

**PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT**  
**QEW S-W RAMP OVER FORD DRIVE**  
**QUEEN ELIZABETH WAY/HIGHWAY 403 IMPROVEMENTS**  
**OAKVILLE, ONTARIO**  
**SITE No. 10-0286**  
**W.O. 09-20007**

**Geocres Number: 30M5-291**

**Report to**

**McCormick Rankin**

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

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## TABLE OF CONTENTS

### PART 1 FACTUAL INFORMATION

1	INTRODUCTION.....	1
2	SITE DESCRIPTION.....	2
3	SITE INVESTIGATION AND FIELD TESTING .....	2
4	LABORATORY TESTING .....	3
5	DESCRIPTION OF SUBSURFACE CONDITIONS .....	3
5.1	Topsoil .....	4
5.2	Shale Fill.....	4
5.3	Silty Clay Fill.....	4
5.4	Silty Clay .....	5
5.5	Shale Bedrock.....	5
5.6	Groundwater Levels .....	6
6	MISCELLANEOUS.....	7

### PART 2 ENGINEERING DISCUSSION AND RECOMMENDATIONS

7	GENERAL .....	8
8	STRUCTURE FOUNDATIONS .....	8
8.1	Spread Footings on Bedrock.....	9
8.2	Spread Footings on Engineered Fill .....	9
8.3	Steel H-Piles Socketed into Bedrock .....	10
8.4	Augered Caissons .....	10
8.5	Abutment Design Considerations .....	10
8.6	Frost Cover .....	11
8.7	Recommended Foundation .....	11
9	DEWATERING .....	11
10	BRIDGE APPROACHES AND EMBANKMENTS .....	11
11	ROADWAY PROTECTION .....	12
12	CONSTRUCTION CONCERNS.....	12
13	INVESTIGATION FOR DETAIL DESIGN .....	12
14	CLOSURE.....	13

## APPENDICES

Appendix A	Record of Borehole Sheets (including Previous Investigation)
Appendix B	Laboratory Test Results
Appendix C	Foundation Comparison
Appendix D	Site Photographs
Appendix E	Borehole Locations and Soil Strata Drawing

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**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual findings obtained from a preliminary foundation investigation conducted for the proposed structure which will carry traffic from northbound (NB) Ford Drive to westbound (WB) Queen Elizabeth Way (QEW) in the Town of Oakville, Ontario. This investigation is part of the QEW/Highway 403 Improvements Project, from Trafalgar Road to Winston Churchill Boulevard.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile and sections, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

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

Thurber carried out the investigation as a sub-consultant to McCormick Rankin, under the Ministry of Transportation Ontario (MTO) Work Order Number 09-20007.

A previous foundation investigation report was completed in 1977 for the existing ramp structure located approximately 5 m south of the proposed structure. The title of the report is as follows:

Foundation Investigation Report for N-W Ramp Structure over Ford Drive,  
QEW/403/Ford Drive Interchange, District 4 ( Hamilton), W.P. 125-66-18 (Geocres  
30M05-107), Site 10-285, dated May 1977

The Record of Borehole sheets for two of the boreholes (BH 7 & 8) drilled during the previous investigation are included in Appendix A, for reference purposes.

## **2 SITE DESCRIPTION**

The site of the proposed structure is located at Ford Drive and the QEW in Oakville, Ontario. The proposed structure will be located approximately 5 m north of the existing ramp structure at Ford Drive that carries traffic from NB Ford Drive to WB QEW. In general, the lands in the vicinity of the site slope gently to the south (construction west) towards Joshua Creek, which is located approximately 150 m to the south. The lands immediately adjacent to the site consist of undeveloped areas of the highway right-of-way. To the east, there is a residential area and to the west and south of the QEW, lies the Ford Motors Canada complex.

The site lies within the South Slope physiographic region, characterized by glacially deposited overburden overlying shale bedrock of the Queenston and Dundas Formations of the upper Ordovician age.

Photographs included in Appendix D show the site of the proposed structure.

## **3 SITE INVESTIGATION AND FIELD TESTING**

The site investigation and field testing for this project were carried out between June 2 and 5, 2013. A total of four boreholes were drilled and sampled at this site, identified as 13-19, 13-20, 13-29, and 13-30. Boreholes 13-19 and 13-29 were drilled close to the proposed east abutment and boreholes 13-20 and 13-30 were drilled close to the proposed west abutment. The borehole depths ranged from 6.1 m to 7.6 m. The Record of Borehole sheets are included in Appendix A.

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing included in Appendix E. The coordinates and elevations of the boreholes are given on the drawing and on the individual Record of Borehole sheets.

The borehole locations were marked in the field and utility clearances were obtained prior to commencement of drilling operations. A Region of Halton Road Occupancy Permit was obtained for unloading and loading the drill rig on the shoulder of Ford Drive for accessing Boreholes BH13-20 and BH13-30. Boreholes BH13-19 and BH13-29 were accessed from QEW.

The drilling was carried out using a CME 55 track-mounted drill rig. A combination of solid stem augers and NQ coring techniques were used to advance the boreholes. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). All rock cores were logged, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The recovered soil and bedrock samples were logged in the field and

processed for transport to Thurber's laboratory in Oakville, Ontario for further examination and testing.

Groundwater conditions were observed in the open boreholes during the drilling operations, where practical. Standpipe piezometers, consisting of 19mm diameter PVC pipe with slotted screen, were installed in two boreholes at this site. The installation details of the piezometers are summarized in Table 3-1 along with the borehole completion details for boreholes with no piezometer installation.

**Table 3-1. Borehole Completion and Piezometer Installation Details**

Borehole	Tip Position		Borehole Completion and Piezometer Installation Details
	Depth (m)	Elev. (m)	
BH13-19	7.6	123.4	Sand filter from 7.6 m to 5.8 m and bentonite holeplug from 5.8 m to surface.
BH13-20	6.4	121.3	Sand filter from 6.4 m to 4.6 m and bentonite holeplug from 4.6 m to surface.
BH13-29	None installed		Borehole backfilled with bentonite holeplug to surface.
BH13-30	None installed		Borehole backfilled with bentonite holeplug to surface.

#### **4 LABORATORY TESTING**

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

Point load tests were conducted on selected portions of the rock cores. The UCS values of the rock were assessed from the point load data and these values are reported on the borehole logs (as average UCS per run).

