



Foundation Investigation Report

Highway 401 Eastbound Express and Collector Lanes between Victoria Park Avenue and Neilson Road - **Superstructure Replacement and High Fill for Embankment Widening at Birchmount Overpass Eastbound Core and Collectors Structure**
(Site 37X-0212/B1 & B3)

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MTO Central Region
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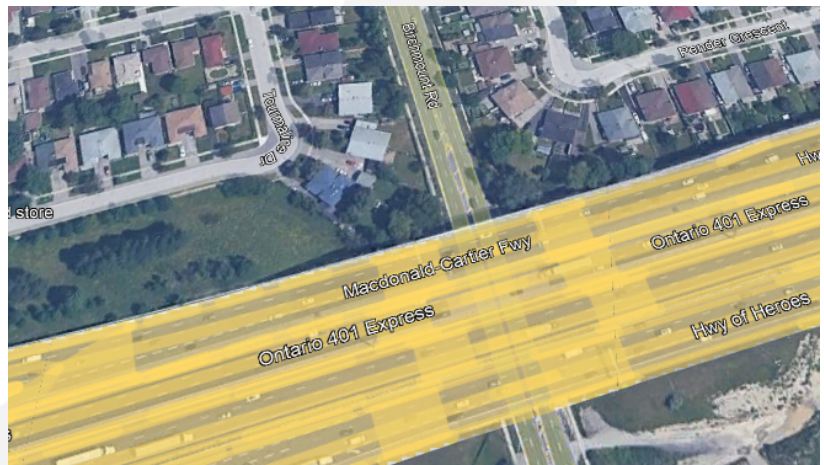
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*Foundation Investigation Report
Highway 401 Eastbound from Victoria Park Avenue to Neilson Road
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Eastbound Core and Collectors Structure (Site 37X-0218/B1 & B3)
Assignment No. 2021-E-0018
Date: December 31, 2024*

Part I: Foundation Investigation Report

Highway 401 Eastbound Express and Collector Lanes between Victoria Park Avenue and Neilson Road – Birchmount Road Overpass (Site 37X-0212/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 Foundation Investigation 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 Birchmount Road Overpass structure (Site 37X-0218/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 structure widening, superstructure replacement, retaining wall replacement, and high fill embankment widening associated with the bridge widening.

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

The GA drawing titled *HWY 401 EB CORE & COLLECTOR VICTORIA PARK TO NEILSON BIRCHMONT RD. OVERPASS GENERAL ARRANGEMENT*, prepared by AECOM, dated SEP. 2022, shows the preliminarily proposed configuration of the Birchmount Road Overpass structure. A summary of the proposed structure is as follows:

1. The existing structure is a 29.72 m long two-span bridge with equal spans between the abutments (14.86 m). It is understood that the existing abutments, piers and retaining wall foundations are supported on spread footings. The existing abutments are supported on approximately 5.6 m and 5.3 m wide spread footings at the express lanes and collectors lanes, respectively. Based on the Foundation and Investigation Design Report *"Bridge Widening and Replacement Highway 401 Rehabilitation from Warden Avenue to Brock Road, Toronto, Ontario, W.O.07-20012."* produced by Golder Associates Ltd., dated April 2012, the west abutment is founded at about Elevation 173.6 m and the east abutment is founded at about Elevation 173.8 m to 174.2 m from the north side to the south side of the bridge. Both abutments were also constructed with a shear key. The center piers are founded on a 1.8 m wide footing founded at about Elevation 174.0 m.
2. The existing structure is proposed to undergo superstructure replacement, which includes replacement of the existing bridge deck and girders, and conversion to semi-integral abutments. Additionally, the bridge will be widened by 4.5 m with a new pier column and cap to attach to the existing structure.
3. The existing retaining wall structures (37x-1765/W and 37x-1766/W) will be replaced with new retaining walls along the south side of widened collector structure.
4. High fills for embankment widening and retaining walls are proposed to accommodate the additional lane of widening that will occur from about 150 m west of Birchmount Road to the CP Rail Overpass structure (located about 200 m east of Birchmount Road).

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The preliminary foundation design report and GA drawing by URS, the contract package drawings titled *Hwy 401 WB Core & Collector Lanes – Birchmount Road Overpass – Bridge Rehabilitation (Cont. No. 2019-2011, WP No. 2403/2404-15-01)*, produced by WSP Global Inc., dated July 2018, and the Foundation and Investigation Design Report (FIDR) by Golder Associates Ltd., *“Birchmount Road Overpass Rehabilitation (Site No. 37-212) Highway 401 Westbound Core and Collector Lanes, Neilson Road to Warden Avenue, City of Toronto, Ontario, MTO G.W.P. 2162-11-00”*, dated January 16, 2019 were included as part of this report is 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 Birchmount Road, approximately 3 km east of Highway 404 in the City of Toronto, Ontario. The site is adjacent to industrial zones to the south and northeast, and adjacent to residential zones to the northwest of the site. In general, the terrain in this area is relatively flat, with the natural ground surface sloping gently towards south. The Highway 401 pavement grade ranges between about Elevation 185 m to 186 m while, the Birchmount Road pavement grade is at approximate Elevation about 176 m to 179.5 m at the structure site (increasing in elevation towards the south). Based on the preliminary GA drawings by AECOM of the Eastbound Core and Collectors and by WSP of the Westbound Core and Collectors, in addition to the Foundation Investigation Design Report by Golder Associates Ltd., the fill thickness is assumed to be 9 m to 10 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 predominate 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, three (3) previous reports were issued which contain relevant information to the proposed Birchmount Road Overpass structure (Site 37X-0212/B1 & B3), as follows:

1. Foundation Investigation Report for Proposed Extension of the Existing Bridge at Hwy. #401 and Birchmount Road, County of York, Township of Scarborough, District #6 (Toronto), W.J. 65-F-49, W.P. 256-61, Geocres No. 30M14-073, The Ministry of Transportation Ontario (MTO), Foundation Section, Materials and Testing Div., dated August 03, 1965.
2. Geocres No. 30M14-338 *“Bridge Widening and Replacement Highway 401 Rehabilitation from Warden Avenue to Brock Road, Toronto, Ontario, W.O.07-20012.”* by Golder Associates Ltd., dated April 2012.

3. Geocres No. 30M14-492 "Birchmount Road Overpass Rehabilitation (Site No. 37-212) Highway 401 Westbound Core and Collector Lanes, Neilson Road to Warden Avenue, City of Toronto, Ontario, MTO G.W.P. 2162-11-00", by Golder Associates Ltd., dated January 16, 2019.

The applicable previous MTO borehole logs are attached as Appendix F in this report. The details of the applicable boreholes completed by the MTO are also outlined in Table 1.1.

Table 1.1: Summary of Applicable Borehole Completed by MTO

Borehole No.	Borehole Location	Location (MTM NAD83 Zone 10)		Latitude	Longitude	Borehole Elevation (m)	Borehole Depth (m)
		Northing	Easting				
73-1	East Abutment, South Side (EBL Collector)	4848065.7	321384.5	43.772366	-79.293992	176.5	11.1
73-2	West Abutment, South Side (EBL Collector)	4848054.1	321349.6	43.772262	-79.294426	175.9	12.6
73-3	Centre Pier, South Side (EBL Collector)	4848072.9	321353.0	43.772431	-79.294383	176.8	12.6

5.0 Field Investigation and Laboratory Analyses

5.1 Site Investigation and Field Testing

A site-specific investigation was undertaken by EXP between November 7, 2022 and December 12, 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. At the time of this report, seven (7) boreholes have been completed for this structure (BH22-1-01, BH22-1-02, BH22-1-03 and BH22-1-08 to BH22-1-11) as part of EXP's 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 or a MARL M10 machine (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. Boreholes were set back at least 10 m from the abutment to avoid drilling through the reinforced approach slab.
5. 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);
6. 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;

7. 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;
8. 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.
9. 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 ± 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
10. 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				
BH22-1-01	Centre Pier, south of O/P	4848043.0	321370.0	43.772165	-79.294168	180.0	9.8
BH22-1-02	West of West Abutment, EBL Collectors	4848051.9	321336.0	43.772243	-79.294595	185.7	15.7
BH22-1-03	East of East Abutment, EBL Collectors	4848071.2	321390.0	43.772415	-79.293924	185.9	15.8
BH22-1-08	West of West Abutment, b/w EBL and WBL Express	4848084.4	321324.7	43.772535	-79.294734	186.0	20.4
BH22-1-09	East of East Abutment, b/w EBL and WBL Express	4848102.3	321380.1	43.772695	-79.294045	186.3	20.4
BH22-1-10	West of West Abutment, b/w EBL and WBL Express	4848077.9	321305.8	43.772477	-79.294969	186.0	15.7
BH22-1-11	East of East Abutment, b/w EBL and WBL Express	4848108.6	321399.1	43.772752	-79.293809	186.3	15.8

5.2 Laboratory Testing

All obtained samples were submitted for natural moisture content testing. In addition, unit weight, Atterberg limits and grain size analysis (sieve and hydrometer) tests were performed on selected soil samples (performed by EXP). Chemical analyses were also carried out on three 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 results of the laboratory tests are shown 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
BH22-1-01	10	2	3	3	1	---
BH22-1-02	16	2	4	4	6	1
BH22-1-03	13	3	4	4	5	1
BH22-1-08	19	2	4	4	6	---
BH22-1-09	18	2	4	4	5	---
BH22-1-10	18	3	4	4	3	---
BH22-1-11	14	2	3	3	6	---

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.

In general, the subsurface conditions below the roadway/pavement structure encountered within the depths of EXP’s geotechnical investigation consists of gravelly sand fill followed by silty sand to sand and silt fill which is underlain or interbedded with clayey silt fill. The embankment fill is underlain by cohesive (clayey silt) and cohesionless (sand and 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 and MTO.

6.1 Subsoils

6.1.1 Pavement Structure

A pavement structure consisting of asphalt and concrete was encountered at the surface in boreholes BH22-1-01, BH22-1-02, BH22-1-03, BH22-1-08, BH22-1-09, BH22-1-10 and BH22-1-11. The thickness of the pavement structure ranged between 255 mm and 460 mm.

6.1.2 Topsoil

A thin layer of topsoil, 300 mm in thickness, was encountered at the surface in boreholes 73-1 and 73-2 during MTO’s investigation in 1965.

