

**PRELIMINARY  
FOUNDATION INVESTIGATION REPORT  
ROSENDALE CREEK BRIDGES – EBL & WBL  
HIGHWAY 7 – NEW, KITCHENER TO GUELPH  
G.W.P. 408-88-00**

**Geocres Number: 40P8-201**

**Report to**

**Ministry of Transportation Ontario  
West Region**

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Memos\Rosendale Bridge (C6)\Rosendale Creek Bridge -  
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**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual findings obtained from a preliminary foundation investigation conducted for the proposed Rosendale Creek bridges along the proposed Highway 7-New mainline alignment in the Regional Municipality of Waterloo, Ontario. Two bridges are proposed to carry the westbound and eastbound lanes (WBL and EBL) of the Highway 7-New.

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 profiles, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions under the potential foundation footprint was developed from the data obtained in the course of the investigation.

The information collected in the course of the investigation and presented in this report is intended for preliminary design purposes only. Additional site investigation, field testing and engineering analysis will be required at the detailed design stage. The extent of the additional investigation will depend, in part, on the final location and General Arrangement of the structure.

Thurber carried out the investigation for the Ministry of Transportation Ontario, Southwestern Region (MTO) under Purchase Order Number 3006-E-0123.

**2 SITE DESCRIPTION**

At the site of the proposed Rosendale Creek bridges, the Highway 7-New alignment runs parallel to the existing Bridge Street (Regional Road 52), and approximately 90 m to the south. The site lies at the eastern edge of the City of Waterloo and it is approximately 1.3 Km west of Ebycrest Road (Regional Road 17).

The site lies within an area of agricultural lands and farmsteads. There are farmsteads to the east and north of the proposed EBL and WBL bridges and a gravel pit is located to the west.

Rosendale Creek flows from north to south and crosses the proposed Highway 7-New alignment near station 22+783. The Grand River is located approximately 400 m south of the bridge site.

A photograph of the site is included in Appendix C and shows the general nature of the surrounding lands.

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within an area referred to as the Guelph Drumlin Field, an area of drumlinized till plain, also mapped as containing eskers. The till is described as stony with boulders at the surface. Chapman and Putnam give a typical gradation of the till as being 50% sand, 35% silt and 15% clay. Swampy valleys are reported to occur between the drumlins and associated gravel terraces.

### 3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing was carried out on February 7, 2012 and consisted of drilling and sampling four boreholes (identified as RDC-1 to RDC-4) to depths of 9.3 m to 9.8 m (Elevations 297.5 to 296.0).

One borehole was located near each of the proposed abutments indicated in Table 3.1.

**Table 3.1 – Borehole location**

Foundation Element		Borehole
Hwy 7 EBL	West abutment	RDC-1
	East abutment	RDC-2
Hwy 7 WBL	West abutment	RDC-4
	East abutment	RDC-3

The Record of Borehole sheets are included in Appendix A. The approximate locations of the four boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D.

Prior to commencing the site investigation, clearance was obtained from utility companies having plant in the area. MTO obtained Permissions to Enter (PTE) the two properties where the boreholes were located.

A member of Thurber's technical staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

A CME-75 track-mounted drill rig was used at this site and solid stem augers were used to advance the boreholes. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils.

Groundwater conditions were observed in the open boreholes during the drilling operations. A standpipe piezometer was installed in Borehole RDC-4 to permit longer term groundwater level monitoring. The standpipe piezometer consisted of 25 mm diameter PVC pipe with a slotted

screen enclosed in filter sand. The boreholes were backfilled with bentonite holeplug in general accordance with O.Reg. 903 upon completion. The locations and completion details of the boreholes and piezometer are presented in Table 3.2.

**Table 3.2 – Borehole Borehole Abandonment Details**

<b>Borehole</b>	<b>Piezometer Tip Depth/ Elevation (m)</b>	<b>Abandonment Details</b>
RDC-1	No installation	Borehole caved to 7.2 m. Borehole backfilled with bentonite holeplug from 7.2 m to 1.6 m, then auger cuttings to surface.
RDC-2	No installation	Borehole caved to 3.8 m. Borehole backfilled with bentonite holeplug from 3.8 m to 1.1 m, then auger cuttings to surface.
RDC-3	No installation	Borehole caved to 6.6 m. Borehole backfilled with bentonite holeplug from 6.6 m to 2.2 m, then auger cuttings to surface.
RDC-4	9.0 / 298.1	Piezometer with 1.5 m slotted screen installed. Sand filter from 9.0 m to 6.9 m, bentonite holeplug from 6.9 m to 1.8 m, then auger cuttings to surface.

#### **4 LABORATORY TESTING**

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

#### **5 DESCRIPTION OF SUBSURFACE CONDITIONS**

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil stratigraphy along the proposed bridge alignments are presented in this appendix and on the “Borehole Locations and Soil Strata” drawings in Appendix D. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the stratigraphy encountered at this site consists of a layer of topsoil overlying native clayey silt which is underlain by deposits of sand and silt and sand and silt till. Below the sand and silt till, native silty clay to clayey silt tills were encountered. A layer of silt till was encountered below the silty clay till in Borehole RDC-2, drilled at the east abutment of the Hwy 7 EBL.

### **5.1 Topsoil**

A layer of topsoil was encountered surficially in all four boreholes drilled at this site. This topsoil layer was black in colour. It contained some roots and rootlets and was described as clayey.

The thickness of topsoil ranged from 100 mm to 400 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 Clayey Silt**

A thin layer of clayey silt layer was encountered below the topsoil in all four boreholes. The clayey silt was brown in colour and contained some sand, trace gravel, and occasional roots and rootlets.

The thickness of the clayey silt ranged from 0.3 m to 0.8 m, with the lower boundary of the layer encountered at depths of 0.7 m to 0.9 m (Elevations 306.2 to 305.1).

