



THURBER ENGINEERING LTD.



**DRAFT
FOUNDATION INVESTIGATION AND DESIGN REPORT
REPLACEMENT OF THE HIGHWAY 401 EBL AND WBL OVERPASSES AT PITT STREET
CORNWALL, ON
SITE 31-211/1, W.P. 4085-13-01 & SITE 31-211/2, W.P. 4083-01-01
ASSIGNMENT NUMBER: 4014-E-0014**

GEOCRES NUMBER: -

**SUBMITTED TO
WSP CANADA**

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) for the replacement of the Highway 401 eastbound and westbound overpass structures at Pitt Street located within the City of Cornwall, Ontario. Thurber carried out the investigation as a subconsultant to WSP Canada (WSP), under Agreement No. 4014-E-0014.

General Arrangement (GA) drawings and base plan mapping were provided by WSP for the preparation of this report.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on this data, provide a borehole location plan, record of boreholes, a stratigraphic profile, laboratory test results and a written description of the subsurface conditions.

2 SITE DESCRIPTION

Sites 31-211/1 and 31-211/2 are located on the eastbound and westbound Highway 401, respectively, approximately 1.4 km east of the Brookdale Avenue (Highway 138) / Highway 401 Interchange in Cornwall, Ontario. The location of the structure is shown on the inset Key Plan on Drawing No. 1 in Appendix A.

Both of the existing structures are three-span, slab-on-steel girder structures each carrying two-lanes of Highway 401 traffic over Pitt Street. Based on the historical Preliminary General Arrangement Drawing each bridge is approximately 42.2 m long and 11.1 m wide. Beyond the structures, the eastbound and westbound lanes are generally separated by a grassy median ditch. There are steel beam guide rails located along the median and concrete barriers/noise walls on the outside lanes of the highway in both directions.

It is noted that for project orientation purposes, Highway 401 will be assumed to be oriented east-west and Pitt Street is assumed to be oriented north-south.

Within the project limits Pitt Street has one through lane and one full width paved parking lane in each direction with concrete curb and gutter located along both edges of pavement. A concrete sidewalk is found along the east side of Pitt Street. Concrete slope pavers are installed on the abutment foreslopes which are graded at approximately 2H:1V.

The site is located within a physiographic region known as the Glengarry till plain which is characterized as lowlands in which the surface is undulating to rolling, consisting of long morainic

ridges and a few well-formed drumlins. The till deposit of sand and gravel till is very stony, and contains large near surface boulders (Chapman and Putnam, 1984).

The lands surrounding the project limits are typically residential properties. Storm water drainage in the area is to existing ditches and catchbasins. The existing approach embankments are up to approximately 6.0 m high with slopes that extend down at approximately 2H:1V (Horizontal:Vertical). The embankment slopes are vegetated with long grasses, and occasional shrubs.

Site photographs showing the general conditions at the site, along Highway 401 and Pitt Street are presented in Appendix E.

3 SITE INVESTIGATION

3.1 Previous Investigations

A GEOCREC report is available for this site (Report 31G00-128, 1955). This investigation was carried out for the design and construction of the current structure and included three boreholes. A copy of the borehole location plan and the Record of Boreholes from the historical investigation are provided in Appendix C.

The stratigraphy in the area of the bridges is generally characterized as a dense to very dense sandy glacial till with frequent cobbles and boulders. The boreholes were terminated within till material and bedrock was not encountered during the 1955 geotechnical investigation.

3.2 Field Investigation

The field investigation plan was finalized after discussion with the MTO Foundations Section. The field investigation for this site included advancing fourteen boreholes between May 8, 2017 and May 17, 2017. The approximate locations and elevations of the boreholes are shown on Drawing No. 1 provided in Appendix A and are summarized in Table 3-1.

Table 3-1: Borehole Summary

Borehole	Location	Latitude (degrees)	Longitude (degrees)	Ground Surface Elevation (m)	Depth (m)
17-1	WBL West abutment	45.05196	-74.75567	62.7	13.9
17-2	WBL East abutment	45.05199	-74.75537	63.7	15.4
17-3	WBL East abutment	45.05186	-74.75529	64.0	12.4
17-4	EBL West abutment	45.05174	-74.75548	62.9	14.5
17-5	EBL East abutment	45.05175	-74.7552	64.0	12.3
17-6	EBL East abutment	45.05164	-74.75509	64.2	12.5
17-7	Northwest retaining wall	45.05205	-74.75575	63.2	6.7

Borehole	Location	Latitude (degrees)	Longitude (degrees)	Ground Surface Elevation (m)	Depth (m)
17-8	Northeast retaining wall	45.05208	-74.75544	63.1	6.7
17-9	Southwest retaining wall	45.05158	-74.75537	63.4	6.7
17-10	Southeast retaining wall	45.05156	-74.75499	63.5	6.7
17-11	WBL West noise wall	45.05196	-74.75591	68.0	6.7
17-12	WBL East noise wall	45.05199	-74.75512	68.9	6.4
17-13	EBL West noise wall	45.05161	-74.75565	68.4	6.2
17-14	EBL East noise wall	45.05164	-74.75485	68.4	6.7

As a component of our standard procedures and due diligence, Thurber contacted Ontario One Call to obtain utility locates/clearances for the intended borehole locations.

The boreholes were advanced with either a CME truck mounted drill rig equipped with hollow stem augers or a limited access track mounted drill with NW casing. The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. Split spoon samples were collected at regular depth intervals in the boreholes during the completion of Standard Penetration Tests (SPT), following the methods described in ASTM Standard D1586-11. All soil samples recovered from the boreholes were placed in moisture-proof containers and the samples were transported to Thurber's Ottawa geotechnical laboratory for further examination and testing.

A 19 mm inside diameter PVC piezometer was installed in Boreholes 17-7, 17-8, 17-9, and 17-10 to allow for measurement of the groundwater level at the site. The piezometer construction details are illustrated on the Record of Borehole sheets for Boreholes 17-7, 17-8, 17-9, and 17-10 provided in Appendix B. The piezometers was decommissioned on June 2, 2017, after the water levels were read.

The boreholes without piezometer installations were backfilled with a low-permeability combination of cuttings, and bentonite pellets in general accordance with the intent of Ontario MOE Regulation 903.

The as-drilled locations of the boreholes and ground surface elevations at the borehole locations were surveyed by Thurber on June 20, 2017. The vertical datum used was the geodetic benchmark (GBM) identified on the plans provided by WSP, located on southwest wall of the eastbound bridge abutment. The GBM has a geodetic elevation of 68.295 m. The location of the GBM is indicated on Drawing No. 1 in Appendix A.

3.3 Laboratory Testing

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all soil samples in accordance with the current MTO standards. Grain size distribution analyses were also carried out on selected samples to MTO and ASTM standards. Chemical analysis for determination of pH, resistivity, soluble sulphate and chloride

concentrations was carried out on four soil samples. A copy of the chemical analysis results are provided in Appendix D.

The laboratory test results are presented on the Record of Borehole sheets in Appendix B and are illustrated on the figures in Appendix D.

4 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 Overview / General

Reference is made to the Record of Borehole sheets in Appendix B for details of the soil stratigraphy encountered in the boreholes. A stratigraphic profile for the site is presented on Drawing No. 1 and 2 in Appendix A for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the Record of Boreholes governs any interpretation of the site conditions.

In general, the stratigraphy in the area of the boreholes is generally characterized by granular fill over glacial till, containing occasional to frequent cobbles and boulders. This stratigraphy is generally consistent with the stratigraphy encountered in the previous MTO investigation.

More detailed descriptions of the individual strata are presented below.

4.2 Topsoil

Ten boreholes were advanced in locations with topsoil at surface. The thickness of the topsoil ranged from 40 mm to 100 mm. Topsoil thickness may vary between boreholes and in other areas of the site.

4.3 Concrete Paving Stones

Boreholes 17-3 and 17-5 were advanced in locations with concrete paving stones at surface. The thickness of the concrete paving stones was measured at 70 mm.

4.4 Fill – Silty Sand to Silty Gravel

In all boreholes, a fill layer consisting predominantly of brown to grey silty sand to silty gravel containing cobbles and occasional boulders was encountered at surface or below any surficial layers. The top of this layer ranges from Elevation 62.6 m to 68.8 m and has a thickness ranging from 1.4 m to 4.6 m. The SPT 'N' values ranged from 1 to greater than 100 indicating a very loose to very dense condition, but typically compact to dense.

The moisture content of the samples tested ranged from 4% to 20%. The results of grain size analysis completed on samples of this material indicated a gravel content of 14% to 50%, sand content of 24% to 43%, and fines content (combined silt and clay size particles) of 13% to 50%. The results of the grain size analysis are illustrated on Figures 1, 2, and 3 in Appendix D.

4.5 Clayey Silt (Ml)

A thin layer of clayey silt was encountered beneath the fill in Borehole 17-11. The top of this layer was at Elevation 63.0 m and has a thickness of 0.2 m. This material was noted to contain trace amounts of rootlets.

The moisture content of the sample tested was 26%. The results of Atterberg Limits testing completed on the sample of this material indicated a liquid limit of 42, a plastic limit of 27, and plasticity index of 15, indicating a clayey silt of intermediate plasticity (MI). The Atterberg Limit results are illustrated on Figure 9 in Appendix D.

4.6 Glacial Till

A stratum of glacial till consisting predominantly of sand and silt with varying amounts of gravel was encountered beneath the clayey silt layer in Borehole 17-11 and the fill layers in all remaining boreholes. The top of this layer ranges from Elevation 59.3 m to 64.6 m. All boreholes were terminated in the till at elevations ranging from 48.3 to 62.5 m. The SPT 'N' values ranged from 10 to greater than 100 indicating a compact to very dense condition, typically very dense. Occasional cobbles were often noted within the till layer, particularly at deeper depths. In Boreholes 17-1, 17-2, and 17-4 frequent cobbles and boulders were encountered below approximate elevation 51 m. Coring techniques were required to get through the cobbles and boulders at some locations.

The moisture contents of the samples tested ranged from 4% to 20%. The results of grain size analysis completed on samples of this material indicated a gravel content ranging from 1% to 52%, sand content of 21% to 62%, and fines content (combined silt and clay size particles) of 15% to 73%. The results of the grain size analysis testing are illustrated on Figure 4 through 8 in Appendix .

Based on the results of Atterberg Limits testing the fines content is generally classified as non-plastic silt (ML). In Borehole 17-1, SS14 the fines were classified as a silty clay (CL-ML). The Atterberg Limit results are illustrated on Figure 9 in Appendix C.

4.7 Groundwater Conditions

The groundwater levels were measured in the piezometers installed in Boreholes 17-7, 17-8, 17-9, and 17-10 on June 2, 2017; the piezometers were subsequently decommissioned following the final measurement. The following table summarizes the water level readings.

Table 4-2: Piezometer Summary

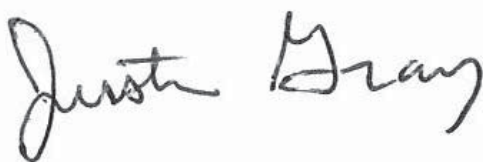
Borehole	Water Level Elevation (m)	Depth to Water Level (m)
17-7	62.8	0.4
17-8	62.9	0.2
17-9	62.6	0.8
17-10	62.9	0.6

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

5 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Thurber surveyed the borehole locations, and determined the ground surface elevations based on contract drawings provided by WSP Canada. George Downing Estate Drilling Ltd. of Hawkesbury, Ontario and Forage M3 Drilling Services Inc. of Hawkesbury, Ontario supplied and operated the drilling equipment to carry out the drilling, sampling, and in-situ testing. The drilling, and sampling operations in the field were supervised on a full-time basis by Justin Gray or Christopher Murray of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory in Ottawa.

Overall project management and direction of the field program was provided by Paul Carnaffan, P.Eng. Interpretation of the field data and preparation of this report was completed by Justin Gray, E.I.T. The report was reviewed by Paul Carnaffan, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations Projects.



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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

6 GENERAL

This report presents the interpretation of the factual data obtained from a foundation investigation conducted by Thurber for the replacement of the Highway 401 overpass structures at Pitt Street in Cornwall, Ontario. Geotechnical recommendations are provided to assist the design team in designing a suitable foundation for the proposed bridge replacements.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation, and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. Contractors must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

The following sections address geotechnical recommendations for the replacement of the existing overpass structures and related noise walls and retaining walls. The discussions and recommendations presented in this report are based on the information provided by WSP and on the factual data obtained during the course of this investigation.

6.1 Existing Foundations

Based on the Historical Preliminary General Arrangement Drawings, the existing east and west abutments of both structures are perched within the approach embankments and supported on 12BP53 steel piles driven to refusal. The pier foundations are supported on spread footings founded on native glacial till. The embankment side slopes were identified as being 2H:1V. The foreslopes were noted to be graded at 1.5H:1V and covered with hand-laid rip-rap. It is noted that the foreslopes are currently covered with concrete slope pavers as opposed to rip-rap. Settlement and shifting of the concrete slope pavers on the foreslopes was noted during a site reconnaissance. No evidence of settlement of the existing foundations was noted.

6.2 Proposed Structure

It is understood that the replacement of the bridge structures will be on the existing alignments with full closures of the EBI or WBL using staged construction with median crossovers for the Highway 401 traffic.

Based on the results of the preliminary design stage and as shown on the preliminary GA drawing provided by WSP, details regarding the proposed replacement of the structures include:

- Each bridge is to be replaced with a single span rigid frame structure with an internal span of 21.2 m.
- The foreslopes between the structures and on both sides of the proposed structures will be formed by retained soil wall systems (RSS). The maximum exposed free height for the RSS walls between the structures is to be 3 m. The exposed free height of the RSS walls located at beyond the ends of the structures will taper down from 3 m to existing grade. The face-to-face distance between the RSS systems between the structures is to be 22.3 m.
- The existing noise barrier walls on the outsides of the approaches will be realigned to accommodate the wider bridge structure.

Based on the preliminary general arrangement drawings and required clearance requirements, the top of pavement elevation (vertical profile) for Pitt Street will be lowered slightly beneath the overpasses.

6.3 Applicable Codes and Design Considerations

The geotechnical assessment presented below has been prepared based on the available data regarding the proposed foundations and existing ground conditions and in accordance with the Canadian Highway Bridge Design Code, version CSA S6-14 (CHBDC).

In accordance with CHBDC, the analysis and design of structures takes into consideration the importance of the structure and the consequence associated with exceeding limit states. The importance category and consequence classification are defined by the Regulatory Authority, which in this case is the Ministry of Transportation, Ontario (MTO).

It is understood that MTO has designated this structure as follows:

Table 6-1: Bridge Structure Classification

Criteria	Classification	CHBDC Section
Importance Category	Major Route Bridge	4.4.2
Consequence Classification	Typical Consequence	6.5.1

Accordingly, a consequence factor (Ψ) of 1.0, as per Table 6.1 of the CHBDC, has been used in assessing factored geotechnical resistances. If the consequence classification changes, the geotechnical assessment will need to be reviewed and revised.

6.4 Frost Protection

The frost penetration depth at this site is 1.7 m as per OPSD 3090.101. Accordingly, a minimum of 1.7 m of earth cover, or equivalent insulation, must be provided above the base of the shallow foundations or pile caps to serve as frost protection.

6.5 Geotechnical Assessment

Based on the results of the field and laboratory investigation and the information provided by WSP with regards to the proposed project requirements, the geotechnical foundation design considerations include:

- The native glacial till deposit can support shallow foundations with moderate to high bearing resistance. Existing fill would have to be removed from beneath shallow foundations to expose native undisturbed compact to dense glacial till.
- There are existing watermains and storm sewers beneath Pitt Street. The founding elevation for the new bridge abutments must ensure that foundation loads are not exerted on the utilities and that the bearing resistance is not impacted by the presence of trench backfill. In addition, protection of the foundation in the event of a watermain break has been identified as a design consideration. The alignment and invert elevations of the utilities will need to be determined to allow for a detailed review of the potential for conflict and/or interaction.
- The soil beneath the base of the approach embankments consists of glacial till; embankment settlement and global stability are not expected to be concerns for the proposed embankments.

