

**FOUNDATION INVESTIGATION REPORT
OFF LAKE BRIDGE REPLACEMENT
HIGHWAY 615
TOWNSHIP OF CHAPPLE, ONTARIO
RAINY RIVER DISTRICT**

G.W.P. 6092-10-01, SITE No. 45-13

Geocres Number: 52C-30

Report to

GENIVAR

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

October 30, 2013
File: 19-5308-40

H:\19\5308\40 NWR 11 Bridge 3 Culvert Rehabs\Reports &
Memos\Off Lake Bridge\Off Lake FIR FINAL.doc

TABLE OF CONTENTS

PART 1 FACTUAL INFORMATION

1 INTRODUCTION 1

2 SITE DESCRIPTION 1

3 SITE INVESTIGATION AND FIELD TESTING 2

4 LABORATORY TESTING 3

5 DESCRIPTION OF SUBSURFACE CONDITIONS 3

 5.1 Asphalt 4

 5.2 Embankment Fill 4

 5.3 Peat and Marl 4

 5.4 Sand 5

 5.5 Silty Sand to Sandy Silt 5

 5.6 Silt 6

 5.7 Silty Clay 6

 5.8 Silt 7

 5.9 Clayey Silt Till 7

 5.10 Sand and Gravel with Cobbles and Boulders 7

 5.11 Bedrock 8

 5.12 Water Levels 8

6 MISCELLANEOUS 10

Appendices

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Site Photographs
Appendix D	Borehole Locations and Soil Strata Drawings

**FOUNDATION INVESTIGATION REPORT
OFF LAKE BRIDGE REPLACEMENT
HIGHWAY 615
TOWNSHIP OF CHAPPLE, ONTARIO
RAINY RIVER DISTRICT**

G.W.P. 6092-10-01, SITE No. 45-13

Geocres Number: 52C-30

PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the location of the Off Lake Bridge along Highway 615 in the Township of Chapple, Rainy River District, 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 sections, 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 6092-10-00.

2 SITE DESCRIPTION

The Off Lake Bridge is located on Highway 615 between French Road and Fleming Road, approximately 45 km northwest of Fort Frances and 30 km northeast of the intersection of Highways 11 and 71. The bridge is located at the west end of Off Lake and spans the west inlet.

The lands immediately surrounding the bridge site consist of forested and low-lying swamp areas. There are several private residences to the north and south of the bridge site, off Highway 615.

The existing bridge comprises a seven-span timber-concrete composite structure supported on six pier bents and two abutments, each carried by five timber piles. The bridge is approximately 32 m long and 7 m wide. The existing approach embankments are in the order of 1.5 m to 2.0 m high.

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. The soil deposits in the area comprise glaciolacustrine deposits of sand, silt and clay locally overlain by alluvial and organic deposits in low lying areas. Bedrock at depth is formed of felsic to intermediate metavolcanic rock.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between August 23 and October 14, 2011 and consisted of drilling and sampling six boreholes, identified as OFF-01 to OFF-06. The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata Drawing included in Appendix D.

Boreholes OFF-02 to OFF-05 were drilled to depths of 29.8 to 37.4 m adjacent to the existing bridge abutments. Boreholes OFF-01 and OFF-06 were drilled to 11.3 m depth through the approaches. A 2.8 m length of bedrock core was recovered from Borehole OFF-05. Borehole OFF-04 was terminated upon refusal in the dense sand and gravel layer containing cobbles and boulders above the bedrock.

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

Drilling was carried out using a truck-mounted CME 75 drill rig. The boreholes were advanced using a combination of hollow-stem augers and wash-boring/NW casing. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

NQ coring techniques were used to penetrate cobbles and boulders in the sand and gravel layer above the bedrock and to recover bedrock core samples. All rock cores were logged, and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

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 bedrock samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed during the drilling operations. Groundwater levels observed after completion of wash-boring and coring operations were not representative of site conditions as water was introduced into the borehole. Standpipe piezometers were installed in two boreholes to monitor groundwater levels at the site. Completion details of the piezometers and boreholes are summarized in Table 3.1. The piezometers were decommissioned in general accordance with MOE Regulation 903 at the end of October 2012.

Table 3.1 – Borehole Completion Details

Location	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
North Approach	OFF-01	None installed	Backfilled with bentonite holeplug from 11.3m to 3.0m, cuttings from 3.0m to 0.1m, then asphalt cold patch to surface.
North Abutment	OFF-02	34.1 / 65.8	Piezometer with 3.1m slotted screen installed with sand filter to 30.6m, bentonite from 30.6m to 0.6m, cement mix from 0.6m to 0.1m, then asphalt cold patch to surface.
	OFF-03	None installed	Borehole caved to 11.3m, borehole backfilled with bentonite holeplug and grout from 11.3m to 1.2m, cuttings from 1.2m to 0.15m, then asphalt cold patch to surface.
South Abutment	OFF-04	None installed	Grouted with bentonite holeplug from 29.8m to 2.9m, backfilled with cuttings from 2.9m to 0.3m, then asphalt cold patch to surface.
	OFF-05	30.4 / 69.5	Piezometer with 1.5m slotted screen installed with sand filter to 27.0m, bentonite and grout from 27.0m to 2.5m, sand from 2.5m to 0.4m, cement mix from 0.4m to surface.
South Approach	OFF-06	None installed	Backfilled with bentonite from 11.3m to 3.1m, cuttings from 3.1m to 0.1m, then asphalt cold patch to surface.

4 LABORATORY TESTING

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

Point load tests were carried out on selected samples of intact bedrock in the laboratory to evaluate the unconfined compressive strength (UCS) of the bedrock. The UCS values of the rock samples assessed from the point load test data are included on the borehole logs presented 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.

The subsurface conditions at the site typically consist of existing sand to sand and gravel embankment fill overlying a discontinuous layer of peat and marl, underlain by very loose to compact native sand to silt and sand, which in turn is underlain by typically firm to stiff silty clay.

Beneath the silty clay deposit is a layer of silt or clayey silt till, and a deposit of very dense sand and gravel with cobbles and boulders which overlies bedrock.

More detailed descriptions of the individual strata are presented below.

5.1 Asphalt

An approximate 25mm to 50mm thick layer of asphalt was encountered surficially in all boreholes drilled through the Highway 615 pavement.

5.2 Embankment Fill

Brown granular fill consisting of sand to sand and gravel was encountered below the asphalt in all boreholes. The fill contained trace to some silt (locally silty) and occasional cobbles, boulders and rock fragments. A 200 mm thick layer of silty clay was encountered at 1.2 m depth locally within the fill in Borehole OFF-01. The fill thickness ranged from 2.3 m to 3.4 m, with the lower boundary at Elev. 96.5 to 97.6.

SPT N-values ranged from 10 blows for 0.3 m penetration to 50 blows for no penetration, indicating a compact to very dense relative density. The fill is typically compact and the high recorded N-values are believed to be due to the sampler encountering cobbles and boulders within the fill. The moisture content of samples of the sand and gravel fill typically ranged from 2% to 15%.

Laboratory grain size analysis testing was undertaken on three samples of the fill and the results of the testing are summarized below. The results are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are shown in Figure B1 of Appendix B.

Gravel %	6 to 47
Sand %	40 to 87
Silt and Clay %	6 to 29

5.3 Peat and Marl

A layer of dark brown to black peat was encountered below the granular embankment fill in all boreholes except for Borehole OFF-05. The peat was typically silty and contained wood fragments. The peat layer was 0.5 m thick in all boreholes except Borehole OFF-02 where it was 1.2 m thick. The lower boundary was encountered at depths of 3.4 m to 3.7 m (Elev. 96.5 to 96.2).

In Boreholes OFF-01, OFF-02 and OFF-06, the peat was underlain by grey silty marl containing shell fragments. This layer was 0.5 m to 0.6 m thick, with a lower boundary at 4.1 m depth (Elev. 95.8).

SPT N-values recorded in the peat layer ranged from 2 to 6 blows for 0.3 m penetration, indicating a very loose to loose condition. Moisture contents of the peat and marl ranged from 120% to 217%.

5.4 Sand

A layer of native grey sand with trace to some silt and gravel was encountered beneath the fill, peat and marl in all boreholes. The thickness of the sand layer ranged from 1.9 m to 4.5 m. The lower boundary of this deposit was at depths of 5.3 m to 8.2 m (Elev. 94.6 to 91.7).

SPT N-values recorded in the sand layer ranged from 2 to 29 blows for 0.3 m penetration, indicating a very loose to compact relative density. Moisture contents ranged from 11% to 20%.

The results of grain size analysis testing conducted on samples of the sand are presented on the Record of Borehole sheets included in Appendix A and the grain size distribution curves plotted on Figure B2 of Appendix B. The results are summarized as follows:

Gravel %	1 to 4
Sand %	77 to 95
Silt and Clay %	2 to 22

5.5 Silty Sand to Sandy Silt

Below the sand layer, a cohesionless deposit grading from sandy silt to silty sand with trace to some clay was encountered. Borehole OFF-01 was terminated within this deposit at 11.3 m depth (Elev. 88.6). In the remaining boreholes, the thickness of this layer ranged from 2.7 m to 6.6 m. The lower boundary was at depths of 9.4 m to 14.2 m (Elev. 90.5 to 85.7).

SPT N-values recorded in the silty sand to sandy silt layer ranged from 1 to 12 blows for 0.3 m penetration, indicating a very loose to compact relative density. Moisture contents ranged from 14% to 32%.

