

**FOUNDATION INVESTIGATION REPORT
NUGGET CREEK BRIDGE REPLACEMENT
HIGHWAY 17
BETWEEN DRYDEN AND IGNACE ONTARIO
TOWNSHIP OF ZEALAND, ONTARIO**

W.P. 6145-04-00, Site No. 41S-62

Geocres Number: 52F-38

Report to

Hatch Mott MacDonald

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of a proposed replacement of the existing bridge structure which carries Highway 17 over Nugget Creek, in the Town of Wabigoon in the Township of Zealand, Ontario.

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 and cross-sections, laboratory test results and a written description 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 Hatch Mott MacDonald, under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0010.

2 SITE DESCRIPTION

The Nugget Creek Bridge is located on Highway 17 at the east end of the Town of Wabigoon in the Township of Zealand, Ontario (between Dryden and Ignace) in the District of Thunder Bay.

At present, the highway crosses Nugget Creek on a four-span structure supported on timber piles. The two end spans are 5.94 m and 4.5 m in length, while the two interior spans are 6.1 m in length. The total length of the bridge is 25.8 m and the width is 13.03 m. There is a pedestrian walkway that crosses the creek along the north side of the bridge. Nugget Creek flows from the south to the north. Wabigoon Lake, from where Nugget Creek originates, is located approximately 250 m south of the bridge.

The area surrounding the bridge site is relatively flat. The areas to the north and southwest of the site are treed and include individual residential dwellings, while the area to the southeast consists of low lying marsh vegetation. The Town of Wabigoon and its associated infrastructure are located just west of the site.

Photographs in Appendix C show the general nature of the site.

The site lies within the physiographic region known as the Wabigoon Subprovince of the Superior Province of the Canadian Shield, which is underlain by Archean rocks. The region is characterized by mafic to intermediate metavolcanic rocks consisting of basaltic and andesitic flows, tuffs and breccias, chert, iron formation, minor metasedimentary and intrusive rocks and related migmatites. Locally, the bedrock is mantled by glaciolacustrine varved silty clay and silt deposits.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out during the period of July 22 to 27, 2011 and consisted of drilling and sampling six boreholes (numbered NGT-01 to NGT-06) through the highway embankment in the area of the existing west and east approaches and abutments. Boreholes NGT-01 and NGT-06 were drilled at the west and east approaches, respectively and were both terminated at a depth of 11.3 m (elevation 359.5). Boreholes NGT-02 and NGT-03 were drilled near the west abutment to depths of 21.2 m and 16.2 m, respectively (elevations 349.6 and 354.7). Boreholes NGT-04 and NGT-05 were drilled near the east abutment to depths of 16.8 m and 21.3 m, respectively (elevations 354.1 and 349.6).

Bedrock was proved in Boreholes NGT-02 and NGT-05 by NQ size diamond coring. Boreholes NGT-02 and NGT-05 were advanced 2.9 m and 3.0 m into bedrock.

The approximate locations of the boreholes are shown on the attached Borehole Location and Soil Strata Drawing in Appendix D.

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

For Boreholes NGT-01 to NGT-05, the drilling was carried out from the highway grade using a CME 75 truck-mounted drill rig. For Borehole NGT-06, the drilling was again carried out from highway grade, however a Hilty drill rig was used. NW casing was used to advance the boreholes through the overburden deposits and NQ coring methods were used to advance selected boreholes through the bedrock. Overburden samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). In situ vane shear testing was carried out in selected boreholes to assess the undrained shear strength of soft to firm cohesive deposits.

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 and rock 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.

One standpipe piezometer, consisting of 19 mm diameter PVC pipe with slotted screen and enclosed in filter sand, was installed at this site to permit longer term groundwater level monitoring. Upon completion, the boreholes were backfilled with bentonite holeplug in general accordance with O.Reg. 903. The location and completion details of the piezometer and boreholes are presented in Table 3.1.

Table 3.1 – Borehole Abandonment Details

Location	Borehole	Piezometer Tip Depth/ Elevation (m)	Abandonment Details
West Approach	NGT-01	None installed	Borehole backfilled with bentonite holeplug from 11.3 m to 0.3 m, concrete from 0.3 m to 0.1 m, then asphalt cold patch to surface.
West Abutment	NGT-02	None installed	Borehole backfilled with bentonite holeplug from 21.2 m to 0.3 m, concrete from 0.3 m to 0.1 m, then asphalt cold patch to surface.
	NGT-03	None installed	Borehole backfilled with bentonite holeplug from 16.2 m to 0.3 m, concrete from 0.3 m to 0.1 m, then asphalt cold patch to surface.
East Abutment	NGT-04	16.8 / 354.0	Sand from 16.8 m to 14.9 m, bentonite holeplug from 14.9 m to 0.3 m, concrete from 0.3 m to 0.1 m, then asphalt cold patch to surface.
	NGT-05	None installed	Borehole backfilled with bentonite holeplug from 21.3 m to 0.3 m, concrete from 0.3 m to 0.1 m, then asphalt to surface.
East Approach	NGT-06	None installed	Borehole backfilled with sand to 0.1 m, then asphalt cold patch to surface.

The piezometers will be decommissioned in accordance with O. Reg. 903 prior to the end of 2012.

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 grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing, where appropriate. The results of this testing

program are summarized on the Record of Borehole sheets in Appendix A and shown 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 in Appendix A. Details of the encountered soil stratigraphy are presented in these sheets and on the “Borehole Locations and Soil Strata” drawings 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. It must be recognized that soil conditions may vary between and beyond borehole locations.

In general terms, the stratigraphy encountered at this site consists of asphalt and at some locations asphalt over concrete overlying granular fill, which is underlain by native sand to sand and gravel layers. Native silty clay was encountered below the sand and gravel layer. The silty clay was underlain by silty sand/sandy silt layers. Slightly weathered to fresh, grey, mafic to intermediate metavolcanic bedrock was contacted below the silty sand/sandy silt at depths ranging from 16.2 m to 18.3m.

More detailed descriptions of the individual strata are presented below.

5.1 Asphalt and Concrete

Asphalt was encountered surficially in all the boreholes drilled through the existing Highway 17 roadway. The thickness of the asphalt ranged from 75 mm on the west side of the bridge to 150 mm on the east side of the bridge.

Concrete was encountered below the asphalt in Boreholes NGT-02 to NGT-05, which were drilled through the existing bridge approach slabs. The concrete was 200 mm to 250 mm thick.

5.2 Sand to Sand and Gravel Fill

Granular fill consisting of sand to sand and gravel was encountered below the asphalt in Boreholes NGT-01 and NGT-06 and below the concrete in Boreholes NGT-02 to NGT-05. The granular fill is brown to grey and contains trace silt and clay and cobbles and boulders. Wood fragments and fibres were encountered in some of the samples of the granular fill. Coring through boulders encountered within the fill, was required in Boreholes NGT-01

and NGT-02 to advance the boreholes. It must be recognized that embankment fills are heterogeneous in nature and may contain rockfill in areas where no boreholes were drilled.

The thickness of the granular fill ranged from 2.0 m to 3.5 m.

The depth to the base of the granular fill ranged from 2.1 m to 3.8 m (elevations 367.0 to 368.7).

SPT 'N' values recorded in the granular fill generally ranged from 17 to 47 blows for 0.3 m penetration, indicating a compact to dense relative density. SPT 'N' values of 50 blows for less than 0.3 m were also recorded in the granular fill at depths where cobbles or boulders were encountered.

The moisture content of the samples of the granular fill generally ranged from 5% to 20%.

Three samples of the granular fill underwent laboratory gradation analysis, the results of which are presented below. These results are also summarized on the Record of Borehole sheets in Appendix A and presented in Figure B1, Appendix B.

Soil Particles	Percentage (%)
Gravel	52 to 88
Sand	9 to 42
Silt and Clay	2 to 6

5.3 Sand to Sand and Gravel

Native grey sand to sand and gravel layers were encountered below the granular fill in all the boreholes.

Cobbles and boulders were encountered within this granular layer in Boreholes NGT-01 and NGT-05. Coring through cobbles and boulders was required to advance Borehole NGT-05.

The thickness of this layer ranged from 0.9 m to 2.2 m, with a lower boundary at a depth of 4.1 m to 5.3 m (elevations 365.5 to 366.7).

SPT 'N' values recorded in the sand to sand and gravel layer typically ranged from 15 to 26 blows for 0.3 m penetration, indicating a compact relative density. Higher 'N' values of 50 blows for less than 0.3 m penetration were recorded where cobbles or boulders were encountered.

The moisture content of samples of the native sand to sand and gravel layers typically ranged from 8% to 12%. A moisture content of 30% was measured in Borehole NGT-06 at a depth of 3.9 m.

A sample of the sand and gravel was selected for laboratory gradation analysis. The results of this test are summarized on the Record of Borehole sheets in Appendix A and

the grain size distribution curve for this sample is plotted on Figure B2, Appendix B. The results of this test are as follows:

Soil Particles	Percentage (%)
Gravel	58
Sand	37
Silt and Clay	5

5.4 Silty Clay

A deposit of silty clay was encountered below this native sand to sand and gravel layers in all the boreholes. The silty clay is typically brown to grey and contains trace sand and occasional wood fibres. The silty clay was described as varved.

Where fully penetrated, the thickness of the silty clay layer ranged from 10.2 m to 11.7 m.

The depth to the base of the silty clay ranged from 15.5 m to 16.3 m (elevations 354.5 to 355.3).

Boreholes NGT-01 and NGT-06 were terminated at a depth of 11.3 m (elevation 359.5) within the silty clay layer.

SPT 'N' values recorded in the silty clay typically ranged from 0 to 8 blows for 0.3 m penetration, indicating a very soft to firm consistency. A SPT 'N' value of 26 blows for 0.3 m penetration was recorded in Borehole NGT-06 at a depth of approximately 5.0 m, near the surface of this layer.

In-situ vane shear tests were carried out to assess the undrained shear strength of soft to firm cohesive deposits. Typically, shear strengths of 8 kPa to 20 kPa were measured in the silty clay layer. A shear strength of 32 kPa was measured in Borehole NGT-04 at a depth of approximately 5.5 m. Based on remoulded shear vane tests, the silty clay had a Sensitivity Value ranging from 3 to 10.

