FOUNDATION INVESTIGATION REPORT
HAWKEYE CREEK BRIDGE REPLACEMENT
HIGHWAY 589, NORTH OF LAPPE, ONTARIO
THUNDER BAY UNORGANIZED DISTRICT
G.W.P. 6045-08-00, SITE 48W-241

Geocres Number: 52A-150

Report to

GENIVAR

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TABLE OF CONTENTS

PART 1 FACTUAL INFORMATION

Appendices

FOUNDATION INVESTIGATION REPORT
HAWKEYE CREEK BRIDGE REPLACEMENT
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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 Hawkeye Creek. The existing bridge carries Highway 589 over the Hawkeye Creek, approximately 20 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 bridge is located on Highway 589 (Dog Lake Road), between Paul Lake Road and Mary Lake Road, approximately 20 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 7.9 m and 6.75 m, respectively.

At this location, the Hawkeye Creek flows from west to east.

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 clays, silts and sands.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out on July 15, 17 to 19 and 21 to 23, 2011 and consisted of drilling and sampling six boreholes (identified as HCB-01 to HCB-06), at the existing bridge location through the existing highway embankments. Boreholes HCB-01 to HCB-04 were drilled near the north and south abutments and advanced within the overburden to depths ranging from 20.1 m to 24.1m (elevations 72.9 to 77.2), where the auger encountered refusal. Bedrock was proved in Boreholes HCB-01 and HCB-03 by NQ size diamond coring. Borehole HCB-01 was advanced 3.0 m into bedrock and terminated at 27.1 m depth (Elevation 69.9). Borehole HCB-03 was advanced 3.6 m into bedrock and terminated at 25.5 m depth (Elevation 71.8).

Boreholes HCB-05 and HCB-06 were drilled at the south and north approaches, respectively, and terminated at 12.8 m and 11.3 m depth (elevations 84.6 and 85.5).

Boreholes HCB-01 to HCB-04 were supplemented by dynamic cone penetration testing (DCPT) conducted adjacent to each borehole. The depths to the DCPT ranged from 18.6 m to 22.7 m (elevations 74.2 to 78.6).

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 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. One standpipe piezometer consisting of 19 mm diameter PVC pipe with a slotted screen was installed at each abutment 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
North Abutment	HCB-01	18.9 / 78.1	Piezometer with 1.5 m slotted screen installed with sand filter to 15.5 m, holeplug from 15.5 m to 14.9 m, grout from 14.9 m to 1.8 m, holeplug from 1.8 m to 0.15 m, then concrete to surface. Flushmount installed.
	HCB-02	None installed	Backfilled with bentonite holeplug from 20.4 m to 2.1 m, then sand and gravel to surface.
South Abutment	HCB-03	25.5/71.8	Piezometer with 1.5 m slotted screen installed with sand filter from 25.5 m to 21.8 m, holeplug from 21.8 m to 0.6 m, then sand and gravel to surface.
	HCB-04	None installed	Backfilled with holeplug from 10.9 m to 1.5 m, then sand and gravel to surface.
South Approach	HCB-05	None installed	Backfilled with holeplug from 6.7 m to 1.5 m, then sand and gravel to surface.
North Approach	HCB-06	None installed	Backfilled with holeplug from 7.0 m 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 D. 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 and gravel fill over native layers of sand and gravel, sand, sandy silt and silt. Cobbles and boulders

were encountered at some locations within the sand and sand and gravel layers. A 1.1 m to 2.9 m thick layer of organic silt was contacted at the north approach and north abutment. The overburden is underlain by highly weathered to fresh diorite bedrock. More detailed descriptions of the individual strata are presented below.

5.1 Fill

Granular fill was encountered surficially in all the boreholes. The granular fill consists of layers of brown sand and sand and gravel containing some silt and trace to some clay. The thickness of the cohesionless fill ranges from 1.5 m to 4.1 m.

The elevations to the base of the fill range from 93.3 to 95.5.

SPT N-values ranging from 4 to 35 blows for 0.3 m penetration were recorded in the sand fill and sand and gravel fill, indicating a loose to dense relative density.

The moisture contents of the sand fill and sand and gravel fill range from 5% to 19%.

Grain size distribution curves for selected fill samples are presented on the Record of Borehole sheets and on Figures B1 and B2 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Sand Fill (%)	Sand and Gravel Fill (%)
Gravel	7 to 8	28
Sand	67 to 86	56
Silt	23	-
Clay	3	-
Silt and Clay	6	16

5.2 Sand

Native brown to grey sand containing trace to some gravel, clay and silt was encountered in the boreholes at depths and elevations indicated in Table 5.1. Cobbles and boulders were encountered within the sand layer near elevation 77.3 in Borehole HCB-02.

Table 5.1 – Depths and Elevations of Native Sand

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
North Abutment	HCB-01	2.3 to 4.6	94.7 to 92.4	2.3
	HCB-02	1.5 to 7.6 9.0 to 13.7 15.2 to 21.0 (borehole termination depth)	95.4 to 89.3 88.0 to 83.2 81.7 to 75.9	6.1 4.7 5.8
South Abutment	HCB-03	2.9 to 4.6 13.7 to 15.2	94.3 to 92.6 83.5 to 82.0	1.7 1.5
	HCB-04	8.5	88.7	Less than 300 mm
South Approach	HCB-05	4.1 to 12.8 (borehole termination depth)	93.3 to 84.6	8.7
North Approach	HCB-06	2.9 to 6.1	93.9 to 90.7	3.2

SPT 'N' values measured in the sand ranged from 3 to 12 blows per 0.3 m of penetration indicating a very loose to compact relative density. In Borehole HCB-02, SPT 'N' values measured in sand below elevation 81.7, ranged from 22 to 28 blows per 0.3 m of penetration, indicating a compact relative density. A SPT 'N' of 50 blows without any penetration was measured in Borehole HCB-02 near elevation 77.3, which corresponds to the zone where cobbles and boulders were encountered.

The natural moisture contents generally lay in the range of 17% to 58%.

Grain size distribution curves for selected native sand samples are presented on the Record of Borehole sheets and on Figures B3 and B4 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 28
Sand	52 to 93
Silt	13
Clay	3
Silt and Clay	3 to 20

5.3 Organic silt

Dark brown to black organic silt containing some sand to sandy, trace clay and occasional roots was contacted below the native sand at 4.6 m and 6.1 m depth (elevations 92.4 and 90.7) in Boreholes HCB-01 and HCB-06, respectively. The thickness of the organic silt was 2.9 m and 1.1 m.

A layer of organic silt, approximately 800 mm thick, was encountered in Borehole HCB-01 drilled at the south abutment, at 1.5 m depth (elevation 95.5).

The depths to the base of the organic silt layer were 7.5 m and 7.2 m (elevations 89.5 and 89.7).

SPT N-values of 3 to 4 blows for 0.3 m penetration were recorded in the organic silt layer, indicating a very loose to loose relative density.

The moisture content of organic silt ranged from 81% to 159%.

A grain size distribution curve for an organic silt sample is presented on the Record of Borehole sheets and on Figure B7 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	24
Silt	71
Clay	5

5.4 Sand and Gravel

Layers of dark brown to grey sand and gravel were encountered in Boreholes HCB-01, HCB-03 and HCB-04 at depths and elevations indicated in Table 5.2.

Table 5.2 – Depths and Elevations of Native Sand and Gravel

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
North Abutment	HCB-01	20 to 24.1	77.0 to 72.9	4.1
South Abutment	HCB-03	4.6 to 13.7 15.2 to 21.9	92.6 to 83.5 82.0 to 75.3	9.1 6.7
	HCB-04	2.3 to 20.1	94.9 to 77.2	17.8

Cobbles and boulders were encountered at various depths through the sand and gravel layers. Frequent cobbles and boulders were encountered below elevation 83.0 in Borehole HCB-04, drilled at the south abutment. Cobbles and boulders were also contacted below elevation 78.0 in Boreholes HCB-02 and HCB-03.

SPT N-values in the sand and gravel layer, ranged from 3 to 55 blows per 0.3 m of penetration indicating very loose to dense relative density. In Borehole HCB-04, below elevation 83.0 generally where cobbles and boulders were contacted, the SPT 'N' values were 100 blows per 0.25 m of penetration.

The moisture contents of samples of the sand and gravel range from 8% to 20%. A sample from Borehole HCB-04, near elevation 82.5, revealed a moisture content of 3%.

Grain size distribution curves for selected 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	18 to 64
Sand	28 to 79
Silt and Clay	1 to 14

5.5 Sandy Silt

A layer of grey sandy silt containing trace clay was contacted below the organic silt layer at 7.5 m depth (elevation 89.5) in Borehole HCB-01. The thickness of the sandy silt layer was 12.5 m.

The depth to the base of the sandy silt was 20.0 m (elevation 77.0).

SPT 'N' values of the sandy silt layer ranged from 2 to 27 blows per 0.3 m of penetration, indicating a very loose to compact relative density. Near elevation 77.5, a SPT 'N' value of 44 blows per 0.3 m of penetration, indicating a dense relative density.

