TUNNELLING INVESTIGATION REPORT
STORM SEWER OUTLETS TO BRONTE CREEK
QEW BRONTE CREEK TWIN BRIDGE

W.P. 2264-03-01

Geocres Number: 30M5-236

Report to

McCormick Rankin Corporation

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual information obtained from a tunnelling investigation conducted at the proposed locations of new storm sewer outlets to Bronte Creek adjacent to the proposed QEW twin bridge in Oakville, Ontario.

The proposed storm sewers will be installed down the slopes of the Bronte Creek valley with drops of about 24 and 25 m on the west and east sides of the valley, respectively.

The purpose of the investigation was to explore the subsurface conditions at the outlet locations and, based on the data obtained, to provide borehole logs, borehole location plans, stratigraphic profiles, and written descriptions of the subsurface conditions. A model of the subsurface conditions was developed through interpretation of the data obtained in the course of the present investigation.

Thurber Engineering Ltd. (Thurber) carried out the investigation as a sub-consultant to McCormick Rankin Corporation (MRC), under the Ministry of Transportation Ontario (MTO) Agreement Number 2005-A-000346.

2 SITE DESCRIPTION

The proposed sewer outlet sites are located approximately 35 and 50 m south of the existing structure carrying the QEW over Bronte Creek. Bronte Road runs along the east valley slope of Bronte Creek and passes under the QEW through the second from east span of the existing bridge.

The creek valley is incised approximately 25 m below the surrounding tableland. The valley slopes are steep and, at a bend in the creek a short distance to the south, a near-vertical bluff is eroded in the shale bedrock. The width of the valley at the site is approximately 200 m crest-to-crest. The creek is about 20 m wide with a normal water level near elevation 90.0m and a 100-year high level at elevation 91.3m.

Drainage at the site flows down the valley slopes and directly into Bronte Creek, which flows southward to Lake Ontario. A storm sewer outfall exists at the toe of the east valley slope approximately 50 m south of the QEW bridge. Present on the opposite bank is a concrete structure that appears to be a former bridge abutment with a storm outfall in the face.

The lands north of the QEW are occupied by Bronte Creek Provincial Park west of Bronte Road, and by Deerfield Golf Course east of Bronte Road. To the south of the QEW, the lands are developed for commercial and industrial uses.

3 INVESTIGATION PROCEDURES

3.1 Field Investigation

The site investigation and field testing for this project were carried out between September 4 and 22, 2005 and consisted of drilling seven boreholes at selected locations along the alignment of the proposed storm sewers. The boreholes were extended to depths ranging from 4.2 to 24.1 m using both soil drilling and rock coring procedures. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing in Appendix C.

The proposed borehole locations were staked in the field and ground elevations were provided by J.D. Barnes Limited surveyors. Where site access conditions required repositioning of boreholes, the revised borehole location and elevation were estimated by Thurber field personnel relative to the staked location.

DBW Drilling Limited supplied and operated the drilling and sampling equipment used for the investigation. Solid stem augers were used to advance the boreholes and samples were obtained using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Rock coring operations were carried out using a diamond bit NQ core barrel.

A member of Thurber's technical staff supervised the drilling and sampling operations on a full time basis. The supervisor recorded the borehole stratigraphy, logged the recovered samples, and transported the labelled samples to Thurber's office. The groundwater conditions in the boreholes were observed during drilling.

Standpipe piezometers consisting of 19 mm PVC pipe were installed in all boreholes to monitor groundwater levels. The piezometer installation details are shown on the borehole logs, Appendix A. The boreholes were backfilled with bentonite grout to the ground surface.

Packer testing was carried out at three intervals to evaluate the bulk permeability of the rock mass. The packer testing involved flushing the borehole with clean water to clear the borehole sidewalls, lowering the double-packer test assembly to the selected depth interval, inflating the packers, and recording the rate of water flow into the bedrock between the packers over sequential time periods for a series of different chamber pressures. The results of the packer tests are presented in Appendix A.

3.2 Laboratory Testing

All recovered soil samples were subjected to visual identification 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 subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing where appropriate. The test results are shown on the Record of Borehole sheets in Appendix A and on the figures in Appendix B.

All recovered cores of the shale bedrock were visually examined in the laboratory to confirm and supplement the field descriptions. Selected core samples were also subjected to unconfined compressive strength (UCS) and swell testing. The test results are shown on the Record of Borehole sheets in Appendix A and on the figures in Appendix B. Point Load tests conducted on the cores were not representative since the cores would easily split along the bedding planes at very low loads.

4 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 General

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets in Appendix A and the Borehole Locations and Soil Strata Drawing in Appendix C. A generalized description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the borehole logs takes precedence over this general description and interpretation of the site conditions. Subsurface conditions may vary between borehole locations.

In general terms, the soil stratigraphy encountered along the sewer alignments consists of fill and silty clay deposits overlying shale bedrock.

More detailed descriptions of the individual strata are presented below.

4.2 Topsoil

A 50 to 150 mm thick layer of topsoil was identified surficially in all boreholes except borehole 05-6 drilled on Bronte Road. The topsoil consists of a layer of roots and decayed organic matter that has developed over old fill material.

4.3 Fill

Fill was encountered in all boreholes. The composition of the fill varied as follows:

- Above the slope on the west side of the valley, the fill comprised gravelly silty sand over crushed shale/silty clay in borehole 05-1, silty clay in borehole 05-2, and silt and sand in borehole 05-3. The fill is compact to dense/hard with SPT N-values of 26 blows/0.3 m penetration to 50 blows/0.1 m. The fill extends to depths of 2.3 to 4.9 m (elevation 110.4 to 107.2 m).
- In borehole 05-4 on the west side of the valley base, a soft, dark brown silty clay layer was encountered to 0.8 m depth (elevation 88.3). This material may represent a creek alluvium.

- On the east side of the creek, the fill consists of silty clay. SPT N-values in the clay fill typically ranged from 7 to 27 blows/0.3 m, indicating a generally stiff to very stiff consistency. The lower boundary of the fill varied from elevation 87.0 m (5.8 m depth) at the toe of the valley slope, elevation 91.0 m (14.9 m depth) in borehole 05-6 drilled through the Bronte Road embankment, and elevation 99.6 m (3.5 m depth) in borehole 05-7 drilled east of Bronte Road.

In borehole 05-6 drilled on Bronte Road, the fill is overlain by a roadway pavement structure consisting of 165 mm of asphalt over approximately 900 mm of compact sand and gravel.

The results of grain size distribution analyses conducted on the various types of fill are presented on Figures B1 and B2, Appendix B. The percentage of clay size particles in the silty clay fill ranged from about 17 to 30%. The results of Atterberg Limits tests conducted on the clay, presented on Figure B3, indicate low plasticity (CL), with Plastic Limits of about 16 to 17 and Liquid Limits from 25 to 31. Moisture contents ranged from about 4 to 10% in the cohesionless fill and 7 to 21% in the silty clay fill.

Shale and limestone fragments were encountered throughout the fill material. The potential exists that larger rock fragments and/or other obstructions will be encountered.

4.4 Silty Clay

In boreholes 05-3 and 05-7, a native silty clay layer was encountered below the fill. N-values obtained in the clay exceeded 50 blows/0.15 m penetration, indicating a hard consistency, but may also reflect the presence of shale fragments at the sampler tip. The silty clay layer was 1.6 and 1.4 m thick in boreholes 05-3 and 05-7, respectively.