SPT N-values recorded in the clayey silt ranged from 1 to 5 blows for 0.3 m penetration, indicating a very soft to firm consistency.

Moisture contents of samples of the clayey silt ranged from 23% to 34%.

### **5.3 Silt and Sand**

A layer of brown silt and sand was encountered below the clayey silt at 0.8 m and 0.9 m depth (elevations 305.7 and 306.2) in Boreholes RDC-1 and RDC-4, respectively. Both boreholes were drilled at the west abutments of the Hwy 7-New EBL and WBL. The silt and sand layer contained some clay to clayey and trace gravel.

The silt and sand layer was 1.5 m thick in Borehole RDC-1 and 1.3 m thick in Borehole RDC-4, with the lower boundary of the silt and sand layer encountered at depths of 2.3 m and 2.2 m (Elevations 304.2 and 304.9) in Boreholes RDC-1 and RDC-4, respectively.

SPT N-values recorded in the silt and sand ranged from 5 to 9 blows for 0.3 m penetration, indicating a loose relative density.

The moisture content of samples of the silt and sand layer ranged from 12% to 18%.

One sample from the silt and sand layer was selected for laboratory gradation analysis testing, the results of which are summarized below. These results are also included on the Record of Borehole sheets included in Appendix A. The grain size distribution curve for the sand and silt sample is plotted on Figure B1, Appendix B.

Soil Particles	Sand and Silt (%)
Gravel	2
Sand	44
Silt	36
Clay	18

#### 5.4 Silt and Sand Till

Brown silt and sand till containing some clay and trace to some gravel was contacted in all the boreholes at depths and elevations indicated in Table 5.1.

**Table 5.1 – Depths and Elevations of Sand and Gravel**

Foundation Unit		Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
Hwy 7 EBL	West abutment	RDC-1	2.3 to 5.7	304.2 to 300.8	3.4
	East abutment	RDC-2	0.7 to 6.7	305.1 to 299.1	6.0
Hwy 7 WBL	East abutment	RDC-3	0.8 to 9.3 (borehole termination depth)	305.1 to 296.6	8.5
	West abutment	RDC-4	2.2 to 7.2	304.9 to 299.9	5.0

SPT N-values recorded in the silt and sand till ranged from 13 blows for 0.3 m penetration to 100 blows for less than 0.3 m penetration, indicating a compact to very dense relative density. In general, the relative density of the silt and sand till increased with depth. Although not encountered in the boreholes, glacial tills inherently contain cobbles and boulders which may account for some high blow counts.

Moisture contents of samples of the silt and sand till ranged from 7% to 15%.

Five samples of the silt and sand till underwent laboratory grain size analysis testing, the results of which are presented below. These results are also summarized on the Record of Borehole sheets included in Appendix A and the grain size distribution curves for these samples are plotted on Figure B2, Appendix B.

Soil Particles	Silt and Sand Till
Gravel (%)	2 to 11
Sand (%)	31 to 41
Silt (%)	36 to 50
Clay (%)	13 to 20

### 5.5 Clayey Silt to Silty Clay Till

Clayey silt to silty clay till was encountered below the silt and sand till in Boreholes RDC-1, RDC-2 and RDC-4 at 5.7 m, 6.7 m and 7.2 m depth (elevations 300.8, 299.1 and 299.9), respectively. The silty clay till was grey and contained some sand to sandy and trace gravel.

The silty clay till was 1.7 m thick in Borehole RDC-2, with the lower boundary encountered at a depth of 8.4 m (Elevation 297.4). Boreholes RDC-1 and RDC-4 were terminated within the clayey silt/silty clay till at depths of 9.3 m and 9.6 m (Elevations 297.2 and 297.5), respectively.

SPT N-values measured in the clayey silt till/silty clay till were 100 blows for less than 0.3 m penetration, indicating a hard consistency. Although not encountered in the boreholes, glacial tills inherently contain cobbles and boulders which may account for some high blow counts.

The moisture content of samples of the clayey silt till/silty clay till ranged from 10% to 12%.

Selected samples of the clayey silt/silty clay till underwent laboratory grain size analysis and Atterberg Limits testing. These results are summarized on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figure B3 of Appendix B and the results of the Atterberg Limits tests are plotted on Figure B4. The results of these tests are as follows:

Soil Particles	Clayey silt/silty clay till (%)
Gravel	1 to 3
Sand	20 to 30
Silt	31 to 44
Clay	25 to 44

Index Property	(%)
Liquid Limit	20 to 29
Plastic Limit	11 to 13
Plasticity Index	9 to 16

The results of the Atterberg Limits tests indicate that the silty clay till is low plastic with a group symbol of CL.



## 5.6 Silt Till

A layer of silt till was encountered below the silty clay till, at 8.4 m depth (elevation 297.4) in Borehole RDC-2, drilled at the Hwy-7 New EBL east abutment. The silt till was grey in colour and contained trace sand and gravel.

The silt till was not fully penetrated and Borehole RDC-2 was terminated at a depth of 9.8 m (Elevation 296.0).

A single SPT N-value, of 65 blows for 0.3 m penetration, was recorded in the silt till, indicating a very dense relative density.

The moisture content of a sample of the silt till was measured to be 14%.

## 5.7 Groundwater Conditions

Water levels were observed in the boreholes upon completion of drilling. One standpipe piezometer was installed at this site, in Borehole RDC-4, to monitor water levels after completion of drilling. The water levels measured in the piezometer are summarized in Table 5.2, along with the measurements in the open boreholes upon completion of drilling.

**Table 5.2 – Water Level Measurements**

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RDC-1	Feb. 7, 2012	3.2	303.3	Open borehole
RDC-2	Feb. 7, 2012	0.8	305.0	Open borehole
RDC-3	Feb. 7, 2012	1.9	304.0	Open borehole
RDC-4	Feb. 8, 2012	0.8	306.3	Piezometer
	Feb. 27, 2012	5.6	301.5	Piezometer
	Apr. 17, 2012	2.4	304.7	Piezometer

The groundwater level measured in the piezometer was about 2.4 m below the ground surface (elevation 304.7).

