FOUNDATION INVESTIGATION REPORT
HAWKEYE CREEK TRIBUTARY BRIDGE REPLACEMENT
HIGHWAY 589, NORTH OF LAPPE, ONTARIO
THUNDER BAY UNORGANIZED DISTRICT
G.W.P. 6045-08-00, SITE 48W-240

Geocres Number: 52A-151

Report to

GENIVAR

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TABLE OF CONTENTS

PART 1 FACTUAL INFORMATION

Appendices

FOUNDATION INVESTIGATION REPORT
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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the location of a proposed bridge replacement crossing the Hawkeye Creek Tributary. The existing bridge carries Highway 589 over the Hawkeye Tributary Creek, approximately 19.6 Km north of Lappe, Ontario, in Thunder Bay Unorganized District.

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 written descriptions of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to GENIVAR, under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0012.

2 SITE DESCRIPTION

The Hawkeye Creek Tributary Bridge is located on Highway 589 (Dog Lake Road), approximately 210 m south of Paul Lake Road, approximately 19.6 Km north of Lappe, Ontario.

Higwhay 589 is an unpaved two-lane road. The existing bridge consists of a single span bridge with timber stringers and deck. The length and width of the existing bridge are 7.4 m and 6.5 m, respectively.

At this location, the Hawkeye Tributary Creek flows from southwest to northeast.

The lands immediately surrounding the bridge site consist of forested areas.

A Photograph in Appendix C shows the general nature of the surrounding land.

The site is underlain by Precambrian rocks and is covered with Pleistocene and recent deposits. These deposits consist of sand, silty sand till and silt.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out on July 5, 7, 8 and 10 to 14, 2011 and consisted of drilling and sampling six boreholes (identified as HCT-01 to HCT-06), at the existing bridge location through the existing highway embankments. Boreholes HCT-02 to HCT-05 were drilled near the north and south abutments and advanced within the overburden to depths ranging from 14.4 m to 17.0 m (elevations 82.4 to 85.3), where the auger encountered refusal. Bedrock was proved in Boreholes HCT-03 and HCT-04 by NQ size diamond coring. Boreholes HCT-03 and HCT-04 were advanced 3.2 m into bedrock and terminated at 18.8 m and 19.7 m depth (Elevations 80.9 and 79.6), respectively.

Boreholes HCT-01 and HCT-06 were drilled at the south and north approaches, respectively, and terminated at 8.8 m and 11.1 m (elevations 91.1 and 86.5).

The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata Drawing included in Appendix D.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling.

The drilling was carried out from the highway grade using a CME75 truck-mounted drill rig. A combination of hollow-stem auger drilling techniques and NQ coring methods were used to advance the boreholes. Overburden samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

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

All rock cores were logged, and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Groundwater conditions were observed in the open boreholes during and upon completion of the drilling operations. Two standpipe piezometers consisting of 19 mm diameter PVC pipe with a slotted screen were installed at the abutments and enclosed in filter sand to permit longer term groundwater level monitoring. The boreholes were backfilled with bentonite holeplug in general accordance with O.Reg. 903 upon completion. The locations and completion details of the boreholes are shown in Table 3.1.

Table 3.1 – Borehole Abandonment Details

Location	Borehole	Piezometer Tip Depth/ Elevation (m)	Abandonment Details
South Approach	HCT-01	None installed	Borehole grouted to 2.6 m then auger cuttings to surface.
South Abutment	HCT-02	14.4/85.3	Piezometer with 1.5 m slotted screen installed with sand filter from 14.4 m to 11.0 m, holeplug from 11.0 m to surface.
	HCT-03	None installed	Borehole backfilled with holeplug to 1.5 m, then sand and gravel to surface.
North Abutment	HCT-04	19.7/79.6	Piezometer with 1.5 m slotted screen installed with sand filter from 19.7 m to 14.5 m, holeplug from 14.5 m to 3.0 m, auger cuttings from 3.0 m to 1.8 m, holeplug from 1.8 m to 0.9 m, sand filter from 0.9 m to 0.3, then concrete to surface.
	HCT-05	None installed	Backfilled with holeplug to 1.5 m, then sand and gravel to surface.
North Approach	HCT-06	None installed	Backfilled with holeplug to 1.5 m, then sand and gravel to surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to gradation analysis. The results of these tests are summarized on the Record of Borehole sheets included in Appendix A and are presented on the figures included in Appendix B.

Point load tests were carried out on selected samples of intact bedrock upon arrival at the laboratory to assist in evaluation of the compressive strength of the bedrock. Results of point load tests on the rock core samples are included in Appendix B and on the Record of Borehole sheets in Appendix A.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil and rock stratigraphy are presented in these sheets and on the "Borehole Locations and Soil Strata" drawing included in Appendix F. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions.

In general terms, the overburden soil stratigraphy encountered at this site consists of sand fill over native layers of sand, silty sand till, sand and gravel till and silt. Cobbles and boulders were encountered at various depths within the native cohesionless soils. The overburden is underlain by slightly to moderately weathered diorite bedrock. More detailed descriptions of the individual strata are presented below.

5.1 Fill

Brown sand fill containing trace to some gravel, with occasional cobbles, trace silt and clay was encountered surficially in all the boreholes. The thickness of the cohesionless fill ranges from 1.4 m to 2.8 m. A 100-mm thick layer of organics was noted at the base of the fill in Borehole HCT-02.

The depths to the base of the fill ranged from 1.4 m to 2.8 m (elevations 94.8 to 98.1).

SPT N-values ranging from 4 to 27 blows for 0.3 m penetration were recorded in the sand fill, indicating a loose to compact relative density. An SPT 'N' value of 42 blows per 0.3 m of penetration, indicating a dense relative density, was measured in Borehole HCT-06 near elevation 95.0.

The moisture contents of the sand fill range from 5% to 18%.

Grain size distribution curves for selected fill samples are presented on the Record of Borehole sheets and on Figure B1 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	3 to 15
Sand	56 to 90
Silt	26
Clay	3
Silt and Clay	7

5.2 Silty Sand Till

Brown to grey silty sand till containing trace to some gravel, trace clay and occasional cobbles was encountered in most of the boreholes at depths and elevations indicated in Table 5.1.

Table 5.1 – Depths and Elevations of Native Silty Sand Till

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
South Approach	HCT-01	2.2 to 8.8 (borehole termination depth)	97.7 to 91.1	6.6
South Abutment	HCT-02	3.9 to 6.1	95.8 to 93.6	2.2
	HCT-03	2.2 to 15.6	97.5 to 84.1	13.4
North Abutment	HCT-04	6.9 to 12.2	92..4 to 87.1	5.3
North Approach	HCT-06	4.3 to 7.2	93.3 to 90.4	2.9

Grinding of the drill augers were noted at various depths in a number of boreholes also indicating presence of cobbles and boulders. Boulders and bedrock fragments were noted above the bedrock in Borehole HCT-03. Cobbles and boulders were generally encountered below elevation 93.5 at both abutments. In Borehole HCT-05, drilled at the north abutment, coring through cobbles and boulders encountered near elevation 96.5 was required to advance the borehole.

SPT N-values in the silty sand till deposit, ranged from 18 to 91 blows per 0.3 m of penetration indicating compact to very dense relative density. Higher SPT 'N' values of 50 blows per 0.075 m of penetration were measured at various depths within the silty sand till. These high SPT 'N' values may indicate the presence of cobbles and boulders within the silty sand till deposit.

The moisture contents of samples of the sand and gravel range from 8% to 22%.

Grain size distribution curves for selected samples are presented on the Record of Borehole sheets and on Figures B2 and B3 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	2 to 20
Sand	46 to 73
Silt	17 to 33
Clay	3 to 5

5.3 Sand

Native brown to grey sand containing trace to some gravel, occasional cobbles, clay and silt was encountered in the boreholes at depths and elevations indicated in Table 5.2.

Table 5.2– Depths and Elevations of Native Sand

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
South Abutment	HCT-02	1.6 to 3.9 6.1 to 11.1	98.1 to 95.8 93.6 to 88.6	2.3 5.0
North Abutment	HCT-04	1.9 to 6.9	97.4 to 92.4	5.0
	HCT-05	8.1 to 14.0	91.3 to 85.3	5.9
North Approach	HCT-06	2.8 to 4.3 7.2 to 9.9	94.8 to 93.3 90.4 to 87.7	1.5 2.7

Cobbles and boulders were encountered within the sand layer below elevation 93.7 in Borehole HCT-04, at elevation 94.5 in Borehole HCT-06 and near elevation 89.0 in Borehole HCT-05. Grinding of the dill augers was noted at 3.6 m depth in Borehole HCT-02. Occasional organics were noted in the sand layer in Borehole HCT-04 near elevation 96.9.

