FOUNDATION INVESTIGATION AND DESIGN REPORT
PICKERING PEDESTRIAN BRIDGE
Liverpool Road and Highway 401
City of Pickering

Report to

AECOM

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of a proposed pedestrian bridge in Pickering, Ontario. The proposed structure will carry pedestrian traffic across Highway 401 from the parking lot of Pickering Town Centre to the Pickering GO Station.

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.

Thurber carried out this investigation as a sub-consultant to AECOM.

2. SITE DESCRIPTION

The site of the investigation is located approximately 325 m east of Liverpool Road at Highway 401 in Pickering, Ontario. The proposed pedestrian bridge will span Highway 401, GO Transit tracks and platforms, and CN Rail tracks. At this location Highway 401 consists of seven (7) eastbound lanes and six (6) westbound lanes as well as a 2-lane ramp to Liverpool Road.

The proposed 6-span bridge consists of a terminal structure at each end as well as five piers. The foundations for two of the piers (Pier 4 and Pier 5) have already been constructed in conjunction with the highway widening.

The surrounding area is relatively flat and well developed. Pickering Town Centre is located to the north of the proposed bridge and the Pickering GO Station is located to the south.

Physiographically, the site is located within the Iroquois Plain which consists predominantly of permeable sands that were deposited along the shores of the glacial Lake Iroquois. This plain also consists of till plains, drumlins, and areas of silty lacustrine deposits.

3. SITE INVESTIGATION AND FIELD TESTING

The initial site investigation and field testing for this project were carried out between March 1 and March 16, 2010. A total of five boreholes, identified as Boreholes 10-01 to 10-05, were advanced to depths ranging from 14.3 m to 19.1 m. Boreholes 10-01 and 10-05 were drilled near the proposed locations of the south and north terminals, respectively and Boreholes 10-02 to 10-04 were drilled near the proposed locations of the three bridge pier foundations that remain to be constructed.

Three boreholes (Boreholes 1, 2, and 3) were drilled in 1995 by Peto MacCallum Ltd. near the proposed locations of Pier 5, Pier 4, and the northern terminal. The borehole logs from the 1995 investigation are included in Appendix A.

Two additional boreholes were drilled on December 20 to 22, 2010 adjacent to existing Pier 4 (BH10-06) and Pier 5 (BH10-07). Since detailed description of the overburden soils were provided in previous Boreholes 1 and 2, overburden sampling was not carried out to about 9 m depth in these boreholes. Once bedrock was encountered, the boreholes were advanced a further 10.7 and 11.5 m by rock coring, to total depths of 26.0 and 23.8 m. The boreholes were backfilled with bentonite upon completion.

The approximate locations of all boreholes from current and previous investigations are shown on the attached Borehole Location and Soil Strata Drawing in Appendix D.

All of the boreholes were drilled with a truck-mounted drill rig, with the exception of Borehole 10-03 which was drilled with a track-mounted rig. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils. Upon encountering bedrock, the boreholes were advanced approximately 3 to 11.5 m into the bedrock by NQ size diamond coring techniques.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. A standpipe piezometer consisting of 25 mm PVC pipe with a slotted screen was installed in selected boreholes upon completion of drilling. The depth and completion details for each piezometer are shown below in Table 3.1.

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

All rock cores were logged in the field, and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Table 3.1 – Borehole Completion Details

Borehole	Details	
	Piezometer Tip Depth/Elevation (m)	Completion Details
10-01	18.1/67.2	Piezometer with 1.5 m slotted screen installed with sand filter to 13.8 m, mixture of bentonite and cuttings from 13.8 m to ground surface. Flushmount cover installed.
10-02	19.1/67.7	Piezometer with 1.5 m slotted screen installed with sand filter to 14.8 m, mixture of bentonite and cuttings from 14.8 m to ground surface. Stick-up of 0.76 m.
10-03	16.8/67.2	Piezometer with 1.5 m slotted screen installed with sand filter to 12.2 m, mixture of bentonite and cuttings from 12.2 m to ground surface. Stick-up of 0.9 m.
10-04	15.6/70.4	Piezometer with 1.5 m slotted screen installed with sand filter to 12.0 m, bentonite seal from 12.0 m to 0.15 m, and cement from 0.15 m to ground surface. Flushmount cover installed.
10-05	14.3/70.2	Piezometer with 1.5 m slotted screen installed with sand filter to 9.8 m, mixture of bentonite and cuttings from 9.8 m to ground surface. Flushmount cover installed.

4. LABORATORY TESTING

The recovered soil samples were submitted to Thurber's laboratory for geotechnical testing, including Visual Identification (VI) and 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 and Atterberg Limits tests and the results of these tests are also shown on the Record of Borehole sheets in Appendix A as well as on the figures contained in Appendix B.

Selected rock core samples were subjected to point load testing and Uniaxial Compressive Strengths (UCS) were assessed from the point load tests. The results of these tests are also summarized on the Record of Borehole sheets in Appendix A.

In addition to the routine geotechnical testing, selected soil samples were submitted to AGAT Laboratories for analysis relating to the disposal of surplus soil. The following tests were performed by AGAT Laboratories:

Test	Number
O.Reg. 153/04, metals and inorganics	3
O.Reg 558, TCLP metals and inorganics	2
Petroleum hydrocarbons, F1-F4/BTEX	1
Polyaromatic hydrocarbons (PAH)	1

The AGAT Certificates of Analysis are included in Appendix C.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

This section presents a general summary of the subsurface conditions encountered at the borehole locations drilled for the proposed pedestrian bridge. Reference is made to the Record of Borehole sheets included in Appendix A. A stratigraphic profile is also presented on the Borehole Locations and Soil Strata Drawings in Appendix D. An overall description of the soil and rock 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 terms, the soil stratigraphy encountered in the five boreholes drilled for this investigation consists of asphalt or topsoil over fill which in turn overlies native silty clay and silt with some clay which in turn overlies sandy silt to silty sand till. Shale bedrock was encountered under the overburden deposits. Descriptions of the individual stratum are presented below.

5.1 Asphalt

Asphalt was encountered at the surface in Boreholes 10-01 and 10-04 to 10-07. The asphalt at these locations varied in thickness from 25 mm to 150 mm. The asphalt thickness may vary between and beyond the borehole locations.

5.2 Topsoil

At Borehole 10-03, 200 mm of topsoil was encountered which contained some rootlets. Topsoil thickness may vary in other parts of the site and this limited data is not suitable for estimating a topsoil stripping quantity.

5.3 Fill

Granular roadbase fill was encountered below the asphalt in Boreholes 10-01 and 10-04 to 10-07. The fill consisted primarily of sand with some gravel to silty sand. Cohesive fill which consisted of clayey silt to silty clay was encountered below the granular roadbase fill in Boreholes 10-04 and 10-05. Silty sand and sandy silt fill was encountered below the pavement structure in Borehole 10-01 and from the surface in Borehole 10-02.

The granular roadbase fill ranged from 0.6 to 1.8 m in thickness (underside elevation 83.7 to 85.4 m) and the cohesive fill ranged from 0.4 to 1.3 m in thickness (underside elevation 82.4 to 83.7 m). The silty sand/sandy silt fill is 0.8 m thick in Borehole 10-01 and 2.3 m thick in Borehole 10-02 (underside elevation 83.7 to 84.5 m).

The granular roadbase fill is damp to moist and the moisture contents ranged from 3 to 16%. SPT N-values recorded in the granular fill ranged from 14 to 34 blows for 0.3 m penetration, indicating compact to dense conditions. The moisture contents of the cohesive fill ranged from 15 to 25%. SPT N-values recorded in the cohesive fill ranged from 6 to 14 blows for 0.3 m penetration, indicating a firm to stiff consistency.

The moisture content of the silty sand/sandy silt fill ranges from 6 to 15%. SPT N-values range from 5 to 20 blows for 0.3 m penetration indicating the fill is in a loose to compact state.

5.4 Clayey Silt

In Borehole 10-03, a 2.1 m thick layer of clayey silt was encountered below the topsoil. The underside elevation of this clayey silt layer is 81.7 m. The SPT N-values for this deposit ranged from 7 to 10 blows for 0.3 m of penetration indicating a firm to stiff consistency. The moisture content of this layer ranges from 11 to 21%.

5.5 Silty Clay

Underneath the fill and the clayey silt layer, a layer of silty clay was encountered in all of the sampled boreholes, interlayered with a layer of silt with trace sand. The silt layer is described in the following section. The combined thickness of the silty clay layers ranged from 6.0 m in Borehole 10-01 to 2.4 m in Borehole 10-05. The underside elevation of the silty clay layer ranges from 75.4 to 76.6 m. The silty clay contains trace to some sand and trace gravel. The moisture contents of the silty clay layer ranged from 14 to 32%.

SPT N-values recorded in the silty clay ranged from 0 to 11 blows per 0.3 m of penetration indicating a very soft to stiff consistency. In general, the consistency ranged from soft to firm.

The results of the laboratory Atterberg Limits and gradation tests are summarized below:

Index Property	Percentage (%)
Liquid Limit	21 to 35
Plastic Limit	13 to 20

Soil Particles	Percentage (%)
Gravel	0
Sand	0 to 2
Silt	62 to 77
Clay	22 to 36

The grain size distribution curves for the selected silty clay samples are shown in Figure B1, Appendix B. The results of the Atterberg Limits tests for the selected silty clay samples are shown in Figure B5, Appendix B.

5.6 Silt

A layer of silt was encountered in all sampled boreholes, bedded within the silty clay. The thickness of the silt layer ranged from 1.5 to 4.6 m with underside elevation ranging from 76.9 to 79.1 m. The silt contains some clay and trace sand and is grey and wet, with moisture contents from 20 to 28%.

SPT N-values recorded in the silt deposit ranged from 2 to 8 blows per 0.3 m of penetration, indicating very loose to loose conditions.

The results of laboratory gradation tests performed on selected silt samples are summarized below:

Soil Particles	(%)
Gravel	0
Sand	1 to 2
Silt	78 to 85
Clay	13 to 26

The grain size distribution curves of the selected silt samples are shown in Figure B2, Appendix B.

5.7 Sandy Silt to Silty Sand Till

Sandy silt to silty sand till was encountered below the silty clay in all of the sampled boreholes except Borehole 10-04, where a layer of sand was encountered between the silty clay and the sandy silt to silty sand till. The till contains trace to some clay and trace gravel and is grey and varies from damp to wet. The thickness of this till deposit ranges from 1.6 to 6.1 m with underside elevation of 70.3 to 73.8 m.

SPT N-values recorded in the silty sand to sandy silt till deposit ranged from 0 to 82 blows per 0.3 m of penetration, indicating very loose to dense conditions. SPT N-values of 100 blows for 0.275 m of penetration and 50 blows for 0.05 m of penetration were also recorded. The SPT N-values were typically greater than 40 blows per 0.3 m of penetration, indicating that the silty sand to sandy silt till typically has a dense condition. The moisture content of the till ranges from 6 to 13%.

The results of laboratory gradation tests performed on selected sandy silt to silty sand till samples are summarized below:

Soil Particles	(%)
Gravel	4 to 10
Sand	42 to 48
Silt	31 to 44
Clay	10 to 13

The grain size distribution curves of selected sandy silt to silty sand till samples are shown in Figure B3, Appendix B.

5.8 Sand

A layer of sand was encountered below the silty clay in Borehole 10-04 and below the sandy silt to silty sand till in Borehole 10-05. The sand contains some gravel, some silt, and trace clay and is grey and wet. The thickness of the sand layer ranges from 0.4 to 1.0 m with and underside elevation of 73.4 to 75.6 m. The SPT N-value recorded in this sand unit was 9 to 20 blows for 0.3 m of penetration, which indicates a loose to compact condition.

The results of a laboratory gradation test are summarized below:

Soil Particles	(%)
Gravel	17
Sand	72
Silt & Clay	11

The grain size distribution curve for the sand sample is shown in Figure B4, Appendix B.

5.9 Bedrock

The overburden soils described above are underlain by weathered to fresh shale bedrock with hard limestone interbeds. Table 5.1 summarizes the bedrock depth and the elevations of the top of bedrock at each borehole location.

Table 5.1 – Depth to Bedrock at Borehole Locations

Borehole	Depth to Bedrock (m)	Top of Bedrock Elevation (m)
10-01	13.0	72.3
10-02	15.8	71.0
10-03	13.7	70.3
10-04	12.3	73.7
10-05	11.1	73.4
10-06	14.9	71.3
10-07	12.2	73.8

Total core recovery (TCR) in the bedrock was generally between 92 and 100%, with the exception of Run 1 in Borehole 10-01 where the TCR was 20%. The RQD ranged from 13 to 100%, again with the exception of Run 1 in Borehole 10-01 where the RQD was 0%. These values indicate that the quality of the shale bedrock is quite variable and ranges from very poor to excellent. In Boreholes 10-06 and 10-07, the RQD typically ranged from 82 to 100% (good to excellent quality) with one value of 71% (fair quality) in the initial run. The RQD values appear to increase with depth.

A total of sixty-six (66) point load tests were performed on the bedrock core samples. Based on the results of the laboratory point load tests, the assessed Uniaxial Compressive Strength (UCS) of the selected bedrock samples ranged from 1.0 to 20 MPa. These values indicate a strength classification of very weak to weak. It should be noted that the rock contains hard limestone interbeds.

5.10 Water Levels

A standpipe piezometer was installed in Boreholes 10-01 to 10-05. Water levels were observed in the open boreholes during drilling and were measured a few weeks after drilling was completed. The water level readings from the piezometers are presented in Table 5.2.

