THURBER ENGINEERING LTD.

FINAL

FOUNDATION INVESTIGATION REPORT
HIGHWAY 11 CULVERT
4.2 KM SOUTH OF HIGHWAY 101, BOWMAN TOWNSHIP
NEAR STATION 20+165

G.W.P. 5054-01-00

Geocres No.: 42A00-119

Report to:

McIntosh Perry Consulting Engineers Limited

Latitude: 48.50272°
Longitude: -80.43515°

October 2018
Thurber File No.: 13058

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FINAL
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PART 1. FACTUAL INFORMATION

1 INTRODUCTION

This section of the report presents the factual findings obtained from a foundation investigation completed at the Highway 11 culvert crossing near Station 20+165. The culvert is located approximately 4.2 km south of Highway 101 within Bowman Township. Thurber Engineering Limited (Thurber) carried out the current investigation as a sub-consultant to McIntosh Perry Consulting Engineers Ltd. (MPCE) under Agreement No. 5015-E-0041.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions influencing design and construction was developed in the course of the current investigation. No previous foundation investigation information was available for the subject culvert site within the Geocres library.

2 SITE DESCRIPTION

The existing culvert is a non-structural single-span timber culvert reported to be 950 mm wide by 900 mm high and approximately 32.4 m long with a generally east to west alignment. The flow through the culvert is to the east.

At the location of the culvert at Station 20+160 (Linear Highway Referencing System Base Point: 17450, Offset: 10.2), Highway 11 is a two-lane highway with a rural cross-section and gravel shoulders. The Highway 11 embankment fill height is approximately 4.6 m with the road surface at approximate elevation 283.3 m. The existing embankment slopes are inclined between approximately 2H:1V to 3H:1V. No guiderails are present in the vicinity of the culvert. The land adjacent to the highway is generally undeveloped and densely vegetated with shrubs and trees. Single family dwellings are located near the culvert on both the northeast and southwest sides. Traffic volumes on Highway 11 are understood to be 3,250 AADT (2016).

Select photographs showing the existing conditions in the area of the culvert are included in Appendix D for reference.

3 SITE INVESTIGATION AND FIELD TESTING

The initial site investigation and field testing program was carried out between October 17th and October 20th, 2016. A supplemental site investigation was carried out between May 1st and May 8th, 2018. The field investigations consisted of advancing six boreholes identified as 16-01 through 16-04, 18-05 and 18-06. The drilling was carried out using portable equipment for off-road boreholes 16-03, 16-04 and 18-06, a track mounted CME 850 drill rig for the on-road boreholes 16-01 and 16-02 and a truck mounted CME 55 drill rig for on-road borehole 18-05. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Boreholes 16-03, 16-04 and 18-06, which were drilled with portable equipment, also utilized a full-weight hammer for SPT testing. In-situ shear vane testing was completed in the cohesive soils deposits. The boreholes were sampled to depths ranging from 7.5 to 15.8 m (elev. 271.8 to 267.4 m) below the existing ground surface.

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

A 19 mm diameter standpipe piezometer was installed in Borehole 16-03 to allow for measurements of the groundwater level after completion of drilling. The piezometer installation details are illustrated on the respective Record of Borehole sheet, provided in Appendix B. Following completion of the field investigation the remaining boreholes were backfilled in accordance with MOE requirements (O.Reg. 903 as amended). Boreholes 16-01, 16-02 and 18-05 were capped with 150 mm of cold patch asphalt to reinstate the traveling surface.

The borehole locations are shown on the Borehole Locations and Soil Strata Drawing included in Appendix A. The coordinates and elevation of the boreholes are provided on this drawing and on the individual Record of Borehole sheets.

4 LABORATORY TESTING

The recovered soil samples were subjected to visual identification and to natural moisture content determination. Selected samples were also subjected to gradation analysis (hydrometer and/or sieve) and Atterberg Limit testing. The results of these tests are summarized on the Record of Borehole sheets included in Appendix B. Three samples of soil recovered from within the boreholes were selected and submitted for analytical testing of corrosivity parameters and sulphate content. All laboratory test results from the field investigation are provided in Appendix C.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and the Borehole Location and Soil Strata drawing included in Appendix A. A general description of the stratigraphy, based on the conditions encountered

in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description for interpretation of the site conditions. It must be recognized that the soil and groundwater conditions may vary between and beyond borehole locations.

In general terms, the site was found to be underlain by asphalt and granular fill over clay fill overlying a deposit of native clay underlain by silt. Bedrock was not encountered within the depth of investigation.

5.1 Embankment

5.1.1 Asphalt

Boreholes 16-01, 16-02 and 18-05 were drilled through the existing Highway 11 embankment and encountered a layer of asphalt with a thickness of 125 to 160 mm.

5.1.2 Fill: Sand with Gravel to Sand with Silt and Gravel

Non-cohesive granular fill was encountered below the asphalt in Boreholes 16-01, 16-02 and 18-05 and below a clay fill inter-layer in Borehole 18-05. The granular fill was found to range in composition from sand with gravel to sand with silt and gravel. The underside of the fill ranged in depth from 1.5 to 3.8 m below the existing roadway surface (elev. 281.8 to 279.3 m).

The SPT tests conducted in the unfrozen sand fill gave N-values typically ranging from 8 to 29 blows indicating a relative density of loose to compact. A single SPT test with a result as high as 100 blows for 250 mm of penetration was recorded near the surface of Borehole 16-01. At the time of drilling, the sand fill encountered in Borehole 18-05 was frozen and as a result those N-values have been omitted from the above ranges.

Recorded moisture contents ranged from 2 to 20%. The results of grain size analyses conducted on three samples of the sand fill are summarized below and are illustrated on Figure C1 of Appendix C.

Soil Particle	Percentage (%)
Gravel	7 - 39
Sand	56 - 84
Silt & Clay	5 - 9

5.1.3 Fill: Clay

A layer of clay fill with trace to some sand was encountered directly below the sand fill in Boreholes 16-01 and 16-02 and between sand fill layers in Borehole 18-05. The recorded thickness of the clay fill ranged from 0.4 to 3.1 m with an underside depth of 2.1 to 5.1 m below the existing roadway surface (elev. 281.0 to 278.1 m). Boreholes 16-03 and 16-04 encountered sandy clay fill from the surface to a depth of 1.4 to 1.5 m (elev. 278.2 m). An organic layer was observed in Borehole 16-01 near the base of the clay fill layer at a depth of 5.1 m.

The SPT tests conducted in the clay fill gave N-values ranging from 1 to 23 blows. Two field vane tests were performed within the fill and recorded undrained shear strength from

39 to 46 kPa. The clay fill is firm in consistency. Remolded field vane testing indicates that the clay fill shows some sensitivity.

The recorded moisture contents varied from 17 to 42%. The results of grain size analyses conducted on two samples of the clay fill material are summarized below and are illustrated on Figure C2 of Appendix C.

Soil Particle	Percentage (%)
Gravel	0
Sand	9 - 38
Silt	33 - 38
Clay	29 - 53

Atterberg Limit testing was completed on two samples of the clay fill. The results are summarized on the Record of Borehole sheets in Appendix B and the Atterberg Limit graphs are included in Figure C6 of Appendix C. The laboratory results are summarized below and indicate that the clay fill exhibits intermediate plasticity (CI)

Parameter	Value
Liquid Limit	36 - 39
Plastic Limit	14 - 20
Plasticity Index	16 - 25

5.2 Clay (CL to CI)

A native deposit of clay was encountered below the fill layers in Boreholes 16-01 through 16-04 and 18-05 and from ground surface in Borehole 18-06. The clay became silty with depth in Boreholes 16-03 and 18-06. Borehole 18-05 and 18-06 were terminated within this layer at a depth below ground surface of 7.5 to 11.3 m (elev. 271.8 to 269.6 m). Where fully penetrated in Boreholes 16-01 through 16-04, the layer had a thickness ranging from 6.1 m to 7.1 m with an underside elevation of 272.6 to 271.0 m. The SPT N-values ranged from weight of hammer to 14 blows. Field vane tests were performed within the deposit and recorded undrained shear strengths ranging from 29 to 98 kPa indicating a firm to stiff consistency. Remolded field vane testing indicates that the clay shows some sensitivity.

The moisture content of the samples tested ranged from 20% to 54%. The results of grain size analyses conducted on ten samples of the native clay are summarized below and are illustrated on Figures C3 and C4 in Appendix C.

Soil Particle	Percentage (%)
Gravel	0
Sand	0 - 39
Silt	26 - 60
Clay	30 - 70

Atterberg Limit testing was completed on ten samples of the native clay deposit. The results are summarized on the Record of Borehole sheets in Appendix B and the Atterberg Limit graphs are included in Figures C7 and C8 of Appendix C. The laboratory results are summarized below and indicate that the clay varies from low to intermediate plasticity (CL to CI).

