



**THURBER** ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT  
REPLACEMENT OF STRUCTURAL CULVERT No. 29-249/C1  
LOCHA CREEK CULVERT CROSSING OF HIGHWAY 17  
TOWNSHIP OF McNAB/BRAESIDE, ON  
G.W.P. 4061-17-00  
AGREEMENT NUMBER: 4016-E-0014**

**GEOCRES NUMBER: 31F-205**

**SUBMITTED TO  
McINTOSH PERRY CONSULTING ENGINEERS**

**LOCATION:  
LATITUDE: 45.44406°  
LONGITUDE: -76.53489°**

**March 2019  
20482**

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**PART 1: FACTUAL INFORMATION**

## **1 INTRODUCTION**

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) at the Locha Creek Culvert site located on Highway 17, within the Township of McNab/Breaside, in Renfrew County Ontario. Thurber carried out the investigation as a subconsultant to McIntosh Perry Consulting Engineers (MPCE) as part of Agreement No. 4016-E-0014.

A base plan, Preliminary General Arrangement (GA) and construction staging drawings were provided by MPCE for the preparation of this report. A copy of the GA Drawing is provided in Appendix A.

No previous foundation reports were available for this site.

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

## **2 SITE DESCRIPTION**

Culvert 29-249/C1 is located at approximately Station 15+692 on Highway 17, approximately 170 m west of the intersection with Miller Road (northbound) / Anderson Road (southbound), in Renfrew County, Ontario. The location of the culvert is shown on the Key Plan on Drawing No. 1 in Appendix A.

It is noted that for project orientation purposes, Highway 17 within the project limits, will be assumed to run east-west. Flow through the culvert is from south to north.

In the vicinity of the culvert site, Highway 17 is an undivided highway with one through lane in each direction. An eastbound righthand turn taper is also present at the culvert crossing. Based on the drawing provided, the driving lanes are 3.7 m wide and the turn taper has a maximum width of 3.5 m. A steel cable guide rail is present along the south side of the highway.

The existing 48 m long corrugated steel sectional plate arch culvert is 4.8 m wide and 3.0 m high. The existing Highway 17 embankment slopes are graded at 2H:1V (Horizontal:Vertical) and 3H:1V at the inlet and outlet respectively. The slopes are covered with grass and brush. The June 2018 GA drawing indicates that the top of pavement at the centreline of Highway 17 above the culvert alignment is at elevation 138.9 m. The cover over the existing culvert from shoulder to the top of the culvert is approximately 4.5 m. Rip-rap is present on the side slopes surrounding both

the inlet and outlet. No signs of settlement or erosion of the existing embankment slopes were noted at the time of the investigation. Storm water drainage in the area is to ditches and Locha Creek.

The site is located within a physiographic region known as the Ottawa Valley Clay Plains which is characterized by clay plains interrupted by ridges of rock or sand.

The lands surrounding the project limits are gently rolling with a mixture of wooded areas and open fields. There is a strip of flat land, covered with grass and brush, that curves out from Highway 17 toward Miller Road to the northwest, suggesting a possible former road alignment. A buried Enbridge natural gas pipeline is present to the north and east of the existing culvert running parallel to Miller Road.

Site photographs showing the general conditions at the site, along the existing highway embankment and at the inlet and outlet and along the proposed culvert alignment are presented in Appendix D.

### 3 SITE INVESTIGATION AND FIELD TESTING

A field investigation was carried out between September 11<sup>th</sup> and 25<sup>th</sup>, 2017, based on the initial plans for the replacement of the culvert on the same alignment with a culvert of similar length. The investigation included advancing seven boreholes (Boreholes 17-1 through 17-7). Borehole 17-4 was advanced beyond the planned drilling/sampling depth by advancing a dynamic cone penetration test.

Based on the design development and results of the initial (2017) investigation, a supplemental investigation was carried out in 2018 for a potentially longer culvert that would extend beneath the future 4-laning of Highway 17 (to be constructed to the north of the existing Highway 17 alignment).

The 2018 field investigation was carried out between June 11<sup>th</sup> and June 15<sup>th</sup>, 2018, and included advancing three additional boreholes (18-101 through 18-103).

The approximate MTM Zone 9 locations and ground surface elevations of the boreholes are indicated on Drawing No. 1, provided in Appendix A and are summarized in Table 3-1. The borehole elevations were surveyed relative to HPC 152 which was identified on the base plans as having a geodetic elevation of 139.100 m. The survey was completed with a Nikon-AP-8 automatic level with an instrument accuracy of +/-1.5 mm. The reported elevations are considered accurate within 0.1 m.

**Table 3-1: Borehole Summary**

Borehole	Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Borehole Termination Elevation (m)
17-1	Existing Inlet/Cofferdam	5033771.3	302079.3	131.9	121.2
17-2	Existing Inlet/Cofferdam	5033773.2	302072.3	131.9	119.8
17-3	Highway 17 Eastbound	5033789.1	302072.6	138.9	120.0
17-4	Highway 17 Westbound	5033794.5	302085.7	138.8	119.9* 107.7**
17-5	Existing Outlet/Cofferdam	5033825.9	302077.5	133.8	122.5



<b>Borehole</b>	<b>Location</b>	<b>Northing (m)</b>	<b>Easting (m)</b>	<b>Ground Surface Elevation (m)</b>	<b>Borehole Termination Elevation (m)</b>
17-6	Existing Outlet/Cofferdam	5033825.8	302089.1	132.7	119.9
17-7	Embankment Widening	5033821.8	302109.2	134.3	121.5
18-101	Proposed Outlet	5033858.0	302096.9	132.5	100.3
18-102	Culvert	5033812.3	302076.5	137.7	104.7
18-103	Proposed Inlet	5033766.1	302084.0	133.9	105.5

NOTES: \* – Termination of Sampled Borehole  
\*\* – DCPT refusal

As a component of our standard procedures and due diligence, Thurber contacted Ontario One Call to provide utility locates/clearances for the borehole locations.

The boreholes completed during the 2017 field investigation were advanced using a CME75 truck mounted drill rig for the roadway embankment boreholes, and portable drilling equipment using a full weight hammer and tripod for the inlet and outlet boreholes. The boreholes completed during the 2018 field investigation were advanced using a CME45C track mounted drill rig equipped with NQ size coring equipment.

The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. Split spoon samples were collected at regular depth intervals in all boreholes during the completion of Standard Penetration Tests (SPT), following the methods described in ASTM Standard D1586-11. Thin-walled tube samples (Shelby tube samples) were collected in the cohesive deposits in Boreholes 17-2, 17-3, and 18-101 through 18-103. In-situ shear vane testing was carried out within the cohesive strata. All soil samples recovered from the boreholes were placed in moisture-proof containers and the samples were transported to Thurber's Ottawa geotechnical laboratory for further examination and testing. Bedrock was cored with NQ size coring equipment, following ASTM Standard D6032-08, in Boreholes 18-101 through 18-103. Bedrock core samples were stored in wooden core boxes for transport.

A 25 mm inside diameter PVC piezometer was installed in Boreholes 17-5 and 18-102 to allow for measurement of the groundwater level at the site. Piezometer construction details are illustrated on the Record of Borehole sheets for Boreholes 17-5 and 18-102, provided in Appendix B. The piezometers were decommissioned in accordance with Ontario MOE Regulation 903, as amended, after taking the final groundwater measurement.

The boreholes without a piezometer were backfilled with a low-permeability combination of auger cuttings and bentonite pellets in accordance with Ontario MOE Regulation 903, as amended. Boreholes advanced within paved areas were capped with 150 mm of cold patch asphalt.

The as-drilled locations of the boreholes and ground surface elevations at the borehole locations were surveyed by Thurber. The vertical datum used was Horizontal Control Point (HCP) 152, located in the westbound shoulder to the west of the culvert at approximate Station 15+555. Data provided by MPCE indicated that HCP 152 has a geodetic elevation of 139.100 m.

## **4 LABORATORY TESTING**

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all soil samples. Grain size distribution analyses and Atterberg Limits testing were carried out on selected samples to MTO and ASTM standards. One dimensional consolidation tests were carried out on four thin-walled tube samples. All recovered bedrock core was logged and core recoveries and Rock Quality Designation (RQD) values were determined. Unconfined compressive strength testing was carried out on select samples of the recovered bedrock.

The geotechnical laboratory test results are presented on the Record of Borehole sheets in Appendix B and are illustrated on the figures in Appendix C.

Chemical analysis for determination of pH, resistivity, soluble sulphate, sulphides, conductivity, and chloride concentrations was carried out on three samples of the soil recovered during the field investigations. Copies of the chemical analysis results are provided in Appendix C.

## **5 DESCRIPTION OF SUBSURFACE CONDITIONS**

### **5.1 Overview / General**

Reference is made to the Record of Borehole sheets in Appendix B for details of the soil stratigraphy encountered in the boreholes. A stratigraphic profile for the proposed culvert alignment is presented on Drawing No. 1 in Appendix A for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the Record of Boreholes governs any interpretation of the site conditions.

For reference, the stratigraphy in the area of the boreholes is characterized by embankment fill, overlying a deep clay deposit, over a thin glacial till deposit over marble bedrock. Relatively thin deposits of silty sand, sandy silt, organic silt with sand, sandy clay and silty clayey sand were encountered above the clay or between the fill and clay deposits at some borehole locations.

More detailed descriptions of the individual strata are presented below.

### **5.2 Surface Cover**

Boreholes 17-3 and 17-4 were advanced through the Highway 17 lane or shoulder pavement structure. The thickness of the asphalt at the borehole locations was 170 mm and 290 mm.

A 50 mm thick layer of rootmat/topsoil was observed at the surface of Borehole 18-103.

### **5.3 Embankment Fill**

#### **Sand with Gravel to Silty Sand: FILL**

A fill layer consisting predominantly of sand with varying amounts of gravel and silt was encountered below the asphalt layer of Boreholes 17-3 and 17-4. The top of this layer was encountered at elevations 138.7 m and 138.5 m, and the layer had a thickness 1.2 m in both Boreholes 17-3 and 17-4 respectively. The SPT N values ranged from 6 to 49, indicating a loose to dense condition; but typically compact.

The moisture content of the samples tested ranged from 4% to 20%. The results of a grain size analysis test conducted on a sample of this material indicated a gravel content of 6%, a sand content of 80%, and a fines content (combined silt and clay size particles) of 14%. Grain size analysis results are illustrated on Figure 1 in Appendix C.

### **Sand /Silty Sand: FILL**

A fill layer was encountered beneath the pavement structure in Boreholes 17-3 and 17-4, below the surface cover in Borehole 18-103, and at the ground surface in Boreholes 17-5, 17-6, 17-7, and 18-102. The fill layer consisted mainly of sand to silty sand, however, the deposit also contained layers or pockets of sandy silt, sandy clay and silty clay, as well as trace amounts of organic material. Cobbles and boulders were encountered within the fill in Borehole 17-4 and may be present at other locations. The top of this fill deposit ranges from elevation 132.7 m to 137.7 m. The thickness of the layer ranged from 0.8 m to 5.5 m. The SPT N values ranged from 2 to 54, indicating a very loose to very dense condition; but typically loose to compact.

The moisture content of the samples tested ranged from 3% to 54%. The results of grain size analysis tests conducted on samples of this material indicated a gravel content ranging from 1% to 25%, a sand content ranging from 69% to 87%, and a fines content ranging from 3% to 12%. Grain size analysis results are illustrated on Figure 2 in Appendix C.

### **5.4 Silty Sand (SM) to Sandy Silt (ML)**

A stratum of silt and sand was encountered at the ground surface of Boreholes 17-1, and 17-2, beneath the sandy clay in Boreholes 17-3 and 18-101, and beneath the fill in Borehole 17-5. Organic material was noted in this stratum. The top of this layer was encountered at elevations ranging from 131.3 m to 131.9 m. The thickness of the layer ranged from 0.5 m to 2.2 m. The SPT N values ranged from 2 to 8; indicating a very loose to loose condition.

The moisture content of the samples tested ranged from 32% to 51%. The results of grain size analysis tests conducted on samples of this material indicated a gravel content of 0% and 10%, a sand content ranging from 19% to 91% and a fines content ranging from 9% to 81%. Grain size analysis results are illustrated on Figure 3 in Appendix C.

The results of Atterberg Limits testing completed on a sample of the fines of this material indicated a non-plastic silt.

### **5.5 Organic Silt (OL) with Sand**

A layer of organic silt with sand was encountered below the sand with silt layer in Boreholes 17-1, and 17-2. The top of this layer was encountered at elevations 130.7 m and 131.1 m, and the layer had a thickness of 0.8 m and 1.0 m in Boreholes 17-1 and 17-2 respectively. The SPT N value was 1, indicating a very loose condition.

The moisture content of the samples tested were 98% and 133%. The results of a grain size analysis test conducted on a sample of this material indicated a gravel content of 0%, a sand content of 39% and a silt content of 30% and a clay content of 31%. Grain size analysis results are illustrated on Figure 4 in Appendix C.

The results of Atterberg Limits testing completed on a sample of this material indicated a non-plastic silt.

## **5.6 Sandy Clay (CL/CI) to Silty Clayey Sand (SC-SM)**

A deposit that ranged from sandy clay to silty clayey sand was encountered in Boreholes 17-2, 17-3, 17-4, 18-101, 18-102 and 18-103. Occasional sand seams and organic matter were noted within this deposit at some borehole locations. The top of this layer ranges from elevation 130.1 m to 132.7 m. The thickness of the layer ranges from 0.5 m to 2.1 m. The SPT N values ranged from 1 to 14 indicating a very soft to very stiff consistency.

The moisture content of the samples tested ranged from 18% to 62%. The results of grain size analysis tests conducted on samples of this material indicated a gravel content ranging from 0% to 3%, a sand content ranging from 33% to 57%, a silt content ranging from 18% to 34% and a clay content ranging from 22% to 33%. Grain size analysis results are illustrated on Figure 5 in Appendix C.

The results of Atterberg Limits testing completed on samples of this material indicated a liquid limit ranging from 19 to 37, a plastic limit ranging from 13 to 22, and a plasticity index ranging from 6 to 17. Atterberg Limits analysis results are illustrated on Figure 6 in Appendix C and indicate a clay of low to intermediate plasticity (CL to CI). The results of the Atterberg Limits testing on the fines of the material with 40% fines indicated that the fines consisted of silty clay (CL-ML) resulting in an overall description of silty clayey sand (SC-SM).

## **5.7 Clay (CL to CH)**

Underneath the above soil layers, a clay deposit was encountered in all boreholes. The top of clay layer ranges from elevation 129.1 m to 133.5 m. The thickness of this layer, where fully penetrated, ranged from 18.6 m to 23.6 m. Borehole 17-4, was extended beyond sampling limits by DCPT with refusal encountered at elevation 107.7 m, suggesting a clay thickness of approximately 23.5 m. All boreholes from the 2017 investigation were terminated in this layer. In-situ shear vane test results indicated undrained shear strengths ranging from 25 kPa to greater than 100 kPa; indicating a firm to very stiff consistency, but typically firm to stiff. The measured sensitivity of the deposit ranged from 1.5 to 32; indicating a low sensitivity to quick clay deposit, but typically low sensitive to sensitive.

The moisture content of the samples tested ranged from 24% to 55%. The results of grain size analysis tests conducted on samples of this material indicated a gravel content ranging from 0% to 7%, a sand content ranging from 0% to 22%, a silt content ranging from 35% to 57% and a clay content ranging from 30% to 65%. Grain size analysis results are illustrated on Figures 7 to 10 in Appendix C.

The results of Atterberg Limits testing completed on samples of this material indicated a liquid limit ranging from 22 to 56, a plastic limit ranging from 13 to 27, and a plasticity index ranging from 8 to 33. The liquidity index ranged from 0.4 to 35; typically between 1.0 and 2.3. Atterberg Limits analysis results are illustrated on Figures 11 to 14 in Appendix C, and indicate a clay of low to high plasticity (CL to CH); but typically low to intermediate plasticity (CL to CI).

The results of laboratory oedometer (one-dimensional consolidation) tests carried out on four undisturbed clay sample are summarized in Table 5-1.

**Table 5-1: Consolidation Test Results**

Parameter	Value			
	17-2	17-3	18-101	18-101
Borehole	17-2	17-3	18-101	18-101
Sample	ST9	ST17	ST5	ST9
Sample Depth, (m)	10.2	15.6	4.9	11
Sample Elevation, (m)	121.7	123.3	127.7	121.5
Estimated Existing Effective Stress, ( $P_0$ ), (kPa)	83	193	37	85
Moisture Content, (%)	45	49	43	45
Unit Weight, ( $\gamma$ ) (kN/m <sup>3</sup> )	17.5	16.8	17.5	17.6
Specific Gravity ( $G_s$ )	2.746	2.746	2.750	2.750
Initial Void Ratio ( $e_0$ )	1.229	1.383	1.197	1.211
Pre-consolidation Pressure ( $P'_c$ ), (kPa)	210	200	285	185
Compression Index ( $C_c$ )	0.654	0.746	0.475	0.648
Recompression Index ( $C_r$ )	0.054	0.080	0.023	0.017
Overconsolidation Ratio (OCR)	2.5	1.0	7.7	2.2

It is noted that Borehole 17-3 was drilled through the existing Highway 17 embankment, resulting in the higher existing effective stress and lower OCR. A summary of the clay properties with depth are presented in Appendix F.

## 5.8 Silty Clayey Sand (SC-SM) with Gravel to Sandy Silty Clay: Till

A glacial till deposit ranging from silty clayey sand with gravel to sandy silty clay was encountered beneath the clay in Boreholes 18-101 through 18-103. The top of this layer ranges from elevation 107.8 m to 111.2 m. The thickness of the layer ranges from 1.4 m to 3.8 m. The SPT N values ranged from 7 to 45; indicating a loose to dense condition. It should be noted that artesian conditions were noted in this layer which may have decreased these values.

Occasional cobbles and boulders were noted within the glacial till, particularly within the lower portion of this layer and coring techniques were required to penetrate the layer.

The moisture content of the samples tested ranged from 17% to 36%. The results of grain size analysis tests conducted on two samples of this material indicated a gravel content of 3% and 11%, a sand content of 37% and 75% and a fines content of 14% and 60%. Grain size analysis results are illustrated on Figure 15 in Appendix C.

The results of Atterberg Limits testing completed on the material with 60% fines indicated that the fines consisted of silty clay (CL-ML). Atterberg Limits analysis results are illustrated on Figures 16 in Appendix C.

## 5.9 Marble Bedrock

The overburden materials were underlain by a grey to white marble bedrock. All three boreholes from the 2018 investigation were advanced into bedrock by coring with NQ-size coring equipment.

A summary of the bedrock surface elevation is provided in Table 5-2.

**Table 5-2: Bedrock Summary**

Borehole	Location	Ground Surface Elevation (m)	Top of Bedrock Elevation (m)
18-101	Proposed culvert outlet (North end)	132.5	104.0
18-102	Mid-point of proposed culvert alignment	137.7	107.9
18-103	Proposed Inlet (South end)	133.9	109.3

The total core recovery ranged from 92% to 100%, the solid core recovery ranged from 30% to 100% and the RQD ranged from 20% to 100%. Unconfined compressive strength testing was carried out on three samples of the bedrock; (see results in Appendix C). The results ranged from 127 MPa to 165 MPa. Photographs of the bedrock core are presented in Appendix C.

Based on the RQD value the bedrock is classified as very poor to excellent quality; but typically fair. Based on unconfined compressive strength testing the bedrock is very strong.

### 5.10 Groundwater Conditions

The water level in Locha Creek was measured at an approximate elevation of 132.1 m on June 16, 2018. The groundwater level in the area of the culvert is expected to reflect the creek water level.

Piezometers were installed at the site in Boreholes 17-5 and 18-102. A summary of the measured water levels are provided in Table 5-3 below.

**Table 5-3: Summary of Groundwater Conditions**

Borehole	Screened Material	Depth (mbgs)	Groundwater Elevation (m)	Date of Measurement
17-5	Fill	1.1	132.7	October 6, 2017
18-102	Clay	5.9	131.8	June 15, 2018

Artesian conditions were noted at the site upon completion of drilling in Boreholes 18-101, 18-102 and 18-103. It is suspected that the artesian condition originates from the glacial till layer which is overlain by between 18.6 m (Borehole 18-103) and 23.6 m (Borehole 18-101) of clay. The non-stabilized artesian levels were measured in the drill casing and are presented in Table 5-4. The artesian flow was sealed at the source with a combination of bentonite and clay spoils while decommissioning the boreholes.

**Table 5-4: Summary of Artesian Groundwater Conditions**

Borehole	Screened Material	Depth (mbgs)	Groundwater Elevation (m)	Date of Measurement
18-101	Till	-3.0*	135.5	June 12, 2018
18-102	Till	-0.5*	138.2	June 13, 2018
18-103	Till	-2.4*	138.2	June 15, 2018

\* Negative values denote measurements above the ground surface

All observations are considered short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

## 5.11 Analytical Test Results

Samples of the native soils were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate, sulphides, chloride concentrations, resistivity and electrical conductivity. The analysis results are summarized in Table 5-3. Copies of the test results are provided in Appendix C.

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

Sample	Depth (m)	pH	Resistivity (Ohm-cm)	Chloride (µg/g)	Sulphate (µg/g)	Sulphide (%)	Conductivity uS/cm
17-1 SS5	3.5	7.72	1730	174	69	-	-
17-6 SS4	2.6	7.90	849	741	16	-	-
18-101 SS2B	1.2	7.32	7280	18	20	< 0.02	137



## 6 MISCELLANEOUS

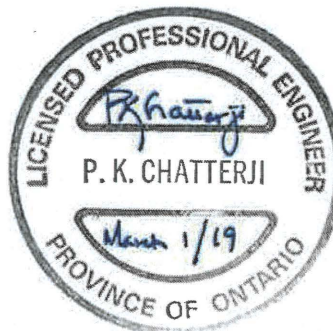
Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Thurber surveyed the borehole locations and determined the ground surface elevations based on construction drawings provided by McIntosh Perry Consulting Engineers. George Downing Estate Drilling Ltd. and Forage M3 Drilling Services Inc., both of Hawkesbury, Ontario supplied and operated the drilling equipment to carry out the drilling, sampling, and in-situ testing. The drilling, and sampling operations in the field were supervised on a full-time basis by Katya Edney, P.Eng. and Christopher Murray, P.Eng. of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory in Ottawa. Unconfined Compressive Strength Testing of the bedrock and oedometer testing was carried out by Stantec Consulting Ltd. in its MTO-approved laboratory in Ottawa.