SPT 'N' values measured in the sand ranged from 13 to 54 blows per 0.3 m of penetration indicating a compact to very dense relative density. SPT 'N' values measured within the zones where cobbles and boulders were encountered, ranged from 56 blows per 0.3 m of penetration to 50 blows per 0.125 m of penetration, indicating a very dense relative density. An SPT 'N' value of 4 blows per 0.3 m of penetration, indicating a very loose relative density, was measured in Borehole HCT-02 near elevation 98.0.

The natural moisture contents generally lay in the range of 8% to 32%. Moisture content of 41% was measured in one sample.

Grain size distribution curves for selected native sand samples are presented on the Record of Borehole sheets and on Figure B4 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	22 to 26
Sand	65 to 66
Silt and Clay	8 to 13

5.4 Sand and Gravel Till

A layer of brown sand and gravel till containing trace silt and clay was contacted in Borehole HCT-05 below the fill at 1.4 m depth (elevation 97.9). The thickness of the sand and gravel was 6.7 m.

The depth to the base of the sand and gravel till was 8.1 m (elevation91.3).

Cobbles and boulders were encountered in this till from 2.4 m to 4.1 m depth.

SPT 'N' values measured in the sand and gravel till ranged from 42 blows per 0.3 m of penetration to 100 blows per 0.1 m of penetration, indicting a dense to very dense relative density.

The natural moisture contents generally lay in the range of 5% to 10%.

Grain size distribution curves for selected sand and gravel till samples are presented on the Record of Borehole sheets and on Figure B5 of Appendix B. The results of the laboratory are summarized as follows:

Soil Particles	(%)
Gravel	60 to 61
Sand	28 to 34
Silt and clay	6 to 11

5.5 Silt

Grey silt containing trace sand and trace clay and occasional cobbles was contacted below the sand or silty sand till in Boreholes HCT-02, HCT-04 and HCT-06 at depths ranging from 9.9 m to 12.2 m (elevations 87.1 to 88.6). In Borehole HCT-05, the silt was contacted at 14.0 m depth (elevation 85.3). The thickness of the silt ranged from 1.2 m to 4.3 m.

The depth to the base of the silt was 16.5 m (elevation 82.8) in Borehole HCT-04, drilled at the north abutment.

Boreholes HCT-02, HCT-05 and HCT-06 were terminated within the silt layer at 14.4 m, 17.0 m and 11.1 m depth, respectively, upon auger refusal on probable bedrock (elevations 85.3, 82.4 and 86.5).

SPT 'N' values of the silt ranged from 41 blows per 0.3 m of penetration to 100 blows per 0.1 m of penetration, indicating a dense to very dense relative density.

The moisture content in the sandy silt ranged from 9% to 22%.

Grain size distribution curves for selected silt samples are presented on the Record of Borehole sheets and on Figure B6 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	1 to 6
Silt	89 to 95
Clay	4 to 9

5.6 Bedrock

The overburden soils described above are underlain by grey diorite bedrock. Occasional mechanical breaks and sub-vertical fractures were noted throughout the bedrock cores. The bedrock is generally described as slightly to moderately weathered.

Bedrock was proved by coring in Boreholes HCT-03 and HCT-04 drilled at the south and north abutments, respectively. Table 5.3 summarizes depths and elevations to the top of bedrock or depth to auger refusal in the boreholes.

Table 5.3 – Depths and Elevations of Top of Bedrock/Auger Refusal

Location	Borehole	Top of Bedrock/ Auger Refusal	
		Depth (m)	Elevation (m)
South Approach	HCT-01	8.8	91.1
South Abutment	HCT-02	14.4	85.3
	HCT-03*	15.6	84.1
North Abutment	HCT-04*	16.5	82.8
	HCT-05	17.0	82.4
North Approach	HCT-06	11.1	86.5

*Bedrock proved by coring

Total core recovery (TCR) in the bedrock was 100% in all the cores. Generally RQD values ranged from 52% to 100%, indicating fair to excellent rock quality. The RQD values in Boreholes HCT-03 Run 1 and HCT-04 Run 3 were 23% and 37%, representing a very poor to poor rock quality.

The estimated unconfined compressive strength of the rock cores ranges from 55 MPa to 325 MPa, which denote a strong to extremely strong rock. These estimated rock strength values are interpreted from point load tests that were conducted on rock cores recovered from the boreholes. A summary of the Point Load Test Results is presented in Appendix B.

5.7 Water Levels

Water levels were observed in the open boreholes upon completion of drilling operations. Two standpipe piezometers were installed in Boreholes HCT-02 and HCT04 to monitor water levels after completion of drilling. The water levels measured in the open boreholes and piezometers are summarized in Table 5.3.

Table 5.3 – Water Level Measurements

Location	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
South Approach	HCT-01	August 14, 2011	2.3	97.6	Open borehole
South Abutment	HCT-02	August 17, 2011 August 17, 2011	3.0 1.8	96.7 97.9	Open borehole Piezometer
	HCT-03	July 10, 2011	3.0	96.7	Open borehole
North Abutment	HCT-04	July 13, 2011 August 17, 2011	1.2 1.9	98.1 97.4	Piezometer
North Approach	HCT-06	July 14, 2011	3.0	94.6	In open borehole

The piezometric readings reveal that the groundwater level ranges from elevation 97.4 to 98.1.

GA drawing indicates that water level of Hawkeye Tributary Creek at the bridge location was at elevation 97.8 on April 14, July 19 and August 15, 2011.

The above values 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

Borehole locations were selected in the field by Thurber Engineering Ltd. Borehole elevations and coordinates were provided by Genivar.

Thurber obtained utility clearances for the borehole locations prior to drilling.

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied a truck mounted CME 75 drill rig and conducted the drilling, sampling and in-situ testing operations.

The field program was supervised on a full time basis by Mr. Stephane Loranger, C.E.T. of Thurber Engineering Ltd.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Overall planning and supervision of the field program was conducted by Mr. Mark Farrant, P. Eng. Interpretation of the data and preparation of this report were carried out by Ms. R. Palomeque Reyna, P.Eng.

The report was reviewed by Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer

P. K. Chatterji, P.Eng.
Review Principal

Appendix A

Record of Borehole Sheets

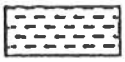
EXPLANATION OF ROCK LOGGING TERMS

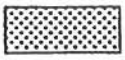
ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
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 structure are preserved.

SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

DISCONTINUITY SPACING

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

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 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample
	AS Auger (Grab) Sample	
	TW Thin Wall Shelby Tube Sample	
	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	
	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	
	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

$\blacktriangledown$ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	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	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and 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. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCT-01 1 OF 1 METRIC

W.P. 6045-08-00 LOCATION N 9 941.2 E 100 15.3 Hawkeye Creek Tributary Bridge ORIGINATED BY SLL

HWY 589 BOREHOLE TYPE Hollow Stem Augers/Casing/Tricone COMPILED BY AN

DATUM DATE 2011.07.14 - 2011.07.14 CHECKED BY LRB

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
99.9											
0.0	**SAND**, some gravel Compact Brown Moist (FILL)		1	GS					○		
	Occasional cobbles		1	SS	27		99		○		
97.7			2	SS	10		98		○		
2.2	Silty **SAND**, trace gravel, trace clay, occasional cobbles Dense to Very Dense Brown to Grey Moist (TILL)		3	SS	36	▽	97		○		9 61 25 5
			4	SS	50/ 0.075		96		○		
	Auger grinding at 4.2m		5	SS	44		95		○		
			6	SS	36		94		○		8 65 24 3
	Sand layer from 6.9m to 7.5m		7	SS	50/ 0.075		93		○		
	Casing and tricone at 8.0m						92				
91.1			8	SS	50/				○		
8.8	END OF BOREHOLE AT 8.8m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. WATER OBSERVED AT 2.3m DURING DRILLING. BOREHOLE GROUTED TO 2.6m THEN AUGER CUTTINGS TO SURFACE.				0.075						

