



**THURBER** ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT  
METROLINX RAILWAY BRIDGE FROM WELLINGTON STREET NORTH TO  
VICTORIA STREET CONNECTION  
HIGHWAY 7-NEW, KITCHENER TO GUELPH  
G.W.P. 408-88-00**

**GEOCRES No. 40P8-277**

**Latitude 43.457463 ° , Longitude -80.470548 °**

**Report**

**to**

**WSP**

Date: June 9, 2020  
File: 11375



## TABLE OF CONTENTS

### PART 1: FACTUAL INFORMATION

1.	INTRODUCTION .....	1
2.	SITE DESCRIPTION .....	2
3.	INVESTIGATION PROCEDURES.....	2
4.	LABORATORY TESTING.....	4
5.	DESCRIPTION OF SUBSURFACE CONDITIONS .....	5
5.1	Topsoil.....	5
5.2	Cohesionless Fill .....	5
5.3	Organics .....	6
5.4	Silty Sand, Sandy Silt and Upper Sand.....	6
5.5	Gravelly Sand.....	7
5.6	Clayey Silt Till.....	8
5.7	Silty Clay .....	9
5.8	Lower Sand .....	10
5.9	Sandy Silt Till and Sand and Silt Till.....	11
5.10	Sand and Gravel .....	12
5.11	Groundwater Conditions .....	12
6.	CORROSIVITY AND SULPHATE TEST RESULTS.....	13
7.	MISCELLANEOUS .....	13

### APPENDICES

Appendix A	Record of Borehole Sheets and Laboratory Test Results – Present investigation
Appendix B	Record of Borehole Sheets and Laboratory Test Results – Previous investigation
Appendix C	Analytical Laboratory Test Results – Present investigation
Appendix D	Borehole Locations and Soil Strata Drawing



**FINAL  
FOUNDATION INVESTIGATION REPORT  
METROLINX RAILWAY BRIDGE FROM WELLINGTON STREET NORTH TO  
VICTORIA STREET CONNECTION  
HIGHWAY 7-NEW, KITCHENER TO GUELPH  
G.W.P. 408-88-00**

**GEOCRES No. 40P8-277**

**PART 1: FACTUAL INFORMATION**

**1. INTRODUCTION**

This report presents the factual findings obtained from a detailed foundation investigation conducted at the site of the proposed Metrolinx bridge/tracks over the planned Wellington Street North to Victoria Street Connection in the Regional Municipality of Waterloo, Ontario. The proposed structure is part of the Highway 7-New Project.

The purpose of the investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profiles, cross sections, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions under the potential foundation footprint was developed from the data obtained in the course of the investigation.

Thurber was retained by WSP to carry out the site investigation under the Ministry of Transportation Ontario (MTO) Agreement Order Number 3014-E-0013.

Reference has been made to information on subsurface conditions contained in a previous foundation report prepared for this site during the preliminary design phase. The title of the report is:



- Preliminary, Foundation Investigation and Design Report, Bruce Street Extension Under CNR, Highway 7-New, Kitchener to Guelph, G.W.P. 408-88-00, Geocres No. 40P8-163, Report to Ministry of Transportation Ontario West Region, File: 15-64-17, dated June 2, 2009. (Reference 1).

## **2. SITE DESCRIPTION**

The site lies approximately 100 m east of the Kitchener-Waterloo Expressway (KWE) and the existing Metrolinx Rail bridge, and 115 m north of Victoria Street, in the Regional Municipality of Waterloo, Ontario. Twin Metrolinx tracks run from east to west at this site. The rail tracks are built within an embankment that is approximately 3.0 m high.

The site lies within an area of industrial and commercial lands and is generally flat. A parking lot is currently situated on the south side of the Metrolinx tracks. The lands immediately north of the Metrolinx tracks are vacant and covered with long grass and shrubs.

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within the physiographic region known as the Waterloo Hills, characterized by ridges of sandy till and kames or kame moraines, with outwash sands occupying the intervening hollows.

## **3. INVESTIGATION PROCEDURES**

A detailed geotechnical investigation was conducted from July 2 to 19, 2019 and consisted of drilling four boreholes (numbered CN16-13 to CN16-16) at the proposed bridge abutments. Boreholes CN16-14 and CN16-15 were terminated at 35.2 m depth (Elevations 288.0 and 286.9), and Boreholes CN16-13 and CN16-16 at 15.8 m depth (Elevations 307.1 and 306.3). It should be noted that no borehole was drilled to investigate the railway embankment due to access constraints as well as restrictions imposed by Metrolinx.

The approximate locations of the present boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D. The coordinates and elevations of the boreholes drilled during the present investigation are given on the drawings and on the individual Record of Borehole Sheets in Appendix A.



Borehole 08-046, drilled during the previous investigation (Reference 1), has been incorporated in this report. Borehole 08-046 was terminated at 33.7 m depth (Elevation 288.2). The Record of Borehole sheet of Borehole 08-046 is included in Appendix B.

The ground surface elevations and coordinates of the recent boreholes were provided by WSP.

Prior to commencing the site investigation, utility clearances were obtained for all borehole locations.

During the present investigation, the boreholes were drilled using a track-mounted drill rig and advanced with a combination of hollow stem augers and mud rotary drilling. Samples were obtained at selected depth intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

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

Groundwater conditions in the open boreholes were observed during the drilling operations. One piezometer was installed in Borehole CN16-16 to permit long term monitoring of groundwater levels. The piezometer consisted of 25 mm diameter PVC pipe with a slotted screen enclosed in filter sand. The location and completion details of the piezometer are summarized in Table 3.1 along with the borehole completion details. The completion of the boreholes was carried out in accordance with the requirements of O. Reg. 903 (as amended by O. Reg. 372/07). The piezometers are planned to be decommissioned in the summer of 2020.



**Table 3.1 – Borehole Completion Details**

Foundation Unit	Borehole	Borehole Ground Surface Elevation	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
West Abutment	CN16-13	322.9	15.8/307.1	None installed	Borehole backfilled with cement and grout to 0.6 m, then bentonite holeplug to surface.
	CN16-15	322.1	35.2/286.9	None installed	Borehole backfilled with bentonite holeplug, sand and cement to surface.
	CN16-16	322.2	15.8/306.3	7.6/314.6	Piezometer with 3.0 m slotted screen installed with grout from 15.8 m to 7.6 m, sand filter from 7.6 m to 4.0 m, bentonite holeplug from 4.0 m to ground surface.
East Abutment	CN16-14	323.2	35.2/288.0	None installed	Borehole backfilled with cement, gravel and bentonite holeplug to surface.
	08-046	321.9	33.7/288.2	33.5/288.4	Piezometer with 1.5 m slotted screen installed with sand filter to 31.7 m, holeplug to 30.8 m, grout mix with auger cuttings to 1.2 m, holeplug to 0.6 m, then concrete to surface.

#### 4. LABORATORY TESTING

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

The results of the laboratory testing conducted during the previous investigation (Reference 1) are summarized on the Record of Borehole sheets in Appendix B, and also presented on the figures included in Appendix B.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, a sample of the existing native soil was collected. The sample was submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of corrosivity parameters and sulphate



content. The results of the analytical testing are summarized in Section 6 and are presented in Appendix C.

## **5. DESCRIPTION OF SUBSURFACE CONDITIONS**

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendices A and B. 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 and must be used for interpretation of the site conditions. It should be recognized and expected that soil conditions may vary between and beyond borehole locations.

In general, the soil stratigraphy at this site consisted of surficial topsoil over loose to dense silty sand to sand fill, overlying native compact to dense silty sand, sandy silt and upper sand and compact gravelly sand. An extensive deposit of very stiff to hard silty clay was contacted below the cohesionless soils. Underlying the silty clay, layers of very dense sand and sandy silt till were contacted. Layers of very dense sandy silt till/sand and silt till and very stiff to hard clayey silt till were contacted within the silty clay deposit. A layer of very dense sand and gravel was contacted below the sandy silt till in Borehole CN16-15. The groundwater level measured in the piezometers was 1.9 m below the ground surface (Elevation 320.3).

### **5.1 Topsoil**

Topsoil was encountered surficially in the four boreholes drilled at this site during the present investigation. The thickness of the topsoil layer ranged from 100 mm to 150 mm.

The topsoil thickness may vary between the borehole locations and in other areas of the site.

### **5.2 Cohesionless Fill**

Cohesionless fill was encountered immediately below the topsoil in Boreholes CN16-13 to CN16-16 drilled at the site during the present investigation, and surficially in Borehole 08-046 drilled during the previous investigation.

The cohesionless fill consisted of brown to black sand and silty sand containing trace gravel to gravelly, trace to some clay and occasional cobbles. Occasional organics and decayed wood fragments were encountered in the fill in Boreholes CN16-13, CN16-15, CN16-16 and 08-046. A gasoline odour was noted in the cohesionless fill in Boreholes CN16-16 and 08-046.

Client: WSP

Date: June 9, 2020

File No.: 11375

Page: 5 of 16

E file: H:\10000+11375 Hwy 7 New PD and DD Foundations\Reports & Memos\Rail Bridges\Victoria St\Final\11375 - Wellington to Victoria Connection Final FIR-June8-20.docx



The thickness of the cohesionless fill ranged from 2.1 m to 2.9 m, with the lower boundary of this layer encountered at depths ranging from 2.1 m to 3.0 m (Elevation 320.2 to 319.1).

SPT N-values recorded in the cohesionless fill generally ranged from 5 to 34 blows for 0.3 m penetration, indicating a loose to dense state. SPT 'N' values of 1 to 3 blows per 0.3 m of penetration, indicating a very loose state, were measured in Borehole CN16-15 and 08-46. Moisture content of samples of the cohesionless fill generally ranged from 6 percent to 30 percent. A moisture content of 98 percent was measured within the cohesionless fill in Borehole CN16-15, at a depth of 2.6 m, indicating the presence of organics.

The results of grain size analyses conducted on samples of the silty sand and sand fill are provided on the Record of Borehole sheets in Appendix A, and illustrated on Figure A1 of Appendix A. The results are summarized as follows:

<b>Soil Particles</b>	<b>Cohesionless Fill (Percent)</b>
Gravel	4 to 22
Sand	37 to 75
Silt	17 to 32
Clay	3 to 11

### 5.3 Organics

A layer of organics was encountered below the cohesionless fill layer in Borehole CN16-14, at a depth of 3.0 m (Elevation 320.2). The thickness of the organics layer was 500 mm.

The SPT N-Value recorded in the organic layer was 15 blows for 0.3 m penetration, indicating a compact state.

The moisture content from a sample of the organics layer was measured to be 124 percent.

### 5.4 Silty Sand, Sandy Silt and Upper Sand

Native brown to grey silty sand to sandy silt was encountered below the cohesionless fill and organics at depths ranging from 2.1 m to 3.5 m (Elevations 319.9 to 319.1) in Boreholes CN16-13, CN16-14, CN16-16 and 08-046. The thickness of the silty sand/sandy silt ranged from 1.1 m to 4.3 m.



An upper layer of brown sand containing trace silt and trace clay was contacted at 3.0 m depth (Elevation 319.1) in Borehole CN16-15. The thickness of the sand was 4.2 m.

Occasional cobbles were encountered within the sandy silt layer in Borehole 08-046. A gasoline odour was also noted in the sandy silt layer in Borehole 08-046.

SPT N-values recorded in the silty sand, sandy silt and upper sand ranged from 11 to 41 blows for 0.3 m penetration, indicating a compact to dense state. An SPT 'N' value of 7 blows per 0.3 m of penetration, indicating a loose condition, was measured in Borehole 08-046 near Elevation 319.5.

Moisture content of samples of the silty sand, sandy silt and upper sand generally ranged from 12 percent to 23 percent. A moisture content of 46 percent was measured below the layer of organics in Borehole CN16-14.

Samples of the sand and sandy silt from the present and previous investigation, underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendices A and B. The grain size distribution curves for these samples are plotted on Figures A2 and B1 of Appendices A and B. The results of this testing are summarized as follows:

Soil Particles	Sandy Silt (Percent)	Sand (Percent)
Gravel	2	0
Sand	44	91
Silt	50	8
Clay	4	1

## 5.5 Gravelly Sand

A layer of brown gravelly sand containing trace silt and trace clay was encountered below the native silty sand layer in Borehole CN16-16, at a depth of 5.6 m (Elevation 316.6). The thickness of the gravelly sand layer was 1.6 m.

The depth to the base of the gravelly sand was contacted at 7.2 m (Elevation 315.0).

An SPT N-value recorded in the gravelly sand was 15 blows for 0.3 m penetration, indicating a compact state.

The moisture content of a sample of the gravelly sand was 13 percent.



## 5.6 Clayey Silt Till

Brown to grey clayey silt till with sand to some sand, trace gravel and occasional silty sand seams was encountered below the sandy silt and sand layers in Boreholes CN16-15 and 08-046, at depths of 7.2 m and 6.4 m, respectively (Elevations 314.9 and 315.5), respectively.

The thickness of the clayey silt till deposit ranged from 2.7 m to 4.3 m, with the lower boundary encountered at depths of 11.5 and 9.1 m (Elevations 310.6 and 312.8) in Boreholes 16-15 and 08-046, respectively.

SPT N-values recorded in the clayey silt till ranged from 23 blows to 45 blows for 0.3 m penetration, indicating a very stiff to hard consistency. Moisture content of samples of the clayey silt till generally ranged from 10 percent to 26 percent.

The results of grain size distribution analyses carried out on samples of the clayey silt till are presented on the Record of Borehole sheets included in Appendices A and B. Grain size distribution curves of the samples tested are presented on Figures A3 and B2 of Appendices A and B. The results of the grain size distribution analyses are summarized below:

Soil Particles	Clayey Silt Till (Percent)
Gravel	1 to 4
Sand	18 to 25
Silt	46 to 54
Clay	25 to 27

The results of Atterberg Limits tests conducted on samples of clayey silt till are presented on the Record of Borehole sheets in Appendices A and B, and illustrated in Figures A6 and B6 of Appendices A and B. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	24 to 26
Plastic Limit	14
Plasticity Index	10 to 13



The above results indicate that the clayey silt till is of low plasticity with a group symbol of CL.

It should be noted that glacial tills are known to contain cobbles and boulders.

## 5.7 Silty Clay

Brown to grey silty clay containing trace sand was encountered below the silty sand, sandy silt and sand layers in Boreholes CN16-13 and CN16-14, below clayey silt till layer in Boreholes CN16-15 and 08-046, and below the gravelly sand layer in Borehole CN16-16. The silty clay was contacted at depths ranging from 4.1 m to 11.5 m (Elevations 318.8 to 310.6).

Where fully penetrated in Boreholes CN16-14, CN16-15 and 08-046, the silty clay layer ranged in thickness from 15.9 m to 23.6 m, with the base of the layer contacted at depths from 27.4 m to 30.8 m (Elevation 294.7 to 292.4). Boreholes CN16-13 and CN16-16 were terminated in the silty clay layer at a depth of 15.8 m (Elevations 307.1 and 306.3). Layers of sandy silt till and sand and silt till were encountered within the silty clay in Borehole CN16-14.

SPT N-values recorded in the silty clay ranged from 18 to 90 blows for 0.3 m penetration, indicating a very stiff to hard consistency. SPT 'N' values of 100 blows for less than 0.3 m penetration, indicating a hard consistency, were also measured in Boreholes CN16-15 and 08-046 near Elevations 302.0 and 305.0.

Moisture content of samples of the silty clay generally ranged from 12 percent to 38 percent.

