



**THURBER** ENGINEERING LTD.

**FINAL**  
**FOUNDATION INVESTIGATION REPORT**  
**CULVERT STRUCTURE NO. 40-116/C**  
**HIGHWAY 35 BLACK CREEK CULVERT, LUTTERWORTH TOWNSHIP**  
**AGREEMENT NO. 5015-E-0043**

**G.W.P. 5087-11-00**

Geocres No.: 31D-690

Report to:

**McIntosh Perry Consulting Engineers Limited**

Latitude: 44.8025  
Longitude: -78.8141

September 2018  
Thurber File: 16284

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**FOUNDATION INVESTIGATION AND DESIGN REPORT  
CULVERT STRUCTURE NO. 40-116/C  
HIGHWAY 35 BLACK CREEK CULVERT, LUTTERWORTH TOWNSHIP  
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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 for the Black Creek Culvert crossing of Highway 35 located approximately 1.2 km south of Haliburton Rd 2 (Deep Bay Rd) within Lutterworth 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-0043.

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 reports were available for the subject culvert site within the online Geocres library.

**2 SITE DESCRIPTION**

The existing culvert conveys creek flow from the west to the east under Highway 35. As described within the RFP, it is an open footing box culvert consisting of two types of construction. The east and west sections are reinforced concrete rigid frame open footing culverts constructed in 1968; the length is 4.9 m at the west end and 8.5 m at the east end, the span is 3.0 m and the height 3.0 m. The center section of the culvert is a reinforced concrete rigid frame open footing culvert of unknown age however the RFP indicates the culvert may have been constructed in the 1950's. The span for this section is 3.0 m, the height 2.4 m and the length approximately 20.6 m.

At the location of the culvert (Linear Highway Referencing System Base Point: 27945, Offset: 3.1), Highway 35 is a two-lane highway with a rural cross-section and gravel shoulders. A right turn taper is present in the northbound direction leading to a sideroad which is less than 20 m north of the culvert. The Highway 35 fill height above the culvert is approximately 2.4 m with the road surface at approximate elevation 273.7 m. The creek bed was at approximate elevation 268.2 and 268.1 m at the inlet and outlet respectively. The existing embankment slopes are inclined at approximately 2H:1V. Steel guiderails with steel posts are present in the vicinity of the culvert. Moore Lake is located approximately 100 m east of the culvert. The land adjacent to the highway is occupied by single family

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dwelling and cottage properties and is vegetated with shrubs and trees. Traffic volumes on this section of Highway 35 are understood to be 3150 AADT (2013).

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

### **3 SITE INVESTIGATION AND FIELD TESTING**

The site investigation and field testing program was carried out between May 8<sup>th</sup> to May 9<sup>th</sup>, 2017 for the on-road investigation and between August 14<sup>th</sup> to 17<sup>th</sup>, 2017 for the off-road investigation. The field investigation consisted of advancing six boreholes identified as 17-01 through 17-06. The drilling was carried out using portable equipment for off-road boreholes 17-03, 17-04, 17-05 and 17-06 and a truck mounted CME 75 drill rig for the on-road boreholes 17-01 and 17-02. 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 17-03, 17-04, 17-05 and 17-06, which were drilled with portable equipment, also utilized a full-weight hammer for SPT testing. The boreholes were sampled to depths ranging from 9.7 to 15.8 m (elev. 257.2 to 258.4 m) below the existing ground or creek bed surface. Boreholes 17-01, 17-02 and 17-03 were extended below the base of the sampled borehole with a Dynamic Cone Penetration Test (DCPT) to elevations ranging from 250.3 to 253.2 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 for further laboratory examination and testing.

Following completion of the field investigation the boreholes were backfilled in accordance with MOEE requirements (O.Reg. 903). Boreholes 17-01 and 17-02 were capped with 150 mm of cold patch asphalt to reinstate the traveling surface.

The approximate 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. One sample of soil recovered from within each of Boreholes 17-03 and 17-05 was 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 overlying a deposit of fine grained material varying from clay to silt over a silty sand and sand deposit. A layer consisting of organic silt was present at the ground surface (underwater) at one of the off-road borehole on the west side of the culvert. Bedrock was not sampled within the depth of investigation.

## 5.1 Embankment Fill

### 5.1.1 Asphalt

Boreholes 17-01 and 17-02 were drilled through the existing Highway 35 embankment and encountered a layer of asphalt with a thickness of 180 and 165 mm, respectively.

### 5.1.2 Fill: Sand with Silt and Gravel

Below the asphalt in Boreholes 17-01 and 17-02 and from the creek bed surface in Borehole 17-06 was a layer of fill consisting of sand with silt and gravel. Cobbles and boulders were noted at ground surface in Borehole 17-06. The underside of the fill was at 4.4 to 5.3 m (elev. 268.3 to 269.4 m) below the existing roadway surface in Boreholes 17-01 and 17-02, respectively and at 1.6 m (elev. 266.9 m) below the existing creek bed in Borehole 17-06.

The SPT tests conducted in this fill gave N-values ranging from 3 to 72 blows indicating a relative density of very loose to very dense.

Recorded moisture contents ranged from 6 to 19%. The results of grain size analyses conducted on three samples of the fill materials are summarized below and are illustrated on Figure C1 in Appendix C.

Soil Particle	Percentage (%)
Gravel	10 - 32
Sand	63 - 84
Silt	3 - 6
Clay	

### 5.1.3 Fill: Silty Sand trace Gravel

A 100 mm layer of fill material consisting of silty sand with traces of gravel and organics was encountered at the creek bed surface in Borehole 17-04. The underside of the fill was at elev. 268.1 m. One moisture content of the fill was recorded at 26%.

## 5.2 Organic Silt (OL)

A 600 mm layer of organic silt was encountered at creek bed surface in Borehole 17-03. The underside of the organic silt was at 0.6 m (elev. 267.4 m) below the existing creek bed surface.

An SPT test conducted in this surficial layer gave an N-value of 3 blows indicating a relative density of very loose.

One moisture content of the silt was recorded at 46%. The result of a grain size analyses conducted on one sample of the organic silt is summarized below and is illustrated on Figure C2 in Appendix C.

Soil Particle	Percentage (%)
Gravel	0
Sand	8
Silt	62
Clay	30

An Atterberg Limit test was completed on one sample of the organic silt deposit. The result is summarized on the Record of Borehole sheets in Appendix B and the Atterberg Limit graph is included in Figure C9 of Appendix C. The laboratory results are summarized below and indicate that the material is a low plasticity organic (OL).

Parameter	Value
Liquid Limit	31
Plastic Limit	24
Plasticity Index	7

## 5.3 Silt (ML)

Boreholes 17-01, 17-03, 17-05 and 17-06 encountered a native layer of silt with clay seams and varying amounts of sand. The thickness of this layer ranged from 0.8 to 2.5 m with a base elevation ranging from 264.9 to 268.6 m.

The SPT tests conducted in this layer gave N-values ranging from 2 to 10 indicating a relative density of very loose to compact.

Recorded moisture contents ranged from 27 to 40%. The results of grain size analyses conducted on two samples of the silt are summarized below and illustrated on Figure C3 in Appendix C.

Soil Particle	Percentage (%)
Gravel	0
Sand	0 - 1
Silt	81 - 83
Clay	16 - 19

Atterberg Limit testing was completed on one sample of the silt 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 are summarized below and indicate that the material ranges from a non-plastic to an inorganic silt (ML).

Parameter	Value
Liquid Limit	29
Plastic Limit	24
Plasticity Index	5

#### 5.4 Clay (CL)

A native deposit of clay with occasional silt seams was encountered below fill material in Borehole 17-04 and below the silt in Borehole 17-01. The thickness of this clay deposit ranged from 3.6 to 3.0 m with a bottom elevation of 264.9 to 265.1 m. The SPT N-values ranged from 1 to 12 blows indicating a consistency of approximately very soft to stiff.

The moisture content of the samples tested ranged from 26 to 40%. The results of grain size analyses conducted on two samples of the clay are summarized below and are illustrated on Figure C4 in Appendix C.

Soil Particle	Percentage (%)
Gravel	0
Sand	1 - 2
Silt	67 - 75
Clay	24 - 31

Atterberg Limit testing was completed on two samples of the clay deposit. The results are summarized on the Record of Borehole sheets in Appendix B and the Atterberg Limit graph is included in Figure C11 of Appendix C. The laboratory results are summarized below and indicate that the clay is of low plasticity (CL).

Parameter	Value
Liquid Limit	32
Plastic Limit	22 – 23
Plasticity Index	9 – 10

### 5.5 Silty Clay (CL-ML)

A native deposit of silty clay was encountered below the embankment fill in Borehole 17-02. This thickness of this silty clay deposit was 2.0 m with a bottom elevation of 266.3 m. The SPT N-values ranged from 3 to 7 blows indicating a soft to firm consistency.

The moisture content of the samples tested ranged from 38 to 42%. The results of grain size analyses conducted on one sample of the silty clay are summarized below and illustrated on Figure C5 in Appendix C.

Soil Particle	Percentage (%)
Gravel	0
Sand	1
Silt	80
Clay	19

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 C12 of Appendix C. The laboratory results are summarized below and indicate that the silty clay has low plasticity (CL-ML).

