THURBER ENGINEERING LTD.

FINAL

FOUNDATION INVESTIGATION REPORT
HIGHWAY 11 CULVERT
4.3 KM SOUTH OF HIGHWAY 101, BOWMAN TOWNSHIP
NEAR STATION 20+230

G.W.P. 5054-01-00

Geocres No.: 42A00-120

Report to:

McIntosh Perry Consulting Engineers Limited

Latitude: 48.50213°
Longitude: -80.43476°

October 2018
Thurber File No.: 13058

104, 2460 Lancaster Road, Ottawa ON K1B 4S5 T. 613 247 2121 F. 613 247 2185
thurber.ca

TABLE OF CONTENTS

PART 1. FACTUAL INFORMATION

APPENDICES

FINAL
FOUNDATION INVESTIGATION REPORT
HIGHWAY 11 CULVERT
4.3 KM SOUTH OF HIGHWAY 101, BOWMAN TOWNSHIP
NEAR STATION 20+230

G.W.P. 5054-01-00
Geocres No.: 42A00-120

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+230. The culvert is located approximately 4.3 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 35.3 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+227 (Linear Highway Referencing System Base Point: 17450, Offset: 10.1), Highway 11 is a two-lane highway with a rural cross-section and gravel shoulders. The Highway 11 embankment fill height is approximately 4.9 m with the road surface at approximate elevation 281.8 m. The existing embankment slopes are inclined at approximately 2H:1V and 3H:1V. Wooden posts and a steel cable guiderail are present along the north bound lanes 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 to the northeast and southwest. 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 15th 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 rubber track mount 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 vane shear testing was completed in the cohesive soils. The boreholes were sampled to depths ranging from 6.7 to 15.8 m (elev. 269.8 to 264.2 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 16-04 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 piezometer was decommissioned on June 12, 2017 in accordance with MOE requirements.

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 a pavement structure and granular fill followed by 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 190 mm.

5.1.2 Fill: Sand

Below the asphalt pavement in Boreholes 16-01, 16-02 and 18-05 was a layer of fill ranging from sand with silt and gravel to sand with silt. The underside of the fill was 1.5 to 2.3 m (elev. 280.3 to 279.3 m) below the existing roadway surface.

The SPT tests conducted in the unfrozen sand fill gave N-values typically ranging from 11 to 27 blows indicating a compact relative density. A single SPT test result of 100 blows per 200 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 26%. The results of grain size analyses conducted on two samples of the sand fill material are summarized below and are illustrated on Figure C1 in Appendix C.

Soil Particle	Percentage (%)
Gravel	3 - 14
Sand	80 - 90
Silt & Clay	6 - 7

5.1.3 Fill: Clay

A layer of fill consisting of clay with sand to clay was encountered directly below the sand fill in Boreholes 16-01, 16-02 and 18-05 with a recorded thickness of 3.8 to 4.6 m and an underside depth of 6.1 m (elev. 275.7 to 275.5 m) below the existing roadway surface. Trace organics were noted within the lower 1.5 m of the clay fill in Borehole 18-05.

The SPT tests conducted in the clay fill gave N-values ranging from weight of hammer to 9 blows. Two field vane tests were performed within the fill and recorded undrained shear strength from 40 to 46 kPa indicating 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 23 to 56%. The results of grain size analyses conducted on three samples of the clay fill material are summarized below and are illustrated on Figure C2 of Appendix C.

Soil Particle	Percentage (%)
Gravel	0
Sand	4 - 21
Silt	37 - 52
Clay	42 - 44

Atterberg Limit testing was completed on three 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 C7 of Appendix C. The laboratory results are summarized below and indicate that the clay fill exhibits intermediate plasticity.

Parameter	Value
Liquid Limit	38
Plastic Limit	14 - 16
Plasticity Index	22 - 24

5.2 Clay (CI to CL)

A native deposit of clay was encountered below the fill layers in the on-road boreholes and below a veneer (50 mm maximum) of topsoil in the off-road boreholes. The near surface clay within Borehole 16-03 consisted of clay and silt to a depth of 0.6 m. The near surface clay within Boreholes 16-04 and 18-06 contained some sand to a depth of 2.5 m and 1.4 m respectively. Silt layers were observed with the clay. Borehole 18-06 was terminated within this layer at a depth of 6.7 m (elevation 269.8 m). Where fully penetrated the clay layer had a total thickness ranging from 1.5 to 8.5 m with an underside elevation of 274.2 to 269.1 m. The SPT N-values ranged from weight of hammer to 11 blows. Field vane tests were performed within the deposit and generally recorded undrained shear strengths ranging from 20 to greater than 100 kPa indicating a soft to very stiff consistency. One undrained shear strength value of 15 kPa was observed in Borehole 18-06. Remolded field vane testing indicates that the clay shows some sensitivity.

The moisture content of the samples tested ranged from 20% to 52%. The results of grain size analyses conducted on nine 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 - 14
Silt	31 - 51
Clay	37 - 66

Atterberg Limit testing was completed on nine 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 C8 and C9 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	28 - 46
Plastic Limit	10 - 20
Plasticity Index	16 - 28

5.3 Silty Clay (CL-ML)

A layer consisting of silty clay was encountered below the clay deposit in Borehole 18-05. The borehole was terminated within this stratum at a depth of 12.8 m (elev. 268.7 m). SPT N-values of 7 and 12 blows were recorded and no vane tests were able to be pushed into this material indicating a very stiff consistency.

The moisture content for the samples tested ranged from was 22% to 24%. The results of grain size analysis conducted on one sample of the silty clay found the sample to be composed of 0% gravel, 2% sand, 72% silt and 26% clay. The grain size distribution is illustrated on Figure C5 in Appendix C.

Atterberg Limit testing was completed on one sample of the silty clay deposit. The results are summarized on the Record of Borehole sheets in Appendix B and the Atterberg Limit graph is included in Figure C10 of Appendix C. The laboratory results found the silty clay to have a liquid limit of 19%, a plastic limit of 14% and a plasticity index of 5% and indicates that the silty clay is of low plasticity (CL-ML).

5.4 Silt (ML)

A layer consisting of silt with trace to some sand was encountered below the clay deposit in Boreholes 16-01 through 16-04. These boreholes were terminated in this stratum at a depth of 12.8 to 15.8 m (elev. 266.0 to 264.2 m). The SPT N-values generally ranged from 6 to 30 blows indicating a loose to compact relative density. One value of 3 was observed in Borehole 16-02.

The moisture content for the samples tested ranged from was 18% to 37%. The results of grain size analyses conducted on four samples of the silt are summarized below and are illustrated on Figure C6 in Appendix C.

Soil Particle	Percentage (%)
Gravel	0
Sand	1 - 12
Silt	80 - 91
Clay	5 - 17

Atterberg Limit testing was completed on four samples of the silt deposit, all of which indicated the silt to be non-plastic.

5.5 Groundwater

At the completion of drilling, the groundwater level was measured at 11.2 m (elev. 266.4 m) below the ground surface within the standpipe piezometers installed in Borehole 16-04. The culvert was dry at the time of the field investigation. During a site visit on April 17, 2017 the water level within the standpipe was observed at 10.5 m (elev. 267.1 m) below the ground surface and some water was observed in the culvert. The water level in the standpipe piezometer was recorded at 10.6 m (elev. 267.0 m) below ground surface on June 12, 2018 and was subsequently decommissioned.

During the 2018 field investigation, Borehole 18-05 was dry upon completion. A reliable 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.

5.6 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 (C7-3*)	SS2	0.7 – 1.4	19	7.5	4430	226	11
16-04 (C7-4*)	SS3	1.5 – 2.1	21	7.6	1620	616	187
18-05	SS8	5.3 – 5.9	11	6.8	1770	564	284

Note: (*) sample label as submitted to Paracel

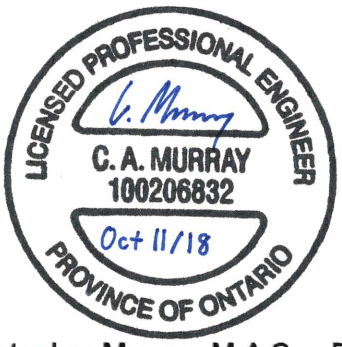
6 MISCELLANEOUS

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 surveyed 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 provided by Mr. Stephen Peters, P.Eng.

