THURBER ENGINEERING LTD.

FOUNDATION INVESTIGATION REPORT
CULVERT 53 AT STATION 18+402
HIGHWAY 17 NEAR SCHREIBER, ONTARIO
KILLRAINE TOWNSHIP
G.W.P. 6294-11-00

GEOCRES NUMBER: 42D-43

SUBMITTED TO

AINLEY GROUP

September 2016
19-6478-6

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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) for Culvert 53 located on Highway 17, within the Township of Killraine, approximately 4 km west of Schreiber, Ontario. Thurber carried out the investigation as a subconsultant to Ainley Group (Ainley) as part of Agreement No. 5014-E-0046.

No previous foundation investigation information for the subject culvert was available. Base plan mapping and cross section data was provided by Ainley for the preparation of this report.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on this data, provide a borehole location plan, record of boreholes, a stratigraphic profile, laboratory test results and a written description of the subsurface conditions.

2 SITE DESCRIPTION

Culvert 53 is located at Station 18+402 in Killraine Township on Highway 17, approximately 4 km west of Schreiber, Ontario. It is noted that for project orientation purposes, Highway 17 within the project limits, will be assumed to run east-west. The location of the culvert is shown on the inset Key Plan on Drawing No. 1 in Appendix A.

In the area of the culvert, Highway 17 is a two-lane, undivided highway with a three cable guide rail located on the north side of the highway. Based on field measurements the roadway cross-section consists of two, 3.5 m wide lanes with approximately 3.3 m wide granular shoulders. Culvert 53 carries flow from south to north below the highway. The posted speed limit within the project limits is 90 km/hr. The 2012 AADT is reported to be 2050. The highway profile slopes down to the east at approximately 4.8%.

The available CAD drawings indicate that the existing culvert is a 910 mm diameter, 26.0 m long corrugated steel pipe (CSP) culvert. The height of the fill over the culvert based on available cross sections ranges from 2.6 m to 3.6 m. The slopes of the embankment were observed to be covered with rockfill and were graded at approximately 1.4H:1V (Horizontal:Vertical). The elevation at the centreline of the roadway was approximately 363.6 m. The elevation of the culvert invert was approximately 360.1 m and 358.3 m at the inlet and outlet respectively.

The lands surrounding the roadway are typically forested with little to no development in the area. Frequent bedrock outcrops were noted in the area in close proximity to the southeast and southwest of the culvert site. Storm water drainage in the area is to ditches and culverts. Typical site photographs are presented in Appendix D.

3 SITE INVESTIGATION AND FIELD TESTING

As a component of our standard procedures and due diligence, Thurber contacted Ontario One Call to provide utility locate clearances for the intended borehole locations. The results of the utility locates indicated that there were no buried utilities in the area of the proposed test holes at the time of the field investigation. It should be noted that utility locate clearances will be required for any future excavations.

The field investigation for this site included advancing four boreholes drilled on November 11, 14, 29 and 30, 2015. The northing, easting and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A and are summarized in Table 3-1.

Table 3-1: Borehole Summary

Borehole	Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Depth (m)
15-5	Culvert Inlet	5 409 545.4	281 008.4	360.6	2.1
15-6	Highway 17 Eastbound	5 409 552.8	281 009.6	363.5	8.3
15-7	Highway 17 Westbound	5 409 559.8	281 017.4	363.3	11.3
15-8	Culvert outlet	5 409 577.7	281 021.7	355.6	3.0

The boreholes through the roadway embankment were advanced with a CME track mounted drill rig equipped with NW size casing. The inlet and outlet boreholes were advanced with portable drilling equipment. The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. Split spoon samples were collected at regular depth intervals in the boreholes via the completion of Standard Penetration Tests (SPT), following the methods described in ASTM Standard D1586-11. All soil samples recovered from the boreholes were placed in moisture-proof containers and the samples were transported to Thurber's Ottawa geotechnical laboratory for further examination and testing. Bedrock was cored in both embankment boreholes using NQ size coring equipment following ASTM Standard D6032-08. Bedrock core samples were stored in core boxes for transport.

The boreholes were backfilled with a low-permeability mixture of auger cuttings and bentonite pellets in general accordance with the intent of Ontario MOE Regulation 903 and where required topped with asphalt patch.

The as-drilled locations of the boreholes were measured by Thurber personnel on November 30, 2015 and elevations were obtained from CAD drawings and cross sections provided by Ainley.

4 LABORATORY TESTING

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all soil samples in accordance with the current MTO standards. Grain size

distribution analyses testing was also carried out on selected samples to MTO and ASTM standards.

The geotechnical laboratory test results are presented on the Record of Borehole sheets in Appendix B and are illustrated on the figures in Appendix C.

Chemical laboratory testing, performed by Paracel Laboratories in Ottawa, Ontario, consisted of analysis of pH, water soluble sulphate and chloride concentrations, and resistivity. The analysis results are summarized in the following table.

