



THURBER ENGINEERING LTD.

**FINAL
FOUNDATION INVESTIGATION REPORT
HIGHWAY 11 CULVERT
0.6 KM NORTH OF HIGHWAY 572, PLAYFAIR TOWNSHIP
NEAR STATION 11+975**

G.W.P. 5054-01-00

Geocres No.: 42A00-121

Report to:

McIntosh Perry Consulting Engineers Limited

Latitude: 48.43951°
Longitude: -80.34223°

October 2018
Thurber File No.: 13058

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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 11+975. The culvert is located approximately 0.6 km north of Highway 572 within Playfair 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 900 mm diameter non-structural corrugated steel pipe (CSP) culvert and is approximately 45.6 m long with a generally northeast to southwest alignment. The flow through the culvert is to the southwest.

At the location of the culvert at Station 11+977 (Linear Highway Referencing System Base Point: 17450, Offset: 0.6), Highway 11 is a two-lane highway with a rural cross-section and gravel shoulders. The Highway 11 embankment fill height is approximately 6.1 m with the road surface at approximate elevation 283.2 m. The existing slopes are inclined at approximately 2H:1V to 2.7H:1V. No guiderails are present at the site. The land adjacent to the highway is generally undeveloped and consist of densely vegetated areas with shrubs and trees, and open farm fields. Fibre optic cables are in close proximity to the west end of the culvert and cross the road just south of the culvert. A buried gas pipeline also crosses the road just south of the culvert. Wildgoose Creek crosses Highway 11 approximately 600 m north of the culvert. 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 14th and October 16th, 2016. A supplemental site investigation was carried out on April 30th, 2018. The field investigations consisted of advancing five boreholes identified as 16-01 through 16-04 and 18-05. The drilling was carried out using portable equipment for off-road Boreholes 16-03 and 16-04, a rubber tired CME 550 drill rig and 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 and 16-04, 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. A Thin Walled (Shelby) Tube sample of clay was retrieved from Borehole 16-01 to obtain a relatively undisturbed soil sample for further laboratory testing. The boreholes were sampled to depths ranging from 12.8 to 17.4 m (elev. 270.3 to 265.0 m) below the existing ground surface. Borehole 16-03 was extended below the base of the sampled borehole with a Dynamic Cone Penetration Test (DCPT) to a base elevation of 264.1 m.

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 Record of Borehole sheet for Borehole 16-04, 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. A single sample, obtained with a Thin Walled (Shelby) Tube, underwent one-dimensional consolidation testing. 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 silty sand. 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 130 mm. A 75 mm thick buried asphalt layer was encountered in Borehole 18-05 within the sand fill at a depth of 0.7 m.

5.1.2 Fill: Sand

Below the asphalt pavement in Boreholes 16-01, 16-02 and 18-05 was a layer of fill consisting of sand with gravel over sand with silt and gravel. The underside depth of the fill was 1.5 to 2.3 m below the existing roadway surface (elev. 281.7 to 280.9 m).

The SPT tests conducted in the unfrozen sand fill gave N-values typically ranging from 15 to 29 blows indicating a compact relative density. It is noted that the sand fill encountered in Borehole 18-05 was frozen at the time of drilling and those N-values have not been included in the range given above. A single SPT test with results as high as 100 blows for 175 mm of penetration was recorded near the surface of Borehole 16-02. Recorded moisture contents ranged from 1 to 24%. 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	22 - 26
Sand	70 - 71
Silt & Clay	3 - 8

5.1.3 Fill: Clay

A layer of clay fill was encountered directly below the sand fill in Boreholes 16-01, 16-02 and 18-05 with a recorded thickness 4.6 to 5.5 m and an underside depth of 6.1 to 7.6 m below the existing roadway surface (elev. 277.1 to 275.6 m).

The SPT tests conducted in the clay fill gave N-values ranging from 4 to 16 blows. Shear vane testing was attempted at four locations in Borehole 18-05 and resulted in an undrained shear strength of greater than 106 kPa indicating a very stiff consistency. The recorded moisture contents varied from 18 to 46%. The results of grain size analyses conducted on four samples of the clay fill material are summarized below and are illustrated on Figure C2 of Appendix C.

Soil Particle	Percentage (%)
Gravel	0 - 1
Sand	1 - 7
Silt	29 - 72
Clay	26 - 70

Atterberg Limit testing was completed on four 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 to high plasticity (CI to CH).

Parameter	Value
Liquid Limit	39 - 52
Plastic Limit	17 - 23
Plasticity Index	16 - 32

5.2 Clay (CI to CH)

A native deposit of clay was encountered below the fill layers in Boreholes 16-01, 16-02 and 18-05 and from the surface in Boreholes 16-03 and 16-04. Silt layers were observed in the clay deposit. Where fully penetrated this layer has a thickness ranging from 7.6 m to 11.9 m with an underside elevation of 268.0 to 265.9 m. Borehole 18-05 and 16-03 were terminated within this layer at sampled depths of 12.8 m below the ground surface (elev. 270.3 and 265.7 m respectively).

The SPT N-values ranged from weight of hammer to 4 blows. Field vane tests were performed within the deposit and recorded undrained shear strengths ranging from 18 to 75 kPa indicating a soft to stiff consistency. Remolded field vane testing indicates that the clay shows some sensitivity. The moisture content of the samples tested ranged from 32% to 70%. The results of grain size analyses conducted on eleven 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 - 7
Silt	17 - 52
Clay	44 - 83

Atterberg Limit testing was completed on eleven 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 intermediate to high plasticity (CI to CH).

Parameter	Value
Liquid Limit	35 - 63
Plastic Limit	18 - 28
Plasticity Index	16 - 40

An Oedometer (one-dimensional consolidation) Test was carried out on a relatively undisturbed sample obtained from a Thin Walled (Shelby) tube sample taken in Borehole 16-01 at a depth of 7.9 m. The results are presented in Appendix C and summarized in the following table. The compressibility characteristics will vary with depth in accordance with the soil index parameters and stress history.

Table 5-1. Summary of Oedometer Test Results and Interpretations

Parameter		Units	Value
Borehole		-	BH16-01
Sample Depth (Elevation)		m	7.9 (275.3)
Natural Moisture Content, w_n		%	56.9
Initial Void Ratio, e_o		-	1.526
Unit Weight, γ		kN/m ³	16.5
Existing Vertical Effective Stress, σ'_{vo}		kPa	140
Preconsolidation Pressure, σ'_c		kPa	140
Over Consolidation Ratio, OCR		-	~1
Recompression Zone	Recompression Index, C_r	-	0.088
	Coefficient of Consolidation, c_{vr}	cm ² /s	3.3 to 0.06 x 10 ⁻²
	Average Permeability, k_{vr}	m/s	2 x 10 ⁻⁹
Virgin Compression Zone	Compression Index, C_c	-	0.64
	Coefficient of Consolidation, c_v	cm ² /s	4.9 to 0.3 x 10 ⁻⁴
	Average Permeability, k_v	m/s	5 x 10 ⁻¹¹
Modulus of Elasticity (Constrained), E_c		kPa	1,650

5.3 Silty Clay (CL-ML)

Below the clay within Boreholes 16-01 and 16-02 was a deposit of silty clay. The silty clay was 1.6 m thick in Borehole 16-02 with an underside depth of 16.8 m (elev. of 266.4 m). Borehole 16-01 was terminated 2.2 m into the silty clay at a depth of 17.4 m (elev. 265.8 m).

The SPT N-value ranged from 3 to 16 blows. The moisture content of the samples tested ranged from 23 to 48%. A single gradation analysis was completed on the silty clay material with results of 0% gravel, 1% sand 75% silt and 24% clay. The results of the grain size analysis are illustrated on Figure C5 in Appendix C. An Atterberg Limit test provided a liquid limit of 24 and a plastic limit of 19 resulting in a plasticity index of 5 and a CL-ML classification. The result of the Atterberg limit test is presented in Figure C10 in Appendix C.

5.4 Silty Sand

A layer consisting of silty sand with gravel was encountered below the silty clay in Borehole 16-02 and below the clay in Borehole 16-04. Both boreholes were terminated within this stratum at a depth of 12.8 to 17.4 m (elev. of 265.8 to 265.0 m).

The SPT N-values of 20 to 55 blows were recorded indicating a compact to very dense relative density. The moisture content for the samples tested ranged from 12% to 15%. A single grain size analysis was conducted on the silty sand material with results of 26% gravel, 51% sand and 23% fines. The results of the grain size analysis are illustrated on Figure C6 in Appendix C.

5.5 Groundwater

At the completion of drilling, the groundwater level was measured at 9.1 m below the ground surface (elev. 268.7 m) within the standpipe piezometer installed in Borehole 16-04. The culvert was dry at the time of the field investigation. During site visits on April 17, 2017 and June 12, 2017 the water level within the standpipe piezometer was observed at 9.3 m (elev. 268.5 m) and 8.8 m (elev. 269.0) below the ground surface respectively. A low level of water was present in the culvert on April 17, 2017. The standpipe piezometer was decommissioned on June 12, 2017.

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

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 the native soils 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 (C28-3*)	SS2	0.7 – 1.4	15	7.5	1310	765	343
16-04 (C28-4*)	SS1	0 – 0.6	21	7.6	1000	999	493
18-05	SS9	7.6 – 8.2	14	7.6	2450	408	118

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 borehole from the 2018 field investigation based on benchmarks provided by MPCE.

