



**THURBER** ENGINEERING LTD.

**FINAL  
FOUNDATION INVESTIGATION REPORT  
HIGHWAY 118 CULVERT STA. 22+597, OAKLEY TOWNSHIP  
ASSIGNMENT NO. 5017-E-0003  
G.W.P. 5287-14-00**

Geocres No.: 31E-399

Report to:

**McIntosh Perry Consulting Engineers Limited**

Latitude: 45.028040°  
Longitude: -78.994622°

August 2019  
Thurber File No.: 20244

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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 a culvert at Sta. 22+597 on Highway 118. The culvert crossing is located approximately 0.4 km west of the Black River Bridge within Oakley Township in the District of Muskoka. Thurber Engineering Limited (Thurber) carried out the current field investigation as a sub-consultant to McIntosh Perry Consulting Engineers Ltd. (MPCE) under Assignment No. 5017-E-0003.

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 online Geocres Library. A Project Assessment Report (PAR) and a historical base plan survey were provided by MPCE.

**2 SITE DESCRIPTION**

For project purposes, Highway 118 will be considered oriented east-west with chainage increasing to the east. The existing culvert conveys (unnamed) creek flow from the south to the north under a high fill embankment supporting Highway 118. The existing culvert is a non-structural corrugated steel pipe (CSP) culvert with a measured diameter of 0.8 m. As indicated on the base plan drawings provided by MCPE, the length of the culvert is 36.5 m. The invert of the culvert is at approximate elevation 308.3 m and 307.9 m at the inlet (south) and outlet (north), respectively. The culvert is partially blocked by sediment at both the inlet and outlet (see Photos 1 and 2 in Appendix D). No signs of erosion or slope instability were noted on the existing highway embankments during the field investigation. The roadway surface over the culvert was generally in good condition with no dips or bumps noted during the field investigation. The existing culvert, as assessed by MPCE, showed minor signs of corrosion.

At the location of the culvert, Highway 118 is a two-lane highway with paved shoulders. Both horizontal and vertical highway alignment curves are present east and west of the culvert. Black River flows southward under Highway 118 approximately 370 m east of the culvert site. The Highway 118 fill height above the culvert is approximately 5.3 m with the road surface at approximate elevation 314.3 m. The existing embankment slopes are inclined at approximately 2.5H:1V. Cable guidewires with wooden posts are present on both sides of the highway in the vicinity of the culvert. The land adjacent to the highway and creek alignment is densely vegetated with shrubs and predominantly coniferous trees. A historical alignment of a gravel road is located north of Highway 118, just west of the culvert site. Overhead utility lines run parallel to the highway immediately north of Highway 118. Traffic volumes on this section of Highway 118 are understood to be 1,600 AADT (2016).

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 from September 13<sup>th</sup> to 27<sup>th</sup>, 2018. The field investigation consisted of advancing four boreholes identified as 18-1 through 18-4. The drilling was carried out using portable equipment for off-road boreholes 18-1 and 18-4 and a truck mounted CME 75 drill rig for the on-road boreholes 18-2 and 18-3. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

The northing, easting and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 included in Appendix A, the individual Record of Borehole sheets in Appendix B and within Table 3-1. The termination depth of each of the boreholes is also provided below. The site is within MTM Zone 10. The borehole elevations were surveyed with a Nikon-AP-8 with an accuracy of +/- 1.5 mm. The survey referenced the tops of the north and south ends of the culvert which have elevations of 309.170 m and 308.730 m, respectively, as provided by MPCE. Horizontal locations were measured relative to existing site features.



**Table 3-1: Borehole Summary**

<b>Borehole No.</b>	<b>Drilled Location</b>	<b>Northing (m)</b>	<b>Easting (m)</b>	<b>Ground Surface Elevation (m)</b>	<b>Termination Depth * (m)</b>
18-1	Near Culvert Outlet	4 987 708.3	344 616.5	308.4	11.3
18-2	Westbound Lane HWY 118	4 987 695.1	344 629.1	314.3	18.8
18-3	Eastbound Lane HWY 118	4 987 697.3	344 638.2	314.2	19.2
18-4	Near Culvert Inlet	4 987 686.3	344 650.1	308.8	12.0

*Note: (\*) depths provided in table are from the ground surface*

Soil samples were obtained at select intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) following ASTM D1586. A half-weight (32 kg) hammer was used during SPT testing in Boreholes 18-1 and 18-4, which were drilled with portable equipment. The N-values reported herein and on the borehole logs for these off-road boreholes have been adjusted to an equivalent standard weight hammer (64 kg). A standard weight hammer was used during SPT testing in Boreholes 18-2 and 18-3, thus no adjustments to the results were necessary. Boreholes 18-2, 18-3 and 18-4 were advanced into bedrock with either NW or NWT casing in conjunction with coring techniques.

The drilling and sampling operations were supervised on a full-time basis by an experienced member of Thurber's technical staff. The drilling supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's Ottawa geotechnical laboratory for further examination and testing.

A 19 mm diameter standpipe piezometer was installed in Borehole 18-4 to allow for measurements of the groundwater level after completion of drilling. The piezometer installation details are illustrated on the respective Record of Borehole sheet provided in Appendix B. The boreholes were backfilled in accordance with MOE requirements (O.Reg. 903 as amended). Boreholes 18-2 and 18-3 were backfilled with granulars within the depth of pavement structure and capped with 150 mm of cold patch asphalt to reinstate the travelling surface.

#### **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 18-1 and 18-4 was selected for analytical testing of corrosivity parameters. All laboratory test results are provided in Appendix C.

## **5 GENERAL 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 the Soil Strata Drawing and the general description. 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, granular fill and rock fill overlying native deposits of sand, silt, and gravel. Granite bedrock was encountered at varying elevations in Boreholes 18-2, 18-3 and 18-4.

### **5.1 Embankment**

#### **5.1.1 Asphalt**

Boreholes 18-2 and 18-3 were drilled through the existing Highway 118 embankment and encountered a 100 mm thick layer of asphalt at the ground surface.

#### **5.1.2 Gravel with Sand and Sand with Silt, Fill**

Granular fill ranging from gravel with sand to sand with silt was encountered below the asphalt in Borehole 18-3. The underside of this fill was at 1.5 m below the existing roadway surface (elev. 312.7 m).

The SPT tests conducted in the granular fill gave N-values of 37 and 51 blows, indicating a relative density of dense to very dense.

Recorded moisture contents ranged from 4 to 7%. The results of a grain size analysis conducted on one sample of the gravel fill indicated this material to consist of 60% gravel, 35% sand and 5% fines. The results are provided on the Record of Borehole sheets in Appendix B and illustrated on Figure C1 in Appendix C.