The moisture content of samples of the silty clay ranged from 26% to 88%, typically greater than 50%.

Selected samples of the silty clay underwent laboratory grain size analysis testing and Atterberg Limits testing, the results of which are summarized below. These results are also summarized on the Record of Borehole sheets in Appendix A. The grain size distribution curves for tested samples of the silty clay are included in Figures B3 to B5, Appendix B. The results of the Atterberg Limits tests are also presented in Figures B7 and B8.

Soil Particles	Percentage (%)
Gravel	0
Sand	0 to 3
Silt	18 to 56
Clay	43 to 82

Index	Percentage (%)
Plastic Limit	19 to 22
Liquid Limit	42 to 56

The above results indicate that the silty clay is of medium to high plasticity with group symbols of CI-CH.

5.5 Sandy Silt to Silty Sand

A layer of native grey sandy silt to silty sand was encountered below the silty clay in Boreholes NGT-02 to NGT-05. This sandy silt to silty sand layer contains trace gravel, trace clay and occasional cobbles.

This layer was fully penetrated in Boreholes NGT-02 and NGT-05 and the thickness was 2.0 m and 2.1 m. In both boreholes, the lower boundary of the sandy silt/silty sand was encountered at a depth of 18.3 m (elevation 352.5 and 352.6).

Boreholes NGT-03 and NGT-04 penetrated 0.7 m to 1.0 m into this layer and were terminated upon auger refusal on probable bedrock or boulder at 16.2 m and 16.8 m depth, respectively (elevations 354.7 and 354.1).

SPT 'N' values recorded in the sandy silt/silty sand layer on the west side of the bridge ranged from 7 to 8 blows for 0.3 m penetration, indicating a loose relative density. An SPT 'N' value of 42 blows for 0.3 m penetration was recorded in the silty sand layer on the east side of the bridge, indicating a dense relative density.

The moisture content of samples of the sandy silt to silty sand layer ranged from 8% and 48%.

One sample of the sandy silt was selected for gradation analysis, the results of which are summarized below. These results are also presented on the Record of Borehole sheets in Appendix A and on Figure B6, Appendix B.

Soil Particles	Percentage (%)
Gravel	2
Sand	20
Silt	74
Clay	4

5.6 Bedrock and Refusal

The overburden soils described above are underlain by mafic to intermediate metavolcanic bedrock. The bedrock was grey with occasional white bands and slightly weathered to fresh. Occasional mechanical breaks and horizontal joints were noted throughout the bedrock cores.

Bedrock was proved by coring in Boreholes NGT-02 and NGT-05. Boreholes NGT-03 and NGT-04 were terminated upon auger refusal on probable bedrock. Table 5.1 summarizes depths and elevations to the top of bedrock and auger refusal.

Table 5.1 – Depths and Elevations of Top of Bedrock and Auger Refusal

Foundation Element	Borehole	Top of Bedrock	
		Depth (m)	Elevation (m)
West abutment	NGT-02	18.3*	352.5*
	NGT-03	16.2	354.7
East abutment	NGT-04	16.8	354.1
	NGT-05	18.3*	352.6*

*Bedrock proved by coring

Core recovery in the bedrock was 100%. The RQD values ranged from 78% to 100%, indicating good to excellent rock quality.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was generally less than 2. A FI greater than 5 was noted in Run 2 of Borehole NGT-02.

The estimated unconfined compressive strength of the rock cores ranged generally from 138 MPa to 219 MPa, indicating a very strong rock. Only one point load test result from Borehole NGT-05 Run 1, was 86 MPa, which indicates a strong rock. These estimated rock strength values are interpreted from point load tests that were conducted on rock cores recovered from the boreholes. The results of these tests are summarized on the Record of Borehole sheets included in Appendix A and in Point Load Test Sheets in Appendix B.

5.7 Water Levels

Water levels were monitored in the open boreholes upon completion of drilling. One standpipe piezometer was installed at this site, in Borehole NGT-04, to monitor water levels after completion of drilling. The water levels measured in the piezometer and open boreholes are summarized in Table 5.2.

Table 5.2 – Water Level Measurements

Foundation Unit	Borehole	Date	Water Level (m)		Comments
			Depth	Elevation	
West Approach	NGT-01	27-Jul-2011	2.6	368.2	Open borehole
West Abutment	NGT-02	23-Jul-2011	0.0	370.8	Open borehole
	NGT-03	25-Jul-2011	2.4	368.4	Open borehole
East Abutment	NGT-04	24-Jul-2011	1.5	369.3	Piezometer
		25-Jul-2011	0.8	370.0	
		17-Aug-2011	0.5	370.3	
		15-Sep-2011	0.8	370.0	
	NGT-05	27-Jul-2011	0.6	370.3	Open borehole
East Approach	NGT-06	25-Jul-2011	2.4	368.4	Open borehole

Piezometric readings indicate that the water level is near elevation 370.1.

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.

Preliminary GA drawings indicate that the water level in Nugget Creek was near Elevation 368.7 on April 28, 2011.

During drilling of Borehole NGT-02, an artesian head of 0.3 m above ground surface was noted in the sandy silt layer at 18.2 m depth (elevation 352.6).

6 MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. Hatch Mott MacDonald surveyed the borehole locations and provided the co-ordinates and the ground surface elevations.

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 for Boreholes NGT-01 to NGT-05. Ohlmann Geotechnical Services (OGS) Inc., of Almonte, Ontario supplied a Hilty drill rig and conducted the drilling, sampling and in-situ testing operations for Borehole NGT-06.

The drilling and sampling operations in the field were supervised on a full time basis by Ms. Eckie Siu and Mr. George Azzopardi, both 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 the report were carried out by Ms. Lindsey Blaine, E.I.T. and Ms. Rocio Palomeque Reyna, P.Eng..

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

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Appendix A

Record of Borehole Sheets

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
 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			

EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			Field Estimation of Hardness*
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	Uniaxial Compressive Strength (psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	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

<u>TERMS</u>	
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.

RECORD OF BOREHOLE No NGT-01

1 OF 2

METRIC

W.P. 6936-10-00 LOCATION N 5 509 138.5 E 333 625.7 Nugget River Bridge ORIGINATED BY GA
 HWY 17 BOREHOLE TYPE Casing COMPILED BY AN
 DATUM Geodetic DATE 2011.07.27 - 2011.07.27 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	FLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
370.8	ASPHALT: (75mm)											
0.0												
0.1												
	SAND, trace gravel Dense to Compact Brown Wet (FILL) Cored through boulder at 0.6m		1	SS	39		370					
			2	SS	39							
			3	SS	21		369					
368.7												
2.1	SAND and GRAVEL, with cobbles and boulders Very Dense Brown		4	SS			368					
			5	SS	50/ 0.0							
							367					
366.5												
4.3	Silty CLAY, trace sand Firm to Very Soft Grey		6	SS	7		366					0 2 35 63
							365					
			7	SS	2							
							364					
			8	SS	1		363					
							362					
			9	SS	1							0 0 32 68
							361					

Continued Next Page

+ 3, x 3

Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No NGT-01

2 OF 2

METRIC

W.P. 6936-10-00 LOCATION N 5 509 138.5 E 333 625.7 Nugget River Bridge ORIGINATED BY GA
HWY 17 BOREHOLE TYPE Casing COMPILED BY AN
DATUM Geodetic DATE 2011.07.27 - 2011.07.27 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
								20 40 60 80 100						
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
								w _p w w _L						
								WATER CONTENT (%)						
								20 40 60						

METRIC

[illegible]

+ 3, X 3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No NGT-02

2 OF 3

METRIC

W.P. 6936-10-00 LOCATION N 5 509 130.3 E 333 630.7 Nugget River Bridge ORIGINATED BY GA
HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN
DATUM Geodetic DATE 2011.07.22 - 2011.07.23 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		WATER CONTENT (%) w _p w w _L				
	Silty CLAY , varved Very Soft Grey		10	SS	2		360							0 0 37 63
							359	5						
			11	SS	1		358							
							357							
			12	SS	1		356	4						
							355							
			13	SS	1		354							
354.5							353							
16.3	Sandy SILT , trace gravel, trace clay Loose Grey		14	SS	7		352							2 20 74 4
	Occasional cobbles at 17.4m						351							
352.5	Artesian pressure at 18.2m													
18.3	BEDROCK , mafic to intermediate metavolcanic, slightly weathered to fresh, grey, occasional white bands, occasional mechanical breaks Coring started at 18.3m Horizontal joint at 19.1m Sub-horizontal joints at 18.3m, 18.4m and 19.2m		1	RUN										RUN #1 TCR=100% SCR=77% RQD=93% UCS=190MPa (Average)

Continued Next Page

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

RECORD OF BOREHOLE No NGT-02

3 OF 3

METRIC

W.P. 6936-10-00 LOCATION N 5 509 130.3 E 333 630.7 Nugget River Bridge ORIGINATED BY GA
HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN
DATUM Geodetic DATE 2011.07.22 - 2011.07.23 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
	Continued From Previous Page						20 40 60 80 100							
							20 40 60 80 100							

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

RECORD OF BOREHOLE No NGT-03

1 OF 2

METRIC

W.P. 6145-04-00 LOCATION N 5 509 134.9 E 333 633.3 Nugget River Bridge ORIGINATED BY GA
HWY 17 BOREHOLE TYPE Casing COMPILED BY AN
DATUM Geodetic DATE 2011.07.25 - 2011.07.25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
							20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
							20 40 60 80 100	WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE				
								● QUICK TRIAXIAL × LAB VANE				
370.8												
0.0	ASPHALT: (75mm)											
370.5	CONCRETE: (225mm)											
0.3			1	SS	32				○			
	SAND and GRAVEL, trace silt, trace clay, occasional cobbles Dense to Compact Brown Wet (FILL)		2	SS	37		370		○			
			3	SS	32		369		○			
	Grey Boulders and cobbles from 2.2m to 2.8m		4	SS	45		368		○			76 22 2 (SI+CL)
			5	SS	21							
367.0												
3.8	SAND, some gravel, occasional wood fibres Compact Grey Wet		6	SS	15		367					
							366		○			
365.5												
5.3	Silty CLAY Soft Grey		7	SS	3		365					0 0 18 82
							364					
			8	SS	1		363				○	
			9	SS	1		362				○	0 0 27 73
							361					

Continued Next Page

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

RECORD OF BOREHOLE No NGT-03

2 OF 2

METRIC

W.P. 6936-10-00 LOCATION N 5 509 134.9 E 333 633.3 Nugget River Bridge ORIGINATED BY GA
HWY 17 BOREHOLE TYPE Casing COMPILED BY AN
DATUM Geodetic DATE 2011.07.25 - 2011.07.25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%) 20 40 60				
	Silty CLAY Very Soft Grey		10	SS	1		360	+ ⁶					
							359						
			11	SS	0		358						
							357	+ ⁴					
			12	SS	1		356						
355.3													
15.5	Sandy SILT Loose Grey Wet		13	SS	8		355						
354.7													
16.2	END OF BOREHOLE AT 16.2m UPON REFUSAL. WATER LEVEL AT 2.4m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG FROM 16.2m TO 0.3m, CONCRETE FROM 0.3m TO 0.1m, THEN ASPHALT TO SURFACE.												