Landcore Drilling of Chelmsford, Ontario supplied and operated the 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. and Mr. Sean O'Bryan 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. One-dimensional consolidation testing was completed by Stantec's laboratory in Ottawa, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa, Ontario.

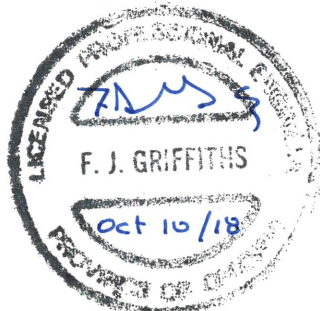
Interpretation of the factual data and preparation of this report were carried out by Mr. Christopher Murray, P.Eng. and Mr. Stephen Peters P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundation Projects.



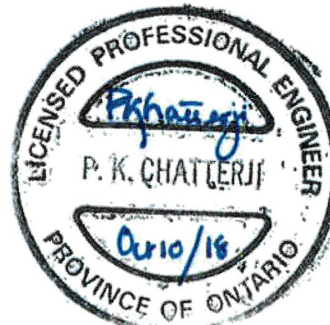
Christopher Murray, M.A.Sc., P.Eng.
Geotechnical Engineer



Stephen Peters, P.Eng.
Geotechnical Engineer



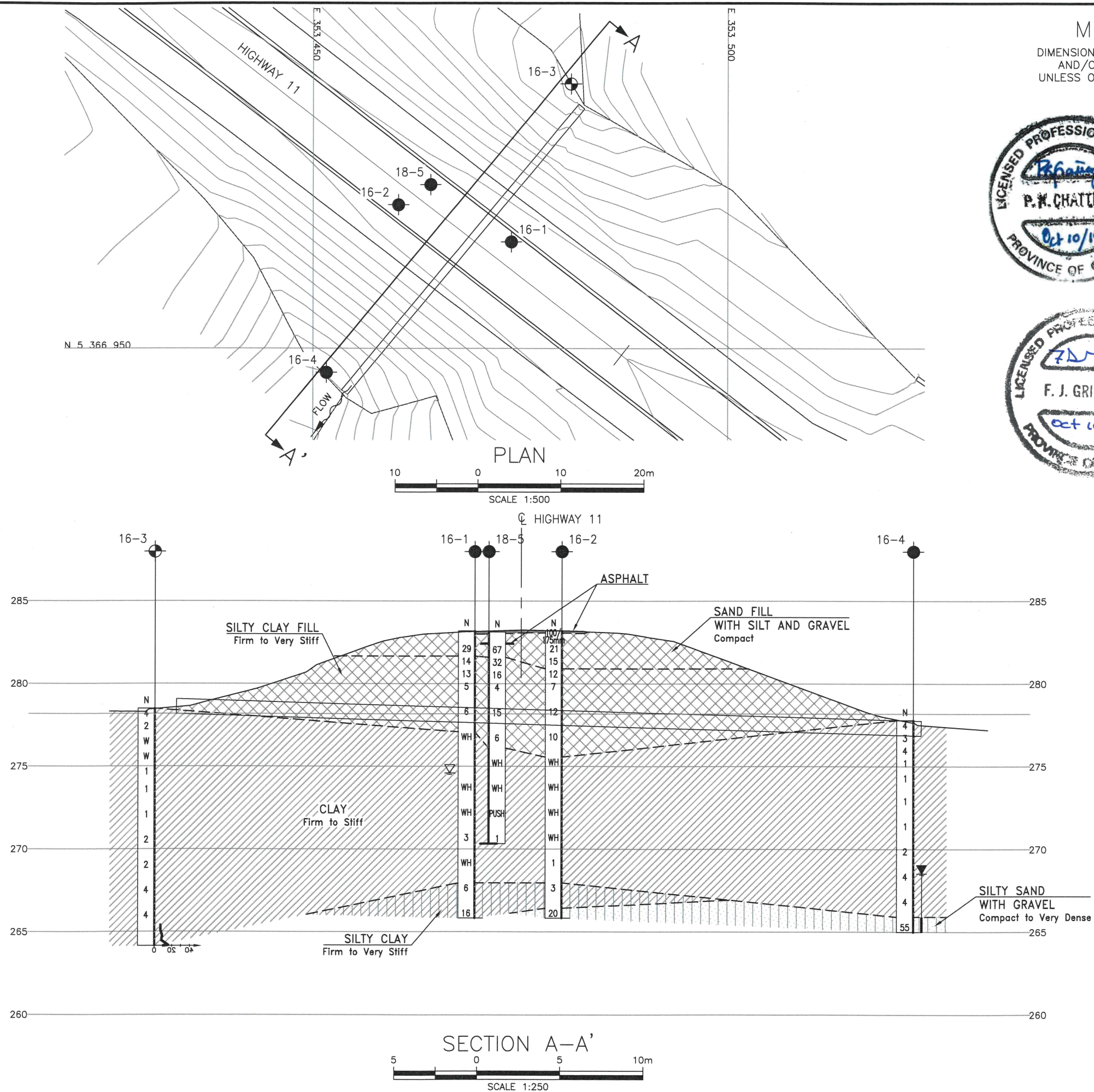
Dr. Fred Griffiths, P.Eng.
Senior Associate
Senior Geotechnical Engineer



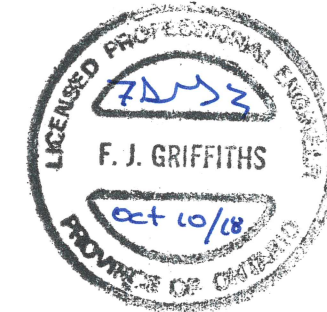
Dr. P.K. Chatterji, P.Eng.
Review Principal
Senior Geotechnical Engineer

Appendix A.

Drawings

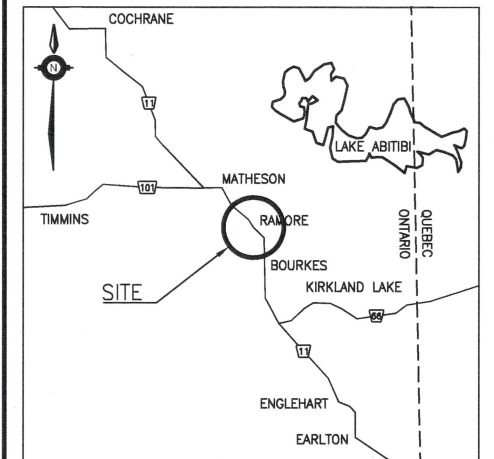


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN








CONT No	(
GWP No 5054-01-00	

HIGHWAY 11
CULVERT AT 11+975
PLAYFAIR TOWNSHIP
BOREHOLE LOCATIONS AND SOIL STRATA



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

[illegible]

-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.

GEOCRES No. 42A00-121

REVISIONS										
	DATE	BY	DESCRIPTION							
DESIGN	SBP	CHK	CODE		LOAD		DATE	OCT 2018		
DRAWN	AN	CHK	SBP	SITE	STRUCT	DWG	1			

Appendix B.
Record of Borehole Sheets



SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

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

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

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

RECOVERY:

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

N-VALUE:

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

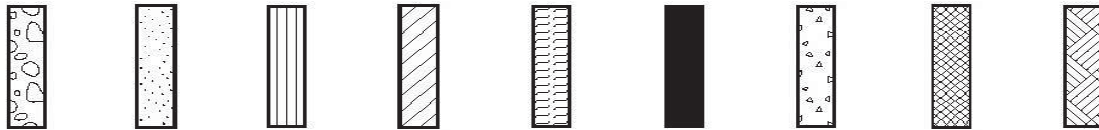
DYNAMIC CONE PENETRATION TEST (DCPT):

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



STRATA PLOT:

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



Boulders
Cobbles
Gravel Sand Silt Clay Organics Asphalt Concrete Fill Bedrock

TEXTURING CLASSIFICATION OF SOILS

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

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

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

SAMPLE TYPES

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

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

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

MODIFIED UNIFIED SOIL CLASSIFICATION

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

Note - W_L = Liquid Limit



EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

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

TERMS

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

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

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

RECORD OF BOREHOLE No 16-01

1 OF 2

METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.4394362°, Long: -80.3420829°
Hwy 11 BOREHOLE TYPE HSA / CME 550 Buggy Mount ORIGINATED BY SOB
DATUM Geodetic DATE 2016.10.14 - 2016.10.14 COMPILED BY JM
CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								20 40 60 80 100				
								20 40 60 80 100				
283.2												
0.0	ASPHALT (130mm)						283					
0.1	SAND with gravel Compact Brown FILL		1	AS								
282.4												
0.8	SAND with silt and gravel Brown Compact FILL		1	SS	29		282					
281.7												
1.5	CLAY Stiff to firm Brownish grey FILL		2	SS	14		281					
			3	SS	13							
			4	SS	5		280					
			5	SS	6		279					
							278					
277.1												
6.1	CLAY (CH) Grey Firm to stiff		6	SS	WH		277					
							276					
			1	ST								
							275					
274.1							274					
9.1	CLAY (Cl) Grey Stiff		7	SS	WH							

Continued Next Page

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

DOUBLE LINE 13058 CULVERT 28.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

