FOUNDATION INVESTIGATION REPORT

PARKDALE AVENUE E-N/S RAMP REALIGNMENT

HIGHWAY 417 OPERATIONAL IMPROVEMENTS – PARKDALE AVENUE INTERCHANGE

OTTAWA, ONTARIO

W.P. 4068-10-00

Geocres Number: 31G5-255

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) along the alignments of the retaining wall and noise barrier wall planned in connection with the realignment of the E-N/S ramp of the Highway 417/ Parkdale Avenue interchange in Ottawa, Ontario. The ramp realignment is part of the Highway 417 expansion project.

The retaining wall will be located on the south side of the proposed re-aligned ramp and the noise barrier wall will be located along the north side of the re-aligned ramp.

The purpose of this investigation was to explore the subsurface conditions along the proposed wall alignments and, based on the data obtained, to provide a borehole location plan, record of borehole sheets, stratigraphic profiles, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions along the proposed wall alignments was developed from the data obtained in the course of the investigation.

Subsequent to the investigation, the alignment of the noise barrier wall between Rosemount and Melrose Avenues was shifted to the north MTO property line. For the revised alignment, existing subsurface data from MTO Geocres files and a previous contract drawing were used to supplement the information obtained during the current investigation.

Thurber carried out the investigation as a sub-consultant to MMM Group Limited (formerly McCormick Rankin), under the Ministry of Transportation Ontario (MTO) Agreement Number 4009-E-0007.

2 SITE DESCRIPTION

At present, the existing Highway 417 E-N/S ramp to Parkdale Avenue descends from Highway 417 grade to connect with Westmount Avenue at Beverly Avenue approximately 190 m east of Parkdale Avenue. Westmount Avenue then carries the off-ramp traffic to Parkdale Avenue.

Highway 417 crosses Parkdale Avenue on an overpass structure. A crib wall supports the Highway 417 approach embankment along the rear of former residential lots fronting onto Westmount Avenue. The houses formerly located on the strip of land between Highway 417 and Westmount Avenue have been demolished in preparation for realignment of the ramp.

Highway 417 at the south end of the ramp is located within a localized cut section. A retaining wall supports the north side of the cut in the vicinity of Sherbrooke and Melrose Avenues.

The properties adjacent to the top of the retaining wall and on the north side of Westmount Avenue are residential.

The site lies within the Ottawa Valley Clay Plains physiographic region, which comprises a clay plain interrupted by ridges of sand or rock. At this specific site however, the general stratigraphy consists of fill overlying silty sand till, underlain by bedrock. The bedrock is generally of the Gull River Formation of the Ottawa Group, consisting of interbedded dolostone, shale and sandstone. A fault crosses the alignment near Sherbrooke Avenue, and the bedrock to the east of this fault consists of limestone of the Bobcaygeon Formation. The fault and up-folded bedrock surface is exposed on the south side of Highway 417 opposite the site.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between November 6 and 19, 2012 and consisted of drilling and sampling a total of ten boreholes identified as Boreholes PD-01 to PD-10.

Boreholes PD-01 to PD-06 were drilled along the proposed noise barrier alignment and terminated upon auger refusal on probable bedrock at depths of 1.5 to 4.8 m. Boreholes PD-07 to PD-10 were drilled along the proposed retaining wall alignment and were terminated at depths of 7.2 to 9.8 m including recovery of 3.0 to 3.6 m of bedrock core.

Subsequent to the current investigation, the alignment of the noise barrier wall between Rosemount and Melrose Avenues was shifted to the north MTO property line, at a higher ground level than at Borehole PD-05. As access along this alignment was not possible, existing subsurface data was used to supplement the information obtained during the current investigation. Further information in this regard is provided in Section 6.

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

The borehole locations were marked in the field where possible and utility clearances were obtained prior to commencement of drilling operations. Boreholes were repositioned as necessary to avoid conflicts with utilities.

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

Groundwater conditions were observed in the open boreholes throughout the drilling operations, where possible. Standpipe piezometers consisting of 19 mm diameter PVC pipe with a slotted screen were installed in selected boreholes for monitoring of groundwater levels. The installation details of the piezometers and the borehole completion details are summarized in Table 3.1. Following the final water level reading, the piezometers were decommissioned in general accordance with MOE Regulation 903.

Table 3.1 – Piezometer Installation and Borehole Complete Details

Borehole	Tip Position (m) Depth / Elev.	Installation / Completion Details
PD-01	None installed	Backfilled with bentonite holeplug and cuttings to surface.
PD-02	4.8 / 62.7	Sand filter from 4.8 to 3.0 m, bentonite from 3.0 to 2.1 m, cuttings from 2.1 m to surface. Flush-mount casing protector at surface.
PD-03	2.4 / 64.7	Sand filter from 2.4 to 0.6 m, bentonite from 0.6 m to surface. Flush-mount casing protector at surface.
PD-04	None installed	Borehole caved to 0.9 m. Backfilled with cuttings to 0.1 m and asphalt patch at surface.
PD-05	None installed	Backfilled with bentonite holeplug and cuttings, then asphalt cold patch at surface.
PD-06	3.9 / 67.3	Sand filter from 3.9 to 2.1 m, bentonite from 2.1 to 1.4 m, and cuttings from 1.4 m to surface. Flush-mount casing protector at surface.
PD-07	8.3 / 61.3	Sand filter from 8.3 to 5.0 m, bentonite from 5.0 to 4.3 m, and cuttings and bentonite mixture from 4.3 m to surface.
PD-08	None installed	Backfilled with bentonite holeplug and cuttings to surface.
PD-09	6.2 / 61.8	Sand filter from 6.2 to 2.8 m, bentonite from 2.8 to 2.2 m, then cuttings to surface.
PD-10	None installed	Backfilled with bentonite holeplug and cuttings, then asphalt cold patch at surface.

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

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 gradation analysis (sieve and hydrometer). The results of this testing program are summarized on the Record of Borehole sheets included in Appendix A and are plotted on the figures included in Appendix B.

Point load tests were carried out on selected samples of intact bedrock core to assist in evaluation of the compressive strength of the bedrock. Results of the point load tests are included on the Record of Borehole sheets included in Appendix A (as average per core run).

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A and to the Borehole Locations and Soil Strata Drawings included in Appendix D for the details of the encountered soil stratigraphy. Overall descriptions of the stratigraphy encountered in the boreholes at the noise barrier wall and retaining wall are given in the following paragraphs. However, the factual data presented in the borehole logs takes precedence over this general description and interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond borehole locations.

5.1 Noise Barrier Wall – Boreholes PD-01 to PD-06

The stratigraphy encountered in Boreholes PD-01 to PD-06 consisted of asphalt and concrete (where boreholes were drilled on existing pavement) over sand fill and silty sand till underlain by probable bedrock. More detailed descriptions of the individual strata encountered in the boreholes are presented below.

5.1.1 Asphalt and Concrete

Asphalt was encountered at surface in Boreholes PD-03 to PD-06 drilled on the existing Parkdale Avenue E-N/S ramp. The thickness of the asphalt ranged from 150 to 225 mm.

A layer of concrete was encountered below the asphalt in Boreholes PD-03 to PD-05. The concrete layer was 150 to 450 mm thick.

5.1.2 Fill

A layer of cohesionless fill, consisting of sand and gravel to silty sand, was encountered at the ground surface in Boreholes PD-01 and PD-02, below the concrete in Boreholes PD-03 to PD-05, and below the asphalt in Borehole PD-06. The cohesionless fill was typically brown and locally contained wood pieces and cobbles.

The thickness of the fill ranged from 0.9 to 1.5 m, with the lower boundary of the fill encountered at depths of 1.4 to 1.9 m (Elevations 69.7 to 65.7).

SPT N-values recorded in the cohesionless fill ranged from 11 to 59 blows for 0.3 m penetration, indicating a compact to very dense (typically compact) relative density. N-values of 50 blows for less than 0.3 m recorded at the bedrock surface are not representative of the fill density.

The moisture content of samples of the cohesionless fill ranged from 3% to 15%.

Two samples of the cohesionless fill were selected for laboratory grain size analysis testing. The results of these tests are summarized below. These results are also presented on the corresponding Record of Borehole sheets included in Appendix A and Figure B1 in Appendix B.

Gravel %	4 to 33
Sand %	52 to 86
Silt & Clay %	10 to 15

5.1.3 Silty Sand Till

Silty sand till was encountered below the fill in Boreholes PD-01 to PD-03 and PD-06. The silty sand till was brown to grey and contained trace to some gravel and trace to some clay.

The thickness of the silty sand till ranged from 1.0 to 3.3 m, with the lower boundary of the till encountered at depths of 2.4 to 4.8 m (Elevations 67.3 to 62.7).

SPT N-values recorded in the silty sand till generally ranged from 8 to 16 blows for 0.3 m penetration, indicating a loose to compact relative density. Localized values of 50 blows for less than 0.3 m were recorded on a possible cobble or probable bedrock below the till.

The moisture content of samples of the silty sand till ranged from 7% to 13%.

Three samples of the silty sand till underwent laboratory grain size analysis testing. The results of these tests are summarized below and are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figure B3, Appendix B.