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.

Boreholes RDC-2 and RDC-3 caved-in to 3.8 m and 6.6 m depth, respectively, upon completion of drilling.

The General Arrangement (GA) drawings provided by MMM Group Limited indicate that the water levels at Rosendale Creek are estimated to be at following elevations:

- 100-year water level – 306.23
- 2-year water level – 305.85

## 6 MISCELLANEOUS

DBW Drilling of Ajax, Ontario supplied a CME75 track-mounted drill rig and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. Stephane Loranger, C.E.T. of Thurber.

The coordinates for the boreholes and the ground surface elevations were obtained by Thurber Engineering Ltd. using GPS equipment.

Overall supervision of the field program was conducted by Ms. Lindsey Blaine, E.I.T. Interpretation of the data and preparation of the report were carried out by Ms. Lindsey Blaine, E.I.T and Ms. R. Palomeque Reyna, P.Eng.

Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.

Thurber Engineering Ltd.

*L. Blaine Oct 31/12*

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Review Principal, Designated MTO Contact



## **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 <sup>(1)</sup> '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
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

## EXPLANATION OF ROCK LOGGING TERMS

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

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			<u>Field Estimation of Hardness*</u>
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	Approximate Uniaxial Compressive Strength (psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
<u>TERMS</u>		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.				
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

RECORD OF BOREHOLE No RDC-1

1 OF 2

METRIC

W.P. 408-88-00 LOCATION N 4 816 212.1 E 228 480.9 ORIGINATED BY SLL  
HWY 7 - New BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2012.02.07 - 2012.02.07 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
306.5 0.0	TOPSOIL: (150mm)											
0.2	Clayey SILT, some sand, trace gravel Soft Brown		1	SS	3		306					
305.7 0.8	SILT and SAND, some clay, trace gravel Loose Brown Moist		2	SS	9		305					
			3	SS	6							2 44 36 18
304.2 2.3	SILT and SAND, some clay, trace to some gravel Dense to Very Dense Brown Moist (TILL)		4	SS	35		304					
			5	SS	47		303					
							302					
	Grey		6	SS	68							
300.8							301					
5.7	Clayey SILT to Silty CLAY, sandy, trace gravel Hard Grey (TILL)		7	SS	100/ 0.250		300					
							299					
			8	SS	100/ 0.225							1 30 44 25
							298					
297.2 9.3	END OF BOREHOLE AT 9.3m. BOREHOLE OPEN TO 7.2m AND WATER LEVEL AT 3.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH		9	SS	100/ 0.150							

Continued Next Page

+ 3, X 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

## METRIC

[illegible]

Continued From Previous Page

BENTONITE HOLEPLUG TO 1.6m,  
THEN AUGER CUTTINGS TO  
SURFACE.



# RECORD OF BOREHOLE No RDC-2

1 OF 2

METRIC

W.P. 408-88-00 LOCATION N 4 816 223.2 E 228 517.6 ORIGINATED BY SLL  
 HWY 7 - New BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.02.07 - 2012.02.07 CHECKED BY LRB

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 <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
305.8								20 40 60 80 100	○ UNCONFINED      + FIELD VANE	20 40 60				
0.0	TOPSOIL, occasional peaty, organics, occasional roots and rootlets		1	SS	1				● QUICK TRIAXIAL      × LAB VANE					
305.4	Black Moist (400mm)													
0.4														
305.1	Clayey SILT, occasional rootlets		2	SS	23		305							
0.7	Soft Brown													
	SILT and SAND, some clay, trace gravel													
	Compact Brown Moist (TILL)		3	SS	21		304						8 41 38 13	
			4	SS	24		303							
	Very Dense Grey		5	SS	71		302						2 33 50 15	
			6	SS	90		301							
			7	SS	100/ 0.275		300							
299.1	Silty CLAY, some sand to sandy, trace gravel						299							
6.7	Hard Grey (TILL)		8	SS	100/ 0.075		298						3 25 31 41	
297.4	SILT, trace sand and gravel						297							
8.4	Very Dense Grey Moist (TILL)		9	SS	65									
296.0														
9.8	END OF BOREHOLE AT 9.8m													

Continued Next Page

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No RDC-2**

**2 OF 2**

**METRIC**

W.P. 408-88-00 LOCATION N 4 816 223.2 E 228 517.6 ORIGINATED BY SLL  
 HWY 7 - New BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.02.07 - 2012.02.07 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>				
	Continued From Previous Page BOREHOLE CAVED TO 3.8m AND WATER LEVEL AT 0.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.1m, THEN AUGER CUTTINGS TO SURFACE.													

## METRIC

W.P.	408-88-00	LOCATION	N 4 816 244.4 E 228 491.9	ORIGINATED BY	SLL
HWY	7 - New	BOREHOLE TYPE	Solid Stem Augers	COMPILED BY	AN
DATUM	Geodetic	DATE	2012.02.07 - 2012.02.07	CHECKED BY	LRB

[illegible]

20  
15 5  
10 (%) STRAIN AT FAILURE

## METRIC

[illegible]

# RECORD OF BOREHOLE No RDC-4

1 OF 2

METRIC

W.P. 408-88-00 LOCATION N 4 816 233.0 E 228 455.7 ORIGINATED BY SLL  
 HWY 7 - New BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.02.07 - 2012.02.07 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE			
									WATER CONTENT (%)			
307.1 0.0 0.1	TOPSOIL, occasional roots and rootlets. (100mm)  Clayey SILT, trace rootlets Firm Brown		1	SS	5							
306.2 0.9	SILT and SAND, some clay to clayey, trace gravel Loose Brown Moist to Wet		2	SS	6							
			3	SS	5							
304.9 2.2	SILT and SAND, some clay, trace gravel Very Dense Brown Moist (TILL)       Grey		4	SS	50							
			5	SS	59							5 31 44 20
			6	SS	100/ 0.200							
			7	SS	100/ 0.175							
299.9 7.2	Silty CLAY, some sand, trace gravel Hard Grey (TILL)		8	SS	100/ 0.275							2 20 34 44
			9	SS	100/ 0.275							
297.5 9.6	END OF BOREHOLE AT 9.6m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe											