RECORD OF BOREHOLE No 16-01

2 OF 2

METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.4394362°, Long: -80.3420829°
Hwy 11 BOREHOLE TYPE HSA / CME 550 Buggy Mount ORIGINATED BY SOB
DATUM Geodetic DATE 2016.10.14 - 2016.10.14 COMPILED BY JM
CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
	Continued From Previous Page													
	CLAY (Cl) Grey Stiff						273			4.8				
			8	SS	WH		272			6.0				
							271			3.3				
			9	SS	3		270							
							269							
			10	SS	WH		268							
							267							
							266							
268.0														
15.2	Silty CLAY (CL-ML) Grey Stiff		11	SS	6									0 1 75 24
			12	SS	16									
265.8														
17.4	End of borehole Water level measured at 8.6 m B.G.S. on completion													

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

RECORD OF BOREHOLE No 16-02

1 OF 2

METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.4394777° Long: -80.3422662°
Hwy 11 BOREHOLE TYPE SSA / NW Casing / CME 850 Trackmount ORIGINATED BY SOB
DATUM Geodetic DATE 2016.10.16 - 2016.10.16 COMPILED BY JM
CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								UNCONFINED + FIELD VANE					
								● QUICK TRIAXIAL × LAB VANE					
							WATER CONTENT (%)						
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
							W P W W L						
							20 40 60 80 100						
							20 40 60 80 100						
							20 40 60						
283.2													
0.0													
0.1	ASPHALT (130mm)						283						26 71 3 (SI+CL)
	SAND with gravel		1	SS	100/								
	Brown				175mm								
	Very dense												
282.4	FILL												
0.8	SAND with silt and gravel												
	Brown		2	SS	21								
	Compact												
	FILL												
							282						
			3	SS	15								
							281						
280.9													
2.3	CLAY												
	Greyish brown		4	SS	12								1 7 50 42
	Stiff												
	FILL												
							280						
			5	SS	7								
							279						
			6	SS	12								
							278						
							277						
			7	SS	10								
							276						
275.6													
7.6	CLAY (CH)												
	Grey		8	SS	WH								0 0 23 77
	Firm to stiff												
							275						
							274						
			9	SS	WH								

Continued Next Page

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

DOUBLE LINE 13058 CULVERT 28.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

RECORD OF BOREHOLE No 16-02

2 OF 2

METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.4394777° Long: -80.3422662°
Hwy 11 BOREHOLE TYPE SSA / NW Casing / CME 850 Trackmount ORIGINATED BY SOB
DATUM Geodetic DATE 2016.10.16 - 2016.10.16 COMPILED BY JM
CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
	Continued From Previous Page													
272.5	CLAY (CH) Grey Firm to stiff						273			5.5				
10.7	CLAY (CI) Grey Firm to stiff		10	SS	WH		272			4.4				
							271			6.0				
			11	SS	WH		270							
							269							
268.0	Silty CLAY (CL-ML) Grey Stiff		13	SS	3		268							
266.4	Silty SAND (SM) with gravel Grey Compact		14	SS	20		267							
265.8							266							
17.4	End of borehole													

DOUBLE LINE 13058 CULVERT 28.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

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

RECORD OF BOREHOLE No 16-03

1 OF 2

METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.4396074° Long: -80.3419834°
Hwy 11 BOREHOLE TYPE NW Casing / Tripod ORIGINATION BY JM
DATUM Geodetic DATE 2016.10.14 - 2016.10.14 COMPILED BY JM
CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE											
								● QUICK TRIAXIAL × LAB VANE											
278.5							20	40	60	80	100								
0.0	CLAY Greyish brown Firm - crust		1	SS	4											0 7 41 52			
277.9																			
0.6	CLAY (CH) Grey Firm		2	SS	2														
			3	SS	WH											0 0 24 76			
			4	SS	WH														
			5	SS	1														
			6	SS	1														
273.0																			
5.5	CLAY (Cl) Grey Firm to stiff																		
			7	SS	1														
			8	SS	2														
			9	SS	2											0 0 29 71			

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 16-03

2 OF 2

METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.4396074° Long: -80.3419834°
Hwy 11 BOREHOLE TYPE NW Casing / Tripod ORIGINATED BY JM
DATUM Geodetic DATE 2016.10.14 - 2016.10.14 COMPILED BY JM
CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	Continued From Previous Page															
	CLAY (Cl) Grey Firm to stiff		10	SS	4		268									
							267									
			11	SS	4		266									
							265									
264.1	End of borehole															

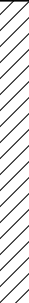

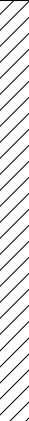
+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 16-04

1 OF 2

METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.4392958°, Long: -80.3423861°
Hwy 11 BOREHOLE TYPE NW Casing / Tripod ORIGINATED BY JM
DATUM Geodetic DATE 2016.10.14 - 2016.10.15 COMPILED BY JM
CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
277.8								20 40 60 80 100											
0.0	CLAY (CH) Brownish grey Firm - crust		1	SS	4														
			2	SS	3												0 4 52 44		
			3	SS	4														
275.7																			
2.1	CLAY (CH), silt layers Grey Firm		4	SS	1														
					5	SS	1												
					6	SS	1										0 0 23 77		
			7	SS	1														
271.1																			
6.7	CLAY (Cl), silt layers Grey Firm																		
					8	SS	2												
			9	SS	4														
																</			

Continued Next Page

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

DOUBLE LINE 13058 CULVERT 28.GPJ 2012TEMPLATE(MTO) GDT 10/10/18

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								20 40 60 80 100	W P W L					
	Continued From Previous Page							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
265.9 11.9	CLAY (Cl), silt layers Grey Firm		10	SS	4		267							0 0 51 49
265.0 12.8	Silty SAND Grey Very Dense		11	SS	55		266							
	End of borehole Piezometer readings: DATE DEPTH (m) ELEV. (m) 2016.10.20 9.1 268.7 2017.04.17 9.3 268.5 2017.06.12 8.8 269.0						265							

+³, ×³: Numbers refer to Sensitivity

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity


DOUBLE LINE 13058 CULVERT 28.GPJ 2012TEMPLATE(MTO).GDT 10/10/18

RECORD OF BOREHOLE No 18-05

2 OF 2

METRIC

GWP# 5015-E-0041 LOCATION Lat: 48.4394994° Long: -80.3422134°
Hwy 11 BOREHOLE TYPE HSA / CME 55 Truck Mount ORIGINATED BY NW
DATUM Geodetic DATE 2018.04.30 - 2018.04.30 COMPILED BY CM
CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
	Continued From Previous Page							20	40	60	80	100								
270.3	CLAY (CH) Grey Firm to stiff						273													
			10	ST	PUSH		272													

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

Appendix C.
Laboratory Testing

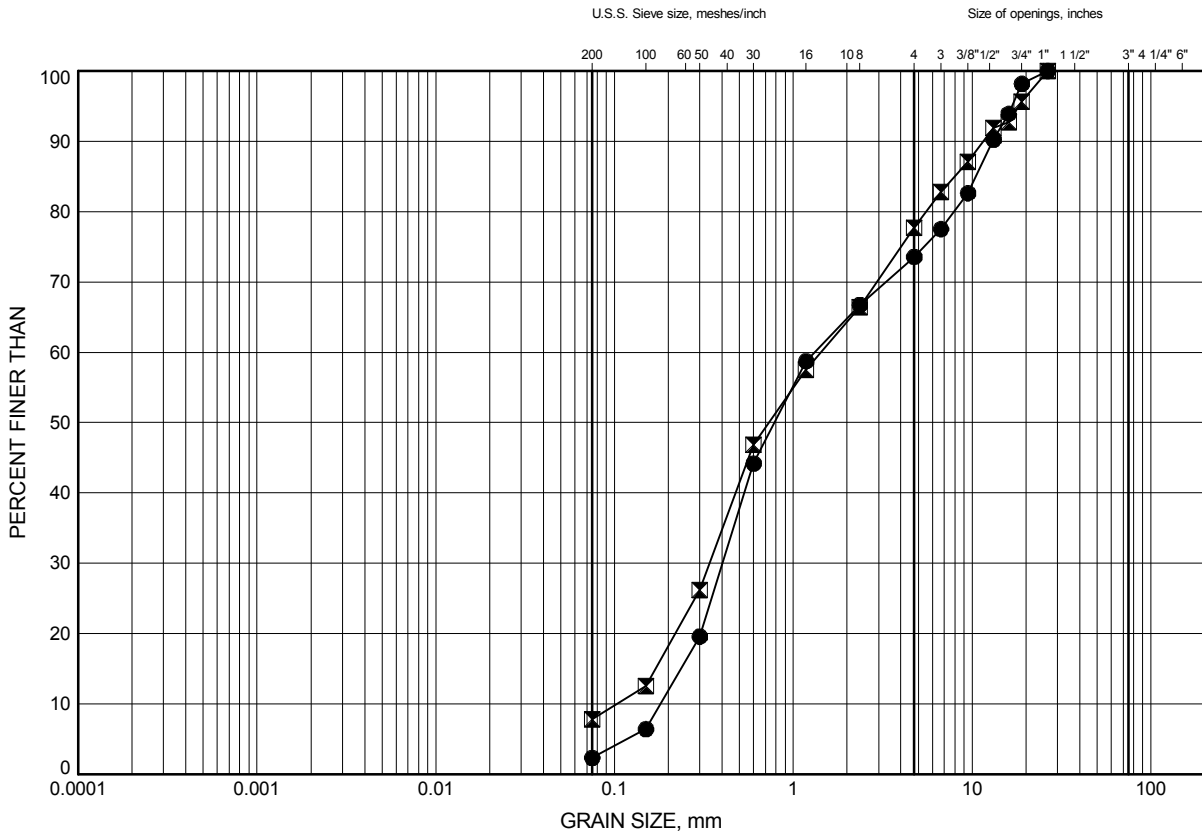
Appendix C.1
Particle Size Analysis Figures

