



**THURBER** ENGINEERING LTD.

**PRELIMINARY  
FOUNDATION INVESTIGATION REPORT  
HIGHWAY 17 TWINNING, RENFREW AREA  
BONNECHERE RIVER BRIDGE  
STA. 20+200, HORTON TOWNSHIP  
EASTBOUND STRUCTURE - SITE NO. 29X-0192/B1  
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009**

Geocres No.: 31F-236

Report to:

**Ministry of Transportation Ontario**

Latitude: 45.486519°  
Longitude: -76.657840°

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## TABLE OF CONTENTS

### PART 1. FACTUAL INFORMATION

1	INTRODUCTION .....	1
2	SITE DESCRIPTION .....	2
2.1	General .....	2
2.2	Site Geology .....	2
3	SITE INVESTIGATION AND FIELD TESTING.....	3
3.1	Previous Investigation (2003) .....	3
3.2	Current Investigation (2020, 2021, and 2024) .....	4
4	LABORATORY TESTING.....	6
5	GENERAL DESCRIPTION OF SUBSURFACE CONDITIONS.....	6
5.1	Topsoil .....	7
5.2	Fill .....	7
5.3	Silty Clay to Clayey Silt.....	7
5.3.1	Silty Clay (Weathered Crust).....	7
5.3.2	Clayey Silt (CL) .....	8
5.4	Silty Sand to Clayey Silt (SM, ML, CL-ML, CL).....	10
5.5	Silty Sand to Sand Some Silt .....	11
5.6	Sand and Gravel .....	11
5.7	Bedrock.....	12
5.8	Groundwater .....	13
5.9	Analytical Testing .....	15
6	MISCELLANEOUS .....	16



## **Appendices**

- APPENDIX A. BOREHOLE LOCATION PLAN AND STRATIGRAPHIC DRAWING
- APPENDIX B. RECORD OF TESTHOLE SHEETS AND FIELD TESTING
  - APPENDIX B.1 CURRENT (2020/2021/2024) INVESTIGATION
  - APPENDIX B.2 PREVIOUS (2003) INVESTIGATION
  - APPENDIX B.3 CONE PENETRATION TEST SUMMARY SHEETS (CONETEC INVESTIGATIONS LTD.)
  - APPENDIX B.4 MASW TESTING SUMMARY (GEOPHYSICS GPR INTERNATIONAL INC.)
  - APPENDIX B.5 SOIL SUMMARY PLOTS
- APPENDIX C. LABORATORY TESTING CURRENT (2020/2021/2024) INVESTIGATION
- APPENDIX D. LABORATORY TESTING PREVIOUS (2003) INVESTIGATION
- APPENDIX E. SITE PHOTOGRAPHS



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**PART 1. FACTUAL INFORMATION**

**1 INTRODUCTION**

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

This report addresses the proposed eastbound Highway 17 bridge over the Bonnechere River (Site No. 29X-0192/B1) near Renfrew, Ontario. The existing Highway 17 alignment at this site will become the future Highway 17 westbound lanes and new eastbound lanes will be constructed to the south of the existing alignment.

Previous foundation investigation information from boreholes completed in 2003 for the proposed eastbound bridge structure was available under Geocres 31F-136. The original investigation for the existing Highway 17 six-span bridge was available under Geocres 31F-018.

This section of the report presents the factual findings obtained from the available historical foundation investigation reports and from the foundation investigation completed as part of the current study.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions influencing design and construction of the proposed bridge and approaches was developed in the course of the investigation.

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





## 2 SITE DESCRIPTION

### 2.1 General

The site is located on Highway 17 approximately 1.0 km west of O'Brien Road (Highway 60). Highway 17 is generally oriented southeast to northwest and the Bonnechere River at the site is oriented roughly southwest to northeast. For project purposes, the highway and river are herein described as oriented east-west and north-south, respectively.

The land adjacent to the site typically consists of agricultural fields and forests. The historical riverbanks of the Bonnechere River Valley that abut the relatively flat terrain beyond (at Elevation 120 m and higher), are incised as much as 30 m (down to Elevation 83 m) to form the river valley. Along the proposed Bonnechere River Bridge alignment, the upper slope of the west bank is inclined at about 6H:1V, down to a bench at about mid-height (Elevation 102 m). The lower portion of the west bank is inclined as steep as about 1.8H:1V. The east bank is more uniform along its entire height and sloped at about 2.5H:1V. At the time of the current investigation, the east bank was heavily forested. It is noted that, similar to most river valleys, the existing slopes have a history of instability. Geocres Report 31F-018 indicates a major slump occurred about 400 m upstream of the existing bridge.

Existing Highway 17 in this area consists of a two-lane undivided highway with paved shoulders, 3-cable guiderails, and a posted speed limit of 90 km/hr. The AADT for the section of Highway 17 near the site was reported to be 13,900 in 2016. The existing embankment side slopes did not show any visible signs of distress at the time of the investigation and were sloped at approximately 2.0H:1V.

At the existing bridge approaches, the Highway 17 road surface elevation is approximately 110.4 m and 111.2 m at the east and west approaches, respectively. The river level is at approximate elevation 83.4 m

West of the river, the proposed Highway 17 approach to the bridge will require embankment fills up to about 11.5 m in height. East of the river, Highway 17 enters a cut section with the cuts up to about 6 m deep within the area of interest addressed herein.

Photographs showing the existing conditions in the area of the site at the time of the field investigation are included in Appendix E for reference.

### 2.2 Site Geology

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



Ontario Geological Survey Map P.3784 for Precambrian Geology for the Horton Area suggests the bedrock is comprised of dolomitic and calcitic carbonate metasedimentary bedrock including dolomite and calcite marble.

### 3 SITE INVESTIGATION AND FIELD TESTING

The foundation investigation for the existing bridge was carried out in 1971 and included 12 boreholes, as reported in Geocres 31F-018. The information from this report has been reviewed to establish stratigraphic context with some specific, relevant data included within the present report.

An initial foundation investigation for the proposed twin structure was carried out in October 2003 (Geocres 31F-136) as input to the preliminary design and environmental assessment study.

The current investigation was carried out in three phases between September 2020 and May 2024 to collect additional subsurface information for design of the proposed twin bridge structure and associated approaches.

#### 3.1 Previous Investigation (2003)

A total of six boreholes were put down as part of the 2003 investigation. Please refer to Geocres Report 31F-136 for details on investigation methodology. The boreholes were advanced to depths ranging from 18.5 m to 34.4 m below the existing ground surface.

The northing, easting and ground surface elevation of each of the 2003 boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A, the individual Record of Borehole sheets in Appendix B, and in Table 3-1, below. The site is located within MTM Zone 9.

**Table 3-1: Borehole Summary – Previous Investigation (2003)**

Test Hole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface* Elevation (m)	Termination Depth (m)
BON-1	West Abutment	5038578.0 (45.487015)	292351.3 (-76.659255)	102.4	30.5
BON-2	Pier 1	5038548.1 (45.486747)	292414.8 (-76.658442)	87.2	34.4
BON-3	Pier 2	5038497.2 (45.486291)	292509.5 (-76.657229)	86.1	26.0
BON-4	Pier 3	5038463.3 (45.485987)	292564.5 (-76.656525)	89.7	18.5
BON-6	West Approach	5038595.5 (45.487172)	292317.1 (-76.659693)	103.0	27.5
BON-7	West Approach	5038628.5 (45.487468)	292261.1 (-76.660410)	113.0	31.1

\* Ground surface elevation measured during investigation and may have changed in intervening time.



Piezometers, 19 mm in diameter, were installed in all six boreholes. The installation details are illustrated on the respective Record of Borehole sheets provided in Appendix B.

### 3.2 Current Investigation (2020, 2021, and 2024)

The current site investigation and field-testing program was carried out in three phases: August to September 2020, August to November 2021, and April to May 2024. The current investigation consisted of advancing a total of 17 test holes, comprising 15 boreholes (denoted as BON19-1 to BON19-9, BON-P1 to BON-P3, and BON24-1 to BON24-3) and two Cone Penetration Tests (CPT, denoted as BON-E and BON-W). Shear wave velocity measurements were taken at regular intervals of depth during advancement of the CPT soundings.

Multi-Channel Analysis of Surface Wave (MASW) testing was carried out near the proposed eastbound highway alignment on both sides of the river. The MASW testing was carried out by Geophysics GPR International Inc. and the results were provided to Thurber in:

- Geophysics GPR International Inc., *"Shear Wave Velocity Soundings for Determining Site Classifications, Three locations along Highway 17, in Renfrew County (ON),"* dated June 24, 2020 (Report No. GPR-19-01787).

A summary of the MASW test locations and results is included in Appendix B.

Prior to commencement of drilling, utility clearances were obtained in the vicinity of the test hole locations.

The locations and elevations of the testholes were surveyed by Thurber with a Trimble Catalyst DA1 antenna with centimeter accuracy. The northing, easting and ground surface elevation of the test holes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A, the individual Record of Borehole sheets and CPT plots in Appendix B, and in Table 3-2, below.

**Table 3-2: Borehole Summary – Current Investigation (2019/2020/2021)**

Test Hole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
BON19-1	West Approach	5038613.9 (45.487337)	292296.7 (-76.659955)	107.1	34.0* 39.6**
BON19-2	West Approach	5038599.4 (45.487207)	292321.5 (-76.659637)	103.0	32.6* 39.9**
BON19-3	West Abutment	5038587.0 (45.487096)	292358.5 (-76.659163)	103.0	47.7
BON19-4	East Abutment	5038442.4 (45.485799)	292616.2 (-76.655864)	98.9	20.1
BON19-5	East Abutment	5038435.7 (45.485741)	292610.5 (-76.655935)	98.9	22.5
BON19-6	East Approach	5038422.9 (45.485625)	292651.3 (-76.655414)	116.9	14.3

Test Hole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
BON19-7	East Approach	5038407.3 (45.485485)	292674.7 (-76.655113)	118.0	14.3
BON19-8	East Approach	5038384.8 (45.485283)	292718.9 (-76.654548)	117.7	14.3
BON19-9	East Approach	5038365.0 (45.485106)	292751.0 (-76.654137)	117.8	14.0
BON-P1	Pier 1	5038552.4 (45.486786)	292418.8 (-76.658392)	87.9	30.5
BON-P2	Pier 2	5038497.3 (45.486292)	292506.7 (-76.657266)	86.1	21.3
BON-P3	Pier 3	5038469.0 (45.486038)	292562.5 (-76.656551)	89.2	18.3
BON-E (CPT)	East Approach	5038418.8 (45.485588)	292650.9 (-76.655419)	116.9	14.5
BON-W (CPT)	West Approach	5038619.4 (45.487386)	292269.6 (-76.660301)	112.0	33.4
BON24-1	West Abutment	5038617.8 (45.487373)	292297.6 (-76.659943)	107.8	39.5
BON24-2	West Abutment	5038605.7 (45.487263)	292276.8 (-76.660209)	108.5	13.6
BON24-3	West Abutment	5038599.3 (45.487207)	292323.0 (-76.659618)	104.0	52.5

**Notes:** \* - Termination of Sampled Borehole

\*\* - DCPT refusal

The boreholes were drilled using a track-mounted drill rig (CME 850, CME 45, CME 75, or Diedrich D-50) equipped with hollow stem augers and either NW or HW casing. Bedrock was cored in Boreholes BON19-4 and BON19-5 with NQ-sized coring. Drill water for coring was obtained from temporary filtered pumps in the river.

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). A thin-walled (Shelby) tube sample of the cohesive materials at the west approach was obtained with open push advancement in Borehole BON19-3 for further laboratory testing. In-situ vane shear testing was conducted in cohesive deposits with an MTO 'N' sized vane.

Monitoring wells, 50 mm in diameter, were installed in Boreholes BON19-1, BON19-3, BON19-5, BON19-6, BON-P1, BON-P2 and BON-P3. The installation details are illustrated on the respective Record of Borehole sheets provided in Appendix B. The monitoring wells were installed as part of the current foundation investigation as well as a concurrent hydrogeological investigation. The piezometers and monitoring wells installed as part of the current investigation will be decommissioned by Thurber, as outlined in the Hydrogeological Investigation and Design Report.

The boreholes were backfilled in accordance with MOE requirements (O.Reg 903, as amended).



The drilling and sampling operations were supervised on a full-time basis by members of Thurber's geotechnical staff. The drilling supervisors logged the boreholes and processed the recovered soil samples for transport to Thurber's Ottawa geotechnical laboratory for further examination and testing, as well as submission to external laboratories.

#### **4 LABORATORY TESTING**

Laboratory testing was selected in accordance with the current MTO Guideline for Foundation Engineering Services, Section 5. Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all retained soil samples. At least 25% of the recovered soil samples were subjected to testing for grain size distribution analysis and, where appropriate, Atterberg Limits in accordance with MTO and ASTM standards. One-dimensional consolidation testing was carried out on thin-walled tube samples from BON19-1 and BON24-1. Chemical analysis for determination of pH, conductivity, resistivity, sulphide, sulphate and chloride was carried out on selected soil samples.

Rock cores were logged and total core recovery (TCR), solid core recovery (SCR) and rock quality designation (RQD) were determined in the field. Point load and unconfined compressive strength (UCS) testing was carried out on selected samples to give an indication of the bedrock strength.

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

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

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and the Borehole Location and Soil Strata Drawing included in Appendix A. A general description of the stratigraphy based on the conditions encountered in the boreholes is given in the following sections. However, the factual data presented on the Borehole Records takes precedence over the Soil Strata Drawing and the general description. It must be recognized that the soil, bedrock and groundwater conditions may vary between and beyond borehole locations. Soil classification is in accordance with ASTM D2487. Description of cohesive soils and secondary components of all deposits from the current boreholes are described as outlined in the MTO Guideline for Foundation Engineering Services Manual (October 2020) and the 4<sup>th</sup> edition of the Canadian Foundation Engineering Manual (2006). Terminology from the historic borehole information may vary from current practice.

In general, the stratigraphy at the site consists of a deposit of silty clay to clayey silt overlying layer of sandy silt to clayey silt. These upper, generally fine-grained deposits are underlain by glaciofluvial deposits of silty sand to sand containing varying amounts of gravel, cobbles, and boulders which are, in turn, underlain by marble bedrock.



## **5.1 Topsoil**

Topsoil was encountered at surface in boreholes BON-1 through BON-7, BON-P2, BON-P3, BON19-6 and BON19-7. The thickness ranged from 25 mm to 250 mm. The natural moisture content of the two samples tested was 31% and 44%.

## **5.2 Fill**

Fill was encountered beneath the topsoil in Borehole BON-2 and at the ground surface at BON-P1 which are both located near the proposed Pier 1, just west of the river. The fill was described as a clayey silt with some sand to a sand with some gravel and silt. The thickness of the fill materials was 1.4 to 1.5 m (base elevation 85.8 m and 86.4 m). The moisture content ranged from 9% to 19%. The N-values obtained from SPTs conducted in the clayey silt fill ranged from 9 to 16, indicating a stiff to very stiff consistency. A single SPT N-value in the sand fill was 29, indicating a compact relative density.

## **5.3 Silty Clay to Clayey Silt**

At ground surface or beneath the topsoil or fill, a deposit of silty clay to clayey silt was encountered at all test hole locations except BON-P2 and BON-P3. The deposit generally transitions from a silty clay to clayey silt with depth. The overall thickness of the deposit ranges from about 2 m within the river valley (Boreholes BON-2, BON-3, BON-4, BON-P1, BON19-4 and BON19-5) to over 31 m at the western approach (Borehole BON-7) with base elevations ranging from deeper than 81.9 m at the western approach, 81.1 m within the river valley, to 108.1 m at the eastern approach.

Further description of the material properties and field test results within the layers of the silty clay to clayey silt deposit are described in the following sections.

### **5.3.1 Silty Clay (Weathered Crust)**

Away from the base of the river valley, the upper portion of the deposit is weathered to a grey-brown silty clay crust, which generally ranges from about 2 m to 10 m thick (approximate base elevations of 92.4 to 109.9 m). Sand seams were noted in this layer. The weathered portion of the deposit is generally not present within the lower river valley which has been incised into the overburden. SPTs conducted in the weathered crust gave N-values ranging from 3 to 26 blows per 0.3 m of penetration. In-situ shear vane tests in the weathered crust gave undrained shear strength values of 106 to 118 kPa (the maximum values recordable with the available shear vanes), indicating a very stiff consistency.

The corrected CPT tip resistance ( $q_t$ ) recorded during advancement of the CPT through the weathered crust ranged between about 1,500 and 3,000 kPa. The shear wave velocity interpreted from the MASW and measured during advancement of the CPT through the weathered crust ranged from about 200 to 300 m/s.

The natural moisture content of samples of the weathered crust ranged from 19% to 51%. The results of grain size analysis test conducted on 18 samples of the weathered crust collected during the current investigation and four samples collected during the 2003 investigation are summarized below and are illustrated on Figures C1.1 to C1.3 in Appendix C and Figures D1.1 and D1.2 in Appendix D.

<b>Soil Particle</b>	<b>Percentage (%)</b>
Gravel	0 – 1
Sand	0 – 8
Silt	32 – 74
Clay	23 – 66

The results of Atterberg Limits testing carried out on 18 samples of the weathered silty clay crust collected during the current investigation and three samples obtained during the 2003 investigation are summarized below and are illustrated on Figures C2.1 to C2.3 in Appendix C and Figure D2 in Appendix D. The laboratory results indicate that the material is a generally a silty clay of intermediate plasticity (CI).

<b>Parameter</b>	<b>Value</b>
Liquid Limit	27 – 57
Plastic Limit	16 – 27
Plasticity Index	11 – 36

### 5.3.2 Clayey Silt (CL)

Below the weathered crust, the lower portion of the deposit consists of unweathered clayey silt which was encountered in all boreholes except BON19-04, BON19-05, BON19-6, BON-P2, BON-P3 and BON-6. Sand seams were observed in this layer. The thickness generally ranged from about 1.9 m to 8.4 m (base elevation 81.1 m to 106.4 m). The thickness of the deposit increases to the west, illustrated by Borehole BON-7, which was terminated in this layer at elevation 81.9 m with an observed layer thickness of greater than 25.3 m. The N-values obtained from SPTs conducted in the unweathered portion of the deposit ranged from weight of hammer (WH) to 17 blows per 0.3 m of penetration. In situ shear vane tests in the unweathered clayey silt gave undrained shear strengths as low as 47 kPa, but generally greater than 70 kPa, to the maximum recordable shear strength values of up to 118 kPa, indicating a stiff to very stiff consistency.

The peak shear strength values of the silty clay to clayey silt deposit measured at borehole locations along the west and east approaches are shown on Figures B5.1 and B5.2 in Appendix B, respectively.

The corrected CPT tip resistance ( $q_t$ ) recorded during advancement of the CPT through the unweathered clayey silt ranged between about 1,500 and 2,200 kPa, with spikes up to about 5,000 kPa. The shear wave velocity interpreted from the MASW and measured during advancement of the CPT through the unweathered clayey silt ranged from about 200 to 250 m/s on the west side of the river, and about 300 to 400 m/s on the east side of the river.





The natural moisture content of samples of the clayey silt ranged from 22% to 51%. The results of grain size analysis test conducted on 11 samples of the unweathered clayey silt collected during the current investigation and five samples collected during the 2003 investigation are summarized below and are illustrated on Figures C3.1 to C3.2 in Appendix C and Figures D1.1 and D1.2 in Appendix D.

Soil Particle	Percentage (%)
Gravel	0 – 1
Sand	0 – 44
Silt	34 – 64
Clay	21 – 54

The results of Atterberg Limits testing carried out on 11 samples of the clayey silt collected during the current investigation and three samples obtained during the 2003 investigation are summarized below and are illustrated on Figures C4.1 to C4.2 in Appendix C and Figure D2 in Appendix D. The laboratory results indicate that the material is typically a clayey silt of low plasticity (CL). The lab results from Borehole BON-2 SS6 (Elevation 82.4 m) indicate that material is a highly elastic silt (MH).

Parameter	Typical Values	BON-2 SS6
Liquid Limit	25 – 42	52
Plastic Limit	15 – 22	30
Plasticity Index	8 – 20	22

The results of one-dimensional consolidation tests performed on four samples of the overall silty clay to clayey silt deposit are presented in Table 5-1, below.

**Table 5-1: Summary of One-Dimensional Consolidation Testing – Silty Clay to Clayey Silt**

Parameter	Results			
Borehole	BON 19-1	BON 24-1	BON-7	BH 2
Sample	ST1	ST9	TW1*	TW5
Material	Silty Clay (Crust)	Silty Clay	Clayey Silt	Clayey Silt (Crust)
Sample Depth, (m)	4.9	11.0	12.5	3.8
Sample Elevation, (m)	102.2	96.8	100.5	98.8
Approx. Existing Effective Stress, $P_0'$ , (kPa)	85.8	192.5 kPa	155.0	66.5
Moisture Content, (%)	40.4	40.0	44.5	30.0
Liquid Limit, %	57	36	42	34
Plastic Limit, %	21	21	24	22
Plasticity Index	36	15	18	12



Parameter	Results			
Moist Unit Weight, $\gamma$ (kN/m <sup>3</sup> )	17.3	17.6	17.2	-
Degree of Saturation, $S_{ro}$	93.5	97.0	96.1	-
Specific Gravity, $G_s$	2.73	2.73	2.78	-
Initial Void Ratio $e_o$	1.179	1.129	1.287	0.929
Pre-consolidation Pressure, $P_c'$ , (kPa)	620	350	130	315
Over Consolidation Ratio, OCR	7	1.8	1	4.7
Compression Index, $C_c$	0.80	0.58	0.34	0.17
Recompression Index, $C_r$	0.06	0.035	0.066	.02
Coefficient of consolidation, $c_v$ (cm <sup>2</sup> /s)	0.001	0.008	0.003	-
Coefficient of re-consolidation, $c_{vr}$ (cm <sup>2</sup> /s)	0.02	0.003	0.004	-

\* test results indicate some sample disturbance prior to testing

The samples obtained from the current and 2003 investigations (Boreholes BON19-1 and BON-7, respectively) were obtained with open-push advancement of thin-walled Shelby tubes into the stiff to very stiff silty clay.

The consolidation results for BH 2 Sample 5 have been extracted from Geocres Report 31F-018. It is noted that Sample 12 of the clayey silt from the same borehole underwent an isotropically consolidated undrained triaxial test which indicated an apparent effective cohesion of zero and an apparent effective angle of friction of 28.5 degrees.

#### 5.4 Silty Sand to Clayey Silt (SM, ML, CL-ML, CL)

A layer ranging from silty sand to clayey silt was encountered below the surficial topsoil in BON-P2 and BON-P3 and below the clayey silt in BON19-1 through BON19-7, BON-P1, BON-1, BON-2, BON-3, BON-4 and BON24-1. The layer composition was variable across the site but consisted predominantly of silt with varying amounts of sand and clay. Where the majority of the layer comprises fine-grained particles, laboratory test results indicated that it was low to non-plastic.

The thickness ranged from 0.3 m to 10.4 m (base elevation 78.1 m to 103.7 m). The N-values obtained from SPTs conducted in this material ranged from 1 to 45 blows per 0.3 m of penetration, indicating a very loose to dense relative density.

The natural moisture content of samples of the silty sand to clayey silt ranged from 4% to 39%. The results of grain size analysis test conducted on ten samples of the deposit collected during the current investigation and two samples collected during the 2003 investigation are summarized below and are illustrated on Figures C5.1 to C5.2 in Appendix C and Figure D3 in Appendix D.

Soil Particle	Percentage (%)
Gravel	0 – 7
Sand	13 – 83
Silt	26 – 64
Clay	11 – 27

Atterberg Limits testing was carried out on eight samples of the silt collected during the current investigation. The result from four cohesive samples are summarized below and are illustrated on Figure C6.1 in Appendix C. The laboratory results indicate that the material ranged from a non-plastic silt to a slightly or low plastic clayey silt (ML, CL-ML, CL). Four of the Atterberg Limit tests carried out gave non-plastic results.

Parameter	Values
Liquid Limit	18 – 24
Plastic Limit	15 – 16
Plasticity Index	2 – 9

## 5.5 Silty Sand to Sand Some Silt

A glaciofluvial sand deposit with varying quantities of silt and gravel was encountered beneath the silty sand to clayey silt in Boreholes BON19-1, BON-P1, BON-P2, BON-02 and BON-03. Clay layers were noted within this deposit. The thickness ranged from 2.9 m to 20.7 m (base elevation 60.5 m to 85.0 m). The N-values obtained from SPTs conducted in this material ranged from 2 to 40 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural moisture content of samples of the sand ranged from 1% to 37%. The results of grain size analysis test conducted on four samples of the sand collected during the current investigation and one sample collected during the 2003 investigation are summarized below and are illustrated on Figure C7.1 in Appendix C and Figure D4 in Appendix D.

Soil Particle	Percentage (%)
Gravel	0 – 2
Sand	59 – 89
Silt and Clay	11 – 41

An Atterberg Limit test was carried out on one sample; it was found to be non-plastic.

## 5.6 Sand and Gravel

A generally coarse deposit often with significant quantities of cobbles and boulders was encountered below the silty sand to sand some silt deposit in BON19-1, BON-P1, BON-P2, BON-2 and BON-3; below the silty sand to clayey silt in BON19-2, BON19-3, BON19-4, BON19-5, BON24-1, BON24-3, BON-P3, BON-1 and BON-4; and below the clayey silt in BON19-8, BON19-9 and BON 6. The sand and gravel layer was not observed in Boreholes BON19-6, BON19-7 and BON-7. The base of the sand and gravel layer was confirmed only in Boreholes BON19-4,



BON19-5, BON-2, BON-3 and BON-4. Where fully penetrated, the layer thickness ranges from 9.0 m to 18.8 m (base elevation 55.9 m to 82.3 m). At the borehole locations that did not fully penetrate the deposit, it ranged up to 24.8 m thick (BON19-3) and was encountered as deep as Elevation 51.5 m (BON24-3).

The material ranged in gradation from gravel some sand to silty sand some gravel with variable silt and gravel content. Cobbles and boulders were noted to be occasional to frequent components. The lower 5.6 m portion of this layer in Borehole BON-4 and the upper 2.0m thick portion of this layer in Borehole BON-6 consisted almost entirely of cobbles and boulders with some sand and gravel.

The N-values obtained from SPTs conducted in this material ranged from 1 to greater than 100 blows per 0.3 m of penetration, indicating a loose to very dense relative density, but was typically greater than 20 blows per 0.3 m of penetration indicating a compact to very dense relative density. The use of coring techniques was required in order to advance the boreholes through this deposit in numerous boreholes.

The CPT generally met effective refusal before penetrating the deposit. The shear wave velocity interpreted from the MASW in the deposit ranged from about 400 to 600 m/s.

The natural moisture content of samples of this layer ranged from 1% to 38%. The results of grain size analysis test conducted on 20 samples of the sand and gravel collected during the current investigation and six samples collected during the 2003 investigation are summarized below and are illustrated on Figures C8.1 to C8.4 in Appendix C and Figure D5 in Appendix D.

Soil Particle	Percentage (%)
Gravel	0 – 79
Sand	20 – 93
Silt and Clay	0 – 37

## 5.7 Bedrock

Bedrock was encountered in Boreholes BON19-4, BON19-5, BON-2, BON-3, and BON-4. The bedrock encountered consisted of moderately weathered to fresh, fine to coarse grained, marble that is predominantly white, grey, and black in colour. Bedrock logs are provided in Appendix B. Photographs of the bedrock cores are provided in Appendix C. The following table summarizes the rock core quality:

**Table 5-2: Summary of Bedrock Core Quality**

Summary of Rock Core Quality Parameter	Range	Average
Total Core Recovery (TCR), %	83 – 100	96
Solid Core Recovery (SCR), %	4 – 100	61
Rock Quality Designation (RQD), %	0 – 100	36
Fracture Index (fractures per 0.3m)	0 – >10	5

Based on the RQD values, the bedrock is classified as very poor to fair quality.

**Table 5-3: Summary of Bedrock Depth/Elevation**

Borehole No.	Depth to Bedrock Surface (mbgs)	Bedrock Surface Elevation (m)
BON19-4	16.8	82.1
BON19-5	16.6	82.3
BON-2	31.3	55.9
BON-3	22.3	63.8
BON-4	17.9	71.8

Unconfined compressive strength (UCS) testing was carried out on samples of the bedrock from Boreholes BON19-04 and BON19-05. The UCS values were 41 and 55 MPa, respectively. Based on the unconfined compressive strength testing the bedrock is classified as medium strong. The UCS values measured for samples obtained and tested as part of the 2003 investigation ranged from 110 to 139 MPa. However, it should be noted that the UCS values provided on the 2003 borehole logs were estimated from point load tests which can significantly overestimate the bedrock strength.

A summary of the bedrock surface information is provided in Table 5-3 above.

## 5.8 Groundwater

Groundwater levels recorded in the monitoring wells and piezometers are presented in Table 5-4.

**Table 5-4: Summary of Groundwater Levels**

Borehole No. [Diameter]	Bottom of Screen Elevation (m)	Screened Material	Groundwater Depth (m)	Groundwater Elevation (m)	Date of Measurement
BON19-1	76.6	Gravel some Sand	23.5	83.6	2021/09/21
			23.2	83.9	2021/11/21
			23.2	83.9	2021/11/29
			23.1	84.0	2022/01/11
BON19-3	75.7	Silty Sand some Gravel	19.2	83.8	2021/11/04
			19.2	83.8	2021/11/05
			19.0	84.0	2022/01/22



Borehole No. [Diameter]	Bottom of Screen Elevation (m)	Screened Material	Groundwater Depth (m)	Groundwater Elevation (m)	Date of Measurement
BON19-5	77.4	Bedrock	14.9	84.0	2020/09/29
			14.7	84.2	2021/08/04
			14.9	84.0	2021/12/01
			14.8	84.1	2022/01/11
BON19-6 (shallow)	110.2	Silty Clay	Dry	n/a	2020/09/17
			Dry	n/a	2020/09/29
			Dry	n/a	2020/11/11
			Dry	n/a	2021/08/06
			Dry	n/a	2021/09/29
			Dry	n/a	2022/01/11
BON19-6 (deep)	103.3	Sand some Silt	Dry	n/a	2020/09/17
			Dry	n/a	2020/09/29
			Dry	n/a	2020/11/11
			Dry	n/a	2021/08/04
			Dry	n/a	2021/08/06
			Dry	n/a	2021/12/21
			Dry	n/a	2022/01/11
BON-P1	57.4	Sand and Gravel	4.1	83.8	2021/11/04
			4.1	83.8	2021/11/30
			3.9	84.0	2022/01/25
BON-P2	65.4	Sand and Gravel	2.5	83.6	2021/11/17
			2.5	83.6	2021/11/30
			2.4	83.7	2022/01/11
BON-P3	71.7	Sand and Gravel	5.3	83.9	2021/11/09
			5.5	83.7	2021/11/17
			5.5	83.7	2021/12/01
			5.4	83.8	2022/01/05
			5.5	83.7	2022/01/11
BON-1	72.1	Sand and Gravel	18.59	83.8	2003/10/22
			18.15	84.3	2003/12/19
			17.95	84.5	2004/02/04
			18.71	83.7	2021/09/21

Borehole No. [Diameter]	Bottom of Screen Elevation (m)	Screened Material	Groundwater Depth (m)	Groundwater Elevation (m)	Date of Measurement
BON-2	54.7	Till/Bedrock	3.47	83.7	2003/11/22
			3.42	83.8	2003/12/19
			2.72	84.5	2004/02/04
			3.47	83.7	2021/09/21
BON-3	60.2	Bedrock	Destroyed		2003/12/19
BON-4	73.1	Sand and Gravel	5.35	84.4	2004/02/04
BON-6	83.2	Gravelly Sand	18.37	84.6	2003/12/19
			18.26	84.7	2004/02/04
BON-7	81.9	Silty Clay	Destroyed		2004/02/04

These 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 levels are to be expected. In particular, the levels may be at a higher elevation after periods of significant and/or prolonged precipitation. Though not encountered in the piezometers installed during the field investigations, artesian conditions may be encountered within the flood plain during construction.

The elevation of the Bonnechere River was surveyed during the course of the field work and was measured to be at approximate Elevations of 83.3 m and 83.6 m on September 17, 2020 and October 22, 2021, respectively. The river level is expected to fluctuate seasonally.

## 5.9 Analytical Testing

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

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

Borehole	Sample (Soil Type)	Depth (m)	Chloride (µg/g)	Sulphate (µg/g)	Sulphide (%)	pH (-)	Resistivity (Ohm-cm)
BON19-3	SS 5 (Silty Clay)	3.1 – 3.7	9	< 5	< 0.04	7.66	7,360
BON19-5	SS2 (Clayey Silt)	0.8 – 1.4	8	9	<0.04	7.22	14,300
BON-P1	SS 6 (Sandy Silt)	3.8 – 4.4	34	260	0.05	7.72	3,050



BON-P2	SS 6 (Silty Sand)	3.8 – 4.4	5	< 5	< 0.04	7.63	14,100
BON-P3	SS 8 (Sand)	5.3 – 5.9	7	< 5	< 0.04	7.81	15,900
BON24-2	SS 4 (Clay)	3.1 – 3.7	12	24	< 0.01	6.79	3,500

## 6 MISCELLANEOUS

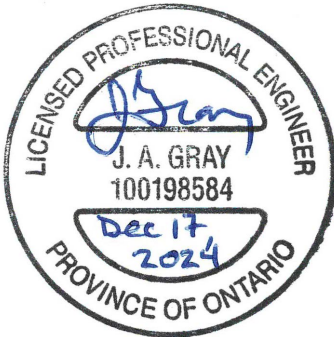
Please refer to Geocres Report 31F-136 for details on methodology and results from that investigation. It must be noted that conditions on site, particularly near ground surface may have been altered since that work was carried out.

Borehole locations for the current investigation were selected by Thurber relative to existing site features and were accessed from the adjacent properties or temporary access paths constructed from Highway 17. The as-drilled locations and ground surface elevation of the boreholes were surveyed by Thurber following completion of the field program. The elevation survey was carried out with reference to geodetic elevation benchmarks provided by the MTO.

Marathon Underground Ltd. of Greely, Ontario and Forage Downing Drilling Lt. of Grenville-sur-la-Rouge, Quebec supplied and operated the drilling equipment and carried out the drilling, soil sampling, in-situ testing, piezometer/monitoring well installation. ConeTec Investigations Ltd. of Richmond Hill, Ontario supplied and operated the CPT equipment and carried out the in-situ testing. The field investigation was supervised on a full-time basis by Richard Howarth, Nick Weil, Jamil Pirani, Anderson de Oliveira, Sarah Harrold, Justin Gray and Benoit Coote of Thurber. Overall supervision of the investigation program was provided by Justin Gray, P.Eng.

Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. UCS and consolidation testing was completed by Stantec's laboratory in Ottawa, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa.

