THURBER ENGINEERING LTD.

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FOUNDATION INVESTIGATION REPORT
RAMP FROM HIGHWAY 401 WBC TO HIGHWAY 403 WBC
HIGHWAY 401/403/410 INTERCHANGE
BRIDGE REHABILITATION
TORONTO, ONTARIO
G.W.P. 2206-16-00; SITE NO. 24-315

GEOCRES No. 30M12-409

Report

to

Associated Engineering Ltd.

Date: September 14, 2017
File: 17549

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THURBER

60 YEARS

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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 proposed rehabilitation of the existing ramp bridge connecting Highway 401 Westbound Collector (WBC) with Highway 403 Westbound Collector (WBC) at the Highway 401/403/410 interchange in Mississauga, Ontario. This work is part of the project that involves rehabilitation of eight bridges at the Highway 401/403/410 Interchange complex.

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

Thurber was retained by Associated Engineering Ltd. to carry out this foundation investigation under the MTO Assignment Number 2016-E-0042.

For preparation of this report, reference has been made to the following previous report:

- Foundation Investigation Report for Highway 403 Westbound over Highway 401 Westbound, Bridge #52, District #6, Toronto, W.P. 127-66-07, Site 24-315, Geocres No. 30M12-76, dated December 1976 (Reference 1).

2. SITE DESCRIPTION

The site is located at the interchange of Highways 401, 403 and 410 in Mississauga, Ontario. The ramp is located at the northeast quadrant of the interchange, and carries Highway 403 Westbound over Highway 401 WBC and Tomken (formerly Heart Lake) Road.

This bridge structure was built in 1977. The bridge is a three-span structure, approximately 160 m long. The approach fills adjacent to the north and south abutments are up to 8.5 m high.

A visual inspection, conducted on site at the time of the field investigation, revealed that the existing approach embankments are in a generally stable condition. The slope faces are vegetated with no sign of distress or erosion. There is also no visible evidence of distress on the abutment walls.

The lands surrounding this interchange are generally used for commercial and industrial purposes. The Pearson International Airport is located to the north and east of the interchange. The topography is generally flat in this area.

Selected photographs of the immediate surroundings of the site are presented in Appendix E.

The general site area is located within the physiographic region known as the Peel Plain, which is characterized by a level to undulating cohesive glacial till underlain at shallow depth by grey shale bedrock with limestone interbeds of the Georgian Bay Formation.

3. INVESTIGATION PROCEDURES

The site investigation and field testing for this project were carried out on April 2, 2017, and consisted of drilling and sampling two boreholes (numbered 17-01 and 17-02) at the site. The two boreholes were drilled from the ramp grade near the existing abutments, and were terminated at 9.8 m and 9.2 m depths (Elevations 170.8 and 173.3).

Prior to the start of drilling, the borehole locations were marked in the field and utility clearances were obtained. The co-ordinates and elevations of the as-drilled boreholes were subsequently provided by Associated Engineering Ltd. (AE). The approximate locations of these two boreholes are shown on a Borehole Locations and Soil Strata drawing included in Appendix D. The coordinates and elevations of these boreholes are given on this drawing and on the individual Record of Borehole Sheets in Appendix A.

A previous investigation was conducted in 1973 at this site for the design and construction of this ramp. The investigation consisted of drilling 6 boreholes (numbered 1 to 6) along the then

proposed ramp alignment. The records of the previous boreholes are included in Appendix C and their locations are also shown on the Borehole Locations and Soil Strata drawing in Appendix D.

A track-mounted drill rig was used to drill and sample the Boreholes 17-01 and 17-02. Solid stem augers were used to advance the boreholes until the target depth was reached. In general, soil samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with the Standard Penetration Testing (SPT).

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing. Results of field drilling and sampling are presented on the Record of Borehole sheets in Appendix A.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Upon completion, the boreholes were abandoned in general accordance with Ontario Regulation 903 amended by Ontario Reg. 372. The details of borehole completion are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Foundation Element	Borehole No.	Borehole Depth / Base Elevation (m)	Completion Details
North Abutment	17-01	9.8/170.8	Borehole backfilled with bentonite holeplug and auger cuttings to 0.15 m, then asphalt patch to surface.
South Abutment	17-02	9.2/173.3	Borehole backfilled with bentonite holeplug and auger cuttings to 0.15 m, then asphalt patch to surface.

4. LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size analysis and Atterberg Limits testing. All the laboratory tests were carried out in accordance to MTO and/or ASTM Standards, as appropriate. The results of the laboratory testing are summarized on the Record of Borehole sheets in Appendix A and are presented on the figures in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A for details of the encountered soil stratigraphy. Soil profiles at the abutment areas of the bridge are presented on the "Borehole Locations and Soil Strata" drawing in Appendix D. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond borehole locations. More detailed descriptions of the individual strata are presented below.

In general, the subsurface conditions encountered in the boreholes drilled at the abutments of the Highway 401 WBC to Highway 403 WBC ramp during the present investigation consist of a pavement structure (asphalt over granular fill) overlying embankment fill (sand, sand and gravel, and clayey silt), which is in turn underlain by native silty clay till. Both boreholes were dry upon completion of drilling.

It is noted that during the previous investigation conducted in 1997 (Reference 1, Appendix C), shale bedrock was contacted below the cohesive glacial till.

More detailed descriptions of the individual stratum are presented below.

5.1 Asphalt

Boreholes 17-01 and 17-02, advanced from ramp grade at the north and south approaches respectively, encountered 100 mm to 125 mm of asphalt surficially.