The moisture content in the sandy silt ranged from 16% to 30%, and one sample was 62%.

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

Soil Particles	(%)
Gravel	0
Sand	24 to 33
Silt	63 to 72
Clay	4 to 5

5.6 Silt

Grey silt containing trace to some sand, trace clay and occasional roots was contacted in Boreholes HCB-02 and HCB-06 at depths and elevations indicated in Table 5.3.

Table 5.3 – Depths and Elevations of Native Silt

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
North Abutment	HCB-02	7.6 to 9.0 13.7 to 15.2	89.3 to 88.0 83.2 to 81.7	1.4 1.5
South Approach	HCB-06	7.2 to 11.3 (borehole termination depth)	89.7 to 85.5	4.1

SPT 'N' values measured in the silt ranged from 2 to 16 blows per 0.3 m of penetration indicating a very loose to compact relative density.

The natural moisture contents generally lay in the range of 17% to 19%. One sample from Borehole HCB-02 revealed moisture content of 78%.

Grain size distribution curves for selected silt samples are presented on the Record of Borehole sheets and on Figure B8 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	2 to 14
Silt	82 to 94
Clay	4

5.7 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 moderately weathered to fresh. The cores obtained from Runs 1 and 2 of Borehole HCB-01 were described as highly weathered.

Bedrock was proved by coring in Boreholes HCB-01 and HCB-03 drilled at the north and south abutment, respectively. Table 5.4 summarizes depths and elevations to the top of bedrock or depth to auger refusal in the boreholes.

Table 5.4 – Depths and Elevations of Top of Bedrock / Auger Refusal

Location	Borehole	Top of Bedrock/Refusal	
		Depth (m)	Elevation (m)
North Abutment	HCB-01*	24.1	72.9
	HCB-02	21.0	75.9
South Abutment	HCB-03*	21.9	75.3
	HCB-04	20.1	77.2

*Bedrock proved by coring

Total core recovery (TCR) in the bedrock was 100% in most of the cores and 76% in Borehole HCB-03 Run 1. The RQD values ranged from 25% to 68%, indicating poor to fair rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was generally 0 to 8. The FI was greater than 10 in cores from Borehole HCB-01.

The estimated unconfined compressive strength of the rock cores generally ranges from 50 MPa to 193 MPa, indicating a strong to very strong rock. Lower estimated unconfined compressive strength of 12 MPa was measured in Borehole HCB-01 Run1, indicating a weak 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.

5.8 Water Levels

Water levels were observed in the open boreholes upon completion of drilling operations. Two standpipe piezometers were installed in Boreholes HCB-01 and HCB03 to monitor water levels after completion of drilling. The water levels measured in the open boreholes and piezometers are summarized in Table 5.5.

Table 5.5 – Water Level Measurements

Location	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
North Abutment	HCB-01	August 17, 2011	1.4	95.6	Piezometer
South Abutment	HCB-03	August 17, 2011	1.6	95.6	Piezometer
	HCB-04	July 21, 2011	1.8	95.4	Open borehole
South Approach	HCB-05	July 23, 2011	2.3	95.1	Open borehole
North Approach	HCB-06	July 23, 2011	1.7	95.1	Open borehole

The piezometric readings reveal that the groundwater level is at elevation 95.6, 1.4 m to 1.6 m below ground surface.

GA drawing indicates the following water levels/elevations of the Hawkeye Creek at the bridge location at various dates:

- 95.8 on April 14, 2011
- 95.2 on July 19, 2011
- 95.4 on 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. Jason Mei and Mr. George Azzopardi of Thurber.

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.

Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer

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

Appendix A

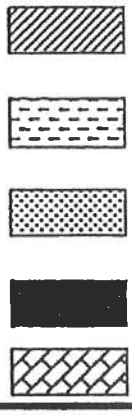
Record of Borehole Sheets

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



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

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

∇ 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

RECORD OF BOREHOLE No HCB-01 1 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 101 17.0 E 9 976.5 Hawkeye Creek Bridge ORIGINATED BY GA

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

DATUM Geodetic DATE 2011.07.15 - 2011.07.15 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
97.0									
0.0	**SAND**, some silt, trace clay, trace gravel Compact Brown Damp (FILL)		1	SS	20				
			2	SS	16				7 67 23 3
95.5									
1.5	**ORGANIC SILT**, occasional rootlets Loose Dark Brown to Black		3	SS	4				
94.7									
2.3	**SAND** Loose to Compact Brown Wet		4	SS	6				
			5	SS	12				
92.4									
4.6	**ORGANIC SILT**, sandy, trace clay Loose Dark Brown to Black		6	SS	4				
			7	SS	4				
89.5									
7.5	Sandy **SILT**, trace clay Very Loose to Loose Grey Damp		8	SS	2				0 24 71 5
	Compact		9	SS	9				

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

ELEVATION SCALE 97 96 95 94 93 92 91 90 89 88

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

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

ONTMT4S 0840.GPJ 10/12/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-01 2 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 101 17.0 E 9 976.5 Hawkeye Creek Bridge ORIGINATED BY GA
HWY 589 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.07.15 - 2011.07.15 CHECKED BY LRB

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)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy SILT, trace clay Compact Grey Wet										
			10	SS	16		86				0 24 72 4
			11	SS	15		85				
			12	SS	16		84				
			13	SS	13		83				0 33 63 4
			14	SS	27		82				
			15	SS	23		81				
			16	SS	44		80				
	Dense						79				
77.0							78				

Continued Next Page

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

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

ONTMT4S 0840.GPJ 9/29/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-01 3 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 101 17.0 E 9 976.5 Hawkeye Creek Bridge ORIGINATED BY GA
HWY 589 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2011.07.15 - 2011.07.15 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page								
20.0	**SAND** and **GRAVEL**, some silt and clay Dense Grey Wet						77		
			17	SS	42		76		51 35 14 (SI+CL)
							75		
							74		
			18	SS	50/ 0.00				
72.9							73	FI	
24.1	**BEDROCK DIORITE**, highly weathered, grey, occasional mechanical and sub-vertical breaks Coring started at 24.1m Highly broken zone from 24.2m to 24.6m and 24.9m to 25.2m Horizontal joints at 24.1m		1	RUN				>5 >10 3 >10 0	RUN #1 TCR=100% SCR=30% RQD=25% UCS=12MPa (Average)
							72		
	Highly broken zone from 25.6m to 25.9m and 25.9m to 26.0m Fresh		2	RUN			71	>10 >5 0 0 0	RUN #2 TCR=100% SCR=68% RQD=68% UCS=52MPa (Average)
69.9							70		
27.1	END OF BOREHOEL AT 27.1m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Aug.17/11 1.4 95.6								

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

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

ONTMT4S 0840.GPJ 9/29/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-02 1 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 101 17.4 E 9 981.1 Hawkeye Creek Bridge ORIGINATED BY GA
HWY 589 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.07.17 - 2011.07.17 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
96.9							
0.0	**SAND and GRAVEL** Dense to Compact Brown Damp (FILL)		1	SS	35		
			2	SS	11		
95.4							
1.5	**SAND**, some gravel, some silt and clay Loose Grey Wet		3	SS	9		
	Occasional wood fibres		4	SS	8		
			5	SS	3		
	Occasional cobbles		6	SS	4		
	Layer of organics from 6.0m to 6.7m		7	SS	4		
89.3							
7.6	**SILT**, trace sand, trace clay Very Loose Grey Wet		8	SS	2		
88.0							
9.0	**SAND** Loose Grey Wet		9	SS	8		

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 (%)

GR	SA	SI	CL	
	28	52	20	(SI+CL)
	0	90	10	(SI+CL)

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 0840.GPJ 9/29/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-02 2 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 101 17.4 E 9 981.1 Hawkeye Creek Bridge ORIGINATED BY GA
HWY 589 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.07.17 - 2011.07.17 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page								
	SAND, trace to some silt, trace clay Compact Grey Wet								
			10	SS	11		86		
			11	SS	12		85		
83.2							84		
13.7	**SILT**, trace sand, trace clay Compact Grey Wet		12	SS	16		83		0 2 94 4
81.7							82		
15.2	**SAND**, trace gravel, trace silt and clay Compact Grey Wet		13	SS	22		81		
			14	SS	28		80		6 84 10 (SI+CL)
			15	SS	22		79		
	Cobbles and boulders from 19.5m to 21.0m		16	SS	50/		78		
							77		

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

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 0840.GPJ 9/29/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-02 3 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 101 17.4 E 9 981.1 Hawkeye Creek Bridge ORIGINATED BY GA

HWY 589 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2011.07.17 - 2011.07.17 CHECKED BY LRB

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	w_P w w_L	γ kN/m^3	GR SA SI CL
	Continued From Previous Page										
	SAND, trace gravel, trace clay, cobbles and boulders Compact Grey Wet				0.00						
75.9							76				
21.0	END OF BOREHOLE AT 21.0m UPON AUGER REFUSAL ON PROBABLE BEDROCK OR BOULDERS. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG FROM 20.4m TO 2.1m, THEN SAND AND GRAVEL TO SURFACE.										

SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE

WATER CONTENT (%): 20 40 60

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

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

ONTMT4S 0840.GPJ 10/5/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-03 1 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 101 05.7 E 9 981.3 Hawkeye Creek Bridge ORIGINATED BY JM

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

DATUM Geodetic DATE 2011.07.18 - 2011.07.19 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 + 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
97.2											
0.0	**SAND** and **GRAVEL** Loose to Compact Brown Moist (FILL)		1	AS			97		○		
			1	SS	12				○		
			2	SS	4		96		○		
	Trace silt Brown to Dark Brown Moist to Wet		3	SS	8		95		○		
94.3											
2.9	**SAND**, trace gravel, some silt, trace clay, occasional organics Very Loose Dark Brown Wet		4	SS	3		94		○		7 77 13 3
92.6											
4.6	**SAND** and **GRAVEL**, trace silt and clay Loose to Compact Dark Brown Wet		5	SS	8		93		○		
							92				
			6	SS	12		91		○		45 54 1 (SI+CL)
							90				
			7	SS	5		89		○		
							88				
	Grey		8	SS	5				○		

Continued Next Page

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

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

ONTMT4S 0840.GPJ 9/29/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-03 2 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 101 05.7 E 9 981.3 Hawkeye Creek Bridge ORIGINATED BY JM

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

DATUM Geodetic DATE 2011.07.18 - 2011.07.19 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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **GRAVEL**, trace silt and clay Loose to Compact Grey Wet						87				
			9	SS	7		86		○		63 34 3 (SI+CL)
			10	SS	10		85		○		
83.5							84				
13.7	**SAND**, trace gravel, trace silt Compact Grey Wet		11	SS	11		83		○		
82.0											
15.2	**SAND** and **GRAVEL**, trace silt and clay Compact to Very Dense Grey Wet		12	SS	24		82		○		
	Cobbles and boulders		13	SS	55		81		○		64 28 8 (SI+CL)
			14	SS	47		80		○		
							79		○		
	Cobbles and boulders from 19.8m to 21.1m		15	SS	100/		78				

Continued Next Page

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

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

ONTMT4S 0840.GPJ 9/29/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-03 3 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 101 05.7 E 9 981.3 Hawkeye Creek Bridge ORIGINATED BY JM

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

DATUM Geodetic DATE 2011.07.18 - 2011.07.19 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page								
	SAND and **GRAVEL**, trace silt and clay Compact Grey Wet				0.025		77		
	Cobbles and boulders from 19.8m to 21.1m						76		
75.3			16	SS	23				
21.9	**BEDROCK DIORITE**, moderately to slightly weathered, grey, occasional mechanical and sub-vertical breaks Coring started at 2.2m Horizontal breaks at 22.3m, 22.7m, 22.8m, 22.9m, 23.1m, 23.2m, 23.4m Sub-vertical breaks: 150mm at 22.5m 100mm at 22.6m 100mm at 23.4m		1	RUN			75	FI 8 6 5	RUN #1 TCR=76% SCR=71% RQD=33% UCS=163MPa (Average)
	Sub-vertical breaks (25mm to 50mm thick) at 23.8m, 23.9m, 24.0m, 24.1m, 24.4m and 24.5m Bedrock, granite at 24.0m, white and pink, slightly weathered to fresh Horizontal breaks at 25.0m, 25.1m, 25.2m and 25.3m		2	RUN			74 73	4 3 4 1	RUN #2 TCR=100% SCR=100% RQD=63% UCS=105MPa (Average)
71.8	125mm thick sub-vertical breaks at 24.9m		3	RUN			72	3 8 4	RUN #3 TCR=100% SCR=87% RQD=44% UCS=102MPa (Average)
25.5	END OF BOREHOLE AT 25.5m. BOREHOLE OPEN TO 25.5m AND WATER LEVEL AT 2.1m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Aug.17/11 1.6 95.6								

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

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

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

ONTMT4S 0840.GPJ 10/5/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-04 1 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 101 05.3 E 9 978.1 Hawkeye Creek Bridge ORIGINATED BY GA

HWY 589 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2011.07.21 - 2011.07.23 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
97.2											
0.0	**SAND** and **GRAVEL** Brown Moist (FILL)		1	AS							
	Compact to Loose		1	SS	13						
			2	SS	9	▽					
94.9											
2.3	**SAND** and **GRAVEL**, trace silt and clay, occasional organics Loose Dark Brown Wet		3	SS	9						32 61 7 (SI+CL)
			4	SS	9						
	Very Loose		5	SS	4						
	Compact		6	SS	21						
	Grey		7	SS	13						
	Layer of sand, some gravel at 8.5m		8	SS	14						18 79 3 (SI+CL)

97 96 95 94 93 92 91 90 89 88

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 0840.GPJ 10/5/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCB-04 2 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 101 05.3 E 9 978.1 Hawkeye Creek Bridge ORIGINATED BY GA

HWY 589 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2011.07.21 - 2011.07.23 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 + 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
	Continued From Previous Page											
	SAND and **GRAVEL**, trace silt and clay Compact to Loose Grey Wet		9	SS	10		87					
			10	SS	5		86					
	Very Loose		11	SS	3		85					
	Cobble at 14.0m						84					
	Cobble at 14.3m						83					
	Boulder at 14.6m		12	SS	100/ 0.125		82					
	Boulder at 15.2m						81					
	Boulder at 15.5m		13	SS	100/0.150		80					37 53 10 (SI+CL)
	Boulder at 17.1m		14	SS	100/ 0.150		79					
	Boulder at 18.6m		15	SS	100/ 0.025		78					

Continued Next Page

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

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

ONTMT4S 0840.GPJ 1/18/12

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-04 3 OF 3 METRIC

W.P. 6045-08-00 LOCATION N 101 05.3 E 9 978.1 Hawkeye Creek Bridge ORIGINATED BY GA

HWY 589 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2011.07.21 - 2011.07.23 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
77.2	Continued From Previous Page										
20.1	END OF BOREHOLE AT 20.1m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN TO 10.9m AND WATER LEVEL AT 1.8m. BOREHOLE BACKFILLED WITH HOLEPLUG FROM 10.9m TO 1.5m, THEN SAND AND GRAVEL TO SURFACE.						77				

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

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

ONTMT4S 0840.GPJ 10/5/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-05 1 OF 2 METRIC

W.P. 6045-08-00 LOCATION N 100 97.8 E 9 983.1 Hawkeye Creek Bridge ORIGINATED BY JM
HWY 589 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.07.23 - 2011.07.23 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 + 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
97.4											
0.0	**SAND** and **GRAVEL**, some silt and clay Brown Moist (FILL)		1	AS			97		○		
	Loose to Compact		1	SS	8				○		
			2	SS	17		96		○		28 56 16 (SI+CL)
			3	SS	20	▽	95		○		
			4	SS	8		94		○		
93.3											
4.1	**SAND**, trace gravel, trace silt and clay Loose Grey Wet		5	SS	8		93		○		
			6	SS	6		92				
			7	SS	9		91		○		15 81 4 (SI+CL)
			8	SS	4		90				
							89		○		
							88		○		0 93 7 (SI+CL)

Continued Next Page

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

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

ONTMT4S 0840.GPJ 9/29/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-05 2 OF 2 METRIC

W.P. 6045-08-00 LOCATION N 100 97.8 E 9 983.1 Hawkeye Creek Bridge ORIGINATED BY JM

HWY 589 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2011.07.23 - 2011.07.23 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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	SAND, trace silt and clay Loose Grey Wet						87				
			9	SS	7		86		○		
84.6			10	SS	8		85				
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN TO 6.7m AND WATER LEVEL AT 2.3m. BOREHOLE BACKFILLED WITH HOLEPLUG FROM 6.7m 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 9/29/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-06 1 OF 2 METRIC

W.P. 6045-08-00 LOCATION N 101 25.1 E 9 976.4 Hawkeye Creek Bridge ORIGINATED BY GA
HWY 589 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.07.23 - 2011.07.23 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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
96.8											
0.0	**SAND**, trace gravel, trace silt and clay Compact to Dense Brown Moist (FILL)		1	AS					○		
			1	SS	17		96		○		
			2	SS	34	▽	95		○		
			3	SS	9				○		8 86 6 (SI+CL)
93.9	Loose						94				
2.9	**SAND**, trace gravel, trace silt and clay Loose Grey Wet		4	SS	9				○		
							93				
			5	SS	5		92		○		
90.7							91				
6.1	**ORGANIC SILT**, sandy, trace clay, occasional roots Very Loose Dark Brown to Black Wet		6	SS	3				105 ○		0 24 71 5
89.7							90				
7.2	**SILT**, trace to some sand, trace clay, occasional roots Very Loose to Loose Grey Wet		7	SS	3		89				
			8	SS	9		88		○		
86.9							87				

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

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

ONTMT4S 0840.GPJ 10/12/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HCB-06 2 OF 2 METRIC

W.P. 6045-08-00 LOCATION N 101 25.1 E 9 976.4 Hawkeye Creek Bridge ORIGINATED BY GA

HWY 589 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2011.07.23 - 2011.07.23 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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
9.9	**SILT**, some sand, trace clay Loose Grey Wet										
85.5			9	SS	8		86		○		0 14 82 4
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 7.0m AND WATER LEVEL AT 1.7m. BOREHOLE BACKFILLED WITH HOLEPLUG FROM 7.0m TO 1.5m, THEN SAND AND GRAVEL TO SURFACE.										