Table 5.2: Water Level Measurements

Borehole	Tip Depth/ Elevation (m)	Date	Water Level (m)	
			Depth Below Surface	Elevation
10-01	18.1 / 67.2	Mar. 2, 2010	5.6	79.7
		Mar. 30, 2010	6.1	79.2
		Apr.19, 2010	6.0	79.3
10-02	19.1 / 67.7	Mar. 5, 2010	4.2	82.6
		Mar. 30, 2010	6.9	79.9
		Apr.19, 2010	7.0	79.9
10-03	16.8 / 67.2	Mar. 30, 2010	1.8	82.2
		Apr.19, 2010	4.9	79.2
10-04	15.6	Mar. 15, 2010	4.6	81.4
		Mar. 30, 2010	1.0	85.0
10-05	14.3 / 70.2	Mar. 3, 2010	3.7	80.8
		Mar. 30, 2010	7.1	77.4
		Apr.19, 2010	7.7	76.8

The values presented in Table 5.2 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

DBW Drilling Ltd. of Ajax, Ontario supplied the drill rigs and conducted the drilling, sampling and in-situ testing operations.

The field work was supervised on a full time basis Mr. Jason Mei and Ms. Eckie Sui of Thurber Engineering Ltd. Laboratory testing was carried out at Thurber's laboratory in Oakville, Ontario.

Planning of the field program was conducted by Mrs. Lindsey Blaine, E.I.T. Interpretation of the field data and preparation of the investigation report was conducted by Mrs. Lindsey Blaine, E.I.T.

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

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. GENERAL

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

Information provided by AECOM indicates that the pedestrian bridge will have six spans of varying length for a total length of 201.5 m. The proposed bridge consists of a terminal structure at each end as well as five piers. The five piers will consist of reinforced concrete shafts which will be supported on concrete foundations. Based on the information provided, the foundations for the two piers located in/on Highway 401 have already been constructed during the Highway 401 expansion in the late 1990s. The two terminal structures will be reinforced concrete and will house both stairs and elevators.

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 encountered in the sampled boreholes drilled at the locations of the bridge piers and the terminals consists of a pavement structure overlying 0.8 to 2.3 m of sand, silt and clay fill overlying a sequence of soft to firm silty clay over dense to very dense silty sand till. Shale bedrock was encountered at depths of 11 to 16 m at the borehole locations.

Initial consideration was given to the following foundation types:

- Spread footings
- Caissons
- Driven steel H-piles

A comparison of the foundation alternatives based on advantages and disadvantages of each is discussed below.

8.1 Spread Footings

The consistency of the clay soil near the surface ranges from soft to firm, occasionally stiff. Accordingly, spread footings are not recommended as foundations for the bridge piers or terminals on account of the low available bearing resistance and the potential for uneven differential settlement.

It is also noted that the two foundation units that have been pre-built within the Highway 401 lanes are founded on piles. For this reason also, piled foundations are recommended in order to provide compatible foundation performance along the structure.

Spread footings could, however, be considered for the support of the ends of the stairs remote from the terminal tower. The spread footings must be founded on undisturbed native soil or on engineered fill pads bearing on the native soil. These footings can be designed on the basis of the following bearing resistances:

ULS_f	150 kPa
SLS	100 kPa

Alternatively, the spread footings could be founded on a pad of engineered fill consisting of OPSS Granular A compacted to 100% of the standard Proctor maximum dry density at optimum moisture content ±2%. Provided the engineered fill is at least 1.5 m thick below the footing, the following bearing resistances may be used:

ULS_f	450 kPa
SLS	300 kPa

The performance of the spread footings will differ from the piled foundations in that grater movement must be anticipated, i.e. settlement and possible movement in the winter. This relative movement must be taken into account, especially where the stair structure is tied into the main structure.

8.2 Caissons

Caissons foundations are an option to support the structure at this site.

Caissons may be founded in the bedrock that was encountered underlying the site. Based on the available information, bedrock lies at Elevation 70.3 at Borehole 10-03 to Elevation 73.8 at Borehole 10-07.

The caissons must be advanced through the overburden and into the bedrock and must be advanced using a steel liner to support the walls and reduce the risk of material falling in from the sides of the hole. It will be necessary to advance the liner to the top of the bedrock.

The method of installation can be selected by the contractor, provided it meets the requirements of the foundation design.

The factored axial geotechnical resistances at ULS recommended for three typical caisson designs, founded in shale bedrock and designed for end bearing, are provided in Table 8.1.

Table 8.1- Axial Geotechnical Resistance of Caissons

Socket Depth below Sound Shale Surface (m)	Caisson Diameter (m)	Factored Axial Resistance at ULS (kN)
1.5	0.9	2,000
1.5	1.2	4,000
3.0	1.2	6,500

The SLS condition will not govern for caissons founded in bedrock.

The use of end bearing caissons, however, requires hand cleaning and inspection of the caisson base prior to concreting. If this cleaning and inspection cannot be assured at the time of design, then caissons are not recommended as the preferred foundation option.

8.3 Driven Steel Piles

The ground conditions at the site are considered to be suitable for the support of foundations on steel H-piles driven to refusal in the bedrock. Piled foundations are considered to be suitable for the piers and for the main towers at the terminals.

The anticipated pile lengths and tip elevations for piles driven to bedrock are as shown in Table 8.2.

Table 8.2 – Estimated Pile Lengths for Piles Driven to Bedrock

Borehole No.	Estimated Pile Tip Elevation	Estimated Length of Pile[1] (m)
10-01	72.3	13.0
10-02	71.0	15.8
10-03	70.3	13.7
10-04	73.7	12.3
10-05	73.4	11.1

1) From existing ground surface.

We understand that foundation loads will be relatively low at the Terminal Buildings and GO Platform Stairs (Boreholes 10-01, 10-02 and 10-03), and use of lower capacity piles is preferred. The preliminary design indicates maximum factored design loads will be up to 400 kN/pile at ULS and 350 kN/pile at SLS. It is recommended that piles supporting these lower design loads be driven to the very dense silty sand/sandy silt till at or below Elevation 74.0.

8.3.1 Axial Geotechnical Resistance

The axial geotechnical resistance of selected pile sections driven to bedrock that could be considered for use at this site are as follows:

Table 8.3 - Axial Geotechnical Resistance of Piles Driven to Bedrock

Pile Section	Factored Axial Resistance at ULS (kN)
HP 310 X 79	1,000
HP 310 X 110	2,000
HP 310 X 132	2,400
HP 310 X 152	2,750

The SLS condition will not govern for piles founded on bedrock.

For HP 310X79 piles driven to the very dense sand/silt till at or below Elevation 74.0, the following values for axial geotechnical resistance are recommended:

ULS_f	600 kN/pile
SLS	500 kN/pile

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

Oversize materials (e.g. greater than 75 mm nominal diameter) must not be used in any fills through which the piles will be driven.

8.3.2 Downdrag

Since the project does not include the placement of fill above existing grade, downdrag on the piles is not considered to be an issue at this site.

8.3.3 Pile Tips

The tips of all driven piles must be fitted with cast steel, H-section rock points from an approved manufacturer such as Titus Steel (Standard H-point) or APF hard Bite or approved equivalent.

8.3.4 Pile Installation

Pile installation must be in accordance with OPSS 903.

8.3.5 Pile Driving

The piles at this site must be founded on bedrock at the piers or very dense sand/silt till at the terminal buildings and stairs.

The appropriate pile driving note for piles driven to bedrock is "Piles to be driven to bedrock". The appropriate pile diving note for piles driven into the very dense sand/silt till is "Piles to be driven in accordance with Standard SS 103-11 using an Ultimate Geotechnical Resistance of 1,200 kN per pile" (or twice the maximum factored design load at ULS if this is less than 1,200 kN).

8.3.6 Predrilled Holes

We understand that setting of the piles in predrilled holes is being considered as an alternative to conventional pile driving operations to reduce construction noise and vibration. If predrilling is employed, it is recommended that the piles be installed in 600 mm diameter holes extending at least 1.5 m below the shale surface and backfilled with concrete.

Respective axial geotechnical resistances of 1,000 kN/pile and 1,500 kN/pile at factored ULS are recommended for non-driven HP 310X79 and HP 310X110 steel piles installed in predrilled holes in rock. The SLS condition will not govern design of piles set in predrilled holes in rock.

Construction of the predrilled holes will require use of a steel liner advanced to the bedrock surface to support the sidewalls, minimize groundwater inflow, and enable machine-cleaning of the socket base. Installation procedures that deal with potential instability due to the presence of a high groundwater table and cohesionless soil deposits must be employed.

An appropriate installation note is "Piles to be placed in bedrock. Suitability of bedrock to be confirmed by Geotechnical Engineer during construction of predrilled hole."

8.4 Recommended Foundation

From a geotechnical perspective, the recommended foundation system for this structure is steel H-piles driven to bedrock. Steel piles driven to very dense sand/silt till may be considered for the Terminal Buildings and Platform Stairs.

8.5 Frost Cover

The design depth of frost penetration at this site is 1.3 m. It is recommended that pile caps and footings founded on soils be provided with a minimum of 1.3 m of earth cover above the underside of the pile cap.

8.6 Lateral Resistance of Piles and Caissons

We understand that horizontal loads at the South and North Platform Stairs (BH10-02 and 10-03) will be resisted by passive forces developed along the sides of the deep foundation units. The lateral resistance of the piles/caissons may be calculated using values for the coefficient of horizontal subgrade reaction (k_s) and ultimate lateral resistance (p_{ult}) computed as follows:

Non-cohesive Sands and Silts:

$k_s = n_h\ z / D$ (kN/m³)

$p_{ult} = 3\ \gamma\ z\ K_p$ (kPa)

Cohesive Silty Clays and Clayey Silts:

$k_s = 67\ c_u / D$ (kN/m³)

$p_{ult} = 9\ c_u$ (kPa)

where z = depth of embedment of pile/caisson in metres

D = pile/caisson width/diameter in metres

n_h = coefficient related to soil density (see table below)

c_u = undrained shear strength (see table below)

γ = bulk unit weight (see table below)
use submerged unit weight below water table

K_p = passive earth pressure coefficient (see table below)

Geotechnical parameters recommended for use in the above equations are as follows:

Table 8.4 - Parameters for Calculation of Lateral Pile/Caisson Resistance

Location	Elevation	Soil	n_h (kN/m³)	c_u (kPa)	K_p	Unit Weight (kN/m³)
South Platform Stairs (BH10-02)	85.0 to 84.5	Sandy Silt Fill	2,000	-	2.8	19
	84.5 to 80.7	Silty Clay	-	50	2.8	9*
	80.7 to 77.7	Silt	1,500	-	3.0	10*
	77.7 to 76.2	Silty Clay	-	35	2.5	9*
	76.2 to 71.1	Silty Sand Till	12,000	-	3.8	11*
North Platform Stairs (BH10-03)	85.0 to 83.5	Earth Fill	2,000	-	2.8	19
	83.5 to 81.7	Clayey Silt	-	60	2.8	9*
	81.7 to 79.4	Silty Clay	-	40	2.5	9*
	79.4 to 77.9	Silt	1,500	-	3.0	10*
	77.9 to 76.4	Silty Clay	-	35	2.5	9*
	76.4 to 73.3	Sandy Silt Till	10,000	-	3.6	11*
	73.3 to 70.3	Silty Sand Till	12,000	-	3.8	11*

*Buoyant unit weight below the water table.

The above equations and recommended parameters may be used to analyze the interaction between a pile and the surrounding soil. The lateral pressures obtained from the analysis should not exceed the ultimate lateral resistance.

The spring constant, K, for analysis may be obtained by the expression, $K = k_s \times L \times D$ (kN/m), where k_s is the coefficient of horizontal subgrade reaction (kN/m^3), D is the pile width (m) and L is the length (m) of the pile segment or element used in the analysis. The ultimate lateral resistance, P_{ult}, may be obtained from the expression, $P_{ult} = p_{ult} \times L \times D$. This represents the ultimate load at which the pile fails and will not support any additional load at greater displacements. It is recommended, however, that the total lateral resistance assumed in one pile be limited to no more than 120 kN at ULS and 40 kN at SLS.

The modulus of subgrade reaction may have to be reduced, based on the pile/caisson spacing. The reduction factors to be used for a pile group oriented perpendicular or parallel to the direction of loading are provided in the following table. Intermediate values may be obtained by linear interpolation.

Table 8.5 - Subgrade Reaction Reduction Factors for Pile/Caisson Spacing

Condition	Pile/Caisson Spacing, Centre to Centre*	Reduction Factor
Pile group oriented ***perpendicular*** to direction of loading	4D	1.0
	1D	0.5
Pile group oriented ***parallel*** to direction of loading	8D	1.0
	6D	0.7
	4D	0.4
	3D	0.25

* where D is the width of pile/caisson

8.7 Micropile and Rock Anchor Design

It is understood that additional resistance to large moments and associated uplift forces will be required for the existing foundations at Piers 4 and 5. Use of micropiles or rock anchors is being considered to resist the uplift forces.

Anchorage for micropiles and/or rock anchors should be developed within sound shale bedrock. In Boreholes 10-06 and 10-07 cored at Piers 4 and 5, sound shale was encountered at depths of 15.9 and 13.5 m (Elev. 70.3 and 72.5 m), respectively. The recommended allowable grout/sound rock adhesion for design of permanent micropiles/ anchors in sound shale is 170 kPa.

Contract Drawing S505 indicates that the proposed micropile design consists of a 75 mm diameter Dywidag threadbar installed in a 200 mm diameter hole with a minimum bond length of 10 m in sound bedrock. The allowable micropile/anchor capacity in tension for this configuration is 1,000 kN per micropile.