5.2 Sand to Sand and Gravel Fill

Layers of brown to grey sand and gravel fill, and sand fill containing trace to some silt and clay, were contacted immediately below the asphalt. The thickness of the sand to sand and gravel fill was 4.0 m and 2.5 m in Boreholes 17-01 and 17-02, respectively. The depth to the base of the cohesionless fill was at 4.1 m and 2.6 m (Elevations 176.5 and 179.9), in Boreholes 17-01 and 17-02, respectively.

SPT 'N' values measured in the cohesionless fill ranged from 11 to 38 blows per 0.3 m of penetration indicating a compact to dense state. Measured moisture contents of the cohesionless fill ranged from 3 percent to 7 percent.

The results of grain size analyses conducted on a sample of each of the sand fill and sand and gravel fill are presented on the Record of Borehole sheets in Appendix A, and are illustrated in Figures B1 and B2 of Appendix B. The laboratory test results are summarized in the following table.

Soil Particle	Sand Fill (Percent)	Sand and Gravel Fill (Percent)
Gravel	12	38
Sand	75	48
Silt & Clay	13	14

5.3 Clayey Silt Fill

Brown clayey silt fill containing trace to some gravel, trace to some sand and occasional organics, was contacted underlying the granular fill at 4.1 m and 2.6 m depth in Boreholes 17-01 and 17-02, respectively. The thickness of the clayey silt fill was 3.9 m and 2.9 m in Boreholes 17-01 and 17-02, respectively. The depth to the base of the cohesive fill was at 8.0 m and 5.5 m (Elevations 172.6 and 177.0) in Boreholes 17-01 and 17-02, respectively.

SPT 'N' values obtained in the clayey silt fill ranged from 11 to 14 blows for 0.3 m penetration, indicating a stiff consistency. Measured moisture contents of the clayey silt fill varied from 8 percent to 16 percent.

5.4 Silty Clay Till

A deposit of native brown to grey silty clay till with sand and trace to some gravel was encountered below the embankment fill in the boreholes. The silty clay till was contacted at 8.0 m and 5.5 m depths in Boreholes 17-01 and 17-02, respectively. The boreholes were terminated within the silty clay till at 9.8 m depth and 9.2 m (Elevations 170.8 and 173.3).

SPT 'N' values recorded in the silty clay till typically varied between 20 and 26 blows for 0.3 m of penetration indicating stiff to very stiff consistency. An SPT 'N' value of 50 blows per 0.075 m of penetration was recorded at the termination depth of Borehole 17-02. Measured moisture contents of the silty clay till ranged from 12 percent to 24 percent.

The results of grain size analyses conducted on two samples of the silty clay till are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figure B3 of Appendix B. The results are summarized as follows:

Soil Particle	Percent
Gravel	2 to 10
Sand	34 to 35
Silt	31 to 39
Clay	24 to 25

The results of Atterberg Limits tests conducted on two samples of the silty clay are provided on the Record of Borehole sheets in Appendix A and illustrated in Figure B4 of Appendix B. The results are summarized as follows:

Index Property	Percent
Liquid Limit	29 to 40
Plasticity Index	14 to 23

The results of the Atterberg Limits testing indicate the deposit to be of low to medium plasticity with group symbols CL to CI.

It is noted that glacial till inherently contains cobbles and boulders.

5.5 Shale Bedrock

Data from the previous investigation conducted in 1977 (Reference 1) revealed that the glacial till deposit is underlain by dark grey shale bedrock contacted at approximate Elevation 170.0, and from Elevations 172.6 to 174.5 at the north and south abutments, respectively. The bedrock contains interbedded limestone, and its upper 0.5 m to 1.5 m portion was described as weathered.

5.6 Groundwater Conditions

The water levels in Boreholes 17-01 and 17-02 were observed during the drilling operations and upon completion of drilling. Both boreholes were open to the depths investigated and dry upon completion of drilling.

It is envisaged that the current groundwater level at this site is governed by the drainage systems along the roadways at this highway interchange.

6. MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Associated Engineering Ltd. provided the northing and easting coordinates and ground surface elevations.

Walker Drilling Ltd. from Utopia, Ontario, supplied and operated a track-mounted drill rig to carry out the drilling, sampling and in-situ testing operations in the boreholes.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. Abdul Nasri of Thurber. Geotechnical laboratory testing was carried out by Thurber in its MTO-approved laboratory. Overall supervision of the field program was carried out by Mr. Stephane Loranger, CET.

Overall project management was provided by Dr. Sydney Pang, P.Eng. Interpretation of the field data and preparation of this report was completed by Ms. R. Palomeque Reyna, P. Eng. and Dr. Sydney Pang, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

THURBER

60 YEARS

Thurber Engineering Ltd.

