THURBER ENGINEERING LTD.

FOUNDATION INVESTIGATION AND DESIGN REPORT
CULVERT 12+739 FENWICK
HIGHWAY 17 NEAR GOULAIS RIVER
SAULT STE MARIE AREA
G.W.P. 545-00-00

GEOCRES Number: 41K-101

Report

to

WSP Canada Inc.

Thurber Engineering Ltd.
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September 22, 2016
19-5308-95

THURBER

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FOUNDATION INVESTIGATION AND DESIGN REPORT
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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) of a culvert carrying drainage under Highway 17 near Goulais River, Ontario.

No previous foundation investigation information was available for the subject culvert.

The purpose of this investigation was to obtain subsurface information at the site and, based on the data obtained, to provide a model of the subsurface conditions including a borehole location plan, stratigraphic profile, records of boreholes, laboratory test results and a written description of the subsurface conditions.

Thurber was retained by WSP Canada Inc. (WSP) to carry out this foundation investigation under MTO Agreement Number 5014-E-0008.

2 SITE DESCRIPTION

The culvert site is located on Highway 17, approximately 2.8 kilometres north of the intersection of Highway 552 and Highway 17 in the Township of Fenwick. A 1.22 m diameter by 105.8 m long corrugated steel pipe culvert (CSP) is present at the site and covered with approximately 9 m of fill. The culvert provides drainage under Highway 17 and is oriented on a skew of about 45 degrees to the highway centreline. The flow in the culvert is from west to east. The invert elevation is 238.4 m at the east end and 241.5 m at the west end.

The grade of the existing Highway 17 in the vicinity of the culvert is at 250.4 m geodetic. The culvert is located within a fill section. The embankment is constructed with side slopes approximately 2.5 horizontal to 1 vertical (2.5H:1V) and approximately 3 horizontal to 1 vertical (3H:1V), corresponding to the east and west slopes respectively. The embankment slopes are

benched mid height. The lower side slopes are estimated at 2 horizontal to 1 vertical (2H:1V). The embankment fill height is approximately 12 m at the east side and approximately 8.9 m at the west side. The existing roadway includes two 3.5 m wide lanes, 2.0 m wide partially paved shoulders and 0.5 m rounding. Three cable guiderail is present on both sides of the highway. The AADT is reported to be 2650. The highway profile slopes down to the south at approximately 2.9%.

The site is located in a rural area with forests, swamps, creeks. Local topography is generally rolling. Selected photographs of the culvert site are attached in Appendix D.

The surficial geology of the area is typical of the Wisconsin glaciation. Soil cover consists primarily glaciolacustrine (clay, silt, and sand) deposits underlain by glacial till.

3 SITE INVESTIGATION AND FIELD TESTING

This borehole investigation and field testing program was carried out between January 20 and 23, 2016. The program consisted of drilling and sampling four boreholes (numbered 15-33, 15-34, 15-35, and 15-36) to depths ranging from 10.3 m to 21.9 m. Of these boreholes, one was located near the culvert inlet (15-36), one located near the culvert outlet (15-33), and two (15-34 and 15-35) were located through the embankment on opposite sides of the road near the culvert.

Prior to the start of drilling, the borehole locations were established in the field and utility clearances were obtained. The co-ordinates and elevations of the as-drilled boreholes were subsequently determined by Thurber based on elevation data provided by WSP.

A truck-mounted drill rig equipped with hollow stem augers was used to drill and sample the boreholes on the roadway, and a portable tripod drill rig was used to drill and sample the culvert inlet and outlet boreholes. Soil samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT). In-situ shear vane testing was performed in cohesive soils with an MTO N-sized vane.

Results of the field drilling and sampling are presented on the Record of Borehole sheets in Appendix B.

A member of Thurber’s technical staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, secured the recovered soil samples in labelled containers, and transported the samples to Thurber’s laboratory for further examination and testing.

The boreholes were backfilled with soil cuttings mixed with bentonite and topped to surface with the existing granular material and asphalt patch where required.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification and to Natural Moisture Content determination. Selected soil samples were subjected to Grain Size Distribution analyses (sieve and hydrometer) and Atterberg Limit testing. The results of this laboratory testing program are shown on the Record of Borehole sheets in Appendix B and on the Figures in Appendix C.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole sheets in Appendix B for details of the soil stratigraphy encountered in the boreholes. A stratigraphic profile for the culvert alignment is presented on the Borehole Locations and Soil Strata Drawing in Appendix A for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the record of boreholes governs any interpretation of the site conditions.

In general, the subsurface conditions encountered in the boreholes consist of granular fill over clay embankment fill overlying a native silty sand deposit. Bedrock was not encountered in any of the four boreholes. More detailed descriptions of the individual strata are presented below.

5.2 Sand Fill

A layer of asphalt 120 mm in thickness was encountered at ground surface in Borehole 15-35 which was drilled through the roadway. Borehole 15-34 was drilled through the westbound gravel shoulder.

Sand with gravel to sand with silt and gravel fill extended to a depth of 2.4 m to 3.2 m below the road surface. The base of the pavement structure and the underlying granular fill was encountered at elevations ranging from 246.7 to 248.3 m. Occasional cobbles were found within this layer in Borehole 15-35.

The moisture content of the fill ranged from 4% to 7%. The ground was frozen at the time of the field investigation thus the relative density of the granular could not be determined reliably.

The results of grain size analyses conducted on two samples of the granular fill are presented on Fig. No 1 in Appendix C. The results are summarized in the following table.

Soil Particles	%
Gravel	12 and 31
Sand	79 and 57
Silt and Clay	9 and 12

5.3 Embankment Clay Fill

Embankment fill was encountered below the pavement base and granular fill in Boreholes 15-34 and 15-35. The thickness of the embankment fill ranged from 6.1 to 6.7 m. The base of the embankment fill was encountered at elevations ranging from 240.5 to 241.6 m.

The embankment fill was typically observed to be layers of clay and silty clay. A 0.4 m thick layer of sand with silt fill was noted below the clay fill in Borehole 15-35.

The SPT N-value for the embankment fill ranged from 4 to 21 blows per 0.3 m penetration. In-situ shear vane test results indicated undrained shear strengths ranging from 82 kPa to greater than 106 kPa; indicating a firm to very stiff consistency. The water contents of the recovered clay to silty clay embankment fill samples ranged between 21% and 32%, while the sand with silt fill in Borehole 15-35 had a moisture content of 6%. The colour of the embankment fill is brown to reddish brown.

The results of grain size analyses conducted on four samples of the fill are presented on Fig. No 2 in Appendix C. The results are summarized in the following table.

Soil Particles	%
Gravel	0
Sand	2 to 5
Silt	58 to 85
Clay	11 to 37

Atterberg limit testing was carried out four samples of the clay to silty clay embankment fill. The samples varied and included classifications including silty clay, clay of low plasticity (CL), and clay of intermediate plasticity (CI). The results are presented on Fig. No 6 in Appendix C and summarized in the table below.

Test	%
Plastic Limit	18 to 19
Liquid Limit	26 to 39
Plasticity Index	7 to 21

5.4 Topsoil

Topsoil, 25 mm in thickness was encountered at the inlet and outlet boreholes (15-33 and 15-36). The topsoil thickness may vary between and beyond the borehole locations, and the limited data is not suitable for estimating quantities or quality. The water content of one recovered sample of topsoil was 49%.

5.5 Silty Sand

A thin silty sand deposit was encountered in both inlet and outlet boreholes. This soil was found just below the topsoil in Boreholes 15-33 and 15-36. The thickness was found to be 0.5 m and 0.9 m and the base of the layer was at elevations 240.8 m and 241.5 m.

