



Foundation Investigation and Design Report

High Mast Light Poles

QEW & Highway 403 Interchange Improvements, Burlington, Ontario

Ministry of Transportation, Ontario

GWP 2065-17-00 and 2066-17-00

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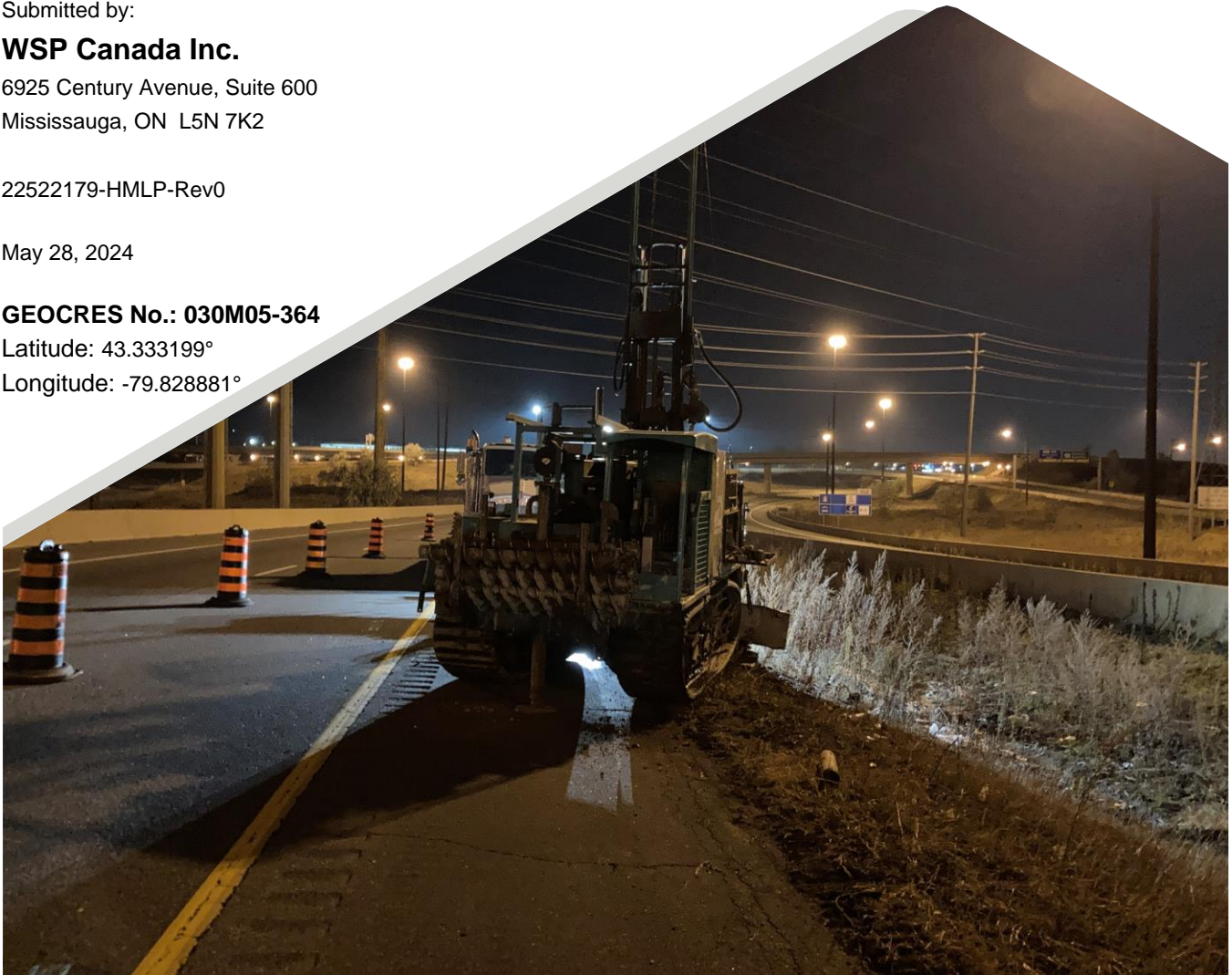
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PART A

**FOUNDATION INVESTIGATION REPORT
HIGH MAST LIGHT POLES
QEW & HIGHWAY 403 INTERCHANGE IMPROVEMENTS,
BURLINGTON, ONTARIO
MINISTRY OF TRANSPORTATION, ONTARIO
MTO GWP 2065-17-00 AND 2066-17-00**

1.0 INTRODUCTION

WSP Canada Inc. (WSP) has been retained by the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for various structures as part of the improvements to the Queen Elizabeth Way (QEW) and Highway 403 interchange (Freeman Interchange) in the City of Burlington. The foundation scope of work in this report includes investigation and design services for ten (10) high mast light poles located between the north end of the Burlington Bay Skyway and Guelph Line.

This report summarizes the results of field and laboratory work (including field investigation procedures, borehole stratigraphy, bedrock lithology, and geotechnical and analytical laboratory test results) and provides a description of interpreted soil, bedrock, and groundwater conditions at the ten high mast light pole locations.

2.0 PROJECT AND SITE DESCRIPTION

The orientation (i.e., north, south, east, west) stated in the text of the report is referenced to project/construction north, and therefore, may differ from magnetic north shown on the foundations drawing. For the purpose of this report, the QEW is described as oriented in a north-south direction south/west of the Freeman Interchange and oriented in an east-west direction north/east of the Freeman Interchange.

The proposed high mast light poles are located within the QEW and Highway 403 corridor, from approximately 600 m south of the Fairview St/Plains Road Overpass, to approximately 250 m west of the Brant Street Overpass. Along this corridor, the QEW has been constructed on approximately 2 m to 11 m high embankments, with the highway grade ranging from about Elevation 93.7 m to about Elevation 109.9 m. The highway grade generally decreases in elevation to the south.

The area adjacent to the existing site is urbanized and is comprised of commercial and residential developments.

3.0 INVESTIGATION PROCEDURES

The foundation investigation for the high mast light poles was carried out between November 14 and 27, 2023, during which time a total of ten (10) boreholes (designated as Boreholes BH22-7, BH23-3, and BH23-9 to BH23-16) were advanced near the proposed high mast light pole locations.

The borehole investigation was carried out using a CME-55 track-mounted and CME-75 truck-mounted drill rig, supplied and operated by Davis Drilling of Milton, Ontario. Traffic control was performed in accordance with the Ontario Traffic Manual Book 7 – Temporary Conditions. The boreholes were advanced through the overburden using 160 mm to 210 mm outside diameter (OD) continuous flight hollow stem augers. Soil samples were typically obtained at 0.75 m and 1.5 m intervals of depth, using a 50 mm outside diameter split spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ATM D1586). 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.

The field work was observed on a full-time basis by members of WSP's engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, and logged the boreholes. The samples were identified in the field, placed in appropriate containers, labelled, and transported to WSP's Mississauga laboratory where the samples underwent further visual examination. Geotechnical laboratory testing (water content, grain size distribution, and Atterberg limits) was carried out on select soil samples, in accordance with MTO and / or ASTM Standards, as appropriate. In

addition, select soil samples were submitted to Bureau Veritas Laboratories of Mississauga, Ontario for analysis of select parameters to assess for the potential of corrosion of buried steel and deterioration of concrete.

The groundwater conditions were noted in the boreholes during and upon completion of drilling and were backfilled in accordance with Ontario Regulation 903 (Wells, as amended), and the asphalt surface was capped with tamped cold patch asphalt.

Rock coring was carried out in Boreholes BH23-9, BH23-10, BH23-11, and BH22-7 using diamond drilling techniques with HQ sized equipment. Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD), weathering and strength indices, discontinuity characteristics (type, shape, and surface roughness) and classification data of the retrieved rock core samples were generally recorded in the field based on visual observation. The bedrock was sequentially photographed, packed, and transported to WSP's Mississauga laboratory for further visual examination. The core photos are included in Appendix B of this report. Select rock core samples were submitted to Geomechanica Inc. of Oakville, Ontario for geotechnical laboratory testing for strength testing (unconfined compression (UC)). Classification of the rock mass quality of the bedrock with respect to RQD is described based on Table 3.10 of the Canadian Foundation Engineering Manual (CFEM, 2023) while the strength of the bedrock core samples is based on Table 3.5 of CFEM (2023). The degree of weathering of the bedrock core samples and the strength classification of the intact rock mass based on field identification are described in accordance with Table B.3 and Table B.6, respectively, of the International Society of Rock Mechanics (ISRM, 1985) standard classification system.

As natural gas (e.g., methane and hydrogen sulphide) is known to be present at some locations within the shale bedrock of the Queenston Formation, a portable RKL multi-gas detector, was used to monitor for natural gas concentrations released from these boreholes during the drilling process. The presence of natural gas was not observed (e.g., bubbling of drilling fluid) and gas concentrations were not detected during drilling and coring at the borehole locations.

The as-drilled borehole locations and elevations were surveyed by WSP using a Trimble Catalyst DA2 GNSS Receiver. The borehole locations are referenced to NAD 83(CSRS)v6 MTM Zone 10 coordinates and the ground surface elevations are referenced to geodetic datum benchmark. The borehole locations (including in geographic coordinates of latitude and longitude), ground surface elevations, and drilled depths are summarized in the table below.

Borehole No.	MTM NAD83 Northing (Latitude, °)	MTM NAD83 Easting (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
BH22-7	4,798,916.1 (43.329663)	278,281.9 (-79.826998)	107.4	27.6
BH23-3	4,798,756.6 (43.328231)	278,370.0 (-79.825904)	106.6	12.8
BH23-9	4,800,385.2 (43.342908)	278,871.9 (-79.819791)	108.3	7.9
BH23-10	4,800,195.5 (43.341189)	278,564.3 (-79.823576)	109.9	9.7
BH23-11	4,799,309.6 (43.333199)	278,131.0 (-79.828881)	104.4	15.6
BH23-12	4,799,127.3 (43.331561)	278,202.9 (-79.827982)	107.6	12.8

Borehole No.	MTM NAD83 Northing (Latitude, °)	MTM NAD83 Easting (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
BH23-13	4,798,594.4 (43.326773)	278,449.9 (-79.824911)	101.8	12.8
BH23-14	4,798,460.3 (43.325569)	278,546.8 (-79.823709)	97.7	12.8
BH23-15	4,798,311.6 (43.324235)	278,681.0 (-79.822047)	95.0	12.4
BH23-16	4,798,219.6 (43.323410)	278,781.1 (-79.820809)	93.7	12.5

4.0 SUBSURFACE CONDITIONS

4.1 Regional Geology

The site is located within the physiographic region known as the Iroquois Plain, as delineated in The Physiography of Southern Ontario (Chapman and Putnam, 1984). The Iroquois Plain stretches along the northern shoreline of Lake Ontario, extending from the Niagara Escarpment in the west to the Scarborough Bluffs in the east. The shallow conditions of the Iroquois Plain consist of glaciolacustrine sediments deposited in the former Lake Iroquois. These sediments are primarily comprised of sand, silt and gravel, with shallow cover of glacial till over bedrock. The bedrock within the project area is comprised of red shale of the Queenston Formation.

4.2 Subsurface Conditions

The detailed subsurface soil, bedrock, and groundwater conditions as encountered in the boreholes are presented on the borehole records in Appendix A. To assist in the interpretation of the borehole records, Method of Soil Classification, Abbreviations and Terms Used on Records of Boreholes and Test Pits and List of Symbols sheets are provided in Appendix A. The geotechnical laboratory test results are presented in Appendix B. The analytical laboratory test results are presented in Appendix C.

The results of the in situ tests (i.e., SPT “N”-values) as presented on the borehole records and in Section 4.2 are uncorrected for overburden pressure and energy transfers. The ‘N’-values are based on SPT sampling procedures carried out with a standard weight (i.e., 63.5 kg), and an automatic hammer.

The stratigraphic boundaries shown on the borehole records are inferred from observations of drilling progress, generally non-continuous sampling, and in-situ testing, and therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond boreholes.

In general, the subsurface conditions at the site consist of a road pavement structure underlain or topsoil underlain by non-cohesive to cohesive fill varying in depth and in composition. In some instances, buried topsoil was encountered below the fill. The fill is underlain by overburden consisting of clayey silt, an upper silt and sand to silty sand deposit, or a cohesive glacial till. The overburden is underlain by shale bedrock of the Queenston Formation. A more detailed descriptions of the subsurface conditions encountered in the boreholes during the field investigations in provided in the following sections.

4.2.1 Asphalt

An approximately 100 mm to 180 mm thick layer of surficial asphalt pavement was encountered at ground surface in Boreholes BH22-7, BH23-3, and BH23-13 to BH23-16 which were drilled from the QEW highway grade.

4.2.2 Topsoil

An approximately 80 mm to 100 mm thick layer of surficial topsoil was encountered at ground surface in Boreholes BH23-9 to BH23-12.

An approximately 500 mm thick layer of buried topsoil was encountered below the fill (described in Section 4.2.3 below) in Borehole 22-7 at a depth of about 11.2 m below ground surface (Elevation 96.3 m).

4.2.3 Fill

Approximately 1.2 m to 11.1 m of fill was encountered below the surficial asphalt / surficial topsoil in all the boreholes, extending to depths ranging from about 1.4 m to 10.2 m below ground surface (Elevations 92.3 m to 106.1 m). A summary of the fill depths, thickness, and base elevations is provided in the table below.

The fill varies in composition from non-cohesive silty sand / silty sand and gravel / gravelly sand / sand and gravel to cohesive sandy clayey silt / clayey silt / silty clay. The fill contains organics in Boreholes BH23-10 and contains shale/rock fragments in Borehole BH22-7, as noted on the borehole records. Auger grinding was observed while advancing through the fill in Boreholes BH23-3, BH23-9, and BH23-10, as noted on the borehole records. Where auger grinding was noted in Borehole BH23-3, this can potentially be the buried road surface of the pre-existing Plains Road.

Borehole No.	Approximate Fill Thickness (m)	Fill Depth (Base of Fill) (m)	Elevation of Base of Fill (m)
BH23-3	10.1	10.2	96.3
BH23-9	2.1	2.2	106.1
BH23-10	4.6	4.7	105.2
BH23-11	5.5	5.6	98.8
BH23-12	8.6	8.7	98.9
BH23-13	6.1	6.3	95.5
BH23-14	2.0	2.2	95.5
BH23-15	1.2	1.4	93.6
BH23-16	1.2	1.4	92.3
BH22-7	11.1	11.2	96.3

The Standard Penetration Test (SPT) “N”-values measured within the non-cohesive fill layers range from 17 blows to greater than 100 blows per 0.3 m of penetration, indicating a compact to very dense state of compactness. The SPT “N”-values measured within the cohesive fill range from 5 blows to 35 blows per 0.3 m of penetration, suggesting a firm to hard consistency; except for one sample (Sample 10 in Borehole BH23-3) measured an SPT “N”-value of 100 blows per 0.13 m of penetration with refusal from an inferred cobble / boulder.

Grain size distribution testing was carried out on six samples of the non-cohesive fill layers and on eight samples of the cohesive fill layers, and the results are presented on Figures B-1 and B-2 in Appendix B, respectively.

Atterberg limits testing was carried out on nine samples of the cohesive fill layers with measured liquid limits of 27% to 37%, plastic limits of 15% to 18%, and plastic indices of 11% to 19%. The Atterberg limits testing results are presented on Figure B-3 in Appendix B.

The natural water content measured on selected samples of the non-cohesive fill range from about 3% to 13%. The natural water content measured on selected samples of the cohesive fill range from about 9% to 19%.

4.2.4 Clayey Silt (Upper Deposit)

An upper 1.0 m thick deposit of clayey silt was encountered below the fill in Borehole BH23-9 at a depth of about 2.2 m below ground surface (Elevation 106.1 m) and extended to a depth of about 3.2 m below ground surface (Elevation 105.1 m). The upper deposit contains organics and some sand.

One SPT “N”-value measured within the upper clayey silt deposit is 7 blows per 0.3 m of penetration, suggesting a firm consistency.

The natural water content measured on one sample of the upper clayey silt is about 33%.

4.2.5 Silt and Sand to Sand (Upper Deposit)

An approximately 1.1 m to 5.0 m thick layer of silt and sand to sand was encountered underlying the fill in Boreholes BH22-7, BH23-3, and BH23-13 to BH23-16 at depths ranging from 1.4 m to 11.7 m below ground surface (Elevations 92.3 m to 96.3 m). The deposit extends to depths ranging from about 4.5 m to 13.3 m below ground surface (Elevations 89.2 m to 94.8 m). The deposit ranges in composition from silt and sand to silty sand to gravelly silty sand to sand, and at Borehole BH22-7, the deposit is classified as clayey sand. At Borehole BH23-13 the deposit contains rootlets and organics as noted on the borehole record.

The Standard Penetration Test (SPT) “N”-values measured within the upper silt and sand to sand deposit range from 4 blows to 29 blows per 0.3 m of penetration, indicating a loose to compact state of compactness.

Grain size distribution testing was carried out on six samples of the upper silt and sand to sand deposit and the results are presented in Figure B-4 in Appendix B.

Atterberg limits testing was carried out on one sample of the upper silt and sand to sand deposit (clayey sand) from Borehole BH22-7 and measured a liquid limit of 28%, a plastic limit of 22%, and a plastic index of 6%. The Atterberg limits testing results are presented on Figure B-5 in Appendix B.

The natural water content measured on ten samples of the upper silt and sand to sand deposit range from about 4% to 24%.

4.2.6 Glacial Till

A till deposit was encountered underlying the fill / upper silt and sand to sand deposit in Boreholes BH22-7, BH23-3, and BH23-11 to BH23-16. The surface of the till deposit was encountered at depths ranging from 4.5 m to 11.3 m below ground surface (Elevations 89.2 m to 98.8 m). Where fully penetrated (at Boreholes BH22-7, BH23-11, and BH23-14 to BH23-16), the till deposit is 4.6 m, 4.5 m, 4.2 m, 4.2 m, and 10.6 m thick, respectively. Boreholes BH23-3, BH23-12, and BH23 13 were terminated in the till deposit, penetrating it for a thickness of 1.1 m, 4.1 m, and 3.0 m, respectively.

The till generally consists of clayey silt, some sand to sandy, trace gravel. At Borehole BH23 11, the clayey silt till is underlain by sandy silty gravel till. At Borehole BH23-14, an approximately 0.9 m thick interlayer of gravel was

encountered within the till deposit at a depth of about 10.2 m below ground surface (Elevation 87.5 m). Auger grinding was observed while advancing through the till deposit in Boreholes BH23-11 and BH23-12, as noted on the borehole records. Based on our experience with glacial till in the area, and the observed auger grinding, cobbles and boulders are anticipated within the till deposit.

The SPT “N”-values measured within the clayey silt glacial till deposit generally range from 22 blows to 71 blows per 0.3 m of penetration, suggesting a very stiff to hard consistency. One SPT “N” value measured within the sandy silty gravel till deposit is 100 blows for 0.13 m of penetration, suggesting a very dense state of compactness at this location.

Grain size distribution testing was carried out on nine samples of the till deposit and the results are presented in Figure B-6 in Appendix B.

Atterberg limits testing was carried out on eight samples of the till deposit and measured liquid limits of 22% to 34%, plastic limits of 15% to 18%, and plastic indices of 7% to 16%. The Atterberg limits testing results are presented on Figure B-7 in Appendix B.

The natural water content measured on fifteen samples of the till deposit range from about 10% to 21%.

4.2.7 Clayey Silt (Lower Deposit)

A lower deposit of clayey silt was encountered below the till in Boreholes BH23-15 and BH23-16 at depths of about 8.7 m below ground surface (Elevation 86.3 m and 85.0 m). At Borehole BH23-16, the clayey silt was interlayered with a sandy silt deposit and the borehole was terminated within the clayey silt deposit at a depth of about 12.5 m below ground surface (Elevation 81.2 m). At Borehole BH23-16, the clayey silt deposit was about 1.5 m thick and extended to a depth of about 10.2 m below ground surface (Elevation 84.8 m). The lower clayey silt deposit contains trace sand and trace gravel.

The SPT “N”-values measured within the lower clayey silt deposit range from 25 blows per 0.3 m of penetration to 100 blows per 0.13 m of penetration, suggesting a hard consistency.

Grain size distribution testing was carried out on two samples of the lower clayey silt deposit and the results are presented in Figure B-8 in Appendix B.

Atterberg limits testing was carried out on two samples of the clayey silt deposit and measured liquid limits of 29% to 32%, plastic limits of 18%, and plastic indices of 11% to 14%. The Atterberg limits testing results are presented on Figure B-9 in Appendix B.

4.2.8 Silt to Silty Sand (Lower Deposit)

An approximately 1.1 m to 2.2 m thick lower silt to silty sand deposit was encountered below the till / lower silty clay deposits in Boreholes BH23-14 to BH23-16. The surface of this deposit was encountered at depths ranging between 10.2 m to 11.7 m below ground surface (Elevations 83.5 m to 86.0 m). Where fully penetrated (at Borehole BH23-16), the deposit is 1.5 m thick and extended to a depth of 11.7 m (Elevation 82.0 m). Boreholes BH23-14 and BH23-15 were terminated in this deposit, penetrating it for a thickness of 1.1 m and 2.2 m, respectively.

The SPT “N”-values measured within the lower silt to silty sand deposit generally range from 39 blows to 84 blows per 0.3 m of penetration, with one SPT “N” value of 100 blows for 0.08 m of penetration, indicating a dense to very dense state of compactness.

Grain size distribution testing was carried out on three samples of the lower silt to silty sand deposit and the results are presented on Figure B-11 in Appendix B.

The natural water content measured on three samples of the lower silt to silty sand deposit range from about 10% to 26%.

Based on the factual information, this material may be considered as transition to residual soil.

4.2.9 Residual Soil

An approximately 0.5 m to 1.6 m thick layer of residual soil was encountered below the fill / upper clayey silt deposit / glacial till deposit in Boreholes BH22-7, BH23-9, and BH23-10. The surface of the residual soil deposit was encountered at depths ranging from 3.2 m to 22.4 m below ground surface (Elevations 85.0 to 105.2 m) and extends to depths ranging from 7.9 m to 15.6 m below ground surface (Elevations 88.8 m to 100.4 m).

The residual soil in Boreholes BH23-9 and BH23-10 consists of clayey silt, some sand, trace gravel. The residual soil in Borehole BH22-7 consists of silt and sand, some gravel.

The SPT “N”-values measured within the cohesive residual soil deposit in Boreholes BH23-9 and BH23-10 are 20 blows and 25 blows per 0.3 m of penetration, suggesting a very stiff consistency. The SPT “N”-value measured within the non-cohesive residual soil in Borehole BH22-7 is 69 blows per 0.3 m of penetration, indicating a very dense state of compactness.

Grain size distribution testing was carried out on three samples of the residual soil and the results are presented on Figure B-12 in Appendix B.

Atterberg limits testing was carried out on three samples of the residual soil deposit and measured liquid limits of 32% to 34%, plastic limits of 16% to 18%, and plastic indices of 14% to 18%. One of the Atterberg limits testing from Borehole BH22-7 was measured to be non-plastic. The Atterberg limits testing results are presented on Figure B-13 in Appendix B.