Gravel %	6 to 15
Sand %	46 to 50
Silt %	24 to 33
Clay %	11 to 12

It should be noted that glacial tills inherently contain cobbles and boulders.

5.1.4 Bedrock

Auger refusal on probable bedrock was encountered below the fill in Boreholes PD-04 and PD-05, and below the till in the remaining boreholes. The depths and elevations of the probable bedrock surface at each borehole location are summarized in Table 5.1.

Table 5.1 – Depths and Elevations of Probable Bedrock Surface

Borehole	Probable Bedrock Surface	
	Depth (m)	Elevation (m)
PD-01	3.9	64.3
PD-02	4.8	62.7
PD-03	2.4	64.7
PD-04	1.5	67.2
PD-05	1.9	68.6
PD-06	3.9	67.3

5.1.5 Groundwater

Groundwater levels were measured in the open boreholes upon completion of drilling. Three standpipe piezometers were installed along the proposed noise barrier alignment upon completion of drilling (one of these in a gravelled area could not subsequently be located however). The groundwater depths and elevations measured in the piezometers as well as in the open boreholes upon completion are presented in Table 5.2.

Table 5.2 – Groundwater Depths and Elevations

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
PD-02	08-Nov-2012	1.9	65.6	Upon completion
PD-03	13-Nov-2012	Dry	-	Upon completion
	21-Nov-2012	1.6	65.5	In piezometer
	05-Dec-2012	0.8	66.3	In piezometer
PD-06	11-Nov-2012	Dry	-	Upon completion
	21-Nov-2012	3.7	67.5	In piezometer
	05-Dec-2012	2.1	69.1	In piezometer

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

5.2 Retaining Wall – Boreholes PD-07 to PD-10

The stratigraphy encountered in Boreholes PD-07 to PD-10 generally consisted of fill comprising sand and silt to gravelly sand, overlying silty sand till, underlain by limestone bedrock. Asphalt was encountered at the surface in Borehole PD-10, which was drilled on the paved shoulder of Highway 417.

5.2.1 Asphalt

Asphalt was encountered at surface in Borehole PD-10 drilled on the shoulder of Highway 417. The asphalt was 125 mm thick at this location.

5.2.2 Fill

Fill consisting of sand and silt to sand, some silt, was encountered at the ground surface in Boreholes PD-07 to PD-09 drilled in the area of the former dwellings on the south side of Westmount Avenue. In Borehole PD-10 located on the shoulder of Highway 417, gravelly sand fill was encountered below the asphalt layer. The fill varied in colour between brown, dark brown, black and grey, and contained brick and wood fragments as well as occasional cobbles.

The thickness of the fill ranged from 2.1 to 3.5 m, with the lower boundary encountered at Elevations 67.4 to 65.7 m).

SPT 'N' values recorded in the fill typically ranged from 7 to 26 blows for 0.3 m penetration, indicating a loose to compact relative density. N-values of 38 and 59 blows for 0.3 m were recorded locally in Borehole PD-07, indicating a dense to very dense condition.

Moisture contents varied from 5 to 22%.

Samples of the fill underwent laboratory grain size analysis testing. The results of these tests are summarized below and are presented on the corresponding Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figures B1 and B2, Appendix B.

	Sand & Silt	Gravelly Sand
Gravel %	4	32
Sand %	49 to 51	57
Silt %	34 to 35	11
Clay %	11 to 12	

5.2.3 Silty Sand Till

Silty sand till was encountered below the fill in Boreholes PD-07 to PD-09. The silty sand till was grey in colour and contained trace to some gravel, trace to some clay, and occasional cobbles.

The thickness of the till ranged from 2.7 to 4.7 m, with the lower boundary encountered at depths of 5.0 to 6.8 m (Elevations 63.5 to 61.2 m).

SPT 'N' values recorded in the silty sand till ranged from 2 to greater than 100 blows for 0.3 m penetration, indicating a variable relative density ranging from very loose to very dense. An 'N' value of 50 blows for 0.075 m penetration was recorded at the till-bedrock interface in Borehole PD-07 and is not representative of the relative density of the till.

Moisture contents of samples of the silty sand till ranged from 6 to 13%.

Three samples of the till were selected for laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A, and the grain size distribution curves are plotted on Figure B3, Appendix B.

Gravel %	8 to 13
Sand %	47 to 53
Silt %	24 to 31
Clay %	10 to 14

It should be noted that glacial tills inherently contain cobbles and boulders.

5.2.4 Bedrock

Bedrock was encountered below the silty sand till in Boreholes PD-07 to PD-09 and directly below the gravelly sand fill in Borehole PD-10. Bedrock was proven by coring a minimum 3.0 m into the bedrock in all four boreholes. The depths and elevations at which bedrock was encountered are summarized in Table 5.3.

Table 5.3 – Depths and Elevations of Bedrock Surface

Borehole	Bedrock Surface	
	Depth (m)	Elevation (m)
PD-07	6.2	63.5
PD-08	6.8	61.2
PD-09	5.0	63.0
PD-10	3.6	67.1

The bedrock was described as dark grey limestone with shale interbeds. Total Core Recovery (TCR) in the bedrock ranged from 89% to 100%, locally 60% for the first run

in Borehole PD-10. The RQD values ranged from 0 to 63% in the initial 275 to 675 mm long run at the bedrock surface, indicating a very poor to fair rock quality, and from 83 to 100 % below this level, indicating a good to excellent quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was typically 0 to 5.

The estimated unconfined compressive strength of the rock, interpreted from point load tests conducted on intact limestone cores, varied from 43 to 193 MPa, indicating a medium strong to very strong rock strength classification. Lower rock strengths may be exhibited in the shale interbeds.

5.2.5 Water Levels

Water levels were not measured in the open boreholes during drilling since water was added to the boreholes during bedrock coring. Two standpipe piezometers were installed upon completion of drilling. The groundwater depths and elevations measured in the piezometers are listed in Table 5.4.

Table 5.4 – Groundwater Depths and Elevations

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
PD-07	07-Nov-2012	6.3	63.3	In piezometer
	21-Nov-2012	4.3	65.3	
	05-Dec-2012	4.7	64.9	
PD-09	08-Nov-2012	1.6	66.4	In piezometer
	21-Nov-2012	1.3	66.7	
	05-Dec-2012	1.4	66.6	

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

6 SUBSURFACE INFORMATION FROM PREVIOUS INVESTIGATIONS

Subsequent to the current investigation, the alignment of the noise barrier wall between Rosemount and Melrose Avenues was shifted to the north MTO property line, at the higher ground level above the existing retaining wall. The subsurface information documented in Borehole PD-05 drilled from the existing highway level may therefore not reflect conditions to be encountered along the wall. Confirmation of the stratigraphy at the higher level behind the wall was not possible as access was restricted by the existing noise wall and private properties along the top of the retaining wall.

In view of the above, existing subsurface data from a previous contract drawing and MTO Geocres files were used to supplement the information obtained during the current investigation. Relevant borehole logs and borehole locations plans from the previous investigations are reproduced in Appendix C. The soil stratigraphy interpreted from the previous information is illustrated on the Borehole Locations and Soil Strata drawings provided in Appendix D. The borehole locations and bedrock elevations must be viewed as approximate, and varying subsurface conditions and bedrock elevations must be anticipated.

6.1 Previous Contract

Soils Survey Data from eight power hand-auger probes previously advanced along the retaining wall alignment was available from Contract 80-58, W.P. 246-77-01 (Sheet 14). The tabular borehole data is provided in Appendix C. The approximate ground surface elevations at the borehole locations were estimated from the noise wall profile provided by MMM Group.

The stratigraphy encountered in the probes typically consisted of 150 mm of topsoil overlying silty sand to the west of Sherbrooke Avenue and overlying silty clay to the east. Bedrock was encountered at depths of 150 and 300 mm in two boreholes at Sherbrooke Avenue (Boreholes 4 and 5), refusal on possible bedrock was encountered at depths of 1.4 and 1.2 m in two additional boreholes between Sherbrooke and Melrose Avenue (Boreholes 6 and 7), and bedrock was not encountered within the exploration depths of 2.4 m in the outer boreholes (Boreholes 1 to 3 and 8).

This information indicates that the bedrock surface rises sharply for a short distance near Sherbrooke Avenue, consistent with the faulted/folded bedrock surface exposed on the south side of Highway 417. Sharp variations in the bedrock surface are likely to be encountered in accordance with the nature of this type of feature.

6.2 Previous Foundation Investigations

Borehole information was available for this section of wall in two previous investigation reports:

- Report on Soils Investigation for Proposed Retaining Walls along Route of Ottawa Queensway from Station 296+00 to 309+00, McRostie and Associates, July 31, 1959. Geocres No. 31G5-121.
- Report No. 2 on Soils Investigation for Proposed Retaining Walls along Route of Ottawa Queensway, McRostie and Associates, February 15, 1960. Geocres No. 31G5-121.

The relevant boreholes were designated 306+00 60'Left, 307+09 75'L, and 307+91 58'L. The logs and provided in Appendix C, and the locations are indicated on the drawing in Appendix D.