Overall project management and direction of the field program was provided by Paul Carnaffan, P.Eng. Interpretation of the field data and preparation of this report was completed by Kenton Power, P.Eng. The report was reviewed by Paul Carnaffan, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.  
Report Prepared By:



Paul Carnaffan, P.Eng.  
Principal, Senior Geotechnical Engineer



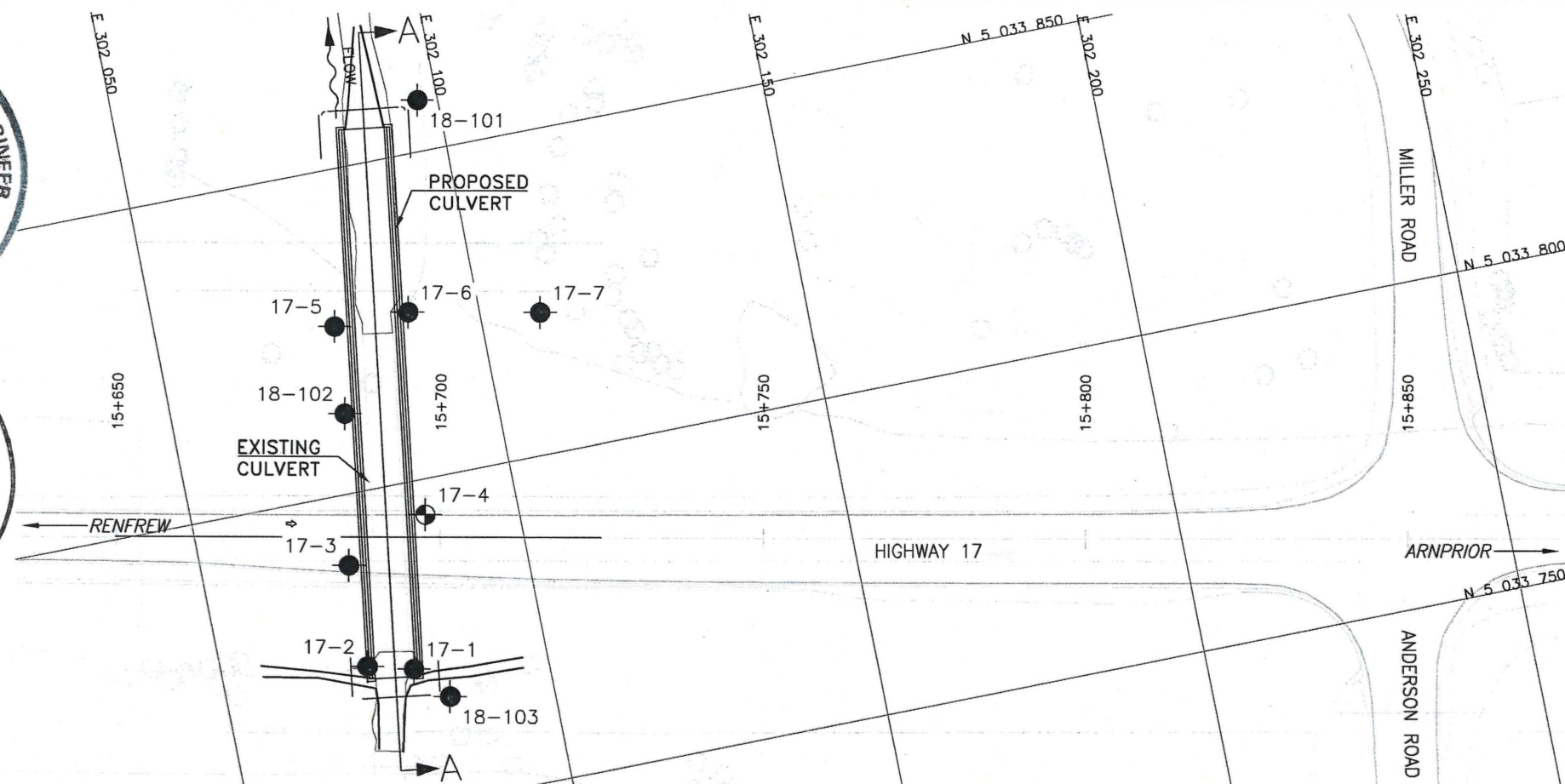
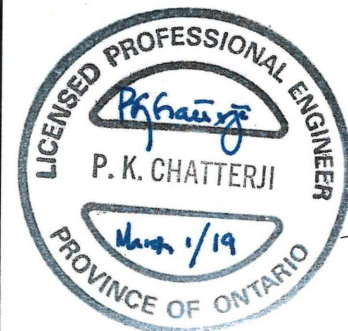
P.K. Chatterji, P.Eng.  
Review Principal, Designated MTO Contact



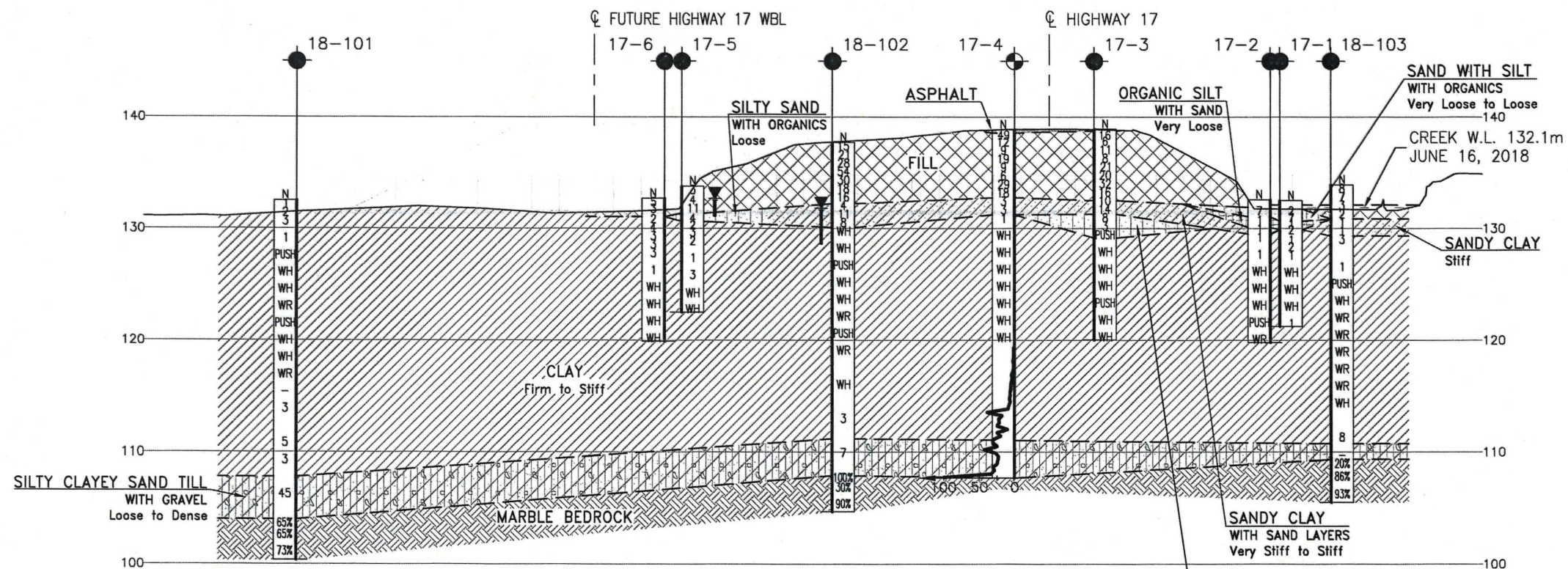
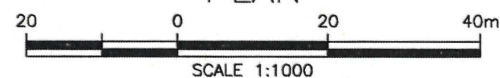
## **APPENDIX A**

### **BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS**

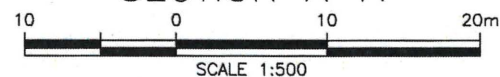




PLAN



SECTION A-A



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

CONT No  
GWP No 4232-15-00

HIGHWAY 17  
LOCHA CREEK CULVERT  
REPLACEMENT  
BOREHOLE LOCATIONS AND SOIL STRATA

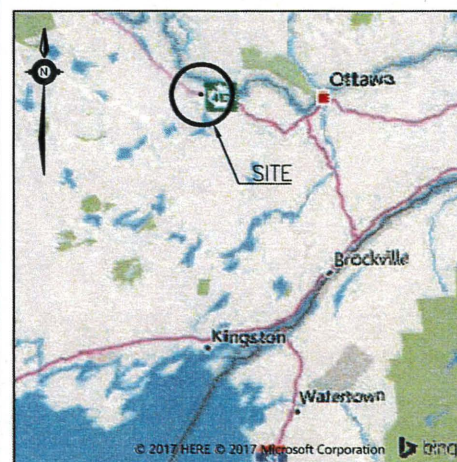


SHEET

McINTOSH PERRY



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

•	Borehole
•	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
W	Water Level
W	Head Artesian Water
W	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
17-1	132.5	5 033 771.3	302 079.3
17-2	132.6	5 033 773.2	302 072.3
17-3	138.9	5 033 789.1	302 072.6
17-4	138.8	5 033 794.5	302 085.7
17-5	133.8	5 033 825.9	302 077.5
17-6	132.7	5 033 825.8	302 089.1
17-7	134.3	5 033 821.8	302 109.2
18-101	132.5	5 033 858.0	302 096.9
18-102	137.7	5 033 812.3	302 076.5
18-103	133.9	5 033 766.1	302 084.0

## -NOTES-

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

GEOCRES No.

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	KP	CHK -	CODE
DRAWN	MFA	CHK KP	SITE
			STRUCT
			DWG 1



**APPENDIX B**  
**RECORD OF BOREHOLE SHEETS**



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

### TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

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

### TERMINOLOGY DESCRIBING SOIL STRUCTURE:

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

### RECOVERY:

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

### N-VALUE:

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

### DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.



### STRATA PLOT:

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



Boulders  
Cobbles  
Gravel      Sand      Silt      Clay      Organics      Asphalt      Concrete      Fill      Bedrock

### TEXTURING CLASSIFICATION OF SOILS

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

### TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

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

### SAMPLE TYPES

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

### TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

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

### MODIFIED UNIFIED SOIL CLASSIFICATION

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

Note -  $W_L$  = Liquid Limit



## EXPLANATION OF ROCK LOGGING TERMS

### ROCK WEATHERING CLASSIFICATION

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

### TERMS

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

### DISCONTINUITY SPACING

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

### STRENGTH CLASSIFICATION

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

# RECORD OF BOREHOLE No 17-1

1 OF 2

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.443868°, Long: -76.5347792°  
MTO Zone 9: N 5 033 771.3 E 302 079.3 ORIGINATED BY KE  
HWY 17 BOREHOLE TYPE Portable / NW Casing COMPILED BY DJP  
DATUM Geodetic DATE 2017.09.22 - 2017.09.22 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE							
								● QUICK TRIAXIAL	× LAB VANE							
132.5	Top of Drilling Platform						20 40 60 80 100				20 40 60	kN/m <sup>3</sup>	GR SA SI CL			
0.0																
132.0																
131.5	Water															
0.6	SAND with silt - with organic matter Very loose to loose Brown to grey		1	SS	2									10 81 9 (SI+CL)		
			2	SS	7											
130.7																
1.8	Organic SILT (OL) with sand Very loose Grey		3	SS	1											
129.9			4	SS	2											
2.6	CLAY (Cl) Stiff to firm Grey															
			5	SS	1											
			6	SS	2									0 1 43 56		
			7	SS	1											
			8	SS	WH											
			9	SS	WH											
	- becomes firm below 8.5 m															
			10	SS	WH											

Continued Next Page

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



# RECORD OF BOREHOLE No 17-1

2 OF 2

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.443868°, Long: -76.5347792° MTO Zone 9: N 5 033 771.3 E 302 079.3 ORIGINATED BY KE  
 HWY 17 BOREHOLE TYPE Portable / NW Casing COMPILED BY DJP  
 DATUM Geodetic DATE 2017.09.22 - 2017.09.22 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT  W P	NATURAL MOISTURE CONTENT  W	LIQUID LIMIT  W L	UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									WATER CONTENT (%)
	Continued From Previous Page							20	40	60	80	100					
							122		2.4 +								
121.2	CLAY (Cl) Firm Grey		11	SS	1												0 0 50 50
11.3	End of Borehole																

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

20  
15  
10

(%) STRAIN AT FAILURE

## 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			20 40 60 80 100	W P W L	WATER CONTENT (%)			
132.6 0.0	Top of Drilling Platform												
132.0 0.7	WATER												
131.1 1.5	SAND with silt - with organic matter Loose Brown to grey		1	SS	7								
130.1 2.5	Organic SILT (OL) with sand Very loose Grey		2	SS	1								
129.6 3.0	SANDY CLAY (CI) - with wood pieces Stiff Grey		3	SS	1								
	CLAY (CI) - with silt seams Stiff to firm Grey		4	SS	1								
			5	SS	1								
			6	SS	WH								
			7	SS	WH								
	- becomes firm below 8.2 m		8	SS	WH								

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

DOUBLE LINE LOCHA CREEK REPLACEMENT.GPJ 2012TEMPLATE(MTO).GDT 5/2/19

# RECORD OF BOREHOLE No 17-2

2 OF 2

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.443885°, Long: -76.5348687° MTO Zone 9: N 5 033 773.2 E 302 072.3 ORIGINATED BY KE  
 HWY 17 BOREHOLE TYPE Portable / NW Casing COMPILED BY DJP  
 DATUM Geodetic DATE 2017.09.25 - 2017.09.25 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE      LIQUID 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			SHEAR STRENGTH kPa				W P      W      W L				
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE				WATER CONTENT (%)				
	Continued From Previous Page							20	40	60	80	100	20	40	60	
119.8  <																

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

# RECORD OF BOREHOLE No 17-3

1 OF 2

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4440281° Long: -76.5348649° MTO Zone 9: N 5 033 789.1 E 302 072.6 ORIGINATED BY CAM  
 HWY 17 BOREHOLE TYPE HSA COMPILED BY KP  
 DATUM Geodetic DATE 2017.09.11 - 2017.09.12 CHECKED BY PC

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						
								○ UNCONFINED 20 40 60 80 100	+ FIELD VANE	× LAB VANE				
								WATER CONTENT (%)						
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W <sub>p</sub> W W <sub>L</sub>						
138.9														
0.0	170 mm ASPHALT													
0.2	Silty sand with gravel to silty sand trace gravel Compact to loose Brown FILL		1	SS	16									
			2	SS	6									
137.5														
1.4	Silty clay Stiff Grey FILL		3	SS	11									
136.6														
2.3	Silty sand Loose Brown FILL		4	SS	8									
136.2														
2.7														
135.9	Silty clay Stiff Grey FILL		5	SS	21									
3.0														
	Silty sand, with clay seams Compact to dense Brown FILL		6	SS	20									
			7	SS	32									
			8	SS	16									
132.5			9	SS	10									
6.4	SANDY CLAY (CI) - occasional sand seams Very Stiff Grey		10	SS	14									
131.3														
7.6	SAND with silt to SILT with sand Very loose to loose Grey		11	SS	8									
			12	SS	3									
			13	ST	PUSH									
129.1														
9.8	CLAY (CI to CL)													

Continued Next Page

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

# RECORD OF BOREHOLE No 17-3

2 OF 2

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4440281° Long: -76.5348649° MTO Zone 9: N 5 033 789.1 E 302 072.6 ORIGINATED BY CAM  
 HWY 17 BOREHOLE TYPE HSA COMPILED BY KP  
 DATUM Geodetic DATE 2017.09.11 - 2017.09.12 CHECKED BY PC

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					
								○ UNCONFINED + FIELD VANE					
								● QUICK TRIAXIAL × LAB VANE					
Continued From Previous Page							WATER CONTENT (%)						
	CLAY (Cl to CL) Stiff to firm Grey  - becomes firm below 13.4 m												
			14	SS	WH		128						
							127						
			15	SS	WH		126						0 1 48 51
							125						
			16	SS	WH		124						
							123						
			17	ST	PUSH		122						
							121						
			18	SS	WH								
			19	SS	WH								0 0 55 45
120.0													
18.9	End of Borehole												

DOUBLE LINE LOCHA CREEK REPLACEMENT.GPJ 2012TEMPLATE(MTO).GDT 5/2/19

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

# RECORD OF BOREHOLE No 17-4

1 OF 4

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4440768°, Long: -76.5346975°  
MTO Zone 9: N 5 033 794.5 E 302 085.7 ORIGINATED BY KE  
HWY 17 BOREHOLE TYPE HSA COMPILED BY KP  
DATUM Geodetic DATE 2017.09.11 - 2017.09.11 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								WATER CONTENT (%)					
138.8													
0.0	290 mm ASPHALT												
138.5													
0.3	Sand with gravel Dense Brown		1	SS	49								
138.0													
0.8	FILL												
	Silty sand Compact Brown		2	SS	12								
137.3													
1.5	FILL												
	Sandy silt Loose Brown		3	SS	9								
136.7													
2.1	FILL												
	Silty clay Stiff Grey		4	SS	19								
136.2													
2.6	FILL												
	Sand with silt, some gravel Loose to compact Brown		5	SS	9								
			6	SS	6								
	- cobbles and boulders from 4.5 m to 6.1 m		7	SS	29								
			8	SS	18								
132.7													
6.1	SANDY CLAY (Cl) - frequent sand layers Stiff Grey		9	SS	3								
			10	SS	3								
131.2													
7.6	CLAY (Cl to CL) Stiff Grey		11	SS	1								
			13	SS	WH								
	- vane attempted $S_u > 106$ kPa												

DOUBLE LINE LOCHA CREEK REPLACEMENT.GPJ 2012TEMPLATE(MTO).GDT 5/2/19

Continued Next Page

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

## METRIC

[illegible]

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

DOUBLE LINE LOCHA CREEK REPLACEMENT.GPJ 2012TEMPLATE(MTO).GDT 5/2/19

# RECORD OF BOREHOLE No 17-4

3 OF 4

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4440768° Long: -76.5346975° MTO Zone 9: N 5 033 794.5 E 302 085.7 ORIGINATED BY KE  
 HWY 17 BOREHOLE TYPE HSA COMPILED BY KP  
 DATUM Geodetic DATE 2017.09.11 - 2017.09.11 CHECKED BY PC

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>	20 40 60			
	Continued From Previous Page DCPT continued							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
							118							
							117							
							116							
							115							
							114							
							113							
							112							
							111							
							110							
							109							

Continued Next Page

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



# RECORD OF BOREHOLE No 17-4

4 OF 4

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4440768°, Long: -76.5346975° MTO Zone 9: N 5 033 794.5 E 302 085.7 ORIGINATED BY KE  
 HWY 17 BOREHOLE TYPE HSA COMPILED BY KP  
 DATUM Geodetic DATE 2017.09.11 - 2017.09.11 CHECKED BY PC

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								
	Continued From Previous Page												
107.7	DCPT continued						108						
31.1	DCPT refusal												

DOUBLE LINE LOCHA CREEK REPLACEMENT.GPJ 2012TEMPLATE(MTO).GDT 5/2/19

## METRIC

[illegible]

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

DOUBLE LINE LOCHA CREEK REPLACEMENT.GPJ 2012TEMPLATE(MTO).GDT 5/2/19

# RECORD OF BOREHOLE No 17-5

2 OF 2

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4443593° Long: -76.5348025° MTO Zone 9: N 5 033 825.9 E 302 077.5 ORIGINATED BY KE  
 HWY 17 BOREHOLE TYPE Portable / NW Casing COMPILED BY DJP  
 DATUM Geodetic DATE 2017.09.18 - 2017.09.19 CHECKED BY PC

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					
122.5	CLAY (C) Firm Grey		11	SS	WH		123										
11.3	End of Borehole WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2017.10.06 1.1 132.7																

# RECORD OF BOREHOLE No 17-6

1 OF 2

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4443584° Long: -76.5346542° MTO Zone 9: N 5 033 825.8 E 302 089.1 ORIGINATED BY KE  
HWY 17 BOREHOLE TYPE Portable / NW Casing COMPILED BY DJP  
DATUM Geodetic DATE 2017.09.19 - 2017.09.20 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			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				GR SA SI CL			
								20 40 60 80 100	20 40 60	20 40 60	20 40 60	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)						
132.7																			
0.0	Sand with gravel trace silt - occasional cobbles and boulders Loose to very loose FILL		1	SS	5												25 72 3 (SI+CL)		
131.5			2	SS	3														
1.2	Clayey silt with sand Very loose Grey brown FILL																		
131.0			3	SS	2														
1.7	CLAY (CH to CL) Stiff to firm Grey																		
			4	SS	4														
			5	SS	3												0 0 41 59		
			6	SS	3														
			7	SS	3														
			8	SS	1														
			9	SS	WH														
	- becomes firm below 8.5 m		10	SS	WH														

Continued Next Page

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

# RECORD OF BOREHOLE No 17-6

2 OF 2

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4443584° Long: -76.5346542° MTO Zone 9: N 5 033 825.8 E 302 089.1 ORIGINATED BY KE  
 HWY 17 BOREHOLE TYPE Portable / NW Casing COMPILED BY DJP  
 DATUM Geodetic DATE 2017.09.19 - 2017.09.20 CHECKED BY PC

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

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

# RECORD OF BOREHOLE No 17-7

1 OF 2

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4443225° Long: -76.5343972° MTO Zone 9: N 5 033 821.8 E 302 109.2 ORIGINATED BY KE  
 HWY 17 BOREHOLE TYPE Portable / NW Casing COMPILED BY DJP  
 DATUM Geodetic DATE 2017.09.20 - 2017.09.21 CHECKED BY PC

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						
134.3								20 40 60 80 100						
0.0	Silty sand with organics trace gravel Very loose Brown FILL		1	SS	2		134							
133.5			2	SS	5									
0.8	CLAY (CH to Cl) Very stiff to stiff Grey						133							
			3	SS	11									
			4	SS	7		132							
			5	SS	5		131							
			6	SS	5		130							
			7	SS	4		129							
							128							
	- becomes Clay (Cl) below 5.5 m		8	SS	1		127							
							126							
			9	SS	WH		125							
							</							

Continued Next Page

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

# RECORD OF BOREHOLE No 17-7

2 OF 2

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4443225° Long: -76.5343972° MTO Zone 9: N 5 033 821.8 E 302 109.2 ORIGINATED BY KE  
 HWY 17 BOREHOLE TYPE Portable / NW Casing COMPILED BY DJP  
 DATUM Geodetic DATE 2017.09.20 - 2017.09.21 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
	Continued From Previous Page							20 40 60 80 100							
121.5  <															

DOUBLE LINE LOCHA CREEK REPLACEMENT.GPJ 2012TEMPLATE(MTO).GDT 5/2/19

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

**METRIC**[illegible]

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

DOUBLE LINE LOCHA CREEK REPLACEMENT.GPJ 2012TEMPLATE(MTO).GDT 5/2/19



## METRIC

Continued Next Page




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

# RECORD OF BOREHOLE No 18-101

3 OF 4

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4446478° Long: -76.5345541° MTO Zone 9: N 5 033 858.0 E 302 096.9 ORIGINATED BY CM  
 HWY 17 BOREHOLE TYPE HSA / NW / NQ COMPILED BY KP  
 DATUM Geodetic DATE 2018.06.11 - 2018.06.12 CHECKED BY PC


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 (%)				
								20   40   60   80   100	W P                      W                      W L					
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE						
Continued From Previous Page														GR   SA   SI   CL
107.8 24.7	<b>CLAY (CL)</b> Stiff to very stiff   - frequent silt to fine sand seams below 21 m   - vane attempted S <sub>u</sub> > 106 kPa    - vane attempted S <sub>u</sub> > 106 kPa						112							
			15	SS	5		111							
							110							
			16	SS	3		109							
							108							
104.0 28.5	<b>Silty Clayey SAND (SC-SM) TILL</b> Dense Grey Wet    - gravel and cobbles below 27 m    - cored 75 mm cobble at 28 m						107						11   75   14 (SI+CL)	
			17	SS	45		106							
							105							
							104							
							103							
	<b>MARBLE BEDROCK</b> Freshly weathered Very strong Close joint spacing Fair to good quality Coarse grained White		1	RUN									FI 3 2	RUN #1 TCR=100% SCR=100% RQD=65%
			2	RUN									5 2	RUN #2 TCR=93% SCR=80% RQD=65%