ONTMT4S 0840.GPJ 11/1/11

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

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCT-02 1 OF 2 METRIC

W.P. 6045-08-00 LOCATION N 9 949.7 E 100 17.9 Hawkeye Creek Tributary Bridge ORIGINATED BY SLL

HWY 589 BOREHOLE TYPE Hollow Stem Augers/Casing/Tricone COMPILED BY AN

DATUM — DATE 2011.07.11 - 2011.07.11 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.7											
0.0	Silty **SAND**, some gravel, trace clay Brown Moist (FILL)		1	GS					○		
	Loose		1	SS	9		99		○		15 56 26 3
98.1	Layer of organics (100mm)										
1.6	**SAND**, trace gravel Loose to Compact Dark Brown Moist		2	SS	4		98		○		
			3	SS	17		97		○		
	Very Dense Auger grinding at 3.6m Casing and tricone at 3.9m		4	SS	54		96		○		
95.8											
3.9	Silty **SAND**, some gravel to gravelly, trace clay, occasional cobbles Dense Grey Moist (TILL)		5	SS	38		95		○		17 46 33 4
93.6											
6.1	**SAND**, some gravel, some silt and clay, occasional cobbles Very Dense Grey Moist		6	SS	50/ 0.125		94		○		
			7	SS	100/ 0.275		93				
	Cobbles		8	SS	100/ 0.275		92				
							91		○		22 65 13 (SI+CL)
							90				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 0840.GPJ 10/31/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCT-02 2 OF 2 METRIC

W.P. 6045-08-00 LOCATION N 9 949.7 E 100 17.9 Hawkeye Creek Tributary Bridge ORIGINATED BY SLL

HWY 589 BOREHOLE TYPE Hollow Stem Augers/Casing/Tricone COMPILED BY AN

DATUM DATE 2011.07.11 - 2011.07.11 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O 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
	Continued From Previous Page										
	SAND, some gravel to gravelly, some silt and clay Very Dense Grey Wet		9	SS	86		89		o		
88.6	Cobbles										
11.1	**SILT**, trace gravel, trace clay Very Dense Grey Moist		10	SS	73		88		o		
			11	SS	73		87		o		0 1 95 4
							86				
85.3	Cobbles		12	SS	100/				o		
14.4	END OF BOREHOLE AT 14.4m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. WATER OBSERVED AT 3.0m DURING DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 2.74m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Aug.17/11 1.8 97.9				0.100						

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

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

ONTMT4S 0840.GPJ 10/31/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCT-03 1 OF 2 METRIC

W.P. 6045-08-00 LOCATION N 9 949.9 E 100 15.1 Hawkeye Creek Tributary Bridge ORIGINATED BY SLL
HWY 589 BOREHOLE TYPE Hollow Stem Augers/Casing/Tricone/NQ Coring COMPILED BY AN
DATUM DATE 2011.07.07 - 2011.07.10 CHECKED BY LRB

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
99.7											
0.0	**SAND**, some gravel Brown Moist (FILL)		1	GS					○		
	Loose to Compact		1	SS	9				○		
			2	SS	15				○		
97.5											
2.2	Silty **SAND**, some gravel, trace clay Compact Brown Moist (TILL)		3	SS	18				○		
	Occasional cobbles Very Dense to Dense Wet		4	SS	63/ 0.275	▽			○		20 59 17 4
	Auger grinding										
	Some gravel		5	SS	30				○		
			6	SS	53				○		
	Occasional cobbles and boulders Grey Casing at 7.0m		7	SS	100/ 0.225				○		
			8	SS	66				○		

ELEVATION SCALE: 99, 98, 97, 96, 95, 94, 93, 92, 91, 90

Continued Next Page

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 0840.GPJ 11/1/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCT-03 2 OF 2 METRIC

W.P. 6045-08-00 LOCATION N 9 949.9 E 100 15.1 Hawkeye Creek Tributary Bridge ORIGINATED BY SLL
HWY 589 BOREHOLE TYPE Hollow Stem Augers/Casing/Tricone/NQ Coring COMPILED BY AN
DATUM DATE 2011.07.07 - 2011.07.10 CHECKED BY LRB

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 (O 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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND**, trace clay, trace gravel, occasional cobbles and boulders Very Dense Grey Wet (TILL)		9	SS	89		89		o		
			10	SS	67		88		o		2 73 20 5
			11	SS	59		87				
			12	SS	100/ 0.275		86				
84.1	Boulders and bedrock fragments						85		o		
15.6	**BEDROCK DIORITE**, moderately weathered, grey, occasional mechanical and sub-vertical breaks Sub-vertical breaks (250mm) at 16.1m Sub-vertical breaks from 16.5m to 16.9m Vertical breaks (75mm) at 16.7m Sub-vertical breaks: 125mm at 17.8m 100mm at 17.9m 100mm at 18.1m 38mm at 18.2m		1	RUN			84			FI 3 3 4	RUN #1 TCR=100% SCR=94% RQD=23% UCS=280MPa (Average)
			2	RUN			83			5 1 2	RUN #2 TCR=100% SCR=100% RQD=69% UCS=76MPa (Average)
			3	RUN			82			2 3 5	RUN #3 TCR=100% SCR=88% RQD=52% UCS=138MPa (Average)
80.9			4	RUN			81			0	RUN #4 TCR=100% SCR=100% ~~RQD=100%~~
18.8	END OF BOREHOLE AT 18.8m. WATER OBSERVED AT 3.0m DURING DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG TO 1.5m, THEN SAND AND GRAVEL TO SURFACE.										UCS=207MPa (Average)

ONTMT4S 0840.GPJ 10/31/11

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

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCT-04 1 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 9 962.7 E 100 17.8 Hawkeye Creek Tributary Bridge ORIGINATED BY SLL

HWY 589 BOREHOLE TYPE Hollow Stem Augers/Casing/Tricone/NQ Coring COMPILED BY AN

DATUM DATE 2011.07.12 - 2011.07.13 CHECKED BY LRB

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
99.3											
0.0	**SAND**, some gravel Compact Brown Moist (FILL)		1	GS			99		○		
			1	SS	16		98		○		
97.4			2	SS	19		97		○		
1.9	**SAND**, some gravel, some silt and clay, occasional organics Compact to Dense Brown Moist		3	SS	21		96		○		
	Casing at 3.0m		4	SS	25		95		○		26 66 8 (SI+CL)
	Cobbles and boulders		5	SS	13		94		○		
	Very Dense		6	SS	50/ 0.100		93		○		
92.4							92		○		
6.9	Silty **SAND**, trace gravel, trace clay Very Dense to Compact Grey Moist (TILL)		7	SS	57		91		○		
			8	SS	19		90		○		5 60 32 3

Continued Next Page

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

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCT-04 2 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 9 962.7 E 100 17.8 Hawkeye Creek Tributary Bridge ORIGINATED BY SLL

HWY 589 BOREHOLE TYPE Hollow Stem Augers/Casing/Tricone/NQ Coring COMPILED BY AN

DATUM DATE 2011.07.12 - 2011.07.13 CHECKED BY LRB

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: O 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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND**, trace gravel, trace clay Very Dense Grey Moist (TILL)		9	SS	91		89				
							88				
			10	SS	50/ 0.100						
87.1	Cobbles and boulders										
12.2	**SILT**, trace gravel, trace clay Very Dense Grey Wet		11	SS	69		87				
							86				
							85				
			12	SS	77						0 1 90 9
							84				
			13	SS	100/ 0.100		83				
82.8										FI	
16.5	**BEDROCK DIORITE**, slightly to moderately weathered, grey, occasional mechanical and sub-vertical breaks Coring started at 16.5m		1	RUN						3	RUN #1 TCR=100% SCR=92% RQD=62% UCS=236MPa (Average)
										3	
							82			3	
	Sub-vertical breaks (100mm) at 16.9m		2	RUN						3	RUN #2 TCR=100% SCR=98% RQD=88% UCS=263MPa (Average)
	Sub-vertical breaks (138mm) at 17.3m									2	
										3	
	Sub-vertical breaks at: 50mm at 18.5m 100mm at 18.6m 113mm at 18.8m 100mm at 18.9m 75mm at 19.5m 75mm at 19.3m		3	RUN			81			6	RUN #3 TCR=100% SCR=100% RQD=37% UCS=170MPa (Average)
										2	
										4	RUN #4 TCR=100% SCR=100% RQD=100% UCS=198MPa (Average)
			4	RUN			80			3	
79.6										1	
19.7	END OF BOREHOLE AT 19.7m Piezometer installation consists of										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