#### **5.1.3 Rock Fill**

A layer consisting predominantly of rock fill was encountered below the gravel fill in Borehole 18-3. This layer had a thickness of 3.1 m with an underside elevation of 309.6 m. Borehole 18-3 was advanced through the rock fill using casing and coring techniques. Rock fill pieces were cored and indicated mainly granite particles with cored lengths of up to

660 mm. Sample recovery was poor or not feasible within this layer. Where obtainable, SPT N-values of 15 and 64 blows were recorded.

#### 5.1.4 Silty Sand to Sand with Silt, Fill

Below the asphalt in Borehole 18-2 and below the rock fill in Borehole 18-3 was a layer of fill consisting of silty sand trace gravel to sand with silt. The fill ranged from 0.7 to 5.7 m in thickness with the underside of this fill ranging from 5.3 to 5.8 m below the existing roadway surface (elev. 308.5 to 308.9 m). A 430 mm boulder was encountered within Borehole 18-2 and was cored at a depth of 4.4 m.

The SPT tests conducted in the sand fill gave N-values ranging from 13 to 40 blows, indicating a relative density of compact to dense.

Recorded moisture contents ranged from 8 to 19%. The results of grain size analyses conducted on two samples of the sand fill are summarized in the table below and are illustrated on Figure C1 in Appendix C.

Soil Particle	Percentage (%)
Gravel	0 – 10
Sand	71 – 90
Silt	10 – 19
Clay	

## 5.2 Sand (SP-SM) to Silty Sand (SM)

A native deposit of sand with silt to silty sand was encountered at the ground surface in Boreholes 18-1 and 18-4 and below the granular fills in Boreholes 18-2 and 18-3. The thickness of this layer ranged from 2.1 to 3.3 m (underside elev. 305.2 to 306.5 m). Trace organics were encountered near the top of this deposit in Boreholes 18-2 and 18-3. Wood particles were also noted in Borehole 18-3.

A 0.3 m thick layer of compact sand was also encountered within the sandy silt to silt (Section 5.3) deposit at a depth of 2.7 m within Borehole 18-1.

SPT tests conducted in the native sand deposit gave N-values ranging from 5 to 34 blows, indicating a relative density of loose to dense. The lower N-values were typically noted near ground surface in the off-road boreholes.

Recorded moisture contents of the sand ranged from 17 to 27%. The results of grain size analyses conducted on three samples of the sand to silty sand are summarized in the table below and are illustrated in Figure C2 in Appendix C.

Soil Particle	Percentage (%)
Gravel	0 – 1
Sand	89 – 94
Silt	6 – 10
Clay	

### 5.3 Silt (ML) to Sandy Silt (ML)

A deposit of silt with varying amounts of sand was encountered below the sand to silty sand deposit in Boreholes 18-1 through 18-4. Within Borehole 18-1 the layer transitioned to sandy silt with depth and the borehole was terminated within the sandy silt at a final depth of 11.3 m (elev. 297.1 m). The thickness of this layer in the remaining boreholes ranged from 5.3 to 6.9 m (underside elev. 299.0 to 301.2 m). A layer of sand with a thickness of 0.3 m was encountered at a depth of 2.7 m (elev. 305.7 m) within this deposit in Borehole 18-1.

SPT tests conducted in the silt deposit gave N-values ranging from 13 to 54 blows, indicating a relative density of compact to very dense.

Recorded moisture contents of the silt ranged from 17 to 29%. The results of grain size analysis conducted on six samples of the silt are summarized in the table below and are illustrated in Figure C3 in Appendix C.

Soil Particle	Percentage (%)
Gravel	0
Sand	3 – 32
Silt	66 – 93
Clay	2 – 6

Atterberg Limit tests completed on six samples of the silt deposit indicated that the material is non-plastic.

### 5.4 Gravel (GW-GM)

A layer of gravel with silt and sand was encountered below the silt deposit in Borehole 18-4. The thickness of this layer was 1.0 m with an underside elevation of 300.2 m.

A single SPT test gave an N-value of 74 blows, indicating a relative density of very dense.

The moisture content was 6% for a sample from this deposit. The results of a grain size analysis conducted on one sample of the gravel indicated this material to consist of 49% gravel, 43% sand and 8% fines. These results are illustrated on Figure C4 in Appendix C.

## 5.5 Bedrock

Bedrock was proven by coring in Boreholes 18-2 through 18-4. Information on where the bedrock surface was encountered is summarized in Table 5-1.

**Table 5-1: Summary of Bedrock Elevations**

Borehole No.	Depth to Bedrock (m)	Bedrock Elevation (m)
18-1	Not encountered to 11.3 m depth	Not encountered above 297.1 m
18-2	15.3	299.0
18-3	14.8	299.4
18-4	8.6	300.2

The bedrock core samples consisted of slightly weathered to fresh granite. The Total Core Recovery (TCR) from all core samples was 100%, the Solid Core Recovery (SCR) ranged from 83 to 100% and the Rock Quality Designation (RQD) ranged from 85 to 100%. Based on the measured RQD values, the bedrock is classified as good to excellent quality (Table 3.10, Canadian Foundation and Engineering Manual 2006).

Photographs of the bedrock core are provided in Appendix C.

## 5.6 Groundwater

Representative water levels could not be recorded in the open boreholes due to water being introduced as part of the drilling operations. The groundwater water level within the standpipe piezometer installed in Borehole 18-4 was recorded at a depth of 0.4 m below the ground surface (elev. 308.4 m) two days after installation on September 29, 2018. Water flow through the culvert was not observed throughout the duration of field investigation, however ponded water was noted in close proximity to the culvert outlet.

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.

## 5.7 Analytical Testing

Two samples of the native soils were submitted for analysis of pH, water soluble sulphate and chloride concentrations, and resistivity. The analysis results are summarized in the Table 5-2 and a copy of the test results is provided in Appendix C.

**Table 5-2: Results of Chemical Analysis**

Borehole (Sample)	Depth <sup>(*)</sup> (mbgs)	Sulphate (µg/g)	pH ( - )	Resistivity (Ohm-cm)	Conductivity (uS/cm)	Chloride (µg/g)	Sulphide (%)
18-1 (SS2)	0.7 – 1.3	11	6.44	3,310	302	168	<0.02
18-4 (SS3)	1.5 – 2.1	<5	5.59	65,300*	15	<5	<0.02

*\*The Resistivity test result for 18-4 SS3 is very high. The test results from 18-1 SS-2 should be utilized to assess corrosion potential.*

## 6 MISCELLANEOUS

Borehole locations were selected by Thurber relative to existing site features and the existing culvert location. The as-drilled location and ground surface elevation of the boreholes were measured by Thurber following completion of drilling. Elevation benchmarks were provided by MPCE.