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

Reference is made to the Record of Borehole sheets included in Appendix A, and the Borehole Locations and Soil Strata Drawing included in Appendix E. An overall description of the stratigraphy, based on the conditions encountered in the boreholes, 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 stratigraphy encountered at the proposed foundation elements typically consists of a surficial layer of organics overlying a localized layer of shale fill all underlain by a layer of silty clay fill.

Below the fill sequence was native silty clay followed by shale bedrock. More detailed descriptions of the individual strata encountered at the proposed structure site are presented below.

### **5.1 Topsoil**

A thin layer of topsoil (100 mm) was encountered at the surface in all four boreholes drilled for this structure. The topsoil thickness may vary between and beyond borehole locations and the data is not intended for the purpose of estimating quantities.

### **5.2 Shale Fill**

A localized layer of shale fill was encountered directly below the topsoil in borehole BH13-19. The thickness of the shale fill was 0.6 m with an underside depth of 0.7 m (Elev. 130.3 m).

A single SPT N-value of 10 blows per 300 mm of penetration was recorded, indicating a compact condition. The corresponding moisture content was 9%.

### **5.3 Silty Clay Fill**

Silty clay fill with trace sand was encountered below the shale fill in borehole BH13-19 and below the topsoil in the remaining three boreholes. The thickness of the silty clay fill varies from 0.6 to 1.5 m with an underside depth of 0.7 to 1.6 m (Elev. 126.1 to 130.7 m).

SPT N-values recorded in the fill ranged from 7 to 24 blows per 300 mm of penetration, indicating stiff to very stiff consistency. The moisture content varied from 14 to 21%.

Laboratory grain size distribution analyses were carried on three samples of the fill. The results of these tests are presented on the corresponding Record of Borehole sheets included in Appendix A and the grain size distribution curves are presented in Figure B1 of Appendix B. The results are summarized below:

Gravel %	0 to 2
Sand %	0 to 13
Silt %	49 to 65
Clay %	27 to 38

A single sample of the fill underwent Atterberg Limits testing. The results of the test is presented on the Record of Borehole sheet included in Appendix A and are also presented in Figure B3 of Appendix B and indicates that the silty clay fill exhibits intermediate plasticity with a plastic limit of 21 and a liquid limit of 37.

#### 5.4 Silty Clay

Silty clay with trace sand was encountered directly below the fill in three of the four boreholes (BH13-19, 13-29 and 13-30). The thickness of the silty clay varies between 0.7 to 1.7 m with an underside depth of 1.5 to 2.4 m (Elev. 126.2 to 129.1 m).

SPT N-values recorded in the silty clay ranged from 12 to 28 blows per 300 mm of penetration, indicating stiff to very stiff consistency. The moisture content varied from 14 to 19%.

Laboratory grain size distribution analysis testing was performed on one sample of the silty clay. The results of this test are summarized below and are presented on the corresponding Record of Borehole sheet included in Appendix A and the grain size distribution curve is plotted on Figure B2 of Appendix B.

Gravel %	0
Sand %	8
Silt %	63
Clay %	29

A single sample of the silty clay underwent Atterberg Limits testing. The results of the test is presented on the Record of Borehole sheet included in Appendix A and are also presented in Figure B3 of Appendix B and indicates that the silty clay exhibits intermediate plasticity with a plastic limit of 21 and a liquid limit of 40.

#### 5.5 Shale Bedrock

Bedrock was encountered below the silty clay fill in borehole BH13-20 and below the native silty clay in the remaining three boreholes. The depths and elevations at which bedrock was encountered in the borehole locations are summarized in Table 5-1.

**Table 5-1. Depths and Elevations of Bedrock Surface**

Foundation Element	Borehole	Bedrock Surface	
		Depth (m)	Elevation (m)
East Abutment	BH13-19	2.2	128.8
	BH13-29	2.4	129.1
	8 <sup>(1)</sup>	2.9	127.4
West Abutment	BH13-20	1.6	126.1
	BH13-30	1.5	126.2
	7 <sup>(1)</sup>	2.1	126.3

Note: (1) Geocres 30M05-107, Site 10-285



The bedrock was described as thinly laminated reddish brown shale containing occasional grey shale interbeds and hard grey limestone interbeds up to 100 mm in thickness. The shale was generally described as weathered at the soil-bedrock interface and described as slightly weathered to fresh with increased depth. Frequent horizontal fractures, occasional vertical fractures, and clay seams were observed in the bedrock cores.

Total Core Recovery (TCR) in the bedrock was 100%. The Rock Quality Designation (RQD) values ranged from 57 to 95%, indicating a fair to excellent rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to 4.

The average estimated unconfined compression strength (UCS) of the shale with hard limestone interbeds, interpreted from point load tests conducted on intact cores, ranged from 42 to 84 MPa, indicating a medium strong to strong rock strength classification.

## 5.6 Groundwater Levels

Water levels were observed in the open boreholes prior to the start of the coring operations. Standpipe piezometers were installed in Boreholes 13-19 and 13-20, within the bedrock. The water levels measured in the open boreholes and piezometers are summarized below.

**Table 5-2. Groundwater Depths and Elevations**

Borehole	Date of Reading	Water Level		Comment
		Depth (m)	Elevation	
BH13-19	June 3, 2013	Dry	N/A	Prior to coring
	June 7, 2013	7.1	123.9	Piezometer
	June 26, 2013	7.5	123.5	Piezometer
BH13-20	June 4, 2013	Dry	N/A	Prior to coring
	June 7, 2013	4.2	123.5	Piezometer
	June 26, 2013	4.1	123.6	Piezometer
BH13-29	June 2, 2013	Dry	N/A	Prior to coring
BH13-30	June 5, 2013	Dry	N/A	Prior to coring

It should be noted that the recorded ground water levels are short term and are susceptible to seasonal fluctuations. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of significant and/or prolonged precipitation.

## 6 MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. Surveyors from MMM Group provided co-ordinates and the ground surface elevations at the boreholes drilled.

DBW Drilling Ltd. from Ajax, Ontario supplied a track mounted CME 55 drill rig and conducted the drilling, sampling and in-situ testing operations.

