PRELIMINARY
FOUNDATION INVESTIGATION AND DESIGN REPORT
S-E RAMP OVER BRUCE STREET
HIGHWAY 7-NEW, KITCHENER TO GUELPH
G.W.P. 408-88-00

Geocres Number: 40P8-168

Report to

Ministry of Transportation Ontario
Southwestern Region

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June 4, 2009
File: 15-64-17

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents factual information that may be used in the preliminary design of the foundations of the structure carrying the S-E Ramp over Bruce Street in the City of Kitchener. The proposed ramp is part of the Highway 7-New project.

No boreholes were drilled within the footprint of this structure because permission to enter the private property within which the site lies was not granted by the property owner. Accordingly, a preliminary soil stratigraphy has been extrapolated from nearby boreholes (BH 08-022 and BH 08-026) drilled for other structures.

This stratigraphy may be used, with caution, for preliminary design purposes and it must be recognized that there is a higher-than-normal probability that revisions will be required during detail design and after site-specific investigation has been carried out.

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

2 SITE DESCRIPTION

The site lies approximately 150 m to the east of the existing Kitchener-Waterloo Expressway and Wellington Street interchange. At this location, the proposed S-E Ramp will cross over the proposed Bruce Street extension. The site lies within an area of industrial and commercial lands and is generally flat.

Three photographs of the site, looking at the east side of KWE and south side of Wellington Street (Borehole 08-022) are included in Appendix E and show the general nature of the surrounding land.

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within the physiographic region known as the

Waterloo Hills, characterized by ridges of sandy till and kames or kame moraines, with outwash sands occupying the intervening hollows.

3 SITE INVESTIGATION AND FIELD TESTING

The geotechnical investigation plan for this site was to drill two boreholes, one at each abutment of a possible single-span structure arrangement. As permission has not been granted to access the lands on the southeast quadrant of Wellington Street and KWE interchange, it has not been possible to drill boreholes at the proposed structure location over the proposed Bruce Street extension. In preparation of this report, reference has been made to available information from Boreholes 08-022 and 08-026 recently drilled for the proposed N-E and S-E Ramps over Wellington Street and Shirley Avenue.

The site investigation and field testing used for the extrapolated stratigraphy was carried out from July 3 to 8, 2008. Two boreholes, numbered 08-022 and 08-026, were drilled beyond the west and east boundaries of the site. The depths of Boreholes 08-022 and 08-026 were 12.6 and 29.2 m (Elevations 309.6 and 297.3), respectively. The Record of Borehole sheets for the boreholes are included in Appendix A. The approximate locations of the two boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix F.

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

The boreholes were drilled using hollow stem auger equipment operated by a CME75 truck-mounted drill rig. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Boreholes were grouted with benseal upon completion.

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.

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 (sieve and hydrometer) and Atterberg Limits testing where appropriate. 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.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

The subsurface conditions described below have been extrapolated from boreholes drilled for adjacent structures. When exploration can be carried out on the structure site, the actual subsurface conditions may vary from those described below.

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil stratigraphy at the borehole locations are presented in this appendix and on the "Borehole Locations and Soil Strata" drawing in Appendix F. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

The soil stratigraphy at the proposed structure location was extrapolated from Boreholes 08-022 and 08-026 drilled at the proposed N-E and S-E Ramps over Wellington Street/Shirley Avenue. The subsurface conditions encountered at Boreholes 08-022 and 08-026 consists of topsoil underlain by granular fill over native sand, silty clay till and sandy silt till.

5.1 Topsoil

Topsoil was identified at the ground surface in both boreholes. The topsoil thickness was 200 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 Fill

Fill was encountered below the topsoil in both boreholes. The fill consists of brown silty sand containing trace gravel and occasional roots. Thickness of the fill ranged from 0.7 m. to 1.3 m. The base of the fill extended to depths of 0.9 m and 1.5 m (Elevations 321.4 and 325.0) in Boreholes 08-022 and 08-026, respectively.

The fill is classified as loose to compact, based on SPT values ranging from 8 to 26 blows for 0.3 m of penetration. The natural moisture content ranged from 15% to 19%.

5.3 Sand

Native brown to grey sand containing some silt, trace clay and trace gravel and occasional cobbles was also encountered in both boreholes at depths and elevations as indicated in Table 5.1.

Table 5.1 – Depths and Elevations of the Native Sand Layer

Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
08-022	0.9 to 2.7 7.2 to 12.5	321.4 to 319.5 315.1 to 309.8	1.8 5.3
08-026	1.5 to 5.6 10.2 to 15.2	325.0 to 320.9 316.3 to 311.3	4.1 5.0

The sand is classified as compact to very dense, based on SPT 'N' values ranging from 14 to 100 blows for 0.3 m of penetration. Several SPT 'N' values higher than 100 blows per 0.275 were also measured within the sand layers. The natural moisture content ranged from 3% to 21%.

Grain size distribution curves for sand samples are presented on the Record of Borehole sheets and on Figure B1 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 6
Sand	80 to 96
Silt & Clay	4 to 20

5.4 Silty Clay Till

Native brown grey silty clay till containing some sand to sandy, trace gravel, occasional sand seams and occasional cobbles and boulders was contacted below the native sand at depths and elevations indicated in Table 5.2.

Table 5.2 – Depths and Elevations of Native Silty Clay Till

Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
08-022	2.7 to 7.2	319.5 to 315.1	4.5
08-026	5.6 to 10.2 15.2 to 29.2 (Borehole termination depth)	320.9 to 316.3 311.3 to 297.3	4.6 >14.0

The cohesive layer is very stiff to hard in consistency, based on SPT 'N' values ranging from 17 blows per 0.3 m of penetration to greater than 100 blows per 0.15 m of penetration. The moisture content varied from 8% to 23%.

Grain size distribution curves for silty clay till samples are presented on the Record of Borehole sheets and on Figure B2 of Appendix B. Atterberg Limits test results are presented on Figure B4 of Appendix B.

The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	4 to 26
Silt	45 to 52
Clay	29 to 50

Liquid Limit	32 to 40
Plastic Limit	17 to 19

The above results show that the silty clay till is of low to medium plasticity with group symbols of CL-CI.

It should be noted that glacial tills are known to contain cobbles and boulders.

5.5 Sandy Silt Till

Grey sandy silt till containing trace clay was encountered at 12.5 m depth (Elevations 309.8) in Borehole 08-022. Borehole 08-022 was terminated within the sandy silt till layer at 12.6 m depth (Elevation 309.7).

Grain size distribution curve for a sandy silt till sample is presented on the Record of Borehole sheets and on Figure B3 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	46
Silt	51
Clay	3

Although not encountered in the boreholes, this glacial till layer may contain cobbles and boulders.

5.6 Groundwater Conditions

Water levels observed in the open boreholes during and upon completion of drilling are summarized in Table 5.3.

Table 5.3 – Water Level Measurements

Borehole	Date (2008)	Water Level (m)		Comment
		Depth	Elevation	
08-022	July 8	0.9	321.4	During drilling
08-026	July 4	4.5	322.0	During drilling

Perched water may also occur within the sand layer in the boreholes.