6.1.3 Cohesionless Fill: Gravelly Sand to Sand and Gravel

During EXP's geotechnical investigation, gravelly sand fill was encountered below the pavement structure (asphalt/concrete) in boreholes BH22-1-01, BH22-1-02, BH22-1-03, BH22-1-08, BH22-1-09, BH22-1-10 and BH22-1-11. Sand and gravel was also encountered at the surface at borehole 73-3 during MTO's geotechnical investigation in 1965. The approximate elevations of the surface and base of each fill layer, thickness, description and SPT "N" Values encountered in the boreholes are summarized in Table 1.4 below:

Table 1.4: Summary of Cohesionless Fill: Gravelly Sand to Sand and Gravel Layers

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT “N” Value Range
	Top	Bottom				
EXP (2022)						
BH22-1-01	179.7	179.6	0.3	0.1	Sand and Gravel	N/A ¹
BH22-1-02	185.2	184.9	0.5	0.3	Gravelly Sand	N/A ¹
BH22-1-03	185.6	184.5	0.3	1.1	Gravelly Sand	24
BH22-1-08	185.7	183.7	0.3	2.0	Gravelly Sand	38 – 41
BH22-1-09	185.8	184.0	0.5	1.8	Gravelly Sand	48 – 50
BH22-1-10	185.7	184.9	0.3	0.8	Gravelly Sand	N/A ¹
BH22-1-11	186.0	185.5	0.3	0.5	Gravelly Sand	N/A ¹
MTO (1965)						
73-3	176.8	176.3	0	0.5	Sand and Gravel	N/A ¹

Notes:

1.0 No SPT sampling within layer, only auger samples retrieved.

This layer consists of mainly sand and gravel with trace to some silt and trace clay. The material was brown to grey in colour and moist. SPT "N" values obtained within this layer range from 24 to 50 blows per 300 mm penetration, corresponding to compact to very dense in compactness.

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

Moisture Content (EXP):

- 3% to 8%

Grain Size Distribution (EXP):

- 30% gravel;
- 53% sand;
- 13% silt;
- 4% 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 performed by EXP are also provided in Figure 1 in Appendix E.

6.1.4 Cohesionless Fill: Silty Sand to Sand and Silt

During EXP's geotechnical investigation, silty sand to sand and silt fill was encountered below the gravelly sand and sand and gravel fill in boreholes BH22-1-02, BH22-1-03, BH22-1-08, BH22-1-09, BH22-1-10 and BH22-1-11. The approximate elevations of the surface and base of each fill layer, thickness, description and SPT "N" Values encountered in the boreholes are summarized in Table 1.5 below:

Table 1.5: Summary of Cohesionless Fill: Silty Sand to Sand and Silt Layers

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT “N” Value Range
	Top	Bottom				
EXP (2022)						
BH22-1-02	184.9	176.6	0.8	8.3	Silty Sand	18 – 45
BH22-1-03	184.5	179.5	1.4	5.0	Silty Sand	24 – 28
BH22-1-08	183.7	176.9	2.3	6.8 ¹	Silty Sand	5 – 35 ²
BH22-1-09	184.0	178.7	2.3	5.3	Silty Sand	17 – 86
BH22-1-10	184.9	176.4	1.1	8.5 ¹	Sand and Silt	25 – 54 ²
BH22-1-11	185.5	178.7	0.8	6.8	Sand and Silt	31 – 59

Notes:

- 1.0 Includes cohesive fill layer within the overall cohesionless fill thickness (see Table 1.6).
- 2.0 Range for SPT "N" values only within cohesionless fill.

This layer predominately consists of sand and silt with trace to some gravel and trace to some clay. Thin layers of clayey silt were also observed in the fill in borehole BH22-1-10. The material was brown to grey in colour and damp to moist. The SPT "N" values within this layer ranged from 5 to 86 blows per 300 mm penetration, corresponding to loose to very dense, but generally compact to dense in compactness.

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

Moisture Content: (EXP)

- 3% to 17%

Grain Size Distribution: (EXP)

- 0% to 12% gravel;
- 40% to 71% sand;
- 20% to 50% silt;
- 3% to 10% clay;

Unit Weight: (EXP)

- 21.0 kN/m³ to 24.2 kN/m³

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

6.1.5 Cohesive Fill: Clayey Silt

During EXP's geotechnical investigation, a cohesive fill was encountered below the cohesionless fill layers in boreholes BH22-1-03, BH22-1-08, BH22-1-09, BH22-1-10 and BH22-1-11.

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)						
BH22-1-03	179.5	176.8	6.4	2.7	Clayey Silt	18 – 20
BH22-1-08	179.9	178.4	6.1	1.5	Clayey Silt	20
BH22-1-09	178.7	176.7	7.6	2.0	Clayey Silt	7 – 36
BH22-1-10	179.9	176.9	6.1	3.0	Clayey Silt	23 – 34
BH22-1-11	178.7	177.2	7.6	1.5	Clayey Silt	15

This layer predominately consists of silt and clay and can be considered sandy with trace gravel. The material was light brown to dark grey in colour and moist. The SPT "N" value within this layer ranged between 7 to 36 blows per 300 mm penetration, corresponding to firm to hard in consistency. Atterberg limits tests suggest that this cohesive fill material is low plastic.

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

Moisture Content (EXP):

- 8% to 15%

Grain Size Distribution: (EXP)

- 1% to 2% gravel;
- 30% to 45% sand;
- 39% to 58% silt;
- 11% to 17% clay;

Atterberg Limits: (EXP)

- Liquid Limit: 16% to 17%;

- Plastic Limit: 10% to 12%;
- Plasticity Index: 5% to 7%

Unit Weight: (EXP)

- 22.2 kN/m³ to 22.5 kN/m³

The results of the moisture content, grain size distribution, Atterberg limits and unit weight tests performed by EXP are provided on the record of borehole sheets in Appendix D. The results of grain size distribution and Atterberg limits tests are also provided on Figure 3 and 6 in Appendix E.

6.1.6 Sandy Silt to Silty Sand (Till)

During EXP's geotechnical investigation, a native non-cohesive till deposit was encountered below the 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 Cohesive Till: Clayey Silt Layers

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT “N” Value Range
	Top	Bottom				
EXP (2022)						
BH22-1-01	179.6	170.4	0.4	9.2	Sandy Silt to Silty Sand	26 – 97
BH22-1-02	176.6	170.0	9.1	6.6	Sandy Silt to Silty Sand	10 – 106
BH22-1-03	176.8	170.1	9.1	6.7	Sandy Silt to Silty Sand	18 – 44
BH22-1-08	176.9	165.6	9.1	11.3	Sandy Silt to Silty Sand	21 – 94
BH22-1-09	176.7	165.9	9.6	10.8 ¹	Sandy Silt to Silty Sand	15 – 64
BH22-1-10	176.4	170.3	9.6	6.1 ¹	Sandy Silt to Silty Sand	13 – 180/280 mm
BH22-1-11	177.2	170.5	9.1	6.7 ¹	Sandy Silt to Silty Sand	18 – 37
MTO (1965)						
73-1	176.2	165.4	0.3	10.8 ¹	Silty Sand to Sandy Silt	80 – 162
73-2	175.6	163.2	0.3	12.4 ¹	Silty Sand to Sandy Silt	39 – 169/230 mm
73-3	176.3	164.1	0.5	12.2 ¹	Silty Sand to Sandy Silt	33 – 129

Notes:

1.0 End of borehole terminated within this layer.

This layer predominately consists of sand and silt with trace to some gravel and trace to some clay. Additionally, trace organics were observed in borehole BH22-1-08. The material was grey to brown in colour and dry to wet. The SPT "N" value within this layer ranged between 10 blows per 300 mm penetration to 180 blows per 280 mm, corresponding to compact to very dense, but generally dense to very dense in consistency. Atterberg limits tests suggest that this layer is non-plastic to low plastic.

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

Moisture Content (EXP):

- 2% to 20%

Grain Size Distribution: (EXP)

- 0% to 19% gravel;
- 26% to 52% sand;
- 25% to 54% silt;
- 8% to 24% clay;

Atterberg Limits: (EXP)

- Non-plastic
- Liquid Limit: 16% to 28%;
- Plastic Limit: 10% to 13%;
- Plasticity Index: 6% to 15%

Unit Weight: (EXP)

- 21.0 kN/m³ to 23.6 kN/m³

The results of the moisture content, grain size distribution, Atterberg limits and unit weight tests performed by EXP are provided on the record of borehole sheets in Appendix D. The results of grain size distribution and Atterberg limits tests are also provided on Figure 4 and 7 in Appendix E.

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).

Due to safety concerns, all relevant boreholes were drilled on roads without standpipe piezometers.

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 F.

Table 1.9: Summary of observed groundwater levels

Borehole	Ground Surface Elevation (m)	Water level Depth/ Elevation (m)	Date
EXP (2022)			
BH22-1-08	186.0	18.6/167.4 ¹	November 2 - 3, 2022
MTO (1965)			
73-1	176.5	8.4/168.1	May 12, 1965
73-2	175.9	8.3/167.6	May 12, 1965
73-3	176.8	8.9/167.9	May 12 - 13, 1965

Notes:

1.0 Groundwater level inferred from split spoon observations.

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

Three (3) soil samples were selected for chemical analysis during current investigation. The soils samples collected by EXP were tested at the Bureau Veritas Laboratories (formerly Maxxam Analytics), a CALA-certified and accredited laboratory in Mississauga, Ontario.

The analytical results are summarized in Table 1.11 below and are presented in Appendix E.

Table 1.11. Summary of chemical analysis results

Sample Identification	pH (Unitless)	Soluble Chloride (ppm)	Soluble Sulphate (ppm)	Resistivity (ohm-cm)	Conductivity (umho/cm)	Redox Potential (mV)
BH22-1-02, SS3	10.1	430	57 – 59	1100	0.852 – 0.870	37 – 58
BH22-1-03, SS10	7.87	560	<20	810	1.230	190

*Foundation Investigation Report
Highway 401 Eastbound from Victoria Park Avenue to Neilson Road
Superstructure Replacement at Birchmount Road Overpass
Eastbound Core and Collectors Structure (Site 37X-0218/B1 & B3)
Assignment No. 2021-E-0018
Date: December 31, 2024*

7.0 Closure

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.

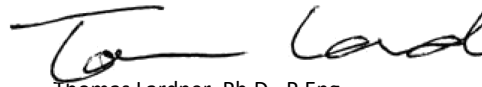
Details of the limitations of this report are presented as Appendix A, "Limitations and Use of Report".

This Foundation Investigation Report has been prepared by Elvis Lu, M.Eng., EIT and Thomas Lardner, Ph.D., P.Eng. It was reviewed by TaeChul Kim, M.E.Sc., P.Eng. and Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact. The field investigation was supervised by Stephen Fredricks, M.Eng., and Osama Drbe P.H.D and Ciarra Alexander, M.Eng.


Yours truly,


EXP Services Inc.

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Technical Specialist


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




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


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Executive Vice-President
Designated MTO Foundation Contact



Encl.

References

- Barnett, P.J., Cowan, W.R., & Henry, A.P. 1991. *Quaternary geology of Ontario, southern sheet*; Ontario Geological Survey, Map 2556, scale 1:1 000 000.
- Canadian Geotechnical Society, 2023. *Canadian Foundation Engineering Manual*, 5th Edition. The Canadian Geotechnical Society, BiTech Publisher Ltd., British Columbia.
- Canadian Standards Association (CSA), 2019. *Canadian Highway Bridge Design Code and Commentary on CAN/CSA-S6-19*. CSA Special Publication.
- Chapman, L.J. and Putnam, D.F. 1984. *The physiography of Southern Ontario*. Ontario Geological Survey, Special volume 2, 3rd Edition. Ontario Ministry of Natural Resources.
- Chapman, L.J. and Putnam, D.F. 2007. *The Physiography of Southern Ontario*. Ontario Geological Survey, Miscellaneous Release-Data 228.
- Ministry of Transportation, April 2014. MTO Gravity Pipe Design Guidelines. Circular Culverts and Storm Sewers.
- Ministry of Transportation, April 2022. Guideline for MTO Foundation Engineering Services, Version 03.
- Molinas, A., and Mommandi, A., 2009. Development of New Corrosion/Abrasion Guidelines for Selection of Culvert Pipe Materials, Report No. CDOT-2009-11. Colorado Department of Transportation, DTD Applied Research and Innovation Branch.
- 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.