Overall planning and supervision of the field program was conducted by Ms. Lindsey Blaine, P.Eng.. The field investigation was supervised by Mr. George Azzopardi of Thurber.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Interpretation of the data and preparation of the report were carried out by Ms. Lindsey Blaine, P.Eng. and Mr. Alastair Gorman, P.Eng.. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Lindsey Blaine, P.Eng.  
Geological Engineer

Alastair Gorman, P.Eng.  
Senior Foundations Engineer



P.K. Chatterji, P.Eng.  
Review Principal



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**PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS**

**7 GENERAL**

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

Our understanding of the project, based on the GA, consists of:

- the proposed structure will carry traffic from northbound Ford Drive to westbound Queen Elizabeth Way (QEW)
- the proposed overpass structure will comprise of a single 39.8 m deck span, flanked by RSS Walls and carry three lanes of traffic
- the proposed pavement elevation of QEW at the west and east abutment will be 131.2 and 132.7 m, respectively
- Ford Drive will be at approximate elevation 123.7 m

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

**8 STRUCTURE FOUNDATIONS**

The stratigraphy identified in the preliminary investigation consisted of a surficial layer of organics overlying a localized layer of shale fill all underlain by a layer of silty clay fill. Below the fill sequence was native silty clay followed by shale bedrock. The short term groundwater levels measured in the piezometers was at Elev. 123.5 to 123.6 m.

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

- Spread footings bearing on bedrock
- Spread footings bearing on engineered fill
- Steel H-Piles socketed into bedrock
- Augered caissons socketed into bedrock

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

### **8.1 Spread Footings on Bedrock**

Ford Drive is constructed in a cut at the proposed structure locations. Due to the shallow depth of overburden, spread footings founded on shale bedrock are considered feasible to support the structural loads.

As interpreted from the boreholes, spread footing should be founded on undisturbed, sound shale bedrock at or below elevation 125.0 and 128.0 m at the west and east abutments, respectively. The elevations presented are the highest recommended founding elevation and must be reviewed during the detail design based on the final bridge arrangement and results of the site investigation and field testing to be completed at that time.

For preliminary design, footing founded on undisturbed, sound shale should be designed using a factored geotechnical ULS resistance of 1000 kPa. This value includes a resistance factor of 0.5 as per Table 6.1 of the CHBDC. The SLS condition will not govern design of footings founded on bedrock.

The geotechnical resistances quoted above are for concentric, vertical loads only. In the case of eccentric or inclined loading, the geotechnical resistance must be calculated in accordance with the CHBDC.

### **8.2 Spread Footings on Engineered Fill**

If higher founding elevations are required, than those provided in Section 8.1, spread footings could be constructed on an engineered fill pad consisting of Granular “A” material. This option would be suitable for abutment footings which may be perched within the approach embankment and above the existing bedrock surface elevation.

For preliminary design, footings founded on engineered fill should be designed using a factored resistance at ULS of 900 kPa and a SLS of 350 kPa.

The engineered fill must bear on undisturbed shale at or below elevations provided in Section 8.1. The Granular “A” pad must be placed in 150 mm lifts and compacted to 100% 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.

The geotechnical resistances quoted above are for concentric, vertical loads only. In the case of eccentric or inclined loading, the geotechnical resistance must be adjusted as shown in the CHBDC (2006) Clause 6.7.3 and 6.7.4. During detail design, the geotechnical resistance must also be reviewed taking account of the position of the footing relative to the forward slope.

### **8.3 Steel H-Piles Socketed into Bedrock**

Since bedrock is shallow at this site, steel H-piles would typically not be considered cost effective or feasible from a foundation point of view. However, piles socketed into the bedrock could be used to provide axial geotechnical resistance and to accommodate the design of an integral abutment, if required.

In the case of an integral abutment, excavation of bedrock will be required within the abutment footprint and special considerations must be given to the details of the pile installation in order to provide the required flexibility in the upper 3.0 m length. Preliminary recommendations are provided but must be reviewed 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

For HP 310x110 steel H-piles placed in rock sockets, a factored axial geotechnical resistance at ULS of 2,000 kN is recommended. This value includes a geotechnical resistance factor of 0.4 as per the CHBDC. The SLS condition will not govern for piles socketed into bedrock.

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

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

### **8.4 Augered Caissons**

Drilled shaft foundations socketed into shale bedrock are not considered appropriate for this site and have not been developed further.

### **8.5 Abutment Design Considerations**

From a geotechnical perspective, the conditions at this site are considered to be suitable for conventional or semi-integral abutment design, principally due to the shallow depth to bedrock.

However, if other design and/or maintenance issues favour the use of an integral abutment design, this can be accommodated through excavation of shale bedrock within the abutment area to accommodate the use of H-pile foundations.

### **8.6 Frost Cover**

The design depth of frost penetration at this site is 1.2 m. It is recommended that all footings be provided with a minimum of 1.2 m of earth cover above the underside of the pile cap or footing. Frost protection is also required for footings founded on shale bedrock.

### **8.7 Recommended Foundation**

From a geotechnical perspective, and based on current information, the recommended foundation consists of spread footing bearing on undisturbed, sound shale bedrock.

## **9 DEWATERING**

Excavations for spread footings at the elevations given in Section 8.1 are not expected to penetrate below the groundwater level. However, if deeper excavations are required they may penetrate below the groundwater level and some seepage into the excavation may occur. However, due to the relatively low permeability of the shale, the volumes are expected to be small. Similarly, minor seepage from the fill may be encountered and surface water flow may enter the excavations.

Given the small volumes of water that are expected, it is considered that pumping from sumps will be adequate for dewatering excavations at this site. The exposed shale at the base of the foundation excavation must be protected from deterioration.

In the case of sockets drilled in the bedrock for deep foundations, pumping accumulated water from the socket prior to concreting will be adequate.

## **10 BRIDGE APPROACHES AND EMBANKMENTS**

Based on the current and previous boreholes drilled at this site, the approach embankments will be constructed over foundation soils consisting of stiff to very stiff native silty clay and shale bedrock. The foundation soils are considered to provide adequate stability for approach embankments if constructed at a side slope of 2H:1V or RSS wall using SSM or granular fill.

Constructing the approach embankments with cohesive fill may be possible but will be dependent on the mechanical properties of the material. An embankment constructed of cohesive material will typically not perform as well as an embankment constructed using SSM or granular fill and will require flatter side slopes which will extend the footprint of the embankment.