7 SEISMIC CONSIDERATIONS

7.1 Spectral and Peak Acceleration Hazard Values

The seismic hazard data for the CHBDC is based on the fifth generation seismic model developed by the Geological Survey of Canada (GSC). Seismic hazard data for this site has been obtained from the GSC's seismic hazard calculator. The data includes peak ground acceleration (PGA), peak ground velocity (PGV), and the 5% damped spectral response acceleration values ($S_a(T)$) for the reference ground condition (Site Class C) for a range of periods (T) and for a range of return periods including the 475-year, 975-year and 2475-year events. The GSC seismic hazard calculation data sheet for this site is presented in Appendix G.

The site coefficients used to determine the design spectral acceleration and displacement values are a function of the Site Class and the peak ground acceleration (PGA).

7.2 CHBDC Seismic Site Classification

In accordance with the CHBDC, the selection of the seismic site classification is based on the soil conditions encountered in the upper 30 m of the stratigraphy.

Based on the soil and bedrock conditions encountered below the anticipated bridge foundation elevation, the site is classified as a Seismic Site Class C in accordance with Table 4.1 of the CHBDC.

7.3 Seismic Liquefaction

The soils beneath the anticipated founding elevation consist of compact to very dense glacial till deposits, which are not considered susceptible to liquefaction under earthquake loading using the site specific PGA value of 0.375g.

8 FOUNDATION DESIGN ALTERNATIVES

The results of the field and laboratory investigation and historical data indicate that the embankment fill is underlain by glacial till deposits.

Approximate key elevations are as follows:

- | | |
|---------------------------------------------------------------|------------------|
| • Existing ground surface at the proposed abutments | 62.7 m to 64.2 m |
| • Top of glacial till deposit near the proposed east abutment | 60.4 m to 61.6 m |
| • Top of glacial till deposit near the proposed west abutment | 59.3 m to 59.8 m |

The glacial till deposit predominantly consists of sand and silt with varying amounts of gravel and clay and includes occasional to frequent cobbles and boulders.

Given the soil stratigraphy encountered and the requirements of the proposed structure provided by WSP, the following foundation alternatives were considered for the new bridge foundations:

- Steel Piles (H-piles and pipe piles)
- Caissons (drilled shaft piles)
- Spread footings

These foundation alternatives are presented in the following sections and evaluated from a geotechnical perspective in terms of their respective advantages, disadvantages, risks and consequences. The evaluation is summarized in the table provided in Appendix F. A preferred foundation from a geotechnical engineering perspective is recommended.

8.1 Deep Foundations

Steel H piles driven to refusal in the dense to very dense glacial till is a feasible foundation option at this site, however, the cost would be greater than for shallow foundations.

Caissons foundation are not recommended at this site since the caissons would have to be installed in stoney cohesionless till that contains cobbles and boulders under the groundwater table. These conditions will present difficulties for installation of caissons.

8.2 Shallow Foundations

The existing fill materials encountered in Boreholes 17-1 through 17-6 advanced near the proposed abutment locations are not considered suitable to support shallow foundations. Spread footings must be founded on the undisturbed native glacial till or on a granular fill pad overlying the native glacial till.

Based on the preliminary GA drawing, the finished grade in front of the abutments will be no lower than approximately elevation 63.0 m. The footings would therefore need to be founded no higher than elevation 61.3 m to achieve the required frost protection. The top of the native glacial till ranges from approximately 59.3 to 61.6 m. Founding the abutments at elevation 61.3 m would require granular pads up to 2 m thick. Founding at a lower elevation would reduce the limits of excavation required to construct the granular pads and would also reduce the risk of interaction with utility trenches or of impacts to the footings in the event of a watermain break. Therefore, a founding elevation of 60.5 m has been adopted.

8.3 Recommended Foundation

Based on the proposed structure geometry and evaluation of foundation alternatives presented above, the recommended foundation approach from a geotechnical perspective is to support the abutments on spread footings founded on native compact to dense glacial till or where required engineered fill over glacial till.

9 FOUNDATION DESIGN RECOMMENDATIONS

9.1 Abutments - Shallow Foundations

Shallow foundations for the abutments can be founded directly on undisturbed native glacial till or an engineered fill pad over undisturbed native glacial till. The engineered fill pad should consist of OPSS Granular A placed and compacted in accordance with OPSS.PROV 501.

The base of the engineered fill pad should encompass the influence zone of the footings which is defined by an imaginary line extending downward and outward from the bottom edges of the footings at 1H:1V.

Abutment footings between 2 m and 3 m in width founded at elevation 60.5 m and constructed as outlined above may be designed based on the following factored geotechnical resistances:

- Factored geotechnical resistance at ULS 550 kPa
- Factored geotechnical resistance at SLS 400 kPa

The factored geotechnical resistance at SLS corresponds to total footing settlement of 25 mm.

The factored geotechnical resistances include the following factors:

- Consequence factor (Ψ) of 1.0
- Geotechnical resistance factors (CHBDC Table 6.2):
 - $\phi_{gu} = 0.5$ (static analysis; typical degree of understanding)
 - $\phi_{gs} = 0.8$ (static analysis; typical degree of understanding)

The geotechnical resistances are for vertical concentric loading and will need to be adjusted for the effects of inclined or eccentric loading, if applicable. The geotechnical resistance should be calculated as illustrated in the CHBDC Clause 6.10.3 and Clause 6.10.4.

Resistance to lateral forces and sliding resistance between concrete and underlying materials should be evaluated using an unfactored coefficients of friction provided in Table 9.1.

Table 9-1: Unfactored Coefficients of Friction between Concrete and Founding Material

Culvert Material	Founding Material	
	Native Till	Granular A
Cast-in-place concrete	0.50	0.55
Pre-cast concrete	0.45	0.50

9.2 Lateral Earth Pressures

The abutment walls and retaining walls will be subject to lateral earth pressures. The lateral earth pressure parameters provided in Table 9-4 and 9-5 in the sections below are based on the assumption that the backfill is fully drained so that there are no unbalanced hydrostatic pressures. If adequate drainage cannot be confirmed, the potential for buildup of hydrostatic pressures should be considered in the design.

9.2.1 Static Lateral Earth Pressure Coefficients

Lateral earth pressures acting on the abutment walls and retaining walls should be computed in accordance with the CHBDC but generally are given by the expression:

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

where:

P_h = horizontal pressure on the wall (kPa)

K = earth pressure coefficient

γ = unit weight of retained soil (kN/m³)

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

q = value of any surcharge (kPa)

The recommended lateral earth pressure parameters for use in design are provided in Table 9-2. The values for OPSS Granular A & B Type II should be used for abutment walls which include granular backfill as per OPSD 3101.150. The values for the existing fill and native till are provided for conceptual design of protection systems if required.

Table 9-2: Static Lateral Earth Pressure Coefficient

Parameter	OPSS Granular A & B Type II	Existing Fill	Native Till
Soil Unit Weight, kN/m ³ , γ	21.0	20.0	21.0
Angle of Internal Friction, ϕ	35°	30°	37°
Horizontal Backfill			
Coefficient of at Rest Earth Pressure, K_o (Restrained Wall)	0.43	0.50	0.40
Coefficient of Active Earth Pressure, K_a (Unrestrained Wall)	0.27	0.33	0.25
2H:1V Backfill			
Coefficient of at Rest Earth Pressure, K_o (Restrained Wall)	0.43	0.50	0.40
Coefficient of Active Earth Pressure, K_a (Unrestrained Wall)	0.27	0.33	0.35

For rigid structures, it is recommended that at-rest horizontal lateral earth pressures be used for design. Active pressures should be used for the design of unrestrained walls.

For static analysis, passive earth resistance should be ignored, and therefore have not been provided. A lateral pressure due to backfill compaction should be added to the calculated lateral earth pressure in accordance with Section 6.12.3 of the CHBDC.

9.2.2 Combined Static and Seismic Lateral Earth Pressure Parameters

The following recommendations are per Section C4.6.5 of the Commentary of the CHBDC. The recommended seismic lateral earth pressure parameters provided in Table 9-3 below have been assessed based on seismic hazard data outlined in Section 7.0 (Seismic Site Class of C, and a PGA with a 2% probability of exceedance in 50 years of 0.375g).

For the horizontal backfill condition, the seismically induced lateral soil pressures may be calculated using the Mononobe-Okabe Method with:

- $k_h = \frac{1}{2} F(PGA) \cdot PGA$ for structures that allow for 25 mm to 50 mm of movement, and
- $k_h = F(PGA) \cdot PGA$ for non-yielding walls

For the 2H:1V backfill, the parameters are beyond the limitations for the Mononobe-Okabe method and the general limit equilibrium method has been used to calculate the seismic lateral earth pressures.

The ratio of wall movement to wall height required to mobilize the active condition would be approximately 0.002 for a yielding structure with respect to the assessment of seismically induced lateral earth pressures.

Table 9-3: Lateral Earth Pressure (Under Seismic Loads)

Parameter	OPSS Granular A & B Type II
Soil Unit Weight, kN/m^3 , γ	21.0
Angle of Internal Friction, ϕ	35°
Horizontal Backfill	
Coefficient of Active Earth Pressure, K_{AE} (Restrained Wall)	0.39
Coefficient of Active Earth Pressure, K_{AE} (Unrestrained Wall)	0.55
2H:1V Backfill	
Coefficient of Active Earth Pressure, K_{AE} (Restrained Wall)	0.93
Coefficient of Active Earth Pressure, K_{AE} (Unrestrained Wall)	1.49

The total pressure due to combined static and seismic loads acting at a specific depth below the top of the wall may be determined using the following equation that includes consideration of material properties and the soil profile:

$$\sigma_h = K\gamma d + (K_{AE} - K_a) \gamma (H - d)$$

where:

σ_h = lateral earth pressure at depth, d (kPa)
 d = depth below the top of the wall (m)

K = static earth pressure coefficient
(K_a for yielding walls, K_o for non-yielding walls)
 γ = unit weight of the backfill soil (kN/m^3)
 K_{AE} = combined static and seismic earth pressure coefficient
 H = total height of the wall (m)

9.3 Approach Embankments and Retaining Walls

The existing approach embankments are up to approximately 6.0 m high with side slopes that extend down at approximately 2H:1V. The foreslopes are typically graded at 1.5H:1V and covered with slope paving. As part of the replacement of the existing three span structures with single span structures, a triangular wedge between the new abutments, existing slope paving and Highway 401 will be backfilled and will represent new embankment loading.

It is understood that the foreslopes between the structures and on both sides of the proposed structures will be formed by retained soil wall systems (RSS). The maximum exposed free height for the RSS walls is between the structures is to be 3 m. The RSS walls will tie-into the 2H:1V approach embankments.

Embankment construction should be carried out in accordance with OPSS.PROV 206. The embankment material behind the proposed structure walls should consist of imported Granular B Type II material or better.

Granular fill should be placed and compacted in accordance with OPSS.PROV 501. Where new embankment fill is placed against existing embankment slopes or fill slope must be benched in accordance with OPSD 208.010.

An assessment of settlement, bearing and global stability is summarized in the sections that follow.

9.3.1 Assessment of Settlement

An assessment of the settlement that would result from construction of the proposed embankment reinstatement behind the abutments and retaining walls using conventional granular fill was carried out using elastic settlement theory.

Based on settlement analysis, if the proposed grade raise is constructed as outlined above using conventional granular fill, the predicted settlement is less than 25 mm and is considered to be immediate.

9.3.2 RSS Foundations

The design of proprietary retained soil systems (RSS) is the responsibility of the supplier. Typically, such systems do not provide full frost protection as they are able to tolerate some movement due to frost heave.

The lateral pressure comments provided Section 9.2 may be used in RSS design.

For preliminary assessment, it has been assumed that the base of the reinforced mass will have a width equal to 0.7 times the height (i.e. 2.1 m). The following values can be used to assess the geotechnical resistance of the soils below the reinforced mass where a 1.0 m thick pad of

OPSS.PROV 1010 Granular A is provided beneath the RSS, the underside of the reinforced mass is 2.1 m wide and is embedded at least 1.2 m below finished grade:

- Factored geotechnical resistance at ULS 275 kPa
- Factored geotechnical resistance at SLS 200 kPa

The factored geotechnical resistance at SLS corresponds to total footing settlement of 25 mm.

The factored geotechnical resistances include the following factors:

- Consequence factor (Ψ) of 1.0
- Geotechnical resistance factors (CHBDC Table 6.2):
 - $\phi_{gu} = 0.5$ (static analysis; typical degree of understanding)
 - $\phi_{gs} = 0.8$ (static analysis; typical degree of understanding)

9.3.3 Assessment of Global Stability

The global stability for the proposed grade raise behind the RSS walls constructed using OPSS.PROV 1010 Granular B Type II, with 2H:1V side slopes was evaluated using GeoStudio 2012 Slope/W software for limit equilibrium analysis. Input parameters for the analysis are based on the in-situ SPT 'N' values. The following additional parameters were used in the analysis:

- A seismic horizontal loading of 0.1725, equal to $\frac{1}{2}$ of the site adjusted PGA value (0.345g) was used for seismic analysis
- Maximum wall height of 3 m, and a minimum reinforced zone of 2.1 m
- Leveling pad 1.0 m thick, constructed with OPSS.PROV 1010 Granular A material with a top of pad elevation of 61.5 m

Table 9-4: Global Stability Analysis Results

Location	Factor of Safety	
	Static Conditions	Seismic Conditions
RSS Walls	1.6	1.1

9.4 Noise Barrier Wall Foundations

For the design of the noise barrier wall foundations, reference may be made to the following documents:

- Ministry of Transportation, Ontario (2004) "Guidelines for the Design of High Mast Pole Foundations", Fourth Edition, BRO-009, Engineering Standards Branch, Bridge Office.
- Canadian Highway Bridge Design Code and Commentary, CAN/CSA-S6-14 and S6.1-14

It is anticipated that the proposed noise barrier walls will be supported on conventional augered caissons (i.e. drilled shafts) with typical diameters ranging from 0.6 m to 0.9 m. However, larger diameters may be required at locations of poor foundation conditions. Table 1 provided in Appendix G presents the recommended geotechnical design parameters for the augered caisson foundations.

To take into account frost action and surficial disturbance, the ultimate lateral passive resistance of a caisson within the upper 1.7 m below final grade should be neglected in the foundation design. It is recommended that all surficial weak soils, including topsoil and organics, be neglected in determining lateral resistance. The sloping earth berm and highway embankments in front of a caisson will result in reduced lateral passive resistance that must be taken into account during design.

When designing for portions of the caissons below the groundwater level in cohesionless soils (sands and silts) and fills, the submerged soil unit weight, γ' , should be used. The required depth of the drilled shaft will be governed by lateral loads, including wind loads, acting on the pole. The length of the caisson should also be sufficient to counteract frost jacking (upward) forces.

An equivalent caisson width equal to 2 times the caisson diameter may be assumed for lateral resistance calculations. Appropriate load and resistance factors should be applied for caisson design.

Caisson construction should be carried out in accordance with OPSS.PROV 903 - Construction Specification for Deep Foundations.

Caisson installation equipment must be able to dislodge, handle and remove cobbles and boulders or other obstructions within the fill, where encountered. Cobbles and boulders may also be encountered within the glacial till. A draft NSSP is provided in Appendix H alerting the contractor to the potential for encountering cobbles and boulders.

The overburden soils include very loose and loose granular soil and excavations for caissons may extend below the groundwater level. Soil sloughing and water seepage may occur in unsupported holes. Temporary liners should be available to support the caisson sidewalls and to provide seepage cut-off where required.

9.5 Cement Type and Corrosion Potential

Four soil samples were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate and chloride concentrations, and resistivity. The analysis was completed to determine the potential for degradation of the concrete in the presence of soluble sulphates and the potential for corrosion of exposed steel used in foundations to buried infrastructure. The analysis results are summarized in the Table 9-5. A copy of the test results is provided in Appendix D.

Table 9-5: Results of Chemical Analysis

Borehole	Sample	Depth (m)	pH	Resistivity (Ohm-cm)	Chloride ($\mu\text{g/g}$)	Sulphate ($\mu\text{g/g}$)
17-2	SS3	1.8	8.0	3040	85	58
17-2	SS5	3.4	7.9	1980	160	133
17-4	SS3	1.8	7.9	1110	293	306
17-4	SS7	4.9	7.9	2470	36	236

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. The sulphate results in Table 9-5 were compared with Table 3 of Canadian Standards Association Standards A23.1-14

(CSA A23.1) and generally indicate a low degree of sulphate attack potential on concrete structures at this site.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment.