The results of grain size analysis testing conducted on samples of the sand/silt are presented on the Record of Borehole sheets included in Appendix A and the grain size distribution curves plotted on Figures B3 and B4, Appendix B. The results are summarized as follows:

Gravel %	0 to 5
Sand %	23 to 76
Silt %	22 to 58
Clay %	2 to 19

5.6 Silt

A 1.4 m thick layer of silt with some clay and trace of sand was encountered below the sand/silt locally in Borehole OFF-02. The lower boundary was at 15.2 m depth (Elev. 84.7). An SPT N-value of 4 blows for 0.3 m was recorded in the silt, indicating a loose condition. A moisture content of 23% was measured.

The results of a grain size analysis conducted on the silt are presented on the Record of Borehole sheets in Appendix A and summarized below. The grain size curve is shown on Figure B5, Appendix B.

Gravel %	0
Sand %	7
Silt %	79
Clay %	14

5.7 Silty Clay

Grey silty clay with occasional silt and sand seams was encountered below the sand and silt deposits in all boreholes except for Borehole OFF-01. Borehole OFF-06 was terminated within this layer at 11.3 m depth (Elev. 88.6). The thickness of the clay layer in the remaining boreholes varied from 10.5 m to 14.7 m, with the lower boundary at depths of 24.1 m to 26.1 m (Elev. 75.8 to 73.8).

SPT N-values recorded in the clay ranged from 3 to 19 blows for 0.3 m of penetration, indicating a very soft to very stiff consistency, typically firm to stiff. Moisture contents ranged from 22% to 49%, generally less than 30%.

Grain size distribution curves from ten samples are presented on the Record of Borehole sheets included in Appendix A and on Figures B6 and B7 of Appendix B. Atterberg Limits test results are presented on Figure B8. The results are summarized below:

Gravel %	0 to 1
Sand %	1 to 13*
Silt %	25 to 71
Clay %	22 to 72

* 23% in one sample with sand seams

Liquid Limit	27 to 69
Plastic Limit	15 to 21

The results indicate that the silty clay is typically of low to intermediate plasticity with a group symbol of CL to CI. One sample from Borehole OFF-02 exhibited high plasticity (CH).

5.8 Silt

A layer of silt with some clay was encountered below the silty clay in Boreholes OFF-02 and OFF-03. The silt layer was 2.6 to 3.0 m thick with a lower boundary at depths of 27.1 and 28.7 m (Elev. 72.8 and 71.2). SPT N-values of 12 and 15 blows for 0.3 m were recorded in the silt, indicating a compact condition. Moisture contents of 23% and 24% were measured.

The results of grain size analyses conducted on the silt are presented on the Record of Borehole sheets in Appendix A and summarized below. The grain size curves are shown on Figure B5, Appendix B.

Gravel %	0 to 2
Sand %	0 to 9
Silt %	73 to 87
Clay %	13 to 16

5.9 Clayey Silt Till

A layer of clayey silt till with occasional cobbles and boulders was encountered below the silty clay in Boreholes OFF-04 and OFF-05. The till layer was 2.7 m to 3.0 m thick with a lower boundary at depths of 27.4 and 27.7 m (Elev. 72.5 and 72.2).

SPT N-values of 100 for 0.075 m and 38 blows for 0.3 m of penetration were recorded in the till, indicating a hard consistency. The higher N-value may indicate the presence of a cobble however. Moisture contents of 27% and 29% were measured.

5.10 Sand and Gravel with Cobbles and Boulders

A layer of sand and gravel with cobbles and boulders was encountered below the silt and clayey silt till layers in Boreholes OFF-02 to OFF-05. In Boreholes OFF-02 and OFF-05, rock coring procedures were required to penetrate the cobbles and boulders in this deposit. Cobble and boulder sizes of 100 mm to 680 mm were noted in the recovered core runs.

Boreholes OFF-02 and OFF-03 were terminated within this deposit at 37.4 m depth (Elev. 62.5), indicating a layer thickness of at least 8.7 to 10.3 m. Borehole OFF-04 was terminated upon auger refusal on probable boulders at 29.8 m depth (Elev. 70.1). Bedrock was contacted below the sand and gravel at 31.3 m depth (Elev. 68.6) in Borehole OFF-05, for a layer thickness of 3.6 m.

SPT N-values recorded in the sand and gravel typically ranged from 52 blows for 0.3 m to 100 blows for 0.025 m of penetration, indicating a very dense condition and/or the presence of cobble and boulders. Locally at depths of 31.5 and 33.0 m (Elev. 68.4 and

66.9) in Borehole OFF-03, N-values of 26 and 28 blows per 0.3 m of penetration were recorded, indicating a compact zone.

One moisture content of 14% was measured in the sand and gravel.

5.11 Bedrock

Bedrock was contacted below the layer of sand and gravel in Borehole OFF-05 at 31.3 m depth (Elev. 68.6), and a 2.8 m length of rock core was recovered. The bedrock recovered in the core was described as grey intermediate metavolcanic rock.

Total core recovery in the bedrock was 100% except for the final core run where recovery was 44%. The Rock Quality Designation (RQD) varied from 0% to 46%, indicating very poor to poor rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 5 to 15.

The unconfined compressive strength estimated from the results of point load tests conducted on the rock cores ranged from 155 MPa to 346 MPa, indicating a very strong to extremely strong rock.

5.12 Water Levels

Water levels were monitored in the open boreholes during drilling where possible. Wash boring and rock coring methods were used to advance Boreholes OFF-02 to OFF-05 and therefore water levels in these boreholes were not representative of the groundwater conditions. Piezometers were installed in Boreholes OFF-02 and OFF-05 upon completion of drilling.

The water levels recorded in the boreholes during drilling and subsequently in the piezometers are summarized in Table 5.1.

The GA drawing provided by GENIVAR indicates that the water level at the inlet to Off Lake was at Elev. 98.3 when measured in May 2011.

The above values are short-term readings and seasonal fluctuations of the lake and groundwater level are to be expected. In particular, the lake and groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

Table 5.1 – Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
OFF-01	Aug. 23, 2011	2.7	97.2	Open borehole
OFF-02	Oct. 02, 2011	4.1	95.8	In piezometer
	Oct. 04, 2011	3.9	96.0	
	Oct. 13, 2011	3.9	96.0	
	Oct. 20, 2011	3.8	96.1	
	Oct. 27, 2012	1.4	98.5	
OFF-03	Oct. 14, 2013	2.4	97.5	Open borehole
OFF-05	Oct. 02, 2011	0.9	99.0	In piezometer
	Oct. 04, 2011	0.9	99.0	
	Oct. 13, 2011	0.9	99.0	
	Oct. 20, 2011	0.9	99.0	
	Oct. 27, 2012	1.4	98.5	
OFF-06	Aug. 23, 2011	3.3	96.6	Open borehole

6 MISCELLANEOUS

Borehole locations were selected in the field by Thurber Engineering Ltd. The coordinates and ground surface elevations for the boreholes were established based on topographic surface information provided by GENIVAR.

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

Eastern Ontario Diamond Drilling of 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 by Ms Eckie Siu, Mr George Azzopardi, Mr Jason Mei, and Mr Stephane Loranger, C.E.T. of Thurber.

Overall 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. Rocio Palomeque Reyna, P.Eng. and Ms. Mei T. Cheong, P.Eng.

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

Thurber Engineering Ltd

Mei T. Cheong, M.Phil., P.Eng.
Geotechnical Engineer



Murray R. Anderson M.Eng., P.Eng.
Senior Foundations Engineer



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



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

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


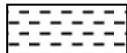



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (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>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(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.

METRIC

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT	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	W P W L	PLASTIC LIMIT		LIQUID LIMIT
99.9 0.0	ASPHALT:(50mm) SAND and GRAVEL, some silt Compact Brown Damp (FILL)		1	GS								
			1	SS	22							
	Layer of silty clay (200mm) at 1.2m Occasional cobbles Grey Moist		2	SS	19							47 40 13 (SI+CL)
			3	SS	10							
96.8 3.1	PEAT, silty, with decayed wood fibres Very Loose Dark Brown		4	SS	2						181	
96.3 3.6	Wet MARL, silty, shell fragments Grey										145	
95.8 4.1	SAND, some silt, trace clay, trace gravel Compact Grey Wet		5	SS	23							4 79 14 3
93.8 6.1	Silty SAND to SILT and SAND, trace to some clay Very Loose to Loose Grey Wet		6	SS	1							0 76 22 2
			7	SS	8							
			8	SS	5							0 60 34 6

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No OFF-01

2 OF 2

METRIC

W.P. 6092-10-00 LOCATION N 1 004 0.9 E 9 994.7 Off Lake Bridge ORIGINATED BY ES
 HWY 615 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Top of Pavement DATE 2011.08.23 - 2011.08.23 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	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					
88.6	Continued From Previous Page Silty SAND to SILT and SAND , trace to some clay Loose Grey Wet		9	SS	5		89									0 43 43 14	
11.3	END OF BOREHOLE AT 11.3m. WATER LEVEL AT 2.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, AUGER CUTTINGS TO 0.1m THEN ASPHALT COLD PATCH TO SURFACE.																