Overall project management and direction of the field program was provided by Fred Griffiths, P.Eng. Interpretation of the factual data and preparation of this report were carried out by Justin Gray, P.Eng., Matt Kennedy, P.Eng., and Fred Griffiths, P.Eng. The report was reviewed by P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



Justin Gray, P.Eng.  
Geotechnical Engineer



Matt Kennedy, M.Sc.(Eng.), P.Eng.  
Senior Geotechnical Engineer



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



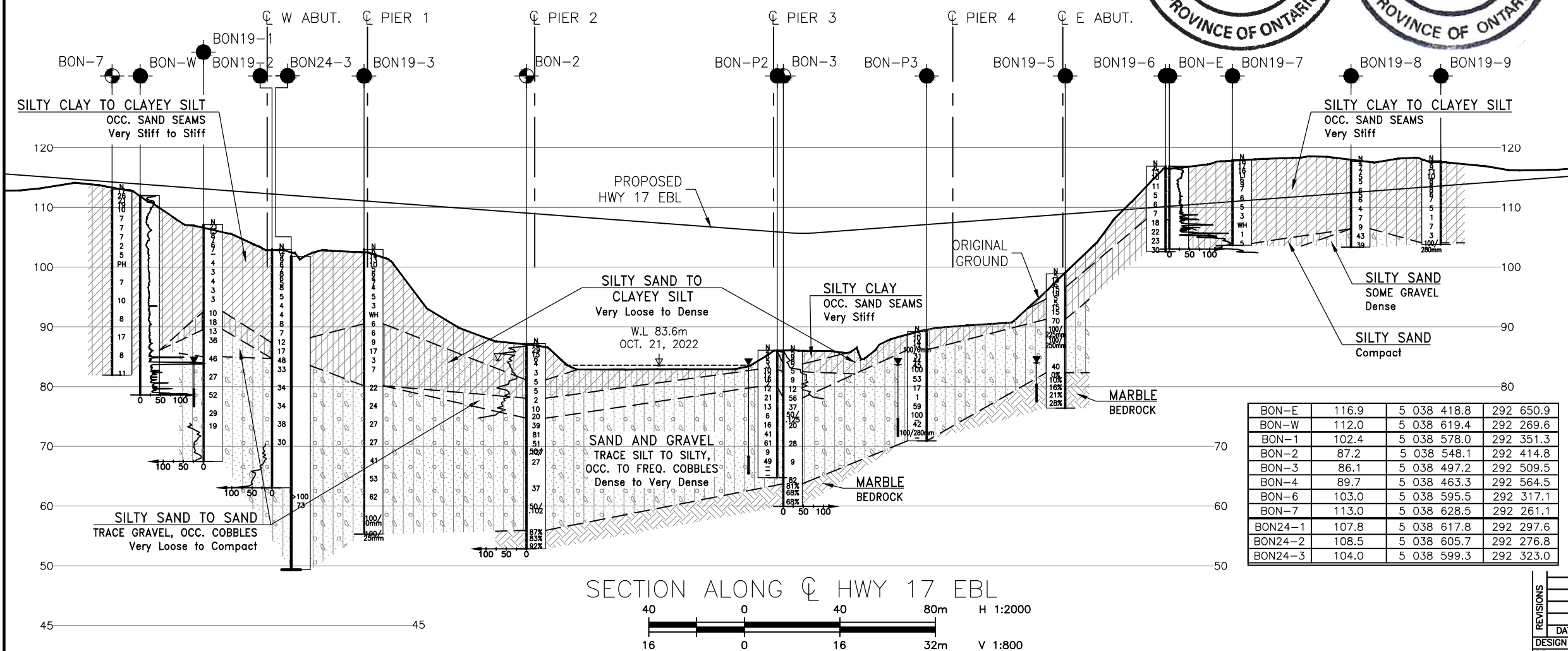
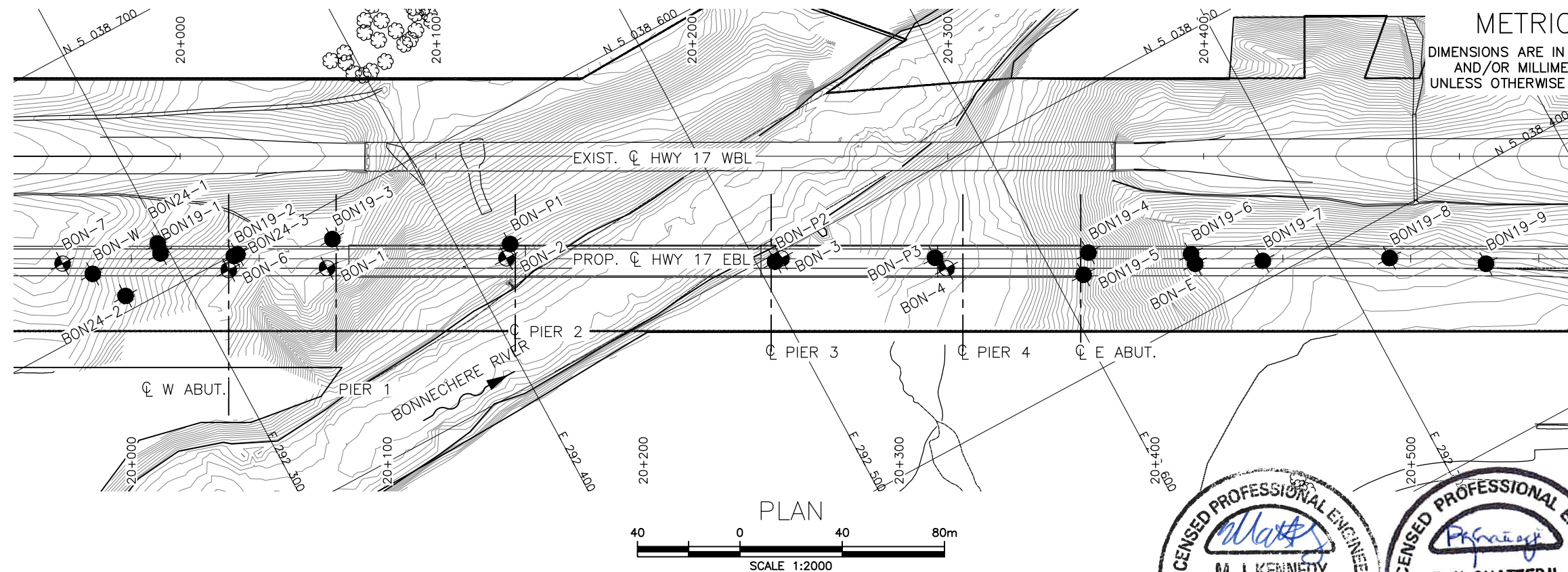
Dr. P.K. Chatterji, P.Eng.  
MTO Review Principal,  
Senior Geotechnical Engineer





## **Appendix A.**

### **Borehole Location Plan and Stratigraphic Drawing**

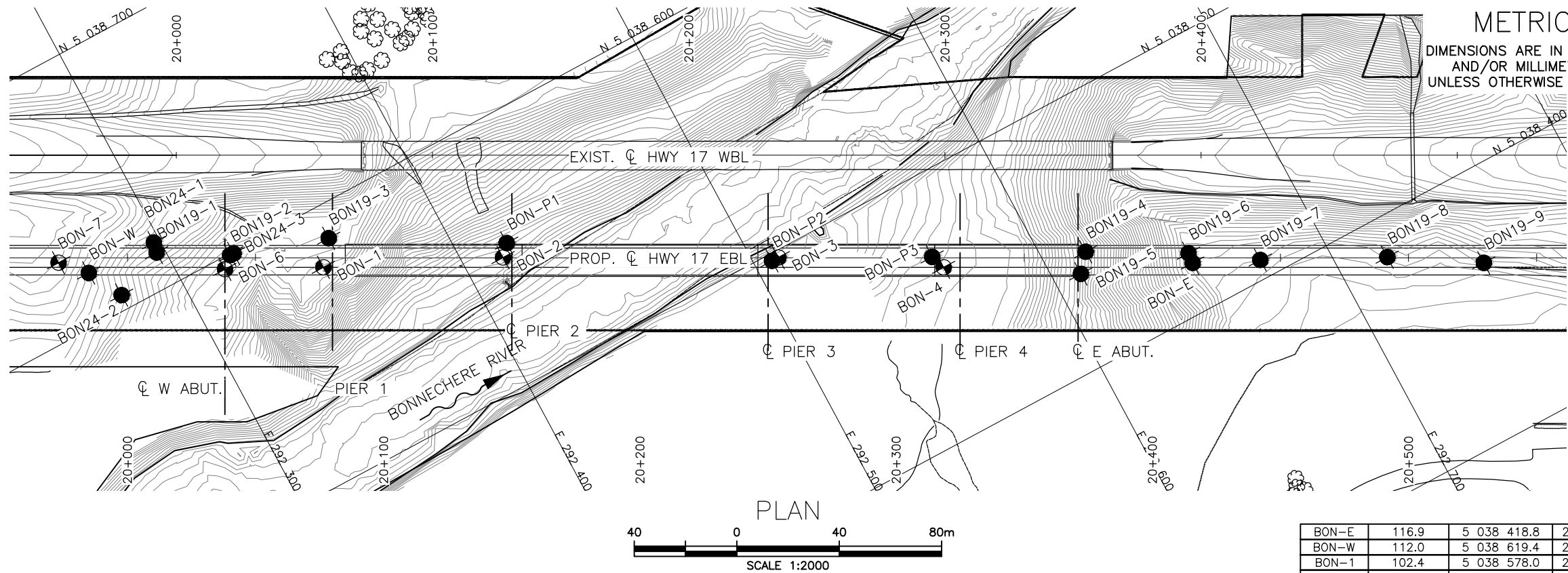


BON-E	116.9	5 038 418.8	292 650.9
BON-W	112.0	5 038 619.4	292 269.6
BON-1	102.4	5 038 578.0	292 351.3
BON-2	87.2	5 038 548.1	292 414.8
BON-3	86.1	5 038 497.2	292 509.5
BON-4	89.7	5 038 463.3	292 564.5
BON-6	103.0	5 038 595.5	292 317.1
BON-7	113.0	5 038 628.5	292 261.1
BON24-1	107.8	5 038 617.8	292 297.6
BON24-2	108.5	5 038 605.7	292 276.8
BON24-3	104.0	5 038 599.3	292 323.0

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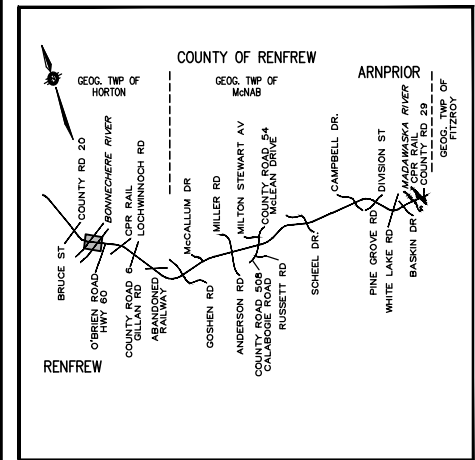




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AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No  
WP No 4068-09-00

HIGHWAY 17 TWINNING  
BONNECHERE RIVER  
BRIDGE  
BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN

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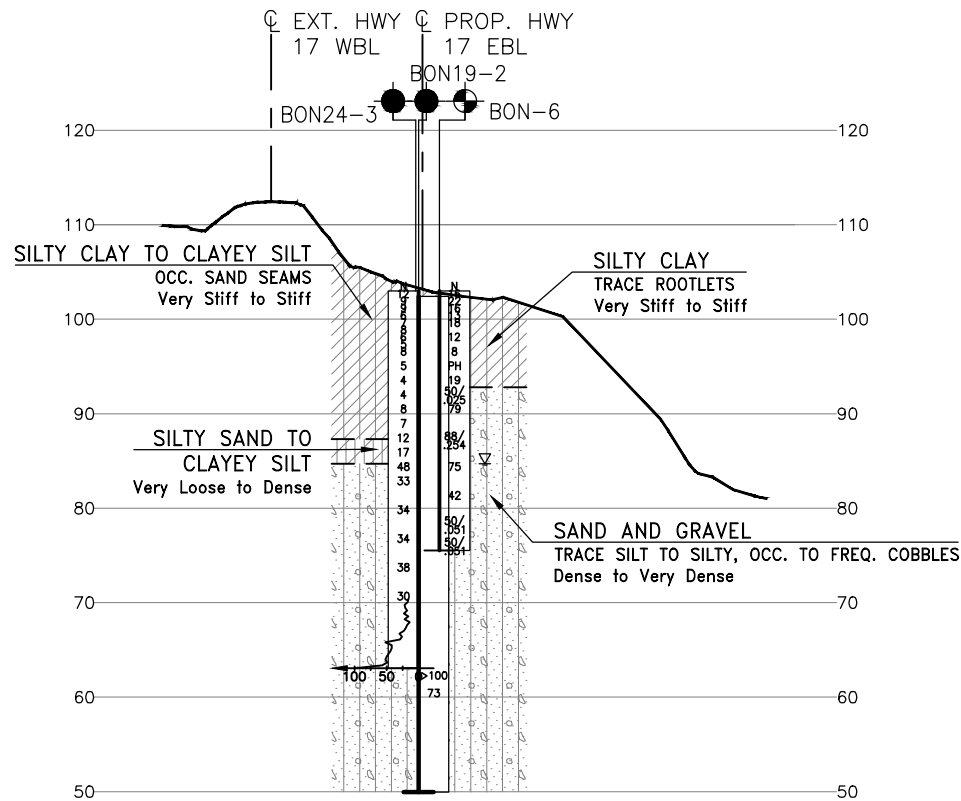
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- Borehole (Previous Investigation)
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- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level Upon Completion of Drilling
- Water Level in Monitoring Well/Piezometer
- Monitoring Well/Piezometer Screen
- Rock Quality Designation (RQD)
- Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BON19-1	107.1	5 038 613.9	292 296.7
BON19-2	103.0	5 038 599.4	292 321.5
BON19-3	103.0	5 038 587.0	292 358.5
BON19-4	98.9	5 038 442.4	292 616.2
BON19-5	98.9	5 038 435.7	292 610.5
BON19-6	116.9	5 038 422.9	292 651.3
BON19-7	118.0	5 038 407.3	292 674.7
BON19-8	117.7	5 038 384.8	292 718.9
BON19-9	117.8	5 038 365.0	292 751.0
BON-P1	87.9	5 038 552.4	292 418.8
BON-P2	86.1	5 038 497.3	292 506.7
BON-P3	89.2	5 038 469.0	292 562.5

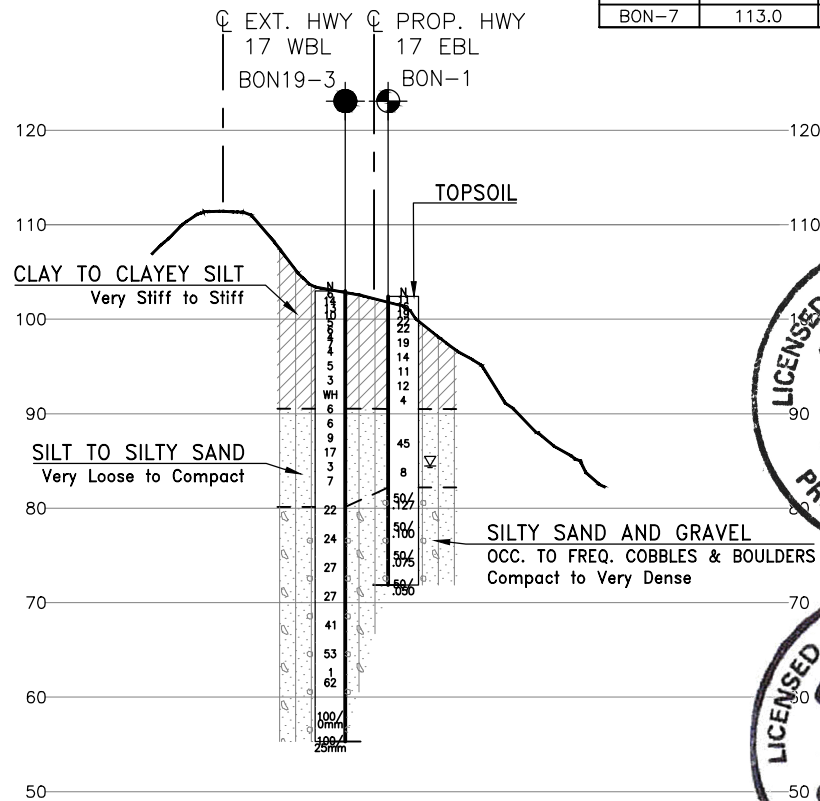
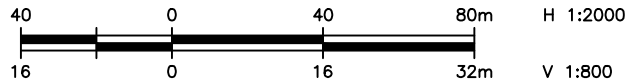
-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 9.

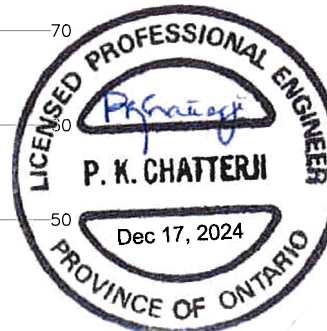
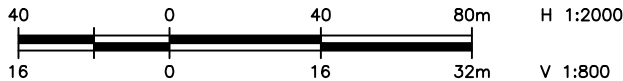
GEOCRES No. 31F-236



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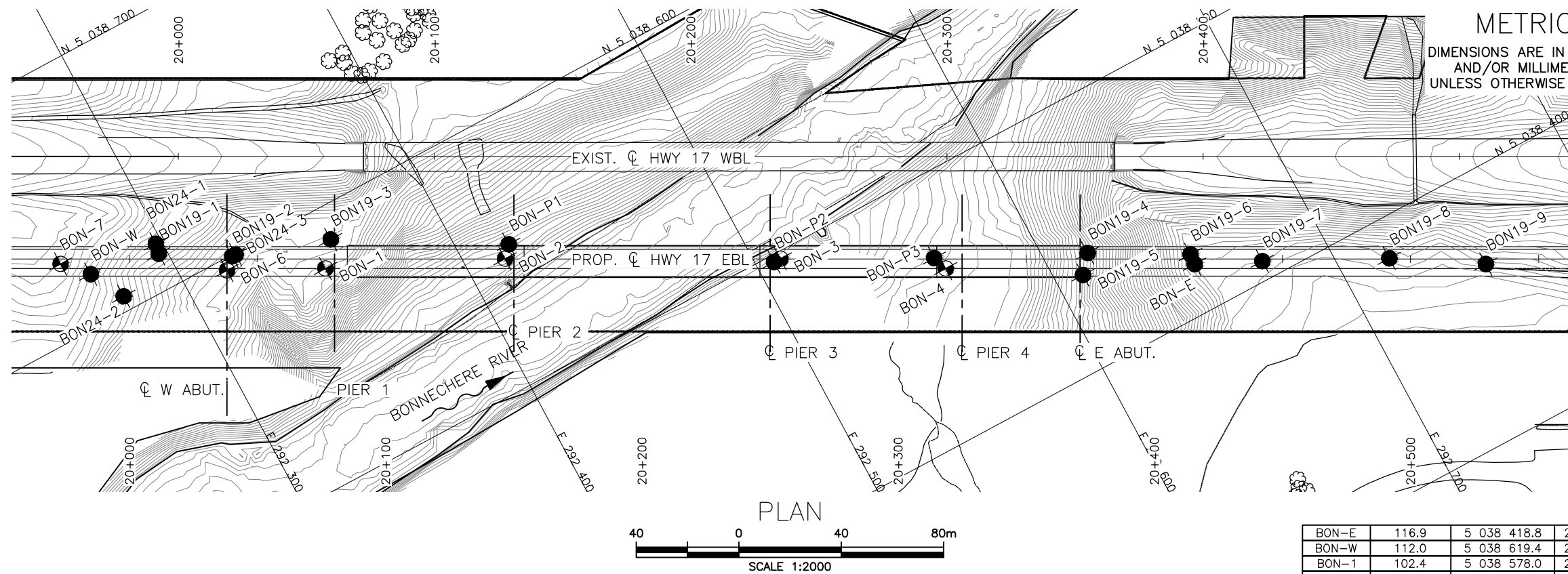


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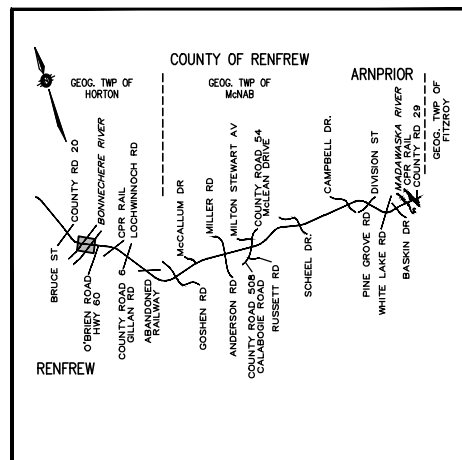
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DRAWN	AN/MFA	CHK	JG
CODE	LOAD	DATE	AUG 2024
SITE	STRUCT	DWG	2



CONT No  
WP No 4068-09-00HIGHWAY 17 TWINNING  
BONNECHERE RIVER  
BRIDGE  
BOREHOLE LOCATIONS AND SOIL STRATA

Ontario

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

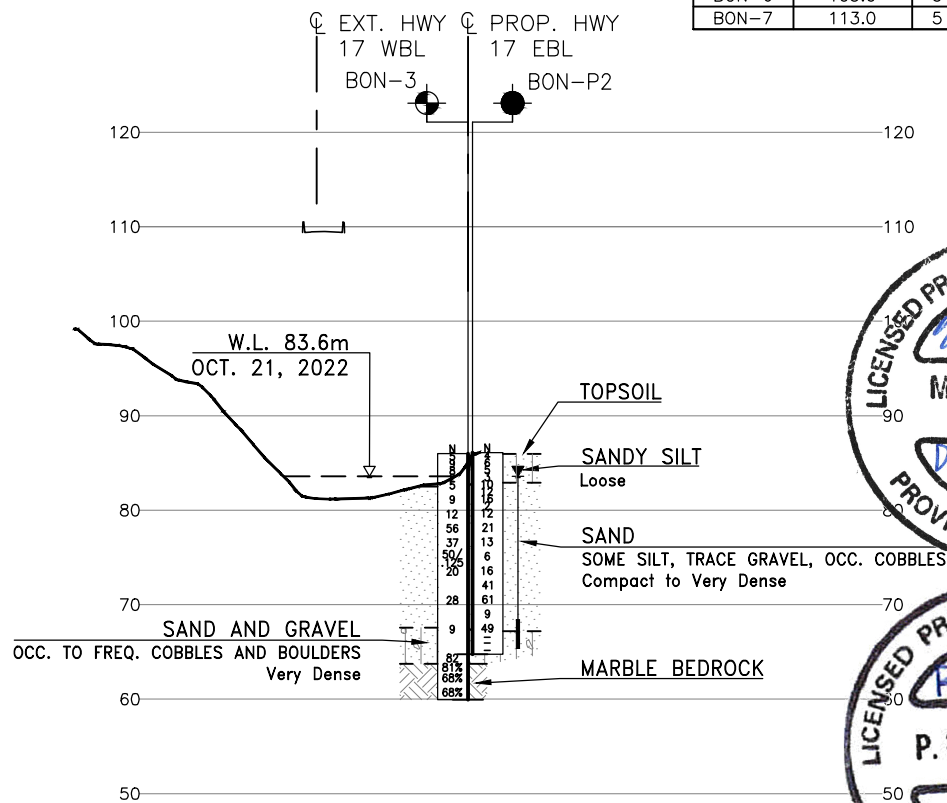
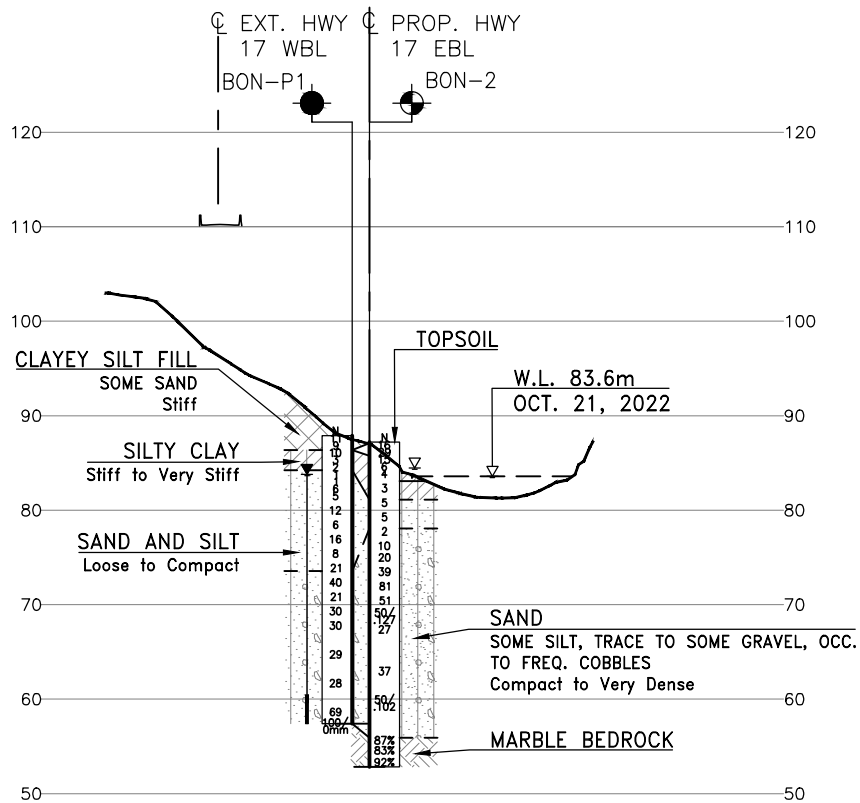
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- Borehole (Previous Investigation)
- N
- CONE
- PH
- Water Level Upon Completion of Drilling
- Water Level in Monitoring Well/Piezometer
- Monitoring Well/Piezometer Screen
- 90% Rock Quality Designation (RQD)
- A/R

NO	ELEVATION	NORTHING	EASTING
BON19-1	107.1	5 038 613.9	292 296.7
BON19-2	103.0	5 038 599.4	292 321.5
BON19-3	103.0	5 038 587.0	292 358.5
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BON-P2	86.1	5 038 497.3	292 506.7
BON-P3	89.2	5 038 469.0	292 562.5

-NOTES-

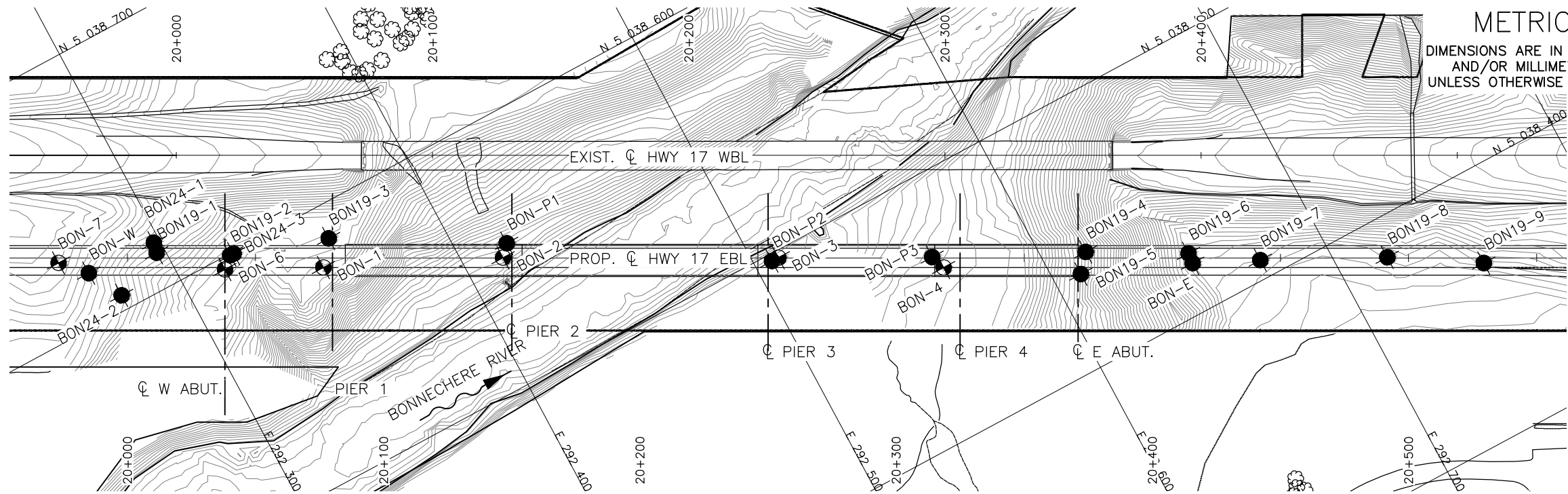
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GEOCRES No. 31F-236



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STRUCT			
DWG	3		

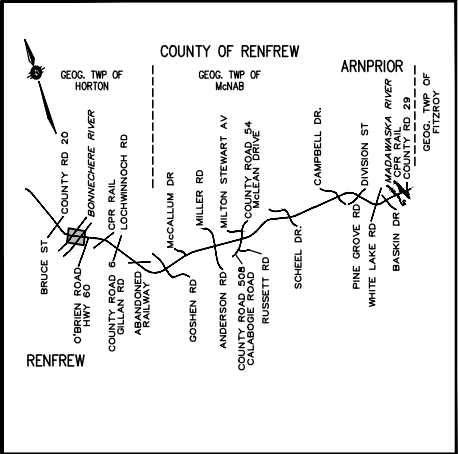




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AND/OR MILLIMETRES  
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BON-7	113.0	5 038 628.5	292 261.1



KEYPLAN

LEGEND

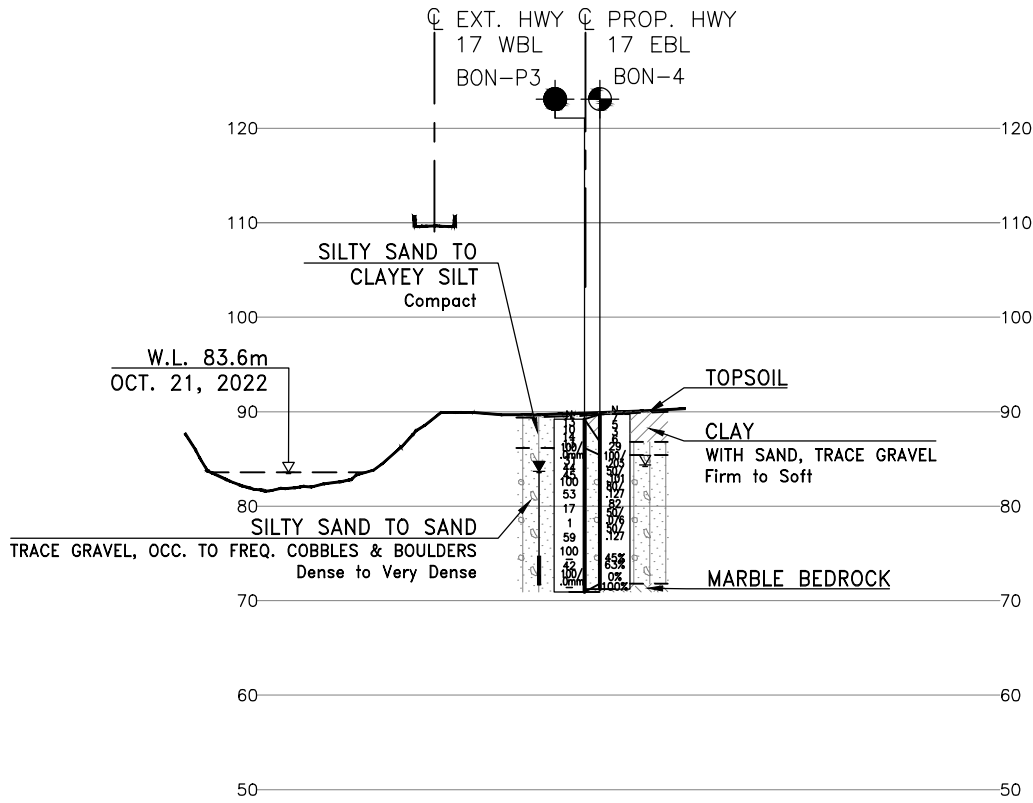
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- Borehole (Previous Investigation)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level Upon Completion of Drilling
- Water Level in Monitoring Well/Piezometer
- Monitoring Well/Piezometer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

NO	ELEVATION	NORTHING	EASTING
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BON19-2	103.0	5 038 599.4	292 321.5
BON19-3	103.0	5 038 587.0	292 358.5
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BON19-8	117.7	5 038 384.8	292 718.9
BON19-9	117.8	5 038 365.0	292 751.0
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BON-P2	86.1	5 038 497.3	292 506.7
BON-P3	89.2	5 038 469.0	292 562.5

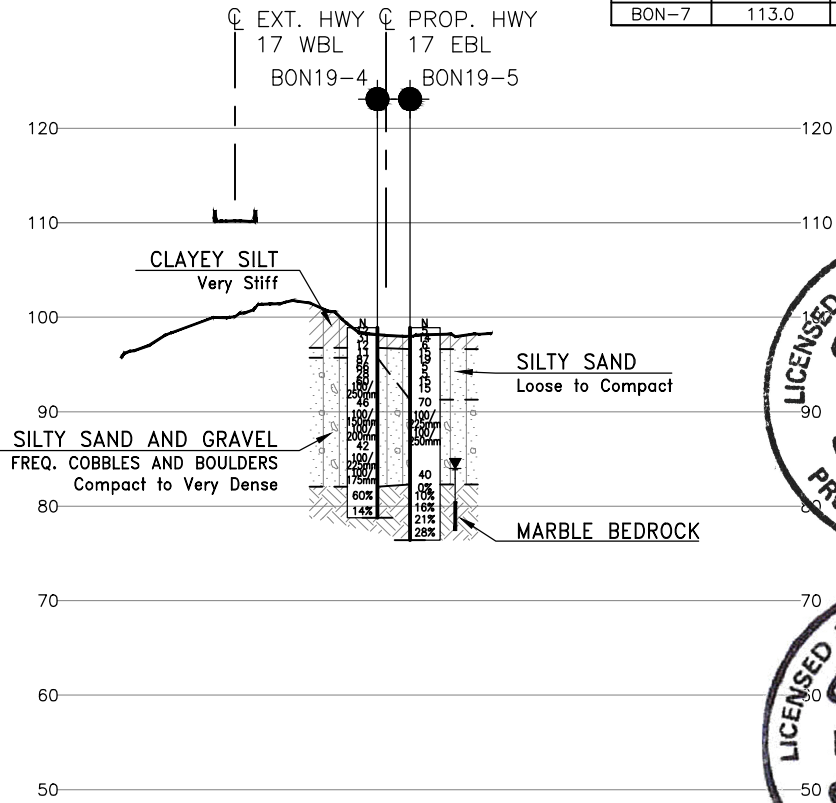
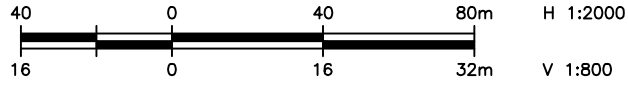
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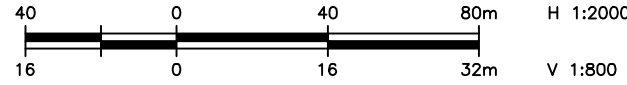
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SECTION ALONG PIER 4



SECTION ALONG E. ABUT



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CODE	LOAD	DATE	OCT 2023
SITE	STRUCT	DWG	4



## **Appendix B.**

### **Record of Testhole Sheets and Field Testing**



## **Appendix B.1**

### **Current (2020/2021/2024) Investigation**

# RECORD OF BOREHOLE No BON19-1

1 OF 5

METRIC

WP# 4068-09-00 LOCATION Lat: 45.487337°, Long: -76.659955°  
Bonnechere River Bridge N 5 038 613.9 E 292 296.7 ORIGINATED BY BC  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / HSA / HW Casing COMPILED BY MIK  
DATUM Geodetic DATE 2021.09.07 - 2021.09.14 CHECKED BY MJK

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			
107.1	Ground Surface							20 40 60 80 100									
0.0	CLAY (CH) to SILTY CLAY (CI) trace sand Occasional sand seams Very stiff Grey-brown [WEATHERED CRUST]		1	SS	21												
			2	SS	13												
			3	SS	8												
			4	SS	7												1 5 38 56
			5	SS	6												
			6	SS	7												
			1	ST	-												0 0 52 48
101.0																	
6.1	CLAYEY SILT (CL) Occasional sand seams Stiff to very stiff Grey-brown to grey		7	SS	4												
			8	SS	3												
			9	SS	4												

Continued Next Page

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23



## METRIC

[illegible]

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

# RECORD OF BOREHOLE No BON19-1

3 OF 5

METRIC

WP# 4068-09-00 LOCATION Lat: 45.487337°, Long: -76.659955°  
Bonnehore River Bridge N 5 038 613.9 E 292 296.7 ORIGINATED BY BC  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / HSA / HW Casing COMPILED BY MIK  
DATUM Geodetic DATE 2021.09.07 - 2021.09.14 CHECKED BY MJK

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		
	Continued From Previous Page							SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
								WATER CONTENT (%)						
								20	40	60	80	100		
85.0							87							
22.1	Gravelly SAND Dense Brown		16	SS	46		86							
							85							
							84							
							83							
82.0							82							
25.1	GRAVEL some sand Compact to dense Red-brown to dark grey		17	SS	27		81							
							80							
							79							
			18	SS	52		78							

Continued Next Page

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

## METRIC

SOIL PROFILE					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES	GROUND WATER CONDITIONS	ELEVATION SCALE
			NUMBER	TYPE	"N" VALUES
	Continued From Previous Page				
	GRAVEL some sand Compact to dense Red-brown to dark grey		19	SS	29
			20	SS	19
73.1 34.0	Inferred gravel and sand				
67.5 39.6	End of Borehole				

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

## METRIC

[illegible]

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

# RECORD OF BOREHOLE No B0N19-2

1 OF 5

METRIC

WP# 4068-09-00 LOCATION Lat: 45.487207°, Long: -76.659637°  
Bonnechere River Bridge N 5 038 599.4 E 292 321.5 ORIGINATED BY RH  
HWY 17 BOREHOLE TYPE Diedrich D-50 / HW Casing COMPILED BY MIK  
DATUM Geodetic DATE 2021.10.07 - 2021.10.08 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE												
103.0	Ground Surface																				
0.0	<b>SILTY CLAY (CI)</b> Very stiff Grey-brown [WEATHERED CRUST]		1	SS	12																
			2	SS	9																
			3	SS	9													0 4 53 43			
			4	SS	6																
			5	SS	7																
			6	SS	8																
			7	SS	6																
			8	SS	5																
			9	SS	8													0 1 59 40			
95.4																					
7.6	<b>CLAYEY SILT (CL)</b> Very stiff Grey		10	SS	5																
			11	SS	4																

Continued Next Page

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

DOUBLE LINE 24726 B0N.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

## METRIC

[illegible]

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

# RECORD OF BOREHOLE No B0N19-2

3 OF 5

METRIC

WP# 4068-09-00 LOCATION Lat: 45.487207°, Long: -76.659637°  
Bonnechere River Bridge N 5 038 599.4 E 292 321.5 ORIGINATED BY RH  
HWY 17 BOREHOLE TYPE Diedrich D-50 / HW Casing COMPILED BY MIK  
DATUM Geodetic DATE 2021.10.07 - 2021.10.08 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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										
Continued From Previous Page							20 40 60 80 100					PLASTIC LIMIT W <sub>P</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub>						
	Gravelly <b>SAND</b> trace silt Occasional cobbles Dense Grey-brown		18	SS	33		82											
			19	SS	34		81											
			20	SS	34		80											
													</					

Continued Next Page

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

# RECORD OF BOREHOLE No B0N19-2

4 OF 5

METRIC

WP# 4068-09-00 LOCATION Lat: 45.487207°, Long: -76.659637°  
Bonnechere River Bridge N 5 038 599.4 E 292 321.5 ORIGINATED BY RH  
HWY 17 BOREHOLE TYPE Diedrich D-50 / HW Casing COMPILED BY MIK  
DATUM Geodetic DATE 2021.10.07 - 2021.10.08 CHECKED BY MJK

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 (%)					
	Continued From Previous Page													
70.4	Gravelly <b>SAND</b> trace silt Occasional cobbles Dense Grey-brown		22	SS	30									
32.6	Inferred gravelly sand													
63.1														

Continued Next Page

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



# RECORD OF BOREHOLE No B0N19-2

5 OF 5

METRIC

WP# 4068-09-00 LOCATION Lat: 45.487207°, Long: -76.659637°  
Bonnechere River Bridge N 5 038 599.4 E 292 321.5 ORIGINATED BY RH  
 HWY 17 BOREHOLE TYPE Diedrich D-50 / HW Casing COMPILED BY MIK  
 DATUM Geodetic DATE 2021.10.07 - 2021.10.08 CHECKED BY MJK

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W P W W L 20 40 60					
39.9	Continued From Previous Page <b>End of Borehole</b> (DCPT Refusal)																

# RECORD OF BOREHOLE No B0N19-3

1 OF 5

METRIC

WP# 4068-09-00 LOCATION Lat: 45.487096°, Long: -76.659163°  
Bonnechere River Bridge N 5 038 587.0 E 292 358.5 ORIGINATED BY NW/RH  
HWY 17 BOREHOLE TYPE Diedrich D-50 / HW Casing COMPILED BY MIK  
DATUM Geodetic DATE 2021.10.01 - 2021.10.07 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT		UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
103.0	Ground Surface							20 40 60 80 100	20 40 60	W <sub>P</sub> W      W <sub>L</sub>			
0.0	CLAY (CH) to SILTY CLAY (CI) Very stiff Brown [WEATHERED CRUST]		1	SS	6			○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE					
			2	SS	14		102						0 4 42 54
			3	SS	13		101						
			4	SS	10		100						
			5	SS	5		99						0 2 61 37
			6	SS	6		98						
			7	SS	4		97						
			8	SS	7		96						
96.9	-300mm thick sand with gravel layer at 5.6 m depth						95						
6.1	CLAYEY SILT (CL) Very stiff to stiff Brown		9	SS	4		94						
			10	SS	5								
			11	SS	3								

Continued Next Page

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

DOUBLE LINE 24726 B0N.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

# RECORD OF BOREHOLE No B0N19-3

2 OF 5

METRIC

WP# 4068-09-00 LOCATION Lat: 45.487096°, Long: -76.659163°  
Bonnechere River Bridge N 5 038 587.0 E 292 358.5 ORIGINATED BY NW/RH  
HWY 17 BOREHOLE TYPE Diedrich D-50 / HW Casing COMPILED BY MIK  
DATUM Geodetic DATE 2021.10.01 - 2021.10.07 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT		UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE		WATER CONTENT (%) W <sub>P</sub> W      W <sub>L</sub>			
	Continued From Previous Page							20   40   60   80   100		20   40   60			
			12	SS	WH		92						0   3   62   35
									8.4 +				
							91		8.0 +				
90.5			13	SS	6								
12.5	SILT (ML) some sand Loose to compact Grey						90						
			14	SS	6		89						0   13   64   23
							88						
			15	SS	9								
87.2							87						
15.8	SANDY SILT (ML) Very loose to compact Grey												
			16	SS	17		86						
							85						
			17	SS	3								
							84						

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

## METRIC

[illegible]

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

# RECORD OF BOREHOLE No BON19-3

5 OF 5

METRIC

WP# 4068-09-00 LOCATION Lat: 45.487096°, Long: -76.659163°  
Bonnechere River Bridge N 5 038 587.0 E 292 358.5 ORIGINATED BY NW/RH  
HWY 17 BOREHOLE TYPE Diedrich D-50 / HW Casing COMPILED BY MIK  
DATUM Geodetic DATE 2021.10.01 - 2021.10.07 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
								WATER CONTENT (%)									
	Continued From Previous Page						20	40	60	80	100	20	40	60			
39.9	<b>SAND</b> some silt Very dense Grey		1	GS	-								○				
							62										
			25	SS	62								○				
61.1							61										
41.9	Inferred <b>SAND and GRAVEL</b> Frequent cobbles and boulders <b>[TILL]</b>  - casing refusal on 400mm boulder at 41.9m    - gravel/cobbles 20mm to 100mm recovered in core barrel		1	NQ			60										
							59										
			2	NQ			58										
			26	SS	100/ 0mm		57										
			3	NQ			56										
55.3			27	SS	100/ 25mm												
47.7	<b>End of Borehole</b> Monitoring well installation consists of 50 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen  WATER LEVEL READINGS: DATE      DEPTH (m)      ELEV. (m) 2021.11.04    19.2          83.8 2021.11.05    19.2          83.8 2022.01.22    19.0          84.0																

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

# RECORD OF BOREHOLE No B0N19-4

1 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485799°, Long: -76.655864°  
Bonnechere River Bridge N 5 038 442.4 E 292 616.2 ORIGINATED BY JP  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / HSA/ HW Casing / HQ Coring COMPILED BY JP  
DATUM Geodetic DATE 2020.08.26 - 2020.09.03 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
98.9	Ground Surface							<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></di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Continued Next Page

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

# RECORD OF BOREHOLE No B0N19-4

2 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485799°, Long: -76.655864°  
Bonnechere River Bridge N 5 038 442.4 E 292 616.2 ORIGINATED BY JP  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / HSA/ HW Casing / HQ Coring COMPILED BY JP  
DATUM Geodetic DATE 2020.08.26 - 2020.09.03 CHECKED BY MJK

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 (%)					
								○ UNCONFINED      + FIELD VANE									
								● QUICK TRIAXIAL      × LAB VANE	20	40	60	80	100	W <sub>P</sub>			W
	Continued From Previous Page																
	<b>SILTY SAND</b> some gravel to <b>GRAVEL</b> , some sand Frequent Cobbles/Boulders Compact to Very Dense Brown		12	SS	100/ 200mm		88						○				
							87										
				13	SS	42								○			
								86									
				14	SS	100/ 225mm		85						○			
								84									
			15	SS	100/ 175mm								○				
							83										
82.1							82								FI		
16.8	<b>MARBLE BEDROCK</b> White-Grey Coarse Grained Smooth Fresh Jointed to Slightly Weathered		1	RUN			81								2	RUN #1 TCR=96% SCR=93% RQD=60% UCS=41.2MPa	
														2			
														2			
														3			
														4			
														3			
							80								>10	RUN #2 TCR=100% SCR=58% RQD=14%	
			2	RUN										6			
														5			
							79							>10			