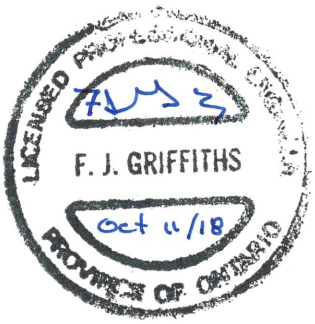
Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa, Ontario.

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.

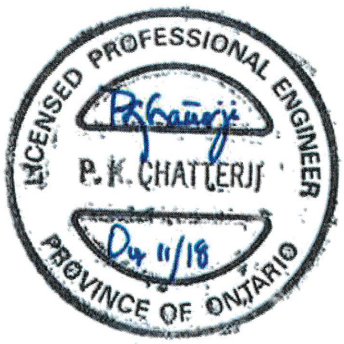


Christopher Murray, M.A.Sc., P.Eng.
Geotechnical Engineer

Stephen Peters, P.Eng.
Geotechnical Engineer



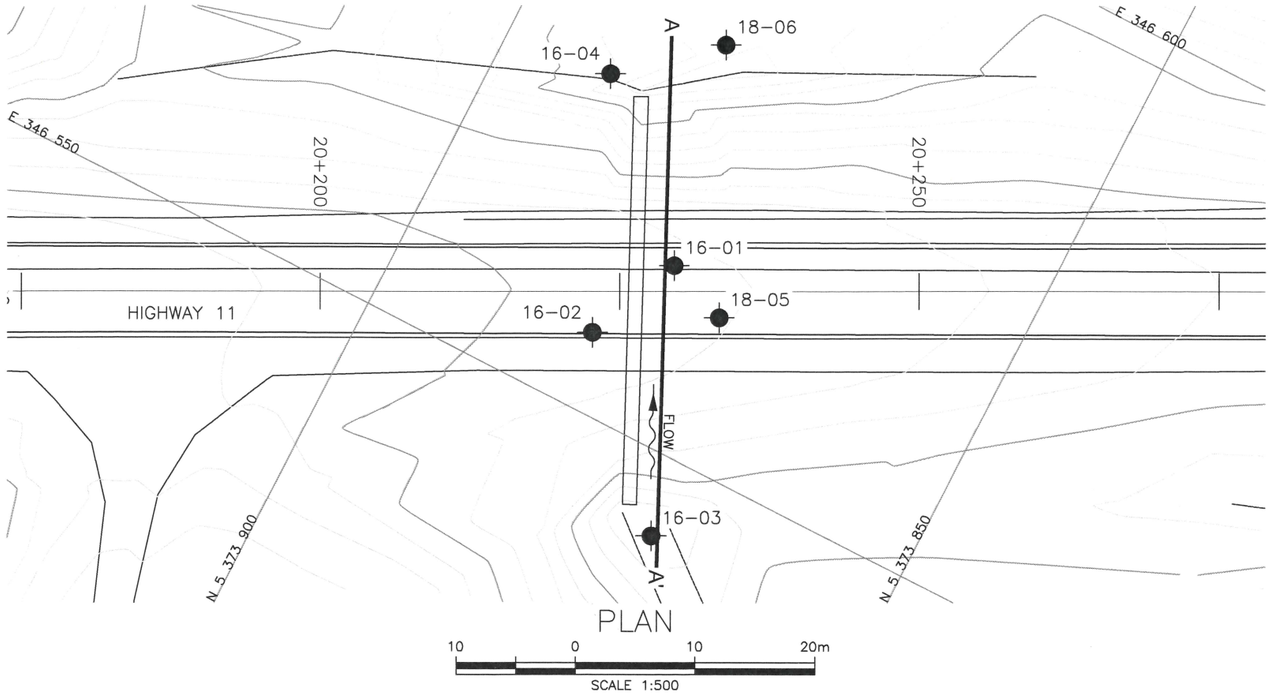
Dr. Fred Griffiths, P.Eng.
Senior Associate
Senior Geotechnical Engineer



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

Appendix A.

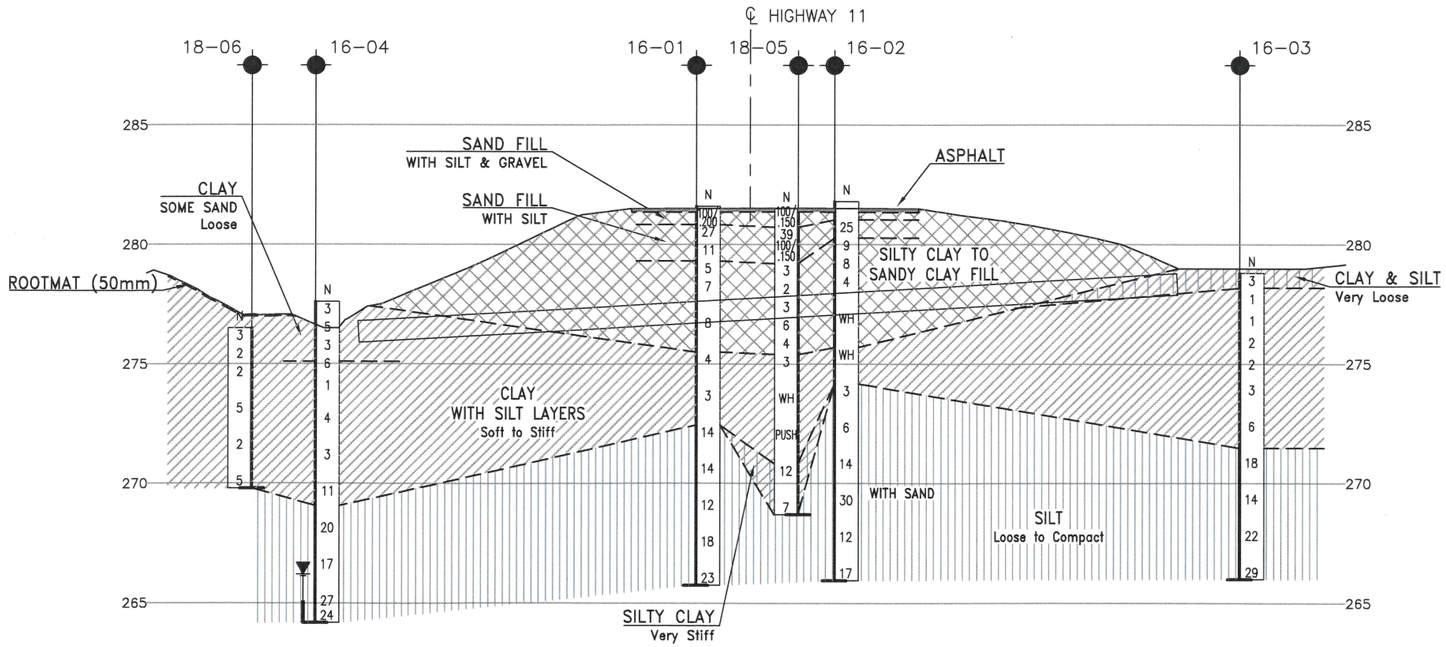
Drawings



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

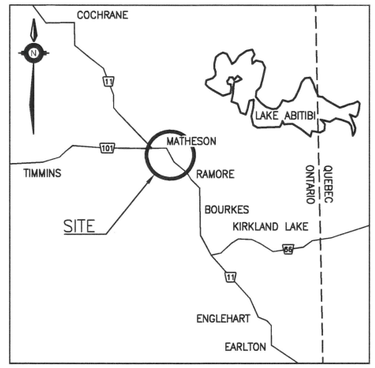
CONT No
GWP No 5054-01-00

SHEET

HIGHWAY 11
CULVERT AT 20+230
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	281.6	5 373 878.7	346 564.5
16-02	281.8	5 373 882.2	346 556.4
16-03	278.7	5 373 870.1	346 543.5
16-04	277.6	5 373 890.8	346 576.3
18-05	281.5	5 373 873.4	346 562.3
18-06	276.5	5 373 883.3	346 582.9