Continued Next Page

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RDC-4

2 OF 2

METRIC

W.P. 408-88-00 LOCATION N 4 816 233.0 E 228 455.7 ORIGINATED BY SLL  
HWY 7 - New BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2012.02.07 - 2012.02.07 CHECKED BY LRB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL											
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa																
	Continued From Previous Page with a 1.52m slotted screen.																							
	<p>WATER LEVEL READINGS:</p> <table border="1"> <thead> <tr> <th>DATE</th> <th>DEPTH (m)</th> <th>ELEV. (m)</th> </tr> </thead> <tbody> <tr> <td>Feb.08/12</td> <td>0.8</td> <td>306.3</td> </tr> <tr> <td>Feb.27/12</td> <td>5.6</td> <td>301.5</td> </tr> <tr> <td>Apr.17/12</td> <td>2.4</td> <td>304.7</td> </tr> </tbody> </table>	DATE	DEPTH (m)	ELEV. (m)	Feb.08/12	0.8	306.3	Feb.27/12	5.6	301.5	Apr.17/12	2.4	304.7											
DATE	DEPTH (m)	ELEV. (m)																						
Feb.08/12	0.8	306.3																						
Feb.27/12	5.6	301.5																						
Apr.17/12	2.4	304.7																						

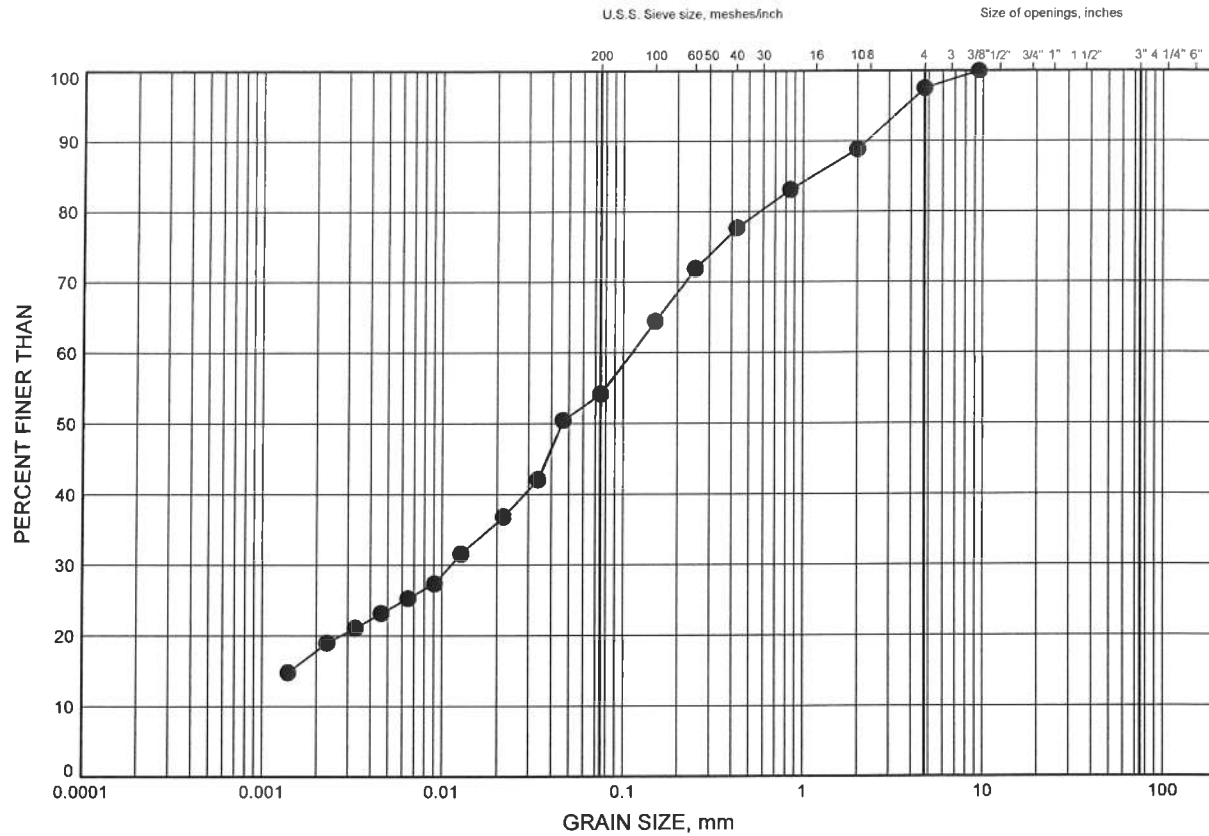
## **Appendix B**

### **Laboratory Test Results**

# Highway 7 - New - Rosendale Creek GRAIN SIZE DISTRIBUTION

FIGURE B1

## SILT & SAND



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

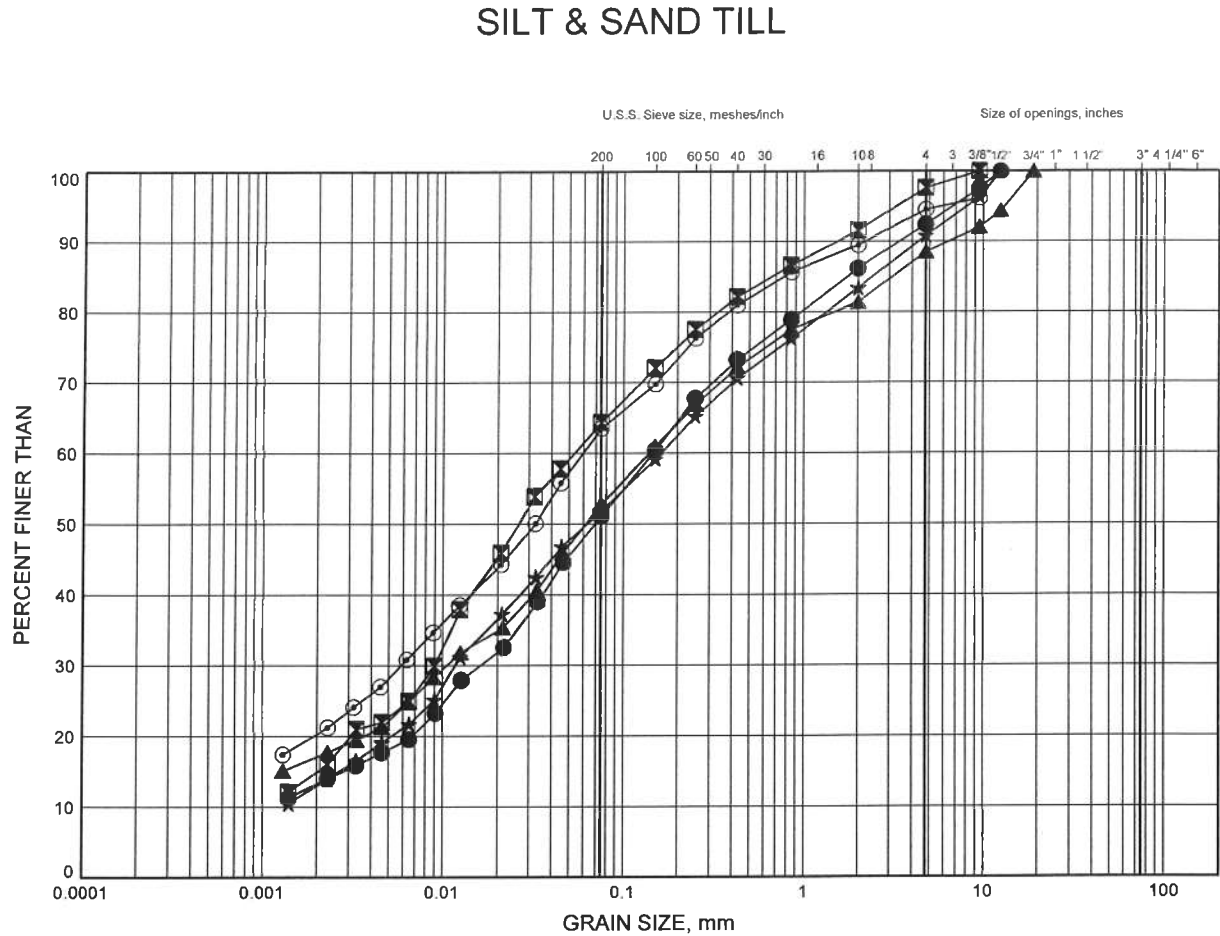
### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RDC-1	1.83	304.67



# Highway 7 - New - Rosendale Creek GRAIN SIZE DISTRIBUTION

FIGURE B2



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

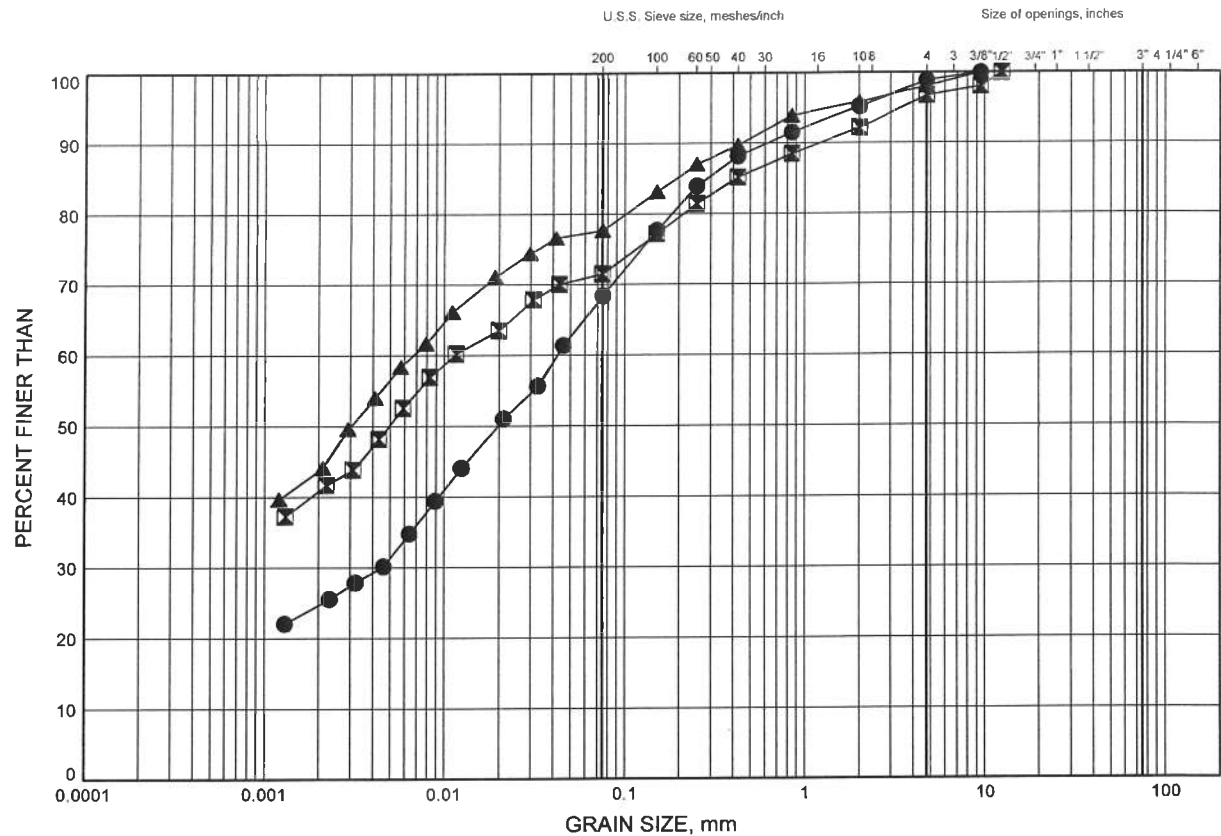
### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RDC-2	1.83	303.97
⊠	RDC-2	3.30	302.50
▲	RDC-3	1.98	303.92
★	RDC-3	4.88	301.02
⊙	RDC-4	3.35	303.75

