

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

**Geocres Number: 40P8-167**

**Report to**

**Ministry of Transportation Ontario**  
**Southwestern Region**

Thurber Engineering Ltd.  
2010 Winston Park Drive, Suite 103  
Oakville, Ontario  
L6H 5R7  
Phone: (905) 829 8666  
Fax: (905) 829 1166

June 3, 2009  
File: 15-64-17

\\Torserver1\Projects\15\64\17 Hwy 7 New\Reports &  
Memos\Structures\N-E Ramp over EW-S Ramp - 10&12\15-  
64-17 NE Ramp over EW-S Ramp FIDR-Final.doc

## TABLE OF CONTENTS

### PART 1 FACTUAL INFORMATION

1	INTRODUCTION .....	1
2	SITE DESCRIPTION .....	1
3	SITE INVESTIGATION AND FIELD TESTING.....	2
4	LABORATORY TESTING .....	3
5	DESCRIPTION OF SUBSURFACE CONDITIONS .....	3
5.1	Topsoil .....	3
5.2	Upper Sand.....	3
5.3	Silty Clay Till and Silty Clay .....	3
5.4	Silty Sand Till .....	4
5.5	Lower Sand .....	5
5.6	Sandy Silt Till .....	5
5.7	Groundwater Conditions .....	6
6	MISCELLANEOUS .....	6

### PART 2 ENGINEERING DISCUSSION AND RECOMMENDATIONS

7	GENERAL.....	8
8	STRUCTURE FOUNDATIONS.....	8
8.1	Spread Footings on Native Soil .....	9
8.2	Spread Footings on Engineered Fill.....	10
8.3	Steel H-Piles.....	10
8.3.1	Axial Resistance .....	11
8.3.2	Downdrag .....	11
8.4	Abutment Design Considerations .....	12
8.5	Frost Cover.....	12
8.6	Recommended Foundation .....	12
9	BRIDGE APPROACHES AND EMBANKMENTS .....	12
10	CONSTRUCTION CONCERNS .....	13
11	INVESTIGATION FOR DETAIL DESIGN.....	14
12	CLOSURE .....	14

## Appendices

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Foundation Comparison
Appendix D	Figure
Appendix E	Slope Stability Output
Appendix F	Site Photographs
Appendix G	Drawing titled "Borehole Locations and Soil Strata"

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

**Geocres Number: 40P8-167**

**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual findings obtained from a preliminary foundation investigation conducted at the site of the proposed N-E entrance ramp to Highway 7 over the Wellington Street E/W-S Ramp in the Regional Municipality of Waterloo. The proposed N-E ramp is part of the Highway 7-New project.

The purpose of the 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, a stratigraphic profile, 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 detail 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**

The site lies in the northwest quadrant of existing Kitchener Waterloo Expressway and Wellington Street interchange in Waterloo, Ontario. At this location, the proposed N-E Ramp to Highway 7 will cross over the proposed Wellington Street E/W-S Ramp.

Three photographs of the site are included in Appendix F 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 site investigation and field testing at this site was carried out from July 14 to 16, 2008. Two boreholes, numbered 08-010 and 08-012, were drilled approximately at the north and south abutments of a possible single-span structure arrangement. The depths of Boreholes 08-010 and 08-012 were 12.6 m and 29.3 m (Elevations 304.9 and 288.3), 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 G.

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 track-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. In Borehole 08-010, drilled at the proposed north abutment, a standpipe piezometer consisting of 25 mm diameter PVC pipe with a slotted screen was installed and enclosed in filter sand to permit longer term groundwater level monitoring. The location and completion details of the piezometer are shown in Table 3.1. Borehole 08-012 without piezometer installation was grouted with bentonite upon completion. The borehole completion details are shown in Table 3.1.

The completion of the borehole and the standpipe piezometer were carried out in accordance with the requirements of O. Reg. 903 (as amended by O. Reg. 372/07).

**Table 3.1 – Borehole Completion Details**

<b>Foundation Unit</b>	<b>Borehole Location</b>	<b>Piezometer Tip Depth/Elevation (m)</b>	<b>Completion Details</b>
North abutment	08-010	12.6/304.8	Piezometer with 1.5 m slotted screen installed with sand filter to 10.0 m, holeplug from 10.0 m to 9.8 m, grout and auger cuttings to surface.
South abutment	08-012	No Installation	Borehole backfilled with bentonite benseal to 0.3 m, then holeplug to surface.

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**

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

In general, the site is underlain by topsoil overlying native layers of sand, silty clay till, silty clay and sandy silt till.

##### **5.1 Topsoil**

Topsoil was encountered surficially in both boreholes. Thickness of topsoil was 100 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 Upper Sand**

A 0.4-m thick layer of native brown sand was contacted below the topsoil in Borehole 08-010. This upper sand extended to 0.5 m depth (Elevation 317.0).

##### **5.3 Silty Clay Till and Silty Clay**

Native brown to grey silty clay till and silty clay containing trace sand to sandy, trace gravel were contacted below topsoil and upper native sand layer and at lower depths as indicated in Table 5.1.

**Table 5.1 – Depths and Elevations of Native Silty Clay and Silty Clay Till**

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
North abutment	08-010	0.5 to 2.7*	317.0 to 314.7	2.2
		3.8 to 6.1	313.6 to 311.3	2.3
South abutment	08-012	0.1 to 7.6	317.6 to 310.0	7.5
		8.5 to 24.1	309.1 to 293.6	15.6

\* Silty clay till

The cohesive layer is very stiff to hard in consistency, based on SPT 'N' values ranging from 15 to 93 blows per 0.3 m of penetration. The moisture content varied from 8% to 21%.

Grain size distribution curves for selected silty clay and silty clay till samples are presented on the Record of Borehole sheets and on Figures B1 and B2 Appendix B. Atterberg Limits test results are presented on Figure B6 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 1
Sand	0 to 33
Silt	36 to 45
Clay	28 to 64

Liquid Limit	23 to 52
Plastic Limit	16 to 21

The above results show that the silty clay and silty clay till are 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.

#### 5.4 Silty Sand Till

Native grey silty sand till containing trace gravel and trace clay was contacted below the silty clay till in Borehole 08-010 at 2.7 m depth (Elevation 314.7).

Thickness of this layer was 1.1 m. The depth to the base of the silty sand till was 3.8 m (Elevation 313.6).

Grain size distribution curve for a silty sand 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	5
Sand	64
Silt	21
Clay	10

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

### 5.5 Lower Sand

Lower layers of grey sand containing trace to some silt, trace gravel and trace clay was contacted at depths and elevations indicated in Table 5.2.

**Table 5.2 – Depths and Elevations of Native Lower Sand**

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
North abutment	08-010	6.1 to 12.3	311.3 to 305.2	6.2
South abutment	08-012	7.6 to 8.5	310.0 to 309.1	0.9
		27.7 to 27.9	290.0 to 289.8	0.2

The sand is classified as dense to very dense, based on SPT values ranging from 60 blows for 0.3 m of penetration to higher than 100 blows per 0.15 m of penetration. In Borehole 08-010, an SPT 'N' value of 4 blows per 0.3 m of penetration, indicating a loose relative density, was measured at 7.4 m depth (Elevation 310.0). However, this value may be due to soil disturbance due to unbalanced water head. The natural moisture content ranged from 10% to 19%.

Grain size distribution curves for lower sand samples tested are presented on the Record of Borehole sheets and on Figure B4 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Sand (%)
Gravel	0 to 3
Sand	87 to 90
Silt & Clay	7 to 13

### 5.6 Sandy Silt Till

Grey sandy silt till containing trace gravel and some clay was contacted at 12.3 m and 24.1 m depth (Elevations 305.2 and 293.6) in Boreholes 08-010 and 08-012, respectively. Both boreholes were terminated within the sandy silt till layer at 12.6 m and 29.3 m (Elevations 304.9 and 288.3).



SPT 'N' values measured in the sandy silt till ranged from 52 blows for 0.3 m of penetration to higher than 100 blows per 0.225 m of penetration, indicating a very dense relative density. The natural moisture contents generally lay in the range of 10 to 20%.

Grain size distribution curves for two samples tested are presented on the Record of Borehole sheets and on Figure B5 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	7 to 9
Sand	47 to 54
Silt	30 to 33
Clay	9 to 11

Although not encountered in the boreholes, this glacial till layer may contain cobbles and boulders which may account for some high SPT 'N' values and resistance to augering.

### 5.7 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. A standpipe piezometer was installed in Borehole 08-010 (north abutment) to monitor water levels after completion of drilling. The water levels measured in the piezometer are summarized in Table 5.3.