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	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						WATER CONTENT (%)
							○ UNCONFINED		+ FIELD VANE				
99.9 0.0	ASPHALT: (50mm)		1	GS									
	SAND and GRAVEL, some silt, occasional cobbles Compact Brown Damp to Moist (FILL)		1	SS	28								
			2	SS	19								
97.6 2.3		PEAT, silty, with decayed wood fragments Loose to Very Loose Dark Brown Wet		3	SS	5							
			4	SS	3								
96.4 3.5	MARL, silty, trace sand, shell fragments Grey												
95.8 4.1	SAND, some silt, trace clay, trace gravel Compact Grey Moist		5	SS	24								
			6	SS	29								
92.7 7.2	Silty SAND to SILT and SAND, trace to some clay Very Loose to Compact Grey Wet		7	SS	3								
			8	SS	9								

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No OFF-02

2 OF 4

METRIC

W.P. 6092-10-00 LOCATION N 1 003 3.5 E 9 996.0 Off Lake Bridge ORIGINATED BY ES
 HWY 615 BOREHOLE TYPE Hollow Stem Augers/Casing/NQ Coring COMPILED BY AN
 DATUM Top of Pavement DATE 2011.08.24 - 2011.08.26 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			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	W _P W W _L									
							20 40 60 80 100	● QUICK TRIAXIAL × LAB VANE											
	Continued From Previous Page																		
	Silty SAND to SILT and SAND , trace to some clay Very Loose to Compact Grey Wet		9	SS	4		89						○						
							88												
			10	SS	12								○				0 64 29 7		
							87												
86.1																			
13.8	SILT , some clay, trace sand Loose Grey		11	SS	4		86						○				0 7 79 14		
							85												
84.7																			
15.2	Silty CLAY , varved, trace sand Firm Grey		12	SS	4								○				0 11 67 22		
							84												
			13	SS	6		83						○						
							82												
			14	SS	8								○	—			0 4 65 31		
							81												
							80												

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15 10 5 0
 (%) STRAIN AT FAILURE

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT 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		15	SS	19								0 3 25 72
	Occasional sand seams		16	SS	11								
73.8 26.1	SILT, some clay Compact Grey		17	SS	12								0 0 87 13
71.2 28.7	SAND and GRAVEL, with cobbles and boulders Very Dense Grey Wet		18	SS	52								

+³, ×³: Numbers refer to Sensitivity

METRIC

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No OFF-03

1 OF 4

METRIC

W.P. 6092-10-00 LOCATION N 1 003 3.1 E 9 992.0 Off Lake Bridge ORIGINATED BY SLL/JM
 HWY 615 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Top of Pavement DATE 2011.10.02 - 2011.10.14 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							PLASTIC LIMIT w _P NATURAL MOISTURE CONTENT w LIQUID LIMIT w _L WATER CONTENT (%)			
99.9								20	40	60	80	100						
99.0	ASPHALT:(40mm) SAND, some gravel, occasional cobbles Compact Brown Moist (FILL)		1	SS	22		99							○				
							98											
			2	SS	24													
97.0																		
2.9	PEAT, silty, decayed wood fragments Black Wet						97											
96.5																		
3.4	SAND, some silt, trace clay Compact Grey Wet		3	SS	24		96											
							95											
94.6																		
5.3	Silty SAND to SILT and SAND, trace to some clay Loose to Compact Grey Wet		4	SS	10		94							○				0 63 22 15
			5	SS	8		93							○				
							92											
			6	SS	12									○				
							91											
90.5																		
9.4	Silty CLAY, trace to some sand Firm to Stiff Grey						90											

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OFF-03

2 OF 4

METRIC

W.P. 6092-10-00 LOCATION N 1 003 3.1 E 9 992.0 Off Lake Bridge ORIGINATED BY SLL/JM
 HWY 615 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Top of Pavement DATE 2011.10.02 - 2011.10.14 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												
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
								WATER CONTENT (%)												
								20 40 60												
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT												
								W P W W L												
	Continued From Previous Page																			
	Silty CLAY , varved, trace to some sand Firm to Stiff Grey		7	SS	6															
							89													
			8	SS	12		88													
	Occasional silty sand seams						87													
			9	SS	8															
							86													
			10	SS	6		85												0 4 71 25	
							84													
			11	SS	6															
							83													
	Occasional silty sand seams Stiff to Very Stiff																			
			12	SS	12		82													
							81													
			13	SS	18															
							80													

Continued Next Page

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

RECORD OF BOREHOLE No OFF-03

3 OF 4

METRIC

W.P. 6092-10-00 LOCATION N 1 003 3.1 E 9 992.0 Off Lake Bridge ORIGINATED BY SLL/JM
 HWY 615 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Top of Pavement DATE 2011.10.02 - 2011.10.14 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	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	WATER CONTENT (%)					
	Continued From Previous Page													
75.8	Silty CLAY , occasional silty sand seams Very Stiff Grey		14	SS	16									0 12 47 41
24.1	SILT , some clay, trace to some sand, trace gravel Compact Grey		15	SS	15									2 9 73 16
72.8	SAND and GRAVEL , with cobbles and boulders, some silt Very Dense Grey		16	SS	100/ 0.050									
27.1	Boulder (600mm) at 27.7m													
	Boulders (230mm and 200mm) at 29.0m		17	SS	100/									

Continued Next Page

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OFF-03

4 OF 4

METRIC

W.P. 6092-10-00 LOCATION N 1 003 3.1 E 9 992.0 Off Lake Bridge ORIGINATED BY SLL/JM
 HWY 615 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Top of Pavement DATE 2011.10.02 - 2011.10.14 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	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										WATER CONTENT (%)													
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE																							
	Continued From Previous Page				0.150			20	40	60	80	100		20	40	60															
	SAND and GRAVEL with cobbles and boulders, some silt Grey Wet Compact																														
			18	SS	26																										
	Very Dense		20	SS	100/ 0.225																										
	Boulder (275mm) at 35.9m		21	SS	100/ 0.075																										

ONTMT4S 0840.GPJ 2012TEMPLATE(MTO).GDT 10/21/13

METRIC

SOIL PROFILE			SAMPLES		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
99.9 0.0	ASPHALT: (40mm) SAND and GRAVEL, some silt Compact to Very Dense Brown Moist (FILL)	[Pattern]	1	SS	30/ 0.125
	With cobbles/rock fragments	[Pattern]	2	SS	24
		[Pattern]	3	SS	50/ 0.150
96.7 3.2	PEAT, silty, decayed wood pieces Loose Black	[Pattern]	4	SS	6
96.2 3.7	SAND, some silt, trace gravel Compact to Very Loose Grey Wet	[Pattern]	5	SS	11
		[Pattern]	6	SS	9
		[Pattern]	7	SS	3
91.7 8.2	Sandy SILT, some clay Loose Grey Wet	[Pattern]	8	SS	5
<div>DYNAMIC CONE PENETRATION RESISTANCE PLOT</div> <div>SHEAR STRENGTH kPa</div> <div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div> <div>WATER CONTENT (%)</div> <div>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</div> <div>UNIT WEIGHT γ</div> <div>REMARKS & GRAIN SIZE DISTRIBUTION (%)</div>					

+³, ×³: Numbers refer to Sensitivity

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No OFF-04

3 OF 4

METRIC

W.P. 6092-10-00 LOCATION N 1 000 2.5 E 9 997.4 Off Lake Bridge ORIGINATED BY SLL
 HWY 615 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Top of Pavement DATE 2011.10.01 - 2011.10.01 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	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	WATER CONTENT (%)					
	Continued From Previous Page													
75.2	Silty CLAY , trace sand, occasional silty seams Stiff Grey		16	SS	13									
24.7	Clayey SILT , some sand to sandy, trace gravel, occasional cobbles and boulders Hard Grey (TILL)		17	SS	100/ 0.075									
72.5														
27.4	SAND and GRAVEL , some silt to silty, with cobbles and boulders Very Dense Grey Wet Boulder (530mm) at 27.6m		18	SS	64									
70.1														
29.8	END OF BOREHOLE AT 29.8m													

Continued Next Page

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

RECORD OF BOREHOLE No OFF-04

4 OF 4

METRIC

W.P. 6092-10-00 LOCATION N 1 000 2.5 E 9 997.4 Off Lake Bridge ORIGINATED BY SLL
 HWY 615 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Top of Pavement DATE 2011.10.01 - 2011.10.01 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	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																
	UPON REFUSAL ON PROBABLE BOULDERS. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.9m, AUGER CUTTINGS TO 0.3m, THEN ASPHALT COLD PATCH TO SURFACE.																