Continued Next Page

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23




# RECORD OF BOREHOLE No BON19-4

3 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485799°, Long: -76.655864°  
Bonnechere River Bridge N 5 038 442.4 E 292 616.2 ORIGINATED BY JP  
 HWY 17 BOREHOLE TYPE CME 850 Trackmount / HSA/ HW Casing / HQ Coring COMPILED BY JP  
 DATUM Geodetic DATE 2020.08.26 - 2020.09.03 CHECKED BY MJK

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>		
78.8	Continued From Previous Page																
20.1	End of Borehole																

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

# RECORD OF BOREHOLE No BON19-5

1 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485741°, Long: -76.655935°  
Bonnechere River Bridge N 5 038 435.7 E 292 610.5 ORIGINATED BY JP  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / HSA/ HW Casing / HQ Coring COMPILED BY JP  
DATUM Geodetic DATE 2020.09.08 - 2020.09.11 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
98.9	Ground Surface							20 40 60 80 100						
0.0	<b>CLAYEY SILT (CL)</b> Very Stiff Grey-Brown [WEATHERED CRUST]		1	SS	5									
			2	SS	14									
			3	SS	6									
96.6	<b>SILTY SAND</b> Loose to Compact Brown to Grey-Brown		4	SS	15									
2.3			5	SS	19									
			6	SS	5									
			7	SS	5									
			8	SS	15									
			9	SS	15									
91.3	<b>SAND and GRAVEL</b> , some silt to silty Occasional To Frequent Cobbles/Boulders Brown to Grey-Brown Dense to Very Dense		10	SS	70									
7.6														
			11	SS	100/ 225mm									

Continued Next Page

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

## METRIC

[illegible]

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

RECORD OF BOREHOLE No B0N19-5

3 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485741°, Long: -76.655935°  
Bonnechere River Bridge N 5 038 435.7 E 292 610.5 ORIGINATED BY JP  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / HSA/ HW Casing / HQ Coring COMPILED BY JP  
DATUM Geodetic DATE 2020.09.08 - 2020.09.11 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								○ UNCONFINED      + FIELD VANE				w P      w      w L				
								● QUICK TRIAXIAL      × LAB VANE								
	Continued From Previous Page		4	RUN			20	40	60	80	100	20	40	60	3	RUN #4 TCR=97% SCR=54% RQD=21%
															4	
															>10	
			5	RUN											6	RUN #5 TCR=89% SCR=57% RQD=28% UCS=55.1MPa
															0	
															3	
76.4															4	
22.5	End of Borehole														4	
	Monitoring well installation consists of 50 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen															
	DATE      DEPTH (m)      ELEV. (m)															
	2020.09.29      14.9      84.0															
	2021.08.04      14.7      84.2															
	2021.12.01      14.9      84.0															
	2022.01.11      14.8      84.1															

# RECORD OF BOREHOLE No B0N19-6

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485625°, Long: -76.655414°  
Bonnechere River Bridge N 5 038 422.9 E 292 651.3 ORIGINATED BY JG  
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP  
DATUM Geodetic DATE 2020.09.17 - 2020.09.17 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
116.9	Ground Surface							20 40 60 80 100		W <sub>P</sub> W   W <sub>L</sub>				
0.0	TOPSOIL 100mm							20 40 60 80 100						
0.1	SILTY CLAY (CI) Occasional silty sand seam Very Stiff Brown [WEATHERED CRUST]		1	SS	6									
			2	SS	13									
			3	SS	10									
			4	SS	11									
			5	SS	5									
			6	SS	6									
			7	SS	7									
			8	SS	18									
108.1	SAND some silt to silty Compact Brown													

Continued Next Page

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

# RECORD OF BOREHOLE No B0N19-6

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485625°, Long: -76.655414°  
Bonnechere River Bridge N 5 038 422.9 E 292 651.3 ORIGINATED BY JG  
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP  
DATUM Geodetic DATE 2020.09.17 - 2020.09.17 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE									
	Continued From Previous Page							20	40	60	80	100					
102.6	<b>SAND</b> some silt to silty Compact Brown		9	SS	22		106								○		0 83 17 (SI+CL)
							105										
			10	SS	23		104								○		
			11	SS	30		103								○		
14.3	<b>End of Borehole</b>  Borehole dry on completion  Monitoring well installation consists of two nested 50 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen  WATER LEVEL READINGS: Shallow Well <b>Date      Depth (m)      Elev. (m)</b> 2020.09.29    dry 2020.11.11    dry 2021.08.06    dry 2022.01.11    dry  Deep Well <b>Date      Depth (m)      Elev. (m)</b> 2020.09.29    dry 2020.11.11    dry 2021.08.06    dry 2022.01.11    dry																

DOUBLE LINE 24726 B0N.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

# RECORD OF BOREHOLE No B0N19-7

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485485°, Long: -76.655113°  
Bonnechere River Bridge N 5 038 407.3 E 292 674.7 ORIGINATED BY SH  
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP  
DATUM Geodetic DATE 2020.09.16 - 2020.09.17 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT		UNIT WEIGHT  <b>γ</b>  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>				WATER CONTENT (%)
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE						
118.0	Ground Surface						20	40	60	80	100			
0.0	TOPSOIL 150mm							20	40	60	80	100		
0.2	SILTY CLAY (CI) Occasional sand seam Very Stiff Grey-Brown [WEATHERED CRUST]		1	SS	16									
			2	SS	17		117							0   2   36   62
			3	SS	16		116							
			4	SS	11		115							
			5	SS	6		114							
			6	SS	9		113							0   0   54   46
			7	SS	7		112							
			8	SS	6		111							
109.9	CLAYEY SILT (CL) Very Stiff Grey	9	SS	5	110									
8.1						109							0   0   58   42	
		10	SS	3										

Continued Next Page

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

# RECORD OF BOREHOLE No BON19-7

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485485°, Long: -76.655113°  
Bonnechere River Bridge N 5 038 407.3 E 292 674.7 ORIGINATED BY SH  
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP  
DATUM Geodetic DATE 2020.09.16 - 2020.09.17 CHECKED BY MJK

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					
	Continued From Previous Page															
	CLAYEY SILT (CL) Very Stiff Grey		11	SS	WH		107									
							106									
			12	SS	1		105									
							104									
104.0			13	SS	5											
14.0	SILTY SAND															
103.7	Compact															
14.3	Brown															
	End of Borehole Borehole dry upon completion															

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



# RECORD OF BOREHOLE No B0N19-8

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485283°, Long: -76.654548°  
Bonnechere River Bridge N 5 038 384.8 E 292 718.9 ORIGINATED BY JP  
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP  
DATUM Geodetic DATE 2020.09.15 - 2020.09.15 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			W P W W L				GR SA SI CL				
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)									
117.7	Ground Surface							20 40 60 80 100	20 40 60										
0.0	SILTY CLAY (CI) Occasional sand seams Very Stiff Grey-Brown [WEATHERED CRUST]		1	SS	4														
			2	SS	7										0 7 40 53				
			3	SS	7														
			4	SS	5														
			5	SS	5														
			6	SS	6										0 0 52 48				
			7	SS	5														
			8	SS	6														
			9	SS	4										0 1 56 43				
109.5																			
8.2	CLAYEY SILT (CL) Stiff to very stiff Grey-Brown to Brown																		
			10	SS	7														

Continued Next Page

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




DOUBLE LINE 24726 B0N.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

# RECORD OF BOREHOLE No BON19-8

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485283°, Long: -76.654548°  
Bonnechere River Bridge N 5 038 384.8 E 292 718.9 ORIGINATED BY JP  
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP  
DATUM Geodetic DATE 2020.09.15 - 2020.09.15 CHECKED BY MJK

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 (%)								
								○ UNCONFINED      + FIELD VANE					w <sub>P</sub> w      w <sub>L</sub>								
								● QUICK TRIAXIAL      × LAB VANE													
	Continued From Previous Page							20	40	60	80	100									
106.4	CLAYEY SILT (CL) Stiff to very stiff Grey-Brown to Brown		11	SS	9		107												0   8   59   33		
11.3	SILTY SAND some gravel Dense Brown		12	SS	43		106								○						
							105														
							104								○						
103.4			13	SS	39																
14.3	End of Borehole Borehole dry upon completion																				

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

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

# RECORD OF BOREHOLE No B0N19-9

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485106°, Long: -76.654137°  
Bonnechere River Bridge N 5 038 365.0 E 292 751.0 ORIGINATED BY JP  
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP  
DATUM Geodetic DATE 2020.09.14 - 2020.09.14 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL	
								○ UNCONFINED      + FIELD VANE	● QUICK TRIAXIAL      × LAB VANE												
117.8	Ground Surface																				
0.0	<b>SILTY CLAY (CI)</b> Occasional sand seams Very stiff Grey-brown <b>[WEATHERED CRUST]</b>		1	SS	4																
			2	SS	9																
			3	SS	11																
			4	SS	10																
			5	SS	8																
			6	SS	8																
			7	SS	8																
			8	SS	6																
			9	SS	7																
			10	SS	5																
109.9			11	SS	1																
7.9	<b>CLAYEY SILT (CL)</b> Occasional sand seams Stiff Grey																				

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

Continued Next Page

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

## METRIC

SOIL PROFILE						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE
			NUMBER	TYPE	"N" VALUES	
	Continued From Previous Page					
	<b>CLAYEY SILT (CL)</b> Occasional sand seams Stiff Grey					
			12	SS	7	
			13	SS	3	
104.1						
13.7	<b>SAND</b> some silt, some gravel		14	SS	100/	
103.8	Very dense, grey-brown				280mm	
14.0	<b>End of Borehole</b> Water level at 11.9m in open hole upon completion of drilling					

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

## METRIC

[illegible]

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

## METRIC

[illegible]

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

## METRIC

[illegible]

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23



# RECORD OF BOREHOLE No BON-P1

4 OF 4

METRIC

WP# 4068-09-00 LOCATION Lat: 45.486786°, Long: -76.658392°  
Bonnechere River Bridge N 5 038 552.4 E 292 418.8 ORIGINATED BY NW  
HWY 17 BOREHOLE TYPE Diedrich D-50 / HSA / HW Casing COMPILED BY MIK  
DATUM Geodetic DATE 2021.09.29 - 2021.10.01 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT  W <sub>P</sub>	NATURAL MOISTURE CONTENT  W	LIQUID LIMIT  W <sub>L</sub>	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page							20	40	60	80	100					GR SA SI CL
57.4			22	SS	100%												
30.5	<b>End of Borehole</b> Monitoring well installation consists of 50 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen  WATER LEVEL READINGS: DATE      DEPTH (m)      ELEV. (m) 2021.11.04      4.1      83.8 2021.11.30      4.1      83.8 2022.01.25      3.9      84.0				0mm												

# RECORD OF BOREHOLE No BON-P2

1 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.486292°, Long: -76.657266°  
Bonnechere River Bridge N 5 038 497.3 E 292 506.7 ORIGINATED BY AO  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / NW Casing COMPILED BY AO  
DATUM Geodetic DATE 2021.11.09 - 2021.11.10 CHECKED BY MJK

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		
86.1	Ground Surface													
0.0	TOPSOIL (150 mm)						86							
0.2	SANDY SILT (ML) Loose to very loose Brown with orange mottling		1	SS	4									
			2	SS	6		85							
	- clayey silt interbedding													
			3	SS	5		84							
			4	SS	3									
82.9							83							
3.2	SAND, some silt trace gravel Compact to very loose Brown		5	SS	10									
			6	SS	12		82							
			7	SS	16		81							
			8	SS	2									
80.0							80							
6.1	SAND some silt, some gravel Loose to very dense Grey Stratified structure		9	SS	12									
							79							
			10	SS	21		78							
							77							
			11	SS	13									

Continued Next Page

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

20  
15  
10

(%) STRAIN AT FAILURE

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

## METRIC

Continued Next Page

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

# RECORD OF BOREHOLE No BON-P2

3 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.486292°, Long: -76.657266°  
Bonnechere River Bridge N 5 038 497.3 E 292 506.7 ORIGINATED BY AO  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / NW Casing COMPILED BY AO  
DATUM Geodetic DATE 2021.11.09 - 2021.11.10 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT  <b>γ</b>  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>		
								○ UNCONFINED	+ FIELD VANE								
						● QUICK TRIAXIAL	× LAB VANE										
	Continued From Previous Page						20	40	60	80	100	20	40	60			
	Inferred <b>SAND and GRAVEL</b> Frequent cobbles, occasional boulders <b>[TILL]</b>		19	NQ	-		66										
			20	NQ	-		65										
64.8																	
21.3	<b>End of Borehole</b>  Monitoring well installation consists of 50 mm diameter Schedule 40 PVC pipe with a 3 m slotted screen Unstabilized water level at 2.3m below the ground surface upon completion of drilling.  WATER LEVEL READINGS: Date      Depth (m)      Elev. (m) 2021.11.17    2.5            83.6 2021.11.30    2.5            83.6 2022.01.11    2.4            83.7																

# RECORD OF BOREHOLE No BON-P3

1 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.486038°, Long: -76.656551°  
Bonnechere River Bridge N 5 038 469.0 E 292 562.5 ORIGINATED BY AO  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / NW Casing COMPILED BY AO  
DATUM Geodetic DATE 2021.11.08 - 2021.11.09 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  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 (%) w <sub>P</sub> w      w <sub>L</sub>				GR	SA	SI	CL
89.2	Ground Surface							20	40	60	80	100							
0.0	TOPSOIL (150 mm)							20	40	60	80	100							
0.2	SILTY SAND to SANDY SILT Compact Dark brown to brown		1	SS	13		89							○					
			2	SS	10		88							○					
			3	SS	14									○					
87.1							87							○					
2.1	SANDY CLAYEY SILT, trace Gravel Occasional sand partings Very stiff Light brown with orange mottling		4	SS	13									○					
86.2			5	SS	100/		86							○					
3.0	SAND, trace to some gravel and silt Occasional cobbles Very dense to very loose Light brown				0mm		85							○					
			6	SS	31									○					
			7	SS	44		84							○					
			8	SS	45									○					
			9	SS	100		83							○					
							82							○					
			10	SS	53		81							○					
							80							○					
			11	SS	17									○					

Continued Next Page

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

# RECORD OF BOREHOLE No BON-P3

2 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.486038°, Long: -76.656551°  
Bonnehore River Bridge N 5 038 469.0 E 292 562.5 ORIGINATED BY AO  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / NW Casing COMPILED BY AO  
DATUM Geodetic DATE 2021.11.08 - 2021.11.09 CHECKED BY MJK

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

	Continued From Previous Page																
	<b>SAND</b> , trace to some gravel and silt Occasional cobbles Very dense to very loose Light brown		12	SS	1		79										7 87 6 (SI+CL)
							78										
77.0							77										
12.2	<b>SAND</b> , some gravel Occasional to frequent cobbles Very dense Light brown [TILL]		13	SS	59		76										
			14	SS	100		75										
			15	NQ	-		74										15 81 4 (SI+CL)
			16	SS	42		73										
			17	SS	100/ 280mm		72										
	- Frequent cobbles below 16.8 m depth		18	NQ	-		71										
70.9																	
18.3	<b>End of Borehole</b>  Monitoring well installation consists of 50 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen  Unstabilized water level at 5.3 m below the ground surface upon completion of drilling.																

Continued Next Page

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23

# RECORD OF BOREHOLE No BON-P3

3 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.486038°, Long: -76.656551°  
Bonnechere River Bridge N 5 038 469.0 E 292 562.5 ORIGINATED BY AO  
HWY 17 BOREHOLE TYPE CME 850 Trackmount / NW Casing COMPILED BY AO  
DATUM Geodetic DATE 2021.11.08 - 2021.11.09 CHECKED BY MJK

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																										
	Continued From Previous Page																																	
	<p>WATER LEVEL READINGS:</p> <table border="1"> <thead> <tr> <th>Date</th> <th>Depth (m)</th> <th>Elev. (m)</th> </tr> </thead> <tbody> <tr> <td>2021.11.09</td> <td>5.3</td> <td>83.9</td> </tr> <tr> <td>2021.11.17</td> <td>5.5</td> <td>83.7</td> </tr> <tr> <td>2021.12.01</td> <td>5.5</td> <td>83.7</td> </tr> <tr> <td>2022.01.05</td> <td>5.4</td> <td>83.8</td> </tr> <tr> <td>2022.01.11</td> <td>5.5</td> <td>83.7</td> </tr> </tbody> </table>	Date	Depth (m)	Elev. (m)	2021.11.09	5.3	83.9	2021.11.17	5.5	83.7	2021.12.01	5.5	83.7	2022.01.05	5.4	83.8	2022.01.11	5.5	83.7															
Date	Depth (m)	Elev. (m)																																
2021.11.09	5.3	83.9																																
2021.11.17	5.5	83.7																																
2021.12.01	5.5	83.7																																
2022.01.05	5.4	83.8																																
2022.01.11	5.5	83.7																																

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 10-19-23




RECORD OF BOREHOLE No B0N24-1

1 OF 4

METRIC

WP# 4068-09-00 LOCATION Lat: 45.487373°, Long: -76.659943°  
Bonnechere River Bridge N 5 038 617.8 E 292 297.6 ORIGINATED BY BC  
HWY 17 BOREHOLE TYPE CME 750 Trackmount / NW Casing COMPILED BY RH  
DATUM Geodetic DATE 2024.04.10 - 2024.04.23 CHECKED BY MJK

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 (%)			GR	SA	SI	CL
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×			LAB VANE	w <sub>P</sub>	w	w <sub>L</sub>			
107.8	Ground Surface																				
0.0	CLAY (CH) to SILTY CLAY (CI) contains sand partings very stiff grey-brown [WEATHERED CRUST]		1	SS	9																
			2	SS	9																
			3	SS	9																
			4	SS	5																
			5	SS	4																
			6	SS	3																
			7	ST	-																

Continued Next Page

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 12-9-24

## METRIC

[illegible]

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

## METRIC

[illegible]

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 12-9-24

## METRIC

SOIL PROFILE					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES	GROUND WATER CONDITIONS	ELEVATION SCALE
			NUMBER	TYPE	"N" VALUES
<div>DYNAMIC CONE PENETRATION RESISTANCE PLOT<div>20406080100</div><div>○ UNCONFINED + FIELD VANE● QUICK TRIAXIAL × LAB VANE</div></div> <div>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT<div>w<sub>p</sub> w w<sub>L</sub></div></div> <div>SHEAR STRENGTH kPa</div> <div>WATER CONTENT (%)</div> <div>204060</div> <div>UNIT WEIGHT</div> <div>kN/m<sup>3</sup></div> <div>REMARKS &amp; GRAIN SIZE DISTRIBUTION (%)</div> <div>GR SA SI CL</div>					
	Continued From Previous Page				
	GRAVEL and SAND to SANDY GRAVEL (GW) compact to dense grey-brown				
		18	SS	28	
		19	SS	31	
		1	RUN	-	
70.3	SANDY GRAVEL compact grey-brown				
37.5		20	SS	24	
		2	RUN	-	
68.9	GRAVELLY SAND occasional cobbles compact grey-brown				
38.9		21	SS	20	
68.3					
39.5	End of Borehole				

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 12-9-24

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

RECORD OF BOREHOLE No B0N24-2

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.487263°, Long: -76.660209°  
Bonnechere River Bridge N 5 038 605.7 E 292 276.8 ORIGINATED BY BC  
HWY 17 BOREHOLE TYPE CME 750 Trackmount / NW Casing COMPILED BY RH  
DATUM Geodetic DATE 2024.04.09 - 2024.04.09 CHECKED BY MJK

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 (%)			GR	SA	SI	CL
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×					LAB VANE						
108.5	Ground Surface																						
0.0	CLAY (CH) very stiff brown to grey-brown [WEATHERED CRUST]		1	SS	9																		
			2	SS	9																		
			3	SS	12																		
			4	SS	8																		
			5	SS	4																		
			6	SS	5																		

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE


DOUBLE LINE 24726 B0N.GPJ 2012TEMPLATE(MTO).GDT 12-9-24

## METRIC

SOIL PROFILE					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES	GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT
			NUMBER  TYPE  "N" VALUES		20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w p w w L
	Continued From Previous Page				
	SILTY CLAY (CI) stiff to very stiff brown		9 SS WH		98
			10 SS WH		97
94.9					96
13.6	End of Borehole				95

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

## METRIC

SOIL PROFILE						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS
			NUMBER	TYPE	"N" VALUES	
104.0 0.0	Ground Surface  Refer to adjacent Borehole logs for upper stratigraphy.					
<div>DYNAMIC CONE PENETRATION RESISTANCE PLOT</div> <div>SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE</div> <div>WATER CONTENT (%) PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT w<sub>P</sub>                  w                  w<sub>L</sub></div>						
ELEVATION SCALE	20	40	60	80	100	
103						
102						
101						
100						
99						
98						
97						
96						
95						
UNIT WEIGHT γ kN/m³						
REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						

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

## 2 OF 6

METRIC

SOIL PROFILE						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES	N° VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
						DYNAMIC CONE PENETRATION RESISTANCE PLOT  PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w <sub>p</sub> w w <sub>L</sub> WATER CONTENT (%)
<div>Continued From Previous Page</div> <div>Refer to adjacent Borehole logs for upper stratigraphy.</div>						<div>Shear Strength kPa</div> <div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div>
						<div>20 40 60 80 100</div> <div>20 40 60</div> <div>kN/m³ GR SA SI CL</div>
						93
						92
						91
						90
						89
						88
						87
						86
						85

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 12-9-24



## 3 OF 6

METRIC


[illegible]


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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 12-9-24

## 4 OF 6

METRIC

ELEV. DEPTH	SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT  NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT  $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES							
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
	Continued From Previous Page							20    40    60    80    100 20    40    60    80    100 WATER CONTENT (%) 20    40    60	W P                  W                  W L ○		kN/m <sup>3</sup>	GR SA SI C

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE      LIQUID CONTENT      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 (%)					
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE				W <sub>p</sub> W      W <sub>L</sub>					
	Continued From Previous Page  Refer to adjacent Borehole logs for upper stratigraphy.							20	40	60	80	100		20	40	60	
							73										
							72										
							71										
							70										
							69										
							68										
67.7							67										
36.3	Inferred <b>SAND and GRAVEL</b> Frequent cobbles and boulders [TILL]		1	RUN			66										
			2	RUN			65										

Continued Next Page

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

DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 12-9-24

## METRIC

[illegible]

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


DOUBLE LINE 24726 BON.GPJ 2012TEMPLATE(MTO).GDT 12-9-24

RECORD OF BOREHOLE No B0N24-3

6 OF 6

METRIC

WP# 4068-09-00 LOCATION Lat: 45.487207°, Long: -76.659618°  
Bonnetchere River Bridge N 5 038 599.3 E 292 323.0 ORIGINATED BY BC  
HWY 17 BOREHOLE TYPE CME 750 Trackmount / NW Casing COMPILED BY RH  
DATUM Geodetic DATE 2024.05.03 - 2024.05.07 CHECKED BY MJK

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									
	Continued From Previous Page						20	40	60	80	100						
	Inferred <b>SAND and GRAVEL</b> Frequent cobbles and boulders [TILL]		4	RUN	-												
			5	RUN	-												
			6	RUN	-												
51.5																	
52.5	End of Borehole																



## **Appendix B.2**

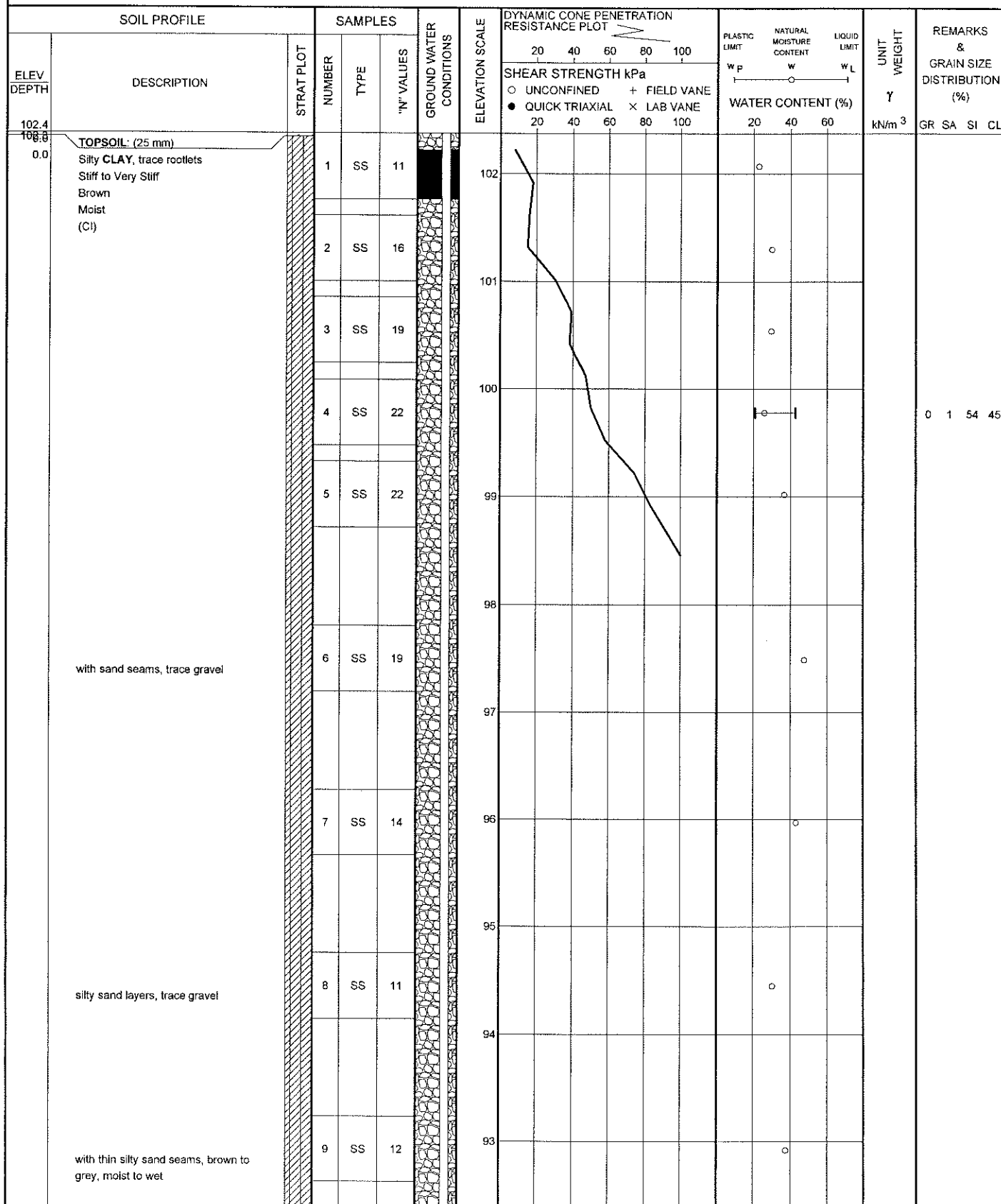
### **Previous (2003) Investigation**

# RECORD OF BOREHOLE No BON-1

1 OF 4

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 578.0, E 292 351.3 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 16.10.03 - 20.10.03 CHECKED BY SMS



Continued Next Page

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No BON-1

2 OF 4

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 578.0, E 292 351.3 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 16.10.03 - 20.10.03 CHECKED BY SMS

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		
								SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
								WATER CONTENT (%)						
								20	40	60	80	100		
								20	40	60	80	100		
92														
	Firm, grey, wet		10	SS	4									0 6 64 30
91														
90.5								2.27						
90	Silty SAND to Sandy SILT Loose to Dense Grey Wet		1	TW										
89														
88														
87			11	SS	45									
86														
85														
84			12	SS	8									0 20 63 17
83														

Continued Next Page

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

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No BON-1

3 OF 4

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 578.0, E 292 351.3 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 16.10.03 - 20.10.03 CHECKED BY SMS

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			20 40 60 80 100	20 40 60 80 100					
82.2														
20.2	Gravelly SAND, occasional cobbles and boulders		13	SS	50/ .127		82							
							81							
							80							
							79							
			14	SS	50/ .100		78							
							77							
							76							
75.2							75							
27.1	SAND and GRAVEL, trace silt, occasional cobbles and boulders Very Dense Grey Wet		15	SS	50/ .075		74							
			1	RUN			73							

Continued Next Page

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

20  
15 10 5  
(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No BON-1

4 OF 4

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 578.0, E 292 351.3 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 16.10.03 - 20.10.03 CHECKED BY SMS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
71.8			16	SS	507		72										
30.5	END OF BOREHOLE AT 30.53m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) 22/10/03 18.59 19/12/03 18.15 04/02/04 17.95				.050												

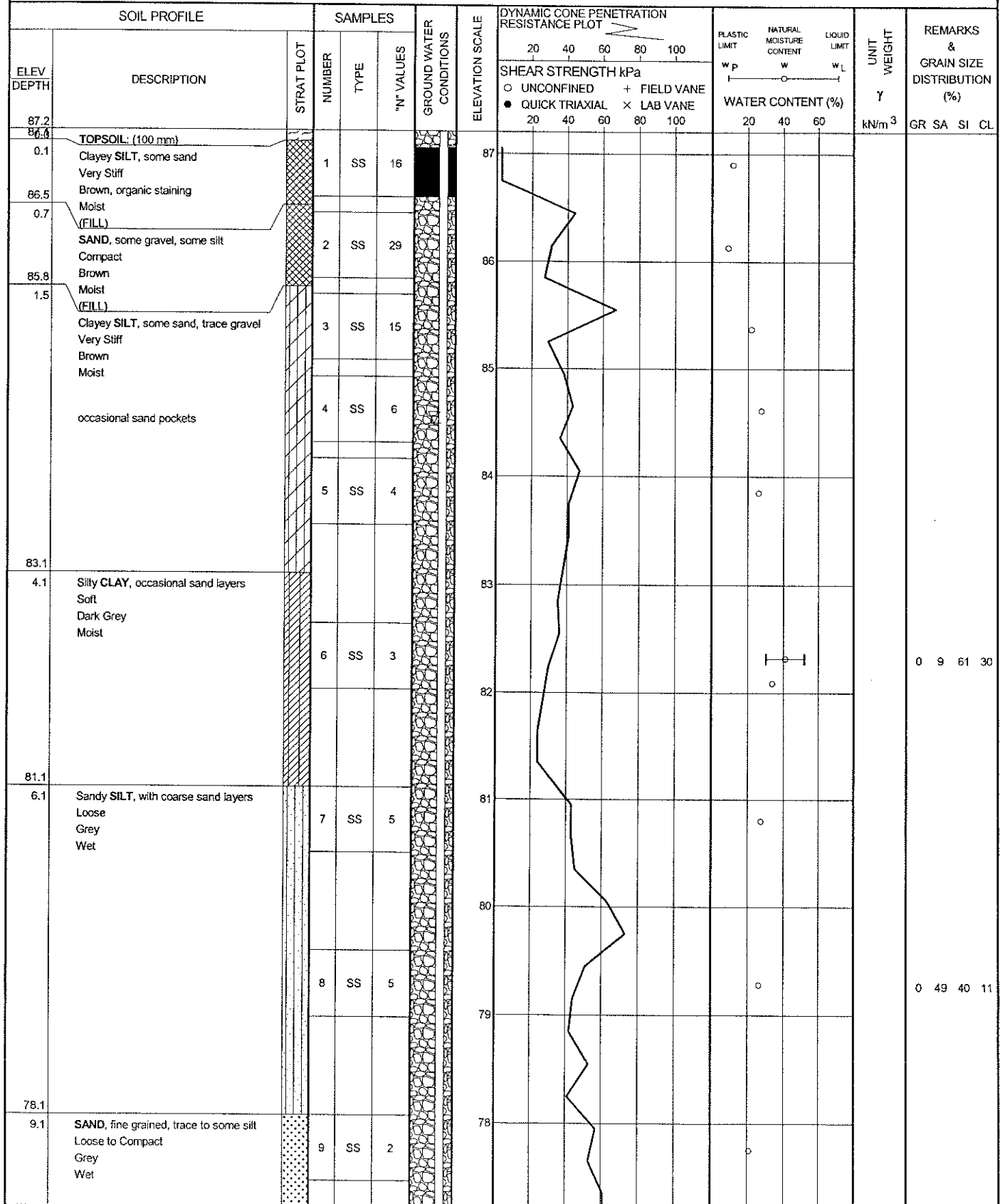
ONTM14 7450BON.GPJ 11/05/04

# RECORD OF BOREHOLE No BON-2

1 OF 4

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 548.1, E 292 414.8 (Bonnechere River) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, HQ Casing, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 14.10.03 - 16.10.03 CHECKED BY SMS



Continued Next Page

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

# RECORD OF BOREHOLE No BON-2

2 OF 4

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 548.1, E 292 414.8 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, HQ Casing, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 14.10.03 - 16.10.03 CHECKED BY SMS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  Y 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	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	W P W W L	WATER CONTENT (%)		GR SA SI CL
74.7	with clay layers to 50 mm thick		10	SS	10		77					
							76					
			11	SS	20		75					
12.5	SAND, medium to coarse grained, trace gravel, occasional cobbles Compact to Very Dense Grey Wet clay layers to 25 mm thick						74					
			12	SS	39		73					0 80 20 (SI+CL)
							72					
			13	SS	81		71					
							70					
	medium grained, trace gravel, occasional cobbles		14	SS	51		69					
							68					
			15	SS	50/ .127							
			16	SS	27							

Continued Next Page

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No BON-2

3 OF 4

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 548.1, E 292 414.8 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, HQ Casing, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 14.10.03 - 16.10.03 CHECKED BY SMS

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					
	boulders from 20.6m to 21.34m												start coring from 20.6m to 21.3m
			17	SS	37								2 93 5 (SI+CL)
59.8			18	SS	50								
27.4	SAND, coarse grained, trace gravel, occasional cobbles and boulders				102								continuous coring
	boulders and cobbles from 28.22m to 28.55m												
	400 mm boulder from 29.9m to 30.33m.												

Continued Next Page

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

ONTMT4 7450BON.GPJ 13/08/04

# RECORD OF BOREHOLE No BON-2

4 OF 4

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 548.1, E 292 414.8 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, HQ Casing, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 14.10.03 - 16.10.03 CHECKED BY SMS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
55.9					FI		57								
31.3	<b>MARBLE, BEDROCK</b> Slightly to moderately weathered, very thinly to thinly bedded, grey with dark grey and white subhorizontal banding, very strong Subvertical joints from 31.85m to 31.9m, from 31.93m to 32.13m Multiple rock fragments in gravel and cobble sizes with clay coating from 30.63m to 31.24m Multiple joints from 32.79m to 32.89m, 34.26m to 34.37m		1	RUN	1		56								RUN 1# TCR=100%, SCR=100%, RQD=87%, UCS=139.0MPa RUN 2# TCR=100%, SCR=100%, RQD=83%, UCS=110.4MPa
			2		2		55								
			2	RUN	1		54								
			4		4										RUN 3# TCR=100%, SCR=100%, RQD=92%, UCS=135.9MPa
			4		4										
			1		1										
52.8			3	RUN	0		53								
34.4	END OF BOREHOLE AT 34.37m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.83m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) 22/11/03 3.47 19/12/03 3.42 04/02/04 2.72														

## METRIC

ORIGINATED BY SL

COMPILED BY SS

CHECKED BY                      SMS

Continued Next Page

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

# RECORD OF BOREHOLE No BON-3

2 OF 3

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 497.2, E 292 509.5 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 03.11.03 - 03.11.03 CHECKED BY SMS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>				
							76							
			10	SS	50/ .125		75							
			11	SS	20		74							
							73							
							72							
			12	SS	28		71							
							70							
							69							
							68							
67.7							67							
18.4	Silty SAND, trace gravel, occasional cobbles, and limestone fragments Loose Grey Wet (TILL) (ML- nonplastic)		13	SS	9									10 58 23 8

Continued Next Page

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

ONTMT4 7450BON.GPJ 13/09/04

## METRIC

[illegible]

+ 3, x 3: Numbers refer to Sensitivity



## METRIC

[illegible]

+ 3, x 3: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No BON-4

2 OF 3

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 463.3, E 292 564.5 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 30.10.03 - 31.10.03 CHECKED BY SMS

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							
							20	40	60	80	100				
							○ UNCONFINED	+	FIELD VANE						
							● QUICK TRIAXIAL	×	LAB VANE						
							WATER CONTENT (%)								
							20	40	60	80	100				
10.0	Gravelly SAND with cobbles, occasional boulders Dense to Very Dense Grey Wet Grey		10	SS	50/ .076		79								
77.4			11	SS	50/ .127		78								
12.3	COBBLES and BOULDERS, some sand and gravel Very Dense Grey Wet						77								continuous coring
							76								
			1	RUN			75								RUN 2# TCR=83%, SCR=83%, RQD=45%, UCS=127.5MPa
	large boulder from 15.0m to 16.4m		2	RUN			74								RUN 3# TCR=93%, SCR=68%, RQD=63%, UCS=119.6MPa
			3	RUN			73								RUN 4# TCR=45%, SCR=23%, RQD=0%
			4	RUN			72								
71.8															
17.9	MARBLE, BEDROCK Moderately weathered, thinly bedded, grey with white subhorizontal banding, very strong		5	RUN											RUN 5# TCR=100%, SCR=100%, RQD=100%, UCS=125.4MPa
71.2															
18.5	Subvertical joints from 15.72m to 15.9m, 18.06m to 18.16m, 18.21m to 18.29m Vertical joint from 17.91m to 18.16m Multiple joints, broken core and gravel pieces from 14.94m to 15.14m, 16.03m to 16.38m, 16.38m to 17.91m END OF BOREHOLE AT 18.47m. Piezometer installation consists of														

Continued Next Page

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

# RECORD OF BOREHOLE No BON-4

3 OF 3

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 463.3, E 292 564.5 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 30.10.03 - 31.10.03 CHECKED BY SMS

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						
	19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) 04/02/04 5.35							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100						

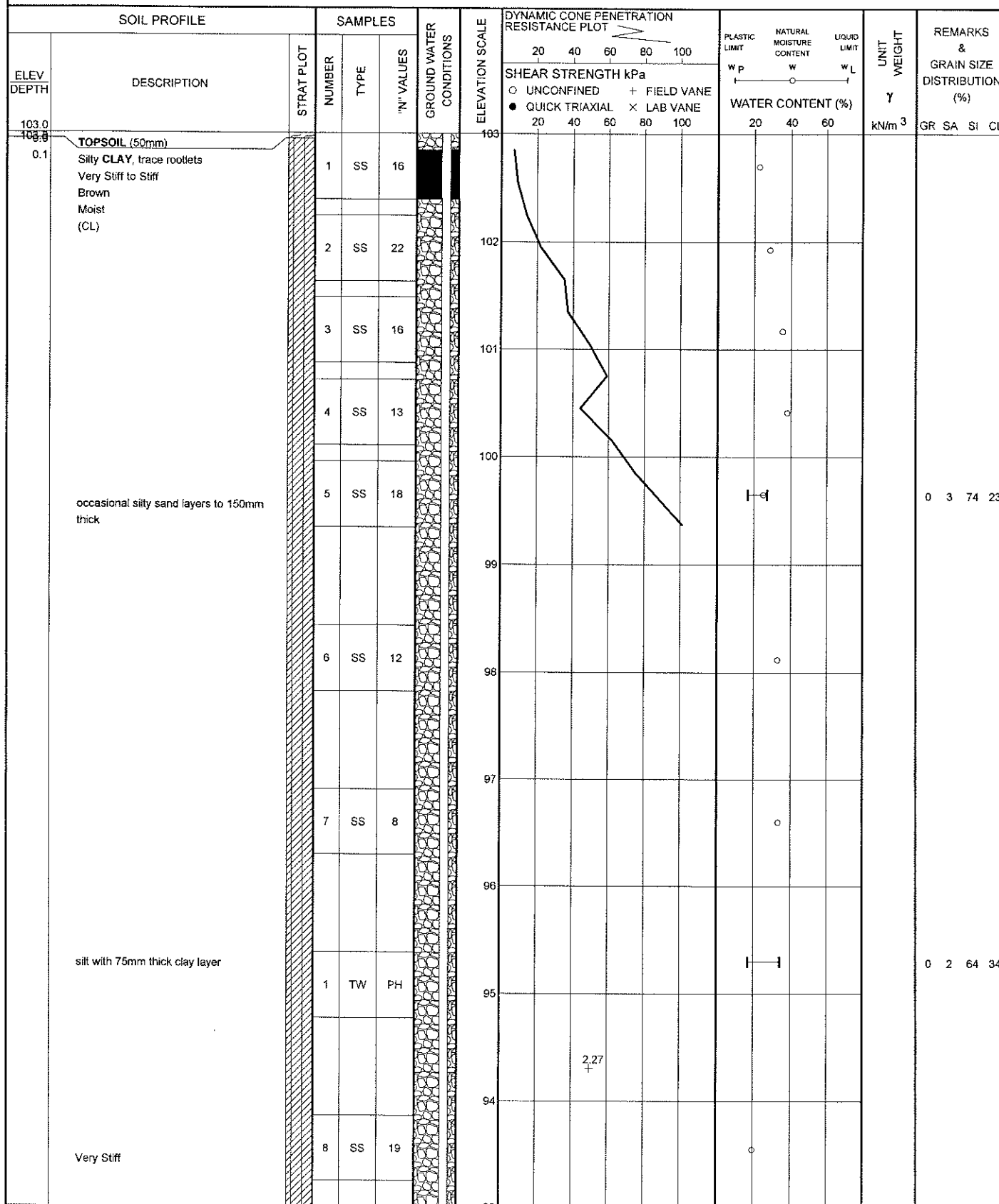
ONTMT4 7450BON GPJ 11/05/04

# RECORD OF BOREHOLE No BON-6

1 OF 3

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 595.5, E 292 317.1 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 20.10.03 - 21.10.03 CHECKED BY SMS



