

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 11 NBL OVER STIRLING CREEK TRIBUTARY
HIGHWAY 11, BURK'S FALLS TO SOUTH RIVER
ONTARIO
G.W.P. 742-93-00, W.P. 5100-06-01, SITE: 44-438/1**

Geocres Number: 31E-275

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the the location of a proposed bridge carrying Highway 11 NBL over Stirling Creek Tributary north of Burk's Falls, 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 present investigation.

Thurber carried out the investigation as a sub-consultant to MMM Group Limited (MMM), under the Ministry of Transportation Ontario (MTO) Agreement Number 5005-A-000188.

2 SITE DESCRIPTION

The site lies on the east side of existing Highway 11 approximately 500 m north of the intersection with Pevensey Road.

At present, the creek flows from north to south along the east toe of the Highway 11 embankment and turns westward into a culvert under the existing highway at the proposed bridge site. A smaller creek flows east to west to join the main creek as it turns westward into the culvert. This smaller creek forms a small pond under the proposed bridge, due to what may be an old, overgrown beaver dam.

A Hydro One pole line traverses the site in a generally north-south direction, parallel to existing Highway 11.

The site lies within the Canadian Shield, characterized by low, rounded hills of Pre-Cambrian bedrock mantled by varying thicknesses of overburden. At this site, the bedrock is mantled by

cohesionless sand deposits that probably originated from glacial outwash and are typical of the soils encountered in this stretch of the Highway 11 corridor.

There is no development within the immediate vicinity of the site.

Photographs in Appendix C show:

1. A view looking north over the general site of the two structures with the small beaver pond in the middle ground and the Hydro One lines visible.
2. A view of the point where the two streams meet and flow westward under the existing highway.
3. A view looking south on existing Highway 11 over the south approaches to the future structures.
4. A view north along existing Highway 11 over the future SBL structure site. The north approaches are behind the trees to the right.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out from June 19 to 28, 2007 and from July 3 to 5, 2007 and consisted of drilling and sampling eight boreholes at the foundation elements to depths ranging from 14.3 m to 23.2 m and two boreholes at the approach embankments to depths of 9.1 m and 12.3 m. The boreholes were numbered SCN-1 to SCN-10 and their approximate locations are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D.

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

Drilling was carried out using a track mounted CME 75 drill rig. A combination of hollow-stem auger drilling techniques and rotary coring methods were used to advance the boreholes and samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils. Boreholes SCN-4 to SCN-6 and SCN-9 were also advanced 3.0 m to 4.0 m into bedrock by NQ size diamond coring.

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.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Standpipe piezometers consisting of 19 mm PVC pipe with slotted screens were installed and enclosed in filter sand in four boreholes (one at each foundation element) to permit longer term groundwater level monitoring. The locations and completion details of the piezometers are shown in Table 3.1.

Table 3.1 – Borehole Completion Details

Foundation Unit	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
South Approach	SCN-1	None installed	Borehole grouted using benseal grout to surface.
South Abutment			
West	SCN-2	18.4/296.0	Sand from 18.4 m to 15.7 m, holeplug from 15.7 m to 14.9 m, bentonite grout from 14.9 m to 0.6 m and holeplug from 0.6 m to surface.
East	SCN-3	None installed	Borehole grouted using benseal grout to surface.
South Pier			
West	SCN-4	None installed	Borehole grouted using benseal grout to surface.
East	SCN-5	23.2/292.3	Borehole caved (sand and gravel) immediately after PVC pipe was installed. Sand and gravel from 23.2 m to 3.5 m, and bentonite grout from 3.5 m to surface.
North Pier			
West	SCN-6	21.6/293.6	Sand from 21.6 m to 19.8 m, holeplug from 19.8 m to 19.2 m, bentonite grout from 19.2 m to 0.9 m and holeplug from 0.9 m to surface.
East	SCN-7	None installed	Borehole grouted using benseal grout from 15.7 m to 0.9 m and holeplug from 0.9 m to surface.
North Abutment			
West	SCN-8	None installed	Borehole grouted using bentonite from 14.3 m to 0.9 m and auger cutting from 0.9 m to surface.
East	SCN-9	21.8/299.1	Sand from 21.8 m to 17.4 m, bentonite from 17.4 m to 0.9 m, holeplug from 0.9 m to 0.6 m and auger cutting from 0.6 m to surface.
North Approach	SCN-10	None installed	Borehole grouted using benseal grout to surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A. Selected samples were also subjected to gradation analysis and the results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained 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 selected rock core samples are shown in Table 1 immediately following the text 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 and rock stratigraphy are presented in these sheets and on the "Borehole Locations and Soil Strata" and "Stratigraphic Sections" 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.

In general terms, the overburden soil stratigraphy encountered at this site consists of topsoil overlying 9.0 m to 19.0 m of cohesionless soils consisting of native sandy silt, sand, silty sand, and sand with some gravel, cobbles and boulders. Migmatitic gneiss bedrock was contacted below the native soils. More detailed descriptions of the individual strata are presented below.

5.1 Topsoil

Topsoil was identified at ground surface in most of the boreholes, except in Borehole SCN-7, where a 300 mm thick layer of silt was noted at the surface. The topsoil thickness generally ranged from 125 mm to 300 mm. The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

5.2 Sand

An extensive deposit of native brown to grey sand containing trace to some gravel, trace to some silt and trace of clay was contacted below the topsoil in all the boreholes and below the silt in Borehole SCN-7. Occasional cobbles and boulders were also inferred within the native sand deposit.

Deeper layers of brown to grey sand with occasional cobbles and boulders were also contacted in Boreholes SCN-2 and SCN-3 at 16.0 m and 16.8 m depth (elevations 298.4 m and 297.5 m), respectively.

Boreholes SCN-1, SCN-2, SCN-3 and SCN-10 were terminated within the sand deposit at depths varying from 9.1 m to 19.9 m (elevations 294.4 m to 309.0 m).

Boreholes SCN-7 and SCN-8 were terminated upon refusal on probable boulder or bedrock at 15.7 m and 14.3 m depths (elevations 298.0 m and 305.8 m), respectively.

Thickness of the sand, determined from Boreholes SCN-4 to SCN-6 and SCN-9, generally ranged from 11.4 m to 18.7 m. The depth to the base of the sand deposit ranged from Elevations 293.1 m to 302.4 m.

SPT 'N' values ranged from 10 to 100 blows for 0.3 m penetration in this stratum indicating a compact to very dense relative density. SPT 'N' values ranging from 1 to 9 blows per 0.3 m penetration, indicating loose conditions, were observed at various depths in Boreholes SCN-2, SCN-3, SCN-5, SCN-6, SCN-8 and SCN-9. Higher 'N' values (more than 50 blows for under 0.3 m penetration) were observed near the base and borehole termination depths of the sand deposit. These high values may indicate the presence of cobbles and boulders within the deposit.

The moisture content of samples from this deposit ranged from 5% to 39%.

Borehole SCN-5 was advanced using diamond coring upon encountering boulders at 17.8 m depth, (elevation 297.7 m). Coring and washboring continued through the soils between the boulders, although recovery was limited to a few pieces of gravel and cobbles.

Grain size distribution curves for the samples tested are presented on the Record of Borehole sheets and on Figures B1 to B4. The results of laboratory tests carried out on samples of the sand are summarized as follows:

Soil Particles	(%)
Gravel	0 to 26
Sand	71 to 99
Silt and Clay	1 to 24

5.3 Silt and Sandy Silt

Layers of native brown and grey silt and sandy silt with trace to some gravel and trace of clay were observed in five boreholes at various depths as indicated in Table 5.1.