10 CONSTRUCTION CONSIDERATIONS

10.1 Excavations

It is anticipated that temporary excavations in the order of 3.7 m will be required for the construction of the abutments footings.

All excavations must be conducted in accordance with the requirements of the Occupational Health & Safety Act & Regulations (OHSA) for Construction Projects. The soil at the site should be classified as Type 3 in accordance with OHSA.

Subgrade preparation and construction of foundations must be carried out in the dry.

Selection of the equipment and methodology to excavate and prepare the founding surface is the responsibility of the Contractor. As cobbles and boulders were observed in the boreholes a NSSP alerting bidders to their presence has been provided in Appendix H.

10.2 Temporary Protection Systems

It is understood that temporary protection systems may be required to protect Pitt Street and existing utilities beneath it. If required, temporary protection systems should be provided in accordance with OPSS.PROV 539. Typically, Performance Level 2 would be appropriate for this application but the performance level should be reviewed once the proximity to the existing utilities has been determined.

Design of the temporary protection systems is the responsibility of the contractor. Increased difficulty with the installation of protection systems should be anticipated due to the presence of cobbles and boulders within the native glacial till. Sheet piles systems are not considered suitable within the glacial till deposit due to the presence of cobbles and boulders. Protection systems would likely consist of H-piles with timber lagging installed by pre-auguring holes through within the till for the installation of H-piles. All protection systems should be designed by a Professional Engineer experienced in such designs.

10.3 Dewatering

All excavations for foundation construction must be dewatered prior to the placement of concrete, as per OPSS 902.

The Contractor must be prepared to control the groundwater and surface water flow at the site to permit construction in a dry and stable excavation. Water from either surface flow and/or groundwater must be diverted away from the excavation at all times. Groundwater perched within the embankment fill and, surface runoff will tend to seep into, and accumulate in proposed excavations.

Dewatering design and decisions regarding dewatering, must be carried out by the Contractor. The groundwater level in the area of the excavation should be lowered to 0.5 m below the final excavation level. Due to the shallow excavation depths being considered and the depth to groundwater at the site it is anticipated that conventional sump and pump techniques should be sufficient.

10.4 Erosion Protection

Slope protection and drainage measures will be required to ensure the long-term surficial stability of the embankment slopes. The contractor should provide silt fences and erosion control blankets, as required, throughout the duration of the construction to prevent silt/sediments from running off the site as per OPSS 805. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion in general accordance with OPSS.PROV 804.

10.5 Construction Concerns

The planned construction methodology includes excavations for shallow foundations and augured caissons for noise barrier wall supports.

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

- Confirmation that the backfill is adequately placed and compacted to specifications.
- Boulders may be encountered in the glacial till subgrade surface at the founding elevation and may require localized sub-excavation and replacement.
- Cobbles and boulders may be encountered during drilling for noise barrier wall supports and the contractor must have appropriate equipment on site to get through these ground conditions.
- Temporary liners may be required to keep drill holes for noise barrier wall supports open.

The successful performance of the construction of this structure will depend largely upon good workmanship and quality control during construction. Observation of the excavation and backfilling operations by the QVE will be required during construction to confirm that the foundation recommendations are correctly implemented and material specifications are met.

11 CLOSURE

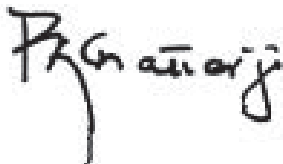
Overall project management and direction of the field program was provided by Paul Carnaffan, P.Eng. Interpretation of the field data and preparation of this report was completed by Kenton Power, P.Eng. The report was reviewed by Paul Carnaffan, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations Projects.



Kenton C. Power, P.Eng.
Geotechnical Engineer



Paul Carnaffan, P.Eng.
Principal, Ottawa Branch Manager

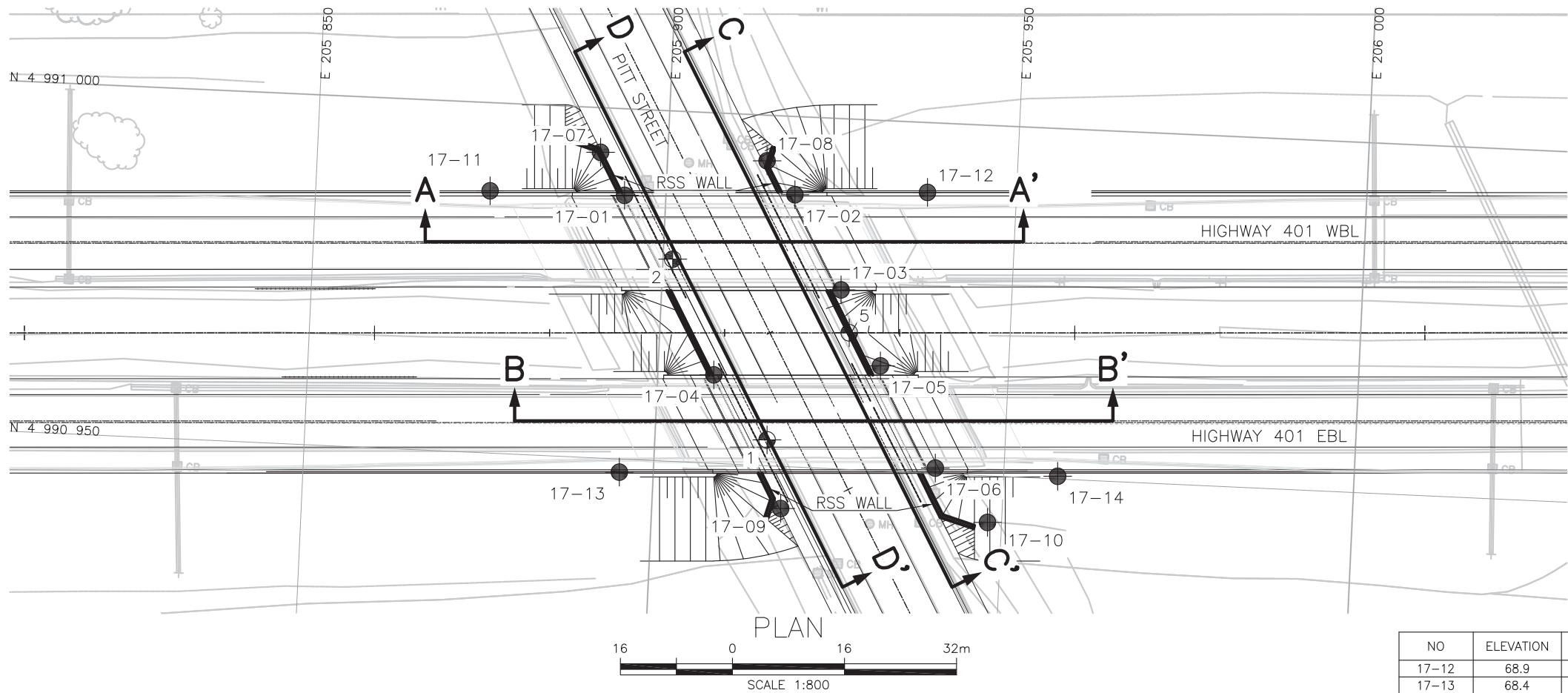


P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

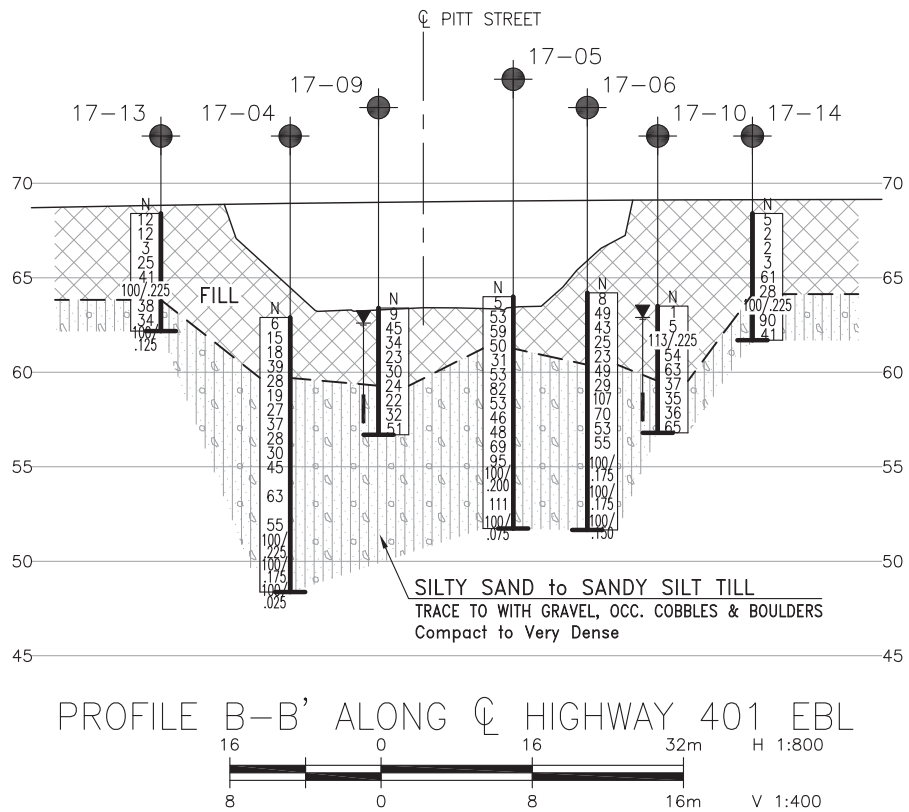
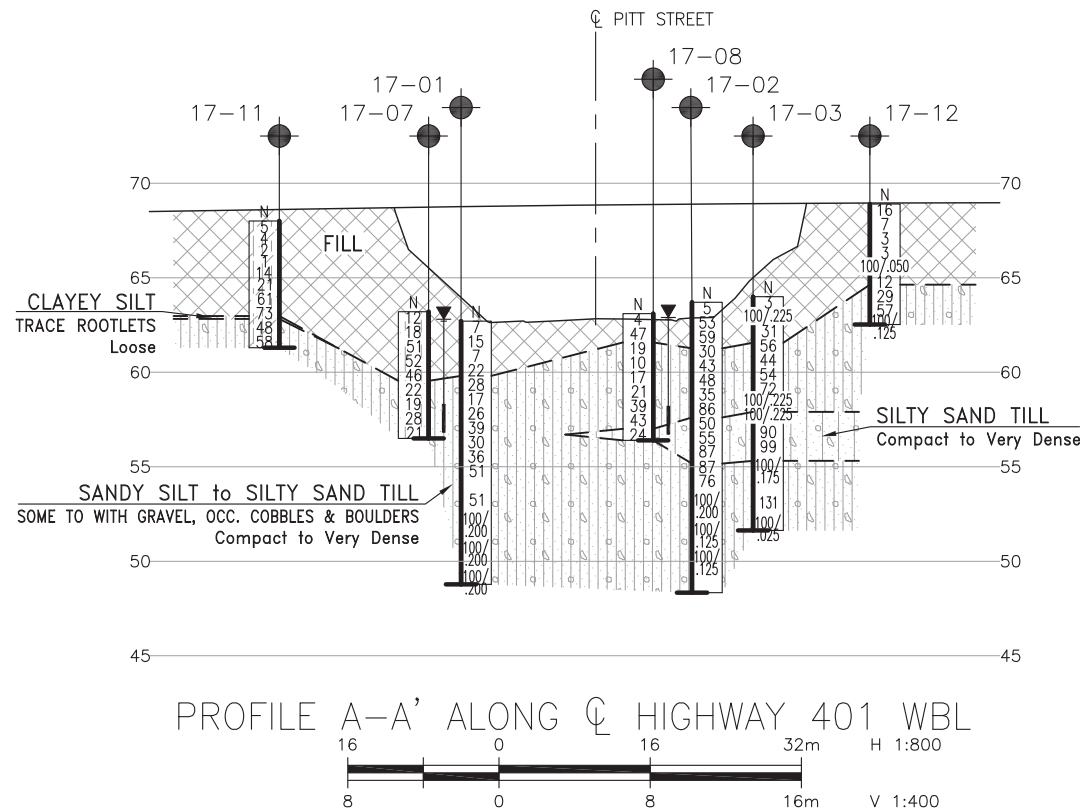
APPENDIX A

BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS – 2017 INVESTIGATION

DRAFT



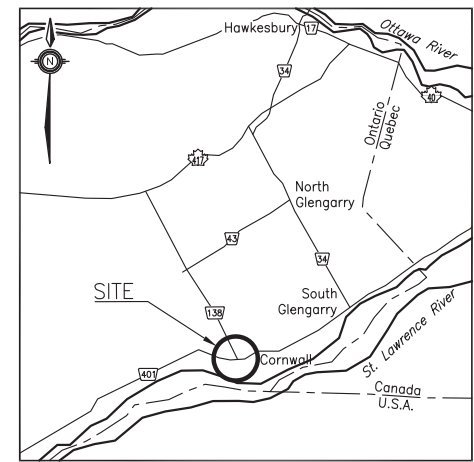
NO	ELEVATION	NORTHING	EASTING
17-12	68.9	4 990 990.0	205 937.3
17-13	68.4	4 990 948.1	205 895.1
17-14	68.4	4 990 950.4	205 957.7



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

CONT No
WP No 4085-13-01 & 4383-01-01

HIGHWAY 401
OVERPASS AT
PITT STREET
BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN

LEGEND

	Borehole (Present Investigation)
	Borehole (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

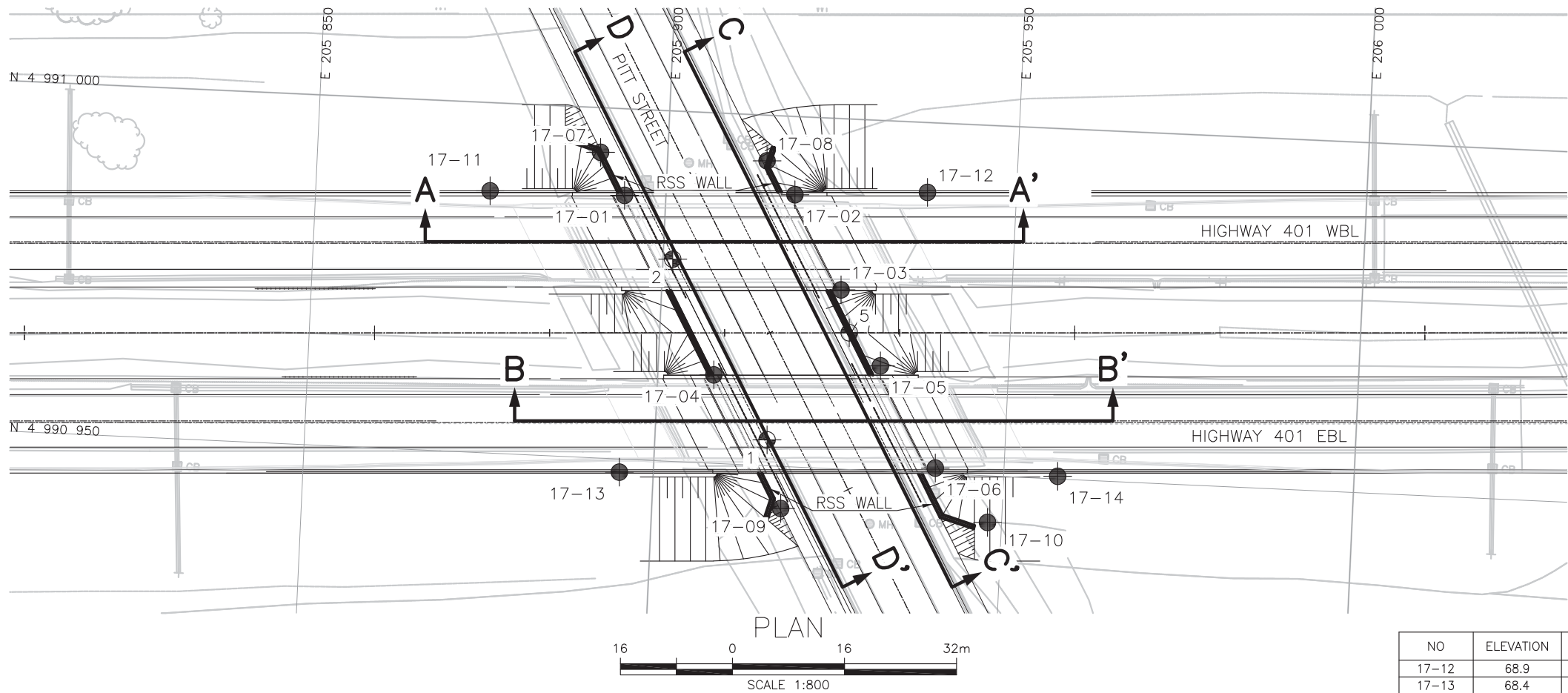
NO	ELEVATION	NORTHING	EASTING
17-01	62.7	4 990 987.6	205 894.1
17-02	63.7	4 990 988.8	205 918.4
17-03	64.0	4 990 975.6	205 925.6
17-04	62.9	4 990 962.6	205 908.0
17-05	64.0	4 990 965.0	205 931.7
17-06	64.2	4 990 950.8	205 940.2
17-07	63.2	4 990 993.6	205 890.4
17-08	63.1	4 990 993.5	205 914.2
17-09	63.4	4 990 944.0	205 918.4
17-10	63.5	4 990 943.4	205 948.0
17-11	68.0	4 990 987.4	205 874.9

