



## Foundation Investigation and Design Report

Highway 401 Eastbound Express and Collector Lanes between Victoria Park Avenue and Neilson Road - **Full Structure Replacement and Bridge Widening at CN Rail Overhead Eastbound Core and Collectors Structure (Site 37X-0215/B1 & B3)**

Assignment No. 2021-E-0018  
MTO Central Region  
Geocres Number: 30M14-551

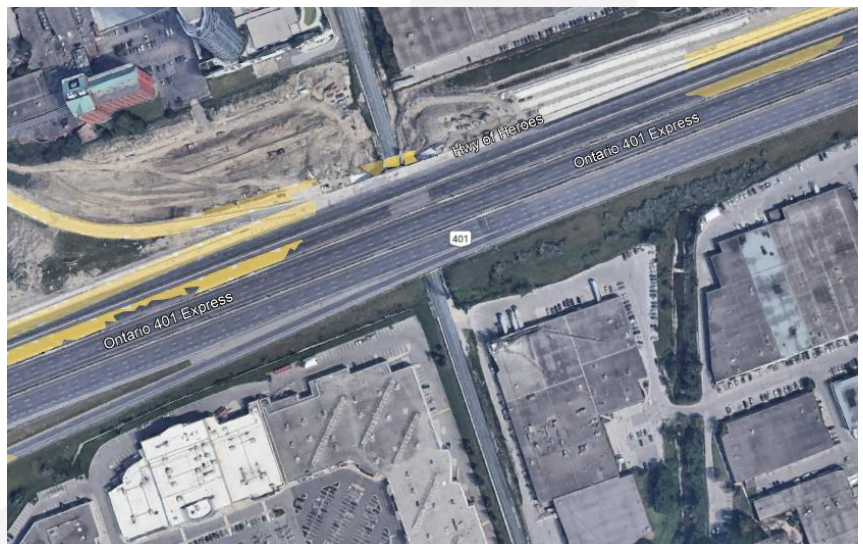
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## Part I: Foundation Investigation Report

Highway 401 Eastbound Express and Collector Lanes between Victoria Park Avenue and Neilson Road – CN Rail Overhead (Site 37X-0215/B1 & B3)

## 1.0 Introduction

EXP Services Inc. (EXP) was retained by AECOM on behalf of The Ministry of Transportation (MTO) to provide detailed foundation investigation and engineering services for the proposed Highway 401 Eastbound rehabilitation and construction project. The findings, analyses and recommendations are presented in a Geotechnical Design Report created for each structure along the proposed highway. The work was undertaken under Assignment No. 2021-E-0018. The terms of reference (TOR) and the scope of work for the foundation investigation are outlined in Ministry of Transportation Ontario's (MTO) Request for proposal, dated June 2021. The scope of this report is specifically limited to the proposed location of the CN Rail overhead structure (Site 37X-0215/B1 & B3).

The General Arrangement drawings (GA) for the bridge structure were provided to EXP by AECOM. The purpose of the investigation was to evaluate the subsurface conditions along the structure alignment to permit a detailed design for the proposed full structure replacement and new retaining wall.

The site-specific geotechnical investigation consisted of borings, soil sampling, borehole logging, and field and laboratory testing. The field and laboratory work for this structure was performed by EXP. Based on collected geotechnical data, this report provides an assessment of the geotechnical issues, geotechnical design parameters, and geotechnical foundation design recommendations for the proposed structure. Geotechnical-related construction recommendations are also provided.

This foundation investigation report has been prepared specifically and solely for the project described herein. It contains the factual results of the investigation and the laboratory testing completed for this project.

## 2.0 Structure Description

General arrangement drawings prepared by URS (dated March 2012) shows the preliminarily proposed configuration of the CN Rail overhead structure. A summary of the proposed structure is as follows:

- The existing overhead structure is a 13.7 m long single-span concrete structure. The existing abutments are supported on approximately 1.8 m and 3.4 m wide spread footings for the Express and Collector Structures, respectively, founded at approximately Elev. 164.2 m. Based on the contract package drawing for Hwy 401 Westbound Core and Collector Lanes, Bridge Replacement GO Transit/Metrolinx Mile 56.3 Uxbridge Subdivision (CONT. NO. 2019-2011, WP No. 2395/2397-15-01, DWG No. 1), the existing Highway 401 pavement grade is at approximately Elev. 174.0 m at the structure location, and the CN rail track grade is at approximately Elev. 165.5 m.
- The existing structure will undergo full structure replacement. This includes replacing the superstructure (existing bridge deck and girders) and foundations. The structure will also be widened by about 1.1 m on the south side of the EB Collector. A new retaining wall will be constructed along the south side of the widened collector structure. The replaced overhead structure will be an approximately 15.99 m long single-span concrete structure (from west to east abutment).
- The previous FIDRs and preliminary GA drawing by AECOM, in addition to contract package drawings were reviewed as part of this report. These background documents were used for initial context to address the nature and scope of the investigation. It is understood that some changes might occur as a result of normal refinement or the findings of the geotechnical report.

## 3.0 Site Description and Geological Setting

### 3.1 Site Description

The site is located at the intersection of Highway 401 and CN Rail overhead, approximately 5 km east of Highway 404 in the City of Toronto, Ontario. The site is adjacent to industrial zones to the east, commercial zones to the southwest, and residential zones to the northwest (high-rise apartments).

In general, the terrain in this area is relatively flat, with the natural ground surface in the immediate vicinity of the structure at about Elev. 165 m to 166 m. The CN Rail tracks have been constructed near the original ground surface, with the rail grade below Highway 401 at Elev. 165.6 m. The existing Highway 401 grade is at approximate Elev. 174.3 m to 174.6 m.

A site location plan is presented as Drawing 1 in Appendix C.

### 3.2 Geological Setting

Based on a review of geological maps of Southern Ontario (Chapman and Putnam, 1984; 2007), the site is situated within the South Slope physiographic region where the predominant landforms are Till Plains (Drumlinized) and Drumlins. The South Slope represents the southern slope of the Oak Ridges Moraine but also includes a strip south of the Peel Plain, extending from the Niagara Escarpment to the Trent River. The South Slope gradually, fairly and uniformly slopes down towards Lake Ontario.

According to the Ministry of Northern Development and Mines, Map 2556 (Quaternary Geology of Ontario, Southern Sheet, 1991) the surface conditions in the vicinity of the project area consists of Halton Till, predominately silt to silty clay matrix, high in matrix carbonate content and clast poor with occasional sand to silt zones. In addition, Map 2544 (Bedrock Geology of Ontario, Southern Sheet, 1991), the bedrock geology at the site consists of shale, limestone, dolostone and siltstone: Georgian Bay Formation, Blue Mountain Formation, Bilings Formation, Collingwood Member, Eastview Member.

## 4.0 Previous Geotechnical Investigation

During the tender design for the project, two (2) previous reports were issued which contain relevant information to the proposed CN rail overhead structure (Site 37X-0215/B1 & B3), as follows:

1. Foundation Investigation Report for The Proposed Extension of Highway. #401 and C.N.R Overhead Extensions, some ¼ Mile East of Kennedy Road Interchange, Twp. of Scarborough, District #6, W.J. 66-P-88, W.P. 259-61, Geocres No. 30M14-068, The Ministry of Transportation Ontario (MTO), Foundation Section, Materials and Testing Div., dated January 12, 1967.
2. Preliminary Foundation Investigation and Design Report, Bridge Widening and Replacement, Highway 401 Rehabilitation from Warden Avenue to Brock Road, Toronto, Ontario, W.O. 07-20012, Report Number: 09-1111-6055-1, Geocres No. 30M14-338, Golder Associates Ltd., dated April 2012.

The Golder Associates Ltd (Golder) and MTO borehole logs are attached as Appendix I in this report. The details of the boreholes completed by the Golder and MTO are outlined in Table 1.1.

**Table 1.1: Summary of Applicable Boreholes Completed by Golder and MTO**

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Borehole No.	Borehole Location	Location (MTM NAD83 Zone 10)		Latitude	Longitude	Borehole Elevation (m)	Borehole Depth (m)
		Northing	Easting				
<b>2011-01<sup>1</sup></b>	Toe of SW Embankment	4848414.2	322538.0	43.775474	-79.279652	166.3	43.3
<b>68-3<sup>2</sup></b>	East Abut. (b/w EBL and WBL)	4848481.2	322535.9	43.776077	-79.279674	165.0	12.6
<b>68-4<sup>2</sup></b>	East Abut. (EBL Collector)	4848443.9	322556.6	43.775743	-79.279415	165.6	18.7
<b>68-5<sup>2</sup></b>	West Abut. (EBL Collector)	4848438.0	322543.4	43.775690	-79.27958	165.9	15.7

Notes:

- (1) Borehole drilled by Golder (Geocres No. 30M14-338)  
 (2) Borehole drilled by MTO (Geocres No. 30M14-068)

## 5.0 Field Investigation and Laboratory Analyses

### 5.1 Site Investigation and Field Testing

A site-specific investigation was undertaken by EXP between September 20 to October 17, 2022, and it included the following:

1. A walkover site assessment was carried out by a Geotechnical Engineer from EXP;
2. Subsequent to the borehole layouts in the field, existing utilities were cleared by public utility companies;
3. Six boreholes were completed for this structure (BH22-3-1A, BH 22-3-1B, BH 22-3-1A, BH 22-3-1B, BH 22-3-3, and BH22-3-4) as part of the additional investigation. A summary of boreholes completed by EXP are listed in Table 1.2 below. The boreholes were drilled using a truck-mounted CME-75 (owned and operated by Drilltech Drilling Ltd.) equipped with solid and hollow stem augers, mud rotary equipment, and fitted with capability for Standard Penetration Testing (SPT);
4. Soil samples in the boreholes were taken at frequent intervals of depth by the Standard Penetration Test method (SPT), in general accordance with ASTM D1586. The test consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm O.D. split barrel (SS-split-spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance, or the N-value, of the soil which is indicative of the compactness of granular (or cohesionless) soils (gravels, sands and silts) or the consistency of cohesive soils (clays and clayey soils);
5. The fieldwork was supervised by a member of EXP's engineering staff who directed the drilling and sampling operation, logged borehole data in accordance with MTO and/or ASTM Standards for Soils Classification, and retrieved soil samples for subsequent laboratory testing and identification;
6. All spoon samples obtained in the Standard Penetration Tests (SPT, ASTM D-1586) were placed in moisture proof bags after field classification. Samples were allocated from the spoon samples for moisture content testing without delay. They were subsequently re-examined under controlled laboratory conditions prior to assigning other laboratory tests;
7. Selected soil samples for corrosivity testing were sent to the Bureau Veritas Laboratories (formerly Maxxam Analytics), a CALA-certified and accredited laboratory in Mississauga, Ontario. The selected soil samples for the analytical testing were placed in a laboratory prepared glass jar, labelled, and stored in a secure cooler.
8. The borehole locations and their ground surface elevations were surveyed by EXP using a Trimble DA2 GNSS receiver with Trimble Catalyst GNSS positioning, having an accuracy of  $\pm 0.10$  m horizontal and vertical directions. MTM NAD83 Zone 10 coordinates and the geodetic elevation for the boreholes are listed in Table 1.2 below. It can also be found on the Record of Borehole Sheet (Appendix D); and

9. Upon completion of drilling and field testing, the boreholes were backfilled with a mixture of bentonite and auger cuttings. The borehole decommissioning was in general accordance with the Ministry of the Environment Regulation 903, as amended by Regulation 128/03 (the well regulation under the Ontario Water Resources Act).

**Table 1.2: Summary of boreholes completed by EXP**

Borehole No.	Borehole Location	Location (MTM NAD83 Zone 10)		Latitude	Longitude	Borehole Elevation (m)	Borehole Depth (m)
		Northing	Easting				
BH22-3-1A	West Abut. (EBL Collector)	4848438	322529	43.775690	-79.279763	174.44	15.8
BH22-3-1B <sup>1</sup>	West Abut. (EBL Collector)	4848437	322527	43.775681	-79.279788	174.44	24.6
BH22-3-2A	East Abut. (EBL Express)	4848484	322555	43.776104	-79.279439	174.34	20.6
BH22-3-2B <sup>2</sup>	East Abut. (EBL Express)	4848485	322558	43.776113	-79.279401	174.34	25.0
BH22-3-3	West Abut. (EBL Express)	4848472	322517	43.775997	-79.279911	174.57	15.8
BH22-3-4	East Abut. (EBL Express)	4848488	322570	43.776139	-79.279522	174.33	15.8

Notes:

- (1) Companion borehole drilled approximately 3m west of BH22-3-1A  
 (2) Companion borehole drilled approximately 3m east of BH22-3-2A

## 5.2 Laboratory Testing

Selected samples were submitted for natural moisture content testing. In addition, Atterberg Limit and Grain size analysis (sieve and hydrometer) tests were performed on selected soil samples (performed by EXP). In addition, chemical analyses were carried out on two soil samples selected by EXP. The samples were tested at the Bureau Veritas Laboratories (formerly Maxxam Analytics), a CALA-certified and accredited laboratory in Mississauga, Ontario. The completed laboratory testing program is listed in Table 1.3.

**Table 1.3: List of Laboratory Test Completed by EXP**

Borehole No.	Moisture Content	Atterberg Limits	Sieve	Hydrometer	Unit Weight	Corrosivity
BH22-3-1A	14	2	4	3	2	---
BH22-3-1B	6	---	1	1	1	---
BH22-3-2A	18	1	5	5	3	---
BH22-3-2B	3	---	1	1	---	---
BH22-3-3	14	---	3	3	2	1
BH22-3-4	13	---	3	3	1	1

The laboratory test results are provided on the attached borehole log sheets in Appendix D as well as graphically in Appendix E.



## 6.0 Subsurface Conditions

The detailed subsurface conditions encountered in the boreholes advanced during this investigation are presented on the borehole log sheets in Appendix D. The "Explanation of Terms Used in Report," preceding the borehole logs in Appendix D, forms an integral part of and should be read in conjunction with this report.

A borehole location plan and stratigraphic sections are provided in Appendix C. It should be noted that the stratigraphic boundaries indicated on the borehole log and stratigraphic sections are inferred from semi-continuous sampling, observations of drilling progress, and results of Standard Penetration Tests. These boundaries typically represent transitions from one soil type to another and should not be interpreted as exact planes of geological change. Furthermore, subsurface conditions may vary between and beyond the borehole locations.

The general stratigraphy encountered within the investigated depths of EXP's geotechnical investigation indicates the following sub-surface sequence: a pavement structure composed of asphalt and concrete over sand and gravel fill, followed by embankment fill comprised of sand and silt, sandy clayey silt, and clayey silt. The fill is underlain by varying compositions of native cohesionless soil (silty sand to sand and silt/sand and silt till to sandy silt to silt) and cohesive soil (clayey silt/clayey silt till).

A detailed description of the stratigraphy encountered is discussed further in subsequent sections. It should be noted that the following sections are based on the geotechnical investigation conducted by EXP, Golder, and MTO.

### 6.1 Subsoils

#### 6.1.1 Pavement Structure

A pavement structure consisting of asphalt and concrete was encountered at the surface of boreholes BH22-3-1A and B, BH22-3-2A, BH22-3-3, and BH22-3-4. The thickness of the pavement structure ranged between approximately 300 mm and 450 mm.

#### 6.1.2 Topsoil

An approximately 200 mm thick layer of surficial topsoil was encountered in borehole 2011-01.

#### 6.1.3 Sand and Gravel (Fill)

Sand and gravel fill was encountered below the pavement structure in boreholes BH22-3-1A, BH22-3-2A, BH22-3-3, and BH22-3-4. The approximate elevations of the surface and base of each layer, thickness, description, and SPT "N" value encountered in the boreholes are summarized in Table 1.4 below:

**Table 1.4: Summary of Sand and Gravel Fill Layers**

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT “N” Value Range
	Top	Bottom				
EXP (2022)						
BH22-3-1A	173.8	171.8	0.6	2.0	Sand and Gravel	32

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Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
<b>BH22-3-2A</b>	173.8	171.2	0.5	2.6	Sand and Gravel	16 – 22
<b>BH22-3-3</b>	174.3	173.8	0.3	0.5	Sand and Gravel	---
<b>BH22-3-4</b>	174.0	172.8	0.3	1.2	Sand and Gravel	20

The fill layer consists predominantly of sand and gravel with some silt and clay. The soil is moist to wet in moisture condition and brown to greyish brown in color. The SPT "N" values within this layer ranged from 16 to 32 blows per 300 mm penetration, corresponding to compact to dense in terms of compactness condition.