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

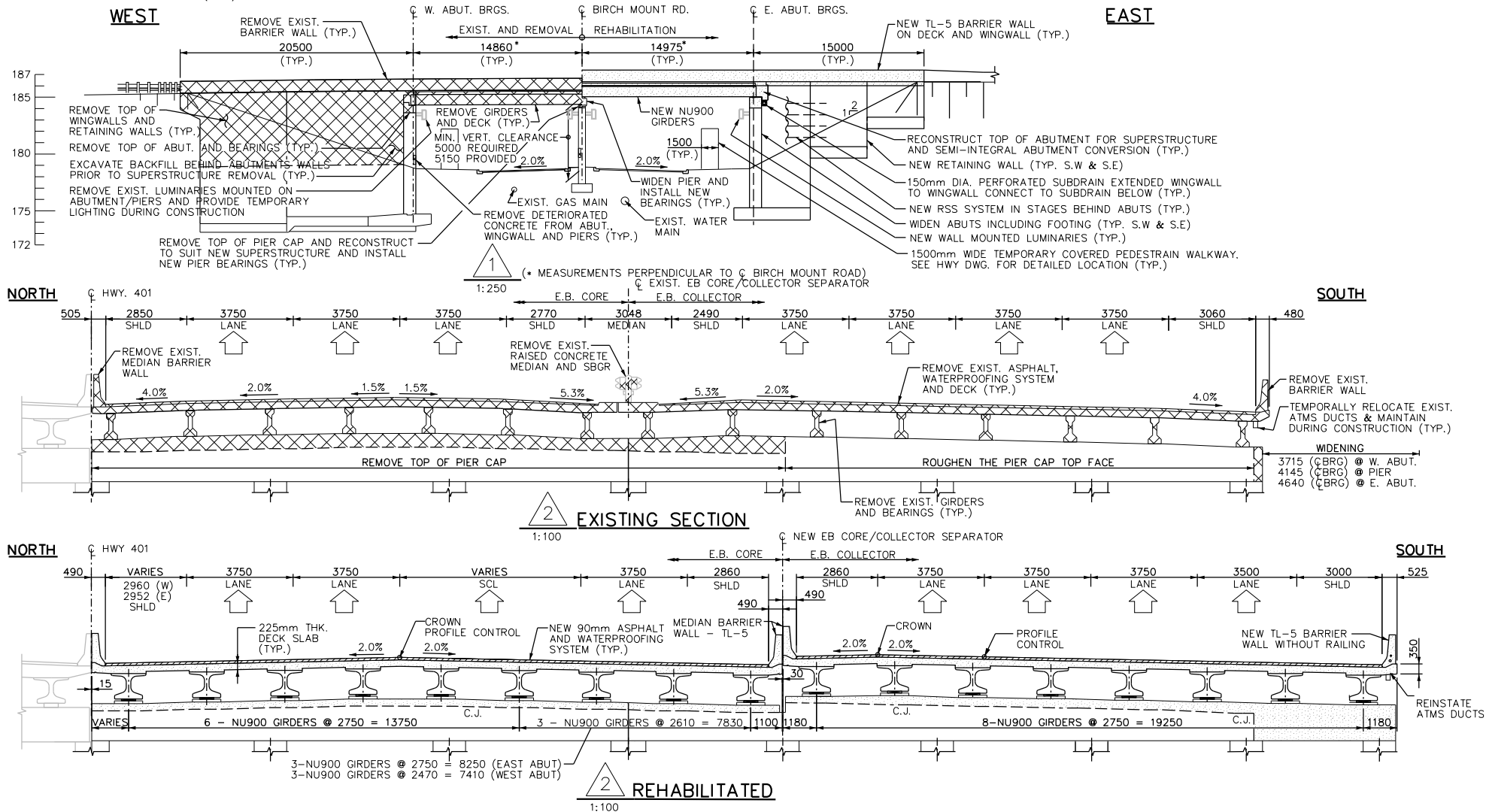
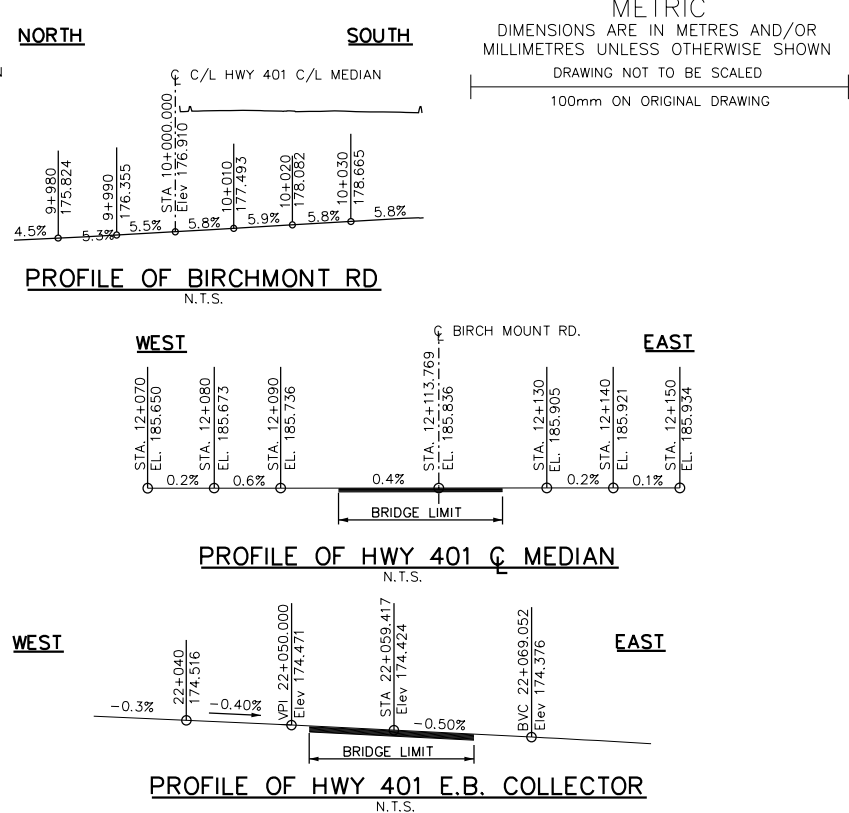
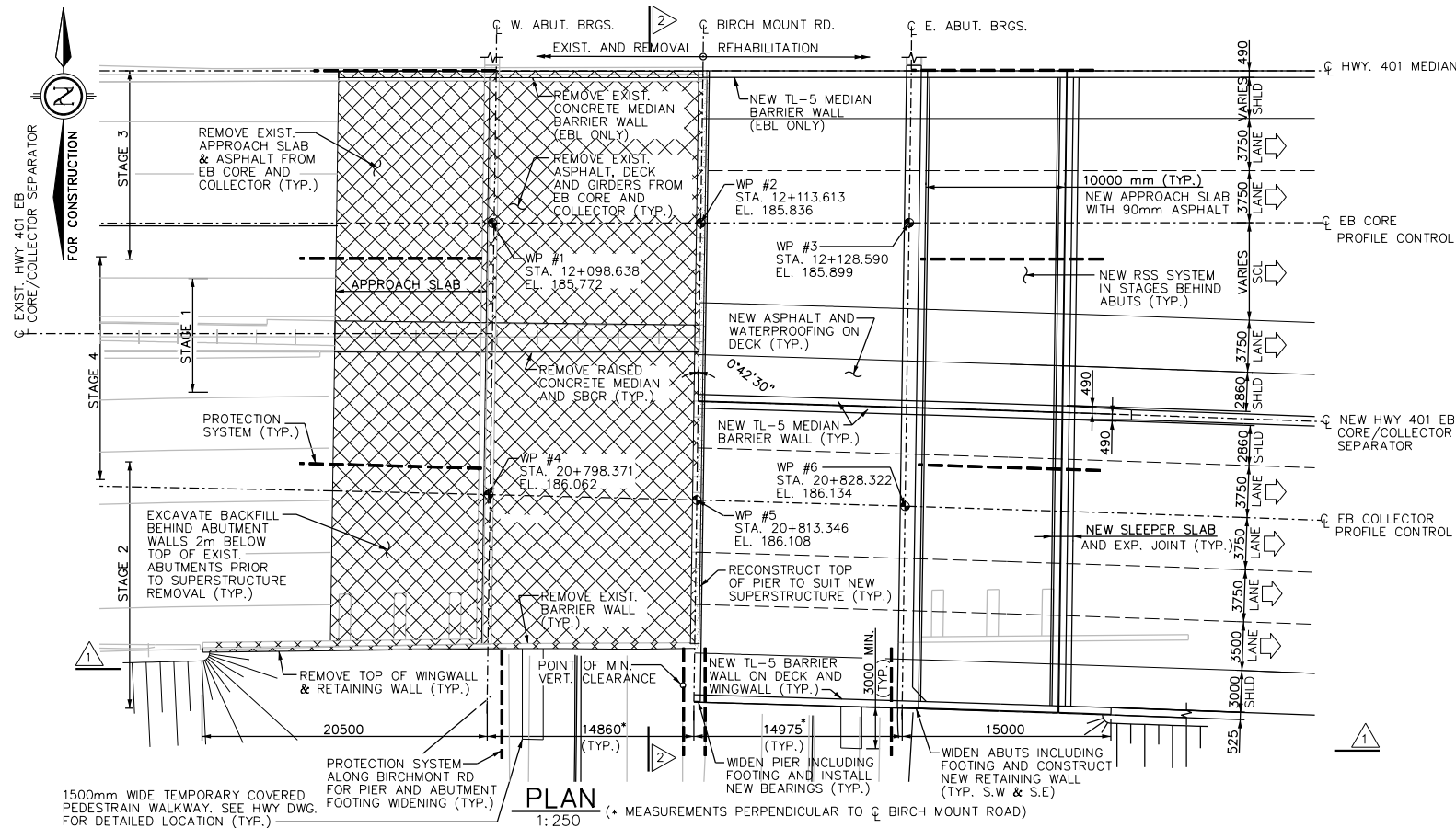
The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. No other party may use or rely upon the Report in whole or in part without the written consent of exp. Any use of the Report, or any portion of the Report, by a third 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

CADD FILE NAME : C:\Users\jia.zheng\Desktop\Hwy401_Victoria to Napan\Site 37X-0212-B1&B3_Birchmount Rd OP\B4-01_EBL_Birchmount Rd.gcd
MINISTRY OF TRANSPORTATION, ONTARIO
ANS-D
2017-08



Ontario

Ministry of Transportation

CONT
WP

HWY 401 EB CORE & COLLECTOR
BIRCHMOUNT RD. OVERPASS
GENERAL ARRANGEMENT

SHEET
S1

- GENERAL NOTES:**
- SPECIFIED 28-DAY COMPRESSIVE STRENGTH.....30 MPa
UNLESS NOTED OTHERWISE
SPECIFIED 28-DAY COMPRESSIVE STRENGTH FOR PRECAST
GIRDERS ARE GIVEN ON PRESTRESSED GIRDER DRAWINGS.
 - CLEAR COVER TO REINFORCING STEEL
FOOTING.....100 ±20
DECK TOP.....70 ±20
BOTTOM.....40 ±10
PIER COLUMNS, SHAFTS AND CAPS.....70 ±20
UNLESS NOTED OTHERWISE.
 - REINFORCING STEEL:
- REINFORCING STEEL SHALL BE GRADE 500W UNLESS
OTHERWISE SPECIFIED.
- BAR MARKS WITH PREFIX 'S' DENOTE STAINLESS STEEL
BARS.
- STAINLESS REINFORCING STEEL SHALL BE TYPE 316LN
OR DUPLEX 2205 AND HAVE MINIMUM YIELD STRENGTH
OF 500 MPa.
- 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 DRAWINGS SS12-1 UNLESS
INDICATED OTHERWISE.
- UNLESS SHOWN OTHERWISE TENSION LAP SPLICES SHALL
BE CLASS B.

