THURBER ENGINEERING LTD.

FOUNDATION INVESTIGATION REPORT
TRENCHLESS UTILITY CROSSING OF HIGHWAY 401 EBL AND WBL
AT PITT STREET, CORNWALL, ON
GWP. 4003-14-00
AGREEMENT NUMBER: 4014-E-0014

GEOCRES NUMBER: 31G-264

SUBMITTED TO

WSP CANADA

LOCATION:

LATITUDE: 45.05184°
LONGITUDE: -74.75500°

APRIL 2018
19-5161-263

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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 trenchless utility crossing of Highway 401 immediately east of the Pitt Street overpass structures, 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.

Utility 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

The Highway 401 overpass structures of Pitt Street (Sites 31-211/1 and 31-211/2) are located approximately 1.4 km east of the Brookdale Avenue (Highway 138) / Highway 401 Interchange in Cornwall, Ontario. The location of the structures and the area of the proposed utility alignment are shown on the inset Key Plan on Drawing No. 1 in Appendix A.

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.

Based on the utility drawings provided, the proposed utility crossing is to be located approximately 30 m east of the centreline of Pitt Street, beyond the existing east abutments for the Highway 401 / Pitt Street overpass structures. The alignment is shown as parallel to Pitt Street (north-south).

At the proposed crossing, Highway 401 is supported on highway fill embankments. The eastbound and westbound lanes are separated by a grassy median ditch. There are steel beam guide rails present along the median and concrete barriers/noise walls on the outside lanes of the highway in both directions.

The existing approach embankments are up to approximately 6.0 m high with side slopes at approximately 2H:1V. The embankment slopes are vegetated with long grasses, and occasional shrubs. The areas beyond the existing embankment footprint at the location of the entry/exit pits and construction staging areas are generally flat and grass covered. There are buried utilities that run parallel to Highway 401 along the MTO right-of-way both north and south, in the general area of the proposed site works.

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.

Storm water drainage in the area is to existing catchbasins and storm sewers.

Site photographs showing the general conditions at the site are presented in Appendix E.

3 SITE INVESTIGATION

3.1 Previous Investigations

Existing Bridge Investigation

A GEOCRES report is available for this bridge site (Report 31G00-128, 1955). This investigation was carried out for the design and construction of the current Pitt Street overpass structures 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 stoney till material and bedrock was not encountered during the 1955 geotechnical investigation.

2017 Detailed Design Investigation for Bridge Replacement

A foundation investigation was carried out as part of the detailed design assignment for the replacement of the existing overpass structures. During this investigation Boreholes 17-12 and 17-14 were advanced approximately 30 m east of the centerline of Pitt Street in the vicinity of the proposed crossing location for the design of new noise barrier walls. The approximate location of Boreholes 17-12 and 17-14 are illustrated on Drawing No. 1 in Appendix A, and copies of the Record of Boreholes are provided in Appendix B.

It should be noted that Boreholes 17-12 and 17-14 do not meet the MTO design criteria requirement for trenchless crossings that all boreholes be advanced a minimum depth of three times the pipe diameter below the proposed pipe invert elevation and further investigation was warranted.

The soil stratigraphy encountered in Boreholes 17-12 and 17-14 is generally characterized as very loose to very dense embankment fill overlying compact to very dense glacial till. Frequent cobbles and boulders were noted in both the fill and till materials.

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 three boreholes between December 13 and December 19, 2017. The approximate locations and elevations of the boreholes from the current investigation and for Boreholes 17-12 and 17-14 from the adjacent bridge investigation 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)
17-101	Exit pit	45.05153	-74.75477	65.0	6.7
17-102	Highway 401 median	45.05184	-74.75500	68.6	9.8
17-103	Entry pit	45.05218	-74.75526	65.0	6.7
17-12	WBL East noise wall	45.05199	-74.75512	68.9	6.4
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 a CME track mounted drill rig equipped with hollow stem augers and NW casing equipment. 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.

Vibrating wire piezometers were installed, in Boreholes 17-101 through 17-103 to allow for measurement of the groundwater level at the site. The vibrating wire piezometer construction details are detailed on the Record of Borehole sheets provided in Appendix B.

The as-drilled locations of the boreholes and ground surface elevations at the borehole locations were surveyed by WSP relative to the geodetic benchmark (GBM) identified on the plans provided by WSP, located on the 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 and Atterberg Limits testing were carried out on selected samples to MTO and ASTM standards.

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

Chemical analysis for determination of pH, resistivity, soluble sulphate and chloride concentrations was carried out on three soil samples. Samples were selected to coincide with the proposed invert elevation of the utility crossing. A copy of the chemical analysis results is provided 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. Stratigraphic profiles for the site are presented on Drawing No 1 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 characterized by granular fill overlying glacial till, both containing occasional to frequent cobbles and boulders. This stratigraphy is generally consistent with the stratigraphy encountered in the previous investigations.

More detailed descriptions of the individual strata are presented below.

4.2 Topsoil

A layer of topsoil was encountered at the ground surface in Boreholes 17-12 and 17-14. The thickness of this layer ranged from 50 mm to 60 mm at the borehole locations.

4.3 Fill – Silty Clayey Sand to Silty Gravel with Sand

In all boreholes, embankment fill consisting predominantly of brown to grey silty clayey sand to silty gravel with sand was encountered at surface or below any surficial layers. Occasional cobbles and boulders were noted in all boreholes. Trace organics was noted in the fill near the ground surface. The elevation of the top of this layer was Elevation 65.0 m (entry/exit boreholes) and 68.6 m (median borehole). The thickness of this layer ranges from 1.5 m to 4.7 m in Borehole 17-102. The SPT ‘N’ values ranged from 2 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 9% to 38%. The results of grain size analysis completed on samples of this material indicated a gravel content of 11% to 41%, sand content of 36% to 42%, and fines content (combined silt and clay size particles) of 21% to 49%. The results of the grain size analysis are illustrated on Figure 1 in Appendix D.

The results of Atterberg Limits testing completed on samples of the fines of this material indicated a plastic limit of 18 and 21, a liquid limit of 13, and a plasticity index of 5 and 8, indicating a fines ranging from low plastic to non-plastic. Atterberg Limits analysis results are illustrated on Figure 2 in Appendix D.

4.4 Glacial Till – Sandy Silt (ML) some Gravel to Silty Sand (SM) with Gravel

A stratum of glacial till consisting predominantly of sand and silt with varying amounts of gravel was encountered beneath the fill materials in all boreholes. The top of this layer ranges from Elevation 63.1 m to 64.6 m. All boreholes were terminated within this layer at elevations ranging from Elevation 58.3 m to 58.8 m in the Boreholes 17-101 through 17-103 and 62.5 m to 61.7 m in Boreholes 17-12 and 17-14.

Cobbles and boulders were encountered in the till layer and coring techniques were required to advance the boreholes through the cobbles and boulders at some locations.

The SPT 'N' values ranged from 21 to greater than 100 indicating a compact to very dense condition.

The moisture contents of the samples tested ranged from 9% to 13%. The results of grain size analysis completed on samples of this material indicated a gravel content ranging from 10% to 31%, sand content of 28% to 40%, a silt content ranging 32% to 41% and a clay content ranging from 7% to 10%. The results of the grain size analysis testing are illustrated on Figure 3 in Appendix D.

Based on the results of Atterberg Limits testing the fines content is generally classified as non-plastic silt (ML). The Atterberg Limit results are illustrated on Figure 4 in Appendix C.

4.5 Groundwater Conditions

The groundwater levels were measured at the vibrating wire piezometers installed in Boreholes 17-101 through 17-103 on February 8, 2018 and again on March 6, 2018.