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No OFF-05

2 OF 4

METRIC

W.P. 6092-10-00 LOCATION N 9 996.5 E 9 998.1 Off Lake Bridge ORIGINATED BY GA
 HWY 615 BOREHOLE TYPE Casing/NQ Coring COMPILED BY AN
 DATUM Top of Pavement DATE 2011.09.19 - 2011.09.21 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	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	WATER CONTENT (%)					
	Continued From Previous Page													
	SILT and SAND , some clay Very Loose to Loose Grey Wet		10	SS	3		89							
							88							
			11	SS	8		87							
86.2														
13.7	Silty CLAY , some sand, occasional silt seams Soft to Firm Grey		12	SS	7		86							
							85							
			13	SS	3		84							
							83							
	Varved		14	SS	4		82							
							81							
			15	SS	7		80							

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

SOIL PROFILE				SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT 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												
75.2 24.7	Silty CLAY , occasional silt seams Stiff Grey		16	SS	8								
	With sand seams		17	SS	11								
72.2 27.7	Clayey SILT , some sand to sandy, trace gravel Hard Grey (TILL)		18	SS	38								
70	SAND and GRAVEL , with cobbles and boulders, some silt Grey		1	RUN									
			2	RUN									

+³, ×³: Numbers refer to Sensitivity

ONTMT4S 0840.GPJ 2012TEMPLATE(MTO).GDT 10/21/13

RECORD OF BOREHOLE No OFF-05

4 OF 4

METRIC

W.P. 6092-10-00 LOCATION N 9 996.5 E 9 998.1 Off Lake Bridge ORIGINATED BY GA
 HWY 615 BOREHOLE TYPE Casing/NQ Coring COMPILED BY AN
 DATUM Top of Pavement DATE 2011.09.19 - 2011.09.21 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	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						
68.6	SAND and GRAVEL , with cobbles and boulders, some silt Grey		19	SS	100/0.150		69											
31.3	BEDROCK metavolcanic, grey		1	RUN														
	Rubble zone (75mm) at 32.1m		2	RUN			68											
	Rubble zone (25mm) at 32.8m Highly fractured		3	RUN														
65.8			4	RUN			67											
34.1	END OF BOREHOLE AT 34.1m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct.02/11 0.9 99.0 Oct.04/11 0.9 99.0 Oct.13/11 0.9 99.0 Oct.20/11 0.9 99.0 Oct.27/12 1.4 98.5																	

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

RECORD OF BOREHOLE No OFF-06

1 OF 2

METRIC

W.P. 6092-10-00 LOCATION N 9 989.2 E 9 999.7 Off Lake Bridge ORIGINATED BY ES
 HWY 615 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Top of Pavement DATE 2011.08.23 - 2011.08.23 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
99.9								20 40 60 80 100					
0.0	ASPHALT:(25mm)												
	SAND, some silt to silty, trace to some gravel, trace clay, occasional cobbles Very Dense to Compact Brown to Grey Damp (FILL)		1	GS									
			2	SS	50/ 0.125		99						6 65 22 7
			3	SS	27		98						
			4	SS	16		97						
96.8													
3.1	PEAT, trace rootlets, occasional wood fibre Very Loose Dark Brown		5	SS	2							120	
96.3													
3.6	MARL, silty, some clay, trace sand, shell fragments Grey						96						
95.8													
4.1	SAND, trace gravel, trace silt Very Loose to Loose Grey Wet		6	SS	2		95						4 94 2 (SI+CL)
							94						
			7	SS	3		93						1 95 4 (SI+CL)
92.7													
7.2	SILT and SAND, some clay Loose Grey Wet		8	SS	4		92						0 36 49 15
							91						
	Layer of sand, some silt		9	SS	6								0 89 11 (SI+CL)
90.0							90						

Continued Next Page

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

RECORD OF BOREHOLE No OFF-06

2 OF 2

METRIC

W.P. 6092-10-00 LOCATION N 9 989.2 E 9 999.7 Off Lake Bridge ORIGINATED BY ES
 HWY 615 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Top of Pavement DATE 2011.08.23 - 2011.08.23 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	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									
9.9	Silty CLAY , some sand Firm Grey																
88.6			10	SS	5		89										0 10 65 25
11.3	END OF BOREHOLE AT 11.3m. WATER LEVEL AT 3.3m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, AUGER CUTTINGS TO 0.05m THEN ASPHALT COLD PATCH TO SURFACE.																

Appendix B

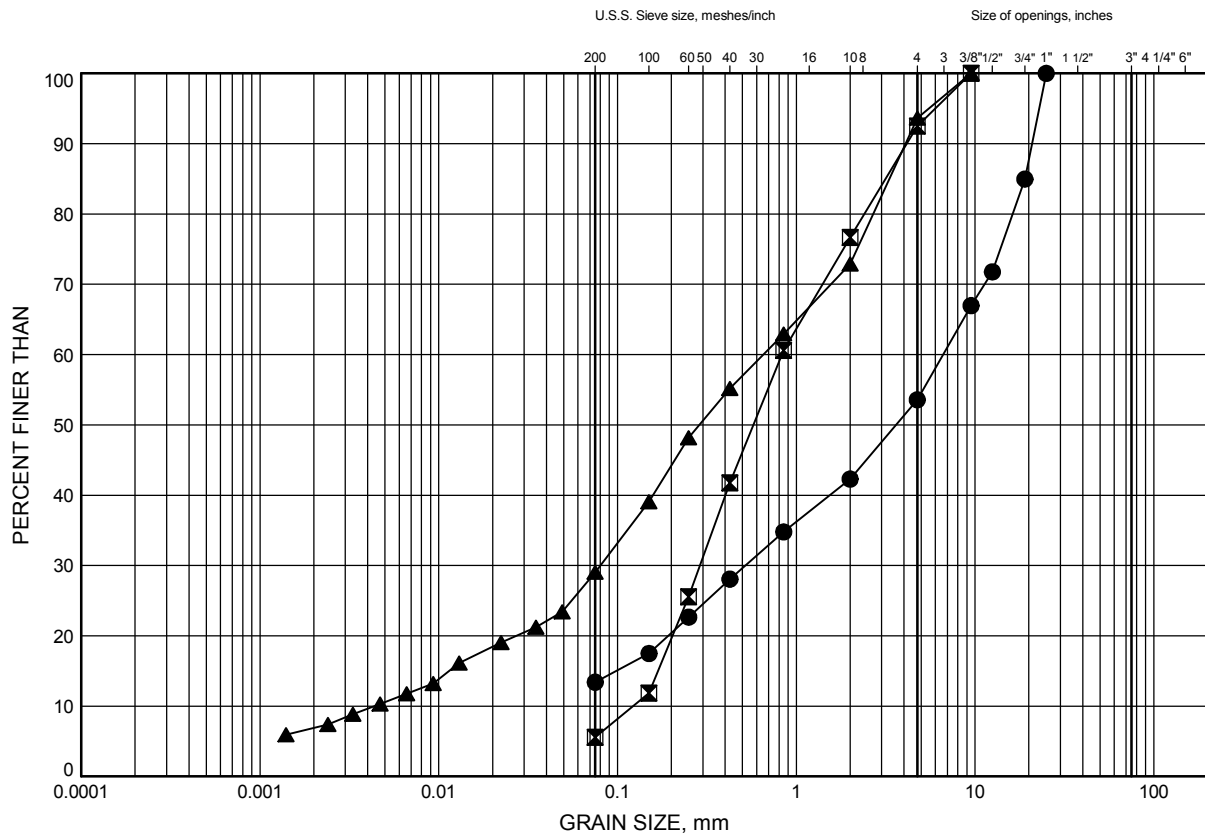
Laboratory Test Results

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND TO SAND & GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OFF-01	1.83	98.07
⊠	OFF-05	1.07	98.83
▲	OFF-06	1.07	98.83

Date ..October 2013.....
W.P. ..6092-10-00.....

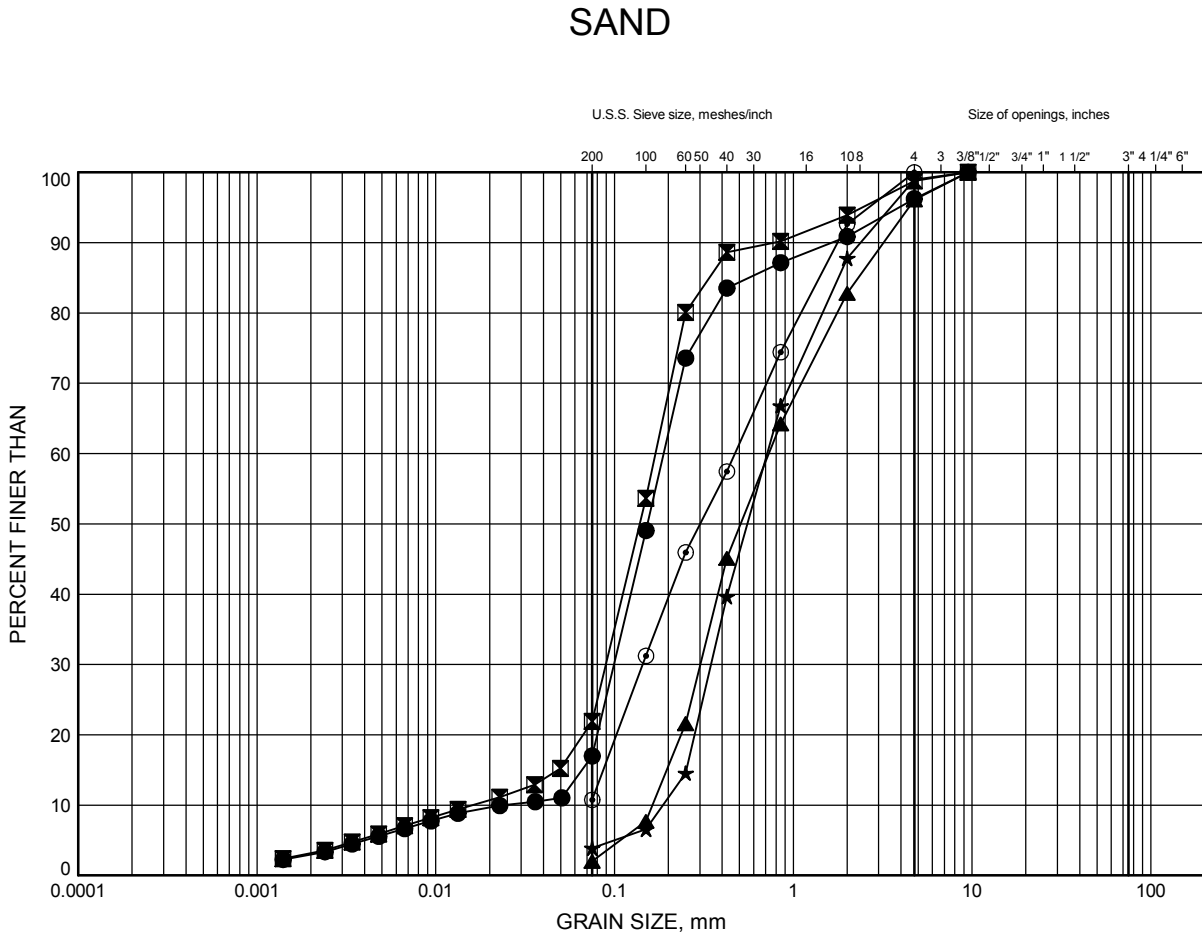


Prep'dMFA.....
Chkd.MC.....