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

## METRIC

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 (%)				
								20   40   60   80   100	○ UNCONFINED      + FIELD VANE	● QUICK TRIAXIAL      × LAB VANE	W <sub>p</sub> W      W <sub>L</sub>					
100.3	Continued From Previous Page													3	RUN #3 TCR=98% SCR=98% RQD=73% UCS=127MPa	
	<b>MARBLE BEDROCK</b> Freshly weathered Very strong Close joint spacing Fair to good quality Coarse grained White					102								>10		
														1		
				3	RUN		101									2
														3		
														4		
														0		
32.2	End of Borehole Groundwater rose to at least 3.0 m above existing grade (elev. 135.5 m) on 2018-06-12, just prior to decommissioning															

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

# RECORD OF BOREHOLE No 18-102

1 OF 4

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4442368° Long: -76.5348154° MTO Zone 9: N 5 033 812.3 E 302 076.5 ORIGINATED BY CM  
HWY 17 BOREHOLE TYPE HSA / NW / NQ COMPILED BY KP  
DATUM Geodetic DATE 2018.06.12 - 2018.06.13 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
137.7	Silty sand some gravel Compact Brown Dry FILL		1	SS	15		137						GR SA SI CL		
0.0															
			2	SS	21							7 84 9 (SI+CL)			
			3	SS	28										
135.6	Sand with silt and gravel Very dense to compact Grey to brown FILL						135					24 69 7 (SI+CL)			
2.1															
			4	SS	54										
			5	SS	30										
			6	SS	18										
			7	SS	16										
132.2	SANDY CLAY (CL) to SILTY CLAYEY SAND - frequent sand layers Stiff Grey Moist - sand layer from 6.2 m to 6.5 m		8	SS	4		132					3 57 18 22			
5.5															
			9	SS	11										
			10	SS	8										
130.1	CLAY (CL) Very stiff to firm Grey  - vane attempted S <sub>u</sub> > 106 kPa		11	SS	WH		130								
7.6															
			12	SS	WH										

Continued Next Page

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

## METRIC

[illegible]

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

# RECORD OF BOREHOLE No 18-102

3 OF 4

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4442368°, Long: -76.5348154° MTO Zone 9: N 5 033 812.3 E 302 076.5 ORIGINATED BY CM  
HWY 17 BOREHOLE TYPE HSA / NW / NQ COMPILED BY KP  
DATUM Geodetic DATE 2018.06.12 - 2018.06.13 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE									
								● QUICK TRIAXIAL	× LAB VANE									
	Continued From Previous Page							20 40 60 80 100										
	CLAY (CL) Firm to stiff																	
	- becomes stiff below 22 m		19	SS	WH									0 4 46 50				
								4.0 +										
								6.4 +										
			20	SS	3													
								2.5 +										
								2.5 +										
111.2 26.5	Sandy Silty Clay to Silty Clayey Sand TILL Stiff Grey Wet																	
			21	SS	7									3 37 38 22				
	- gravel, cobbles and boulders below 28 m																	
	- cored 200 mm boulder at 29 m		1	RUN	-													
107.9 29.8	MARBLE BEDROCK		2	RUN									FI	RUN #2				

Continued Next Page

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

# RECORD OF BOREHOLE No 18-102

4 OF 4

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4442368°, Long: -76.5348154° MTO Zone 9: N 5 033 812.3 E 302 076.5 ORIGINATED BY CM  
 HWY 17 BOREHOLE TYPE HSA / NW / NQ COMPILED BY KP  
 DATUM Geodetic DATE 2018.06.12 - 2018.06.13 CHECKED BY PC

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							
								20   40   60   80   100				20   40   60							
							○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE				WATER CONTENT (%)								
							20   40   60   80   100				20   40   60								
	Continued From Previous Page																		
	<b>MARBLE BEDROCK</b> Freshly weathered White Very strong Close joint spacing Poor to excellent quality Coarse grained		3	RUN		107									0	TCR=100% SCR=100% RQD=100%  RUN #3 TCR=100% SCR=98% RQD=30%			
																	4		
															5				
															2				
						4	RUN	106										2	RUN #4 TCR=100% SCR=100% RQD=90% UCS=165MPa
																		0	
														0					
104.7						105									3				
33.0															1				
	End of Borehole WATER LEVEL READINGS: DATE      DEPTH (m)      ELEV. (m) 2018.06.15      5.9      131.8 Note: Groundwater rose to at least 0.5 m above ground surface upon completion of drilling. The bottom 20 m of the borehole was backfilled with a bentonite and clay seal prior to installing a monitoring well screened within the clay.																		

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

## METRIC

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 (%)												
							20	40	60	80	100	20	40	60					
133.9	50 mm ROOTMAT  Sand with silt Loose Brown FILL		1	SS	8								○				10	82	8
0.1																		(SI+CL)	
			2	SS	7									○					
132.2	Sandy clay with silt, trace to some wood pieces Firm Grey FILL		3	SS	3								○						
1.7													○						
			4	SS	2										○				
130.9	SANDY CLAY (CL) - occasional sand seams Stiff Grey		5	SS	1									○			0	43	32
3.0														○					
			6	SS	1										○			1	45
129.3	CLAY (CL) Stiff to firm Grey Wet		7	SS	3									○					
4.6																			
			8	SS	1									○					
			9	ST	PUSH														
	- becomes firm below 9.5 m																		

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

DOUBLE LINE LOCHA CREEK REPLACEMENT.GPJ 2012TEMPLATE(MTO).GDT 5/2/19



# RECORD OF BOREHOLE No 18-103

2 OF 3

METRIC

GWP# 4061-17-00 LOCATION Lat: 45.4438208°, Long: -76.5347193° MTO Zone 9: N 5 033 766.1 E 302 084.0 ORIGINATED BY CM  
 HWY 17 BOREHOLE TYPE HSA / NW / NQ COMPILED BY KP  
 DATUM Geodetic DATE 2018.06.14 - 2018.06.15 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE							
								● QUICK TRIAXIAL	× LAB VANE							
Continued From Previous Page								20 40 60 80 100		20 40 60						
<div>CLAY (CL) Firm to stiff</div> <div>- becomes stiff below 14 m</div>			10	SS	WH		123	5.1 +								
								12.0 +								
			11	SS	WR		122							1 3 57 39		
								13.0 +								
							121	7.7 +								
			12	SS	WR		120									
								5.2 +								
								10.0 +								
			13	SS	WR		119									
								7.4 +								
							118	5.8 +								
			14	SS	WR		117									
								6.0 +								
							4.0 +									
		15	SS	WR		116										
								3.5 +								
						115		8.0 +								
		16	SS	WH		114										

Continued Next Page

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

## METRIC

[illegible]

DOUBLE LINE LOCHA CREEK REPLACEMENT.GPJ 2012TEMPLATE(MTO).GDT 5/2/19

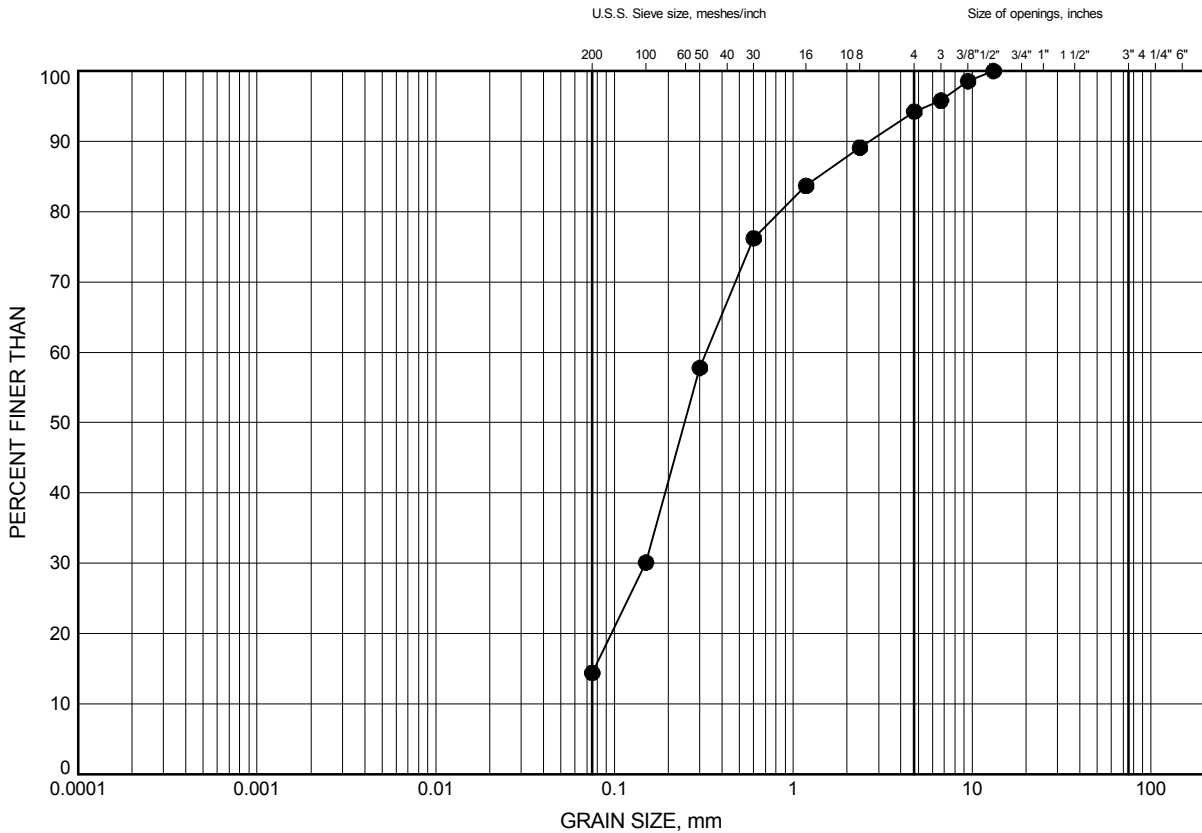
+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

**APPENDIX C**  
**LABORATORY TEST RESULTS**

Site 29-249/C1 Locha Creek Culvert  
**GRAIN SIZE DISTRIBUTION**

FIGURE 1

**Sand Fill**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-3	1.07	137.83

Date February 2019  
 GWP# 4061-17-00

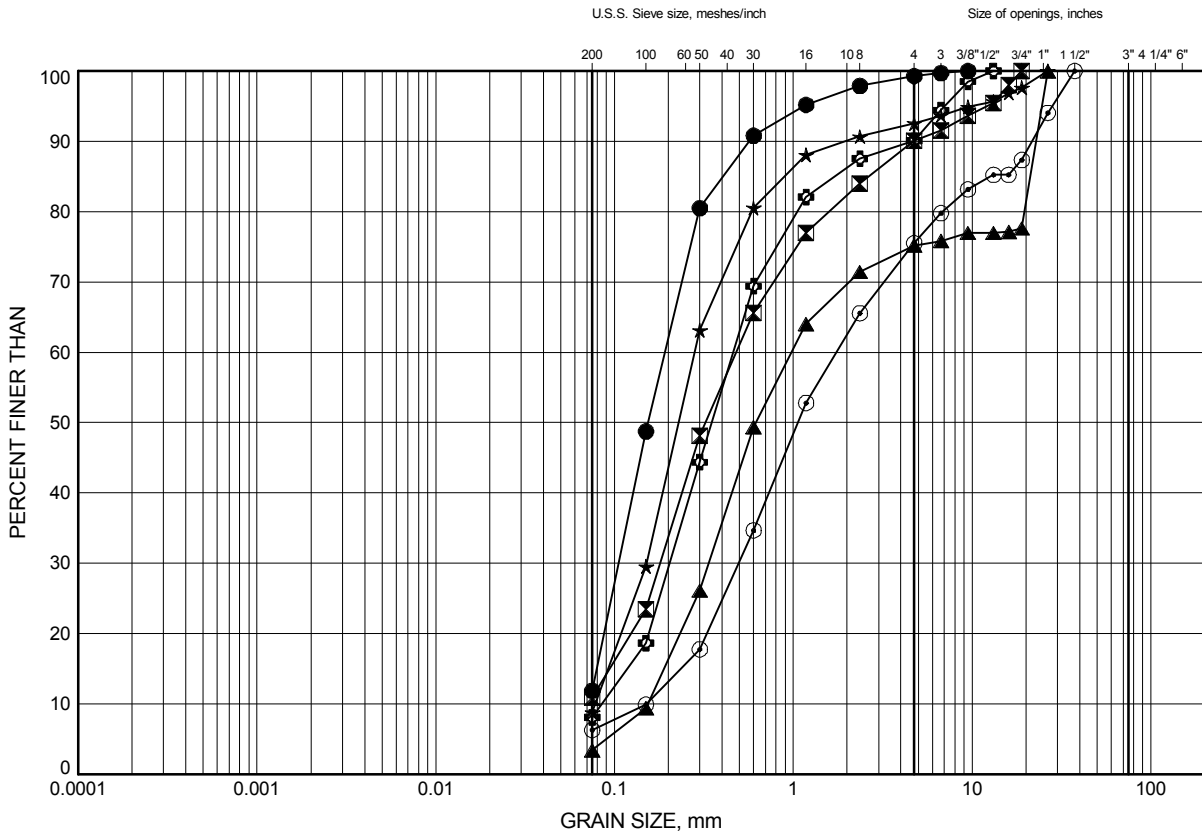


Prep'd DJP  
 Chkd. PC

Site 29-249/C1 Locha Creek Culvert  
GRAIN SIZE DISTRIBUTION

FIGURE 2

Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-3	4.88	134.02
⊠	17-4	4.11	134.69
▲	17-6	0.30	132.40
★	18-102	1.07	136.63
⊙	18-102	4.88	132.82
⊕	18-103	0.33	133.57

Date July 2018  
GWP# 4061-17-00

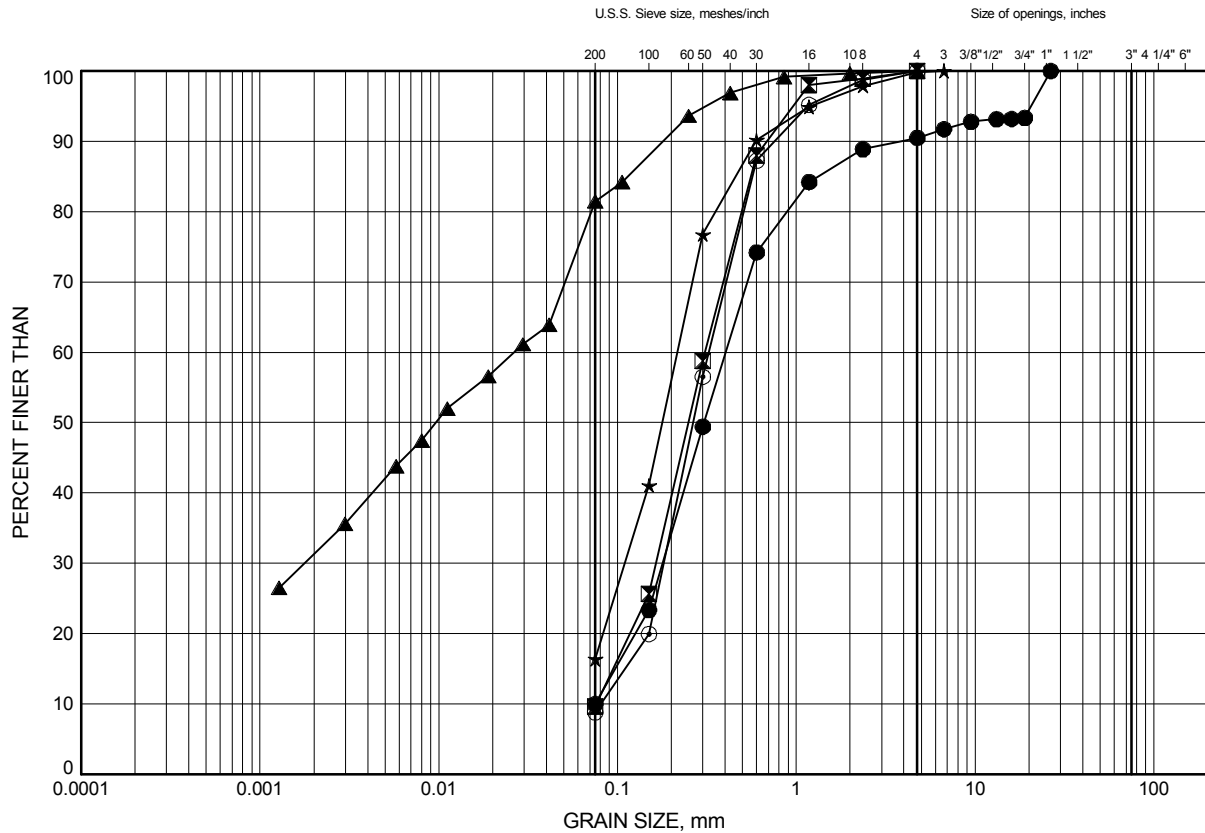


Prep'd KCP  
Chkd. PC

Site 29-249/C1 Locha Creek Culvert  
**GRAIN SIZE DISTRIBUTION**

FIGURE 3

Silty Sand (SM) to Sandy Silt (ML)



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-1	0.91	131.59
⊠	17-3	7.92	130.98
▲	17-3	8.69	130.21
★	17-5	2.86	130.94
⊙	18-101	0.91	131.59

Date July 2018  
 GWP# 4061-17-00

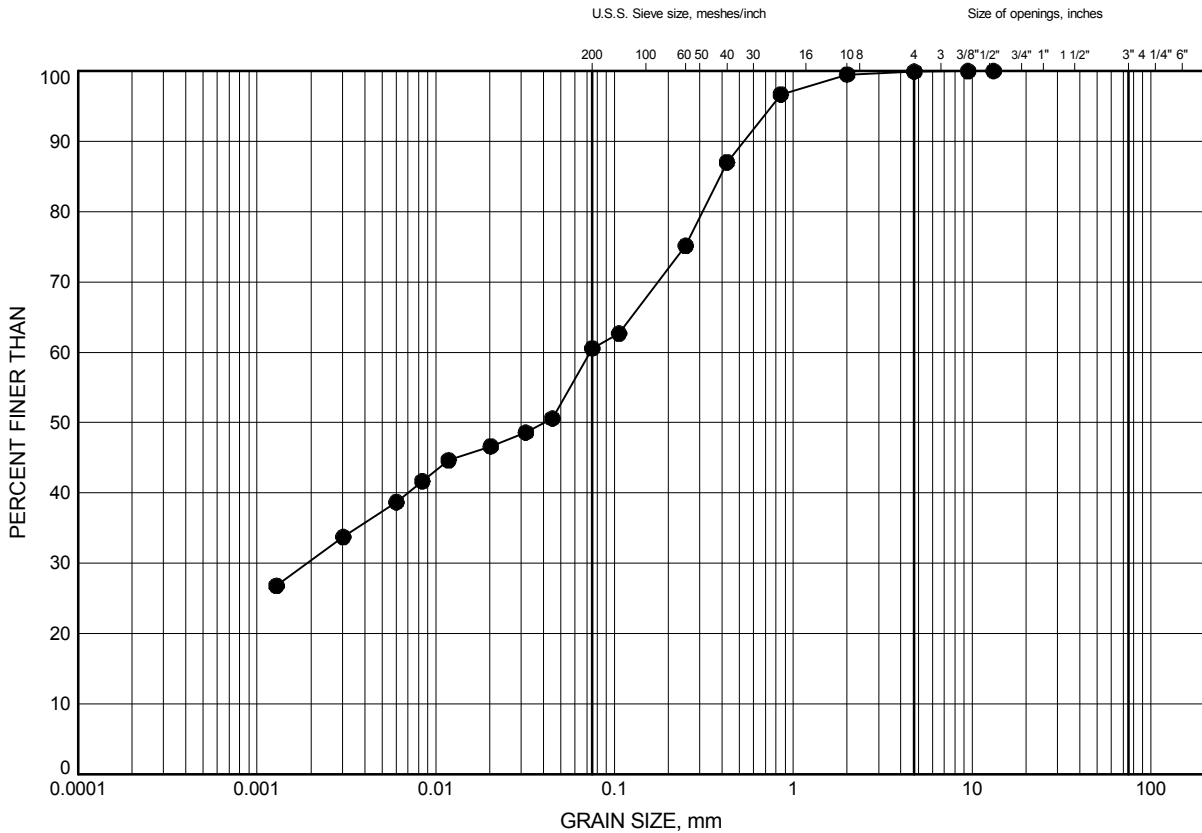


Prep'd KCP  
 Chkd. PC

Site 29-249/C1 Locha Creek Culvert  
**GRAIN SIZE DISTRIBUTION**

FIGURE 4

**Organic Silt (OL) with Sand**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-2	1.83	130.77

Date July 2018  
 GWP# 4061-17-00

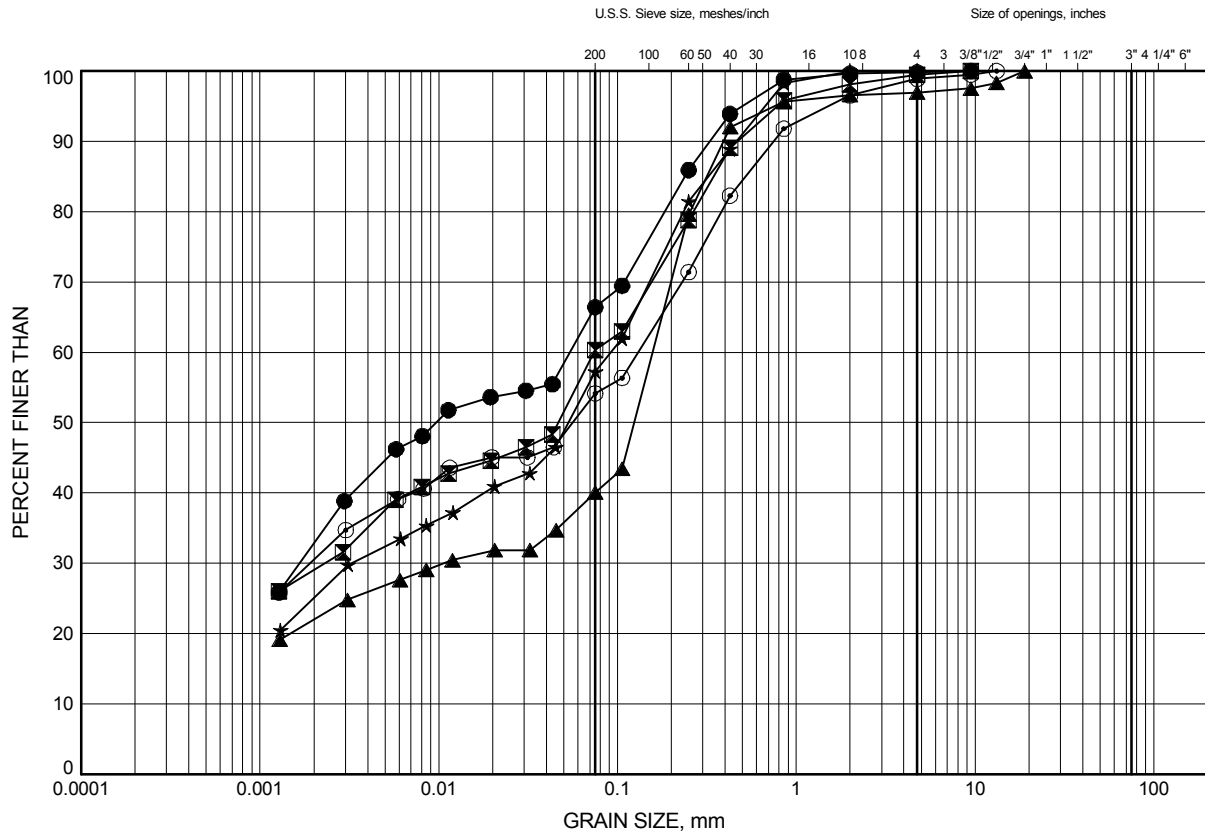


Prep'd KCP  
 Chkd. PC

Site 29-249/C1 Locha Creek Culvert  
**GRAIN SIZE DISTRIBUTION**

FIGURE 5

**Sandy Clay to Silty Clayey Sand**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-3	7.16	131.74
⊠	17-4	7.16	131.64
▲	18-102	7.32	130.38
★	18-103	3.35	130.55
⊙	18-103	4.11	129.79