Continued Next Page

+ 3 × 3 : Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

## METRIC

SOIL PROFILE						SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		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				PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w			LIQUID LIMIT w <sub>L</sub>
						SHEAR STRENGTH kPa				WATER CONTENT (%)				
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
						20   40   60   80   100								

[illegible]

+ 3, × 3: Numbers refer to Sensitivity

## METRIC

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 P W W L					WATER CONTENT (%)
								20 40 60 80 100	20 40 60 80 100	20 40 60					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
								20 40 60 80 100				20 40 60		GR SA SI	

[illegible]

ONTMT4 7450BON.GPJ 11/05/04

+ 3, × 3: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No BON-7

1 OF 4

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 628.5, E 292 261.1 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 25.11.03 - 26.11.03 CHECKED BY SMS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
113.0								20	40	60	80	100				
110.9	TOPSOIL (125mm)							20	40	60	80	100				
0.1	Silty CLAY Very Stiff to Stiff Brown Moist (Cl)  occasional sand pockets		1	SS	17											
			2	SS	26											
			3	SS	21											
			4	SS	19											0 2 32 66
			5	SS	10											
			6	SS	7											
107.2																
5.8	Silty CLAY, trace shell fragments Firm to Stiff Grey Moist to Wet Grey (Cl)		7	SS	7											
			8	SS	7											
			9	SS	2											
	Soft															

Continued Next Page

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

# RECORD OF BOREHOLE No BON-7

2 OF 4

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 628.5, E 292 261.1 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 25.11.03 - 26.11.03 CHECKED BY SMS

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						
	Stiff to Very Stiff (CH)						103	2.4			
			10	SS	5		102				0 0 56 44
							101				
			1	TW	PH		100				
							99				
							98				
			11	SS	7		97				
							96				
							95				
			12	SS	10		94				
							93				

Continued Next Page

+ 3, X 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No BON-7

3 OF 4

METRIC

G.W.P. 647-92-00 LOCATION N 5 038 628.5, E 292 261.1 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 25.11.03 - 26.11.03 CHECKED BY SMS

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													
92.5	Silty <b>CLAY</b> , with occasional sand layers to 100mm thick Very Stiff Grey (CL)		13	SS	8		93											
92																		
91																		
90																		
89																		
88																		
87																		
86																		
85																		
84																		
83																		

Continued Next Page

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No BON-7

4 OF 4

METRIC

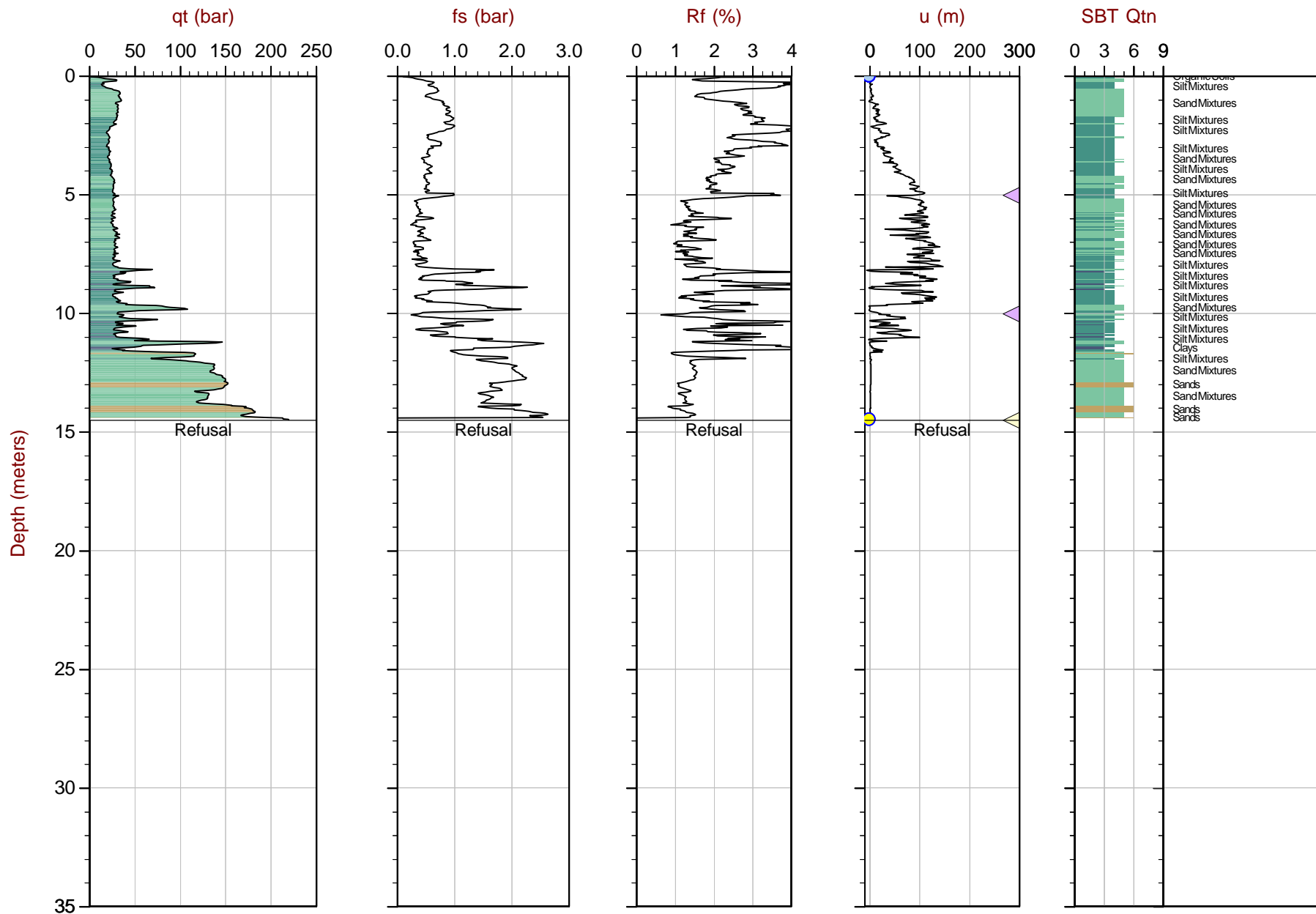
G.W.P. 647-92-00 LOCATION N 5 038 628.5, E 292 261.1 ( Bonnechere River ) ORIGINATED BY SL  
 HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, NQ Coring COMPILED BY SS  
 DATUM Geodetic DATE 25.11.03 - 26.11.03 CHECKED BY SMS

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								
81.9			16	SS	11								
31.1	END OF BOREHOLE AT 31.09m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH(m) 04/02/04 destroyed												



## **Appendix B.3**

**Cone Penetration Test Summary Sheets (ConeTec Investigations Ltd.)**



Max Depth: 14.500 m / 47.57 ft  
Depth Inc: 0.025 m / 0.082 ft  
Avg Int: Every Point

File: 21-05-22576\_SP-BON-E.COR  
Unit Wt: SBTQtn (PKR2009)

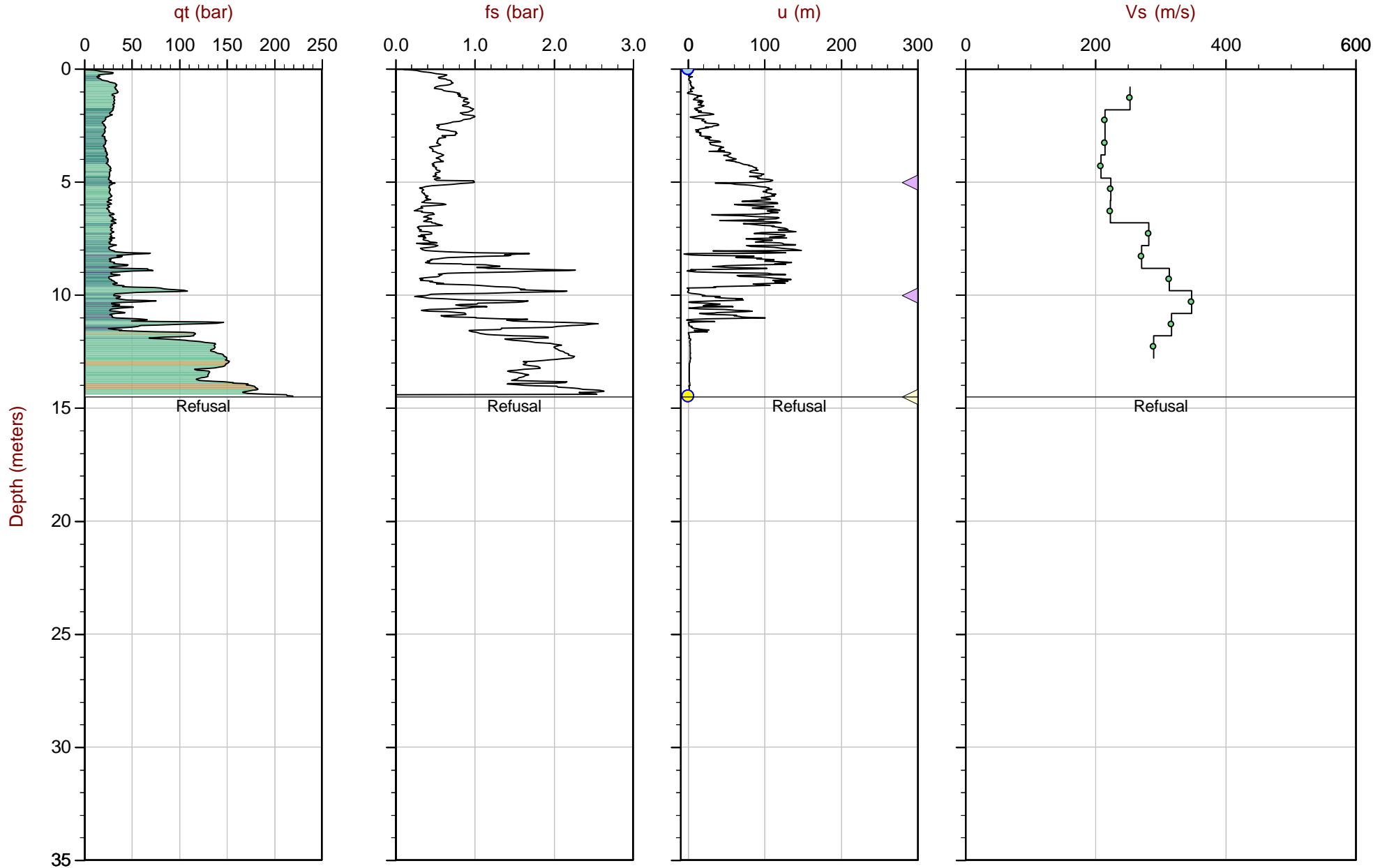
SBT: Robertson, 2009 and 2010  
Coords: MTM 9N N:5038418.8m E:292650.9m Elev.116.9m  
Page No: 1 of 1

Overplot Item: ● Assumed Ueq ● Ueq

▲ Dissipation, equilibrium achieved  
▲ Dissipation, equilibrium assumed

— Hydrostatic Line  
▲ Dissipation, equilibrium not achieved

— Equilibrium Profile



Max Depth: 14.500 m / 47.57 ft  
Depth Inc: 0.025 m / 0.082 ft  
Avg Int: Every Point

File: 21-05-22576\_SP-BON-E.COR  
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010  
Coords: MTM 9N N:5038418.8m E:292650.9m Elev.116.9m  
Page No: 1 of 1

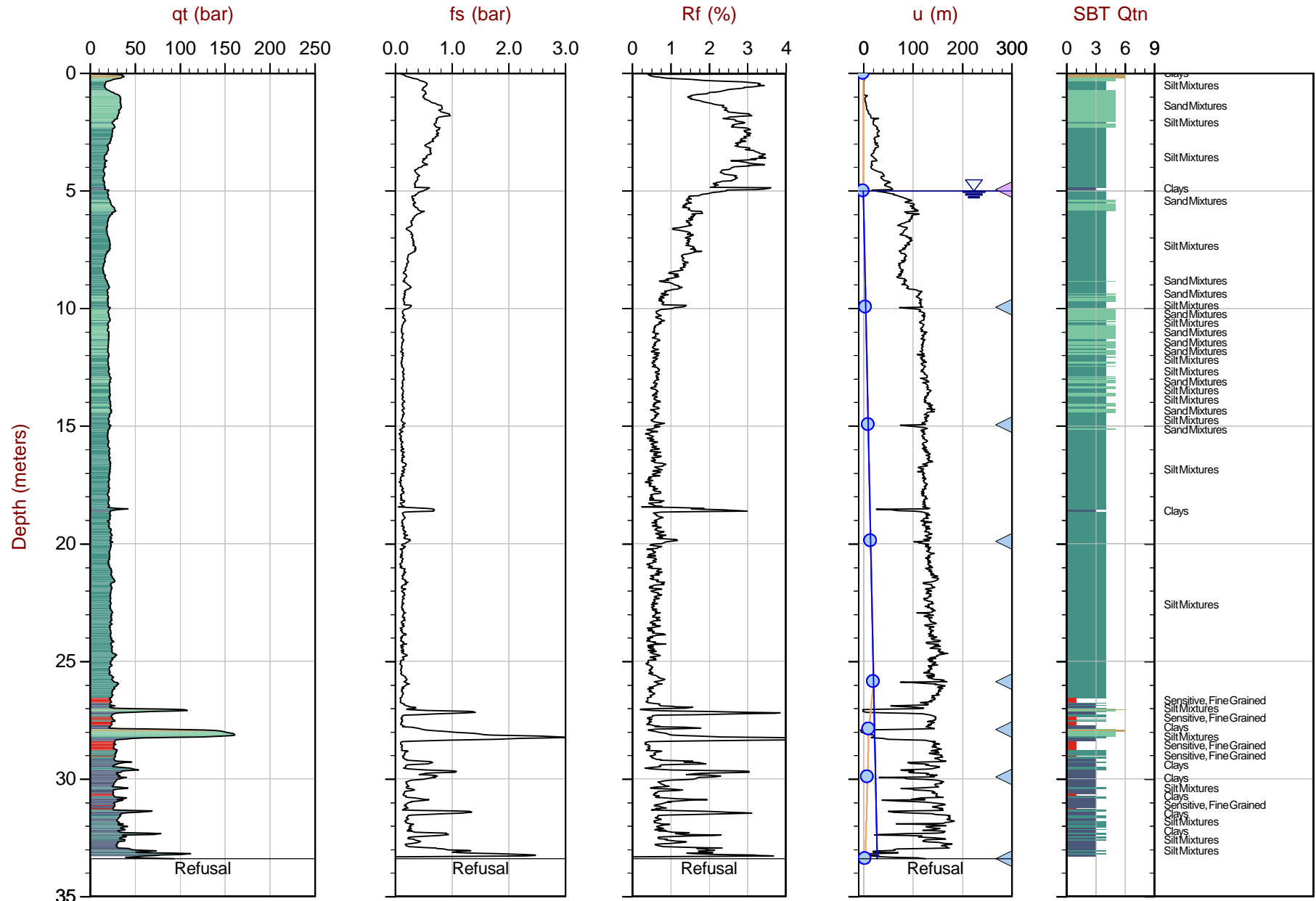
Overplot Item:

● Assumed Ueq  
● Ueq

◀ Dissipation, equilibrium achieved  
◀ Dissipation, equilibrium assumed

— Hydrostatic Line  
◀ Dissipation, equilibrium not achieved

— Equilibrium Profile



Max Depth: 33.400 m / 109.58 ft  
Depth Inc: 0.025 m / 0.082 ft  
Avg Int: Every Point

File: 21-05-22576\_SP-BON-W.COR  
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010  
Coords: MTM 9N N:5038619.4m E:292269.6m Elev.112.0m  
Page No: 1 of 1

Overplot Item:

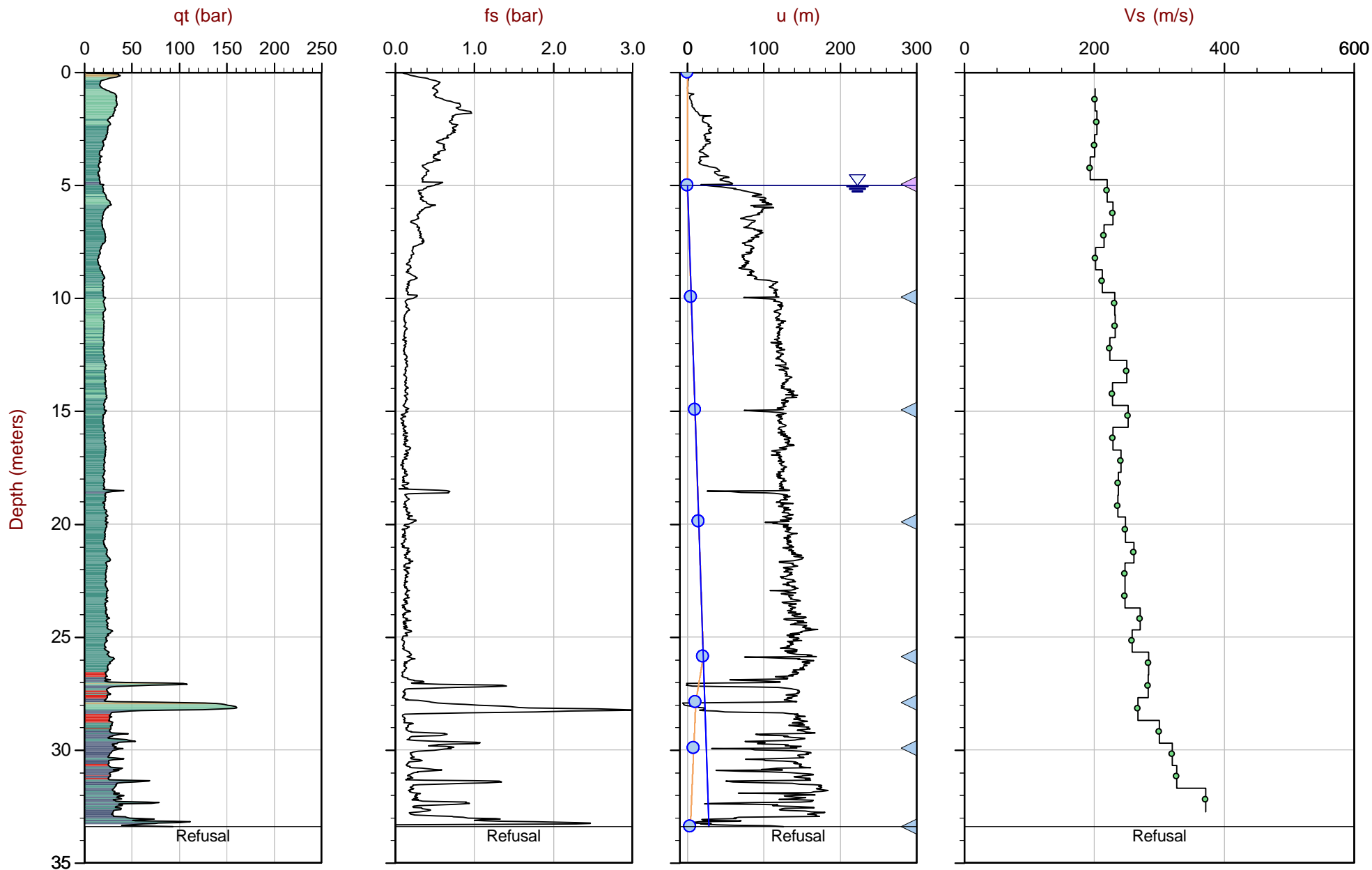
- Assumed Ueq
- ▲ Dissipation, equilibrium achieved
- Hydrostatic Line
- Equilibrium Profile
- Ueq
- ▲ Dissipation, equilibrium assumed
- ▲ Dissipation, equilibrium not achieved



# Thurber Engineering

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

Sounding: BON-W  
Cone: 609:T1500F15U35



Max Depth: 33.400 m / 109.58 ft  
Depth Inc: 0.025 m / 0.082 ft  
Avg Int: Every Point

File: 21-05-22576\_SP-BON-W.COR  
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010  
Coords: MTM 9N N:5038619.4m E:292269.6m Elev.112.0m  
Page No: 1 of 1

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



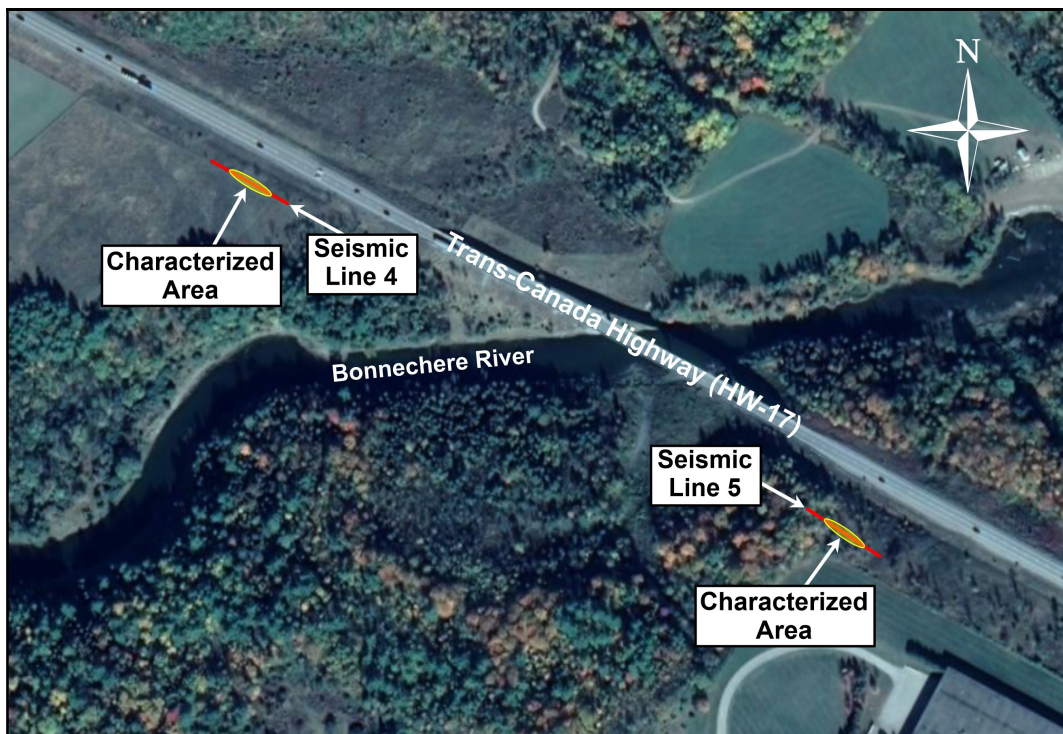
#### **Appendix B.4**

##### **MASW Testing Summary (Geophysics GPR International Inc.)**

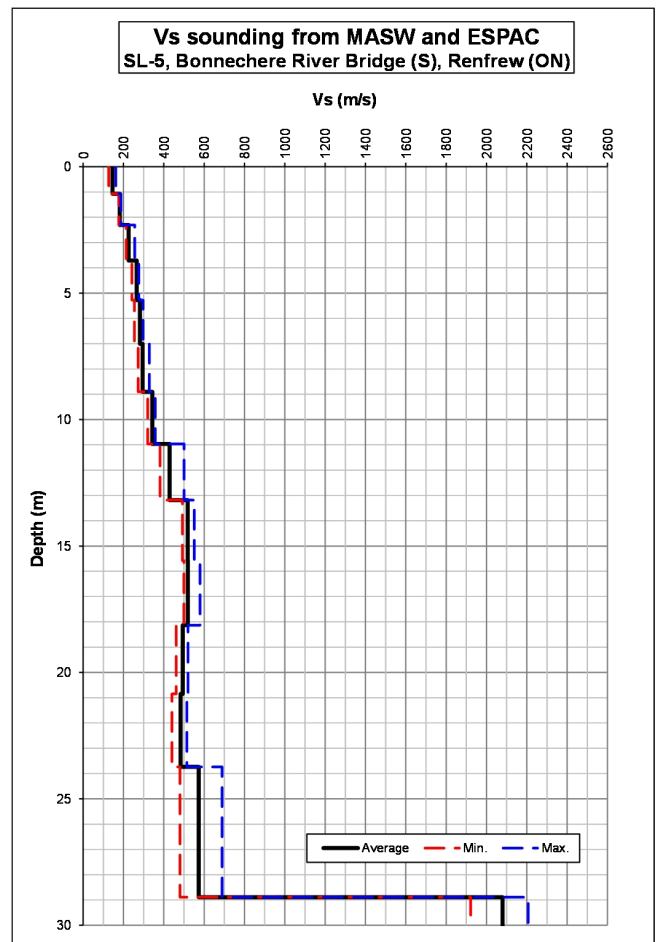
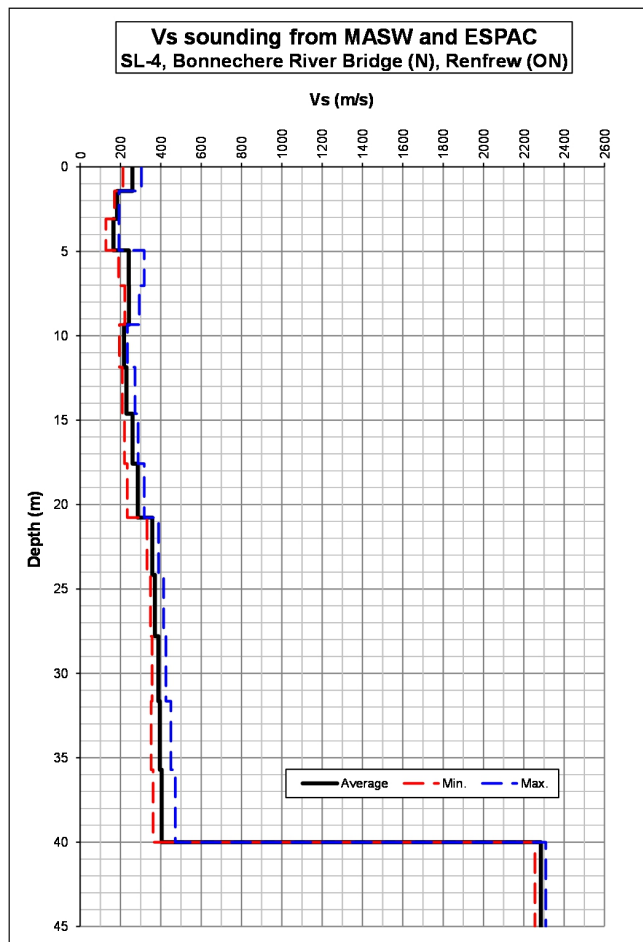




**Figure 2b: Location of the seismic spread SL-3**  
(source: Google Earth™)



**Figure 2c: Location of the seismic spreads SL-4 and SL-5**  
(source: Google Earth™)



**Figure 6c: MASW Shear-Wave Velocity Soundings**





**Appendix B.5**  
**Soil Summary Plots**

FIGURE B5.1

**SOIL SUMMARY - BONNECHERE RIVER BRIDGE**

WEST APPROACH (BON19-1, BON19-2, BON19-3, BON24-1, BON24-2, BON-1, BON-2, BON-7, BON-W)  
SILTY CLAY TO CLAYEY SILT

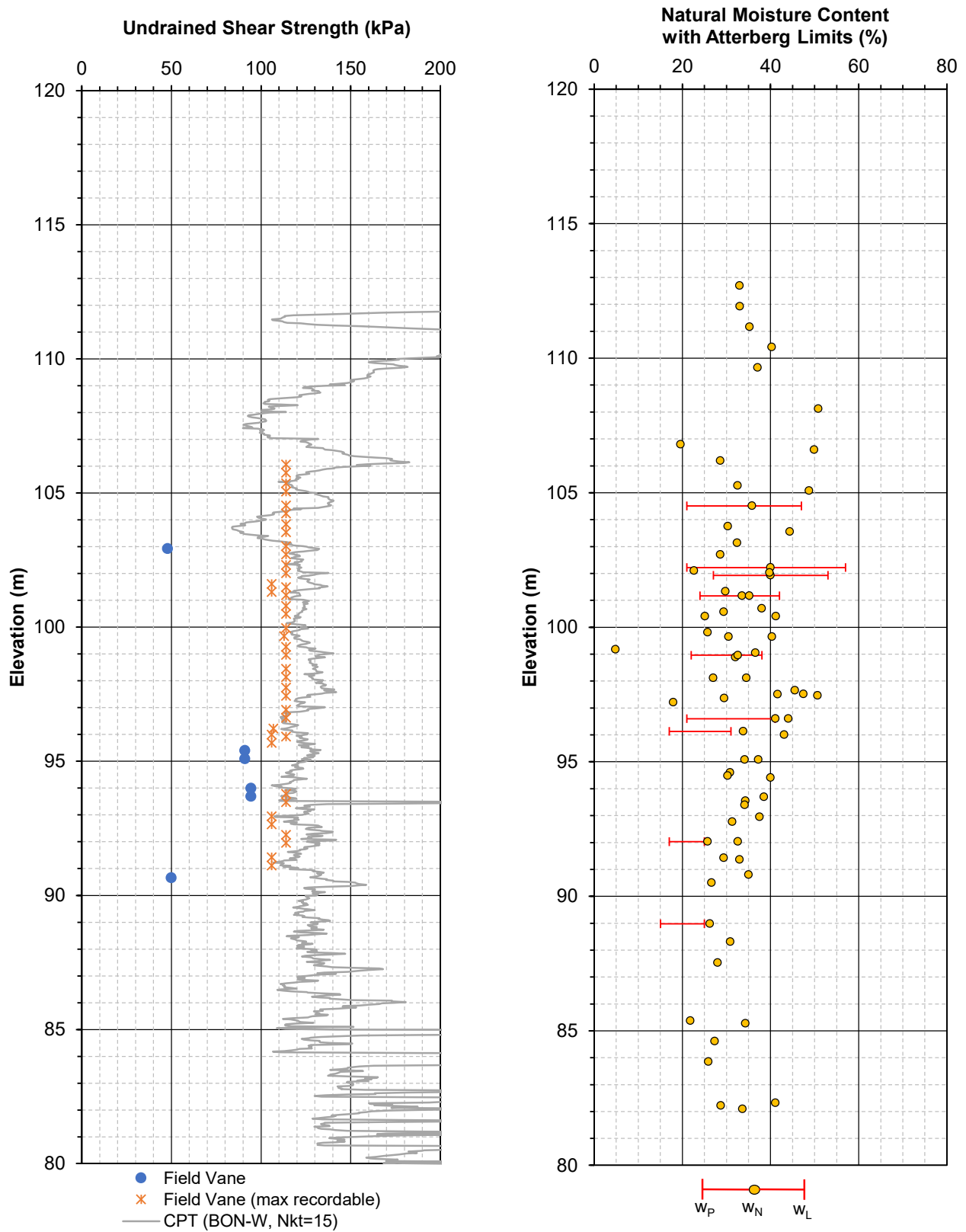
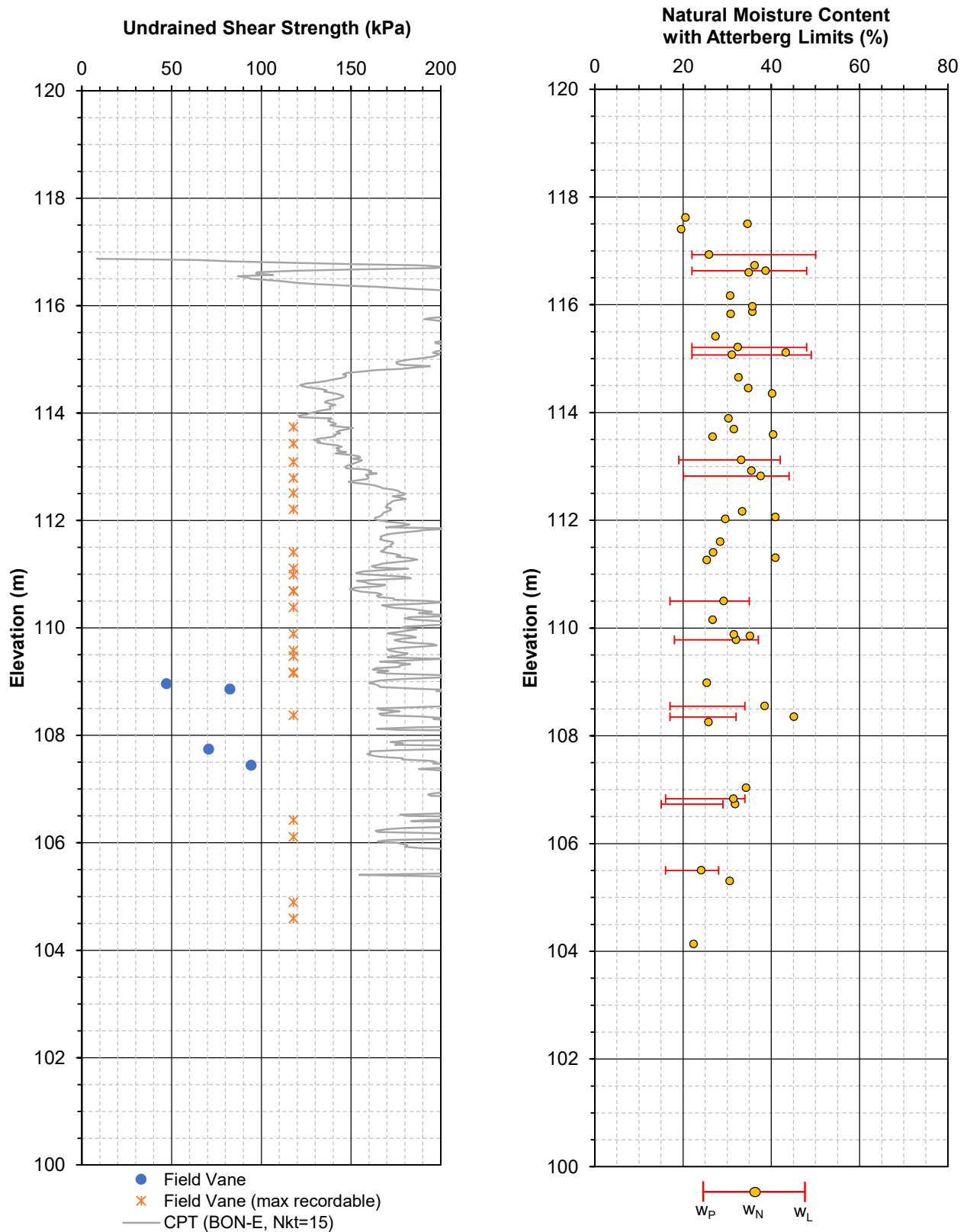


FIGURE B5.2

**SOIL SUMMARY - BONNECHERE RIVER BRIDGE**  
 EAST APPROACH (BON19-6, BON19-7, BON19-8, BON19-9, BON-E)  
 SILTY CLAY TO CLAYEY SILT





## **Appendix C.**

### **Laboratory Testing**

#### **Current (2020/2021/2024) Investigation**



## **Appendix C.1**

### **Particle Size Analysis Figures**

#### **Atterberg Limit Test Results**

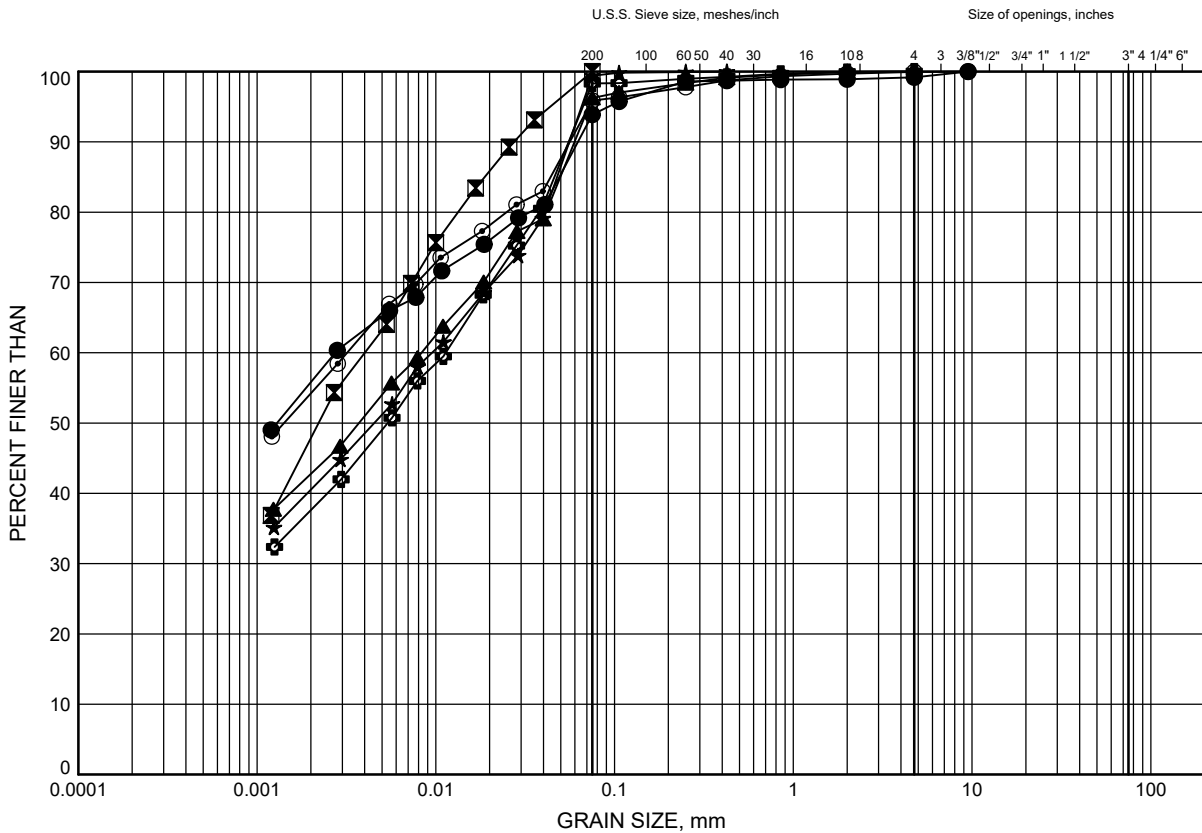
#### **One Dimensional Consolidation Test Results**

# Highway 17 Twinning, Bonnechere River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C1.1

### Silty Clay (Weathered Crust)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-1	2.6	104.5
⊠	BON19-1	4.9	102.2
▲	BON19-2	1.8	101.2
★	BON19-2	6.4	96.6
⊙	BON19-3	1.1	101.9
⊕	BON19-3	4.1	98.9

