



**THURBER** ENGINEERING LTD.

**FINAL  
FOUNDATION INVESTIGATION REPORT  
HIGHWAY 118 CULVERT STA. 18+874, DRAPER TOWNSHIP  
ASSIGNMENT NO. 5017-E-0003**

**G.W.P. 5287-14-00**

Geocres No.: 31E-401

Report to:

**McIntosh Perry Consulting Engineers Limited**

Latitude: 44.993000  
Longitude: -79.194572

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Thurber File: 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 for a culvert at Sta. 18+874 on Highway 118. The culvert crossing is located approximately 150 m east of River Road within Draper 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 drawing were provided by MPCE.

**2 SITE DESCRIPTION**

For project purposes, Highway 118 will be considered to be 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. As described on the historical base plan drawings provided by MPCE, the existing culvert is a non-structural corrugated steel pipe (CSP) culvert with a diameter of 0.8 m and a length of 27.2 m. The invert of the culvert is at approximate elevation 299.8 and 297.5 m at the inlet (south) and the outlet (north), respectively. 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 some signs of corrosion

and the exposed south end of the culvert had substantial sediment and overgrowth. At the location of the culvert, Highway 118 is a two-lane highway with paved shoulders. The Highway 118 fill height above the culvert varies along its length and ranges from approximately 4.8 to 7.1 m with the road surface at approximate elevation 305.6 m. The existing embankment slopes are inclined at approximately 1.8H:1V and 1.5H:1V to the north and south, respectively. Cobbles and boulders were observed on the embankment slopes. Cable guiderails with wooden posts are present on both sides of the highway in the vicinity of the culvert. The water level in the Muskoka River, which is located 50 m northwest of the culvert outlet, is controlled by a dam at Matthiasville Falls. The land adjacent to the highway and creek alignment is densely vegetated with shrubs and predominately coniferous trees. Single family dwellings are located approximately 150 m west of the culvert on River Road. Bedrock outcrops and rock cuts are present within close proximity to the culvert site. Overhead utility lines run parallel to the south side of the highway. Traffic volumes on this section of Highway 118 are understood to be 4,300 AADT (2016).

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 September 18<sup>th</sup> and 20<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 in Appendix A, the individual Record of Borehole sheets in Appendix B and in 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 top of the south end of the culvert which has an elev. 300.792 m, 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 below the Existing Ground Surface (m)</b>
18-1	Near Culvert Outlet	4 983 722.8	328 868.7	295.3	4.1
18-2	Westbound Lane HWY 118	4 983 707.6	328 878.9	305.6	10.8
18-3	Eastbound Lane HWY 118	4 983 704.8	328 886.2	305.6	13.0
18-4	Near Culvert Intlet	4 983 693.8	328 888.6	300.5	4.3

Soil samples were obtained at selected 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 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 for the on-road boreholes and no correction was necessary. All boreholes 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 traveling 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 18-2 and 18-4 was selected and submitted for analytical testing of corrosivity parameters. Select rock core samples underwent unconfined compression strength testing. 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 over sand and silt fill layers overlying deposits of organic silt over glacial till. Granite bedrock was encountered at varying elevations within the depth of investigation in all boreholes.

### **5.1 Embankment**

#### **5.1.1 Asphalt**

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

#### **5.1.2 Silty Sand with Gravel (Fill)**

Below the asphalt in Boreholes 18-2 and 18-3 was a pavement granular layer consisting of silty sand with gravel. The thickness of this fill was at 0.5 m with a base elevation of 305.0 m.

The SPT tests conducted in the fill gave N-values of 23 and 54 blows, indicating a relative density of compact to very dense. Recorded moisture contents were 5 and 6%.

#### **5.1.3 Sand with Silt (Fill)**

Below the silty sand with gravel fill in Boreholes 18-2 and 18-3 was a fill layer consisting of sand with silt. Cobbles and boulders were encountered below a depth of 2.1 m in Borehole 18-3. Coring was required to get through this layer containing cobbles and boulders. The thickness of the fill ranged from 3.1 to 3.4 m with an underside depth of 3.7 to 4.0 m below

the existing roadway surface (elev. 301.9 to 301.6 m) in Boreholes 18-2 and 18-3, respectively.

The SPT tests conducted in the sand with silt fill gave N-values of 8 to 59 blows, indicating a relative density of loose to very dense.

Recorded moisture contents ranged from 12 to 19%. The results of a grain size analysis conducted on one sample of the sand fill indicated this material to consist of 1% gravel, 93% sand and 6% fines. These results are illustrated on Figure C1 in Appendix C.

#### **5.1.4 Silt with Sand (Fill)**

A layer of fill consisting of silt with sand with trace to some organics was encountered below the sand fill in Boreholes 18-2 and 18-3. The silt fill was 2.4 to 1.3 m thick with an underside depth at 6.1 and 5.3 m below the existing roadway surface (elev. 299.5 and 300.3 m) in Boreholes 18-2 and 18-3, respectively.

The SPT tests conducted in the silt with sand fill gave N-values ranging from 7 to 23 blows, indicating a relative density of loose to compact.

Recorded moisture contents ranged from 12 to 35%. The results of a grain size analysis conducted on one sample of the silt fill indicated this material to consist of 1% gravel, 28% sand, 68% silt and 3% clay. These results are also illustrated on Figure C1 in Appendix C.

An Atterberg Limit test was completed on one sample of the silt with sand fill and indicated that the material is non-plastic.

## **5.2 Organic Sandy Silt (OL)**

A native deposit of organic sandy silt was encountered below the silt fill in Boreholes 18-2 and 18-3. The organic sandy silt deposit was 0.9 to 1.4 m thick with an underside depth at 7.0 and 6.7 m below the existing roadway surface (elev. 298.6 and 298.9 m) in Boreholes 18-2 and 18-3, respectively.

SPT tests conducted in the organic sandy silt gave N-values ranging from 5 to 6 blows, indicating a loose relative density.