4.2.10 Shale Bedrock

Bedrock was encountered during auger advancement and was cored in Boreholes BH22-7, BH23-9, BH23-10, and BH23-11. The ground surface elevation, depth to bedrock surface, the corresponding bedrock surface elevation, and the core depths are summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Comments
BH22-7	107.4	23.9	83.5	0.6 m of auger penetration. Bedrock cored 3.2 m.
BH23-9	108.3	3.7	104.6	1.2 m of auger penetration. Bedrock cored 3.4 m.
BH23-10	109.9	5.3	104.6	0.4 m of auger penetration. Bedrock cored 3.9 m.
BH23-11	104.4	12.0	92.4	0.3 m of auger penetration. Bedrock cored 3.5 m.

Based on a review of the bedrock core samples, the bedrock consists of shale of the Queenston Formation. In general, the bedrock samples are described as highly weathered to fresh (W4 to W1), thinly bedded, red, fine

grained, slightly porous, very weak to weak (R1 to R2) shale, interbedded with strong to very strong (R3 to R5) greenish-grey to grey siltstone/limestone layers. The thickness of limestone/siltstone layers encountered in the boreholes ranges from approximately 10 mm to 270 mm. Up to 130 mm thick layers of extremely weak rock (R0) were encountered within the core at various depths as indicated on the logs. Photographs of the recovered bedrock core samples are shown in Figures BR-13 to BR-17 in Appendix B.

The Total Core Recovery (TCR) and solid Core Recovery (SCR) based on the core samples recovered in Boreholes BH22-7, BH23-9, BH23-10, and BH23-11 range from 65% to 100%, and 0% to 100%, respectively. The Rock Quality Designation (RQD) ranges from 22% to 100%, indicating a rock mass of poor to excellent quality as per Table 3.10 of CFEM (2023).

Unconfined Compression (UC) tests were completed on four samples of the Queenston shale bedrock by Geomechanica Inc. The results are included in Appendix B and are summarized in the table below.

Borehole No.	Rock Type	Sample Depth (m)	Density (g/cm ³)	Young's Modulus E (GPa)	Unconfined Compressive Strength, UCS (MPa)
BH22-7	Shale	27.00 – 27.25	2.6	4.2	17.3
BH23-9	Shale	6.97 – 7.13	2.6	4.4	16.3
BH23-10	Shale	8.37 – 8.55	2.6	5.7	34.3
BH23-11	Shale	14.65 – 14.83	2.6	5.6	26.3

4.3 Groundwater Conditions

The groundwater levels were generally measured within the open boreholes, and/or inside the augers in boreholes where coring took place (prior to coring operations). The observed groundwater conditions are summarized below. Groundwater and surface water levels in the area are subject to season fluctuations and variations due to precipitation events.

Borehole No	Water Level		Reading Type	Date
	Depth (m)	Elevation (m)		
BH22-7	NA	NA	NA	May 7, 2023
BH23-3	dry	dry	open borehole	November 21, 2023
BH23-9	1.3	107.0	inside augers prior to coring	November 14, 2023
BH23-10	dry	dry	inside augers prior to coring	November 15, 2023
BH23-11	dry	dry	inside augers prior to coring	November 16, 2023
BH23-12	dry	dry	open borehole	November 16, 2023
BH23-13	8.2	93.6	open borehole	November 23, 2023
BH23-14	6.4	91.3	open borehole	November 23, 2023
BH23-15	10.1	84.9	open borehole	November 27, 2023
BH23-16	6.4	87.7	open borehole	November 24, 2023

"NA" indicates groundwater conditions could not be observed due to addition of water into borehole, to aid in drilling efforts.

4.4 Analytical Testing

Ten (10) soil samples were submitted to Bureau Veritas Laboratories for corrosivity testing to assess the potential for the soil to cause corrosion to buried steel and concrete. Detailed corrosivity testing results are provided in Appendix C and the results are summarized in the table below.

BH No.	SA No.	Sample Depth (m)	Soil Type	Parameters						
				Redox Potential (mv)	Sulphide (mg/kg)	Chloride (µg/g)	Sulphate (µg/g)	pH	Conductivity (µmho/cm)	Resistivity (ohm-cm)
BH22-7	5	3.0 – 3.7	Clayey Silt Fill	230	5.6	570	510	7.79	753	1300
BH23-3	3	1.5 – 2.1	Clayey Silt Fill	190	8.0	570	810	8.02	1550	640
BH23-9	4	2.3 – 2.9	Clayey Silt	280	1.1	200	48	7.54	664	1500
BH23-10	3	1.5 – 2.1	Silty Clay Fill	260	3.0	770	190	7.74	1660	600
BH23-11	4	2.3 – 2.9	Clayey Silt Fill	270	0.8	200	140	7.69	696	1400
BH23-12	4	2.3 – 2.9	Clayey Silt Fill	260	2.4	130	730	7.89	1130	880
BH23-13	4	2.3 – 2.9	Clayey Silt Fill	130	3.5	110	380	7.69	669	1500
BH23-14	3	1.5 – 2.1	Clayey Silt Fill	130	2.0	720	350	7.80	2070	480
BH23-15	3	1.5 – 2.1	Silt to Silty Sand	190	19.4	640	390	7.39	1570	640
BH23-16	3	1.5 – 2.1	Silty Sand	290	<0.5	660	350	6.95	1420	710

5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Maor Levy, EIT, and reviewed by Ms. Anastasia Poliacik, P.Eng., and Senior Geotechnical Engineer with WSP and an MTO Principal Foundations Contact. Mr. David Staseff, P. Eng., a Senior Principal and MTO Principal Foundations Contact with WSP, conducted an independent technical and quality review of this report.

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PART B

**FOUNDATION DESIGN REPORT
HIGH MAST LIGHT POLES
QEW & HIGHWAY 403 INTERCHANGE IMPROVEMENTS,
BURLINGTON, ONTARIO
MINISTRY OF TRANSPORTATION, ONTARIO
MTO GWP 2065-17-00 AND 2066-17-00**

6.0 DISCUSSIONS AND FOUNDATION ENGINEERING RECOMMENDATIONS

This section of the report provides geotechnical engineering parameters and foundation recommendations for ten high mast light poles, in support of the improvements to the Queen Elizabeth Way (QEW) and Highway 403 interchange (Freeman Interchange) in the City of Burlington. These recommendations are based on interpretation of the factual data obtained from the boreholes advanced in the vicinity of each sign location.

The discussion and recommendations presented are intended to provide the designer with sufficient information to carry out the design of the sign foundations. The Foundation Investigation Report, discussions and recommendations are intended for the use of the Ministry of Transportation, Ontario (MTO), and shall not be used or relied upon for any other purpose or by any other parties, including the construction or design-build contractor. The contractor must make their own interpretation based on the factual data in the Foundation Investigation (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 the 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 Design of High Mast Light Pole Foundations

Based on the information provided by WSP's Design Team, the proposed high mast light pole (HMLP) locations (station) and relevant boreholes are summarized in the table below. The locations are also shown on Drawing 1.

HMLP ID.	Location (Station No.)	Reference Borehole ID
HMLP-1	11+720	BH23-9
HMLP-2	11+437	BH23-10
HMLP-3	10+365	BH23-11
HMLP-4	10+152	BH23-12
HMLP-5	9+935	BH22-7
HMLP-6	9+746	BH23-3
HMLP-7	9+578	BH23-13
HMLP-8	9+429	BH23-14
HMLP-9	9+286	BH23-15
HMLP-10	9+085	BH23-16

The High Mast Light Pole foundations should be designed in accordance with MTO's *Guidelines for the Design of High Mast Light Pole Foundations, Fourth Edition*, (MTO 2004) and the *Canadian Highway Bridge Design Code* (CHBDC 2019) Section 6.17 – Pole Foundations, based on the interpreted stratigraphy and groundwater conditions and the recommended geotechnical design parameters given in Table 1 following the text of this report. Table 1 provides a summary of the subsurface conditions encountered within the boreholes advanced in the vicinity of each High Mast Light Pole location. The parameters presented in Table 1 are based on field and laboratory test data as well as accepted correlations (NAVFAC, 1986, Bowles, 1997, and Kulhawy and Mayne, 1990) and the analysis was tempered by engineering judgement based on experience in similar soils.

In the design of the foundations, the passive resistance of the soil within the upper 1.2 m below ground surface should be neglected to account for frost action as interpreted from OPSD 3090.101 (Foundation, Frost Penetration Depth for Southern Ontario). In addition, horizontal deflection is required to fully mobilize passive earth pressure conditions and the values of K_p provided in Tables 1 may need to be reduced by an appropriate factor to account for such conditions.

6.1.1 Resistance of Lateral Loads

The design of drilled shafts (caissons) subjected to lateral loads should take into account such factors as the relative rigidity of the drilled shaft to the surrounding soil, the structural capacity of the foundation to withstand bending moments, the soil resistance that can be mobilized, and the tolerable lateral deflections at the top of the drilled shaft (caisson). For design purposes, both the structural and geotechnical resistances should be evaluated to establish the governing case.

The resistance to lateral loading in front of a drilled shaft (caisson) may be calculated using subgrade reaction theory where the coefficient of horizontal subgrade reaction, k_h (kPa/m), is based on the equations below. However, the response of a drilled shaft (caisson) to lateral loads is highly non-linear and methods that assume linear behaviour (such as subgrade reaction theory) are only appropriate where the maximum drilled shaft deflections are less than 1% of the pile or drilled shaft diameter, where the loading is static (no cycling) and where the pile material is linear (CFEM5, 2023, Section 9.8). If one or more of these conditions are not satisfied, lateral pile analysis should be carried out using p-y curves.

For non-cohesive soils:

$$k_h = \frac{n_h z}{B}$$

Where: n_h = constant of horizontal subgrade reaction (kPa/m)
 z = depth of the drilled shaft below finished grade (m), and,
 B = width of pile or diameter of drilled shaft (m)

For cohesive soils:

$$k_h = \frac{67s_u}{B}$$

Where: s_u = undrained shear strength of the soil (kPa), and,
 B = width of pile or diameter of drilled shaft (m)

The values of n_h (Terzaghi, 1955) and s_u to be incorporated into the calculations of the coefficient of horizontal subgrade reaction (k_h) within the native overburden, to be used for the structural analysis of the drilled shafts (caissons) at this site are summarised in Table 1 following the text of this report.

6.2 Construction Considerations

6.2.1 Foundations

The foundations of the high mast light poles are assumed to consist of drilled shafts (caissons). The drilled shafts (caissons) should be constructed in accordance with Ontario Provincial Standard Specification, provincially oriented OPSS.PROV 631 (Concrete Footings and Maintenance Platforms for High Mast Lighting Poles) and OPSS.PROV 903 (Deep Foundations).

6.2.2 Notice to Contractor

It is recommended that a Notice to Contractor be included in the Contract Documents to alert the Contractor of the following specific subsurface conditions. An example Notice to Contractor is provided in Appendix D.

- **Running and/or Flowing Cohesionless Soils:** It is anticipated that perched groundwater may be present at the base of the pavement structure or within the loose to compact cohesionless soils within the fill overlaying the native/till deposits. Given the cohesionless soils and potential for groundwater seepage near the boundary of any surface fill materials or within the granular deposits, it is expected these cohesionless soil will run or flow into an open caisson hole during or after drilling for the foundations. It is recommended that a Notice of Contractor and/or Non-Standard Special Provision be incorporated in the contract documents to alert the contractor of these conditions, which will require use of temporary liners and/or drilling slurry, and concrete placement via tremie methods.
- **Obstructions:** Cobbles and boulders should be expected within the glacially derived till deposits. It is recommended that this be included in a Notice to Contractor so that the contractor is prepared to address the presence of cobbles and boulders during caisson installation, as required. Additionally, buried asphalt was encountered within / below the fill at two borehole locations and therefore should be expected at some sign locations.
- **Variable Subsurface Conditions (Shallow Bedrock):** The caisson excavation for three proposed high mast light pole locations (HMLP-1 at Station 11+720, HMLP-2 at Station 11+437, and HMLP-3 at Station 10+365) will encounter the upper portion of the underlying shale bedrock, which is interpreted to be completely to slightly weathered based on the borehole information. For bidding purposes, the contractor should be prepared to penetrate the bedrock for the bottom 1 m of the caisson foundation using appropriate construction procedures and equipment (such as coring or churn drilling equipment).

6.2.3 Corrosion Assessment and Protection

The results of analytical testing on selected soil samples from each sign location / borehole are presented in Section 4.4 and the analytical laboratory test report is included in Appendix C. The suite of parameters tested is intended to allow the design engineer to assess the requirements for the appropriate type of cement to be used in construction and the need for corrosion protection of steel elements.

The analytical test results for sulphate were compared to CSA A23.1 Table 3 (“Additional requirements for concrete subjected to sulphate attack”) to assess the potential severity of sulphate attack on concrete during its service life. The sulphate concentration measured on the submitted soil samples are less than 0.002%, which is below the “moderate” degree of exposure (i.e., below the Class S-3 exposure limits) and the degree of sulphate attack is considered “negligible” according to Table 7.2 in MTO’s Gravity Pipe Design Guidelines (2014).

Therefore, based on the soil samples tested, when the designer is selecting the exposure class for the concrete structure, the effects of sulphates from within the site soils in contact with any portion of the proposed structures constructed below the ground surface may not need to be considered.

The measured pH from the soil samples tested ranged between 6.95 and 8.02. According to the MTO Gravity Pipe Design Guidelines (2014), a pH less than 5.5 is considered strongly acidic while a pH greater than 8.5 is considered strongly alkaline, both of which are indicative of an increased potential for corrosion. It should be noted that the water levels in the area are subject to seasonal fluctuations and variations due to the precipitation events and the soil/water chemistry could also be variable.

The resistivity measured in the tested soil samples generally ranged between 480 ohm-cm and 1500 ohm-cm, which indicates that the soil corrosiveness is severe ($R < 2,000$ ohm-cm) as per Table 3.2 of the MTO Gravity Pipe Design Guidelines (2014). Further, given that the structure foundations could be exposed to de-icing salts from the adjacent highways and/or interchange ramps, consideration should be given by the designer to design for a “C” type exposure class as defined by CSA A23.1 Table 1.

These recommendations are provided as guidance only; the structural designer should take the results of the laboratory testing and the potential for corrosion into consideration as part of the materials selection. Ultimately, it is the designer’s decision to determine the appropriate exposure class and to ensure that all aspects of CSA A23.1 Section 4.1.1 (Durability Requirements) are satisfied.

7.0 CLOSURE

This Foundation Design Report was prepared by Mr. Maor Levy, EIT, and reviewed by Ms. Anastasia Poliacik, P.Eng., and Senior Geotechnical Engineer with WSP and an MTO Principal Foundations Contact. Mr. David Staseff, P. Eng., a Senior Principal and MTO Principal Foundations Contact with WSP, conducted an independent technical and quality review of this report.

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Ministry of Transportation, MTO Gravity Pipe Design Guidelines, MTO Drainage and Hydrology Design and Contract Standards Office, May 2014.

ASTM International:

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

Ontario Provisional Standard Drawings:

OPSD 3090.101 Foundation, Frost Penetration Depths for Southern Ontario

Ontario Provincial Standard Specifications:

OPSS.PROV 903 Construction Specification for Deep Foundations

OPSS.PROV 631 Concrete Footings and Maintenance Platforms for High Mast Lighting Poles

Ontario Water Resources Act:

Ontario Regulation 903 Wells (as amended)

TABLE 1
GEOTECHNICAL DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS AT FREEMAN INERCHANGE

Pole ID (Location)	Reference Borehole	Ground Surface Elevation at Reference Borehole (m)	Approximate Finished Ground Surface Elevation at Pole Location (m)	Stratum	Elevation in Reference Borehole (m)	Design Groundwater Elevation ¹ (m)	Design Parameters ^{3, 4, 5}							
							S _u (kPa)	Φ'	γ (kN/m ³)	γ' (kN/m ³)	n _h (kPa/m)	K _p	K _{p2:1}	UCS, MPa (Bulk Density, g/cm ³)
HMLP-1 (Sta. 11+720)	BH23-9	108.3	-	Topsoil	108.3 to 108.2	108.0	-	-	-	-	-	-	-	-
				Firm clayey silt fill	108.2 to 107.6		40	29	18	8	-	2.88	1.06	-
				Compact to dense silty sand fill	107.6 to 106.1		-	30	19	9	9000	3.00	1.12	-
				Firm to very stiff clayey silt	106.1 to 105.1		50	29	19	9	-	2.88	1.06	-
				Very stiff clayey silt residual soil	105.1 to 104.5		150	35	22	12	-	3.69	1.40	-
				Weathered shale bedrock	104.5 to 103.4		-	36	21	11	-	3.85	1.45	-
				Shale bedrock	Below 103.4		-	-	22	12	-	-	-	12 (2.6)
HMLP-2 (Sta. 11+437)	BH23-10	109.9	-	Topsoil	109.9 to 109.8	104.6	-	-	-	-	-	-	-	-
				Compact silty sand fill	109.8 to 108.4		-	30	19	9	9000	3.00	1.12	-
				Firm to stiff silty clay fill	107.4 to 105.2		50	29	19	9	-	2.88	1.06	-
				Very stiff clayey silt residual soil	105.2 to 104.6		150	35	22	12	-	3.69	1.40	-
				Weathered shale bedrock	104.6 to 104.2			36	21	11	-	3.85	1.45	-
				Shale bedrock	Below 104.2		-	-	22	12	-	-	-	12 (2.6)
HMLP-3 (Sta. 10+365)	BH23-11	104.4	-	Topsoil	104.4 to 104.3	97.8	-	-	-	-	-	-	-	-
				Compact silty sand fill	104.3 to 103.7		-	30	19	9	9000	3.00	1.12	-
				Stiff to very stiff clayey silt fill	103.7 to 98.8		100	29	19	9	-	2.88	1.06	-
				Hard clayey silt till	98.8 to 94.2		200	35	21	11	-	3.69	1.40	-
				Very dense sandy silty gravel till	94.2 to 92.4		-	35	21	11	25000	3.69	1.40	-
				Weathered shale bedrock	92.4 to 92.1			36	21	11	-	3.85	1.45	-
				Shale bedrock	Below 92.1		-	-	22	12	-	-	-	12 (2.6)
HMLP-4 (Sta. 10+152)	BH23-12	107.6	-	Topsoil	107.6 to 107.5	98.9	-	-	-	-	-	-	-	-
				Firm to very stiff clayey silt to sandy clayey silt fill	107.5 to 98.9		50	29	19	9	-	2.88	1.06	-
				Very stiff clayey silt till	65.6 to 94.8		150	34	21	11	-	3.54	1.34	-
HMLP-5 (Sta. 9+935)	BH22-7	107.4	-	Asphalt	107.4 - 107.3	96.3	-	-	-	-	-	-	-	-
				Dense gravelly sand fill	107.3 - 106.7		-	32	20	10	20000	3.25	1.23	-
				Stiff to very stiff sandy clayey silt fill	106.7 - 96.3		100	29	19	9	-	2.88	1.06	-
				Topsoil	96.3 - 95.7		20	27	16	6	-	2.66	0.90	-
				Stiff clayey sand	95.7 - 94.2		50	30	20	10	6000	3.00	1.12	-
				Hard sandy clayey silt till	94.2 - 85.0		200	35	21	11	-	3.69	1.40	-
				Very dense silt and sand residual soil	85.0 - 83.5		-	35	22	12	15000	3.69	1.40	-

NOTES:

- The design groundwater level was evaluated by taking the groundwater level encountered in the borehole, adding 1 m to account for seasonal fluctuations. If groundwater was not encountered in the borehole, the design groundwater level was taken at the interface between brown and grey soil or at the top of bedrock.
- Depths are relative to the existing ground surface at the time the borehole was advanced. Although S_u, φ' and K_p parameters are given for the full depth of the soil, the passive resistance in the upper 1.2 m should be neglected in the high mast light pole design to account for frost action.
- Design parameters:

s_u

= undrained shear strength (kPa);

φ'

= effective friction angle (degrees);

γ

= bulk unit weight (kN/m3);

γ'

= effective unit weight below the groundwater level (kN/m3);

n_h

= constant of horizontal subgrade reaction (kPa/m);

K_p

= passive earth pressure coefficient; and

K_{p2:1}

= passive earth pressure coefficient adjusted to account for 2H:1V sloping ground within two caisson diameters of the foundation element.
- Where both undrained shear strength and effective friction angle parameters are provided for the assumed existing fill, the structural assessment should be completed for both undrained and drained conditions, and the selected design should be based on the more conservative approach.
- K_p values are unfactored and should be reduced by an appropriate factor that considers the allowable deflection of the caisson to account for the fact that a large strain would be required for mobilization of the full passive lateral earth pressure.
- Weathered shale bedrock denotes completely to moderately weathered shale bedrock.
- Shale bedrock denotes slightly weathered to fresh bedrock.