Parameter	Value
Liquid Limit	29
Plastic Limit	22
Plasticity Index	7

### 5.6 Silty Sand

All Boreholes encountered a layer of silty sand. The silty sand was encountered below the clay deposit in Boreholes 17-01 and 17-04, below the silty clay deposit in Borehole 17-02 and below the silt in Boreholes 17-03, 17-05 and 17-06. Boreholes 17-02, 17-03, 17-04 and 17-05 were terminated within this silty sand layer at elevations ranging from 257.7 to 258.4 m. Where fully penetrated, the thickness of this layer ranged from 3.4 to 6.7 m with a base elevation ranging from 259.0 to 261.6 m.

The SPT tests conducted in this silty sand layer gave N-values ranging from 4 to 19 blows indicating a relative density of loose to compact.

Measured moisture contents ranged from 19 to 30%. The results of grain size analyses conducted on seven samples of the silty sand material are summarized below and are illustrated on Figures C6 and C7 in Appendix C.

Soil Particle	Percentage (%)	
Gravel	0	
Sand	43 – 81	
Silt	51 – 56	19 – 53
Clay	1	

Atterberg Limit testing was completed on two samples of the silty sand deposit. The laboratory results indicated the silty sand to be non-plastic.

### 5.7 Sand

Boreholes 17-01 and 17-06 encountered a sand deposit below the silty sand. Both Boreholes were terminated within this layer with a base elevation ranging from 257.2 to 257.9 m.

The SPT tests conducted in this sand layer gave N-values ranging from 3 to 10 blows indicating a relative density of very loose to compact.

Recorded moisture contents ranged from 20 to 24%. The results of grain size analyses conducted on two samples of the silty sand material are summarized below and are illustrated on Figure C8 in Appendix C.

Soil Particle	Percentage (%)	
Gravel	0	
Sand	91 – 95	
Silt	5 – 9	
Clay		

### 5.8 Refusal

Bedrock was not encountered within the sampled depth of investigation. Boreholes 17-01, 17-02 and 17-03 were extended below sampled depth with a Dynamic Cone Penetration Test (DCPT) to refusal at elevations ranging from 250.3 to 253.2 m on inferred bedrock. It is noted that refusal could also be possible due to the presence of boulders, cobbles or very dense glacial till.

### 5.9 Groundwater

The water level of Black Creek was recorded during the off-road portion of the field work at elevations ranging from 269.1 to 269.3 m between August 14<sup>th</sup> to 17<sup>th</sup>, 2017. The water levels recorded in the open boreholes upon completion of drilling during the on-road portion of the field work ranged in elevations from 269.5 to 269.6 m between May 8<sup>th</sup> to 9<sup>th</sup>, 2017.

These observations are considered short term and it should be noted that the groundwater level at the time of construction 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 events.

### 5.10 Analytical Testing

Two 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 (mbgs)	Sulphate ( $\mu\text{g/g}$ )	pH (-)	Resistivity (Ohm-cm)	Conductivity ( $\mu\text{S/cm}$ )	Chloride ( $\mu\text{g/g}$ )
17-03	SS2	0.8 - 1.4	23	8.33	10100	99	11
17-05	SS3	1.5 - 2.1	25	8.05	5680	176	51

## 6 MISCELLANEOUS

Borehole locations were selected by Thurber relative to existing site features and the anticipated foundation locations. The as-drilled locations and ground surface elevation were measured by Thurber and MPCE following completion of the field program.

George Downing Estate Drilling Ltd. of Hawkesbury, Ontario supplied and operated the drilling equipment to conduct the drilling, soil sampling and in-situ testing and borehole decommissioning of the on-road boreholes. Forage M3 Drilling Services Inc. of Hawkesbury, Ontario supplied and operated the raft supported portable drilling equipment to conduct the drilling, soil sampling, in-situ testing, and borehole decommissioning of the off-road holes. The field investigation was supervised on a full-time basis by Mr. Jeff Morrison, E.I.T. and Miss Katya Edney P.Eng. 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 Dr. Fred Griffiths, P.Eng., Miss Katya Edney P.Eng. and Mr. Stephen Peters P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundation Projects.



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**Appendix A.**

**Borehole Location Plan and Stratigraphic Drawings**



**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).

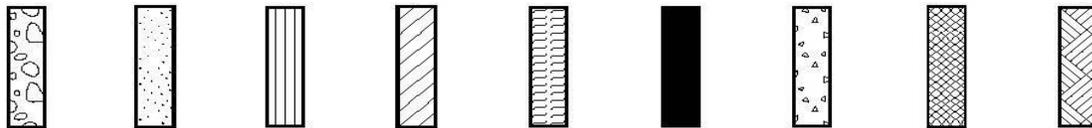
### DYNAMIC CONE PENETRATION TEST (DCPT):

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
<b>COARSE GRAINED SOIL</b>	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.
<b>FINE GRAINED SOILS</b>	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 or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
<b>HIGHLY ORGANIC SOILS</b>		Pt	Peat and other organic soils.

Note -  $W_L$  = Liquid Limit



## EXPLANATION OF ROCK LOGGING TERMS

### ROCK WEATHERING CLASSIFICATION

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

### TERMS

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

### DISCONTINUITY SPACING

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

### STRENGTH CLASSIFICATION

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



### RECORD OF BOREHOLE No 17-1

2 OF 3

METRIC

GWP# 5087-11-00 LOCATION Black Creek, MTM Zone 12: N 4962739.1 E 359057.4 ORIGINATED BY JM  
 HWY 35 BOREHOLE TYPE CME75 Truck with NW Casing COMPILED BY DJP  
 DATUM Geodetic DATE 2017.05.08 - 2017.05.08 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60	20 40 60					
Continued From Previous Page															
261.6	<b>SILTY SAND (SM)</b> Loose Grey		12	SS	5										
12.2	Poorly graded <b>SAND</b> Trace Fines Loose to Very Loose Grey		13	SS	9									0 95 5 (SI+CL)	
			14	SS	8										
257.9			15	SS	3										
15.8	End of sampled Borehole DCPT performed from to 15.8 to 22.1m														

ONTMT4S\_16284\_BLACK\_CREEK.GPJ 2012TEMPLATE(MTO).GDT 16/3/18

Continued Next Page

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

### RECORD OF BOREHOLE No 17-1

3 OF 3

**METRIC**

GWP# 5087-11-00 LOCATION Black Creek, MTM Zone 12: N 4962739.1 E 359057.4 ORIGINATED BY JM  
 HWY 35 BOREHOLE TYPE CME75 Truck with NW Casing COMPILED BY DJP  
 DATUM Geodetic DATE 2017.05.08 - 2017.05.08 CHECKED BY SP

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	20 40 60 80 100			20 40 60	W P	W					
251.6	Continued From Previous Page DCPT continued						253									
22.1	End of DCPT upon refusal at 22.1m Water level at 4.3 m in open borehole upon completion of drilling															

ONTMT4S\_16284\_BLACK\_CREEK.GPJ 2012TEMPLATE(MTO).GDT 16/03/18

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

### RECORD OF BOREHOLE No 17-2

1 OF 3

METRIC

GWP# 5087-11-00 LOCATION Black Creek, MTM Zone 12: N 4962728.2 E 359063.9 ORIGINATED BY JM  
 HWY 35 BOREHOLE TYPE CME75 Truck with NW Casing COMPILED BY DJP  
 DATUM Geodetic DATE 2017.05.09 - 2017.05.09 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60								
273.6														
0.0	<b>165 mm ASPHALT</b>													
0.2	SAND With Silt and Gravel Very Dense to Loose Brown FILL		1	SS	72									
			2	SS	17									
			3	SS	6									
			4	SS	5									
			5	SS	6									
			6	SS	10									
			7	SS	10									
268.3	<b>SILTY CLAY (CL-ML)</b> Soft to Firm Grey		8	SS	7									
5.3			9	SS	3									
266.3	<b>SILTY SAND (SM)</b> Compact Grey		10	SS	14									
7.3			11	SS	10									

ONTMT4S\_16284\_BLACK\_CREEK.GPJ\_2012TEMPLATE(MTO).GDT\_16/3/18

Continued Next Page

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



### RECORD OF BOREHOLE No 17-2

3 OF 3

**METRIC**

GWP# 5087-11-00 LOCATION Black Creek, MTM Zone 12: N 4962728.2 E 359063.9 ORIGINATED BY JM  
 HWY 35 BOREHOLE TYPE CME75 Truck with NW Casing COMPILED BY DJP  
 DATUM Geodetic DATE 2017.05.09 - 2017.05.09 CHECKED BY SP

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	20 40 60 80 100			20 40 60	W P	W					
	Continued From Previous Page DCPT continued															
250.3 23.3	End of DCPT upon refusal at 23.3m Water level at 4.0 m in open borehole upon completion of drilling															

ONTMT4S\_16284\_BLACK\_CREEK.GPJ 2012TEMPLATE(MTO).GDT 16/03/18

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

### RECORD OF BOREHOLE No 17-3

1 OF 2

**METRIC**

GWP# 5087-11-00 LOCATION Black Creek, MTM Zone 12: N 4962740.3 E 359041.3 ORIGINATED BY KE  
 HWY 35 BOREHOLE TYPE Portable Raft / NW Casing COMPILED BY KE  
 DATUM Geodetic DATE 2017.08.14 - 2017.08.15 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100								
						PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W <sub>p</sub> W W <sub>L</sub> WATER CONTENT (%) 20 40 60						GR SA SI CL		
269.1 0.0	<b>WATER</b>													
268.0	- Boulders and Cobbles at ground surface													
1.1 267.4	<b>organic SILT (OL)</b> With Clay Seams, trace Sand Very loose Grey		1	SS	3						H	○	0 8 62 30	
1.7 267.4	<b>SILT (ML)</b> With Clay Seams Very loose Grey		2	SS	2							○		
			3	SS	3						H	○	0 0 81 19	
	-Becoming Compact below 3.4 m		4	SS	10							○		
264.9 4.2	<b>SILTY SAND (SM)</b> Loose to Compact Grey		5	SS	8							○		
			6	SS	11							○		
			7	SS	7							○	0 79 21 (SI+CL)	
			8	SS	6							○		