Dark brown silty clay was encountered below the fill in borehole 05-6 at 14.9 m depth (elevation 91.0 m). The clay is very stiff with one N-value of 24 blows/0.3 m obtained. This borehole was terminated in the clay at 15.8 m depth (elevation 90.1 m).

4.5 Bedrock

Shale bedrock was encountered below the fill and clay till deposits in all boreholes except borehole 05-6. The depth to bedrock ranged from 0.8 to 5.8 m as follows:

Table 4.1 – Depth to Bedrock

Borehole Number	Shale Bedrock	
	Depth (m)	Elevation (m)
05-1	4.9	109.3
05-2	2.3	110.4
05-3	4.3	105.6
05-4	0.8	88.3
05-5	5.8	87.0
05-6	-	-
05-7	4.9	98.2

The bedrock comprises reddish-brown shale of the Queenston Formation. The shale contains frequent interbeds of grey siltstone of up to 200 mm in thickness, typically less than 50 mm, at the borehole locations. Seams of very weathered material (essentially a silty clay), about 20 to 80 mm thick, were also present in the shale at the valley base level and in the upper 1.0 m of shale on the tableland. Occasional near-vertical fracturing was also encountered within the cores.

Total core recovery (TCR) of the bedrock cores ranged from 78 to 100%. The Rock Quality Designation (RQD) of the rock cores obtained from above the valley slopes indicates that this formation is of fair to good quality (RQD of 48 to 88%) in the upper 5 to 8 m and becomes good to excellent quality (RQD of 83 to 100%) below this depth. In borehole 05-4 drilled within the valley, and in borehole 05-3 below a corresponding elevation of 88.5m (21.4 m depth), the shale is of very poor quality with RQD values of 13 to 25%.

The unconfined compressive strength (UCS), unit weight and Young's Modulus of selected rock cores determined by laboratory compression testing (Appendix B) were as follows:

Table 4.2 – Laboratory Unconfined Compressive Strength Tests

Borehole No.	Run No.	Depth (m)	Unit Weight (kN/m^3)	Young's Modulus E_{50} (MPa)	Unconfined Compressive Strength (MPa)
05-2	2	5.23 – 5.43	28.7	-	5.7
	7	13.94 – 14.23	25.1	-	46.5
05-7	2	4.97 – 5.24	24.6	1,700	8.5

The results of swell tests carried out on samples of the shale are presented in Table 4.3. The suppression pressure is defined as the confining pressure above which the bedrock swelling potential is essentially zero.

Table 4.3 – Laboratory Swell Tests

Borehole No.	Run No.	Depth (m)	Suppression Pressure (kPa)
05-2	1	3.94 – 4.02	7.5
05-3	7	13.94 – 14.23	32.5

Packer tests were carried out in the shale bedrock at two depths in borehole 05-2 and at one depth in borehole 05-3. The results are presented in Appendix B. Bulk permeabilities of 4.11×10^{-10} and 1.24×10^{-10} m/sec were determined at two test locations and no appreciable flow into the rock was measured in the third test.

4.6 Water Levels

Upon completion of drilling, water was measured at 4.7 m depth in borehole 05-5, and was not observed in borehole 05-6. Water was introduced into the remaining boreholes during coring and therefore water levels were not obtained. The groundwater levels subsequently measured in the piezometers installed in the boreholes are summarized in Table 4.4.

Table 4.4 – Piezometer Water level Readings

Borehole	Date	Water Level Measured in Piezometer	
		Depth (m)	Elevation
05-1	22-Sept-2005 27-Oct-05	5.40 4.50	108.8 109.7
05-2	22-Sept-2005 27-Oct-05	4.20 4.40	108.5 108.3
05-3	22-Sept-2005 27-Oct-05	20.17 19.90	89.7 90.0
05-4	22-Sept-2005 27-Oct-05	1.75 0.35	87.3 88.8
05-5	22-Sept-2005 27-Oct-05	4.40 4.16	88.4 88.6
05-6	-	-	
05-7	22-Sept-2005 27-Oct-05	6.40 6.00	96.7 97.1

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

5 MISCELLANEOUS

Full time supervision of the field activities, including obtaining utility clearances, was carried out by Mr. Stephane Loranger of Thurber.

Interpretation of the field data and preparation of the investigation report was conducted by Mr. Murray Anderson, P.Eng. Development of the field program was performed by Mr. Alastair E. Gorman, P.Eng. The investigation report was reviewed by Mr. Paulo Branco, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.
Murray R. Anderson, P.Eng.
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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

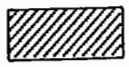
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, 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			

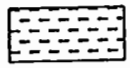
EXPLANATION OF ROCK LOGGING TERMS

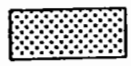
ROCK WEATHERING CLASSIFICATION

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

SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

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RECORD OF BOREHOLE No 05-1 1 OF 1 METRIC

W.P. 2264-03-01 LOCATION N: 4 807 539.3 E: 285 134.0 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 21.09.05 - 21.09.05 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
114.2											
0.0	**TOPSOIL** (150 mm)						114				
0.2	Gravelly, Silty **SAND**, trace clay, with shale and limestone fragments, Compact to Dense, Reddish Brown, Moist to Dry, (FILL)		1	SS	28				○		
			2	SS	37		113		○		25 40 28 7
			3	SS	50/.100		112		○		
111.2											
3.0	**CRUSHED SHALE** Dense, Reddish Brown, Moist, (FILL)		4	SS	31		111		○		
109.3			5	SS	88		110		○ ○		
4.9	Highly weathered, very weak to weak, reddish brown to grey, **SHALE**, occasional limy interbeds					▼	109				
108.0			6	SS	50/.100				○		
6.2	END OF BOREHOLE AT 6.20m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)
22/09/05	5.40
27/10/05	4.50

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5192.GPJ 28/10/05

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RECORD OF BOREHOLE No 05-2 1 OF 2 METRIC

W.P. 2264-03-01 LOCATION N: 4 807 540.5 E: 285 160.3 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers / NQ Coring COMPILED BY WM/HS

DATUM Geodetic DATE 20.09.05 - 21.09.05 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
112.7											
0.0	**TOPSOIL** (100mm)										
0.1	Silty **CLAY**, some sand, with shale and limestone fragments Hard Reddish Brown Moist (FILL)		1	SS	32		112				
			2	SS	38		111				
110.4											
2.3	Highly weathered, very weak to weak, reddish brown, **SHALE**, very thinly bedded		3	SS	38		110				0 4 81 14
			4	SS	50/.075						
	3.41m - 3.49m clay seams		1	RUN		▼	109				RUN #1 TCR=100% SCR=100% RQD=78%
	4.11m - 4.24m siltstone layers 4.13m - 4.21m vertical joint										
	slightly weathered, weak		2	RUN			108				RUN #2 TCR=98% SCR=98% RQD=63% UCS=5.7 MPa
	5.79m - 5.87m siltstone layer						107				
	6.15m - 6.25m, 6.25m - 6.28m and 6.31m - 6.40m siltstone layers		3	RUN			106				RUN#3 TCR=100% SCR=100% RQD=88%
	7.49m - 7.60m siltstone layer						105				
	8.08m - 8.13m and 8.15m - 8.17m siltstone layers		4	RUN							RUN#4 TCR=93% SCR=93% RQD=84%
	8.51m - 8.61m and 9.02m - 9.05m siltstone layers						104				
	9.19m - 9.24m and 9.89m - 9.91m siltstone layers						103				