TABLE 1
GEOTECHNICAL DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS AT FREEMAN INERCHANGE

Pole ID (Location)	Reference Borehole	Ground Surface Elevation at Reference Borehole (m)	Approximate Finished Ground Surface Elevation at Pole Location (m)	Stratum	Elevation in Reference Borehole (m)	Design Groundwater Elevation ¹ (m)	Design Parameters ^{3, 4, 5}							
							S _u (kPa)	Φ'	γ (kN/m ³)	γ' (kN/m ³)	n _h (kPa/m)	K _p	K _{p2:1}	UCS, MPa (Bulk Density, g/cm ³)
HMLP-6 (Sta. 9+476)	BH23-3	106.6	—	Asphalt	106.6 - 106.5	93.8	-	-	-	-	-	-	-	-
				Dense gravelly sand fill	106.5 - 105.8		-	32	20	10	20000	3.25	1.23	-
				Stiff to very stiff clayey silt fill	105.8 - 96.3		100	29	19	9	-	2.88	1.06	-
				Compact sand	96.3 - 94.8		-	31	20	10	15000	3.12	1.18	-
				Hard sandy clayey silt till	94.8 - 93.8		200	35	21	11	-	3.69	1.40	-
HMLP-7 (Sta. 9+578)	BH23-13	101.8	-	Asphalt	101.8 to 101.6	94.6	-	-	-	-	-	-	-	-
				Very dense gravelly sand fill	101.6 to 101.2		-	33	20	10	20000	3.39	1.29	-
				Stiff to very stiff clayey silt fill	101.2 to 95.5		100	29	19	9	-	2.88	1.06	-
				Loose to compact silty sand to gravelly silty sand	95.5 to 92.0		-	30	19	9	12000	3.00	1.12	-
				Hard sandy clayey silt till	92.0 to 89.0		200	35	21	11	-	3.69	1.40	-
HMLP-8 (Sta. 9+429)	BH23-14	97.7	-	Asphalt	97.7 to 97.6	90.3	-	-	-	-	-	-	-	-
				Very dense sand and gravel fill	97.6 to 97.1		-	33	19	9	20000	3.39	1.29	-
				Stiff to very stiff clayey silt fill	97.1 to 95.5		100	29	19	9	-	2.88	1.06	-
				Loose to compact silty sand to gravelly silty sand	95.5 to 90.6		-	29	19	9	12000	2.88	1.06	-
				Hard clayey silt till	90.6 to 87.5		200	35	21	11	-	3.69	1.40	-
				Dense gravel	87.5 to 86.7		-	35	21	11	25000	3.69	1.40	-
				Hard clayey silt till	90.6 to 87.5		200	35	21	11	-	-	-	-
				Very dense silt	87.5 to 85.0		-	34	20	10	20000	3.54	1.34	-
HMLP-9 (Sta. 9+286)	BH23-15	95.0	-	Asphalt	95.0 to 94.8	85.9	-	-	-	-	-	-	-	-
				Very dense gravelly sand fill	94.8 to 94.2		-	32	19	9	21400	3.25	1.23	-
				Stiff clayey silt fill	94.2 to 93.6		75	29	19	9	-	2.88	1.06	-
				Loose to compact silt and sand to silty sand	93.6 to 90.5		-	30	19	9	12000	3.00	1.12	-
				Very stiff to hard sandy clayey silt till	90.5 to 86.3		200	35	21	11	-	3.69	1.40	-
				Hard clayey silt	86.3 to 84.8		175	30	18	8	-	3.00	1.12	-
				Compact to very dense silty sand	84.8 to 82.6		-	33	20	10	20000	3.39	1.29	-
HMLP-10 (Sta. 9+085)	BH23-16	93.7	-	Asphalt	93.7 to 93.5	88.7	-	-	-	-	-	-	-	-
				Very dense gravelly sand fill	93.5 to 93.1		-	32	19	9	20000	3.25	1.23	-
				Stiff clayey silt fill	93.1 to 92.3		100	29	19	9	-	2.88	1.06	-
				Loose to compact silty sand	92.3 to 89.2		-	31	19	9	12000	3.12	1.18	-
				Very stiff to hard sandy clayey silt till	89.2 to 85.0		200	35	21	11	-	3.69	1.40	-
				Very stiff clayey silt	85.0 to 83.5		175	30	18	8	-	3.00	1.12	-
				Dense sandy silt	83.5 to 82.0		-	33	19	9	20000	3.39	1.29	-
				Hard clayey silt	82.0 to 81.2		200	31	18	8	-	3	1.18	-

NOTES:

- The design groundwater level was evaluated by taking the groundwater level encountered in the borehole, adding 1 m to account for seasonal fluctuations. If groundwater was not encountered in the borehole, the design groundwater level was taken at the interface between brown and grey soil or at the top of bedrock.
- Depths are relative to the existing ground surface at the time the borehole was advanced. Although S_u, φ' and K_p parameters are given for the full depth of the soil, the passive resistance in the upper 1.2 m should be neglected in the high mast light pole design to account for frost action.
- Design parameters:

s_u

= undrained shear strength (kPa);

φ'

= effective friction angle (degrees);

γ

= bulk unit weight (kN/m3);

γ'

= effective unit weight below the groundwater level (kN/m3);

n_h

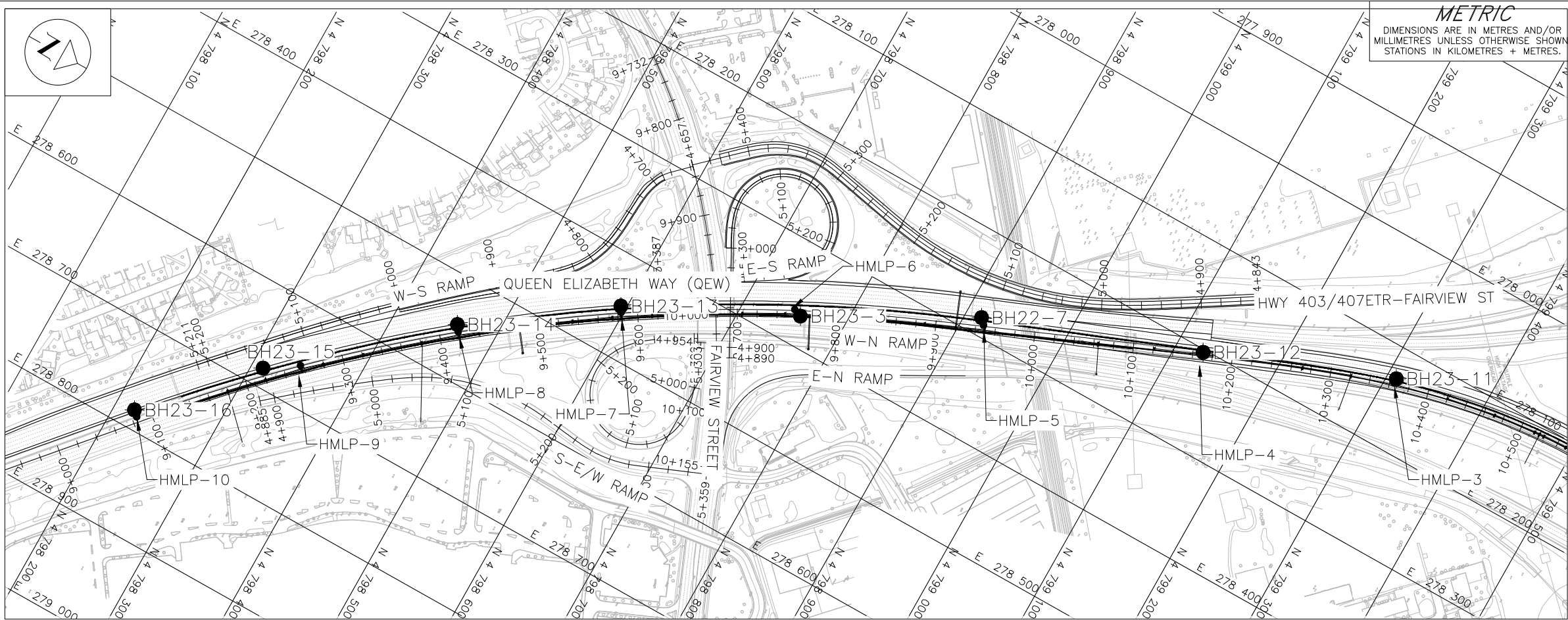
= constant of horizontal subgrade reaction (kPa/m);

K_p

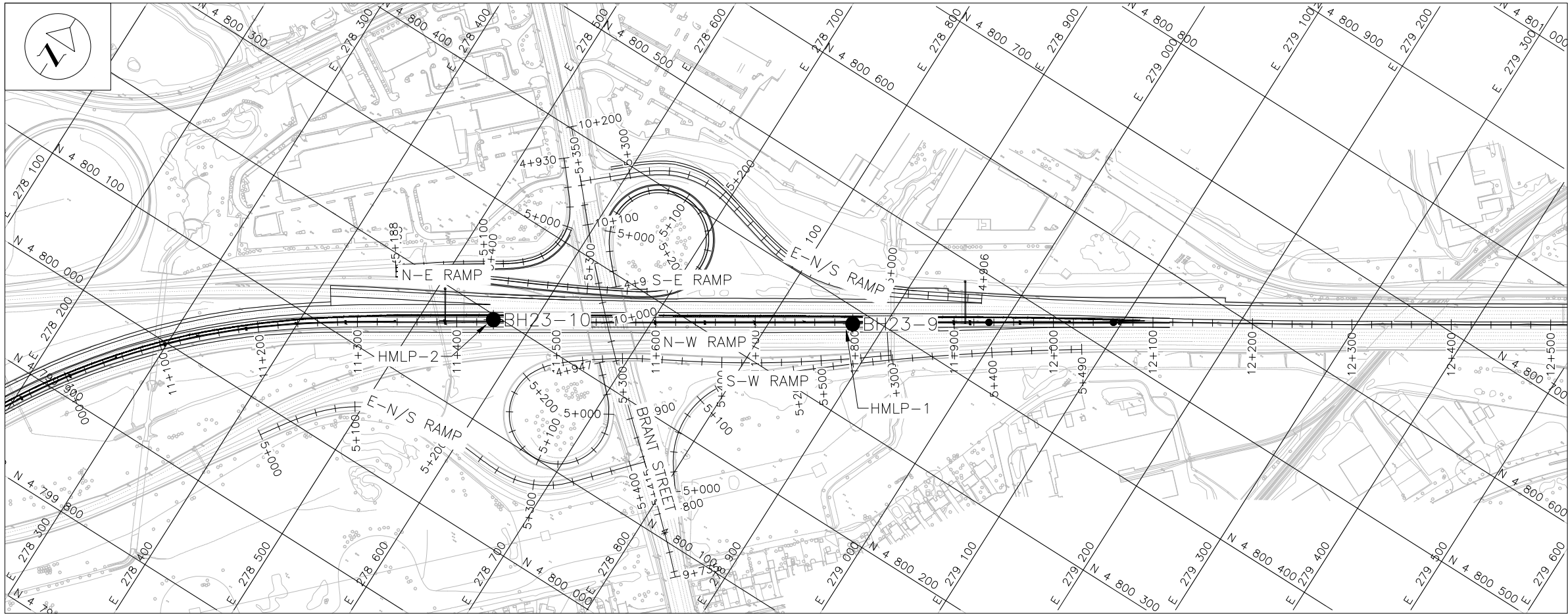
= passive earth pressure coefficient; and

K_{p2:1}

= passive earth pressure coefficient adjusted to account for 2H:1V sloping ground within two caisson diameters of the foundation element.
- Where both undrained shear strength and effective friction angle parameters are provided for the assumed existing fill, the structural assessment should be completed for both undrained and drained conditions, and the selected design should be based on the more conservative approach.
- K_p values are unfactored and should be reduced by an appropriate factor that considers the allowable deflection of the caisson to account for the fact that a large strain would be required for mobilization of the full passive lateral earth pressure.
- Weathered shale bedrock denotes completely to moderately weathered shale bedrock.
- Shale bedrock denotes slightly weathered to fresh bedrock.



PLAN



PLAN



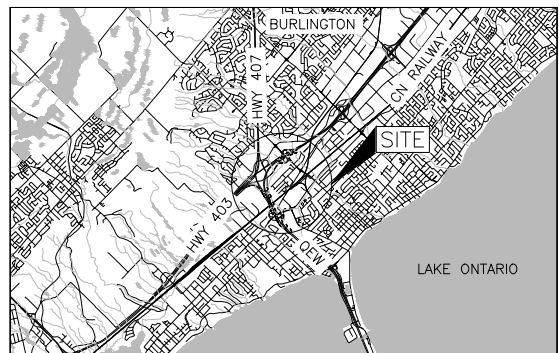
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. .
GWP No. 2065-17-00 AND 2066-17-00

QEW AND HIGHWAY 403
HIGH MAST LIGHT POLES

SHEET

BOREHOLE LOCATIONS PLAN



KEY PLAN



LEGEND

● Borehole – High Mast Light Poles (HMLP)

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
BH22-7	107.4	4798916.1	278281.9
BH23-3	106.6	4798756.6	278370.0
BH23-9	108.3	4800385.2	278871.9
BH23-10	109.9	4800195.5	278564.3
BH23-11	104.4	4799309.6	278130.7
BH23-12	107.6	4799127.3	278202.9
BH23-13	101.8	4798594.4	278449.9
BH23-14	97.7	4798460.3	278546.8
BH23-15	95.0	4798311.6	278681.0
BH23-16	93.7	4798219.6	278781.1



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.

REFERENCE

Horizontal Alignments provided in digital format by WSP, file no. QEW and Hwy 403 Alignments.xml, received September 29, 2023.
Base plan provided in digital format by WSP, drawing file no. H221-10635-00-XB01 Base Mapping.dwg, received September 28, 2023.
Design plans provided in digital format by WSP, Hwy 403 Improvements - NEW HIGH MAST POLE FOOTING LOCATIONS - REV1 - Oct 2, 2023.dwg, received October 3, 2023 and H221-10635-00-XN01 Cont 1 New Construction.dwg, received March 7, 2024.

NO.	DATE	BY	REVISION
Geocres No. 030M05-364			
HWY. QEW / 403		PROJECT NO. 211-10635-00	DIST. .
SUBM'D. ML	CHKD. ML	DATE: 5/28/2024	SITE: .
DRAWN: DD/SA	CHKD. AMP	APPD. DS	DWG. 1

APPENDIX A

Borehole Records

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	19 to 75	0.75 to 3
	Fine	4.75 to 19	(4) to 0.75
		2.00 to 4.75	(10) to (4)
SAND	Coarse	0.425 to 2.00	(40) to (10)
	Medium	0.075 to 0.425	(200) to (40)
	Fine		
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>i.e.</i> , SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (<i>i.e.</i> , some sand)
≤ 10	trace (<i>i.e.</i> , 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 cm² 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, G_s)
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

Compactness¹

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

1. 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 grain size. 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.

2. 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.

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

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
ν	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

(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
$C_{a(e)}$	secondary compression index
C_a	rate of secondary compression
$C_{a(e)}$	modified 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
c'	effective cohesion
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
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 or q'	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

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

Notes: 1
2

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

PROJECT	221-10635-00	RECORD OF BOREHOLE	No. BH22-7	Sheet 1 of 3	METRIC
G.W.P.	2065-17-00	LOCATION	N 4798916.1; E 278281.9 NAD83 / MTM Zone 10 (LAT. 43.329663; LONG. -79.826998)	ORIGINATED BY	D.R.
DIST	CENTRAL HWY QEW	BOREHOLE TYPE	83 mm OD Hollow Stem Augers ; Mud Rotary Tri-cone	COMPILED BY	M.L.
DATUM	Surface Elevation:107.4 m	DATE	May 07, 2023 - May 08, 2023	CHECKED BY	A.M.P

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL						
0.0	ASPHALT (150 mm)																				
107.3 0.2	Gravelly SAND (SW-SM), some fines (FILL) Dense Grey Moist		1	SS	35		107										35	53	10	2	
106.7 0.8	Sandy CLAYEY SILT (CL), trace gravel, containing shale fragments (FILL) Stiff to very stiff Brown to reddish grey Moist		2	SS	12																
							106														
			3	SS	9																
			4A	SS	13		105														
	- 2.6 to 3.0 m: Rock fragments		4B																		
			5	SS	10																
							104														
			6	SS	15																
							103										4	30	48	18	
			7	SS	10																
							102														
			8	SS	9		101														
							100														
			9	SS	9												6	23	45	26	
							99														

Continued on Next Page

+³, x³ : Numbers refer to Sensitivity o³% STRAIN AT FAILURE




PROJECT 221-10635-00		RECORD OF BOREHOLE No. BH22-7		Sheet 2 of 3		METRIC	
G.W.P. 2065-17-00		LOCATION N 4798916.1; E 278281.9 NAD83 / MTM Zone 10 (LAT. 43.329663; LONG. -79.826998)		ORIGINATED BY D.R.			
DIST CENTRAL HWY QEW		BOREHOLE TYPE 83 mm OD Hollow Stem Augers ; Mud Rotary Tri-cone		COMPILED BY M.L.			
DATUM Surface Elevation:107.4 m		DATE May 07, 2023 - May 08, 2023		CHECKED BY A.M.P			

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT					REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L		GR	SA	SI	CL	
								Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined								NP Nonplastic					
								20 40 60 80 100					20 40 60								
96.3	Sandy CLAYEY SILT (CL), trace gravel, containing shale fragments (FILL) Stiff to very stiff Brown to reddish grey Moist		10	SS	35		98														
11.2	TOPSOIL Dark brown, organic odour		11				96														
95.7	CLAYEY SAND-SILTY SAND (SC-SM), some gravel to gravelly Stiff Brown Wet		12	SS	9		95										20	50	25	5	
13.3	Sandy CLAYEY SILT (CL), trace gravel (TILL) Hard Grey Moist		13	SS	30		94														
			14	SS	40		92										6	22	48	24	
			15	SS	47		90														

Continued on Next Page

+³, x³ : Numbers refer to Sensitivity o³% STRAIN AT FAILURE

PROJECT	221-10635-00	RECORD OF BOREHOLE	No. BH22-7	Sheet 3 of 3	METRIC
G.W.P.	2065-17-00	LOCATION	N 4798916.1; E 278281.9 NAD83 / MTM Zone 10 (LAT. 43.329663; LONG. -79.826998)	ORIGINATED BY	D.R.
DIST	CENTRAL HWY QEW	BOREHOLE TYPE	83 mm OD Hollow Stem Augers ; Mud Rotary Tri-cone	COMPILED BY	M.L.
DATUM	Surface Elevation:107.4 m	DATE	May 07, 2023 - May 08, 2023	CHECKED BY	A.M.P

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L						
							Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined														
								20	40	60	80	100		20	40	60					
	Sandy CLAYEY SILT (CL), trace gravel (TILL) Hard Grey Moist		16	SS	71									○							
			17	SS	55																
			18	SS	41									○							
85.0																					
22.4	SILT (ML) and sand, some gravel (RESIDUAL SOIL) Very dense Reddish brown Wet		19	SS	69									○		NP		14	38	44	4
83.5																					
23.9	Inferred highly weathered red SHALE (BEDROCK)																				
83.0			20	SS	100/0.10																
24.5	Continued on Record of Drillhole																				
	NOTES: 1. Water was aided to aid drilling operations at a depth of about 9.1 m below ground surface (Elev. 98.3 m)																				

METRIC

ORIGINATED BY D.R.

COMPILED BY M.L.

CHECKED BY A.M.P

[illegible]

Continued on Next Page

⁺, x³ : Numbers refer to Sensitivity o^{30%} STRAIN AT FAILURE

PROJECT	221-10635-00	LOCATION	N 4798756.6; E 278370 NAD83 / MTM Zone 10 (LAT. 43.328231; LONG. -79.825904)	Sheet 2 of 2	METRIC
G.W.P.	2065-17-00	BOREHOLE TYPE	210 mm OD Hollow Stem Augers	ORIGINATED BY	D.R.
DIST	CENTRAL HWY QEW	DATE	Nov 20, 2023 - Nov 21, 2023	COMPILED BY	M.L.
DATUM	Surface Elevation:106.6 m			CHECKED BY	A.M.P

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L						
							Field Vane														
							Remoulded														
							Pocket Pen														
							Quick Triaxial														
							Unconfined														
								20	40	60	80	100		20	40	60					
96.3	Sandy CLAYEY SILT (CL), trace gravel (FILL)																				
10.2	Stiff to very stiff																				
	Brown																				
	Moist																				
	SAND (SP-SM), some fines																				
	Compact																				
	Brown		11	SS	20													1	88	(11)	
	Moist																				
94.8																					
11.7	Sandy CLAYEY SILT (CL), some gravel (TILL)																				
	Hard																				
	Reddish brown																				
	Moist																				
93.8			12	SS	37													14	22	45 19	
12.8	End of Borehole																				
	NOTES:																				
	1. Borehole caved to a depth of 11.0 m below ground surface (Elev. 95.6 m) upon completion of drilling.																				
	2. Borehole dry upon completion of drilling.																				

PROJECT	221-10635-00	LOCATION	N 4800385.2; E 278871.9 NAD83 / MTM Zone 10 (LAT. 43.342908; LONG. -79.819792)	RECORD OF BOREHOLE No. BH23-9	Sheet 1 of 1	METRIC
G.W.P.	2065-17-00	BOREHOLE TYPE	160 mm OD Hollow Stem Augers	ORIGINATED BY	M.L.	
DIST	CENTRAL HWY QEW	DATE	Nov 14, 2023	COMPILED BY	M.L.	
DATUM	Surface Elevation:108.3 m			CHECKED BY	A.M.P	

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y	GR	SA	SI	CL	REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L						
0.0	TOPSOIL (80 mm)							20	40	60	80	100	20	40	60						
108.2	CLAYEY SILT (CL), trace sand, trace gravel, contains rootlets (FILL)		1	SS	7		108														
0.1	Firm																				
	Reddish brown																				
107.6	Moist																				
0.7	SILTY SAND (SM) and gravel, trace clay (FILL)		2	SS	40		107										38	46	14	2	
	Compact to dense																				
	Reddish brown																				
	Moist to wet																				
	- 1.5 to 2.3 m: Auger grinding		3	SS	18																
106.1																					
2.2	CLAYEY SILT (CL), some sand, contains organics		4	SS	7		106														
	Firm to very stiff																				
	Blackish brown to reddish brown																				
	Moist																				
105.1																					
3.2	CLAYEY SILT (CL), some sand, trace gravel (RESIDUAL SOIL)		5	SS	25		105										0	14	54	32	
	Very stiff																				
	Brown to reddish brown																				
104.5	Moist																				
3.7	Inferred completely to highly weathered SHALE (BEDROCK)		6A	SS	100/0.13		104														
			6B																		
103.4			7	SS	100/0.13																
4.9	Continued on Record of Drillhole																				
	NOTES:																				
	1. Water measured in augers at a depth of 1.3 m below ground surface (Elev. 107.0 m) prior to coring.																				

RECORD OF DRILLHOLE: BH23-9 Rock

Sheet 1 of 1

CLIENT:Ministry of Transportation (MTO)

PROJECT:MTO 2020 E 2022 QEW and Hwy 403

PROJECT NO:221-10635-00

LOCATION:Burlington, Ontario

DATE:November 13, 2023

INCLINATION:90.0°

CONTRACTOR:Davis Drilling Ltd.

ELEVATION:108.28 m (Geodetic)

COORDINATES:N: 4800385.2 m E: 278871.9 m

COORD SYS:MTM Zone 10

HORZ DATUM:NAD83

DEPTH (m)	DRILL RIG	DRILL METHOD	MATERIAL PROFILE			RUN NO.	JN - Joint FLT - Fault SHR - Shear B - Bedding FO - Foliation PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished SK - Slickensided SM - Smooth RO - Rough VR - Rough CA - Calcite Cl - Clay CON - Contact Fe - Iron MI - Mica Py - Pyrite M - Silt MN - Manganese CR - Carbon SH - Shale CO - Coal CN - Clean SOL - Solutioning W - Weathered Mech - Poss. Mechanical																FAULT / BRECCIA / GOUGE BROKEN CORE LOST CORE SHEAR ZONE	ADDITIONAL OBSERVATIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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PROJECT	221-10635-00	LOCATION	N 4800195.5; E 278564.3 NAD83 / MTM Zone 10 (LAT. 43.341189; LONG. -79.823576)	Sheet 1 of 1	METRIC
G.W.P.	2065-17-00	BOREHOLE TYPE	160 mm OD Hollow Stem Augers	ORIGINATED BY	M.L.
DIST	CENTRAL HWY QEW	DATE	Nov 14, 2023 - Nov 15, 2023	COMPILED BY	M.L.
DATUM	Surface Elevation:109.9 m			CHECKED BY	A.M.P

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y	GR	SA	SI	CL	REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L						
0.0 109.8 0.1	TOPSOIL (80 mm) SILTY SAND (SM) and gravel (FILL) Compact Brown Moist - 0.8 to 1.5 m: Auger grinding		1	SS	18		109	20	40	60	80	100	20	40	60						
			2	SS	25												39	46	13	2	
108.4 1.4	SILTY CLAY (Cl), some sand, trace gravel, contains organics (FILL) Firm to stiff Brown to grey Moist		3	SS	15		108														
			4	SS	10		107										8	14	43	35	
			5	SS	10																
			6	SS	11		106														
105.2 4.7	CLAYEY SILT (CL), trace sand, trace gravel (RESIDUAL SOIL) Very stiff Reddish brown Moist		7A				105										6	7	57	30	
104.6 5.3	Inferred highly weathered red SHALE (BEDROCK)		7B	SS	20																
104.2 5.7	Continued on Record of Drillhole NOTES: 1. Borehole dry inside augers prior to coring.		8	SS	139/0.23																

RECORD OF DRILLHOLE: BH23-10 Rock

Sheet 1 of 1

CLIENT:Ministry of Transportation (MTO)

PROJECT:MTO 2020 E 2022 QEW and Hwy 403

PROJECT NO:221-10635-00

LOCATION:Burlington, Ontario

DATE:November 14, 2023

INCLINATION:90.0°

CONTRACTOR:Davis Drilling Ltd.