ONTMT4S\_16284\_BLACK\_CREEK.GPJ\_2012TEMPLATE(MTO).GDT\_16/03/18

Continued Next Page

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

### RECORD OF BOREHOLE No 17-3

2 OF 2

METRIC

GWP# 5087-11-00 LOCATION Black Creek, MTM Zone 12: N 4962740.3 E 359041.3 ORIGINATED BY KE  
 HWY 35 BOREHOLE TYPE Portable Raft / NW Casing COMPILED BY KE  
 DATUM Geodetic DATE 2017.08.14 - 2017.08.15 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
258.3	SILTY SAND (SM) Loose Grey		9	SS	6		259								
10.8	End of sampled Borehole DCPT performed from 10.8 to 15.9 m						258								
253.2							257								
15.9	End of DCPT upon refusal at 15.9 m						256								
							255								
							254								

ONTMT4S\_16284\_BLACK\_CREEK.GPJ 2012TEMPLATE(MTO).GDT 16/03/18

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

### RECORD OF BOREHOLE No 17-4

1 OF 2

METRIC

GWP# 5087-11-00 LOCATION Black Creek, MTM Zone 12: N 4962733.6 E 359045.2 ORIGINATED BY KE  
 HWY 35 BOREHOLE TYPE Portable Raft / NW Casing COMPILED BY KE  
 DATUM Geodetic DATE 2017.08.15 - 2017.08.15 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL	
269.2 0.0	<b>WATER</b>															
268.2	- Boulders and Cobbles at ground surface															
268.0 1.1	<b>SILTY SAND</b> trace Gravel, with Organics Very Loose Grey-Brown <b>FILL</b>		1	SS	1											
	<b>CLAY (CL)</b> With Silt Seams Very Soft to Firm Grey		2	SS	2										0	1 75 24
			3	SS	4											
			4	SS	7											
265.1 4.1	<b>SILTY SAND (SM)</b> Loose to Compact Grey		5	SS	4											
			6	SS	7										0	76 24 (SI+CL)
			7	SS	19											
			8	SS	10											

ONTMT4S\_16284\_BLACK\_CREEK.GPJ 2012TEMPLATE(MTO).GDT 16/3/18

Continued Next Page

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

### RECORD OF BOREHOLE No 17-4

2 OF 2

**METRIC**

GWP# 5087-11-00 LOCATION Black Creek, MTM Zone 12: N 4962733.6 E 359045.2 ORIGINATED BY KE  
 HWY 35 BOREHOLE TYPE Portable Raft / NW Casing COMPILED BY KE  
 DATUM Geodetic DATE 2017.08.15 - 2017.08.15 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
258.4	<b>SILTY SAND (SM)</b> Loose Grey		9	SS	4		259										
10.8	End of Borehole																

ONTMT4S\_16284\_BLACK\_CREEK.GPJ 2012TEMPLATE(MTO).GDT 16/03/18

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



### RECORD OF BOREHOLE No 17-5

2 OF 2

**METRIC**

GWP# 5087-11-00 LOCATION Black Creek, MTM Zone 12: N 4962725.9 E 359080.0 ORIGINATED BY KE  
 HWY 35 BOREHOLE TYPE Portable Raft / NW Casing COMPILED BY KE  
 DATUM Geodetic DATE 2017.08.16 - 2017.08.16 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
258.3	Continued From Previous Page <b>SILTY SAND (SM)</b> Loose Grey		9	SS	5		259										
10.9	End of Borehole																

ONTMT4S\_16284\_BLACK\_CREEK.GPJ 2012TEMPLATE(MTO).GDT 16/03/18

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



### RECORD OF BOREHOLE No 17-6

2 OF 2

**METRIC**

GWP# 5087-11-00 LOCATION Black Creek, MTM Zone 12: N 4962730.3 E 359080.9 ORIGINATED BY KE  
 HWY 35 BOREHOLE TYPE Portable Raft / NW Casing COMPILED BY KE  
 DATUM Geodetic DATE 2017.08.16 - 2017.08.17 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
259.0	Continued From Previous Page																
10.2	Poorly graded <b>SAND</b> Trace Fines Loose to Compact Grey		9	SS	6		259									0 91 9 (SI+CL)	
							258										
257.2			10	SS	10												
12.0	End of Borehole																

ONTMT4S\_16284\_BLACK\_CREEK.GPJ\_2012TEMPLATE(MTO).GDT\_16/3/18

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

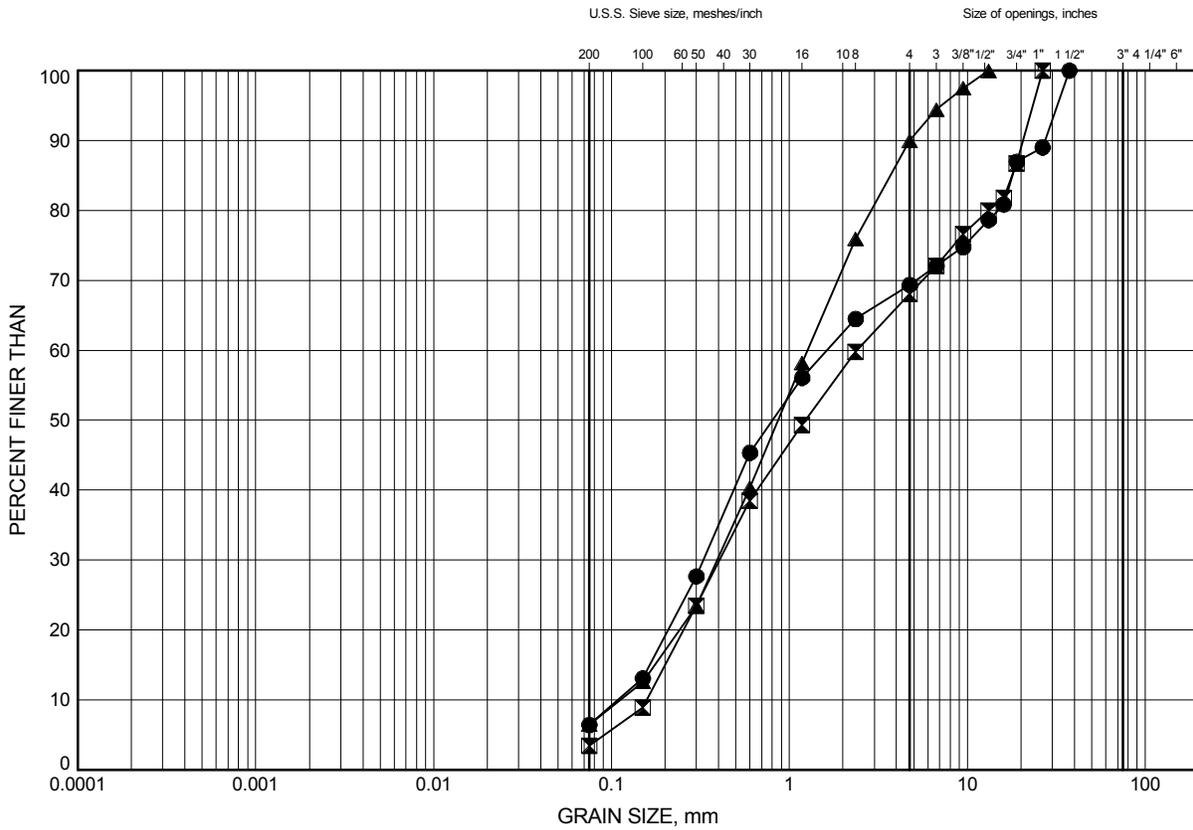
**Appendix C.**  
**Laboratory Testing**

**Appendix C.1**  
**Particle Size Analysis Figures**

Hwy's 35 and 523, 5 Structures  
**GRAIN SIZE DISTRIBUTION**

FIGURE C1

**FILL**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-1	1.83	271.94
⊠	17-2	2.59	270.98
▲	17-6	2.11	267.14

GRAIN SIZE DISTRIBUTION - THURBER - 16284 BLACK CREEK.GPJ 26/9/18

Date ..September 2018.....  
 GWP# ..5087-11-00.....

