

**FOUNDATION INVESTIGATION REPORT
HODDER AVENUE/COPENHAGEN ROAD UNDERPASS
HIGHWAY 11/17 FOUR-LANING FROM 1.0 KM WEST OF
HODDER AVENUE/COPENHAGEN ROAD EASTERLY FOR 5.8 KM
W.P. 334-94-00**

Geocres Number: 52A-143

Report to

McCormick Rankin Corporation

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for a proposed underpass structure at Hodder Avenue/Copenhagen Road and Highway 11/17 in Thunder Bay, Ontario. The proposed structure will carry Hodder Avenue/Copenhagen Road over the future four-laned Highway 11/17.

MTO carried out a subsurface investigation for the proposed structure in 1991 and the results were presented in a report dated April 10, 1992 (Geocres No. 52A-111). Peto MacCallum Ltd. subsequently prepared a Preliminary Foundation Investigation and Design Report dated May 17, 2007 (Geocres No. 52A-130) based solely on the information obtained during the MTO study.

The purpose of the current investigation was to review the existing subsurface information, conduct additional exploration at the site where deemed necessary for detail design and, based on the data obtained, to provide a borehole location plan, record of borehole sheets, stratigraphic profiles 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 and previous investigations.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation, under the Ministry of Transportation Ontario (MTO) Agreement Number 6008-E-0005.

2 SITE DESCRIPTION

The site lies at the northeast limit of the City of Thunder Bay at the existing intersection of Highway 11/17 and Hodder Avenue/Copenhagen Road. Highway 11/17 is presently an undivided highway with one lane eastbound, one lane westbound entering the intersection, two lanes westbound beyond the intersection, and right and left turning lanes. Hodder Avenue and Copenhagen Road are two-lane undivided roadways.

The existing level crossing is at approximate elevation 262.0 m. Existing grades on Highway 11/17 generally slope down towards the west, falling approximately 16 m to the Current River bridge located about 450 m to the west. Grades on Hodder Avenue slope down to the south, and grades on Copenhagen Road north of Highway 11/17 undulate slightly.

The surrounding lands are forested. Residential properties are present on the west side of Hodder Avenue beginning approximately 200 m to the south of the intersection.

Geologically, the site area is located within the physiographic region known as the Canadian Shield, characterized by Pre-Cambrian bedrock typically occurring as rounded knobs and ridges where exposed. At this site, the bedrock consists of the Gunflint Formation, a sequence of limestone, graphitic shale, tuff, taconite, chert-carbonite and chert. Intrusions/sills of diorite are present locally. The bedrock is overlain by a discontinuous layer of glacial till comprising a heterogeneous mixture of clayey silt, silt, sand and gravel.

Photographs of the site are included in Appendix D.

3 SITE INVESTIGATION AND FIELD TESTING

MTO carried out a foundation investigation at the site in August 1991 and the results were documented in a Foundation Investigation Report dated April 10, 1992 (Geocres No. 52A-111). The investigation consisted of two boreholes at each proposed foundation unit (north abutment, pier and south abutment) advanced to depths of 2.3 to 10.9 m, with 5 m of rock core recovered from one borehole. The Record of Borehole sheets from the earlier investigation are reproduced in Appendix C.

The current site investigation was carried out in several stages between June 24 and December 14, 2009. Initially three supplementary boreholes (numbered 09-92A, 09-92B and 09-93) were advanced at the south abutment where bedrock was previously encountered at shallow depth, and one borehole was drilled approximately 20 m beyond each abutment (boreholes 09-47 and 09-91). Subsequently two additional boreholes (Nos. 09-94 and 09-95) were drilled at the north abutment location.

The four boreholes at the south abutment and approach were advanced to total depths of 4.4 to 6.2 m by coring 3.0 to 3.7 m into bedrock. The boreholes at the north abutment were extended to depths of 10.0 and 7.8 m, including 3.0 m of rock core in borehole 09-94. The borehole at the north approach was terminated upon auger refusal at 2.6 m depth.

The approximate locations of the boreholes drilled during the previous and current investigations are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix E. The borehole elevations, locations and depths are summarized in Table 3.1.

Table 3.1 – Borehole Summary

Foundation Unit	Borehole	Ground Surface Elevation (m)	Location		Total Depth (m)	Length of Core in Bedrock (m)
			Northing	Easting		
North Approach	09-47	260.4	5 372 030.9	365 262.0	2.6*	-
North Abutment	09-94	261.1	5 372 019.4	365 254.2	10.0	3.0
	09-95	260.7	5 372 019.2	365 269.2	7.8	-
	1	261.9	5 372 010.9	365 255.9	10.8	-
	2	260.5	5 372 010.9	365 268.9	7.7	-
Pier	3	261.2	5 371 984.4	365 255.9	9.2	-
	4	261.8	5 371 984.4	365 269.1	10.9	-
South Abutment	09-92A	261.6	5 371 947.2	365 269.1	6.1	3.3
	09-92B	260.2	5 371 947.2	365 256.1	4.4	2.7
	09-93	261.4	5 371 953.4	365 262.6	6.2	3.6
	5	260.5	5 371 957.9	365 256.1	7.6	5.0
	6	261.5	5 371 958.0	365 269.1	2.3*	-
South Approach	09-91	261.4	5 371 937.9	365 262.7	5.8	3.5

* Probable bedrock

Prior to commencing the site investigation, clearance was obtained from utility companies having plant in the area.

Hollow-stem augers were used to advance the boreholes to bedrock or auger refusal. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the soils. The boreholes at the abutments where rock was encountered were advanced 3.0 to 3.7 m into bedrock by BQ size diamond coring techniques.

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), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. In boreholes 09-92B and 09-094, standpipe piezometers consisting of 19 mm PVC pipe with a slotted screen were installed and enclosed in filter sand to permit longer term groundwater level monitoring. The completion details of the piezometers are shown in Table 3.2. Following the final water level reading, the piezometers were decommissioned in accordance with MOE Regulation 903.

The boreholes in which no piezometers were installed were backfilled with bentonite and cuttings. The borehole completion details are shown in Table 3.2.

Table 3.2 – Borehole Completion Details

Borehole	Piezometer Tip		Completion Details
	Depth (m)	Elevation (m)	
09-47	-	-	Borehole backfilled with cuttings to surface
09-91	-	-	Borehole backfilled with bentonite to 0.1 m, then gravel cuttings to surface
09-92A	-	-	Borehole backfilled with bentonite to 0.1 m, then cold patch asphalt to surface
09-92B	4.4	255.8	Piezometer with 1.5 m slotted screen installed with sand filter to 2.6 m, bentonite seal from 2.6 m to ground surface.
09-93	-	-	Borehole backfilled with bentonite to 0.1 m, then cold patch asphalt to surface
09-94	6.2	254.9	Piezometer with 1.5 m slotted screen installed with sand filter to 4.4 m, bentonite seal from 2.6 m to 0.6 m, cuttings to ground surface
09-95	-	-	Borehole backfilled with bentonite to 1.5 m, then cuttings 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 testing was conducted on rock core samples retrieved from the boreholes. The results of the point load tests are shown on the borehole logs in Appendix A.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A and Appendix C. Details of the encountered soil and rock stratigraphy are presented in these appendices and on the “Borehole Locations and Soil Strata” drawing in Appendix E. 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, the site is underlain by a surficial topsoil, fill and/or silty clay/clayey silt layer overlying compact to very dense/hard glacial till consisting of sand and silt, trace clay to clayey. Sand to sand and gravel was encountered within or below the till. Bedrock was encountered at relatively shallow depth at the south abutment and approach, and below the till in one borehole at the north abutment.

5.1 Topsoil/Organics

A 0.2 to 2.1 m thick layer of topsoil or peaty organics was encountered in the boreholes drilled at the north abutment and approach. The topsoil was loose to compact with SPT 'N' values of 7 to 21 blows/0.3 m. The lower boundary of the topsoil/organic layer was encountered at elevation 259.1 to 260.9 m.

In boreholes 09-47, 09-94 and 09-95, the organic layer was underlain by a further 0.6 to 1.1 m thick layer of dark brown clayey silt/silty clay with roots and rootlets. The silt/clay was firm ('N' values of 4 and 8). Moisture contents of 18 and 19% were determined. The underside of this layer was at elevation 258.9 to 260.3 m.

The topsoil/organic thickness may vary between and beyond the borehole locations, and the data presented in this report should not be used for quantity estimation purposes.

5.2 Fill

Fill was encountered in all boreholes at the pier, south abutment and south approach. The fill thickness ranged from 1.2 to 2.1 m and the underside of the fill layer was recorded at elevations between 258.6 m and 260.6 m. A 125 and 75 mm thick asphalt layer was encountered over the fill in boreholes 09-92A and 09-93 drilled on the existing roadway.