The borehole data from these boreholes is generally consistent with the auger probe information, indicating that the bedrock surface rises sharply at Sherbrooke Avenue. In Borehole 306+00 at Sherbrooke Avenue, weathered/broken bedrock was encountered below fill at a depth of 550 mm (Elev. 74.4). The fractured bedrock surface was encountered at a depth of 6.9 m (Elev. 67.5) in Borehole 307+09 located midway between Sherbrooke and Melrose Avenues, and was not encountered within the exploration depth of 6.6 m (Elev. 65.9) in Borehole 307+91 located near Melrose Avenue.

The deposits overlying the bedrock in the deeper boreholes consisted of fine sand overlying non-cohesive till at depths of 1.2 to 1.4 m. SPT N-values recorded in the till deposits ranged from 10 to 52 blows for 0.3 m penetration, indicating a typically compact to dense condition.

Water was measured in the open boreholes at depths of 3.8 and 2.4 m (Elev. 70.6 and 70.1) on the day following drilling.

7 MISCELLANEOUS

The borehole locations were selected and established in the field by Thurber Engineering Ltd. Surveyors from MMM Group determined the co-ordinates and ground surface elevations at the boreholes after completion of the site investigation.

Underground Service Locators Inc. obtained utility clearances on behalf of Thurber for the selected borehole locations prior to drilling.

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied both track-mounted and truck-mounted drill rigs and conducted the drilling, sampling and in-situ testing operations.

The field investigation was supervised by Ms. Gabrielle Marcotte, E.I.T. of Thurber. Overall planning and supervision of the field program was conducted by Ms. Lindsey Blaine, E.I.T.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

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

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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

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

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

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS

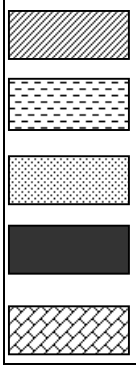
ROCK WEATHERING CLASSIFICATION

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

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

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

BEDROCK

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

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 % 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.

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THURBER

RECORD OF BOREHOLE No PD-01 1 OF 1 METRIC

W.P. 4068-10-00 LOCATION N 5 028 946.8 E 365 343.5 ORIGINATED BY GM

HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.11.08 - 2012.11.08 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	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
68.2											
0.0	**SAND**, some silt, trace gravel, occasional wood pieces Compact Brown Wet (FILL)		1	SS	16		68		○		
			2	SS	12		67		○		
66.7											
1.5	Silty **SAND**, trace to some gravel, trace to some clay Compact Brown Moist (TILL)		3	SS	15				○		6 50 33 11
			4	SS	16		66		○		
	Grey		5	SS	16		65		○		
64.3											
3.9	END OF BOREHOLE AT 3.9m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PD-02 1 OF 1 METRIC

W.P. 4068-10-00 LOCATION N 5 028 982.9 E 365 398.3 ORIGINATED BY GM

HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.11.08 - 2012.11.08 CHECKED BY LRB

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
67.5											
0.0	**SAND**, some silt, some gravel Compact Brown Damp (FILL)		1	SS	19		67		○		
			2	SS	11				○		
66.0							66				
1.5	Silty **SAND**, some gravel, trace to some clay Compact Brown Moist (TILL) Grey		3	SS	13				○		
			4	SS	16		65		○		
			5	SS	10		64		○		15 49 24 12
			6	SS	50/0.025		63		○		
62.7											
4.8	END OF BOREHOLE AT 4.8m UPON AUGER REFUSAL ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov. 08/12 1.9 65.6 Nov. 21/12 Could not locate Dec. 05/12 Could not locate										

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PD-03 1 OF 1 METRIC

W.P. 4068-10-00 LOCATION N 5 029 032.9 E 365 471.6 ORIGINATED BY GM

HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.11.13 - 2012.11.13 CHECKED BY LRB

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
67.1											
0.0	**ASPHALT:** (150mm)						67				
66.8	**CONCRETE:** (150mm)										
0.3	Silty **SAND**, some gravel Compact Brown Damp (FILL)		1	SS	18				○		
65.7							66				
1.4	Silty **SAND**, some gravel, trace to some clay Loose to Compact Brown Damp (TILL)		2	SS	9				○		15 46 27 12
64.7			3	SS	50/		65		○		
2.4	END OF BOREHOLE AT 2.4m UPON AUGER REFUSAL ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov. 13/12 Dry Nov. 21/12 1.6 65.5 Dec. 05/12 0.8 66.3				0.150						

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

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

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THURBER

RECORD OF BOREHOLE No PD-04 1 OF 1 METRIC

W.P. 4068-10-00 LOCATION N 5 029 057.0 E 365 529.0 ORIGINATED BY GM

HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.11.13 - 2012.11.13 CHECKED BY LRB

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 (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	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
68.7											
0.0	**ASPHALT:** (150mm)										
0.2	**CONCRETE:** (450mm)										
68.1											
0.6	**SAND** and **GRAVEL**, occasional cobbles Dense Brown Wet (FILL)		1	SS	50		68		○		
67.2											
1.5	END OF BOREHOLE AT 1.5m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN TO 0.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.										

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

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

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THURBER

RECORD OF BOREHOLE No PD-05 1 OF 1 METRIC

W.P. 4068-10-00 LOCATION N 5 029 086.7 E 365 590.2 ORIGINATED BY GM

HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.11.13 - 2012.11.13 CHECKED BY LRB

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
70.5											
0.0	**ASPHALT:** (150mm)										
0.2 / 70.1	**CONCRETE:** (175mm)										
0.4	**SAND** and **GRAVEL** Grey Damp						70				
69.6 / 0.9	(FILL)		1	SS	19				○		4 86 10 (SI+CL)
	SAND, trace gravel Compact Brown								○		
68.9 / 1.6	Damp (FILL)		2	SS	50/ 0.075		69		○		
68.6 / 1.9	Silty **SAND**, some gravel Very Dense Black Wet (FILL)										
	END OF BOREHOLE AT 1.9m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS, WITH ASPHALT COLD PATCH AT SURFACE.										

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

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

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Ontario

THURBER

RECORD OF BOREHOLE No PD-06 1 OF 1 METRIC

W.P. 4068-10-00 LOCATION N 5 029 125.4 E 365 654.2 ORIGINATED BY GM

HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2012.11.11 - 2012.11.11 CHECKED BY LRB

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
71.2											
0.0	**ASPHALT:** (225mm)										
0.2	Gravelly **SAND**, some silt Very Dense to Compact Brown Damp (FILL) Silty sand layer (150mm) at 0.8m		1	SS	59		71		○		33 52 15 (SI+CL)
			2	SS	21		70		○		
69.7											
1.5	Silty **SAND**, some gravel, trace clay Loose to Compact Grey Wet (TILL)		3	SS	11	▼	69		○		
			4	SS	8				○		
			5	SS	16		68		○		
67.3											
3.9	END OF BOREHOLE AT 3.9m UPON REFUSAL ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov. 11/12 Dry Nov. 21/12 3.7 67.5 Dec. 05/12 2.1 69.1										

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

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

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THURBER

RECORD OF BOREHOLE No PD-07 1 OF 2 METRIC

W.P. 4068-10-00 LOCATION N 5 028 917.8 E 365 324.1 ORIGINATED BY GM

HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2012.11.06 - 2012.11.07 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
69.6											
0.0	**SAND** and **SILT**, trace to some gravel, occasional brick and wood fragments Compact to Very Dense Black/Brown Damp (FILL) Occasional cobble		1	SS	13		69	○	○		
			2	SS	38				○		4 51 34 11
			3	SS	59		68		○		
67.4											
2.3	Silty **SAND**, some gravel, some clay Compact to Very Loose Grey Wet (TILL)		4	SS	21		67		○		
			5	SS	10				○		12 48 27 13
							66				
			6	SS	2	▼	65		○		
							64				
63.5			7	SS	50/0.075				○		
6.2	**BEDROCK**, limestone with shale interbeds, thinly laminated, dark grey Very broken from 6.4m to 6.6m and 6.7m to 6.9m		1	RUN			63			FI 4 8	RUN #1 TCR=100% SCR=24% RQD=24% UCS=87MPa (Average)
			2	RUN			62			5 0 0 1 1	RUN #2 TCR=100% SCR=80% RQD=100% UCS=76MPa (Average)
			3	RUN			61			0 0	RUN #3 TCR=100% SCR=100% RQD=86%
60.4										2	
9.2	END OF BOREHOLE AT 9.2m. WATER LEVEL AT 6.3m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe										UCS=57MPa (Average)

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 PD-07 2 OF 2 METRIC

W.P. 4068-10-00 LOCATION N 5 028 917.8 E 365 324.1 ORIGINATED BY GM

HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2012.11.06 - 2012.11.07 CHECKED BY LRB

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										
	with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov. 21/12 4.3 65.3 Dec. 05/12 4.7 64.9										

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

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

ONTMT4S 1201C.GPJ 2012TEMPLATE(MTO).GDT 10/29/13

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PD-08 1 OF 2 METRIC

W.P. 4068-10-00 LOCATION N 5 028 951.3 E 365 381.3 ORIGINATED BY GM

HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2012.11.07 - 2012.11.07 CHECKED BY LRB