ELEVATION:109.88 m (Ground)

COORDINATES:N: 4800195.5 m E: 278564.3 m

COORD SYS:MTM Zone 10

HORZ DATUM:NAD83

DEPTH (m)	DRILL RIG	DRILL METHOD	MATERIAL PROFILE			RUN NO.	JN - Joint FLT - Fault SHR - Shear B - Bedding FO - Foliation PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished SK - Slickensided SM - Smooth RO - Rough VR - Rough CA - Calcite Cl - Clay CON - Contact Fe - Iron MI - Mica Py - Pyrite M - Silt MN - Manganese CR - Carbon SH - Shale CO - Coal CN - Clean SOL - Solutioning W - Weathered Mech - Poss. Mechanical																FAULT/BRECCIA/GOUGE ■ BROKEN CORE ■ LOST CORE □ SHEAR ZONE	ADDITIONAL OBSERVATIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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PROJECT	221-10635-00	LOCATION	N 4799309.6; E 278130.7 NAD83 / MTM Zone 10 (LAT. 43.3332; LONG. -79.828882)	RECORD OF BOREHOLE No. BH23-11	Sheet 1 of 2	METRIC
G.W.P.	2065-17-00	BOREHOLE TYPE	160 mm OD Hollow Stem Augers	ORIGINATED BY	M.L.	
DIST	CENTRAL HWY QEW	DATE	Nov 16, 2023	COMPILED BY	M.L.	
DATUM	Surface Elevation:104.4 m			CHECKED BY	A.M.P	

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y	GR	SA	SI	CL	REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L						
								20	40	60	80	100	20	40	60						
0.0	TOPSOIL (100 mm)																				
104.3	SILTY SAND (SM), some gravel, some clay (FILL)		1	SS	17		104											15	41	29	15
0.1	Compact Dark brown Moist																				
103.7	CLAYEY SILT (CL), some sand, trace gravel (FILL)		2	SS	13		103														
0.7	Stiff to very stiff Brown (Mottled) Moist																				
			3	SS	15		102											4	18	45	33
			4	SS	13		101														
101.4	SILTY SAND (SM), some gravel (FILL)		5A	SS	20		101														
3.0	Compact Reddish brown Moist																				
101.0	CLAYEY SILT (CL), some sand, trace gravel (FILL)		5B	SS	24		100														
3.4	Stiff to very stiff Brown Moist																				
			6A	SS	27		99														
100.0	Sandy SILT (ML)		6B	SS	30		98														
4.3	Compact Brown Moist																				
99.9	CLAYEY SILT (CL), some sand, trace gravel (FILL)		7	SS	35		97														
4.5	Stiff to very stiff Brown Moist																				
			8	SS	30		96														
98.8	CLAYEY SILT (CL), some sand, trace gravel (TILL)																				
5.6	Hard Brown to grey Moist																				
			9	SS	35																

- 8.7 m: Auger grinding

Continued on Next Page

+³, x³ : Numbers refer to Sensitivity o³% STRAIN AT FAILURE

PROJECT	221-10635-00	LOCATION	N 4799309.6; E 278130.7 NAD83 / MTM Zone 10 (LAT. 43.3332; LONG. -79.828882)	Sheet 2 of 2	METRIC
G.W.P.	2065-17-00	BOREHOLE TYPE	160 mm OD Hollow Stem Augers	ORIGINATED BY	M.L.
DIST	CENTRAL HWY QEW	DATE	Nov 16, 2023	COMPILED BY	M.L.
DATUM	Surface Elevation:104.4 m			CHECKED BY	A.M.P

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL						
								Field Vane	Remoulded	Pocket Pen	Quick Triaxial	Unconfined	W _p	W	W _L						
								20	40	60	80	100	20	40	60						
94.2	CLAYEY SILT (CL), some sand, trace gravel (TILL) Hard Brown to grey Moist		10	SS	43		95														
10.2	Sandy SILTY GRAVEL (GM), trace clay (TILL) Very dense Reddish brown Moist		11	SS	100/0.13		94										28	26	43	3	
92.4	- 12.0 m: Observed increase in auger resistance Inferred highly weathered red SHALE (BEDROCK)						93														
12.0 92.1			12	SS	100/0.08																
12.3	Continued on Record of Drillhole NOTES: 1. Borehole dry inside augers prior to coring.																				

RECORD OF DRILLHOLE: BH23-11 Rock

Sheet 1 of 1

CLIENT:Ministry of Transportation

PROJECT:MTO 2020 E 2022 QEW and Hwy 403

PROJECT NO:221-10635-00

LOCATION:Burlington, Ontario

DATE:November 16, 2023

INCLINATION:90.0°

CONTRACTOR:Davis Drilling Ltd.

ELEVATION:104.39 m (Ground)

COORDINATES:N: 4799309.6 m E: 278130.7 m

COORD SYS:MTM Zone 10

HORZ DATUM:NAD83

DEPTH (m)	DRILL RIG	DRILL METHOD	MATERIAL PROFILE			RUN NO.	JN - Joint FLT - Fault SHR - Shear B - Bedding FO - Foliation PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished SK - Slickensided SM - Smooth RO - Rough VR - Rough CA - Calcite CI - Clay CON - Contact Fe - Iron MI - Mica Py - Pyrite M - Silt CO - Coal CN - Clean SOL - Solutioning W - Weathered Mech - Poss. Mechanical														FRACTURE INDEX (m)	DISCONTINUITY		FAULT/BRECCIA/GOUGE BROKEN CORE LOST CORE SHEAR ZONE	ADDITIONAL OBSERVATIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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PROJECT	221-10635-00	LOCATION	N 4799127.3; E 278202.9 NAD83 / MTM Zone 10 (LAT. 43.331561; LONG. -79.827982)	Sheet 1 of 2	METRIC
G.W.P.	2065-17-00	BOREHOLE TYPE	160 mm OD Hollow Stem Augers	ORIGINATED BY	M.L.
DIST	CENTRAL HWY QEW	DATE	Nov 16, 2023	COMPILED BY	M.L.
DATUM	Surface Elevation:107.6 m			CHECKED BY	A.M.P

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y	GR	SA	SI	CL	REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L						
0.0 107.5 0.1	TOPSOIL (80 mm) Sandy CLAYEY SILT (CL), trace gravel to CLAYEY SILT (CL), some sand, trace gravel (FILL) Firm to very stiff Grey to brown Moist		1	SS	10		107	20	40	60	80	100	20	40	60						
			2	SS	9												4	24	45	27	
			3	SS	19		106														
			4	SS	14		105														
			5	SS	7		104														
			6	SS	8																
	- 4.5 to 7.2 m: Grey mottling		7	SS	5		103										7	20	45	28	
			8	SS	6		102														
			9	SS	14		100														
98.9							99														
8.7	CLAYEY SILT (CL), some sand, trace gravel (TILL) Very stiff Brown to grey Moist - 9.1 to 12.2 m: Auger grinding		10	SS	28		98										0	13	45	42	

Continued on Next Page

+³, x³ : Numbers refer to Sensitivity o³⁰% STRAIN AT FAILURE

PROJECT	221-10635-00	LOCATION	N 4798594.4; E 278449.9 NAD83 / MTM Zone 10 (LAT. 43.326773; LONG. -79.824911)	Sheet 1 of 2	METRIC
G.W.P.	2065-17-00	BOREHOLE TYPE	210 mm OD Hollow Stem Augers	ORIGINATED BY	D.R.
DIST	CENTRAL HWY QEW	DATE	Nov 22, 2023 - Nov 23, 2023	COMPILED BY	M.L.
DATUM	Surface Elevation:101.8 m			CHECKED BY	A.M.P

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT	GR	SA	SI	CL	REMARKS	
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL							
							<div><div>Field Vane</div><div>Remoulded</div><div>Pocket Pen</div><div>Quick-Trialial</div><div>Unconfined</div></div>															

Continued on Next Page

+³, x³ : Numbers refer to Sensitivity o³% STRAIN AT FAILURE

PROJECT 221-10635-00		RECORD OF BOREHOLE No. BH23-13		Sheet 2 of 2		METRIC	
G.W.P. 2065-17-00		LOCATION N 4798594.4; E 278449.9 NAD83 / MTM Zone 10 (LAT. 43.326773; LONG. -79.824911)		ORIGINATED BY D.R.			
DIST CENTRAL HWY QEW		BOREHOLE TYPE 210 mm OD Hollow Stem Augers		COMPILED BY M.L.			
DATUM Surface Elevation:101.8 m		DATE Nov 22, 2023 - Nov 23, 2023		CHECKED BY A.M.P			

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT	GR	SA	SI	CL	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL							
								Field Vane	Remoulded	Pocket Pen	Quick Triaxial	Unconfined	W _p	W	W _L							
							20	40	60	80	100	20	40	60	Y							
	SILTY SAND (SM), trace gravel, trace clay, contains rootlets Loose to compact Dark brown to blackish grey Moist		9	SS	6	N												1	77	20	2	
93.1 8.7	Gravelly SILTY SAND (SM) Compact Brown Wet																					
			10	SS	29																	
92.0 9.8	Sandy CLAYEY SILT (CL), trace gravel (TILL) Hard Grey Moist																					
			11	SS	37																	
			12	SS	35													5	24	48	23	
			13	SS	55																	
89.0 12.8	NOTES: 1. Borehole caved to a depth of 11.9 m below ground surface (Elev. 89.9 m) upon completion of drilling. Water measured in borehole at a depth of 8.2 m below ground surface (Elev. 93.6 m) upon completion of drilling.																					

+³, x³ : Numbers refer to Sensitivity o³% STRAIN AT FAILURE

PROJECT	221-10635-00	LOCATION	N 4798460.3; E 278546.8 NAD83 / MTM Zone 10 (LAT. 43.325569; LONG. -79.823709)	Sheet 1 of 2	METRIC
G.W.P.	2065-17-00	BOREHOLE TYPE	210 mm OD Hollow Stem Augers	ORIGINATED BY	D.R.
DIST	CENTRAL HWY QEW	DATE	Nov 23, 2023	COMPILED BY	M.L.
DATUM	Surface Elevation:97.7 m			CHECKED BY	A.M.P

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y	GR	SA	SI	CL	REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L						
0.0	ASPHALT (150 mm)							20	40	60	80	100	20	40	60						
97.6 0.2	SAND (SP) and gravel, trace silt (FILL) Very dense Brown Moist		1	SS	100/0.13		97											2	26	46	26
97.1 0.6	Sandy CLAYEY SILT (CL), trace gravel (FILL) Stiff to very stiff Brown Moist		2	SS	15		96														
			3	SS	22																
95.5 2.2	SILTY SAND (SM), some gravel to gravelly Loose to compact Dark brown to reddish brown Moist to wet - 3.0 to 3.7 m: Contains organics		4	SS	13		95														
			5	SS	4		94											20	62	17	1
			6	SS	6																
			7	SS	9		93														
			8	SS	6		92														
							91														
90.6 7.2	Sandy CLAYEY SILT (CL), trace gravel (TILL) Hard Brown to grey Moist		9	SS	30		90														
							89														




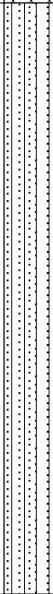


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+³, x³ : Numbers refer to Sensitivity o³⁰% STRAIN AT FAILURE

PROJECT	221-10635-00	LOCATION	N 4798460.3; E 278546.8 NAD83 / MTM Zone 10 (LAT. 43.325569; LONG. -79.823709)	RECORD OF BOREHOLE No. BH23-14	Sheet 2 of 2	METRIC
G.W.P.	2065-17-00	BOREHOLE TYPE	210 mm OD Hollow Stem Augers	ORIGINATED BY	D.R.	
DIST	CENTRAL HWY QEW	DATE	Nov 23, 2023	COMPILED BY	M.L.	
DATUM	Surface Elevation: 97.7 m			CHECKED BY	A.M.P	

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y	GR	SA	SI	CL	REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L						
								Field Vane	Remoulded	Pocket Pen	Quick Triaxial	Unconfined	NP Nonplastic								
								20	40	60	80	100	20	40	60						
87.5	Sandy CLAYEY SILT (CL), trace gravel (TILL) Hard Brown to grey Moist		10	SS	46		88										7	24	53	16	
10.2	GRAVEL (GP), some sand, trace silt Dense Grey Wet		11 A	SS	37		87														
86.7	Sandy CLAYEY SILT (CL), trace gravel (TILL) Hard Brown to grey Moist		11 B				86														
86.0	SILT (ML), some sand, trace gravel Very dense Reddish brown Moist to wet		12 A	SS	84		85										4	15	80	1	
12.8			12 B																		
85.0	NOTES: 1. Borehole caved to a depth of 9.5 m below ground surface (Elev. 88.2 m) upon completion of drilling. ater measured in open borehole at a depth of 6.4 m below ground surface (Elev. 91.3 m) upon completion of drilling,																				

PROJECT	221-10635-00	LOCATION	N 4798311.6; E 278681 NAD83 / MTM Zone 10 (LAT. 43.324235; LONG. -79.822047)	Sheet 1 of 2	METRIC
G.W.P.	2065-17-00	BOREHOLE TYPE	210 mm OD Hollow Stem Augers	ORIGINATED BY	D.R.
DIST	CENTRAL HWY QEW	DATE	Nov 27, 2023	COMPILED BY	M.L.
DATUM	Surface Elevation:95.0 m			CHECKED BY	A.M.P

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L						
							Field Vane	Remoulded	Pocket Pen	Quick Triaxial	Unconfined	NP Nonplastic			Y						
0.0	ASPHALT (180 mm)						20	40	60	80	100	20	40	60	kN/m³						
94.9																					
0.2	Gravelly SAND (SP), trace fines (FILL) Very dense Grey Moist		1	SS	161																
94.2																					
0.8	CLAYEY SILT (CL), trace sand, some gravel (FILL) Stiff Brown Moist		2	SS	14		94														
93.6																					
1.4	SILT (ML) and sand to SILTY SAND (SM), trace clay Loose to compact Brown Moist to wet		3	SS	18		93														
			4	SS	9																
	- 3.0 to 3.2 m: Clayey Silt layer		5A				92														
			5B	SS	4																
			6	SS	5		91														
90.5																					
4.5	Sandy CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT (CL), trace gravel (TILL) Very stiff to hard Brown to grey Moist		7	SS	35		90														
							89														
			8	SS	26																
							88														

Continued on Next Page

+3, x3 : Numbers refer to Sensitivity o3% STRAIN AT FAILURE

PROJECT	221-10635-00	LOCATION	N 4798219.6; E 278781.1 NAD83 / MTM Zone 10 (LAT. 43.32341; LONG. -79.820809)	RECORD OF BOREHOLE No. BH23-16	Sheet 1 of 2	METRIC
G.W.P.	2065-17-00	BOREHOLE TYPE	210 mm OD Hollow Stem Augers	ORIGINATED BY	D.R.	
DIST	CENTRAL HWY QEW	DATE	Nov 24, 2023	COMPILED BY	M.L.	
DATUM	Surface Elevation:93.7 m			CHECKED BY	A.M.P	

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y	GR	SA	SI	CL	REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L						
0.0 93.5	ASPHALT (180 mm)							20	40	60	80	100	20	40	60						
0.2 93.1	Gravelly SAND (SP), trace fines (FILL) Very Dense Grey Moist		1	SS	100/0.13		93														
0.6 92.3	CLAYEY SILT (CL), trace sand, trace gravel (FILL) Stiff Brown Moist		2	SS	14																
1.4 92.3	SILTY SAND (SM) Loose to compact Brown Moist to wet		3	SS	13		92														
			4	SS	6		91										0	82	13	5	
			5	SS	14		90														
			6	SS	14																
89.2 4.5	Sandy CLAYEY SILT (CL), trace gravel (TILL) Very stiff to hard Brown Moist		7	SS	26		89										3	22	51	24	
			8	SS	100/0.13		88														
							87														

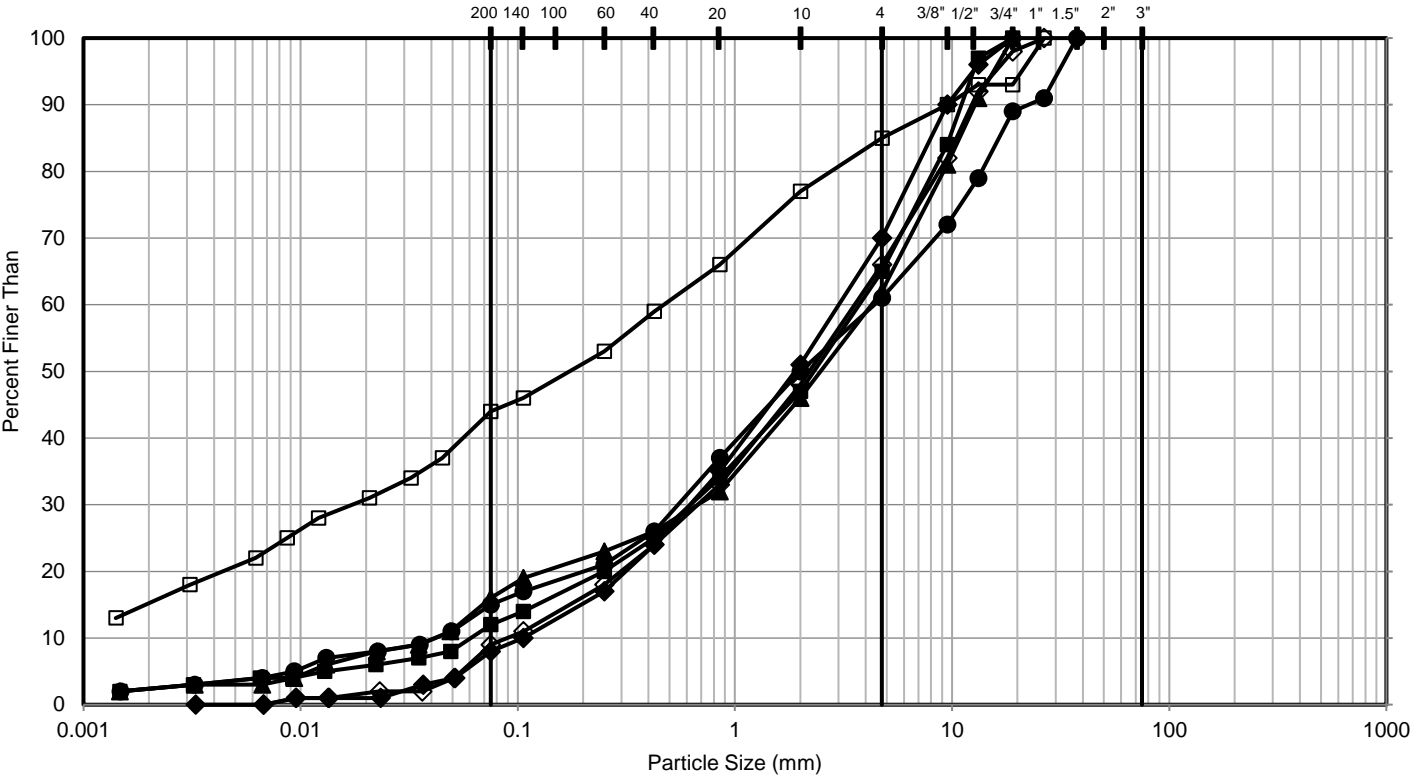
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+3, x3 : Numbers refer to Sensitivity o3% STRAIN AT FAILURE

APPENDIX B

**Geotechnical Laboratory
Test Results**

GRAIN SIZE DISTRIBUTION



FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH22-7	1	0.2 - 0.8	107.3 to 106.7
◆	BH23-3	1	0.1 - 0.7	106.5 to 105.8
▲	BH23-9	2	0.8 - 1.4	107.5 to 106.9
●	BH23-10	2	0.8 - 1.4	109.1 to 108.5
□	BH23-11	1	0.1 - 0.7	104.3 to 103.7
◇	BH23-13	1	0.2 - 0.4	101.6 to 101.4

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DESIGNED ML

PREPARED ML

REVIEWED AMP

APPROVED DS

PROJECT

HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE

FILL (Non-Cohesive)

PROJECT NO.

221-10635-00

CONTROL

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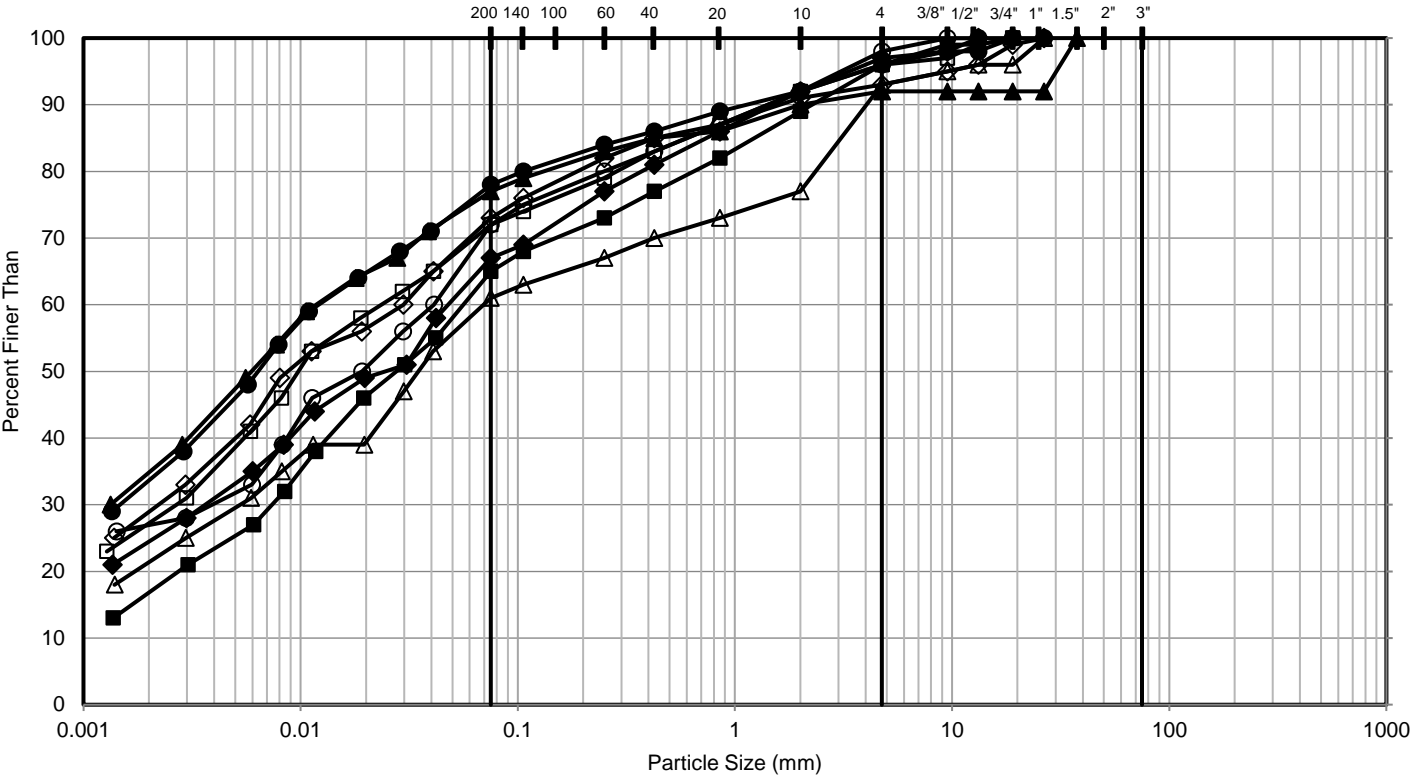
REV.

