, oedometer (incremental loading) consolidation testing, and triaxial testing were completed by Stantec's laboratory in Ottawa, Ontario. CRS consolidation testing was carried out at the Western University laboratory in London, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa, Ontario. Interpretation of the factual data and preparation of this report were carried out by Deanna Pizycki, P.Eng., Stephen Dunlop, P.Eng. and Dr. Fred Griffiths, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundation Projects.



Deanna Pizycki, M.Eng., P.Eng.  
Geotechnical Engineer



Stephen Dunlop, M.A.Sc., P.Eng.  
Associate, Senior Geotechnical Engineer



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



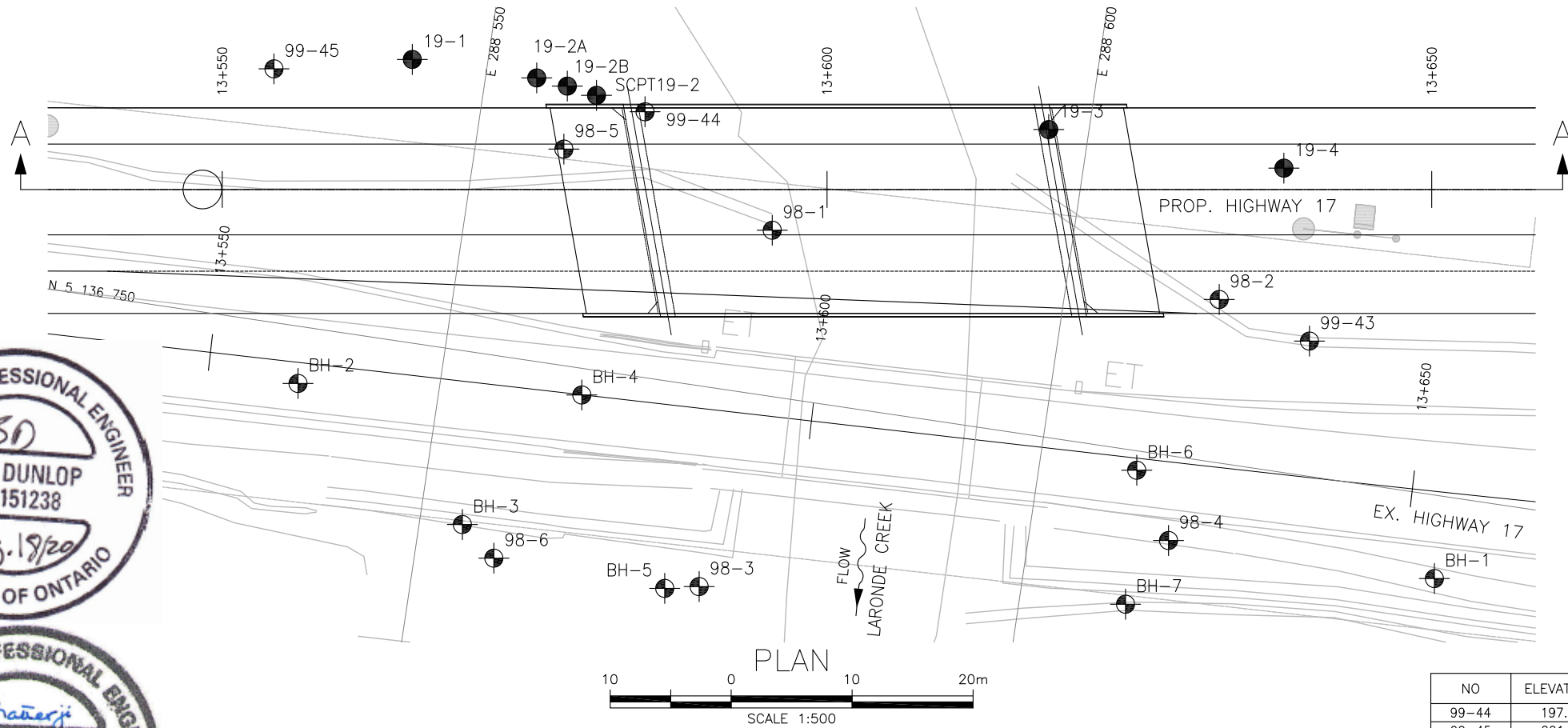
Dr. P.K. Chatterji, P.Eng.  
MTO Review Principal  
Senior Geotechnical Engineer



## **Appendix A.**

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





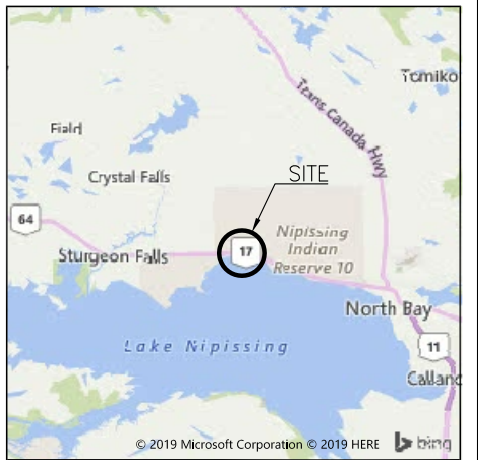
METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No  
GWP No 5198-13-00



HIGHWAY 17  
LARONDE CREEK  
BRIDGE REPLACEMENT  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

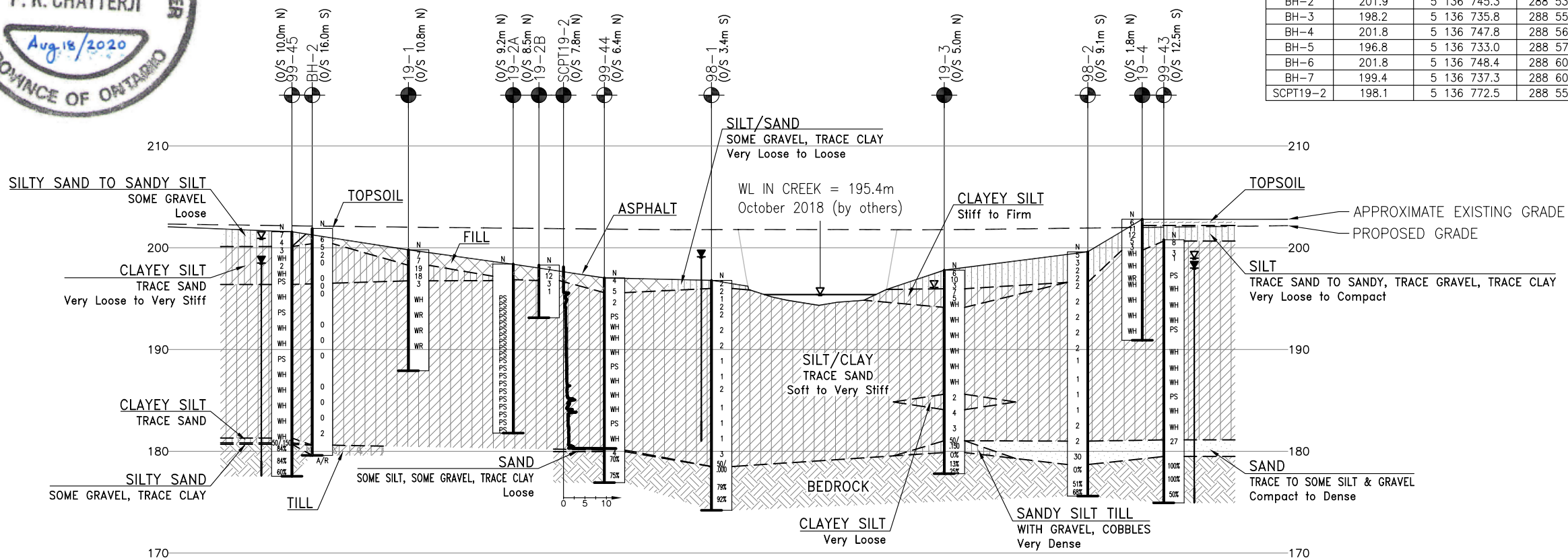
●	Borehole (Current Investigation)
○	Borehole (Previous Investigations)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
W	Water Level
HA	Head Artesian Water
P	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
19-1	199.8	5 136 773.2	288 543.8
19-2A	198.4	5 136 773.2	288 554.2
19-2B	198.3	5 136 772.9	288 556.8
19-3	197.8	5 136 775.2	288 596.7
19-4	202.8	5 136 774.9	288 616.4
98-1	196.8	5 136 763.6	288 575.3
98-2	199.6	5 136 763.4	288 612.7
98-3	197.5	5 136 733.6	288 573.7
98-4	201.4	5 136 743.1	288 611.5
98-5	197.3	5 136 767.7	288 557.3
98-6	198.4	5 136 733.4	288 556.5
99-43	200.8	5 136 761.1	288 620.6

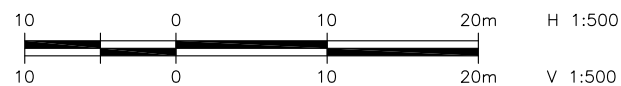
-NOTES-

- 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 10.

GEOCRES No. 31L-224



PROFILE A-A ALONG Q PROPOSED HIGHWAY 17



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	DP	CHK SD	CODE
DRAWN	MFA	CHK DP	SITE
LOAD	DATE	JUN 2020	
STRUCT	DWG	1	



## **Appendix B.**

### **Record of Borehole Sheets SCPT Log**





## 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).

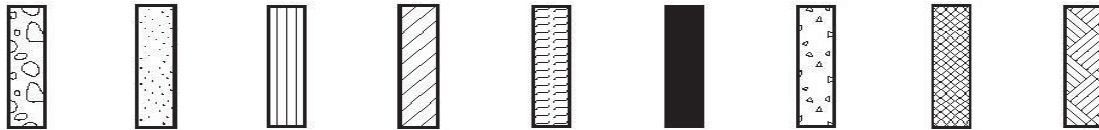
### DYNAMIC CONE PENETRATION TEST (DCPT):

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 19-01

1 OF 2

METRIC

GWP# 5198-13-00 LOCATION Lat: 46.370468°, Long: -79.711292°  
 HWY 17 BOREHOLE TYPE CME 55 Trackmount, NW Casing ORIGINATED BY SOB  
 DATUM Geodetic DATE 2019.08.09 - 2019.08.09 COMPILED BY MW  
 CHECKED BY FG

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			20 40 60 80 100	20 40 60	W <sub>P</sub> W W <sub>L</sub>	GR SA SI CL		
199.8	Pavement Surface												
0.0	ASPHALT (50mm)												
0.2	CONCRETE (100mm)												
	Silty SAND Loose Brown Moist (FILL)		1	SS	7								1 55 44 (SI+CL)
			2	SS	7								
198.3													
1.5	Clayey SILT (CL-ML) Very stiff Grey-brown		3	SS	19								
			4	SS	18								
196.8													
3.0	Clayey SILT (CL) to CLAY (CI to CH) Varved Firm Grey		5	SS	3								
			6	SS	WH								
			7	SS	WR								
			8	SS	WR								
			9	SS	WR								

Continued Next Page

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


DOUBLE LINE 23411 LARONDE.GPJ 2012TEMPLATE(MTO).GDT 15/6/20

# RECORD OF BOREHOLE No 19-01

2 OF 2

METRIC

GWP# 5198-13-00 LOCATION Lat: 46.370468°, Long: -79.711292°  
 HWY 17 BOREHOLE TYPE CME 55 Trackmount, NW Casing ORIGINATED BY SOB  
 DATUM Geodetic DATE 2019.08.09 - 2019.08.09 COMPILED BY MW  
 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	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									
	Continued From Previous Page							20	40	60	80	100					
	Clayey SILT (CL) to CLAY (CI to CH) Varved Firm Grey																
			10	TW	-												
187.9																	
11.9	End of Borehole																

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

# RECORD OF BOREHOLE No 19-02A

1 OF 2

METRIC

GWP# 5198-13-00 LOCATION Lat: 46.370468°, Long: -79.711158°  
Laronde Creek Bridge MTM Zone 10 N 5 136 773.2 E 288 554.2 ORIGINATED BY SOB/MJJ  
HWY 17 BOREHOLE TYPE CME 55 Trackmount, NW Casing COMPILED BY MJJ  
DATUM Geodetic DATE 2019.08.13 - 2019.08.13 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20    40    60    80    100	W <sub>P</sub> W      W <sub>L</sub>	WATER CONTENT (%)			GR		SA	SI	CL	
198.4	Pavement Surface																	
0.0	See 19-2B for stratigraphy																	
195.4	<b>CLAY (CI to CH)</b> Varved Firm Grey - <b>TW1</b> : varve thickness ranged from 4 to 25 mm between 3.0 and 3.6 m depth; grey to light grey; varves are similar in composition; occ. SILT (ML) seams.  - <b>TW5</b> : varve thickness ranged from 5 to 20 mm between 5.5 and 6.1 m depth; grey to light grey; varves are similar in composition; occ. SILT (ML) seams.  - <b>TW8</b> : varve thickness ranged from 4 to 15 mm between 7.3 and 7.9 m depth; grey to light grey; varves are similar in composition; occ. SILT (ML) seams.		1	TW	-													
			2	TW	-													
			3	TW	-													
			4	TW	-													
			5	TW	-													
			6	TW	-													
			7	TW	-													
			8	TW	-													
			9	TW	-													
			10	TW	-													
			11	TW	-													

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 19-02A

2 OF 2

METRIC

GWP# 5198-13-00 LOCATION Lat: 46.370468°, Long: -79.711158°  
Laronde Creek Bridge MTM Zone 10 N 5 136 773.2 E 288 554.2 ORIGINATED BY SOB/MJJ  
HWY 17 BOREHOLE TYPE CME 55 Trackmount, NW Casing COMPILED BY MJJ  
DATUM Geodetic DATE 2019.08.13 - 2019.08.13 CHECKED BY FG

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 (%)  GR   SA   SI   CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)							
	Continued From Previous Page							20   40   60   80   100		W <sub>P</sub> W      W <sub>L</sub>							
	<b>CLAY (Cl to CH)</b> Varved Firm Grey  - <b>TW15:</b> varve thickness ranged from 3 to 45 mm between 12.2 and 12.8 m depth; grey to light grey to red; varves alternating between clay and silt with occasional sand seams.		12	TW	-									0   0   46   54 0   4   82   14 non-plastic			
					13			TW	-								
					14			TW	-								
					15			TW	-								
			16	TW	-												
			17	TW	-												
			18	TW	-												
			19	TW	-												
			20	TW	-												
181.8 16.6	End of Borehole Vibrating wire piezometer installed. Tip at elevation 182.5 m. Interpreted water level at 0.4 m above the ground surface (Elev. 198.8m) on August 27, 2019.																

DOUBLE LINE 23411 LARONDE.GPJ 2012TEMPLATE(MTO).GDT 15/6/20



# RECORD OF BOREHOLE No 19-02B

1 OF 1

METRIC

GWP# 5198-13-00 LOCATION Lat: 46.370465°, Long: -79.711124°  
Laronde Creek Bridge MTM Zone 10 N 5 136 772.9 E 288 556.8 ORIGINATED BY SOB/MJJ  
HWY 17 BOREHOLE TYPE CME 55 Trackmount, NW Casing COMPILED BY MJJ  
DATUM Geodetic DATE 2019.08.14 - 2019.08.14 CHECKED BY FG

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								
198.3	Pavement Surface															
0.0	ASPHALT (150 mm)															
0.2	SAND Loose to Compact Brown Moist (FILL)		1	SS	7		198									
			2	SS	12											
196.8							197									
1.5	CLAY (CI), some fibrous organics Stiff Grey-Brown		3	SS	3											
196.0							196									
2.3	Clayey SILT (CL) to CLAY (CI to CH) Varved Firm Grey		4	SS	1											
							195									
							194									
193.1																
5.2	End of Borehole															

DOUBLE LINE 23411 LARONDE.GPJ 2012TEMPLATE(MTO).GDT 15/6/20

# RECORD OF BOREHOLE No 19-03

1 OF 3

METRIC

GWP# 5198-13-00 LOCATION Lat: 46.370487°, Long: -79.710605°  
Laronde Creek Bridge MTM Zone 10 N 5 136 775.2 E 288 596.7 ORIGINATED BY MJJ  
HWY 17 BOREHOLE TYPE Explo Portable, NW Casing / NQ Coring COMPILED BY MW  
DATUM Geodetic DATE 2019.08.16 - 2019.08.17 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		<div><div></div><div>20406080100</div></div>	<div><div>PLASTIC LIMIT</div><div>NATURAL MOISTURE CONTENT</div><div>LIQUID LIMIT</div></div> <div><div>W<sub>P</sub></div><div>W</div><div>W<sub>L</sub></div></div>	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
197.8	Ground Surface							○ UNCONFINED	+ FIELD VANE				
0.0	SILT, occ. organics near surface Loose to very loose Grey to brown Dry to moist  -becoming clayey at 1.2 m		1	SS	6			● QUICK TRIAXIAL	× LAB VANE				
			2	SS	10								
			3	SS	3								
196.0													
1.8	Clayey SILT (CL-ML to CL) Stiff to firm Grey		4	SS	7								
			5	SS	5								
			6	SS	WH								
194.1													
3.7	Clayey SILT (CL) to CLAY (CI to CH) Varved Soft to firm Grey												
								5.0 +					
								5.8 +					
			7	SS	WH								
								7.0 +					
								7.5 +					
			8	SS	WH								
								6.5 +					
								13.6 +					
			9	SS	WH								
							5.8 +						
							6.0 +						
		10	SS	WH									

Continued Next Page

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

## METRIC

[illegible]

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

DOUBLE LINE 23411 LARONDE.GPJ 2012TEMPLATE(MTO).GDT 15/6/20

RECORD OF BOREHOLE No 19-03

3 OF 3

METRIC

GWP# 5198-13-00 LOCATION Lat: 46.370487°, Long: -79.710605°  
Laronde Creek Bridge MTM Zone 10 N 5 136 775.2 E 288 596.7 ORIGINATED BY MJJ  
HWY 17 BOREHOLE TYPE Explo Portable, NW Casing / NQ Coring COMPILED BY MW  
DATUM Geodetic DATE 2019.08.16 - 2019.08.17 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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	W P	W	W L	WATER CONTENT (%)		
20.0	Continued From Previous Page  End of Borehole Vibrating wire piezometer installed. Tip at elevation 193.0 m. Water level at a depth of 1.7 m below the ground surface (Elev. 196.1 m) on August 27, 2019.													


DOUBLE LINE 23411 LARONDE.GPJ 2012TEMPLATE(MTO).GDT 15/6/20

# RECORD OF BOREHOLE No 19-04

1 OF 2

METRIC

GWP# 5198-13-00 LOCATION Lat: 46.370484°, Long: -79.710349°  
 HWY 17 BOREHOLE TYPE Explo Portable, NW Casing ORIGINATED BY MJJ  
 DATUM Geodetic DATE 2019.08.15 - 2019.08.15 COMPILED BY MW  
 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W <sub>P</sub> W      W <sub>L</sub>				GR   SA   SI   CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
202.8	Ground Surface							20   40   60   80   100					W <sub>P</sub> W      W <sub>L</sub>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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Continued Next Page

+ 3, × 3: Numbers refer to  
Sensitivity

20  
15  
10


(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 19-04

2 OF 2

METRIC

GWP# 5198-13-00 LOCATION Lat: 46.370484°, Long: -79.710349°  
 HWY 17 BOREHOLE TYPE Explo Portable, NW Casing ORIGINATED BY MJJ  
 DATUM Geodetic DATE 2019.08.15 - 2019.08.15 COMPILED BY MW  
 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			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	W <sub>P</sub> W      W <sub>L</sub>							
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE			WATER CONTENT (%)					
	Clayey SILT (CL) to CLAY (CI to CH) Varved Soft to Firm Grey															
			12	SS	WH		192		4.5 + 3.8 + 2.8 + 3.2 +							
							191									
190.9 11.9	End of Borehole															

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



THURBER ENGINEERING LTD.

Thurber Engineering Ltd.

104, 2460 Lancaster Road

Ottawa, ON

www.thurber.ca

Project: Laronde Creek Bridge, MTM Zone 10

Location: Highway 17

CPT: SCPT19-02

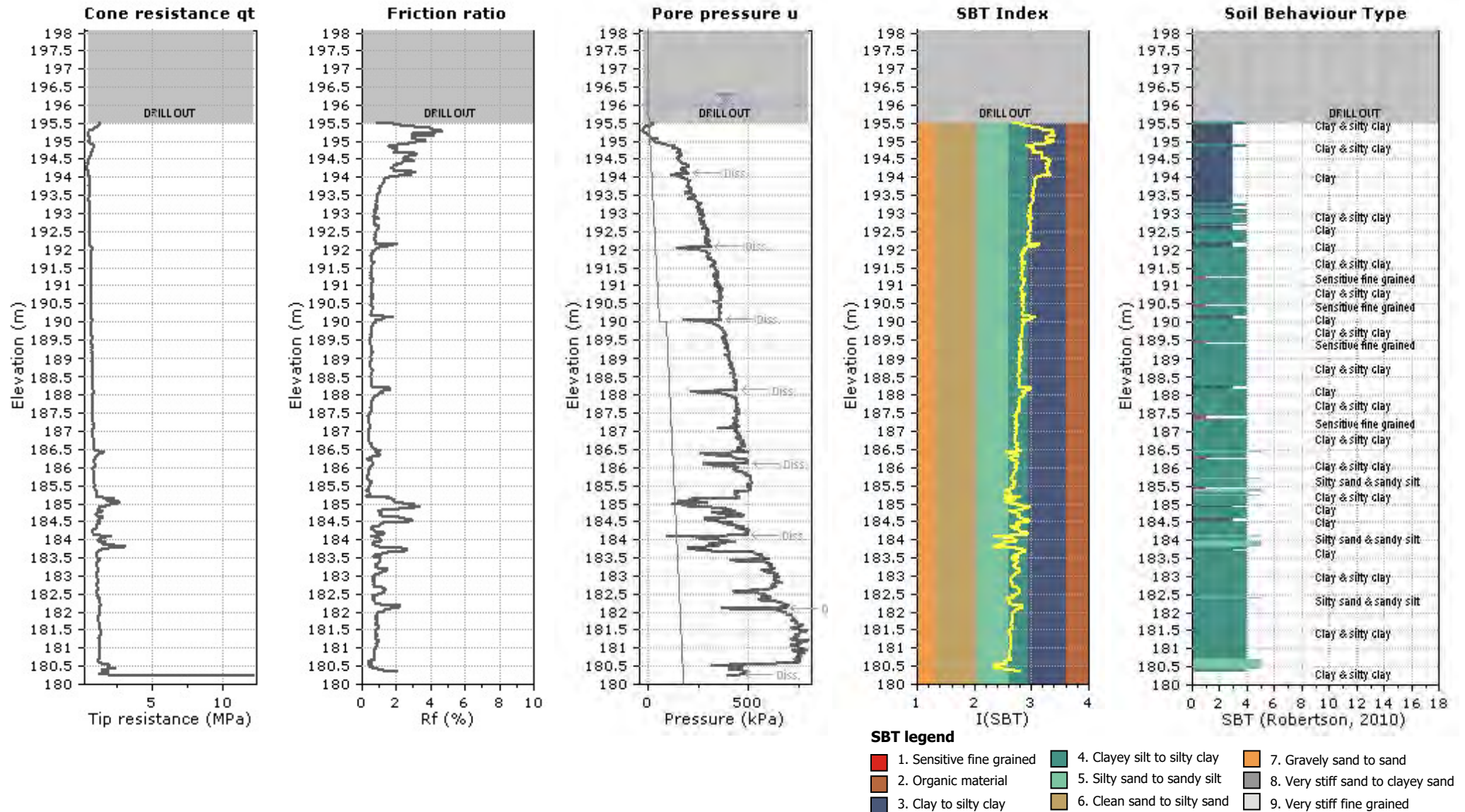
Total depth: 17.88 m, Date: 2019-08-08

Surface Elevation: 198.12 m

Coords: X:288559.30, Y:5136772.50

Cone Type: 15cm2

Cone Operator: ConeTec







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Project: Laronde Creek Bridge, MTM Zone 10

Location: Highway 17

CPT: SCPT19-02

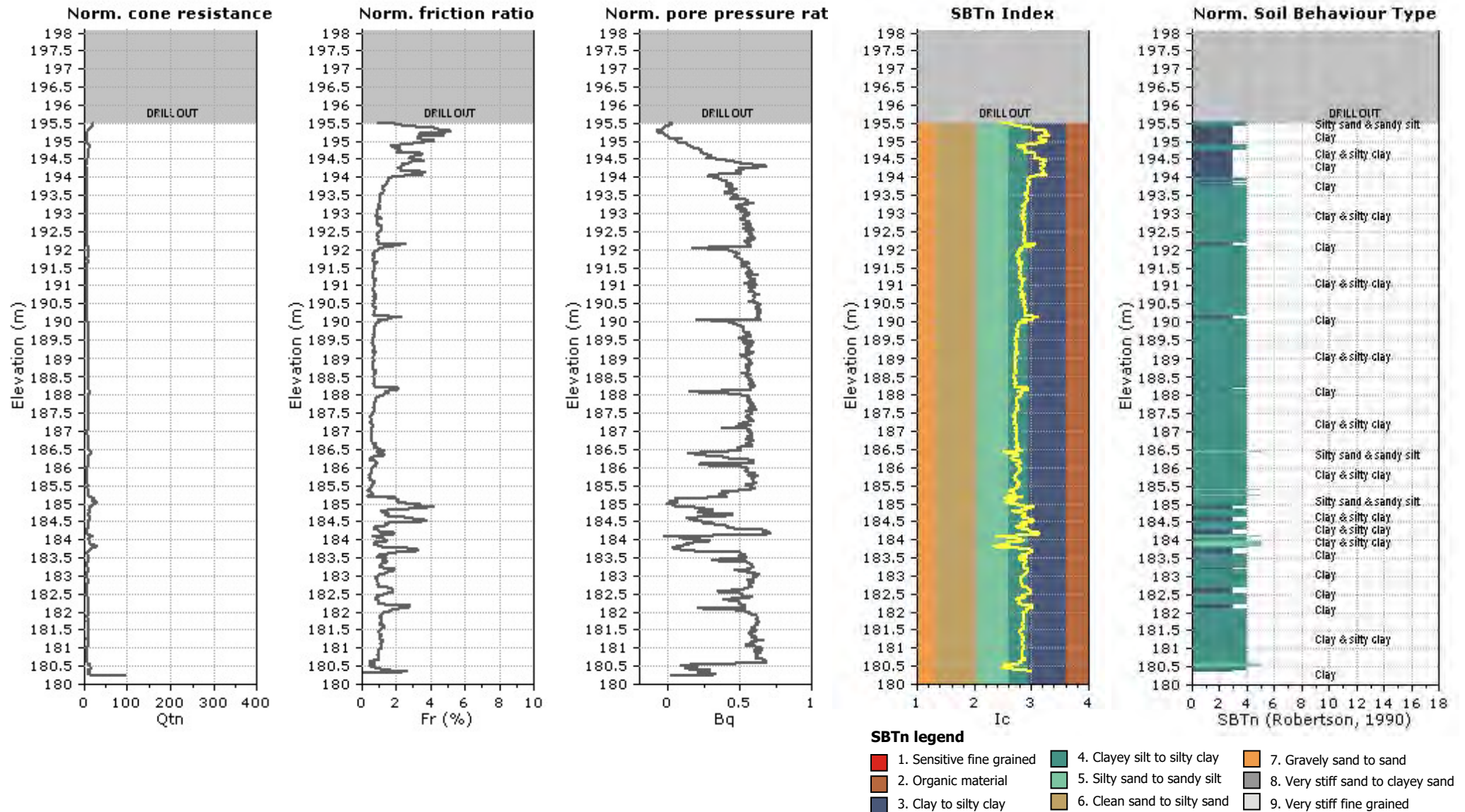
Total depth: 17.88 m, Date: 2019-08-08

Surface Elevation: 198.12 m

Coords: X:288559.30, Y:5136772.50

Cone Type: 15cm2

Cone Operator: ConeTec







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Project: Laronde Creek Bridge, MTM Zone 10

Location: Highway 17

CPT: SCPT19-02

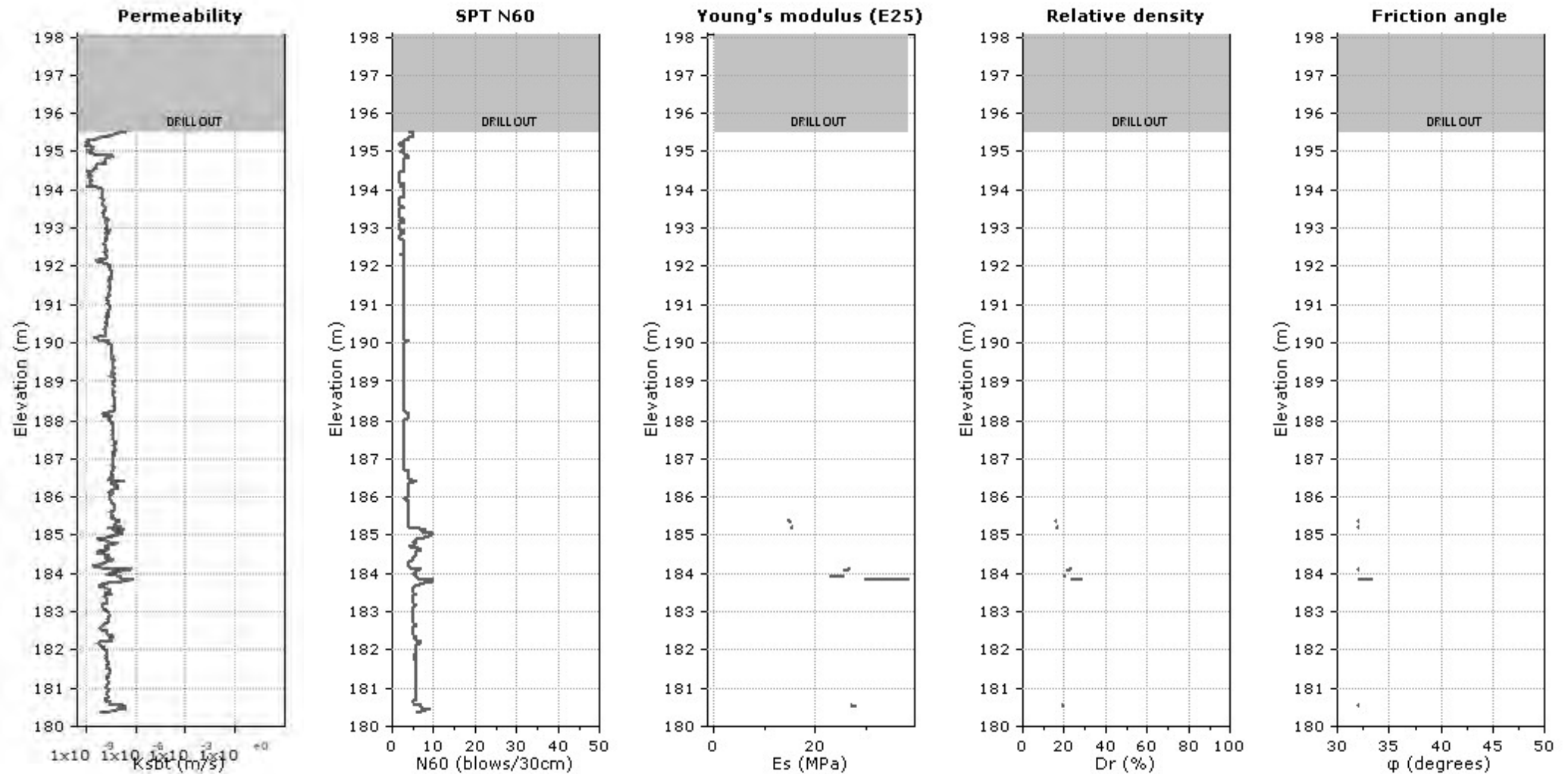
Total depth: 17.88 m, Date: 2019-08-08

Surface Elevation: 198.12 m

Coords: X:288559.30, Y:5136772.50

Cone Type: 15cm2

Cone Operator: ConeTec



#### Calculation parameters

Permeability: Based on  $SBT_n$

SPT  $N_{60}$ : Based on  $I_c$  and  $q_t$

Young's modulus: Based on variable alpha using  $I_c$  (Robertson, 2009)

Relative density constant,  $C_{Dr}$ : 350.0

Phi: Based on Kulhawy & Mayne (1990)

● User defined estimation data



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Project: Laronde Creek Bridge, MTM Zone 10

Location: Highway 17

CPT: SCPT19-02

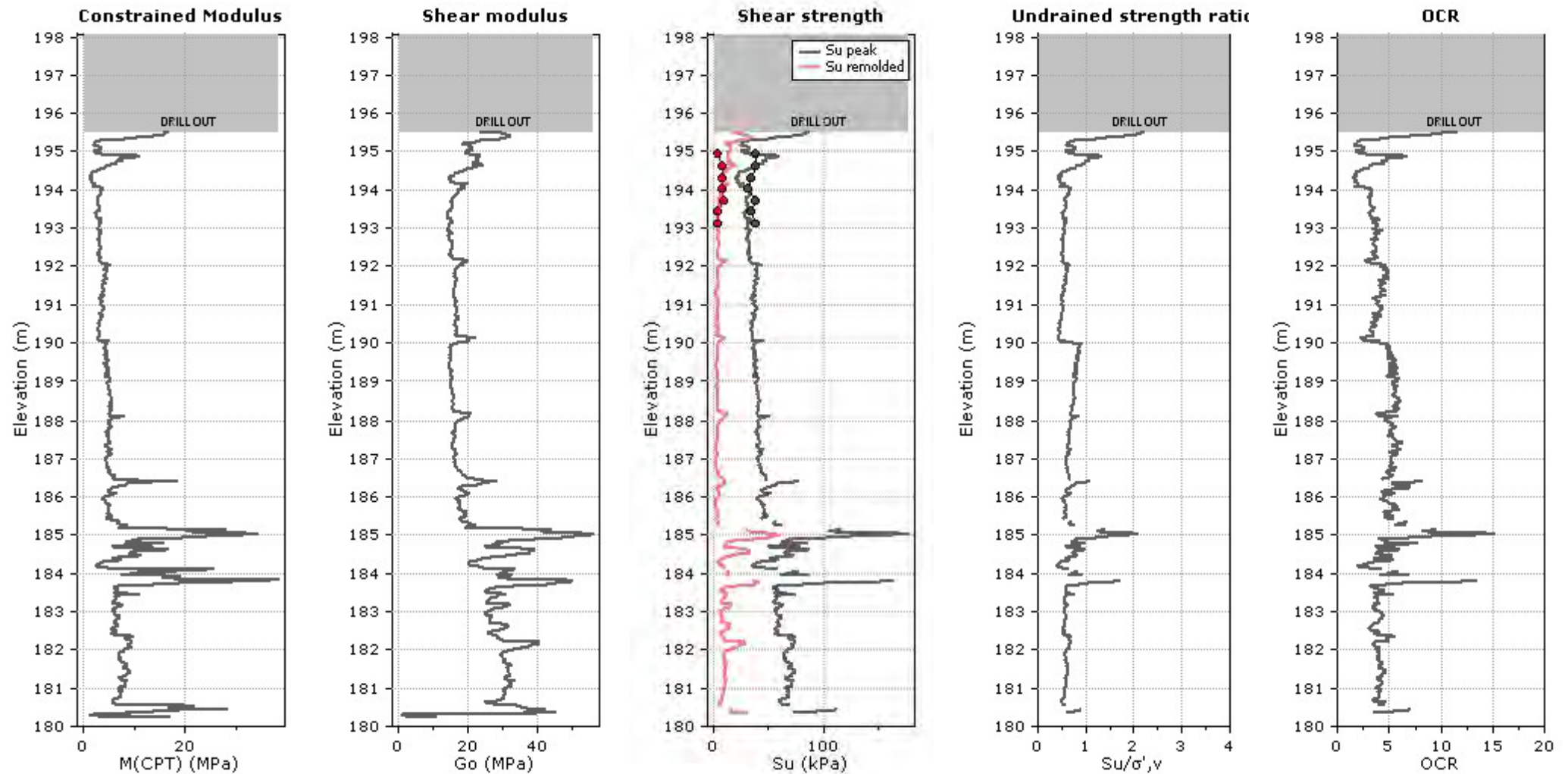
Total depth: 17.88 m, Date: 2019-08-08

Surface Elevation: 198.12 m

Coords: X:288559.30, Y:5136772.50

Cone Type: 15cm2

Cone Operator: ConeTec



#### Calculation parameters

Constrained modulus: Based on variable alpha using  $I_c$  and  $Q_{tn}$  (Robertson, 2009)

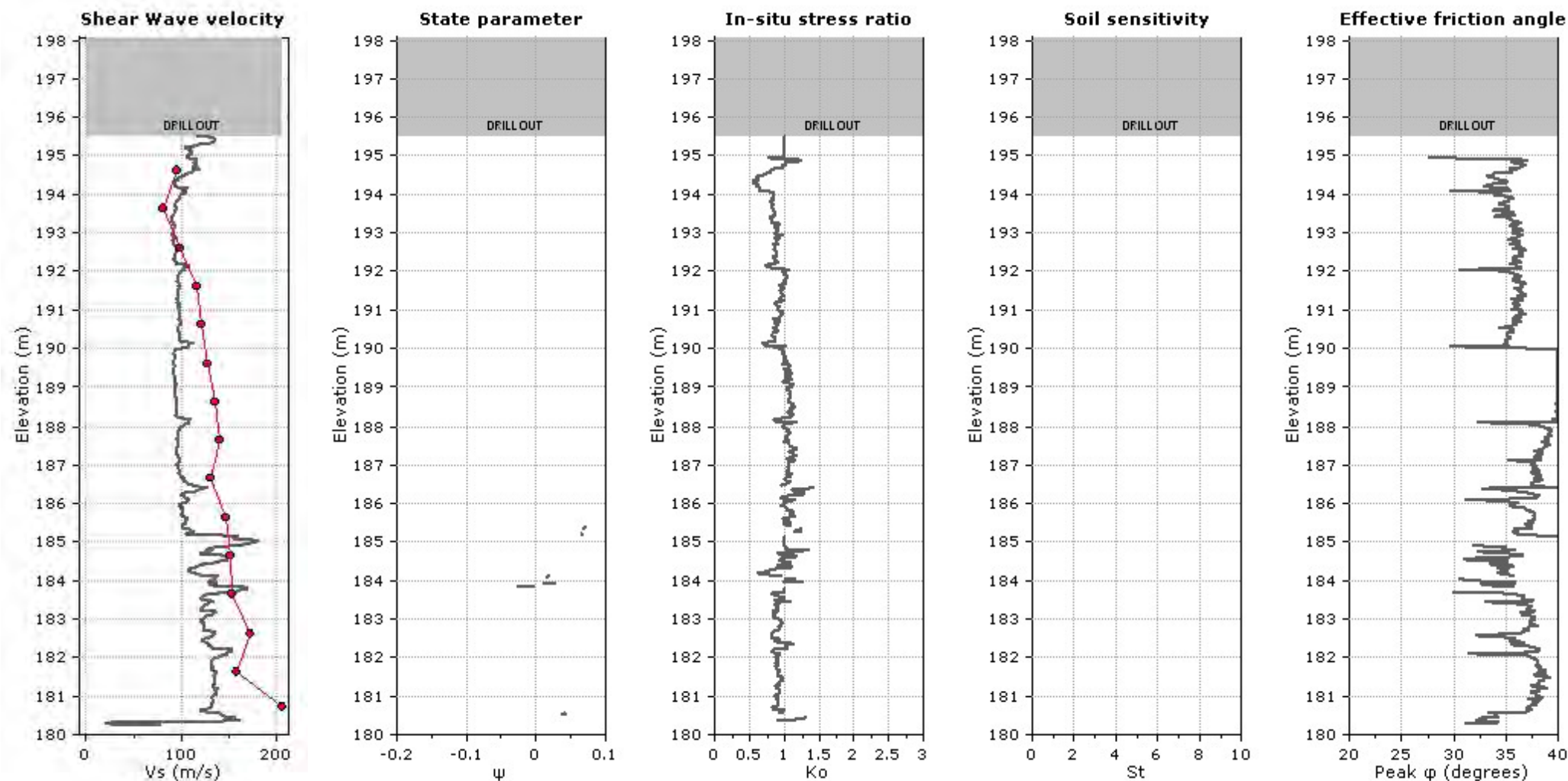
Go: Based on variable alpha using  $I_c$  (Robertson, 2009)

Undrained shear strength cone factor for clays,  $N_{kt}$ : 14

OCR factor for clays,  $N_{kt}$ : Auto

—●— User defined estimation data

—●— Flat Dilatometer Test data



**Calculation parameters**

Sol Sensitivity factor,  $N_s$ : 350.00

—●— User defined estimation data



Job No: 19-05054  
Client: Thurber Engineering  
Project: Laronde Creek Bridge  
Sounding ID: SCPT19-01  
Date: 08-Aug-2019

Seismic Source: Beam  
Source Offset (m): 1.00  
Source Depth (m): 0.00  
Geophone Offset (m): 0.20

### SCPT<sub>u</sub> SHEAR WAVE VELOCITY TEST RESULTS - V<sub>s</sub>

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	2.97			
4.00	3.80	3.93	0.96	9.93	96
5.00	4.80	4.90	0.97	12.05	81
6.03	5.83	5.92	1.01	10.20	99
7.00	6.80	6.87	0.96	8.21	117
8.03	7.83	7.89	1.02	8.42	121
9.00	8.80	8.86	0.96	7.56	127
10.00	9.80	9.85	0.99	7.34	135
11.00	10.80	10.85	1.00	7.13	140
12.00	11.80	11.84	1.00	7.63	131
13.03	12.83	12.87	1.03	6.96	147
14.00	13.80	13.84	0.97	6.35	152
15.00	14.80	14.83	1.00	6.48	154
16.00	15.80	15.83	1.00	5.77	173
17.00	16.80	16.83	1.00	6.31	158
17.88	17.68	17.71	0.88	4.26	206

## Dissipation Tests Results

### Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for  $t_{50}$ , which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction  $c_h$  was then calculated by Houlsby and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Houlsby and Teh's (1988) theory corresponding to the porepressure position

r: piezocone radius

$I_r$ : stiffness index, equal to shear modulus G divided by the undrained strength of clay ( $S_u$ ).

$t_{50}$ : time corresponding to 50% consolidation

### Permeability estimates based on dissipation test

The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction ( $c_h$ ) which is influenced by a combination of the soil permeability ( $k_h$ ) and compressibility (M), as defined by the following:

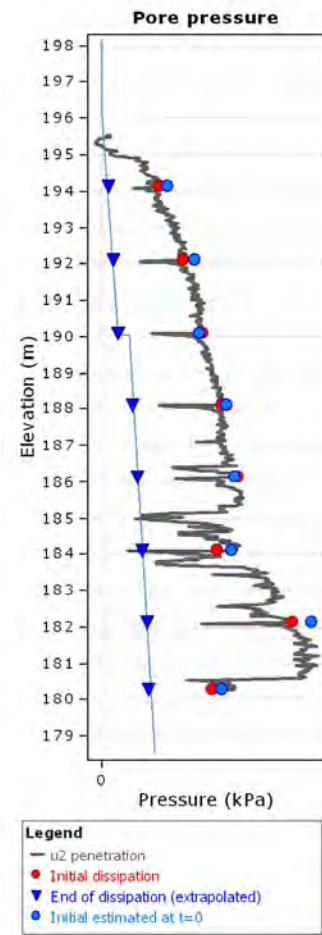
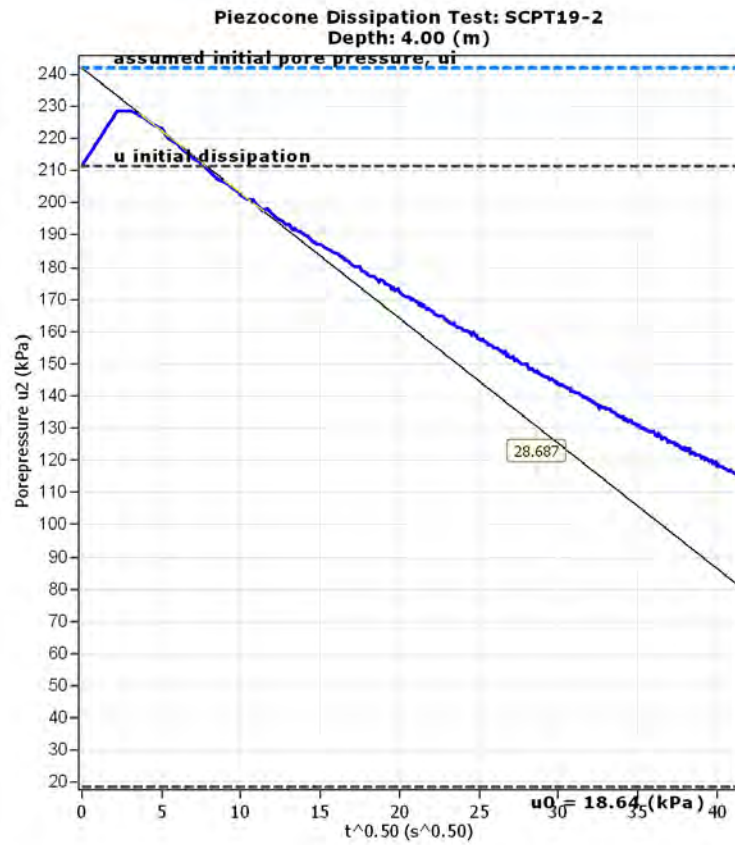
$$k_h = c_h \times \gamma_w / M$$

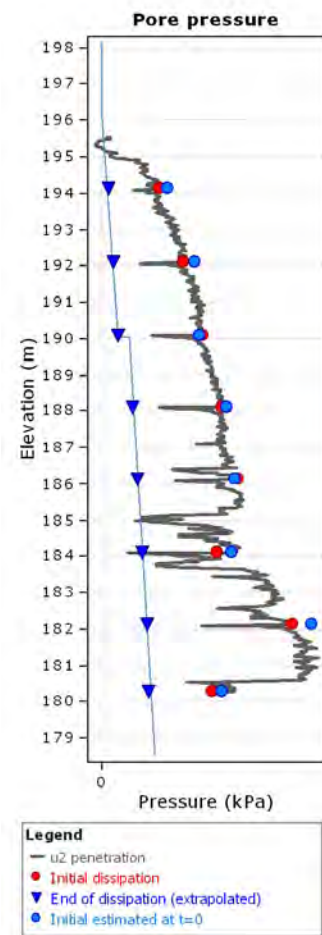
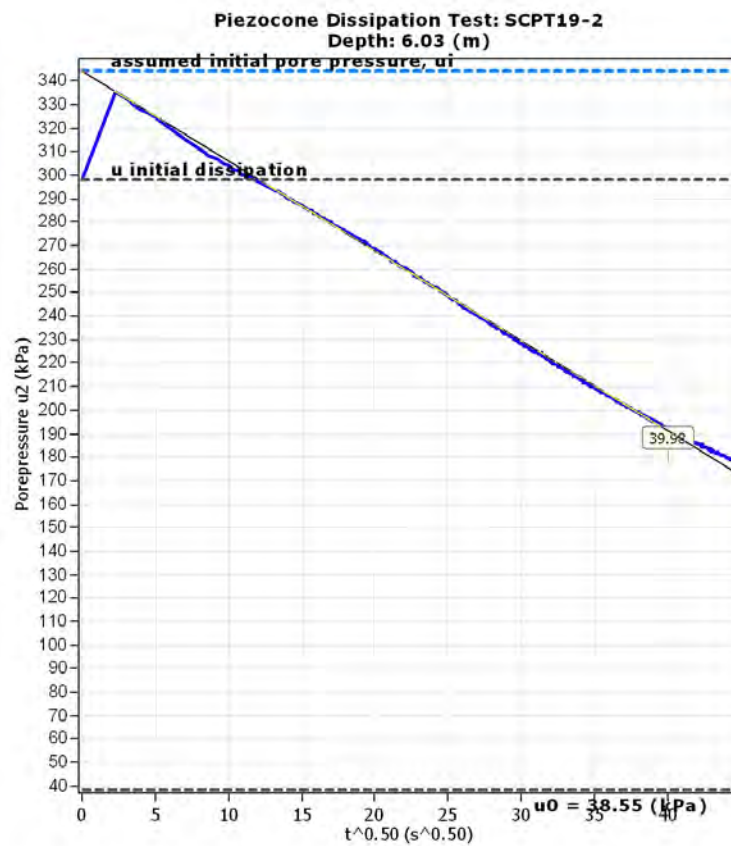
where: M is the 1-D constrained modulus and  $\gamma_w$  is the unit weight of water, in compatible units.