Continued Next Page

+^{3}, ×^{3}: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5192.GPJ 28/10/05

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Ontario

THURBER

RECORD OF BOREHOLE No 05-2 2 OF 2 METRIC

W.P. 2264-03-01 LOCATION N: 4 807 540.5 E: 285 160.3 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers / NQ Coring COMPILED BY WM/HS

DATUM Geodetic DATE 20.09.05 - 21.09.05 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
102.0	10.21m - 10.29m siltsone layer		5	RUN							RUN#5 TCR=100% SCR=100% RQD=95%
10.7	END OF BOREHOLE AT 10.72m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.						102				

WATER LEVEL READINGS:

DATE	DEPTH (m)
22/09/05	4.20
27/10/05	4.40

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 5192.GPJ 28/10/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 05-3 1 OF 3 METRIC

W.P. 2264-03-01 LOCATION N: 4 807 595.2 E: 285 209.2 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers / NQ Coring COMPILED BY WM/HS

DATUM Geodetic DATE 16.09.05 - 19.09.05 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
109.9											
0.0	**TOPSOIL** (50mm)										
0.0	**SILT and SAND**, some clay, trace gravel, some shale and limestone fragments Compact to Dense Reddish Brown Moist (FILL)		1	SS	26		109				3 45 38 14
			2	SS	42		108				
107.2			3	SS	85/ 275						
2.7	Silty **CLAY**, with shale fragments Hard Reddish Brown		4	SS	95/ 225		107				
105.6							106				
4.3	Highly to moderately weathered, very weak to weak, reddish brown, **SHALE**, thinly bedded 4.59m - 4.72m rubble zone		1	RUN			105				RUN#1 TCR=100% SCR=80% RQD=48%
	5.54m - 5.59m, 5.89m - 5.97m and 5.99m to 6.02m siltstone layers						104				
	6.71m - 6.76m siltstone layer 7.01m - 7.06m rubble zone slightly weathered, weak to medium strong 7.52m - 7.55m siltstone layer 7.64m - 7.82m vertical joint		2	RUN			103				RUN#2 TCR=98% SCR=92% RQD=87%
	7.94m - 7.97m siltstone layer 8.21m - 8.33m and 8.43m - 8.48m siltstone layers 8.51m - 8.61m and 9.04m - 9.12m vertical joints 8.82m - 8.84m and 8.92m - 8.99m siltstone layers		3	RUN			102				RUN#3 TCR=100% SCR=98% RQD=57%
	9.80m - 9.85m siltstone layer		4	RUN			101				RUN#4 TCR=100% SCR=100% RQD=100%
							100				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

ONTMT4S 5192.GPJ 21/11/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 05-3 2 OF 3 METRIC

W.P. 2264-03-01 LOCATION N: 4 807 595.2 E: 285 209.2 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers / NQ Coring COMPILED BY WM/HS

DATUM Geodetic DATE 16.09.05 - 19.09.05 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	10.26m - 10.28m, 10.46m - 10.48m and 10.97m - 10.99m siltstone layers						99				RUN#5 TCR=100% SCR=92% RQD=61%
	11.33m - 11.35m, 11.41m - 11.43m and 11.51m - 11.63m siltstone layers		5	RUN			98				
	11.94m - 12.09m, 12.24m - 12.26m and 12.26m - 12.39m siltstone layers										RUN#6 TCR=100% SCR=100% RQD=97%
	13.61m - 13.67m and 13.87m - 13.89m siltstone layer		6	RUN			97				
	14.41m - 14.49m and 14.94m - 14.99m siltstone layer						96				RUN#7 TCR=100% SCR=100% RQD=97% UCS=46.5 MPa
	15.02m - 15.09m siltstone layer		7	RUN			95				
	16.59m - 16.66m siltstone layer										RUN#8 TCR=100% SCR=98% RQD=93%
	16.97m - 17.09m, 17.51m - 17.55m, 17.68m - 17.70m and 17.73m - 17.75m siltstone layers		8	RUN			94				
	18.19m - 18.24m, 18.61m - 18.80m and 18.95m - 19.00m siltstone layers						93				RUN#9 TCR=100% SCR=97% RQD=84%
	19.49m - 19.51m, 19.53m - 19.55m and 19.66m - 19.71m siltstone layers 19.76m - 19.78m and 19.89m - 19.96m		9	RUN			92				
											RUN#10 TCR=90% SCR=87% RQD=83%
			10	RUN			91				
							90				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5192.GPJ 21/11/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 05-3 3 OF 3 METRIC

W.P. 2264-03-01 LOCATION N: 4 807 595.2 E: 285 209.2 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers / NQ Coring COMPILED BY WM/HS

DATUM Geodetic DATE 16.09.05 - 19.09.05 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	siltstone layers 20.27m - 20.37m, 20.41m - 20.42m and 20.76m - 20.88m siltstone layers		11	RUN			89				RUN#11 TCR=100% SCR=100% RQD=100%
	21.01m - 21.07m and 21.24m - 21.29m siltstone layers Highly weathered, weak to very weak						88				RUN#12 TCR=88% SCR=67% RQD=25%
	21.89m - 21.91m and 22.30m - 22.35m clay seams 22.00m - 22.10m and 22.20m - 22.33m rubble zones		12	RUN			87				
	23.04m - 23.24m and 23.57m - 23.70m siltstone layers 23.58m - 23.64m vertical joint		13	RUN			86				RUN#13 TCR=78% SCR=75% RQD=20%
85.8											
24.1	END OF BOREHOLE AT 24.13m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)
22/09/05	20.17
27/10/05	19.90

$+^3$, $\times^3$: Numbers refer to Sensitivity

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

ONTMT4S 5192.GPJ 21/11/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 05-4 1 OF 1 METRIC

W.P. 2264-03-01 LOCATION N: 4 807 626.7 E: 285 228.3 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers / NQ Coring COMPILED BY WM/HS

DATUM Geodetic DATE 15.09.05 - 15.09.05 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
89.1											
0.0	**TOPSOIL** (150mm)						89				
0.2	Silty **CLAY**, trace roots and wood fragments, occasional sand seams Soft Dark Brown Wet		1	SS	2						
88.3	(FILL)		2	SS	50/.075						
0.8	Highly weathered, very weak, reddish brown, **SHALE**, very thinly bedded, 1.15m - 1.17m siltstone layer 1.35m - 1.39m and 1.45m - 1.47m clay seams 1.50m - 1.81m and 2.29m - 2.31m clay seams 1.93m - 2.03m and 2.34m - 2.39m vertical joints 2.18m - 2.20m and 2.59m to 2.61m siltstone layers		1	RUN			88				RUN#1 TCR=97% SCR=65% RQD=22%
	2.84m - 2.94m and 3.49m - 3.51m siltstone layers 3.18m to 3.23m clay seam		2	RUN			87				RUN#2 TCR=82% SCR=77% RQD=13%
	3.64m - 3.74m and 3.86m - 3.89m siltstone layers						86				
84.9							85				
4.2	END OF BOREHOLE AT 4.19m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)
22/09/05	1.75
27/10/05	0.35

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5192.GPJ 28/10/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 05-5 1 OF 1 METRIC