George Downing Estate Drilling Ltd. and Forage M3 Drilling Services Inc. both of Hawksbury, Ontario supplied and operated the drilling equipment to conduct the drilling, soil sampling, in-situ testing, standpipe installation and decommissioning of the boreholes. NC Traffic Management Inc. of Kirkland Lake, Ontario supplied the traffic control for lane closures required for the field work. The field investigation was supervised on a full-time basis by Miss Allison Chow, EIT and Mr. Sean O'Bryan, C.E.T. of Thurber. Overall supervision of the investigation was provided by Miss Katya Edney, 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 Miss Allison Chow, EIT, 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.

*Allison Chow*  
*August 26, 2019*

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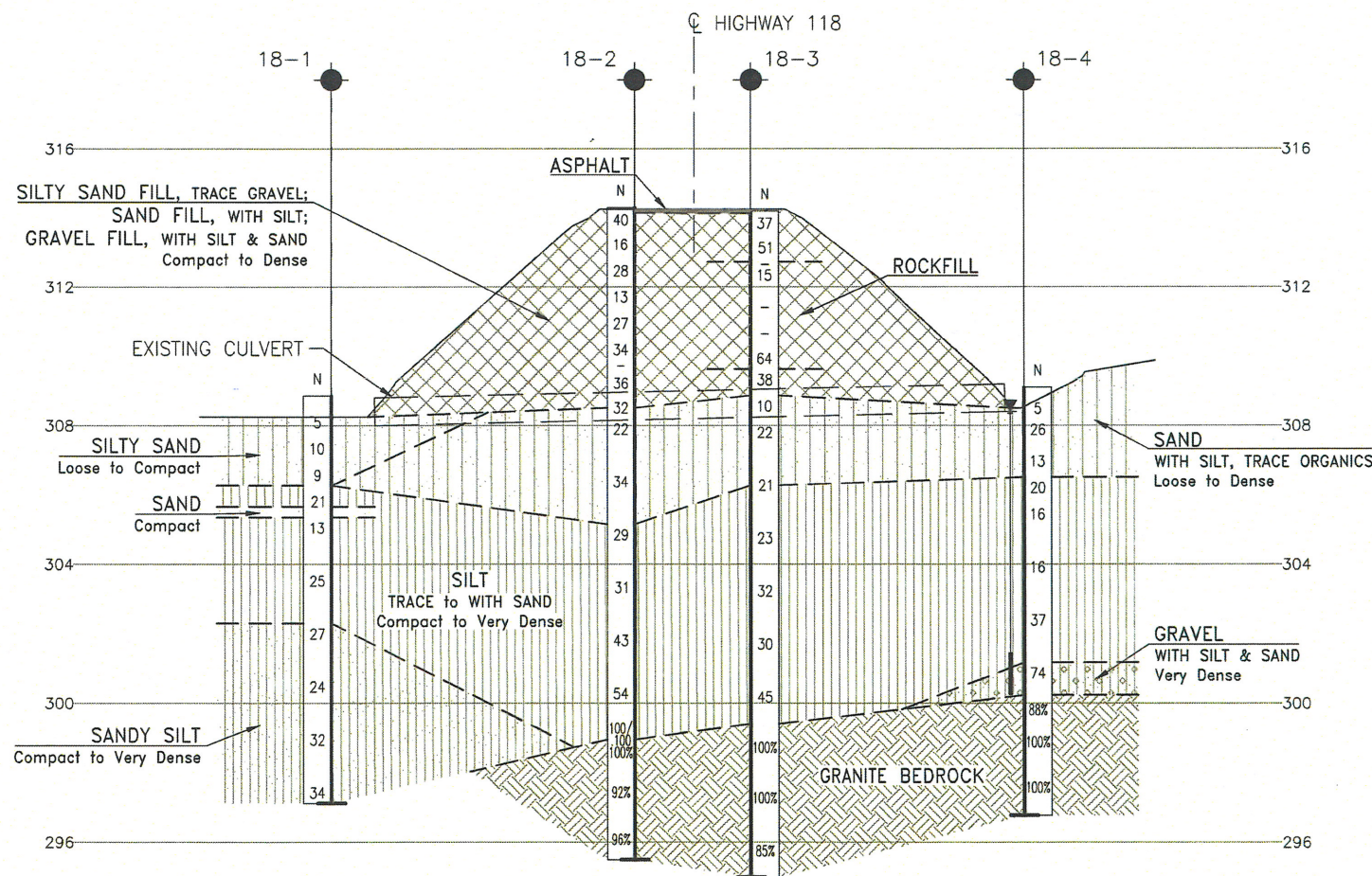
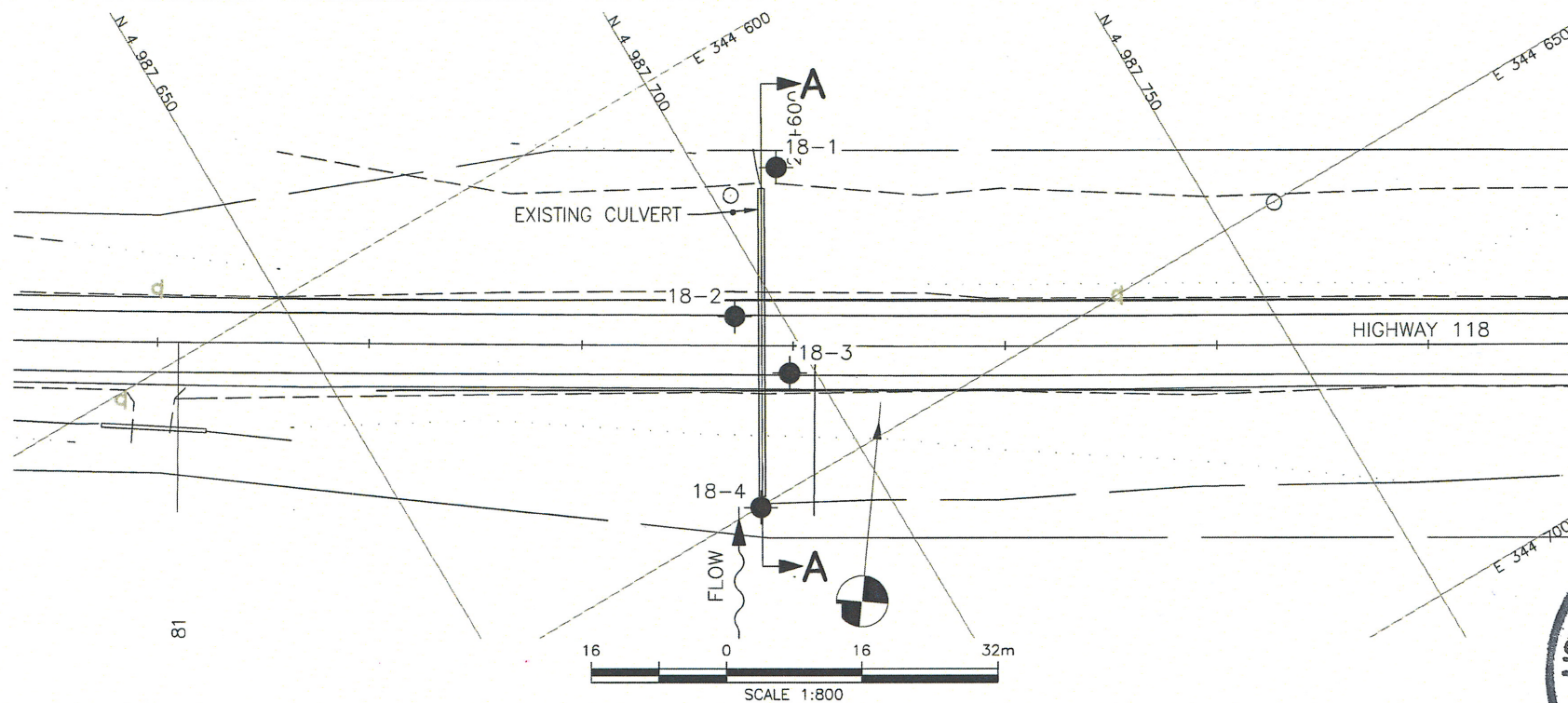
Dr. P.K. Chatterji, P.Eng.  
Review Principal  
Senior Geotechnical Engineer