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No NGT-04

2 OF 2

METRIC

W.P. 6936-10-00 LOCATION N 5 509 117.5 E 333 658.1 Nugget River Bridge ORIGINATED BY GA
HWY 17 BOREHOLE TYPE COMPILED BY AN
DATUM Geodetic DATE 2011.07.24 - 2011.07.24 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%) 20 40 60			GR SA SI CL
355.0	Silty CLAY, trace sand Very Soft Reddish Brown to Grey		9	SS	1		360					
							359					
			10	SS	0		358					0 0 41 59
							357					
			11	SS	1		356					
							355					
15.8	Sandy SILT Grey											
354.1	Cobbles from 15.9m to 16.6m											
16.8	END OF BOREHOLE AT 16.8m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN TO 16.8m AND WATER LEVEL AT 1.5m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jul 25/11 0.8 370.0 Aug 17/11 0.5 370.3 Sep.15/11 0.8 370.0											

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

RECORD OF BOREHOLE No NGT-05

1 OF 3

METRIC

W.P. 6936-10-00 LOCATION N 5 509 122.5 E 333 660.6 Nugget River Bridge ORIGINATED BY GA
HWY 17 BOREHOLE TYPE Casing COMPILED BY AN
DATUM Geodetic DATE 2011.07.26 - 2011.07.27 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
370.9												
0.0	ASPHALT: (100mm)											
370.5	CONCRETE: (200mm)											
0.3	SAND and GRAVEL Dense to Compact Brown Wet (FILL)		1	SS	30		370					
			2	SS	32							
			3	SS	28		369					88 9 3 (SI+CL)
	Occasional cobbles		4	SS	38							
367.8			5	SS			368					
3.1	SAND and GRAVEL, with cobbles and boulders Cored through cobbles and boulders from 2.9m to 4.3m						367					
366.3			6	SS	2		366					
4.6	Silty CLAY, varved Very Soft Grey						365					
			7	SS	1							0 0 43 57
			8	SS	1		363					
			9	SS	1		362					
							361					

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

[illegible]

+ 3, × 3: Numbers refer to Sensitivity

ONTMT4S 5121.GPJ 10/10/12

RECORD OF BOREHOLE No NGT-05

3 OF 3

METRIC

W.P. 6936-10-00 LOCATION N 5 509 122 5 E 333 660 6 Nugget River Bridge ORIGINATED BY GA
HWY 17 BOREHOLE TYPE Casing COMPILED BY AN
DATUM Geodetic DATE 2011.07.26 - 2011.07.27 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
	Continued From Previous Page							SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL X LAB VANE						
								20	40	60	80	100		
								WATER CONTENT (%)						
								w _p — w — w _L						
								20 40 60						
349.5	BEDROCK, mafic to intermediate metavolcanic, slightly weathered to fresh, grey, occasional white bands, occasional mechanical breaks Quartz seam at 20.2m		2	RUN			350						0	RUN #2 TCR=100% SCR=100% RQD=100% UCS=205MPa (Average)
21.3	END OF BOREHOLE AT 21.3m. WATER LEVEL AT 0.6m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG FROM 21.3m TO 0.3m, CONCRETE FROM 0.3m TO 0.1m, THEN ASPHALT TO SURFACE.													

+³, X³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No NGT-06

1 OF 2

METRIC

W.P. 6936-10-00 LOCATION N 5 509 118.4 E 333 669.9 Nugget River Bridge ORIGINATED BY ES
HWY 61 BOREHOLE TYPE Casing COMPILED BY AN
DATUM DATE 2011.07.25 - 2011.07.25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
370.8												
0.0	ASPHALT: (150mm)											
0.2	SAND and GRAVEL Brown Moist (FILL) Occasional cobbles Compact		1	GS			370					
			2	GS								
			1	SS	25		369					
			2	SS	17							
			3	SS	25		368					
367.6	Occasional wood fibres											
3.2	SAND, some gravel Compact Moist		4	SS	16		367					
366.7	Silty CLAY, trace sand, occasional wood pieces Very Stiff Grey		5	SS	26		366					0 1 56 43
			6	SS	2		365					
	Very Soft		7	SS	3		363					
			8	SS	6		362					0 0 38 62
							361					

Continued Next Page

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

RECORD OF BOREHOLE No NGT-06

2 OF 2

METRIC

W.P. 6936-10-00 LOCATION N 5 509 118 4 E 333 669 9 Nugget River Bridge ORIGINATED BY ES
HWY 17 BOREHOLE TYPE Casing COMPILED BY AN
DATUM Geodetic DATE 2011.07.25 - 2011.07.25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	w _p w w _L				
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	WATER CONTENT (%)					
								20 40 60 80 100	20 40 60					
359.5	Silty CLAY , varved Firm Reddish Brown to Grey		9	SS	8		360					>>>		
11.3	END OF BOREHOLE AT 11.3m. WATER LEVEL AT 2.4m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH SAND TO 0.05m, THEN ASPHALT TO SURFACE.													

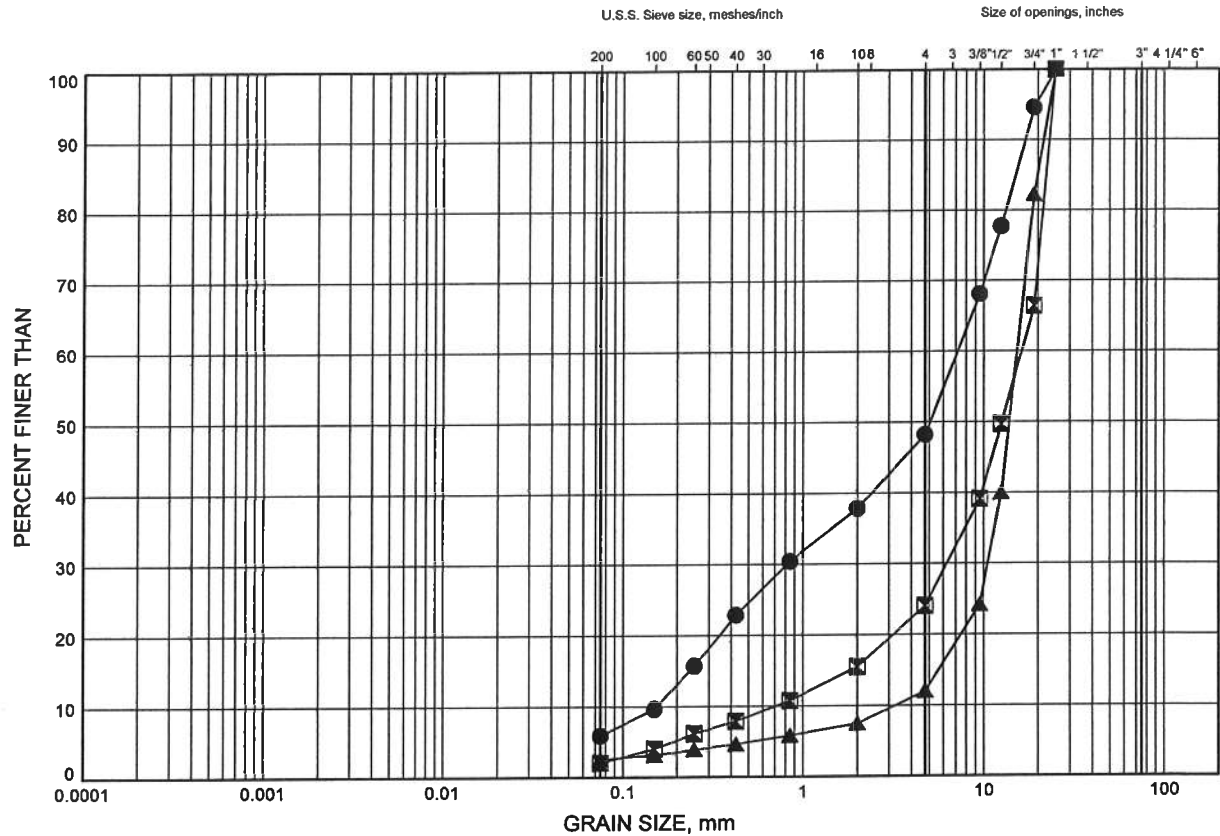
Appendix B

Laboratory Test Results

6010-E-0010 Bridge and Culvert Rehabs NWR
GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND & GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NGT-02	1.83	368.98
⊠	NGT-03	2.59	368.24
▲	NGT-05	1.83	369.02