Table 5.3 – Water Level Measurements

Foundation Unit	Borehole	Date (2008)	Water Level (m)		Comment
			Depth	Elevation	
North abutment	08-010	July 16	6.3	311.1	In piezometer
		August 20	5.9	311.5	

The piezometric reading indicates that the groundwater level is near Elevation 311.5 m.

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

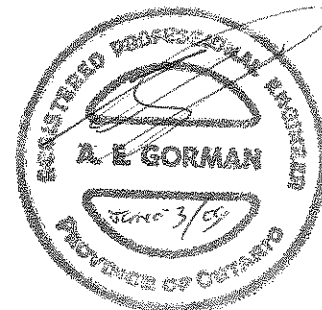
Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.

Thurber Engineering Ltd.

Rocio Palomeque Reyna, P.Eng.  
Geotechnical Engineer



Alastair E. Gorman, P.Eng.  
Senior Foundations Engineer



P.K. Chatterji, P.Eng.  
Review Principal, Designated MTO Contact



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

**Geocres Number: 40P8-167**

**PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS**

**7 GENERAL**

This report presents interpretation of the 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.

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

- The N-E entrance ramp to Highway 7 will cross over the Wellington Street E/W-S Ramp. The proposed finished grade of the N-E ramp will be 335.6. The existing ground surface in the vicinity of the proposed ramp structure is near Elevations 317.5. Hence, N-E ramp embankments will be about 18.0 m high relative to the surrounding grade.
- The new grade of the proposed Wellington Street E/W-S Ramp will be at elevation 318.4. Cut and fill of approximately 1.0 m will be required to establish the E/W-S ramp grade.

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 stratigraphy identified in the preliminary investigation consisted primarily of topsoil overlying native layers of compact to very dense upper sand and silty sand, very stiff to hard silty clay till and silty clay and lower layers of very dense sand and sandy silt till. The groundwater level measured in the piezometer was at 5.9 m (Elevation 311.5) below the ground surface.

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

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

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.

The design of spread footings bearing on native undisturbed very stiff to hard silty clay till and silty clay must be in accordance with the elevations and bearing resistances given in Table 8.1.

**Table 8.1 – Bearing Resistances for Spread Footings**

Element	Depth (m)	Elev.	ULS <sub>r</sub> (kPa)	SLS (kPa)
North abutment (BH 08-010)	1.0	316.4	375	250
	2.4	315.0	600	400
South abutment (BH 08-012)	0.7	317.0	300	200
	4.7	313.0	450	300
	7.7	310.0	600	400

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.

Founding elevations presented in Table 8.1 are generally above groundwater level measured in the piezometer. However, if temporary excavations required to construct these footings extend in cohesionless soils below the water table, groundwater control will be required prior to excavation to construct the footings in the dry, to prevent sloughing of the sides and to prevent disturbance of the footing bases due to the inflow of groundwater.

## 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, or other deleterious materials must be stripped from the footprint of the foundation to expose competent native subgrade material. The engineered fill should bear on native very stiff silty clay till or silty clay and the highest permitted founding elevations at which engineered fill pads may be placed, are given in Table 8.2.

**Table 8.2 – Founding Elevations for Engineered Fill Pads**

<b>North Abutment (BH 08-010)</b>	<b>South Abutment (BH 08-012)</b>
316.8	316.9

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  $\pm 2\%$ . 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 soil stratigraphy encountered at this site 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 very dense sand and sandy silt till encountered at this site. Based on an HP 310 X 110 pile, a minimum embedment depth of 6 m is required. The preliminary information in EA Plates 2A and 2B indicates that this depth of embedment can be achieved at the abutments. The depths and

elevations at which the H-piles are expected to develop the required resistance are given in Table 8.3.

**Table 8.3 – Estimated Pile Tip Elevation**

Foundation Unit	Pile Tip Depth (m)	Highest Pile Tip Elevation	Soil
West Abutment (BH 08-010)	10.4	307.0	Very dense sand
North abutment (BH 08-012)	27.2	290.5	Very dense sandy silt 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 very dense sand and very dense sandy silt till are presented in Tables 8.4.

**Table 8.4 – Axial Resistance of Two Pile Sections Founded on 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 glacial sandy silt till layer at the expected founding layer, 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, as frost protection.

#### **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 sandy silt till, despite the higher cost noted in Appendix C.

### **9 BRIDGE APPROACHES AND EMBANKMENTS**

Based on the two boreholes drilled at the site, the approach embankments will be constructed over very stiff to hard silty clay and silty clay till.

Preliminary analysis indicates that at the abutments, settlement in the order of 55 to 65 mm is estimated in the foundation soils under the loading imposed by approximately 18.0 m of the approach fill. Due to the stiff to hard nature of the foundation soils, these settlements, as well as the settlements of the fill itself, will be essentially completed when construction of the fill is completed. Further settlement analysis should be conducted during the detail phase design.

The 18.0 m high embankments likely to be constructed will be stable at side slopes of 2H:1V if constructed using SSM or granular fill. Where earth fill embankments are higher than 8 m, mid-height berms should be incorporated in the design. The berms should:

- extend for the length through which the embankment height exceeds 8 m
- be at least 2 m wide
- have 2% positive grade to shed run-off water.

For the purpose of preliminary embankment stability analyses, the commercially available slope stability program GSLOPE developed by Mitre Software Inc. was used. The Bishop's simplified method for stability analysis was employed.

Global stability analyses were conducted for 2H:1V SSM or earth fill embankments. The stability of the embankments was also checked under seismic loading assuming an acceleration of 0.08g. The computed factors of safety are as shown in Table 9.1. Slope stability computation outputs are included in Appendix E.

**Table 9.1 Computed Factors of Safety**

<b>Location / Material</b>	<b>Condition</b>	<b>Factor of Safety</b>	<b>Figure (Appendix E)</b>
<b>18 m High</b>			
Earth Fill	Normal	1.3	1
Earth Fill	Seismic = 0.08g	1.1	2

These factors of safety are considered to be acceptable for the proposed embankment bearing on cohesive soil.

The global, internal and surficial stability of the approach embankment fills should be further evaluated during the detail design phase.

During detail design, when the grade has been finalized, permanent drainage and slope protection requirements must be addressed.

## **10 CONSTRUCTION CONCERNS**

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

### **1. Pile refusal at higher elevation.**

Although there was little direct evidence of their presence during drilling, glacial till deposits inherently contain 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 re-driving 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 the detail design phase of the project, additional site investigation and field testing will be required. The following minimum program is recommended:

1. Boreholes for structure foundations.

Additional boreholes may be required for the structure foundations, especially if the structure is built off the current N-E ramp to Highway 7 over E/W-S ramp to Wellington Street alignment and thus removed from the alignment of the current investigation.

2. Boreholes for approaches.

A minimum of one borehole is recommended in each approach fill.

## 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.

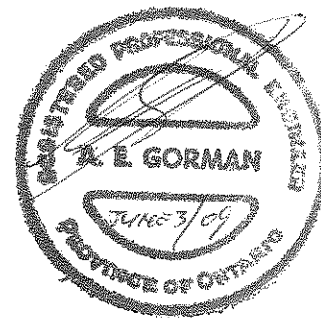
The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

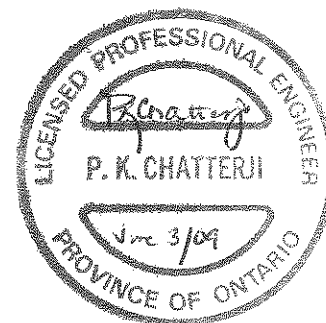
Rocío Palomeque Reyna, P.Eng., M.Eng.  
Geotechnical Engineer



Alastair E. Gorman, P.Eng.,  
Senior Foundations Engineer



P. K. Chatterji, P.Eng.,  
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 <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

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

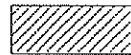
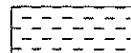



 Water Level  
 Shear Strength Determination by Pocket Penetrometer

- (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

ROCK WEATHERING CLASSIFICATION		SYMBOLS			
Fresh (FR)	No visible signs of weathering.				
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE		
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE		
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE		
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL		
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)		
DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
TERMS		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 0.3 m of core run.				