## **Appendix A.**

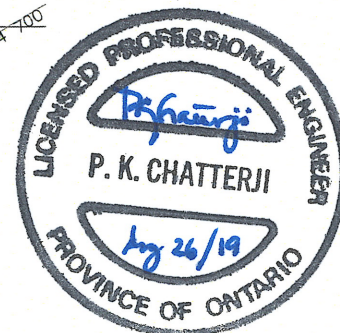
### **Borehole Location Plan and Stratigraphic Drawing**





SECTION A-A

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



CONT No  
GWP No 5287-14-00

HIGHWAY 118  
STATION 22+597  
CULVERT REPLACEMENT  
BOREHOLE LOCATIONS AND SOIL STRATA

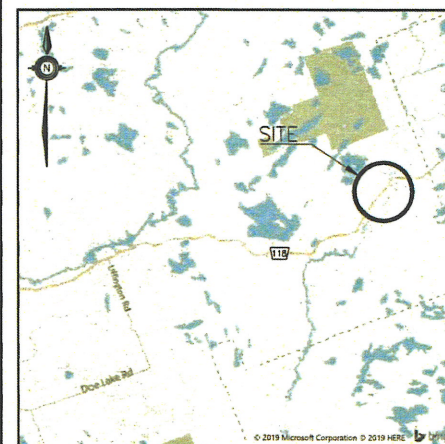


SHEET

McINTOSH PERRY



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

●	Current Borehole by Thurber
○	Previous Borehole by Others (Approx.)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
W	Water Level
H	Head Artesian Water
P	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
18-1	308.4	4 987 708.3	344 616.5
18-2	314.3	4 987 695.1	344 629.1
18-3	314.2	4 987 697.3	344 638.2
18-4	308.8	4 987 686.3	344 650.1

-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 31E-399

DATE	BY	DESCRIPTION
DESIGN	KE	CHK SP
DRAWN	MFA	CHK KE
		CODE
		LOAD
		DATE
		APR 2019
		DWG





## **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 18-1

1 OF 2

METRIC

GWP# 5287-14-00 LOCATION Lat: 45.028241°, Long: -78.994716°  
 HWY 118 BOREHOLE TYPE Portable NWT Coring ORIGINATED BY SOB  
 DATUM Geodetic DATE 25.09.2018 - 25.09.2018 COMPILED BY AC  
 CHECKED BY KE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			
								○ UNCONFINED	+ FIELD VANE											
								● QUICK TRIAXIAL	× LAB VANE											
308.9							20	40	60	80	100									
0.0	STAND																			
308.4																				
0.5	SILTY SAND (SM) loose to compact brown		1	SS	5								○							
			2	SS	10								○							
			3	SS	9								○							
306.3																				
2.6	SANDY SILT (ML) compact grey												○							
305.7			4	SS	21								○							
3.2	SAND (SP) compact brown																			
305.4																				
3.5	SILT (ML) trace sand compact grey		5	SS	13								○							
			6	SS	25								○							
304																				
303																				
302.3																				
6.6	SANDY SILT (ML) compact to dense grey-brown		7	SS	27								○							
			8	SS	24								○							
300																				
299			9	SS	32								○							

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 18-1

2 OF 2

METRIC

GWP# 5287-14-00 LOCATION Lat: 45.028241°, Long: -78.994716° ORIGINATED BY SOB  
 HWY 118 BOREHOLE TYPE Portable NWT Coring COMPILED BY AC  
 DATUM Geodetic DATE 25.09.2018 - 25.09.2018 CHECKED BY KE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
	Continued From Previous Page													
	SANDY SILT (ML) compact to dense grey-brown						298							
297.1														
11.7	End of Borehole													
	A half-weight (32 kg) drop hammer was used to advance the split-spoon sampler. The N values presented have been adjusted to provide an equivalent N value that would have been obtained with a standard 64 kg hammer.													