Provision must be included in the installation for post-grouting of the anchors/ micropiles. The rock anchors/micropiles should be provided with double corrosion protection.

Each production anchor/micropile should be proof tested as per ASTM to confirm that they can resist the required uplift load.

The drilling of holes for installation of micropiles or anchors will encounter clays, silts, sand and silt till below the water table. Free water was observed at 2.7m depth in Borehole 95-2 and caving of the borehole sidewalls was noted at depths of 1.8 to 4.5m in Boreholes 95-1 and 95-2. It is anticipated that temporary casing will be required to support the side walls of the holes drilled for installation of the micropiles/anchors.

The silt till may contain cobbles and boulders. The Contractor's drilling equipment must be able to dislodge, remove or penetrate any cobbles or boulders encountered in the till.

Hard limestone interbeds will be encountered while advancing the micropile holes within the shale bedrock. The Contractor's drilling equipment must be able to penetrate the sound bedrock and hard interbeds to achieve the design bond length.

9. EXCAVATION AND BACKFILL

9.1 General

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA) and in accordance with OPSS 902. For the purposes of the OHSA, the native soils may be classed as Type 2 soil and the fill as Type 3 soils.

9.2 Foundations

The excavation and backfilling for foundations must be carried out in accordance with OPSS 902.

9.3 Pavement Restoration

Following backfilling of the foundation excavations in the median and shoulders of Highway 401, the pavement structure must be reconstructed to match the thickness of the adjacent existing pavement structure. Boreholes drilled in the shoulder and median of the existing highway indicated a pavement structure consisting of about 130 mm of asphalt over 350 mm of Granular A base and 400 mm of Granular B (average values).

If the excavation limits extend into the travelled lanes, a significantly thicker asphalt layer should be anticipated (likely in the order of 250 to 300 mm, to be confirmed during construction). Disturbance of the pavement structure in the travelled lanes must be minimized.

Asphalt mixes used for pavement restoration on Highway 401 should consist of Superpave 12.5 FC2 for the surface course (40 mm thick) and HDBC for binder courses. The PGAC grade for the surface course and top binder course lift should be upgraded to PG 70-28.

10. GROUNDWATER AND SURFACE WATER CONTROL

The data obtained from the standpipe piezometers indicates that the groundwater level lies at depths below the existing ground ranging from 1.0 to 7.7 m, corresponding to Elevation 85.0 to Elevation 76.8. These levels, especially the higher levels, are believed to be representative of the groundwater in the lower soil strata and therefore will not affect the design or construction of shallow excavations. It must, however, be assumed that there is water perched in the fill materials encountered at the ground surface.

It is anticipated that excavations for the structure foundations will not extend more than 3 m ± below the existing ground level. These excavations will lie in the existing fill and may penetrate to the underlying silty clay.

It is anticipated that seepage from the shallow, perched groundwater into the foundation excavations can be controlled by pumping from shallow sumps.

The volumes of water removed by dewatering/unwatering are not expected to need a Permit to Take Water (PTTW). However, it may be advisable to submit an application for a PTTW to MOE in time to have the PTTW in place at the time of contract award. In this way, the permit will be in place should there be any events on site that trigger the requirement.

All surface water should be diverted away from any temporary excavation.

11. PROTECTION SYSTEMS

Shoring required for roadway protection or for the support of temporary excavations must be designed in accordance with OPSS 539. Performance Level 2 is recommended for roadway protection within the Highway 401 corridor. For work within the railway right of way, reference should be made to the requirements in AREMA.

Recommended geotechnical parameters for review of the shoring design are presented in Table 11.1. The shoring design must take into account any surcharge loads such as rail and road traffic. Soils should not be stockpiled adjacent to the excavation.

Design of the protection system is the responsibility of the Contractor. All shoring systems should be designed by a Professional Engineer experienced in such designs.

Table 11.1 - Shoring Design Parameters

Soil Type	γ (kN/m³)	ϕ' (deg.)	K_a	K_o	K_p
Sand and Gravel Fill - upper 0.8 to 1.9 m in Boreholes 10-01, 10-04, 10-05, 95-01 and 95-02	22	32	0.3	0.47	3.3
Silty Sand/Sandy Silt Fill - 0.9 to 1.6 m in Borehole 10-01, upper 2.3 m in Borehole 10-02	21	30	0.33	0.5	3.0
Clayey Silt/Silty Clay Fill - upper 2.3 m in Borehole 10-03, 1.9 to 2.3 m in Borehole 10-04, 0.8 to 2.1 m in Borehole 10-05	20	26	0.4	0.56	2.5
Silty Clay - below depths of 1.4 to 2.3 m in all boreholes	19	28	0.36	0.53	2.8

Notes: Submerged unit weights (γ - 9.8 kN/m^3) should be used below the base of the excavation.
Earth pressure coefficients are for a level ground surface. For the case of a sloping backfill, the coefficients should be reviewed by Thurber.

12. EARTH PRESSURE

For fully drained conditions, earth pressures acting on retaining structures should be computed in accordance with Clause 6.9 of the CHBDC but generally are given by the expression:

$$P_h = K(\gamma h + q)$$

P_h = horizontal pressure on the wall at depth h (kPa)

K = earth pressure coefficient (see table 12.1)

γ = unit weight of retained soil (see table 12.1)

h = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

In accordance with Clause 6.9.3 of the CHBDC, a compaction surcharge should be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for Granular B Type I or at a depth of 1.7 m for Granular A or Granular B Type II.

Table 12.1 – Earth Pressure Coefficients

	Earth Pressure Coefficient (K)			
	OPSS Granular A or OPSS Granular B Type II $\phi = 35°; \gamma = 22.8\ kN/m^3$		OPSS Granular B Type I $\phi = 32°; \gamma = 21.2\ kN/m^3$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (Unrestrained Wall)	0.27	0.40*	0.31	0.48*
At rest (Restrained Wall)	0.43	-	0.47	-
Passive (Movement Towards Soil Mass)	3.70	-	3.30	-

* For wing walls.

13. SEISMIC CONSIDERATIONS

13.1 Seismic Design Parameters

The site is treated as lying in Seismic Zone 1. The following seismic parameters should be used for design:

- Velocity Related Seismic Zone 1
- Zonal Velocity Ratio 0.05
- Acceleration Related Seismic Zone 1
- Zonal Acceleration Ratio 0.05
- Peak Horizontal Acceleration 0.08

The soil profile type at this site has been classified as Type II. Therefore, according to Table 4.4 of the CHBDC, a Site Coefficient "S" (ground motion amplification factor) of 1.2 should be used in seismic design.

13.2 Liquefaction Potential

The potential for liquefaction of the foundations soils was assessed using the Seed and Idriss (1971) method[1].

Using this method, the clay soils at the site are not considered to be prone to liquefaction.

[1] Seed, H.B. and Idriss, I.M. 1971, "Simplified Procedure for Evaluating Soil Liquefaction Potential" *Journal of Soil Mechanics and Foundations Division,* ASCE, Vol. 101, No. SM9, September, pp. 1249-1273.

13.3 Retaining Wall Dynamic Earth Pressures

In accordance with Clause 4.6.4 of the CHBDC, retaining structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading. For the design of retaining walls, the coefficients of horizontal earth pressure in Table 13.1 may be used.

Table 13.1 – Earth Pressure Coefficient (K) for Earthquake Loading

	Granular A or Granular B Type II $\phi = 35°$, $\gamma = 22.8$ kN/m^3		OPSS Granular B Type I $\phi = 32°$ $\gamma = 21.2$ kN/m^3	
Wall Condition	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (K_{AE})*	0.3	0.47	0.34	0.58
Passive (K_{PE})	3.6	-	3.2	-
At Rest (K_{OE})**	0.53	-	0.58	-

* After Mononobe and Okabe, passive case assumes a horizontal surface in front of the wall.
** After Woods

14. DISPOSAL OF SURPLUS EXCAVATED SOIL

A total of seven soil samples were selected for submission to AGAT Laboratories Limited for analytical testing to assess disposal requirements for surplus excavated soil.

In general, visual and olfactory examination of the soil samples revealed no evidence of staining or odours indicative of hydrocarbon impact or other contamination.

The analytical results for the three samples tested for selected inorganic parameters outlined in O.Reg. 153/04 were compared to the criteria for Table 1 (Full Depth Background Site Condition Standards) and Table 2 (Full Depth Generic Site Condition Standards in a Potable Groundwater Condition). The concentrations of all of the parameters tested met the more stringent background standards presented in Table 1, except for Electrical Conductivity (EC), Sodium Absorption Ration (SAR) and chloride in all three samples. Upon comparison with Table 2 of the Regulation (for Industrial, Commercial or Community land use) all of the concentrations met the guideline criteria except for the EC and SAR values in the sample collected from Borehole BH10-01. These results likely reflect the impact of road salting operations.

The results of the petroleum hydrocarbon and polyaromatic hydrocarbon (PAH) analyses were also compared to the Table 1 and Table 2 criteria. The concentrations of petroleum hydrocarbon Fractions F3 and F4 exceeded the Table 1 criteria, but did not exceed the Table 2 criteria. All other petroleum hydrocarbon concentrations (BTEX, F1, and F2), as well as the PAH concentrations met the Table 1 and Table 2 criteria.

The results of the TCLP tests were compared to the guidelines established by O.Reg. 558. All of the concentrations met the guideline.

Based on the analytical results summarized above the following recommendations are provided:

- In general, excess soils from the site may be classified as "non-subject waste" and disposed of at a suitable receiving site or reused on-site provided their geotechnical properties (i.e. water content, compactibility) are satisfactory.
- Acceptance criteria stipulated by individual receivers may vary and some receivers may require that all results meet the stringent Table 1 standards or other specified criteria. Bidders should confirm the requirements or their proposed receiving sites at the tendering stage.
- The EC, SAR and chloride values measured in the samples are believed to reflect the effects of road de-icing salt, and may impact vegetation growth if placed near the surface of a receiving site.
- Excavated pavement materials such as asphalt and concrete should be removed separately from granular materials and recycled at an approved recycling facility or disposed of appropriately off-site. Asphalt should not be mixed with excess excavated soil; fill receivers may not accept excess excavated soil if it contains asphalt.

15. CLOSURE

Engineering analysis and preparation of the report were carried out by Mr. Alastair E. 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.

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

STATEMENT OF GENERAL CONDITIONS

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering or environmental consulting practices in this area. No other warranty, expressed or implied, is made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purpose that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT. WE WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS "APPROVED USERS". The contents of the Report remain our copyright property and we authorize only the Client and Approved Users to make copies of the Report only in such quantities as are reasonably necessary for the use of the Report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make the Report, or any portion thereof, available to any party without our written permission. Any use which a third party makes of the Report, or any portion of the Report, are the sole responsibility of such third parties. We accept no responsibility for damages suffered by any third party resulting from unauthorized use of the Report.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgemental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

(see over...)

APPENDIX A

RECORD OF BOREHOLE SHEETS

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT(1) 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

SS Split Spoon Sample | WS Wash Sample | AS Auger (Grab) Sample
TW Thin Wall Shelby Tube Sample | TP Thin Wall Piston Sample
PH Sampler Advanced by Hydraulic Pressure | PM Sampler Advanced by Manual Pressure
WH Sampler Advanced by Self Static Weight | RC Rock Core | SC Soil Core

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

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

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

SYMBOLS

- CLAYSTONE
- SILTSTONE
- SANDSTONE
- COAL
- Bedrock (general)

DISCONTINUITY SPACING

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

TERMS

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

STRENGTH CLASSIFICATION

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

THURBER

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-01

METRIC

G.W.P. 19-5438-33 LOCATION N 4 854 678.5 E 338 260.9 ORIGINATED BY JM

HWY 401 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 03.01.2010 - 03.02.2010 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	GR	SA	SI	CL
85.3 / 0.0	ASPHALT: (25mm)									
0.1	SAND, some gravel, some silt, Compact, Brown, Moist (FILL)	1	SS	21	85	o				
84.5 / 0.8	Silty SAND, trace clay, trace gravel, Compact, Brown, Moist (FILL)	2	SS	12	84	o				
83.7 / 1.6	Silty CLAY, trace sand, Firm to Stiff, Brown to Grey, Moist to Wet (CL)	3	SS	10		o (with plastic/liquid limits)	0	2	62	36
		4	SS	6	83	o				
		5	SS	5	82	o				
		6	SS	4	81	o (with plastic/liquid limits)	0	0	75	25
79.2 / 6.1	Sandy SILT, Very Loose, Grey, Wet	7	SS	3	80 / 79	o				
77.7 / 7.6	Silty CLAY, trace to some sand, trace gravel, Very Soft, Grey, Moist to Wet	8	SS	0	78 / 77	o				
76.2 / 9.1	Silty SAND, trace clay, trace gravel, Compact, Grey, Moist (TILL)	9	SS	19	76	o				

Continued Next Page

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L

UNIT WEIGHT γ kN/m³ ; REMARKS & GRAIN SIZE DISTRIBUTION (%)

+³, ×³: Numbers refer to Sensitivity

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

ONTMT4S 3833.GPJ 5/19/10

Ministry of Transportation Ontario

RECORD OF BOREHOLE No BH10-01

METRIC

G.W.P. 19-5438-33 LOCATION N 4 854 678.5 E 338 260.9 ORIGINATED BY JM

HWY 401 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 03.01.2010 - 03.02.2010 CHECKED BY LRB

Continued From Previous Page

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT / FI	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Silty SAND, trace clay, trace gravel Very Dense Grey Moist (TILL)				75			
		10	SS	100/ .275		o		8 48 32 12
					74			
		11	SS	82	73	o		
72.3 / 13.0	SHALE, fresh, grey, weak to strong, thinly bedded to medium bedded				72			
		1	RUN		71		FI 25	RUN 1# TCR=20%, SCR=0%, RQD=0%
		2	RUN		70		15 14 11 5	RUN 2# TCR=100%, SCR=13%, RQD=13% UCS=3MPa
		3	RUN		69 68		7 6 5 3 0 4	RUN 3# TCR=100%, SCR=92%, RQD=92% UCS=3MPa
67.2 / 18.1	END OF BOREHOLE AT 18.1m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.							