The fill typically comprises sand, trace gravel to gravelly and trace to some silt. Clayey silt fill was encountered in boreholes 09-91 and 09-92B.

Standard Penetration Tests 'N' values ranged from 10 to 60 blows/0.3 m in the sand fill, indicating a compact to very dense condition. 'N' values of 6 to 12 blows/0.3 m were obtained in the clayey silt fill, indicating a firm to stiff consistency.

Moisture contents ranged from approximately 5 to 19 % in the sand fill and 19 to 30% in the clayey silt fill.

The results of laboratory grain size distribution tests carried out on samples of the fill were as follows:

	<u>Sand Fill</u>	<u>Clayey Silt Fill</u>
Gravel (%)	1 to 14	0 to 1
Sand (%)	70 to 91	12 to 17
Silt (%)	8 to 14	66 to 67
Clay (%)	3 to 4	15 to 22

The grain size distribution curves for the samples tested during the current investigation are shown in Figure B1 in Appendix B. The results of Atterberg Limits testing conducted on a sample of clayey silt fill are presented on Figure B4.

5.3 Sand and Silt Till

A glacial till deposit consisting of sand and silt with variable content of clay and gravel was encountered below the organic layer and fill in all boreholes. The till contains cobbles and boulders.

At the south abutment and approach, the till overlies bedrock encountered at depths of 1.4 to 2.6 m (elevation 257.9 to 259.2 m), and varies from 0.2 to 1.2 m in thickness. At the pier, it overlies sand and gravel encountered at 7.0 and 5.4 m depth (elevation 254.2 and 256.4 m) and is 5.8 and 4.2 m thick. In the boreholes at the north abutment, the till variously extends to at least 7.7 m depth (elevation 252.8 m), overlies sand at 6.6 to 6.7 m depth (elevation 254.0 to 254.5 m), or extends to at least 10.8 m depth but is interrupted by a sand and gravel deposit. Refusal was encountered at 2.6 m depth (elevation 257.8 m) in the borehole at the north approach (borehole 09-47).

The results of laboratory grain size distribution tests carried out on samples of the till are illustrated in Figure B2, Appendix B. The results from the current and previous studies were as follows:

Gravel (%)	2 to 50
Sand (%)	23 to 59
Silt (%)	25 to 52
Clay (%)	5 to 20

The till is generally very dense, locally hard, with SPT 'N' values exceeding 50 blows for 0.3 m penetration. 'N' values of 9 to 11 blows/0.3 m were encountered in the upper 0.8 m of this deposit in three boreholes (boreholes 09-92A, 09-94 and 09-95), indicating a compact condition.

The moisture content of samples from this deposit ranged from about 5 to 20%, typically 5 to 12%.

5.4 Sand to Sand and Gravel

Sand, trace gravel, to sand and gravel was encountered below the till in boreholes 3, 4, 09-94 and 09-95, and within the till at 6.9 to 9.9 m depth in borehole 1. In boreholes 3, 4 and 09-95, the sand/gravel layer extended to the exploration depths of 7.8 to 10.9 m (elevation 250.9 to 252.9 m) and was at least 1.1 to 5.5 m thick. The sand was 0.4 m thick and underlain by bedrock at 7.0 m depth (elevation 254.1 m) in borehole 09-94.

The results of laboratory grain size distribution tests carried out on samples of the sand were as follows:

Gravel (%)	3 to 24
Sand (%)	65 to 86
Silt and Clay (%)	3 to 17

The grain size distribution curve for a sample tested during the current investigation is shown in Figure B3 in Appendix B.

Standard Penetration tests in the sand gave 'N' values exceeding 50 blows per 0.3 m penetration, indicating a very dense condition.

The moisture content of samples from this unit varies between 10 and 15%.

5.5 Bedrock

Bedrock and probable bedrock were encountered below the till and sand deposits in all boreholes at the south abutment and approach and in one borehole at the north abutment. Auger refusal was also encountered in borehole 09-47 at the north approach, however this may have occurred on a boulder in the till.

The depths to bedrock proved by coring or inferred by auger refusal are summarized in Table 5.1.

Table 5.1 – Depth to Bedrock at Borehole Locations

Location	BH Number	Depth to Bedrock (m)	Top of Bedrock Elevation (m)	Cored/ Inferred
South Approach	09-91	2.3	259.1	Cored
South Abutment	09-92A	2.6	259.0	Cored
	09-92B	1.4	258.8	Cored
	09-93	2.5	258.9	Cored
	5	2.6	257.9	Cored
	6	2.3	259.2	Inferred
North Abutment	09-94	7.0	254.1	Cored
North Approach	09-47	2.6	257.8	Inferred

The bedrock recovered in the cores was described as chert carbonate at the south abutment and grainstone at the north abutment during the current investigation. It was identified as chert with siderite (iron carbonate) during the MTO investigation. Shale partings and greenalite granules were also noted. The bedrock is considered to be from the Gunflint Formation.

The bedrock is described as thinly banded and fresh to slightly weathered. Its colour is charcoal grey/greyish black to olivine green/light olive grey.

Core recovery in the bedrock was between 83% and 100%. RQD values recorded during the current investigation generally ranged from 72 to 100% indicating good to excellent rock quality. Lower RQD values of 28 and 50% were encountered in two runs, indicating poor quality. RQD values recorded during the MTO study (borehole 5) ranged from 33 to 83%, indicating poor to good rock quality.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to 6. Rubble zones of 400 and 200 mm in thickness were noted in borehole 09-93. Vertical and sub-vertical fractures were encountered at various depths.

The unconfined compressive strength of the rock, estimated from the results of point load tests conducted on the rock core samples, ranges between 145 and 376 MPa, indicating a very strong to extremely strong intact rock. The point load test results are included on the borehole logs in Appendix A.

5.6 Groundwater

The groundwater depths and elevations observed in the boreholes upon completion of drilling and subsequently measured in the piezometers are shown in Table 5.2.

Table 5.2 – Groundwater Depths and Elevations

Location	Borehole	Borehole Completion Date	Water Levels on Completion (m)		Water Levels in Piezometers		
			Depth (m)	Elevation (m)	Date	Depth (m)	Elevation (m)
North Approach	09-47	14-July-07	Dry	-	-	-	-
North Abutment	09-94	14-Dec-09	*	-	17-Dec-09 01-Mar-10	1.9 2.2	259.2 258.9
	09-95	10-Dec-09	4.2	256.5	-	-	-
	1	15-Aug-91	4.5	257.4	-	-	-
	2	22-Aug-91	2.0	258.5	-	-	-
Pier	3	22-Aug-91	-	-	25-Aug-91	1.5	259.7
	4	20-Aug-91	-	-	25-Aug-91	2.0	259.8
South Abutment	09-92A	24-Jun-09	*	-	-	-	-
	09-92B	26-Jun-09	*	-	23-Nov-09 01-Mar-10	1.9 2.4	258.3 257.8
	09-93	25-Jun-09	*	-	-	-	-
	5	19-Aug-91	*	-	-	-	-
	6	20-Aug-91	Dry	-	-	-	-
South Approach	09-91	25-Jun-09	*	-	-	-	-

* Where rock coring was carried out, water was introduced into the boreholes as part of the coring operation and therefore water levels were not recorded upon completion.

The above water levels reflect the unstabilized conditions in the boreholes upon completion of drilling or the piezometric head at the level of the piezometer tips at the time of the readings. The measurements are short-term observations and seasonal fluctuations of the groundwater level are to be expected.

Based on the water levels measured in the piezometers, the groundwater level is expected to vary from about elevation 259.0 m at the north abutment, to elevation 259.8 m at the centre pier, and elevation 258.0 m at the south abutment. The groundwater level at the time of underpass construction may vary depending upon staging of the highway cut.

6 MISCELLANEOUS

J.D. Barnes Limited determined the co-ordinates and ground elevations at the boreholes prior to or following completion of the site investigation.

TBT Engineering Consulting Group of Thunder Bay, Ontario supplied and operated the drilling and sampling equipment for the current field program. Full time supervision of the field activities, including obtaining utility clearances, was carried out by Mr. Stephane Loranger and Mr. Luke Gilarski of Thurber.