W.P. 2264-03-01 LOCATION N: 4 807 677.3 E: 285 289.9 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 15.09.05 - 15.09.05 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
92.8								20 40 60 80 100	20 40 60		
0.0	**TOPSOIL** (100mm)										
0.1	Silty **CLAY**, trace to some sand, occasional topsoil pockets, roots and rootlets, occasional shale and limestone fragments Hard to Stiff Reddish Brown Moist (FILL)		1	SS	42		92				
			2	SS	23		91				
			3	SS	10						0 11 64 26
			4	SS	13		90				
	Very Stiff Wet					▼	89				
			5	SS	22		88				
87.0											
5.8	Highly weathered, very weak, reddish brown, **SHALE**, occasional clay seams		6	SS	50/.100		87				
							86				
85.7			7	SS	50/.125						
7.1	END OF BOREHOLE AT 7.14m. BOREHOLE OPEN AND WATER LEVEL AT 4.72 m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) 22/09/05 4.40 27/10/05 4.16										

+ ³, × ³: Numbers refer to Sensitivity

15 (20/10) 5 (%) STRAIN AT FAILURE

ONTMT4S 5192.GPJ 28/10/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 05-6 1 OF 2 METRIC

W.P. 2264-03-01 LOCATION N: 4 807 711.2 E: 285 316.4 ORIGINATED BY SLL
HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY WM/HS
DATUM Geodetic DATE 22.09.05 - 22.09.05 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
105.9								20 40 60 80 100	20 40 60		
0.0	**ASPHALT**(165 mm)										
0.2	**SAND and GRAVEL** Compact Brown Moist (FILL)										
104.8			1	SS	16		105				
1.1	Silty **CLAY**, some sand, trace gravel, trace rootlets, occasional shale fragments Stiff to Very Stiff Brown Moist (FILL)		2	SS	8		104				1 18 61 20
	occasional wood fibers		3	SS	18		103				
			4	SS	7		102				
			5	SS	27		101				0 15 55 30
			6	SS	17		100				
			7	SS	18		99				
			8	SS	8		98				0 14 66 20
							97				
							96				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 5192.GPJ 28/10/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 05-6 2 OF 2 METRIC

W.P. 2264-03-01 LOCATION N: 4 807 711.2 E: 285 316.4 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 22.09.05 - 22.09.05 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
							95		○		
			9	SS	23						
							94		○		
			10	SS	16						
							93				
			11	SS	22		92		○		
91.0											
14.9	Silty **CLAY**, trace sand, trace topsoil Very Stiff Dark Brown Moist		12	SS	24		91		○		
90.1											
15.8	END OF BOREHOLE AT 15.85m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m)										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 5192.GPJ 28/10/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 05-7 1 OF 1 METRIC

W.P. 2264-03-01 LOCATION N: 4 807 725.3 E: 285 324.3 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers / NQ Coring COMPILED BY WM/HS

DATUM Geodetic DATE 14.09.05 - 15.09.05 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
103.1											
0.0	**TOPSOIL:** (100 mm)						103				
0.1	Silty **CLAY**, trace sand, occasional wood fragments Stiff Reddish Brown Moist (FILL)		1	SS	14			○			
			2	SS	10		102		○ ⊢⊣		0 6 77 17
			3	SS	7		101		○		
	trace shale fragments		4	SS	8		100		○ ○		
99.6											
3.5	Silty **CLAY**, trace sand, trace rootlets, occasional shale and limestone fragments Firm to Hard Brown Moist		5	SS	50/.100		99				
98.2									○		
4.9	Highly weathered, very weak, reddish brown, **SHALE** 4.88m - 4.90m, 5.31m - 5.33m and 5.62m - 5.66m clays seams		1	RUN			98				RUN#1 TCR=85% SCR=62% RQD=53%
96.7							97				
6.4	END OF BOREHOLE AT 6.40m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) 22/09/05 6.4 27/10/05 6.00										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$15 \oplus \frac{20}{10} 5$ (%) STRAIN AT FAILURE

ONTMT4S 5192.GPJ 28/10/05

PACKER TEST RESULTS SUMMARY

BOREHOLE 05-2 TEST 1

Borehole diameter = 47.00 mm 1.85 inches
Borehole radius = 23.50 mm
Length of test zone = 1525 mm Depth below ground surface = 4.0 to 5.5 m
Height of Gauge above GWT = 1900 mm Depth below bedrock surface = 0.6 to 2.1 m

STAGE NUMBER	FLOW RATE (USgal/min)	FLOW RATE (ft^3/min)	GAUGE PRESSURE (psi)	DIFF. HEAD (ft)	k (ft/min)	k (m/sec)	$k_{average}$ (m/sec)
1	0	0.00000	4.0	15.5	0.00E+00	0.00E+00	0.00E+00
2	0	0.00000	8.0	24.7	0.00E+00	0.00E+00	
3	0	0.00000	13.0	36.2	0.00E+00	0.00E+00	
4	0	0.00000	40.0	98.5	0.00E+00	0.00E+00	

BOREHOLE 05-2 TEST 2

Borehole diameter = 47.00 mm 1.85 inches
Borehole radius = 23.50 mm
Length of test zone = 1525 mm Depth below ground surface = 7.6 to 9.1 m
Height of Gauge above GWT = 4400 mm Depth below bedrock surface = 4.3 to 5.8 m

STAGE NUMBER	FLOW RATE (USgal/min)	FLOW RATE (ft^3/min)	GAUGE PRESSURE (psi)	DIFF. HEAD (ft)	k (ft/min)	k (m/sec)	$k_{average}$ (m/sec)
1	0.0005	0.00007	8.0	32.9	2.70E-07	1.37E-09	4.11E-10
2	0.0005	0.00007	16.0	51.4	1.73E-07	8.77E-10	
3	0	0.00000	25.0	72.1	0.00E+00	0.00E+00	
4	0.00025	0.00003	38.0	102.1	4.34E-08	2.21E-10	
5	0	0.00000	16.0	51.4	0.00E+00	0.00E+00	
6	0	0.00000	8.0	32.9	0.00E+00	0.00E+00	

BOREHOLE 05-3 TEST 1

Borehole diameter = 47.00 mm 1.85 inches
Borehole radius = 23.50 mm
Length of test zone = 1525 mm Depth below ground surface = 12.2 to 13.7 m
Height of Gauge above GWT = 20300 mm Depth below bedrock surface = 7.6 to 9.1 m

STAGE NUMBER	FLOW RATE (USgal/min)	FLOW RATE (ft^3/min)	GAUGE PRESSURE (psi)	DIFF. HEAD (ft)	k (ft/min)	k (m/sec)	$k_{average}$ (m/sec)
1	0	0.00000	13.0	96.6	0.00E+00	0.00E+00	1.24E-10
2	0.0005	0.00007	26.0	126.6	7.01E-08	3.56E-10	
3	0.00025	0.00003	40.0	158.9	2.79E-08	1.42E-10	
4	0	0.00000	55.0	193.5	0.00E+00	0.00E+00	