- CONSTRUCTION NOTES:**
- THE CONTRACTOR SHALL VERIFY ALL RELEVANT DIMENSIONS,
ELEVATIONS AND DETAILS ON-SITE AND REPORT ANY
DISCREPANCIES TO THE CONTRACT ADMINISTRATOR PRIOR TO
PROCEEDING WITH REHABILITATION WORK.
 - TYPICAL AREAS OF REPAIRS ARE INDICATED ON THE DRAWINGS.
WHERE REPAIR LIMITS ARE NOT SHOWN, LIMITS SHALL BE
IDENTIFIED BY THE CONTRACT ADMINISTRATOR.
 - 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 HIS OWN EXPENSE.
 - PROTECTION SYSTEM SHALL MEET REQUIREMENTS FOR
PERFORMANCE LEVEL 2. EXACT LOCATIONS AND LIMITS OF
PROTECTION SYSTEM SHALL BE DETERMINED BY CONTRACTOR.
 - BACKFILL SHALL NOT BE PLACED BEHIND THE NEW
SEMI-INTEGRAL ABUTMENTS UNTIL THE NEW CONCRETE HAS
ACHIEVED 75% OF DESIGN COMPRESSIVE STRENGTH.
 - SAWCUT IN CONCRETE, WHERE DESIGNATED, SHALL BE 25mm
DEEP OR TO THE FIRST LAYER OF REINFORCING STEEL,
WHICHEVER IS LESS.
 - 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.
 - THE CONTRACTOR IS FULLY RESPONSIBLE FOR ADEQUATE
PROTECTION OF ALL UTILITIES, SERVICES, ROADWAYS, ETC.,
DURING CONSTRUCTION OPERATIONS.
 - 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.
 - 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.
 - 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.

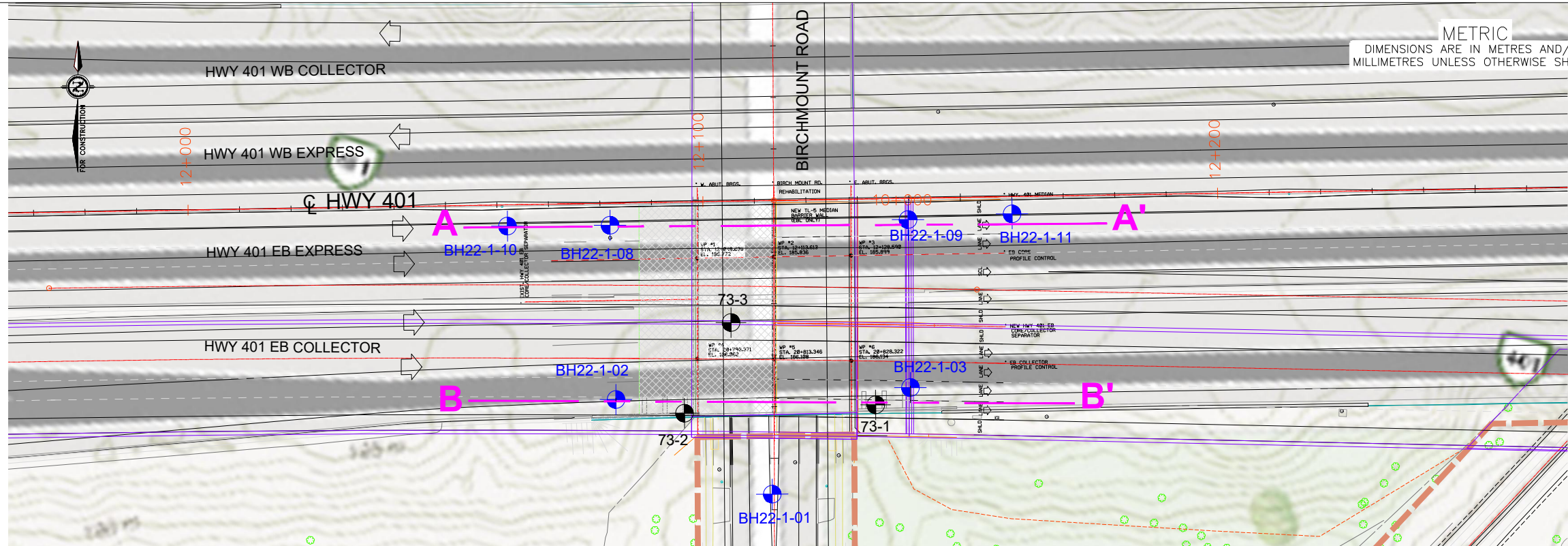
LEGEND:

	EXIST. CONCRETE TO REMAIN		NEW CONCRETE
	REMOVAL		NEW ASPHALT

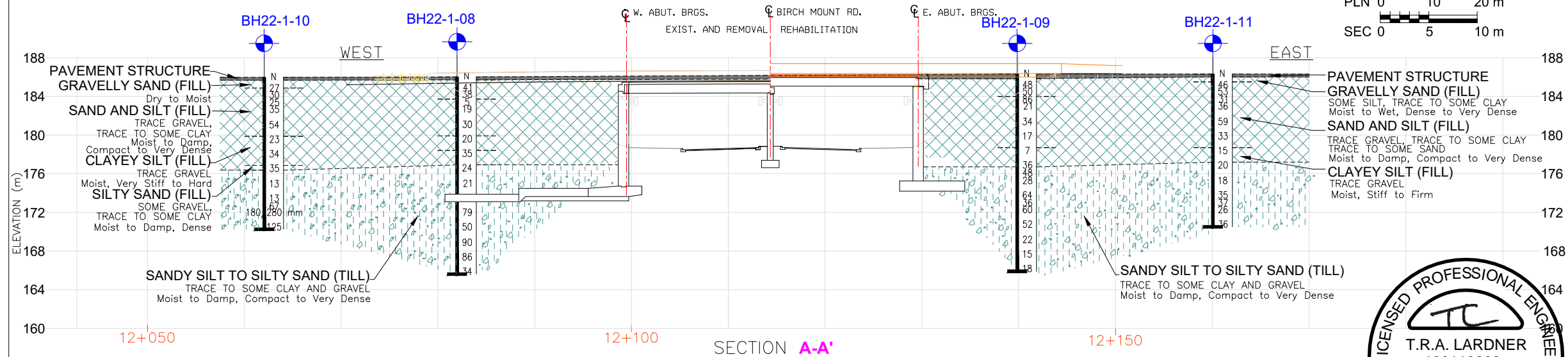
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DESIGN J.C.	CHK U.P.	CODE CAN/CSA S6-19
DRAWN T.K/O.Z.	CHK J.C.	SITE 37X-0212/B1&B3
		LOAD CL 625-ONT
		DATE OCT. 2024
		DWG R4-01

Appendix C – Borehole Location Plan and Stratigraphic Profile

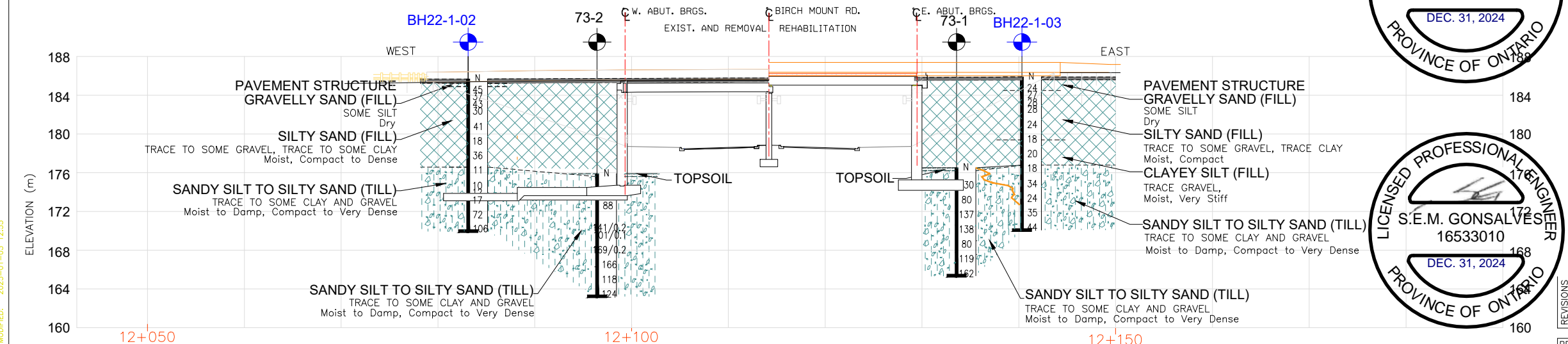
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PLAN



SECTION A-A'



SECTION B-B'

CONT No.
ASSIG No. 2021-E-0018
GWP No.

HIGHWAY 401 EB CORE & COLLECTOR
BIRCHMOUNT RD. OVERPASS
Latitude: 43.772525°, Longitude: -79.294316°
BOREHOLE LOCATION PLAN & SOIL STRATA

SHEET
1

exp.

