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REPORT

Foundation Investigation and Design Report

Noise Barrier Walls Between Bayview Avenue and Leslie Street
Highway 401 Eastbound Collectors Widening, Avenue Road to Warden Avenue
MTO G.W.P. 2130-01-00

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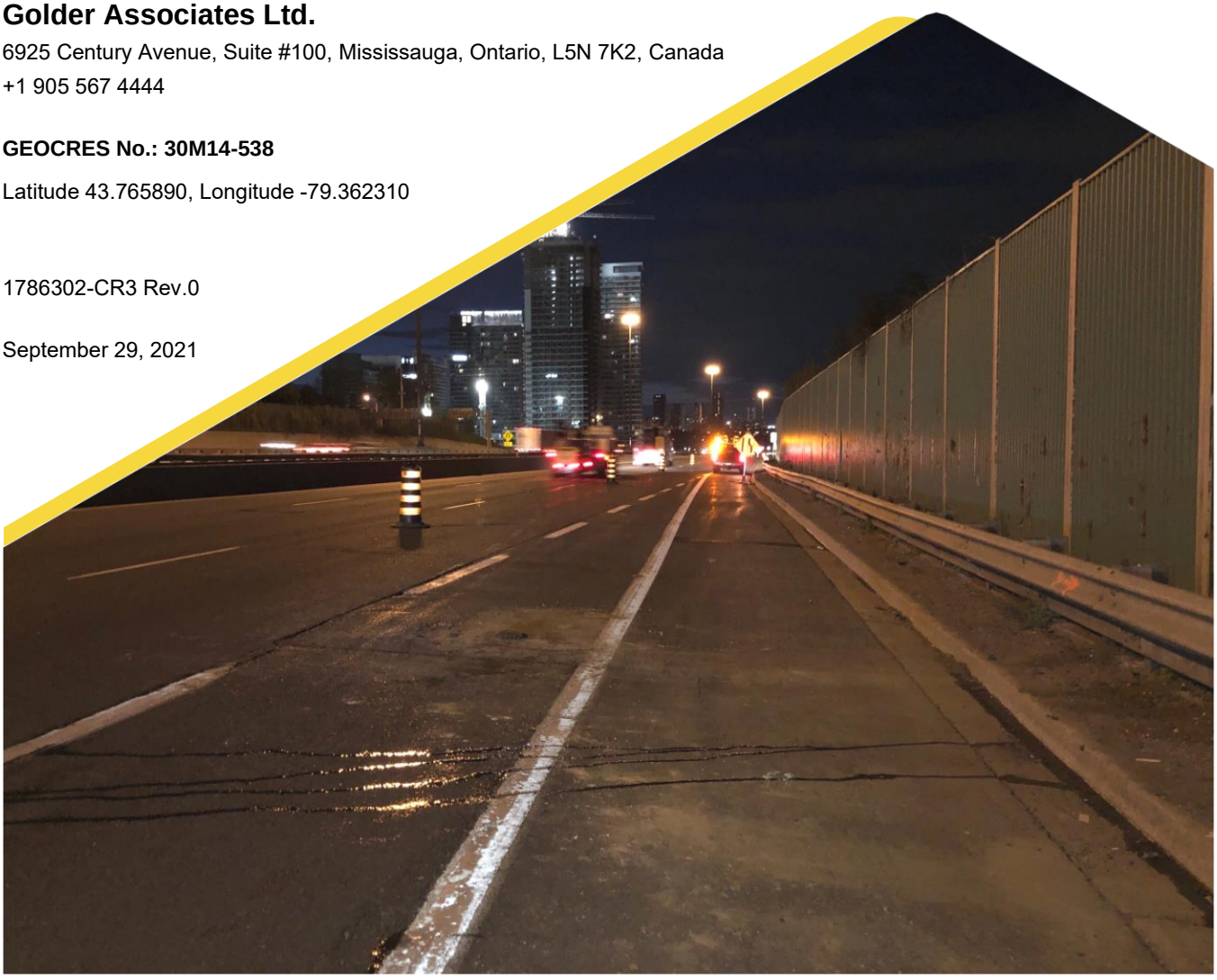

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PART A

FOUNDATION INVESTIGATION REPORT
NOISE BARRIER WALLS BETWEEN AVENUE ROAD AND LESLIE STREET
HIGHWEAY 401 EASTBOUND COLLECTORS WIDENING, AVENUE ROAD TO WARDEN AVENUE
MTO G.W.P. 2130-01-00

1.0 INTRODUCTION

Golder Associates Ltd. (Golder), member of WSP, has been retained by AECOM on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the detail design of the rehabilitation of the Highway 401 Eastbound Collector lanes between Avenue Road and Warden Avenue (approximately 10 km) in City of Toronto, Ontario (MTO Assignment No. 2016-E-0089).

This report presents the subsurface conditions for the replacement of the noise barrier walls between Bayview Avenue and Leslie Street, along the Highway 401 Eastbound Collector (EBC) lanes. This report was developed based on the result from Golder's foundation investigation and laboratory testing, and previous investigations and testing completed by other on MTO's GEOCRES System.

The results of foundation investigations for other works associated with this assignment are presented in separate reports.

2.0 SITE DESCRIPTION

There are two sections of existing noise barrier walls along the Highway 401 EBC between Bayview Avenue and Leslie Street. The first section of the noise barrier wall is located just east of Bayview Avenue, while the other section is from about the N-E Ramp at Bayview Avenue westerly to Leslie Street E-N/S Ramp. The limits of the proposed replacement of the two noise barrier walls are from STA 23+764 to 23+887 and from STA 23+840 to 25+022, respectively as shown on Drawing 1. The noise barrier wall from STA 25+022 easterly is to be replaced under a separate contract.

The existing noise barrier wall is 4 m high and is generally located at the crest of highway or top of cut slope. From about STA 24+031 to 24+335, the existing noise barrier wall was constructed on retaining walls up to about 2.5 m high. It should be noted that the retaining wall from STA 24+031 to 24+151 was constructed in a fill section (i.e., the front of the retaining wall faces away from the highway) while the section of retaining wall from STA 24+151 to 24+335 was constructed in a cut section (i.e. the front of the retaining wall faces the highway).

3.0 INVESTIGATION PROCEDURES

3.1 2015 Investigation (GEOCRES No. 30M14-440)

Between March and April of 2015, a foundation investigation was carried out by Thurber Engineering Ltd. (Thurber) during which time a total of two boreholes were drilled for the retaining/noise barrier wall. One of the two boreholes (Borehole W-01) was drilled near the east limit of noise barrier wall. The results of the Thurber investigation are contained in their report titled, "Foundation Investigation Report, W-N/S Ramp Leslie Street/CNR Overhead and Pedestrian Overpass, Highway 401 and Leslie Street Interchange, Toronto, Ontario, W.P. 2061-13-00, Site 37-206/5", dated October 26, 2016 (GEOCRES Report No. 30M14-440). The locations of Borehole W-01 is summarized in the table below along with the geographic coordinates, ground surface elevations (referenced to Geodetic Datum), and the drilled depths based on the Thurber borehole records. Borehole W-01 is shown in plan on Drawing 1 and the borehole records and the summary of the relevant laboratory testing results from the Thurber investigation are presented in Appendix A.

Borehole No.	Location	Location (MTM NAD 83 Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing (Latitude, °)	Easting (Longitude, °)		
W-01	Near the East Limit of Noise Barrier Wall	4,847,294.6 (43.765538)	315,151.6 (-79.371430)	154.6	9.6

3.2 Current Investigation

The foundation investigation for the proposed replacement of noise barrier walls was carried out between May 10, 2021, and May 18, 2021, during which time a total of eight boreholes (designated as Boreholes NW3-1 to NW3-8) were advanced in the vicinity of existing noise barrier wall. The locations of the boreholes are shown on Drawing 1 and the borehole records are provided in Appendix B. Lists of abbreviations and symbols and lithological terminology are also provided in Appendix B to assist in the interpretation of the borehole records.

Due to the existing reinforced concrete composite pavement structure along Highway 401, the coring of the pavement structure was completed by 254 mm outside diameter (O.D.) core bit, at all borehole locations advanced through the highway, supplied and operated by Canadian Cutting and Coring of Brampton, Ontario. Upon completion of the coring of the pavement structure, boreholes were advanced using a CME-75 truck-mounted drill rig, supplied and operated by Geo-Environmental Drilling Inc. of Halton Hills, Ontario.

Soil samples from boreholes were generally obtained at 0.75 m and 1.5 m intervals of depth, using a 50 mm O.D. split-spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures. The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 35 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension would not be sampled or represented in the grain size distributions. Field vane shear tests were carried out in cohesive soils for assessment of undrained shear strengths using MTO Standard ‘N’ size vanes.

Groundwater conditions and water levels in the open boreholes were observed during and immediately following the drilling operations. All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 Wells (as amended), and the ground surface was restored to near original condition as practical using cold-patch asphalt and quick-set concrete, as applicable.

The field work was observed by members of Golder’s engineering and technical staff, who marked the borehole locations, arranged for the clearance of underground utilities, observed the drilling, sampling and in-situ testing operations, and logged the boreholes and cone penetration testing. The soil samples were identified in the field, placed in appropriate containers, labelled, and transported to Golder’s Mississauga geotechnical laboratory where the samples and cores underwent further visual examination and laboratory testing in accordance with MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected soil samples. The results of the laboratory testing on the soil and rock core samples from the current investigation are included in Appendix C.

Selected soil samples were submitted to Bureau Veritas Laboratories, a Standards Council of Canada (SCC) accredited laboratory of Mississauga, Ontario for chemical analysis. The selected samples were analyzed for a suite of corrosivity parameters, including conductivity, resistivity, soluble chloride, soluble sulphate and pH. The results of the chemical analysis are presented in Appendix C.

The as-drilled borehole locations and the ground surface elevations were obtained using either a GPS Trimble GEO 7X, having an accuracy of approximately 0.1 m in the vertical and 0.1 m in the horizontal directions, or were measured relative to identifiable site features and superimposed on the base plan. The locations given on the borehole records and shown on Drawing 1 are positioned related to MTM NAD 83 (Zone 10) CSRS CGVD28 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, geographic coordinates, ground surface elevations and depths advanced prior to termination are summarized below.

Borehole No.	Location (MTM NAD 83 Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (Latitude, °)	Easting (Longitude, °)		
NW3-1	4,847,007.8 (43.762981)	313,930.4 (-79.386606)	175.8	8.2
NW3-2	4,847,043.6 (43.763302)	314,047.3 (-79.385153)	175.8	8.2
NW3-3	4,847,076.2 (43.763594)	314,183.1 (-79.383466)	173.8	11.3
NW3-4	4,847,108.9 (43.763887)	314,280.1 (-79.382261)	172.6	11.3
NW3-5	4,847,136.9 (43.764138)	314,374.9 (-79.381083)	171.1	8.2
NW3-6	4,847,165.4 (43.764393)	314,486.0 (-79.379703)	169.2	8.2
NW3-7	4,847,198.0 (43.764685)	314,611.3 (-79.378146)	167.1	9.8
NW3-8	4,847,222.9 (43.764908)	314,701.6 (-79.377024)	165.8	8.2

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The area surrounding between Bayview Avenue and Leslie Street is within the physiographic region known as the South Slope, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984) [1].

The South Slope physiographic region is characterized by a smooth to drumlinized till plain that was formed as a result of glacial action and deposition of till material south of the Oak Ridges Moraine. The South Slope contains a variety of soil deposits that have developed over till and the overburden soils can typically be more than 50 m thick. The underlying bedrock consists of grey shale of the Georgian Bay Formation interbedded with limestone, siltstone and sandstone. Within and adjacent to the East Don River, interglacial and post-glacial flooding in the valley has produced deposits of glaciolacustrine sands, silts, and silty clay.

4.2 Subsurface Conditions

The borehole records and laboratory testing summary figures from the previous investigations are presented in Appendix A. The borehole records from the current investigation are presented in Appendix B, while the geotechnical and analytical laboratory test results from the current investigation are presented in Appendix C.

The results of in-situ tests (i.e., SPT and shear vane) as presented in the borehole records and in Section 4.2 are uncorrected. The boundaries between the soil deposits on the borehole records have been inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Variation in the stratigraphic boundaries between and beyond boreholes will exist and is to be expected.

In general, the subsurface soils encountered consist of surficial layers of composite pavement structure, underlain by cohesive and non-cohesive fill. The fill is then underlain by a deposit of silty clay to clayey silt to clayey silt-silt and/or a deposit of silty sand to sand. Detailed descriptions of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Asphalt and Concrete Pavement Structure

An approximately 60 mm to 125 mm thick layer of asphalt was encountered at the ground surface in all boreholes.

An approximately 200 mm to 240 mm thick layer of concrete was encountered underlying the asphalt in all boreholes except Borehole W-01. Photographic records of the asphalt and concrete core are presented on Figure B1 to Figure B8 in Appendix B.

4.2.2 Sandy SILT (ML) to SILTY SAND (SM) to SAND (SP) (FILL)

A 0.4 m to 3.1 m thick layer of non-cohesive fill consisting of sandy silt to silty sand to sand, trace to some gravel to gravelly was encountered underlying the asphalt or composite pavement structure in all boreholes. The top of the non-cohesive fill was encountered at depths ranging from 0.1 m to 0.3 m below ground surface (between Elevations 175.5 m and 154.5 m) and extended to depths ranging from 0.7 m to 4.0 m below ground surface (between Elevations 175.1 m and 153.7 m).

[1] Chapman, L.J. and Putnam, D,F. 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P. 2715, Scale 1:600,000.

The SPT “N”-values measured within the non-cohesive fill ranges from 18 to 47 blows per 0.3 m of penetration, indicating a compact to dense state of compactness.

Grain size distribution testing was carried out on two samples of the sandy silt to silty sand fill, and the results are presented on Figures C1 in Appendix C. The water content measured on samples of the non-cohesive fill ranges from about 3% to 13%.

4.2.3 CLAYEY SILT (CL) to Sandy CLAYEY SILT-SILT (CL-ML) to CLAYEY SAND-SILTY SAND (SC-SM) to CLAYEY SAND (SC) (FILL)

A 1.6 m to 3.8 m thick layer of cohesive fill was encountered at underlying the non-cohesive fill in Boreholes NW3-1 to NW3-4. The cohesive fill consists of clayey silt to sandy clayey silt-silt to clayey sand-silty sand to clayey sand, trace gravel, and containing organics. In Borehole NW3-1 a 0.3 m thick layer of silty sand fill was encountered below the cohesive fill. The cohesive fill was encountered at depth of 0.7 m to 0.8 m below ground surface (between Elevations 175.1 m and 171.9 m) and extends to depths ranging from 1.7 m to 4.5 m below ground surface (between Elevations 172.4 m and 170.9 m).

The SPT “N”-values measured within the cohesive fill ranges from 4 to 40 blows per 0.3 m of penetration, suggested a firm to hard consistency.

Grain size distribution testing was carried out on four samples of the clayey silt to clay sand fill, and the results are presented on Figure C2 in Appendix C. Atterberg limits testing was carried out on four samples of the cohesive fill and measured a liquid limit ranging from about 16% to 30%, and a plastic limit ranging from about 10% to 14%, and plastic indices ranging from about 6% and 16%. The Atterberg limit test results are presented on Figure C3 in Appendix C and indicates that the fill ranges from a clayey silt to clayey sand of low plasticity. The water content measured on samples of the deposit ranges from about 11% to 23%.

4.2.4 SILTY CLAY (CI) to CLAYEY SILT (CL) to CLAYEY SILT-SILT and SAND (CL-ML/ML)

A 1.4 m to 7.2 m thick deposit of silty clay to sandy clayey silt to clayey silt-silt and sand was encountered underlying the fill in Boreholes NW3-1 to NW3-3, NW3-7, NW3-8, and W-01. The top of the cohesive deposit was encountered at depths ranging from 0.8 m to 4.5 m below ground surface (between Elevations 172.4 m and 153.7 m) and extends to depths ranging from 2.2 m to 9.8 m below ground surface (between Elevations 167.6 m and 151.8 m). Boreholes NW3-1, NW3-2, and NW3-7 were terminated within this deposit.

Interlayers of silty sand measuring 0.8 m to 1.1 m thick were encountered within this cohesive deposit in Boreholes NW3-2 and NW3-3. The interlayers were encountered at depths ranging from 4.5 m to 6.4 m (between Elevations 169.3 m and 169.5 m) and extends to depths ranging from 5.6 m to 7.2 m (between Elevations 168.2 m and 168.6 m).

