

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 401 UNDERPASS AT NORWICH AVENUE
CITY OF WOODSTOCK, ONTARIO
SITE 23-170, G.W.P. 3054-13-00**

GEOCREs No.: 40P2-78

**Report to
MMM Group Limited**

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the results of a foundation investigation completed at the location of a proposed replacement of the Highway 401 Underpass at Norwich Avenue (Highway 59) near Woodstock, Ontario. The replacement of the Norwich Avenue structure constitutes part of the Highway 401 improvement project.

The purpose of this investigation was to explore the subsurface conditions at the project site and, based on the data obtained and available archive data, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions presented in the report was developed from the compilation of data obtained in the course of the current and previous investigations.

A previous foundation investigation was carried out at this site in 1990 for the-then proposed widening of Highway 401. The results of the investigation were documented in the MTO report titled "Foundation Investigation and Design Report for Highway 59 Underpass and Athlone Avenue (N/S-W Ramp), W.P. 481-89-03, Site 23-170, Highway 401, District 2, London, GEOCRES 40P2-45", dated September, 1990. The information presented in the above noted report was reviewed and incorporated in this report. Relevant Record of Borehole sheets and the Borehole Location and Soil Strata drawing are enclosed in Appendix F, for reference.

Thurber Engineering Ltd. (Thurber) carried out the investigation as a sub-consultant to MMM Group Limited (MMM) under the Ministry of Transportation (MTO) Agreement Number 3013-E-0027.

2 SITE DESCRIPTION

The site of the underpass is located at the intersection of Highway 401 and Norwich Avenue (Highway 59), south of the City of Woodstock. At the project site, Norwich Avenue runs generally in the north-south direction and Highway 401 runs in the west-east direction. The existing bridge is a single span structure approximately 33 m in length and accommodates two lanes of traffic in each

direction; with the middle lane used for left-turn traffic immediately north and south of the structure. The existing interchange ramps are in a diamond configuration.

The surrounding land use generally consists of a mixture of commercial properties to the west, north and east of the project site with agricultural land and a golf course located to the south.

Photographs of the bridge and surrounding area are presented in Appendix D.

The topography of the site is generally undulating with drumlins to the south and southeast. The site is situated in the Physiographic Region known as the Oxford Till Plain characterized by drumlinized till deposits. The surficial deposits contain mainly silt with variable amounts of clay, sand and gravel particles.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project was carried out between November 10 and 17, 2014 and between December 14 and 16, 2015, and consisted of drilling and sampling a total of thirteen (13) boreholes, identified as NW-01 to NW-10 and PA-01 to PA-03. During the 2014 field investigation, two boreholes (NW-02 and NW-03) were drilled at the location of the north bridge abutment, one borehole (NW-04) at the south abutment and the remainder of boreholes, namely Boreholes NW-05 to NW-10, were advanced along the proposed realignment of the Norwich Avenue embankment to the north and south of the bridge. During the 2015 investigation, additional three boreholes denoted as PA-01 to PA-03 were drilled along Pattullo Avenue West located to the south of the Underpass Structure. Boreholes were extended to depths ranging from 6.4 to 15.8 m below the existing ground surface. The approximate borehole locations are shown on the Borehole Locations and Soil Strata Drawings included in Appendix E.

Prior to commencement of drilling, utility clearances were obtained for all borehole locations. In 2014, drilling was carried out using a track mounted CME 55 drill rig with solid stem augers; during the 2015 investigation, drilling was conducted using Diedrich D-120 with hollow stem augers. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with 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 in Oakville, Ontario for further examination and testing.

Groundwater conditions were observed in the open boreholes during and upon completion of the drilling operations. Three standpipe piezometers were installed in the boreholes. Two piezometers consisted of 25 mm Schedule 40 PVC pipe with a 1.5 m long slotted screen were installed at alternate corners of the structure within boreholes NW-02 and 04, and a piezometer consisting of 19 mm Schedule 40 PVC pipe with a 3 m long slotted screen was installed in Borehole PA-01 on Pattullo Avenue West. The piezometers screens were enclosed in filter sand to permit groundwater level monitoring. Following the final water level reading, the piezometers were decommissioned and

boreholes backfilled in general accordance with MOE Regulation 903. Details of the borehole depths, base elevations and completion details are summarized in Table 3.1 below.

Table 3-1. Borehole Installation and Backfilling Details

Borehole	Borehole Depth/ Base Elevation (m)	Borehole Backfilling Details
NW-01	10.2 / 285.5	Backfilled with bentonite holeplug and cuttings to surface.
NW-02	14.0 / 289.9	Piezometer with 1.5 m slotted screen installed with tip at 12.2 m/Elev. 291.8. Filter to 10.4 m, bentonite holeplug to 9.8 m, bentonite holeplug and cuttings to 600 mm then concrete to surface.
NW-03	11.0 / 284.5	Backfilled with bentonite holeplug and cuttings to surface.
NW-04	10.8 / 282.4	Piezometer with 1.5 m slotted screen installed with tip at 9.1 m /Elev. 284.1. Sand filter to 7.3 m, bentonite holeplug to 6.7 m, bentonite holeplug and cuttings to surface.
NW-05	10.1 / 282.3	Backfilled with bentonite holeplug and cuttings to surface.
NW-06	6.4 / 292.3	Backfilled with bentonite holeplug and cuttings to surface.
NW-07	6.7 / 285.4	Backfilled with bentonite holeplug and cuttings to surface.
NW-08	6.7 / 287.6	Backfilled with bentonite holeplug and cuttings to surface.
NW-09	6.7 / 285.3	Backfilled with bentonite holeplug and cuttings to surface.
NW-10	6.7 / 284.9	Backfilled with bentonite holeplug and cuttings to surface.
PA-01	15.8 / 274.4	Piezometer with 3.0 m slotted screen installed with tip at 11.9 m/Elev. 278.3. Filter to 8.5 m, bentonite holeplug to surface.
PA-02	15.8 / 276.3	Backfilled with bentonite holeplug and cuttings to surface.
PA-03	15.8 / 279.5	Backfilled with bentonite holeplug and cuttings 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 gradation analysis (hydrometer and/or sieve) and Atterberg Limits testing, where appropriate. The results of these tests are summarized on the Record of Borehole sheets included in Appendix A, and are presented on the figures included in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix A and on the “Borehole Locations and Soil Strata” drawings included in Appendix E.

A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description for interpretation of the site conditions. It should be recognised that soil conditions may vary between and beyond borehole locations.

The subsurface information documented in the 1990 MTO report (Geocres 40P2-45) was reviewed and relevant borehole information utilized in preparation of this report to supplement the soil stratigraphy at the pier and abutments. The Record of Boreholes 1 to 7, and the Borehole Location and Soil Strata drawing from the above report are enclosed in Appendix F.

In summary, the soil stratigraphy below the fill materials and topsoil generally consists of a native deposit of sandy silt and silty clay to clayey silt believed to be of the glaciolacustrine origin, underlain by a very dense cohesionless till and very stiff to hard silty clay till. The water levels in the piezometers installed in Borehole NW04 and PA-01 were measured at 3.5 m depth (Elev. 289.7) and 5.5 m depth (Elev. 284.7), respectively. In Borehole NW-02, the piezometer was dry.

Descriptions of the individual strata are presented below.

5.1 Pavement Structure

Borehole NW-02 was drilled through the existing Norwich Avenue north approach and encountered a pavement structure consisting of approximately 125 mm of asphalt overlying 1.4 m of granular road base extending to a 1.5 m depth (Elev. 302.4). In Boreholes PA-01 to PA-03 drilled through the shoulder of Pattullo Avenue, the road base was encountered extending to a depth between 2.1 m and 2.3 m or to Elev. 288.1 and Elev. 283.0, respectively. The granular road base was predominantly sand and gravel with trace to some silt. A silty sand layer with some clay was noted in Borehole PA-01 at 0.8 m depth. SPT tests performed in this material gave N-values ranging from 9 to 34 blows per 0.3 m of penetration, indicating a loose to dense relative density. Moisture contents within this fill varied from 2 to 10%.

Grain size analysis was completed on a sample of the road base material. The results are summarized on the Record of Borehole sheet in Appendix A, and the grain size distribution curve for the sample is included in Figure B1 of Appendix B. The results of the tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	16 to 44
Sand	42 to 56
Silt	31
Clay	11
Silt and Clay	7 to 13

5.2 Topsoil

A surficial layer of topsoil was encountered in the remaining boreholes (NW-01 and NW-03 through NW-10) drilled adjacent to the west side of Norwich Avenue. The thickness of the topsoil layer varied from 125 to 150 mm.

Boreholes 3 to 5 from the 1990 investigation encountered 200 mm to 700 mm of topsoil/organic soil.

5.3 Embankment Fill

Boreholes NW-02 and 7 (1990 investigation) were advanced from the top of the existing Norwich Avenue approaches to the bridge and encountered an embankment fill. The fill was classified as sandy clayey silt in Borehole NW-02 drilled on the north side of the bridge. In Borehole 7, drilled on the south site, the fill was described as sand with some silt and some gravel. The fill extended to a depth of 6.1 m (Elev. 297.8) in Borehole NW-02, and to 5.9 m depth (Elev. 295.6) in Borehole 7. SPT tests performed in the sandy clayey silt fill gave N-values between 8 and 31 blows per 0.3 m of penetration, indicating a stiff to hard consistency of the material. The sand fill (on the north side) was compact to dense.

Moisture contents within the cohesive fill varied from 10 % to 16%; no moisture content measurements were available for Borehole 7 completed in 1990. The Atterberg Limits testing was performed on a sample of this fill and a Liquid Limit of 25% and Plasticity Index of 9 % was obtained (Figure B6 in Appendix B) indicating low plasticity of this material.

Boreholes NW-06 to NW-10 were drilled along the west toe of the Norwich Avenue embankment and encountered as much as 2.8 m of fill. The fill in Borehole NW-06 located on the north side of the bridge consisted of approximately 1.4 m of sand and silt with some clay and occasional cobbles. The base of this fill was encountered at 1.5 m depth (Elev. 297.2).

The fill in Boreholes NW-07 to NW-010 located on the south side of the bridge consisted of predominantly granular material ranging in composition from silt to sand and silt with trace to some gravel and clay. The granular fill thickness ranged from 1.3 m to 2.8 m, with the base of fill encountered between Elev. 290.5 and Elev. 291.3. SPT tests performed in the granular fill gave N-values between 7 and 18 blows per 0.3 m of penetration, indicating a loose to compact relative density. Moisture contents within the granular fill varied from 15 to 22 %.

In Borehole NW-10, a 0.6 m thick layer of clayey silt fill was encountered below the topsoil with the base at Elev. 290.8. One SPT test performed in this fill gave N-value of 18 blows per 0.3 m of penetration, indicating a very stiff consistency. Moisture content of 20 % was measured in this fill.

The fill in Boreholes PA-01 to PA-03 located along Pattullo Avenue West consisted of predominantly silty sand to sand silt with trace to some gravel, some clay and occasional cobble. Frequent silty clay lenses were noted within this fill material. The fill thickness

ranged from 3.8 m to 5.0 m. The base of the fill was encountered between Elev. 284.1 in Borehole PA-01 and Elev. 289.2 in Borehole PA-03.

SPT tests performed in the fill gave N-values between 1 and 30 blows per 0.3 m of penetration, indicating a very loose to compact relative density. A very loose fill zone in Boreholes PA-01 and PA-02 between 2.1 m and 3.8 m depth may indicate presence of soft silty clay lenses in the fill, as no water was observed during drilling. Borehole PA-02 was dry on completion of drilling operations, and the water level in Borehole PA-01 was encountered at 9.2 m depth, below the soft zones.

In Borehole PA-01, a 900 mm layer of sand and gravel fill was encountered underlying the silty sand fill. The base of the sand and gravel fill was encountered at 7.0 m depth or at Elev. 283.2.

Moisture contents within the granular fill varied from 8 to 22 %.

Grain size analysis were completed on selected samples of the fill material. The results are summarized on the Record of Borehole sheets in Appendix A, and the grain size distribution curves for these samples are included in Figures B2a and B2b of Appendix B. The results of the tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0 to 41
Sand	28 to 47
Silt	28 to 54
Clay	10 to 18
Silt and Clay	13

Atterberg Limits tests were completed on a sample of the sandy clayey silt collected from Borehole NW-02. The results are summarized on the Record of Borehole sheet in Appendix A and the Atterberg Limits plot is presented on Figure B7 of Appendix B. The results of the laboratory tests indicate on a low plasticity of the deposit.

5.4 Sandy Silt/Silt to Sand

A deposit ranging in composition from sandy silt to silt to sand with trace to some clay and trace of gravel was encountered underlying the fill or topsoil in Boreholes NW-02, NW-03, NW-07, NW-10 and in Borehole 5 (1990). In Borehole NW-09, approximately 1.8 m of this deposit was encountered embedded in the silty clay/clayey silt. Occasional clay seams were noted in this deposit. The thickness of this layer ranged from 0.8 to 3.0 m with an underside depth of 1.4 m to 9.1 m (Elev. 294.8 to Elev. 287.9).

SPT tests performed in this layer gave N-values from 9 to 109 blows per 0.3 m of penetration indicating a loose to very dense relative density, predominantly being compact. The moisture content of this cohesionless layer ranged between 8% and 22%.

Grain size analyses were completed on two samples of this layer. The results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves for these samples are included in Figure B3 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	21 to 22
Silt	60
Clay	18 to 19

Atterberg Limits analysis was also completed on samples of the sandy silt with some clay consisting of clayey silt seam collected from Boreholes NW-03 and NW-09. The Liquid Limits of 17% and 22% and the Plasticity Indices of 6% and 9% were obtained, indicating a low plasticity seams within the transition of the sandy silt to silty clay/clayey silt. The results of the Atterberg Limits testing are presented on Figure B8 in Appendix B, and on the Record of Borehole sheets.

5.5 Silty Clay to Clayey Silt

A deposit of silty clay to clayey silt with trace to some sand and trace gravel was encountered in all boreholes either below the fill or native cohesionless deposit or below the topsoil. Where fully penetrated in the boreholes drilled in the northern part of the site, namely in Boreholes NW-01 to NW-06 and Boreholes 3 to 5 and 7, the thickness of this layer ranged from 1.3 m to 7.0 m with an underside depth of 1.5 to 12.9 m (Elev. 294.2 to 286.3 m). Boreholes NW-07 to 10 were terminated within this layer at a depth of 6.7 m below the ground surface (Elev. 287.6 to 284.9).

SPT tests performed in this deposit gave N-values ranging from 4 to in excess of 100 blows per 0.3 m of penetration indicating a firm to hard consistency. Typically, the N-values ranged from 9 to 40 blows per 0.3 m of penetration indicating a stiff to hard consistency of the deposit. Moisture contents within this layer varied from 11 to 32%.

Grain size analyses were completed on selected samples of the silty clay/clayey silt. The results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves for these samples are included in Figures B4a and B4b of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	5 to 21
Silt	37 to 70
Clay	14 to 51

Atterberg Limits tests were also completed on selected samples of the silty clay/clayey silt. The results are summarized on the Record of Borehole sheets in Appendix A and the Atterberg Limits plots for these samples are included in Figure B9 of Appendix B. The results of the laboratory tests indicate on a low to intermediate plasticity of the deposit.

Parameter	Value
Plastic Limit	15 to 19
Liquid Limit	25 to 38
Plasticity Index	9 to 19

5.6 Sandy Silt to Silty Sand Till

A till deposit grading from sandy silt to silty sand with trace to some clay and trace gravel was encountered in Boreholes NW-01 to NW-06, PA-01, PA-02 and Boreholes 3 to 5 and 7 underlying the silty clay to clayey silt or extending below the fill. Occasional layers of gravelly sand and occasional cobbles were also encountered within the till during drilling. Boreholes NW-01 to 05 and Boreholes 3 to 5 and 7 were terminated within this layer at a depth varying from 6.4 to 25.9 m below ground surface (Elev. 292.3 to 271.2). In Boreholes PA-01 and PA-02, the silty sand to sandy silt till was 6.6 m and 4.2 m in thickness and extended to depths of 13.6 m (Elev. 276.6) and 11.3 m (Elev.280.8).

In Boreholes 3 and 5 from the 1990 investigation, the content of gravel was noted to increase to as much as 18 % below a depth of 10.6 (Elev. 284.6) and at 21.8 m (Elev. 272.5), respectively. This deposit was classified in the 1990 investigation as “Heterogeneous mixture of clayey silt, sand and gravel (Glacial Till)”, which would be comparable to the silty sand/sandy silt till with some clay and gravel described in this section. Boreholes 3 and 5 were terminated in this till at a depth of 18.7 m and 23.1 m (Elev. 276.5 and 271.2).

SPT tests performed in this layer gave N-values from 21 to in excess of 100 blows per 0.3 m of penetration indicating a compact to very dense relative density. The majority of the recorded N-values were higher than 100 blows per 0.3 m of penetration, indicating a very dense relative density of the till. The moisture content of the till layers ranged between 9% and 25%.

Grain size analyses were completed on selected samples of this deposit. The results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves for these samples are included in Figures B5a and B5b of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	3 to 32
Sand	18 to 61
Silt	25 to 71
Clay	7 to 14
Silt and Clay	7

Glacial till inherently contain cobbles and boulders.