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Geotechnical Engineer

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Associate, Senior Foundations Engineer

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Review Principal, Designated MTO Contact

Appendix A

Record of Borehole Sheets
(Current investigation)

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

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

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

UNIFIED SOILS CLASSIFICATION

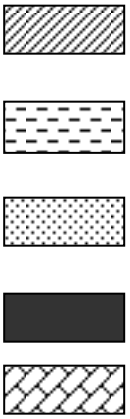
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels,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

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

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

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

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

TERMS

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

STRENGTH CLASSIFICATION

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

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RECORD OF BOREHOLE No 17-01 1 OF 2 METRIC

W.P. 2206-16-00 LOCATION Ramp Hwy 401 WBC to Hwy 403 WBC, Sta. 10+712 N 4 833 686.0 E 292 376.0 ORIGINATED BY AN

HWY 401/403/410 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.04.02 - 2017.04.02 CHECKED BY RPR

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
180.6	GROUND SURFACE										
0.0	**ASPHALT:** (125mm)										
0.1	**SAND** and **GRAVEL**, trace to some silt and clay Brown to Grey Moist (FILL)										
180.0							180				
0.6	**SAND**, some gravel, some silt and clay Compact Brown Moist (FILL)		1	GS					○		
			1	SS	21		179		○		
			2	SS	11		178		○		12 75 13 (SI+CL)
			3	SS	11		177		○		
176.5											
4.1	Clayey **SILT**, trace to some sand, trace gravel, occasional organics Stiff Brown Moist (FILL)		4	SS	12		176		○		
			5	SS	11		175		○		
			6	SS	11		174		○		
172.6							173				
8.0	Silty **CLAY**, with sand, trace gravel Stiff to Very Stiff Brown to Grey Moist (TILL)								⊕		2 34 39 25
			7	SS	26		172		○		
170.8							171				
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No 17-01 2 OF 2 METRIC

W.P. 2206-16-00 LOCATION Ramp Hwy 401 WBC to Hwy 403 WBC, Sta. 10+712 N 4 833 686.0 E 292 376.0 ORIGINATED BY AN

HWY 401/403/410 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.04.02 - 2017.04.02 CHECKED BY RPR

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										
	BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.15m, THEN PATCHED WITH ASPHALT TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S MTO-17549.GPJ 2017TEMPLATE(MTO).GDT 17/8/23

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THURBER

RECORD OF BOREHOLE No 17-02 1 OF 2 METRIC

W.P. 2206-16-00 LOCATION Ramp Hwy 401 WBC to Hwy 403 WBC, Sta. 10+905 N 4 833 545.0 E 292 270.9 ORIGINATED BY AN

HWY 401/403/410 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.04.02 - 2017.04.02 CHECKED BY RPR

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.5	GROUND SURFACE										
0.0	**ASPHALT:** (100mm)										
0.1	**SAND** and **GRAVEL**, trace to some silt and clay Brown Moist (FILL)		1	GS			182		○		38 48 14 (SI+CL)
	Dense to Compact		1	SS	38		181		○		
179.9			2	SS	12		180		○		
2.6	Clayey **SILT**, some gravel, trace sand, occasional organics Stiff Brown Moist (FILL)		3	SS	13		179		○		
177.0			4	SS	14		178		○		
5.5	Silty **CLAY**, with sand, some gravel Very Stiff Grey Wet (TILL)		5	SS	20		177		○		10 35 31 24
	Resistance to augering		6	SS	25		176		⊢○⊣		
173.3	Hard		7	SS	50/		175		○		
9.2	END OF BOREHOLE AT 9.2m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND				0.075		174				

Continued Next Page

+ ³ , × ³ : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S MTO-17549.GPJ 2017TEMPLATE(MTO).GDT 17/8/23

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-02 2 OF 2 METRIC

W.P. 2206-16-00 LOCATION Ramp Hwy 401 WBC to Hwy 403 WBC, Sta. 10+905 N 4 833 545.0 E 292 270.9 ORIGINATED BY AN

HWY 401/403/410 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.04.02 - 2017.04.02 CHECKED BY RPR

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										
	AUGER CUTTINGS TO 0.15m, THEN PATCHED WITH ASPHALT TO SURFACE.										

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S MTO-17549.GPJ 2017TEMPLATE(MTO).GDT 17/8/23