-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. 42A00-120

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

THURBER

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:

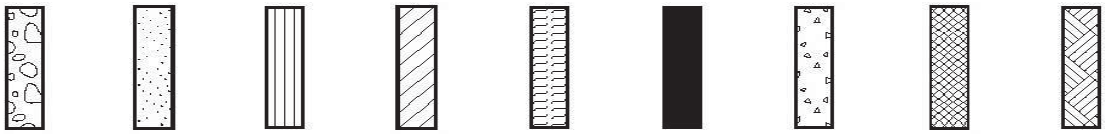
Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented,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

THURBER

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

THURBER

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

THURBER

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: 48.5021281°, Long: -80.4347807° Hwy 11 - Culvert at 20+230 MTM z12: N 5 373 878.7 E 346 564.5 ORIGINATED BY SOB

HWY 11 BOREHOLE TYPE SSA / NW Casing / CME 850 Trackmount 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 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
281.6											
0.0	**ASPHALT (190mm)**										
0.2	SAND with silt and gravel Brown Very dense **FILL**		1	SS	100/ 200mm		281				
280.8											
0.8	SAND with Silt Brown Compact **FILL**		2	SS	27						3 90 7 (SI+CL)
			3	SS	11		280				
279.3											
2.3	CLAY with sand Brown to grey Loose **FILL**		4	SS	5		279				
			5	SS	7		278				
			6	SS	8		277				0 21 37 42
275.5							276				
6.1	**CLAY (Cl)** - with silt layers Grey Firm		7	SS	4		275				
			8	SS	3		274	4.5 4.4			0 0 43 57
272.5							273				
9.1	**SILT (ML)** Grey Compact		9	SS	14		272				

Continued Next Page

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

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

DOUBLE LINE 13058 CULVERT 7.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: 48.5021281°, Long: -80.4347807° Hwy 11 - Culvert at 20+230 MTM z12: N 5 373 878.7 E 346 564.5 ORIGINATED BY SOB

HWY 11 BOREHOLE TYPE SSA / NW Casing / CME 850 Trackmount 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						271				
			10	SS	14				o		
							270				
			11	SS	12				o		0 1 91 8 non-plastic
							269				
							268				
			12	SS	18				o		
							267				
			13	SS	23				o		
265.8							266				
15.8	End of Borehole										

DOUBLE LINE 13058 CULVERT 7.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

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

20 / 15 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: 48.5021601°, Long: -80.4348899° Hwy 11 - Culvert at 20+230 MTM z12: N 5 373 882.2 E 346 556.4 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 / 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
281.8								20 40 60 80 100	20 40 60		
0.0	**ASPHALT(130mm)**										
0.1	SAND with silt and gravel Brown Very dense		1	AS					○		
281.0	**FILL**						281				
0.8	SAND with silt Brown Compact		1	SS	25				○		
280.3	**FILL**										
1.5	CLAY with sand Brown Firm		2	SS	9		280		○		0 20 38 42
	FILL		3	SS	8				○		
			4	SS	4		279		○		
							278				
			5	SS	WH		277	6.0 7.0	○		
275.7											
6.1	**CLAY (CI)** Grey Firm		6	SS	WH		276		○		0 2 37 61
274.2							275	5.0 7.0			
7.6	**SILT (ML)** Grey Loose to compact		7	SS	3		274		○		
			8	SS	6		273		○		
							272				

DOUBLE LINE 13058 CULVERT 7.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-02 2 OF 2 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.5021601°, Long: -80.4348899° Hwy 11 - Culvert at 20+230 MTM z12: N 5 373 882.2 E 346 556.4 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 20 40 60 80 100 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	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										
	SILT (ML) Grey Very loose to compact										
			9	SS	14		271		○		0 3 80 17 non-plastic
							270				
	- with sand		10	SS	30				○		
							269				
			11	SS	12		268		○		
							267				
266.0			12	SS	17				○		
15.8	End of Borehole						266				

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

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 13058 CULVERT 7.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: 48.5020522°, Long: -80.4350657° Hwy 11 - Culvert at 20+230 MTM z12: N 5 373 870.1 E 346 543.5 ORIGINATED BY JM

HWY 11 BOREHOLE TYPE NW Casing / Tripod COMPILED BY JM

DATUM Geodetic DATE 2016.10.15 - 2016.10.15 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
278.7											
0.0	**CLAY AND SILT** Brownish grey Very loose		1	SS	3						
278.1							278				
0.6	**CLAY (CI)** with sandy silt layers Grey Firm to stiff		2	SS	1			7.0			
							277				
			3	SS	1						0 3 31 66
								7.5			
			4	SS	2		276				
								8.0			
			5	SS	2		275				0 1 39 60
								8.4			
			6	SS	3		274				
								6.4			
							273				
			7	SS	6						
271.4							272				
7.3	**SILT (ML)** Grey Compact										
			8	SS	18		271				
			9	SS	14		270				
							269				

Continued Next Page

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

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

DOUBLE LINE 13058 CULVERT 7.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: 48.5020522°, Long: -80.4350657° Hwy 11 - Culvert at 20+230 MTM z12: N 5 373 870.1 E 346 543.5 ORIGINATED BY JM

HWY 11 BOREHOLE TYPE NW Casing / Tripod COMPILED BY JM

DATUM Geodetic DATE 2016.10.15 - 2016.10.15 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										
							268				
			10	SS	22				○		
							267				
265.9			11	SS	29		266		○		0 12 83 5 non-plastic
12.8	End of Borehole										

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

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

DOUBLE LINE 13058 CULVERT 7.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: 48.5022361°, Long: -80.4346198° Hwy 11 - Culvert at 20+230 MTM z12: N 5 373 890.8 E 346 576.3 ORIGINATED BY JM

HWY 11 BOREHOLE TYPE NW Casing / Tripod COMPILED BY JM

DATUM Geodetic DATE 2016.10.17 - 2016.10.17 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"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
277.6								20 40 60 80 100	20 40 60		
0.0	**CLAY (Cl)**, some sand Brownish grey Soft		1	SS	3		277				
			2	SS	5						0 14 49 37
			3	SS	3		276				
275.1											
2.5	**CLAY (Cl)** with silt layers Grey Soft to firm		4	SS	6		275	3.8			
			5	SS	1		274	7.0			
			6	SS	4		273	6.0			0 0 42 58
			7	SS	3		272				
			8	SS	11		271				
269.1							270				
8.5	**SILT (ML)** Grey Compact		9	SS	20		269				0 6 85 9 non-plastic
							268				

Continued Next Page

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

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

DOUBLE LINE 13058 CULVERT 7.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: 48.5022361°, Long: -80.4346198° Hwy 11 - Culvert at 20+230 MTM z12: N 5 373 890.8 E 346 576.3 ORIGINATED BY JM

HWY 11 BOREHOLE TYPE NW Casing / Tripod 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										
	SILT (ML) Grey Compact						267				
			10	SS	17				○		
							266				
			11	SS	27				○		
264.2			12	SS	24		265		○		
13.4	End of Borehole DATE DEPTH (m) ELEV. (m) 2016.10.20 11.2 266.4 2017.04.17 10.5 267.1 2017.06.12 10.6 267.0										

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

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

DOUBLE LINE 13058 CULVERT 7.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 18-05 1 OF 2 METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.5020802°, Long: -80.4348104° Hwy 11 - Culvert at 20+230 MTM z12: N 5 373 873.4 E 346 562.3 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
281.5											
0.0	**ASPHALT (125mm)**										
0.1	SAND with silt and gravel Brown Frozen		1	SS	100/ 150mm		281				
280.8	**FILL**										
0.8	SAND with Silt some Gravel Brown Frozen **FILL**		2	SS	39						14 80 6 (SI+CL)
			3	SS	100/ 150mm		280				
279.3											
2.3	CLAY Brown to grey Very Stiff **FILL**		4	SS	3		279				
			5	SS	2						
			6	SS	3		278				0 4 52 44
	- trace organics from 4.6 to 6.1 m		7	SS	6		277				
			8	SS	4		276	>>			
275.5											
6.1	**CLAY (Cl)** with silt layers Grey Firm to Stiff		9	SS	3		275	6.0 3.0			0 5 41 54
			10	SS	WH		274				
							273	3.0 >>			
			11	ST	PUSH		272				