Hwy 11 - Culvert at 11+975

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)
●	16-02	0.30	282.90
⊠	18-05	1.07	282.06

Date June 2018
GWP# 5015-E-0041



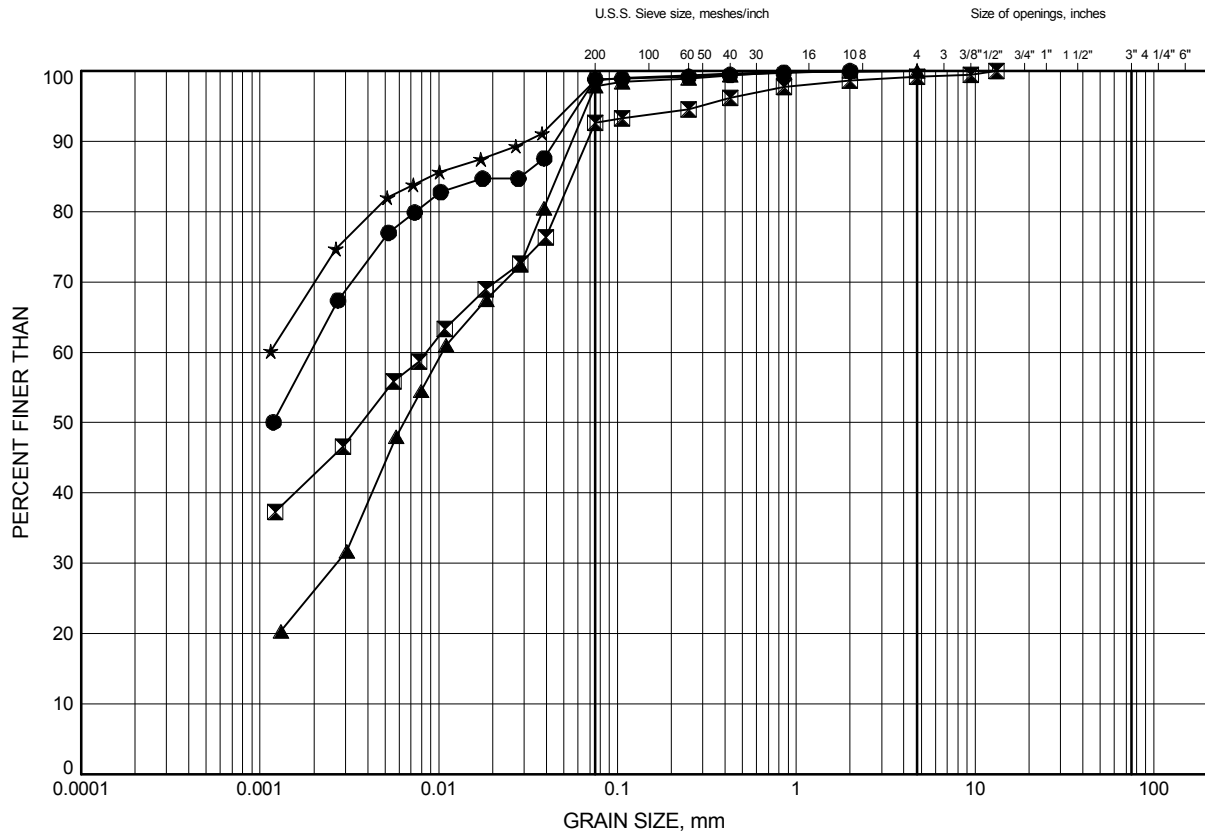
Prep'd CM
Chkd. SP

Hwy 11 - Culvert at 11+975

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	3.35	279.85
⊠	16-02	2.59	280.61
▲	18-05	4.88	278.25
★	18-05	6.40	276.73

Date June 2018

GWP# 5015-E-0041



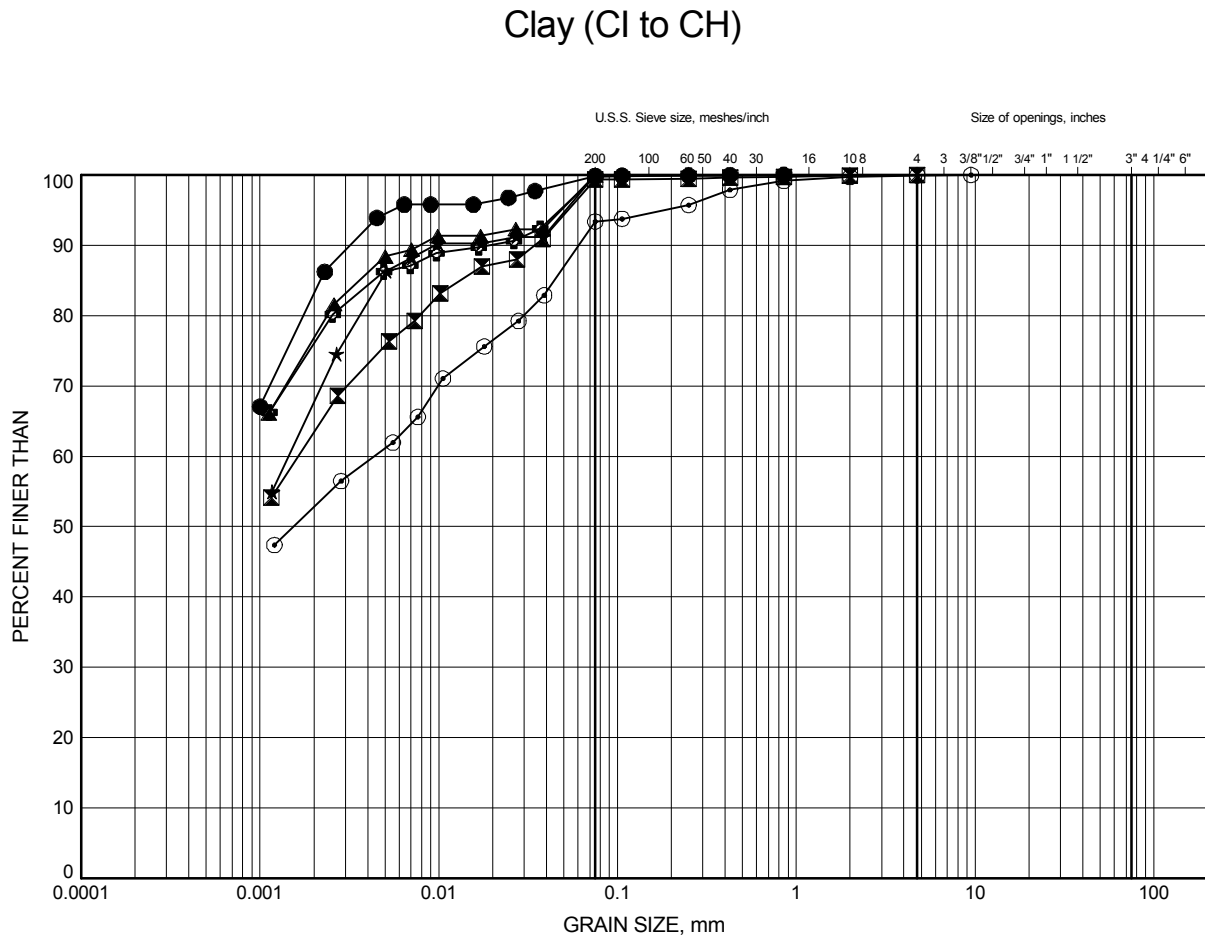
Prep'd CM

Chkd. SP

Hwy 11 - Culvert at 11+975

GRAIN SIZE DISTRIBUTION

FIGURE C3



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	275.28
⊠	16-01	9.45	273.75
▲	16-02	7.92	275.28
★	16-02	12.50	270.70
⊙	16-03	0.30	278.20
⊕	16-03	1.98	276.52