Preliminary analysis indicates that settlement of the foundation soils under the imposed embankment loading is expected to be less than 25 mm. Considering the competency of the foundation soils the settlement will be essentially completed when construction of the fill is completed.

Further settlement analysis and the global, internal and surficial stability of the approach embankment fills should be further evaluated during the detail design phase. Additionally, permanent drainage and slope protection requirements must be addressed during the detail design.

## **11 ROADWAY PROTECTION**

Excavation support systems may be required for temporary roadway protection during foundation construction where stable slopes cannot be constructed. The temporary excavation support system should be designed and constructed in accordance with Special Provision OPSS 539. In general, the lateral movement of the temporary shoring system should meet Performance Level 2 as specified in OPSS 539. The feasibility of installing protection systems should be assessed once further subsurface investigation is carried out during detail design.

## **12 CONSTRUCTION CONCERNS**

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

- The shale bedrock should be concreted within 24 hours after the bedrock surface has been properly prepared and is free of loose debris, to prevent softening and deterioration.
- Excavation must not undermine the footings of the existing QEW-Ford Drive overpass

## **13 INVESTIGATION FOR DETAIL DESIGN**

During the detail design phase of this project, additional site investigation and field testing may be required. The scope and results of this investigation must be reviewed at that time to determine if they meet the current Ministry requirements and if additional investigation and analysis is necessary.

## 14 CLOSURE

Engineering analysis and preparation of the report were carried out by Mr. Stephen Peters, P.Eng. and Mr. Alastair Gorman, P.Eng.. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Stephen Peters, P.Eng.  
Geotechnical Engineer

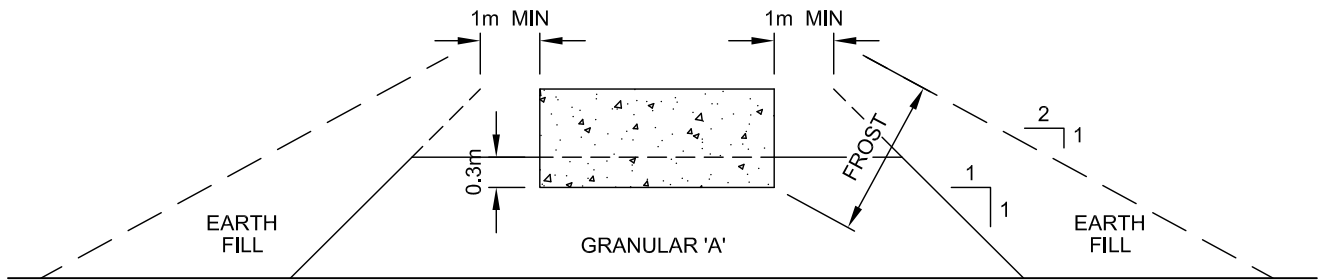
Alastair Gorman, P.Eng.  
Senior Foundations Engineer



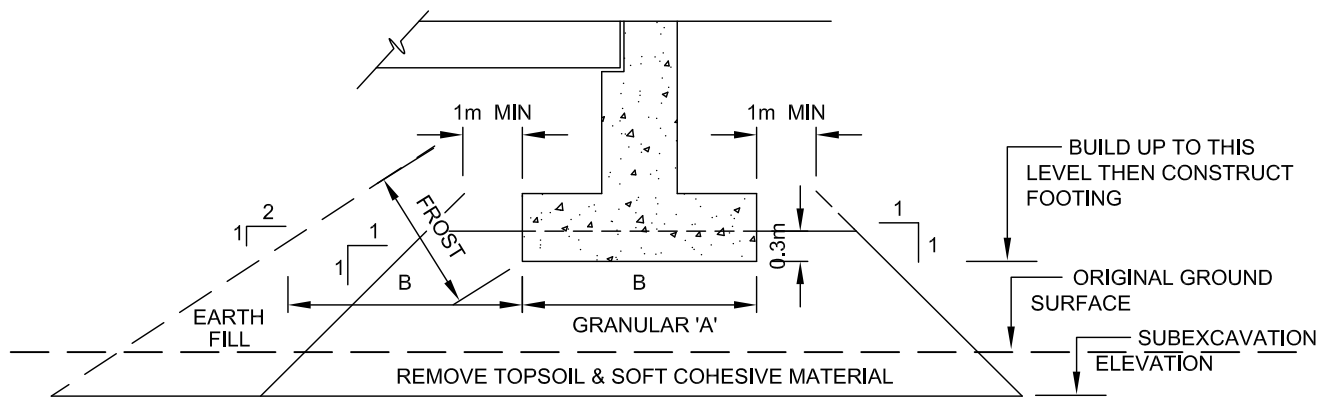
P.K. Chatterji, P.Eng.  
Review Principal







## CROSS-SECTION



## LONGITUDINAL SECTION

### 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.

ABUTMENT ON COMPACTED FILL  
SHOWING GRANULAR 'A' CORE



**THURBER ENGINEERING LTD.**

ENGINEER:

SBP

DRAWN:

MFA

APPROVED:

AEG

DATE:

OCTOBER 2013

SCALE:

N.T.S.

DRAWING No.

FIGURE 1

**Appendix A**  
**Record of Borehole Sheets**

## EXPLANATION OF ROCK LOGGING TERMS


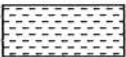



### ROCK WEATHERING CLASSIFICATION

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

### DISCONTINUITY SPACING

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

### SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

### STRENGTH CLASSIFICATION

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

### TERMS

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

# 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			

## SYMBOLS AND TERMS USED ON TEST HOLE LOGS

### 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 naked eye

### COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	< 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

### TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROX. SPT <sup>(1)</sup> "N" VALUE
Very Soft	< 10	< 2
Soft	10 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	> 200	> 30

(1) Standard Penetration Test – the number of blows from a 63.5kg hammer falling through 0.76m to advance a 60 degree truncated cone 0.3m

### TERMS DESCRIBING DENSITY(COHESIONLESS SOILS)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

### HIERARCHY OF SOIL STRENGTH PREDICTION

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT Value
- 5) Pocket Penetrometer

### LEGEND FOR TEST HOLE LOGS

 Shelby Tube   
 A – Casing   
  SPT   
  Grab/Auger sample   
  Core   
  No Recovery