Continued Next Page

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

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

DOUBLE LINE 13058 CULVERT 7.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: 48.5020802°, Long: -80.4348104° Hwy 11 - Culvert at 20+230 MTM z12: N 5 373 873.4 E 346 562.3 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

SOIL PROFILE			SAMPLES			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)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	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										
270.9	**CLAY (Cl)** - with silt layers Grey Firm to Stiff						271	3.0			
10.7	**Silty CLAY (CL-ML)** Grey Very Stiff		12	SS	12		270				0 2 72 26
268.7			13	SS	7		269				
12.8	End of borehole Borehole dry on completion										

DOUBLE LINE 13058 CULVERT 7.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: 48.502168°, Long: -80.4345314° Hwy 11 - Culvert at 20+230 MTM z12: N 5 373 883.3 E 346 582.9 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 (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
276.5											
0.0 / 0.1	**50 mm Rootmat**										
	CLAY (CL), some sand with silt layers Grey Soft		1	SS	3		276				
			2	SS	2						0 12 51 37
275.1 / 1.4	**CLAY (CL)** with silt layers Grey Soft to stiff		3	SS	2		275				
							274	14.0 5.0			
			4	SS	5		273	6.0			
	- unable to push N-vane, silt observed on vane						272				
			5	SS	2						0 0 47 53
							271	14.0 6.0			
			6	SS	5		270				
269.8 / 6.7	End of Borehole										

DOUBLE LINE 13058 CULVERT 7.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

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

(%) STRAIN AT FAILURE

Appendix C.

Laboratory Testing

Appendix C.1

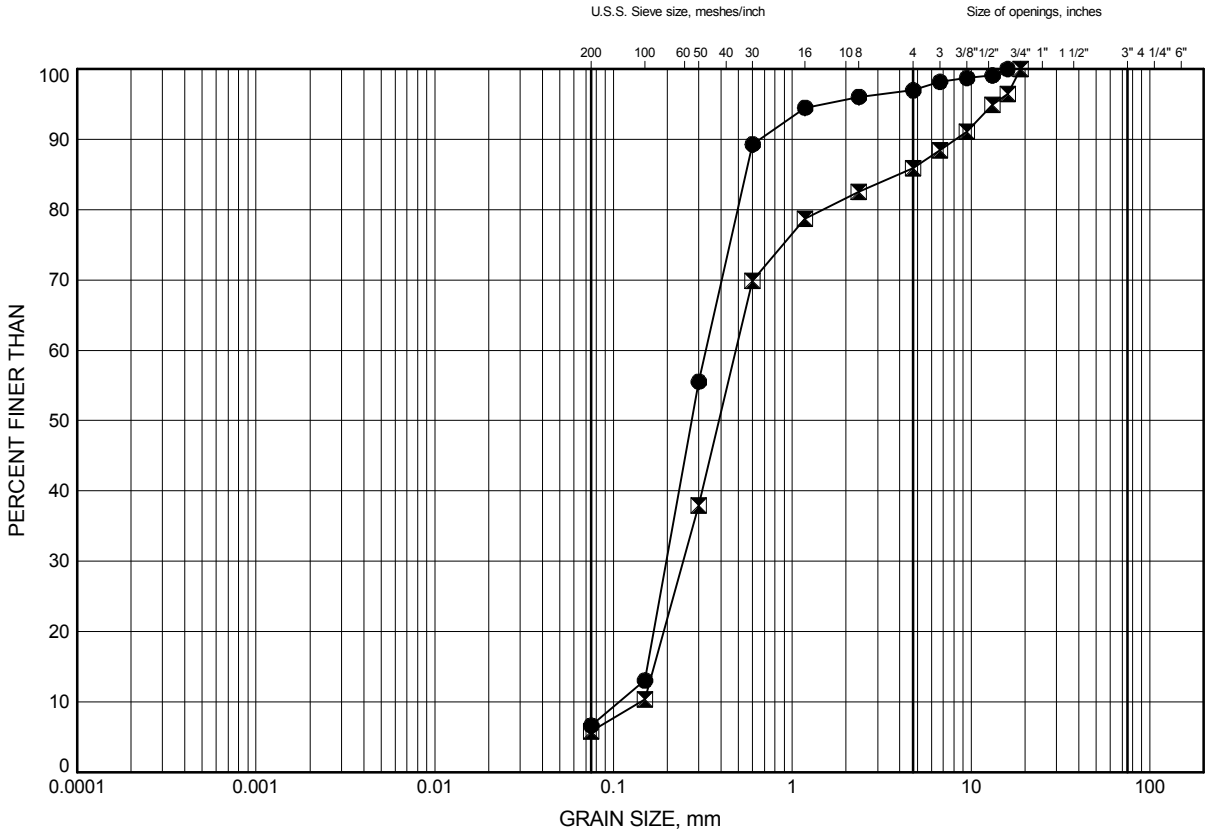
Particle Size Analysis Figures

Hwy 11 - Culvert at 20+230

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	280.53
⊠	18-05	1.07	280.48

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd CM

Chkd. SP

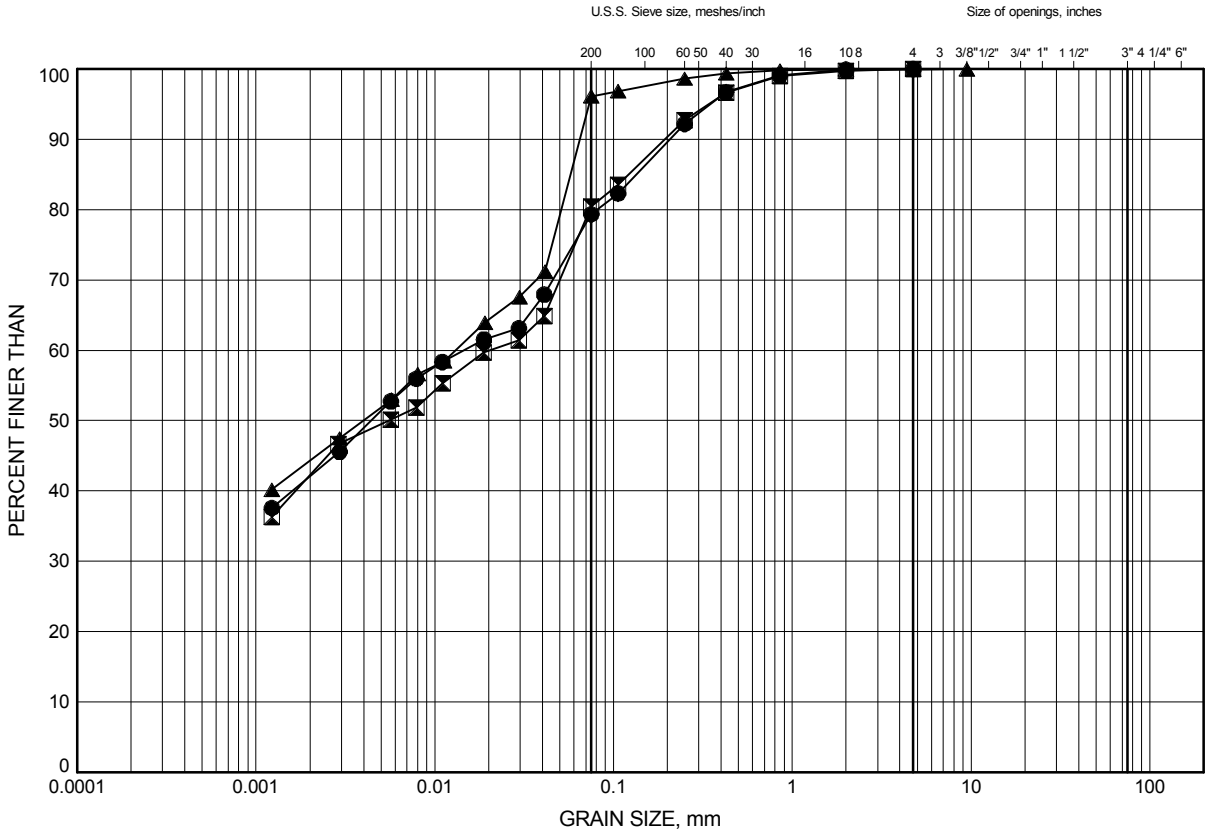
GRAIN SIZE DISTRIBUTION - THURBER 13058 CULVERT 7.GPJ 25/6/18

Hwy 11 - Culvert at 20+230

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)
●	16-01	4.88	276.72
⊠	16-02	1.83	279.97
▲	18-05	4.11	277.43