15 10 20 5 (%) STRAIN AT FAILURE

ONTMT4S 0840.GPJ 10/31/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCT-04 3 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 9 962.7 E 100 17.8 Hawkeye Creek Tributary Bridge ORIGINATED BY SLL

HWY 589 BOREHOLE TYPE Hollow Stem Augers/Casing/Tricone/NQ Coring COMPILED BY AN

DATUM DATE 2011.07.12 - 2011.07.13 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.										
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jul.13/11 1.2 98.1 Aug.17/11 1.9 97.4										

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

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

ONTMT4S 0840.GPJ 10/31/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCT-05 1 OF 2 METRIC

W.P. 6045-08-00 LOCATION N 9 962.5 E 100 14.9 Hawkeye Creek Tributary Bridge ORIGINATED BY SLL

HWY 589 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN

DATUM Geodetic DATE 2011.07.05 - 2011.07.05 CHECKED BY LRB

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
99.3											
0.0	**SAND**, some gravel Brown Moist (FILL)		1	GS			99		○		
	Loose		1	SS	4		98		○		
97.9											
1.4	**SAND** and **GRAVEL**, trace silt and clay Dense to Very Dense Brown Moist (TILL) Coring through cobbles and boulders from 2.4m to 4.1m		2	SS	100/ 0.100		97		○		
			3	SS	42		96		○		60 34 6 (SI+CL)
			4	SS	85		95				
	Cobbles and boulders		5	SS	100/ 0.275		94		○		
			6	SS	69		93				
91.3							92		○		61 28 11 (SI+CL)
8.1	**SAND**, some silt, trace gravel, occasional cobbles Dense Brown Moist to Wet Casing and tricone at 8.5m		7	SS	40		91		○		
							90				

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0840.GPJ 1/18/12

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCT-05 2 OF 2 METRIC

W.P. 6045-08-00 LOCATION N 9 962.5 E 100 14.9 Hawkeye Creek Tributary Bridge ORIGINATED BY SLL
HWY 589 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN
DATUM DATE 2011.07.05 - 2011.07.05 CHECKED BY LRB

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / 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
	Continued From Previous Page										
	SAND, some silt, trace gravel, cobbles and boulders Very Dense Brown Moist to Wet		8	SS	56		89		○		
			9	SS	60		88		○		
			10	SS	87		87		○		
85.3							86				
14.0	**SILT**, trace clay, trace sand Very Dense Grey Moist		11	SS	81		85		○		0 1 90 9
			12	SS	41		84		○		
82.4	Dense						83				
17.0	END OF BOREHOLE AT 17.0m UPON REFUSAL ON PROBABLE BOULDER. DCPT STARTS FROM 15.5m. DCPT TERMINATED AT 18.3m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE BACKFILLED WITH HOLELPLUG TO 1.5m, THEN SAND AND GRAVEL TO SURFACE.										

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

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

ONTMT4S 0840.GPJ 10/31/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCT-06 1 OF 2 METRIC

W.P. 6045-08-00 LOCATION N 9 966.2 E 100 19.4 Hawkeye Creek Tributary Bridge ORIGINATED BY SLL

HWY 589 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM — DATE 2011.07.14 - 2011.07.14 CHECKED BY LRB

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
99.1							99				
0.0	**ASPHALT:** (50mm)										
	SAND, trace gravel, trace silt and clay Compact to Dense Brown Moist (FILL)		1	GS							
			1	SS	17		98				
			2	SS	13						3 90 7 (SI+CL)
96.3			3	SS	42		97				
2.8	**SAND**, some gravel, trace silt and clay, occasional cobbles Very Dense to Dense Brown to Grey Moist to Wet					▽					
			4	SS	52		96				
94.8							95				
4.3	Silty **SAND**, some gravel, trace clay Dense Grey Moist (TILL)		5	SS	48		94				
			6	SS	45		93				10 59 28 3
91.9							92				
7.2	**SAND**, some gravel, trace silt and clay Dense Grey Wet		7	SS	34		91				
			8	SS	43		90				
89.2											

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 0840.GPJ 10/31/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCT-06 2 OF 2 METRIC

W.P. 6045-08-00 LOCATION N 9 966.2 E 100 19.4 Hawkeye Creek Tributary Bridge ORIGINATED BY SLL

HWY 589 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM DATE 2011.07.14 - 2011.07.14 CHECKED BY LRB

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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
9.9	**SILT**, trace sand, trace clay Dense Grey Wet						89				
88.0			9	SS	95		88				0 6 89 5
11.1	END OF BOREHOLE AT 11.1m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. WATER OBSERVED AT 3.0m DURING DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG TO 1.5m, THEN SAND AND GRAVEL TO SURFACE.										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 0840.GPJ 10/31/11

Appendix B

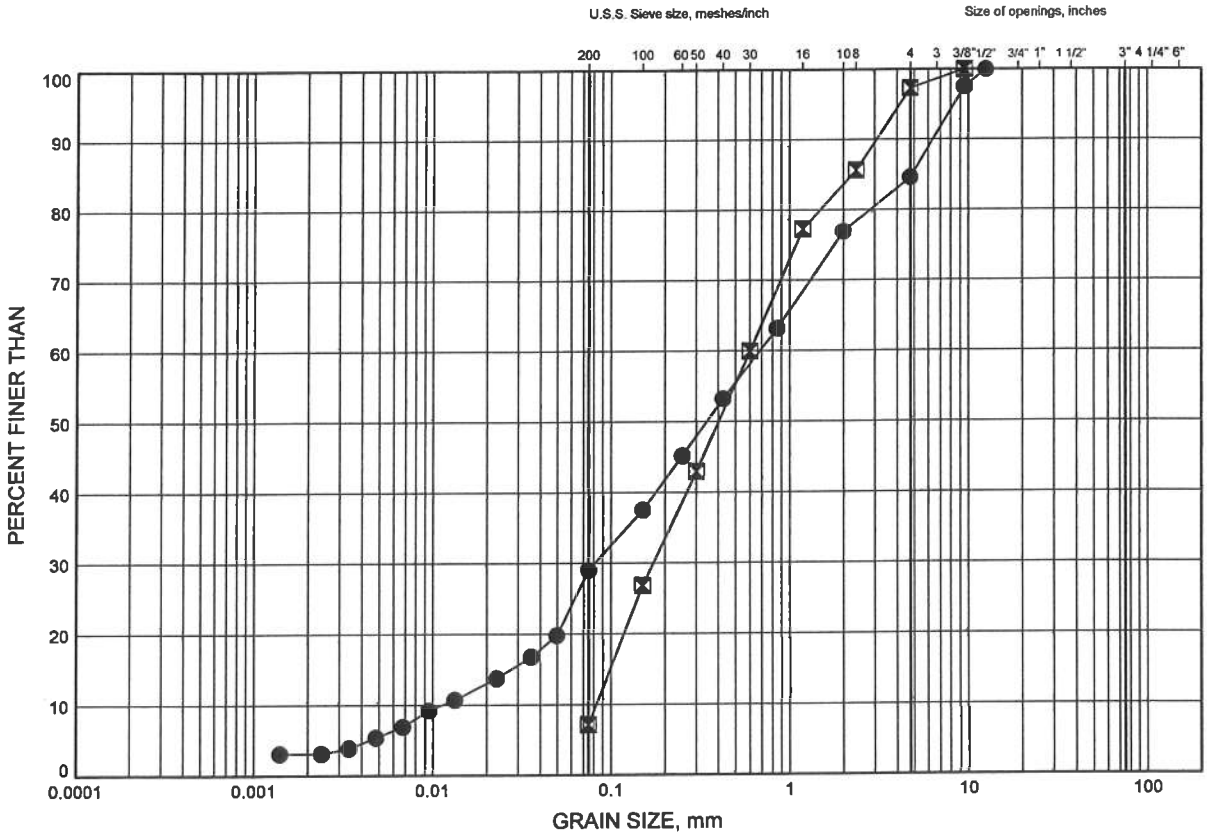
Laboratory Test Results

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B1

SILTY SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCT-02	1.07	98.64
⊠	HCT-06	1.83	95.77