- MC – Moisture Content (% by Weight) as determined by sample



Water Level

C <sub>vane</sub>	Shear Strength Determination by Field Insitu Vane
C <sub>pen</sub>	Shear Strength Determination by Pocket Penetrometer
C <sub>lab</sub>	Shear Strength Determination using a Laboratory Vane Apparatus
C <sub>u</sub>	Undrained Shear Strength determined by Unconfined Compression Test
AS/GS/BS	Auger Sample/Grab Sample/ Block Sample
SS	Split-spoon
SC	Soil core
AED	Oedometer test
TXL	Triaxial test

# RECORD OF BOREHOLE No 13-19

1 OF 1

METRIC

W.P. \_\_\_\_\_ LOCATION N 4 817 242.3 E 290 705.9 ORIGINATED BY GA  
 HWY 403/QEW BOREHOLE TYPE Solid Stem Augers/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2013.06.03 - 2013.06.03 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
131.0								20 40 60 80 100					
0.0	<b>TOPSOIL:</b> (100mm)												
0.1	<b>SHALE</b> , occasional clay pockets, silty Compact Reddish Brown Damp (FILL)		1	SS	10								
130.3													
0.7	Silty <b>CLAY</b> , trace sand Very Stiff Reddish Brown (FILL)		2	SS	24								
129.6													
1.4	Silty <b>CLAY</b> , trace sand, occasional shale fragments Very Stiff Brown/Reddish Brown		3	SS	28								
128.8													
2.2	<b>SHALE</b> , with limestone interbeds, weathered, thinly bedded, brownish grey		4	SS	50/ 0.150								
			5	SS	50/ 0.125								
	Start coring at 4.5m												
	Weathered to fresh, thinly bedded, grey, occasional limestone interbeds												
	Clay seam (100mm) at 4.6m												
	Limestone interbeds (25mm thick) at 4.1m, 4.8m, 5.7m and (125mm) at 5.0m		1	RUN									
	Horizontal fractures at 4.6m, 4.7m, 5.0m, 5.4m, 5.5m, 5.9m, 6.0m												
	Limestone interbeds (25mm to 50mm thick) at 6.1m, 6.6m, 7.0m, 7.1m, 7.4m, 7.5m and (150mm) at 6.2m		2	RUN									
	Horizontal fractures at 6.1m, 6.2m, 6.4m, 6.5m, 6.6m, 7.4m, 7.5m												
123.4													
7.6	END OF BOREHOLE AT 7.6m. BOREHOLE OPEN TO 7.6m AND WATER LEVEL AT 4.5m UPON COMPLETION OF CORING. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.												
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) June 7/13 7.1 123.9 June 26/13 7.5 123.5												

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

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 13-20

1 OF 1

METRIC

W.P. \_\_\_\_\_ LOCATION N 4 817 188.1 E 290 718.9 ORIGINATED BY GA  
 HWY 403/QEW BOREHOLE TYPE Solid Stem Augers/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2013.06.04 - 2013.06.04 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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						
127.7								20	40	60	80	100		
0.0	<b>TOPSOIL:</b> (100mm)													
0.1	Silty <b>CLAY</b> , trace to some sand, trace gravel Firm to Very Stiff Brown (FILL)		1	SS	7		127							2 13 49 36
			2	SS	22									
126.1			3	SS	50/ 0.150		126							
1.6	<b>SHALE</b> , with limestone interbeds, weathered, thinly bedded, grey		4	SS	50/ 0.000		125							
			5	SS	50/ 0.125									
	Start coring at 3.3m Weathered to fresh, thinly bedded, grey, occasional limestone interbeds		1	RUN			124							RUN #1 TCR=100% SCR=87% RQD=57% UCS=43MPa (Average)
	Soft zone (175mm) at 3.3m													
	Sub-vertical fracture (50mm) at 3.6m													
	Limestone interbeds (25mm to 50mm thick) at 3.7m, 3.8m, 4.0m, 4.3m, 4.7m, 4.8m, (125mm) at 4.4m and (75mm) at 4.5m						123							RUN #2 TCR=100% SCR=100% RQD=87% UCS=47MPa (Average)
	Horizontal fracture at 3.5m, 3.6m, 3.7m, 3.8m, 3.9m, 4.1m, 4.3m, 4.5m, 4.8m													
	Limestone interbeds (25mm thick) at 4.9m, 5.3m, 5.7m, 5.8m, 5.9m, 6.0m, 6.1m, 6.2m, (100mm) at 5.1m and (125mm) at 5.5m		2	RUN			122							
121.3	Horizontal fracture at 4.9m, 5.2m, 5.4m, 5.6m, 5.7m, 5.8m, 6.0m													
6.4	END OF BOREHOLE AT 6.4m. BOREHOLE OPEN TO 6.4m AND WATER LEVEL AT 4.2m UPON COMPLETION OF CORING. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.													
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) June 7/13 4.2 123.5 June 26/13 4.1 123.6													

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

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 13-29

1 OF 1

METRIC

W.P. \_\_\_\_\_ LOCATION N 4 817 243.7 E 290 717.7 ORIGINATED BY GA  
 HWY 403/QEW BOREHOLE TYPE Solid Stem Augers/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2013.06.02 - 2013.06.02 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
131.4								20	40	60	80	100		
0.0	<b>TOPSOIL:</b> (100mm)													
0.1	Silty <b>CLAY</b> , trace sand, occasional rootlets		1	SS	8		131							
130.7	Stiff Brown (FILL)													
0.7	Silty <b>CLAY</b> , trace sand		2	SS	12									0 8 63 29
	Stiff to Very Stiff Brown													
			3	SS	27									
129.1							129							
2.4	<b>SHALE</b> , with limestone interbeds, weathered, thinly bedded, brownish grey		4	SS	57									
			5	SS	86		128							
	Start coring at 4.5m						127							
	Weathered to fresh, thinly bedded, occasional limestone interbeds													
	Clay seam (250mm) at 4.5m													
	Limestone interbeds (25mm thick) at 5.2m, 5.3m, 5.5m, (125mm) at 5.0m and (150mm) at 5.5m		1	RUN			126							
	Horizontal fractures at 4.8m, 4.9m, 5.1m, 5.2m, 5.9m													
							125							
	Limestone interbeds (25mm to 75mm thick) from 6.2m to 7.1m, 7.3m, 7.4m, 7.5m, 7.6m,		2	RUN										
	Horizontal fractures at 6.1m, 6.7m, 7.1m, 7.4m, 7.5m						124							
123.8														
7.6	END OF BOREHOLE AT 7.6m. BOREHOLE OPEN TO 7.6m AND WATER LEVEL AT 4.8m UPON COMPLETION OF CORING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													