The results of grain size distribution analyses carried out on samples of the silty clay are presented on the Record of Borehole sheets included in Appendices A and B. Grain size distribution curves of the samples tested are presented on Figures A4 and B3 of Appendices A and B. The results of the grain size distribution analyses are summarized below:

Soil Particles	Silty Clay (Percent)
Gravel	0
Sand	1 to 7
Silt	23 to 45
Clay	54 to 75



The results of Atterberg Limits tests conducted on samples of silty clay are presented on the Record of Borehole sheets in Appendices A and B, and illustrated in Figures A7 and B7 of Appendices A and B. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	39 to 50
Plastic Limit	17 to 21
Plasticity Index	21 to 30

The above results indicate that the silty clay is of intermediate plasticity with a group symbol of CI.

### 5.8 Lower Sand

A lower sand layer was encountered below the silty clay in Boreholes CN16-15 and 08-046, at depths of 27.4 m and 28.7 m (Elevation 294.7 and 293.3), respectively. The lower sand was generally brown to grey in colour, with some silt, trace to some gravel and trace clay.

The thickness of the lower sand layer ranged from 1.5 m to 3.7 m, with the bottom boundary encountered at depths of 31.1 m and 30.2 m (Elevations 291.0 and 291.8) in Boreholes CN16-15 and 08-046, respectively.

SPT N-values recorded in the lower sand ranged from 79 to 80 blows for 0.3 m penetration, indicating a very dense relative density.

Moisture content of samples of the lower sand generally ranged from 12 percent to 20 percent.

One sample of the lower sand underwent laboratory gradation analysis. These results are presented on the Record of Borehole sheets included in Appendix B and the grain size distribution curves for these samples are plotted on Figure B4 of Appendix B. The results of this testing are summarized as follows:

Soil Particles	Lower Sand (Percent)
Gravel	5
Sand	69
Silt and Clay	26



## 5.9 Sandy Silt Till and Sand and Silt Till

Layers of grey sandy silt till and, sand and silt till containing trace clay and occasional cobbles were contacted at 11.7 m and 14.7 m depth (Elevations 311.2 and 308.5) in Boreholes CN16-13 and CN16-14, and also at depths ranging from 30.2 m and 31.1 m (Elevations 291.0 to 292.4) in Boreholes CN16-14, CN16-15 and 08-46. Where fully penetrated, the thickness of the sandy silt till/sand and silt till ranged from 1.8 m to 3.3 m.

The depth to the base of the upper sandy silt till and, sand and silt till layers in Boreholes CN16-13 and CN16-14 was at 14.8 m and 16.5 m (Elevations 308.1 and 306.7). The depth to the base of the lower sandy silt till layer in Borehole CN16-15 was 34.4 m (Elevation 287.7).

Boreholes 08-046 and CN16-14 were terminated in the sandy silt till layer at depths of 33.7 m and 35.2 m, respectively (Elevation 288.2 and 288.0).

SPT N-values recorded in the sandy silt till/sand and silt till ranged from 76 blows for 0.3 m penetration to 100 blows for 0.05 m penetration, indicating a very dense relative density. Tricone grinding was noted in this layer, which indicates the presence of cobbles and/or boulders.

Moisture content measured in the sandy silt till/sand and silt till generally ranged from 7 percent to 27 percent.

The results of grain size distribution analyses carried out on samples of the sandy silt till/sand and silt till are presented on the Record of Borehole sheets included in Appendices A and B. Grain size distribution curves of the samples tested are presented on Figures A5 and B5 of Appendices A and B. The results of the grain size distribution analyses are summarized below:

<b>Soil Particles</b>	<b>Sandy Silt Till/ Sand and Silt Till (Percent)</b>
Gravel	0 to 4
Sand	31 to 44
Silt	43 to 61
Clay	7 to 19

It should be noted that glacial tills are known to contain cobbles and boulders.



### 5.10 Sand and Gravel

A layer of grey sand and gravel was encountered below the sandy silt till in Borehole CN16-15, at a depth of 34.4 m (Elevation 287.7).

Borehole CN16-15 was terminated within the sand and gravel layer at a depth of 35.2 m (Elevation 286.9).

The SPT N-value recorded in the gravelly sand was 100 blows for 0.1 m penetration, indicating a very dense condition. The moisture content of the sand and gravel was 13 percent.

### 5.11 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in Boreholes 08-046 and CN16-16, to monitor water levels after completion of drilling. The water levels measured in the piezometer installed at CN16-16 are summarized in Table 5.1, along with the measurements in the open boreholes upon completion of drilling. Unfortunately, the piezometer installed at borehole 08-046 was destroyed before any reading could be obtained.

Previous geotechnical investigation conducted in 1966 (information provided in Reference 1), indicates that groundwater level is near Elevation 318.4.

Water level was measured at 3.2 m depth (Elevation 319.0) on October 5, 2008, in a previous piezometer installed at the site, in close proximity to the existing CN bridge over KWE.

**Table 5.1 – Water Level Measurements**

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
CN16-14	July 17, 2019	4.6	318.6	Open borehole
CN16-16	July 2, 2019	4.0	318.2	Open borehole Piezometer Piezometer
	Aug 8, 2019	1.9	320.3	
	Aug 29, 2019	1.9	320.3	
08-046	Aug 7, 2008	N/A	N/A	No water level readings available - piezometer was destroyed.



The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

## 6. CORROSIVITY AND SULPHATE TEST RESULTS

A sample of the silty sand fill from Borehole CN16-15 was submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are shown in Table 6.1. The laboratory certificates of analysis are presented in Appendix C.

**Table 6.1 – Analytical Test Results**

Parameter	Units (Soil)	Test Results
		CN16-15, SS4 Depth 2.6 m
Soil Redox Potential	mV	255
Sulphide	%	0.02
pH	pH Units	7.88
Chloride	µg/g	60
Sulphate	µg/g	100
Conductivity	uS/cm	400
Resistivity (calculated)	ohms.cm	2500

## 7. MISCELLANEOUS

Landshark Drilling of Brantford, Ontario supplied a rubber track mounted B-57 drill rig and conducted the drilling, sampling and in-situ testing operations for the present investigation.

The coordinates for the boreholes were obtained with GPS equipment by Thurber, and the elevations were provided by WSP.

The drilling and sampling operations in the field for the current investigation were supervised on a full-time basis by Thurber field technicians.

Geotechnical laboratory testing was carried out at Thurber's geotechnical laboratory. Analytical laboratory testing was carried out by SGS Canada Inc.

Overall supervision of the field program for the present investigation was conducted by Dr. Nancy Berg, P.Eng.

Client: WSP  
File No.: 11375

Date: June 9, 2020  
Page: 13 of 16

E file: H:\10000+11375 Hwy 7 New PD and DD Foundations\Reports & Memos\Rail Bridges\Victoria St\Final\11375 - Wellington to Victoria Connection Final FIR-June8-20.docx



Interpretation of the data and preparation of the current report was carried out by Ms. Judy Mei, EIT and Ms. Rocio Palomeque Reyna, P.Eng.

Mr. Jason Lee, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.



Thurber Engineering Ltd.

A handwritten signature in black ink, appearing to read 'Judy Mei', written over a horizontal line.

Judy Mei, EIT  
Geotechnical EIT



Jason Lee, P.Eng.  
Principal/Senior Geotechnical Engineer



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



## **Appendix A**

### **Record of Borehole Sheets and Laboratory Test Results Present Investigation**

# SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

## 1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

## 3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT <sup>(1)</sup> '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.

UNIFIED SOILS CLASSIFICATION

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

## EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>			
<b>Fresh (FR)</b>	No visible signs of weathering.				
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.				CLAYSTONE
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.				SILTSTONE
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.				SANDSTONE
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.				COAL
<b>Completely Weathered (CW)</b>	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.				Bedrock (general)
<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
<u>TERMS</u>					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				



**RECORD OF BOREHOLE No CN16-13 2 OF 2 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 207.8 E 226 304.9 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.09 - 2019.07.09 LATITUDE 43.463650 LONGITUDE -80.470080 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
311.2	Silty <b>CLAY</b> , trace sand Very Stiff Grey Moist		10	SS	22		312								
11.7	Sandy <b>SILT</b> , trace clay Very Dense Grey Moist (TILL)  Moist to Wet		11	SS	76		311							0 31 61 8	
308.1	Silty <b>CLAY</b> , trace sand Hard Grey Moist		12	SS	100/ 0.275		309								
14.8	Silty <b>CLAY</b> , trace sand Hard Grey Moist		13	SS	84		308								
307.1	15.8 END OF BOREHOLE AT 15.8m. BOREHOLE CAVED IN AND IT WAS NOT POSSIBLE TO MEASURE THE WATER LEVEL UPON COMPLETION. BOREHOLE BACKFILLED WITH CEMENT AND GROUT TO 0.6m, THEN BENTONITE HOLEPLUG TO SURFACE.														

ONTMT4S2\_MTO-11375(GINTDATA),GPJ\_2017TEMPLATE(MTO),GDT\_2/18/20

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

## RECORD OF BOREHOLE No CN16-14 1 OF 4 METRIC

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 200.2 E 226 312.3 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.16 - 2019.07.17 LATITUDE 43.463566 LONGITUDE -80.469959 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	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 (%)							
						W <sub>p</sub>	W	W <sub>L</sub>					
323.2	GROUND SURFACE												
0.0	<b>TOPSOIL:</b> (100mm)												
0.1	Silty <b>SAND</b> , trace gravel, trace clay Compact to Loose Brown Moist (FILL)		1	SS	18								
			2	SS	8								
			3	SS	5							4 75 17 4	
			4	SS	23								
320.2													
3.0	<b>ORGANICS</b> occasional roots and rootlets Compact Black Wet		5	SS	15							Switch to tricone	
319.7													
3.5	Silty <b>SAND</b> , trace to some gravel Compact to Dense Brown Moist to Wet												
			6	SS	26								
			7	SS	32								
316.0													
7.2	Silty <b>CLAY</b> , trace sand Hard Brown Moist		8	SS	36								
			9	SS	37								
	Grey												

ONTMT452\_MTO-11375(GINTDATA),GPJ\_2017TEMPLATE(MTO),GDT\_2/18/20

Continued Next Page

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

**RECORD OF BOREHOLE No CN16-14 2 OF 4 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 200.2 E 226 312.3 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.16 - 2019.07.17 LATITUDE 43.463566 LONGITUDE -80.469959 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
Continued From Previous Page	Silty <b>CLAY</b> , trace sand Hard to Very Stiff Grey Moist						313								
			10	SS	38		312							0 2 32 66	
			11	SS	23		311								
			12	SS	83		310								
308.5							309								
14.7	<b>SAND</b> and <b>SILT</b> , trace clay Very Dense Grey Wet (TILL)		13	SS	100/ 0.250		308							0 44 49 7	
306.7							307								
16.5	Silty <b>CLAY</b> , trace sand Hard Grey Moist		14	SS	32		306								
			15	SS	79		305								
							304								

ONTMT4S2\_MTO-11375(GINTDATA),GPJ\_2017TEMPLATE(MTO),GDT\_2/18/20

Continued Next Page

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

## RECORD OF BOREHOLE No CN16-14 3 OF 4 METRIC

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 200.2 E 226 312.3 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.16 - 2019.07.17 LATITUDE 43.463566 LONGITUDE -80.469959 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60					
	Continued From Previous Page													
	Silty <b>CLAY</b> , trace sand Hard Grey Moist	16	SS	59		303								
		17	SS	75		300								
		18	SS	41		297								
		19	SS	48		294								0 1 45 54

ONTMT452\_MTO-11375(GINTDATA),GPJ\_2017TEMPLATE(MTO),GDT\_2/18/20

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No CN16-14 4 OF 4 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 200.2 E 226 312.3 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.16 - 2019.07.17 LATITUDE 43.463566 LONGITUDE -80.469959 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	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	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	W <sub>p</sub>	W	W <sub>L</sub>		
							WATER CONTENT (%)							
							20 40 60							
292.4	Silty <b>CLAY</b> , trace sand Hard Grey Moist					293								
30.8	Sandy <b>SILT</b> , trace gravel, trace clay, occasional cobbles Very Dense Grey Moist (TILL)					292								
			20	SS	100/	291								Tricone grinding
					0.100									
			21	SS	100/	290								
					0.125									
288.0			22	SS	100/	289								
					0.125									
35.2	END OF BOREHOLE AT 35.2m. BOREHOLE OPEN AND WATER LEVEL AT 4.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH CEMENT, GRAVEL AND BENTONITE TO SURFACE.													

ONTMT452\_MTO-11375(GINTDATA),GPJ\_2017TEMPLATE(MTO),GDT\_2/18/20

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

## RECORD OF BOREHOLE No CN16-15 1 OF 4 METRIC

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 168.4 E 226 309.6 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.18 - 2019.07.19 LATITUDE 43.463365 LONGITUDE -80.470109 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	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 (%) 20 40 60				GR SA SI CL		
322.1	GROUND SURFACE														
0.0	<b>ORGANICS:</b> (100mm)														
0.1	Silty <b>SAND</b> , mixed with organics, some gravel, trace clay Loose to Very Loose Black to Brown Moist (FILL)		1	SS	9									11 55 28 6	
			2	SS	2										
			3	SS	1									15 48 32 5	
			4	SS	11									Switch to tricone	
319.1	Compact Wet														
3.0	<b>SAND</b> , trace silt, trace clay Dense to Compact Brown Wet		5	SS	25									Tricone grinding	
			6	SS	33									0 91 8 1	
			7	SS	20										
314.9	Clayey <b>SILT</b> , with sand, trace gravel Very Stiff to Hard Grey Moist to Wet (TILL)		8	SS	29									Tricone grinding	
7.2			9	SS	45									4 25 46 25	

ONTMT4S2\_MTO-11375(GINTDATA),GPJ\_2017TEMPLATE(MTO),GDT\_2/18/20

Continued Next Page

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

**RECORD OF BOREHOLE No CN16-15 2 OF 4 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 168.4 E 226 309.6 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.18 - 2019.07.19 LATITUDE 43.463365 LONGITUDE -80.470109 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	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							
	Continued From Previous Page													
310.6	Clayey <b>SILT</b> , with sand, trace gravel Hard Grey Moist to Wet (TILL)	10	SS	43									No recovery	
11.5	Silty <b>CLAY</b> , trace sand Hard Grey Moist to Wet	11	SS	39										
		12	SS	37										
		13	SS	52										
		14	SS	61										
		15	SS	71										

ONTMT4S2\_MTO-11375(GINTDATA),GPJ\_2017TEMPLATE(MTO),GDT\_2/18/20

Continued Next Page

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

## RECORD OF BOREHOLE No CN16-15 3 OF 4 METRIC

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 168.4 E 226 309.6 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.18 - 2019.07.19 LATITUDE 43.463365 LONGITUDE -80.470109 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	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							
Continued From Previous Page														
	Silty <b>CLAY</b> , trace sand Hard Grey Moist to Wet	16	SS	100/ 0.300		302								
		17	SS	53		299			○				0 2 23 75	
		18	SS	37		296			○					
294.7 27.4		19	SS	80		293			○					
	<b>SAND</b> , some gravel, some silt, trace clay Very Dense Brown Moist					294								