In general, the SPT “N”-values measured within the cohesive deposit ranges from 13 blows per 0.3 m of penetration to 100 blows per 0.18 m of penetration, suggested a stiff to hard consistency. SPT “N”- values of 2 and 6 blows per 0.3 m of penetration was measured in Borehole NW3-7, indicating a soft to firm consistency. In-situ field vane tests carried out within the deposit measured undrained shear strengths greater than 96 kPa with sensitivity values. In consideration of the SPT “N”-values as well as the field vane test results, this cohesive deposit is considered to have a soft to hard consistency. The SPT “N”-values measured with the non-cohesive interlayer ranged from 39 to 68 blows per 0.3 m of penetration, suggesting a dense to very dense state of compactness.

Grain size distribution testing was carried out on eight samples of the cohesive deposit and the results are shown on Figures A1 in Appendix A and Figure C4 in Appendix C. Atterberg limits testing was carried out on seven samples of the cohesive deposit and the results are presented on Figure A2 in Appendix A and Figure C5 in Appendix C. The Atterberg limits tests measured liquid limits ranging from about 18% to 47%, plastic limits ranging from about 12% to 21%, and plasticity indices ranging from about 6% to 26%, indicating that the material is a silty clay of intermediate plasticity to clayey silt-silt of low plasticity. The water content was measured on samples of the cohesive deposit ranges from about 6% to 28%.

4.2.5 Sandy SILT (ML) to SILTY SAND (SM) to SAND (SP)

A 2.6 m to 9.6 m thick deposit of sandy silt to silty sand to sand, containing trace to some gravel was encountered underlying the fill and/or cohesive deposits in Boreholes NW3-3 to NW3-6, NW3-8 and W-01. The top of the non-cohesive deposit was encountered at depths ranging from 1.5 m to 8.7 m below ground surface (between Elevations 169.7 m and 151.8 m) and extends to depths ranging from 7.2 m to 11.3 m below ground surface (between Elevations 162.9 m and 147.4 m). Boreholes NW3-3 to NW3-6, and NW3-8 were terminated within this deposit.

Interlayers of silty clay measuring 0.6 m to 1.9 m thick were encountered within this non-cohesive deposit in Boreholes NW3-4, NW3-5, and NW3-8. The interlayers were encountered at depths ranging from 3.0 m to 4.9 m (between Elevations 169.6 m and 160.9 m) and extends to depths ranging from 4.5 m to 5.6 m (between Elevations 168.1 m and 160.3 m).

In general, the SPT “N”-values measured within the non-cohesive deposit ranges from 24 blows per 0.3 m of penetration to 51 blows per 0.13 m of penetration, indicating a compact to very dense state of compactness. A SPT “N”- value of 2 blows per 0.3 m of penetration was measured in Borehole NW3-8, indicating a loose state of compactness. The SPT “N”-values measured with the cohesive interlayer ranged from 14 to 45 blows per 0.3 m of penetration, suggesting a stiff to hard consistency.

Grain size distribution testing was carried out on ten samples of the silt to sand deposit, and the results are presented on Figures A3 in Appendix A, and on Figure C6A and C6B in Appendix C. The water content measured on samples of the deposit range from about 2% to 23%.

Grain size distribution testing was carried out on two samples of the silty clay interlayers and the results are shown on Figure C7 in Appendix C. Atterberg limits testing was carried out on two samples of the silty clay interlayers and the results are presented on Figure C8 in Appendix C. The Atterberg limits tests measured liquid limits ranging from about 44% to 45%, plastic limits ranging from about 18% to 20%, and plasticity indices ranging from about 25% to 26%, indicating that the material is a silty clay of intermediate plasticity. The water content measured on samples of the deposit range from about 15% to 26%.

4.2.6 SILTY CLAY (CL)

A 2.4 m thick deposit of silty clay, containing trace to some sand was encountered underlying silt and sand deposit in Boreholes W-01. The top of the non-cohesive deposit was encountered at a depth of 7.2 m below ground surface (at Elevation 147.4 m) and extends to a depth of 9.6 m below ground surface (at Elevation 145.0 m). Borehole W-01 was terminated within this deposit.

The SPT “N”-values measured within the cohesive deposit ranges from 82 to 88 blows per 0.3 m of penetration, suggesting a hard consistency.

Grain size distribution testing was carried out on a sample of the silty clay deposit, and the results are presented on Figures A1 in Appendix A. The water content measured on samples of the deposit range from about 17% to 20%.

4.3 Groundwater Conditions

In general, the soil samples taken in the boreholes were moist. Boreholes NW3-1 to NW3-4, NW3-6 and NW3-8 were noted to be dry upon completion of drilling while groundwater was observed at a depth of 6.1 m (between Elevations 165.0 m and 161.0 m) in Boreholes NW3-5 and NW3-7. However, these conditions and groundwater levels do not represent the stabilized groundwater level at the site.

It should be noted that the groundwater level is subject to seasonal fluctuations and precipitation events and should be expected to be higher during wet periods of the year.

4.4 Analytical Testing

Eight samples were collected and submitted to Bureau Veritas Laboratories for analysis of parameters used to assess corrosion potential and sulphate attack. A summary of the results is presented in the following table. The Certificates of Analysis are provided in Appendix C.

Borehole Number	Sample	Sample Depth (Elevation) (m)	Soil Type	Parameters				
				Chloride (µg/g)	Sulphate (µg/g)	pH	Conductivity (µmho/cm)	Resistivity (ohm-cm)
NE3-1	3	173.7 - 174.3	Sandy Clayey Silt to Clayey Silt – Silty Sand Fill	980	140	8.01	1920	520
NW3-2	2	174.4 - 175.0	Clayey Sand Fill	1200	350	7.88	2350	420
NW3-3	4	170.9 – 171.5	Sandy Clayey Silt	350	<20	7.79	666	1500
MW3-4	3B	170.5 – 170.9	Silt	900	50	7.98	1700	590
NW3-5	4	168.2 – 168.8	Silty Sand	390	73	8.04	867	1200
NW3-6	5	165.5 – 166.2	Silty Sand	940	27	8.03	1840	540
NW3-7	3	165.0 – 165.6	Silty Sand Fill	640	<20	7.88	1060	940
NW3-8	4	162.9 – 163.5	Sand	220	<20	8.07	413	2400

5.0 CLOSURE

The Foundation Investigation Report was prepared by Mr. Shantanu Kar, M.Eng., P.Eng., and reviewed by Mr. Christopher Ng, P.Eng., a Senior Geotechnical Engineer and Associate with Golder and MTO Foundations Designated Contact with Golder.

Signature Page

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https://golderassociates.sharepoint.com/sites/20393g/deliverables/foundations/10 - noise wall (cr3)/3. final/1786302-cr3-fidr-rev.0 noise barrier wall-29'september'2021.docx

PART B

FOUNDATION DESIGN REPORT
NOISE BARRIER WALLS BETWEEN AVENUE ROAD AND LESLIE STREET
HIGHWEAY 401 EASTBOUND COLLECTORS WIDENING, AVENUE ROAD TO WARDEN AVENUE
MTO G.W.P. 2130-01-00

6.0 DISCUSSION AND ENGINEERING INVESTIGATION

This section of the report provides geotechnical parameters and recommendations for the replacement of the noise barrier walls foundations between Bayview Avenue and Leslie Street, along the Highway 401 Eastbound Collector (EBC) lanes. These recommendations are based on the interpretation of the factual data obtained from the boreholes advanced during the previous and current field investigations. The discussion and recommendations presented are intended to provide the designers with information to delineate these walls in the contract drawings, and for information for the proprietary wall supplier/designer. The Foundation Design Report, discussion and recommendations are intended for the use of MTO and its designers and shall not be used or relied upon for any other purpose or by any other parties, including the construction contractor. Contractors must make their own interpretation based on the factual data presented in the Foundation Investigation Report (Part A of this report).

Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project and for which special provisions may be required in the Contract Documents. Those requiring information on aspects of construction must make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

6.1 General

The existing Noise Barrier Wall alignments are shown on Drawings 1. It is understood the existing noise barrier walls is to be replaced with 5 m high noise barrier walls, sections of which will be supported on retaining walls up to 2.5 m high. Due to property constraints and the proximity of the existing noise barrier/retaining wall to the limit of the right-of-way, it is understood that the proposed noise barrier/retaining wall will be constructed adjacent to/in front of the existing noise barrier/retaining wall. The existing noise barrier wall will be removed; however, the existing section of retaining wall is to remain in place. The proposed noise barrier/retaining wall will be supported on drilled shafts/augered footings to be designed by proprietary wall supplier/designer. Recommendations for support of the noise barrier walls are presented in the subsequent sections of this report.

6.2 Design of Noise Barrier Walls Foundation

Geotechnical parameters for design of the caisson foundations for the replacement of existing Noise Barrier Wall are provided in Table 1 following the text of this report, based on the subsurface conditions encountered in the boreholes advanced in the vicinity of the noise barrier walls. The stratigraphy presented in Table 1 has been simplified from the detailed stratigraphic descriptions present the Record of Boreholes for the purposes of the noise barrier wall foundation design, and the design values and locations over which they apply has been further simplified in Special Provision 760F01 and amending OPSS 760 (*Noise Barrier Systems*) for the designer fill-in table of design parameters. The parameters presented in Table 1 are based on field and laboratory test data as well as on accepted correlations (NAVFAC (1986), Bowles (1984) and Kulhawy and Mayne, (1990)) and the analysis was tempered by engineering judgment based on experience in similar soils.

Where both undrained shear strength (s_u) and drained parameters (effective cohesion,c', and effective friction angle,φ') have been given in Table 1 for a cohesive deposit, the drilled shaft/augered footing design should be checked for both the total and effective stress conditions, and the greater of the two calculated caisson depths shall govern.

The resistance within the upper 1.2 m below ground surface should be neglected to account for frost action within the depth of frost penetration zone as interpreted from OPSD 3090.101 (*Foundation Frost Penetration Depths for Southern Ontario*). Passive resistance below the depth of frost penetration provided in Table 1 should be reduced

by an appropriate factor considering the allowable wall movement in accordance with Figure C6.27 of the Canadian Highway Bridge Design Code (CHBDC, 2019).

6.3 Construction Considerations

6.3.1 Control of Soil and Groundwater for Drilled Shafts/Augered Footings

Construction of drilled shaft/augered footing is anticipated to require augering / excavation through the existing fill, overburden deposits, which may be susceptible to disturbance during excavation and construction. Wet non-cohesive soil deposits should be expected to collapse into the drilled/augered hole, especially during wet periods of the year. In accordance with OPSS.PROV 903 (*Deep Foundations*), as amended by SP 109F57, the contractor is required to maintain sidewall stability throughout the excavation of the drilled shafts/augered footings and concrete placement.

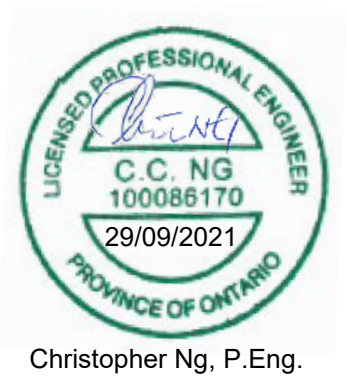
7.0 CLOSURE

The Foundation Investigation Report was prepared by Mr. Shantanu Kar, M.Eng., P.Eng., and reviewed by Mr. Christopher Ng, P.Eng., a senior geotechnical engineer and Associate with Golder and MTO Foundations Designated Contact with Golder.

Signature Page

Golder Associates Ltd.

Shantanu Kar, M.Eng., P.Eng.
Geotechnical Engineer



Christopher Ng, P.Eng.
Associate, MTO Foundations Designated Contact

SK/CN/ml

https://golderassociates.sharepoint.com/sites/20393g/deliverables/foundations/10 - noise wall (cr3)/3. final/1786302-cr3-fidr-rev.0 noise barrier wall-29'september'2021.docx

REFERENCES

Bowles, J.E. 1984. *Physical and Geotechnical Properties of Soils*, Second Edition, McGraw Hill Book Company, New York.

Canadian Geotechnical Society. 2006. *Canadian Foundation Engineering Manual* (CFEM), 4th Edition. The Canadian Geotechnical Society, BiTech Publisher Ltd., British Columbia.

Chapman, L.J. and Putnam, D.F. 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000.

Kulhway, F.H. and Mayne, P.W. 1990. *Manual on Estimating Soil Properties for Foundation Design*. EL-6800, Research Project 1493-6. Prepared for Electric Power Research Institute, Palo Alto, California

Unified Facilities Criteria, U.S. Navy. 1986. *NAVFAC Design Manual 7.02. Soil Mechanics, Foundation and Earth Structures.* Alexandria, Virginia.

Ontario Provisional Standard Drawing

OPSD 3090.101 Foundation Frost Penetration Depths for Southern Ontario

Ontario Provincial Standard Specifications

OPSS.PROV 903 Construction Specification for Deep Foundations

Special Provisions

109F57 Amendment to OPSS 903
760F01 Amendment to OPSS 760

Ontario Water Resources Act

Ontario Regulation 903 Wells (as amended)

Table 1: Geotechnical Design Parameters for Noise Barrier Walls

Approximate Noise Barrier Wall Location (Station) [1]	Relevant Boreholes	Deposit / Layer	Approximate Deposit Depth [2] (m)	Approximate Elevation [2] (m)	Design Groundwater Elevation [3] (m)	Design Parameters[4,5,6]						
						s_u (kPa)	φ' (°)	γ (kN/m^3)	γ' (kN/m^3)	K_o	K_a	K_p
Highway 401 EBC Station 23+764 to 24+093	NW3-1 and NW3-3	Stiff to hard Clayey Silt to Clayey Sand (FILL)	0.7 – 4.5	175.1 – 171.3	165.0	65	34	20	10	0.44	0.28	3.5
		Compact Silty Sand (FILL)	3.7 – 4.0	172.1 – 171.8		-	34	21	11	0.44	0.28	3.5
		Stiff to hard Silty Clay to Clayey Silt	4.0 – 8.2	171.8 – 167.6		85	32	21	11	0.47	0.31	3.2
		Dense to very dense Silty Sand Interlayer	4.5 – 7.2	169.5 – 168.2		-	35	21	11	0.43	0.27	3.7
		Dense to very dense Silty Sand	8.7 – 11.3	165.1 – 162.5		-	36	21	11	0.41	0.26	3.9
Highway 401 EBC Station 24+093 to 25+022	NW3-4 to NW3-8, and W-01	Compact to dense Silty Sand to Sandy Silt (FILL)	0.1 – 3.4	172.3 – 153.7		-	35	21	11	0.43	0.27	3.7
		Stiff to very stiff Clayey Silt (FILL)	0.7 – 1.7	173.1 – 170.9		65	32	21	11	0.47	0.31	3.2
		Firm to hard Silty Clay to Clayey Silt	0.8 – 9.8	165.0 – 151.8		50	35	21	11	0.43	0.27	3.7
		Compact to very dense Silt to Silty Sand to Sand	1.7 – 11.3	170.9 – 147.4		-	36	21	10	0.41	0.26	3.9
		Stiff to hard Silty Clay Interlayer	3.0 – 5.6	169.6 – 160.3		90	32	21	11	0.47	0.31	3.2
		Hard Silty Clay	7.2 – 9.6	147.4 – 145.0		200	35	21	11	0.43	0.27	3.7

NOTES:

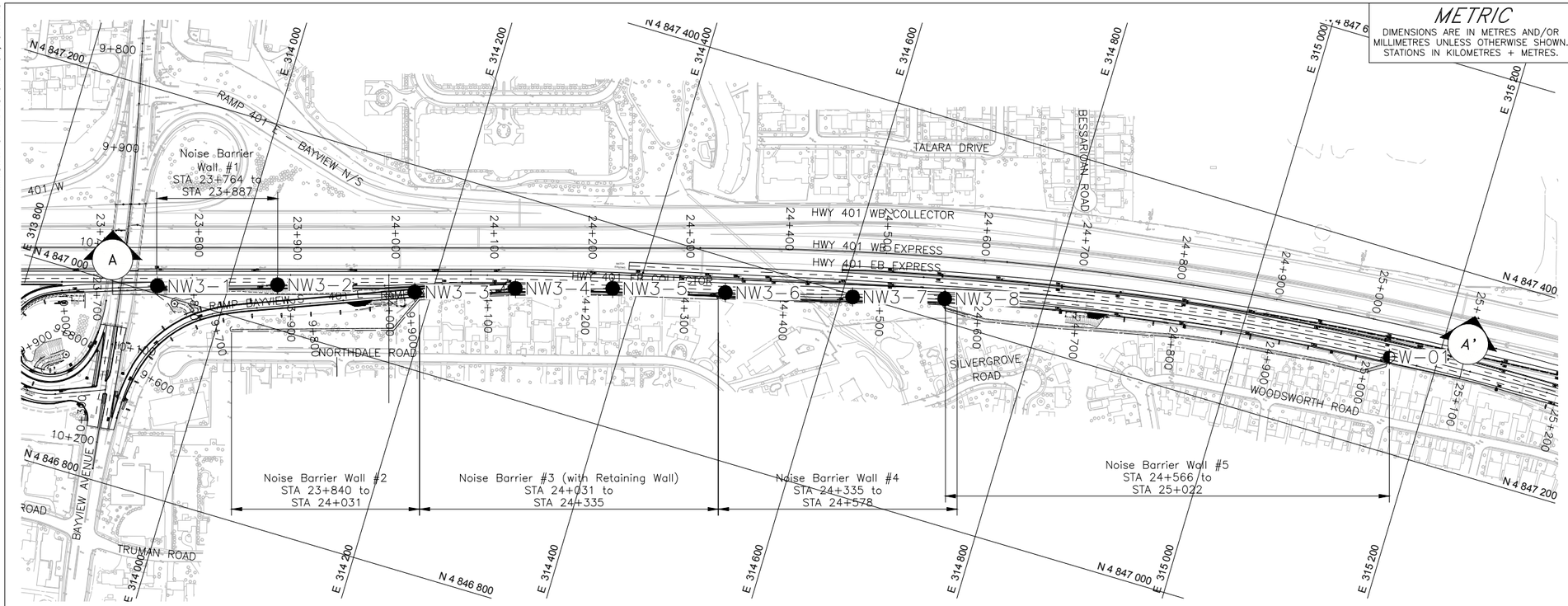
1. Approximate stationing provided along Highway 401 EBC. See Drawings 1 for noise barrier wall locations.
2. Depths are given related to the borehole ground surface elevation; the ground surface elevation at the borehole location(s) should be compared to the ground surface elevation at the noise barrier wall location, and the depths to various soil stratum adjusted accordingly
3. Groundwater level inferred based on the groundwater level measured inside augers upon completion of drilling at Boreholes NW3-5 and NW3-7
4. Design parameters:

   s_u = undrained shear strength (kPa)
   c' = effective (drained) cohesion (kPa)
   φ' = effective (drained) friction angle (°)
   K_a = active earth pressure coefficient
   K_p = passive earth pressure coefficient
   K_o = earth pressure coefficient at rest
   γ = bulk unit weight (kN/m^3)
   γ' = effective unit weight (below the groundwater level) (kN/m^3)

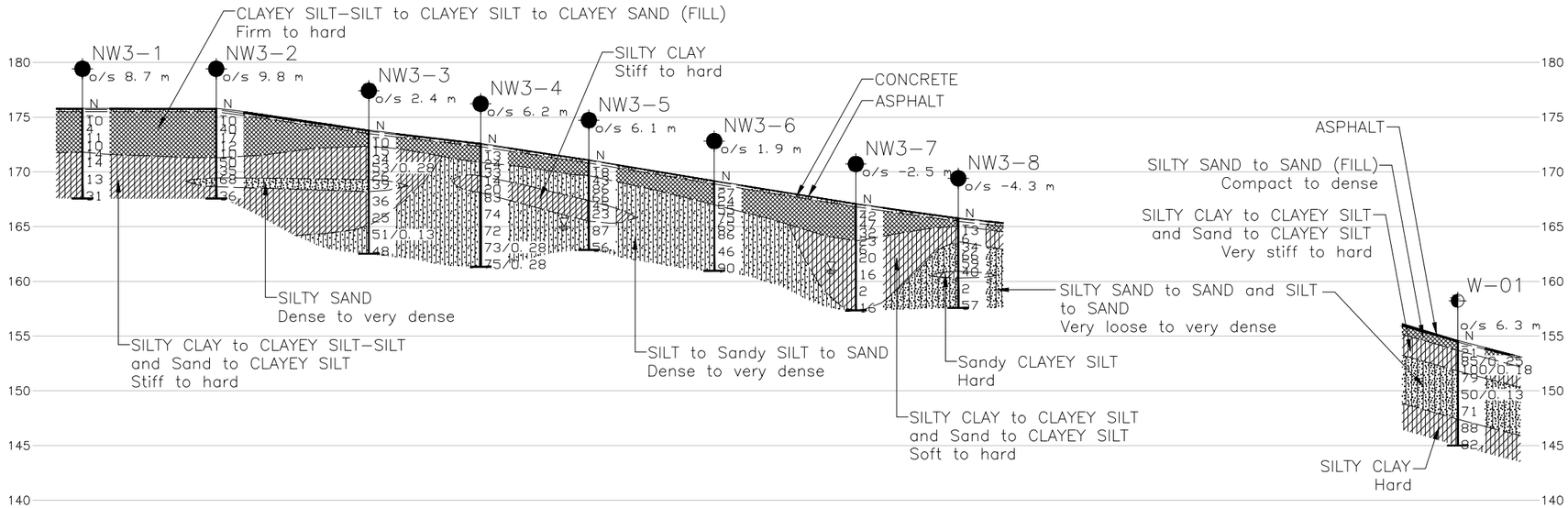
1. The resistance in the upper 1.2 m below ground surface should be neglected to account for frost action.
2. The total passive resistance below frost depth may be calculated based on the values of K_p provided, reduced by an appropriate factor that considers allowable wall movement in accordance with Figure C6.27 of the *Canadian Highway Bridge Design Code* (CHBDC, 2019) to account for large strains required to mobilize full passive resistance.

Drawings

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN
SCALE
50 0 50 100 m



PLAN
VERTICAL SCALE
5 0 5 10 m
HORIZONTAL SCALE
50 0 50 100 m

PLOT DATE: October 1, 2021
FILENAME: S:\Clients\MTO\Vwy_401_Leslie_Street\PJ_PROJ\1786302\40_PROD\0010_NRM_Bayview_Ave-Leslie\1786302-0010-BG-0001.dwg

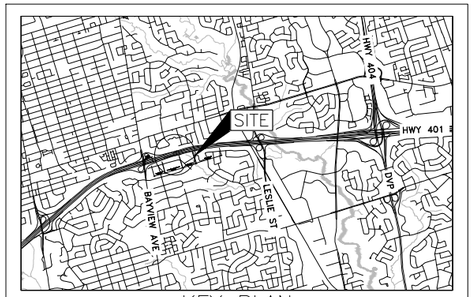
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
WP No.

SHEET

BOREHOLE LOCATIONS AND SOIL STRATA

GOLDER
MEMBER OF WSP



KEY PLAN
SCALE
1 0 1 2 km

LEGEND

- Borehole – Current Investigation
- Borehole – Previous Investigation Thurber
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling

BOREHOLE CO–ORDINATES (NAD 83 MTM ZONE 10)

No.	ELEVATION	NORTHING	EASTING
NW3–1	175.8	4847007.8	313930.4
NW3–2	175.8	4847043.6	314047.3
NW3–3	173.8	4847076.2	314183.1
NW3–4	172.6	4847108.9	314280.1
NW3–5	171.1	4847136.9	314374.9
NW3–6	169.2	4847165.4	314486.0
NW3–7	167.1	4847198.0	314611.3
W–01	154.6	4847294.6	315151.6

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.

REFERENCE

Base and design plans provided in digital format by AECOM, drawing file no. 401_EBC_Avenue–Warden_base.dwg, received February 7, 2019 and 401_EBC_Avenue–Warden_plan.dwg, received March 29, 2021.

LICENSED PROFESSIONAL ENGINEER
S. KAR
100507526
Sep. 24, 2021
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
C.C. NG
100086170
Sep. 24, 2021
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 30M14–538

HWY. 401	PROJECT NO. 1786302		DIST. .
SUBM'D. SK	CHKD. SK	DATE: 09/24/2021	SITE: .
DRAWN: DD	CHKD. CN	APPD. CN	DWG. 1

APPENDIX A

Previous Investigations – (MTO GEOCRES No. 30M14-440)

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

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

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

$\blacktriangledown$ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

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

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

UNIFIED SOILS CLASSIFICATION

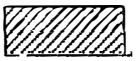
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels,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

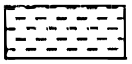
EXPLANATION OF ROCK LOGGING TERMS

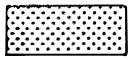
ROCK WEATHERING CLASSIFICATION

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

SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No W-01 1 OF 2 METRIC

W.P. 2061-13-00 LOCATION Combination Wall N 4 847 294.6 E 315 151.6 ORIGINATED BY ES

HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.11.30 - 2015.11.30 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
154.6	GROUND SURFACE										
0.0	**ASPHALT:**(125mm)										
0.1	**SAND**, some gravel Brown Moist (FILL)		1	GS			154		○		
153.7											
0.9	Silty **CLAY**, some sand, trace gravel Very Stiff to Hard Brown Moist		1	SS	21				○		0 11 63 26
			2	SS	85/ 0.250		153		○		0 13 63 24
			3	SS	100/ 0.175		152		○		
151.8											
2.8	**SAND** and **SILT**, trace clay, trace gravel Very Dense Brown to Grey Moist		4	SS	79		151		○		
			5	SS	50/ 0.125		150		○		3 43 50 4
			6	SS	71		149		○		
147.4							148				
7.2	Silty **CLAY**, trace to some sand Hard Grey Moist		7	SS	88		147		○		0 10 58 32
			8	SS	82		146		○		
145.0							145				
9.6	END OF BOREHOLE AT 9.6m. BOREHOLE OPEN AND DRY UPON										

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No W-01 2 OF 2 METRIC

W.P. 2061-13-00 LOCATION Combination Wall N 4 847 294.6 E 315 151.6 ORIGINATED BY ES

HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.11.30 - 2015.11.30 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.										

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

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

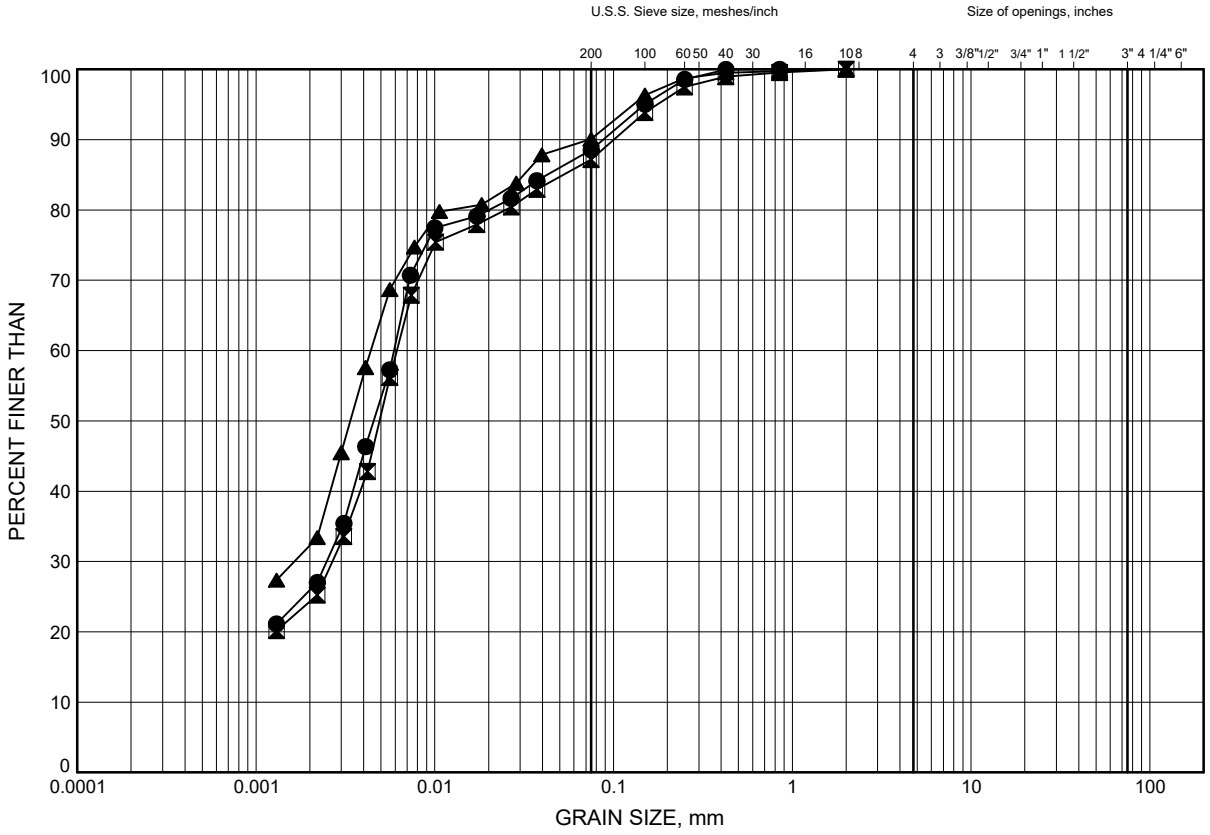
ONTMT4S 10656.GPJ 2015TEMPLATE(MTO).GDT 3/30/16

Combination Wall

GRAIN SIZE DISTRIBUTION

FIGURE A1

Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	W-01	1.07	153.53
⊠	W-01	1.73	152.87
▲	W-01	7.85	146.75

Date March 2016

W.P. 2061-13-00

THURBER

Prep'd AN

Chkd. SKP

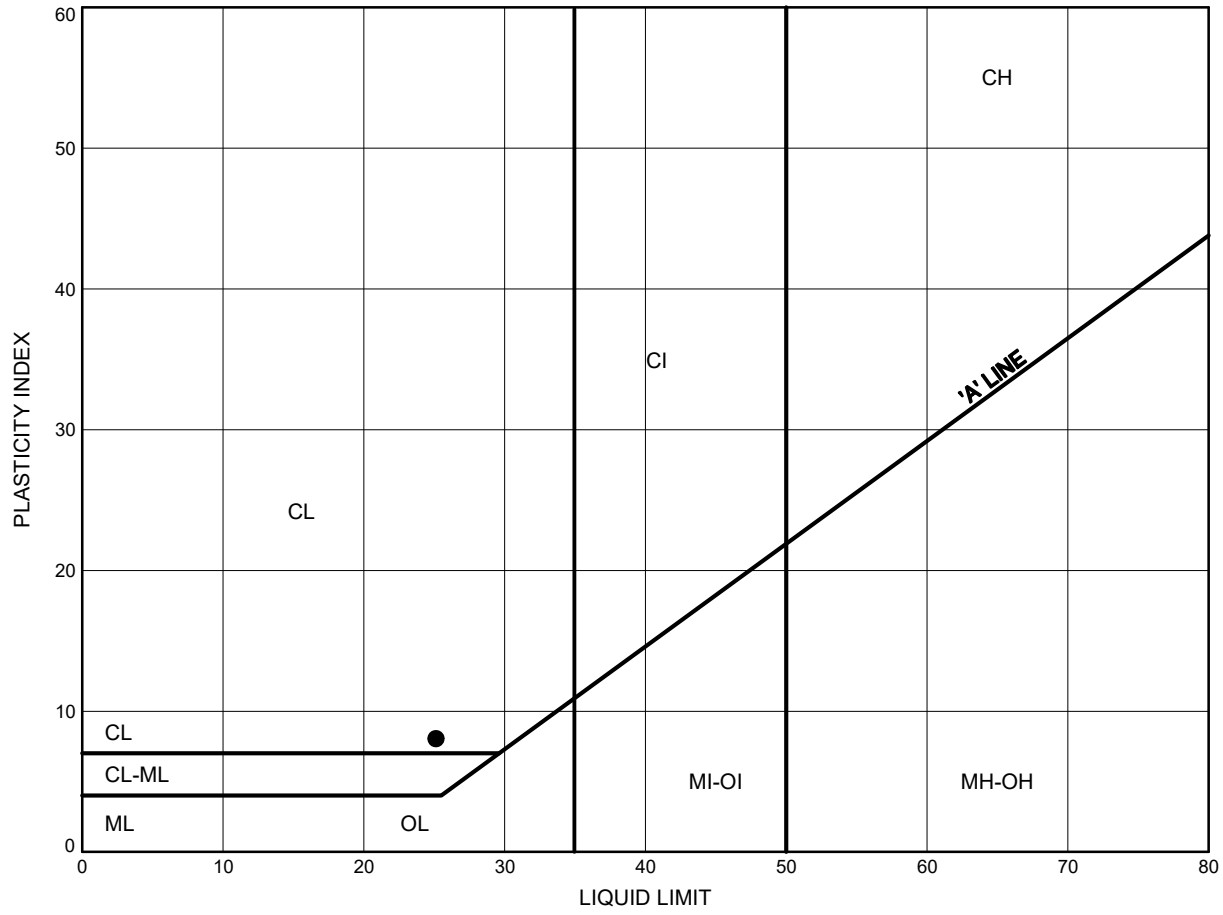
GRAIN SIZE DISTRIBUTION - THURBER 10656.GPJ 3/30/16