GRAIN SIZE DISTRIBUTION - THURBER 5121.GPJ 11/23/11

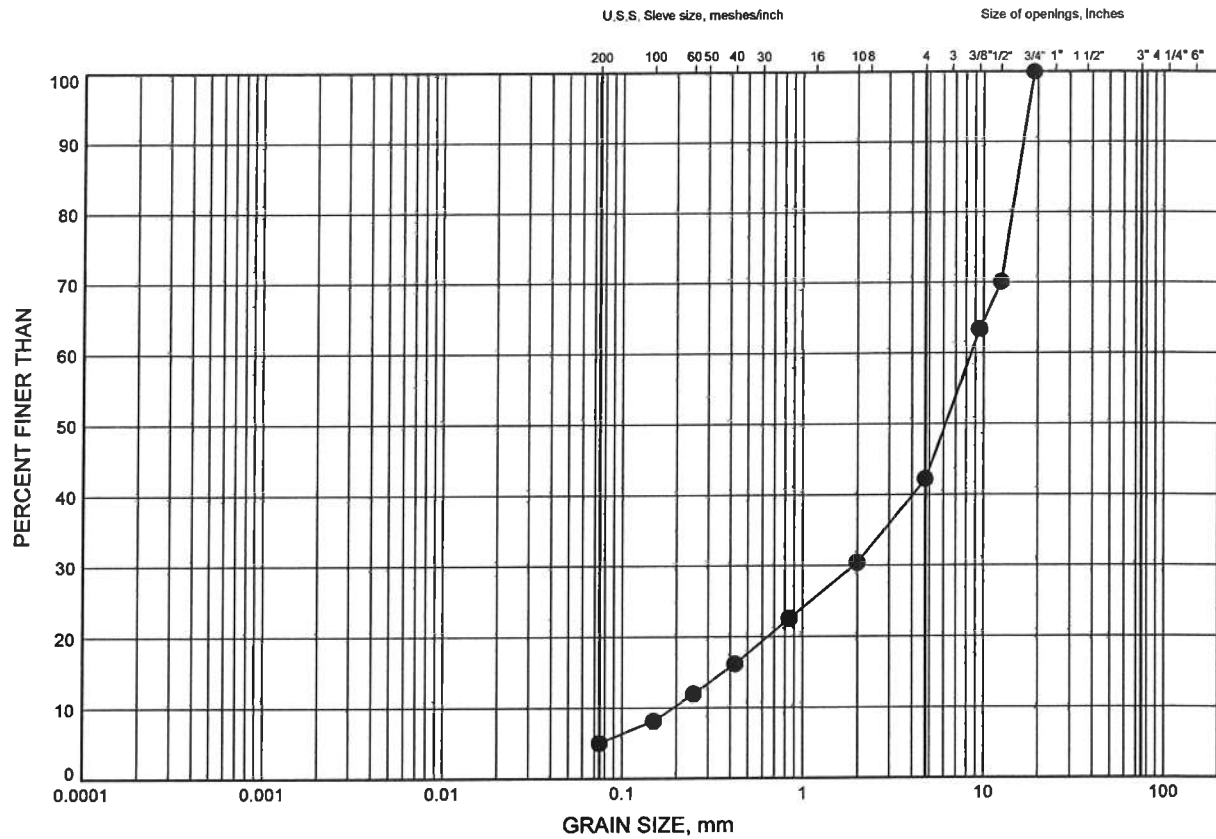
W.P.# 6145-04-00
Prepared By AN
Checked By LRB



6010-E-0010 Bridge and Culvert Rehabs NWR
GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND & GRAVEL



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

LEGEND

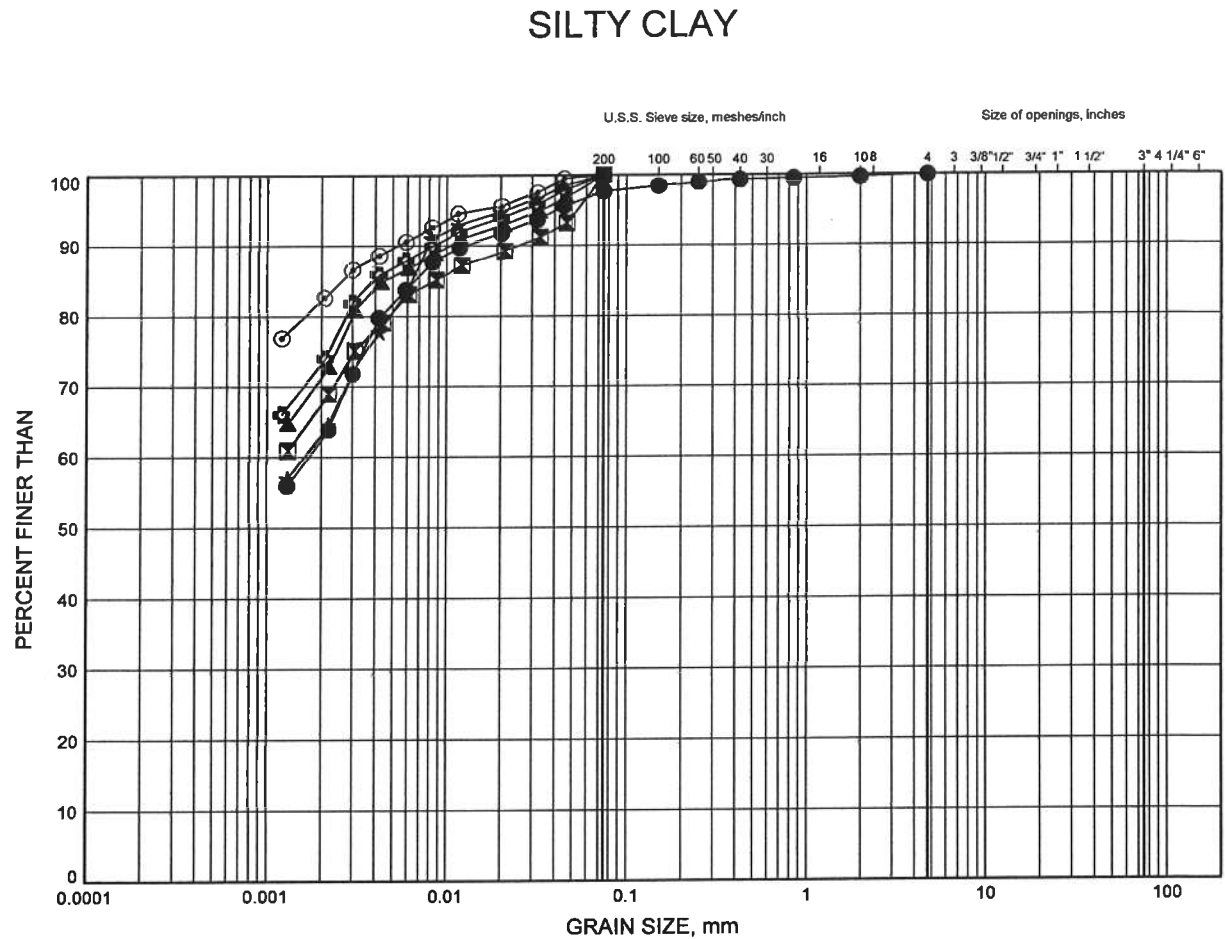
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NGT-04	3.35	367.49



W.P.# 6145-04-00
Prepared By AN
Checked By LRB

6010-E-0010 Bridge and Culvert Rehabs NWR
GRAIN SIZE DISTRIBUTION

FIGURE B3



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NGT-01	4.88	365.92
■	NGT-01	9.45	361.34
▲	NGT-02	7.92	362.88
★	NGT-02	10.97	359.83
⊙	NGT-03	6.40	364.43
⊕	NGT-03	9.45	361.39

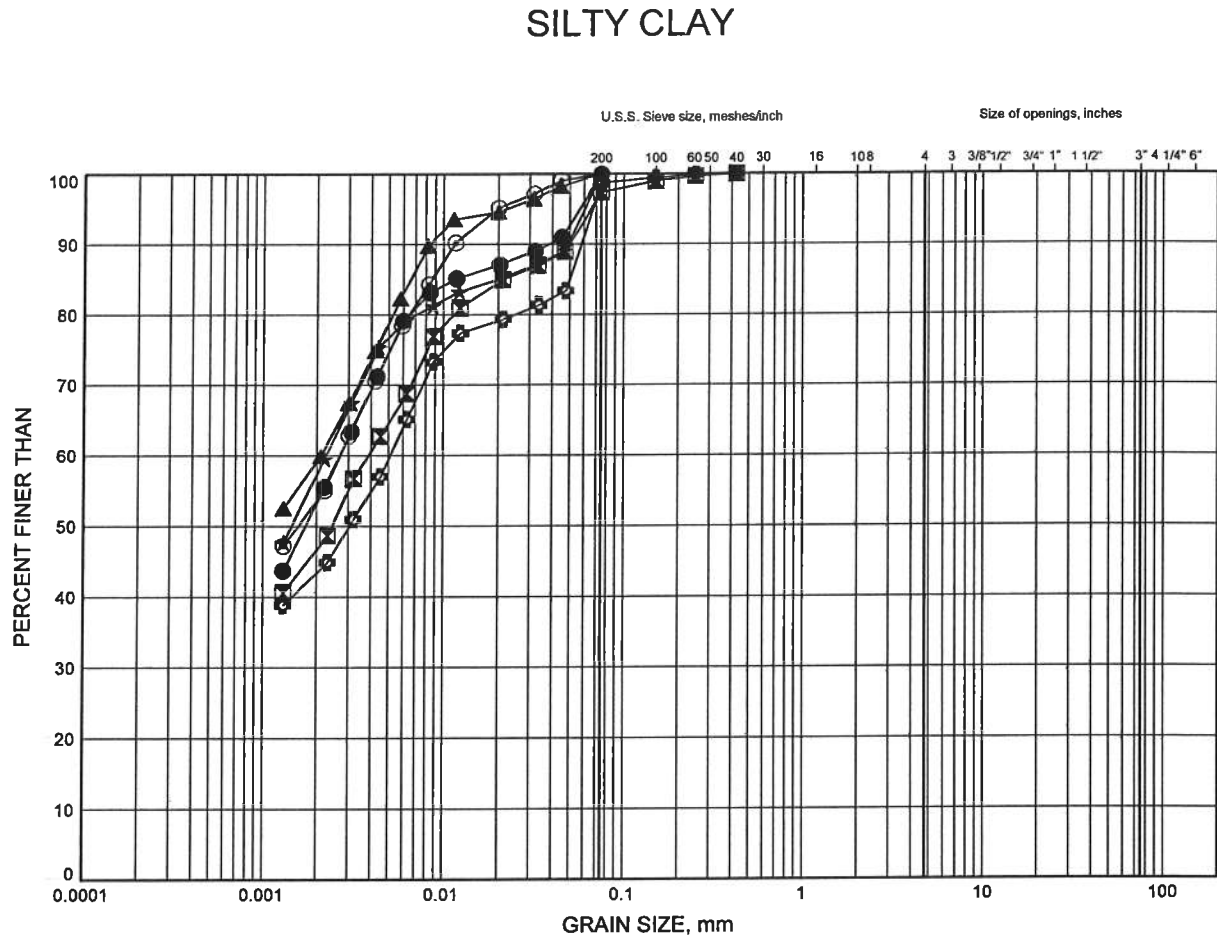
GRAIN SIZE DISTRIBUTION - THURBER 5121.GPJ 11/23/11

W.P.# .6145-04:00.....
Prepared By .AN.....
Checked By .LRB.....