Table 5.1 – Depths and Elevations of Native Silt and Sandy Silt

Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
SCN-1	0.2 to 1.0	314.8 to 314.0	0.8
SCN-3	14.2 to 14.9	300.1 to 299.4	0.7
SCN-7	0.0 to 0.3	313.7 to 313.4	0.3
SCN-8	0.2 to 5.6	320.0 to 314.6	5.4
SCN-9	1.1 to 7.1	319.9 to 313.8	6.0

Based on SPT N-values ranging from 1 to 18 blows for 0.3 m of penetration, the silt is described as being very loose to compact. The natural moisture contents of the samples recovered from the silt layers ranged from 10 to 25%. Higher moisture contents of 35% and 39% were observed in Boreholes SCN-7 and SCN-9.

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

Soil Particles	(%)
Gravel	0
Sand	1 to 15
Silt	80 to 90
Clay	4 to 9

5.4 Sand and Gravel

A 5.8-m thick layer of grey sand and gravel with trace of silt and clay and occasional cobbles was contacted in Borehole SCN-2 (south abutment) at 10.2 m depth (elevation 304.2 m). The sand and gravel layer was wet.

Layers of sand and gravel were also observed in Boreholes SCN-3 and SCN-5 at 14.9 m and 16.0 m depth (elevations 299.4 m and 299.5 m), respectively.

A 500-mm diameter boulder was encountered within the sand and gravel layer in Borehole SCN-3.

Standard Penetration tests in this deposit gave 'N' values ranging from 21 blows per 0.3 m of penetration to greater than 100 blows for 0.075 m of penetration, indicating a compact to very dense density. Higher 'N' values (more than 50 blows for under 0.3 m penetration) may be attributed to the presence of cobbles and boulders within the deposit.

The moisture content of samples from this deposit varies between 4% and 19%.

Grain size distribution curve for a sample tested is presented on the Record of Borehole sheet for Borehole SCN-2 and on Figure B5. The results of laboratory tests carried out on this sample of sand and gravel was as follows:

Soil Particles	(%)
Gravel	55
Sand	42
Silt & Clay	3

5.5 Bedrock

The overburden soils described above are underlain by Pre-Cambrian migmatitic gneiss bedrock. The migmatitic gneiss bedrock is described as slightly weathered to fresh. Its colour is dark grey to black with occasional pink and white bands visible in most cores.

Bedrock was proved by coring at both piers and north abutment. Table 5.2 summarizes depths and elevations to the top of bedrock.

Effective refusal, defined as an SPT value exceeding 100 blows for 0.3 m of penetration (or 50 blows for less than 150 mm penetration), was encountered in the native deposit of sand with cobbles and boulders above the bedrock surface in Borehole SCN-5, SCN-6 and SCN-9 and near the borehole termination depths in Boreholes SCN-1 to SCN-3, SCN-7 and SCN-8. The depths at which effective refusal was encountered are also shown in Table 5.2.

Table 5.2 – Depths and Elevations of Refusal and Top of Bedrock

Foundation Unit	Borehole	Refusal		Top of Bedrock	
		Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
South Approach	SCN-1	12.3	302.7	-	-
South Abutment					
West	SCN-2	15.2	299.2	-	-
East	SCN-3	17.1	297.2	-	-
South Pier					
West	SCN-4	-	-	18.9	293.1
East	SCN-5	16.8	298.7	19.2	296.2
North Pier					
West	SCN-6	18.4	296.8	18.6	296.6
East	SCN-7	15.7	298.0	15.7*	298.0*
North Abutment					
West	SCN-8	13.7	306.5	14.3*	305.8*
East	SCN-9	17.4	303.5	18.5	302.4
North Approach	SCN-10	-	-	-	-

*Inferred from auger refusal (could also be refusal on boulder)

Core recovery in the bedrock generally ranged from 63% to 100%. The RQD values generally ranged from 63% to 100% indicating fair to excellent rock quality.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was generally low ranging from 0 to 3 although zones of >10 fractures per 0.3 m of core were recorded in Borehole SCN-5. Horizontal and vertical joints were encountered within the rock mass in all the cores.

The unconfined compressive strength of the rock cores is estimated to range between 112 and 186 MPa indicating very strong rock. These estimated rock strength values are based on point load tests that were conducted on rock cores recovered from the boreholes. A summary of the Point Load Test Results is presented in Table 1 immediately following the text of this report.

5.6 Water Levels

Water levels were observed in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in four boreholes to monitor water levels after completion of drilling. The water levels measured in the piezometers are summarized in Table 5.3, along with the measurements in the boreholes upon completion of drilling.

Table 5.3 – Water Level Measurements

Foundation Unit	Borehole	Date (2007)	Water Level (m)		Comment
			Depth	Elevation	
South Approach	SCN-1	June 20	1.5	313.5	In open borehole
South Abutment					
West	SCN-2	June 25	2.0	312.4	In piezometer
		June 28	2.0	312.4	
		July 6	2.4	312.0	
		July 23	3.1	311.3	
East	SCN-3	June 21	-	-	In open borehole
South Pier					
West	SCN-4	June 22	-	-	In open borehole
East	SCN-5	June 25	2.3	313.2	In piezometer
		June 28	2.3	313.2	
		July 6	2.4	313.1	
		July 23	3.1	312.4	
North Pier					
West	SCN-6	July 23	3.3	311.9	In piezometer
East	SCN-7	July 5	2.1	311.6	In open borehole
North Abutment					
West	SCN-8	June 27	10.2	310.0	In open borehole
East	SCN-9	June 28	8.6	312.3	In piezometer
		July 6	8.9	312.0	
		July 23	9.0	311.9	
North Approach	SCN-10	June 26	5.0	313.0	In open borehole

The piezometric readings indicate that the groundwater levels range from Elevations 311.3 m to 313.0 m.

GA Drawing indicates that the water level of the Stirling creek was 311.8 m in December, 1997.

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

6 MISCELLANEOUS

Borehole locations were selected by Thurber Engineering Ltd. Surveyors from MMM Group Limited staked these locations in the field, confirmed the co-ordinates and obtained the ground surface elevations.

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

George Downing Estate Drilling Ltd. supplied a track mounted CME 75 drill rig and conducted the drilling, sampling and in-situ testing operations.

The field program was supervised on a full time basis by Mr. George Azzopardi, Mr. Stephane Loranger and Ms. Jessica Lee of Thurber.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Overall supervision of the field program was conducted by Mr. Alastair E. Gorman, P.Eng. Interpretation of the data and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng and Ms. R. Palomeque Reyna, P.Eng.