Combination Wall

ATTERBERG LIMITS TEST RESULTS

FIGURE A2

Silty CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	W-01	1.07	153.53

Date March 2016

W.P. 2061-13-00

THURBER

Prep'd AN

Chkd. SKP

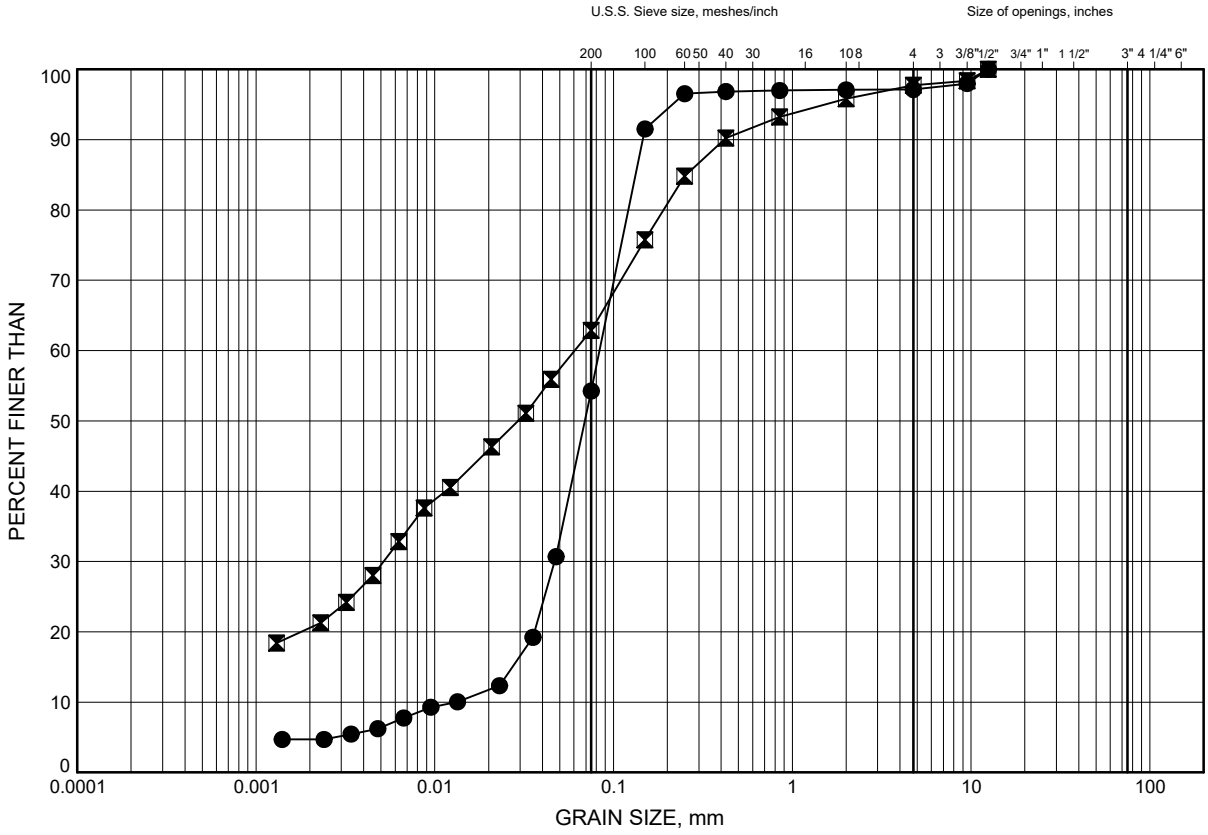
THURBALT 10656.GPJ 3/30/16

Combination Wall

GRAIN SIZE DISTRIBUTION

FIGURE A3

SAND & SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	W-01	4.71	149.89
⊠	W-02	3.35	149.65

Date March 2016

W.P. 2061-13-00

THURBER

Prep'd AN

Chkd. SKP

GRAIN SIZE DISTRIBUTION - THURBER 10656.GPJ 3/30/16

APPENDIX B

Current Investigation – Record of Boreholes and Pavement Core Photographs

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS
MINISTRY OF TRANSPORTATION, ONTARIO

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>200	>8
COBBLES	Not Applicable	75 to 200	3 to 8
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
FINES	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY COMPONENTS[1,2]

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component (*i.e.,* SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (*i.e.,* some sand)
≤ 10	trace (*i.e.,* trace fines)

1. Only applicable to components not described by Primary Group Name.
2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)
An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve friction (f_s) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

COARSE-GRAINED SOILS

Compactness[1]

Term	SPT 'N' (blows/0.3m)[2]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

3. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.
4. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

FINE-GRAINED SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	< 12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	> 200	> 30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress = $(\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
U	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
E	void ratio
N	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$
2 shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING CLASSIFICATION

Fresh (W1): no visible sign of rock material weathering.

Slightly Weathered (W2): discoloration indicates weathering of rock mass material on discontinuity surfaces. **Less than 5%** of rock mass is altered or weathered.

Moderately Weathered (W3): less than 50% of the rock mass is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones.

Highly Weathered (W4): more than 50% of the rock mass is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones.

Completely Weathered (W5): 100% of the rock mass is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact.

Residual Soil (W6): all rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole, a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

AXJ Axial Joint
BD Bedding
BC Broken Core
CC Continuous Core
CL Closed
CO Contact
CU Curved
CT Coated
FLT Fault
FOL Foliation
FR Fracture
GO Gouge
IN Infilled
IR Irregular
JN Joint
KV Karstic Void
K Slickensided
LC Lost Core
MB Mechanical Break
PL Planar
PO Polished
RO Rough
SA Slightly Altered
SH Shear
SM Smooth
SR Slightly Rough
SY Stylolite
UN Undulating
VN Vein
VR Very Rough

ISRM Intact Rock Material Strength Classification

Grade	Description	Approx. Range of Uniaxial Compressive Strength (MPa)
R0	Extremely weak rock	0.25 – 1.0
R1	Very weak rock	1.0 – 5.0
R2	Weak rock	5.0 – 25
R3	Medium strong rock	25 – 50
R4	Strong rock	50 -100
R5	Very strong rock	100 -250
R6	Extremely strong rock	>250

GOLDER
MEMBER OF WSP

RECORD OF BOREHOLE No NW3-1

SHEET 1 OF 1 **METRIC**

PROJECT 1786302
G.W.P. 2130-01-00 LOCATION N 4847007.8; E 313930.4 MTM NAD 83 ZONE 10 (LAT. 43.762981; LONG. -79.386606) ORIGINATED BY BL
DIST Central HWY 401 BOREHOLE TYPE CME 75, 165 mm O.D., Hollow Stem Augers (Auto Hammer) COMPILED BY SK
DATUM Geodetic DATE May 10, 2021 CHECKED BY SK/KN

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
175.8	GROUND SURFACE										
0.0	ASPHALT (100 mm)										
	CONCRETE (200 mm)		1	AS	-						
175.1	SAND (SP), trace silt (FILL) Brown Moist										
0.7	Sandy CLAYEY SILT (CL-ML) to CLAYEY SAND-SILTY SAND (SC-SM), trace to some gravel, contains organics (FILL) Firm to stiff Brown Moist		2	SS	10		175				
			3	SS	4		174				13 39 33 15
			4	SS	11		173				
172.1			5	SS	10						9 30 39 22
171.8	SILTY SAND (SM) (FILL) Compact Brown Moist		6A 6B	SS	14		172				
4.0	CLAYEY SILT (CL), trace gravel Stiff Brown Moist		7	SS	14		171				
170.2											
5.6	CLAYEY SILT-SILT (CL-ML/ML) and Sand, trace gravel Stiff Brown Moist - Grey below a depth of 6.1 m (Elev. 169.7 m)		8	SS	13		170				1 39 45 15
							169				
167.6			9	SS	31		168				
8.2	END OF BOREHOLE										

NOTES:

1. Borehole dry upon completion of drilling.

2. Borehole caved to depth of 6.4 m below ground surface (Elev.169.4 m) upon removal of augers.

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

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GOLDER
MEMBER OF WSP

RECORD OF BOREHOLE No NW3-2

SHEET 1 OF 1

METRIC

PROJECT 1786302

G.W.P. 2130-01-00 LOCATION N 4847043.6; E 314047.3 MTM NAD 83 ZONE 10 (LAT. 43.763302; LONG. -79.385153) ORIGINATED BY BL

DIST Central HWY 401 BOREHOLE TYPE CME 75, 165 mm O.D., Hollow Stem Augers (Auto Hammer) COMPILED BY SK

DATUM Geodetic DATE May 10 and 11, 2021 CHECKED BY SK/AM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
175.8	GROUND SURFACE										
0.0	ASPHALT (100 mm)										
	CONCRETE (200 mm)										
175.1	SAND (SP), some gravel, trace silt (FILL) Brown Moist		1	GS	-						
0.7	CLAYEY SAND (SC), some gravel (FILL) Stiff to hard Brown to grey Moist		2	SS	10		175				
			3	SS	40		174				
			4	SS	17		173				
			5	SS	12						12 46 28 14
171.3			6	SS	10		172				
4.5	SILTY CLAY (Cl), trace sand, trace gravel Hard Brown Moist		7	SS	50		171				
			8	SS	35		170			47	2 2 30 66
169.5			9A 9B	SS	68						
6.4	SILTY SAND (SM) Very dense Brown Moist						169				
168.6											
7.2	Sandy CLAYEY SILT (CL) Hard Grey Moist		10	SS	36		168				
167.6											
8.2	END OF BOREHOLE										

NOTES:

1. Borehole dry upon completion of drilling.

2. Borehole caved to a depth of 6.7 m below ground surface (Elev. 169.1 m) upon removal of augers.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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GOLDER
MEMBER OF WSP

RECORD OF BOREHOLE No NW3-3

SHEET 1 OF 1

METRIC

PROJECT 1786302

G.W.P. 2130-01-00 LOCATION N 4847076.2; E 314183.1 MTM NAD 83 ZONE 10 (LAT. 43.763594; LONG. -79.383466) ORIGINATED BY BL

DIST Central HWY 401 BOREHOLE TYPE CME 75, 165 mm O.D., Hollow Stem Augers (Auto Hammer) COMPILED BY SK

DATUM Geodetic DATE May 11, 2021 CHECKED BY SK/AM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.8	GROUND SURFACE										
0.0	ASPHALT (100 mm)										
	CONCRETE (200 mm)										
173.1	SAND (SP), some gravel, trace silt (FILL) Brown Moist		1	AS	-						
0.7	Sandy CLAYEY SILT (CL) (FILL) Stiff Grey Moist		2	SS	10		173				
172.4	Sandy CLAYEY SILT (CL), trace gravel Very stiff to hard Grey to brown Moist		3	SS	15		172				6 26 44 24
1.5			4	SS	34		171				
			5	SS	53/0.28						
			6	SS	26		170				
169.3											
4.5	SILTY SAND (SM) Dense Brown Moist		7	SS	39		169				
168.2											
5.6	CLAYEY SILT (CL) trace sand Very stiff to hard Grey Moist		8	SS	36		168				0 2 61 37
			9	SS	25		167				
165.1							166				
8.7	SILTY SAND (SM), trace gravel Dense to very dense Brown Wet		10	SS	51/0.13		165				1 85 12 2
							164				
			11	SS	48		163				
162.5											
11.3	END OF BOREHOLE										

NOTES:

1. Borehole dry upon completion of drilling.

2. Borehole caved to a depth of 5.1 m below ground surface (Elev. 168.7 m) upon removal of augers.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER
MEMBER OF WSP

RECORD OF BOREHOLE No NW3-4

SHEET 1 OF 1

METRIC

PROJECT 1786302

G.W.P. 2130-01-00 LOCATION N 4847108.9; E 314280.1 MTM NAD 83 ZONE 10 (LAT. 43.763887; LONG. -79.382261) ORIGINATED BY BL

DIST Central HWY 401 BOREHOLE TYPE CME 75, 165 mm O.D., Hollow Stem Augers (Auto Hammer) COMPILED BY SK

DATUM Geodetic DATE May 12, 2021 CHECKED BY SK/AM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.6	GROUND SURFACE										
0.0	ASPHALT (80 mm)										
	CONCRETE (220 mm)		1	AS	-						
171.9	SAND (SP), some silt, some gravel (FILL)						172				
0.7	Brown Moist		2	SS	13						0 14 34 52
	CLAYEY SILT (CL), some sand (FILL) Stiff to very stiff Brown Moist		3A 3B	SS	24		171				
170.9											
1.7	SILT (ML), some sand Compact to dense Brown Moist		4	SS	33		170				0 16 79 5
169.6											
3.0	SILTY CLAY (CI), trace sand Stiff to very stiff Grey Moist		5	SS	14		169				
			6	SS	20						0 1 36 63
168.1											
4.5	SAND (SP), trace fines, trace gravel Very dense Brown Moist		7	SS	83		168				
			8	SS	74		167				1 91 7 1
			9	SS	72		166				
163.9							165				
8.7	Sandy SILT (ML) Very dense Grey						164				
163.2	Moist		10A 10B	SS	73/0.28						
9.4	SILTY SAND (SM) Very dense Grey Moist						163				
			11	SS	75/0.28		162				
161.3											
11.3	END OF BOREHOLE										

NOTES:

1. Borehole dry upon completion of drilling.

2. Borehole caved to a depth of 7.3 m below ground surface (Elev. 165.3 m) upon removal of augers.

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

$\circ^{3\%}$ STRAIN AT FAILURE

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GOLDER
MEMBER OF WSP

RECORD OF BOREHOLE No NW3-5

SHEET 1 OF 1

METRIC

PROJECT 1786302

G.W.P. 2130-01-00 LOCATION N 4847136.9; E 314374.9 MTM NAD 83 ZONE 10 (LAT. 43.764138; LONG. -79.381083) ORIGINATED BY BL

DIST Central HWY 401 BOREHOLE TYPE CME 75, 165 mm O.D., Hollow Stem Augers (Auto Hammer) COMPILED BY SK

DATUM Geodetic DATE May 12, 2021 CHECKED BY SK/AM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.1	GROUND SURFACE						171				
0.0	ASPHALT (60 mm)										
	CONCRETE (240 mm)		1	AS	-						
170.4	SAND (SP), some silt, some gravel (FILL) Brown Moist		2	SS	18		170				
0.7	Gravelly SILTY SAND (SM) (FILL) Compact to dense Brown Moist		3	SS	43				○		22 40 32 6
169.7	SILTY SAND (SM), some gravel Dense to very dense Brown Moist		4	SS	86		169				
1.5			5	SS	66		168				
167.4											
3.7	SILTY CLAY (Cl), trace sand Very stiff to hard Grey Moist		6	SS	45		167			45	0 1 34 65
			7	SS	23		166				
165.5											
5.6	SAND (SP-SM), trace fines, trace gravel Very dense Brown to grey Moist		8	SS	87	▽	165		○		3 88 6 3
	- Grey below a depth of 7.6 m (Elev. 163.5 m)		9	SS	56		164				
162.9							163				
8.2	END OF BOREHOLE										

NOTES:

1. Groundwater level measured inside augers at a depth of 6.1 m (Elev. 165.0 m) below ground surface upon completion of drilling.