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 (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	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
68.0											
0.0	**SAND** and **SILT**, trace to some gravel, occasional rootlets and wood fragments Loose to Compact Brown Damp (FILL)		1	SS	7		68		○		
			2	SS	17		67		○		4 49 35 12
65.9			3	SS	14		66		○		
2.1	Silty **SAND**, trace to some gravel, trace to some clay, occasional cobbles Very Loose to Very Dense Grey Damp (TILL)		4	SS	13				○		
			5	SS	2		65		○		
			6	SS	49		64		○		13 53 24 10
			7	SS	82/ 0.275		63		○		
61.2							62				
6.8	**BEDROCK**, limestone with shale interbeds, dark grey Diagonal fracture at 6.9m		1	RUN			61			FI 5	RUN #1 TCR=100% SCR=64% RQD=0% UCS=158MPa (Average)
			2	RUN			60			4 1 0 1 1	RUN #2 TCR=89% SCR=78% RQD=83% UCS=43MPa (Average)
			3	RUN			59			0 1 2	RUN #3 TCR=100% SCR=98% RQD=90% UCS=91MPa (Average)
58.2											
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
10

ONTMT4S 1201C.GPJ 2012TEMPLATE(MTO).GDT 10/29/13

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PD-08 2 OF 2 METRIC

W.P. 4068-10-00 LOCATION N 5 028 951.3 E 365 381.3 ORIGINATED BY GM

HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2012.11.07 - 2012.11.07 CHECKED BY LRB

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 (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE BACKFILLED WITH BENTONITE AND CUTTINGS TO SURFACE.										

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

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

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Ontario

THURBER

RECORD OF BOREHOLE No PD-09 1 OF 1 METRIC

W.P. 4068-10-00 LOCATION N 5 028 991.7 E 365 446.5 ORIGINATED BY GM

HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2012.11.07 - 2012.11.07 CHECKED BY LRB

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
68.0											
0.0	**SAND**, some silt, trace gravel, occasioanl brick and wood frgaments Compact Dark Brown Damp (FILL)		1	SS	26		68				
67.1											
0.9	**SAND** and **SILT**, some gravel, trace rootlets Loose Brown Damp (FILL)		2	SS	9		67				
			3	SS	10		66				
65.7											
2.3	Silty **SAND**, some clay, trace gravel Compact to Very Dense Grey Wet (TILL)		4	SS	18						
			5	SS	10		65				8 50 31 11
							64				
63.0			6	SS	69					FI	
5.0	**BEDROCK**, limestone with shale interbeds, dark grey		1	RUN			63			5	RUN #1 TCR=100% SCR=100% RQD=63% UCS=70MPa (Average)
			2	RUN			62			1 3 0 0	RUN #2 TCR=100% SCR=100% RQD=84% UCS=101MPa (Average)
			3	RUN			61			1 0 0 1	RUN #3 TCR=100% SCR=100% RQD=100% UCS=152MPa (Average)
60.0										2	
8.0	END OF BOREHOLE AT 8.0m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov. 08/12 1.6 66.4 Nov. 21/12 1.3 66.7 Dec. 05/12 1.4 66.6										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PD-10 1 OF 1 METRIC

W.P. 4068-10-00 LOCATION N 5 029 025.5 E 365 512.5 ORIGINATED BY GM

HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2012.11.19 - 2012.11.19 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / 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
70.7											
0.0	**ASPHALT:** (125mm)										
0.1	Gravelly **SAND**, some silt Loose to Compact Dark Brown/Grey Damp (FILL)		1	SS	14		70	○	○		
	Occasional wood fragments		2	SS	8		69		○		
			3	SS	13		68		○		32 57 11 (SI+CL)
67.1			4	SS	8				○		
3.6	**BEDROCK**, limestone with shale interbeds, dark grey		1	RUN			67			FI 4 1 3	RUN #1 TCR=60% SCR=32% RQD=32% UCS=193MPa (Average)
			2	RUN			66			2 0 2	RUN #2 TCR=100% SCR=58% RQD=92% UCS=109MPa (Average)
			3	RUN			65			1 0 2	RUN #3 TCR=100% SCR=100% RQD=97% UCS=99MPa (Average)
63.5							64			0 2 1	
7.2	END OF BOREHOLE AT 7.2m. BOREHOLE BACKFILLED WITH BENTONITE AND CUTTINGS, WITH ASPHALT PATCH AT SURFACE.										

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

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

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Appendix B

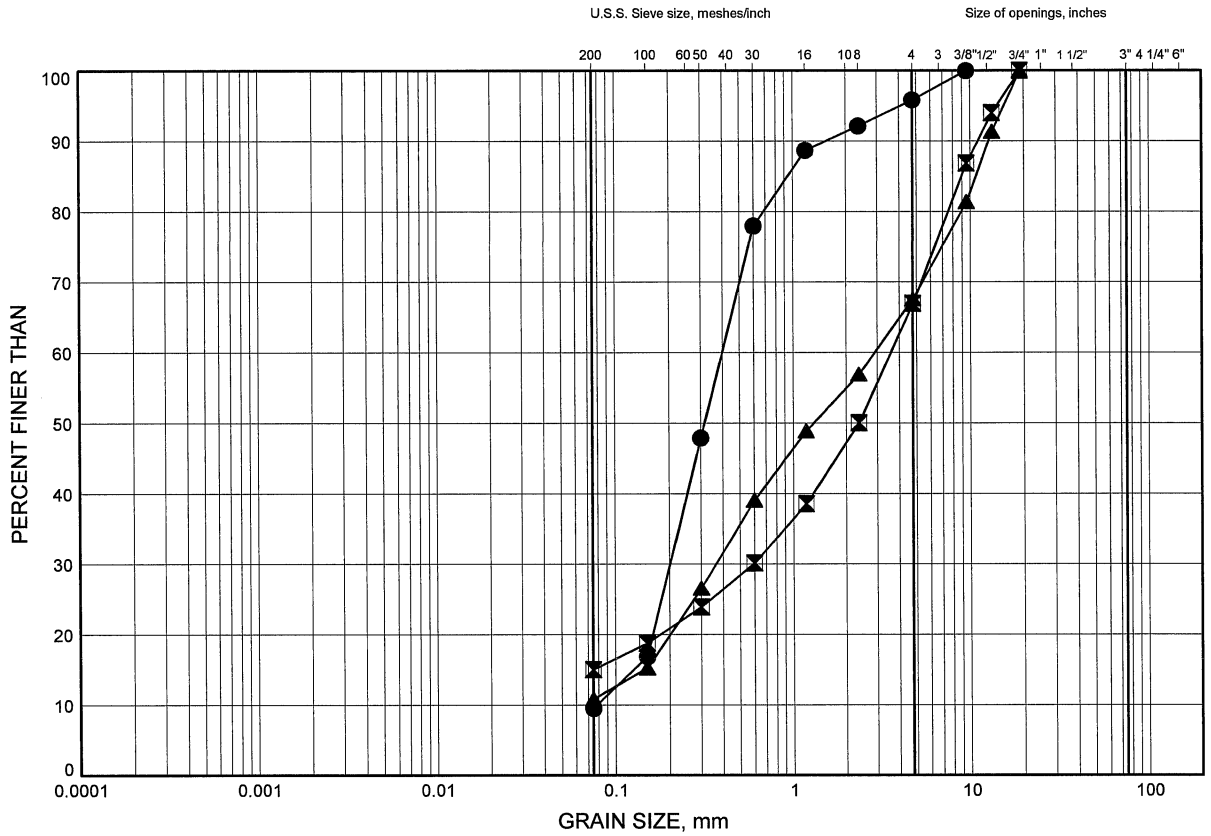
Laboratory Test Results

Highway 417 Ottawa: Parkdale Avenue Improvement

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND to GRAVELLY SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PD-05	1.13	69.40
⊠	PD-06	0.46	70.73
▲	PD-10	2.59	68.12