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

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TABLE 1 -Point Load Results

STIRLING CREEK TRIBUTARY NBL
HIGHWAY 11, BURK'S FALLS TO SOUTH RIVER

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SCN-4	DEPTH			Is (MPa)	Is50 (MPa)	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS							
RUN #1	62	6	19.05	7.794	7.570	181.68				
	63	7	19.38	8.183	7.949	190.76				
	65	0	19.81	6.979	6.779	162.69				
	66	0	20.12	8.042	7.811	187.46				
RUN #2	67	0	20.42	8.077	7.845	188.29		AVERAGE	MAX	MIN
	68	0	20.73	6.944	6.744	161.86	RUN #1:	177	191	163
	69	0	21.03	6.766	6.572	157.73	RUN #2:	160	188	116
	69	10	21.29	4.960	4.817	115.61	RUN #2:	83	146	83
RUN #3	70	11	21.62	6.270	6.090	146.17				
	72	0	21.95	3.543	3.441	82.58				

SCN-5	DEPTH			Is (MPa)	Is50 (MPa)	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS							
RUN #1	63	3	19.28	4.992	4.850	116.40				
	64	5	19.63	5.700	5.538	132.91				
	65	5	19.94	5.983	5.813	139.52				
	66	5	20.24	4.602	4.472	107.32				
RUN #2	67	6	20.57	5.063	4.919	118.05		AVERAGE	MAX	MIN
	68	6	20.88	5.169	5.022	120.53	RUN #1:			
	69	6	21.18	3.894	3.784	90.81	RUN #2:	130	140	116
	70	6	21.49	5.381	5.229	125.48	RUN #3:	112	125	91
RUN #3	71	6	21.79	4.461	4.334	104.02	RUN #4:	115	140	100
	72	4	22.05	5.240	5.091	122.18				
	73	6	22.40	6.019	5.848	140.34				
	74	6	22.71	4.284	4.162	99.89				
	75	4	22.96	4.709	4.575	109.80				

STIRLING CREEK TRIBUTARY NBL
HIGHWAY 11, BURK'S FALLS TO SOUTH RIVER

19-1423-39

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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

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


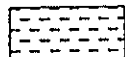



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (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

ROCK WEATHERING CLASSIFICATION		SYMBOLS	
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)

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
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.

TERMS					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
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.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
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 SCN-1

1 OF 2

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 682.31 E 310 692.91 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2007.06.20 - 2007.06.20 CHECKED BY AEG

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						
315.0								20 40 60 80 100						
0.0	TOPSOIL: (200mm)						315							
0.2	Sandy SILT, trace clay Loose Brown Moist													
314.0														
1.0	SAND, trace silt and clay Dense Brown Moist		1	SS	33		314							
			2	SS	35									
							313							
	Compact		3	SS	17									
			4	SS	22		312							
							311							
			5	SS	21									
							310							
							309							
	Grey Wet		6	SS	13									
							308							
	trace gravel Very Dense to Dense		7	SS	52		307							
							306							
			8	SS	46									
305.0														

Continued Next Page

+ 3, X 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCN-1

2 OF 2

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 682.31 E 310 692.91 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2007.06.20 - 2007.06.20 CHECKED BY AEG

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 NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L				
Continued From Previous Page							20 40 60 80 100				20 40 60			
10.0	SAND, trace gravel, trace silt and clay Very Dense Grey Wet 													

+³ ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCN-2

1 OF 2

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 695.20 E 310 677.45 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Casing COMPILED BY MFA
 DATUM Geodetic DATE 2007.06.19 - 2007.06.20 CHECKED BY AEG

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE								
314.4																			
0.0	TOPSOIL: (125mm)																		
0.1	SAND, trace silt and clay Compact Brown Moist		1	SS	19														
	Moist to Wet		2	SS	11											0 98 2 (SI+CL)			
	Loose Wet		3	SS	9														
	trace gravel, occasional cobbles Compact to Dense		4	SS	26														
			5	SS	30														
	becoming gravelly Grey		6	SS	27											26 71 3 (SI+CL)			
	Very Dense		7	SS	50														
			8	SS	52														

Continued Next Page

+³ . X³ : Numbers refer to
Sensitivity

20
15 10 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCN-2

2 OF 2

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 695.20 E 310 677.45 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Casing COMPILED BY MFA
 DATUM Geodetic DATE 2007.06.19 - 2007.06.20 CHECKED BY AEG

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 × LAB VANE						
								WATER CONTENT (%)						
								20	40	60	80	100		
304.2														
10.2	SAND and GRAVEL, trace silt and clay, occasional cobbles Very Dense Grey Wet		9	SS	59		304							55 42 3 (SH+CL)
							303							
			10	SS	50		302							
					.075		301							
	Compact		11	SS	21		300							
							299							
	Very Dense		12	SS	100		298							
					.075		297							
298.4														
16.0	SAND, some silt, trace gravel Very Dense Brown Wet		13	SS	100									
					.075									
296.0			14	SS	100									
18.4	END OF BOREHOLE AT 18.39m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 06/25/07 2.0 312.4 06/28/07 2.0 312.4 07/06/07 2.4 312.0 07/23/07 3.1 311.3				.100									

ONTMT4S 2339 GPJ 4/1/08

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

RECORD OF BOREHOLE No SCN-3

1 OF 3

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 701.13 E 310 699.71 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY MFA
 DATUM Geodetic DATE 2007.06.20 - 2007.06.21 CHECKED BY AEG

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		
314.3														
0.0	TOPSOIL: (175mm)													
0.2	SAND, trace to some silt Dense Brown Moist		1	SS	35		314							
	Loose to Compact		2	SS	20		313							
			3	SS	6		312							
			4	SS	5		311							
			5	SS	6		310							
			6	SS	29		308							
	Compact to Very Dense Brown to Grey Wet		7	SS	51		307							
	some gravel, trace silt and clay Reddish Brown		8	SS	11		306							
	Grey						305							

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15-5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCN-3

2 OF 3

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 701.13 E 310 699.71 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY MFA
 DATUM Geodetic DATE 2007.06.20 - 2007.06.21 CHECKED BY AEG

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	Continued From Previous Page							20 40 60 80 100							
	SAND, trace gravel, trace silt, trace clay Compact to Dense Grey Wet		9	SS	26		304								
	occasional cobbles		10	SS	32		302								
			11	SS	30		301								
300.1							300								
14.2	Sandy SILT: (700mm layer)						299								
299.4							298								
14.9	SAND and GRAVEL Dense Grey Wet Granite BOULDER (500mm) at 14.9m						297								
297.5	Boulder (200mm)		12	SS	100/.050		296								
16.8	SAND, trace gravel, trace silt, occasional cobbles and boulders Very Dense Grey Wet		13	SS	100/.100		295								
294.4			14	SS	100/.100										
19.9															

Continued Next Page

+³ × 3³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCN-3

3 OF 3

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 701.13 E 310 699.71 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY MFA
 DATUM Geodetic DATE 2007.06.20 - 2007.06.21 CHECKED BY AEG

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page																
	END OF BOREHOLE AT 19.86m. BOREHOLE BACKFILLED WITH BENSEAL GROUT TO SURFACE.				.050												


ONTM14S 2339 GPJ 3/25/08

RECORD OF BOREHOLE No SCN-4

1 OF 3

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 720.35 E 310 670.79 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Casing COMPILED BY MFA
 DATUM Geodetic DATE 2007.06.22 - 2007.06.22 CHECKED BY AEG

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					
								20 40 60 80 100					
312.0													
0.0	TOPSOIL: (150mm)						312						
0.2	SAND, trace to some gravel, trace silt and clay Compact Brown Moist		1	SS	25		311						
			2	SS	19		310						
			3	SS	27		309						
			4	SS	39		308						
			5	SS	26		307						10 89 1 (SI+CL)
			6	SS	18		306						
			7	SS	23		305						
			8	SS	25		304						2 95 3 (SI+CL)
							303						
	coarse grained Grey												

Continued Next Page

+³ x³: Numbers refer to Sensitivity
 20
 15 10 5
 (%) STRAIN AT FAILURE

METRIC

Continued Next Page


+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No SCN-4

3 OF 3

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 720.35 E 310 670.79 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Casing COMPILED BY MFA
 DATUM Geodetic DATE 2007.06.22 - 2007.06.22 CHECKED BY AEG