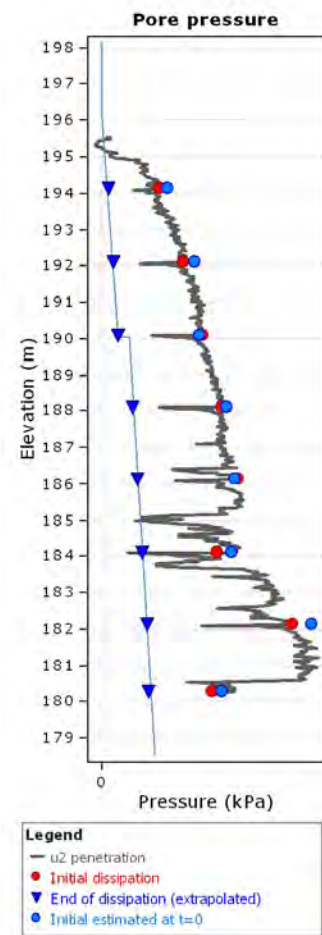
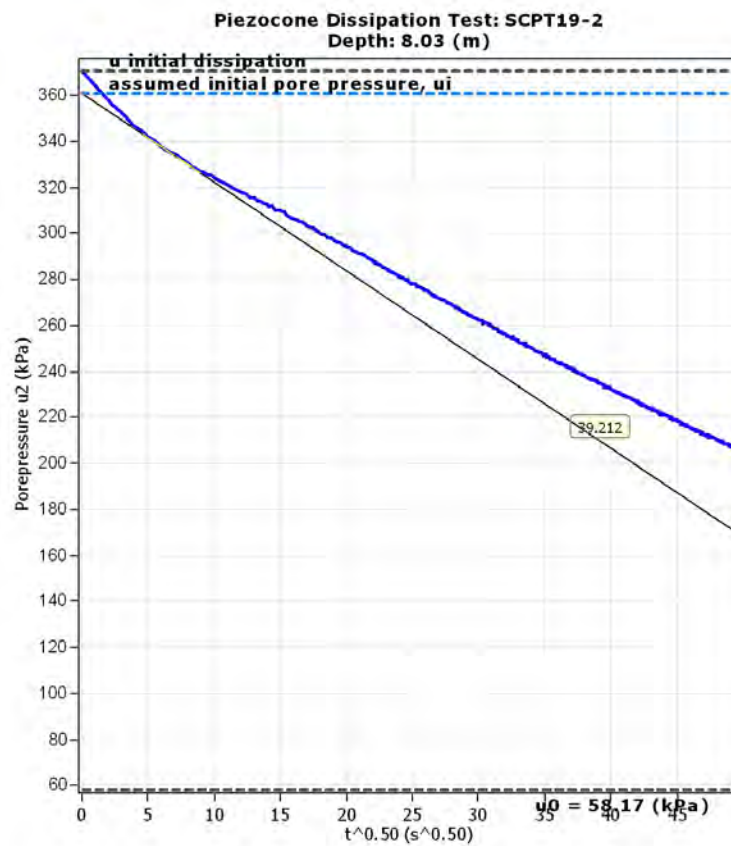
### Tabular results

CPTU Borehole	Depth (m)	$(t_{50})^{0.50}$	$t_{50}$ (s)	$t_{50}$ (years)	G/ $S_u$	$c_h$ (m <sup>2</sup> /s)	$c_h$ (m <sup>2</sup> /year)	M (MPa)	$k_h$ (m/s)
SCPT19-2	4.00	28.7	823	2.61E-005	212.30	2.08E-006	66	2.25	9.05E-009
SCPT19-2	6.03	40.0	1598	5.07E-005	381.96	1.44E-006	45	4.84	2.91E-009
SCPT19-2	8.03	39.2	1538	4.88E-005	357.57	1.45E-006	46	5.15	2.75E-009
SCPT19-2	10.00	33.7	1132	3.59E-005	390.44	2.05E-006	65	6.71	3.00E-009
SCPT19-2	12.00	30.5	933	2.96E-005	264.90	2.05E-006	65	7.31	2.75E-009
SCPT19-2	14.00	5.8	34	1.07E-006	100.00	3.49E-005	1099	15.63	2.19E-008
SCPT19-2	16.00	38.5	1483	4.70E-005	422.62	1.63E-006	51	14.02	1.14E-009
SCPT19-2	17.85	3.7	14	4.33E-007	100.00	8.61E-005	2715	6.70	1.26E-007

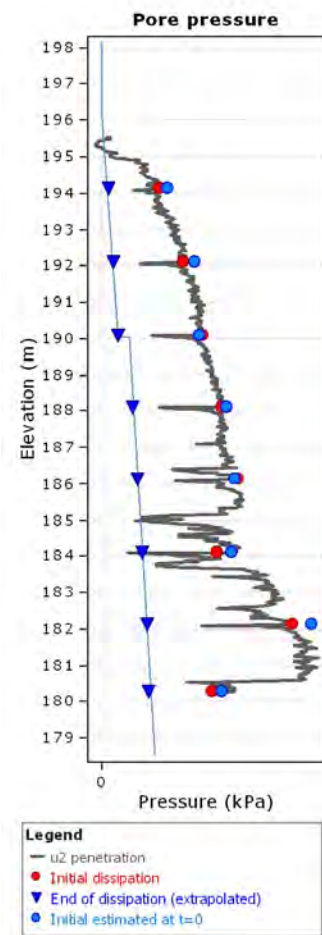
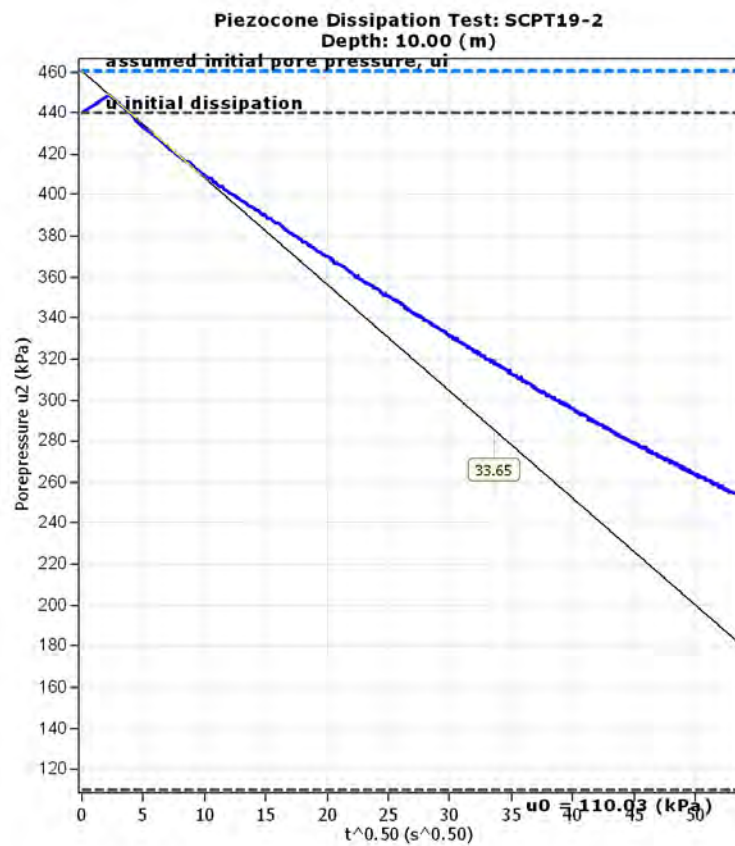


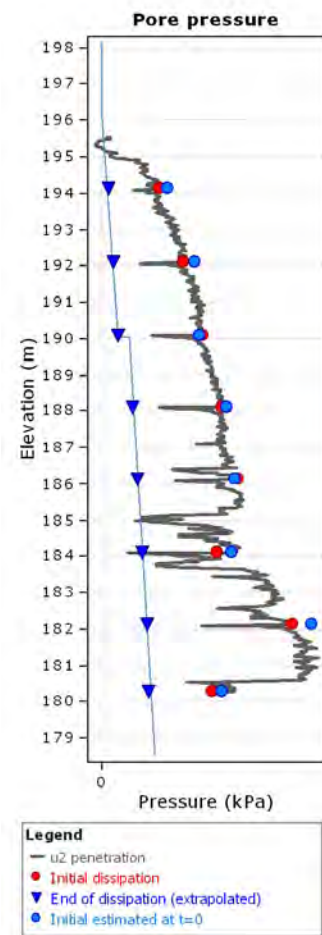
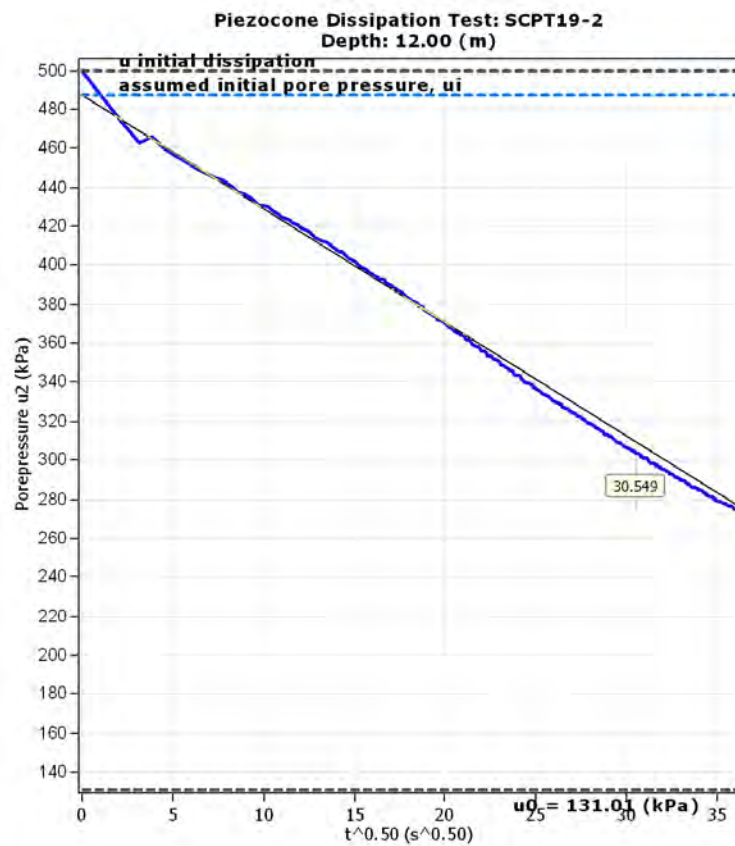


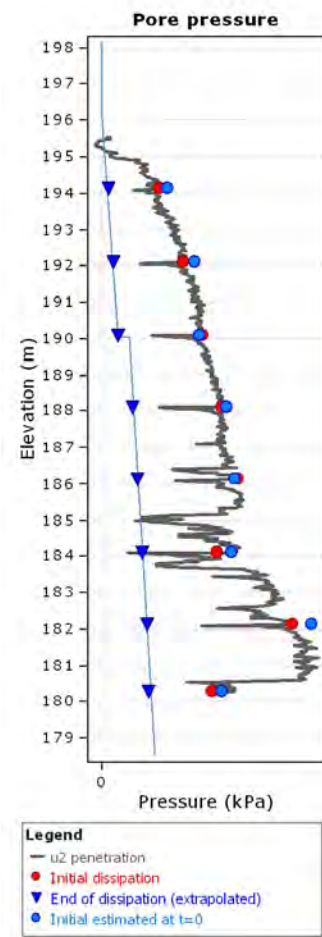
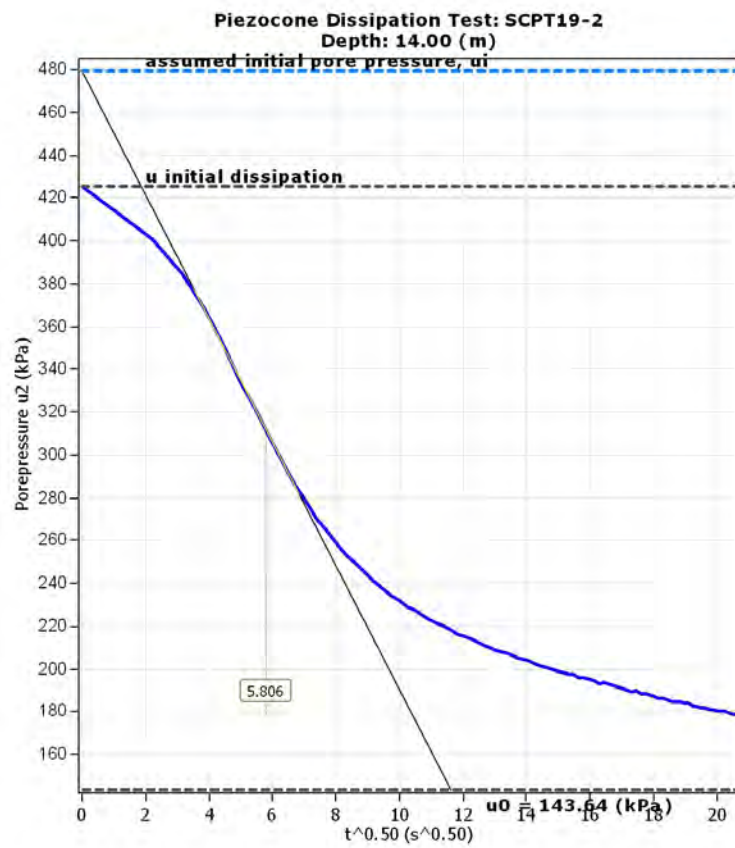


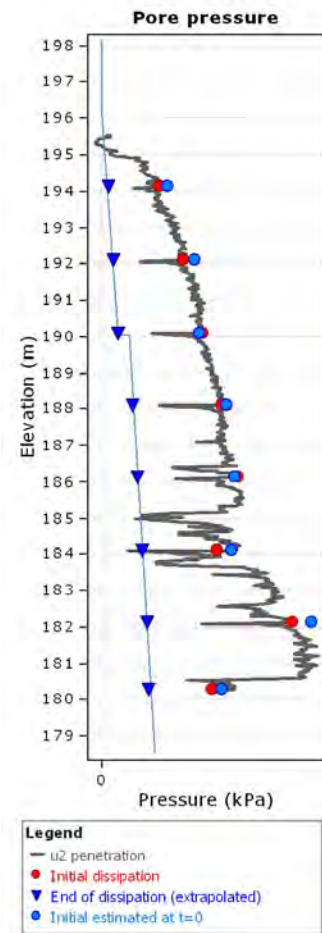
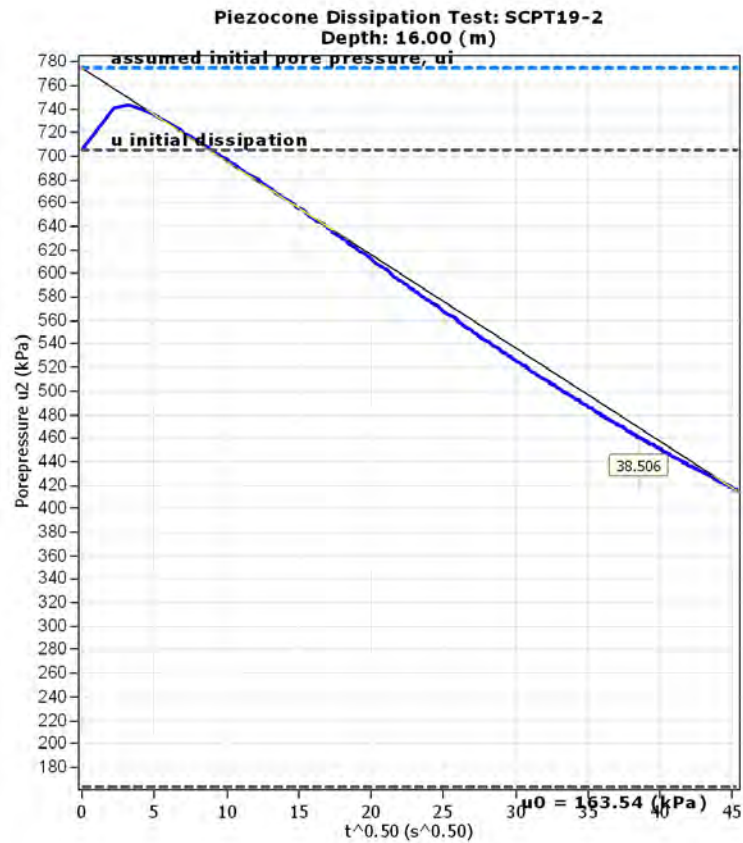


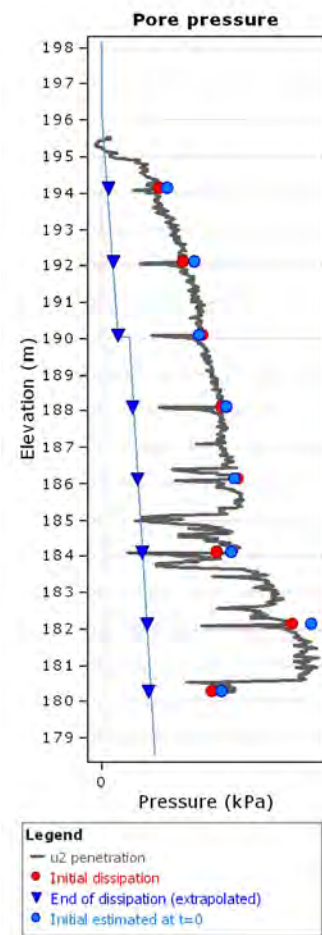
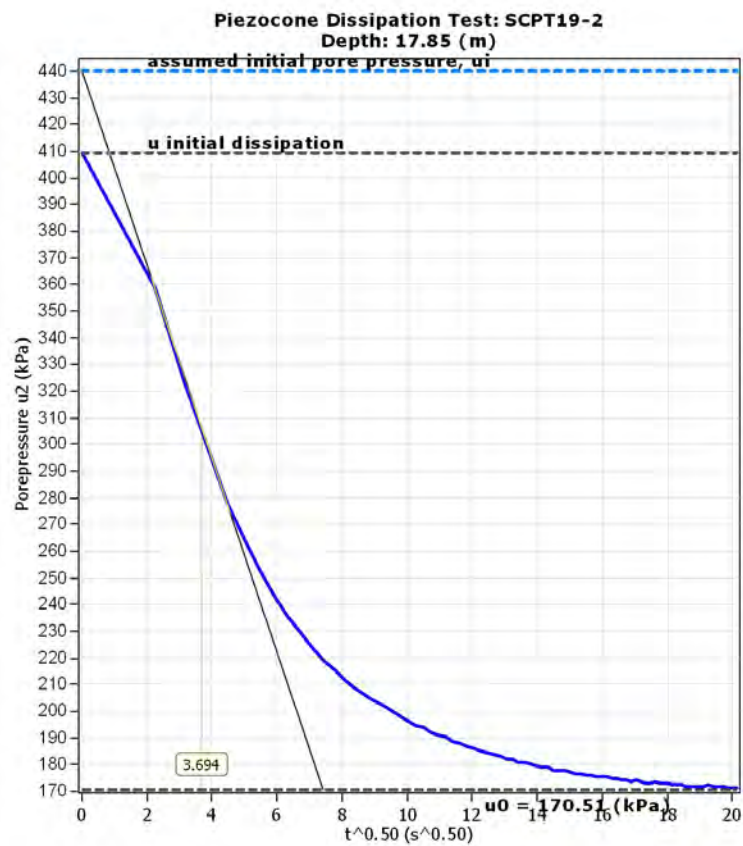














## **Appendix C.**

### **Laboratory Testing**



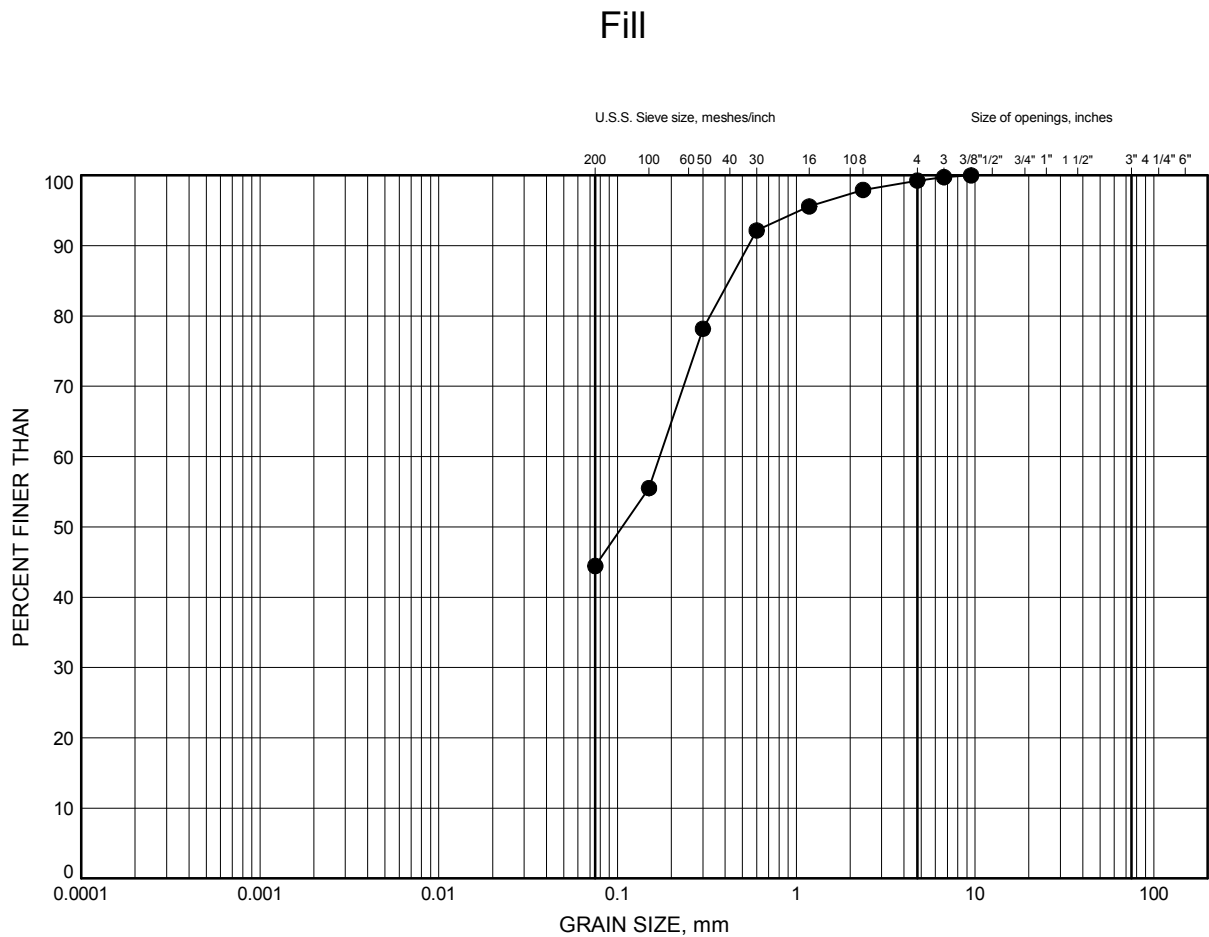
## **Appendix C.1**

### **Particle Size Analysis and Atterberg Limits Figures**

# Highway 17 Laronde Creek Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C1



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-01	0.3	199.5

Date August 2020  
GWP# 5198-13-00



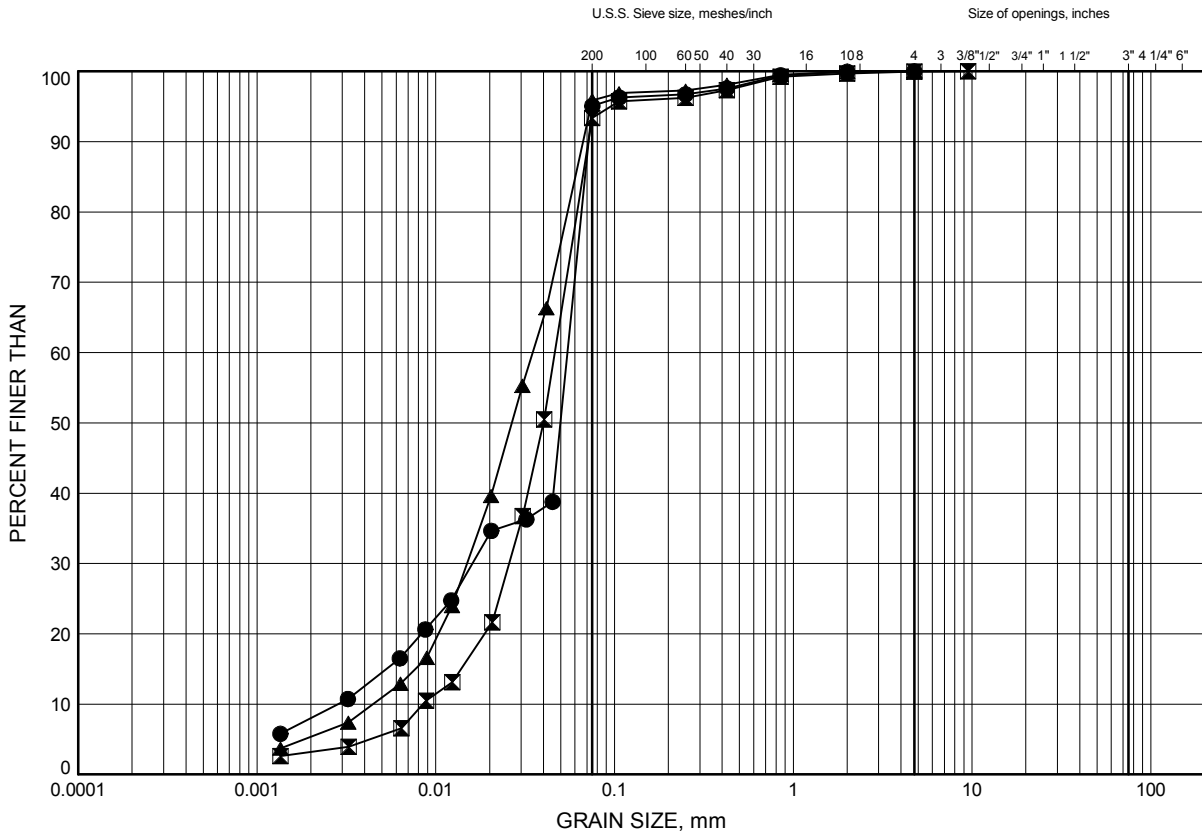
Prep'd DJP  
Chkd. FG



# Highway 17 Laronde Creek Bridge GRAIN SIZE DISTRIBUTION

FIGURE C2

## Surficial Sand and Silt



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-3	0.9	196.9
⊠	19-4	0.9	201.9
▲	19-4	2.7	200.1

Date August 2020  
GWP# 5198-13-00



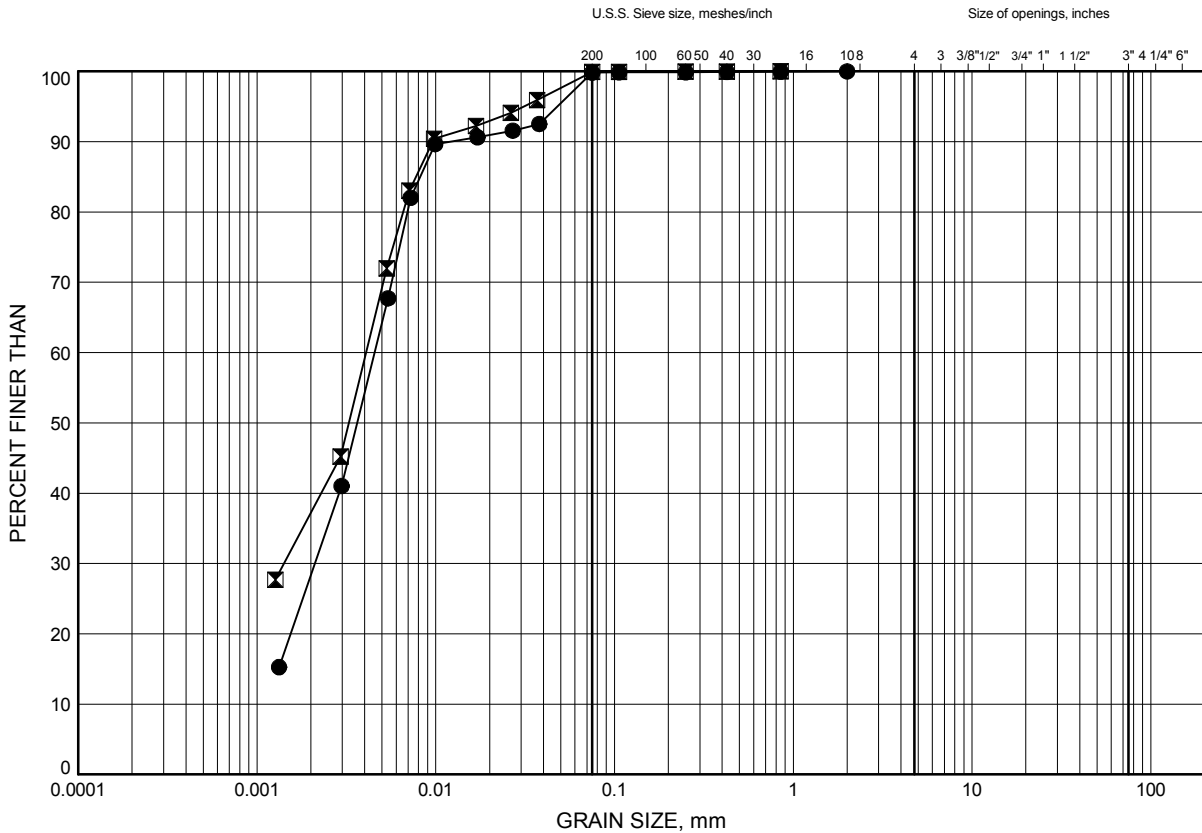
Prep'd DJP  
Chkd. FG

# Highway 17 Laronde Creek Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C3

### Upper Clayey Silt (CL-ML to CL)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-01	2.6	197.2
⊠	19-3	3.4	194.4

Date August 2020  
GWP# 5198-13-00



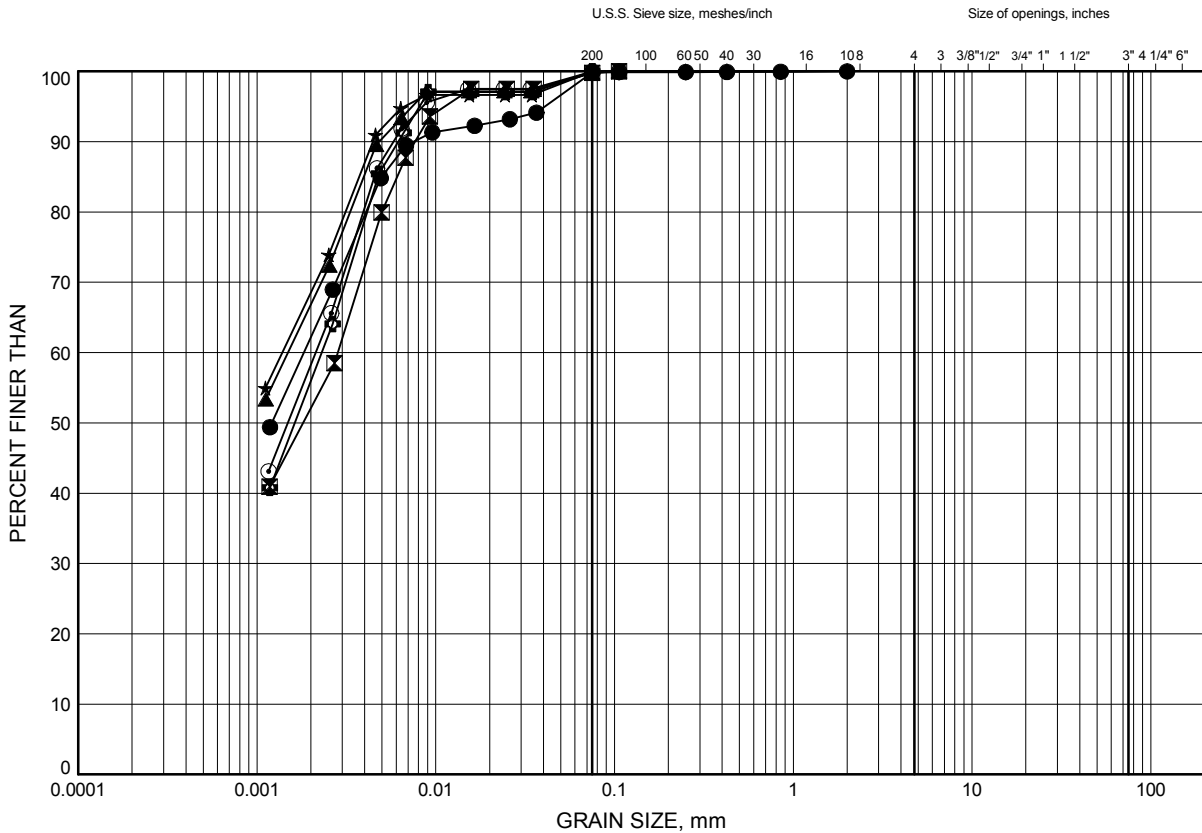
Prep'd DJP  
Chkd. FG

# Highway 17 Laronde Creek Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C4

Lower Clayey Silt (CL to CL-ML) to Clay (CI to CH)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-01	7.9	191.9
⊠	19-2A	3.4	195.0
▲	19-2A	5.6	192.8
★	19-2A	5.8	192.6
⊙	19-2A	5.9	192.5
⊕	19-2A	7.6	190.8

Date August 2020  
GWP# 5198-13-00



Prep'd DJP  
Chkd. FG

## FIGURE C5

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

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-02A	12.4	186.0
☒	19-02B	1.8	196.5
▲	19-03	12.5	185.3
★	19-04	4.6	198.2
⊙	19-04	9.4	193.4



THURBER

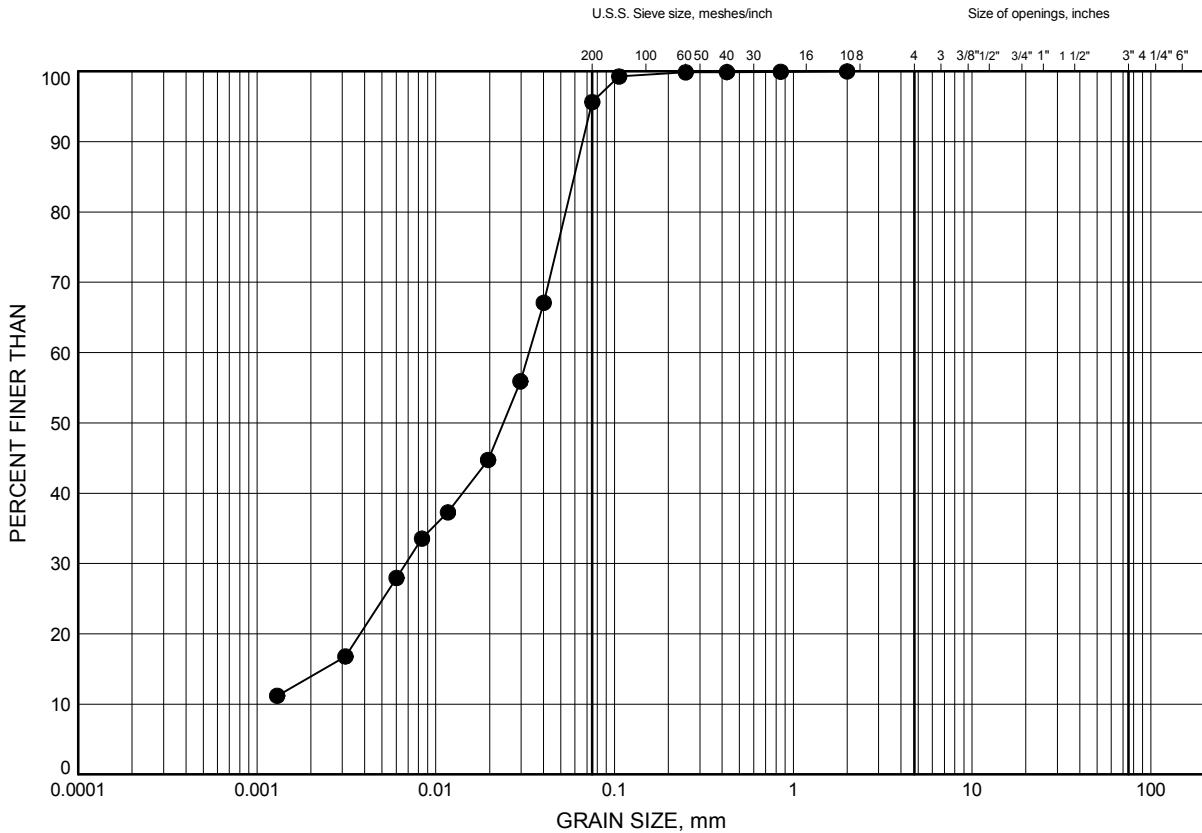
Prep'd ..... DJP.....  
Chkd. .... FG.....

# Highway 17 Laronde Creek Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C6

### Lower Clayey Silt (CL) to Clay (CI to CH) - Silt Layer



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-2A	12.6	185.8

Date August 2020  
GWP# 5198-13-00



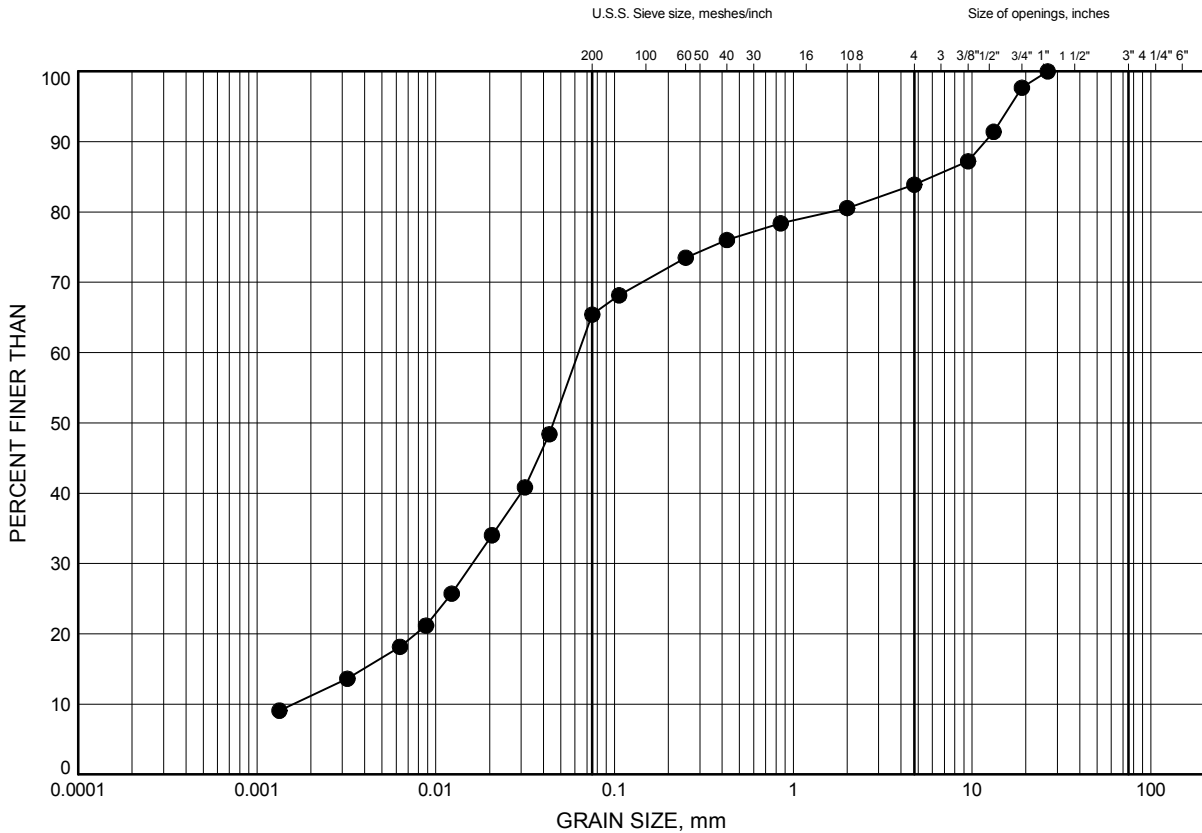
Prep'd DJP  
Chkd. FG

# Highway 17 Laronde Creek Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C7

### Sandy Silt with Gravel Till



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-3	16.9	180.9

Date August 2020  
GWP# 5198-13-00

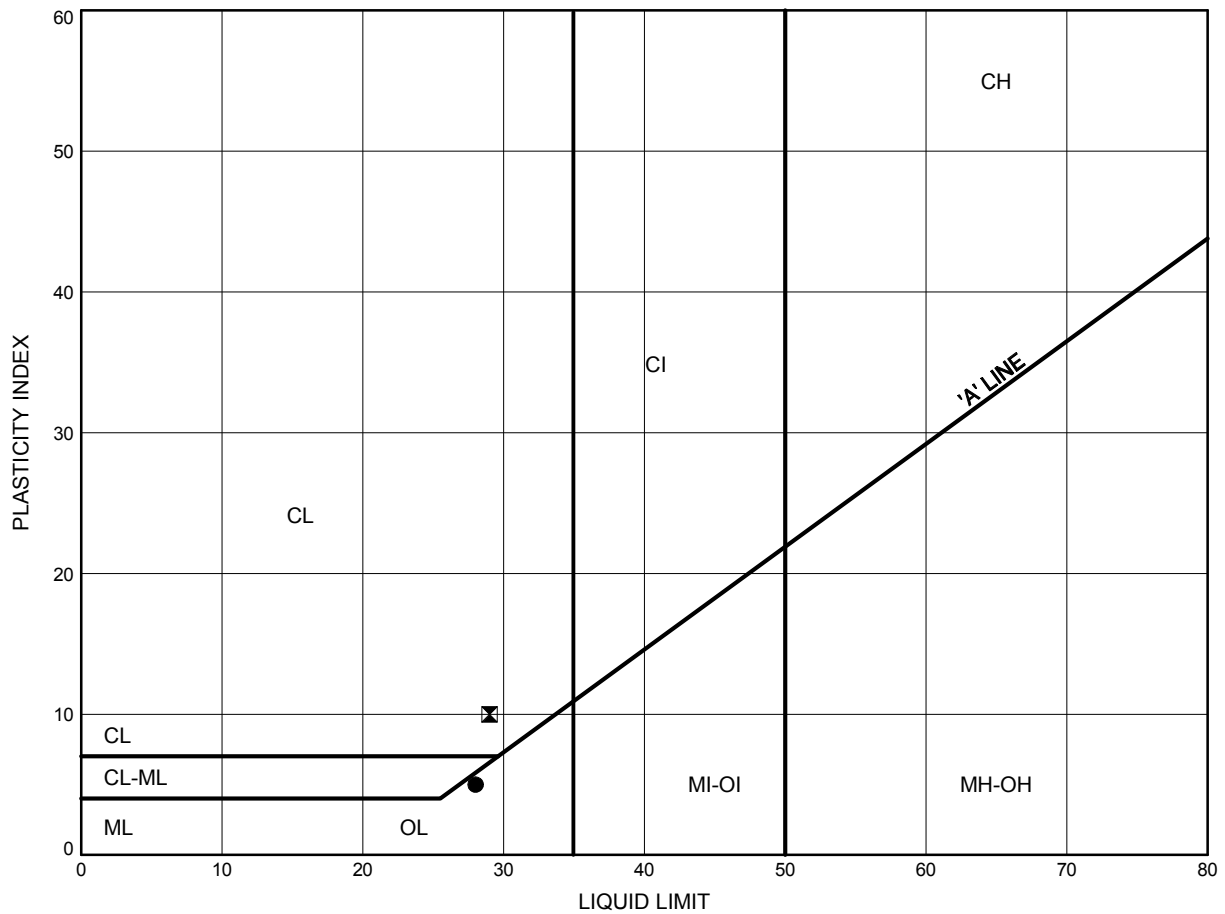


Prep'd DJP  
Chkd. FG

# Highway 17 Laronde Creek Bridge ATTERBERG LIMITS TEST RESULTS

FIGURE C8

### Upper Clayey Silt (CL-ML to CL)



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-01	2.6	197.2
⊠	19-3	3.4	194.4

Date August 2020  
GWP# 5198-13-00

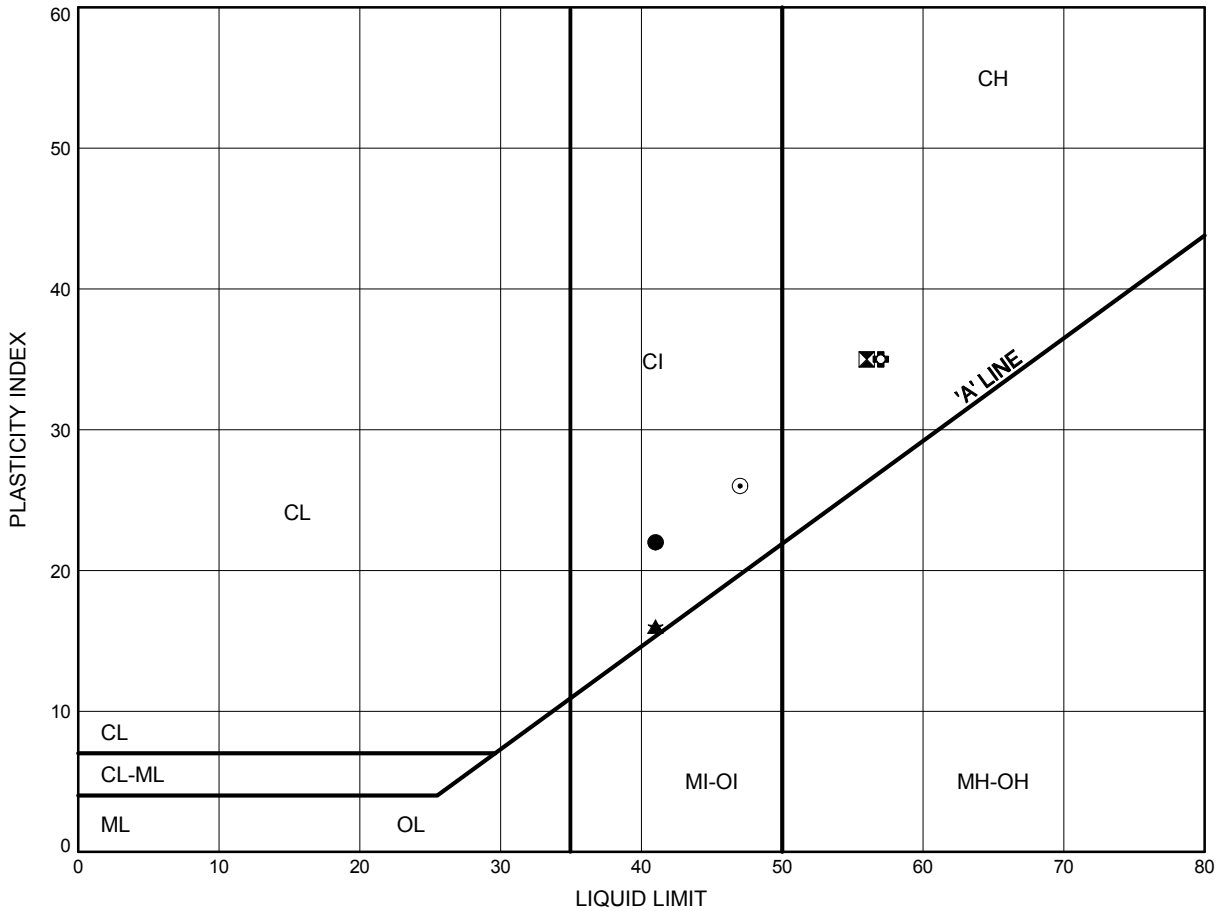


Prep'd DJP  
Chkd. FG

Highway 17 Laronde Creek Bridge  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C9

Lower Clayey Silt (CL to CL-ML) to Clay (CI to CH)



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-01	7.9	191.9
⊠	19-2A	3.4	195.0
▲	19-2A	5.1	193.3
★	19-2A	5.3	193.1
⊙	19-2A	5.6	192.8
⊕	19-2A	5.8	192.6

Date August 2020  
 GWP# 5198-13-00



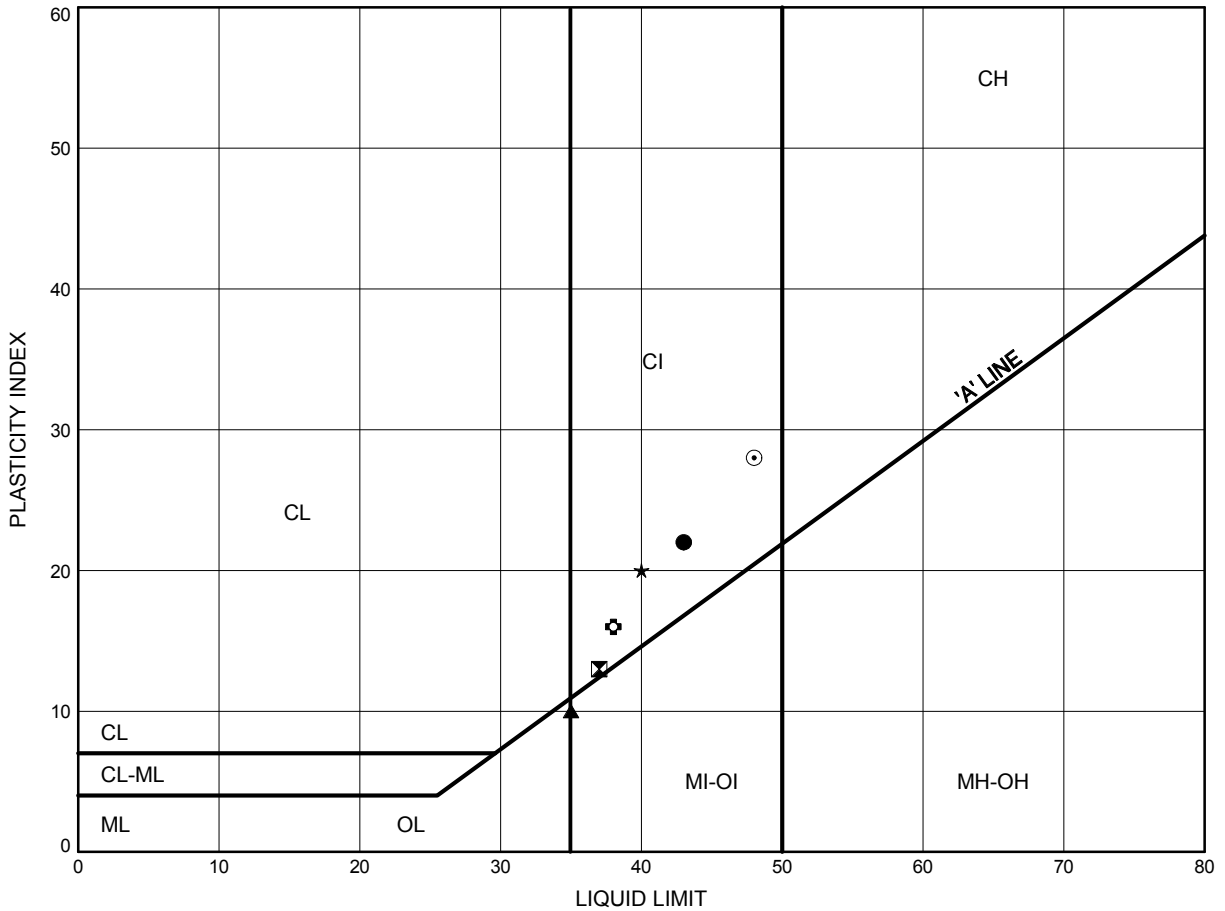
Prep'd DJP  
 Chkd. FG



Highway 17 Laronde Creek Bridge  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C10

Lower Clayey Silt (CL to CL-ML) to Clay (CI to CH)



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-2A	5.9	192.5
⊠	19-2A	6.3	192.1
▲	19-2A	6.5	191.9
★	19-2A	7.6	190.8
⊙	19-2A	12.4	186.0
⊕	19-2B	1.8	196.5

Date August 2020  
 GWP# 5198-13-00

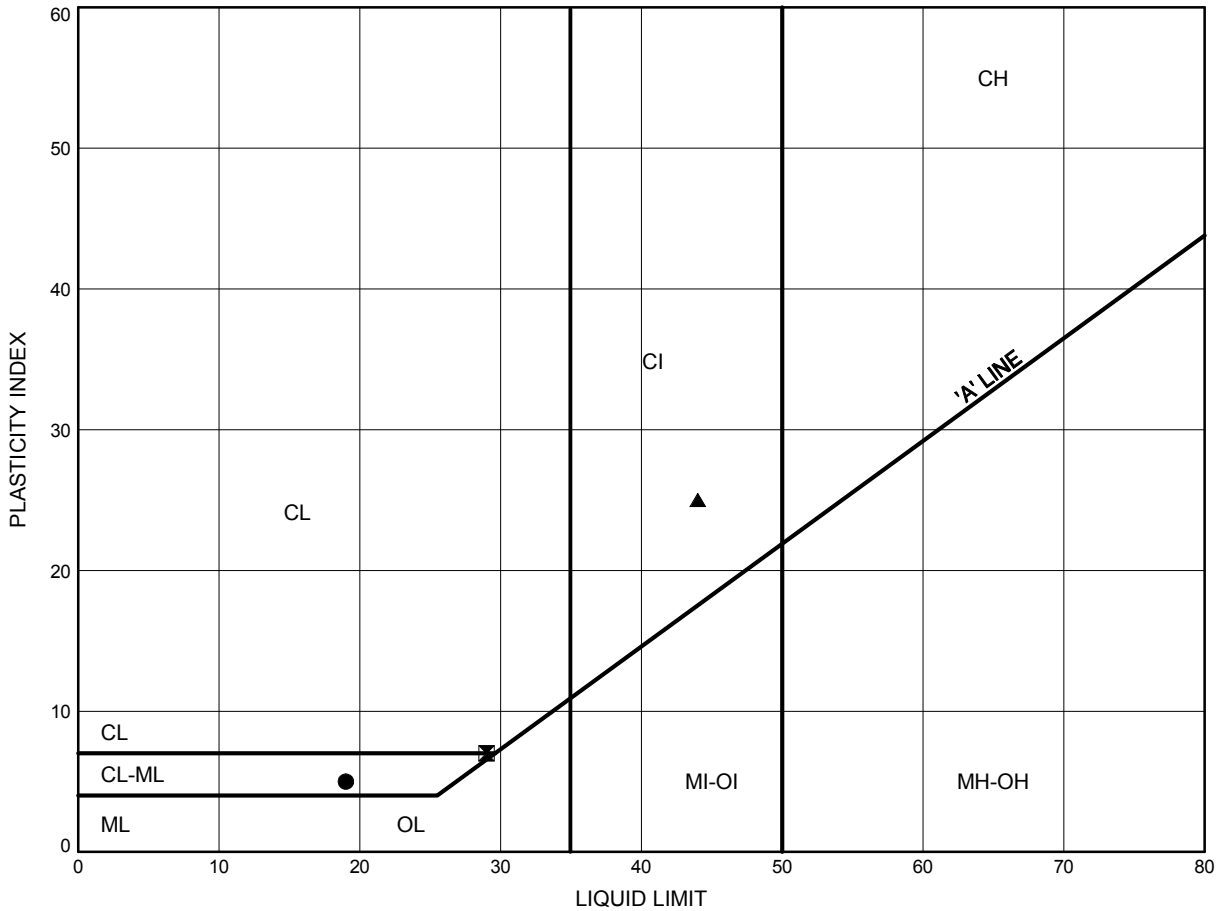


Prep'd DJP  
 Chkd. FG

Highway 17 Laronde Creek Bridge  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C11

Lower Clayey Silt (CL to CL-ML) to Clay (CI to CH)



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-3	12.5	185.3
⊠	19-4	4.6	198.2
▲	19-4	9.4	193.4

Date August 2020  
 GWP# 5198-13-00

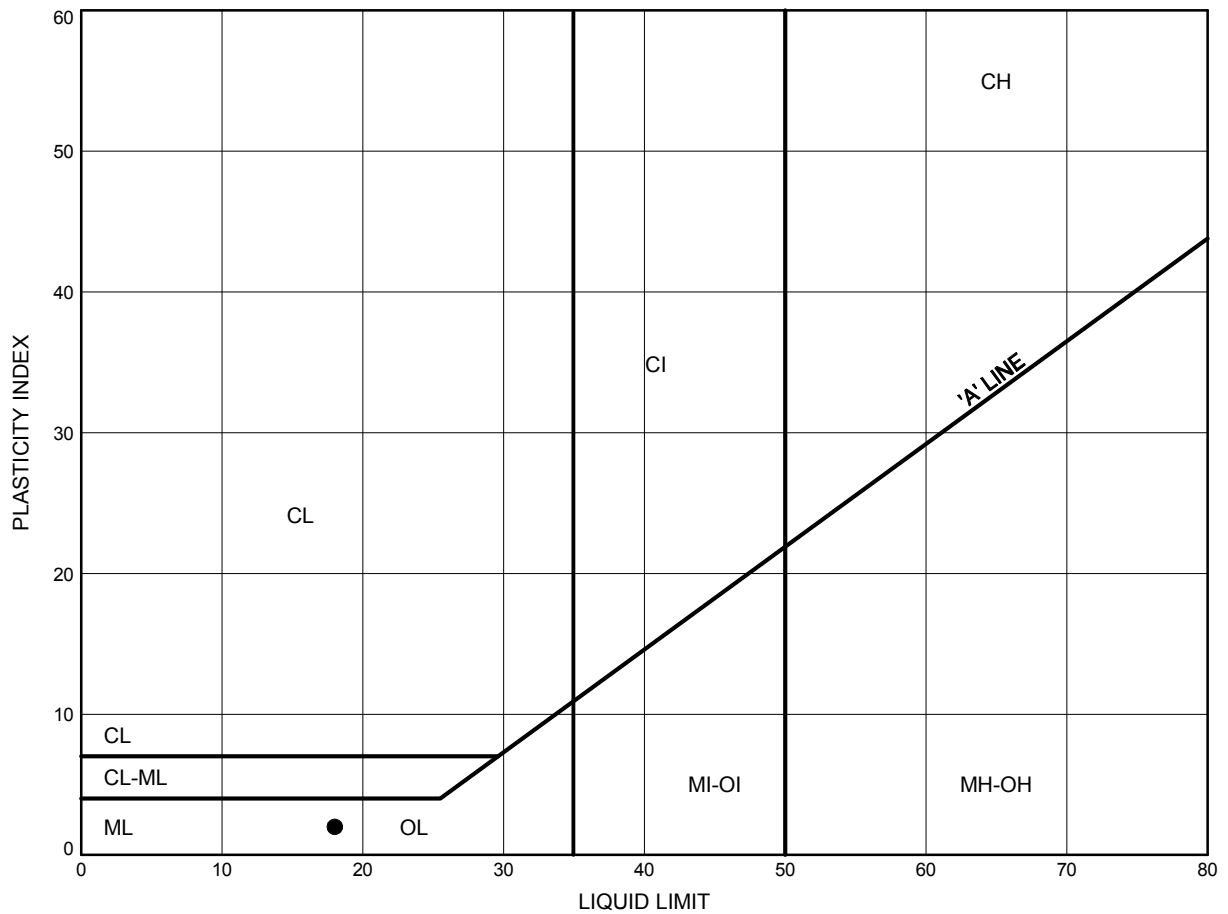


Prep'd DJP  
 Chkd. FG

Highway 17 Laronde Creek Bridge  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C12

Sandy Silt with Gravel Till



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-3	17.0	180.8

Date August 2020  
 GWP# 5198-13-00



Prep'd DJP  
 Chkd. FG



## **Appendix C.2**

### **Consolidation Test Results**



Stantec Consulting Ltd.  
400 - 1331 Clyde Avenue, Ottawa ON K2C 3G4

November 15, 2019  
File: 122410864

**Attention: Deanna Pizycki, M. Eng., P.Eng.**  
Thurber Engineering Ltd.  
104 – 2460 Lancaster Road  
Ottawa, Ontario, Canada, K1B 4S5  
Tel: 613-274-2121 ext. 7106  
E-mail: dpizycki@thurber.ca

Dear Ms. Pizycki,

**Reference: Consolidation Test Results for Hwy 17 (Laronde) project, Thurber Consulting Ltd.,  
File #23411: BH 19-2A, TW 1 & TW 5, sampled on August 13, 2019**

This letter presents the results of one-dimensional consolidation tests carried out on the above referenced samples in accordance with ASTM D2435/D2435M - 11. The test results are provided in the attached tables and figures.