6010-E-0010 Bridge and Culvert Rehabs NWR
GRAIN SIZE DISTRIBUTION

FIGURE B4



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

LEGEND

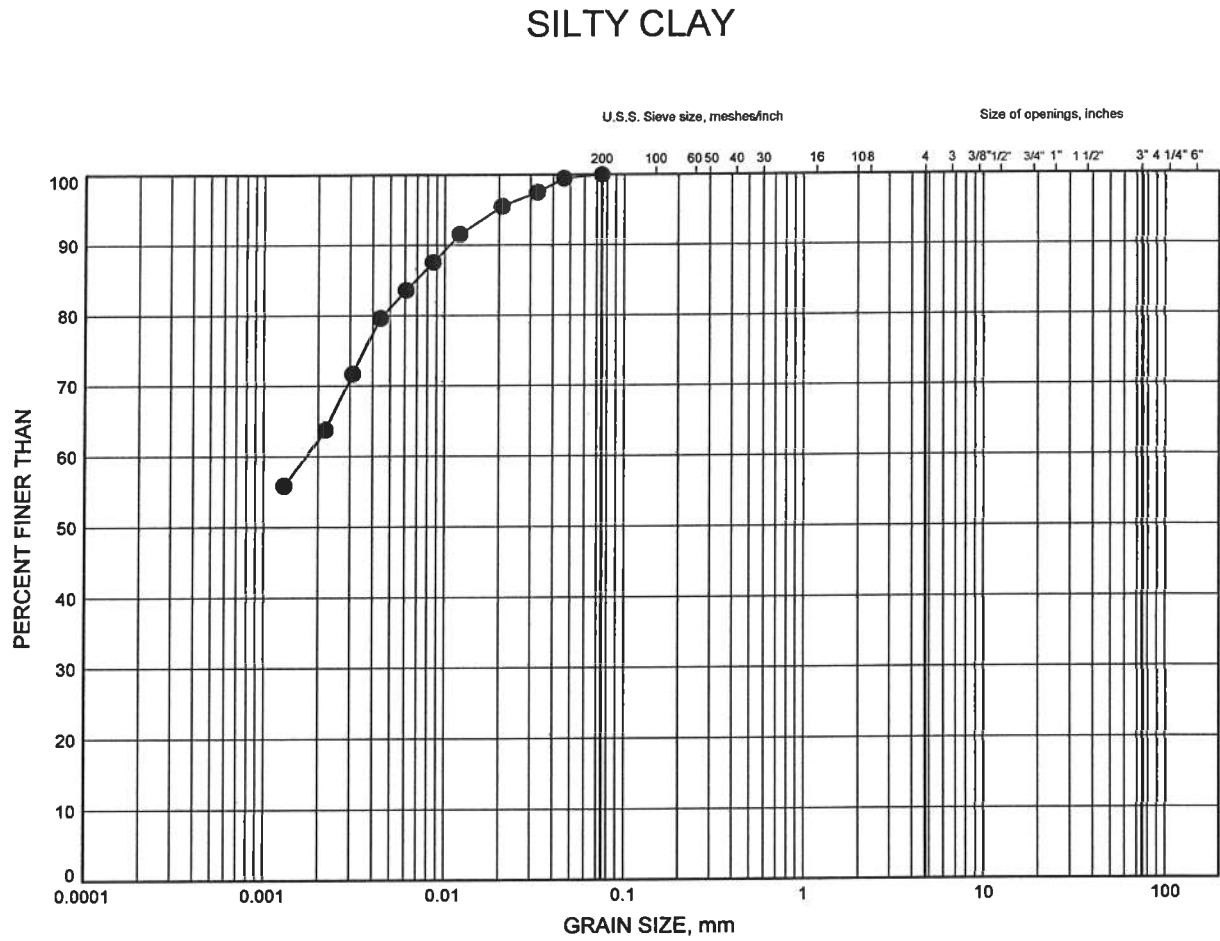
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NGT-03	14.02	356.81
⊠	NGT-04	4.88	365.97
▲	NGT-04	12.50	358.35
★	NGT-05	6.40	364.45
⊙	NGT-05	10.97	359.88
⊗	NGT-06	4.88	365.94



W.P.# 6145-04-00
Prepared By .AN.
Checked By .LRB.

6010-E-0010 Bridge and Culvert Rehabs NWR
GRAIN SIZE DISTRIBUTION

FIGURE B5



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NGT-06	9.45	361.37

GRAIN SIZE DISTRIBUTION - THURBER 5121.GPJ 11/23/11

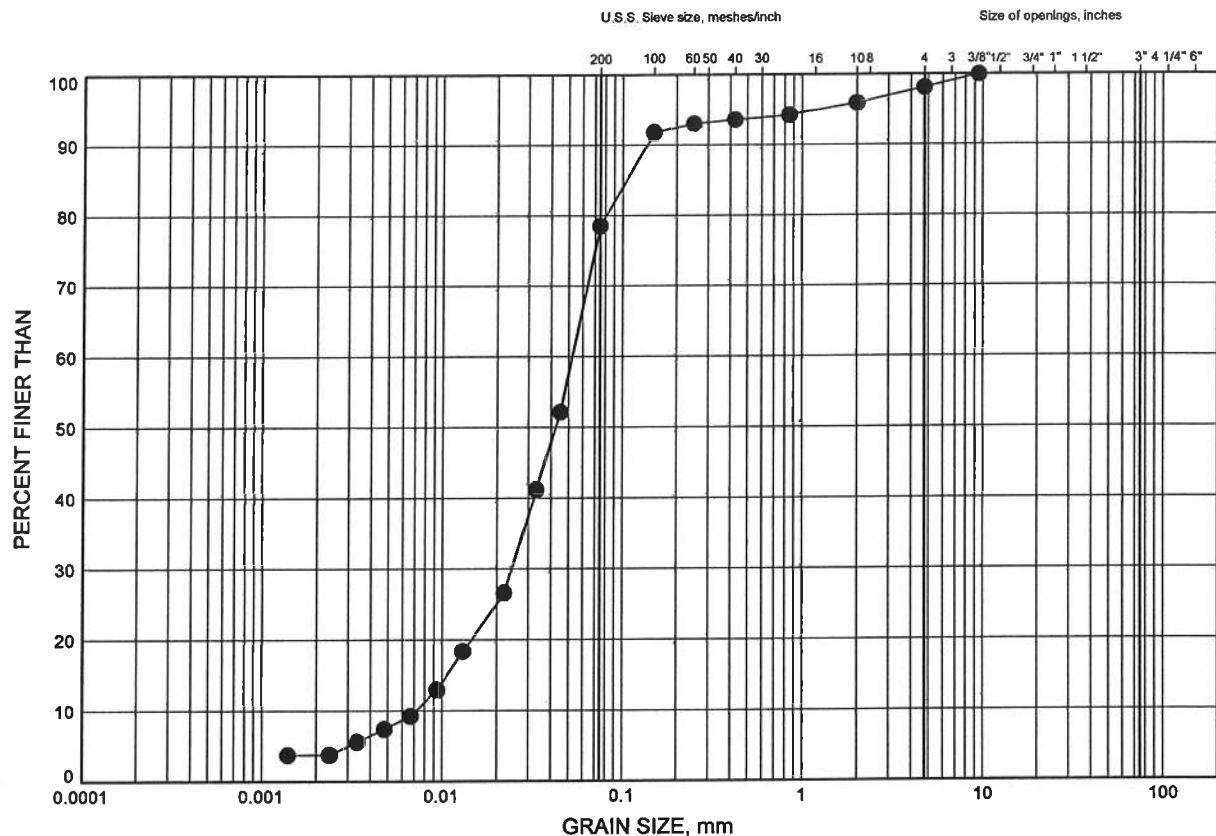
W.P.# 6145-04-00
 Prepared By AN
 Checked By LRB



6010-E-0010 Bridge and Culvert Rehabs NWR
GRAIN SIZE DISTRIBUTION

FIGURE B6

SANDY SILT



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

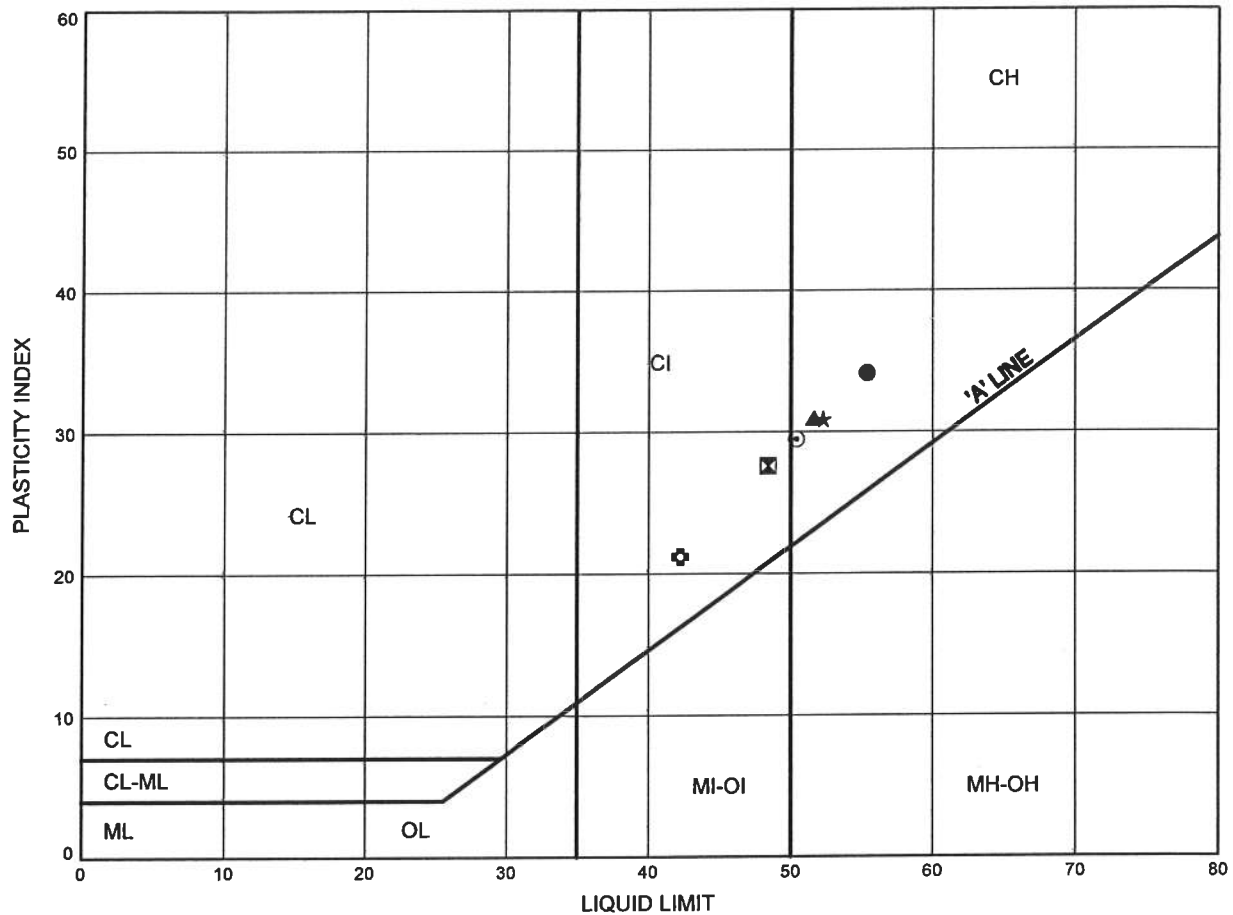
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NGT-02	17.07	353.74