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							20 40 60 80 100							
	MIGMATITIC GNEISS BEDROCK, fresh to slightly weathered, black Sub-vertical joints at 20.0, 20.2 and 20.4m Horizontal joint at 20.3m		2	RUN			292							1 2 1 1 0	SCR=100%, RQD=96%, UCS=162MPa
	Sub-vertical joint at 21.5 and 21.7m		3	RUN			291							1 1 0	RUN 3# TCR=100%, SCR=100%, RQD=100%, UCS=114MPa
289.9 22.1	END OF BOREHOLE AT 22.10m. BOREHOLE BACKFILLED WITH BENSEAL GROUT TO SURFACE.						290							0	

METRIC

[illegible]

+ 3, X 3: Numbers refer to Sensitivity

METRIC

+³, ×³: Numbers refer to Sensitivity

ONTMT4S 2339.GPJ 3/31/08

METRIC

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No SCN-6

1 OF 3

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 761.01 E 310 659.94 ORIGINATED BY CA
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Casing COMPILED BY JHL
 DATUM Geodetic DATE 2007.07.03 - 2007.07.04 CHECKED BY AEG

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					
								20 40 60 80 100					
315.2													
0.0	TOPSOIL: (300mm), sandy with roots and rootlets												
314.9													
0.3	SAND, trace silt and clay Compact Brown Moist												
			1	SS	21								
			2	SS	18								
			3	SS	18								
			4	SS	21								
			5	SS	13								
	Loose		6	SS	9								
	Very Dense		7	SS	84								
	trace gravel		8	SS									

Continued Next Page

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

RECORD OF BOREHOLE No SCN-6

2 OF 3

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 761.01 E 310 659.94 ORIGINATED BY GA
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Casing COMPILED BY JHL
 DATUM Geodetic DATE 2007.07.03 - 2007.07.04 CHECKED BY AEG

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						20 40 60 80 100											
	SAND, trace to some silt and clay Compact to Very Dense Brown Wet		9	SS	18		305											
							304											
			10	SS	44		303											
							302											
			11	SS	65		301											
							300											
			12	SS	37		299											
							298											
			13	SS	36		297											
							296											
296.6	Possible sand and gravel below 18m, Very Dense		14	SS	50/ .000													
18.6	MIGMATITIC GNEISS BEDROCK, fresh, massive, dark grey, pink bands Coring started at 18.6m																	
	Rubble zone at 19.20 to 19.23m		1	RUN														

ONTMT4S 2338.GPJ 4/1/08

Continued Next Page

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

RECORD OF BOREHOLE No SCN-6

3 OF 3

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 761.01 E 310 659.94 ORIGINATED BY GA
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Casing COMPILED BY JHL
 DATUM Geodetic DATE 2007.07.03 - 2007.07.04 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
	Continued From Previous Page							20 40 60 80 100				W _p	W	W _L		
								○ UNCONFINED + FIELD VANE								
								● QUICK TRIAXIAL × LAB VANE								
								20 40 60 80 100				20 40 60				
293.5	MIGMATITIC GNEISS BEDROCK, fresh to slightly weathered, massive, dark grey, pink bands		2	RUN			295									RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=177MPa
							294									
21.6	END OF BOREHOLE AT 21.64m. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 07/23/07 3.3 311.9															

+³ ×³ Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCN-7

1 OF 2

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 766.11 E 310 679.30 ORIGINATED BY GA
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JHL
 DATUM Geodetic DATE 2007.07.05 - 2007.07.05 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)			
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL							x LAB VANE		
313.7							20	40	60	80	100	W _p	W	W _L	GR	SA	SI	CL	
0.0	SILT, occasional sand, trace rootlets		1	SS	18	▽													
313.4	Brown																		
0.3	SAND, trace silt and clay, occasional iron oxide staining Compact to Dense Brown Damp		2	SS	27														
			3	SS	18														
			4	SS	12														
			5	SS	10														
			6	SS	35														
			7	SS	40														
			8	SS	30														
			9	SS	28														
						</													

Continued Next Page

+³ ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCN-7

2 OF 2

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 766.11 E 310 679.30 ORIGINATED BY GA
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JHL
 DATUM Geodetic DATE 2007.07.05 - 2007.07.05 CHECKED BY AEG

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						
	Continued From Previous Page							20 40 60 80 100						
	SAND, trace to some silt and clay Compact to Dense Brown Wet		10	SS	48		303							
								302						
								301						
								300						
					12	SS	15		299					
					13	SS	40							
298.0			14	SS	100/									
15.7	END OF BOREHOLE AT 15.70m. AUGER REFUSAL, POSSIBLE BOULDER OR BEDROCK AT 15.70m. BOREHOLE OPEN AND WATER LEVEL AT 2.13m UPON COMPLETION. BOREHOLE GROUTED WITH BENTONITE TO SURFACE.				.000									

ONTMT4S 2339 GPJ 3/25/08

RECORD OF BOREHOLE No SCN-8

1 OF 2

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 786.10 E 310 653.34 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JHL
 DATUM Geodetic DATE 2007.06.27 - 2007.06.28 CHECKED BY AEG

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				
320.2								20 40 60 80 100				
0.0	TOPSOIL: (225mm) with roots and rootlets							20 40 60 80 100				
0.2	Sandy SILT, sand seams, trace clay Compact to Loose Brown Moist		1	SS	14		320					
			2	SS	9		319					
			3	SS	11		318					
			4	SS	6		317					
	Loose to Compact						316					
			5	SS	10		315					
314.6												
5.6	SAND, trace silt and clay Dense to Very Dense Brown Moist		6	SS	31		314					
							313					
	Grey Wet		7	SS	59		312					
			8	SS	51		311					

Continued Next Page

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

METRIC

[illegible]

RECORD OF BOREHOLE No SCN-9

1 OF 3

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 790.89 E 310 671.51 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Casing COMPILED BY JHL
 DATUM Geodetic DATE 2007.06.27 - 2007.06.27 CHECKED BY AEG

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				
320.9							20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _P W W _L				
0.0	TOPSOIL: (200mm) sandy, with roots and rootlets							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
0.2	SAND, trace silt Compact Brown Wet							WATER CONTENT (%)				
319.9			1	SS	12			20 40 60 80 100	20 40 60			
1.1	SILT, trace to some sand, trace clay Very Loose to Compact Brown Moist											
			2	SS	6							
			3	SS	7							
			4	SS	1							
	Moist to Wet		5	SS	16							
			6	SS	13							
313.8												
7.1	SAND, trace silt Dense Grey Wet		7	SS	40							
			8	SS	43							

Continued Next Page

+ 3, X 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

CHECKED BY AEG

Continued Next Page



(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCN-9

3 OF 3

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 790.89 E 310 671.51 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Casing COMPILED BY JHL
 DATUM Geodetic DATE 2007.06.27 - 2007.06.27 CHECKED BY AEG

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	Continued From Previous Page							20 40 60 80 100	20 40 60 80 100	20 40 60					
	MIGMATITIC GNEISS BEDROCK fresh to slightly weathered, dark grey Horizontal joints at 20.1, 20.8, 21.1 and 21.1m Vertical joints at 20.5 and 20.7m Sub-horizontal joints at 20.7 and 21.1m		2	RUN			301							1	RUN 2# TCR=100%, SCR=100%, RQD=88%, UCS=186MPa
							300							1	
														3	
299.1														3	
21.8	END OF BOREHOLE AT 21.79m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 06/28/07 8.6 312.3 07/06/07 8.9 312.0 07/23/07 9.0 311.9													0	

RECORD OF BOREHOLE No SCN-10

1 OF 2

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 805.10 E 310 658.91 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JHL
 DATUM Geodetic DATE 2007.06.26 - 2007.06.26 CHECKED BY AEG

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		
318.0														
0.0	TOPSOIL: (225mm) sandy with roots and rootlets						318							
0.2	SAND, trace silt Compact to Dense Brown Moist		1	SS	39		317							
			2	SS	30		316							
	becoming Grey		3	SS	14		315							
	Moist to Wet		4	SS	11		314							
			5	SS	20		313							
			6	SS	21		312							
			7	SS	46		311							
							310							
309.0														
9.1	END OF BOREHOLE AT 9.07m. AUGER REFUSAL, POSSIBLE BOULDER OR BEDROCK AT 9.07m. BOREHOLE OPEN TO 5.30m AND WATER LEVEL AT 5.0m UPON COMPLETION.													