Date April 2022  
 WP# 4068-09-00



Prep'd MIK  
 Chkd. MJK

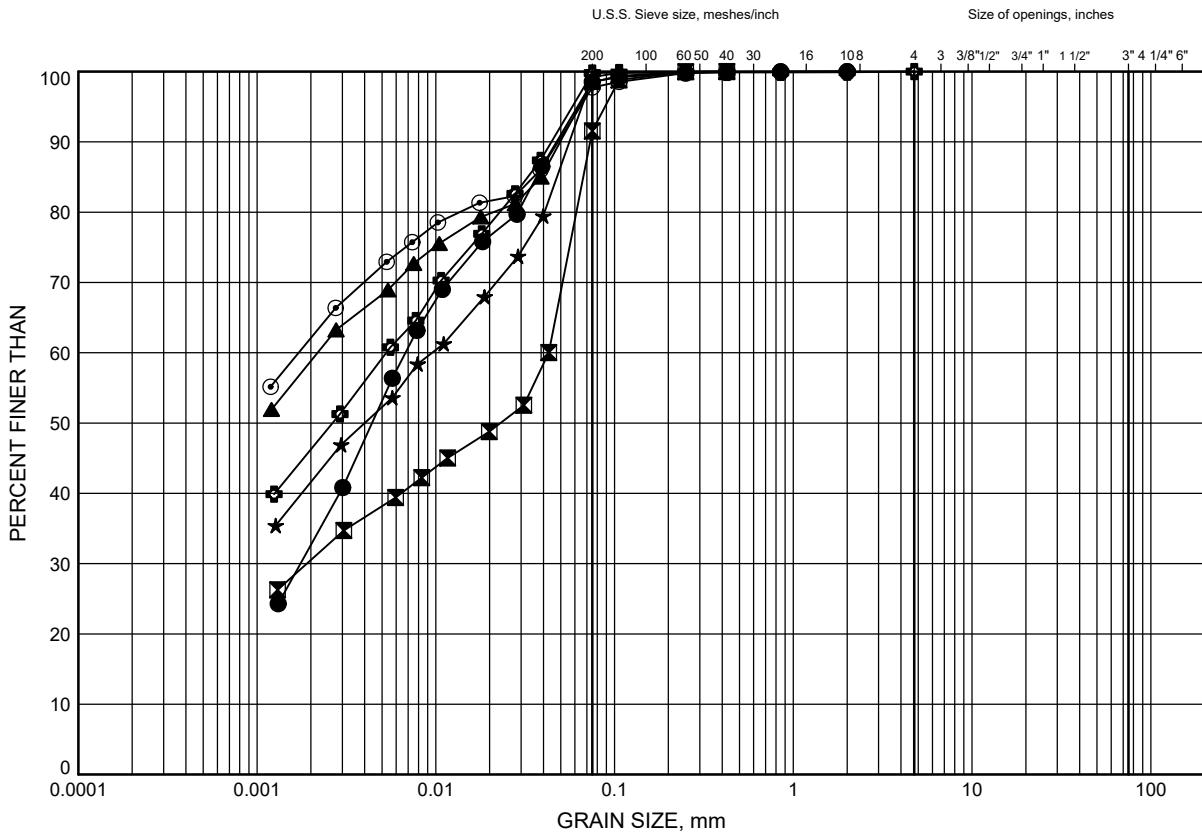


# Highway 17 Twinning, Bonnechere River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C1.2

### Silty Clay (Weathered Crust)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-4	1.1	97.8
⊠	BON19-5	1.8	97.1
▲	BON19-6	1.8	115.1
★	BON19-6	6.4	110.5
⊙	BON19-7	1.1	116.9
⊕	BON19-7	4.9	113.1

Date April 2022  
WP# 4068-09-00



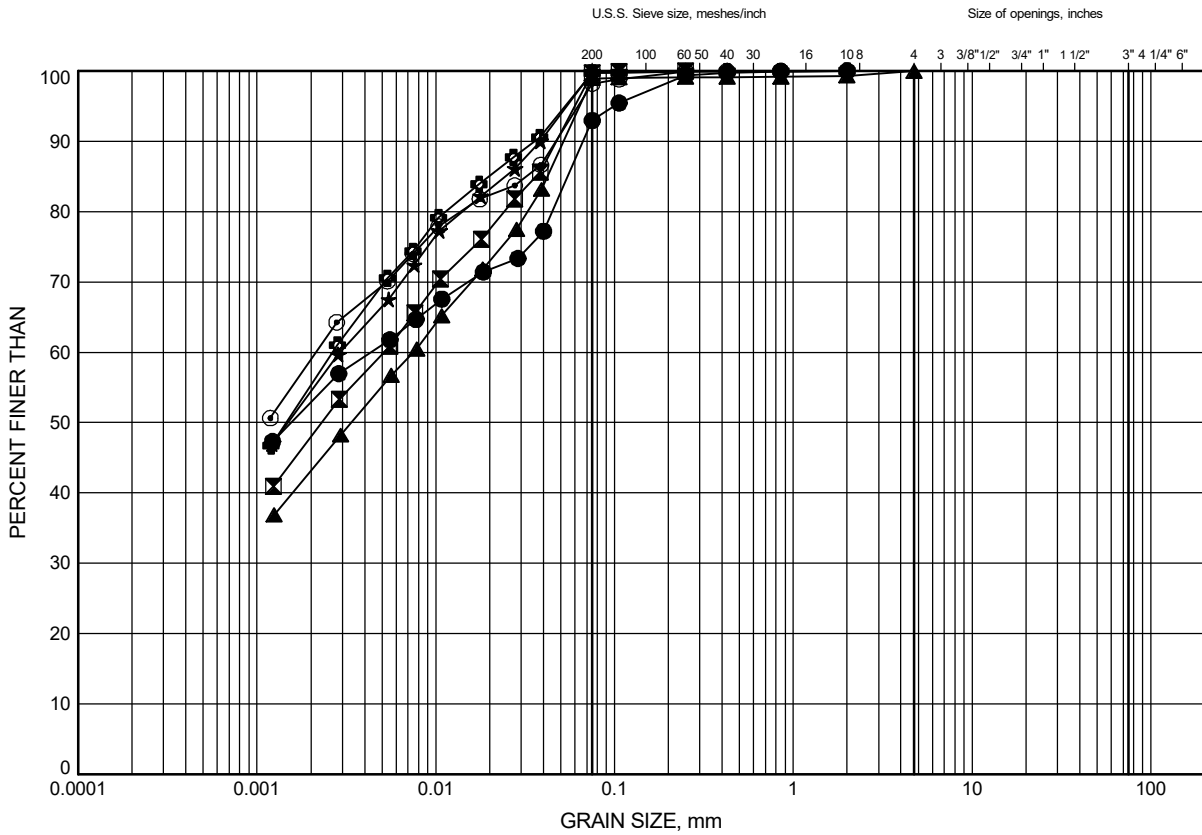
Prep'd MIK  
Chkd. MJK

# Highway 17 Twinning, Bonnechere River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C1.3

### Silty Clay (Weathered Crust)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-8	1.1	116.6
⊠	BON19-8	4.9	112.8
▲	BON19-8	7.9	109.8
★	BON19-9	2.6	115.2
⊙	BON24-2	1.8	106.7
⊕	BON24-2	6.4	102.1

Date August 2024  
 WP# 4068-09-00

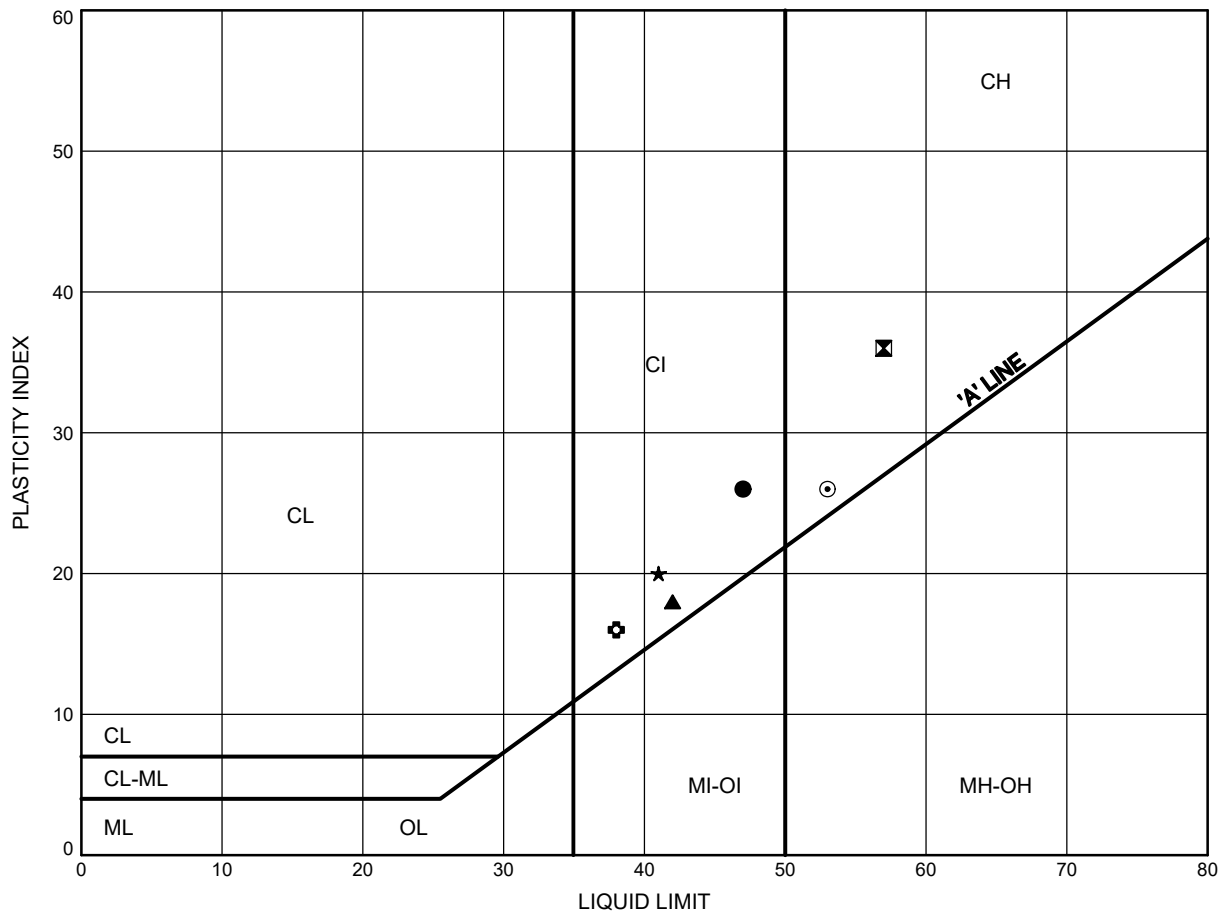


Prep'd RH  
 Chkd. MJK

Highway 17 Twinning, Bonnechere River Bridge  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C2.1

Silty Clay (Weathered Crust)



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-1	2.6	104.5
⊠	BON19-1	4.9	102.2
▲	BON19-2	1.8	101.2
★	BON19-2	6.4	96.6
⊙	BON19-3	1.1	101.9
⊕	BON19-3	4.1	98.9

Date April 2022  
 WP# 4068-09-00

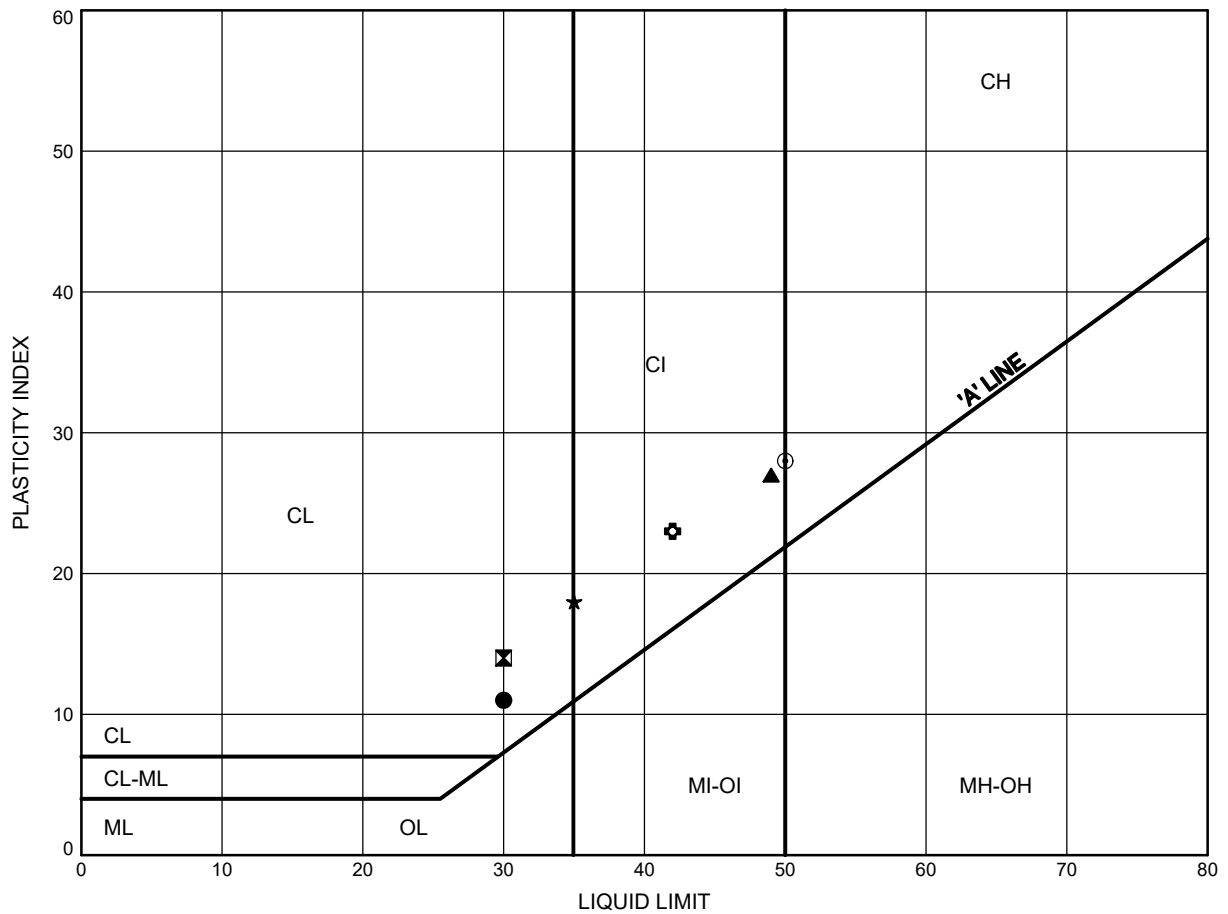


Prep'd MIK  
 Chkd. MJK

Highway 17 Twinning, Bonnechere River Bridge  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C2.2

Silty Clay (Weathered Crust)



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-4	1.1	97.8
⊠	BON19-5	1.8	97.1
▲	BON19-6	1.8	115.1
★	BON19-6	6.4	110.5
⊙	BON19-7	1.1	116.9
⊕	BON19-7	4.9	113.1

Date April 2022  
 WP# 4068-09-00

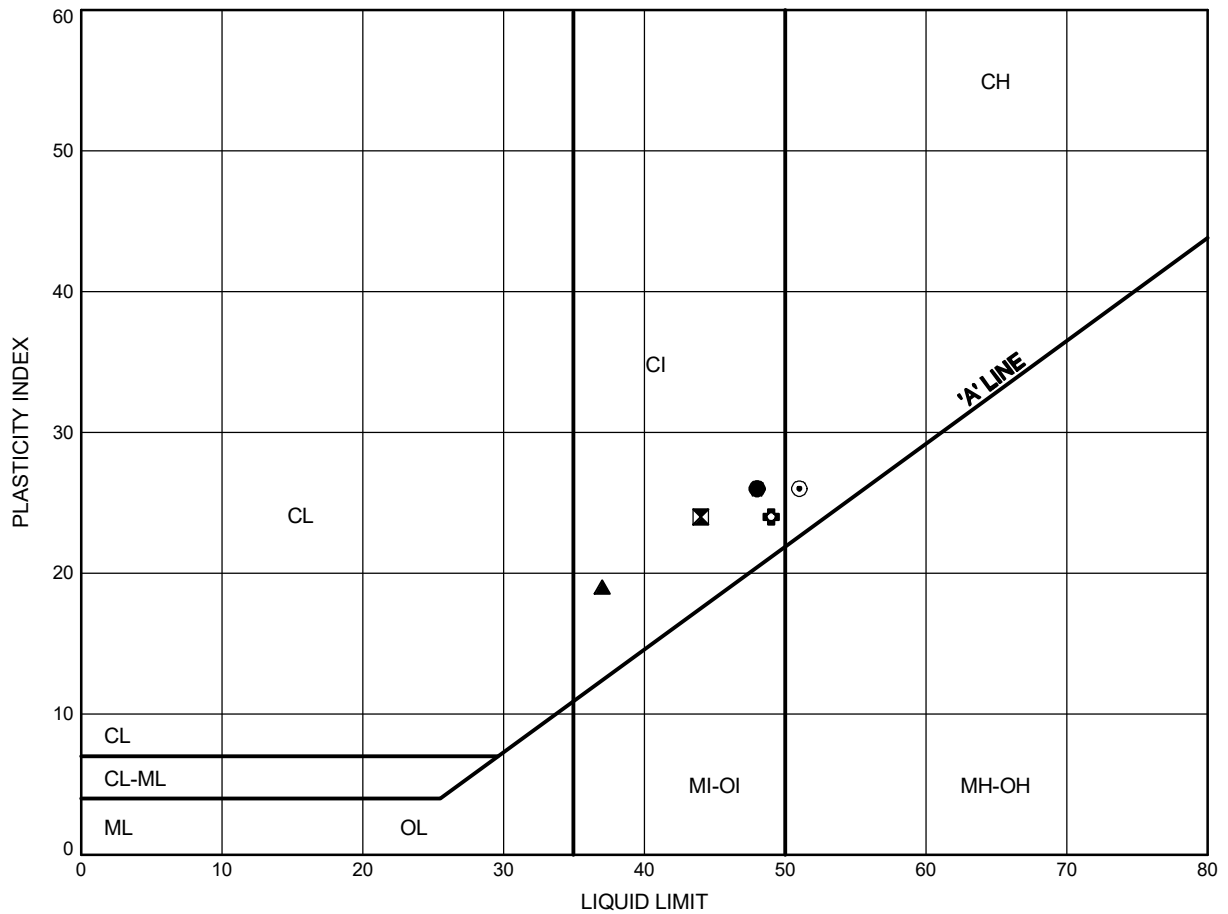


Prep'd MIK  
 Chkd. MJK

# Highway 17 Twinning, Bonnechere River Bridge ATTERBERG LIMITS TEST RESULTS

FIGURE C2.3

### Silty Clay (Weathered Crust)



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-8	1.1	116.6
⊠	BON19-8	4.9	112.8
▲	BON19-8	7.9	109.8
★	BON19-9	2.6	115.2
⊙	BON24-2	1.8	106.7
⊕	BON24-2	6.4	102.1

Date August 2024  
 WP# 4068-09-00

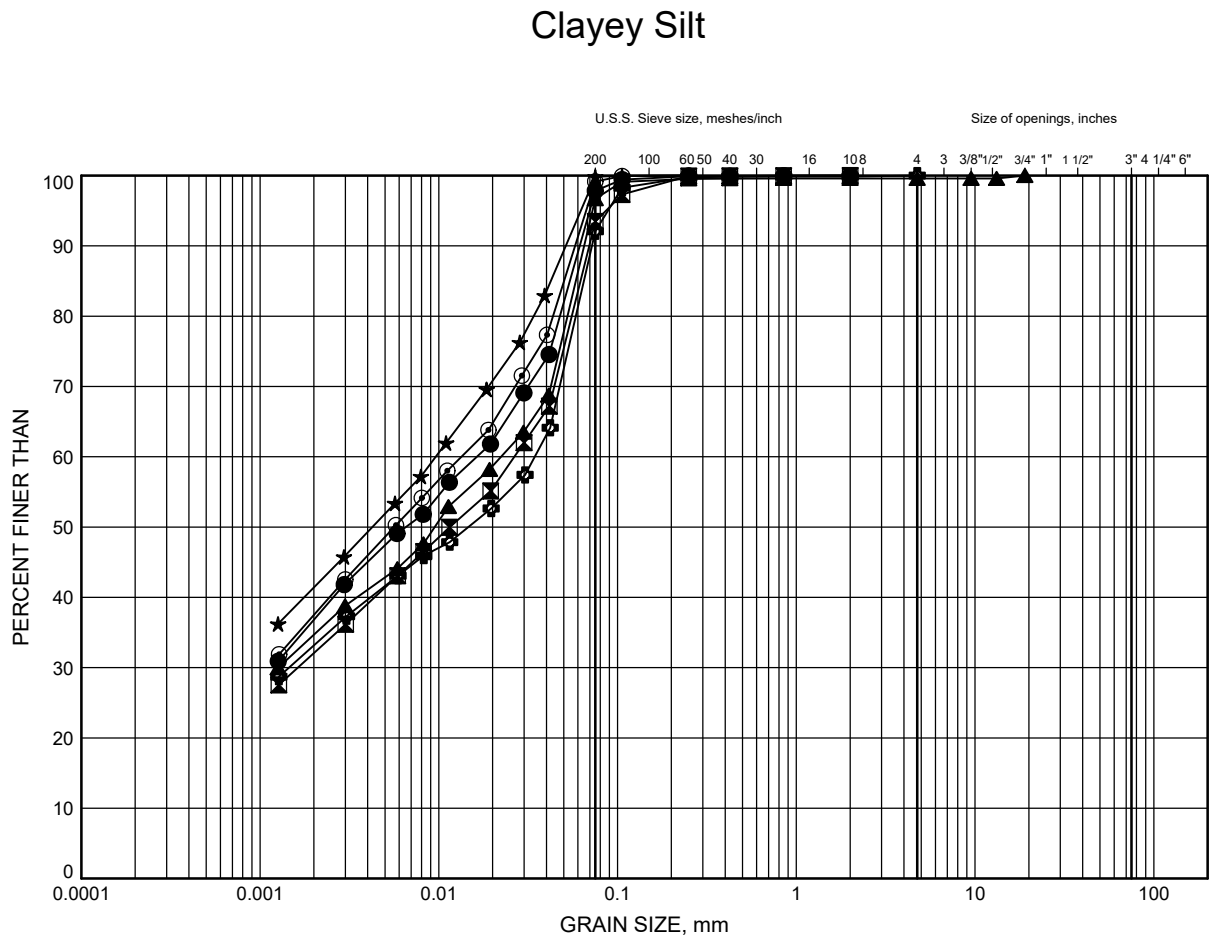


Prep'd RH  
 Chkd. MJK

# Highway 17 Twinning, Bonnechere River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C3.1



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-1	11.0	96.1
⊠	BON19-2	14.0	89.0
▲	BON19-3	11.0	92.0
★	BON19-7	9.4	108.6
⊙	BON19-7	12.5	105.5
⊕	BON19-8	11.0	106.7

Date April 2022  
WP# 4068-09-00

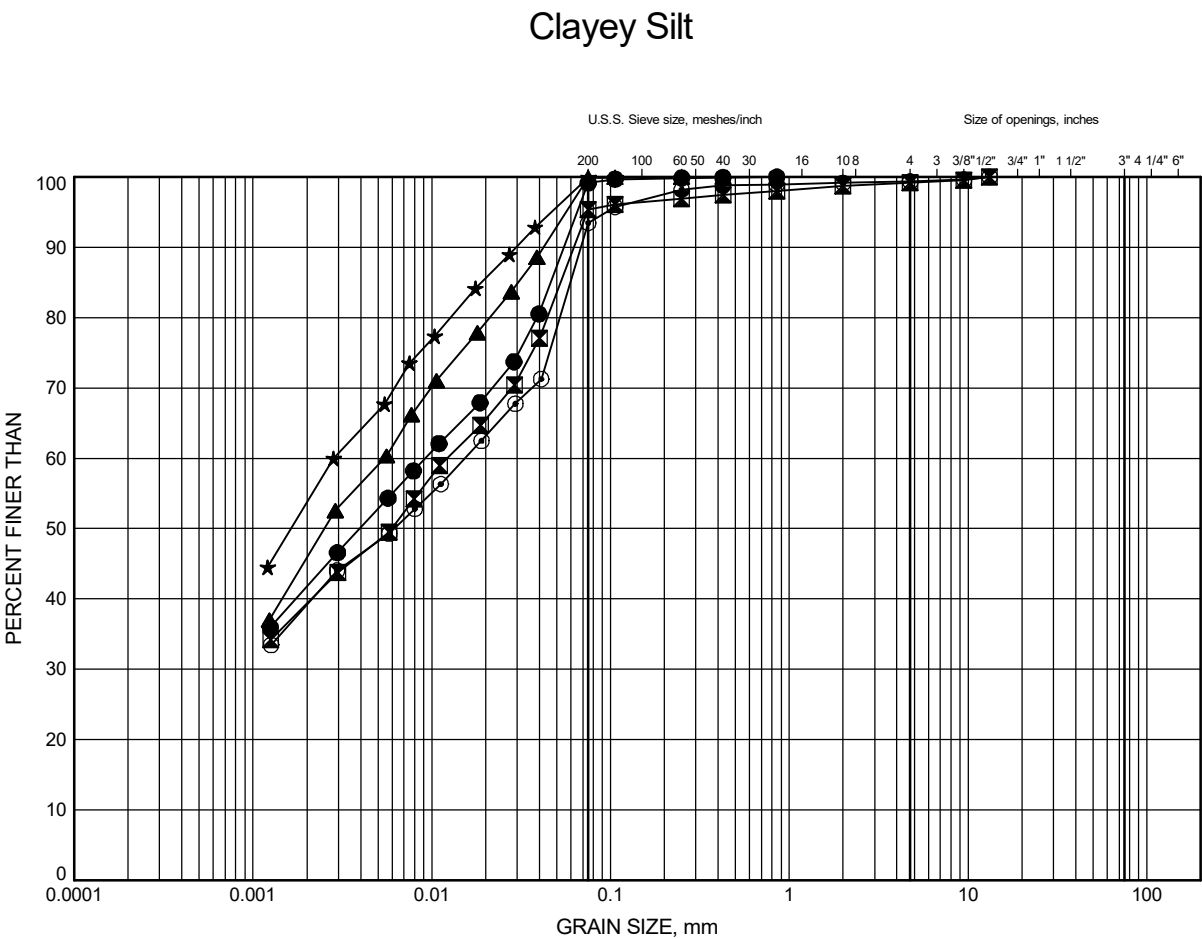


Prep'd MIK  
Chkd. MJK

Highway 17 Twinning, Bonnechere River Bridge

GRAIN SIZE DISTRIBUTION

FIGURE C3.2



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-9	9.4	108.4
⊠	BON19-9	11.0	106.8
▲	BON24-1	11.0	96.8
★	BON24-2	11.0	97.5
⊙	BON-P1	2.6	85.3

GRAIN SIZE DISTRIBUTION - THURBER 24726 BON.GPJ 8-22-24

Date August 2024

WP# 4068-09-00



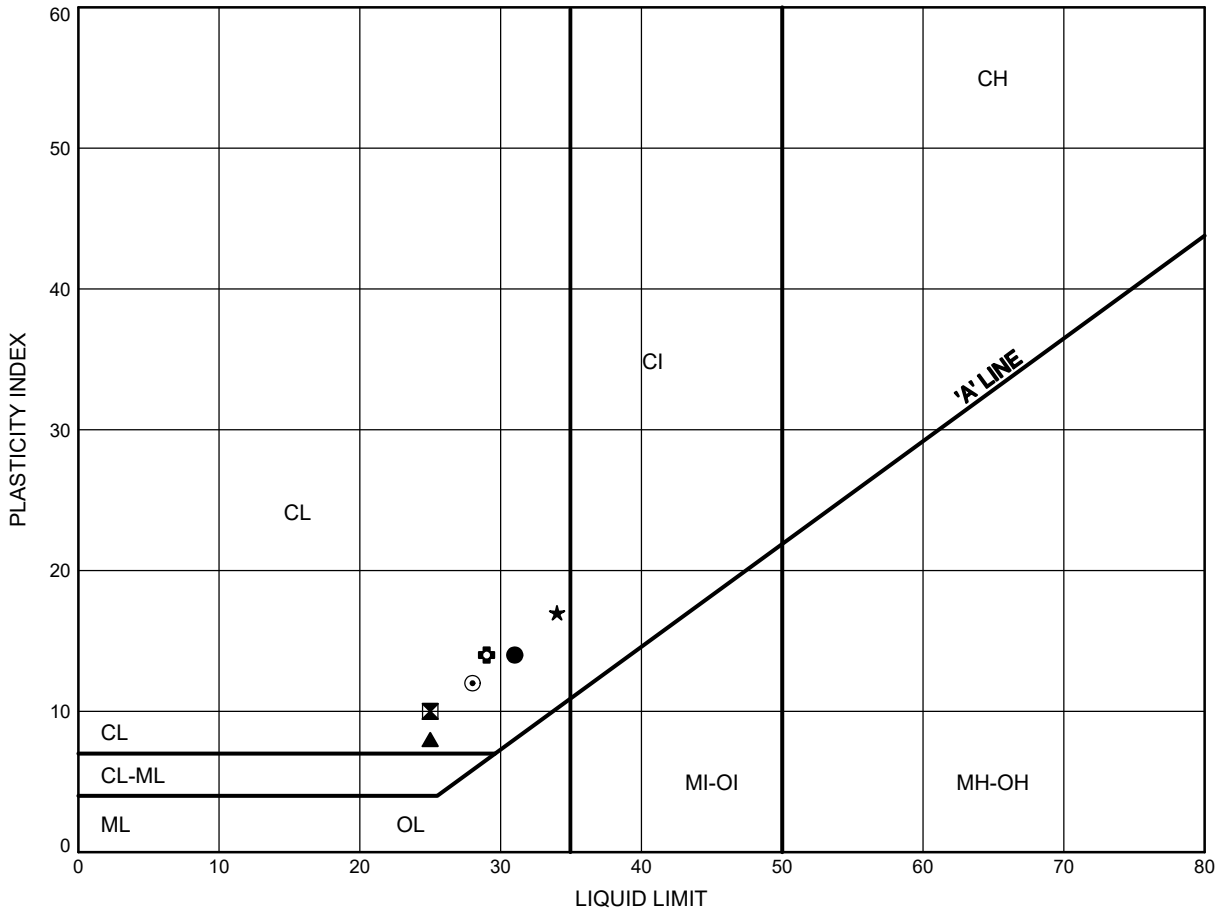
Prep'd RH

Chkd. MJK

Highway 17 Twinning, Bonnechere River Bridge  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C4.1

Clayey Silt



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-1	11.0	96.1
⊠	BON19-2	14.0	89.0
▲	BON19-3	11.0	92.0
★	BON19-7	9.4	108.6
⊙	BON19-7	12.5	105.5
⊕	BON19-8	11.0	106.7

Date April 2022  
 WP# 4068-09-00



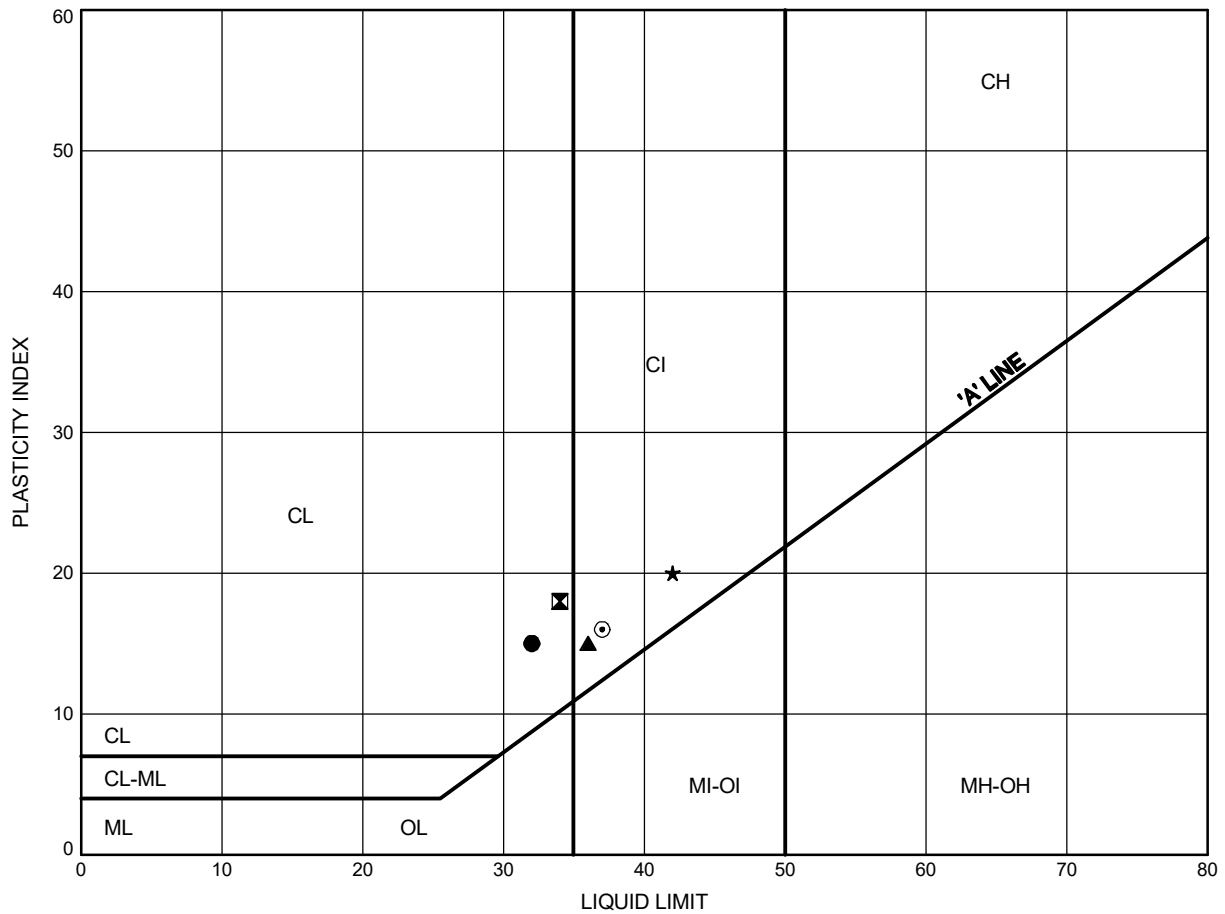
Prep'd MIK  
 Chkd. MJK



# Highway 17 Twinning, Bonnechere River Bridge ATTERBERG LIMITS TEST RESULTS

FIGURE C4.2

### Clayey Silt



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-9	9.4	108.4
⊠	BON19-9	11.0	106.8
▲	BON24-1	11.0	96.8
★	BON24-2	11.0	97.5
⊙	BON-P1	2.6	85.3

Date August 2024  
 WP# 4068-09-00



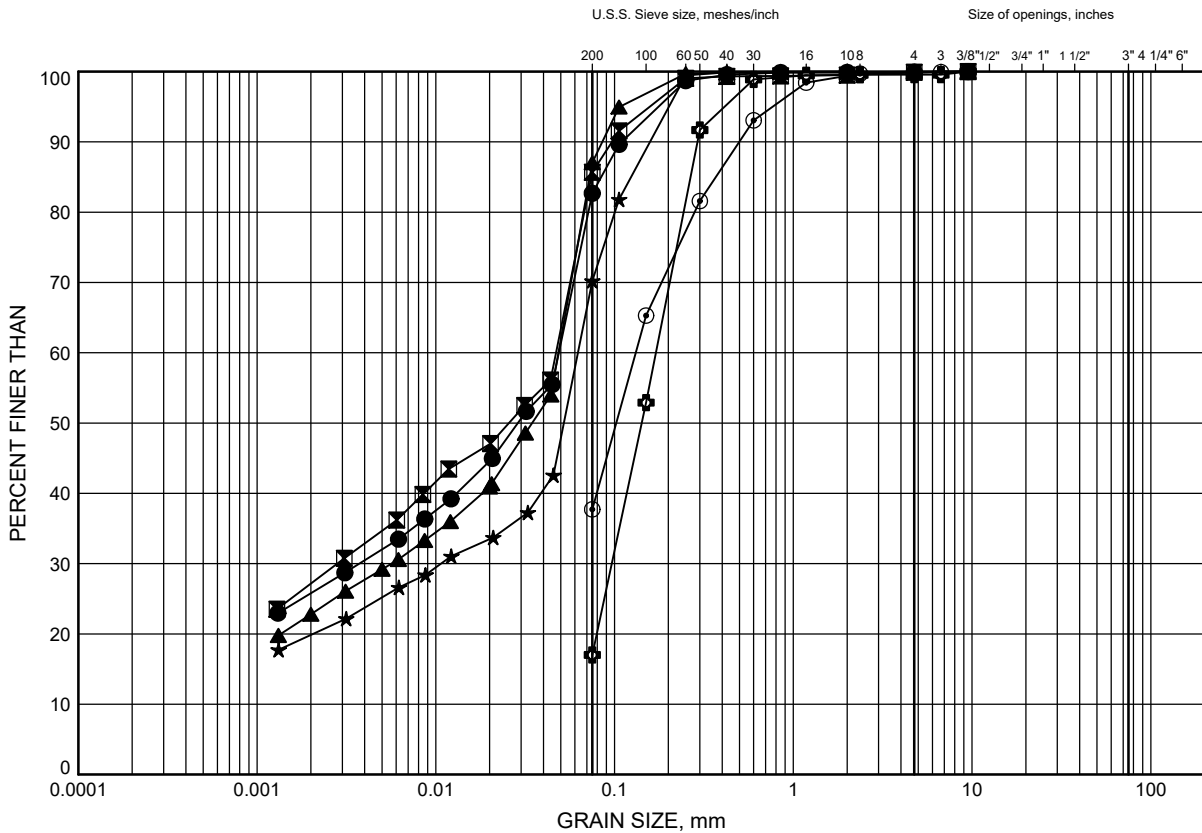
Prep'd RH  
 Chkd. MJK

# Highway 17 Twinning, Bonnechere River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C5.1

### Silty Sand to Clayey Silt



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-1	16.3	90.8
⊠	BON19-2	17.1	85.9
▲	BON19-3	14.0	89.0
★	BON19-3	20.1	82.9
⊙	BON19-5	5.6	93.3
⊕	BON19-6	11.0	105.9

Date April 2022  
WP# 4068-09-00



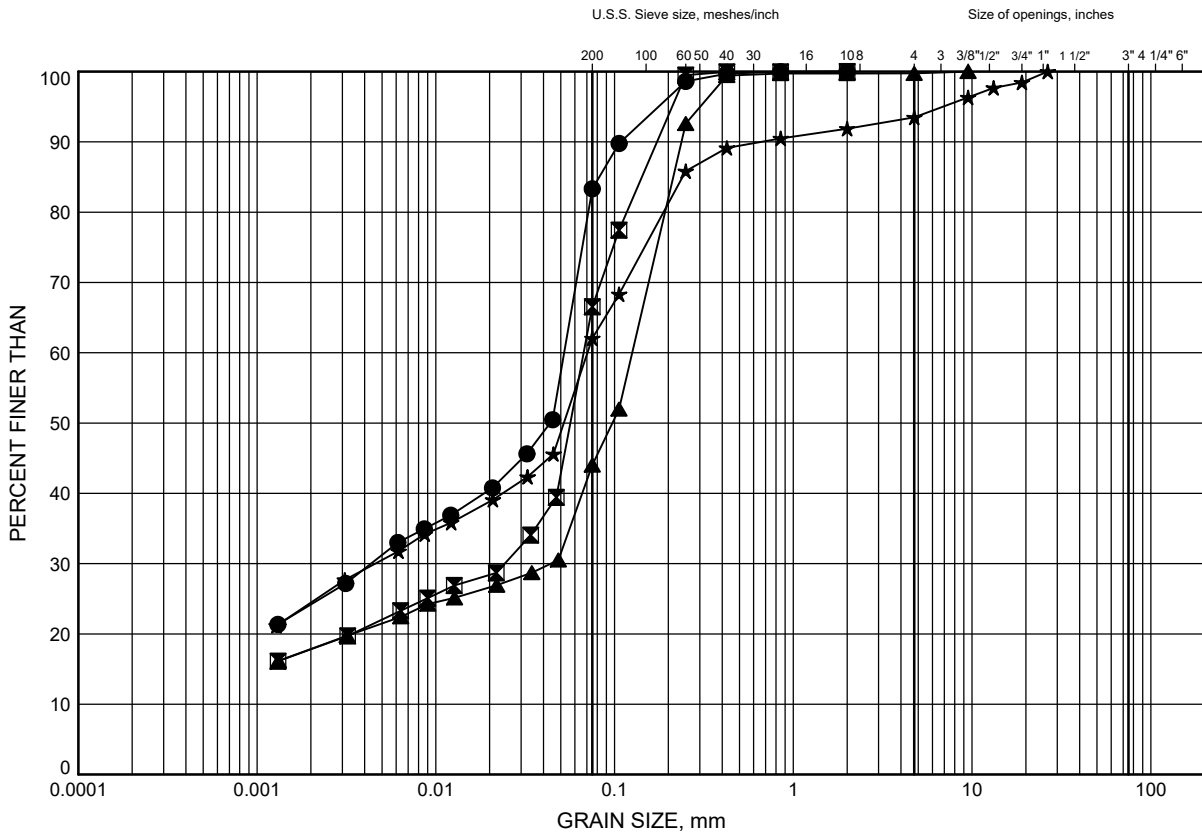
Prep'd MIK  
Chkd. MJK

# Highway 17 Twinning, Bonnechere River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C5.2

### Silty Sand to Clayey Silt



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON-P1	4.9	83.0
⊠	BON-P2	2.6	83.5
▲	BON-P3	1.1	88.1
★	BON-P3	2.6	86.6