W.P.# 6045-08-00
Prepared By AN
Checked By RPR

THURBER

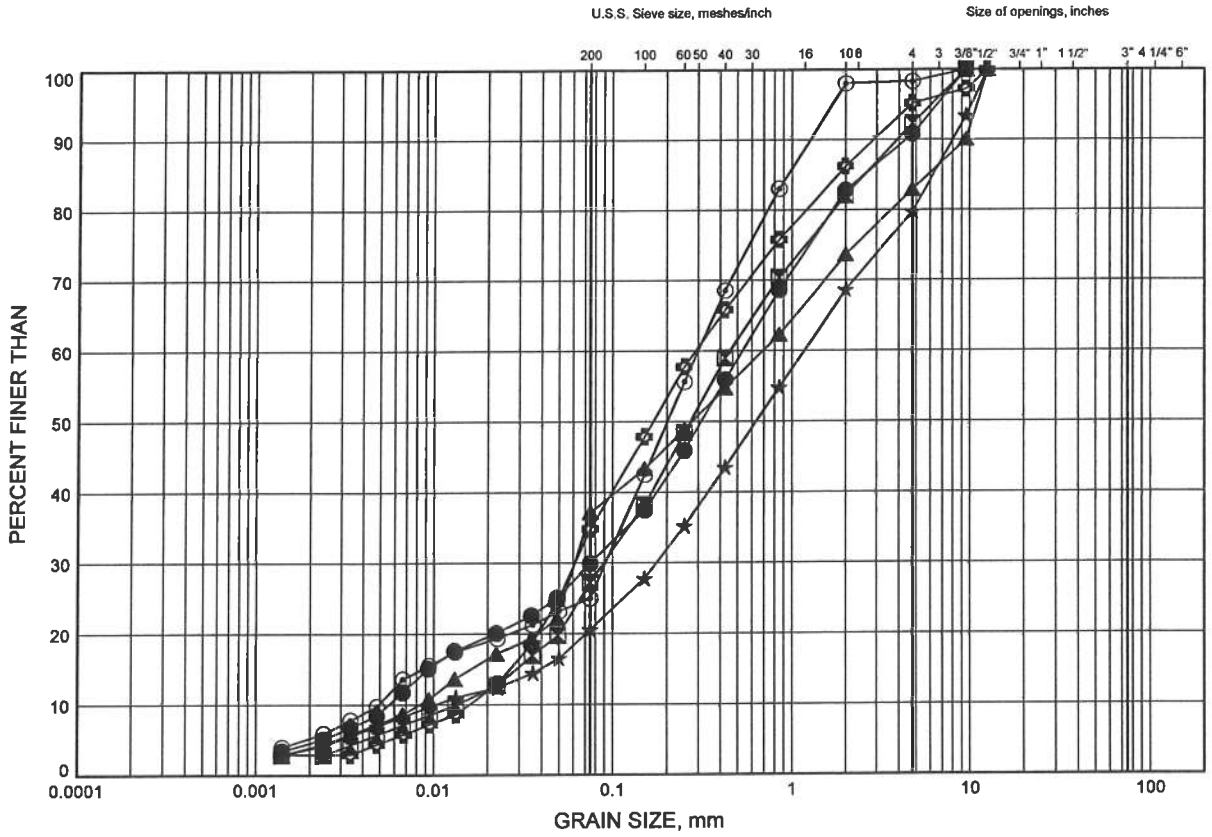
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/21/11

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCT-01	2.59	97.30
⊠	HCT-01	6.40	93.49
▲	HCT-02	4.88	94.83
★	HCT-03	3.35	96.33
⊙	HCT-03	11.89	87.79
✿	HCT-04	8.84	90.46

W.P.# 6045-08-00
Prepared By AN
Checked By RPR

THURBER

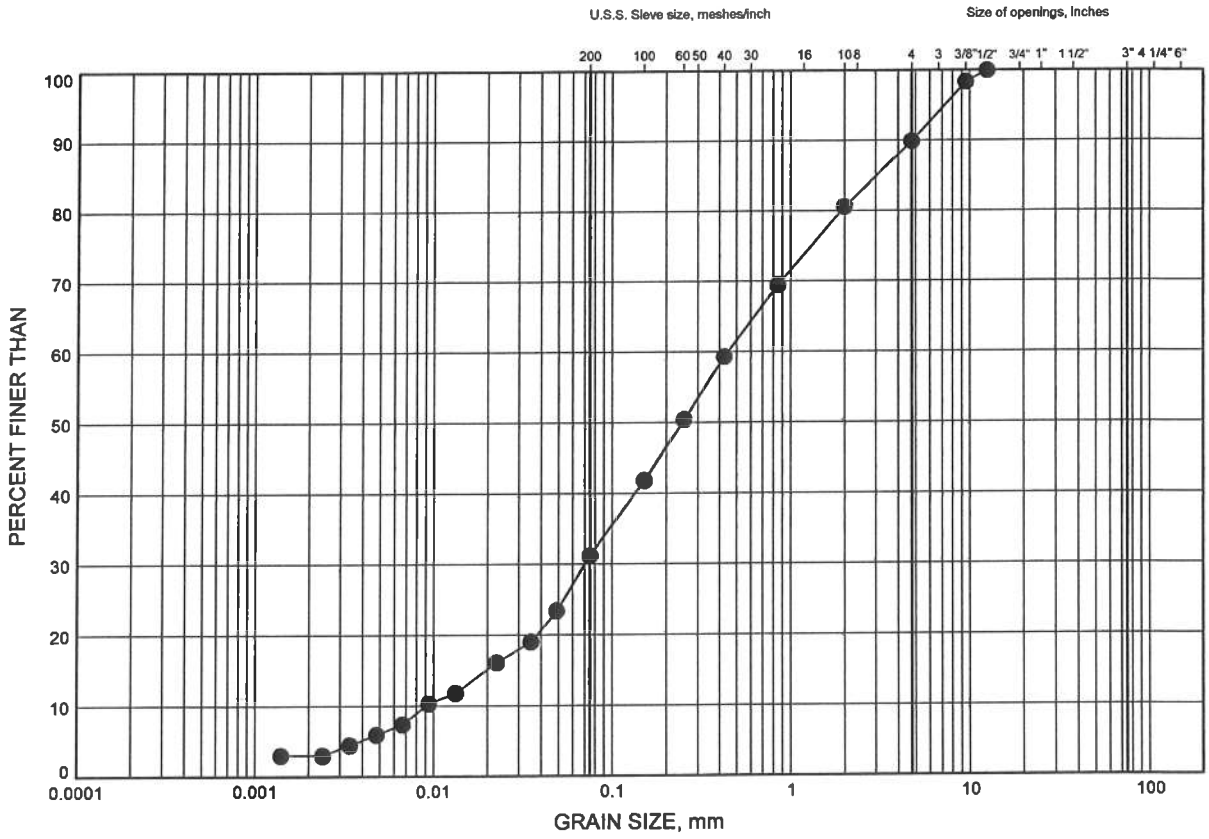
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/21/11