# Highway 7 - New - Rosendale Creek GRAIN SIZE DISTRIBUTION

FIGURE B3

### CLAYEY SILT TILL to SILTY CLAY TILL



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

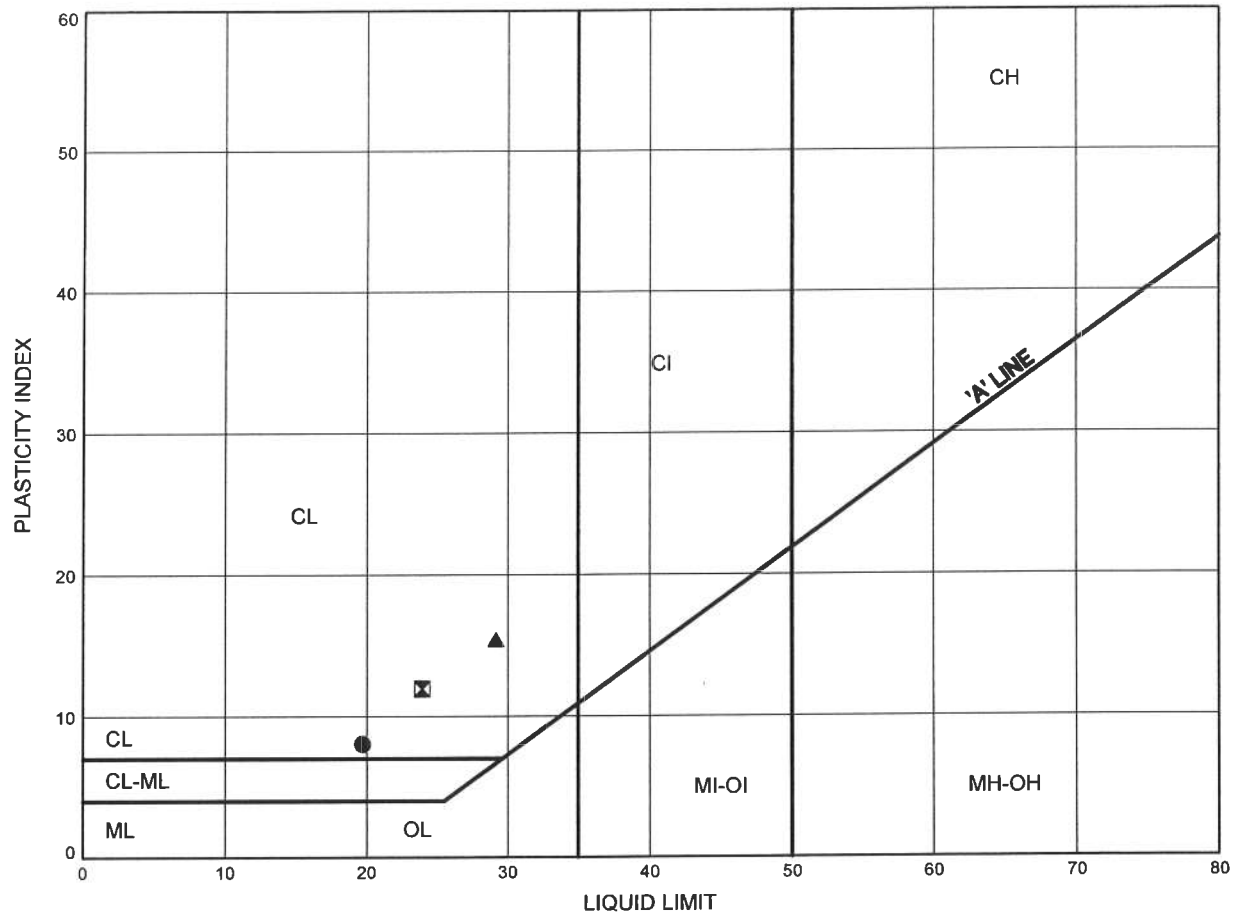
### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RDC-1	7.81	298.69
⊠	RDC-2	7.80	298.00
▲	RDC-4	7.85	299.25

Highway 7 - New - Rosendale Creek  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B4

CLAYEY SILT TILL to SILTY CLAY TILL



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RDC-1	7.81	298.69
⊠	RDC-2	7.80	298.00
▲	RDC-4	7.85	299.25