NOTES

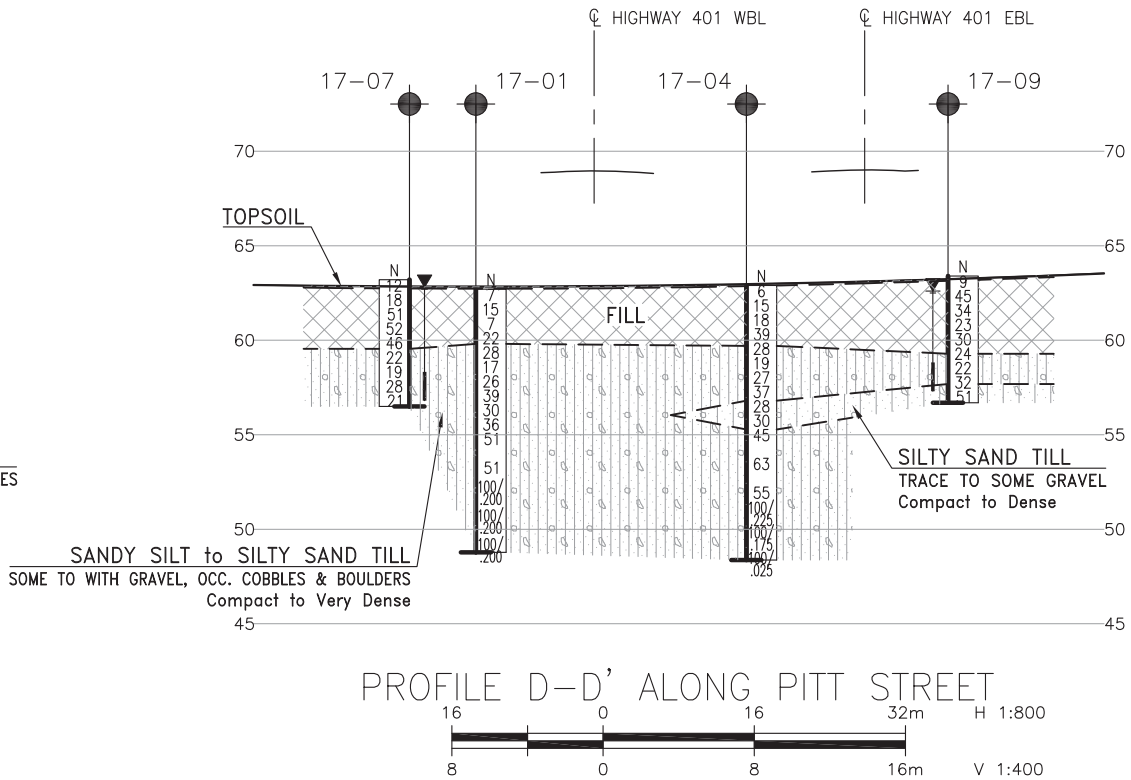
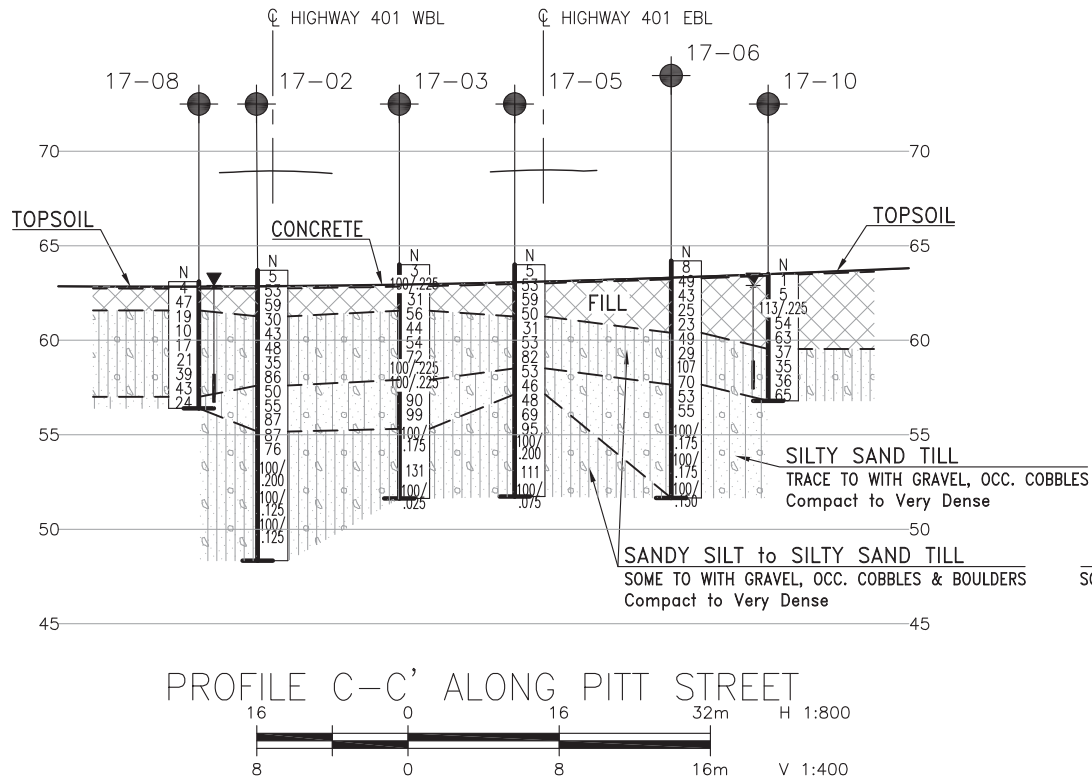
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Borehole locations are shown in MTM Zone 8 coordinates.

GEOCRES No.

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	JG	CHK KP	CODE
DRAWN	MFA	CHK JG	SITE
			LOAD
			STRUCT
			DWG 1
			DATE AUG 2017



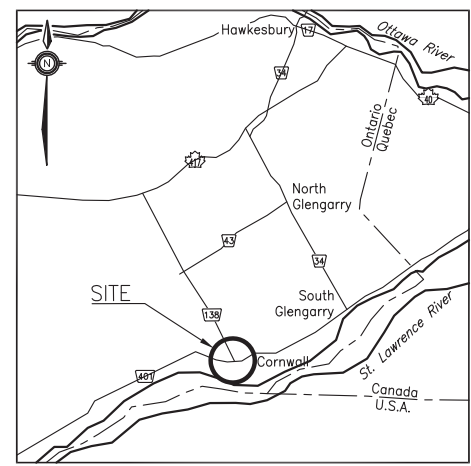
NO	ELEVATION	NORTHING	EASTING
17-12	68.9	4 990 990.0	205 937.3
17-13	68.4	4 990 948.1	205 895.1
17-14	68.4	4 990 950.4	205 957.7



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

CONT No
WP No 4085-13-01 & 4383-01-01

HIGHWAY 401
OVERPASS AT
PITT STREET
BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN

LEGEND

●	Borehole (Present Investigation)
○	Borehole (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
17-01	62.7	4 990 987.6	205 894.1
17-02	63.7	4 990 988.8	205 918.4
17-03	64.0	4 990 975.6	205 925.6
17-04	62.9	4 990 962.6	205 908.0
17-05	64.0	4 990 965.0	205 931.7
17-06	64.2	4 990 950.8	205 940.2
17-07	63.2	4 990 993.6	205 890.4
17-08	63.1	4 990 993.5	205 914.2
17-09	63.4	4 990 944.0	205 918.4
17-10	63.5	4 990 943.4	205 948.0
17-11	68.0	4 990 987.4	205 874.9

NOTES

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Borehole locations are shown in MTM Zone 8 coordinates.

GEOCRES No.

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	JG	CHK KP	CODE
DRAWN	MFA	CHK JG	SITE
			LOAD
			DATE
			AUG 2017
			STRUCT
			DWG 2

APPENDIX B
RECORD OF BOREHOLE SHEETS – 2017 INVESTIGATION

DRAFT

SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.

STRATA PLOT:

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel



Sand



Silt



Clay



Organics



Asphalt



Concrete



Fill



Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT "N" Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	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	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, 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.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L = Liquid Limit

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
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 structures are preserved.

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 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

RECORD OF BOREHOLE No 17-01

1 OF 2

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 987.6 E 205 894.1 ORIGINATED BY JG
HWY 401 BOREHOLE TYPE Hollow Stem augers COMPILED BY JG
DATUM Geodetic DATE 2017.05.08 - 2017.05.08 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE		● QUICK TRIAXIAL × LAB VANE		w P w w L				
								20	40	60	80	100	20	40		
62.7																
0.0	70 mm TOPSOIL															
0.1	GRAVEL, silty with sand, occasional cobbles Loose to compact Brown FILL		1	SS	7							○			49 38 13 (SH+CL)	
			2	SS	15							○				
			3	SS	7							○				
			4	SS	22							○				
59.8																
2.9	SILTY SAND (SM) some gravel TILL, to Silty SAND (SM) with gravel TILL - Occasional cobbles Compact to very dense Grey		5	SS	28							○				
			6	SS	17							○			12 24 54 10	
			7	SS	26							○				
	- Dense to very dense below 5.3 m		8	SS	39							○				
			9	SS	30							○				
	- Coarse sand layer at 6.5 m		10	SS	36							○				
			11	SS	51							○				
			12	SS	51							○			17 37 35 11	

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

RECORD OF BOREHOLE No 17-01

2 OF 2

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 987.6 E 205 894.1 ORIGINATED BY JG
 HWY 401 BOREHOLE TYPE Hollow Stem augers COMPILED BY JG
 DATUM Geodetic DATE 2017.05.08 - 2017.05.08 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
								20 40 60 80 100									
Continued From Previous Page											WATER CONTENT (%) 20 40 60						
48.8 <																	

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

RECORD OF BOREHOLE No 17-02

1 OF 2

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 988.8 E 205 918.4 ORIGINATED BY JG
HWY 401 BOREHOLE TYPE NW Casing COMPILED BY JG
DATUM Geodetic DATE 2017.05.11 - 2017.05.12 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
63.7														
0.0	100 mm TOPSOIL													
0.1	Silty sand with gravel, occasional cobbles Loose to very dense Brown FILL		1	SS	5		63							35 24 41 (SI+CL)
			2	SS	53		62							
	- Frequent cobbles below 1.5 m		3	SS	59		61							
61.3			4	SS	30		60							12 21 58 9
2.4	Sandy SILT (ML) some gravel TILL - Occasional cobbles Dense to very dense Grey		5	SS	43		59							
			6	SS	48		58							
			7	SS	35									
			8	SS	86									
57.6			9	SS	50		57							1 53 46 (SI+CL)
6.1	SILTY SAND (SM) TILL Very dense Grey		10	SS	55		56							
			11	SS	87		55							
55.2			12	SS	87		54							8 38 44 10
8.5	Sandy SILT (ML) some gravel TILL , to Silty GRAVEL (GM) with sand TILL - Occasional to frequent cobbles and boulders Very dense Grey		13	SS	76									

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

METRIC

[illegible][illegible]

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 17-03

1 OF 2

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 975.6 E 205 925.6 ORIGINATED BY JG
HWY 401 BOREHOLE TYPE NW Casing COMPILED BY CM
DATUM Geodetic DATE 2017.05.12 - 2017.05.12 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
64.0								20	40	60	80	100							
0.0 0.1	70 mm Concrete Paving Stone							20	40	60	80	100							
	Silt sand with gravel, occasional cobbles Loose to Very Dense Brown FILL - 240 mm Boulder at 1.0 m		1	SS	3														
			2	SS	100/ 225mm														
			3	SS	31														
61.6																			
2.4	SILTY SAND (SM) with gravel SILTY SAND (SM) with gravel TILL, to Sandy SILT (ML) with gravel TILL - Occasional cobbles Dense to Very Dense Grey		4	SS	56														
			5	SS	44														
			6	SS	54														
			7	SS	72														
			8	SS	100/ 225mm														
57.9																			
6.1	SILTY SAND (SM) some gravel TILL Very Dense Grey		9	SS	100/ 225mm														
			10	SS	90														
			11	SS	99														
55.3																			
8.7	SILTY SAND (SM) with gravel TILL, to Sandy SILT (ML) some gravel TILL - Occasional cobbles Very Dense Grey		12	SS	100/ 175mm														

ONTMT4S 31-2111-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

[illegible]

METRIC

SOIL PROFILE									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
62.9			NUMBER TYPE "N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	W P W L WATER CONTENT (%)		GR SA SI CL
0.8	40 mm TOPSOIL	[Pattern]	1 SS 6						
	SILTY SAND with gravel, occasional cobbles Loose to very dense Brown to grey FILL	[Pattern]	2 SS 15		62				
	- Grey	[Pattern]	3 SS 18		61				
	- Brown	[Pattern]	4 SS 39		60				
59.7			5 SS 28						
3.2	SILT (ML) with sand, some gravel TILL Compact to dense Grey	[Pattern]	6 SS 19		59				7 21 61 1
		[Pattern]	7 SS 27		58				
		[Pattern]	8 SS 37		57				
56.8			9 SS 28						
6.1	SILTY SAND (SM) trace to some gravel TILL Compact Grey	[Pattern]	10 SS 30		56				5 44 42 9
55.3			11 SS 45		55				
7.6	SILTY SAND (SM) with gravel TILL, to Sandy SILT (ML) with gravel TILL - Occasional to frequent cobbles and boulders Dense to very dense Grey	[Pattern]	12 SS 63		54				
		[Pattern]			53				

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 17-04

2 OF 2

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 962.6 E 205 908.0 ORIGINATED BY JG
HWY 401 BOREHOLE TYPE Hollow Stem augers COMPILED BY JG
DATUM Geodetic DATE 2017.05.08 - 2017.05.08 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
WATER CONTENT (%)				20 40 60										
	Continued From Previous Page													
48.4 														
























ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

RECORD OF BOREHOLE No 17-05

1 OF 2

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 965.0 E 205 931.7 ORIGINATED BY JG
HWY 401 BOREHOLE TYPE NW Casing COMPILED BY CM
DATUM Geodetic DATE 2017.05.15 - 2017.05.15 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
64.0							20	40	60	80	100								
0.0																			
0.1	70 mm Concrete Paving Stone		1	SS	5														
	SILTY SAND with gravel, occasional cobbles Loose to Very Dense Brown FILL																		
			2	SS	53														
																			
			3	SS	59														
																			
			4	SS	50														
61.3																			
2.7	SILTY SAND (SM) some gravel TILL, to SILT (ML) with sand trace gravel TILL Dense to Very Dense Brown to Grey		5	SS	31														
																			
			6	SS	53														
																			
			7	SS	82														
																			
			8	SS	53														
58.5																			
5.5	SILTY SAND (SM) trace gravel TILL Dense to Very Dense Grey		9	SS	46														
																			
			10	SS	48														
57.1																			
6.9	Sandy SILT (ML) some gravel TILL, to Silty GRAVEL (GM) with sand TILL - Occasional cobbles Dense to Very Dense Grey		11	SS	69														
																			