RECORD OF BOREHOLE No 08-010

1 OF 2

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 523.45 E 226 013.77 ORIGINATED BY SLL  
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA  
DATUM Geodetic DATE 2008.07.14 - 2008.07.15 CHECKED BY RPR

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		
317.4	TOPSOIL: (100mm), with roots and rootlets											
0.0												
0.1												
317.0	SAND, trace silt Brown Moist											
0.5												
	Silty CLAY, some sand to sandy, trace gravel, trace rootlets Very Stiff Brown (TILL)		1	SS	27		317					
			2	SS	16		316					
	Hard Grey											
314.7			3	SS	56		315					1 33 38 28
2.7	Silty SAND, trace gravel, trace clay Very dense Grey Moist to Wet (TILL)											5 64 21 10
			4	SS	101		314					
313.6												
3.8	Silty CLAY Hard Grey											
			5	SS	34		313					0 0 36 64
							312					
311.3												
6.1	SAND, trace to some silt, trace clay Very Dense Grey Moist to Wet		6	SS	100/ 250		311					
	Loose											
							310					
			7	SS	4							0 89 11 (SI+CL)
							309					
	Trace to some gravel Very Dense		8	SS	100/ 125		308					

Continued Next Page

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

RECORD OF BOREHOLE No 08-010

2 OF 2

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 523.45 E 226 013.77 ORIGINATED BY SLL  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA  
 DATUM Geodetic DATE 2008.07.14 - 2008.07.15 CHECKED BY RPR

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		
	Continued From Previous Page							SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE						
								WATER CONTENT (%)						
								20	40	60	80	100		
305.2	SAND, some silt, trace clay Very Dense Grey Wet		9	SS	100/ 150		307							0 87 13 (SI+CL)
12.3														
304.9	Sandy SILT, some clay Very Dense Grey Moist (TILL)		10	SS	100/ 225		306							
12.6	END OF BOREHOLE AT 12.6m. Piezometer installation consists of 25mm diameter schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.07.16 6.3 311.1 2008.08.20 5.9 311.5						305							



RECORD OF BOREHOLE No 08-012

1 OF 3

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 492.60 E 226 030.18 ORIGINATED BY SLL  
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA  
DATUM Geodetic DATE 2008.07.15 - 2008.07.16 CHECKED BY RPR

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			w <sub>p</sub>	w	w <sub>L</sub>		GR	SA	SI	CL	
								○ UNCONFINED	+ FIELD VANE										
								● QUICK TRIAXIAL	× LAB VANE										
317.7						20	40	60	80	100	20	40	60						
0.0	TOPSOIL: (100mm), with roots and rootlets																		
0.1	Silty CLAY, trace sand, trace rootlets Very Stiff to Hard Brown		1	SS	17														
			2	SS	21														
			3	SS	15											0	4	37	59
	sand seams Mottled Brown to Grey		4	SS	17														
			5	SS	34											0	0	45	55
			6	SS	29														
310.0																			
7.6	SAND, trace silt Very Dense Grey Wet		7	SS	60											3	90	7	(SI+CL)
309.1																			
8.5	Silty CLAY, trace sand Hard Grey		8	SS	93														

Continued Next Page

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 08-012

2 OF 3

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 492.60 E 226 030.18 ORIGINATED BY SLL  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA  
 DATUM Geodetic DATE 2008.07.15 - 2008.07.16 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  Y  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				
								20	40			60
	Continued From Previous Page											
	Silty CLAY, trace sand Hard Grey		9	SS	51	307						0 1 44 55
						306						
						305						
						304						
						303						
						302						0 3 36 61
						301						
						300						
						299						
						298						
			Layer of sand: (100mm)		10	SS	79					
			11	SS	48							
			12	SS	33							
			13	SS	67							
			14	SS	42							

Continued Next Page

+ 3 . X 3 : Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 08-012

3 OF 3

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 492.60 E 226 030.18 ORIGINATED BY SLL  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA  
 DATUM Geodetic DATE 2008.07.15 - 2008.07.16 CHECKED BY RPR

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										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE												
								● QUICK TRIAXIAL × LAB VANE												
	Continued From Previous Page						20 40 60 80 100													
	Silty CLAY Hard Grey		15	SS	47															
							297													
							296													
							295													
			16	SS	67		294													
293.6																				
24.1	Sandy SILT, some clay, trace gravel Very Dense Grey Wet (TILL)		17	SS	52		293									9 47 33 11				
							292													
			18	SS	100/ .150		291													
							290									7 54 30 9				
	Layer of sand. (200mm)		19	SS	100/ .175		289													
288.3			20	SS	100/ 225															
29.3	END OF BOREHOLE AT 29.3m. BOREHOLE BACKFILLED WITH BENTONITE BENSEAL TO 0.3m THEN HOLEPLUG TO SURFACE.																			