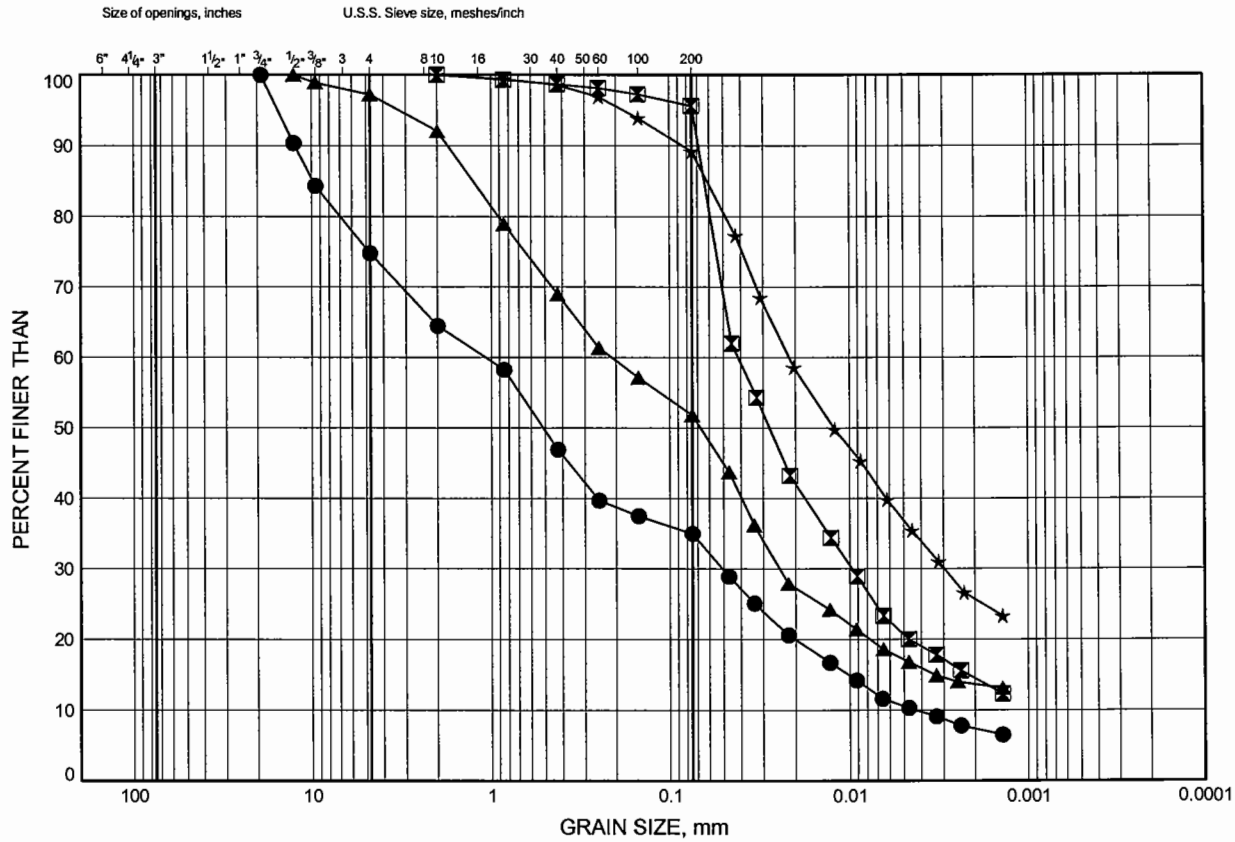
Appendix B

Laboratory Test Results

Bronte Creek Sewer Outfalls

GRAIN SIZE DISTRIBUTION

FIGURE B1



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	05-1	1.83	112.37
⊠	05-2	2.59	110.11
▲	05-3	1.07	108.83
★	05-5	2.59	90.21

Date November 2005

Project 2264-03-01

THURBER

Prep'd HS

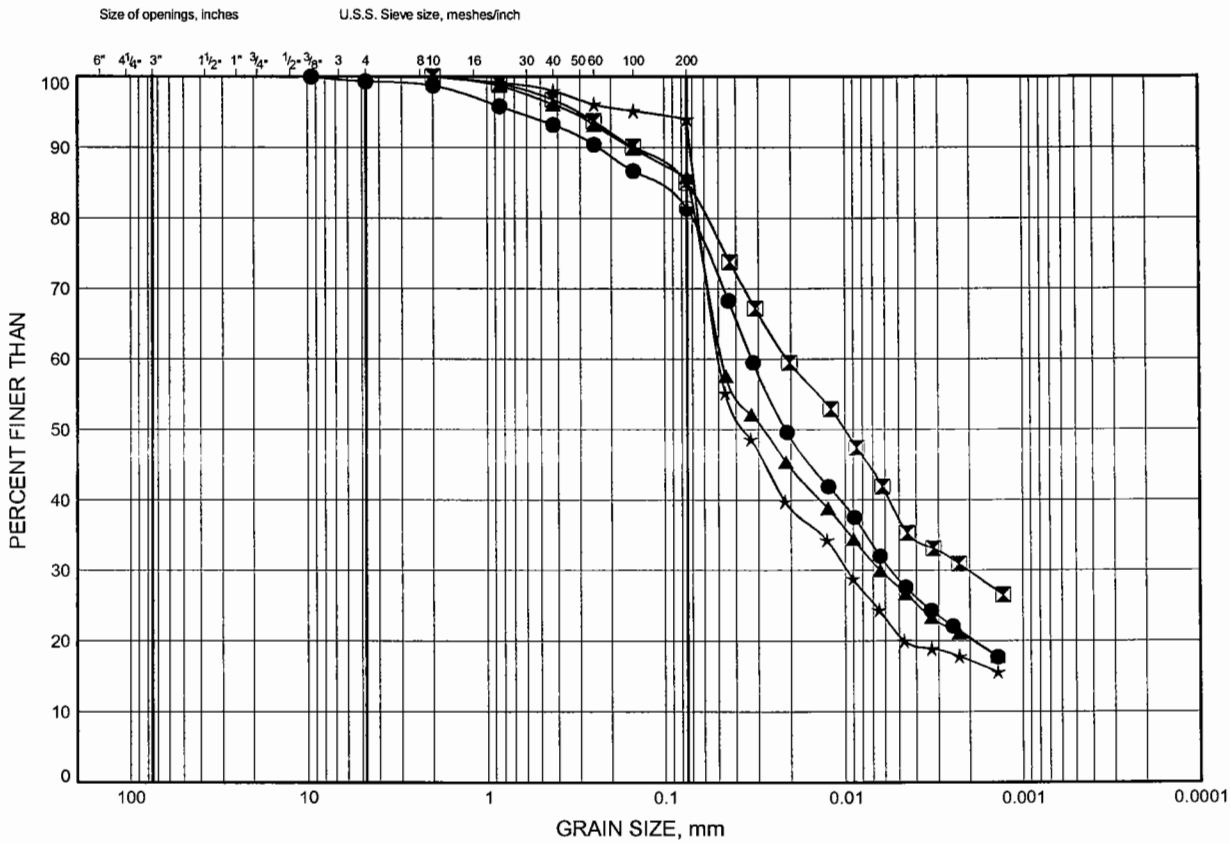
Chkd. MRA

THURBGSD 5192.GPJ 21/11/05

Bronte Creek Sewer Outfalls

GRAIN SIZE DISTRIBUTION

FIGURE B2



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	05-6	1.83	104.07
⊠	05-6	4.88	101.02
▲	05-6	9.45	96.45
★	05-7	1.83	101.27