ONTMT452\_MTO-11375(GINTDATA),GPJ\_2017TEMPLATE(MTO),GDT\_2/18/20

Continued Next Page

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

## RECORD OF BOREHOLE No CN16-15 4 OF 4 METRIC

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 168.4 E 226 309.6 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.18 - 2019.07.19 LATITUDE 43.463365 LONGITUDE -80.470109 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	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 PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W <sub>p</sub> W W <sub>L</sub> WATER CONTENT (%) 20 40 60							
							UNCONFINED + FIELD VANE QUICK TRIAXIAL X LAB VANE							
291.0	Continued From Previous Page <b>SAND</b> , some gravel, some silt, trace clay Very Dense Brown Moist													
31.1	Sandy <b>SILT</b> , trace clay, trace gravel Very Dense Grey Moist (TILL)		20	SS	100/0.100								Tricone grinding	
	Occasional cobbles		21	SS	100/ 0.075								Tricone grinding	
287.7	<b>SAND</b> and <b>GRAVEL</b> Very Dense Grey Moist		22	SS	100/								Tricone grinding	
286.9	END OF BOREHOLE AT 35.2m. BOREHOLE CAVED IN AND IT WAS NOT POSSIBLE TO MEASURE THE WATER LEVEL UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG, SAND, AND CEMENT TO SURFACE.				0.100									

ONTMT4S2\_MTO-11375(GINTDATA),GPJ\_2017TEMPLATE(MTO),GDT 2/18/20

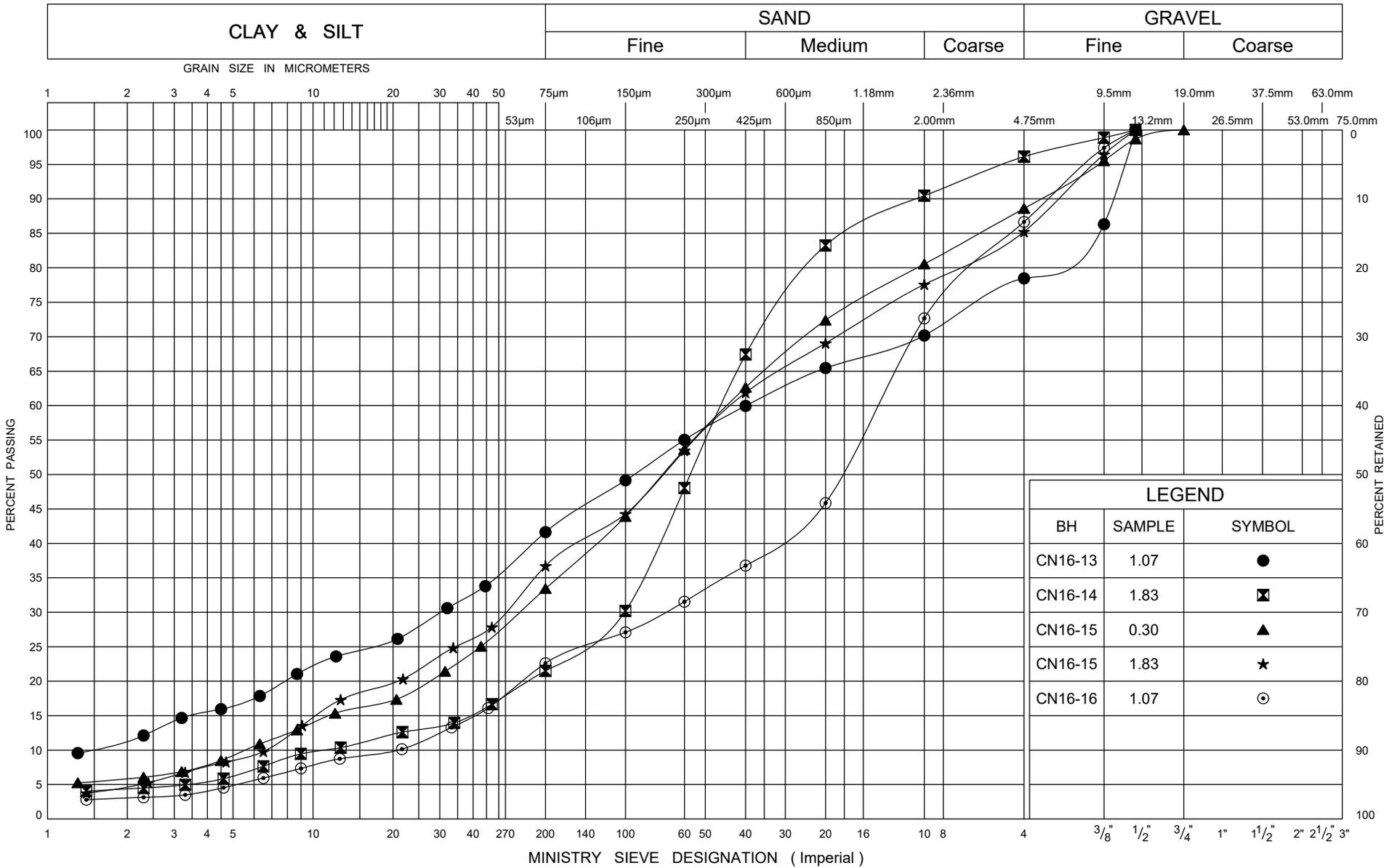


**RECORD OF BOREHOLE No CN16-16 2 OF 2 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 160.0 E 226 308.9 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.02 - 2019.07.02 LATITUDE 43.463263 LONGITUDE -80.470014 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
Continued From Previous Page	Silty <b>CLAY</b> , trace sand Very Stiff to Hard Grey Moist						312								
			10	SS	18		311								0 7 34 59
			11	SS	20		310								
			12	SS	35		309								
			13	SS	33		308								
306.3							307								
15.8	END OF BOREHOLE AT 15.8m. WATER LEVEL AT 4.0m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.04m slotted screen.  WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2019.08.08 1.9 320.3 2019.08.29 1.9 320.3														

ONTMT4S2\_MTO-11375(GINTDATA),GPJ\_2017TEMPLATE(MTO),GDT\_2/18/20

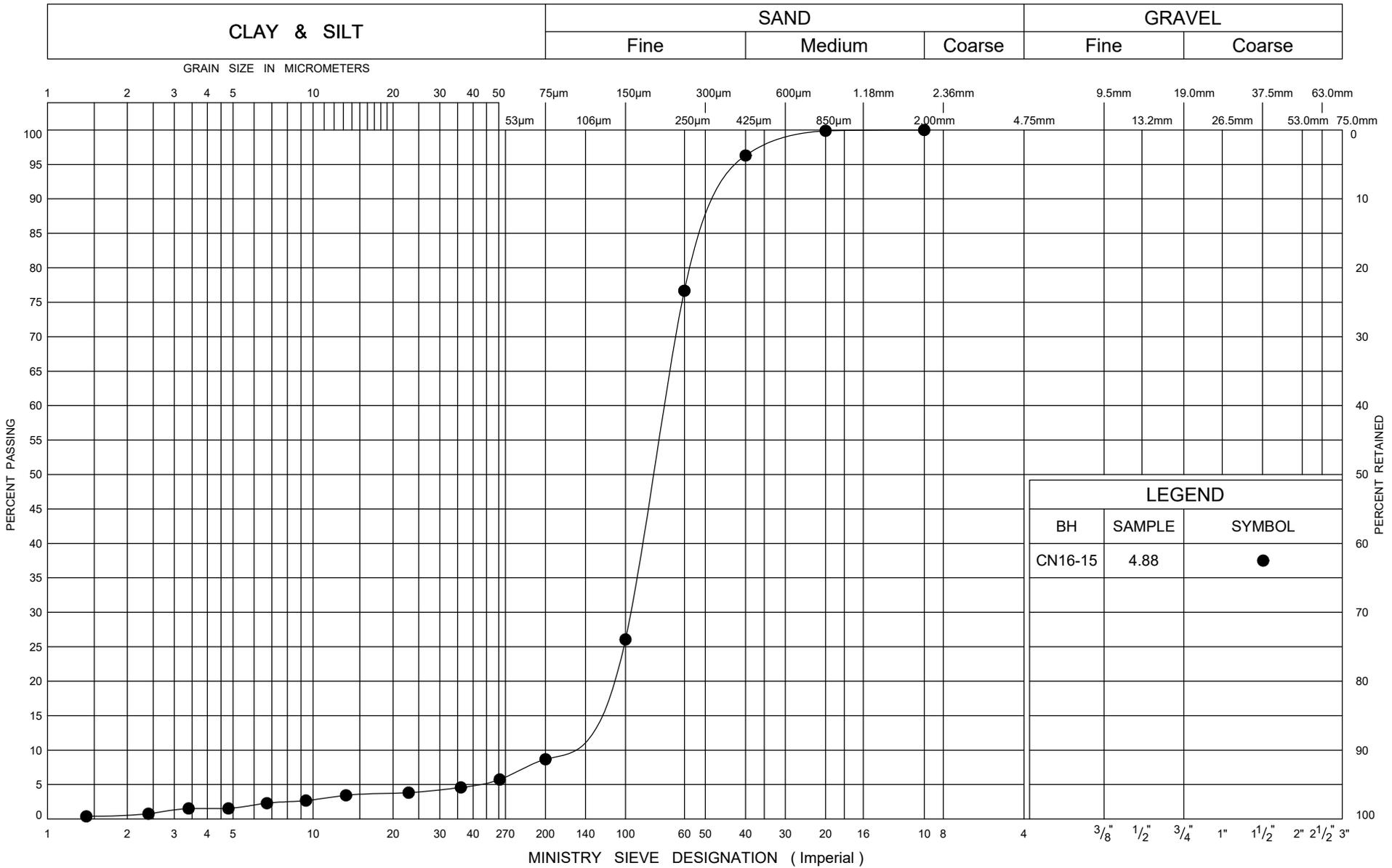


ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA)\GPJ\_ONTARIO MOT.GDT 1/7/20



**GRAIN SIZE DISTRIBUTION**  
Silty SAND FILL

FIG No A1  
W P 408-88-00

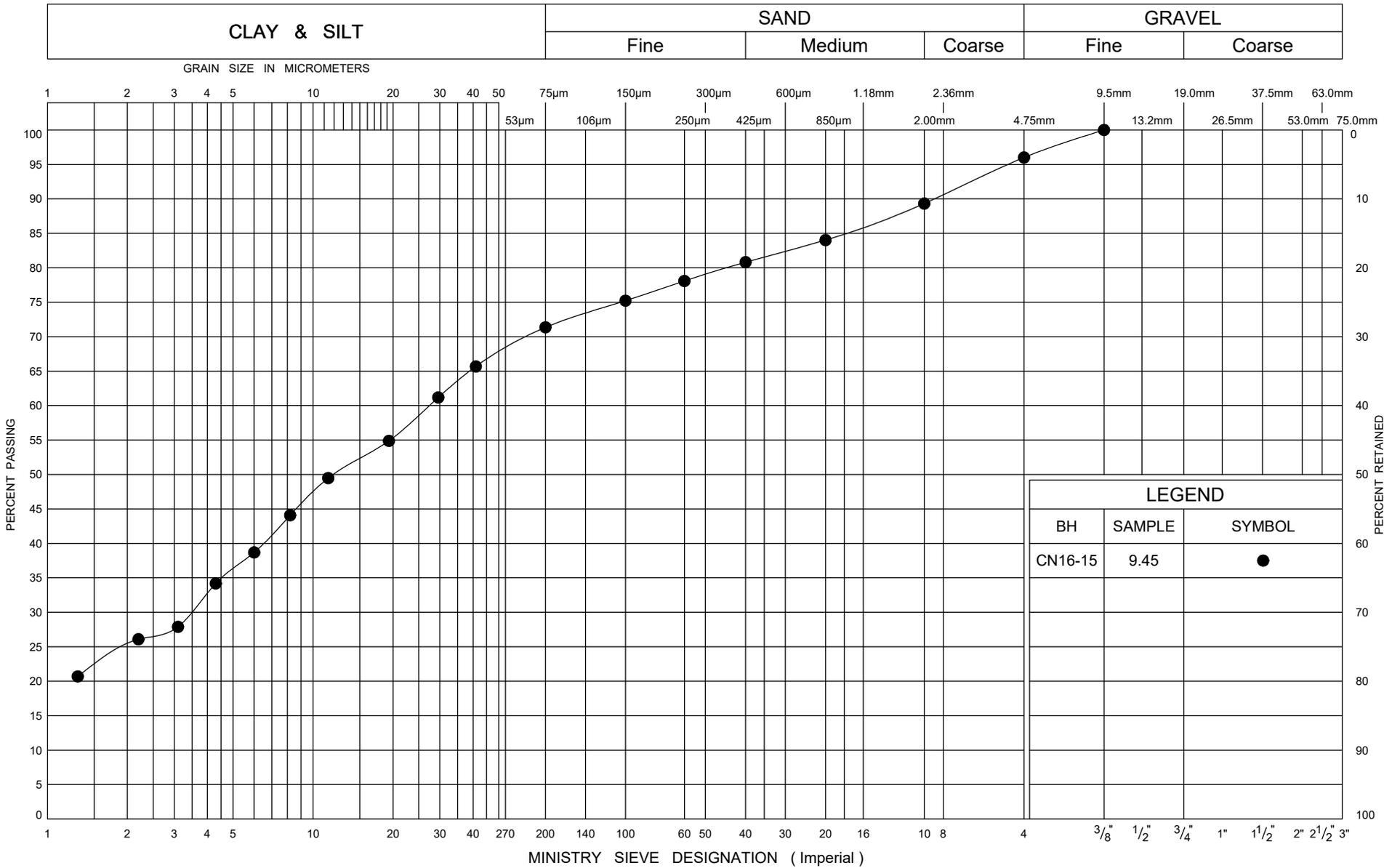


ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA)\GPJ\_ONTARIO MOT.GDT 1/7/20



## GRAIN SIZE DISTRIBUTION SAND

FIG No A2  
W P 408-88-00



ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA)\GPJ\_ONTARIO MOT.GDT 1/7/20