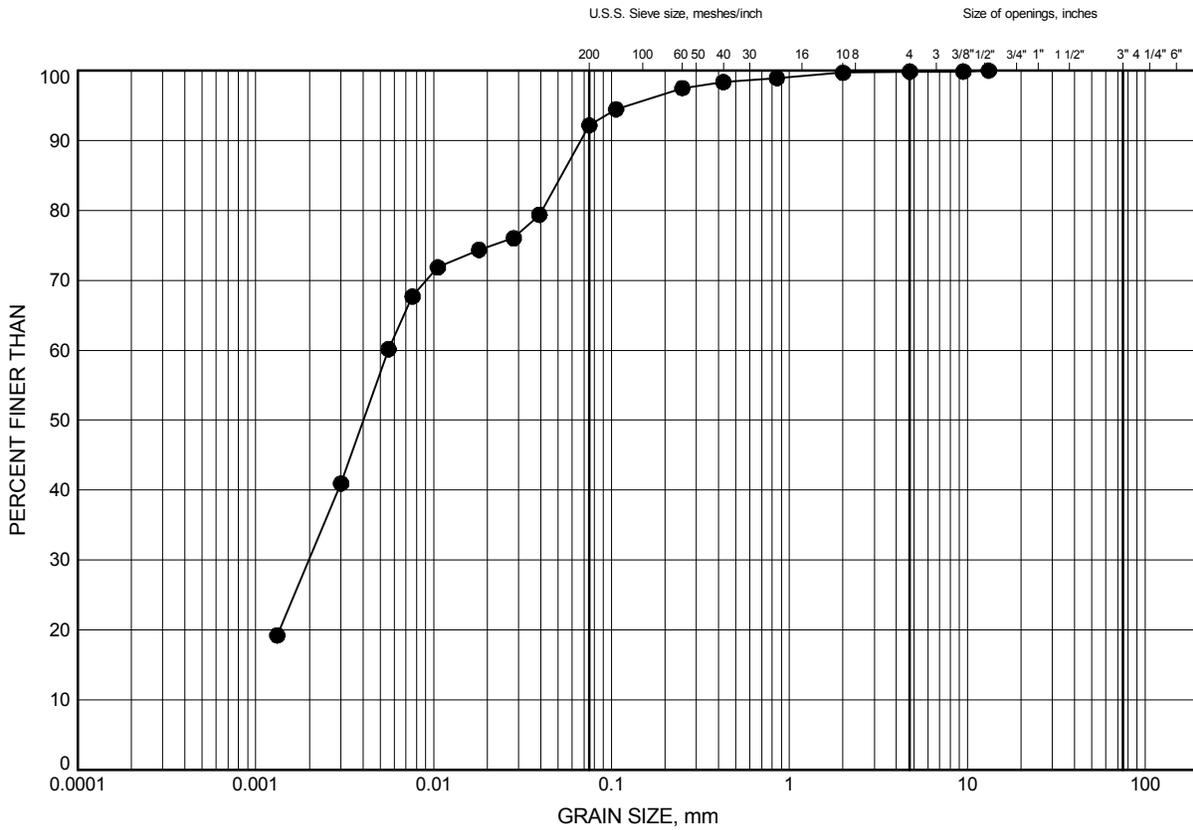


Prep'd .....KE.....  
 Chkd. ....SP.....

Hwy's 35 and 523, 5 Structures  
**GRAIN SIZE DISTRIBUTION**

FIGURE C2

**ORGANIC SILT**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-3	1.40	267.72

GRAIN SIZE DISTRIBUTION - THURBER - 16284 BLACK CREEK.GPJ 26/9/18

Date ..September 2018.....  
 GWP# ..5087-11-00.....

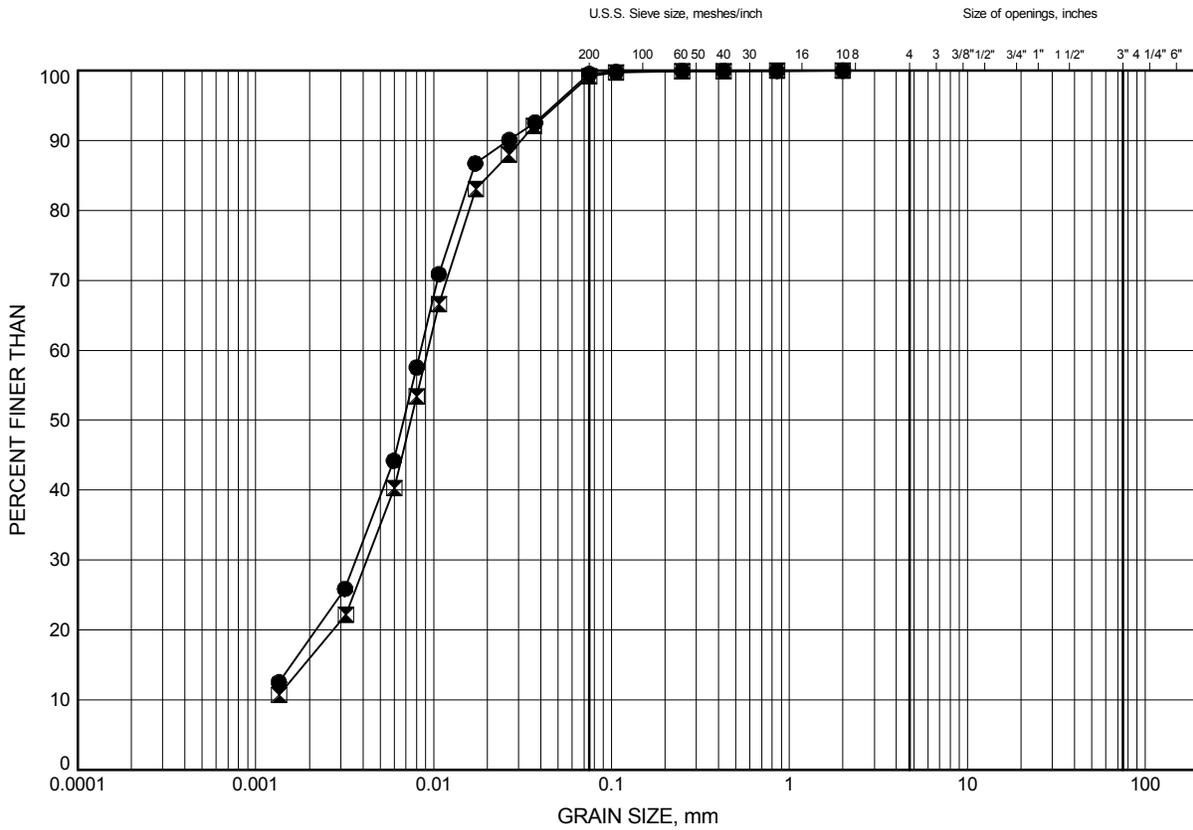


Prep'd .....KE.....  
 Chkd. ....SP.....

Hwy's 35 and 523, 5 Structures  
**GRAIN SIZE DISTRIBUTION**

FIGURE C3

**SILT**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-3	2.97	266.15
⊠	17-5	2.13	267.07

GRAIN SIZE DISTRIBUTION - THURBER - 16284 BLACK CREEK.GPJ 26/9/18

Date ..September 2018.....  
 GWP# ..5087-11-00.....

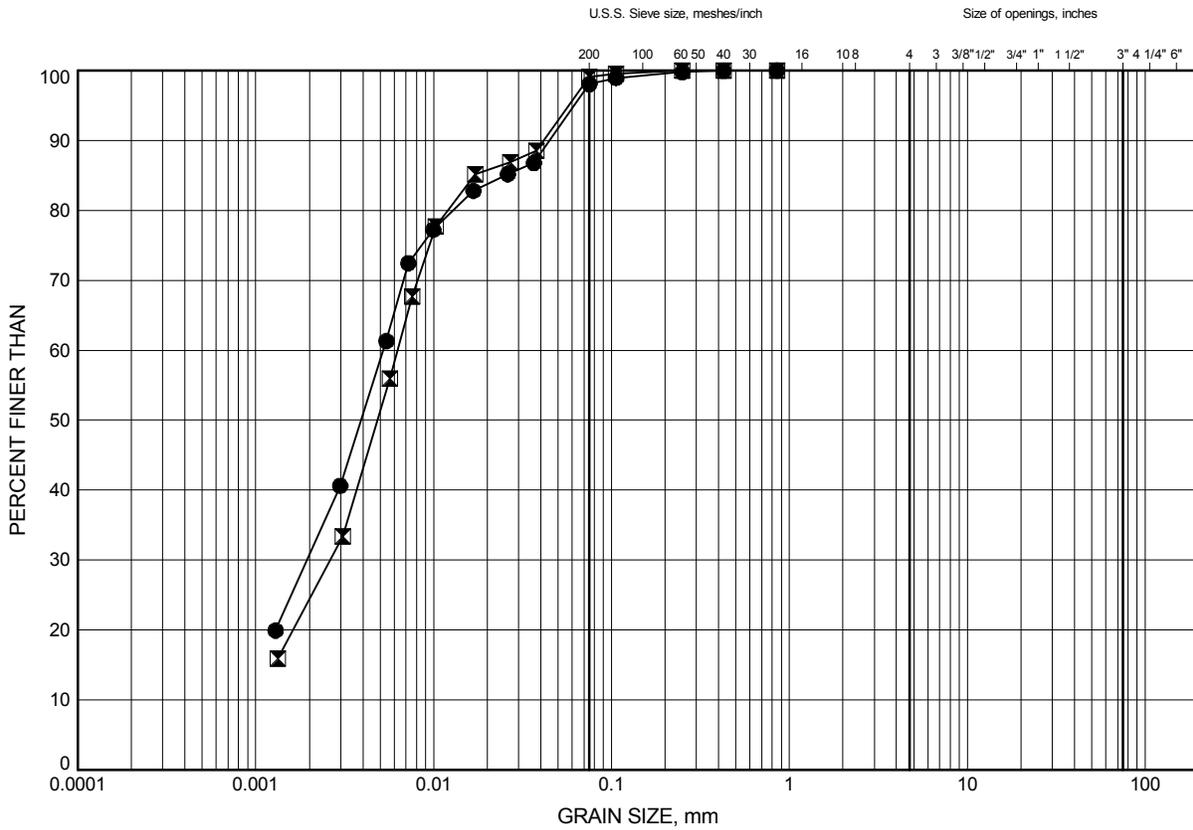


Prep'd .....KE.....  
 Chkd. ....SP.....