Date October 2005

Project 2264-03-01

THURBER

Prep'd WM

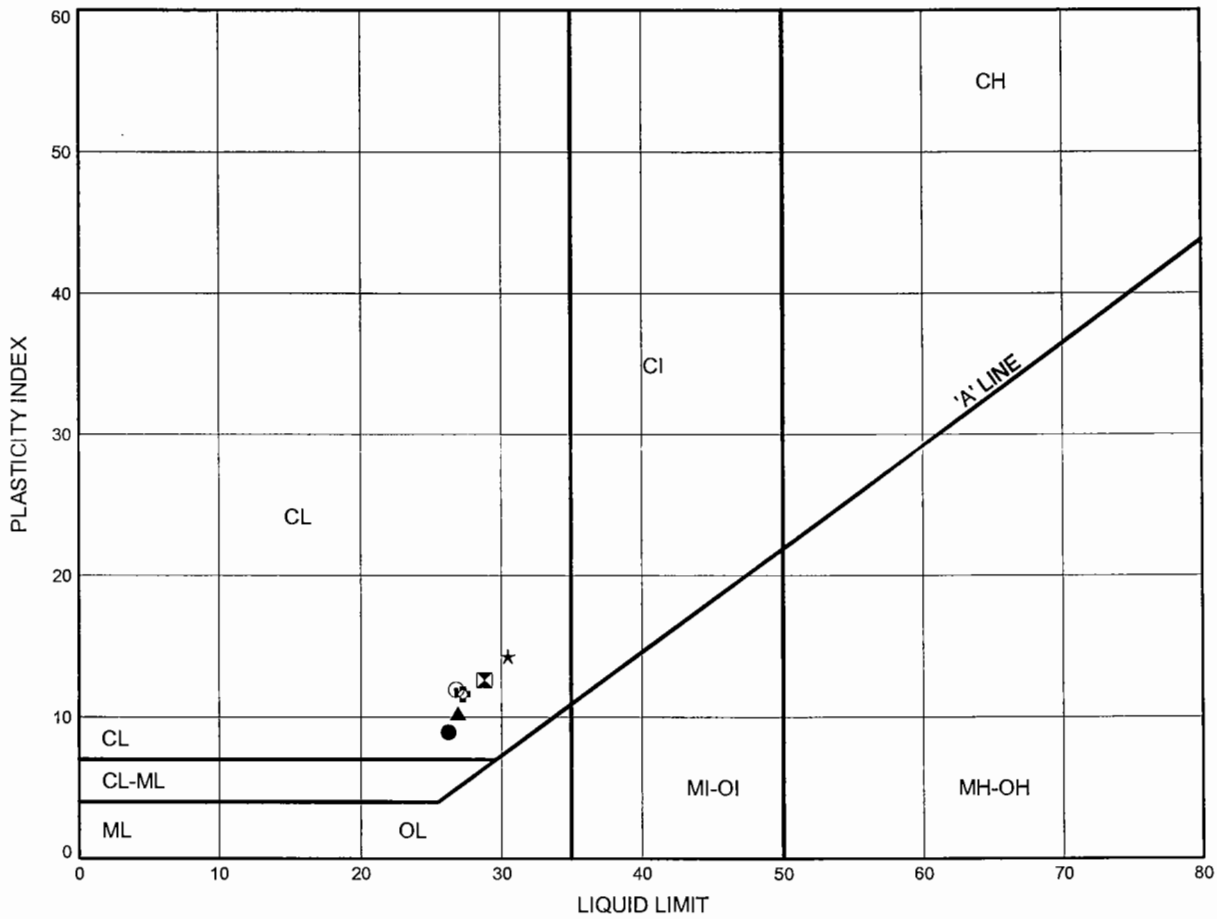
Chkd. MRA

THURBGSD 5192.GPJ 31/10/05

Bronte Creek Sewer Outfalls

ATTERBERG LIMITS TEST RESULTS

FIGURE B3



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	05-2	2.59	110.11
⊠	05-5	2.59	90.21
▲	05-6	1.83	104.07
★	05-6	4.88	101.02
⊙	05-6	9.45	96.45
✿	05-7	1.83	101.27

Date October 2005

Project 2264-03-01

THURBER

Prep'd WM

Chkd. MRA

THURBALT 5192.GPJ 31/10/05

ONE-DIMENSIONAL SWELL POTENTIAL OF COHESIVE SOILS
ASTM D4546-03

SAMPLE IDENTIFICATION

Project Number	05-1116-041	Sample Number	Run 1
Borehole Number	05-2-NQ	Sample Depth, m	3.94-4.02

TEST CONDITIONS

Test Method	B	Load Duration, hr	46.8
Oedometer Number	8		
Date Started	09/26/2005		
Date Completed	09/28/2005		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.91	Unit Weight, kN/m^3	24.45
Sample Diameter, cm	4.83	Dry Unit Weight, kN/m^3	23.26
Area, cm^2	18.32	Specific Gravity, assumed	2.70
Volume, cm^3	35.00	Solids Height, cm	1.678
Water Content, %	5.13	Volume of Solids, cm^3	30.74
Wet Mass, g	87.25	Volume of Voids, cm^3	4.26
Dry Mass, g	82.99	Degree of Saturation, %	100.0

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm
0.00	1.910	0.139	1.910
7.54	1.909	0.138	1.910

Notes:

Swell pressure σ_{sp}=7.54 kPa

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.91	Unit Weight, kN/m^3	24.68
Sample Diameter, cm	4.83	Dry Unit Weight, kN/m^3	23.26
Area, cm^2	18.32	Specific Gravity, assumed	2.70
Volume, cm^3	34.98	Solids Height, cm	1.678
Water Content, %	6.07	Volume of Solids, cm^3	30.74
Wet Mass, g	88.03	Volume of Voids, cm^3	4.25
Dry Mass, g	82.99		

Prepared By: LFG

Golder Associates

Checked By: MM

ONE-DIMENSIONAL SWELL POTENTIAL OF COHESIVE SOILS
ASTM D4546-03

SAMPLE IDENTIFICATION

Project Number	05-1116-041	Sample Number	Run 7
Borehole Number	05-3-NQ	Sample Depth, m	13.94-14.23

TEST CONDITIONS

Test Method	B	Load Duration, hr	18.2
Oedometer Number	8		
Date Started	09/28/2005		
Date Completed	09/29/2005		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.91	Unit Weight, kN/m^3	23.45
Sample Diameter, cm	4.83	Dry Unit Weight, kN/m^3	22.83
Area, cm^2	18.32	Specific Gravity, assumed	2.70
Volume, cm^3	35.00	Solids Height, cm	1.647
Water Content, %	2.74	Volume of Solids, cm^3	30.17
Wet Mass, g	83.70	Volume of Voids, cm^3	4.82
Dry Mass, g	81.47	Degree of Saturation, %	46.2

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm
0.00	1.910	0.160	1.910
32.51	1.910	0.160	1.910

Notes:

Swell pressure σ_{sp}=32.51 kPa

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.91	Unit Weight, kN/m^3	23.86
Sample Diameter, cm	4.83	Dry Unit Weight, kN/m^3	22.83
Area, cm^2	18.32	Specific Gravity, assumed	2.70
Volume, cm^3	34.99	Solids Height, cm	1.647
Water Content, %	4.49	Volume of Solids, cm^3	30.17
Wet Mass, g	85.13	Volume of Voids, cm^3	4.82
Dry Mass, g	81.47		

Prepared By: LFG

Golder Associates

Checked By: MM

UNCONFINED COMPRESSION TEST (UC)

ASTM D 2166-00e1

SAMPLE IDENTIFICATION

PROJECT NUMBER	05-1116-041	SAMPLE NUMBER	Run 2
BOREHOLE NUMBER	05-2-NQ	SAMPLE DEPTH, m	5.23-5.43

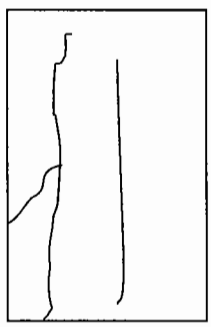
TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.97