Recorded moisture contents of the organic sandy silt ranged from 33 to 54%. The results of a grain size analysis conducted on one sample of the organic silt indicated this material to consist of 1% gravel, 34% sand, 58% silt and 7% clay. These results are illustrated on Figure C2 in Appendix C.

An Atterberg Limit test was completed on one sample of the organic sandy silt deposit and indicated that the material is non-plastic. Organic contents were measured at 10.5 and 10.8%.

### 5.3 Gravel (GP) with Sand to Gravel (GW-GM) with Silt and Sand

A deposit of gravel with sand and varying amounts of silt was encountered at surface in off-road Boreholes 18-1 and 18-4. The gravel deposit was 1.0 m thick with underside elevations of 294.3 and 299.5 m below the ground surface in Boreholes 18-1 and 18-4, respectively.

The SPT tests conducted in this layer gave N-values of 11 and 30 blows, indicating a relative density of compact. Blow counts of over 100 were encountered just above the bedrock surface.

The moisture content of the samples tested ranged from 7 to 11%. The results of grain size analyses conducted on two samples of the gravel are summarized in the table below and are illustrated on Figure C3 in Appendix C.

Soil Particle	Percentage (%)
Gravel	53 – 57
Sand	37 – 44
Silt	3 – 6
Clay	

### 5.4 Silty Sand (SM) with Gravel – (Glacial Till)

A deposit of glacial till consisting of silty sand with gravel was encountered below the organic silt in Borehole 18-3. Frequent cobbles and boulders were encountered throughout the till deposit and coring techniques were required to advance through the layer. The thickness of this layer was 2.7 m with an underside elevation at 296.2 m.

A SPT test conducted in the till deposit gave an N-value of 45 blows, indicating a dense relative density.

Recorded moisture contents ranged from 6 to 13%. The results of a grain size analysis conducted on one sample of the till indicated this material to consist of 13% gravel, 55% sand and 32% fines. An additional grain size analysis conducted on sample of the lower till indicated the lower material to consist of 62% gravel, 33% sand, 5% fines, however, it has been assumed that part of the fines and sand have been washed away with the introduction of water through coring techniques. These results are illustrated on Figure C4 in Appendix C.

## 5.5 Bedrock

Bedrock was proven by coring in all boreholes. A summary of the bedrock surface is summarized in Table 5-1.

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

Borehole No.	Depth to Bedrock (m) below existing ground surface	Bedrock Elevation (m)
18-1	1.0	294.3
18-2	7.0	298.6
18-3	9.4	296.2
18-4	1.0	299.5

The bedrock was slightly weathered to fresh granite. The Total Core Recovery (TCR) measured on the recovered bedrock core ranged from 74 to 100%, the Solid Core Recovery (SCR) ranged from 64 to 100% and the Rock Quality Designation (RQD) ranged from 66 to 100%. Based on the measured RQD values, the bedrock is classified as fair to excellent in quality (Table 3.10, Canadian Foundation and Engineering Manual 006).

Unconfined Compressive Strength (UCS) testing was carried out on two samples of the intact bedrock. The results of UCS testing carried out on the rock core ranged from 76 to 128 MPa, indicating the intact granite bedrock to be strong to very strong. 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 coring operations. The groundwater water level measured in the standpipe piezometer installed in Borehole 18-4 was recorded at a depth of 0.1 m below the ground surface (elev. 300.4 m) 9 day after completion of installation on September 29, 2018. The culvert was dry at the time of the drilling investigation.

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 encountered at the site were submitted for analysis of pH, water soluble sulphate and chloride concentrations, resistivity, and sulphide content. The

analysis results are summarized in the Table 5-2. 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 (%)
18-2 (SS8)	5.3 – 5.9	70	4.82	745	1,340	1,260	< 0.02
18-4 (SS1)	0.0 – 0.6	6	6.26	8,090	124	19	< 0.02



## 6 MISCELLANEOUS

Borehole locations were selected by Thurber relative to existing site features and the anticipated culvert location. The as-drilled locations and ground surface elevation of the boreholes were measured by Thurber following completion of the field program. 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 and shoulder 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. Organic content and UCS testing was completed by Stantec's laboratory in Ottawa, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa, Ontario. Interpretation of the factual data and preparation of this report were carried out by, 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.