Supervision of the field program, interpretation of the field data, and preparation of the report was performed by Mr. Tony Harte and Mr. Murray Anderson, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng., and by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.
Murray R. Anderson, P.Eng., M.Eng.
Senior Geotechnical Engineer



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

C_{pen}

Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

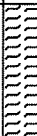

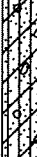
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. $(W_L < 30\%)$.
		CI	Inorganic clays of medium plasticity, silty clays. $(30\% < W_L < 50\%)$.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

RECORD OF BOREHOLE No 09-047

1 OF 1

METRIC

G.W.P. 334-94-00 LOCATION N 5 372 030.9 E 365 262.0 ORIGINATED BY SLL
 HWY 11/17 BOREHOLE TYPE Hollow Stem augers COMPILED BY AN
 DATUM Geodetic DATE 2009-07-14 - 2009-07-14 CHECKED BY TH

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						WATER CONTENT (%) PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L	
260.4							20	40	60	80	100	20	40	60	
0.0	ORGANICS, peat, with roots and rootlets Brown						260								
259.5															
0.9	Clayey SILT, topsoil stained, trace roots and rootlets Firm Dark Brown		1	SS	8		259								
258.9															
1.5	Clayey SILT and SAND, trace gravel Hard Brown (TILL)		2	SS	61										4 34 48 14
257.8															
2.6	END OF BOREHOLE AT 2.6m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.						258								

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

RECORD OF BOREHOLE No 09-092A

1 OF 1

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 947.2 E 365 269.1 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/BQ Coring COMPILED BY MFA
 DATUM Geodetic DATE 2009.06.24 - 2009.06.24 CHECKED BY TH

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 x LAB VANE						WATER CONTENT (%) w _p w w _L					
261.6							20	40	60	80	100								
0.0	ASPHALT: (125mm)																		
0.1	SAND, some silt, some gravel Compact Black Moist (FILL)		1	SS	21														13 70 14 3
260.2																			
1.4	SAND and SILT, trace gravel, trace clay Compact to Very Dense Dark Brown Moist (TILL)		2	SS	11														9 47 36 8
259.0			3	SS	100/ .150														
2.6	GUNFLINT FORMATION, very strong to extremely strong (chert carbonate), thinly banded, fresh to slightly weathered, charcoal grey to olive green Vertical fracture at 3.4 to 3.7m		1	RUN															RUN 1# TCR=100%, SCR=61%, RQD=28%, UCS=257MPa

+ 3, X 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 09-092B

1 OF 1

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 947.2 E 365 256.1 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/BQ Coring COMPILED BY MFA
 DATUM Geodetic DATE 2009.06.26 - 2009.06.26 CHECKED BY TH

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							
260.2								20 40 60 80 100							
0.0	Clayey SILT, some sand, trace gravel Firm to Stiff Brown Moist to Wet (FILL)		1	SS	6		260								
259.0			2	SS	12										1 17 67 15
258.8	SAND and SILT, trace gravel, trace clay Compact Brown Moist (TILL)		3	SS	100/		259						FI		
1.4					.075								4		
	GUNFLINT FORMATION, very strong to extremely strong (chert carbonate), thinly banded, fresh to slightly weathered, charcoal grey to olivine green Occasional shale partings. Sub-vertical fractures, planar, smooth Vertical fracture at 2.0 to 2.1m		1	RUN			258						3		RUN 1# TCR=100%, SCR=92%, RQD=88% UCS=229MPa
													1		
							257						1		RUN 2# TCR=100%, SCR=100%, RQD=100% UCS=202MPa
	Vertical fracture at 3.7 to 4.4m		2	RUN									4		
													2		
													3		
255.8							256						0		
4.4	END OF BOREHOLE AT 4.4m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.11.23 1.9 258.3 2010.03.01 2.4 257.8														

+³, X³: Numbers refer to Sensitivity 20 15 10 5 0 (% STRAIN AT FAILURE)

RECORD OF BOREHOLE No 09-093

1 OF 1

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 953.4 E 365 262.6 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/BQ Coring COMPILED BY MFA
 DATUM Geodetic DATE 2009.06.25 - 2009.06.25 CHECKED BY TH

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							
261.4							20 40 60 80 100	○ UNCONFINED + FIELD VANE							
0.0	ASPHALT: (75mm)						20 40 60 80 100	● QUICK TRIAXIAL X LAB VANE							
0.1	SAND, trace silt, trace gravel Compact Brown to Black Moist (FILL)		1	SS	14										
			2	SS	12										
259.3															
2.1	SAND and SILT, some gravel, trace clay, trace rock pieces Compact to Very Dense Moist to Wet (TILL)		3	SS	100/ 125										
258.9			1	RUN											
2.5	GUNFLINT FORMATION, very strong to extremely strong (chert carbonate), thinly banded, fresh to slightly weathered, charcoal grey to olivine green Occasional shale partings. Sub-vertical fractures, planar, smooth Fracture at 2.7, 2.9, and 3.3m Vertical fractures at 2.8, and 3.5 to 3.7m		2	RUN											
			3	RUN											
	Rubble zone at 4.0 to 4.4, and 5.6 to 5.8m														
255.2															
6.2	END OF BOREHOLE AT 6.2m. BOREHOLE BACKFILLED WITH BENTONITE TO 0.1m, THEN COLD PATCH ASPHALT TO SURFACE.														

+³ X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 09-094

1 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 372 019.4 E 365 254.2 ORIGINATED BY SLL
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/BQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2009.12.11 - 2009.12.14 CHECKED BY TH

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				
261.1								20 40 60 80 100				
0.0	TOPSOIL: (150mm)											
0.2	Clayey SILT, trace gravel, trace sand Dark Brown											
260.3												
0.8	SAND and SILT, some gravel, trace clay Loose to Very Dense Brown Moist (TILL)		1	SS	9							
			2	SS	48							
			3	SS	100/ 250							
	occasional cobbles and boulders		4	SS	100/ .025							
			5	SS	100/ .150							
			6	SS	100/ .075							
254.5												
6.6	SAND, some gravel, some silt, occasional cobbles and boulders Very Dense Grey Moist		1	RUN								
254.1			2	RUN								
7.0	GUNFLINT FORMATION, very strong to extremely strong (grainstone), occasional quartz veining, carbonate rich layers Haematite precipitation on fracture planes, fractures subhorizontal		3	RUN								
	175mm sub-vertical joints at 8.9m											
251.1												

Auger refusal at 2.2m, moved 0.6m west.

11 40 42 7

RUN 1#
TCR=100%,
SCR=87%,
RQD=72%
UCS=337MPa

RUN 2#
TCR=100%,
SCR=91%,
RQD=87%
UCS=267MPa

RUN 3#
TCR=100%,
SCR=100%,
RQD=90%
UCS=201MPa

Auger refusal at
2.2m, moved
0.6m west.
11 40 42 7

RUN 1#
TCR=100%,
SCR=87%,
RQD=72%
UCS=337MPa
RUN 2#
TCR=100%,
SCR=91%,
RQD=87%
UCS=267MPa
RUN 3#
TCR=100%,
SCR=100%,
RQD=90%
UCS=201MPa

Continued Next Page

+³ ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

ONTMT4S 1156.GPJ 5/28/10

RECORD OF BOREHOLE No 09-094

2 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 372 019.4 E 365 254.2 ORIGINATED BY SLL
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/BQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2009.12.11 - 2009.12.14 CHECKED BY TH

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					W _P	W	W _L		
10.0	Continued From Previous Page END OF BOREHOLE AT 10.0m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.12.17 1.9 259.2 2010.03.01 2.2 258.9																

ONTMT4S 1156.GPJ 5/28/10

RECORD OF BOREHOLE No 09-095

1 OF 1

METRIC

G.W.P. 334-94-00 LOCATION N 5 372 019.2 E 365 269.2 ORIGINATED BY SLL
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2009.12.10 - 2009.12.10 CHECKED BY TH

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						
260.7								20	40	60	80	100		
0.0	ORGANICS, black peat (275mm)													
260.4														
0.3	Silty CLAY, trace sand, rootlets Firm Dark Brown		1	SS	4		260							
259.3														
1.4	SAND and SILT, some gravel, trace clay, occasional cobbles and boulders Very Dense Brown Moist (TILL)		2	SS	10		259							8 51 32 9
			3	SS	100/ 250		258							
			4	SS	100/ .200		257							
			5	SS	100/ .150		256							
			6	SS	100/ .150		255							
254.0							254							
6.7	SAND, some silt, trace gravel, occasional cobbles Very Dense Grey Moist		7	SS	100/ .150		253							3 86 11
252.9														(SI+CL)
7.8	END OF BOREHOLE AT 7.8m. BOREHOLE OPEN TO 6.3m AND WATER LEVEL AT 4.2m ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO 1.5m, THEN CUTTINGS TO SURFACE.													