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 TO SILTY SAND (TILL)	CLAYEY SILT TO SILTY CLAY (TILL)

BOREHOLE CO-ORDINATES/ NAD 83/ MTM ON-10			
BH No.	ELEV.	NORTHING	EASTING
BH22-1-01	180.0	4848043	321370
BH22-1-02	185.7	4848052	321336
BH22-1-03	185.9	4848071	321390
BH22-1-08	186.0	4848084	321325
BH22-1-09	186.3	4848102	321380
BH22-1-10	186.0	4848078	321306
BH22-1-11	186.3	4848109	321399
73-1	176.5	4848066	321385
73-2	175.9	4848053	321350
73-3	176.8	4848073	321353

BOREHOLE CO-ORDINATES/ NAD 83/ MTM ON-10			
BH No.	ELEV.	NORTHING	EASTING
BH22-1-01	180.0	4848043	321370
BH22-1-02	185.7	4848052	321336
BH22-1-03	185.9	4848071	321390
BH22-1-08	186.0	4848084	321325
BH22-1-09	186.3	4848102	321380
BH22-1-10	186.0	4848078	321306
BH22-1-11	186.3	4848109	321399
73-1	176.5	4848066	321385
73-2	175.9	4848053	321350
73-3	176.8	4848073	321353

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.	-
SUBM'D SH	CHKD. SM	DATE	JAN. 06, 2025
DRAWN SH	CHKD. TC	APPRD SG	SITE 37X-0212/B1 & B3
			DWG 01



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.

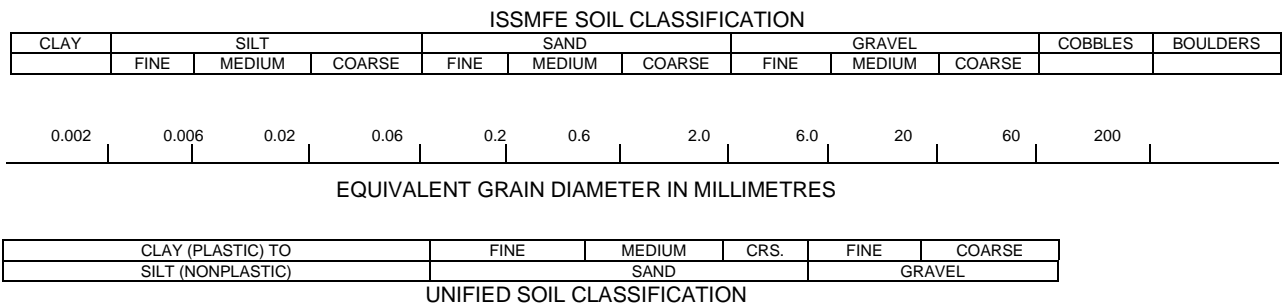
Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

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:

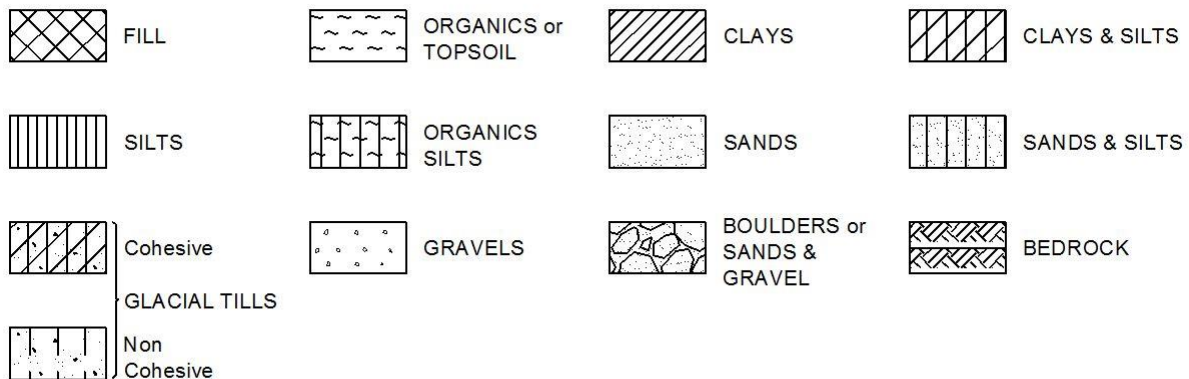
Table c: Consistency of Cohesive Soil

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
σ	kPa	Total normal stress
σ'	kPa	Effective normal stress
τ	kPa	Shear stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal stresses
ε	%	Linear strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	Principal strains
E	kPa	Modulus of linear deformation
G	kPa	Modulus of shear deformation
μ	1	Coefficient of friction

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	Coefficient of volume change
c_c	1	Compression index
c_s	1	Swelling index
c_r	1	Recompression index
c_v	m ² /s	Coefficient of consolidation
H	m	Drainage path
T_v	1	Time factor
U	%	Degree of consolidation
σ'_{v0}	kPa	Effective overburden pressure
σ'_p	kPa	Preconsolidation pressure
τ_f	kPa	Shear strength
c'	kPa	Effective cohesion intercept
ϕ'	—°	Effective angle of internal friction
c_u	kPa	Apparent cohesion intercept
ϕ_u	—°	Apparent angle of internal friction
τ_R	kPa	Residual shear strength
τ_r	kPa	Remoulded shear strength
S_t	1	Sensitivity = c_u/τ_r

PHYSICAL PROPERTIES OF SOIL

P_s	kg/m ³	Density of solid particles
γ_s	kN/m ³	Unit weight of solid particles
ρ_w	kg/m ³	Density of water
γ_w	kN/m ³	Unit weight of water
ρ	kg/m ³	Density of soil
γ	kN/m ³	Unit weight of soil
ρ_d	kg/m ³	Density of dry soil
γ_d	kN/m ³	Unit weight of dry soil
ρ_{sat}	kg/m ³	Density of saturated soil
γ_{sat}	kN/m ³	Unit weight of saturated soil
ρ'	kg/m ³	Density of submerged soil
γ'	kN/m ³	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 ³ /s	Rate of discharge
v	m/s	Discharge velocity
i	1	Hydraulic gradient
k	m/s	Hydraulic conductivity
j	kN/m ³	Seepage force

Brampton, Ontario

RECORD OF BOREHOLE No BH22-1-01

1 OF 1

METRIC

W.P. Site 37X-0212/B1&B3 LOCATION Hwy 401 - Birchmount Road O/P, Toronto, ON, MTM ON-10 321370.4E 4848043.3N ORIGINATED BY CA
DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount MARL M10 / SSA COMPILED BY CA
DATUM Geodetic DATE 2023.03.20 - 2023.03.20 LATITUDE 43.772165 LONGITUDE -79.294168 CHECKED BY TL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE		● QUICK TRIAXIAL × LAB VANE									
180.0							20	40	60	80	100								
179.8	PAVEMENT STRUCTURE - 25 mm of asphalt, and 230 mm of concrete SAND AND GRAVEL (FILL) - trace to some silt, grey, moist SILTY SAND TO SAND AND SILT (TILL) - trace to some gravel, trace to some clay, brown to brownish grey, moist, compact to very dense		AS1	AS															
179.3			SS2	SS	79														
0.4																			
			SS3	SS	35														
			SS4	SS	37														
			SS5	SS	44														
			SS6	SS	26														
			SS7	SS	97														
			SS8	SS	32														
170.4	- brownish grey below ~ 9.1 m depth		SS9	SS	27														
9.6	END OF BOREHOLE NOTE: 1) No groundwater was encountered in open borehole upon completion of drilling.																		

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

Brampton, Ontario

RECORD OF BOREHOLE No BH22-1-02

1 OF 1

METRIC

W.P. Site 37X-0212/B1&B3 LOCATION Hwy 401 - Birchmount Road O/P, Toronto, ON, MTM ON-10 321336.0E 4848051.9N ORIGINATED BY SF/OD
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY SF/OD
 DATUM Geodetic DATE 2022.11.28 - 2022.11.28 LATITUDE 43.772243 LONGITUDE -79.294595 CHECKED BY TL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)			GR	SA	SI	CL
								20	40	60	80					100	○ UNCONFINED	+ FIELD VANE				
185.7																						
0.0																						
185.2																						
184.9																						
0.8																						
	</																					

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

ONTARIO MTO H401 - BIRCHMOUNT - 07022023.GPJ ONTARIO MTO.GDT 1/22/24

Brampton, Ontario

RECORD OF BOREHOLE No BH22-1-03

1 OF 1

METRIC

W.P. Site 37X-0212/B1&B3 LOCATION Hwy 401 - Birchmount Road O/P, Toronto, ON, MTM ON-10 321390.0E 4848071.2N ORIGINATED BY SF/OD
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY SF/OD
 DATUM Geodetic DATE 2022.12.12 - 2022.12.12 LATITUDE 43.772415 LONGITUDE -79.293924 CHECKED BY TL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE										
						● QUICK TRIAXIAL × LAB VANE												
						20 40 60 80 100												
185.9	PAVEMENT STRUCTURE - 90 mm of asphalt, and 210 mm of concrete																	
186.0			AS1	AS														
0.3	GRAVELLY SAND (FILL) - some silt, brown, moist, compact		SS2	SS	24		185											
184.5			SS3	SS	27		184											
1.4	SILTY SAND (FILL) - trace to some gravel, trace clay, light brown to light grey, slightly moist, compact		SS4	SS	28		183											
			SS5	SS	28		182											
							181											
			SS6	SS	24		180											
							179											
179.5	CLAYEY SILT (FILL) - sandy, trace gravel, light brown to grey, moist, very stiff		SS7	SS	18		178											
6.4			SS8	SS	20		177											
176.8	SILTY SAND TO SAND AND SILT (TILL) - trace to some gravel, trace to some clay, light brown to grey, moist, compact to dense		SS9	SS	18		176											
9.1							175											
			SS10	SS	34		174											
							173											
			SS11	SS	24		172											
							171											
			SS12	SS	35													
170.1	- becoming dark brown to grey below a depth of 10.7 m																	
15.8			SS13	SS	44													
170.1	END OF BOREHOLE																	
15.8	NOTE: 1) No groundwater was encountered in open borehole upon completion of drilling.																	