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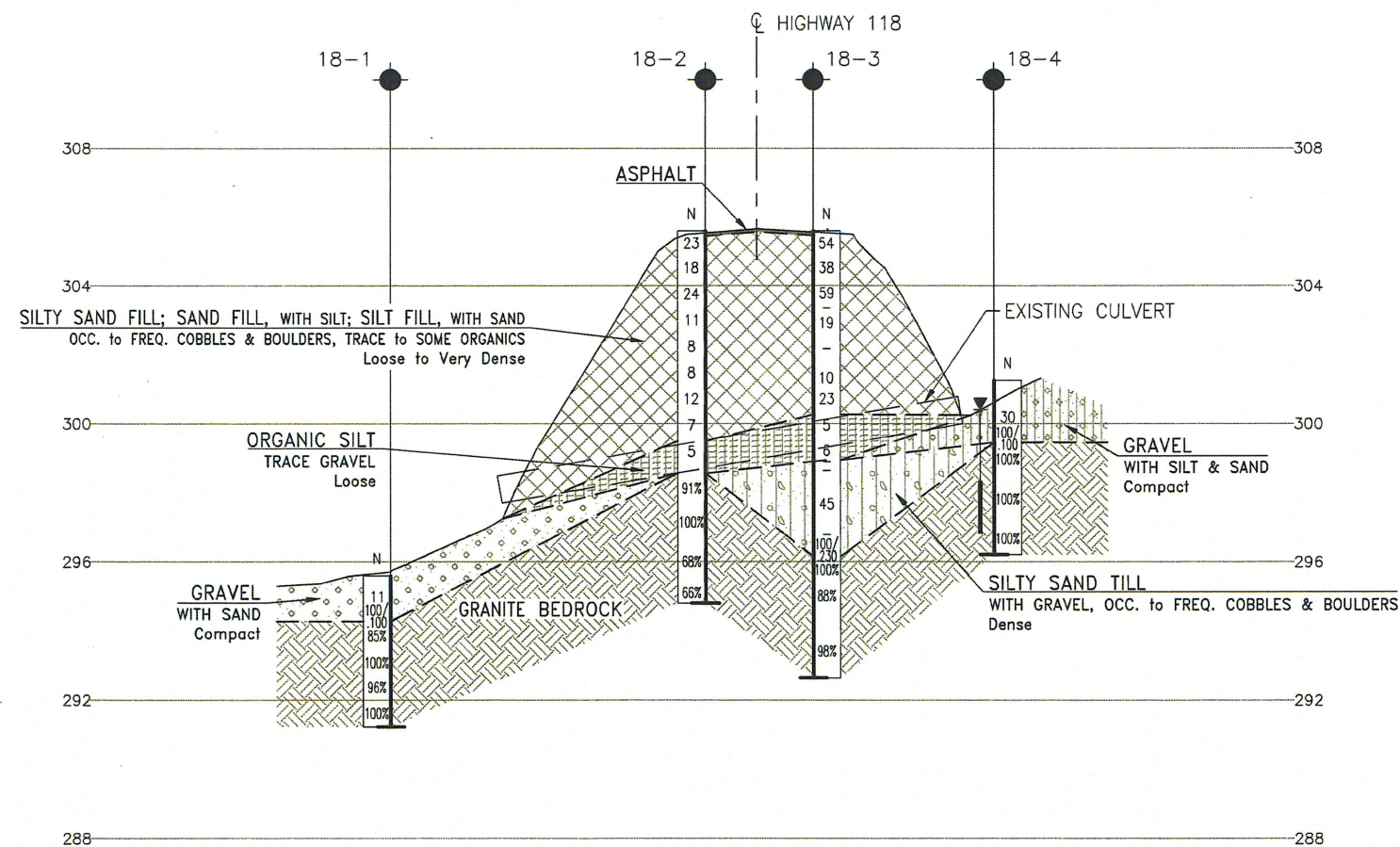
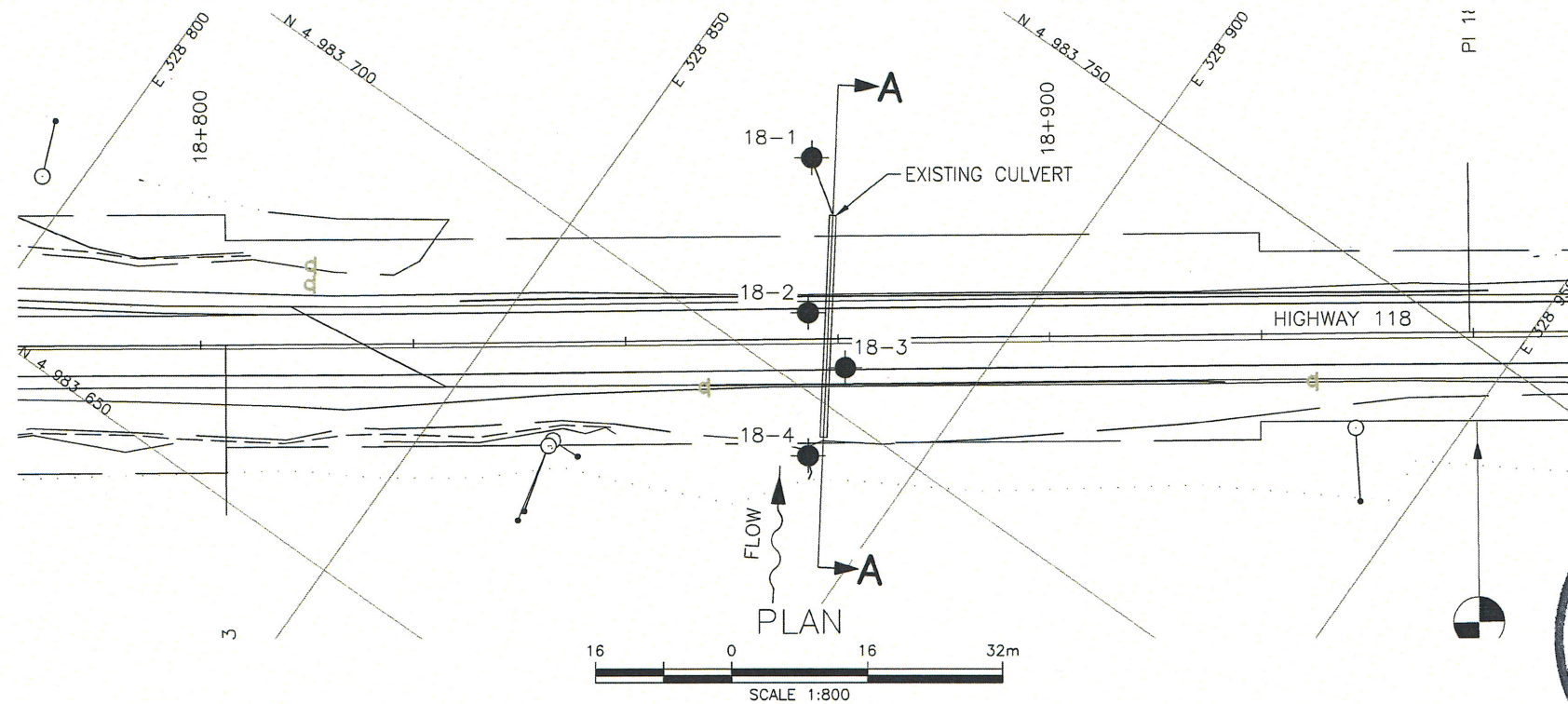