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

6 MISCELLANEOUS

All-Terrain Drilling of Waterloo, Ontario supplied a truck-mounted CME75 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, under the direction of Mr. Alastair E. Gorman, P.Eng and Mr. Mark Farrant, P. Eng.

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 Mr. Alastair E. Gorman, P.Eng. and Mr. M. Farrant, P. Eng. Interpretation of the data extrapolation to this site and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng 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.

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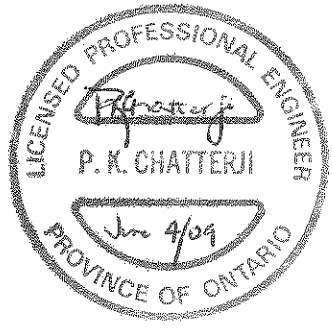

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

This report presents interpretation of the extrapolated geotechnical data in the factual report and presents preliminary geotechnical design recommendations to assist the design team to select and design a suitable foundation system for the new ramp structure.

Boreholes were not drilled at the proposed S-E ramp structure due to access restrictions. Accordingly, the preliminary recommendations provided in this report are based on boreholes drilled at the locations of the nearby proposed N-E and S-E Ramps over Wellington Street and Shirley Avenue (Boreholes 08-022 and 08-026) in the Regional Municipality of Waterloo; both structures are also part of the Highway 7-New project. During final design stage, the recommendations provided in this report should be carefully reviewed as soil conditions may vary at the actual S-E Ramp location.

Based on the Plates 2A and 2B of the E.A:

- The proposed grade of the S-E Ramp to Highway 7 will be near elevation 330.0. Ground surface elevations at the locations of Boreholes 08-022 and 08-026 were 322.3 and 326.5, respectively. Plate 2A indicates that ground surface elevation at proposed Bruce Street is about 325.0. Hence, it is anticipated that the S-E Ramp embankments will be about 3.5 m to 7.7 m high relative to the surrounding grade.
- The proposed Bruce Street extension grade will be in a cut with base elevation 322.0. A cut of approximately 3.0 m depth will be required to pass Bruce Street extension under S-E Ramp.

The discussion and recommendations presented in this report are based on our understanding of the project and on the factual data obtained in the course of this investigation.

8 STRUCTURE FOUNDATIONS

The soil stratigraphy at the proposed structure location was extrapolated from Boreholes 08-022 and 08-026 drilled at the proposed N-E and S-E Ramps over Wellington Street/Shirley Avenue. The subsurface conditions identified at the site in the preliminary investigation consisted primarily of topsoil and granular fill overlying native layers of compact to very dense sand, very stiff to hard silty clay till and very dense sandy silt till.

The groundwater level observed in open boreholes after completion of drilling was near elevations 321.4 to 322.0. Perched water may also occur within the sand layer

In the preparation of the preliminary geotechnical design recommendations, consideration was given to the viability of the following foundation types:

- Spread footings bearing on native soil
- Spread footings on engineered fill
- Steel H-piles driven into the very dense or hard soil

Due to the lack of site-specific information, the recommendations presented in the following sections should be regarded as conceptual and subject to revision after exploration has been carried out on the site.

A comparison of the foundation alternatives based on advantages and disadvantages of each is included in Appendix C.

8.1 Spread Footings on Native Soil

Spread footings bearing on native soil generally are the least expensive form of construction.

If fill exists at the site, it must be regarded as unsuitable for the support of footings.

Table 8.1 presents recommendations based on information obtained at Boreholes 08-022 and 08-026 drilled 30 m west and 100 m east, respectively, of the subject structure. Conceptually, spread footings designed at the geotechnical resistances shown in Table 8.1 may be considered for this structure at elevations close to the range shown in the table.

Table 8.1 – Bearing Resistances for Spread Footings

Location	Depth (m)	Elev.	ULS_f (kPa)	SLS (kPa)	Soil
BH 08-022	2.0	320.3	300	200	Compact sand
	4.5	317.8	450	300	Very stiff to hard silty clay till
	Below 7.6	Below 314.7	750	500	Very dense sand
BH 08-026	1.7	324.8	450	300	Compact sand
	Below 2.5	Below 324.0	750	500	Very dense sand

The bearing resistances in Table 8.1 are for vertical, concentric loading. In the case of eccentric or inclined loading, the bearing resistance must be adjusted as shown in the CHBDC (2006) Clause 6.7.3 and Clause 6.7.4.

The geotechnical SLS resistance values given above are based on an estimated total settlement not exceeding 25 mm. This settlement is expected to be substantially complete by the end of construction. Differential settlement is not expected to exceed 20 mm across the width of the structure or between foundation elements.

Depending on the results of site-specific investigation, ground water control may be required.

8.2 Spread Footings on Engineered Fill

Spread footings can also be founded on Granular "A" engineered fill pads. These would be most useful in the case of perched abutments on footings.

If an engineered fill pad is used, all topsoil, fill or other deleterious materials must be stripped from the footprint of the foundation to expose competent native subgrade material. The engineered fill must bear on native compact to dense sand and the highest permitted founding elevations at which engineered fill pads may be placed are given in Table 8.2.

Table 8.2 presents recommended elevations for engineered fill pads based on information obtained at Boreholes 08-022 and 08-026 drilled 30 m west and 100 m east, respectively, of the subject structure. Conceptually, engineered fill pads could be considered for this structure and could be founded at elevations close to the range shown in the table.

Table 8.2 –Founding Elevations for Engineered Fill Pads

East Abutment (BH 08-022)	West Abutment (BH 08-026)
321.4	325.0

Typically, spread footings on pads of engineered granular fill at least 2 m thick may be designed for the following geotechnical resistances:

- Factored ULS 900 kPa
- SLS 350 kPa

These resistance values are for concentric, vertical loads only. In the case of eccentric or inclined loading, the geotechnical resistance must be calculated as illustrated in the CHBDC Clause 6.7.3 and Clause 6.7.4.

For footings designed on the basis of the geotechnical resistance values given above, total settlement under a footing is expected to not exceed 25 mm. Differential settlement is not expected to exceed 20 mm across the width of the structure or between foundation elements.

The Granular A pad must be compacted to 100% of Standard proctor maximum dry density (SPMDD) at optimum moisture content ±2%. The geometry of the fill pad must conform to the general requirements shown in Figure 1 in Appendix D.

8.3 Steel H-Piles

The extrapolated soil stratigraphy is considered to be suitable for the support of foundations on driven steel piles.

It is recommended that the H-piles be driven to achieve resistance in the hard silty clay till or very dense sand. The depths and elevations at which the H-piles are expected to develop the required resistance are provided in Table 8.3 and correspond to Boreholes 08-022 and 08-026 drilled approximately 30 m west and 100 m east from the proposed S-E Ramp.