## **Appendix C**

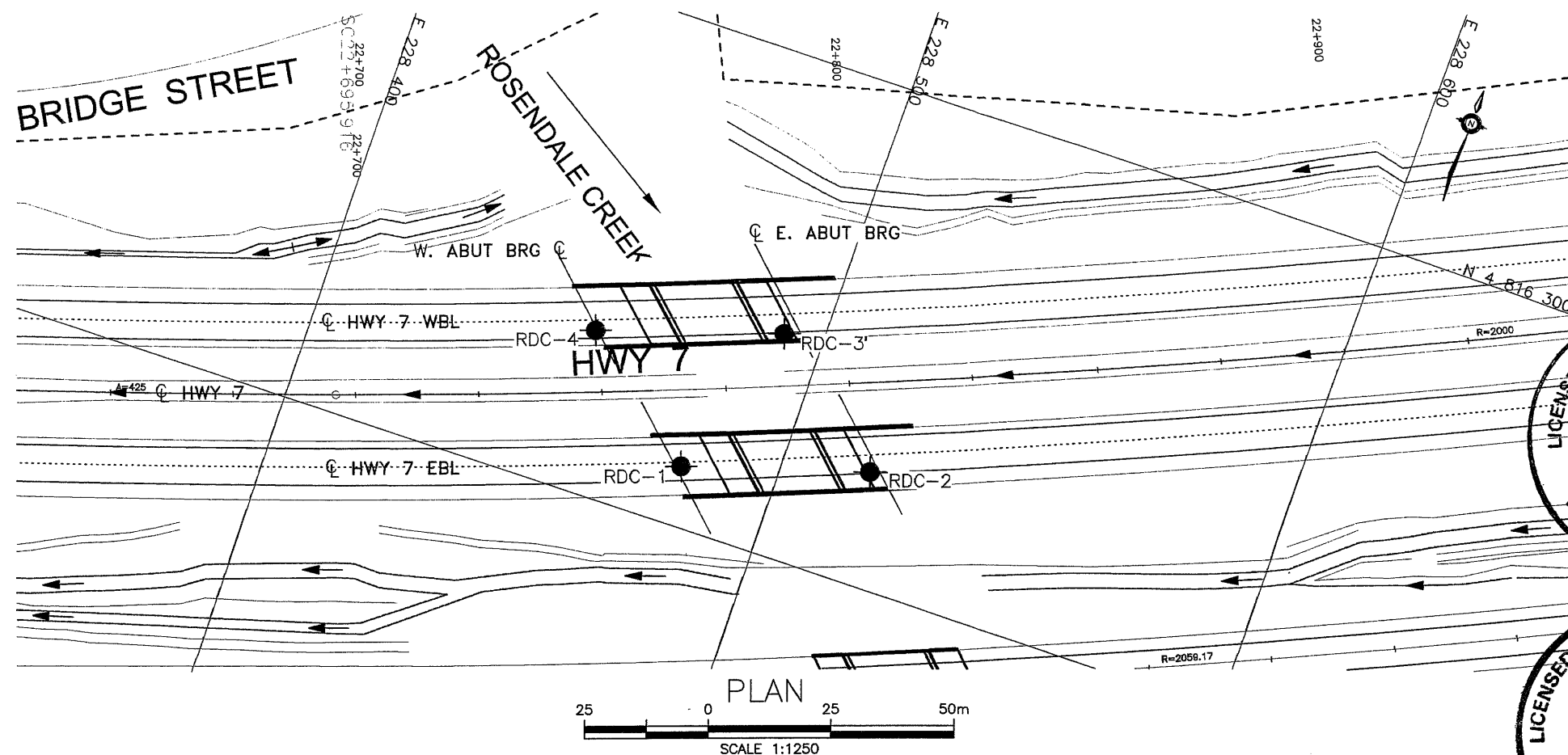
### **Site Photographs**



**Photo 1.** Site of proposed Rosendale Creek bridges - looking south from Bridge Street E

## **Appendix D**

**Drawing titled “Borehole Locations and Soil Strata”**



## METRIC

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



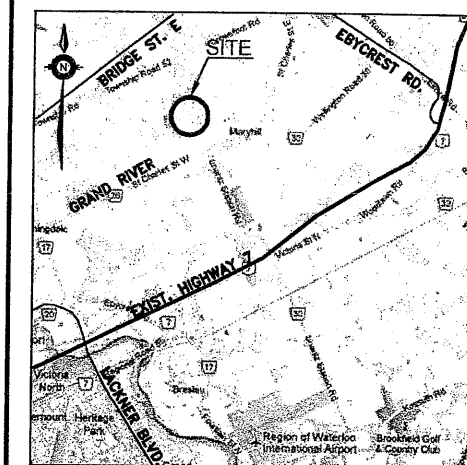
CONT No  
WP No 408-88-00

HIGHWAY 7 NEW  
ROSENDALE CREEK BRIDGES  
EBL & WBL  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET








**THURBER ENGINEERING LTD**



## KEYPLAN

### LEGEND

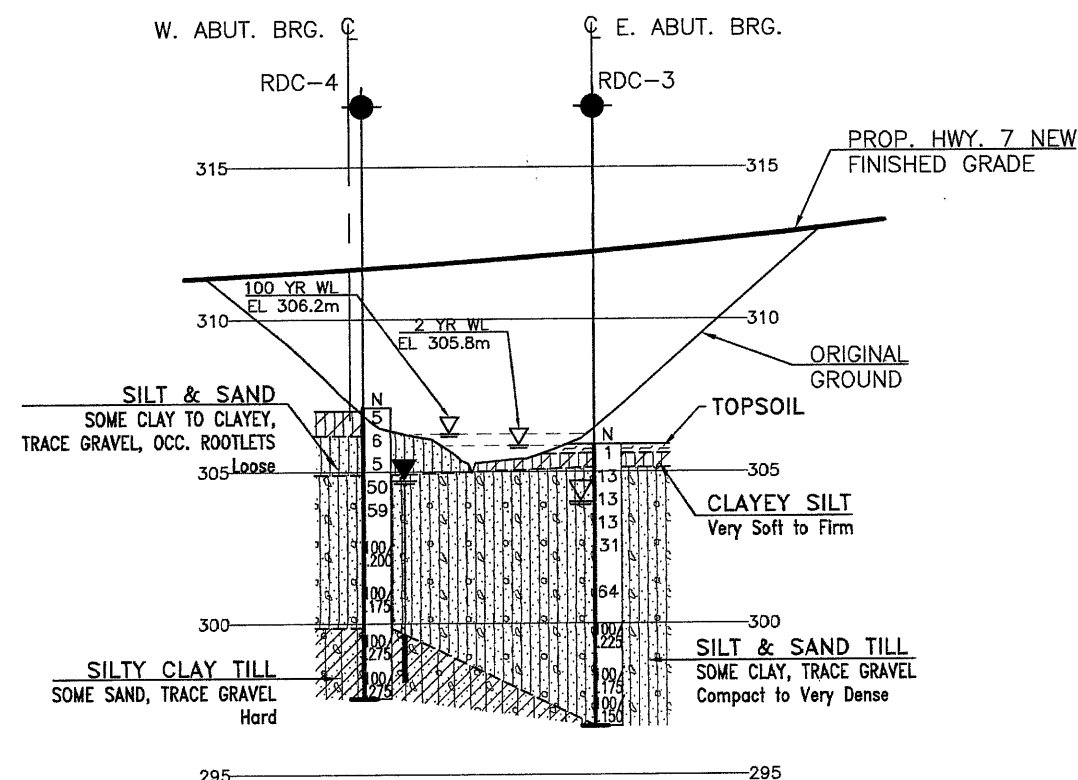
- |   |                                       |
|---|---------------------------------------|
|  | Borehole                              |