			12	SS	95														
																			
			13	SS	100/ 200mm														
																			

Continued Next Page

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

METRIC

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 17-06

1 OF 2

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 950.8 E 205 940.2 ORIGINATED BY JG
 HWY 401 BOREHOLE TYPE NW Casing COMPILED BY JG
 DATUM Geodetic DATE 2017.05.11 - 2017.05.11 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								○ UNCONFINED		+ FIELD VANE					
								● QUICK TRIAXIAL	× LAB VANE	WATER CONTENT (%)					
64.2						20	40	60	80	100	W P	W	W L		
0.0						20	40	60	80	100					
0.1	100 mm TOPSOIL														
	Silty sand with gravel, occasional cobbles Loose to very dense Brown FILL		1	SS	8							○			
			2	SS	49							○			
			3	SS	43							○			31 38 31 (SI+CL)
			4	SS	25							○			
			5	SS	23							○			
60.4															
3.8	Sandy SILT (ML) some gravel TILL Compact to very dense Brown to grey		6	SS	49							○			11 30 59 (SI+CL)
			7	SS	29							○			
			8	SS	107							○			
			9	SS	70							○			
57.6															
6.6	SILTY SAND (SM) some gravel SILTY SAND (SM) with gravel TILL, to Silty GRAVEL (GM) with sand TILL - Occasional cobbles Very dense Grey		10	SS	53							○			
			11	SS	55							○			15 45 40 (SI+CL)
			12	SS	100/ 175mm							○			

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

RECORD OF BOREHOLE No 17-06

2 OF 2

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 950.8 E 205 940.2 ORIGINATED BY JG
 HWY 401 BOREHOLE TYPE NW Casing COMPILED BY JG
 DATUM Geodetic DATE 2017.05.11 - 2017.05.11 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				W P W W L WATER CONTENT (%)				GR	SA	SI	CL
	Continued From Previous Page							20	40	60	80	100							
51.7 <																			

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

RECORD OF BOREHOLE No 17-07

1 OF 1

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 993.6 E 205 890.4 ORIGINATED BY JG
 HWY 401 BOREHOLE TYPE Hollow Stem augers COMPILED BY JG
 DATUM Geodetic DATE 2017.05.09 - 2017.05.09 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
63.2								20	40	60	80	100			
0.0								20	40	60	80	100			
0.1	80 mm TOPSOIL							20	40	60	80	100			
	Silty sand some gravel, occasional cobbles Loose to very dense Brown to grey FILL		1	SS	12		63								
			2	SS	18		62								14 36 50 (SI+CL)
			3	SS	51		61								
			4	SS	52		60								
			5	SS	46		59								
59.6			6	SS	22		58								
3.7	Sandy SILT (SM) some to with gravel TILL Compact Grey		7	SS	19		57								12 23 55 10
			8	SS	28										
			9	SS	21										15 30 48 7
56.5															
6.7	End of Borehole Groundwater level measured in the piezometer at 0.4 m BGS (elev. 62.8 m) on 2017.06.02														

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

RECORD OF BOREHOLE No 17-08

1 OF 1

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 993.5 E 205 914.2 ORIGINATED BY JG
 HWY 401 BOREHOLE TYPE Hollow Stem augers COMPILED BY JG
 DATUM Geodetic DATE 2017.05.09 - 2017.05.09 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								WATER CONTENT (%)					
63.1													
0.0													
0.1	80 mm TOPSOIL		1	SS	4								
	Silty sand with gravel, occasional cobbles Loose to very dense Brown FILL		2	SS	47								28 32 40 (SI+CL)
61.6													
1.5	SILTY SAND (SM) with gravel TILL, to Sandy SILT (ML) with gravel TILL Compact to dense Grey		3	SS	19								
			4	SS	10								16 34 40 10
			5	SS	17								
			6	SS	21								
			7	SS	39								
			8	SS	43								
57.0													
6.1	SILTY SAND (SM) trace to some gravel TILL Compact Grey		9	SS	24								4 47 42 7
56.4													
6.7	End of Borehole Groundwater level measured in the piezometer at 0.2 m BGS (elev. 62.9 m) on 2017.06.02												

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

RECORD OF BOREHOLE No 17-09

1 OF 1

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 944.0 E 205 918.4 ORIGINATED BY JG
HWY 401 BOREHOLE TYPE Hollow Stem augers COMPILED BY JG
DATUM Geodetic DATE 2017.05.09 - 2017.05.09 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
							WATER CONTENT (%)							
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _P W W _L							
63.4														
0.0														
0.1	80 mm TOPSOIL		1	SS	9		63							
	Silty sand with gravel, occasional cobbles													
	Loose to very dense		2	SS	45		62							
	Brown													
	FILL		3	SS	34									
			4	SS	23		61				○			34 34 32 (SI+CL)
			5	SS	30		60				○			
59.3			6	SS	24		59				○			
4.1	Sandy SILT (ML) TILL													
	Dense		7	SS	22		58				○			3 32 57 8
	Grey													
			8	SS	32						○			
57.7														
5.7	SILTY SAND (SM) some gravel TILL													
	Dense		9	SS	51		57				○			11 45 36 8
	Grey													
56.7														
6.7	End of Borehole													
	Groundwater level measured in the piezometer at 0.8 m BGS (elev. 62.6 m) on 2017.06.02													

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

RECORD OF BOREHOLE No 17-10

1 OF 1

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 943.4 E 205 948.0 ORIGINATED BY JG
 HWY 401 BOREHOLE TYPE Hollow Stem augers COMPILED BY JG
 DATUM Geodetic DATE 2017.05.09 - 2017.05.09 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
							WATER CONTENT (%)										
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT										
							W P W W L										
							20 40 60 80 100										
							20 40 60 80 100										
63.5																	
0.0	80 mm TOPSOIL Silty sand some gravel, occasional cobbles Loose to very dense Brown FILL		1	SS	1		63										
0.1																	
			2	SS	5		62										
			3	SS	113/ 225mm												
			4	SS	54		61										
			5	SS	63		60										
59.5	Sandy SILT (ML) trace to some gravel TILL Dense to very dense Grey		6	SS	37		59										
4.0																	
			7	SS	35		58										
			8	SS	36		57										
			9	SS	65												
56.8	End of Borehole Groundwater level measured in the piezometer at 0.6 m BGS (elev. 62.9 m) on 2017.06.02																
6.7																	

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

RECORD OF BOREHOLE No 17-11

1 OF 1

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 987.4 E 205 874.9 ORIGINATED BY CM
 HWY 401 BOREHOLE TYPE NW Casing COMPILED BY CM
 DATUM Geodetic DATE 2017.05.17 - 2017.05.17 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)						
68.0								20	40	60	80	100	W _p	W	W _L			
0.0	Silty sand with gravel Very Loose to Compact Brown to Grey FILL		1	SS	5													
			2	SS	4													
			3	SS	2													
			4	SS	1													
			5	SS	14													
65.0																		
3.0	Gravel, silty with sand, frequent cobbles Compact to Very Dense Brown to Grey FILL		6	SS	21													
			7	SS	61													
			8	SS	73													
63.0																		
62.9	CLAYEY SILT (MI), trace rootlets																	
5.2	Loose Grey		9	SS	48													
	SANDY SILT (ML) with gravel TILL Dense to Very Dense Grey																	
			10	SS	58													
61.3																		
6.7	End of Borehole																	

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

RECORD OF BOREHOLE No 17-12

1 OF 1

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 990.0 E 205 937.3 ORIGINATED BY JG
 HWY 401 BOREHOLE TYPE NW Casing COMPILED BY CM
 DATUM Geodetic DATE 2016.05.16 - 2016.05.16 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
								20 40 60 80 100								
68.9																
68.9	50mm Topsoil		1	SS	16											41 38 21 (SI+CL)
	Silty sand with gravel, to silty gravel with sand - Occasional cobbles Very Loose to Very Dense Brown FILL		2	SS	7											
			3	SS	3											
			4	SS	3											
			5	SS	100/ 50mm											
	- 220 mm Boulder at 3.3 m		6	SS	12											
64.6			7	SS	29											
4.3	Sandy SILT (ML) some gravel TILL, to Silty SAND (GM) with gravel TILL Compact to Very Dense Grey		8	SS	57											10 40 40 10
			9	SS	100/ 125mm											
62.5																
6.4	End of Borehole															

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO) GDT 24/8/17

RECORD OF BOREHOLE No 17-13

1 OF 1

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 948.1 E 205 895.1 ORIGINATED BY CM
 HWY 401 BOREHOLE TYPE NW Casing COMPILED BY CM
 DATUM Geodetic DATE 2017.05.17 - 2017.05.17 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
					WATER CONTENT (%)									
					20 40 60 80 100									
					20 40 60 80 100									
					20 40 60 80 100									
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ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

RECORD OF BOREHOLE No 17-14

1 OF 1

METRIC

W.P. 4085-13-01 & 4383-01-01 LOCATION Pitt St., MTM z8: N 4 990 950.4 E 205 957.7 ORIGINATED BY JG
 HWY 401 BOREHOLE TYPE NW Casing COMPILED BY CM
 DATUM Geodetic DATE 2016.05.16 - 2016.05.16 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
					WATER CONTENT (%)									
					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT									
					W P W W L									
68.4														
68.0	60mm Topsoil		1	SS	5		68							
	Silty sand with gravel, occasional cobbles													
	Very Loose to Very Dense		2	SS	2		67							
	Brown FILL													
			3	SS	2		66							18 42 40 (SI+CL)
			4	SS	3		65							
			5	SS	61		64							
64.1			6	SS	28		63							
4.3	Sandy SILT (ML) some gravel TILL													
	- Occasional cobbles		7	SS	100/225mm		62							
	Very Dense													
	Grey		8	SS	90		61							11 39 40 10
			9	SS	41		60							
61.7														
6.7	End of Borehole													

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 24/8/17

APPENDIX C

HISTORICAL BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS HISTORICAL RECORD OF BOREHOLE SHEETS

DRAFT

APPENDIX D

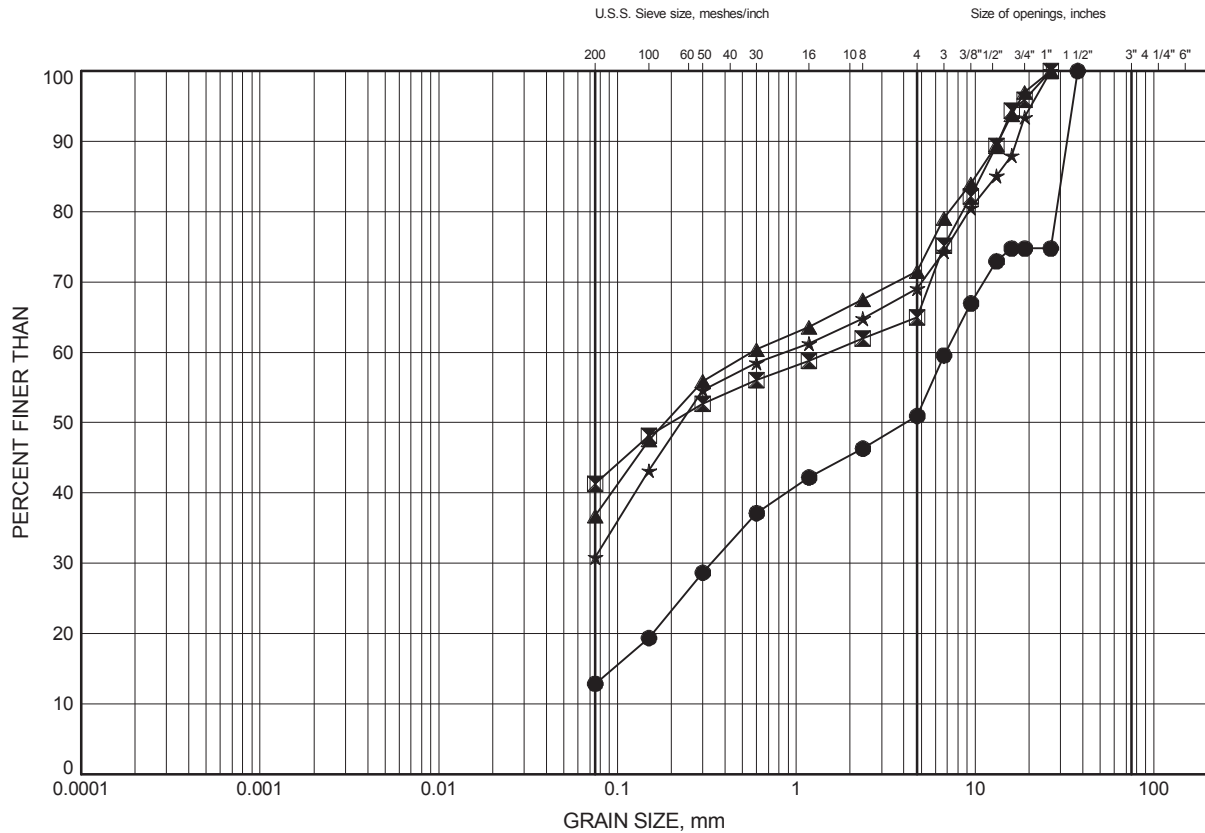
LABORATORY TEST RESULTS – 2017 INVESTIGATION

DRAFT

Pitt Street
GRAIN SIZE DISTRIBUTION

FIGURE 1

Silty Sand to Silty Gravel FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-01	0.30	62.43
⊠	17-02	0.99	62.71
▲	17-03	4.04	59.96
★	17-06	1.83	62.37

Date July 2017

W.P. 4085-13-01 & 4383-01-01



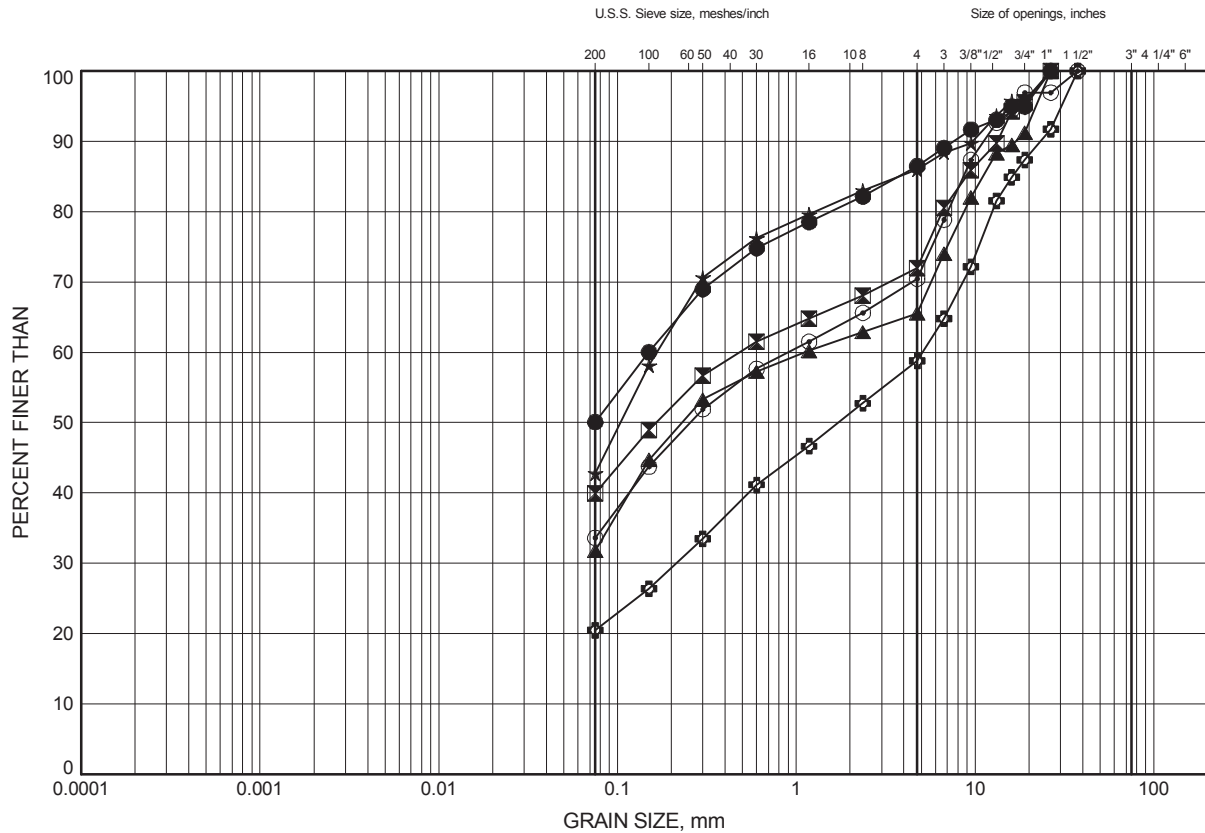
Prep'd KCP

Chkd. PC

Pitt Street
GRAIN SIZE DISTRIBUTION

FIGURE 2

Silty Sand to Silty Gravel FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-07	1.07	62.15
⊠	17-08	1.07	62.04
▲	17-09	2.59	60.79
★	17-10	2.59	60.89
⊙	17-11	1.52	66.52
⊕	17-12	0.30	68.56