Table 4-1: Results of Chemical Analysis

Borehole	Sample	Depth (m)	pH	Resistivity (Ohm-cm)	Chloride (µg/g)	Sulphate (µg/g)
15-5	SS2	0.9	4.44	2360	8	7

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 Overview / 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 area is presented on Drawing No. 1 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.

For reference, the stratigraphy in the area of the boreholes through the embankment is generally characterized by asphalt overlying sand with gravel fill overlying rockfill and underlain by granite bedrock.

More detailed descriptions of the individual strata are presented below.

5.2 Pavement Structure

Surface Treatment:

An asphalt layer with a thickness of 50 mm was encountered in both embankment boreholes.

Base Materials:

A granular fill layer consisting predominantly of sand with gravel with varying amounts of cobbles was encountered below the asphalt in the embankment boreholes. This layer has a top elevation ranging from 363.4 m to 363.2 m and a thickness ranging from 0.8 m to 1.1 m in Boreholes 15-6 and 15-7. The SPT ‘N’ values ranged from 28 blows per 0.3 m of penetration to 100 blows for 0.27 m of penetration; indicating a compact to very dense condition. The high blow counts may also indicate the presence of cobbles and/or boulders.

The moisture content of the samples tested ranged between 3% and 4%. The results of a grain size analysis conducted on one sample of the granular fill material is summarized in Table 5-1 and illustrated on Figure 1 in Appendix C.

Table 5-1: Gradation Results for Granular Fill

Soil Particles	%
Gravel	34
Sand	59
Silt and Clay	7

5.3 Embankment Fill (Rockfill)

A fill layer consisting predominantly of rockfill with frequent cobbles and boulders was encountered beneath the pavement structure fill in both embankment boreholes. This layer has a top elevation of 362.2 m to 362.7 m and a thickness ranging from 3.8 m to 6.7 m in Boreholes 15-6 and 15-7. Due to the nature of this material, no SPT values were obtained within this layer as the borehole had to be advanced using casing and coring techniques. Boulders were cored over lengths ranging from 300 mm to 750 mm and were noted to be the main constituent in this rockfill. Boulders estimated as large as 1.0 m in diameter were observed on the side slopes of the embankment in the area of the culvert.

5.4 Rootmat

A rootmat layer with a thickness of 50 mm and 150 mm was found at ground surface in Boreholes 15-5 and 15-8 respectively.

5.5 Sand with Organics

Underlying the rootmat, a deposit of sand with organics and frequent cobbles and boulders was encountered in Borehole 15-5. This layer was observed to be 0.5 m in thickness with an elevation of the base of the unit of 360.0 m.

The SPT N-value for this deposit was 3 blows per 0.3 m penetration, indicating a very loose state. The water content of the recovered sample was 30%. The colour of this deposit is brown.

5.6 Sand with Gravel

A native soil deposit ranging of sand with gravel with varying amounts of cobbles and boulders was encountered in Boreholes 15-5 and 15-8. This soil was found just below the sand with organics layer in Borehole 15-5 and just below the rootmat in Borehole 15-8. The thickness was observed to range from 0.7 m to 1.0 m with the base of unit elevation of 354.7 m to 359.0 m.

The SPT N-values for this deposit varied from 2 blows per 0.3 m penetration to 100 blows for 0.0 m of penetration, indicating a very loose to very dense state. The water content of the recovered samples ranged between 12% and 13%. The colour of this deposit is brown.

5.7 Gravel with Silt and Sand

Gravel with silt and sand was encountered in Borehole 15-8. This soil was found just below the sand with gravel layer. The thickness was 1.8 m and the base of the unit was at elevation 352.9 m. The upper portion of this deposit contained organics.

The SPT N-values for this deposit varied from 28 to 52 blows per 0.3 m penetration, indicating a compact to very dense state. The water content of the recovered samples ranged between 17% and 52%. The colour of this deposit is brown.

Grain size analyses conducted on two samples of the soil are presented on Figure 2 in Appendix C. These results are summarized in the following table.

Table 5-2: Gradation Results for Granular Fill

Soil Particles	%
Gravel	52 to 55
Sand	39 to 42
Silt and Clay	6

5.8 Silty Sand with Gravel

A native silty sand with gravel deposit was encountered in Borehole 15-8. This soil was found just below the gravel with silt and sand layer. This layer has a thickness of 0.3 m and a bottom elevation of 352.6 m terminating on probable bedrock.

The SPT N-value for this deposit was 100 blows for 0.23 m of penetration, indicating a very dense state. The water content of the recovered sample was 19%. The colour of this deposit is brown.

A grain size analysis conducted on one sample of the soil is presented on Figure 3 in Appendix C. These results are summarized in the following table.

Table 5-3: Gradation Results for Granular Fill

Soil Particles	%
Gravel	18
Sand	63
Silt	18
Clay	1

5.9 Cobbles and Boulders

A native layer consisting predominantly of cobbles and boulders was encountered beneath the sand with gravel layer in Borehole 15-5. This layer has a thickness of 0.5 m and a bottom elevation of 358.5 m terminating on probable bedrock. Due to the nature of this material, no SPT values were obtained within this layer as the borehole had to be advanced using portable casing and coring techniques.