ONTWT4S 6417R.GPJ 9/15/08

+ 3 × 3 : Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

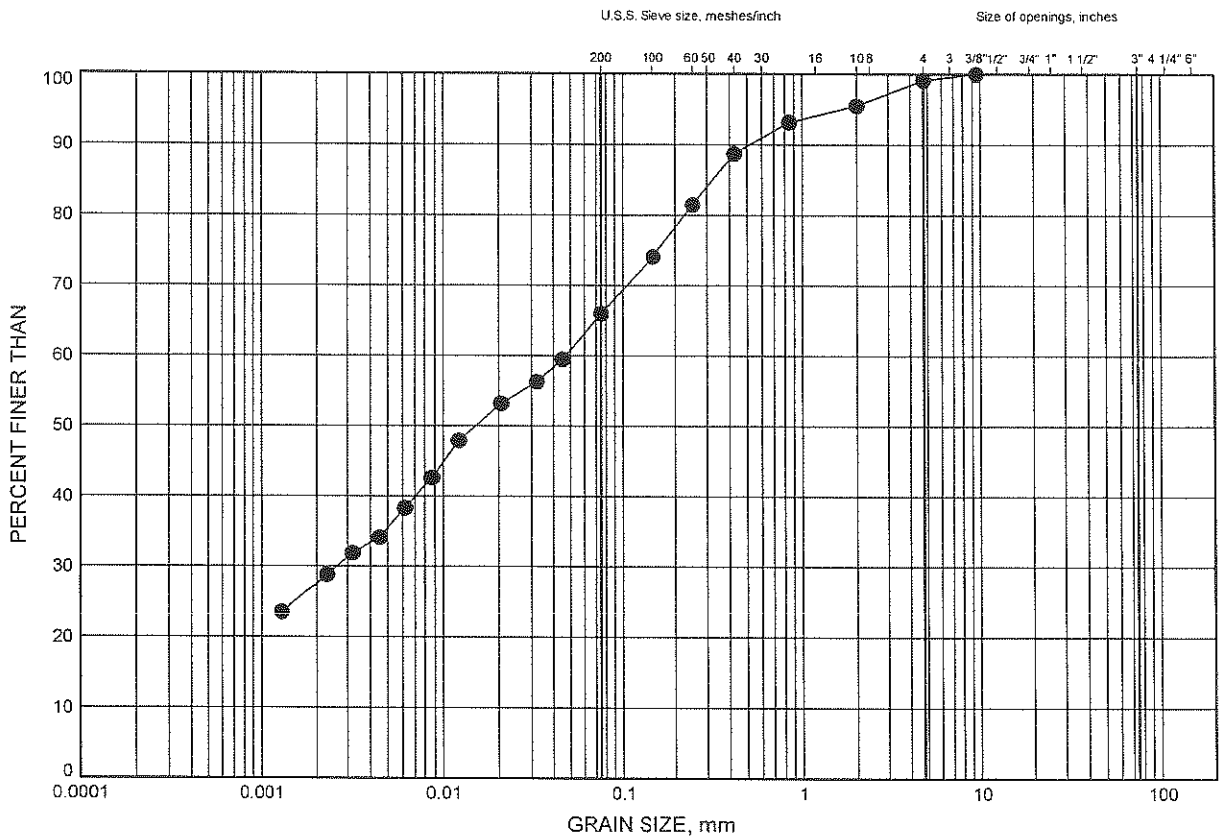
## **Appendix B**

### **Laboratory Test Results**

# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B1

Silty Clay Till



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-010	2.50	314.94

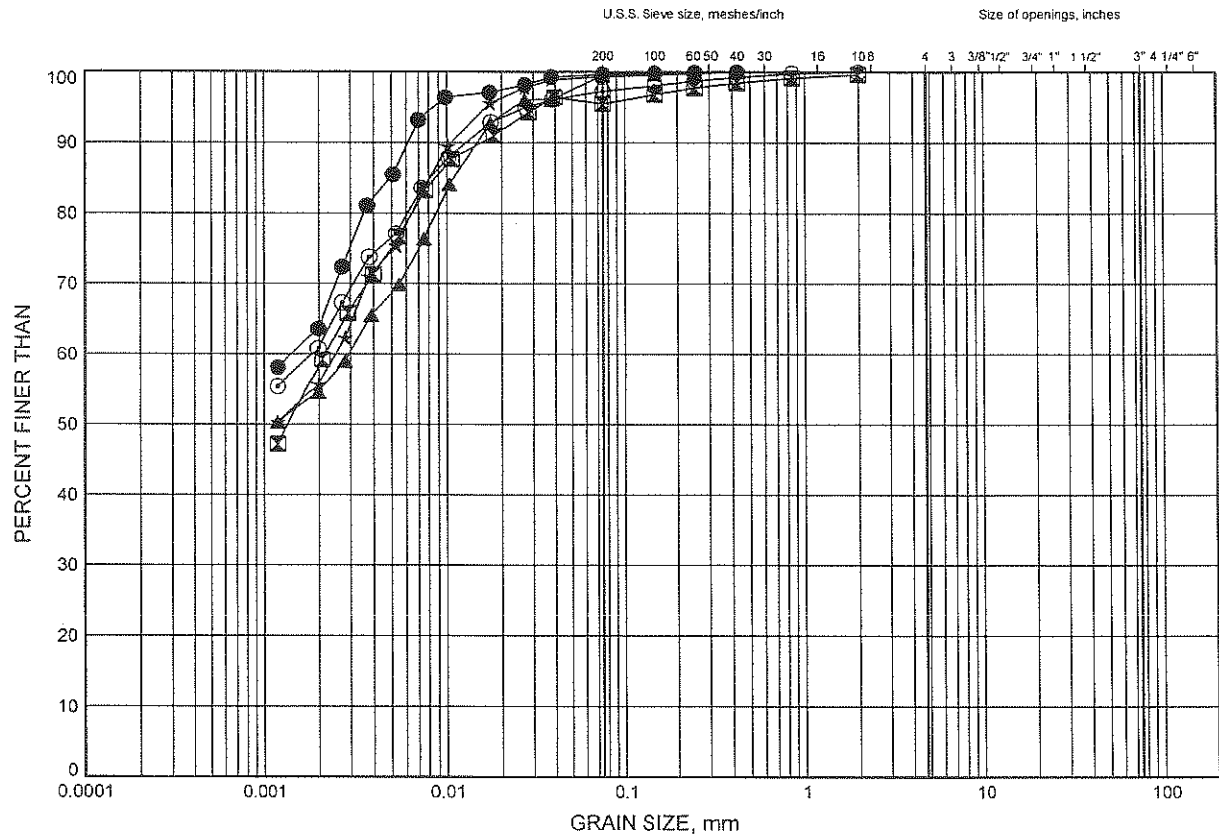


W.P.# 408-88-00  
Prepared By MFA  
Checked By RPR

# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B2

Silty Clay



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-010	4.88	312.57
⊠	08-012	2.59	315.08
▲	08-012	4.88	312.79
☆	08-012	10.90	306.77
⊙	08-012	15.54	302.13

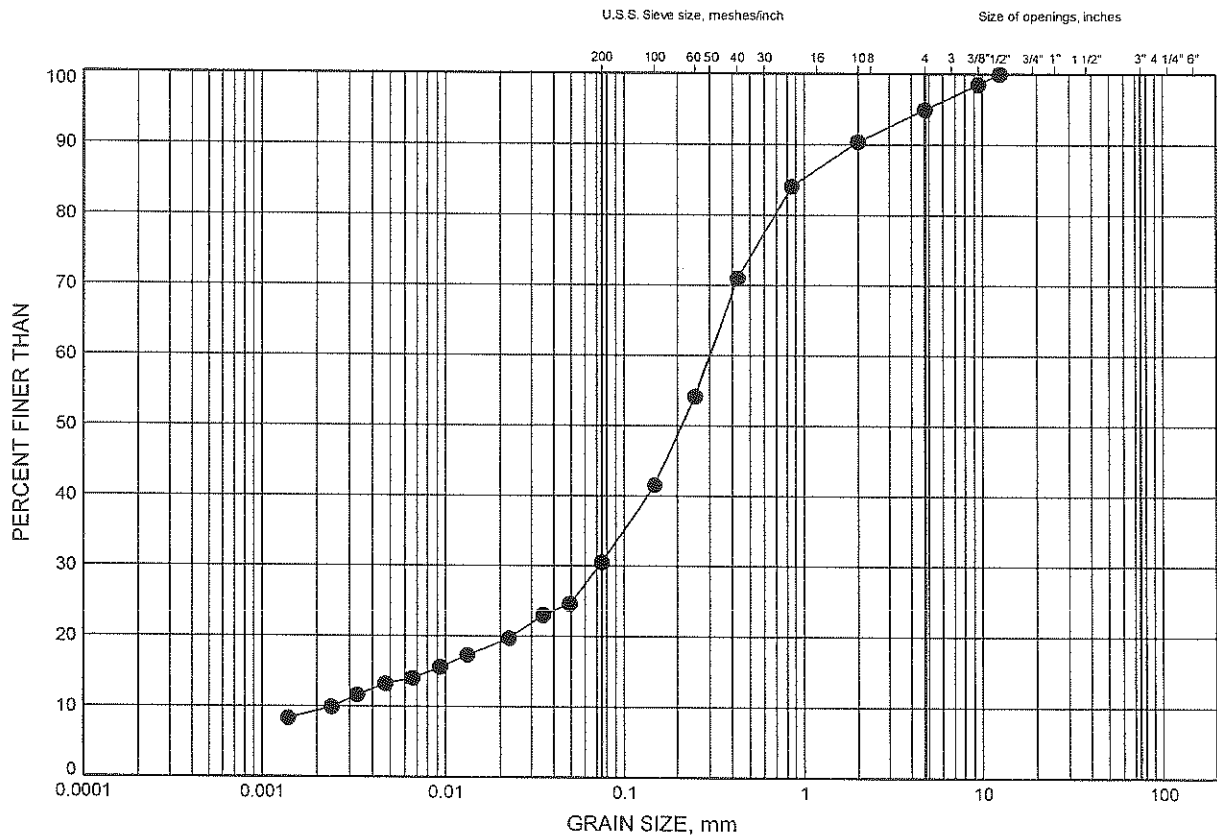


W.P.# 408-88-00  
Prepared By MFA  
Checked By RPR

# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B3

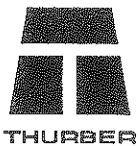
Silty Sand Till



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

## LEGEND

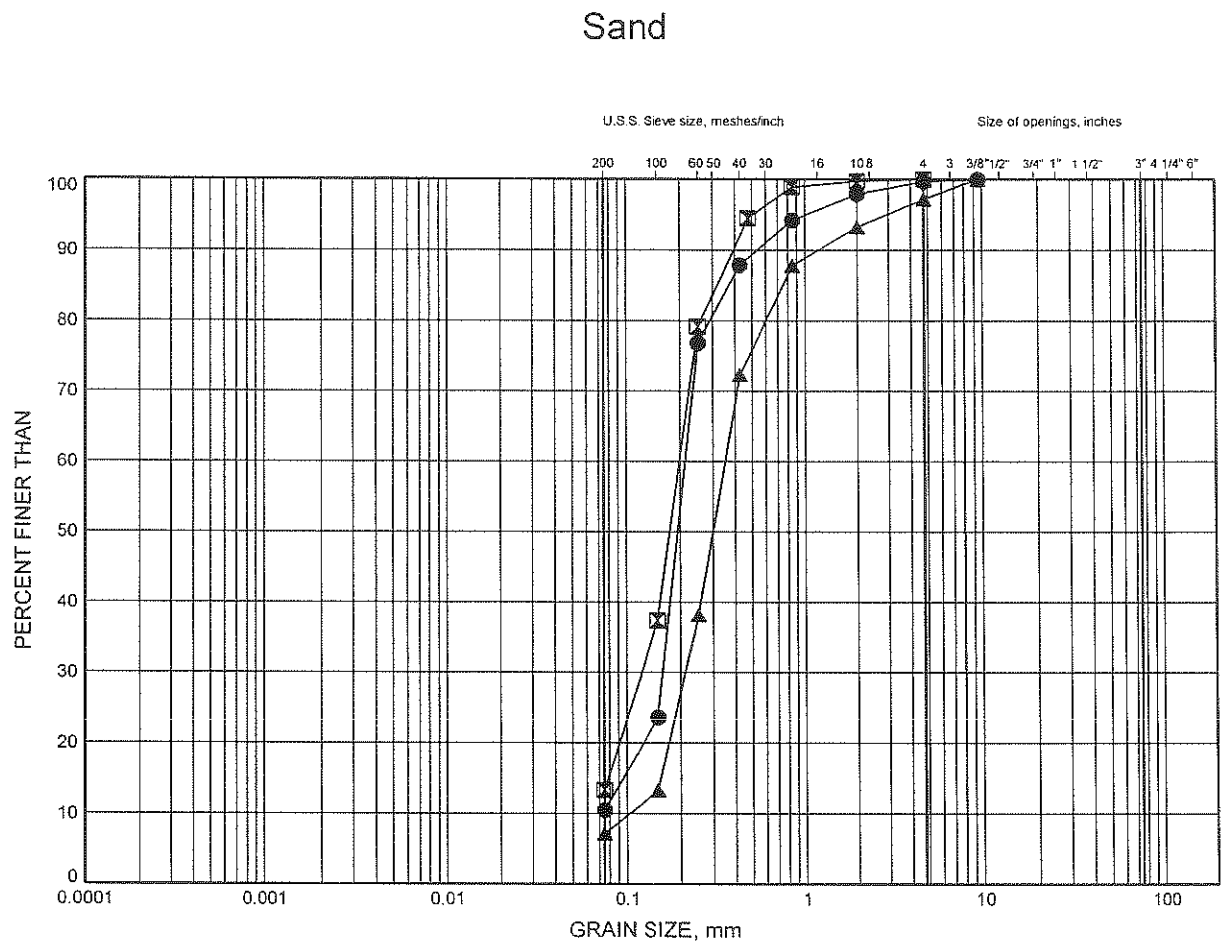
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-010	2.80	314.65