Parameter	Value
Liquid Limit	27 - 43
Plastic Limit	13 - 21
Plasticity Index	7 - 26

5.3 Silt (ML)

A layer consisting of silt trace sand to sandy silt was encountered below the clay deposit in Boreholes 16-01 through 16-04. These boreholes were terminated in this stratum at a depth of 11.0 to 15.8 m (elev. 268.6 to 267.8 m). The SPT N-values ranged from 6 to 22 blows indicating a compact relative density.

The moisture content for the samples tested ranged from 18% to 26%. The results of grain size analyses conducted on three samples of the silt are summarized below and are illustrated on Figure C5 in Appendix C.

Soil Particle	Percentage (%)
Gravel	0
Sand	5 - 25
Silt	66 - 86
Clay	9 - 19

Atterberg Limit testing was completed on one sample of the silt deposit and indicates that the silt has low plasticity (ML).

5.4 Groundwater

At the completion of drilling, the groundwater level was measured at 10.8 m (elev. 268.9 m) below the ground surface within the standpipe piezometer installed in Borehole 16-03. The culvert was dry at the time of the field investigation. During a site visit on April 17, 2017 the standpipe was observed to be dry, however some water was observed in the culvert. The water level in the standpipe piezometer was recorded at 11.3 m below ground surface (elev. 268.4 m) on June 12, 2017 and was subsequently decommissioned at the same date.

During the 2018 field investigation, Borehole 18-05 was dry upon completion. An accurate water level could not be obtained within Borehole 18-06 due to water being introduced into the borehole as part of the drilling operation.

These observations are considered short term and it should be noted that the groundwater level at the time of construction may be different and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation.

5.5 Analytical Testing

Three samples of soil were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate and chloride concentrations, resistivity and conductivity. The analysis results are summarized in the table below:

Borehole	Sample	Depth (m)	Sulphate (μg/g)	pH	Resistivity (Ohm-cm)	Conductivity (uS/cm)	Chloride (μg/g)
16-03 (C6-3*)	SS2	0.7 – 1.4	21	7.5	1260	795	314
16-04 (C6-4*)	SS3a	1.5 – 1.8	14	7.6	2910	344	67
18-05	SS11	7.6 – 8.2	23	7.8	3250	308	56

Note: (*) sample label as submitted to Paracel

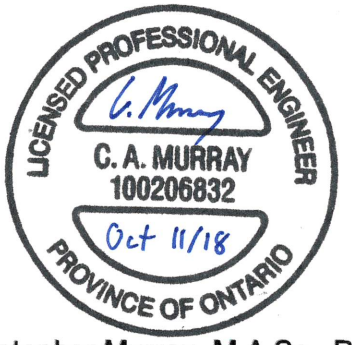
6 MISCELLANEOUS

Borehole locations were selected by Thurber relative to existing site features and the culvert location. The as-drilled locations and ground surface elevation of the 2016 borehole investigation were measured by McIntosh Perry following completion of the initial field program. Thurber surveyed the location of the boreholes from the 2018 field investigation based on benchmarks provided by MPCE.

Landcore Drilling of Chelmsford, Ontario supplied and operated the drilling equipment to conduct the drilling, soil sampling, in-situ testing and borehole decommissioning. The field investigation was supervised on a full-time basis by Mr. Jeff Morrison, E.I.T., Mr. Sean O'Bryan and Mr. Nick Weil of Thurber. Overall supervision of the investigation program was conducted by Mr. Stephen Peters, P.Eng.

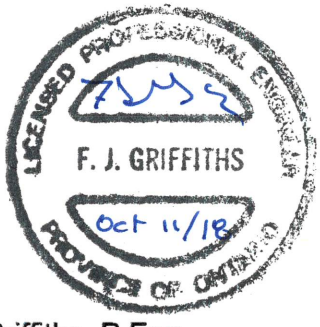
Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa, Ontario.

Interpretation of the factual data and preparation of this report were carried out by Mr. Christopher Murray, P.Eng. and Mr. Stephen Peters P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundation Projects.

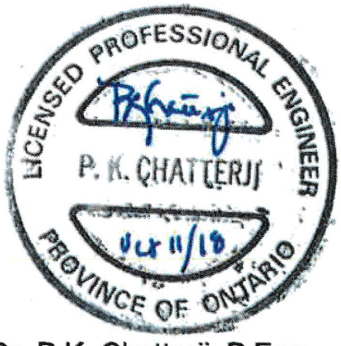


Christopher Murray, M.A.Sc., P.Eng.
Geotechnical Engineer

Stephen Peters, P.Eng.
Geotechnical Engineer



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

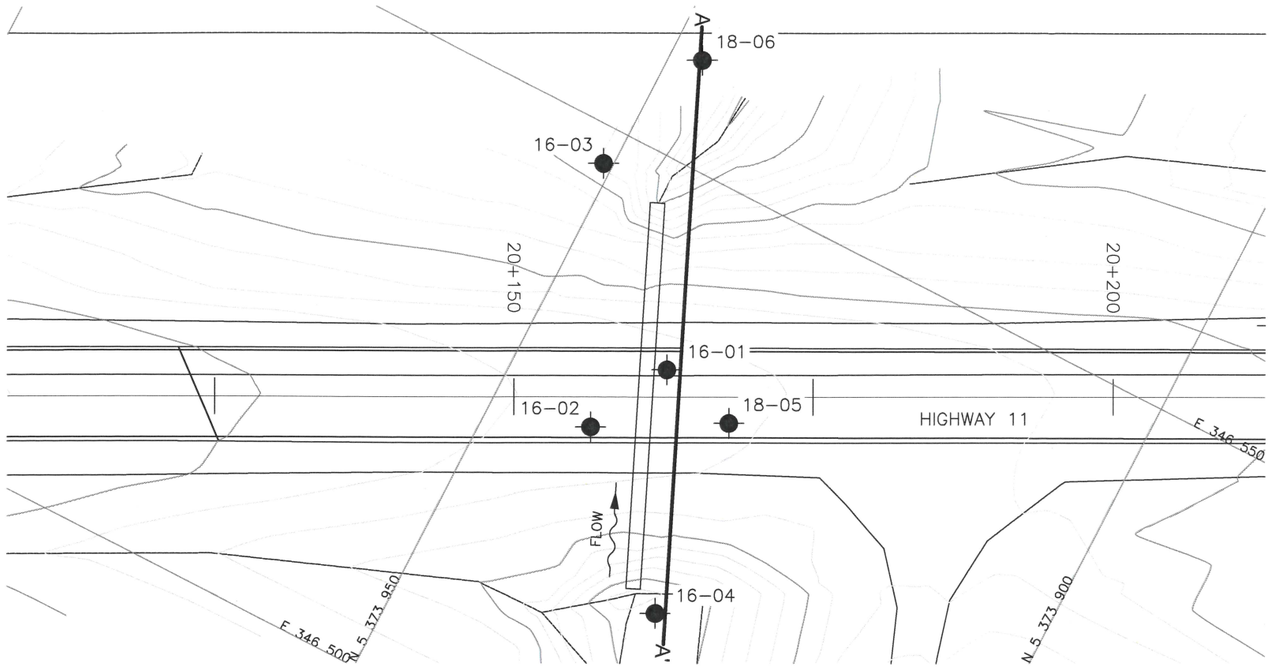


Dr. P.K. Chatterji, P.Eng.
Review Principal
Senior Geotechnical Engineer

Appendix A.