Table 4-1 summarizes the measured water level readings.

Table 4-1: Groundwater Summary

Borehole	Ground Surface Elevation (m)	February 6, 2018		March 6, 2018	
		Depth to Water Level (m)	Water Level Elevation (m)	Depth to Water Level (m)	Water Level Elevation (m)
17-101	65.0	4.6	60.4	4.9	60.1
17-102	68.6	3.7	64.9	3.9	64.7
17-103	65.0	4.2	60.8	4.3	60.7

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. The topography and presence of the median ditch may also create localized variation in the groundwater level.

4.6 Analytic Test Results

Three 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 buried infrastructure. The analysis results are summarized in the Table 4-2. A copy of the test results is provided in Appendix D.

Table 4-2: Results of Chemical Analysis

Borehole	Sample	Depth (m)	Elevation (m)	pH	Resistivity (Ohm-cm)	Chloride (µg/g)	Sulphate (µg/g)
17-101	SS3	1.8	63.2	7.9	3260	99	29
17-102	SS8	5.6	63.0	7.9	3590	74	19
17-103	SS4	2.6	62.4	8.8	6000	18	86

5 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. WSP surveyed the borehole locations, and determined the ground surface elevations at the borehole locations. George Downing Estate Drilling Ltd. and Forage M3 Drilling Services Inc. both of Hawkesbury, Ontario supplied and operated the drilling equipment to carry out the drilling, sampling, and in-situ testing. Traffic control services were provided by Beacon Lite of Ottawa, Ontario. The drilling, and sampling operations in the field were supervised on a full-time basis by Justin Gray or Nick Weil 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 Kenton Power, P.Eng. The report was reviewed by Paul Carnaffan, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Kenton C. Power, P.Eng.
Geotechnical Engineer

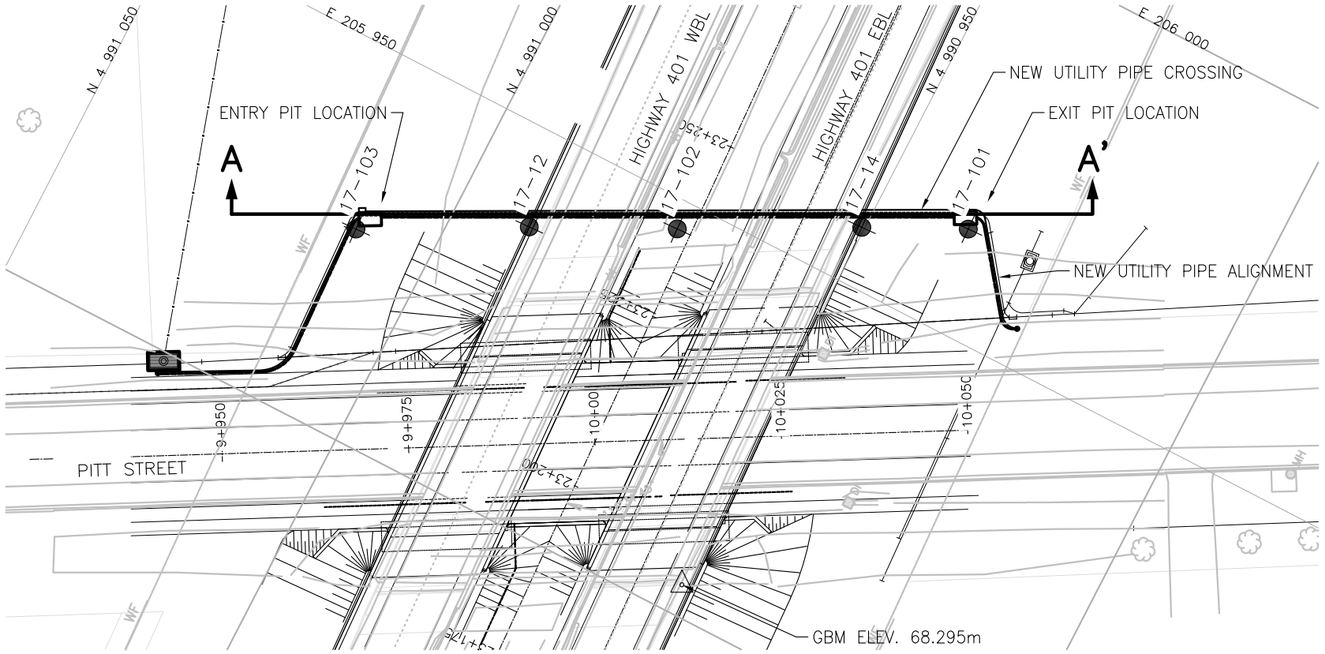
Paul Carnaffan, P.Eng.
Principal, Senior Geotechnical Engineer

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

APPENDIX A

BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS – 2017 INVESTIGATION

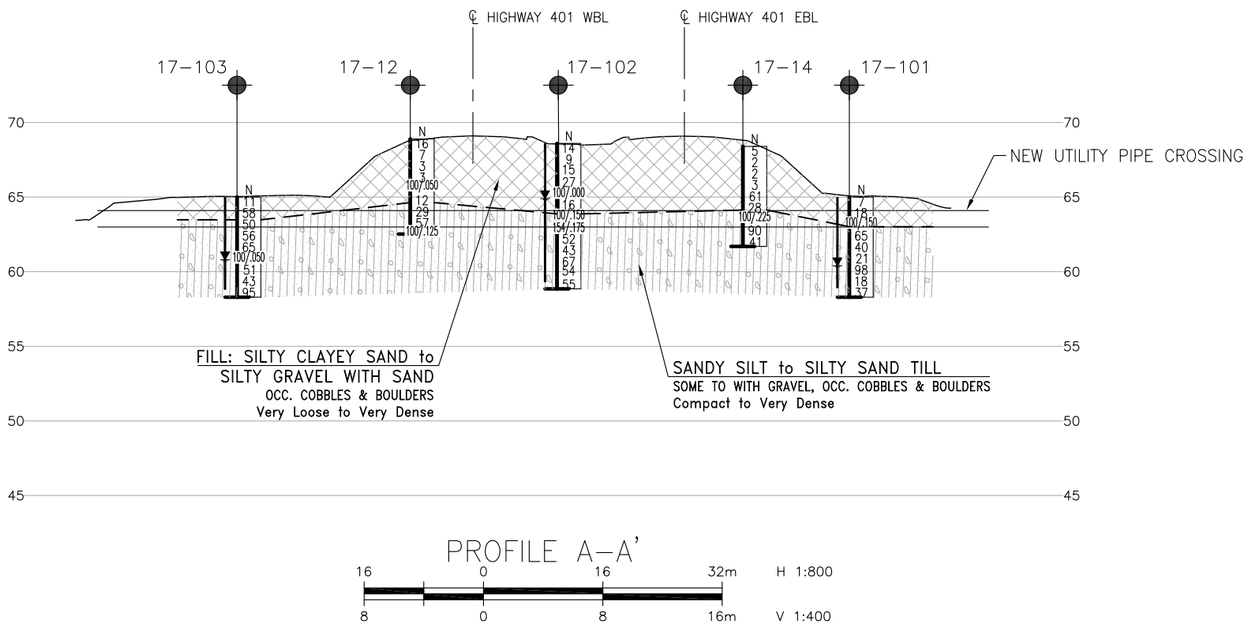
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

16 0 16 32m

SCALE 1:800



PROFILE A–A'

16 0 16 32m H 1:800

8 0 8 16m V 1:400

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
K. T. C. POWER
100130652
2018/04/03
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
April 3/18
PROVINCE OF ONTARIO

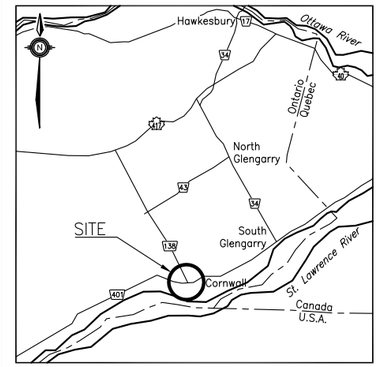
CONT No 2018-4007
GWP No 4003-14-01

HIGHWAY 401
TRENCHLESS UTILITY INSTALLATION
AT PITT STREET
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 73-2

WSP

THURBER ENGINEERING LTD.