The SPT N-value for this deposit was 6 to 7 blows per 0.3 m penetration, indicating a loose state. The water contents of the recovered samples ranged between 8% and 15%. The colour of this deposit is brown.

5.6 Silty Sandy Clay

Silty sandy clay was encountered underlying the silty sand deposit in Borehole 15-33 and Borehole 15-36 with a thickness of 1.0 m to 1.2 m and base elevation of 239.7 m and 240.3 m, respectively. The SPT N-value in the clay deposit was 3 to 6 blows per 0.3 m penetration. In-situ shear vane test results indicated undrained shear strengths of 67 kPa; indicating a stiff consistency. A sandy silt layer with trace clay was found within this deposit in Borehole 15-36. The colour of the clay is greyish brown. The water content of the recovered clay sample was 25%.

The results of grain size analyses conducted on two samples of the clay with sandy silt are presented on Fig. No 3 in Appendix C. The results are summarized in the following table.

Soil Particles	%
Gravel	1 and 0
Sand	27 and 40
Silt	53 and 51
Clay	19 and 9

Atterberg limit testing was carried out on two samples of this deposit. In one sample the liquid limit was 40% and the plasticity index was 24% and can be classified as clay of intermediate plasticity (CI). A sample containing a sandy silt layer was determined to be non-plastic. The results are presented on Fig. No 6 in Appendix C and summarized in the table below.

Test	%
Plastic Limit	16 and NP
Liquid Limit	40 and NA
Plasticity Index	24 and NA

5.7 Silty Sand with Gravel

A thin silty sand with gravel deposit was encountered in both inlet and outlet boreholes. This soil was found just below the silty sandy clay with sand deposit in Boreholes 15-33 and 15-36. The thickness was found to be 0.9 m and 0.6 m and the base elevation 238.8 m and 239.7 m.

The SPT N-value for this deposit was 16 to 18 blows per 0.3 m penetration, indicating a compact state. The water contents of the recovered samples ranged between 9% and 16%. The colour of this deposit is brown to grey.

5.8 Silt some Sand to Sand with Silt

A native soil deposit ranging from silt some sand to sand with silt was encountered in all boreholes. This soil was found below a silty sand with gravel layer in both inlet and outlet boreholes and below the embankment fill in 15-34 and 15-35. All boreholes were terminated within this deposit at elevations ranging from 232.1 m to 227.8 m. The deposit was more than 12.6 m thick in Borehole 15-34.

The SPT N-values for this deposit was 4 to greater than 100 blows per 0.3 m penetration, indicating a loose to very dense state. Typically the deposit was compact to dense. The water contents of the recovered samples ranged between 5% and 23%. The colour of this deposit is brown to greyish brown.

The results of a grain size analyse conducted on nine samples of the sandy silt are presented on Fig. No 4 and Fig. No 5 in Appendix C. The results are summarized in the following table.

Soil Particles	%
Gravel	0 to 3
Sand	12 to 93
Silt and Clay	7 to 88

5.9 Groundwater Conditions

Groundwater was not observed in the boreholes during drilling. All four boreholes were dry upon completion of drilling. In Borehole 15-36 water was observed at a depth of 2.2 m or elevation

229.9 m on January 21, one day after completion of drilling prior to backfilling. On January 20, 2016 the top of ice was observed at elevations 241.7 m and 238.0 m just outside of the culvert at the west and east ends respectively.

Where surface water is present, the groundwater level should be assumed to coincide with the local surface or creek water level. Local high water levels and the effects of heavy rainfalls must also be taken into consideration.

6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling.

Marathon Drilling Ltd. of Greely, Ontario, supplied and operated a truck-mounted CME 55 drill rig to carry out the drilling, sampling and in-situ testing operations on the existing highway platform. Ohlmann Geotechnical Services (OGS) Inc. of Almonte, Ontario, supplied and operated the portable drill rig.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. Justin Gray E.I.T. and Mr. Chris Murray E.I.T. of Thurber. Laboratory testing was carried out by Stantec (Ottawa) in its MTO-approved laboratory.

Overall project management and direction of the field program was provided by Dr. Fred Griffiths, P.Eng. Interpretation of the field data and preparation of this report was completed by Mr. Justin Gray E.I.T. and Dr. Fred Griffiths P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Justin A. Gray
Geotechnical E.I.T.

Fred J. Griffiths, P.Eng.
Senior Associate, Senior Foundations Engineer

P. K. Chatterji, P.Eng.,
Review Principal, Designated MTO Contact

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

Following the investigation and during the design stages it was determined by WSP that installing a culvert liner is sufficient to meet project needs. The culvert does not need to be replaced. Foundation recommendations are not required at this site at this time.

8 CLOSURE

Preparation of this foundation design report was carried out by Mr. Justin Gray, and Dr. Fred Griffiths P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng.

Justin A. Gray
Geotechnical E.I.T.

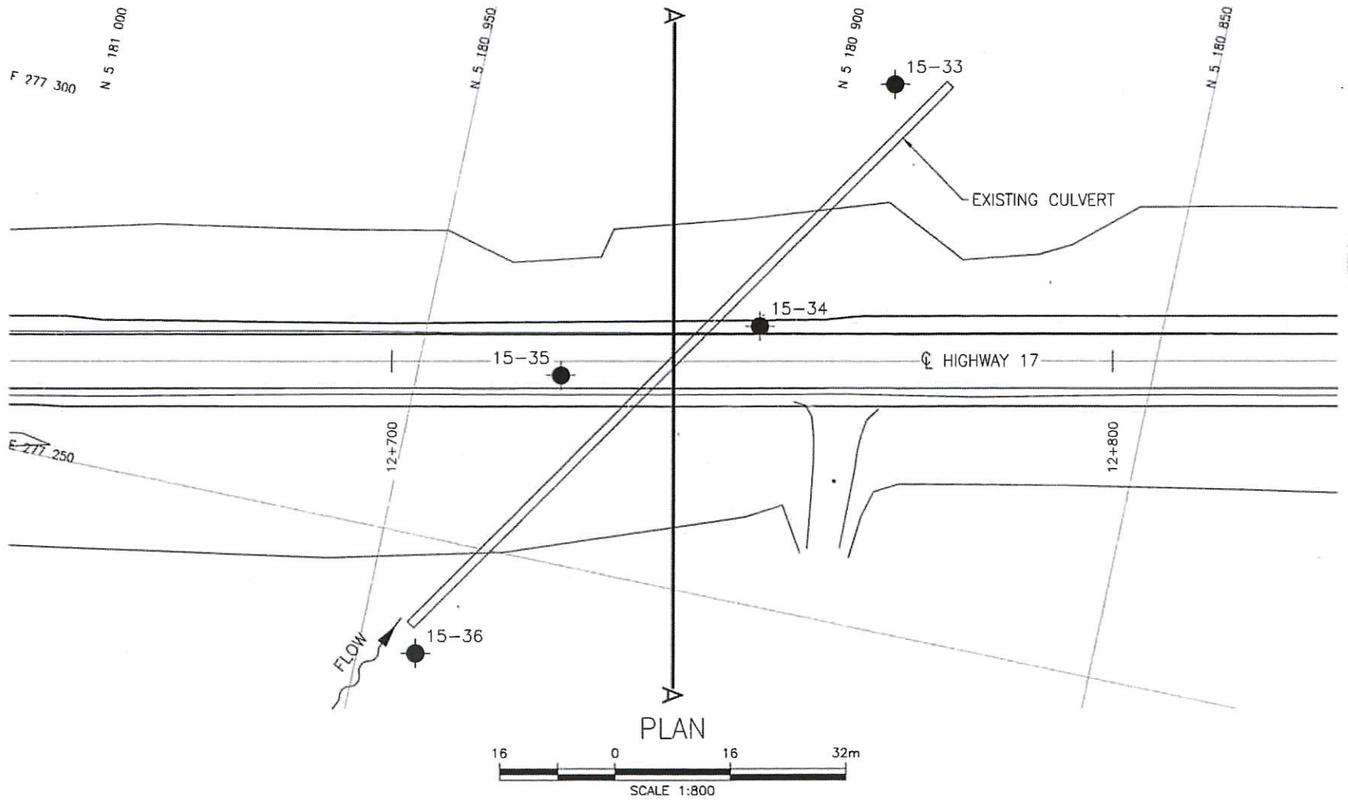
Fred J. Griffiths, P.Eng.
Senior Associate, Senior Foundations Engineer