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
Mar.02/10	5.56	79.7
Mar.30/10	6.07	79.2
Apr.19/10	5.98	79.3

Dynamic cone penetration resistance plot: 20 40 60 80 100. Shear strength kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100. Plastic limit w_P, natural moisture content w, liquid limit w_L. Unit weight γ kN/m³.

+³, ×³: Numbers refer to Sensitivity. 20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No BH10-02

METRIC

G.W.P. 19-5438-33	LOCATION N 4 854 714.9 E 338 235.7	ORIGINATED BY JM
HWY 401	BOREHOLE TYPE Hollow Stem Augers/NQ Coring	COMPILED BY AN
DATUM Geodetic	DATE 03.04.2010 - 03.04.2010	CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
86.8 / 0.0	Silty SAND, trace to some gravel, occasional roots, Compact, Dark Brown, Moist (FILL)	1	SS	20				
86.1 / 0.8	Sandy SILT, trace clay, trace gravel, occasional roots, Loose to Compact, Brown, Moist (FILL)	2	SS	10				
		3	SS	5				
84.5 / 2.3	Silty CLAY, trace sand, Firm to Stiff, Brown to Grey, Moist	4	SS	6	0	1	68	31
		5	SS	11				
		6	SS	7				
80.7 / 6.1	SILT, some clay, trace sand, Loose to Very Loose, Grey, Moist to Wet	7	SS	2	0	1	78	21
		8	SS	4				
77.7 / 9.1	Silty CLAY, some sand, Soft, Grey, Moist	9	SS	3				

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; ELEVATION SCALE (86, 85, 84, 83, 82, 81, 80, 79, 78, 77); DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE, 20 40 60 80 100; PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

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

Ministry of Transportation Ontario

RECORD OF BOREHOLE No BH10-02

METRIC

G.W.P. 19-5438-33 | LOCATION N 4 854 714.9 E 338 235.7 | ORIGINATED BY JM

HWY 401 | BOREHOLE TYPE Hollow Stem Augers/NQ Coring | COMPILED BY AN

DATUM Geodetic | DATE 03.04.2010 - 03.04.2010 | CHECKED BY LRB

Continued From Previous Page

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT	UNIT WEIGHT / FI	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.2 / 10.7	Silty SAND, trace to some clay, trace gravel; Dense to Very Dense; Grey; Moist; (TILL)	10	SS	40	76	o		
		11	SS	70	75	o		6 45 36 13
		12	SS	68	74 / 73	o		
71.1 / 15.8		13	SS	78	72	o	FI	
	SHALE, fresh, medium bedded, grey, weak to strong, occasional mechanical breaks	1	RUN		71		1, 2, 1, 1	RUN 1# TCR=92%, SCR=79%, RQD=79% UCS=7MPa
		2	RUN		70 / 69		2, 2, 2, 4	RUN 2# TCR=98%, SCR=78%, RQD=78% UCS=3MPa
67.8 / 19.1		3	RUN		68		1, 1	RUN 3# TCR=100%, SCR=100%, RQD=100% UCS=3MPa
	END OF BOREHOLE AT 19.1m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.							

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: O UNCONFINED; + FIELD VANE; ● QUICK TRIAXIAL; × LAB VANE — 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m³

Continued Next Page

$+^3, \times^3$: Numbers refer to Sensitivity — 20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-02

METRIC

G.W.P. 19-5438-33 | LOCATION N 4 854 714.9 E 338 235.7 | ORIGINATED BY JM
HWY 401 | BOREHOLE TYPE Hollow Stem Augers/NQ Coring | COMPILED BY AN
DATUM Geodetic | DATE 03.04.2010 - 03.04.2010 | CHECKED BY LRB

SOIL PROFILE			SAMPLES						DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, X LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE					GR	SA	SI	CL
	Continued From Previous Page														
	WATER LEVEL READINGS:														

DATE	DEPTH (m)	ELEV. (m)
Mar.05/10	4.22	82.58
Mar.30/10	6.87	79.93
Apr.19/10	6.95	79.85

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

15-○-5 (20 above, 10 below) (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No BH10-03

METRIC

G.W.P. 19-5438-33 LOCATION N 4 854 740.4 E 338 221.7 ORIGINATED BY JM

HWY 401 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 03.15.2010 - 03.16.2010 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	WATER CONTENT (%)	GR	SA	SI	CL
84.0 / 0.0	TOPSOIL, some rootlets								
0.2	Firm, Brown, Moist	1	SS	9					
	Clayey SILT, trace sand, trace gravel; Firm to Stiff; Brown; Moist	2	SS	10					
		3	SS	7					
81.7 / 2.3	Silty CLAY, trace sand; Soft to Firm; Brown to Grey; Moist to Wet; (CL)	4	SS	3		0	0	66	34
		5	SS	5					
79.4 / 4.6	SILT, some clay, trace sand; Loose; Grey; Wet	6	SS	4		0	1	85	14
77.9 / 6.1	Silty CLAY, trace sand, trace gravel; Soft; Grey; Moist	7	SS	3					
76.4 / 7.6	Sandy SILT, some clay, trace gravel; Loose; Grey; Moist; (TILL)	8	SS	8					
	Becomes very dense	9	SS	56					

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE (84 to 75); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Continued Next Page

+³, ×³: Numbers refer to Sensitivity   20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No BH10-03

METRIC

G.W.P. 19-5438-33 | LOCATION N 4 854 740.4 E 338 221.7 | ORIGINATED BY JM

HWY 401 | BOREHOLE TYPE Hollow Stem Augers/NQ Coring | COMPILED BY AN

DATUM Geodetic | DATE 03.15.2010 - 03.16.2010 | CHECKED BY LRB

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page				74			
73.3 / 10.7	Sandy SILT, some clay, trace gravel, Very Dense, Grey, Moist (TILL)							
	Silty SAND, trace gravel, trace to some clay, Very Dense, Grey, Moist (TILL)	10	SS	50	73	o		10 47 31 12
					72			
		11	SS	72		o		
					71			
70.3 / 13.7		~~12~~	~~SS~~	~~50/~~ .025		o	FI	
	SHALE, fresh, slightly weathered, medium bedded, weak, grey, trace mechanical breaks				70		>10	
							>10	
		1	RUN				8	RUN 1# TCR=100%, SCR=53%, RQD=53% UCS=3MPa
							>10	
					69		>10	
							3	
							4	
		2	RUN		68		3	RUN 2# TCR=100%, SCR=77%, RQD=77% UCS=3MPa
							3	
67.2 / 16.8							>10	

END OF BOREHOLE AT 16.8m.
Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.

WATER LEVEL READINGS

DATE	DEPTH (m)	ELEV. (m)
2010.03.30	1.80	82.2
2010.04.19	4.85	79.2

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE

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

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

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-04

METRIC

G.W.P. 19-5438-33 LOCATION N 4 854 827.9 E 338 163.9 ORIGINATED BY SLL

HWY 401 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 03.14.2010 - 03.15.2010 CHECKED BY LRB

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	GR	SA	SI	CL
86.0					86					
0.0	ASPHALT: (140mm)									
0.1	SAND, trace to some gravel, Compact, Brown, Damp (FILL)	1	SS	25						
	Occasional cobbles	2	SS	14	85					
		3	SS	14						
84.1 / 1.9	Silty CLAY, some sand, trace gravel, Stiff, Brown, Damp (FILL)				84					
83.7 / 2.3	Silty CLAY, trace sand, Firm, Greyish Brown, Moist (CL)	4	SS	7			0	1	77	22
		5	SS	7	83					
81.9 / 4.1	SILT, some clay, trace sand, Loose, Grey, Wet				82					
		6	SS	5	81					
		7	SS	6	80		0	2	85	13
79.1 / 6.9	Silty CLAY, trace sand, trace gravel, Firm, Grey, Moist				79					
		8	SS	4	78					
					77					
76.6 / 9.4	SAND, some silt, trace clay, trace gravel, Loose, Grey	9	SS	9						

Continued Next Page

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, X LAB VANE (20 40 60 80 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (20 40 60); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BH10-04

METRIC

G.W.P. 19-5438-33
LOCATION N 4 854 827.9 E 338 163.9
ORIGINATED BY SLL
HWY 401
BOREHOLE TYPE Holloe Stem Augers/NQ Coring
COMPILED BY AN
DATUM Geodetic
DATE 03.14.2010 - 03.15.2010
CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION (SOIL PROFILE)	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							
75.6	Wet				76			
10.4	Silty SAND, trace gravel, trace clay Dense Grey Damp (TILL)	10	SS	46	75	o		4 42 44 10
		11	SS	50/ 050	74	o	FI	
73.7 / 12.3	SHALE, weathered, thinly bedded, occasional mechanical breaks, occasional limestone interbeds, weak, grey	1	RUN		73		>10 >10 >5 >5	RUN 1# TCR=100%, SCR=85%, RQD=56% UCS=3MPa
		2	RUN		72		2 3 >5 >10 4	RUN 2# TCR=100%, SCR=82%, RQD=82% UCS=3MPa
		3	RUN		71		3 2	RUN 3# TCR=100%, SCR=83%, RQD=83% UCS=3MPa
70.4 / 15.6	END OF BOREHOLE AT 15.6m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.							

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
Mar.15/10	4.55	81.45
Mar.30/10	1.04	84.96

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60

ONTMT4S 3833.GPJ 5/19/10

+3, ×3: Numbers refer to Sensitivity; 20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No BH10-05

METRIC

G.W.P.	19-5438-33	LOCATION	N 4 854 848.5 E 338 150.9	ORIGINATED BY	JM
HWY	401	BOREHOLE TYPE	Hollow Stem Augers/NQ Coring	COMPILED BY	AN
DATUM	Geodetic	DATE	03.02.2010 - 03.03.2010	CHECKED BY	LRB

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	Water Content (%)	GR	SA	SI	CL
84.5									
0.0	ASPHALT: (150mm)								
0.2	SAND and GRAVEL, trace silt, Dense, Brown, Moist (FILL)	1	SS	34					
83.7 / 0.8	Clayey SILT, trace sand, trace gravel, Firm to Stiff, Grey to Brown, Moist to Wet (FILL)	2	SS	13					
		3	SS	6					
82.4 / 2.1	Silty CLAY, trace sand, Firm, Brown, Moist (CL)	4	SS	6		0	1	68	31
81.5 / 3.0	SILT, some clay, trace sand, Loose, Brown to Grey, Wet	5	SS	6					
		6	SS	5		0	2	72	26
		7	SS	5					
76.9 / 7.6	Silty CLAY, trace sand, trace gravel, Soft, Grey, Wet	8	SS	2					
75.4 / 9.1	Sandy SILT, trace clay, trace to some gravel, Very Loose, Grey, Wet (TILL)	9	SS	0					

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

15-⊕-5 (20/10) (%) STRAIN AT FAILURE

ONTMT4S 3833.GPJ 5/19/10

Ministry of Transportation Ontario

RECORD OF BOREHOLE No BH10-05

METRIC

G.W.P. 19-5438-33	LOCATION N 4 854 848.5 E 338 150.9	ORIGINATED BY JM
HWY 401	BOREHOLE TYPE Hollow Stem Augers/NQ Coring	COMPILED BY AN
DATUM Geodetic	DATE 03.02.2010 - 03.03.2010	CHECKED BY LRB

Continued From Previous Page

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
					74			
73.8 / 10.7	SAND, some silt, some gravel Compact Grey Wet	10	SS	20		o	FI	17 72 11
73.4 / 11.1	SHALE, fresh, medium to thickly bedded, weak to strong, grey, trace to occasional mechanical breaks	1	RUN		73		6, 2, 5, 9	RUN 1# (SI+CL) TCR=100%, SCR=33%, RQD=33% UCS=3MPa
		2	RUN		72		3, 2, 8, 1	RUN 2# TCR=100%, SCR=93%, RQD=93% UCS=3MPa
		3	RUN		71		3, 5, 1	RUN 3# TCR=100%, SCR=88%, RQD=88% UCS=6MPa
70.2 / 14.3	END OF BOREHOLE AT 14.3m. BOREHOLE OPEN TO 14.3m, AND WATER LEVEL AT 3.7m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.							

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
Mar.03/10	3.71	80.8
Mar.30/10	7.12	77.4
Apr.19/10	7.73	76.8

Chart headings: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60; STRAT PLOT; GROUND WATER CONDITIONS.