Laboratory testing performed on selected samples consisted of moisture content and grain size distribution tests. The test results of the sand and gravel fill are as follow:

Moisture Content (EXP):

- 4% to 14%

Grain Size Distribution (EXP):

- 43% gravel
- 44% sand
- 13% silt and clay

The results of the moisture content and grain size distribution tests performed by EXP are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution tests performed by EXP are also provided on Figure 1 in Appendix E.

#### 6.1.4 Sand and Silt (Fill)

Sand and silt fill was encountered below the sand and gravel fill in boreholes BH22-3-2A, BH22-3-3, and BH22-3-4. The approximate elevations of the surface and base of each layer, thickness, description, and SPT "N" value encountered in the boreholes are summarized in Table 1.5 below:

**Table 1.5: Summary of Sand and Silt Fill Layers**

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT “N” Value Range
	Top	Bottom				
EXP (2022)						
BH22-3-2A	171.2	165.2	3.1	6.0	Sand and Silt	15 – 25
BH22-3-3	173.8	165.3	0.8	8.5	Sand and Silt	14 – 46
BH22-3-4	172.0	165.2	2.3	6.8	Sand and Silt	19 – 27

The fill layer consists predominantly sand and silt with trace to some gravel, trace to some clay, and trace organics. Traces of asphalt inclusions were also encountered in BH22-3-4. The soil is slightly moist to moist in terms of moisture condition, and its color ranged from brown to greyish brown to grey. The SPT "N" values within this layer ranged from 14 to 46 blows per 300 mm penetration, corresponding to compact to dense in terms of compactness condition.

Laboratory testing performed on selected samples consisted of moisture content, unit weight, and grain size distribution tests. The test results of the sand and silt fill are as follow:

Moisture Content: (EXP)

- 4% to 15%

Grain Size Distribution: (EXP)

- 1% to 5% gravel
- 43% to 47% sand
- 42% to 43% silt
- 6% to 12% clay

Unit Weight: (EXP)

- 23.2 kN/m<sup>3</sup>

The results of the moisture content, unit weight, and grain size distribution tests performed by EXP are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution tests performed by EXP are also provided on Figure 2 in Appendix E.

#### 6.1.5 Cohesive Fill: Clayey Silt

Cohesive fill was encountered below the sand and gravel layer in boreholes BH22-3-1A and BH22-3-4 and below the topsoil in borehole 2011-01. The approximate elevations of the surface and base of each fill layer, thickness, description, and SPT "N" value encountered in the boreholes are summarized in Table 1.6 below:

**Table 1.6: Summary of Cohesive Fill: Clayey Silt Layers**

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT “N” Value Range
	Top	Bottom				
EXP (2022)						
BH22-3-1A	171.8	165.3	2.6	6.5	Clayey Silt	11 – 25
BH22-3-4	172.8	172.0	1.5	0.8	Clayey Silt	5
Golder (2011)						
2011-01	166.1	165.5	0.2	0.6	Clayey Silt	12

The fill layer consists predominantly of clay and silt and ranges in sand content from some sand to being sandy with trace to some gravel. Rootlets and organics were encountered in borehole 2011-01. The soil within this layer is slightly moist to moist in terms of moisture condition and brown to grey in colour. The SPT "N" values measured within this layer ranged from 5 to 25 blows per 300 mm of penetration, corresponding to firm to very stiff in terms of consistency.

Laboratory testing performed on selected samples consisted of moisture content and grain size distribution, and Atterberg limits tests. The test results of the clayey silt fill soil are as follow:

Moisture Content (EXP and Golder):

- 13% to 26%

#### Grain Size Distribution: (EXP)

- 3% gravel
- 27% sand
- 38% silt
- 32% clay

#### Atterberg Limits: (EXP)

- Liquid Limit: 24%
- Plastic Limit: 12%;
- Plasticity Index: 12%

The results of the moisture content, grain size distribution and Atterberg limit tests performed by EXP are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution and Atterberg limit tests performed by EXP are also provided on Figures 3 and 7 in Appendix E. The results of tests performed by Golder are shown on the borehole logs attached in Appendix I.

#### 6.1.6 Native Cohesionless Soil

Native cohesionless soil consisting of various compositions (silt, sandy silt, silt and sand, silty sand, silty sand till, sandy silt till, silt and sand till) was encountered below the embankment fill in all boreholes. The approximate elevations of the surface and base of each layer, thickness, description, and SPT “N” value encountered in the boreholes are summarized in Table 1.7 below:

**Table 1.7: Summary of Native Cohesionless Soil Layers**

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT “N” Value Range
	Top	Bottom				
EXP (2022)						
BH22-3-1A	165.3	164.5	9.1	0.8	Silty Sand	31
	160.7	158.6	13.7	2.1	Silty Sand	58 – 70
BH22-3-1B	156.1	151.5	18.3	4.6	Silty Sand	68 - 107/125mm
	150.0	149.8	24.4	0.2	Silty Sand	100/200mm
BH22-3-2A	164.4	160.6	9.9	3.8	Silt	14 – 49
	160.6	154.5	13.7	6.1	Sand and Silt	10 – 85
	154.5	153.7	19.8	0.8	Silt	115
BH22-3-2B	153.0	149.9	21.3	3.1	Sandy Silt	56 – 80

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Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
	149.9	149.3	24.4	0.6	Sandy Silt (Till)	108
<b>BH22-3-3</b>	165.3	158.8	9.3	6.5	Sand and Silt (Till)	26 – 121
<b>BH22-3-4</b>	165.2	160.6	9.1	4.6	Sandy Silt	17 – 27
	160.6	158.5	13.7	2.1	Sand and Silt (Till)	65 – 114
<b>Golder (2011)</b>						
<b>2011-01</b>	165.5	163.3	0.8	2.2	Silty Sand (Till)	7 - 23
	161.7	152.9	4.6	8.8	Sand and Silt (Till)	20 - 90 <sup>1</sup>
	152.9	145.3	13.4	7.6	Sand and Silt	18 – 143/280mm
<b>MTO (1966)</b>						
<b>68-3</b>	165.0	152.4	0.0	12.6	Sandy Silt to Sand and Silt	34 – 163
<b>68-4</b>	165.6	157.4	0.0	8.2	Silt to Sand and Silt	21 – 100/127mm
	155.2	146.9	10.4	8.3	Silty Sand to Sandy Silt	35 – 185
<b>68-5</b>	165.9	157.3	0.0	8.6	Silt to Sand and Silt	17 – 100/127mm
	155.2	150.2	10.7	5.0	Silty Sand to Sandy Silt	36 – 100/127mm

**Notes:**

- (1) SPT "N" blow count of 1 was encountered in this layer, however it was considered to have been affected by disturbance due to groundwater inflow to borehole.

The native cohesionless layers consist predominantly of silt and sand which largely varies in composition including silt and sand ranging from silt, sandy silt, silt and sand, silty sand, silty sand till, sandy silt till, and silt and sand till with trace to some gravel, trace to some clay, and occasional clayey silt pockets/layers. The soil is slightly moist to wet in terms of moisture condition and brown to grey in terms of color. The SPT "N" values within this layer ranged from 10 blows per 300 mm penetration to 107 blows per 125 mm of penetration, corresponding to compact to very dense but generally dense to very dense in terms of compactness condition.

Laboratory testing performed on selected samples consisted of moisture content, unit weight, and grain size distribution tests. The test results of the native cohesionless soils are as follow:

**Moisture Content (EXP, Golder, and MTO):**

- 6% to 21%

**Grain Size Distribution: (EXP, Golder, and MTO)**

- 0% to 6% gravel;
- 5% to 71% sand;
- 28% to 93% silt;

- 1% to 11% clay;

Unit Weight: (EXP)

- 20.9 kN/m<sup>3</sup> to 23.9 kN/m<sup>3</sup>

The results of the moisture content, grain size distribution, Atterberg Limit, unit weight tests performed by EXP are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution tests performed by EXP are also provided on Figure 4 and 5 in Appendix E. The results of tests performed by Golder and MTO are shown on the borehole logs attached in Appendix I.

#### 6.1.7 Native Cohesive Soil

Layers of clayey silt and clayey silt till were encountered in boreholes BH22-3-1A, BH22-3-1B, BH22-3-2A, 2011-01, 68-4, and 68-5. The approximate elevations of the surface and base of each layer, thickness, description and SPT (N Value) encountered in the boreholes are summarized in Table 1.8 below:

**Table 1.8: Summary of Native Cohesive Soil Layers**

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT “N” Value Range
	Top	Bottom				
EXP (2022)						
BH22-3-1A	164.5	160.7	9.9	3.8	Clayey Silt (Till)	40 - 102
BH22-3-1B	157.6	156.1	16.8	1.5	Clayey Silt (Till)	36
	151.5	150.0	22.9	0.5	Clayey Silt (Till)	106/180mm
BH22-3-2A	165.2	164.4	9.1	0.8	Clayey Silt (Till)	13
Golder (2011)						
2011-01	163.3	161.7	3.0	1.6	Clayey Silt (Till)	15 - 24
	145.3	134.1	21.0	11.2	Clayey Silt	22 - 56
	134.1	123.0	32.2	11.1	Clayey Silt (Till)	20 - 36
MTO (1966)						
68-4	157.4	155.2	8.2	2.2	Clayey Silt	95
68-5	157.3	155.2	8.6	2.1	Clayey Silt	76

The native cohesive layers consist predominantly clay and silt and is considered sandy with trace to some gravel in the till layers. Some organics were encountered in borehole BH22-3-2A. The soil is slightly moist to wet in terms of moisture condition and brown to grey in terms of color. The SPT "N" values within this layer ranged from 13 blows per 300 mm of penetration to 106 blows per 180 mm of penetration, corresponding to stiff to hard but generally very stiff to hard in terms of consistency.

Laboratory testing performed on selected samples consisted of moisture content, unit weight, grain size distribution, Atterberg Limit tests. The test results of clayey silt soil are as follow:

Moisture Content (EXP, Golder and MTO):

- 8% to 21%

#### Grain Size Distribution: (EXP and Golder)

- 0% to 4% gravel
- 0% to 44% sand
- 40% to 72% silt
- 13% to 30% clay;

#### Atterberg Limits: (EXP, Golder and MTO)

- Liquid Limit: 13% to 29%
- Plastic Limit: 6% to 15%
- Plasticity Index: 5% to 14%

#### Unit Weight: (EXP)

- 21.2 kN/m<sup>3</sup> to 24.0 kN/m<sup>3</sup>

The results of the moisture content, grain size distribution, and Atterberg limit tests performed by EXP are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution and Atterberg limit tests performed by EXP are also provided on Figures 6 and 8 in Appendix E. The results of tests performed by Golder and MTO are shown on the borehole logs attached in Appendix I.

## 6.2 Groundwater Conditions

Groundwater levels were observed upon completion of some of the boreholes. Groundwater levels measured on completion of boreholes may not be considered stabilized and therefore may not represent the established long-term average groundwater table (phreatic surface).

A summary of the groundwater levels encountered during the investigations are summarized in Table 1.9 and are also presented on the Record of Borehole Sheets attached in Appendix D and Appendix I.

**Table 1.9: Summary of observed groundwater levels**

Borehole	Ground Surface Elevation (m)	Water level Depth/ Elevation (m)	Date
<b>EXP (2022)</b>			
<b>BH22-3-1A</b>	174.3	11.5/162.8	September 20, 2022
<b>BH22-3-2A</b>	174.3	13.8/160.5	September 22, 2022
<b>Golder (2011)</b>			
<b>2011-01</b>	166.3	4.3/162.0	April 6, 2011
<b>MTO (1966)</b>			
<b>68-3</b>	165.0	3.5/161.5	November 15, 1966
<b>68-4</b>	165.6	1.8/163.8	November 18, 1966
<b>68-5</b>	165.9	5.5/160.4	November 14, 1966

It should be noted that fluctuations in the level of the groundwater may occur due to seasonal variations, (precipitation, snowmelt, rainfall), local soil permeability, construction remediation activities, and other related factors.

### 6.3 Chemical Analyses

Two soil sample were selected for chemical analysis during current investigation. The soils samples were tested at the Bureau Veritas Laboratories (formerly Maxxam Analytics) and AGAT Laboratories, respectively, a CALA-certified and accredited laboratory in Mississauga, Ontario. The analytical results are summarized in Table 1.10 below and are presented in Appendix D.

**Table 1.10: Summary of chemical analysis results**

Borehole I.D.	Sample I.D.	Depth (m)	pH (Unitless)	Soluble Chloride (ppm)	Soluble Sulphate (ppm)	Resistivity (ohm-cm)	Conductivity (mS/cm)	Redox Potential (mV)
BH22-3-3	SS10	9.9 – 10.5	7.92	130	<20	3600	0.279	270
BH22-3-4	SS5	3.1 – 3.7	7.75	480	<20	1100	0.945	190



*Foundation Investigation Report  
Highway 401 Eastbound from Victoria Park Avenue to Neilson Road  
Full Structure Replacement and Bridge Widening at CN Rail Overhead (Site 37X-0215/B1 & B3)  
Assignment No. 2021-E-0018  
Date: December 20, 2024*

## 7.0 Closure

The recommendations made in this report are in accordance with our present understanding of the project and are provided solely for the team responsible for the design of the works described herein.

A subsurface investigation is a limited sampling of a site; the subsurface conditions have been established only at the test hole locations. Should conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to assess this additional information and our recommendations, as appropriate. It may then be necessary to perform additional investigations and analyses.

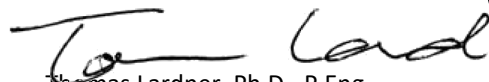
Details of the limitations of this report are presented as Appendix A, "Limitations and Use of Report".

This Foundation Investigation Design Report has been prepared by Elvis Lu, M.Eng., EIT, Daniel Mroz, M.E.Sc., EIT and Sugitha Anandakumar, M.Eng., P.Eng, PMP. It was reviewed by and Thomas Lardner, Ph.D., P.Eng., TaeChul Kim, M.E.Sc., P.Eng. and Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact.

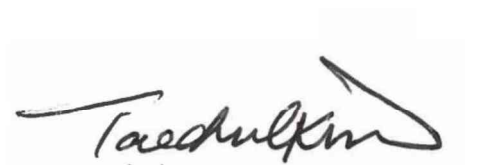
Yours truly,


EXP Services Inc.

Sugitha Anandakumar, M.Eng., P.Eng., PMP  
Geotechnical Engineer

  
Thomas Lardner, Ph.D., P.Eng.  
Senior Geotechnical Engineer



  
TaeChul Kim, M.E.Sc., P.Eng.  
Senior Foundation/ Geotechnical Specialist

  
Stan E. Gonsalves, M.Eng., P.Eng.  
Executive Vice-President  
Designated MTO Foundation Contact



Encl.

## References

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- Canadian Standards Association (CSA), 2019. *Canadian Highway Bridge Design Code and Commentary on CAN/CSA-S6-19*. CSA Special Publication.
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- Ontario Geological Survey. 1991. *Bedrock geology of Ontario, southern sheet*; Ontario Geological Survey, Map 2544, scale 1:1 000 000.
- Preliminary Foundation Investigation and Design Report, Bridge Widening and Replacement, Highway 401 Rehabilitation from Warden Avenue to Brock Road, Toronto, Ontario, W.O. 07-20012, Report Number: 09-1111-6055-1, Geocres No. 30M14-338, Golders Associates Ltd., dated April 2012.
- US Army Corps of Engineers, Engineering and Design Manual for Retaining and Flood Walls, 29 September 1989.
- Asaoka, A., 1978. Observational Procedure of Settlement Prediction.

## Appendix A – Limitations and Use of Report



## **LIMITATIONS AND USE OF REPORT**

### **BASIS OF REPORT**

This report ("Report") is based on site conditions known or inferred by the geotechnical investigation undertaken as of the date of the Report. Should changes occur which potentially impact the geotechnical condition of the site, or if construction is implemented more than one year following the date of the Report, the recommendations of exp may require re-evaluation.