2. Borehole caved at a depth of 6.4 m below ground surface (Elev. 164.7 m) upon removal of augers.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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GOLDER
MEMBER OF WSP

RECORD OF BOREHOLE No NW3-6

SHEET 1 OF 1

METRIC

PROJECT 1786302

G.W.P. 2130-01-00 LOCATION N 4847165.4; E 314486.0 MTM NAD 83 ZONE 10 (LAT. 43.764393; LONG. -79.379703) ORIGINATED BY BL

DIST Central HWY 401 BOREHOLE TYPE CME 75, 165 mm O.D., Hollow Stem Augers (Auto Hammer) COMPILED BY SK

DATUM Geodetic DATE May 13, 2021 CHECKED BY SK/AM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
169.2	GROUND SURFACE						169				
0.0	ASPHALT (75 mm)										
	CONCRETE (240 mm)		1	AS	-						
168.5	SAND (SP), some silt, some gravel (FILL)										
0.7	Brown Moist		2	SS	27		168				
	Sandy SILT (ML), trace gravel (FILL) Compact Brown Moist		3	SS	24				○		1 34 53 12
167.0							167				
2.2	SILTY SAND (SM), some gravel Dense to very dense Brown Moist		4	SS	55						
			5	SS	75		166				
			6	SS	65		165		○		12 50 32 6
			7	SS	86						
							164				
			8	SS	46		163		○		10 55 27 8
							162				
			9	SS	90						
161.0							161				
8.2	END OF BOREHOLE										

NOTES:

1. Borehole dry upon completion of drilling.

2. Borehole caved to a depth of 6.4 m below ground surface (Elev. 162.8 m) upon removal of augers.

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

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401_LESLIE_STREET\02_DATA\GINT\HWY_401_LESLIE_STREET.GPJ GAL-GTA.GDT 9/17/21

GOLDER
MEMBER OF WSP

RECORD OF BOREHOLE No NW3-7

SHEET 1 OF 1

METRIC

PROJECT 1786302

G.W.P. 2130-01-00 LOCATION N 4847198.0; E 314611.3 MTM NAD 83 ZONE 10 (LAT. 43.764685; LONG. -79.378146) ORIGINATED BY BL

DIST Central HWY 401 BOREHOLE TYPE CME 75, 165 mm O.D., Hollow Stem Augers (Auto Hammer) COMPILED BY SK

DATUM Geodetic DATE May 13, 2021 CHECKED BY SK/AM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.1	GROUND SURFACE						167				
0.0	ASPHALT (60 mm)										
	CONCRETE (230 mm)		1	AS	-						
166.4	SAND (SP), some silt, some gravel (FILL)										
0.7	Brown Moist		2	SS	42		166				
	SILTY SAND (SM), trace gravel (FILL) Compact to dense Brown Moist		3	SS	47						
			4	SS	32		165		○		8 69 18 5
163.7			5A 5B	SS	23		164		○		
3.4	CLAYEY SILT (CL) and Sand, trace gravel Soft to very stiff Grey Moist		6	SS	6		163				
			7	SS	20				⊖—⊖		1 41 31 27
						▽	162				
			8	SS	16		161				
	- Trace organics between depths of 7.6 m and 8.8 m (between Elev. 159.5 m and 158.3 m)		9	SS	2		160		○		
							159	>96+			
	- 50 mm wood fragments encountered at 9.1 m (Elev. 158.0 m)		10	SS	16		158				
157.4											
9.8	END OF BOREHOLE										

NOTES:

1. Groundwater level measured in open borehole at a depth of 6.1 m (Elev. 161.0 m) upon completion of drilling,

2. Borehole caved to a depth of 8.2 m below ground surface (Elev. 158.9 m) upon removal of augers.

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

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401_LESLIE_STREET\02_DATA\GINT\HWY_401_LESLIE_STREET.GPJ GAL-GTA.GDT 9/17/21

GOLDER
MEMBER OF WSP

RECORD OF BOREHOLE No NW3-8

SHEET 1 OF 1

METRIC

PROJECT 1786302
G.W.P. 2130-01-00
LOCATION N 4847222.9; E 314701.6 MTM NAD 83 ZONE 10 (LAT. 43.764908; LONG. -79.377024)
ORIGINATED BY AM
DIST Central HWY 401
BOREHOLE TYPE CME 75, 165 mm O.D., Hollow Stem Augers (Auto Hammer)
COMPILED BY SK
DATUM Geodetic
DATE May 18, 2021
CHECKED BY SK/AM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
165.8	GROUND SURFACE										
0.0	ASPHALT (80 mm)										
0.3	CONCRETE (230 mm)										
165.0	SAND (SP), some silt, some gravel (FILL)		1	GS	-						
0.8	Brown Moist Sandy CLAYEY SILT (CL), trace gravel Firm to stiff Brownish grey Moist		2	SS	13		165				2 31 34 33
			3	SS	6		164				
163.6											
2.2	SAND (SP-SM), trace fines, trace gravel Dense to very dense Brown Moist		4	SS	34		163				
			5	SS	66				○		2 91 6 1
			6	SS	59		162				
160.9			7A 7B	SS	40		161		○		
4.9	Sandy CLAYEY SILT (CL) Hard Brown Moist										
160.3											
5.5	SILTY SAND (SM), trace gravel Very loose to very dense Brown Moist to wet		8	SS	2		160		○		8 72 18 2
			9	SS	57		159				
157.6							158				
8.2	END OF BOREHOLE										

NOTES:

1. Borehole dry upon completion of drilling.

2. Borehole caved to a depth of 4.3 m below ground surface (Elev. 161.5 m) upon removal of augers.

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

$\circ^{3\%}$ STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401_LESLIE_STREET\02_DATA\GINT\HWY_401_LESLIE_STREET.GPJ GAL-GTA.GDT 9/17/21

PROJECT

Highway 401 EB Collectors Avenue to Warden, North York, Toronto, Ontario

TITLE

PAVEMENT CORE PHOTOGRAPH
BOREHOLE NW3-1
0 mm to 300 mm

GOLDER
MEMBER OF WSP

PROJECT No. 1786302			FILE No. ----		
DESIGN	SK	20210803	SCALE	NTS	VER. 1.
CADD	--		**FIGURE B1**		
CHECK	SK	20210923			
REVIEW	CN	20210923			

REVISION DATE: 20200304 BY: KN Project: 1786302

PROJECT

Highway 401 EB Collectors Avenue to Warden, North York, Toronto, Ontario

TITLE

PAVEMENT CORE PHOTOGRAPH
BOREHOLE NW3-2
0 mm to 300 mm

GOLDER
MEMBER OF WSP

PROJECT No. 1786302			FILE No. ----		
DESIGN	SK	20210803	SCALE	NTS	VER. 1.
CADD	--		**FIGURE B2**		
CHECK	SK	20210923			
REVIEW	CN	20210923			

REVISION DATE: 20200304 BY: KN Project: 1786302

REVISION DATE: 20200304 BY: KN Project: 1786302

PROJECT

Highway 401 EB Collectors Avenue to Warden, North York, Toronto, Ontario

TITLE

PAVEMENT CORE PHOTOGRAPH
BOREHOLE NW3-3
0 mm to 300 mm

GOLDER
MEMBER OF WSP

PROJECT No. 1786302			FILE No. ----		
DESIGN	SK	20210803	SCALE	NTS	VER. 1.
CADD	--		**FIGURE B3**		
CHECK	SK	20210923			
REVIEW	CN	20210923			

REVISION DATE: 20200304 BY: KN Project: 1786302

PROJECT

Highway 401 EB Collectors Avenue to Warden, North York, Toronto, Ontario

TITLE

PAVEMENT CORE PHOTOGRAPH
BOREHOLE NW3-4
0 mm to 300 mm

GOLDER
MEMBER OF WSP

PROJECT No. 1786302			FILE No. ----		
DESIGN	SK	20210803	SCALE	NTS	VER. 1.
CADD	--		**FIGURE B4**		
CHECK	SK	20210923			
REVIEW	CN	20210923			

PROJECT

Highway 401 EB Collectors Avenue to Warden, North York, Toronto, Ontario

TITLE

PAVEMENT CORE PHOTOGRAPH
BOREHOLE NW3-5
0 mm to 300 mm

GOLDER
MEMBER OF WSP

PROJECT No. 1786302			FILE No. ----		
DESIGN	SK	20210803	SCALE	NTS	VER. 1.
CADD	--		**FIGURE B5**		
CHECK	SK	20210923			
REVIEW	CN	20210923			

REVISION DATE: 20200304 BY: KN Project: 1786302

PROJECT

Highway 401 EB Collectors Avenue to Warden, North York, Toronto, Ontario

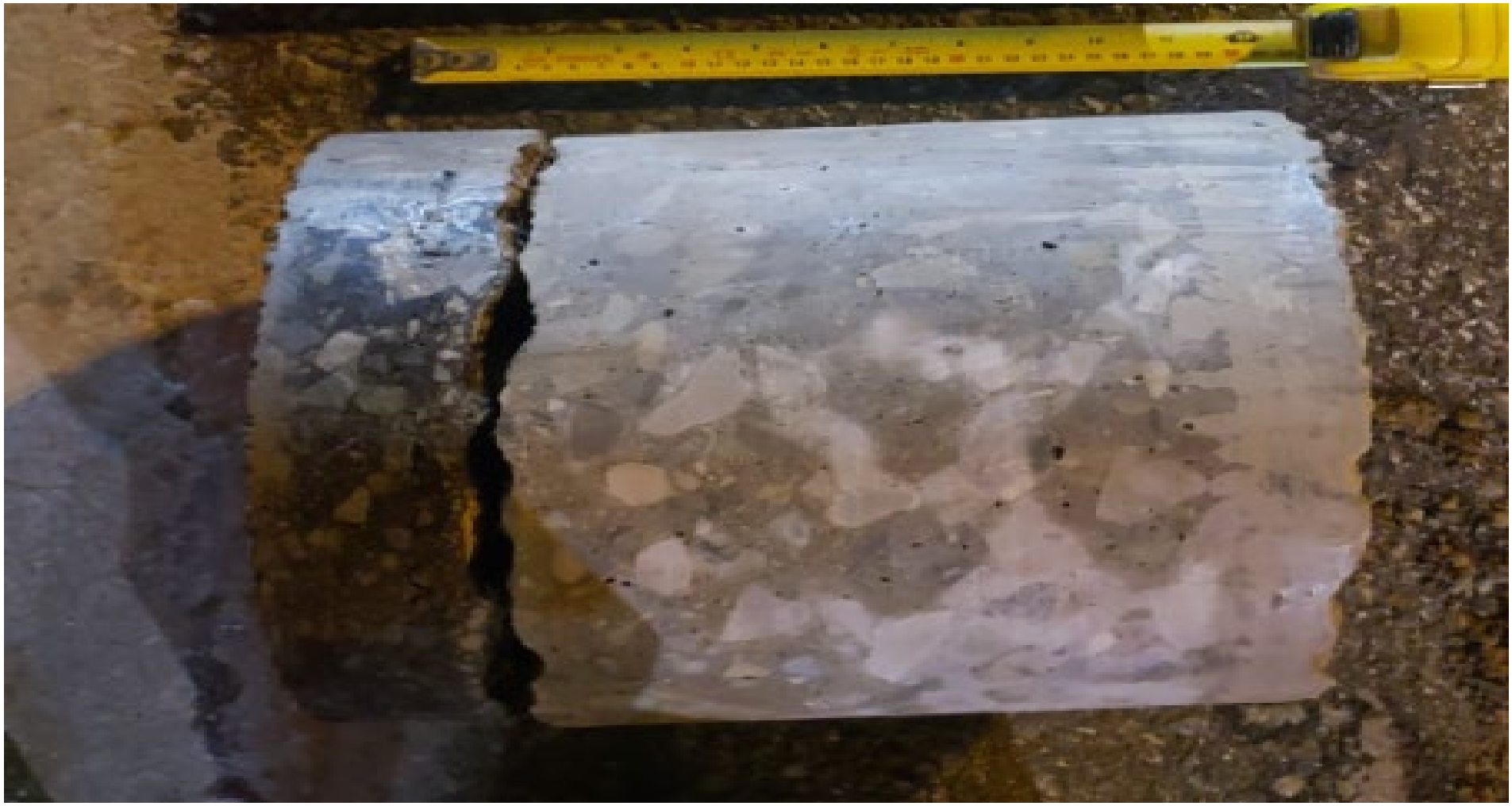
TITLE

PAVEMENT CORE PHOTOGRAPH
BOREHOLE NW3-6
0 mm to 315 mm

GOLDER
MEMBER OF WSP

PROJECT No. 1786302			FILE No. ----		
DESIGN	SK	20210803	SCALE	NTS	VER. 1.
CADD	--		**FIGURE B6**		
CHECK	SK	20210923			
REVIEW	CN	20210923			

REVISION DATE: 20200304 BY: KN Project: 1786302



PROJECT

Highway 401 EB Collectors Avenue to Warden, North York, Toronto, Ontario

TITLE

PAVEMENT CORE PHOTOGRAPH
BOREHOLE NW3-7
0 mm to 290 mm

GOLDER
MEMBER OF WSP

PROJECT No. 1786302			FILE No. ----		
DESIGN	SK	20210803	SCALE	NTS	VER. 1.
CADD	--		**FIGURE B7**		
CHECK	SK	20210923			
REVIEW	CN	20210923			

REVISION DATE: 20200304 BY: KN Project: 1786302

PROJECT

Highway 401 EB Collectors Avenue to Warden, North York, Toronto, Ontario

TITLE

PAVEMENT CORE PHOTOGRAPH
BOREHOLE NW3-8
0 mm to 310 mm

GOLDER
MEMBER OF WSP

PROJECT No. 1786302			FILE No. ----		
DESIGN	SK	20210803	SCALE	NTS	VER. 1.
CADD	--		**FIGURE B8**		
CHECK	SK	20210923			
REVIEW	CN	20210923			

REVISION DATE: 20200304 BY: KN Project: 1786302

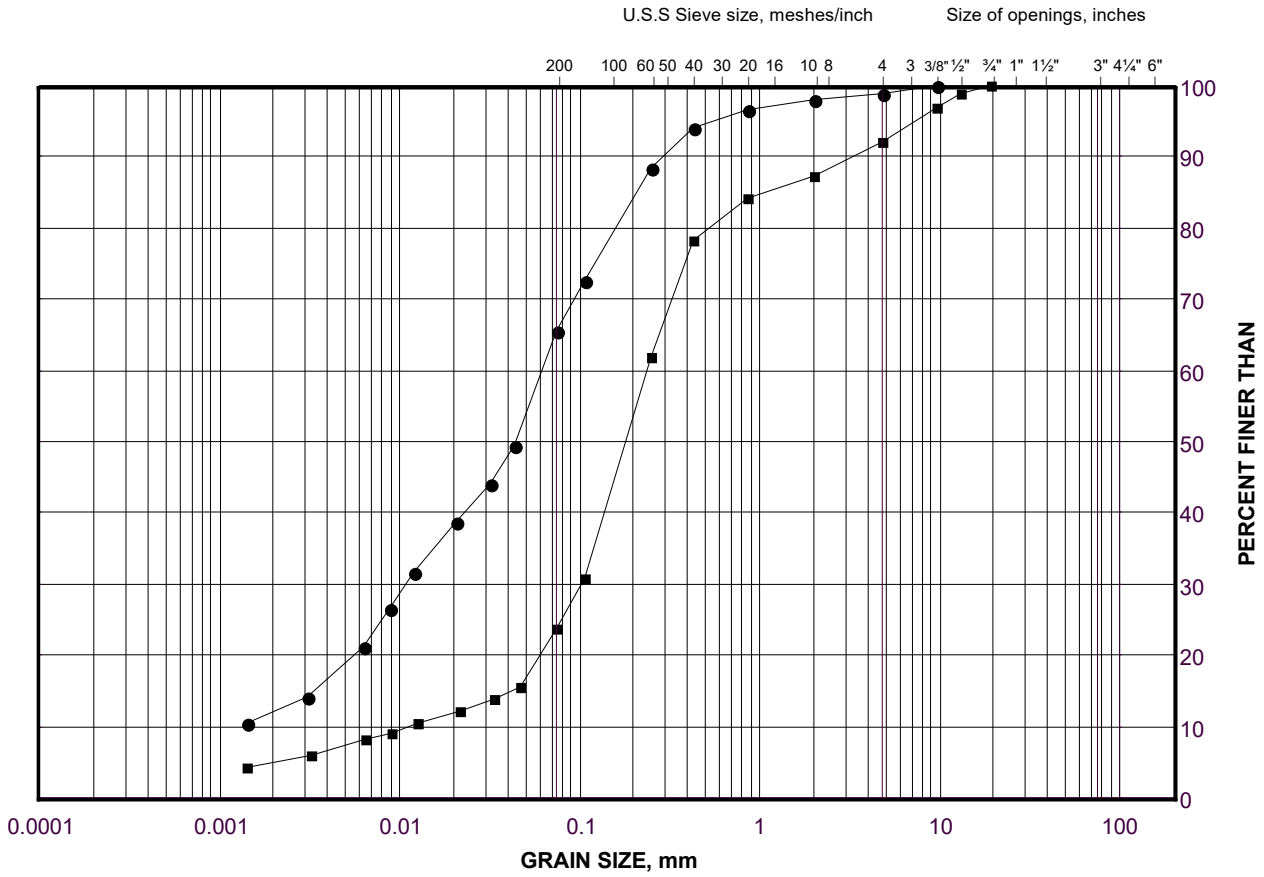
APPENDIX C

Geotechnical and Analytical Test Results

GRAIN SIZE DISTRIBUTION

Sandy SILT (ML) to SILTY SAND (SM) (FILL)