This letter provides test results only and does not constitute any interpretation or engineering recommendations with respect to material suitability or specification compliance.

We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

Regards,

**STANTEC CONSULTING LTD.**

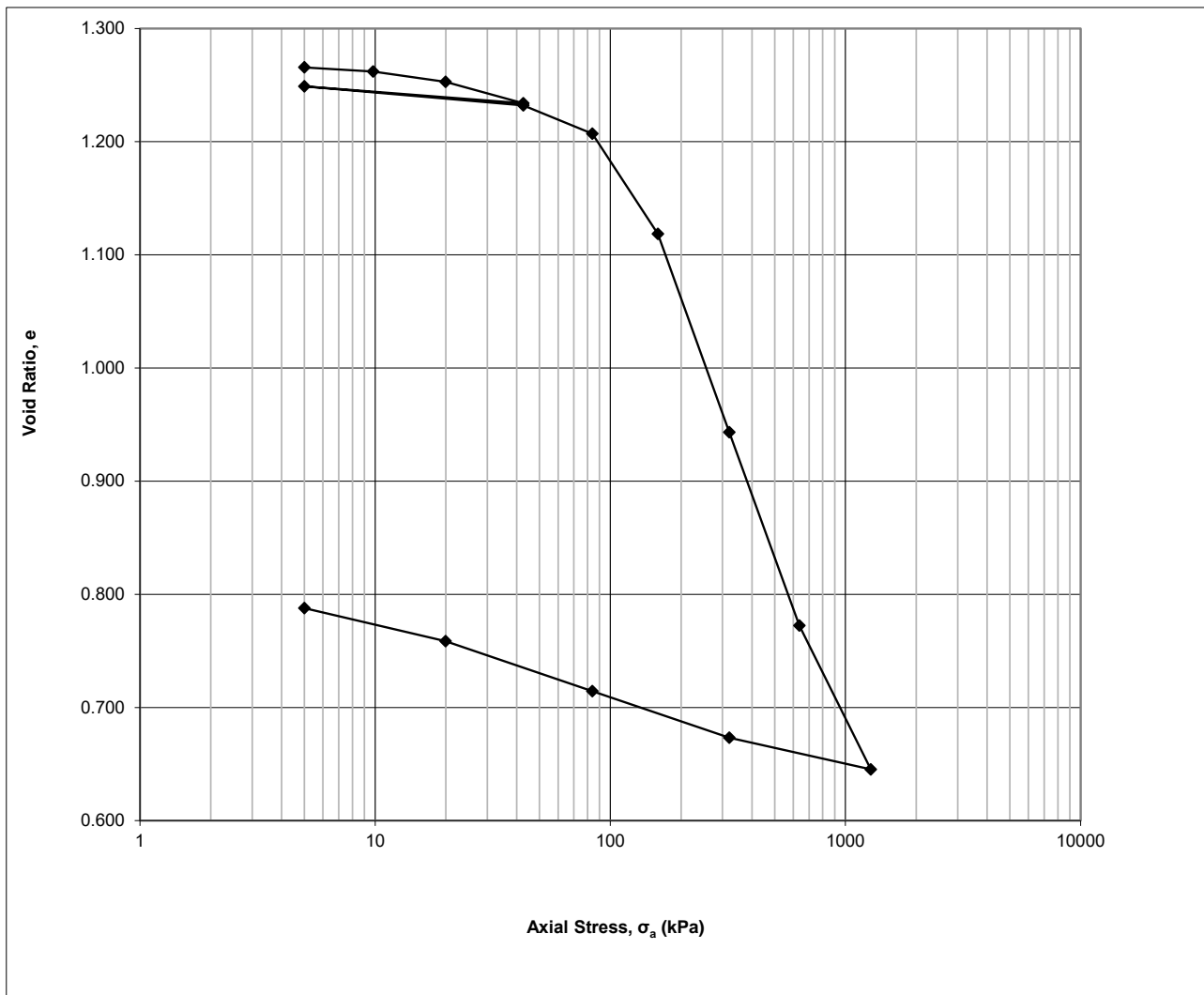
A handwritten signature in blue ink, appearing to read "Rajib Dey".

**Rajib Dey** Ph.D., P.Eng.  
Geotechnical Engineer  
Rajib.dey@stantec.com

v:\01216\active\laboratory\_standing\_offers\2019 laboratory standing offers\122410864 thurber engineering\sept 4, four consols, hydros, lims, sgs, file#23411\consolidation\122410864\_let\_consolidation\_bh19-2a tw 1& 5.docx

Project  
Project No.  
Borehole No.  
Sample No.  
Sample Depth

Thurber Engineering, File# 23411  
122410864  
BH19-2A  
TW 1  
10-12 ft.





## Stantec Consulting Ltd.

### One-Dimensional Consolidation Test using Incremental Loading ASTM D2435/D2435M - 11

#### Specimen Details

Project Name	Thurber Engineering, File# 23411
Project Location	Hwy 17, Laronde
Borehole	BH19-2A
Sample No.	TW 1
Depth	10-12 ft.
Sample Date	August 13, 2019
Test Number	Three
Technician Name	Daniel Boateng

#### Soil Description & Classification

Clay and silt, grey, varved, moist - CH	
Specific Gravity of Solids	2.715
Liquid Limit %	56
Plastic Limit %	21
Plasticity Index %	35
Average water content of trimmings %	46
Additional Notes (information source, occurrence and size of large isolated particles etc.)	

#### Initial Specimen Conditions

Height	mm	19.01
Diameter	mm	50.02
Area	mm <sup>2</sup>	1965
Volume	mm <sup>3</sup>	37356
Mass	g	65.30
Dry Mass	g	44.72
Density	Mg/m <sup>3</sup>	1.748
Dry Density	Mg/m <sup>3</sup>	1.197
Water Content	%	46.02
Degree of Saturation	%	98.5
Height of Solids	mm	8.38
Initial Void Ratio		1.268

#### Final Specimen Conditions

Water Content	%	29.72
Final Void Ratio		0.788
Differential Height	mm	14.99

## One-Dimensional Consolidation Test using Incremental Loading

### ASTM D2435/D2435M - 11

**Specimen Details**

Project Name	Thurber Engineering, File# 23411
Project Location	Hwy 17, Laronde
Borehole	BH19-2A
Sample No.	TW 1
Depth	10-12 ft.
Sample Date	August 13, 2019
Test Number	Three
Technician Name	Daniel Boateng

**Test Procedure**

Date Started	September 9, 2019
Date Finished	November 8, 2019
Machine Number	Frame A
Cell Number	A
Ring Number	A
Trimming Procedure	Turntable/Cutting shoe
Moisture Condition	Inundated
Axial Stress at Inundation kPa	5
Water Used	Deaired Tap water
Test Method	A
Interpretation Procedure for $c_v$	2

**All Departures from Outlined ASTM D2435/D2435M-11 Procedure**
**Calculations**

Load Increment	Increment Duration min	Axial Stress $\sigma_a$ kPa	Corrected Deformation $\Delta H$ mm	Specimen Height H mm	Axial Strain $\epsilon_a$ %	Void Ratio e
Seating	0.0	0	0.0000	19.0100	0.00	1.268
1	1440.0	5	0.0190	18.9910	0.10	1.266
2	1440.0	10	0.0500	18.9600	0.26	1.262
3	1440.0	20	0.1250	18.8850	0.66	1.253
4	1440.0	43	0.2840	18.7260	1.49	1.234
5	4320.0	5	0.1590	18.8510	0.84	1.249
6	1440.0	43	0.3000	18.7100	1.58	1.232
7	1440.0	84	0.5090	18.5010	2.68	1.207
8	60480.0	160	1.2530	17.7570	6.59	1.118
9	1440.0	321	2.7220	16.2880	14.32	0.943
10	1440.0	636	4.1530	14.8570	21.85	0.772
11	4320.0	1281	5.2190	13.7910	27.45	0.645
12	1440.0	321	4.9850	14.0250	26.22	0.673
13	1440.0	84	4.6390	14.3710	24.40	0.714
14	1440.0	20	4.2690	14.7410	22.46	0.759
15	1440.0	5	4.0240	14.9860	21.17	0.788





## Stantec Consulting Ltd.

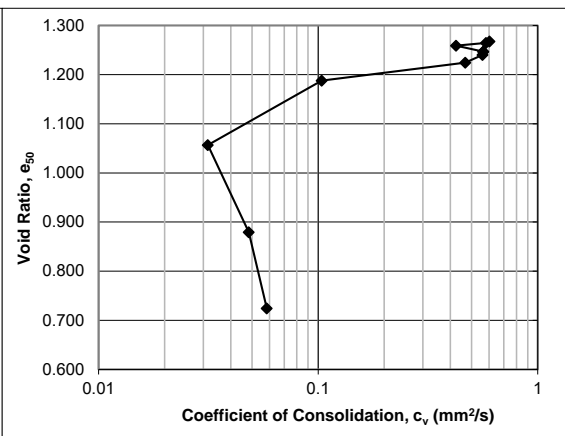
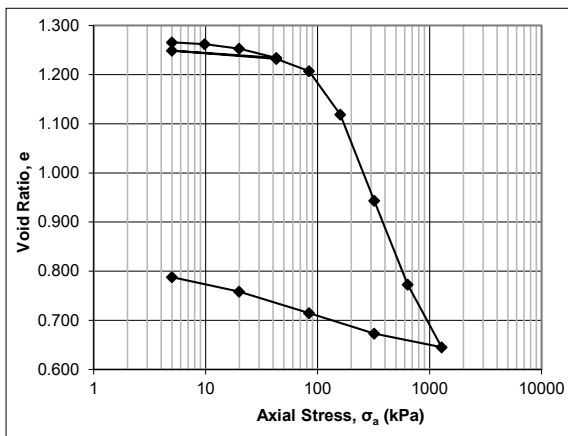
### One-Dimensional Consolidation Test using Incremental Loading ASTM D2435/D2435M - 11

#### Specimen Details

Job Ref.	Thurber Engineering, File# 23411
Job Location	Hwy 17, Laronde
Borehole	BH19-2A
Sample No.	TW 1
Depth	10-12 ft.
Sample Date	August 13, 2019
Test Number	Three
Technician Name	Daniel Boateng

#### Calculations

Load Increment	Axial Stress $\sigma_a$ , average kPa	Calculated using Interpretation Procedure 2				Interpretation Procedure 1		Interpretation Procedure 2	
		Corrected Deformation $\Delta H_{50}$ mm	Specimen Height $H_{50}$ mm	Axial Strain $\epsilon_{a,50}$ %	Void Ratio $e_{50}$	Time $t_{50}$ sec	Coeff. Consol. $c_v$ mm <sup>2</sup> /s	Time $t_{90}$ sec	Coeff. Consol. $c_v$ mm <sup>2</sup> /s
Seating	0								
1	3	0.0039	19.0061	0.02	1.267			127	6.03E-01
2	7	0.0291	18.9809	0.15	1.264			131	5.82E-01
3	15	0.0750	18.9350	0.39	1.259			179	4.25E-01
4	31	0.1784	18.8316	0.94	1.247			133	5.66E-01
5	24	0.2328	18.7772	1.22	1.240				
6	24	0.2331	18.7769	1.23	1.240			133	5.61E-01
7	63	0.3648	18.6452	1.92	1.224			157	4.68E-01
8	122	0.6702	18.3398	3.53	1.188			687	1.04E-01
9	240	1.7696	17.2404	9.31	1.057			2003	3.15E-02
10	479	3.2566	15.7534	17.13	0.879			1090	4.83E-02
11	959	4.5548	14.4552	23.96	0.725			760	5.83E-02
12	801	5.0965	13.9135	26.81	0.660				
13	202	4.8383	14.1717	25.45	0.691				
14	52	4.5156	14.4944	23.75	0.729				
15	12	4.2267	14.7833	22.23	0.764				





Project No.: 122410864

Project Name: Thurber Engineering, File# 23411

Photo Log

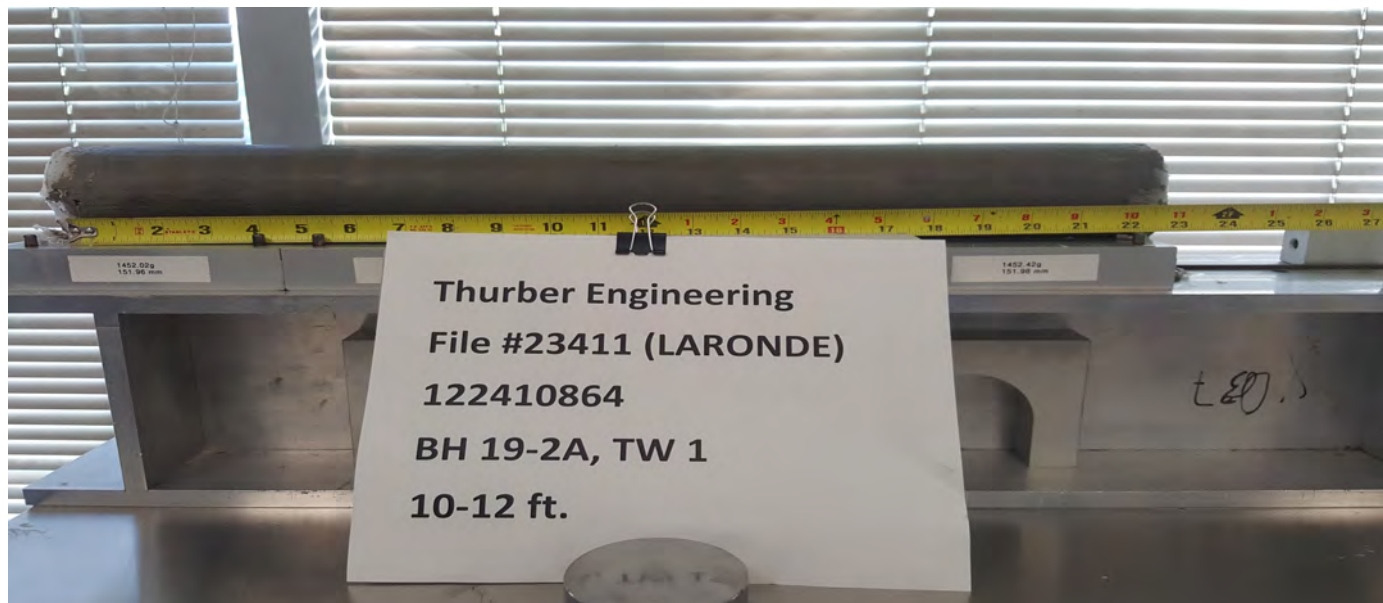


Photo No.:

1

Borehole: BH19-2A TW-1

Depth: 10 – 12 ft



Photo No.:

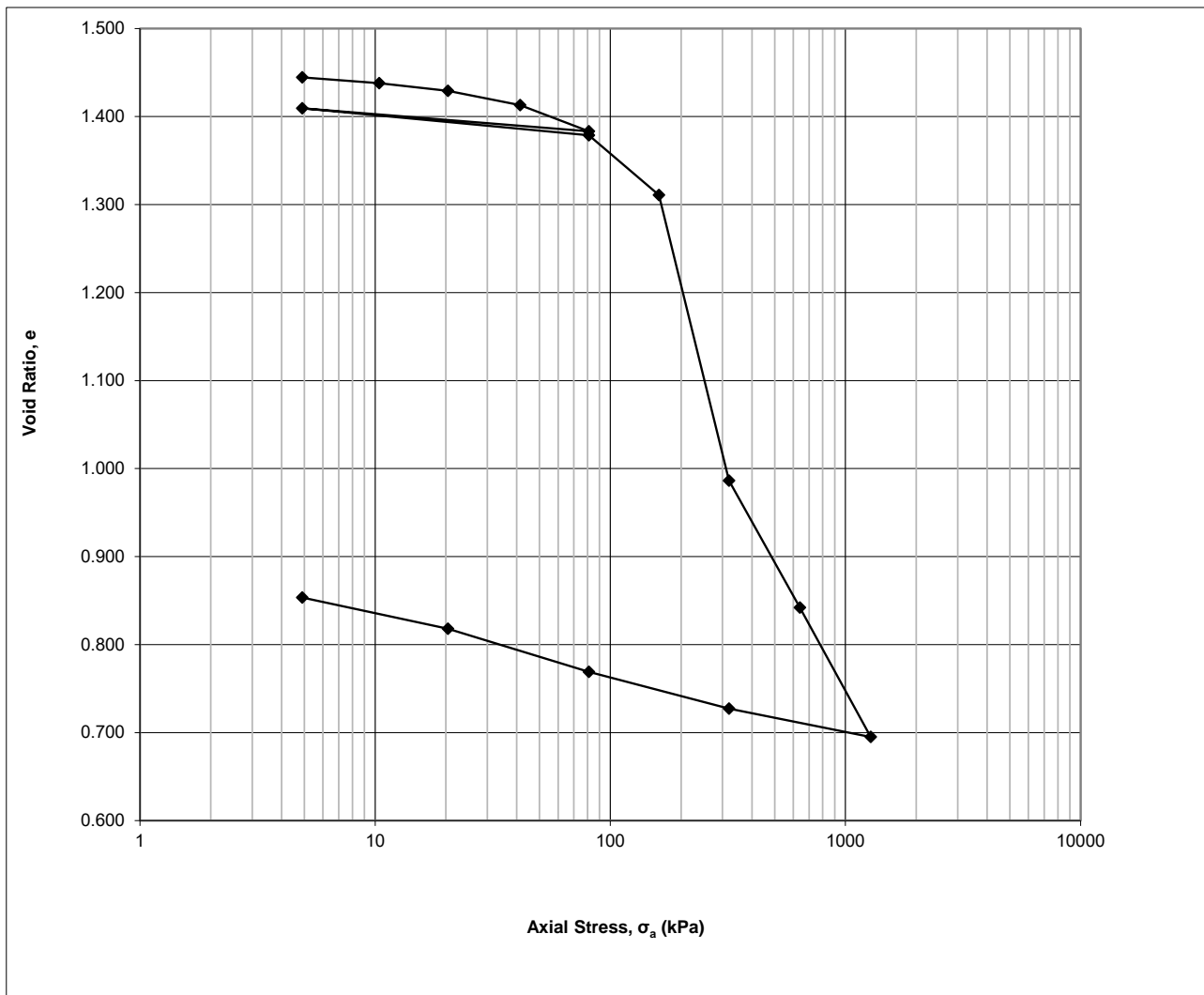
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Borehole: BH19-2A TW-1

Depth: 10 – 12 ft

Project  
Project No.  
Borehole No.  
Sample No.  
Sample Depth

Thurber Engineering, File# 23411  
122410864  
BH19-2A  
TW 5  
18-20 ft.





## Stantec Consulting Ltd.

### One-Dimensional Consolidation Test using Incremental Loading ASTM D2435/D2435M - 11

#### Specimen Details

Project Name	Thurber Engineering, File# 23411
Project Location	Hwy 17, Laronde
Borehole	BH19-2A
Sample No.	TW 5
Depth	18-20 ft.
Sample Date	August 13, 2019
Test Number	Four
Technician Name	Daniel Boateng

#### Soil Description & Classification

Clay and silt, grey, varved, moist - CI	
Specific Gravity of Solids	2.732
Liquid Limit %	47
Plastic Limit %	21
Plasticity Index %	26
Average water content of trimmings %	51
Additional Notes (information source, occurrence and size of large isolated particles etc.)	

#### Initial Specimen Conditions

Height	mm	19.03
Diameter	mm	50.86
Area	mm <sup>2</sup>	2032
Volume	mm <sup>3</sup>	38662
Mass	g	65.21
Dry Mass	g	43.12
Density	Mg/m <sup>3</sup>	1.687
Dry Density	Mg/m <sup>3</sup>	1.115
Water Content	%	51.23
Degree of Saturation	%	96.6
Height of Solids	mm	7.77
Initial Void Ratio		1.449

#### Final Specimen Conditions

Water Content	%	30.66
Final Void Ratio		0.853
Differential Height	mm	14.40

## One-Dimensional Consolidation Test using Incremental Loading

### ASTM D2435/D2435M - 11

**Specimen Details**

Project Name	Thurber Engineering, File# 23411
Project Location	Hwy 17, Laronde
Borehole	BH19-2A
Sample No.	TW 5
Depth	18-20 ft.
Sample Date	August 13, 2019
Test Number	Four
Technician Name	Daniel Boateng

**Test Procedure**

Date Started	September 9, 2019
Date Finished	November 7, 2019
Machine Number	Frame B
Cell Number	B
Ring Number	B
Trimming Procedure	Turntable/Cutting shoe
Moisture Condition	Inundated
Axial Stress at Inundation kPa	5
Water Used	Deaired Tap water
Test Method	A
Interpretation Procedure for $c_v$	2

**All Departures from Outlined ASTM D2435/D2435M-11 Procedure**
**Calculations**

Load Increment	Increment Duration min	Axial Stress $\sigma_a$ kPa	Corrected Deformation $\Delta H$ mm	Specimen Height H mm	Axial Strain $\epsilon_a$ %	Void Ratio e
Seating	0.0	0	0.0000	19.0300	0.00	1.449
1	1440.0	5	0.0390	18.9910	0.20	1.445
2	1440.0	10	0.0890	18.9410	0.47	1.438
3	1440.0	20	0.1570	18.8730	0.83	1.429
4	1440.0	41	0.2840	18.7460	1.49	1.413
5	4320.0	81	0.5160	18.5140	2.71	1.383
6	1440.0	5	0.3130	18.7170	1.64	1.409
7	1440.0	81	0.5510	18.4790	2.90	1.379
8	1440.0	161	1.0770	17.9530	5.66	1.311
9	59040.0	320	3.6000	15.4300	18.92	0.986
10	1440.0	640	4.7190	14.3110	24.80	0.842
11	1440.0	1280	5.8620	13.1680	30.80	0.695
12	4320.0	320	5.6110	13.4190	29.49	0.727
13	1440.0	81	5.2860	13.7440	27.78	0.769
14	1440.0	20	4.9070	14.1230	25.79	0.818
15	1440.0	5	4.6320	14.3980	24.34	0.853



## Stantec Consulting Ltd.

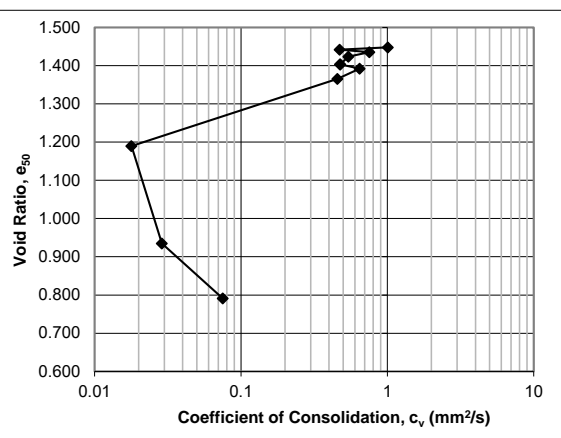
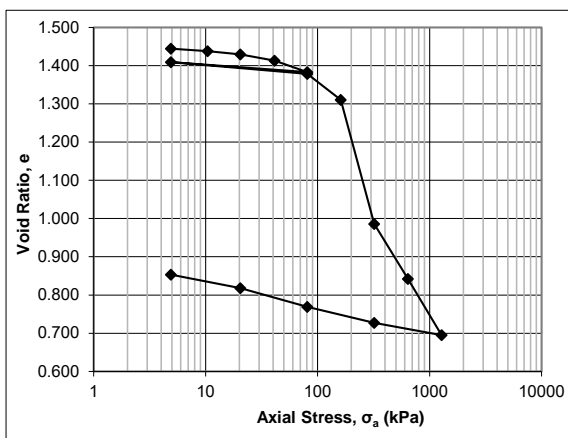
### One-Dimensional Consolidation Test using Incremental Loading ASTM D2435/D2435M - 11

#### Specimen Details

Job Ref.	Thurber Engineering, File# 23411
Job Location	Hwy 17, Laronde
Borehole	BH19-2A
Sample No.	TW 5
Depth	18-20 ft.
Sample Date	August 13, 2019
Test Number	Four
Technician Name	Daniel Boateng

#### Calculations

Load Increment	Axial Stress $\sigma_a$ , average kPa	Calculated using Interpretation Procedure 2				Interpretation Procedure 1		Interpretation Procedure 2	
		Corrected Deformation $\Delta H_{50}$ mm	Specimen Height $H_{50}$ mm	Axial Strain $\epsilon_{a,50}$ %	Void Ratio $e_{50}$	Time $t_{50}$ sec	Coeff. Consol. $c_v$ mm <sup>2</sup> /s	Time $t_{90}$ sec	Coeff. Consol. $c_v$ mm <sup>2</sup> /s
Seating	0								
1	2	0.0120	19.0180	0.06	1.448			76	1.01E+00
2	8	0.0572	18.9728	0.30	1.442			161	4.73E-01
3	15	0.1070	18.9230	0.56	1.436			101	7.54E-01
4	31	0.2012	18.8288	1.06	1.424			139	5.42E-01
5	61	0.3574	18.6726	1.88	1.404			155	4.76E-01
6	43	0.4136	18.6164	2.17	1.396				
7	43	0.4439	18.5861	2.33	1.392			113	6.48E-01
8	121	0.6548	18.3752	3.44	1.365			157	4.56E-01
9	240	2.0198	17.0102	10.61	1.190			3430	1.79E-02
10	480	3.9972	15.0328	21.00	0.935			1661	2.88E-02
11	960	5.1168	13.9132	26.89	0.791			545	7.53E-02
12	800	5.7221	13.3079	30.07	0.713				
13	201	5.5036	13.5264	28.92	0.741				
14	51	5.1500	13.8800	27.06	0.787				
15	13	4.8489	14.1811	25.48	0.825				







Project No.: 122410864

Project Name: Thurber Engineering, File# 23411

Photo Log

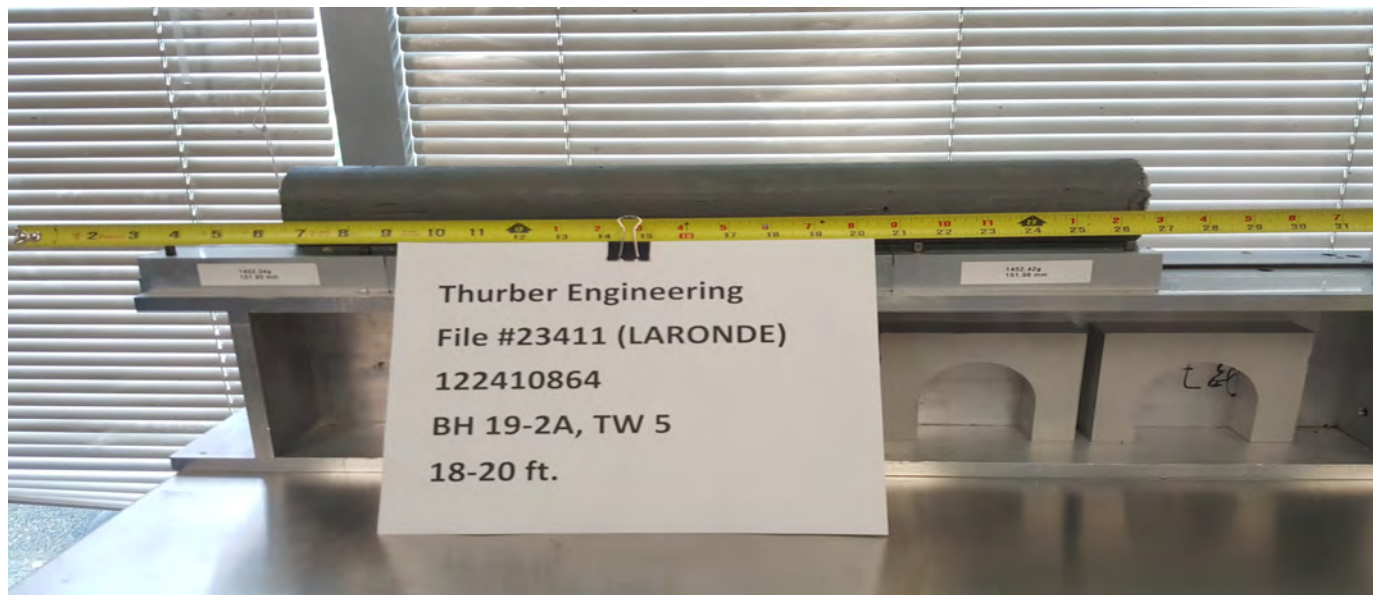


Photo No.:

1

Borehole: BH19-2A TW-5

Depth: 18 – 20 ft



Photo No.:

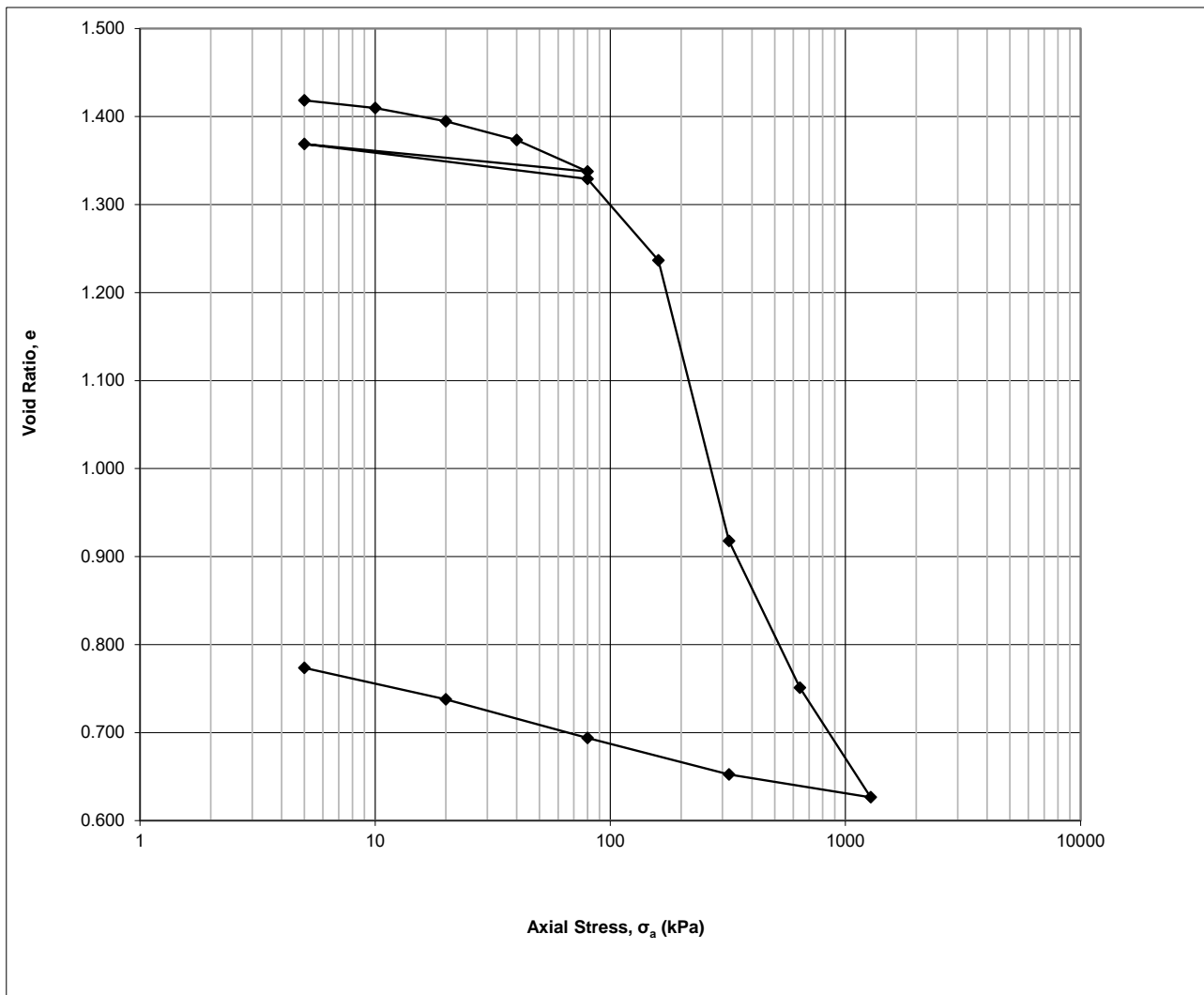
2

Borehole: BH19-2A TW-5

Depth: 18 – 20 ft

Project  
Project No.  
Borehole No.  
Sample No.  
Sample Depth

Thurber Engineering, File# 23411  
122410864  
BH19-2A  
TW 8  
24-26 ft.







## Stantec Consulting Ltd.

### One-Dimensional Consolidation Test using Incremental Loading ASTM D2435/D2435M - 11

#### Specimen Details

Project Name	Thurber Engineering, File# 23411
Project Location	Hwy 17, Laronde
Borehole	BH19-2A
Sample No.	TW 8
Depth	24-26 ft.
Sample Date	August 13, 2019
Test Number	Frame D
Technician Name	Daniel Boateng

#### Soil Description & Classification

Clay and silt, grey, varved, moist - CI	
Specific Gravity of Solids	2.725
Liquid Limit %	40
Plastic Limit %	20
Plasticity Index %	20
Average water content of trimmings %	47
<b>Additional Notes (information source, occurrence and size of large isolated particles etc.)</b>	
Loading Schedule Provided by Client	

#### Initial Specimen Conditions

Height	mm	20.00
Diameter	mm	50.00
Area	mm <sup>2</sup>	1963
Volume	mm <sup>3</sup>	39270
Mass	g	64.84
Dry Mass	g	44.06
Density	Mg/m <sup>3</sup>	1.651
Dry Density	Mg/m <sup>3</sup>	1.122
Water Content	%	47.16
Degree of Saturation	%	90.0
Height of Solids	mm	8.23
Initial Void Ratio		1.429

#### Final Specimen Conditions

Water Content	%	25.08
Final Void Ratio		0.774
Differential Height	mm	14.60

# **One-Dimensional Consolidation Test using Incremental Loading** **ASTM D2435/D2435M - 11**

**Specimen Details**

Project Name	Thurber Engineering, File# 23411
Project Location	Hwy 17, Laronde
Borehole	BH19-2A
Sample No.	TW 8
Depth	24-26 ft.
Sample Date	August 13, 2019
Test Number	Three
Technician Name	Daniel Boateng

**Test Procedure**

Date Started	September 6, 2019
Date Finished	September 23, 2019
Machine Number	Frame D
Cell Number	D
Ring Number	D
Trimming Procedure	Turntable/Cutting Ring
Moisture Condition	Inundated
Axial Stress at Inundation kPa	5
Water Used	Deaired Tap Water
Test Method	A
Interpretation Procedure for $c_v$	2

**All Departures from Outlined ASTM D2435/D2435M-11 Procedure**
**Calculations**

Load Increment	Increment Duration min	Axial Stress $\sigma_a$ kPa	Corrected Deformation $\Delta H$ mm	Specimen Height H mm	Axial Strain $\epsilon_a$ %	Void Ratio e
Seating	0.0	0	0.0000	20.0000	0.00	1.429
1	1440.0	5	0.0853	19.9147	0.43	1.418
2	1440.0	10	0.1566	19.8434	0.78	1.410
3	1440.0	20	0.2813	19.7187	1.41	1.395
4	1440.0	40	0.4571	19.5429	2.29	1.373
5	1440.0	80	0.7499	19.2501	3.75	1.338
6	1440.0	5	0.4940	19.5060	2.47	1.369
7	1440.0	80	0.8198	19.1802	4.10	1.329
8	1440.0	160	1.5824	18.4176	7.91	1.237
9	1440.0	320	4.2080	15.7920	21.04	0.918
10	1440.0	640	5.5824	14.4176	27.91	0.751
11	1440.0	1280	6.6069	13.3931	33.03	0.626
12	1440.0	320	6.3919	13.6081	31.96	0.653
13	1440.0	80	6.0524	13.9476	30.26	0.694
14	1440.0	20	5.6907	14.3093	28.45	0.738
15	1440.0	5	5.3954	14.6046	26.98	0.774



## Stantec Consulting Ltd.

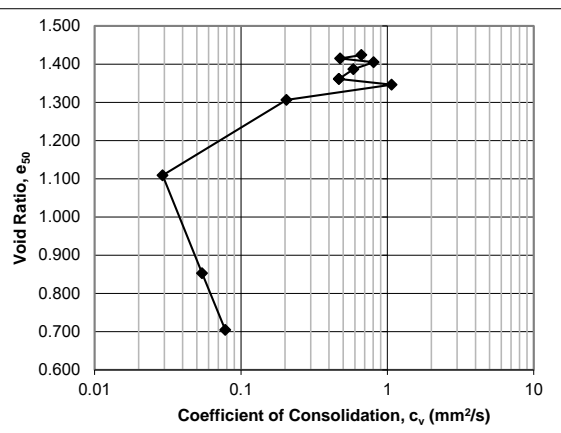
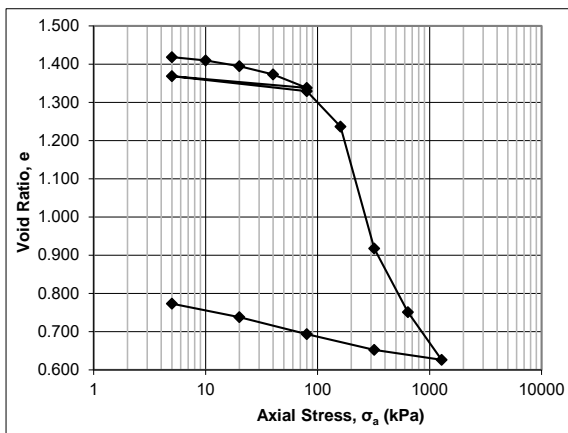
### One-Dimensional Consolidation Test using Incremental Loading ASTM D2435/D2435M - 11

#### Specimen Details

Job Ref.	Thurber Engineering, File# 23411
Job Location	Hwy 17, Laronde
Borehole	BH19-2A
Sample No.	TW 8
Depth	24-26 ft.
Sample Date	August 13, 2019
Test Number	Three
Technician Name	Daniel Boateng

#### Calculations

Load Increment	Axial Stress $\sigma_a$ , average kPa	Calculated using Interpretation Procedure 2				Interpretation Procedure 1		Interpretation Procedure 2	
		Corrected Deformation $\Delta H_{50}$ mm	Specimen Height $H_{50}$ mm	Axial Strain $\epsilon_{a,50}$ %	Void Ratio $e_{50}$	Time $t_{50}$ sec	Coeff. Consol. $c_v$ mm <sup>2</sup> /s	Time $t_{90}$ sec	Coeff. Consol. $c_v$ mm <sup>2</sup> /s
Seating	0								
1	3	0.0414	19.9586	0.21	1.424			127	6.64E-01
2	8	0.1117	19.8883	0.56	1.415			176	4.76E-01
3	15	0.1969	19.8031	0.98	1.405			103	8.05E-01
4	30	0.3439	19.6561	1.72	1.387			139	5.88E-01
5	60	0.5533	19.4467	2.77	1.362			171	4.68E-01
6	43	0.5970	19.4030	2.99	1.356				
7	43	0.6776	19.3224	3.39	1.346			74	1.07E+00
8	120	1.0067	18.9933	5.03	1.306			374	2.04E-01
9	240	2.6329	17.3671	13.16	1.109			2192	2.92E-02
10	480	4.7393	15.2607	23.70	0.853			911	5.42E-02
11	960	5.9649	14.0351	29.82	0.704			534	7.82E-02
12	800	6.4835	13.5165	32.42	0.641				
13	200	6.2338	13.7662	31.17	0.672				
14	50	5.9331	14.0669	29.67	0.708				
15	13	5.6028	14.3972	28.01	0.748				





Project No.: 122410864

Project Name: Thurber Engineering, File# 23411

Photo Log

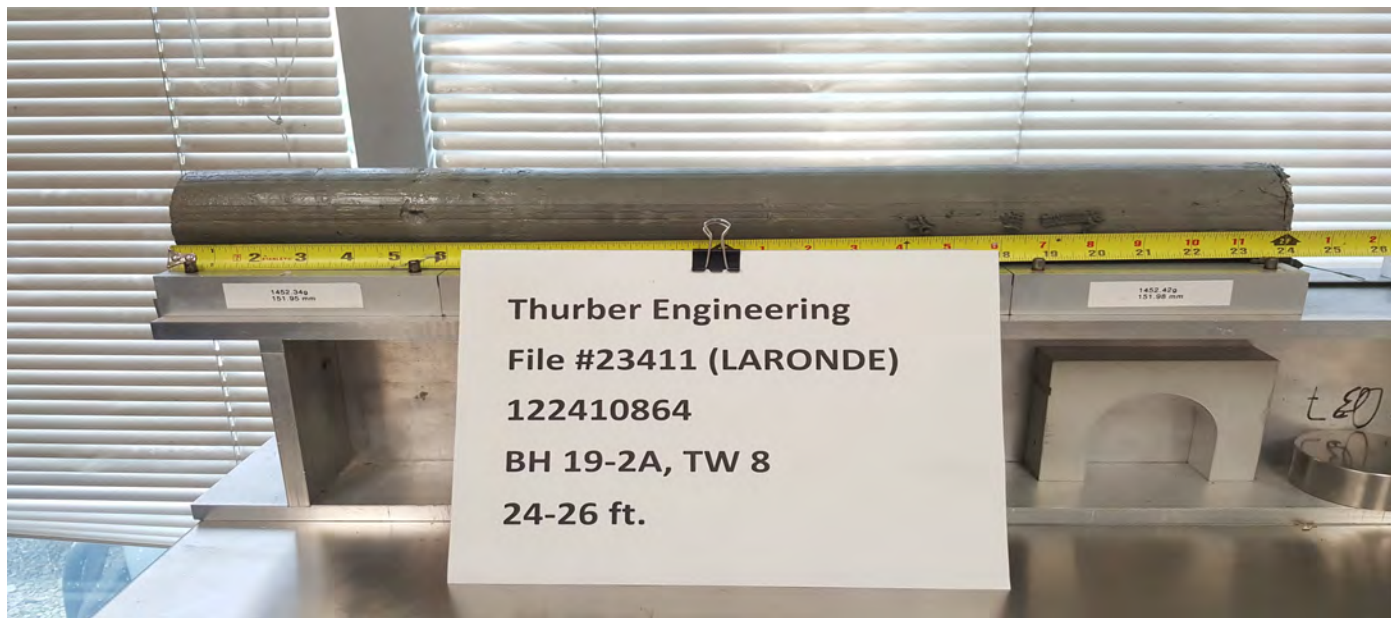


Photo No.:

1

Borehole: BH19-2A TW-8

Depth: 24 – 26 ft



Photo No.:

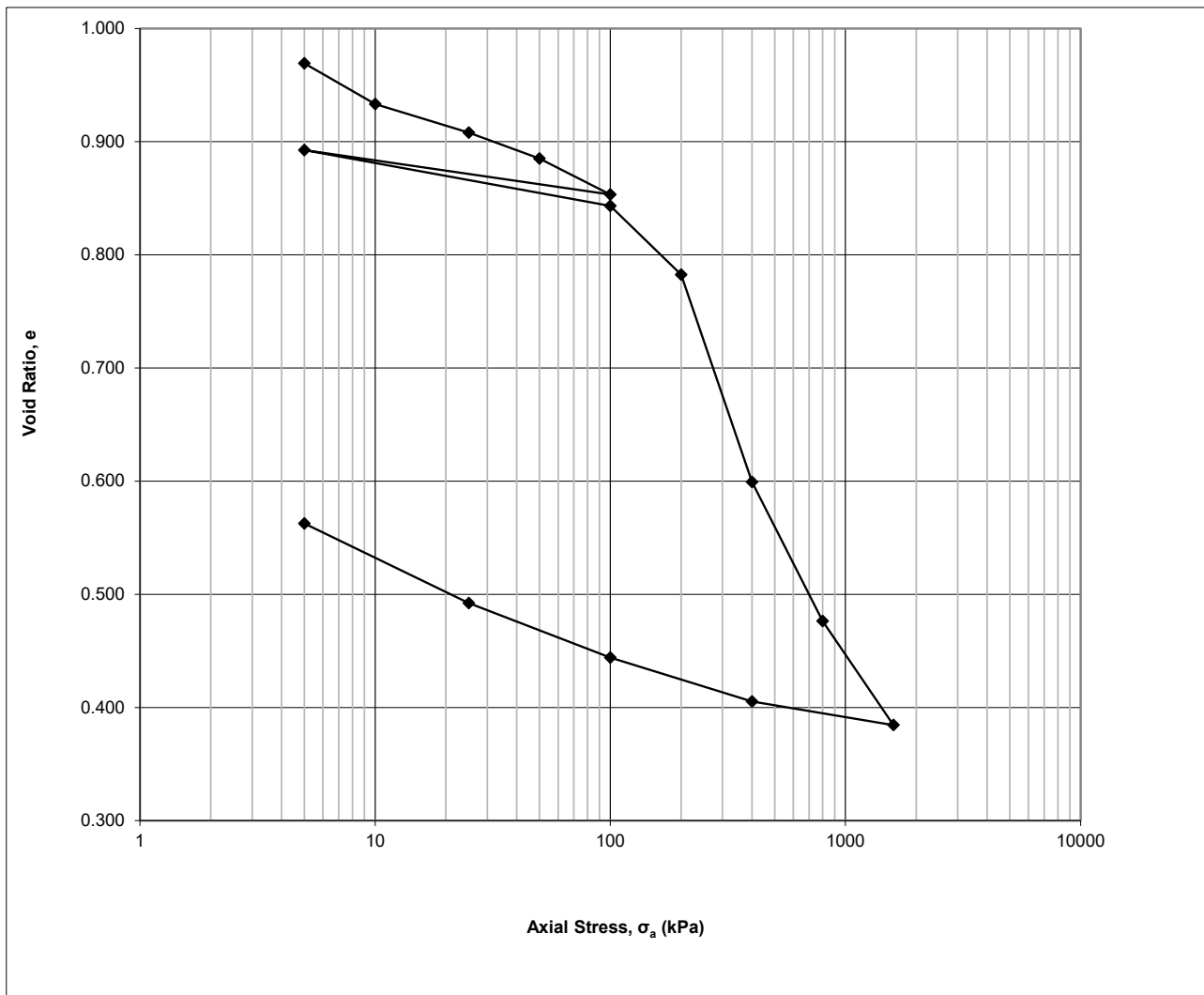
2

Borehole: BH19-2A TW-8

Depth: 24 – 26 ft

Project  
Project No.  
Borehole No.  
Sample No.  
Sample Depth

Thurber Engineering, File# 23411  
122410864  
BH19-2A  
TW 15  
40-42 ft.