The Report is provided solely for the guidance of design engineers and on the assumption that the design will be in accordance with applicable codes and standards. Any changes in the design features which potentially impact the geotechnical analyses or issues concerning the geotechnical aspects of applicable codes and standards will necessitate a review of the design by exp. Additional field work and reporting may also be required.

Where applicable, recommended field services are the minimum necessary to ascertain that construction is being carried out in general conformity with building code guidelines, generally accepted practices and exp's recommendations. Any reduction in the level of services recommended will result in exp providing qualified opinions regarding the adequacy of the work. exp can assist design professionals or contractors retained by the Client to review applicable plans, drawings, and specifications as they relate to the Report or to conduct field reviews during construction.

Contractors contemplating work on the site are responsible for conducting an independent investigation and interpretation of the borehole results contained in the Report. The number of boreholes necessary to determine the localized underground conditions as they impact construction costs, techniques, sequencing, equipment and scheduling may be greater than those carried out for the purpose of the Report.

Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates are based on investigations performed in accordance with the standard of care set out below and require the exercise of judgment. As a result, even comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations or building envelope descriptions involve an inherent risk that some conditions will not be detected. All documents or records summarizing investigations are based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated. Some conditions are subject to change over time. The Report presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, these should be disclosed to exp to allow for additional or special investigations to be undertaken not otherwise within the scope of investigation conducted for the purpose of the Report.

### **RELIANCE ON INFORMATION PROVIDED**

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to exp by the Client and others. The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client. exp has relied in good faith upon such representations, information and instructions and accepts no responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions expressed in the Report are only valid to the extent that there has been no material alteration to or variation from any of the information provided to exp.

### **STANDARD OF CARE**

The Report has been prepared in a manner consistent with the degree of care and skill exercised by engineering consultants currently practicing under similar circumstances and locale. No other warranty, expressed or implied, is made. Unless specifically stated otherwise, the Report does not contain environmental consulting advice.

### **COMPLETE REPORT**

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment form part of the Report. This material includes, but is not limited to, the terms of reference given to exp by its client ("Client"), communications between exp and the Client, other reports, proposals or documents prepared by exp for the Client in connection with the site described in the Report. In order to properly understand the suggestions, recommendations and opinions expressed in the Report, reference must be made to the Report in its entirety. exp is not responsible for use by any party of portions of the Report.



## **USE OF REPORT**

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. No other party may use or rely upon the Report in whole or in part without the written consent of exp. Any use of the Report, or any portion of the Report, by a third party are the sole responsibility of such third party. exp is not responsible for damages suffered by any third party resulting from unauthorised use of the Report.

## **REPORT FORMAT**

Where exp has submitted both electronic file and a hard copy of the Report, or any document forming part of the Report, only the signed and sealed hard copy shall be the original documents for record and working purposes. In the event of a dispute or discrepancy, the hard copy shall govern. Electronic files transmitted by exp have utilize specific software and hardware systems. exp makes no representation about the compatibility of these files with the Client's current or future software and hardware systems. Regardless of format, the documents described herein are exp's instruments of professional service and shall not be altered without the written consent of exp.

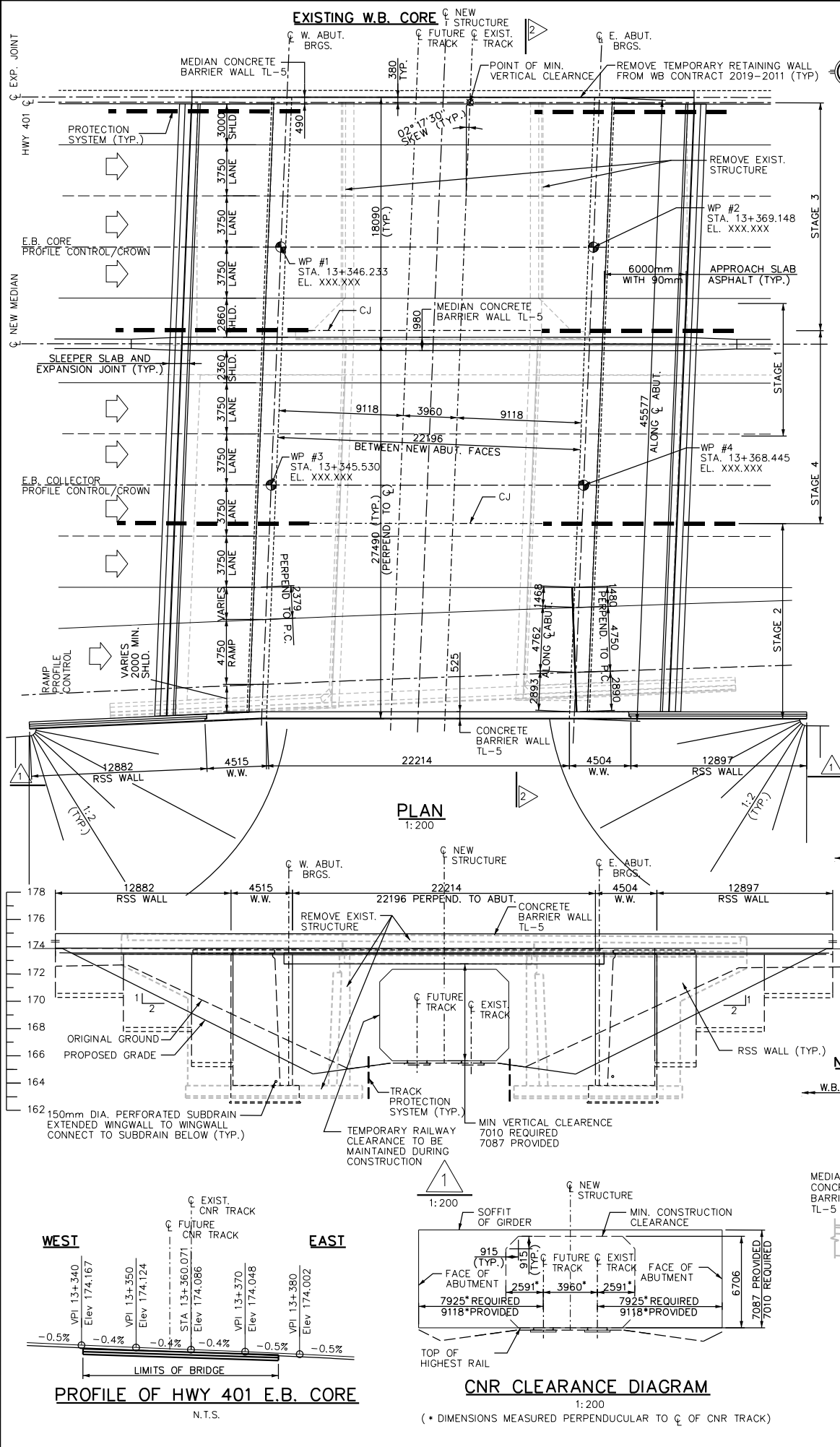
## Appendix B – General Arrangement Drawings

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2017-08

ANSI-D

MINISTRY OF TRANSPORTATION, ONTARIO



### CONSTRUCTION NOTES:

1. THE CONTRACTOR SHALL VERIFY ALL RELEVANT DIMENSIONS, ELEVATIONS AND DETAILS ON SITE AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR PRIOR TO PROCEEDING WITH WORK.
2. THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND REINFORCING STEEL TO SUIT THE ACTUAL HEIGHT OF THE BEARING SUPPLIED. THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING FULL BEARING CONTACT TO GIRDER SOFFIT AND BEARING SEAT. ADDITIONAL COST DUE TO ANY CHANGES IN ELEVATIONS OF THE TOP OF BEARINGS BY THE CONTRACTOR SHALL BE AT THEIR OWN EXPENSE.
3. PROTECTION SYSTEM SHALL MEET REQUIREMENTS FOR PERFORMANCE LEVEL 2. EXACT LOCATIONS AND LIMITS OF PROTECTION SYSTEM SHALL BE DETERMINED BY CONTRACTOR.
4. BACKFILL SHALL NOT BE PLACED BEHIND THE NEW INTEGRAL ABUTMENTS UNTIL THE NEW CONCRETE HAS ACHIEVED 75% OF DESIGN COMPRESSIVE STRENGTH.
5. SAWCUT IN CONCRETE, WHERE DESIGNATED, SHALL BE 25mm DEEP OR TO THE FIRST LAYER OF REINFORCING STEEL, WHICHEVER IS LESS.
6. ANY DAMAGE DURING CONSTRUCTION TO THE EXISTING STRUCTURES UTILITIES AND ADJACENT PROPERTIES NOT DESIGNATED FOR REPAIR SHALL BE REPAIRED GOOD BY THE CONTRACTOR TO THE SATISFACTION OF THE CONTRACT ADMINISTRATOR AND AT NO COST TO THE OWNER.
7. THE CONTRACTOR IS FULLY RESPONSIBLE FOR ADEQUATE PROTECTION OF ALL UTILITIES, SERVICES, ROADWAYS, ETC., DURING CONSTRUCTION OPERATIONS.
8. THE CONTRACTOR SHALL PROVIDE DEBRIS PLATFORMS AND NECESSARY CONTAINMENT MEASURES TO COLLECT FALLING CONCRETE AND CONSTRUCTION DEBRIS SUCH THAT NO DEBRIS OR MATERIALS RESULTING FROM THE REMOVAL WORK FALLS IN AREAS BELOW THE BRIDGE.
9. THE CONTRACTOR SHALL NOT REMOVE THE EXISTING SUPERSTRUCTURE WITHIN EACH STAGE UNTIL EXISTING APPROACH SLABS AND BACKFILL BEHIND BOTH ABUTMENTS ARE REMOVED TO THE SPECIFIED DEPTH. BACKFILL SHALL BE REMOVED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 300mm.
10. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH DECK ENDS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 300mm.

### LIST OF ABBREVIATIONS

ABUT.	ABUTMENT
BRGS.	BEARINGS
C.J.	CONSTRUCTION JOINT
DIA.	DIAMETER
E.B.	EASTBOUND
EBL	EASTBOUND LANE
E.J.	EXPANSION JOINT
EL.	ELEVATION
EQ.SP.	EQUALLY SPACED
EXIST.	EXISTING
REINF.	REINFORCEMENT
SCL	SPEED CHANGE LANE
SHLD	SHOULDER
STA.	STATION
T/P	TOP OF PAVEMENT
TYP.	TYPICAL
W.B.	WESTBOUND
WBL	WESTBOUND LANE
WP	WORKING POINT

METRIC  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN  
DRAWING NOT TO BE SCALED  
100mm ON ORIGINAL DRAWING

### LIST OF DRAWINGS

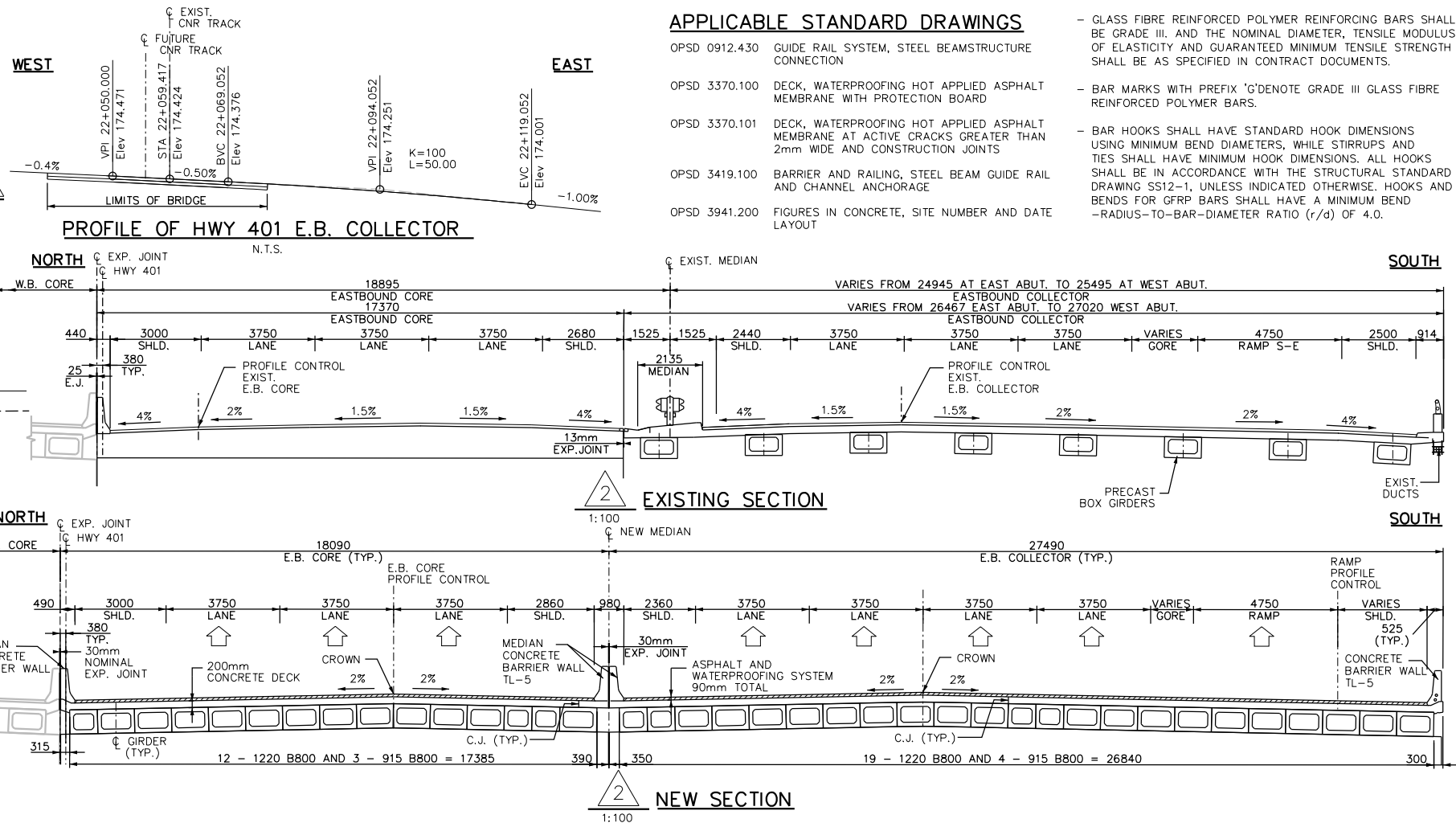
- R3-1. GENERAL ARRANGEMENT  
R3-2. GO TRANSIT/METROLINX GENERAL NOTES  
R3-3. BOREHOLE LOCATIONS  
R3-4. SOIL STRATA I  
R3-5. SOIL STRATA II  
R3-6. SOIL STRATA III  
R3-7. CONSTRUCTION STAGING I  
R3-8. CONSTRUCTION STAGING II  
R3-9. FOOTING LAYOUT AND DETAILS  
R3-10. ABUTMENT LAYOUT  
R3-11. ABUTMENT REINFORCEMENT  
R3-12. WINGWALL REINFORCEMENT  
R3-13. RETAINING WALL LAYOUT  
R3-14. GIRDER LAYOUT  
R3-15. PRESTRESSED BOX GIRDERS AND BEARINGS I  
R3-16. PRESTRESSED BOX GIRDERS AND BEARINGS II  
R3-17. PRESTRESSED BOX GIRDERS AND BEARINGS III  
R3-18. DECK DETAILS AND REINFORCEMENT I  
R3-19. DECK DETAILS AND REINFORCEMENT II  
R3-20. SOUTH BARRIER WALL WITHOUT RAILING TL-5  
R3-21. MEDIAN BARRIER WALL WITHOUT RAILING TL-5  
R3-22. MEDIAN BARRIER WALL WITHOUT RAILING ON RSS WALL TL-5  
R3-23. 6000mm APPROACH SLAB I  
R3-24. 6000mm APPROACH SLAB II  
R3-25. EXPANSION JOINT AND SLEEPER SLAB  
R3-26. SEQUENCE OF EXPANSION JOINT INSTALLATION  
R3-27. STRIP SEAL EXPANSION JOINT FOR SLEEPER SLAB  
R3-28. TRACK PROTECTION  
R3-29. STANDARD AND MISCELLANEOUS DETAILS