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FIGURE

B-1

GRAIN SIZE DISTRIBUTION



FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH22-7	6	3.8 - 4.4	103.6 to 103.0
◆	BH23-3	4	2.3 - 2.9	104.3 to 103.7
▲	BH23-10	4	2.3 - 2.9	107.6 to 107.0
●	BH23-11	3	1.5 - 2.1	102.9 to 102.3
□	BH23-12	2	0.8 - 1.4	106.8 to 106.2
◇	BH23-12	7	4.6 - 5.2	103.0 to 102.4
△	BH23-13	5	3.0 - 3.7	98.7 to 98.1
○	BH23-14	2	0.8 - 1.4	97.0 to 96.4

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HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE

FILL (Cohesive)

PROJECT NO.

221-10635-00

CONTROL

0

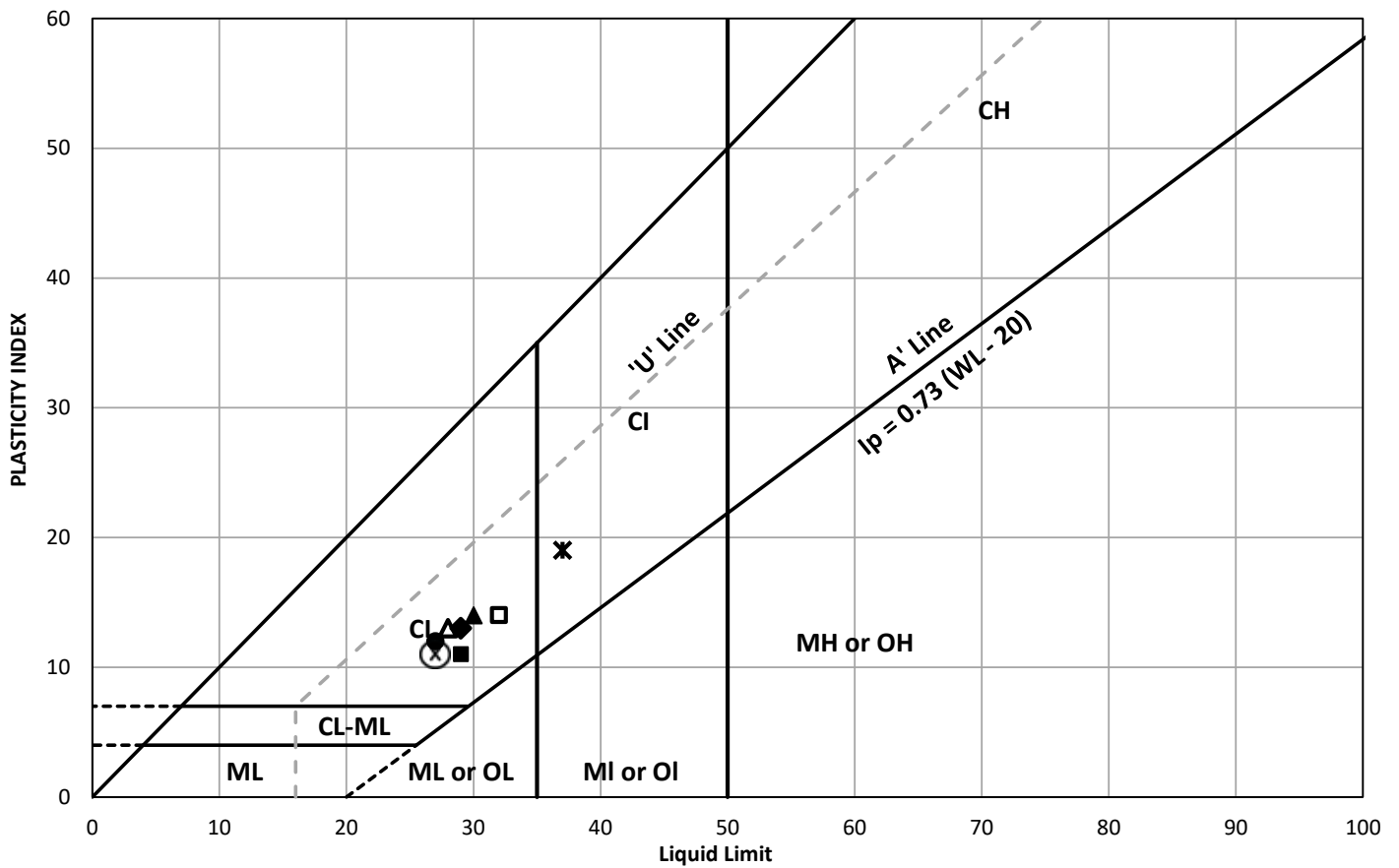
REV.

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FIGURE

B-2

PLASTICITY CHART




	Sample Location	Sample / Specimen Number	Depth (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	BH22-7	6	3.8 - 4.4	12.6	29	18	11	-0.49
◆	BH22-7	9	7.6 - 8.2		29	16	13	
▲	BH23-3	4	2.3 - 2.9	13.8	30	16	14	-0.16
●	BH23-3	9	7.6 - 8.2	12.7	27	15	12	-0.19
*	BH23-10	4	2.3 - 2.9	16	37	18	19	-0.11
⊗	BH23-12	2	0.8 - 1.4	12.8	27	16	11	-0.29
□	BH23-12	7	4.6 - 5.2	18.9	32	18	14	0.06
◇	BH23-13	5	3.0 - 3.7	14.9	29	16	13	-0.08
△	BH23-14	2	0.8 - 1.4	15.8	28	15	13	0.06

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PREPAREDM.L.
REVIEWEDAMP
APPROVEDDS

PROJECT

HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE

FILL (Cohesive)

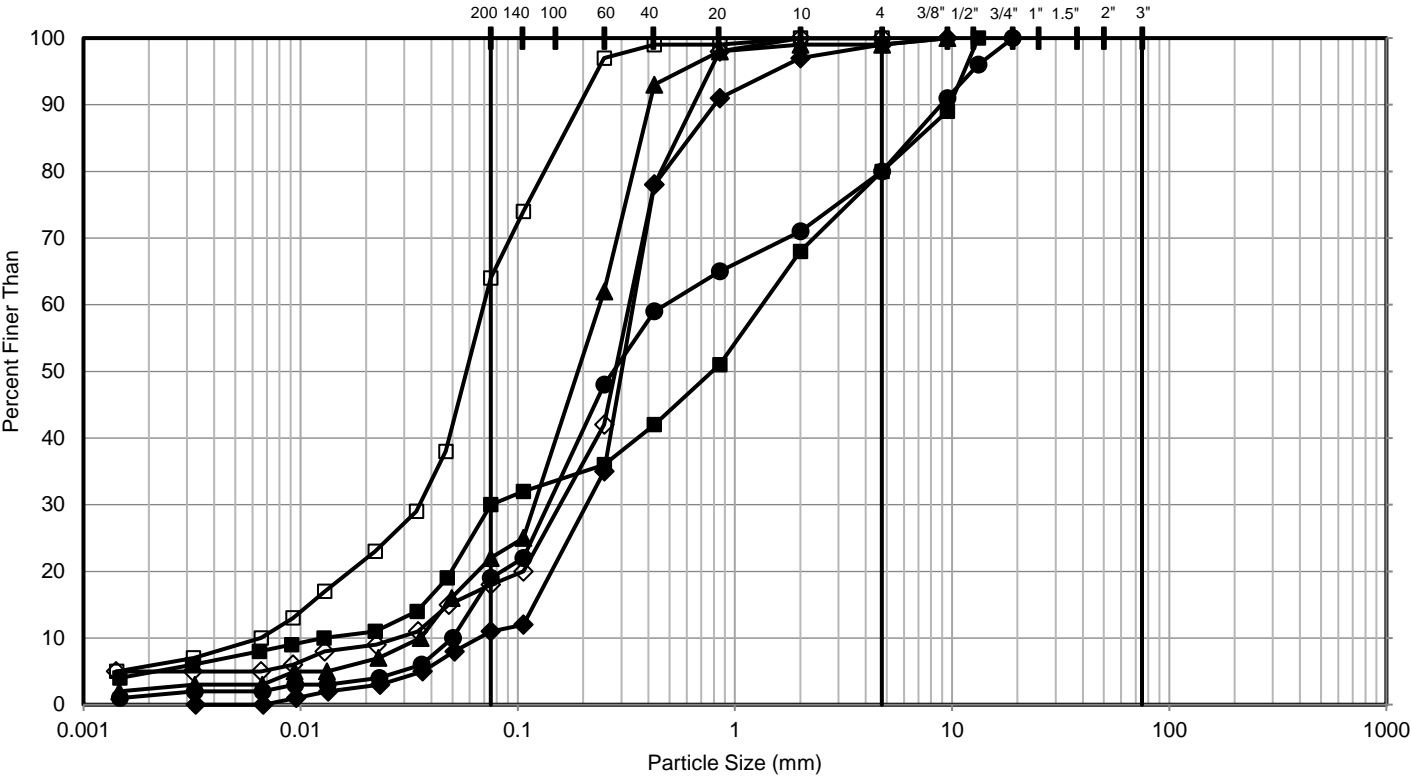
PROJECT NO.
221-10635-00

CONTROL
0

REV.
0

FIGURE
B-3

GRAIN SIZE DISTRIBUTION



FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH22-7	12	12.2 - 12.8	95.2 to 94.6
◆	BH23-3	11	10.7 - 11.3	95.9 to 95.3
▲	BH23-13	9	7.6 - 8.2	94.2 to 93.6
●	BH23-14	5	3.0 - 3.7	94.7 to 94.1
□	BH23-15	4	2.3 - 2.9	92.7 to 92.1
◇	BH23-16	4	2.3 - 2.9	91.4 to 90.8

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APPROVED DS

PROJECT

HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE

SILT (ML) and sand to SILTY SAND (SM) (Upper Deposit)

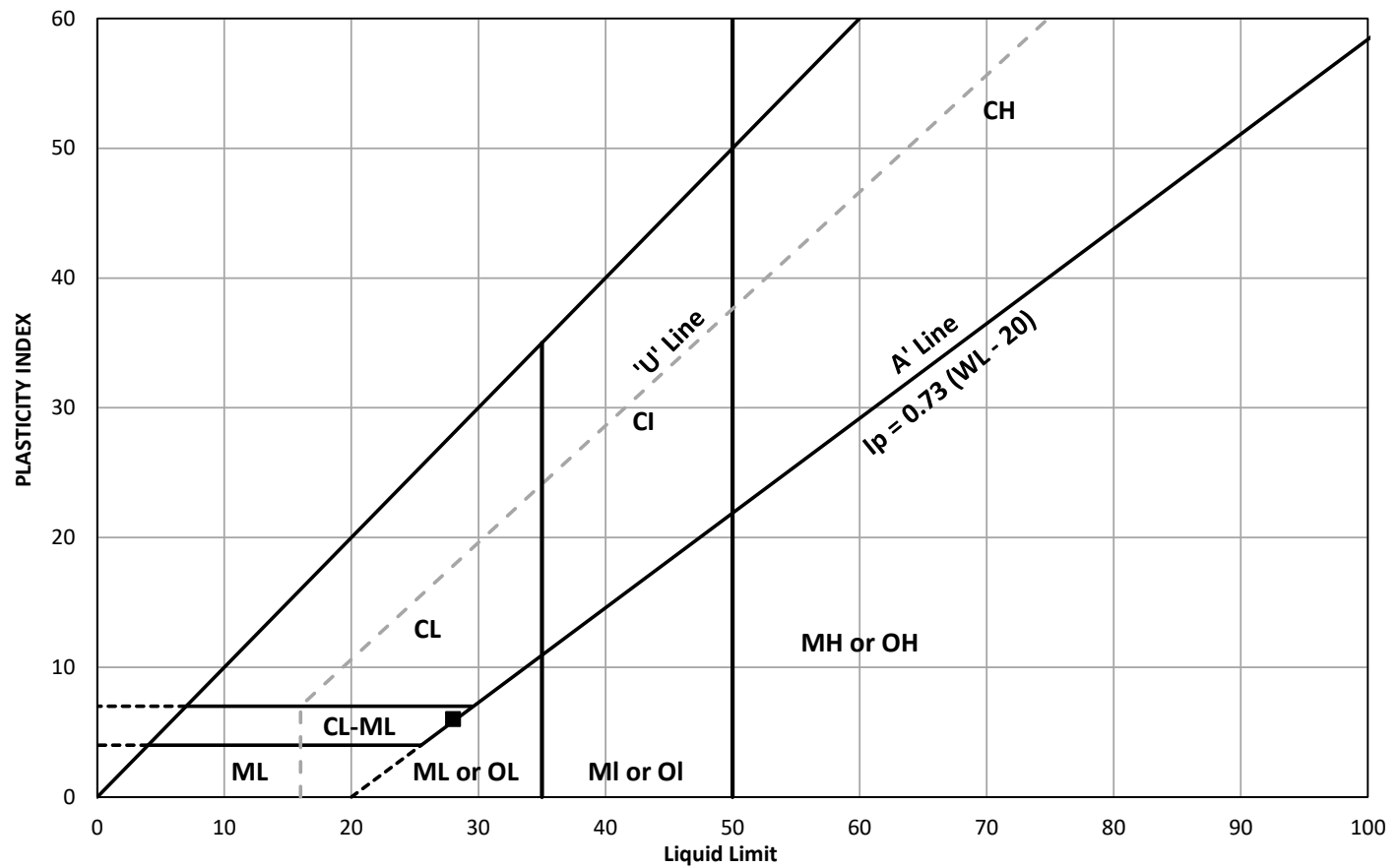
PROJECT NO.
221-10635-00

CONTROL
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REV.
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FIGURE
B-4

PLASTICITY CHART




	Sample Location	Sample / Specimen Number	Depth (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	BH22-7	12	12.2 - 12.8	21.7	28	22	6	-0.05

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2023-04-05

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M.L.

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AMP

APPROVED

DS

PROJECT

HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE

CLAYEY SAND-SILTY SAND (SC-SM)

PROJECT NO.

221-10635-00

CONTROL

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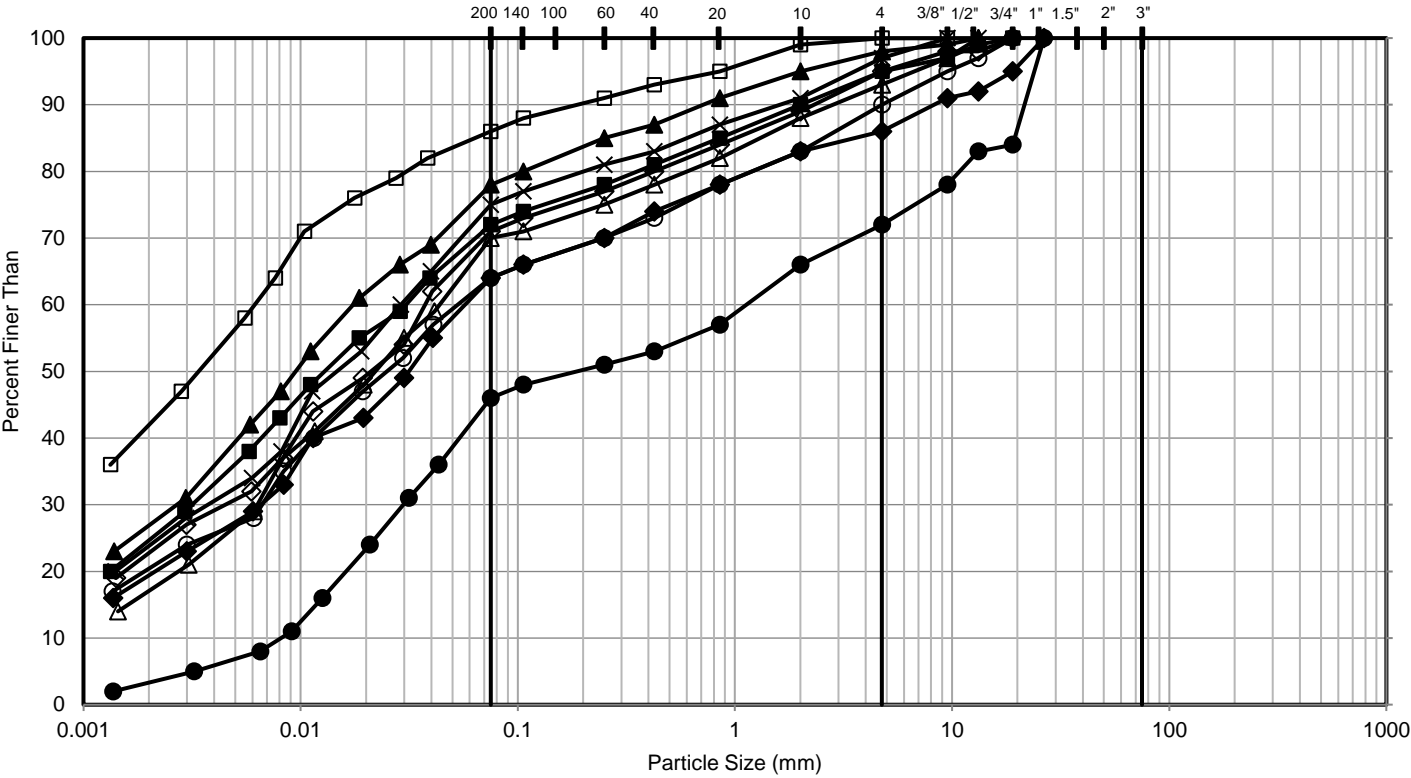
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FIGURE

B-5

GRAIN SIZE DISTRIBUTION



FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH22-7	14	15.2 - 15.9	92.2 to 91.6
◆	BH23-3	12	12.2 - 12.8	94.4 to 93.8
▲	BH23-11	8	6.1 - 6.7	98.3 to 97.7
●	BH23-11	11	10.7 - 11.0	93.7 to 93.4
□	BH23-12	10	9.1 - 9.8	98.4 to 97.8
◇	BH23-13	12	10.7 - 11.3	91.1 to 90.5
△	BH23-14	10	9.1 - 9.8	88.6 to 88.0
○	BH23-15	8	6.1 - 6.7	88.9 to 88.3
×	BH23-16	7	4.6 - 5.2	89.1 to 88.5

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PROJECT

HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE

GLACIAL TILL

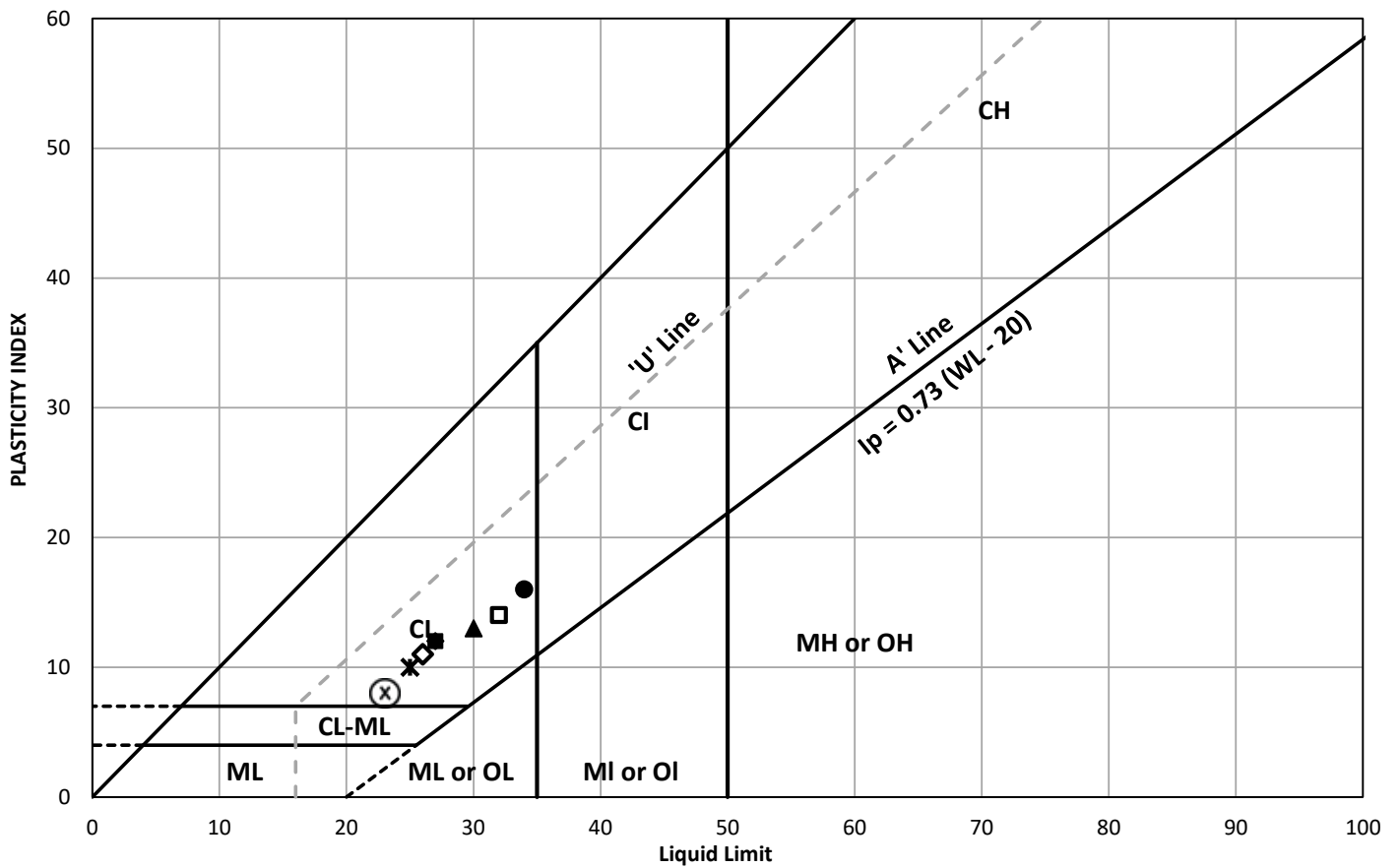
PROJECT NO.
221-10635-00

CONTROL
0

REV.
0

FIGURE
B-6

PLASTICITY CHART




	Sample Location	Sample / Specimen Number	Depth (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	BH22-7	14	15.2 - 15.9	13.3	27	15	12	-0.14
◆	BH23-3	12	12.2 - 12.8	12.6	27	15	12	-0.20
▲	BH23-11	8	6.1 - 6.7	12.3	30	17	13	-0.36
●	BH23-12	10	9.1 - 9.8	15.9	34	18	16	-0.13
*	BH23-13	12	10.7 - 11.3	15.6	25	15	10	0.06
⊗	BH23-14	10	9.1 - 9.8	13.3	23	15	8	-0.21
□	BH23-15	10	9.1 - 9.8	4.5	32	18	14	-0.96
◇	BH23-16	7	4.6 - 5.2	11.5	26	15	11	-0.32

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M.L.

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PROJECT

HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE

GLACIAL TILL

PROJECT NO.