+³, ×³: Numbers refer to Sensitivity   (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-06

METRIC

W.P. 19-5438-33 | LOCATION N 4 854 766.9 E 338 196.6 (Pier 4) | ORIGINATED BY ES

HWY 401 | BOREHOLE TYPE Hollow Stem Augers/Casing/NQ Coring | COMPILED BY AN

DATUM Geodetic | DATE 12.20.2010 - 12.21.2010 | CHECKED BY WM

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT (WATER CONTENT %)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
86.2											
0.0	**ASPHALT:** (100mm)										
0.1	**SAND**, some gravel Brown Damp (FILL)						86				
85.4 0.8	Clayey **SILT**, some sand Brown						85 84 83 82 81				
80.1 6.1	Clayey **SILT**, some sand, trace gravel Brown (TILL)						80 79 78				
77.1 9.1	Silty **SAND**, trace to some gravel Loose Grey Wet		1	SS	5		77				

Continued Next Page

Legend: O UNCONFINED; + FIELD VANE; ● QUICK TRIAXIAL; × LAB VANE. DCPT scale 20 40 60 80 100; shear strength scale 20 40 60 80 100; water content scale 20 40 60; w_P, w, w_L.

$+^3, \times^3$: Numbers refer to Sensitivity   20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-06

METRIC

W.P. 19-5438-33 LOCATION N 4 854 766.9 E 338 196.6 (Pier 4) ORIGINATED BY ES

HWY 401 BOREHOLE TYPE Hollow Stem Augers/Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 12.20.2010 - 12.21.2010 CHECKED BY WM

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT kN/m3 / FI	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	Continued From Previous Page					
74.0 / 12.2	Sandy SILT, trace gravel Dense Grey Damp (TILL)	2	SS	44		
71.3 / 14.9	SHALE, highly weathered Grey	3	SS	50/ 0.050	FI	
70.9 / 15.3	SHALE, slightly weathered to fresh, occasional limestone fragments, grey; (GEORGIAN BAY FORMATION) Limestone interbeds between 50mm to 100mm at 15.4m, 15.5m, 15.9m, 16.1m, 17.3m, 17.4m and 17.5m 50mm vertical fractures at 16.6m Sub-vertical fractures at 16.4m, 16.9m, 17.4m, 17.7m, 17.9m and 18.2m	1	RUN		2, 2, 1, 2, 2, >5	RUN 1# TCR=100%, SCR=100%, RQD=90% UCS=5.6MPa (Shale)
		2	RUN		3, 3, >10, >5, >5	RUN 2# TCR=100%, SCR=82%, RQD=82% UCS=12.8MPa (Shale)
	Limestone interbeds between 50mm to 100mm at 18.7m, 19.4m, 19.9m, 20.4m, 20.6m, 20.8m, 20.9m, 21.3m, 21.9m and 22.0m Sub-vertical fractures at 18.4m, 18.5m, 18.8m, 19.3m, 19.7m, 20.1m, 20.4m, 21.2m, 21.4m, 21.5m and 22.1m 150mm mechanical breaks at 19.8m	3	RUN		5, 3, 2, 2	RUN 3# TCR=98%, SCR=97%, RQD=97% UCS=6.7MPa (Shale)

Elevation scale: 76, 75, 74, 73, 72, 71, 70, 69, 68, 67

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE: 20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L — WATER CONTENT (%): 20 40 60

GR SA SI CL

Continued Next Page

+3, ×3: Numbers refer to Sensitivity 15-○-5 (20/10) (%) STRAIN AT FAILURE

ONTMT4S 3833.GPJ 12/23/10

Ministry of Transportation Ontario

RECORD OF BOREHOLE No BH10-06

METRIC

W.P. 19-5438-33 | LOCATION N 4 854 766.9 E 338 196.6 (Pier 4) | ORIGINATED BY ES

HWY 401 | BOREHOLE TYPE Hollow Stem Augers/Casing/NQ Coring | COMPILED BY AN

DATUM Geodetic | DATE 12.20.2010 - 12.21.2010 | CHECKED BY WM

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						>10	
						66	3	
							1	
		4	RUN				1	RUN 4# TCR=100%, SCR=100%, RQD=90% UCS=16.3MPa (Shale)
						65	1	
	Sub-horizontal fracture at 21.2m						>5	
							2	
							2	
		5	RUN			64	0	RUN 5# TCR=98%, SCR=98%, RQD=90% UCS=13.5MPa (Shale)
							1	
							2	
						63	2	
							3	
		6	RUN				2	RUN 6# TCR=98%, SCR=95%, RQD=85% UCS=9.5MPa (Shale)
						62	1	
	Clay seam at 25.2m						2	
	Sub-vertical fractures at 25.5m and 25.9m						1	
		7	RUN			61	2	
	Sub-horizontal fractures at 25.1m, 25.4m and 25.4m						2	RUN 7# TCR=100%, SCR=100%, RQD=100% UCS=9.4MPa (Shale)
60.2							1	
26.0	END OF BOREHOLE AT 26.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.5m, CONCRETE TO 0.1m THEN ASPHALT TO SURFACE.							

Plot column headings: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20, 40, 60, 80, 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (20, 40, 60); STRAT PLOT.

ONTMT4S 3833.GPJ 12/23/10

+3, ×3: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BH10-07

METRIC

W.P.	19-5438-33	LOCATION	N 4 854 808.9 E 338 180.3 (Pier 5)	ORIGINATED BY	ES
HWY	401	BOREHOLE TYPE	Hollow Stem Augers/Casing/NQ Coring	COMPILED BY	AN
DATUM	Geodetic	DATE	12.21.2010 - 12.22.2010	CHECKED BY	WM

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
86.0				
0.0	**ASPHALT:** (130mm)			
0.1	**SAND**, some gravel Brown Damp (FILL)			
85.2 0.9	Clayey **SILT**, some sand, trace gravel Brown			
79.9 6.1	Clayey **SILT**, some sand, trace gravel Firm Grey (TILL)	1	SS	4
76.4 9.6	Silty **SAND**, trace to some gravel Very Loose			

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; ELEVATION SCALE (86, 85, 84, 83, 82, 81, 80, 79, 78, 77); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20, 40, 60, 80, 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (20, 40, 60); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Continued Next Page

$+^3, \times^3$: Numbers refer to Sensitivity   15-⊕-5 (20 above, 10 below) (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No BH10-07

METRIC

W.P.	19-5438-33	LOCATION	N 4 854 808.9 E 338 180.3 (Pier 5)	ORIGINATED BY	ES
HWY	401	BOREHOLE TYPE	Hollow Stem Augers/Casing/NQ Coring	COMPILED BY	AN
DATUM	Geodetic	DATE	12.21.2010 - 12.22.2010	CHECKED BY	WM

Continued From Previous Page

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	Grey Moist				76		
					75		
					74	FI	
73.8 12.2	**SHALE**, weathered Grey	2	SS	50/ 0.050		>10	
						5	
73.0 13.0	**SHALE**, slightly weathered to fresh, thinly bedded, horizontally laminated, occasional mechanical breaks, grey. **(GEORGIAN BAY FORMATION)** Sub-vertical fractures at 12.5m, 12.7m, 13.0m, 13.3m, 13.8m and 14.7m	1	RUN		73	>5 3 1 3	RUN 1# TCR=100%, SCR=86%, RQD=71% UCS=1.0MPa (Shale)
	Sub-horizontal fractures at 13.8m and 14.7m	2	RUN		72	1 1 2	RUN 2# TCR=100%, SCR=100%, RQD=88% UCS=5.6MPa (Shale)
	Limestone interbeds between 50mm to 100mm at 13.5m, 13.6m, 14.0m, 14.6m, 15.0m, 16.3m, 16.7m, 16.9m and 17.2m 50mm clay seam at 15.8m Sub-vertical fractures at 16.4m, 17.0m and 17.6m 125mm at 16.6m	3	RUN		71 70	0 0 0 2 0 4	RUN 3# TCR=100%, SCR=97%, RQD=97% UCS=5.2MPa (Shale)
		4	RUN		69 68	1 1 1 0 0	RUN 4# TCR=100%, SCR=93%, RQD=92% UCS=17.6MPa (Shale)
	Broken zone at 18.5m	5	RUN		67	2 0 1 0	RUN 5# TCR=100%, SCR=98%, RQD=98% UCS=12.5MPa (Shale)
	Limestone interbeds between 50mm to 100mm at 19.2m, 19.5m, 19.6m and 19.8m					2	

Plot columns (no data plotted): DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE, 20 40 60 80 100; PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L, WATER CONTENT (%) 20 40 60; GROUND WATER CONDITIONS; STRAT PLOT; GR SA SI CL.

Continued Next Page

$+^3, \times^3$: Numbers refer to Sensitivity   20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BH10-07

METRIC

W.P.	19-5438-33	LOCATION	N 4 854 808.9 E 338 180.3 (Pier 5)	ORIGINATED BY	ES
HWY	401	BOREHOLE TYPE	Hollow Stem Augers/Casing/NQ Coring	COMPILED BY	AN
DATUM	Geodetic	DATE	12.21.2010 - 12.22.2010	CHECKED BY	WM

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	UNIT WEIGHT γ kN/m3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	Continued From Previous Page				66	1	
		6	RUN			0	RUN 6#
	Sub-vertical fracture at 20.1m					2	TCR=100%, SCR=100%, RQD=97%
	25mm clay seam at 20.5m					0	UCS=20.0MPa (Shale)
					65	2	
	25mm broken zone at 21.1m					0	
		7	RUN			0	RUN 7#
	25mm sub-vertical fracture at 21.1m				64	0	TCR=100%, SCR=98%,
						0	RQD=98% UCS=10.3MPa (Shale)
						0	
	Limestone interbeds between 50mm to 100mm at 23.3m and 23.6m				63	0	
		8	RUN			0	RUN 8# TCR=100%,
62.3						0	SCR=100%, RQD=100%
23.8	END OF BOREHOLE AT 23.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.4m, CONCRETE TO 0.07m THEN ASPHALT TO SURFACE.						UCS=9.1MPa (Shale)

Column headings: SOIL PROFILE; SAMPLES; STRAT PLOT; GROUND WATER CONDITIONS; DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE, 20 40 60 80 100; PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60; GR SA SI CL

ONTMT4S 3833.GPJ 12/23/10

$+^3, \times^3$: Numbers refer to Sensitivity   15 ⊕ 5 (20, 10) (%) STRAIN AT FAILURE

PetoMacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 1

PROJECT PROPOSED BICYCLE/PEDESTRIAN CROSSING

LOCATION Highway 401, East of Liverpool Road, Pickering, Ontario

BORING DATE November 1, 1995

BORING METHOD Continuous Flight Solid Stem Augers

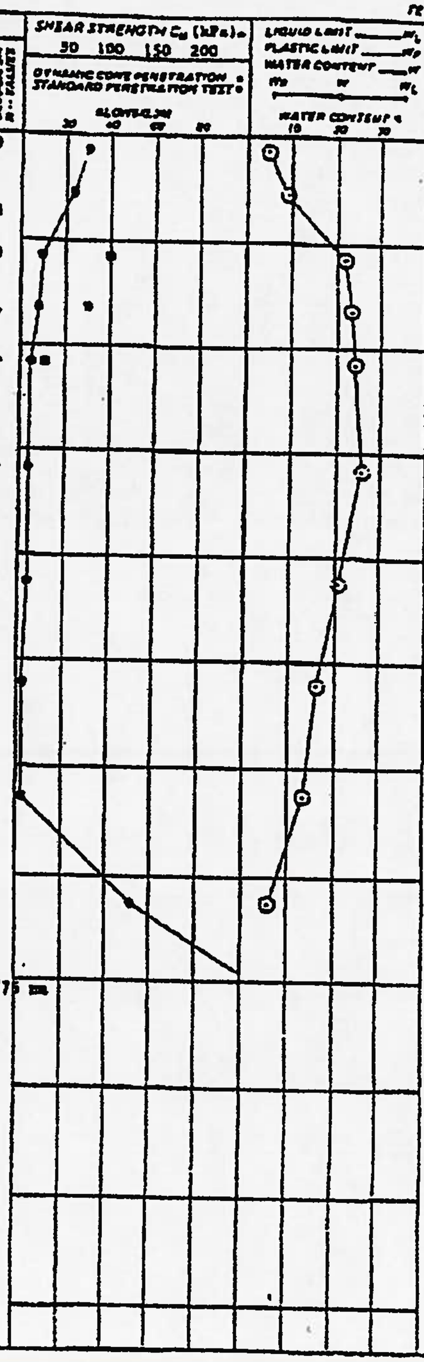
OUR PROJECT NO. 95TF056

ENGINEER J.H.

TECHNICIAN K.K.

GROUND ELEVATION 86.10

Depth (metres)	Description (Soil Profile)	Elevation	Sample Number	Type	Blows/0.3 m N-Values	Ground Water Observations and Remarks
	FILL: brown gravelly sand, some silt, scattered clay and silt inclusions, moist		1	SS	29	
		85	2	SS	23	
1.50	CLAY: stiff to soft brown silty clay, trace to some sand, scattered wet silt and sand seams, APL to WTPL		3	SS	9	
		84	4	SS	7	
		83	5	SS	4	
3.35	becoming very soft, grey	82				
		81	6	SS	3	
[illegible]	SILT: very loose grey sandy silt trace clay, scattered clay seams, saturated	80	7	SS	3	After sample 7, wet cave at 3.35 m
		79				
7.90	becoming very soft grey clayey silt, some sand, trace gravel, WTPL	78	8	SS	2	
		77				
9.45	SAND: very loose grey silty sand, trace to some gravel, saturated		9	SS	2	
10.05	SILT TILL: hard grey clayey silt some sand, trace gravel, numerous shale fragments, DTPL	76				
		75	10	SS	33	
12.05	SHALE: weathered dark grey shale, moist	74	11	SS	50/75 mm	
12.25	BOREHOLE TERMINATED AT 12.25 m	73				Upon completion of augering, wet cave at 1.80 m



NOTES:

CHECKED BY: JH

PetoMacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 2

PROJECT PROPOSED BICYCLE/PEDESTRIAN CROSSING

LOCATION Highway 401, East of Liverpool Road, Pickering, Ontario

BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE November 1, 1993

OUR PROJECT NO 95T7036

ENGINEER J.H.