Date March 2013

W.P. 4068-10-00

THURBER

Prep'd AN

Chkd. LRB

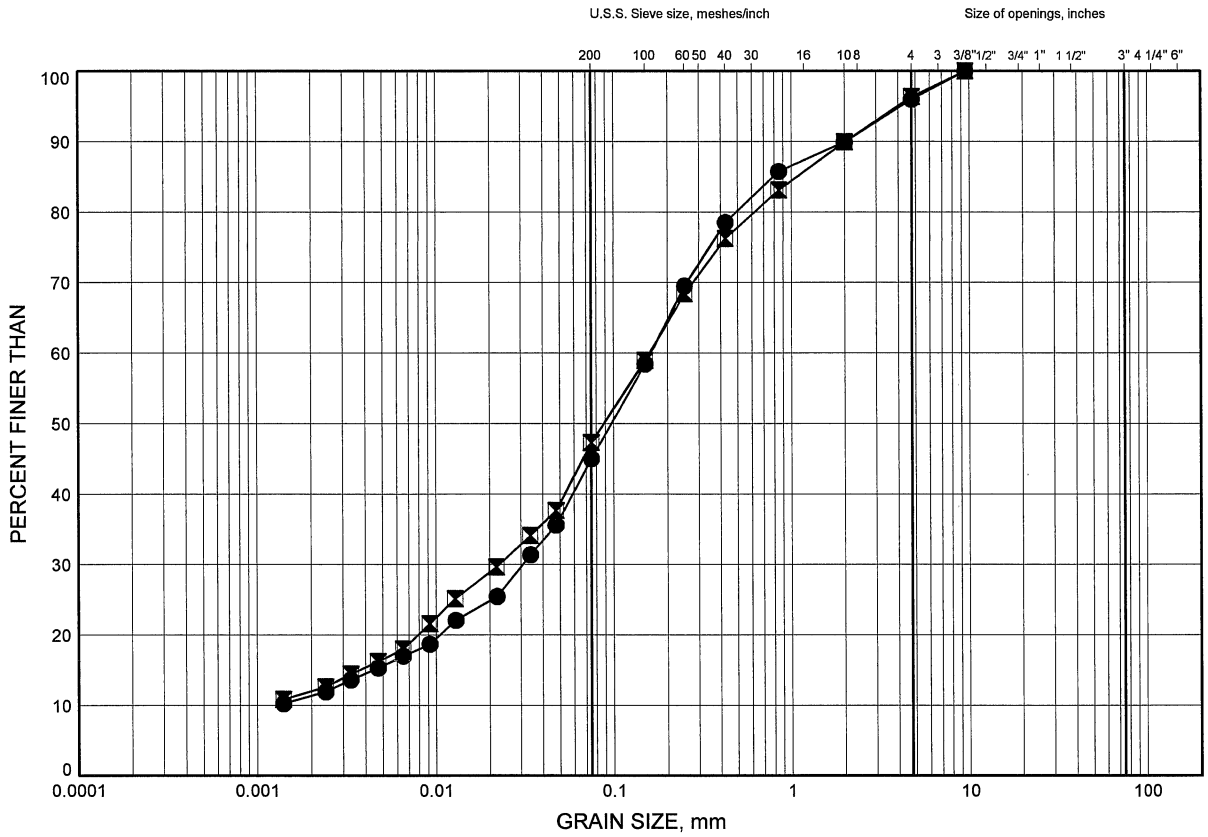
GRAIN SIZE DISTRIBUTION - THURBER 1201C.GPJ 3/14/13

Highway 417 Ottawa: Parkdale Avenue Improvement

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND & SILT FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PD-07	1.07	68.58
⧓	PD-08	1.07	66.96

Date March 2013

W.P. 4068-10-00

THURBER

Prep'd AN

Chkd. LRB

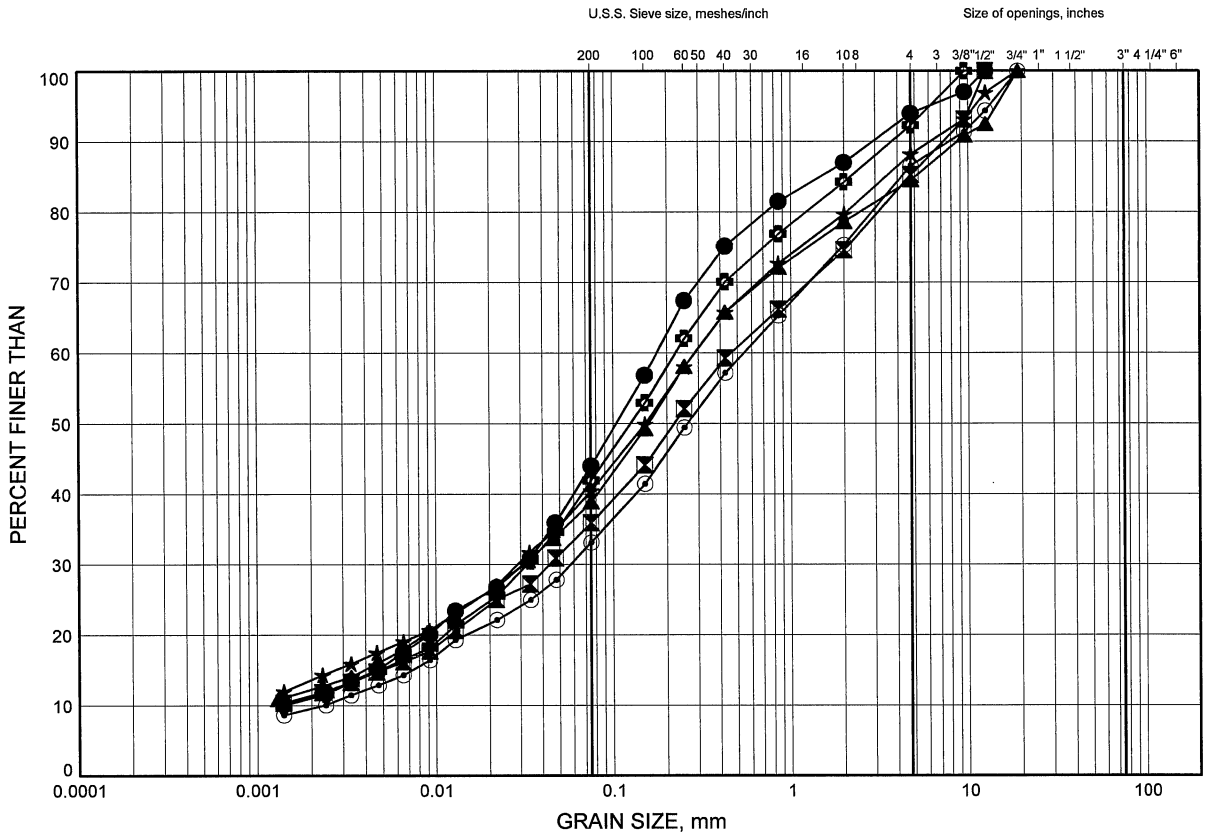
GRAIN SIZE DISTRIBUTION - THURBER 1201C.GPJ 3/14/13

Highway 417 Ottawa: Parkdale Avenue Improvement

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PD-01	1.83	66.37
⊠	PD-02	3.35	64.12
▲	PD-03	1.83	65.28
★	PD-07	3.35	66.29
⊙	PD-08	4.88	63.15
✿	PD-09	3.35	64.68

Date March 2013

W.P. 4068-10-00

THURBER

Prep'd AN

Chkd. LRB

GRAIN SIZE DISTRIBUTION - THURBER 1201C.GPJ 3/14/13

Appendix C

Data from Previous Investigations

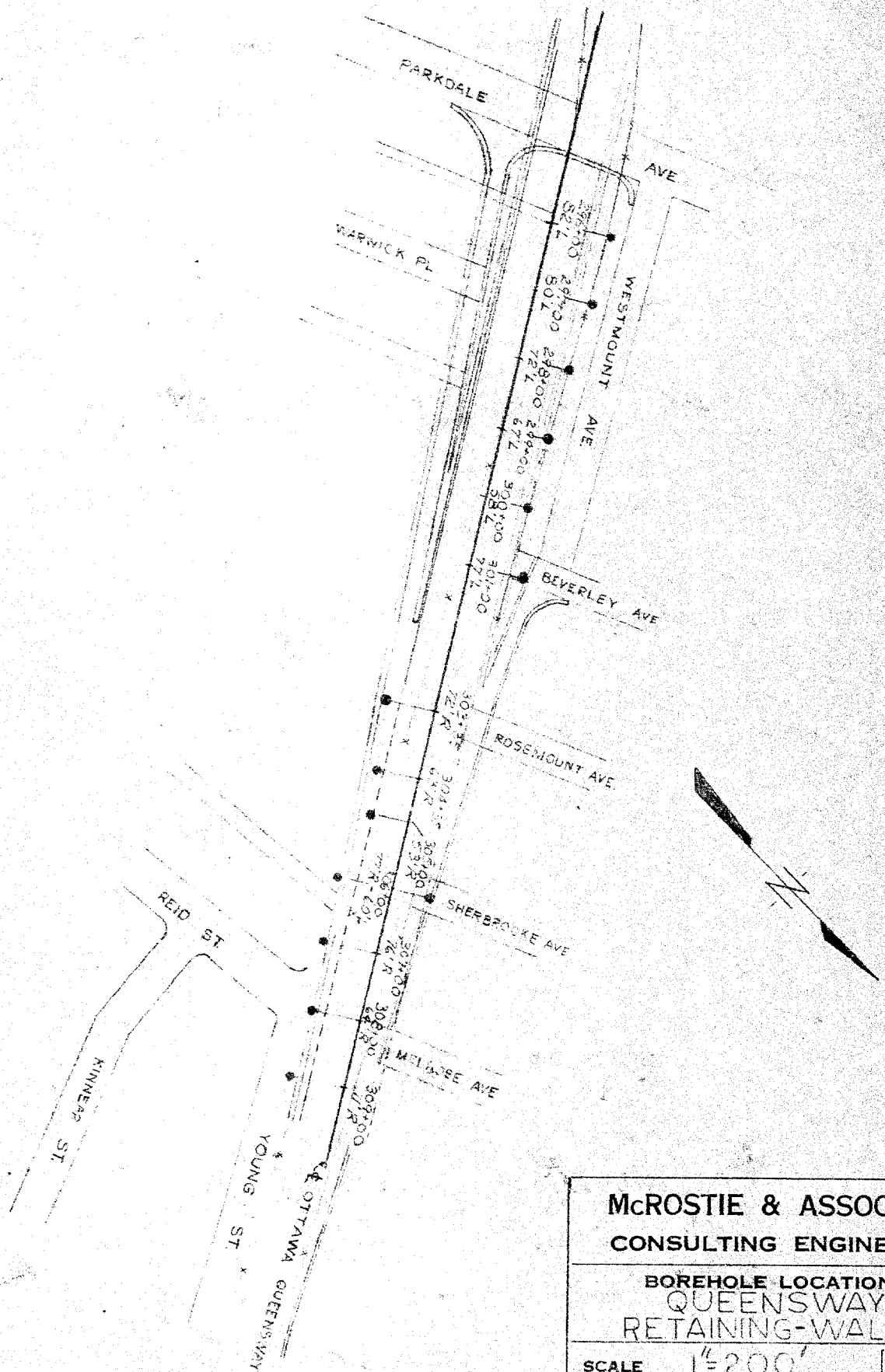
Soils Survey Data from Contract No. 80-58, W.P. No. 246-77-01