221-10635-00

CONTROL

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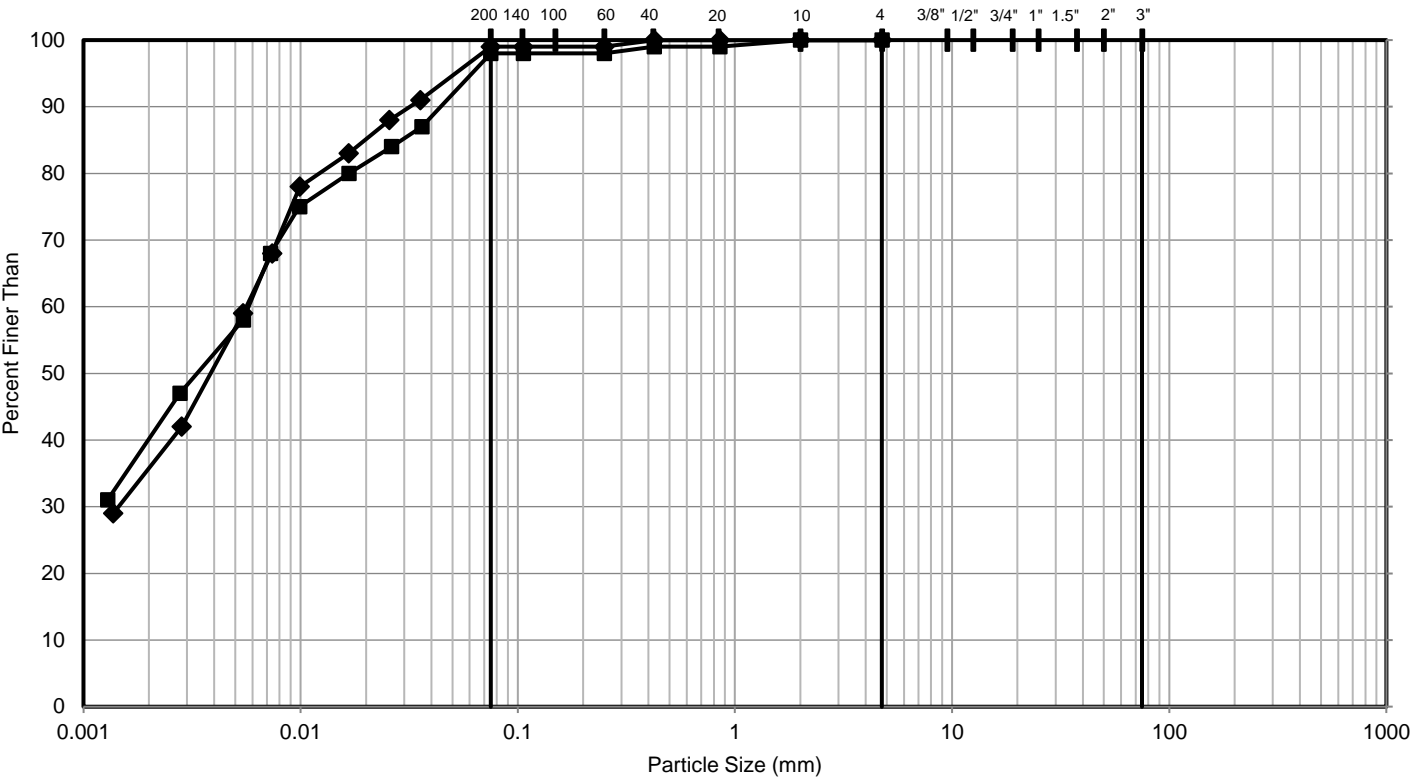
REV.

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FIGURE

B-7

GRAIN SIZE DISTRIBUTION



FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH23-15	10	9.1 - 9.8	85.9 to 85.3
◆	BH23-16	10	9.1 - 9.8	84.6 to 84.0

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APPROVED DS

PROJECT

HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE

CLAYEY SILT (CL) (Lower Deposit)

PROJECT NO.

221-10635-00

CONTROL

0

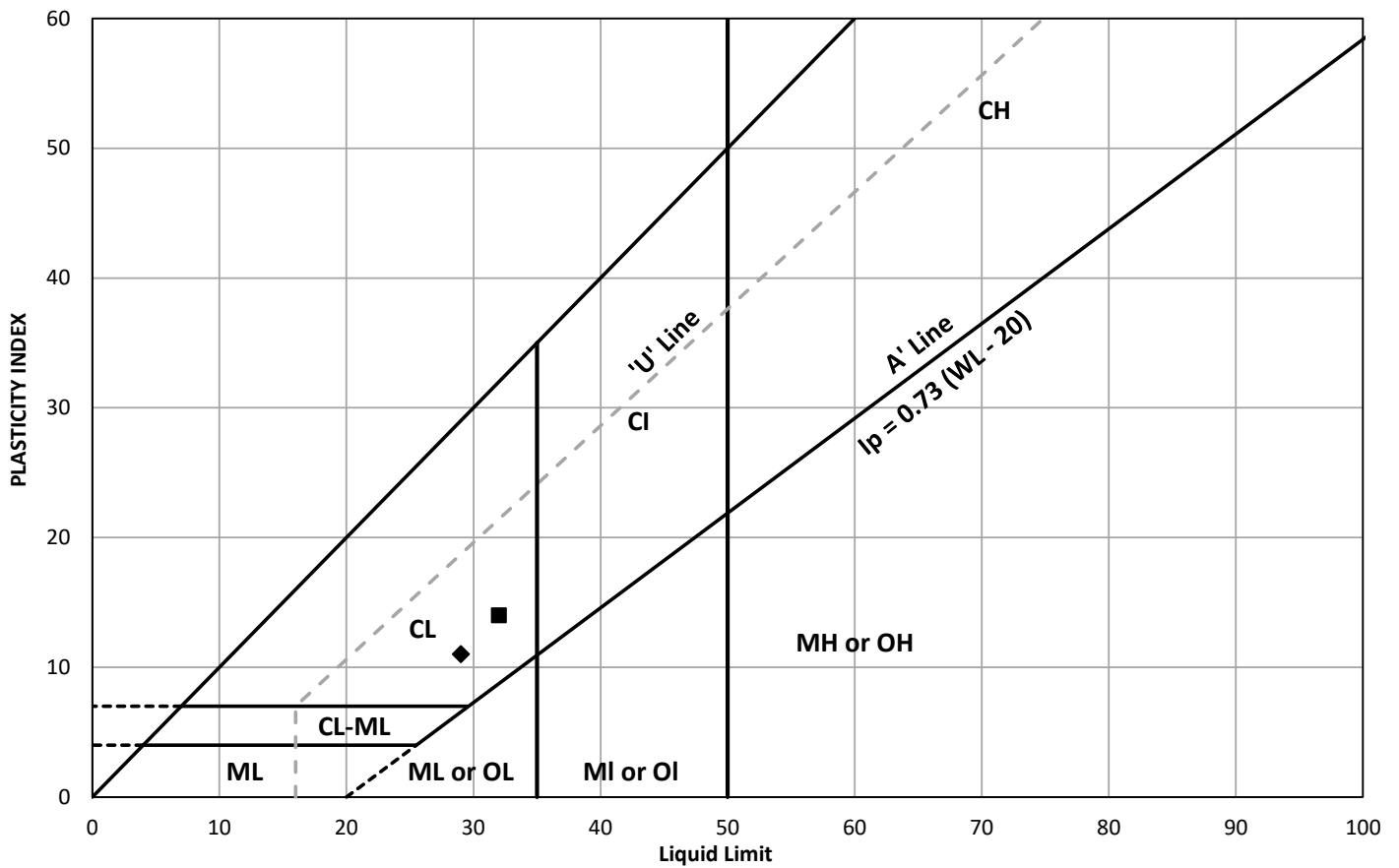
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FIGURE

B-8

PLASTICITY CHART




	Sample Location	Sample / Specimen Number	Depth (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	BH23-15	10	9.1 - 9.8	4.5	32	18	14	-0.96
◆	BH23-16	10	9.1 - 9.8	25.8	29	18	11	0.71

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2023-04-05

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AMP

APPROVED

DS

PROJECT

HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE

CLAYEY SILT (CL) (Lower Deposit)

PROJECT NO.

221-10635-00

CONTROL

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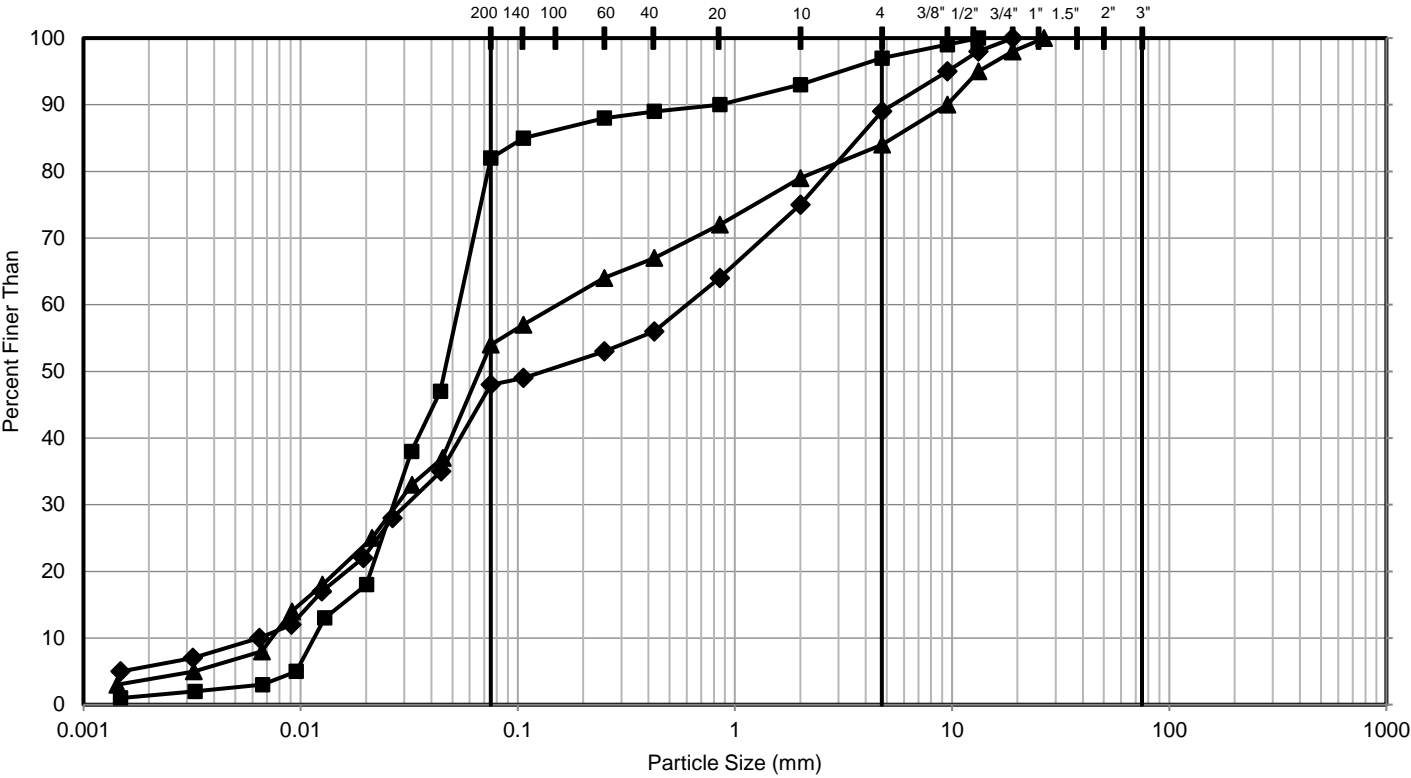
REV.

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FIGURE

B-9

GRAIN SIZE DISTRIBUTION



FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH23-14	12A	12.2 - 12.6	85.5 to 85.1
◆	BH23-15	12	12.2 - 12.4	82.8 to 82.6
▲	BH23-16	11	10.7 - 11.3	83.1 to 82.4

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PROJECT

HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE

SILT (ML) to SILTY SAND (SM) (Lower Deposit)

PROJECT NO.

221-10635-00

CONTROL

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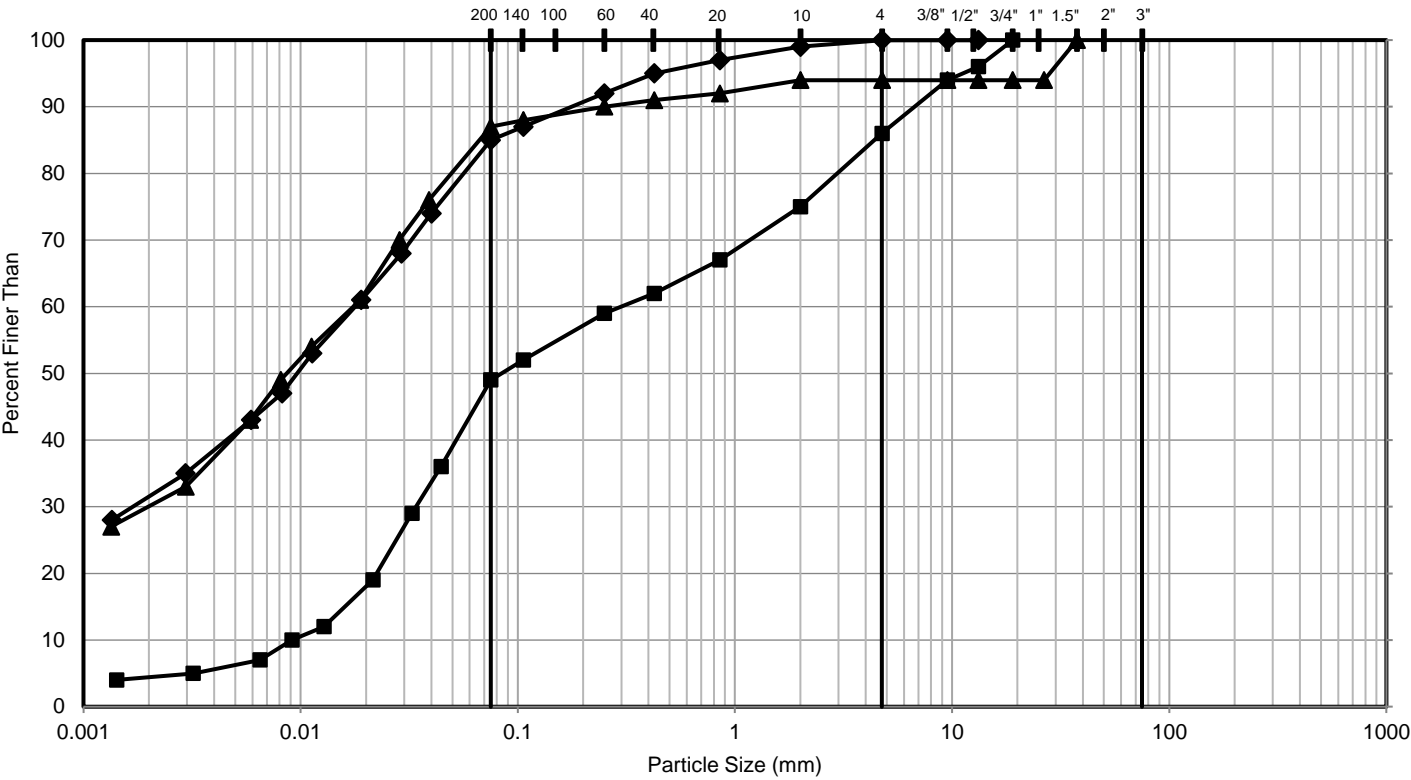
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FIGURE

B-10


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GRAIN SIZE DISTRIBUTION

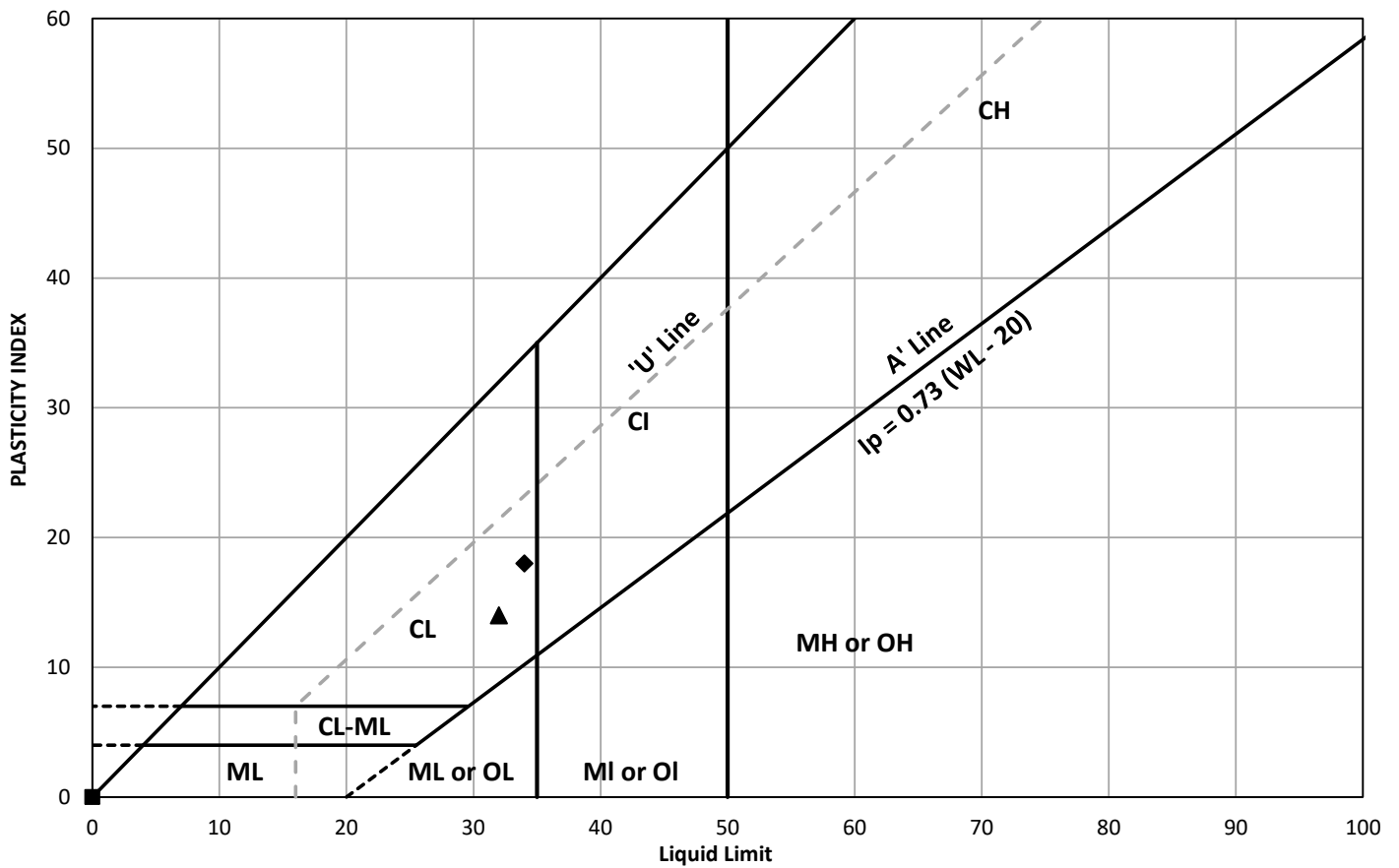


FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH22-7	19	22.9 - 23.5	84.6 to 84.0
◆	BH23-9	5	3.0 - 3.7	105.2 to 104.6
▲	BH23-10	7B	4.7 - 5.2	105.2 to 104.7

CLIENT		PROJECT	
MINISTRY OF TRANSPORTATION ONTARIO (MTO)		HIGH MAST LIGHT POLES QEW & HIGHWAY 403, BURLINGTON	
CONSULTANT	YYYY-MM-DD	2024-04-05	
	DESIGNED	ML	
	PREPARED	ML	
	REVIEWED	AMP	
	APPROVED	DS	
		TITLE	
		RESIDUAL SOIL	
PROJECT NO.		CONTROL	REV.
221-10635-00		0	0
		FIGURE	
		B-11	

PLASTICITY CHART




	Sample Location	Sample / Specimen Number	Depth (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	BH22-7	19	22.9 - 23.5	13.3	0	NP	0	
◆	BH23-9	5	3.0 - 3.7	15.5	34	16	18	-0.03
▲	BH23-10	7B	4.7 - 5.2	13.4	32	18	14	-0.33

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2023-04-05

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M.L.

REVIEWED

AMP

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DS

PROJECT

HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE

RESIDUAL SOIL

PROJECT NO.

221-10635-00

CONTROL

0

REV.