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

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

ONTMT4S 0840.GPJ 10/5/11

Appendix B

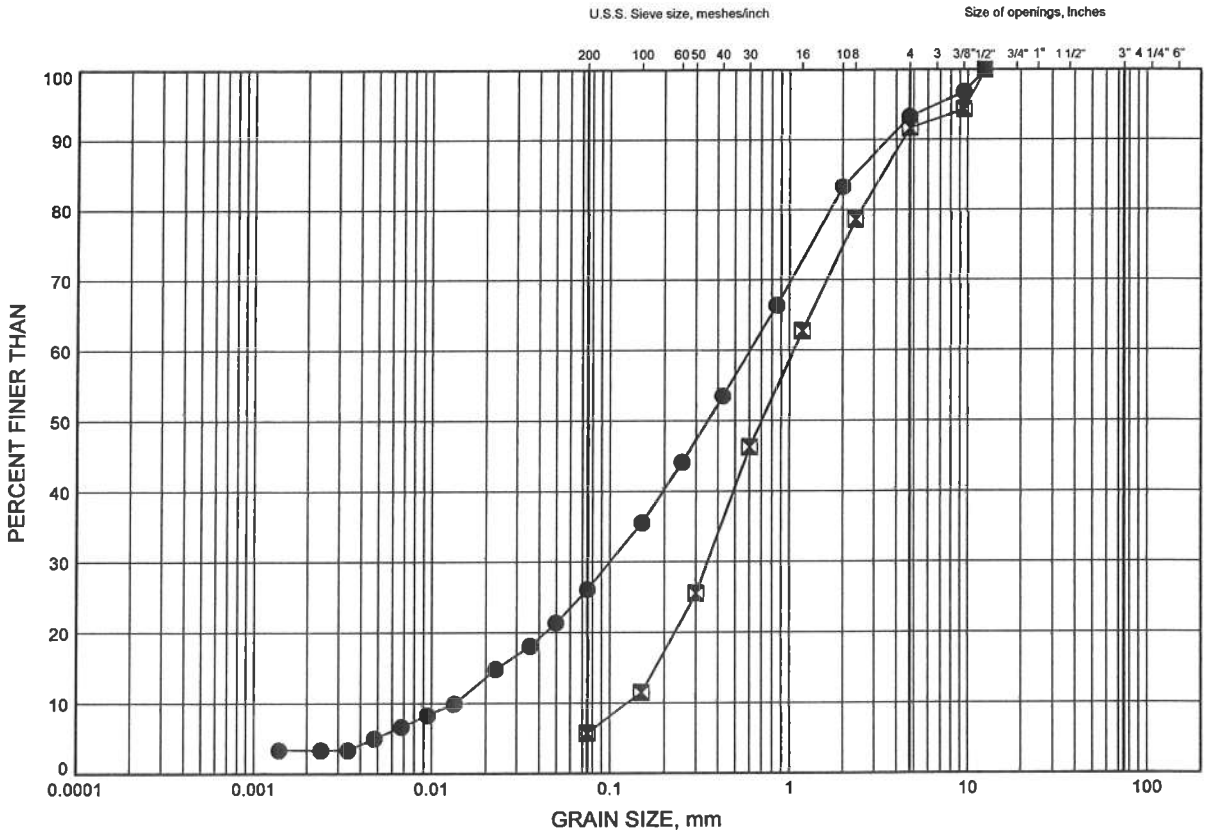
Laboratory Test Results

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCB-01	1.07	95.94
⊠	HCB-06	2.59	94.23

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

THURBER

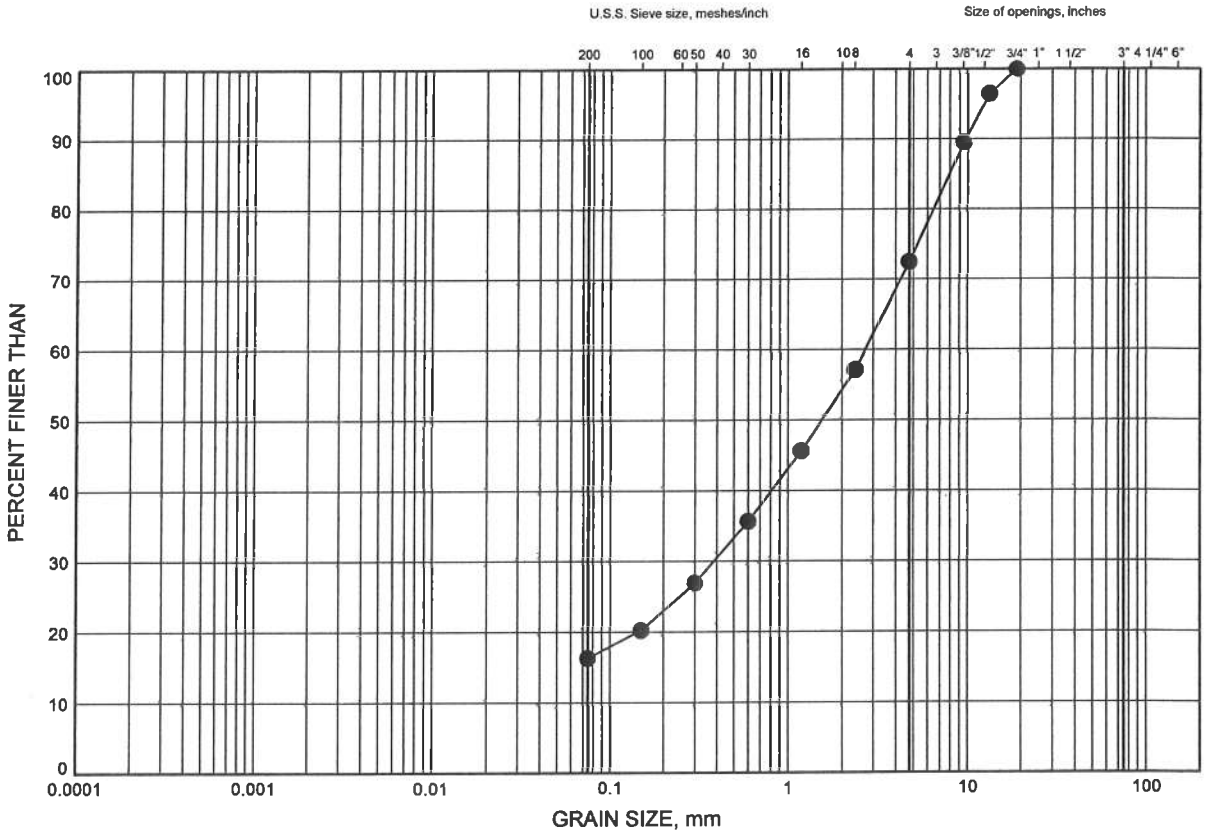
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/5/11

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND & GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCB-05	1.83	95.61