Table 8.3 – Estimated Pile Tip Elevation

Location	Pile Tip Depth (m)	Highest Pile Tip Elevation	Soil
BH 08-022	10.8	311.5	Very dense sand
BH 08-026	27.0	299.5	Hard silty clay till

8.3.1 Axial Resistance

For preliminary design, the vertical, axial, factored geotechnical resistance at Ultimate Limit States (ULS) and geotechnical resistance at Serviceability Limit States (SLS) for two pile sections when driven into the hard silty clay till and very dense sand are presented in Tables 8.4.

Table 8.4 – Axial Resistance of Two Pile Sections Founded on Hard/Very Dense Soils

Pile Section	Geotechnical Resistance (kN)	
	Factored ULS	SLS
HP 310 X 110	1,600	1,400
HP 360 X 132	1,800	1,600

The structural resistance of the pile must be checked by the structural designer.

Installation of the piles must be in accordance with SP 903S01 and must be controlled using the Hiley Formula and an ultimate resistance of 3,200 kN for an HP 310 X 110 pile and 3,600 kN for the HP 360 X 132 pile.

These are preliminary recommendations and may change during detail design based on the final alignment, final bridge arrangement and the results of the site investigation and field testing to be completed at that time.

Due to the possible presence of cobbles and boulders in the silty clay till and in dense sand layers at the expected founding level, the tips of all driven piles should be fitted with steel H-Pile driving shoes in accordance with OPSD 3000.100.

8.3.2 Downdrag

Downdrag on the piles is not an issue at this site.

8.4 Abutment Design Considerations

From a geotechnical perspective, the conditions at this site are considered to be suitable for the design of conventional, semi-integral or integral abutments.

8.5 Frost Cover

The design depth of frost penetration for this site is 1.4 m. All footing bases and undersides of pile caps/abutment stems must be provided with at least 1.4 m of soil cover.

8.6 Recommended Foundation

From a geotechnical perspective, and based on current information, the recommended abutment foundation consists of steel H-piles driven into the very dense native sand and hard silty clay till, despite the higher cost noted in Appendix C.

9 BRIDGE APPROACHES AND EMBANKMENTS

Based on the two boreholes drilled near the proposed S-E Ramp location, the approach embankments will be constructed over compact to dense sand and may incorporate the existing silty sand fill.

No long term settlement or global stability issues are anticipated for approach embankments built at this site. The 3.5 m to 7.7 m high embankments likely to be constructed will be stable at side slopes of 2H:1V if constructed using SSM or granular fill.

Permanent earth cuts are required to extend Bruce Street at this site. The cut will be formed predominantly through 3.0 m of existing silty sand fill and native sand. The proposed base of cut for Bruce Street shown on EA Plate 2A is at the groundwater table observed during the field investigation (elevation 322.0). However, perched water might be also observed during excavation within the silty sand fill and native sand layers.

During detail design, when the grade has been finalized, permanent drainage (if necessary) and slope protection requirements must be addressed. The cut slopes will be stable at slopes with a maximum inclination of 2H: 1V. MTO policy requires a mid-height bench in cut slopes higher than 8.0 m. All cut and fill slopes should be protected for erosion.

10 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

1. Pile refusal at higher elevation.

   Glacial till deposits inherently contain cobbles and boulders. It is possible that a pile will achieve refusal at a higher elevation than anticipated due to encountering a boulder. If it is suspected that this is happening, the QVE must immediately bring it to the attention of the CA. If the CA cannot resolve the issue, it must be referred to the design team for resolution.

2. Pile fails to develop specified resistance.

   If a pile has not developed the specified resistance after being driven 2 m beyond the anticipated pile tip elevation, stop driving and check the Hiley calculation and all input values. If the calculation still shows that the pile has not reached the specified resistance, the following procedure should be implemented:

   a) Stop driving in that pile group for 48 hours (minimum)
   b) After 48 hours, warm up the hammer on another pile then commence redriving the subject pile and measure the resistance.
   c) If the pile still does not reach the specified resistance, the QVE must immediately advise the CA who, in turn, should refer the issue to the design team.

3. Destabilization of excavations

   If excavation is carried out in cohesionless soil without prior implementation of adequate measures to control groundwater and surface water, there is a risk that the sides and or base of the excavation will be destabilized. This could lead to a risk to personnel working on site, or to a loss of bearing resistance in the soil.

   Accordingly, it must be emphasized to the contractor that proper groundwater and surface water control measures must be in place prior to commencing excavation.

11 INVESTIGATION FOR DETAIL DESIGN

During detail the design phase, a program of site investigation and field testing that meets current Ministry requirements must be carried out. As a minimum, this program must include:

- One borehole at each foundation element
- One borehole in each approach fill
- One borehole on each side on side of the structure in the Bruce Street cut.
- The boreholes in the cut must include piezometers for groundwater monitoring.

12 CLOSURE

Engineering analysis and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng and Ms. R. Palomeque Reyna, P.Eng.

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

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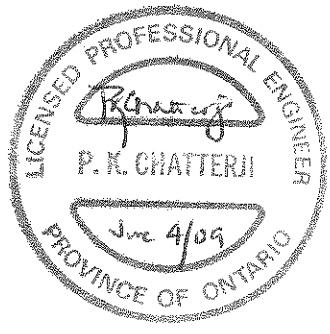


Appendix A

Record of Borehole Sheets

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 08-022 1 OF 2 METRIC

G.W.P. 408-88-00 LOCATION N 4 814 421.49 E 226 319.68 ORIGINATED BY SA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.07.07 - 2008.07.08 CHECKED BY RPR

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) (40 80 120 160 200)	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
322.3											
0.0	**TOPSOIL**, occasional roots (200mm)										
0.2	Dark Brown Moist		1	SS	26		322				
	Silty **SAND**, trace gravel, occasional roots										
321.4	Compact					▽					
0.9	Brown to Grey Moist (FILL)		2	SS	22		321				
	SAND, trace gravel Compact Grey Wet		3	SS	14						0 96 4 (SI+CL)
319.5			4	SS	20		320				
2.7	Silty **CLAY**, some sand, trace gravel Very Stiff to Hard Brown To Grey (TILL)		5	SS	17		319				
	Occasional silty sand seams		6	SS	37		318				0 14 52 34
							317				
315.1			7	SS	27		316				
7.2	**SAND**, some silt, trace clay Very Dense Grey Wet		8	SS	56		315				
							314				
			9	SS	100/225		313				0 80 20 (SI+CL)

Continued Next Page

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

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

ONTMT4S 6417R.GPJ 4/16/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-022 2 OF 2 METRIC

G.W.P. 408-88-00 LOCATION N 4 814 421.49 E 226 319.68 ORIGINATED BY SA

HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA

DATUM Geodetic DATE 2008.07.07 - 2008.07.08 CHECKED BY RPR

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) (40 80 120 160 200)	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
	Continued From Previous Page										
	SAND, some silt, trace clay Very Dense Grey Wet						312				
			10	SS	100				○		
							311				
			11	SS	100/ .275		310		○		0 46 51 3
309.8 12.5											
309.6 12.6	Sandy **SILT**, trace clay Very Dense Grey Moist (TILL)								○		
	END OF BOREHOLE AT 12.6m.□ WATER LEVEL OBSERVED AT 0.9m DURING DRILLING. BOREHOLE BACKFILLED WITH BENSEAL TO 0.6m THEN HOLEPLUG TO SURFACE.										