6010-E-0010 Bridge and Culvert Rehabs NWR
ATTERBERG LIMITS TEST RESULTS

FIGURE B7

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	NGT-01	9.45	361.34
⊠	NGT-02	7.92	362.88
▲	NGT-02	10.97	359.83
★	NGT-03	6.40	364.43
⊙	NGT-03	9.45	361.39
⊕	NGT-03	14.02	356.81

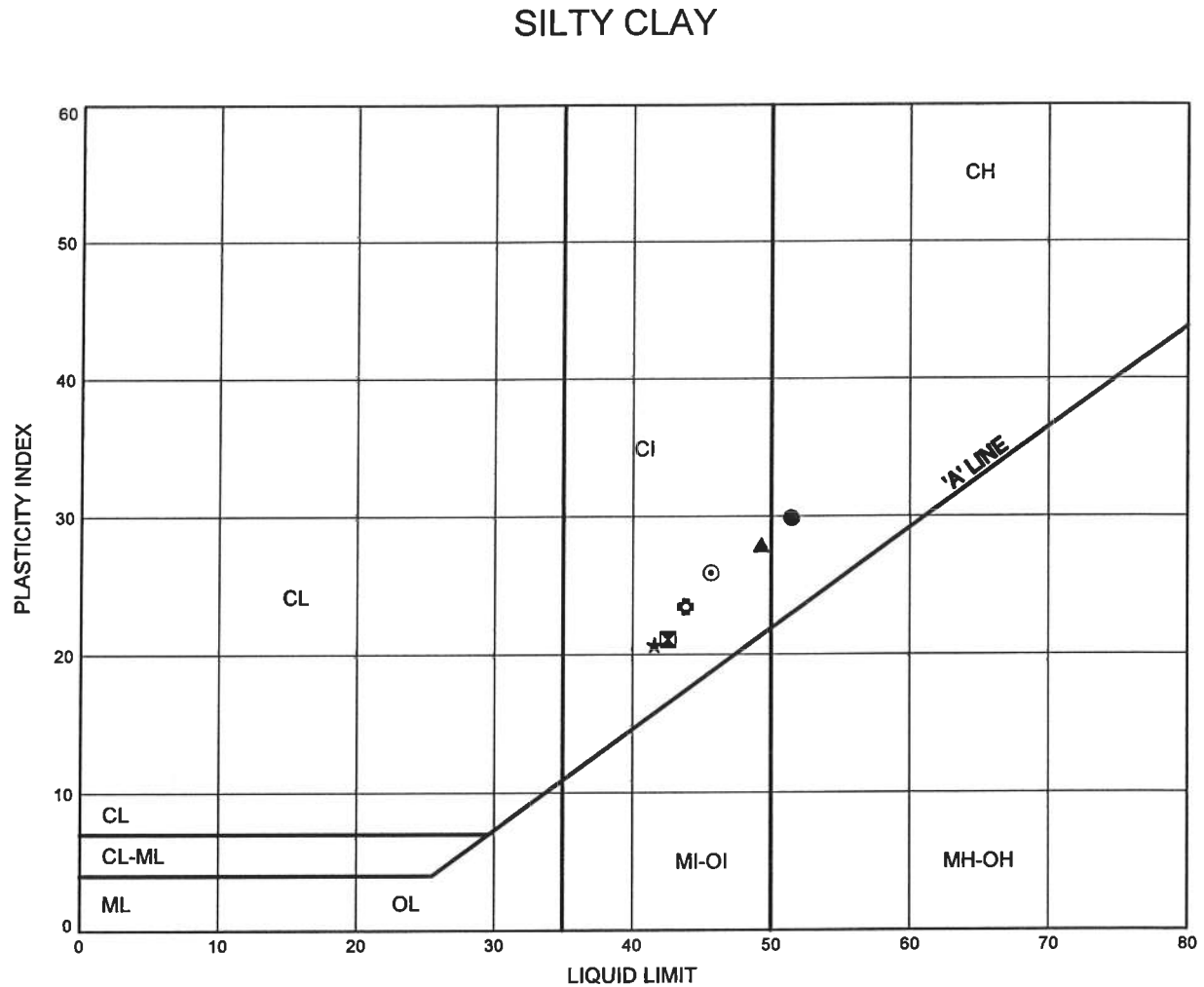
Date November 2011
 Project 6145-04-00



Prep'd AN
 Chkd. LRB

6010-E-0010 Bridge and Culvert Rehabs NWR
ATTERBERG LIMITS TEST RESULTS

FIGURE B8



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	NGT-04	4.88	365.97
⊠	NGT-04	12.50	358.35
▲	NGT-05	6.40	364.45
★	NGT-05	10.97	359.88
⊙	NGT-06	4.88	365.94
⊕	NGT-06	9.45	361.37



THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

POINT LOAD TEST SHEET

Job No : 19-1605-121 Client : HMM
Date Drilled : July 23, 2011
Project Name : Nugget Creek Bridge Date Tested : July 29, 2011
Core Size : NQ BH No : NGT-02 Tester : MAT

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	18.5	D	20.0	47.3	104.6	209.2	Mafic	Very Strong
2	1	18.8	D	19.7	47.3	108.0	206.3	Mafic	Very Strong
3	1	19.5	D	19.8	47.3	112.7	206.9	Mafic	Very Strong
4	1	20.9	D	13.3	47.4	95.9	138.6	Mafic	Very Strong
5	2	20.0	D	13.5	47.4	97.2	140.8	Mafic	Very Strong
6	2	20.8	D	20.0	47.4	114.7	208.3	Mafic	Very Strong
7	2	21.0	D	20.0	47.4	90.7	208.4	Mafic	Very Strong
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
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 $0.7 \times D$ on either side of test point.



THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

POINT LOAD TEST SHEET

Job No : 19-1605-121 Client : HMM
Date Drilled : July 27, 2011
Project Name : Nugget Creek Bridge Date Tested : August 05, 2011
Core Size : NQ BH No : NGT-05 Tester : JM

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	18.4	D	18.4	47.2	151.4	192.9	Mafic	Very Strong
2	1	18.7	D	17.1	47.1	137.1	180.1	Mafic	Very Strong
3	1	19.1	D	9.5	47.1	189.5	100.0	Mafic	Strong
4	1	19.3	D	15.7	47.3	132.4	164.1	Mafic	Very Strong
5	1	19.8	A	9.8	47.3	46.2	86.6	Mafic	Strong
6	2	20.0	D	17.2	47.3	87.4	180.3	Mafic	Very Strong
7	2	20.3	D	18.1	47.4	113.2	189.1	Mafic	Very Strong
8	2	20.5	D	21.0	47.4	116.4	219.4	Mafic	Very Strong
9	2	20.9	D	21.0	47.4	127.3	219.4	Mafic	Very Strong
10	2	21.3	D	21.0	47.4	90.5	219.4	Mafic	Very Strong
11									
12									
13									
14									
15									
16									
17									
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30									