P.K. Chatterji, P.Eng.
Principal, Designated MTO Contact

Appendix A

Borehole Locations and Soil Strata Drawings

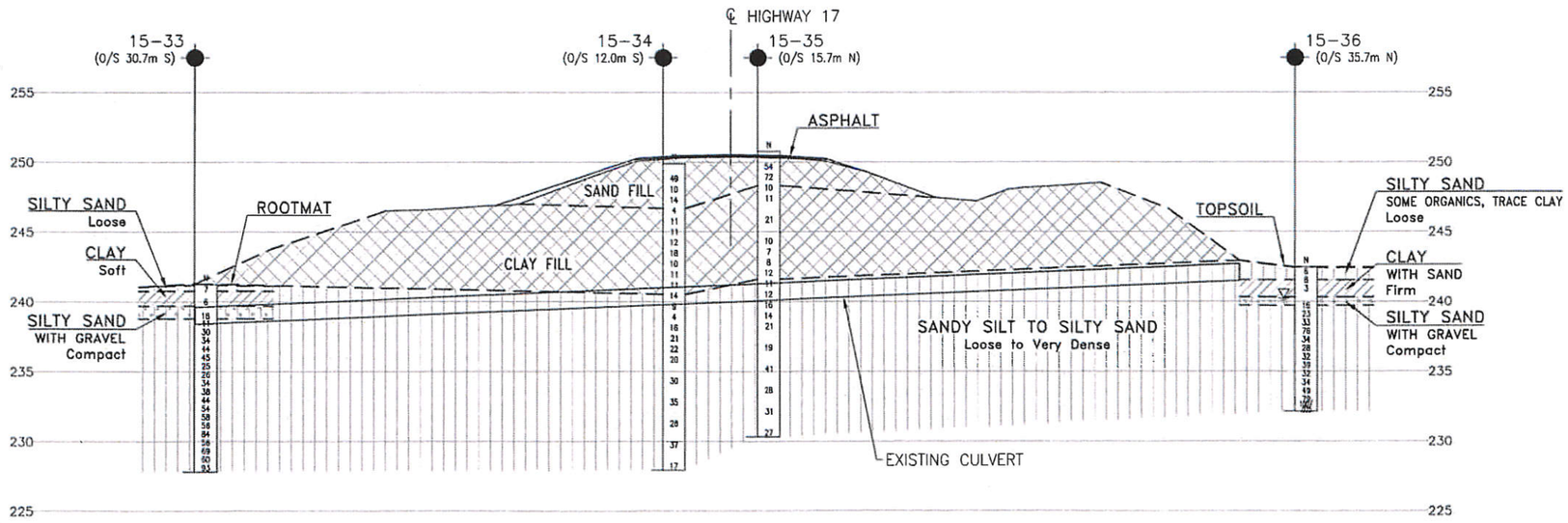
19-5308-95



PLAN

16 0 16 32m

SCALE 1:800



SECTION ALONG A-A

8 0 8 16m

SCALE 1:400

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Sep 19/2016
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
F. J. GRIFFITHS
Sept 19/16
PROVINCE OF ONTARIO

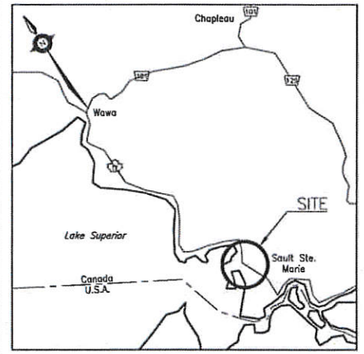
CONT No
WP No

HIGHWAY 17
12+739
CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

WSP

THURBER ENGINEERING LTD.



KEYPLAN

	LEGEND
●	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▼	Head Artesian Water
▮	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
15-33	241.2	5 180 893.5	277 324.9
15-34	249.9	5 180 904.8	277 288.2
15-35	250.8	5 180 930.4	277 275.8
15-36	242.5	5 180 942.0	277 233.9

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41K-101

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN JG	CHK -	CODE	LOAD
DRAWN MFA	CHK JG	SITE	STRUCT

DATE SEP 2016
DWG 1

FILENAME: H:\Drafting\19\5308\95\Lec0895-Plan&Profile(Culvert 70).dwg
PLOTDATE: 6/12/2016 10:43 AM

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Appendix B

Record of Borehole Sheets

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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.

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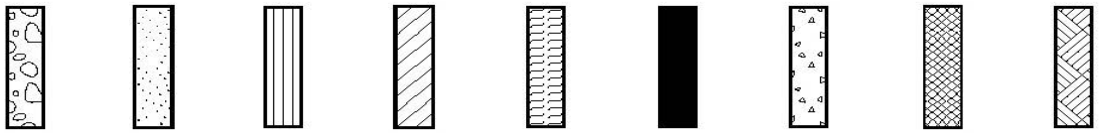
STRATA PLOT:
Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



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

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 (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.

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

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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

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EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

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

TERMS

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

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-33 1 OF 2 METRIC

GWP# 545-00-00 LOCATION Culvert 12+739, Highway 17 Goulais River N 5 180 893.5 E 277 324.9 ORIGINATED BY CAM

HWY 17 BOREHOLE TYPE Portable / Casing COMPILED BY SML

DATUM Geodetic DATE 2016.01.21 - 2016.01.22 CHECKED BY FJG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.2											
0.0	**ROOTMAT** (25 mm)										
240.8	**SILTY SAND** Loose Brown Moist		1	SS	7		241				
0.5											
	SILTY SANDY CLAY Stiff Greyish brown		2	SS	6		240				
239.7											
1.5	**SILTY SAND** with gravel Compact Brown Moist			GS							
238.8			3	SS	18		239				
2.4	**SANDY SILT** to **SAND** with silt Compact to very dense Brown to brownish grey Moist		4	SS	11						0 44 55 1
			5	SS	30		238				
			6	SS	34						
			7	SS	44		237				
			8	SS	45						
			9	SS	25		236				
			10	SS	26						0 88 12 (SI+CL)
			11	SS	34		235				
			12	SS	38						
			13	SS	44		234				
			14	SS	54						
			15	SS	58		233				
							232				

Continued Next Page

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

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

ONTMT4S 19-5308-95.GPJ 2012TEMPLATE(MTO).GDT 9/15/16

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Ontario

THURBER

RECORD OF BOREHOLE No 15-33 2 OF 2 METRIC

GWP# 545-00-00 LOCATION Culvert 12+739, Highway 17 Goulais River N 5 180 893.5 E 277 324.9 ORIGINATED BY CAM