Hwy's 35 and 523, 5 Structures  
**GRAIN SIZE DISTRIBUTION**

FIGURE C4

**CLAY**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-1	5.64	268.13
⊠	17-4	2.23	266.96

GRAIN SIZE DISTRIBUTION - THURBER - 16284 BLACK CREEK.GPJ 26/9/18

Date ..September 2018.....  
 GWP# ..5087-11-00.....

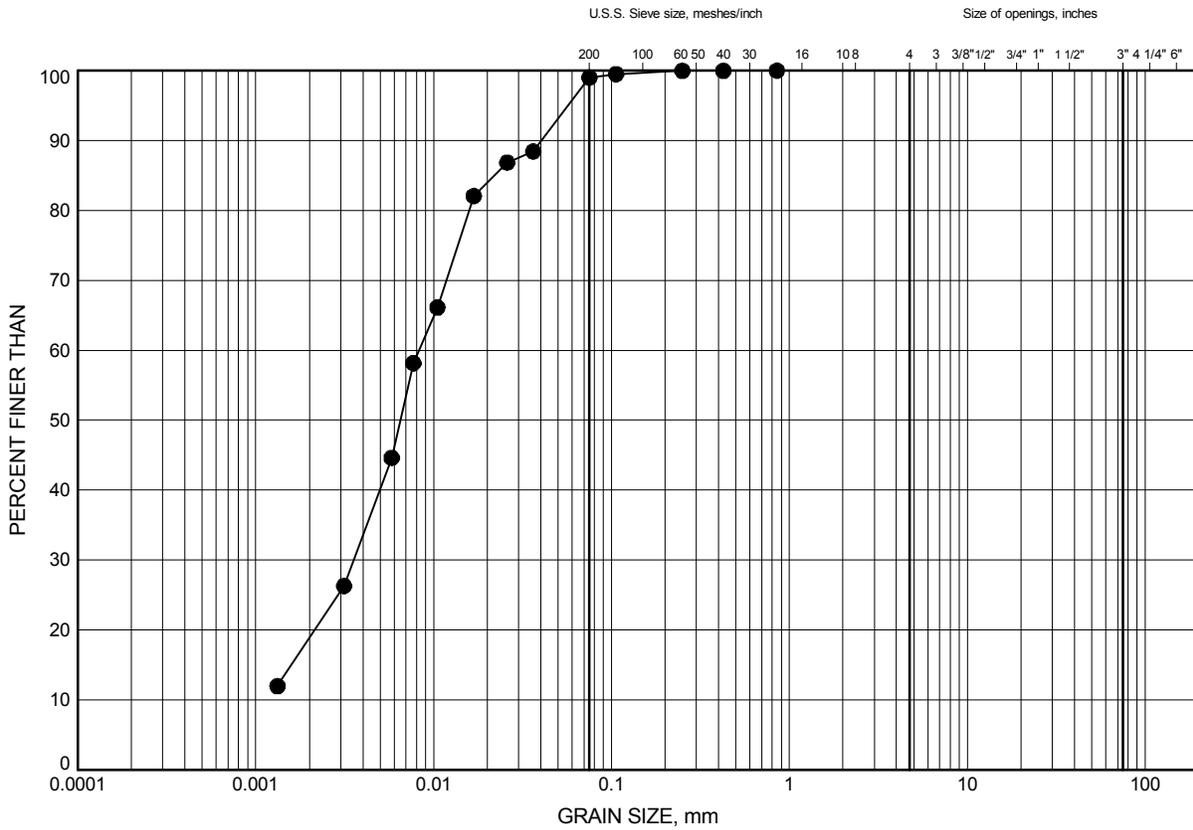


Prep'd .....KE.....  
 Chkd. ....SP.....

Hwy's 35 and 523, 5 Structures  
**GRAIN SIZE DISTRIBUTION**

FIGURE C5

**SILTY CLAY**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-2	6.40	267.17

GRAIN SIZE DISTRIBUTION - THURBER - 16284 BLACK CREEK.GPJ - 26/9/18

Date ..September 2018.....  
 GWP# ..5087-11-00.....

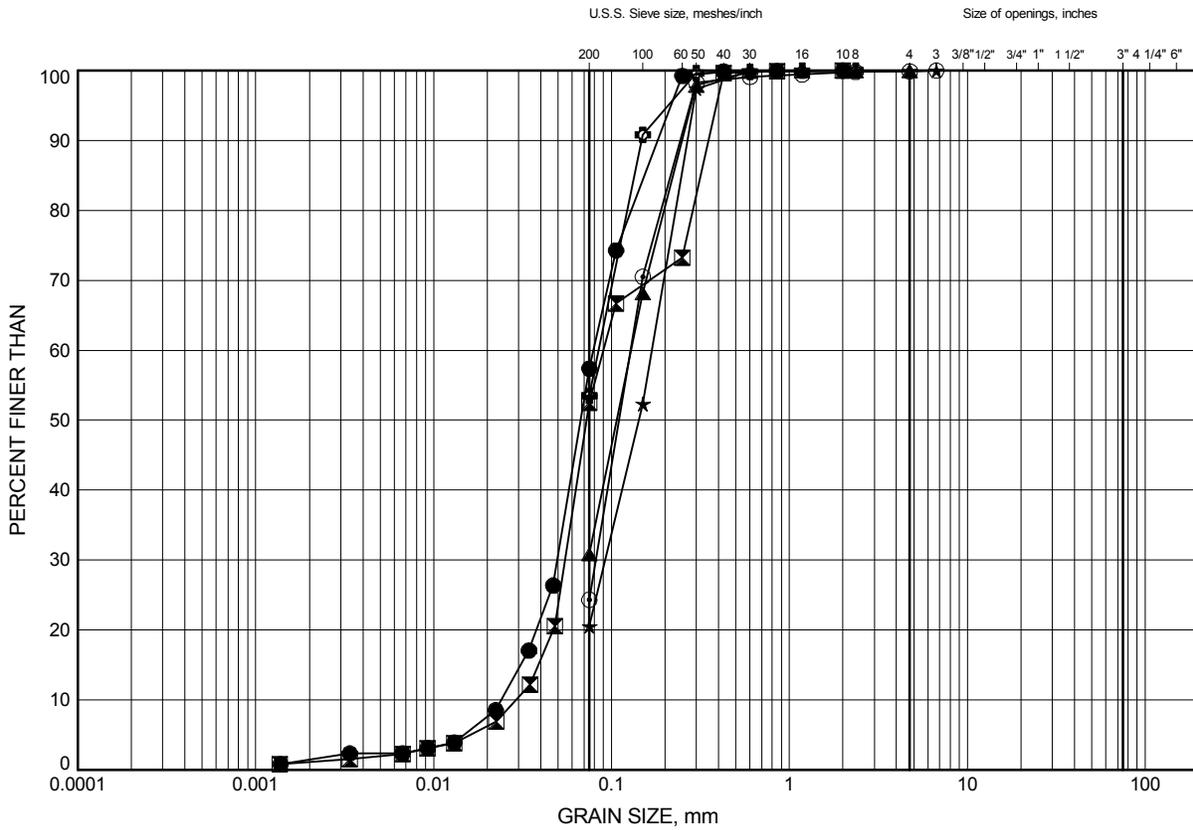


Prep'd .....KE.....  
 Chkd. ....SP.....

Hwy's 35 and 523, 5 Structures  
**GRAIN SIZE DISTRIBUTION**

FIGURE C6

**SILTY SAND**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-1	9.45	264.32
⊠	17-2	10.97	262.60
▲	17-2	15.54	258.03
★	17-3	7.52	261.60
⊙	17-4	6.07	263.12
⊕	17-5	3.71	265.49

GRAIN SIZE DISTRIBUTION - THURBER - 16284 BLACK CREEK.GPJ - 26/9/18

Date ..September 2018.....  
 GWP# ..5087-11-00.....