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	14.03	WATER CONTENT, (specimen) %	4.60
SAMPLE DIAMETER, cm	4.72	UNIT WEIGHT, kN/m^3	28.69
SAMPLE AREA, cm^2	17.50	DRY UNIT WT., kN/m^3	27.66
SAMPLE VOLUME, cm^3	245.49	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	625.72	VOID RATIO	0.11
DRY WEIGHT, g	598.20		

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, kPa	5,715

REMARKS:

DATE: 09/28/2005

UNCONFINED COMPRESSION TEST (UC)

ASTM D 2166-00e1

SAMPLE IDENTIFICATION

PROJECT NUMBER	05-1116-041	SAMPLE NUMBER	Run 7
BOREHOLE NUMBER	05-3-NQ	SAMPLE DEPTH, m	13.94-14.23

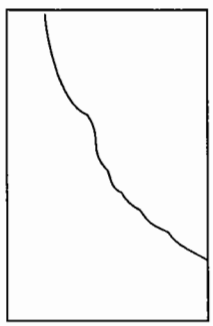
TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.89

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	13.59	WATER CONTENT, (specimen) %	2.40
SAMPLE DIAMETER, cm	4.71	UNIT WEIGHT, kN/m^3	25.13
SAMPLE AREA, cm^2	17.42	DRY UNIT WT., kN/m^3	27.90
SAMPLE VOLUME, cm^3	236.78	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	617.66	VOID RATIO	0.06
DRY WEIGHT, g	603.18		

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, kPa	46,489

REMARKS:

DATE: 09/28/2005

UNCONFINED COMPRESSION TEST (UC)

ASTM D 2166-00e1

SAMPLE IDENTIFICATION

PROJECT NUMBER	05-1116-041	SAMPLE NUMBER	Run 2
BOREHOLE NUMBER	05-7	SAMPLE DEPTH, m	4.97-5.24

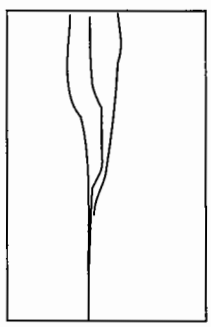
TEST CONDITIONS

MACHINE SPEED, mm/min	0.35	TYPE OF SPECIMEN	Rock Core
RATE OF AXIAL STRAIN, %/min	0.44	L/D	1.67

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	7.87	WATER CONTENT, (specimen) %	5.50
SAMPLE DIAMETER, cm	4.71	UNIT WEIGHT, kN/m^3	24.58
SAMPLE AREA, cm^2	17.42	DRY UNIT WT., kN/m^3	23.30
SAMPLE VOLUME, cm^3	137.12	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	343.83	VOID RATIO	0.14
DRY WEIGHT, g	325.91		