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

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

ONTMT4S 6417R.GPJ 6/4/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-026 1 OF 4 METRIC

G.W.P. 408-88-00 LOCATION N 4 814 474.88 E 226 422.03 ORIGINATED BY SA

HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA

DATUM Geodetic DATE 2008.07.03 - 2008.07.04 CHECKED BY RPR

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 40 80 120 160 200	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
326.5											
0.0	**TOPSOIL**, occasional roots (200mm)										
0.2	Dark brown Moist		1	SS	12		326				
	Silty **SAND**, trace clay Loose to Compact Brown Moist (FILL)		2	SS	8						
325.0							325				
1.5	**SAND**, some silt, trace gravel, trace clay Compact to Very Dense Brown Moist		3	SS	28						
			4	SS	66		324				6 82 12 (SI+CL)
			5	SS	110/ 275		323				
	Wet		6	SS	80		322				0 90 10 (SI+CL)
320.9							321				
5.6	Silty **CLAY**, some sand to sandy, trace gravel Hard Grey (TILL)		7	SS	58		320				
			8	SS	51		319				0 26 45 29
	occasional silty fine sand seams		9	SS	102/ 225		318				
							317				

Continued Next Page

+ ³, × ³ : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 6417R.GPJ 4/16/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 08-026 2 OF 4 METRIC

G.W.P. 408-88-00 LOCATION N 4 814 474.88 E 226 422.03 ORIGINATED BY SA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.07.03 - 2008.07.04 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							
316.3 / 10.2	Silty CLAY, some sand to sandy, trace gravel Hard Grey (TILL)						316	
	SAND, some silt, trace gravel, trace clay Compact Grey Wet		10	SS	16			
	Very Dense		11	SS	52		315	0 87 13 (SI+CL)
	occasional cobbles		12	SS	101/.275		314	
311.3							313	
15.2	Silty CLAY, trace gravel, trace sand Hard Grey (TILL)		13	SS	116/.275		312	
			14	SS	58		311	0 4 46 50
			15	SS	51		310	
							309	
							308	
							307	

SOIL PROFILE | SAMPLES | 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) (40 80 120 160 200) | 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 (%)

Continued Next Page

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

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

ONTMT4S 6417R.GPJ 4/16/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 08-026 3 OF 4 METRIC

G.W.P. 408-88-00 LOCATION N 4 814 474.88 E 226 422.03 ORIGINATED BY SA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.07.03 - 2008.07.04 CHECKED BY RPR

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 (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (40 80 120 160 200)	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
	Continued From Previous Page										
	Silty CLAY, trace gravel, trace sand Hard Grey (TILL)		16	SS	53		306				0 6 51 43
			17	SS	68		303				
			18	SS	100/ .150		300				
			~~19~~	~~SS~~	~~100/~~ .025		299				
	occasional cobbles and boulders						298				
297.3			20	SS	114/						
29.2	END OF BOREHOLE AT 29.2m. WATER LEVEL OBSERVED AT 4.5m DURING DRILLING. BOREHOLE BACKFILLED WITH BENSEAL TO 0.6m THEN				.225						

Continued Next Page

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

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

ONTMT4S 6417R.GPJ 4/16/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 08-026 4 OF 4 METRIC

G.W.P. 408-88-00 LOCATION N 4 814 474.88 E 226 422.03 ORIGINATED BY SA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.07.03 - 2008.07.04 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 40 80 120 160 200	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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	HOLEPLUG TO SURFACE.										

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

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

ONTMT4S 6417R.GPJ 4/16/09

Appendix B

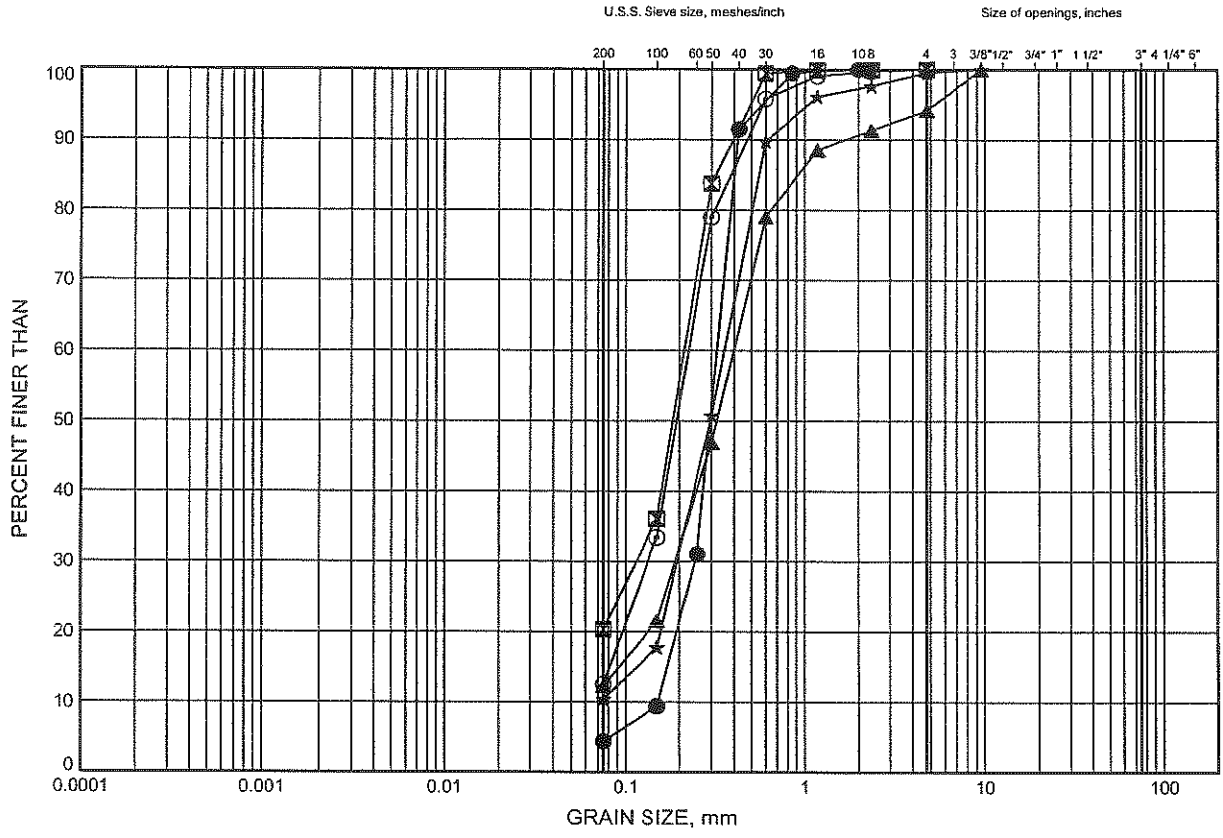
Laboratory Test Results

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B1

Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-022	1.83	320.42
⊠	08-022	9.45	312.80
▲	08-026	2.59	323.92
★	08-026	4.88	321.63
⊙	08-026	12.50	314.01