5.7 Silty Clay Till

Underlying the cohesionless till in Boreholes PA-01 and PA-02, and fill in Borehole PA-03 was a cohesive till consisting of silty clay with trace to some sand and trace gravel. Occasional coarser layers were encountered in the cohesive till. In Borehole PA-03, the upper 0.9 m layer of the deposit consisted of significant proportion of sand and was classified as sandy silty clay till, and a layer of gravelly silty sand was encountered at the base of this borehole. Boreholes PA-01 to PA-03 were terminated in the silty clay till at a depth of 15.8 m below the ground surface with the base of the boreholes between Elev. 274.4 and Elev. 279.5.

SPT tests performed in this deposit gave N-values ranging from 10 to in excess of 100 blows per 0.3 m of penetration indicating a stiff to hard consistency. Typically, the consistency of the silty clay till was hard with a stiff zones encountered in Borehole PA-03 to approximately 10 m depth. Moisture contents within the silty clay till varied from 8 to 35%.

Grain size analyses were completed on selected samples of the silty clay till. The results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves for these samples are included in Figure B6 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0 to 4
Sand	5 to 48
Silt	29 to 37
Clay	19 to 63

Atterberg Limits tests were also completed on selected samples of the silty clay till. The results are summarized on the Record of Borehole sheets in Appendix A and the Atterberg Limits plots for these samples are included in Figure B10 of Appendix B. The results of the laboratory tests indicate on an intermediate plasticity of the deposit.

Parameter	Value
Plastic Limit	19 to 22
Liquid Limit	39 to 44
Plasticity Index	20 to 24

Glacial till inherently contain cobbles and boulders.

5.8 Groundwater Levels

Water levels were observed during drilling operations and in the open boreholes upon completion of the drilling. As outlined in Table 3-1, standpipe piezometers were installed in Boreholes NW-02, NW-04 and PA-01 to monitor groundwater levels after drilling. The measured groundwater levels are summarized in Table 5-1, below.

The values shown 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 periods of significant or prolonged precipitation events.

Table 5-1. Measured Groundwater Levels

Borehole	Date	Groundwater Level		Comment
		Depth (m)	Elevation (m)	
NW-01	Nov. 12, 2014	9.4	286.4	Open Borehole
NW-02	Nov. 17, 2014	Dry	-	Open Borehole
	Nov. 28, 2014	Dry	-	Piezometer
	Jul. 15, 2015	Dry	-	
NW-03	Nov. 12, 2014	7.3	288.1	Open Borehole
NW-04	Nov. 14, 2014	1.6	291.6	Open Borehole
	Nov. 19, 2014	3.9	289.3	Piezometer
	Nov. 28, 2014	3.7	289.5	
	Jul. 15, 2015	3.5	289.7	
NW-05	Nov. 13, 2014	4.3	288.1	Open Borehole
NW-06	Nov. 11, 2014	Dry	-	Open Borehole

Borehole	Date	Groundwater Level		Comment
		Depth (m)	Elevation (m)	
NW-07	Nov. 13, 2014	4.6	287.5	Open Borehole
NW-08	Nov. 13, 2014	4.3	290.0	Open Borehole
NW-09	Nov. 10, 2014	4.1	287.9	Open Borehole
NW-10	Nov. 10, 2014	Dry	-	Open Borehole
PA-01	Dec. 15, 2015	9.2	281.0	Piezometer
	Jan. 06, 2016	5.5	284.7	
PA-02	Dec. 15, 2016	Dry to 8.8	Dry to 283.3	Open Borehole
PA-03	Dec. 16, 2016	12.2	283.1	Open Borehole
3 ^{*)}	Apr. 20, 1990	3.2	292.0	Open Borehole
4 ^{*)}	Apr. 23, 1990	4.8	290.3	Open Borehole
5 ^{*)}	Apr. 19, 1990	2.3	292.0	Open Borehole
7 ^{*)}	Apr. 26, 1990	12.0	289.5	Open Borehole

Note: ^{*)} Geocres No. 40P2-45

5.9 Analytical Testing

Two representative soil samples retrieved from the site were submitted to AGAT Laboratories in Mississauga, Ontario for analysis of pH and soluble sulphates. The analysis results are presented below in Table 5-2.

Table 5-2. Results of Analytical Testing

Location	Borehole	Sample	Depth (m)	pH	Sulphate (µg/g)
North Abutment	NW-02	SS 11	12.5	7.9	42
South Abutment	NW-04	SS1	0.3	7.6	18

The results of the analyses are enclosed in Appendix C.

6 MISCELLANEOUS

Borehole locations were selected and marked in the field by an experienced Thurber staff member and were established with a Trimble Pathfinder ProXRT differential GPS unit. The co-ordinates and ground surface elevations at the boreholes were surveyed by MMM Group Limited upon completion of drilling.

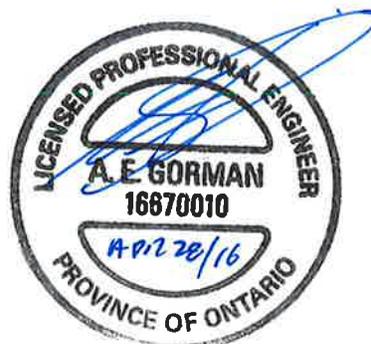
Determination Drilling and Soil Investigations Holdings Inc. from Hamilton, Ontario supplied and operated the drill rig, sampling and in-situ testing equipment for the field program carried out in 2014. Altech Drilling and Investigative Services Ltd. of Elmira, Ontario, supplied and operated the drilling, sampling and in-situ testing equipment for the field program conducted in 2015. The field investigation was supervised on a full time basis by Mr. George Azzopardi of Thurber in 2014 and Mr. Tim Craplewe in 2015, both of Thurber. Overall supervision of the investigation program was conducted by Mr. Stephane Loranger, C.E.T and Weiss Mehdawi, P.Eng.

Routine laboratory testing was carried out by Thurber's geotechnical laboratory in Oakville, Ontario. Interpretation of the data and preparation of this report were carried out by Ms. Anna Piascik, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng. and by Dr. P.K. Chatterji, P.Eng., who is a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



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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
 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.

EXPLANATION OF ROCK LOGGING TERMS

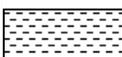
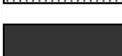
ROCK WEATHERING CLASSIFICATION

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		Field Estimation of Hardness*
	(MPa)	(psi)	
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.

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			

RECORD OF BOREHOLE No NW-01 2 OF 2 METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 259.9 E 204 177.4 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.12 - 2014.11.12 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100	W _p	W	W _L			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
285.5	Continued From Previous Page		10	SS	111													
10.2	END OF BOREHOLE AT 10.2m. BOREHOLE OPEN TO 10.2m AND WATER LEVEL AT 9.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																	

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

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

RECORD OF BOREHOLE No NW-02

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 252.1 E 204 206.5 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.17 - 2014.11.17 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
						PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L WATER CONTENT (%)								
						20 40 60								
303.9	GROUND SURFACE													
0.0	ASPHALT:(125mm)													
0.1	SAND and GRAVEL, trace silt Dense Brown Moist (FILL)		1	SS	34								41 52 7 (SI+CL)	
			2	SS	32									
302.4	Clayey SILT, sandy Stiff to Hard Brown/Grey Moist (FILL)		3	SS	16									
			4	SS	17									
			5	SS	31								0 28 54 18	
			6	SS	8									
297.8	Sandy SILT, trace gravel Very Dense Brown Moist		7	SS	70									
			8	SS	109									
294.8	Silty CLAY, some sand Hard Grey Moist		9	SS	36								0 12 42 46	
294														

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Continued Next Page

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

RECORD OF BOREHOLE No NW-02

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 252.1 E 204 206.5 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.17 - 2014.11.17 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page						20 40 60 80 100							
291.8			10	SS	104/ 0.150									
12.2	Sandy SILT, trace gravel Very Dense Brown Moist (TILL)		11	SS	106/ 0.150									
289.9			12	SS	62/ 0.150									
14.0	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN TO 12.8m AND DRY. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2014.11.28 Dry 2015.07.15 Dry													

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

RECORD OF BOREHOLE No NW-03

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 238.5 E 204 184.8 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.12 - 2014.11.12 CHECKED BY SBP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
					20	40	60	80	100							
295.4	GROUND SURFACE															
0.0	TOPSOIL: (125mm)															
0.1	Sandy SILT, some clay, trace gravel Compact Brown Moist	1	SS	16												
	Clayey silt seams	2	SS	28											0 21 60 19	
293.9																
1.5	Silty CLAY, trace to some sand, trace gravel Hard Brown Moist	3	SS	36												
		4	SS	57												
292.4																
3.0	Silty SAND to SILT, some sand, some clay, trace gravel Very Dense Brown Moist (TILL)	5	SS	107											7 60 25 8	
		6	SS	103/ 0.150												
		7	SS	112/ 0.150												
		8	SS	109											0 18 71 11	
		9	SS	103												

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Continued Next Page

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

RECORD OF BOREHOLE No NW-03

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 238.5 E 204 184.8 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.12 - 2014.11.12 CHECKED BY SBP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	Continued From Previous Page						20	40	60	80	100					
284.5			10	SS	114											
11.0	END OF BOREHOLE AT 11.0m. BOREHOLE OPEN TO 11.0m AND WATER LEVEL AT 7.3m BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.															

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

RECORD OF BOREHOLE No NW-04

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 160.3 E 204 200.0 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.14 - 2014.11.04 CHECKED BY SBP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
					20	40	60	80	100	20	40	60			
293.2	GROUND SURFACE														
0.0	TOPSOIL: (150mm)														
0.2	Silty CLAY, trace to some sand Firm to Hard Grey Moist	1	SS	4							○				
		2	SS	4							○				
		3	SS	7							○			0 9 46 45	
		4	SS	38							○				
		5	SS	37							○				
		6	SS	43							○			0 21 37 42	
287.7	SAND and SILT, trace clay, trace to some gravel Very Dense Grey Wet (TILL)	7	SS	105							○				
5.5		8	SS	110							○			0 43 50 7	
		9	SS	104/ 0.150							○				

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Continued Next Page

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

RECORD OF BOREHOLE No NW-04

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 160.3 E 204 200.0 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.14 - 2014.11.04 CHECKED BY SBP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
Continued From Previous Page																
282.4			10	SS	114/											
10.8	END OF BOREHOLE AT 10.8m. BOREHOLE OPEN TO 10.8m AND WATER LEVEL AT 1.6m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2014.11.19 3.9 289.3 2014.11.28 3.7 289.5 2015.07.15 3.5 289.7				0.150											

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

RECORD OF BOREHOLE No NW-05

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 135.8 E 204 205.9 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.13 - 2014.11.13 CHECKED BY SBP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60	kn/m ³	GR SA SI CL
292.4	GROUND SURFACE														
0.0	TOPSOIL: (125mm)														
0.1	Silty CLAY, trace sand, occasional rootlets in the upper 1.0m zone Firm to Hard Dark Brown Moist	1	SS	8							○				
		2	SS	9							○				
		3	SS	6							○				
		4	SS	28							○				0 5 50 45
		5	SS	31							○				
		6	SS	30							○				
286.3	Sandy SILT to Silty SAND, some gravel, trace clay Very Dense Grey Wet (TILL)	7	SS	102							○				
6.1		8	SS	104							○				
		9	SS	112							○				11 53 28 8

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Continued Next Page

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

RECORD OF BOREHOLE No NW-05

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 135.8 E 204 205.9 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.13 - 2014.11.13 CHECKED BY SBP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
							20	40	60	80	100	W _p	W	W _L		
282.3	Continued From Previous Page		10	SS	108											
10.1	END OF BOREHOLE AT 10.1m. BOREHOLE OPEN TO 10.1m AND WATER LEVEL AT 4.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.				0.150											

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

RECORD OF BOREHOLE No NW-06

1 OF 1

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 283.2 E 204 178.9 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.11 - 2014.11.11 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
						WATER CONTENT (%)								
						PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	W _p	W	W _L			
298.7	GROUND SURFACE													
0.0	TOPSOIL: (125mm)													
0.1	SAND and SILT , some clay Compact Brown Moist (FILL)		1	SS	11				○					
			2	SS	15				○				0 39 43 18	
297.2														
1.5	Clayey SILT , trace to some sand, trace gravel Hard Brown Moist		3	SS	43				○					
			4	SS	59				○					
			5	SS	70				○					
294.2														
4.6	SILT , some sand, some clay, trace gravel Very Dense Brown Moist (TILL)		6	SS	80				○				0 18 68 14	
292.3														
6.4	END OF BOREHOLE AT 6.4m. BOREHOLE OPEN TO 6.4m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.		7	SS	104				○					

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

RECORD OF BOREHOLE No NW-07

1 OF 1

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 112.9 E 204 215.1 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.13 - 2014.11.13 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
						PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L WATER CONTENT (%)								
						20	40	60	80	100	20	40	60	GR SA SI CL
292.1	GROUND SURFACE													
0.0	TOPSOIL: (150mm)													
0.2	SAND and SILT, some clay, occasional rootlets Compact Brown Moist (FILL)		1	SS	10									
			2	SS	18									0 40 43 17
290.6	SAND, some gravel, trace silt Compact Brown/Dark Brown Moist		3	SS	19									
289.9	Silty CLAY, trace sand, trace gravel Very Stiff Grey Moist		4	SS	29									
			5	SS	22									
			6	SS	17									
			7	SS	22									0 9 40 51
285.4	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND WATER LEVEL AT 4.6m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.													

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

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

RECORD OF BOREHOLE No NW-08

1 OF 1

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 097.2 E 204 222.0 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.13 - 2014.11.13 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60	kn/m ³	GR SA SI CL	
294.3	GROUND SURFACE															
0.0	TOPSOIL: (150mm)															
0.2	Silty SAND, some gravel, some clay Loose to Very Dense Brown Moist (FILL)		1	SS	12											
			2	SS	50/ 0.150											
	Occasional cobbles														12 47 31 10	
			3	SS	10											
			4	SS	6											
291.3	Clayey SILT to Silty CLAY, some sand, trace gravel Stiff to Hard Brown Moist		5	SS	8											
			6	SS	30										0 12 41 47	
			7	SS	32											
287.6	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND WATER LEVEL AT 4.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.															

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

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

RECORD OF BOREHOLE No NW-09

1 OF 1

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 041.3 E 204 235.2 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.10 - 2014.11.10 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100								
						WATER CONTENT (%)								
						PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	W _p	W	W _L			
292.0	GROUND SURFACE													
0.0	TOPSOIL: (125mm)													
0.1	SAND and SILT, some clay, occasional rootlets Loose Brown Moist (FILL)		1	SS	8									
			2	SS	7								0 41 42 17	
290.5														
1.5	Clayey SILT, trace sand, trace gravel Very Stiff Brown Moist		3	SS	16									
289.7														
2.3	Sandy SILT to Silty SAND, some gravel, trace to some clay Loose to Compact Brown Moist		4	SS	9									
			5	SS	27									
287.9														
4.1	Clayey SILT to Silty CLAY, trace sand Hard Grey Moist		6	SS	32								0 16 70 14	
285.3			7	SS	51									
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND WATER LEVEL AT 4.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.													

ONTMT4S_1224.GPJ_2015TEMPLATE(MTO).GDT_4/27/16

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

RECORD OF BOREHOLE No NW-10

1 OF 1

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 012.3 E 204 248.7 ORIGINATED BY GA
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.10 - 2014.11.10 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100								
						WATER CONTENT (%)								
						PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	W _p	W	W _L			
291.6	GROUND SURFACE													
0.0	TOPSOIL: (150mm)													
0.2	Clayey SILT, trace sand, occasional rootlets		1	SS	18									
290.8	Very Stiff Brown Moist (FILL)													
0.8	Sandy SILT, some clay, occasional clay seams		2	SS	33									
	Compact to Dense Brown Moist													
			3	SS	20									
			4	SS	27								0 22 60 18	
288.6														
3.0	Silty CLAY, trace sand		5	SS	24									
	Stiff to Very Stiff Brown Moist													
			6	SS	15									
			7	SS	26								0 8 51 41	
284.9														
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.													