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCT-06	6.40	91.20

W.P.# 6045-08-00
Prepared By AN
Checked By RPR

THURBER

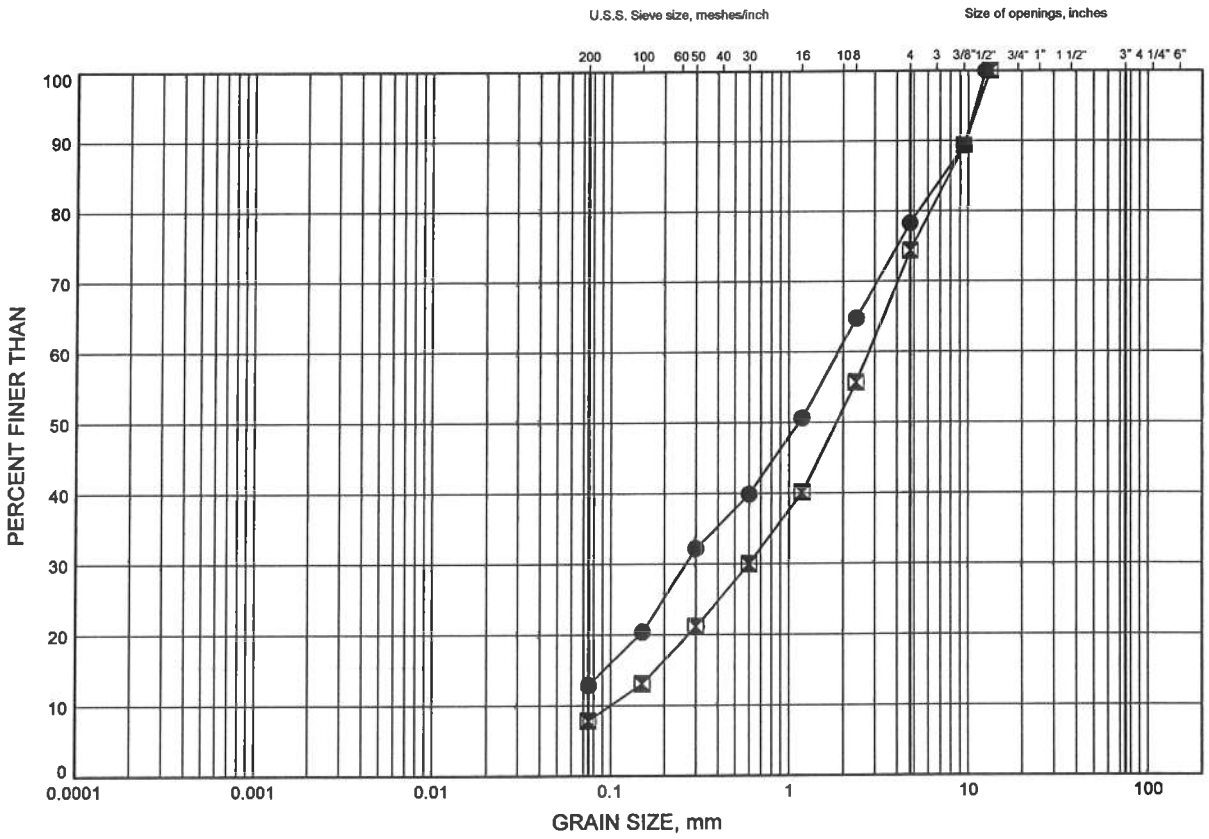
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/21/11

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND, Some Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCT-02	8.75	90.96
⊠	HCT-04	4.27	95.03

W.P.# 6045-08-00
Prepared By AN
Checked By RPR

THURBER

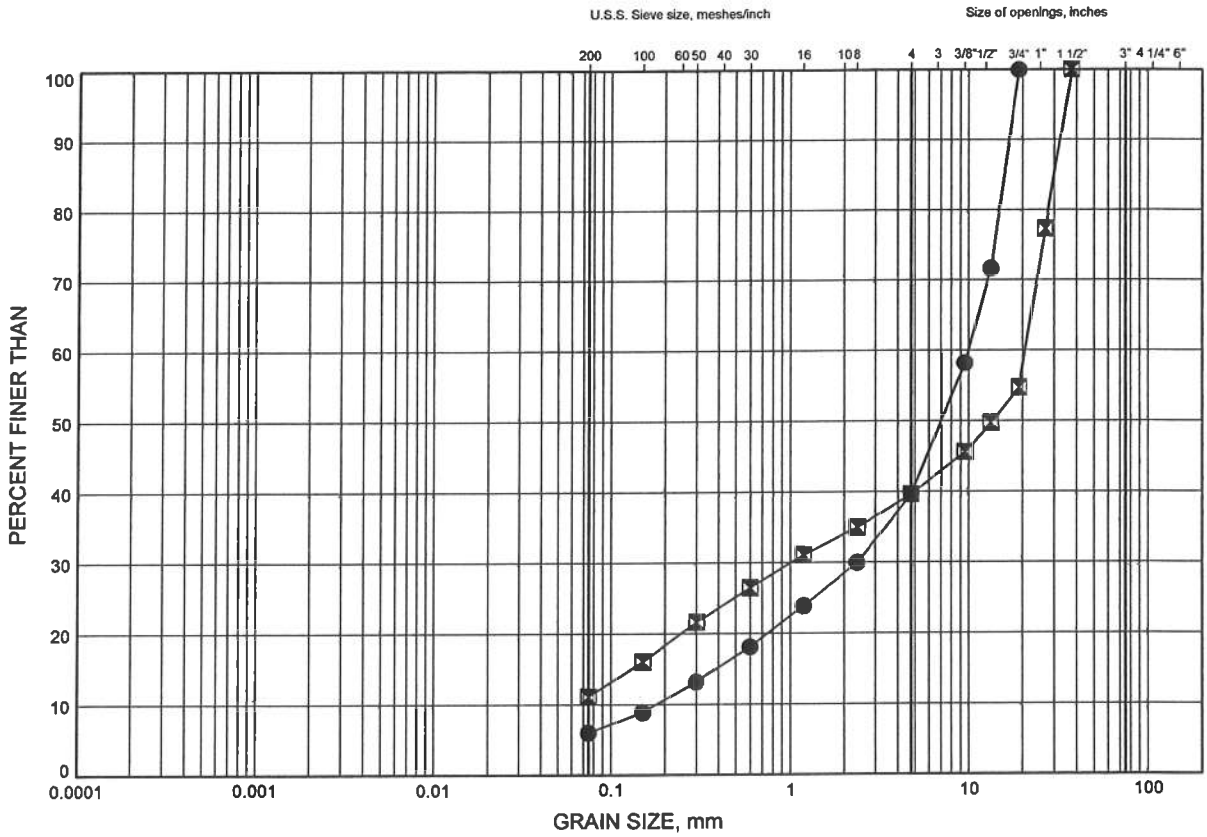
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/21/11

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND & GRAVEL TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCT-05	2.74	96.59
⊠	HCT-05	7.32	92.01

W.P.# 6045-08-00
Prepared By AN
Checked By RPR

THURBER

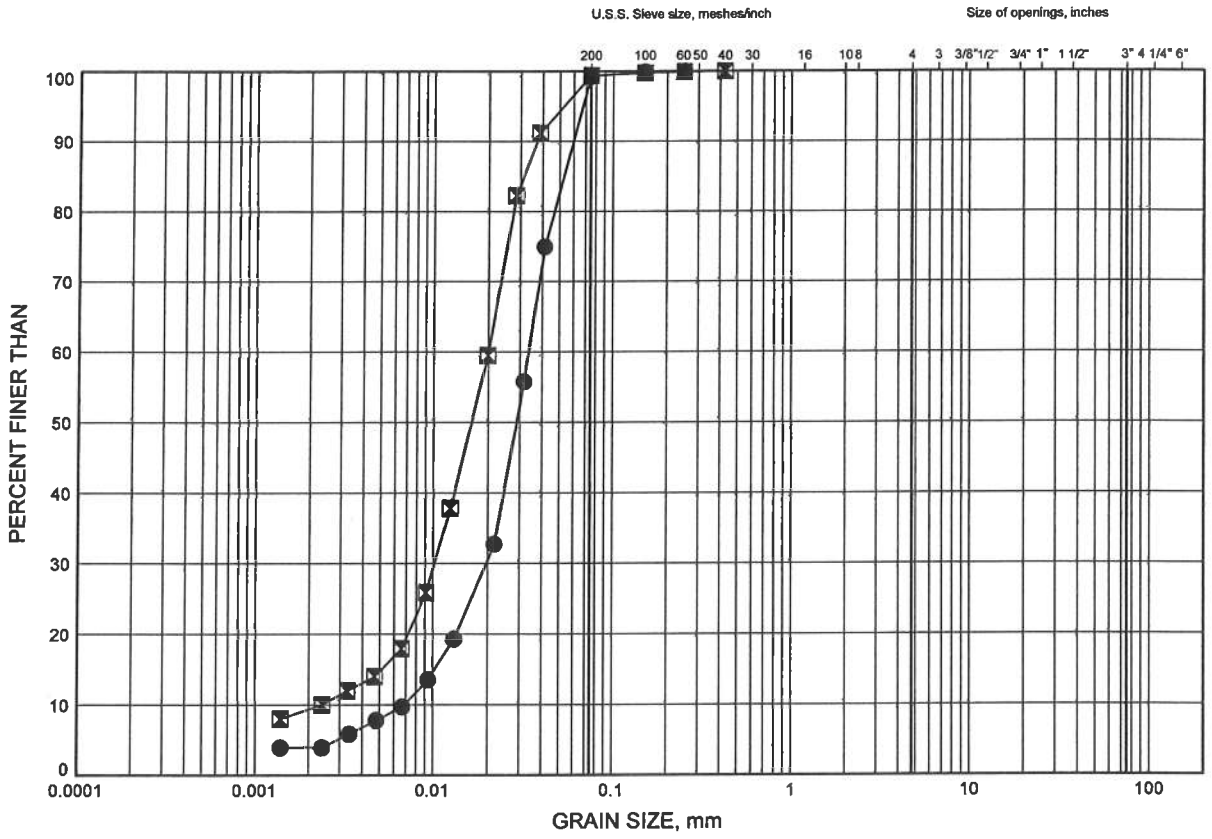
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/21/11