5.10 Bedrock

Granitic bedrock was encountered beneath the rockfill in both the embankment boreholes; as identified by visual inspection of NQ coring. Borehole 15-5 and 15-8 were terminated at refusal on inferred bedrock. The bedrock surface ranged in elevation from 352.6 m to 358.9 m. Bedrock total core recovery ranged from 97% to 100% in both cored boreholes, solid core recovery ranged from 90% to 98% and the RQD values ranged from 42% to 96%. Based on the RQD values the rock mass quality ranges from poor to excellent. The bedrock fractures had a flat

orientation in Borehole 15-6 and both a flat and vertical orientation in Borehole 15-7. The fracture index was 1 fracture per 0.3 m. A photograph of the bedrock cores is provided in Appendix B.

5.11 Groundwater Conditions

Groundwater levels were measured on completion of drilling in the open boreholes prior to backfilling. Free water was observed in both Boreholes 15-5 and 15-8 at a depth of 0.6 m corresponding to elevations of 360.0 and 355.0 m respectively.

There was no water flowing through the culvert at the time of Thurber's field investigation although water could be heard flowing through the embankment fill below the culvert.

The groundwater level in the area of the culvert is expected to reflect the water level in stream flowing through the culvert. These observations are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Thurber measured the borehole locations, and determined the coordinates and ground surface elevations based on contract drawings provided by Ainley. RPM Drilling of Thunder Bay, Ontario supplied and operated the track mount CME 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 drilling equipment. The drilling, and sampling operations in the field were supervised on a full time basis by Mr. Christopher Murray, E.I.T. of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory in Ottawa.

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. Christopher Murray, E.I.T. The report was reviewed by Dr. Fred Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations Projects.

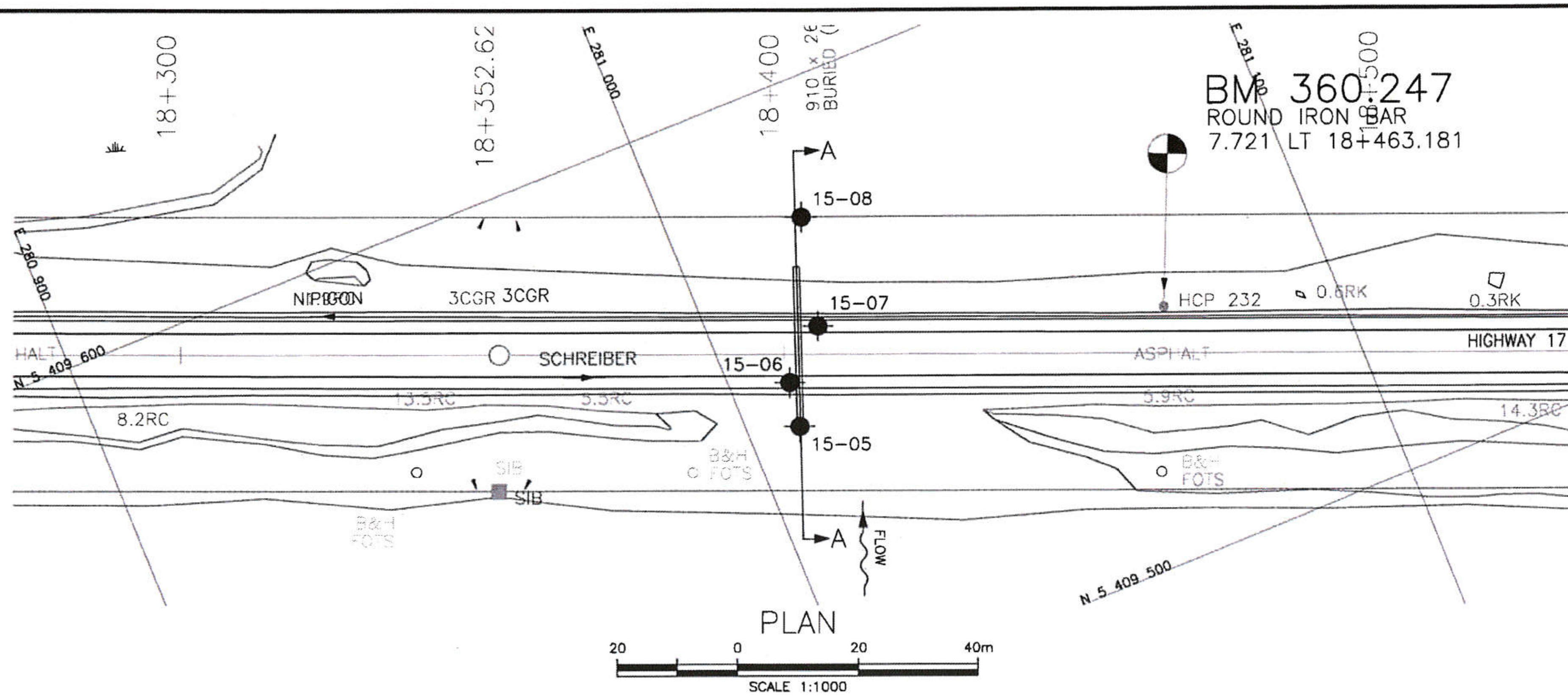
Christopher Murray, M.Sc.
Geotechnical E.I.T.