Continued Next Page

+ ³ × ³ : Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCN-10

2 OF 2

METRIC

G.W.P. 742-93-00 LOCATION Stirling Creek Tributary NBL N 5 059 805.10 E 310 658.91 ORIGINATED BY SLL
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JHL
 DATUM Geodetic DATE 2007.06.26 - 2007.06.26 CHECKED BY AEG

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	SHEAR STRENGTH kPa					WATER CONTENT (%)			
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE					W _P W W _L 20 40 60					
	Continued From Previous Page															
	BOREHOLE GROUTED WITH BENTONITE TO SURFACE.															

ONTMT4S 2339.GPJ 3/25/08

Appendix B

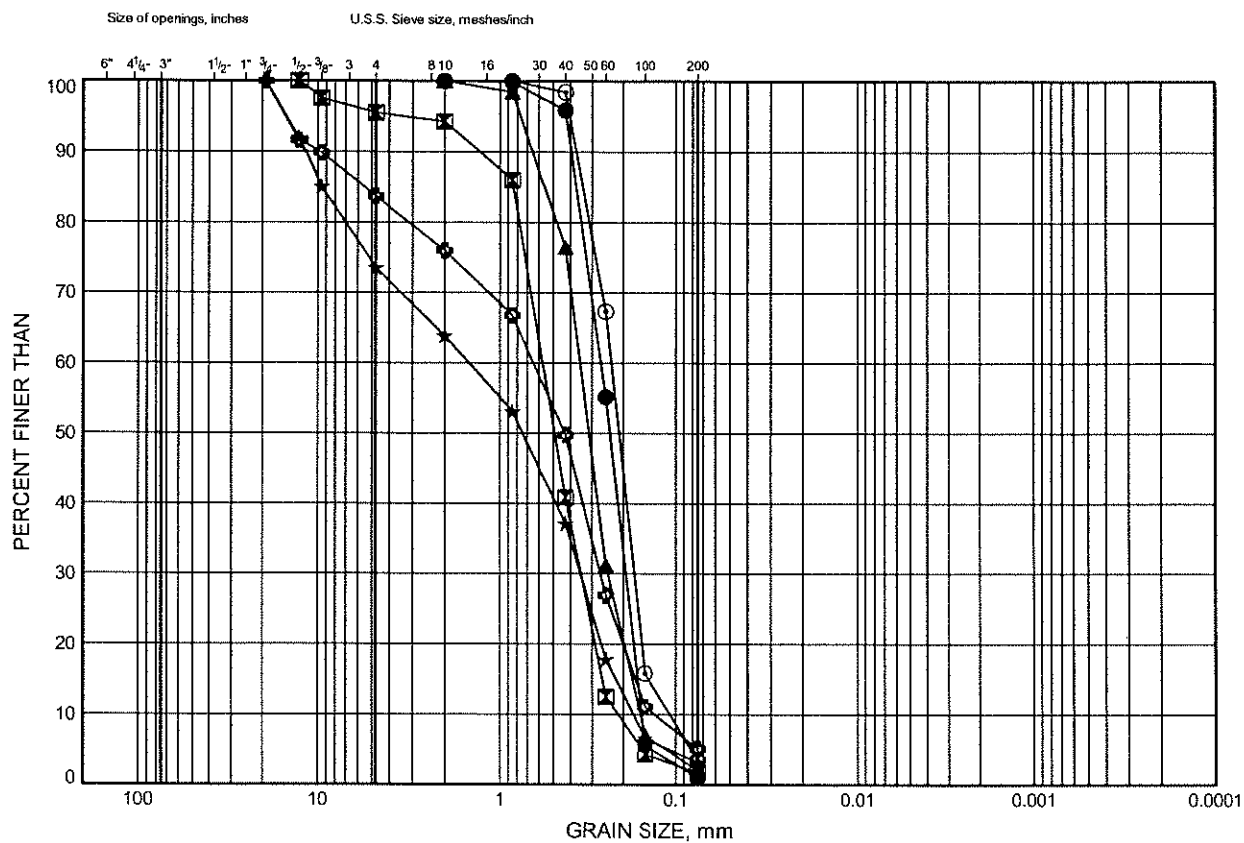
Laboratory Test Results

Stirling Creek Tributary Bridges

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	SCN-1	3.35	311.64
⊠	SCN-1	10.95	304.04
▲	SCN-2	1.83	312.60
★	SCN-2	6.40	308.03
⊙	SCN-3	2.59	311.71
⊗	SCN-3	8.10	306.20