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B2



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OFF-01	4.88	95.02
⊠	OFF-02	4.88	95.02
▲	OFF-06	4.88	95.02
★	OFF-06	6.40	93.50
⊙	OFF-06	9.45	90.45

Date ..October 2013.....
W.P. ..6092-10-00.....



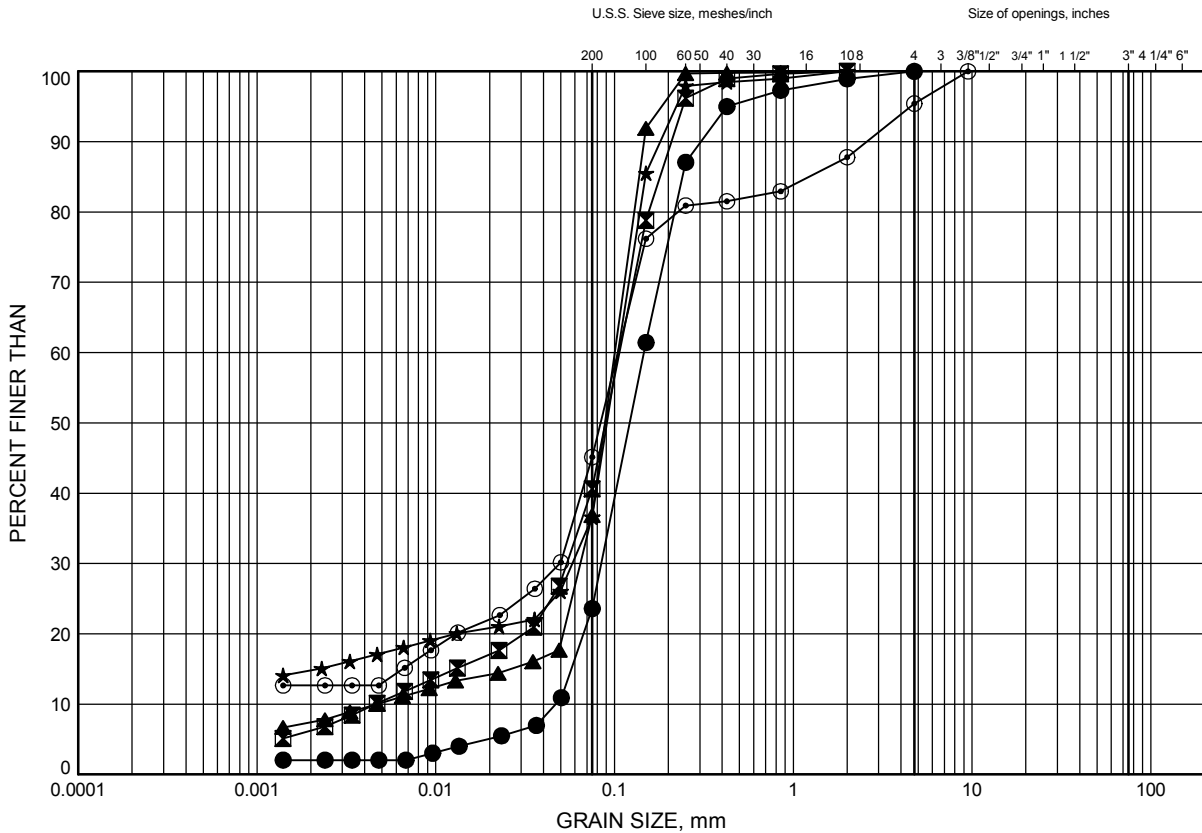
Prep'dMFA.....
Chkd.MC.....

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OFF-01	6.40	93.50
⊠	OFF-01	9.45	90.45
▲	OFF-02	12.50	87.40
★	OFF-03	5.64	94.26
⊙	OFF-05	7.92	91.98

Date ..October 2013.....
W.P. ..6092-10-00.....



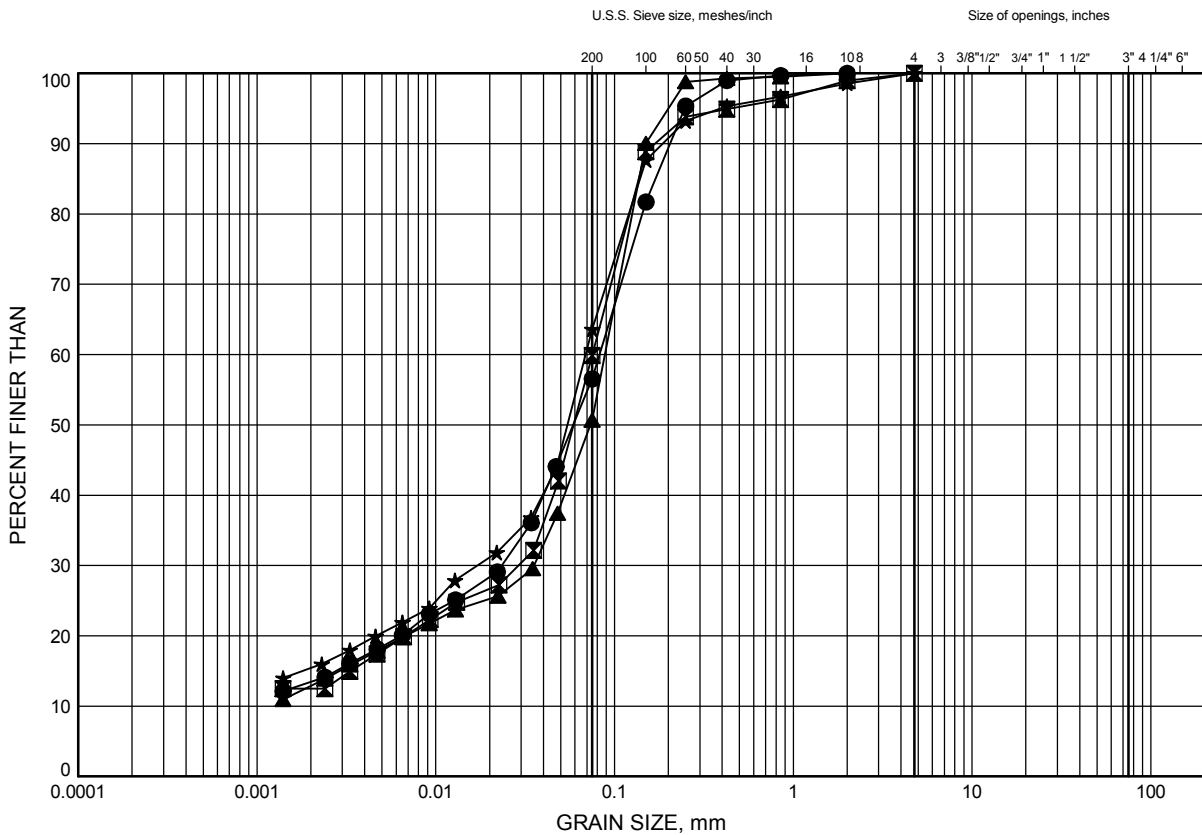
Prep'dMFA.....
Chkd.MC.....

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B4

SILT & SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OFF-01	10.97	88.93
⊠	OFF-02	7.92	91.98
▲	OFF-02	9.45	90.45
★	OFF-06	7.92	91.98

Date ..October 2013.....
W.P. ..6092-10-00.....