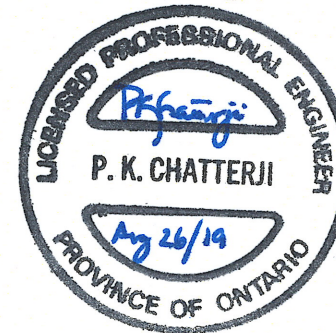
## **Appendix A.**

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





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



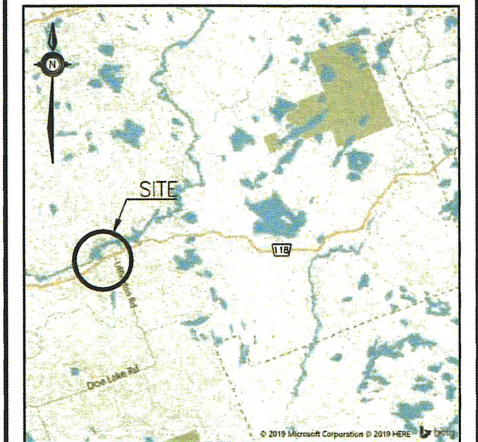
CONT No  
GWP No 5287-14-00

HIGHWAY 118  
STATION 18+874  
CULVERT REPLACEMENT  
BOREHOLE LOCATIONS AND SOIL STRATA

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

NO	ELEVATION	NORTHING	EASTING
18-1	295.3	4 983 722.8	328 868.7
18-2	305.6	4 983 707.6	328 878.9
18-3	305.6	4 983 704.8	328 886.2
18-4	300.5	4 983 693.8	328 888.6

-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-401

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





## **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 1

METRIC

GWP# 5287-14-00 LOCATION Lat: 44.993085°, Long: -79.194747° St. 18+874 N 4 983 722.8 E 328 868.7 ORIGINATED BY SOB  
HWY 118 BOREHOLE TYPE Portable NWT Coring COMPILED BY AC  
DATUM Geodetic DATE 18.09.2018 - 19.09.2018 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
295.6														
0.0	STAND													
295.3														
0.3	GRAVEL (GP) with sand compact brown		1	SS	11		295							53 44 3 (SI+CL)
294.3			2	SS	100/									
1.3	BEDROCK GRANITE fresh to slightly weathered coarse grained strong to very strong pink and grey		3	NQ	100 mm		294							RUN #1 TCR=100% SCR=100% RQD=85%
			1	RUN										
			2	RUN			293							RUN #2 TCR=100% SCR=100% RQD=100% UCS=127.8MPa
			3	RUN										RUN #3 TCR=100% SCR=96% RQD=96%
			4	RUN			292							RUN #4 TCR=100% SCR=100% RQD=100%
291.2														
4.4	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.													

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

## METRIC

[illegible]

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

DOUBLE LINE ST 18+874.GPJ 2012TEMPLATE(MTO).GDT 23/8/19



# RECORD OF BOREHOLE No 18-2

2 OF 2

METRIC

GWP# 5287-14-00 LOCATION Lat: 44.992948°, Long: -79.194619°  
St. 18+874 N 4 983 707.6 E 328 878.9 ORIGINATED BY AC  
HWY 118 BOREHOLE TYPE NW Washboring COMPILED BY AC  
DATUM Geodetic DATE 18.09.2018 - 19.09.2018 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 $\gamma$ 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					WATER CONTENT (%)				
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
	Continued From Previous Page																
294.8	<b>BEDROCK</b> GRANITE fresh medium to coarse grained strong to very strong grey and pink vertical fracture from 10.6 to 10.8 m End of Borehole		4	RUN		295											
10.8																	

# RECORD OF BOREHOLE No 18-3

1 OF 2

METRIC

GWP# 5287-14-00 LOCATION Lat: 44.992922°, Long: -79.194526° St. 18+874 N 4 983 704.8 E 328 886.2 ORIGINATED BY AC  
 HWY 118 BOREHOLE TYPE NW Washboring COMPILED BY AC  
 DATUM Geodetic DATE 18.09.2018 - 18.09.2018 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 (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)					GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
305.6								20	40	60	80	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													

Continued Next Page

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

20  
15  
10

(%) STRAIN AT FAILURE

DOUBLE LINE ST 18+874.GPJ 2012TEMPLATE(MTO).GDT 23/8/19

# RECORD OF BOREHOLE No 18-3

2 OF 2

METRIC

GWP# 5287-14-00 LOCATION Lat: 44.992922°, Long: -79.194526° St. 18+874 N 4 983 704.8 E 328 886.2 ORIGINATED BY AC  
 HWY 118 BOREHOLE TYPE NW Washboring COMPILED BY AC  
 DATUM Geodetic DATE 18.09.2018 - 18.09.2018 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									
	Continued From Previous Page		2	RUN			295							0	RUN #2 TCR=95% SCR=88% RQD=88%		
														0			
														0			
														2			
														>5			
			3	RUN			294							0	RUN #3 TCR=98% SCR=98% RQD=98%		
														0			
														0			
														1			
														0			
292.6							293										
13.0	End of Borehole																

# RECORD OF BOREHOLE No 18-4

1 OF 1

METRIC

GWP# 5287-14-00 LOCATION Lat: 44.992823°, Long: -79.194496° St. 18+874 N 4 983 693.8 E 328 888.6 ORIGINATED BY SOB  
 HWY 118 BOREHOLE TYPE Portable NWT Coring COMPILED BY AC  
 DATUM Geodetic DATE 20.09.2018 - 20.09.2018 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
301.3								20	40	60	80	100		
0.0	STAND													
300.5														
0.8	GRAVEL (GW-GM) with silt and sand brown compact		1	SS	30									
299.5			2	SS	100/									
			3	NQ	100 mm									
1.8	BEDROCK GRANITE fresh coarse grained strong to very strong grey and pink		1	RUN										
			2	RUN										
			3	RUN										
296.2														
5.1	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: 29/09/2018 0.1 mbgs (elev. 300.4 m)													