|  | Borehole and Cone                     |
| N   | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE  | Blows /0.3m (60° Cone, 475J/blow)     |
| PH  | Pressure, Hydraulic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

NO	ELEVATION	NORTHING	EASTING
RDC-1	306.5	4 816 212.1	228 480
RDC-2	305.8	4 816 223.2	228 517
RDC-3	305.9	4 816 244.4	228 491
RDC-4	307.1	4 816 233.0	228 455

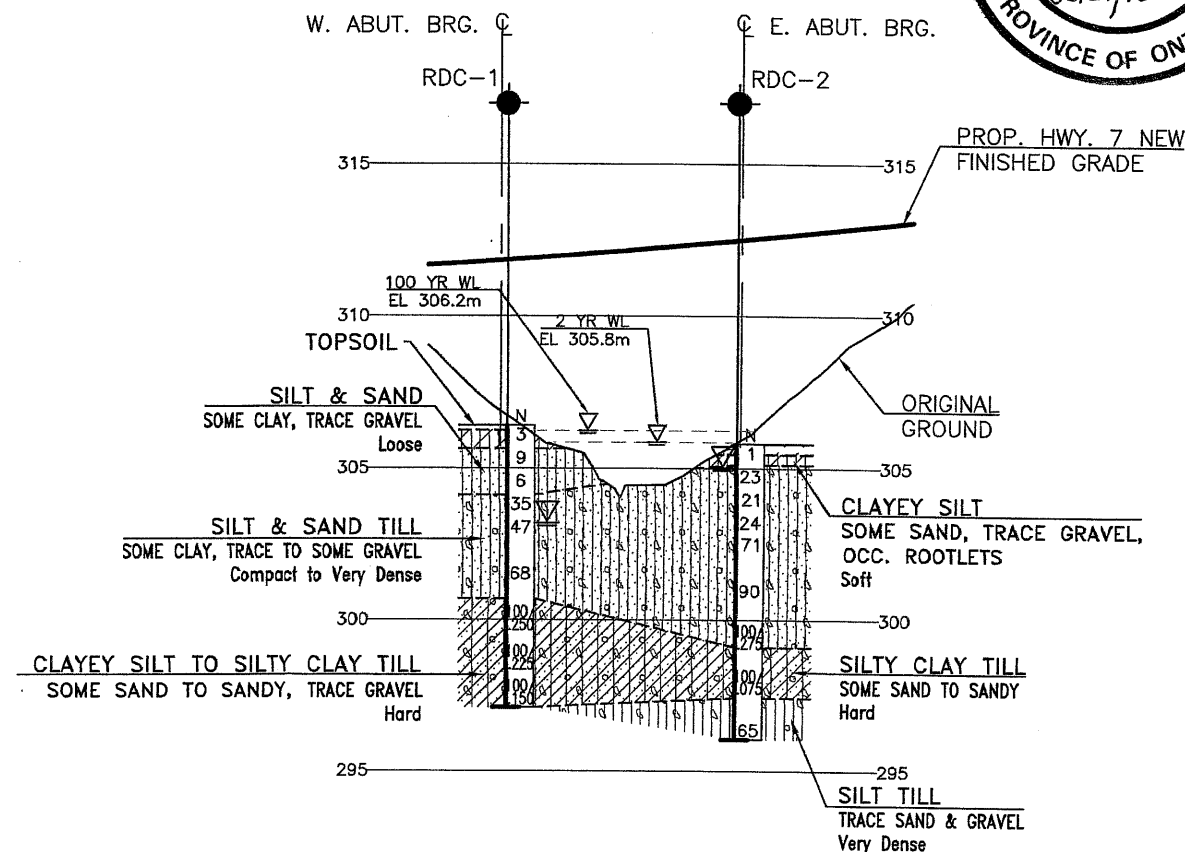
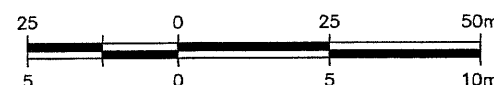
-NOTES-

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

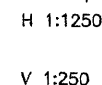
GEOCRES No. 40P8-201



PROFILE ALONG C HWY 7 WBL



PROFILE ALONG C HWY 7 EBL



REVISIONS									
	DATE	BY				DESCRIPTION			
DESIGN	LRB	CHK	LRB	CODE		LOAD		DATE	OCT. 20
DRAWN	AN	CHK		SITE		INSTRCT	INWG	1	