Drawings

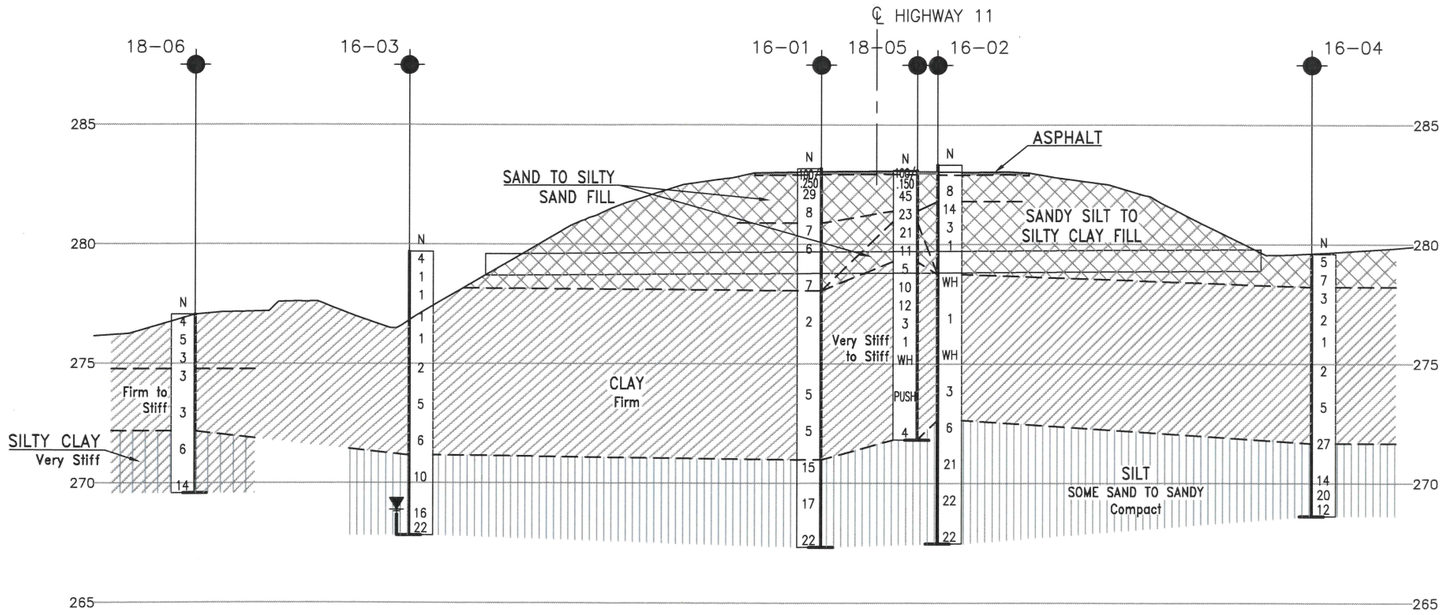
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

10 0 10 20m

SCALE 1:500



SECTION A–A'

5 0 5 10m

SCALE 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Oct 10/18
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
F. J. GRIFFITHS
Oct 10/18
PROVINCE OF ONTARIO

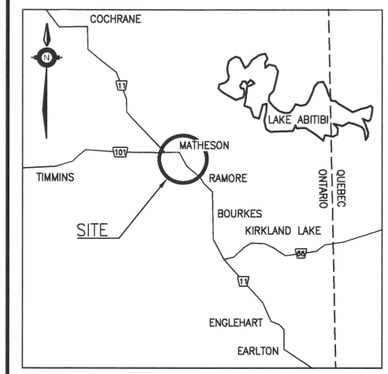
CONT No
GWP No 5054–01–00

SHEET

HIGHWAY 11
CULVERT AT 20+165
BOWMAN TOWNSHIP
BOREHOLE LOCATIONS AND SOIL STRATA

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
▽	Water Level
▼	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
16–01	283.2	5 373 938.2	346 534.1
16–02	283.3	5 373 941.7	346 526.9
16–03	279.7	5 373 950.8	346 547.0
16–04	279.6	5 373 929.7	346 515.5
18–05	283.1	5 373 931.5	346 532.5
18–06	277.1	5 373 947.4	346 558.4

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Borehole locations are shown in MTM Zone 12 coordinates.

GEOCRES No. 42A00-119

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	SBP	CHK –	CODE	LOAD	DATE OCT 2018
DRAWN	MFA	CHK SBP	SITE	STRUCT	DWG 1

FILENAME: H:\Drafting\13000\13058\TED-13058-BHPP (Culvert 6 & 7).dwg
PLOTDATE: 10/10/2018 3:46 PM

Appendix B.

Record of Borehole Sheets

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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.

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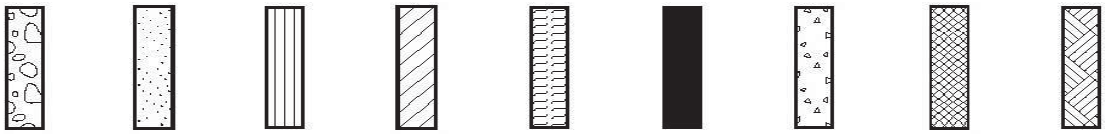
STRATA PLOT:
Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



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

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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

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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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-01 1 OF 2 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.5026652°, Long: -80.4351861° Hwy 11 - Culvert at 20+165 MTM z12: N 5 373 938.2 E 346 534.1 ORIGINATED BY SOB

HWY 11 BOREHOLE TYPE SSA / NW Casing / CME 850 Trackmount COMPILED BY JM

DATUM Geodetic DATE 2016.10.17 - 2016.10.17 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
283.2											
0.0	**ASPHALT (130mm)**										
0.1	SAND with Silt and Gravel Brown Very Dense to Compact **FILL**		1	SS	100/ 250mm		283				
			2	SS	29		282				23 70 7 (SI+CL)
			3	SS	8		281				
280.9											
2.3	CLAY, silty Grey Firm **FILL**		4	SS	7		280				
			5	SS	6		279				
278.1	- organic layer at 5.1 m		6	SS	7		278				
5.1	**CLAY (CL)** Grey Firm		7	SS	2		277	7.3 5.1			
			1	ST			276				
							275	6.0 4.4			
			8	SS	5		274				0 0 49 51

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}$ 5 $\frac{}{10}$ (%) STRAIN AT FAILURE

DOUBLE LINE 13058 CULVERT 6.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-01 2 OF 2 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.5026652°, Long: -80.4351861° Hwy 11 - Culvert at 20+165 MTM z12: N 5 373 938.2 E 346 534.1 ORIGINATED BY SOB

HWY 11 BOREHOLE TYPE SSA / NW Casing / CME 850 Trackmount COMPILED BY JM

DATUM Geodetic DATE 2016.10.17 - 2016.10.17 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAY (CL) Grey Firm						273				
			9	SS	5		272				
271.0											
12.2	**SILT (ML)** some Sand Grey Compact		10	SS	15		271				0 10 71 19
			11	SS	17		270				
							269				
			12	SS	22		268				
267.4											
15.8	End of borehole Unable to take water level measurement (water used to run casing)										

DOUBLE LINE 13058 CULVERT 6.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-02 1 OF 2 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.5026972°, Long: -80.4352832° Hwy 11 - Culvert at 20+165 MTM z12: N 5 373 941.7 E 346 526.9 ORIGINATED BY SOB

HWY 11 BOREHOLE TYPE SSA / NW Casing / CME 850 Trackmount COMPILED BY JM

DATUM Geodetic DATE 2016.10.20 - 2016.10.20 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
283.3											
0.0	**ASPHALT (160mm)**										
0.2	SAND with Silt and Gravel Brown Loose **FILL**		1	AS			283				
			1	SS	8						
281.8							282				
1.5	CLAY, silty, trace sand Brownish Grey Firm **FILL**		2	SS	14						
			3	SS	3		281				0 9 38 53
			4	SS	1		280	5.3 5.1			
278.7							279				
4.6	**CLAY (Cl)** Grey Firm		5	SS	WH		278	4.4 5.7			
			6	SS	1		277	6.3 6.7			
			7	SS	WH		276				
							275	3.6 4.4			
			8	SS	3		274				0 0 46 54

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

$\frac{20}{15}$ $\frac{5}{10}$ (%) STRAIN AT FAILURE

DOUBLE LINE 13058 CULVERT 6.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-02 2 OF 2 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.5026972°, Long: -80.4352832° Hwy 11 - Culvert at 20+165 MTM z12: N 5 373 941.7 E 346 526.9 ORIGINATED BY SOB

HWY 11 BOREHOLE TYPE SSA / NW Casing / CME 850 Trackmount COMPILED BY JM

DATUM Geodetic DATE 2016.10.20 - 2016.10.20 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
272.6	**CLAY (Cl)** Grey Firm						273				
10.7	**SILT** with Sand Grey Compact		9	SS	6		272		○		
			10	SS	21		271		○		
			11	SS	22		270		○		
			12	SS	22		269		○		0 25 66 9
267.5							268				
15.8	End of borehole Unable to take water level measurement (water used to run casing)										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

DOUBLE LINE 13058 CULVERT 6.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-03 1 OF 2 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.5027777°, Long: -80.4350103° Hwy 11 - Culvert at 20+165 MTM z12: N 5 373 950.8 E 346 547.0 ORIGINATED BY JM

HWY 11 BOREHOLE TYPE NW Casing / Tripod COMPILED BY JM

DATUM Geodetic DATE 2016.10.17 - 2016.10.18 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
279.7											
0.0	Sandy SILT to Silty CLAY Brownish Grey Loose to Very Loose **FILL**		1	SS	4		279				
			2	SS	1						
278.2							278				
1.5	**CLAY (Cl to CL)** Brownish Grey Firm		3	SS	1			14.0			
			4	SS	1		277				0 5 39 56
			5	SS	1		276	7.0 7.0			
			6	SS	2		275	5.8			
			7	SS	5		274				
			8	SS	6		273				
271.2							272				0 1 60 39
8.5	**SILT (ML)** Grey Compact		9	SS	10		271				
							270				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