Date August 2018  
 GWP# 4061-17-00



Prep'd KCP  
 Chkd. PC

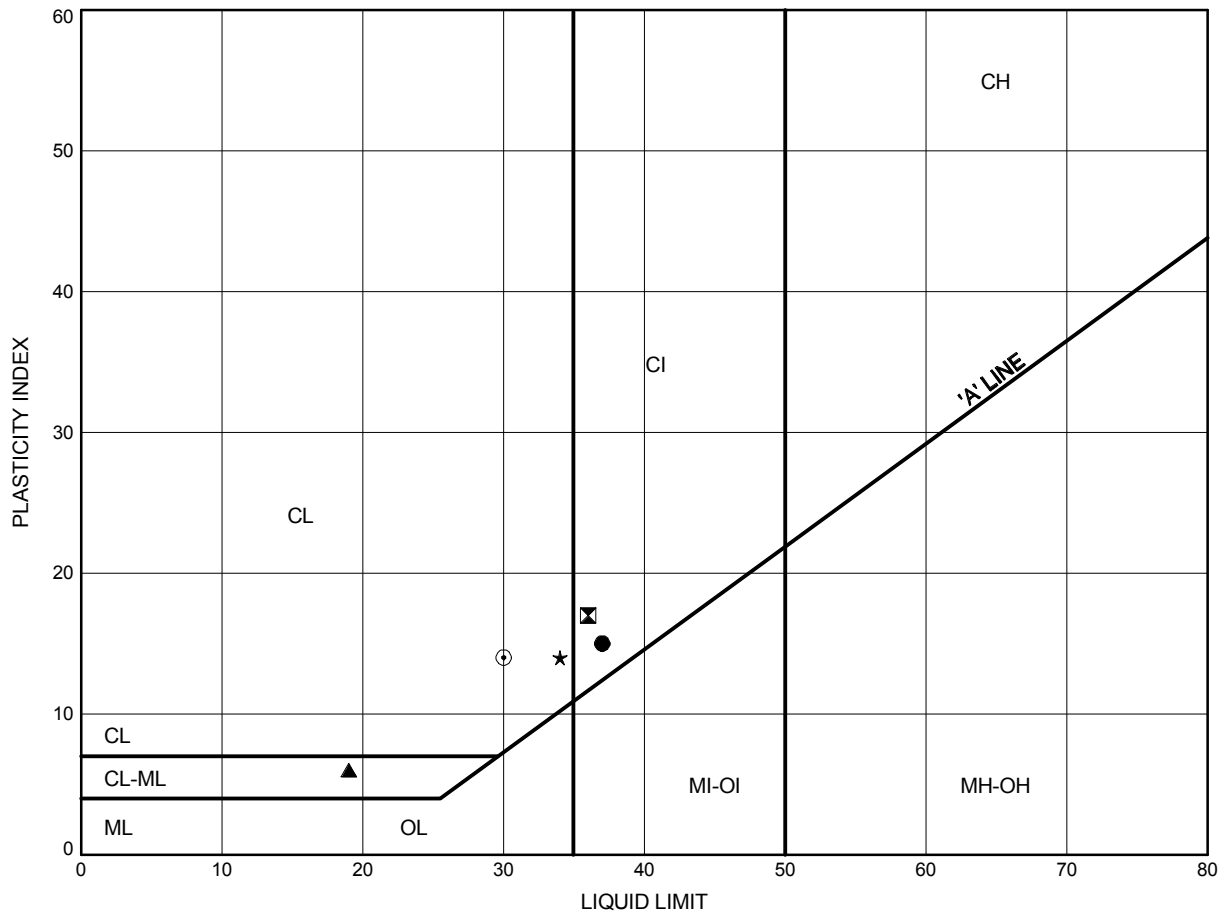


Site 29-249/C1 Locha Creek Culvert

# ATTERBERG LIMITS TEST RESULTS

FIGURE 6

Sandy Clay to Silty Clayey Sand



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-3	7.16	131.74
⊠	17-4	7.16	131.64
▲	18-102	7.32	130.38
★	18-103	3.35	130.55
⊙	18-103	4.11	129.79

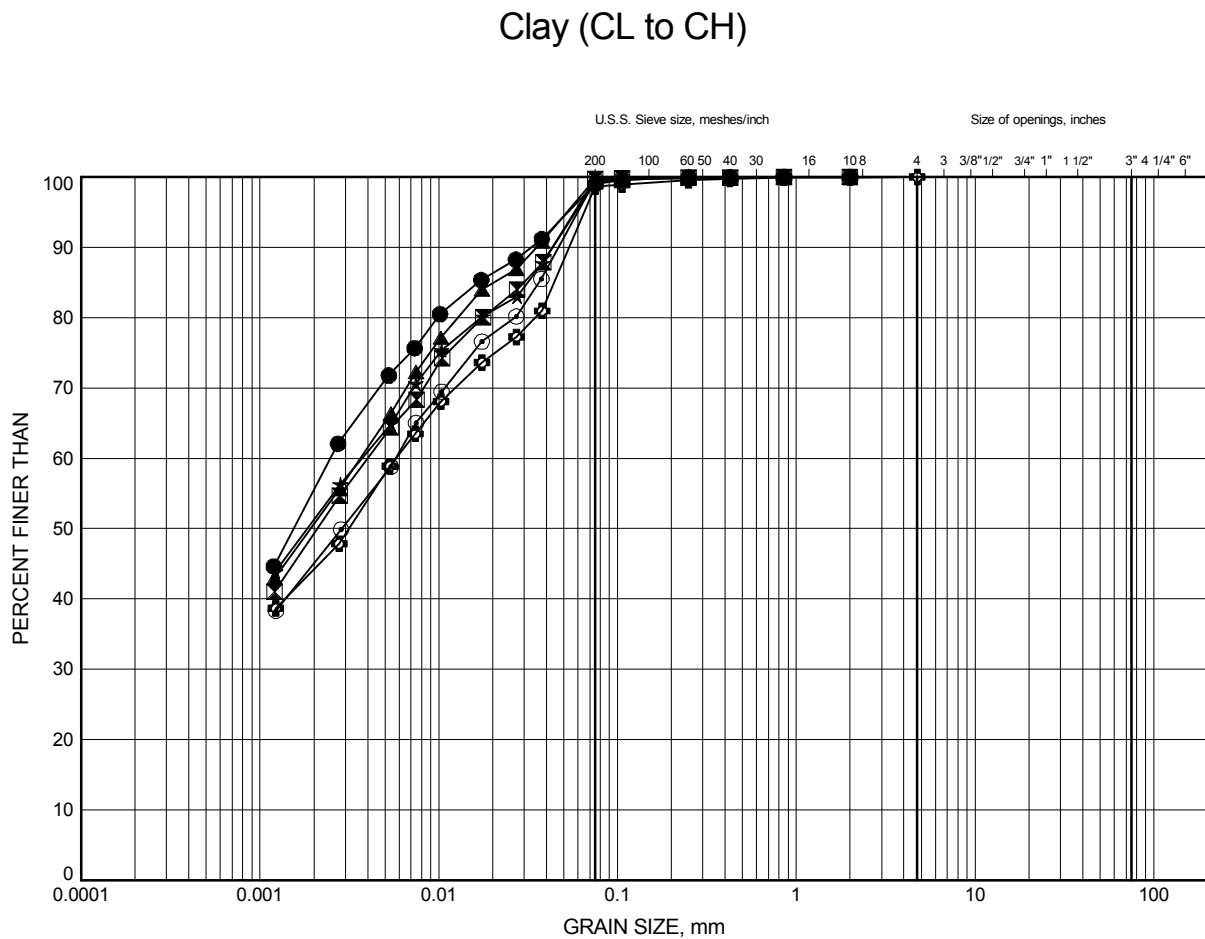
Date August 2018  
GWP# 4061-17-00



Prep'd KCP  
Chkd. PC

Site 29-249/C1 Locha Creek Culvert  
GRAIN SIZE DISTRIBUTION

FIGURE 7



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-1	4.11	128.39
⊠	17-1	10.97	121.53
▲	17-2	7.92	124.68
★	17-3	12.50	126.40
⊙	17-3	18.59	120.31
⊕	17-4	12.50	126.30

Date July 2018

GWP# 4061-17-00

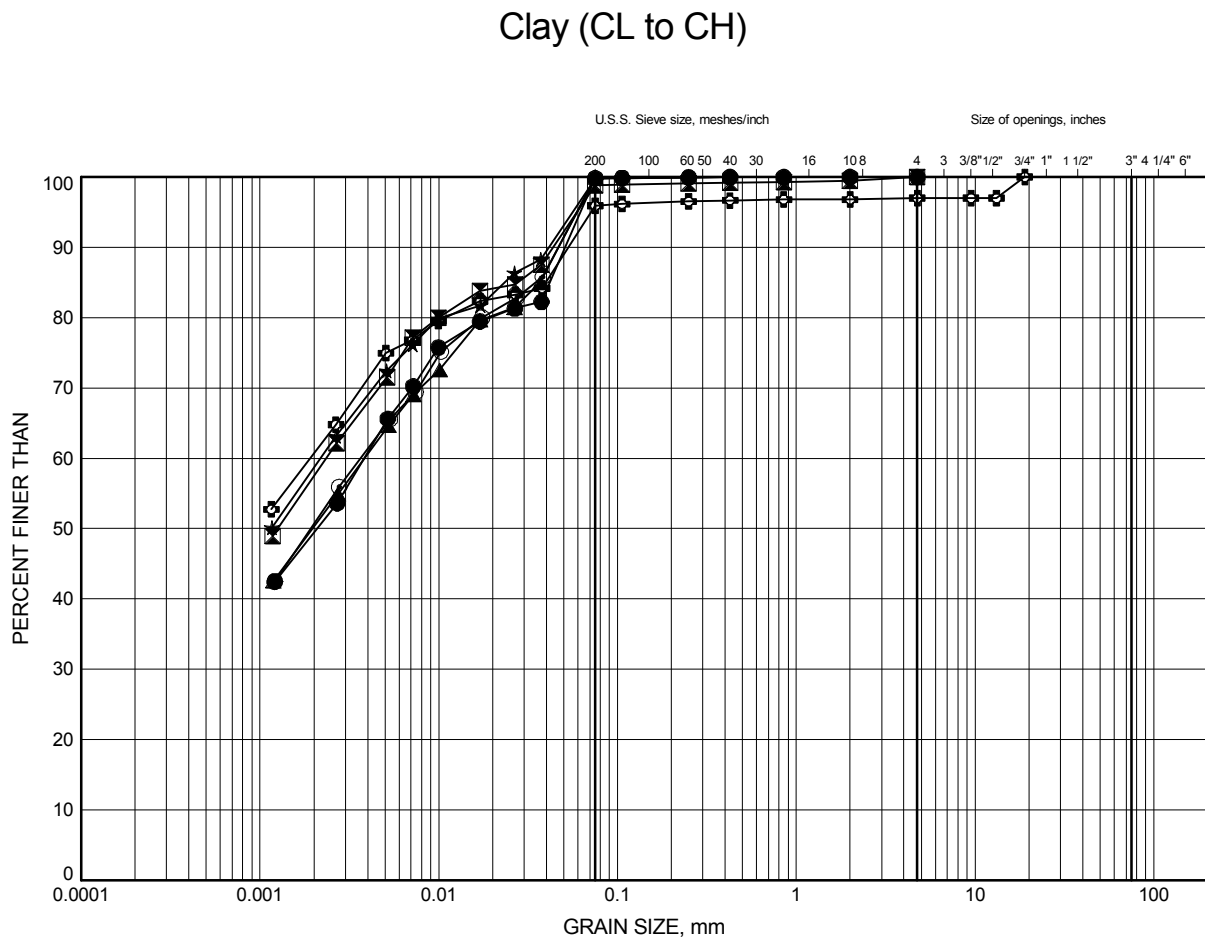


Prep'd KCP

Chkd. PC

Site 29-249/C1 Locha Creek Culvert  
GRAIN SIZE DISTRIBUTION

FIGURE 8



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-4	17.07	121.73
⊠	17-5	3.45	130.35
▲	17-5	9.55	124.25
★	17-6	3.35	129.35
⊙	17-6	10.97	121.73
⊕	17-7	1.83	132.47

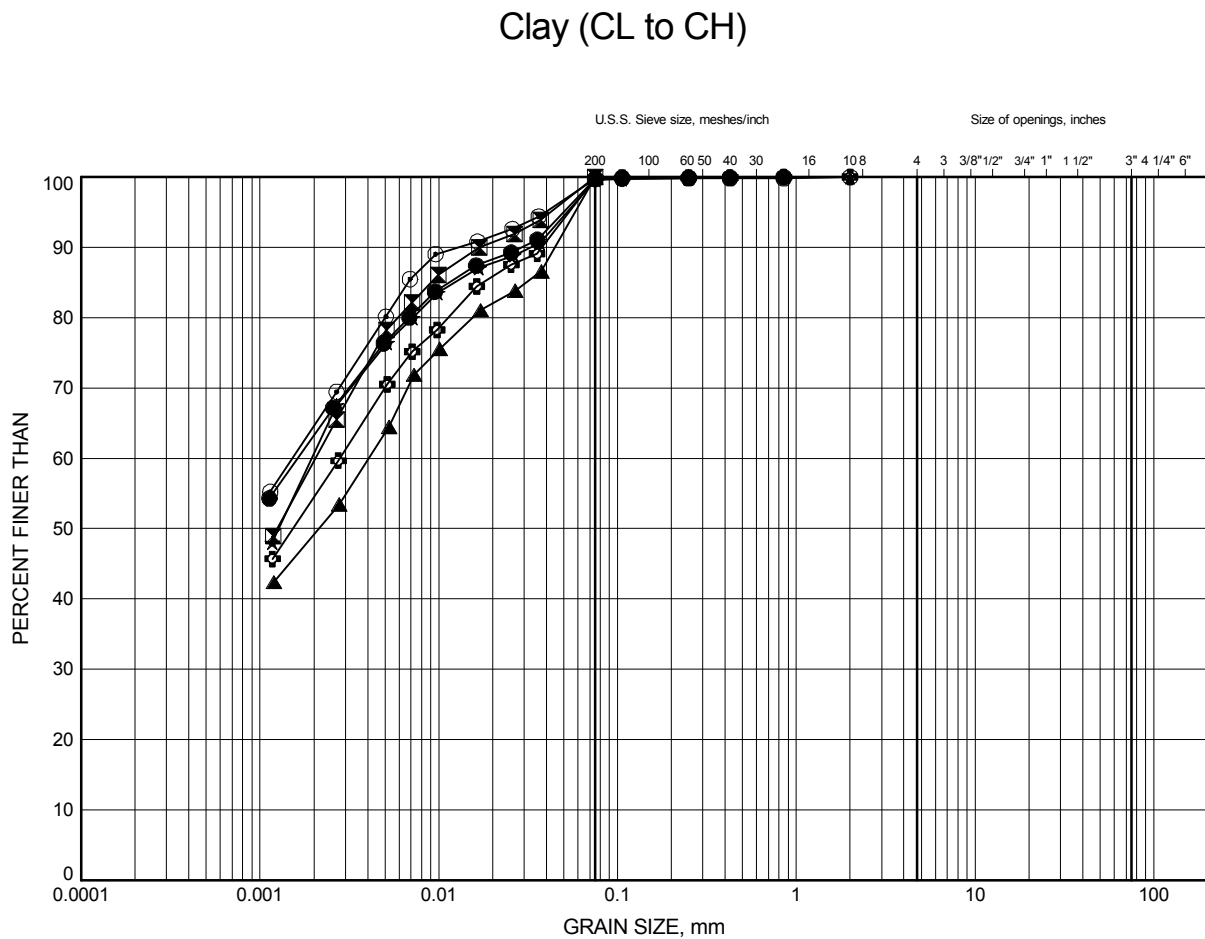
Date July 2018  
GWP# 4061-17-00



Prep'd KCP  
Chkd. PC

Site 29-249/C1 Locha Creek Culvert  
GRAIN SIZE DISTRIBUTION

FIGURE 9



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-7	4.11	130.19
⊠	17-7	6.40	127.90
▲	17-7	12.50	121.80
★	18-101	1.83	130.67
⊙	18-101	3.35	129.15
⊕	18-101	14.02	118.48

Date July 2018

GWP# 4061-17-00

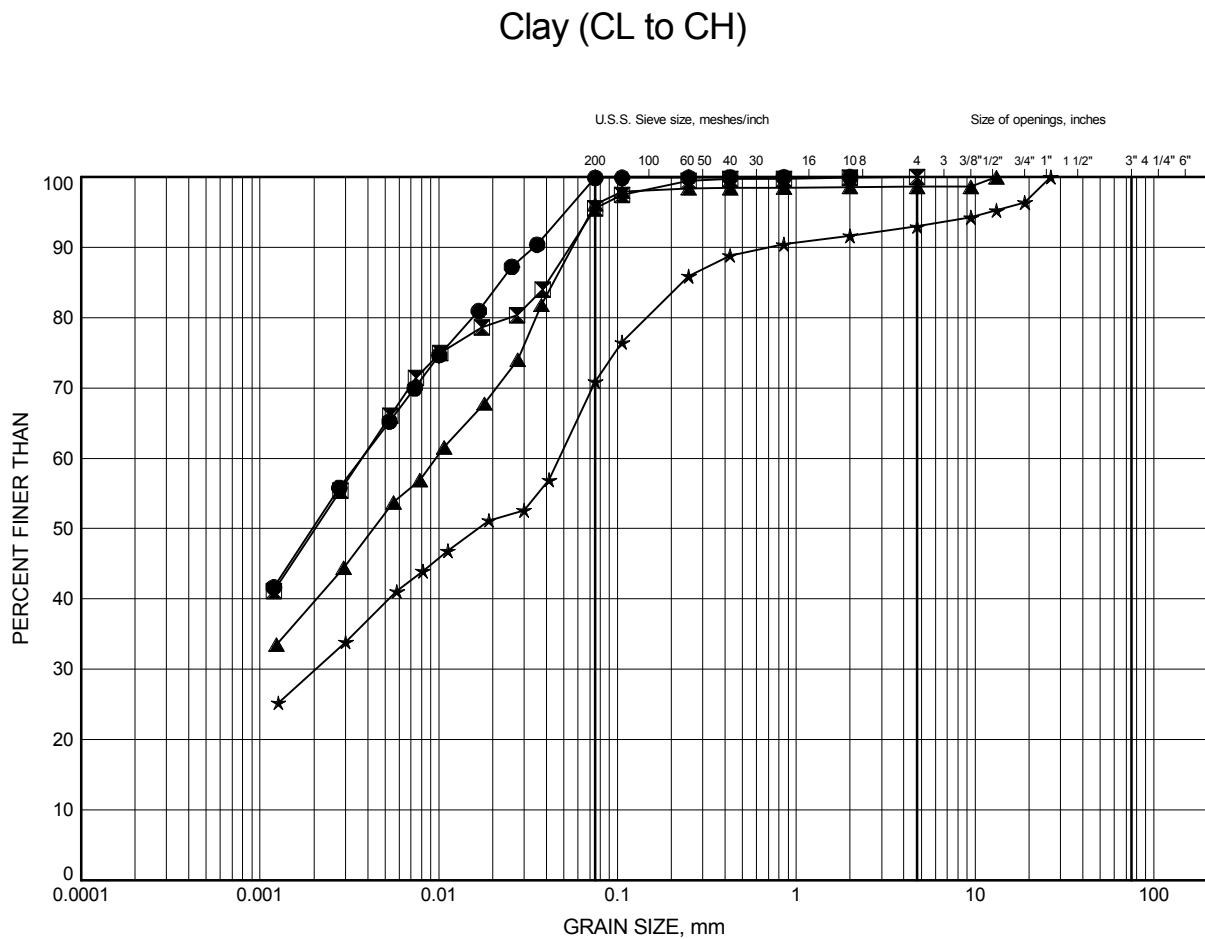


Prep'd KCP

Chkd. PC

Site 29-249/C1 Locha Creek Culvert  
GRAIN SIZE DISTRIBUTION

FIGURE 10



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-102	12.50	125.20
◻	18-102	21.64	116.06
▲	18-103	11.89	122.01
★	18-103	22.56	111.34