0

FIGURE

B-12

Top of core (Elev. 85.9 m)

Run 1

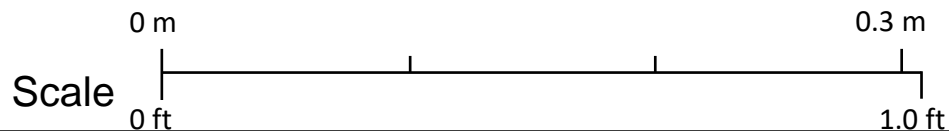
Run 1

Run 1

Run 1

Run 1

End of Run 1 (Elev. 84.37 m)



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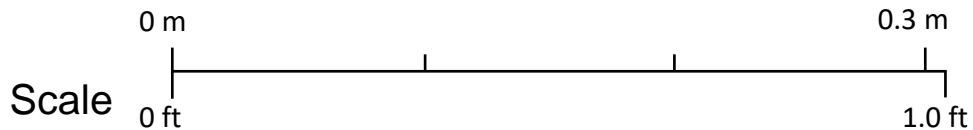
DATE 2024-03-21
PREPARED ML
DESIGN ML
REVIEW AMP
APPROVED DS

PROJECT
HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON
TITLE
BEDROCK CORE PHOTOGRAPHS
BOREHOLE BH22-4 (21.72 m – 23.21 m)
PROJECT No. 221-10635-00
PHASE No. 900.901
FIGURE No. BR-13A

Start of Run 2 (Elev. 84.37 m)



Bottom of core (Elev. 82.87 m)



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DATE 2024-03-21
PREPARED ML
DESIGN ML
REVIEW AMP
APPROVED DS

PROJECT
HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON
TITLE
BEDROCK CORE PHOTOGRAPHS
BOREHOLE BH22-4 (23.21 m – 24.71 m)
PROJECT No. 221-10635-00
PHASE No. 900.901
FIGURE No. BR-13B

Top of core (Elev. 82.97 m)

Run 1

Run 1

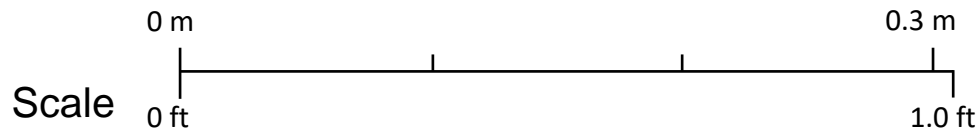
Run 1

Run 1

Run 1



End of Run 1 (Elev. 84.37 m)



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DATE 2024-03-21
PREPARED ML
DESIGN ML
REVIEW AMP
APPROVED DS

PROJECT
HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON
TITLE
BEDROCK CORE PHOTOGRAPHS
BOREHOLE BH22-7 (24.47 m – 26.21 m)
PROJECT No. 221-10635-00
PHASE No. 900.901
FIGURE No. BR-14A

Start of Run 2 (Elev. 84.37 m)

Run 2

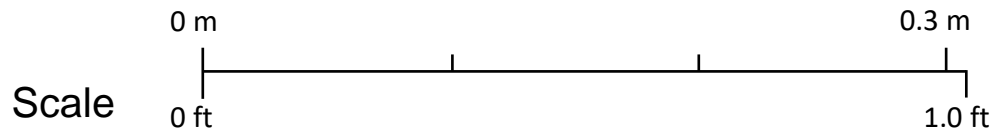
Run 2

Run 2

Run 2

Run 2

Bottom of core (Elev. 79.80 m)



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wsp

DATE
PREPARED
DESIGN
REVIEW
APPROVED

PROJECT
HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE
BEDROCK CORE PHOTOGRAPHS
BOREHOLE BH22-7 (26.21 m – 27.64 m)

PROJECT No.
221-10635-00

PHASE No.
900.901

FIGURE No.
BR-14B

Top of core (Elev. 103.71 m)

Run 1



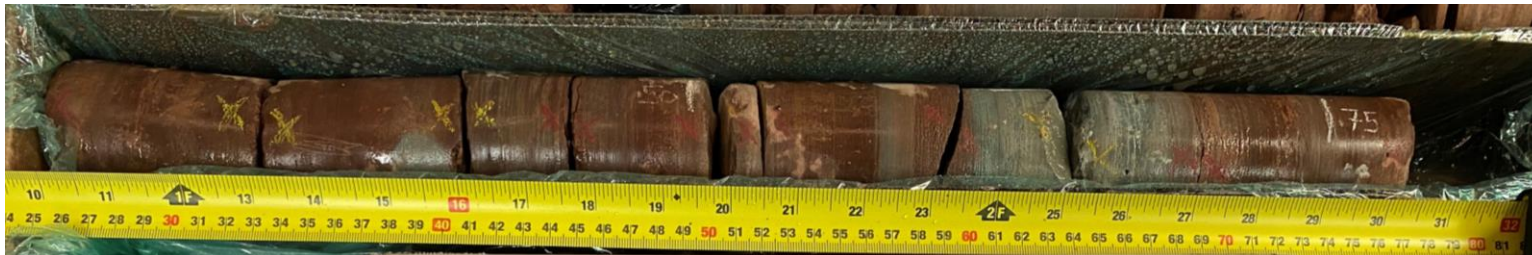
End of Run 1 (Elev. 103.40 m)

Run 2

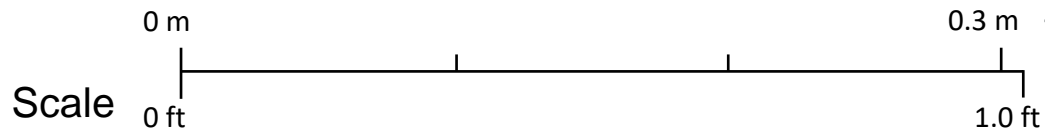


Run 2

Run 2



Run 2



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Ministry of Transportation, Ontario (MTO)

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DATE	2024-03-21
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PROJECT	HIGH MAST LIGHT POLES
	QEW & HIGHWAY 403, BURLINGTON
TITLE	BEDROCK CORE PHOTOGRAPHS
	BOREHOLE BH23-9 (4.88 m - 5.87 m)
PROJECT No.	221-10635-00
PHASE No.	900.901
FIGURE No.	BR-15A

Run 2



Run 2

End of Run 2 (Elev. 101.86 m)

Run 2

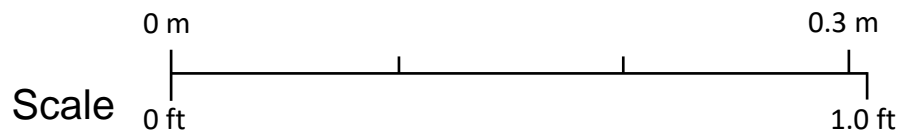


Run 3

Run 3



Run 3



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PROJECT
HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

TITLE
BEDROCK CORE PHOTOGRAPHS
BOREHOLE BH23-9 (5.87 m – 7.13 m)

PROJECT No.
221-10635-00

PHASE No.
900.901

FIGURE No.
B-15B

Run 3

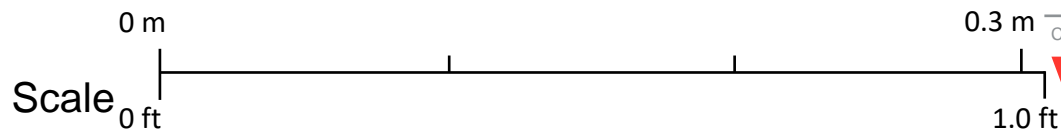


Run 3

Run 3



Bottom of core (Elev. 100.34 m)



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PROJECT
HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON

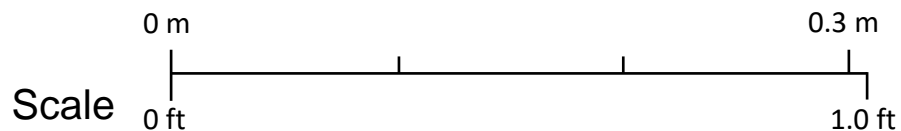
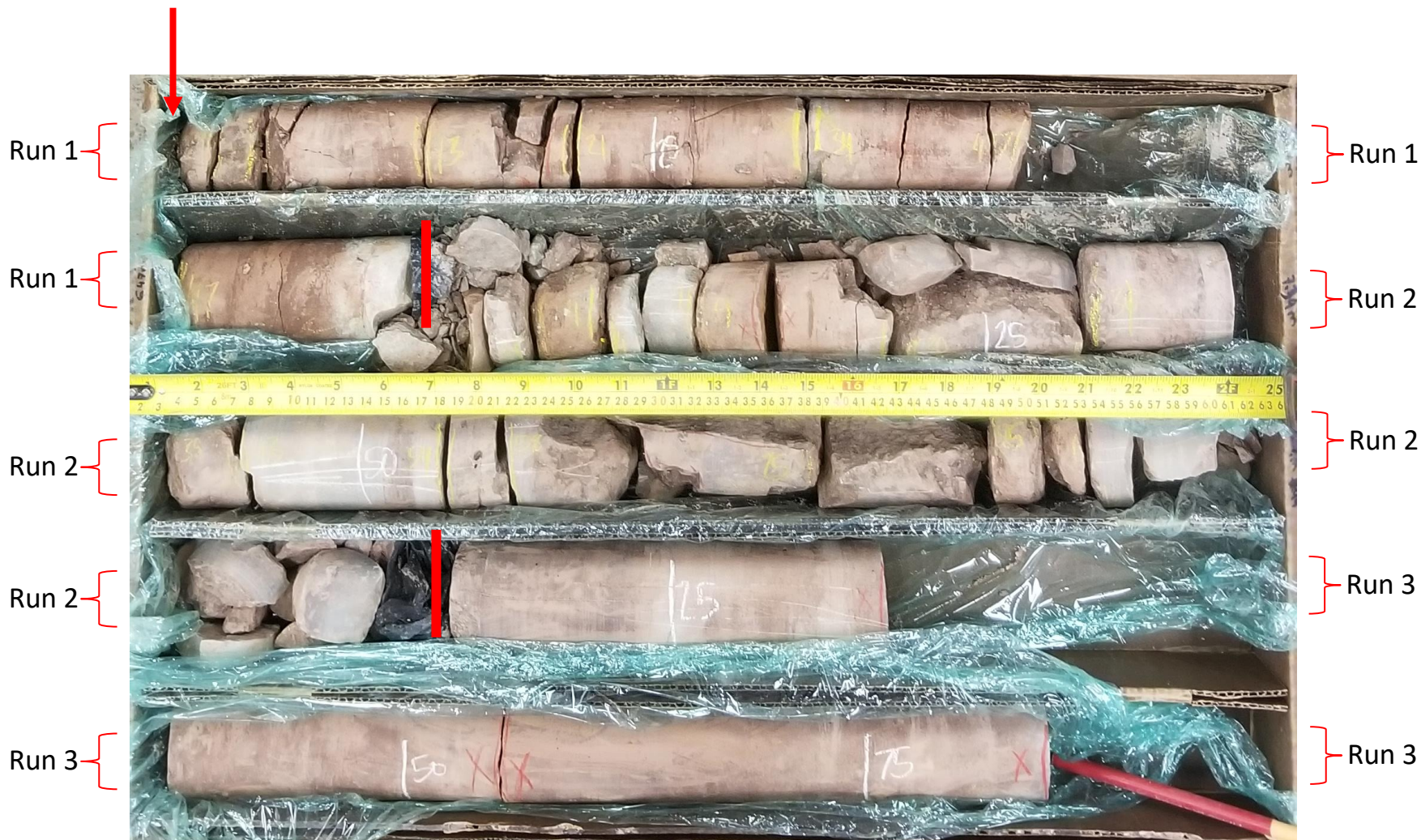
TITLE
BEDROCK CORE PHOTOGRAPHS
BOREHOLE BH23-9 (7.13 m – 7.94 m)

PROJECT No.
221-10635-00

PHASE No.
900.901

FIGURE No.
BR-15C

Top of core (Elev. 104.16 m)



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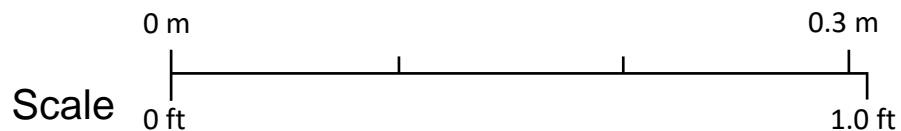


DATE 2024-03-21
PREPARED ML
DESIGN ML
REVIEW AMP
APPROVED DS

PROJECT
HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON
TITLE
BEDROCK CORE PHOTOGRAPHS
BOREHOLE BH23-10 (5.72 m – 8.75 m)
PROJECT No. 221-10635-00
PHASE No. 900.901
FIGURE No. BR-16A



Bottom of core (Elev. 100.22 m)



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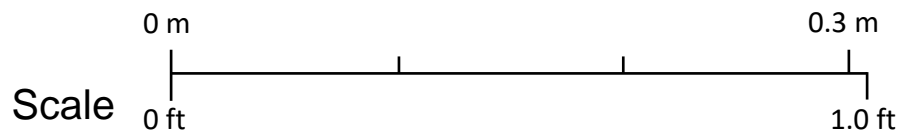
CONSULTANT



DATE 2024-03-21
PREPARED ML
DESIGN ML
REVIEW AMP
APPROVED DS

PROJECT
HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON
TITLE
BEDROCK CORE PHOTOGRAPHS
BOREHOLE BH23-10 (8.75 m – 9.66 m)
PROJECT No. 221-10635-00
PHASE No. 900.901
FIGURE No. BR-16B

Top of core (Elev. 92.35 m)



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DATE 2024-03-21
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PROJECT
HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON
TITLE
BEDROCK CORE PHOTOGRAPHS
BOREHOLE BH23-11 (12.04 m – 14.58 m)
PROJECT No. 221-10635-00
PHASE No. 900.901
FIGURE No. BR-17A

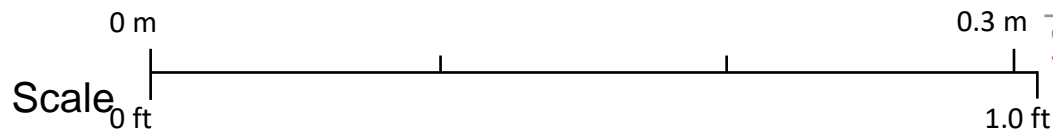
Run 3 {

Run 3 {

} Run 3



Bottom of core (Elev. 88.81 m)



CLIENT
Ministry of Transportation, Ontario (MTO)

CONSULTANT



DATE 2024-03-21
PREPARED ML
DESIGN ML
REVIEW AMP
APPROVED DS

PROJECT
HIGH MAST LIGHT POLES
QEW & HIGHWAY 403, BURLINGTON
TITLE
BEDROCK CORE PHOTOGRAPHS
BOREHOLE BH23-11 (14.58 m – 15.58 m)
PROJECT No. 221-10635-00
PHASE No. 900.901
FIGURE No. BR-17B

APPENDIX C

Analytical Laboratory Test Results



Your Project #: 221-10635-00 (900.901)
Your C.O.C. #: 963469-01-01

Attention: Maor Levy

WSP Canada Inc.
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2023/11/30
Report #: R7935399
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C3AB193

Received: 2023/11/17, 08:00

Sample Matrix: Soil
Samples Received: 8

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	8	2023/11/21	2023/11/22	CAM SOP-00463	MOE E3013 m
Conductivity	8	2023/11/21	2023/11/21	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 2)	6	N/A	2023/11/29	AB SOP-00002	CCME PHC-CWS m
Moisture (Subcontracted) (1, 2)	2	N/A	2023/11/30	AB SOP-00002	CCME PHC-CWS m
Sulphide in Soil (1)	8	N/A	2023/11/27	AB SOP-00080	EPA9030B/SM4500S2-DF
pH CaCl2 EXTRACT	4	2023/11/21	2023/11/21	CAM SOP-00413	EPA 9045 D m
pH CaCl2 EXTRACT	4	2023/11/22	2023/11/22	CAM SOP-00413	EPA 9045 D m
Redox Potential (3)	8	2023/11/22	2023/11/23	CAM SOP-00421	SM 2580 B
Resistivity of Soil	8	2023/11/17	2023/11/21	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	8	2023/11/21	2023/11/22	CAM SOP-00464	MOE E3013 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, MELCCFP, 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.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.



Your Project #: 221-10635-00 (900.901)
Your C.O.C. #: 963469-01-01

Attention: Maor Levy

WSP Canada Inc.
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2023/11/30
Report #: R7935399
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C3AB193

Received: 2023/11/17, 08:00

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

- (1) This test was performed by Bureau Veritas Calgary (19th), 4000 19th Street NE, Calgary, AB, T2E 6P8
- (2) Offsite analysis requires that subcontracted moisture be reported.
- (3) Oxidation-Reduction Potential (ORP) values are determined using a Ag/AgCl reference electrode. The test is therefore, not SCC accredited for this matrix.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:

Ankita Bhalla, Project Manager
Email: Ankita.Bhalla@bureauveritas.com
Phone# (905) 817-5700

=====

This report has been generated and distributed using a secure automated process.

Bureau Veritas 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 Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.

BUREAU
VERITAS

Bureau Veritas Job #: C3AB193

Report Date: 2023/11/30

WSP Canada Inc.

Client Project #: 221-10635-00 (900.901)

Sampler Initials: ML

SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		XQA227			XQA227			XQA228	XQA229		
Sampling Date		2023/11/13			2023/11/13			2023/11/14	2023/11/15		
COC Number		963469-01-01			963469-01-01			963469-01-01	963469-01-01		
	UNITS	BH23-4	RDL	QC Batch	BH23-4 Lab-Dup	RDL	QC Batch	BH23-9	BH23-10	RDL	QC Batch

Calculated Parameters

Resistivity	ohm-cm	1400		9056200				1500	600		9056200
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CONVENTIONALS

Redox Potential	mV	290	N/A	9062866				280	260	N/A	9062866
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Inorganics

Soluble (20:1) Chloride (Cl-)	ug/g	150	20	9062142				200	770	20	9062142
Conductivity	umho/cm	739	2	9062581				664	1660	2	9062581
Available (CaCl2) pH	pH	7.92		9062750				7.54	7.74		9062750
Soluble (20:1) Sulphate (SO4)	ug/g	330	20	9062125				48	190	20	9062125
Sulphide	mg/kg	0.5 (1)	0.5	9082757	<0.5	0.5	9082757	1.1	3.0	0.5	9082757

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

N/A = Not Applicable

(1) Matrix spike exceeds acceptance limits due to matrix interference.

Bureau Veritas ID		XQA230	XQA231	XQA232	XQA233		XQA234		
Sampling Date		2023/11/15	2023/11/16	2023/11/16	2023/11/17		2023/11/17		
COC Number		963469-01-01	963469-01-01	963469-01-01	963469-01-01		963469-01-01		
	UNITS	BH23-6	BH23-11	BH23-12	BH23-5	QC Batch	BH23-7	RDL	QC Batch

Calculated Parameters

Resistivity	ohm-cm	810	1400	880	1500	9056200	540		9056200
-------------	--------	-----	------	-----	------	---------	-----	--	---------

CONVENTIONALS

Redox Potential	mV	250	270	260	250	9062866	170	N/A	9062866
-----------------	----	-----	-----	-----	-----	---------	-----	-----	---------

Inorganics

Soluble (20:1) Chloride (Cl-)	ug/g	500	200	130	250	9062142	930	20	9062142
Conductivity	umho/cm	1230	696	1130	687	9062581	1860	2	9062581
Available (CaCl2) pH	pH	7.76	7.69	7.89	7.45	9065326	8.69		9062750
Soluble (20:1) Sulphate (SO4)	ug/g	140	140	730	53	9062125	120	20	9062125
Sulphide	mg/kg	<0.5	0.8	2.4	<0.5	9082757	8.0 (1)	0.5	9082757

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

N/A = Not Applicable

(1) Sample contained greater than 10% headspace at time of extraction.



BUREAU
VERITAS

Bureau Veritas Job #: C3AB193
Report Date: 2023/11/30

WSP Canada Inc.
Client Project #: 221-10635-00 (900.901)
Sampler Initials: ML

RESULTS OF ANALYSES OF SOIL

Bureau Veritas ID		XQA227	XQA228		XQA229		XQA230		
Sampling Date		2023/11/13	2023/11/14		2023/11/15		2023/11/15		
COC Number		963469-01-01	963469-01-01		963469-01-01		963469-01-01		
	UNITS	BH23-4	BH23-9	QC Batch	BH23-10	QC Batch	BH23-6	RDL	QC Batch
Physical Testing									
Moisture-Subcontracted	%	10	18	9082756	19	9082758	19	0.30	9082756
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									

Bureau Veritas ID		XQA231		XQA232	XQA233	XQA234		
Sampling Date		2023/11/16		2023/11/16	2023/11/17	2023/11/17		
COC Number		963469-01-01		963469-01-01	963469-01-01	963469-01-01		
	UNITS	BH23-11	QC Batch	BH23-12	BH23-5	BH23-7	RDL	QC Batch
Physical Testing								
Moisture-Subcontracted	%	12	9082758	11	18	6.2	0.30	9082756
RDL = Reportable Detection Limit								
QC Batch = Quality Control Batch								



BUREAU
VERITAS

Bureau Veritas Job #: C3AB193

Report Date: 2023/11/30

WSP Canada Inc.

Client Project #: 221-10635-00 (900.901)

Sampler Initials: ML

TEST SUMMARY

Bureau Veritas ID: XQA227
Sample ID: BH23-4
Matrix: Soil

Collected: 2023/11/13
Shipped:
Received: 2023/11/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9062142	2023/11/21	2023/11/22	Alina Dobreanu
Conductivity	AT	9062581	2023/11/21	2023/11/21	Leily Karimi
Moisture (Subcontracted)	BAL	9082756	N/A	2023/11/29	Ashley Henderson
Sulphide in Soil	SPEC	9082757	N/A	2023/11/27	Ly Vu
pH CaCl ₂ EXTRACT	AT	9062750	2023/11/21	2023/11/21	Taslina Aktar
Redox Potential	COND	9062866	2023/11/22	2023/11/23	Kien Tran
Resistivity of Soil		9056200	2023/11/21	2023/11/21	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9062125	2023/11/21	2023/11/22	Alina Dobreanu

Bureau Veritas ID: XQA227 Dup
Sample ID: BH23-4
Matrix: Soil

Collected: 2023/11/13
Shipped:
Received: 2023/11/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphide in Soil	SPEC	9082757	N/A	2023/11/25	Ly Vu

Bureau Veritas ID: XQA228
Sample ID: BH23-9
Matrix: Soil

Collected: 2023/11/14
Shipped:
Received: 2023/11/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9062142	2023/11/21	2023/11/22	Alina Dobreanu
Conductivity	AT	9062581	2023/11/21	2023/11/21	Leily Karimi
Moisture (Subcontracted)	BAL	9082756	N/A	2023/11/29	Ashley Henderson
Sulphide in Soil	SPEC	9082757	N/A	2023/11/27	Ly Vu
pH CaCl ₂ EXTRACT	AT	9062750	2023/11/21	2023/11/21	Taslina Aktar
Redox Potential	COND	9062866	2023/11/22	2023/11/23	Kien Tran
Resistivity of Soil		9056200	2023/11/21	2023/11/21	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9062125	2023/11/21	2023/11/22	Alina Dobreanu

Bureau Veritas ID: XQA229
Sample ID: BH23-10
Matrix: Soil

Collected: 2023/11/15
Shipped:
Received: 2023/11/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9062142	2023/11/21	2023/11/22	Alina Dobreanu
Conductivity	AT	9062581	2023/11/21	2023/11/21	Leily Karimi
Moisture (Subcontracted)	BAL	9082758	N/A	2023/11/30	Simranjeet Batth
Sulphide in Soil	SPEC	9082757	N/A	2023/11/27	Ly Vu
pH CaCl ₂ EXTRACT	AT	9062750	2023/11/21	2023/11/21	Taslina Aktar
Redox Potential	COND	9062866	2023/11/22	2023/11/23	Kien Tran
Resistivity of Soil		9056200	2023/11/21	2023/11/21	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9062125	2023/11/21	2023/11/22	Alina Dobreanu



**BUREAU
VERITAS**

Bureau Veritas Job #: C3AB193
Report Date: 2023/11/30

WSP Canada Inc.
Client Project #: 221-10635-00 (900.901)
Sampler Initials: ML

TEST SUMMARY

Bureau Veritas ID: XQA230
Sample ID: BH23-6
Matrix: Soil

Collected: 2023/11/15
Shipped:
Received: 2023/11/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9062142	2023/11/21	2023/11/22	Alina Dobreanu
Conductivity	AT	9062581	2023/11/21	2023/11/21	Leily Karimi
Moisture (Subcontracted)	BAL	9082756	N/A	2023/11/29	Ashley Henderson
Sulphide in Soil	SPEC	9082757	N/A	2023/11/27	Ly Vu
pH CaCl2 EXTRACT	AT	9065326	2023/11/22	2023/11/22	Kien Tran
Redox Potential	COND	9062866	2023/11/22	2023/11/23	Kien Tran
Resistivity of Soil		9056200	2023/11/21	2023/11/21	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9062125	2023/11/21	2023/11/22	Alina Dobreanu

Bureau Veritas ID: XQA231
Sample ID: BH23-11
Matrix: Soil

Collected: 2023/11/16
Shipped:
Received: 2023/11/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9062142	2023/11/21	2023/11/22	Alina Dobreanu
Conductivity	AT	9062581	2023/11/21	2023/11/21	Leily Karimi
Moisture (Subcontracted)	BAL	9082758	N/A	2023/11/30	Simranjeet Batth
Sulphide in Soil	SPEC	9082757	N/A	2023/11/27	Ly Vu
pH CaCl2 EXTRACT	AT	9065326	2023/11/22	2023/11/22	Kien Tran
Redox Potential	COND	9062866	2023/11/22	2023/11/23	Kien Tran
Resistivity of Soil		9056200	2023/11/21	2023/11/21	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9062125	2023/11/21	2023/11/22	Alina Dobreanu

Bureau Veritas ID: XQA232
Sample ID: BH23-12
Matrix: Soil

Collected: 2023/11/16
Shipped:
Received: 2023/11/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9062142	2023/11/21	2023/11/22	Alina Dobreanu
Conductivity	AT	9062581	2023/11/21	2023/11/21	Leily Karimi
Moisture (Subcontracted)	BAL	9082756	N/A	2023/11/29	Ashley Henderson
Sulphide in Soil	SPEC	9082757	N/A	2023/11/27	Ly Vu
pH CaCl2 EXTRACT	AT	9065326	2023/11/22	2023/11/22	Kien Tran
Redox Potential	COND	9062866	2023/11/22	2023/11/23	Kien Tran
Resistivity of Soil		9056200	2023/11/21	2023/11/21	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9062125	2023/11/21	2023/11/22	Alina Dobreanu

Bureau Veritas ID: XQA233
Sample ID: BH23-5
Matrix: Soil

Collected: 2023/11/17
Shipped:
Received: 2023/11/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9062142	2023/11/21	2023/11/22	Alina Dobreanu
Conductivity	AT	9062581	2023/11/21	2023/11/21	Leily Karimi
Moisture (Subcontracted)	BAL	9082756	N/A	2023/11/29	Ashley Henderson



BUREAU
VERITAS

Bureau Veritas Job #: C3AB193

Report Date: 2023/11/30

WSP Canada Inc.