+ 3, X 3: Numbers refer to
Sensitivity

20
15
10

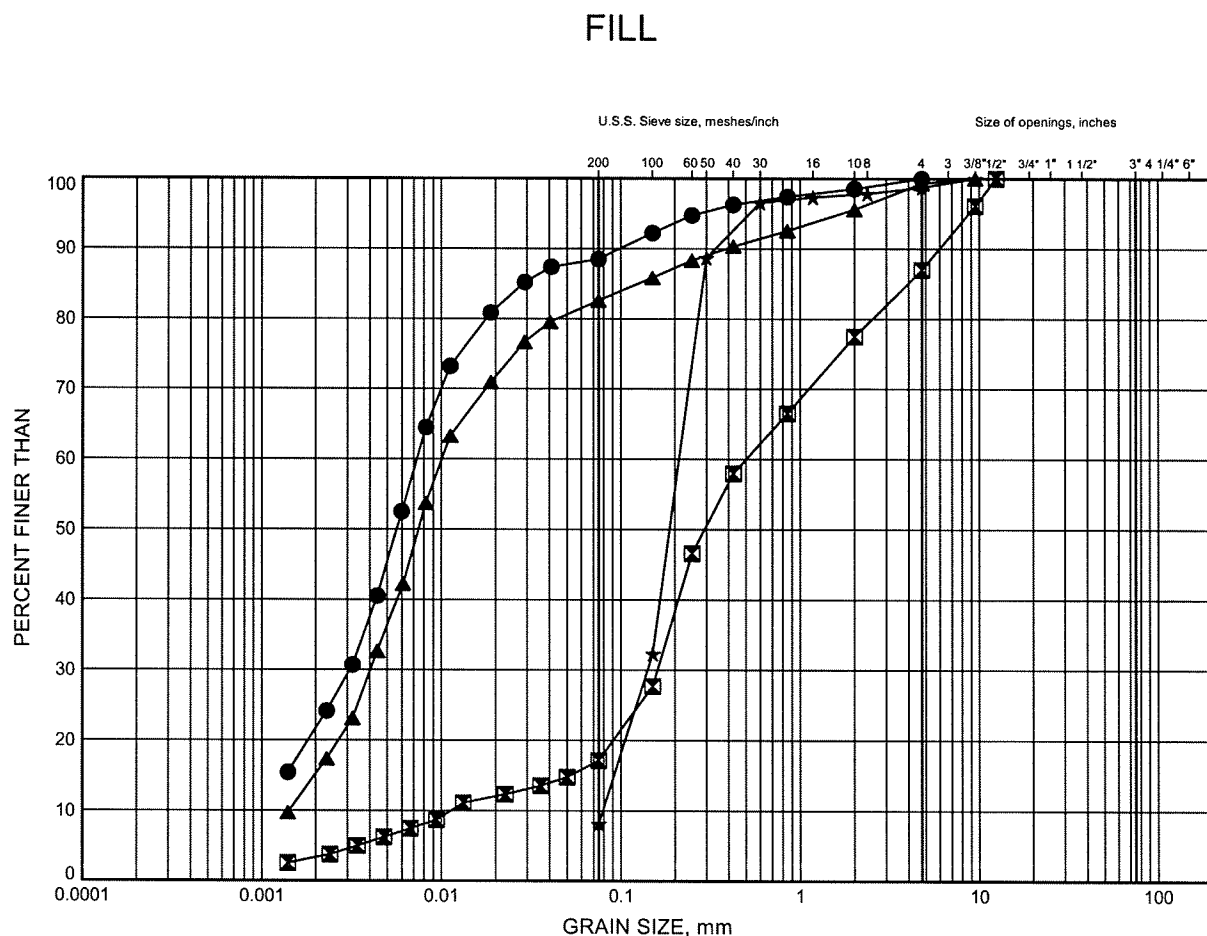
(%) STRAIN AT FAILURE

Appendix B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE B1



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	09-091	1.75	259.65
⊠	09-092A	0.99	260.61
▲	09-092B	0.99	259.21
★	09-093	1.80	259.60

GRAIN SIZE DISTRIBUTION - THURBER 1156.GPJ 2/1/10

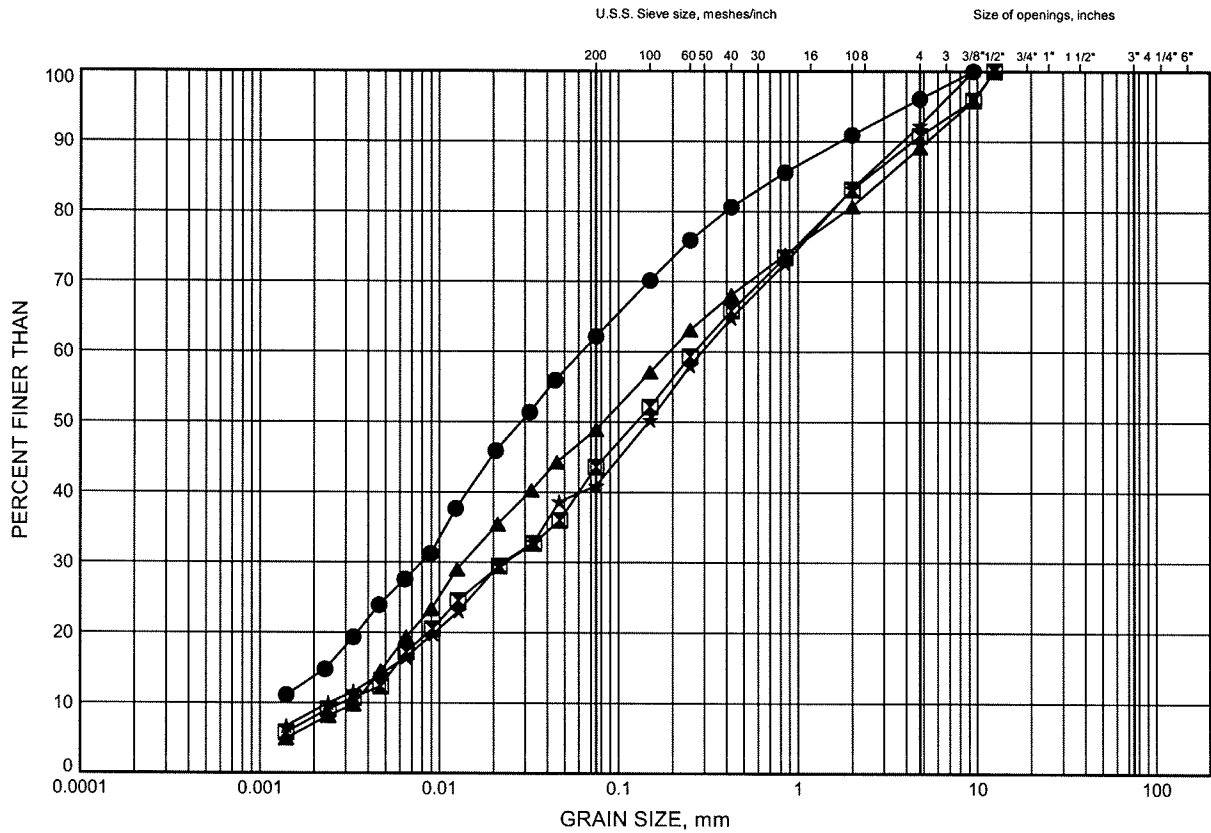
W.P.# 334-94-00
 Prepared By MFA
 Checked By MRA



GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND AND SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	09-047	1.83	258.57
⊠	09-092A	1.83	259.77
▲	09-094	2.49	259.01
★	09-095	1.83	259.75