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

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

RECORD OF BOREHOLE No PA-01

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION N 4 774 966.2 E 204 187.9 ORIGINATED BY TIM
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2015.12.14 - 2015.12.15 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
						WATER CONTENT (%)								
						PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	W _p	W	W _L			
290.2	GROUND SURFACE													
0.0	SAND and GRAVEL , some silt Loose to Compact Grey Moist (FILL) Layer of silty sand with some clay and gravel between 0.8 and 1.2m depth		1	SS	20								44 46 10 (SI+CL)	
			2	SS	16								16 42 31 11	
			3	SS	9									
288.1														
2.1	Silty SAND , some gravel, some clay, occasional cobbles, frequent silty clay lenses Very Loose to Compact Grey Moist (FILL)		4	SS	6									
			5	SS	3									
			6	SS	12									
284.1														
6.1	SAND and GRAVEL , some silt Dense Brown Wet (FILL)		7	SS	38								41 46 13 (SI+CL)	
283.2														
7.0	Silty SAND to Sandy SILT , trace to some gravel, trace clay, occasional cobbles Compact to Very Dense Brown Wet (TILL)		8	SS	21									
			9	SS	50/ 0.100									

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

Continued Next Page

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

RECORD OF BOREHOLE No PA-01

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION N 4 774 966.2 E 204 187.9 ORIGINATED BY TIM
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2015.12.14 - 2015.12.15 CHECKED BY AMP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100			PLASTIC LIMIT w _p
Continued From Previous Page														
276.6		10	SS	50/ 0.163										
278		11	SS	200/ 0.100										
276.6	Silty CLAY, trace to some sand, trace gravel Hard Brown Moist (TILL)	12	SS	42										0 6 37 57
274.4		13	SS	39										
15.8	END OF BOREHOLE AT 15.8m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2015.12.15 9.2 281.0 2016.01.06 5.5 284.7													

ONTMT4S_1224.GPJ_2015TEMPLATE(MTO).GDT_4/27/16

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

RECORD OF BOREHOLE No PA-02 1 OF 2 METRIC

GWP# 3054-13-00 LOCATION N 4 774 971.2 E 204 210.3 ORIGINATED BY TIM
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2015.12.15 - 2015.12.15 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60								
292.1	GROUND SURFACE													
0.0	SAND and GRAVEL , some silt Compact Brown Moist (FILL)		1	SS	12									34 53 13 (SI+CL)
			2	SS	16									
			3	SS	17									
290.0														
2.1	Silty SAND , some gravel, some clay, occasional cobbles, frequent silty clay lenses Very Loose to Compact Brown Moist (FILL)		4	SS	3									
			5	SS	1									
	Slight organic odour		6	SS	26									16 42 28 14
			7	SS	11									
285.0														
7.1	Silty SAND to Sandy SILT , trace to some gravel, trace clay, occasional cobbles Very Dense Brown Moist (TILL) 0.5m layer of gravelly sand at 7.5m depth		8	SS	28									32 61 7 (SI+CL)
			9	SS	62									

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

Continued Next Page

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

RECORD OF BOREHOLE No PA-02 2 OF 2 METRIC

GWP# 3054-13-00 LOCATION N 4 774 971.2 E 204 210.3 ORIGINATED BY TIM
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2015.12.15 - 2015.12.15 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page					20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60								
280.8			10	SS	50/ 0.150									
11.3	Silty CLAY, trace to some sand, trace gravel, occasional cobbles Very Stiff to Hard Brown Moist (TILL)		11	SS	80								0 16 34 50	
			12	SS	46									
276.3			13	SS	18								0 5 32 63	
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 8.8m DEPTH AFTER AUGER REMOVAL AND DRY BOREHOLE BACKFILLED WITH CUTTINGS AND BENTONITE HOLEPLUG TO SURFACE.													

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

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

RECORD OF BOREHOLE No PA-03

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION N 4 774 978.5 E 204 249.5 ORIGINATED BY TIM
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2015.12.16 - 2015.12.16 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60	kn/m ³	GR SA SI CL	
295.3	GROUND SURFACE															
0.0	SAND and GRAVEL , some silt Compact to Dense Brown Moist (FILL)		1	SS	13											
			2	SS	33										31 56 13 (SI+CL)	
			3	SS	31											
293.0	Sandy SILT , some clay, trace to some gavel, occasional cobbles, frequent silty clay lenses Compact Brown Moist (FILL)		4	SS	30										8 38 42 12	
			5	SS	11											
			6	SS	23											
289.2	Silty CLAY , trace to some sand, trace gravel, becoming sandy to 7.0m depth, occasional cobbles, slight organic odour Stiff to Hard Brown Moist (TILL)		7	SS	10										4 48 29 19	
			8	SS	37											
			9	SS	10										0 6 33 61	

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

Continued Next Page

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

RECORD OF BOREHOLE No PA-03

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION N 4 774 978.5 E 204 249.5 ORIGINATED BY TIM
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2015.12.16 - 2015.12.16 CHECKED BY AMP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page															
		10	SS	77												
		11	SS	21												
		12	SS	79												
	Becoming gravelly below 15m depth	13	SS	108											25 44 31 (SI+CL)	
279.5	15.8	END OF BOREHOLE AT 15.8m. WATER LEVEL AT 12.2m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS AND BENTONITE HOLEPLUG TO GROUND SURFACE.														

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

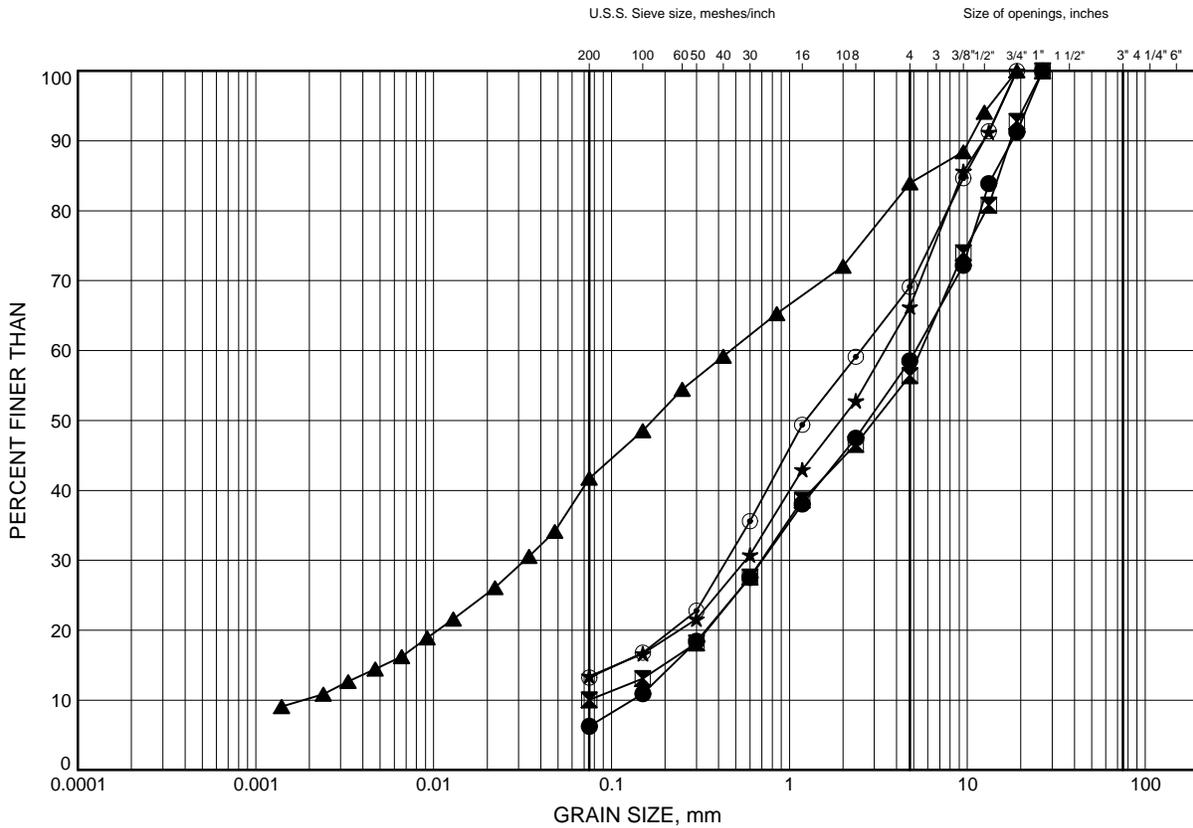
+³, ×³: Numbers refer to Sensitivity
 20
 15 5
 10 (%) STRAIN AT FAILURE

Appendix B
Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND & GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-02	1.07	302.88
⊠	PA-01	0.30	289.90
▲	PA-01	1.07	289.13
★	PA-02	0.30	291.80
⊙	PA-03	1.07	294.23

Date April 2016
GWP# 3054-13-00

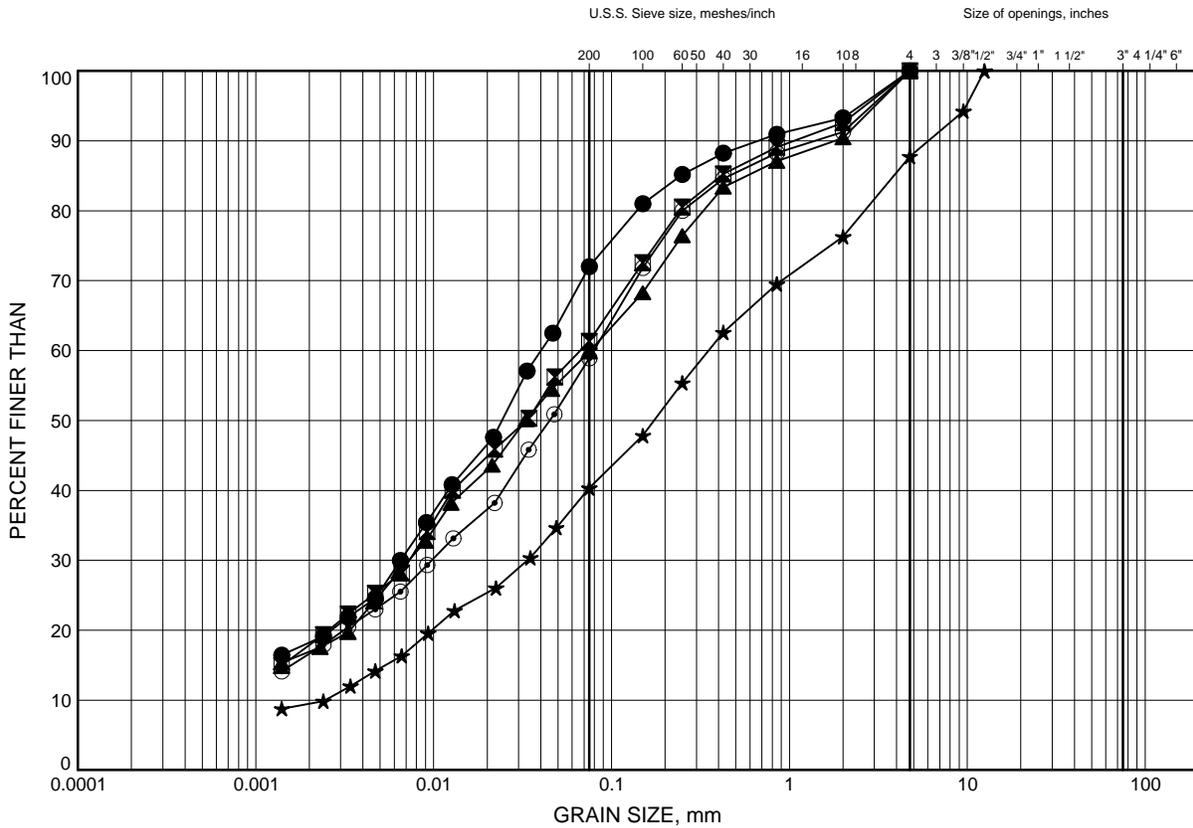


Prep'd AN
Chkd. AMP

GRAIN SIZE DISTRIBUTION

FIGURE B2a

EMBANKMENT FILL MATERIALS



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-02	3.35	300.59
⊠	NW-06	1.07	297.68
▲	NW-07	1.07	291.07
★	NW-08	1.83	292.47
⊙	NW-09	1.07	290.95

Date April 2016
GWP# 3054-13-00

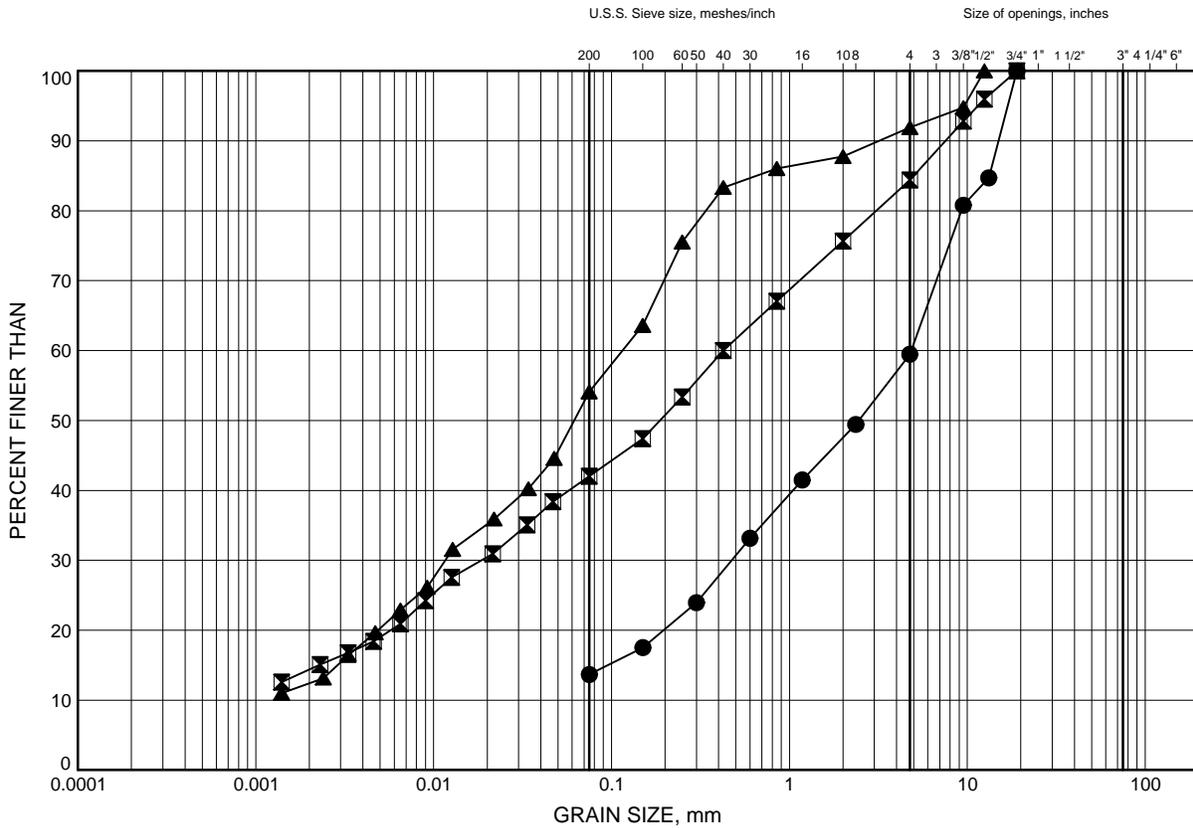


Prep'd AN
Chkd. AMP

GRAIN SIZE DISTRIBUTION

FIGURE B2b

EMBANKMENT FILL MATERIALS



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PA-01	6.40	283.80
⊠	PA-02	4.88	287.22
▲	PA-03	2.59	292.71

Date April 2016
GWP# 3054-13-00

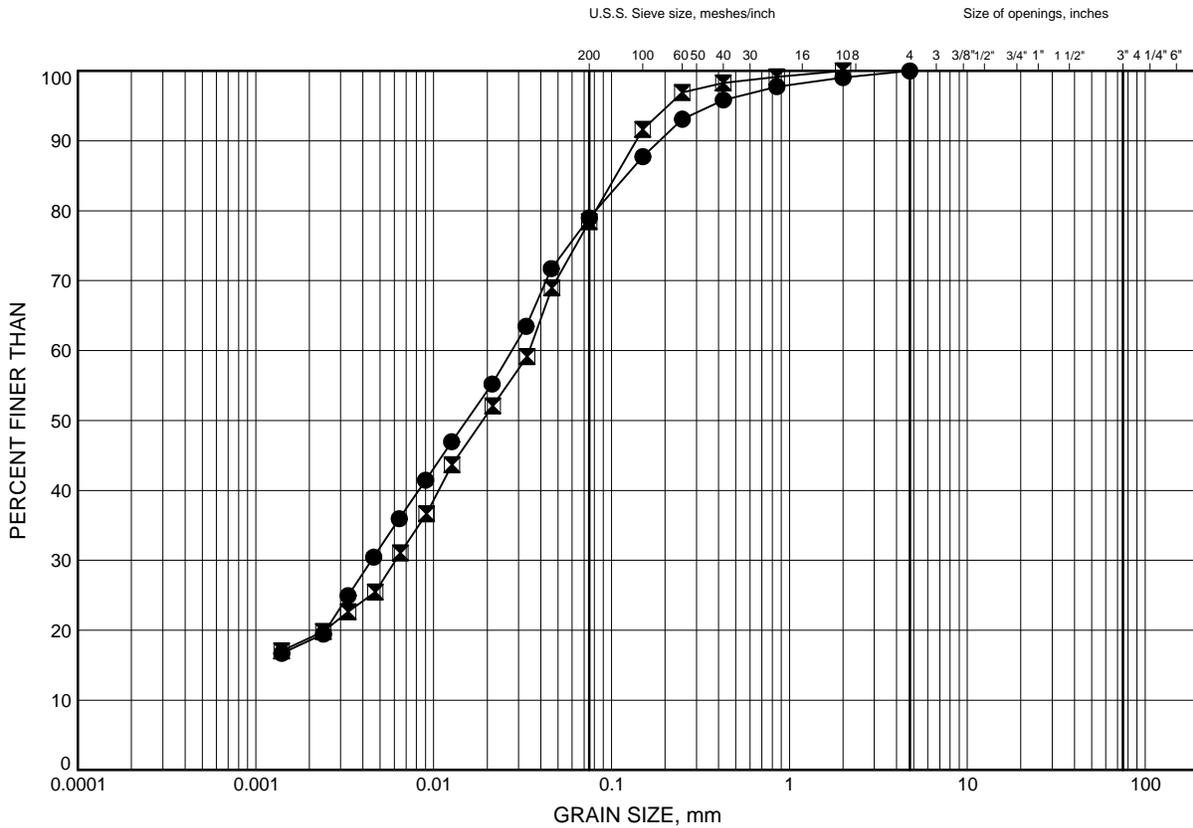


Prep'd AN
Chkd. AMP

GRAIN SIZE DISTRIBUTION

FIGURE B3

SANDY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-03	1.07	294.38
⊠	NW-10	2.59	289.03

GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 4/27/16

Date April 2016
GWP# 3054-13-00

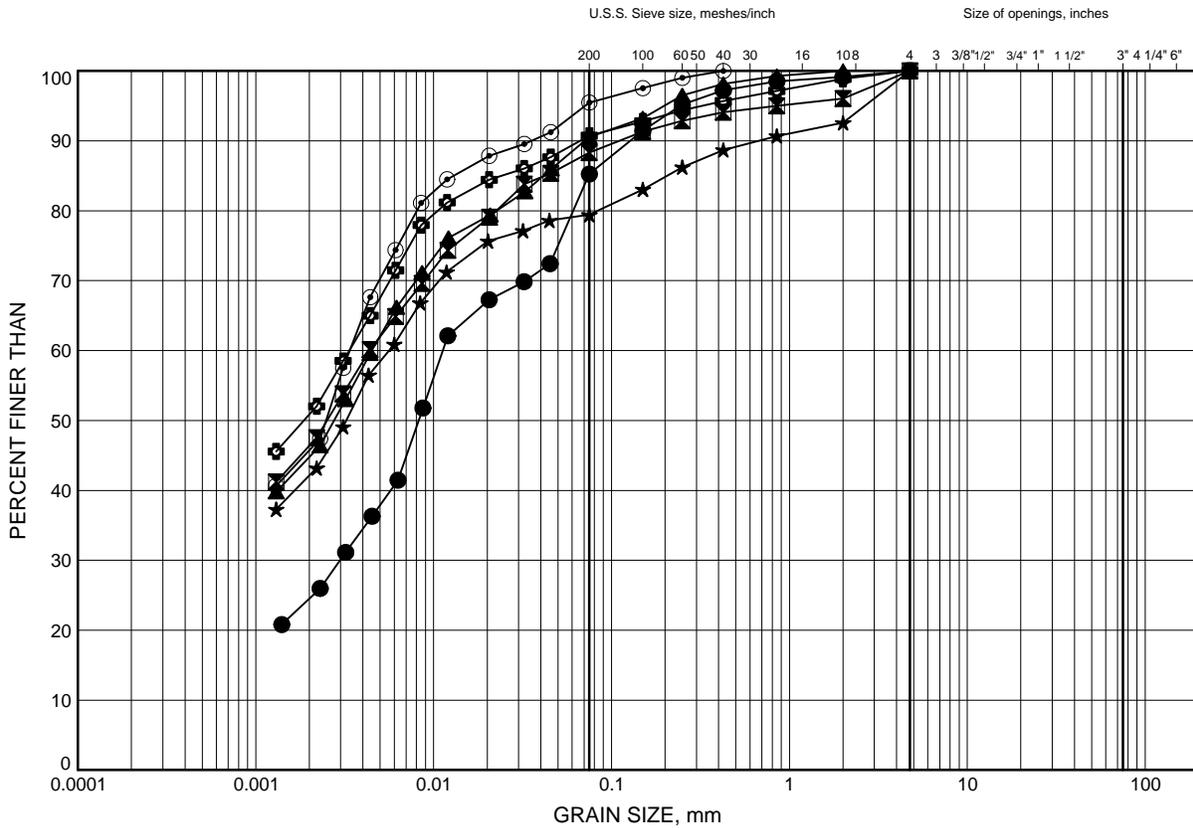


Prep'd AN
Chkd. AMP

GRAIN SIZE DISTRIBUTION

FIGURE B4a

SILTY CLAY to CLAYEY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-01	1.07	294.69
⊠	NW-02	9.45	294.49
▲	NW-04	1.83	291.40
★	NW-04	4.88	288.36
⊙	NW-05	2.59	289.78
⊕	NW-07	6.40	285.74

Date April 2016
GWP# 3054-13-00

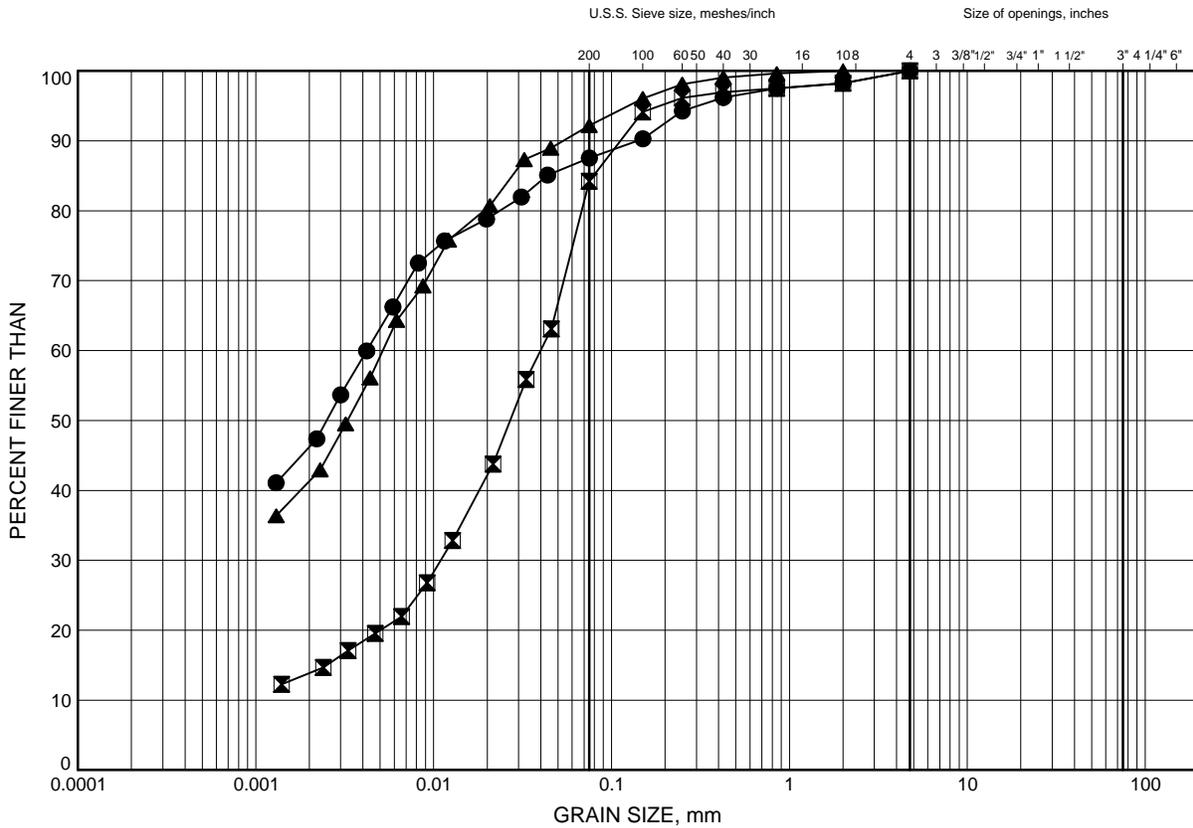


Prep'd AN
Chkd. AMP

GRAIN SIZE DISTRIBUTION

FIGURE B4b

SILTY CLAY to CLAYEY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-08	4.88	289.42
⊠	NW-09	4.88	287.14
▲	NW-10	6.40	285.22

Date April 2016
GWP# 3054-13-00

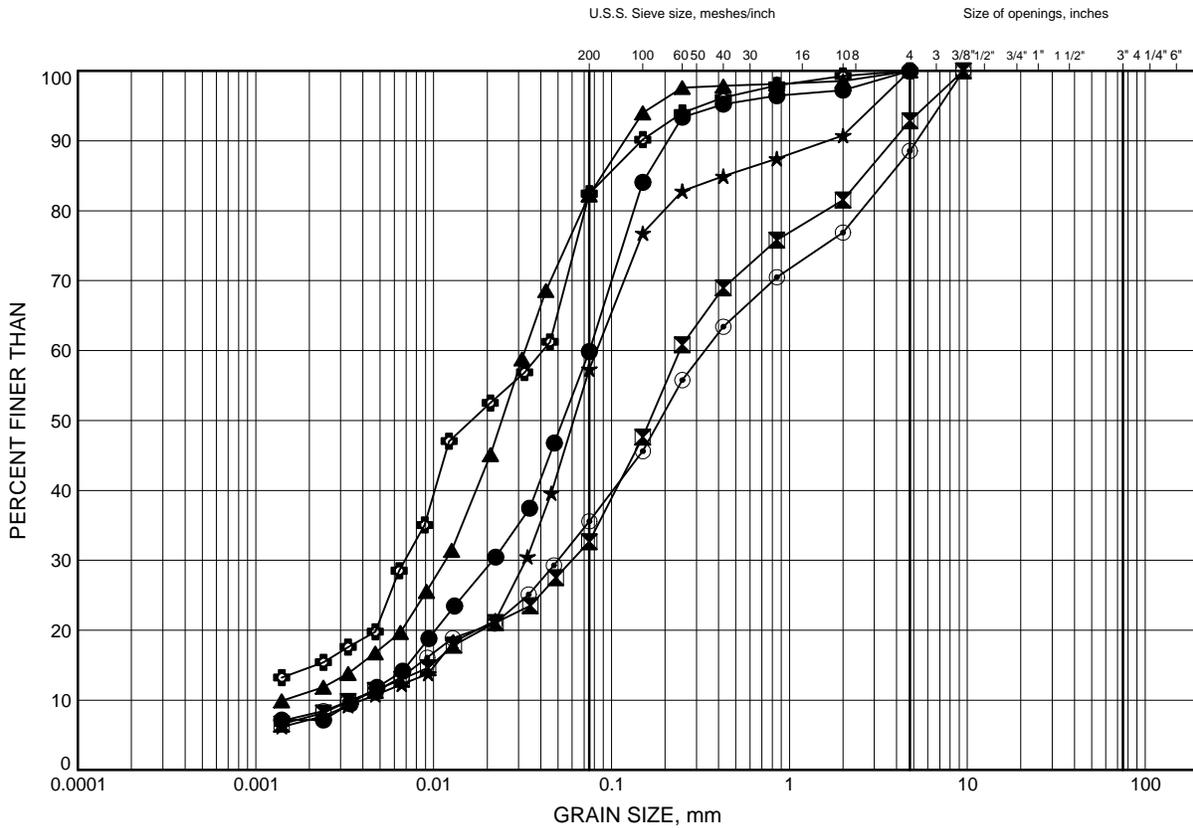


Prep'd AN
Chkd. AMP

Norwich Ave. Underpass
GRAIN SIZE DISTRIBUTION

FIGURE B5a

SILTY SAND to SANDY SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-01	6.40	289.36
⊠	NW-03	3.35	292.09
▲	NW-03	7.92	287.52
★	NW-04	7.92	285.31
⊙	NW-05	9.45	282.92
⊕	NW-06	4.88	293.87

Date April 2016
 GWP# 3054-13-00

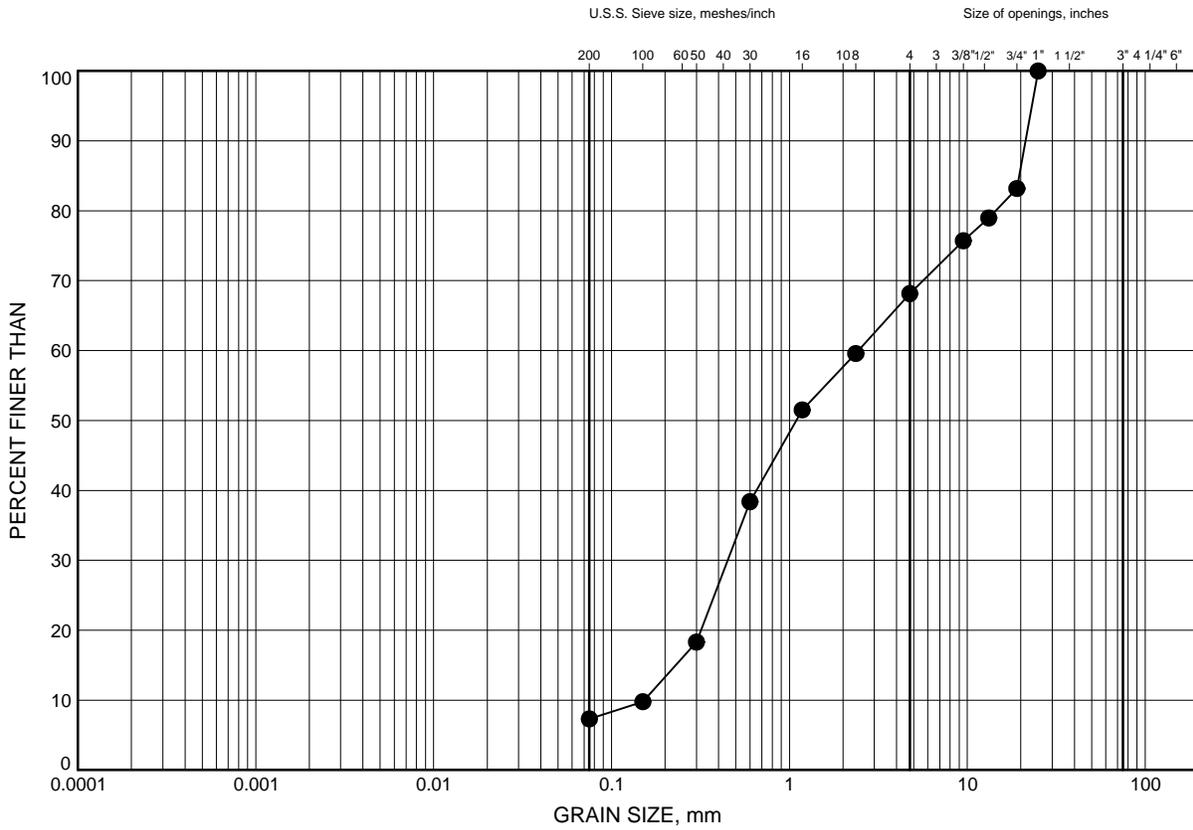


Prep'd AN
 Chkd. AMP

GRAIN SIZE DISTRIBUTION

FIGURE B5b

SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PA-02	7.92	284.18

Date April 2016
GWP# 3054-13-00

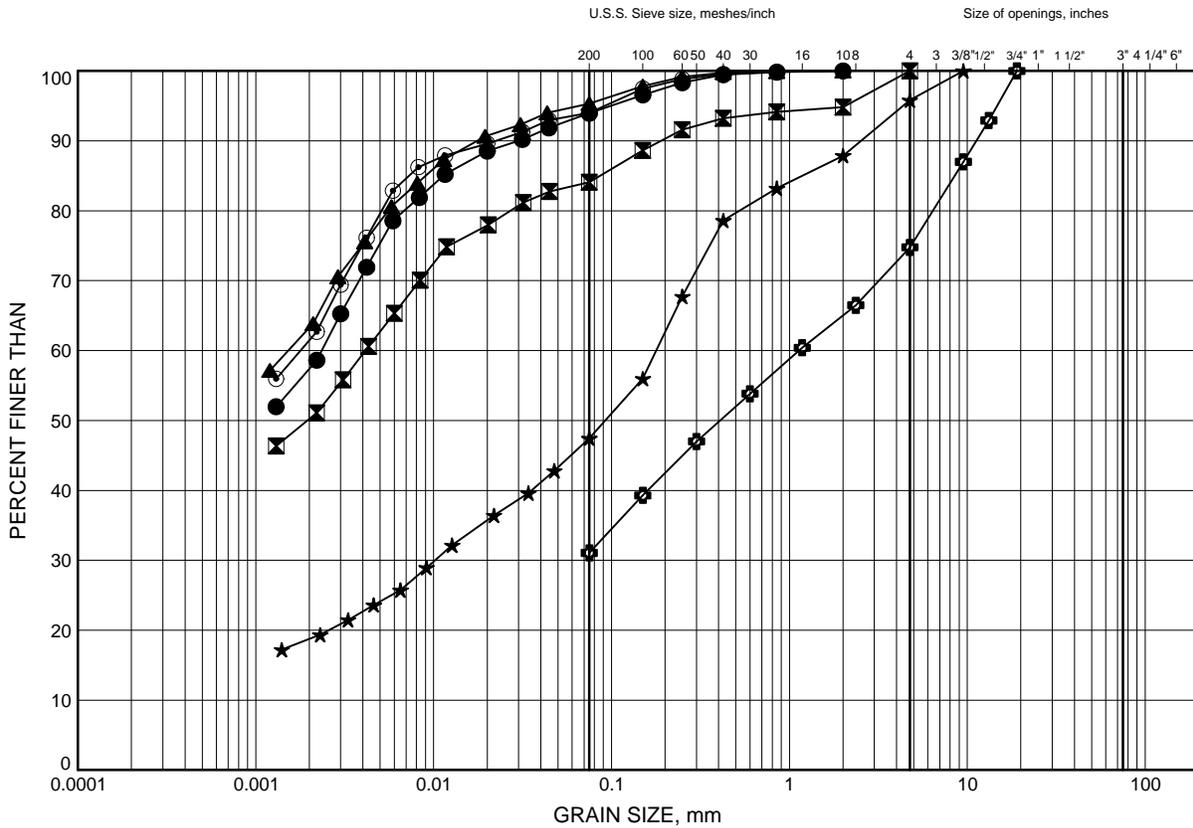


Prep'd AN
Chkd. AMP

GRAIN SIZE DISTRIBUTION

FIGURE B6

SILTY CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PA-01	14.02	276.18
▲	PA-02	15.54	276.56
★	PA-03	6.40	288.90
○	PA-03	9.45	285.85
◻	PA-03	15.54	279.76