Date June 2017

W.P. 4085-13-01 & 4383-01-01



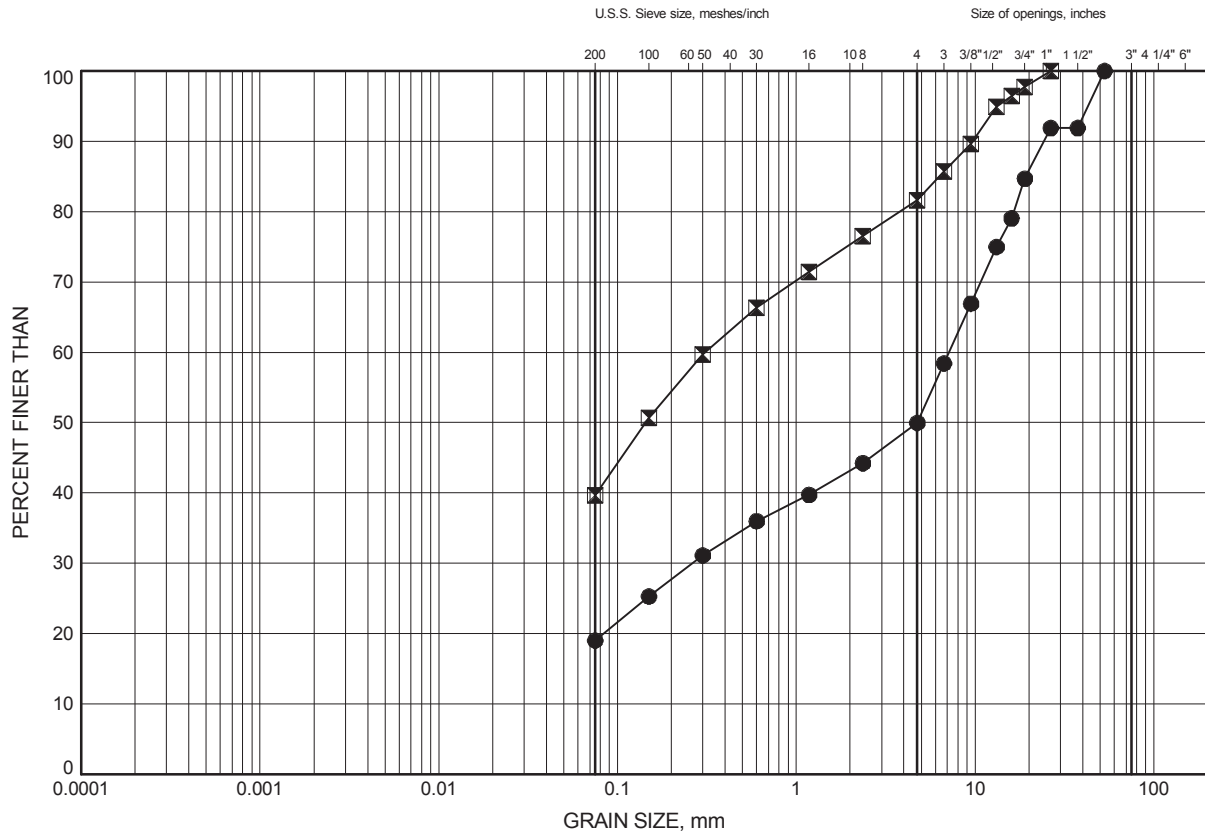
Prep'd JM

Chkd. PC

Pitt Street
GRAIN SIZE DISTRIBUTION

FIGURE 3

Silty Sand to Silty Gravel FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-13	2.59	65.84
⊠	17-14	1.83	66.57

Date June 2017
W.P. 4085-13-01 & 4383-01-01

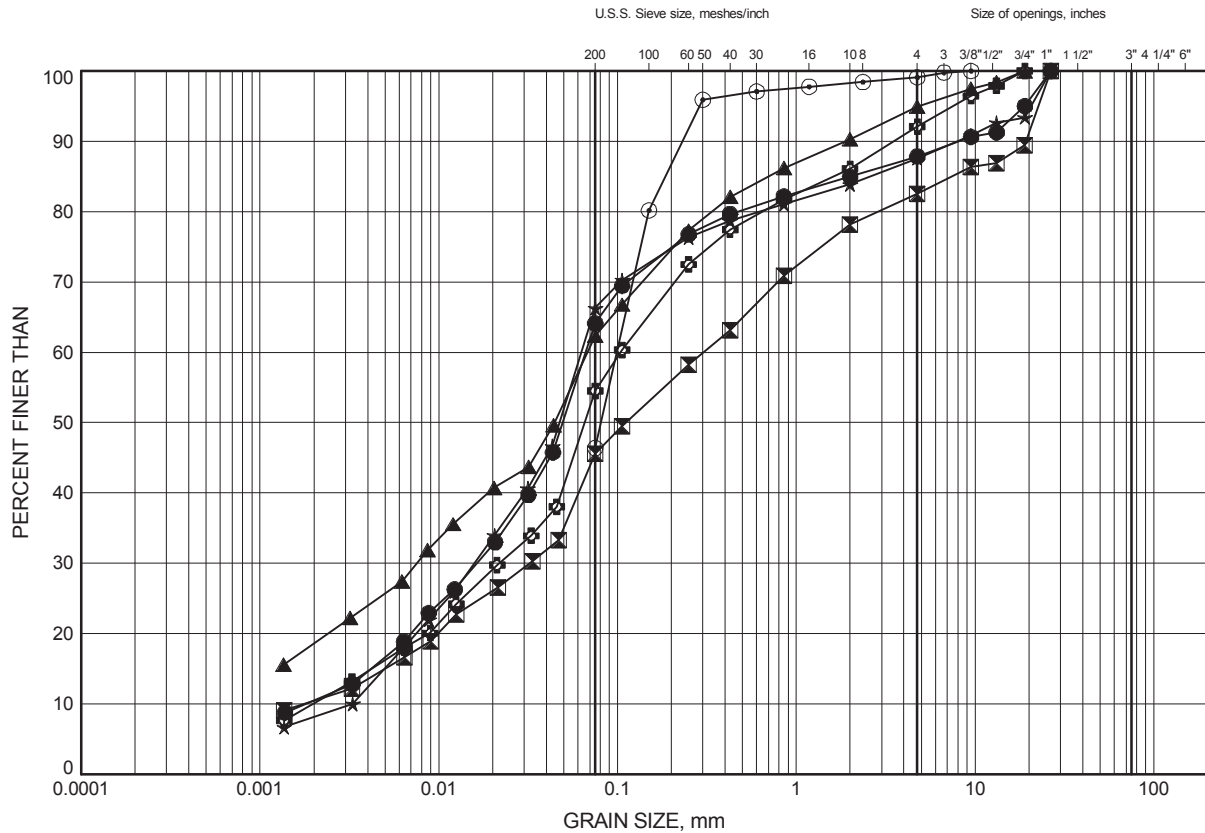


Prep'd JM
Chkd. PC

Pitt Street
GRAIN SIZE DISTRIBUTION

FIGURE 4

Glacial TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-01	4.11	58.62
⊠	17-01	9.45	53.29
▲	17-01	12.29	50.45
★	17-02	4.11	59.59
⊙	17-02	6.40	57.30
⊕	17-02	9.45	54.25

Date June 2017

W.P. 4085-13-01 & 4383-01-01



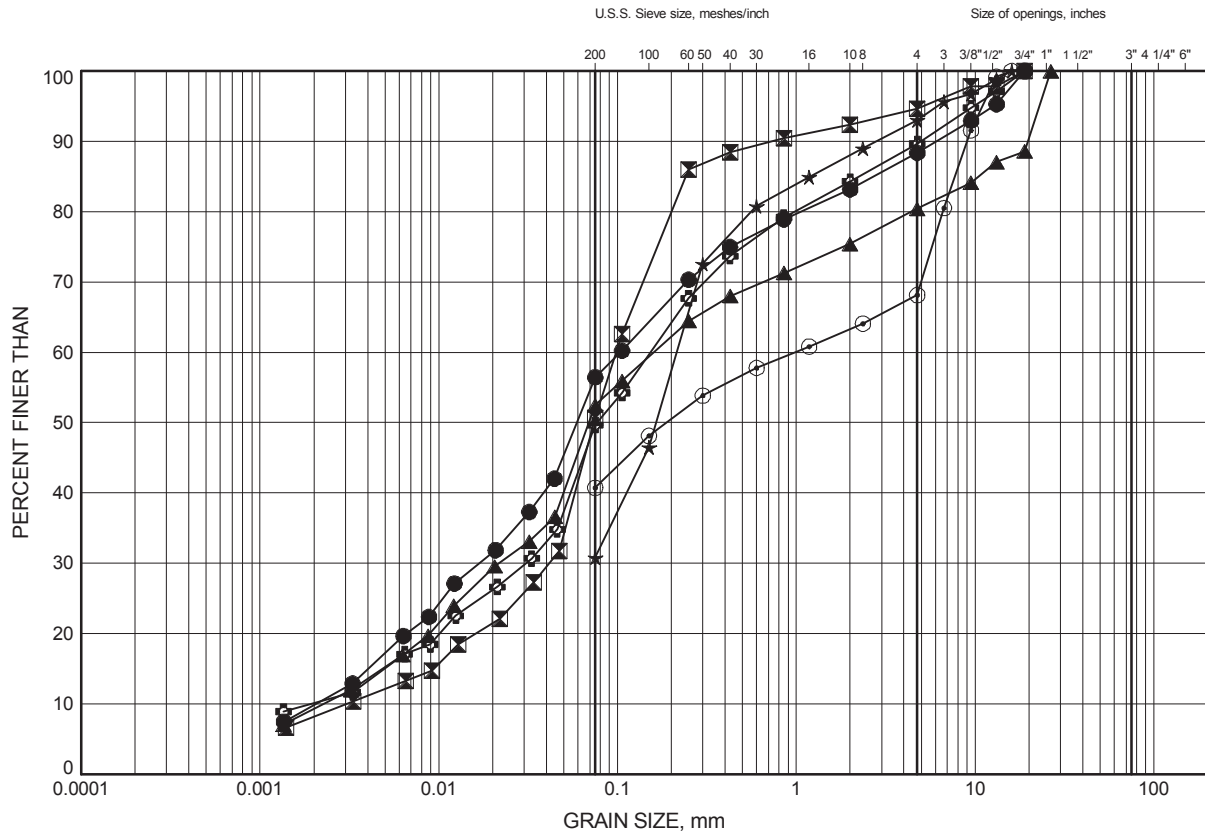
Prep'd JM

Chkd. PC

Pitt Street
GRAIN SIZE DISTRIBUTION

FIGURE 5

Glacial TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-03	10.90	53.10
⊠	17-04	7.16	55.73
▲	17-04	10.97	51.92
★	17-05	6.40	57.60
⊙	17-05	10.97	53.03
⊕	17-12	5.61	63.25

Date July 2017

W.P. 4085-13-01 & 4383-01-01



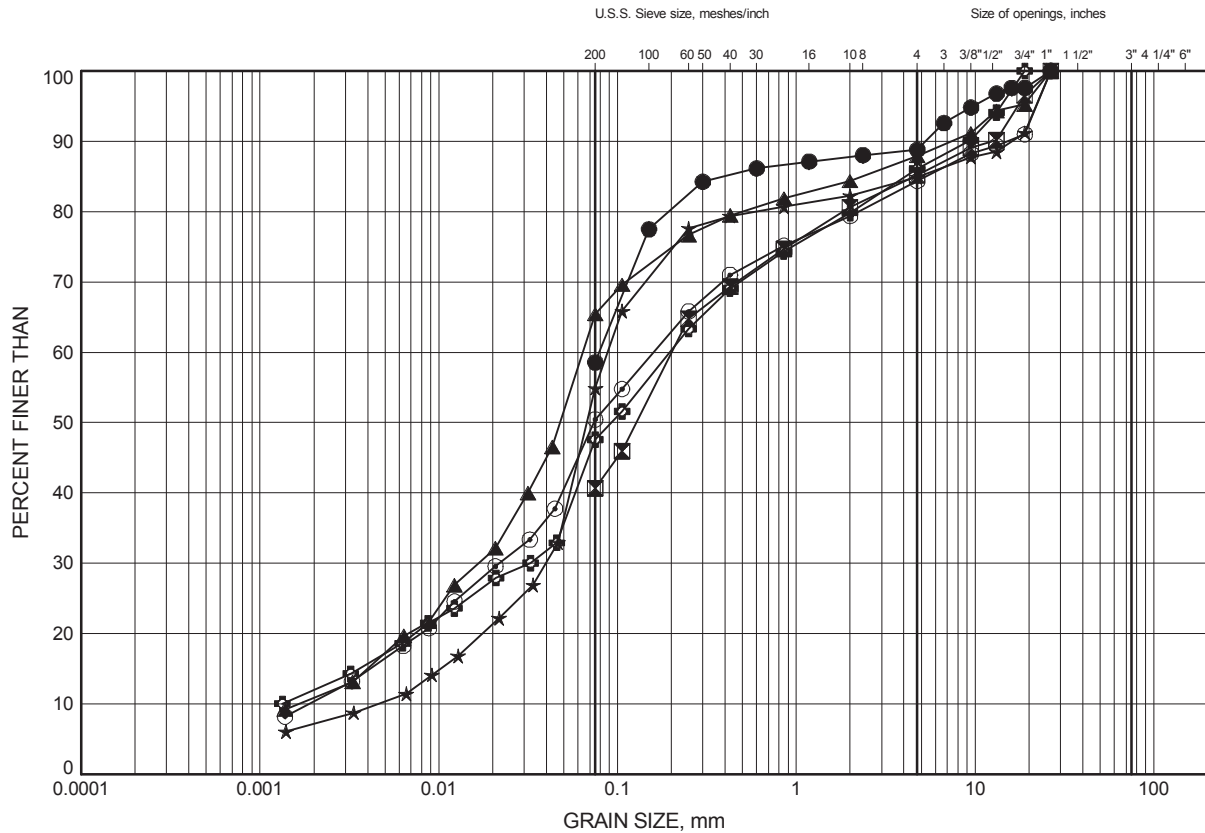
Prep'd KCP

Chkd. PC

Pitt Street GRAIN SIZE DISTRIBUTION

FIGURE 6

Glacial TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-06	4.11	60.08
⊠	17-06	7.92	56.27
▲	17-07	4.88	58.34
★	17-07	6.40	56.82
⊙	17-08	2.59	60.51
⊕	17-13	4.88	63.55