Parkdale Avenue E-N/S Ramp Realignment

Borehole No. (Appendix D)	Depth (m)	Soil Type
1	0 – 0.15 0.15 – 2.4	Brown sand topsoil Brown silty sand
2	0 – 0.15 0.15 – 2.4	Brown sand topsoil Brown silty sand
3	0 – 2.4	Brown silty sand
4	0 – 0.15 0.15	Brown sand topsoil No further penetration - bedrock
5	0 – 0.15 0.15 – 0.3 0.3	Brown sand topsoil Brown silty clay No further penetration – bedrock
6	0 – 0.15 0.15 – 1.4 1.4	Brown sand topsoil Brown silty clay No further penetration – possible bedrock
7	0 – 0.15 0.15 – 1.2 1.2	Brown sand topsoil Brown silty clay with gravel No further penetration – possible bedrock
8	0 – 0.15 0.15 – 2.4	Brown sand topsoil Brown silty clay

* All boreholes were advanced with a power hand-auger, October 1979 to April 1980.

FORM S-11-2



McROSTIE & ASSOCIATES
CONSULTING ENGINEERS

BOREHOLE LOCATIONS
QUEENSWAY
RETAINING-WALLS

SCALE 1"=200'

PLATE 1

FORM S-10-2 REV.

McROSTIE & ASSOCIATES
CONSULTING ENGINEERS
OTTAWA CANADA

SOIL PROFILE AND SUMMARY OF FIELD AND LABORATORY TESTS

OTTAWA QUEENSWAY

ELEVATION OF GROUND SURFACE (ZERO DEPTH) 245.9 DATE Apr. 17/59

REMARKS Elevation referred to Geodetic datum. North of Abandoned C.N.R. Right-Of-Way

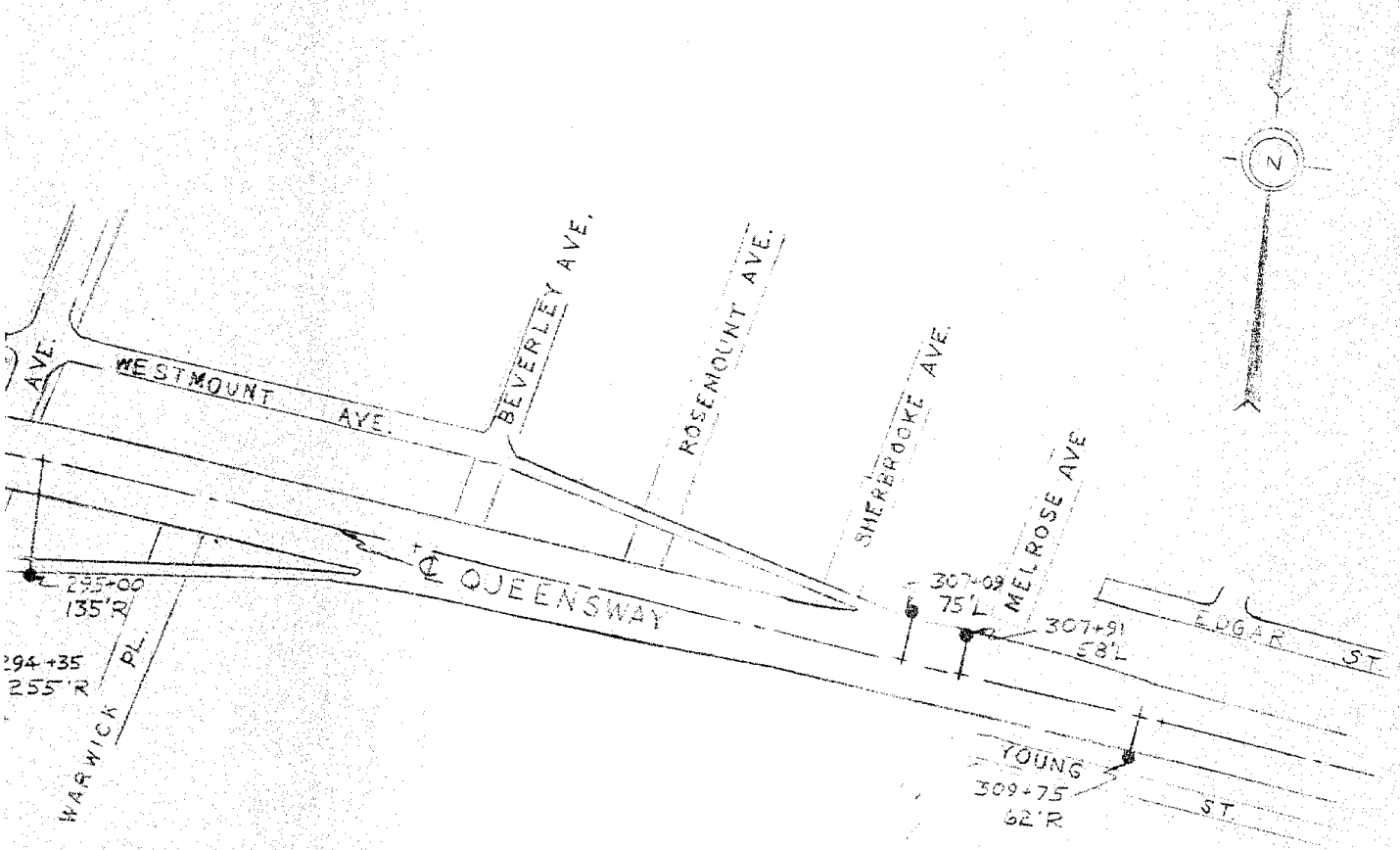
HOLE NO. 306 + 00 60' Left

UNCONFINED COMPRESSIVE STRENGTH KIPS/FT.²	SMALL SCALE PENETROMETER KIPS/FT.²	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION	PROBING OR VANE TEST (.....LB. HAMMER, ...INCH DROP; NO CASING, ...INCH DIA. ROD; BLOWS PER FOOT OR SHEAR STRENGTH IN KIPS PER FT.²)
				GROUND SURFACE	0	245.9	
				Fill (Asphalt, Sand & Gravel)	1.8	244.1	
				Weathered Or Broken Rock, Core Recovery 67%	5.2	240.7	
				Rock Partly Weathered & Broken Shaley Limestone & Limey Shale Bedding 30° to 40° To Horizontal. Core Recovery 76%	9.8	236.1	Hole Dry Overnight
				Bottom of Hole			

% WATER CONTENT
NATURAL ○
LIQUID LIMIT □
PLASTIC LIMIT △

PLATE 17

L.-M. CO.—A31832



McROSTIE & ASSOCIATES LTD.
CONSULTING ENGINEERS

BOREHOLE LOCATIONS
QUEENSWAY
RETAINING WALLS #2

SCALE 1"=200 PLATE 1

FORM S-10-4

McROSTIE & ASSOCIATES
CONSULTING ENGINEERS
OTTAWA CANADA

SOIL PROFILE AND SUMMARY OF FIELD AND LABORATORY TESTS

QWY. RETAINING WALLS #2

ELEVATION OF GROUND SURFACE (ZERO DEPTH) 243.9' DATE FEB. 1/60

HOLE NO. 307+09 75'L.