Date July 2018  
GWP# 4061-17-00



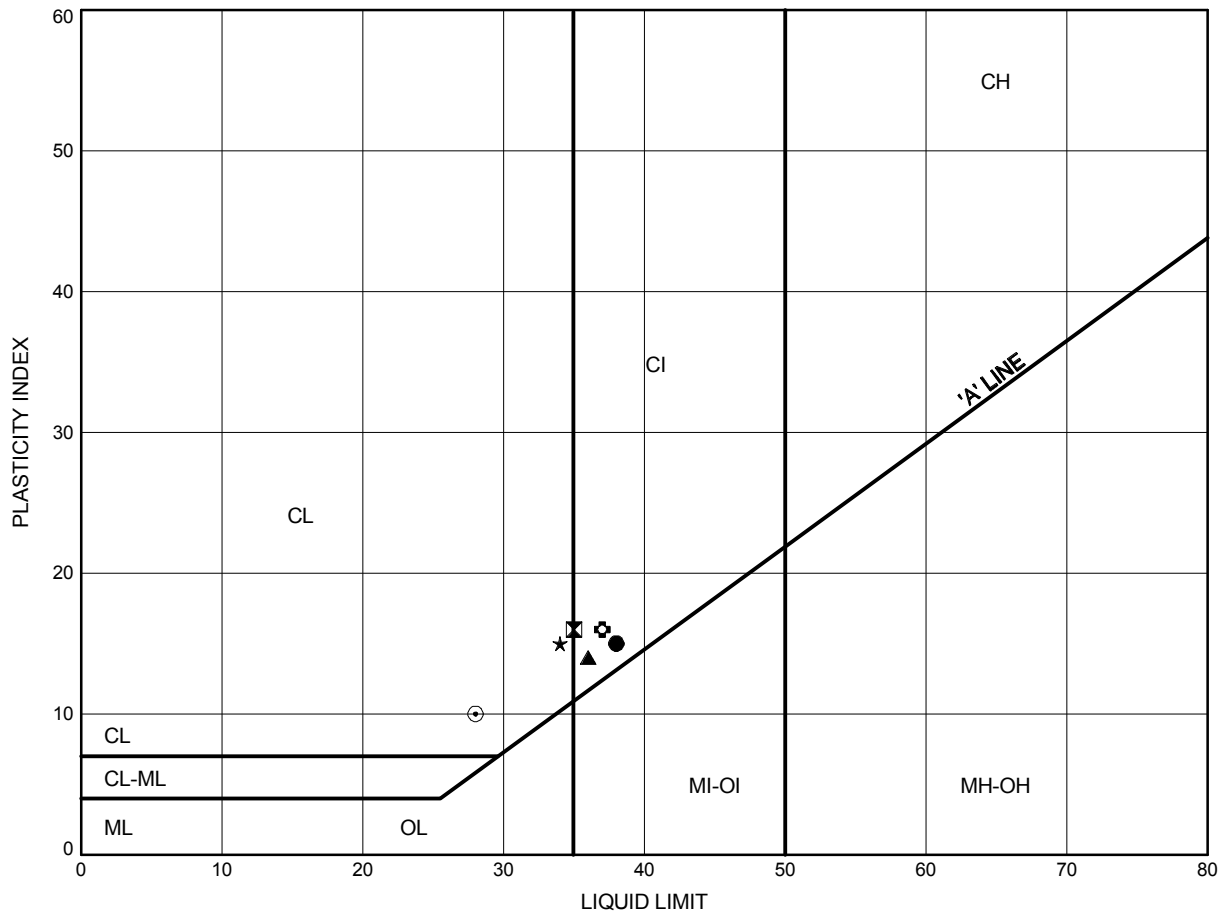
Prep'd KCP  
Chkd. PC

Site 29-249/C1 Locha Creek Culvert

# ATTERBERG LIMITS TEST RESULTS

FIGURE 11

Clay (CL to CH)



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-1	4.11	128.39
⊠	17-1	10.97	121.53
▲	17-3	12.50	126.40
★	17-3	18.59	120.31
⊙	17-4	12.50	126.30
⊕	17-4	17.07	121.73

Date July 2018

GWP# 4061-17-00



Prep'd KCP

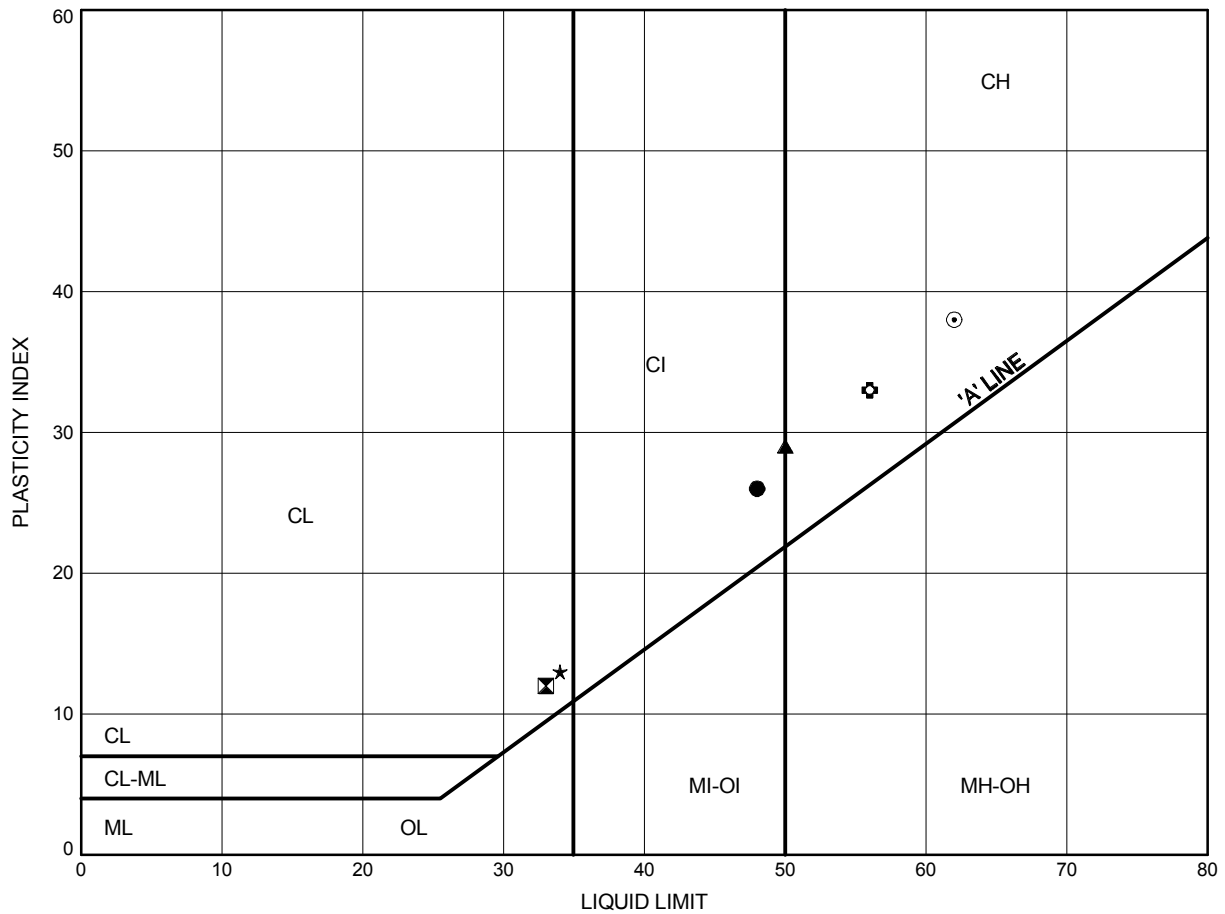
Chkd. PC

Site 29-249/C1 Locha Creek Culvert

# ATTERBERG LIMITS TEST RESULTS

FIGURE 12

Clay (CL to CH)



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-5	3.45	130.35
⊠	17-5	9.55	124.25
▲	17-6	3.35	129.35
★	17-6	10.97	121.73
⊙	17-7	1.83	132.47
⊕	17-7	4.11	130.19

Date July 2018

GWP# 4061-17-00



Prep'd KCP

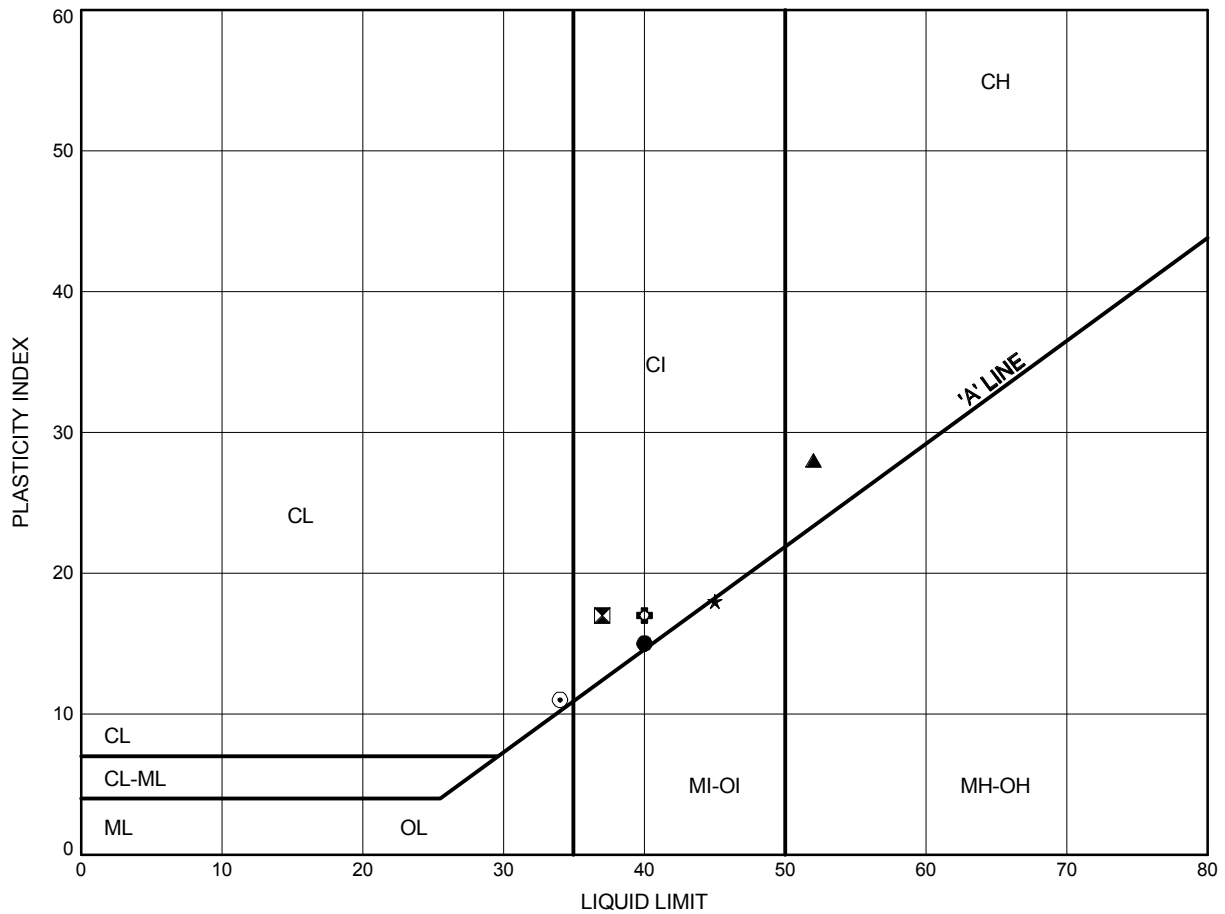
Chkd. PC

Site 29-249/C1 Locha Creek Culvert

# ATTERBERG LIMITS TEST RESULTS

FIGURE 13

Clay (CL to CH)



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-7	6.40	127.90
⊠	17-7	12.50	121.80
▲	18-101	1.83	130.67
★	18-101	3.35	129.15
⊙	18-101	14.02	118.48
⊕	18-102	21.64	116.06

Date July 2018

GWP# 4061-17-00



Prep'd KCP

Chkd. PC

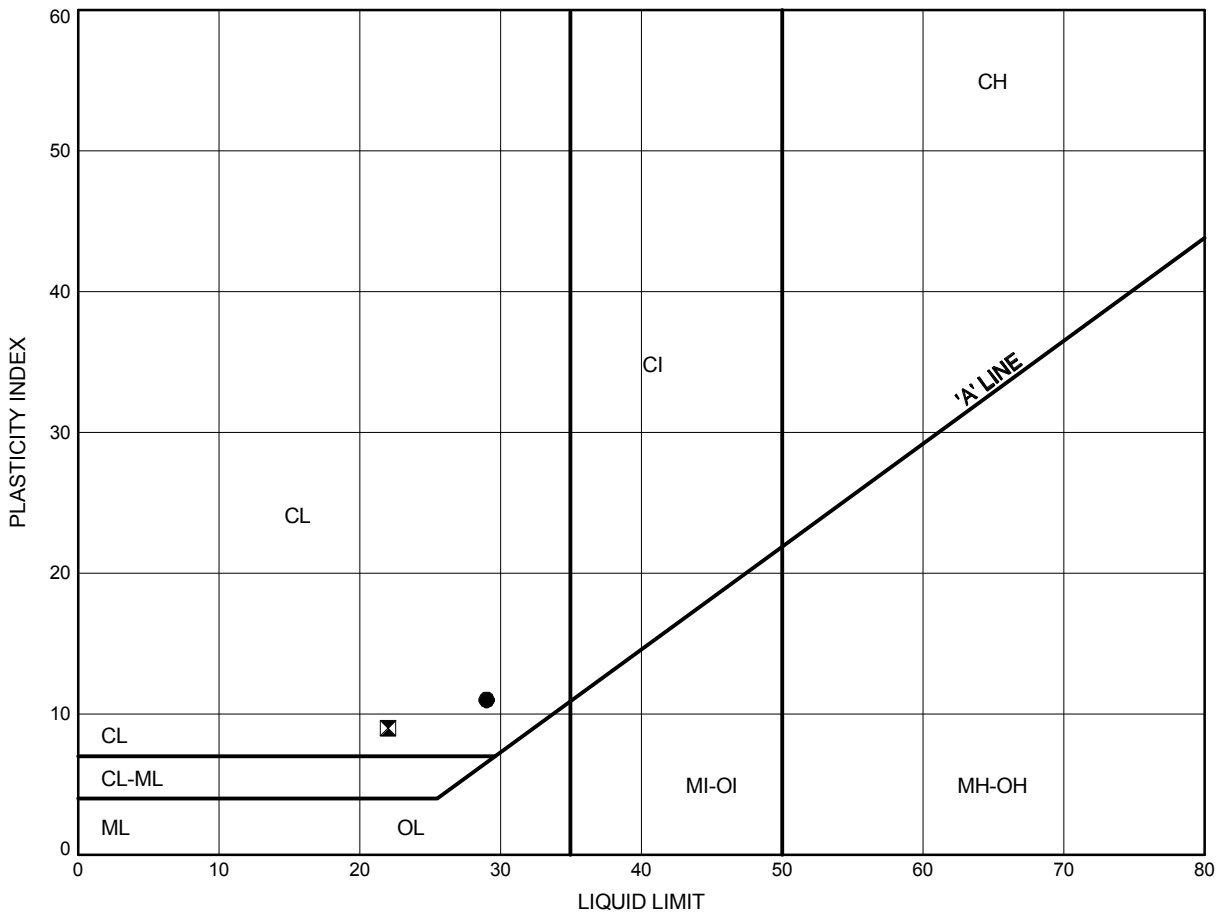


Site 29-249/C1 Locha Creek Culvert

# ATTERBERG LIMITS TEST RESULTS

FIGURE 14

Clay (CL to CH)



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-103	11.89	122.01
⊠	18-103	22.56	111.34

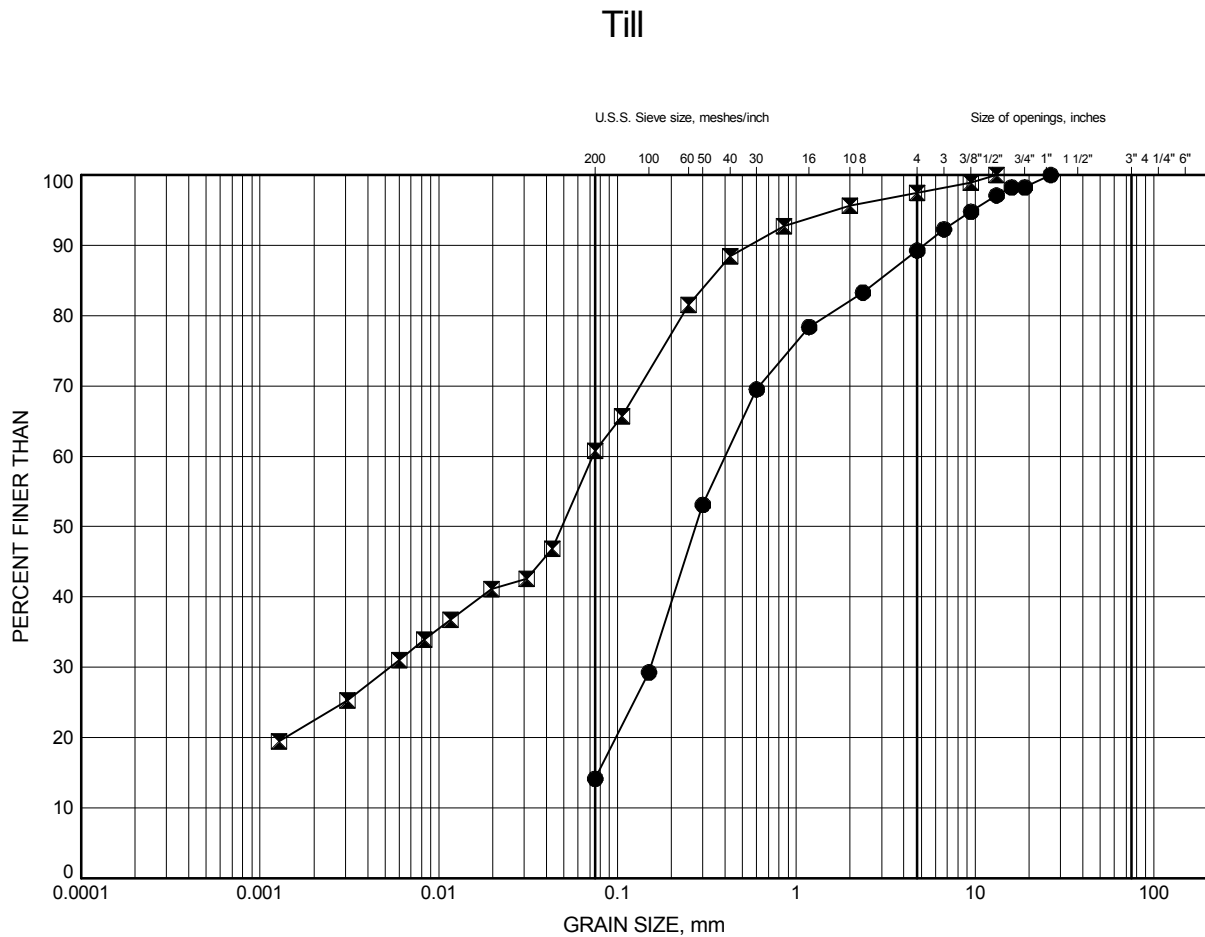
Date July 2018  
GWP# 4061-17-00



Prep'd KCP  
Chkd. PC

Site 29-249/C1 Locha Creek Culvert  
GRAIN SIZE DISTRIBUTION

FIGURE 15



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-101	26.21	106.29
⊠	18-102	27.74	109.96

Date ..October 2018.....  
GWP# ..4061-17-00.....

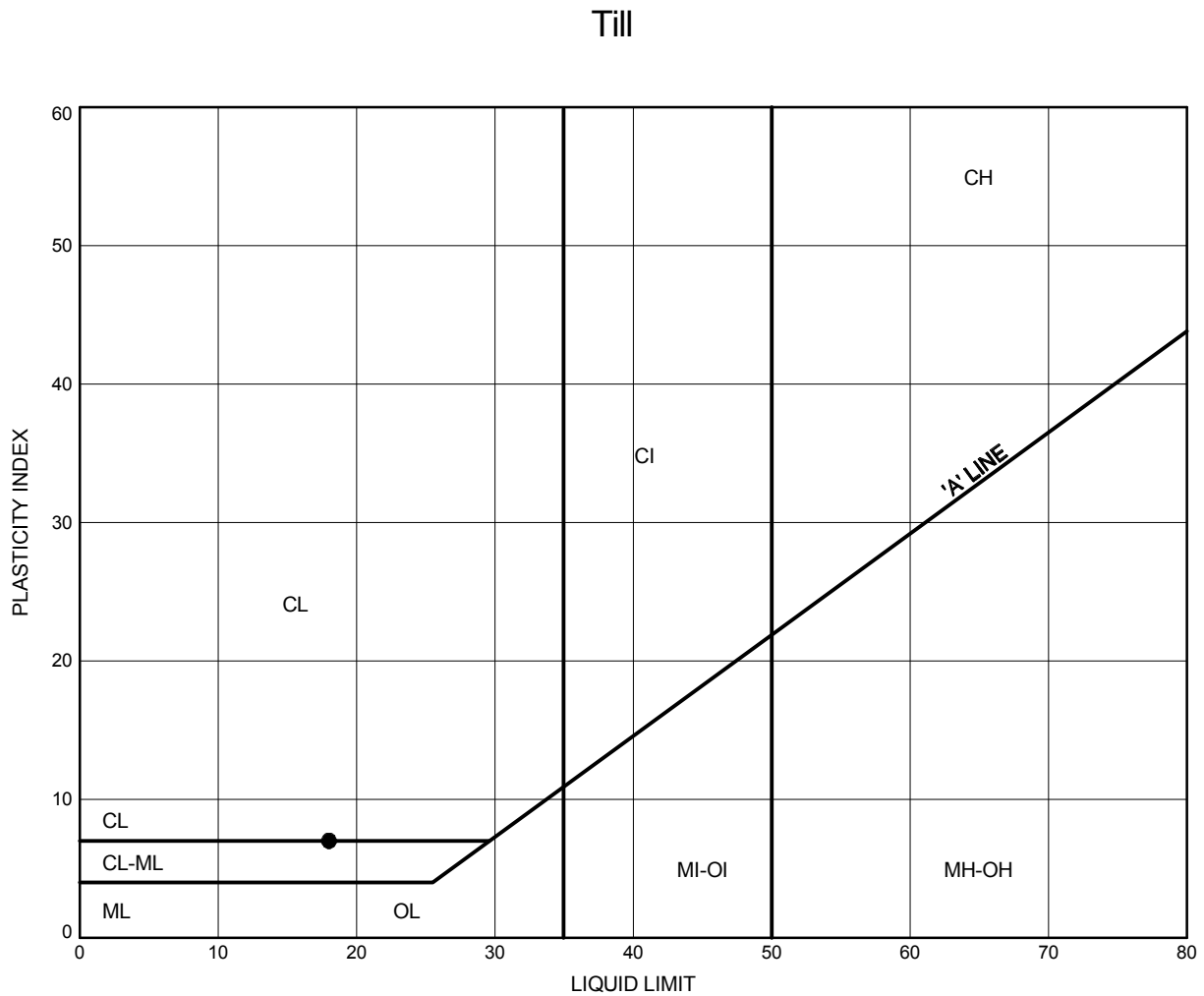


Prep'd .....KCP.....  
Chkd. ....PC.....

Site 29-249/C1 Locha Creek Culvert

# ATTERBERG LIMITS TEST RESULTS

FIGURE 16



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-102	27.74	109.96

Date ..October 2018.....  
 GWP# ..4061-17-00.....



Prep'd .....KCP.....  
 Chkd. ....PC.....