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd CM

Chkd. SP

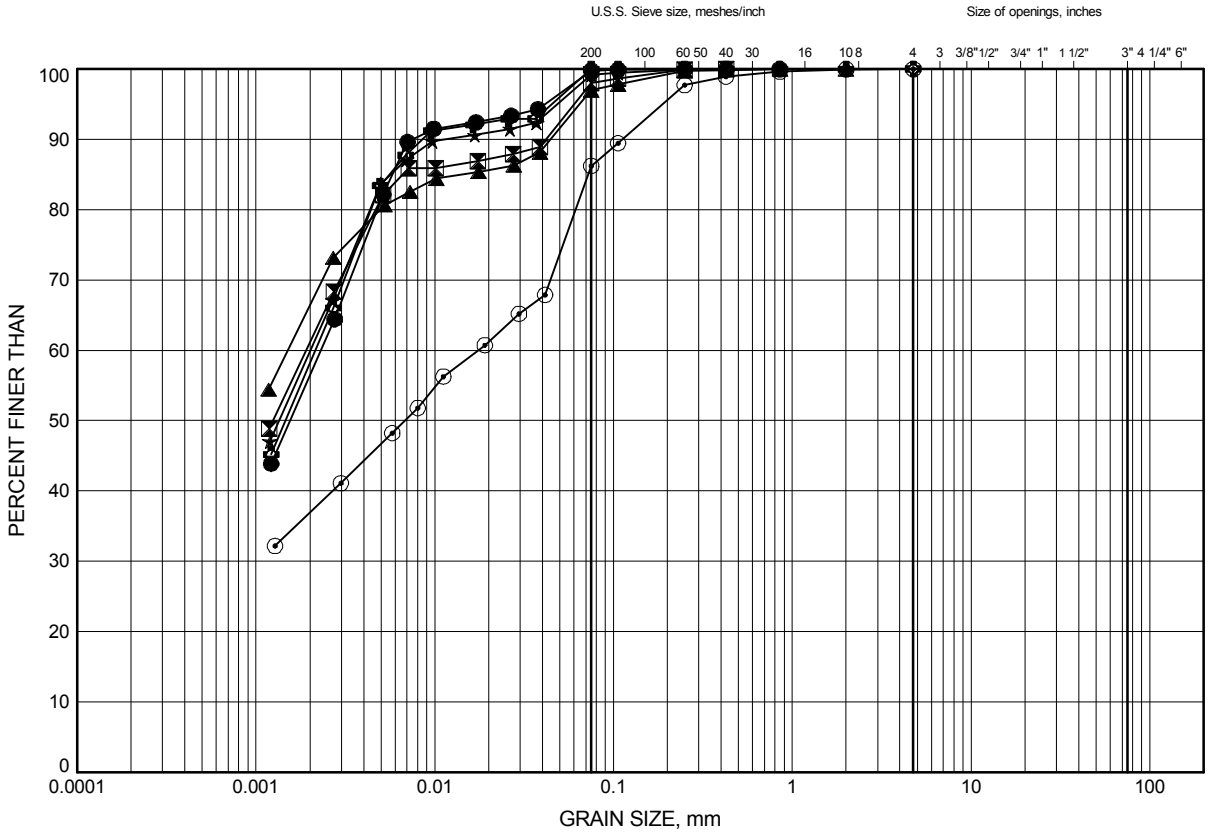
GRAIN SIZE DISTRIBUTION - THURBER 13058 CULVERT 7.GPJ 25/6/18

Hwy 11 - Culvert at 20+230

GRAIN SIZE DISTRIBUTION

FIGURE C3

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)
●	16-01	7.92	273.68
⊠	16-02	6.40	275.40
▲	16-03	1.98	276.72
★	16-03	3.81	274.89
⊙	16-04	1.07	276.53
✿	16-04	4.88	272.72

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd CM

Chkd. SP

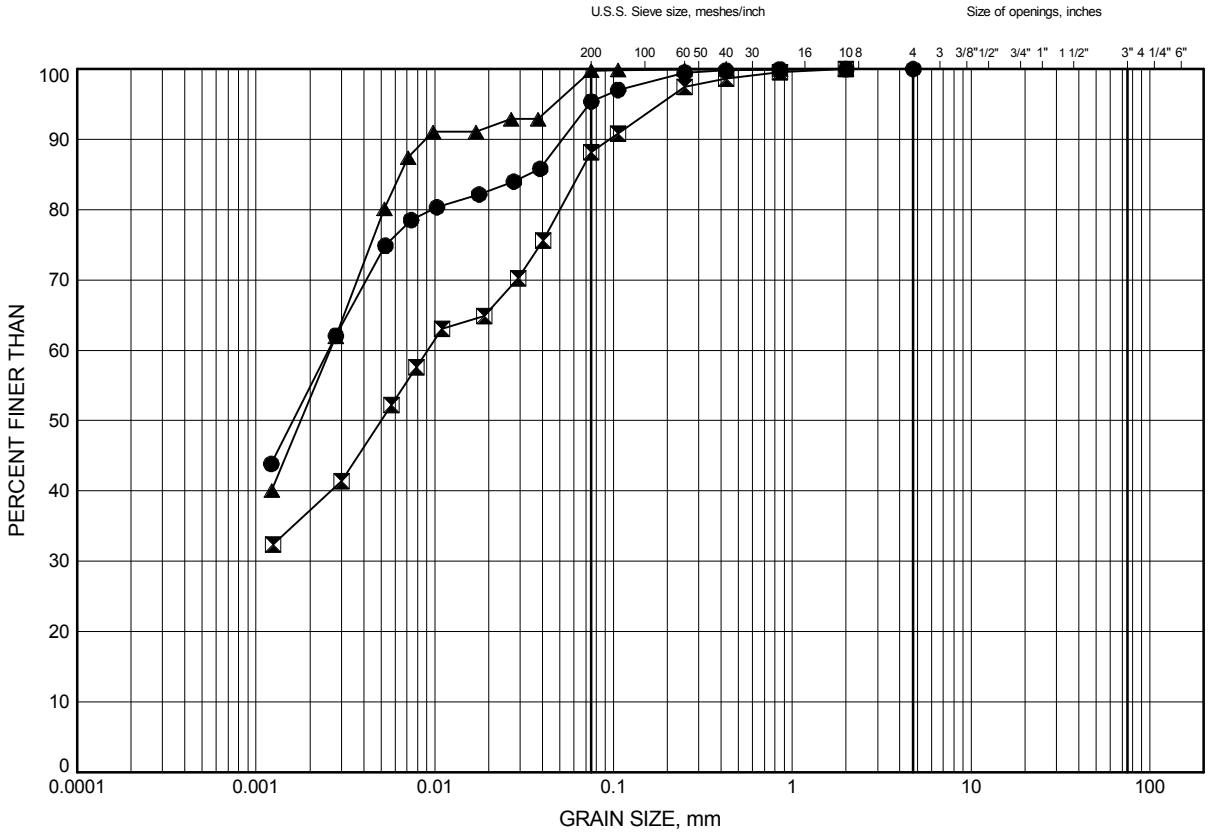
GRAIN SIZE DISTRIBUTION - THURBER 13058 CULVERT 7.GPJ 25/6/18

Hwy 11 - Culvert at 20+230

GRAIN SIZE DISTRIBUTION

FIGURE C4

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)
●	18-05	6.40	275.15
⊠	18-06	1.07	275.45
▲	18-06	4.88	271.64