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

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

APPENDIX A

BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS

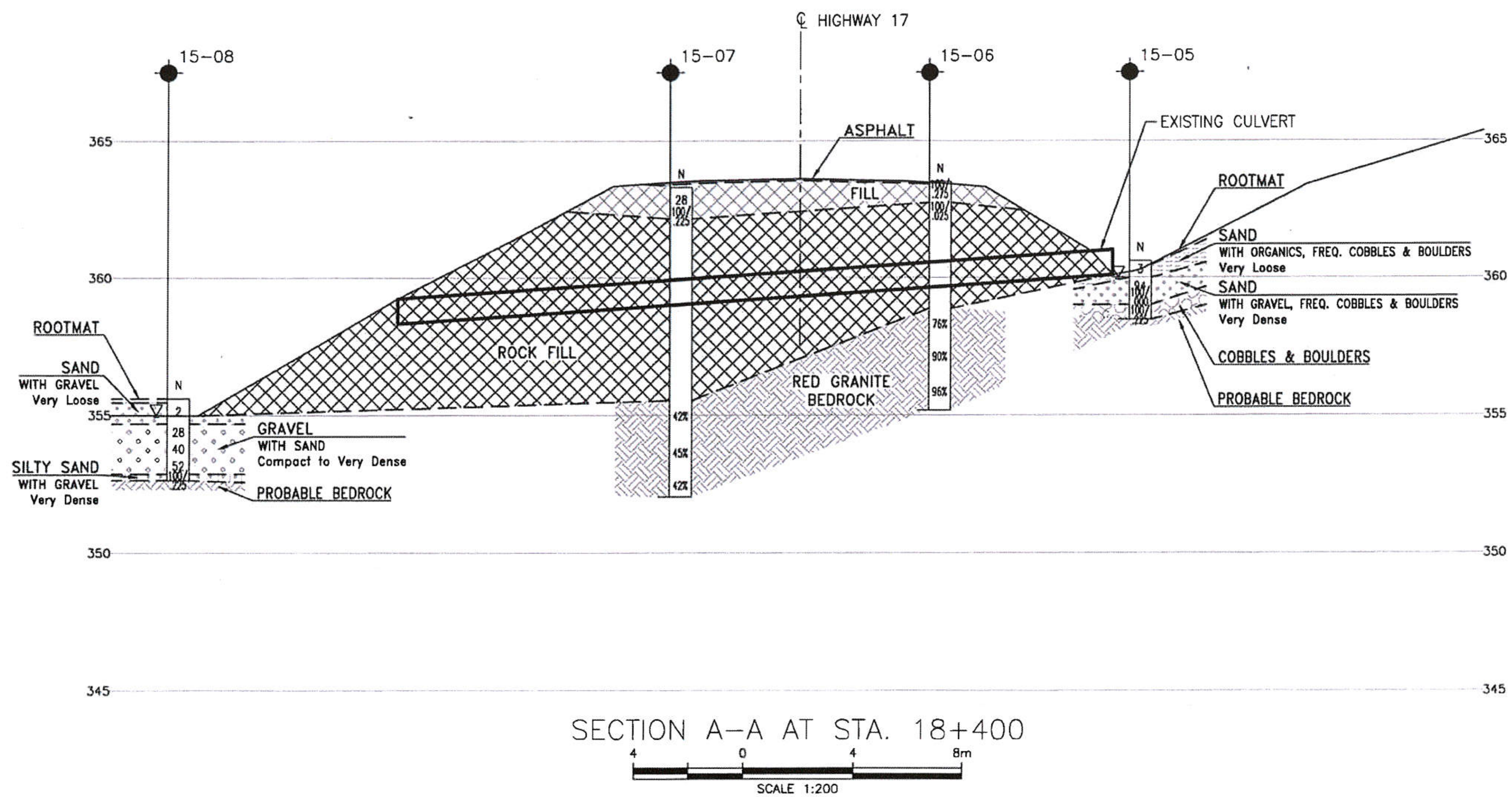


METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Sep 23/2016
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
F. J. GRIFFITHS
Sept 23/16
PROVINCE OF ONTARIO