W.P.# 408-88-00
Prepared By AN
Checked By RPR

THURBER

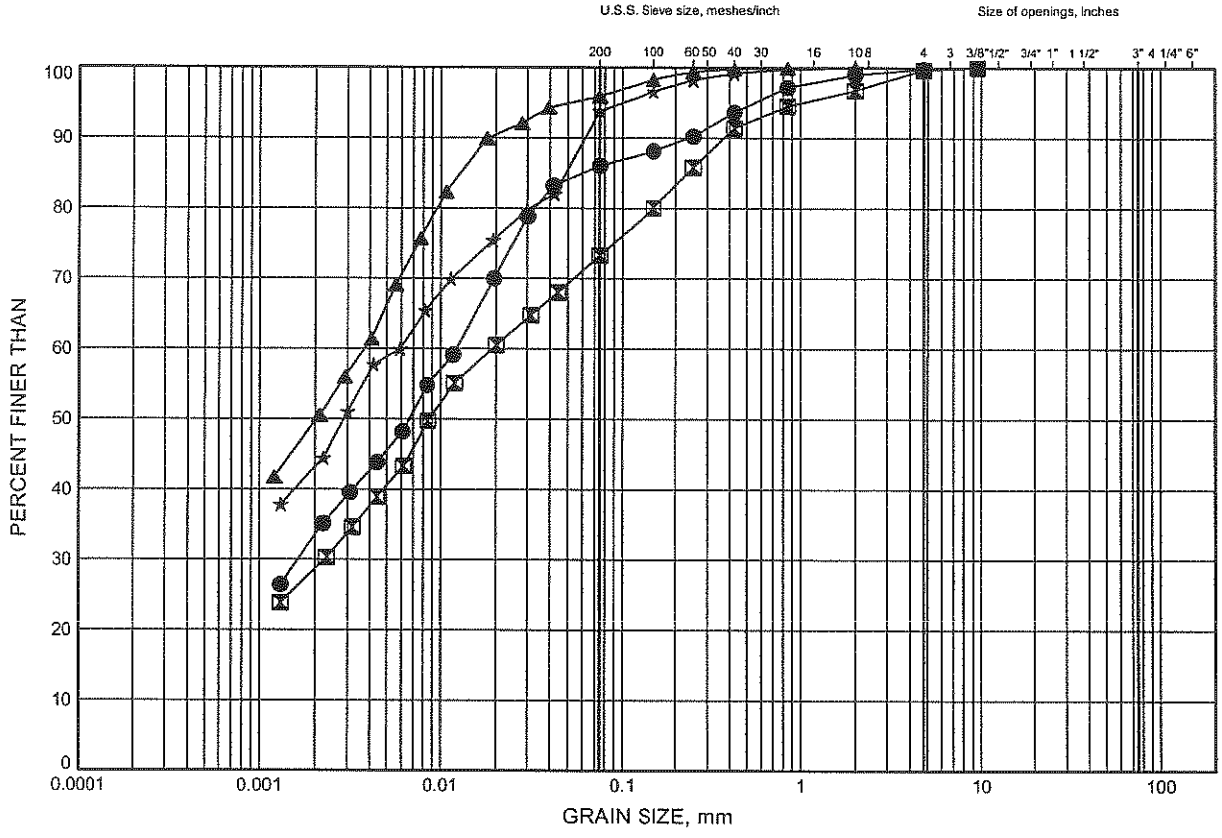
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 4/16/09

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B2

Silty Clay TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-022	4.88	317.38
⊠	08-026	7.92	318.59
▲	08-026	15.46	311.05
★	08-026	20.12	306.39

W.P.# 408-88-00
Prepared By AN
Checked By RPR

THURBER

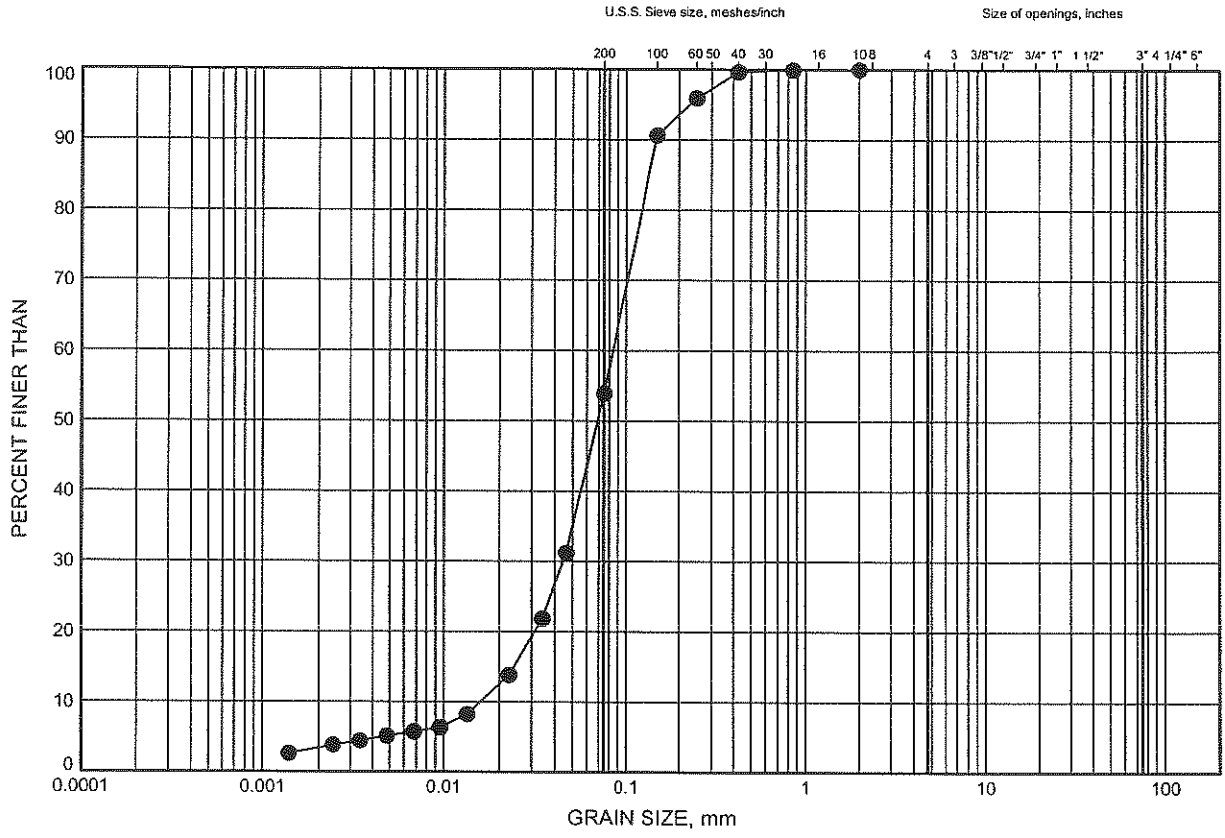
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 4/16/09