DOUBLE LINE 13058 CULVERT 6.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-03 2 OF 2 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.5027777°, Long: -80.4350103° Hwy 11 - Culvert at 20+165 MTM z12: N 5 373 950.8 E 346 547.0 ORIGINATED BY JM

HWY 11 BOREHOLE TYPE NW Casing / Tripod COMPILED BY JM

DATUM Geodetic DATE 2016.10.17 - 2016.10.18 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR	SA	SI	CL
	Continued From Previous Page														
	SILT (ML) Grey Compact														
			10	SS	16		269		○		0	5	86	9
267.8			22	SS	22		268		○						
11.9	End of borehole Piezometer readings: DATE DEPTH (m) ELEV. (m) 2016.10.20 10.8 268.9 2017.04.17 Note: standpipe dry 2017.06.12 11.3 268.4														

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

DOUBLE LINE 13058 CULVERT 6.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-04 1 OF 2 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.50259°, Long: -80.4354387° Hwy 11 - Culvert at 20+165 MTM z12: N 5 373 929.7 E 346 515.5 ORIGINATED BY JM

HWY 11 BOREHOLE TYPE NW Casing / Tripod COMPILED BY JM

DATUM Geodetic DATE 2016.10.20 - 2016.10.20 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
279.6											
0.0	CLAY, Sandy, Silty Grey Firm **FILL**		1	SS	5		279				0 38 33 29
			2	SS	7						
278.2							278	14.0			
1.4	**CLAY (CI)**, varved Grey Firm		3	SS	3						
			4	SS	2		277	6.0			0 4 32 64
			5	SS	1		276	6.0 5.0			
			6	SS	2		275				
			7	SS	5		274				0 2 48 50
271.7			8	SS	27		273				
7.9	**Sandy SILT (ML)** Grey Compact						272				
			9	SS	14		271				
							270				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 / 10 / 5 (%) STRAIN AT FAILURE

DOUBLE LINE 13058 CULVERT 6.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-04 2 OF 2 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.50259°, Long: -80.4354387° Hwy 11 - Culvert at 20+165 MTM z12: N 5 373 929.7 E 346 515.5 ORIGINATED BY JM

HWY 11 BOREHOLE TYPE NW Casing / Tripod COMPILED BY JM

DATUM Geodetic DATE 2016.10.20 - 2016.10.20 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Sandy SILT (ML) Grey Compact		10	SS	20				○		
			11	SS	12		269		○		
268.6											
11.0	End of borehole Unable to take water level measurement (water used for casing)										

DOUBLE LINE 13058 CULVERT 6.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 18-05 1 OF 2 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.5026051°, Long: -80.4352088° Hwy 11 - Culvert at 20+165 MTM z12: N 5 373 931.5 E 346 532.5 ORIGINATED BY NW

HWY 11 BOREHOLE TYPE HSA / CME 55 Truck Mount COMPILED BY CM

DATUM Geodetic DATE 2018.05.01 - 2018.05.01 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
283.1											
0.0	**ASPHALT (125mm)**						283				
0.1	SAND with Gravel Brown Frozen **FILL**		1	SS	100/ 150mm						
			2	SS	45		282				39 56 5 (SI+CL)
281.4											
1.7	CLAY, silty Grey		3	SS	23						
281.0	Stiff						281				
2.1	**FILL**										
	SAND with Silt trace Gravel Brown Compact **FILL**		4	SS	21						
			5	SS	11		280				7 84 9 (SI+CL)
279.3											
3.8	**CLAY (CL to CI)** Grey Very Stiff to Stiff		6	SS	5		279				
			7	SS	10						
	- Sandy		8	SS	12		278				0 39 31 30
			9	SS	3		277				
			10	SS	1		276				0 4 26 70
			11	SS	WH		275	4.0 3.0			
			12	ST	PUSH		274				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

DOUBLE LINE 13058 CULVERT 6.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 18-05 2 OF 2 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.5026051°, Long: -80.4352088° Hwy 11 - Culvert at 20+165 MTM z12: N 5 373 931.5 E 346 532.5 ORIGINATED BY NW

HWY 11 BOREHOLE TYPE HSA / CME 55 Truck Mount COMPILED BY CM

DATUM Geodetic DATE 2018.05.01 - 2018.05.01 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page									
	CLAY (CL to Cl) Grey Very Stiff to Stiff						273	3.0 at 80; 3.0 at 100		
			13	SS	4				○ at 40	
271.8							272			
11.3	End of borehole Borehole dry on completion									

DOUBLE LINE 13058 CULVERT 6.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 18-06 1 OF 1 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.5027462°, Long: -80.434856° Hwy 11 - Culvert at 20+165 MTM z12: N 5 373 947.4 E 346 558.4 ORIGINATED BY NW

HWY 11 BOREHOLE TYPE HW Casing / Tripod COMPILED BY CM

DATUM Geodetic DATE 2018.05.08 - 2018.05.08 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
277.1											
0.0	**CLAY (Cl)** Brown Firm		1	SS	4		277				
			2	SS	5		276				
			3	SS	3		275				0 10 38 52
274.8											
2.3	**CLAY (Cl to CL)**, frequent Silt interbeds Grey Firm to Stiff		4	SS	3		274	5.0 13.0			
			5	SS	3		273	6.0			
	- becoming silty		6	SS	6		272	>>			0 1 60 39
			7	SS	14		271				
269.6							270				
7.5	End of borehole										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

$\frac{20}{15}$ 5 $\frac{}{10}$ (%) STRAIN AT FAILURE

DOUBLE LINE 13058 CULVERT 6.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

Appendix C.

Laboratory Testing

Appendix C.1

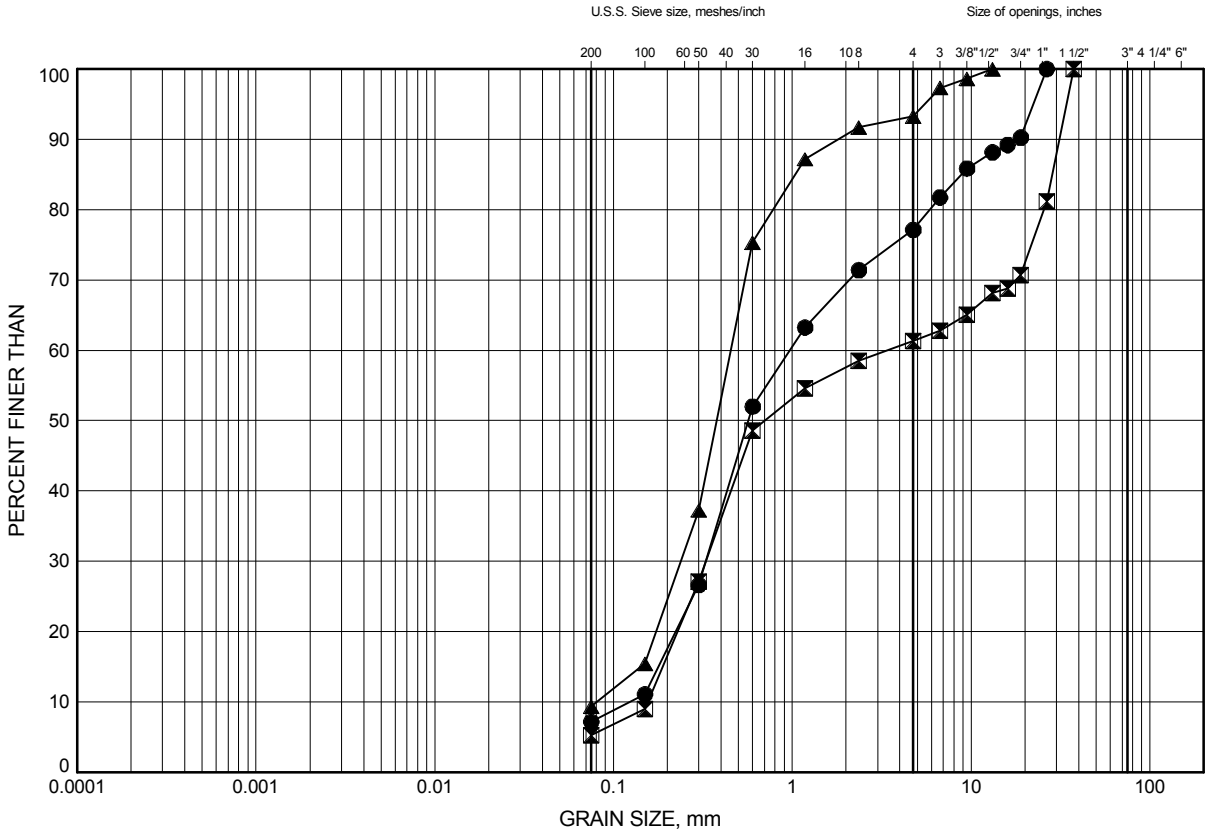
Particle Size Analysis Figures

Hwy 11 - Culvert at 20+165

GRAIN SIZE DISTRIBUTION

FIGURE C1

Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	1.07	282.13
⊠	18-05	1.22	281.88
▲	18-05	3.35	279.75