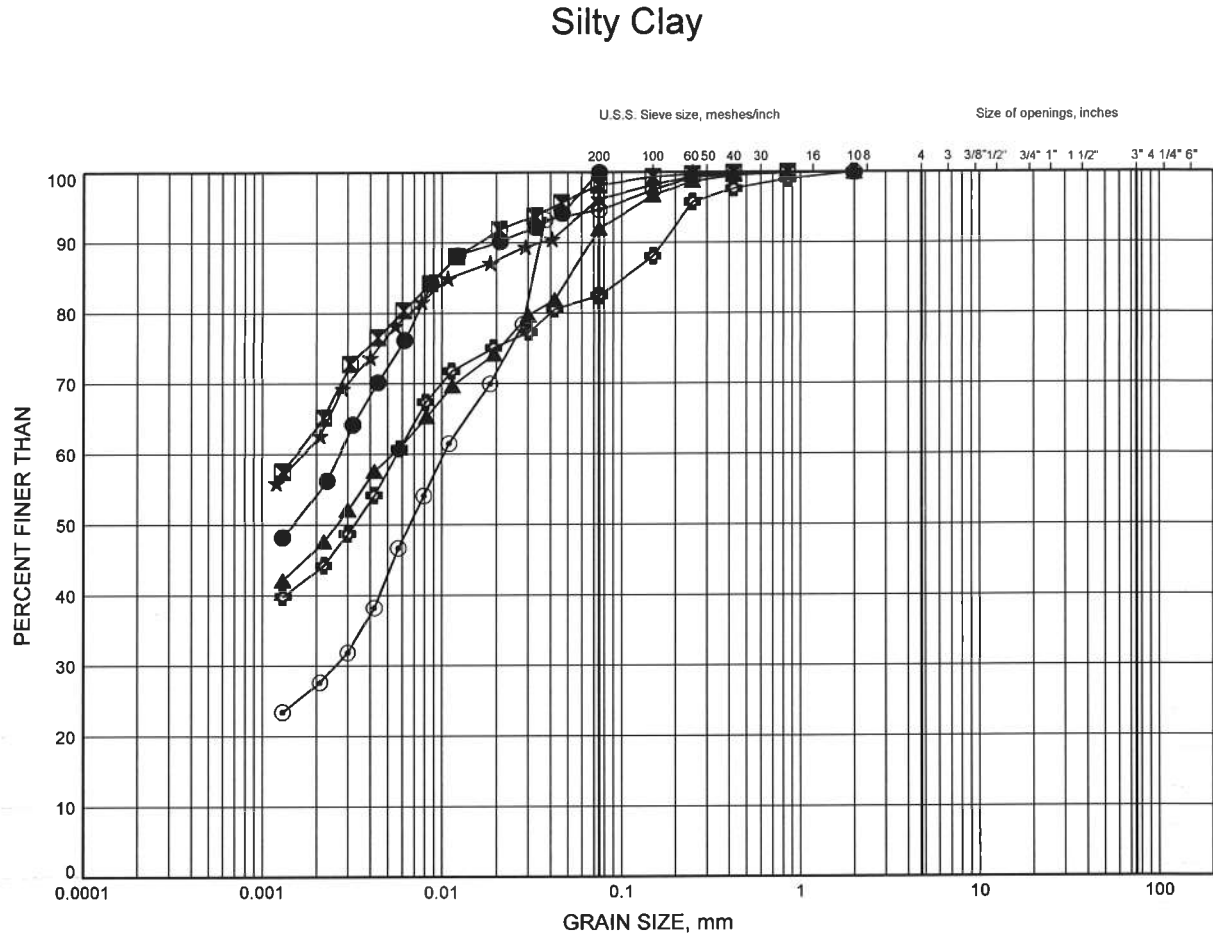
* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1

Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have $0.7 \times D$ on either side of test point.

Hwy 69 Four-Laning North of Hwy 529 GRAIN SIZE DISTRIBUTION

FIGURE H2



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C231-1	2.59	190.81
⊠	C231-2	8.53	186.47
▲	BH45-02	1.07	191.73
★	BH45-03L	1.83	190.87
⊙	BH45-04	1.07	191.53
⊕	BH45-04	3.20	189.40

Appendix C

Site Photographs

Nugget Creek Bridge Replacement
Highway 17, Site 41S-62



Photograph 1– Nugget Creek Bridge - Looking West



Photograph 2 – Nugget Creek Bridge, Looking East



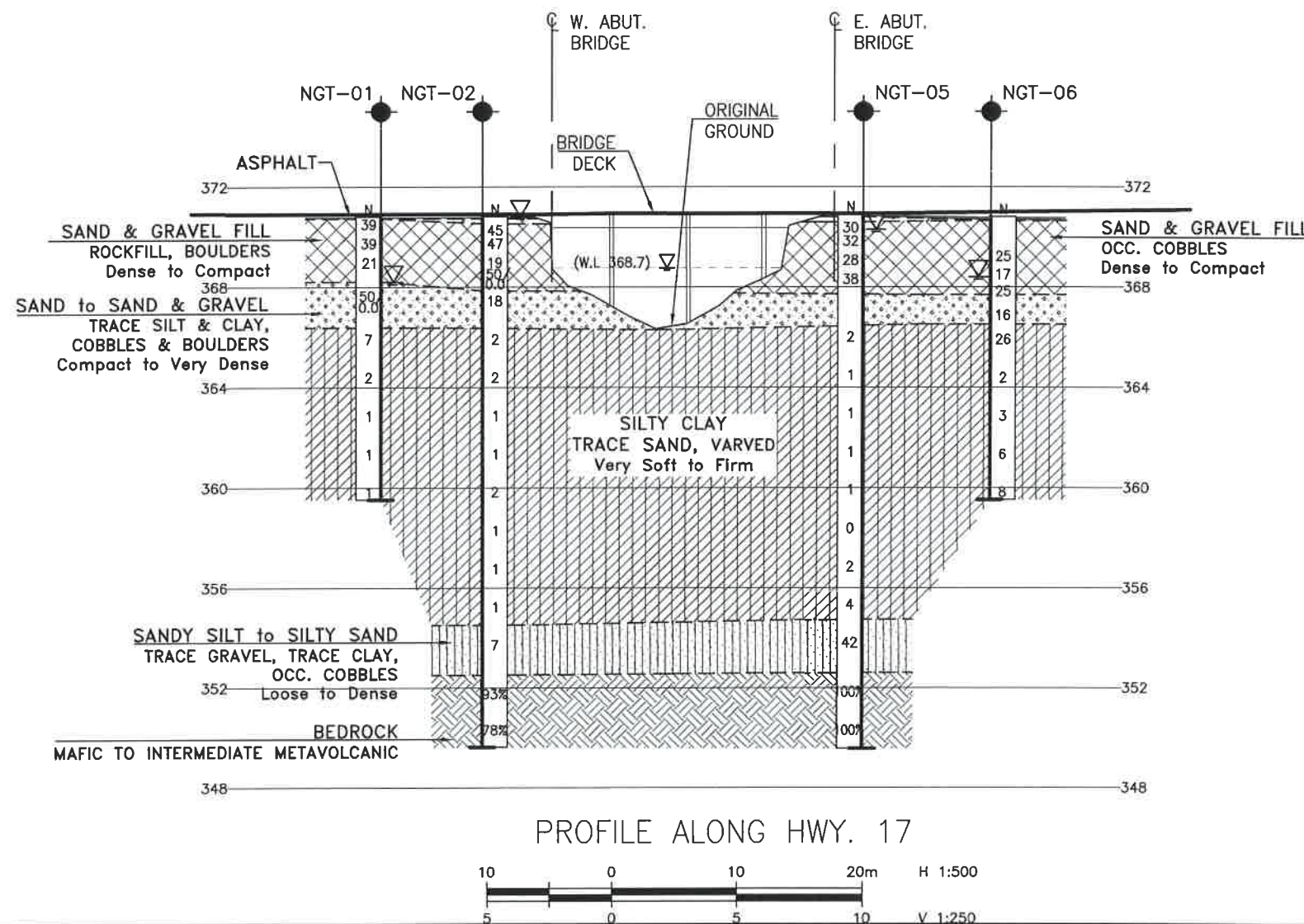
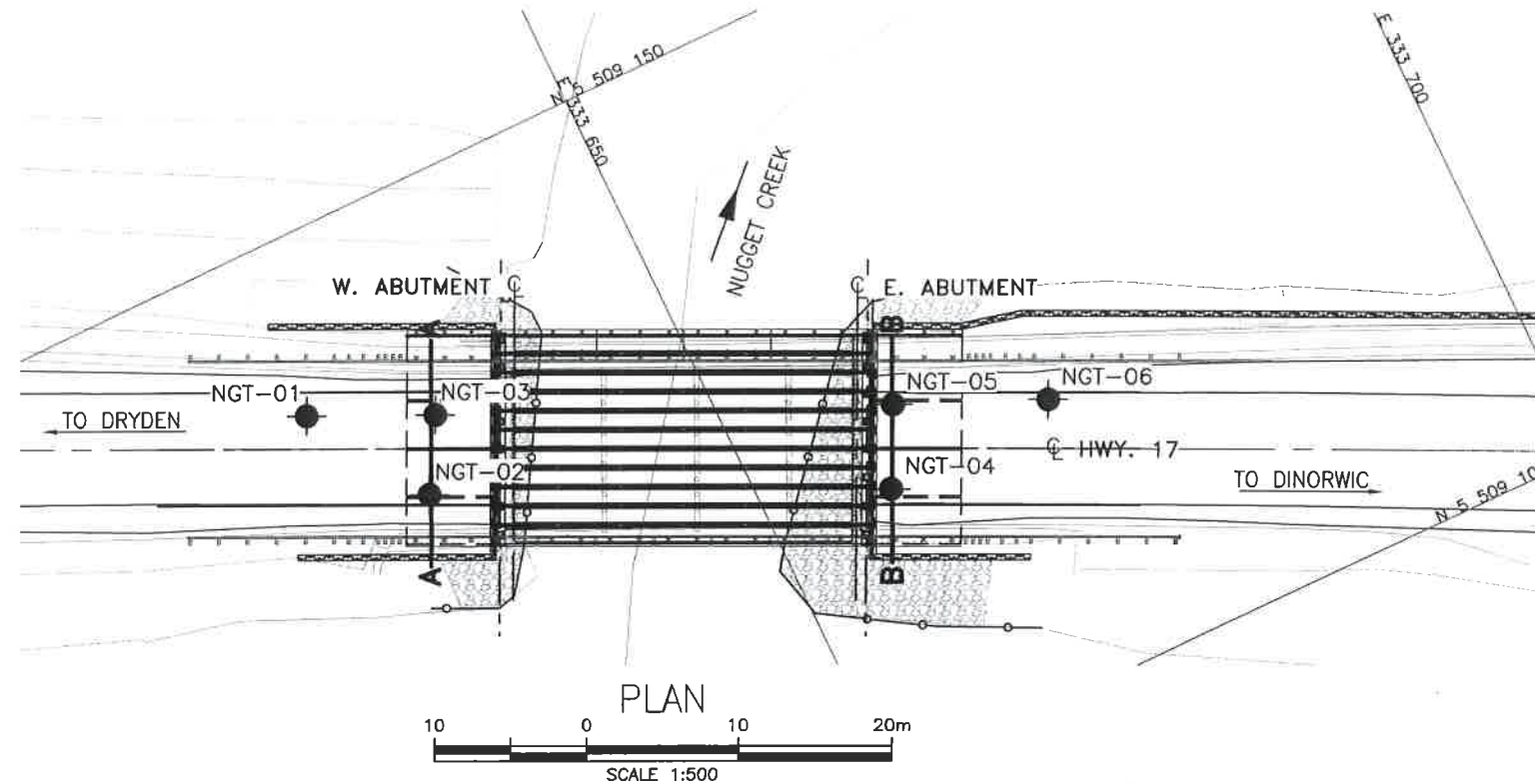
Photograph 3 – Nugget Creek, Looking North from Bridge



Photograph 4 – South Side of Nugget Creek Bridge

Appendix D

Drawing titled “Borehole Locations and Soil Strata”



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

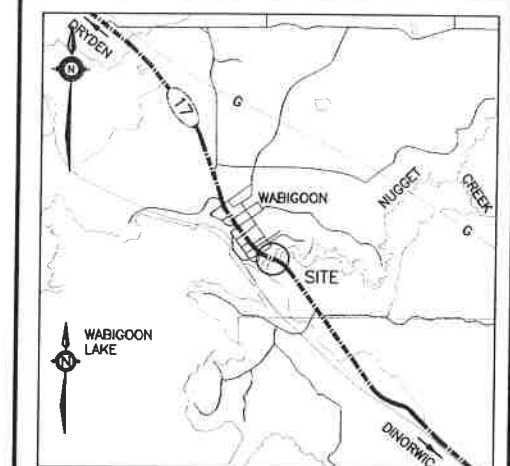
CONT No 2012-6014
WP No 6056-08-02

HIGHWAY 17
NUGGET CREEK
BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
9

Hatch Mott MacDonald

THURBER ENGINEERING LTD.