Date April 2022  
WP# 4068-09-00

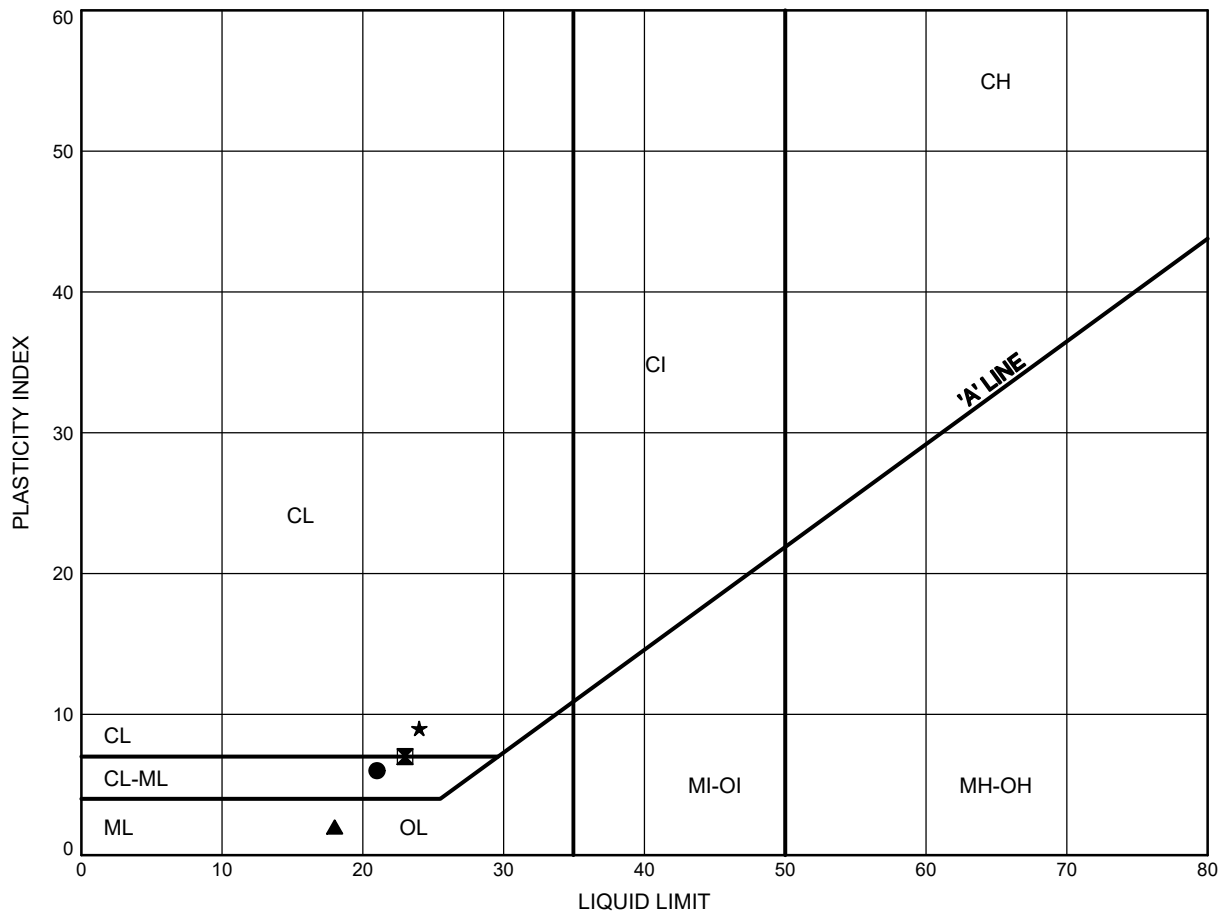


Prep'd MIK  
Chkd. MJK

# Highway 17 Twinning, Bonnechere River Bridge ATTERBERG LIMITS TEST RESULTS

FIGURE C6.1

### Silty Sand to Clayey Silt



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-1	16.3	90.8
⊠	BON19-2	17.1	85.9
▲	BON-P1	4.9	83.0
★	BON-P3	2.6	86.6

Date April 2022  
 WP# 4068-09-00



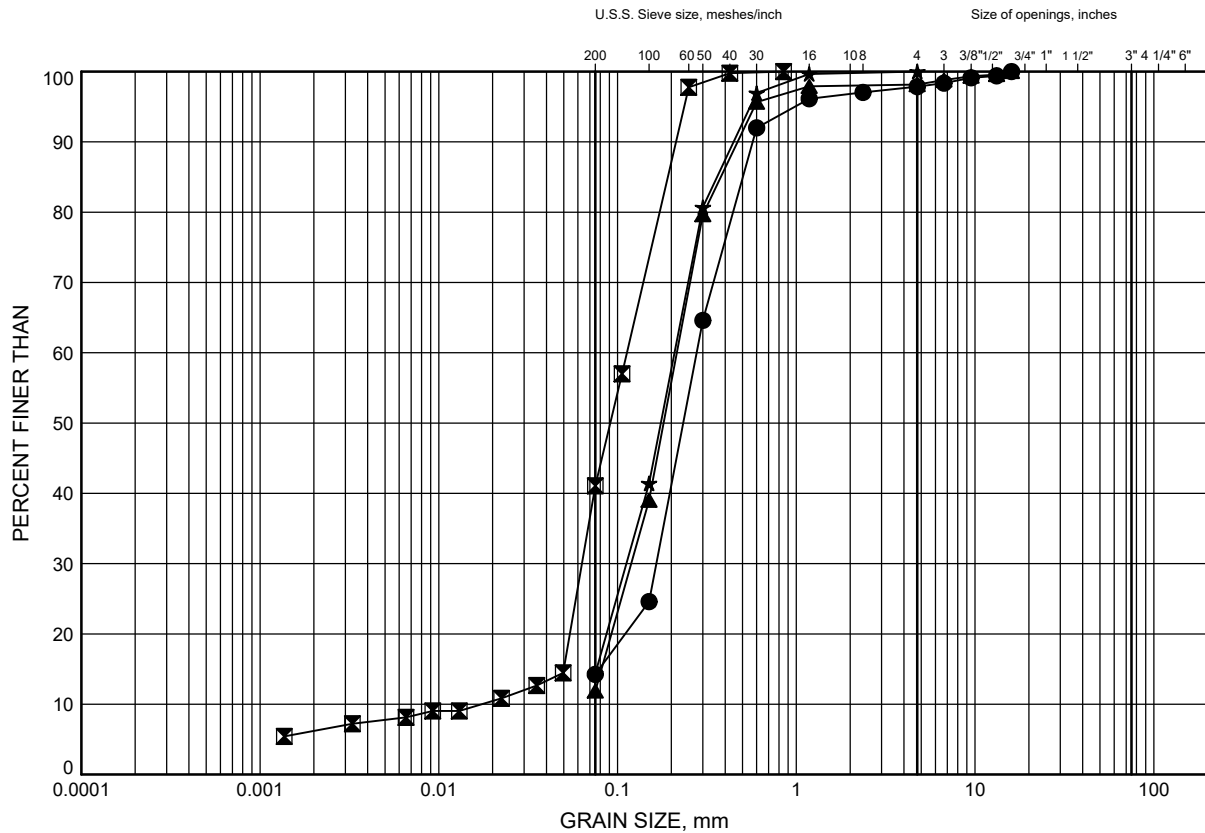
Prep'd MIK  
 Chkd. MJK

# Highway 17 Twinning, Bonnechere River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C7.1

### Silty Sand to Sand



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-1	17.8	89.3
⊠	BON-P1	7.9	80.0
▲	BON-P1	15.5	72.4
★	BON-P2	3.4	82.7

Date April 2022  
WP# 4068-09-00



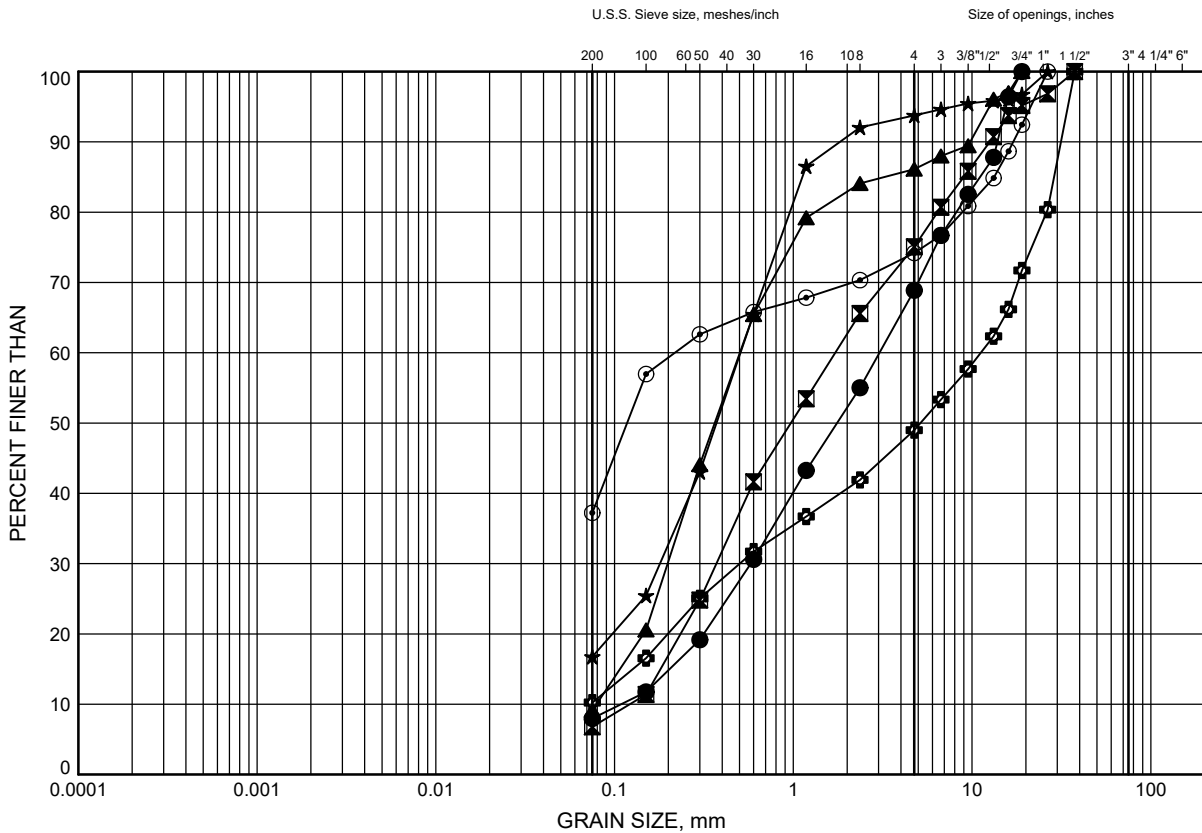
Prep'd MIK  
Chkd. MJK

# Highway 17 Twinning, Bonnechere River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C8.1

### Sand and Gravel



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-1	22.4	84.7
⊠	BON19-2	23.2	79.8
▲	BON19-2	32.3	70.7
★	BON19-3	38.4	64.6
⊙	BON19-4	3.4	95.5
⊕	BON19-4	5.6	93.3

Date May 2022  
WP# 4068-09-00



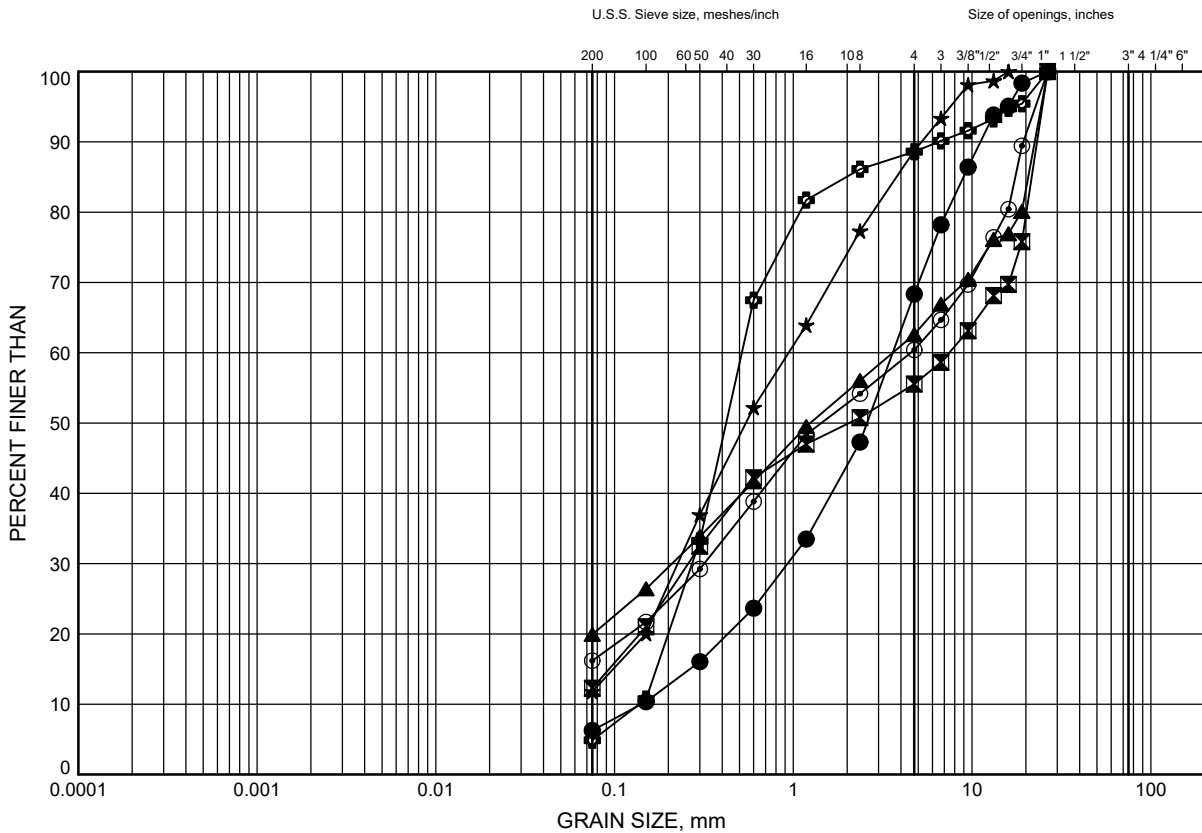
Prep'd MIK  
Chkd. MJK

# Highway 17 Twinning, Bonnechere River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C8.2

### Sand and Gravel



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-4	7.9	91.0
⊠	BON19-5	7.9	91.0
▲	BON19-5	15.5	83.4
★	BON19-9	13.9	103.9
⊙	BON-P1	29.3	58.6
⊕	BON-P2	15.5	70.6

Date May 2022  
WP# 4068-09-00



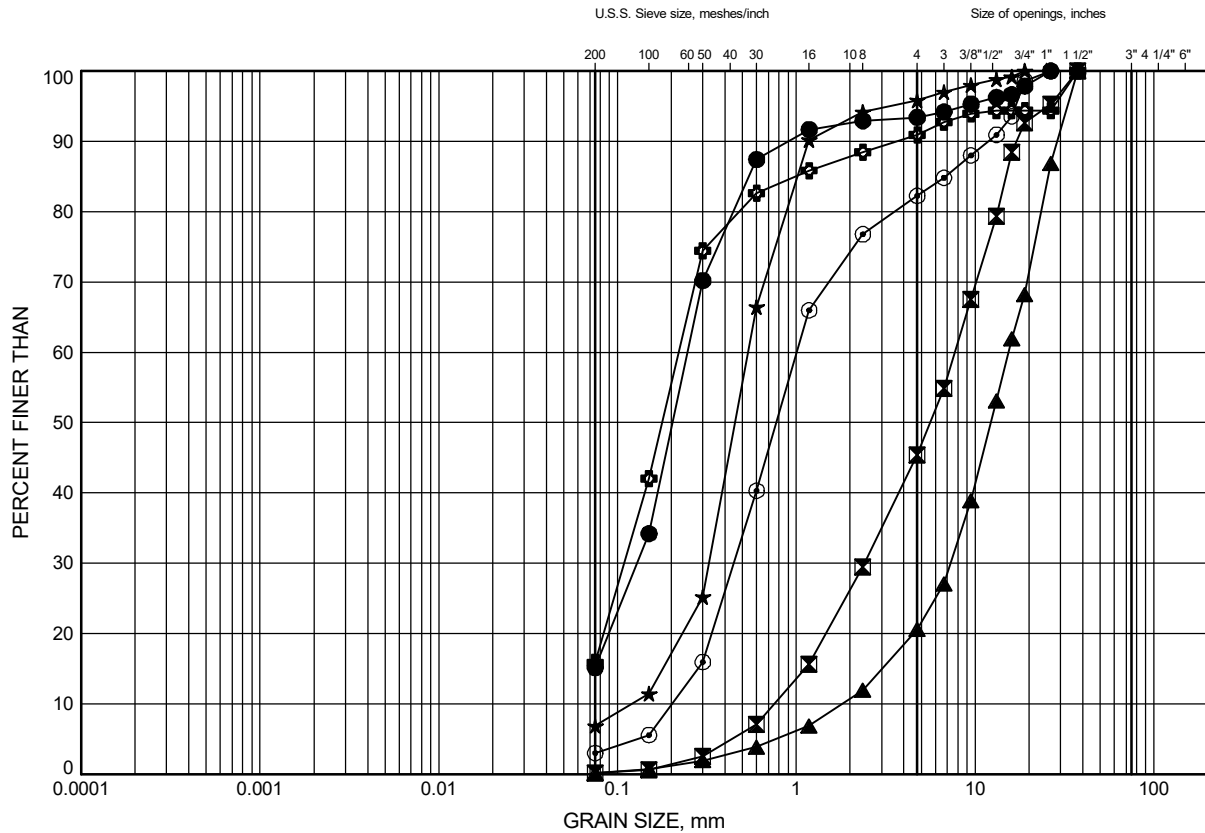
Prep'd MIK  
Chkd. MJK

# Highway 17 Twinning, Bonnechere River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C8.3

### Sand and Gravel



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON24-1	22.6	85.2
⊠	BON24-1	28.7	79.1
▲	BON24-1	34.7	73.1
★	BON24-3	41.8	62.2
⊙	BON24-3	44.2	59.8
⊕	BON-P3	4.9	84.3

Date August 2024  
WP# 4068-09-00



Prep'd RH  
Chkd. MJK

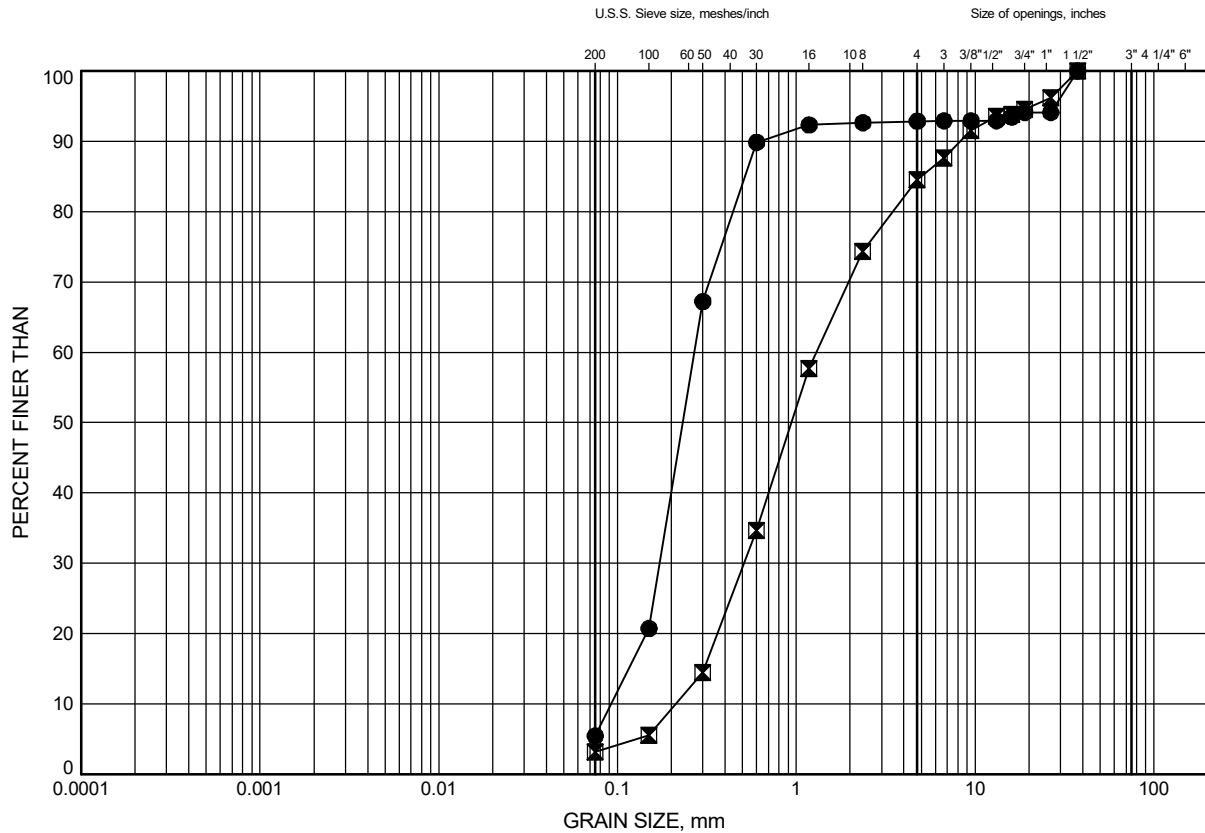


# Highway 17 Twinning, Bonnechere River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE C8.4

### Sand and Gravel



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON-P3	11.0	78.2
⊠	BON-P3	15.4	73.8

Date August 2024  
 WP# 4068-09-00



Prep'd RH  
 Chkd. MJK



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

October 18, 2021  
File: 122410864

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

Thurber Engineering Ltd.  
104-2460 Lancaster Road  
Ottawa, Ontario, Canada, K1B 4S5  
Tel: 1-613-274-2121 ext. 7106  
E-mail: dpizycki@thurber.ca

Dear Ms. Pizycki,

**Reference: Consolidation Test Results: Hwy 17 Twinning, Hwy 17, ON, Thurber Engineering Ltd.,  
File # 24726.200a.202**

This letter presents the results of one-dimensional consolidation test carried out on one Shelby tube sample in accordance with ASTM D2435/D2435M – 11(2020). The test results are provided in the attached tables and figures.

**Summary of sample tested**

Sample ID	Depth (ft)	Date sampled
BON 19-1, ST1	15-17	September 7, 2021

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,

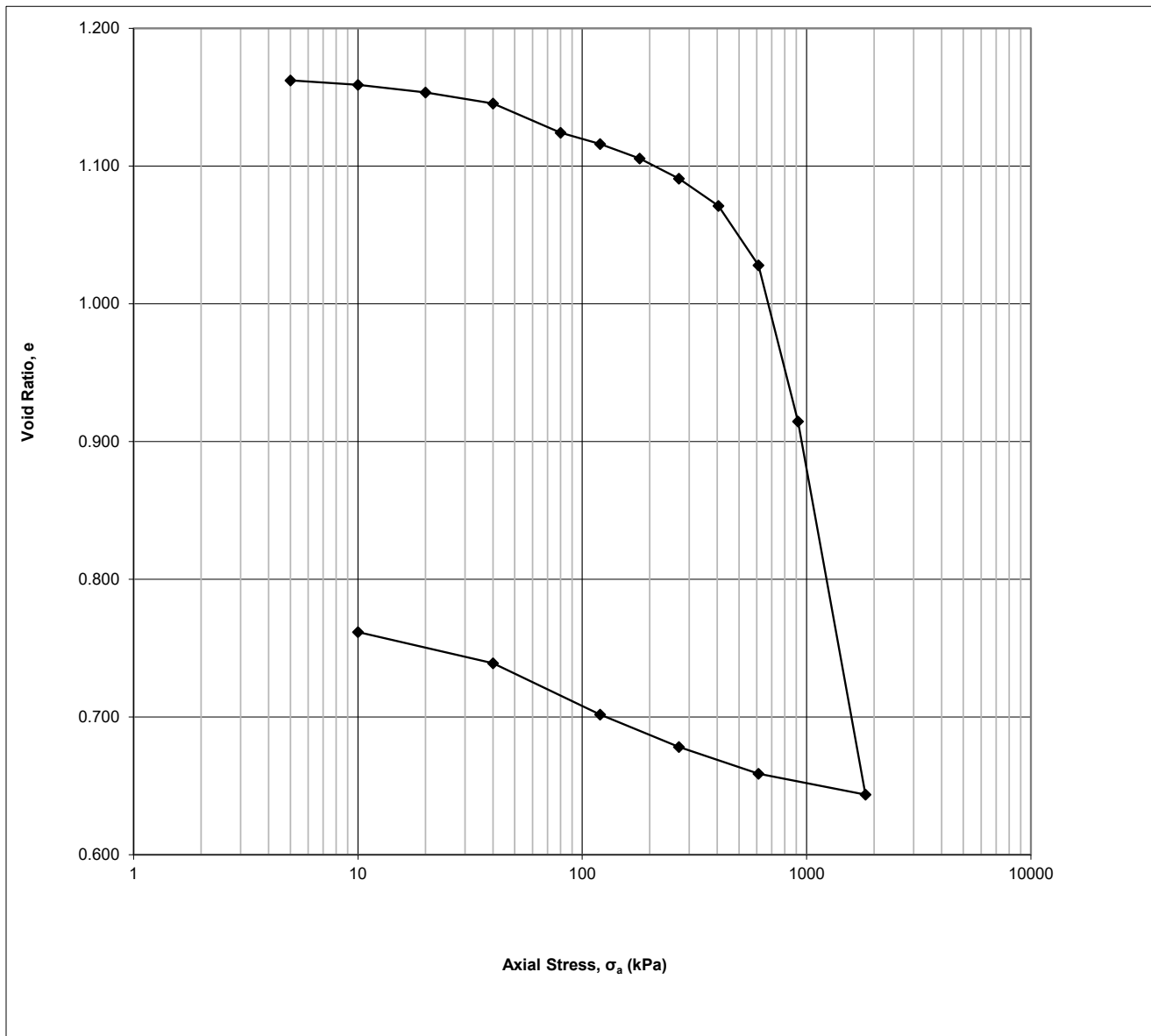
**Stantec Consulting Ltd.**

**Gwangha Roh** Ph.D., P.Eng.  
Technical Lead  
Mobile: 435 770-2425  
Gwangha.Roh@stantec.com

v:\01216\active\laboratory\_standing\_offers\2021 laboratory standing offers\122410864 thurber engineering\september 16, 1 consol, 1 limits, 1 hydro, 1 sg, file# 24726\122410864\_let\_24726.200a.202\_consolidation\_hwy 17 twinning.docx

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

**Thurber Engineering, File#24726.200a.202**  
**122410864**  
**BON 19-1**  
**ST1**  
**15-17 ft**



**One-Dimensional Consolidation Test using Incremental Loading**  
ASTM D2435/D2435M - 11(2020)

October 18, 2021  
October 18, 2021

Date: Date:  
D. Boateng R. Gwangha

Checked by: Approved by:

**Specimen Details**

Project Name	Thurber Engineering, File#24726.200a.202
Project Location	Ontario, Canada
Borehole	BON 19-1
Sample No.	ST1
Depth	15-17 ft
Sample Date	September 7, 2021
Test Number	One
Technician Name	Daniel Boateng

**Soil Description & Classification**

<i>Silts &amp; clays, brown, desiccated, moist- (Fat clay)-CH</i>	
Specific Gravity of Solids	2.731
Liquid Limit %	56.6
Plastic Limit %	20.5
Plasticity Index %	36.1
Average water content of trimmings %	40.37
<b>Additional Notes (information source, occurrence and size of large isolated particles etc.)</b>	
<i>Loading schedule provided by the client</i>	

**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	69.07
Dry Mass	g	49.21
Density	Mg/m <sup>3</sup>	1.759
Dry Density	Mg/m <sup>3</sup>	1.253
Water Content	%	40.36
Degree of Saturation	%	93.5
Height of Solids	mm	9.18
Initial Void Ratio		1.179

**Final Specimen Conditions**

Water Content	%	29.04
Final Void Ratio		0.762
Final Height	mm	16.17

**One-Dimensional Consolidation Test using Incremental Loading**  
ASTM D2435/D2435M - 11(2020)

**Specimen Details**

Project Name	Thurber Engineering, File#24726.200a.202
Project Location	Ontario, Canada
Borehole	BON 19-1
Sample No.	ST1
Depth	15-17 ft
Sample Date	September 7, 2021
Test Number	One
Technician Name	Daniel Boateng

**Test Procedure**

Date Started	September 17, 2021
Date Finished	October 5, 2021
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 (2020) Procedure**

--

**Calculations**

Load	Increment	Axial	Corrected	Specimen	Axial	Void
Increment	Duration	Stress	Deformation	Height	Strain	Ratio
	min	$\sigma_a$ kPa	$\Delta H$ mm	H mm	$\epsilon_a$ %	e
Seating	0.0	0	0.0000	20.0000	0.00	1.179
1	1440.0	5	0.1570	19.8430	0.79	1.162
2	1440.0	10	0.1864	19.8136	0.93	1.159
3	1440.0	20	0.2377	19.7623	1.19	1.153
4	1440.0	40	0.3108	19.6892	1.55	1.145
5	1440.0	80	0.5060	19.4940	2.53	1.124
6	1440.0	120	0.5802	19.4198	2.90	1.116
7	1440.0	180	0.6768	19.3232	3.38	1.106
8	1440.0	270	0.8113	19.1887	4.06	1.091
9	1440.0	405	0.9929	19.0071	4.96	1.071
10	1440.0	610	1.3894	18.6106	6.95	1.028
11	1440.0	915	2.4290	17.5710	12.15	0.915
12	1440.0	1830	4.9163	15.0837	24.58	0.644
13	1440.0	610	4.7776	15.2224	23.89	0.659
14	1440.0	270	4.5987	15.4013	22.99	0.678
15	1440.0	120	4.3833	15.6167	21.92	0.702
16	1440.0	40	4.0408	15.9592	20.20	0.739
17	1440.0	10	3.8336	16.1664	19.17	0.762

## One-Dimensional Consolidation Test using Incremental Loading

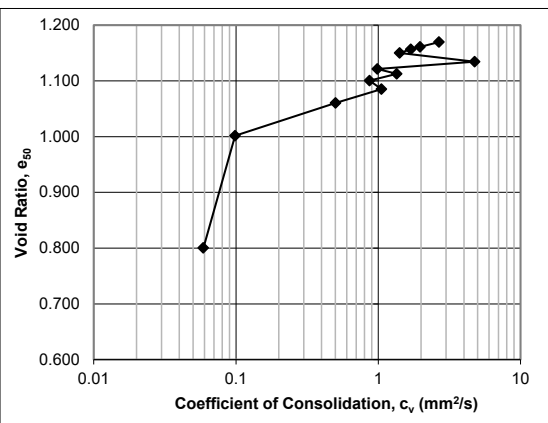
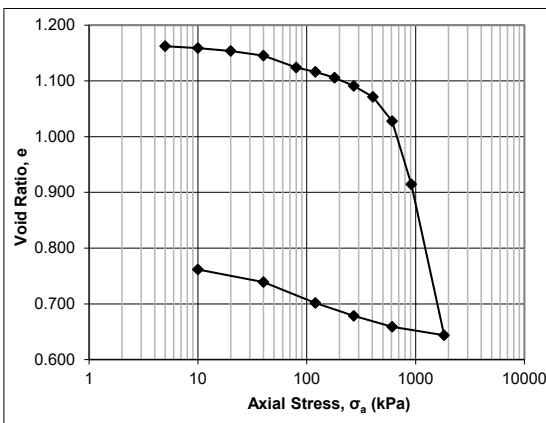
### ASTM D2435/D2435M - 11(2020)


**Specimen Details**

Job Ref.	Thurber Engineering, File#24726.200a.202
Job Location	Ontario, Canada
Borehole	BON 19-1
Sample No.	ST1
Depth	15-17 ft
Sample Date	September 7, 2021
Test Number	One
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	0.0888	19.9112	0.44	1.170			31	2.67E+00
2	8	0.1663	19.8337	0.83	1.161			42	1.96E+00
3	15	0.2073	19.7927	1.04	1.157			49	1.70E+00
4	30	0.2687	19.7313	1.34	1.150			58	1.41E+00
5	60	0.4116	19.5884	2.06	1.135			17	4.76E+00
6	100	0.5310	19.4690	2.65	1.121			81	9.87E-01
7	150	0.6114	19.3886	3.06	1.113			59	1.35E+00
8	225	0.7219	19.2781	3.61	1.101			91	8.69E-01
9	338	0.8629	19.1371	4.31	1.085			74	1.05E+00
10	508	1.0914	18.9086	5.46	1.060			151	5.02E-01
11	763	1.6321	18.3679	8.16	1.002			727	9.84E-02
12	1373	3.4796	16.5204	17.40	0.800			980	5.90E-02
13	1220	4.8464	15.1536	24.23	0.651				
14	440	4.6935	15.3065	23.47	0.668				
15	195	4.4977	15.5023	22.49	0.689				
16	80	4.2309	15.7691	21.15	0.718				
17	25	4.0271	15.9729	20.14	0.741				



 <b>Stantec</b>	Project No.: 122410864	Photo Log
	Project Name: Thurber, File# 24726.200a.202	

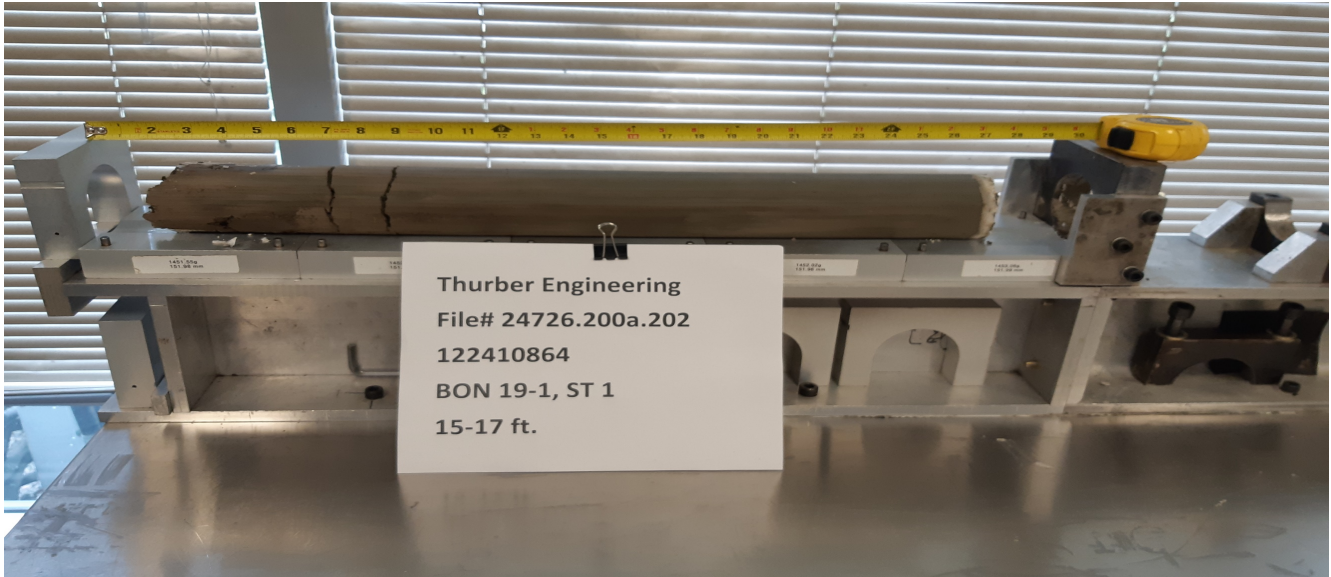


Photo No.:	1	Borehole: BON 19-1, ST1	Depth: 15 – 17 ft
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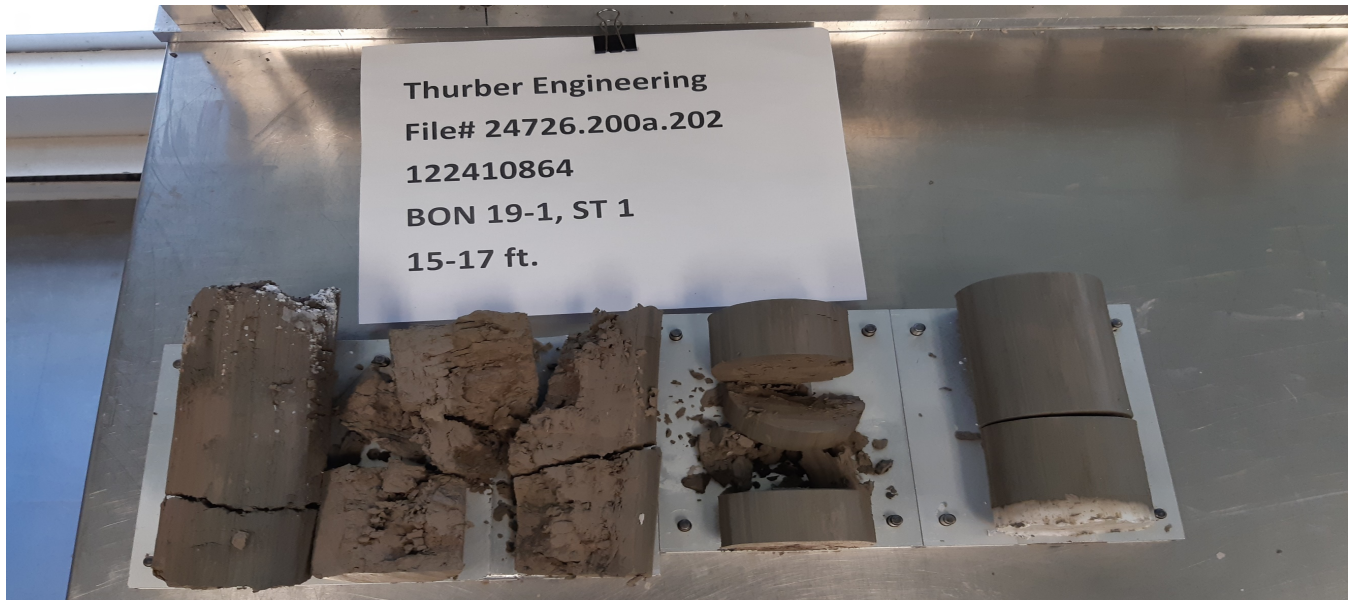
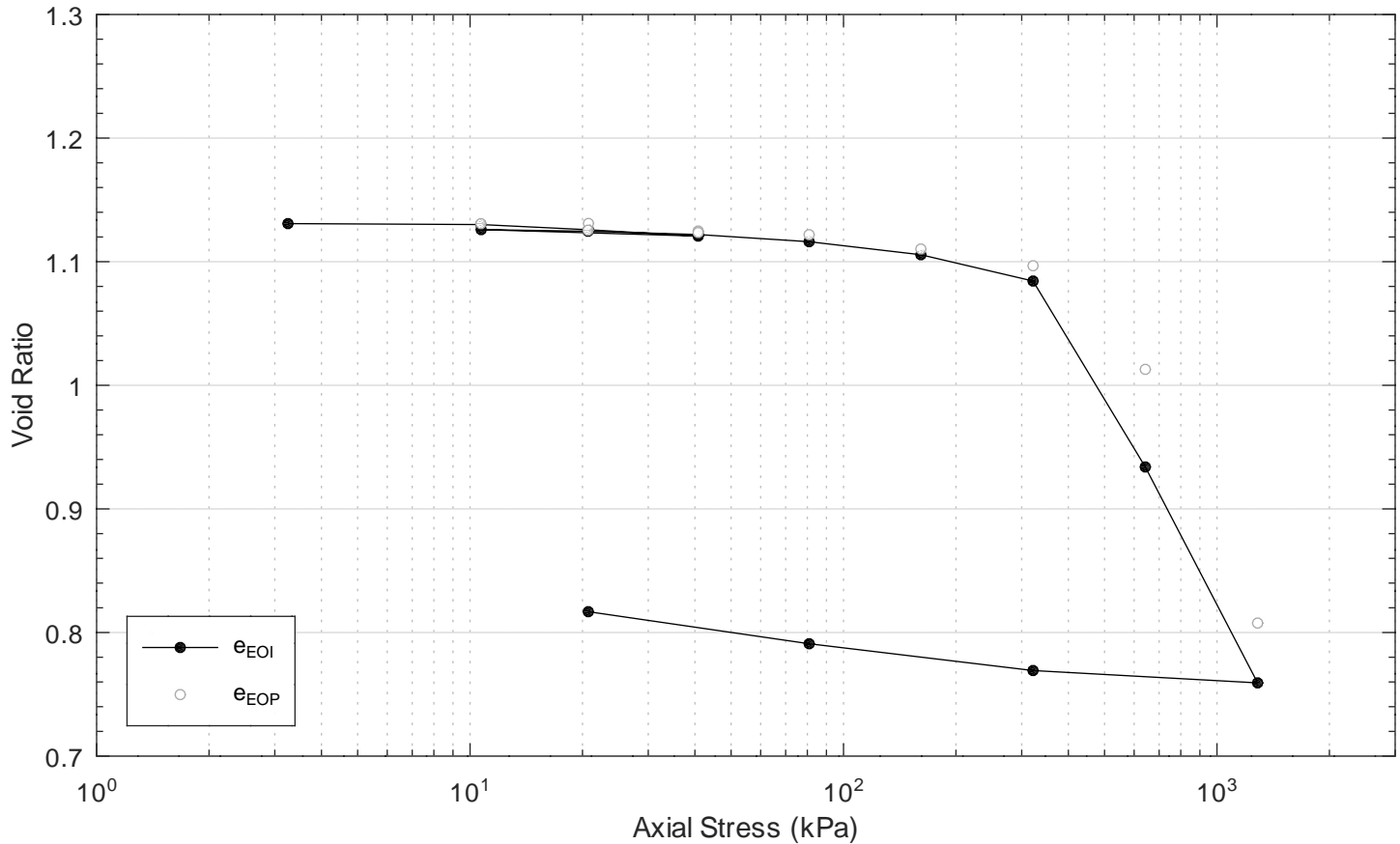