## Stantec Consulting Ltd.

### One-Dimensional Consolidation Test using Incremental Loading ASTM D2435/D2435M - 11

#### Specimen Details

Project Name	Thurber Engineering, File# 23411
Project Location	Hwy 17, Laronde
Borehole	BH19-2A
Sample No.	TW 15
Depth	40-42 ft.
Sample Date	August 13, 2019
Test Number	Frame C
Technician Name	Daniel Boateng

#### Soil Description & Classification

Clay and silt, sand seams, grey, varved, moist - CI	
Specific Gravity of Solids	2.735
Liquid Limit %	48
Plastic Limit %	20
Plasticity Index %	28
Average water content of trimmings %	26
<b>Additional Notes (information source, occurrence and size of large isolated particles etc.)</b>	
Loading Schedule Provided by Client	

#### Initial Specimen Conditions

Height	mm	20.00
Diameter	mm	50.00
Area	mm <sup>2</sup>	1963
Volume	mm <sup>3</sup>	39270
Mass	g	67.73
Dry Mass	g	53.55
Density	Mg/m <sup>3</sup>	1.725
Dry Density	Mg/m <sup>3</sup>	1.364
Water Content	%	26.48
Degree of Saturation	%	72.0
Height of Solids	mm	9.97
Initial Void Ratio		1.006

#### Final Specimen Conditions

Water Content	%	14.64
Final Void Ratio		0.563
Differential Height	mm	15.58

## One-Dimensional Consolidation Test using Incremental Loading

### ASTM D2435/D2435M - 11

**Specimen Details**

Project Name	Thurber Engineering, File# 23411
Project Location	Hwy 17, Laronde
Borehole	BH19-2A
Sample No.	TW 15
Depth	40-42 ft.
Sample Date	August 13, 2019
Test Number	Frame C
Technician Name	Daniel Boateng

**Test Procedure**

Date Started	September 6, 2019
Date Finished	September 23, 2019
Machine Number	Frame C
Cell Number	C
Ring Number	C
Trimming Procedure	Turntable/Cutting Ring
Moisture Condition	Inundated
Axial Stress at Inundation	5 kPa
Water Used	Deaired Tap Water
Test Method	A
Interpretation Procedure for $c_v$	2

**All Departures from Outlined ASTM D2435/D2435M-11 Procedure**
**Calculations**

Load Increment	Increment Duration min	Axial Stress $\sigma_a$ kPa	Corrected Deformation $\Delta H$ mm	Specimen Height H mm	Axial Strain $\epsilon_a$ %	Void Ratio e
Seating	0.0	0	0.0000	20.0000	0.00	1.006
1	1440.0	5	0.3631	19.6369	1.82	0.969
2	1440.0	10	0.7225	19.2775	3.61	0.933
3	1440.0	25	0.9725	19.0275	4.86	0.908
4	1440.0	50	1.2030	18.7970	6.02	0.885
5	1440.0	100	1.5197	18.4803	7.60	0.853
6	1440.0	5	1.1274	18.8726	5.64	0.893
7	1440.0	100	1.6184	18.3816	8.09	0.843
8	1440.0	200	2.2258	17.7742	11.13	0.782
9	1440.0	400	4.0529	15.9471	20.26	0.599
10	1440.0	800	5.2789	14.7211	26.39	0.476
11	1440.0	1600	6.1955	13.8045	30.98	0.384
12	1440.0	400	5.9859	14.0141	29.93	0.405
13	1440.0	100	5.5999	14.4001	28.00	0.444
14	1440.0	25	5.1195	14.8805	25.60	0.492
15	1440.0	5	4.4185	15.5815	22.09	0.563

## One-Dimensional Consolidation Test using Incremental Loading

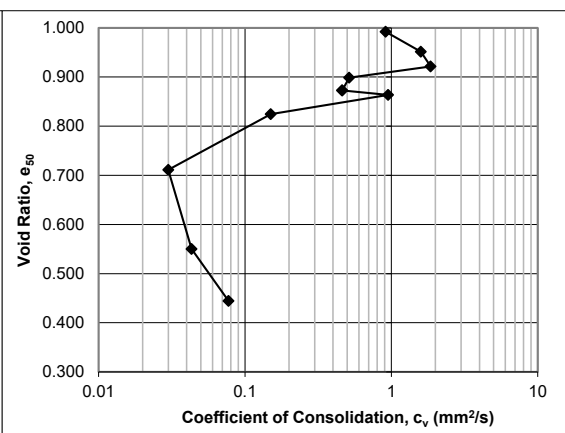
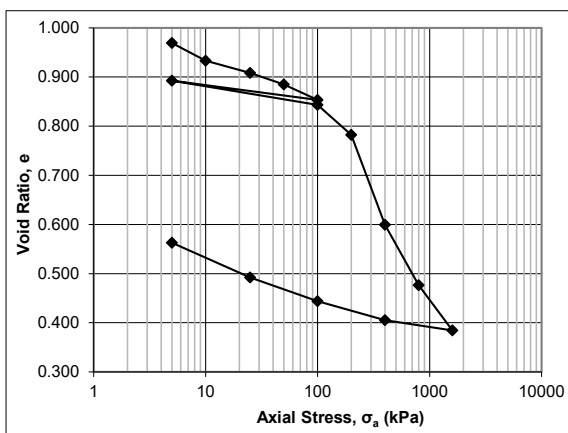
### ASTM D2435/D2435M - 11

**Specimen Details**

Job Ref.	Thurber Engineering, File# 23411
Job Location	Hwy 17, Laronde
Borehole	BH19-2A
Sample No.	TW 15
Depth	40-42 ft.
Sample Date	August 13, 2019
Test Number	Frame C
Technician Name	Daniel Boateng

**Calculations**

Load Increment	Axial Stress $\sigma_a$ , average kPa	Calculated using Interpretation Procedure 2				Interpretation Procedure 1		Interpretation Procedure 2	
		Corrected Deformation $\Delta H_{50}$ mm	Specimen Height $H_{50}$ mm	Axial Strain $\epsilon_{a,50}$ %	Void Ratio $e_{50}$	Time $t_{50}$ sec	Coeff. Consol. $c_v$ mm <sup>2</sup> /s	Time $t_{90}$ sec	Coeff. Consol. $c_v$ mm <sup>2</sup> /s
Seating	0								
1	3	0.1342	19.8658	0.67	0.992			91	9.15E-01
2	8	0.5412	19.4588	2.71	0.951			50	1.59E+00
3	18	0.8381	19.1619	4.19	0.922			42	1.86E+00
4	38	1.0667	18.9333	5.33	0.899			147	5.15E-01
5	75	1.3229	18.6771	6.61	0.873			160	4.62E-01
6	53	1.2907	18.7093	6.45	0.876				
7	53	1.4156	18.5844	7.08	0.864			77	9.52E-01
8	150	1.8076	18.1924	9.04	0.824			467	1.50E-01
9	300	2.9370	17.0630	14.69	0.711			2063	2.99E-02
10	600	4.5417	15.4583	22.71	0.550			1174	4.31E-02
11	1200	5.5977	14.4023	27.99	0.444			570	7.72E-02
12	1000	6.0715	13.9285	30.36	0.397				
13	250	5.8037	14.1963	29.02	0.424				
14	63	5.4190	14.5810	27.10	0.462				
15	15	4.7947	15.2053	23.97	0.525				







Project No.: 122410864

Project Name: Thurber Engineering, File# 25728

Photo Log

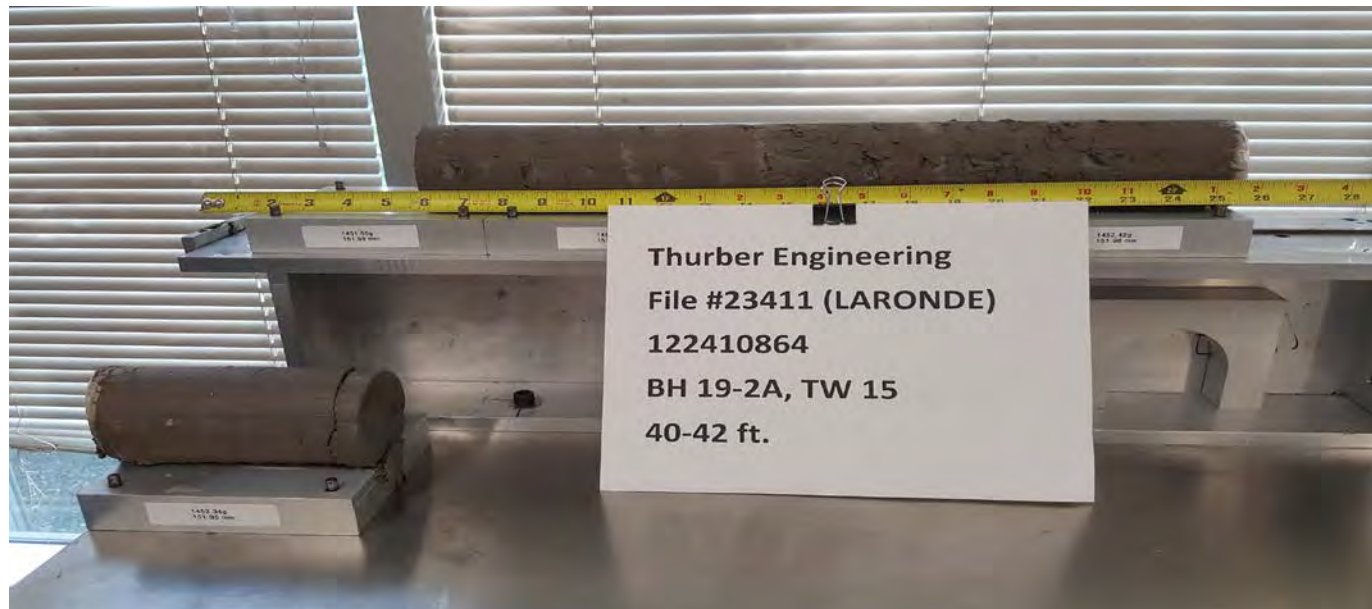


Photo No.:

1

Borehole: BH 19-2A TW-15

Depth: 40 – 42 ft

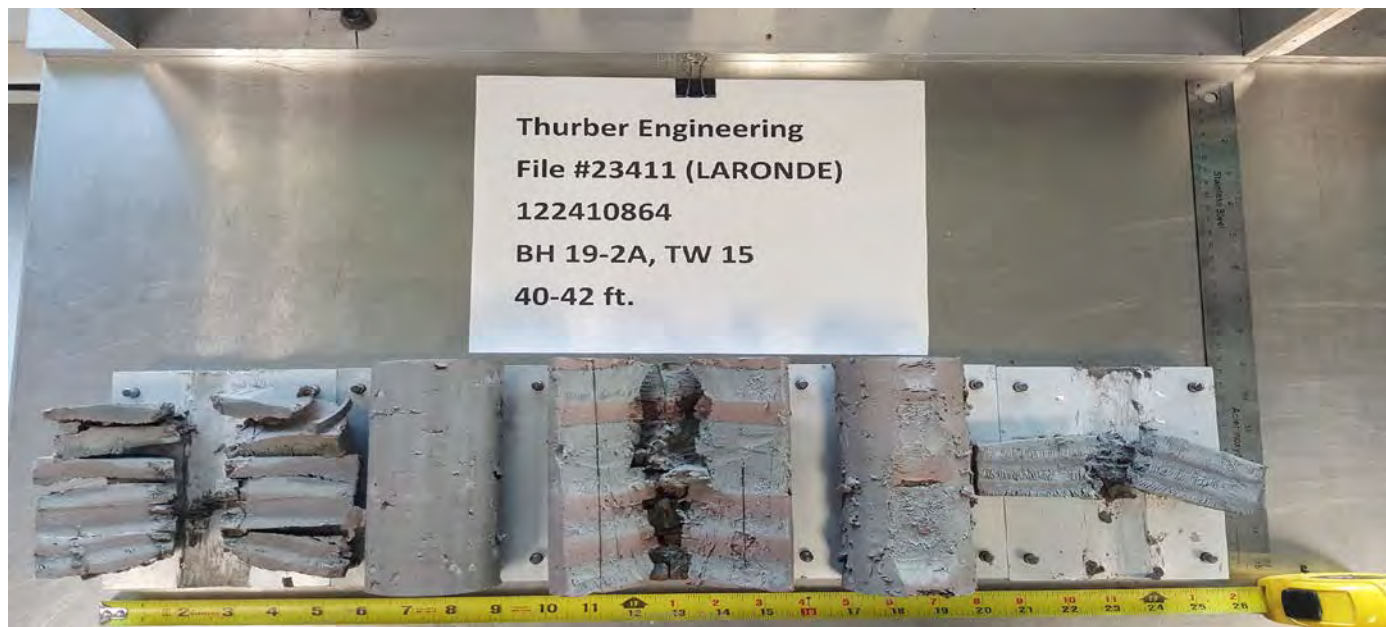


Photo No.:

2

Borehole: BH 19-2A TW-15

Depth: 40 – 42 ft



Stantec Consulting Ltd.  
400 - 1331 Clyde Avenue, Ottawa ON K2C 3G4

January 9, 2020  
File: 122410864

**Attention: Deanna Pizycki, M. Eng., P.Eng.**

Thurber Engineering Ltd.  
104 – 2460 Lancaster Road  
Ottawa, Ontario, Canada, K1B 4S5  
Tel: 613-274-2121 ext. 7106  
E-mail: dpizycki@thurber.ca

Dear Ms. Pizycki,

**Reference: Consolidation Undrained Triaxial Test Results for Laronde Creek Bridge Project,  
Thurber Engineering Ltd., File #23411: BH 19-02A, TW 3, sampled on August 13, 2019**

This letter presents the results of consolidated undrained triaxial compression test carried out on the above referenced samples in accordance with ASTM D4767 - 11. The test results are provided in the attached tables and figures.

This letter provides test results only and does not constitute any interpretation or engineering recommendations with respect to material suitability or specification compliance.

We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

Regards,

**STANTEC CONSULTING LTD.**

A handwritten signature in blue ink, appearing to read "Rajib Dey".

**Rajib Dey** P.Eng.  
Geotechnical Engineer  
Phone: 905 944 6190  
Fax: 905 474 9889  
Rajib.Dey@stantec.com

\\ca0218-ppfss01\work\_group2\01216\active\laboratory\_standing\_offers\2019 laboratory standing offers\122410864 thurber engineering\reports for deanna\122410864\_let\_23411\_consolidation undrained\_19-02a tw3.docx

## Consolidated Undrained Triaxial Compression Test for Cohesive Soils

### ASTM D4767 - 11

Sample Details	Specimen 1	Specimen 2	Specimen 3
Project Name	Thurber Engineering, File# 23411		
Project Location	Laronde Creek Bridge		
Borehole	19-02A	19-02A	19-02A
Sample Number	TW 3	TW 3	TW 3
Depth	14-16 ft	14-16 ft	14-16 ft
Sample Date	August 13, 2019	August 13, 2019	August 13, 2019
Test Number	One	Two	Three
Technician Name	Daniel Boateng	Daniel Boateng	Daniel Boateng

#### Soil Description & Classification

Clay and silt, grey, varved, moist - CH			
Specific Gravity of Solids	2.731	2.731	2.731
Liquid Limit %	59.2	59.2	59.2
Plastic Limit %	22.3	22.3	22.3
Plasticity Index %	36.8	36.8	36.8
<b>Additional Notes (unusual conditions or other information necessary to interpret the test results):</b>			
<i>Effective consolidation stress assigned by client</i>			
<i>Specimen is varved with variable moisture contents across length of shelly tube</i>			
<i>Specimen 2 and 3 consolidated in stages as per ASTM</i>			
<b>Departures from the test procedure outlined in ASTM D4767-11:</b>			

#### Initial Specimen Conditions

Height	mm	151.4	142.2	142.2
Diameter	mm	70.0	70.0	70.0
Dry Unit Weight	Mg/m <sup>3</sup>	0.94	1.00	0.93
Void Ratio		1.90	1.72	1.94
Water Content	%	70.56	65.84	76.88
Degree of Saturation	%	101.6	104.7	108.3
Method used for obtaining water content		Cuttings	Cuttings	Cuttings

#### Membrane Properties

Young's Modulus	kPa	1400	1400	1400
Thickness	mm	0.3	0.3	0.3

#### Filter-Paper Strip Properties

Load carried per unit length	kN/mm	0.00019	0.00019	0.00019
Specimen perimeter covered by strips	mm	220	220	220

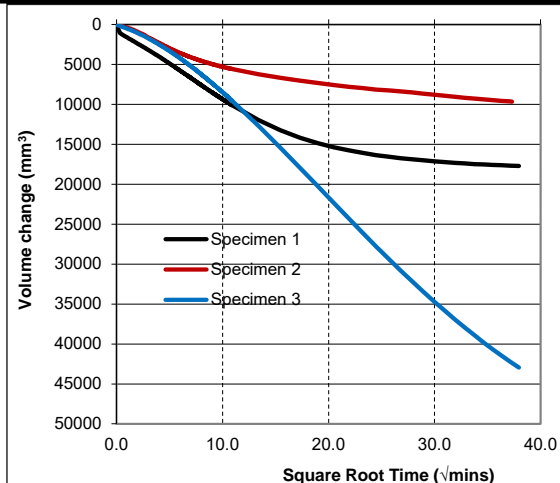
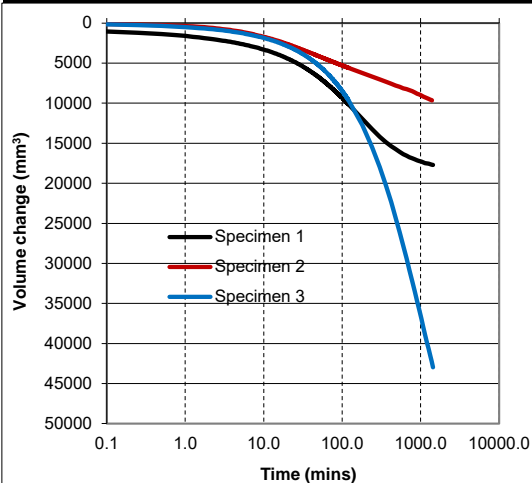
**Consolidated Undrained Triaxial Compression Test for Cohesive Soils**  
ASTM D4767 - 11

Sample Details	Specimen 1	Specimen 2	Specimen 3
Project Name	Thurber Engineering, File# 23411		
Project Location	Laronde Creek Bridge		
Borehole	19-02A	19-02A	19-02A
Sample Number	TW 3	TW 3	TW 3
Depth	14-16 ft	14-16 ft	14-16 ft
Sample Date	August 13, 2019	August 13, 2019	August 13, 2019
Test Number	One	Two	Three
Technician Name	Daniel Boateng	Daniel Boateng	Daniel Boateng

<b>Test Setup</b>			
Date Started	December 24, 2019	December 28, 2019	January 3, 2020
Date Finished	December 28, 2019	January 3, 2020	January 8, 2020
Top Drain Used	Yes	Yes	Yes
Base Drain Used	Yes	Yes	Yes
Side Drains Used (Filter-Paper Strips)	Yes	Yes	Yes
Pressure System Number	21705	21705	21705
Cell Number	21969	21969	21969

<b>Measurement of Pore Pressure Parameter</b>			
Cell Pressure Increment kPa	10.0	10.0	10.0
Cell Pressure at B determination kPa	210.0	210.0	210.0
Back Pressure at B determination kPa	190.0	190.0	190.0
Pore Pressure at B determination kPa	201.7	201.9	201.6
Pore Pressure Parameter B at 2 min	1.0	1.0	1.0
Method used for specimen saturation	Wet	Wet	Wet

<b>End of Consolidation Stage</b>			
Consolidation Stress kPa	50.0	150.0	250.0
Effective Consolidation Stress kPa	48.7	148.2	213.6
Total Back Pressure kPa	200.0	200.0	200.0
Time to 50 % primary consolidation min	112	104	467
Interpretation method used for t <sub>50</sub>	1	1	1
Dry Unit Weight Mg/m <sup>3</sup>	0.95	1.04	1.00
Void Ratio	1.87	1.62	1.73
Water Content %	68.44	57.28	63.68
Degree of Saturation %	100.0	96.7	100.3
Cross-sectional Area, A <sub>c</sub> mm <sup>2</sup>	3783.0	3705.5	3571.2
Method used to determine Area, A <sub>c</sub>	A	A	A

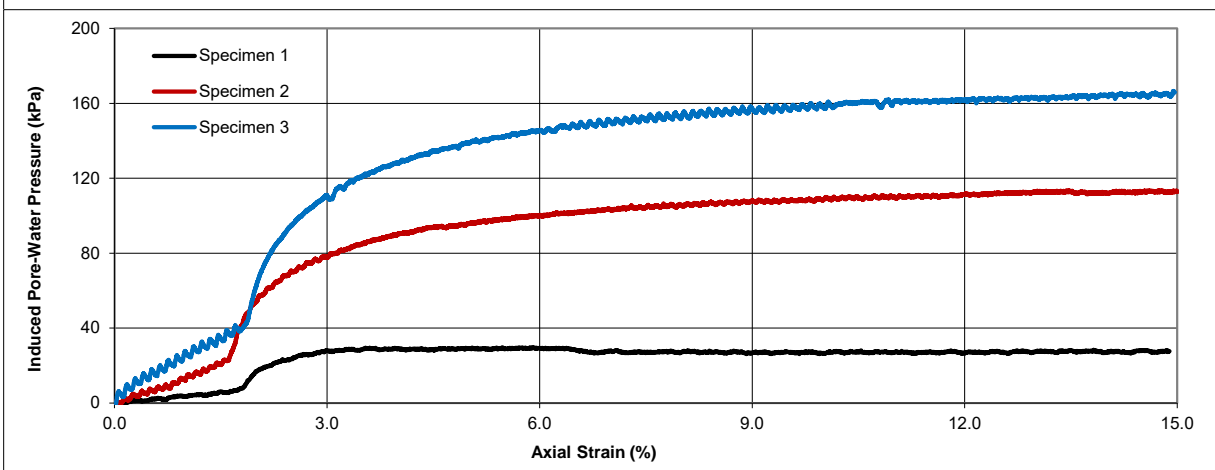
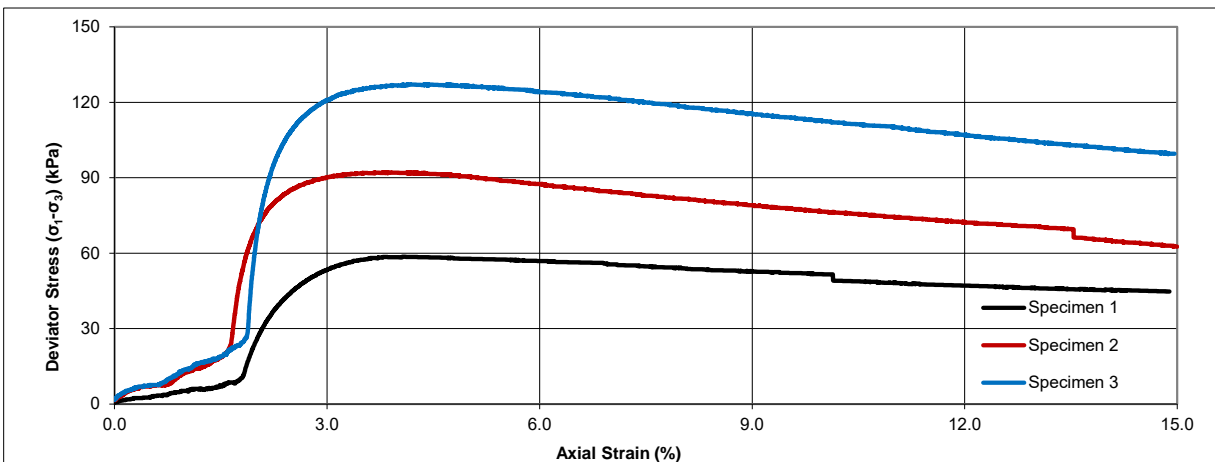


## Consolidated Undrained Triaxial Compression Test for Cohesive Soils ASTM D4767 - 11

Sample Details	Specimen 1	Specimen 2	Specimen 3
Project Name	Thurber Engineering, File# 23411		
Project Location	Laronde Creek Bridge		
Borehole	19-02A	19-02A	19-02A
Sample Number	TW 3	TW 3	TW 3
Depth	14-16 ft	14-16 ft	14-16 ft
Sample Date	August 13, 2019	August 13, 2019	August 13, 2019
Test Number	One	Two	Three
Technician Name	Daniel Boateng	Daniel Boateng	Daniel Boateng

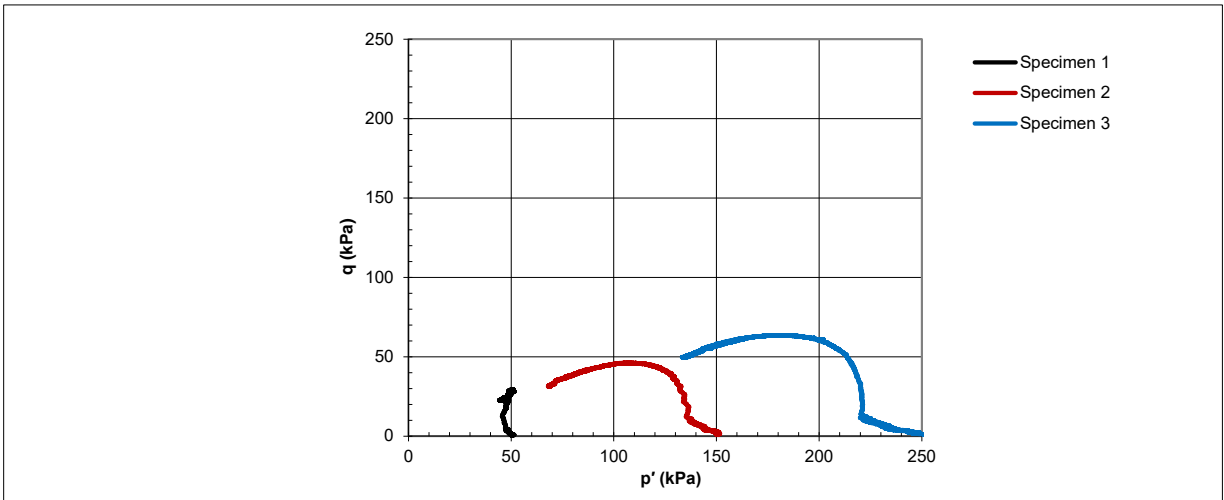
<b>Shearing Stage</b>			
Failure Criterion	15% Axial Strain	15% Axial Strain	15% Axial Strain
Rate of axial strain %/min	0.017	0.006	0.006

<b>Response at Failure</b>			
Deviator Stress ( $\sigma_1 - \sigma_3$ ) kPa	58.6	92.2	127.2
Axial Strain %	4.06	3.78	4.13
Max Effective Principal Stress Ratio ( $\sigma'_1 / \sigma'_3$ )	3.8	2.5	2.1
Effective Major Principal Stress kPa	79.6	154.2	247.2
Effective Minor Principal Stress kPa	21.0	62.0	120.0
Values corrected for membrane?	No	No	No
Values corrected for filter-paper strips?	No	No	No

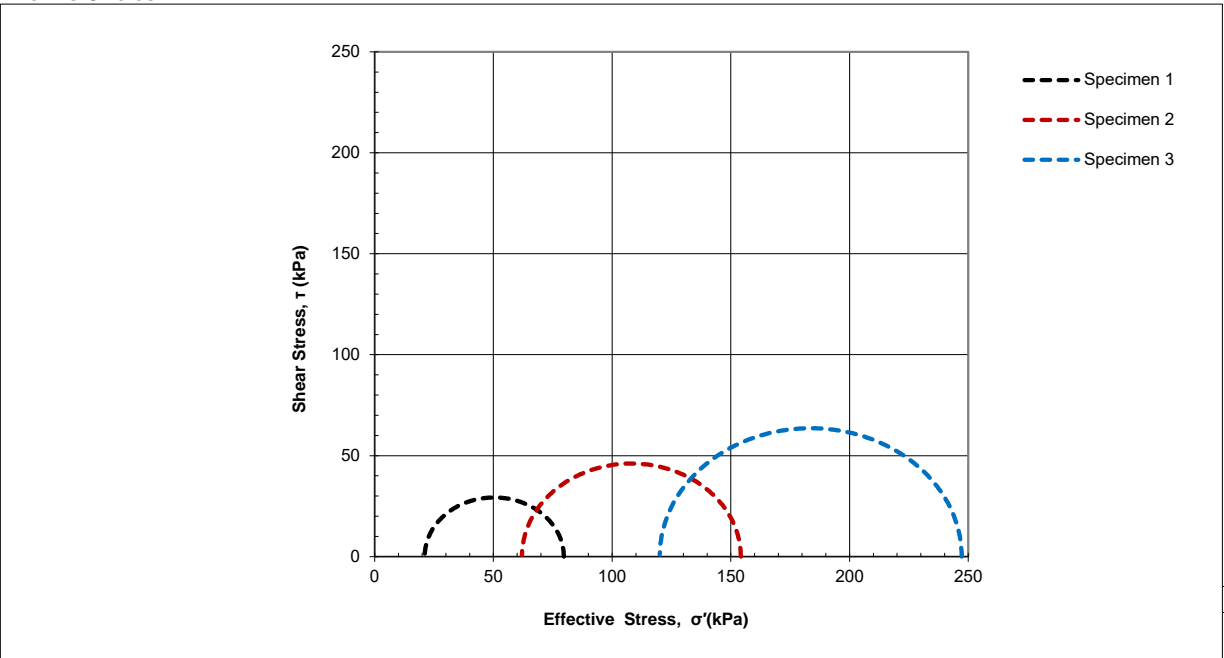


**Consolidated Undrained Triaxial Compression Test for Cohesive Soils**  
ASTM D4767 - 11

Sample Details	Specimen 1	Specimen 2	Specimen 3
Project Name	Thurber Engineering, File# 23411		
Project Location	Laronde Creek Bridge		
Borehole	19-02A	19-02A	19-02A
Sample Number	TW 3	TW 3	TW 3
Depth	14-16 ft	14-16 ft	14-16 ft
Sample Date	August 13, 2019	August 13, 2019	August 13, 2019
Test Number	One	Two	Three
Technician Name	Daniel Boateng	Daniel Boateng	Daniel Boateng



**Mohr's Circles**





**Consolidated Undrained Triaxial Compression Test for Cohesive Soils**  
ASTM D4767 - 11

Sample Details	Specimen 1	Specimen 2	Specimen 3
Project Name	Thurber Engineering, File# 23411		
Project Location	Laronde Creek Bridge		
Borehole	19-02A	19-02A	19-02A
Sample Number	TW 3	TW 3	TW 3
Depth	14-16 ft	14-16 ft	14-16 ft
Sample Date	August 13, 2019	August 13, 2019	August 13, 2019
Test Number	One	Two	Three
Technician Name	Daniel Boateng	Daniel Boateng	Daniel Boateng

**Failure Photographs of the Specimens**



Specimen 1



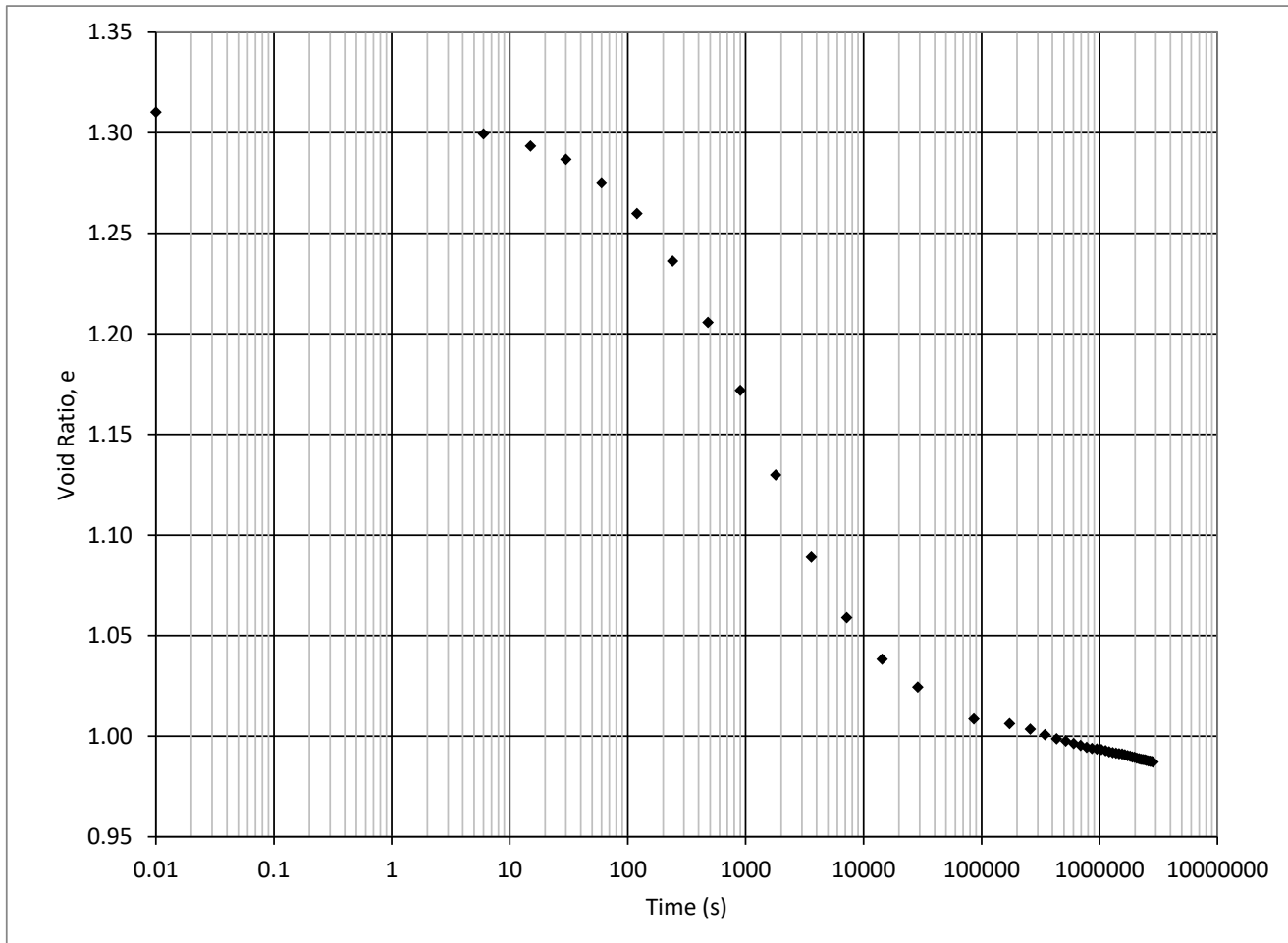
Specimen 2



Specimen 3

**Project**  
**Project No.**  
**Borehole No.**  
**Sample No.**  
**Sample Depth**  
**Axial Stress**

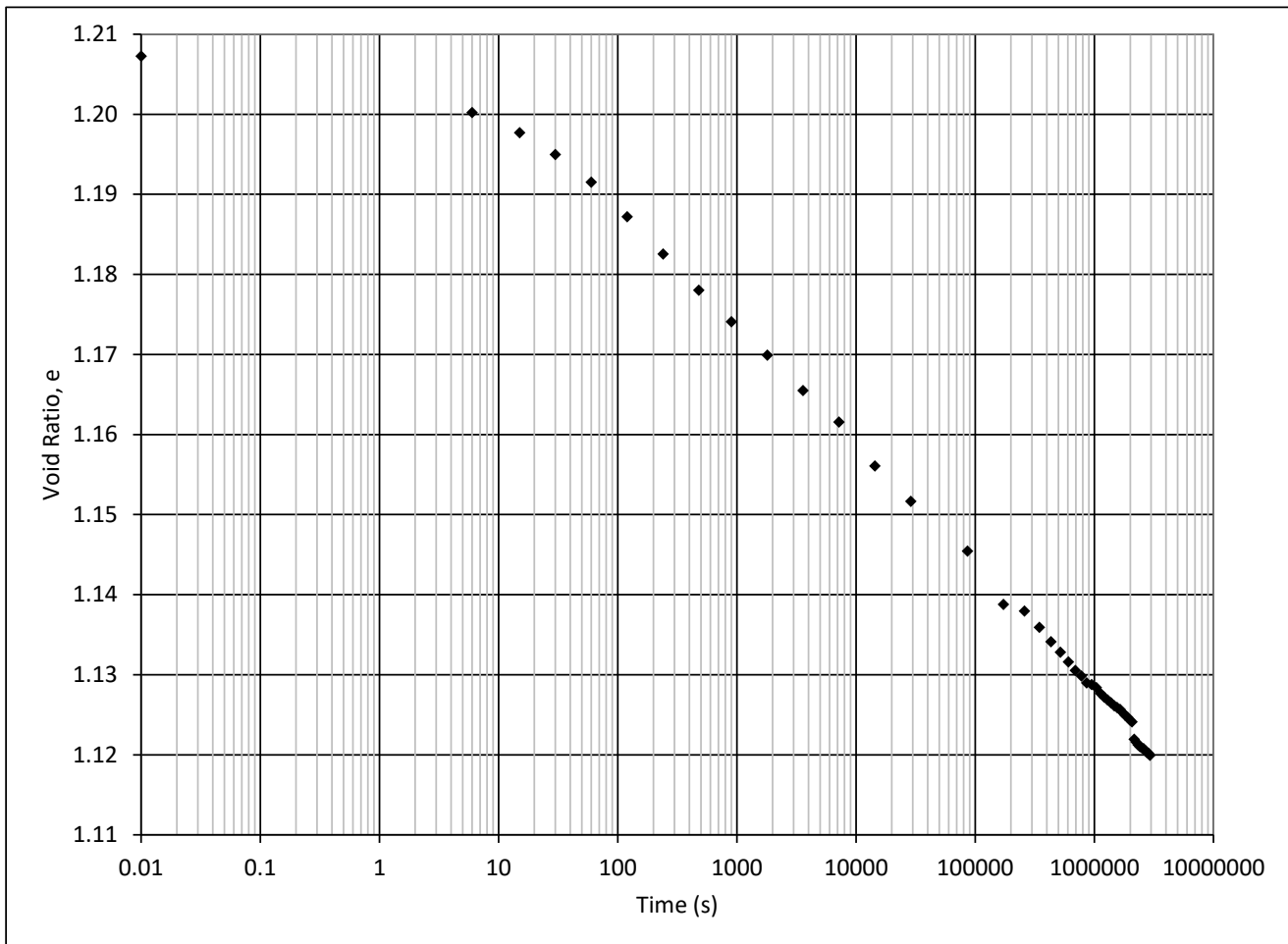
**Thurber Engineering, File# 23411**  
**122410864**  
**BH19-2A**  
**TW 5**  
**18-20 ft.**  
**320.1 kPa**





**Project**  
**Project No.**  
**Borehole No.**  
**Sample No.**  
**Sample Depth**  
**Axial Stress**

**Thurber Engineering, File# 23411**  
**122410864**  
**BH19-2A**  
**TW 1**  
**10-12 ft.**  
**159.5 kPa**



September 11, 2019

CRS Test

BH 19-2A

Sample #1

Depth: 16-18'

Strain rate started at 3%/hr

Saturation pressure 500kPa Saturate over 120min

Consolidation pressure 500kPa

Maximum Stress 640kPa

Creep 1440 min

Height of sample = 25.38mm

Sample diameter = 49.7mm

Sample weight = 77.79g

Initial moisture content = 64.29%

Final moisture content = 43.21%

Tested by Melodie Richards



October 2, 2019

CRS Test

BH 19-2A

Sample #2

Depth: 16-18'

Strain rate started at 0.1%/hr

Saturation pressure 500kPa Saturate over 120min

Consolidation pressure 500kPa

Maximum Stress 400kPa

Creep 1440 min

Height of sample = 25.38mm

Sample diameter = 49.7mm

Sample weight = 78.2g

Initial moisture content = 57.44%

Final moisture content = 44.60%

Tested by Melodie Richards

September 23, 2019

CRS Test

BH 19-2A

Sample #3

Depth: 20-22'

Strain rate started at 1%/hr

Saturation pressure 500kPa Saturate over 120min

Consolidation pressure 500kPa

Maximum Stress 640kPa

Creep 1440 min

Height of sample = 25.38mm

Sample diameter = 49.7mm

Sample weight = 89.23g

Initial moisture content = 46.46%

Final moisture content = 31.41%

Tested by Melodie Richards

September 23, 2019

CRS Test

BH 19-2A

Sample #4

Depth: 20-22'

Strain rate started at 0.3%/hr

Saturation pressure 500kPa Saturate over 120min

Consolidation pressure 500kPa

Maximum Stress 640kPa

Creep 1440 min

Height of sample = 25.38mm

Sample diameter = 49.7mm

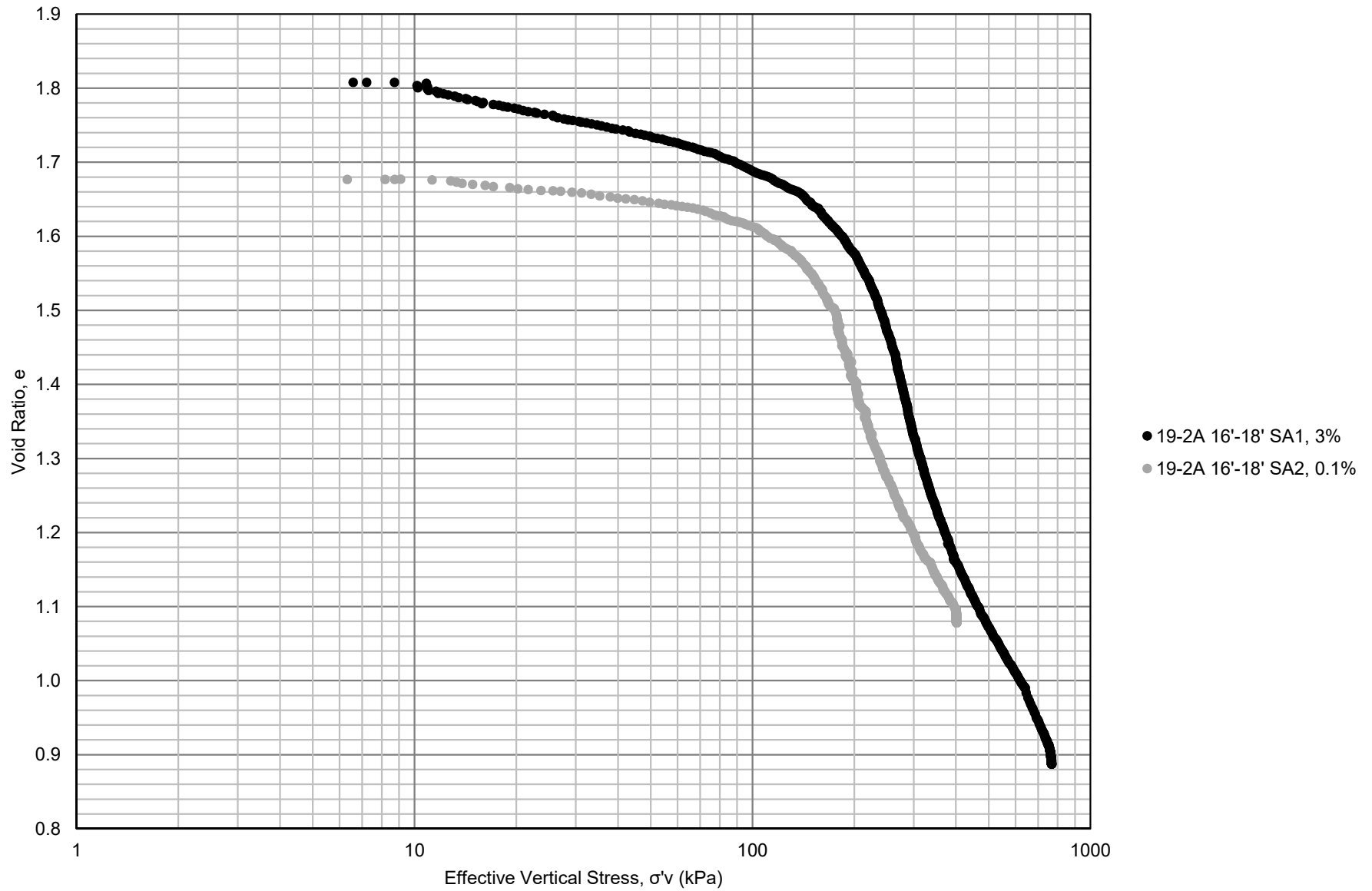
Sample weight = 88.94g

Initial moisture content = 42.87%

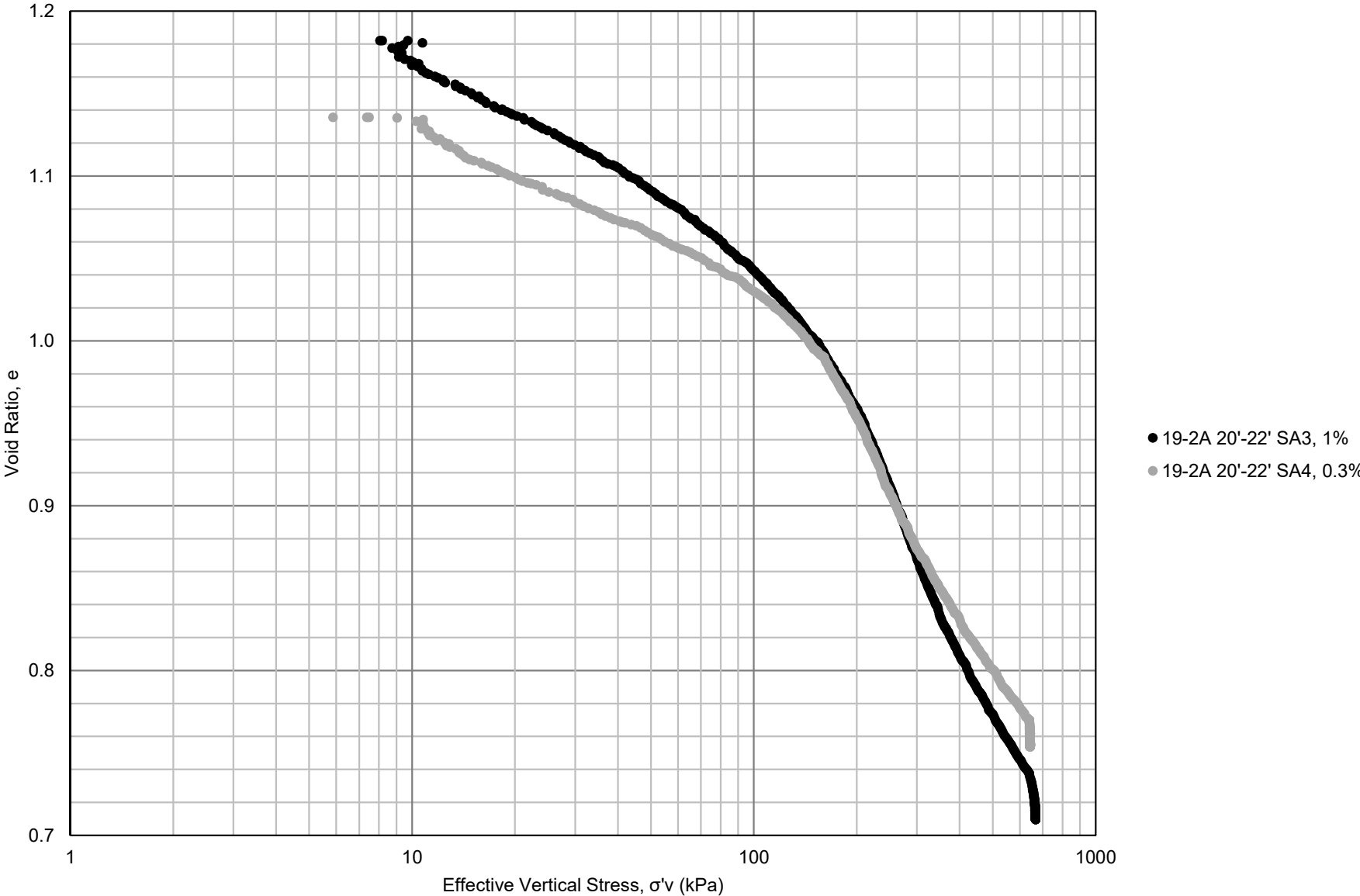
Final moisture content = 31.82%

Tested by Melodie Richards

Laronde Creek Bridge  
Constant Rate of Strain (CRS) Consolidation Test Results  
19-2A 16'-18' SA1 and 2



Laronde Creek Bridge  
Constant Rate of Strain (CRS) Consolidation Test Results  
19-2A 20'-22' SA3 and 4



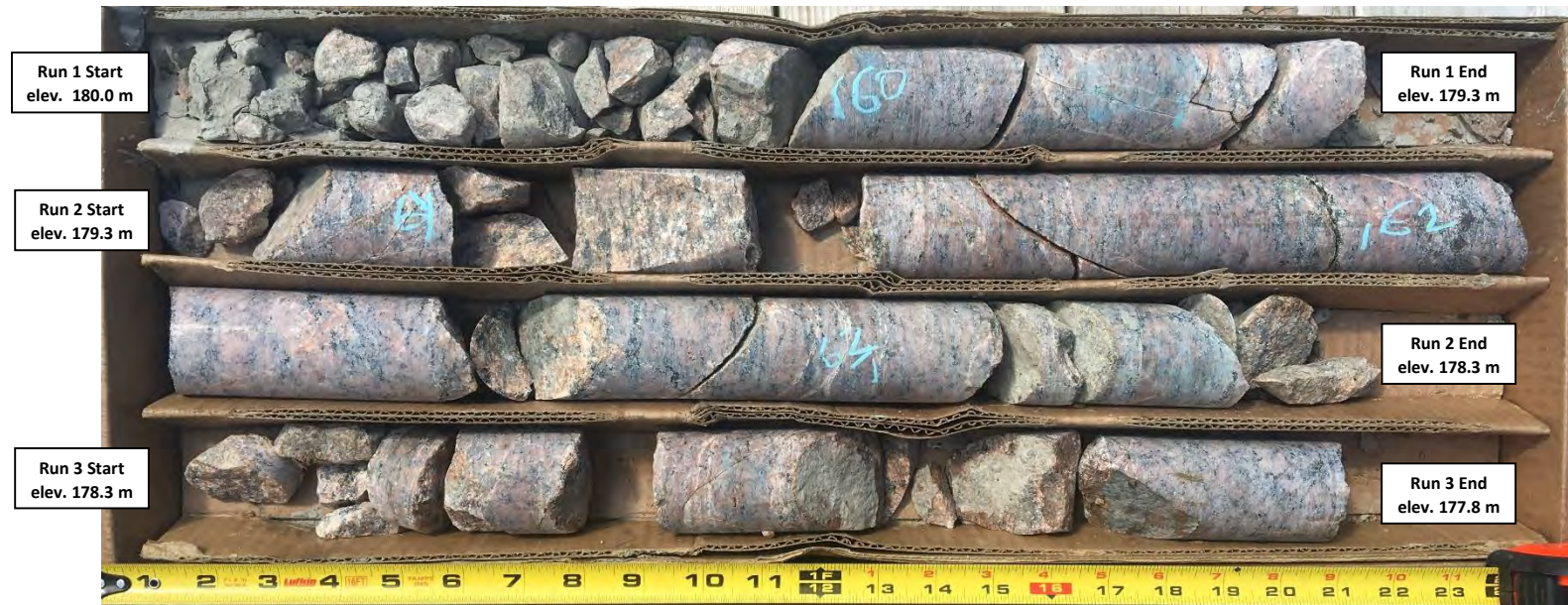


**Appendix C.3**

**Rock Core Photos**  
**Rock Core Testing Results**



**Borehole 19-03**  
**Run 1 to 3**  
**Elevation 179.9 m to 630.29 m**





**Stantec**

**Stantec Consulting Ltd**  
2781 Lancaster Rd, Suite 100 A&B  
Ottawa, ON K1B 1A7  
Tel: (613) 738-6075  
Fax: (613) 722-2799

September 10, 2019  
File: 122410864

**Attention:** Thurber Engineering, File #23411

**Reference:** ASTM D7012, Method C, Unconfined Compressive Strength of Intact Rock Core  
Highway 17 Laronde

The following table summarizes two rock core compressive strength results.