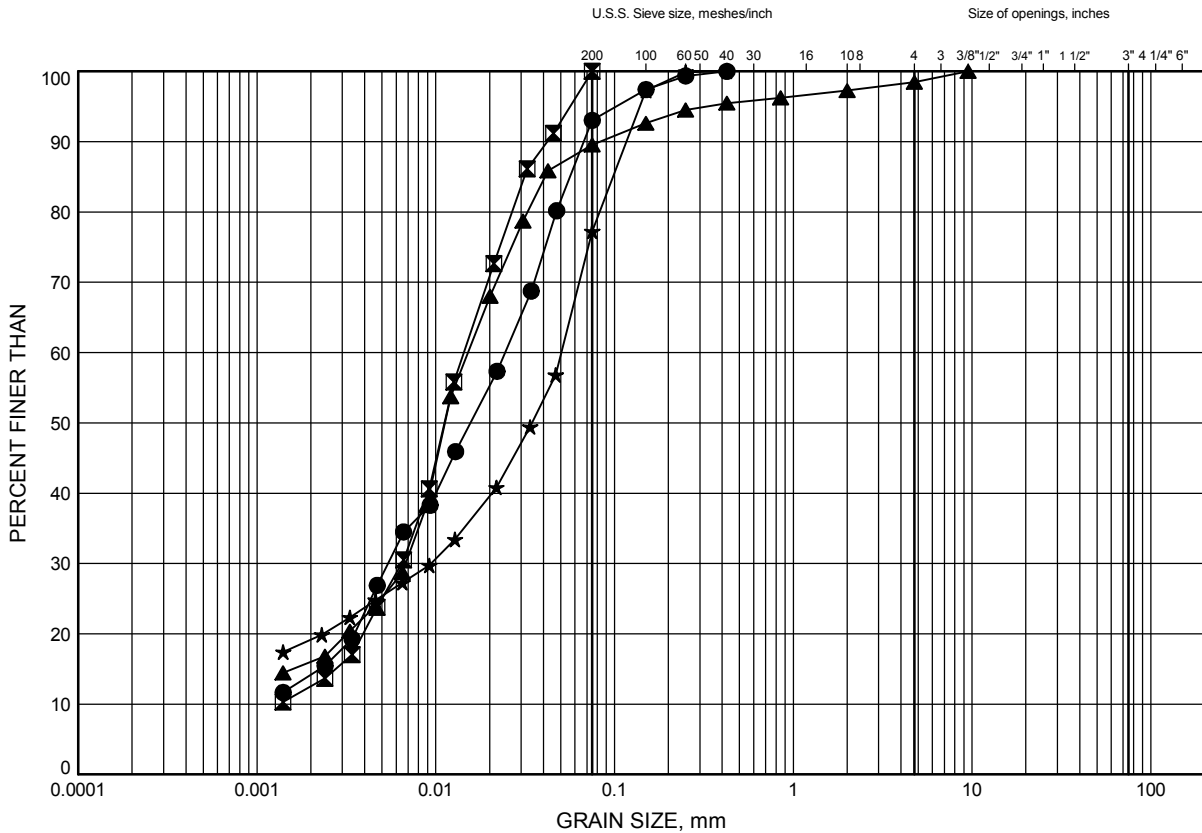
Prep'dMFA.....
Chkd.MC.....

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B5

SILT, Some Clay



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OFF-02	14.02	85.88
⊠	OFF-02	26.21	73.69
▲	OFF-03	25.45	74.45
★	OFF-04	10.21	89.69

Date ..October 2013.....
W.P. ..6092-10-00.....

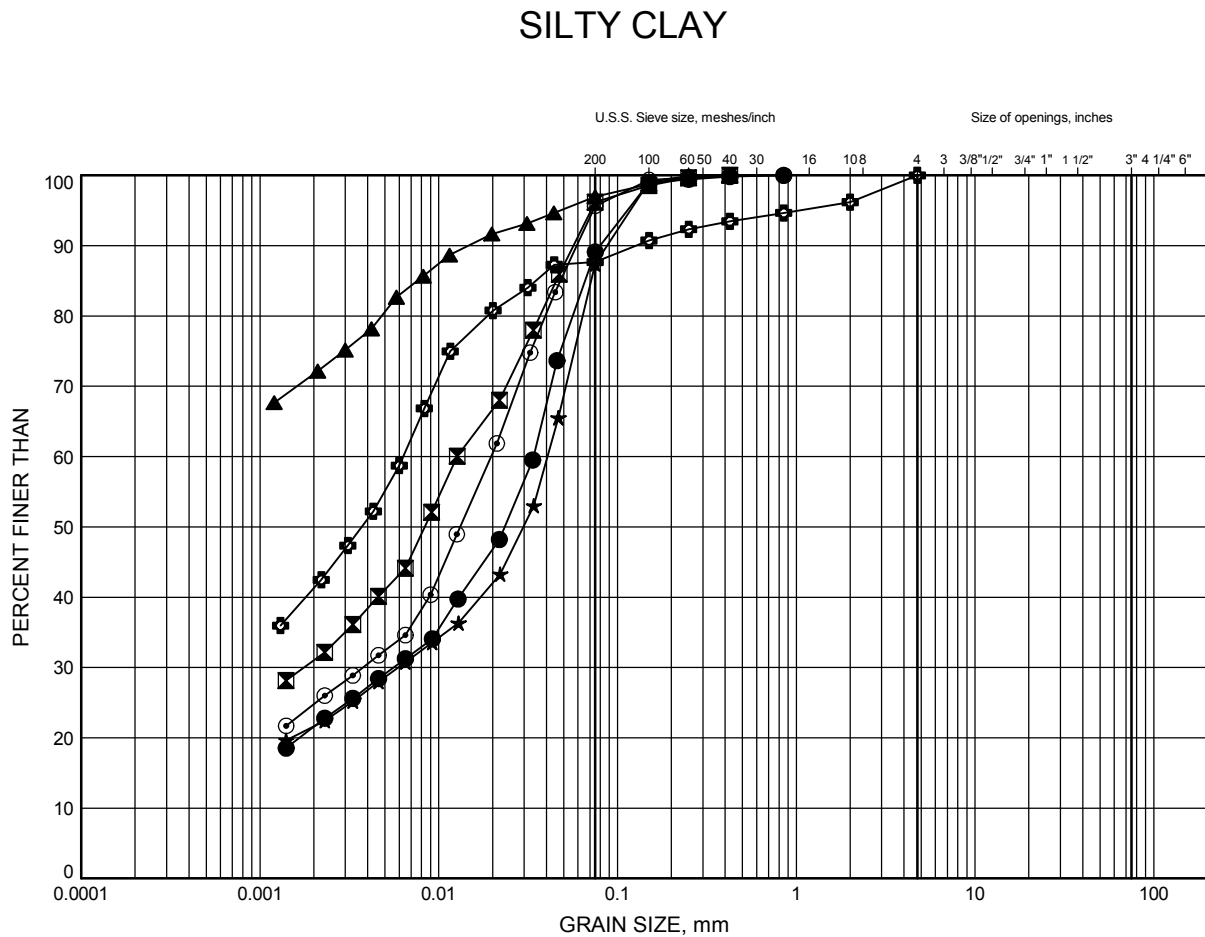


Prep'dMFA.....
Chkd.MC.....

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B6



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OFF-02	15.54	84.36
⊠	OFF-02	18.59	81.31
▲	OFF-02	20.12	79.78
★	OFF-03	10.21	89.69
⊙	OFF-03	14.78	85.12
⊕	OFF-03	22.40	77.50

Date ..October 2013.....
W.P. ..6092-10-00.....

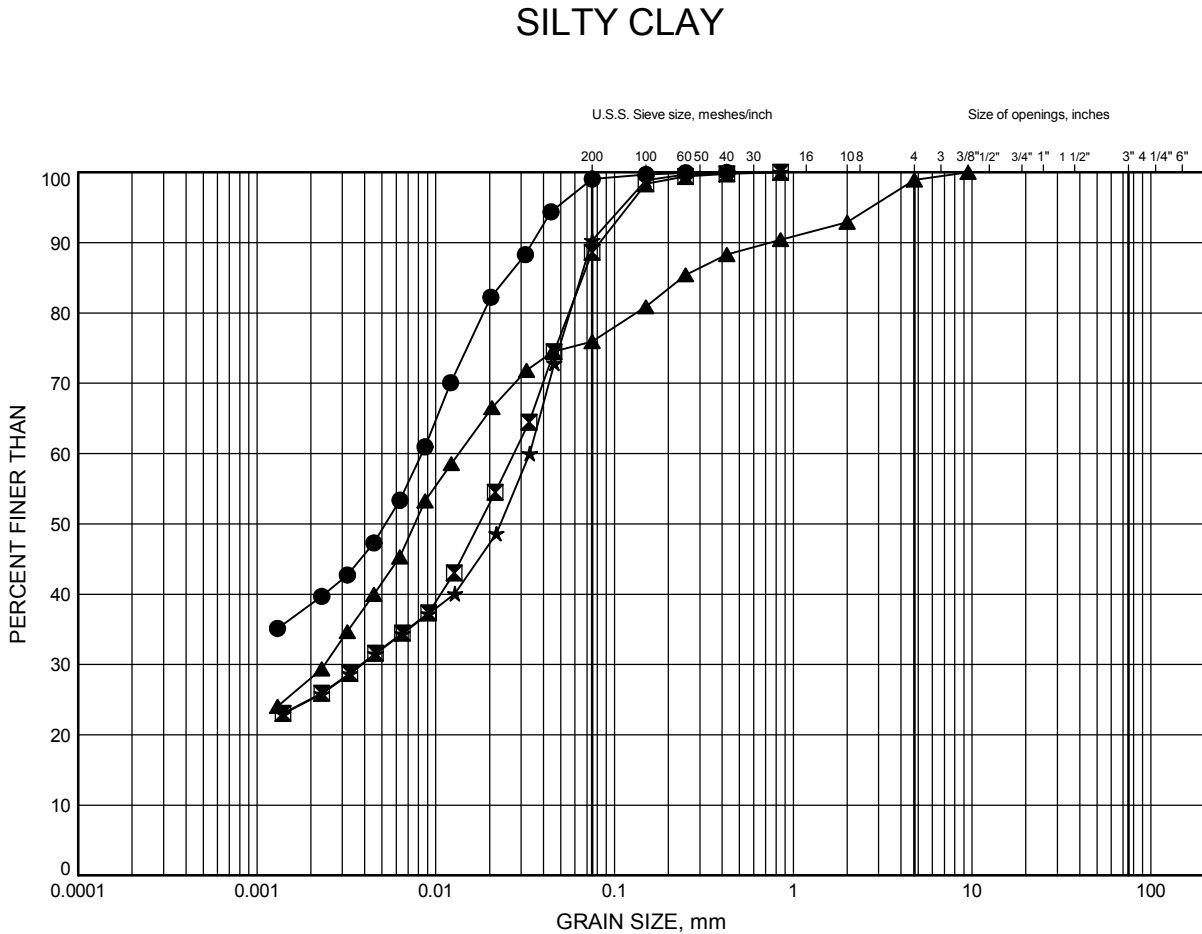


Prep'dMFA.....
Chkd.MC.....