W.P.# 6045-08-00

Prepared By AN

Checked By RPR

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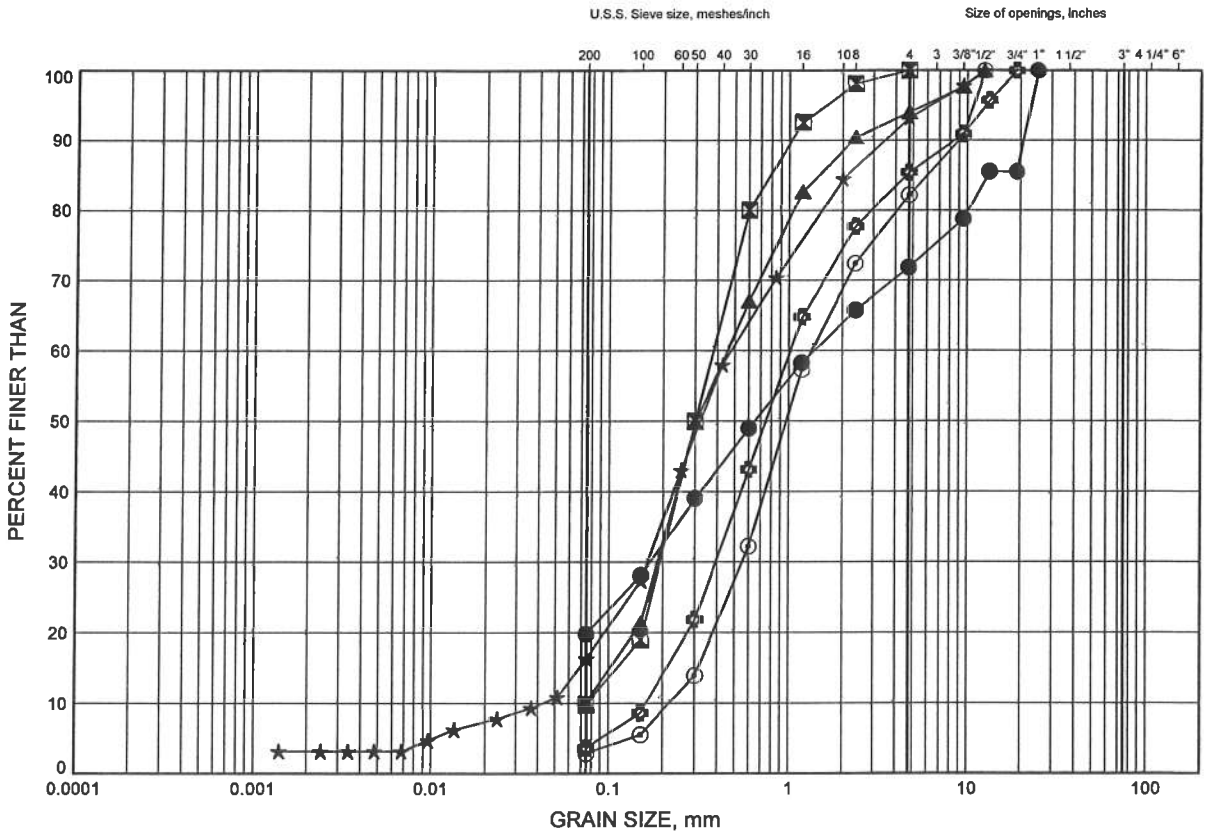
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/5/11

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCB-02	1.83	95.12
⊠	HCB-02	4.88	92.07
▲	HCB-02	17.07	79.88
★	HCB-03	3.35	93.87
⊙	HCB-04	8.84	88.39
✿	HCB-05	6.40	91.04

W.P.# 6045-08-00

Prepared By AN

Checked By RPR

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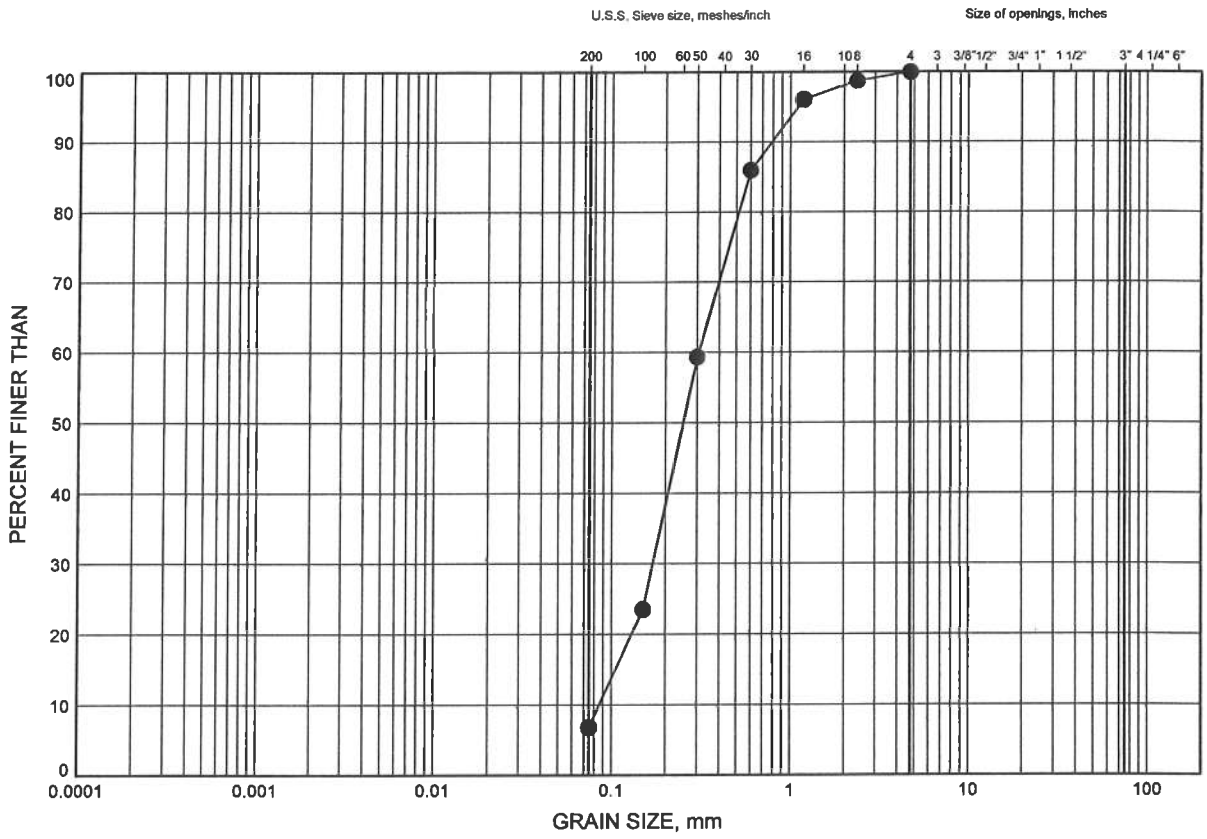
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/5/11

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCB-05	9.45	87.99

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Checked By RPR

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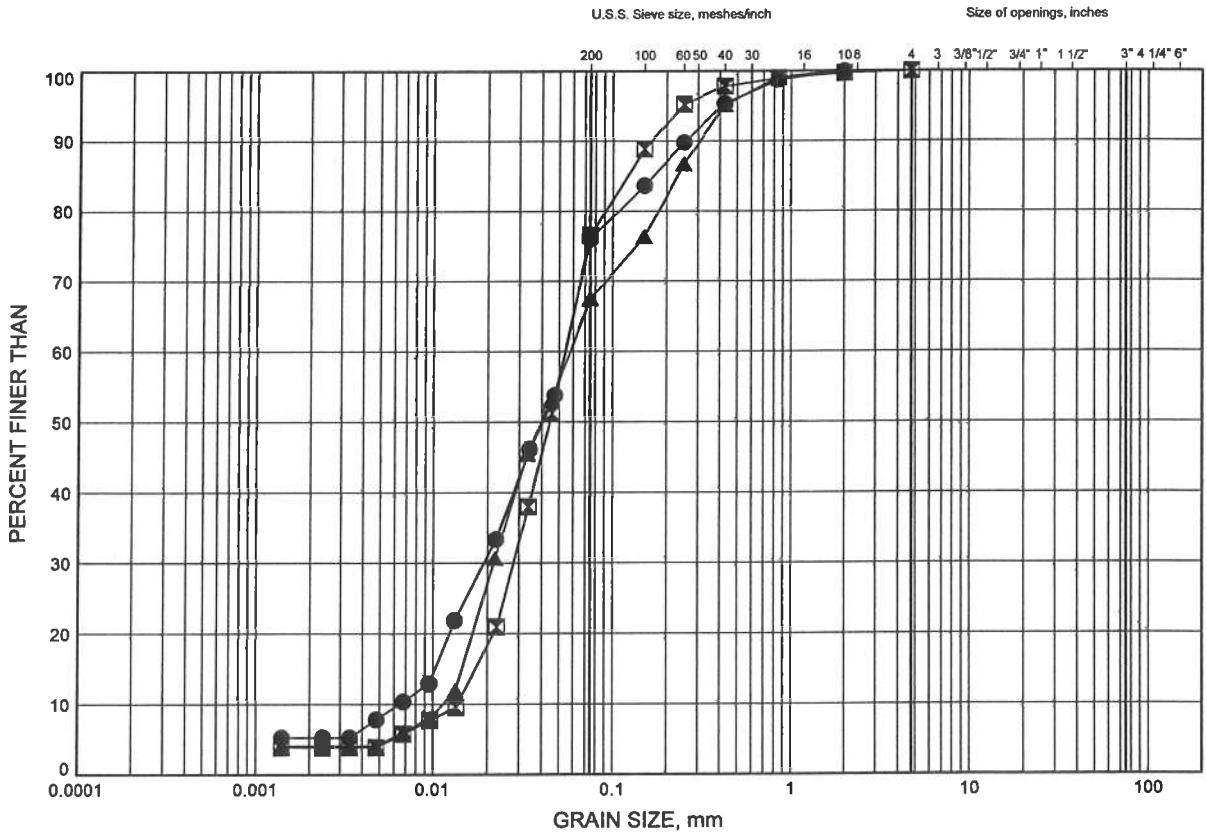
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/5/11