THURBER

60 YEARS

Appendix B

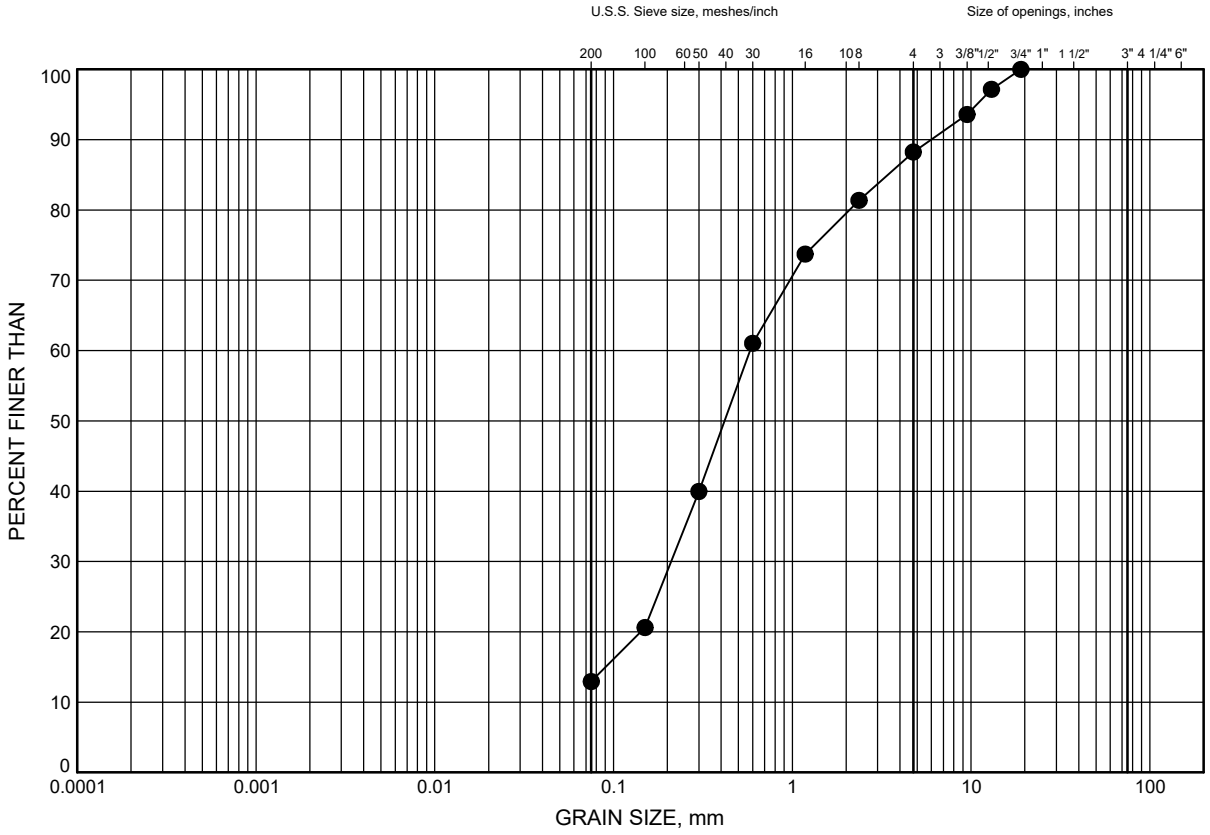
Laboratory Test Results

Ramp HWY 401 WBC to HWY 403 WBC

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-01	2.6	178.0

Date August 2017

W.P. 2206-16-00

THURBER

Prep'd AN

Chkd. SKP

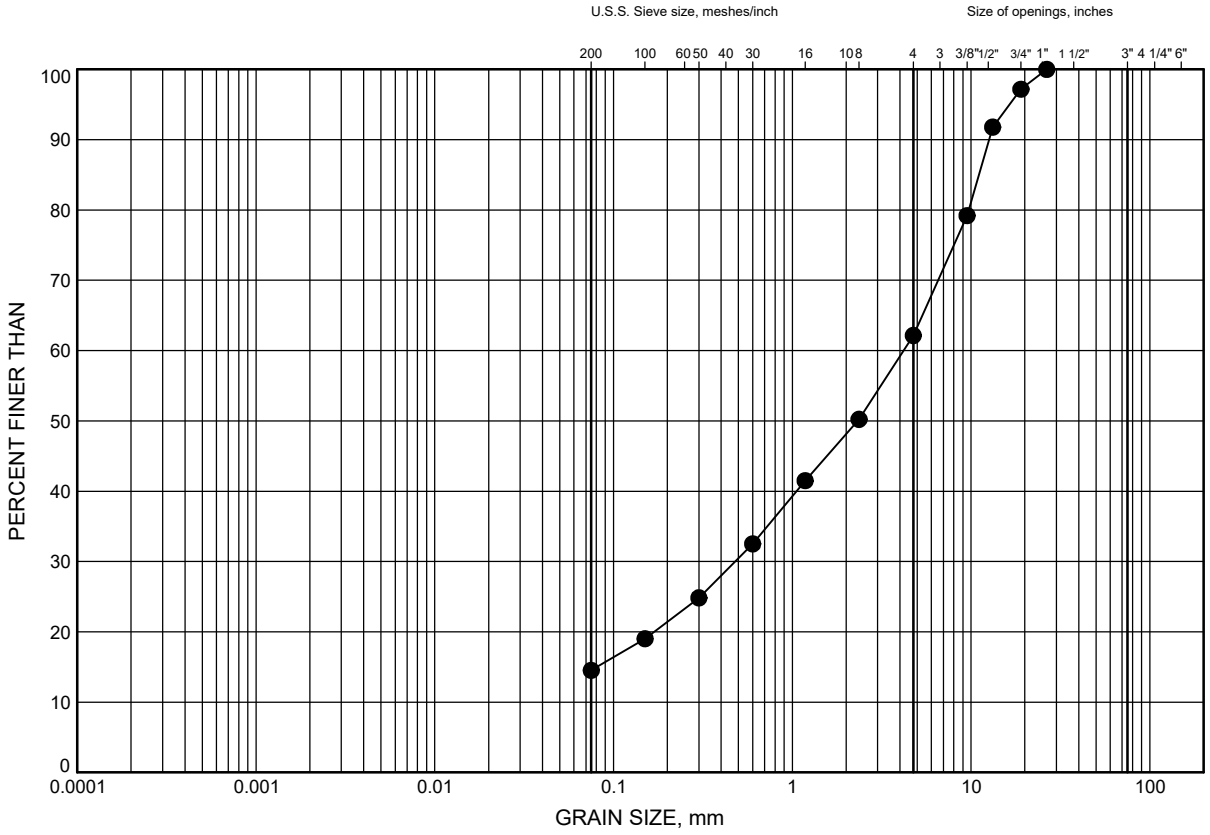
GRAIN SIZE DISTRIBUTION - THURBER MTO-17549.GPJ 17/8/24

Ramp HWY 401 WBC to HWY 403 WBC

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND and GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-02	0.8	181.7