Date March 2008
Project 742-93-00

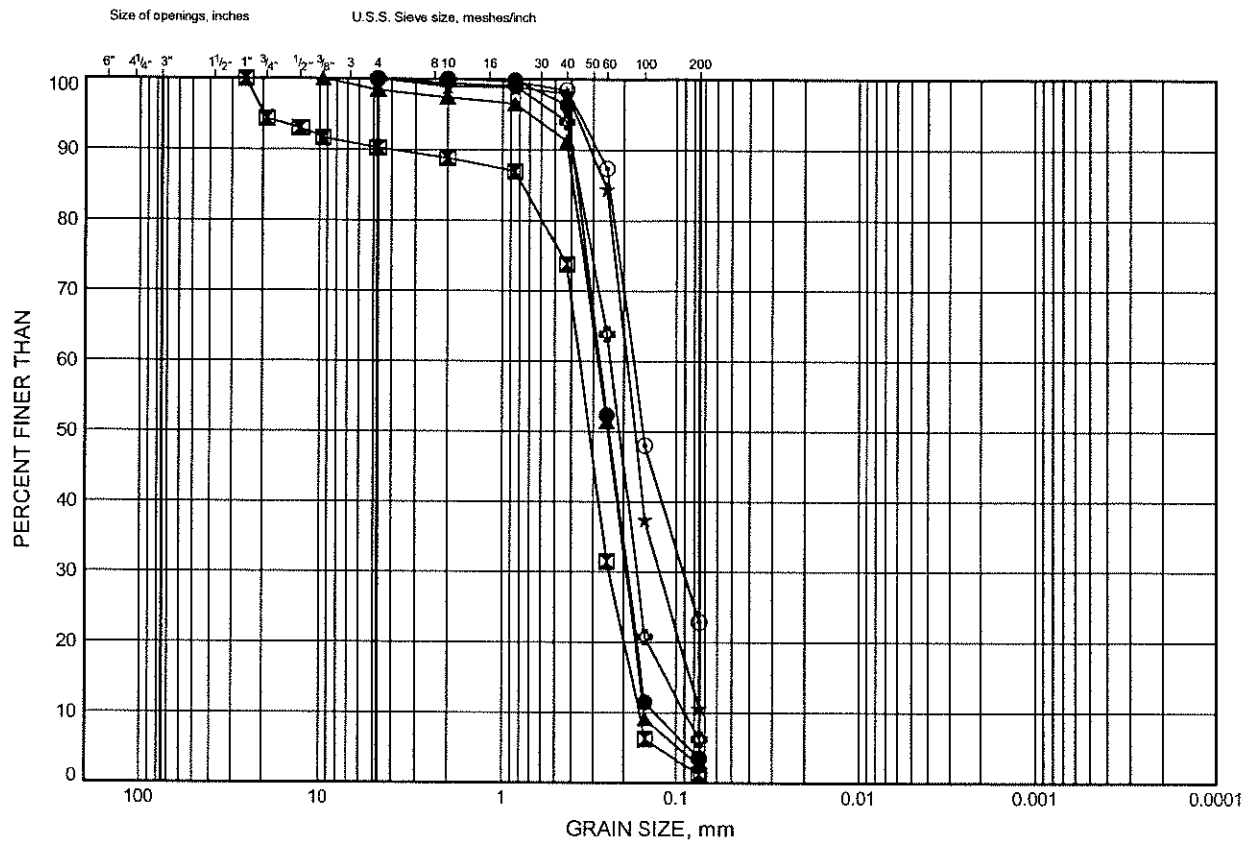
Prep'd MFA
Chkd. RPR

Stirling Creek Tributary Bridges

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	SCN-3	13.94	300.36
⊠	SCN-4	4.88	307.10
▲	SCN-4	7.91	304.07
★	SCN-4	17.07	294.91
⊙	SCN-5	1.83	313.62
⊛	SCN-5	7.92	307.53



Date March 2008
Project 742-93-00

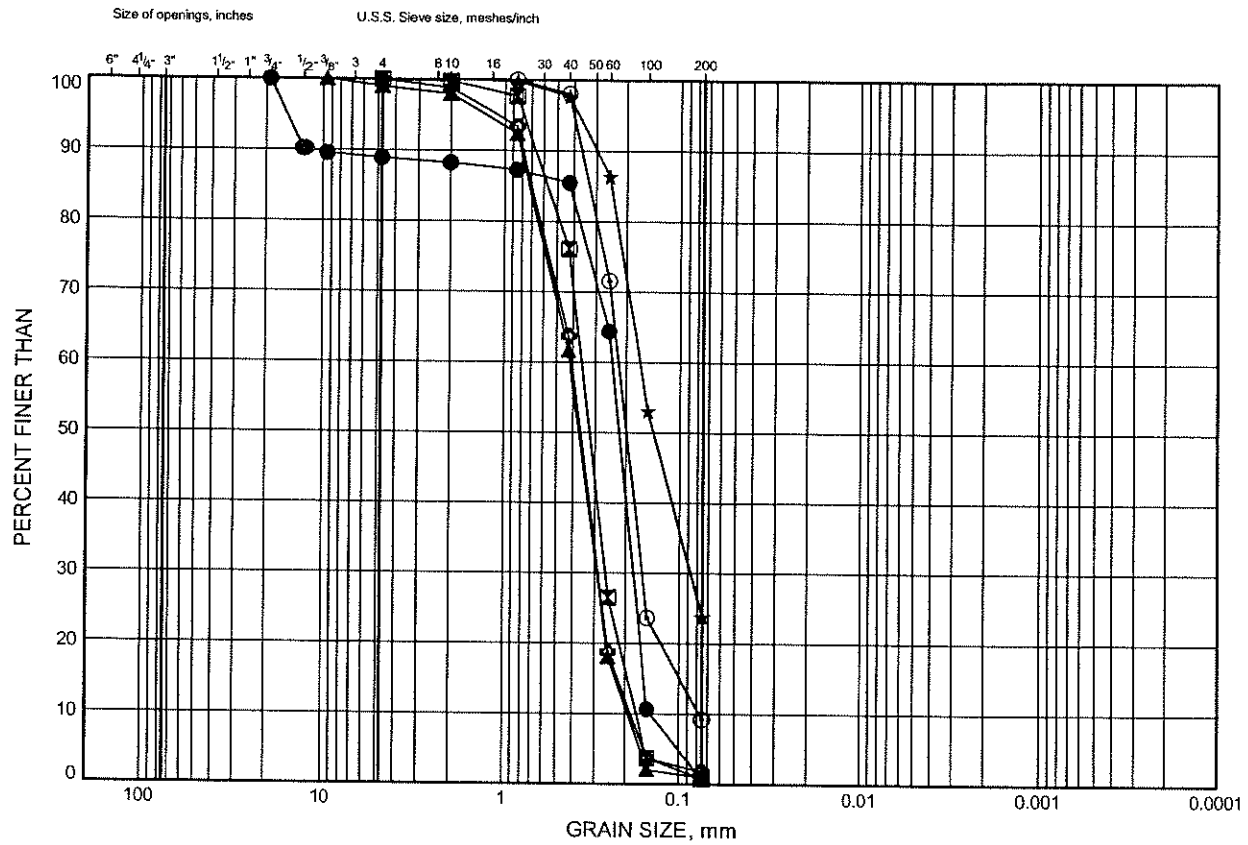
Prep'd MFA
Chkd. RPR

Stirling Creek Tributary Bridges

GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	SCN-5	15.54	299.91
⊠	SCN-6	6.40	308.78
▲	SCN-6	9.45	305.73
★	SCN-6	15.54	299.63
⊙	SCN-7	2.59	311.07
⊞	SCN-7	8.84	304.82