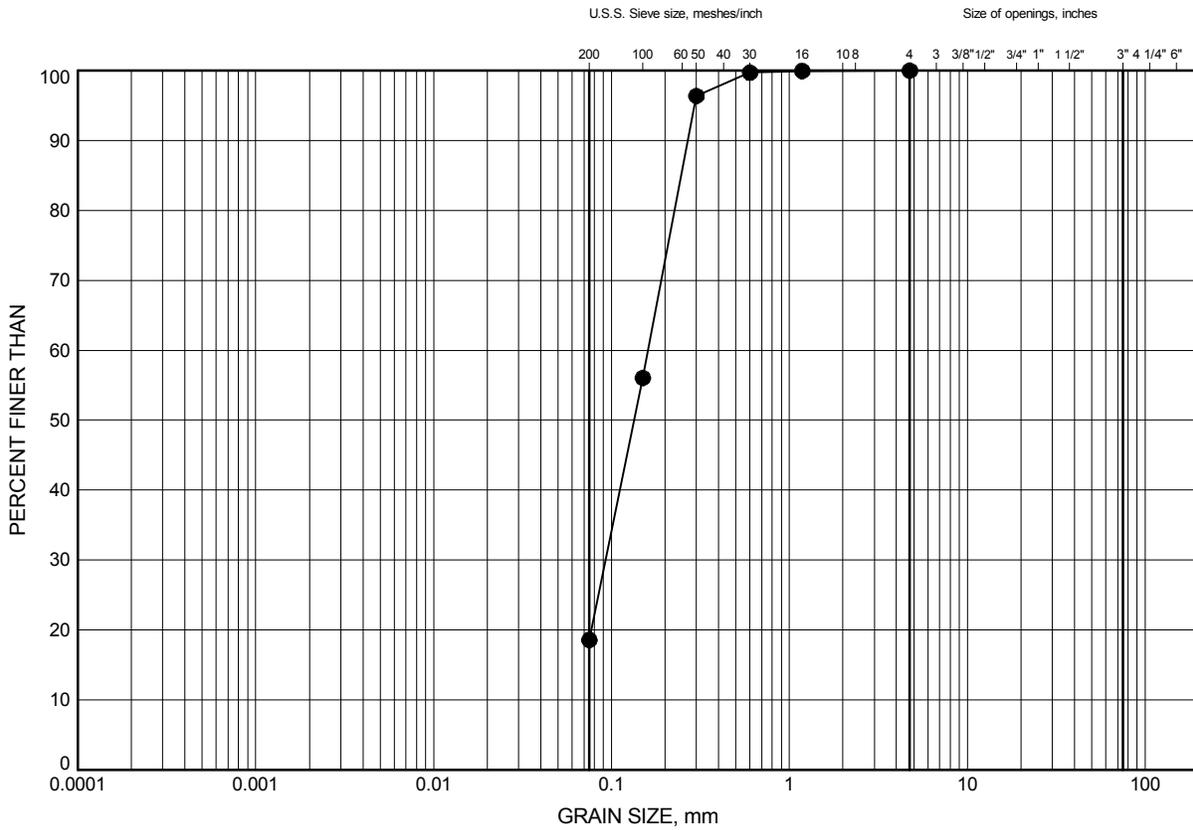


Prep'd .....KE.....  
 Chkd. ....SP.....

Hwy's 35 and 523, 5 Structures  
**GRAIN SIZE DISTRIBUTION**

FIGURE C7

**SILTY SAND**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-6	7.47	261.78

GRAIN SIZE DISTRIBUTION - THURBER 16284 BLACK CREEK.GPJ 26/9/18

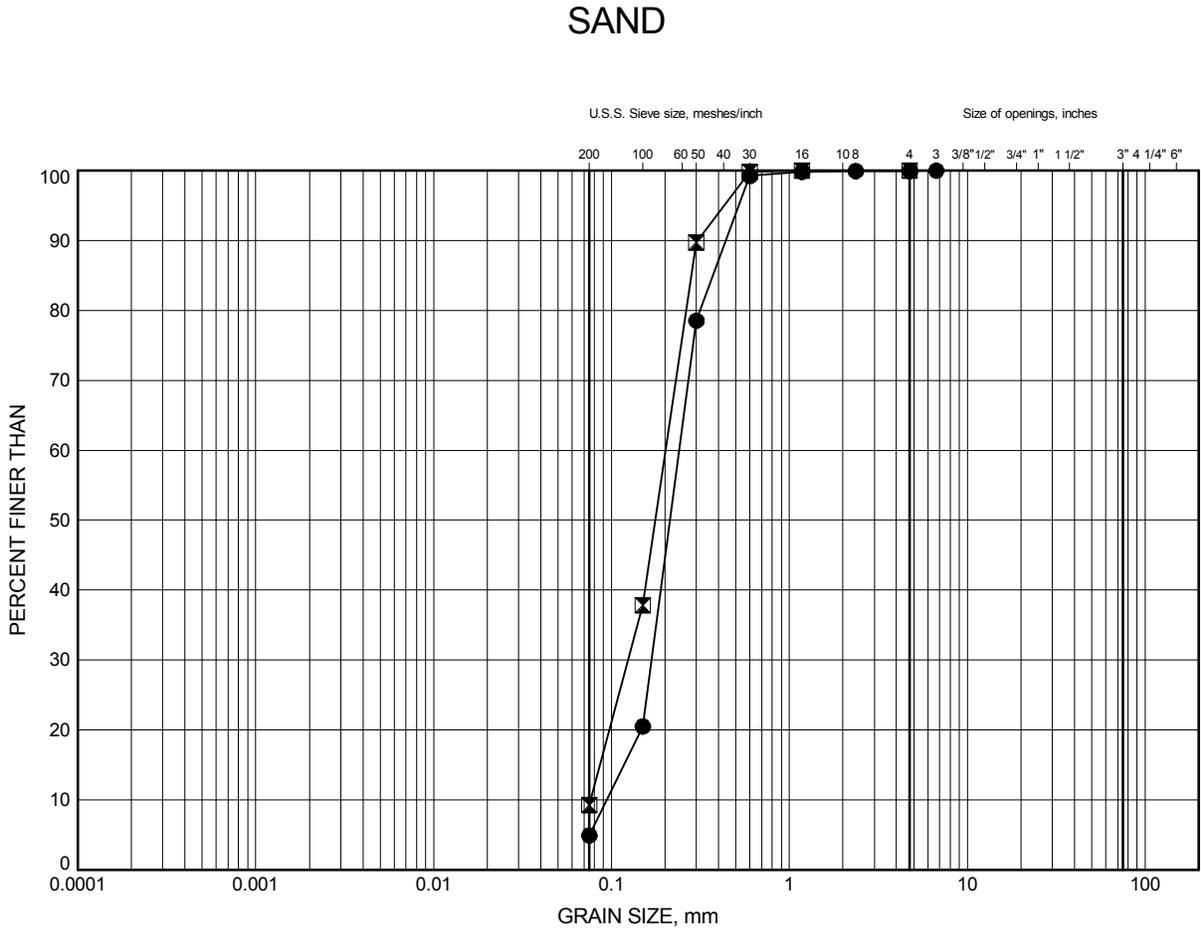
Date ..September 2018.....  
 GWP# ..5087-11-00.....



Prep'd .....KE.....  
 Chkd. ....SP.....

Hwy's 35 and 523, 5 Structures  
**GRAIN SIZE DISTRIBUTION**

FIGURE C8



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-1	12.50	261.27
⊠	17-6	10.52	258.74

GRAIN SIZE DISTRIBUTION - THURBER - 16284 BLACK CREEK.GPJ 26/9/18

Date ..September 2018.....  
 GWP# ..5087-11-00.....



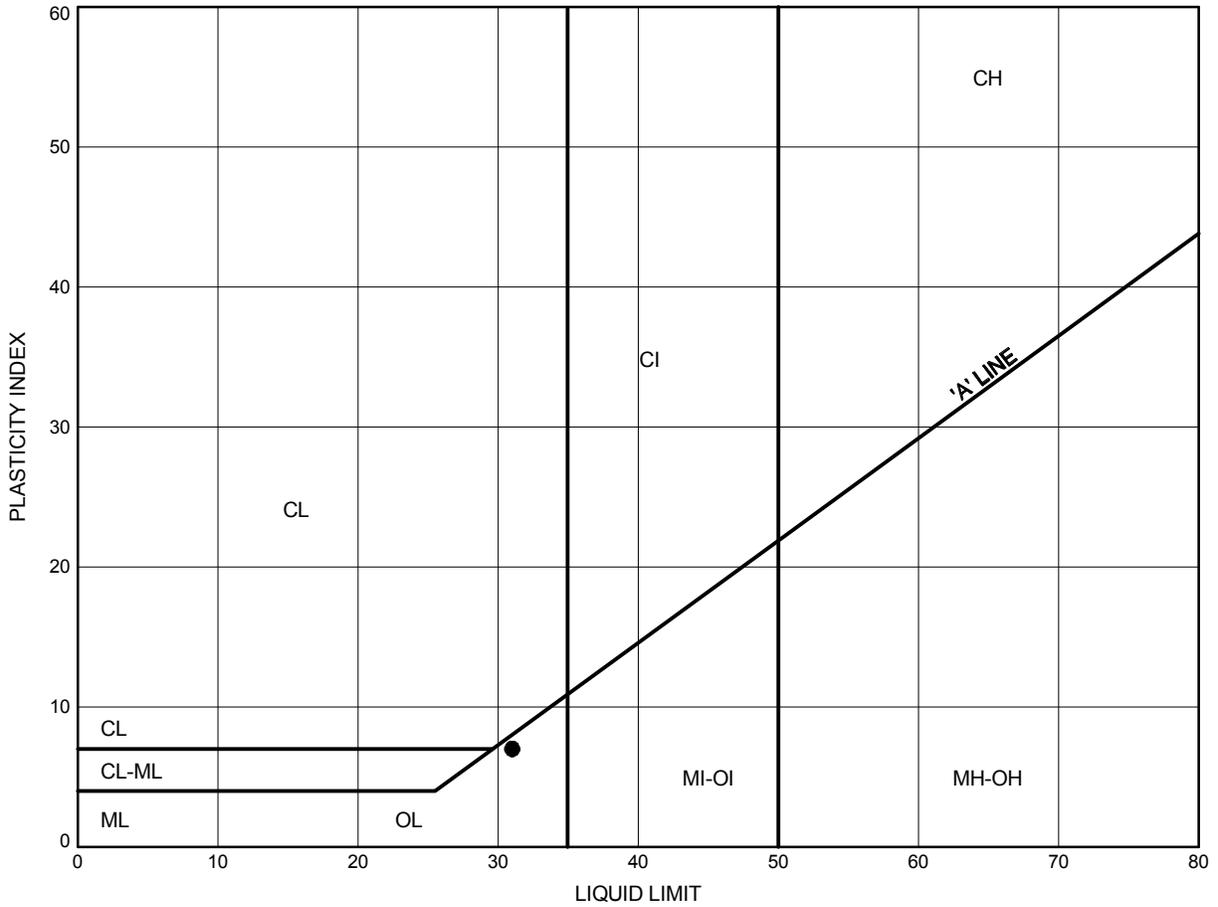
Prep'd .....KE.....  
 Chkd. ....SP.....