Date August 2017

W.P. 2206-16-00

THURBER

Prep'd AN

Chkd. SKP

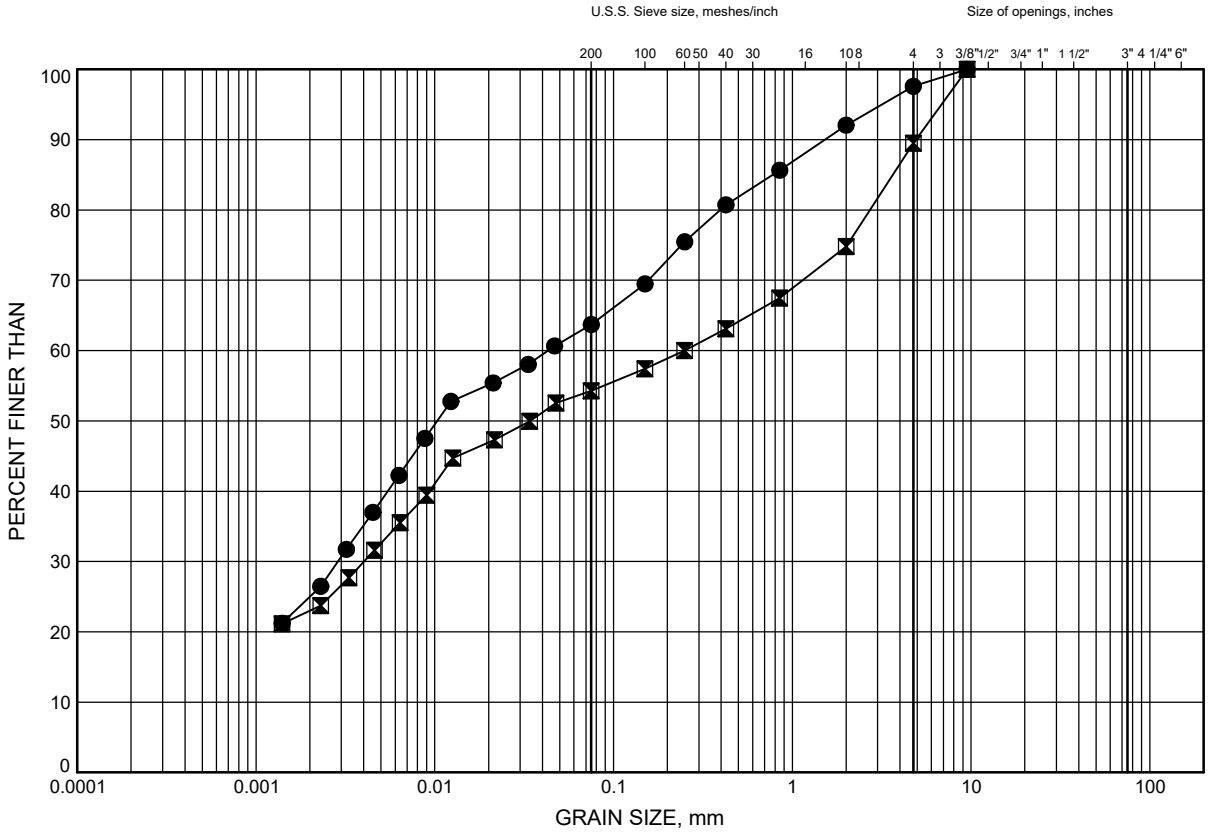
GRAIN SIZE DISTRIBUTION - THURBER MTO-17549.GPJ 17/8/24

Ramp HWY 401 WBC to HWY 403 WBC

GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-01	8.1	172.5
⊠	17-02	6.4	176.1