Date March 2008
Project 742-93-00

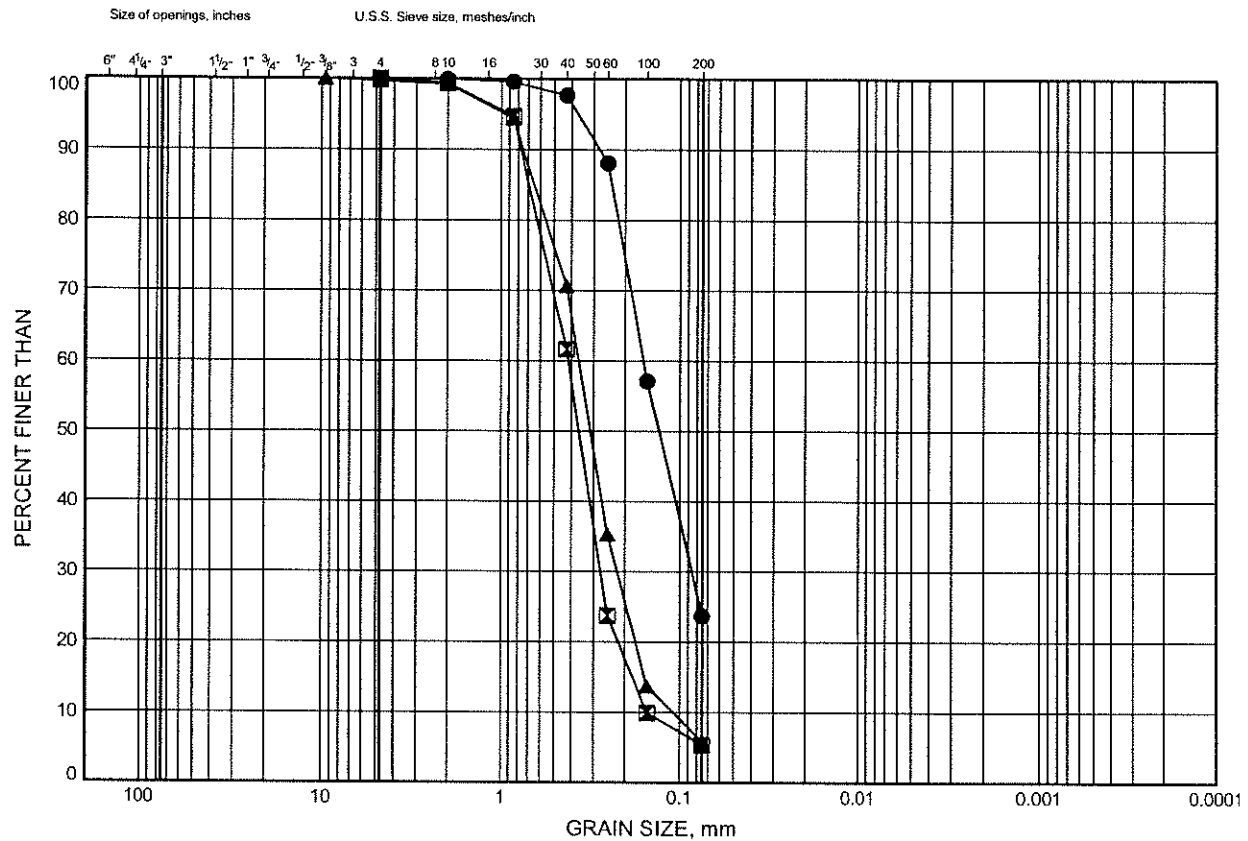
Prep'd MFA
Chkd. RPR

Stirling Creek Tributary Bridges

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	SCN-7	13.41	300.24
⊠	SCN-8	10.97	309.19
▲	SCN-8	12.50	307.66



Date March 2008
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Chkd. RPR

FIGURE B5

Size of openings, inches

U.S.S. Sieve size, meshes/inch

PERCENT FINER THAN

GRAIN SIZE, mm

Grain Size (mm)	Percent Finer (%)
100	100
47.5	85
25	68
15	59
10	55
4.75	45
2.0	35
0.85	29
0.425	21
0.25	12
0.15	5
0.075	2

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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	SCN-2	10.97	303.46

THURBGSD 2339.GPJ 3/25/08

Date March 2008

Project 742-93-00



Prep'd MFA

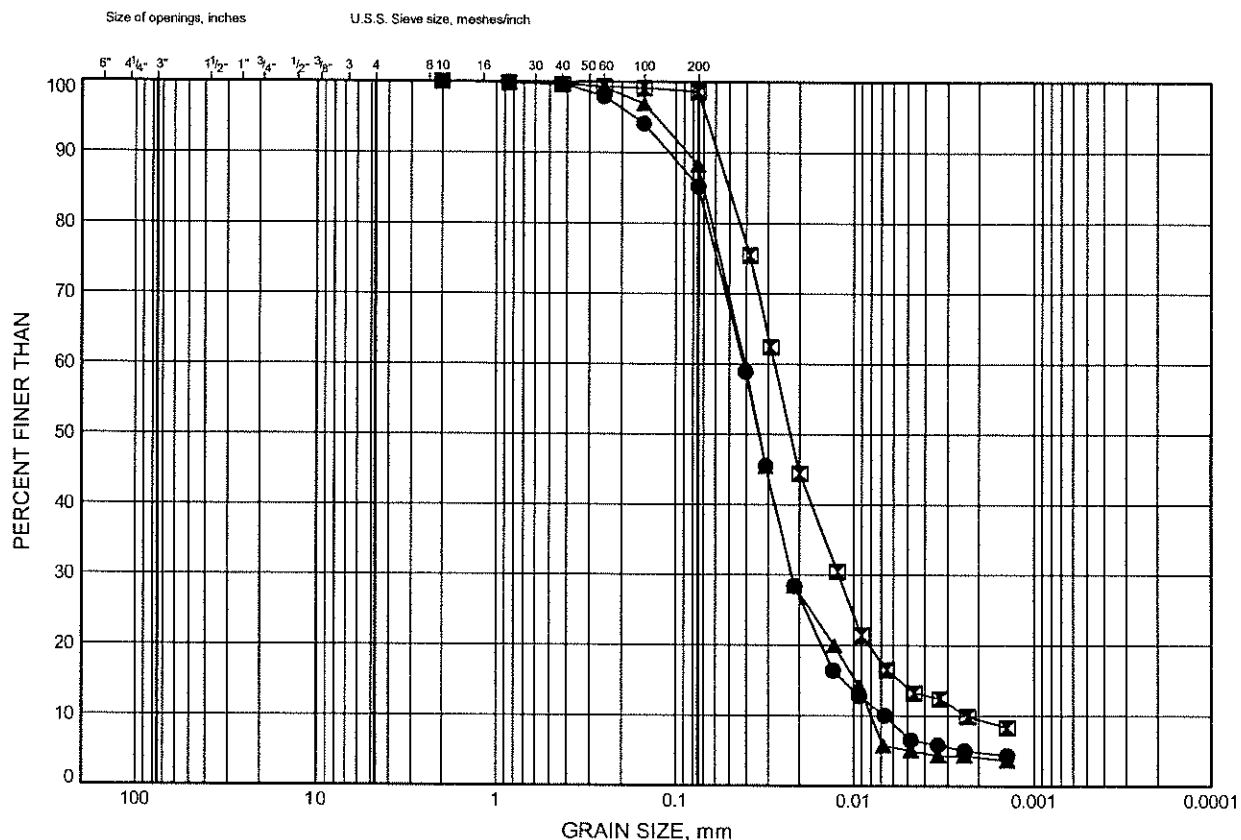
Chkd. RPR

Stirling Creek Tributary Bridges

GRAIN SIZE DISTRIBUTION

FIGURE B6

SILT, SOME SAND TO SANDY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	SCN-8	4.88	315.28
⊠	SCN-9	1.83	319.11
▲	SCN-9	6.40	314.53



Date March 2008
Project 742-93-00

Prep'd MFA
Chkd. RPR

Appendix C

Site Photographs

Highway 11 NBL over Stirling Creek Tributary
Highway 11 Burk's Falls to South River



Photograph 1 – General view of the site, looking northwards, pond in middle ground.



Photograph 2 – Confluence of the two streams at mouth of culvert.

Highway 11 NBL over Stirling Creek Tributary
Highway 11 Burk's Falls to South River



Photograph 3 – South approach looking south along Highway 11.