FAILURE SKETCH

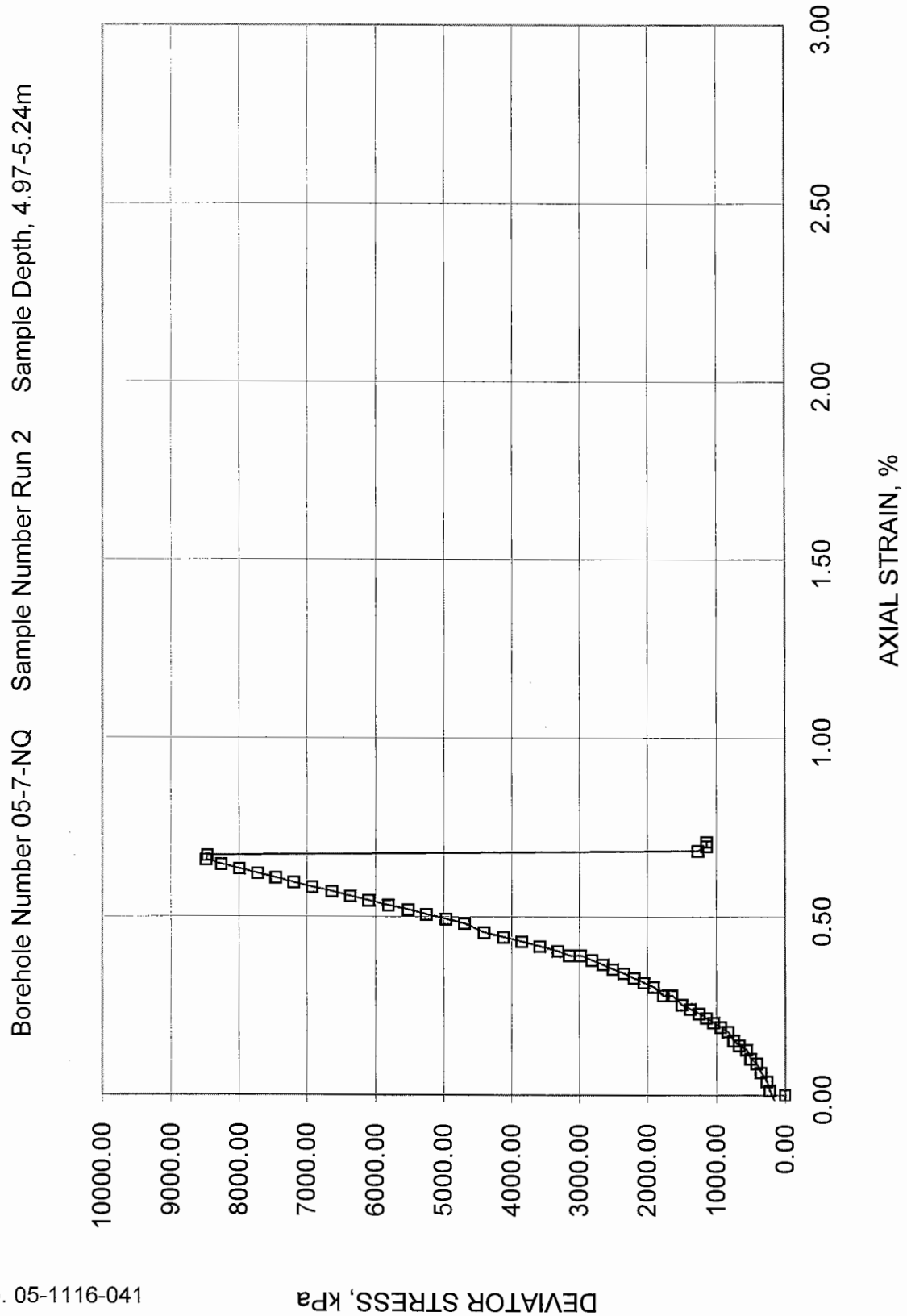


TEST RESULTS

STRAIN AT FAILURE, %	0.7	COMPRESSIVE STRESS, kPa	8,485

REMARKS: L/D ratio not in accordance with specifications. DATE: 09/27/2005

UNCONFINED COMPRESSION TEST (UC) | **FIGURE**



Project No. 05-1116-041

Appendix C

Borehole Locations and Soil Strata Drawing

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT NO 2005-2049

WP NO. 2264-03-01

BRONTE CREEK SEWER OUTFALLS

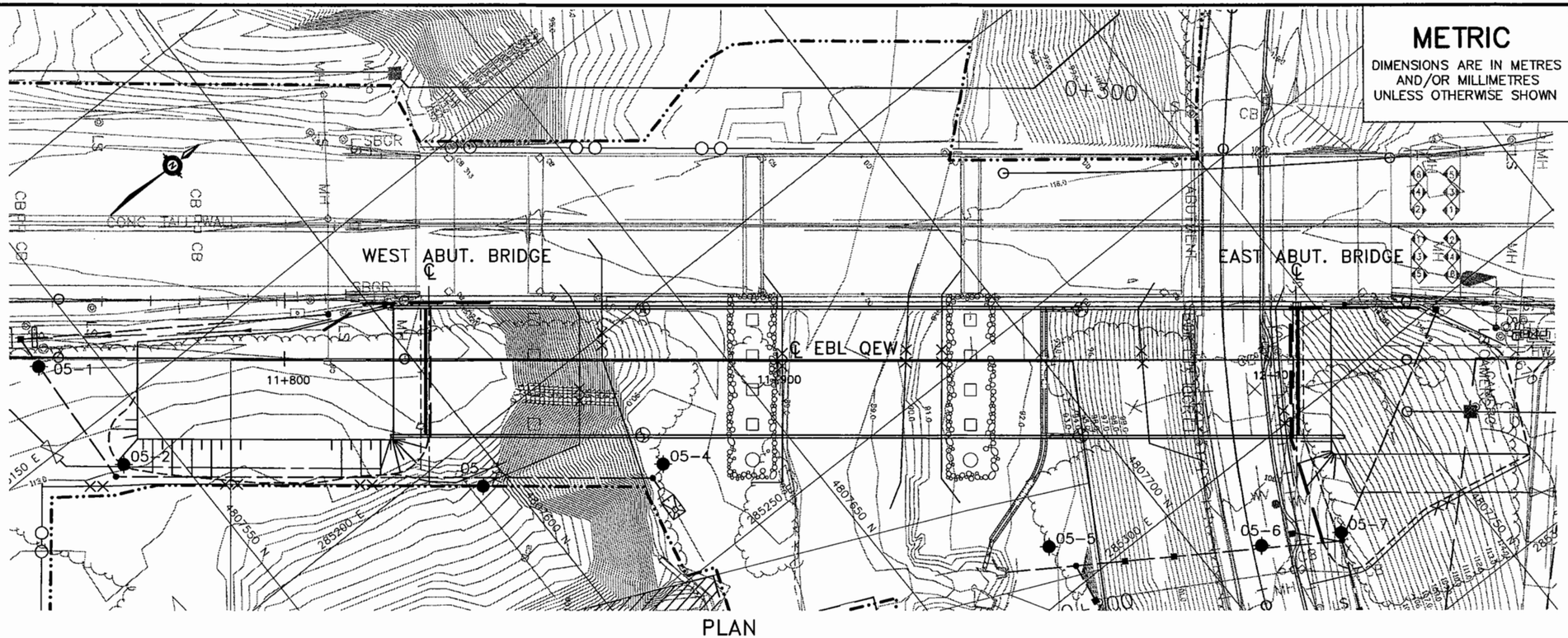
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

McCORMICK RANKIN CORPORATION

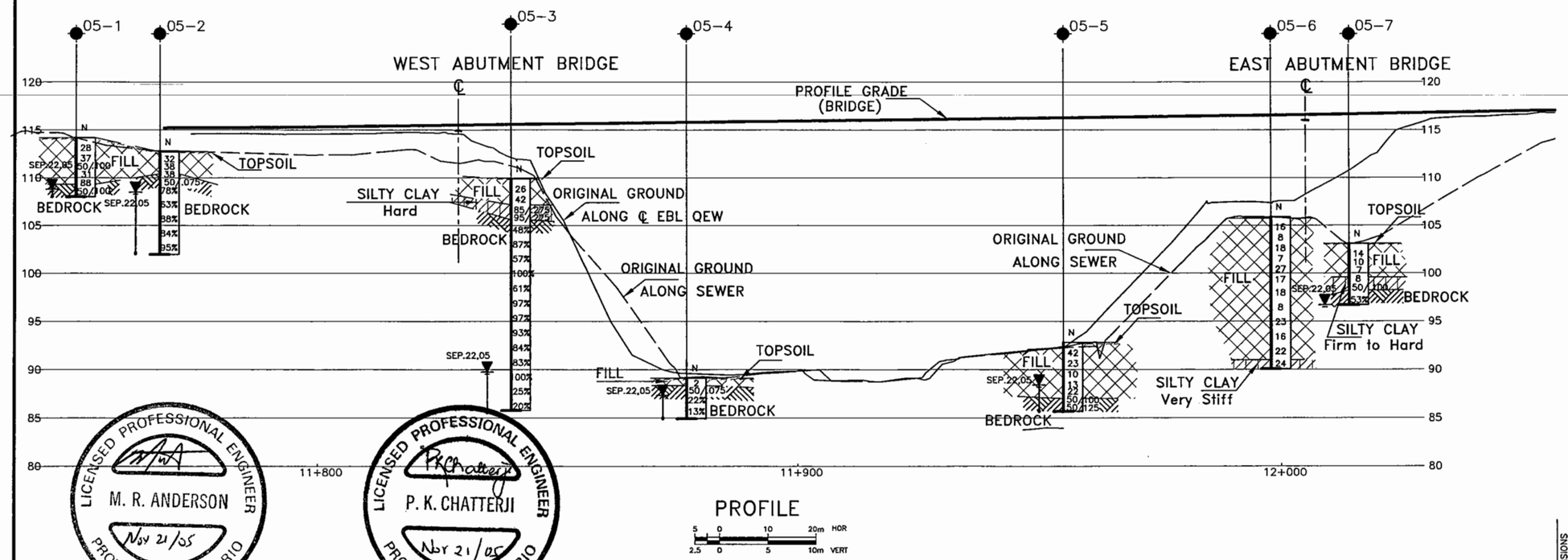
THURBER ENGINEERING LTD.

KEY PLAN



PLAN

5 0 10 20m



PROFILE

5 0 10 20m HOR

2.5 0 5 10m VERT

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Nov 21/05
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Nov 21/05
PROVINCE OF ONTARIO

LEGEND

●	Bore Hole
⊕	Dynamic Cone Penetration Test (cone) or Probe Hole
⊕	Bore Hole & Cone
N	Blows/0.3m (Std pen Test, 475J/blow)
CONE	Blows/0.3m (60° Cone, 475J/blow)
Cu	Undrained Shear Strength from Field Vane
PH	Pressure, Hydraulic
▼	WL in Piezometer at Time of Investigation (Date)
▼	Head Artesian Water
▼	Piezometer
▼	WL in Open Borehole Upon Completion of Drilling
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTH	EAST
05-1	114.2	4807539.3	285134.0
05-2	112.7	4807540.5	285160.3
05-3	109.9	4807595.2	285209.2
05-4	89.1	4807626.7	285228.3
05-5	92.8	4807677.3	285289.9
05-6	105.9	4807711.2	285316.4
05-7	103.1	4807725.3	285324.3

— NOTE —

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS		
OCT, 05	MA	ISSUED AS DRAFT FOR REVIEW
DATE	BY	DESCRIPTION

DESIGN MA	CHK PJB	CODE CHBDC	LOAD	DATE OCT, 2005	
DRAWN HS	CHK MA	SITE	STRUCT	SCHEME	DWG 1