# RECORD OF BOREHOLE No 18-2

1 OF 2

METRIC

GWP# 5287-14-00 LOCATION Lat: 45.028122°, Long: -78.994557°  
 HWY 118 BOREHOLE TYPE NW Washboring ST. 22+597 N 4 987 695.1 E 344 629.1  
 DATUM Geodetic DATE 14.09.2018 - 14.09.2018  
 ORIGINATED BY AC  
 COMPILED BY AC  
 CHECKED BY KE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)										
314.3								20	40	60	80	100											
0.0	ASPHALT (100 mm)																						
0.1	SILTY SAND trace gravel dense brown		1	SS	40		314																
313.5	FILL																						
0.8	SAND with silt compact brown		2	SS	16		313																
	FILL																						
			3	SS	28		312																
			4	SS	13																		
			5	SS	27		311																
310.5																							
3.8	SILTY SAND trace gravel dense brown to grey-brown		6	SS	34		310																
	FILL 430 mm boulder at 4.4 m		7	NQ	-																		
			8	SS	36		309																
308.5			9	SS	32																		
5.8	SAND (SP-SM) with silt trace organics compact to dense grey		10	SS	22		308																
			11	SS	34		307																
							306																
305.2																							
9.1	SILT (ML) with sand compact to very dense grey-brown		12	SS	29		305																

DOUBLE LINE ST 22+590.GPJ 2012TEMPLATE(MTO).GDT 23/8/19

Continued Next Page

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

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 18-2

2 OF 2

METRIC

GWP# 5287-14-00 LOCATION Lat: 45.028122°, Long: -78.994557° St. 22+597 N 4 987 695.1 E 344 629.1 ORIGINATED BY AC  
 HWY 118 BOREHOLE TYPE NW Washboring COMPILED BY AC  
 DATUM Geodetic DATE 14.09.2018 - 14.09.2018 CHECKED BY KE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  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					w <sub>p</sub> w   w <sub>L</sub>				
								20   40   60   80   100					20   40   60				
	Continued From Previous Page						304										
			13	SS	31								○				
							303										
			14	SS	43		302						○				
							301										
			15	SS	54		300						○				
299.0			16	SS	100/		299						○				
15.3	<b>BEDROCK</b> GRANITE fresh to slightly weathered medium to coarse grained very strong grey and pink				100 mm												
			1	RUN													
							298										
			2	RUN													
							297										
			3	RUN			296										
295.5																	
18.8	End of Borehole																

DOUBLE LINE ST 22+590.GPJ 2012TEMPLATE(MTO).GDT 23/8/19

# RECORD OF BOREHOLE No 18-3

1 OF 2

METRIC

GWP# 5287-14-00 LOCATION Lat: 45.028141°, Long: -78.994441°  
ST. 22+597 N 4 987 697.3 E 344 638.2 ORIGINATED BY AC  
HWY 118 BOREHOLE TYPE NW Washboring COMPILED BY AC  
DATUM Geodetic DATE 13.09.2018 - 13.09.2018 CHECKED BY KE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
314.2								20	40	60	80	100							
0.0	ASPHALT (100 mm)						314												
0.1																			
313.8	GRAVEL with sand		1	SS	37														
0.4	dense																		
313.4	dark grey																		
0.8	FILL																		
	SAND with silt		2	SS	51		313												
	dense																		
	brown																		
312.7	FILL																		
1.5	GRAVEL with silt and sand		3	NQ	-														
	very dense																		
	grey		4	SS	15														
	FILL																		
	ROCKFILL						312												
			5	NQ	-														
	660 mm boulder at 3 m						311												
			6	NQ	-														
			7	SS	64		310												
309.6																			
4.6	SILTY SAND some gravel																		
	dense																		
	red-brown		8	SS	38		309												
	FILL																		
308.9																			
5.3	SAND (SP-SM) with silt																		
	trace organics, wood particles																		
	loose to dense		9	SS	10														
	red-brown to grey																		
			10	SS	22		308												
							307												
306.3																			
7.9	SILT (ML) with sand																		
	compact to dense																		
	grey-brown		11	SS	21		306												
							305												
			12	SS	23														

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 18-3

2 OF 2

METRIC

GWP# 5287-14-00 LOCATION Lat: 45.028141°, Long: -78.994441°  
 HWY 118 BOREHOLE TYPE NW Washboring St. 22+597 N 4 987 697.3 E 344 638.2  
 DATUM Geodetic DATE 13.09.2018 - 13.09.2018  
 ORIGINATED BY AC  
 COMPILED BY AC  
 CHECKED BY KE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  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				W <sub>P</sub> W      W <sub>L</sub>				
								20   40   60   80   100				20   40   60				
	Continued From Previous Page						304									
			13	SS	32											
							303									
			14	SS	30											
							302									
							301									
			15	SS	45											
							300									
299.4																
14.8	<b>BEDROCK</b> GRANITE fresh to slightly weathered medium to coarse grained very strong grey with black						299									
			1	RUN											RUN #1 TCR=100% SCR=100% RQD=100%	
							298									
			2	RUN			297								RUN #2 TCR=100% SCR=100% RQD=100%	
							296									
			3	RUN											RUN #3 TCR=100% SCR=83% RQD=85%	
295.0																
19.2	End of Borehole						295									

DOUBLE LINE ST 22+590.GPJ 2012TEMPLATE(MTO).GDT 23/8/19

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

# RECORD OF BOREHOLE No 18-4

1 OF 2

METRIC

GWP# 5287-14-00 LOCATION Lat: 45.028042°, Long: -78.994291° St. 22+597 N 4 987 686.3 E 344 650.1 ORIGINATED BY SOB  
 HWY 118 BOREHOLE TYPE Portable NWT Coring COMPILED BY AC  
 DATUM Geodetic DATE 26.09.2018 - 27.09.2018 CHECKED BY KE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								20    40    60    80    100				w <sub>P</sub> w                      w <sub>L</sub>				
309.1																
0.0	STAND						309									
308.8																
0.3	SAND (SP-SM) with silt loose to compact brown		1	SS	5											
			2	SS	26											
			3	SS	13											
306.5																
2.6	SILT (ML) compact to dense grey-brown		4	SS	20											
			5	SS	16											
			6	SS	16											
													</			

Continued Next Page

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

# RECORD OF BOREHOLE No 18-4

2 OF 2

METRIC

GWP# 5287-14-00 LOCATION Lat: 45.028042°, Long: -78.994291° St. 22+597 N 4 987 686.3 E 344 650.1 ORIGINATED BY SOB  
 HWY 118 BOREHOLE TYPE Portable NWT Coring COMPILED BY AC  
 DATUM Geodetic DATE 26.09.2018 - 27.09.2018 CHECKED BY KE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)						
								20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			w P w w L					
	Continued From Previous Page		2	RUN			299							0	RUN #2 TCR=100% SCR=100% RQD=100%		
	<b>BEDROCK</b> GRANITE fresh to slightly weathered coarse grained very strong grey		3	RUN	298									0			
																0	
																	1
																	0
296.8						297								0	RUN #3 TCR=100% SCR=100% RQD=100%		
12.3	End of Borehole																
	A half-weight (32 kg) drop hammer was used to advance the split-spoon sampler. The N values presented have been adjusted to provide an equivalent N value that would have been obtained with a standard 64 kg hammer.																
	Water levels in 19 mm diameter standpipe: 27/09/2018 at 0.0 mbgs (el. 308.8 m) 29/09/2018 at 0.4 mbgs (el. 308.4 m )																