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
▮	Vibrating Wire Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
17-101	65.0	4 990 937.6	205 964.1
17-102	68.6	4 990 972.3	205 946.2
17-103	65.0	4 991 010.6	205 926.4
17-12	68.9	4 990 990.0	205 937.3
17-14	68.4	4 990 950.4	205 957.7

-NOTES-

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

GEOCRES No. 31G-264

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	JG	CHK	KP	CODE	LOAD	DATE	APR 2018
DRAWN	MFA	CHK	JG	SITE	STRUCT	DWG	1

FILENAME: H:\Drafting\19\5161\263\ted1263-PittStreetTrenchless.dwg
PLOTDATE: 4/3/2018 9:54 AM

APPENDIX B

SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS
RECORD OF BOREHOLE SHEETS – 2017 INVESTIGATIONS

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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.

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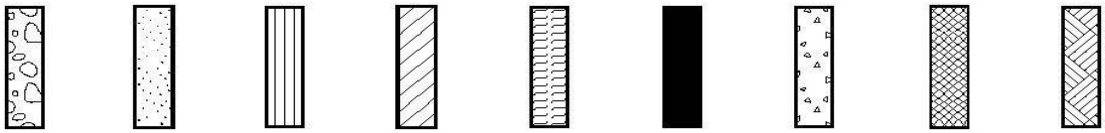
STRATA PLOT:
Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



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

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.

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 (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

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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

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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

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No 17-101 1 OF 1 METRIC

GWP# 4003-14-00 LOCATION Trenchless Utility Crossing, MTM Zone 8: N 4 990 937.6 E 205 964.1 ORIGINATED BY NW

HWY 401 BOREHOLE TYPE NW Casing COMPILED BY KCP

DATUM Geodetic DATE 2017.12.13 - 2017.12.13 CHECKED BY PC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
65.0											
0.0	Silt with sand trace organics Loose Compact Brown		1	SS	7						
64.3	**FILL**						64				
0.8	Silty clayey sand with gravel - occasional cobbles Compact to very dense Brown **FILL**		2	SS	18						19 36 33 12
			3	SS	100/150mm						
63.1	- cobbles cored						63				
2.0	**SILTY SAND (SM) with gravel TILL** - occasional cobbles and boulders Compact to very dense Grey		4	SS	65						
	- cobbles cored		5	SS	40		62				
			6	SS	21		61				
			7	SS	98	▼	60				18 35 38 9
	- boulders cored		8	SS	18		59				
			9	SS	37						
58.3											
6.7	End of Borehole VWP installed with tip at 6.1 m BGS. Groundwater was measured at 4.6 m BGS (elev. 60.5 m) on February 8, 2018.										

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

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

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 2/4/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-102 1 OF 2 METRIC

GWP# 4003-14-00 LOCATION Trenchless Utility Crossing, MTM Zone 8: N 4 990 972.3 E 205 946.2 ORIGINATED BY NW

HWY 401 BOREHOLE TYPE NW Casing COMPILED BY KCP

DATUM Geodetic DATE 2017.12.14 - 2017.12.19 CHECKED BY PC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
68.6											
0.0	Silt with sand trace organics Loose to compact Brown **FILL**		1	SS	14		68		○		
67.8											
0.8	Silty clayey sand with gravel - occasional cobbles Loose to compact Brown **FILL**		2	SS	9						
	- cored 2 - 150 mm cobbles at 1.2 m		3	SS	15		67		⊢○		14 39 36 11
66.3											
2.3	Silty sand some gravel - occasional cobbles and boulders Loose to compact Brown **FILL**		4	SS	27		66		○		
	- cored 100 mm cobble at 2.7 m - cored 270 mm boulder at 3.0 m		5	SS	~~100/ 0mm~~						
	- cored 80 mm cobble at 3.4 m		6	SS	16	▼	65		○		11 40 36 13 Non-plastic
63.8	- cobbles cored		7	SS	100/ 150mm		64		○		
4.7	**SANDY SILT (ML) with gravel TILL** - occasional cobbles Compact to very dense Grey										
	- cored 2 - 120 mm cobbles at 5.6 m		8	SS	154/ 175mm		63		○		
			9	SS	52		62				
	- cored 60 mm cobble at 6.7 m		10	SS	43				○		17 35 38 10 Non-plastic
	- cored 170 mm cobble at 7.3 m		11	SS	67		61		○		
			12	SS	54		60		○		
58.8			13	SS	55		59		○		
9.8											

Continued Next Page

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

20
15 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-102 2 OF 2 METRIC

GWP# 4003-14-00 LOCATION Trenchless Utility Crossing, MTM Zone 8: N 4 990 972.3 E 205 946.2 ORIGINATED BY NW

HWY 401 BOREHOLE TYPE NW Casing COMPILED BY KCP

DATUM Geodetic DATE 2017.12.14 - 2017.12.19 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	End of Borehole VWP installed with tip at 9.3 m BGS. Groundwater was measured at 3.7 m BGS (elev. 64.9 m) on February 8, 2018.										

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 2/4/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-103 1 OF 1 METRIC

GWP# 4003-14-00 LOCATION Trenchless Utility Crossing, MTM Zone 8: N 4 991 010.6 E 205 926.4 ORIGINATED BY NW

HWY 401 BOREHOLE TYPE NW Casing COMPILED BY KCP

DATUM Geodetic DATE 2017.12.15 - 2017.12.15 CHECKED BY PC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
65.0											
0.0	Silt with sand trace organics - occasional cobbles Compact to very dense Brown **FILL**		1	SS	11						
	- cobbles cored		2	SS	110/ 250mm		64		○		
63.5											
1.5	**SILTY SAND (SM) with gravel TILL** - occasional cobbles and boulders Dense to very dense Brown		3	SS	50		63		○		31 30 32 7 Non-plastic
			4	SS	56				○		
			5	SS	65		62				
			6	SS	100/ 50mm		61				
	- cored 200 mm boulder at 4.0 m										
	- cored 2 - 80 mm cobbles at 4.4 m		7	SS	51		60		○		23 28 41 8 Non-plastic
			8	SS	43				○		
			9	SS	95		59		○		
58.3											
6.7	End of Borehole VWP installed with tip at 6.2 m BGS. Groundwater was measured at 4.2 m BGS (elev. 60.8 m) on February 8, 2018.										