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

ONTARIO MTO H401 - BIRCHMOUNT - 07022023.GPJ ONTARIO MTO.GDT 1/22/24

Brampton, Ontario

RECORD OF BOREHOLE No BH22-1-08

1 OF 1

METRIC

W.P. Site 37X-0212/B1&B3 LOCATION Hwy 401 - Birchmount Road O/P, Toronto, ON, MTM ON-10 321324.7E 4848084.4N ORIGINATED BY SF/OD
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY SF/OD
 DATUM Geodetic DATE 2022.11.02 - 2022.11.03 LATITUDE 43.772535 LONGITUDE -79.294734 CHECKED BY TL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE															
186.0								20	40	60	80	100											
186.0	PAVEMENT STRUCTURE - 80 mm of asphalt, and 220 mm of concrete GRAVELLY SAND (FILL) - brown, moist, dense		AS1	AS			185							○									
0.3			SS2	SS	41										○								
			SS3	SS	38										○								
183.7	SILTY SAND (FILL) - trace to some clay, trace gravel, brown, damp to moist, loose to dense		SS4	SS	5		184							○									
2.3			SS5	SS	19									○									
			SS6	SS	30										○								
179.9	CLAYEY SILT (FILL) - sandy, trace gravel, brown to grey, moist, very stiff		SS7	SS	20		180							○									
6.1															○								
178.4	SILTY SAND (FILL) - trace to some clay, trace gravel, brown, damp to moist, dense		SS8	SS	35		179							○									
7.6															○								
176.9	SILTY SAND TO SAND AND SILT (TILL) - trace to some gravel, trace to some clay, brown to grey to black, damp to wet, compact to very dense - trace organics encountered at a depth of ~11.0 m		SS9	SS	24		178							○									
9.1															○								
															○								
															○								
															○								
															○								
															○								
															○								
															○								
															○								
165.6	END OF BOREHOLE NOTE: 1) Groundwater inferred at a depth of 18.6 m based on wet split spoon retrieved during drilling.		SS10	SS	21		177							○									
															○								
															○								
															○								
															○								
															○								
															○								
															○								
															○								
															○								
20.4			SS11	SS	94		176							○									
			SS12	SS	79		175							○									
			SS13	SS	50		174							○									
			SS14	SS	90		173							○									
			SS15	SS	86		172							○									
			SS16	SS	34		171							○									
							170							○									
							169							○									
							168							○									
							167							○									
							166							○									

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

ONTARIO MTO H401 - BIRCHMOUNT - 07022023.GPJ ONTARIO MTO.GDT 1/22/24

Brampton, Ontario

RECORD OF BOREHOLE No BH22-1-09

1 OF 1

METRIC

W.P. Site 37X-0212/B1&B3 LOCATION Hwy 401 - Birchmount Road O/P, Toronto, ON, MTM ON-10 321380.1E 4848102.3N ORIGINATED BY SF/OD
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY SF/OD
 DATUM Geodetic DATE 2022.11.07 - 2022.11.08 LATITUDE 43.772695 LONGITUDE -79.294045 CHECKED BY TL

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL
186.3 0.0	PAVEMENT STRUCTURE - 150 mm of asphalt and 310 mm of concrete		AS1	AS		186													
185.8 0.5			SS2	SS	48	185													
			SS3	SS	50	184													
184.0 2.3	SILTY SAND (FILL) - trace to some clay, trace gravel, brown, damp to moist, compact to very dense		SS4	SS	86	183													
			SS5	SS	21	182													
			SS6	SS	34	181													
			SS7	SS	17	180													
						179													
178.7 7.6	CLAYEY SILT (FILL) - sandy, trace gravel, brown to dark grey, moist, firm to hard		SS8	SS	7	178													
						177													
176.7 9.6	SILTY SAND TO SAND AND SILT (TILL) - trace to some gravel, trace to some clay, brown to dark grey, moist to wet, compact to very dense		SS9	SS	36	176													
			SS10	SS	48	175													
			SS11	SS	28	174													
						173													
			SS12	SS	64	172													
			SS13	SS	36	171													
			SS14	SS	60	170													
						169													
			SS15	SS	52	168													
						167													
165.9 20.4	END OF BOREHOLE		SS16	SS	22	166													
	NOTE: 1) No groundwater was encountered in open borehole upon completion of drilling.																		

ONTARIO MTO H401 - BIRCHMOUNT - 07022023.GPJ ONTARIO MTO.GDT 1/22/24

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

Brampton, Ontario

RECORD OF BOREHOLE No BH22-1-10

1 OF 1

METRIC

W.P. Site 37X-0212/B1&B3 LOCATION Hwy 401 - Birchmount Road O/P, Toronto, ON, MTM ON-10 321305.8E 4848077.9N ORIGINATED BY SF/OD
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY SF/OD
 DATUM Geodetic DATE 2022.11.15 - 2022.11.15 LATITUDE 43.772477 LONGITUDE -79.294969 CHECKED BY TL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)	
186.0								20	40	60	80	100					
186.0	PAVEMENT STRUCTURE - 100 mm of asphalt, and 200 mm of concrete		AS1	AS													
0.3																	
184.9	GRAVELLY SAND (FILL) - brown, moist		SS2	SS	27												
1.1	SAND AND SILT (FILL) - trace gravel, trace clay, brown, moist, compact to very dense		SS3	SS	30												
	- Thin layers of clayey silt were encountered between a depth of 2.3 m and 3.0 m.		SS4	SS	25												
			SS5	SS	35												
			SS6	SS	54												
179.9	CLAYEY SILT (FILL) - sandy, trace gravel, brown to grey, moist, very stiff to hard		SS7	SS	23												
6.1																	
			SS8	SS	34												
176.9	SAND AND SILT (FILL) - some gravel, trace to some clay, brown, moist, dense		SS9	SS	35												
9.1																	
176.4	SILTY SAND TO SAND AND SILT (TILL) - trace to some gravel, trace to some clay, brown to brownish grey, moist, compact to very dense		SS10	SS	13												
9.6																	
			SS11	SS	13												
			SS12	SS	67												
			SS13	SS	180/ 280 mm												
170.3	END OF BOREHOLE		SS14	SS	125												
15.7	NOTE: 1) No groundwater was encountered in open borehole upon completion of drilling.																

ONTARIO MTO H401 - BIRCHMOUNT - 07022023.GPJ ONTARIO MTO.GDT 1/22/24

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

Brampton, Ontario

RECORD OF BOREHOLE No BH22-1-11

1 OF 1

METRIC

W.P. Site 37X-0212/B1&B3 LOCATION Hwy 401 - Birchmount Road O/P, Toronto, ON, MTM ON-10 321399.1E 4848108.6N ORIGINATED BY SF/OD
 DIST Toronto HWY 401 BOREHOLE TYPE Truck Mount CME 75 / SSA COMPILED BY SF/OD
 DATUM Geodetic DATE 2022.11.09 - 2022.11.09 LATITUDE 43.772752 LONGITUDE -79.293809 CHECKED BY TL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								20	40	60						80	100	20
						○ UNCONFINED + FIELD VANE												
						● QUICK TRIAXIAL × LAB VANE												
186.3																		
186.0	PAVEMENT STRUCTURE - 90 mm of asphalt, and 210 mm of concrete		AS1	AS			186											
0.3																		
185.5	GRAVELLY SAND (FILL) - grey, moist		SS2	SS	46		185											
0.8																		
	SAND AND SILT (FILL) - trace to some clay, trace gravel, brown to dark grey, moist, dense to very dense		SS3	SS	53													
							184											
			SS4	SS	31													
							183											
	- A thin layer of clayey silt was encountered at a depth of 2.3 m		SS5	SS	36													
							182											
			SS6	SS	59													
							181											
			SS7	SS	33		180											
							179											
178.7																		
7.6	CLAYEY SILT (FILL) - sandy, trace gravel, brown, moist, very stiff		SS8	SS	15		178											
177.2							177											
9.1			SS9	SS	20													
	SILTY SAND TO SAND AND SILT (TILL) - trace to some gravel, trace to some clay, brown to grey, dry to moist, compact to dense						176											
			SS10	SS	18													
							175											
			SS11	SS	35		174											
			SS12	SS	37		173											
			SS13	SS	26		172											
							171											
			SS14	SS	36													
170.5																		
15.8	END OF BOREHOLE																	
	NOTE: 1) No groundwater was encountered in open borehole upon completion of drilling.																	

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

ONTARIO MTO H401 - BIRCHMOUNT - 07022023.GPJ ONTARIO MTO.GDT 1/22/24

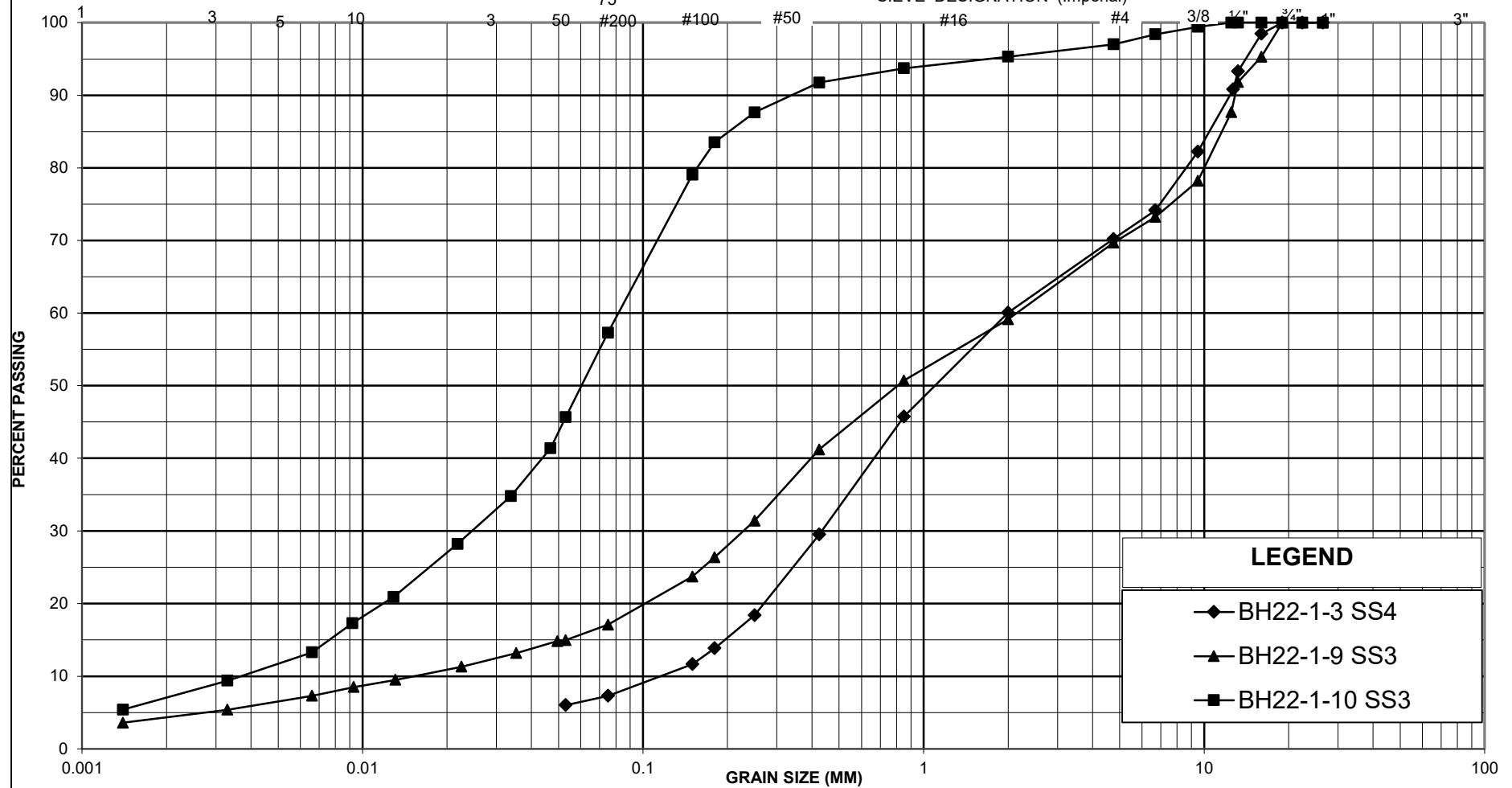
Appendix E – Laboratory Data

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (Imperial)