Date April 2016
GWP# 3054-13-00

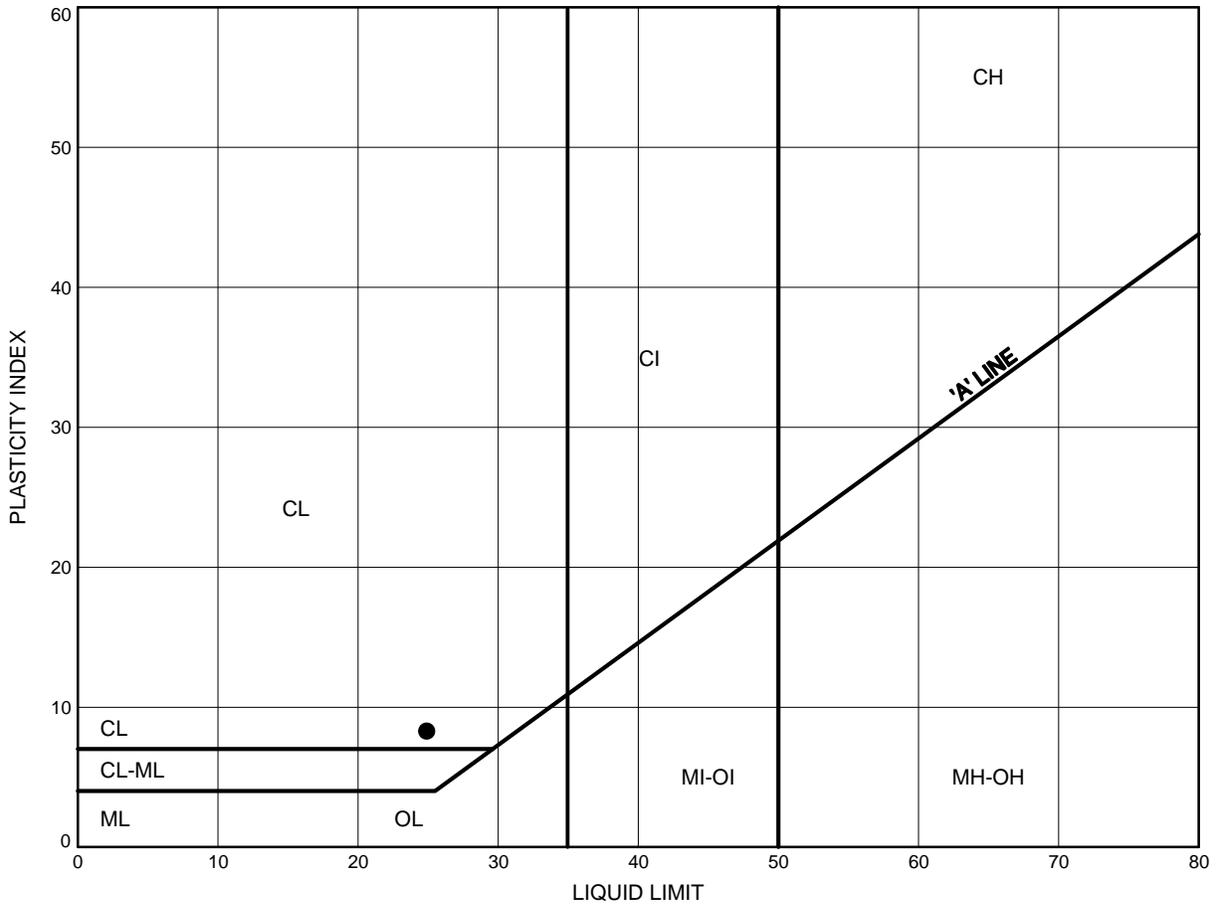


Prep'd AN
Chkd. AMP

ATTERBERG LIMITS TEST RESULTS

FIGURE B7

EMBANKMENT FILL MATERIALS



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-02	3.35	300.59

THURBALT 1224.GPJ 4/27/16

Date April 2016
 GWP# 3054-13-00

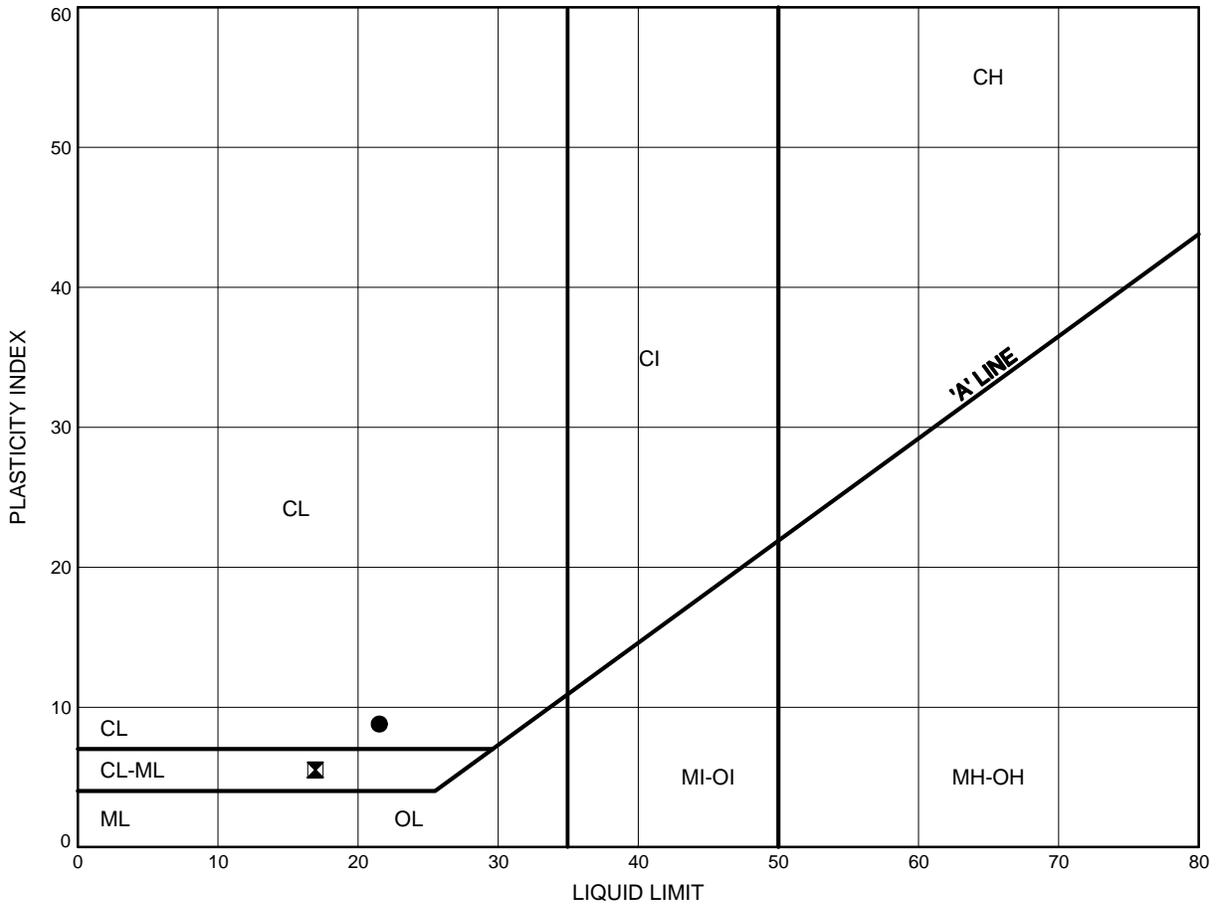


Prep'd AN
 Chkd. AMP

ATTERBERG LIMITS TEST RESULTS

FIGURE B8

CLAYEY SILT



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-03	1.07	294.38
⊠	NW-09	2.59	289.42

THURBALT 1224.GPJ 4/27/16

Date April 2016
 GWP# 3054-13-00

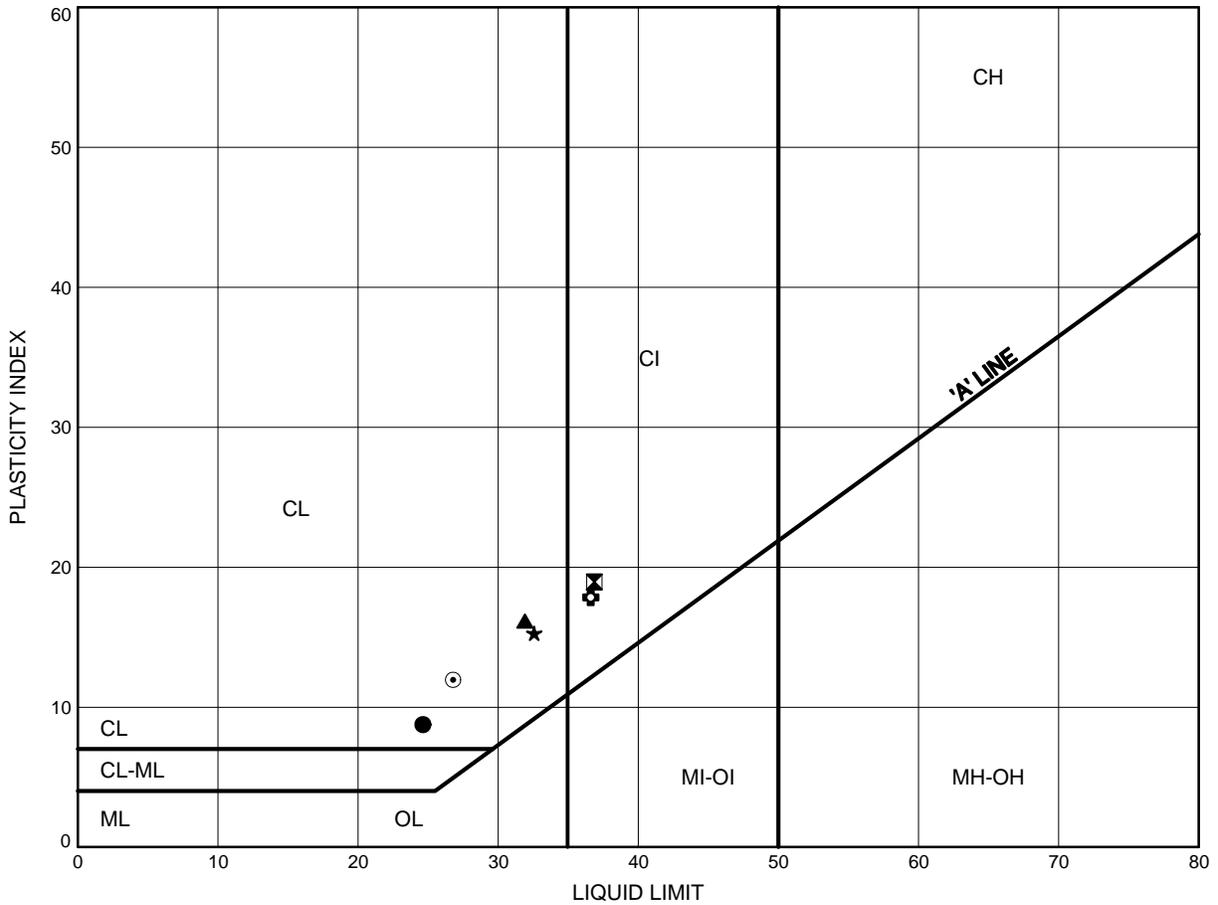


Prep'd AN
 Chkd. AMP

ATTERBERG LIMITS TEST RESULTS

FIGURE B9

SILTY CLAY to CLAYEY SILT



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-01	1.07	294.69
⊠	NW-04	1.83	291.40
▲	NW-04	4.88	288.36
★	NW-05	2.59	289.78
⊙	NW-07	6.40	285.74
⊕	NW-08	4.88	289.42

THURBALT 1224.GPJ 4/27/16

Date April 2016
GWP# 3054-13-00

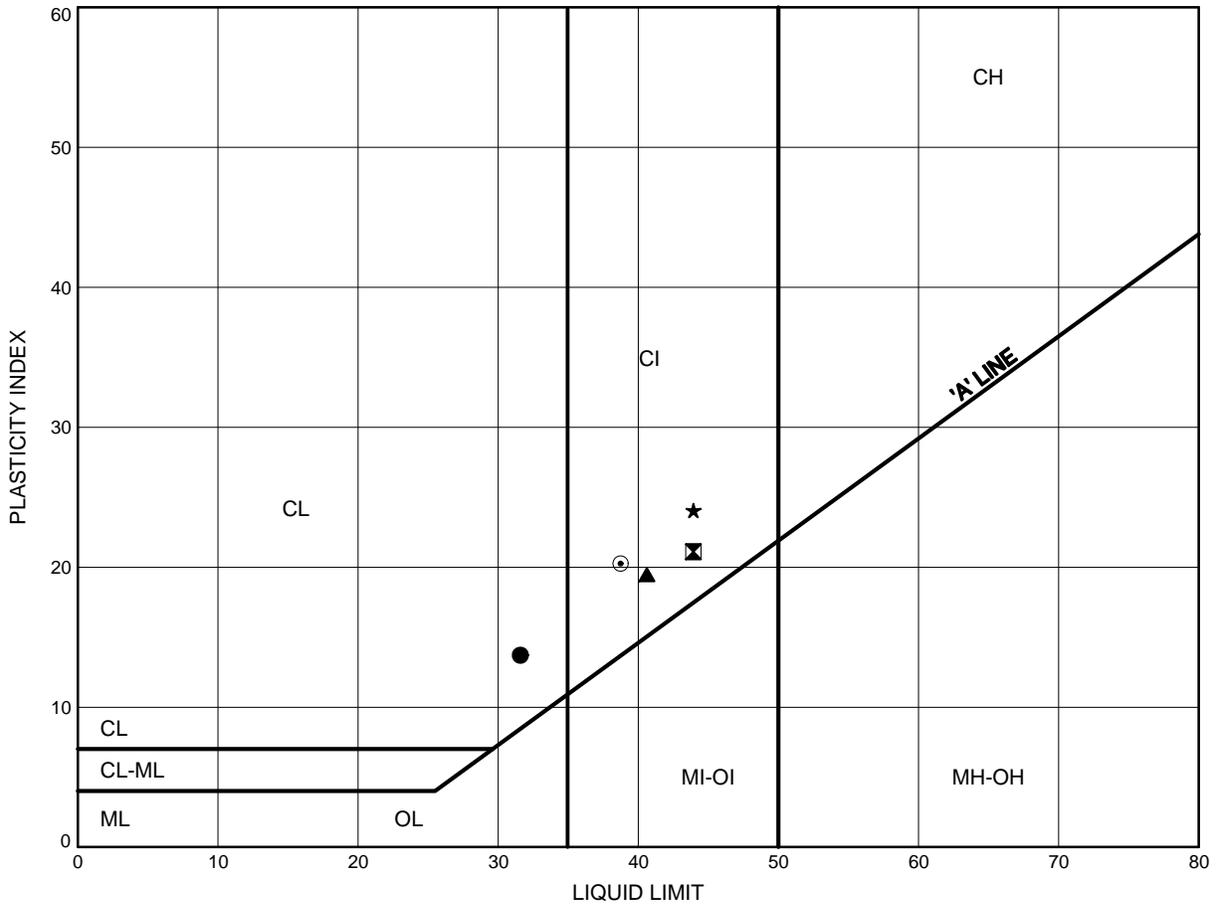


Prep'd AN
Chkd. AMP

ATTERBERG LIMITS TEST RESULTS

FIGURE B10

SILTY CLAY TILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-10	6.40	285.22
⊠	PA-01	14.02	276.18
▲	PA-02	12.50	279.60
★	PA-02	15.54	276.56
⊙	PA-03	9.45	285.85

THURBALT 1224.GPJ 4/27/16

Date April 2016
 GWP# 3054-13-00



Prep'd AN
 Chkd. AMP

Appendix C

Analytical Test Results



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 14T925116

PROJECT: 19-5161-224

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

CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE:

ATTENTION TO: Stephen Peters

SAMPLED BY:

DATE RECEIVED: 2014-12-05		DATE REPORTED: 2014-12-15	
pH, Sulphate (Soil)			
Parameter	Unit	G / S	RDL
pH, 2:1 CaCl2 Extraction	pH Units		
Sulphate (2:1)	µg/g	2	
		14-04 SS11 (40'-42')	NW-04 SS11 (0'-2')
		14-02 SS1 (6"-2')	NW-02 SS11 (40'-42')
		12/4/2014 6157014	12/4/2014 6157026
		8.13 33	7.91 42
		8.12 25	7.57 18
		Soil	Soil
		12/4/2014	12/4/2014
		6157025	6157027

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard



Certified By:



Method Summary

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 14T925116

PROJECT: 19-5161-224

ATTENTION TO: Stephen Peters

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
pH, 2:1 CaCl ₂ Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH



Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 14T925116

PROJECT: 19-5161-224

ATTENTION TO: Stephen Peters

SAMPLING SITE:

SAMPLED BY:

Soil Analysis

RPT Date: Dec 15, 2014			DUPLICATE				Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Measured Value		Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits		
								Lower	Upper		Lower	Upper		Lower	Upper	
pH, Sulphate (Soil)																
pH, 2:1 CaCl2 Extraction	6157135		7.90	7.91	0.1%	NA	100%	80%	120%	NA			NA			
Sulphate (2:1)	6156506		17	17	3.8%	< 2	99%	80%	120%	103%	80%	120%	102%	70%	130%	

Comments: NA signifies Not Applicable.