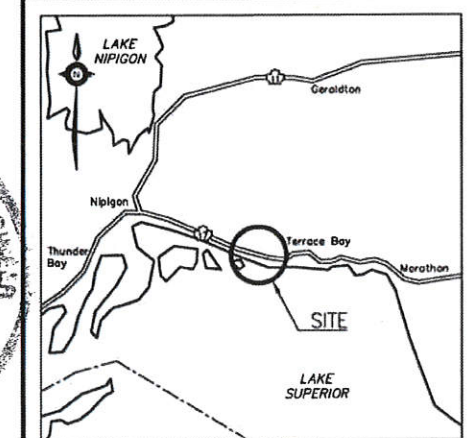
CONT No
GWP No 6294-11-00

HIGHWAY 17
CULVERT REPLACEMENT
CULVERT 53
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Ainley GROUP CONSULTING ENGINEERS PLANNERS

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
15-05	360.6	5 409 545.4	281 008.4
15-06	363.5	5 409 552.8	281 009.6
15-07	363.3	5 409 559.8	281 017.4
15-08	355.6	5 409 577.7	281 021.7

-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.
3) Borehole locations are shown in MTM Zone 14 coordinates.

GEOCRES No. 42D-43

REVISIONS	DATE	BY	DESCRIPTION		
DESIGN CM	CHK -	CODE	LOAD	DATE SEP 2016	
DRAWN MFA	CHK CM	SITE	STRUCT	DWG 1	

FILENAME: H:\Projects\19\6478\6 - Hwy 17 Schreiber\Reports & Memos\Foundations\Final\Culvert 53\ted4786-PLPR-Culvert53\ted4786-PLPR-Culvert53.dwg
PLOTDATE: 9/22/2016 10:59 AM

APPENDIX B

RECORD OF BOREHOLE SHEETS
PHOTOGRAPHS OF ROCK CORE

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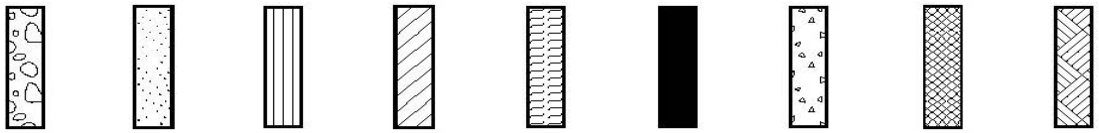
STRATA PLOT:
Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



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

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RECORD OF BOREHOLE No 15-05 1 OF 1 METRIC

GWP# 6294-11-00 LOCATION Culvert Site 53 N 5 409 545.4 E 281 008.4 ORIGINATED BY CAM

HWY 17 BOREHOLE TYPE Portable / Casing COMPILED BY CAM

DATUM Geodetic DATE 2015.11.30 - 2015.11.30 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
360.6											
0.0 / 0.1	**ROOTMAT (50mm)**										
	SAND (SP) with Organics, frequent Cobbles and Boulders Very Loose Brown		1	SS	3	▽	360		○		
360.0 / 0.6	**SAND (SW)** with Gravel, frequent Cobbles and Boulders Very Dense Brown		2	SS	94				○		
			3	SS	100/0mm						
359.0 / 1.6			4	SS	100/225mm		359		○		
	COBBLES AND BOULDERS										
358.5 / 2.1	End of Borehole on probable bedrock at 2.1 m Water table at 0.61 m below ground surface on completion of drilling										

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

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

ONTMT4S 19-6478-6.GPJ 2012TEMPLATE(MTO).GDT 9/16/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-06 1 OF 1 METRIC

GWP# 6294-11-00 LOCATION Culvert Site 53 N 5 409 552.8 E 281 009.6 ORIGINATED BY CAM

HWY 17 BOREHOLE TYPE Solid Stem Auger / Casing / NQ Coring COMPILED BY CAM

DATUM Geodetic DATE 2015.11.11 - 2015.11.11 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
363.5											
0.0	**ASPHALT (50mm)**										
0.0											
0.2	SAND with Gravel Dense Dark Brown **FILL**		1	SS	100/ 275mm		363		○		
362.7			2	SS	100/ 25mm						
0.8	SAND with Gravel, frequent Cobbles Dense Brown **FILL**						362				
	ROCK FILL - Borehole advanced by running casing from 0.8 m to 4.6 m - Boulders ranging from 0.3 m to 0.75 m penetrated						361				
							360				
358.9							359				
4.6	**RED GRANITE BEDROCK** Faintly Weathered to Fresh		1	RUN			358				RUN #1 TCR=100% SCR=98% RQD=76%
			2	RUN			357				RUN #2 TCR=100% SCR=96% RQD=90%
			3	RUN			356				RUN #3 TCR=100% SCR=96% RQD=96%
355.2											
8.3	End of Borehole at 8.3 m										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 19-6478-6.GPJ 2012TEMPLATE(MTO).GDT 9/16/16

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THURBER

RECORD OF BOREHOLE No 15-07 1 OF 2 METRIC

GWP# 6294-11-00 LOCATION Culvert Site 53 N 5 409 559.8 E 281 017.4 ORIGINATED BY CAM