**Stantec Consulting Ltd.**

400 - 1331 Clyde Avenue, Ottawa ON K2C 3G4

November 1, 2017

File: 122410864

**Attention: Kenton Power**

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

Dear Mr. Power,

**Reference: Consolidation Test Results for Lochiel Project, Thurber Consulting Ltd.,  
File #20482: BH 17-3, ST 17 & BH 17-2, ST 9, sampled on September 12 & 25, 2017**

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

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

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

Regards,

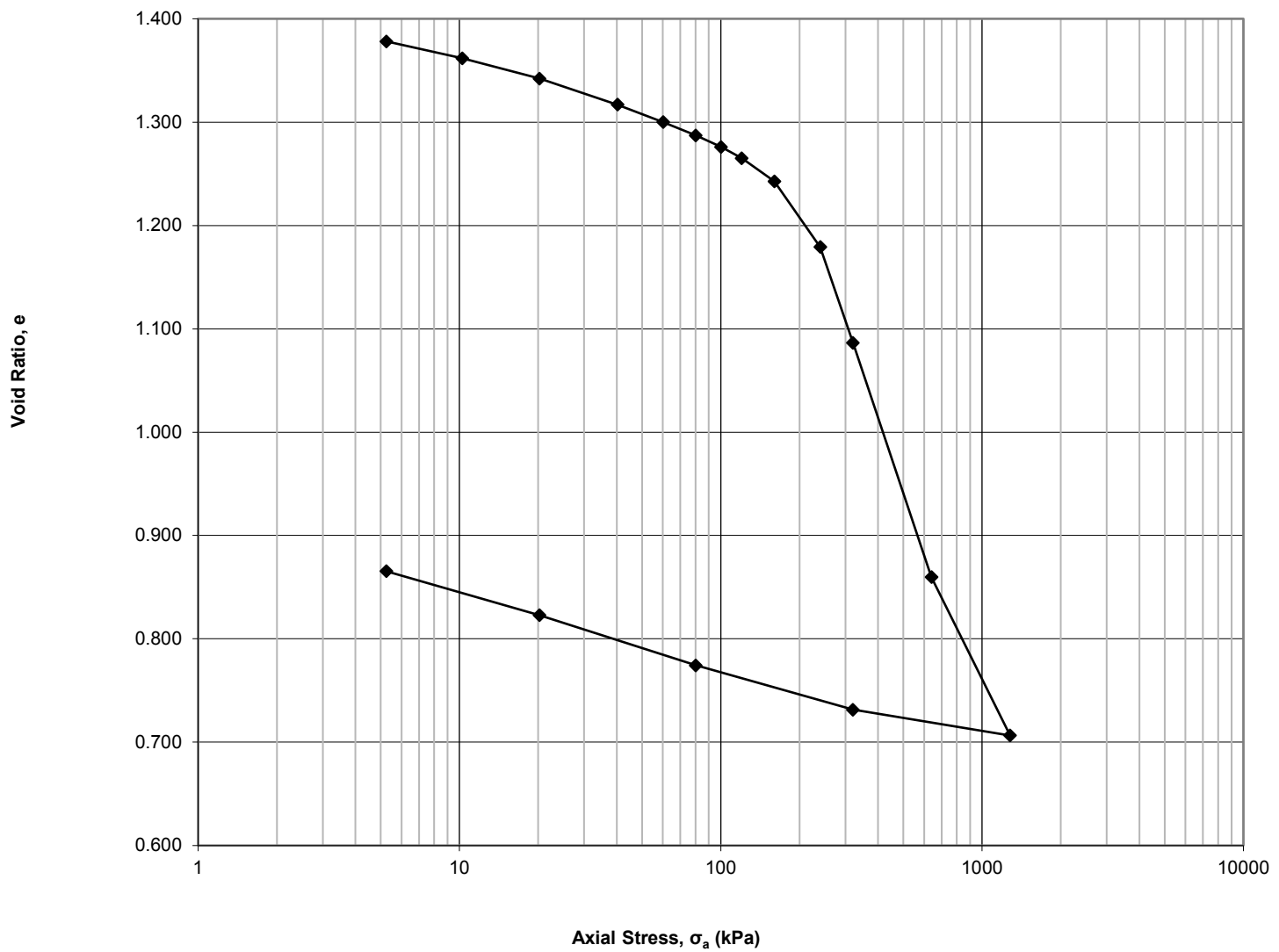
**STANTEC CONSULTING LTD.**

A handwritten signature in blue ink, appearing to read "Ramy Saadeldin", written over a horizontal line.

Ramy Saadeldin, Ph.D., P.Eng.  
Geotechnical Engineering  
Phone: (613) 738-6047  
Fax: (613) 722-2799  
Ramy.Saadeldin@stantec.com

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

**Thurber Engineering, File# 20482**  
**122410864**  
**17-3**  
**ST 17**  
**50-52 ft**



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

1-Nov-17  
1-Nov-17

Date:  
Date:

D. Boateng  
R. Hache

Checked by:  
Approved by:

**Specimen Details**

Project Name	Thurber Engineering, File# 20482
Project Location	Lochiel, ON
Borehole	17-3
Sample No.	ST 17
Depth	50-52 ft
Sample Date	September 12, 2017
Test Number	One
Technician Name	Daniel Boateng

**Soil Description & Classification**

Not Requested	
Specific Gravity of Solids	2.746
Average water content of trimmings %	49
<b>Additional Notes (information source, occurrence and size of large isolated particles etc.)</b>	

**Initial Specimen Conditions**

Height	mm	20.00
Diameter	mm	50.00
Area	mm <sup>2</sup>	1963
Volume	mm <sup>3</sup>	39270
Mass	g	67.42
Dry Mass	g	45.26
Density	Mg/m <sup>3</sup>	1.717
Dry Density	Mg/m <sup>3</sup>	1.153
Water Content	%	48.96
Degree of Saturation	%	97.2
Height of Solids	mm	8.39
Initial Void Ratio		1.383

**Final Specimen Conditions**

Water Content	%	33.74
Final Void Ratio		0.865

## One-Dimensional Consolidation Test using Incremental Loading

### ASTM D2435/D2435M - 11

**Specimen Details**

Project Name	Thurber Engineering, File# 20482
Project Location	Lochiel, ON
Borehole	17-3
Sample No.	ST 17
Depth	50-52 ft
Sample Date	September 12, 2017
Test Number	One
Technician Name	Daniel Boateng

**Test Procedure**

Date Started	October 30, 2017
Date Finished	November 1, 2017
Machine Number	Frame C
Cell Number	C
Ring Number	C
Trimming Procedure	Turntable
Moisture Condition	Inundated
Axial Stress at Inundation kPa	5
Water Used	Distilled
Test Method	B
Interpretation Procedure for $c_v$	2

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

--

**Calculations**

Load Increment	Increment Duration min	Axial Stress $\sigma_a$ kPa	Corrected Deformation $\Delta H$ mm	Specimen Height H mm	Axial Strain $\epsilon_a$ %	Void Ratio e
Seating	0.0	5	0.0000	20.0000	0.00	1.383
1	10.0	5	0.0372	19.9628	0.19	1.378
2	16.5	10	0.1754	19.8246	0.88	1.362
3	18.3	20	0.3391	19.6609	1.70	1.342
4	19.8	40	0.5514	19.4486	2.76	1.317
5	21.5	60	0.6935	19.3065	3.47	1.300
6	29.8	80	0.8005	19.1995	4.00	1.287
7	29.8	100	0.8948	19.1052	4.47	1.276
8	36.5	120	0.9858	19.0142	4.93	1.265
9	53.0	160	1.1741	18.8259	5.87	1.243
10	116.5	240	1.7085	18.2915	8.54	1.179
11	168.8	320	2.4859	17.5141	12.43	1.086
12	128.8	640	4.3883	15.6117	21.94	0.860
13	95.3	1280	5.6756	14.3244	28.38	0.706
14	18.3	320	5.4660	14.5340	27.33	0.731
15	36.8	80	5.1055	14.8945	25.53	0.774
16	63.5	20	4.6979	15.3021	23.49	0.823
17	103.8	5	4.3408	15.6592	21.70	0.865

## One-Dimensional Consolidation Test using Incremental Loading

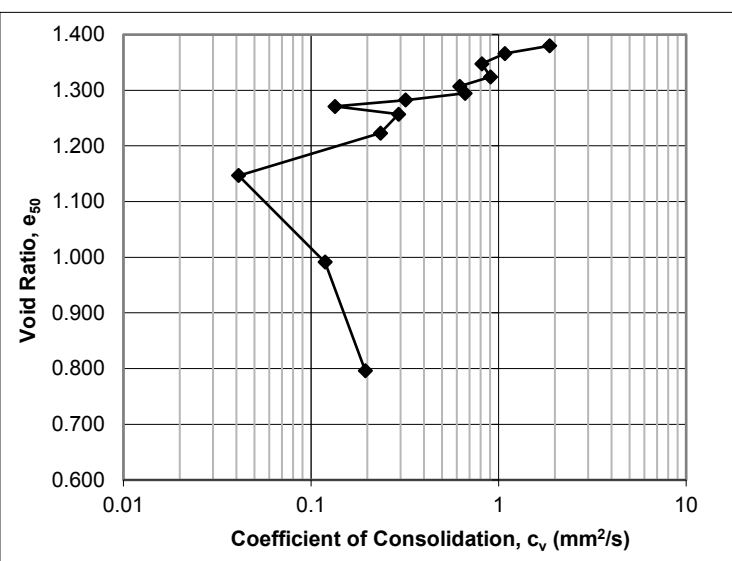
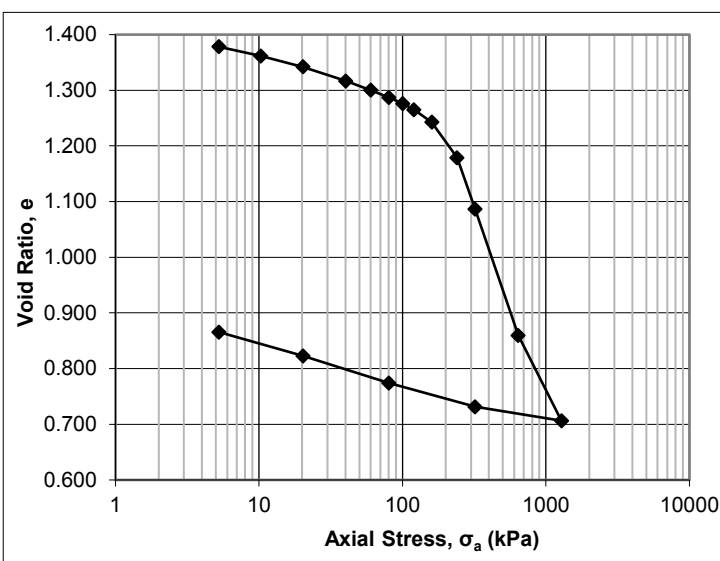
### ASTM D2435/D2435M - 11

**Specimen Details**

Project Name	Thurber Engineering, File# 20482
Project Location	Lochiel, ON
Borehole	17-3
Sample No.	ST 17
Depth	50-52 ft
Sample Date	September 12, 2017
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	3								
1	5	0.0226	19.9774	0.11	1.380			45	1.87E+00
2	8	0.1394	19.8606	0.70	1.366			77	1.08E+00
3	15	0.2925	19.7075	1.46	1.348			101	8.13E-01
4	30	0.4904	19.5096	2.45	1.324			89	9.05E-01
5	50	0.6325	19.3675	3.16	1.307			128	6.20E-01
6	70	0.7391	19.2609	3.70	1.295			119	6.62E-01
7	90	0.8403	19.1597	4.20	1.282			244	3.19E-01
8	110	0.9366	19.0634	4.68	1.271			575	1.34E-01
9	140	1.0537	18.9463	5.27	1.257			260	2.93E-01
10	200	1.3376	18.6624	6.69	1.223			314	2.35E-01
11	280	1.9795	18.0205	9.90	1.147			1673	4.11E-02
12	480	3.2838	16.7162	16.42	0.991			497	1.19E-01
13	960	4.9221	15.0779	24.61	0.796			247	1.95E-01
14	800	5.5093	14.4907	27.55	0.726				
15	200	5.2302	14.7698	26.15	0.760				
16	50	4.8678	15.1322	24.34	0.803				
17	13	4.6825	15.3175	23.41	0.825				







Project No.: 122410864

Project Name: Thurber, File # 20482

Photo Log

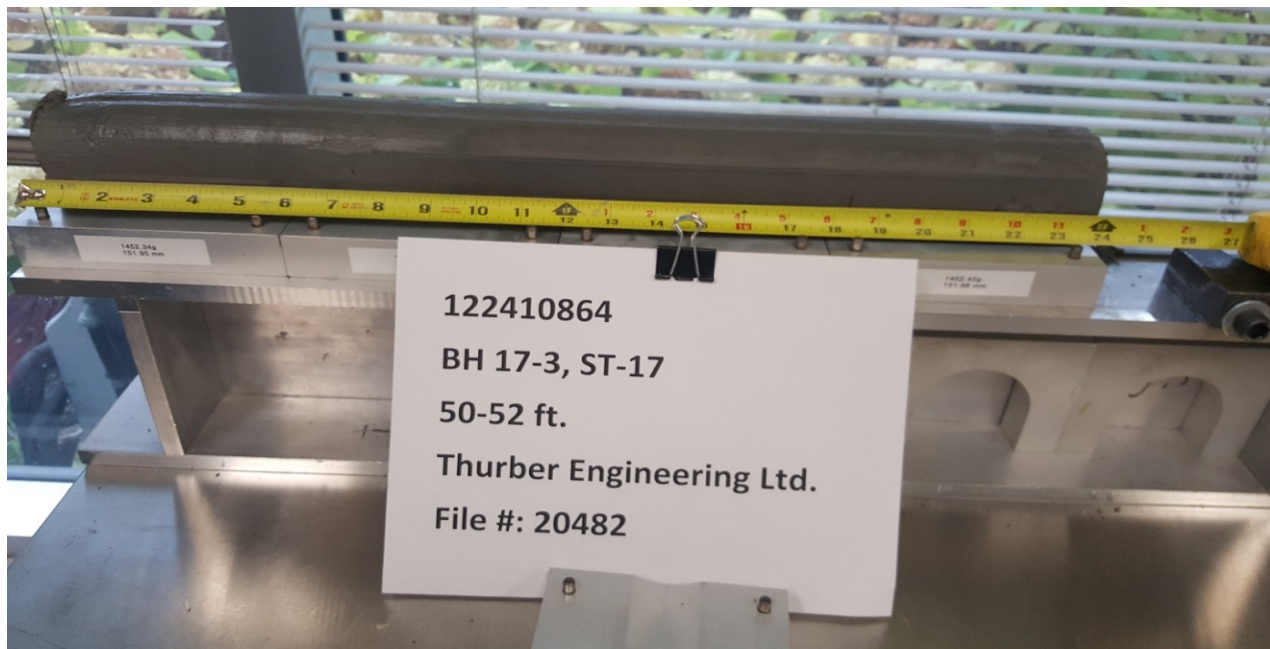


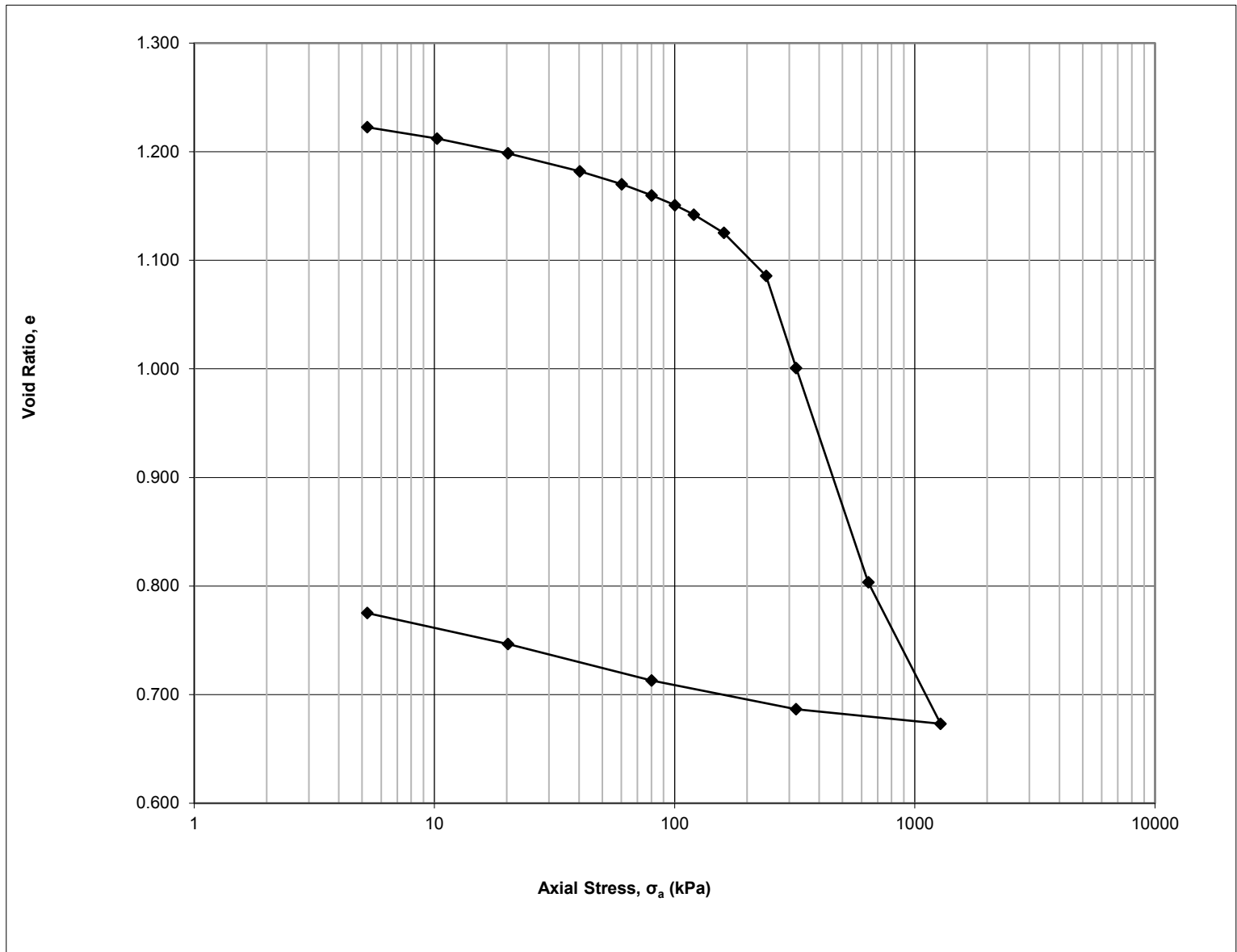
Photo No.: 1 Borehole: BH 17-3, ST 17 Depth: 50-52 ft



Photo No.: 2 Borehole: BH 17-3, ST 17 Depth: 50-52 ft

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

**Thurber Engineering, File# 20482**  
**122410864**  
**17-2**  
**ST 9**  
**35-37 ft**



## One-Dimensional Consolidation Test using Incremental Loading

### ASTM D2435/D2435M - 11

1-Nov-17  
1-Nov-17

Date:  
Date:

D. Boateng  
R. Hache

Checked by:  
Approved by:

**Specimen Details**

Project Name	Thurber Engineering, File# 20482
Project Location	Lochiel, ON
Borehole	17-2
Sample No.	ST 9
Depth	35-37 ft
Sample Date	September 25, 2017
Test Number	Two
Technician Name	Daniel Boateng

**Soil Description & Classification**

Not Requested	
Specific Gravity of Solids	2.746
Average water content of trimmings %	45
<b>Additional Notes (information source, occurrence and size of large isolated particles etc.)</b>	
Specific Gravity of Solids Assumed	

**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	69.92
Dry Mass	g	48.38
Density	Mg/m <sup>3</sup>	1.780
Dry Density	Mg/m <sup>3</sup>	1.232
Water Content	%	44.52
Degree of Saturation	%	99.5
Height of Solids	mm	8.97
Initial Void Ratio		1.229

**Final Specimen Conditions**

Water Content	%	30.07
Final Void Ratio		0.775

## One-Dimensional Consolidation Test using Incremental Loading

### ASTM D2435/D2435M - 11

**Specimen Details**

Project Name	Thurber Engineering, File# 20482
Project Location	Lochiel, ON
Borehole	17-2
Sample No.	ST 9
Depth	35-37 ft
Sample Date	September 25, 2017
Test Number	Two
Technician Name	Daniel Boateng

**Test Procedure**

Date Started	October 30, 2017
Date Finished	November 1, 2017
Machine Number	Frame D
Cell Number	D
Ring Number	D
Trimming Procedure	Turntable
Moisture Condition	Inundated
Axial Stress at Inundation	5 kPa
Water Used	Distilled
Test Method	B
Interpretation Procedure for $c_v$	2

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

--

**Calculations**

Load Increment	Increment Duration  min	Axial Stress $\sigma_a$ kPa	Corrected Deformation $\Delta H$ mm	Specimen Height H mm	Axial Strain $\epsilon_a$ %	Void Ratio e
Seating	0.0	5	0.0000	20.0000	0.00	1.229
1	14.8	5	0.0576	19.9424	0.29	1.223
2	14.8	10	0.1507	19.8493	0.75	1.212
3	21.5	20	0.2735	19.7265	1.37	1.198
4	19.8	40	0.4214	19.5786	2.11	1.182
5	19.8	60	0.5284	19.4716	2.64	1.170
6	28.3	80	0.6203	19.3797	3.10	1.160
7	24.8	100	0.7016	19.2984	3.51	1.151
8	29.8	120	0.7803	19.2197	3.90	1.142
9	34.8	160	0.9306	19.0694	4.65	1.125
10	64.8	240	1.2849	18.7151	6.42	1.086
11	183.5	320	2.0464	17.9536	10.23	1.001
12	132.0	640	3.8172	16.1828	19.09	0.804
13	87.0	1280	4.9864	15.0136	24.93	0.673
14	15.0	320	4.8663	15.1337	24.33	0.687
15	28.3	80	4.6286	15.3714	23.14	0.713
16	53.3	20	4.3271	15.6729	21.64	0.747
17	68.5	5	4.0719	15.9281	20.36	0.775

## One-Dimensional Consolidation Test using Incremental Loading

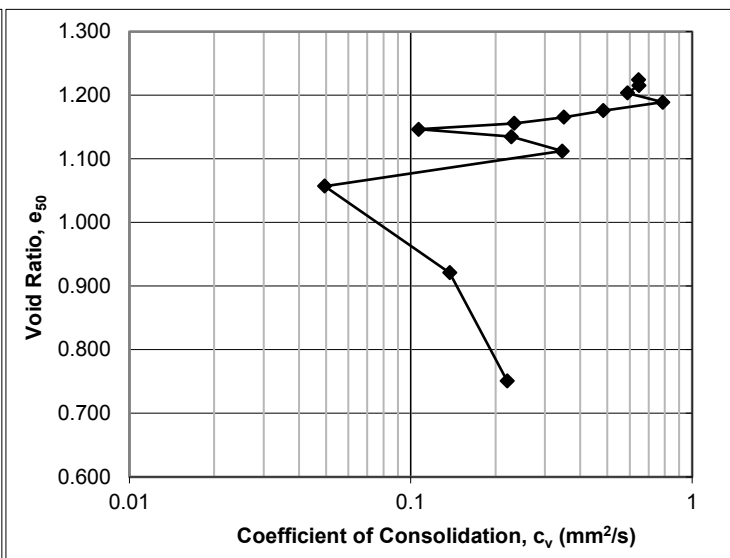
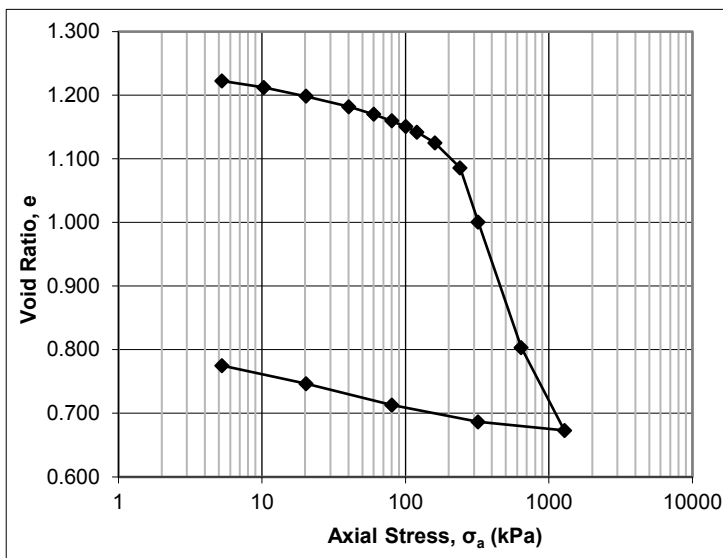
### ASTM D2435/D2435M - 11