HWY 17 BOREHOLE TYPE Portable / Casing COMPILED BY SML

DATUM Geodetic DATE 2016.01.21 - 2016.01.22 CHECKED BY FJG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	SANDY SILT to **SAND** with silt Compact to very dense Brown to brownish grey Moist		16	SS	56		231				
			17	SS	84						
			18	SS	56		230				
			19	SS	69						
			20	SS	60		229				
227.8			21	SS	93		228				
13.4	End of Borehole at 13.41 m Borehole Open Upon Completion Borehole Dry Upon Completion										

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

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

ONTMT4S 19-5308-95.GPJ 2012TEMPLATE(MTO).GDT 9/15/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-34 1 OF 3 METRIC

GWP# 545-00-00 LOCATION Culvert 12+739, Highway 17 Goulais River N 5 180 904.8 E 277 288.2 ORIGINATED BY JAG

HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SML

DATUM Geodetic DATE 2016.01.22 - 2016.01.22 CHECKED BY FJG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
249.9											
0.0	Sand with silt some gravel Dense Brown Moist **FILL**		1	AS					○		
			2	SS	49		249		○		12 79 9 (SI+CL)
248.4											
1.5	Sand with silt and gravel Compact Brown Moist **FILL**		3	SS	10		248		○		
			4	SS	14				○		
246.7							247				
3.2	Clay to Silty Clay, layered, trace organics Very Stiff Reddish Brown Moist **FILL**		5	SS	4				○		
			6	SS	11		246		⊖		0 4 75 21
			7	SS	11		245		○		
			8	SS	12				○		
			9	SS	18		244		⊖		0 4 85 11
			10	SS	10		243		○		
			11	SS	11		242		⊖		0 5 58 37
			12	SS	11				○		
240.5							241		○		
9.3	**SAND** with silt to **SILTY SAND** Loose to dense Brown to greyish brown Moist		13	SS	14		240				

Continued Next Page

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

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

ONTMT4S 19-5308-95.GPJ 2012TEMPLATE(MTO).GDT 9/15/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-34 2 OF 3 METRIC

GWP# 545-00-00 LOCATION Culvert 12+739, Highway 17 Goulais River N 5 180 904.8 E 277 288.2 ORIGINATED BY JAG

HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SML

DATUM Geodetic DATE 2016.01.22 - 2016.01.22 CHECKED BY FJG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	SAND with silt to **SILTY SAND** Loose to dense Brown to greyish brown Moist		14	SS	9						
			15	SS	4		239				3 69 28 (SI+CL)
			16	SS	16		238				
			17	SS	21		237				
			18	SS	22		236				
			19	SS	20		235				0 90 10 (SI+CL)
			20	SS	30		234				
			21	SS	35		233				
			22	SS	26		232				
							231				
							230				

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-34 3 OF 3 METRIC

GWP# 545-00-00 LOCATION Culvert 12+739, Highway 17 Goulais River N 5 180 904.8 E 277 288.2 ORIGINATED BY JAG

HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SML

DATUM Geodetic DATE 2016.01.22 - 2016.01.22 CHECKED BY FJG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT w_P w w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100			GR SA SI CL
	Continued From Previous Page										
	SAND with silt to **SILTY SAND** Loose to dense Brown to greyish brown Moist		23	SS	37				○		
							229				
227.9			24	SS	17				○		0 86 14 (SI+CL)
							228				
21.9	End of Borehole at 21.95 m Borehole Open to 20.4 m Upon Completion Borehole Dry Upon Completion										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 19-5308-95.GPJ 2012TEMPLATE(MTO).GDT 9/15/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-35 1 OF 3 METRIC

GWP# 545-00-00 LOCATION Culvert 12+739, Highway 17 Goulais River N 5 180 930.4 E 277 275.8 ORIGINATED BY JAG

HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SML

DATUM Geodetic DATE 2016.01.23 - 2016.01.23 CHECKED BY FJG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
250.8											
0.0	**ASPHALT** (120 mm)										
0.1	SAND with gravel and RAP		1	AS							
250.2											
0.6	Sand with silt and gravel, occasional cobbles Very Dense Brown Moist **FILL**		2	SS	54		250				31 57 12 (SI+CL)
			3	SS	72		249				
248.3											
2.4	Clay to Silty Clay, layered Stiff to Very Stiff Redish brown Moist **FILL**		4	SS	10		248				
			5	SS	11		247	2.0			
			6	SS	21		246				
			7	SS	10		245				
			8	SS	7		244				
			9	SS	8		243				0 2 68 30
242.1			10	SS	12		242				
8.7	Sand with silt Compact Brown, Dry **FILL**										
241.6											
9.1	**SILT** some sand to **SILTY SAND** Compact to dense Brown Moist		11	SS	11		241				0 12 83 5

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-35 2 OF 3 METRIC

GWP# 545-00-00 LOCATION Culvert 12+739, Highway 17 Goulais River N 5 180 930.4 E 277 275.8 ORIGINATED BY JAG

HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SML

DATUM Geodetic DATE 2016.01.23 - 2016.01.23 CHECKED BY FJG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60		GR SA SI CL
	Continued From Previous Page										
	SILT some sand to **SILTY SAND** Compact to dense Brown Moist		12	SS	12		240				
			13	SS	16						
			14	SS	14		239				0 43 54 3
			15	SS	21		238				
			16	SS	19		237				
			17	SS	41		236				
			18	SS	28		235				0 86 14 (SI+CL)
			19	SS	31		234				
							233				
							232				
							231				

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-35 3 OF 3 METRIC

GWP# 545-00-00 LOCATION Culvert 12+739, Highway 17 Goulais River N 5 180 930.4 E 277 275.8 ORIGINATED BY JAG

HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SML

DATUM Geodetic DATE 2016.01.23 - 2016.01.23 CHECKED BY FJG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
230.3	**SILT** some sand to **SILTY SAND** Compact to dense Brown Moist		20	SS	27				○		
20.4	End of Borehole at 20.42 m Borehole Open Upon Completion Borehole Dry Upon Completion										

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

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

ONTMT4S 19-5308-95.GPJ 2012TEMPLATE(MTO).GDT 9/15/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-36 1 OF 2 METRIC

GWP# 545-00-00 LOCATION Culvert 12+739, Highway 17 Goulais River N 5 180 942.0 E 277 233.9 ORIGINATED BY CAM

HWY 17 BOREHOLE TYPE Portable / Casing COMPILED BY SML

DATUM Geodetic DATE 2016.01.20 - 2016.01.20 CHECKED BY FJG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
242.5								20 40 60 80 100	20 40 60		
0.0	**TOPSOIL** (25 mm)		1	SS	6		242				
	SILTY SAND some organics, trace clay Loose Brown Moist to Wet		2	SS	8						1 27 53 19
241.5 0.9	**SILTY SANDY CLAY**, occasional sandy silt layers Stiff Greyish brown		3	SS	3		241	3.8			0 40 51 9
240.3 2.1	**SILTY SAND** with gravel Compact Grey					▽	240				
239.7 2.7	Wet **SILTY SAND** to **SAND** with silt Compact to Very Dense Light Brown to Brown Moist to wet		4	SS	16						
			5	SS	23		239				
			6	SS	33						
			7	SS	76		238				
			8	SS	34						
			9	SS	28		237				
			10	SS	32						
			11	SS	39		236				
			12	SS	32						
			13	SS	34		235				
			14	SS	49						0 93 7 (SI+CL)
			15	SS	79		234				
			16	SS	100/		233				

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-36 2 OF 2 METRIC

GWP# 545-00-00 LOCATION Culvert 12+739, Highway 17 Goulais River N 5 180 942.0 E 277 233.9 ORIGINATED BY CAM