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# RECORD OF BOREHOLE No 13-30

1 OF 1

METRIC

W.P. \_\_\_\_\_ LOCATION N 4 817 187.5 E 290 708.9 ORIGINATED BY GA  
 HWY 403/QEW BOREHOLE TYPE Solid Stem Augers/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2013.06.05 - 2013.06.05 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
127.7														
0.0	<b>TOPSOIL:</b> (100mm)													
0.1	Silty <b>CLAY</b> , trace sand, occasional rootlets		1	SS	8									0 0 62 38
127.0	Stiff Brown (FILL)													
0.8	Silty <b>CLAY</b> , trace sand		2	SS	12									
	Stiff Brown													
126.2														
1.5	<b>SHALE</b> , with limestone interbeds, weathered, thinly bedded, brownish/grey		3	SS	50/ 0.150									
			4	SS	50/ 0.150									
	Start coring at 3.0m Weathered to fresh, thinly bedded, grey, occasional limestone interbeds													
	Limestone interbeds (25mm to 50mm thick) at 3.3m, 3.5m, 3.6m, 3.7m, 4.3m, 4.4m, 4.5m and (100mm) at 4.1m		1	RUN										RUN #1 TCR=100% SCR=88% RQD=68% UCS=81MPa (Average)
	Clay seam (100mm) at 4.6m													
	Horizontal fracture at 3.3m, 3.4m, 3.5m, 3.6m, 3.8m, 3.9m, 4.0m, 4.1m, 4.2m, 4.3m													
	Limestone interbeds (25mm to 50mm thick) at 4.5m, 4.7m, 4.8m, 4.9m, 5.0m, 5.3m, 5.4m, 5.8m and (125mm) at 5.1m		2	RUN										RUN #2 TCR=100% SCR=100% RQD=95% UCS=55MPa (Average)
	Horizontal fracture at 4.9m, 5.2m, 5.3m, 5.6m, 5.9m													
121.6														
6.1	END OF BOREHOLE AT 6.1m. BOREHOLE OPEN TO 6.1m AND WATER LEVEL AT 4.2m UPON COMPLETION OF CORING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													

ONTMT4S 1184.GPJ 2012TEMPLATE(MTO).GDT 11/10/13

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 7

WP 125-66-18 LOCATION Co-ords N 15 803 726; E 953 787 ORIGINATED BY VK  
 DIST 4 HWY 403 BORING DATE March 23, 1977 COMPILED BY VK  
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger, BXL Core & Cone Test CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
421.4	Ground Level					ELEV										
419.8	Topsoil					420										
1.8	Clayey Silt to Brown Silty Clay, Grey		1	SS	32											0 2 54 44
414.4	Trace of Sand		2	SS	133											
7.0	(Weathered)					410										
8.7	(Sound)		3	BXL	100% REC											
	Shale Bedrock * (See Below)		4	BXL	100% REC											RQD 10%
			5	BXL	100% REC	400										RQD 25%
			6	BXL	100% REC											RQD 35%
			7	BXL	100% REC											RQD 0%
			8	BXL	50% REC											RQD 0%
391.4			9	BXL	100% REC											RQD 0%
30.0	End of Borehole															
	* Intermittent shale, shaly limestone & shale beds (Soft to hard, fine texture, shale is fissile & grey to red grey colour, thin horizontal bedding) with Limestone seams (light grey, soft to hard, fine texture with shale seams present)															
	from 9'3" to 9'8"															
	13'4" to 13'10"															
	18'4" to 18'8"															
	19'4" to 20'4"															
	23'4" to 24'7"															

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 8

WP 125-66-3 LOCATION Co-ords N 15 803 824, E 953 779 ORIGINATED BY VK  
DIST 4 HWY 403 BORING DATE March 23, 1977 COMPILED BY VK  
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger, BXL Core & Cone Test CHECKED BY R.