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

# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B4



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-010	7.92	309.52
⊠	08-010	10.77	306.67
▲	08-012	8.09	309.58



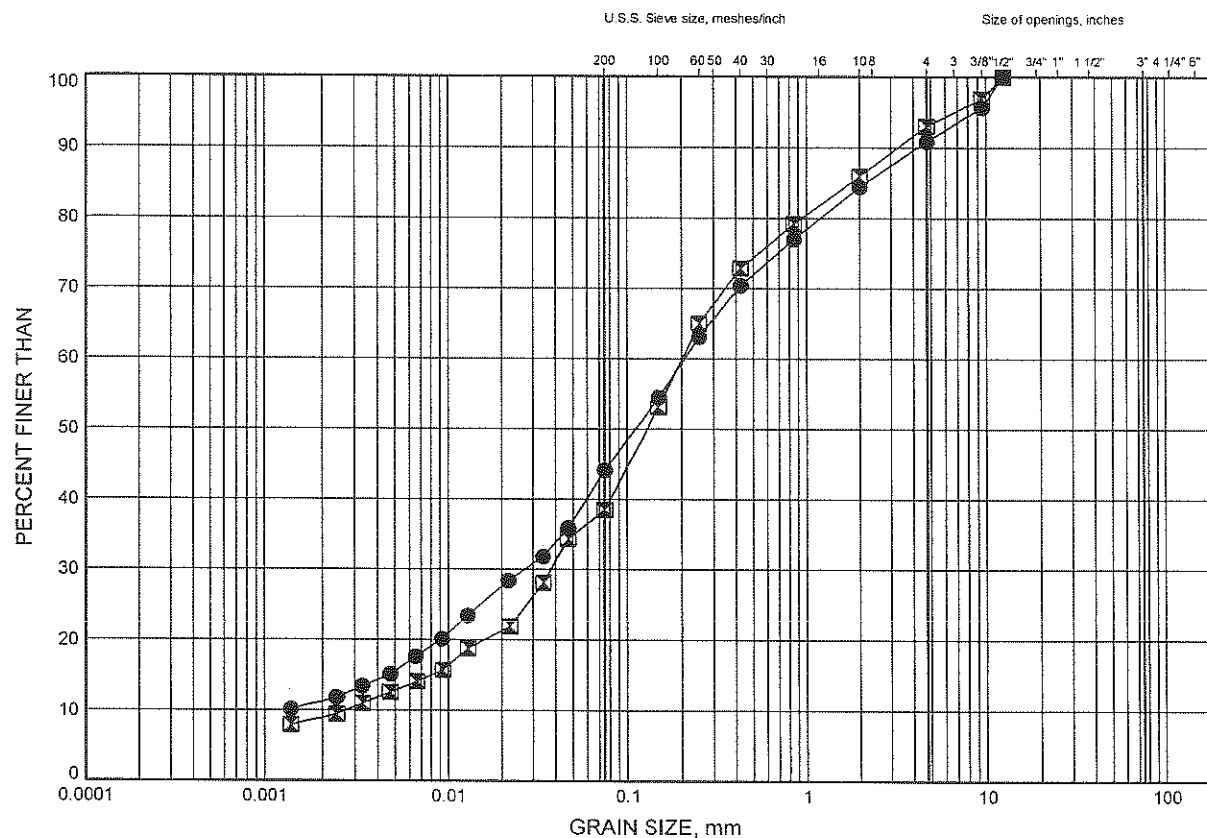
W.P.# 408-88-00  
Prepared By MFA  
Checked By RPR



# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B5

## Sandy Silt Till



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-012	24.69	292.98
◻	08-012	27.74	289.93

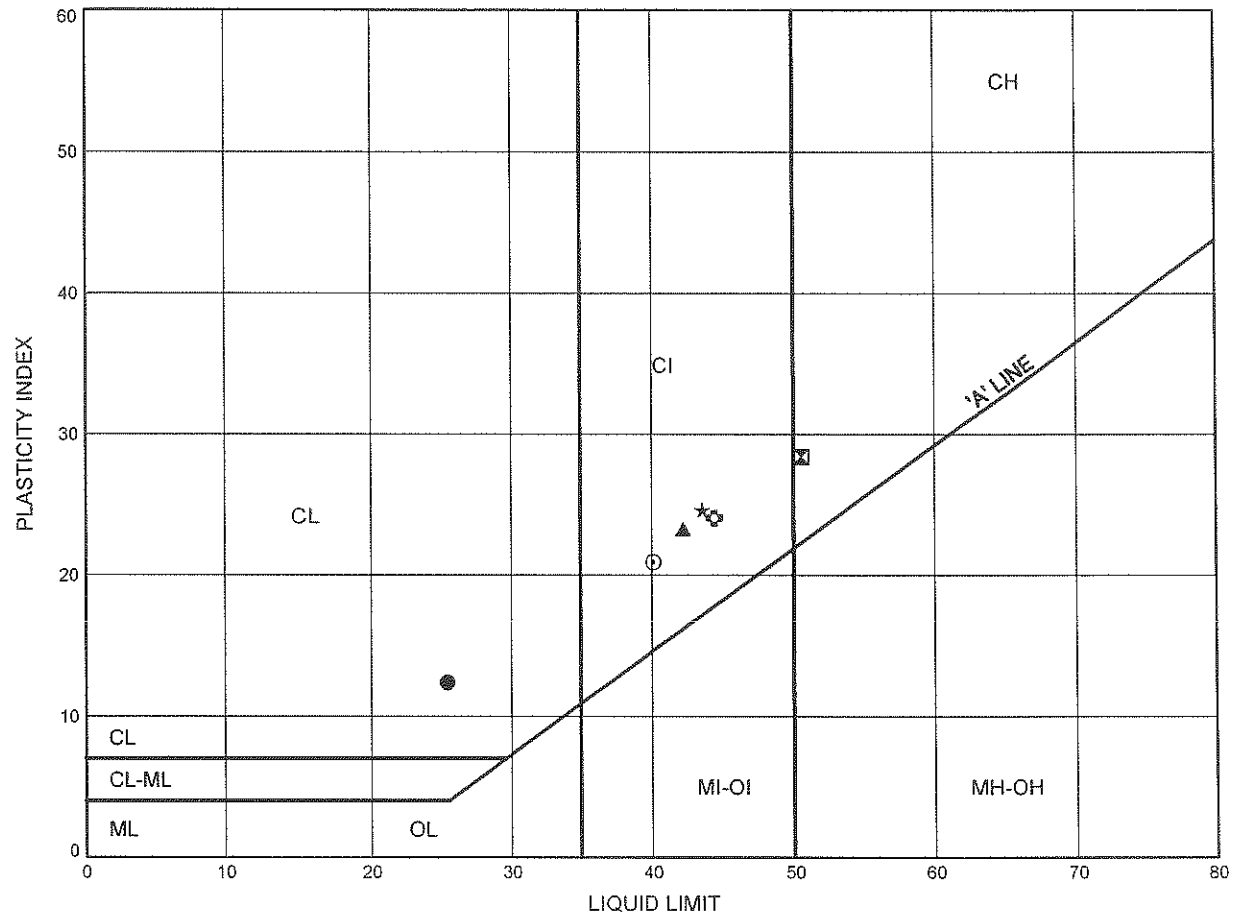


W.P.# 408-88-00  
Prepared By MFA  
Checked By RPR

# Highway 7 - New ATTERBERG LIMITS TEST RESULTS

FIGURE B6

Silty Clay Till



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-010	2.53	314.92
⊠	08-010	4.88	312.57
▲	08-012	2.59	315.08
★	08-012	4.88	312.79
⊙	08-012	10.90	306.77
⊕	08-012	15.54	302.13