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

20  
15  
10

(%) STRAIN AT FAILURE



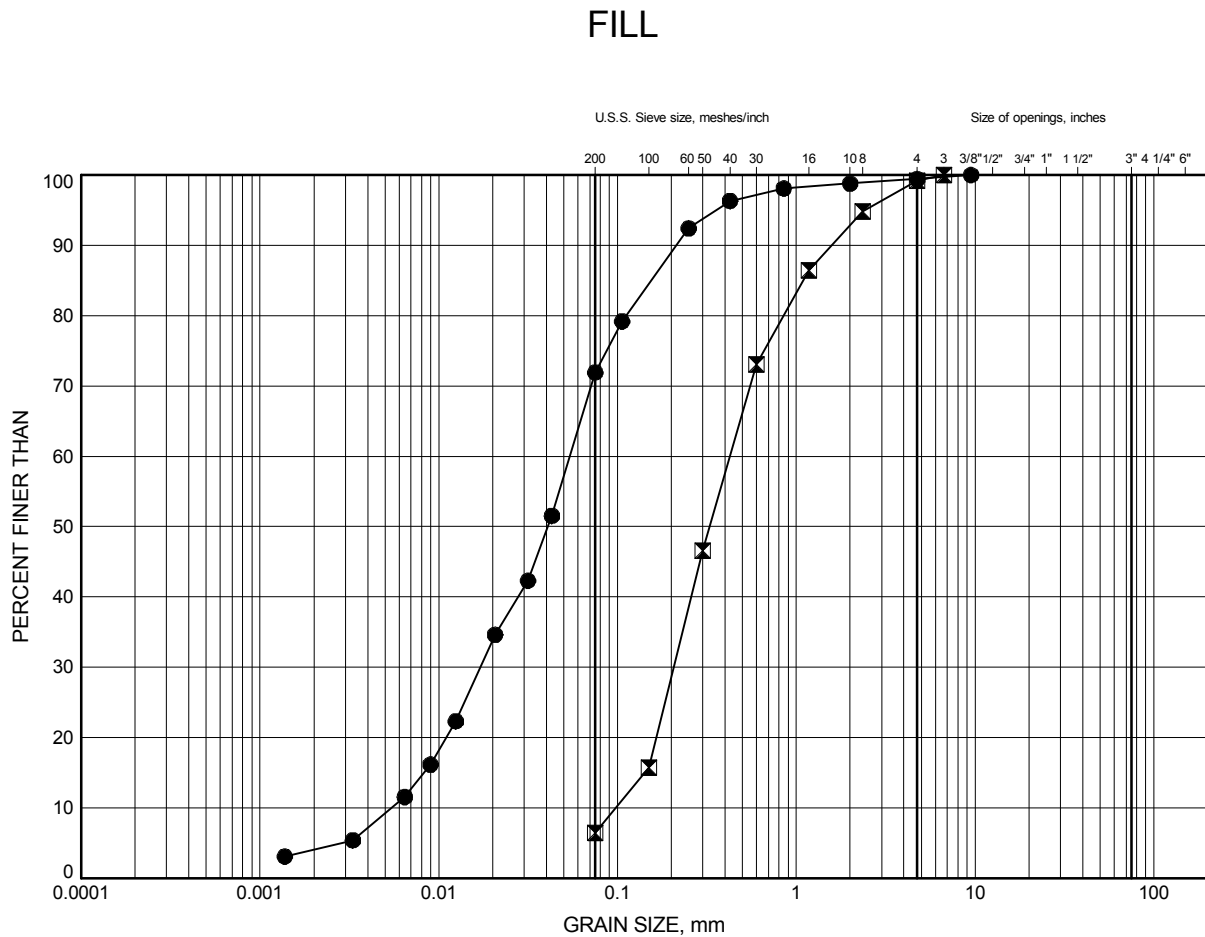
**Appendix C.**  
**Laboratory Testing**



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

# HWY 118 Culverts Station 18+874 GRAIN SIZE DISTRIBUTION

FIGURE C1



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-2	4.1	301.5
⊠	18-3	1.1	304.5