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B5

SANDY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCB-01	7.92	89.08
⊠	HCB-01	10.97	86.04
▲	HCB-01	15.54	81.46

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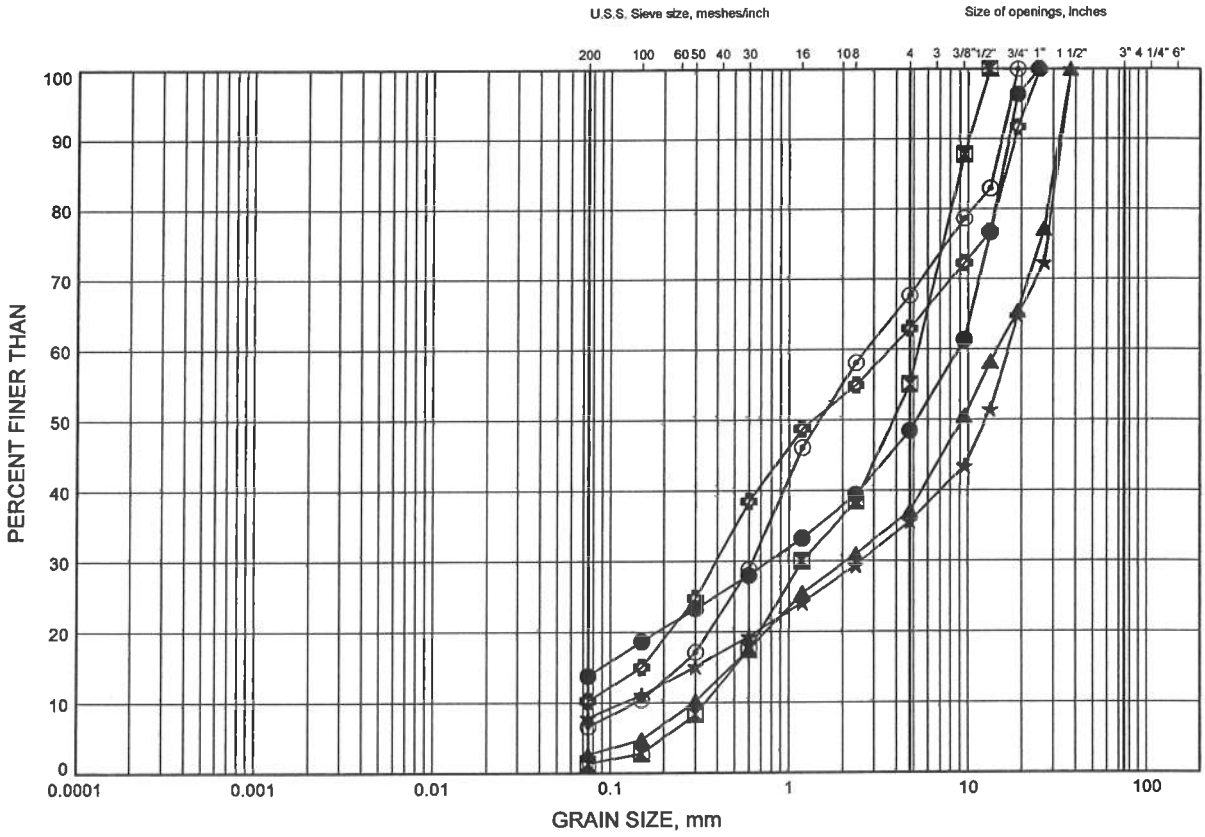
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/5/11

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND & GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCB-01	21.03	75.98
⊠	HCB-03	6.40	90.82
▲	HCB-03	10.97	86.25
★	HCB-03	17.07	80.15
⊙	HCB-04	2.59	94.64
✿	HCB-04	16.23	81.00

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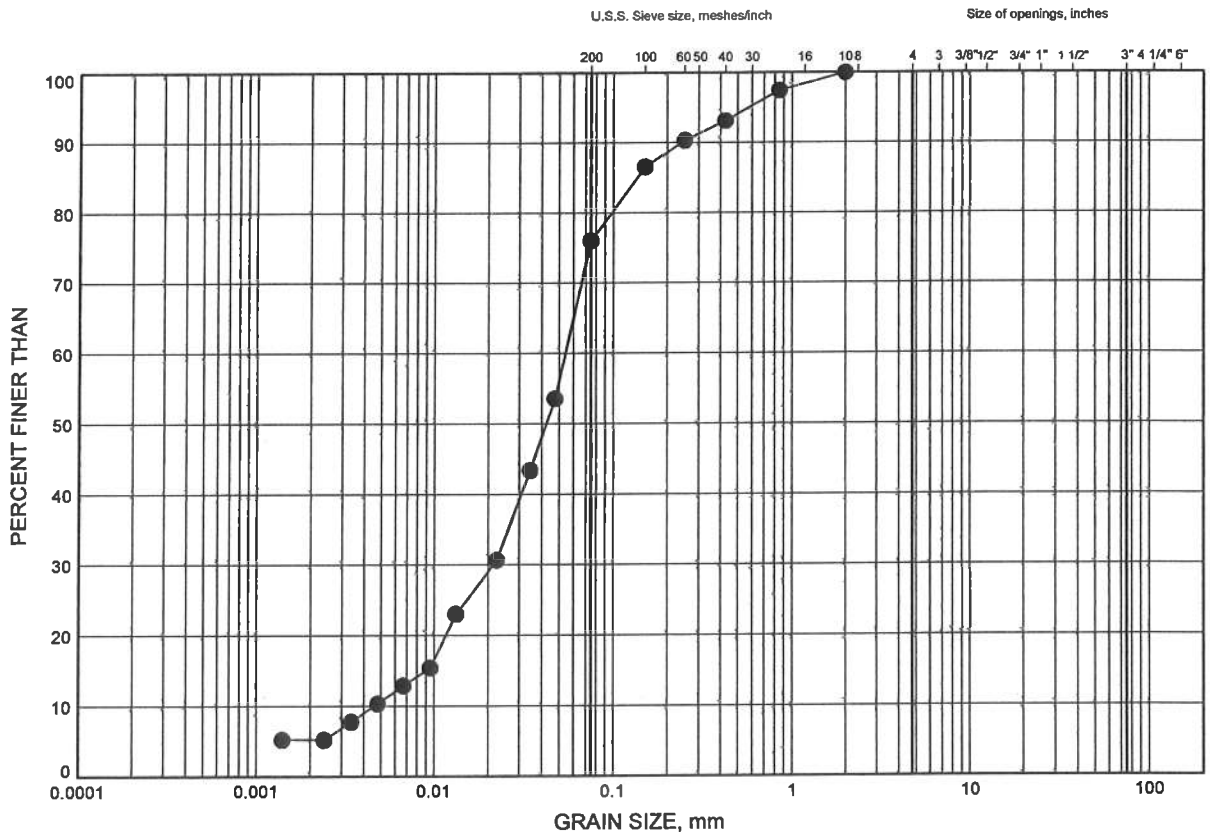
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/5/11

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B7

ORGANIC SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCB-06	6.40	90.42

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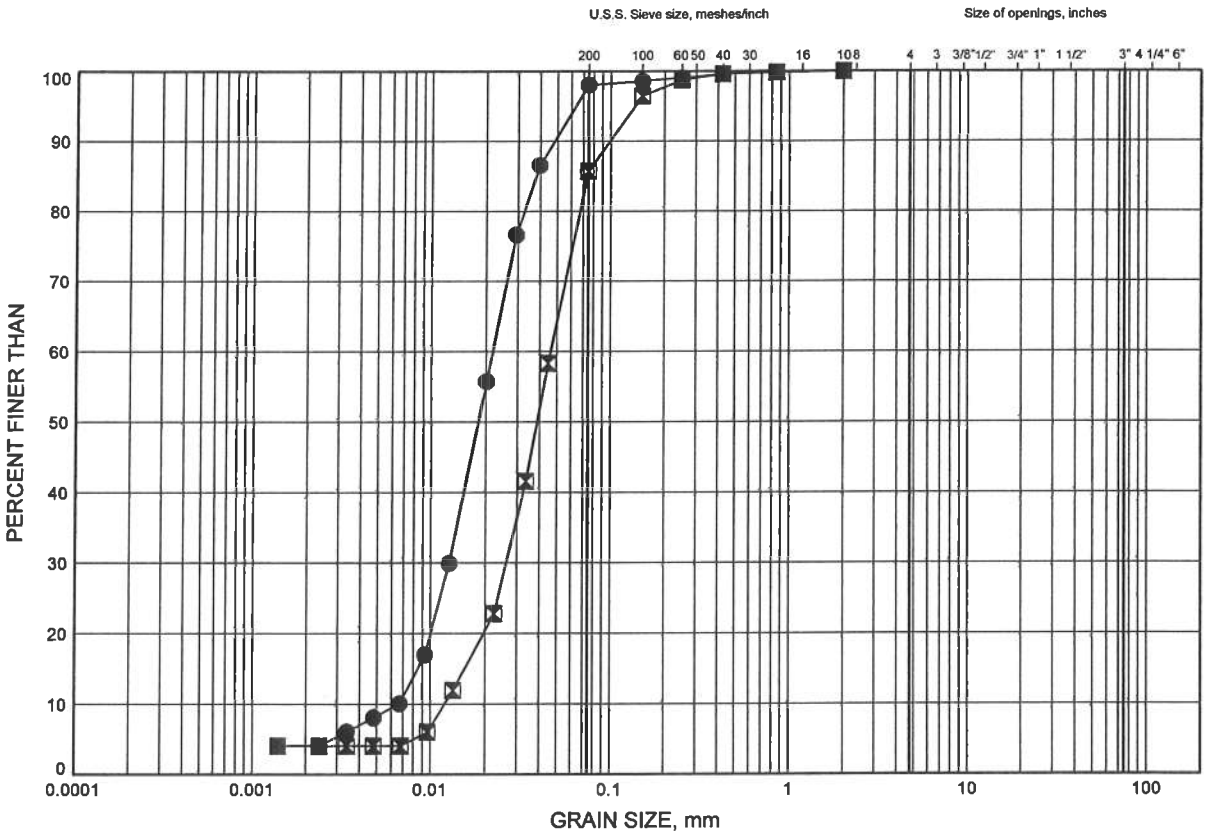
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/12/11