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

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

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 2/4/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-12 1 OF 1 METRIC

GWP# 4003-14-00 LOCATION Pitt Street, MTM Zone 8: 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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
68.9											
0.0 / 0.1	**50mm Topsoil**										
	Silty sand with gravel, to silty gravel with sand - Occasional cobbles Very loose to very dense Brown **FILL**		1	SS	16				○		41 38 21 (SI+CL)
			2	SS	7		68		○		
			3	SS	3		67		○		
			4	SS	3				○		
			5	SS	100/50mm		66		○		
	- cored 220 mm Boulder at 3.3 m										
	- cored 130 mm Cobble at 3.7 m						65				
64.6			6	SS	12				○		
4.3	**Sandy SILT (ML) some gravel TILL** - Occasional cobbles and boulders Compact to very dense Grey		7	SS	29		64		○		
			8	SS	57		63		○H		10 40 40 10
62.5	- boulder		9	SS	100/125mm				○		
6.4	End of Borehole										

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 2/4/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-14 1 OF 1 METRIC

GWP# 4003-14-00 LOCATION Pitt Street, MTM Zone 8: N 4 990 950.4 E 205 957.7 ORIGINATED BY JG

HWY 401 BOREHOLE TYPE NW Casing COMPILED BY CM

DATUM Geodetic DATE 2017.05.16 - 2016.05.16 CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
68.4											
0.0 / 0.1	**60mm Topsoil**										
	Silty sand with gravel, occasional cobbles Very loose to very dense Brown **FILL**		1	SS	5		68		○		
			2	SS	2				○		
			3	SS	2		67		○		18 42 40 (SI+CL)
			4	SS	3		66		○		
	- cobbles		5	SS	61		65		○		
64.1			6	SS	28				○		
4.3	**Sandy SILT (ML)** some gravel **TILL** - Occasional cobbles Dense to very dense Grey - cobbles		7	SS	100/ 225mm		64		○		
			8	SS	90		63		○		11 39 40 10 Non-plastic
			9	SS	41		62		○		
61.7											
6.7	End of Borehole										

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

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

ONTMT4S 31-211-1&2 PITT ST BH LOGS.GPJ 2012TEMPLATE(MTO).GDT 2/4/18

APPENDIX C

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

TL 129
54-90

MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG Core Drill #1
CASING BX (STANDARD SAMPLERS TO FIT UNLESS NOTED)
SAMPLER HAMMER WT 250 # DROP INCHES
JOB 55-F-13 Cornwall
DATUM Sta. 389+14 Ft. 50 at 116° 75'
COMPILED BY B.H. CHECKED BY
BORING Nº 1
DATE REPORT
BORING DATE May 27th & 28th 1955

SAMPLE CONDITION: DISTURBED, GOOD, LOST

SAMPLE TYPES: C.S - CHUNK; DO - DRIVE OPEN; DF - DRIVE FOOT VALVE; TO - THIN WALLED OPEN; WS - WASHED SAMPLE; RC - ROCK CORE

ABBREVIATIONS: V - INSITU VANE SHEAR TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Q_c - TRIAXIAL CONSOLIDATED QUICK; Q - TRIAXIAL QUICK; S - TRIAXIAL SLOW; γ - UNIT WEIGHT; K - PERMEABILITY; C - CONSOLIDATION; CA - CASING; WL - WATER LEVEL IN CASING; WT - WATER TABLE IN SOIL

SOIL PROFILE | SHEAR STRENGTH TONS/SQ.FT. or Qu/2 | WATER CONTENT W% (□ PW, △ LW) | SAMPLES

PENETRATION TEST RESISTANCE BLOWS PER FOOT: 50, 100, 150, 200

Std Energy = 4200 lb in

○ Std Penetration Test
Note: Large stones prevented the taking of a cone penetration test.

ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION
211.0		
209.0 / 2.0		Sandy Topsoil
206.5 / 4.5	V May 30th	
198.0 / 13.0		Sandy Till (very stony)
181.0 / 30.0		Sandy Till (slightly stony)
157.0 / 54.0		Sandy Till (very stony)

— Limit of Bx casing at 48.0
— Limit of Ax core barrel at 54.0

ELEVATION SCALE: 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60

SAMPLES (Penetration resistance: No. of blows at Std Energy = 4200 lb in; Elev. / % Recov., top 211.0)

OTHER TESTS	CONDITION	TYPE	Nº	PENETRATION RESISTANCE	ELEV. RECOV.
		R.C (BX)	1		201.0
	Disturbed	W.S	2		197.0 / 196.0
γ=145#/ft³	Disturbed	D.O.	3	64	55
	Disturbed	W.S	4		192.5 / 191.0
	Disturbed	D.O.	5	113	33
γ=136#/ft³	Disturbed	D.O	6	60	186.0 / 72
		D.O.	7	50-½"	181.0 / 0
	Disturbed	D.O	8	151	172.0 / 16
	Disturbed	RC	9		163.0 / 157.0

Broken Bx rock core from boulders in this section was recovered when the casing was pulled back & the contents dumped.

RC 9 Broken Ax rock core from boulders in this section.

TL 129
54-90

MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG Core Drill #4
CASING BX (STANDARD SAMPLERS TO FIT UNLESS NOTED)
SAMPLER HAMMER WT 250 # DROP — INCHES
JOB 55-F-13 Cornwall
DATUM Sta 389+14 Ft 50 at 63° 25'
COMPILED BY B.H. CHECKED BY
BORING Nº 2
DATE REPORT
BORING DATE May 31st June 1st 1955

SAMPLE CONDITION: DISTURBED, GOOD, LOST

SAMPLE TYPES: C.S - CHUNK; D.O - DRIVE OPEN; D.F - DRIVE FOOT VALVE; TO - THIN WALLED OPEN; WS - WASHED SAMPLE; RC - ROCK CORE

ABBREVIATIONS: V - INSITU VANE SHEAR TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Q_c - TRIAXIAL CONSOLIDATED QUICK; Q - TRIAXIAL QUICK; S - TRIAXIAL SLOW; γ - UNIT WEIGHT; K - PERMEABILITY; C - CONSOLIDATION; CA - CASING; WL - WATER LEVEL IN CASING; WT - WATER TABLE IN SOIL

SOIL PROFILE | SHEAR STRENGTH TONS/SQ.FT. or Qu/2 | WATER CONTENT W% (□ PW, △ LW) | SAMPLES

PENETRATION TEST RESISTANCE BLOWS PER FOOT: 50, 100, 150, 200

Std Energy = 4200 lb in

○ Standard Penetration Test

ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION
210.3		
192.3 / 18.0		Sandy Till (very stony)
179.3 / 31.0		Fine to very fine Sandy Till
171.8 / 38.5		Sandy Till (very stony)

End of Borehole at 38.5 ft El. 171.8

ELEVATION SCALE: 0, 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36, 39, 42, 45

SAMPLES (Std En 4200 lb in; Elev. / % Recov., top 210.3)

Note: The abundance of stones in this section prevented the taking of standard penetration tests & samples.

OTHER TESTS	CONDITION	TYPE	Nº	PENETRATION RESISTANCE	ELEV. RECOV.
γ=144lb/ft³	Disturbed	D.O.	1	54	190.3 / 44
γ=[illegible]	Disturbed	D.O	2	55	185.3 / 67
γ=150lb/ft³	Disturbed	D.O.	3	75 / 104 for last 3"	180.3 / 93
	Lost	D.O.	4	191	175.3 / Lost
	Lost	D.O.	5	164	172.3 / Lost

TL 129
54-90

MATERIALS LABORATORY-DEPARTMENT OF HIGHWAYS - ONTARIO

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG CORE DRILL #1
CASING BX (STANDARD SAMPLERS TO FIT UNLESS NOTED)
SAMPLER HAMMER WT 250 # DROP – INCHES

JOB 55-F-13 CORNWALL
DATUM STA 389+67 ℄
COMPILED BY G.A. CHECKED BY

BORING Nº 5
DATE REPORT
BORING DATE JUNE 8TH & 9TH 1955

SAMPLE CONDITION
- DISTURBED
- GOOD
- LOST

SAMPLE TYPES
- CS - CHUNK
- DO - DRIVE OPEN
- DF - DRIVE FOOT VALVE
- TO - THIN WALLED OPEN
- WS - WASHED SAMPLE
- RC - ROCK CORE