Date July 2017

W.P. 4085-13-01 & 4383-01-01



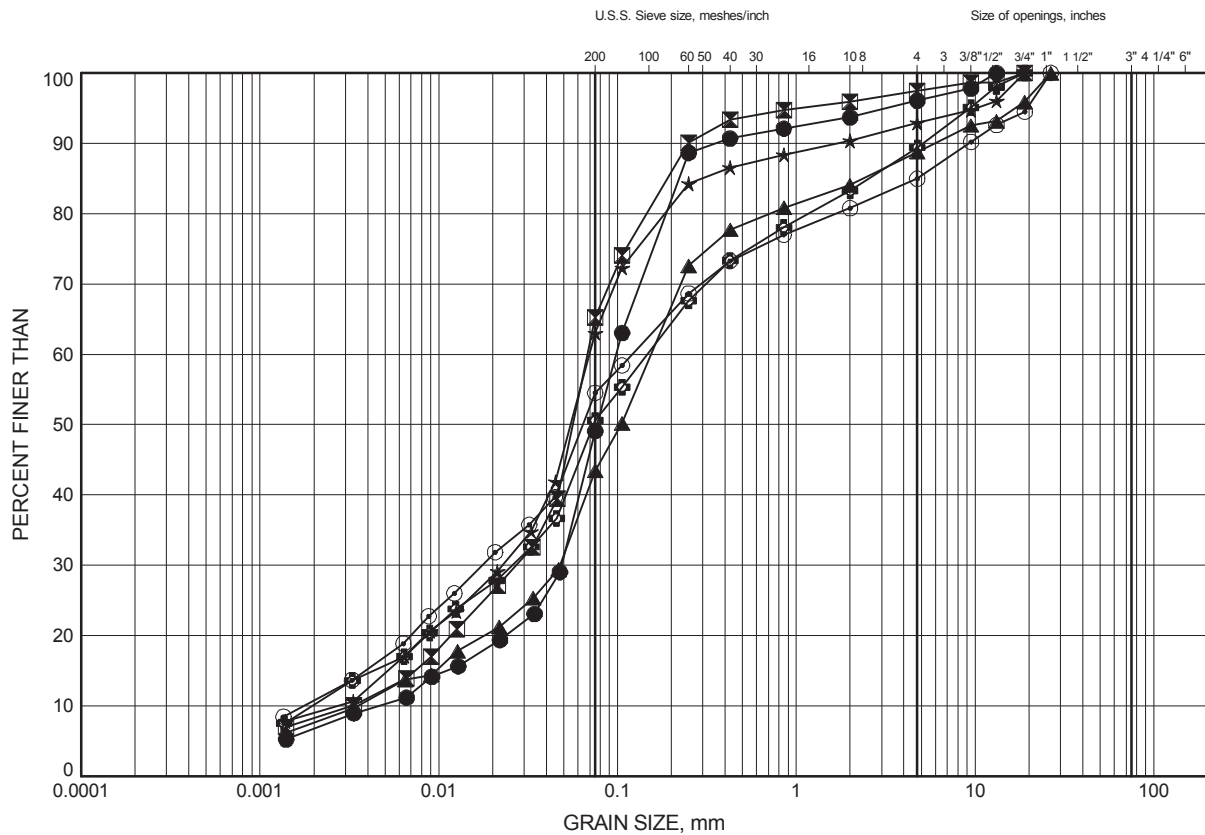
Prep'd KCP

Chkd. PC

Pitt Street
GRAIN SIZE DISTRIBUTION

FIGURE 7

Glacial TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-08	6.40	56.70
⊠	17-09	4.88	58.50
▲	17-09	6.40	56.98
★	17-10	4.88	58.61
⊙	17-11	6.40	61.64
⊕	17-14	5.64	62.76

Date July 2017

W.P. 4085-13-01 & 4383-01-01



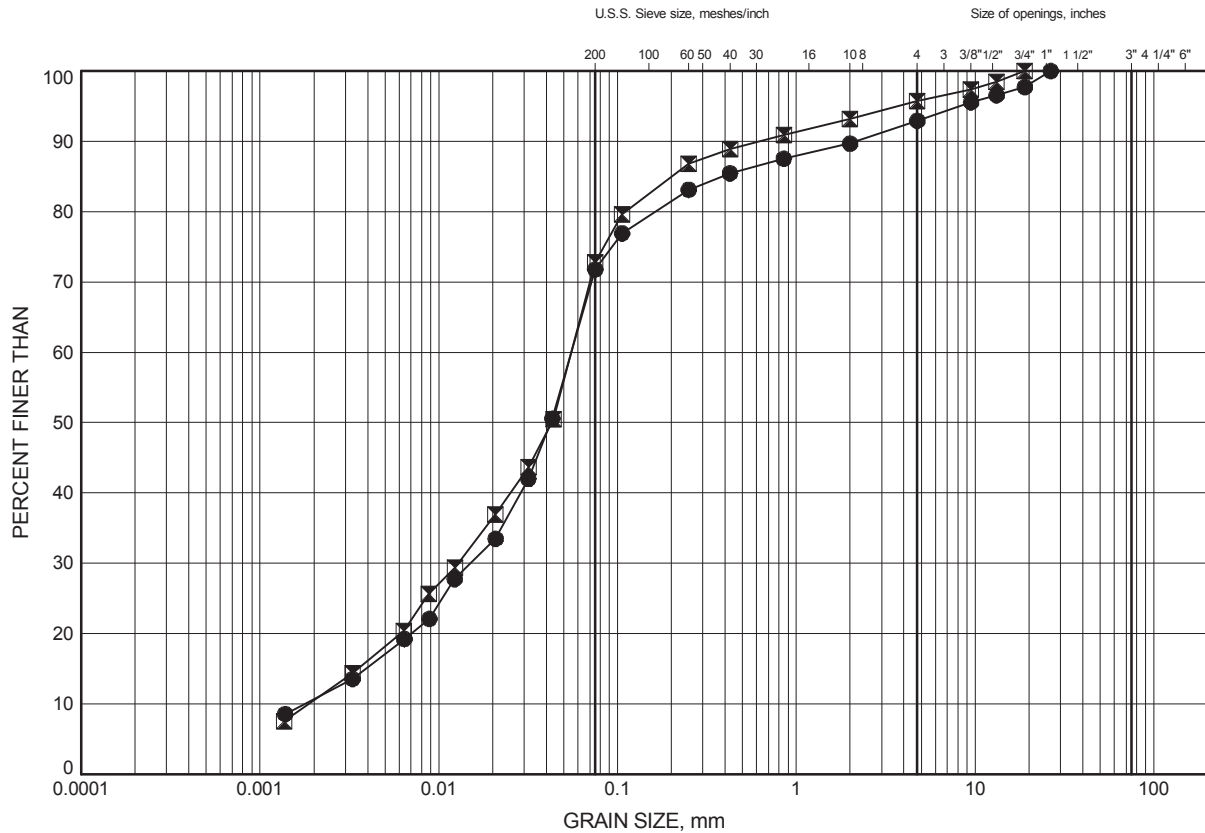
Prep'd KCP

Chkd. PC

Pitt Street GRAIN SIZE DISTRIBUTION

FIGURE 8

Glacial TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-04	4.04	58.85
⊠	17-05	4.88	59.12

Date July 2017

W.P. 4085-13-01 & 4383-01-01



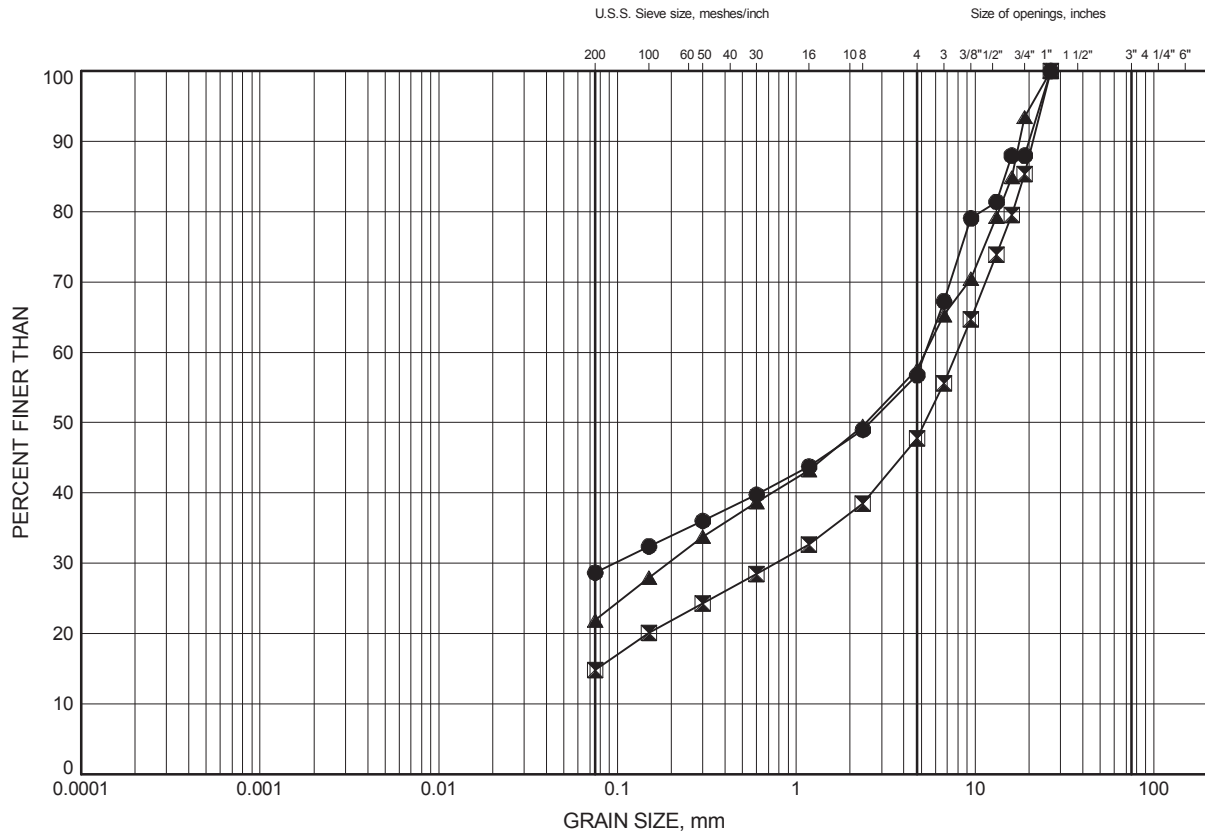
Prep'd KCP

Chkd. PC

Pitt Street
GRAIN SIZE DISTRIBUTION

FIGURE 9

Glacial TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-02	12.38	51.32
⊠	17-06	10.83	53.37
▲	17-11	4.11	63.93

Date July 2017

W.P. 4085-13-01 & 4383-01-01



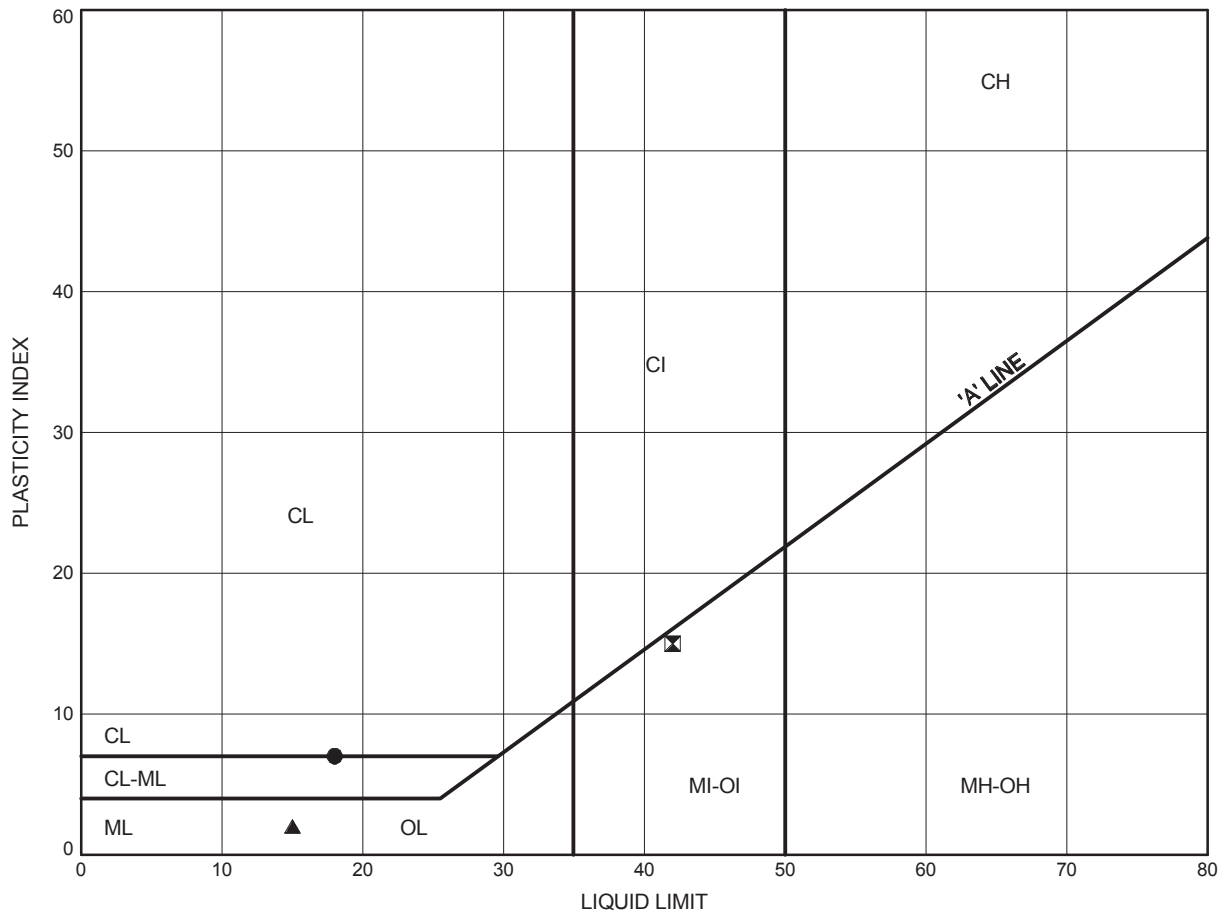
Prep'd KCP

Chkd. PC

Pitt Street

ATTERBERG LIMITS TEST RESULTS

FIGURE 10



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-01	12.29	50.45
⊠	17-11	5.11	62.94
▲	17-12	5.61	63.25

Date July 2017

W.P. 4085-13-01 & 4383-01-01



Prep'd KCP

Chkd. PC

Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Unit 107
Ottawa, ON K1B4S5
Attn: Kenton Power

Client PO:

Project: 19-5161-263 Task 20

Custody: 27361

Report Date: 5-Jun-2017

Order Date: 30-May-2017

Order #: 1722248

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID

1722248-01

1722248-02

1722248-03

1722248-04

Client ID

BH17-4 SS3 5'-7'

BH17-4 SS7 15'-17'

BH17-2 SS3 5'-7'

BH17-2 SS5 10'-12'

Approved By:



Dale Robertson, BSc
Laboratory Director

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 05-Jun-2017

Order Date: 30-May-2017

Project Description: 19-5161-263 Task 20

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	2-Jun-17	2-Jun-17
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	3-Jun-17	3-Jun-17
Resistivity	EPA 120.1 - probe, water extraction	5-Jun-17	5-Jun-17
Solids, %	Gravimetric, calculation	5-Jun-17	5-Jun-17

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 05-Jun-2017

Order Date: 30-May-2017

Project Description: 19-5161-263 Task 20

Client ID:	BH17-4 SS3 5'-7'	BH17-4 SS7 15'-17'	BH17-2 SS3 5'-7'	BH17-2 SS5 10'-12'
Sample Date:	08-May-17	08-May-17	11-May-17	11-May-17
Sample ID:	1722248-01	1722248-02	1722248-03	1722248-04
MDL/Units	Soil	Soil	Soil	Soil

Physical Characteristics

% Solids	0.1 % by Wt.	92.9	92.5	92.1	89.5
----------	--------------	------	------	------	------

General Inorganics

pH	0.05 pH Units	7.90	7.93	7.95	7.91
Resistivity	0.10 Ohm.m	11.1	24.7	30.4	19.8

Anions

Chloride	5 ug/g dry	293	36	85	160
Sulphate	5 ug/g dry	306	236	58	133

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 05-Jun-2017

Order Date: 30-May-2017

Project Description: 19-5161-263 Task 20

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	5	ug/g						
Sulphate	ND	5	ug/g						
General Inorganics									
Resistivity	ND	0.10	Ohm.m						

Certificate of Analysis
 Client: **Thurber Engineering Ltd.**
 Client PO:

Report Date: 05-Jun-2017
 Order Date: 30-May-2017
 Project Description: **19-5161-263 Task 20**

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	349	5	ug/g dry	335			4.0	20	
Sulphate	58.8	5	ug/g dry	59.9			1.8	20	
General Inorganics									
pH	7.78	0.05	pH Units	7.75			0.4	10	
Resistivity	8.39	0.10	Ohm.m	8.73			4.0	20	
Physical Characteristics									
% Solids	92.1	0.1	% by Wt.	89.2			3.2	25	

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 05-Jun-2017

Order Date: 30-May-2017

Project Description: 19-5161-263 Task 20

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	430	5	ug/g	335	94.8	78-113			
Sulphate	164	5	ug/g	59.9	104	78-111			

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 05-Jun-2017
Order Date: 30-May-2017
Project Description: 19-5161-263 Task 20

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

APPENDIX E
SITE PHOTOGRAPHS

DRAFT



Figure 1: Pitt Street looking south towards eastbound structure



Figure 2: Looking west toward southwest embankment slope



Figure 3: Looking west at existing slope paving between bridges



Figure 4: Looking West along westbound noise barrier wall location

APPENDIX F

COMPARISON OF FOUNDATION ALTERNATIVES

DRAFT

Comparison of Foundation Alternatives

Comment	Steel Pipe Piles	Steel H-Piles	Caissons	Spread Footings
Advantages:	High geotechnical resistance	High geotechnical resistance	Provide high axial and lateral resistance compared to steel piles	Quicker installation and lower costs than deep foundations
Disadvantages:	Potential for encountering obstructions in the till. Risk is greater than for H-piles	Potential for encountering obstructions in the till.	Liners required to keep holes open Greater dewatering requirements than for driven piles or spread footings	Provide a lower geotechnical resistance than deep foundations
Risks / Consequences	Difficulty advancing in till/ possible damage to piles / include contingency to pre-auger prior to driving piles	Difficulty advancing in till/ possible damage to piles / include contingency to pre-auger prior to driving piles	Difficulty advancing through obstructions in the till	
Relative Cost	Moderate	Moderate	High	Low
	Feasible	Feasible	Feasible	RECOMMENDED

APPENDIX G

GSC SEISMIC HAZARD CALCULATION SLOPE STABILITY ANALYSIS RESULTS GEOTECHNICAL DESIGN PARAMETERS FOR NOISE BARRIER WALLS

DRAFT

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

June 06, 2017

Site: 45.0518 N, 74.7554 W User File Reference: Pitt St Cornwall

Requested by: , Thurber Engineering Ltd.