FIGURE C1



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-6	3	167.4
■	NW3-7	4	164.5

Project Number: 1786302

Checked By: SK

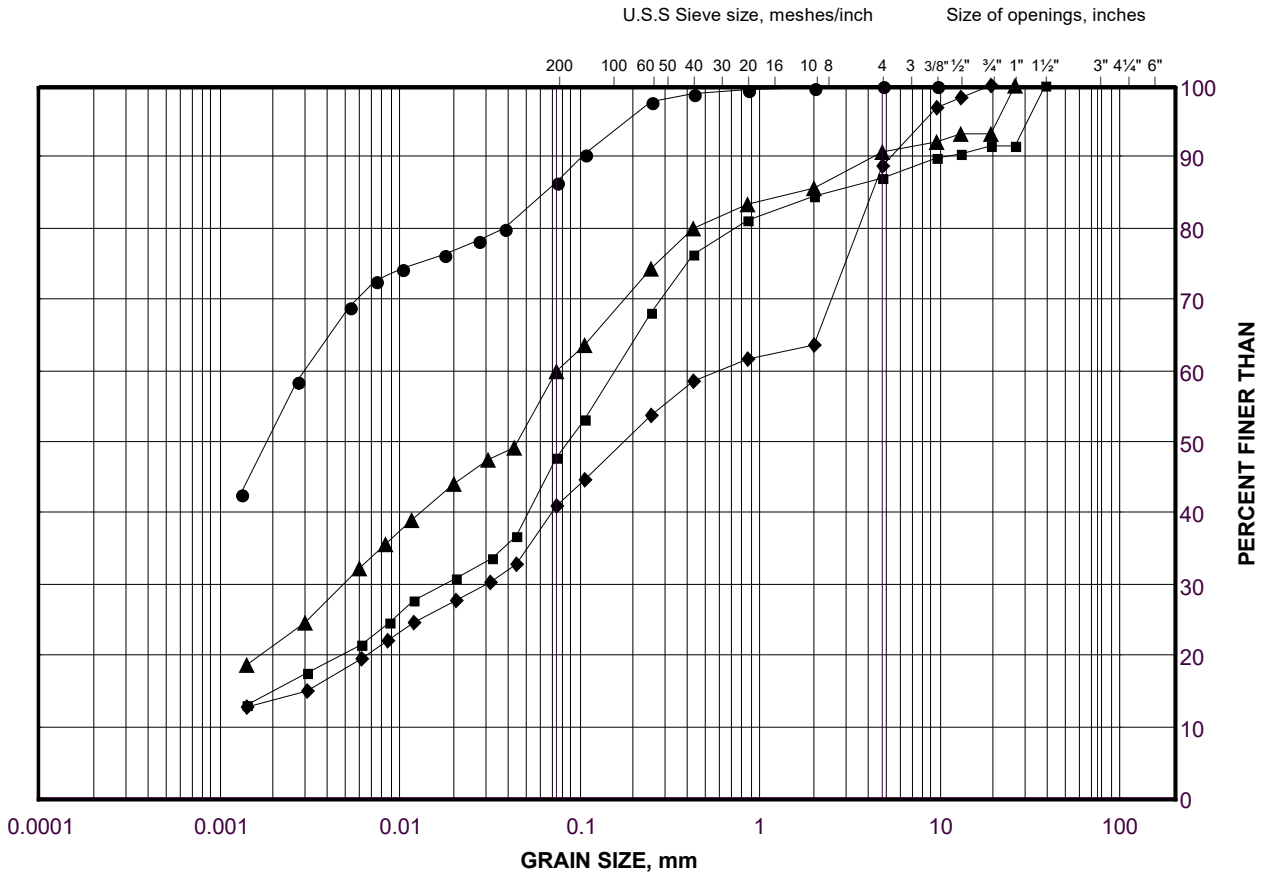
Golder Associates

Date: 31-Jul-21

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (CL) to CLAYEY SAND (SC) (FILL)

FIGURE C2



LEGEND

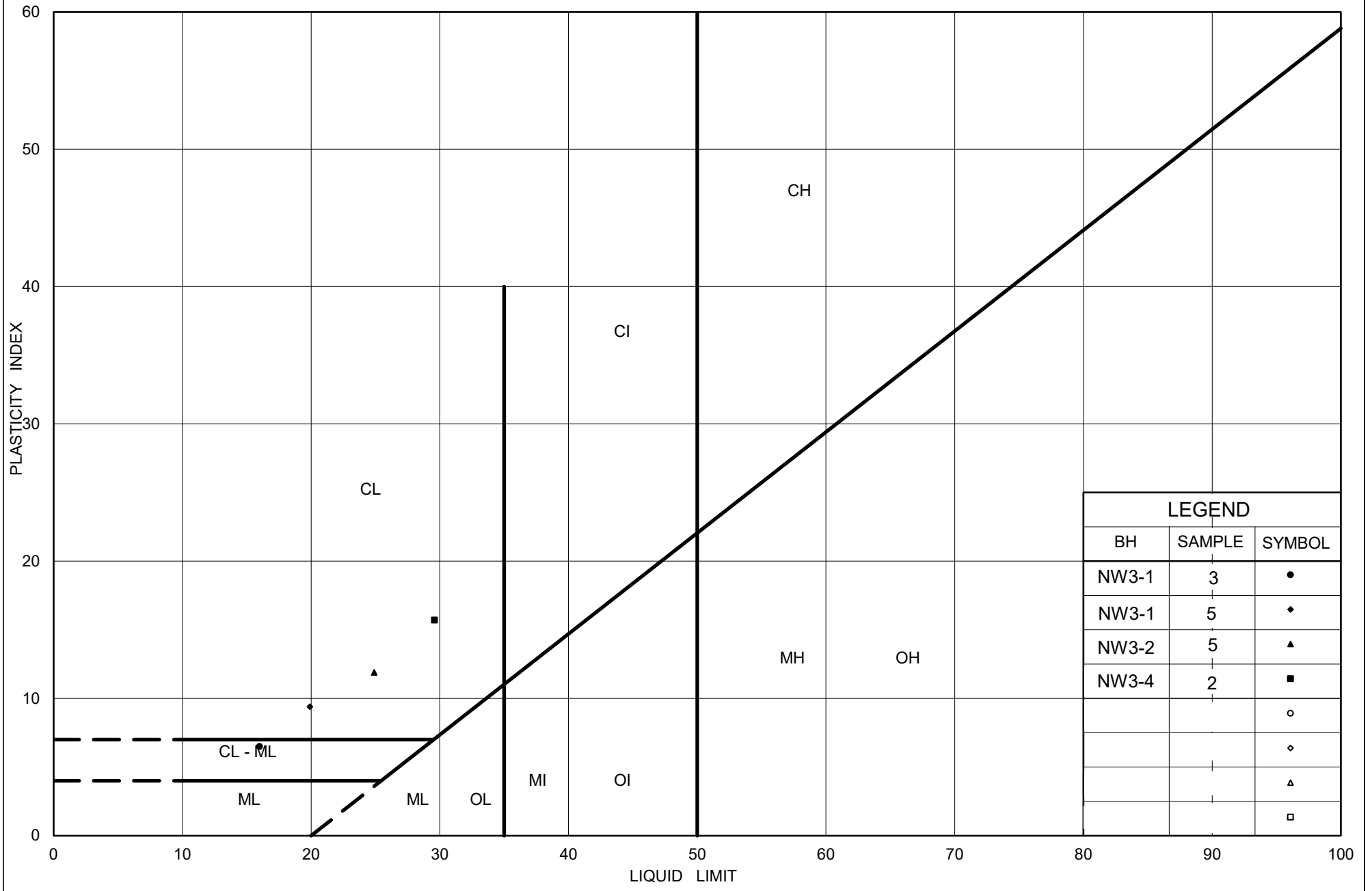
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-4	2	171.5
■	NW3-1	3	174.0
◆	NW3-2	5	172.4
▲	NW3-1	5	172.4

Project Number: 1786302

Checked By: SK

Golder Associates

Date: 31-Jul-21



Ministry of Transportation

Ontario

PLASTICITY CHART

CLAYEY SILT (CL) to CLAYEY SAND (SC) (FILL)

Figure No. C3

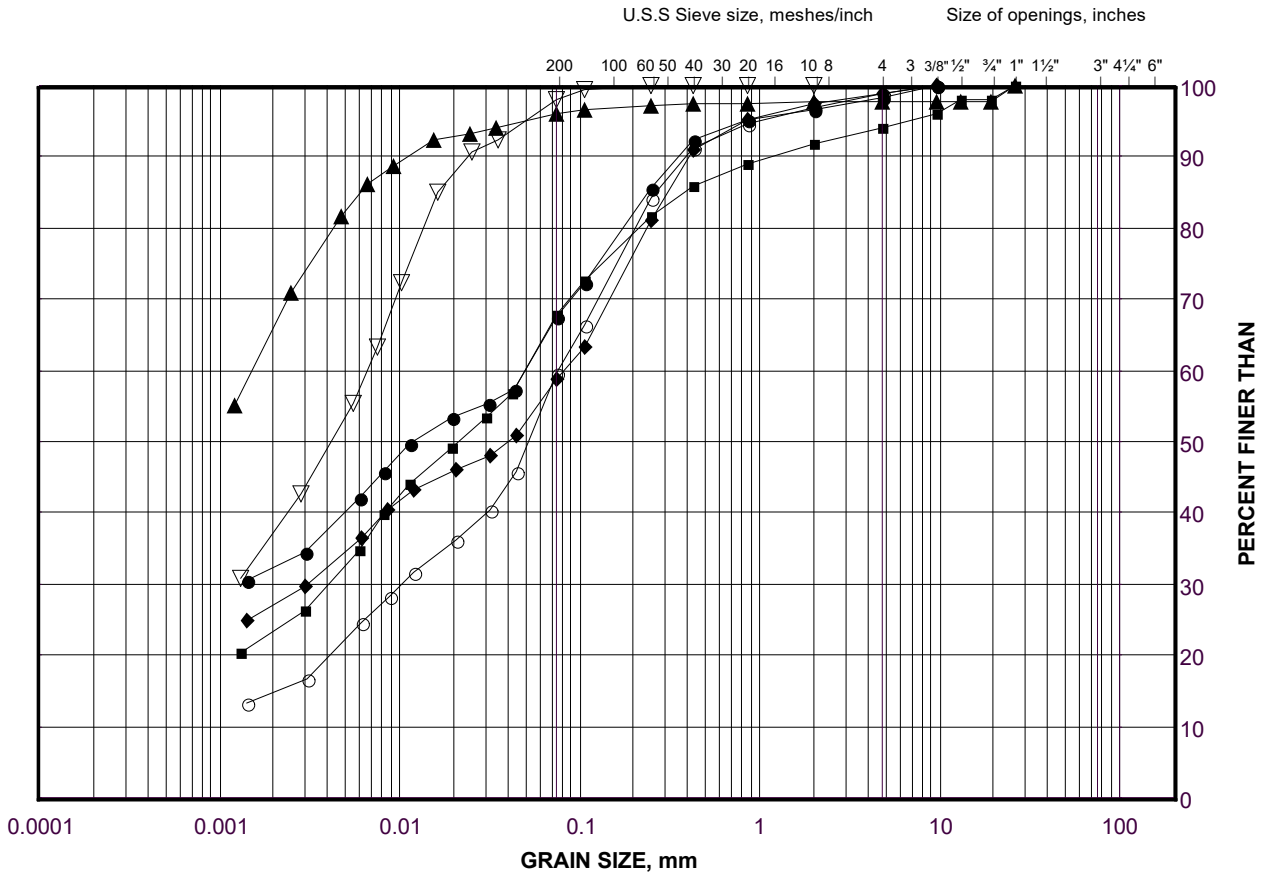
Project No. 1786302 (2500)

Checked By: SK

GRAIN SIZE DISTRIBUTION

SILTY CLAY (CI) to CLAYEY SILT-SILT and SAND (CL-ML/ML)

FIGURE C4



LEGEND

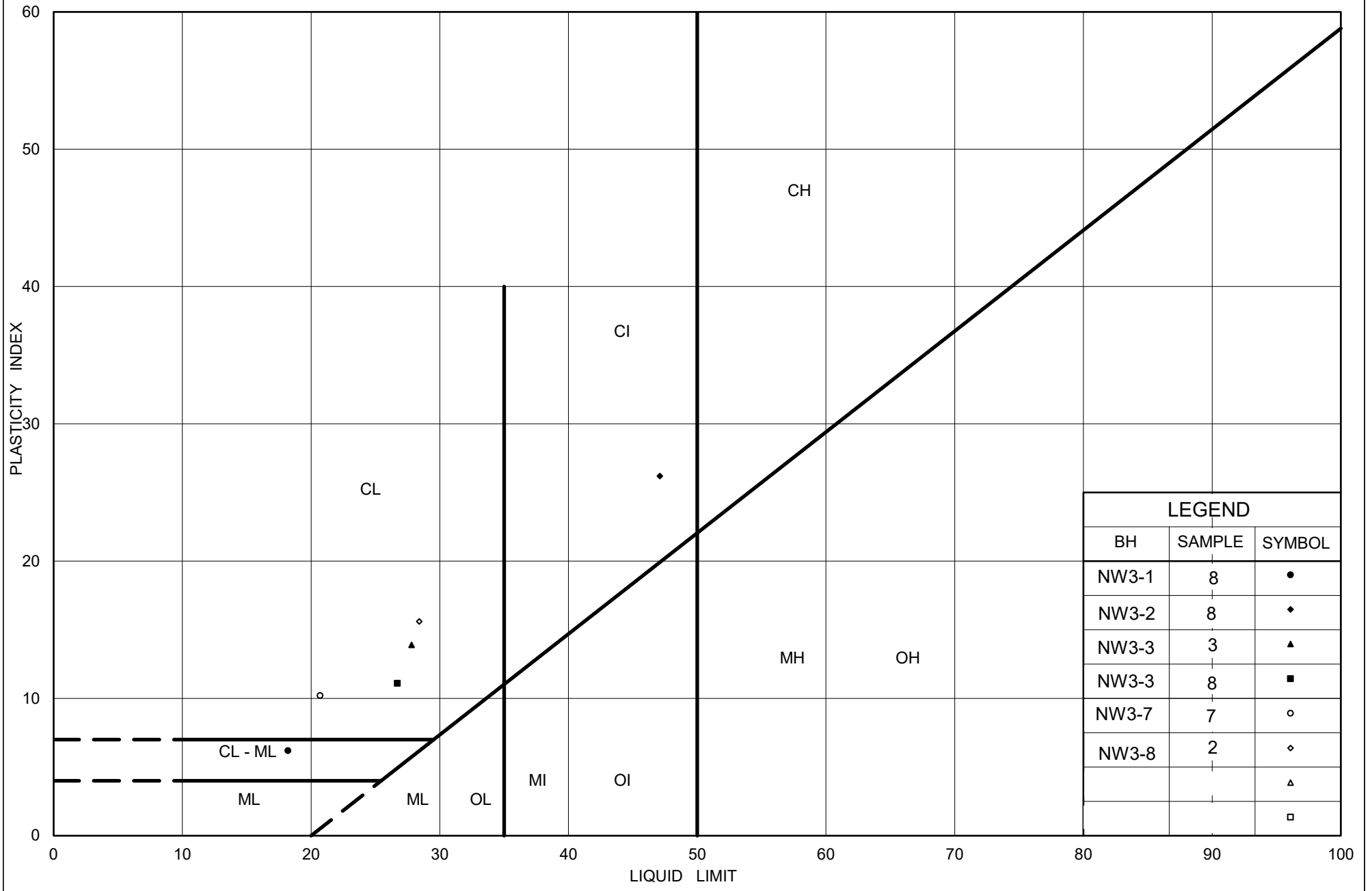
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-8	2	164.7
■	NW3-3	3	172
◆	NW3-7	7	162.2
▲	NW3-2	8	170.2
▽	NW3-3	8	167.4
❍	NW3-1	8	169.4

Project Number: 1786302

Checked By: SK

Golder Associates

Date: 01-Aug-21



Ministry of Transportation

Ontario

PLASTICITY CHART

SILTY CLAY (CI) to CLAYEY SILT-SILT and SAND (CL-ML/ML)