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B3

Sandy Silt TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-022	12.38	309.87

W.P.# 408-88-00
Prepared By AN
Checked By RPR

THURBER

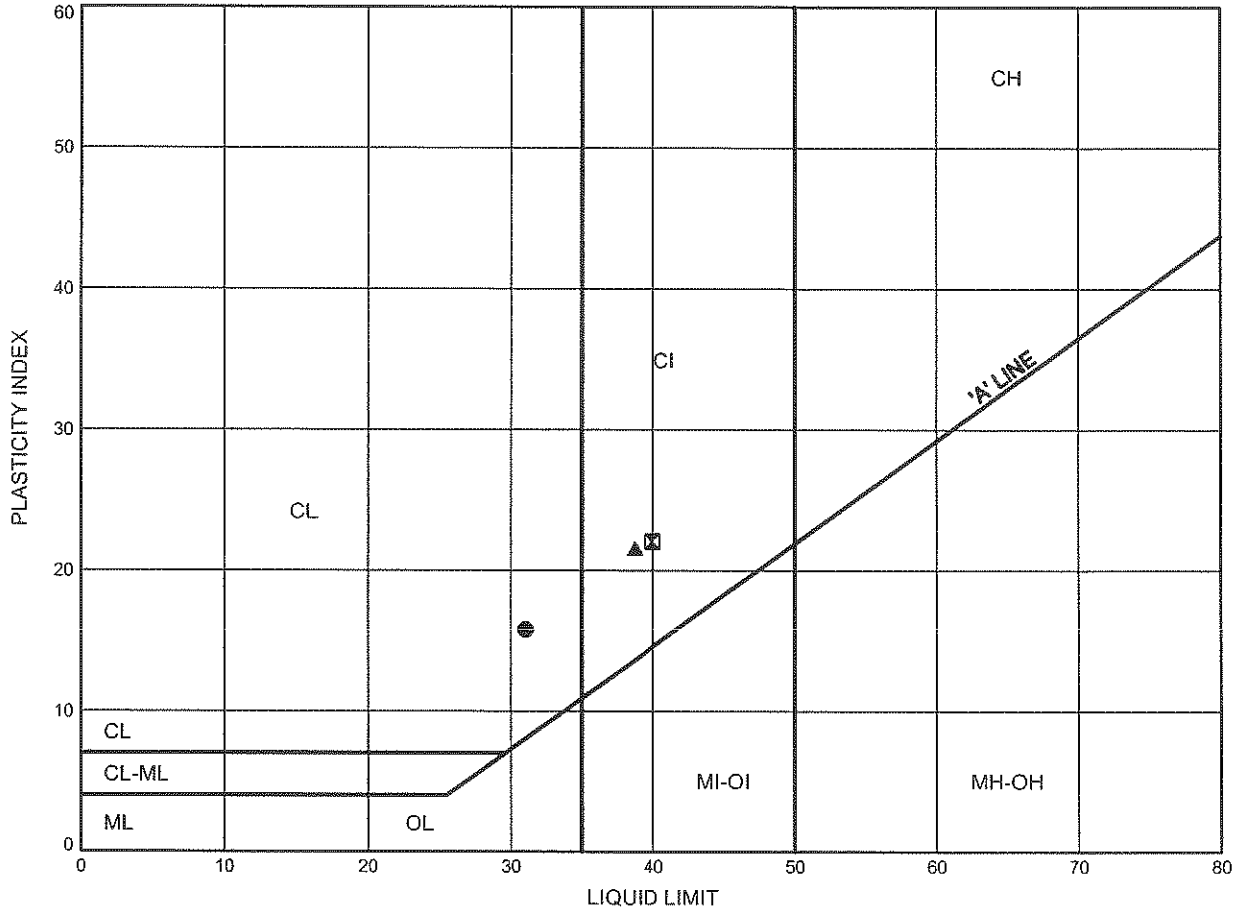
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 4/16/09

Highway 7 - New

ATTERBERG LIMITS TEST RESULTS

FIGURE B4

Silty Clay TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-022	4.88	317.38
⊠	08-026	15.46	311.05
▲	08-026	20.12	306.39

Date April 2009

Project 408-88-00

THURBER

Prep'd AN

Chkd. RPR

THURBALT 6417R.GPJ 4/16/09

Appendix C

Foundation Comparison

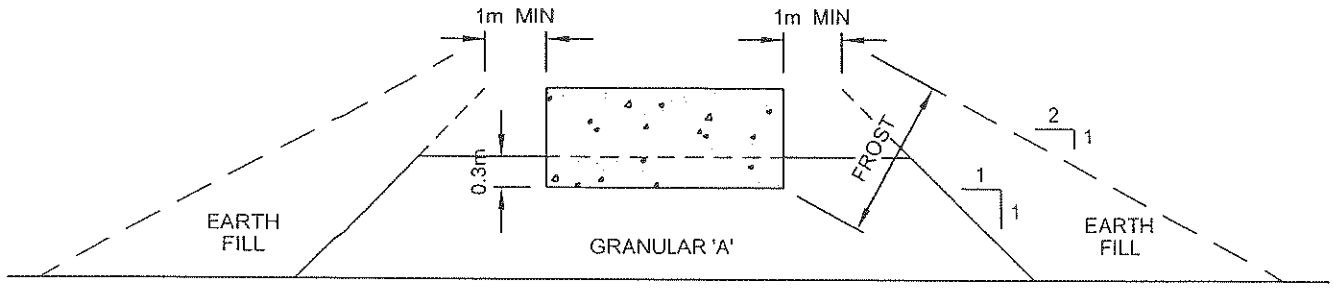
COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT

Foundation Element	Spread Footings	Spread Footings on Engineered Fill	Driven Piles
Abutments	*Advantages:* i. Generally less costly construction than deep foundation elements. *Disadvantages:* i. Lower geotechnical resistance available due to founding on compact soils near the surface. ii. Dewatering may be required, depending on depth of excavation. **NOT RECOMMENDED**	*Advantages:* i. Generally less costly construction than deep foundation elements. *Disadvantages:* i. Better geotechnical resistance than spread footings on native, but still influenced by the compact soils at the surface. ii. Dewatering may be required, depending on depth of excavation. **NOT RECOMMENDED**	*Advantages:* i. High geotechnical resistance may be developed by driving the piles into very dense/hard soils. ii. Comparatively short abutment stem possible iii. Permits integral abutment design *Disadvantages:* i. Higher unit cost compared to footings. ii. Very dense/hard soils at shallow depth will limit length of pile and geotechnical resistance that can be developed. iii. Possible presence of cobbles and boulders in the silty clay till and sandy silt till layers at the expected founding layer **RECOMMENDED**