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd SOB

Chkd. CM

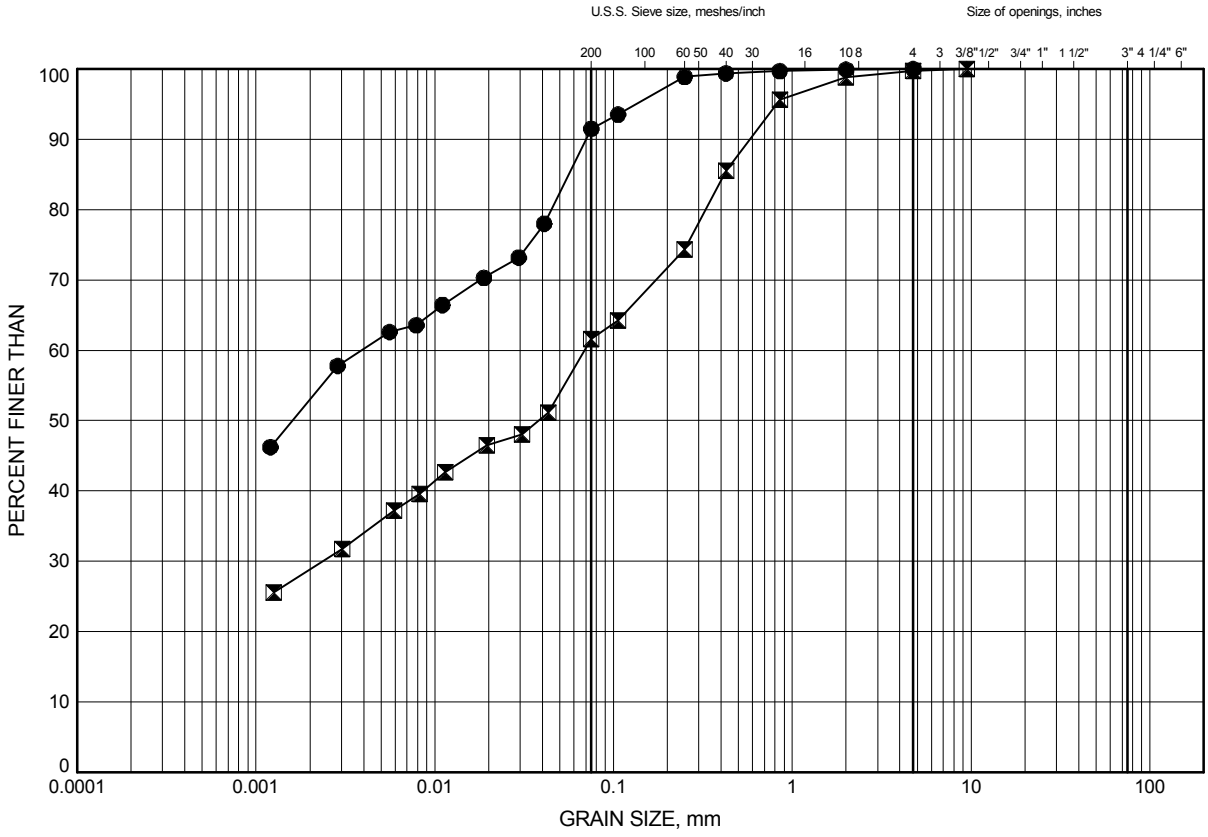
GRAIN SIZE DISTRIBUTION - THURBER 13058 CULVERT 6.GPJ 22/6/18

Hwy 11 - Culvert at 20+165

GRAIN SIZE DISTRIBUTION

FIGURE C2

Clay Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-02	2.59	280.71
⧓	16-04	0.30	279.30

Date June 2018

GWP# 5015-E-0041

THURBER

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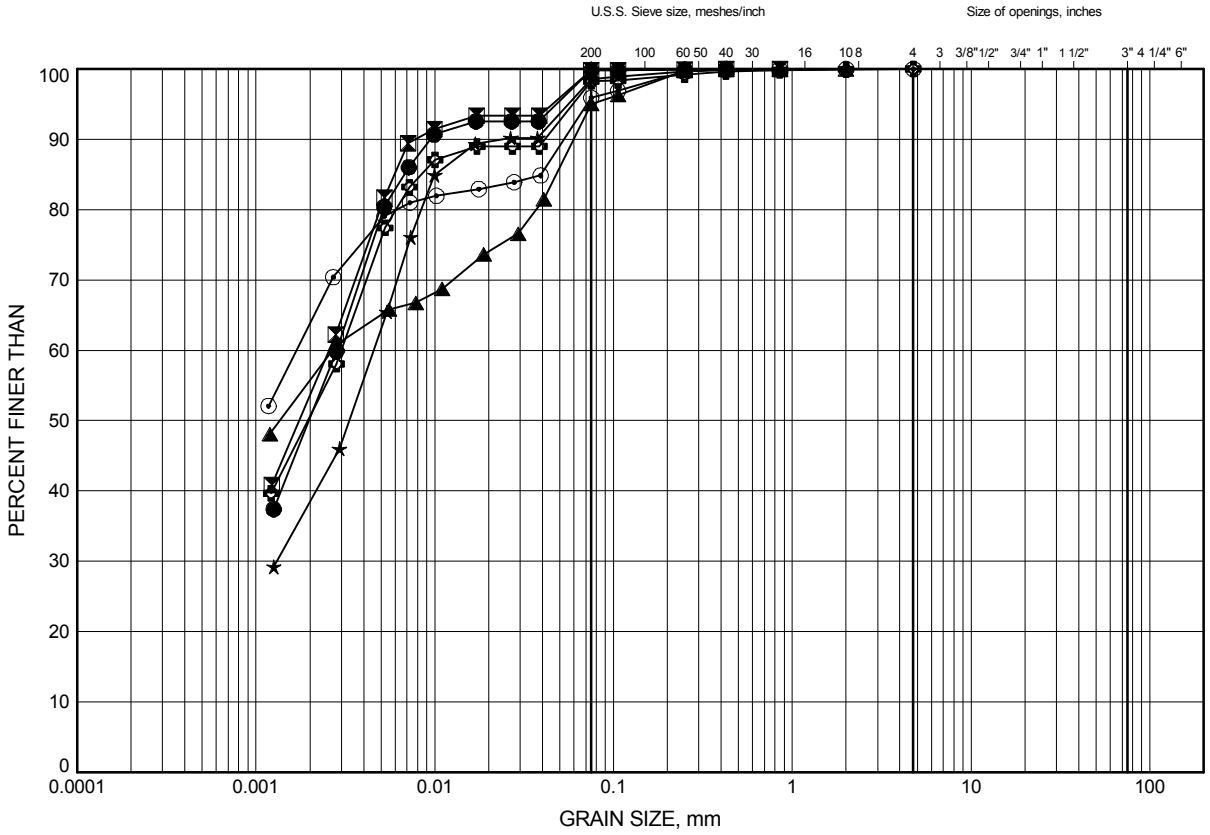
GRAIN SIZE DISTRIBUTION - THURBER 13058 CULVERT 6.GPJ 22/6/18

Hwy 11 - Culvert at 20+165

GRAIN SIZE DISTRIBUTION

FIGURE C3

Clay (Cl to CL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	9.45	273.75
⊠	16-02	9.45	273.85
▲	16-03	2.74	276.96
★	16-03	7.92	271.78
⊙	16-04	2.74	276.86
✿	16-04	6.40	273.20