REMARKS SEE PLATE II FOR MECHANICAL ANALYSIS OF SAMPLE

ELEVATIONS GEODETIC

UNCONFINED COMPRESSIVE STRENGTH KIPS/FT.²	SMALL SCALE PENETROMETER KIPS/FT.²	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION
				GROUND SURFACE	0	243.9'
				TOPSOIL	1'	
				FINE SAND	4'	239.9'
		39	1	DENSE TILL		
		36	2		11.5'	232.4
				MEDIUM DENSE TILL		
		17	3		17.5'	226.4'
		52	4	DENSE TILL	20'	
		24 per 6"	5	DENSE SANDY TILL	22.5'	221.4'
		4" DROP		FRACTURED ROCK		
				CORE RECOVERY - 64%	27.2'	
				ROCK CORE RECOVERY 100%	27.7'	
				ROCK CORE RECOVERY - 92%	28.8'	215.1
				BOTTOM OF HOLE		

PROBING OR VANE TEST

..... LB. HAMMER
..... INCH DROP
NO CASING
..... INCH DIA. ROD
BLOWS PER FOOT OR SHEAR STRENGTH IN KIPS PER FT.²

OVER-NIGHT WATER LEVEL 231.5'

0 10 20 30 40 50
% WATER CONTENT
NATURAL ○
LIQUID LIMIT □
PLASTIC LIMIT △

PLATE 6

R - REMOULDED

L.-M. CO.—A35376

FORM S-10-4

McDONSTIE & ASSOCIATES
CONSULTING ENGINEERS
OTTAWA CANADA

SOIL PROFILE AND SUMMARY OF FIELD AND LABORATORY TESTS

QWY RETAINING WALLS #2

ELEVATION OF GROUND SURFACE (ZERO DEPTH) 237.7' DATE JAN. 29/60

HOLE No. 307+91 58' L.

REMARKS SEE PLATE 12 FOR MECHANICAL ANALYSIS OF SAMPLE.

ELEVATIONS GEODETIC

UNCONFINED COMPRESSIVE STRENGTH KIPS/FT.²	SMALL SCALE PENETROMETER KIPS/FT.²	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION
				GROUND SURFACE	0	237.7'
				GRAVEL	0.3	
				FINE SAND		
					4.5	233.2'
		20	1	MEDIUM DENSE TILL		
					6.5	231.2'
				LOOSE TILL		
		10	2			
				DENSE TILL	12.5	225.2'
		9 for 6" 18	3	MEDIUM DENSE TILL	13.0	
					15'	
		46	4	DENSE TILL		
					16.7	221.0'
		32	5	DENSE SILTY FINE SAND		
					19'	218.7
		17	6	MEDIUM DENSE SILTY FINE SAND		
					21.5	216.2'
				BOTTOM OF HOLE		

PROBING OR VANE TEST

.....LB. HAMMER
.....INCH DROP
NO CASING
.....INCH DIA. ROD

BLOWS PER FOOT OR SHEAR STRENGTH IN KIPS PER FT.²

OVER-NIGHT WATER LEVEL 228.9

0 10 20 30 40 50

% WATER CONTENT
NATURAL ○
LIQUID LIMIT □
PLASTIC LIMIT △

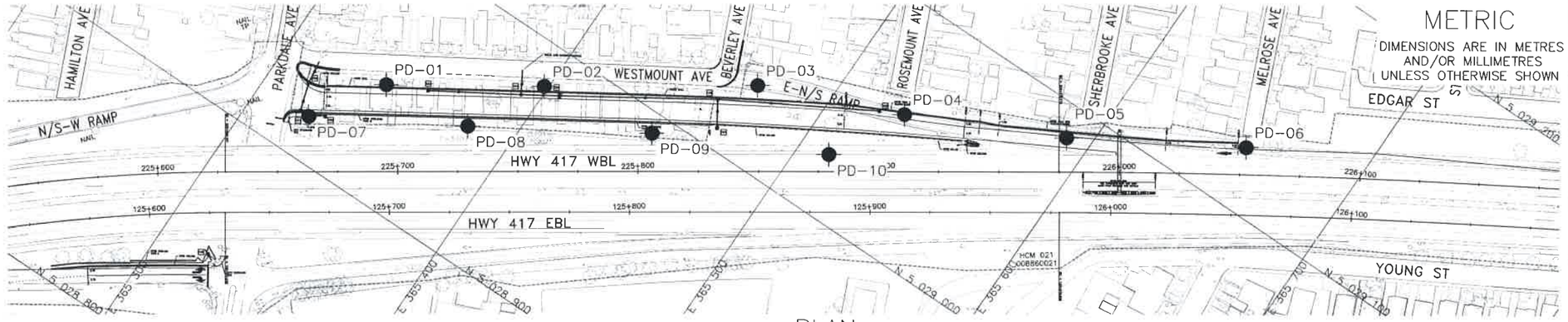
PLATE 7

R - REMOULDED

L.-M. CO.—A33376

Appendix D

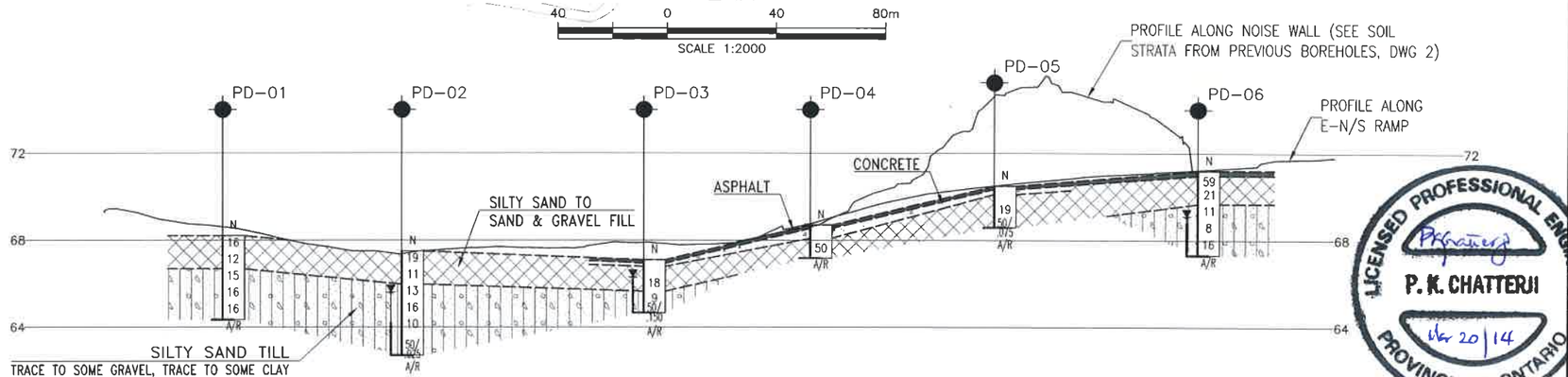
Borehole Location and Soil Strata Drawing



PLAN

40 0 40 80m

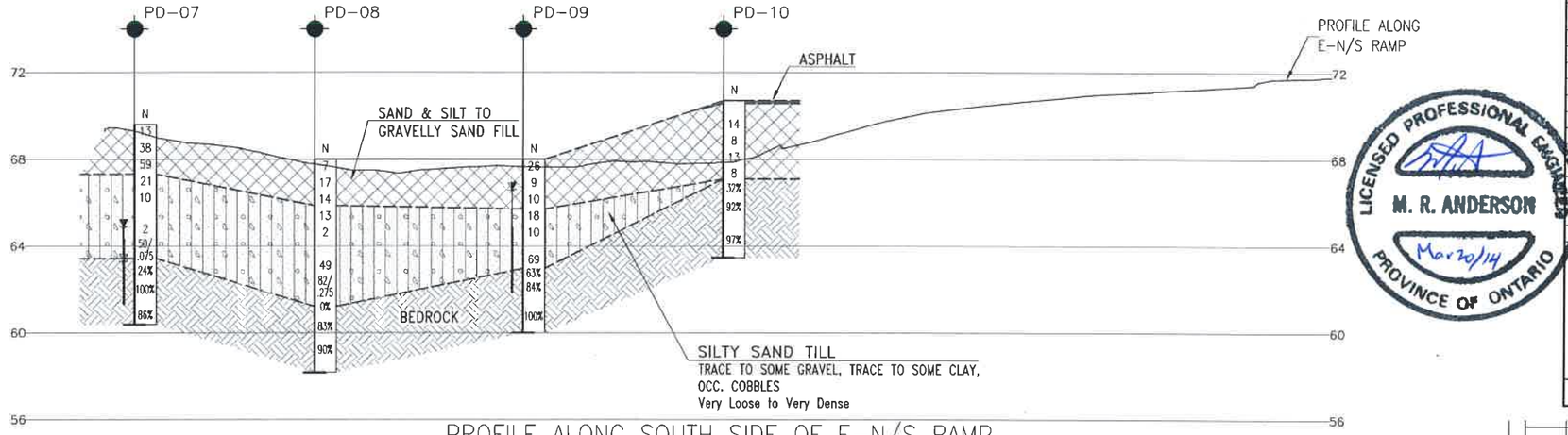
SCALE 1:2000



PROFILE ALONG NORTH SIDE OF E-N/S RAMP

40 0 40 80m H 1:2000

5 0 5 10m V 1:250



PROFILE ALONG SOUTH SIDE OF E-N/S RAMP

40 0 40 80m H 1:2000

5 0 5 10m V 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No

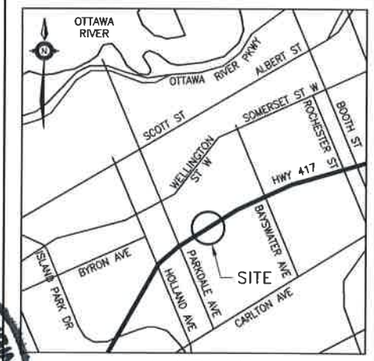
WP No 4068-10-00

SHEET

HIGHWAY 417
E-N/S RAMP
AT PARKDALE AVENUE
BOREHOLE LOCATIONS AND SOIL STRATA

McCORMICK RANKIN

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

●	Current Borehole by Thurber
⊕	Previous Borehole by Others
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level During Drilling
▼	Water Level In Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
PD-01	68.2	5 028 946.8	365 343.5
PD-02	67.5	5 028 982.9	365 398.3
PD-03	67.1	5 029 032.9	365 471.6
PD-04	68.7	5 029 057.0	365 529.0
PD-05	70.5	5 029 086.7	365 590.2
PD-06	71.2	5 029 125.4	365 654.2
PD-07	69.6	5 028 917.8	365 324.1
PD-08	68.0	5 028 951.3	365 381.3
PD-09	68.0	5 028 991.7	365 446.5
PD-10	70.7	5 029 025.5	365 512.5