Location	Sample Depth	Compressive Strength (MPa)	Description of Break
19-3 UCS-3	62'3"-62'7"	146.6	Well-formed cones at both ends
19-3 UCS-2	62'8"-63'2"	162.1	Well-formed cones at both ends

Sincerely,

**Stantec Consulting Ltd**

*Brian Prevost*

Brian Prevost  
Laboratory Supervisor  
Tel: 613-738-6075  
[brian.prevost@stantec.com](mailto:brian.prevost@stantec.com)



**Appendix C.4**  
**Analytical Testing Results**

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO:

Report Date: 06-Sep-2019

Order Date: 3-Sep-2019

Project Description: 23411(Laronde)

<b>Client ID:</b>	19-2B SS2 2'6"-4'-6"	19-2B SS4 7'6"-9'-6"	19-3 SS5 8'-10'	19-3 SS8 20'-22'
<b>Sample Date:</b>	14-Aug-19 09:00	14-Aug-19 09:00	16-Aug-19 09:00	17-Aug-19 09:00
<b>Sample ID:</b>	1936023-01	1936023-02	1936023-03	1936023-04
<b>MDL/Units</b>	Soil	Soil	Soil	Soil

**Physical Characteristics**

% Solids	0.1 % by Wt.	87.7	65.7	74.8	69.9
----------	--------------	------	------	------	------

**General Inorganics**

Conductivity	5 uS/cm	62	637	228	228
pH	0.05 pH Units	7.68	7.70	7.77	8.09
Resistivity	0.10 Ohm.m	153	15.7	43.9	43.9

**Anions**

Chloride	5 ug/g dry	9	231	9	5
Sulphate	5 ug/g dry	<5	14	28	24

**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

13-September-2019

**Date Rec. :** 10 September 2019

**LR Report:** CA12210-SEP19

**Reference:** Project#: 1936023

**Copy:** #1

## CERTIFICATE OF ANALYSIS

### Final Report

Sample ID	Sample Date & Time	Sulphide %
1: Analysis Start Date		13-Sep-19
2: Analysis Start Time		13:06
3: Analysis Completed Date		13-Sep-19
4: Analysis Completed Time		13:21
5: QC - Blank		< 0.02
6: QC - STD % Recovery		115%
7: QC - DUP % RPD		ND
8: RL		0.02
9: 19-2B SS2 2'6"-4'6"	14-Aug-19	0.02
10: 19-2B SS4 7'6"-9'6"	14-Aug-19	0.02
11: 19-2B SS5 8'-10'	16-Aug-19	0.02
12: 19-3 SS8 20'-22'	17-Aug-19	< 0.02

RL - SGS Reporting Limit  
ND - Not Detected

Kimberley Didsbury  
Project Specialist,  
Environment, Health & Safety



**Appendix D.**  
**Site Photographs**





Photo 1: General view of bridge, looking west [October 26, 2018]



Photo 2: General view of bridge, looking east [October 26, 2018]



Photo 3: View of southwest gabion wall and west abutment [October 26, 2018]



Photo 4: View of southeast gabion wall and east abutment [October 26, 2018]





Photo 5: Erosion undermining sidewalk crib footing [October 26, 2018]



Photo 6: Southeast gabion retaining wall [October 26, 2018]





Photo 7: Tension crack above east abutment, note ponding on approach [October 26, 2018]



Photo 8: Tension crack above west abutment, note ponding on approach [October 26, 2018]





Photo 9: Newer asphalt padding on east approach [October 26, 2018]



Photo 10: Newer asphalt padding on west approach [October 26, 2018]





Photo 11: Erosion along northwest wing wall [October 26, 2018]



Photo 12: Piezometer installed in 1998 with active artesian flow [October 26, 2018]





Photo 13: View of east bank on north side of the bridge [October 26, 2018]

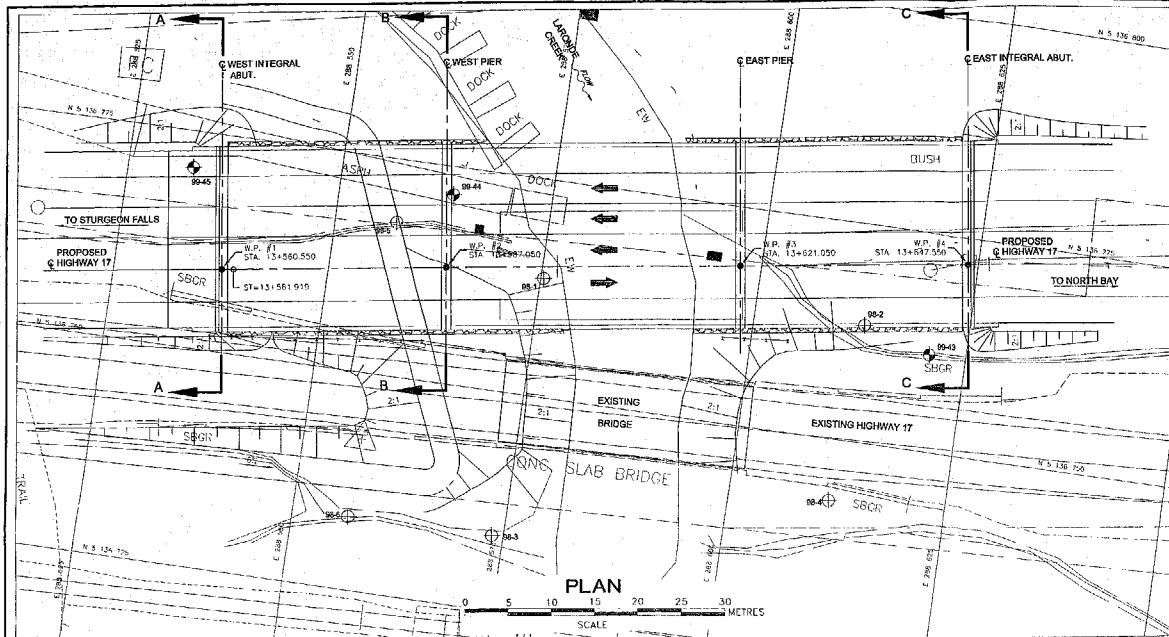


Photo 14: View of west bank on north side of the bridge [October 26, 2018]



## **Appendix E.**

### **Factual Subsurface Information from GEOCRES Reports**



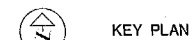
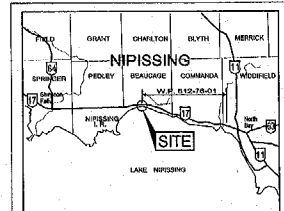
**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT. No.  
WP No. 812-76-02

LARONDE CREEK BRIDGE  
BOREHOLE LOCATIONS & SOIL STRATA



Golder Associates Ltd.  
MISSISSAUGA, ONTARIO, CANADA



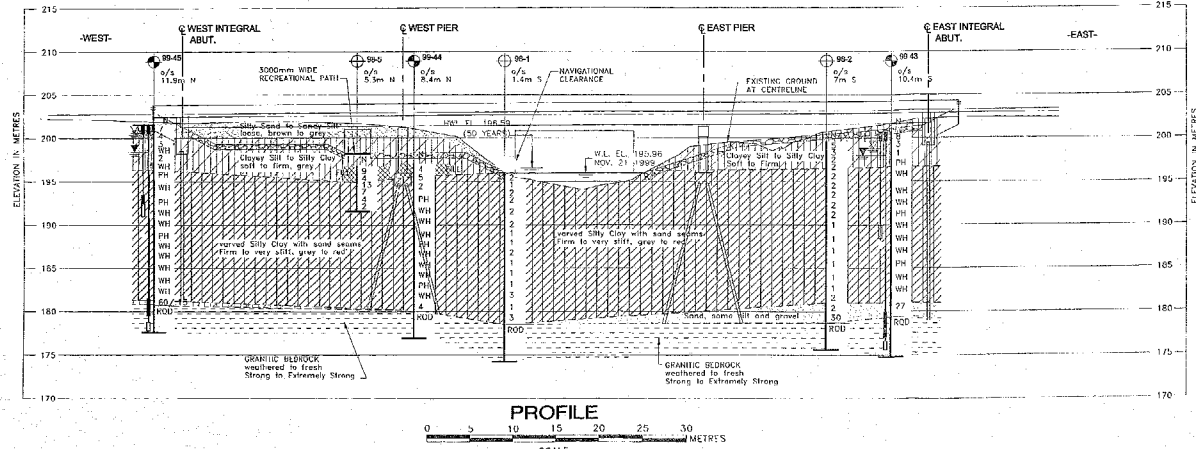
- LEGEND**
- 99-43 Borehole by Golder Associates (current investigation)
  - 99-51 Borehole by Thurber Engineering Ltd. (Report Dated March 1988)
  - Seal
  - Piezometer
  - N Standard Penetration Test value
  - Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 l/blow)
  - 100% Rock Quality Designation (RQD)
  - WL in deep piezometer on Oct. 3, 1989
  - WL in shallow piezometer on Oct. 3, 1999

No.	ELEVATION	NORTHING	EASTING
99-43	200.78	5156761	288620.6
99-44	187.04	5136772	288563.5
99-45	201.57	5136771	288532.6
98-1	196.80	5136764	288575.3
98-2	199.80	5136763	288612.7
98-3	197.50	5136754	288575.7
98-4	201.40	5136754	288611.5
98-5	N/A	5136768	288557.3
98-6	N/A	5136733	288556.5

**REFERENCE**  
This drawing was created from digital files provided by McCannick Barker Corp.

**NOTES**

1. the boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2. For detailed Stratigraphy of Borehole locations refer to Record of Borehole Sheets.



No.	DATE	BY	REVISION
Geocres No. 311	70		
HWY. No. 17			PROJECT NO. 991-1164
SUBM. D. 0/0	CHD. D. 0/0	APP. 0/0	DATE 1999.10.12
DRWING 0/0	CHD. D. 0/0	APP. 0/0	SITE 43 - 65
			FIGURE 2A

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

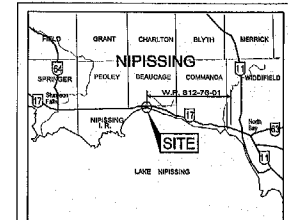
CONT. No.  
WP No. 812-76-02

LARONDE CREEK BRIDGE  
CROSS-SECTIONS  
BOREHOLE LOCATIONS & SOIL STRATA

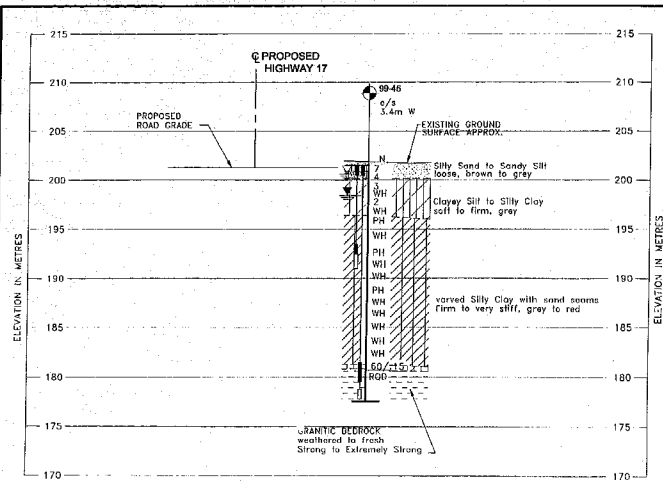
SHEET



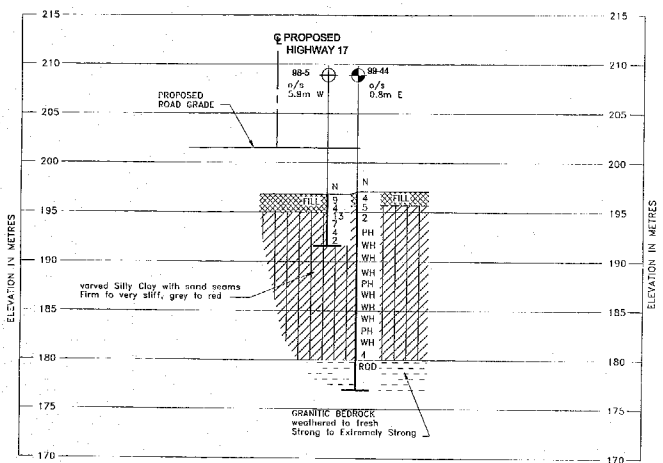
Golden Associates Ltd.  
MISSISSAUGA, ONTARIO, CANADA



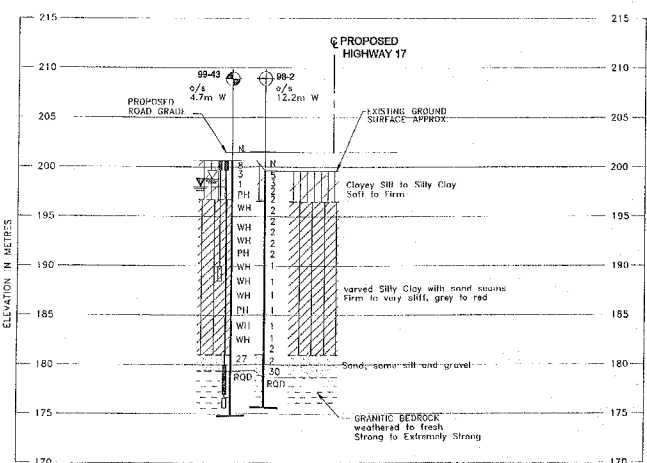
KEY PLAN



**SECTION A-A  
WEST INTEGRAL ABUT.**  
SCALE



**SECTION B-B  
WEST PIER**  
SCALE



**SECTION C-C  
EAST INTEGRAL ABUT.**  
SCALE

**LEGEND**

- 99-43 Borehole by Golden Associates (current investigation)
- 88-1 Borehole by Thwiber Engineering Ltd. (Report Dated March 1999)
- Seal
- Piezometer
- N Standard Penetration Test value
- 15 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 J/Blow)
- ROD Rock Quality Designation (ROD)
- WL In deep piezometer on Oct. 3, 1999
- WL In shallow piezometer on Oct. 3, 1999

**LOCATION**

No.	ELEVATION	NORTHING	EASTING
99-43	200.70	5136761	288520.6
99-44	197.04	5136772	288563.5
99-45	201.57	5136771	288532.6
98-1	196.80	5136764	288575.3
88-2	199.60	5136763	288612.7
98-3	197.50	5136734	288573.7
98-4	201.40	5136734	288611.5
98-5	N/A	5136760	288557.3
98-6	N/A	5136733	288556.5

**REFERENCE**

This drawing was created from digital files provided by McCordick Smith Corp.

**NOTES**

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- For detailed Stratigraphy at Borehole locations refer to Record of Borehole Sheets.

NO.	DATE	BY	REVISION
Geocres No. 31L - 70			
HWY. No. 17	PROJECT NO. 99-1154	DIST. 54	
SUBV'D. BYB	CHKD. DES	DATE: 2000 08 27	SITE 43 - 65
DRAWN: JFC	CHKD. EWB	APPD.	FIGURE 2N



ON\_MOT 991-1164.GPJ ON\_MOT.GDT 27/6/00

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3</sup>% STRAIN AT FAILURE

PROJECT 991-1164				RECORD OF BOREHOLE No 99-43				2 OF 2		METRIC						
W.P. 812-76-01		LOCATION N 5136761.07, E 288620.59 (Laronde Creek, Site 43-65)				ORIGINATED BY DRS										
DIST 54 HWY 17		BOREHOLE TYPE Bombardier CME-55				COMPILED BY BVB										
DATUM Geodetic		DATE 10/2/1999				CHECKED BY DEB										
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 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED								
— CONTINUED FROM PREVIOUS PAGE —																
	Varved Silty Clay, sand seams Firm to stiff Grey to red		12	75 TO	PH		185									
			13	50 DO	WH		184									
			14	50 DO	WH		183									
							182									
181.12							181									
19.66	Sand, some silt and gravel Compact Grey to red		15	50 DO	27		180									
179.50							179									
21.28	Granitic Bedrock Weathered Strong to very strong becoming extremely strong with depth						178									
							177									
							176									
174.93	For bedrock coring details refer to Record of Drillhole 99-43.						175									
25.85	END OF BOREHOLE															
	Notes: Water levels in shallow and deep piezometers at Elev. 198.8m and Elev. 198.0m, respectively on Oct. 3/99.															

ON\_MOT 991-1164.GPJ ON\_MOT.GDT 27/8/00

PROJECT: 991-1164

## RECORD OF DRILLHOLE: 99-43

SHEET 1 OF 1

LOCATION: N 5136761.07; E 288620.59

DRILLING DATE: 10/3/1999

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Bombardier CME-55

DRILLING CONTRACTOR:

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	COLOUR FLUSH % RETURN	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SUCKEN SIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	BC-BROKEN CORE MB-MECH. BREAK B-BEDDING	DIAMETER POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
20		CONTINUED FROM PREVIOUS PAGE		180.78 20.00										
21				179.50 21.28										
22		Granitic Bedrock, weathered Strong to very strong			1		100							
23					2		100							
24				176.46 24.32										
25		Granitic Bedrock, fresh Very to Extremely Strong			3		100							
26		END OF BOREHOLE		174.93 25.85										
27														
28														
29														
30														

DEPTH SCALE

1 : 50



LOGGED: DRS

CHECKED: BVB

DRILLHOLE 1164 ROCK GPJ CLDR CAN GDT 8/2/00

ON MOT 991-1164.GPJ ON MOT.GDT 27/6/00

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

PROJECT 991-1164		RECORD OF BOREHOLE No 99-44		2 OF 2		METRIC															
W.P. 812-76-01		LOCATION N 5136771.75; E 288563.47 (Laronde Creek, Site 43-65)		ORIGINATED BY DRS																	
DIST 54 HWY 17		BOREHOLE TYPE Bombardier CME-55		COMPILED BY BVB																	
DATUM Geodetic		DATE 9/29/1999		CHECKED BY DEB																	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED					WATER CONTENT (%)			γ			GR SA SI CL		
--- CONTINUED FROM PREVIOUS PAGE ---																					
180.12	Varved Silty Clay, sand seams Firm to stiff Grey to red		13	50 DO	WH		181														
176.92	Sand, some silt, some gravel, trace clay Loose Grey Granitic Bedrock Fresh Very to extremely strong		14	50 DO	4		180														
170.7							179														
							178														
176.92	For bedrock coring details refer to Record of Drillhole 99-44.						177														
20.12	END OF BOREHOLE																				

ON\_MOT 991-1164 GPJ ON\_MOT.GDT 27/6/00

PROJECT: 991-1164

## RECORD OF DRILLHOLE: 99-44

SHEET 1 OF 1

LOCATION: N 5136771.75; E 288563.47

DRILLING DATE: 10/30/1999

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Bombardier CME-55

DRILLING CONTRACTOR:

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	PENETRATION RATE (mm/min)	RUN No.	FLUSH	COLOUR % RETURN	FR-FRACTURE		F-FAULT		SM-SMOOTH		FL-FLEXURED		BC-BROKEN CORE		DIAMETRAL INDEX (IPR)	NOTES WATER LEVELS INSTRUMENTATION
									CL-CLEAVAGE		J-JOINT		R-ROUGH		UE-UNEVEN		MB-MECH. BREAK			
									SH-SHEAR		P-POLISHED		ST-STEPPED		W-WAVY		B-BEDDING			
									VN-VEIN		S-SLICKENSIDED		PL-PLANAR		C-CURVED					
RECOVERY		R.Q.D. %		FRACT. INDEX PER 0.3		DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY k, cm/sec												
TOTAL CORE %		SOLID CORE %				DIP w.r.t. CORE AXIS		TYPE AND SURFACE DESCRIPTION												
8 8 8 8		8 8 8 8		8 8 8 8		8 8 8 8		8 8 8 8		8 8 8 8										
15		CONTINUED FROM PREVIOUS PAGE		182.04 15.00																
16																				
17		Granitic Bedrock, fresh Very to Extremely Strong		179.97 17.07																
18																				
19																				
20																				
21		END OF BOREHOLE		176.92 20.12																
22																				
23																				
24																				
25																				

DRILLHOLE 1164 ROCK GPJ GLDR CAN GDT 8/2/00

DEPTH SCALE

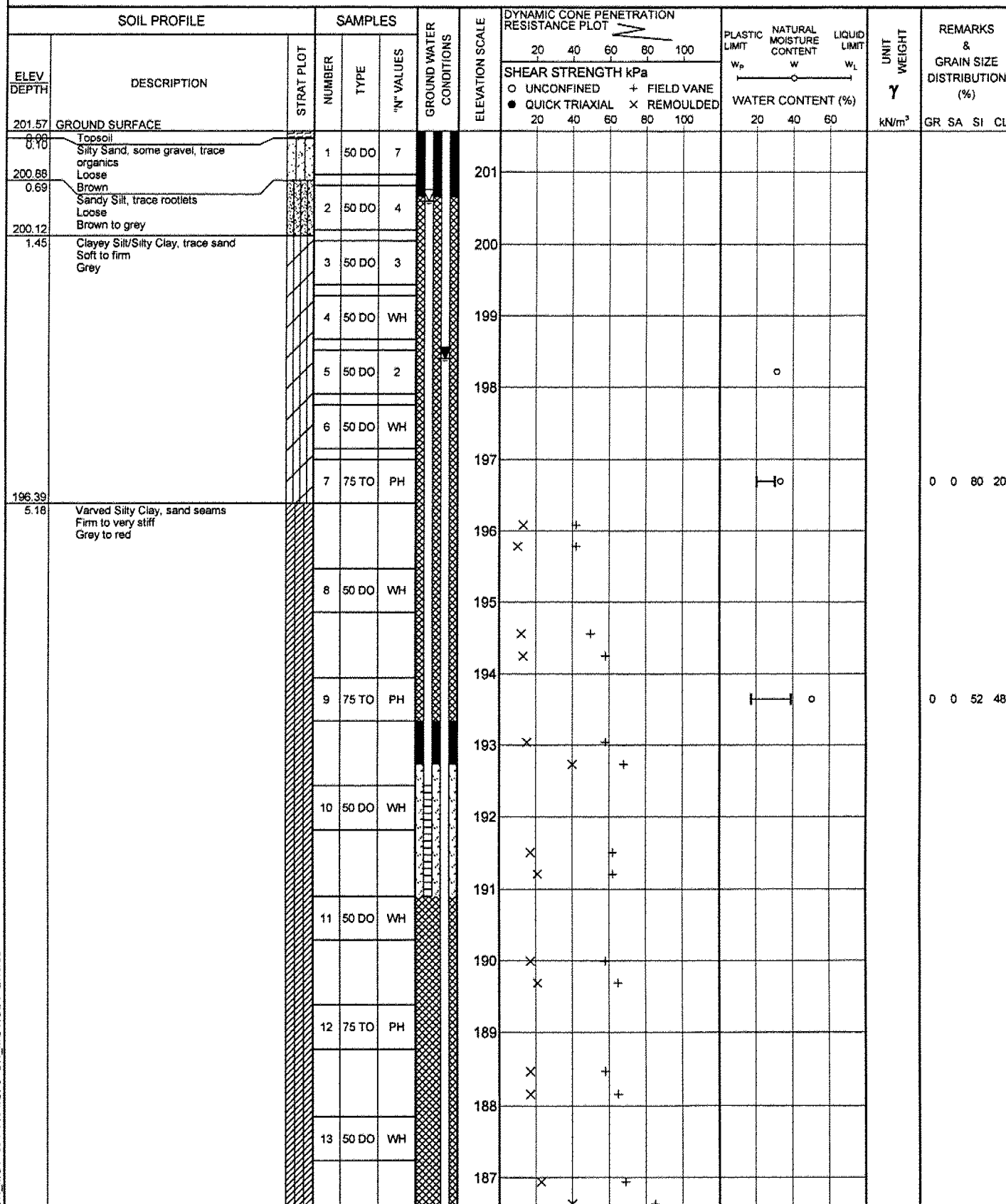
1 : 50



LOGGED: DRS

CHECKED: BVB

PROJECT <u>991-1164</u>		<b>RECORD OF BOREHOLE No 99-45</b>		1 OF 2 <b>METRIC</b>	
W.P. <u>812-76-01</u>		LOCATION <u>N 5136770.75; E 288532.60 (Laronde Creek, Site 43-65)</u>		ORIGINATED BY <u>DRS</u>	
DIST <u>54</u> HWY <u>17</u>		BOREHOLE TYPE <u>Bombardier CME-55</u>		COMPILED BY <u>BVB</u>	
DATUM <u>Geodetic</u>		DATE <u>9/27/1999</u>		CHECKED BY <u>DEB</u>	



ON MOT 991-1164.GPJ ON MOT.GDT 27/6/00

Continued Next Page

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON MOT 991-1164.GPJ ON MOT.GDT 27/6/00

+3, X3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



PROJECT: 991-1164

## RECORD OF DRILLHOLE: 99-45

SHEET 1 OF 1

LOCATION: N 5136770.75; E 288532.60


DRILLING DATE: 9/28/1999

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Bombardier CME-55

DRILLING CONTRACTOR:

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.		RUN No.	PENETRATION RATE (mm/min)	FLUSH COLOUR % RETURN	FR-FRACTURE		F-FAULT		SM-SMOOTH		FL-FLEXURED		BC-BROKEN CORE		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION	
				DEPTH (m)	VEIN				CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN	MB-MECH. BREAK	B-BEDDING							
															SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY			B-BEDDING
RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY k, cm/sec															
TOTAL CORE %	SOLID CORE %			DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	10 <sup>-4</sup>	10 <sup>-3</sup>	10 <sup>-2</sup>	10 <sup>-1</sup>												
20		CONTINUED FROM PREVIOUS PAGE		181.57 20.00																	
21	NQ Core	Granitic Bedrock, fresh Very to Extremely Strong		1	100																
22				2	100																
23				3	100																
24		END OF BOREHOLE		177.55 24.02																	
25																					
26																					
27																					
28																					
29																					
30																					

DEPTH SCALE

1 : 50



LOGGED: DRS

CHECKED: BVB

DRILLHOLE 1164 ROCK GPJ GLDR CAN.GDT 8/2/00

TABLE B1

## SUMMARY OF WATER CONTENT, ATTERBERG LIMITS AND SPECIFIC GRAVITY DETERMINATIONS

PROJECT NUMBER		991-1164			
PROJECT NAME		McCormick Rankin / Highway 17 / North Bay			
DATE TESTED		October/November, 1999			
Borehole No.	Sample No.	Depth (m)	Water Content (%)	Atterberg Limits Wl, Wp, Ip	Specific Gravity
99-43	3	1.52-2.13	10.0		
99-43	5	3.05-3.66	30.2		
99-43	8	6.10-6.71	22.6		
99-44	6	4.57-5.18	55.4		
99-44	11	12.19-12.80	41.2	Wl=28.6, Wp=16.0, Ip=12.6	
99-45	5	3.05-3.51	31.1		
99-45	7	4.57-5.18	33.0	Wl=30.1, Wp=20.1, Ip=10.0	2.70
99-45	9	7.62-8.08	50.3	Wl=38.8, Wp=17.2, Ip=21.6	2.66
99-46	3	1.52-2.13	34.3	Wl=30.6, Wp=19.5, Ip=11.1	
99-46	7	7.62-8.23	56.9	Wl=47.7, Wp=21.4, Ip=26.3	
99-46	14	18.29-18.90	41.4		

Notes: Specific gravity test carried out using distilled water.

Wl = Liquid Limit

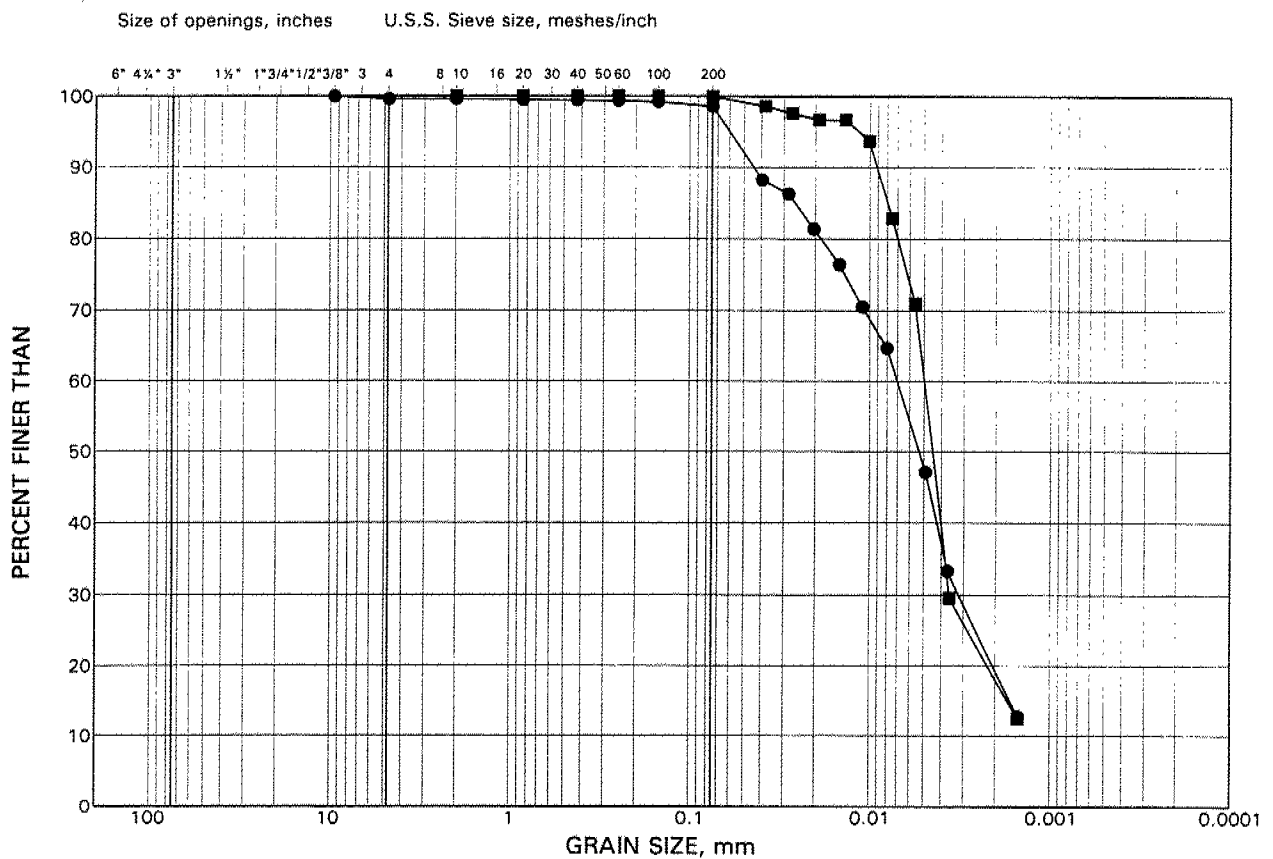
Wp = Plastic Limit

Ip = Plasticity Index

# GRAIN SIZE DISTRIBUTION

Clayey Silt / Silty Clay trace sand

FIGURE B1



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

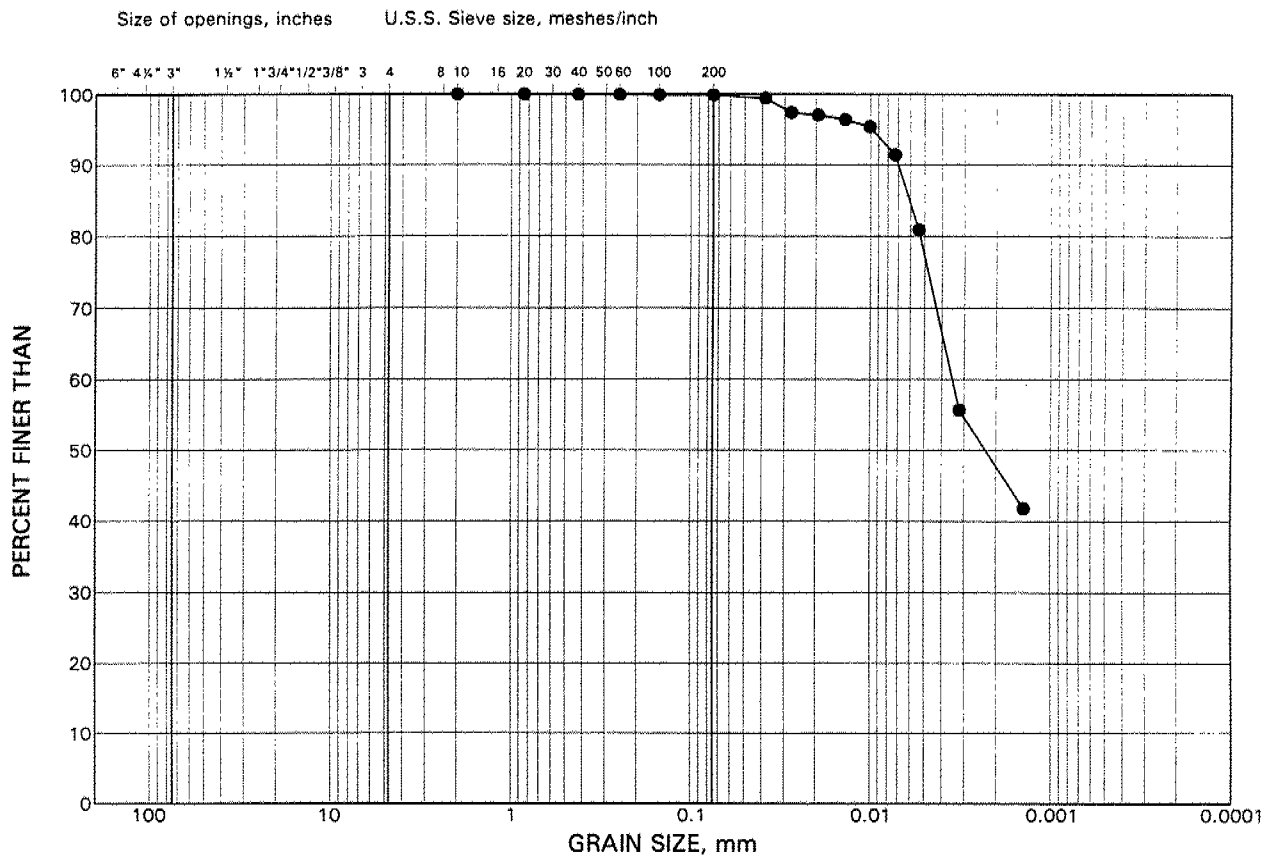
## LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	99-43	3	2.1
■	99-45	7	-

# GRAIN SIZE DISTRIBUTION

Varved Silty Clay

FIGURE B2



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

## LEGEND

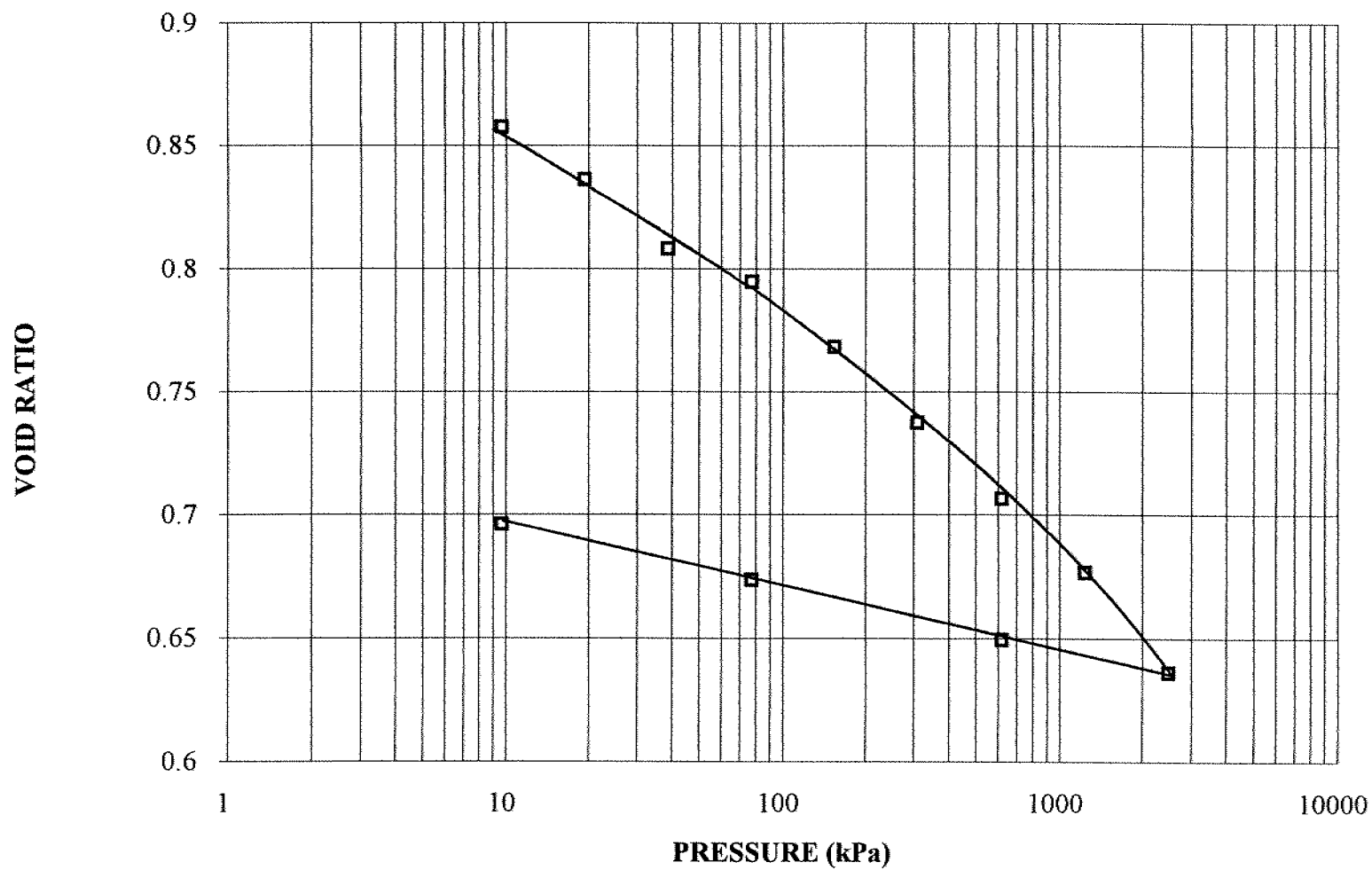
SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
--------	----------	--------	----------

•

99-45

9

CONSOLIDATION TEST  
VOID RATIO vs LOG. PRESSURE  
BH 99-45 SA 7



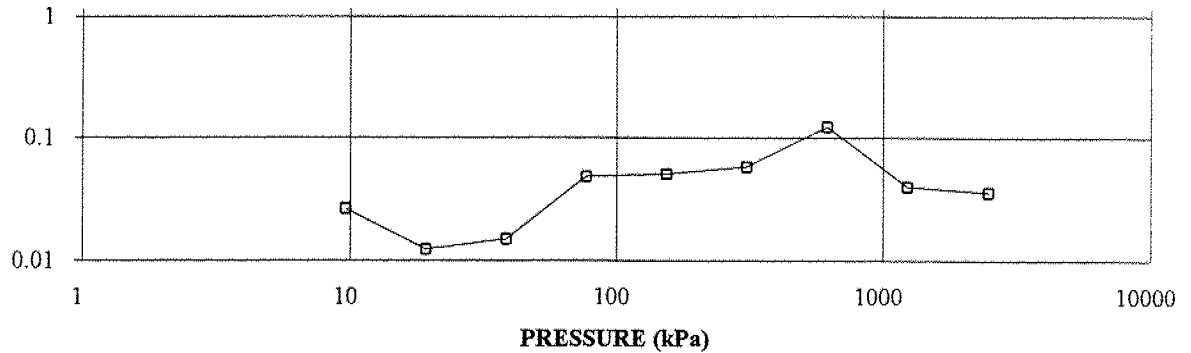
CONSOLIDATION TEST  
VOID RATIO VS. LOG PRESSURE

FIGURE B3

# OEDOMETER CONSOLIDATION SUMMARY

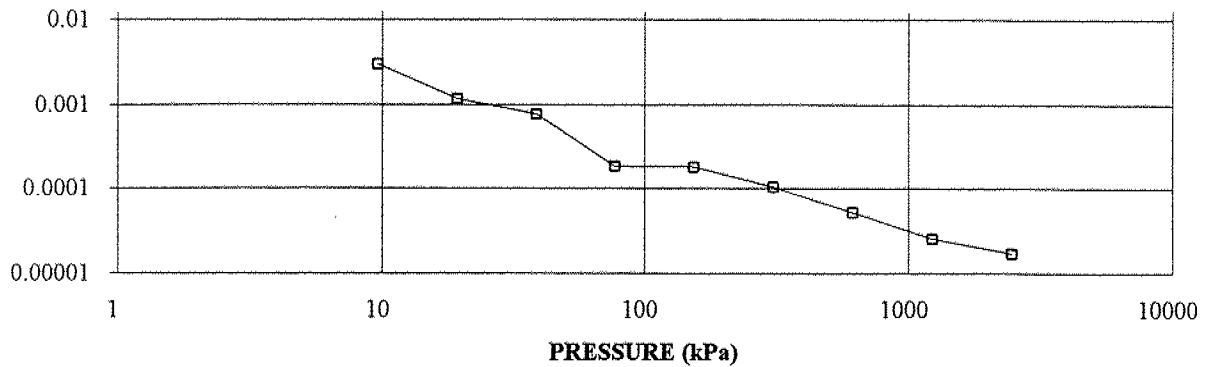
COEFFICIENT OF CONSOLIDATION,  $\text{cm}^2/\text{s}$

CONSOLIDATION TEST  
LOG.  $\text{cv cm}^2/\text{s}$  vs LOG. PRESSURE (kPa)  
BH 99-45 SA 7



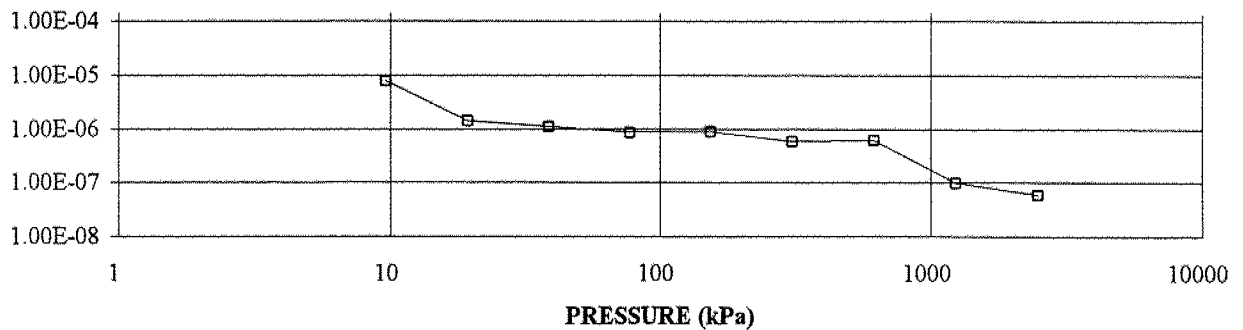
VOLUME  
COMPRESSIBILITY,  
 $\text{m}^2/\text{kN}$

CONSOLIDATION TEST  
LOG.  $\text{mv, m}^2/\text{kN}$  vs LOG. PRESSURE (kPa)  
BH 99-45 SA 7



HYDRAULIC  
CONDUCTIVITY,  $\text{cm/s}$

CONSOLIDATION TEST  
HYDRAULIC CONDUCTIVITY vs LOG. PRESSURE  
BH 99-45 SA 7



## OEDOMETER CONSOLIDATION SUMMARY

### SAMPLE IDENTIFICATION

Project Number	991-1164	Sample Number	7
Borehole Number	99-45	Sample Depth, m	4.6-5.2

### TEST CONDITIONS

Test Type	Quick /Standard	Load Duration, hr	(0.10 - 22)
Oedometer Number	7		
Date Started	99-10-08		
Date Completed	99-10-09		

### SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.88	Unit Weight, kN/m <sup>3</sup>	18.64
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m <sup>3</sup>	13.84
Area, cm <sup>2</sup>	31.67	Specific Gravity, measured	2.70
Volume, cm <sup>3</sup>	59.63	Solids Height, cm	0.984
Water Content, %	34.72	Volume of Solids, cm <sup>3</sup>	31.17
Wet Mass, g	113.37	Volume of Voids, cm <sup>3</sup>	28.47
Dry Mass, g	84.15	Degree of Saturation, %	102.6

### TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	1.883	0.913	1.883				
9.66	1.828	0.858	1.856	28	2.61E-02	3.02E-03	7.71E-06
19.31	1.807	0.836	1.818	57	1.23E-02	1.15E-03	1.39E-06
38.63	1.779	0.808	1.793	46	1.48E-02	7.62E-04	1.11E-06
77.25	1.766	0.795	1.773	14	4.76E-02	1.83E-04	8.53E-07
154.50	1.740	0.768	1.753	13	5.01E-02	1.79E-04	8.81E-07
309.00	1.710	0.737	1.725	11	5.73E-02	1.04E-04	5.85E-07
618.00	1.679	0.706	1.694	5	1.22E-01	5.24E-05	6.25E-07
1236.00	1.650	0.676	1.664	15	3.92E-02	2.54E-05	9.73E-08
2471.99	1.610	0.636	1.630	16	3.52E-02	1.70E-05	5.87E-08
618.00	1.623	0.649	1.617				
77.25	1.647	0.673	1.635				
9.66	1.669	0.696	1.658				

Notes:

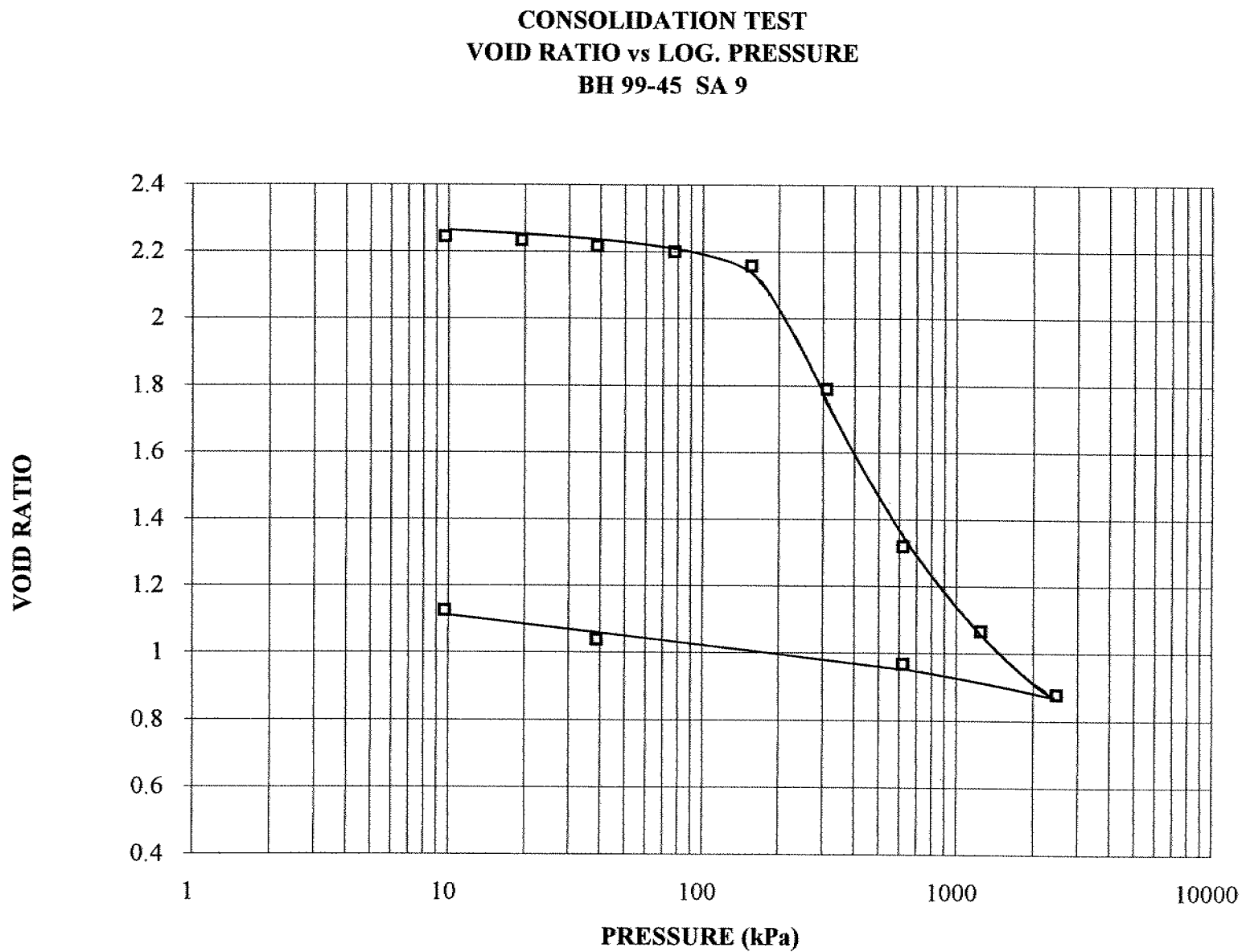
k calculated using cv based on t<sub>90</sub> values.

### SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.67	Unit Weight, kN/m <sup>3</sup>	19.84
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m <sup>3</sup>	15.61
Area, cm <sup>2</sup>	31.67	Specific Gravity, measured	2.70
Volume, cm <sup>3</sup>	52.86	Solids Height, cm	0.984
Water Content, %	27.11	Volume of Solids, cm <sup>3</sup>	31.17
Wet Mass, g	106.96	Volume of Voids, cm <sup>3</sup>	21.69
Dry Mass, g	84.15		

CONSOLIDATION TEST  
VOID RATIO VS. LOG PRESSURE

FIGURE B4

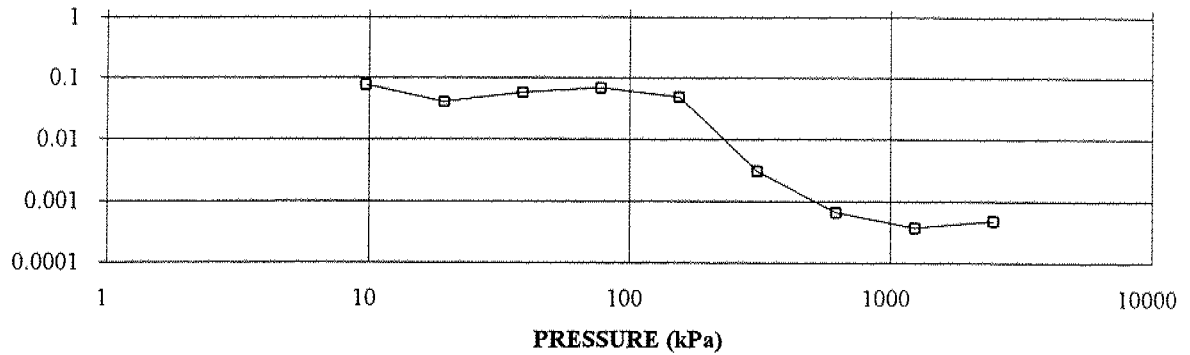




# OEDOMETER CONSOLIDATION SUMMARY

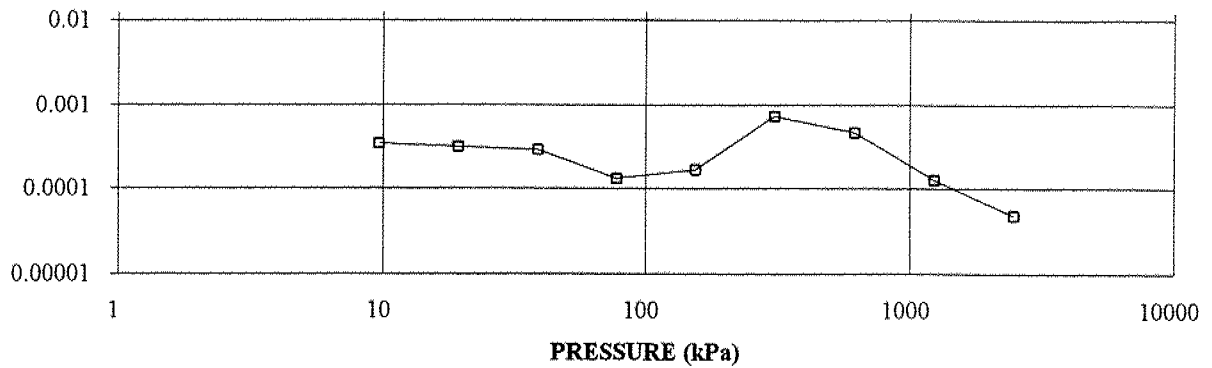
COEFFICIENT OF CONSOLIDATION,  $\text{cm}^2/\text{s}$

CONSOLIDATION TEST  
LOG.  $c_v$   $\text{cm}^2/\text{s}$  vs LOG. PRESSURE (kPa)  
BH 99-45 SA 9



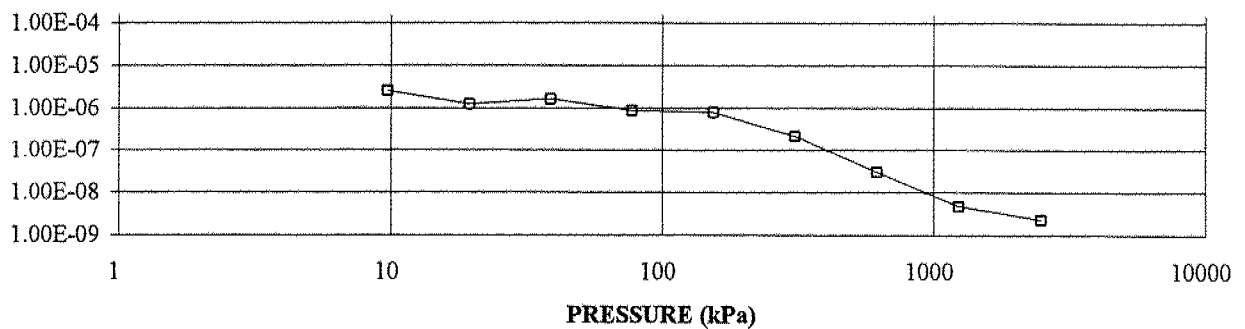
VOLUME  
COMPRESSIBILITY,  
 $\text{m}^2/\text{kN}$

CONSOLIDATION TEST  
LOG.  $m_v$ ,  $\text{m}^2/\text{kN}$  vs LOG. PRESSURE (kPa)  
BH 99-45 SA 9



HYDRAULIC  
CONDUCTIVITY,  $\text{cm}/\text{s}$

CONSOLIDATION TEST  
HYDRAULIC CONDUCTIVITY vs LOG. PRESSURE  
BH 99-45 SA 9



# OEDOMETER CONSOLIDATION SUMMARY

## SAMPLE IDENTIFICATION

Project Number	991-1164	Sample Number	9
Borehole Number	99-45	Sample Depth, m	7.9

## TEST CONDITIONS

Test Type	Quick /Standard	Load Duration, hr	(0.13 - 22)
Oedometer Number	6		
Date Started	99-10-07		
Date Completed	99-10-08		

## SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.90	Unit Weight, kN/m <sup>3</sup>	14.88
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	8.02
Area, cm <sup>2</sup>	31.52	Specific Gravity, measured	2.66
Volume, cm <sup>3</sup>	59.92	Solids Height, cm	0.584
Water Content, %	85.63	Volume of Solids, cm <sup>3</sup>	18.41
Wet Mass, g	90.92	Volume of Voids, cm <sup>3</sup>	41.51
Dry Mass, g	48.98	Degree of Saturation, %	101.0

## TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv, cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	1.901	2.254	1.901				
9.70	1.895	2.243	1.898	10	7.64E-02	3.42E-04	2.56E-06
19.40	1.889	2.233	1.892	19	3.99E-02	3.14E-04	1.23E-06
38.81	1.878	2.215	1.884	13	5.79E-02	2.90E-04	1.64E-06
77.62	1.869	2.199	1.873	11	6.76E-02	1.30E-04	8.63E-07
155.23	1.844	2.157	1.856	15	4.87E-02	1.67E-04	7.96E-07
310.46	1.629	1.788	1.736	211	3.03E-03	7.29E-04	2.17E-07
620.93	1.354	1.318	1.492	708	6.66E-04	4.65E-04	3.04E-08
1241.86	1.207	1.066	1.281	916	3.80E-04	1.25E-04	4.65E-09
2475.89	1.096	0.876	1.152	576	4.88E-04	4.72E-05	2.26E-09
620.93	1.149	0.966	1.122				
38.81	1.191	1.038	1.170				
9.70	1.241	1.124	1.216				

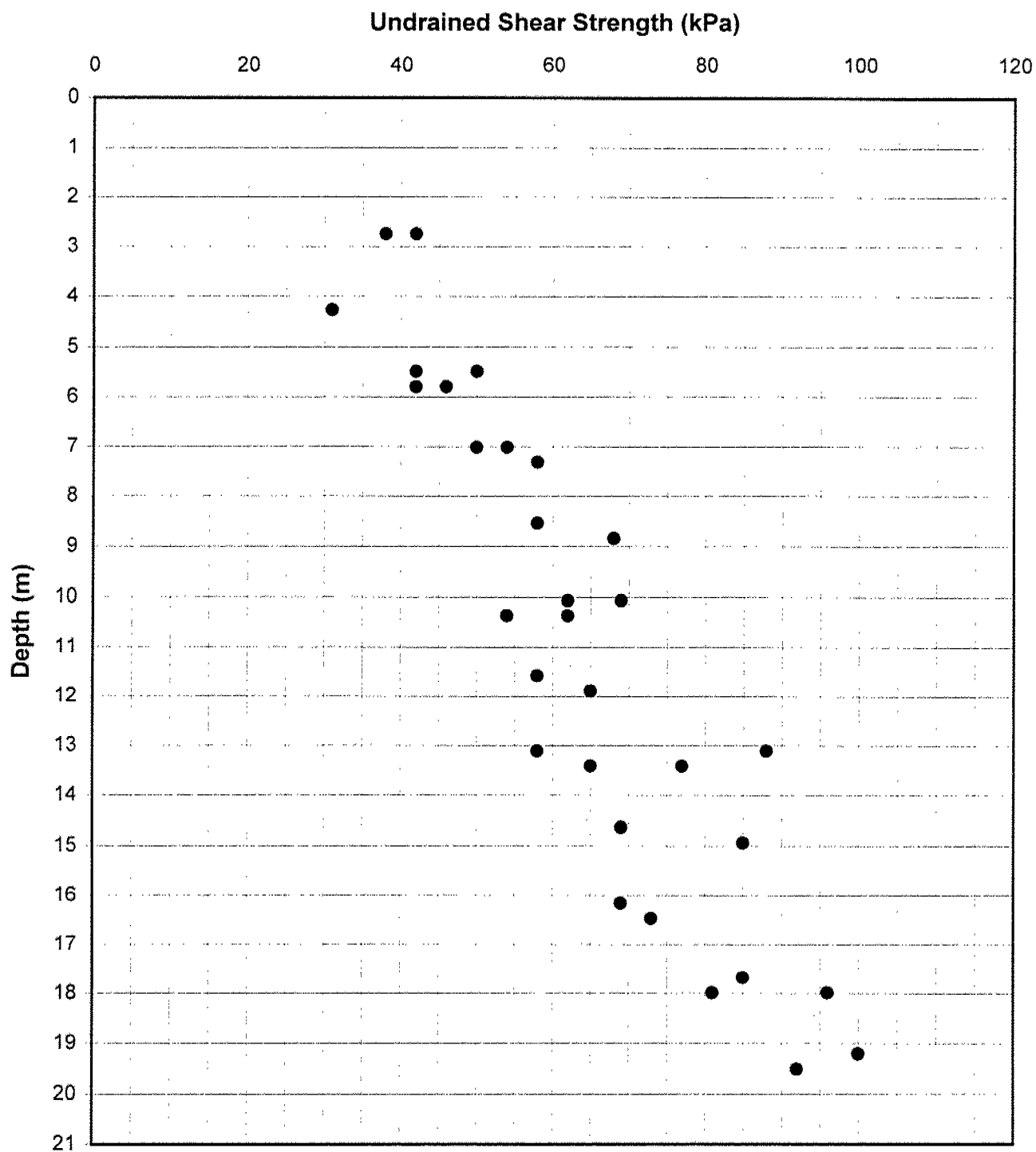
Notes:

k calculated using cv based on t<sub>90</sub> values.

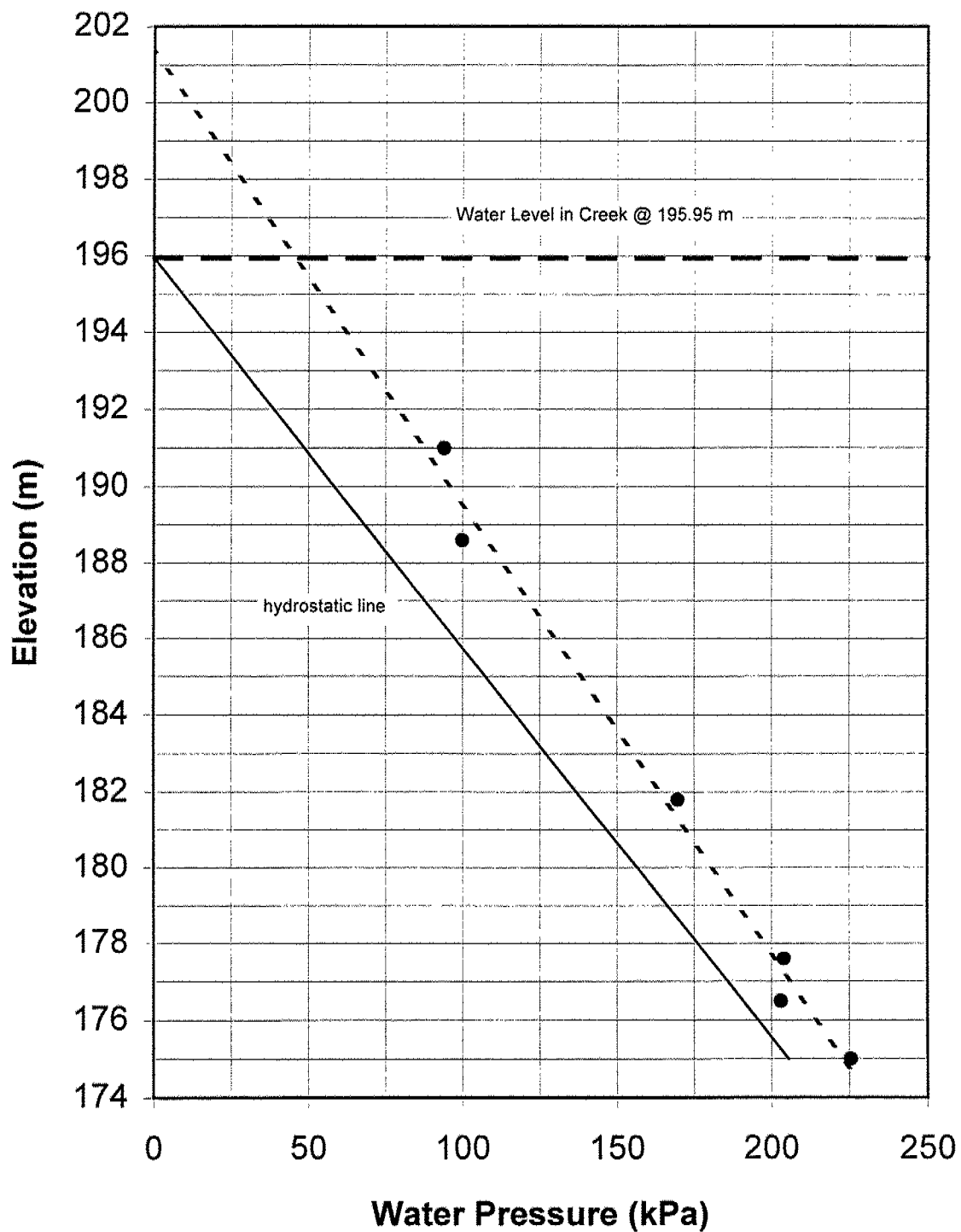
## SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.24	Unit Weight, kN/m <sup>3</sup>	17.92
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	12.28
Area, cm <sup>2</sup>	31.52	Specific Gravity, measured	2.66
Volume, cm <sup>3</sup>	39.11	Solids Height, cm	0.584
Water Content, %	45.92	Volume of Solids, cm <sup>3</sup>	18.41
Wet Mass, g	71.47	Volume of Voids, cm <sup>3</sup>	20.70
Dry Mass, g	48.98		

**FIGURE 3**  
**Vane Results vs. Depth**

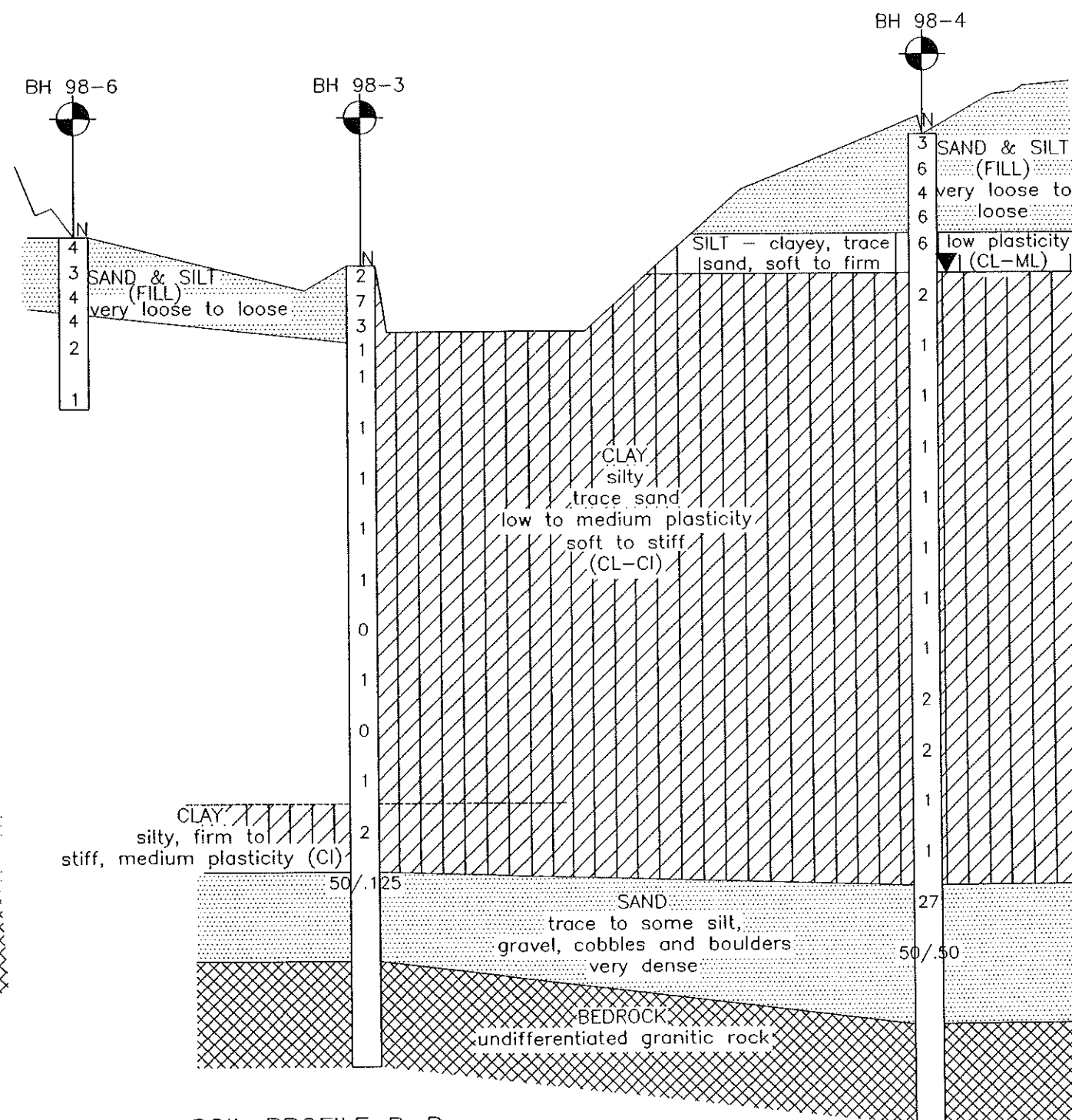
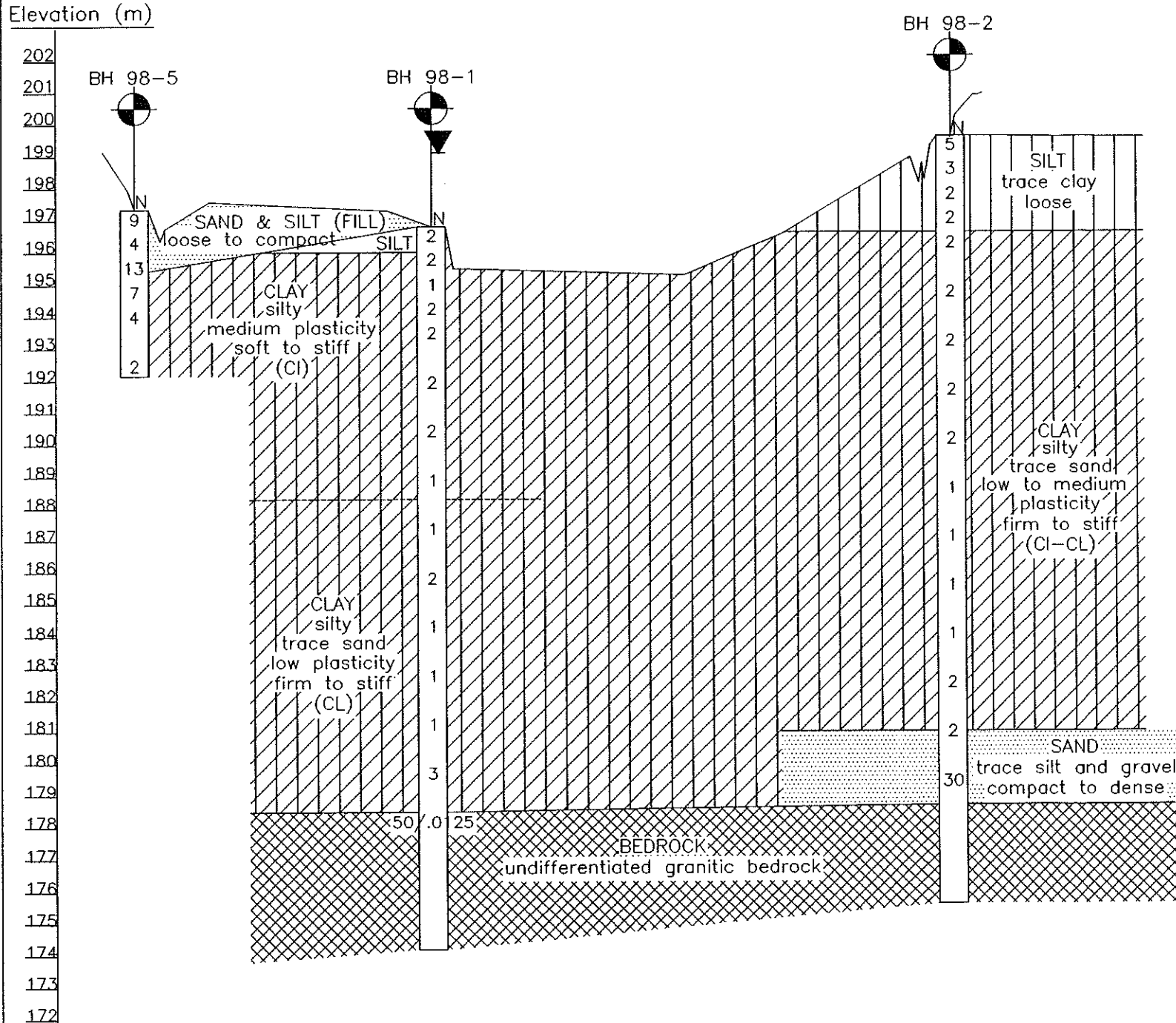


**FIGURE 4**  
**Ground Water Pressure vs. Elevation**







Elevation (m)



**LEGEND**

 BH 98-3  
 WL October 27, 1998  
 'N' Blows/0.3m (Std. Pen Test)

Scale 1:200

0 5 10

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

REVISIONS		DESCRIPTION			
DESIGN	AEG	CHK	PKC	CODE	LOAD
DRAWN	WM	CHK			
		SITE 812-76-00 & 398-91-00		STRUCT	SCHEME
				DWG	2A

# RECORD OF BOREHOLE No 98-1

1 OF 2

METRIC

W.P. 812-76-01,398-91-00

LOCATION Laronde Creek, N 5 136 763.6 E 288 575.3

ORIGINATED BY GA

DIST 54

HWY 17

BOREHOLE TYPE Hollow Stem Augers, N Core

COMPILED BY WM

DATUM Geodetic

DATE 98.10.15 - 98.10.15

CHECKED BY AEG

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			20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	
196.8 0.0	SILT, sandy, very loose, grey, wet		1	SS	2							
196.1 0.8	CLAY, silty, medium plasticity, soft to firm, grey, wet (CI)		2	SS	2		196					
			3	SS	1		195					0 0 41 59
			4	SS	2		194					0 0 42 58
			5	SS	2		193					
			6	SS	2		192					
	some varves evident		7	SS	2		191					
			8	SS	1		189	+				0 0 43 57
188.3 8.5	CLAY, silty, trace sand, low plasticity, firm to stiff, grey, wet (CL)		9	SS	1		188					
			10	SS	2		186	+				0 1 61 38
	some varves evident		11	SS	1		184					
			12	SS	1		183					
							182					

Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity  
20  
15 5  
10 (%) STRAIN AT FAILURE



## METRIC

SOIL PROFILE				SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT	Liquid Limit	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE 20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub>  w <sub>p</sub> ———— w <sub>L</sub> WATER CONTENT (%)	w <sub>L</sub>	γ kN/m³	(%) GR SA SI C
178.5			13	SS	1		181	+ + FIELD VANE		52.930	O 1 63 3
							180			42.840	
18.3	BEDROCK undifferentiated granitic rock, very dense		15	SS	50/.0		178				
	Core #1 REC = 100% RQD = 79%		1 CORE				177				
	Core #2 REC = 100% RQD = 92%		2 CORE				176				
174.2	END OF BOREHOLE AT 22.6m.						175				
22.6	Piezometer installation consist of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE      DEPTH (m) 21/10/98     2.44(above surface) 22/10/98     2.44(above surface) 23/10/98     2.29(above surface) 24/10/98     2.29(above surface) 25/10/98     2.29(above surface) 26/10/98     2.29(above surface) 27/10/98     2.31(above surface)										

+ 3, x 3: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 98-2

1 OF 2

METRIC

W.P. 812-76-01,398-91-00 LOCATION Laronde Creek, N 5 136 763.4 E 288 612.7 ORIGINATED BY GA  
DIST 54 HWY 17 BOREHOLE TYPE Hollow Stem Augers, N Core COMPILED BY WM  
DATUM Geodetic DATE 98.10.20 - 98.10.20 CHECKED BY AEG

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>	
199.6 0.0	SILT, trace clay, very loose to loose, grey to brown, wet (ML)		1	SS	5		199					
			2	SS	3		198					0 0 93 7
			3	SS	2		197					
196.5			4	SS	2		196					
3.0	CLAY, silty, trace sand, low to medium plasticity, firm to stiff, grey, wet (CL-CI)		5	SS	2		195					0 2 54 44
			6	SS	2		194					
			7	SS	2		193					
			8	SS	2		192					
			9	SS	2		191					
	some varves evident		10	SS	1		190					0 0 40 60
	(possibly CL between 10 & 12m)		11	SS	1		189					
			12	SS	1		188					
	(possibly CL between 13 & 15m)						187					
							186					
							185					

Continued Next Page

+ 3, x 3: Numbers refer to 20 15 10  
Sensitivity 5 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 98-2

2 OF 2

METRIC

W.P. 812-76-01,398-91-00 LOCATION Laronde Creek, N 5 136 763.4 E 288 612.7 ORIGINATED BY GA  
DIST 54 HWY 17 BOREHOLE TYPE Hollow Stem Augers, N Core COMPILED BY WM  
OATUM Geodetic DATE 98.10.20 - 98.10.20 CHECKED BY AEG

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			SHEAR STRENGTH kPa					
								20 40 60 80 100					
								20 40 60 80 100					
			13	SS	1		184					40.00	0 1 44 55
							183						
			14	SS	2							47.310	
							182						
181.0			15	SS	2		181						
18.6	SAND, trace silt, trace gravel, compact to dense, grey, wet												
			16	SS	30								
							180						
							179						
178.7													
20.9	BEDROCK undifferentiated granitic rock, very dense Core #1 REC = 100% RQD = 0%		1	CORE			178						
	Core #2 REC = 100% RQD = 51%		2	CORE			177						
	Core #3 REC = 100% RQD = 68%		3	CORE			176						
175.5													
24.0	END OF BOREHOLE AT 24.0m. BOREHOLE GROUTED TO SURFACE.												



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

# RECORD OF BOREHOLE No 98-3

1 OF 2

METRIC

W.P. 812-76-01,398-91-00 LOCATION Laronde Creek, N 5 136 733.6 E 288 573.7 ORIGINATED BY GA  
 DIST 54 HWY 17 BOREHOLE TYPE Hollow Stem Augers, N Core COMPILED BY WM  
 DATUM Geodetic DATE 98.10.24 - 98.10.24 CHECKED BY AEG

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 (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20 40 60 80 100						10 20 30			
197.5 0.0	SILT and SAND, some clay, very loose to loose, dark brown: (FILL)		1	SS	2		197						89.030	0 36 53 11				
			2	SS	7		196											
			3	SS	3													
195.2 2.3	CLAY, silty, trace sand, low to medium plasticity, firm to stiff, grey, wet: (CL-CI)  some varves evident  (CL between 11 & 13m)		4	SS	1		195						46.890	0 0 46 54				
			5	SS	1		194								61.350			
							193	+								48.090		
					6		SS	1	192									
									191							42.420	0 1 38 61	
									190	+						42.430		
					8		SS	1	189									
									188								42.550	
									187		+							
					10		SS	0	186								42.340	
									185								47.70	0 0 64 36
					11		SS	1	184		+							
			12	SS	0	183							40.550					

Continued Next Page




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

# RECORD OF BOREHOLE No 98-3

2 OF 2

METRIC

W.P. 812-76-01,398-91-00 LOCATION Laronde Creek, N 5 136 733.6 E 288 573.7 ORIGINATED BY GA  
DIST 54 HWY 17 BOREHOLE TYPE Hollow Stem Augers, N Core COMPILED BY WM  
DATUM Geodetic DATE 98.10.24 - 98.10.24 CHECKED BY AEG

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			SHEAR STRENGTH kPa					
								20 40 60 80 100					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					
						WATER CONTENT (%) 10 20 30							
181.3	CLAY, silty, medium plasticity, firm to stiff, grey, wet: (CI)		13	SS	1	182							
16.2						181			+				
			14	SS	2		180						41.0
179.2	SAND, some silt, some cobbles and boulders, very dense, grey, wet												
18.3			15	SS	50/ .125	179							
						178							
176.5	BEDROCK, undifferentiated granitic rock, very dense Core #1 REC = 100% ROD = 60%  Core #2 REC = 100% ROD = 75%  Core #3 REC = 100% ROD = 92%					177							
21.0			1	CORE		176							
			2	CORE		175							
173.3			3	CORE		174							
24.2	END OF BOREHOLE AT 24.2m. BOREHOLE BACKFILLED AS FOLLOWS: 0-18m GROUT 18-21m BENTONITE & SAND 21-24.2m BENTONITE												

+ 3, × 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 98-4

1 OF 3

METRIC

W.P. 812-76-01,398-91-00 LOCATION Laronde Creek, N 5 136 743.1 E 288 611.5 ORIGINATED BY GA  
DIST 54 HWY 17 BOREHOLE TYPE Hollow Stem Augers, N Core COMPILED BY WM  
DATUM Geodetic DATE 98.10.22 - 98.10.22 CHECKED BY AEG

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									WATER CONTENT (%)
								20 40 60 80 100									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
201.4																	
0.0	SAND and SILT, very loose to loose, brown: (FILL)		1	SS	3												
			2	SS	6												
			3	SS	4												
			4	SS	6												
198.4																	
3.0	SILT, clayey, trace sand, low plasticity, soft to firm, grey, wet (CL-ML)		5	SS	6												
197.6																	
3.8	CLAY, silty, medium plasticity, soft to firm, grey, wet (CL-CI)  some varves evident																
			6	SS	2												
			7	SS	1												
			8	SS	1												
			9	SS	1												
			10	SS	1												
			11	SS	1												
			12	SS	1												

Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 98-4

3 OF 3

METRIC

W.P. 812-76-01,398-91-00 LOCATION Laronde Creek, N 5 136 743.1 E 288 611.5 ORIGINATED BY GA  
 DIST 54 HWY 17 BOREHOLE TYPE Hollow Stem Augers, N Core COMPILED BY WM  
 DATUM Geodetic DATE 98.10.22 - 98.10.22 CHECKED BY AEG

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										WATER CONTENT (%)
								20	40	60	80	100						





# RECORD OF BOREHOLE No 98-5

1 OF 1

METRIC

W.P. 812-76-01,398-91-00 LOCATION Laronde Creek, N 5 136 767.7 E 288 557.3 ORIGINATED BY GA  
 DIST 54 HWY 17 BOREHOLE TYPE Hollow Stem Augers, N Coring COMPILED BY WM  
 DATUM Geodetic DATE 98.10.19 - 98.10.19 CHECKED BY AEG


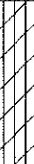

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE														
							20	40	60	80	100											
0.0	SAND and SILT, loose to compact, brown, moist: (FILL)		1	SS	9																	
			2	SS	4																	
			3	SS	13																	
1.9	CLAY, silty, low to medium plasticity, firm to stiff, grey, wet (CL)		4	SS	7																	
			5	SS	4																	
			6	SS	2																	
5.2	END OF BOREHOLE AT 5.18m. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.																					

# RECORD OF BOREHOLE No 98-6

1 OF 1

METRIC

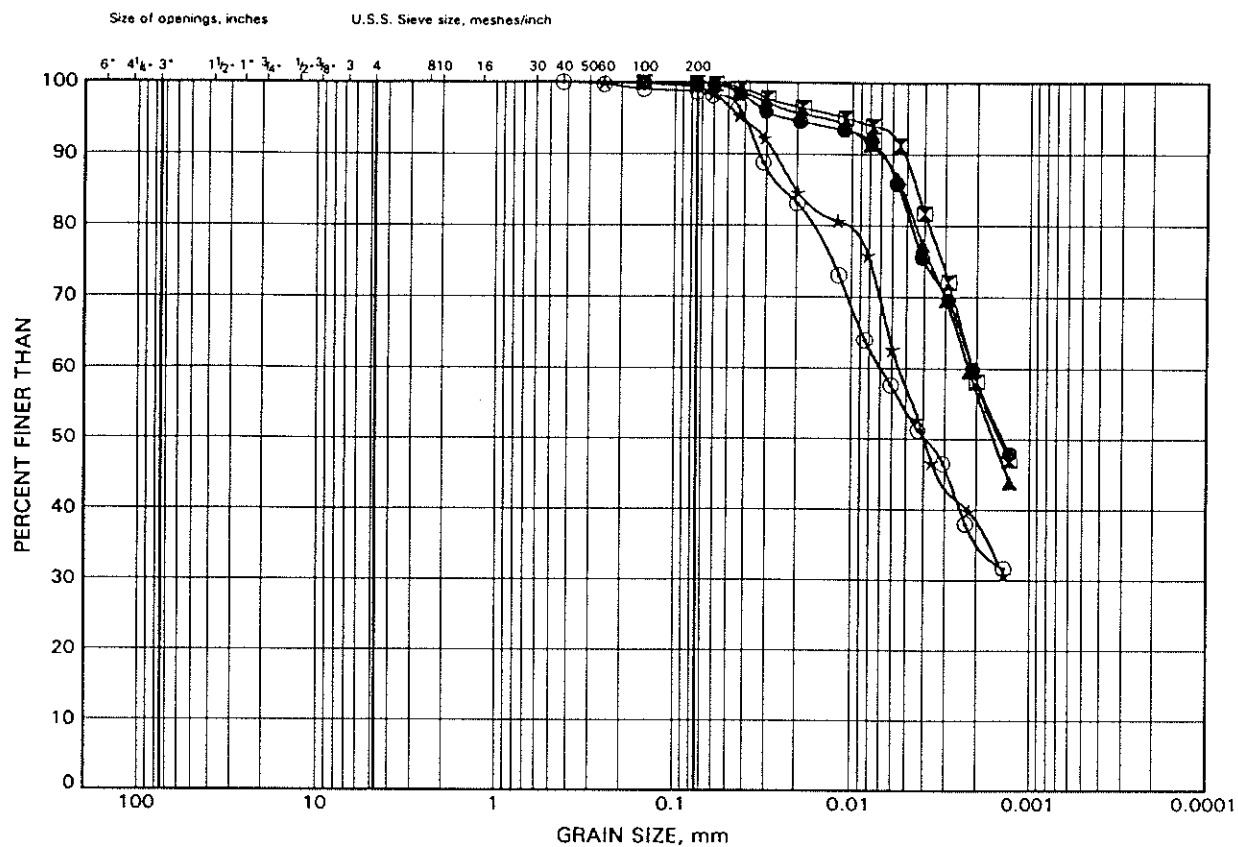
W.P. 812-76-01,398-91-00 LOCATION Laronde Creek, N 5 136 733.4 E 288 556.5 ORIGINATED BY GA  
DIST 54 HWY 17 BOREHOLE TYPE Hollow Stem Augers, N Coring COMPILED BY WM  
DATUM Geodetic DATE 98.10.26 - 98.10.26 CHECKED BY AEG

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										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE												
								● QUICK TRIAXIAL × LAB VANE												
						20	40	60	80	100	10	20	30							
0.0	SILT, sandy, trace gravel, very loose to loose, brown to black, moist to wet: (POSSIBLE FILL) (ML)		1	SS	4															
			2	SS	3															
			3	SS	4															
2.3	SILT, clayey, soft, grey, moist to wet: (ML)		4	SS	4															
			5	SS	2															
4.0	CLAY, silty, medium plasticity, grey, wet: (CI)																			
			6	SS	1															
5.2	END OF BOREHOLE AT 5.18m. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.																			

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

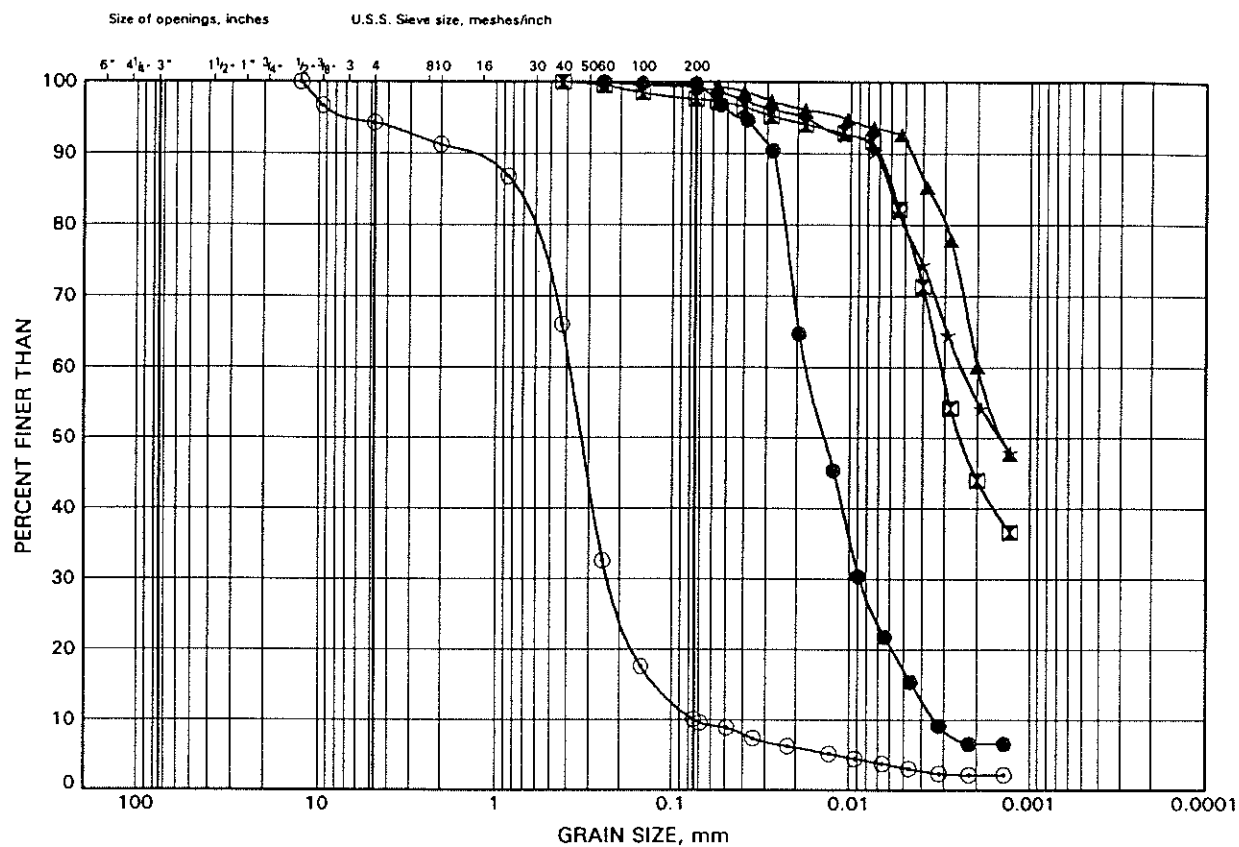
# HWY 17, LARONDE CREEK GRAIN SIZE DISTRIBUTION

FIGURE B1



# HWY 17, LARONDE CREEK GRAIN SIZE DISTRIBUTION

FIGURE B2



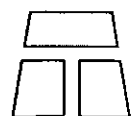
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
--------	----------	-----------	---------------

●	98-2	1.07	198.48
⊠	98-2	3.35	196.20
▲	98-2	9.45	190.10
★	98-2	15.54	184.01
⊙	98-2	20.12	179.43

Date December 1998

Project 812-76-01, 398-91-00



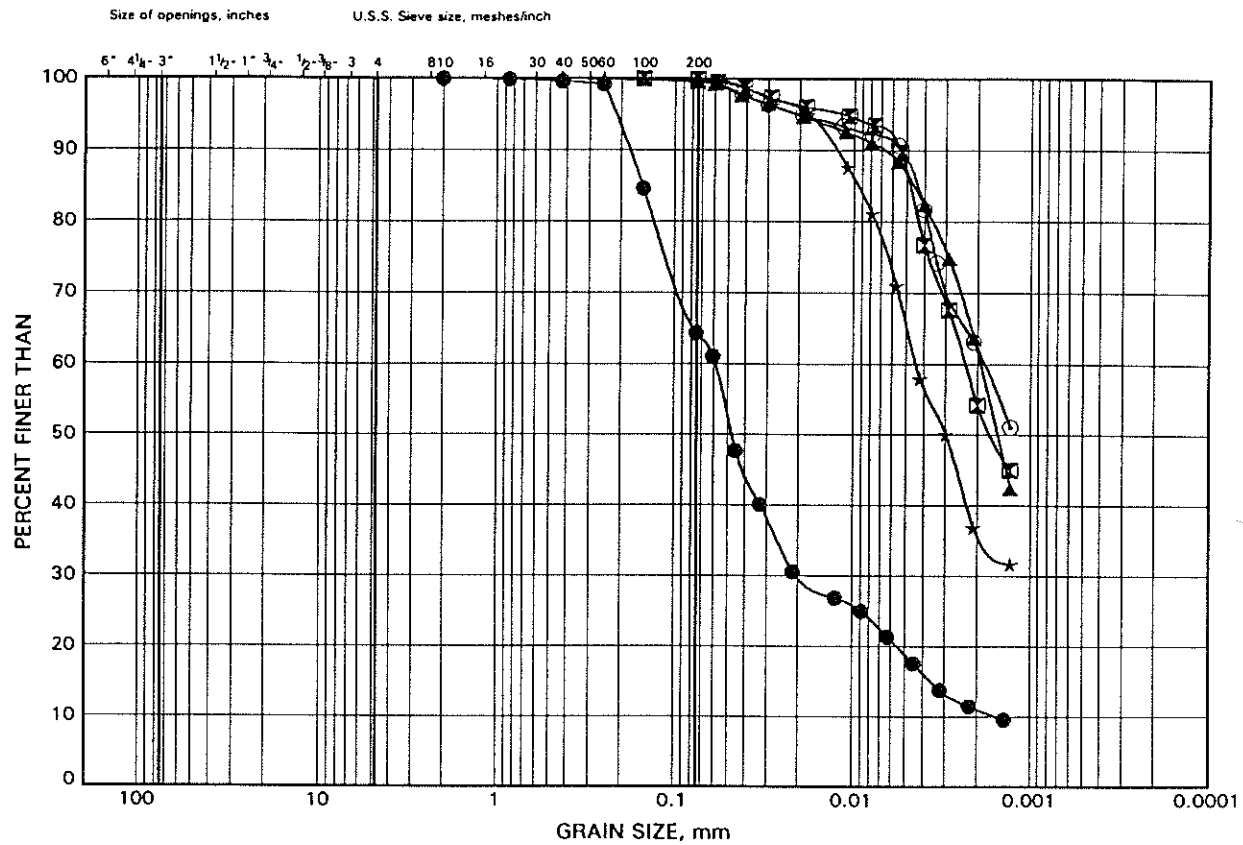
THURBER

Prep'd WM

Chkd. AEG

# HWY 17, LARONDE CREEK GRAIN SIZE DISTRIBUTION

FIGURE B3



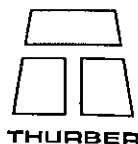
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
--------	----------	-----------	---------------

●	98-3	1.07	196.38
⊠	98-3	2.59	194.86
▲	98-3	6.40	191.05
★	98-3	12.50	184.95
⊙	98-3	17.07	180.38

Date December 1998

Project 812-76-01, 398-91-00

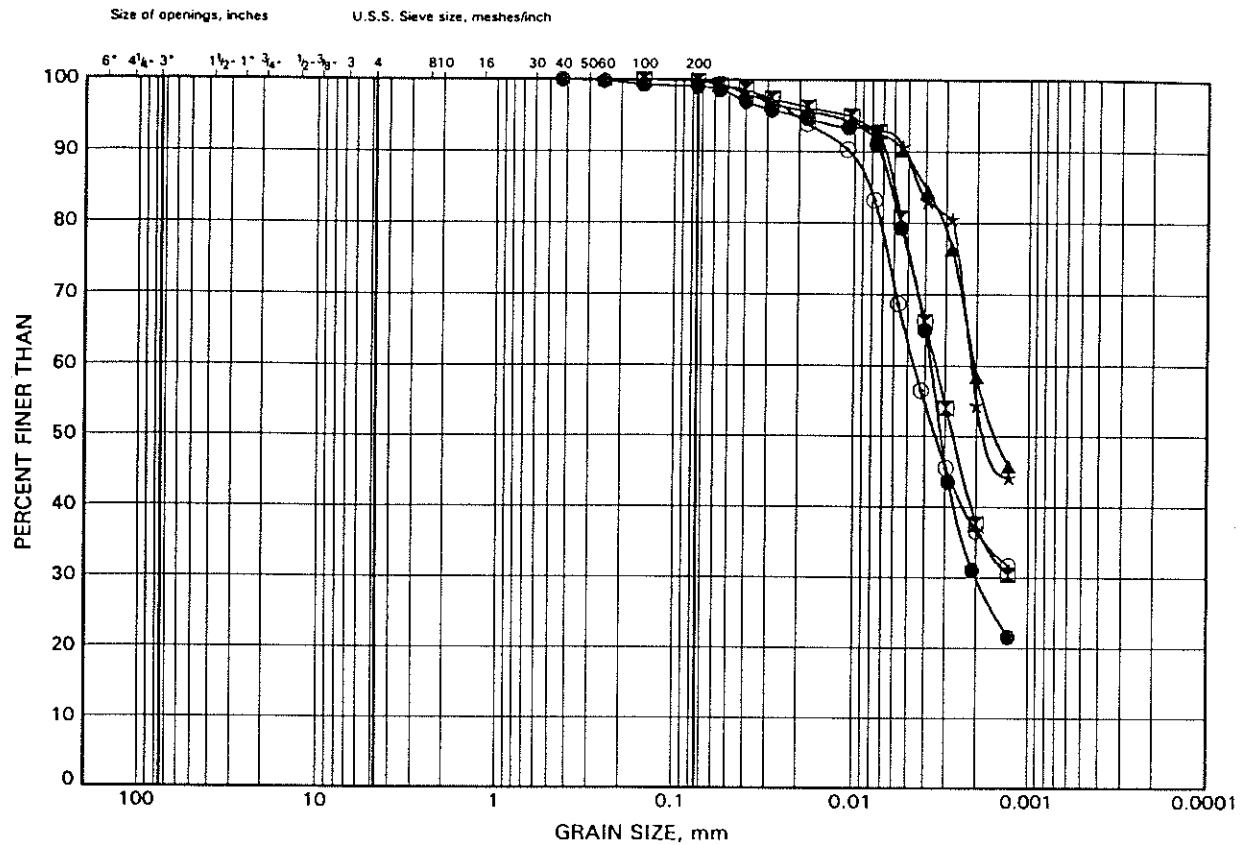


Prep'd WM

Chkd. AEG

# HWY 17, LARONDE CREEK GRAIN SIZE DISTRIBUTION

FIGURE B4

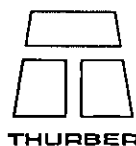


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	98-4	3.35	198.08
⊠	98-4	4.88	196.55
▲	98-4	10.97	190.46
★	98-4	14.02	187.41
⊙	98-4	17.07	184.36

Date December 1998

Project 812-76-01,398-91-00

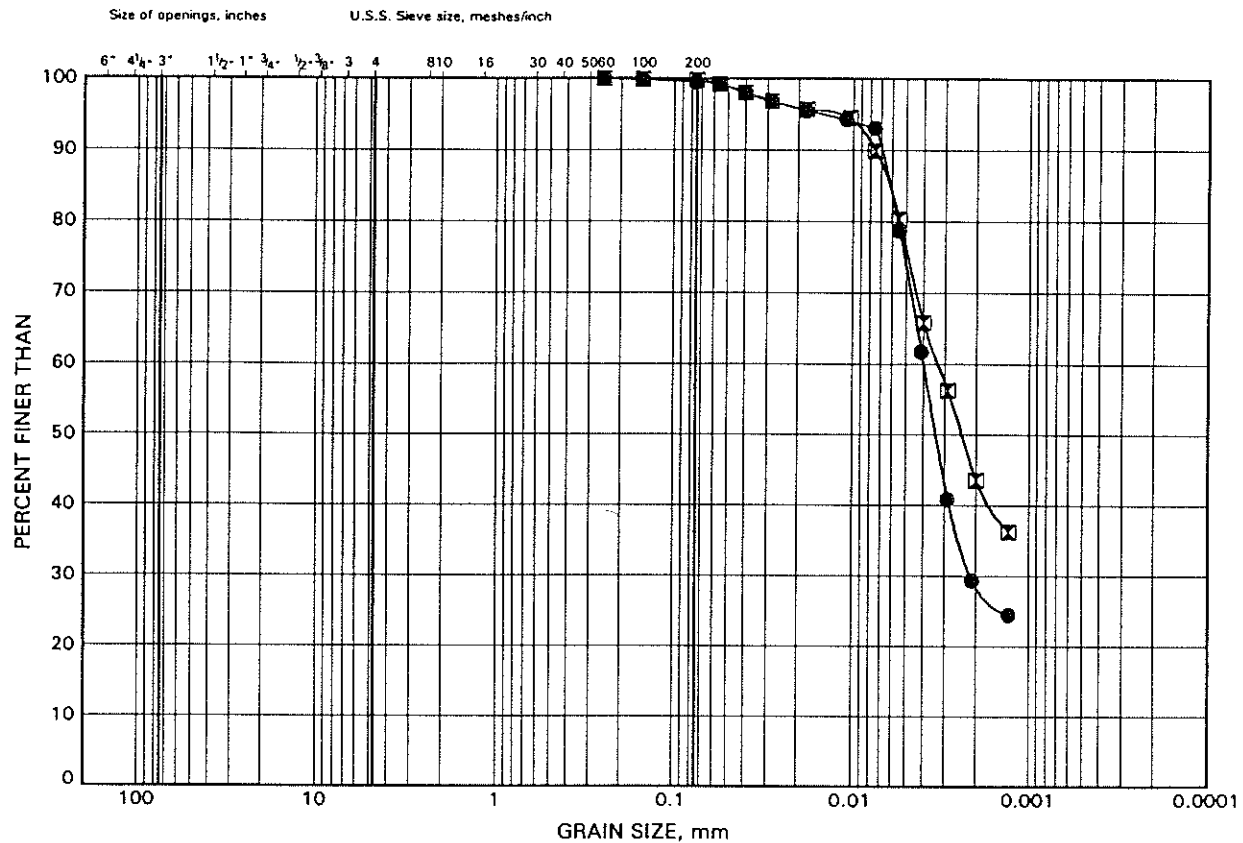


Prep'd WM

Chkd. AEG

# HWY 17, LARONDE CREEK GRAIN SIZE DISTRIBUTION

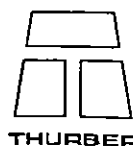
FIGURE B5



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

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

● 98-5 2.59  
 ☒ 98-5 4.88



THURBER


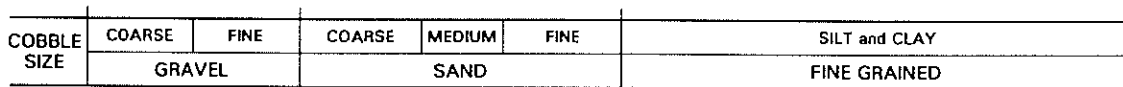
Date December 1998

Project 812-76-01, 398-91-00

Prep'd WM

Chkd. AEG

## FIGURE B6

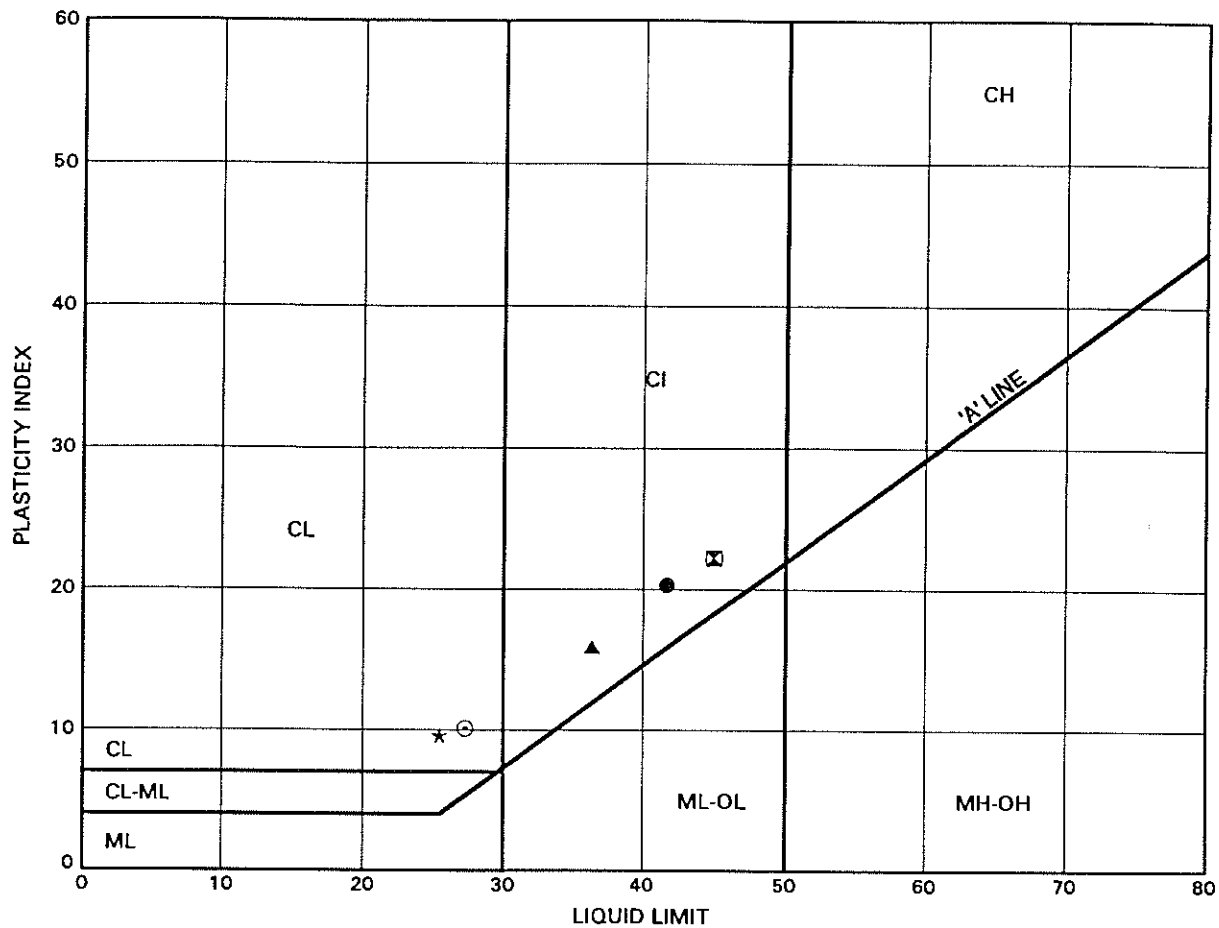


Chkd. .... **AEG** .....