HWY 17 BOREHOLE TYPE Solid Stem Auger / Casing / NQ Coring COMPILED BY CAM

DATUM Geodetic DATE 2015.11.14 - 2015.11.14 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
363.3											
0.0	**ASPHALT (50mm)**										
0.0											
0.2	SAND with Gravel Compact Dark Brown **FILL**		1	SS	28		363		○		34 59 7 (SI+CL)
	SAND with Gravel, frequent Cobbles Compact		2	SS	100/ 225mm				○		
362.2							362				
1.1	Brown **FILL**										
	ROCK FILL - Borehole advanced by running casing from 1.1 m to 7.8 m - Boulders ranging from 0.3 m to 0.6 m penetrated						361				
							360				
							359				
							358				
							357				
							356				
355.5											
7.8	**RED GRANITE BEDROCK** Slightly Weathered Highly Fractured		1	RUN			355				RUN #1 TCR=100% SCR=98% RQD=42%
			2	RUN			354				RUN #2 TCR=97% SCR=90% RQD=45%

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-07 2 OF 2 METRIC

GWP# 6294-11-00 LOCATION Culvert Site 53 N 5 409 559.8 E 281 017.4 ORIGINATED BY CAM

HWY 17 BOREHOLE TYPE Solid Stem Auger / Casing / NQ Coring COMPILED BY CAM

DATUM Geodetic DATE 2015.11.14 - 2015.11.14 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										
							353				
			3	RUN							RUN #3 TCR=100% SCR=94% RQD=42%
352.0											
11.3	End of Borehole at 11.3 m										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 19-6478-6.GPJ 2012TEMPLATE(MTO).GDT 9/16/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 15-08 1 OF 1 METRIC

GWP# 6294-11-00 LOCATION Culvert Site 53 N 5 409 577.7 E 281 021.7 ORIGINATED BY CAM

HWY 17 BOREHOLE TYPE Portable COMPILED BY CAM

DATUM Geodetic DATE 2015.11.29 - 2015.11.29 CHECKED BY FJG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
355.6											
0.0	**ROOTMAT (150mm)**										
0.2	**SAND (SW)** with Gravel Very Loose Brown		1	SS	2	▽	355				
354.7	- Void in Soil from 0.6 m to 0.9 m										
0.9	**GRAVEL (GW-GM)** with Silt and Sand Compact to Very Dense Brown - with Organics from 0.9 m to 1.2 m		2	SS	28				○		52 42 6 (SI+CL)
			3	SS	40		354				
			4	SS	52				○		55 39 6 (SI+CL)
352.9							353				
2.7 352.6	**SILTY SAND (SM)** with Gravel Very Dense Brown		5	SS	100/ 225mm				○		18 63 18 1
3.0	End of Borehole on probable bedrock at 3.0 m Water table at 0.61 m below ground surface on completion of drilling										

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

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

ONTMT4S 19-6478-6.GPJ 2012TEMPLATE(MTO).GDT 9/16/16

Borehole 15-6

RUN 1 to 3 (of 3)

Elevation 358.9 m to 355.2 m

THURBER ENGINEERING LTD.

Foundation Investigation
Highway 17 – Culvert 53
Station 18+402
Township of Killraine, Ontario

GWP: 6294-11-00

Project No.: 19-6478-6

Borehole 15-7

RUN 1 to 3 (of 3)

Elevation 355.5 m to 352.0 m

THURBER ENGINEERING LTD.

Foundation Investigation
Highway 17 – Culvert 53
Station 18+402
Township of Killraine, Ontario