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B7



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OFF-04	16.31	83.59
⊠	OFF-05	15.54	84.36
▲	OFF-05	23.16	76.74
★	OFF-06	10.97	88.93

Date ..October 2013.....
W.P. ..6092-10-00.....

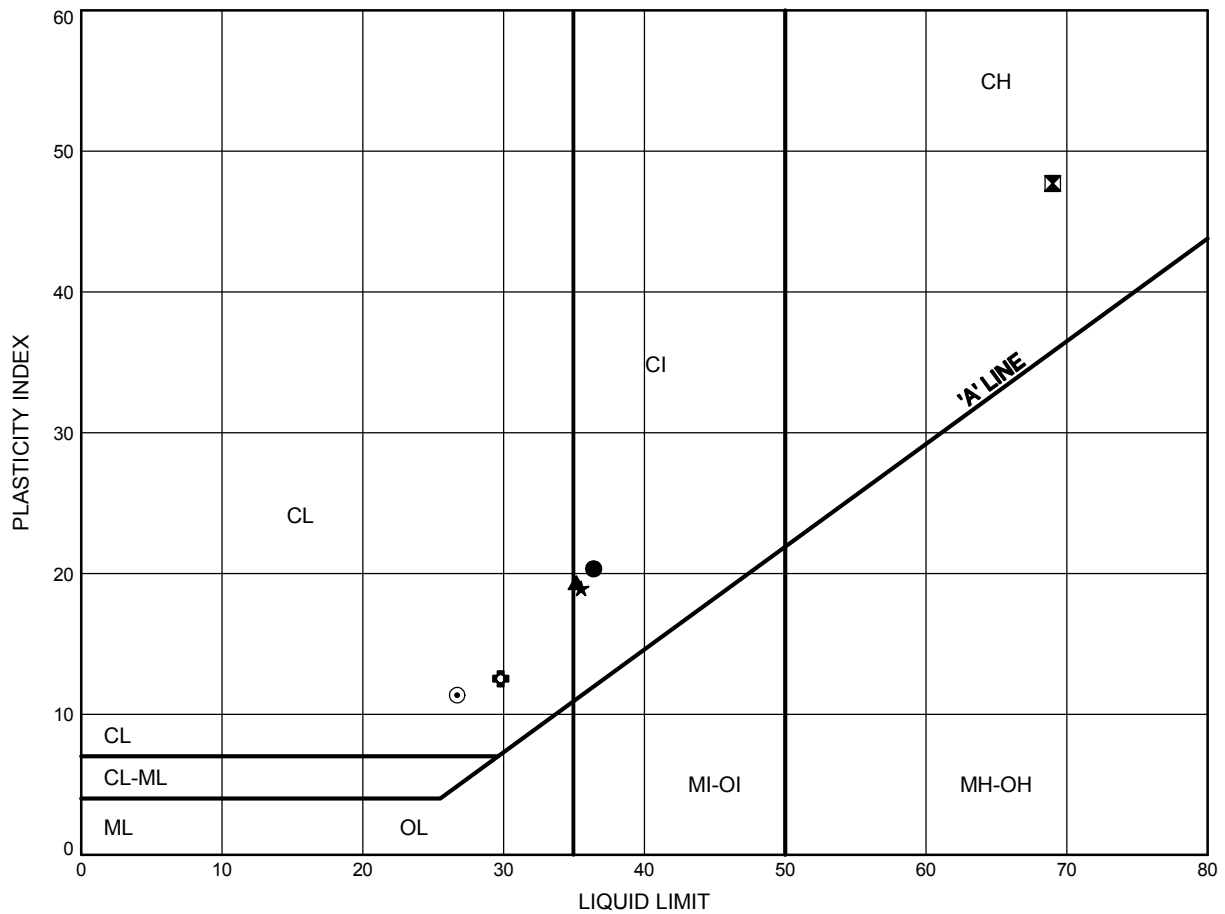


Prep'dMFA.....
Chkd.MC.....

NWR HWY 11 Bridge
ATTERBERG LIMITS TEST RESULTS

FIGURE B8

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OFF-02	18.59	81.31
⊠	OFF-02	20.12	79.78
▲	OFF-03	22.40	77.50
★	OFF-04	16.31	83.59
⊙	OFF-05	15.54	84.36
⊕	OFF-05	23.16	76.74

Date October 2013
W.P. 6092-10-00



Prep'd MFA
Chkd. MC

Appendix C

Site Photographs



Photograph 1 – East side of Off Lake Bridge, looking south



Photograph 2 – West side of Off Lake Bridge, looking north



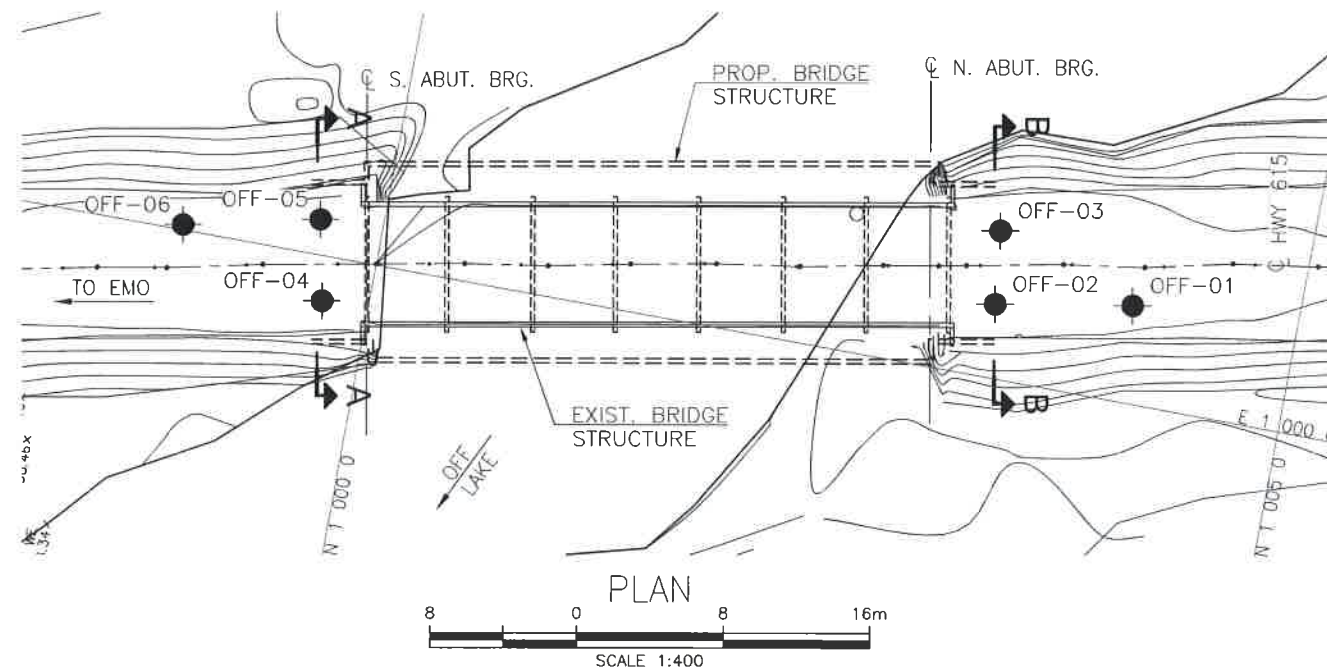
Photograph 3 – Off Lake Bridge, looking north