Date August 2017

W.P. 2206-16-00

THURBER

Prep'd AN

Chkd. SKP

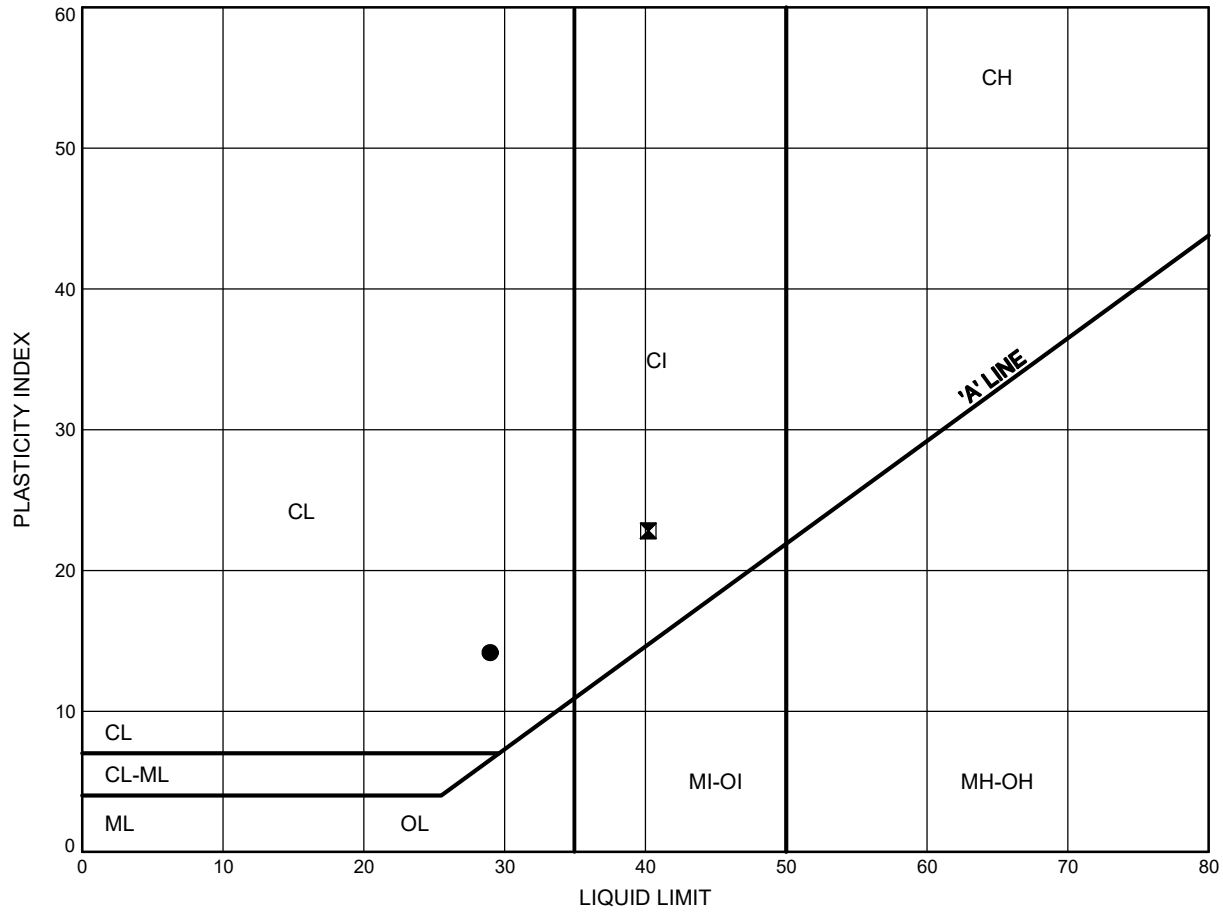
GRAIN SIZE DISTRIBUTION - THURBER MTO-17549.GPJ 17/8/24

Ramp HWY 401 WBC to HWY 403 WBC

ATTERBERG LIMITS TEST RESULTS

FIGURE B4

Silty CLAY TILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-01	8.1	172.5
⊠	17-02	7.9	174.6

Date August 2017

W.P. 2206-16-00

THURBER

Prep'd AN

Chkd. SKP

THURBALT MTO-17549.GPJ 17/8/24

THURBER

60 YEARS

Appendix C

Record of Borehole Sheets
(Previous investigation)

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

WP 127-66-07 LOCATION Co-ords. N.15,857,787 E.959,224 ORIGINATED BY CP

DIST 6 HWY 401 & 403 BORING DATE August 7, 1973 COMPILED BY JB

DATUM Geodetic BOREHOLE TYPE Washboring, BXL Rock Core & Cone Test CHECKED BY [illegible]

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT	LIQUID LIMIT w_L / PLASTIC LIMIT w_p / WATER CONTENT w	UNIT WEIGHT	REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	ELEV	20 40 60 80 100 — SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	w_p — w — w_L ; WATER CONTENT % 20 40 60	γ	% GR SA SI CL
563.8	Ground Level									
0.0	Het.mix.of clayey silt, sand & gravel (Glacial Till)		1	SS	70	560				
557.8	Hard Grey		2	SS	92					
6.0	weathered / sound		3	RC BXL	Rec. 50%					
	Bedrock Shale with occ.limestone layers		4	RC BXL	Rec. 100%					
550.4			5	BXL	100%					
13.4	End of Borehole					550				

20
15 ○ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

WP 127-66-07 LOCATION Co-ords. N.15,857,827 E.959,183 ORIGINATED BY VK

DIST 6 HWY 401 & 403 BORING DATE August 3, 1973 COMPILED BY JB

DATUM Geodetic BOREHOLE TYPE Washboring, BXL Rock Core & Cone Test CHECKED BY JD

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT	LIQUID LIMIT, PLASTIC LIMIT, WATER CONTENT	UNIT WEIGHT	REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	ELEV	20 40 60 80 100 SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	w_p w w_l WATER CONTENT % 20 40 60	γ	% GR SA SI CL
565.6	Ground Level									
0.0	Het.mix.of clayey silt to silty clay,sand & gravel(Glacial Till) with shale & limestone fragments below 560.		1	SS	78					
			2	SS	16/6"	▼ bouncing				
			3	SS	100/3"	560				5 24 42 29
557.6	Hard Grey		4	SS	100/3"					
8.0	Weathered Sound Bedrock Shale with occ. limestone layers.		5	BXL	28%					
			6	BXL	95%					
551.1			7	BXL	89%					
14.5	End of Borehole					550				

OFFICE REPORT ON SOIL EXPLORATION

20
15 ◇ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3

WP 127-66-07 LOCATION Co-ords. N.15,857,665 E.959,074 ORIGINATED BY VK

DIST 6 HWY 401 & 403 BORING DATE August 2, 1973 COMPILED BY JB

DATUM Geodetic BOREHOLE TYPE Washboring, BXL Rock Core & cone test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W	UNIT WEIGHT	REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	ELEV	20 40 60 80 100	W_P W W_L	γ	% GR SA SI CL
568.3	Ground Level						SHEAR STRENGTH: o UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT % 20 40 60		
0.0	Hot mix of clayey silt to silty clay, sand and gravel (Glacial Till) Very Stiff to Hard Grey		1	SS	18					
			2	SS	106					6 8 56 30
559.3			3	SS	100/5"	560				
9.0	Weathered sound Bedrock Shale with occ. limestone layers		4	RC	Rec.					
554.6			5	BXL	88%					
13.7	End of Borehole					550				