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

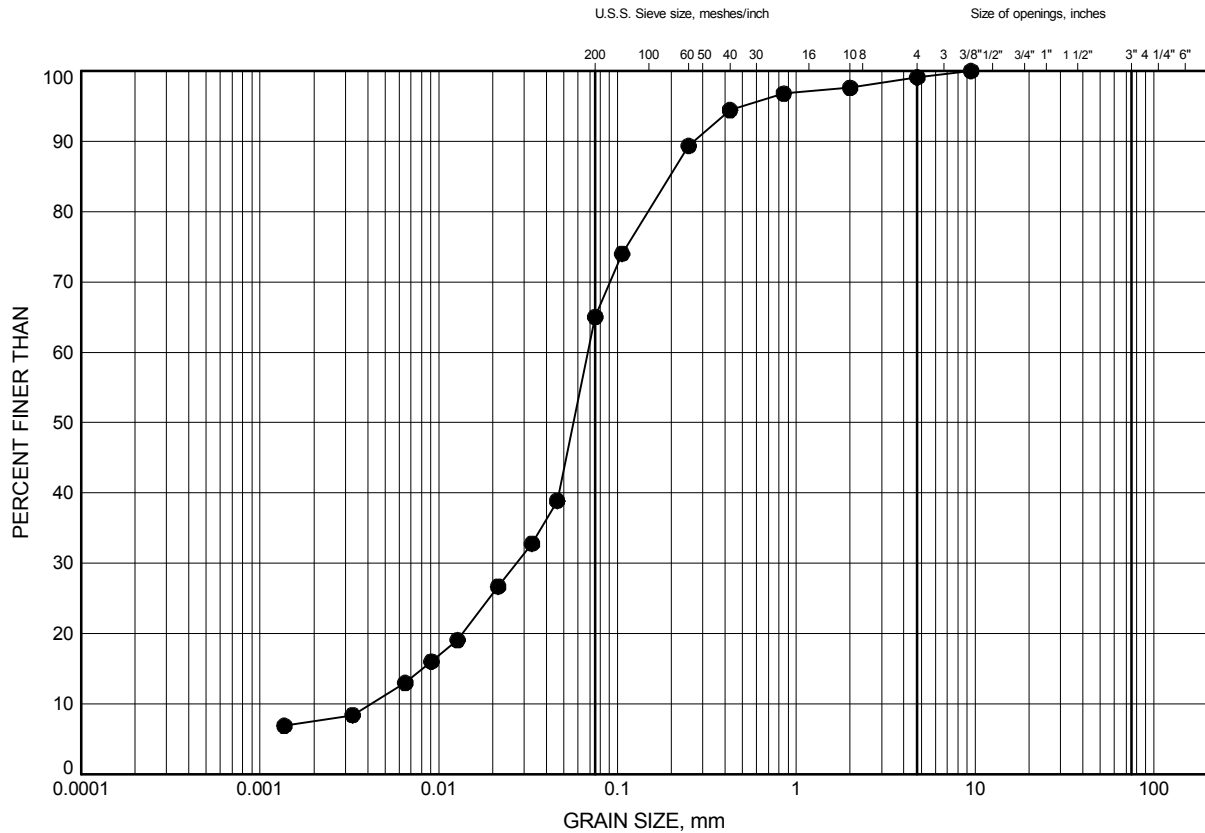


Prep'd .....AC.....  
Chkd. ....KE.....

# HWY 118 Culverts Station 18+874 GRAIN SIZE DISTRIBUTION

FIGURE C2

## ORGANIC SANDY SILT (OL)



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-3	6.4	299.2

Date November 2018  
GWP# 5287-14-00



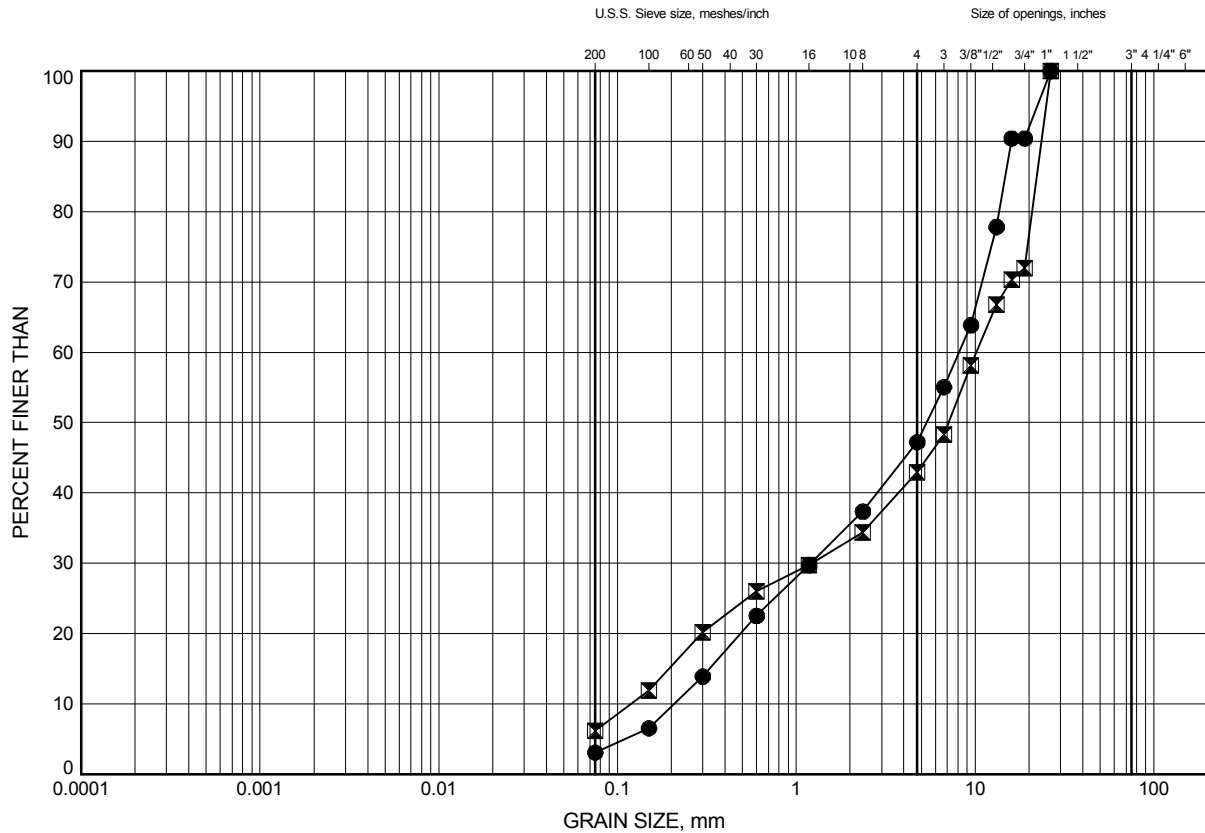
Prep'd AC  
Chkd. KE



# HWY 118 Culverts Station 18+874 GRAIN SIZE DISTRIBUTION

FIGURE C3

GRAVEL (GP) with sand to 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)
●	18-1	0.3	295.0
◻	18-4	0.9	299.6