Date June 2018

GWP# 5015-E-0041



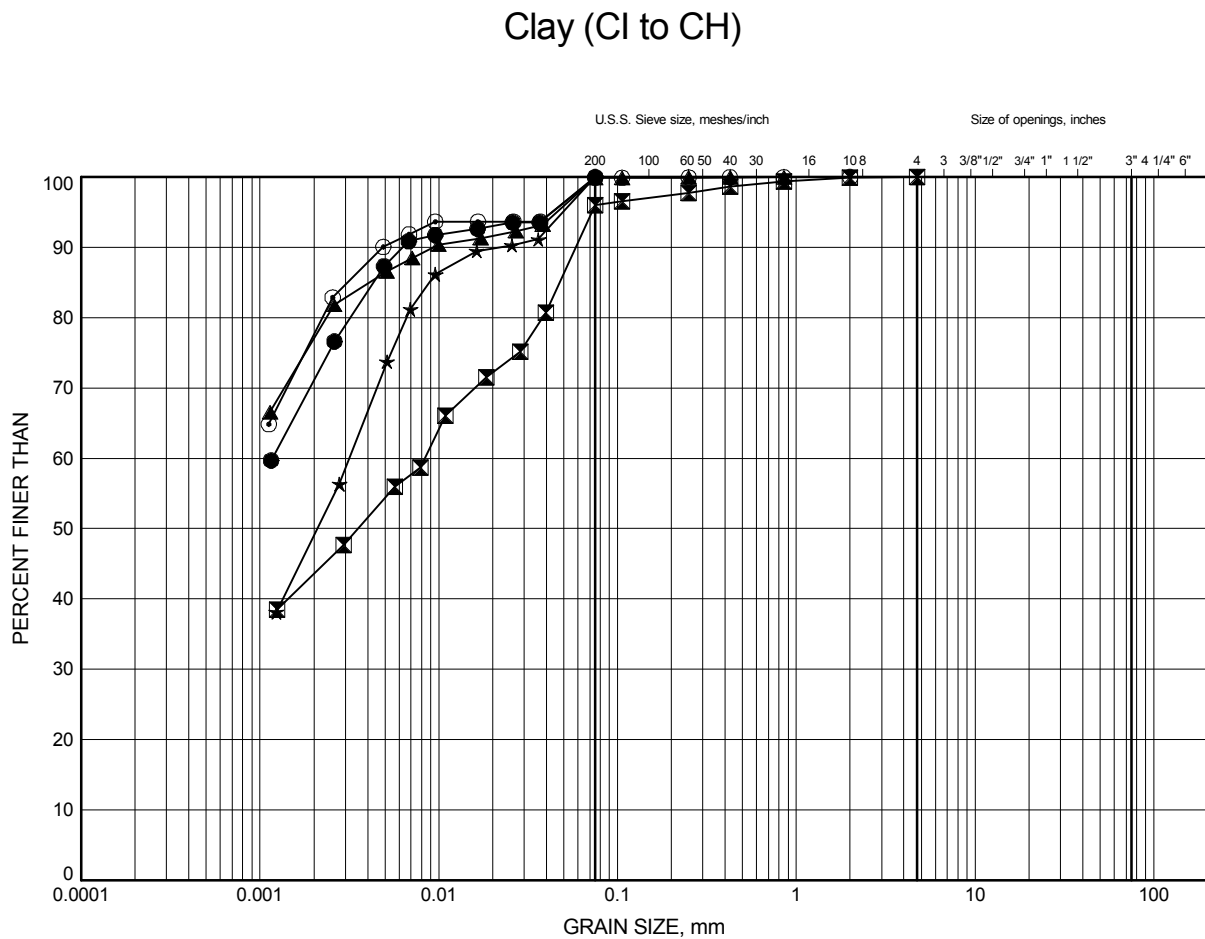
Prep'd CM

Chkd. SP

Hwy 11 - Culvert at 11+975

GRAIN SIZE DISTRIBUTION

FIGURE C4



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-03	9.45	269.05
⊠	16-04	1.07	276.73
▲	16-04	4.88	272.92
★	16-04	10.97	266.83
⊙	18-05	9.45	273.68

Date June 2018

GWP# 5015-E-0041



Prep'd CM

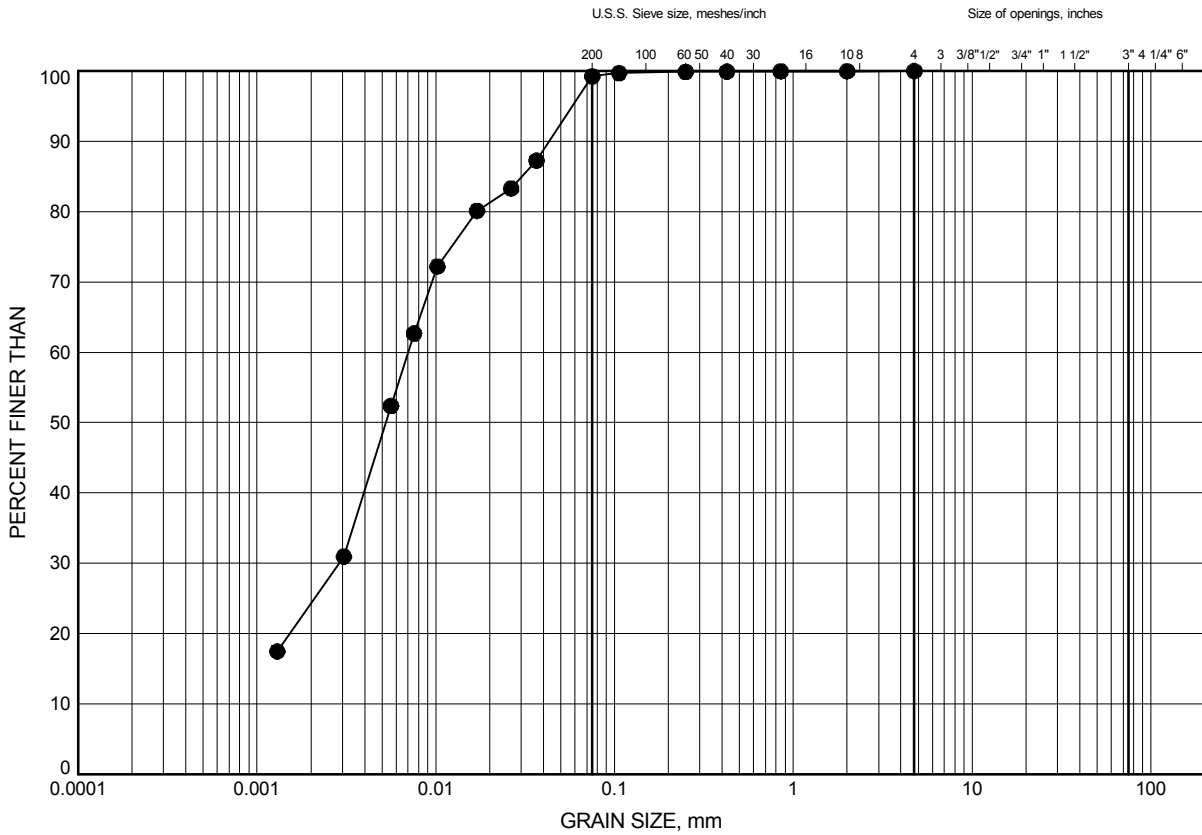
Chkd. SP

Hwy 11 - Culvert at 11+975

GRAIN SIZE DISTRIBUTION

FIGURE C5

Silty Clay (CL-ML)

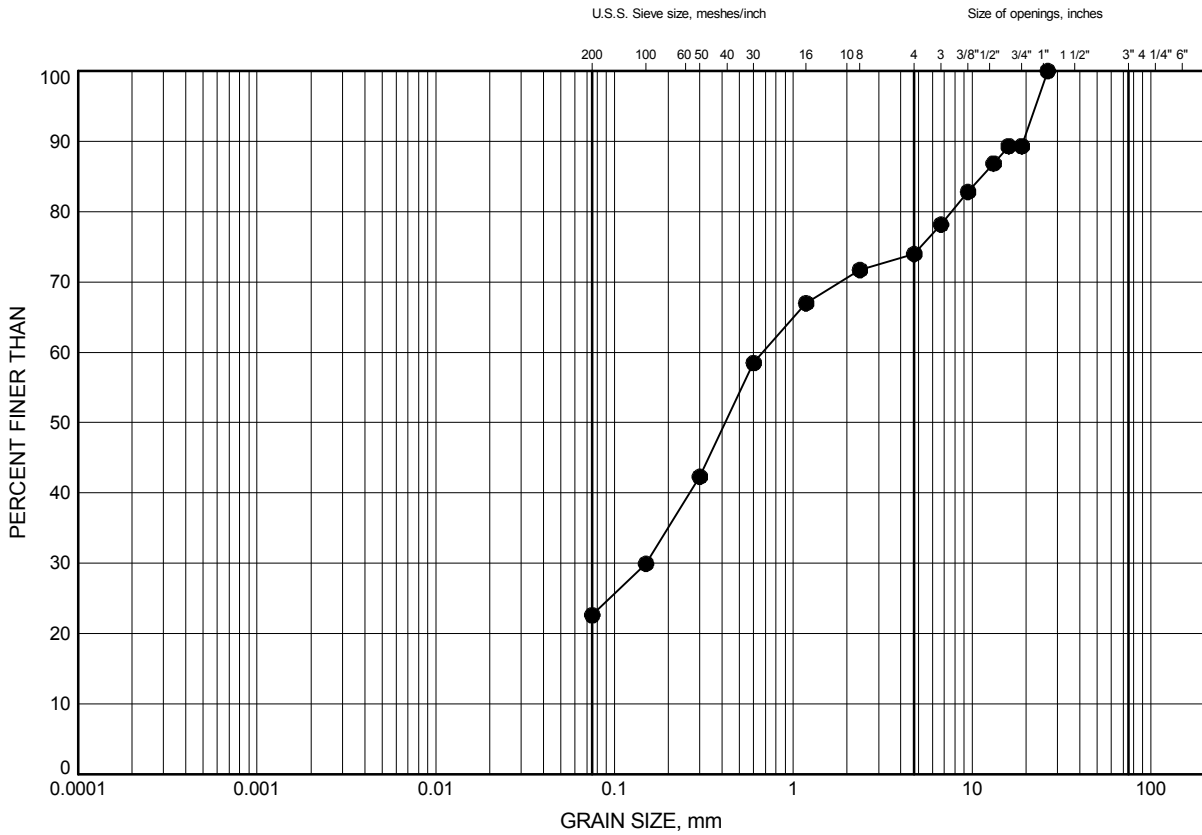


Hwy 11 - Culvert at 11+975

GRAIN SIZE DISTRIBUTION

FIGURE C6

Silty Sand (SM)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-02	17.07	266.13