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	Sa(0.2)	Sa(0.3)	Sa(0.5)	Sa(1.0)	Sa(2.0)	Sa(5.0)	Sa(10.0)	PGA (g)	PGV (m/s)
0.626	0.715	0.588	0.441	0.307	0.146	0.067	0.017	0.0059	0.375	0.253

Notes. Spectral ($S_a(T)$, where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s . Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. *These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.*

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.055	0.205	0.347
Sa(0.1)	0.074	0.250	0.410
Sa(0.2)	0.065	0.210	0.340
Sa(0.3)	0.050	0.158	0.255
Sa(0.5)	0.035	0.109	0.176
Sa(1.0)	0.017	0.052	0.084
Sa(2.0)	0.0068	0.023	0.038
Sa(5.0)	0.0014	0.0053	0.0093
Sa(10.0)	0.0006	0.0020	0.0034
PGA	0.039	0.135	0.219
PGV	0.024	0.083	0.140

References

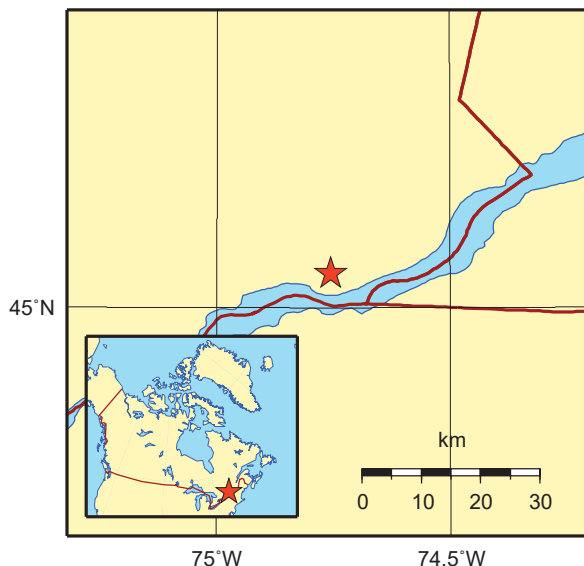
National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

Aussi disponible en français



Natural Resources
Canada

Ressources naturelles
Canada

Canada

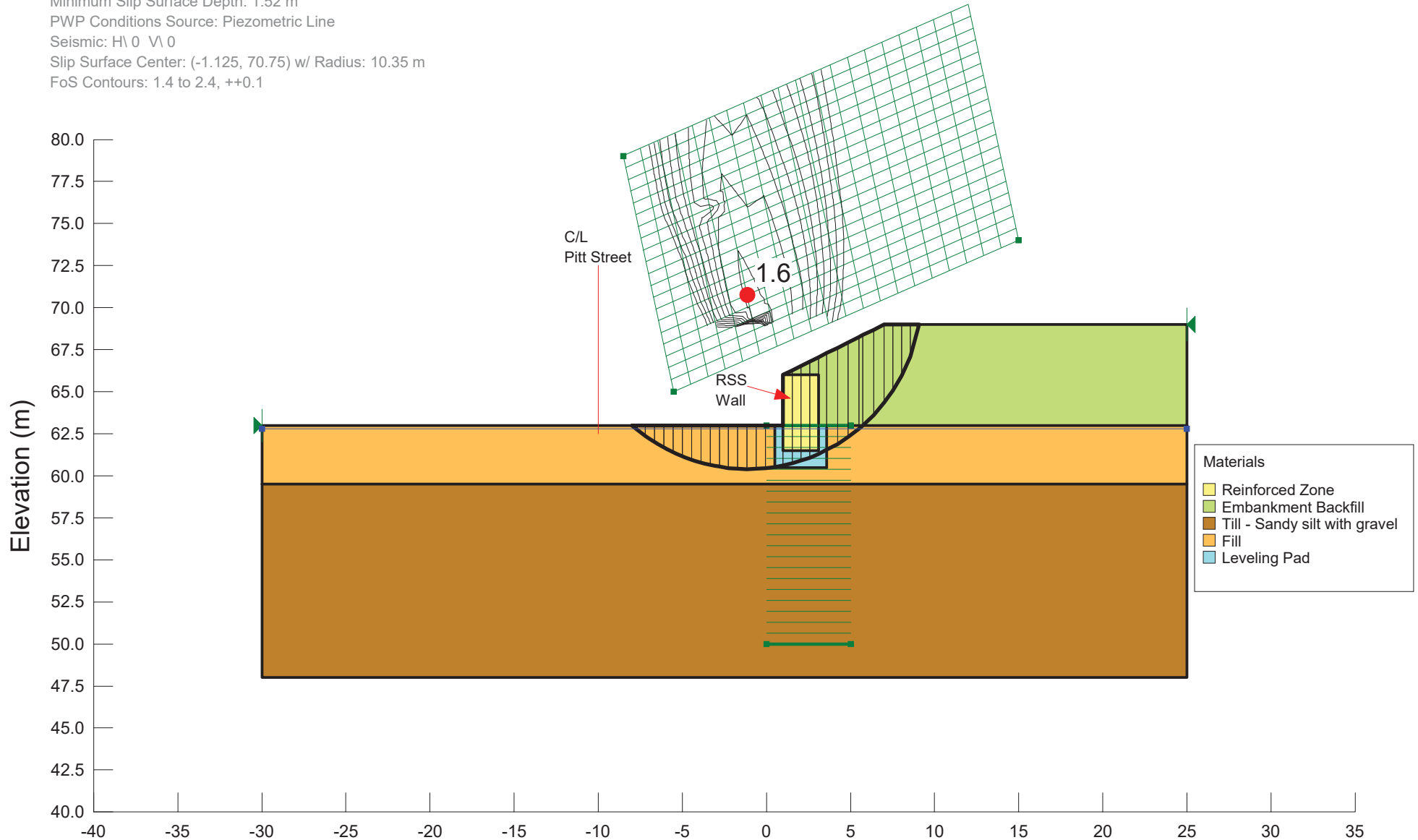
Title: Highway 401 Overpass at Pitt Street

Comments: RSS System Stability Assessment

Name: Static Conditions

Method: Morgenstern-Price, Half-Sine
 Minimum Slip Surface Depth: 1.52 m
 PWP Conditions Source: Piezometric Line
 Seismic: H\ 0 V\ 0
 Slip Surface Center: (-1.125, 70.75) w/ Radius: 10.35 m
 FoS Contours: 1.4 to 2.4, ++0.1

Reinforced Zone	22 kN/m ³	250 kPa	0 °
Embankment Backfill	20 kN/m ³	0 kPa	30 °
Till - Sandy silt with gravel	21 kN/m ³	0 kPa	37 °
Fill	20 kN/m ³	0 kPa	30 °
Leveling Pad	21 kN/m ³	0 kPa	35 °



Reviewed By: _____
 Tool Version: 8.15.5.11777
 Last Solved Date: 7/19/2017, 11:52:57 AM
 Directory: \\192.168.104.30\Project Data\Projects\19\5161\263 - ER Mega 5\Bridges\Site 31-211_1&2-Pitt St Overpass\Foundations\Analysis\SlopeW\Pitt St RSS wall.gsz

Figure 1

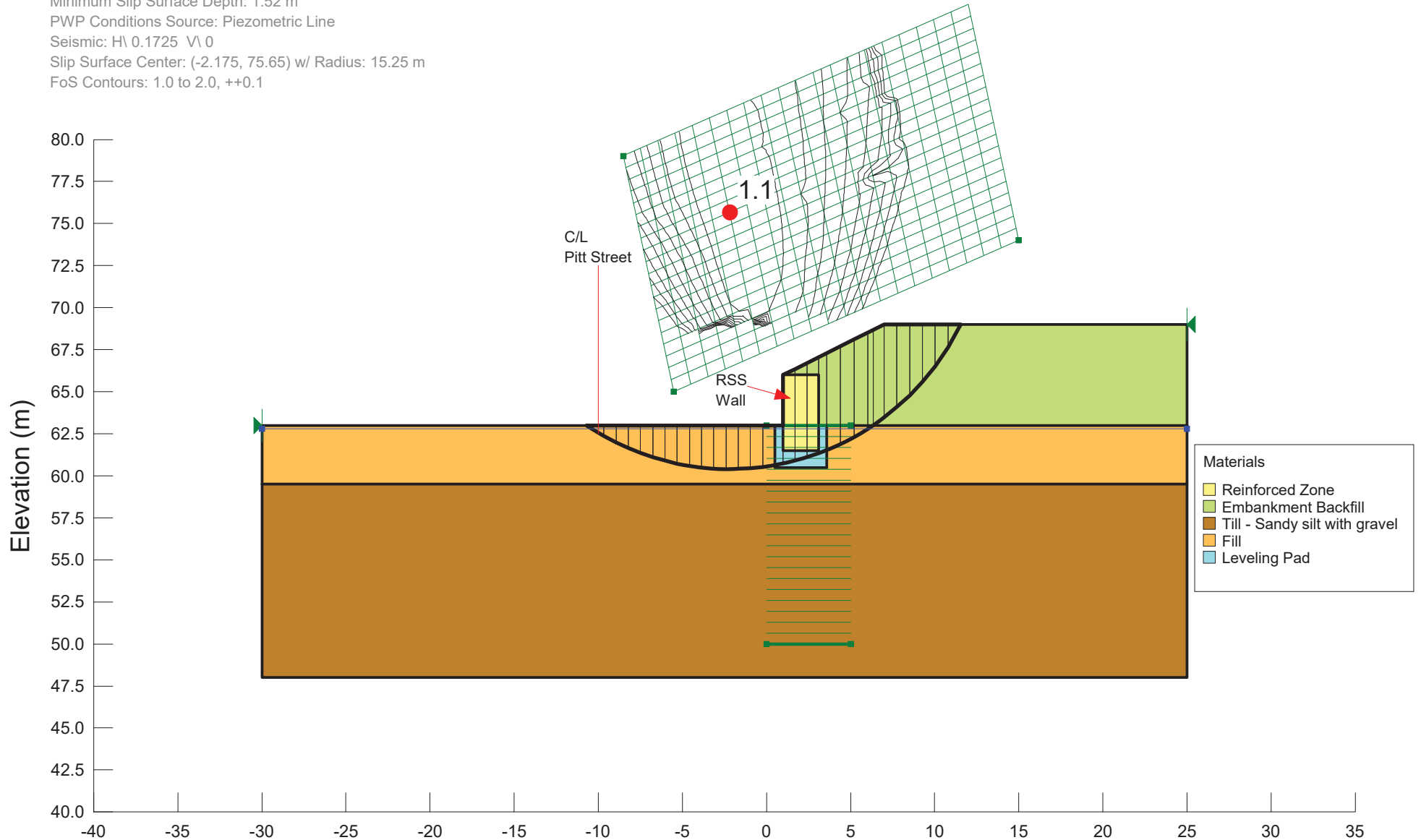
Title: Highway 401 Overpass at Pitt Street

Comments: RSS System Stability Assessment

Name: Seismic Conditions

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
PWP Conditions Source: Piezometric Line
Seismic: H\ 0.1725 V\ 0
Slip Surface Center: (-2.175, 75.65) w/ Radius: 15.25 m
FoS Contours: 1.0 to 2.0, ++0.1

Reinforced Zone	22 kN/m ³	250 kPa	0 °
Embankment Backfill	20 kN/m ³	0 kPa	30 °
Till - Sandy silt with gravel	21 kN/m ³	0 kPa	37 °
Fill	20 kN/m ³	0 kPa	30 °
Leveling Pad	21 kN/m ³	0 kPa	35 °



Reviewed By: _____
Tool Version: 8.15.5.11777
Last Solved Date: 7/19/2017, 11:53:08 AM
Directory: \\192.168.104.30\Project Data\Projects\19\5161\263 - ER Mega 5\Bridges\Site 31-211_1&2-Pitt St Overpass\Foundations\Analysis\SlopeW\Pitt St RSS wall.gsz

Figure 1

Table 1: Geotechnical Design Parameters for Noise Barrier Walls

Wall Segment	Borehole	Simplified Subsurface Stratigraphy for Design	Elevation (m)	Geotechnical Design Parameters				
				ϕ'	γ_t (kN/m ³)	γ' (kN/m ³)	K _p	Groundwater Elevation (m)
The ultimate lateral passive resistance in front of the caisson within the upper 1.7 m below final grade should be neglected in the foundation design.								
EBL 23+150 to 23+200	17-13	Embankment Fill Sandy Silt Till	68.4 to 63.9 63.9 to 62.2	30° 37°	20 21	10 11	3.0 4.0	62.8
EBL 23+225 to 23+275	17-14	Embankment Fill Sandy Silt Till	68.4 to 64.1 64.1 to 61.7	30° 37°	20 21	10 11	3.0 4.0	64.1
WBL 23+140 to 23+190	17-11	Embankment Fill Sandy Silt Till	68.0 to 62.8 62.8 to 61.3	30° 37°	20 21	10 11	3.0 4.0	62.8
WBL 23+210 to 23+260	17-12	Embankment Fill Sandy Silt Till	68.9 to 64.6 64.6 to 62.5	30° 37°	20 21	10 11	3.0 4.0	64.5

APPENDIX H

LIST OF REFERENCED SPECIFICATIONS NON-STANDARD SPECIAL PROVISIONS

LIST OF REFERENCED SPECIFICATIONS

OPSD 3090.101	Foundation, Frost Penetration Depths for Southern Ontario
OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS.PROV 804	Construction Specification for Seed and Cover
OPSS 805	Construction Specification for Temporary Erosion and Sediment Control Measures
OPSS 902	Construction Specification for Excavating and Backfilling-Structures
OPSS.PROV 1010	Material Specification for Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

NSSP – 902.07.05 EXCAVATION

Subsection 902.07.05 of OPSS 902 is amended by the addition of the following:

Excavations at the site may be impeded by obstructions within the existing fill and glacial till. The contractor shall be prepared to dislodge and remove these obstructions and extend the excavations to the design depths.

Reference can be made to the Foundation Investigation Report for the Replacement of the Highway 401 Overpasses at Pitt Street, prepared by Thurber Engineering Ltd., 2017, for further details on likely subsurface conditions at the foundation locations.