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B6

SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCT-02	13.41	86.30
⊠	HCT-05	14.94	84.39

W.P.# 6045-08-00
Prepared By AN
Checked By RPR

THURBER

GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/21/11

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

POINT LOAD TEST SHEET

Job No : 19-5308-40 **Client :** GENIVAR

Date Drilled : July 10,2011

Project Name : Hawkeye Tributay Creek Bridge **Date Tested :** 9/8/2011

Core Size : NQ **BH No :** HTC-03 **Tester :** DB

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	16.0	D	26.5	47.1	47.8	279.5	Diorite	Extremely Strong
2	2	16.4	A	11.4	47.2	48.5	97.4	Diorite	Strong
3	2	16.9	D	5.3	47.1	57.1	55.3	Diorite	Strong
4	3	17.4	A	28.1	47.2	51.4	229.3	Diorite	Very Strong
5	3	17.8	D	3.8	47.1	56.4	39.8	Diorite	Medium Strong
6	3	18.2	A	16.0	47.1	44.4	146.2	Diorite	Very Strong
7	4	18.7	D	19.7	47.1	53.6	207.5	Diorite	Very Strong
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
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19									
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22									
23									
24									
25									
26									
27									
28									
29									
30									

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have 0.7 x D on either side of test point.

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

POINT LOAD TEST SHEET

Job No : 19-5308-40 **Client :** GENIVAR

Date Drilled : July 13,2011

Project Name : Hawkeye Tributay Creek Bridge **Date Tested :** 9/8/2011

Core Size : NQ **BH No :** HTC-04 **Tester :** DB

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	16.6	D	22.5	47.1	87.42.57.13	236.9	Diorite	Very Strong
2	2	16.8	A	27.2	47.1	59.3	199.1	Diorite	Very Strong
3	2	17.2	D	25.3	47.1	58.2	265.8	Diorite	Extremely Strong
4	2	17.7	D	30.6	46.8	23.5	325.1	Diorite	Extremely Strong
5	3	18.0	A	24.3	47.2	70.7	154.7	Diorite	Very Strong
6	3	18.5	D	17.6	47.1	54.2	185.6	Diorite	Very Strong
7	4	18.7	A	27.5	47.1	49.4	231.4	Diorite	Very Strong
8	4	19.3	A	16.3	47.2	38.7	166.1	Diorite	Very Strong
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10									
11									
12									
13									
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27									
28									
29									
30									

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have 0.7 x D on either side of test point.

Appendix C

Site Photographs

Photograph 1 – Hawkeye Creek Tributary Bridge – Looking north

Photograph 2 – Hawkeye Creek Tributary Bridge – Looking south

Photograph 3 – Hawkeye Creek Tributary Bridge –Looking east

Photograph 4 – Hawkeye Creek Tributary Bridge – Looking west

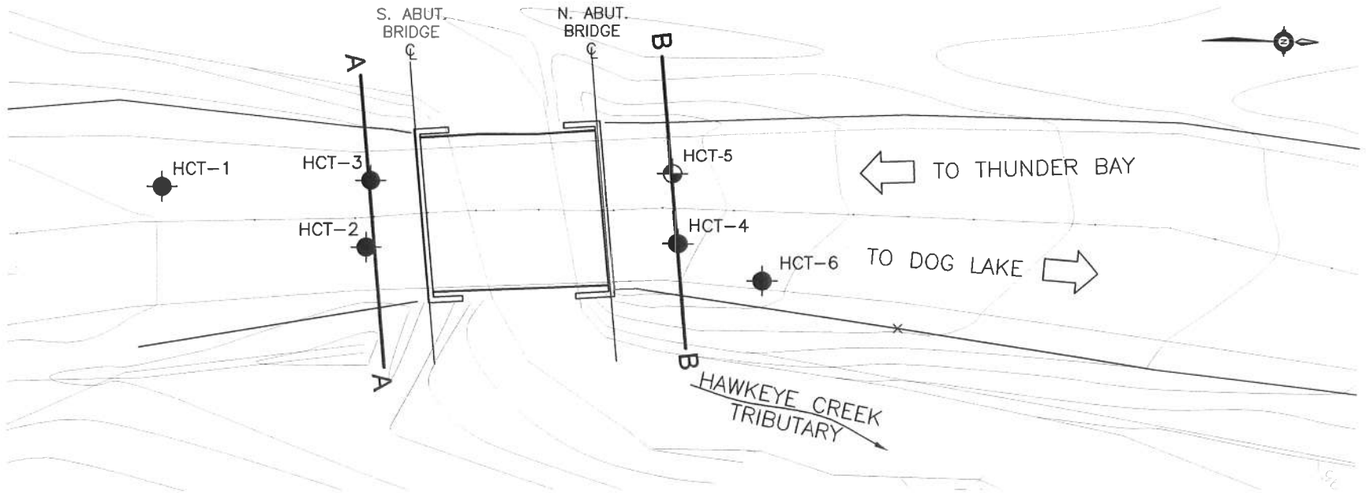
Photograph 5 – Hawkeye Creek Tributary Bridge – Looking southeast

Photograph 6 – Hawkeye Creek Tributary Bridge – Looking south

Appendix D

Borehole Locations and Soil Strata Drawings

MINISTRY OF TRANSPORTATION, ONTARIO



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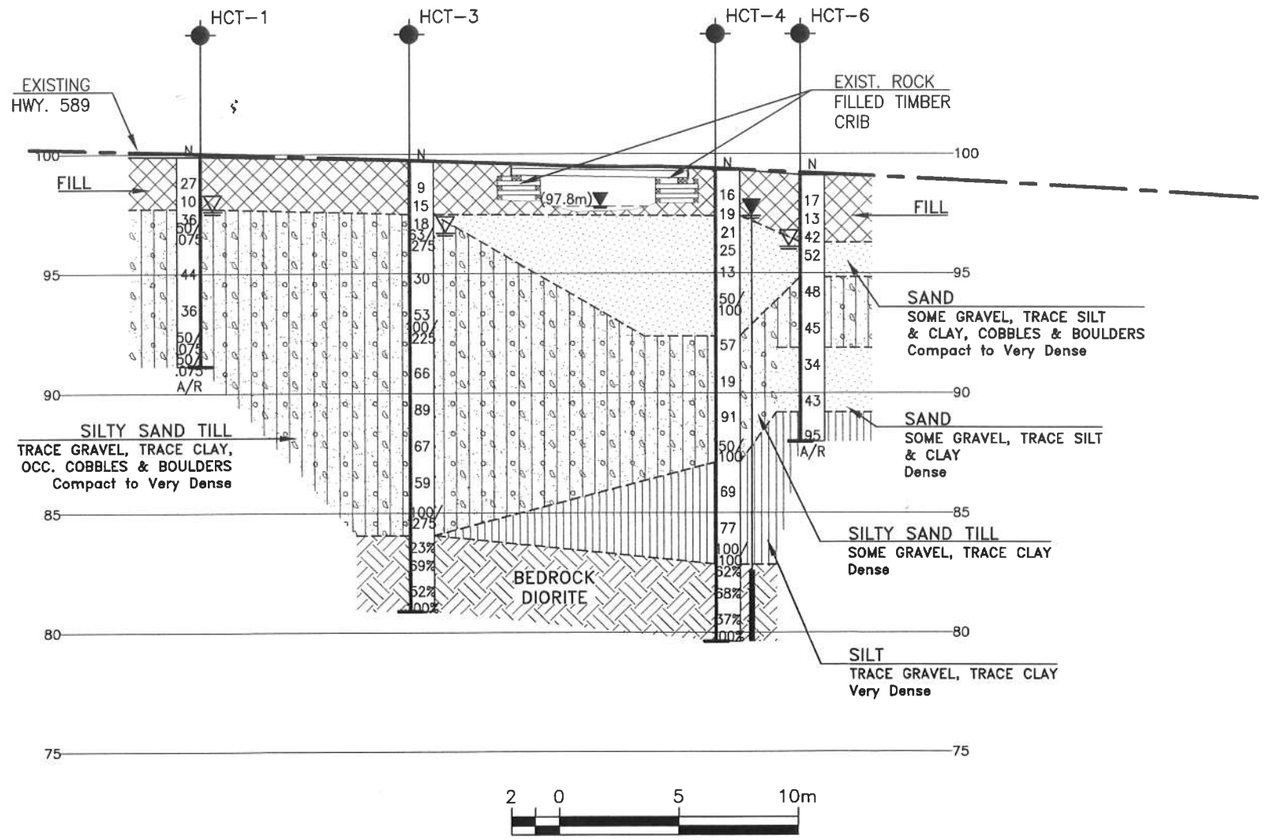
SCALE: 1:250