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd CM

Chkd. SP

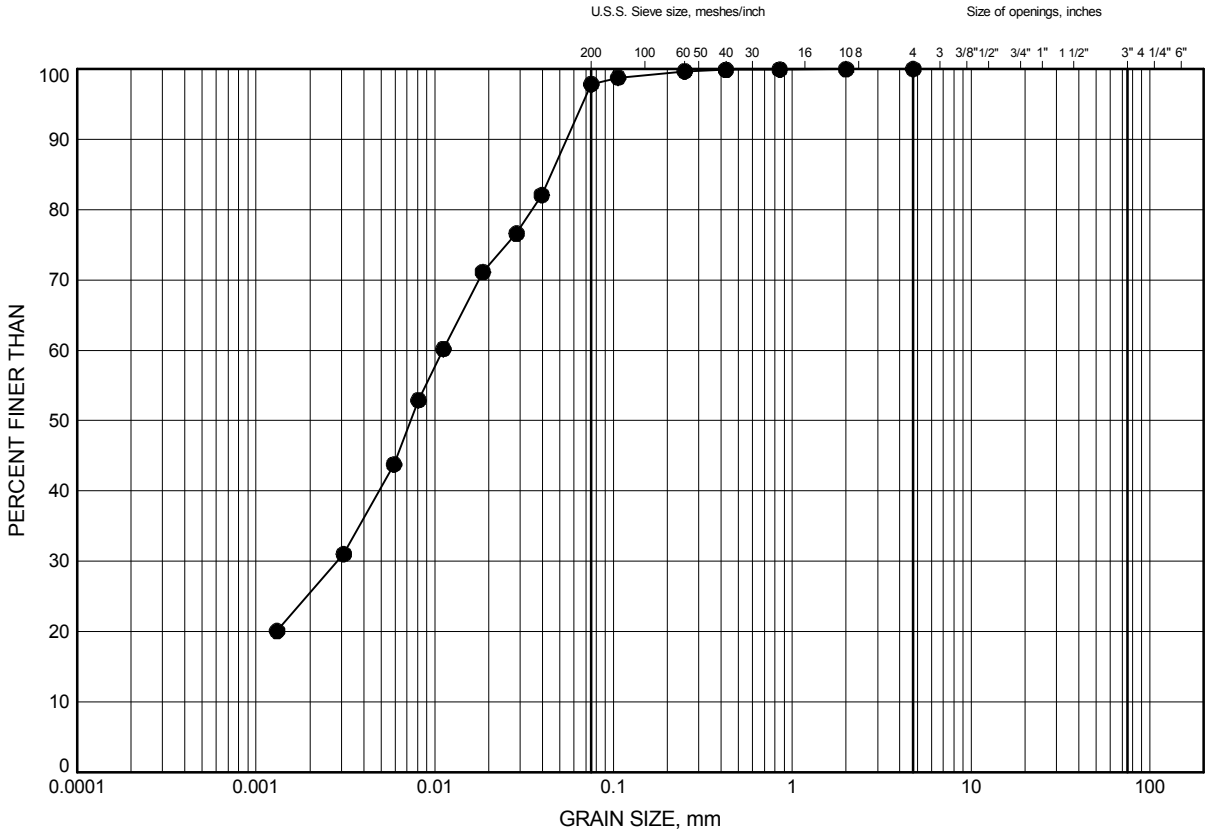
GRAIN SIZE DISTRIBUTION - THURBER 13058 CULVERT 7.GPJ 25/6/18

Hwy 11 - Culvert at 20+230

GRAIN SIZE DISTRIBUTION

FIGURE C5

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)
●	18-05	10.97	270.58

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd CM

Chkd. SP

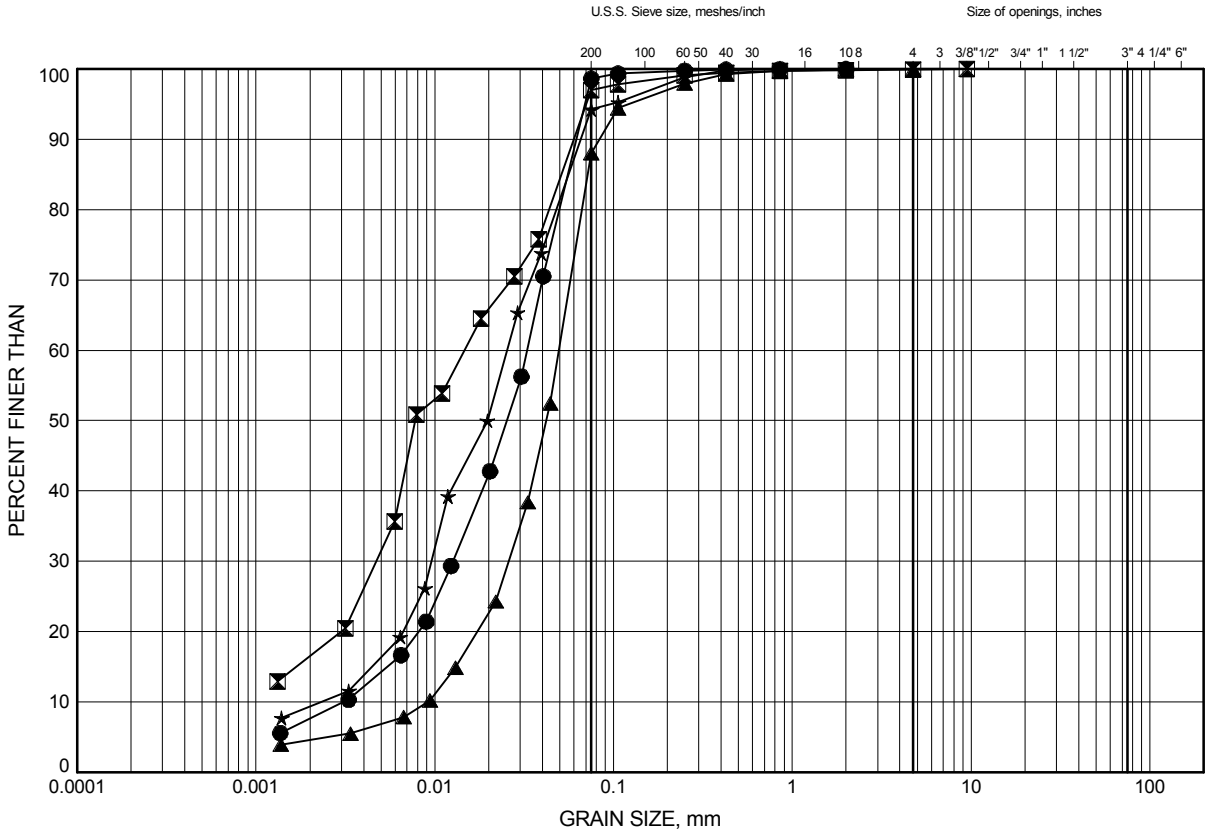
GRAIN SIZE DISTRIBUTION - THURBER 13058 CULVERT 7.GPJ 29/6/18

Hwy 11 - Culvert at 20+230

GRAIN SIZE DISTRIBUTION

FIGURE C6

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	269.10
⊠	16-02	10.97	270.83
▲	16-03	12.50	266.20
★	16-04	9.45	268.15