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B8

SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HCB-02	14.02	82.93
⊠	HCB-06	10.97	85.85

W.P.# 6045-08-00

Prepared By AN

Checked By RPR

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GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 10/5/11

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GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

POINT LOAD TEST SHEET

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

Date Drilled : July 15,2011

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

Core Size : NQ **BH No :** HCB-01 **Tester :** DB

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	25.5	A	1.5	47.1	50.8	12.5	Diorite	Weak
2	2	26.4	D	4.3	47.2	69.8	44.8	Diorite	Medium Strong
3	2	26.9	D	5.7	47.2	59.5	59.9	Diorite	Strong
4									
5									
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7									
8									
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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 19,2011

Project Name : Hawkeye Creek Bridge **Date Tested :** 7/29/2011

Core Size : NQ **BH No :** HCB-03 **Tester :** MAT

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	22.9	D	18.6	47.5	76.4	193.7	Diorite	Very Strong
2	1	23.3	A	20.0	47.4	66.0	133.8	Diorite	Very Strong
3	2	23.6	D	4.4	47.5	94.2	46.1	Diorite	Medium Strong
4	2	23.7	D	11.4	47.6	78.0	118.1	Diorite	Very Strong
5	2	24.4	D	14.5	47.6	81.2	149.8	Diorite	Very Strong
6	3	24.8	D	8.3	47.0	68.8	87.3	Diorite	Strong
7	3	25.3	A	7.3	47.1	48.3	62.3	Diorite	Strong
8	3	25.3	D	14.9	47.1	48.8	157.3	Diorite	Very Strong
9									
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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.