Figure No. C5

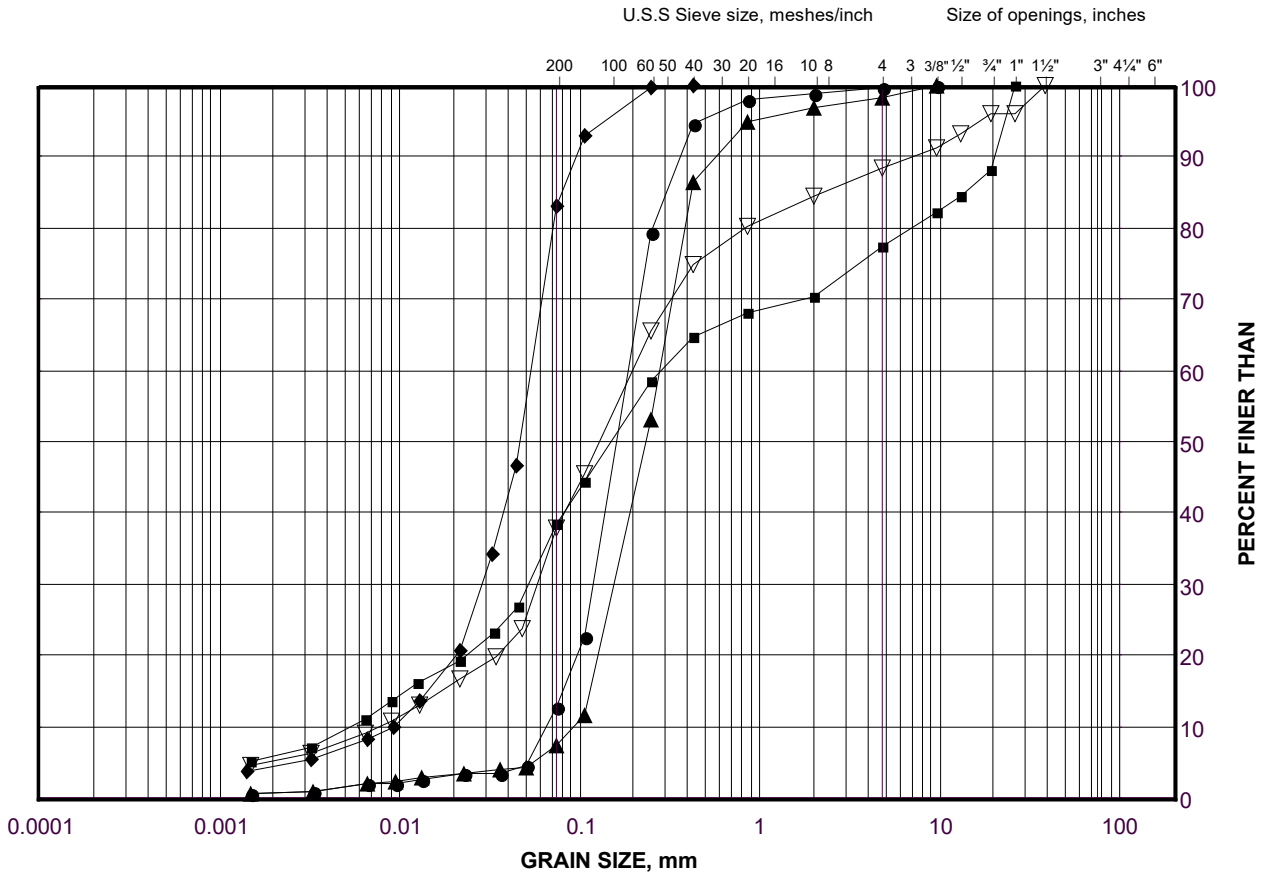
Project No. 1786302 (2500)

Checked By: SK

GRAIN SIZE DISTRIBUTION

SILT (ML) to SAND (SP)

FIGURE C6A



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-3	10	164.5
■	NW3-5	3	169.3
◆	NW3-4	4	170.0
▲	NW3-8	5	162.4
▽	NW3-6	6	165.1

Project Number: 1786302

Checked By: SK

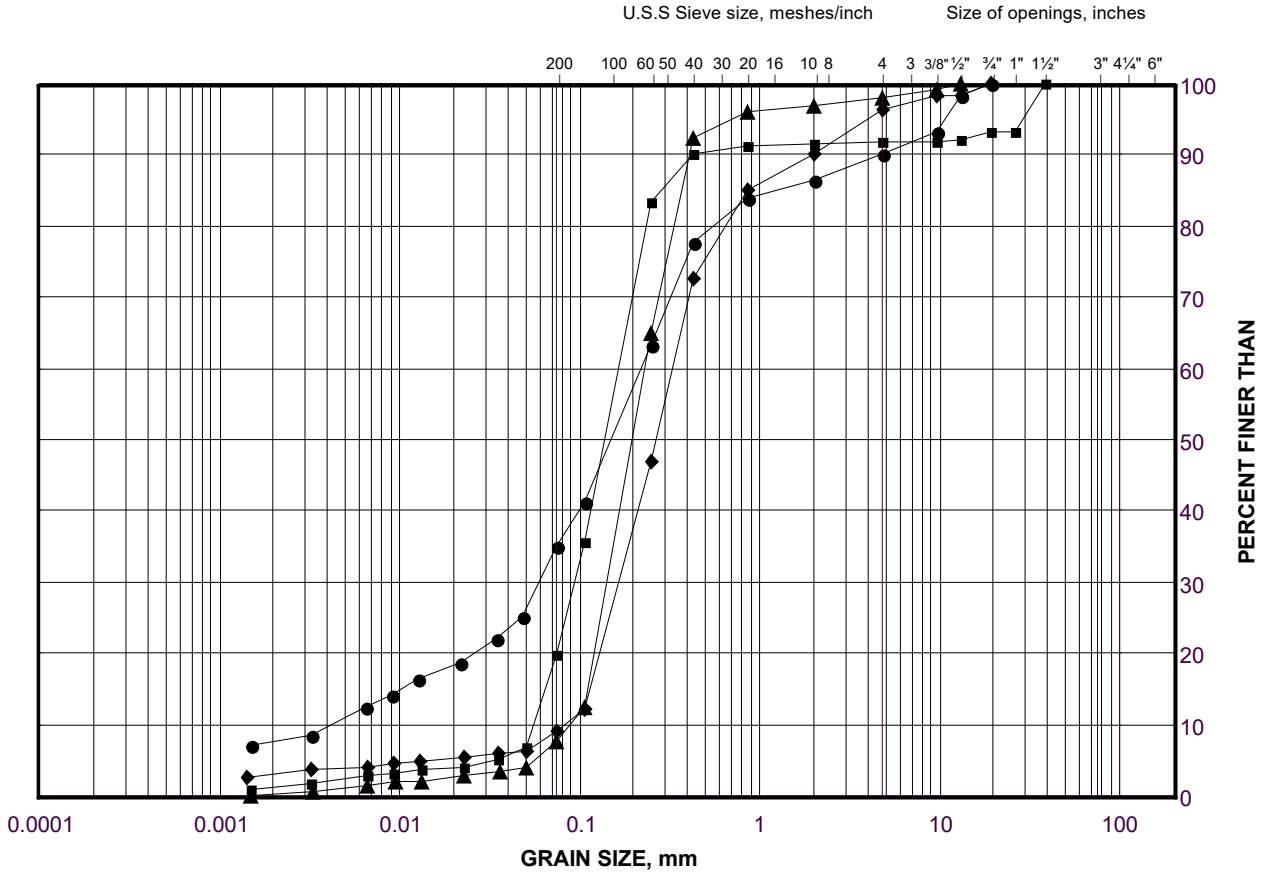
Golder Associates

Date: 31-Jul-21

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM) to SAND (SP-SM)

FIGURE C6B



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-6	8	162.8
■	NW3-8	8	159.4
◆	NW3-5	8	164.8
▲	NW3-4	8	166.2

Project Number: 1786302

Checked By: SK

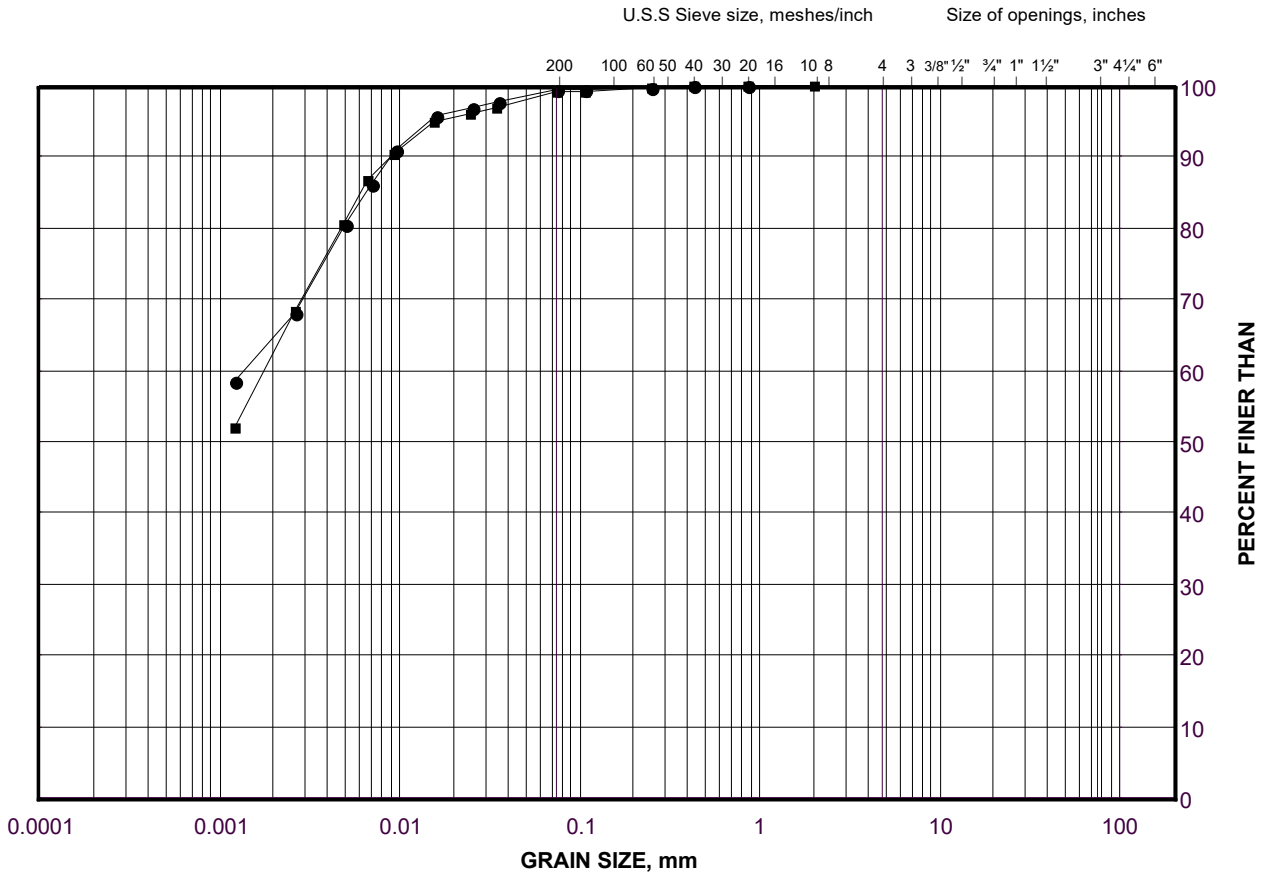
Golder Associates

Date: 31-Jul-21

GRAIN SIZE DISTRIBUTION

SILTY CLAY (CI) - Interlayer

FIGURE C7



LEGEND

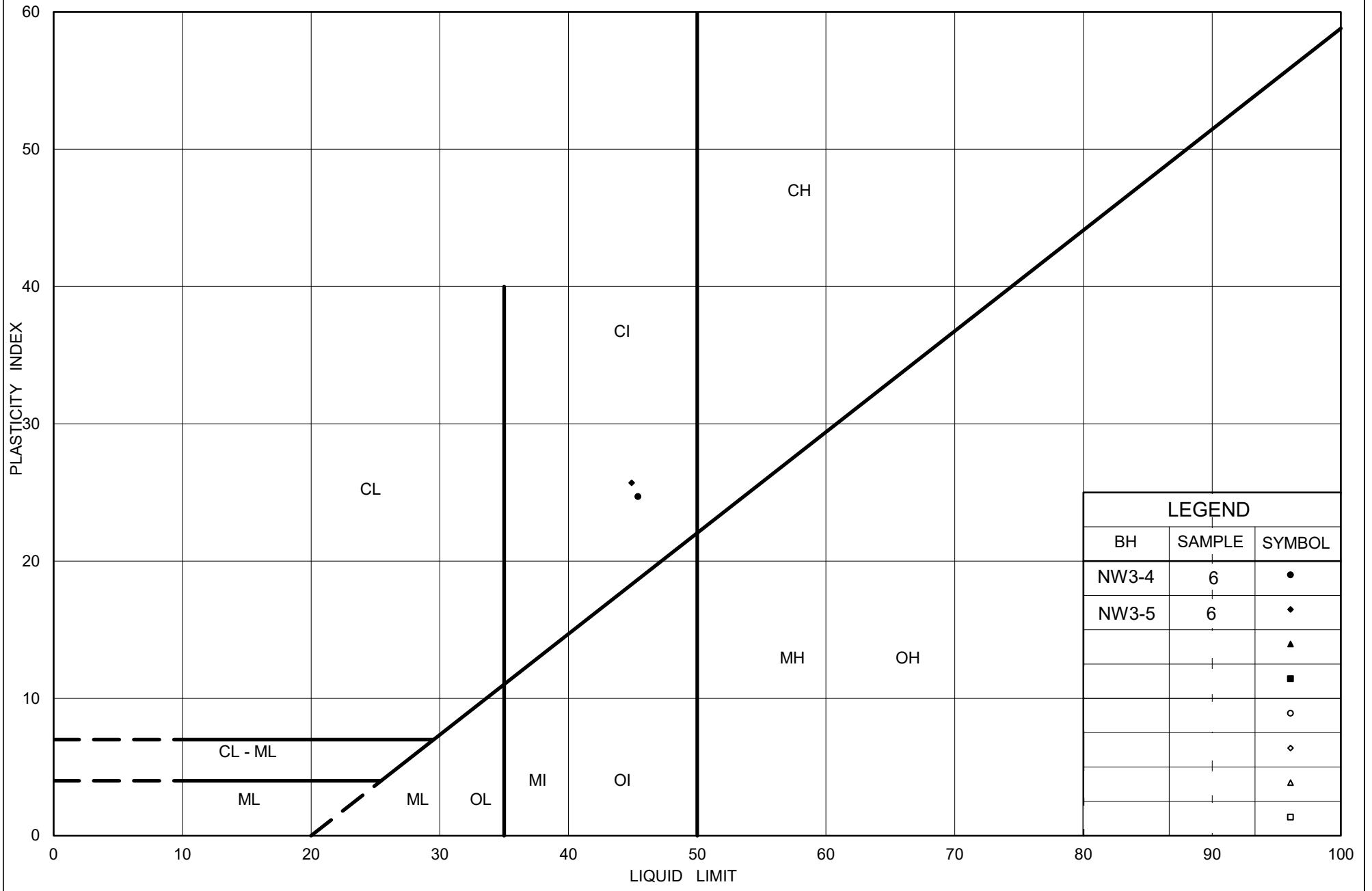
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-5	6	167.0
■	NW3-4	6	168.5

Project Number: 1786302

Checked By: SK

Golder Associates

Date: 01-Aug-21



Ministry of Transportation

Ontario

PLASTICITY CHART

SILTY CLAY (CI) - Interlayer

Figure No. C8

Project No. 1786302 (2500)

Checked By: SK

Your Project #: 1786302/2500/CR3
Site Location: HWY 401/BAYVIEW
Your C.O.C. #: na

Attention: Katelyn Nero

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2021/06/09
Report #: R6668741
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C1F1802
Received: 2021/06/03, 14:03

Sample Matrix: Soil
Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Chloride (20:1 extract)	8	2021/06/08	2021/06/09	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	8	2021/06/08	2021/06/08	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	8	2021/06/08	2021/06/08	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	8	2021/06/03	2021/06/09	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	8	2021/06/08	2021/06/09	CAM SOP-00464	EPA 375.4 m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: 1786302/2500/CR3
Site Location: HWY 401/BAYVIEW
Your C.O.C. #: na

Attention: Katelyn Nero

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2021/06/09
Report #: R6668741
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C1F1802
Received: 2021/06/03, 14:03

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager
Email: emese.gitej@bureauveritas.com
Phone# (905)817-5829

==========

This report has been generated and distributed using a secure automated process.
BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

BV Labs Job #: C1F1802
Report Date: 2021/06/09

Golder Associates Ltd
Client Project #: 1786302/2500/CR3
Site Location: HWY 401/BAYVIEW
Sampler Initials: SK

SOIL CORROSIVITY PACKAGE (SOIL)