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

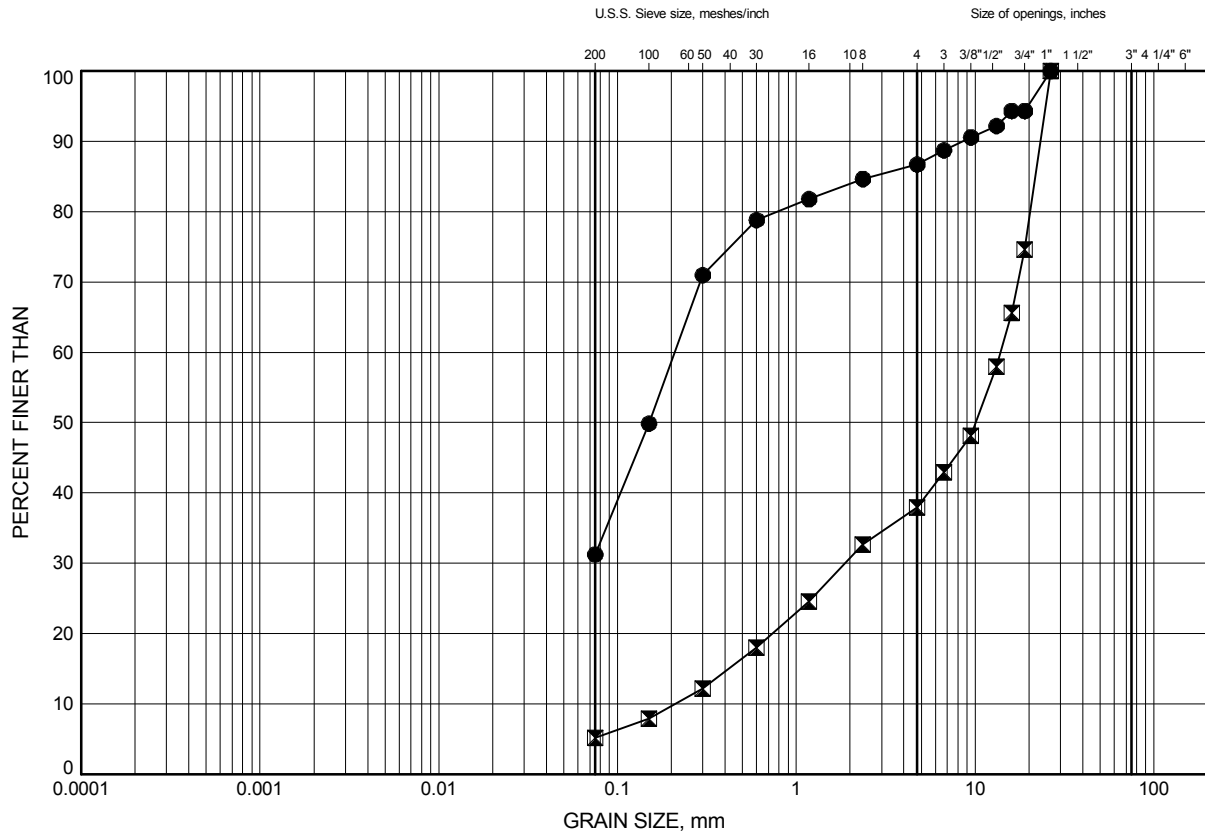


Prep'd .....AC.....  
Chkd. ....KE.....

# HWY 118 Culverts Station 18+874 GRAIN SIZE DISTRIBUTION

FIGURE C4

## SILTY SAND (SM) (GLACIAL TILL)



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-3	8.1	297.5
⊠	18-3	9.3	296.3

Date November 2018  
GWP# 5287-14-00



Prep'd KE  
Chkd. FG



**Appendix C.2**  
**Rock Core Photos**  
**Rock Testing Results**

**Borehole 18-1**  
**Run 1 to 4 (of 4)**  
**Elevation 294.3 m to 291.2 m**



**Borehole 18-2**  
**Run 1 to 4 (of 4)**  
**Elevation 298.6 m to 294.8 m**



**Borehole 18-3**  
**Run 1 to 3 (of 3)**  
**Elevation 296.2 m to 292.6 m**





**Borehole 18-4**  
**Run 1 to 3 (of 3)**  
**Elevation 299.5 m to 296.2 m**





**Stantec**

**Stantec Consulting Ltd**  
2781 Lancaster Rd, Suite 100 A&B  
Ottawa, ON K1B 1A7  
Tel: (613) 738-6075  
Fax: (613) 722-2799

October 17, 2018  
File: 122410864

**Attention:** Thurber Engineering Ltd., File #20244

**Reference:** ASTM D7012, Method C, Unconfined Compressive Strength of Intact Rock Core

The table below summarizes five (5) rock core unconfined compressive strength results.

Location	Sample Depth	Compressive Strength (MPa)	Description of Break
18+550, 18-2 Run-1	26'1"-27'1"	115.0	Diagonal Fracture with no cracking through ends
18+550, 18-4 Run-1	11'6"-12'1"	141.6	Well-formed cone on one end. Vertical crack, no well-defined cone on the other end
18+875, 18-1 Run-2	7'7"-8'1"	127.8	Well-formed cone on one end. Vertical crack, no well-defined cone on the other end
18+875, 18-4 Run-1	7'2"-7'9"	76.2	Columnar vertical crack through both ends, no well-defined cones
11+490, 18-1 Run-2	23'7"-24'3"	88.4	Columnar vertical crack through both ends, no well-defined cones

Sincerely,

**Stantec Consulting Ltd**

*Brian Prevost*

Brian Prevost  
Laboratory Supervisor  
Tel: 613-738-6075  
[brian.prevost@stantec.com](mailto:brian.prevost@stantec.com)





## **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: Hwy 11+118  
Custody: 39862

Report Date: 28-Sep-2018  
Order Date: 24-Sep-2018

**Order #: 1839096**

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

Paracel ID	Client ID
1839096-01	18+250 18-1 SS3 6-8'
1839096-02	18+250 18-4 SS3 5'6"-7-6"
1839096-03	18+875 18-2 SS8 17'6"-19'6"
1839096-04	11+490 18-01 SS3B 7-8'

Approved By:

*Mark Foto*

Mark Foto, M.Sc.  
Lab Supervisor

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

Report Date: 28-Sep-2018  
Order Date: 24-Sep-2018  
Project Description: Hwy 11+118

### Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	26-Sep-18	26-Sep-18
Conductivity	MOE E3138 - probe @25 °C, water ext	27-Sep-18	27-Sep-18
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	27-Sep-18	27-Sep-18
Resistivity	EPA 120.1 - probe, water extraction	27-Sep-18	27-Sep-18
Solids, %	Gravimetric, calculation	27-Sep-18	27-Sep-18