TECHNICIAN E.K.

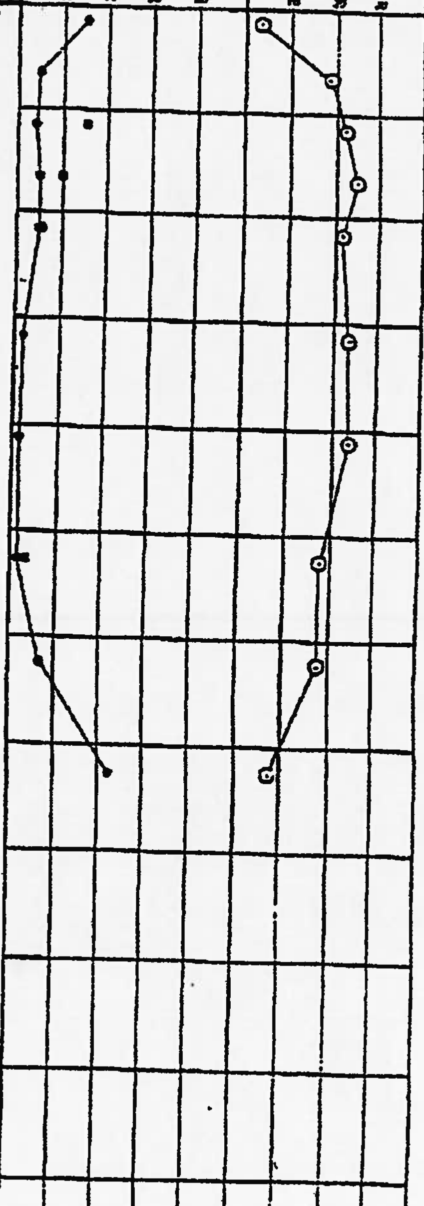
GROUND ELEVATION 86.30

DEPTH METRES	DESCRIPTION	ELEVATION
1.15	FILL: brown gravelly sand, some silt, scattered clay and silt inclusions, moist	86
3.90	CLAY: stiff to soft brown silty clay, trace to some sand, scattered wet silt and sand seams, APL to WTPL	85, 84, 83
4.70	becoming grey	82
7.60	SILT: very loose grey sandy silt trace clay, scattered clay seams saturated	81, 80, 79
8.60	CLAY: very soft grey silty clay, trace sand, trace gravel, UTPL	78
10.15	SAND: compact grey silty sand, trace gravel, saturated	77
11.10	SILT TILL: hard grey clayey silt, some sand, trace gravel, numerous shale fragments, DTPL	76
	BOREHOLE TERMINATED AT 11.10 m	75

Depth scale: 1.5, 3.0, 4.5, 6.0, 7.5, 9.0, 10.5, 12.0, 13.5, 15.0, 16.5

SAMPLES

NUMBER	TYPE	BLOWS/0.3m N-VALUES
1	SS	30
2	SS	8
3	SS	6
4	SS	8
5	SS	8
6	SS	3
7	SS	2
8	SS	2
9	SS	15
10	SS	43



GROUND WATER OBSERVATIONS AND REMARKS

After sample 6, sampler wet

Upon completion of augering, free water at 2.70 m, cave at 4.55 m

NOTES:

CHECKED BY: J.H.

PML.SOKA

PetoMacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 3

PROJECT PROPOSED BICYCLE/PEDESTRIAN CROSSING

LOCATION Highway 401, East of Liverpool Road, Pickering, Ontario **BORING DATE** November 1,1995

BORING METHOD Continuous Flight Solid Stem Augers

OUR PROJECT NO. 95TF036
ENGINEER J.H.
TECHNICIAN K.K.

SHEAR STRENGTH C_u (kPa) ● 50 100 150 200; DYNAMIC CONE PENETRATION ○ STANDARD PENETRATION TEST ● BLOWS/0.3m 20 40 60 80

LIQUID LIMIT W_L; PLASTIC LIMIT W_P; WATER CONTENT W; WATER CONTENT % 10 20 30

DEPTH IN METRES	DESCRIPTION	ELEVATION	SAMPLE NUMBER	TYPE	BLOWS/0.3m N-VALUE	GROUND WATER OBSERVATIONS AND REMARKS
	GROUND ELEVATION 84.90					
0.15	TOPSOIL: dark brown clayey silt, organic		1	SS	7	
0.75	FILL: brown clayey silt, some sand, trace gravel, scattered topsoil inclusions, APL	84	2	SS	8	
3.35	CLAY: stiff to soft brown to grey silty clay, trace to some sand, scattered wet silt and sand seams, APL to WTPL	83, 82	3 4	SS SS	5 3	
5.55	SILT: very loose grey sandy silt, trace clay, scattered clay seams, saturated	81, 80	5 6	SS SS	8 2	After sample 5, sampler wet
7.10	CLAY: soft grey silty clay, trace sand, trace gravel, WTPL	79, 78	7	SS	4	
8.55	SILTY TILL: firm grey clayey silt, some sand, trace gravel, APL	77	8	SS	4	
10.05	SAND: compact grey silty sand, some gravel, saturated	76, 75	9	SS	18	
10.70	SHALE: weathered dark grey shale, moist	74	10	SS	50/30 mm	Upon completion of augering, wet cave at 3.50 m
	BOREHOLE TERMINATED AT 10.70 m					

Depth scale: 1.5, 3.0, 4.5, 6.0, 7.5, 9.0, 10.5, 12.0, 13.5, 15.0, 16.5

NOTES:

CHECKED BY: J.H.

TOTAL P.07

APPENDIX B

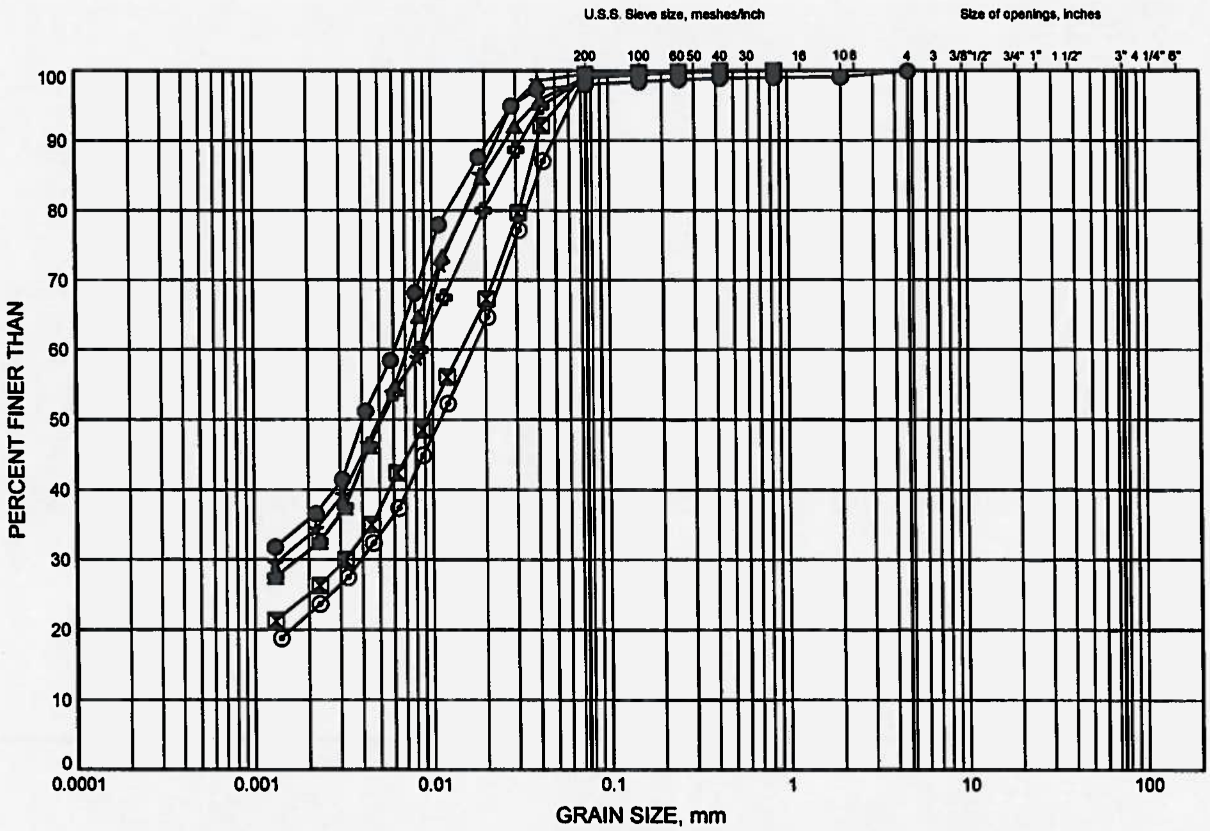
LABORATORY TEST RESULTS

Pickering Pedestrian Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B1

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-01	1.88	83.42
⊠	BH10-01	4.88	80.42
▲	BH10-02	2.59	84.24
★	BH10-03	2.59	81.41
⊙	BH10-04	2.59	83.41
✪	BH10-05	2.59	81.91

W.P.# 19-5438-33

Prepared By AN

Checked By LRB

THURBER

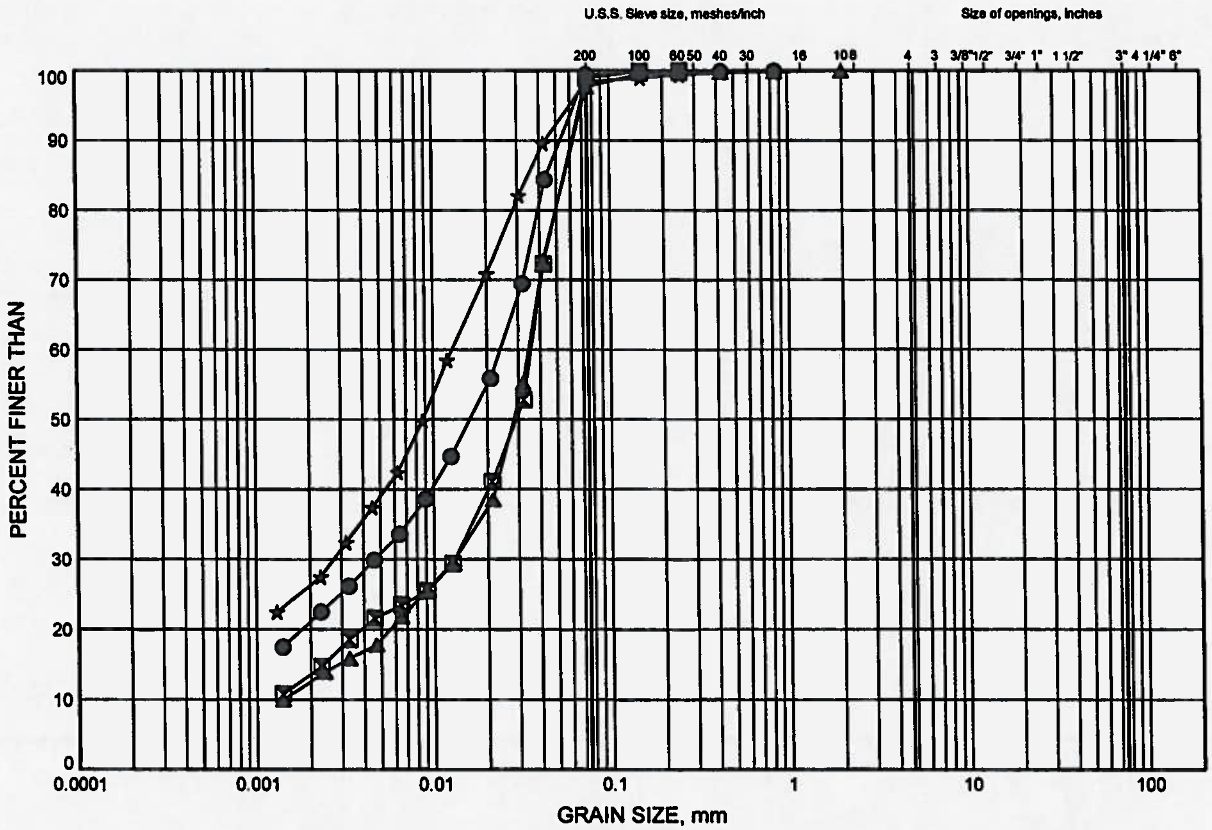
GRAIN SIZE DISTRIBUTION - THURBER 3833.GPJ 5/19/10

Pickering Pedestrian Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILT, Some Clay



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-02	6.40	80.43
⊠	BH10-03	4.88	79.12
▲	BH10-04	6.40	79.60
★	BH10-05	4.88	79.62