**Specimen Details**

Project Name	Thurber Engineering, File# 20482
Project Location	Lochiel, ON
Borehole	17-2
Sample No.	ST 9
Depth	35-37 ft
Sample Date	September 25, 2017
Test Number	Two
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	3								
1	5	0.0411	19.9589	0.21	1.224			131	6.44E-01
2	8	0.1198	19.8802	0.60	1.216			129	6.48E-01
3	15	0.2283	19.7717	1.14	1.203			141	5.89E-01
4	30	0.3571	19.6429	1.79	1.189			104	7.86E-01
5	50	0.4767	19.5233	2.38	1.176			167	4.83E-01
6	70	0.5692	19.4308	2.85	1.165			229	3.50E-01
7	90	0.6562	19.3438	3.28	1.156			341	2.33E-01
8	110	0.7406	19.2594	3.70	1.146			737	1.07E-01
9	140	0.8425	19.1575	4.21	1.135			342	2.28E-01
10	200	1.0466	18.9534	5.23	1.112			221	3.45E-01
11	280	1.5415	18.4585	7.71	1.057			1461	4.95E-02
12	480	2.7615	17.2385	13.81	0.921			458	1.38E-01
13	960	4.2882	15.7118	21.44	0.751			238	2.20E-01
14	800	4.8863	15.1137	24.43	0.684				
15	200	4.7122	15.2878	23.56	0.704				
16	50	4.4499	15.5501	22.25	0.733				
17	13	4.3078	15.6922	21.54	0.749				







Project No.: 122410864

Project Name: Thurber, File# 20482

Photo Log

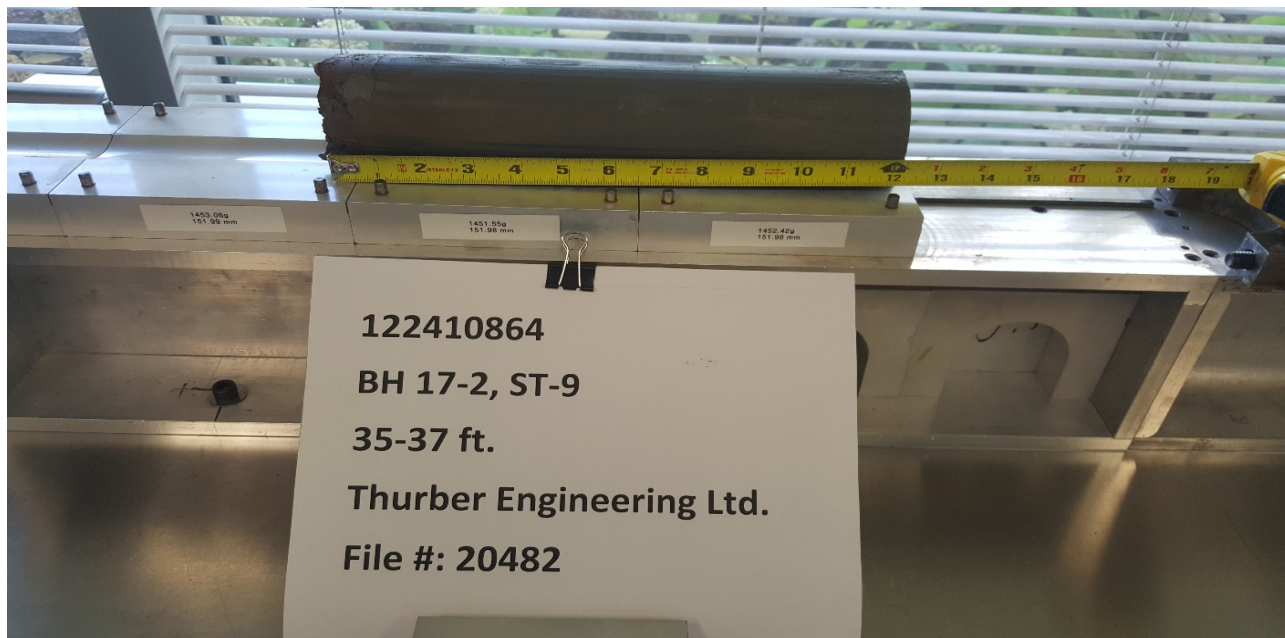


Photo No.: 1 Borehole: BH 17-2, ST 9 Depth: 35-37 ft

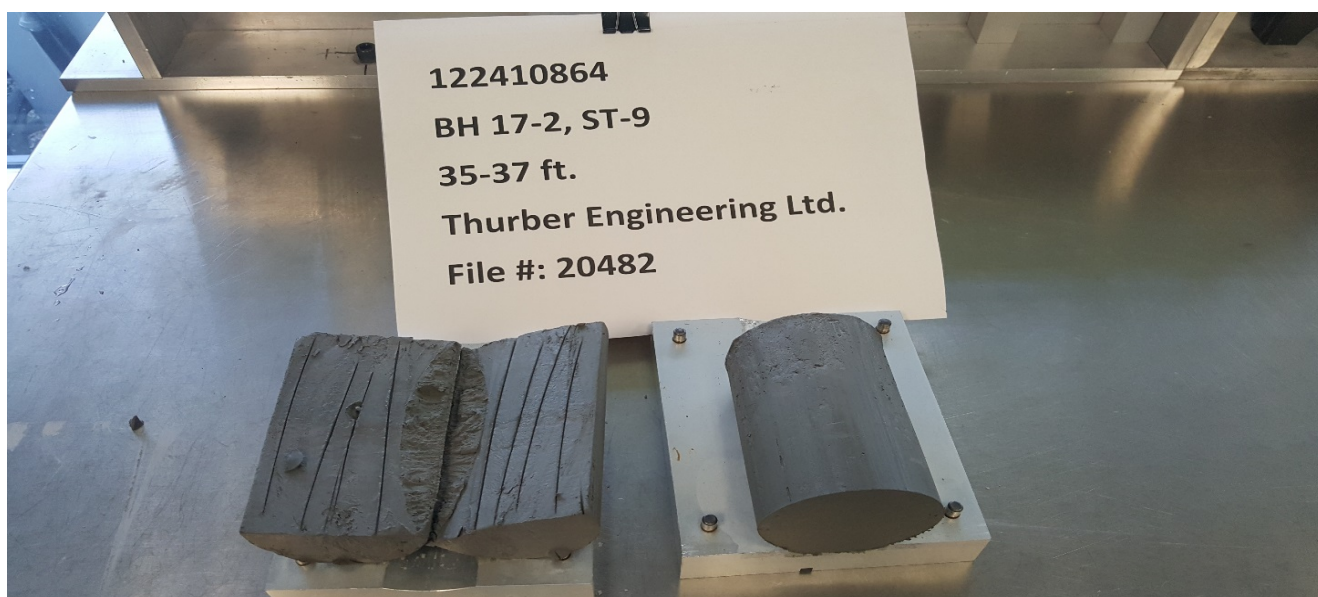


Photo No.: 2 Borehole: BH 17-2, ST 9 Depth: 35-37 ft



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

July 9, 2018  
File: 122410864

**Attention: Kenton Power**  
Thurber Engineering Ltd.  
104 – 2460 Lancaster Road  
Ottawa, Ontario, Canada, K1B 4S5  
Tel: 613-274-2121  
E-mail: kpower@thurber.ca

Dear Mr. Power,

**Reference: Consolidation Test Results for Locha Creek Culvert Project, Thurber Consulting Ltd.,  
File #20482: BH 18-101, ST 5 & 9, sampled on June 11, 2018**

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

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

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

Regards,

**STANTEC CONSULTING LTD.**

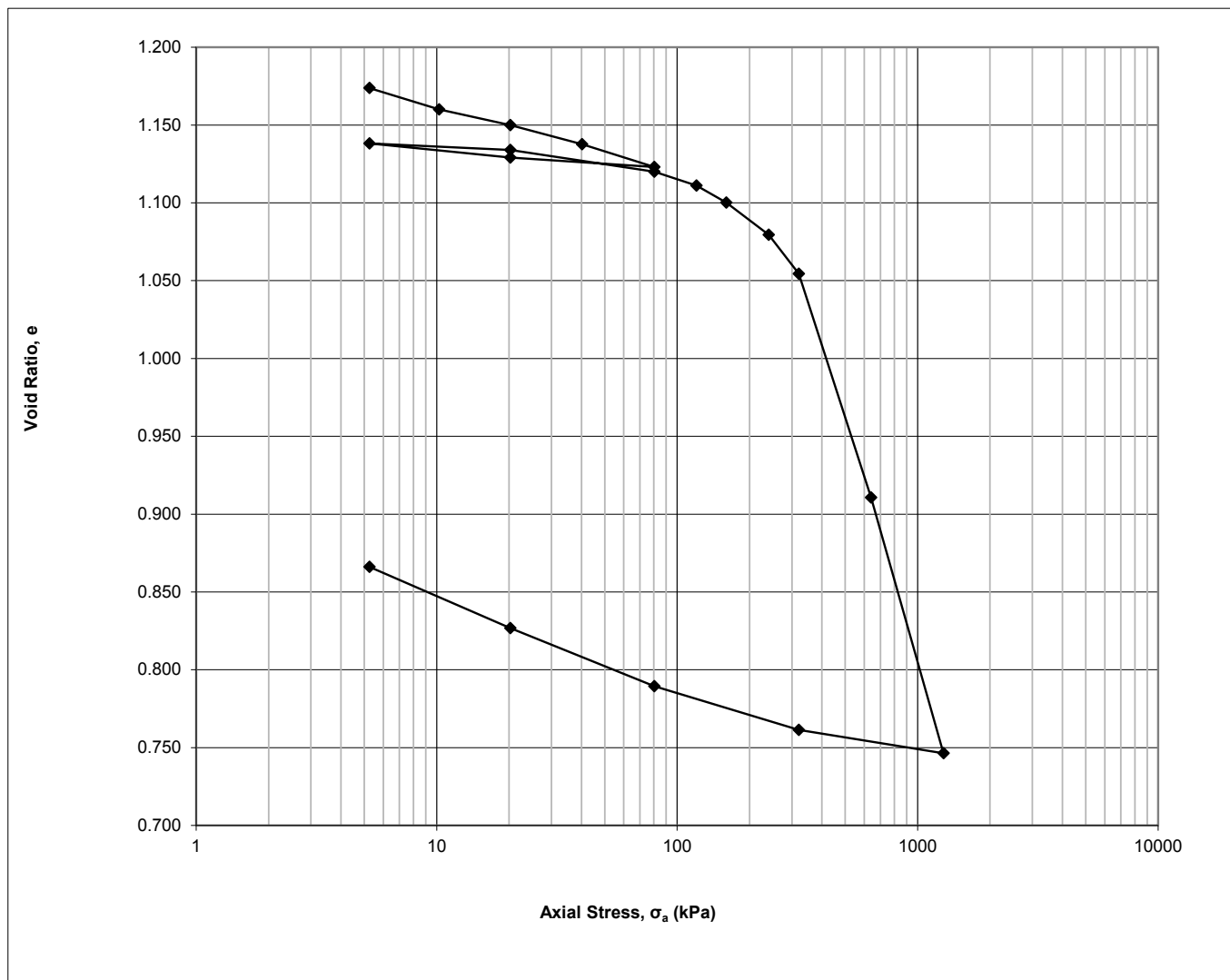
A handwritten signature in blue ink, appearing to read "Ramy Saadeldin", written over a horizontal line.

Ramy Saadeldin, Ph.D., P.Eng.  
Geotechnical Engineering  
Phone: (613) 738-6047  
Fax: (613) 722-2799  
Ramy.Saadeldin@stantec.com

v:\01216\active\laboratory\_standing\_offers\2018 laboratory standing offers\122410864 thurber engineering ltd\june 11, two consolidation, one specific gravity\consolidation letter & results\122410864\_let\_consolidationresults\_bh 18-101 st 5 9.docx

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

**Thurber Engineering, File# 20482**  
**122410864**  
**BH 18-101**  
**ST 5**  
**15 - 17 ft.**





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

7-Jul-18  
7-Jul-18

Date: Date:

D. Boateng  
R. Hache

Checked by:  
Approved by:

**Specimen Details**

Project Name	Thurber Engineering, File# 20482
Project Location	HWY 17, Ontario
Borehole	BH 18-101
Sample No.	ST 5
Depth	15 - 17 ft.
Sample Date	June 11, 2018
Test Number	One
Technician Name	Daniel Boateng

**Soil Description & Classification**

Silty Clay, Brown/Grey, Fissured, Moist	
Specific Gravity of Solids	2.750
Average water content of trimmings %	43
<b>Additional Notes (information source, occurrence and size of large isolated particles etc.)</b>	

**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	70.21
Dry Mass	g	49.16
Density	Mg/m <sup>3</sup>	1.788
Dry Density	Mg/m <sup>3</sup>	1.252
Water Content	%	42.82
Degree of Saturation	%	98.4
Height of Solids	mm	9.10
Initial Void Ratio		1.197

**Final Specimen Conditions**

Water Content	%	34.86
Final Void Ratio		0.866

## One-Dimensional Consolidation Test using Incremental Loading

### ASTM D2435/D2435M - 11

**Specimen Details**

Project Name	Thurber Engineering, File# 20482
Project Location	HWY 17, Ontario
Borehole	BH 18-101
Sample No.	ST 5
Depth	15 - 17 ft.
Sample Date	June 11, 2018
Test Number	One
Technician Name	Daniel Boateng

**Test Procedure**

Date Started	June 22, 2018
Date Finished	July 3, 2018
Machine Number	Frame C
Cell Number	C
Ring Number	C
Trimming Procedure	Turntable
Moisture Condition	Inundated
Axial Stress at Inundation kPa	5
Water Used	Distilled
Test Method	A
Interpretation Procedure for $c_v$	2

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

--

**Calculations**

Load Increment	Increment Duration	Axial Stress $\sigma_a$ kPa	Corrected Deformation $\Delta H$ mm	Specimen Height H mm	Axial Strain $\epsilon_a$ %	Void Ratio e
Seating	0.0	5	0.0000	20.0000	0.00	1.197
1	720.0	5	0.2093	19.7907	1.05	1.174
2	720.0	10	0.3335	19.6665	1.67	1.160
3	720.0	20	0.4253	19.5747	2.13	1.150
4	720.0	40	0.5376	19.4624	2.69	1.138
5	720.0	80	0.6706	19.3294	3.35	1.123
6	720.0	20	0.6159	19.3841	3.08	1.129
7	720.0	5	0.5332	19.4668	2.67	1.138
8	720.0	20	0.5716	19.4284	2.86	1.134
9	720.0	80	0.6981	19.3019	3.49	1.120
10	1440.0	120	0.7793	19.2207	3.90	1.111
11	1440.0	160	0.8794	19.1206	4.40	1.100
12	1440.0	240	1.0681	18.9319	5.34	1.079
13	720.0	320	1.2957	18.7043	6.48	1.054
14	720.0	640	2.6039	17.3961	13.02	0.911
15	720.0	1280	4.1005	15.8995	20.50	0.746
16	720.0	320	3.9638	16.0362	19.82	0.761
17	720.0	80	3.7079	16.2921	18.54	0.789
18	720.0	20	3.3679	16.6321	16.84	0.827
19	720.0	5	3.0108	16.9892	15.05	0.866

## One-Dimensional Consolidation Test using Incremental Loading

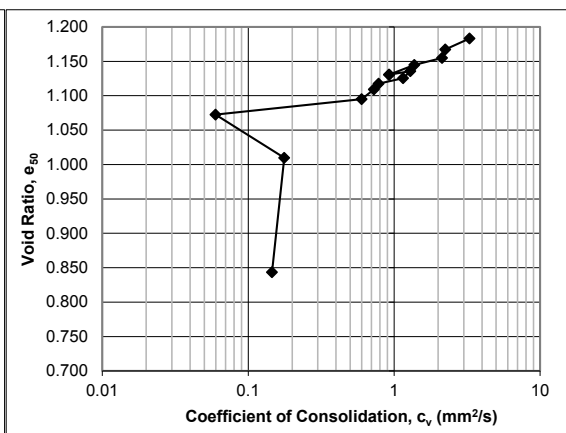
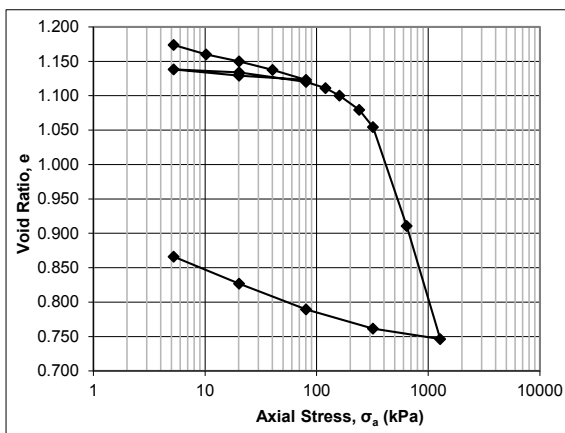
### ASTM D2435/D2435M - 11

**Specimen Details**

Project Name	Thurber Engineering, File# 20482
Project Location	HWY 17, Ontario
Borehole	BH 18-101
Sample No.	ST 5
Depth	15 - 17 ft.
Sample Date	June 11, 2018
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	3								
1	5	0.1235	19.8765	0.62	1.183			25	3.29E+00
2	8	0.2685	19.7315	1.34	1.167			37	2.24E+00
3	15	0.3807	19.6193	1.90	1.155			38	2.13E+00
4	30	0.4727	19.5273	2.36	1.145			59	1.38E+00
5	60	0.6017	19.3983	3.01	1.131			86	9.26E-01
6	50	0.6319	19.3681	3.16	1.127				
7	13	0.5718	19.4282	2.86	1.134				
8	13	0.5570	19.4430	2.79	1.136			62	1.29E+00
9	50	0.6480	19.3520	3.24	1.126			69	1.15E+00
10	100	0.7217	19.2783	3.61	1.117			101	7.83E-01
11	140	0.7983	19.2017	3.99	1.109			108	7.26E-01
12	200	0.9248	19.0752	4.62	1.095			129	6.00E-01
13	280	1.1317	18.8683	5.66	1.072			1264	5.97E-02
14	480	1.7040	18.2960	8.52	1.010			401	1.77E-01
15	960	3.2145	16.7855	16.07	0.844			410	1.46E-01
16	800	4.0149	15.9851	20.07	0.756				
17	200	3.8295	16.1705	19.15	0.776				
18	50	3.5539	16.4461	17.77	0.806				
19	13	3.2472	16.7528	16.24	0.840				





Project No.: 122410864

Project Name: Thurber Engineering, File# 20482

Photo Log

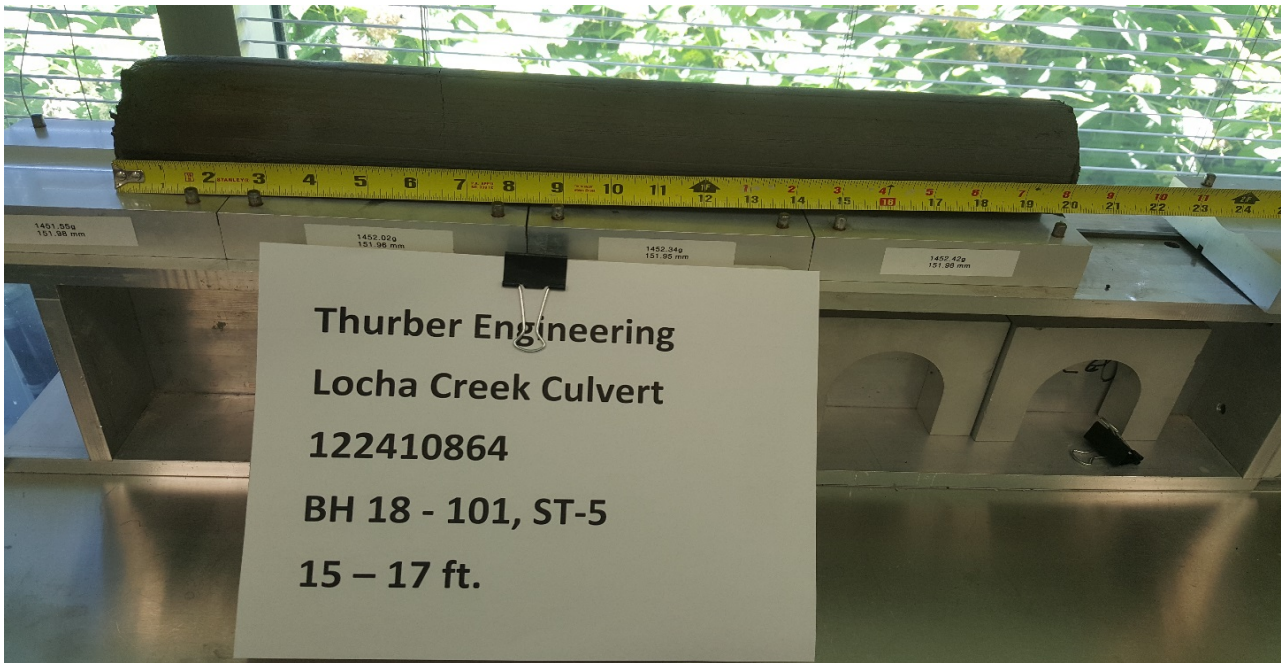


Photo No.:

1

Borehole: BH 18-101 ST 5

Depth: 15 - 17 ft.



Photo No.:

2

Borehole: BH 18-101 ST 5

Depth: 15 - 17 ft.





Project No.: 122410864

Project Name: Thurber Engineering, File# 20482

Photo Log



Photo No.:

3

Borehole: BH 18-101 ST 5

Depth: 15 - 17 ft.