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd CM

Chkd. SP

GRAIN SIZE DISTRIBUTION - THURBER 13058 CULVERT 7.GPJ 29/6/18

Appendix C.2

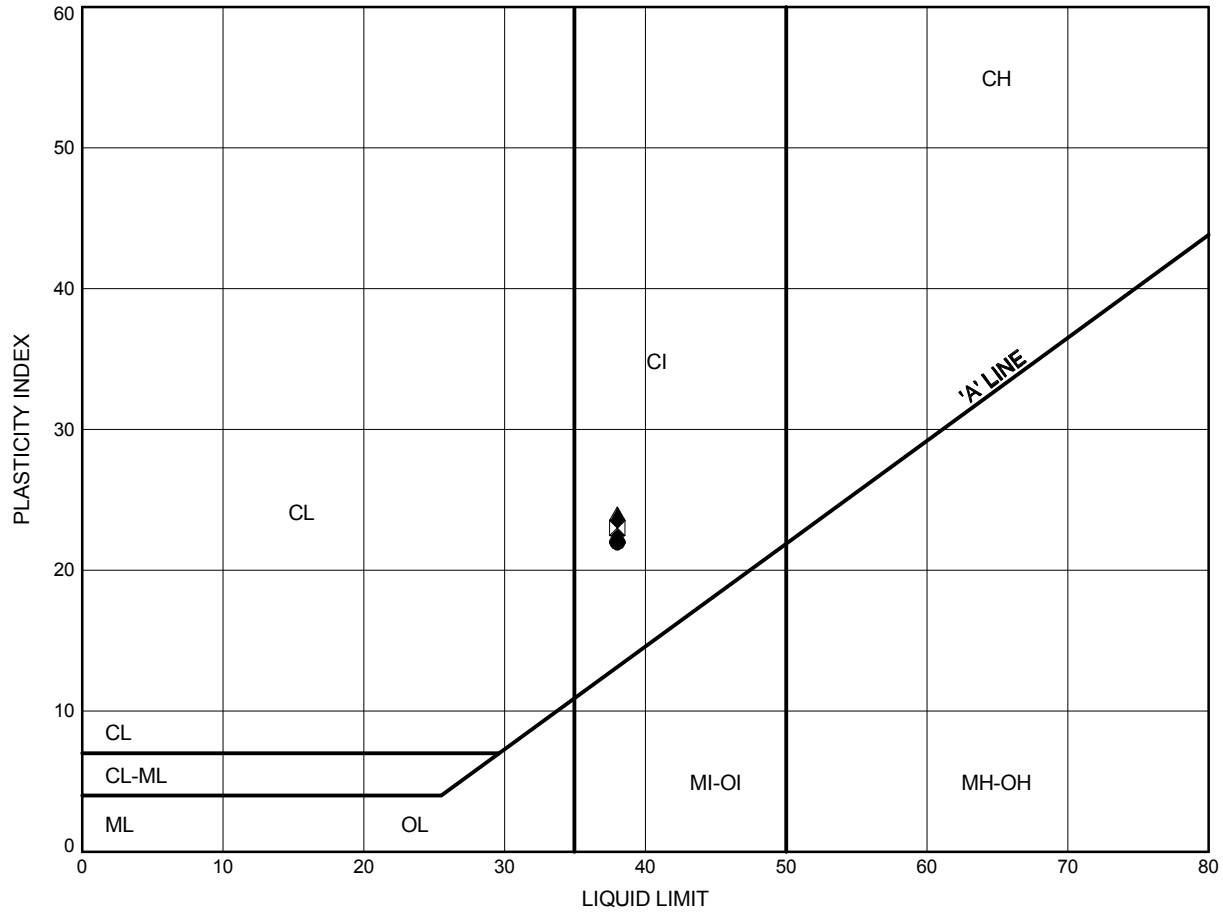
Atterberg Limit Analysis Figures

Hwy 11 - Culvert at 20+230

ATTERBERG LIMITS TEST RESULTS

FIGURE C7

Clay Fill



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	4.88	276.72
⊠	16-02	1.83	279.97
▲	18-05	4.11	277.43

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd CM

Chkd. SP

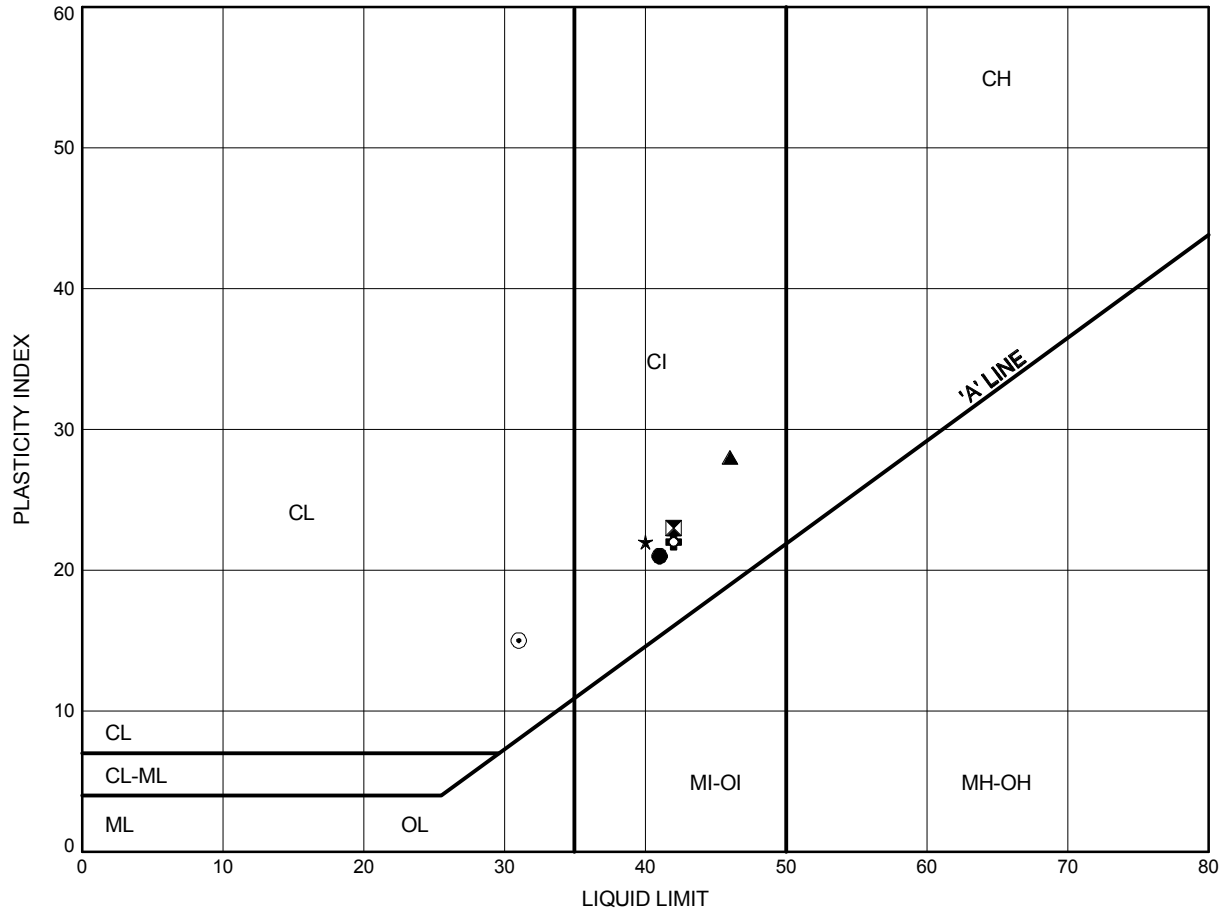
THURBALT 13058 CULVERT 7.GPJ 25/6/18

Hwy 11 - Culvert at 20+230

ATTERBERG LIMITS TEST RESULTS

FIGURE C8

Clay (CI to CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	7.92	273.68
⊠	16-02	6.40	275.40
▲	16-03	1.98	276.72
★	16-03	3.81	274.89
⊙	16-04	1.07	276.53
✿	16-04	4.88	272.72