ABBREVIATIONS
- V - INSITU VANE SHEAR TEST
- M - MECHANICAL ANALYSIS
- U - UNCONFINED COMPRESSION
- Qc - TRIAXIAL CONSOLIDATED QUICK
- Q - TRIAXIAL QUICK
- S - TRIAXIAL SLOW
- γ - UNIT WEIGHT
- K - PERMEABILITY
- C - CONSOLIDATION
- CA - CASING
- WL - WATER LEVEL IN CASING
- WT - WATER TABLE IN SOIL

SOIL PROFILE

ELEVN DEPTH	WATER CONDITIONS	DESCRIPTION
210.7		
209.2 / 1.5		SANDY TOPSOIL
203.2 / 7.5	▽	FINE SANDY TILL (VERY STONY)
177.5 / 33.2		

SHEAR STRENGTH TONS/SQ.FT OR Qu/2

PENETRATION TEST RESISTANCE BLOWS PER FOOT 50 100 150 200

STD. ENERGY = 4200 lb IN / BLOW

○ STD. PENETRATION TEST

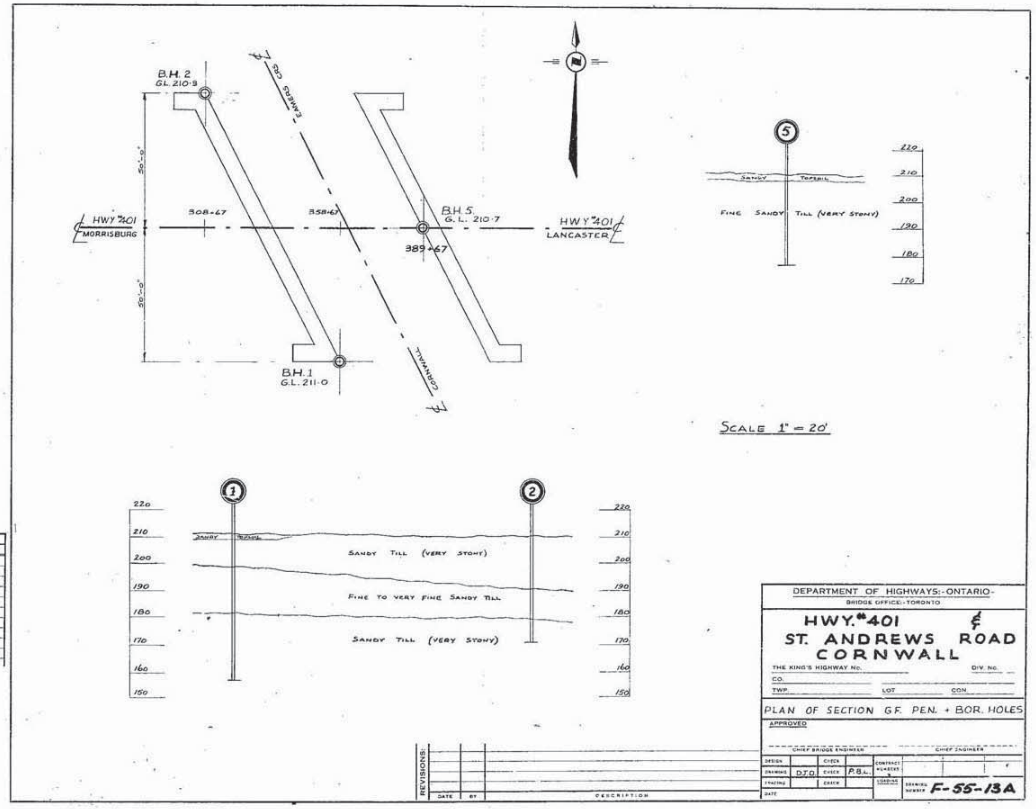
NOTE: THE TOPSOIL WAS TOO STONY TO DO A CONE PENETRATION TEST

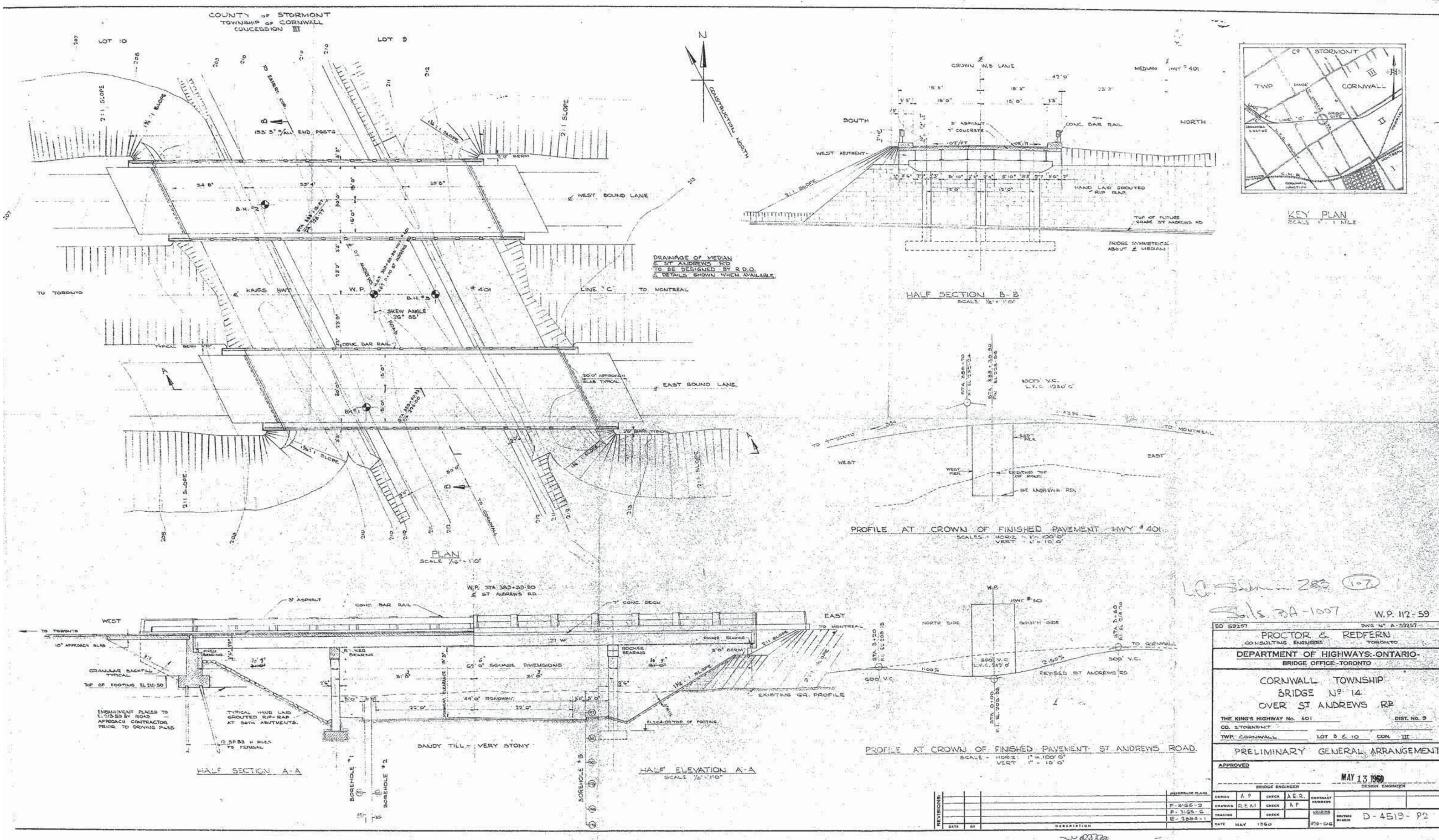
END OF BOREHOLE AT 33.2 FT. = EL. 177.5

WATER CONTENT W% □ PW. △ LW

SAMPLES

OTHER TESTS	CONDITION	TYPE	Nº	PENETRATION RESISTANCE	ELEV. RECOV.
				No of BLOWS/FT AT STD EN. = 4200 lb in.	210.7
γ=144#/ft³	☒	DO	1	89	206.2 / 56
γ=150#/ft³	☒	DO	2	37	200.7 / 56
	☒	DO	3	94	195.7 / 17
γ=150#/ft³	☒	DO	4	175	190.7 / 100
	☒	DO	5	168	185.7 / 83
	■	DO	6	194	180.7 / LOST