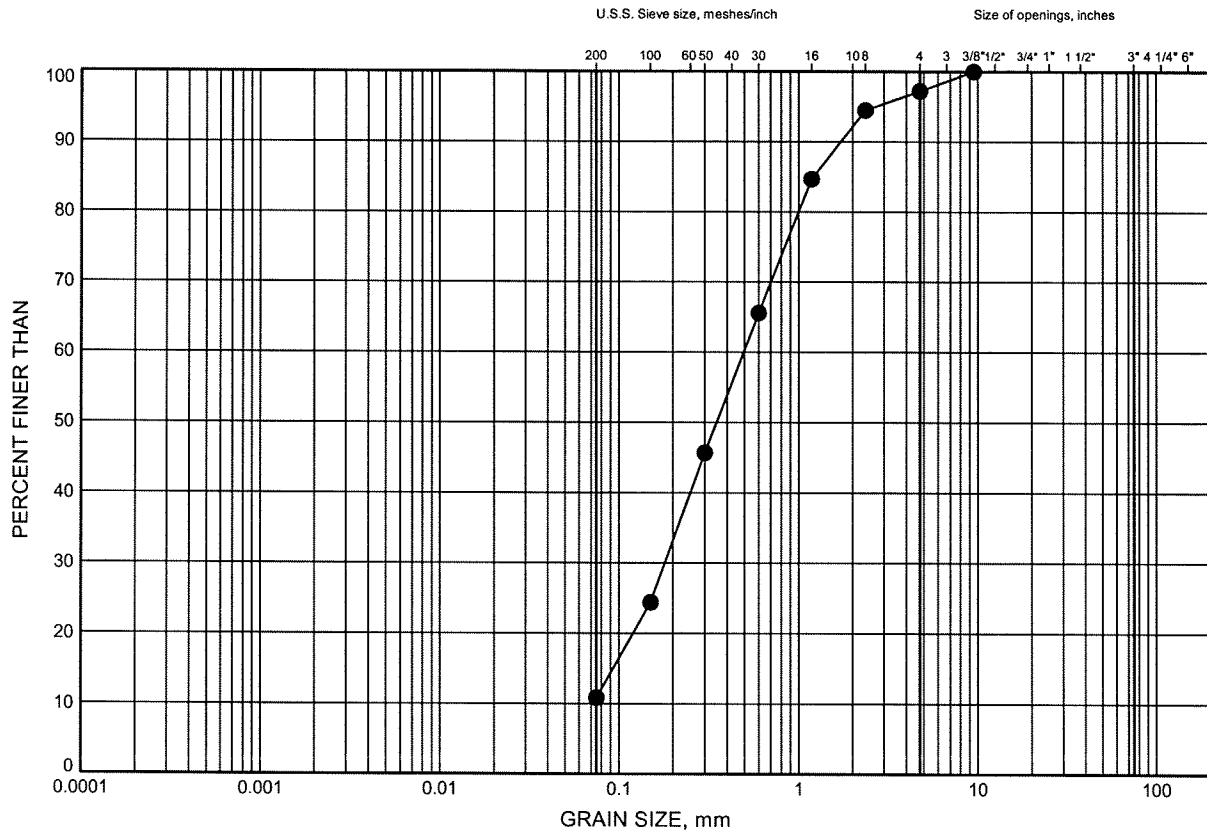


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GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	09-095	7.68	253.89

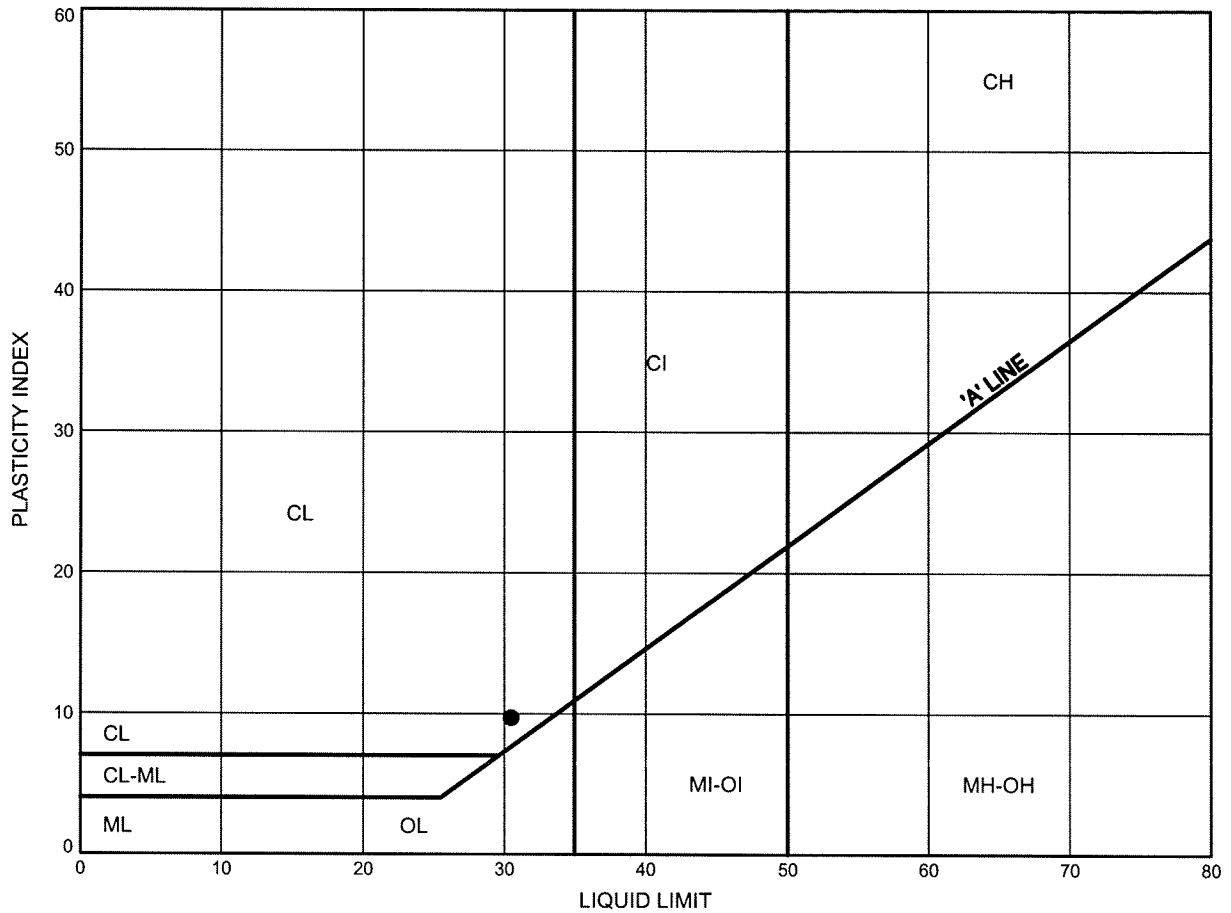


W.P.# 334-94-00
 Prepared By MFA
 Checked By MRA

ATTERBERG LIMITS TEST RESULTS

FIGURE B4

CLAYEY SILT FILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	09-091	1.75	259.65

Date February 2010
Project 334-94-00



Prep'd MFA
Chkd. MRA

Appendix C

Factual Data from Previous Reports

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 31MM O.D. SPT BARREL SAMPLER TO PENETRATE 0.3M INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5KG, FALLING FREELY A DISTANCE OF 0.76M FOR PENETRATIONS OF LESS THAN 0.3M. N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (31MM O.D. 60° CONE ANGLE) DRIVEN BY 1000 J IMPACT ENERGY ON 1" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF KSI/INCH FOR EACH 1" ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH c_u AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
Consistency	VERY SOFT	SOFT	FIAM	STIFF	VERY STIFF	HARD

DENSITY: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSITY AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/30cm)	0 - 3	3 - 10	10 - 30	30 - 50	> 50
Density	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100MM IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD) OF THE ROCK MODIFIED RECOVERY IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
Recovery	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 100mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MID CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

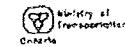
FIELD SAMPLING		MECHANICAL PROPERTIES OF SOIL	
S S SPLIT SPOON	T P THINWALL PISTON	m_v	COEFFICIENT OF VOLUME CHANGE
W S WASH SAMPLE	O S OSTERBERG SAMPLE	C_c	COMPRESSION INDEX
S T SLOTTED TUBE SAMPLE	R C ROCK CORE	C_s	SWELLING INDEX
B S BLOCK SAMPLE	P H T W ADVANCED HYDRAULICALLY	C_d	RATE OF SECONDARY CONSOLIDATION
C S CHUNK SAMPLE	P M T W ADVANCED MANUALLY	C_v	COEFFICIENT OF CONSOLIDATION
T W THINWALL OPEN	F S FOIL SAMPLE	H	DRAINAGE PATH
		T_v	TIME FACTOR
		U	DEGREE OF CONSOLIDATION
		σ'_{vo}	EFFECTIVE OVERBURDEN PRESSURE
		σ'_p	PRECONSOLIDATION PRESSURE
		τ_f	SHEAR STRENGTH
		c'	EFFECTIVE COHESION INTERCEPT
		ϕ'	EFFECTIVE ANGLE OF INTERNAL FRICTION
		c_u	APPARENT COHESION INTERCEPT
		ϕ_u	APPARENT ANGLE OF INTERNAL FRICTION
		τ_R	RESIDUAL SHEAR STRENGTH
		τ_f	REMOULDED SHEAR STRENGTH
		I_s	SENSITIVITY $= \frac{C_u}{C_c}$

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1	VOID RATIO	e_{min}	1	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1	POROSITY	I_D	1	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	N PERCENT - DIAMETER
P	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
Y	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ² /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX $= w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX $= \frac{w - w_p}{w_L - w_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX $= \frac{w_p - w}{w_L - w_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1	VOID RATIO IN LOOSEST STATE	j	kg/m ²	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						



Foundation Design

RECORD OF BOREHOLE No 1 1 OF 1 METRIC

W.P. 143-80-01 LOCATION Site 9-973.5 m/s 6.5m H/L from E of Hedder Ave
DIST 19 HWY 11 & 12 BOREHOLE TYPE HS Auger, Cane Test
DATUM Oseville DATE 91.08.14-15
ORIGINATED BY: JH
COMPILED BY: JH
CHECKED BY: JH