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

Report Date: 28-Sep-2018

Order Date: 24-Sep-2018

Project Description: Hwy 11+118

<b>Client ID:</b>		18+250 18-1 SS3 6-8'	18+250 18-4 SS3 5'6"-7-6"	18+875 18-2 SS8 17'6"-19'6"	11+490 18-01 SS3B 7-8'
<b>Sample Date:</b>		09/12/2018 09:00	09/14/2018 09:00	09/19/2018 09:00	09/16/2018 09:00
<b>Sample ID:</b>		1839096-01	1839096-02	1839096-03	1839096-04
<b>MDL/Units</b>		Soil	Soil	Soil	Soil
<b>Physical Characteristics</b>					
% Solids	0.1 % by Wt.	79.4	79.6	80.3	82.1
<b>General Inorganics</b>					
Conductivity	5 uS/cm	227	243	1340	383
pH	0.05 pH Units	5.86	5.11	4.82	5.32
Resistivity	0.10 Ohm.m	44.1	41.1	7.45	26.1
<b>Anions</b>					
Chloride	5 ug/g dry	40	104	1260	236
Sulphate	5 ug/g dry	129	62	70	24

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

Report Date: 28-Sep-2018  
Order Date: 24-Sep-2018  
Project Description: Hwy 11+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: 28-Sep-2018  
Order Date: 24-Sep-2018  
Project Description: Hwy 11+118

**Method Quality Control: Duplicate**

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	22.3	5	ug/g dry	23.2			4.1	20	
Sulphate	15.1	5	ug/g dry	15.6			3.3	20	
<b>General Inorganics</b>									
Conductivity	211	5	uS/cm	204			3.1	6.2	
pH	7.90	0.05	pH Units	7.93			0.4	10	
Resistivity	47.5	0.10	Ohm.m	48.9			3.1	20	
<b>Physical Characteristics</b>									
% Solids	79.2	0.1	% by Wt.	79.5			0.4	25	

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

Report Date: 28-Sep-2018  
Order Date: 24-Sep-2018  
Project Description: Hwy 11+118

### Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	117	5	ug/g	23.2	93.8	78-113			
Sulphate	120	5	ug/g	15.6	104	78-111			

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

Report Date: 28-Sep-2018  
Order Date: 24-Sep-2018  
Project Description: Hwy 11+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 **1839096**Client Project(s): **Hwy 11+118**Client PO: **20244**Reference: **Standing Offer**CoC Number: **39862**Order Date: 24-Sep-18  
Report Date: 27-Sep-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
1839096-01	18+250 18-1 SS3 6-8'	Sulphide, solid
1839096-02	18+250 18-4 SS3 5'6"-7-6"	Sulphide, solid
1839096-03	18+875 18-2 SS8 17'6"-19'6"	Sulphide, solid
1839096-04	11+490 18-01 SS3B 7-8'	Sulphide, solid

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.  
Lakefield - Ontario - K0L 2H0  
Phone: 705-652-2000 FAX: 705-652-6365

**Paracel Laboratories**

Attn : Dale Robertson

300-2319 St.Laurent Blvd.  
Ottawa, ON  
K1G 4K6, Canada

Phone: 613-731-9577  
Fax:613-731-9064

27-September-2018

**Date Rec. :** 25 September 2018  
**LR Report:** CA13421-SEP18  
**Reference:** Project#: 1839096

**Copy:** #1

## CERTIFICATE OF ANALYSIS

### Final Report

Sample ID	Sample Date & Time	Sulphide %
1: Analysis Start Date		27-Sep-18
2: Analysis Start Time		12:40
3: Analysis Completed Date		27-Sep-18
4: Analysis Completed Time		13:39
5: QC - Blank		< 0.02
6: QC - STD % Recovery		83%
7: QC - DUP % RPD		ND
8: RL		0.02
9: 18+250 18-1 SS3 6-8'	12-Sep-18	< 0.02
10: 18+250 18-4 SS3 5'6"-7-6"	14-Sep-18	< 0.02
11: 18+875 18-2 SS8 17'6"-19'6"	19-Sep-18	< 0.02
12: 11+490 18-01 SS3B 7-8'	16-Sep-18	< 0.02

RL - SGS Reporting Limit  
ND - Not Detected

Kimberley Didsbury  
Project Specialist  
Environmental Services, Analytical

## 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'

*Depths provided in these results are measured from the top of the drilling platform not shown on the Record of Borehole Sheet. Platform height measured 0.8 m at Borehole 18-4.*

Approved By:

*Mark Foto*

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
<b>Physical Characteristics</b>					
% Solids	0.1 % by Wt.	85.4	79.7	90.5	82.8
<b>General Inorganics</b>					
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
<b>Anions</b>					
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	-	-
<b>Physical Characteristics</b>					
% Solids	0.1 % by Wt.	86.5	85.5	-	-
<b>General Inorganics</b>					
Conductivity	5 uS/cm	302	15	-	-
pH	0.05 pH Units	6.44	5.59	-	-
Resistivity	0.10 Ohm.m	33.1	653	-	-
<b>Anions</b>					
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

Parcel 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

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.  
Lakefield - Ontario - K0L 2H0  
Phone: 705-652-2000 FAX: 705-652-6365

**Paracel Laboratories**

Attn : Dale Robertson

300-2319 St.Laurent Blvd.  
Ottawa, ON  
K1G 4K6, Canada

Phone: 613-731-9577  
Fax:613-731-9064

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 Southwest at Culvert 18+874 Outlet (2018/09/11)**





**Photo 2. Looking North at Culvert 18+874 Inlet (2018/09/11)**





**Photo 3. Looking East along HWY 118 at St. 18+874 (2018/09/19)**



**Photo 4. Looking West along HWY 118 at St. 18+874 (2018/09/18)**