Date September 2008  
 Project 408-88-00



Prep'd MFA  
 Chkd. RPR

## **Appendix C**

### **Foundation Comparison**

**COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT**

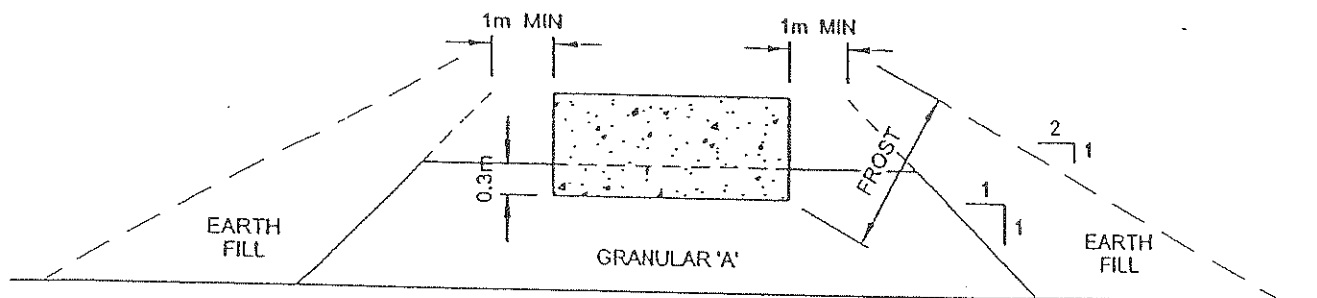
Foundation Element	Spread Footings	Spread Footings on Engineered Fill	Driven Piles
Abutments	<p><i>Advantages:</i></p> <ul style="list-style-type: none"> <li>i. Generally less costly construction than deep foundation elements.</li> </ul> <p><i>Disadvantages:</i></p> <ul style="list-style-type: none"> <li>i. Lower geotechnical resistance available due to founding on compact soils near the surface.</li> <li>ii. Dewatering may be required, depending on depth of excavation.</li> </ul> <p><b>NOT RECOMMENDED</b></p>	<p><i>Advantages:</i></p> <ul style="list-style-type: none"> <li>i. Generally less costly construction than deep foundation elements.</li> </ul> <p><i>Disadvantages:</i></p> <ul style="list-style-type: none"> <li>i. Better geotechnical resistance than spread footings on native, but still influenced by the compact soils at the surface.</li> <li>ii. Dewatering may be required, depending on depth of excavation.</li> </ul> <p><b>NOT RECOMMENDED</b></p>	<p><i>Advantages:</i></p> <ul style="list-style-type: none"> <li>i. High geotechnical resistance may be developed by driving the piles into very dense soils.</li> <li>ii. Comparatively short abutment stem possible</li> <li>iii. Permits integral abutment design</li> </ul> <p><i>Disadvantages:</i></p> <ul style="list-style-type: none"> <li>i. Higher unit cost compared to footings.</li> <li>ii. Very dense soils at shallow depth will limit length of pile and geotechnical resistance that can be developed.</li> </ul> <p><b>RECOMMENDED</b></p>

N-E entrance ramp to HWY 7 over Wellington St. E/W-S ramp  
Highway 7-New, Kitchener to Guelph

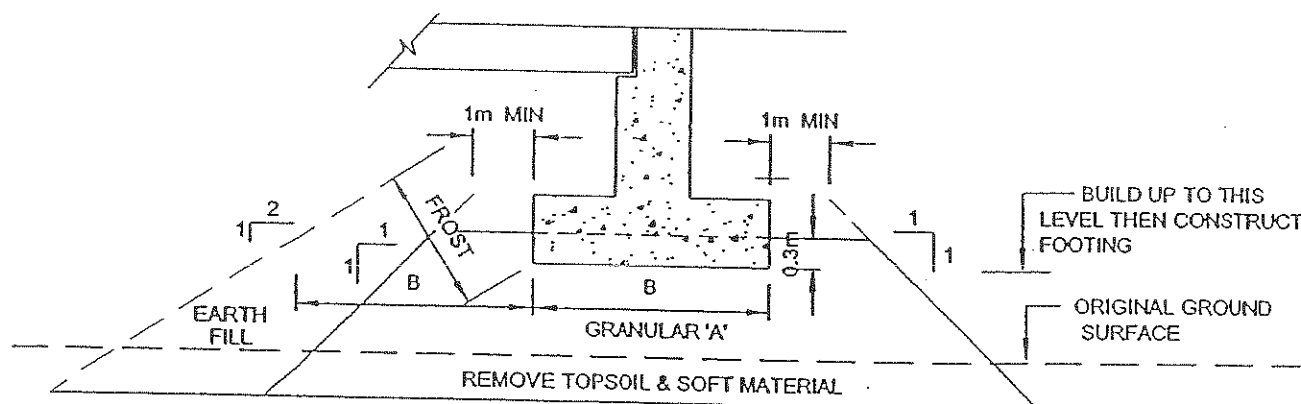
---

## Appendix D

### Figure



CROSS-SECTION

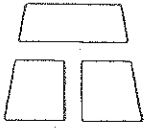


LONGITUDINAL SECTION

NOT TO SCALE

NOTES:

1. REMOVE TOPSOIL AND OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' AND EARTH FILL.
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	ABUTMENT ON COMPACTED FILL SHOWING GRANULAR A CORE	 <b>THURBER</b>
DRAWN	SS		
DATE	April, 2004		
APPROVED	PKC		
SCALE	NTS		
		DWG. NO.	FIGURE 1

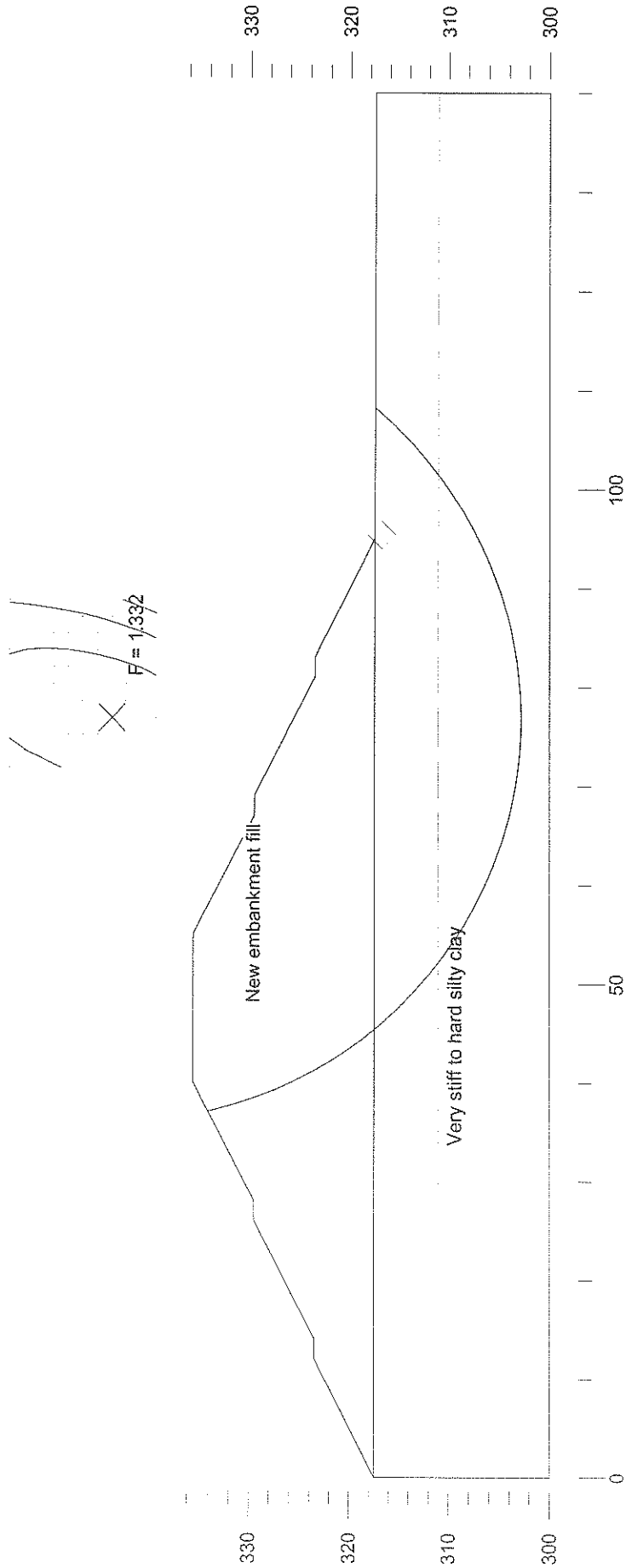
N-E entrance ramp to HWY 7 over Wellington St. E/W-S ramp  
Highway 7-New, Kitchener to Guelph