Certified By: _____

Appendix D

Site Photographs



Photograph 1 – Looking north along the Norwich Avenue bridge deck



Photograph 2 – Looking south along the Norwich Avenue bridge deck



Photograph 3 – Looking east onto Highway 401 from the bridge deck



Photograph 4 – Looking west onto Highway 401 from the bridge deck



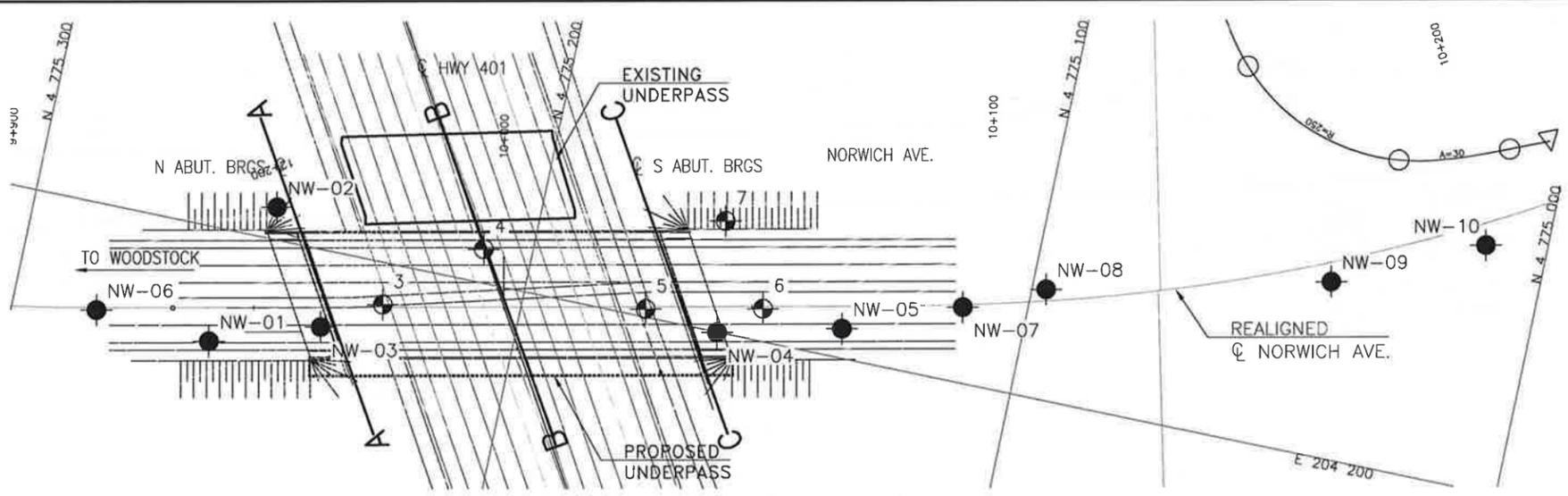
Photograph 5 – Looking north-west towards the bridge.



Photograph 6 – Looking south-east towards the bridge

Appendix E
Borehole Locations and Soil Strata Drawings

CAD FILE LOCATION AND NAME: H:\04\01\18516102\124-Plan\Plan\NorwichAve\NorwichAve.dwg
 MODIFIED: 3/20/2016 2:37:49 PM BY: DRAFTING02
 DATE PLOTTED: 4/21/2016 9:47:03 AM BY: DRAFTING02



PLAN
SCALE 1:1250



HWY 401
 CONT No 2015-3021
 GWP No 3054-13-00

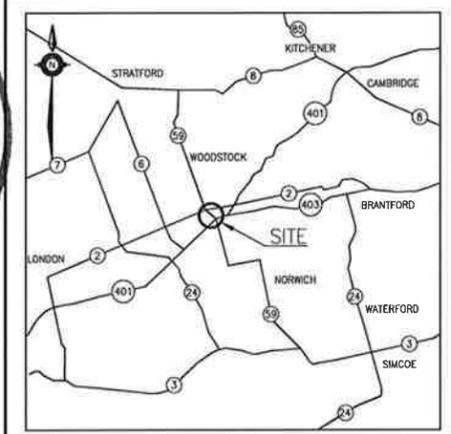


HIGHWAY 401/
 NORWICH AVENUE
 UNDERPASS
 BOREHOLE LOCATIONS AND SOIL STRATA

SHEET ST-2

MMM GROUP METRIC

THURBER ENGINEERING LTD.



KEYPLAN

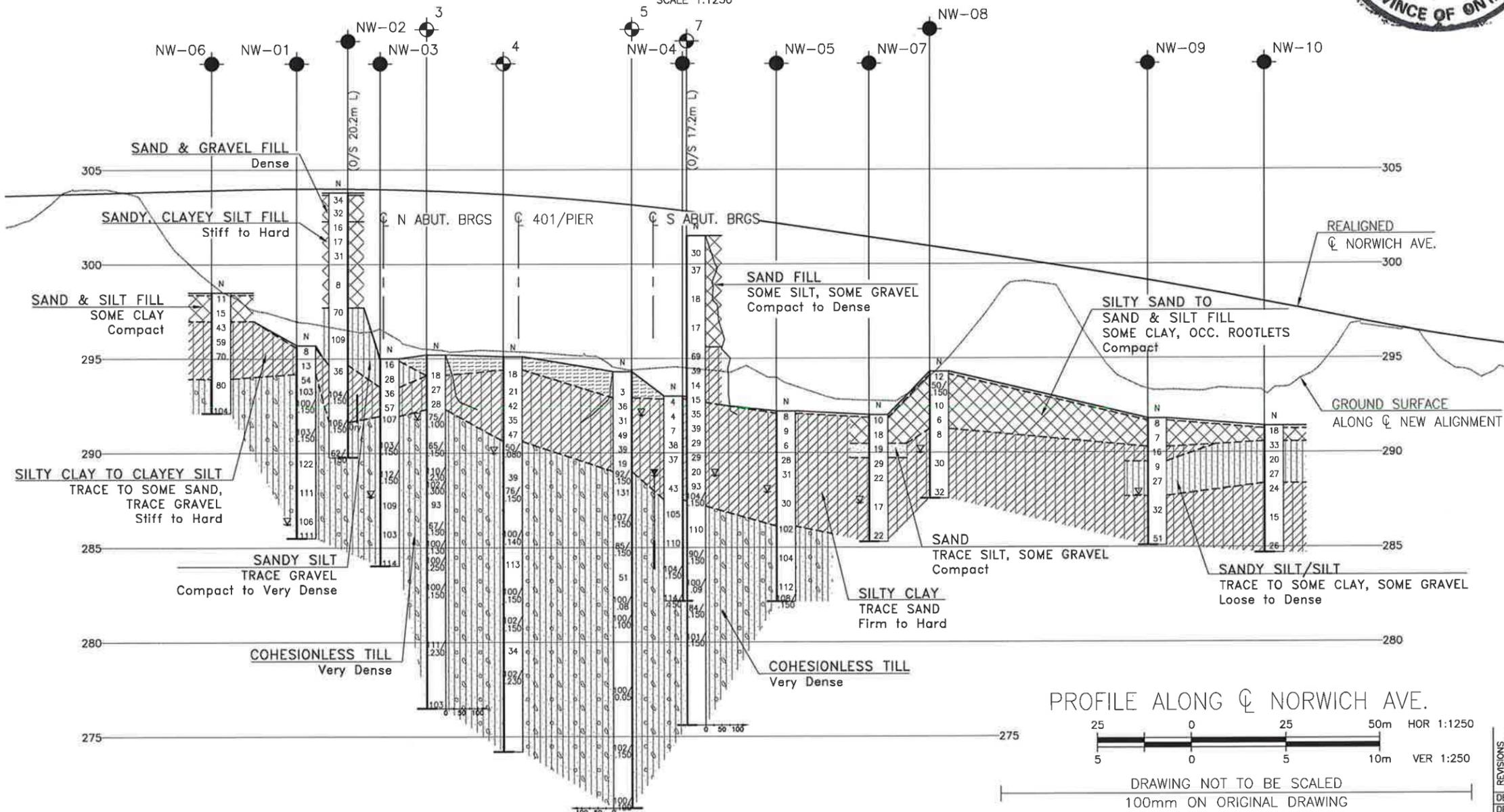
LEGEND

- 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
- Water Level In Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
NW-01	295.7	4 775 259.9	204 177.4
NW-02	303.8	4 775 252.1	204 206.5
NW-03	295.4	4 775 238.5	204 184.8
NW-04	293.0	4 775 160.3	204 200.0
NW-05	292.2	4 775 135.8	204 205.9
NW-06	298.5	4 775 283.2	204 178.9
NW-07	292.0	4 775 112.9	204 215.1
NW-08	294.3	4 775 097.2	204 222.0
NW-09	291.8	4 775 041.3	204 235.2
NW-10	291.4	4 775 012.3	204 248.7
3	295.2	4 775 227.2	204 191.8
4	295.1	4 775 209.7	204 206.8
5	294.3	4 775 175.4	204 201.7
7	301.5	4 775 163.2	204 222.3

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

GEOCREs No. 40P2-78



PROFILE ALONG Q NORWICH AVE.

HOR 1:1250
 VER 1:250
 DRAWING NOT TO BE SCALED
 100mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	CHK	CODE	LOAD	DATE	
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AN		23-170	STRUCT	SCHEME	DWG 2

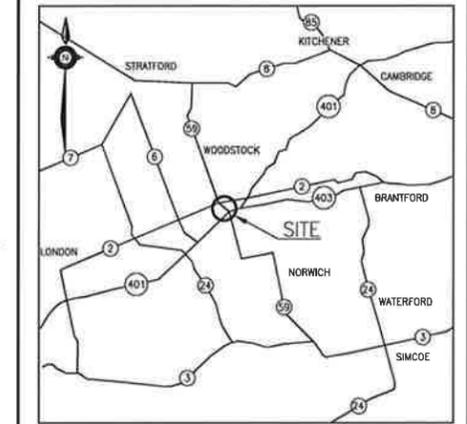
HWY 401
 CONT No 2015-3021
 GWP No 3054-13-00

HIGHWAY 401/
 NORWICH AVENUE
 UNDERPASS
 BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
 ST-3



METRIC



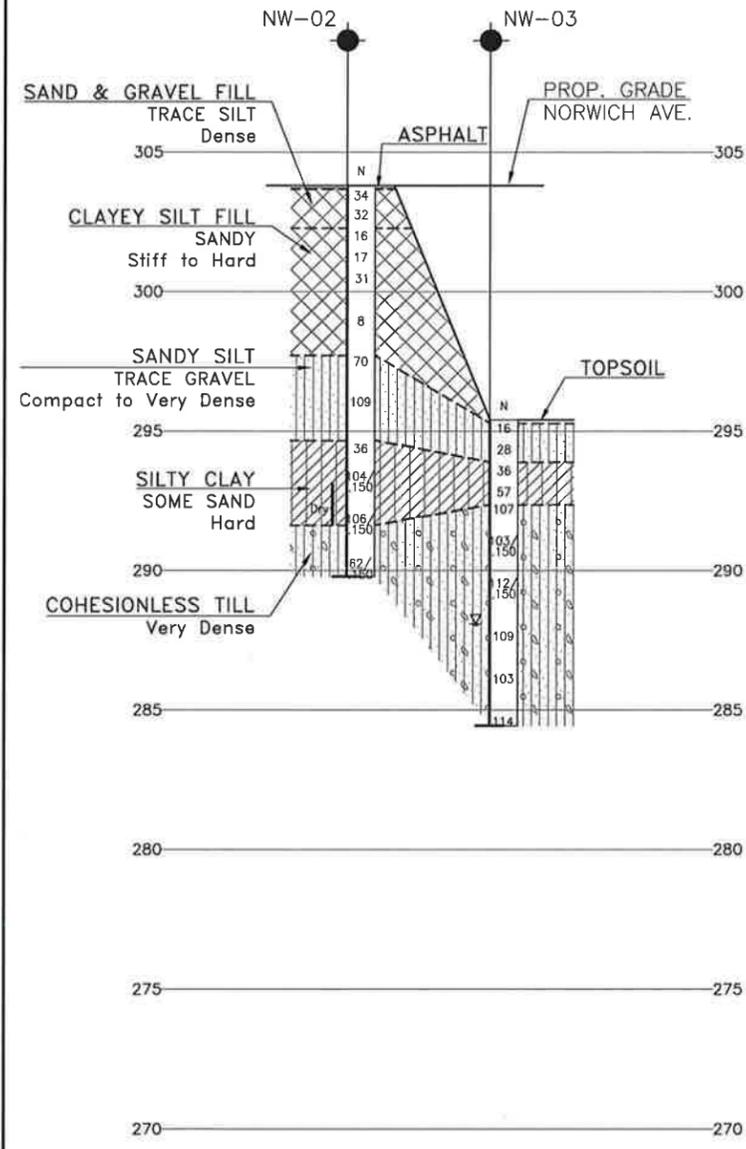
KEYPLAN
 LEGEND

- ◆ 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
- ⊥ Water Level in Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

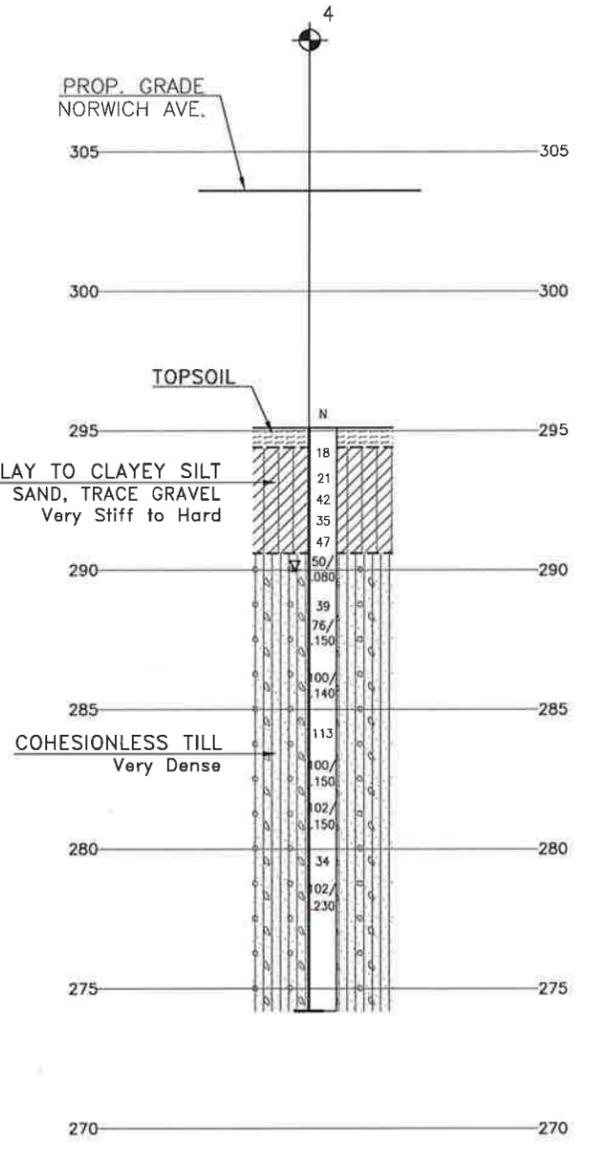
NO	ELEVATION	NORTHING	EASTING
NW-01	295.7	4 775 259.9	204 177.4
NW-02	303.8	4 775 252.1	204 206.5
NW-03	295.4	4 775 238.5	204 184.8
NW-04	293.0	4 775 160.3	204 200.0
NW-05	292.2	4 775 135.8	204 205.9
NW-06	298.5	4 775 283.2	204 178.9
NW-07	292.0	4 775 112.9	204 215.1
NW-08	294.3	4 775 097.2	204 222.0
NW-09	291.8	4 775 041.3	204 235.2
NW-10	291.4	4 775 012.3	204 248.7
3	295.2	4 775 227.2	204 191.8
4	295.1	4 775 209.7	204 206.8
5	294.3	4 775 175.4	204 201.7
7	301.5	4 775 163.2	204 222.3