BV Labs ID		PSY809			PSY810		PSY811		
Sampling Date		2021/05/26			2021/05/26		2021/05/26		
COC Number		na			na		na		
	UNITS	NW3-1 SS3 5'-7'	RDL	QC Batch	NW3-2 SS2 2'6'-4'6'	RDL	NW3-3 SS4 7'6'-9'6'	RDL	QC Batch
Calculated Parameters									
Resistivity	ohm-cm	520		7388747	420		1500		7388747
Inorganics									
Soluble (20:1) Chloride (Cl-)	ug/g	980	20	7395160	1200	40	350	20	7395160
Conductivity	umho/cm	1920	2	7395714	2350	2	666	2	7395714
Available (CaCl2) pH	pH	8.01		7395035	7.88		7.79		7394841
Soluble (20:1) Sulphate (SO4)	ug/g	140	20	7395222	350	20	<20	20	7395222

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs ID		PSY812	PSY813			PSY813		
Sampling Date		2021/06/02	2021/06/02			2021/06/02		
COC Number		na	na			na		
	UNITS	NW3-4 SS3B 5'8'-7'	NW3-5 SS4 7'6'-9'6'	RDL	QC Batch	NW3-5 SS4 7'6'-9'6' Lab-Dup	RDL	QC Batch
Calculated Parameters								
Resistivity	ohm-cm	590	1200		7388747			
Inorganics								
Soluble (20:1) Chloride (Cl-)	ug/g	900	390	20	7395160			
Conductivity	umho/cm	1700	867	2	7395714			
Available (CaCl2) pH	pH	7.98	8.04		7395035			
Soluble (20:1) Sulphate (SO4)	ug/g	50	73	20	7395222	71	20	7395222

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

BV Labs Job #: C1F1802
Report Date: 2021/06/09

Golder Associates Ltd
Client Project #: 1786302/2500/CR3
Site Location: HWY 401/BAYVIEW
Sampler Initials: SK

SOIL CORROSIVITY PACKAGE (SOIL)

BV Labs ID		PSY814		PSY815	PSY816		
Sampling Date		2021/06/02		2021/06/02	2021/06/02		
COC Number		na		na	na		
	UNITS	NW3-6 SS5 10'-12'	QC Batch	NW3-7 SS3 5'-7'	NW3-8 SS4 7'6'-9'6'	RDL	QC Batch
Calculated Parameters							
Resistivity	ohm-cm	540	7388747	940	2400		7388747
Inorganics							
Soluble (20:1) Chloride (Cl-)	ug/g	940	7395160	640	220	20	7395160
Conductivity	umho/cm	1840	7395714	1060	413	2	7395714
Available (CaCl2) pH	pH	8.03	7394841	7.88	8.07		7395035
Soluble (20:1) Sulphate (SO4)	ug/g	27	7395222	<20	<20	20	7395222

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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BV Labs Job #: C1F1802
Report Date: 2021/06/09

Golder Associates Ltd
Client Project #: 1786302/2500/CR3
Site Location: HWY 401/BAYVIEW
Sampler Initials: SK

TEST SUMMARY

BV Labs ID: PSY809
Sample ID: NW3-1 SS3 5'-7'
Matrix: Soil

Collected: 2021/05/26
Shipped:
Received: 2021/06/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7395160	2021/06/08	2021/06/09	Alina Dobreanu
Conductivity	AT	7395714	2021/06/08	2021/06/08	Khushbu Vijay kumar Patel
pH CaCl2 EXTRACT	AT	7395035	2021/06/08	2021/06/08	Surinder Rai
Resistivity of Soil		7388747	2021/06/09	2021/06/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7395222	2021/06/08	2021/06/09	Alina Dobreanu

BV Labs ID: PSY810
Sample ID: NW3-2 SS2 2'6'-4'6'
Matrix: Soil

Collected: 2021/05/26
Shipped:
Received: 2021/06/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7395160	2021/06/08	2021/06/09	Alina Dobreanu
Conductivity	AT	7395714	2021/06/08	2021/06/08	Khushbu Vijay kumar Patel
pH CaCl2 EXTRACT	AT	7394841	2021/06/08	2021/06/08	Surinder Rai
Resistivity of Soil		7388747	2021/06/09	2021/06/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7395222	2021/06/08	2021/06/09	Alina Dobreanu

BV Labs ID: PSY811
Sample ID: NW3-3 SS4 7'6'-9'6'
Matrix: Soil

Collected: 2021/05/26
Shipped:
Received: 2021/06/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7395160	2021/06/08	2021/06/09	Alina Dobreanu
Conductivity	AT	7395714	2021/06/08	2021/06/08	Khushbu Vijay kumar Patel
pH CaCl2 EXTRACT	AT	7394841	2021/06/08	2021/06/08	Surinder Rai
Resistivity of Soil		7388747	2021/06/09	2021/06/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7395222	2021/06/08	2021/06/09	Alina Dobreanu

BV Labs ID: PSY812
Sample ID: NW3-4 SS3B 5'8'-7'
Matrix: Soil

Collected: 2021/06/02
Shipped:
Received: 2021/06/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7395160	2021/06/08	2021/06/09	Alina Dobreanu
Conductivity	AT	7395714	2021/06/08	2021/06/08	Khushbu Vijay kumar Patel
pH CaCl2 EXTRACT	AT	7395035	2021/06/08	2021/06/08	Surinder Rai
Resistivity of Soil		7388747	2021/06/09	2021/06/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7395222	2021/06/08	2021/06/09	Alina Dobreanu

BV Labs ID: PSY813
Sample ID: NW3-5 SS4 7'6'-9'6'
Matrix: Soil

Collected: 2021/06/02
Shipped:
Received: 2021/06/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7395160	2021/06/08	2021/06/09	Alina Dobreanu

BV Labs Job #: C1F1802
Report Date: 2021/06/09

Golder Associates Ltd
Client Project #: 1786302/2500/CR3
Site Location: HWY 401/BAYVIEW
Sampler Initials: SK

TEST SUMMARY

BV Labs ID: PSY813
Sample ID: NW3-5 SS4 7'6'-9'6'
Matrix: Soil

Collected: 2021/06/02
Shipped:
Received: 2021/06/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	7395714	2021/06/08	2021/06/08	Khushbu Vijay kumar Patel
pH CaCl2 EXTRACT	AT	7395035	2021/06/08	2021/06/08	Surinder Rai
Resistivity of Soil		7388747	2021/06/09	2021/06/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7395222	2021/06/08	2021/06/09	Alina Dobreanu

BV Labs ID: PSY813 Dup
Sample ID: NW3-5 SS4 7'6'-9'6'
Matrix: Soil

Collected: 2021/06/02
Shipped:
Received: 2021/06/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate (20:1 Extract)	KONE/EC	7395222	2021/06/08	2021/06/09	Alina Dobreanu

BV Labs ID: PSY814
Sample ID: NW3-6 SS5 10'-12'
Matrix: Soil

Collected: 2021/06/02
Shipped:
Received: 2021/06/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7395160	2021/06/08	2021/06/09	Alina Dobreanu
Conductivity	AT	7395714	2021/06/08	2021/06/08	Khushbu Vijay kumar Patel
pH CaCl2 EXTRACT	AT	7394841	2021/06/08	2021/06/08	Surinder Rai
Resistivity of Soil		7388747	2021/06/09	2021/06/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7395222	2021/06/08	2021/06/09	Alina Dobreanu

BV Labs ID: PSY815
Sample ID: NW3-7 SS3 5'-7'
Matrix: Soil

Collected: 2021/06/02
Shipped:
Received: 2021/06/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7395160	2021/06/08	2021/06/09	Alina Dobreanu
Conductivity	AT	7395714	2021/06/08	2021/06/08	Khushbu Vijay kumar Patel
pH CaCl2 EXTRACT	AT	7395035	2021/06/08	2021/06/08	Surinder Rai
Resistivity of Soil		7388747	2021/06/09	2021/06/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7395222	2021/06/08	2021/06/09	Alina Dobreanu

BV Labs ID: PSY816
Sample ID: NW3-8 SS4 7'6'-9'6'
Matrix: Soil

Collected: 2021/06/02
Shipped:
Received: 2021/06/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7395160	2021/06/08	2021/06/09	Alina Dobreanu
Conductivity	AT	7395714	2021/06/08	2021/06/08	Khushbu Vijay kumar Patel
pH CaCl2 EXTRACT	AT	7395035	2021/06/08	2021/06/08	Surinder Rai
Resistivity of Soil		7388747	2021/06/09	2021/06/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7395222	2021/06/08	2021/06/09	Alina Dobreanu

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BV Labs Job #: C1F1802
Report Date: 2021/06/09

Golder Associates Ltd
Client Project #: 1786302/2500/CR3
Site Location: HWY 401/BAYVIEW
Sampler Initials: SK

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	4.7°C

Results relate only to the items tested.

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BV Labs Job #: C1F1802
Report Date: 2021/06/09

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1786302/2500/CR3
Site Location: HWY 401/BAYVIEW
Sampler Initials: SK

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7394841	Available (CaCl2) pH	2021/06/08			99	97 - 103			0.14	N/A
7395035	Available (CaCl2) pH	2021/06/08			99	97 - 103			0.028	N/A
7395160	Soluble (20:1) Chloride (Cl-)	2021/06/09	NC	70 - 130	103	70 - 130	<20	ug/g	1.5	35
7395222	Soluble (20:1) Sulphate (SO4)	2021/06/09	NC	70 - 130	108	70 - 130	<20	ug/g	1.7	35
7395714	Conductivity	2021/06/08			99	90 - 110	<2	umho/cm	1.1	10

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

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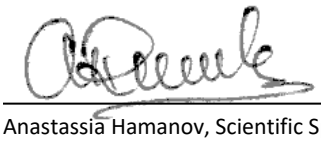
BV Labs Job #: C1F1802
Report Date: 2021/06/09

Golder Associates Ltd
Client Project #: 1786302/2500/CR3
Site Location: HWY 401/BAYVIEW
Sampler Initials: SK

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:



Anastassia Hamanov, Scientific Specialist

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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BUREAU VERITAS

6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
CAM FCD-01191/6

WORK ORDER

CHAIN OF CUSTODY RECORD

Invoice Information	Report Information (if differs from invoice)	Project Information (where applicable)	Turnaround Time (TAT) Required
Company Name: Golder Associates Ltd	Company Name: Golder Associates	Quotation #: B80683	[X] Regular TAT (5-7 days) Most analyses
Contact Name: Accounts Payble	Contact Name: Shantanu Kar / Katelyn Nero	P.O. #/ AFE#:	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Address: 6925 Century Ave, Suite 100 Mississauga, ON, L5N 7K2	Address:	Project #: 1786302/2500/CR3	Rush TAT (Surcharges will be applied) [ ] 1 Day [ ] 2 Days [ ] 3-4 Days
Phone: 905 567 4444 Fax:	Phone: Fax:	Site Location:	
Email: AP_CustomerService@golder.com	Email: shantanu_kar@golder.com / knero@golder.com	Site #: HWY 401/Bayview	Date Required:
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS LABORATORIES' DRINKING WATER CHAIN OF CUSTODY		Site Location Province:	Rush Confirmation #:
		Sampled By: SK	LABORATORY USE ONLY

Regulation 153: [ ] Table 1 [ ] Res/Park [ ] Med/ Fine; [ ] Table 2 [ ] Ind/Comm [ ] Coarse; [ ] Table 3 [ ] Agri/ Other; [ ] Table ____; FOR RSC (PLEASE CIRCLE) Y / N

Other Regulations: [ ] CCME [ ] Sanitary Sewer Bylaw; [ ] MISA [ ] Storm Sewer Bylaw; [ ] PWQO Region ____; [ ] Other (Specify) ____; [ ] REG 558 (MIN. 3 DAY TAT REQUIRED); [ ] REG 406 Table ____

Include Criteria on Certificate of Analysis: Y / N

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

CUSTODY SEAL Y / N (N) — COOLER TEMPERATURES: Present / Intact — 3/6/5

COOLING MEDIA PRESENT: Y / N (N)

	SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / CrVI	BTEX/ PHC F1	PHCs F2 - F4	VOCs	REG 153 METALS & INORGANICS	REG 153 ICPMS METALS	Corrosivity Pkg (Cl, SO4, EC, resistivity, pH)	HOLD- DO NOT ANALYZE	COMMENTS
1	NW3-1 SS3 5' - 7'	2021-05-26	PM	SOIL	1							X		
2	NW3-2 SS2 2'6" - 4'6"	2021-05-26	PM	SOIL	1							X		
3	NW3-3 SS4 7'6" - 9'6"	2021-05-26	PM	SOIL	1							X		
4	NW3-4 SS3B 5'8" - 7'	2021-06-02	PM	SOIL	1							X		
5	NW3-5 SS4 7'6" - 9'6"	2021-06-02	PM	SOIL	1							X		
6	NW3-6 SS5 10' - 12'	2021-06-02	PM	SOIL	1							X		
7	NW3-7 SS3 5' 7'	2021-06-02	PM	SOIL	1							X		
8	NW3-8 SS4 7'6" - 9'6"	2021-06-02	PM	SOIL	1							X		
9														
10														

03-Jun-21 14:03
Ema Gitej
C1F1802
DSG ENV-1432

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	BV JOB #
ANKAREN MAHWSWARAN	2021-06-03			2021/06/03	14:03	

APPENDIX D

Non-Standard Special Provisions

***5m* NOISE BARRIER SYSTEM - Item No.**
***5m* NOISE BARRIER SYSTEM INCLUDING PRECAST NOISE/TRAFFIC BARRIER - Item No.**
NOISE BARRIER ACCESS - Item No.

Special Provision No. 760F01 March 2018

Amendment to OPSS 760, November 2014

760.03 DEFINITIONS

Section 760.03 of OPSS 760 is amended by the deletion of the definitions for **Certificate of Conformance** and **Quality Verification Engineer**.

760.04 DESIGN AND SUBMISSION REQUIREMENTS

760.04.01 Design Requirements

760.04.01.01 Footings

760.04.01.01.01 General

Clause 760.04.01.01.01 of OPSS 760 is amended by the addition of the following paragraph:

The soil design parameters for the design of footings shall be as specified in Table A:

Table A
Soil Design Parameters

Location	Soil Design Parameter
Hwy 401 East Bound Collector Sta 23+764 to Sta 23+887 (#1)	Cu = 65 KPa
Hwy 401 East Bound Collector Sta 23+840 to Sta 24+031 (#2)	Cu = 85 KPa
Hwy 401 East Bound Collector Sta 24+031 to Sta 24+335 (#3)	Ø = 35º
Hwy 401 East Bound Collector Sta 24+335 to Sta 24+578 (#4)	Cu = 85 KPa
Hwy 401 East Bound Collector Sta 24+566 to Sta 25+022 (#5)	Ø = 35º
Hwy 401 East Bound Collector Sta 29+734 to Sta 29+872	Cu = 65 KPa
Hwy 401 East Bound Collector Sta 30+059 to Sta 30+361	Ø = 34º

Subsection 760.04.01 of OPSS 760 is amended by the addition of the following clauses:

760.04.01.02 Wind Load

The wind load applied for the design of structure shall be: 460 Pa for Toronto area.

760.04.01.03 Acoustics

The minimum acoustical characteristic of the noise barrier system shall be such that the noise barrier is: Sound absorptive on both sides.

760.04.01.04 Aesthetics

The colour and texture for the noise barrier system shall be within the following parameters:

Number of colours adjacent to highway: One (1) in the proportion of 100%

Number of textures One (1) in the proportion of 100%

Number of colours adjacent to residential property: One (1) in the proportion of 100%

Number of textures One (1) in the proportion of 100%

Final colour selections shall be determined by the Contract Administrator at the point of manufacture from samples prepared by the manufacturer.

If only one colour and texture are specified, the noise barrier shall be constructed using the colour and texture specified by the Contract Administrator following the award of the Contract. Final colour selection shall be determined at the point of manufacture from samples prepared by the manufacturer.

760.07 CONSTRUCTION

760.07.13 Quality Control

760.07.13.01 Interim Inspection of Footings and Posts

Clause 760.07.13.01 of OPSS 760 is deleted in its entirety and replaced with the following:

760.07.13.01 Inspection before Installation of Noise Barrier Panels

A Request to Proceed shall be submitted to the Contract Administrator after the construction of the noise barrier footings and posts and prior to the installation of the noise barrier panels

The installation of the noise barrier panels shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

760.07.13.02 Certificate of Conformance

Clause 760.07.13.02 of OPSS 760 is deleted in its entirety and replaced by the following:

760.07.13.02 Inspection after Installation of Noise Barrier System

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the installation of the noise barrier system.

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