COUNTY OF STORMONT
TOWNSHIP OF CORNWALL
CONCESSION III
LOT 10
LOT 9
2:1 SLOPE
1½:1 SLOPE
WEST BOUND LANE
EAST BOUND LANE
TO TORONTO
KINGS HWY
W.P.
#401
LINE "C"
TO MONTREAL
SKEW ANGLE
CONC. BAR RAIL
TYPICAL BERM
20'0" APPROACH SLAB TYPICAL
CONSTRUCTION NORTH
DRAINAGE OF MEDIAN
& ST ANDREWS RD
TO BE DESIGNED BY R.D.O.
& DETAILS SHOWN WHEN AVAILABLE
TO CORNWALL
PLAN
CROWN W.B LANE
MEDIAN
HWY # 401
SOUTH
NORTH
3" ASPHALT
7" CONCRETE
CONC. BAR RAIL
WEST ABUTMENT
HAND LAID GROUTED RIP RAP
TOP OF FUTURE GRADE ST ANDREWS RD
BRIDGE SYMMETRICAL ABOUT ℄ MEDIAN
HALF SECTION B-B
KEY PLAN
TWP
CORNWALL
C° STORMONT
WEST
EAST
TO MONTREAL
ST ANDREWS RD
PROFILE AT CROWN OF FINISHED PAVEMENT HWY #401
W.P. STA 380+30.80
℄ ST ANDREWS RD.
3" ASPHALT
CONC. BAR RAIL
7" CONC. DECK
TO TORONTO
10" APPROACH SLAB
GRANULAR BACKFILL TYPICAL
TOP OF FOOTING
EMBANKMENT PLACED TO EL BY ROAD APPROACH CONTRACTOR PRIOR TO DRIVING PILES
TYPICAL HAND LAID GROUTED RIP-RAP AT BOTH ABUTMENTS
ROCKER BEARING
44'0" ROADWAY
EXISTING GR. PROFILE
SANDY TILL - VERY STONY
BOREHOLE #1
BOREHOLE #2
BOREHOLE #3
HALF SECTION A-A
HALF ELEVATION A-A
NORTH SIDE
SOUTH SIDE
TO CORNWALL
REVISED ST ANDREWS RD
PROFILE AT CROWN OF FINISHED PAVEMENT ST ANDREWS ROAD
W.P. 112-59
EO 59257
DWG N° A-59257
PROCTOR & REDFERN
CONSULTING ENGINEERS TORONTO
DEPARTMENT OF HIGHWAYS:-ONTARIO-
BRIDGE OFFICE:-TORONTO
CORNWALL TOWNSHIP
BRIDGE N° 14
OVER ST ANDREWS RD
THE KING'S HIGHWAY No. 401
DIST. No. 9
CO. STORMONT
TWP. CORNWALL
LOT 9 & 10
CON. III
PRELIMINARY GENERAL ARRANGEMENT
APPROVED
MAY 13 1960
BRIDGE ENGINEER
DESIGN ENGINEER
REFERENCE PLANS
F-8165-9
F-3165-6
E-2884-1
DESIGN A P
CHECK A.E.R.
DRAWING R.E.M.
CHECK A P
TRACING
CHECK
DATE MAY 1960
CONTRACT NUMBERS
LOADING
H20-S16
DRAWING NUMBER
D-4519-P2
REVISIONS
DATE
BY
DESCRIPTION

APPENDIX D

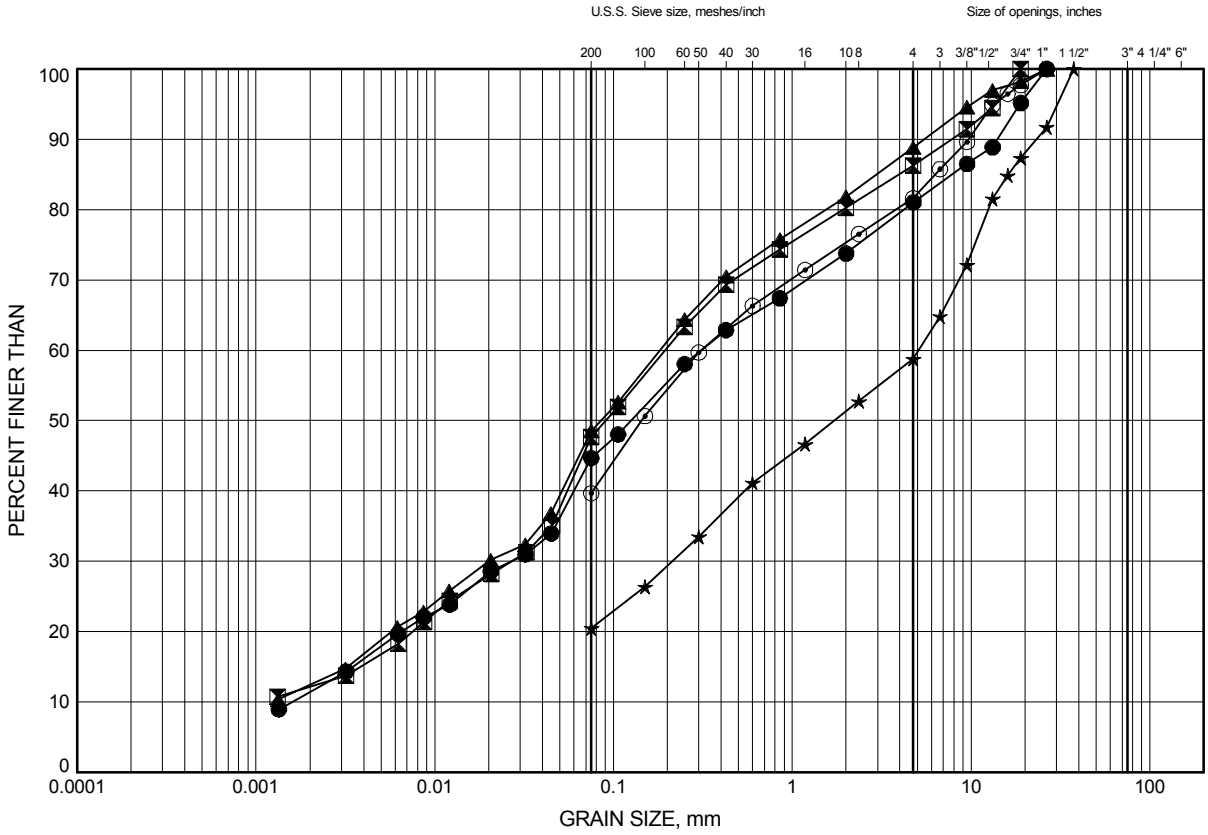
LABORATORY TEST RESULTS – 2017 INVESTIGATION

Trenchless Utility Installation Highway 401 at Pitt Street

GRAIN SIZE DISTRIBUTION

FIGURE 1

Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-101	1.07	63.97
⊠	17-102	1.83	66.73
▲	17-102	4.11	64.45
★	17-12	0.30	68.56
⊙	17-14	1.83	66.57