### LEGEND:

	REMOVAL
	NEW CONCRETE
	NEW ASPHALT

### APPLICABLE STANDARD DRAWINGS

- OPSD 0912.430 GUIDE RAIL SYSTEM, STEEL BEAMSTRUCTURE CONNECTION  
OPSD 3370.100 DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD  
OPSD 3370.101 DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE AT ACTIVE CRACKS GREATER THAN 2mm WIDE AND CONSTRUCTION JOINTS  
OPSD 3419.100 BARRIER AND RAILING, STEEL BEAM GUIDE RAIL AND CHANNEL ANCHORAGE  
OPSD 3941.200 FIGURES IN CONCRETE, SITE NUMBER AND DATE LAYOUT



**Ontario** **Ministry of Transportation**

**CONT WP**

CNR OVERHEAD  
E.B. CORE AND COLLECTORS  
GENERAL ARRANGEMENT

**SHEET S75**

### GENERAL NOTES:

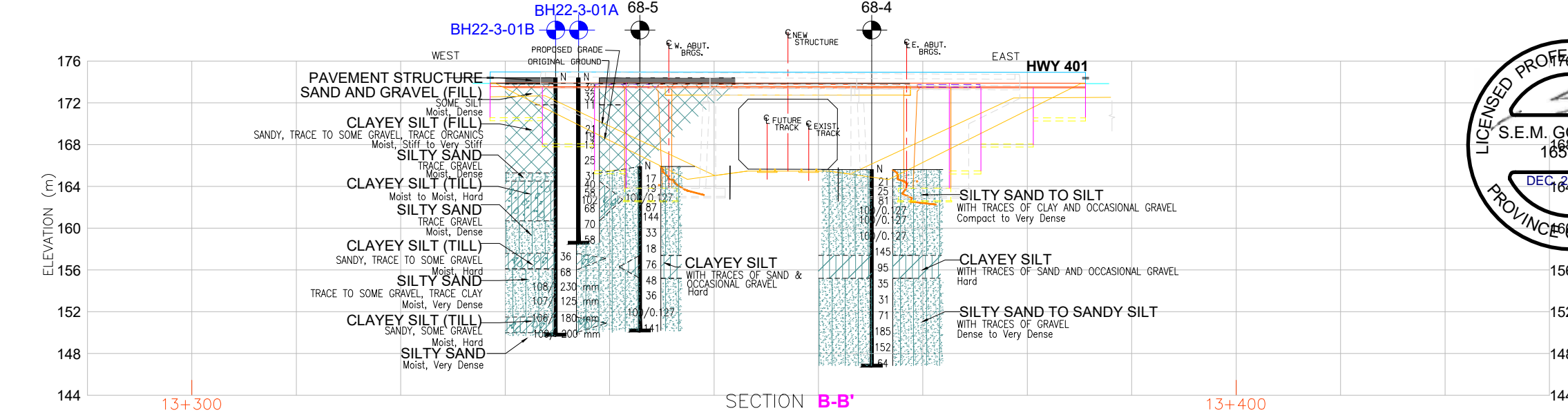
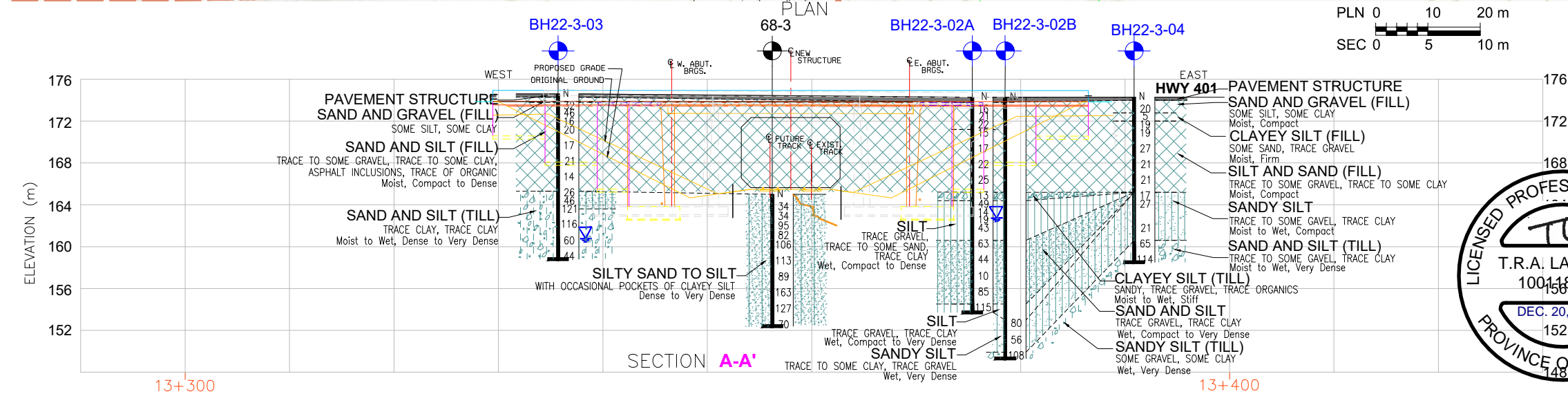
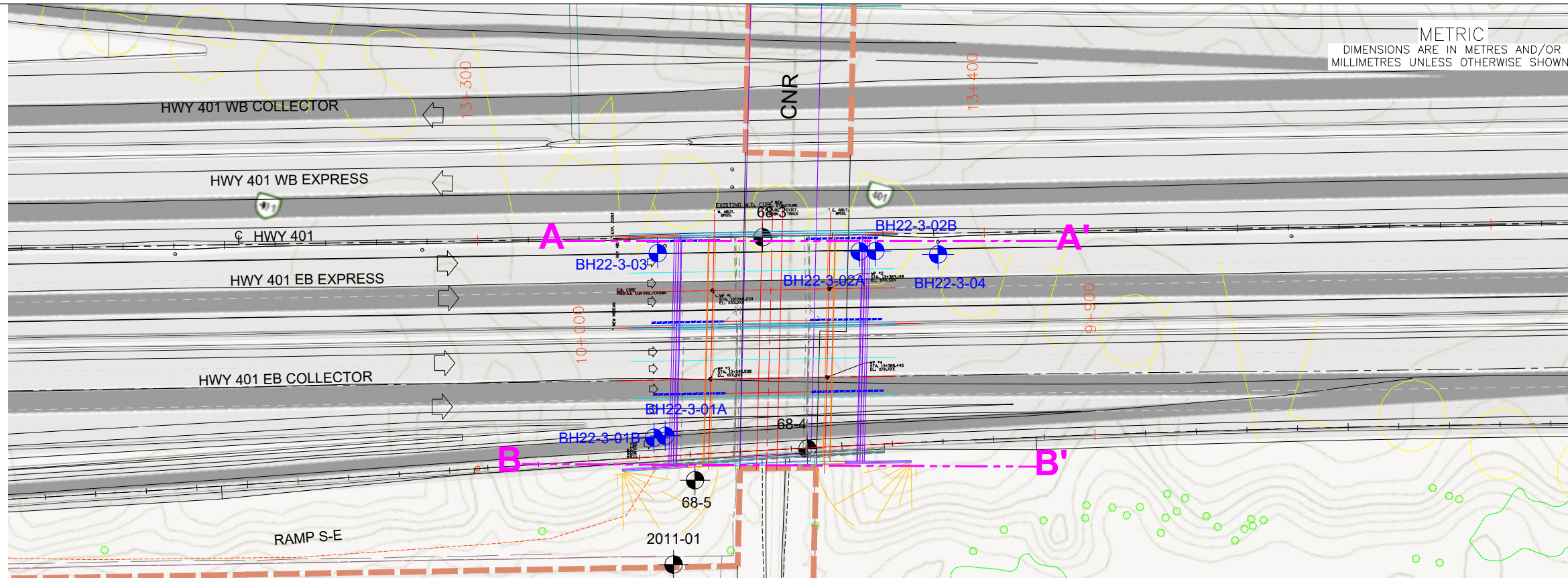
1. SPECIFIED 28-DAY COMPRESSIVE STRENGTH.....30 MPa UNLESS NOTED OTHERWISE.  
SPECIFIED 28-DAY COMPRESSIVE STRENGTH FOR PRECAST GIRDERS ARE GIVEN ON PRESTRESSED GIRDER DRAWINGS.
2. CLEAR COVER TO REINFORCING STEEL :  
FOOTING.....100 ± 25  
DECK-TOP.....70 ± 20  
DECK-BOTTOM.....40 ± 10  
REMAINDER.....70 ± 20 UNLESS OTHERWISE NOTED
3. REINFORCING STEEL:  
- REINFORCING STEEL SHALL BE GRADE 500W.  
- UNLESS SHOWN OTHERWISE, TENSION LAP SPLICES FOR REINFORCING STEEL BARS SHALL BE CLASS 'B'.  
- STAINLESS REINFORCING STEEL SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE A MINIMUM YIELD STRENGTH OF 500MPa, UNLESS OTHERWISE SPECIFIED.  
- BAR MARKS WITH PREFIX 'S' DENOTE STAINLESS STEEL BARS.  
- GLASS FIBRE REINFORCED POLYMER REINFORCING BARS SHALL BE GRADE III. AND THE NOMINAL DIAMETER, TENSILE MODULUS OF ELASTICITY AND GUARANTEED MINIMUM TENSILE STRENGTH SHALL BE AS SPECIFIED IN CONTRACT DOCUMENTS.  
- BAR MARKS WITH PREFIX 'G'DENOTE GRADE III GLASS FIBRE REINFORCED POLYMER BARS.  
- BAR HOOKS SHALL HAVE STANDARD HOOK DIMENSIONS USING MINIMUM BEND DIAMETERS, WHILE STIRRUPS AND TIES SHALL HAVE MINIMUM HOOK DIMENSIONS. ALL HOOKS SHALL BE IN ACCORDANCE WITH THE STRUCTURAL STANDARD DRAWING SS12-1, UNLESS INDICATED OTHERWISE. HOOKS AND BENDS FOR GFRP BARS SHALL HAVE A MINIMUM BEND -RADIUS-TO-BAR-DIAMETER RATIO (r/d) OF 4.0.

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	S.D.	CHK P.O.	CODE CAN/CSA 56-19
DRAWN	R.S.	CHK S.D.	SITE 37X-0215/B1&B3
LOAD	CL 625-ONT	DATE	OCT. 2024
DWG	R3-01		

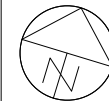
## Appendix C – Borehole Location Plan and Stratigraphic Profile



FILE NAME: I:\2003-Brampton\Proposals\Projects\International\Hwy 401 & Victoria Park Av. to Nelson\working drawings\Structure 3 - CN Rail Overpass\Structure 3 - CN Rail Overpass\_borehole location plan & soil strata.dwg  
MODIFIED: 2024-11-13 14:46



CONT No.  
ASSIG No. 2021-E-0018  
GWP No.  
Full Structure Replacement and Bridge Widening at CN  
Rail Overpass Eastbound Core and Collectors Structure  
Latitude: 43.775934°, Longitude: -79.279597°  
BOREHOLE LOCATION PLAN & SOIL STRATA

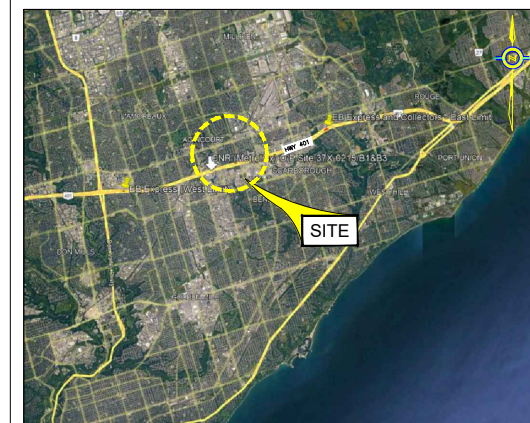


SHEET

1



EXP SERVICES INC.



KEY PLAN  
N.T.S.

LEGEND

- Borehole Location
- Water Level Upon Completion of Drilling  
( W. L. NOT STABILIZED )
- N Blows/0.3m (Std. Pen. Test, 475 J/blow)

SOIL STRATA SYMBOLS

PAVEMENT STRUCTURE	SILT AND SAND	CLAY
FILL	SANDY SILT	CLAYEY SILT
SILT	SILTY SAND	SILTY CLAY
SAND	SANDY SILT (TILL)	CLAYEY SILT (TILL)

BOREHOLE CO-ORDINATES/ NAD 83/ MTM ON-10

BH No.	ELEV.	NORTHING	EASTING
BH22-3-01A	174.4	4848438	322529
BH22-3-01B	174.4	4848437	322527
BH22-3-02A	174.3	4848484	322555
BH22-3-02B	174.3	4848485	322558
BH22-3-03	174.6	4848472	322517
BH22-3-04	174.3	4848488	322570
68-3	165.0	4848481	322536
68-4	165.6	4848444	322557
68-5	165.9	4848431	322537
2011-01	166.3	4848414	322538

NOTES

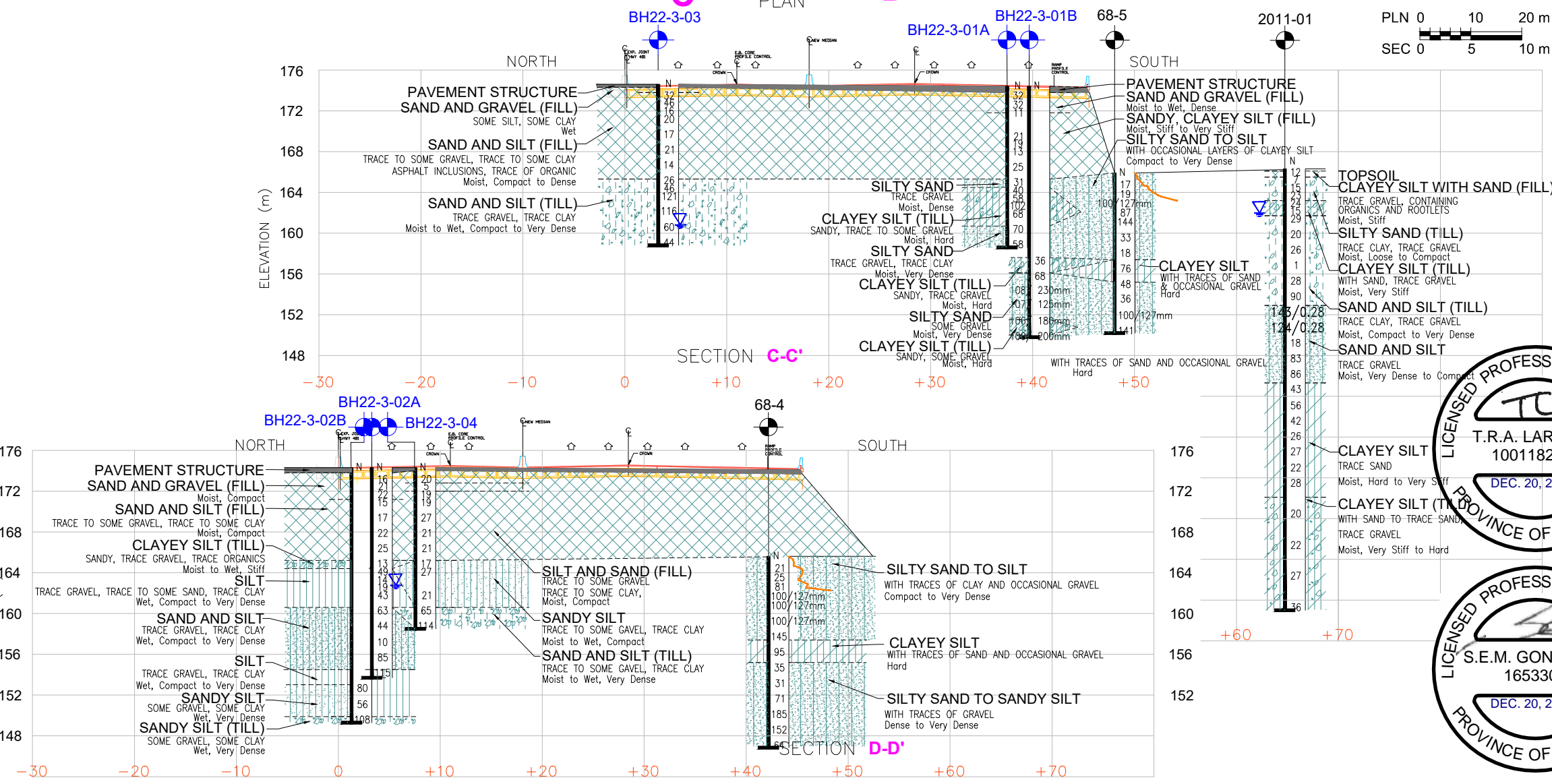
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the contracts Documents.