Client Project #: 221-10635-00 (900.901)

Sampler Initials: ML

TEST SUMMARY

Bureau Veritas ID: XQA233

Sample ID: BH23-5

Matrix: Soil

Collected: 2023/11/17

Shipped:

Received: 2023/11/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphide in Soil	SPEC	9082757	N/A	2023/11/27	Ly Vu
pH CaCl ₂ EXTRACT	AT	9065326	2023/11/22	2023/11/22	Kien Tran
Redox Potential	COND	9062866	2023/11/22	2023/11/23	Kien Tran
Resistivity of Soil		9056200	2023/11/21	2023/11/21	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9062125	2023/11/21	2023/11/22	Alina Dobreanu

Bureau Veritas ID: XQA234

Sample ID: BH23-7

Matrix: Soil

Collected: 2023/11/17

Shipped:

Received: 2023/11/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9062142	2023/11/21	2023/11/22	Alina Dobreanu
Conductivity	AT	9062581	2023/11/21	2023/11/21	Leily Karimi
Moisture (Subcontracted)	BAL	9082756	N/A	2023/11/29	Ashley Henderson
Sulphide in Soil	SPEC	9082757	N/A	2023/11/27	Ly Vu
pH CaCl ₂ EXTRACT	AT	9062750	2023/11/21	2023/11/21	Taslima Aktar
Redox Potential	COND	9062866	2023/11/22	2023/11/23	Kien Tran
Resistivity of Soil		9056200	2023/11/21	2023/11/21	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9062125	2023/11/21	2023/11/22	Alina Dobreanu



GENERAL COMMENTS

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

Package 1	4.0°C
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Results relate only to the items tested.



BUREAU
VERITAS

Bureau Veritas Job #: C3AB193

Report Date: 2023/11/30

QUALITY ASSURANCE REPORT

WSP Canada Inc.

Client Project #: 221-10635-00 (900.901)

Sampler Initials: ML

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
9062125	Soluble (20:1) Sulphate (SO ₄)	2023/11/22	NC	70 - 130	95	70 - 130	<20	ug/g	3.0	35
9062142	Soluble (20:1) Chloride (Cl ⁻)	2023/11/22	NC	70 - 130	96	70 - 130	<20	ug/g	4.3	35
9062581	Conductivity	2023/11/21			102	90 - 110	<2	umho/cm	2.5	10
9062750	Available (CaCl ₂) pH	2023/11/21			100	97 - 103			1.5	N/A
9062866	Redox Potential	2023/11/23			100	95 - 105			15	35
9065326	Available (CaCl ₂) pH	2023/11/22			100	97 - 103			0.079	N/A
9082756	Moisture-Subcontracted	2023/11/29					<0.30	%		
9082757	Sulphide	2023/11/25	45 (1)	75 - 125	78	75 - 125	<0.5	mg/kg	4.0	30
9082758	Moisture-Subcontracted	2023/11/30					<0.30	%		

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)

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.



BUREAU
VERITAS

Bureau Veritas Job #: C3AB193

Report Date: 2023/11/30

WSP Canada Inc.

Client Project #: 221-10635-00 (900.901)

Sampler Initials: ML

VALIDATION SIGNATURE PAGE

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

Cristina Carriere, Senior Scientific Specialist

Ghayasuddin Khan, M.Sc., P.Chem., QP, Scientific Specialist, Inorganics

Veronica Falk, B.Sc., P.Chem., QP, Scientific Specialist, Organics

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Your Project #: 221-10635-00 (900.901)
Site Location: REEMAN INTERCHANGE
Your C.O.C. #: 963469-03-01

Attention: Maor Levy

WSP Canada Inc.
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2023/12/07
Report #: R7944930
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C3AQ135

Received: 2023/11/29, 09:19

Sample Matrix: Soil
Samples Received: 8

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	8	2023/12/04	2023/12/05	CAM SOP-00463	MOE E3013 m
Conductivity	8	2023/12/04	2023/12/04	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 2)	8	N/A	2023/12/06	AB SOP-00002	CCME PHC-CWS m
Sulphide in Soil (1)	8	N/A	2023/12/04	AB SOP-00080	EPA9030B/SM4500S2-DF
pH CaCl2 EXTRACT	8	2023/12/02	2023/12/02	CAM SOP-00413	EPA 9045 D m
Redox Potential (3)	8	2023/12/05	2023/12/05	CAM SOP-00421	SM 24 2580 B
Resistivity of Soil	8	2023/11/30	2023/12/04	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	8	2023/12/04	2023/12/05	CAM SOP-00464	MOE E3013 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, MELCCFP, 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.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

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.

(1) This test was performed by Bureau Veritas Calgary (19th), 4000 19th Street NE, Calgary, AB, T2E 6P8

(2) Offsite analysis requires that subcontracted moisture be reported.



Your Project #: 221-10635-00 (900.901)
Site Location: REEMAN INTERCHANGE
Your C.O.C. #: 963469-03-01

Attention: Maor Levy

WSP Canada Inc.
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2023/12/07
Report #: R7944930
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C3AQ135

Received: 2023/11/29, 09:19

(3) Oxidation-Reduction Potential (ORP) values are determined using a Ag/AgCl reference electrode. The test is therefore, not SCC accredited for this matrix.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:

Ankita Bhalla, Project Manager
Email: Ankita.Bhalla@bureauveritas.com
Phone# (905) 817-5700

=====

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BUREAU
VERITAS

Bureau Veritas Job #: C3AQ135
Report Date: 2023/12/07

WSP Canada Inc.
Client Project #: 221-10635-00 (900.901)
Site Location: REEMAN INTERCHANGE
Sampler Initials: DR

SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		XTF142	XTF143	XTF144	XTF145	XTF146		
Sampling Date		2023/11/23	2023/11/21	2023/11/20	2023/11/20	2023/11/22		
COC Number		963469-03-01	963469-03-01	963469-03-01	963469-03-01	963469-03-01		
	UNITS	BH23- 1 SS3	BH23- 2 SS4	BH23- 3 SS3	BH23- 8 SS3	BH23- 13 SS4	RDL	QC Batch

Calculated Parameters								
Resistivity	ohm-cm	640	760	640	850	1500		9082720
CONVENTIONALS								
Redox Potential	mV	230	150	190	180	130	N/A	9090640
Inorganics								
Soluble (20:1) Chloride (Cl-)	ug/g	590	280	570	530	110	20	9088427
Conductivity	umho/cm	1570	1320	1550	1180	669	2	9088901
Available (CaCl2) pH	pH	7.68	8.06	8.02	7.68	7.69		9086938
Soluble (20:1) Sulphate (SO4)	ug/g	520	930	810	120	380	20	9088445
Sulphide	mg/kg	2.5	2.3	8.0	2.4	3.5	0.5	9089915
RDL = Reportable Detection Limit								
QC Batch = Quality Control Batch								
N/A = Not Applicable								

Bureau Veritas ID		XTF146			XTF147	XTF148			XTF148		
Sampling Date		2023/11/22			2023/11/23	2023/11/24			2023/11/24		
COC Number		963469-03-01			963469-03-01	963469-03-01			963469-03-01		
	UNITS	BH23- 13 SS4 Lab-Dup	RDL	QC Batch	BH23- 14 SS3	BH23- 16 SS3	RDL	QC Batch	BH23- 16 SS3 Lab-Dup	RDL	QC Batch

Calculated Parameters											
Resistivity	ohm-cm				480	710		9082720			
CONVENTIONALS											
Redox Potential	mV	130	N/A	9090640	130	290	N/A	9090640			
Inorganics											
Soluble (20:1) Chloride (Cl-)	ug/g	110	20	9088427	720	660	20	9088427			
Conductivity	umho/cm				2070	1420	2	9088901	1380	2	9088901
Available (CaCl2) pH	pH				7.80	6.95		9086938			
Soluble (20:1) Sulphate (SO4)	ug/g	420	20	9088445	760	350	20	9088445			
Sulphide	mg/kg				2.0	<0.5	0.5	9089915			
RDL = Reportable Detection Limit											
QC Batch = Quality Control Batch											
Lab-Dup = Laboratory Initiated Duplicate											
N/A = Not Applicable											



**BUREAU
VERITAS**

Bureau Veritas Job #: C3AQ135

Report Date: 2023/12/07

WSP Canada Inc.

Client Project #: 221-10635-00 (900.901)

Site Location: REEMAN INTERCHANGE

Sampler Initials: DR

SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		XTF149		
Sampling Date		2023/11/27		
COC Number		963469-03-01		
	UNITS	BH23- 15 SS3	RDL	QC Batch
Calculated Parameters				
Resistivity	ohm-cm	640		9082720
CONVENTIONALS				
Redox Potential	mV	190	N/A	9090640
Inorganics				
Soluble (20:1) Chloride (Cl-)	ug/g	640	20	9088427
Conductivity	umho/cm	1570	2	9088901
Available (CaCl2) pH	pH	7.39		9086938
Soluble (20:1) Sulphate (SO4)	ug/g	390	20	9088445
Sulphide	mg/kg	19.4	0.5	9089915
RDL = Reportable Detection Limit				
QC Batch = Quality Control Batch				
N/A = Not Applicable				



BUREAU
VERITAS

Bureau Veritas Job #: C3AQ135

Report Date: 2023/12/07

WSP Canada Inc.

Client Project #: 221-10635-00 (900.901)

Site Location: REEMAN INTERCHANGE

Sampler Initials: DR

RESULTS OF ANALYSES OF SOIL

Bureau Veritas ID		XTF142	XTF143	XTF144	XTF145	XTF145	XTF146		
Sampling Date		2023/11/23	2023/11/21	2023/11/20	2023/11/20	2023/11/20	2023/11/22		
COC Number		963469-03-01	963469-03-01	963469-03-01	963469-03-01	963469-03-01	963469-03-01		
	UNITS	BH23- 1 SS3	BH23- 2 SS4	BH23- 3 SS3	BH23- 8 SS3	BH23- 8 SS3 Lab-Dup	BH23- 13 SS4	RDL	QC Batch
Physical Testing									
Moisture-Subcontracted	%	12	15	12	13	13	15	0.30	9097524
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									
Lab-Dup = Laboratory Initiated Duplicate									

Bureau Veritas ID		XTF147		XTF148	XTF149		
Sampling Date		2023/11/23		2023/11/24	2023/11/27		
COC Number		963469-03-01		963469-03-01	963469-03-01		
	UNITS	BH23- 14 SS3	QC Batch	BH23- 16 SS3	BH23- 15 SS3	RDL	QC Batch
Physical Testing							
Moisture-Subcontracted	%	12	9097524	6.2	8.2	0.30	9097525
RDL = Reportable Detection Limit							
QC Batch = Quality Control Batch							



BUREAU
VERITAS

Bureau Veritas Job #: C3AQ135

Report Date: 2023/12/07

WSP Canada Inc.

Client Project #: 221-10635-00 (900.901)

Site Location: REEMAN INTERCHANGE

Sampler Initials: DR

TEST SUMMARY

Bureau Veritas ID: XTF142
Sample ID: BH23- 1 SS3
Matrix: Soil

Collected: 2023/11/23
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9088427	2023/12/04	2023/12/05	Alina Dobreanu
Conductivity	AT	9088901	2023/12/04	2023/12/04	Kien Tran
Moisture (Subcontracted)	BAL	9097524	N/A	2023/12/06	Olha Kovalenko
Sulphide in Soil	SPEC	9089915	N/A	2023/12/04	Bailey Morrison
pH CaCl2 EXTRACT	AT	9086938	2023/12/02	2023/12/02	Leily Karimi
Redox Potential	COND	9090640	2023/12/05	2023/12/05	Kien Tran
Resistivity of Soil		9082720	2023/12/04	2023/12/04	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9088445	2023/12/04	2023/12/05	Alina Dobreanu

Bureau Veritas ID: XTF143
Sample ID: BH23- 2 SS4
Matrix: Soil

Collected: 2023/11/21
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9088427	2023/12/04	2023/12/05	Alina Dobreanu
Conductivity	AT	9088901	2023/12/04	2023/12/04	Kien Tran
Moisture (Subcontracted)	BAL	9097524	N/A	2023/12/06	Olha Kovalenko
Sulphide in Soil	SPEC	9089915	N/A	2023/12/04	Bailey Morrison
pH CaCl2 EXTRACT	AT	9086938	2023/12/02	2023/12/02	Leily Karimi
Redox Potential	COND	9090640	2023/12/05	2023/12/05	Kien Tran
Resistivity of Soil		9082720	2023/12/04	2023/12/04	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9088445	2023/12/04	2023/12/05	Alina Dobreanu

Bureau Veritas ID: XTF144
Sample ID: BH23- 3 SS3
Matrix: Soil

Collected: 2023/11/20
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9088427	2023/12/04	2023/12/05	Alina Dobreanu
Conductivity	AT	9088901	2023/12/04	2023/12/04	Kien Tran
Moisture (Subcontracted)	BAL	9097524	N/A	2023/12/06	Olha Kovalenko
Sulphide in Soil	SPEC	9089915	N/A	2023/12/04	Bailey Morrison
pH CaCl2 EXTRACT	AT	9086938	2023/12/02	2023/12/02	Leily Karimi
Redox Potential	COND	9090640	2023/12/05	2023/12/05	Kien Tran
Resistivity of Soil		9082720	2023/12/04	2023/12/04	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9088445	2023/12/04	2023/12/05	Alina Dobreanu

Bureau Veritas ID: XTF145
Sample ID: BH23- 8 SS3
Matrix: Soil

Collected: 2023/11/20
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9088427	2023/12/04	2023/12/05	Alina Dobreanu
Conductivity	AT	9088901	2023/12/04	2023/12/04	Kien Tran



**BUREAU
VERITAS**

Bureau Veritas Job #: C3AQ135

Report Date: 2023/12/07

WSP Canada Inc.

Client Project #: 221-10635-00 (900.901)

Site Location: REEMAN INTERCHANGE

Sampler Initials: DR

TEST SUMMARY

Bureau Veritas ID: XTF145
Sample ID: BH23- 8 SS3
Matrix: Soil

Collected: 2023/11/20
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture (Subcontracted)	BAL	9097524	N/A	2023/12/06	Olha Kovalenko
Sulphide in Soil	SPEC	9089915	N/A	2023/12/04	Bailey Morrison
pH CaCl2 EXTRACT	AT	9086938	2023/12/02	2023/12/02	Leily Karimi
Redox Potential	COND	9090640	2023/12/05	2023/12/05	Kien Tran
Resistivity of Soil		9082720	2023/12/04	2023/12/04	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9088445	2023/12/04	2023/12/05	Alina Dobreanu

Bureau Veritas ID: XTF145 Dup
Sample ID: BH23- 8 SS3
Matrix: Soil

Collected: 2023/11/20
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture (Subcontracted)	BAL	9097524	N/A	2023/12/06	Olha Kovalenko

Bureau Veritas ID: XTF146
Sample ID: BH23- 13 SS4
Matrix: Soil

Collected: 2023/11/22
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9088427	2023/12/04	2023/12/05	Alina Dobreanu
Conductivity	AT	9088901	2023/12/04	2023/12/04	Kien Tran
Moisture (Subcontracted)	BAL	9097524	N/A	2023/12/06	Olha Kovalenko
Sulphide in Soil	SPEC	9089915	N/A	2023/12/04	Bailey Morrison
pH CaCl2 EXTRACT	AT	9086938	2023/12/02	2023/12/02	Leily Karimi
Redox Potential	COND	9090640	2023/12/05	2023/12/05	Kien Tran
Resistivity of Soil		9082720	2023/12/04	2023/12/04	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9088445	2023/12/04	2023/12/05	Alina Dobreanu

Bureau Veritas ID: XTF146 Dup
Sample ID: BH23- 13 SS4
Matrix: Soil

Collected: 2023/11/22
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9088427	2023/12/04	2023/12/05	Alina Dobreanu
Redox Potential	COND	9090640	2023/12/05	2023/12/05	Kien Tran
Sulphate (20:1 Extract)	SKAL/EC	9088445	2023/12/04	2023/12/05	Alina Dobreanu

Bureau Veritas ID: XTF147
Sample ID: BH23- 14 SS3
Matrix: Soil

Collected: 2023/11/23
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9088427	2023/12/04	2023/12/05	Alina Dobreanu
Conductivity	AT	9088901	2023/12/04	2023/12/04	Kien Tran
Moisture (Subcontracted)	BAL	9097524	N/A	2023/12/06	Olha Kovalenko



BUREAU
VERITAS

Bureau Veritas Job #: C3AQ135

Report Date: 2023/12/07

WSP Canada Inc.

Client Project #: 221-10635-00 (900.901)

Site Location: REEMAN INTERCHANGE

Sampler Initials: DR

TEST SUMMARY

Bureau Veritas ID: XTF147
Sample ID: BH23- 14 SS3
Matrix: Soil

Collected: 2023/11/23
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphide in Soil	SPEC	9089915	N/A	2023/12/04	Bailey Morrison
pH CaCl2 EXTRACT	AT	9086938	2023/12/02	2023/12/02	Leily Karimi
Redox Potential	COND	9090640	2023/12/05	2023/12/05	Kien Tran
Resistivity of Soil		9082720	2023/12/04	2023/12/04	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9088445	2023/12/04	2023/12/05	Alina Dobreanu

Bureau Veritas ID: XTF148
Sample ID: BH23- 16 SS3
Matrix: Soil

Collected: 2023/11/24
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9088427	2023/12/04	2023/12/05	Alina Dobreanu
Conductivity	AT	9088901	2023/12/04	2023/12/04	Kien Tran
Moisture (Subcontracted)	BAL	9097525	N/A	2023/12/06	Olha Kovalenko
Sulphide in Soil	SPEC	9089915	N/A	2023/12/04	Bailey Morrison
pH CaCl2 EXTRACT	AT	9086938	2023/12/02	2023/12/02	Leily Karimi
Redox Potential	COND	9090640	2023/12/05	2023/12/05	Kien Tran
Resistivity of Soil		9082720	2023/12/04	2023/12/04	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9088445	2023/12/04	2023/12/05	Alina Dobreanu

Bureau Veritas ID: XTF148 Dup
Sample ID: BH23- 16 SS3
Matrix: Soil

Collected: 2023/11/24
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	9088901	2023/12/04	2023/12/04	Kien Tran

Bureau Veritas ID: XTF149
Sample ID: BH23- 15 SS3
Matrix: Soil

Collected: 2023/11/27
Shipped:
Received: 2023/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9088427	2023/12/04	2023/12/05	Alina Dobreanu
Conductivity	AT	9088901	2023/12/04	2023/12/04	Kien Tran
Moisture (Subcontracted)	BAL	9097525	N/A	2023/12/06	Olha Kovalenko
Sulphide in Soil	SPEC	9089915	N/A	2023/12/04	Bailey Morrison
pH CaCl2 EXTRACT	AT	9086938	2023/12/02	2023/12/02	Leily Karimi
Redox Potential	COND	9090640	2023/12/05	2023/12/05	Kien Tran
Resistivity of Soil		9082720	2023/12/04	2023/12/04	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9088445	2023/12/04	2023/12/05	Alina Dobreanu



GENERAL COMMENTS

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

Package 1	5.3°C
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Results relate only to the items tested.



**BUREAU
VERITAS**

Bureau Veritas Job #: C3AQ135

Report Date: 2023/12/07

QUALITY ASSURANCE REPORT

WSP Canada Inc.

Client Project #: 221-10635-00 (900.901)

Site Location: REEMAN INTERCHANGE

Sampler Initials: DR

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
9086938	Available (CaCl ₂) pH	2023/12/02			100	97 - 103			0.20	N/A
9088427	Soluble (20:1) Chloride (Cl ⁻)	2023/12/05	NC	70 - 130	102	70 - 130	<20	ug/g	4.8	35
9088445	Soluble (20:1) Sulphate (SO ₄)	2023/12/05	NC	70 - 130	96	70 - 130	<20	ug/g	9.3	35
9088901	Conductivity	2023/12/04			104	90 - 110	<2	umho/cm	2.5	10
9089915	Sulphide	2023/12/04	79	75 - 125	99	75 - 125	<0.5	mg/kg	0.65	30
9090640	Redox Potential	2023/12/05			100	95 - 105			1.4	35
9097524	Moisture-Subcontracted	2023/12/06					<0.30	%	3.0	20
9097525	Moisture-Subcontracted	2023/12/06					<0.30	%		

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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VERITAS

Bureau Veritas Job #: C3AQ135

Report Date: 2023/12/07

WSP Canada Inc.

Client Project #: 221-10635-00 (900.901)

Site Location: REEMAN INTERCHANGE

Sampler Initials: DR

VALIDATION SIGNATURE PAGE

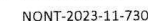
The analytical data and all QC contained in this report were reviewed and validated by:

Anastassia Hamanov, Scientific Specialist

Ghayasuddin Khan, M.Sc., P.Chem., QP, Scientific Specialist, Inorganics

Veronica Falk, B.Sc., P.Chem., QP, Scientific Specialist, Organics

Bureau Veritas 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 Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.

Bureau Veritas Canada (2019) Inc.

APPENDIX D

Notice to Contractor

Temporary Excavations For Drilled Shaft (Caisson) Foundations

Notice to Contractor

The contractor is alerted that water-bearing non-cohesive soils should be expected at the high mast light pole foundation locations, both associated with perched groundwater in fill materials and within the non-cohesive soil deposits underlying the fill materials. Water-bearing non-cohesive fill and native soils should be expected to run or flow into the drillholes during caisson installation. Appropriate equipment and procedures, such as use of casings and/or water/drilling fluid to maintain a positive head of pressure within the drilled hole, will be required to minimize ground loss along the excavation walls and/or to control base disturbance / basal heave due to groundwater pressures / seepage. Further, the placement of concrete by tremie methods will be required where wet conditions exist.

The contractor is also alerted that the fill may contain obstructions including concrete rubble, cobbles, boulders and buried asphalt, and that the native till soils may contain cobbles and boulders. Further, temporary excavations for drilled shafts will extend into residual soil and/or shale bedrock at some high mast light pole foundation locations. Appropriate equipment and procedures will be required to penetrate or remove such obstructions / residual soil / bedrock during caisson foundation construction.