Date February 2018

GWP# 4003-14-00

THURBER

Prep'd KCP

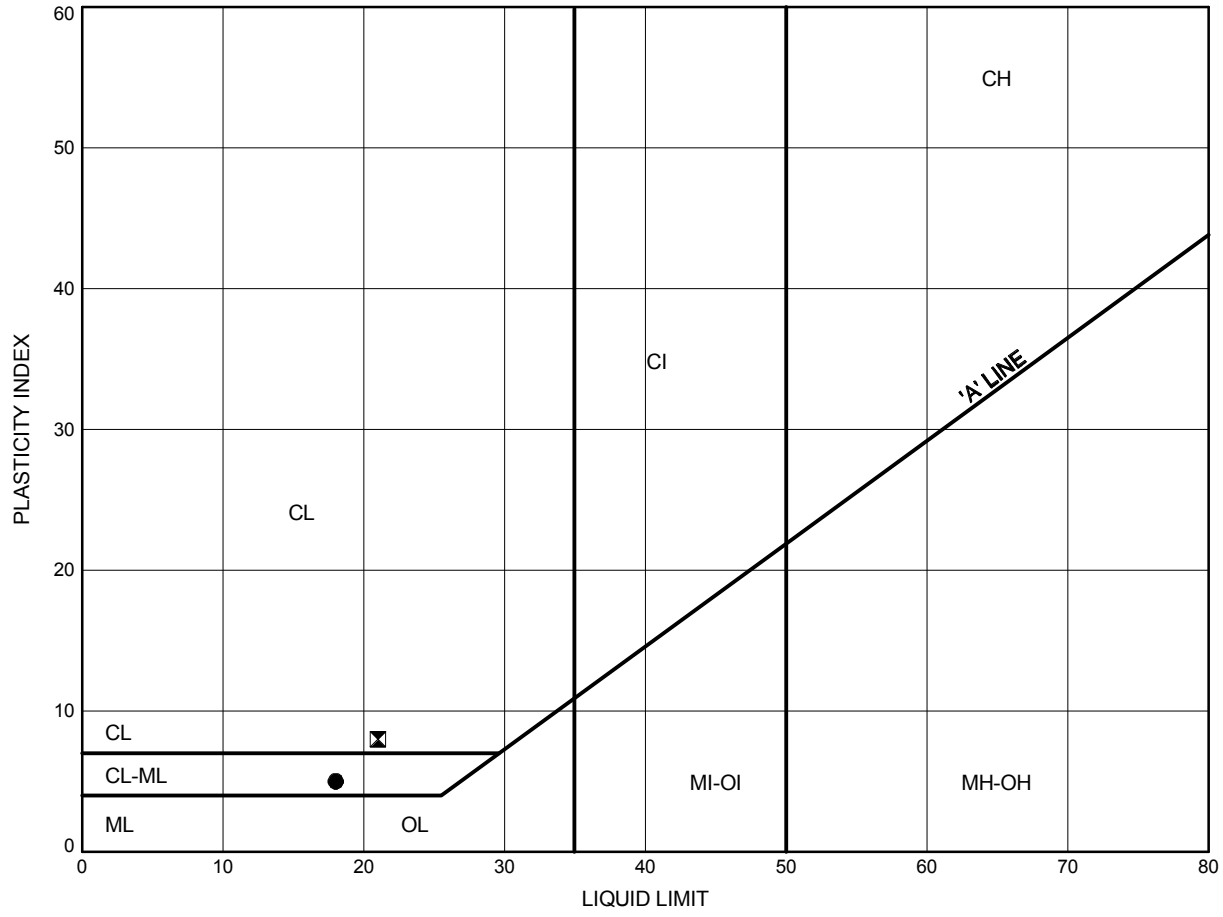
Chkd. PC

GRAIN SIZE DISTRIBUTION - THURBER 31-211-1&2 PITT ST BH LOGS.GPJ 20/2/18

Trenchless Utility Installation Highway 401 at Pitt Street

ATTERBERG LIMITS TEST RESULTS

FIGURE 2



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-101	1.07	63.97
⊠	17-102	1.83	66.73

Date February 2018

GWP# 4003-14-00

THURBER

Prep'd KCP

Chkd. PC

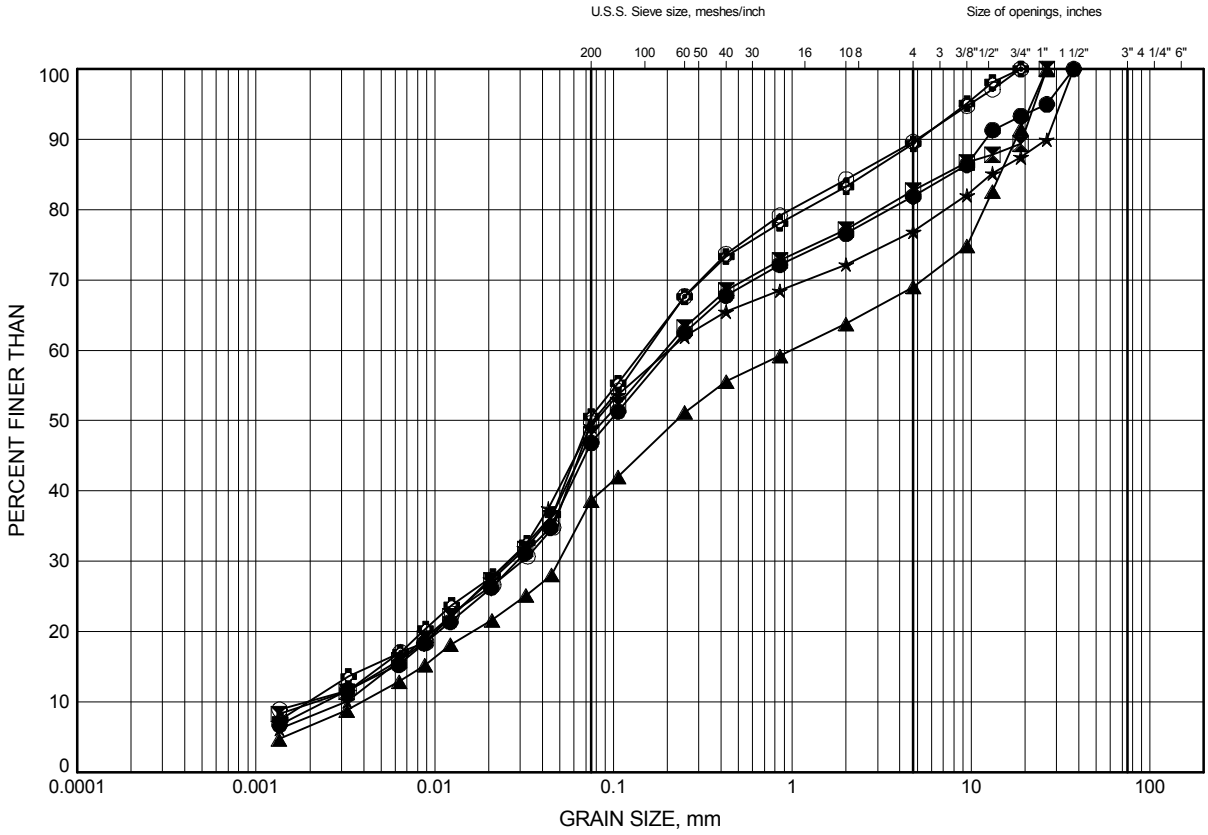
THURBALT 31-211-1&2 PITT ST BH LOGS.GPJ 20/2/18