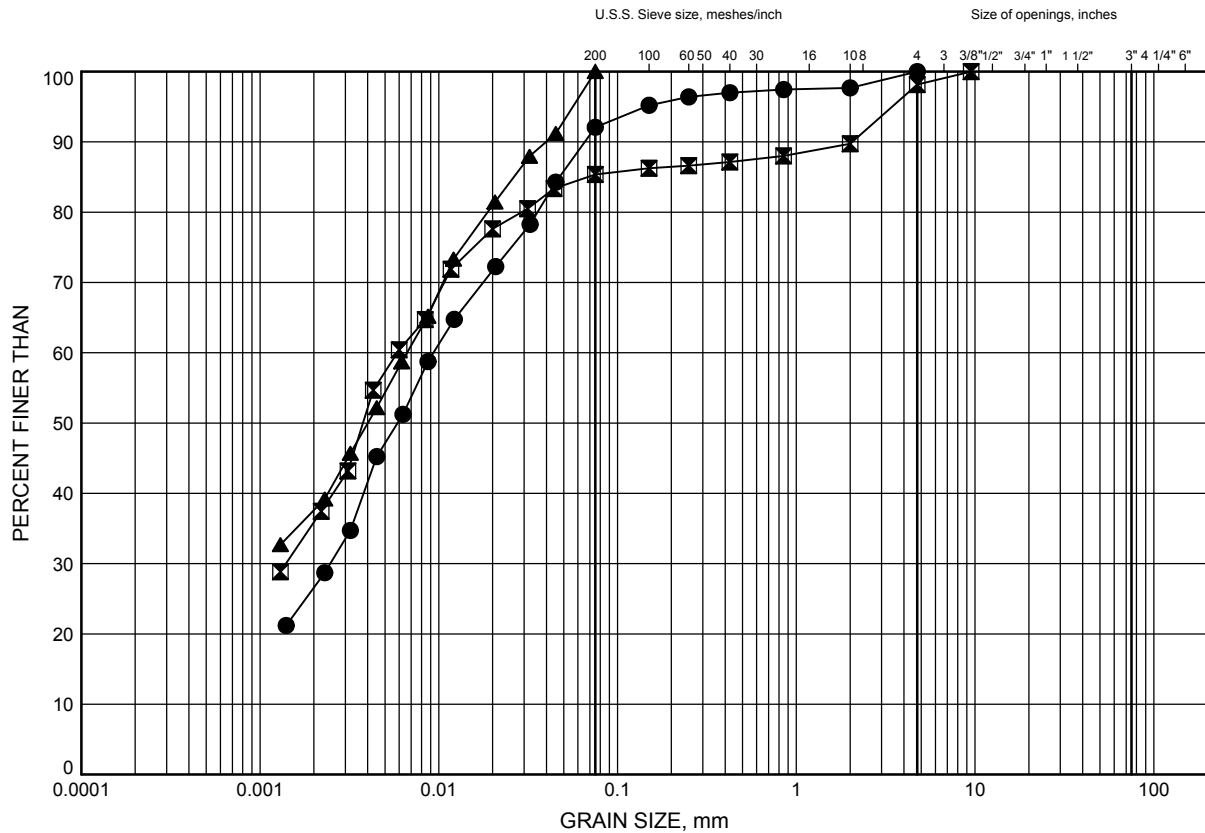
SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT			LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20 40 60 80 100			$W_P$ $W$ $W_L$				
427.4	Ground Level													
0.0	Clayey Silt to Silty Clay, Trace of Sand		1	SS	21									
417.9	Very Stiff to Hard Brown occ. layers of grey		2	SS	71									0 1 70 29
9.5	Shale Bedrock *		3	SS	156	9"								
412.4	(See Below) (Weathered)		4	SS	150	7"								
15.0	(Sound)		5	BXL	100%									RQD 0%
			6	BXL	100% REC									RQD 12%
			7	BXL	100% REC									RQD 5%
396.4			8	BXL	100% REC									RQD 41%
31.0	End of Borehole													
	*Intermittent shale, shaly limestone & shale beds (soft to hard, fine texture, light grey to black colour, shale is fissile, thin horizontal bedding, limestone seams up to 3" thick) with Limestone seams (hard light grey colour, fine texture)													
from	24'8" to 25'6" 29'6" to 31'0"													

**Appendix B**  
**Laboratory Test Results**

QEW and Hwy 403  
GRAIN SIZE DISTRIBUTION

FIGURE B1

Silty CLAY (FILL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13-19	1.07	129.96
⊠	13-20	1.07	126.65
▲	13-30	0.30	127.41

Date July 2013  
W.P. ....

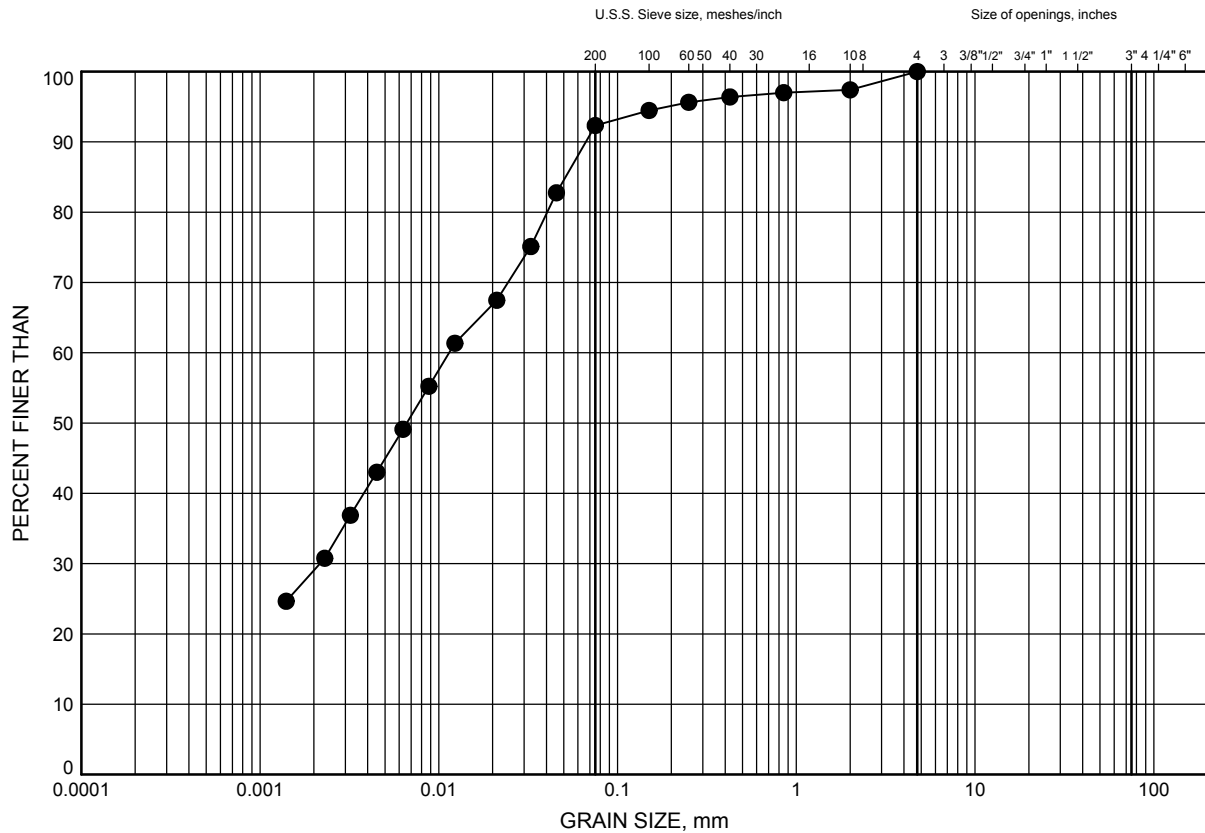


Prep'd SBP  
Chkd. SBP

QEW and Hwy 403  
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)
●	13-29	1.07	130.36

Date July 2013  
W.P. ....