Photo No.:

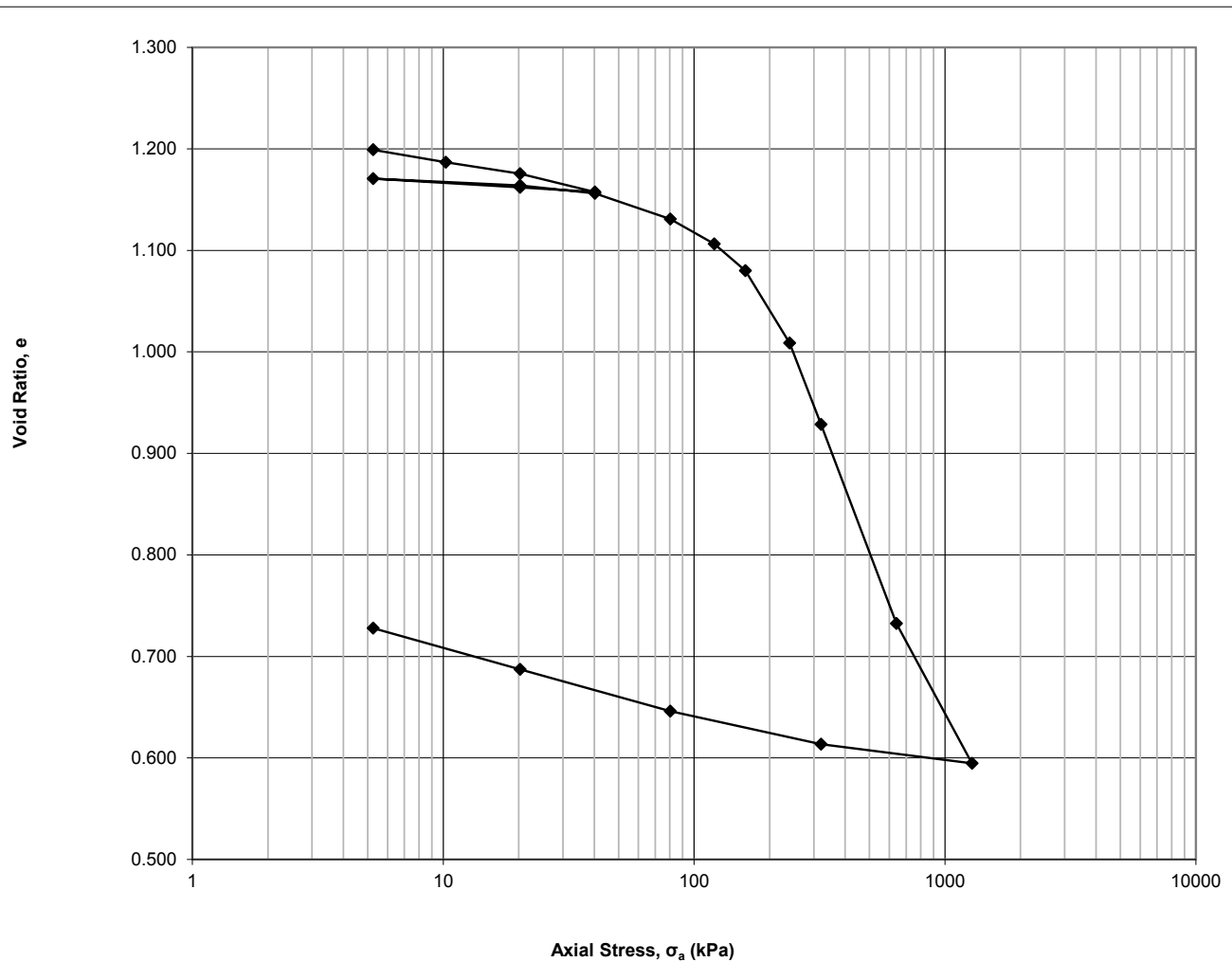
4

Borehole: BH 18-101 ST 5

Depth: 15 - 17 ft.

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

**Thurber Engineering, File# 20482**  
**122410864**  
**BH 18-101**  
**ST 9**  
**35 - 37 ft.**



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

7-Jul-18  
7-Jul-18

Date:  
Date:

D. Boateng  
R. Hache

Checked by:  
Approved by:

**Specimen Details**

Project Name	Thurber Engineering, File# 20482
Project Location	HWY 17, Ontario
Borehole	BH 18-101
Sample No.	ST 9
Depth	35 - 37 ft.
Sample Date	June 11, 2018
Test Number	Two
Technician Name	Daniel Boateng

**Soil Description & Classification**

Silty Clay, Grey, Wet	
Specific Gravity of Solids	2.750
Average water content of trimmings %	45
<b>Additional Notes (information source, occurrence and size of large isolated particles etc.)</b>	
Specific Gravity of Solids Assumed	

**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	70.81
Dry Mass	g	48.84
Density	Mg/m <sup>3</sup>	1.803
Dry Density	Mg/m <sup>3</sup>	1.244
Water Content	%	44.98
Degree of Saturation	%	100.0
Height of Solids	mm	9.05
Initial Void Ratio		1.211

**Final Specimen Conditions**

Water Content	%	33.27
Final Void Ratio		0.728

## One-Dimensional Consolidation Test using Incremental Loading

### ASTM D2435/D2435M - 11

**Specimen Details**

Project Name	Thurber Engineering, File# 20482
Project Location	HWY 17, Ontario
Borehole	BH 18-101
Sample No.	ST 9
Depth	35 - 37 ft.
Sample Date	June 11, 2018
Test Number	Two
Technician Name	Daniel Boateng

**Test Procedure**

Date Started	June 22, 2018
Date Finished	July 3, 2018
Machine Number	Frame D
Cell Number	D
Ring Number	D
Trimming Procedure	Turntable
Moisture Condition	Inundated
Axial Stress at Inundation kPa	5
Water Used	Distilled
Test Method	A
Interpretation Procedure for $c_v$	2

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

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**Calculations**

Load Increment	Increment Duration min	Axial Stress $\sigma_a$ kPa	Corrected Deformation $\Delta H$ mm	Specimen Height H mm	Axial Strain $\epsilon_a$ %	Void Ratio e
Seating	0.0	5	0.0000	20.0000	0.00	1.211
1	720.0	5	0.1089	19.8911	0.54	1.199
2	720.0	10	0.2195	19.7805	1.10	1.187
3	720.0	20	0.3210	19.6790	1.61	1.176
4	720.0	40	0.4844	19.5156	2.42	1.158
5	720.0	20	0.4446	19.5554	2.22	1.162
6	720.0	5	0.3650	19.6350	1.83	1.171
7	720.0	20	0.4256	19.5744	2.13	1.164
8	720.0	40	0.4975	19.5025	2.49	1.156
9	1440.0	80	0.7250	19.2750	3.63	1.131
10	1440.0	120	0.9479	19.0521	4.74	1.106
11	1440.0	160	1.1869	18.8131	5.93	1.080
12	720.0	240	1.8311	18.1689	9.16	1.009
13	720.0	320	2.5549	17.4451	12.77	0.929
14	720.0	640	4.3293	15.6707	21.65	0.733
15	720.0	1280	5.5757	14.4243	27.88	0.595
16	720.0	320	5.4056	14.5944	27.03	0.614
17	720.0	80	5.1101	14.8899	25.55	0.646
18	720.0	20	4.7390	15.2610	23.70	0.687
19	720.0	5	4.3705	15.6295	21.85	0.728



## One-Dimensional Consolidation Test using Incremental Loading

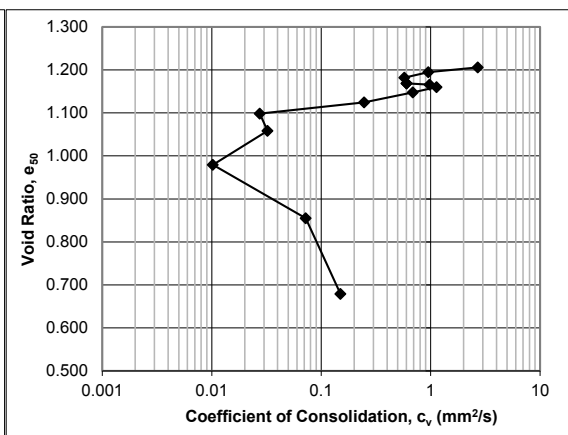
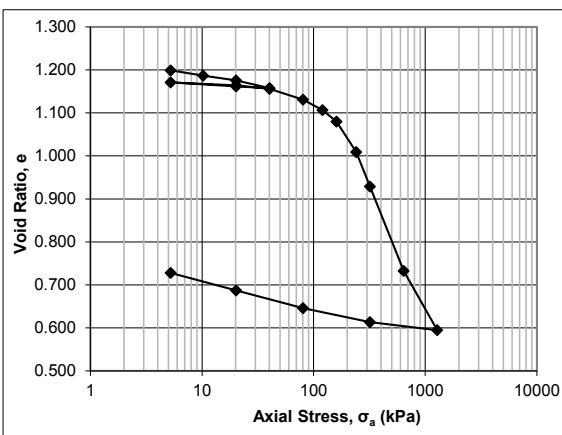
### ASTM D2435/D2435M - 11

**Specimen Details**

Project Name	Thurber Engineering, File# 20482
Project Location	HWY 17, Ontario
Borehole	BH 18-101
Sample No.	ST 9
Depth	35 - 37 ft.
Sample Date	June 11, 2018
Test Number	Two
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	3								
1	5	0.0473	19.9527	0.24	1.206			31	2.70E+00
2	8	0.1455	19.8545	0.73	1.195			88	9.55E-01
3	15	0.2642	19.7358	1.32	1.182			143	5.76E-01
4	30	0.3842	19.6158	1.92	1.169			135	6.05E-01
5	30	0.4595	19.5405	2.30	1.160				
6	13	0.3947	19.6053	1.97	1.168				
7	13	0.4081	19.5919	2.04	1.166			83	9.77E-01
8	30	0.4614	19.5386	2.31	1.160			71	1.13E+00
9	60	0.5709	19.4291	2.85	1.148			116	6.90E-01
10	100	0.7809	19.2191	3.90	1.125			317	2.47E-01
11	140	1.0188	18.9812	5.09	1.099			2775	2.75E-02
12	200	1.3809	18.6191	6.90	1.058			2277	3.23E-02
13	280	2.0988	17.9012	10.49	0.979			6626	1.03E-02
14	480	3.2219	16.7781	16.11	0.855			825	7.23E-02
15	960	4.8114	15.1886	24.06	0.679			326	1.50E-01
16	800	5.4659	14.5341	27.33	0.607				
17	200	5.2376	14.7624	26.19	0.632				
18	50	4.9354	15.0646	24.68	0.665				
19	13	4.5921	15.4079	22.96	0.703				





Project No.: 122410864

Project Name: Thurber Engineering, File# 20482

Photo Log

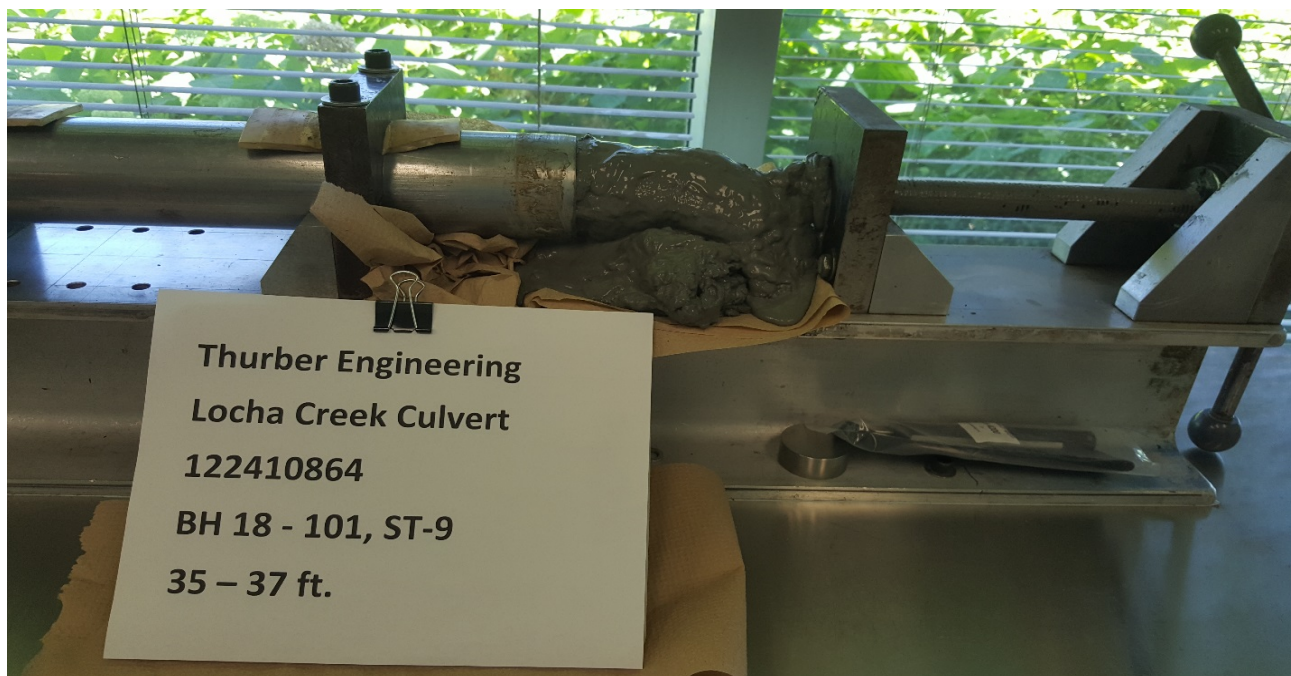


Photo No.: 1

Borehole: BH 18-101 ST 9

Depth: 35 - 37 ft.

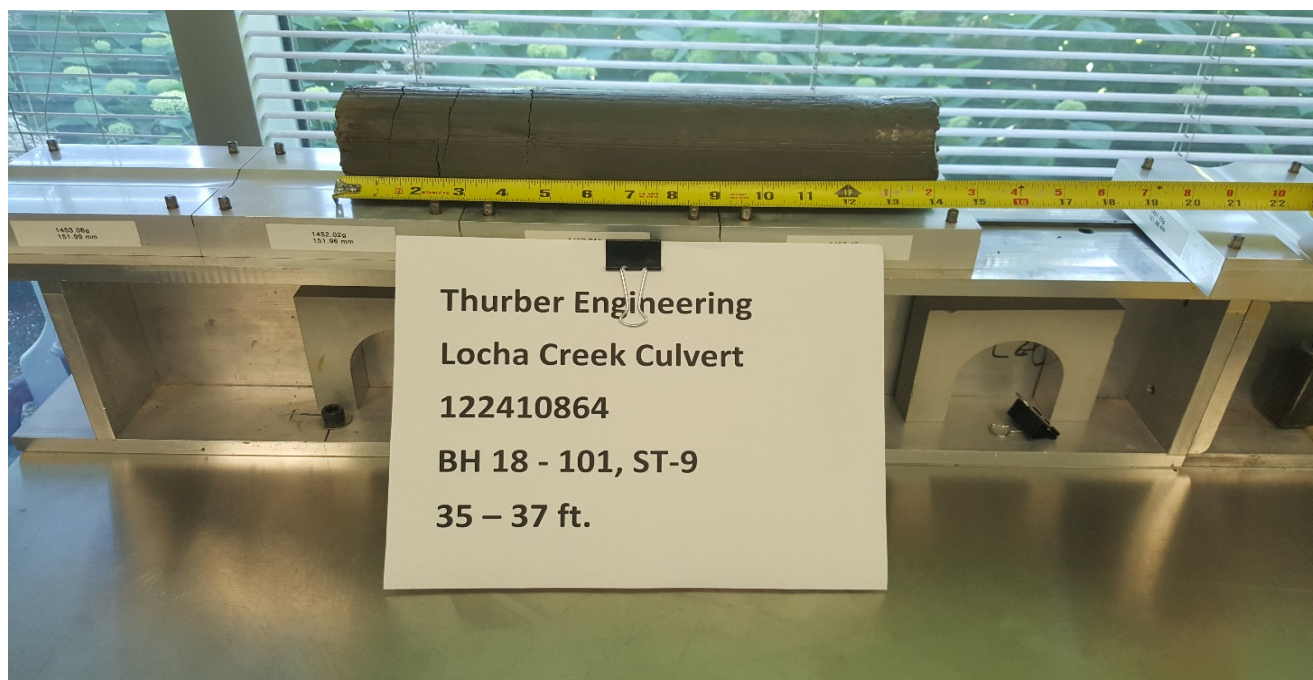


Photo No.: 2

Borehole: BH 18-101 ST 9

Depth: 35 - 37 ft.



Project No.: 122410864

Photo Log

Project Name: Thurber Engineering, File# 20482

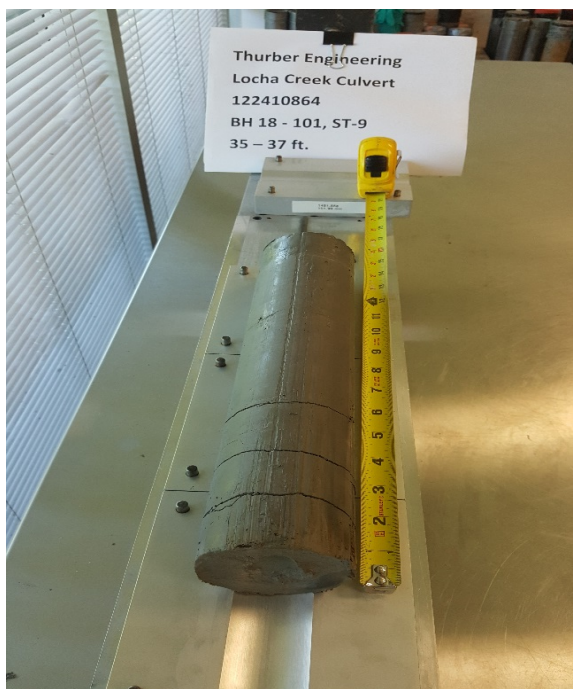


Photo No.:

3

Borehole: BH 18-101 ST 9

Depth: 35 – 37 ft.



Photo No.:

4

Borehole: BH 18-101 ST 9

Depth: 35 – 37 ft.



**Borehole 18-101**  
**Run 1 to 3 (of 3)**  
**Elevation 104.0 m to 100.3 m**



**THURBER** ENGINEERING LTD.

**Foundation Investigation**  
**Locha Creek Culvert Replacement**

**GWP: 4061-17-00**

**Project No.: 20482**

**Borehole 18-102**  
**Run 1 to 3 (of 3)**  
**Elevation 107.9 m to 104.7 m**



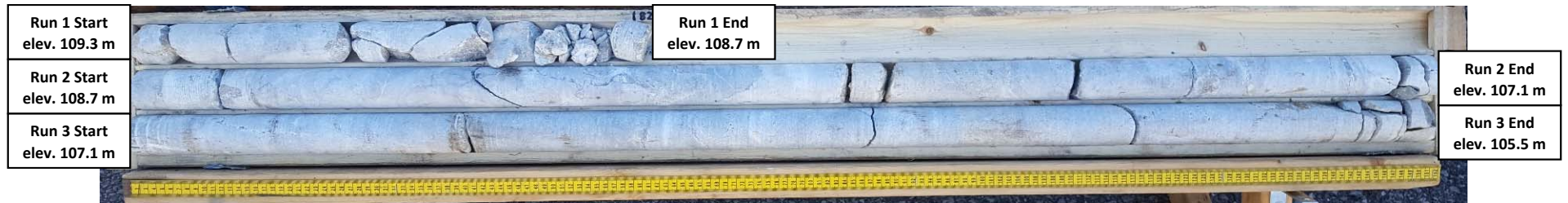
**THURBER** ENGINEERING LTD.

**Foundation Investigation**  
**Locha Creek Culvert Replacement**

**GWP: 4061-17-00**

**Project No.: 20482**

**Borehole 18-103**  
**Run 1 to 3 (of 3)**  
**Elevation 109.3 m to 105.5 m**



**THURBER** ENGINEERING LTD.

**Foundation Investigation**  
**Locha Creek Culvert Replacement**

**GWP: 4061-17-00**

**Project No.: 20482**



**Stantec**

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

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July 11, 2018  
File: 122410864

**Attention: Thurber Engineering Ltd., File #20482**

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

The table below summarizes three (3) rock core unconfined compressive strength results.

Location	Sample Depth	Compressive Strength (MPa)	Description of Break
18-101	Run 3 @ 103'10"	127.2	Diagonal fracture, no cracking in ends
18-102	Run 3 @ 106'	165.2	Specimen shattered
18-103	Run 3 @ 84'5"	156.0	Two well-formed cones both ends

Sincerely,

**Stantec Consulting Ltd**

Denis Rodriguez  
Laboratory Technician  
Tel: 613-738-6075  
[denis.rodriquez@stantec.com](mailto:denis.rodriquez@stantec.com)

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

Report Date: 03-Oct-2017

Order Date: 27-Sep-2017

**Project Description:**

<b>Client ID:</b>	17-6 SS4 7.5 to 9.5	17-1 SS5 10.5-12.5	-	-
<b>Sample Date:</b>	19-Sep-17	22-Sep-17	-	-
<b>Sample ID:</b>	1739321-01	1739321-02	-	-
<b>MDL/Units</b>	Soil	Soil	-	-

**Physical Characteristics**

% Solids	0.1 % by Wt.	67.2	67.4	-	-
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**General Inorganics**

pH	0.05 pH Units	7.90	7.72	-	-
Resistivity	0.10 Ohm.m	8.49	17.3	-	-

**Anions**

Chloride	5 ug/g dry	741	174	-	-
Sulphate	5 ug/g dry	16	69	-	-



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

Report Date: 25-Jun-2018

Order Date: 19-Jun-2018

**Project Description: 20482**

**Client ID:** BH18-101 SS2B 3'6"  
to 4'6"

**Sample Date:** 06/11/2018 09:00

**Sample ID:** 1825316-01

**MDL/Units** Soil

-

-

-

-

-

-

-

-

-

-

-

-

#### Physical Characteristics

% Solids	0.1 % by Wt.	69.5	-	-	-
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#### General Inorganics

Conductivity	5 uS/cm	137	-	-	-
pH	0.05 pH Units	7.32	-	-	-
Resistivity	0.10 Ohm.m	72.8	-	-	-

#### Anions

Chloride	5 ug/g dry	18	-	-	-
Sulphate	5 ug/g dry	20	-	-	-

## Subcontracted Analysis

**Thurber Engineering Ltd.**

2460 Lancaster Rd, Unit 107  
Ottawa, ON K1B4S5  
Attn: Kenton Power

Tel: (613) 247-2121  
Fax: (613) 247-2185

Paracel Report No **1825316**

Client Project(s): **20482**

Client PO:

Reference: **Standing Offer**

CoC Number: **39858**

Order Date: 19-Jun-18  
Report Date: 28-Jun-18

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
1825316-01	BH18-101 SS2B 3'6" to 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,

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

28-June-2018

**Date Rec. :** 21 June 2018  
**LR Report:** CA12710-JUN18  
**Reference:** Project#: 1825316

**Copy:** #1

## CERTIFICATE OF ANALYSIS

### Final Report

Sample ID	Sample Date & Time	Sulphide %
1: Analysis Start Date		28-Jun-18
2: Analysis Start Time		13:23
3: Analysis Approval Date		28-Jun-18
4: Analysis Approval Time		14:45
5: QC - Blank		< 0.02
6: QC - STD % Recovery		105%
7: QC - DUP % RPD		ND
8: RL		0.005
9: BH18-101 SS2B 3'6 to 4'6	11-Jun-18	< 0.02

RL - SGS Reporting Limit  
ND - Not Detected

Kimberley Didsbury  
Project Specialist  
Environmental Services, Analytical

**APPENDIX D**  
**SITE PHOTOGRAPHS**



**Photograph 1: Roadway platform over existing culvert looking northwest along Highway 17 (2017-09-22)**



**Photograph 2: Looking north towards the existing culvert inlet (2018-06-14)**





**Photograph 3: Looking south towards the existing culvert outlet (2017-09-22)**



**Photograph 4: North embankment looking west towards existing culvert (2018-06-14)**





**Photograph 5: South embankment looking west towards culvert inlet (2018-06-14)**



**Photograph 6: Looking north from Highway 17 towards Miller Road (2017-09-06)**