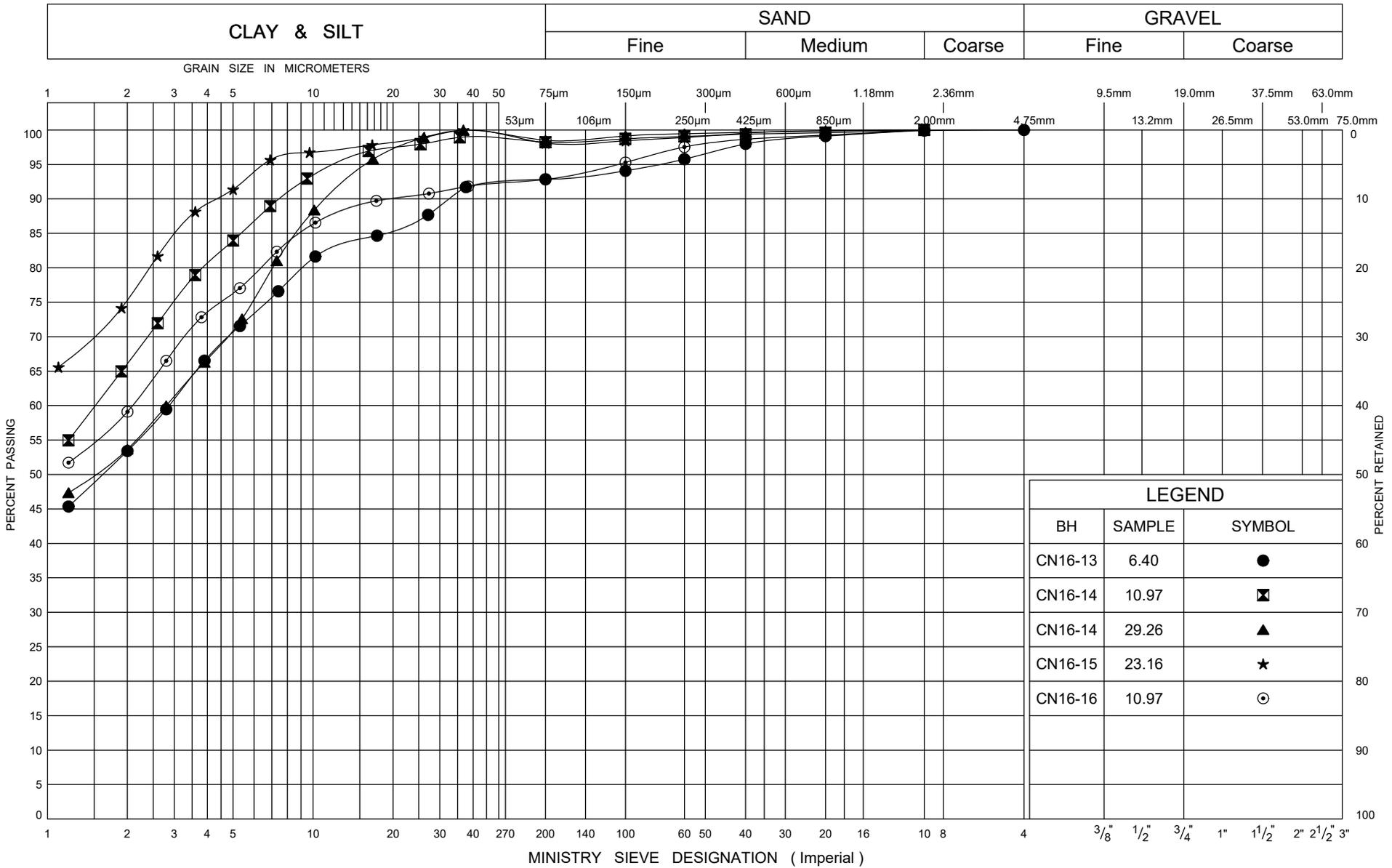


## GRAIN SIZE DISTRIBUTION

### Clayey SILT TILL

FIG No A3

W P 408-88-00



ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA)\GPJ\_ONTARIO MOT.GDT 1/7/20

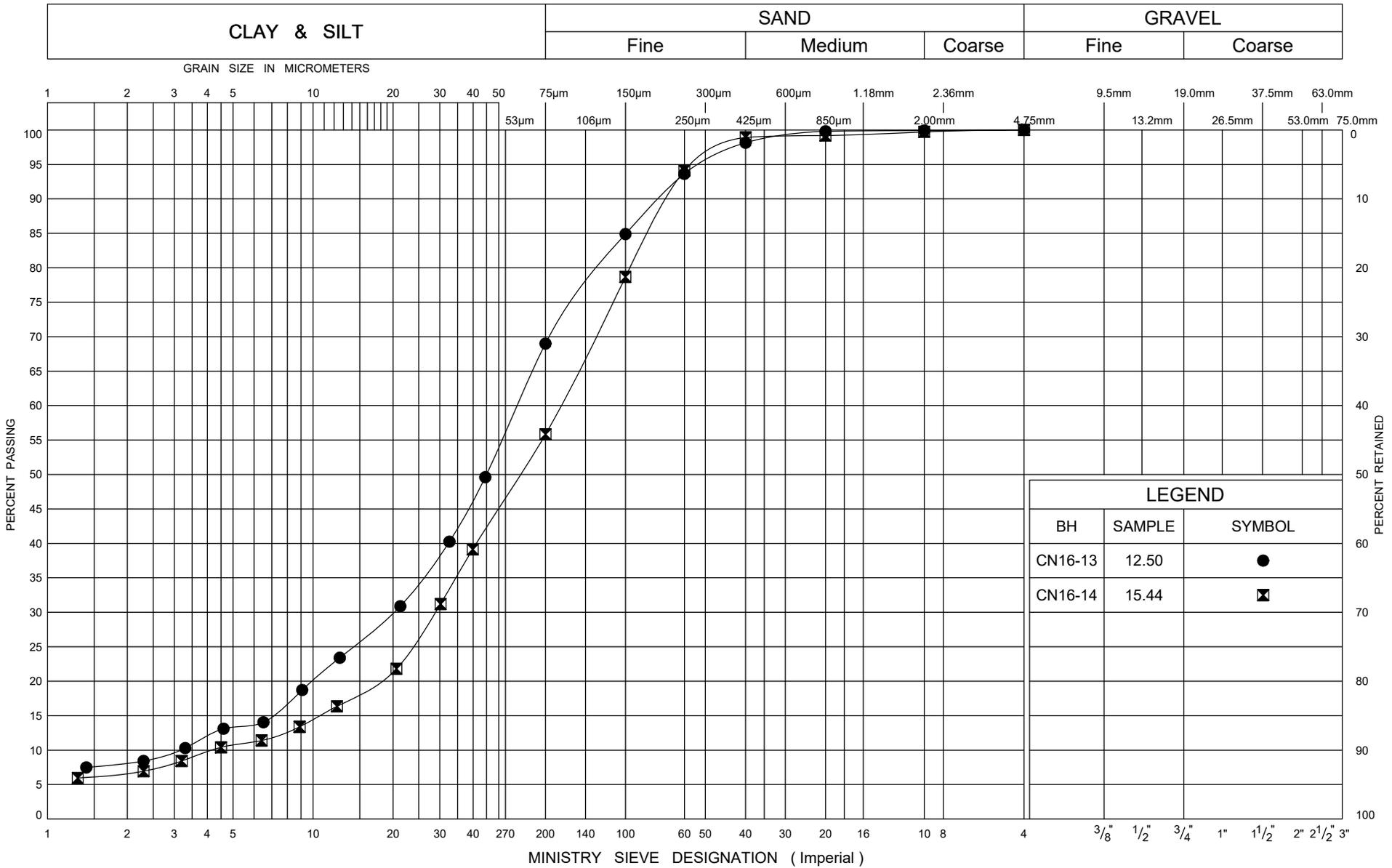


## GRAIN SIZE DISTRIBUTION

### Silty CLAY

FIG No A4

W P 408-88-00



LEGEND		
BH	SAMPLE	SYMBOL
CN16-13	12.50	●
CN16-14	15.44	⊠

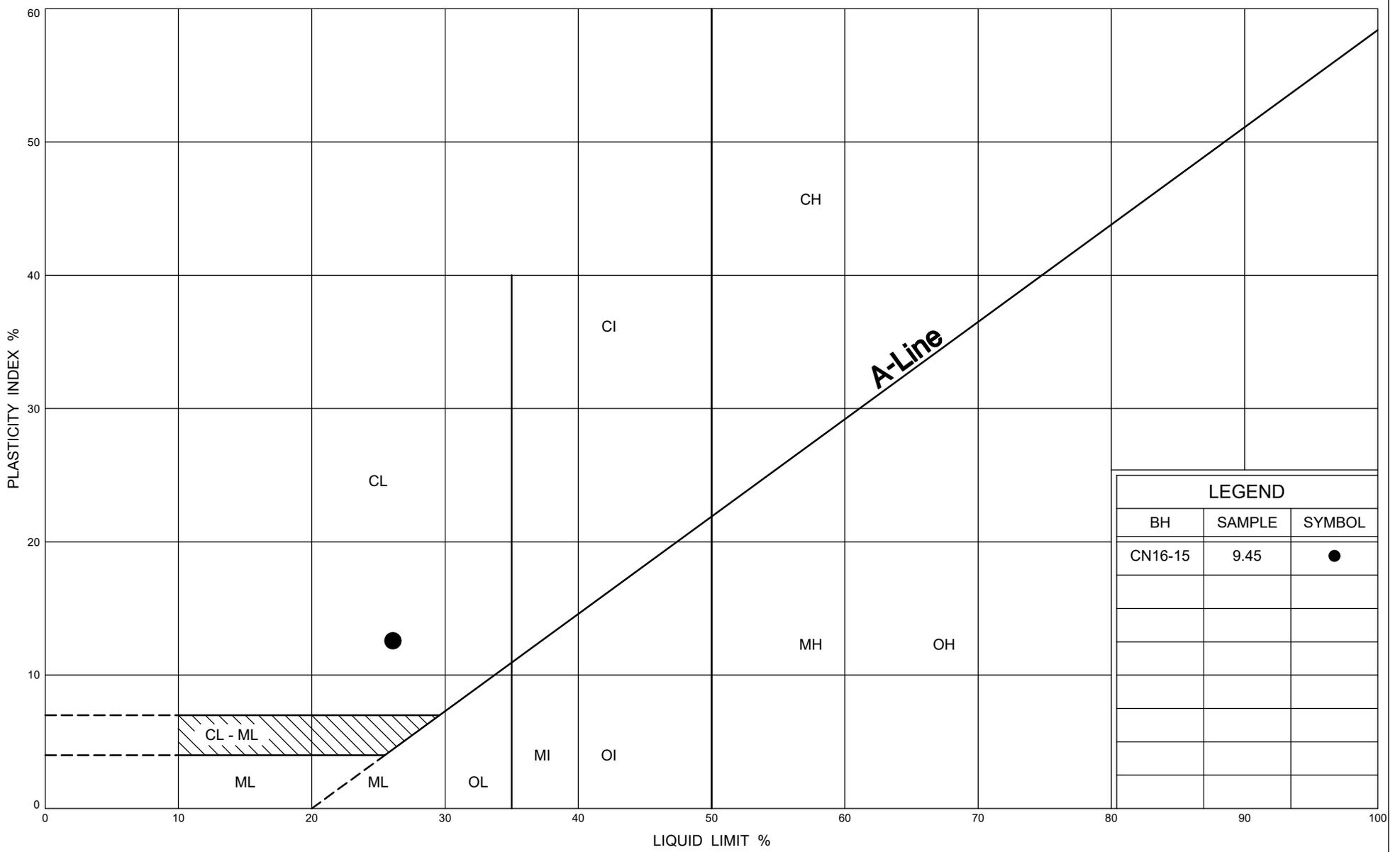
ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA)\GPJ\_ONTARIO MOT.GDT 1/7/20



## GRAIN SIZE DISTRIBUTION

### SAND and SILT TILL / Sandy SILT TILL

FIG No A5  
W P 408-88-00



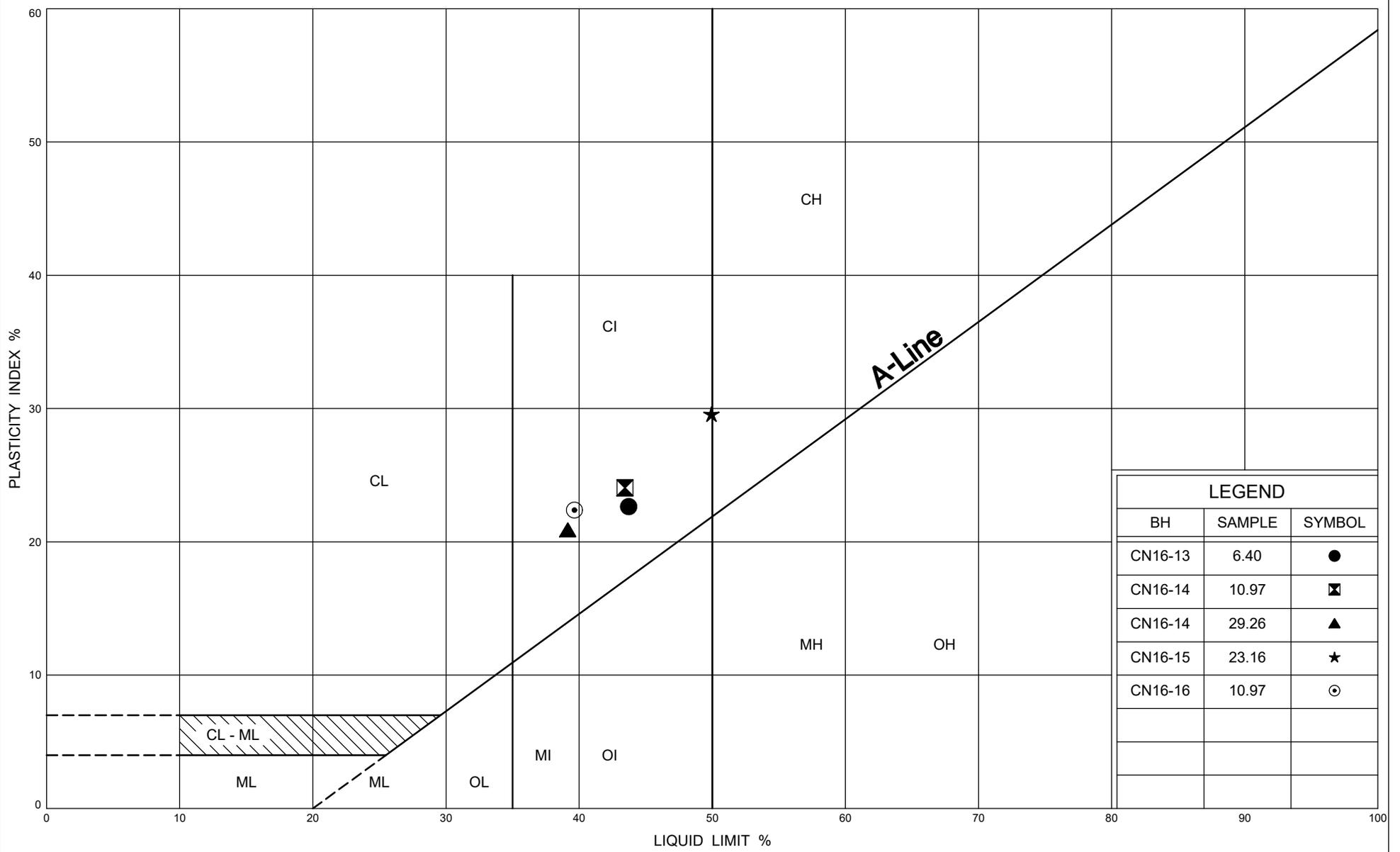
LEGEND		
BH	SAMPLE	SYMBOL
CN16-15	9.45	●

ONTARIO MOT PLASTICITY CHART MTO-11375(GINTDATA).GPJ\_ONTARIO MOT.GDT\_2/18/20



**PLASTICITY CHART**  
Clayey SILT TILL

FIG No A6  
W P 408-88-00



LEGEND		
BH	SAMPLE	SYMBOL
CN16-13	6.40	●
CN16-14	10.97	⊠
CN16-14	29.26	▲
CN16-15	23.16	★
CN16-16	10.97	⊙

ONTARIO MOT PLASTICITY CHART MTO-11375(GINTDATA).GPJ\_ONTARIO MOT. GDT\_1/7/20



**PLASTICITY CHART**  
Silty CLAY

FIG No A7  
W P 408-88-00



## **Appendix B**

### **Record of Borehole Sheets and Laboratory Test Results Previous investigation**

# SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

## 1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

## 3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

## 4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

## 5. LEGEND FOR RECORDS OF BOREHOLES

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

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

Water Level

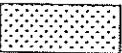
$C_{pen}$  Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

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

## EXPLANATION OF ROCK LOGGING TERMS

<b>ROCK WEATHERING CLASSIFICATION</b>		<b>SYMBOLS</b>		
<b>Fresh (FR)</b>	No visible signs of weathering.			
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.		CLAYSTONE	
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE	
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE	
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.		COAL	
<b>Completely Weathered (CW)</b>	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)	
<b>DISCONTINUITY SPACING</b>		<b>STRENGTH CLASSIFICATION</b>		
<b>Bedding</b>	<b>Bedding Plane Spacing</b>	<b>Rock Strength</b>	<b>Approximate Uniaxial Compressive Strength</b>	<b>Field Estimation of Hardness*</b>
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250 (MPa) Greater than 36,000 (psi)	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m	Very Strong	100-250	Requires many blows of geological hammer to break
Medium bedded	0.2 to 0.6m	Strong	50-100	Requires more than one blow of geological hammer to break
Thinly bedded	60mm to 0.2m	Medium Strong	25.0 to 50.0	Breaks under single blow of geological hammer.
Very thinly bedded	20 to 60mm	Weak	5.0 to 25.0	Can be peeled by a pocket knife with difficulty
Laminated	6 to 20mm	Very Weak	1.0 to 5.0	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Thinly Laminated	Less than 6mm	Extremely Weak (Rock)	0.25 to 1.0	Indented by thumbnail
<b>TERMS</b>				
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.			
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.			
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.			
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen			
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.			