**KEYPLAN
LEGEND**

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

NO	ELEVATION	NORTHING	EASTING
NGT-01	370.8	5 509 138.5	333 625.7
NGT-02	370.8	5 509 130.3	333 630.9
NGT-03	370.8	5 509 134.9	333 633.3
NGT-04	370.9	5 509 117.5	333 658.1
NGT-05	370.9	5 509 122.5	333 660.6
NGT-06	370.8	5 509 118.4	333 669.9

-NOTES-

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

GEOCREs No. 52F-38



REVISIONS	DATE	BY	DESCRIPTION
DESIGN LRB	CHK LRB	CODE CAN/CSA S6-06/LOAD C1-625-0NT	DATE OCT. 2012
DRAWN AN	CHK RPR	SITE 415-62	STRUCT DWG 2

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

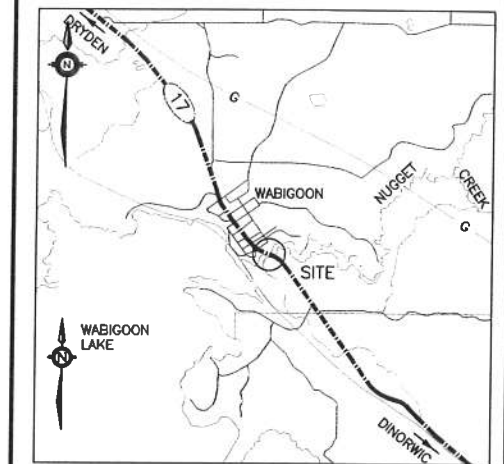
CONT No 2012-6014
WP No 6056-08-02

HIGHWAY 17
NUGGET CREEK
BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
10

**Hatch Mott
MacDonald**

THURBER ENGINEERING LTD.



**KEYPLAN
LEGEND**

- ◆ Borehole
- ◆ Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level
- HA Head Artesian Water
- P Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

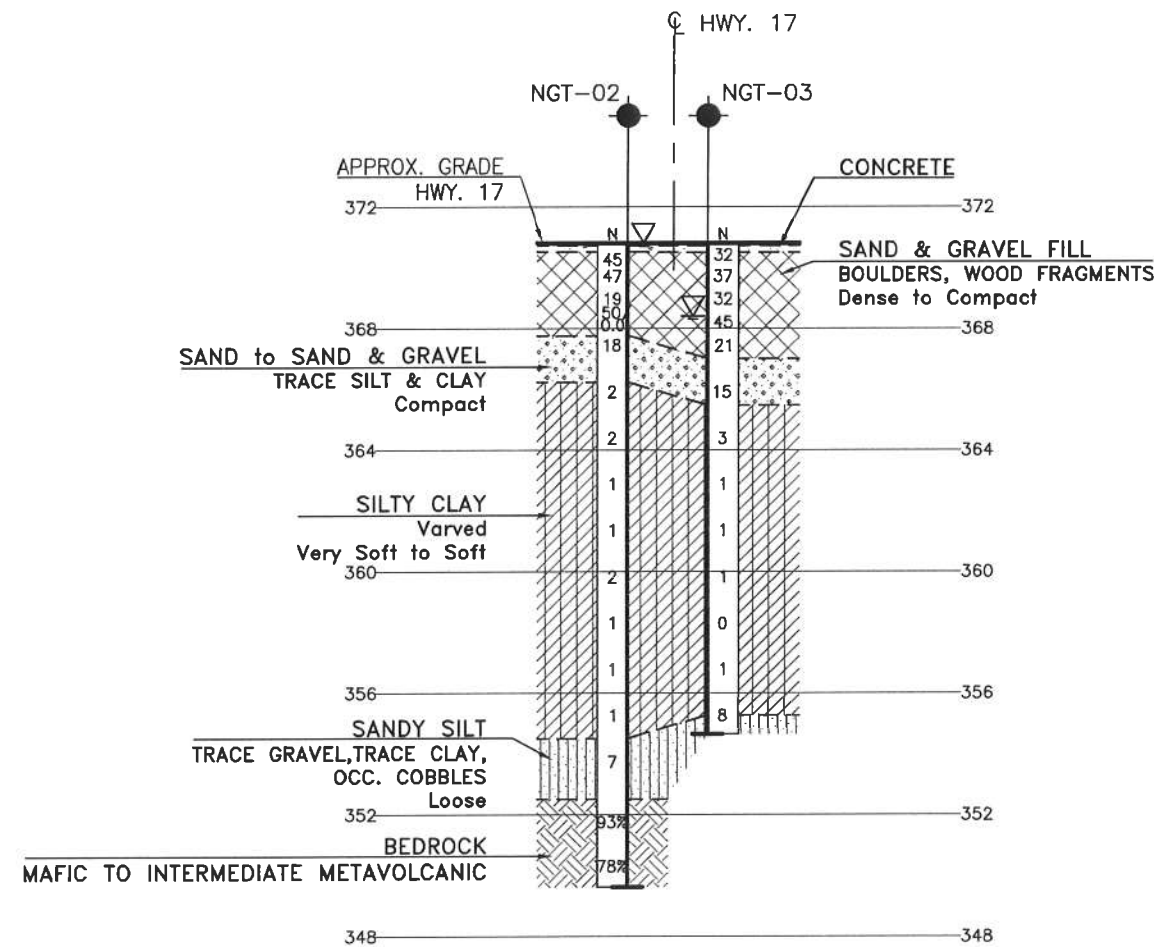
NO	ELEVATION	NORTHING	EASTING
NGT-01	370.8	5 509 138.5	333 625.7
NGT-02	370.8	5 509 130.3	333 630.9
NGT-03	370.8	5 509 134.9	333 633.3
NGT-04	370.9	5 509 117.5	333 658.1
NGT-05	370.9	5 509 122.5	333 660.6
NGT-06	370.8	5 509 118.4	333 669.9

-NOTES-

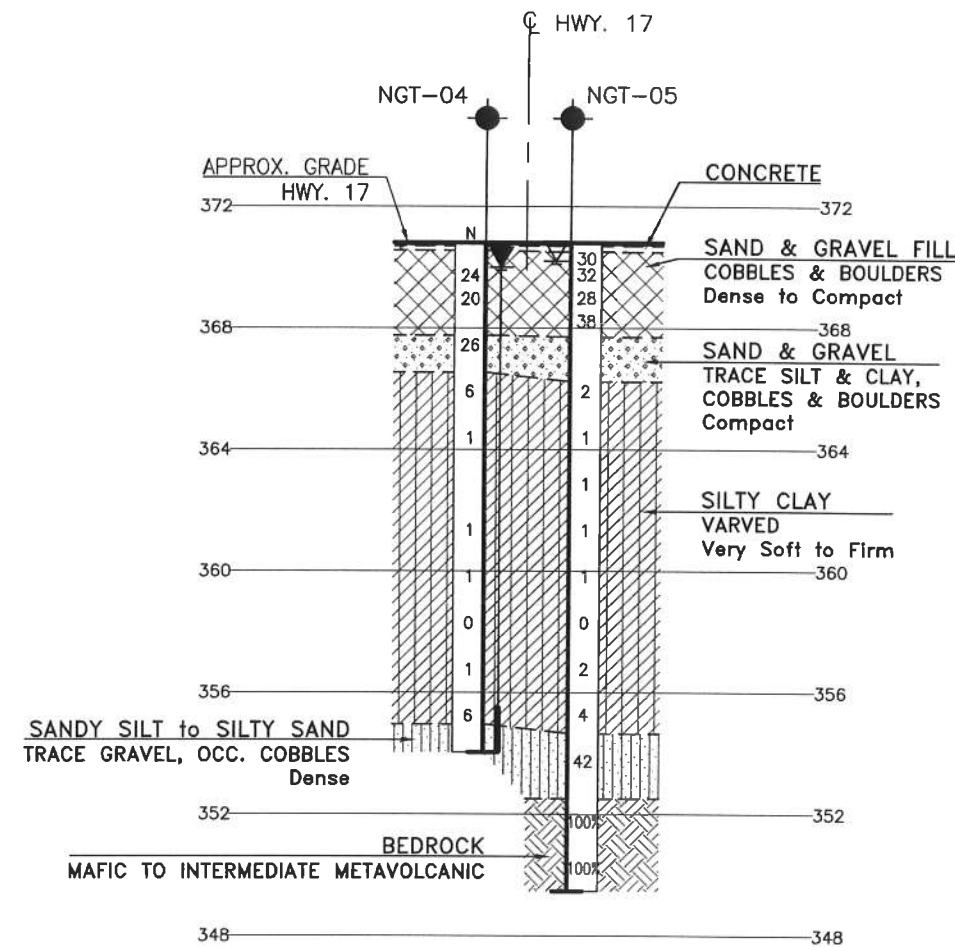
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 52F-38

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	LRB	CHK LRB	CODE CAN/CSA S6-06/LOAD C1-825-ONT/DATE OCT. 2012
DRAWN	AN	CHK RPR	SITE 41S-82/STRUCT J/DWG 3



SECTION ALONG A-A



SECTION ALONG B-B