The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

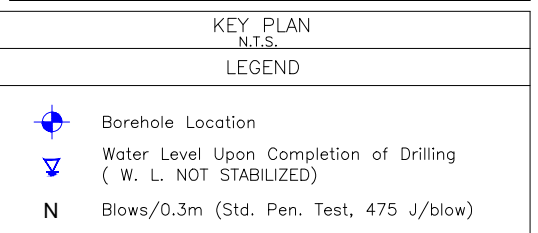
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in the report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of O.P.S. Gen. Cond.

SUBMISSION FOR MTO REVIEW			
NO	DATE	BY	DESCRIPTION
PROJECT No.	ADM-22000797-A0	GEOCREs No.	30M14-551
SUBM'D SH	CHKD. SA	DATE	NOV. 14, 2024
DRAWN SH	CHKD. TC	APPRD SG	SITE 37X-0215/B1 & B3
		DWG	01





CONT No. ASSIG No. 2021-E-0018 GWP No.	
Full Structure Replacement and Bridge Widening at CN Rail Overpass Eastbound Core and Collectors Structure <i>Latitude: 43.775934°, Longitude: -79.279597°</i>	SHEET
BOREHOLE LOCATION PLAN & SOIL STRATA	2



BOREHOLE CO-ORDINATES/ NAD 83/ MTM ON-10			
BH No.	ELEV.	NORTHING	EASTING
BH22-3-01A	174.4	4848438	322529
BH22-3-01B	174.4	4848437	322527
BH22-3-02A	174.3	4848484	322555
BH22-3-02B	174.3	4848485	322558
BH22-3-03	174.6	4848472	322517
BH22-3-04	174.3	4848488	322570
68-3	165.0	4848481	322536
68-4	165.6	4848444	322557
68-5	165.9	4848431	322537
2011-01	166.3	4848414	322538

**NOTES**

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downview, information contained in the report and related documents are specifically excluded in accordance with the conditions of Publication GC 2.01 of OPS Gen. Cond.

SUBMISSION FOR MTO REVIEW			
NO	DATE	BY	DESCRIPTION
PROJECT No.	ADM-22000797-A0		GEOCRESS No. 30M14-551
BM'D SH	CHKD. SA		DATE FEB. 19, 2024 SITE 37X-0215/B1 & B3
AWN SH	CHKD. TC		APPRD SG DWG 02

## Appendix D – Borehole Logs

# Explanation of Terms Used on Borehole Records

## SOIL DESCRIPTION

Terminology describing common soil genesis:

*Topsoil:* mixture of soil and humus capable of supporting good vegetative growth.

*Peat:* fibrous fragments of visible and invisible decayed organic matter.

*Fill:* where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc.; none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

*Till:* the term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Terminology describing soil structure:

*Desiccated:* having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.

*Stratified:* alternating layers of varying material or color with the layers greater than 6 mm thick.

*Laminated:* alternating layers of varying material or color with the layers less than 6 mm thick.

*Fissured:* material breaks along plane of fracture.

*Varved:* composed of regular alternating layers of silt and clay.

*Slickensided:* fracture planes appear polished or glossy, sometimes striated.

*Blocky:* cohesive soil that can be broken down into small angular lumps which resist further breakdown.



*Lensed:* inclusion of small pockets of different soil, such as small lenses of sand scattered through a mass of clay; not thickness.

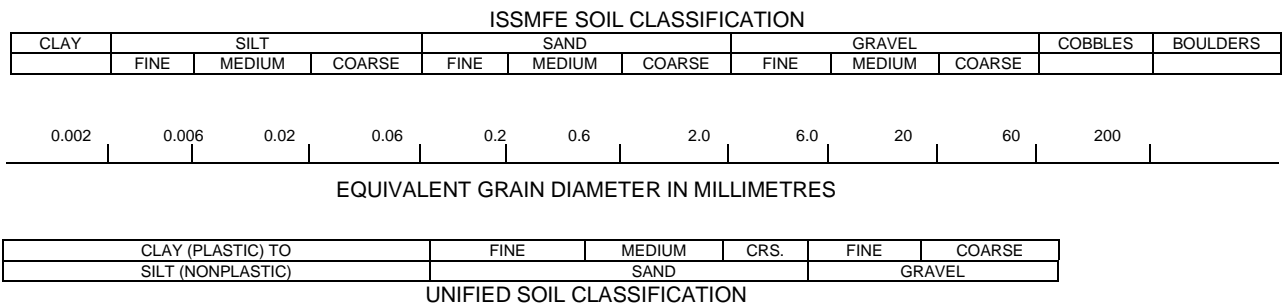
*Seam:* a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

*Homogeneous:* same color and appearance throughout.

*Well Graded:* having wide range in grain sized and substantial amounts of all predominantly on grain size.

*Uniformly Graded:* predominantly on grain size.

All soil sample descriptions included in this report follow generally the ASTM D2487-11 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) with some modification to reflect current MTO practices. The system divides soils into three major categories: (1) coarse grained, (2) fine-grained, and (3) highly organic. The soil is then subdivided based on either gradation or plasticity characteristics. The system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification. The classification excludes particles larger than 76 mm. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually in accordance with ASTM D2488-09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems. Others may use different classification systems; one such system is the ISSMFE Soil Classification.



Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present and as described below in accordance with Canadian Foundation Engineering Manual (CFEM):

Table a: Percent or Proportion of Soil

Term	Description	Criteria
"trace"	trace gravel, trace sand, etc.	1% - 10%
"some"	some gravel, some sand, etc.	10% - 20%
Adjective	gravelly, sandy, silty and clayey	20% - 35%
"and"	and gravel, and sand, etc.	>35%
Noun	gravel, sand, silt, clay	>35% and main fraction

The standard terminology to describe cohesionless soils includes the compactness as determined by the Standard Penetration Test 'N' value:

Table b: Apparent Density of Cohesionless Soil

	'N' Value (blows/0.3 m)
Very Loose	N<5
Loose	5≤N<10
Compact	10≤N<30
Dense	30≤N<50
Very Dense	50≤N

The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests or similar field and laboratory analysis, Standard Penetration Test 'N' values can also be used to provide an approximate indication of the consistency and shear strength of fine grained, cohesive soils:

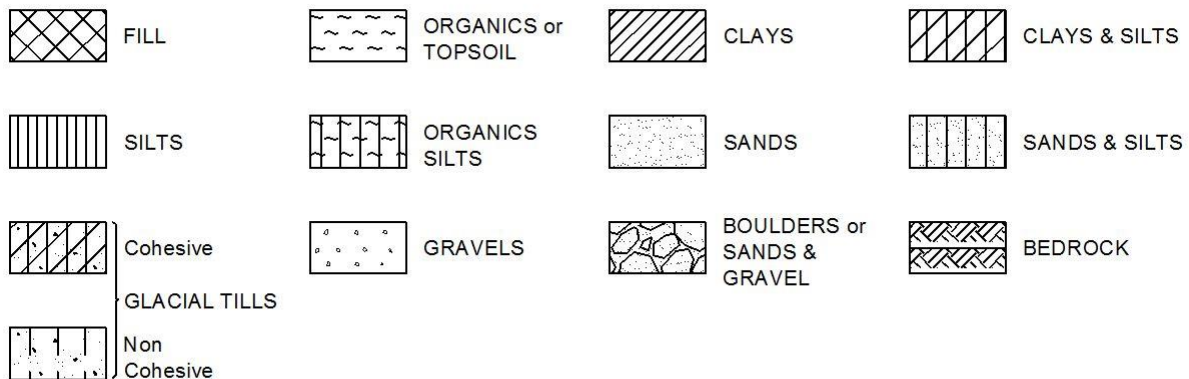
Table c: Consistency of Cohesive Soil

Consistency	Vane Shear Measurement (kPa)	'N' Value
Very Soft	<12.5	<2
Soft	12.5-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

Note: 'N' Value - The Standard Penetration Test records the number of blows of a 140 pound (64kg) hammer falling 30 inches (760mm), required to drive a 2 inch (50.8mm) O.D. split spoon sampler 1 foot (305mm). For split spoon samples where full penetration is not achieved, the number of blows is reported over the sampler penetration in meters (e.g. 50/0.15).

## STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



## WATER LEVEL MEASUREMENT



Open Borehole or Test Pit



Monitoring Well, Piezometer or Standpipe

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

SS	Split spoon sample (obtained from the Standard Penetration Test)
WS	Wash sample
BS	Bulk sample
TW	Thin wall sample or Shelby tube
PS	Piston sample
AS	Auger sample
VT	Vane test
GS	Grab sample
HQ, NQ, etc.	Rock core samples obtained with the use of standard size diamond drilling bits

### STRESS AND STRAIN

$u_w$	kPa	Pore water pressure
$r_u$	1	Pore pressure ratio
$\sigma$	kPa	Total normal stress
$\sigma'$	kPa	Effective normal stress
$\tau$	kPa	Shear stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal stresses
$\varepsilon$	%	Linear strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	Principal strains
E	kPa	Modulus of linear deformation
G	kPa	Modulus of shear deformation
$\mu$	1	Coefficient of friction

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	Coefficient of volume change
$c_c$	1	Compression index
$c_s$	1	Swelling index
$c_r$	1	Recompression index
$c_v$	m <sup>2</sup> /s	Coefficient of consolidation
H	m	Drainage path
$T_v$	1	Time factor
U	%	Degree of consolidation
$\sigma'_{v0}$	kPa	Effective overburden pressure
$\sigma'_p$	kPa	Preconsolidation pressure
$\tau_f$	kPa	Shear strength
$c'$	kPa	Effective cohesion intercept
$\phi'$	—°	Effective angle of internal friction
$c_u$	kPa	Apparent cohesion intercept
$\phi_u$	—°	Apparent angle of internal friction
$\tau_R$	kPa	Residual shear strength
$\tau_r$	kPa	Remoulded shear strength
$S_t$	1	Sensitivity = $c_u/\tau_r$

### PHYSICAL PROPERTIES OF SOIL

$P_s$	kg/m <sup>3</sup>	Density of solid particles
$\gamma_s$	kN/m <sup>3</sup>	Unit weight of solid particles
$\rho_w$	kg/m <sup>3</sup>	Density of water
$\gamma_w$	kN/m <sup>3</sup>	Unit weight of water
$\rho$	kg/m <sup>3</sup>	Density of soil
$\gamma$	kN/m <sup>3</sup>	Unit weight of soil
$\rho_d$	kg/m <sup>3</sup>	Density of dry soil
$\gamma_d$	kN/m <sup>3</sup>	Unit weight of dry soil
$\rho_{sat}$	kg/m <sup>3</sup>	Density of saturated soil
$\gamma_{sat}$	kN/m <sup>3</sup>	Unit weight of saturated soil
$\rho'$	kg/m <sup>3</sup>	Density of submerged soil
$\gamma'$	kN/m <sup>3</sup>	Unit weight of submerged soil
$e$	1, %	Void ratio
$n$	1, %	Porosity
$w$	1, %	Water content
$S_r$	%	Degree of saturation
$W_L$	%	Liquid limit
$W_P$	%	Plastic limit
$W_s$	%	Shrinkage limit
$I_p$	%	Plasticity index = $(W_L - W_P)$
$I_L$	%	Liquidity index = $(W - W_P)/I_p$
$I_C$	%	Consistency index = $(W_L - W)/I_p$
$e_{max}$	1, %	Void ratio in loosest state
$e_{min}$	1, %	Void ratio in densest state
$I_D$	1	Density index = $(e_{max} - e)/(e_{max} - e_{min})$
D	mm	Grain diameter
$D_n$	mm	N percent - diameter
$C_u$	1	Uniformity coefficient
h	m	Hydraulic head or potential
q	m <sup>3</sup> /s	Rate of discharge
v	m/s	Discharge velocity
i	1	Hydraulic gradient
k	m/s	Hydraulic conductivity
j	kN/m <sup>3</sup>	Seepage force

Brampton, Ontario

# RECORD OF BOREHOLE No BH22-3-01A

1 OF 1

METRIC

W.P. Site 37X-0215/B1&B3 LOCATION Hwy 401 - CNR (Metrolinx) O/P, Toronto, ON, MTM ON-10 322529E 4848438N ORIGINATED BY OD  
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY OD  
 DATUM Geodetic DATE 2022.09.29 - 2022.09.29 LATITUDE 43.77569 LONGITUDE -79.279763 CHECKED BY SM/TL

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL P. PENETROMETER									
174.4								20	40	60	80	100					
0.0	PAVEMENT STRUCTURE - 150 mm of asphalt, 250 mm of concrete, and 210 mm of gravel						174										
173.8																	
0.6	SAND AND GRAVEL (FILL) - some silt, greyish brown, moist, dense		SS1	SS	32		173							○			43 44 (13)
	- Switch to mud rotary below 1.5 m		SS2	SS	32									○			
	- Becomes slightly moist to moist from 1.5 m to 2.6 m																
171.8			SS3	SS	11		172							○			
2.6	CLAYEY SILT (FILL) - sandy, trace gravel, grey, slightly moist, stiff to very stiff						171										
							170										
			SS4	SS	21									○			
	- Trace organics/rootlets below 5.3 m		SS5	SS	19		169							○			3 27 38 32
	- Some gravel and trace organics between 6.1 m and 6.7 m.		SS6	SS	13		168							○			
							167										
	- No gravel between 7.6 m and 9.1 m		SS7	SS	25		166							○			
							165										
165.3																	
9.1	SILTY SAND - trace gravel, grey, slightly moist, dense		SS8	SS	31		165							○			
164.5																	
9.9	CLAYEY SILT (TILL) - sandy, trace to some gravel, light brown to grey, slightly moist to moist, hard		SS9	SS	40		164							○		23.6	2 43 41 14
			SS10	SS	58									○			
			SS11	SS	102		163							○			
			SS12	SS	68		162							○			
							161									22.1	
160.7							160							○			0 71 28 1
13.7	SILTY SAND - trace gravel, trace clay, grey, slightly moist, very dense		SS13	SS	70												
							159										
	- becoming wet below 15.2 m		SS14	SS	58									○			
158.6																	
15.8	END OF BOREHOLE																
	NOTES: 1) Borehole terminated at 15.8 m due to collapsing of the open hole. 2) No groundwater was encountered in open borehole upon completion of drilling. 3) A companion borehole (BH22-3-1B) was drilled 3 m west with mud rotary.																

+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO H401 - CNR OVERPASS-12122022.GPJ ONTARIO MTO.GDT 2/24/23



METRIC

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

ONTARIO MTO H401 - CNR OVERPASS-12122022.GPJ ONTARIO MTO.GDT 2/24/23

Brampton, Ontario

## 2 OF 2

METRIC

W.P.	<u>Site 37X-0215/B1&amp;B3</u>	LOCATION	<u>Hwy 401 - CNR (Metrolinx) O/P, Toronto, ON, MTM ON-10 322527E 4848437N</u>			ORIGINATED BY	<u>OD</u>
DIST	<u>Toronto</u>	HWY	<u>401</u>	BOREHOLE TYPE	<u>Truck Mount CME 75 / SSA</u>	COMPILED BY	<u>OD</u>
DATUM	<u>Geodetic</u>	DATE	<u>2022.10.02 - 2022.10.02</u>	LATITUDE	<u>43.775683</u>	LONGITUDE	<u>-79.279792</u>
				CHECKED BY	<u>SM/TL</u>		

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								WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL P. PENETROMETER								
							20	40	60	80	100					
151.5	SILTY SAND - some gravel, grey, moist, very dense <i>(continued)</i>		SS17	SS	230 mm											
			SS18	SS	107/ 125 mm											
22.9	CLAYEY SILT (TILL) - sandy, some gravel, grey, slightly moist, hard		SS19	SS	106/ 180 mm											
150.0	SILTY SAND - grey, slightly moist, very dense END OF BOREHOLE		SS20	SS	100/ 200 mm											
24.6																
NOTES: 1) Borehole charged with drilling mud and water to advance borehole thus groundwater level could not be established during short period of time upon completion of drilling.																