RECORD OF BOREHOLE No 08-046

1 OF 4

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 170.54 E 226 315.49 ORIGINATED BY SA  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FK  
 DATUM Geodetic DATE 2008.06.07 - 2008.08.11 CHECKED BY RPR

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			"N" VALUES	SHEAR STRENGTH kPa							W P
						20	40	60	80	100	20	40	60	kN/m <sup>3</sup>	GR SA SI CL
321.9 0.0	SAND, trace gravel, some silt, occasional topsoil Dark Brown to Black Strong Gasoline Odour Compact Moist (FILL)		1	SS	13										
			2	SS	3										
319.9 2.1	Layer of black sandy silt (100mm) Very Loose Black  Sandy SILT, trace to some gravel, occasional cobbles, gasoline odour Loose to Compact Grey to Brown Wet		3	SS	7										
			4	SS	16										2 44 50 4
			5	SS	28										
315.5 6.4	Clayey SILT, some sand, trace gravel, occasional silty sand seams Very Stiff Brown to Grey (TILL)  Hard Grey		6	SS	23										
			7	SS	34										1 18 54 27
312.8 9.1	Silty CLAY, trace sand Hard Grey		8	SS	39										

Continued Next Page

+<sup>3</sup> X<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15 5  
 10 (%) STRAIN AT FAILURE

ONTMT4S 6417R.GPJ 3/12/09

RECORD OF BOREHOLE No 08-046

2 OF 4

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 170.54 E 226 315.49 ORIGINATED BY SA  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FK  
 DATUM Geodetic DATE 2008.08.07 - 2008.08.11 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	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 X LAB VANE 20 40 60 80 100 PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W P W W L WATER CONTENT (%)							
	Continued From Previous Page												
	Silty CLAY, trace sand Very Stiff to Hard Grey												
			9	SS	24								
			10	SS	32								
			11	SS	42								0 3 40 58
			12	SS	70								
			13	SS	100/ .150								
			14	SS	90								

ONTMT4S 6417R.GPJ 11/24/08

Continued Next Page

+<sup>3</sup> X<sup>3</sup>: Numbers refer to  
Sensitivity  $\frac{20}{15 \pm 5}$  (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-046

3 OF 4

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 170.54 E 226 315.49 ORIGINATED BY SA  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FK  
 DATUM Geodetic DATE 2008.08.07 - 2008.08.11 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			T <sub>N</sub> VALUES	20	40					
Continued From Previous Page														
	Silty CLAY, trace sand Hard Grey		15	SS	89									0 1 34 65
			16	SS	52									
			17	SS	35									
	occasional silt seams		18	SS	50									
293.3														
28.7	SAND, some silt, trace clay Very Dense Grey Wet		19	SS	79									5 69 26 (SI+CL)

Continued Next Page

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

ONTMT4S 6417R.GPJ 11/24/08

### RECORD OF BOREHOLE No 08-046

4 OF 4

**METRIC**

G.W.P. 408-88-00 LOCATION N 4 814 170.54 E 226 315.49 ORIGINATED BY SA  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FK  
 DATUM Geodetic DATE 2008.08.07 - 2008.08.11 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)
291.8	Continued From Previous Page												
30.2	Sandy SILT, some clay, trace gravel, occasional cobbles Very Dense Grey Moist (TILL)	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100	20	SS	100/ .050	292					○		4 35 43 19
			21	SS	100/ .075	291					○		
288.2			22	SS	80/ .050	290					○		
33.7	END OF BOREHOLE AT 33.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  Piezometer destroyed					289					○		

ONTMT4S 6417R.GPJ 3/12/09

+ 3 . X 3 : Numbers refer to  
Sensitivity

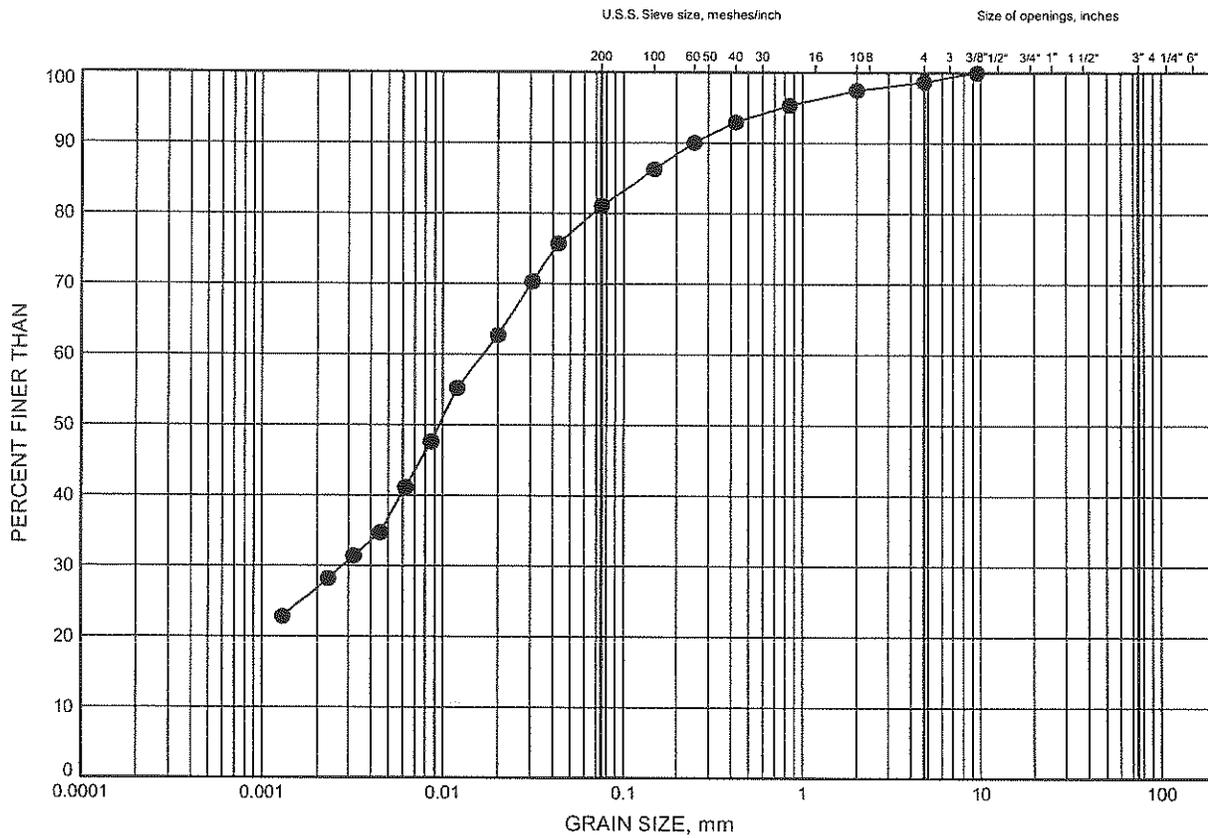
20  
15 ⊕ 5  
10 (%) STRAIN AT FAILURE



# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B2

## CLAYEY SILT TILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-046	7.92	314.01

GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 11/24/08

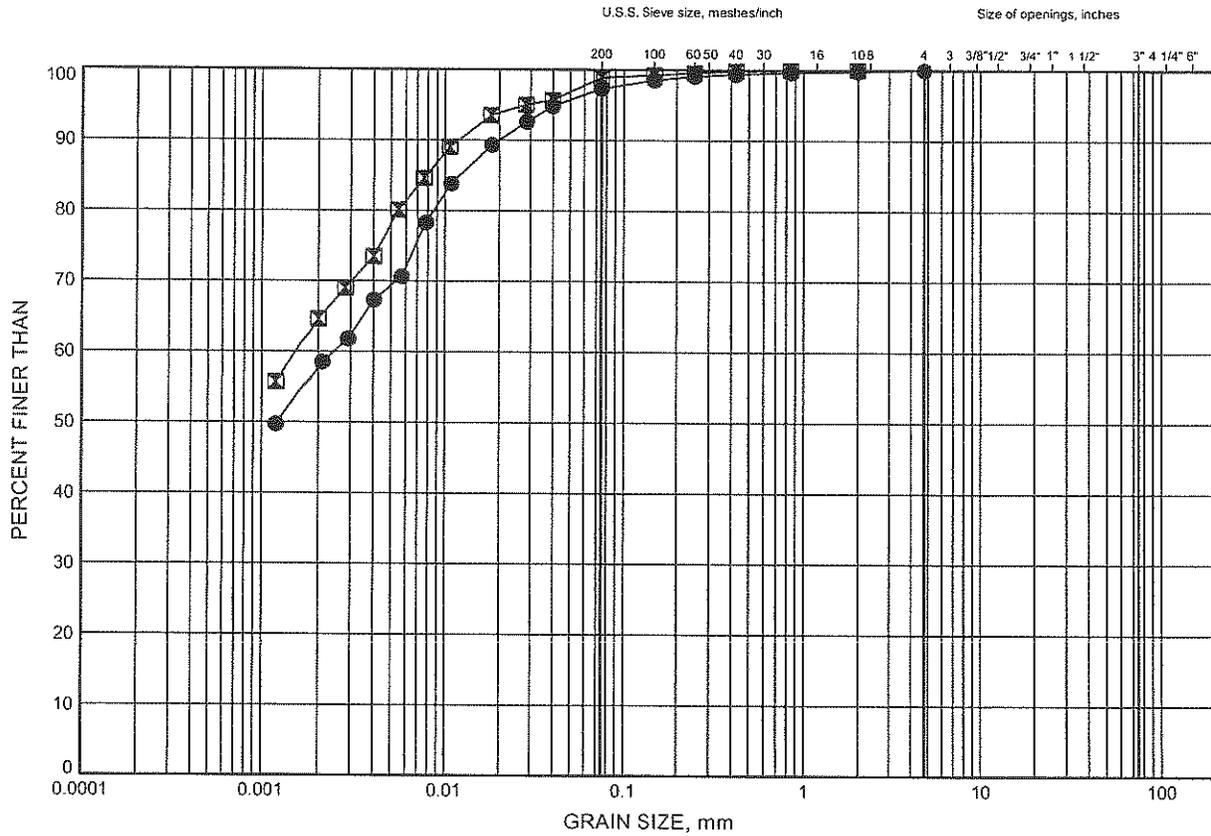
W.P.# 408-88-00.....  
 Prepared By AN.....  
 Checked By RPR.....



# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B3

## SILTY CLAY



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-046	14.02	307.91
■	08-046	20.12	301.82

GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 11/24/08

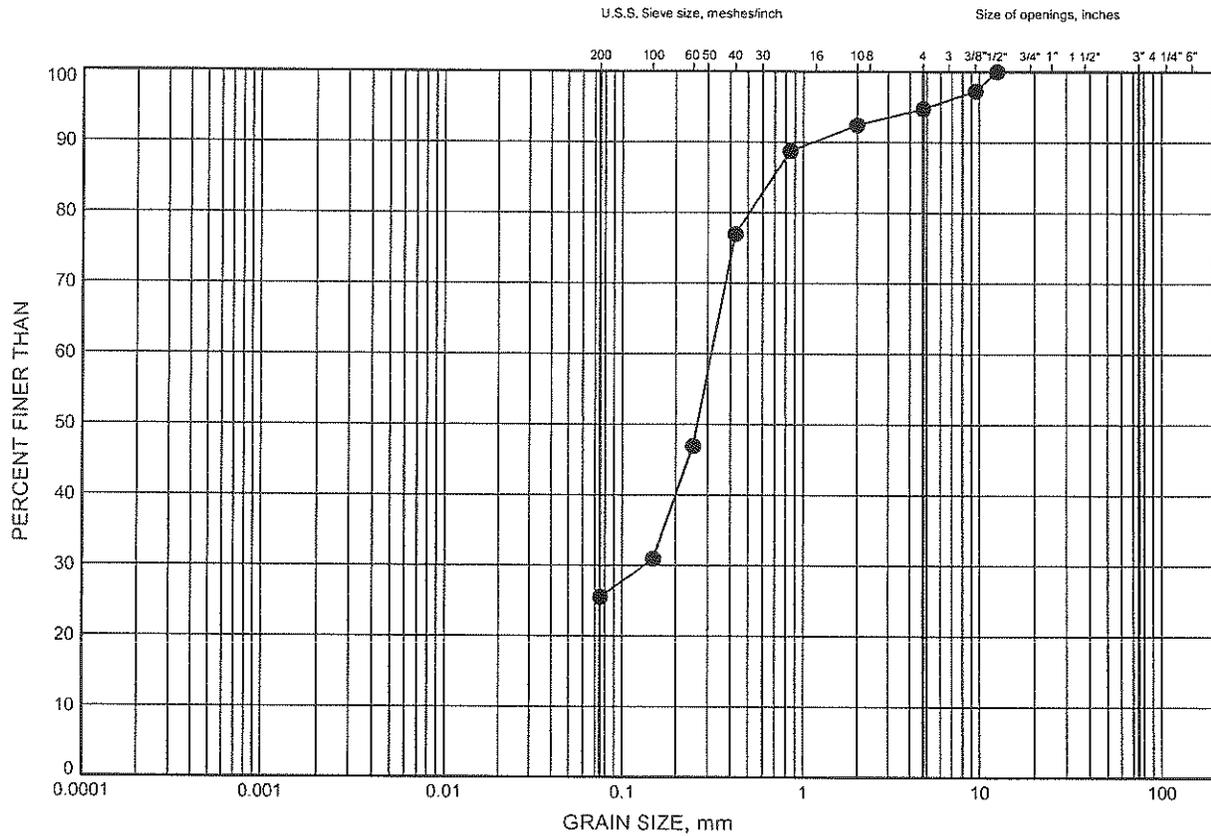
W.P.# .408-88-00.....  
 Prepared By .AN.....  
 Checked By .RPR.....



# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B4

## SAND



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-046	29.26	292.67

GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 11/24/08

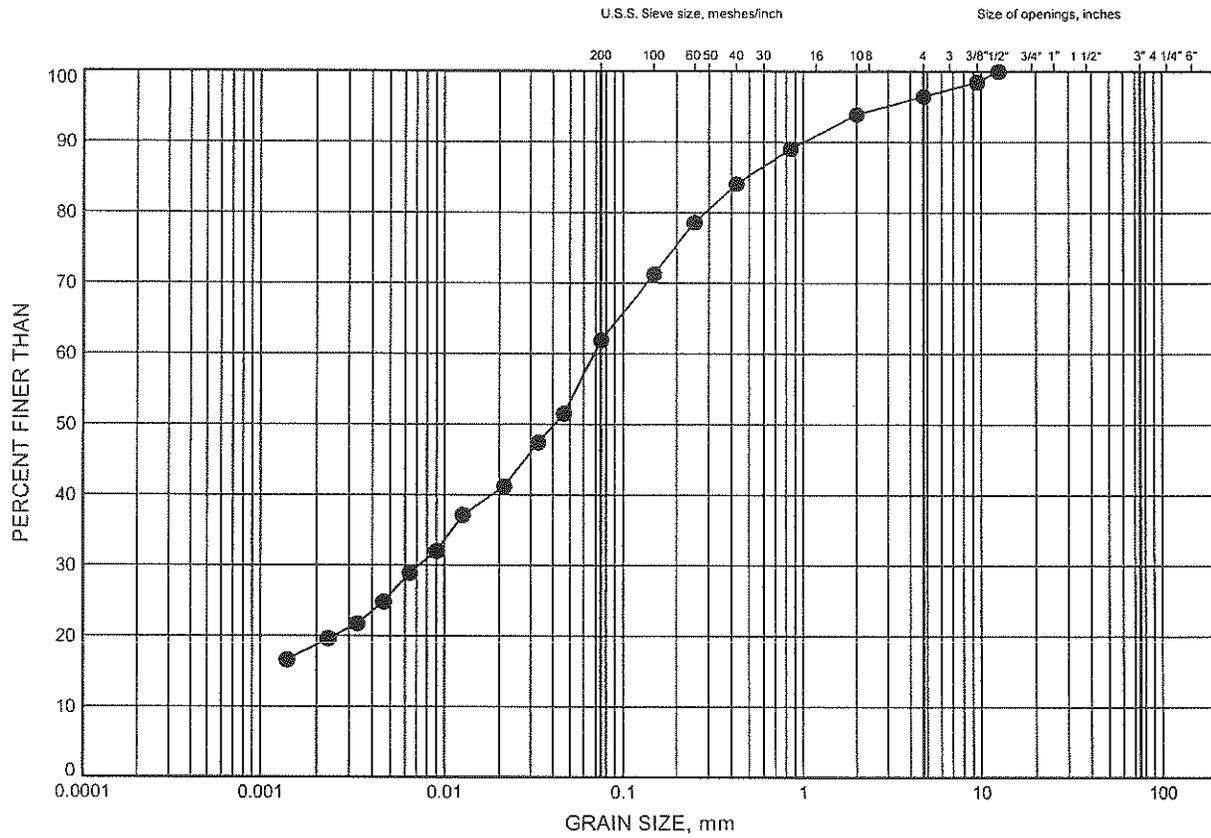
W.P.# . 408-88-00.....  
 Prepared By . AN.....  
 Checked By . RPR.....



# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B5

## SANDY SILT TILL



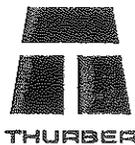
SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-046	30.78	291.15

GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 11/24/08

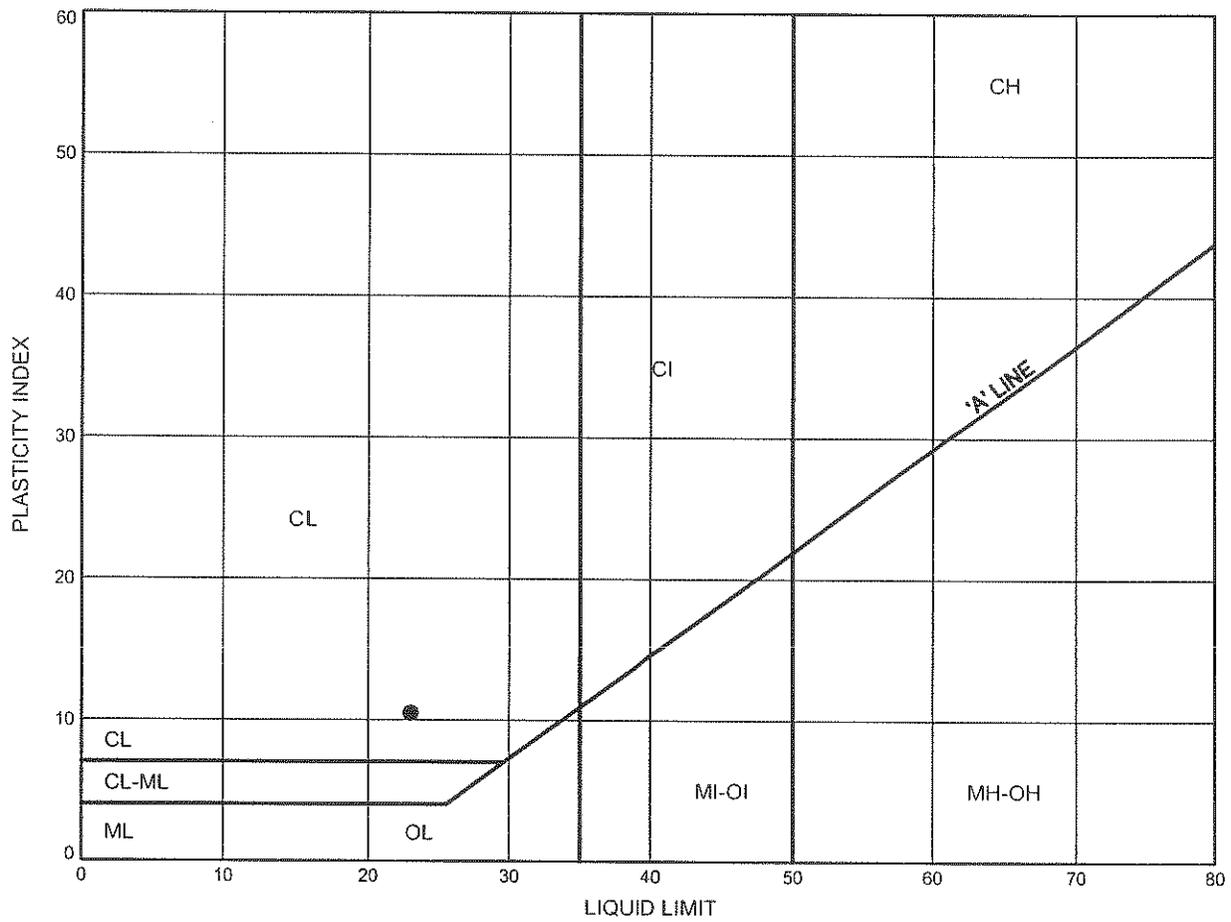
W.P.# .408-88-00.....  
 Prepared By .AN.....  
 Checked By .RPR.....



Highway 7 - New  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B6

**CLAYEY SILT TILL**



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-046	7.92	314.01

THURBALT 6417R.GPJ 11/24/08

Date November 2008

Project 408-88-00



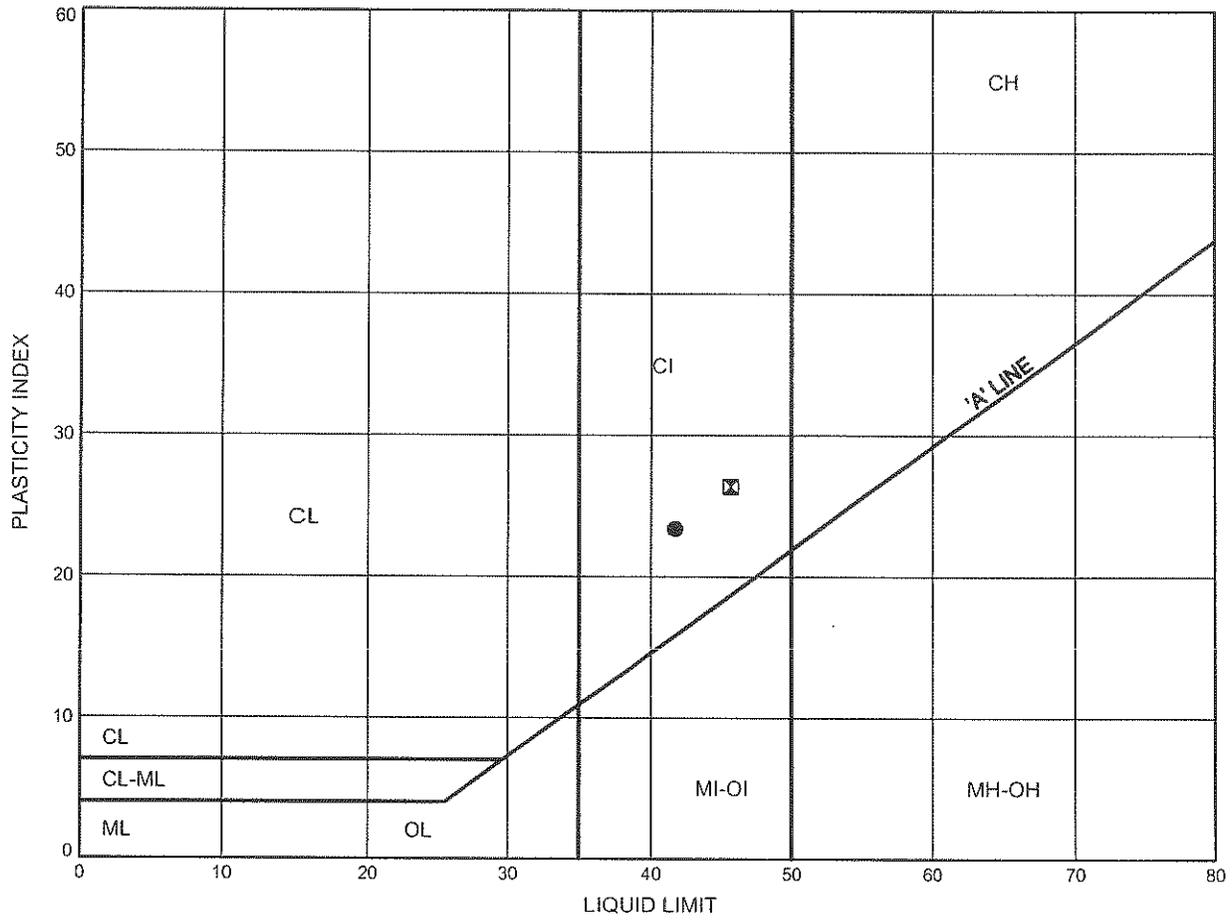
Prep'd AN

Chkd. RPR

Highway 7 - New  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B7

**SILTY CLAY**



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-046	14.02	307.91
⊠	08-046	20.12	301.82

THURBALT 6417R.GPJ 11/24/08

Date November 2008

Project 408-88-00



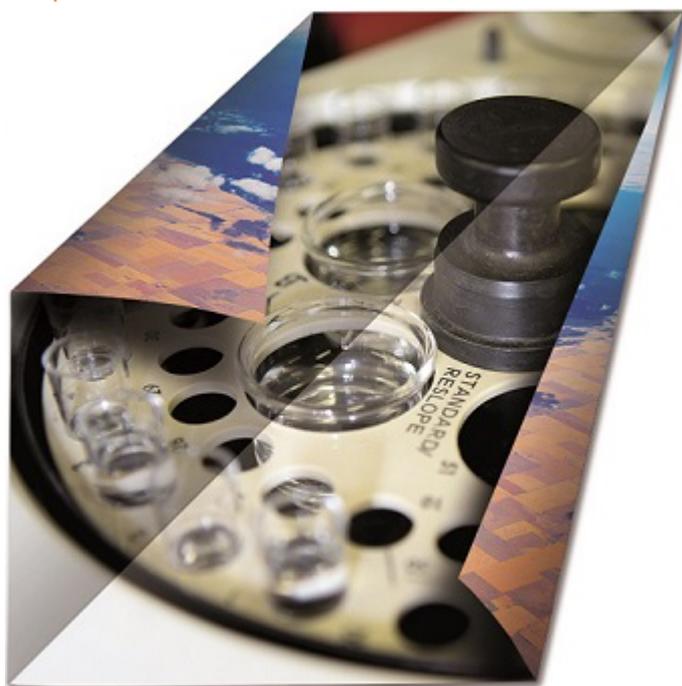
Prep'd AN

Chkd. RPR



## **Appendix C**

### **Analytical Laboratory Test Results Present Investigation**



## FINAL REPORT

CA14437-AUG19 R1

11375 Hwy 7 New, Kitchener

Prepared for

**Thurber Engineering Ltd.**

## First Page

### CLIENT DETAILS

Client **Thurber Engineering Ltd.**

Address **103, 2010 Winston Park Drive  
Oakville, ON  
L6H 5R7, Canada**

Contact **Nancy Berg**

Telephone **905-829-8666 x 228**

Facsimile

Email **nberg@thurber.ca**

Project **11375 Hwy 7 New, Kitchener**

Order Number

Samples **Soil (5)**

### LABORATORY DETAILS

Project Specialist **Rob Irwin B.Sc., C.Chem**

Laboratory **SGS Canada Inc.**

Address **185 Concession St., Lakefield ON, K0L 2H0**

Telephone **705-652-2361**

Facsimile **705-652-6365**

Email **rob.irwin@sgs.com**

SGS Reference **CA14437-AUG19**

Received **08/13/2019**

Approved **08/19/2019**

Report Number **CA14437-AUG19 R1**

Date Reported **08/19/2019**

### COMMENTS

Temperature of Sample upon Receipt: 4 degrees C  
Cooling Agent Present: yes  
Custody Seal Present: no

Chain of Custody Number: 009972

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

### SIGNATORIES

Rob Irwin B.Sc., C.Chem



TABLE OF CONTENTS

---

First Page.....	1
Index.....	2
Results.....	3-4
QC Summary.....	5-6
Legend.....	7
Annexes.....	8



# FINAL REPORT

CA14437-AUG19 R1

Client: Thurber Engineering Ltd.

Project: 11375 Hwy 7 New, Kitchener

Project Manager: Nancy Berg

Samplers: Nancy Berg

PACKAGE: - Corrosivity Index (SOIL)

Sample Number	5	6	7	8	9
Sample Name	CN16-10 SS5	CN16-04 SS4	CN16-15 SS4	RW24-02 SS4	NE16-09 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	19/07/2019	23/07/2019	18/07/2019	06/08/2019	06/08/2019

Parameter	Units	RL	Result	Result	Result	Result	Result	
<b>Corrosivity Index</b>								
Corrosivity Index	none	1	4	1	5	11	14	
Soil Redox Potential	mV	-	306	312	255	263	227	
Sulphide	%	0.02	< 0.02	< 0.02	0.02	< 0.02	< 0.02	
pH	pH Units	0.05	8.56	8.29	7.88	8.18	8.66	
Resistivity (calculated)	ohms.cm	-9999	5100	3200	2500	780	1400	

PACKAGE: - General Chemistry (SOIL)

Sample Number	5	6	7	8	9
Sample Name	CN16-10 SS5	CN16-04 SS4	CN16-15 SS4	RW24-02 SS4	NE16-09 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	19/07/2019	23/07/2019	18/07/2019	06/08/2019	06/08/2019

Parameter	Units	RL	Result	Result	Result	Result	Result	
<b>General Chemistry</b>								
Conductivity	uS/cm	2	195	317	400	1280	736	

PACKAGE: - Metals and Inorganics (SOIL)

Sample Number	5	6	7	8	9
Sample Name	CN16-10 SS5	CN16-04 SS4	CN16-15 SS4	RW24-02 SS4	NE16-09 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	19/07/2019	23/07/2019	18/07/2019	06/08/2019	06/08/2019

Parameter	Units	RL	Result	Result	Result	Result	Result	
<b>Metals and Inorganics</b>								
Moisture Content	%	0.1	20.1	6.1	24.6	13.1	6.5	
Sulphate	µg/g	0.4	25	12	100	31	13	



# FINAL REPORT

CA14437-AUG19 R1

**Client:** Thurber Engineering Ltd.

**Project:** 11375 Hwy 7 New, Kitchener

**Project Manager:** Nancy Berg

**Samplers:** Nancy Berg

PACKAGE: - Other (ORP) (SOIL)

Sample Number	5	6	7	8	9
Sample Name	CN16-10 SS5	CN16-04 SS4	CN16-15 SS4	RW24-02 SS4	NE16-09 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	19/07/2019	23/07/2019	18/07/2019	06/08/2019	06/08/2019

Parameter	Units	RL	Result	Result	Result	Result	Result
Other (ORP)							
Chloride	µg/g	0.4	25	7.8	60	760	430

## QC SUMMARY

### Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-IENVIIC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0262-AUG19	µg/g	0.4	<0.4	9	20	93	80	120	98	75	125
Sulphate	DIO0262-AUG19	µg/g	0.4	<0.4	13	20	94	80	120	96	75	125

### Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-IENVIARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	ECS0029-AUG19	%	0.02	<0.02	ND	20	110	80	120			

### Conductivity

Method: SM 2510 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0246-AUG19	uS/cm	2	< 0.002	0	10	100	90	110	NA		

## QC SUMMARY

### pH

Method: SM 4500 | Internal ref.: ME-CA-ENVIEWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0246-AUG19	pH Units	0.05	NA	0		100			NA		

**Method Blank:** a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

**Duplicate:** Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

**LCS/Spike Blank:** Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

**Matrix Spike:** A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

**Reference Material:** a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

**RL:** Reporting limit

**RPD:** Relative percent difference

**AC:** Acceptance criteria

**Multielement Scan Qualifier:** as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

**Duplicate Qualifier:** for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

**Matrix Spike Qualifier:** for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

**LEGEND**

---

**FOOTNOTES**

**NSS** Insufficient sample for analysis.  
**RL** Reporting Limit.  
    ↑ Reporting limit raised.  
    ↓ Reporting limit lowered.  
**NA** The sample was not analysed for this analyte  
**ND** Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at [http://www.sgs.com/terms\\_and\\_conditions.htm](http://www.sgs.com/terms_and_conditions.htm). The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

This report must not be reproduced, except in full. This report supersedes all previous versions.