GWP: 6294-11-00

Project No.: 19-6478-6

APPENDIX C

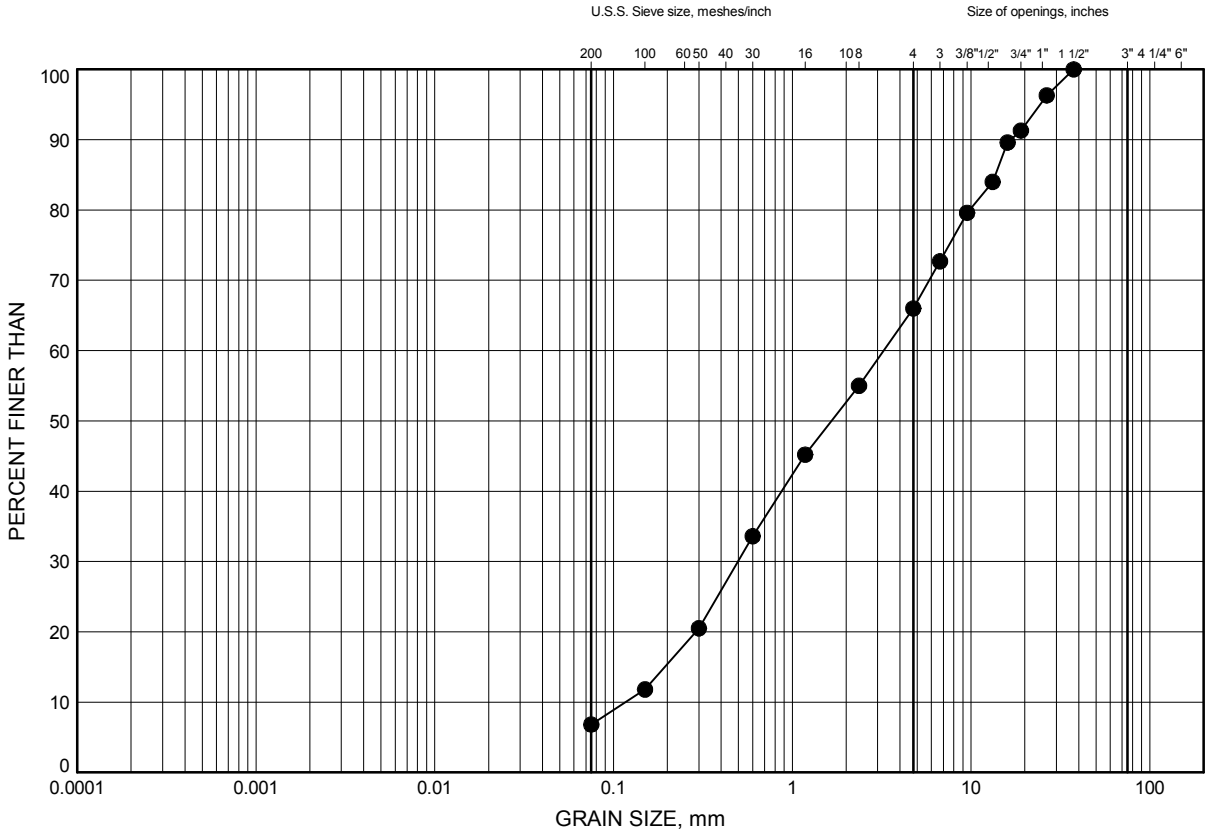
LABORATORY TEST RESULTS

Highway 17

GRAIN SIZE DISTRIBUTION

FIGURE 1

Granular Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-07	0.48	362.82

Date June 2016

GWP# 6294-11-00

THURBER

Prep'd CAM

Chkd. FJG

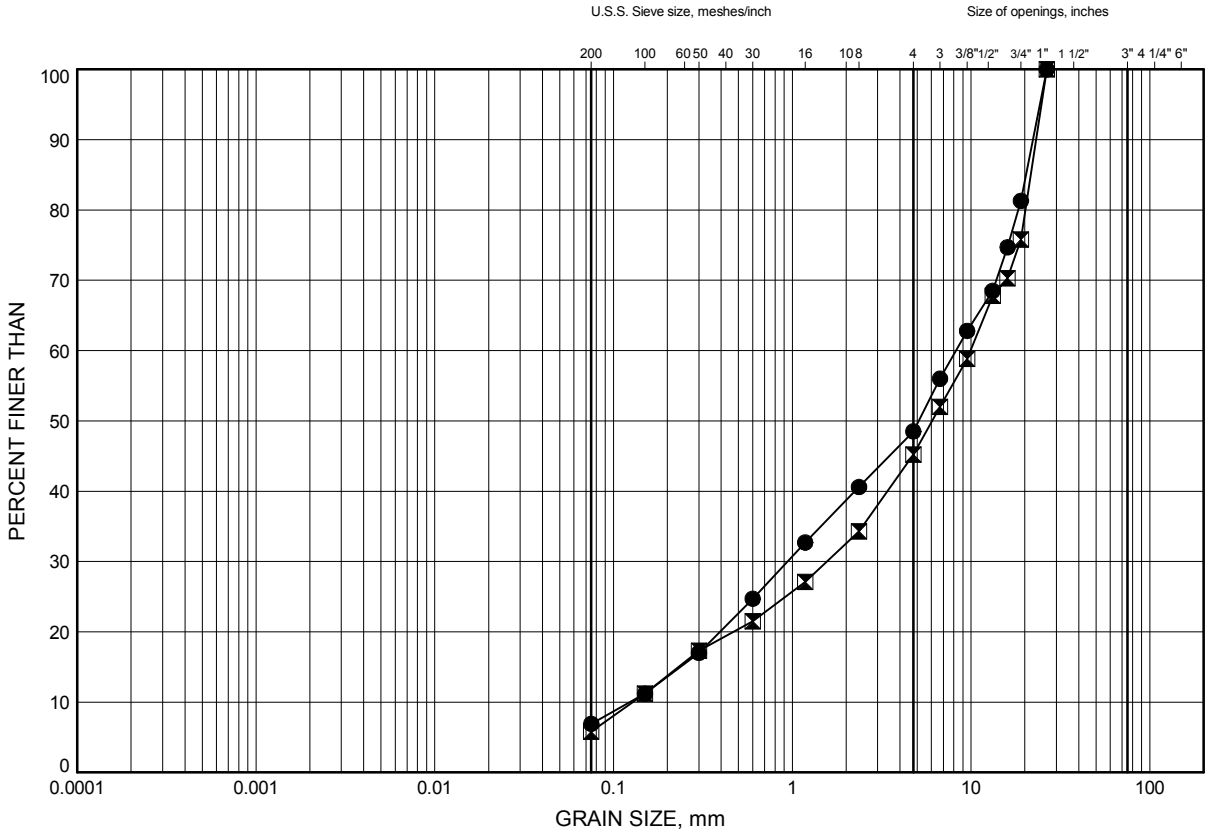
GRAIN SIZE DISTRIBUTION - THURBER 19-6478-6.GPJ 28/6/16