W.P.# 19-5438-33

Prepared By AN

Checked By LRB

THURBER

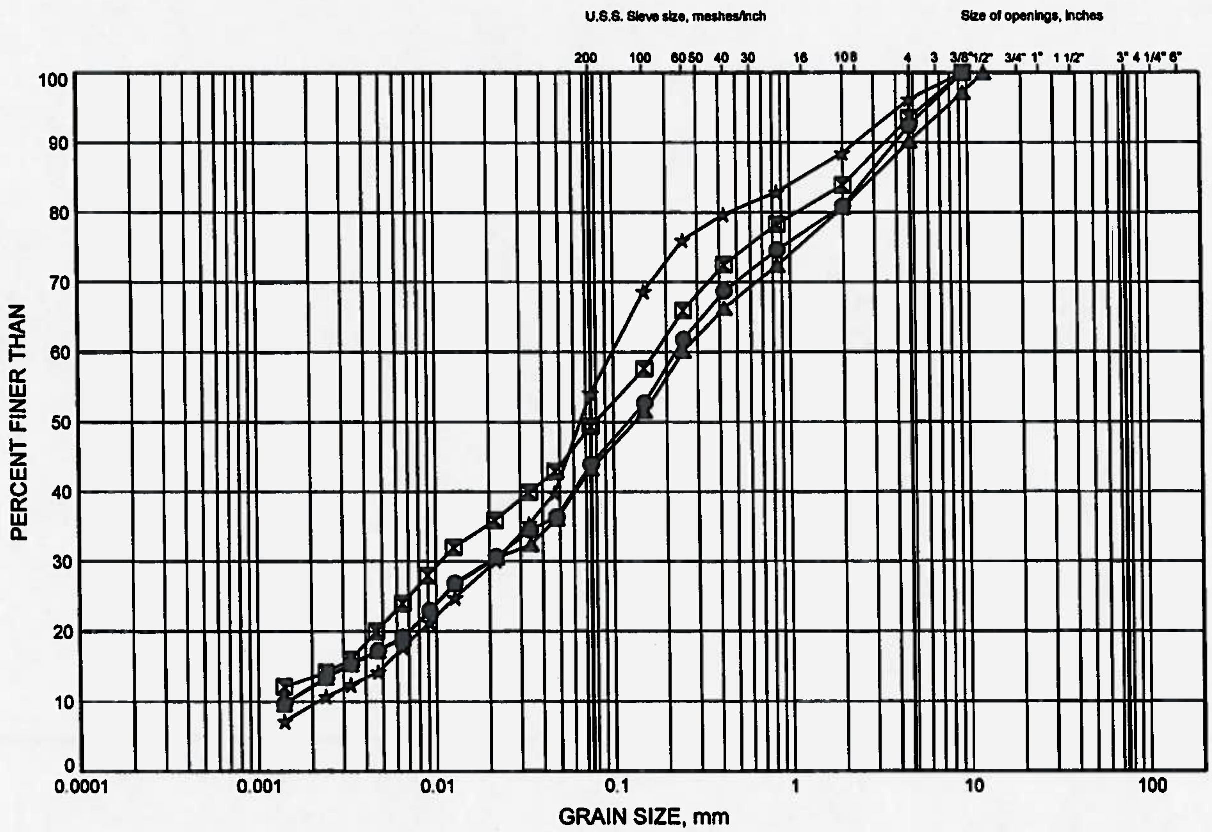
GRAIN SIZE DISTRIBUTION - THURBER 3833.GPJ 5/19/10

Pickering Pedestrian Bridge

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)
●	BH10-01	10.88	74.42
⊠	BH10-02	12.50	74.34
▲	BH10-03	10.97	73.03
★	BH10-04	10.97	75.03

W.P.# 19-5438-33

Prepared By AN

Checked By LRB

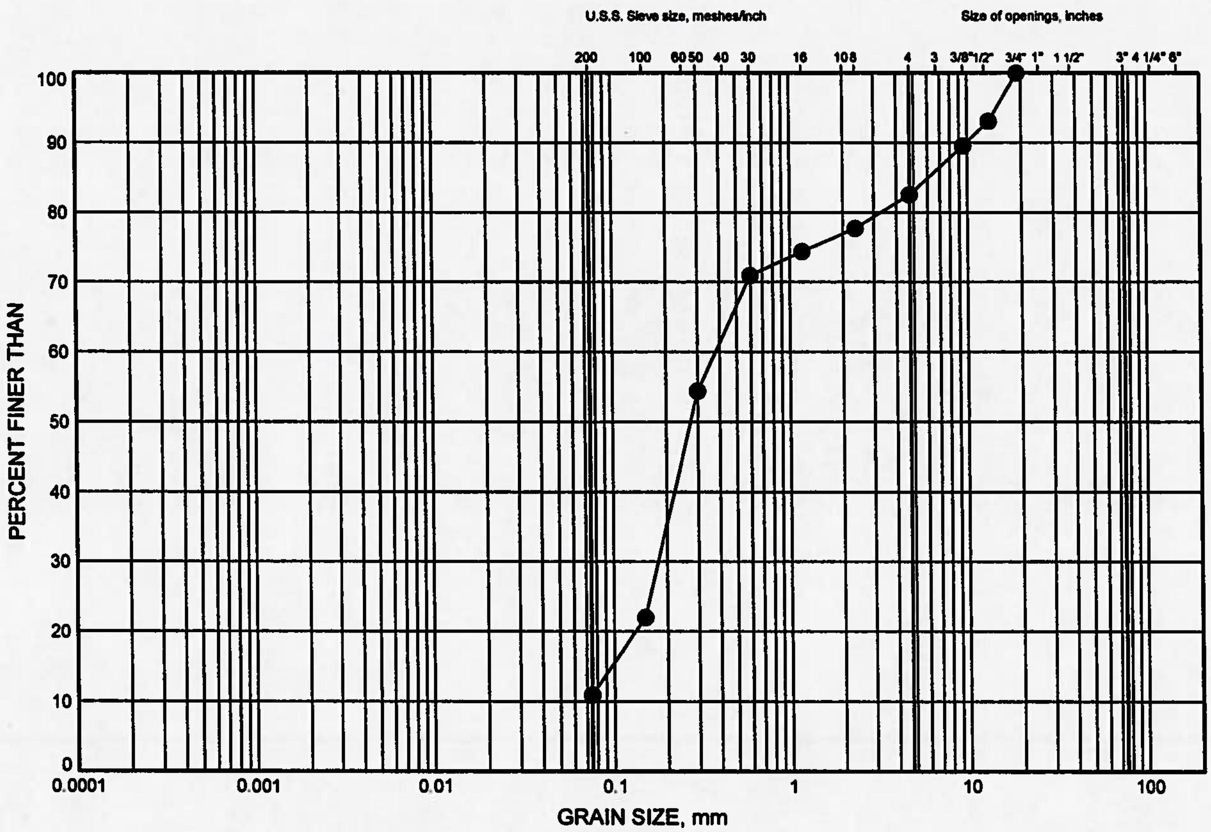
THURBER

Pickering Pedestrian Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-05	10.97	73.53

W.P.# 19-5438-33
Prepared By AN
Checked By LRB

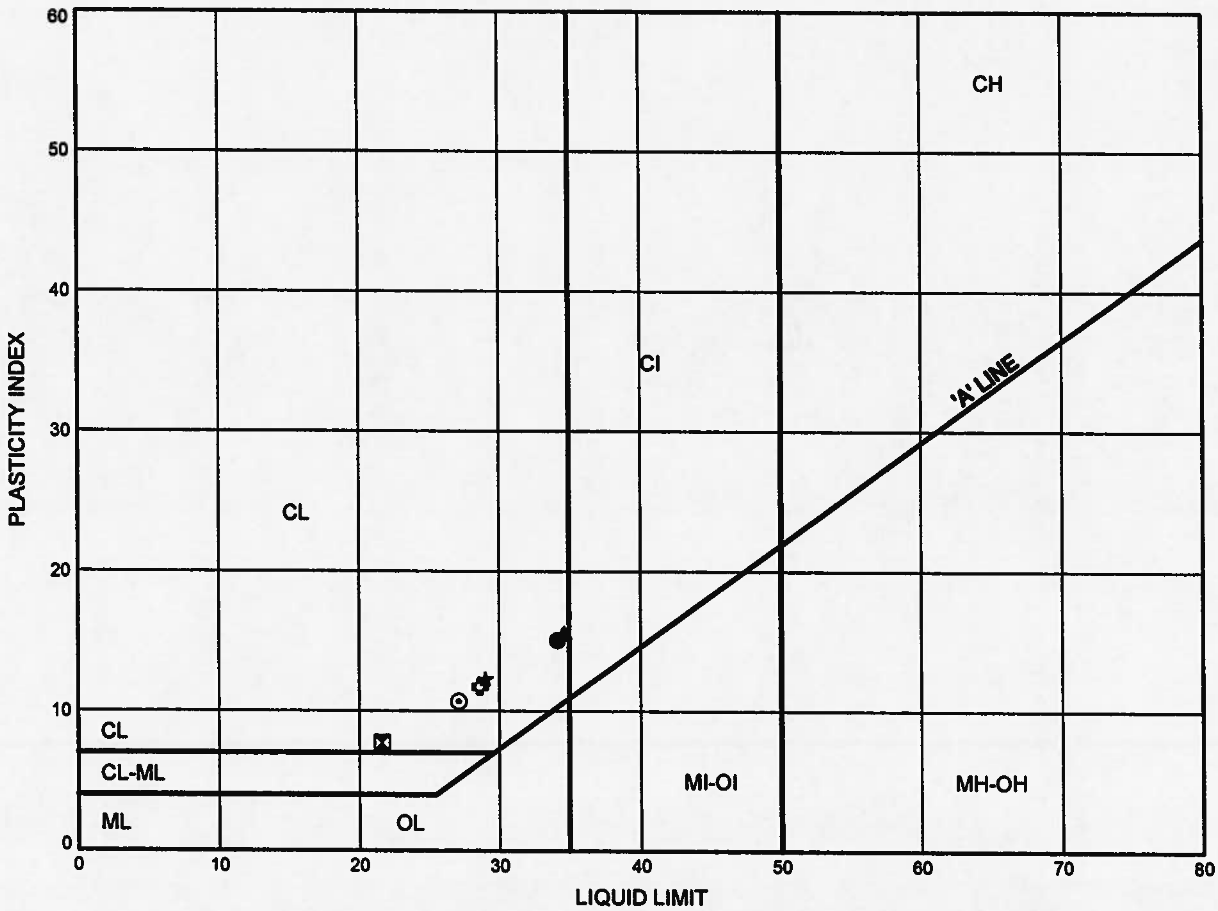
THURBER

Pickering Pedestrian Bridge

ATTERBERG LIMITS TEST RESULTS

FIGURE B5

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH10-01	1.88	83.42
⊠	BH10-01	4.88	80.42
▲	BH10-02	2.59	84.24
★	BH10-03	2.59	81.41
⊙	BH10-04	2.59	83.41
✿	BH10-05	2.59	81.91

THURBALT 3833.GPJ 5/19/10

Date May 2010

Project 19-5438-33

THURBER

Prep'd AN

Chkd. LRB

APPENDIX C

AGAT CERTIFICATE OF ANALYSIS

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 10T389624

PROJECT NO: Pickering Gro Station

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: THURBER ENGINEERING LTD **ATTENTION TO: MARK FARRANT**

(P & T) BTEX - Soil (GC/MS)

DATE SAMPLED: Mar 04, 2010 **DATE RECEIVED: Mar 04, 2010** **DATE REPORTED: Mar 11, 2010** **SAMPLE TYPE: Soil**

Parameter	Unit	G / S	RDL	BH10-2, SS#1 & 2, 0' - 4' 6" 1679587
Benzene	µg/g	0.02	0.002	<0.002
Toluene	µg/g	0.2	0.002	<0.002
Ethylbenzene	µg/g	0.05	0.002	<0.002
m & p-Xylene	µg/g		0.002	<0.002
o-Xylene	µg/g		0.002	<0.002
Xylenes (Total)	µg/g	0.05	0.002	<0.002
Moisture Content	%		0.01	9.7
Surrogate	**Unit**	**Acceptable Limits**		
Toluene-d8	% Recovery	60-130		105
4-Bromofluorobenzene	% Recovery	70-130		108

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T1 (ALL) - New

1679587 Results are based on the dry weight of the soil.

Certified By: Jody Takeuchi

Results relate only to the items tested

Certificate of Analysis

AGAT WORK ORDER: 10T389624
PROJECT NO: Pickering Gro Station

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: MARK FARRANT

O. Reg. 153 - Petroleum Hydrocarbons F1 - F4 (C6 - C50) in Soil

DATE SAMPLED: Mar 04, 2010 DATE RECEIVED: Mar 04, 2010 DATE REPORTED: Mar 11, 2010 SAMPLE TYPE: Soil

Parameter	Unit	G / S	RDL	BH10-2, SS#1 & 2, 0' - 4' 6" 1679587
C6 - C10 (F1)	µg/g		5	<5
C6 - C10 (F1 minus BTEX)	µg/g	10	5	<5
C>10 - C16 (F2)	µg/g	10	10	<10
C>16 - C34 (F3)	µg/g	50	50	150
C>34 - C50 (F4)	µg/g	50	50	97
Gravimetric Heavy Hydrocarbons	µg/g		50	NA
Moisture Content	%		0.1	9.7

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T1 (ALL) - New

1679587 Results are based on sample dry weight.
The C6-C10 fraction is calculated using toluene response factor.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16-C50 and are only determined if the chromatogram of the C34 - C50 hydrocarbons indicates that hydrocarbons >C50 are present.
Total C6 - C50 results are corrected for BTEX contributions.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 + nC16 + nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.