-- End of Analytical Report --

Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment  
 - London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8080 Fax: 519-672-0361

### Laboratory Information Section - Lab use only

Received By: Oleg Mozhin  
 Received Date (mm/dd/yy): 8/15/19 (mm/dd/yy)  
 Received Time: 11:05

Received By (signature): [Signature]  
 Custody Seal Present:  NO  
 Custody Seal Intact:  NO

Cooling Agent Present:  Ice  
 Temperature Upon Receipt (°C): 9.90/9.0

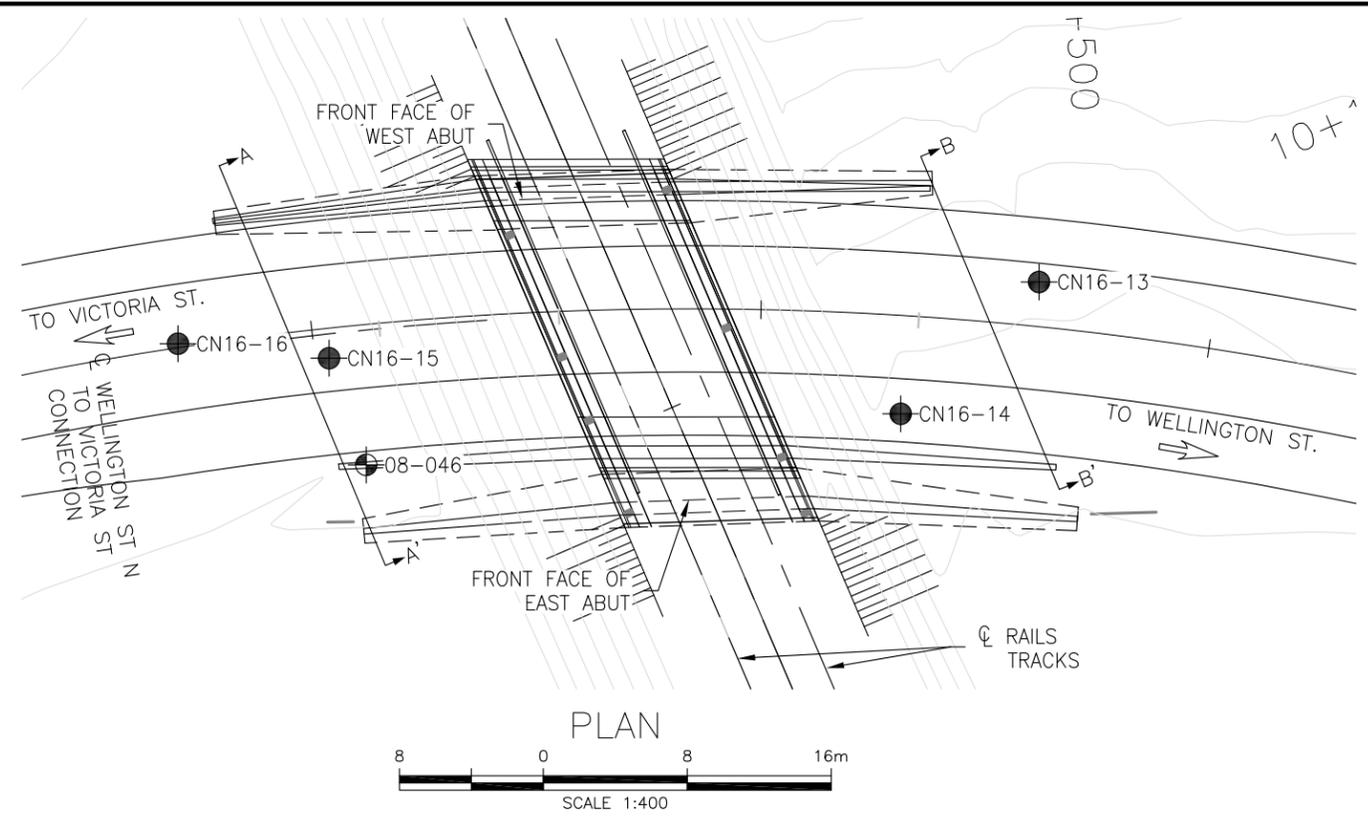
LAB LIMS #: 0A14437-AUG19

REPORT INFORMATION		INVOICE INFORMATION		PROJECT INFORMATION					
Company: <u>Thurber Engineering Ltd</u> Contact: <u>Nancy Berg</u> Address: <u>103 - 2010 Winston Peak Dr</u> <u>Oakville On L6H 5A7</u> Phone: <u>647-633-8417</u> Email: <u>nberg@thurber.ca</u> Email: _____		<input type="checkbox"/> (same as Report Information) Company: _____ Contact: _____ Address: _____ Phone: _____ Email: _____		Quotation #: _____ P.O. #: _____ Project #: <u>11375</u> Site Location/ID: <u>How 7 New, Kitchens</u> <b>TURNAROUND TIME (TAT) REQUIRED</b> TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day <input checked="" type="checkbox"/> Regular TAT (5-7days) <input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3 Days <input type="checkbox"/> 4 Days <b>RUSH TAT (Additional Charges May Apply):</b> <input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3 Days <input type="checkbox"/> 4 Days <b>PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION</b> Specify Due Date: _____ Rush Confirmation ID: _____					
<b>REGULATIONS</b> <b>Regulation 153/04:</b> Table 1 <input type="checkbox"/> R/P/I    Soil Texture: _____ Table 2 <input type="checkbox"/> I/C/C    Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> A/O    Medium <input type="checkbox"/> Table <input type="checkbox"/> _____    Fine <input type="checkbox"/> <b>Other Regulations:</b> <input type="checkbox"/> Reg 347/558 (3 Day min TAT) <input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> PWQO <input type="checkbox"/> MMER <input type="checkbox"/> CCOME <input type="checkbox"/> Other: <input type="checkbox"/> MISA <b>Sewer By-Law:</b> <input type="checkbox"/> Sanitary <input type="checkbox"/> Storm Municipality: _____									
RECORD OF SITE CONDITION (RSC)		DATE SAMPLED		TIME SAMPLED		# OF BOTTLES		MATRIX	
<b>SAMPLE IDENTIFICATION</b> 1 <u>CN16-10 555</u> 2 <u>CN16-04 554</u> 3 <u>CN16-15 554</u> 4 <u>RW24-02 554</u> 5 <u>NE16-09 554</u> 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ 11 _____ 12 _____		July 19/19 July 23/19 July 18/19 Aug 6/19 Aug 7/19		_____ _____ _____ _____ _____		1 1 1 1 1		Soil Soil Soil Soil Soil	
<b>ANALYSIS REQUESTED</b> Field Filtered (Y/N)    Metals & Inorganics    PAH <input type="checkbox"/> ABN <input type="checkbox"/> SVOC(all) <input type="checkbox"/> PCB Total <input type="checkbox"/> Aroclor <input type="checkbox"/> PHC F1-F4 <input type="checkbox"/> VOC <input type="checkbox"/> BTEX <input type="checkbox"/> BTEX/F1 <input type="checkbox"/> F2-F4 <input type="checkbox"/> VOC <input type="checkbox"/> BTEX <input type="checkbox"/> THM <input type="checkbox"/> Pesticides OC <input type="checkbox"/> OP <input type="checkbox"/> TCLP M&I <input type="checkbox"/> VOC <input type="checkbox"/> PCB <input type="checkbox"/> B(a)P <input type="checkbox"/> ABN <input type="checkbox"/> Igit. <input type="checkbox"/> Water Pkg Gen. <input type="checkbox"/> Ext. <input type="checkbox"/> Sewer Use: _____ COMMENTS: _____									
<b>NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY</b>									
Observations/Comments/Special Instructions: _____									
Sampled By (NAME): <u>Nancy Berg</u> Signature: <u>[Signature]</u> Date: <u>08/15/19</u> (mm/dd/yy)						Pink Copy - Client			
Relinquished by (NAME): <u>Nancy Berg</u> Signature: <u>[Signature]</u> Date: <u>08/15/19</u> (mm/dd/yy)						Yellow & White Copy - SGS			



## Appendix D

### Borehole Locations and Soil Strata Drawing



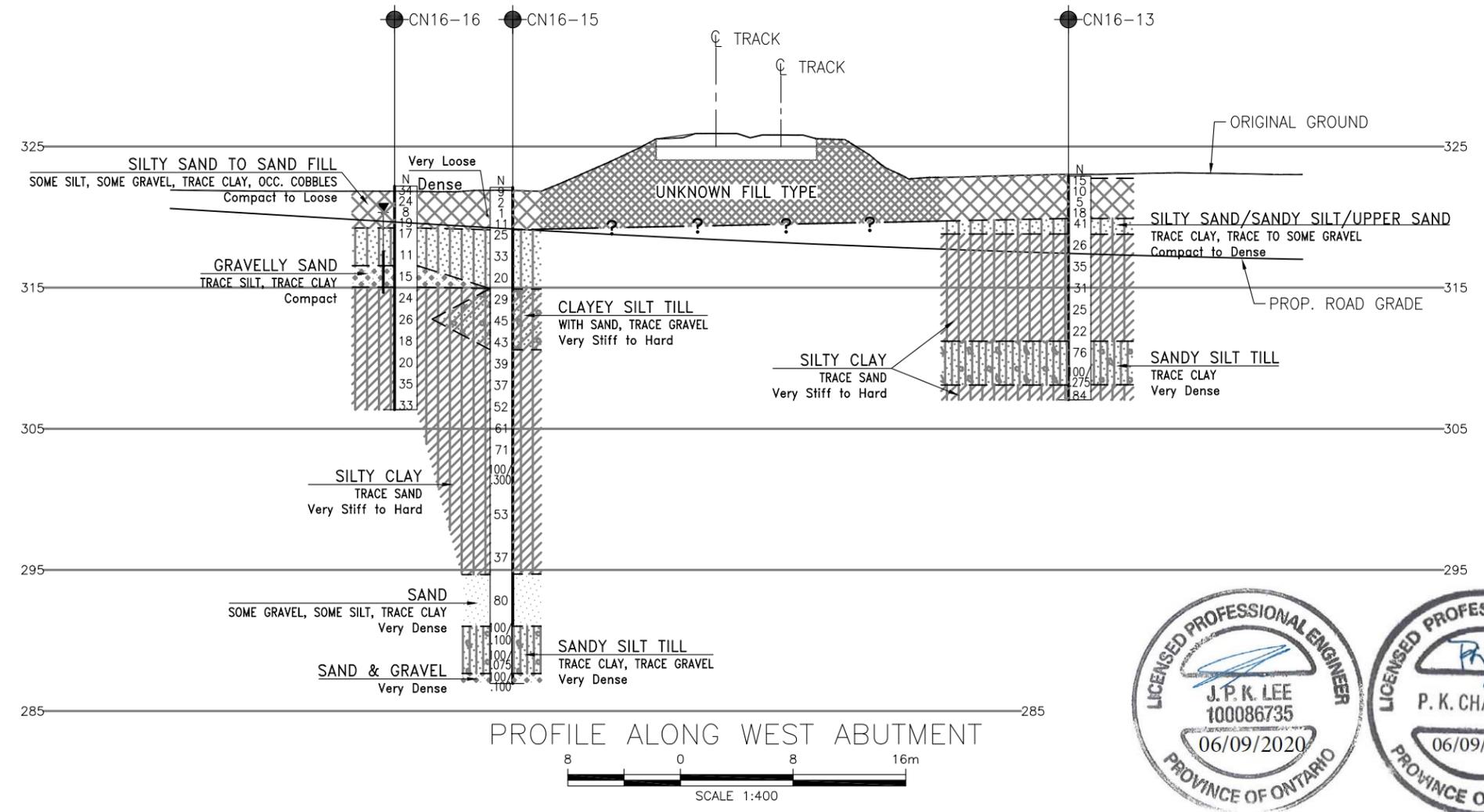
METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No  
GWP No 408-88-00

HIGHWAY 7  
WELLINGTON ST. TO VICTORIA ST.  
CONNECTION BRIDGE  
BOREHOLE LOCATIONS AND SOIL STRATA

**WSP**

**THURBER ENGINEERING LTD.**



**KEYPLAN**

**LEGEND**

- Borehole (Current Investigation)
- ⊕ Borehole (Previous Investigation By Thurber)
- 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