HWY 17 BOREHOLE TYPE Portable / Casing COMPILED BY SML

DATUM Geodetic DATE 2016.01.20 - 2016.01.20 CHECKED BY FJG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60	γ kN/m³	GR SA SI CL
	Continued From Previous Page										
232.1	**SILTY SAND** to **SAND** with silt Compact to Very Dense Light Brown to Brown Moist to wet				25 mm						
10.3	End of Borehole at 10.31 m Borehole Dry Upon Completion Water level at 2.2 m on 2016.01.21 Borehole Open to 2.7 m on 2016.01.21 Completion										

○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

w_P PLASTIC LIMIT; w NATURAL MOISTURE CONTENT; w_L LIQUID LIMIT

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

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

ONTMT4S 19-5308-95.GPJ 2012TEMPLATE(MTO).GDT 9/15/16

Appendix C

Laboratory Test Results

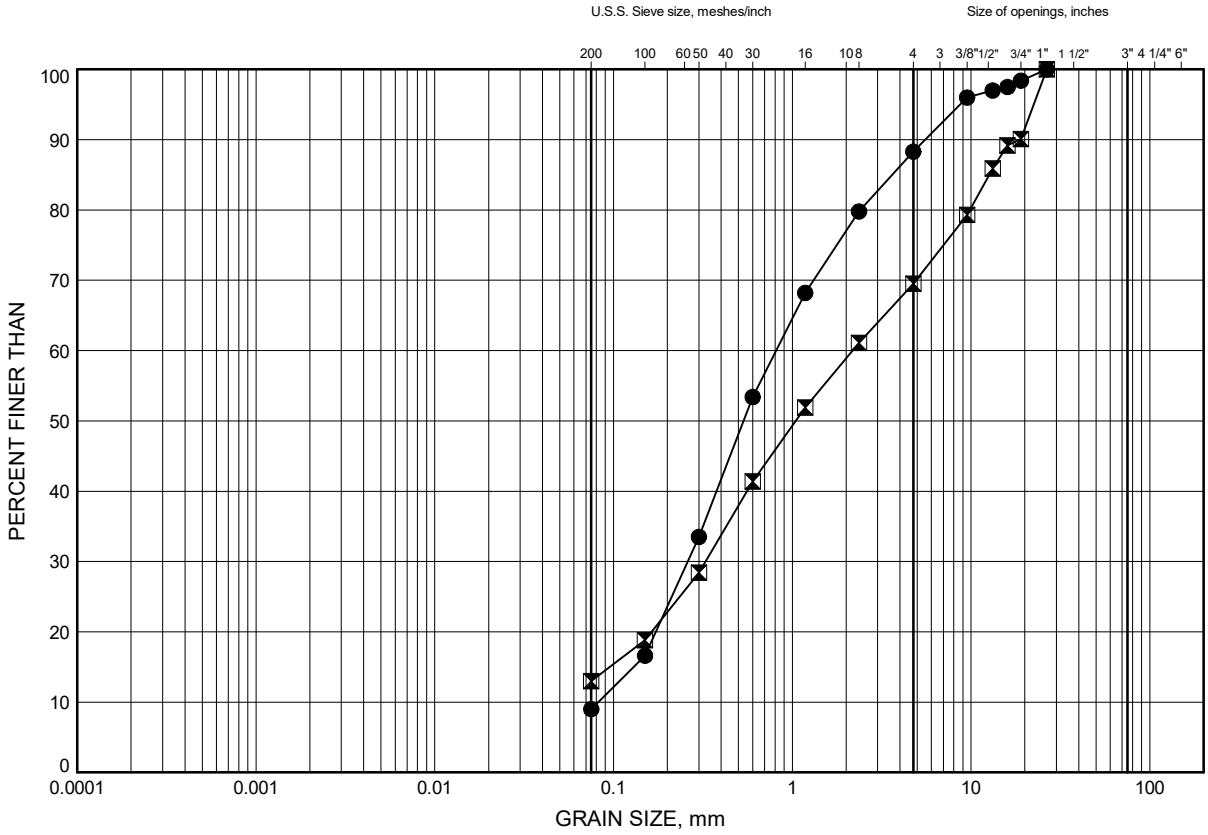
19-5308-95

Culvert 12+739, Highway 17 Goulais River

GRAIN SIZE DISTRIBUTION

FIGURE 1

Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-34	1.07	248.82
⧓	15-35	1.07	249.70

Date September 2016

GWP# 545-00-00

THURBER

Prep'd JAG

Chkd. FJG

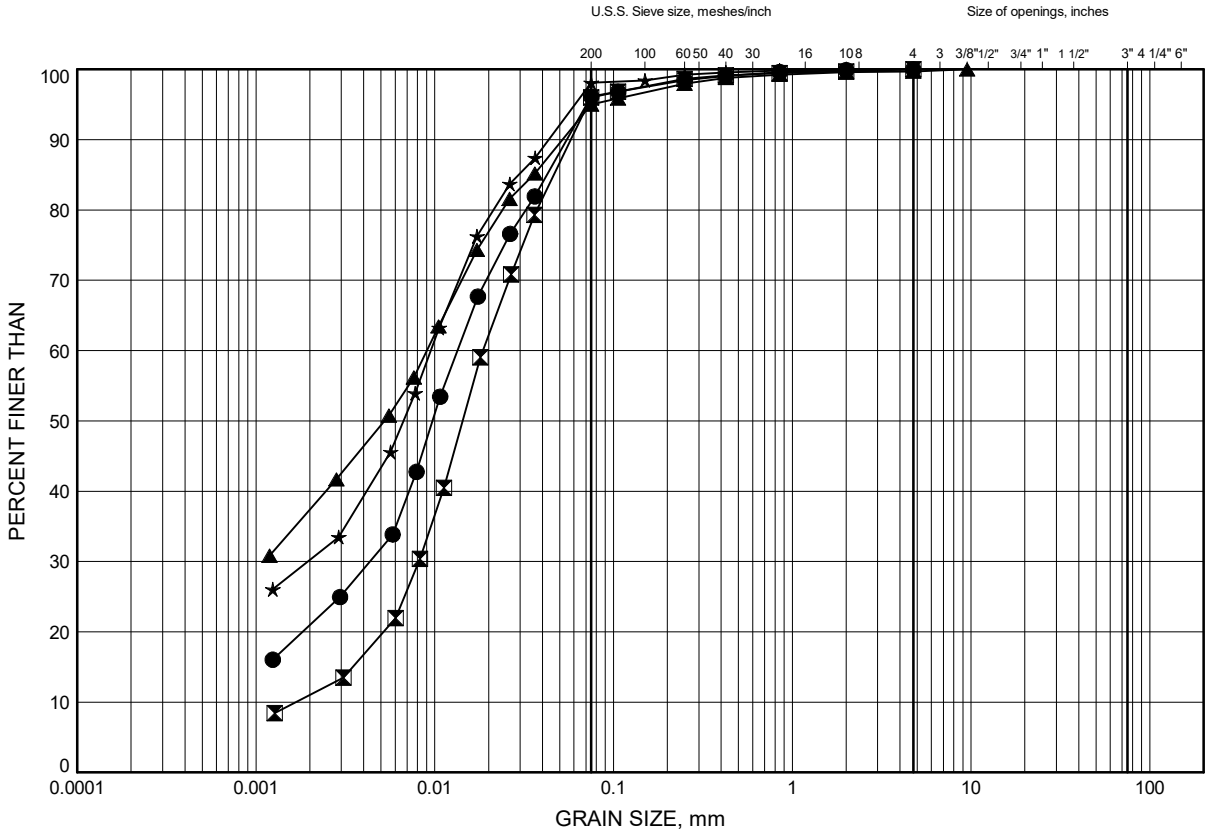
GRAIN SIZE DISTRIBUTION - THURBER 19-5308-95.GPJ 9/20/16