Date June 2018
GWP# 5015-E-0041



Prep'd CM
Chkd. SP

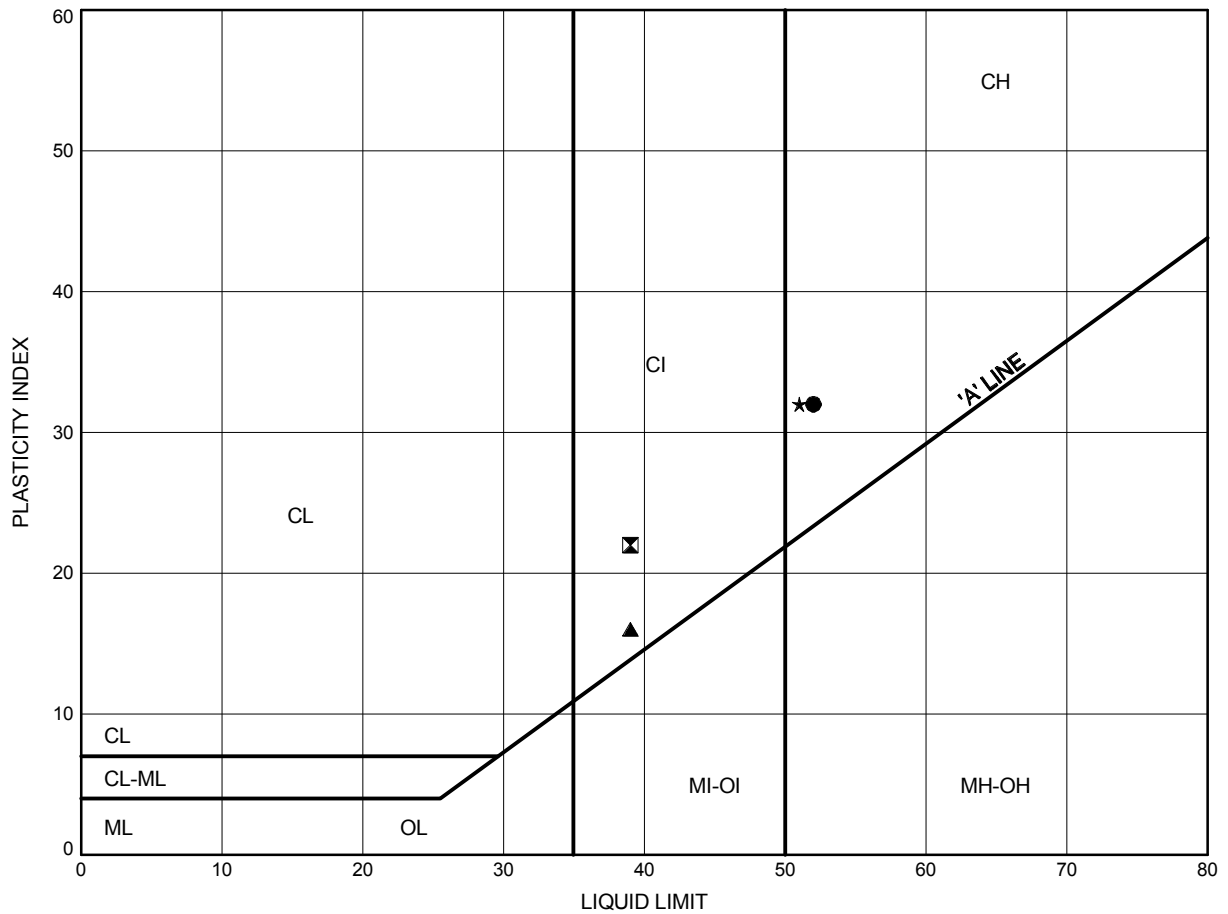
Appendix C.2
Atterberg Limit Analysis Figures

Hwy 11 - Culvert at 11+975

ATTERBERG LIMITS TEST RESULTS

FIGURE C7

Clay Fill



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	3.35	279.85
⊠	16-02	2.59	280.61
▲	18-05	4.88	278.25
★	18-05	6.40	276.73

Date June 2018

GWP# 5015-E-0041



Prep'd CM

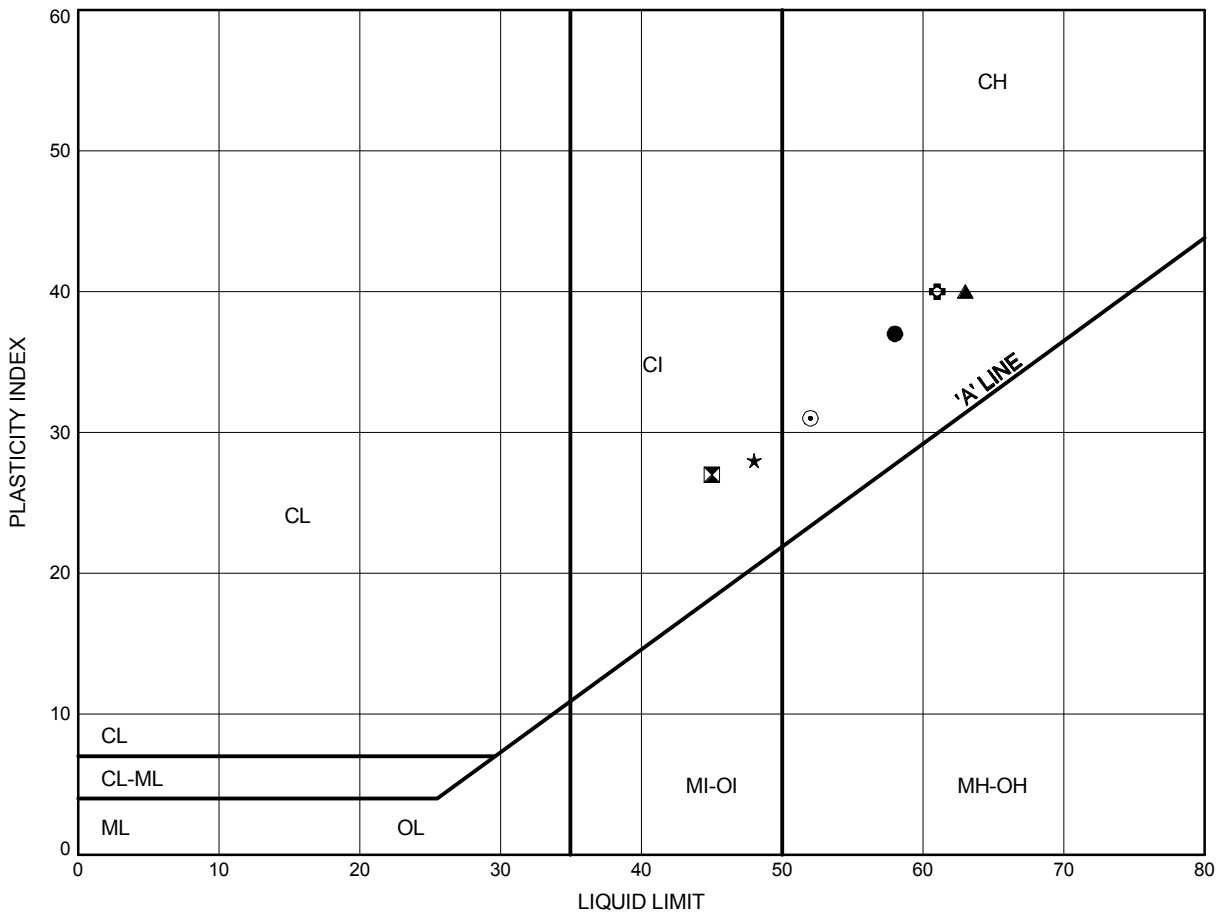
Chkd. SP

Hwy 11 - Culvert at 11+975

ATTERBERG LIMITS TEST RESULTS

FIGURE C8

Clay (CI to CH)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	7.92	275.28
⊠	16-01	9.45	273.75
▲	16-02	7.92	275.28
★	16-02	12.50	270.70
⊙	16-03	0.30	278.20
⊕	16-03	1.98	276.52