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DRAWING CONE PENETRATION RESISTANCE PLOT		WATER CONTENT (%)	UNIT WEIGHT	REMARKS
			NUMBER	TYPE			20 40 60 80 100	20 40 60 80 100			
281.8	Ground Surface										
0.0	Silty Sand, trace organic matter (fossil)		1	SS	15						
259.8			2	SS	21						
2.1	Het. Mixture of Silty Sand and Gravel, trace of clay occasional boulders Very Dense (Classical TB)		3	SS	100						
258.2			4	SS	100						
3.7			5	SS	100						
	Het. Mixture of Clayey Silty Sand and Gravel occasional boulders Hard (Classical TB)		6	SS	100						
			7	SS	55						
255.0			8	SS	100						
6.9	Sand with Gravel occasional boulders Very Dense		9	SS	100						
252.0			10	SS	100						
9.8	Het. Mixture of Silty Sand and Gravel occasional boulders Very Dense (Classical TB)		11	SS	100						
251.1			12	SS	100						
10.8	End of Borehole										

*2, *5, Numbers refer to 100% strain at failure

RECORD OF BOREHOLE No 2 1 OF 1 METRIC											
W.P. 143-99-01		LOCATION Site 91-973.5 m/s 5.5m W from E of Highway Ave				ORIGINATED BY M					
DIST 19 HWY 11 & 12		BOREHOLE TYPE HS Auger				COMPILED BY AS					
DATUM Geodetic		DATE 91 08 22				CHECKED BY JCS					
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE (MPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	7	GR SA SI CL
260.5	Ground Surface										
0.0	Silty Sand, trace of organic matter (fossil)		1	SS	7						
259.1											
1.4	Net. Mixture of Silty Sand and Gravel occasional boulders Very Dense (Clacial Till)		2	SS	58						
257.8											
2.7	Net. Mixture of Clayey Silty Sand and Gravel occasional boulders Hard (Clacial Till)		3	SS	100						
255.1											
5.4											
252.8											
7.7	End of Borehole										

+3, +5, Numbers refer to Sensitivity
20 15-25 (4) STRAIN AT FAILURE
10

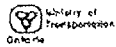
RECORD OF BOREHOLE No 3 1 OF 1 METRIC											
W.P. 143-99-01		LOCATION Site 10-000.0 m/s 5.5m W from E of Highway Ave				ORIGINATED BY M					
DIST 19 HWY 11 & 12		BOREHOLE TYPE HS Auger, SW Coring, BTL, Core, Borehole				COMPILED BY SD					
DATUM Geodetic		DATE 91 08 21-22				CHECKED BY JCK					
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE (MPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	7	GR SA SI CL
261.2	Ground Surface										
0.0	Sand, some silt and gravel Compact (FR)		1	SS	23						
260.0											
1.2	Net. Mixture of Silty Sand and Gravel occasional boulders Very Dense (Clacial Till)		2	SS	100						
258.9											
2.3	Net. Mixture of Clayey Silty Sand and Gravel occasional boulders Hard (Clacial Till)		3	SS	100						
257.7											
3.3											
254.2											
7.0											
254.2	Sand with Gravel occasional boulders Very Dense		4	SS	100						
252.0											
8.2	End of Borehole										

91 08 25
* GROUND WATER CONDITIONS
PIEZ. NO. 1 GROUND WATER ELEVATION (Metres) 259.7

+3, +5, Numbers refer to Sensitivity
20 15-25 (4) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4 1 OF 1 METRIC															
W.P. 143-90-01		LOCATION Sig 10+000.0, 0/8 0.5m W. from S. of Hoober Ave					ORIGINATED BY JH								
DIST 19		HWY 11 & 12		BOREHOLE TYPE HS Auger, BTL Core Barrel, Core Test			COMPILED BY AS								
DATUM Canadian		DATE 01.08.79					CHECKED BY								
SOIL PROFILE		SAMPLES		GROUND WATER		ELEVATION SCALE		DYNAMIC CONE PENETRATION		SHEAR STRENGTH		WATER CONTENT (%)		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLLOT	NUMBER	TYPE	VALUES	CONDITIONS	SCALE	20	40	60	80	100	10	20	30
261.8	Ground Surface														
0.0	Sand, some Silt and Gravel Compact (F ₈)		1	SS	23		261								
160.8			2	SS	100		250								
1.7	Med. Mixture of Silt, Sand and Gravel occasional boulders Very Dense (Gladet T ₈)		3	SS	100		250								
259.1			4	SS	100		250								
2.1	Med. Mixture of Clayey Silt, Sand and Gravel occasional boulders Hard (Gladet T ₈)		5	RC	100		250								
258.4			6	SS	100		250								
5.4			7	SS	100		250								
255.4			8	SS	100		250								
5.4	Sand with Gravel occasional boulders Very Dense		9	SS	100		250								
250.9			10	SS	100		250								
10.9	End of Borehole														
	RC-SS BTL Core Barrel used to penetrate boulders.														
	91.08.25 • GROUND WATER CONDITIONS														
	PIEZO. NO. 1														
	GROUND WATER ELEVATION (Metres) 258.8														

• 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 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422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 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822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000, 1001, 1002, 1003, 1004, 1005, 1006, 1007, 1008, 1009, 1010, 1011, 1012, 1013, 1014, 1015, 1016, 1017, 1018, 1019, 1020, 1021, 1022, 1023, 1024, 1025, 1026, 1027, 1028, 1029, 1030, 1031, 1032, 1033, 1034, 1035, 1036, 1037, 1038, 1039, 1040, 1041, 1042, 1043, 1044, 1045, 1046, 1047, 1048, 1049, 1050, 1051, 1052, 1053, 1054, 1055, 1056, 1057, 1058, 1059, 1060, 1061, 1062, 1063, 1064, 1065, 1066, 1067, 1068, 1069, 1070, 1071, 1072, 1073, 1074, 1075, 1076, 1077, 1078, 1079, 1080, 1081, 1082, 1083, 1084, 1085, 1086, 1087, 1088, 1089, 1090, 1091, 1092, 1093, 1094, 1095, 1096, 1097, 1098, 1099, 1100, 1101, 1102, 1103, 1104, 1105, 1106, 1107, 1108, 1109, 1110, 1111, 1112, 1113, 1114, 1115, 1116, 1117, 1118, 1119, 1120, 1121, 1122, 1123, 1124, 1125, 1126, 1127, 1128, 1129, 1130, 1131, 1132, 1133, 1134, 1135, 1136, 1137, 1138, 1139, 1140, 1141, 1142, 1143, 1144, 1145, 1146, 1147, 1148, 1149, 1150, 1151, 1152, 1153, 1154, 1155, 1156, 1157, 1158, 1159, 1160, 1161, 1162, 1163, 1164, 1165, 1166, 1167, 1168, 1169, 1170, 1171, 1172, 1173, 1174, 1175, 1176, 1177, 1178, 1179, 1180, 1181, 1182, 1183, 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1682, 1683, 1684, 1685, 1686, 1687, 1688, 1689, 1690, 1691, 1692, 1693, 1694, 1695, 1696, 1697, 1698, 1699, 1700, 1701, 1702, 1703, 1704, 1705, 1706, 1707, 1708, 1709, 1710, 1711, 1712, 1713, 1714, 1715, 1716, 1717, 1718, 1719, 1720, 1721, 1722, 1723, 1724, 1725, 1726, 1727, 1728, 1729, 1730, 1731, 1732, 1733, 1734, 1735, 1736, 1737, 1738, 1739, 1740, 1741, 1742, 1743, 1744, 1745, 1746, 1747, 1748, 1749, 1750, 1751, 1752, 1753, 1754, 1755, 1756, 1757, 1758, 1759, 1760, 1761, 1762, 1763, 1764, 1765, 1766, 1767, 1768, 1769, 1770, 1771, 1772, 1773, 1774, 1775, 1776, 1777, 1778, 1779, 1780, 1781, 1782, 1783, 1784, 1785, 1786, 1787, 1788, 1789, 1790, 1791, 1792, 1793, 1794, 1795, 1796, 1797, 1798, 1799, 1800, 1801, 1802, 1803, 1804, 1805, 1806, 1807, 1808, 1809, 1810, 1811, 1812, 1813, 1814, 1815, 1816, 1817, 1818, 1819, 1820, 1821, 1822, 1823, 1824, 1825, 1826, 1827, 1828, 1829, 1830, 1831, 1832, 1833, 1834, 1835, 1836, 183



Foundation Design

RECORD OF BOREHOLE No 6												1 OF 1		METRIC	
W.P. 143-90-01		LOCATION Sig 13+028.2, s/x 6.5m Lt. from E. of Hadder Ave				ORIGINATED BY W									
DIST 15		HWY 11 & 17		BOREHOLE TYPE HS Auger Core Test		COMPILED BY AG									
DATUM Candelle		DATE 91 08 28				CHECKED BY JOK									
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		SHEAR STRENGTH WPC		WATER CONTENT (%)		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT NUMBER	TYPE	W% VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH WPC	WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
261.5	Ground Surface														
0.0															
	Sands, some Silt and Gravel (Fie)														
	Compact														
259.8															
	1.0 Met. Mixture of Sil. Sand and Gravel (Stockp. TR)														
259.2	Very Dense														
	2.3 End of Borehole at probable bedrock														

3, 5, 10 Numbers refer to
15% (N) STRAIN AT FAILURE
10

ROCK CORE DESCRIPTION
WP 143-90-01

Page 1 of 1

CORE RECOVERY			CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% ROD*
5	4	2.59-3.20	100	33
	5	3.20-4.17	90	76
	6	4.17-4.32	100	83
	7	4.32-4.90	83	44
	8	4.90-5.56	100	73
	9	5.56-6.17	100	46
	10	6.17-6.48	100	33
	11	6.48-7.64	93	73
			DEPTH (m)	
			2.59-7.64	
			DESCRIPTION	
			CHERTY IRON FORMATION: chert with siderite (iron carbonate), granules of greenalite (iron silicate), and shale partings, greyish black to light olive grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures moderately close to extremely close spaced, flat to near vertical, undulating to planar, smooth.	