Prep'd SBP  
Chkd. SBP

**Appendix C**  
**Foundation Comparison**

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

<b>Spread Footing on Shale Bedrock</b>	<b>Spread Footing on Engineered Fill</b>	<b>Steel H-Piles Socketed into Shale Bedrock</b>
<p><b><i>Advantages:</i></b></p> <ul style="list-style-type: none"> <li>i. Generally less costly construction than deep foundation elements.</li> </ul> <p><b><i>Disadvantages:</i></b></p> <ul style="list-style-type: none"> <li>i. Dewatering may be required, depending on depth of excavation</li> <li>ii. Ineffective for resistance to uplift or overturning.</li> </ul>	<p><b><i>Advantages:</i></b></p> <ul style="list-style-type: none"> <li>i. Economical to install</li> <li>ii. Accommodates perched abutment</li> </ul> <p><b><i>Disadvantages:</i></b></p> <ul style="list-style-type: none"> <li>i. Dewatering may be required, depending on depth of excavation.</li> <li>ii. Lower geotechnical resistance than spread footings on bedrock</li> <li>iii. Ineffective for resistance to uplift or overturning.</li> </ul>	<p><b><i>Advantages:</i></b></p> <ul style="list-style-type: none"> <li>i. High geotechnical resistance available by socketing piles into bedrock.</li> <li>ii. Provide uplift and overturning resistance</li> <li>iii. Installation less influenced by weather and groundwater than spread footings.</li> <li>iv. Permits integral abutment design</li> <li>v. Comparatively short abutment possible</li> </ul> <p><b><i>Disadvantages:</i></b></p> <ul style="list-style-type: none"> <li>i. Higher unit cost compared to spread footings</li> <li>ii. Difficulty in unwatering, cleaning and inspecting bases</li> <li>iii. Pre-drilling required for installation of socket piles.</li> <li>iv. Potential for difficulty in drilling through hard limestone interbeds</li> </ul>
<b>RECOMMENDED</b>	<b>FEASIBLE</b>	<b>FEASIBLE</b>



**Appendix D**  
**Site Photographs**

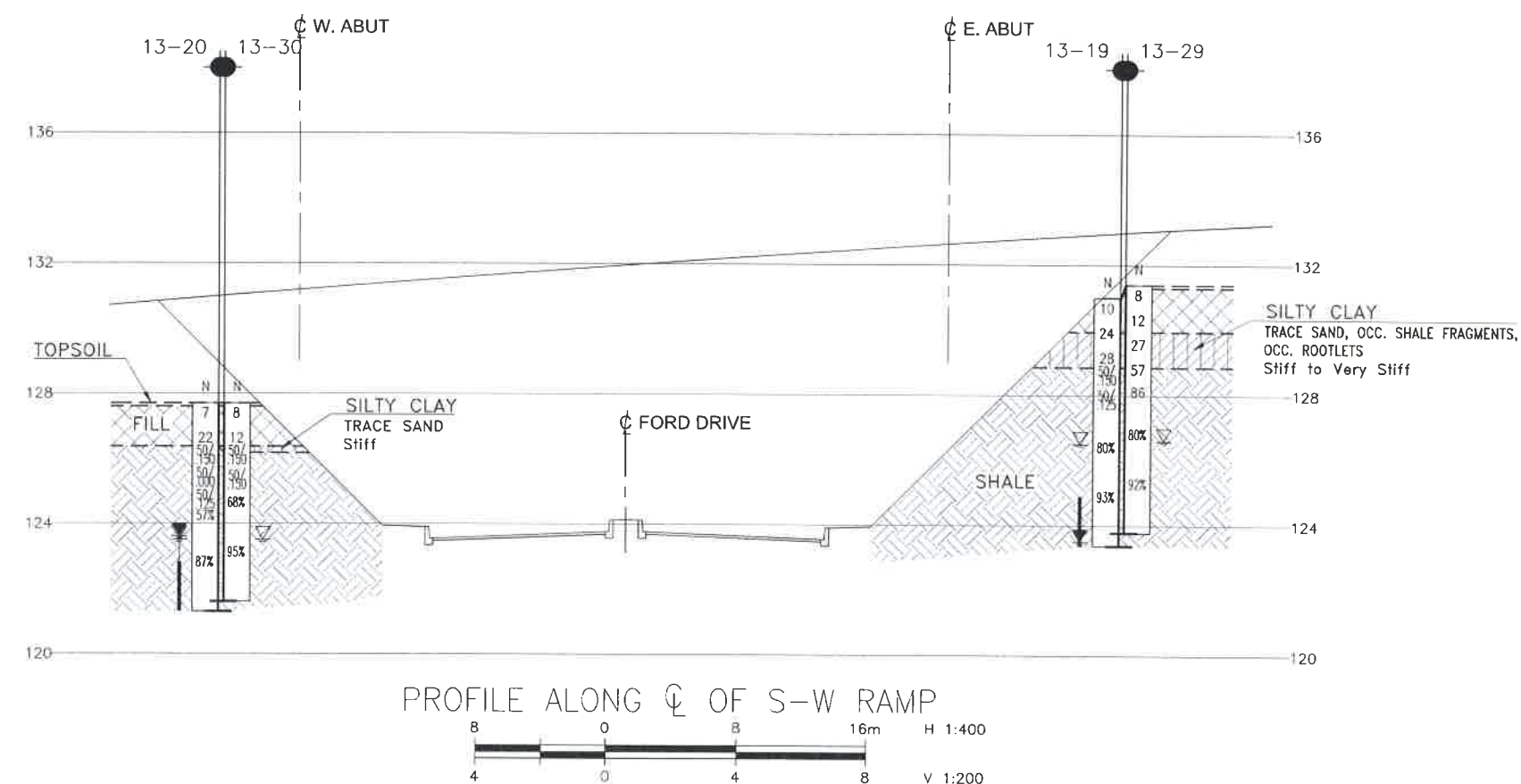


**Photograph 1:** Looking across Ford Drive towards the location of the proposed east abutment.



**Photograph 2:** Looking along Ford Drive towards the location of the proposed west abutment.

**Appendix E**  
**Borehole Locations and Soil Strata Drawing**



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



CONT No
WP No

Q.E.W.  
S-W RAMP  
OVER FORD DRIVE  
BOREHOLE LOCATIONS AND SOIL STRATA






SHEET



**THURBER ENGINEERING LTD.**



KEYPLAN  
LEGEND

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

[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.

GEOCRES No. 30M5-291

REVISES												
	DATE	BY										
DESIGN	SBP	CHK	AEG	CODE		LOAD		DATE	JUL 20			
DRAWN	MFA	CHK	SBP	SITF		STRUCT	FWG					