Date June 2018
GWP# 5015-E-0041



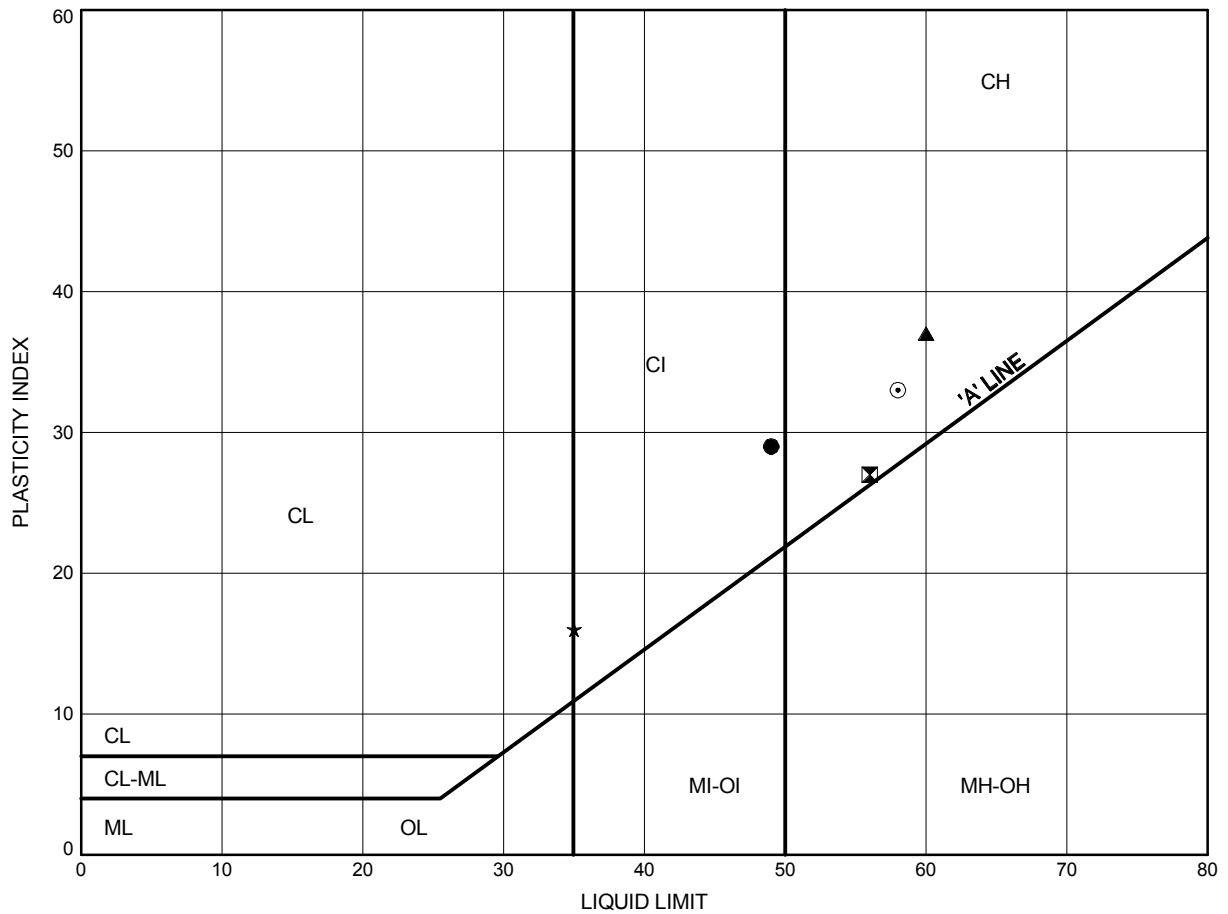
Prep'd CM
Chkd. SP

Hwy 11 - Culvert at 11+975

ATTERBERG LIMITS TEST RESULTS

FIGURE C9

Clay (CI to CH)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-03	9.45	269.05
⊠	16-04	1.07	276.73
▲	16-04	4.88	272.92
★	16-04	10.97	266.83
⊙	18-05	9.45	273.68

Date June 2018
GWP# 5015-E-0041



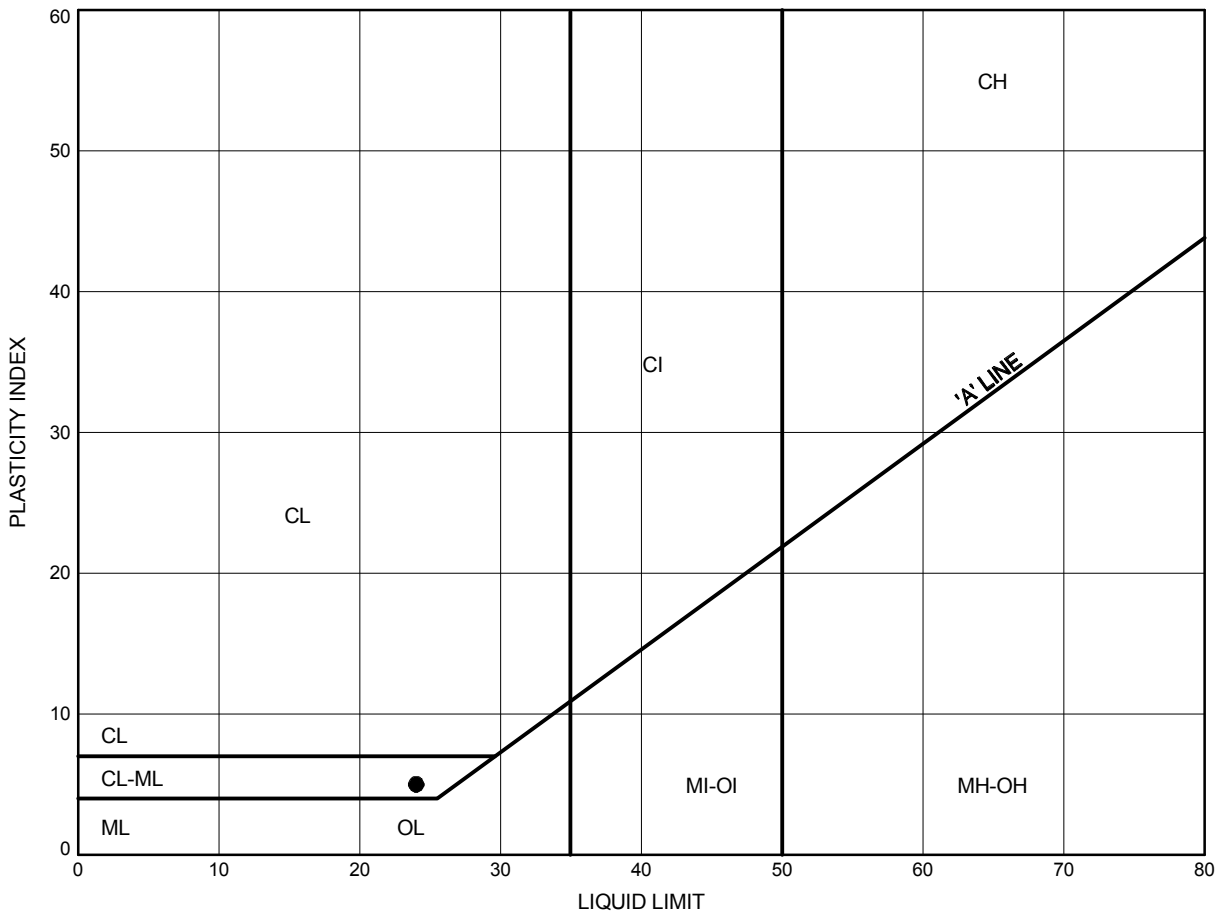
Prep'd CM
Chkd. SP

Hwy 11 - Culvert at 11+975

ATTERBERG LIMITS TEST RESULTS

FIGURE C10

Silty Clay (CL-ML)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	15.54	267.66