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

WP 127-66-07 LOCATION Co-ords. N.15,857,492 E.958,946 ORIGINATED BY VR

DIST 6 HWY 401 & 403 BORING DATE August 1, 1973 COMPILED BY JB

DATUM Geodetic BOREHOLE TYPE Washboring, BXL Rock Core & Cone Test CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER ELEV
572.4	Ground Level					
0.0	Het.mix.of clayey silt to silty clay, sand and gravel (Glacial Till)		1	SS	42	570
			2	SS	42	
564.4	Hard Grey		3	SS	133	
8.0	weathered sound Bedrock Shale with occ. limestone layers.		4	BXL	66%	
			5	RC BXL	Rec. 75%	560
			6	BXL	73%	
553.4	Grey		7	BXL	99%	
19.0	End of Borehole					550

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT %
20 40 60

UNIT WEIGHT γ

REMARKS	% GR	SA	SI	CL
	3	25	46	26

20
15 ◇ 5 % STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 5

WP 127-66-07 LOCATION Co-ords. N.15,857,368 E.958,907 ORIGINATED BY JB

DIST 6 HWY 401 & 403 BORING DATE August 13, 1973 COMPILED BY JB

DATUM Geodetic BOREHOLE TYPE Washboring, BXL Rock Core & Cone Test CHECKED BY

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w (w_P — w — w_L) WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % GR SA SI CL
574.9	Ground Level									
0.0	Met.mix.of clayey silt to silty clay, sand & gravel (Glacial Till)		1	SS	77/3"					8 20 40 32
			2	SS	38	570				
566.4	Hard Grey		3	SS	110					
8.5	Limestone		4	BXL	75%					
	Bedrock Shale with occ. limestone layers			RC	Rec.					
560.9	Grey Sound		5	BXL	85%					
14.0	End of Borehole					560				

20
15 ○ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 6

WP 127-66-07 LOCATION Co-ords. N.15,857,395 E.958,856 ORIGINATED BY VK

DIST 6 HWY 401 & 403 BORING DATE July 31, 1973 COMPILED BY JB

DATUM Geodetic BOREHOLE TYPE Washboring, BXL Rock Core & Cone Test CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER ELEV
576.6	Ground Level					
0.0 / 572.6	Wet, mix. of silty clay, sand & gravel (Glac. Till) Hard Grey		1	SS	34	
4.0	Weathered		2	BXL	111	570
			3	RC BXL	Rec. 50%	
	Sound Bedrock shale with occ. limestone layers.		4	RC BXL	Rec. 98%	
14.3 / 562.3	End of Borehole					560

DYNAMIC CONE PENETRATION RESISTANCE PLOT — 20 40 60 80 100

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

LIQUID LIMIT w_L — PLASTIC LIMIT w_P — WATER CONTENT w (w_P — w — w_L)