ONTARIO MTO H401 - CNR OVERPASS-12122022.GPJ ONTARIO MTO.GDT 2/24/23

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE






Brampton, Ontario

## RECORD OF BOREHOLE No BH22-3-02A

1 OF 2

METRIC

W.P. Site 37X-0215/B1&B3 LOCATION Hwy 401 - CNR (Metrolinx) O/P, Toronto, ON, MTM ON-10 322555E 484848N ORIGINATED BY OD  
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY OD  
 DATUM Geodetic DATE 2022.09.20 - 2022.09.28 LATITUDE 43.776104 LONGITUDE -79.279439 CHECKED BY SM/TL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT   NATURAL MOISTURE   LIQUID CONTENT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			W <sub>P</sub> W                      W <sub>L</sub>				WATER CONTENT (%)	GR	SA	SI	CL
								20   40   60   80   100			20   40   60								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL & P. PENETROMETER											
174.3																			
0.0	PAVEMENT STRUCTURE - 100 mm of asphalt and 350 mm of concrete  SAND AND GRAVEL (FILL) - brown, moist, compact		AS1	AS															
173.8			SS2	SS	16														
0.5			SS3	SS	21														
			SS4	SS	22														
171.2	SAND AND SILT (FILL) - trace to some gravel, trace to some clay, greyish brown to brown, moist, compact		SS5	SS	15														
3.1			SS6	SS	17														
			SS7	SS	22														
			SS8	SS	25														
165.2	CLAYEY SILT (TILL) - sandy, trace gravel, trace organics, brownish grey to grey, moist to wet, stiff		SS9	SS	13														
9.1																			
164.4																			
9.9			SILT - trace to some sand, trace gravel, trace clay, grey, wet, compact to dense	SS10	SS	49													
	SS11	SS		14															
	SS12	SS		19															
	SS13	SS		43															
160.6	SAND AND SILT - trace gravel, trace clay, grey, wet, compact to very dense		SS14	SS	63														
13.7																			
			SS15	SS	44														
			SS16	SS	10														
	- Mud rotary from 19.8 m to 20.6 m.		SS17	SS	85														
154.5																			

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO H401 - CNR OVERPASS-12122022.GPJ ONTARIO MTO.GDT 2/24/23

Brampton, Ontario

# RECORD OF BOREHOLE No BH22-3-02A

2 OF 2

METRIC

W.P. Site 37X-0215/B1&B3 LOCATION Hwy 401 - CNR (Metrolinx) O/P, Toronto, ON, MTM ON-10 322555E 484848N ORIGINATED BY OD  
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY OD  
 DATUM Geodetic DATE 2022.09.20 - 2022.09.28 LATITUDE 43.776104 LONGITUDE -79.279439 CHECKED BY SM/TL

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
19.8	SILT - trace gravel, trace clay, grey, wet, compact to very dense (continued)  END OF BOREHOLE  NOTES: 1) No penetration below 20.6 m depth, possible boulder or cobbles. 2) Groundwater level measured at 11.5 m below the ground surface upon completion of drilling. 3) A companion borehole (BH22-3-2B) was drilled 3 m east with mud rotary.		SS18	SS	115		154	20	40	60	80	100	20	40	60	kN/m <sup>3</sup>	GR SA SI CL 0 6 87 7	
153.7																		
20.6																		

Brampton, Ontario

# RECORD OF BOREHOLE No BH22-3-02B

1 OF 2

METRIC

W.P. Site 37X-0215/B1&B3 LOCATION Hwy 401 - CNR (Metrolinx) O/P, Toronto, ON, MTM ON-10 322555E 484848N ORIGINATED BY OD  
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY OD  
 DATUM Geodetic DATE 2022.10.17 - 2022.10.17 LATITUDE 43.776111 LONGITUDE -79.2794 CHECKED BY SM/TL

SOIL PROFILE					SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  <b>γ</b>  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>				
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL & P. PENETROMETER										
174.3							20	40	60	80	100	20	40	60		
0.0	- Continuation of BH 22-3-2A - Mud rotary to depth 21.3 m															

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO H401 - CNR OVERPASS-12122022.GPJ ONTARIO MTO.GDT 2/24/23

Brampton, Ontario

# RECORD OF BOREHOLE No BH22-3-02B

2 OF 2

METRIC

W.P. Site 37X-0215/B1&B3 LOCATION Hwy 401 - CNR (Metrolinx) O/P, Toronto, ON, MTM ON-10 322555E 484848N ORIGINATED BY OD  
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY OD  
 DATUM Geodetic DATE 2022.10.17 - 2022.10.17 LATITUDE 43.776111 LONGITUDE -79.2794 CHECKED BY SM/TL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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 (%)				
								20 40 60 80 100			w <sub>p</sub> w w <sub>L</sub>				
							○ UNCONFINED + FIELD VANE								
							● QUICK TRIAXIAL P. PENETROMETER								
							20 40 60 80 100			20 40 60					
153.0	- Continuation of BH 22-3-2A - Mud rotary to depth 21.3 m <i>(continued)</i>						154								
21.3	<b>SANDY SILT</b> - trace to some clay, trace gravel, grey, wet, very dense		SS19	SS	80		153								1 22 74 3
							152								
			SS20	SS	56		151								
149.9							150								
24.4	<b>SANDY SILT (TILL)</b> - some gravel, some clay, grey, wet, very dense		SS21	SS	108										
149.3															
25.0	<b>END OF BOREHOLE</b>  NOTES: 1) Borehole charged with drilling mud and water to advance borehole thus groundwater level could not be established during short period of time upon completion of drilling.														

Brampton, Ontario

## RECORD OF BOREHOLE No BH22-3-03

1 OF 1

METRIC

W.P. Site 37X-0215/B1&B3 LOCATION Hwy 401 - CNR (Metrolinx) O/P, Toronto, ON, MTM ON-10 322517E 4848472N ORIGINATED BY OD  
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY OD  
 DATUM Geodetic DATE 2022.09.25 - 2022.09.25 LATITUDE 43.775997 LONGITUDE -79.279911 CHECKED BY SM/TL

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL P. PENETROMETER								WATER CONTENT (%)		
174.6								20	40	60	80	100						
174.9	<b>PAVEMENT STRUCTURE</b> - 100 mm of asphalt and 200 mm of concrete  <b>SAND AND GRAVEL (FILL)</b> - some silt, some clay, greyish brown, wet  <b>SAND AND SILT (FILL)</b> - trace to some gravel, trace to some clay, grey to light brown, slightly moist, compact to dense - Sand lense with some gravel encountered between 1.8 m and 2.3 m  - Asphalt inclusions encountered between 4.6 m and 5.2 m        - Trace of organics encountered bewtten 7.6 m and 8.2 m		AS1	AS			174							○				
0.3			SS2	SS	32		173							○				
173.8			SS3	SS	46		172							○				
0.8			SS4	SS	16		171							○				
			SS5	SS	20		170							○				
							169											
			SS6	SS	17		168							○				
			SS7	SS	21		167							○				
							166											
			SS8	SS	14		165							○				
165.3	<b>SAND AND SILT (TILL)</b> - trace gravel, trace clay, grey, slightly moist to wet, compact to very dense		SS9	SS	26		164							○				
9.3			SS10	SS	46		163							○				
			SS11	SS	121		162							○				
							161											
			SS12	SS	116		160							○				
							159											
			SS13	SS	60										○			
			SS14	SS	44										○			
158.8		<b>END OF BOREHOLE</b>																
15.8	NOTES: 1) Groundwater level measured at 13.8 m below the ground surface upon completion of drilling.																	

ONTARIO MTO H401 - CNR OVERPASS-12122022.GPJ ONTARIO MTO.GDT 2/24/23

Brampton, Ontario

# RECORD OF BOREHOLE No BH22-3-04

1 OF 1

METRIC

W.P. Site 37X-0215/B1&B3 LOCATION Hwy 401 - CNR (Metrolinx) O/P, Toronto, ON, MTM ON-10 322570E 4848488N ORIGINATED BY OD  
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY OD  
 DATUM Geodetic DATE 2022.09.22 - 2022.09.22 LATITUDE 43.776139 LONGITUDE -79.279253 CHECKED BY SM/TL

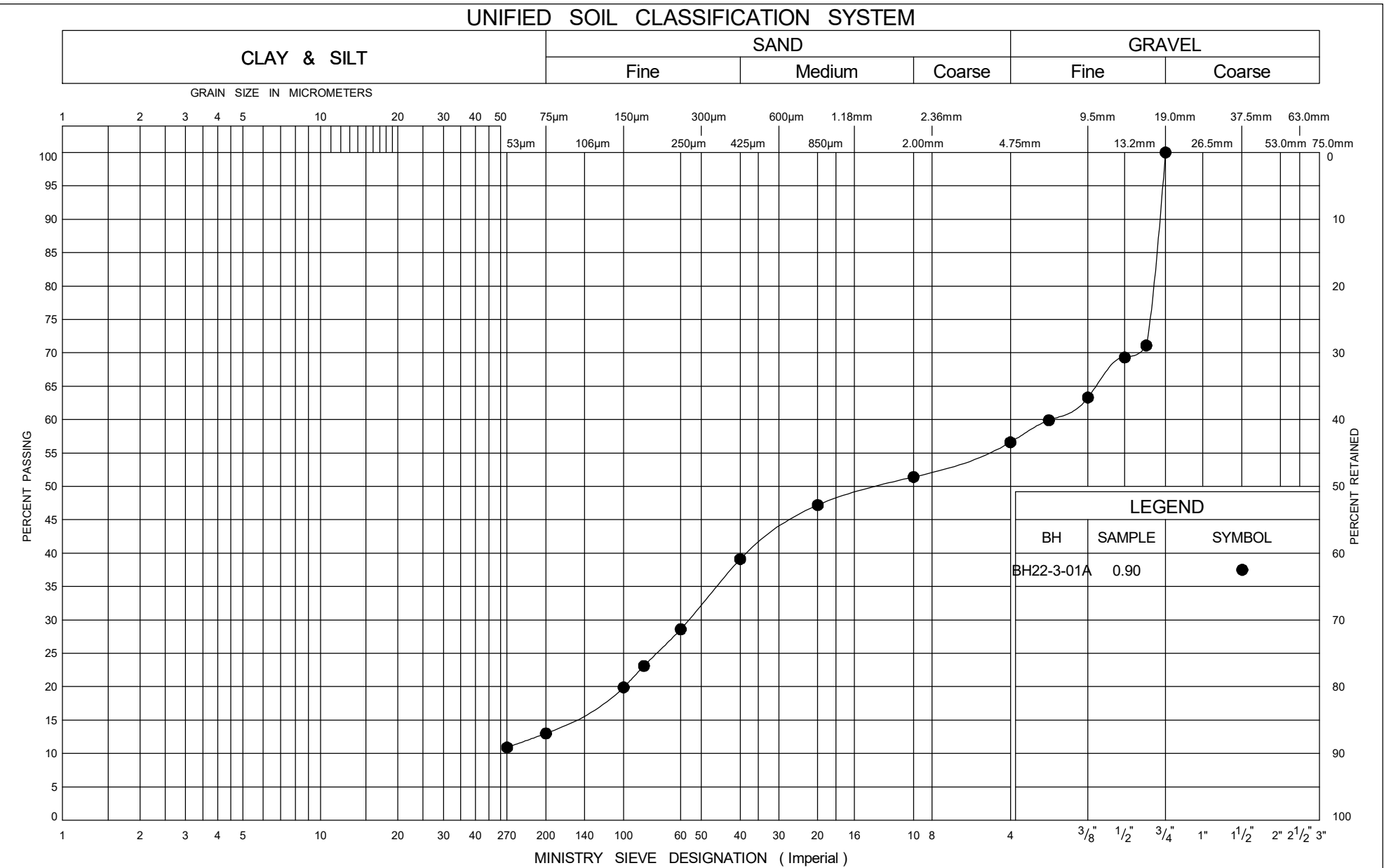
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL P. PENETROMETER								WATER CONTENT (%)		
174.3								20	40	60	80	100						
174.0	PAVEMENT STRUCTURE - 90 mm of asphalt and 210 mm of concrete		AS1	AS			174											
0.3																		
172.8	SAND AND GRAVEL (FILL) - some silt, some clay, brown, moist, compact		SS2	SS	20		173											
1.5	CLAYEY SILT (FILL) - some sand, trace gravel, brown to grey, moist, firm		SS3	SS	5		172											
172.0	SILT AND SAND (FILL) - trace to some gravel, trace to some clay, grey to light brown, slightly moist, compact		SS4	SS	19		171											
2.3																		
					SS5	SS	19		170									
					SS6	SS	27		169									
			SS7	SS	21		168											
			SS8	SS	21		167											
							166											
165.2	SANDY SILT - trace to some gravel, trace clay, grey, moist to wet, compact		SS9	SS	17		165											
9.1																		
					SS10	SS	27		164									
							163											
			SS11	SS	21		162											
160.6	SAND AND SILT (TILL) - trace to some gravel, trace clay, grey, moist to wet, very dense		SS12	SS	65		161											
13.7																		
							160											
			SS13	SS	114		159											
158.5	END OF BOREHOLE																	
15.8																		
	NOTES: 1) No groundwater was encountered in open borehole upon completion of drilling.																	