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

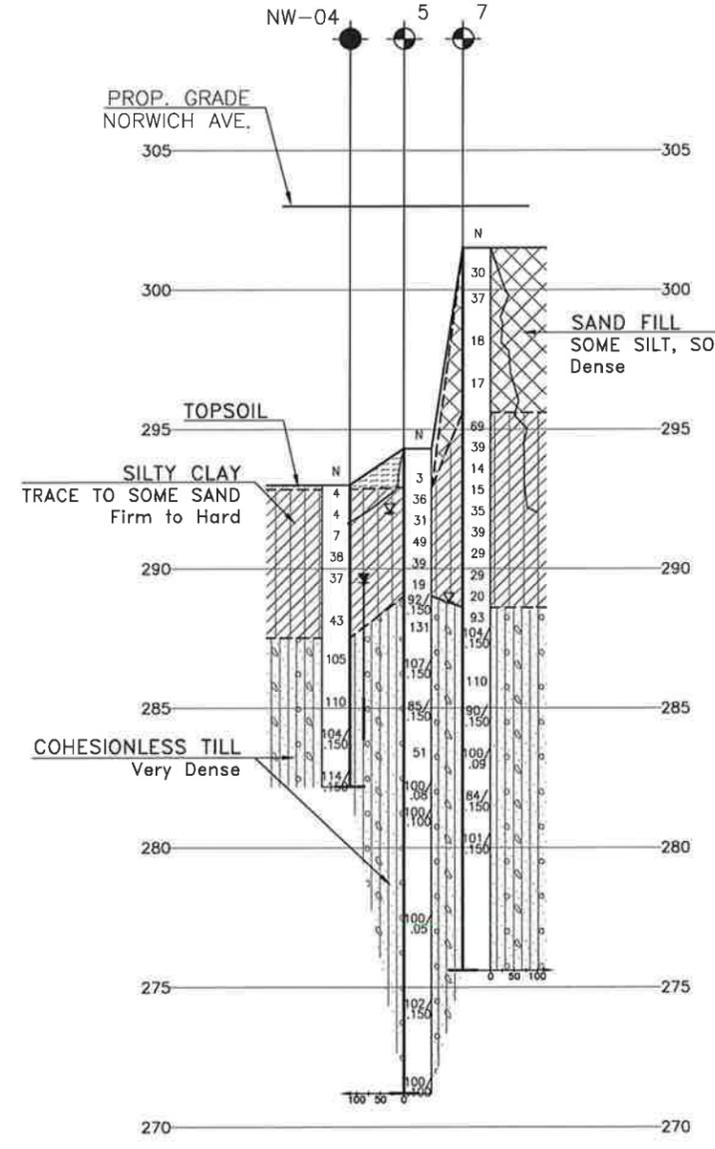
GEOGRES No. 40P2-78



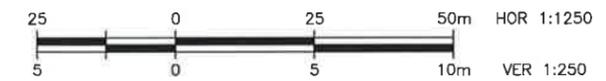
SECTION A-A



SECTION B-B



SECTION C-C



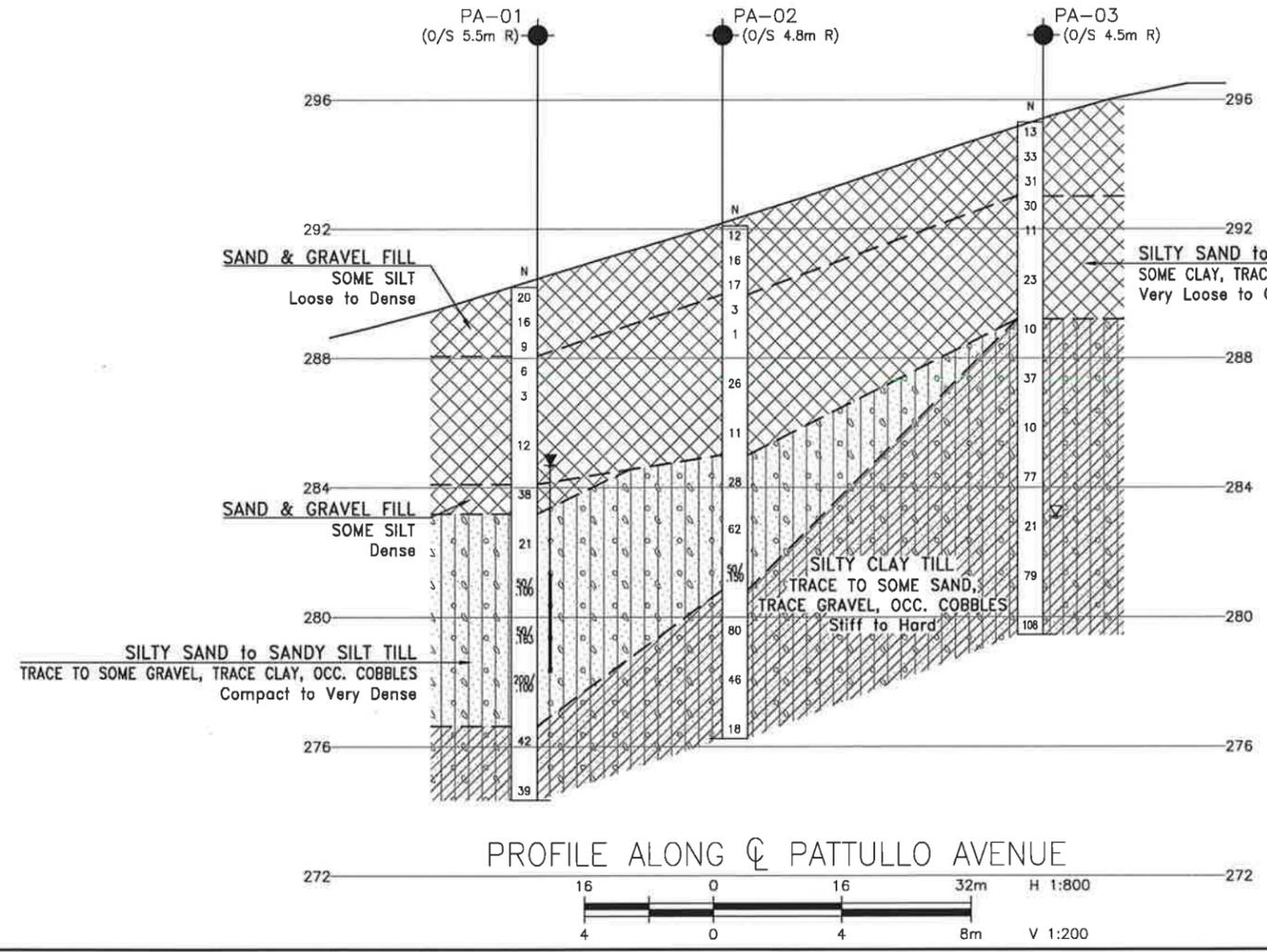
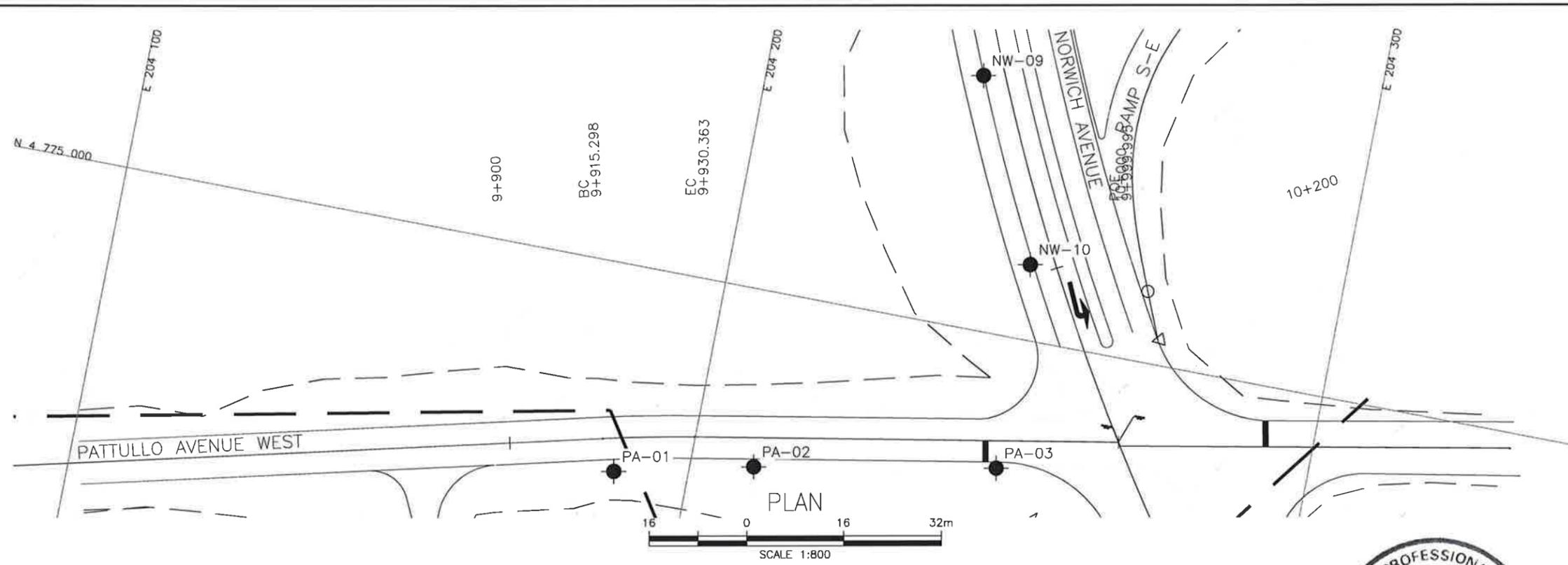
DRAWING NOT TO BE SCALED
 100mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

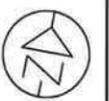
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 MODIFIED: 3/3/2016 2:37:49 PM
 DATE PLOTTED: 4/27/2016 9:47:58 AM
 BY: DRAFTING02
 BY: DRAFTING02

MINISTRY OF TRANSPORTATION, ONTARIO



CONT No 2015-3021
WP No 3054-13-00

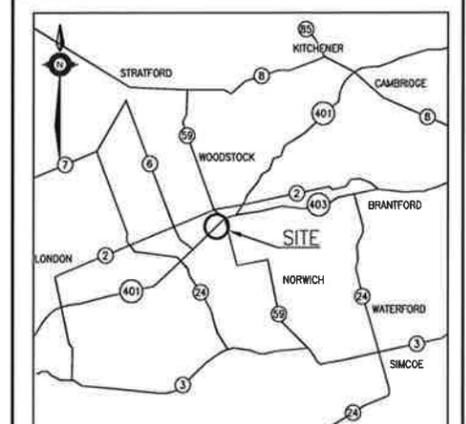


HIGHWAY 401 &
NORWICH AVENUE /
PATTULLO AVENUE WEST
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



METRIC



KEYPLAN
LEGEND

- Borehole
- ⊕ Borehole and Cone
- 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
PA-01	290.2	4 774 966.2	204 187.9
PA-02	292.1	4 774 971.2	204 210.3
PA-03	295.3	4 774 978.5	204 249.5
NW-09	291.8	4 775 041.3	204 235.2
NW-10	291.4	4 775 012.3	204 248.7

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

GEOCREs No. 40P2-78

CAD FILE LOCATION AND NAME: H:\Drawings\195151524\ref\1224\Plan\Profile\PA01-03.dwg
 MODIFIED: 24/2016 2:15:17 PM BY: DRAFTING02
 DATE PLOTTED: 4/27/2016 8:46:28 AM BY: DRAFTING02

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	AMP	CHK	PKC	CODE	LOAD	DATE	APR 2016
DRAWN	MFA	CHK	AMP	SITE	STRUCT	DWG	1

DRAWING NOT TO BE SCALED
50mm ON ORIGINAL DRAWING

Appendix F

**Previous Investigation
Borehole Locations and Soil Strata Drawing and Record of Borehole Sheets
Geocres No.: 40P2-45**

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_r	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No 1 1 OF 1 METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 775 051.1; E 204 202.2 ORIGINATED BY M.V.
 DIST. 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M.V.
 DATUM GEODETIC DATE 90 04 24 CHECKED BY _____

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
304.0	Hwy. 59 Shoulder											
0.0	Sand, Some Silt, Some Gravel, Compact (Fill)	[Strat Plot]	1	SS	96	/15cm	[Cone Penetration Plot]					
			2	SS	17							
			3	SS	15							
			4	SS	14							
298.3	Silty Sand, Trace of Gravel, Very Dense	[Strat Plot]	5	SS	102							
5.7			6	SS	107							
296.5	Silty Clay, Trace of Sand, Trace of Gravel, Hard	[Strat Plot]	7	SS	83							
7.5			8	SS	67							
			9	SS	67							
			10	SS	88							
			11	SS	56							
293.0	Sandy Silt, Trace of Gravel, Very Dense	[Strat Plot]	12	SS	50	/5cm						
11.0			13	SS	75	/8cm						
			14	SS	100	/8cm						
			15	SS	75	/15cm						
			16	SS	91	/15cm						
			17	SS	100	/10cm						
282.4	End of Borehole	[Strat Plot]	18	SS	81	/15cm						
21.6												

+3, x5: Numbers refer to Sensitivity
 20
 15-5 (% STRAIN AT FAILURE
 10

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 775 030.4; E 204 171.0 ORIGINATED BY M V
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST COMPILED BY M V
 DATUM GEODETIC DATE 90 04 20 CHECKED BY _____

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p — w — W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
296.3	Ground Surface									
0.0						296				
293.9						294				
2.4	End of Cone Test							120/25cm		

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 775 007.0; E 204 176.8 ORIGINATED BY M V
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M V
 DATUM GEODETTIC DATE 90 04 20 CHECKED BY _____

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40					
295.2	Ground Surface												
0.0	Topsail												
294.1	Sand, Some Silt, Compact	1	SS	18									
1.1	Clayey Silt, Trace of Sand, Trace of Gravel, Very Stiff	2	SS	27									
292.3		3	SS	28									
2.9		4	SS	75									
2.9	Sandy Gravel, Some Silt	5	SS	65	/15cm								
		6	SS	110	/23cm								
2.9	Silty Sand, Trace of Gravel, Very Dense	7	SS	102	/3cm								
		8	SS	93									
2.9		9	SS	67	/15cm								
		10	SS	100	/13cm								
284.6	Heterogeneous Mixture of Clayey Silt, Sand & Gravel, Hard (Glacial Till)	11	SS	100	/25cm								
10.6		12	SS	100	/15cm								
10.6		13	SS	111	/23cm								
		276.5	14	SS	103								
18.7	End of Borehole												

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

RECORD OF BOREHOLE No 4

1 OF 1 METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 774 989.5; E 204 191.8 ORIGINATED BY M V
 DIST 2 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY M V
 DATUM GEODETIC DATE 90 04 23 CHECKED BY _____

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100						
295.1	Hwy. 401 Median													
294.8	Sand And Organic Silt	1	SS	18									1 8 43 48	
0.7	Silty Clay to Clayey Silt, Trace of Sand, Trace of Gravel, Very Stiff to Hard	2	SS	21										
		3	SS	42										
		4	SS	35										
		5	SS	47										
290.6			6	SS	50									7 22 38 33
4.5	Sandy Silt, Trace of Gravel, Dense to Very Dense	7	SS	39										
		8	SS	76	/15cm									3 44 (53)
		9	SS	100	/14cm									
		10	SS	113										
		11	SS	100	/15cm									
		12	SS	102	/15cm									
		13	SS	34										5 17 (78)
		14	SS	102	/23cm									
274.2														
20.9		End of Borehole												
	• Water Level Not Stabilized													

RECORD OF BOREHOLE No 5 1 OF 1 METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 774 955.2; E 204 186.7 ORIGINATED BY M V
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER & BW CASING COMPILED BY M V
 DATUM GEODETIC DATE 90 04 17 TO 90 04 19 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
284.3	Ground Surface									
0.0	Topsoil									
292.9	Sand And Silt, Trace of Gravel, Loose		1	SS	3					
1.4	Silty Clay, Trace of Sand, Trace of Gravel, Very Stiff to Hard		2	SS	36					
			3	SS	31					
			4	SS	49					
			5	SS	39					
			6	SS	19					
289.0				7	SS	92	/15cm			
5.3	Sand And Gravel		8	SS	131					45 47 (8)
	Sandy Silt, Some Gravel, Occasional Gravel Seams, Very Dense		9	SS	107	/15cm				
			10	SS	85	/15cm				
			11	SS	51					
			12	SS	100	/8cm				
			13	SS	100	/10cm				
			14	SS	100	/5cm				
			15	SS	102	/15cm				
272.5	Heterogeneous Mixture of Clayey Silt, Sand and Gravel, Hard (Glacial Till)		16	SS	100	/10cm				16 45 (39)
21.8										
271.2										
23.1	End of Borehole									

+3, x5: Numbers refer to Sensitivity 20 15-5 (%) STRAIN AT FAILURE 10

RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 774 932.0; E 204 191.6 ORIGINATED BY M V
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST COMPILED BY M V
 DATUM GEODETTIC DATE 90 04 19 CHECKED BY _____

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
293.7	Ground Surface															
0.0						292										
290.1																
3.6	End of Cone Test										120	25cm				

+³, x⁵: Numbers refer to Sensitivity
 20
 15-5 (%) STRAIN AT FAILURE
 10

RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 774 943.0; E 204 207.3 ORIGINATED BY M V
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M V
 DATUM GEODETIC DATE 90 04 25 & 90 04 26 CHECKED BY _____

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE									'N' VALUES
301.5	Hwy. 59 Shoulder												
0.0	Sand, Some Silt, Some Gravel, Compact to Dense (Fill)	[Strat Plot]	1	SS	30								
			2	SS	37								
			3	SS	18								
			4	SS	17								
295.6	Sand, Some Silt, Some Gravel Clayey Silt, Trace of Sand, Trace of Gravel, Very Stiff to Hard	[Strat Plot]	5	SS	69								
5.9			6	SS	39								
			7	SS	14								
			8	SS	15								
			9	SS	35								
			10	SS	39								
			11	SS	29								
			12	SS	29								
			13	SS	20								0 0 63 37
288.5			Silty Sand, Some Gravel, Occasional Gravel Seams, Very Dense	[Strat Plot]	14	SS	93						
12.9	15	SS			104	/15cm						22 45 (33)	
	16	SS			110								
	17	SS			90	/15cm							
	18	SS			100	/8cm							
	19	SS			84	/15cm							
	20	SS			101	/15cm							46 41 (13)
	Sand And Gravel												
275.6	End of Borehole • Water Level Not Stabilized	[Strat Plot]											
25.9													