Culvert 12+739, Highway 17 Goulais River

GRAIN SIZE DISTRIBUTION

FIGURE 2

Embankment Clay Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-34	4.11	245.77
⊠	15-34	6.40	243.49
▲	15-34	7.92	241.96
★	15-35	7.92	242.84

Date September 2016

GWP# 545-00-00

THURBER

Prep'd JAG

Chkd. FJG

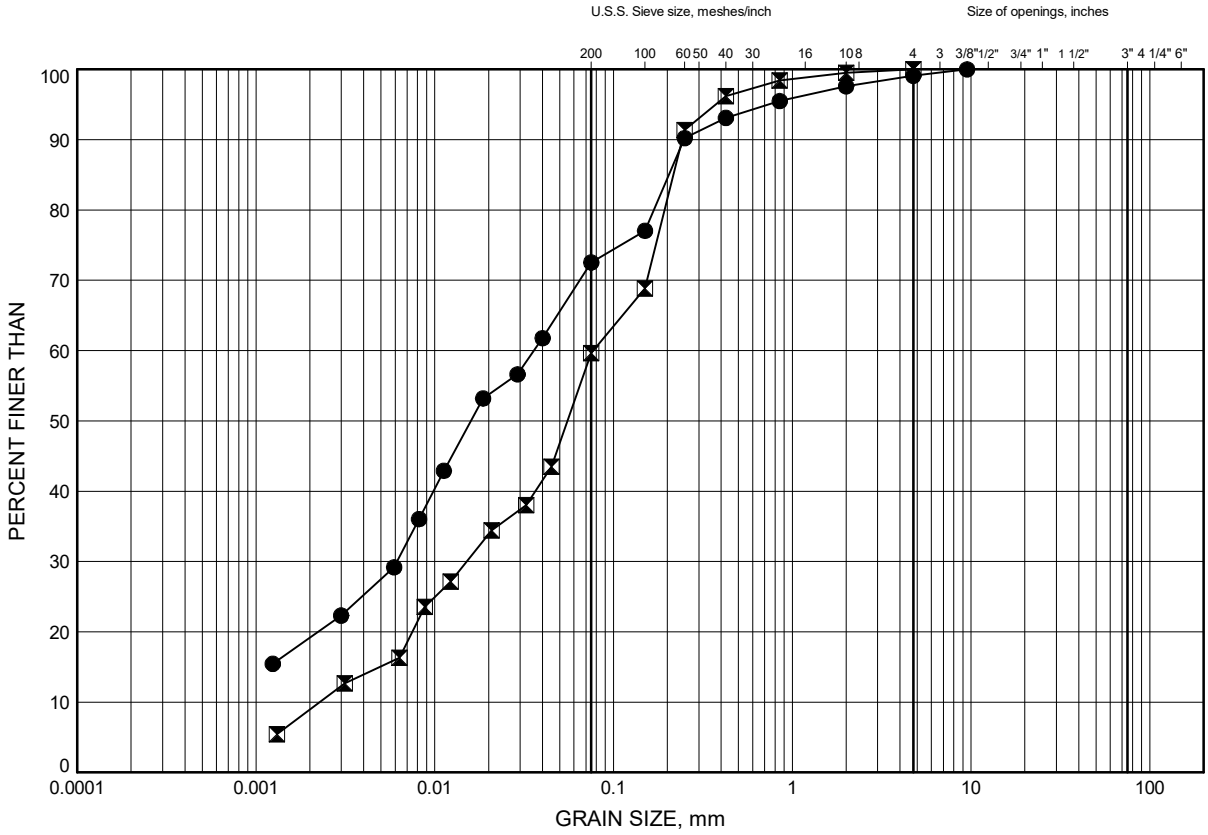
GRAIN SIZE DISTRIBUTION - THURBER 19-5308-95.GPJ 9/20/16

Culvert 12+739, Highway 17 Goulais River

GRAIN SIZE DISTRIBUTION

FIGURE 3

Silty Sandy CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-36	1.07	241.39
⧓	15-36	1.52	240.93

Date September 2016

GWP# 545-00-00

THURBER

Prep'd JAG

Chkd. FJG

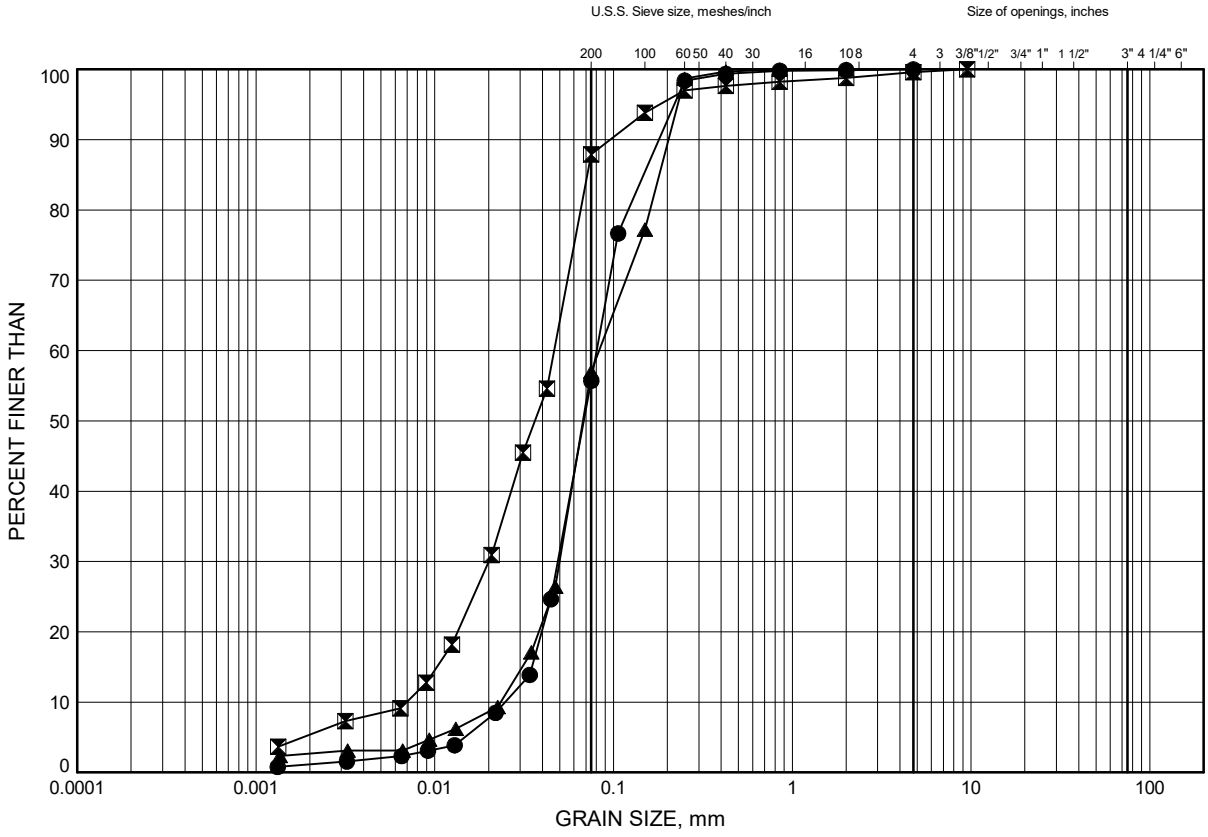
GRAIN SIZE DISTRIBUTION - THURBER 19-5308-95.GPJ 9/20/16