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

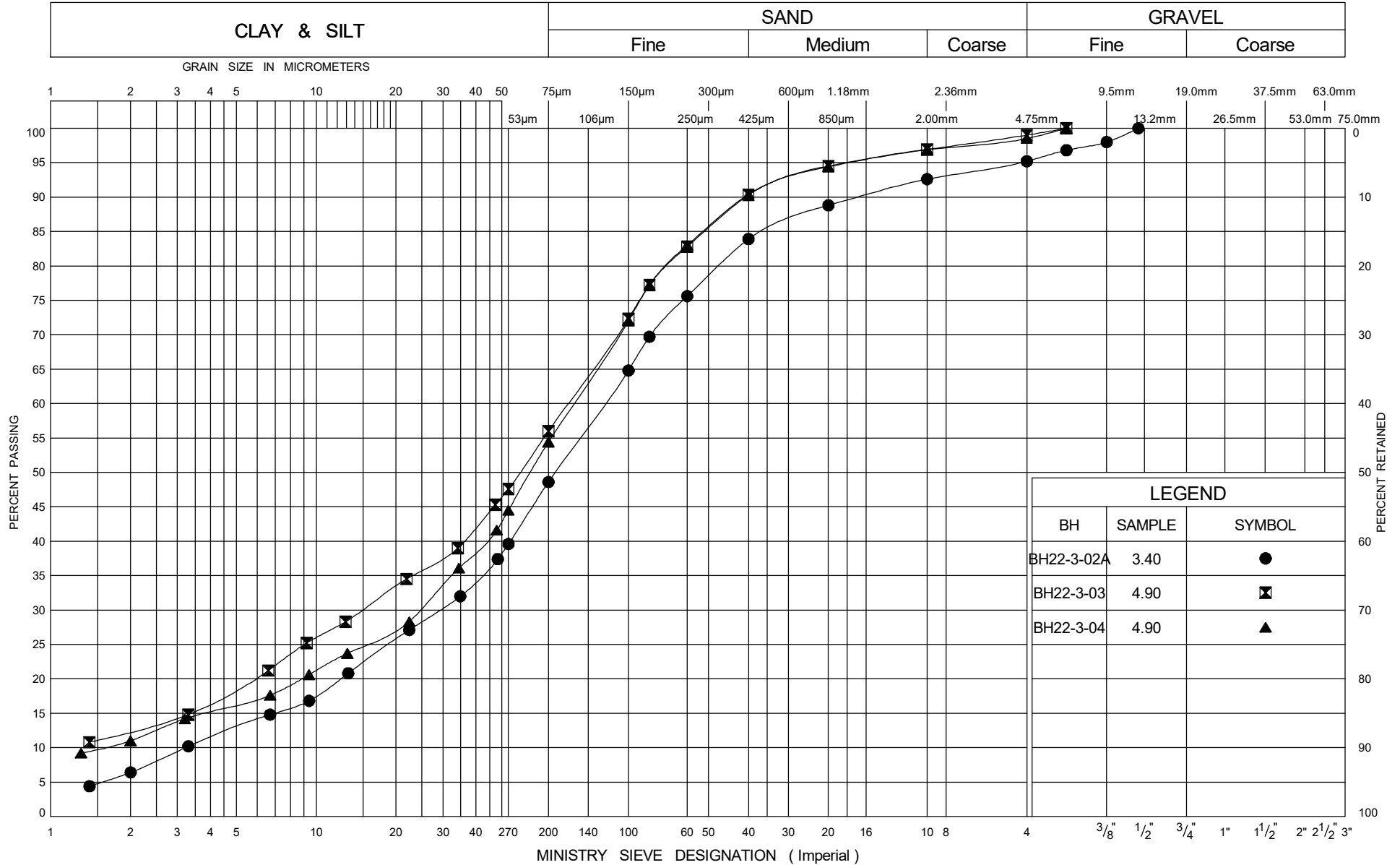
ONTARIO MTO H401 - CNR OVERPASS-12122022.GPJ ONTARIO MTO.GDT 2/24/23



## Appendix E – Laboratory Data



# UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

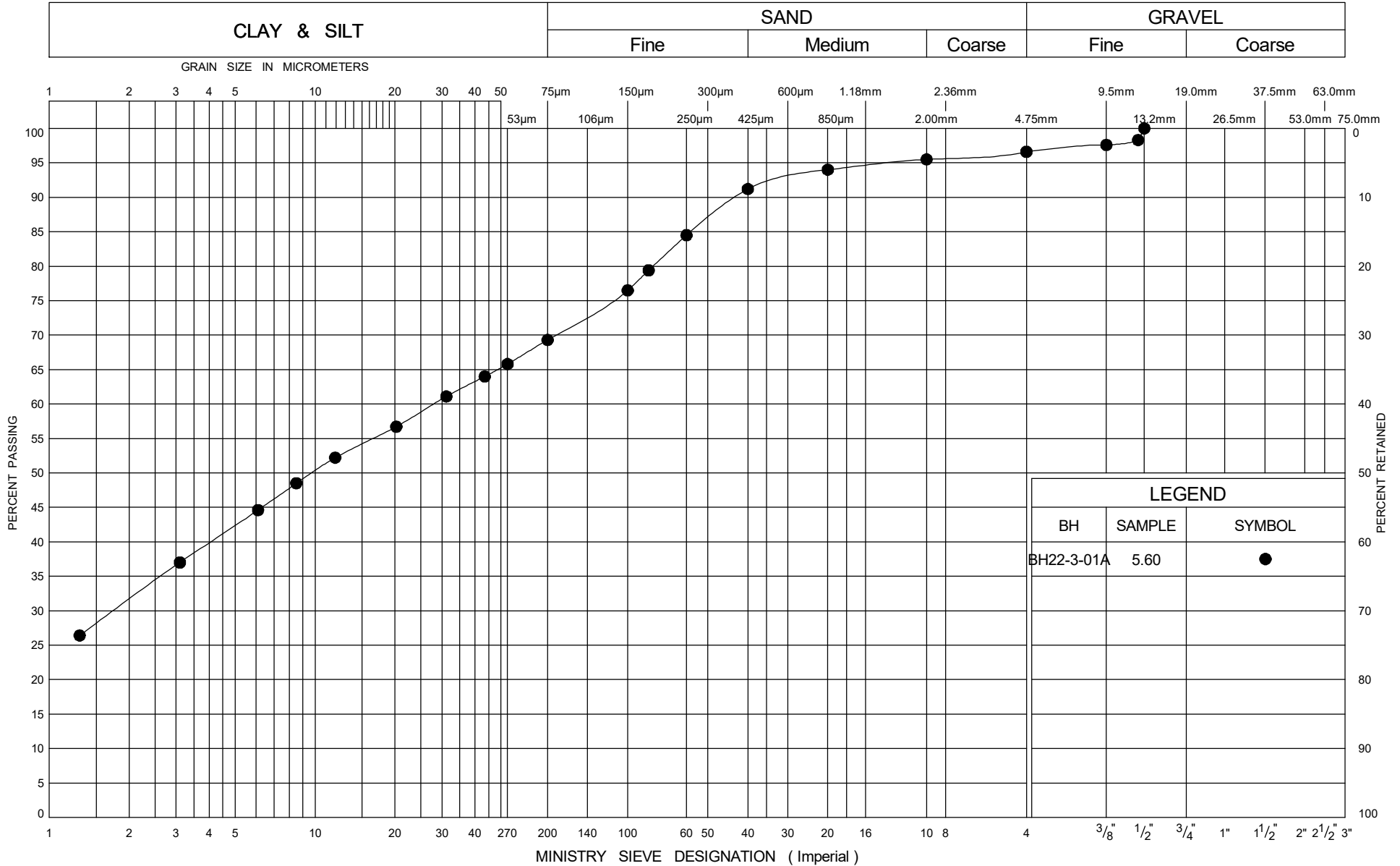
Sand and Silt (FILL)

FIG No 2

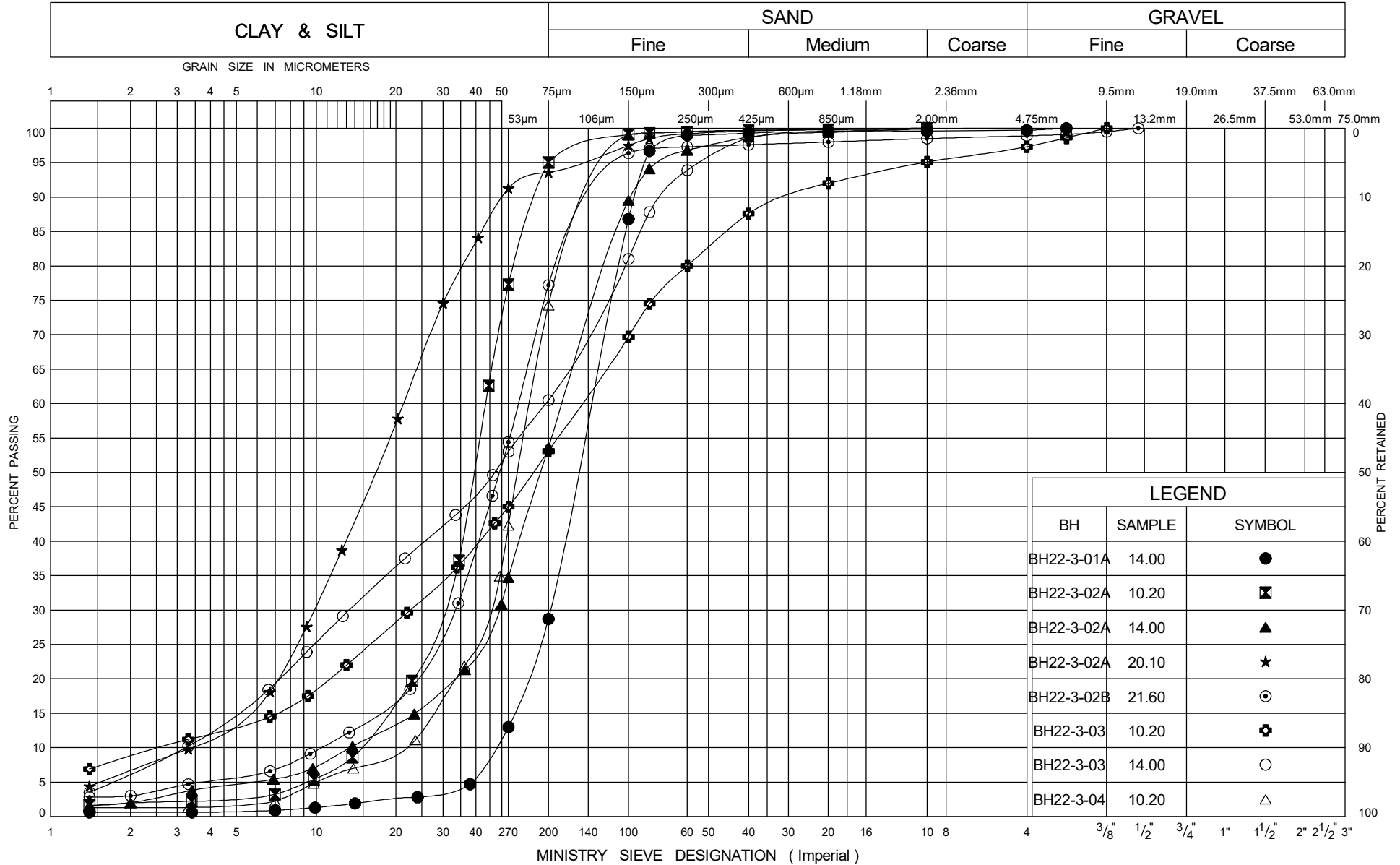
CN Rail Overpass Replacement  
(Site 37X-0215/B1 & B3)

Hwy 401 Eastbound Express and  
Collector Lanes

# UNIFIED SOIL CLASSIFICATION SYSTEM



# UNIFIED SOIL CLASSIFICATION SYSTEM



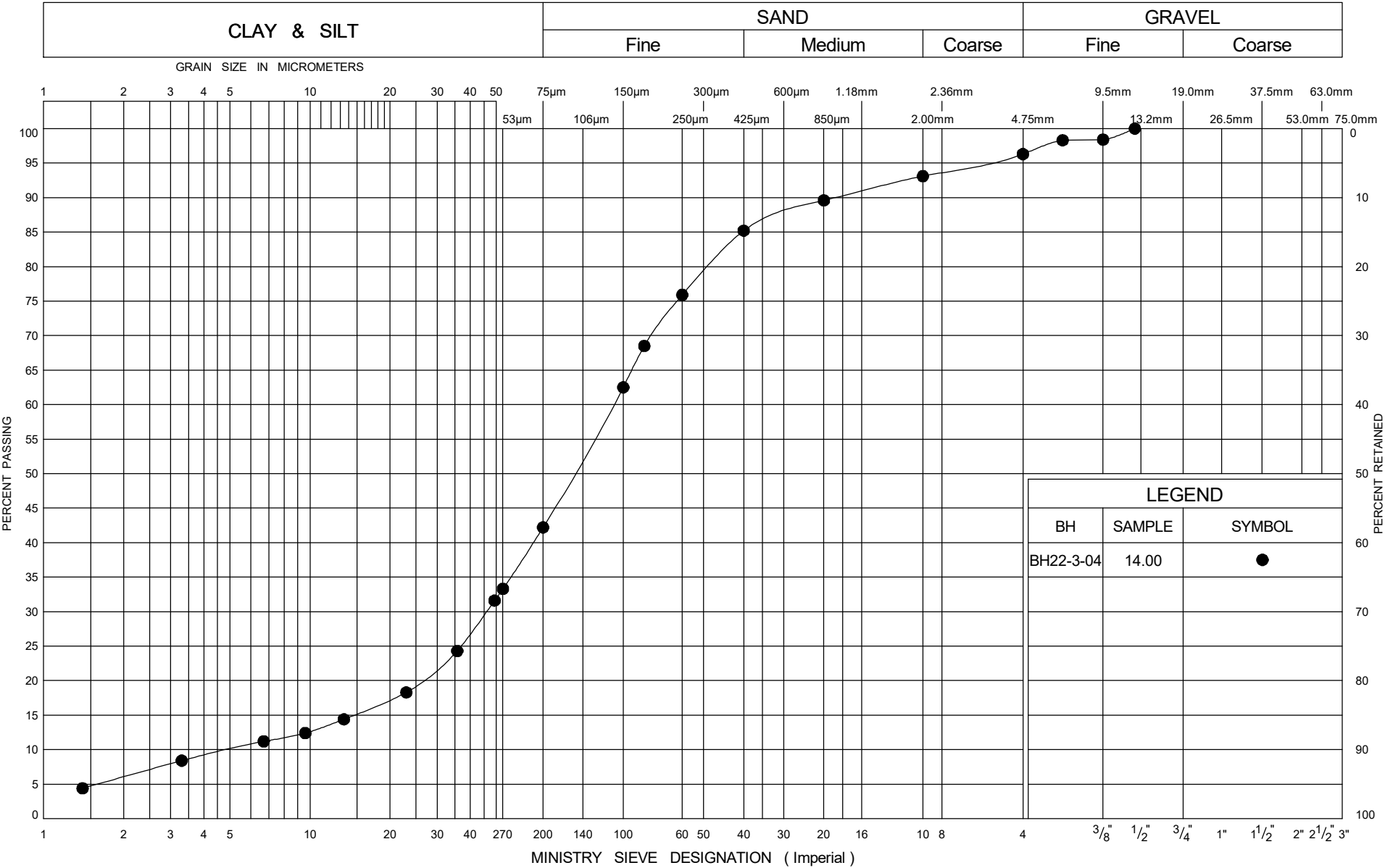
## GRAIN SIZE DISTRIBUTION

Native Cohesionless Soil

FIG No 4

CN Rail Overpass Replacement  
 (Site 37X-0215/B1 & B3)  
 Hwy 401 Eastbound Express and  
 Collector Lanes