**Appendix C.2**  
**Atterberg Limit Analysis Figures**

Hwy's 35 and 523, 5 Structures  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C9

**ORGANIC SILT**



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-3	1.40	267.72

THURBALT 16284 BLACK CREEK.GPJ 26/9/18

Date ..September 2018.....  
 GWP# ..5087-11-00.....

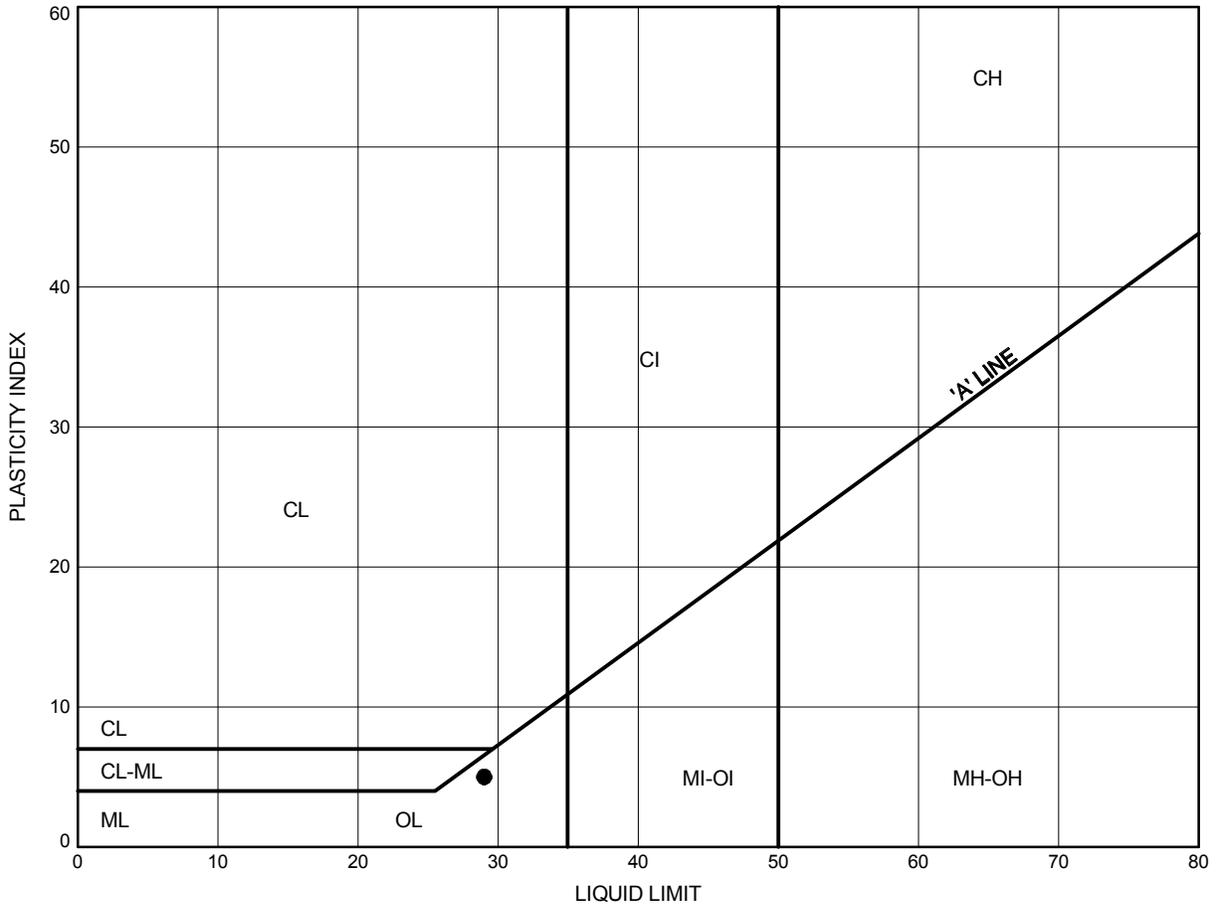


Prep'd .....KE.....  
 Chkd. ....SP.....

Hwy's 35 and 523, 5 Structures  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C10

**SILT**



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-3	2.97	266.15

THURBALT 16284 BLACK CREEK.GPJ 26/9/18

Date ..September 2018.....  
 GWP# ..5087-11-00.....

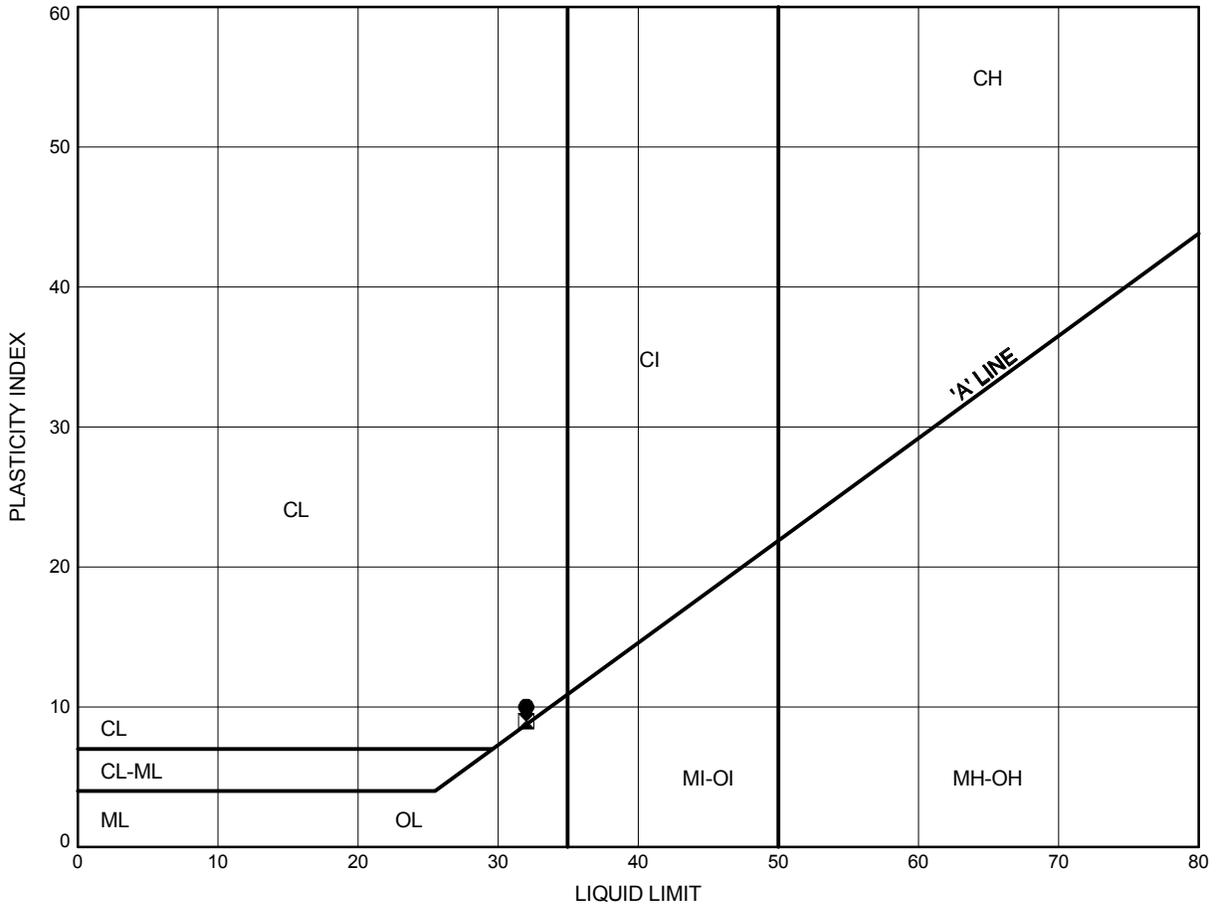


Prep'd .....KE.....  
 Chkd. ....SP.....

Hwy's 35 and 523, 5 Structures  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C11

**CLAY**



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-1	5.64	268.13
⊠	17-4	2.23	266.96

THURBALT 16284 BLACK CREEK.GPJ 26/9/18

Date ..September 2018.....  
 GWP# ..5087-11-00.....