(NOTE: Depths are approximated where core recovery is less than 100%)

*CR = CORE RECOVERY
*ROD = ROCK QUALITY DESIGNATION

Logged by: DAW, Soils and Aggregates Section

Appendix D

Site Photographs

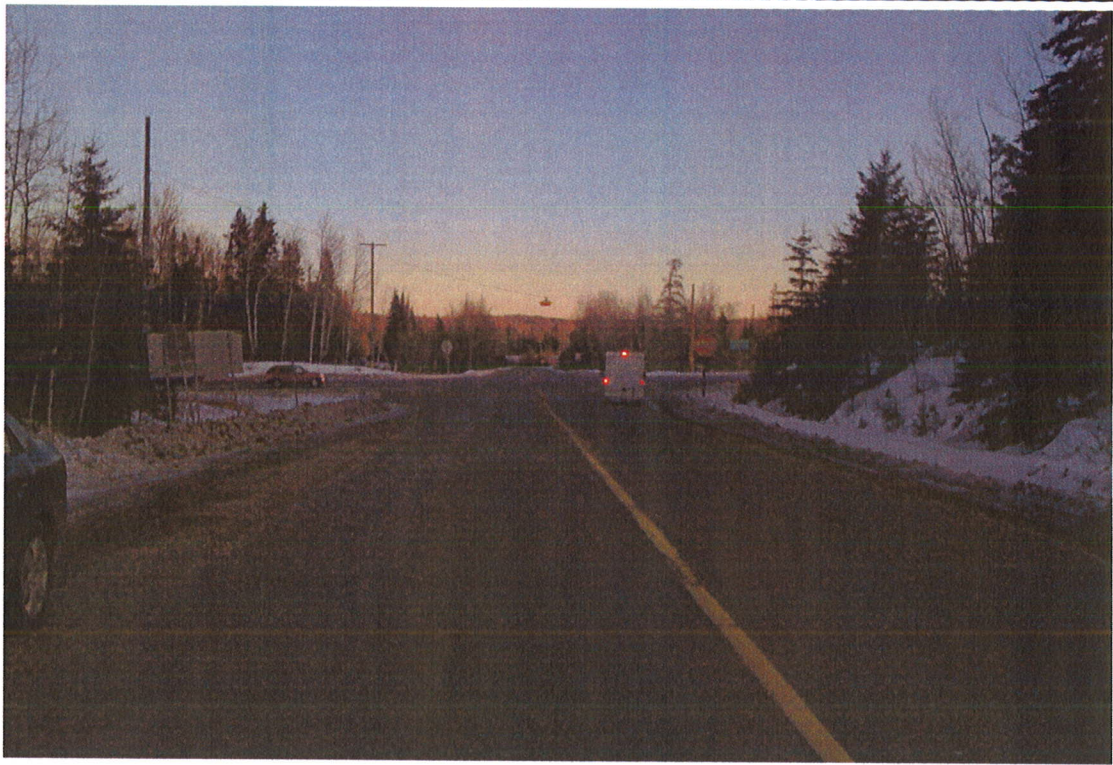


Photo 1 – Looking North on Hodder Avenue towards Hwy 11/17 intersection

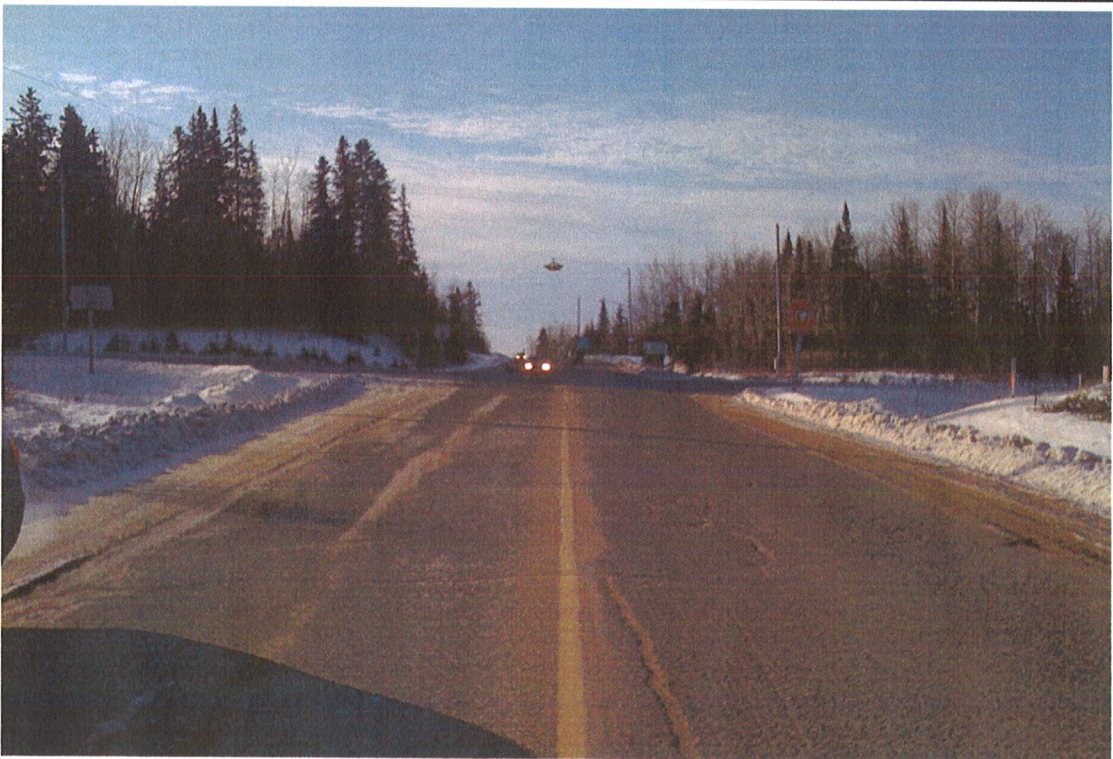


Photo 2 – Looking South on Copenhagen Road towards Hwy 11/17 intersection

Appendix E

Drawings

H 1:500
V 1:200

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

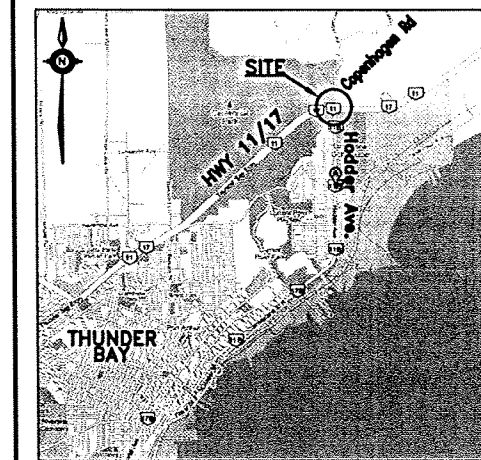
CONT No 2010-6001
GWP No 334-94-00

HIGHWAY 11/17
COPENHAGEN ROAD/
HODDER AVENUE BRIDGE
BOREHOLE LOCATIONS & SOIL STRATA

SHEET
272

MRC McCORMICK RANKIN
CORPORATION

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

- ◆ Borehole (Current Investigation)
- ◆ Borehole (Previous Investigation, 1991)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level
- W Head Artesian Water
- P Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