Photo No.:	2	Borehole: BON 19-1, ST1	Depth: 15 – 17 ft
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Project: 24726  
 Hwy 17 Twinning  
 Borehole: BON24-1  
 Sample: ST9  
 Depth: 11.0m  
 Client: Ministry of Transportation



Start of Test		2024-06-28	
Diameter of Sample	cm	D	6.340
Height of Sample	cm	$H_o$	2.547
Height of Solids	cm	$H_s$	1.196
Water Content	%	$w_o$	39.96
Dry Density	g/cm <sup>3</sup>	$\rho_d$	1.28
Moist Unit Weight	kN/m <sup>3</sup>	$\gamma$	17.6
Void Ratio	-	$e_o$	1.129
Degree of Saturation	-	$S_{ro}$	0.97
Specific Gravity	-	$G_s$	2.730
End of Test		2024-07-13	
Height of Sample	cm	$H_f$	2.173
Water Content	%	$w_f$	30.30
Void Ratio	-	$e_f$	0.817

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

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

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

#### Interpreted Results

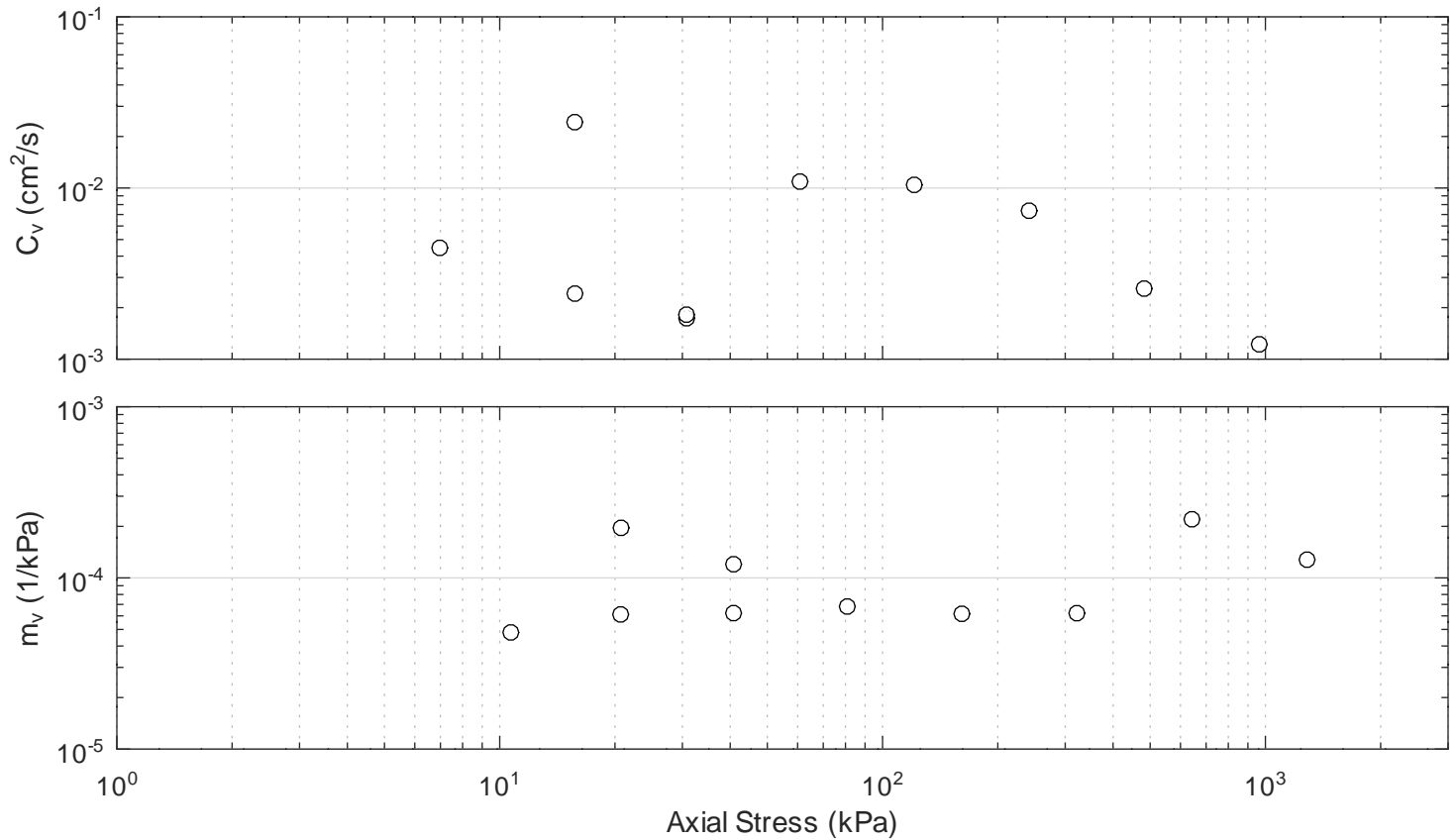
Recompression Index (reloading)	-	$C_r$	0.035
Compression Index	-	$C_c$	0.581
Recompression Index (unloading)	-	$C_r$	0.036
Probable Preconsolidation Pressure	kPa	$p'_c$	361

Check: AO/SP Review: KS





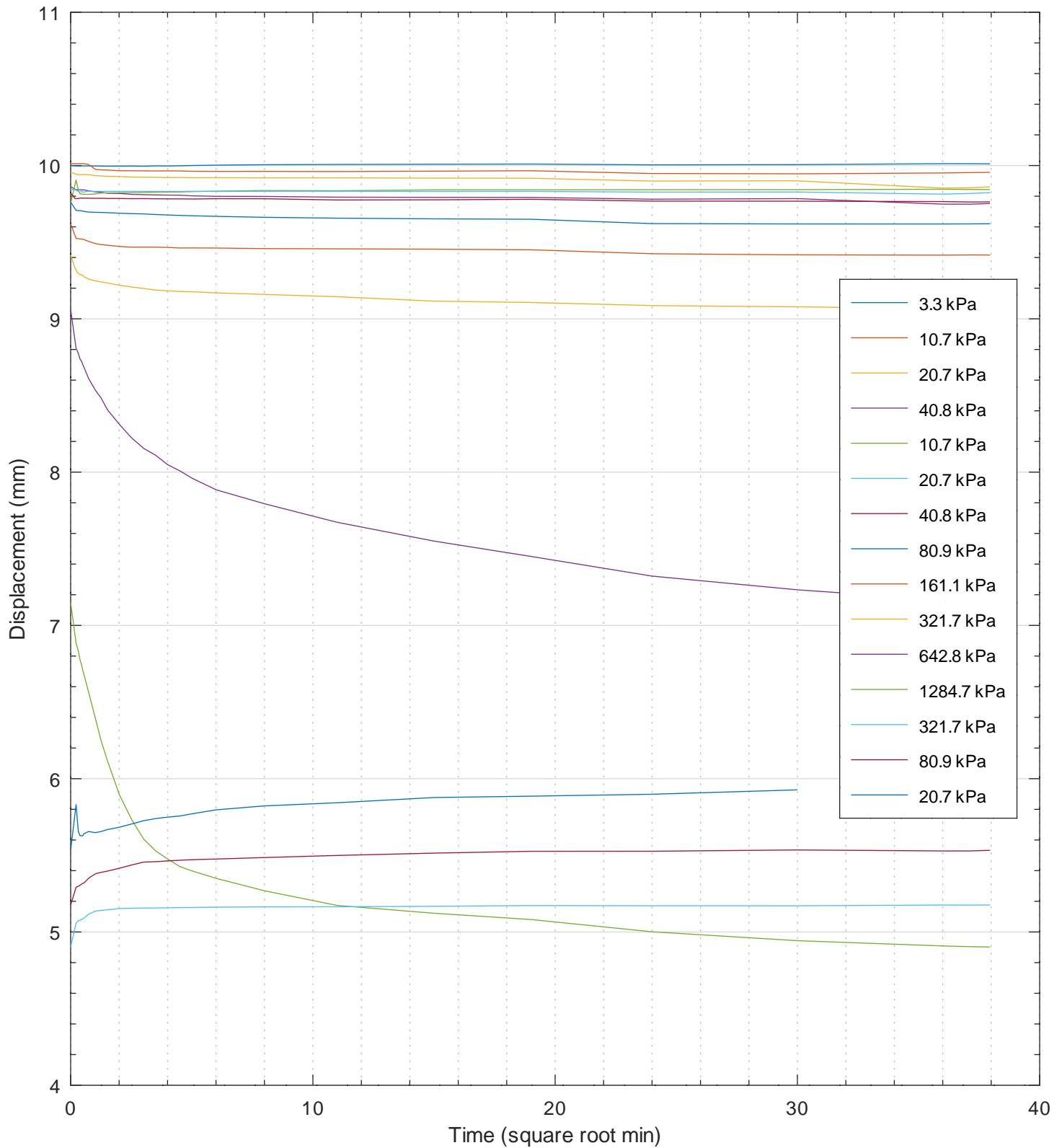
Project: 24726  
 Hwy 17 Twinning  
 Borehole: BON24-1  
 Sample: ST9  
 Depth: 11.0m  
 Client: Ministry of Transportation



Load No.	Axial Stress	Load Duration	System Deflec.	Dial	Sample Height	Axial Strain	Void Ratio	Void Ratio	Time U(0.99)	$C_v$	$k_v$	$C_{ae}$
	kPa	min	mm	mm	cm	%	(EOI)	(EOP)	min	cm <sup>2</sup> /s	cm/s	-
0				10.000	2.547	0.00	1.129					
1	3.3	1440.2	0.006	10.012	2.549	-0.07	1.131					
2	10.7	1440.1	0.053	9.956	2.548	-0.03	1.130	1.131	10.7	4.47e-03	2.11e-08	0.0003
3	20.7	1440.0	0.098	9.861	2.543	0.16	1.126	1.131	19.8	2.42e-03	4.65e-08	0.0012
4	40.8	1440.1	0.145	9.752	2.537	0.40	1.121	1.125	27.3	1.73e-03	2.04e-08	0.0012
5	10.7	1440.0	0.117	9.844	2.543	0.16	1.126					
6	20.7	1440.5	0.123	9.822	2.541	0.22	1.125	1.125	2.0	2.42e-02	1.46e-07	0.0001
7	40.8	1440.0	0.150	9.763	2.538	0.34	1.122	1.124	26.3	1.82e-03	1.11e-08	0.0004
8	80.9	1440.5	0.222	9.620	2.531	0.62	1.116	1.122	4.3	1.09e-02	7.28e-08	0.0012
9	161.1	1440.5	0.301	9.415	2.519	1.11	1.106	1.110	4.4	1.04e-02	6.31e-08	0.0009
10	321.7	1440.1	0.403	9.060	2.493	2.11	1.084	1.097	6.1	7.37e-03	4.49e-08	0.0025
11	642.8	1440.0	0.514	7.149	2.313	9.18	0.934	1.013	12.8	2.58e-03	5.58e-08	0.0192
12	1284.7	1440.0	0.673	4.902	2.104	17.38	0.759	0.808	14.6	1.22e-03	1.53e-08	0.0133
13	321.7	1440.3	0.519	5.176	2.116	16.91	0.769					
14	80.9	1440.1	0.421	5.532	2.142	15.89	0.791					
15	20.7	900.1	0.336	5.927	2.173	14.67	0.817					



Project: 24726  
 Hwy 17 Twinning  
 Borehole: BON24-1  
 Sample: ST9  
 Depth: 11.0m  
 Client: Ministry of Transportation





## **Appendix C.2**

### **Analytical Testing Results**

## Certificate of Analysis

**Thurber Engineering Ltd.**

2460 Lancaster Rd, Suite 104  
Ottawa, ON K1B 4S5  
Attn: Justin Gray

Client PO:  
Project: 24726 Task 200a.202  
Custody: 53443

Report Date: 28-Sep-2020  
Order Date: 22-Sep-2020

**Order #: 2039214**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2039214-01	BON 19-05, SS2 (2'6-4'6)

Approved By:

Dale Robertson, BSc  
Laboratory Director

Certificate of Analysis

Report Date: 28-Sep-2020

Client: Thurber Engineering Ltd.

Order Date: 22-Sep-2020

Client PO:

Project Description: 24726 Task 200a.202

**Analysis Summary Table**

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	24-Sep-20	24-Sep-20
Conductivity	MOE E3138 - probe @25 °C, water ext	24-Sep-20	24-Sep-20
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	22-Sep-20	23-Sep-20
Resistivity	EPA 120.1 - probe, water extraction	24-Sep-20	24-Sep-20
Solids, %	Gravimetric, calculation	23-Sep-20	23-Sep-20

Certificate of Analysis

Report Date: 28-Sep-2020

Client: Thurber Engineering Ltd.

Order Date: 22-Sep-2020

Client PO:

Project Description: 24726 Task 200a.202

Client ID:	BON 19-05, SS2 (2'6-4'6)	-	-	-
Sample Date:	08-Sep-20 09:00	-	-	-
Sample ID:	2039214-01	-	-	-
MDL/Units	Soil	-	-	-

#### Physical Characteristics

% Solids	0.1 % by Wt.	83.9	-	-	-
----------	--------------	------	---	---	---

#### General Inorganics

Conductivity	5 uS/cm	70	-	-	-
pH	0.05 pH Units	7.22	-	-	-
Resistivity	0.10 Ohm.m	143	-	-	-

#### Anions

Chloride	5 ug/g dry	8	-	-	-
Sulphate	5 ug/g dry	9	-	-	-

Certificate of Analysis

Report Date: 28-Sep-2020

Client: Thurber Engineering Ltd.

Order Date: 22-Sep-2020

Client PO:

Project Description: 24726 Task 200a.202

### Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	ND	5	ug/g						
Sulphate	ND	5	ug/g						
<b>General Inorganics</b>									
Conductivity	ND	5	uS/cm						
Resistivity	ND	0.10	Ohm.m						

Certificate of Analysis

Report Date: 28-Sep-2020

Client: Thurber Engineering Ltd.

Order Date: 22-Sep-2020

Client PO:

Project Description: 24726 Task 200a.202

### Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	31.5	5	ug/g dry	29.5			6.5	20	
Sulphate	7.38	5	ug/g dry	7.44			0.8	20	
<b>General Inorganics</b>									
Conductivity	222	5	uS/cm	217			2.3	5	
pH	7.64	0.05	pH Units	7.67			0.4	2.3	
Resistivity	45.0	0.10	Ohm.m	46.0			2.3	20	
<b>Physical Characteristics</b>									
% Solids	95.4	0.1	% by Wt.	95.7			0.3	25	



Certificate of Analysis

Report Date: 28-Sep-2020

Client: Thurber Engineering Ltd.

Order Date: 22-Sep-2020

Client PO:

Project Description: 24726 Task 200a.202

### Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	124	5	ug/g	29.5	94.6	82-118			
Sulphate	103	5	ug/g	7.44	95.7	80-120			

Certificate of Analysis

Report Date: 28-Sep-2020

Client: Thurber Engineering Ltd.

Order Date: 22-Sep-2020

Client PO:

Project Description: 24726 Task 200a.202

**Qualifier Notes:**

None

**Sample Data Revisions**

None

**Work Order Revisions / Comments:**

None

**Other Report Notes:**

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.

Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

## Subcontracted Analysis

**Thurber Engineering Ltd.**

2460 Lancaster Rd, Suite 104  
Ottawa, ON K1B 4S5  
Attn: Justin Gray

Tel: (613) 408-6795  
Fax: (613) 247-2185

Paracel Report No. **2039214**  
Client Project(s): **24726 Task 200a.202**  
Client PO:  
Reference: **Standing Offer**  
CoC Number: **53443**

Order Date: 22-Sep-20  
Report Date: 30-Sep-20

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor's report is attached

Paracel ID	Client ID	Analysis
2039214-01	BON 19-05, SS2 (2'6-4'6)	Sulphide, solid

**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

30-September-2020

**Date Rec. :** 24 September 2020  
**LR Report:** CA14785-SEP20  
**Reference:** Project#:2039214

**Copy:** #1

## CERTIFICATE OF ANALYSIS

### Final Report

Sample ID	Sample Date & Time	Sulphide (Na <sub>2</sub> CO <sub>3</sub> ) %
1: Analysis Start Date		28-Sep-20
2: Analysis Start Time		15:19
3: Analysis Completed Date		29-Sep-20
4: Analysis Completed Time		14:46
5: QC - Blank		< 0.04
6: QC - STD % Recovery		96%
7: QC - DUP % RPD		ND
8: RL		0.02
9: BON 19-05, SS2 (2'6-4'6)	08-Sep-20	<0.04 UAL

RL - SGS Reporting Limit

ND - Not Detected

UAL - Unreliable: Sample Age Exceeds Normal Limit

Processed past holding time as per client's instructions.

Kimberley Didsbury  
Project Specialist,  
Environment, Health & Safety

## Certificate of Analysis

**Thurber Engineering Ltd.**

2460 Lancaster Rd, Suite 104  
Ottawa, ON K1B 4S5  
Attn: Justin Gray

Client PO:  
Project: 24726 Task 200a.202  
Custody: 133258

Report Date: 5-May-2022  
Order Date: 29-Apr-2022

**Order #: 2218690**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2218690-01	BON 19-3, SS5 (10'-0"-12'-0")
2218690-02	BON-P1-MW, SS6 (12'-6"-14'-6")
2218690-03	BON-P2-MW, SS6 (12'-6"-14'-6")
2218690-04	BON-P3-MW, SS8 (17'-6"-19'-6")

Approved By:



Mark Foto, M.Sc.  
Lab Supervisor

Certificate of Analysis

Report Date: 05-May-2022

Client: Thurber Engineering Ltd.

Order Date: 29-Apr-2022

Client PO:

Project Description: 24726 Task 200a.202

**Analysis Summary Table**

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	3-May-22	3-May-22
Conductivity	MOE E3138 - probe @25 °C, water ext	3-May-22	4-May-22
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	3-May-22	3-May-22
Resistivity	EPA 120.1 - probe, water extraction	3-May-22	4-May-22
Solids, %	Gravimetric, calculation	3-May-22	3-May-22

Certificate of Analysis

Report Date: 05-May-2022

Client: Thurber Engineering Ltd.

Order Date: 29-Apr-2022

Client PO:

Project Description: 24726 Task 200a.202

	<b>Client ID:</b>	BON 19-3, SS5 (10'-0"-12'-0")	BON-P1-MW, SS6 (12'-6"-14'-6")	BON-P2-MW, SS6 (12'-6"-14'-6")	BON-P3-MW, SS8 (17'-6"-19'-6")
	<b>Sample Date:</b>	01-Oct-21 09:00	29-Sep-21 09:00	09-Nov-21 09:00	08-Nov-21 09:00
	<b>Sample ID:</b>	2218690-01	2218690-02	2218690-03	2218690-04
	<b>MDL/Units</b>	Soil	Soil	Soil	Soil

**Physical Characteristics**

% Solids	0.1 % by Wt.	72.8	81.7	82.7	88.1
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**General Inorganics**

Conductivity	5 uS/cm	131 [1]	327 [1]	71 [1]	63 [1]
pH	0.05 pH Units	7.66 [1]	7.72 [1]	7.63 [1]	7.81 [1]
Resistivity	0.10 Ohm.m	76.3 [1]	30.5 [1]	141	159

**Anions**

Chloride	5 ug/g dry	9 [1]	34 [1]	5 [1]	7 [1]
Sulphate	5 ug/g dry	<5 [1]	260 [1]	<5 [1]	<5 [1]

Certificate of Analysis

Report Date: 05-May-2022

Client: Thurber Engineering Ltd.

Order Date: 29-Apr-2022

Client PO:

Project Description: 24726 Task 200a.202

## Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	ND	5	ug/g						
Sulphate	ND	5	ug/g						
<b>General Inorganics</b>									
Conductivity	ND	5	uS/cm						
Resistivity	ND	0.10	Ohm.m						



Certificate of Analysis

Report Date: 05-May-2022

Client: Thurber Engineering Ltd.

Order Date: 29-Apr-2022

Client PO:

Project Description: 24726 Task 200a.202

### Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	14.8	5	ug/g	13.1			12.1	20	
Sulphate	54.6	5	ug/g	50.9			7.1	20	
<b>General Inorganics</b>									
Conductivity	116	5	uS/cm	112			3.6	5	
pH	7.30	0.05	pH Units	7.32			0.3	2.3	
Resistivity	86.3	0.10	Ohm.m	89.4			3.6	20	
<b>Physical Characteristics</b>									
% Solids	85.0	0.1	% by Wt.	85.3			0.4	25	

Certificate of Analysis

Report Date: 05-May-2022

Client: Thurber Engineering Ltd.

Order Date: 29-Apr-2022

Client PO:

Project Description: 24726 Task 200a.202

**Method Quality Control: Spike**

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	116	5	ug/g	13.1	103	82-118			
Sulphate	159	5	ug/g	50.9	108	80-120			

Certificate of Analysis

Client: Thurber Engineering Ltd.

Client PO:

Report Date: 05-May-2022

Order Date: 29-Apr-2022

Project Description: 24726 Task 200a.202

**Qualifier Notes:**

***Login Qualifiers :***

Sample - One or more parameter received past hold time - Chloride, pH, resistivity, sulphide, sulphate

*Applies to samples: BON 19-3, SS5 (10'-0"-12'-0"), BON-P1-MW, SS6 (12'-6"-14'-6")*

Sample - One or more parameter received past hold time - Chloride, pH, sulphide, sulphate

*Applies to samples: BON-P2-MW, SS6 (12'-6"-14'-6"), BON-P3-MW, SS8 (17'-6"-19'-6")*

***Sample Qualifiers :***

- 1 : Holding time had been exceeded upon receipt of the sample at the laboratory or prior to the analysis being requested.

**Sample Data Revisions**

None

**Work Order Revisions / Comments:**

None

**Other Report Notes:**

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.

Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

## Subcontracted Analysis

**Thurber Engineering Ltd.**

2460 Lancaster Rd, Suite 104

Ottawa, ON K1B 4S5

Attn: Justin Gray

Paracel Report No. **2218690**Client Project(s): **24726 Task 200a.202**

Client PO:

Reference: **Standing Offer**CoC Number: **133258**

Order Date: 29-Apr-22

Report Date: 11-May-22

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor's report is attached

Paracel ID	Client ID	Analysis
2218690-01	BON 19-3, SS5 (10'-0"-12'-0")	Sulphide, solid
2218690-02	BON-P1-MW, SS6 (12'-6"-14'-6")	Sulphide, solid
2218690-03	BON-P2-MW, SS6 (12'-6"-14'-6")	Sulphide, solid
2218690-04	BON-P3-MW, SS8 (17'-6"-19'-6")	Sulphide, solid

**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

11-May-2022

**Date Rec. :** 03 May 2022  
**LR Report:** CA12045-MAY22  
**Reference:** Project#: 2218690

**Copy:** #1

## CERTIFICATE OF ANALYSIS

### Final Report

Sample ID	Sample Date & Time	Sulphide (Na <sub>2</sub> CO <sub>3</sub> ) %
1: Analysis Start Date		11-May-22
2: Analysis Start Time		07:08
3: Analysis Completed Date		11-May-22
4: Analysis Completed Time		09:07
5: QC - Blank		< 0.04
6: QC - STD % Recovery		100%
7: QC - DUP % RPD		ND
8: RL		0.02
9: BON 19-3, SS5 (10'-0"-12'-0")	01-Oct-21 09:00	< 0.04
10: BON-P1-MW, SS6 (12'6"-14'6")	29-Sep-21 09:00	0.05
11: BON-P2-MW, SS6 (12'6"-14'6")	09-Nov-21 09:00	< 0.04
12: BON-P3-MW, SS8 (17'6"-19'6")	08-Nov-21 09:00	< 0.04

RL - SGS Reporting Limit  
ND - Not Detected

Note: Results for sulphide analysis performed past the 28 day holding time may be unreliable; processed past holding times as per client's instructions.

Kimberley Didsbury  
Project Specialist,  
Environment, Health & Safety

## Certificate of Analysis

**Thurber Engineering Ltd.**

2460 Lancaster Rd, Suite 104

Ottawa, ON K1B 4S5

Attn: Justin Gray

Client PO: Highway 17 Renfrew, Various Sites

Project: 24726 task 700.706a

Custody:

Report Date: 18-Apr-2024

Order Date: 12-Apr-2024

**Order #: 2415421**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2415421-01	SC18-3 SS3A 5'-6'3"
2415421-02	SC23-2 SS5 10'-12'
2415421-03	DOC23-1 SS7, 15'-17'
2415421-04	OBR23-1 SS16 48'-50'
2415421-05	BON24-2 SS4 10'-12'
2415421-06	NSC20-2 SS2A 2'6"-3'3"
2415421-07	SC10-1 SS2B 3'-4'
2415421-08	SC10-4 SS2 2'6"-4'6"

Approved By:

*Mark Foto*

Mark Foto, M.Sc.

Lab Supervisor

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

**Analysis Summary Table**

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	15-Apr-24	15-Apr-24
Conductivity	MOE E3138 - probe @25 °C, water ext	15-Apr-24	15-Apr-24
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	15-Apr-24	15-Apr-24
Resistivity	EPA 120.1 - probe, water extraction	15-Apr-24	15-Apr-24
Solids, %	CWS Tier 1 - Gravimetric	15-Apr-24	16-Apr-24

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

Client ID:	SC18-3 SS3A 5'-6'3"	SC23-2 SS5 10'-12'	DOC23-1 SS7, 15'-17'	OBR23-1 SS16 48'-50'	
Sample Date:	11-Mar-24 09:00	13-Mar-24 09:00	11-Mar-24 09:00	27-Mar-24 09:00	-
Sample ID:	2415421-01	2415421-02	2415421-03	2415421-04	-
Matrix:	Soil	Soil	Soil	Soil	
MDL/Units					

#### Physical Characteristics

% Solids	0.1 % by Wt.	84.8	62.4	68.0	87.9	-	-
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#### General Inorganics

Conductivity	5 uS/cm	108 [1]	1950 [2]	1660 [1]	100	-	-
pH	0.05 pH Units	7.32 [1]	6.91 [2]	7.12 [1]	7.37	-	-
Resistivity	0.1 Ohm.m	92.9 [1]	5.1 [2]	6.0 [1]	100	-	-

#### Anions

Chloride	10 ug/g	10 [1]	175 [1]	682 [1]	<10	-	-
Sulphate	10 ug/g	<10 [1]	2080 [1]	29 [1]	<10	-	-



Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

		Client ID:	BON24-2 SS4 10'-12'	NSC20-2 SS2A 2'6"-3'3"	SC10-1 SS2B 3'-4'	SC10-4 SS2 2'6"-4'6"		
		Sample Date:	09-Apr-24 09:00	02-Apr-24 09:00	21-Mar-24 09:00	04-Apr-24 09:00	-	-
		Sample ID:	2415421-05	2415421-06	2415421-07	2415421-08		
		Matrix:	Soil	Soil	Soil	Soil		
		MDL/Units						
<b>Physical Characteristics</b>								
% Solids	0.1 % by Wt.		72.6	69.1	73.2	77.5	-	-
<b>General Inorganics</b>								
Conductivity	5 uS/cm		286	203	316	247	-	-
pH	0.05 pH Units		6.79	6.65	6.95	6.84	-	-
Resistivity	0.1 Ohm.m		35.0	49.2	31.6	40.5	-	-
<b>Anions</b>								
Chloride	10 ug/g		12	37	97	27	-	-
Sulphate	10 ug/g		24	21	44	<10	-	-

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

### Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>								
Chloride	ND	10	ug/g					
Sulphate	ND	10	ug/g					
<b>General Inorganics</b>								
Conductivity	ND	5	uS/cm					
Resistivity	ND	0.1	Ohm.m					

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

### Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	10.1	10	ug/g	10.1			0.3	35	
Sulphate	ND	10	ug/g	ND			NC	35	
<b>General Inorganics</b>									
Conductivity	1040	5	uS/cm	1050			1.1	5	
pH	7.44	0.05	pH Units	7.46			0.3	2.3	
Resistivity	8.98	0.1	Ohm.m	9.51			5.7	20	
<b>Physical Characteristics</b>									
% Solids	84.9	0.1	% by Wt.	84.7			0.2	25	

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

### Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	110	10	ug/g	10.1	99.4	82-118			
Sulphate	106	10	ug/g	ND	106	80-120			

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

**Qualifier Notes:****Login Qualifiers :**

Sample - One or more parameter received past hold time - Conductivity, chloride, pH, resistivity, and sulphate.

Applies to Samples: SC18-3 SS3A 5'-6'3", DOC23-1 SS7, 15'-17'

**Sample Qualifiers :**

- 1: Holding time had been exceeded upon receipt of the sample at the laboratory or prior to the analysis being requested.
- 2: This analysis was conducted after the accepted holding time had been exceeded.

**Sample Data Revisions:**

None

**Work Order Revisions / Comments:**

None

**Other Report Notes:**

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

Soil results are reported on a dry weight basis unless otherwise noted.

Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

Any use of these results implies your agreement that our total liability in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.



Client Name: Thurber Engineering Ltd.	Project Ref: Highway 17 Renfrew, Various Sites	Page 1 of 1
Contact Name: Justin Gray	Quote #:	Turnaround Time <input type="checkbox"/> 1 day <input type="checkbox"/> 3 day <input type="checkbox"/> 2 day <input checked="" type="checkbox"/> Regular
Address: 104 - 2460 Lancaster Rd Ottawa	PO #: 24726 task 700.706a	
Telephone: 343-542-7957	E-mail: jgray@thurber.ca	
Date Required:		

<input type="checkbox"/> REG 153/04 <input type="checkbox"/> REG 406/19 <input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> Table _____ For RSC: <input type="checkbox"/> Yes <input type="checkbox"/> No		Other Regulation <input type="checkbox"/> REG 558 <input type="checkbox"/> PWQO <input type="checkbox"/> CCME <input type="checkbox"/> MISA <input type="checkbox"/> SU - Sani <input type="checkbox"/> SU - Storm Mun: _____ <input type="checkbox"/> Other: _____	Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)	Required Analysis															
Sample ID/Location Name		Matrix	Air Volume	# of Containers	Sample Taken		pH	Resist. & Conductivity	Chloride	Sulphate	Sulphide								
					Date	Time													
✓ 1	SC18-3 SS3A 5'-6'3"	S		1	2024/03/11		✓	✓	✓	✓	✓								
✓ 2	SC23-2 SS5 10'-12'	S		1	2024/03/13		✓	✓	✓	✓	✓								
✓ 3	DOC23-1 SS7,15'-17'	S		1	2024/03/11		✓	✓	✓	✓	✓								
✓ 4	OBR23-1 SS16 48'-50'	S		1	2024/03/27		✓	✓	✓	✓	✓								
✓ 5	BON24-2 SS4 10'-12'	S		1	2024/04/09		✓	✓	✓	✓	✓								
✓ 6	NSC20-2 SS2A 2'6"-3'3"	S		1	2024/04/02		✓	✓	✓	✓	✓								
✓ 7	SC10-1 SS2B 3'-4'	S		1	2024/03/21		✓	✓	✓	✓	✓								
✓ 8	SC10-4 SS2 2'6"-4'6"	S		1	2024/04/04		✓	✓	✓	✓	✓								
9																			
10																			

Comments: Please proceed with testing even with hold times expired -JG				Method of Delivery: Walk In	
Relinquished By (Sign): <i>[Signature]</i>	Received at Depot:	Received at Lab: <i>[Signature]</i>	Verified By: <i>[Signature]</i>		
Relinquished By (Print): Justin Gray	Date/Time:	Date/Time: April 12, 2024	Date/Time: April 12, 2024 9:57am		
Date/Time: Apr 12, 2024 9pm	Temperature: °C	Temperature: 19.1	pH Verified: <input type="checkbox"/> By:		

## Subcontracted Analysis

**Thurber Engineering Ltd.**2460 Lancaster Rd, Suite 104  
Ottawa, ON K1B 4S5

Attn: Justin Gray

Paracel Report No. **2415421**  
Client Project(s): **24726 task 700.706a**  
Client PO: **Highway 17 Renfrew, Various Sites**  
Reference: **#24-079 Standing Offer**

Order Date: 12-Apr-24  
Report Date: 19-Apr-24

CoC Number:

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor's report is attached

Paracel ID	Client ID	Analysis
2415421-01	SC18-3 SS3A 5'-6'3"	Sulphide, solid
2415421-02	SC23-2 SS5 10'-12'	Sulphide, solid
2415421-03	DOC23-1 SS7, 15'-17'	Sulphide, solid
2415421-04	OBR23-1 SS16 48'-50'	Sulphide, solid
2415421-05	BON24-2 SS4 10'-12'	Sulphide, solid
2415421-06	NSC20-2 SS2A 2'6"-3'3"	Sulphide, solid
2415421-07	SC10-1 SS2B 3'-4'	Sulphide, solid
2415421-08	SC10-4 SS2 2'6"-4'6"	Sulphide, solid

**SGS Canada Inc.**

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

**Paracel Laboratories**

Attn : Dale Robertson

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

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

19-April-2024

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

**Copy:** #1

## CERTIFICATE OF ANALYSIS

### Final Report

Sample ID	Sample Date & Time	Sulphide (Na <sub>2</sub> CO <sub>3</sub> ) %
1: Analysis Start Date		19-Apr-24
2: Analysis Start Time		13:06
3: Analysis Completed Date		19-Apr-24
4: Analysis Completed Time		13:12
5: RL		0.01
6: SC18-3 SS3A 5'-6'3"	11-Mar-24	< 0.01
7: SC23-2 SS5 10'-12'	13-Mar-24	0.83
8: DOC23-1 SS7, 15'-17'	11-Mar-24	0.01
9: OBR23-1 SS16 48'-50'	27-Mar-24	< 0.01
10: BON24-2 SS4 10'-12'	09-Apr-24	< 0.01
11: NSC20-2 SS2A 2'6"-3'3"	02-Apr-24	< 0.01
12: SC10-1 SS2B 3'-4"	21-Mar-24	< 0.01
13: SC10-4 SS2 2'6"- 4'6"	04-Apr-24	< 0.01

RL - SGS Reporting Limit

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

Kimberley Didsbury  
Project Specialist,  
Environment, Health & Safety





SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.