Photograph 4 – Off Lake Bridge, looking south

Appendix D

Borehole Locations and Soil Strata Drawings



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

CONT No
WP No 6092-10-00

HIGHWAY 615
OFF LAKE BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN

LEGEND

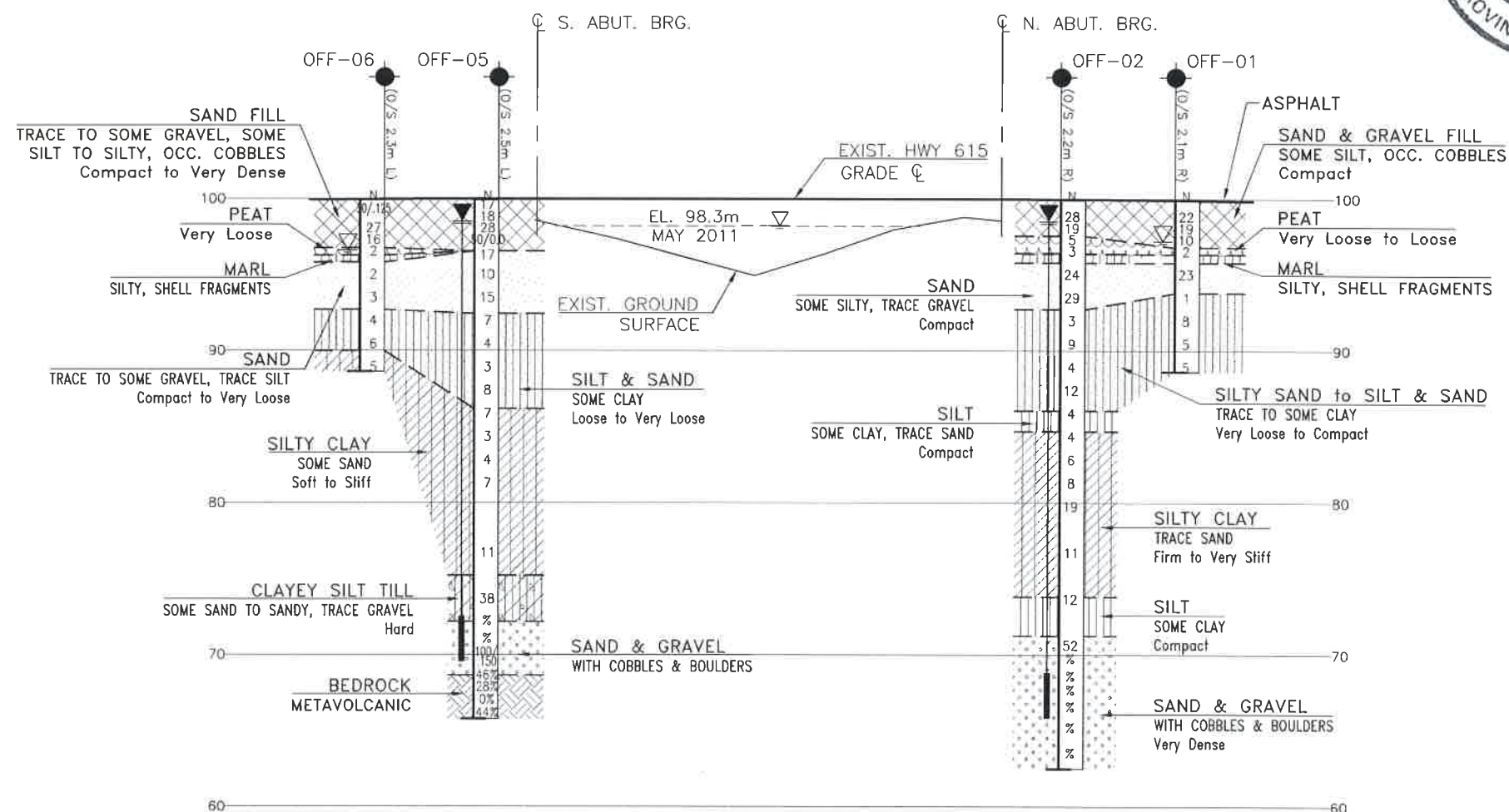
●	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
W	Water Level
HA	Head Artesian Water
P	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
OFF-01	99.9	1 004 0.9	9 994.7
OFF-02	99.9	1 003 3.5	9 996.0
OFF-03	99.9	1 003 3.1	9 992.0
OFF-04	99.9	1 000 2.5	9 997.4
OFF-05	99.9	9 996.5	9 998.1
OFF-06	99.9	9 989.2	9 999.7

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. 52C-30



PROFILE ALONG C HWY 615



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	LRB	CHK	LRB
DRAWN	AN	CHK	SITE 45-13
LOAD	DATE	OCT. 2013	DWG 1

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

CONT No
WP No 6092-10-00

HIGHWAY 615
OFF LAKE BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

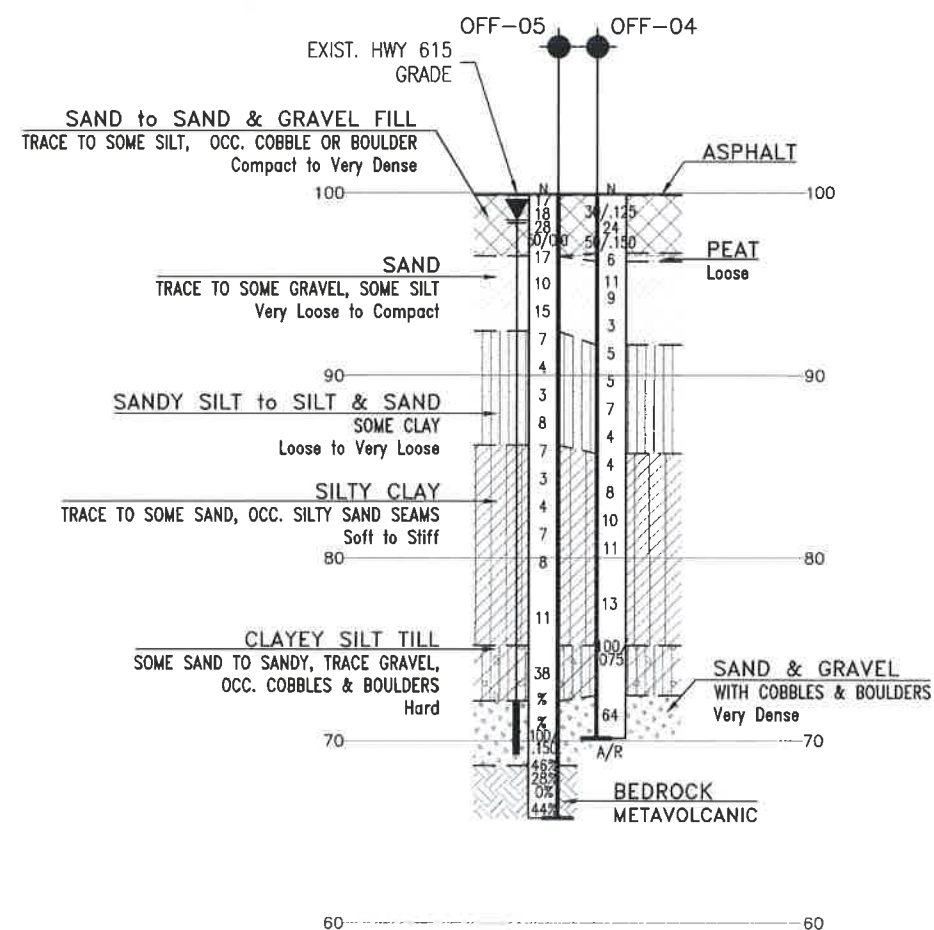
- ◆ Borehole
- ◆ Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level
- HA Head Artesian Water
- PZ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
OFF-01	99.9	1 004 0.9	9 994.7
OFF-02	99.9	1 003 3.5	9 996.0
OFF-03	99.9	1 003 3.1	9 992.0
OFF-04	99.9	1 000 2.5	9 997.4
OFF-05	99.9	9 996.5	9 998.1
OFF-06	99.9	9 989.2	9 999.7

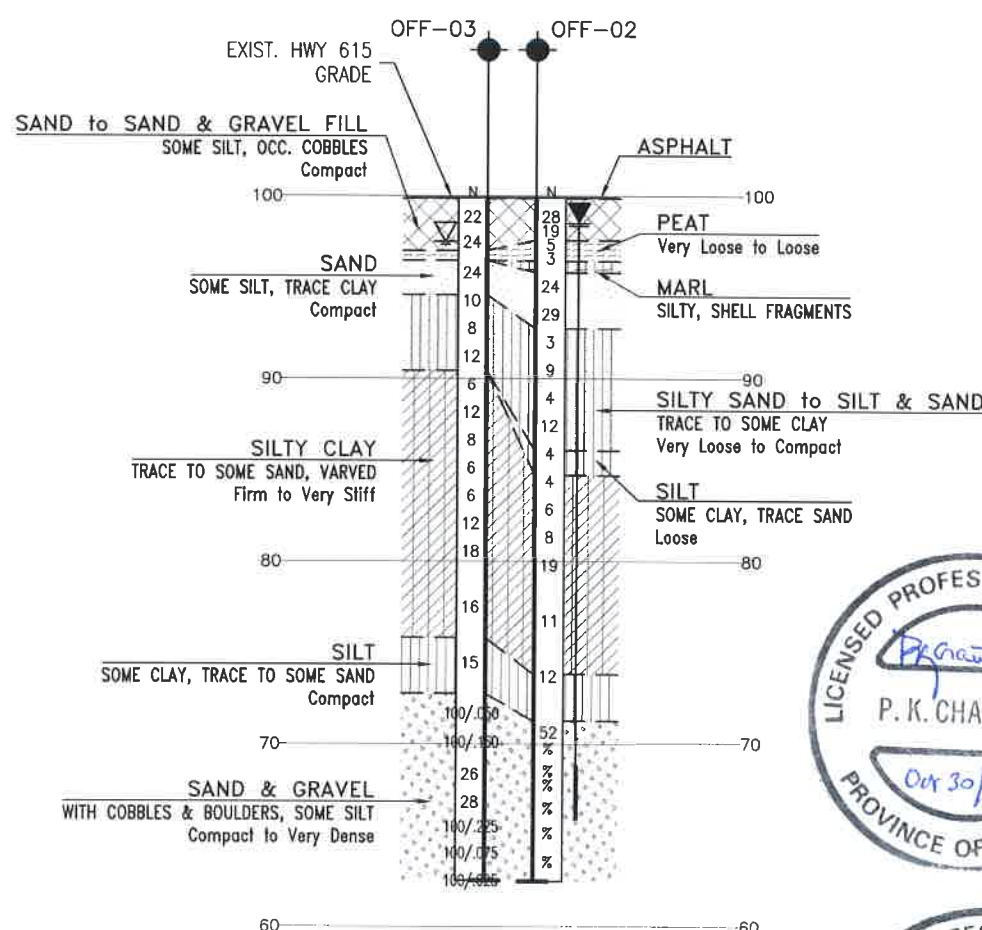
NOTES

- 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. 52C-30



SECTION ALONG A-A



SECTION ALONG B-B



DATE	BY	DESCRIPTION
DESIGN	LRB	CHK LRB
DRAWN	AN	CHK
SITE	45-13	STRUCT
DATE	OCT. 2013	DWG 2