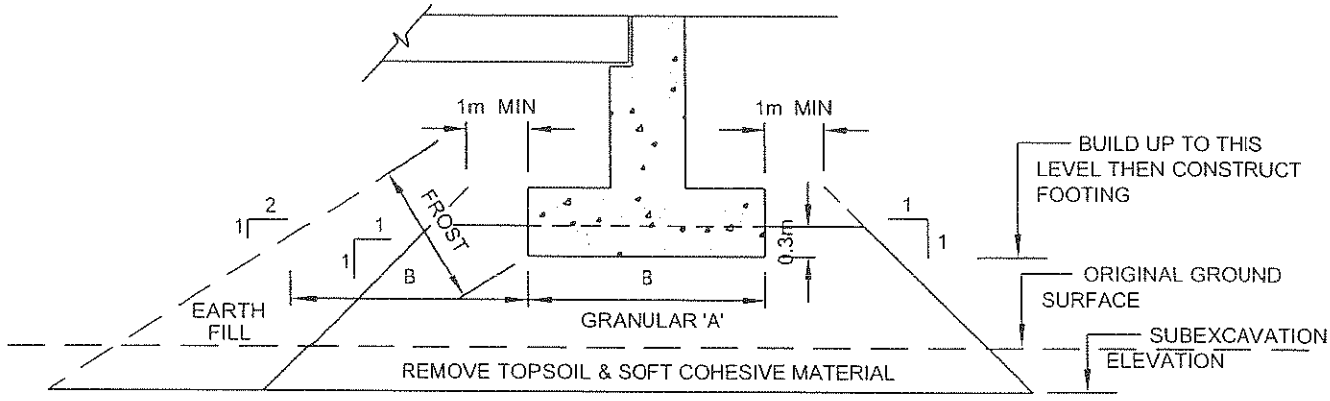
Appendix D

Figure

March , 2004



CROSS-SECTION



LONGITUDINAL SECTION

NOT TO SCALE

NOTES:

1. REMOVE TOPSOIL AND SOFT SILTY CLAY SUBSOIL UNDER FOOTPRINT OF COMPACTED GRANULAR 'A'.
2. PLACE GRANULAR 'A' AND EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO O.P.S.S. 501.
3. CONSTRUCT CONCRETE FOOTING.
4. PLACE REMAINDER OF GRANULAR 'A' AND EARTH FILL AS REQUIRED.
5. SOURCE M.T.C. 1982.

ENGINEER: AEG		
DRAWN: SS	ABUTMENT ON COMPACTED FILL SHOWING GRANULAR A CORE	
DATE: April , 2004		
APPROVED: PKC		
SCALE: NTS		DWG. NO. FIGURE 1

TED35146.DWG

Appendix E

Site Photographs

Photo 1. Looking at the east side of KWE and south side of Wellington Street. Borehole 08-022

Photo 2. Looking at the east side of KWE and south side of Wellington Street. Borehole 08-022

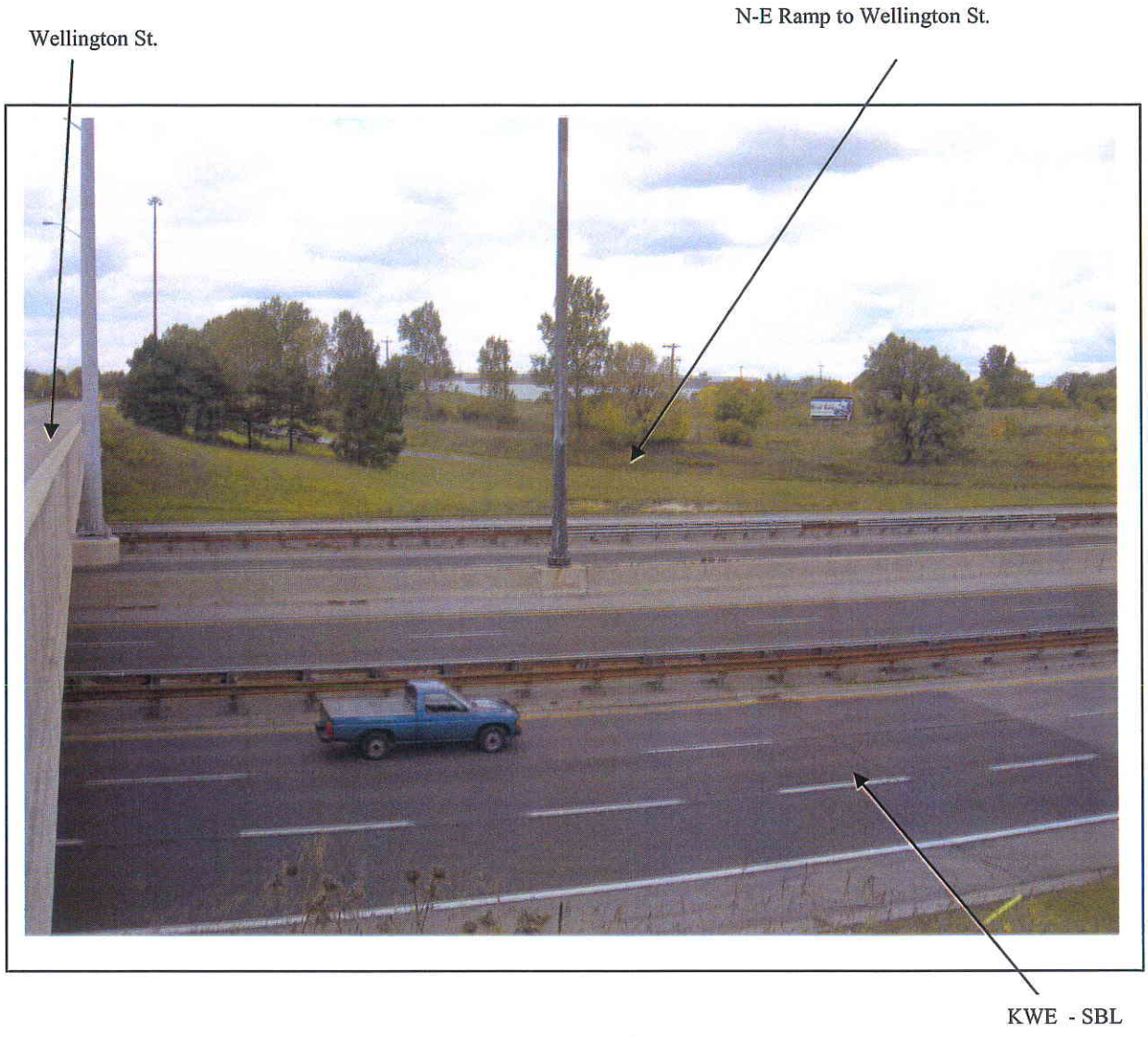
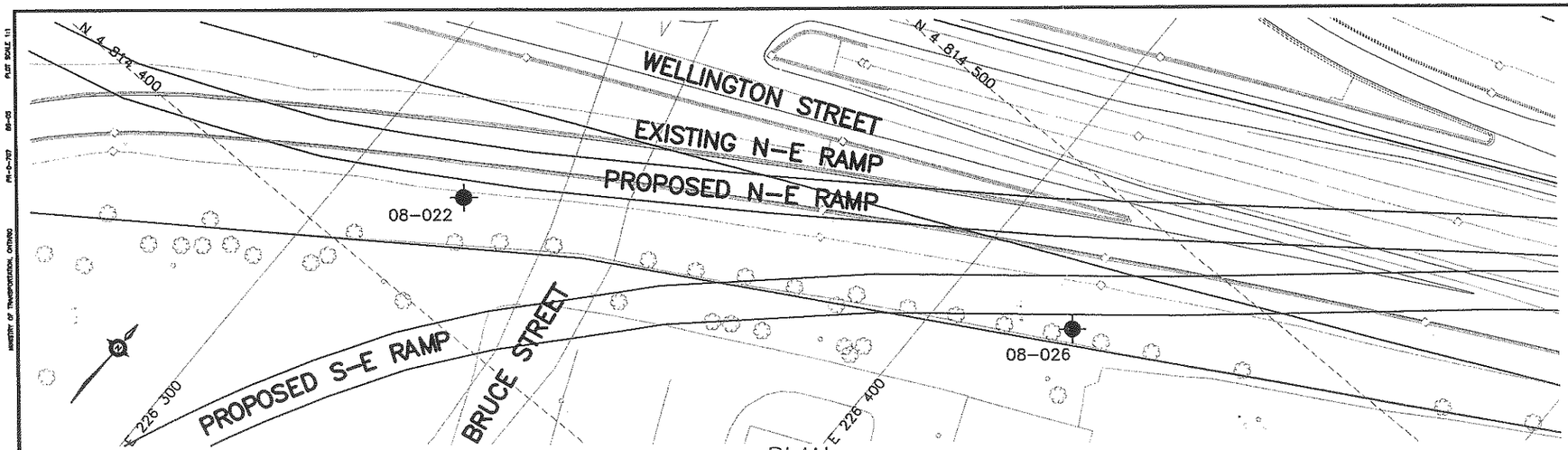