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd SOB

Chkd. CM

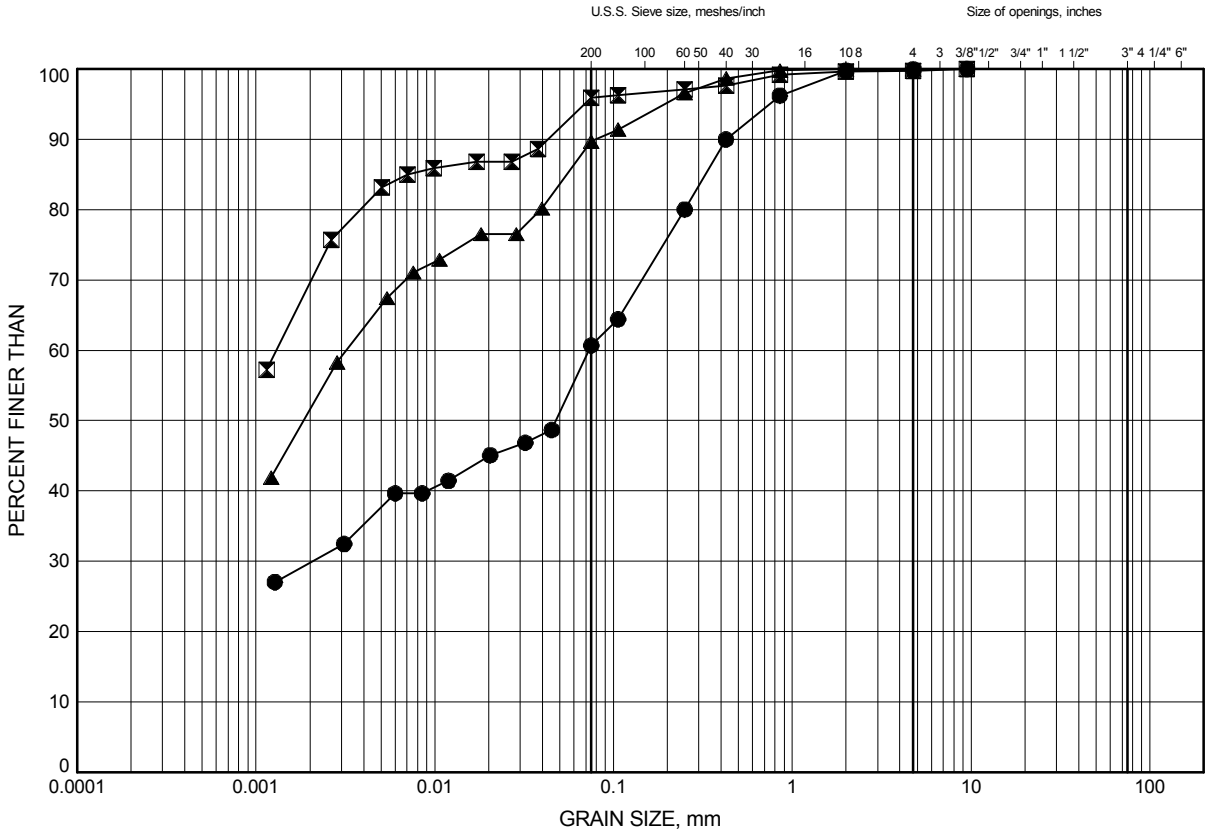
GRAIN SIZE DISTRIBUTION - THURBER 13058 CULVERT 6.GPJ 22/6/18

Hwy 11 - Culvert at 20+165

GRAIN SIZE DISTRIBUTION

FIGURE C4

Clay (CI to CL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-05	5.64	277.46
⊠	18-05	7.16	275.94
▲	18-06	1.83	275.23

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd SOB

Chkd. CM

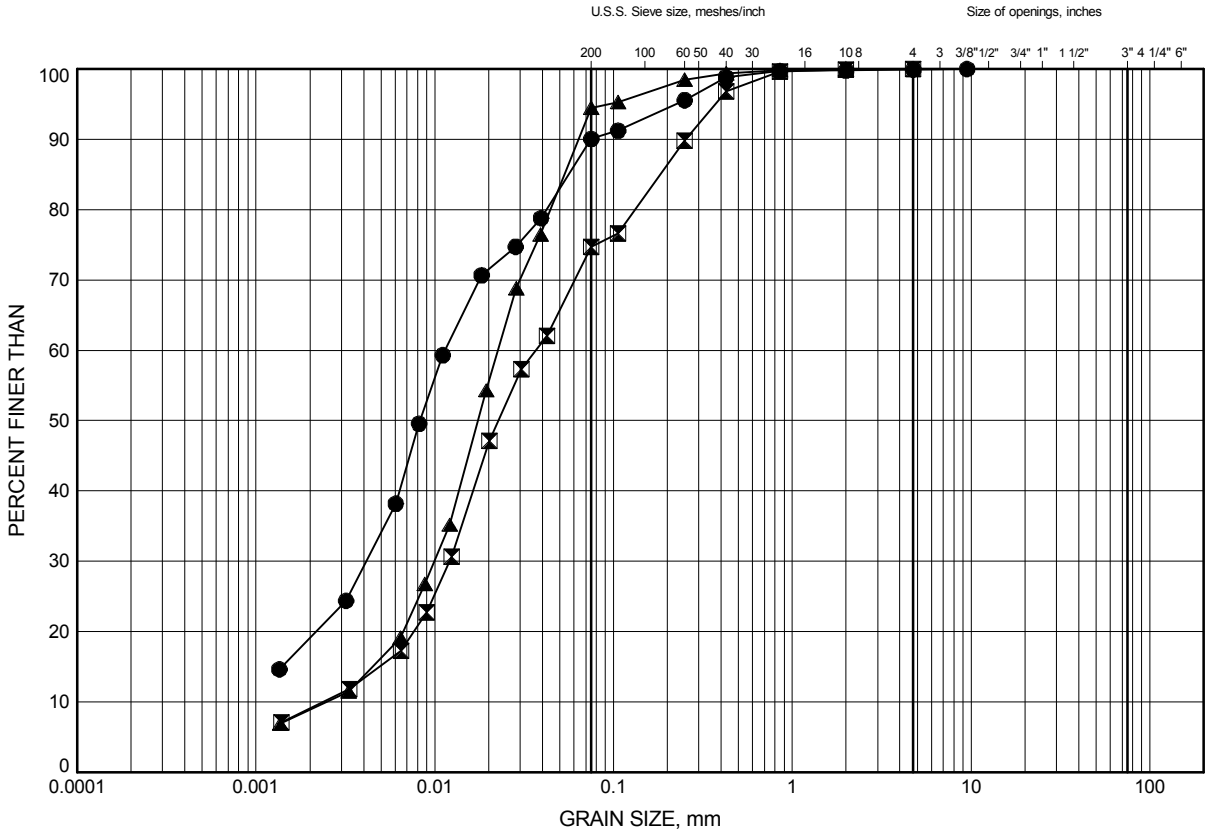
GRAIN SIZE DISTRIBUTION - THURBER 13058 CULVERT 6.GPJ 22/6/18

Hwy 11 - Culvert at 20+165

GRAIN SIZE DISTRIBUTION

FIGURE C5

Silt (ML)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	12.50	270.70
⊠	16-02	15.54	267.76
▲	16-03	10.97	268.73

Date June 2018

GWP# 5015-E-0041

THURBER

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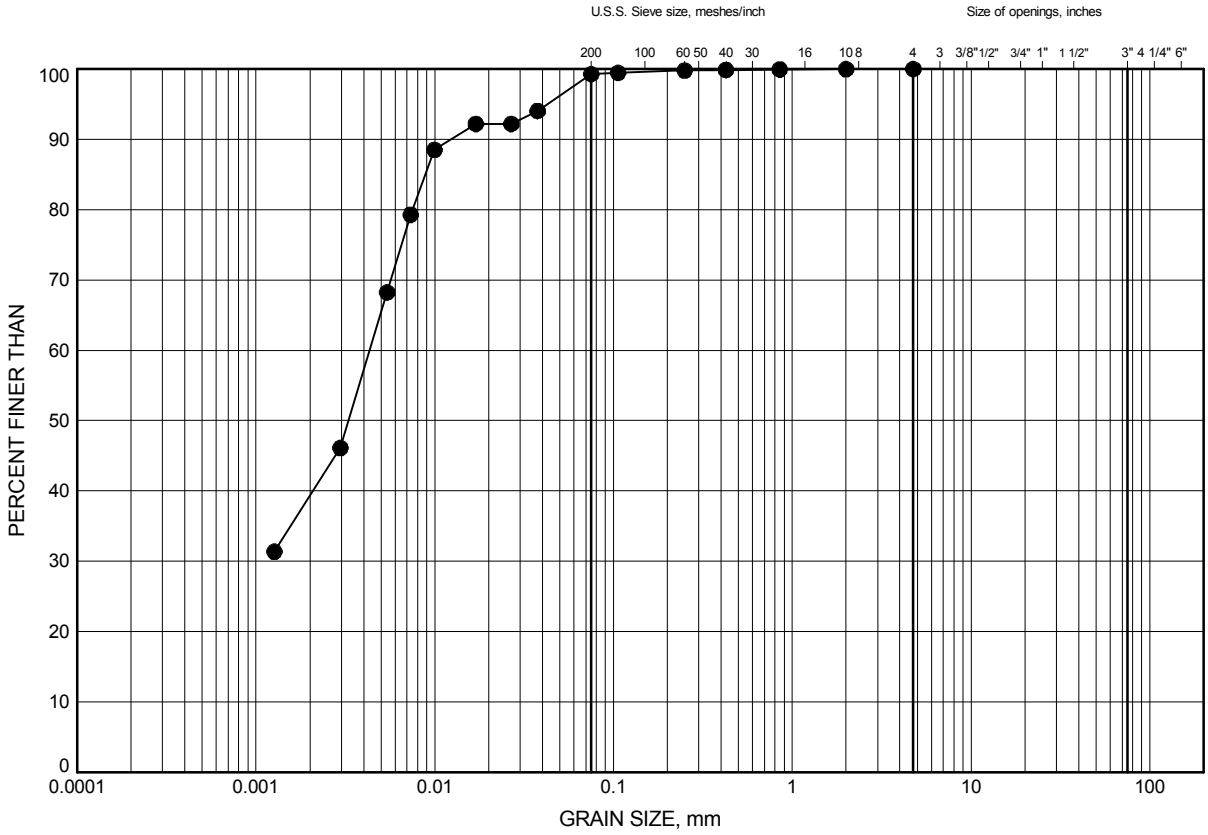
GRAIN SIZE DISTRIBUTION - THURBER 13058 CULVERT 6.GPJ 22/6/18