Culvert 12+739, Highway 17 Goulais River

GRAIN SIZE DISTRIBUTION

FIGURE 4

SILT some Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-33	2.90	238.33
⊠	15-35	9.45	241.31
▲	15-35	11.73	239.03

Date September 2016

GWP# 545-00-00

THURBER

Prep'd JAG

Chkd. FJG

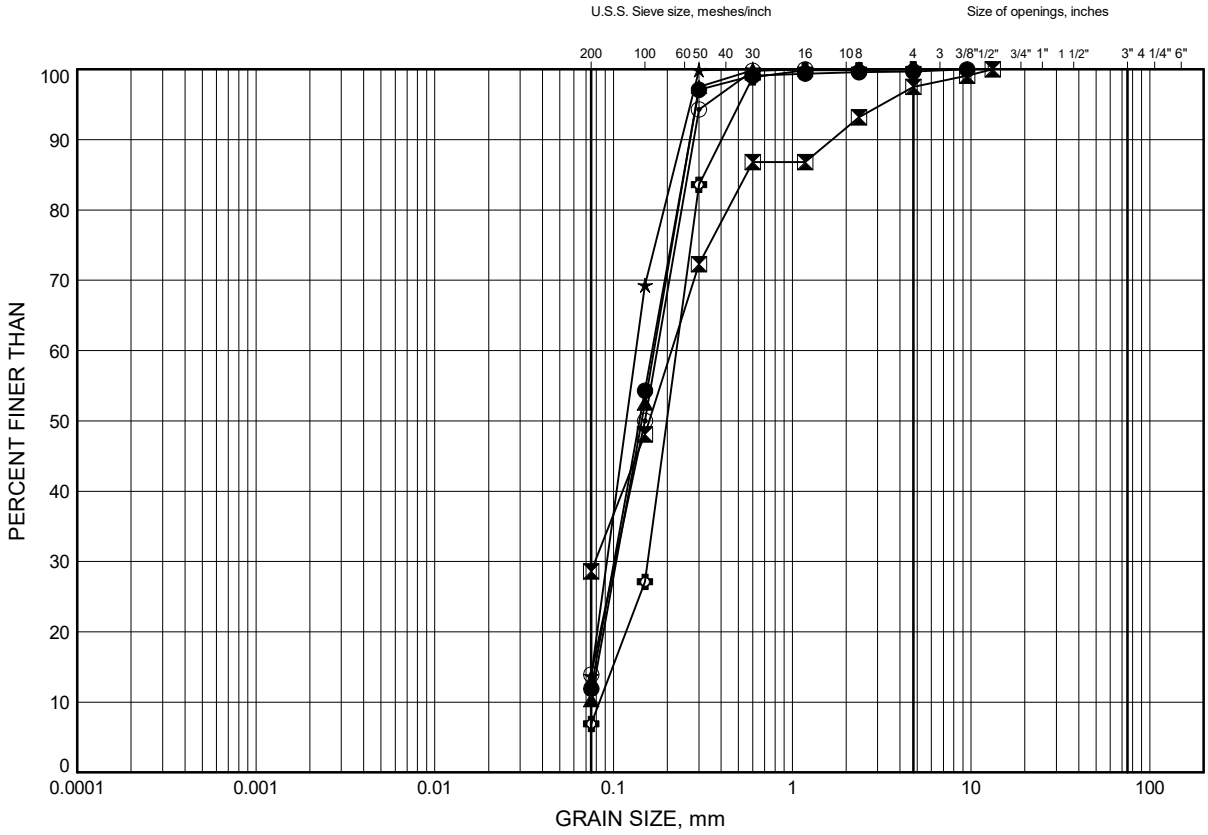
GRAIN SIZE DISTRIBUTION - THURBER 19-5308-95.GPJ 9/20/16

Culvert 12+739, Highway 17 Goulais River

GRAIN SIZE DISTRIBUTION

FIGURE 5

SAND with Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-33	6.40	234.82
⊠	15-34	10.97	238.91
▲	15-34	14.02	235.87
★	15-34	21.64	228.25
⊙	15-35	17.07	233.69
✿	15-36	8.84	233.62

Date September 2016

GWP# 545-00-00

THURBER

Prep'd JAG

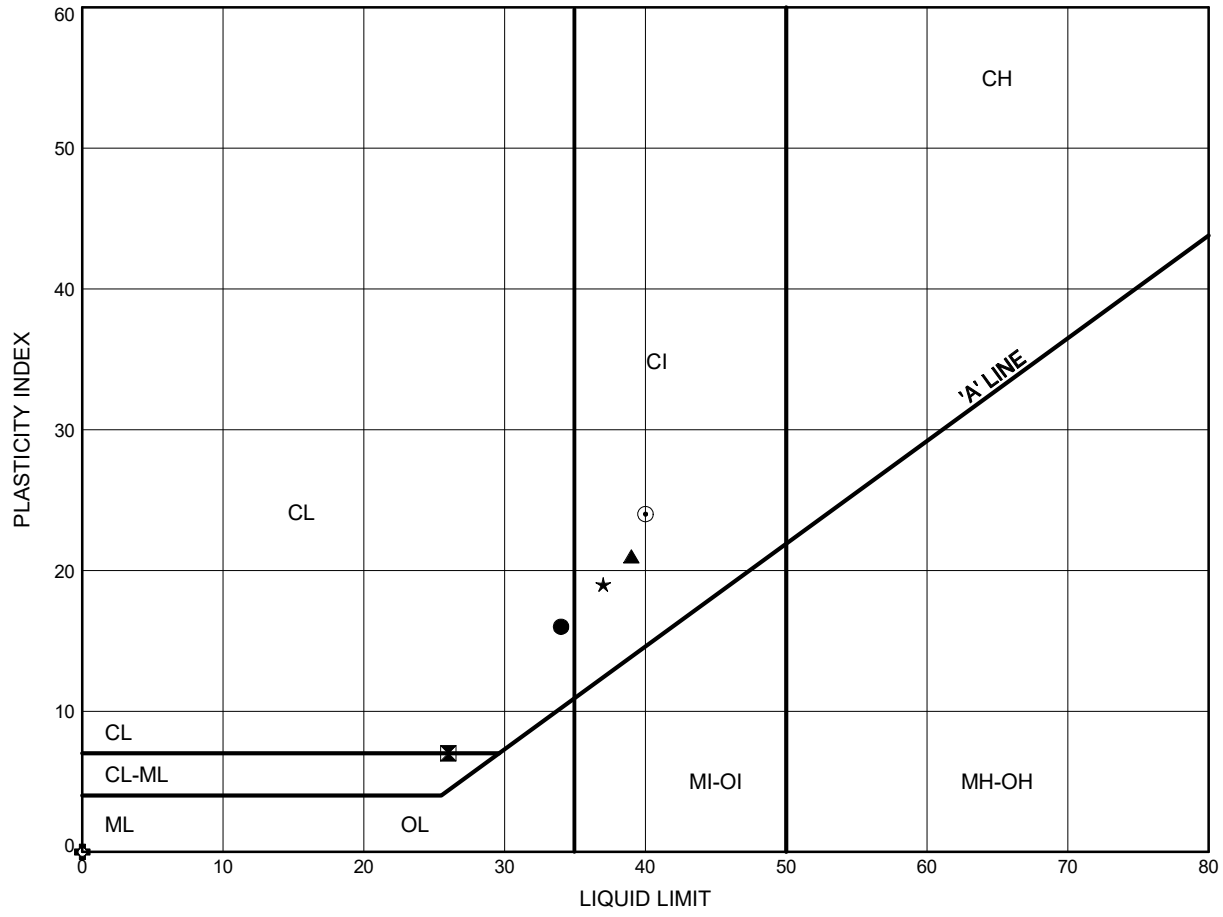
Chkd. FJG

GRAIN SIZE DISTRIBUTION - THURBER 19-5308-95.GPJ 9/20/16

Culvert 12+739, Highway 17 Goulais River

ATTERBERG LIMITS TEST RESULTS

FIGURE 6



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-34	4.11	245.77
⊠	15-34	6.40	243.49
▲	15-34	7.92	241.96
★	15-35	7.92	242.84
⊙	15-36	1.07	241.39
✿	15-36	1.52	240.93