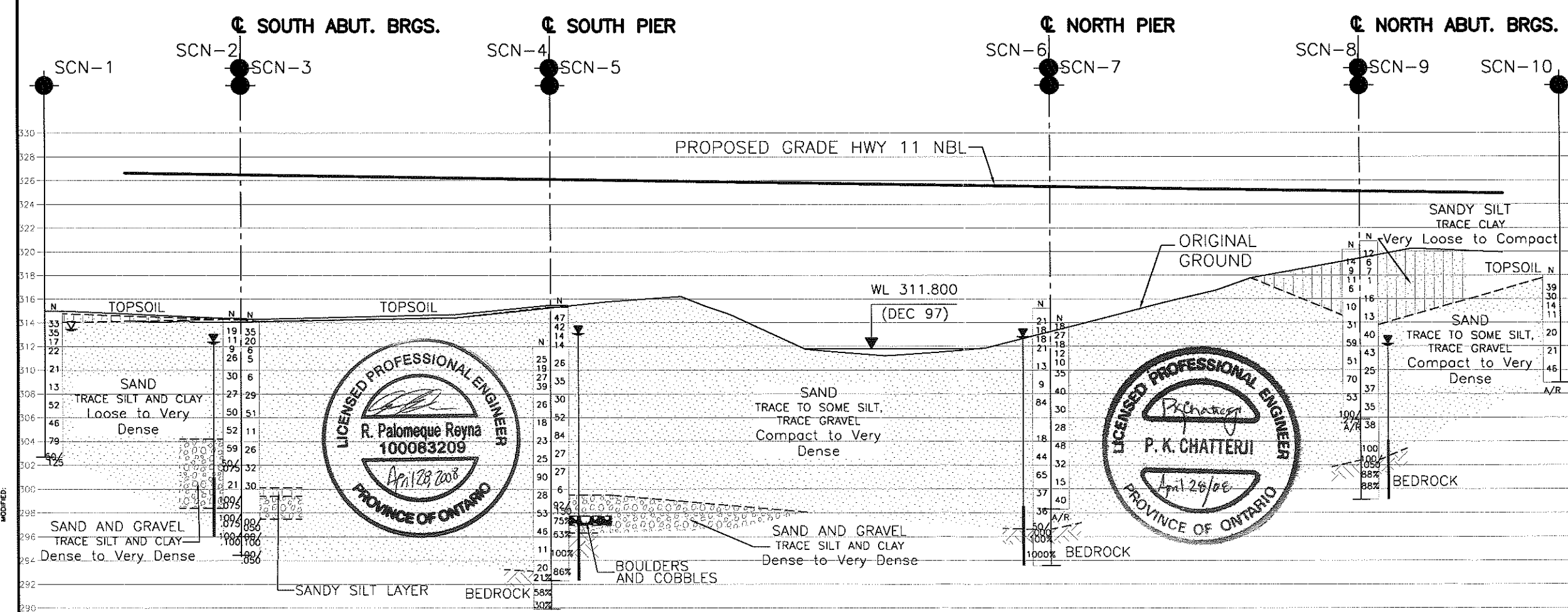
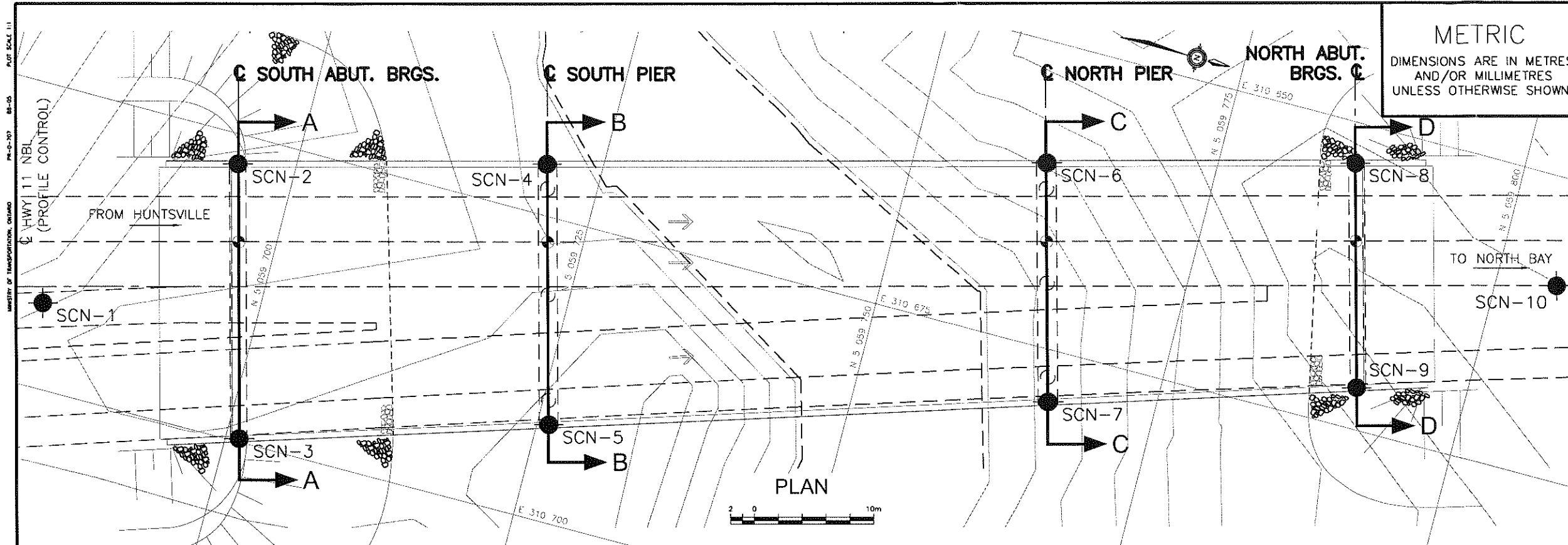


Photograph 4 – Looking north along Highway 11 over future SBL structure site.

Appendix D

Drawing

Borehole Locations and Soil Strata



PROFILE HWY 11 NBL

2 0 10m

DHO BENCHMARK 343-67
ELEVATION 329.137
TABLET IN ROCK OUTCROP
49.337m RL 24+795.574
TWP OF ARMOUR

Refer to DWG 2 for Sections A-A, B-B, C-C and D-D.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

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

CONT No 2008-5113
WP No 5100-06-01

SHEET
273

STIRLING CK TRIBUTARY NBL
BOREHOLE LOCATIONS AND SOIL STRATA

MMM GROUP

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

KEYPLAN

LEGEND

- Borehole by THURBER
- Blows /0.3m (Std Pen Test, 475J/blow)
- Blows /0.3m (60° Cone, 475J/blow)
- Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (ROD)
- Auger Refusal

NO	ELEVATION	NORTHING	EASTING
SCN-1	315.0	5 059 682.31	310 692.91
SCN-2	314.4	5 059 695.20	310 677.45
SCN-3	314.3	5 059 701.13	310 699.71
SCN-4	312.0	5 059 720.35	310 670.79
SCN-5	315.5	5 059 726.00	310 691.89
SCN-6	315.2	5 059 761.01	310 659.94
SCN-7	313.7	5 059 766.11	310 679.30
SCN-8	320.2	5 059 786.10	310 653.34
SCN-9	320.9	5 059 790.89	310 671.51
SCN-10	318.0	5 059 805.10	310 658.91

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. 31E-275

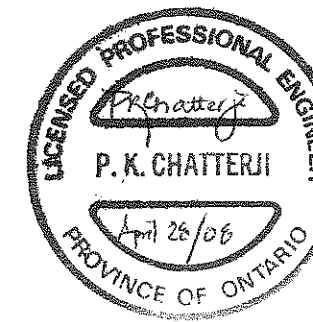
DATE	BY	DESCRIPTION
DESIGN	AEG	CHK AEG CODE
DRAWN	JHL	CHK AEG SITE
LOAD		
STRUCT		
SCHEME		
DWG 2		

FILENAME: C:\JOB FILES\191423\19 Stirling Creek\dwg239-stirlingcreek.dwg
PLOTDATE: May 06, 2008 - 3:10pm



KEYPLAN

GEOCRES No. 31E-275



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