Highway 17

GRAIN SIZE DISTRIBUTION

FIGURE 2

Gravel 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)
●	15-08	1.22	354.38
⧓	15-08	2.44	353.16

Date June 2016

GWP# 6294-11-00

THURBER

Prep'd CAM

Chkd. FJG

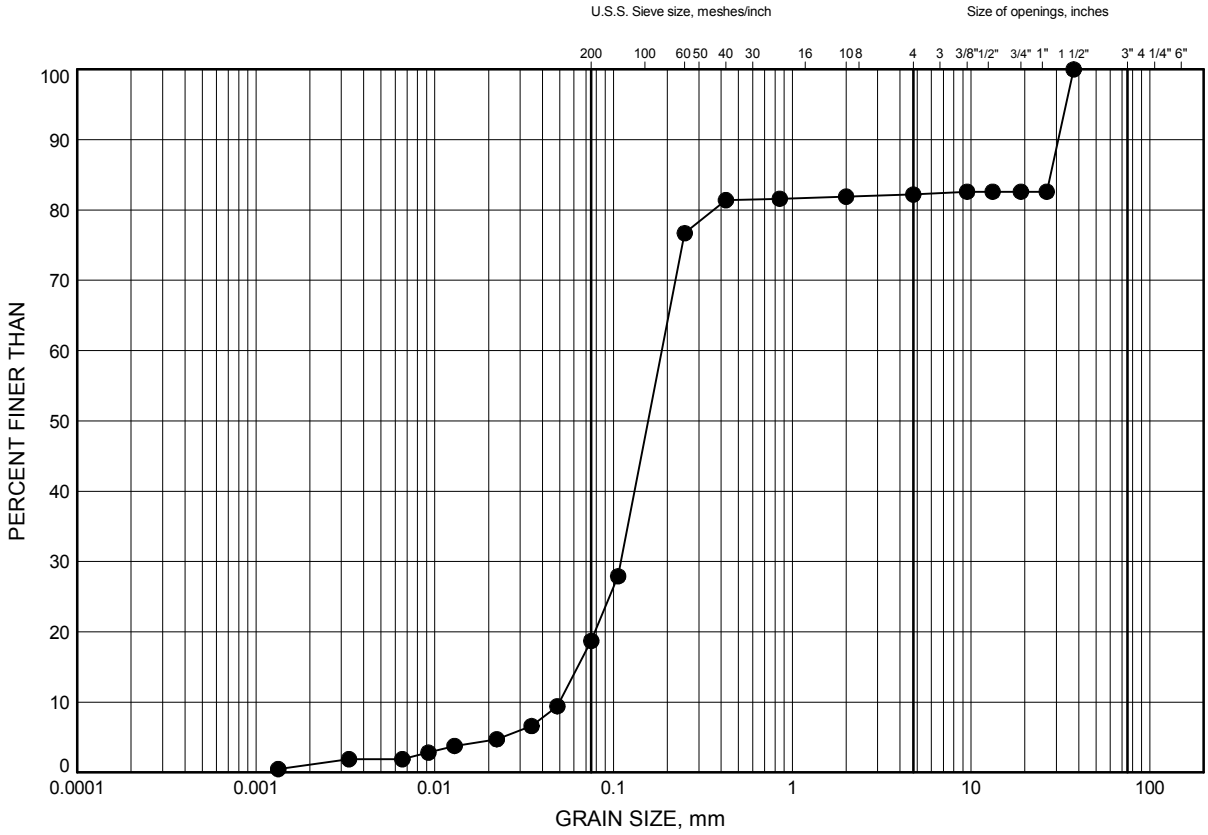
GRAIN SIZE DISTRIBUTION - THURBER 19-6478-6.GPJ 30/6/16

Highway 17

GRAIN SIZE DISTRIBUTION

FIGURE 3

Glacial Till



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15-08	2.86	352.74

Date June 2016

GWP# 6294-11-00

THURBER

Prep'd CAM

Chkd. FJG

GRAIN SIZE DISTRIBUTION - THURBER 19-6478-6.GPJ 28/6/16

APPENDIX D

SELECTED PHOTOGRAPHS

Figure 1: Roadway Platform at Culvert 53 Looking West

Figure 2: Culvert 53 inlet looking North

Figure 3: Terrain in area of Culvert 53 inlet looking west

Figure 4: Culvert 53 outlet looking south

Figure 5: Terrain in area of Culvert 53 outlet looking east