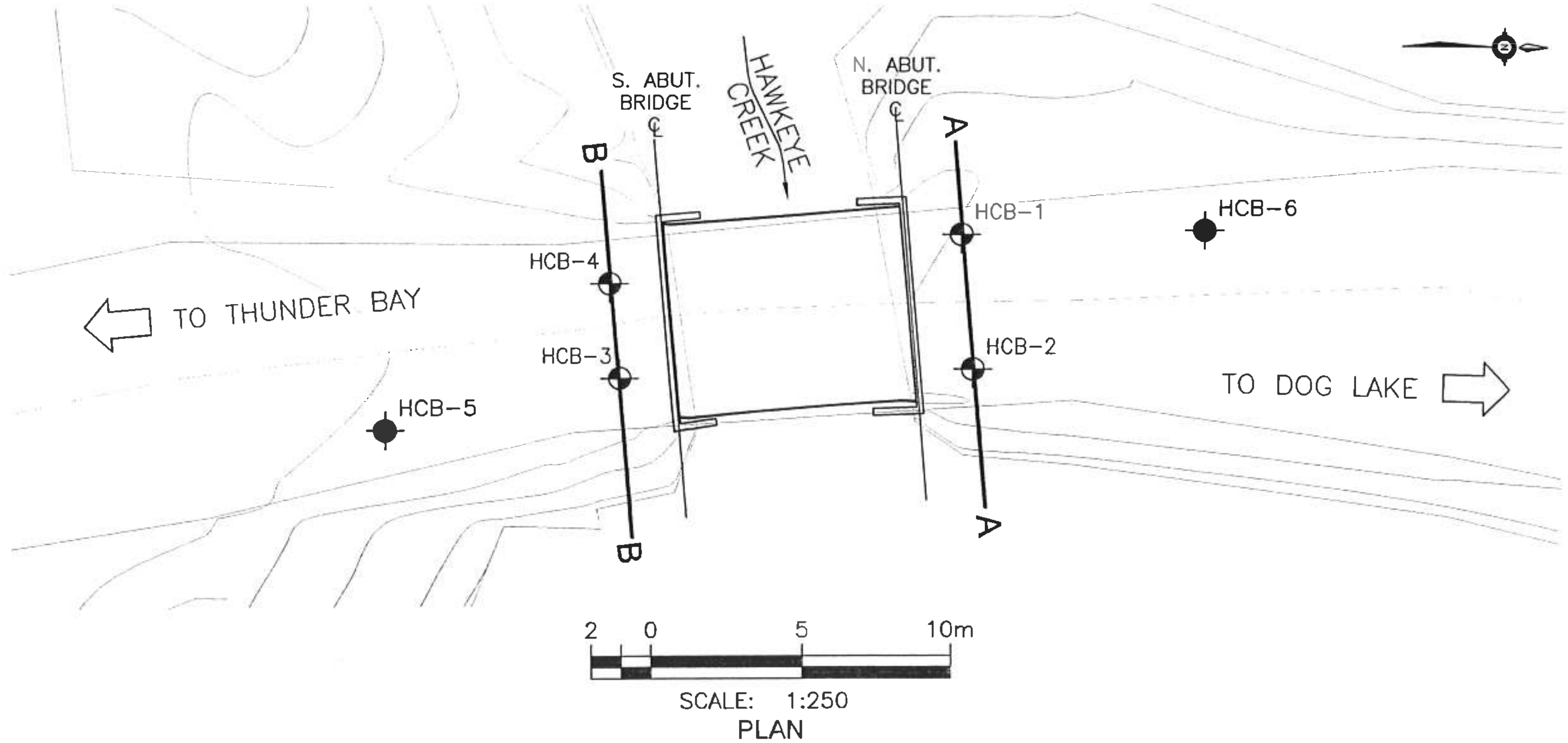
Appendix C

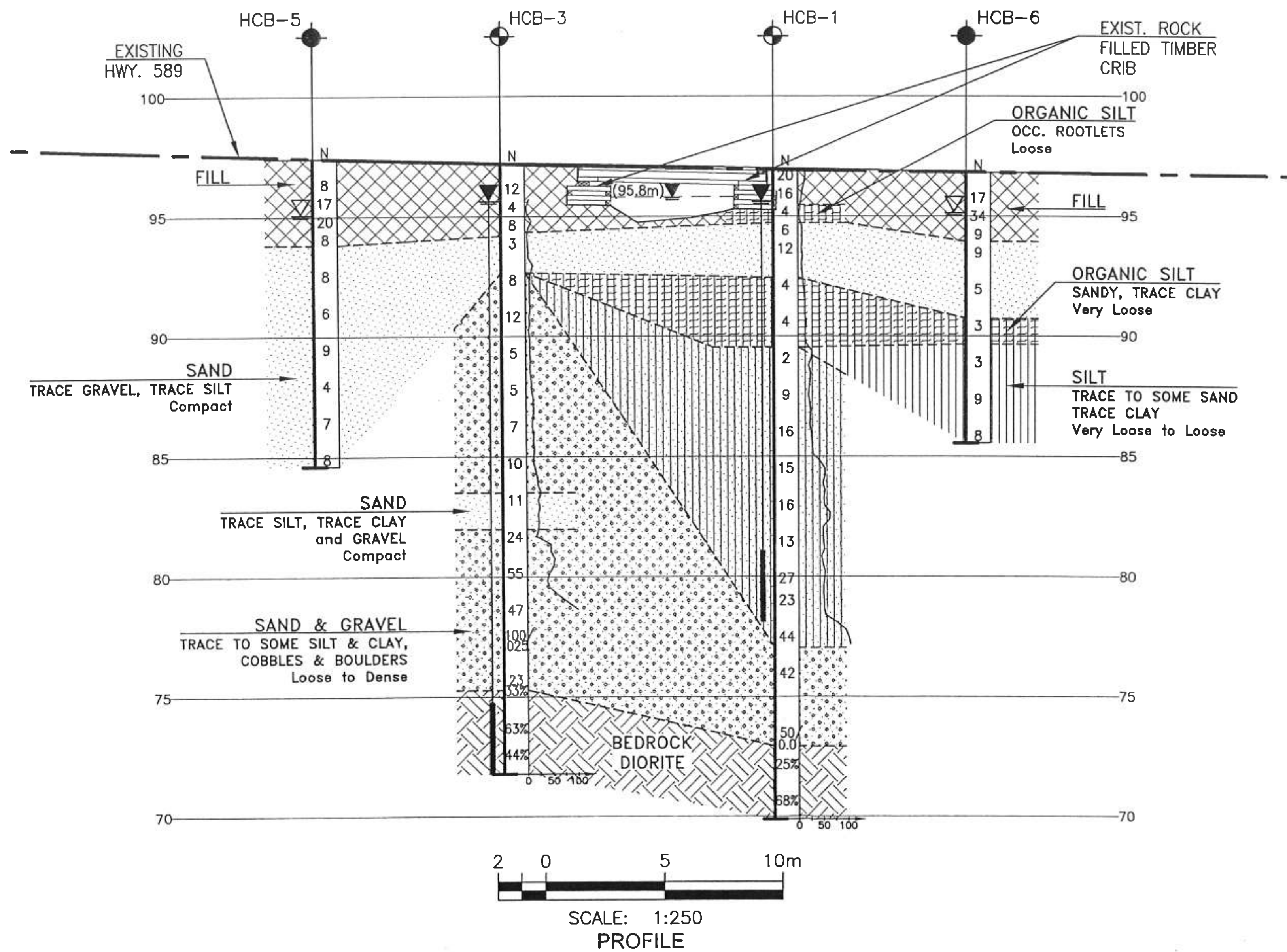
Site Photographs

Photograph 1 – Hawkeye Creek Bridge

Appendix D

Borehole Locations and Soil Strata Drawings





METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

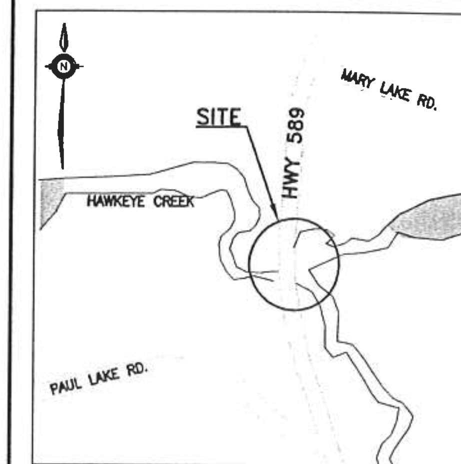
CONT No 2011-6028
WP No 6045-08-00

SHEET

HAWKEYE CREEK BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

GENIVAR

THURBER ENGINEERING LTD.



KEYPLAN

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

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
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
HCB-1	97.0	101 17.0	9 976.5
HCB-2	96.9	101 17.4	9 981.0
HCB-3	97.2	101 05.6	9 981.3
HCB-4	97.2	101 05.3	9 978.1
HCB-5	97.4	100 97.8	9 983.0
HCB-6	96.8	101 25.1	9 976.4

-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-150

REVISIONS	DATE	BY	DESCRIPTION		
DESIGN RPR	CHK RPR	CODE	LOAD	DATE JAN. 2012	
DRAWN AN	CHK	SITE	STRUCT	DWG 2	

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

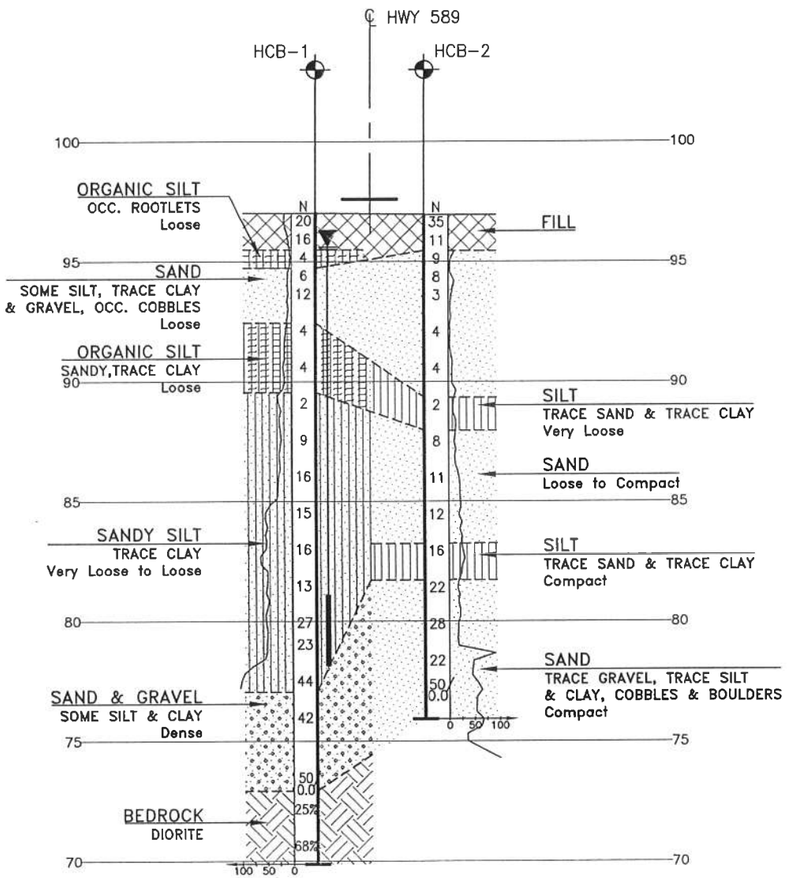
CONT No 2011-6028
WP No 6045-08-00

SHEET

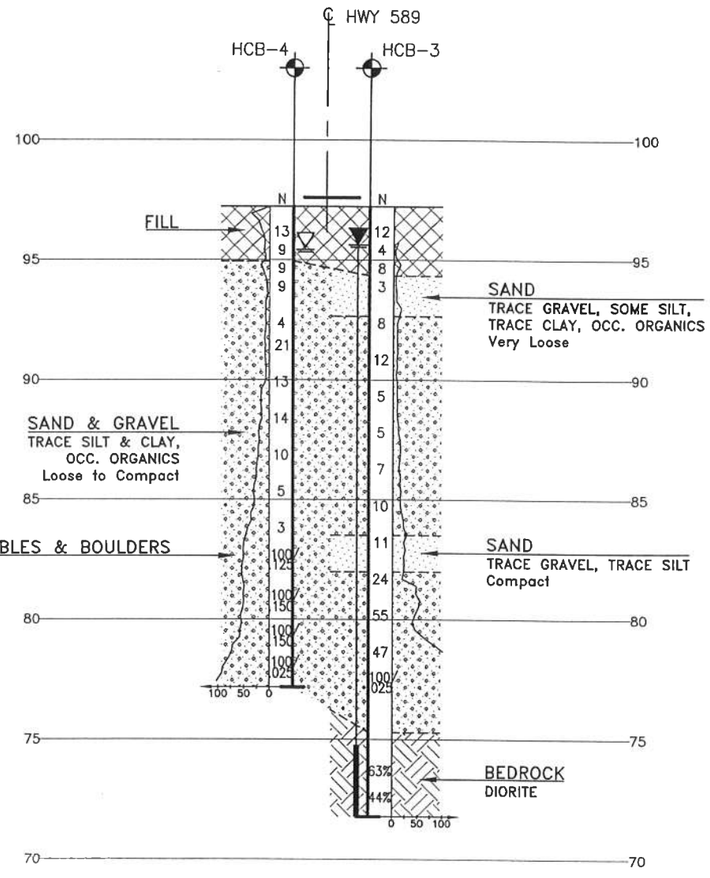
HAWKEYE CREEK BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

GENIVAR

THURBER ENGINEERING LTD.



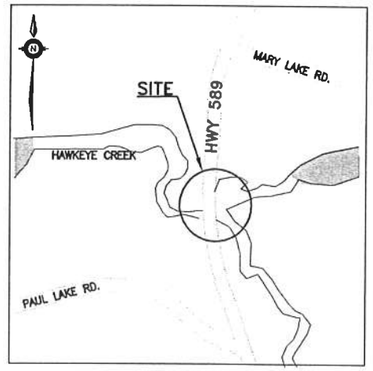
SECTION A-A



SECTION B-B

2 0 5 10m

SCALE: 1:250



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
HCB-1	97.0	101 17.0	9 976.5
HCB-2	96.9	101 17.4	9 981.0
HCB-3	97.2	101 05.6	9 981.3
HCB-4	97.2	101 05.3	9 978.1
HCB-5	97.4	100 97.8	9 983.0
HCB-6	96.8	101 25.1	9 976.4

-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-150

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN RPR	CHK RPR	CODE	LOAD — DATE JAN. 2012
DRAWN AN	CHK	SITE	STRUCT — DWG 3

FILENAME: H:\Drafting\19\5008\40\1ad0840-BoreholePlan&Profile(HawkeyeCreek).dwg