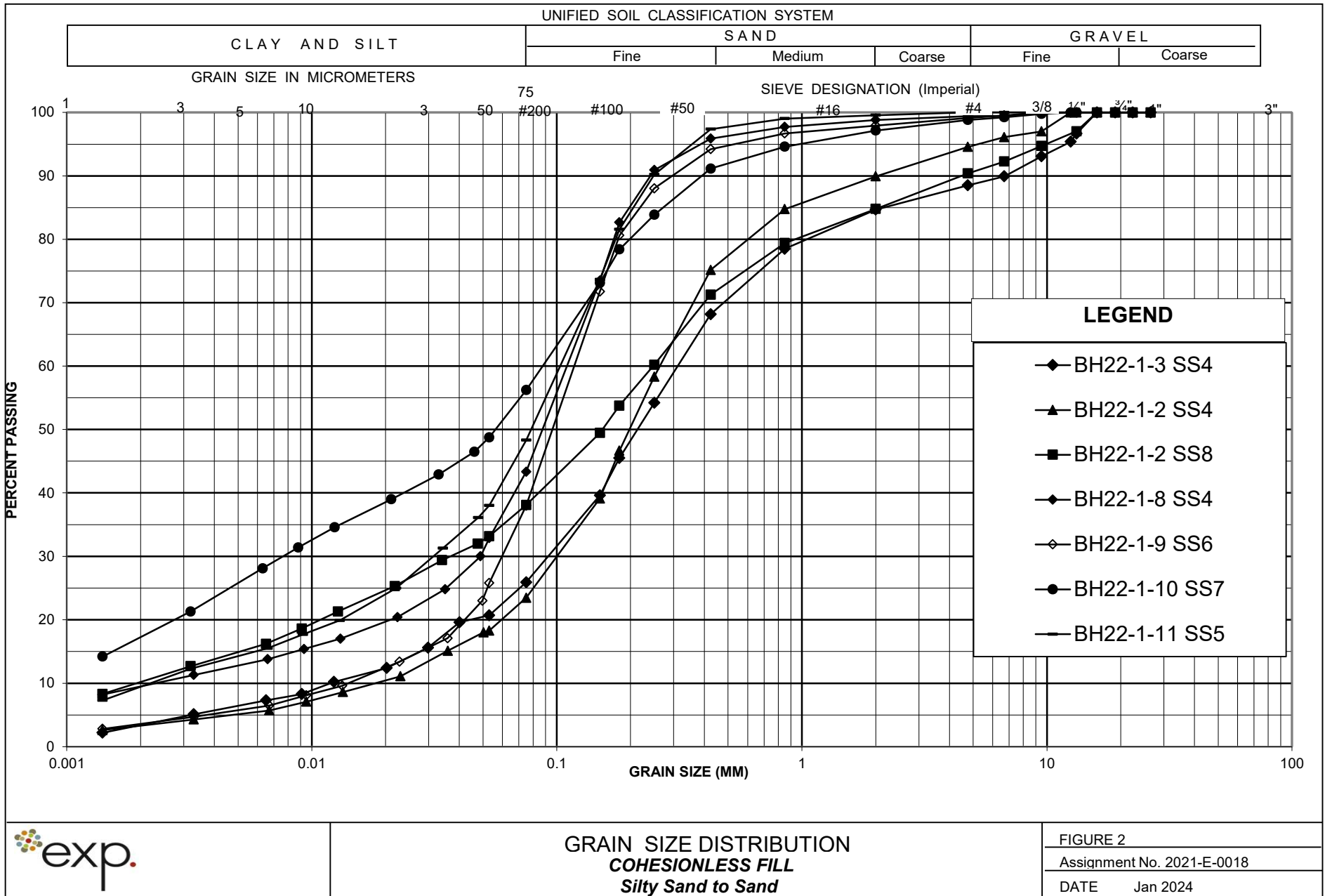


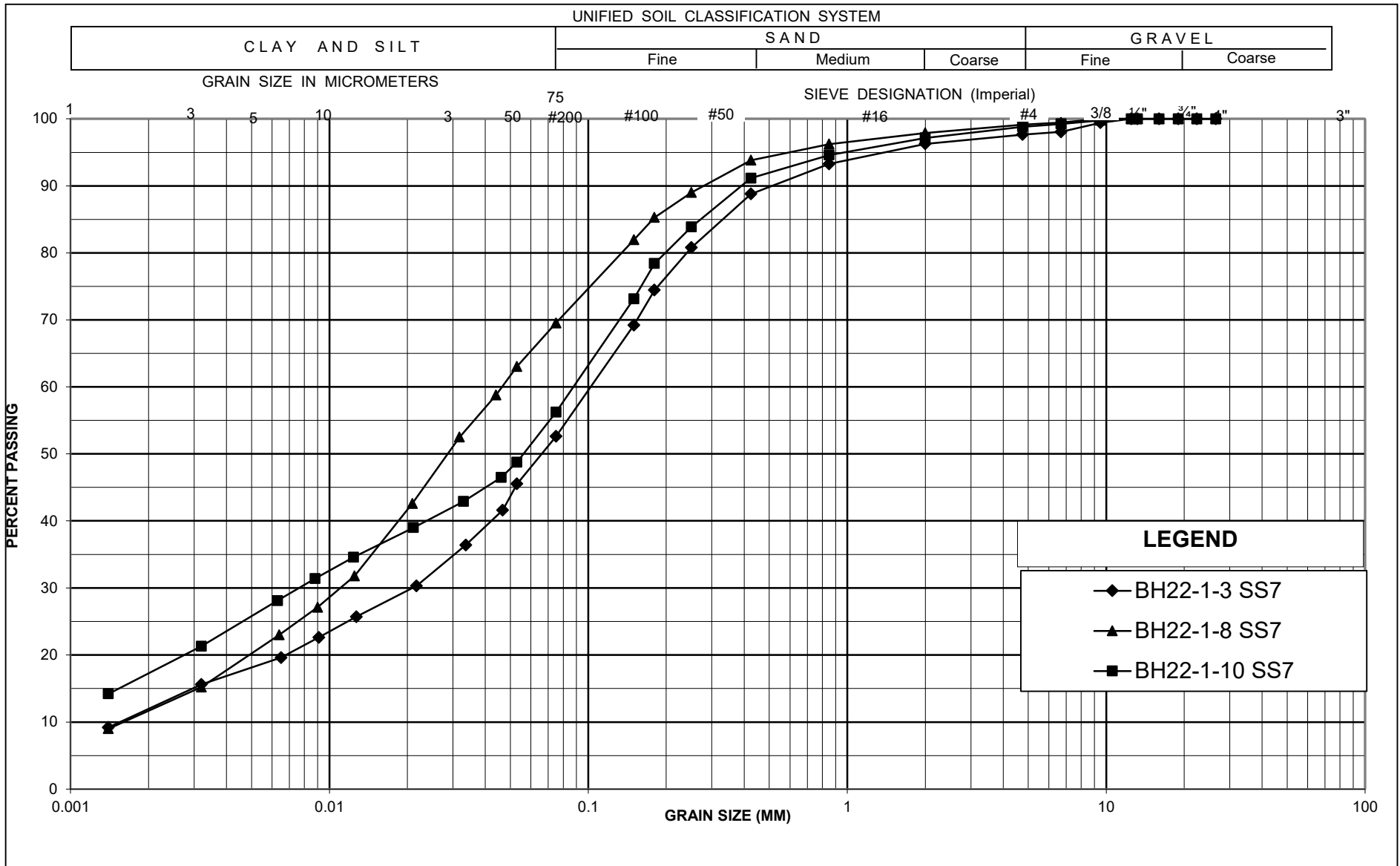
GRAIN SIZE DISTRIBUTION
COHESIONLESS FILL

FIGURE 1

Assignment No. 2021-E-0018

DATE Jan 2024



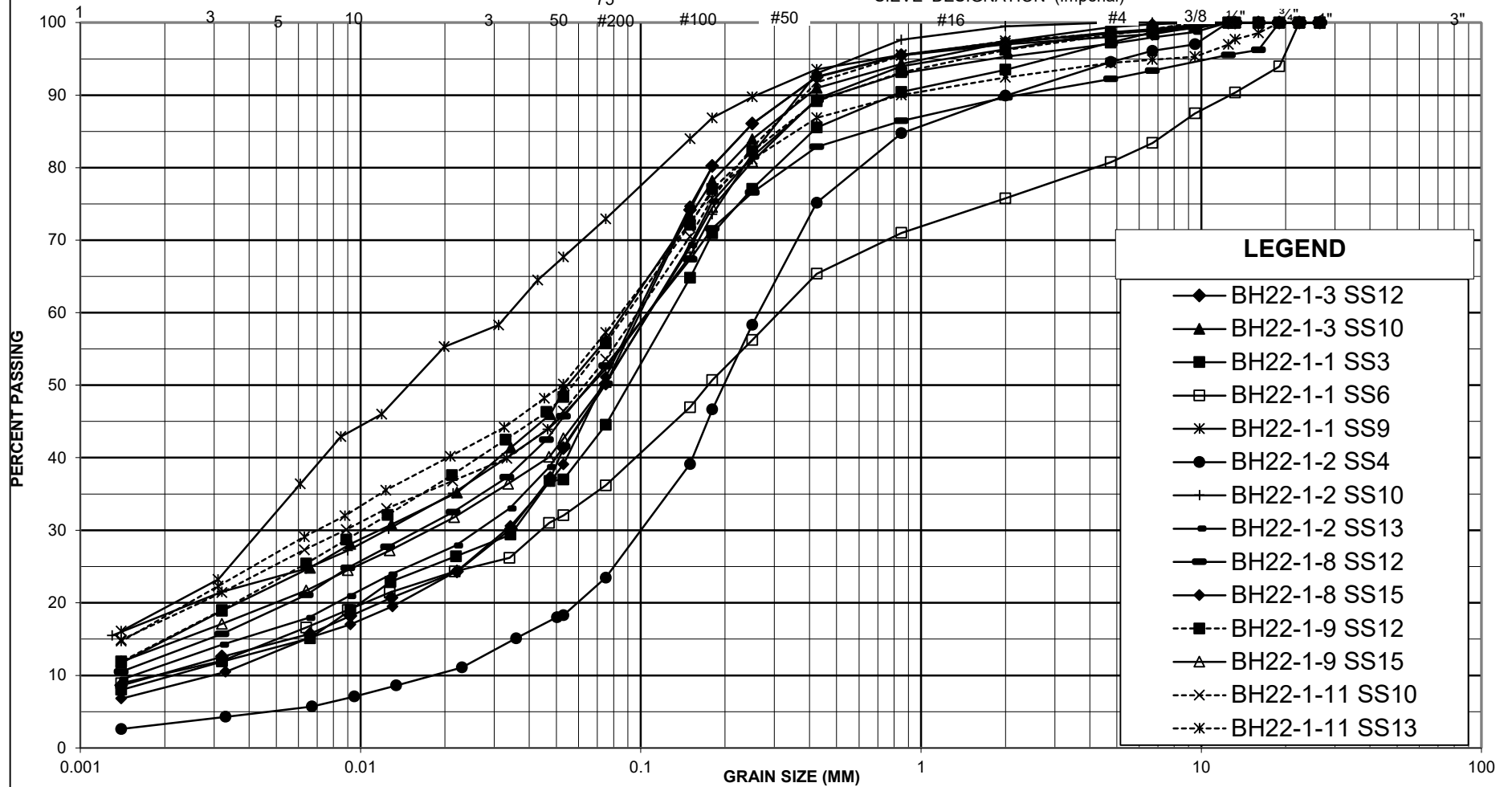


UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (Imperial)