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

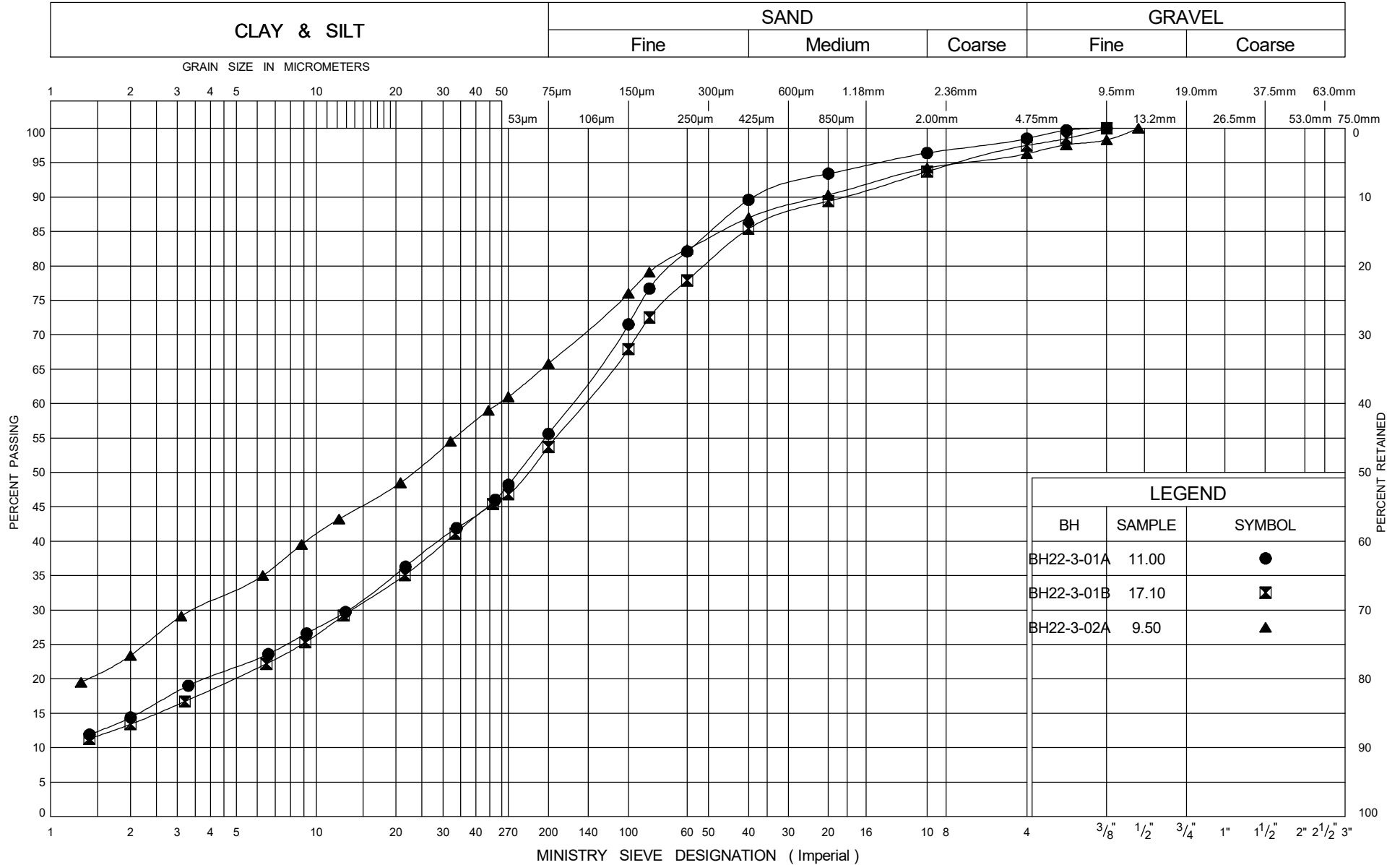
Native Cohesionless Soil

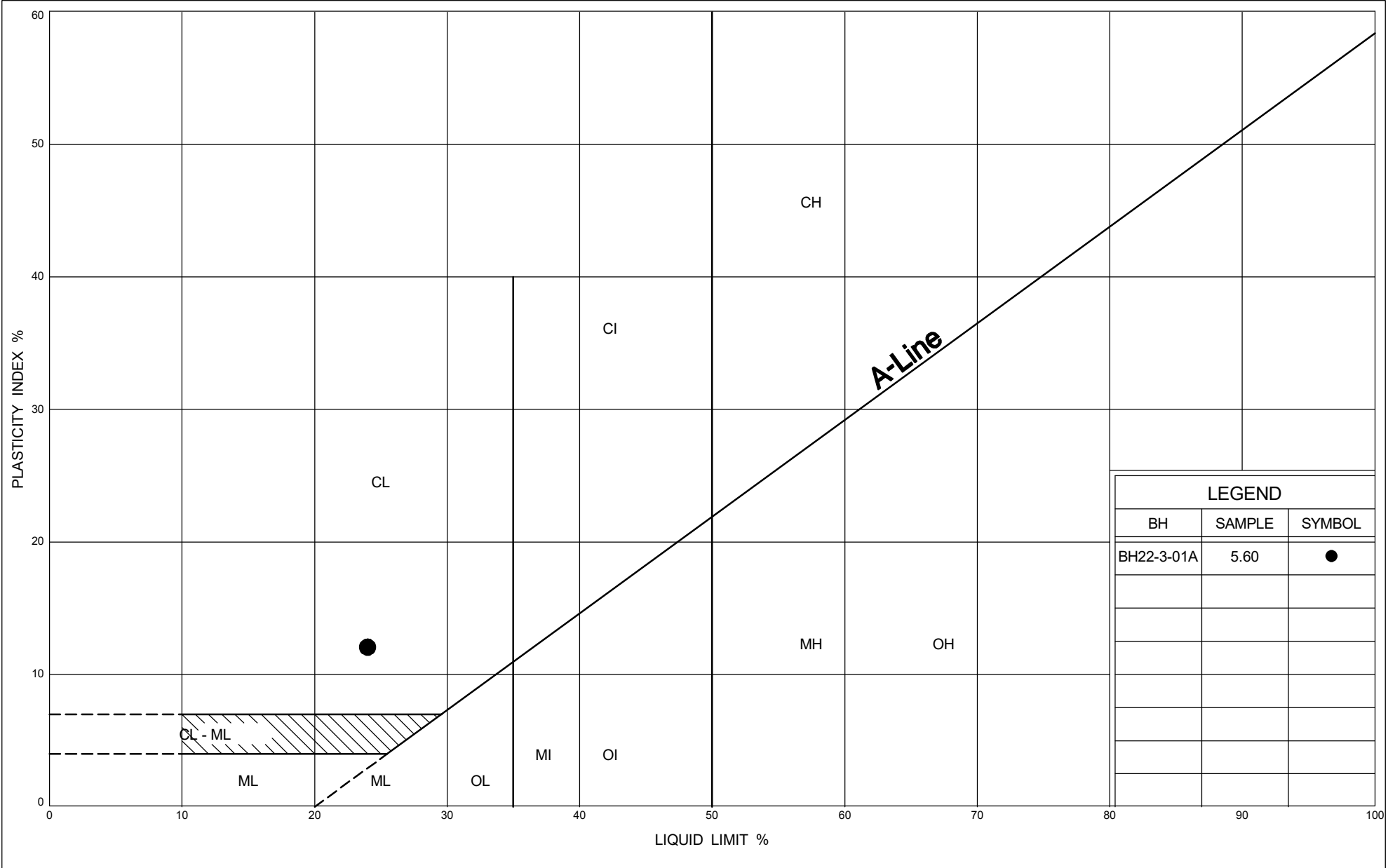
FIG No 5

CN Rail Overpass Replacement  
(Site 37X-0215/B1 & B3)

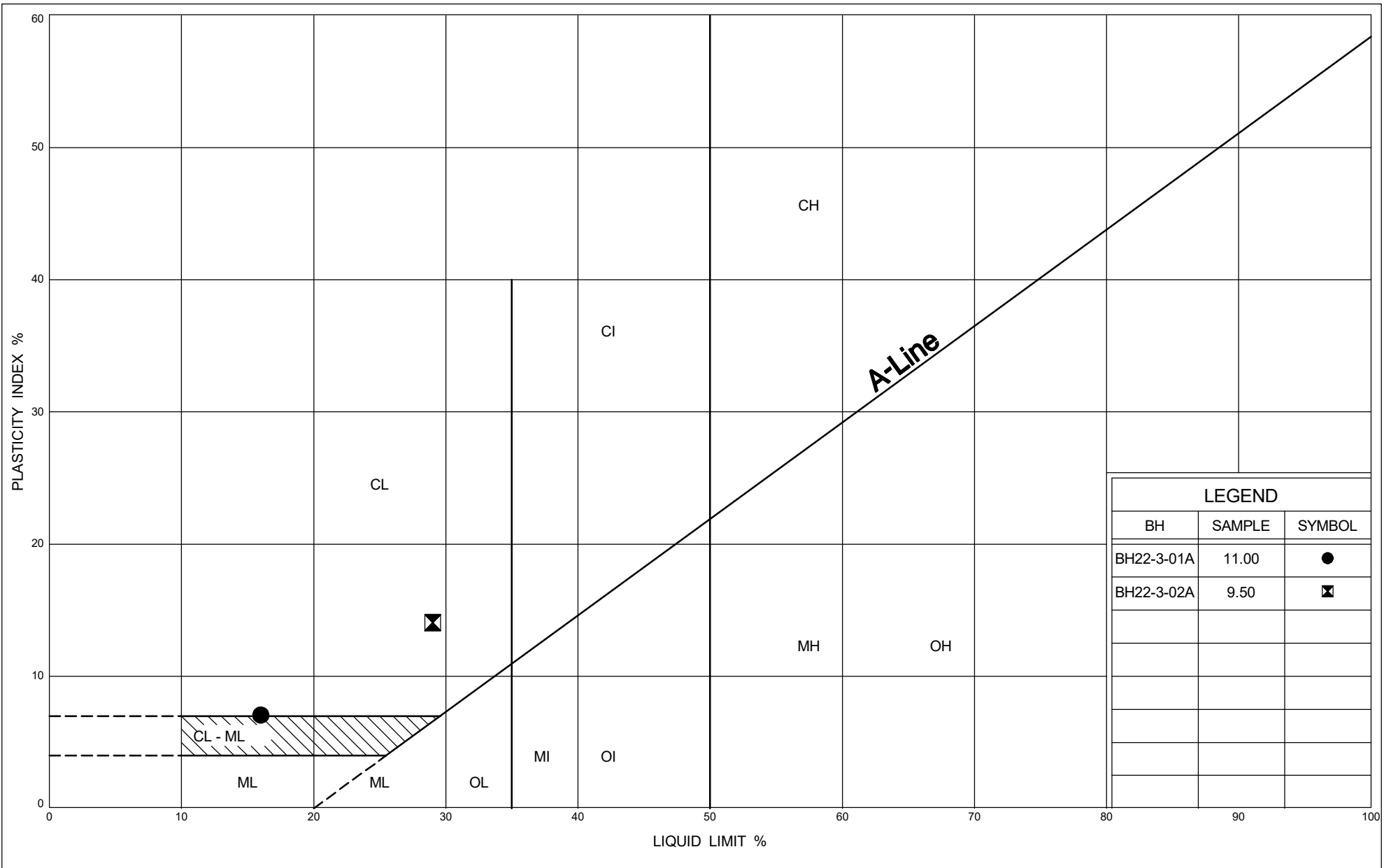
Hwy 401 Eastbound Express and  
Collector Lanes

# UNIFIED SOIL CLASSIFICATION SYSTEM









Ministry of  
Transportation

## PLASTICITY CHART

Clayey Silt (TILL)

FIG No 8

CN Rail Overpass Replacement  
(Site 37X-0215/B1 & B3)

Hwy 401 Eastbound Express and  
Collector Lanes

## Appendix F – Previous Investigation Borehole Logs

PROJECT		09-1111-6055		RECORD OF BOREHOLE No 2011-01		1 OF 4 METRIC											
G.W.P.		07-20012		LOCATION		N 4848414.2 ; E 322538.0											
DIST		Central HWY 401		BOREHOLE TYPE		CME 75 Truck-mount, 108 mm Inner Diameter Hollow Stem Augers											
DATUM		Geodetic		DATE		April 5-6, 2011											
						ORIGINATED BY SB											
						COMPILED BY MAS											
						CHECKED BY LCC											
SOIL PROFILE			SAMPLES			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	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)		γ		GR SA SI CL		
166.3	0.0	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	10 20 30						
165.5	0.2	TOPSOIL		1	SS	12		166	○ UNCONFINED + FIELD VANE	○ QUICK TRIAXIAL × REMOULDED	○						
165.5	0.8	Clayey silt with sand, trace gravel, containing organics and rootlets (FILL)		2	SS	7		165			○						
		Stiff Brown Moist															
		Silty SAND, trace clay, trace gravel (TILL)		3	SS	15		164			○					3	39 53 5
		Loose to compact Brown Moist		4	SS	23											
163.3	3.1	CLAYEY SILT with sand, trace gravel (TILL)		5	SS	24		163			○					4	33 48 15
		Very stiff Brown to grey Moist		6	SS	15		162									
161.7	4.6	SAND and SILT, trace clay, trace gravel (TILL)		7	SS	29		161			○						
		Compact to very dense Grey Moist		8	SS	20		160									
								159									
				9	SS	26		158			○					3	38 48 11
								157									
		Becoming wet below a depth of 9.1 m		10	SS	1*		156									
								155			○						
				11	SS	28		154									
								153									
152.9	13.4	SAND and SILT, trace gravel		12	SS	90											
		Very dense to compact Grey Moist						152			○						
				13	SS	143/0.28											

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 09-1111-6055.GPJ GAL-MASS.GDT 11/7/11 SIB

PROJECT 09-1111-6055		<b>RECORD OF BOREHOLE No 2011-01</b>		2 OF 4 <b>METRIC</b>	
G.W.P. 07-20012	LOCATION N 4848414.2 ; E 322538.0	ORIGINATED BY SB			
DIST Central HWY 401	BOREHOLE TYPE CME 75 Truck-mount, 108 mm Inner Diameter Hollow Stem Augers	COMPILED BY MAS			
DATUM Geodetic	DATE April 5-6, 2011	CHECKED BY LCC			

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								WATER CONTENT (%)		
								20	40	60							80	100
								20	40	60							80	100
— CONTINUED FROM PREVIOUS PAGE —																		
145.3 21.0	SAND and SILT, trace gravel Very dense to compact Grey Moist  Becoming wet below a depth of 16.8 m		14	SS	24/0.28		151											
							150											
							149											
							148											
							147											
							146											
							145											
							144											
							143											
							142											
	CLAYEY SILT, trace sand Hard to very stiff Grey Moist		18	SS	43		145											
						144												
						143												
						142												
						141												
						140												
						139												
						138												
						137												
					19	SS	56									0 0 72 28		
			20	SS	42													
			21	SS	26													
			22	SS	27									0 0 70 30				
			23	SS	22													

GTA-WTO 001 09-1111-6055.GPJ GAL-MISS.GDT 11/7/11 SIB

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE





## 3 OF 4 METRIC

ORIGINATED BY SB

COMPILED BY MAS

CHECKED BY \_\_\_\_\_ LCC

GTA-MTO 001 09-1111-6055.GPJ GAL-MISS.GDT 11/7/11 SIB

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT 09-1111-6055		<b>RECORD OF BOREHOLE No 2011-01</b>		4 OF 4 <b>METRIC</b>	
G.W.P. 07-20012		LOCATION N 4848414.2 ; E 322538.0		ORIGINATED BY SB	
DIST Central HWY 401		BOREHOLE TYPE CME 75 Truck-mount, 108 mm Inner Diameter Hollow Stem Augers		COMPILED BY MAS	
DATUM Geodetic		DATE April 5-6, 2011		CHECKED BY LCC	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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	20 40 60 80 100					W <sub>p</sub>	W			W <sub>L</sub>
								SHEAR STRENGTH kPa									
	— CONTINUED FROM PREVIOUS PAGE —																
	END OF BOREHOLE																
	NOTES:																
	*SPT "N" value considered to have been affected by sample disturbance due to groundwater inflow to borehole.																
	1. Borehole open to a depth of 9.8 m (Elev. 156.5 m) on completion of drilling.																
	2. Water level in open borehole at a depth of 4.3 m (Elev. 162.0 m) on completion of drilling.																

GTA-MTO 001 09-1111-6055.GPJ GAL-MISS.GDT 11/7/11 SIB

## MATERIALS &amp; TESTING DIVISION

RECORD OF BOREHOLE NO. 3

**FOUNDATION SECTION**

JOB 66-F-88 LOCATION Hwy. 401 & C.N.R., Sta. 357 + 09 E ORIGINATED BY V.K.  
W.P. 259-61 BORING DATE November 15, 1966 COMPILED BY V.K.  
DATUM Geodetic BOREHOLE TYPE Pen Drill Auger CHECKED BY AK

[illegible]

**FOUNDATION SECTION**

CHECKED BY                     

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F.	LIQUID LIMIT ——— WL PLASTIC LIMIT ——— WP WATER CONTENT ——— W *P ——— W ——— WL WATER CONTENT % 10 20 30	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT					
543.2	GROUND LEVEL.									
	(Brown)					540				
	Silty sand to silt with traces of clay and occasional gravel		1	SS	21					
			2	SS	25					
	Compact to Very Dense		3	SS	81					
			4	SS	100/5"	530				
			5	SS	100/5"					
	(Grey)		6	SS	100/5"	520				
516.3			7	SS	145					
27.0	Clayey silt with traces of sand and occasional gravel		8	SS	95					
509.3	Hard					510				
34.0	Silty sand to sandy silt with traces of gravel		9	SS	35					
			10	SS	31					
	Dense to Very Dense.		11	SS	71	500				
			12	SS	185					
			13	SS	152	490				
481.8			14	SS	64					
61.5	End of Borehole					480				



## MATERIALS &amp; TESTING DIVISION

## RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 66-F-88LOCATION Hwy. 401 & C.N.R., Sta. 356 + 89 144 Rt.ORIGINATED BY V.K.W.P. 259-61BORING DATE November 14, 1966COMPILED BY V.K.DATUM GeodeticBOREHOLE TYPE Pen Drill and Diamond DrillCHECKED BY SR

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WP	W	WL		
							SHEAR STRENGTH P.S.F.									
544.2	GROUND LEVEL															
	(Brown)															
	Silty sand to silt with occasional layers of clayey silt		1	SS	17	540										
			2	SS	19											
			3	SS	100/5"											
			4	SS	87	530										
			5	SS	144											
	Compact to Very Dense															
	(Grey)		6	SS	33											
						520										
516.2			7	SS	18											
28.0	Clayey silt with traces of sand and occasional gravel		8	SS	76											
509.2	Hard					510										
35.0	Silty sand to sandy silt with traces of gravel		9	SS	48											
			10	SS	36											
			11	SS	100/5"	500										
	Dense to Very Dense															
492.7			12	SS	141											
51.5	End of Borehole					490										

Gr. 6%  
Sa. 52%  
Si. 37%  
Cl. 5El. 526.2  
W.L.