Photo 3. Looking at southeast quadrant of KWE & Wellington Street

Appendix F

Drawing titled "Borehole Locations and Soil Strata"

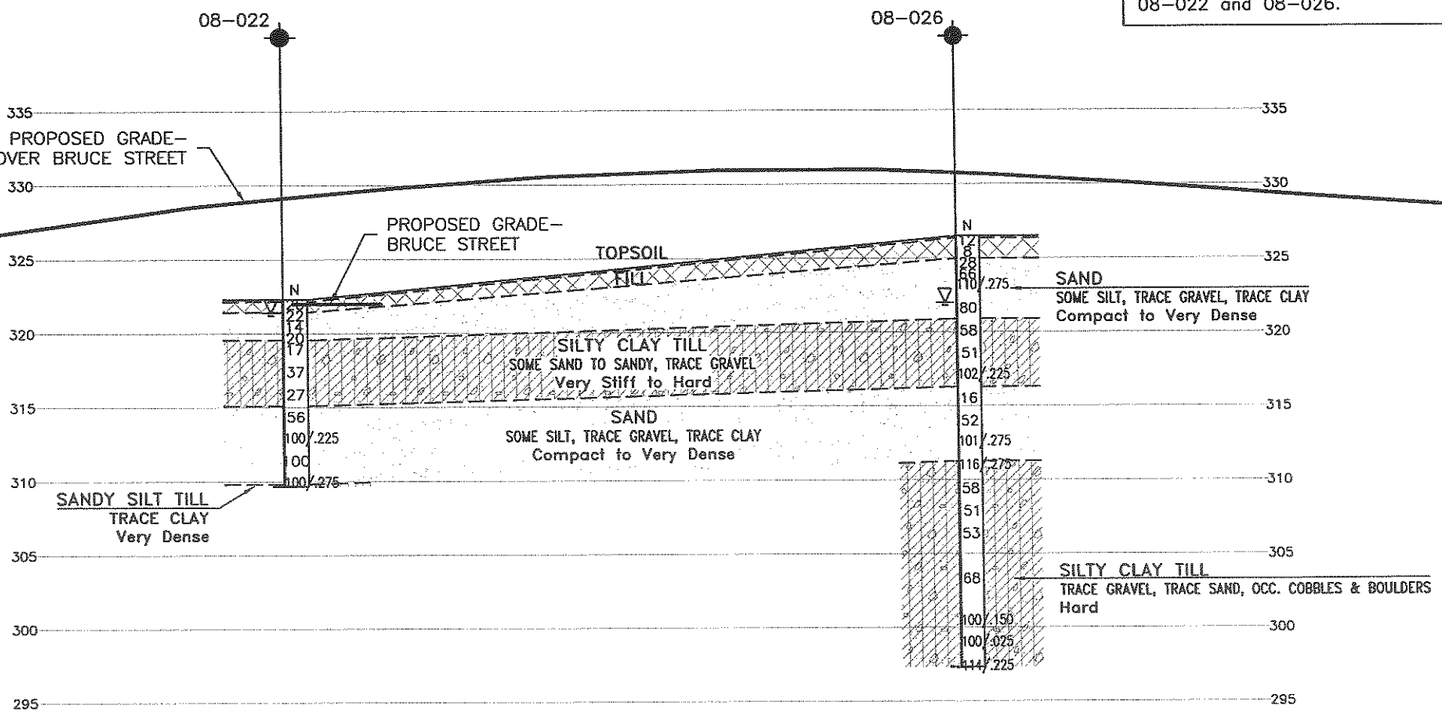


PLAN

0 20 40 60m

SCALE 1:1000

NOTE:
Boreholes at the proposed ramp structure were not drilled due to access restrictions. Accordingly, the stratigraphy has been extrapolated from the nearby Boreholes 08-022 and 08-026.



PROFILE ALONG ℄ OF PROP. S-E RAMP OVER BRUCE STREET

0 20 40 60m HOR 1:1000

0 8 16 24m VER 1:400

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

METRIC

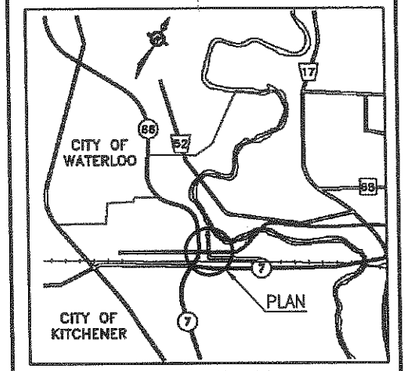
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 408-88-00

SHEET

HIGHWAY 7
RECOMMENDED ROUTE
S-E RAMP OVER BRUCE STREET
BOREHOLE LOCATIONS AND SOIL STRATA

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



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
08-022	322.3	4 814 421.5	226 319.7
08-026	326.5	4 814 474.9	226 422.0

-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.
3) Proposed grades are from Plate 2A of the E.A. Study.

GEOCRES No. 40P8-168

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
June 9/09
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
June 4/09
PROVINCE OF ONTARIO

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	PKC	CODE	LOAD	DATE	JUN. 2009
DRAWN	MFA	CHK	AEG	SITE	STRUCT	DWG	

FILENAME: H:\Drafting\15\64\17\1sd8417-BruceStreet.dwg

MINISTRY OF TRANSPORTATION, ONTARIO
PH-D-707 88-05
PLOT SCALE 1:1