---

**Appendix E**  
**Slope Stability Output**

	Gamma	C	Phi	Piezo
	kN/m3	kPa	deg	Surf.
Earth Fill	21	0	30	1
Silty Clay	19	85	0	1

Thurber Engineering Ltd. - Toronto  
 15-64-17 Highway 7 - New  
 N-E Ramp over E-S Ramp over E/W-S Ramp  
 August 27, 2008  
 North and South Approach Earth Fill





Thurber Engineering Ltd. - Toronto  
 15-64-17 Highway 7 - New  
 N-E Ramp over E-S Ramp over E/W-S Ramp  
 August 27, 2008  
 North and South Approach Earth Fill

	Gamma C	Phi	Piezo
	kN/m3	deg	Surf.
Earth Fill	21	30	1
Silty Clay	19	0	1

Seismic coefficient = 0.08

$F = 1.061$

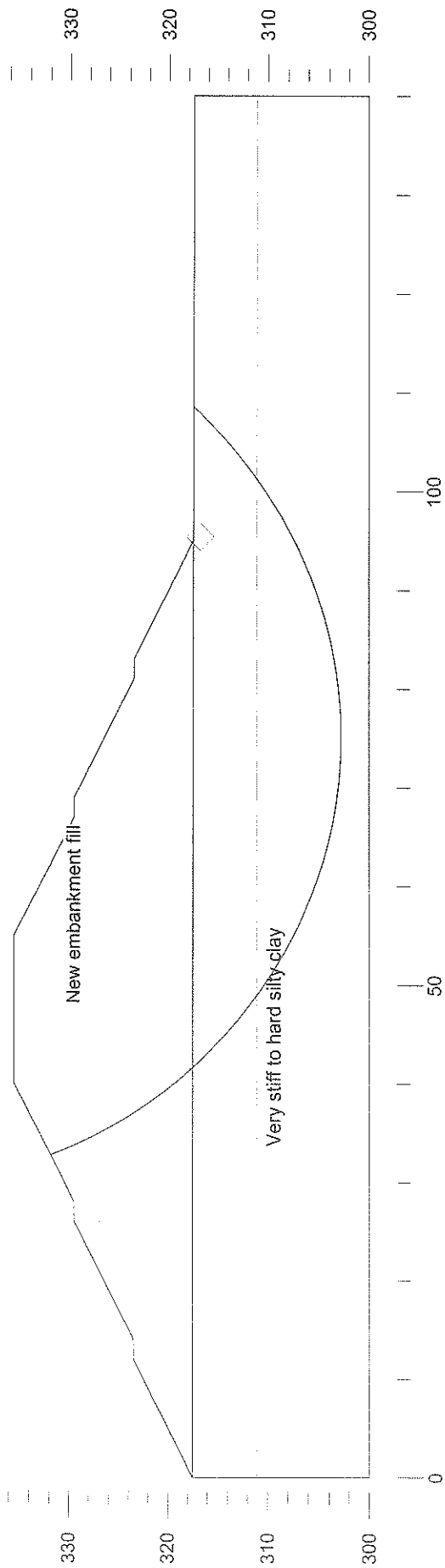


FIGURE 2

N-E entrance ramp to HWY 7 over Wellington St. E/W-S ramp  
Highway 7-New, Kitchener to Guelph

---

## **Appendix F**

### **Site Photographs**

N-E entrance ramp to HWY 7 over Wellington St. E/W-S ramp  
Highway 7-New, Kitchener to Guelph

---

Existing  
N-E/W  
Wellington  
Street Ramp



**Photo 1.** Looking to the north side of Borehole 08-010  
Existing exit ramp from KWE NBL to Wellington Street East/West

N-E entrance ramp to HWY 7 over Wellington St. E/W-S ramp  
Highway 7-New, Kitchener to Guelph

---

KWE

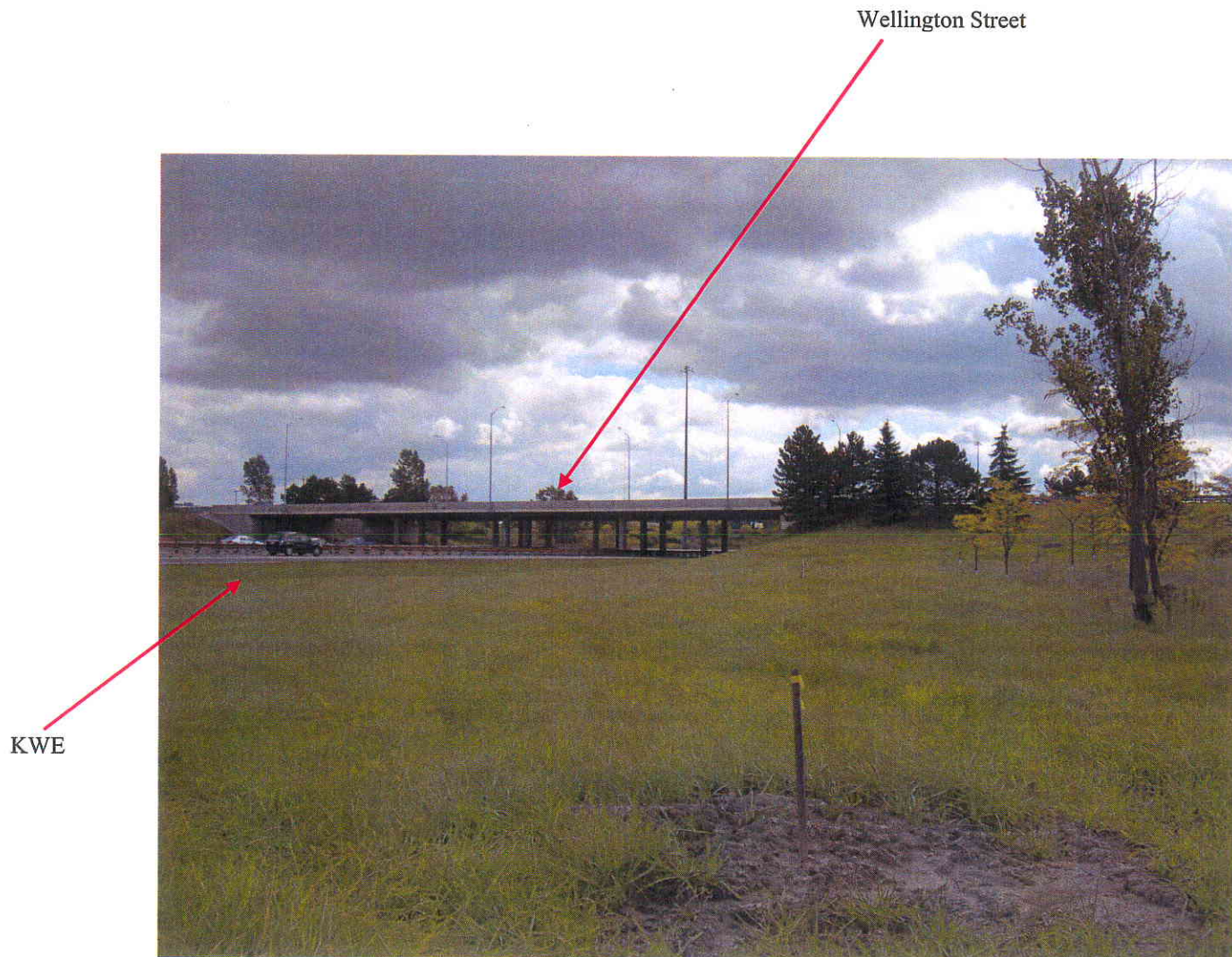


**Photo 2.** Looking to the east side of Borehole 08-010  
KWE



N-E entrance ramp to HWY 7 over Wellington St. E/W-S ramp  
Highway 7-New, Kitchener to Guelph