Date September 2016

GWP# 545-00-00

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THURBALT 19-5308-95.GPJ 9/20/16

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Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104
Ottawa, ON K1B4S5
Attn: Shawn Lapain

Client PO:
Project: 19-5308-95
Custody: 27346

Report Date: 4-Feb-2016
Order Date: 29-Jan-2016

Order #: 1605367

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

Paracel ID	Client ID
1605367-01	BH15-23 SS11 (25'-27')
1605367-02	BH15-3 SS8 (20'-22')
1605367-03	BH15-32 SS3 (4'-6')
1605367-04	BH15-33 GS3 (2.5'-3.5')

Approved By:

Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 04-Feb-2016

Client: **Thurber Engineering Ltd.**

Order Date:29-Jan-2016

Client PO:

Project Description: 19-5308-95

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	3-Feb-16	3-Feb-16
Conductivity	MOE E3138 - probe @25 °C, water ext	2-Feb-16	3-Feb-16
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	1-Feb-16	1-Feb-16
Resistivity	EPA 120.1 - probe, water extraction	2-Feb-16	2-Feb-16
Solids, %	Gravimetric, calculation	30-Jan-16	30-Jan-16

PARACEL LABORATORIES LTD.

Order #: 1605367

Certificate of Analysis

Report Date: 04-Feb-2016

Client: **Thurber Engineering Ltd.**

Order Date: 29-Jan-2016

Client PO:

Project Description: 19-5308-95

	Client ID:	BH15-23 SS11 (25'-27')	BH15-3 SS8 (20'-22')	BH15-32 SS3 (4'-6')	BH15-33 GS3 (2.5'-3.5')
	Sample Date:	07-Jan-16	18-Jan-16	18-Jan-16	21-Jan-16
	Sample ID:	1605367-01	1605367-02	1605367-03	1605367-04
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	85.0	84.7	79.0	85.3
General Inorganics					
Conductivity	5 uS/cm	1400	138	114	108
pH	0.05 pH Units	6.14	6.11	5.34	5.70
Resistivity	0.10 Ohm.m	7.17	72.4	87.8	92.3
Anions					
Chloride	5 ug/g dry	747	73	61	14
Sulphate	5 ug/g dry	22	11	11	17

Method Quality Control: Blank

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

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	8.7	5	ug/g dry	8.4			2.5	20	
Sulphate	298	5	ug/g dry	335			11.5	20	
General Inorganics									
Conductivity	749	5	uS/cm	758			1.3	6.2	
pH	7.76	0.05	pH Units	7.79			0.4	10	
Physical Characteristics									
% Solids	77.8	0.1	% by Wt.	78.6			1.0	25	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	10.3		mg/L	0.8	94.3	78-113			
Sulphate	41.8		mg/L	33.5	83.3	78-111			

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

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

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

Appendix D

Selected Photographs

19-5308-95

Photo 1: **West side – inlet of culvert**

Photo 2: **East side – outlet of culvert**

Photo 3: **Looking west towards culvert inlet.**

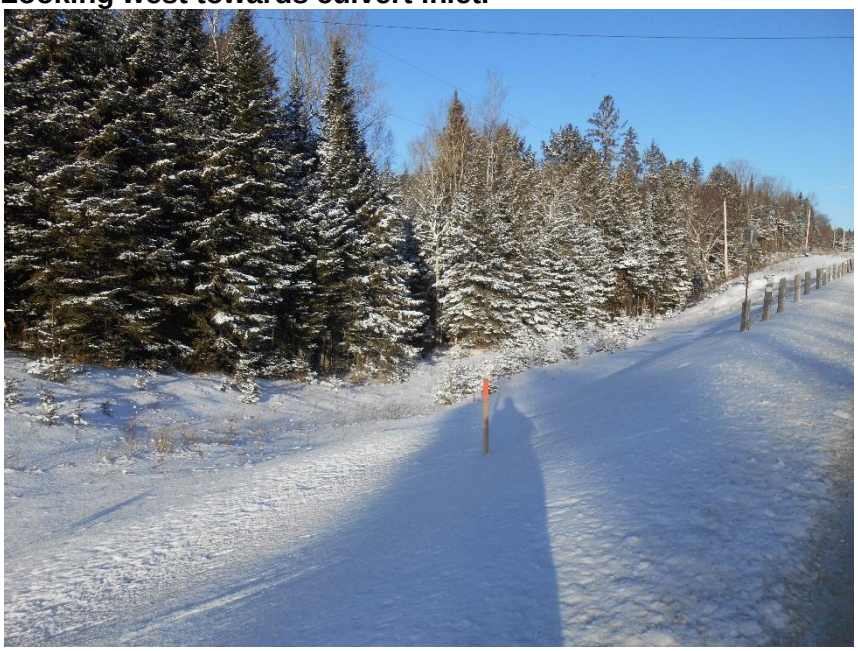

Photo 4: **Looking east towards culvert outlet.**

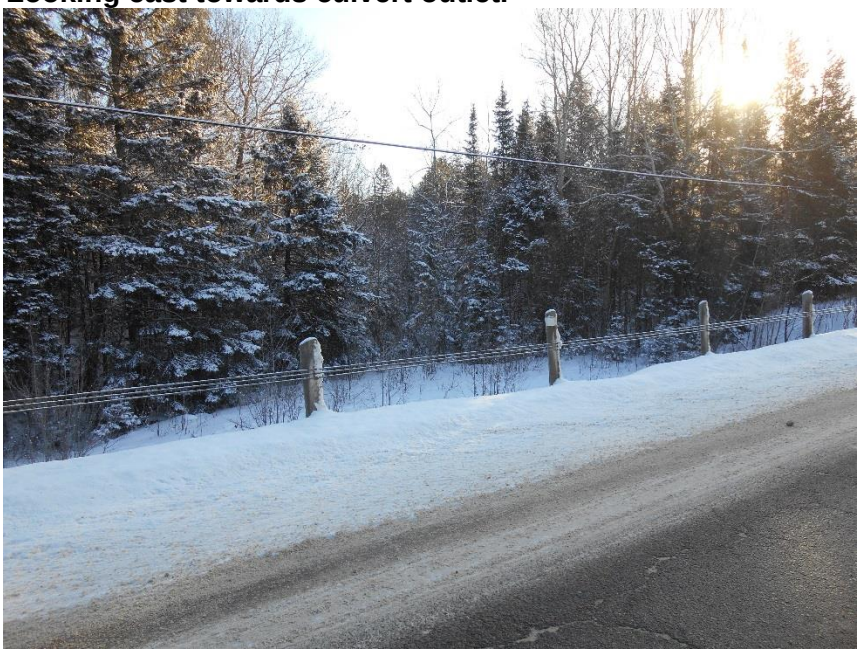

Photo 5: **Looking north towards culvert crossing.**