Hwy 11 - Culvert at 20+165

GRAIN SIZE DISTRIBUTION

FIGURE C6

Silty Clay (CL-ML)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-06	5.64	271.42

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd SOB

Chkd. CM

GRAIN SIZE DISTRIBUTION - THURBER 13058 CULVERT 6.GPJ 22/6/18

Appendix C.2

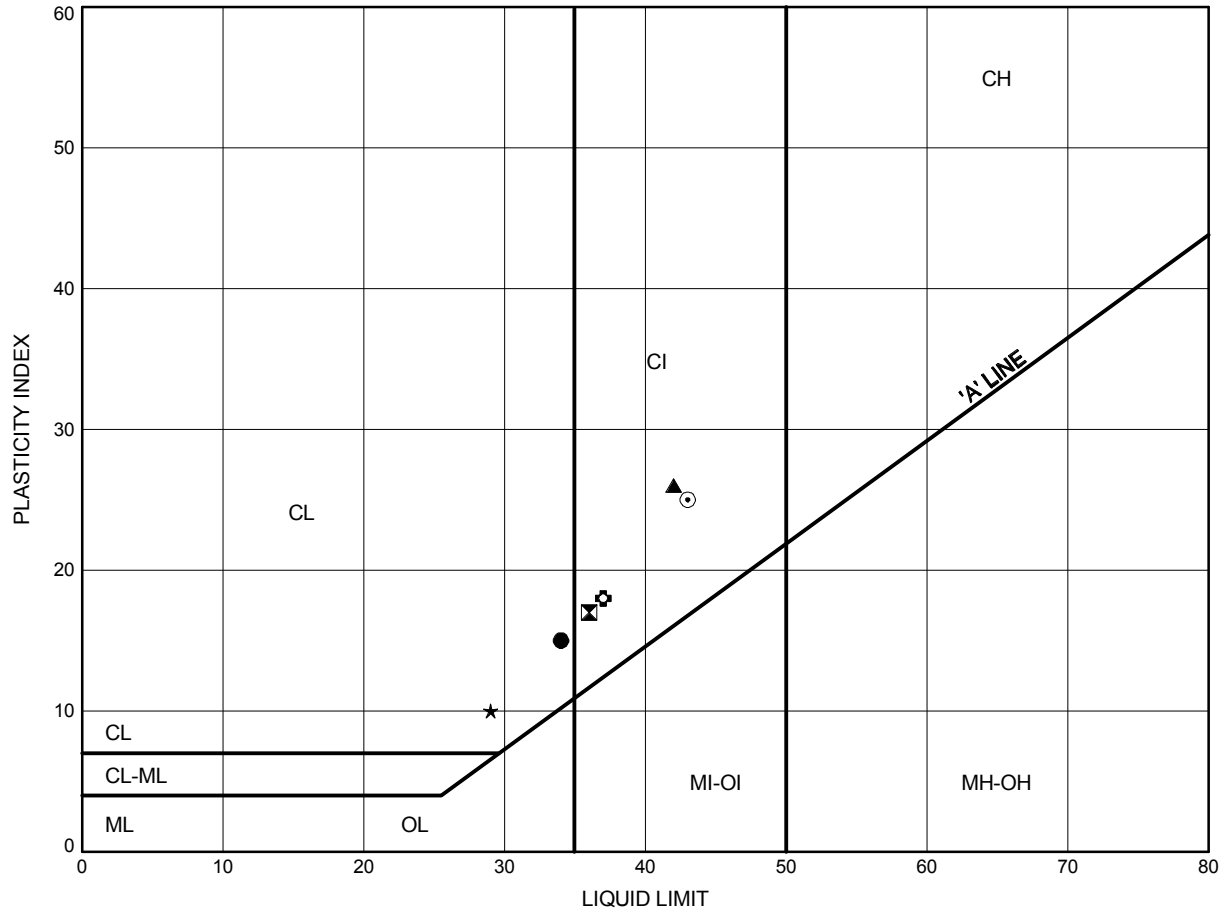
Atterberg Limit Analysis Figures

Hwy 11 - Culvert at 20+165

ATTERBERG LIMITS TEST RESULTS

FIGURE C7

Clay (CI to CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	9.45	273.75
⊠	16-02	9.45	273.85
▲	16-03	2.74	276.96
★	16-03	7.92	271.78
⊙	16-04	2.74	276.86
✿	16-04	6.40	273.20

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd SOB

Chkd. CM

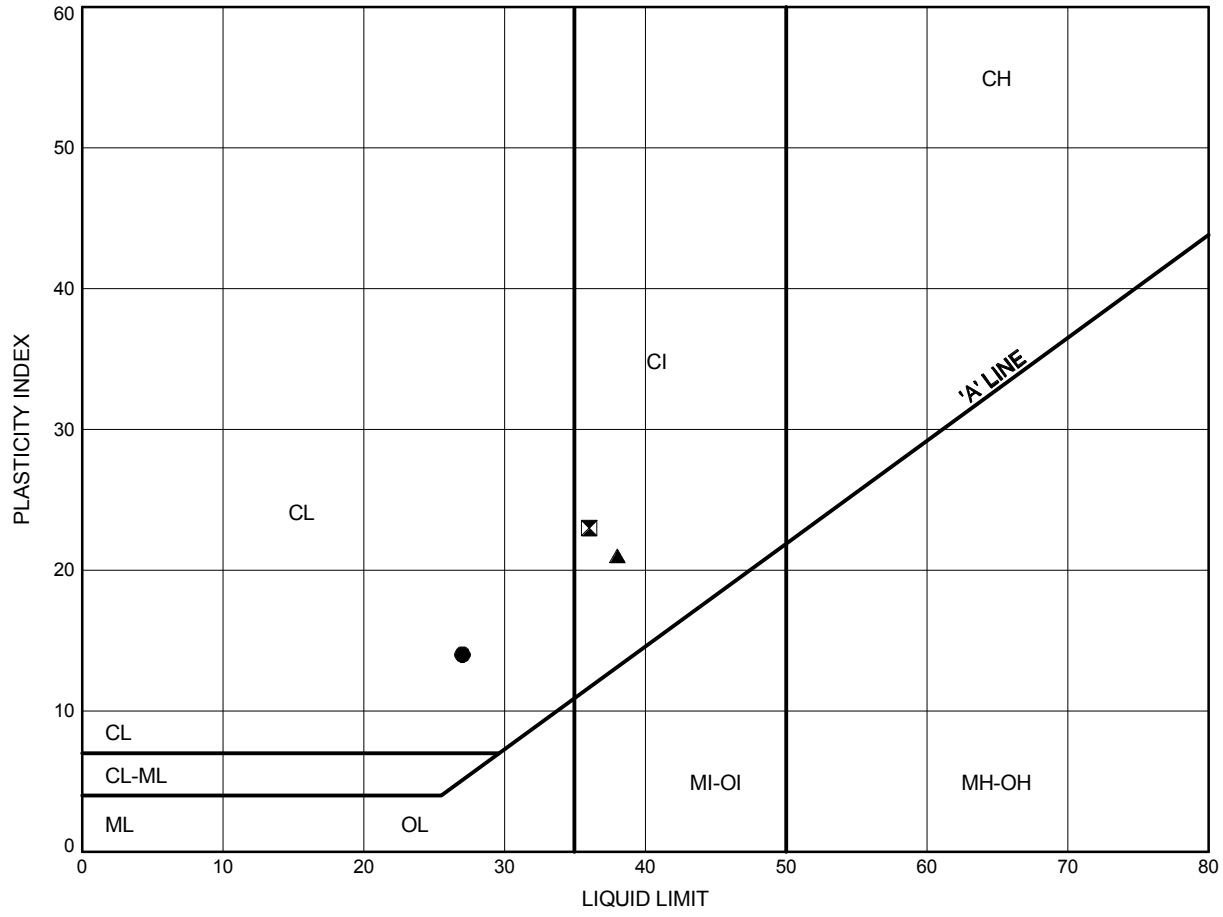
THURBALT 13058 CULVERT 6.GPJ 22/6/18

Hwy 11 - Culvert at 20+165

ATTERBERG LIMITS TEST RESULTS

FIGURE C8

Clay (CI to CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-05	5.64	277.46
⊠	18-05	7.16	275.94
▲	18-06	1.83	275.23