RECORD OF BOREHOLE No R1 1 OF 1 METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 775 135.0; E 204 146.0 ORIGINATED BY M.V.
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M.V.
 DATUM GEODETIC DATE 90 04 26 & 90 04 27 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40					
288.7	Unpaved Parking Area												
0.0	Gravel Fill												
	Clayey Silt to Silt With Sand, Trace of Gravel. Occasional Sand Seams, Very Stiff to Hard (Glacial Till)	1	SS	23		298							
		2	SS	19									3 31 50 16
		3	SS	51									
		4	SS	44									
		5	SS	51									
		6	SS	106									6 34 45 15
		7	SS	102	/23cm								
		8	SS	120									
		9	SS	76	/13cm								2 27 60 11
289.1	Sand, Some Silt, Very Dense												
9.6	End of Borehole												
	Note: Borehole was Terminated Due to Presence of Very Hard Strata												

+3, x5: Numbers refer to Sensitivity 20 15-5 (%) STRAIN AT FAILURE 10

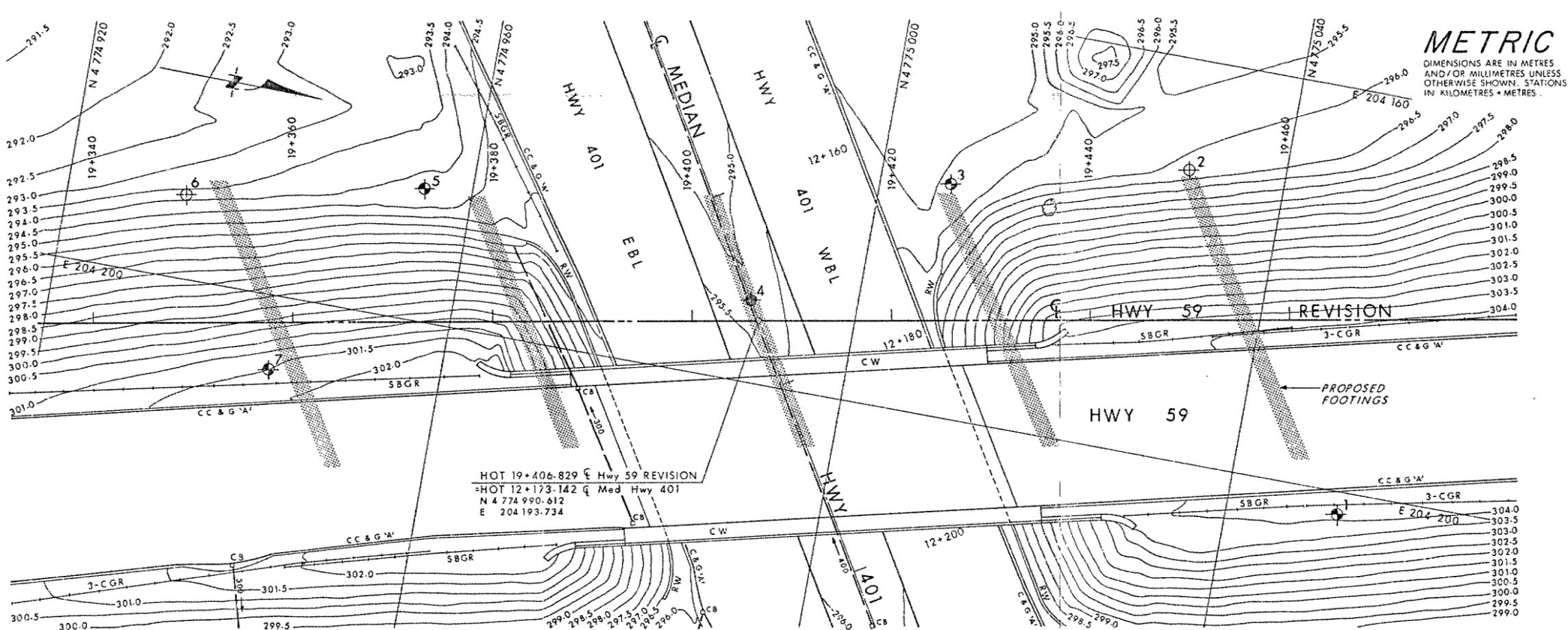
RECORD OF BOREHOLE No R2

1 OF 1

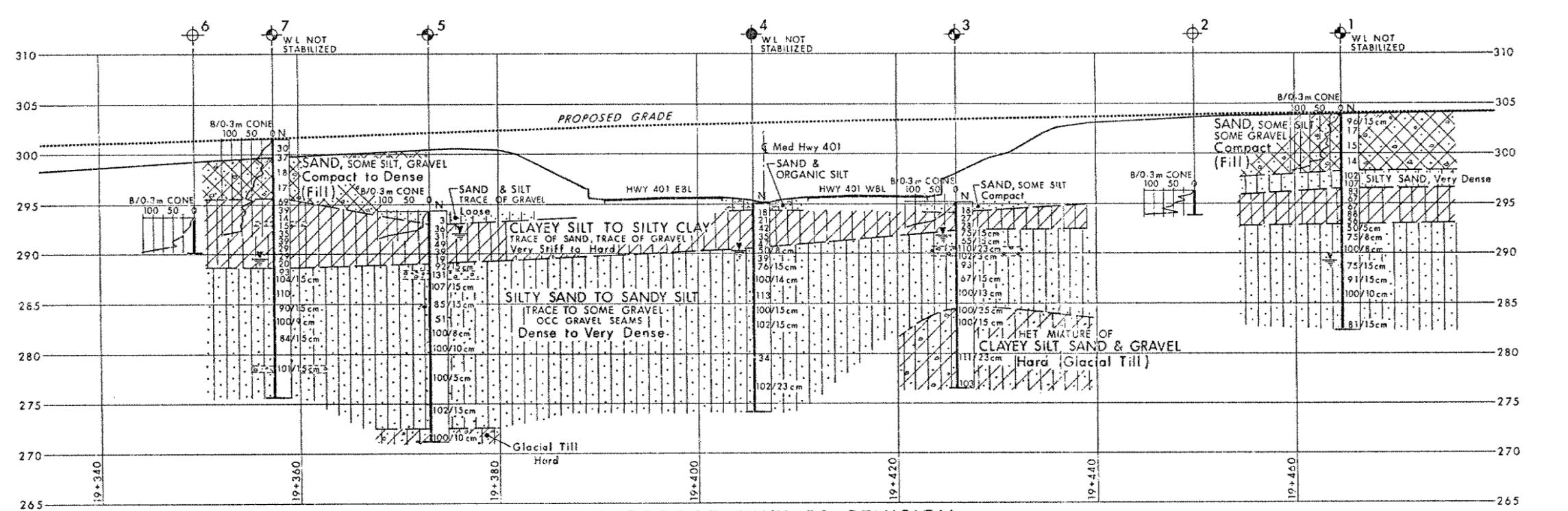
METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 775 107.0; E 204 094.0 ORIGINATED BY M V
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M V
 DATUM GEODETIC DATE 90 04 27 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
296.9	Unpaved Parking Area									
0.0	Gravel Fill		1	SS	36					
			2	SS	46					
	Gravelly Sand, Some Silt, Very Dense		3	SS	60					32 57 (11)
			4	SS	70					
			5	SS	122					
	Clayey Silt to Silt, Some Sand, Trace of Gravel, Occasional Sand Seams, Hard (Glacial Till)		6	SS	76	/15cm				
			7	SS	125					0 17 61 22
289.1			8	SS	55	/3cm				
7.8	End of Borehole									
	Note: Borehole Was Terminated Due to Presence of Very Hard Strata									
	• Water Level Not Stabilized									



PLAN
SCALE
5m 0 5m



PROFILE HWY 59 REVISION

SCALE
5m 0 5m

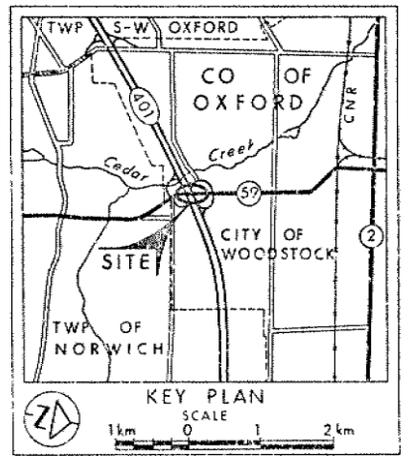
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 481-89-03

HWY 59 UNDERPASS

BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 1990 04

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	304.0	4 775 051.1	204 202.2
2	296.3	4 775 030.4	204 171.0
3	295.2	4 775 007.0	204 176.8
4	295.1	4 774 989.5	204 191.8
5	294.3	4 774 955.2	204 186.7
6	293.7	4 774 932.0	204 191.6
7	301.5	4 774 943.0	204 207.3

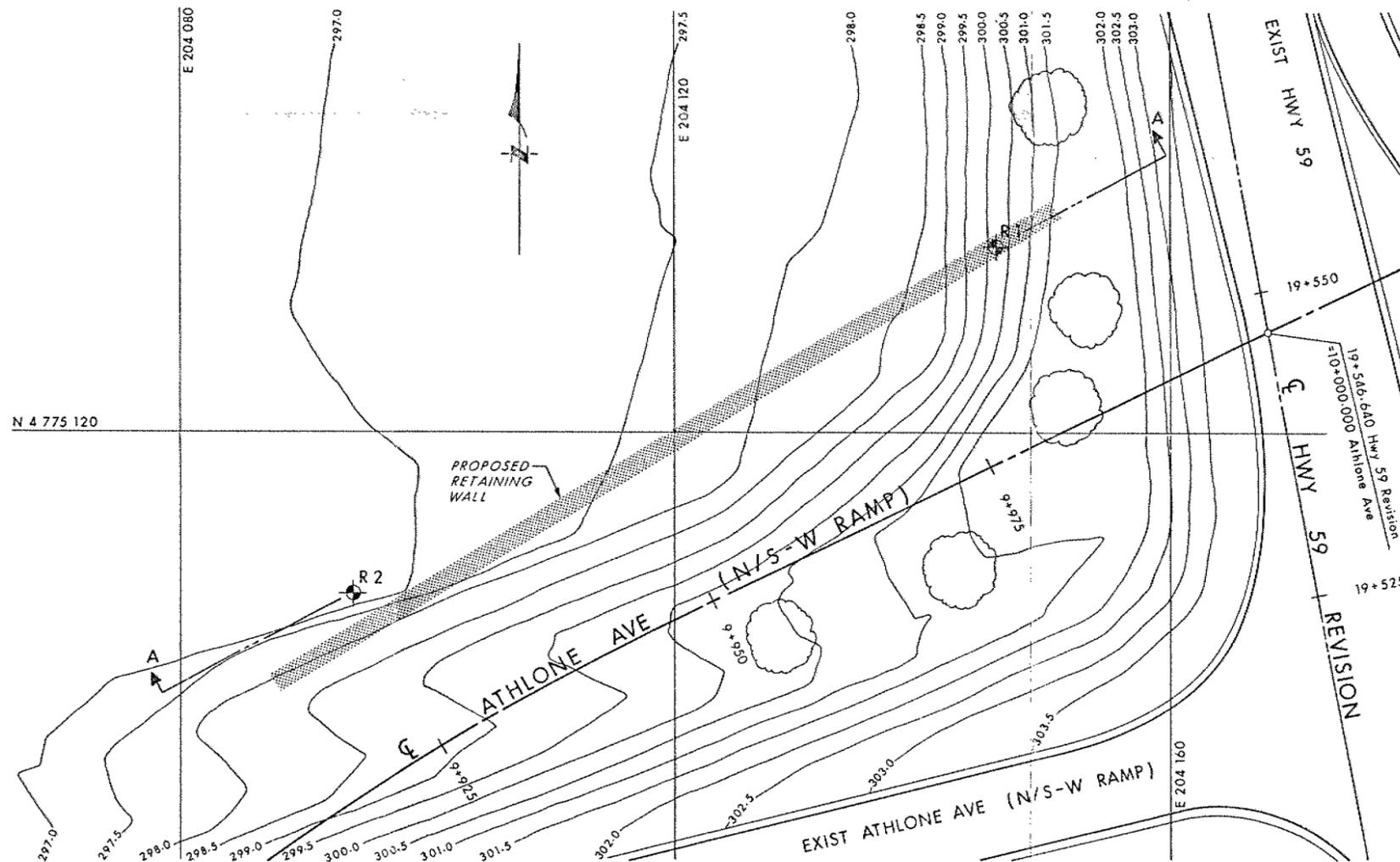
NOTE: The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically included in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION

Geocres No 40P2-45

HWY No 401	DIST 2
SUBMITTED BY: [Signature]	DATE: 1990 09 12
DRAWN BY: [Signature]	CHECKED BY: [Signature]
	APPROVED BY: [Signature]
	SITE: 23-170
	DWG: 4818903-A



PLAN
SCALE
5m 0 5m

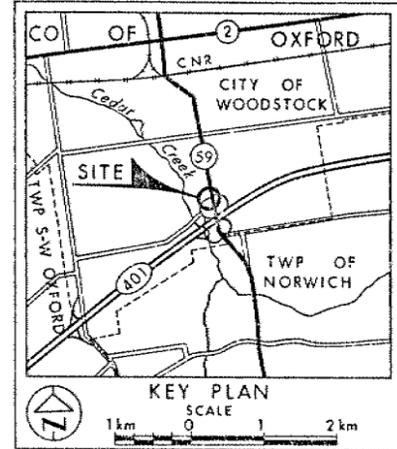
NOTE:
Contours in the area of retaining wall location do not reflect actual conditions encountered at time of field investigation.

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 481-89-03

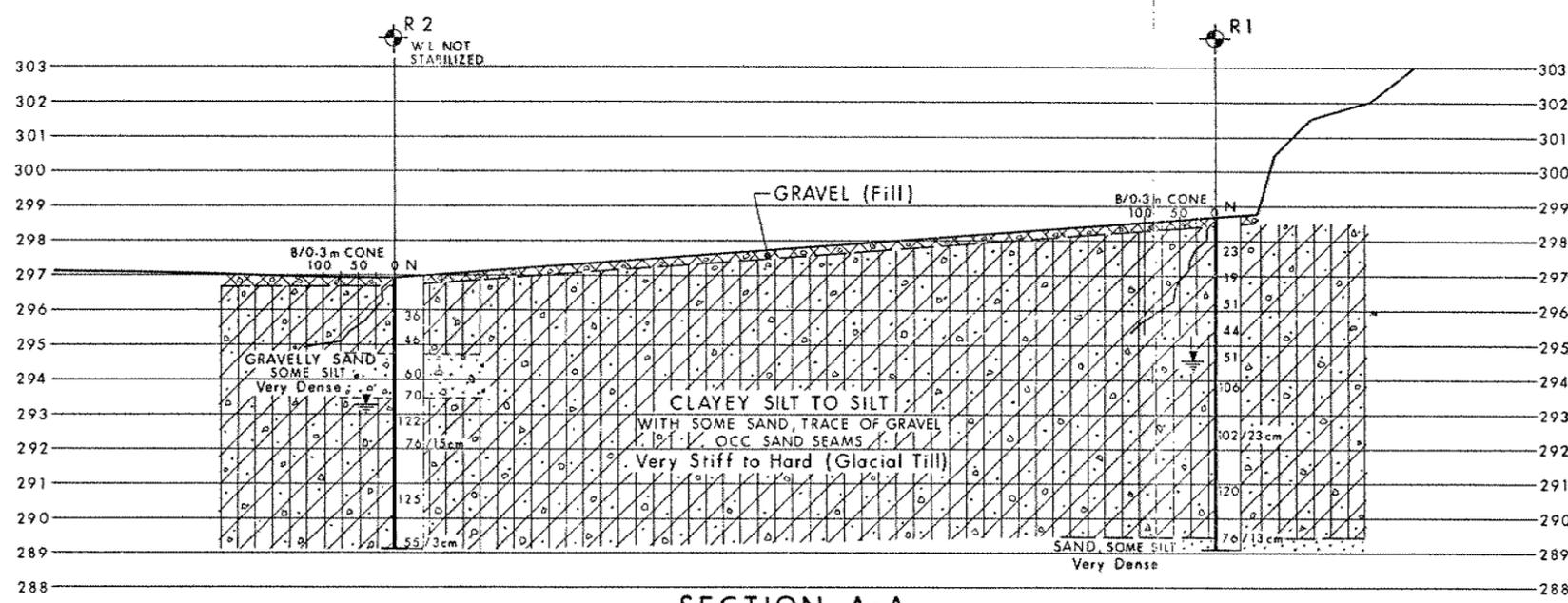
ATHLONE AVE (N/S-W RAMP)
RETAINING WALL
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- ⊙ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 1990 04



SECTION A-A
SCALE
5m 0 5m Horiz
2m 1 0 2m Vert

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
R1	298.7	4 775 135.0	204 146.0
R2	296.9	4 775 107.0	204 094.0

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION

Geocres No 42 P2-45

HWY No 401/59 DIST 2
SUBM'D BY CHECKED DATE 1990 09 14 15 TE
DRAWN BY CHECKED DATE 1990 09 14 15 TE