-NOTES-

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

GEOCRES No. 31G5-255

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Mar 20/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Mar 20/14
PROVINCE OF ONTARIO

REVISIONS

DATE	BY	DESCRIPTION

DESIGN	MRA	CHK	AEC	CODE		LOAD	DATE MAR 2014
DRAWN	MFA	CHK	MRA	SITE		STRUCT	DWG 1

MINISTRY OF TRANSPORTATION, ONTARIO

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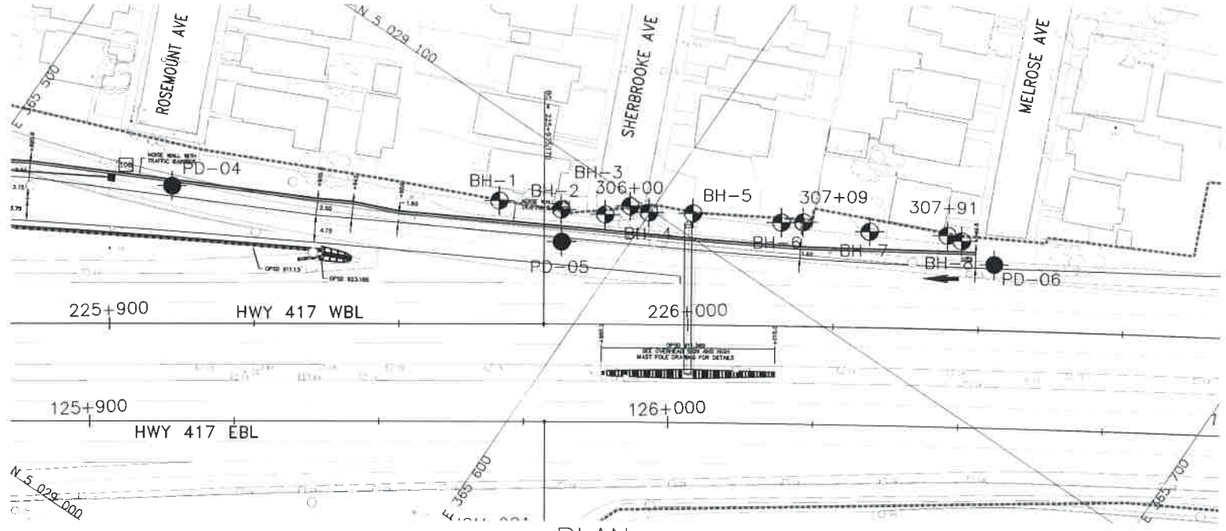
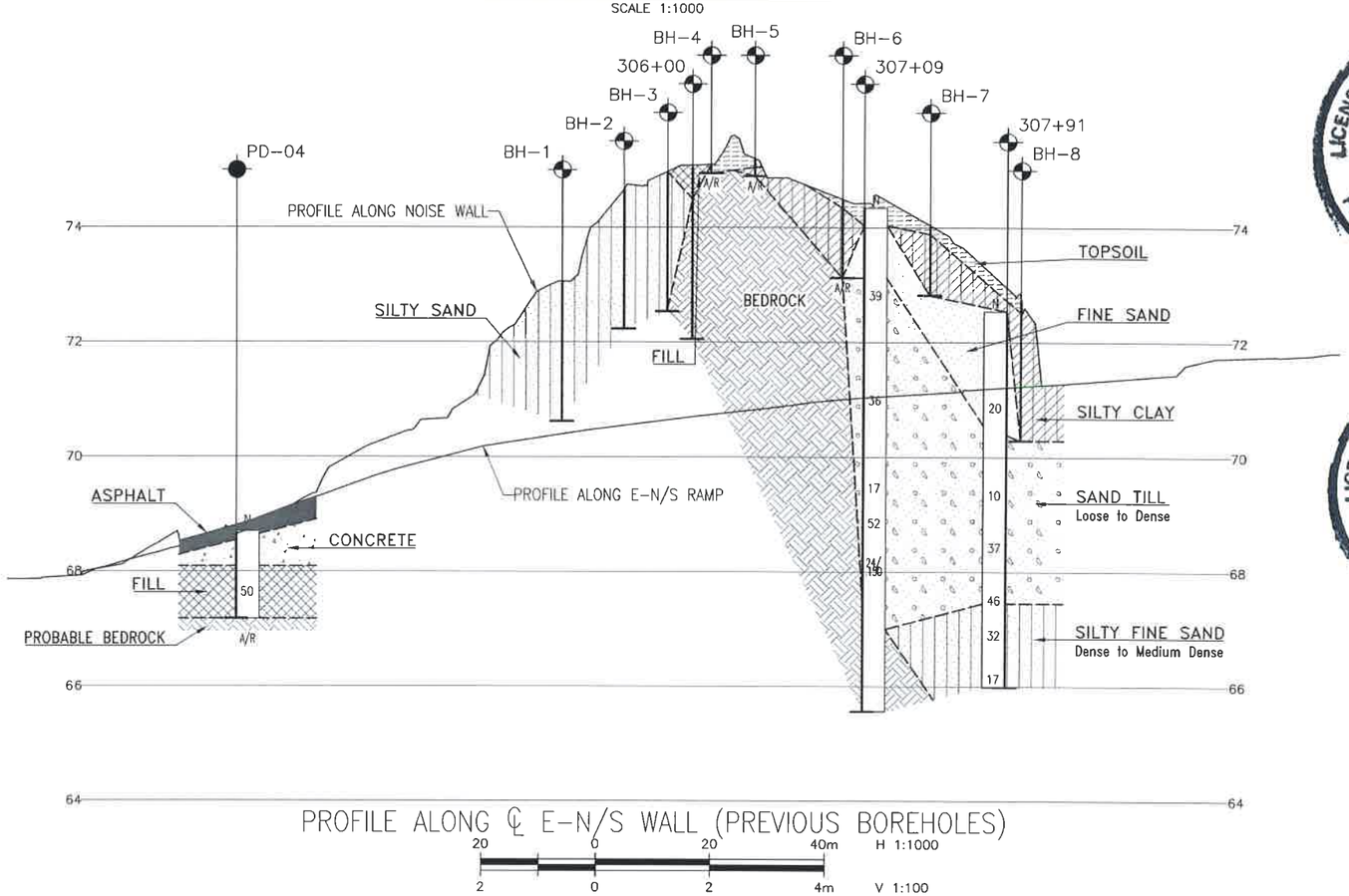


PLAN

20 0 20 40m

SCALE 1:1000



PROFILE ALONG ℄ E-N/S WALL (PREVIOUS BOREHOLES)

20 0 20 40m H 1:1000

2 0 2 4m V 1:100

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

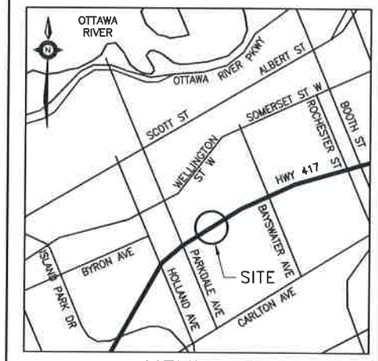
CONT No
WP No 4068-10-00

HIGHWAY 417
E-N/S RAMP
AT PARKDALE AVENUE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MRC McCORMICK RANKIN

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

●	Current Borehole by Thurber
⊕	Previous Borehole by Others
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level During Drilling
▼	Water Level In Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
306+00	75.0	5 029 098.5	365 596.5
307+09	74.3	5 029 113.0	365 622.8
307+91	72.5	5 029 125.1	365 644.6
BH-1	73.1	5 029 086.6	365 577.3
BH-2	74.7	5 029 091.3	365 586.9
BH-3	75.0	5 029 094.9	365 593.7
BH-4	75.1	5 029 099.4	365 599.8
BH-5	75.2	5 029 103.6	365 606.2
BH-6	74.5	5 029 110.9	365 619.7
BH-7	74.0	5 029 118.1	365 633.2
BH-8	72.7	5 029 125.6	365 647.2

-NOTES-

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M. R. ANDERSON
Mar 21/14
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MRA	CHK	AEG	CODE	LOAD
DRAWN	MFA	CHK	MRA	SITE	STRUCT

DATE MAR 2014
DWG 2

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