# HWY 17, LARONDE CREEK ATTERBERG LIMITS TEST RESULTS

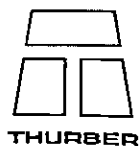
FIGURE B7



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	98-1	1.83	194.98
⊠	98-1	2.59	194.22
▲	98-1	7.92	188.89
★	98-1	10.97	185.84
⊙	98-1	17.06	179.75

THURBALT 8470 98/12/18

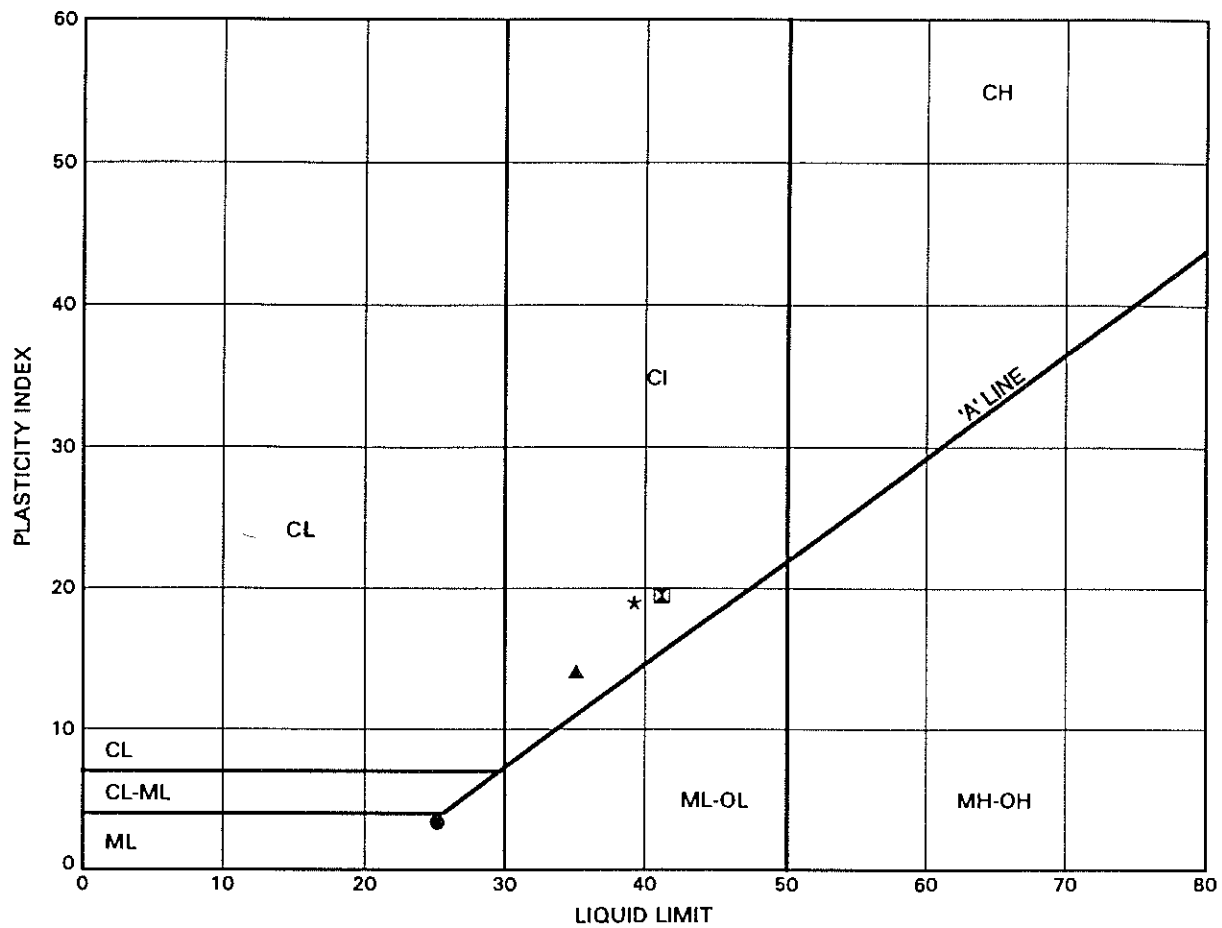
Date December 1998  
 Project 812-76-01,398-91-00



Prep'd WM  
 Chkd. AEG

# HWY 17, LARONDE CREEK ATTERBERG LIMITS TEST RESULTS

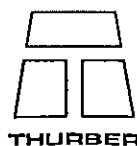
FIGURE B8



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	98-2	1.07	198.48
⊠	98-2	3.35	196.20
▲	98-2	9.45	190.10
★	98-2	15.54	184.01

Date December 1998

Project 812-76-01, 398-91-00

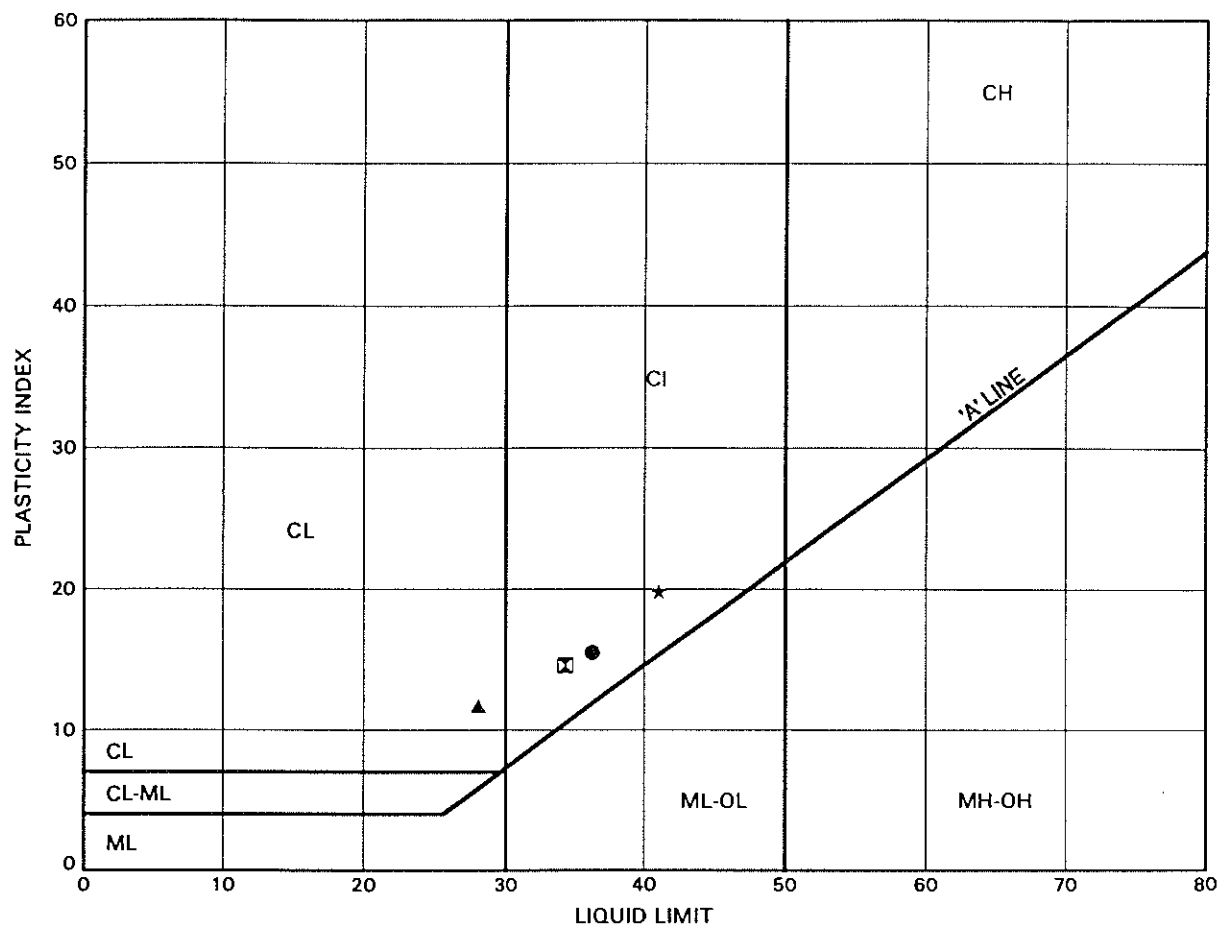


Prep'd WM

Chkd. AEG

# HWY 17, LARONDE CREEK ATTERBERG LIMITS TEST RESULTS

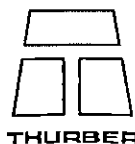
FIGURE B9



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	98-3	2.59	194.86
⊠	98-3	6.40	191.05
▲	98-3	12.50	184.95
★	98-3	17.07	180.38

Date December 1998

Project 812-76-01, 398-91-00

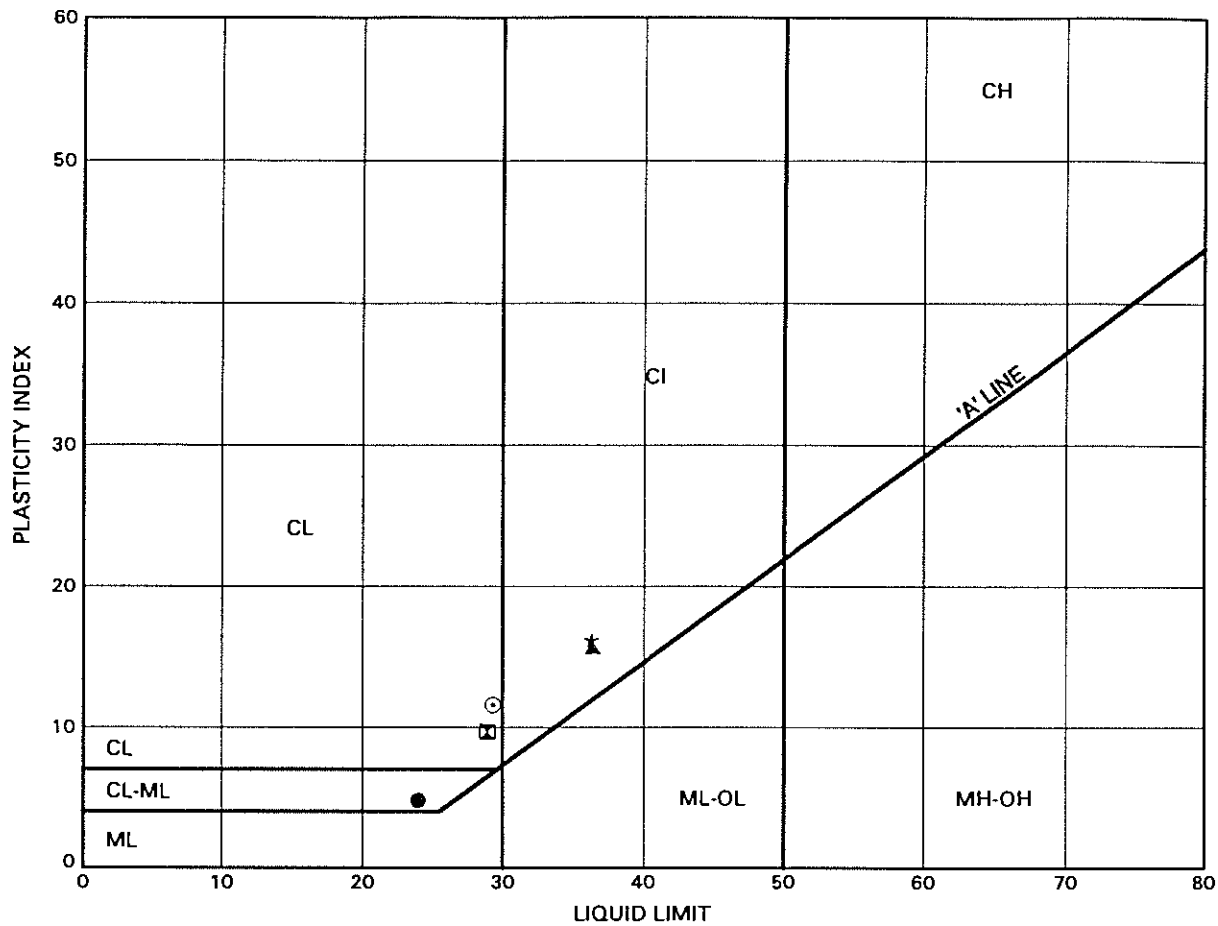


Prep'd WM

Chkd. AEG

# HWY 17, LARONDE CREEK ATTERBERG LIMITS TEST RESULTS

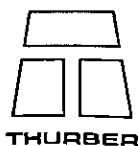
FIGURE B10



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	98-4	3.35	198.08
⊠	98-4	4.88	196.55
▲	98-4	10.97	190.46
★	98-4	14.02	187.41
⊙	98-4	17.07	184.36

Date December 1998

Project 812-76-01,398-91-00

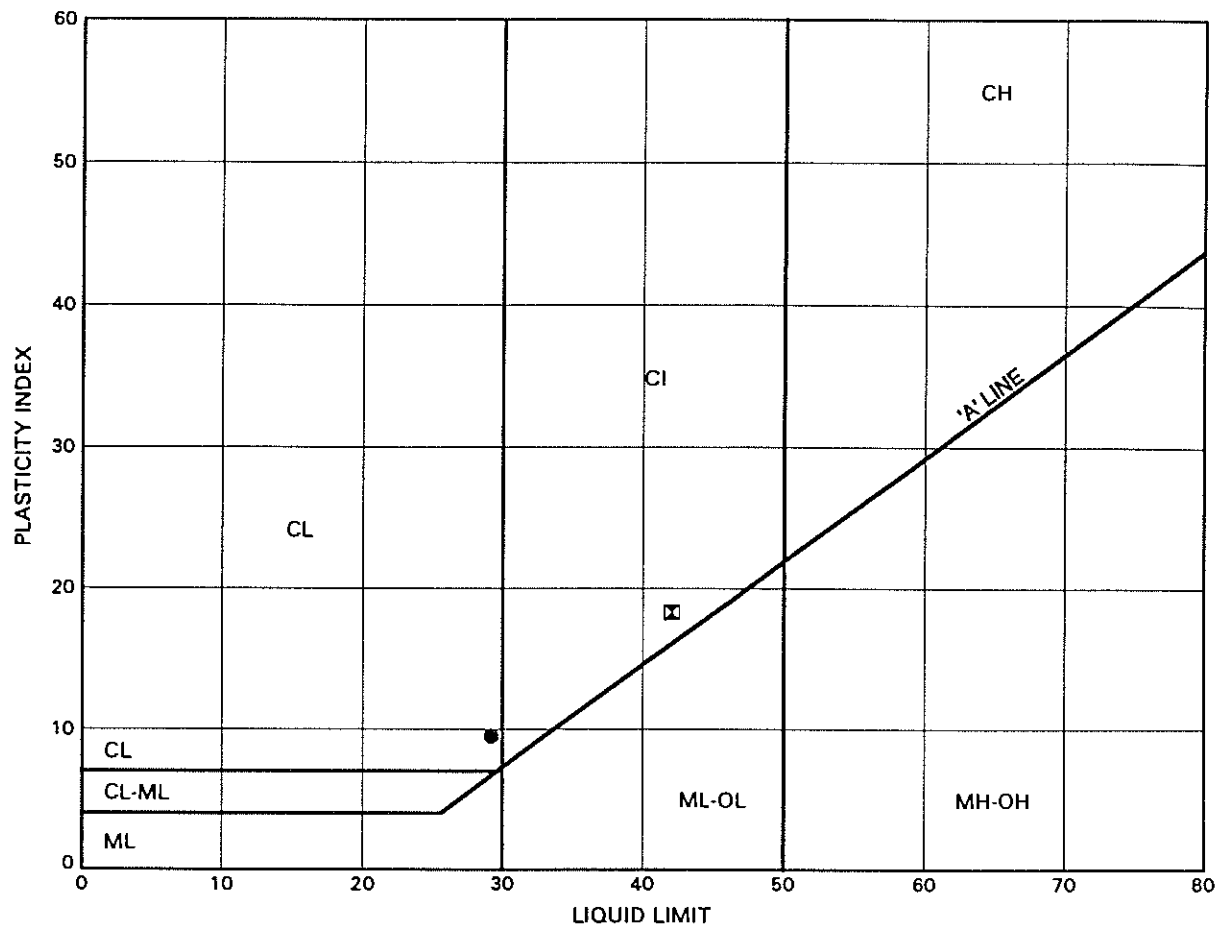


Prep'd WM

Chkd. AEG

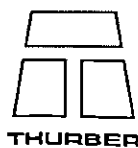
# HWY 17, LARONDE CREEK ATTERBERG LIMITS TEST RESULTS

FIGURE B11



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	98-5	2.60	
⊠	98-5	4.88	

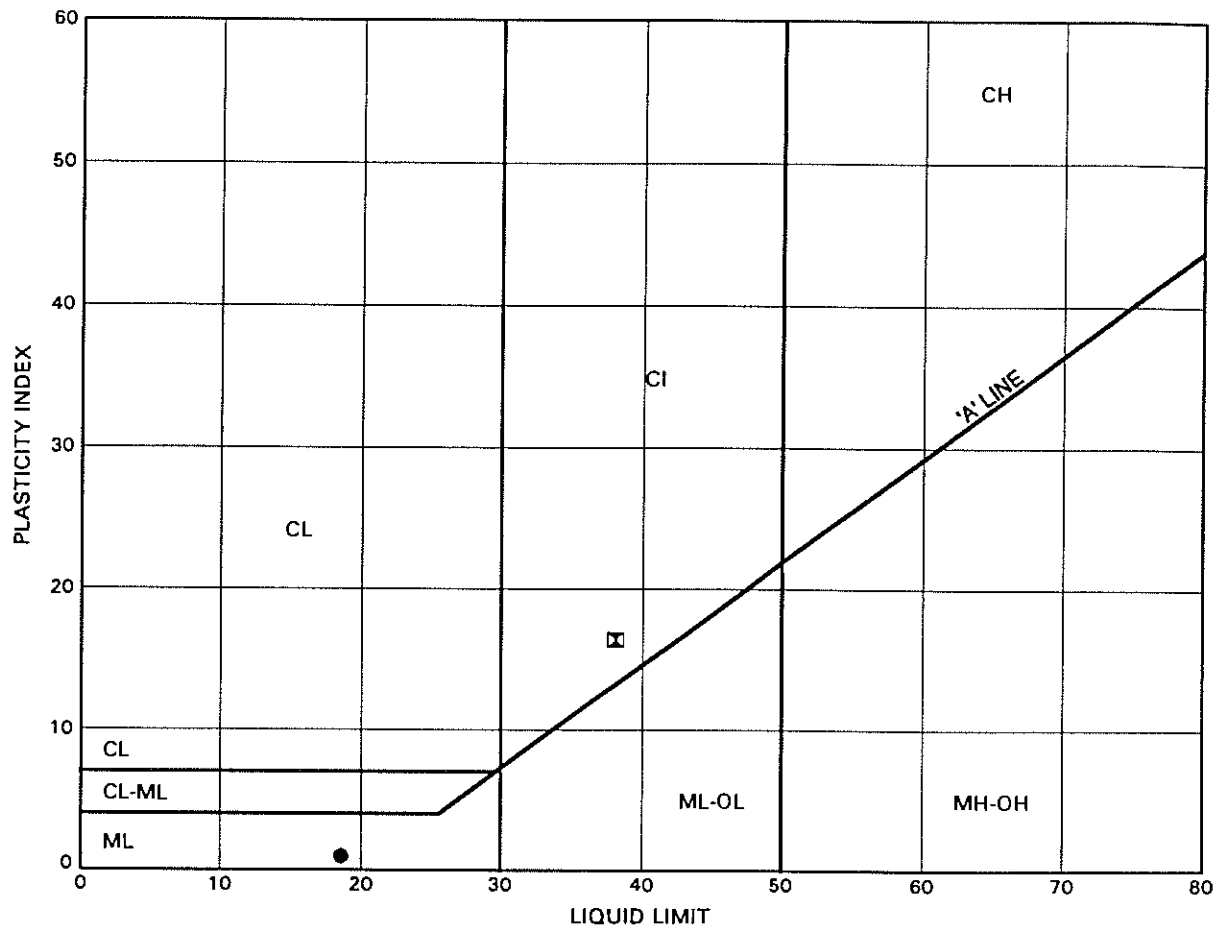
Date December 1998  
 Project 812-76-01,398-91-00



Prep'd WM  
 Chkd. AEG

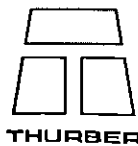
# HWY 17, LARONDE CREEK ATTERBERG LIMITS TEST RESULTS

FIGURE B12



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	98-6	1.83	
⊠	98-6	4.88	

Date December 1998  
 Project 812-76-01,398-91-00



Prep'd WM  
 Chkd. AEG

**Table 1**

**Results of pH and Sulphate Testing**

<b>Sample</b>	<b>Depth (m)</b>	<b>pH</b>	<b>Sulphates (ppm)</b>
98-2, Sa 3	1.8	8.6	36
98-3, Sa 3	2.0	8.0	7.2

DIMENSIONS ARE IN METERS  
AND/OR MILLIMETERS  
UNLESS OTHERWISE SHOWN

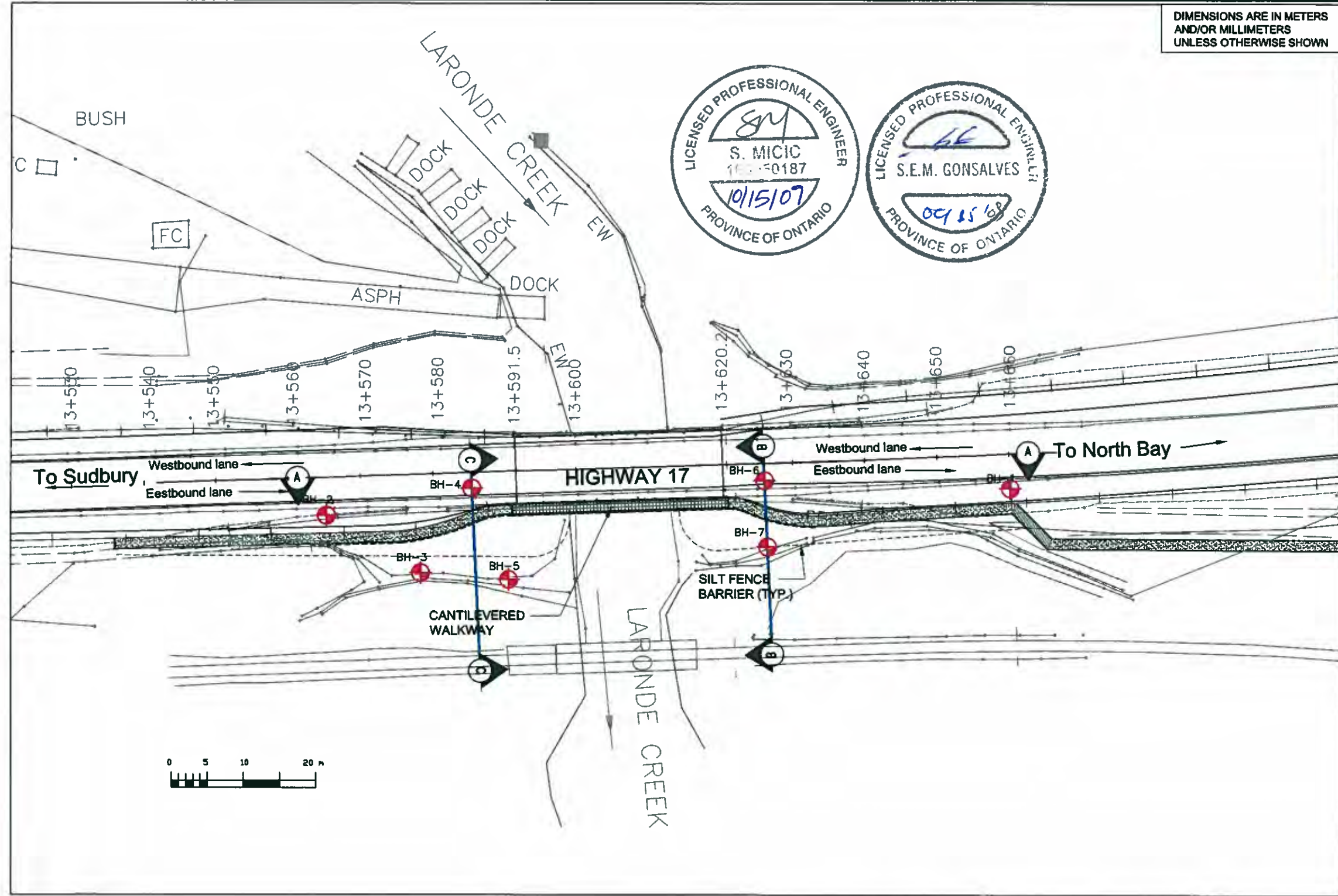
GWP

No. 5274-08-00

SITE PLAN AND  
BOREHOLE LOCATIONS

N

SHEET  
1



KEY MAP  
Not to Scale

LEGEND

BOREHOLE

Water Level (Piezometer)

Water Level (Open hole)

No.	ELEVATION	STATION	OFFSET
BH-1	202.183	13+659.9	4.9
BH-2	201.872	13+565.0	5.3
BH-3	198.224	13+577.7	13.8
BH-4	201.799	13+585.3	2.2
BH-5	196.842	13+590.0	15.2
BH-6	201.824	13+625.9	2.2
BH-7	199.429	13+625.9	11.7

REVISIONS	DATE	BY	DESCRIPTION

Trow Associates Inc.

56 QUEEN STREET EAST, SUIT 301  
BRAMPTON, ONTARIO, L6V 4M8  
(905) 796-3200

PROJECT TITLE AND LOCATION:

Gabion Wall Construction  
near Laronde Creek  
Hwy 17, Sudbury

DRAWING TITLE:

SITE PLAN AND  
BOREHOLE LOCATIONS

PROJECT NO.

5274-08-00

DWN.: GQ

SCALE:

AS NOTED

CHKD.: SM

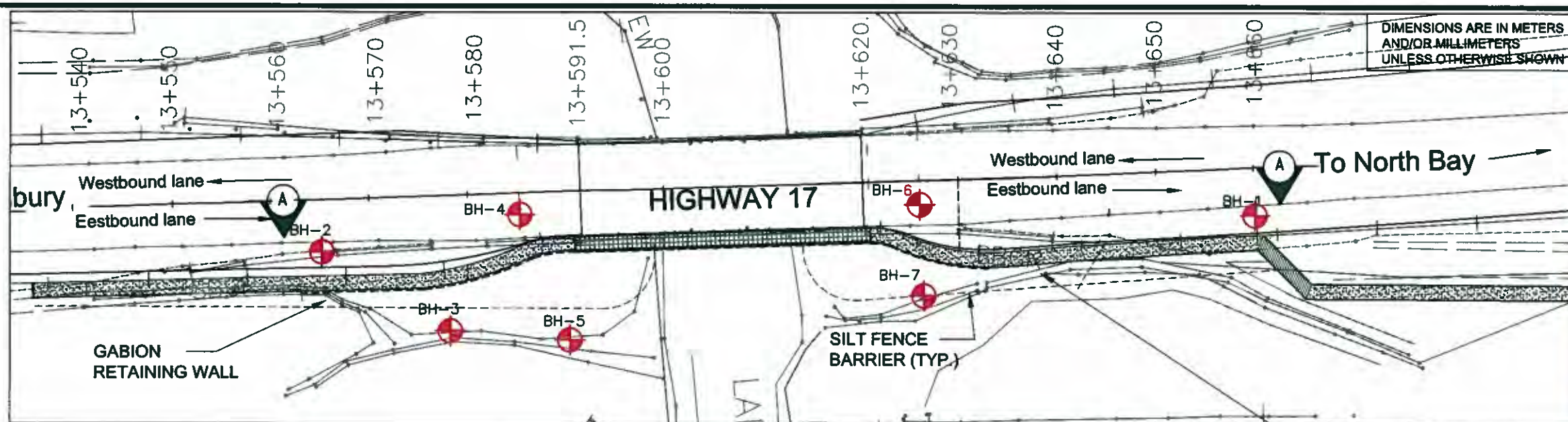
DATE:

Sept. 2009

DWG. No.:

1

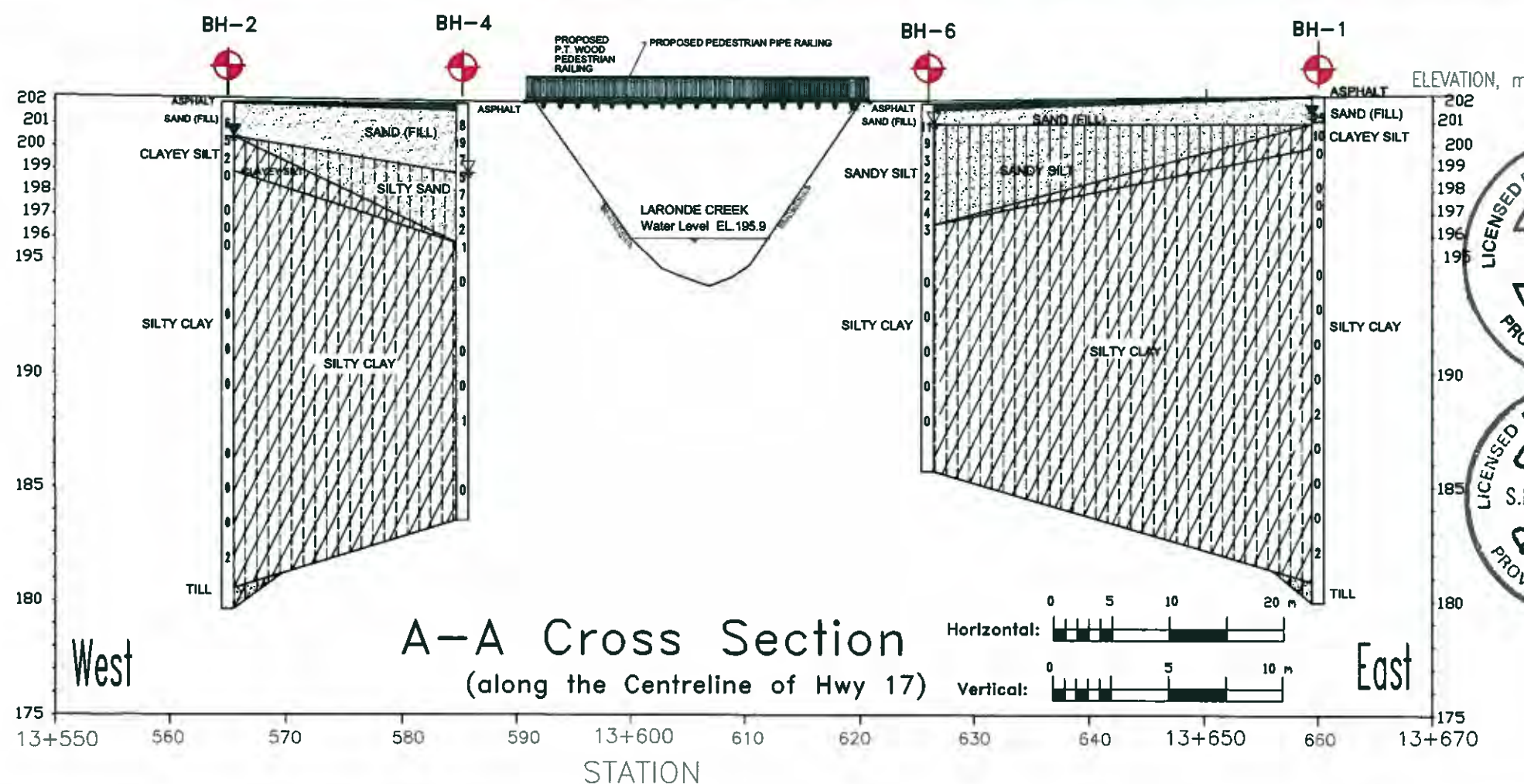




GWP	No. 5274-08-00	 SHEET 2



KEY MAP  
Not to Scale



LEGEND

- BOREHOLE
- Water Level (Piezometer)
- Water Level (Open hole)

No.	ELEVATION	STATION	OFFSET
BH-1	202.183	13+659.9	4.9
BH-2	201.872	13+565.0	5.3
BH-3	198.224	13+577.7	13.8
BH-4	201.799	13+585.3	2.2
BH-5	196.842	13+590.0	15.2
BH-6	201.824	13+625.9	2.2
BH-7	199.429	13+625.9	11.7

NOTES

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing to be read with subject report.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration only.
- Borehole locations are approximate.
- Borehole elevations should not be used to design building(s), or floor slab(s), or parking lot(s) grades.
- The elevation of the water level in the creek was measured by TROW on 11/Sept./2009



DATE	BY	DESCRIPTION

SOIL STRATA SYMBOLS:

	ASPHALT		SAND		SILTY CLAY
	SILTY SAND		CLAYEY SILT		TILL

**TROW Associates Inc.**  
 56 QUEEN STREET EAST, SUIT 301  
 BRAMPTON, ONTARIO, L6V 4M8  
 (905) 796-3200

PROJECT TITLE AND LOCATION:  
**Gabion Wall Construction  
 near Laronde Creek  
 Hwy 17, Sudbury**

DRAWING TITLE:  
**A-A CROSS-SECTION**

PROJECT NO. <b>5274-08-00</b>	DWN.: GQ
SCALE: AS NOTED	CHKD.: SM
DATE: Sept. 2009	DWG. No.: 2





DIMENSIONS ARE IN METERS  
AND/OR MILLIMETERS  
UNLESS OTHERWISE SHOWN

GWP No. 5274-08-00

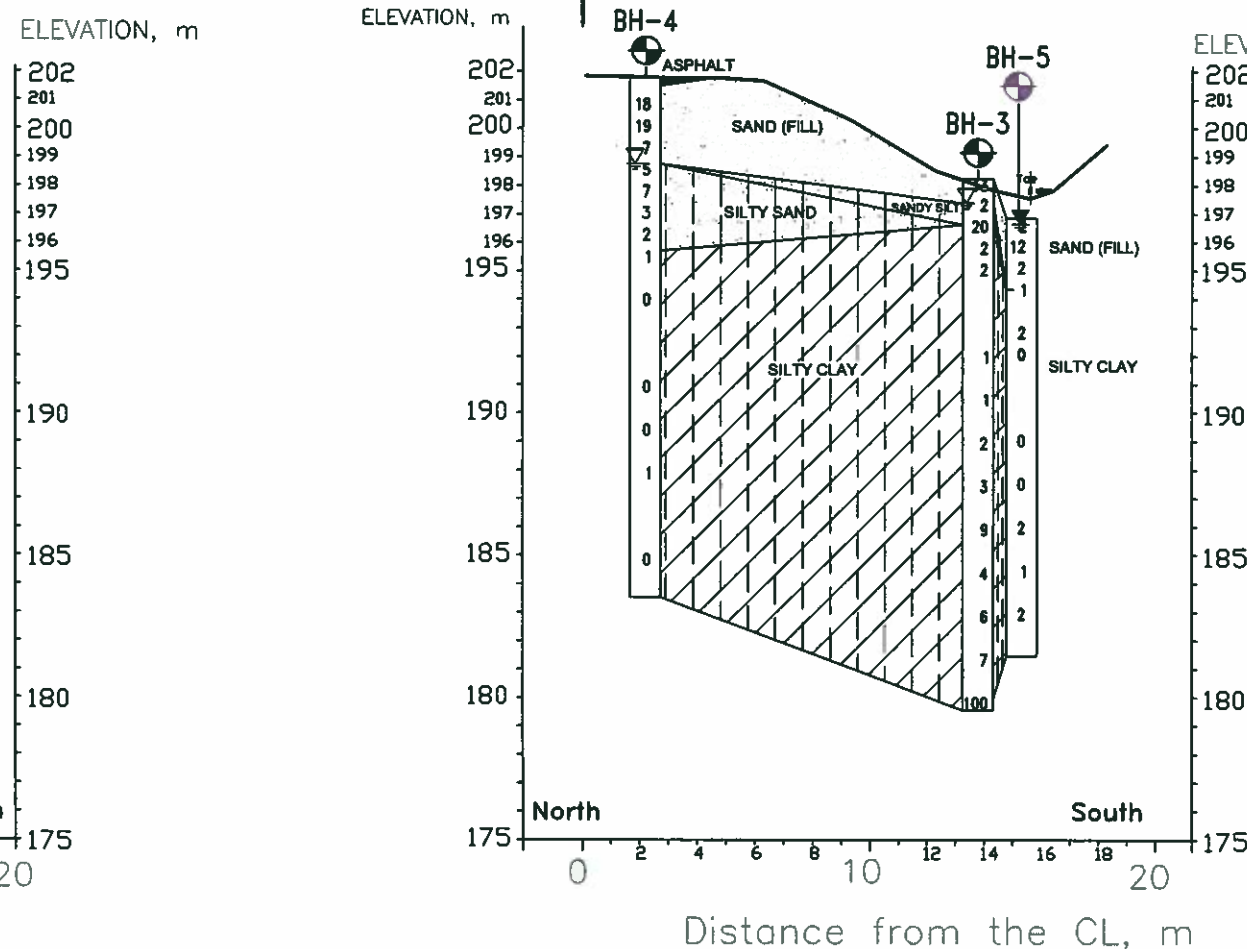
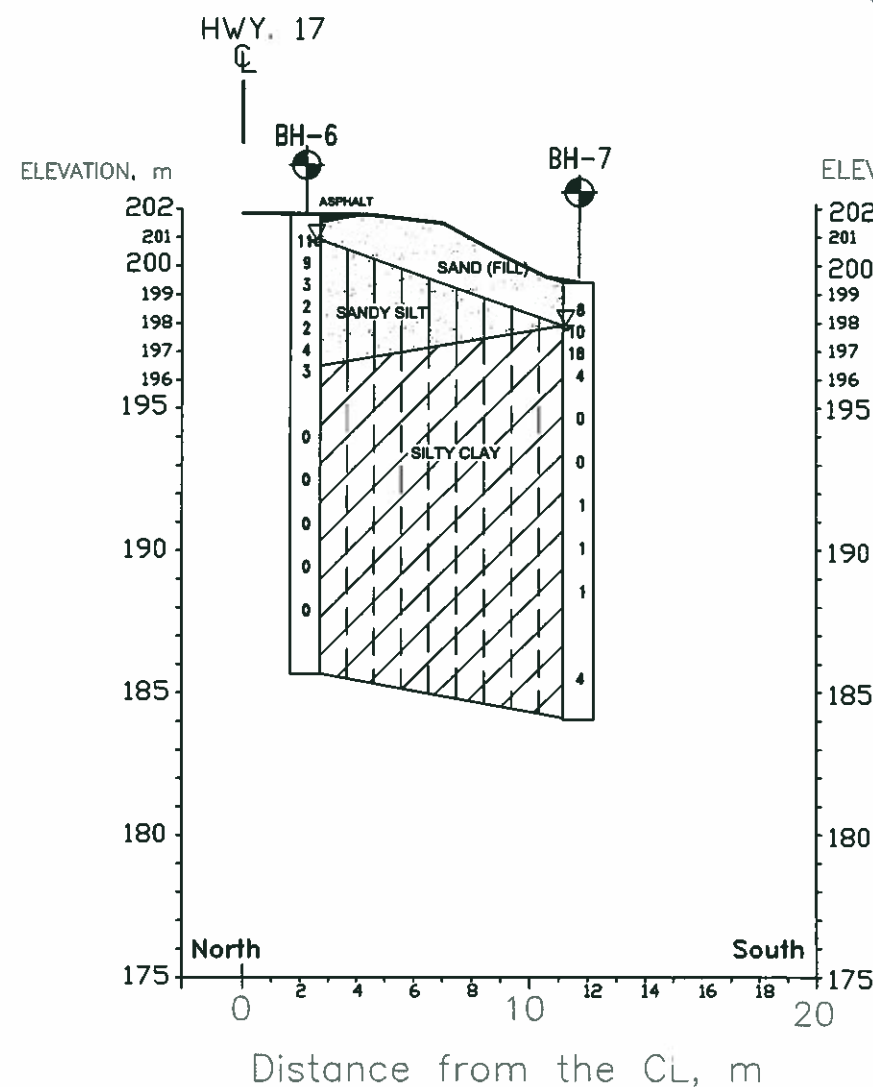


SHEET  
3

Cross Section B-B  
(at Station ~13+626)



Cross Section C-C  
(at Station ~13+585)



KEY MAP  
Not to Scale

LEGEND

- BOREHOLE
- Water Level (Piezometer)
- Water Level (Open hole)

No.	ELEVATION	STATION	OFFSET
BH-1	202.183	13+659.9	4.9
BH-2	201.872	13+565.0	5.3
BH-3	198.224	13+577.7	13.8
BH-4	201.799	13+585.3	2.2
BH-5	196.842	13+590.0	15.2
BH-6	201.824	13+625.9	2.2
BH-7	199.429	13+625.9	11.7

-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing to be read with subject report.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration only.
- Borehole locations are approximate.
- Borehole elevations should not be used to design building(s), or floor slab(s), or parking lot(s) grades.
- The elevation of the water level in the creek was measured by TROW on 11/Sept./2009

REVISIONS	DATE	BY	DESCRIPTION

SOIL STRATA SYMBOLS:

ASPHALT	SAND	SILTY CLAY
SILTY SAND	CLAYEY SILT	TILL

**TROW Associates Inc.**  
56 QUEEN STREET EAST, SUIT 301  
BRAMPTON, ONTARIO, L6V 4M8  
(905) 796-3200

PROJECT TITLE AND LOCATION:  
**Gabion Wall Construction  
near Laronde Creek  
Hwy 17, Sudbury**

DRAWING TITLE:  
**CROSS-SECTIONS  
B-B and C-C**

PROJECT NO. <b>5274-08-00</b>	DWN.: GQ
SCALE: AS NOTED	CHKD.: SM
DATE: Sept. 2009	DWG. No.: 3

# RECORD OF BOREHOLE No BH-1

1 OF 2

METRIC

W.P. 5274-08-00 LOCATION Laronde Creek, Nipissing Indian Reserve No. 10 ORIGINATED BY CS  
 DIST 54 HWY 17 BOREHOLE TYPE CME 200mm OI Hollow Stem Auger COMPILED BY KR  
 DATUM Geodetic DATE 09.9.3 CHECKED BY IM

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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
							WATER CONTENT (%)										
202.2							20	40	60	80	100	10	20	30	GR SA SI CL		
200.0	ASPHALT, (~ 50 mm)		1	AS											64 30 (6)		
201.0	SAND (FILL) (SW), brown, damp, well graded, compact, fine to coarse grained, some gravel, trace to some silt.		2	SS	25												
1.2	Clayey SILT (ML), grey, damp to wet, compact, poorly graded, some fine grained sand.		3	SS	10												
199.9	SILTY CLAY (CL), grey, saturated, low plasticity, soft to stiff.		4	SS	0												
2.3			5	TW			2.4										
			6	SS	0		3.5										
			7	SS	0		3.3							45.1			
			8	SS	0		3.3							50.2			
			9	TW			3.4										
			10	SS	0		3.5										
			11	SS	0		3.5										
			12	SS	0		3.5										
			13	SS	0		3.2										
			14	SS	2		3.6										
			15	SS	0		2.4										
			16	SS	0		2.0										
			17	SS	0		2.3										
							3.4										

Continued Next Page

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

ON\_MOT\_SO11878G - LARONDE CREEK BRIDGE BY GREG & GPJ ON\_MOT\_GDT 09/10/21



# RECORD OF BOREHOLE No BH-2

1 OF 2

METRIC

W.P. 5274-08-00 LOCATION Laronde Creek, Nipissing Indian Reserve No. 10 ORIGINATED BY CS  
 DIST 54 HWY 17 BOREHOLE TYPE CME 200mm OI Hollow Stem Auger COMPILED BY KR  
 DATUM Geodetic DATE 09.9.4 CHECKED BY IM

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 (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE							
201.9								20 40 60 80 100		10 20 30						
200.8	ASPHALT, ( ~ 50 mm)		1	AS												
	SAND (FILL) (SW), brown, damp, loose, well graded, fine to coarse grained, some fine to coarse gravel, trace silt.		2	SS	6											
200.4	- some silt below 0.8 m															
1.5	CLAYEY SILT (ML), grey, wet, very loose to loose, trace sand, trace to some clay.		3	SS	5											
	very loose below ~ 2.29 m depth.		4	SS	2											
198.8	SILTY CLAY (CI), grey, saturated, medium plasticity, firm to stiff.		5	SS	0											
3.1			6	TW												
			7	SS	0											
			8	SS	0											
			9	SS	0											
			10	TW												
			11	SS	0											
			12	SS	0											
			13	SS	0											
			14	TW												
			15	SS	0											
			16	SS	0											
			17	SS	0											

Continued Next Page

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

# RECORD OF BOREHOLE No BH-2

2 OF 2

**METRIC**

W.P. 5274-08-00 LOCATION Laronde Creek, Nipissing Indian Reserve No. 10 ORIGINATED BY CS  
 DIST 54 HWY 17 BOREHOLE TYPE CME 200mm OI Hollow Stem Auger COMPILED BY KR  
 DATUM Geodetic DATE 09.9.4 CHECKED BY IM

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									
								20	40	60	80	100					
			18	SS	2												
180.5							181										
21.3	HARD AUGERING, suspected sand and gravel till.		19	BAG			180										
179.6																	
22.3	BOREHOLE TERMINATED AT ~ 22.25 m DEPTH DUE TO AUGER REFUSAL ON SUSPECTED BEDROCK																
	NOTES: 1. This drawing is to be read with the subject report and project number as presented above. 2. Interpretation assistance by Trow is required before use by others. 3. Date of W.L.=Sept. 11, 2009. 4. Installed monitoring well to 12.2 m depth.																