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



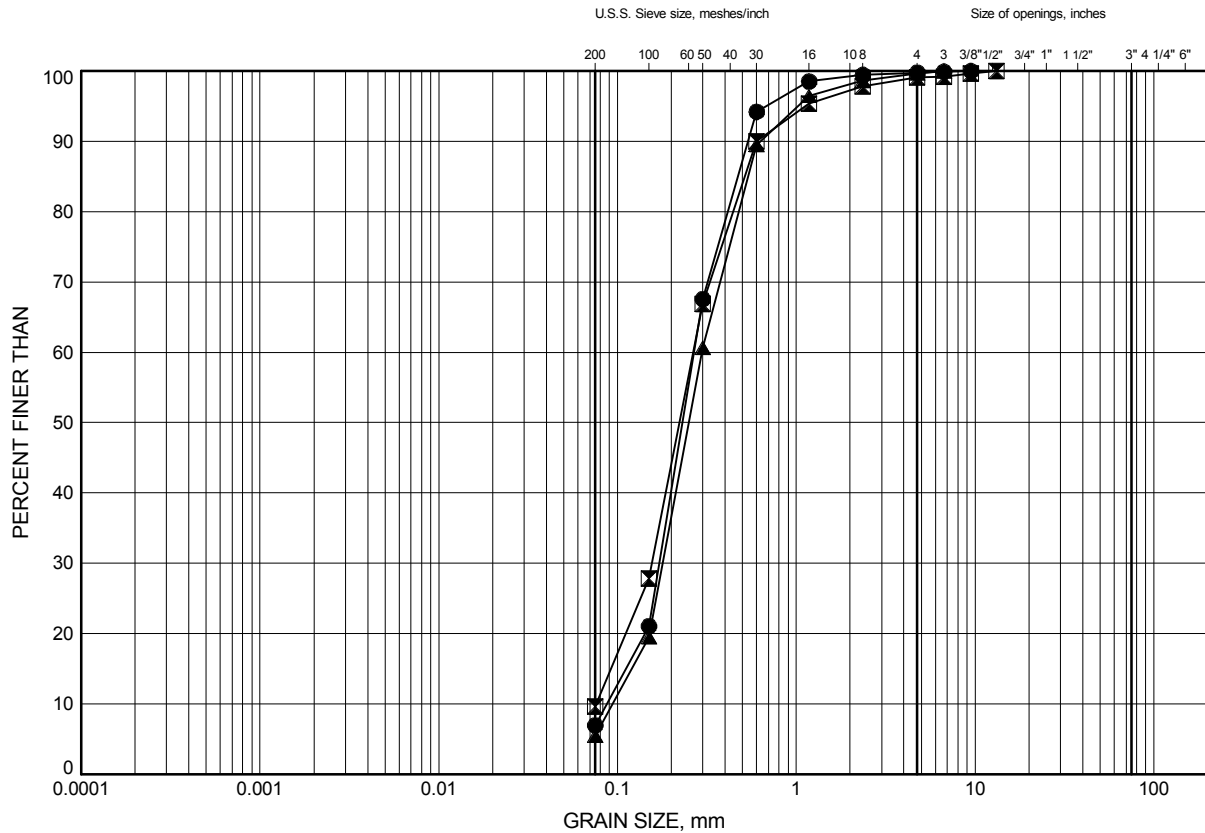
**Appendix C.1**  
**Particle Size Analysis Figures**



# HWY 118 Culverts Station 22+597 GRAIN SIZE DISTRIBUTION

FIGURE C2

## SAND (SP-SM) to SILTY SAND (SM)



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-2	7.9	306.4
⊠	18-3	5.6	308.6
▲	18-4	0.9	307.9

Date ..October 2018.....  
GWP# ..5287-14-00.....

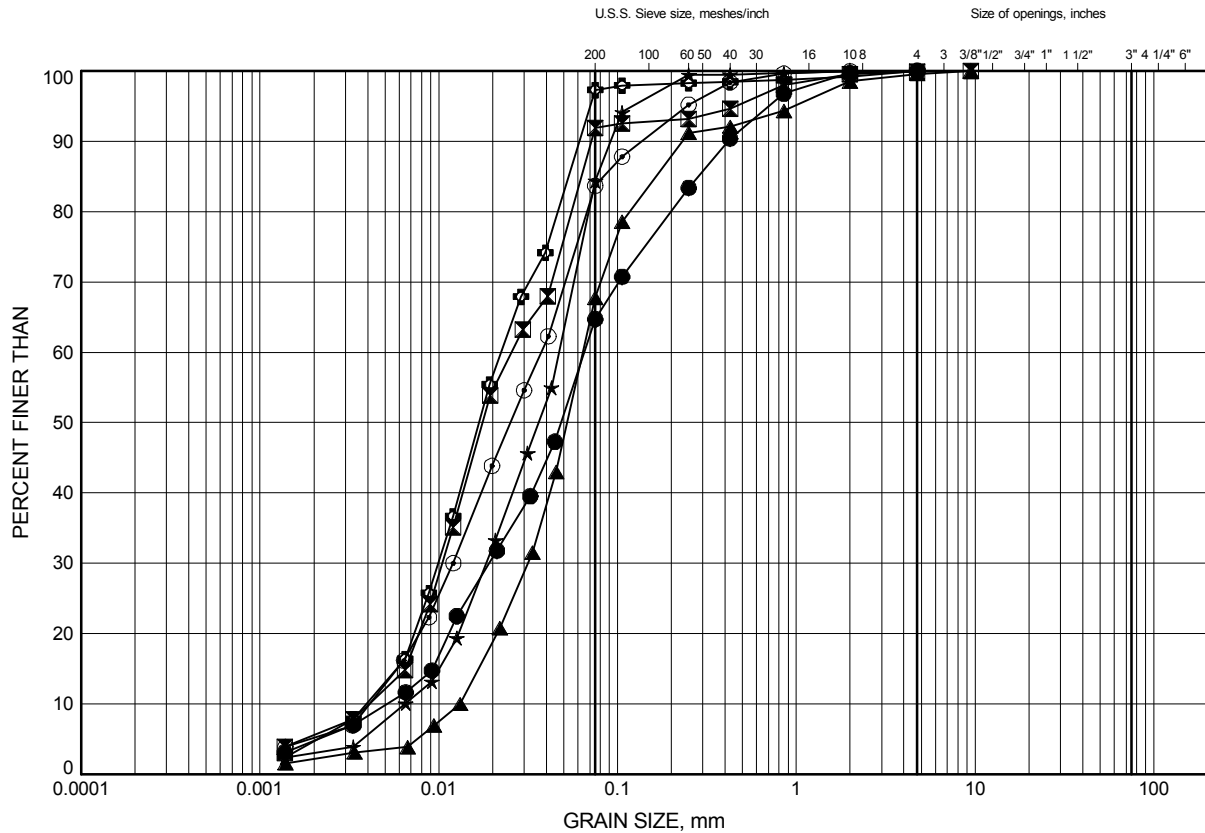


Prep'd .....AC.....  
Chkd. ....KE.....