Trenchless Utility Installation Highway 401 at Pitt Street

GRAIN SIZE DISTRIBUTION

FIGURE 3

Till - Sandy Silt some Gravel to Silty Sand with Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-101	4.88	60.16
⊠	17-102	7.16	61.40
▲	17-103	1.83	63.15
★	17-103	4.88	60.10
⊙	17-12	5.61	63.25
✿	17-14	5.64	62.76

Date February 2018

GWP# 4003-14-00

THURBER

Prep'd KCP

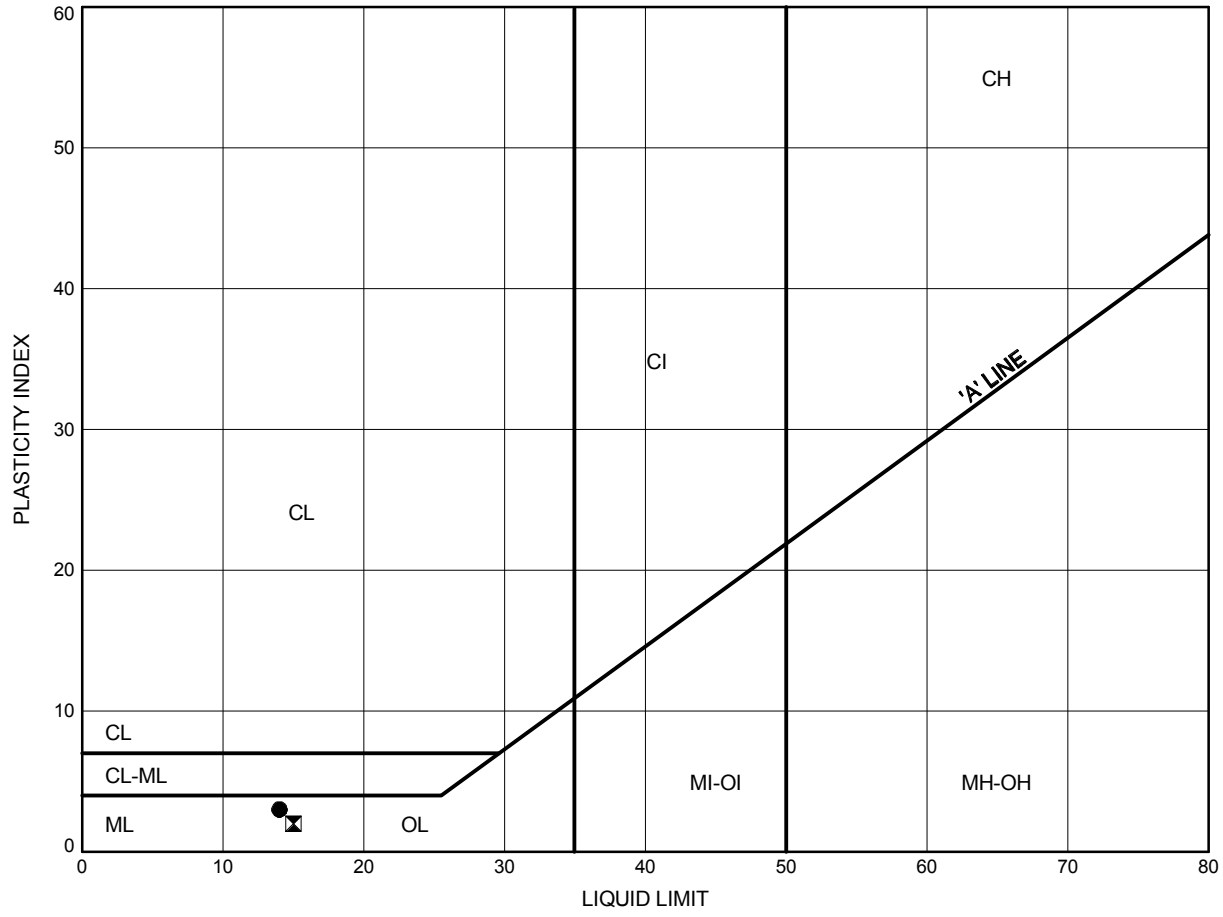
Chkd. PC

GRAIN SIZE DISTRIBUTION - THURBER 31-211-1&2 PITT ST BH LOGS.GPJ 20/2/18

Trenchless Utility Installation Highway 401 at Pitt Street

ATTERBERG LIMITS TEST RESULTS

FIGURE 4



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-101	4.88	60.16
⊠	17-12	5.61	63.25

Date February 2018

GWP# 4003-14-00

THURBER

Prep'd KCP

Chkd. PC

THURBALT 31-211-1&2 PITT ST BH LOGS.GPJ 20/2/18

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Certificate of Analysis

Thurber Engineering Ltd.

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

Client PO:
Project: Pitt St. Utility Gossy 19-5161-263
Custody: 109421

Report Date: 5-Jan-2018
Order Date: 3-Jan-2018

Order #: 1801096

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

Paracel ID	Client ID
1801096-01	BH17-101 SS3 5-7'
1801096-02	BH17-102 SS8 17'6"-19'6"
1801096-03	BH17-103 SS4 7'6"-9'6"

Approved By:

Dale Robertson, BSc
Laboratory Director

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

Report Date: 05-Jan-2018
Order Date: 3-Jan-2018
Project Description: Pitt St. Utility Gossy 19-5161-263

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	4-Jan-18	4-Jan-18
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	3-Jan-18	4-Jan-18
Resistivity	EPA 120.1 - probe, water extraction	4-Jan-18	4-Jan-18
Solids, %	Gravimetric, calculation	3-Jan-18	4-Jan-18

Certificate of Analysis

Report Date: 05-Jan-2018

Client: Thurber Engineering Ltd.

Order Date: 3-Jan-2018

Client PO:

Project Description: Pitt St. Utility Gossy 19-5161-263

	Client ID:	BH17-101 SS3 5-7'	BH17-102 SS8 17'6"-19'6"	BH17-103 SS4 7'6"-9'6"	-
	Sample Date:	13-Dec-17	14-Dec-17	15-Dec-17	-
	Sample ID:	1801096-01	1801096-02	1801096-03	-
	MDL/Units	Soil	Soil	Soil	-
Physical Characteristics					
% Solids	0.1 % by Wt.	87.1	88.6	92.0	-
General Inorganics					
pH	0.05 pH Units	7.91	7.85	8.78	-
Resistivity	0.10 Ohm.m	32.6	35.9	60.0	-
Anions					
Chloride	5 ug/g dry	99	74	18	-
Sulphate	5 ug/g dry	29	19	86	-

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

Report Date: 05-Jan-2018
Order Date: 3-Jan-2018
Project Description: Pitt St. Utility Gossy 19-5161-263

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-Jan-2018
Order Date: 3-Jan-2018
Project Description: Pitt St. Utility Gossy 19-5161-263

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	99.1	5	ug/g dry	98.6			0.5	20	
Sulphate	ND	5	ug/g dry	28.8			0.0	20	
General Inorganics									
pH	7.95	0.05	pH Units	7.91			0.5	10	
Resistivity	32.6	0.10	Ohm.m	32.6			0.2	20	
Physical Characteristics									
% Solids	81.0	0.1	% by Wt.	80.7			0.3	25	

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

Report Date: 05-Jan-2018
Order Date: 3-Jan-2018
Project Description: Pitt St. Utility Gossy 19-5161-263

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	194	5	ug/g	98.6	95.6	78-113			
Sulphate	128	5	ug/g	28.8	99.5	78-111			

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

Photograph 1 : Exit pit location (south end of alignment) looking east.

Photograph 2: Exit pit location (south end of alignment) looking north towards Highway 401 embankment

Photograph 3: Looking east towards Borehole 17-102 along Highway 401 median

Photograph 4: Entry pit location (north end of alignment) looking east