Date June 2018
GWP# 5015-E-0041

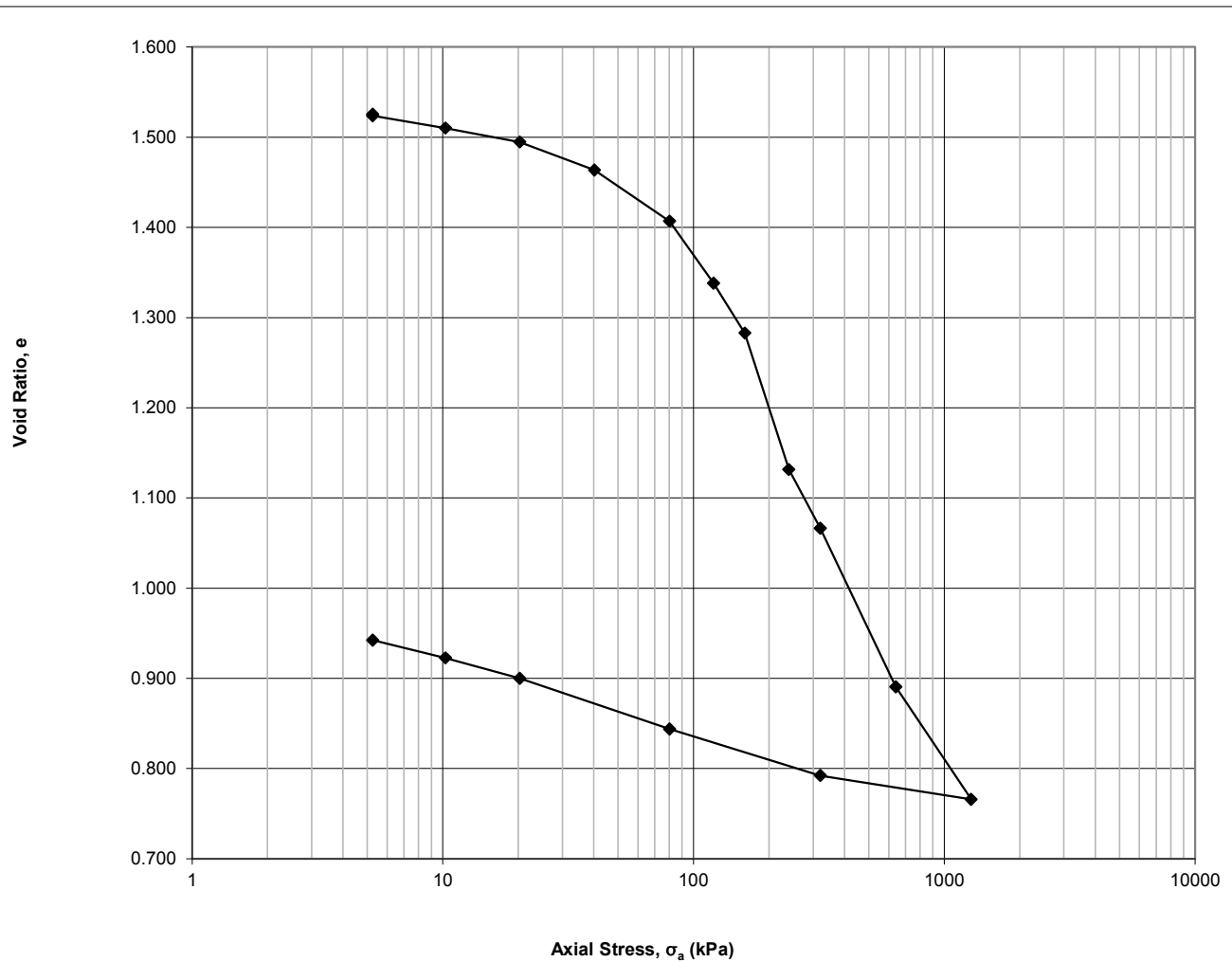


Prep'd CM
Chkd. SP

Appendix C.3
Consolidation Test Results

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

Thurber Engineering, File# 13058
122410864
C28
1
25-27 ft



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

Specimen Details

Project Name	Thurber Engineering, File# 13058
Project Location	-
Borehole	C28
Sample No.	1
Depth	25-27 ft
Sample Date	October 14, 2016
Test Number	Two
Technician Name	Daniel Boateng

Soil Description & Classification

CH	
Specific Gravity of Solids	2.723
Liquid Limit %	58
Plastic Limit %	21
Plasticity Index %	37
Average water content of trimmings %	57
Additional Notes (information source, occurrence and size of large isolated particles etc.)	

Initial Specimen Conditions

Height	mm	20.00
Diameter	mm	50.00
Area	mm ²	1963
Volume	mm ³	39270
Mass	g	66.43
Dry Mass	g	42.34
Density	Mg/m ³	1.692
Dry Density	Mg/m ³	1.078
Water Content	%	56.90
Degree of Saturation	%	100.0
Height of Solids	mm	7.92
Initial Void Ratio		1.526

Final Specimen Conditions

Water Content	%	37.69
Final Void Ratio		0.942

One-Dimensional Consolidation Test using Incremental Loading

ASTM D2435/D2435M - 11

Specimen Details

Project Name	Thurber Engineering, File# 13058
Project Location	-
Borehole	C28
Sample No.	1
Depth	25-27 ft
Sample Date	October 14, 2016
Test Number	Two
Technician Name	Daniel Boateng

Test Procedure

Date Started	November 4, 2016
Date Finished	November 21, 2016
Machine Number	Frame D
Cell Number	D
Ring Number	D
Trimming Procedure	Turntable
Moisture Condition	Inundated
Axial Stress at Inundation kPa	5
Water Used	Distilled
Test Method	A
Interpretation Procedure for c_v	2

All Departures from Outlined ASTM D2435/D2435M-11 Procedure

--

Calculations

Load Increment	Increment Duration	Axial Stress σ_a kPa	Corrected Deformation ΔH mm	Specimen Height H mm	Axial Strain ϵ_a %	Void Ratio e
Seating	0.0	5	0.0000	20.0000	0.00	1.526
1	1440.0	5	0.0140	19.9860	0.07	1.524
2	1440.0	10	0.1224	19.8776	0.61	1.510
3	1440.0	20	0.2449	19.7551	1.22	1.495
4	1440.0	40	0.4907	19.5093	2.45	1.464
5	1440.0	80	0.9403	19.0597	4.70	1.407
6	1440.0	120	1.4845	18.5155	7.42	1.338
7	1440.0	160	1.9231	18.0769	9.62	1.283
8	1440.0	240	3.1216	16.8784	15.61	1.131
9	1440.0	320	3.6364	16.3636	18.18	1.066
10	1440.0	640	5.0294	14.9706	25.15	0.890
11	1440.0	1280	6.0168	13.9832	30.08	0.766
12	1440.0	320	5.8082	14.1918	29.04	0.792
13	1440.0	80	5.3996	14.6004	27.00	0.844
14	1440.0	20	4.9529	15.0471	24.76	0.900
15	1440.0	10	4.7747	15.2253	23.87	0.923
16	1440.0	5	4.6180	15.3820	23.09	0.942

One-Dimensional Consolidation Test using Incremental Loading

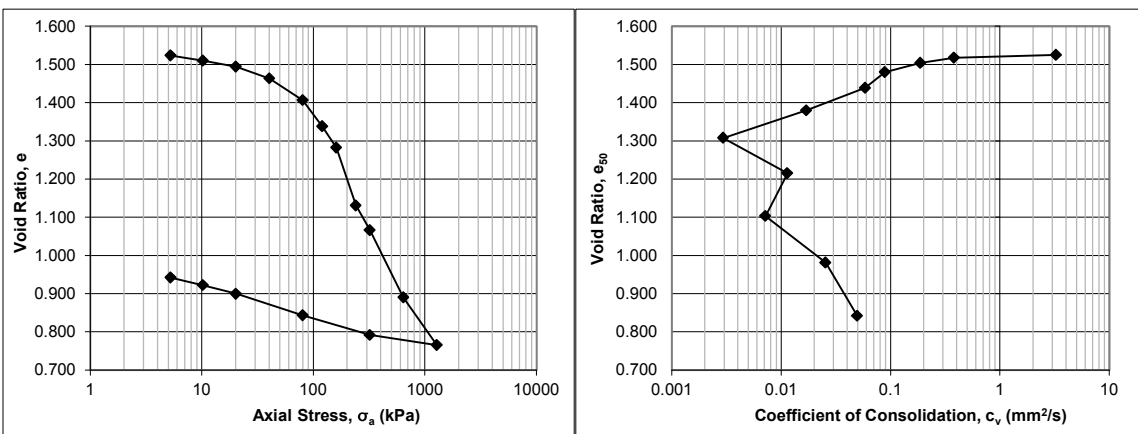
ASTM D2435/D2435M - 11

Specimen Details

Project Name	Thurber Engineering, File# 13058
Project Location	-
Borehole	C28
Sample No.	1
Depth	25-27 ft
Sample Date	October 14, 2016
Test Number	Two
Technician Name	Daniel Boateng

Calculations

Load Increment	Axial Stress σ_a , average kPa	Calculated using Interpretation Procedure 2				Interpretation Procedure 1		Interpretation Procedure 2	
		Corrected Deformation ΔH_{50} mm	Specimen Height H_{50} mm	Axial Strain $\epsilon_{a,50}$ %	Void Ratio e_{50}	Time t_{50} sec	Coeff. Consol. c_v mm ² /s	Time t_{90} sec	Coeff. Consol. c_v mm ² /s
Seating	3								
1	5	0.0018	19.9982	0.01	1.525			26	3.26E+00
2	8	0.0584	19.9416	0.29	1.518			222	3.80E-01
3	15	0.1699	19.8301	0.85	1.504			445	1.87E-01
4	30	0.3625	19.6375	1.81	1.480			922	8.87E-02
5	60	0.6880	19.3120	3.44	1.439			1352	5.85E-02
6	100	1.1510	18.8490	5.75	1.380			4439	1.70E-02
7	140	1.7231	18.2769	8.62	1.308			24053	2.94E-03
8	200	2.4545	17.5455	12.27	1.216			5728	1.14E-02
9	280	3.3423	16.6577	16.71	1.104			8200	7.17E-03
10	480	4.3082	15.6918	21.54	0.982			2052	2.54E-02
11	960	5.4117	14.5883	27.06	0.842			911	4.95E-02
12	800	5.9099	14.0901	29.55	0.779				
13	200	5.5996	14.4004	28.00	0.818				
14	50	5.1929	14.8071	25.96	0.870				
15	15	4.9071	15.0929	24.54	0.906				
16	8	4.7195	15.2805	23.60	0.930				



Appendix C.4
Analytical Testing Results

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

Report Date: 02-Nov-2016

Order Date: 28-Oct-2016

Project Description: 13058

Client ID: Sample Date: Sample ID: MDL/Units		C2-3 SS1 0'-2' 18-Oct-16 1644497-01 Soil	C2-4 SS3 5'-7' 18-Oct-16 1644497-02 Soil	C6-3 SS2 2'-6'-4'-6' 18-Oct-16 1644497-03 Soil	C6-4 SS3A 5'-6' 18-Oct-16 1644497-04 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: Sample Date: Sample ID: MDL/Units		C7-3 SS2 2'-6'-4'-6' 18-Oct-16 1644497-05 Soil	C7-4 SS3 5'-7' 18-Oct-16 1644497-06 Soil	MC16-4 SS1 0'-2' 18-Oct-16 1644497-07 Soil	MC16-6 SS3 5'-7' 18-Oct-16 1644497-08 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: Sample Date: Sample ID: MDL/Units		C28-3 SS2 2'-6'-4'-6' 18-Oct-16 1644497-09 Soil	C28-4 SS1 0'-2' 18-Oct-16 1644497-10 Soil	C34-3 SS3 5'-7' 18-Oct-16 1644497-11 Soil	C34-4 SS1 0'-2' 18-Oct-16 1644497-12 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

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 south along Highway 11.



Photo 2. Looking north along Highway 11.



Photo 3. Looking west of Highway 11.



Photo 4. Looking east of Highway 11.