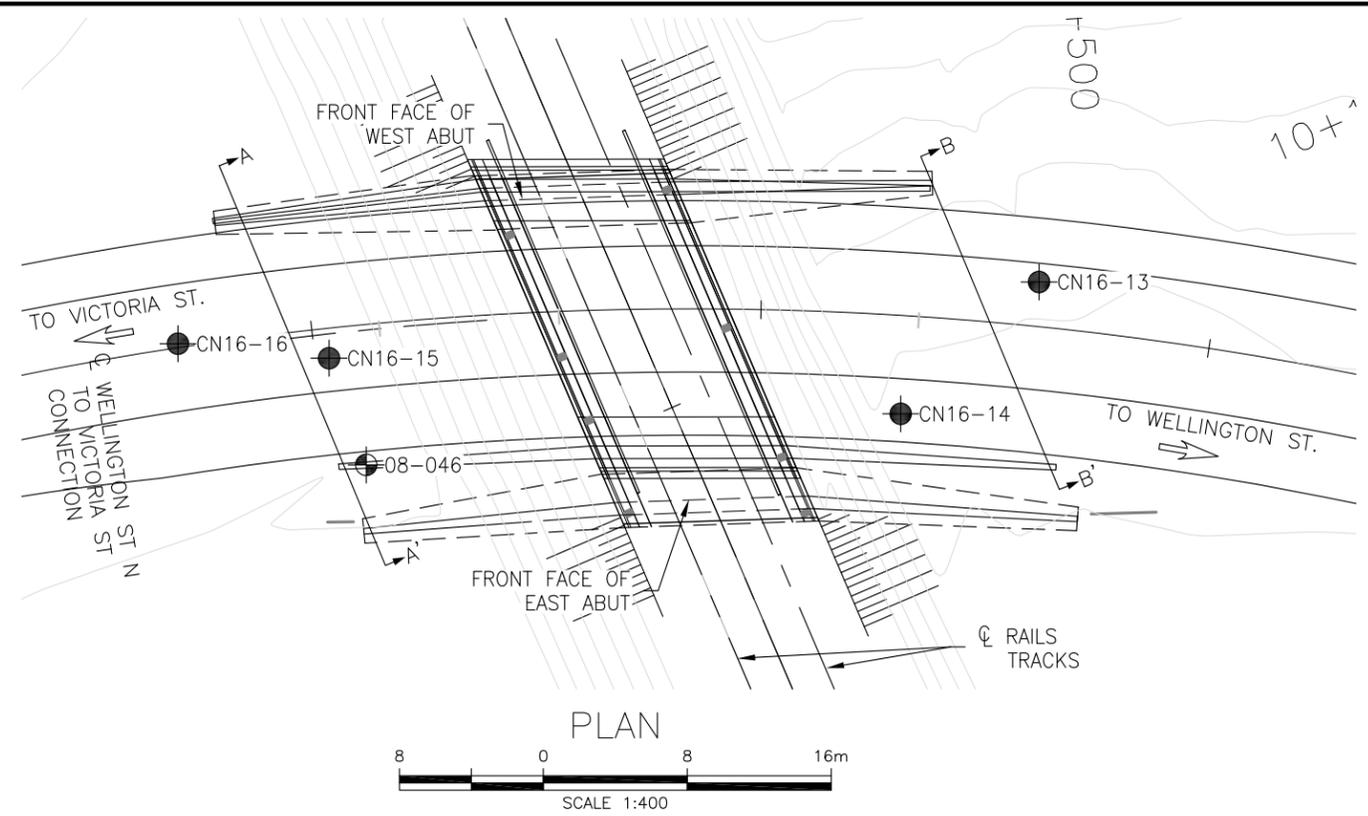
NO	ELEVATION	NORTHING	EASTING
08-046	321.9	4 814 170.5	226 315.5
CN16-13	322.9	4 814 207.8	226 304.9
CN16-14	323.2	4 814 200.2	226 312.3
CN16-15	322.1	4 814 168.4	226 309.6
CN16-16	322.2	4 814 160.0	226 308.9

- NOTES-**
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
  - This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
  - Coordinate system is MTM NAD 83 Zone 10.
- GEOCRES No.**



REVISIONS	DATE	BY	DESCRIPTION

DESIGN NB	CHK PKC	CODE	LOAD	DATE	JUN 2020
DRAWN AN	CHK NB	SITE	STRUCT	DWG	1



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

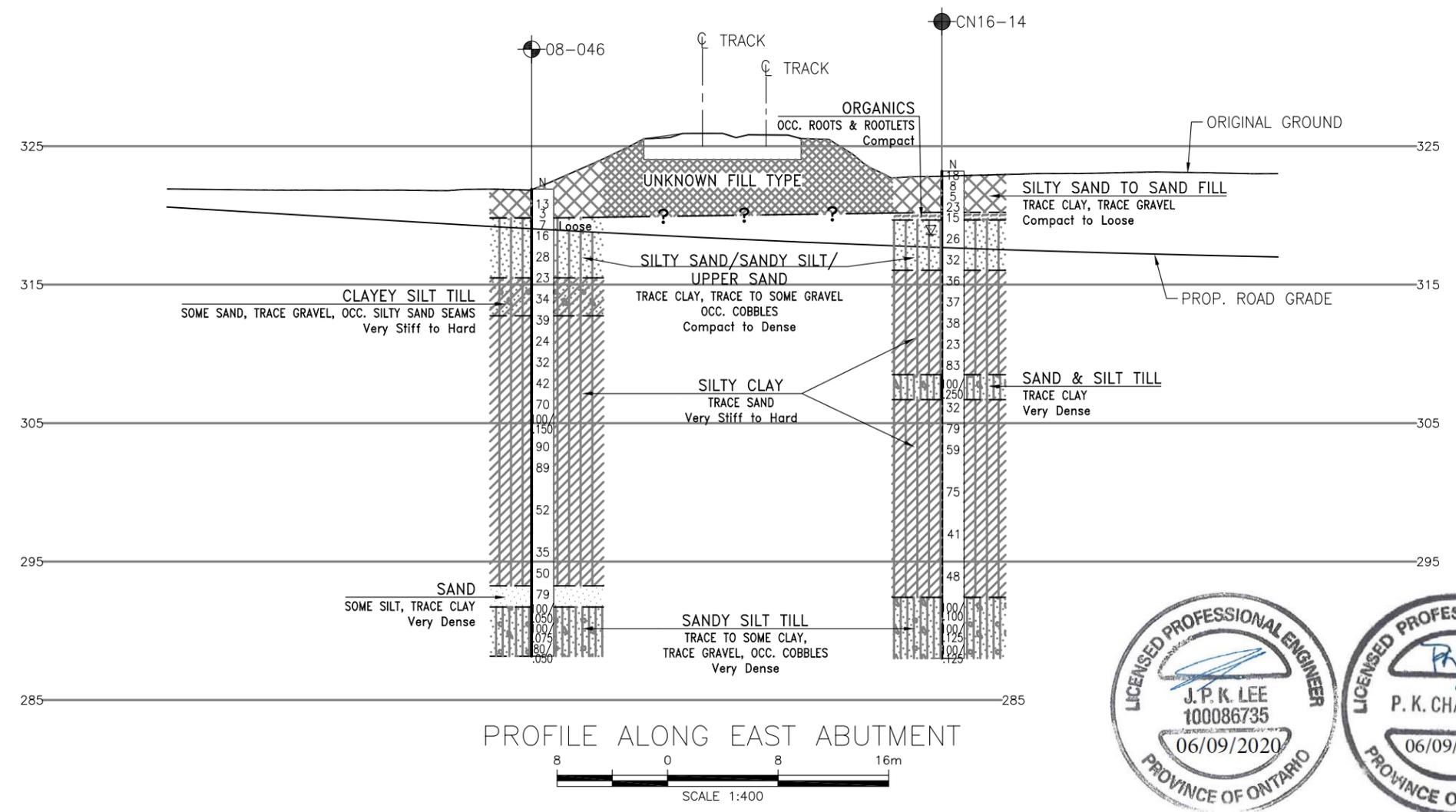
CONT No  
GWP No 408-88-00

HIGHWAY 7  
WELLINGTON ST. TO VICTORIA ST.  
CONNECTION BRIDGE  
BOREHOLE LOCATIONS AND SOIL STRATA

WSP

THURBER ENGINEERING LTD.

SHEET



**LEGEND**

- Borehole (Current Investigation)
- ⊕ Borehole (Previous Investigation By Thurber)
- 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
08-046	321.9	4 814 170.5	226 315.5
CN16-13	322.9	4 814 207.8	226 304.9
CN16-14	323.2	4 814 200.2	226 312.3
CN16-15	322.1	4 814 168.4	226 309.6
CN16-16	322.2	4 814 160.0	226 308.9

- NOTES-**
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
  - This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
  - Coordinate system is MTM NAD 83 Zone 10.
- GEOCRES No.**



REVISIONS	DATE	BY	DESCRIPTION

DESIGN	CHK	PKC	CODE	LOAD	DATE
NB	AN				JUN 2020

DRAWN	CHK	NB	SITE	STRUCT	DWG
AN					2

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

CONT No  
GWP No 408-88-00

HIGHWAY 7  
WELLINGTON ST. TO VICTORIA ST.  
CONNECTION BRIDGE  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

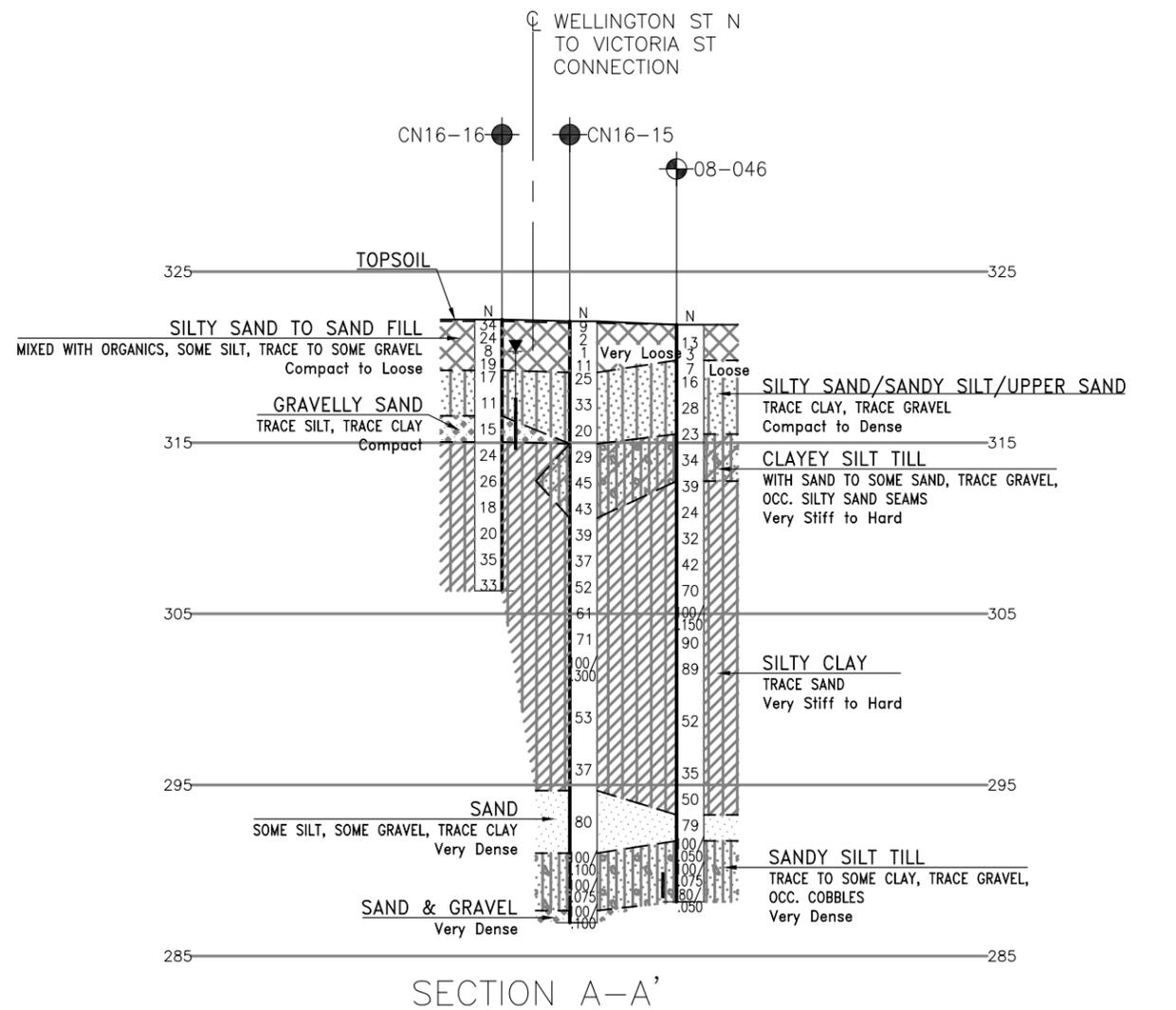
	Borehole (Current Investigation)
	Borehole (Previous Investigation By Thurber)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
08-046	321.9	4 814 170.5	226 315.5
CN16-13	322.9	4 814 207.8	226 304.9
CN16-14	323.2	4 814 200.2	226 312.3
CN16-15	322.1	4 814 168.4	226 309.6
CN16-16	322.2	4 814 160.0	226 308.9

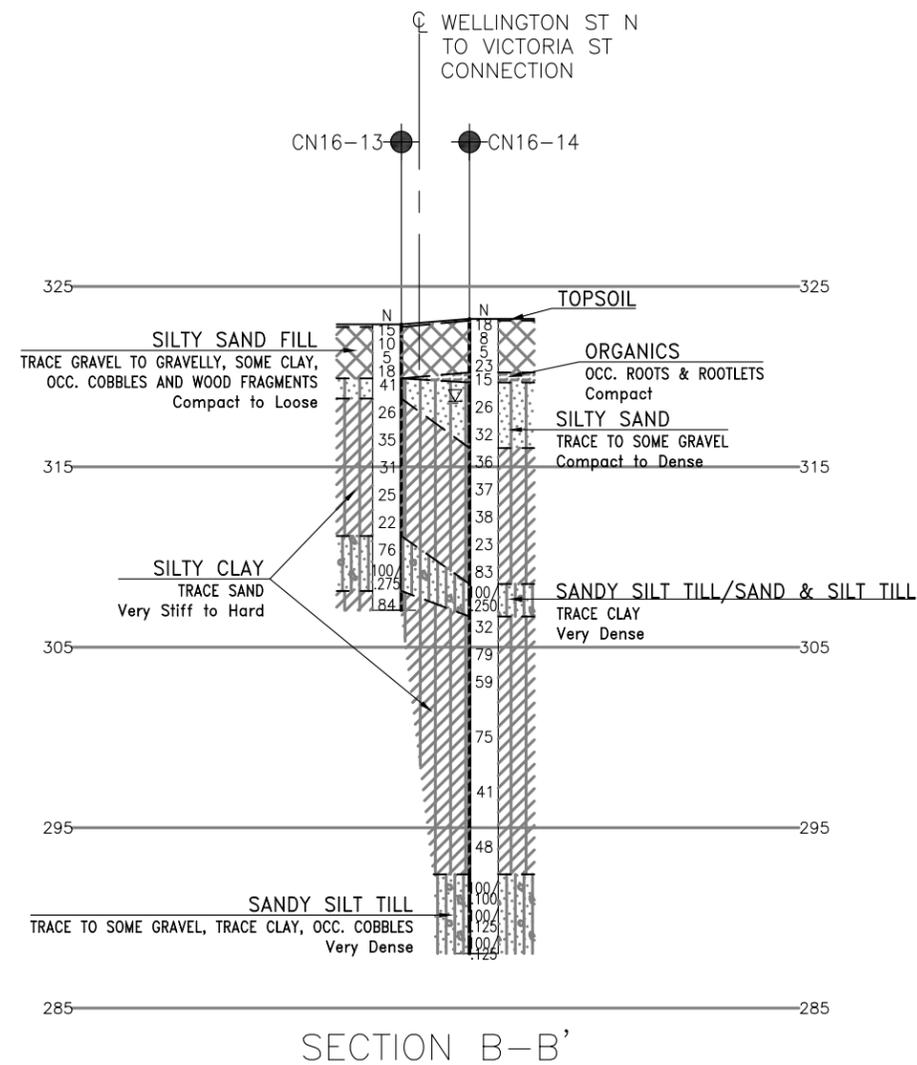
-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 10.

GEORES No.



SECTION A-A'



SECTION B-B'



REVISIONS	DATE	BY	DESCRIPTION

DESIGN	NB	CHK	PKC	CODE	LOAD	DATE	JUN 2020
DRAWN	AN	CHK	NB	SITE	STRUCT	DWG	3