Certified By: Jordy Takeuchi

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 10T389624

PROJECT NO: Pickering Gro Station

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: MARK FARRANT

O. Reg. 153 PAHs in Soil

DATE SAMPLED: Mar 04, 2010 | DATE RECEIVED: Mar 04, 2010 | DATE REPORTED: Mar 11, 2010 | SAMPLE TYPE: Soil

Parameter	Unit	G / S	RDL	BH10-2, SS#3, 5' - 7' 1679621
Naphthalene	µg/g	0.09	0.03	0.05
Acenaphthylene	µg/g	0.093	0.02	<0.02
Acenaphthene	µg/g	0.072	0.03	<0.03
Fluorene	µg/g	0.12	0.02	<0.02
Phenanthrene	µg/g	0.69	0.02	<0.02
Anthracene	µg/g	0.16	0.02	<0.02
Fluoranthene	µg/g	0.56	0.02	<0.02
Pyrene	µg/g	1	0.02	<0.02
Benzo(a)anthracene	µg/g	0.36	0.02	<0.02
Chrysene	µg/g	2.8	0.02	0.04
Benzo(b)fluoranthene	µg/g	0.47	0.02	<0.02
Benzo(k)fluoranthene	µg/g	0.48	0.02	<0.02
Benzo(a)pyrene	µg/g	0.3	0.02	<0.02
Indeno(1,2,3-cd)pyrene	µg/g	0.23	0.02	<0.02
Dibenz(a,h)anthracene	µg/g	0.1	0.02	<0.02
Benzo(g,h,i)perylene	µg/g	0.68	0.02	<0.02
2-and 1-methyl Naphthalene	µg/g	0.59	0.05	<0.05
Moisture Content	%		0.1	11.8
Surrogate	**Unit**	**Acceptable Limits**		
Chrysene-d12	%	60-130		85

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T1 (ALL) - New

1679621 Results are based on the dry weight of the soil.

Certified By: Jody Takeuchi

Guideline Violation

AGAT WORK ORDER: 10T389624

PROJECT NO: Pickering Gro Station

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: MARK FARRANT

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
1679587	BH10-2, SS#1 & 2, 0' - 4' 6"	T1 (ALL) - New	O. Reg. 153 - Petroleum Hydrocarbons F1 - F4 (C6 - C50) in Soil	C>16 - C34 (F3)	50	150
1679587	BH10-2, SS#1 & 2, 0' - 4' 6"	T1 (ALL) - New	O. Reg. 153 - Petroleum Hydrocarbons F1 - F4 (C6 - C50) in Soil	C>34 - C50 (F4)	50	97

Results relate only to the items tested

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 10T393340

PROJECT NO: Pickering Pedestrian Bridge

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: THURBER ENGINEERING LTD **ATTENTION TO: MARK FARRANT**

O. Reg. 153 Metals & Inorganics in Soil

DATE SAMPLED: Mar 01, 2010 **DATE RECEIVED: Mar 23, 2010** **DATE REPORTED: Mar 31, 2010** **SAMPLE TYPE: Soil**

Parameter	Unit	G / S	RDL	BH10-1 SS#1 1701235	BH10-3 SS#2 1701236	BH10-5 SS#2 1701237
Antimony	µg/g	1.0	0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	17	1	2	3	4
Barium	µg/g	210	2	52	73	92
Beryllium	µg/g	1.2	0.5	<0.5	<0.5	<0.5
Boron	µg/g		5	<5	8	9
Boron (Hot Water Extractable)	µg/g		0.10	013	0.15	<0.10
Cadmium	µg/g	1.0	0.5	<0.5	<0.5	<0.5
Chromium	µg/g	71	2	10	18	19
Cobalt	µg/g	21	0.5	3.4	6.5	6.6
Copper	µg/g	85	1	10	17	17
Lead	µg/g	120	1	8	11	9
Molybdenum	µg/g	2.5	0.5	0.6	<0.5	<0.5
Nickel	µg/g	43	1	8	15	15
Selenium	µg/g	1.9	0.4	<0.4	<0.4	<0.4
Silver	µg/g	0.42	0.2	<0.2	<0.2	<0.2
Thallium	µg/g	2.5	0.4	<0.4	<0.4	<0.4
Uranium	ug/g		0.5	<0.5	0.6	0.7
Vanadium	µg/g	91	1	18	26	29
Zinc	µg/g	160	5	34	44	41
Chromium, Hexavalent	µg/g	2.5	0.2	<0.2	<0.2	<0.2
Cyanide, Free	µg/g	0.12	0.05	<0.05	<0.05	<0.05
Mercury	µg/g	0.23	0.01	<0.01	0.02	0.01
Electrical Conductivity (2:1)	mS/cm	0.57	0.002	1.52	1.11	1.36
Sodium Adsorption Ratio (2:1)	N/A	2.4	N/A	16.6	9.81	10.6
pH, 2:1 CaCl2 Extraction	pH Units			8.16	7.99	7.78
Chloride (2:1)	µg/g	330	2	866	561	776
Nitrate + Nitrite	µg/g	61	1	<1	<1	<1

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T1(All)

1701235-1701237 EC, SAR, Chloride & Nitrate/Nitrite were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the extract obtained from the 2:1 leaching procedure (2 parts 0.01M CaCl2:1 part soil).

Certified By: ______

Results relate only to the items tested

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 10T393340
PROJECT NO: Pickering Pedestrian Bridge

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: MARK FARRANT

O. Reg. 558 Metals and Inorganics

DATE SAMPLED: Mar 01, 2010 | **DATE RECEIVED: Mar 23, 2010** | **DATE REPORTED: Mar 31, 2010** | **SAMPLE TYPE: Soil**

Parameter	Unit	G / S	RDL	BH10-1 SS#2 1701238	BH10-5 SS#3 1701239
Arsenic Leachate	mg/L	2.5	0.010	<0.010	<0.010
Barium Leachate	mg/L	100	0.100	0.329	0.600
Boron Leachate	mg/L	500	0.050	<0.050	0.055
Cadmium Leachate	mg/L	0.5	0.010	<0.010	<0.010
Chromium Leachate	mg/L	5.0	0.010	0.014	0.015
Lead Leachate	mg/L	5.0	0.010	0.021	<0.010
Mercury Leachate	mg/L	0.1	0.005	<0.005	<0.005
Selenium Leachate	mg/L	1.0	0.010	<0.010	<0.010
Silver Leachate	mg/L	5.0	0.010	<0.010	<0.010
Uranium Leachate	mg/L	10.0	0.050	<0.050	<0.050
Fluoride Leachate	mg/L	150	0.05	0.20	0.20
Cyanide Leachate	mg/L	20.0	0.05	<0.05	<0.05
(Nitrate + Nitrite) as N Leachate	mg/L	1000	0.70	<0.70	<0.70

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Regulation 558

Certified By:

Results relate only to the items tested

AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 10T393340

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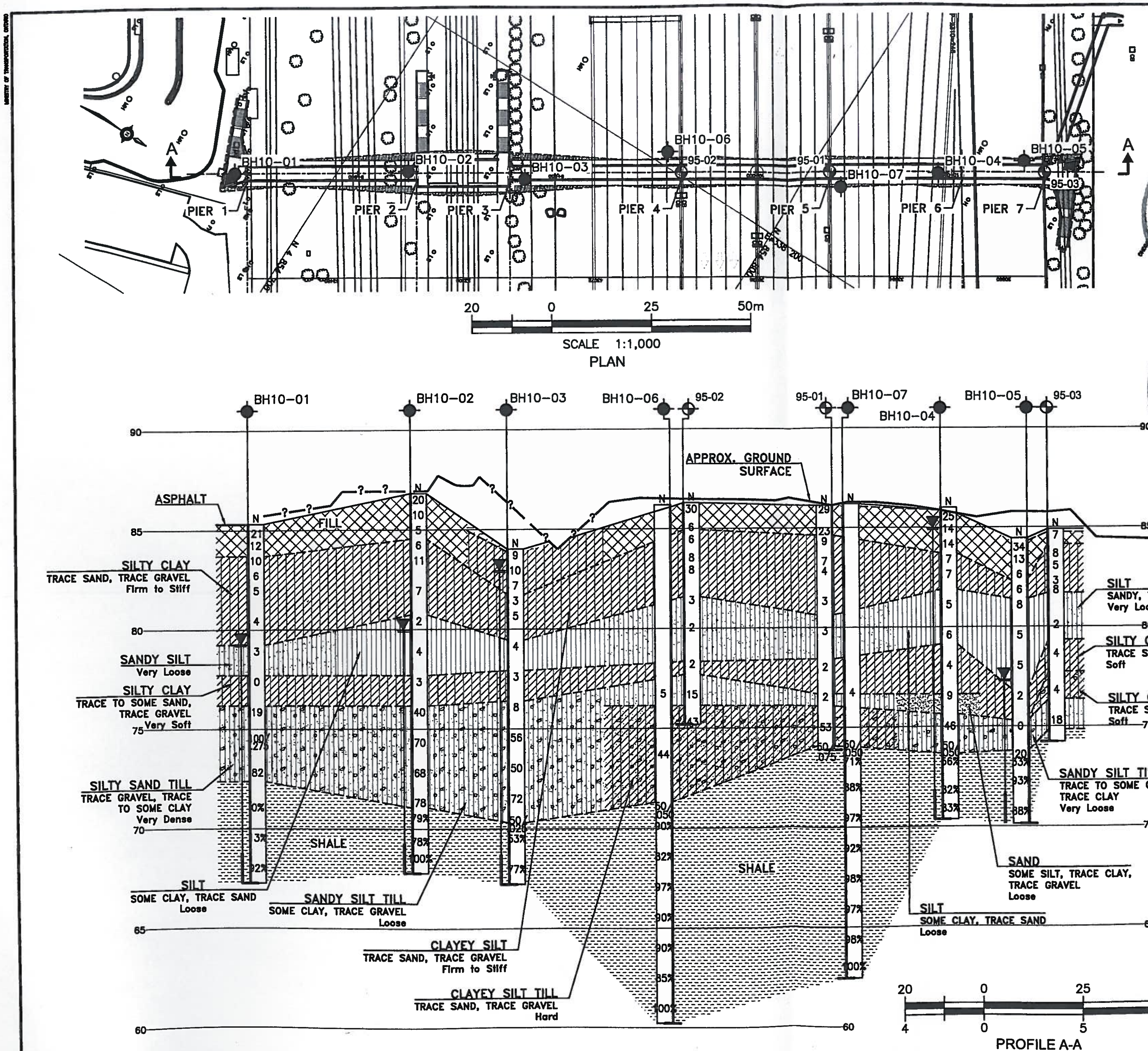
SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
1701235	BH10-1 SS#1	T1(All)	O. Reg. 153 Metals & Inorganics in Soil	Chloride (2:1)	330	866
1701235	BH10-1 SS#1	T1(All)	O. Reg. 153 Metals & Inorganics in Soil	Electrical Conductivity (2:1)	0.57	1.52
1701235	BH10-1 SS#1	T1(All)	O. Reg. 153 Metals & Inorganics in Soil	Sodium Adsorption Ratio (2:1)	2.4	16.6
1701236	BH10-3 SS#2	T1(All)	O. Reg. 153 Metals & Inorganics in Soil	Chloride (2:1)	330	561
1701236	BH10-3 SS#2	T1(All)	O. Reg. 153 Metals & Inorganics in Soil	Electrical Conductivity (2:1)	0.57	1.11
1701236	BH10-3 SS#2	T1(All)	O. Reg. 153 Metals & Inorganics in Soil	Sodium Adsorption Ratio (2:1)	2.4	9.81
1701237	BH10-5 SS#2	T1(All)	O. Reg. 153 Metals & Inorganics in Soil	Chloride (2:1)	330	776
1701237	BH10-5 SS#2	T1(All)	O. Reg. 153 Metals & Inorganics in Soil	Electrical Conductivity (2:1)	0.57	1.36
1701237	BH10-5 SS#2	T1(All)	O. Reg. 153 Metals & Inorganics in Soil	Sodium Adsorption Ratio (2:1)	2.4	10.6

Results relate only to the items tested

APPENDIX D

DRAWING "BOREHOLE LOCATIONS AND SOIL STRATA"



METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER — M. R. ANDERSON — Feb 17/11 — PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER — P. K. CHATTERJI — Feb 17/11 — PROVINCE OF ONTARIO

CONT No
GWP No

HIGHWAY 401
PEDESTRIAN BRIDGE
PICKERING
BOREHOLE LOCATIONS

SHEET

THURBER ENGINEERING LTD.
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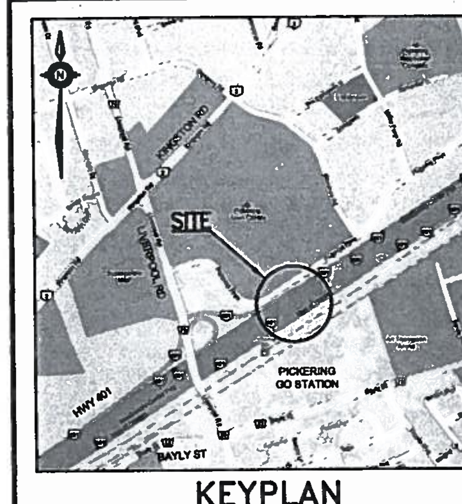

KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
BH10-01	85.3	4 854 678.5	338 260.9
BH10-02	86.8	4 854 714.9	338 235.7
BH10-03	84.0	4 854 740.4	338 221.7
BH10-04	86.0	4 854 827.9	338 163.9
BH10-05	84.5	4 854 848.5	338 150.9
BH10-06	86.2	4 854 766.9	338 196.6
BH10-07	86.0	4 854 808.9	338 180.3

-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.

REVISIONS | DATE | BY | DESCRIPTION

DESIGN LRB	CHK AEG	CODE	LOAD	DATE DEC. 2010
DRAWN AN	CHK PKC	SITE	STRUCT	DWG 1

FILENAME: D:\Drafting\19\8438\33\ted3833-BoreholePlan&Profile.dwg
PLOTDATE: Jan 21, 2011 - 2:58pm