# HWY 118 Culverts Station 22+597 GRAIN SIZE DISTRIBUTION

FIGURE C3

### SILT (ML) to SANDY SILT (ML)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-1	2.5	305.9
⊠	18-1	4.9	303.5
▲	18-1	7.9	300.5
★	18-2	12.5	301.8
⊙	18-3	8.1	306.1
⊕	18-4	6.4	302.4

Date ..October 2018.....

GWP# ..5287-14-00.....



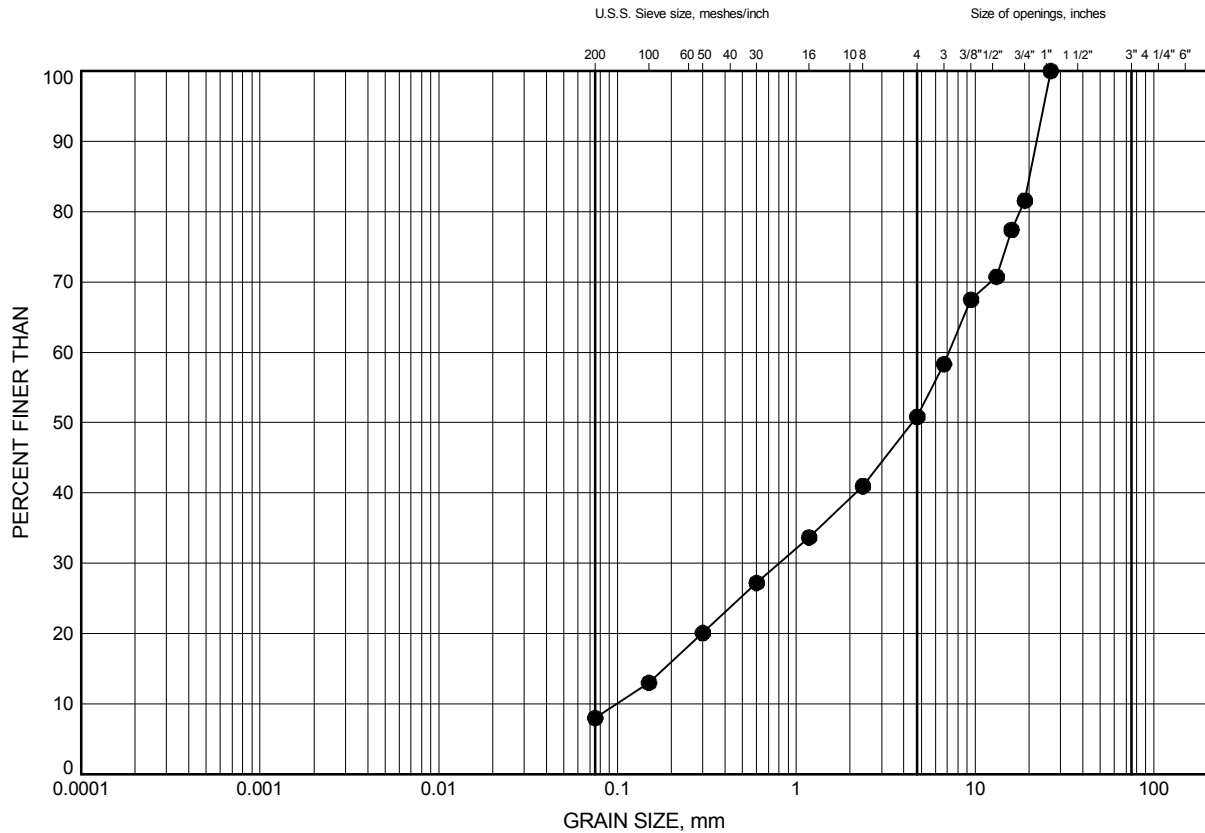
Prep'd .....AC.....

Chkd. ....KE.....

HWY 118 Culverts Station 22+597  
**GRAIN SIZE DISTRIBUTION**

FIGURE C4

**GRAVEL (GW-GM) with silt and sand**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-4	7.9	300.9

Date ..October 2018.....  
 GWP# ..5287-14-00.....



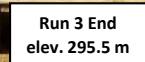
Prep'd .....AC.....  
 Chkd. ....KE.....



## **Appendix C.2**

### **Rock Core Photos**

**Elevation 299.0 m to 295.5 m**



Project No.: 20244

**Borehole 18-3**  
**Run 1 to 3 (of 3)**  
**Elevation 299.4 m to 295.0 m**

Run 1 Start  
elev. 299.4 m

Run 2 Start  
elev. 298.0 m

Run 3 Start  
elev. 296.5 m

Run 1 End  
elev. 298.0 m

Run 2 End  
elev. 296.5 m

Run 3 End  
elev. 295.0 m



**THURBER** ENGINEERING LTD.

**Foundation Investigation**  
**Hwy 118 Culverts St. 22+597**  
**Foundations**

**GWP: 5287-14-00**

**Project No.: 20244**

**Borehole 18-4**  
**Run 1 to 3 (of 3)**  
**Elevation 300.2 m to 296.8 m**





## **Appendix C.3**

### **Analytical Testing Results**



## Certificate of Analysis

### Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104  
Ottawa, ON K1B 4S5  
Attn: Katya Edney

Client PO: 20244  
Project: HWY11+118  
Custody: 39863

Report Date: 9-Oct-2018  
Order Date: 2-Oct-2018

**Order #: 1840220**

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

Paracel ID	Client ID
1840220-01	18+550 18-1 SS3 5'6"-6'2"
1840220-02	18+550 18-4 SS2 3-5
1840220-03	18+875 18-4 SS1 2'6"-4'6"
1840220-04	11+490 18-4 SS3 5-7
1840220-05	22+590 18-1 SS2 4-6
1840220-06	22+590 18-4 SS3 6-8'

*Note: Depths shown in lab results are measured from top of the drilling platform which is not shown in the Record of Borehole Sheets. Platform height measured 0.5 m and 0.3 m for Boreholes 18-1 and 18-4, respectively.*

Approved By:



Mark Foto, M.Sc.  
Lab Supervisor

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 20244

Report Date: 09-Oct-2018

Order Date: 2-Oct-2018

Project Description: HWY11+118

### Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	5-Oct-18	5-Oct-18
Conductivity	MOE E3138 - probe @25 °C, water ext	4-Oct-18	5-Oct-18
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	5-Oct-18	5-Oct-18
Resistivity	EPA 120.1 - probe, water extraction	4-Oct-18	5-Oct-18
Solids, %	Gravimetric, calculation	3-Oct-18	3-Oct-18

Certificate of Analysis  
 Client: Thurber Engineering Ltd.  
 Client PO: 20244

Report Date: 09-Oct-2018

Order Date: 2-Oct-2018

Project Description: HWY11+118

<b>Client ID:</b>	18+550 18-1 SS3 5'6"-6'2"	18+550 18-4 SS2 3-5	18+875 18-4 SS1 2'6"-4'6"	11+490 18-4 SS3 5-7
<b>Sample Date:</b>	09/23/2018 09:00	09/22/2018 09:00	09/20/2018 09:00	09/28/2018 09:00
<b>Sample ID:</b>	1840220-01	1840220-02	1840220-03	1840220-04
<b>MDL/Units</b>	Soil	Soil	Soil	Soil

**Physical Characteristics**

% Solids	0.1 % by Wt.	85.4	79.7	90.5	82.8
----------	--------------	------	------	------	------

**General Inorganics**

Conductivity	5 uS/cm	347	117	124	225
pH	0.05 pH Units	7.47	5.65	6.26	6.22
Resistivity	0.10 Ohm.m	28.8	85.1	80.9	44.5

**Anions**

Chloride	5 ug/g dry	211	55	19	124
Sulphate	5 ug/g dry	10	21	6	7

<b>Client ID:</b>	22+590 18-1 SS2 4-6	22+590 18-4 SS3 6-8'	-	-
<b>Sample Date:</b>	09/25/2018 09:00	09/26/2018 09:00	-	-
<b>Sample ID:</b>	1840220-05	1840220-06	-	-
<b>MDL/Units</b>	Soil	Soil	-	-

**Physical Characteristics**

% Solids	0.1 % by Wt.	86.5	85.5	-	-
----------	--------------	------	------	---	---

**General Inorganics**

Conductivity	5 uS/cm	302	15	-	-
pH	0.05 pH Units	6.44	5.59	-	-
Resistivity	0.10 Ohm.m	33.1	653	-	-

**Anions**

Chloride	5 ug/g dry	168	<5	-	-
Sulphate	5 ug/g dry	11	<5	-	-

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 20244

Report Date: 09-Oct-2018

Order Date: 2-Oct-2018

Project Description: HWY11+118

### 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: 20244

Report Date: 09-Oct-2018

Order Date: 2-Oct-2018

Project Description: HWY11+118

### Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	205	5	ug/g dry	211			2.7	20	
Sulphate	9.29	5	ug/g dry	9.98			7.2	20	
<b>General Inorganics</b>									
Conductivity	364	5	uS/cm	347			4.6	6.2	
pH	11.69	0.05	pH Units	11.61			0.7	10	
Resistivity	27.5	0.10	Ohm.m	28.8			4.6	20	
<b>Physical Characteristics</b>									
% Solids	90.9	0.1	% by Wt.	94.3			3.8	25	

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 20244

Report Date: 09-Oct-2018

Order Date: 2-Oct-2018

Project Description: HWY11+118

### Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	308	5	ug/g	211	97.2	78-113			
Sulphate	110	5	ug/g	9.98	100	78-111			

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 20244

Report Date: 09-Oct-2018  
Order Date: 2-Oct-2018  
Project Description: HWY11+118

**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.

## Subcontracted Analysis

**Thurber Engineering Ltd.**2460 Lancaster Rd, Suite 104  
Ottawa, ON K1B 4S5  
Attn: Katya EdneyTel: (613) 247-2121  
Fax: (613) 247-2185Paracel Report No: **1840220**  
Client Project(s): **HWY11+118**  
Client PO: **20244**  
Reference: **Standing Offer**  
CoC Number: **39863**Order Date: 02-Oct-18  
Report Date: 9-Oct-18

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor's report is attached

Paracel ID	Client ID	Analysis
1840220-01	18+550 18-1 SS3 5'6"-6'2"	Sulphide, solid
1840220-02	18+550 18-4 SS2 3-5	Sulphide, solid
1840220-03	18+875 18-4 SS1 2'6"-4'6"	Sulphide, solid
1840220-04	11+490 18-4 SS3 5-7	Sulphide, solid
1840220-05	22+590 18-1 SS2 4-6	Sulphide, solid
1840220-06	22+590 18-4 SS3 6-8'	Sulphide, solid

*Note: Depths shown in lab results are measured from top of the drilling platform which is not shown in the Record of Borehole Sheets. Platform height measured 0.5 m and 0.3 m for Boreholes 18-1 and 18-4, respectively.*



**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.  
Lakefield - Ontario - K0L 2H0  
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10-October-2018

**Date Rec. :** 04 October 2018  
**LR Report:** CA12131-OCT18  
**Reference:** Project#:1840220

**Copy:** #1

## CERTIFICATE OF ANALYSIS

### Final Report

Sample ID	Sample Date & Time	Sulphide %
1: Analysis Start Date		05-Oct-18
2: Analysis Start Time		13:35
3: Analysis Completed Date		05-Oct-18
4: Analysis Completed Time		14:36
5: QC - Blank		< 0.02
6: QC - STD % Recovery		99%
7: QC - DUP % RPD		1%
8: RL		0.02
9: 18+550 18-1 SS3 5'6"-6'2"	23-Sep-18	< 0.02
10: 18+550 18-4 SS2 3-5	22-Sep-18	< 0.02
11: 18+875 18-4 SS1 2'6"-4'6"	20-Sep-18	< 0.02
12: 11+490 18-4 SS3 5-7	28-Sep-18	< 0.02
13: 22+590 18-1 SS2 4-6	25-Sep-18	< 0.02
14: 22+590 18-4 SS3 6-8'	26-Sep-18	< 0.02

RL - SGS Reporting Limit

Kimberley Didsbury  
Project Specialist  
Environmental Services, Analytical



## **Appendix D.**

### **Site Photographs**



**Photo 1. Looking Northwest at Culvert 22+597 Inlet (2018/09/27). Note, surface water was from drilling operations.**



**Photo 2. Looking Southeast at Culvert 22+597 Outlet (2018/09/26)**



**Photo 3. Looking West on HWY 118 (2018/09/14)**





Photo 4. Looking East on HWY 118 (2018/09/14)