Lakefield - Ontario - KOL 2HO

Phone: 705-652-2000 FAX: 705-652-6365

LR Report :

CA12714-APR24

## Quality Control Report

Inorganic Analysis													
Parameter	Reporting Limit	Unit	Method Blank	Duplicate				LCS / Spike Blank			Matrix Spike / Reference Material		
				Result 1	Result 2	RPD	Acceptance Criteria	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
							%		Low	High		Low	High
Carbon/Sulphur - QCBatchID: ECS0068-APR24													
Sulphide (Na2CO3)	0.01	%	< 0.01										



Client Name: Thurber Engineering Ltd.	Project Ref: Highway 17 Renfrew, Various Sites	Page 1 of 1
Contact Name: Justin Gray	Quote #:	<b>Turnaround Time</b> <input type="checkbox"/> 1 day <input type="checkbox"/> 3 day <input type="checkbox"/> 2 day <input checked="" type="checkbox"/> Regular Date Required: _____
Address: 104 - 2460 Lancaster Rd Ottawa	PO #: 24726 task 700.706a	
Telephone: 343-542-7957	E-mail: jgray@thurber.ca	

<input type="checkbox"/> REG 153/04 <input type="checkbox"/> REG 406/19 <input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> Table _____ For RSC: <input type="checkbox"/> Yes <input type="checkbox"/> No	Other Regulation <input type="checkbox"/> REG 558 <input type="checkbox"/> PWQO <input type="checkbox"/> CCME <input type="checkbox"/> MISA <input type="checkbox"/> SU - Sani <input type="checkbox"/> SU - Storm Mun: _____ <input type="checkbox"/> Other: _____	<b>Matrix Type:</b> S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)	<b>Required Analysis</b>																	
Sample ID/Location Name		Matrix	Air Volume	# of Containers	Sample Taken		pH	Resist. & Conductivity	Chloride	Sulphate	Sulphide									
					Date	Time														
✓ 1	SC18-3 SS3A 5'-6'3"	S		1	2024/03/11		✓	✓	✓	✓	✓									
✓ 2	SC23-2 SS5 10'-12'	S		1	2024/03/13		✓	✓	✓	✓	✓									
✓ 3	DOC23-1 SS7 15'-17'	S		1	2024/03/11		✓	✓	✓	✓	✓									
✓ 4	OBR23-1 SS16 48'-50'	S		1	2024/03/27		✓	✓	✓	✓	✓									
✓ 5	BON24-2 SS4 10'-12'	S		1	2024/04/09		✓	✓	✓	✓	✓									
✓ 6	NSC20-2 SS2A 2'6"-3'3"	S		1	2024/04/02		✓	✓	✓	✓	✓									
✓ 7	SC10-1 SS2B 3'-4'	S		1	2024/03/21		✓	✓	✓	✓	✓									
✓ 8	SC10-4 SS2 2'6"-4'6"	S		1	2024/04/04		✓	✓	✓	✓	✓									
9																				
10																				

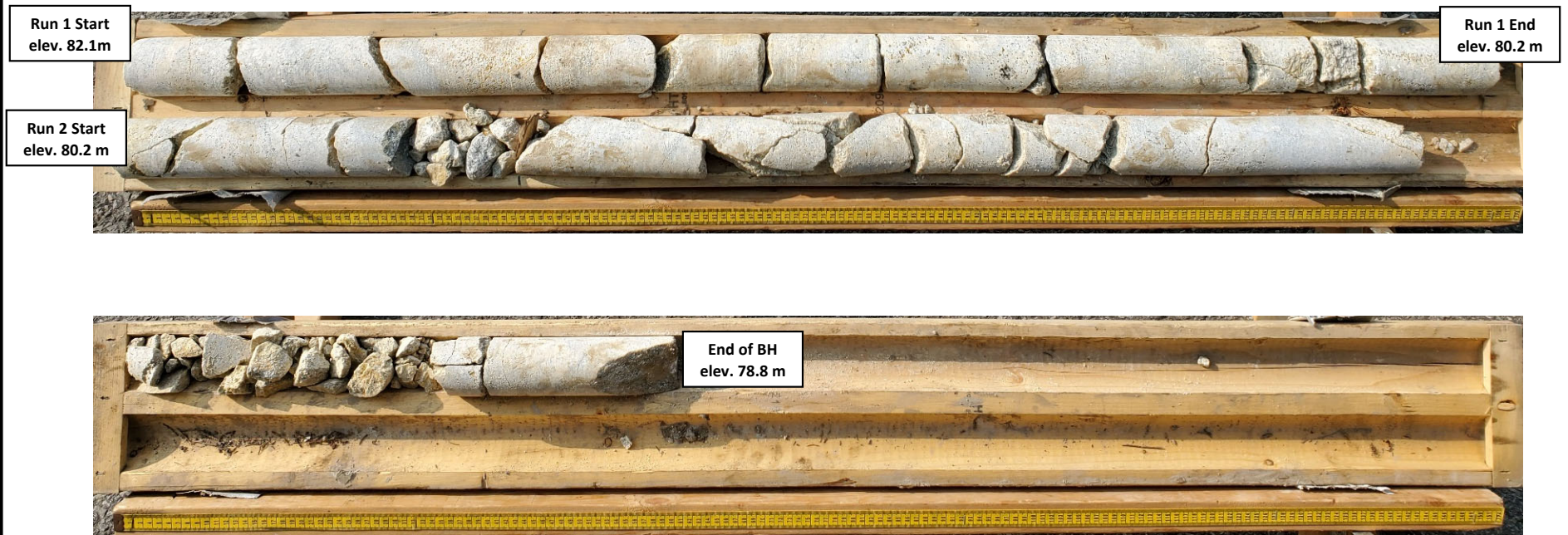
Comments: Please proceed with testing even with hold times expired -JG			Method of Delivery: <u>Walk In</u>	
Relinquished By (Sign): <u>[Signature]</u>	Received at Depot:	Received at Lab: <u>9:10</u>	Verified By: <u>Sp</u>	
Relinquished By (Print): <u>Justin Gray</u>	Date/Time:	Date/Time: <u>April 12/24</u>	Date/Time: <u>April 12, 2024 9:57am</u>	
Date/Time: <u>Apr 12, 2024 9pm</u>	Temperature: _____ °C	Temperature: <u>19.1</u>	pH Verified: <input type="checkbox"/> By: _____	



## **Appendix C.3**

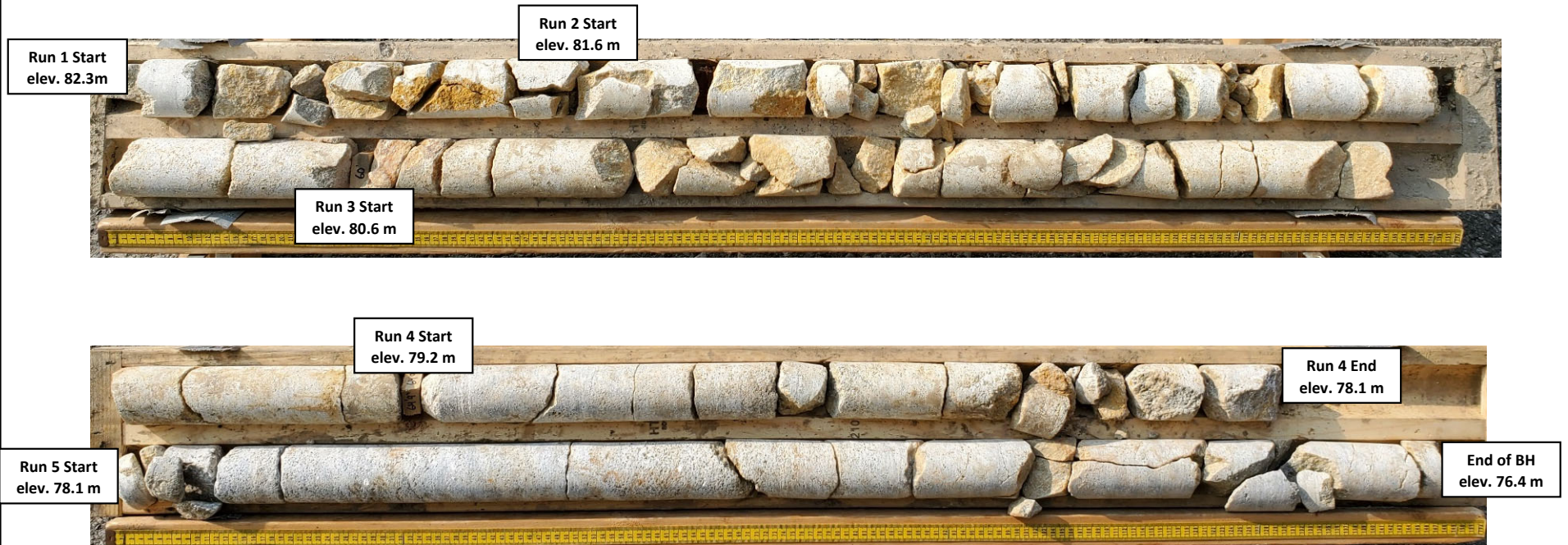
### **Rock Core Photos and UCS Results**

**Borehole BON19-4**  
**Run 1 to 2 (of 2)**  
**Elevation 82.1 m to 78.8 m**





**Borehole BON19-5**  
**Run 1 to 2 (of 2)**  
**Elevation 82.3 m to 76.4 m**





Stantec Consulting Ltd.  
2781 Lancaster Rd, Suite 100 A&B, Ottawa ON K1B 1A7

February 14, 2022  
File: 122410864

Client: Thurber Engineering, File #24726.200a202

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

The following table summarizes unconfined compressive strength results for two intact rock cores.

Location	Sample Depth	Compressive Strength (MPa)	Description of Break
BON19-4 Run-1	60'	41.2	Well-formed cones at both ends.
BON19-5 Run-5	69'6"	55.1	Well-formed cones at both ends.

Sincerely,

Stantec Consulting Ltd.

Brian Prevost  
Laboratory Supervisor  
Tel: 613-738-6075  
Fax: 613-722-2799  
[brian.prevost@stantec.com](mailto:brian.prevost@stantec.com)



## **Appendix D.**

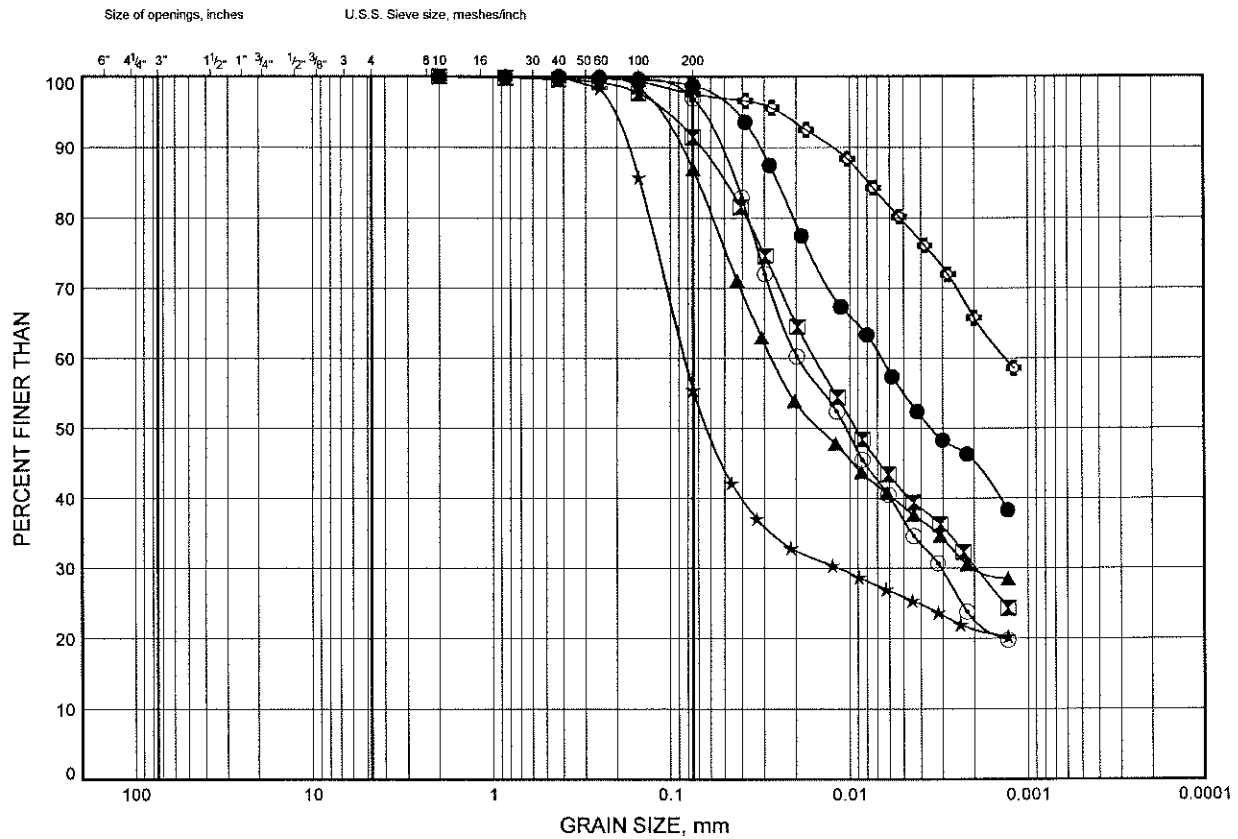
### **Laboratory Testing**

#### **Previous (2003) Investigation**

# HWY 17 Twinning, Arnprior to Renfrew GRAIN SIZE DISTRIBUTION

FIGURE D1.1

## SILTY CLAY

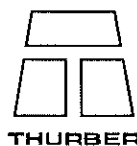


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BON-1	2.59	99.78
⊠	BON-2	4.88	82.36
▲	BON-3	1.83	84.29
★	BON-4	1.83	87.86
⊙	BON-6	3.35	99.65
⊛	BON-7	2.59	110.41

Date April 2004

Project 647-92-00



Prep'd SS

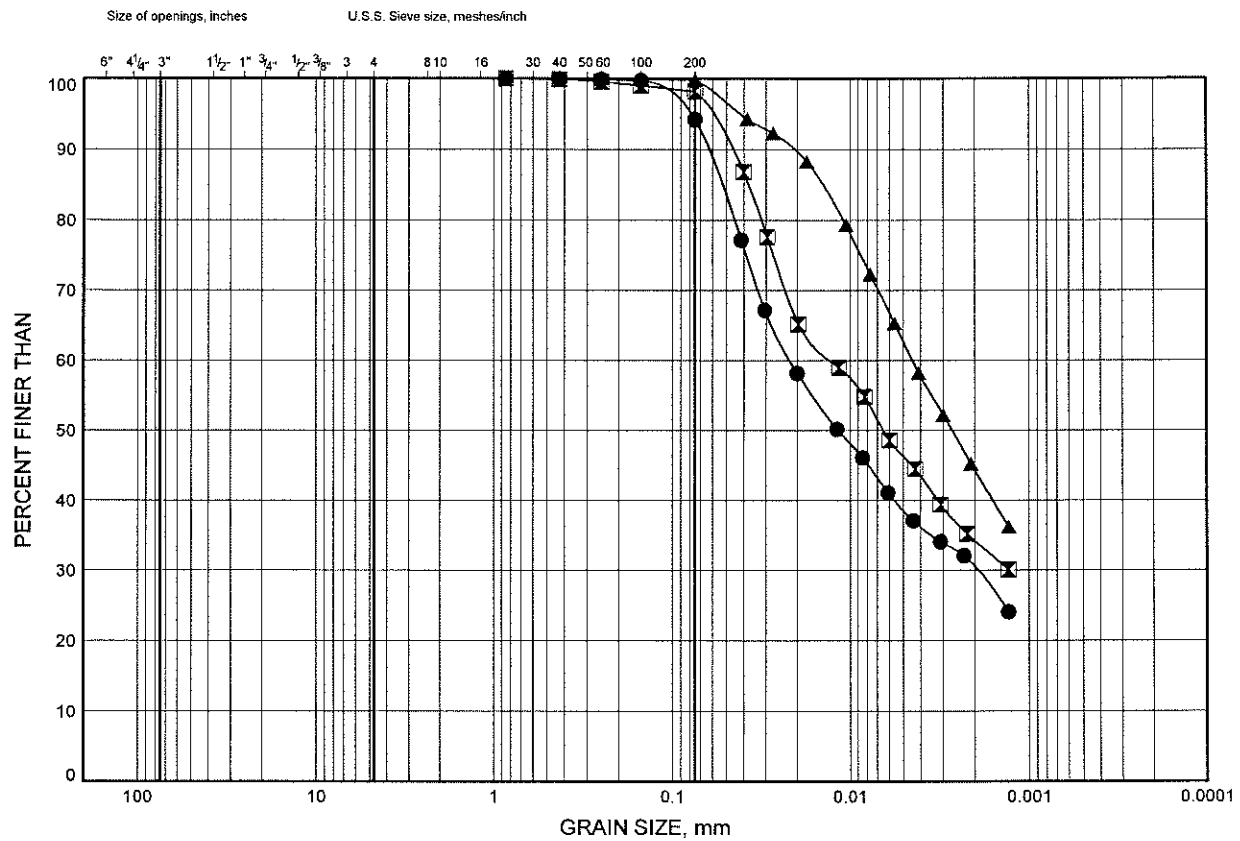
Chkd. SMS



# HWY 17 Twinning, Arnprior to Renfrew GRAIN SIZE DISTRIBUTION

FIGURE D1.2

## SILTY CLAY

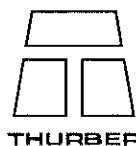


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BON-1	10.97	91.40
⊠	BON-6	7.70	95.30
▲	BON-7	10.97	102.03

Date April 2004

Project 647-92-00



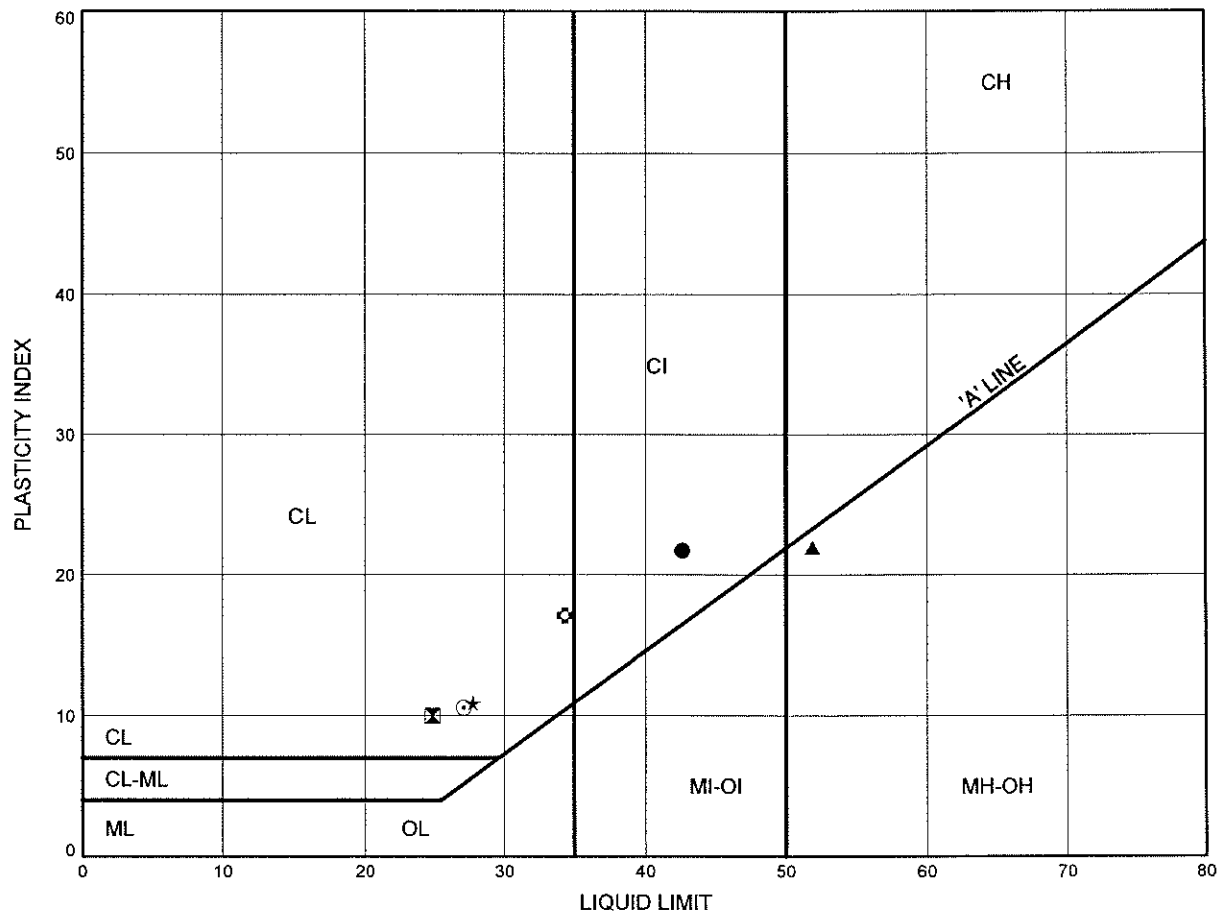
Prep'd SS

Chkd. SMS

# HWY 17 Twinning, Arnprior to Renfrew ATTERBERG LIMITS TEST RESULTS

FIGURE D2

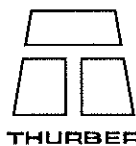
## SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BON-1	2.59	99.78
⊠	BON-1	10.97	91.40
▲	BON-2	4.88	82.36
★	BON-3	1.83	84.29
⊙	BON-6	3.35	99.65
⊗	BON-6	7.70	95.30

Date April 2004

Project 647-92-00



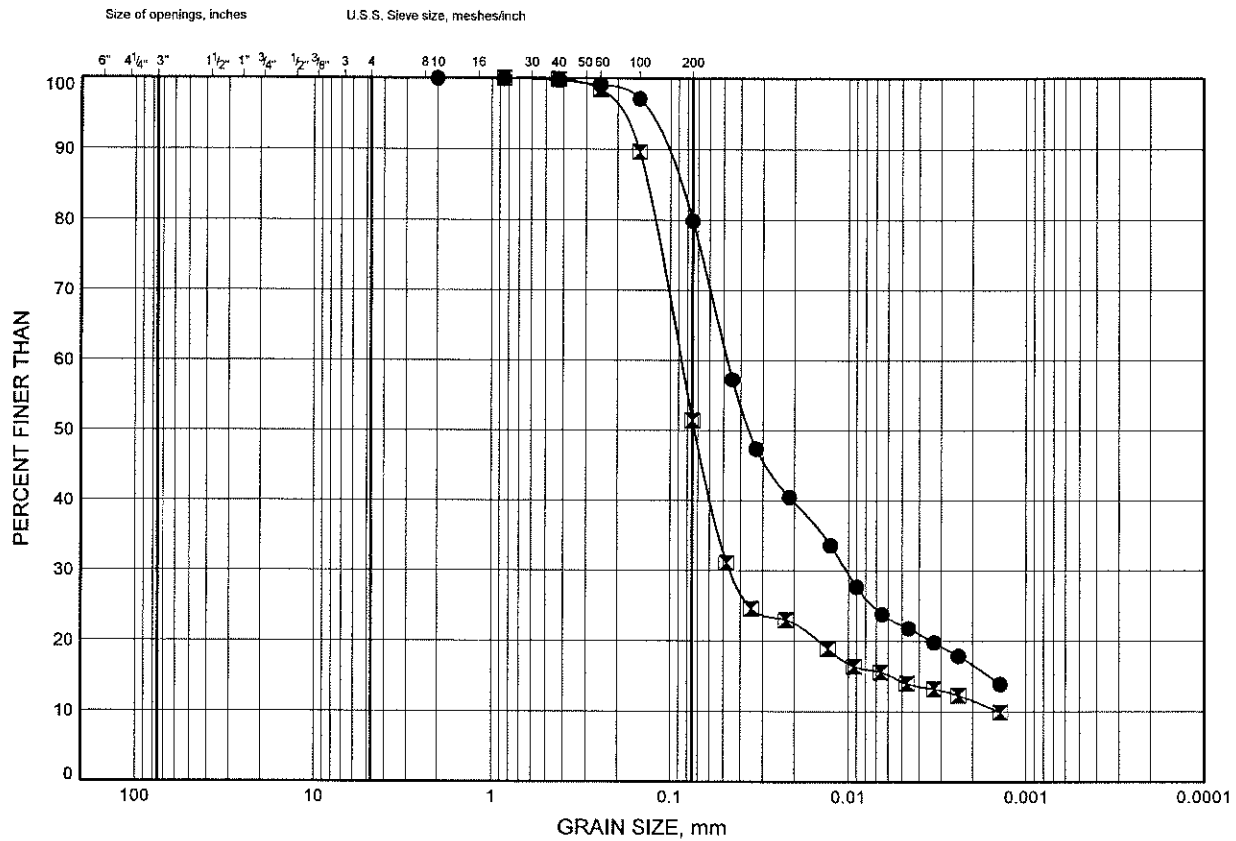
Prep'd SS

Chkd. SMS

# HWY 17 Twinning, Arnprior to Renfrew GRAIN SIZE DISTRIBUTION

FIGURE D3

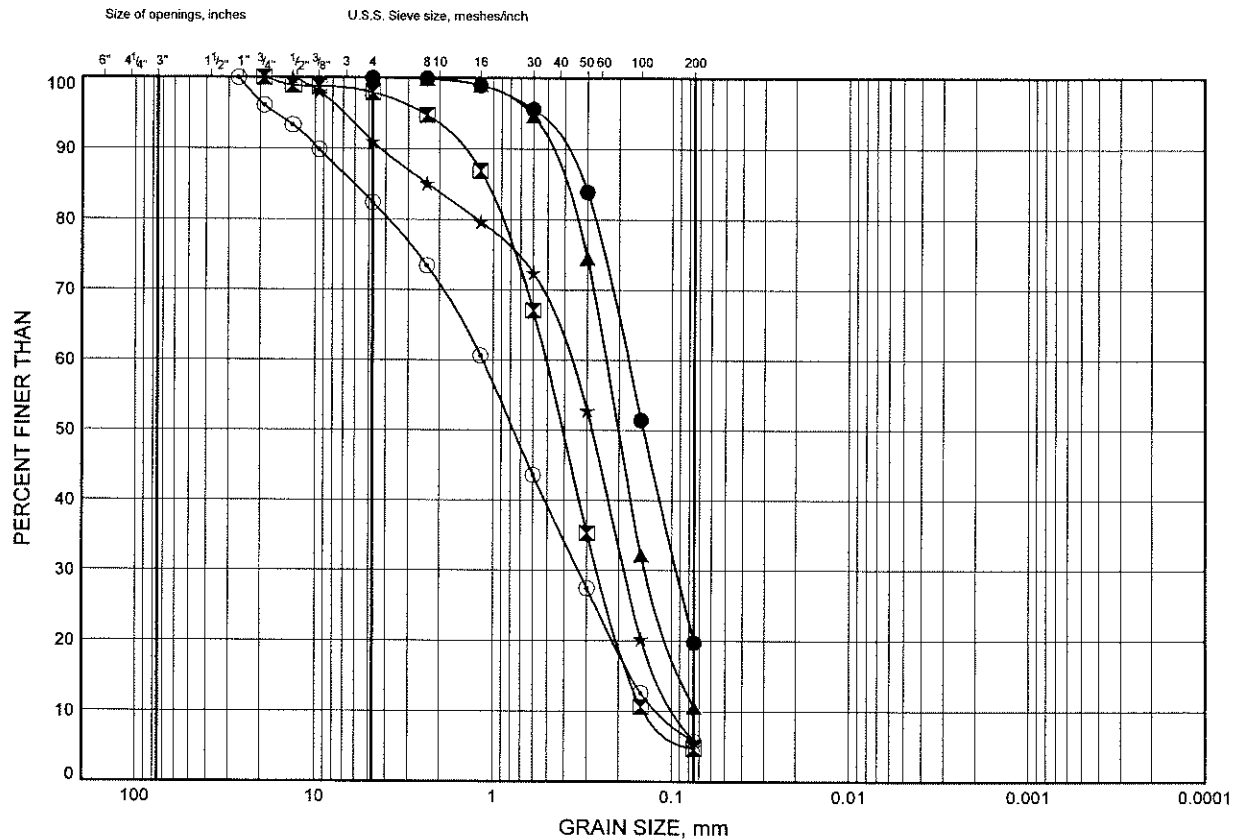
## SANDY SILT



# HWY 17 Twinning, Arnprior to Renfrew GRAIN SIZE DISTRIBUTION

FIGURE D4

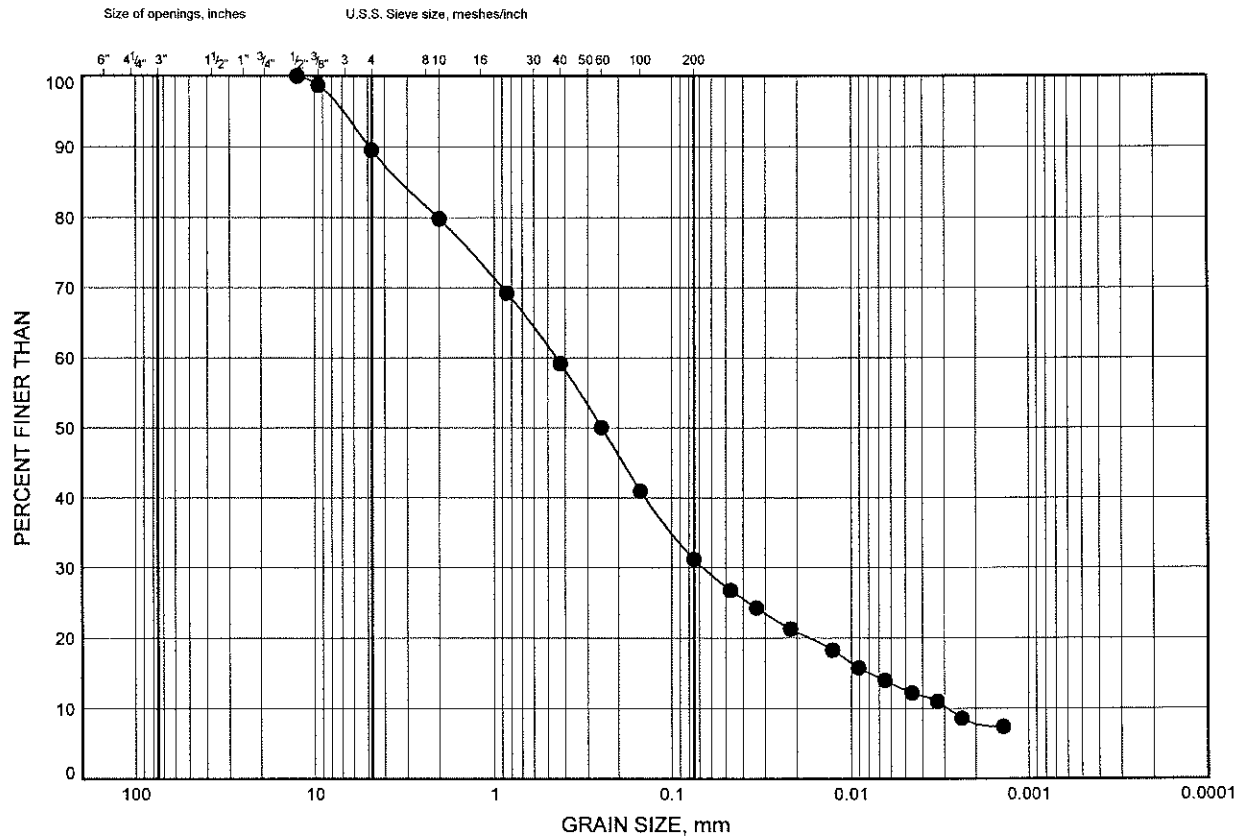
SAND, trace to some silt



# HWY 17 Twinning, Amprior to Renfrew GRAIN SIZE DISTRIBUTION

FIGURE D5

## SANDY SILT TILL

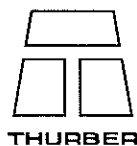


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BON-3	18.67	67.45

Date April 2004

Project 647-92-00



Prep'd SS

Chkd. SMS

## OEDOMETER CONSOLIDATION SUMMARY

## SAMPLE IDENTIFICATION

Project Number	04-1116-011	Sample Number	ST #1
Borehole Number	BON 7	Sample Depth, m	12.2-12.8

## TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	5		
Date Started	2/3/2004		
Date Completed	2/12/2004		

## SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.92	Unit Weight, kN/m <sup>3</sup>	17.22
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m <sup>3</sup>	11.92
Area, cm <sup>2</sup>	31.67	Specific Gravity, measured	2.78
Volume, cm <sup>3</sup>	60.80	Solids Height, cm	0.840
Water Content, %	44.50	Volume of Solids, cm <sup>3</sup>	26.59
Wet Mass, g	106.80	Volume of Voids, cm <sup>3</sup>	34.22
Dry Mass, g	73.91	Degree of Saturation, %	96.1

## 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	1.920	1.287	1.920				
4.69	1.910	1.275	1.915	124	6.27E-03	1.11E-03	6.82E-07
9.53	1.904	1.268	1.907	158	4.88E-03	6.46E-04	3.09E-07
19.28	1.887	1.248	1.896	321	2.37E-03	9.08E-04	2.11E-07
38.69	1.856	1.211	1.872	540	1.38E-03	8.32E-04	1.12E-07
77.39	1.814	1.161	1.835	356	2.01E-03	5.65E-04	1.11E-07
154.57	1.759	1.095	1.787	304	2.23E-03	3.71E-04	8.10E-08
309.16	1.686	1.008	1.723	171	3.68E-03	2.46E-04	8.87E-08
618.34	1.594	0.899	1.640	211	2.70E-03	1.55E-04	4.10E-08
1237.37	1.501	0.788	1.548	211	2.41E-03	7.82E-05	1.85E-08
2472.12	1.416	0.687	1.459	171	2.64E-03	3.59E-05	9.27E-09
1237.37	1.422	0.694	1.419				
309.16	1.447	0.724	1.435				
77.39	1.479	0.762	1.463				
19.28	1.506	0.794	1.493				
4.69	1.548	0.844	1.527				

Notes:

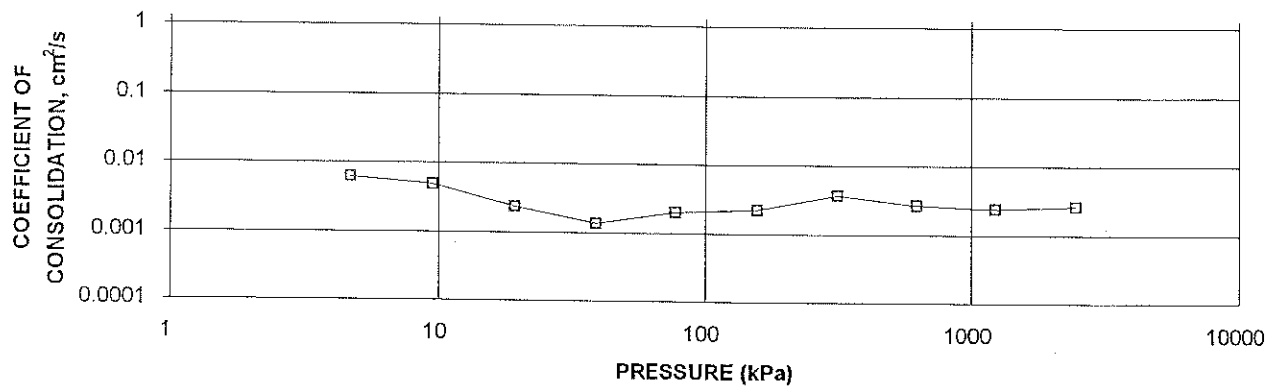
k calculated using cv based on  $\bar{\sigma}_0$  values.

## SAMPLE DIMENSIONS AND PROPERTIES - FINAL

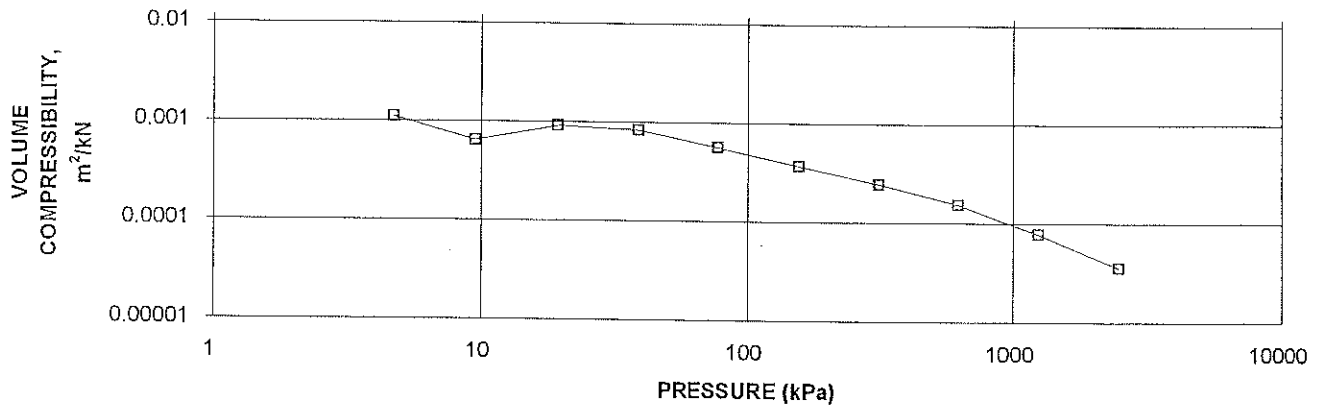
Sample Height, cm	1.55	Unit Weight, kN/m <sup>3</sup>	19.35
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m <sup>3</sup>	14.78
Area, cm <sup>2</sup>	31.67	Specific Gravity, measured	2.78
Volume, cm <sup>3</sup>	49.02	Solids Height, cm	0.840
Water Content, %	30.86	Volume of Solids, cm <sup>3</sup>	26.59
Wet Mass, g	96.72	Volume of Voids, cm <sup>3</sup>	22.44
Dry Mass, g	73.91		

# OEDOMETER CONSOLIDATION SUMMARY

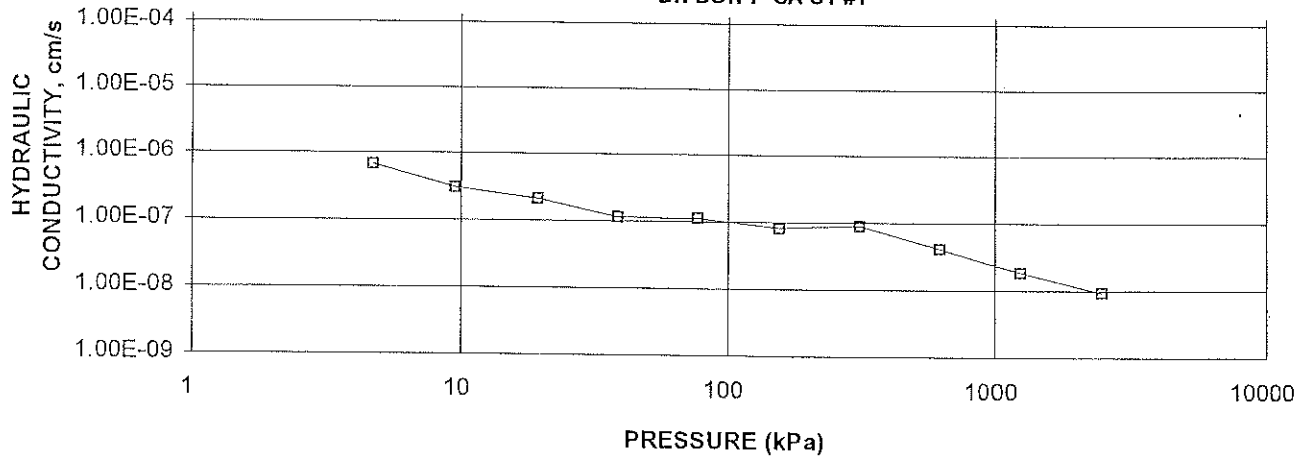
CONSOLIDATION TEST  
CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
BH BON 7 SA ST #1



CONSOLIDATION TEST  
MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
BH BON 7 SA ST #1



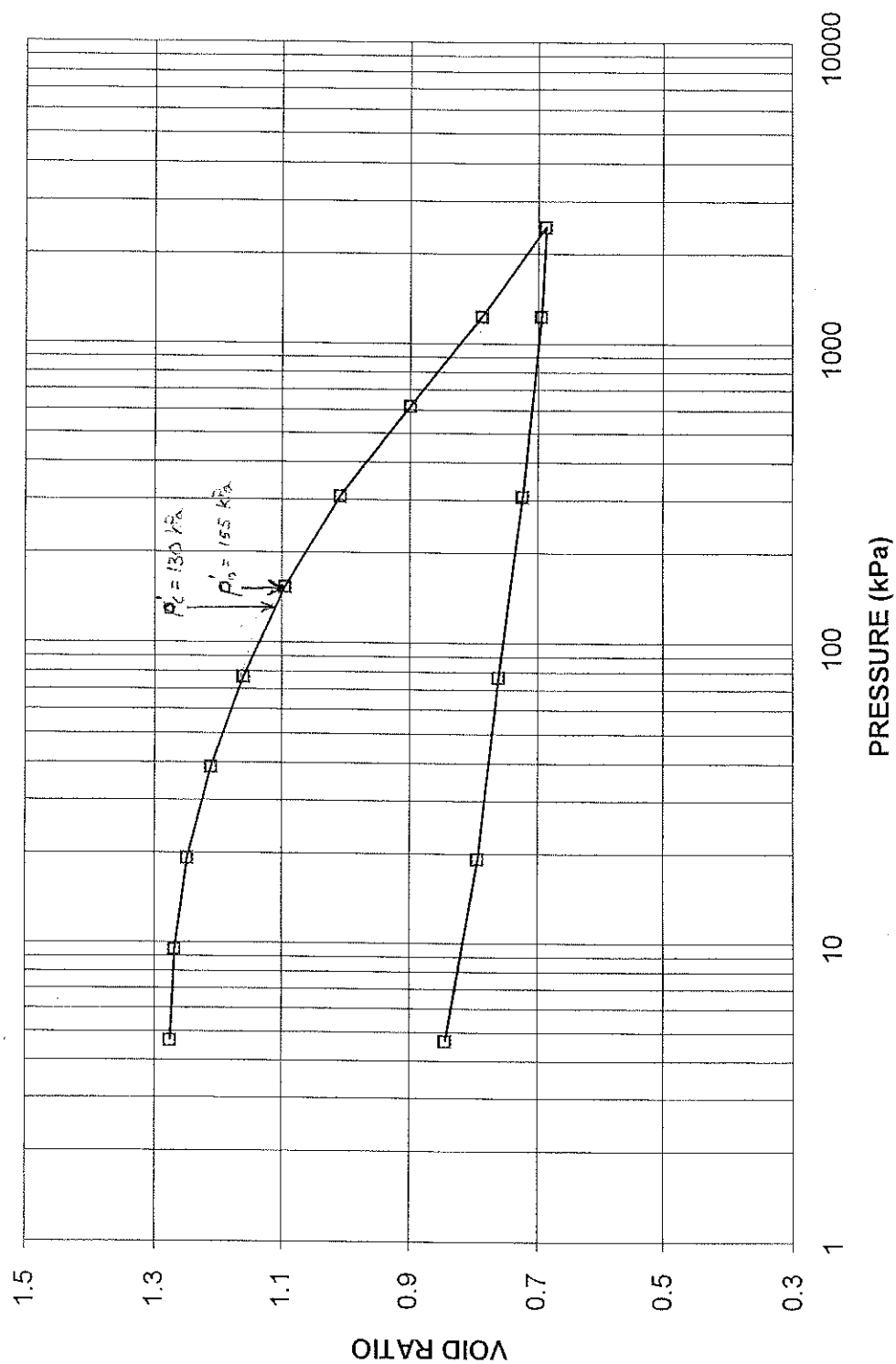
CONSOLIDATION TEST  
HYDRAULIC CONDUCTIVITY vs PRESSURE  
BH BON 7 SA ST #1



# CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE

FIGURE D6

CONSOLIDATION TEST  
VOID RATIO vs. PRESSURE  
BH BON 7 SA ST #1







**Appendix E.**  
**Site Photographs**





**Photo 1. Looking west towards Bonnechere River from below proposed east abutment. (2020/08/28)**



**Photo 2. Looking west from lowland flood plain on east bank of Bonnechere River, near Borehole BON-P2. (2021/11/15)**





**Photo 3. Looking west from near existing west abutment, showing approximate locations of Boreholes BON-P2 and BON-P3. (2021/11/08)**



**Photo 4. Looking east from below existing west abutment. (2019/09/24)**





**Photo 5. Looking east toward east abutment, showing approximate location of Borehole BON-19-4. (2020/09/04)**



**Photo 6. Looking east toward east approach cut section. (2019/09/24)**