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd CM

Chkd. SP

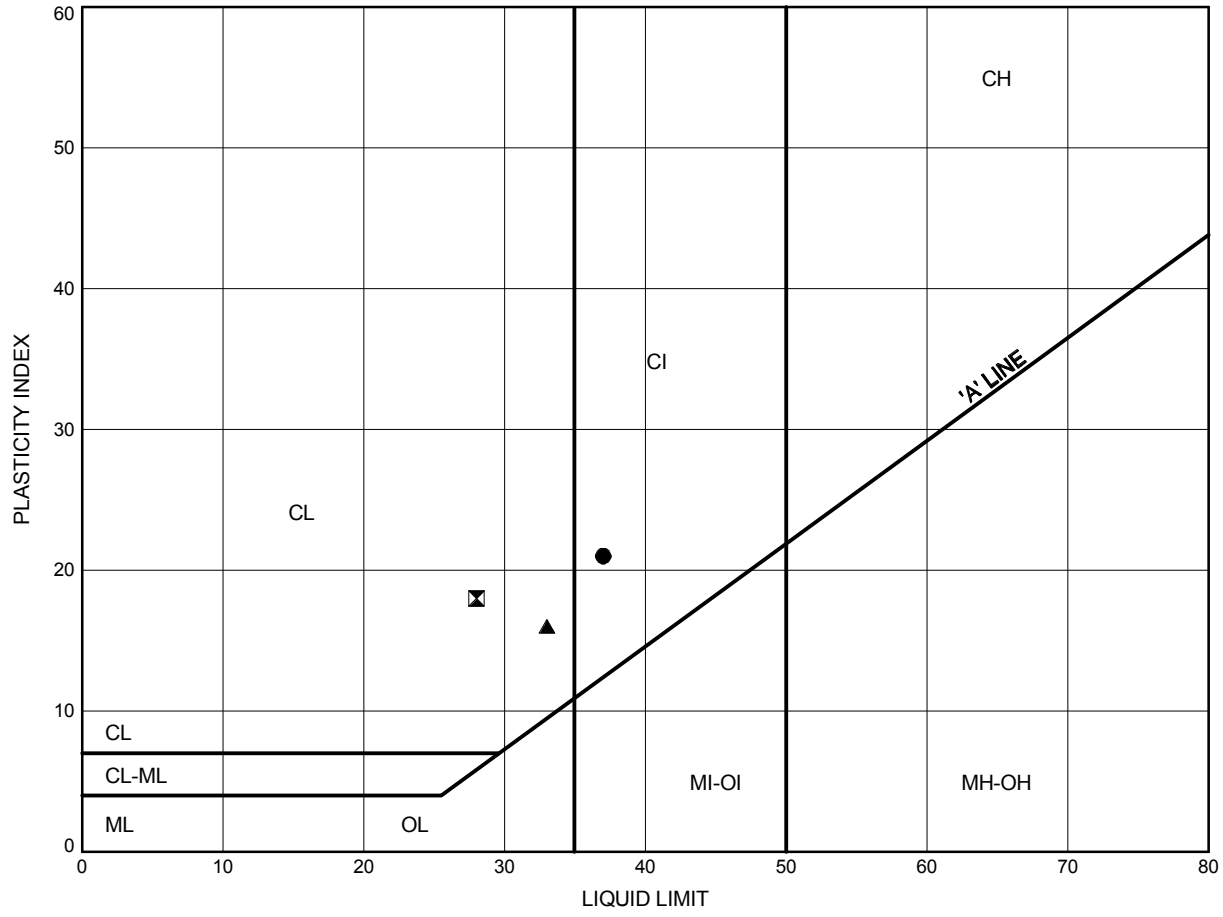
THURBALT 13058 CULVERT 7.GPJ 25/6/18

Hwy 11 - Culvert at 20+230

ATTERBERG LIMITS TEST RESULTS

FIGURE C9

Clay (CI to CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-05	6.40	275.15
⊠	18-06	1.07	275.45
▲	18-06	4.88	271.64

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd CM

Chkd. SP

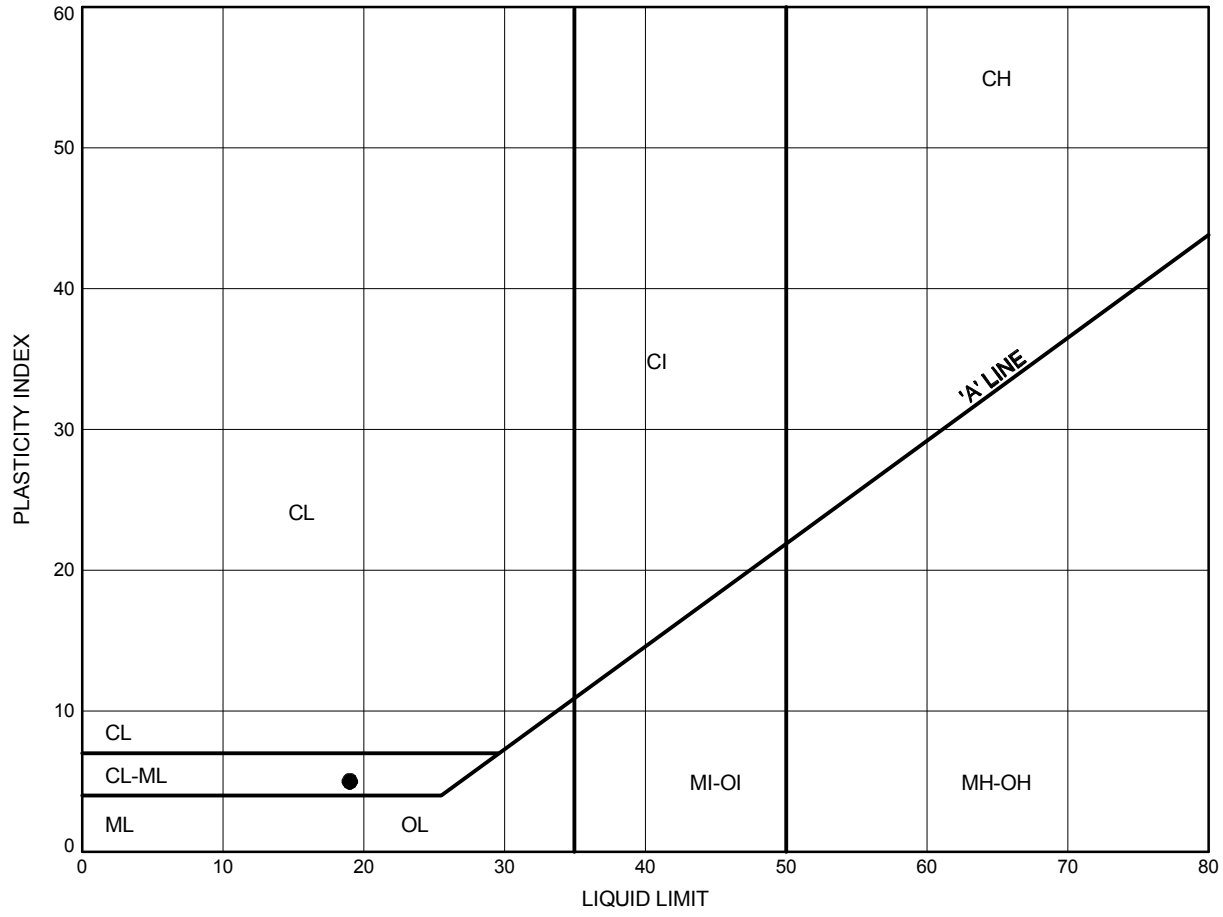
THURBALT 13058 CULVERT 7.GPJ 25/6/18

Hwy 11 - Culvert at 20+230

ATTERBERG LIMITS TEST RESULTS

FIGURE C10

Silty Clay (CL-ML)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-05	10.97	270.58

Date June 2018

GWP# 5015-E-0041

THURBER

Prep'd CM

Chkd. SP

THURBALT 13058 CULVERT 7.GPJ 25/6/18

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 east of Highway 11.

Photo 2. Looking south along Highway 11.

Photo 3. Looking west of Highway 11

Photo 4. Looking north along Highway 11