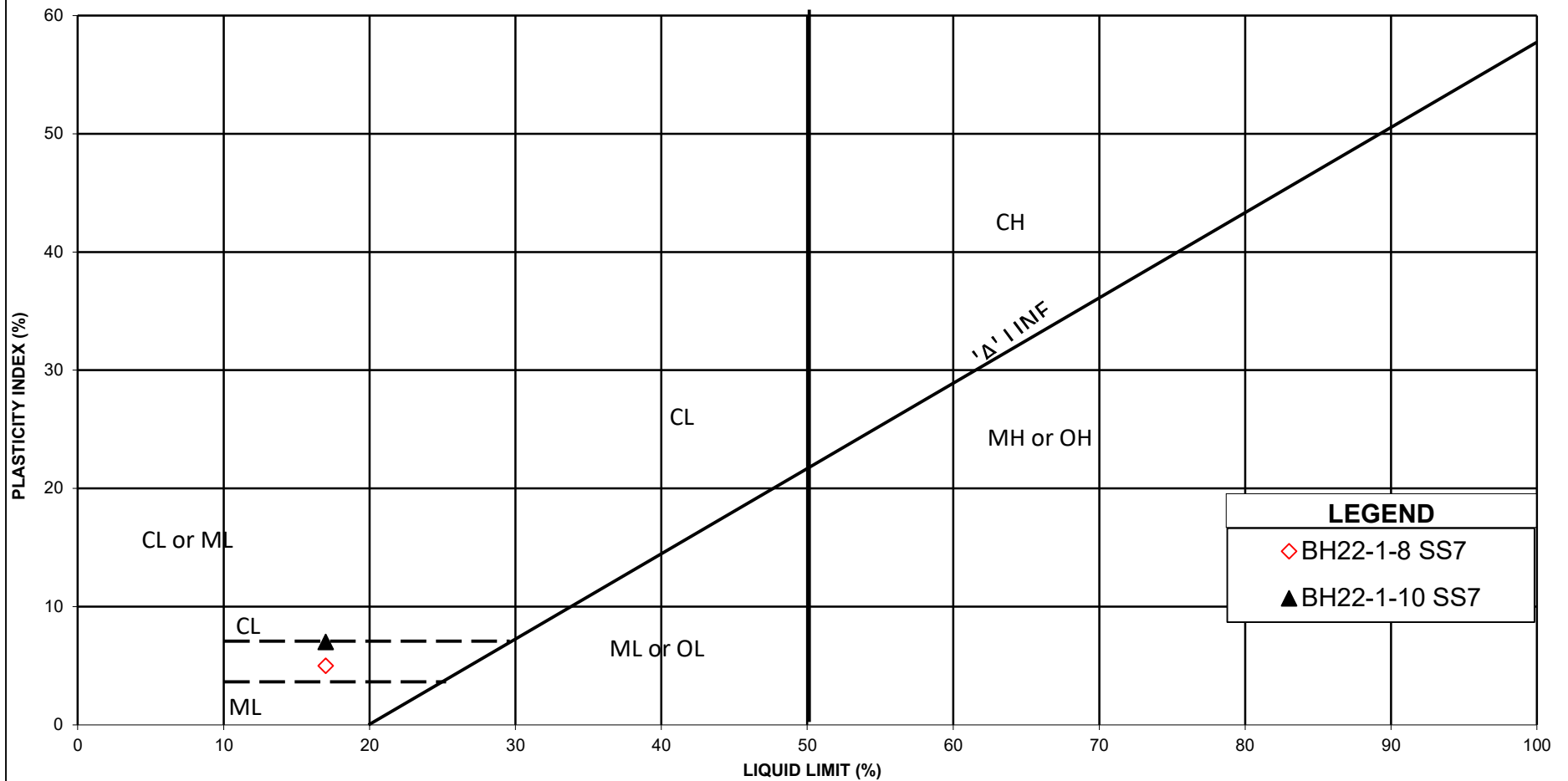
GRAIN SIZE DISTRIBUTION
SILTY SAND TO SANDY SILT (TILL)

FIGURE 4

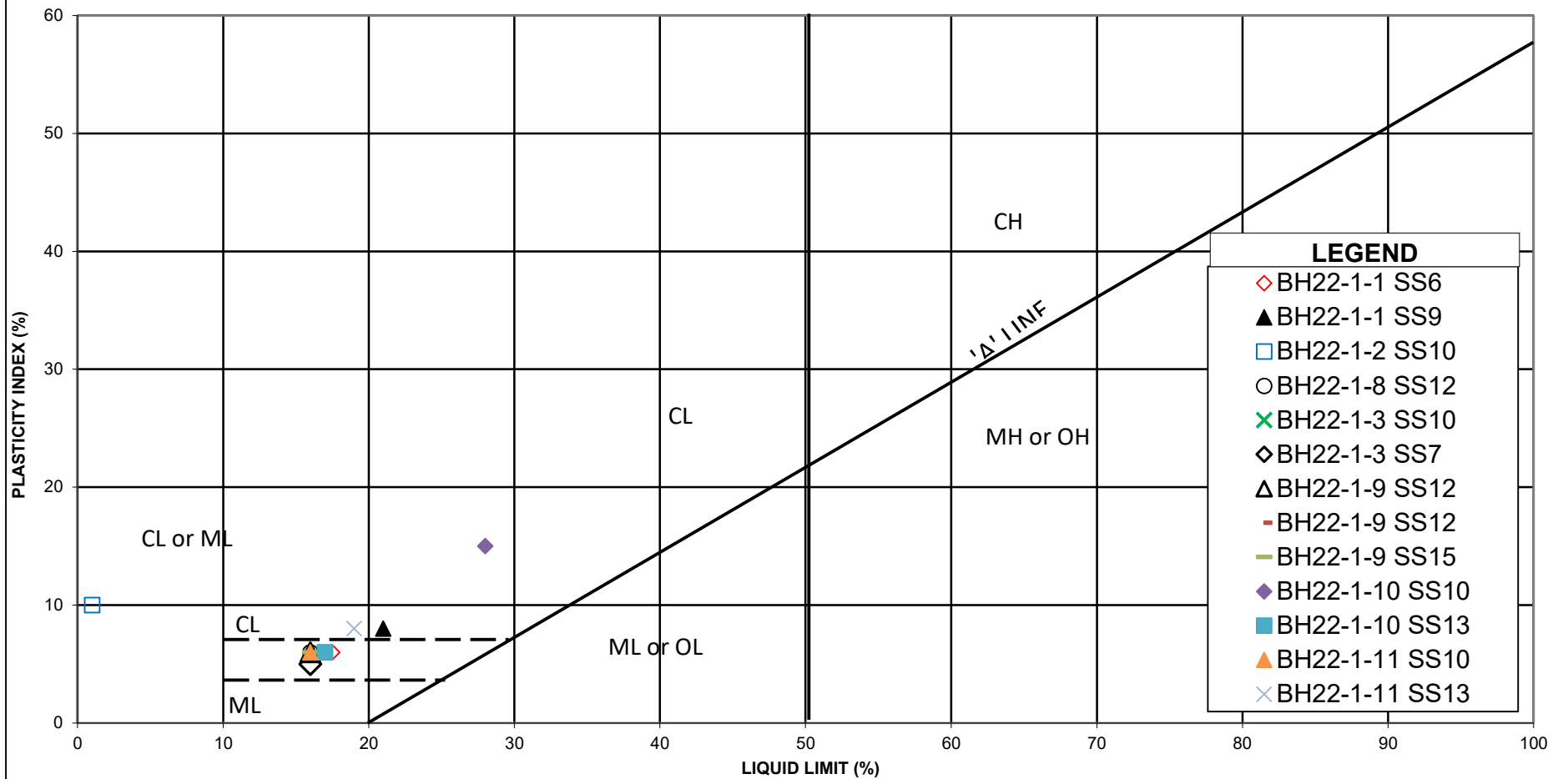
Assignment No. 2021-E-0018

DATE Jan 2024

Highway 401 - Birchmount Road Overpass



Highway 401 - Birchmount Road Overpass



Appendix F – Previous Investigation - BH logs

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 65-F-49LOCATION Hwy. #401 & Birchmount Rd Hwy #401 Ch 316/92 130'-0" RtORIGINATED BY W.W.K.W.P. 256-61BORING DATE May 12, 1965.COMPILED BY W.W.K.DATUM 579.0BOREHOLE TYPE Penndrill 4" Auger.CHECKED BY K.G.S. *GR*

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 WATER CONTENT % 5 10 15	BULK DENSITY P.C.F.	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT					
579.0	Groundlevel									
578.0	Black Org. Topsoil									
1.0	Silty sand to sandy silt with traces of clay and gravel.		1	SS	130					
	Compact to very dense.		2	SS	80					
				for 4"						
			3	SS	137					
			4	SS	138					
			5	SS	80					
				for 4"						
			6	SS	119					
542.5			7	SS	162					
36.5	End of borehole.									

W.L. El.
551.5
Observed in Borehole.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 65-F-49

LOCATION Hwy. #401 Birchmount Rd Hwy #401 Ch 315/72 130'-0" Rt.

ORIGINATED BY W.W.K.

W.P. 256-01

BORING DATE May 12, 1965.

COMPILED BY W.W.K.

DATUM 577.0

BOREHOLE TYPE Penndrill 4" Auger

CHECKED BY *AK*

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		
577.0	Groundlevel															
576.0	Black org. topsoil															
1.0																
	Silty sand to sandy silt with traces of clay and gravel.		1	SS	39	570										
	Compact to very dense.		2	SS	88											
			3	SS	141	560										
				for 7"												
			4	SS	101											
				for 5"												
			5	SS	169	550										
				for 9"												
			6	SS	166											
			7	SS	118	540										
535.5			8	SS	124											
41.5	End of borehole.					530										

W.L. El.
▼ 550.0
Observed in Borehole.

DEPARTMENT OF HIGHWAYS - ONTARIO


MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 65-F-49 LOCATION Hwy #401 & Birchmount Rd Hwy #401 Ch 316+02 75'-0" Rt. ORIGINATED BY W.W.K.
 W.P. 256-61 BORING DATE May 12 & 13, 1965. COMPILED BY W.W.K.
 DATUM 580.0 BOREHOLE TYPE Penndril 4" Auger. CHECKED BY W.W.K.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	WP	WL		
580.0	Groundlevel											
578.5	Sand, gravel - Fill											
1.5												
			1	SS	33							
			2	SS	129	570						
			3	SS	125							
			4	SS	120	560						
			5	SS	80							
			for 3"			550						
			6	SS	80							
			for 2 1/2"									
			7	SS	126							
			8	SS	121	540						
538.5												
41.5	End of borehole.											

W.L. Fl.
 551.0
 Observed in Borehole.