PLAN



2 0 5 10m

SCALE: 1:250

PROFILE ALONG HWY 589

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

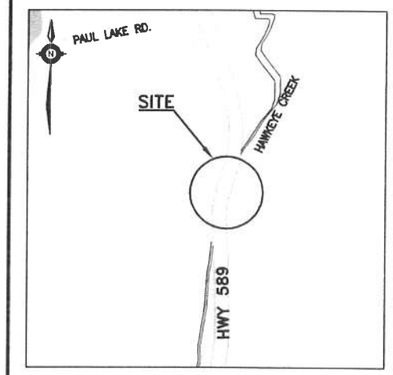
CONT No 2011-6028
WP No 6045-08-00

HAWKEYE CREEK TRIBUTARY BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

GENIVAR

THURBER ENGINEERING LTD.



KEYPLAN

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
Jan/18/2012
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Jan 18/2012
PROVINCE OF ONTARIO

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
HCT-1	99.9	9 941.2	100 15.3
HCT-2	99.7	9 949.7	100 17.9
HCT-3	99.7	9 949.9	100 15.1
HCT-4	99.3	9 962.7	100 17.8
HCT-5	99.3	9 962.5	100 14.9
HCT-6	99.1	9 966.2	100 19.4

-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. 52A-151

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	RPR	CODE	LOAD
DRAWN	AN	CHK		SITE	STRUCT

DATE JAN. 2012
DWG 2

FILENAME: H:\Drafting\19\5309\40\ed0840-BoreholePlanAndProfile(HawkeyeCreekTributary).dwg

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

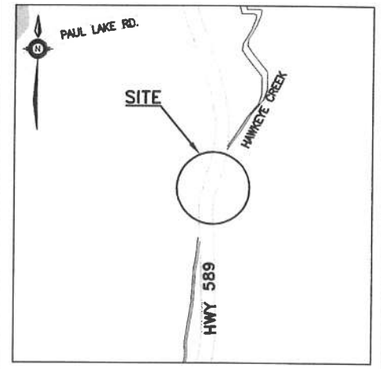
CONT No 2011-6028
WP No 6045-08-00

HAWKEYE CREEK TRIBUTARY
BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

GENIVAR

THURBER ENGINEERING LTD.



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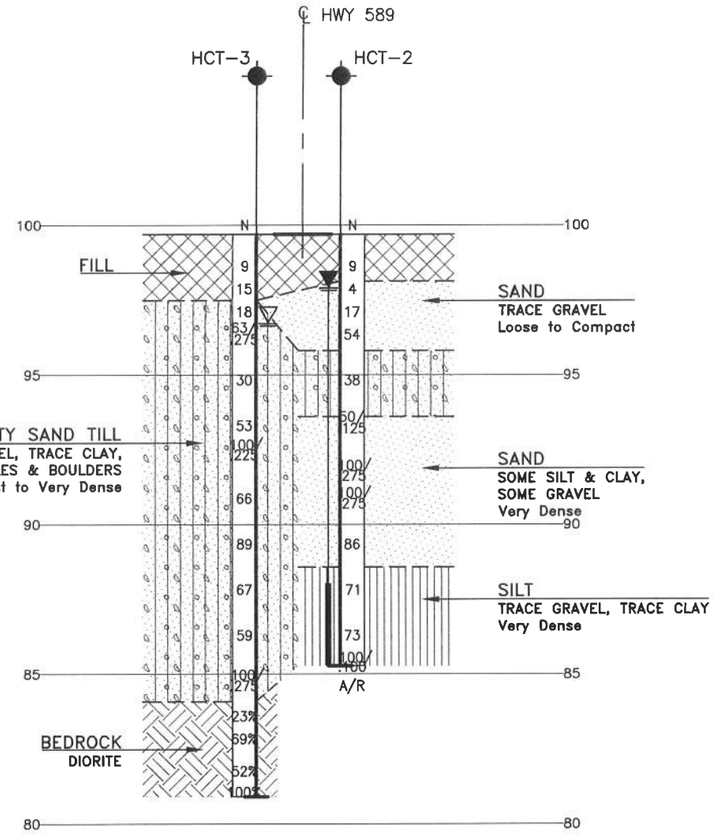
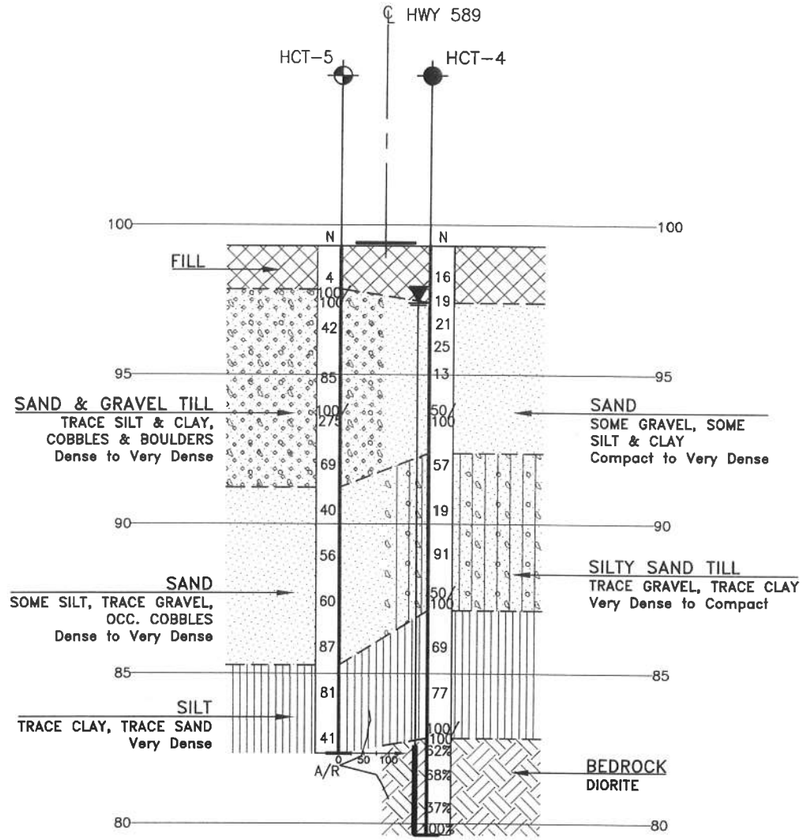


SECTION A-A



SECTION B-B

4 0 10m

SCALE: 1:200

NO	ELEVATION	NORTHING	EASTING
HCT-1	99.9	9 941.2	100 15.3
HCT-2	99.7	9 949.7	100 17.9
HCT-3	99.7	9 949.9	100 15.1
HCT-4	99.3	9 962.7	100 17.8
HCT-5	99.3	9 962.5	100 14.9
HCT-6	99.1	9 966.2	100 19.4

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

-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.

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Jan/18/2012
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LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Jan 16/2012
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK RPR	CODE	LOAD	DATE JAN. 2012
DRAWN	AN	CHK	SITE	STRUCT	DWG 3

FILENAME: H:\Drafting\19\3308\40\acd0840-BoreholePlan&Profile(HawkeyeCreekTributary).dwg