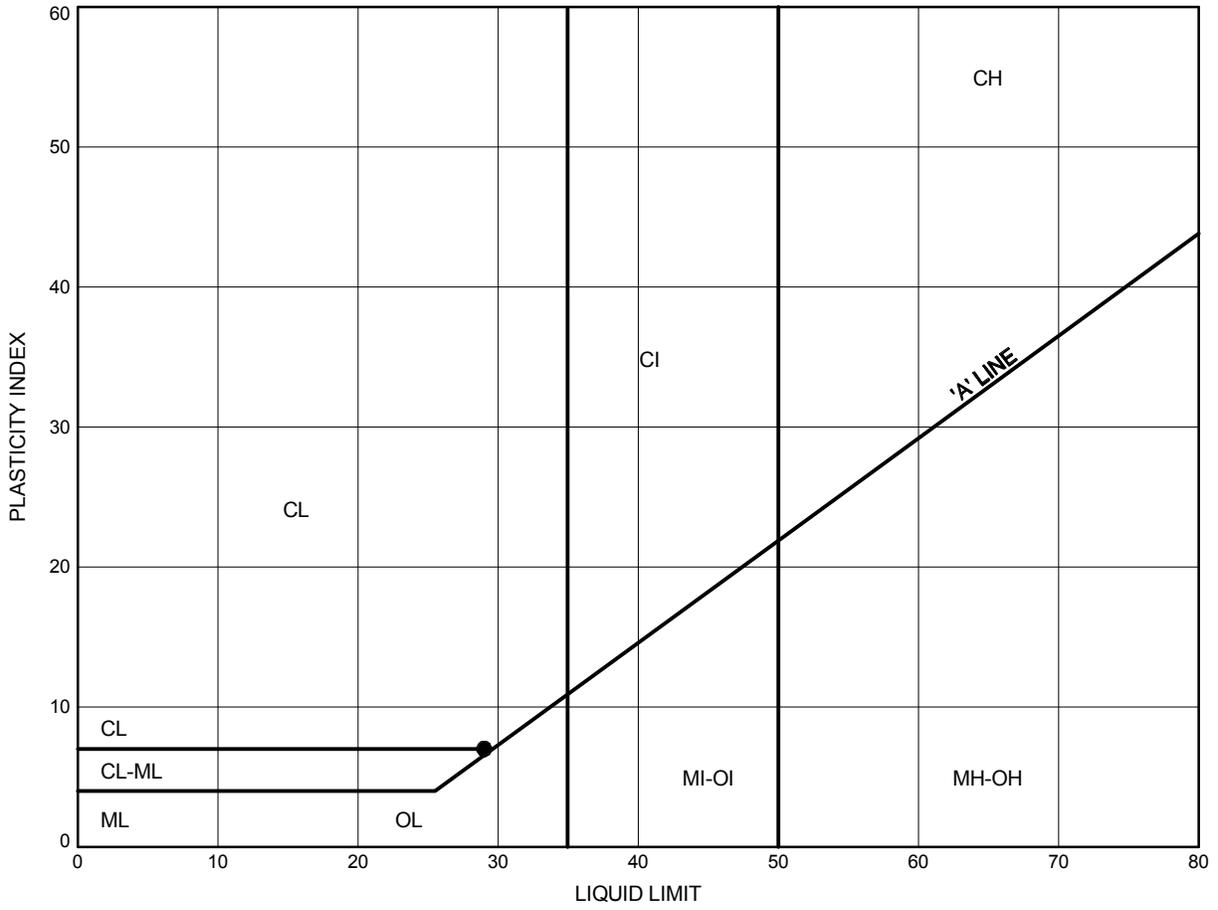


Prep'd .....KE.....  
 Chkd. ....SP.....

Hwy's 35 and 523, 5 Structures  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C12

**SILTY CLAY**



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-2	6.40	267.17

THURBALT 16284 BLACK CREEK.GPJ 26/9/18

Date ..September 2018.....  
 GWP# ..5087-11-00.....



Prep'd .....KE.....  
 Chkd. ....SP.....

**Appendix C.3**  
**Analytical Testing Results**

## Certificate of Analysis

**Thurber Engineering Ltd.**

2460 Lancaster Rd, Suite 104  
Ottawa, ON K1B4S5  
Attn: Stephen Peters

Client PO: 16284  
Project: Hwy 35/523  
Custody: 38404

Report Date: 29-Aug-2017  
Order Date: 23-Aug-2017

**Order #: 1734260**

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

Parcel ID	Client ID
1734260-01	Black Creek 17-3 SS#2 7.83-9.83'
1734260-02	Black Creek 17-5 SS#3 10.17-12.17'
<del>1734260-03</del>	<del>Minor's Bay 17-3 SS#1 0-1.25'</del>
<del>1734260-04</del>	<del>Bark Lake 17-3 SS#3 10-12'</del>
<del>1734260-05</del>	<del>Bark Lake 17-6 SS#2 15-17'</del>

Approved By:



Dale Robertson, BSc  
Laboratory Director

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 16284

Report Date: 29-Aug-2017  
Order Date: 23-Aug-2017  
Project Description: Hwy 35/523

**Analysis Summary Table**

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	25-Aug-17	25-Aug-17
Conductivity	MOE E3138 - probe @25 °C, water ext	29-Aug-17	29-Aug-17
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	28-Aug-17	28-Aug-17
Resistivity	EPA 120.1 - probe, water extraction	29-Aug-17	29-Aug-17
Solids, %	Gravimetric, calculation	26-Aug-17	26-Aug-17

Certificate of Analysis  
Client: **Thurber Engineering Ltd.**  
Client PO: 16284

Report Date: 29-Aug-2017

Order Date: 23-Aug-2017

Project Description: Hwy 35/523

	<b>Client ID:</b>	Black Creek 17-3 SS#2 7.83-9.83'	Black Creek 17-5 SS#3 10.17-12.17'	<del>Miner's Bay 17-3 SS#1 0-1.25'</del>	<del>Bark Lake 17-3 SS#3 10-12'</del>
	<b>Sample Date:</b>	14-Aug-17	16-Aug-17	<del>10-Aug-17</del>	<del>08-Aug-17</del>
	<b>Sample ID:</b>	1734260-01	1734260-02	<del>1734260-03</del>	<del>1734260-04</del>
	<b>MDL/Units</b>	Soil	Soil	<del>Soil</del>	<del>Soil</del>

**Physical Characteristics**

% Solids	0.1 % by Wt.	73.7	76.1	<del>91.0</del>	<del>70.4</del>
----------	--------------	------	------	-----------------	-----------------

**General Inorganics**

Conductivity	5 uS/cm	99	176	<del>220</del>	<del>217</del>
pH	0.05 pH Units	8.33	8.05	<del>7.85</del>	<del>4.91</del>
Resistivity	0.10 Ohm.m	101	56.8	<del>45.6</del>	<del>46.1</del>

**Anions**

Chloride	5 ug/g dry	11	51	<del>8</del>	<del>6</del>
Sulphate	5 ug/g dry	23	25	<del>23</del>	<del>176</del>

	<b>Client ID:</b>	<del>Bark Lake 17-6 SS#2 15-17'</del>	-	-	-
	<b>Sample Date:</b>	<del>09-Aug-17</del>	-	-	-
	<b>Sample ID:</b>	<del>1734260-05</del>	-	-	-
	<b>MDL/Units</b>	<del>Soil</del>	-	-	-

**Physical Characteristics**

% Solids	0.1 % by Wt.	<del>88.8</del>	-	-	-
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**General Inorganics**

Conductivity	5 uS/cm	<del>63</del>	-	-	-
pH	0.05 pH Units	<del>5.70</del>	-	-	-
Resistivity	0.10 Ohm.m	<del>158</del>	-	-	-

**Anions**

Chloride	5 ug/g dry	<del>7</del>	-	-	-
Sulphate	5 ug/g dry	<del>26</del>	-	-	-

Certificate of Analysis  
Client: **Thurber Engineering Ltd.**  
Client PO: **16284**

Report Date: 29-Aug-2017  
Order Date: 23-Aug-2017  
Project Description: **Hwy 35/523**

**Method Quality Control: Blank**

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

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 16284

Report Date: 29-Aug-2017  
Order Date: 23-Aug-2017  
Project Description: Hwy 35/523

**Method Quality Control: Duplicate**

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	10.5	5	ug/g dry	10.7			1.3	20	
Sulphate	22.3	5	ug/g dry	23.3			4.4	20	
<b>General Inorganics</b>									
Conductivity	844	5	uS/cm	841			0.4	6.2	
pH	8.36	0.05	pH Units	8.45			1.1	10	
Resistivity	11.8	0.10	Ohm.m	11.9			0.4	20	
<b>Physical Characteristics</b>									
% Solids	87.3	0.1	% by Wt.	87.2			0.0	25	

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 16284

Report Date: 29-Aug-2017  
Order Date: 23-Aug-2017  
Project Description: Hwy 35/523

**Method Quality Control: Spike**

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	101	5	ug/g	10.7	90.4	78-113			
Sulphate	119	5	ug/g	23.3	96.2	78-111			

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 16284

Report Date: 29-Aug-2017  
Order Date: 23-Aug-2017  
Project Description: Hwy 35/523

**Qualifier Notes:**

None

**Sample Data Revisions**

None

**Work Order Revisions / Comments:**

None

**Other Report Notes:**

n/a: not applicable  
ND: Not Detected  
MDL: Method Detection Limit  
Source Result: Data used as source for matrix and duplicate samples  
%REC: Percent recovery.  
RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.  
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

**Appendix D.**

**Site Photographs**

CULVERT STRUCTURE NO. 40-116/C  
HIGHWAY 35 BLACK CREEK CULVERT, LUTTERWORTH TOWNSHIP

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**Photo 1. Looking north along Highway 35 (2017/08/16)**



**Photo 2. Looking south along Highway 35 (2017/08/16)**



**Photo 3. Outlet looking east (2017/08/16)**



**Photo 4. Inlet looking west (2017/08/16)**



**Photo 5. Outlet with water level measuring instrument (2017/08/17)**