WATER CONTENT % 20 40 60

UNIT WEIGHT γ

REMARKS

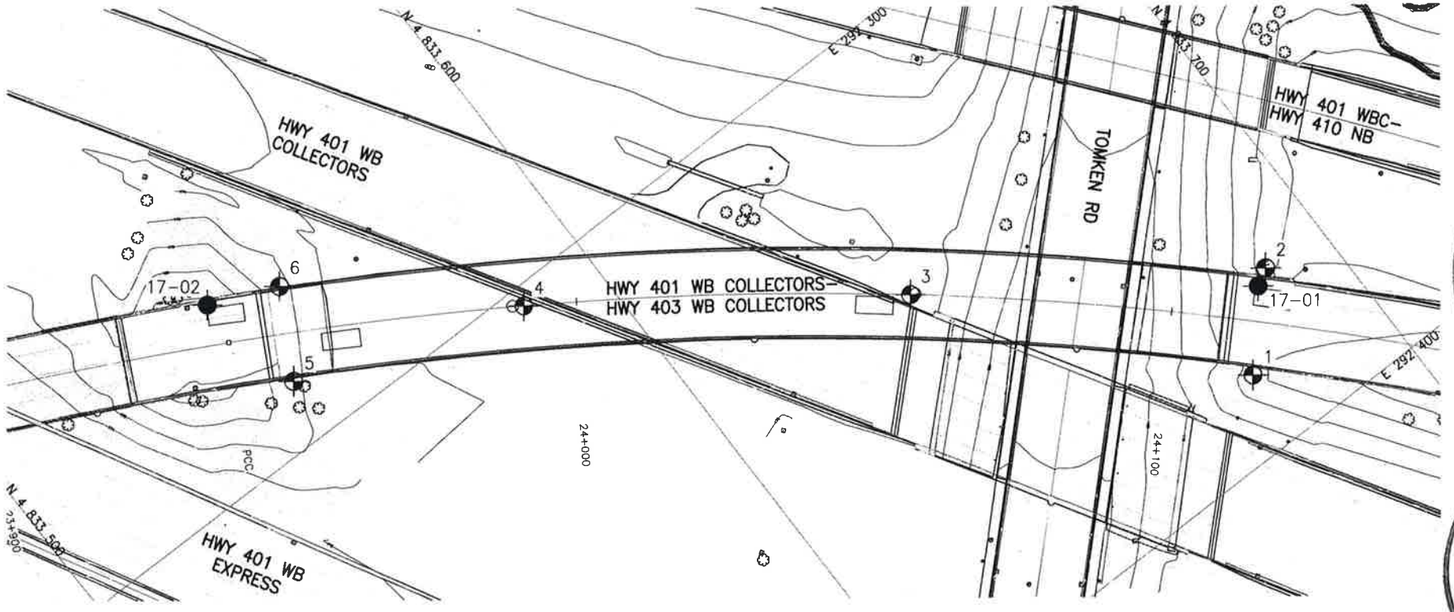
% GR SA SI CL

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Appendix D

Borehole Locations and Soil Strata Drawing



PLAN

20 0 20 40m

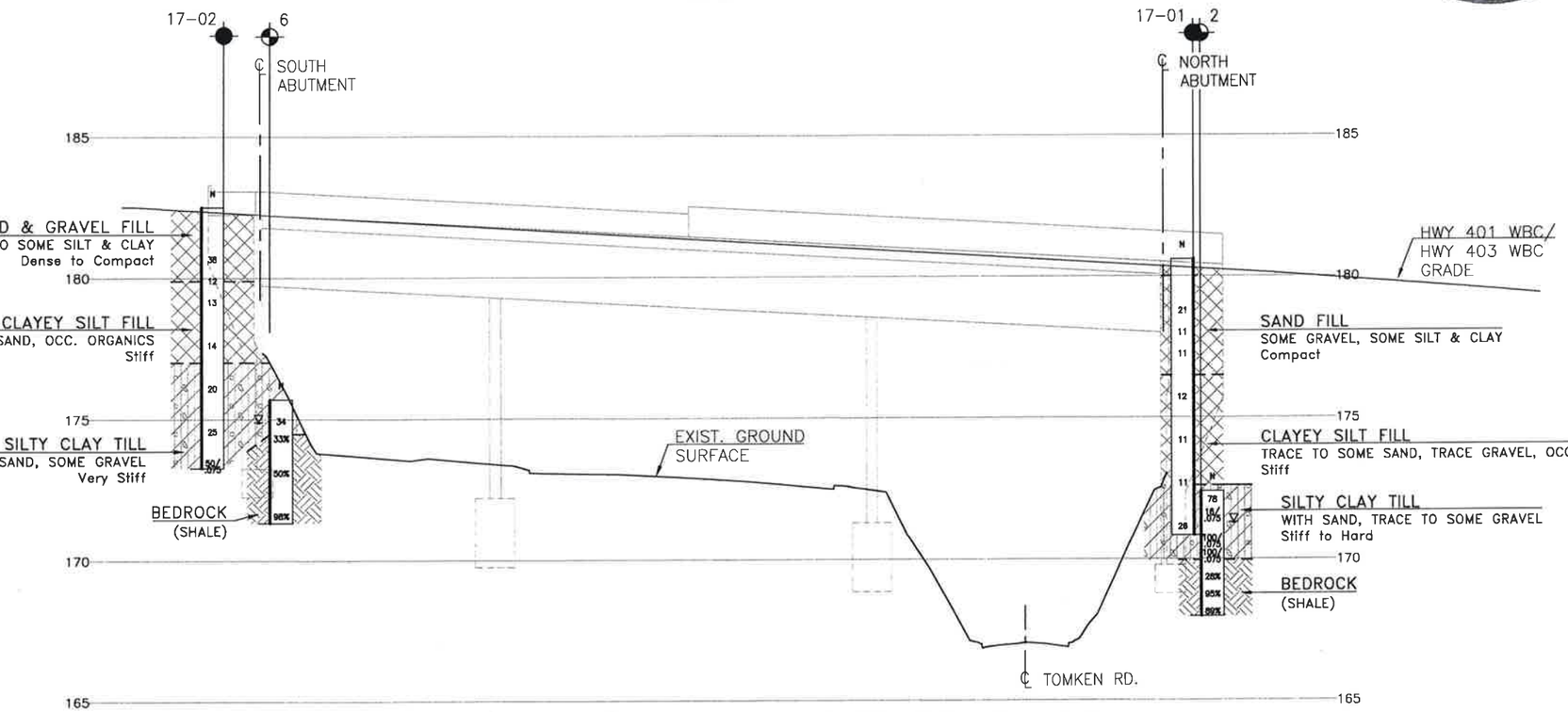
SCALE 1:1000

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Sep 14/17
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
S. PANG
35314509
Sept 4/17
PROVINCE OF ONTARIO



PROFILE ALONG ℄ HWY 401 WBC TO HWY 403 WBC

20 0 20 40m H 1:1000

4 0 4 8m V 1:200

CONT No
WP No 2206-16-00

SHEET

RAMP HWY 401 WBC TO HWY 403 WBC
BOREHOLE LOCATIONS AND SOIL STRATA

Associated Engineering

THURBER ENGINEERING LTD.

KEYPLAN

LEGEND

●	Borehole (Current 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	180.6	4 833 686.0	292 376.0
17–02	182.5	4 833 545.0	292 270.9
1	171.8	4 833 676.2	292 387.3
2	172.4	4 833 688.8	292 374.4
3	173.2	4 833 639.0	292 341.4
4	174.5	4 833 586.5	292 303.1
5	175.2	4 833 548.8	292 289.8
6	175.7	4 833 556.5	292 275.8

-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) Boreholes 1 to 6 were drilled during the previous investigation.

GEOCRES No. 30M12-409

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK SKP	CODE	LOAD	DATE SEP 2017
DRAWN	AN	CHK RPR	SITE	STRUCT	DWG 1

FILENAME: H:\Drafting\17000\17549\TDI-17549-PLPR.dwg
PLOTDATE: 9/15/2017 11:58 AM

Appendix E

Selected Site Photographs

Photo 1. – East side of the Highway 401 WBC to Highway 403 WBC Ramp

Photo 2. – West side of the Highway 401 WBC to Highway 403 WBC Ramp

Photo 3. – North abutment of the Highway 401 WBC to Highway 403 WBC Ramp

Photo 4. – South abutment of the Highway 401 WBC to Highway 403 WBC Ramp