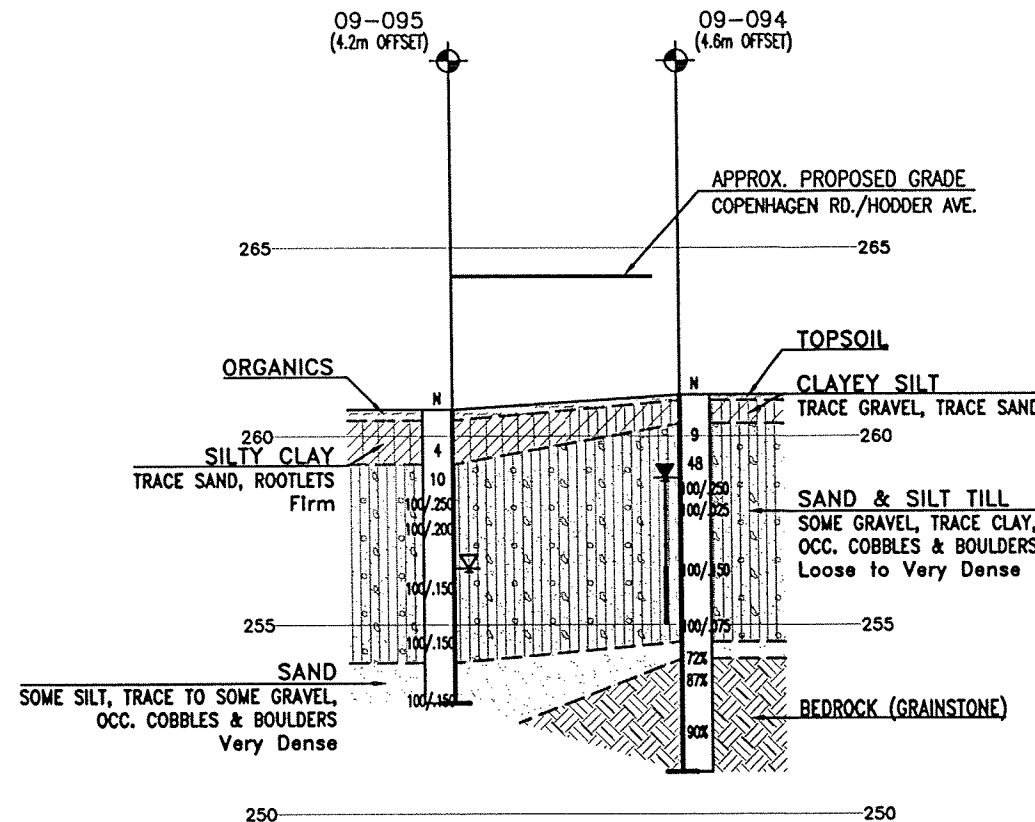
NO	ELEVATION	NORTHING	EASTING
01	261.9	5 372 010.9	365 255.9
02	260.5	5 372 010.9	365 268.9
03	261.2	5 371 984.4	365 255.9
04	261.8	5 371 984.4	365 269.1
05	260.5	5 371 957.9	365 256.1
06	261.5	5 371 958.0	365 269.1
09-047	260.4	5 372 030.9	365 262.0
09-091	261.4	5 371 937.9	365 262.7
09-092A	261.6	5 371 947.2	365 269.1
09-092B	260.2	5 371 947.2	365 256.1
09-093	261.4	5 371 953.4	365 262.6
09-094	261.1	5 372 019.4	365 254.2
09-095	260.7	5 372 019.2	365 269.2

NOTES

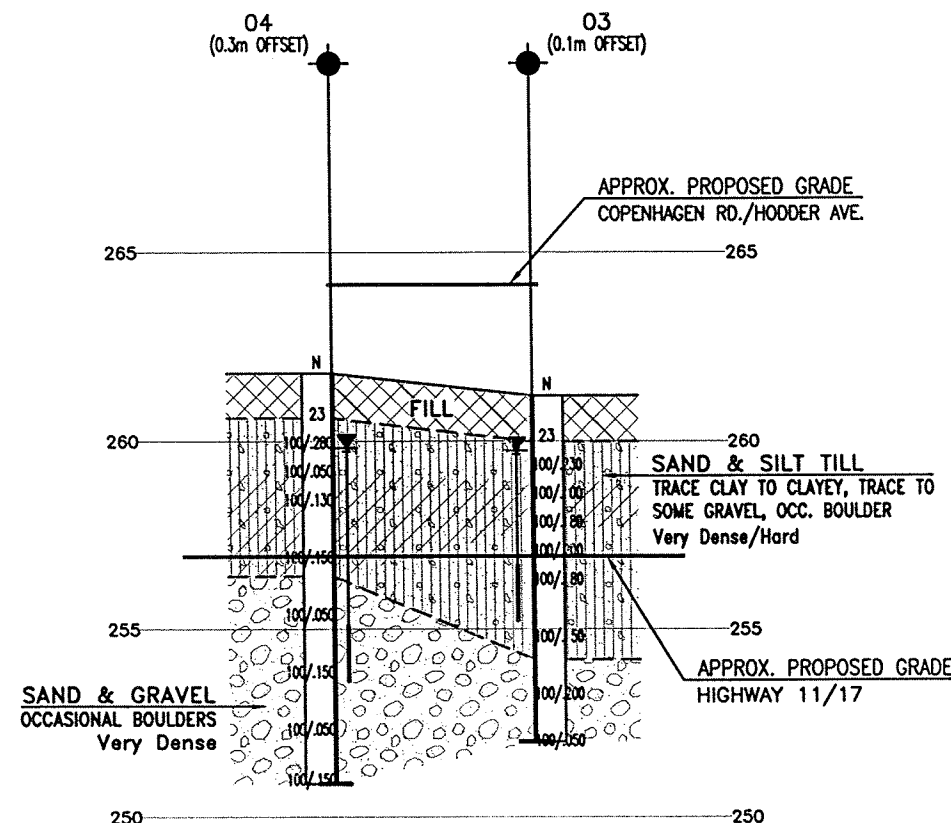
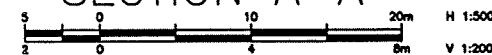
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEORES No. 52A-143

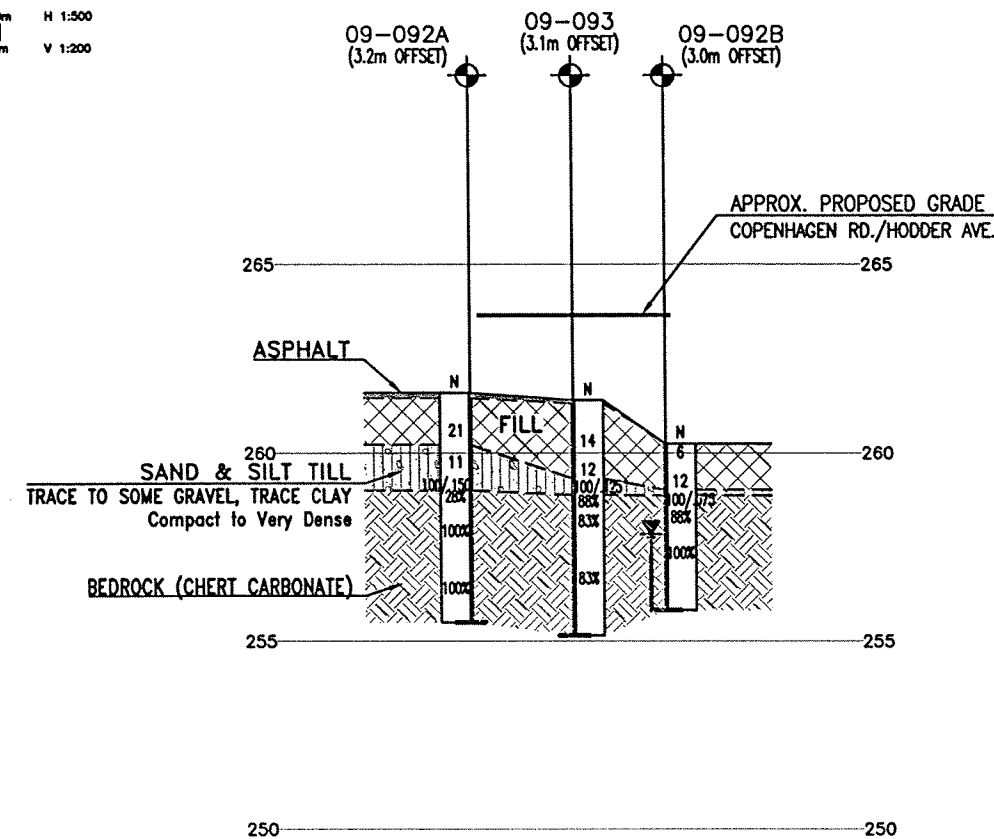
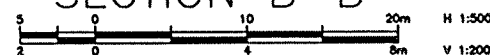
DATE	BY	DESCRIPTION
DESIGN	MRA	CHK AEG
DRAWN	MFA	CHK PKC
		SITE
		STRUCT
		DWG 2



SECTION A-A



SECTION B-B



SECTION C-C