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

# RECORD OF BOREHOLE No BH-3

1 OF 1

METRIC

W.P. 5274-08-00 LOCATION Laronde Creek, Nipissing Indian Reserve No. 10 ORIGINATED BY CS  
 DIST 54 HWY 17 BOREHOLE TYPE Hollow Stem Auger (Wash Boring) COMPILED BY KR  
 DATUM Geodetic DATE 09.9.8 CHECKED BY IM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
198.2							20 40 60 80 100			W <sub>P</sub>	W	W <sub>L</sub>		GR SA SI CL			
0.0	TOPSOIL (~76mm) over		1	SS	13		198								(Gs=2.733) 0 0 35 65		
197.4	<b>SAND (FILL) (SW)</b> , brown, damp, compact, poorly graded, fine to coarse grained, some silt, trace to some gravel.		2	SS	2		197										
0.8	<b>SANDY SILT (SM)</b> , grey, wet, very loose, some gravel.		3	SS	20		196										
196.6	<b>SILTY CLAY (CI-MI)</b> , brown, saturated, medium plasticity, soft to stiff.		4	SS	2		195										
1.6			5	SS	2		194										
	grey below ~ 3.05 m depth.		6	TW			193										
			7	SS	1		192										
			8	SS	1		191										
			9	SS	2		190										
			10	SS	3		189										
			11	SS	9		188										
			12	SS	4		187										
			13	SS	6		186										
			14	SS	7		185										
			15	SS	100		184										
179.6	BOREHOLE TERMINATED AT ~ 18.67 m DEPTH DUE TO SPT REFUSAL ON SUSPECTED BEDROCK					183											
18.7						182											
						181											
						180											

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

ON\_MOT\_SO11878G - LARONDE CREEK BRIDGE BY GREG & GPJ ON\_MOT\_GDT 09/10/21

# RECORD OF BOREHOLE No BH-4

1 OF 2

METRIC

W.P. 5274-08-00 LOCATION Laronde Creek, Nipissing Indian Reserve No. 10 ORIGINATED BY CS  
 DIST 54 HWY 17 BOREHOLE TYPE CME 200mm OI Hollow Stem Auger COMPILED BY KR  
 DATUM Geodetic DATE 09.9.9 CHECKED BY IM

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								WATER CONTENT (%)		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
201.8																		
200.9	ASPHALT, ( ~ 300 mm)																	
0.3	SAND (FILL) (SW), brown, damp, loose to compact, poorly graded, fine grained, trace to some silt, trace gravel. with silt below ~ 0.76 m depth. HARD AUGERING		1	AS														
			2	SS	18													
			3	SS	19													
	No Sample Recovery		4	SS	7													
198.7																		
3.1	SILTY SAND(SM), brown, damp to wet, loose, trace clay.		5	SS	5													
			6	SS	7													
	brown to grey, very loose below ~ 4.57 m depth.		7	SS	3													
			8	SS	2													
195.7	brown, wet, fine to medium grained, trace organics below ~ 5.33 m depth.																	
6.1	SILTY CLAY (CL), grey, saturated, firm to stiff, low plasticity		9	SS	1													
			10	SS	0													
			11	TW														
			12	SS	0													
	varved below ~ 12.19 m depth.		13	SS	0													
			14	SS	1													
			15	TW														
			16	SS	0													
	brown/grey, with silt seems below ~ 16.76 m depth.																	
183.5																		
18.3	BOREHOLE TERMINATED AT ~ 18.28 m DEPTH																	
	NOTES: 1. This drawing is to be read with the subject report and project number as presented above.																	

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON\_MOT\_S011878G - LARONDE CREEK BRIDGE BY GREG & GPJ ON\_MOT\_GDT 09/10/21



# RECORD OF BOREHOLE No BH-4

2 OF 2

**METRIC**

W.P. 5274-08-00 LOCATION Laronde Creek, Nipissing Indian Reserve No. 10 ORIGINATED BY CS  
 DIST 54 HWY 17 BOREHOLE TYPE CME 200mm OI Hollow Stem Auger COMPILED BY KR  
 DATUM Geodetic DATE 09.9.9 CHECKED BY IM




SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			LIQUID LIMIT	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					WATER CONTENT (%)				
						20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>				
	2. Interpretation assistance by Trow is required before use by others. 3. Date of W.L.=Sept. 11, 2009. 4. Installed PVC standpipes to 12.2 m depth.																

# RECORD OF BOREHOLE No BH-5

1 OF 1

METRIC

W.P. 5274-08-00 LOCATION Laronde Creek, Nipissing Indian Reserve No. 10 ORIGINATED BY GQ  
 DIST 54 HWY 17 BOREHOLE TYPE Hollow Stem Auger (Wash Boring) COMPILED BY GQ  
 DATUM Geodetic DATE 09.9.9 CHECKED BY VD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		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		$w_p$	$w$	$w_L$	WATER CONTENT (%)				
								$\circ$ UNCONFINED $\bullet$ QUICK TRIAXIAL	$+$ FIELD VANE $\times$ LAB VANE								
196.8							20 40 60 80 100				10 20 30						
0.0	TOPSOIL, ( ~ 15 mm) over <b>SAND (FILL) (SW)</b> , some silt, trace rootlets and wood deris. brown, damp to wet, very loose to compact, fine grained. - a thin (0.15 m) layer of silty clay at a depth of about 0.9 m - become wet below 1.05 m		1	SS	2		196										
			2	SS	12												
			3	SS	2		195										
194.4																67.8	
2.5	<b>SILTY CLAY (CL)</b> , varved, grey, saturated, soft to stiff, low plasticity		4	SS	1		194										
								5.3									
			5	SS	2		193									68.3	
			6	SS	0		192									56.1	
								2.7									
			7	TW			191										
								4.5									
			8	SS	0		190										
								2.4								53.3	
							189										
			9	SS	0		188									43.3	
								3.1									
							187										
			10	SS	2		186									50.7	
								3.1									
			11	SS	1		185										
								2.1									
			12	SS	2		184									55.5	
								2.2									
							183										
								4.0									
181.5							182										
15.4	BOREHOLE TERMINATED AT ~ 15.4 m DEPTH																
	NOTES: 1. This drawing is to be read with the subject report and project number as presented above. 2. Interpretation assistance by Trow is required before use by others. 3. Date of W.L.=Sept. 11, 2009. 4. Installed monitoring well to 11.2 m depth.																

ON\_MOT\_SO11878G - LARONDE CREEK BRIDGE BY GREG & GPJ ON\_MOT.GDT 09/10/21

# RECORD OF BOREHOLE No BH-6

1 OF 1

METRIC

W.P. 5274-08-00 LOCATION Laronde Creek, Nipissing Indian Reserve No. 10 ORIGINATED BY CS  
 DIST 54 HWY 17 BOREHOLE TYPE CME 200mm OI Hollow Stem Auger COMPILED BY KR  
 DATUM Geodetic DATE 09.9.10 CHECKED BY IM

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								WATER CONTENT (%)		
								○ UNCONFINED	+	FIELD VANE								
						● QUICK TRIAXIAL	×	LAB VANE										
201.8								20	40	60	80	100	10	20	30			
200.9	ASPHALT, ( ~ 300 mm)																	
0.3	SAND (FILL) (SW), brown, damp, fine to coarse grained, trace fine grained gravel, some silt.		1	AS			201											
200.9	SANDY SILT(SM), brown, wet, very loose to compact, trace fine to coarse grained gravel.		2	SS	11													
0.9			3	SS	9		200											
			4	SS	3		199											
	very loose below ~ 2.57 m depth.		5	SS	2		198											
	trace clay below ~ 3.05 m depth.		6	SS	2		197											
			7	SS	4		196											
	clayey below ~ 4.57 m depth.		8	SS	3		195											
196.5	SILTY CLAY (CL), grey, saturated, low plasticity, firm to stiff		9	TW			194											
5.3			10	SS	0		193											
			11	SS	0		192											
			12	SS	0		191											
			13	SS	0		190											
			14	SS	0		189											
			15	TW			188											
185.7	BOREHOLE TERMINATED AT ~ 16.15 m DEPTH						187											
16.2							186											
NOTES: 1. This drawing is to be read with the subject report and project number as presented above. 2. Interpretation assistance by Trow is required before use by others. 3. Date of W.L.=Sept. 11, 2009. 4. Installed PVC standpipes to 12.2 m depth.																		

NOTES:  
 1. This drawing is to be read with  
the subject report and project  
number as presented above.  
 2. Interpretation assistance by Trow  
is required before use by others.  
 3. Date of W.L.=Sept. 11, 2009.  
 4. Installed PVC standpipes to 12.2  
m depth.

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

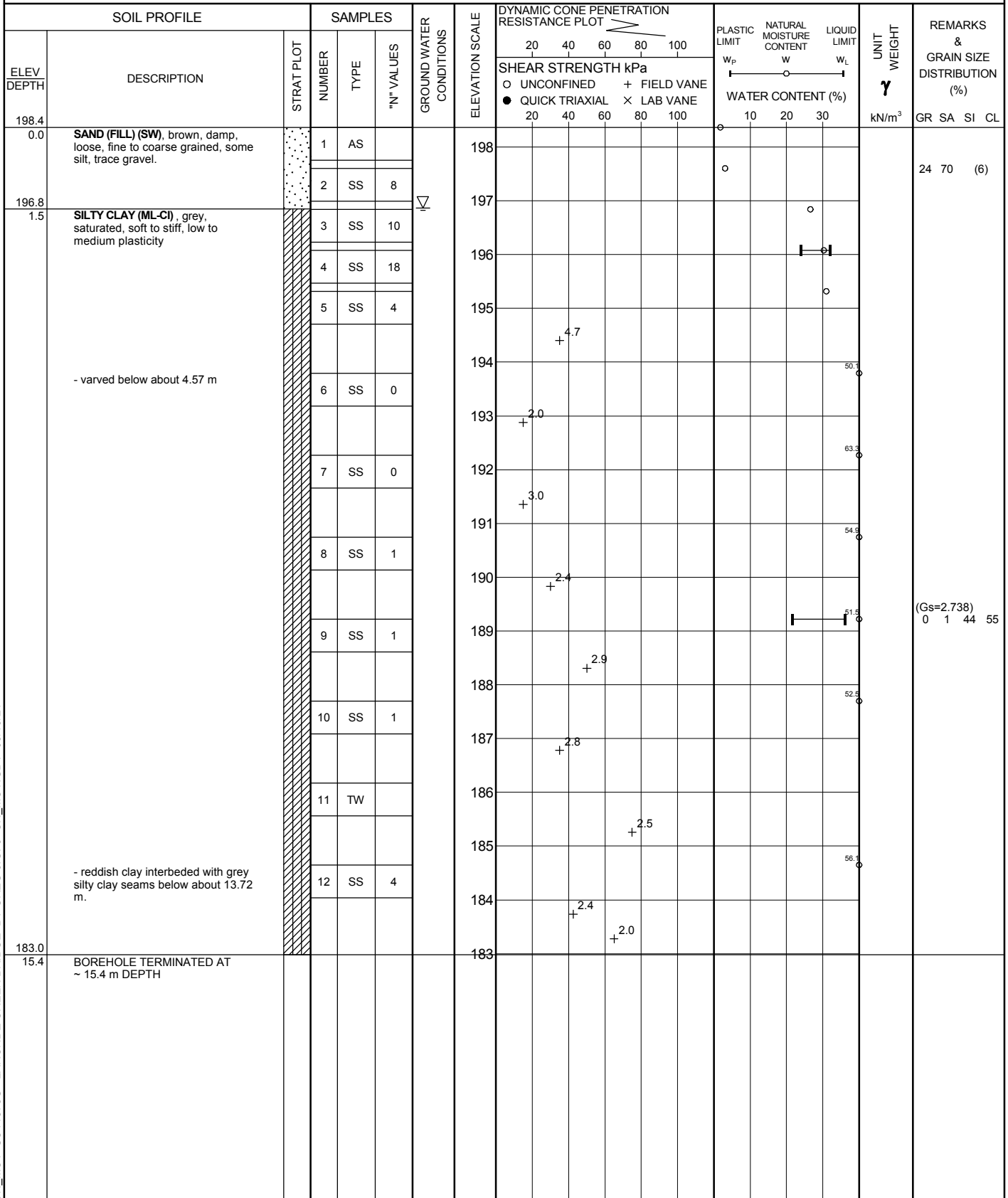
ON\_MOT\_SO11878G - LARONDE CREEK BRIDGE BY GREG & GPJ ON\_MOT.GDT 09/10/21

# RECORD OF BOREHOLE No BH-7

1 OF 1

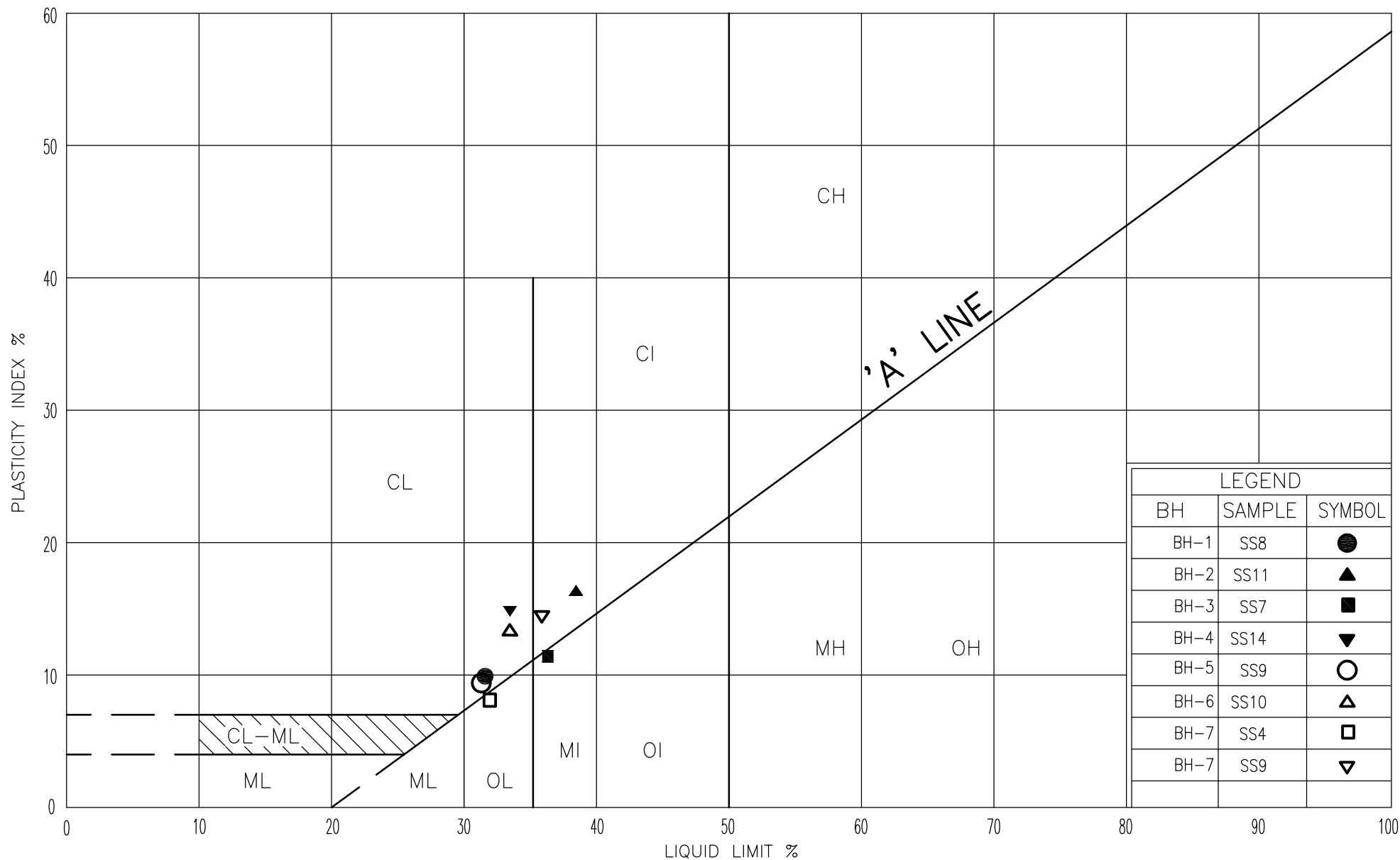
METRIC

W.P. 5274-08-00 LOCATION Laronde Creek, Nipissing Indian Reserve No. 10 ORIGINATED BY GQ  
 DIST 54 HWY 17 BOREHOLE TYPE Hollow Stem Auger (Wash Boring) COMPILED BY GQ  
 DATUM Geodetic DATE 09.9.10 CHECKED BY VD



+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON\_MOT\_SO11878G - LARONDE CREEK BRIDGE BY GREG & GPJ ON\_MOT\_GDT 09/10/21

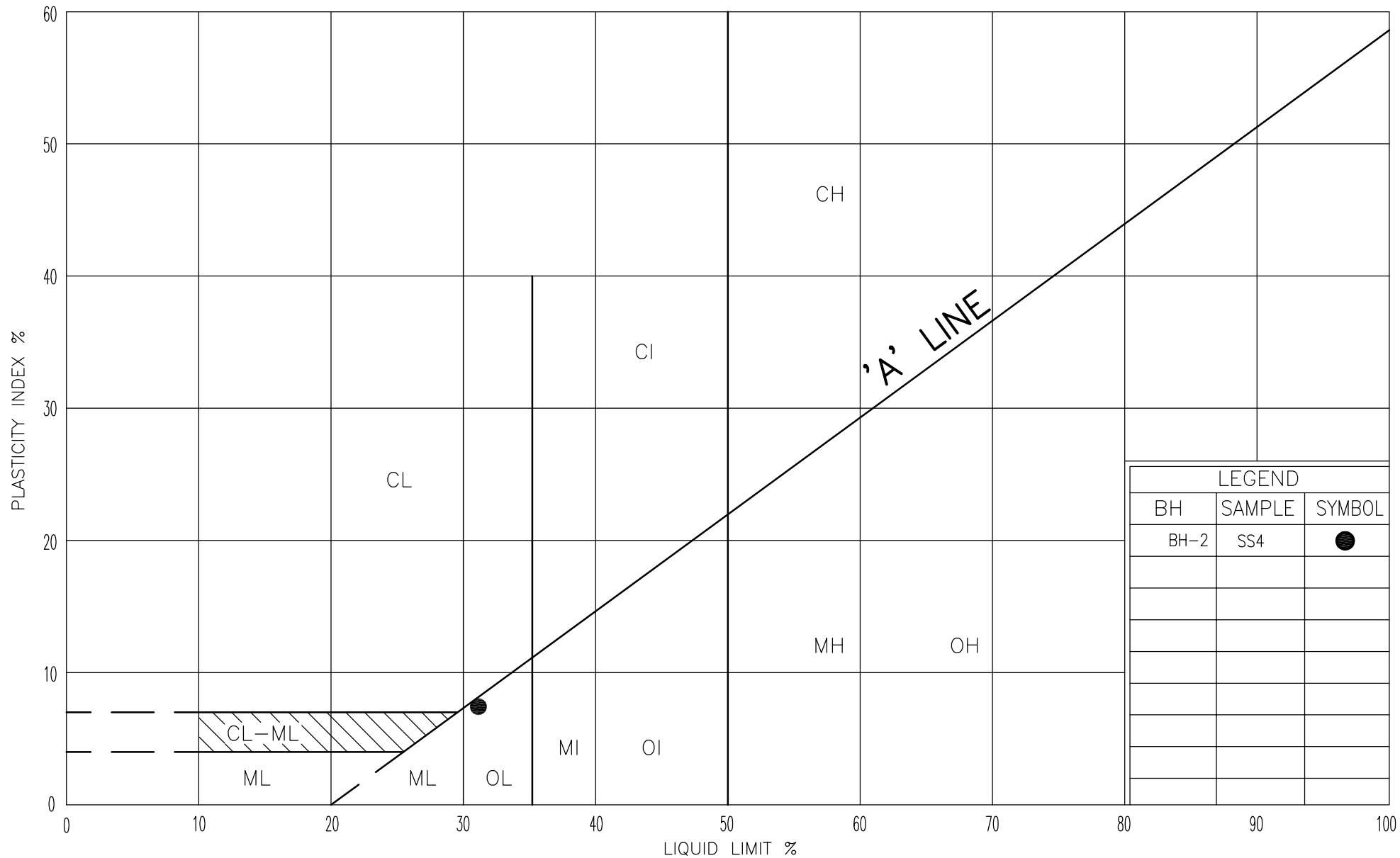


PLASTICITY CHART  
SILTY CLAY, (CL, CI, ML, MI)

FIGURE No. 1

WO: 5274-08-00

Gabion Wall Construction, Hwy 17 Sudbury

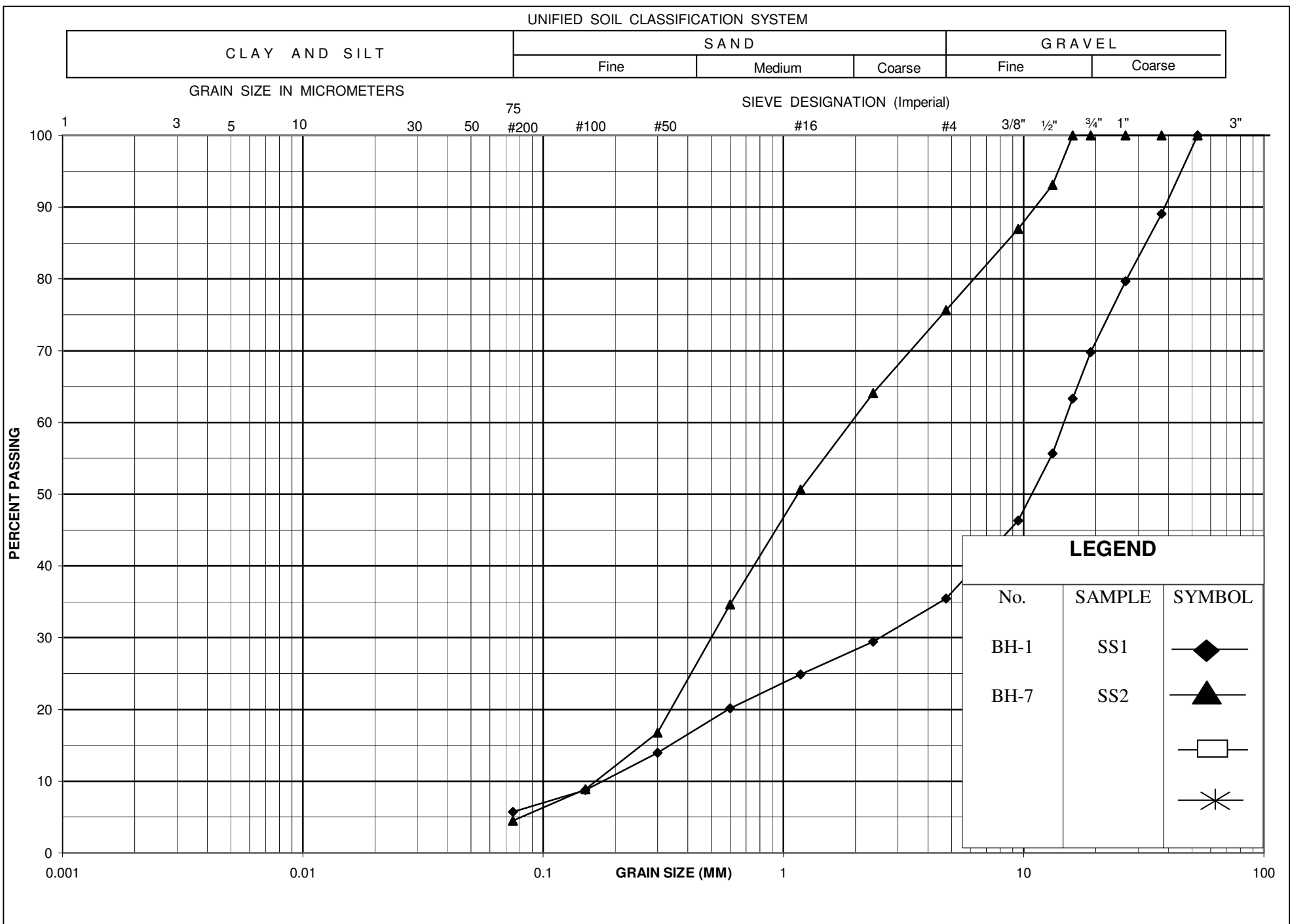


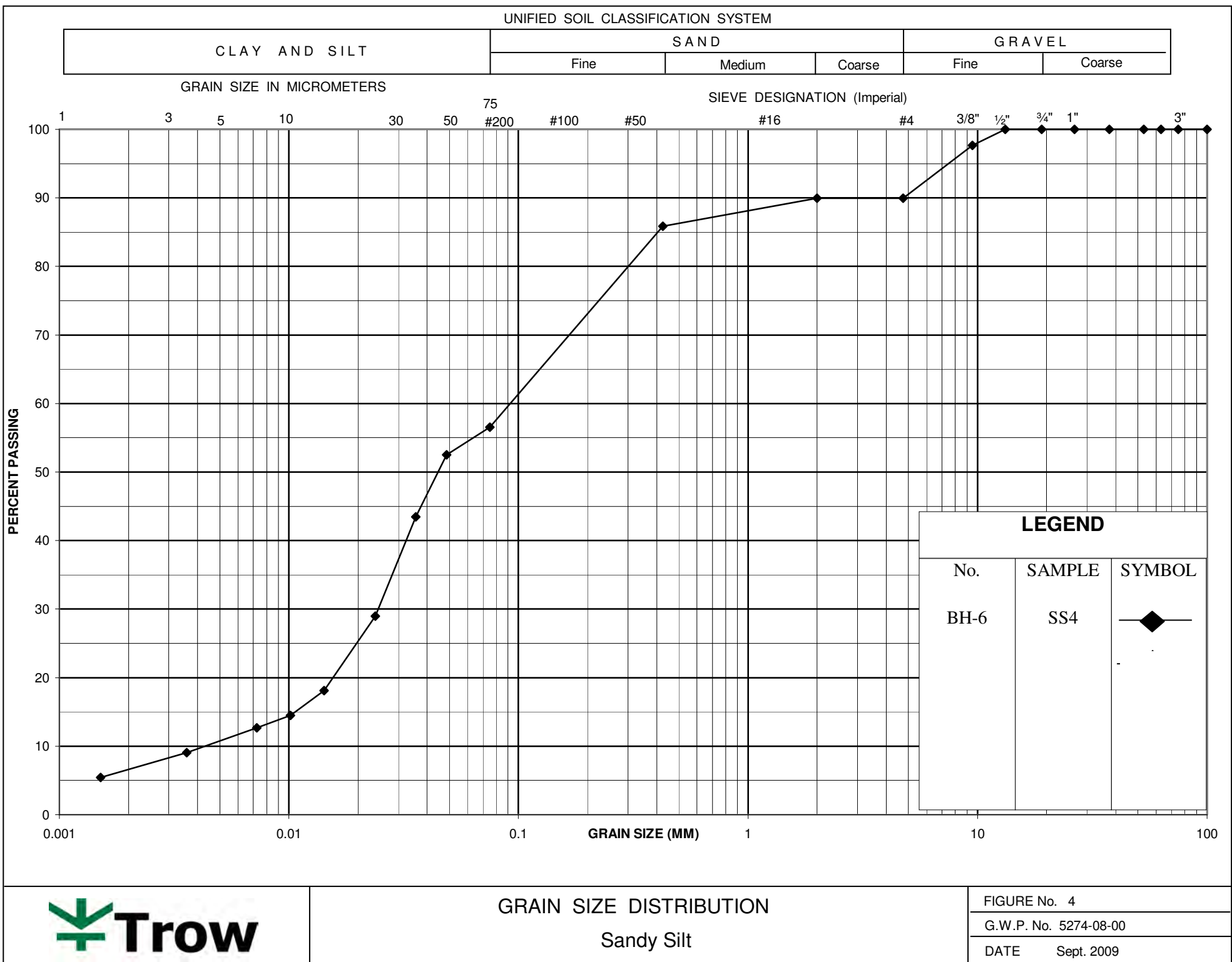
# PLASTICITY CHART SILT, (ML)

FIGURE No. 2

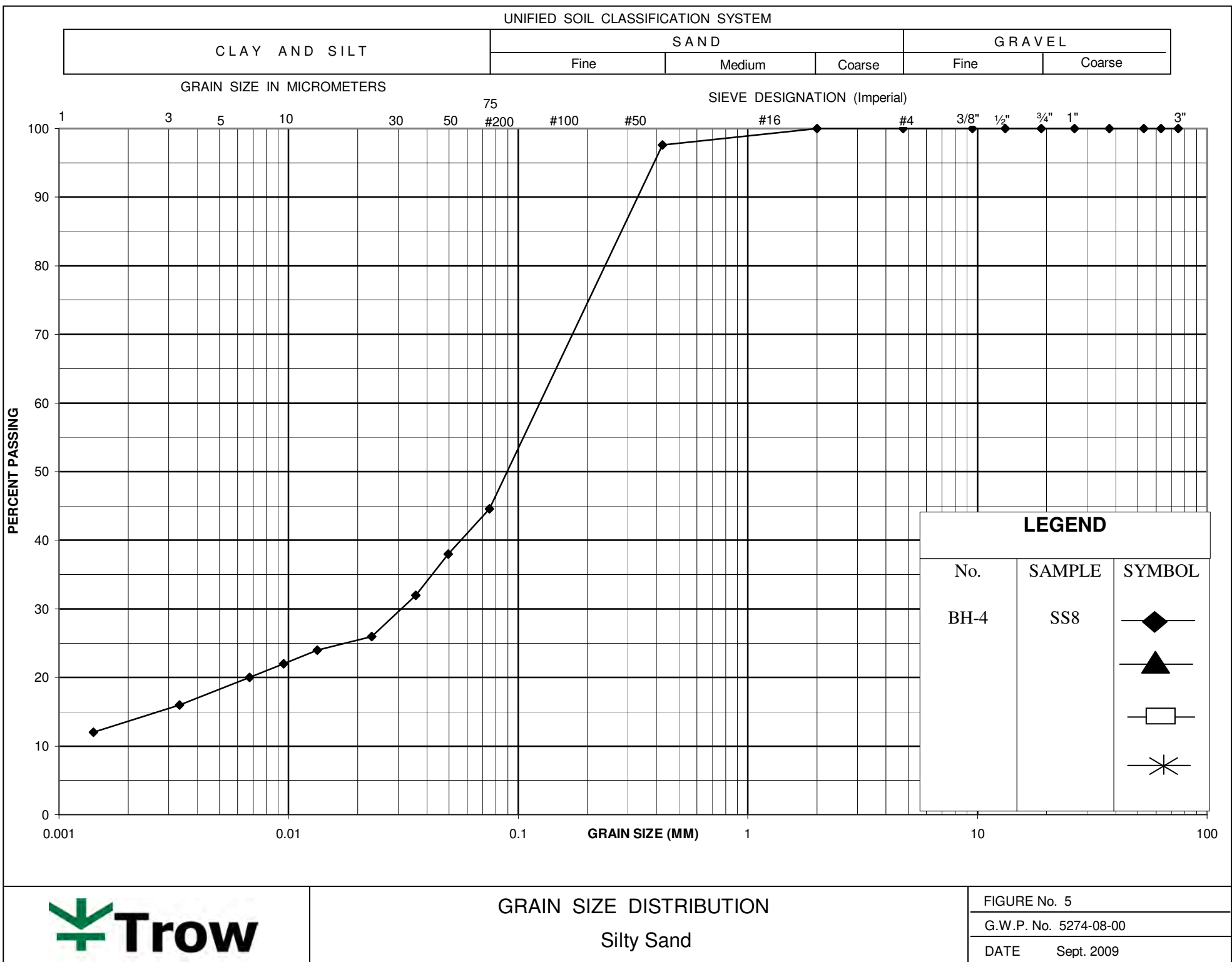
WO: 5274-08-00

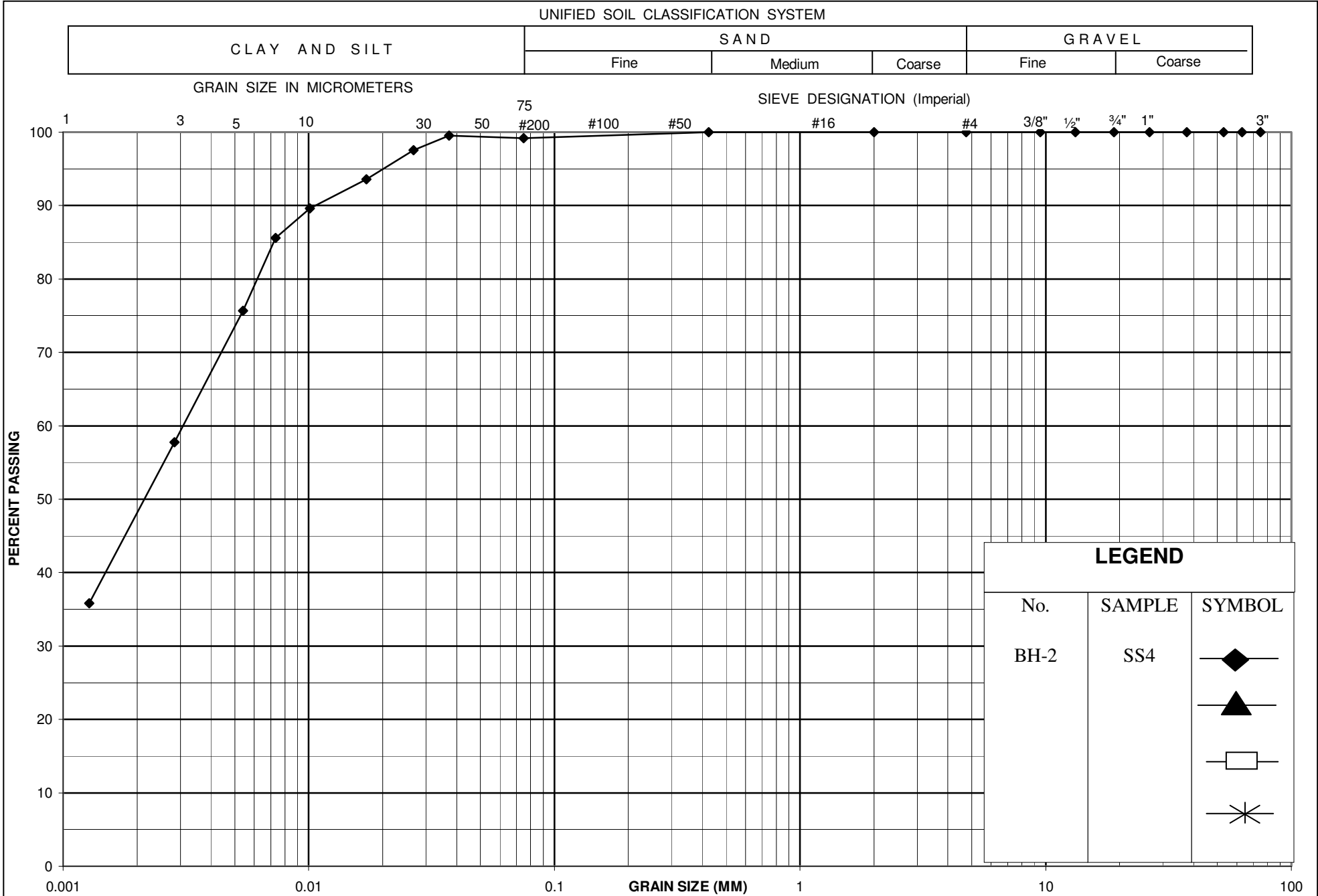
Gabion Wall Construction, Hwy 17 Sudbury

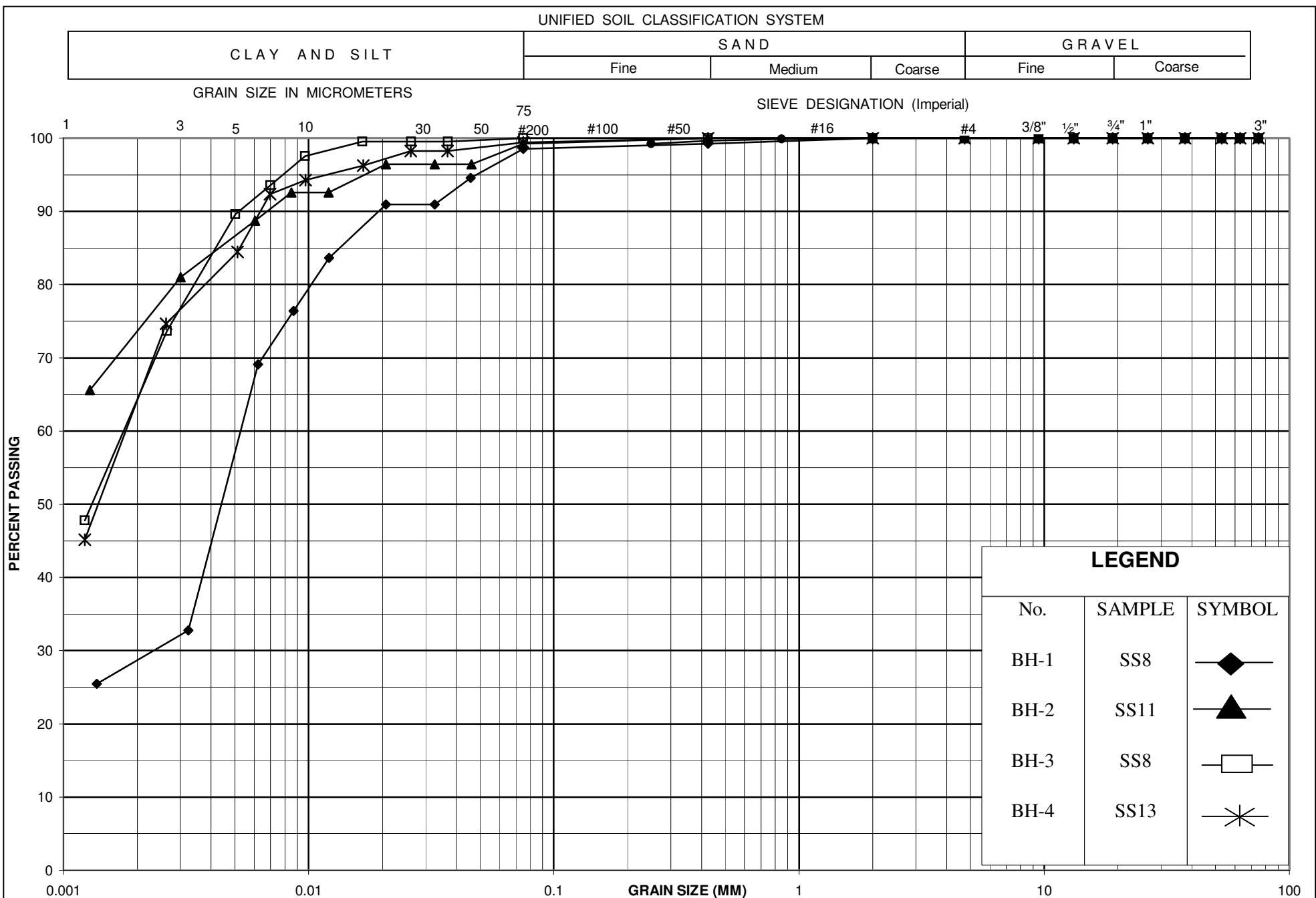


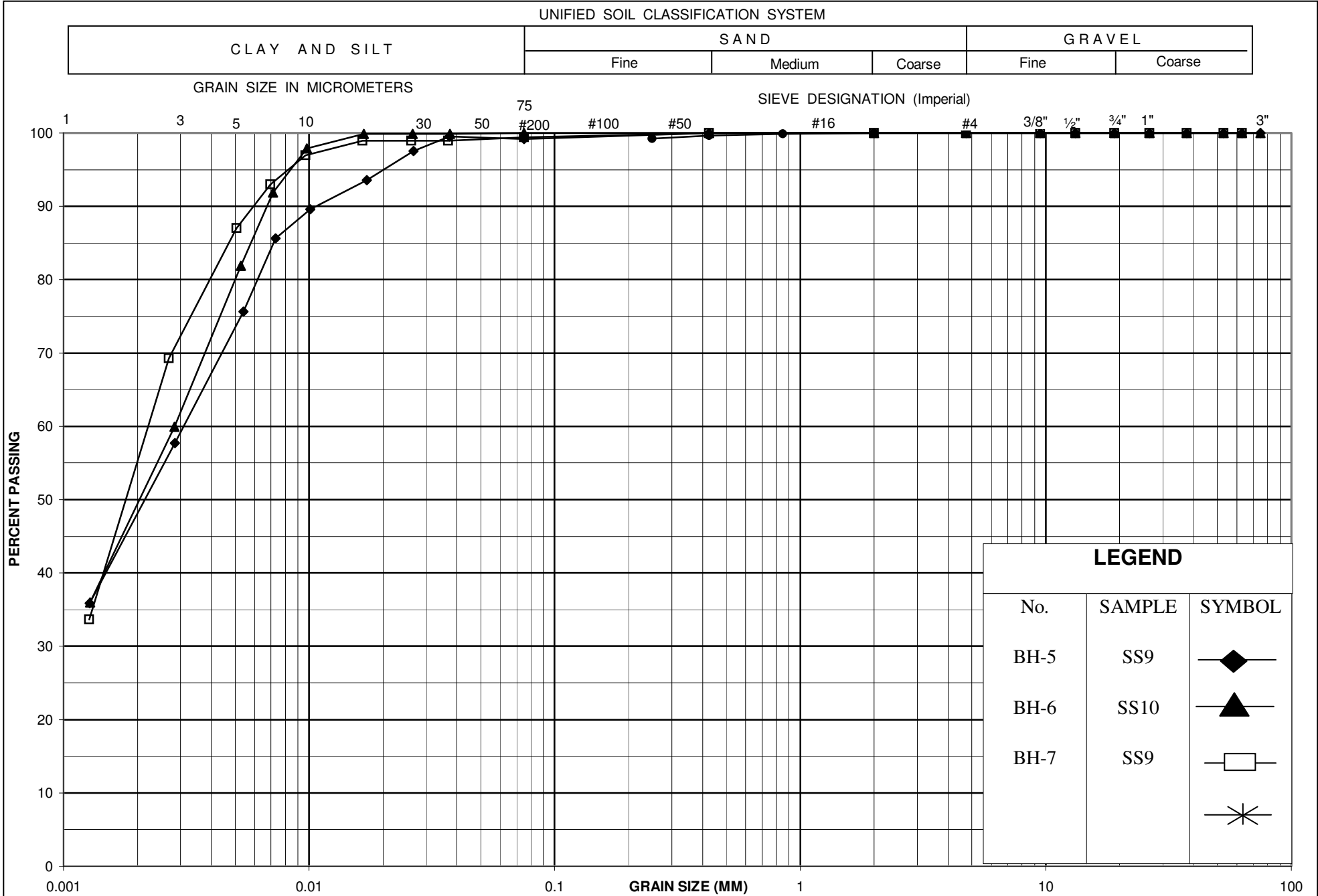








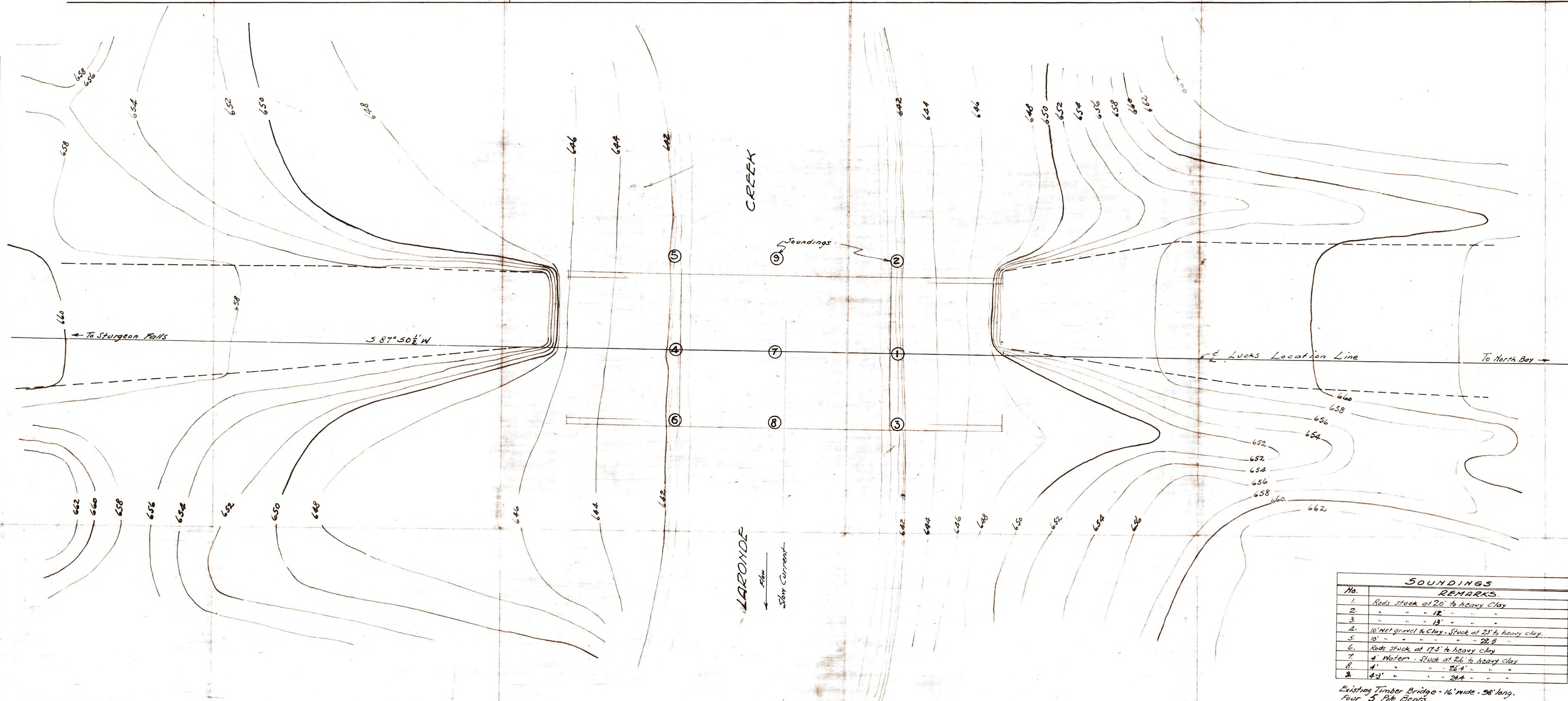






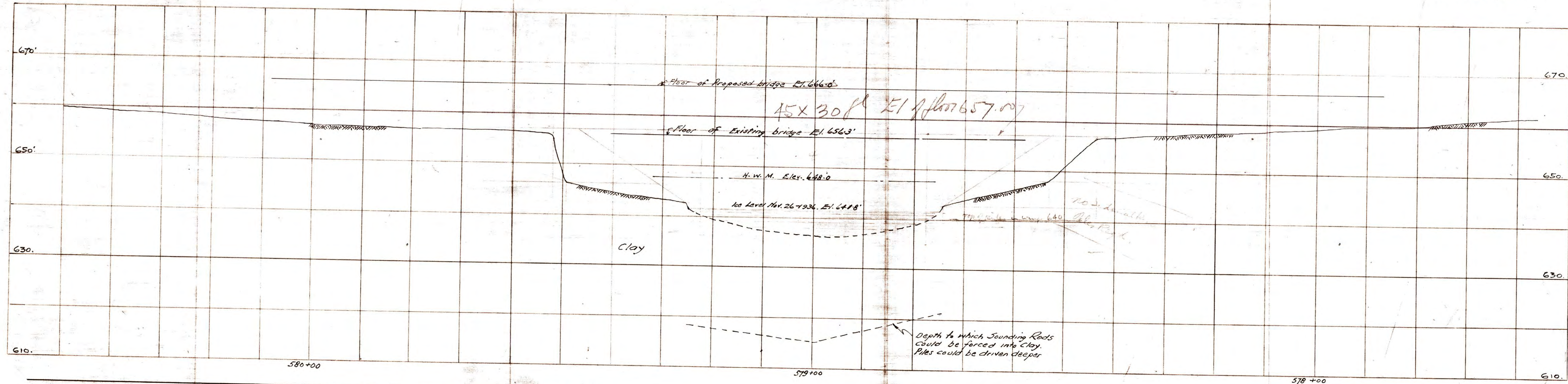
**Appendix F.**  
**Archived Drawings**





SOUNDINGS	
No.	REMARKS
1.	Rods stuck at 20' to heavy clay
2.	" " " 18' " "
3.	" " " 13' " "
4.	10' net gravel & clay. Stuck at 23' to heavy clay.
5.	10' " " " " 22' "
6.	Rods stuck at 17' to heavy clay
7.	4' water - stuck at 26' to heavy clay
8.	4' " " 26' " "
9.	4' " " 24' " "

Existing Timber Bridge - 16' wide - 98' long.  
Four 5' pile bents.



REVISIONS		DATE		REMARKS		REV. BY	
DEPARTMENT OF NORTHERN DEVELOPMENT DISTRICT OF STURGEON FALLS							
PLAN & SECTION OF BRIDGE SITE LARONDE CREEK Lot 8 - Con. 1 TOWNSHIP OF BEAUCAGE							
SCALES: 1 in. = 10 FT.		APPROVED: Engineer of Construction <i>[Signature]</i> District Engineer					
DR. H.L.H. CHKD G.P.A. OFFICE NORTH BAY-ONT. DWG. D TR. P.H.S. CNKD DATE DEC 29 <sup>th</sup> 1936 2325-A							