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd SOB

Chkd. CM

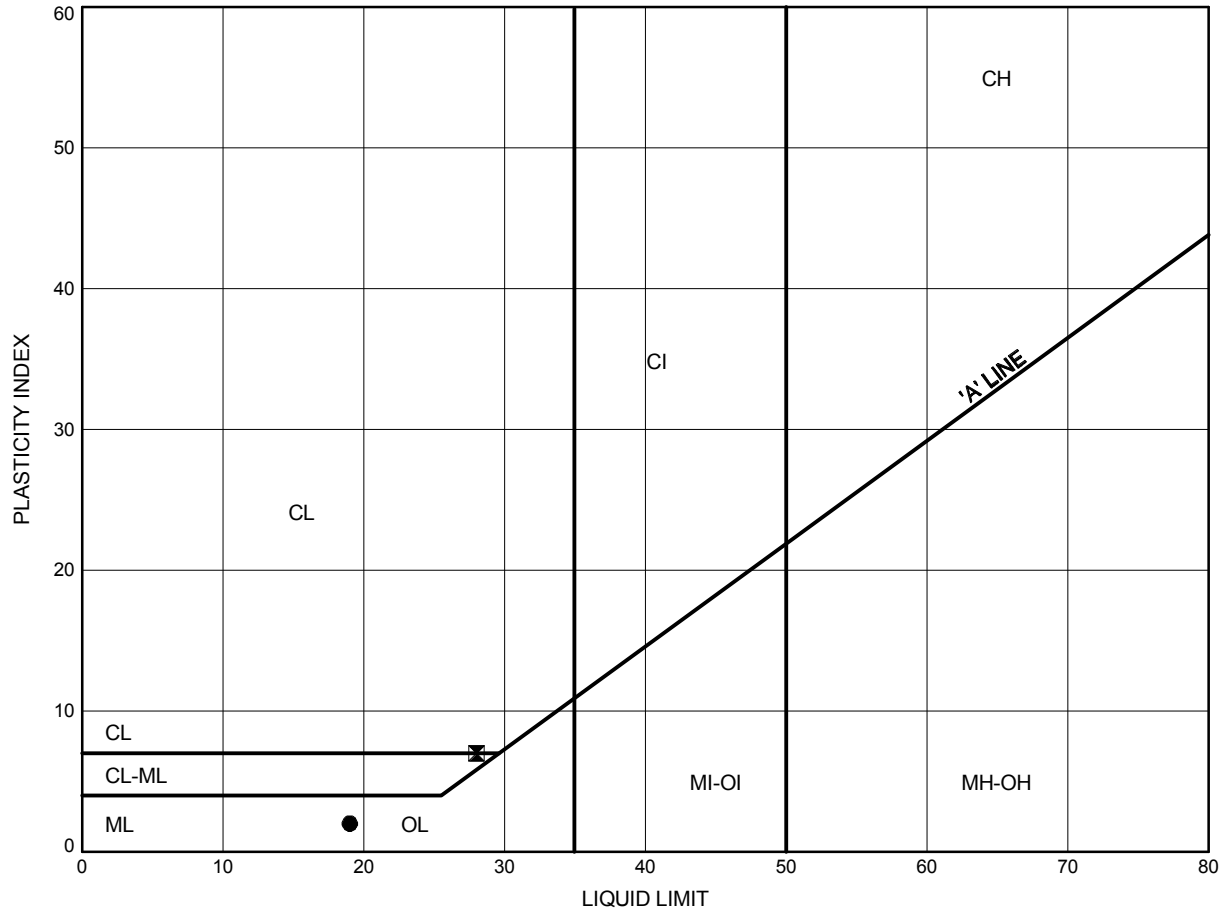
THURBALT 13058 CULVERT 6.GPJ 22/6/18

Hwy 11 - Culvert at 20+165

ATTERBERG LIMITS TEST RESULTS

FIGURE C9

Silt (ML) to Silty Clay (CL-ML)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	12.50	270.70
⊠	18-06	5.64	271.42

Date June 2018

GWP# 5015-E-0041

THURBER

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THURBALT 13058 CULVERT 6.GPJ 22/6/18

Appendix C.3

Analytical Testing Results

PARACEL LABORATORIES LTD.

Order #: 1644497

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

Report Date: 02-Nov-2016
Order Date: 28-Oct-2016
Project Description: 13058

	Client ID:	C2-3 SS1 0'-2'	C2-4 SS3 5'-7'	C6-3 SS2 2'6-4'6	C6-4 SS3A 5'-6'
	Sample Date:	18-Oct-16	18-Oct-16	18-Oct-16	18-Oct-16
	Sample ID:	1644497-01	1644497-02	1644497-03	1644497-04
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	74.7	79.6	76.7	74.5
General Inorganics					
Conductivity	5 uS/cm	357	494	795	344
pH	0.05 pH Units	7.59	7.52	7.54	7.60
Resistivity	0.10 Ohm.m	28.0	20.2	12.6	29.1
Anions					
Chloride	5 ug/g dry	49	236	314	67
Sulphate	5 ug/g dry	11	8	21	14

	Client ID:	C7-3 SS2 2'6-4'6	C7-4 SS3 5'-7'	MC16-4 SS1 0'-2'	MC16-6 SS3 5'-7'
	Sample Date:	18-Oct-16	18-Oct-16	18-Oct-16	18-Oct-16
	Sample ID:	1644497-05	1644497-06	1644497-07	1644497-08
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	64.7	72.9	65.0	88.2
General Inorganics					
Conductivity	5 uS/cm	226	616	729	56
pH	0.05 pH Units	7.52	7.62	6.21	6.35
Resistivity	0.10 Ohm.m	44.3	16.2	13.7	179
Anions					
Chloride	5 ug/g dry	11	187	328	9
Sulphate	5 ug/g dry	19	21	30	7

	Client ID:	C28-3 SS2 2'6-4'6	C28-4 SS1 0'-2'	C34-3 SS3 5'-7'	C34-4 SS1 0'-2'
	Sample Date:	18-Oct-16	18-Oct-16	18-Oct-16	18-Oct-16
	Sample ID:	1644497-09	1644497-10	1644497-11	1644497-12
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	71.3	70.8	79.9	91.9
General Inorganics					
Conductivity	5 uS/cm	765	999	233	208
pH	0.05 pH Units	7.47	7.60	7.65	6.95
Resistivity	0.10 Ohm.m	13.1	10.0	42.8	48.2
Anions					
Chloride	5 ug/g dry	343	493	13	18
Sulphate	5 ug/g dry	15	21	36	24

PARACEL LABORATORIES LTD.

Order #: 1818665

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

Report Date: 10-May-2018
Order Date: 4-May-2018
Project Description: 13058

	Client ID:	20+172 Bowman,18-5,SS11 (25'-27')	11+967 PlayFair,18-5, SS9(25'-27')	20+237 Bowman,18-5,SS8(1 7'6"-19'6")	17+619 Bowman,18-5,SS13 (30'-32')
	Sample Date:	05/02/2018 12:00	04/30/2018 14:30	05/02/2018 16:00	05/03/2018 11:30
	Sample ID:	1818665-01	1818665-02	1818665-03	1818665-04
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	71.9	61.4	72.8	92.1
General Inorganics					
Conductivity	5 uS/cm	308	408	564	654
pH	0.05 pH Units	7.79	7.56	6.82	7.11
Resistivity	0.10 Ohm.m	32.5	24.5	17.7	15.3
Anions					
Chloride	5 ug/g dry	56	118	284	17
Sulphate	5 ug/g dry	23	14	11	7

Appendix D.

Site Photographs

Photo 1. Looking west of Highway 11 (September 2016).

Photo 2. Looking north along Highway 11 (September 2016).

Photo 3. Looking east of Highway 11 (September 2016).

Photo 4. Looking south along Highway 11 (September 2016).