---



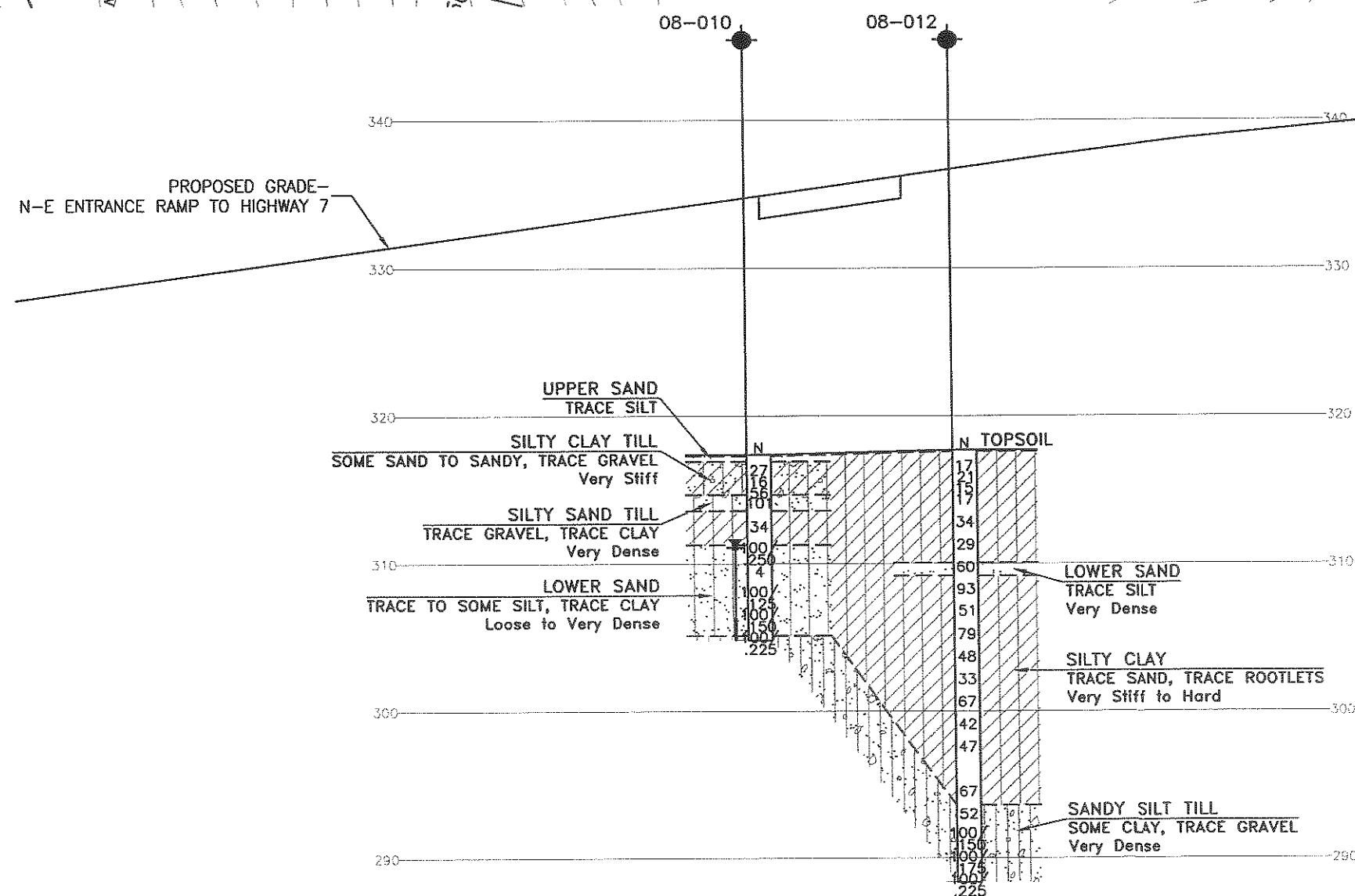
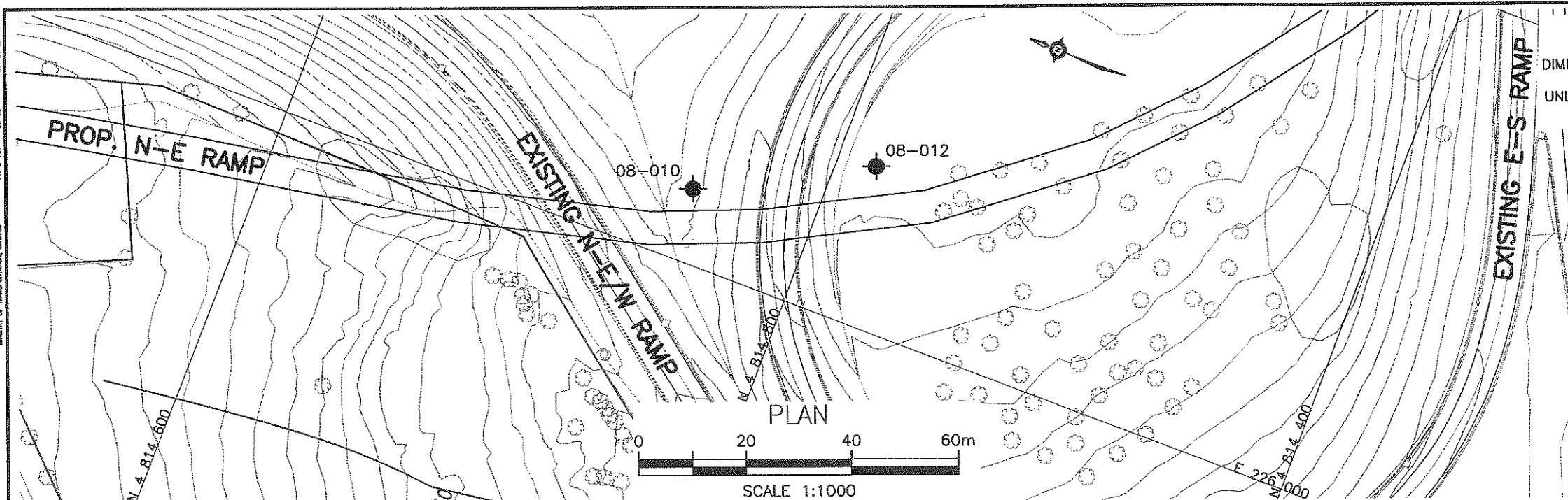
**Photo 3.** Looking to the south side of Borehole 08-012  
KWE & Wellington Street bridge

N-E entrance ramp to HWY 7 over Wellington St. E/W-S ramp  
Highway 7-New, Kitchener to Guelph

---

## **Appendix G**

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



PROFILE ALONG C OF PROP. N-E ENTRANCE RAMP TO HIGHWAY 7



HOR 1:1000

VER 1:400

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

CONT No  
GWP No 408-88-00

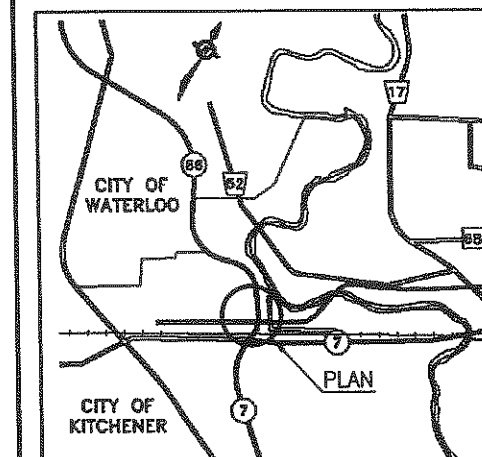
HIGHWAY 7  
RECOMMENDED ROUTE  
N-E ENTRANCE RAMP TO HWY 7 OVER WELLINGTON ST. E/W-S RAMP  
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET








**THUNDER 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                         |

[illegible]

**-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 2B of the E.A. Study.

**GEOCRES No. 40P8-167**

REVISIONS								
	DATE	BY					DESCRIPTION	
	DESIGN	AEG	CHK	PKC	CODE		LOAD	DATE JUN. 2000
	DE&AWN	ME&A	CHK	AFG	SITE		ISTRUCT	LDWG

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING