



Foundation Investigation Report

Rehabilitation/Replacement of 25 Non-Structural Culverts at various locations of Highway 9, Highway 12, Highway, 400, Highway 401, Hwy 404 in Simcoe County, York Region, Durham Region, and City of Toronto - **Highway 400 CSP Culvert Replacement (CV-0252-0400-0050)**

GWP: 2044-23-00

Assignment No. 2020-E-0028

MTO Central Region

Latitude: 44.639180; Longitude: -79.654120

Geocres No. 31D12-002

Type of Document:

Final Report

EXP Project Number:

ADM-22007871-A0

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Date Submitted:

April 30, 2024

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Issue and Revised Record

Rev.	Date	Format	Prepared by	Reviewed by	Approved by	Description
A	April 3, 2024	pdf	S. Fredericks N. Tamrakar	T.C.KIM	S. Gonsalves	Draft Report
B	April 30, 2024	pdf	S. Fredericks N. Tamrakar	T.C.KIM	S. Gonsalves	Final Report

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*Foundation Investigation Report
Highway 400 CSP Culvert Replacement (CV-0252-0400-0050)
GWP 2044-23-00
Assignment No. 2020-E-0028
Date: April 30, 2024*

Part I: Foundation Investigation Report

Rehabilitation/Replacement of 25 Non-Structural Culverts at various locations of Highway 9, Highway 12, Highway, 400, Highway 401, Hwy 404 in Simcoe County, York Region, Durham Region, and City of Toronto - **Highway 400 CSP Culvert Replacement (CV-0252-0400-0050)**

1.0 Introduction

EXP Services Inc. (EXP) was retained by CONSOR Engineers LLC (CONSOR) on behalf of The Ministry of Transportation (MTO) to provide detailed foundation investigation and engineering services and pavement engineering services for the proposed rehabilitation/replacement of 25 Non-Structural Culverts project at various locations of Highway 9, Highway 12, Highway, 400, Highway 401, Hwy 404 in Simcoe County, York Region, Durham Region, and City of Toronto. The findings, analyses and recommendations related to foundation scope are presented in a Foundation Investigation Design Report created for each culvert location. The work was undertaken under GWP 2044-23-00, Assignment No. 2020-E-0028. The terms of reference (TOR) and the scope of work for the foundation investigation are outlined in Ministry of Transportation Ontario's (MTO) Request for Proposal, dated February 2022. The scope of this report is specifically limited to the proposed replacement of the Corrugated Steel Pipe (CSP) culvert on Highway 400 (CV-0252-0400-0050).

The general design drawings for the proposed culvert replacement were provided to EXP by CONSOR. The purpose of the investigation was to evaluate the subsurface conditions along the existing culvert, and based on this data, to permit detailed design for the culvert replacement and to examine the suitability of trenchless methods of replacement both at the existing culvert alignment and at a new alignment.

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

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

2.0 Structure Description

The contract drawing prepared by CONSOR shows the 90% design configuration of the proposed trenchless replacement of the Highway 400 culvert. A summary of the proposed structure is as follows:

- The existing culvert has two segments CSP culverts with a 1150 mm diameter CSP pipe on the west segment and a 1220 mm diameter CSP pipe on the east segment with about a 9-degree skew connection from along its alignment near mid section (located about the median of the Hwy 400). The total length of the existing culvert is about 74.5 m with about 30.7 m and 43.8 m long west and east segments, respectively.
- It is understood that the existing culvert is proposed to be replaced with twin CSP/HDPE culverts of sizes 1400 mm diameter and 800 mm diameter. The 1400 mm diameter culvert with about 400 mm thick substrate and native material will be replaced at the existing inlet and outlet locations while the 800 mm diameter culvert will be installed about 3 diameters (i.e about 4.2 m) south of the existing culvert location or proposed 1400 diameter culvert location. Based on the 90% contract drawing the invert levels of the new 1400 mm diameter culvert is proposed to be 196.86 m and 195.97 m at inlet and outlet locations, respectively. Whereas the invert levels of the 800 mm diameter culvert will be matched the existing culvert levels 196.6 m and 195.7 m at the inlet and outlet, respectively.

- The existing Highway 400 profile grade is planned to remain unchanged. It is understood that trenchless methods will be used to replace the existing culvert.

The 90% contract drawings were included as part of this report is used for initial context to address the nature and scope of the investigation. It is understood that some changes might occur as a result of normal refinement or the findings of the geotechnical report.

3.0 Site Description and Geological Setting

3.1 Site Description

The CSP culvert is located on Highway 400, about 2.7 km southwest of the intersection of Highway 400 with Highway 19 in the Simcoe region, Ontario, in the Ministry of Transportation (MTO) Central Region. Highway 400 generally runs in the north-south direction, however, at the location of Culvert CV-0252-0400-0050, Highway 400 runs in a northeast-southwest direction. At the site, Highway 400 is a four lane roadway with the northbound lane (NBL) and (southbound lane) SBL separated by a boulevard (two lanes each direction). Based on the contract drawings, the NBL and SBL roadway is about 12.9 m and 12.8 m wide from edge of pavement to edge of pavement, respectively. The boulevard between the NBL and SBL is approximately 20.3 m wide from edge of pavement to edge of pavement. In total, the existing roadway with both paved shoulders and median included is about 46.0 m wide along the culvert footprint. The elevation of highway pavement centerline at the site is about 202.0 m for both the NBL and the SBL. The roadway embankment above the existing ground is about 5.5 m on the SBL (inlet) side and 6.3 m on the NBL (outlet) side. The sides of the embankment slope range from approximately 1.3H:1V to 2.7H:1V on the west side and 1.8H:1V to 3.5H:1V on the east side. Selected photographs of the site and existing culvert are presented in Appendix A. The site plan and cross-section profiles for the proposed culvert alignment are shown on the drawings attached in Appendix B.

The general site conditions were assessed during a site reconnaissance on February 6, 2022, and during the field investigation works that took place EXP between February 13 to 15, 2023 and between to April 26 to 27, 2023. At the time of the field investigation, the approximate top of water elevation at the inlet and outlet of the culvert was measured to be about 196.7 m and 195.8 m, respectively. No riprap to protect against scour or erosion was observed on the outlet/east of the culvert. Vegetation at the site consists predominantly of coniferous trees with some deciduous trees wild bushes and shrubs adjacent to the culvert area. The side slopes of the embankment are lightly vegetated. A chain link fence runs across the outlet/east side of culvert near the culvert opening.

Photographs 1 and 2 (taken by MTO) and Photographs 3 to 11 (taken by EXP between February 2023 and April 2023 in Appendix A show the existing site, culvert, and road conditions. Photographs 1 and 2 show the condition of the inside of the culvert. It can be seen that the culvert barrels are heavily corroded at the bottom, especially at the outlet side. Photographs 3 and 4 shows the condition of the culverts from the outside. The outlet of the culvert is completely corroded through the barrel and is partially compressed where the barrel meets the embankment. Photographs 5 and 6 show the side slopes of the embankment and vegetation beyond the culvert footprint. Photographs 7 to 9 show the typical conditions of the roadway surface around the culvert footprint. The highway surface in general is observed to be in a mildly deteriorated condition with a large portion of the roadway experiencing extensive longitudinal and radial cracking. Photographs 10 and 11 show the drilling of borehole BH400-050-01 and BH400-050-02 respectively.

3.2 Geological Setting

Based on a review of geological maps of Southern Ontario (Chapman and Putnam, 1984), the site is situated within the Simcoe Uplands physiographic region where the predominate landforms are broad, rolling till plains separated by steep-sided flat-floored valleys. The numerous shorelines indicate the area lies on the lake bed of glacial Lake Algonquin.

According to the Ministry of Northern Development and Mines, Map 2556 (Quaternary Geology of Ontario, Southern Sheet, 1991) the surface conditions in the vicinity of the project area typically consists of coarse-textured glaciolacustrine deposits comprised predominantly of sandy silt to silt matrix, commonly rich in clasts, often high in total matrix carbonate content. In addition, Map 2544 (Bedrock Geology of Ontario, Southern Sheet, 1991), the bedrock geology at the site consists of limestone, dolostone, shale, arkose, and siltstone belonging to the Ottawa Group and Simcoe Group of the Shadow Lake Formation.

4.0 Previous Investigations

There are no available reports of any previously performed geotechnical investigation at this site in the MTO GEOCRE library. The only available data is from the adjacent sites approximately 2.7 km northeast and 1.6 km southwest from the site. The reports are listed below for reference.

- *Geocres No. 31D00-083. "Soils Report for Highway #400 Underpass at Gravel Rd., Near Coldwater River, W.P. 64-60". E.M. Peto Associates Ltd., dated July, 1960.*
- *Geocres No. 31D00-092. "Soils Report for Highway 400 Underpass". E.M. Peto Associates Ltd., dated June, 1960.*

5.0 Investigation Procedures

5.1 Site Investigation and Field Testing

A site-specific investigation was undertaken by EXP between February 13 to 15, 2023 and between to April 26 to 27, 2023, and it included the following:

1. A walkover site assessment was carried out by a Geotechnical Engineer from EXP;
2. Subsequent to the borehole layouts in the field, existing utilities were cleared by public utility companies;
3. Traffic control required to close the driving lanes of Highway 400 during the drilling of on-road boreholes was provided by Barricade Traffic Services.
4. At the time of this report, the program involved the drilling of six (6) boreholes for sampling numbered BH400-050-01 to BH400-050-05. Two (2) boreholes were located at each end of the existing culverts, which were BH400-050-01 and BH400-050-02. Boreholes BH400-050-04 and BH400-050-05 were drilled on the roadway at the NBL and SBL lanes, respectively. Boreholes BH400-050-03A and BH400-050-03B were drilled at the highway median. BH400-050-01 was drilled approximately 1.2 m south and 1.8 m west of the culvert inlet opening, and BH400-050-02 was drilled approximately 2.9 m south and 1.9 m south of the culvert

outlet opening. The locations of the boreholes drilled during this investigation are shown on Drawing 1 in Appendix C. Table 1.1 provides a summary of the boreholes completed by EXP.

5. The roadway/median boreholes drilled during this fieldwork were advanced using a track mounted MSI 5T98-09 (BH400-050-03A/03B), truck mounted B-53 (BH400-050-04) and truck mounted MST 94 drill rig (BH400-050-05). The offroad boreholes were advanced via manual drilling. The drill rigs were owned and operated by Drilltech drilling Ltd. The machines are equipped with solid stem augers and fitted with capability for Standard Penetration Testing (SPT).
1. Soil samples in the boreholes were taken at frequent intervals of depth by the Standard Penetration Test method (SPT), in general accordance with ASTM D1586. The test consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm O.D. split barrel (SS-split-spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance, or the N-value, of the soil which is indicative of the compactness of granular (or cohesionless) soils (gravels, sands and silts) or the consistency of cohesive soils (clays and clayey soils). However, in the case of sampling done by the manually lifting portable hammer (31.7 kg, half weight of conventional hammer weight), the corresponding blow counts were factored by 0.5;
2. The fieldwork was supervised by a member of EXP's engineering staff who directed the drilling and sampling operation, logged borehole data in accordance with MTO and/or ASTM Standards for Soils Classification, and retrieved soil samples for subsequent laboratory testing and identification;
3. All spoon samples obtained in the Standard Penetration Tests (SPT, ASTM D-1586) were placed in moisture proof bags after field classification. Samples were allocated from the spoon samples for moisture content testing without delay. They were subsequently re-examined under controlled laboratory conditions prior to assigning other laboratory tests;
4. Selected soil samples for chemical analytical testing were sent to the Bureau Veritas Laboratories (formerly Maxxam Analytics), a CALA-certified and accredited laboratory in Mississauga, Ontario. The selected soil samples for the analytical testing were placed in a laboratory prepared glass jar, labelled, and stored in a secure cooler.
5. The borehole locations and their ground surface elevations were surveyed by EXP using a Trimble DA2 GNSS receiver with Trimble Catalyst GNSS positioning, having an accuracy of ± 0.10 m horizontal and vertical directions. MTM NAD83 Zone 10 coordinates and the geodetic elevation for the boreholes are listed in Table 1.1 below. It can also be found on the Record of Borehole Sheet (Appendix D); and
6. Upon completion of drilling and field testing, the boreholes were backfilled with a mixture of bentonite and auger cuttings. groundwater level measurements were carried out in boreholes in accordance with MTO guidelines. The recorded groundwater levels after completion of drilling boreholes were presented in the borehole log sheets in Appendix D.
7. The borehole decommissioning was in general accordance with the Ministry of the Environment Regulation 903, as amended by Regulation 128/03 (the well regulation under the Ontario Water Resources Act).

Table 1.1: Summary of boreholes completed

Borehole No.	Borehole Location	Location (MTM NAD83 Zone 10)		Latitude	Longitude	Borehole Elevation (m)	Borehole Depth (m)
		Northing	Easting				
BH400-050-01	Inlet, off-road	4944363.7	292571.1	44.639176	-79.654148	197.0	8.4
BH400-050-02	Outlet, off-road	4944329.5	292637.1	44.638869	-79.653315	196.5	8.3
BH400-050-03A	Median Boulevard	4944358.7	292608.5	44.639132	-79.653676	200.7	9.1
BH400-050-03B	Median Boulevard	4944357.9	292609.0	44.639124	-79.653670	200.7	10.4
BH400-050-04	NBL, east shoulder	4944342.0	292624.1	44.638982	-79.653480	201.9	12.8
BH400-050-05	SBL, west shoulder	4944363.2	292589.6	44.639172	-79.653915	201.9	13.1

5.2 Laboratory Testing

All samples returned to the laboratory were subjected to visual examination and classification. The laboratory testing program performed by EXP included the determination of the natural moisture content on all samples and particle size distribution and Atterberg limits (for cohesive soils) for approximately 25% of the collected soil samples. Chemical analyses were also carried out on one soil sample selected by EXP. The samples were tested at the Bureau Veritas Laboratories (formerly Maxxam Analytics), a CALA-certified and accredited laboratory in Mississauga, Ontario. All of the laboratory tests were carried out according to MTO and/or ASTM Standards as appropriate. The performed laboratory testing program is listed in Table 1.2.

Table 1.2: List of Laboratory Test Completed by EXP

Borehole No.	Moisture Content	Atterberg Limits	Sieve	Hydrometer	Corrosivity
BH400-050-01	4	1	2	2	1
BH400-050-02	4	1	2	2	---
BH400-050-03A	11	1	3	3	---
BH400-050-03B	2	---	---	---	---
BH400-050-04	15	1	3	3	---
BH400-050-05	15	1	4	3	---

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

6.0 Subsurface Conditions

The detailed subsurface conditions encountered in the boreholes advanced during this investigation are presented on the borehole log sheets in Appendix D. Laboratory test results of grain size analyses and Atterberg limit tests are provided in Appendix E. The “Explanation of Terms Used in Report” preceding the borehole logs in Appendix D forms an integral part of and should be read in conjunction with this report.

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

Below the roadway, the subsurface conditions encountered within the investigated depths of the geotechnical investigation indicates the following subsurface sequence: asphalt underlain by sand and gravel to gravelly sand followed by predominantly sand fill with layers of clayey silt fill. The embankment fill is underlain by clayey silt to silty clay.

At the culvert inlet, the encountered subsurface conditions were observed to consist of topsoil over silty sand followed by gravelly sand underlain by clayey silt to silty clay. At the outlet, the encountered subsurface conditions were observed to consist of topsoil over clayey silt followed by silty sand to sandy silt underlain by clayey silt to silty clay.

A detailed description of the subsurface conditions encountered is discussed further in subsequent sections. It should be noted that the following sections are based on the geotechnical investigation conducted by EXP. The lab test results available at the time of writing this draft report are included, while the other results will be added in the next submission of this report.

6.1 Subsoils

6.1.1 Asphalt

A pavement structure consisting of asphalt was encountered at the ground surface in boreholes BH400-050-04 and BH400-050-05. The thickness of asphalt ranged from approximately 225 mm to 380 mm.

6.1.2 Topsoil

A topsoil layer was encountered at the ground surface of boreholes BH400-050-01, BH400-050-02, and BH400-050-03A/3B. The thickness of this layer ranged from approximately 100 mm to 250 mm.

6.1.3 Cohesionless Fill: Sand and Gravel to Gravelly Sand(SW-GW)

Cohesionless fill consisting of sand and gravel was encountered below the pavement structure in boreholes BH400-050-04 and BH400-050-05. Additionally, a sand and gravel to gravelly sand fill layer was encountered embedded in the sand fill layer in borehole BH400-050-05. The approximate elevations of the surface and base of each fill layer, thickness, description and SPT (N Value) encountered in boreholes are summarized in Table 1.3 below:

Table 1.3: Summary of Sand and Gravel to Gravelly Sand Fill Layers

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
BH400-050-04	201.5	201.1	0.4	0.4	Sand and Gravel	---
BH400-050-05	201.7	201.0	0.2	0.7	Sand and Gravel	---
	199.6	198.1	2.3	1.5	Sand and Gravel to Gravelly Sand	44 – 52

The composition of this fill was predominantly comprised of sand and gravel with some silt and trace clay; trace asphalt fragments were observed near the surface of the layers near the pavement structure. The fill was generally brown to grey to black in colour and ranged from dry to wet. The SPT "N" values within this layer ranged from 44 to 52 blows per 300 mm penetration, corresponding to dense to very dense in compactness condition.

Laboratory testing performed on selected samples consisted of four (4) moisture content tests. The test results are as follows:

Moisture Content:

- 2% to 10%

The results of the moisture content tests are provided on the record of borehole sheets in Appendix D.

6.1.4 Cohesionless Fill: Sand(SW)

Cohesionless fill layers consisting of sand were encountered below the clayey silt fill in borehole BH400-050-03A and below the sand and gravel fill in borehole BH400-050-04 and BH400-050-05. The approximate elevations of the surface and base of each fill layer, thickness, description and SPT (N Value) encountered in boreholes are summarized in Table 1.4 below:

Table 1.4: Summary of Sand Fill Layers

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
BH400-050-03A	199.2	193.6	1.5	5.6	Sand	1 – 15
BH400-050-04	201.1	194.0	0.8	7.1	Sand	2 – 61
BH400-050-05	201.0	199.6	0.9	1.4	Sand	20 – 42
	198.1	196.2	3.8	1.9	Sand	3 – 5
	196.0	194.9	5.9	1.1	Sand	12

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
	194.3	194.1	7.6	0.2	Sand	---

The composition of this fill was predominantly comprised of sand with trace to some gravel, trace clay, trace rootlets, and occasional clayey seams/layers. An obstruction, possibly/likely a cobble, was encountered within this layer in borehole BH400-050-03A. The fill was generally brown to grey to black in colour and ranged from dry to wet. The SPT "N" values within this layer ranged from 1 to 61 blows per 300 mm penetration, corresponding to very loose to very dense but generally very loose to compact in compactness condition.

Laboratory testing performed on selected samples consisted of twenty-five (25) moisture content tests and seven (7) grain size distribution tests. The test results are as follows:

Moisture Content:

- 5% to 63%

Grain Size Distribution:

- 2% to 8% gravel;
- 66% to 83% sand;
- 11% to 26% silt;
- 2% to 6% clay;
- 12% silt and clay;

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

6.1.5 Cohesive Fill: Clayey Silt(CL)/Organic Silty Clay(OI)

Cohesive fill layers consisting of clayey silt were encountered below the topsoil in borehole BH400-050-03A and interbedded in the sand fill layer in borehole BH400-050-05. The approximate elevations of the surface and base of each fill layer, thickness, description and SPT (N Value) encountered in boreholes are summarized in Table 1.5 below:

Table 1.5: Summary of Clayey Silt Fill Layers

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
BH400-050-03A	200.5	199.2	0.3	1.2	Clayey Silt	8 – 14

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
BH400-050-05	196.2	196.0	5.7	0.2	Organic Silty Clay	---
	194.9	194.3	7.0	0.6	Clayey Silt	WH ¹

Notes:

1. WH – split spoon advanced by static weight of hammer (i.e., 0 blows).

The composition of this fill was predominantly comprised clayey silt with trace sand and trace rootlets. The fill was generally brown to grey and wet. The SPT "N" values within this layer ranged from WH to 14 blows per 300 mm penetration, corresponding to very soft to stiff in consistency. In-situ vane testing with this fill layer measured an undrained shear strength of approximately 60 kPa indicating this material is stiff in consistency. Additionally, a layer of organic clayey silt was encountered, which was comprised of some sand and wood debris. The organic clayey silt was black in color and moist.

Laboratory testing performed on selected samples consisted of four (4) moisture content tests. The test results are as follows:

Moisture Content:

- 12% to 29% (Clayey silt)
- 120% (Organic silty clay)

The results of the moisture content tests are provided on the record of borehole sheets in Appendix D.

6.1.6 Silty Sand to Sandy Silt(SM-ML)

Native silty sand to sandy silt was encountered below the topsoil in borehole BH400-050-01 and below the clayey silt layer in borehole BH400-050-02. The approximate elevations of the surface and base of each layer, thickness, description and SPT (N Value) encountered in boreholes are summarized in Table 1.6 below:

Table 1.6: Summary of Silty Sand to Sandy Silt Layers

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
BH400-050-01	196.9	196.2	0.1	0.7	Silty Sand	2
BH400-050-02	196.2	194.3	0.3	1.9	Silty Sand to Sandy Silt	1 – 4

This layer consisted primarily of silt and sand with trace to some clay, trace gravel, and trace rootlets. The soil was dark brown to dark grey to black in color and wet. The SPT “N” values within this layer ranged from 1 to 4 blows per 300 mm penetration, corresponding to very loose in compactness condition.

Laboratory testing performed on selected samples consisted of three (3) moisture content tests. The test results are as follows:

Moisture Content:

- 24% to 35%

The results of the moisture content tests are provided on the record of borehole sheets in Appendix D.

6.1.7 Gravelly Sand(SW)

Native gravelly sand was encountered below the silty sand layer in borehole BH400-050-01. The approximate elevations of the surface and base of the layer, thickness, description and SPT (N Value) encountered in the borehole are summarized in Table 1.7 below:

Table 1.7: Summary of Gravelly Sand Layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT “N” Value Range
	Top	Bottom				
BH400-050-01	196.2	195.5	0.8	0.7	Gravelly Sand	1

This layer consisted primarily of sand and gravel with some silt and trace clay. The soil was grey in color and wet. The SPT “N” value within this layer was 1 blow per 300 mm penetration corresponding to very loose in compactness condition.

Laboratory testing performed on a selected sample consisted of one (1) moisture content test. The test results are as follows:

Moisture Content:

- 34%

The results of the moisture content test are provided on the record of borehole sheets in Appendix D.

6.1.8 Clayey Silt to Silty Clay(CL-CI)

Native cohesive soil was encountered below the gravelly sand layer in borehole BH400-050-01, below the topsoil and below the silty sand to sandy silt layer in borehole BH400-050-02, and below the embankment fill in boreholes BH400-050-03A/3B, BH400-050-04 and BH400-050-05. All boreholes were terminated within this layer. The

approximate elevations of the surface and base of this layer, thickness, description and SPT (N Value) encountered in boreholes are summarized in Table 1.8 below:

Table 1.8: Summary of Clayey Silt to Silty Clay Layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Investigated Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
BH400-050-01	195.5	188.6	1.5	6.9	Clayey Silt to Silty Clay	1 – 2
BH400-050-02	196.4	196.2	0.1	0.2	Clayey Silt	---
	194.3	188.2	2.2	6.1	Clayey Silt to Silty Clay	1 – 4
BH400-050-03A	193.6	191.6	7.1	2.0	Clayey Silt	2 – 4
BH400-050-03B	191.6	190.3	9.1	1.3	Clayey Silt	2 – 3
BH400-050-04	194.0	189.1	7.9	4.9	Clayey Silt	1 – 4
BH400-050-05	194.1	188.8	7.8	5.3	Clayey Silt	5 - 6

The composition of this material generally consisted of clay and silt with trace to some sand, trace gravel and occasional silt lenses. The material was generally grey in colour and wet. The SPT "N" values within this layer ranged from 1 to 6 blows per 300 mm penetration, corresponding to very soft to firm in consistency. Additionally, in-situ vane testing with this layer measured an undrained shear strength ranging from approximately 12 kPa to 120 kPa indicating very soft to very stiff, but generally very soft to stiff in consistency. The Atterberg limits test results suggest that this cohesive layer was of low to high plasticity.

Laboratory testing performed on selected samples consisted of fourteen (14) moisture content tests, seven (7) grain size distribution test, and five (5) Atterberg limits tests. The test results are as follows:

Moisture Content:

- 22% to 65%

Grain Size Distribution:

- 0% to 3% gravel;
- 1% to 23% sand;
- 19% to 69% silt;
- 22% to 80% clay;

Atterberg Limits:

- Liquid Limit: 27% to 61%
- Plastic Limit: 13% to 27%
- Plasticity Index: 13% to 34%

The results of the moisture content, grain size distribution, and Atterberg limits test are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution test and Atterberg limits test are also provided on Figure 2 and Figure 3, respectively, in Appendix E.

6.2 Groundwater and Surface Water Conditions

Groundwater levels were observed upon completion of the boreholes and in piezometers. Groundwater levels measured on completion of boreholes may not be considered stabilized and therefore may not represent the established long-term average groundwater table. A summary of the groundwater levels observed upon completion of the boreholes and in piezometers are summarized in Table 1.9 and are also presented on the record of borehole sheets in Appendix D.

Table 1.9: Summary of Observed Groundwater Levels

Borehole	Ground Surface Elevation (m)	Water Level Depth/ Elevation (m) ¹	Date Measured	Comments
BH400-050-01	197.0	0.6/196.4	February 6, 2024	Taken upon completion of drilling
BH400-050-02	196.5	0.7/195.8	April 26, 2023	Taken upon completion of drilling
BH400-050-03B	200.7	2.8/197.9	Feb. 2, 2024	In piezometer
BH400-050-04	201.9	---	---	Borehole caved at 5.4 m preventing measurement
BH400-050-05	201.9	4.3/197.6	Feb. 15, 2023	Taken upon completion of drilling

Note:

1. Depths are relative to ground surface

The measured elevations of the top of creek water at the existing CSP culvert location was Elev. 196.7 m at the inlet (measured on April 26, 2023) and Elev. 195.8 m at the outlet (measured on February 13, 2023).

Groundwater levels would be expected to reflect levels in the adjacent open water and to fluctuate seasonally. Seasonal variations in the water table should be expected, with higher levels occurring during wetter periods of the year and lower levels during drier periods.

6.3 Chemical Analysis

One soil sample was selected for chemical analysis during the current investigations performed by EXP. The soil sample collected by EXP was tested at a CALA-certified and accredited laboratory. The results of the corrosion potential chemical analysis testing including sulfide, chloride, sulfate, pH, electrical conductivity, resistivity and redox potential are included in Appendix E and summarized in Table 1.10.

Table 1.10: Summary of chemical analysis results

Borehole ID	Sample	Depth (m)	Chloride (ppm)	Sulphate (ppm)	pH	Electrical Conductivity (umho/cm)	Resistivity (ohm-cm)	Redox Potential (mV)
BH400-050-01	SS3	1.5 – 2.1	<20	35	8.08	181	5500	85

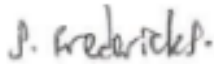
7.0 CLOSURE

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

Contractors bidding on or undertaking any proposed work at this site should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as their own interpretations of the factual results provided herein, so they may draw their own conclusions as to how the subsurface conditions may affect them.

This Foundation Investigation and Design Report has been prepared by Daniel Mroz, M.E.Sc., EIT, Stephen Fredericks, M.Eng., P.Eng., and Nimesh Tamrakar, M.Eng., P.Eng. It was reviewed by TaeChul Kim, M.E.Sc., P.Eng. and by Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact. The field investigation was supervised by Stephen Fredericks, M.Eng., P.Eng.

EXP Services Inc.



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 Designated MTO Foundation Contact



8.0 REFERENCES

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Ministry of Northern Development and Mines Map 2544. Bedrock Geology of Ontario, Southern Sheet, 1991

Ministry of Transportation, May 2007. MTO Gravity Pipe Design Guidelines. Circular Culverts and Storm Sewers.

Ministry of Transportation, October 2022. Guideline for MTO Foundation Engineering Services, Version 03

ASTM International:

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

Ontario Water Resources Act:

R.R.O 1990, Regulation 903 Wells, under Ontario Water Resources Act, R.S.O. 1990, c. O.40

Ontario Occupational Health and Safety Act (OHSA):

Ontario Regulation 213/91 Construction Projects

9.0 LIMITATIONS AND USE OF REPORT

BASIS OF REPORT

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

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

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

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

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

RELIANCE ON INFORMATION PROVIDED

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to EXP by the Client and others. The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client. EXP has relied in good faith upon such representations, information and instructions and accepts no responsibility

*Foundation Investigation Report
Highway 400 CSP Culvert Replacement (CV-0252-0400-0050)
GWP 2044-23-00
Assignment No. 2020-E-0028
Date: April 30, 2024*

for any deficiency, misstatement or inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions expressed in the Report are only valid to the extent that there has been no material alteration to or variation from any of the information provided to EXP.

STANDARD OF CARE

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

COMPLETE REPORT

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

USE OF REPORT

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

REPORT FORMAT

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

Appendix A – Site Photographs



Photograph 1: Inside of existing CSP culvert at inlet side (taken by MTO)



Photograph 2: Inside of existing CSP culvert at outlet side (taken by MTO)



Photograph 3. Condition of culvert at inlet (facing northeast) – February 6, 2024 (taken by EXP)



Photograph 4: Condition of culvert at outlet (facing northeast) – April 26, 2023 (taken by EXP)



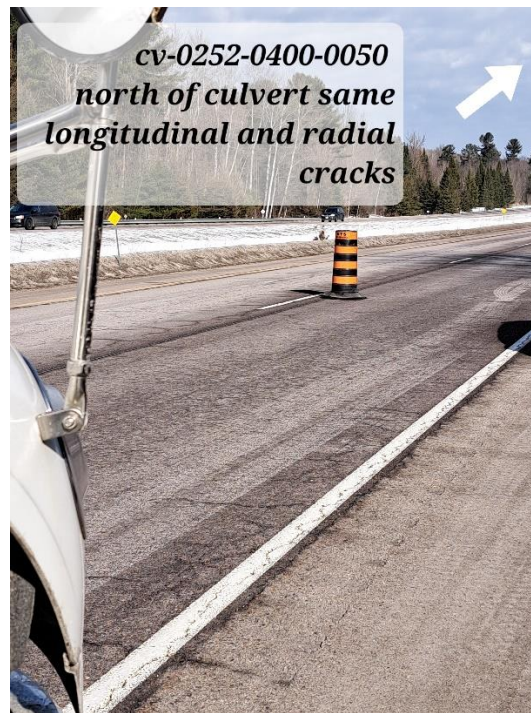
Photograph 5. Embankment side slope at inlet/west side of culvert (facing south)– February 6, 2024 (taken by EXP)



Photograph 6. Embankment side slope at outlet/east side of culvert (facing east)– Feb. 13, 2023 (taken by EXP)



Photograph 7. Typical roadway surface condition (facing north)— Feb. 13, 2023 (taken by EXP)



Photograph 8. Typical roadway surface condition, north of culvert (facing north)— Feb. 13, 2023 (taken by EXP)



Photograph 9. Typical shoulder surface condition (facing south)– Feb. 13, 2023 (taken by EXP)



Photograph 10. Drilling of borehole BH400-050-01 (facing northwest) – February 6, 2024 (taken by EXP)

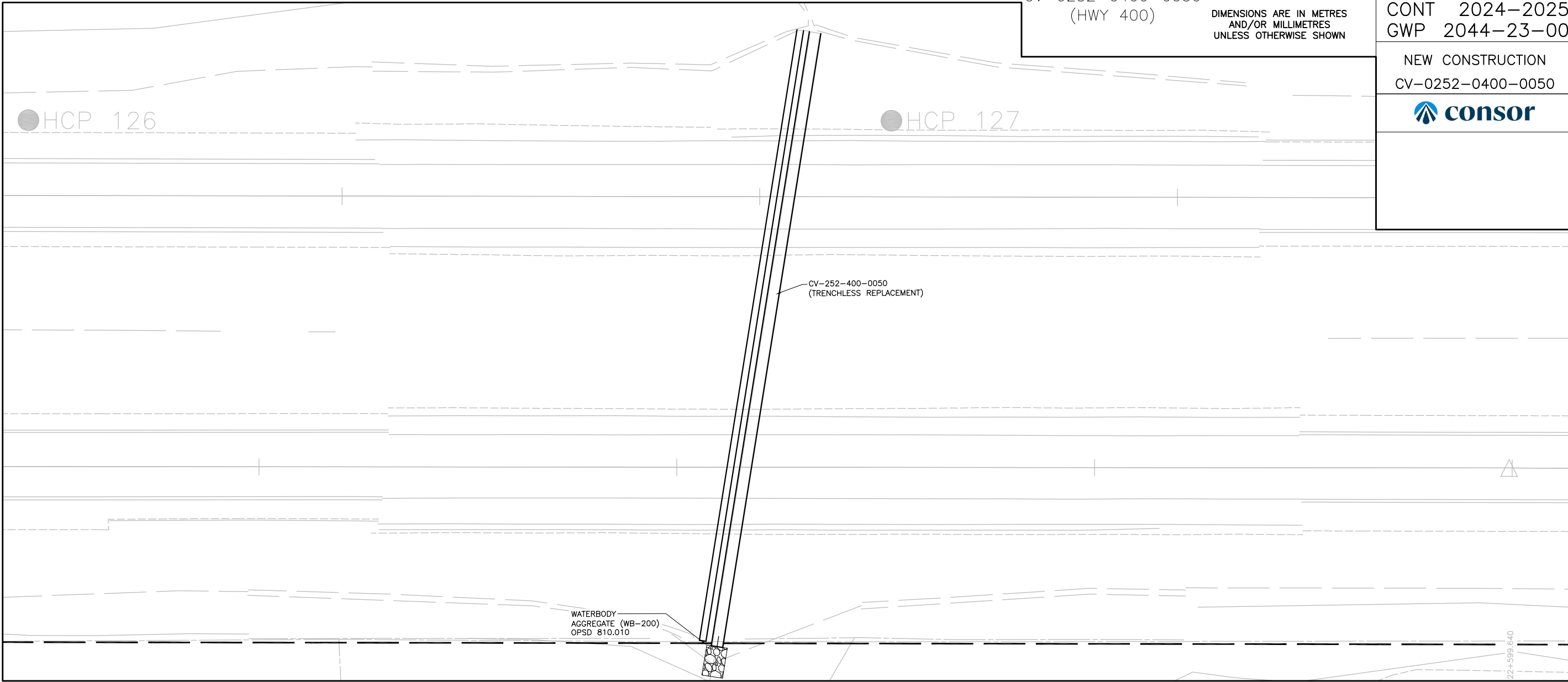


Photograph 11. Drilling of borehole BH400-050-02 (facing west) – February 6, 2024 (taken by EXP)

Appendix B – 90% Contract Drawings

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DATE PLOTTED: 4/4/2024 11:33:48 AM BY: RMISTRY

MINISTRY OF TRANSPORTATION, ONTARIO
ANSI-D
2014-10



CV-0252-0400-0050
(HWY 400)

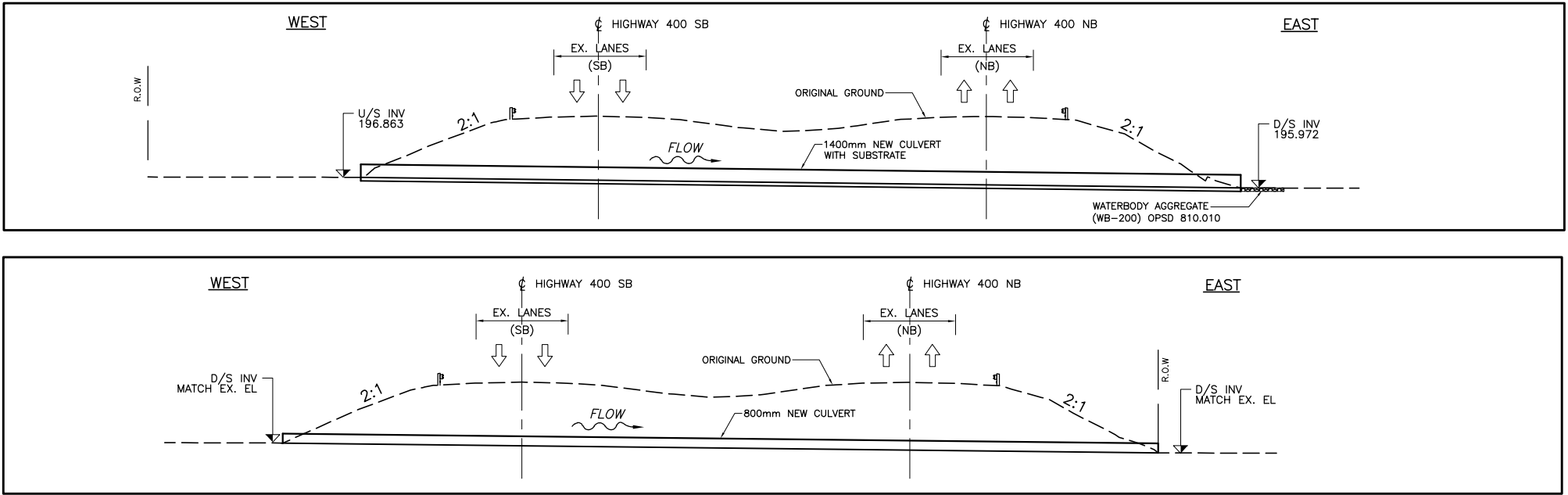
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
CONT 2024-2025
GWP 2044-23-00

NEW CONSTRUCTION
CV-0252-0400-0050



SHEET
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LEGEND

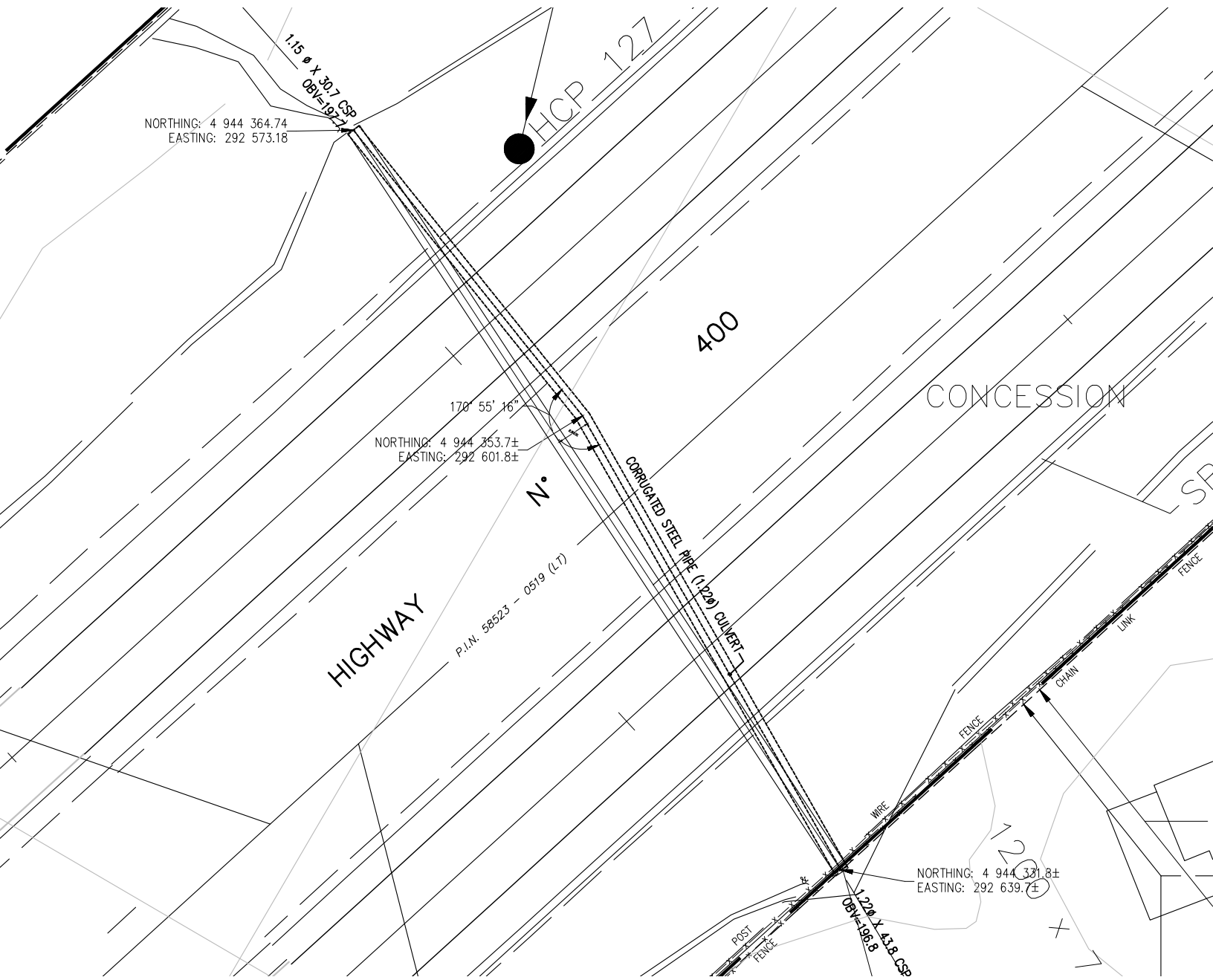
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- CULVERT REPLACEMENT
- CURB AND GUTTER
- GUIDELINE
- LIGHT-DUTY SILT FENCE BARRIER
- FLOW DIRECTION
- BOTTOM OF DITCH
- TOE OF SLOPE
- MTO ROW
- FENCE LINE

NOTES:

- 333, 363, 393, DENOTES PAVEMENT MARKING SPACING (ie., 3 m line, 3 m gap, 3 m line)
- Use ① to Denote PAVEMENT MARKING
- Use [1] to Denote PAVEMENT MARKING, TEMPORARY
- Use △ to Denote PAVEMENT MARKING, TEMPORARY- REMOVABLE
- Use ① to Denote PAVEMENT MARKING, DURABLE
- FROST TAPERS are based on OPSD 803.030, 803.031

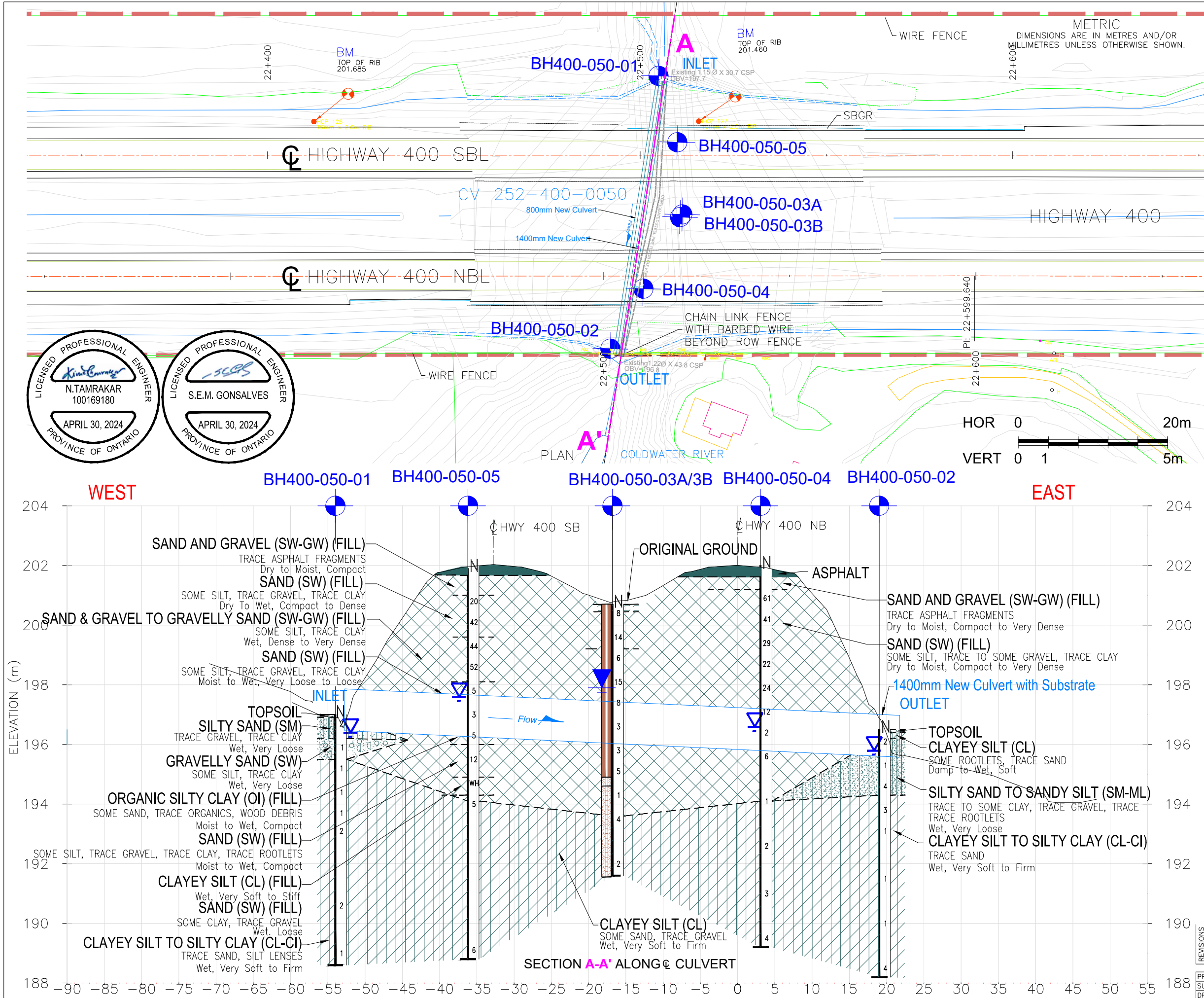
1	SOLID YELLOW,10cm
2	SOLID DOUBLE YELLOW,10cm
3	363 BROKEN YELLOW,10cm
4	SOLID YELLOW,10cm
5	SOLID WHITE,10cm
6	333 BROKEN WHITE,10cm
7	363 BROKEN WHITE,10cm
8	393 BROKEN WHITE,10cm
9	SOLID WHITE,20cm
10	111 BROKEN WHITE,20cm
11	333 BROKEN WHITE,20cm
12	333 BROKEN WHITE ,30cm
13	SOLID WHITE,30cm
14	SOLID WHITE,45cm
15	SOLID WHITE,60cm
20	SYMBOLS
] [LIMITS OF MARKINGS	

SCALE
5m 0 10m




Appendix C – Borehole Location Plan and Soil Strata


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MODIFIED: 2024-04-30 15:01




ASSIG No. 2020-E-0028
GWP No. 2111-19-00







SHEET
1

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CV-252-400-0050
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BOREHOLE LOCATION PLAN & SOIL STRATA







 **EXP SERVICES INC.**


KEY PLAN
N.T.S.

LEGEND

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

SOIL STRATA SYMBOLS

 TOPSOIL	 GRAVELLY SAND
 ASPHALT	 CLAYEY SILT/ SILTY CLAY
 FILL	 SILTY SAND TO SANDY SILT

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

BH No.	ELEV.	NORTHING	EASTING
BH400-050-01	197.0	4944363.7	292571.1
BH400-050-02	196.5	4944329.5	292637.1
BH400-050-03A	200.7	4944358.7	292608.5
BH400-050-03B	200.7	4944357.9	292609.0
BH400-050-04	201.9	4944342.0	292624.1
BH400-050-05	201.9	4944363.2	292589.6

NOTES

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

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

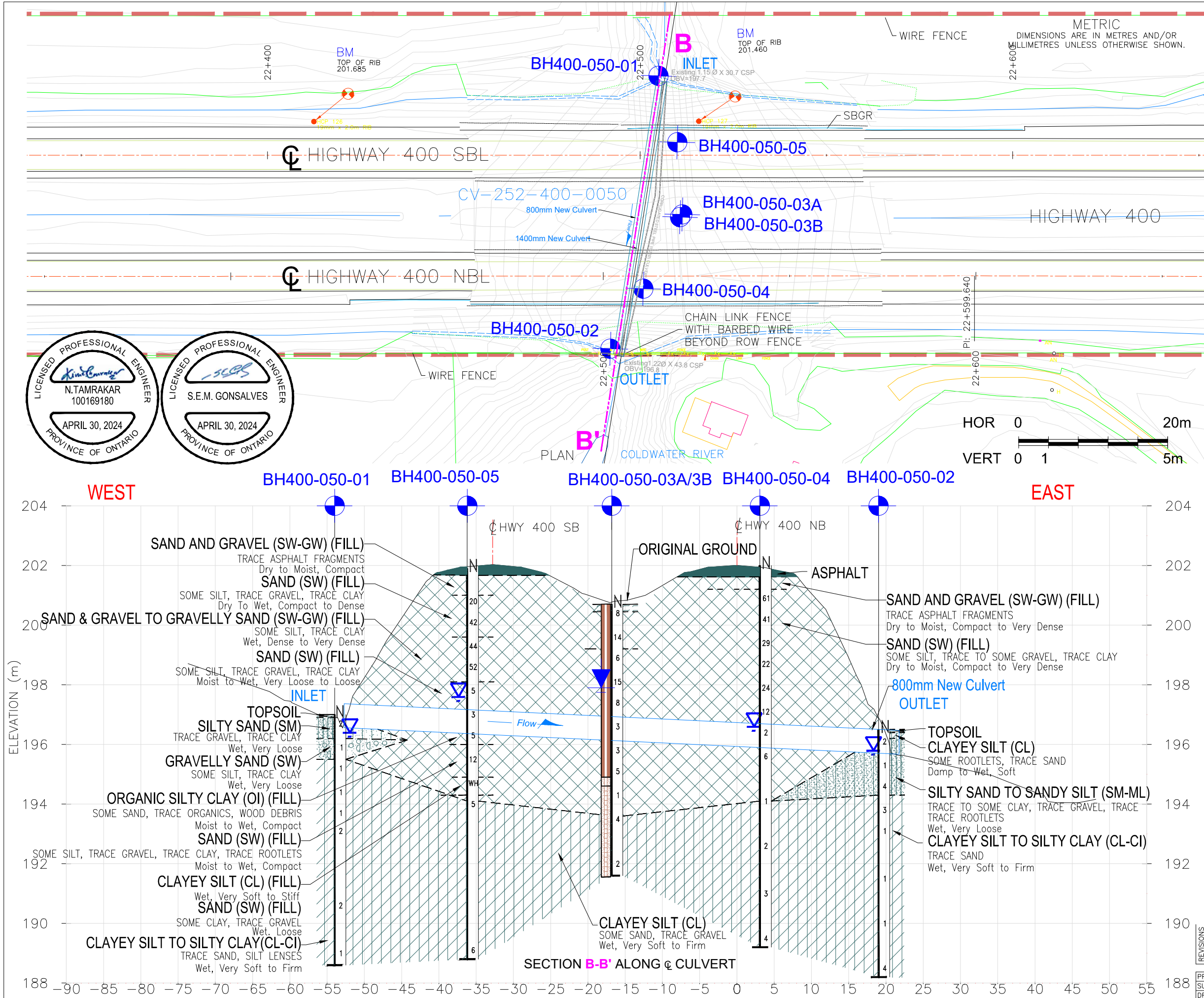
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in the report and related documents are specifically excluded in accordance with the conditions of Section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

REVISIONS


NO	DATE	BY	DESCRIPTION

PROJECT No.	ADM-22007871-A0	GEOCRES No.	31D12-002
SUBM'D SH	CHKD. DM	DATE	APRIL 30, 2024 SITE-
DRAWN SH	CHKD. TC	APPRD	SG DWG 01


FILE NAME: I:\2003-Brampton\Proposals\Projects\International\WTO 2020-E-0028 25 culverts\working drawings\CAD drafting\CV-252-400-0050_Borehole location plan & soil strata.dwg
MODIFIED: 2024-04-30 15:01




ASSIG No. 2020-E-0028
GWP No. 2111-19-00







SHEET
2

HIGHWAY 400 CULVERT REPLACEMENT, SIMCOE, ON
CV-252-400-0050
Latitude: 44.639180° Longitude: -79.654120°
BOREHOLE LOCATION PLAN & SOIL STRATA







 **EXP SERVICES INC.**


KEY PLAN
N.T.S.

LEGEND

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

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 TOPSOIL	 GRAVELLY SAND
 ASPHALT	 CLAYEY SILT/ SILTY CLAY
 FILL	 SILTY SAND TO SANDY SILT

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

BH No.	ELEV.	NORTHING	EASTING
BH400-050-01	197.0	4944363.7	292571.1
BH400-050-02	196.5	4944329.5	292637.1
BH400-050-03A	200.7	4944358.7	292608.5
BH400-050-03B	200.7	4944357.9	292609.0
BH400-050-04	201.9	4944342.0	292624.1
BH400-050-05	201.9	4944363.2	292589.6

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

REVISIONS

NO	DATE	BY	DESCRIPTION

SUBMISSION FOR MTO REVIEW

PROJECT No.	ADM-22007871-A0	GEOCRES No.	31D12-002
SUBM'D SH	CHKD. DM	DATE	APRIL 30, 2024 SITE-
DRAWN SH	CHKD. TC	APPRD	SG DWG 02

Appendix D – Borehole Logs

Explanation of Terms Used on Borehole Records

SOIL DESCRIPTION

Terminology describing common soil genesis:

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

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

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

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

Terminology describing soil structure:

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

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

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

Fissured: material breaks along plane of fracture.

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

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

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

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

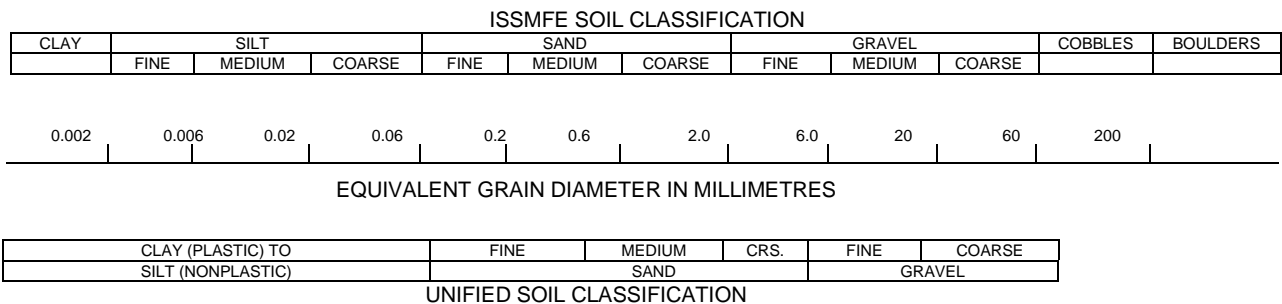
Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

Homogeneous: same color and appearance throughout.

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

Uniformly Graded: predominantly on grain size.

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



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

Table a: Percent or Proportion of Soil

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

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

Table b: Apparent Density of Cohesionless Soil

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

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

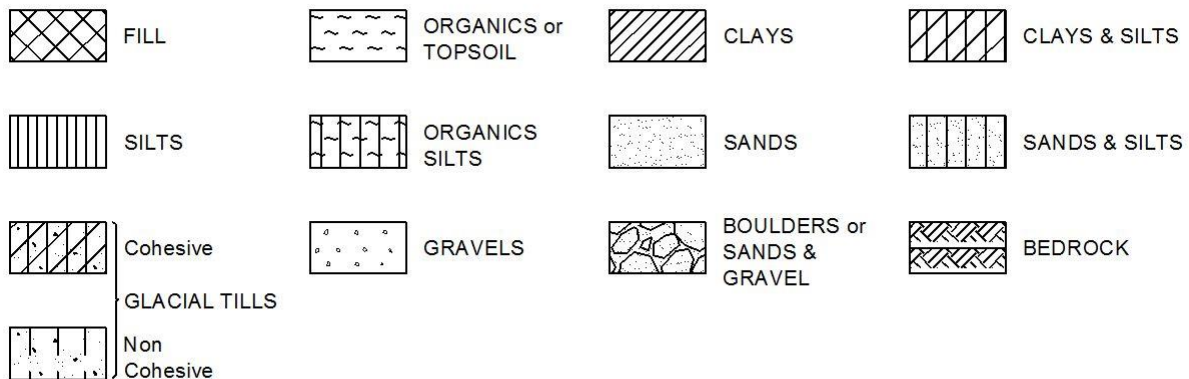
Table c: Consistency of Cohesive Soil

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

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

STRATA PLOT

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



WATER LEVEL MEASUREMENT



Open Borehole or Test Pit



Monitoring Well, Piezometer or Standpipe

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

Brampton, Ontario

RECORD OF BOREHOLE No BH400-050-01

1 OF 1

METRIC

W.P. GWP-2044-23-00 LOCATION CV-0252-0400-0050, Simcoe County, ON, MTM ON-10 292571.1E 4944363.7N ORIGINATED BY OD
DIST Simcoe HWY 400 BOREHOLE TYPE Manual Drilling/SPT/Solid Stem Auger COMPILED BY DM
DATUM Geodetic DATE 2023.04.27 - 2023.04.27 LATITUDE 44.639176 LONGITUDE -79.654148 CHECKED BY NT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE LIQUID LIMIT CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
197.0								20 40 60 80 100		20 40 60				
196.6	TOPSOIL, ~100 mm thick		SS1	SPT	2									
196.2	SILTY SAND (SM), trace gravel, trace clay, dark brown, wet, very loose													
196.2			SS2	SPT	1									
195.5	GRAVELLY SAND(SW), some silt, trace clay, grey, wet, very loose													
195.5			SS3	SPT	1									
195.5														
195.5			SS4	SPT	1									
195.5			FV1	VANE										
195.5			SS5	SPT	1									
195.5			SS6	SPT	2									
195.5														
195.5			FV2	VANE										
195.5														
195.5			SS7	SPT	2									
195.5			FV3	VANE										
195.5														
195.5			SS8	SPT	1									
195.5			FV4	VANE										
195.5														
188.6	END OF BOREHOLE													
8.4	NOTE: 1) Groundwater was encountered at a depth of 0.6 m in open borehole upon completion of drilling.													

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

ONTARIO MTO CV-0252-0400-0050.GPJ ONTARIO MTO.GDT 4/30/24




Brampton, Ontario

RECORD OF BOREHOLE No BH400-050-02

1 OF 1

METRIC

W.P. GWP-2044-23-00 LOCATION CV-0252-0400-0050, Simcoe County, ON, MTM ON-10 292637.1E 4944329.5N ORIGINATED BY OD
 DIST Simcoe HWY 400 BOREHOLE TYPE Manual Drilling/SPT/Solid Stem Auger COMPILED BY DM
 DATUM Geodetic DATE 2023.04.26 - 2023.04.26 LATITUDE 44.638869 LONGITUDE -79.653315 CHECKED BY NT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _P W W _L					WATER CONTENT (%)	
								20 40 60 80 100								
								20 40 60 80 100								
196.5	TOPSOIL , ~100 mm thick CLAYEY SILT(CL) , some rootlets, trace sand, dark brown, damp to wet, soft SILTY SAND TO SANDY SILT (SM-ML) , trace to some clay, trace gravel, trace rootlets, dark brown to dark grey to black, wet, very loose		SS1	SPT	2		196								0 8 62 30	
196.4																
196.2																
0.3																
			SS2	SPT	1											
								195								
			SS3	SPT	4											
194.3	CLAYEY SILT TO SILTY CLAY (CL-CI) , trace sand, grey, wet, very soft to firm		SS4	SPT	3		194									
2.2																
				FV1	VANE											
				SS5	SPT	1		193								
				SS6	SPT	1		192								
			FV2	VANE			191									
			SS7	SPT	1		190									
			FV3	VANE												
							189									

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

Brampton, Ontario

RECORD OF BOREHOLE No BH400-050-03A

1 OF 1

METRIC

W.P. GWP-2044-23-00 LOCATION CV-0252-0400-0050, Simcoe County, ON, MTM ON-10 292608.5E 4944358.7N ORIGINATED BY SF
 DIST Simcoe HWY 400 BOREHOLE TYPE Track Mounted M51 5T98-09/Solid Stem Augers COMPILED BY DM
 DATUM Geodetic DATE 2023.02.14 - 2023.02.14 LATITUDE 44.639132 LONGITUDE -79.653676 CHECKED BY NT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
200.7								20	40	60	80	100						
200.9	TOPSOIL ~250 mm thick		SS1	SPT	8													
0.3	CLAYEY SILT (CL) (FILL), trace sand, trace rootlets, brown to grey, wet, stiff		SS2	SPT	14													
199.2																		
1.5	SAND (SW) (FILL), some silt, trace gravel, trace clay, brown to grey to black, wet, loose to compact - possible cobble encountered at a depth of 2.0 m - trace rootlets encountered between a depth of 3.0 m and 4.4 m - becoming very loose to loose below a depth of 3.8 m		SS3	SPT	6													
			SS4	SPT	15													
			SS5	SPT	8													
			SS6	SPT	3													
			SS7	SPT	3													
			SS8	SPT	5													
			SS9	SPT	1													
193.6																		
7.1	CLAYEY SILT (CL), some sand, grey, wet, soft to stiff		SS10	SPT	4													
			FV1	VANE														
			SS11	SPT	2													
191.6																		
9.1	END OF BOREHOLE		FV2	VANE														
	NOTE: 1) Groundwater could not be measured due to snow melt entering borehole during drilling. 2) Borehole abandoned due to filling up with water which prevented advancement of borehole. A companion borehole (BH400-050-03B) was drilled approximately 1.0 m southeast of borehole BH400-050-03A.																	

ONTARIO MTO CV-0252-0400-0050.GPJ ONTARIO MTO.GDT 4/30/24

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

Brampton, Ontario

RECORD OF BOREHOLE No BH400-050-03B 1 OF 1 METRIC

W.P. GWP-2044-23-00 LOCATION CV-0252-0400-0050, Simcoe County, ON, MTM ON-10 292609.0E 4944357.9N ORIGINATED BY SF
 DIST Simcoe HWY 400 BOREHOLE TYPE Track Mounted M51 5T98-09/Solid Stem Augers COMPILED BY DM
 DATUM Geodetic DATE 2023.02.14 - 2023.02.14 LATITUDE 44.639124 LONGITUDE -79.65367 CHECKED BY NT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								20 40 60 80 100				W _P W W _L				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL P. PENETROMETER									
200.7 0.0	- continuation of BH400-050-03A - solid stem augering to a depth of 9.1 m															
191.6 9.1	CLAYEY SILT(CL), some sand, grey, wet, soft		SS12	SPT	3											
190.3 10.4			SS13	SPT	2											
END OF BOREHOLE																
NOTE: 1) Monitoring Well Readings Date Depth Elev. Feb 2/2024 2.8 197.9																

ONTARIO MTO CV-0252-0400-0050.GPJ ONTARIO MTO.GDT 4/30/24

Brampton, Ontario

1 OF 1

METRIC

W.P.	GWP-2044-23-00	LOCATION	CV-0252-0400-0050, Simcoe County, ON, MTM ON-10 292624.1E 4944342.0N			ORIGINATED BY	SF			
DIST	Simcoe	HWY	400	BOREHOLE TYPE	B-53 Explorer Truck Drill/Solid Stem Auger		COMPILED BY	DM		
DATUM	Geodetic		DATE	2023.02.13 - 2023.02.13	LATITUDE	44.638982	LONGITUDE	-79.65348	CHECKED BY	NT

[illegible]

ONTARIO MTO CV-0252-0400-0050.GPJ ONTARIO MTO.GDT 4/30/24

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

Brampton, Ontario

RECORD OF BOREHOLE No BH400-050-05

1 OF 1

METRIC

W.P. GWP-2044-23-00 LOCATION CV-0252-0400-0050, Simcoe County, ON, MTM ON-10 292589.6E 4944363.2N ORIGINATED BY SF
 DIST Simcoe HWY 400 BOREHOLE TYPE Truck Mounted M5T 94/Solid Stem Augers COMPILED BY DM
 DATUM Geodetic DATE 2023.02.15 - 2023.02.15 LATITUDE 44.639172 LONGITUDE -79.653915 CHECKED BY NT

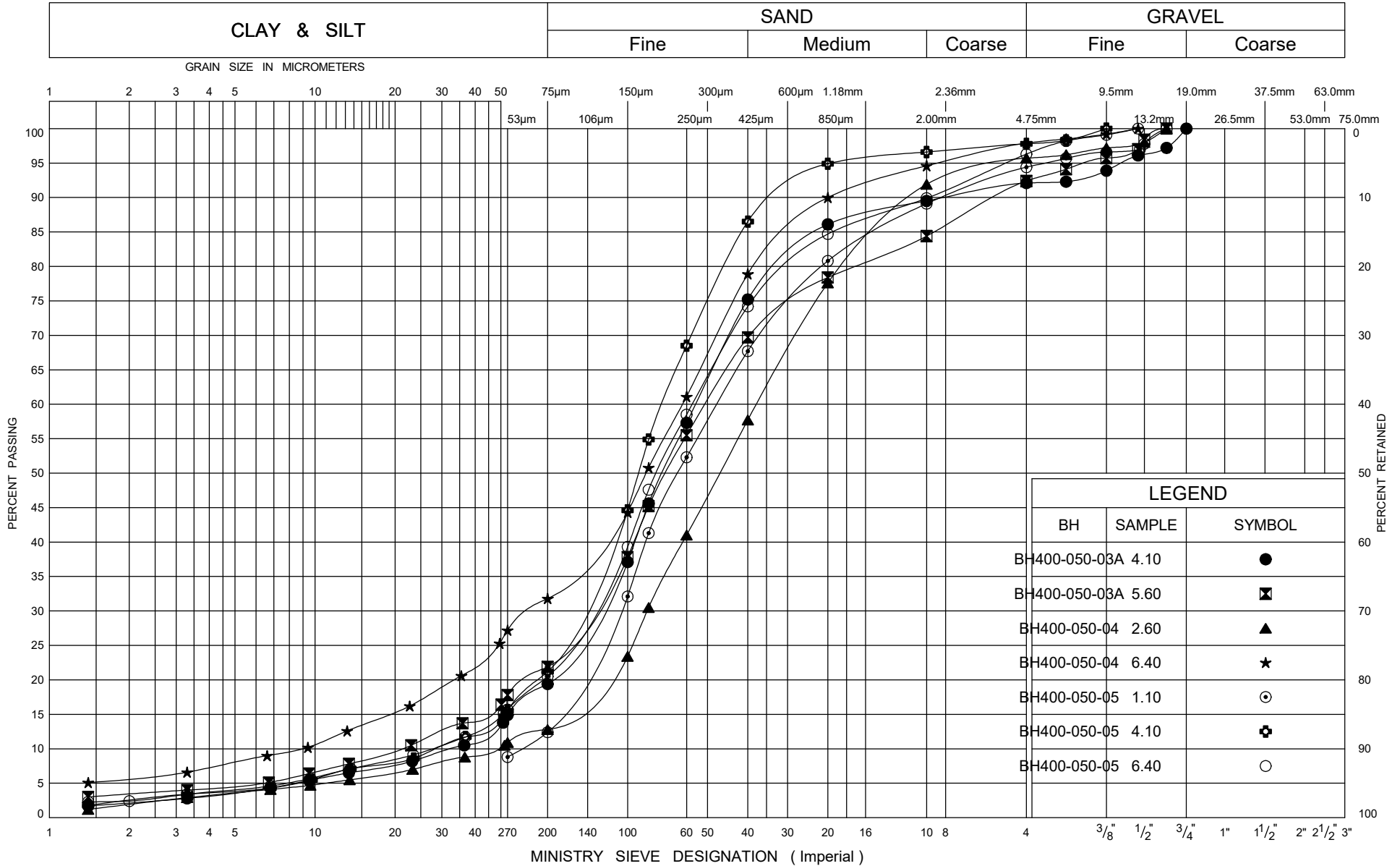
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL & P. PENETROMETER													
201.9								20	40	60	80	100		20	40	60		GR	SA	SI	CL
200.9	ASPHALT, 225 mm thick																				
0.2	SAND AND GRAVEL(SW-GW) (FILL), trace asphalt fragments, grey to black, dry to moist, compact		AS1	AUGER																	
201.0							201											6	82	(12)	
0.9	SAND (SW) (FILL), some silt, trace gravel, trace clay, grey to brown, dry to wet, compact to dense		SS2	SPT	20																
			SS3	SPT	42		200														
199.6																					
2.3	SAND AND GRAVEL TO GRAVELLY SAND (SW-GW) (FILL), some silt, trace clay, grey to brown, wet, dense to very dense		SS4	SPT	44		199														
	- becoming dry below a depth of 3.2 m		SS5	SPT	52																
198.1							198														
3.8	SAND(SW) (FILL), some silt, trace gravel, trace clay, moist to wet, very loose to loose		SS6	SPT	5																
			SS7	SPT	3		197														
196.2			SS8	SPT	5																
196.0	ORGANIC SILTY CLAY(OI) (FILL), some sand, trace organics, wood debris, black, moist, firm						196														
5.9	SAND(SW) (FILL), some silt, trace gravel, trace clay, trace rootlets, brown to black, moist to wet, compact		SS9	SPT	12																
194.9							195														
7.0	CLAYEY SILT(CL) (FILL), brown to grey, wet, very soft to stiff		SS10	SPT	WH																
194.3			FV1	VANE						1.7											
194.6	SAND(SW) (FILL), some clay, trace gravel, grey, wet, loose		SS11	SPT	5		194														
7.8	CLAYEY SILT(CL), trace sand, trace gravel, wet, firm																				
							193														
			ST12	SH																	
			FV2	VANE			192					3.3									
			ST13	SH			191														
			FV3	VANE						1.3											
							190														
			FV4	VANE																	
			SS14	SPT	6		189														
188.8																					
13.1	END OF BOREHOLE																				
	NOTE: 1) Groundwater was encountered at a depth of 4.3 m in open borehole upon completion of drilling.																				

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

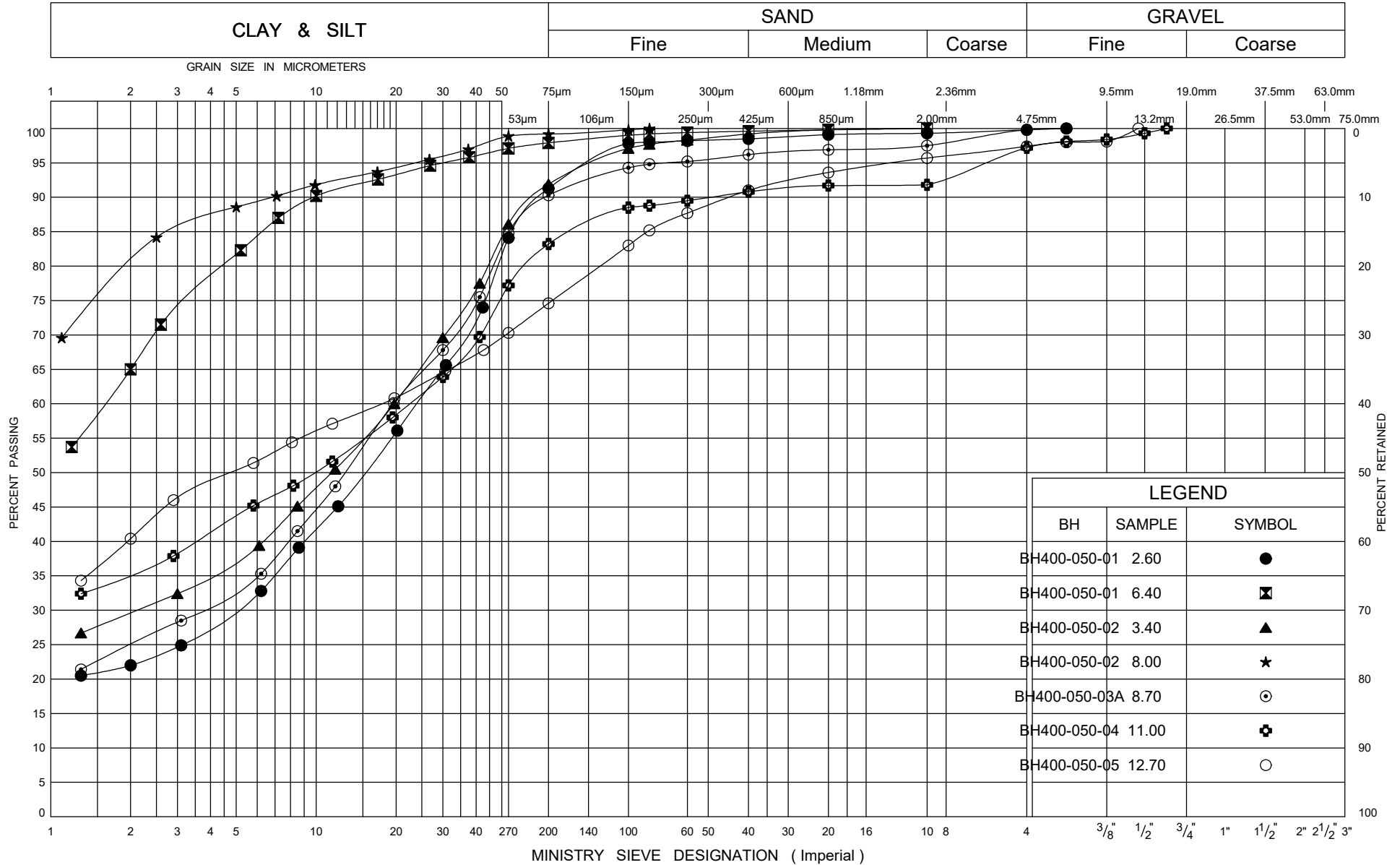
ONTARIO MTO CV-0252-0400-0050.GPJ ONTARIO MTO.GDT 4/30/24

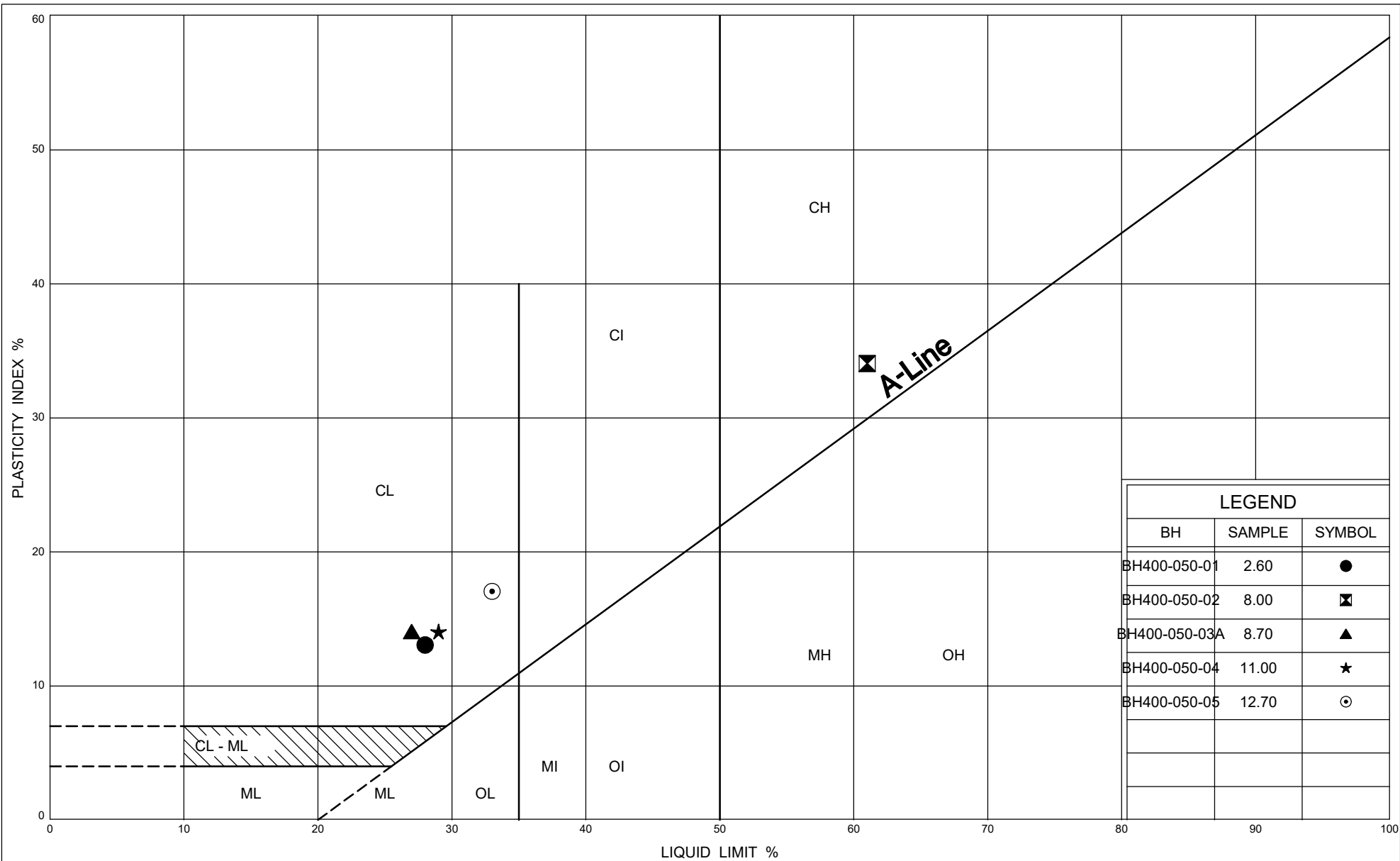
Appendix E – Laboratory Data

UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM





Ministry of
Transportation

PLASTICITY CHART

Clayey Silt to Silty Clay(CL-CI)

FIG No 3

GWP 2111-19-00

Culvert ID CV-0252-0400-0050



Your Project #: ADM-22000797-A0
Site Location: HWY 401 FROM VICTORIA TO NELSON AVE, ON
Your C.O.C. #: 903374-11-01

Attention: Nimesh Tamrakar

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2023/05/04
Report #: R7615044
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C3C0241

Received: 2023/04/28, 11:47

Sample Matrix: Soil
Samples Received: 2

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	2	2023/05/03	2023/05/03	CAM SOP-00463	MOE E3013 m
Conductivity	2	2023/05/03	2023/05/03	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 2)	2	N/A	2023/05/03	AB SOP-00002	CCME PHC-CWS m
Sulphide in Soil (1)	2	N/A	2023/05/03	AB SOP-00080	EPA9030B/SM4500S2-DF
pH CaCl2 EXTRACT	2	2023/05/03	2023/05/03	CAM SOP-00413	EPA 9045 D m
Redox Potential (3)	2	2023/05/02	2023/05/02	CAM SOP-00421	SM 2580 B
Resistivity of Soil	2	2023/04/28	2023/05/04	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	2	2023/05/03	2023/05/03	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, MELCC, EPA, APHA.

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

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

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

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 #: ADM-22000797-A0
Site Location: HWY 401 FROM VICTORIA TO NELSON AVE, ON
Your C.O.C. #: 903374-11-01

Attention: Nimesh Tamrakar

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2023/05/04
Report #: R7615044
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C3C0241

Received: 2023/04/28, 11:47

(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:

Patricia Legette, Project Manager

Email: Patricia.Legette@bureauveritas.com

Phone# (905)817-5799

=====

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.



SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		VRE196			VRE196			VRE197		
Sampling Date		2023/04/27 12:00			2023/04/27 12:00			2023/04/27 12:00		
COC Number		903374-11-01			903374-11-01			903374-11-01		
	UNITS	BH400-050-01-SS3	RDL	QC Batch	BH400-050-01-SS3 Lab-Dup	RDL	QC Batch	BH400-0501-01-SS3	RDL	QC Batch

Calculated Parameters

Resistivity	ohm-cm	5500		8635096				6700		8635096
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CONVENTIONALS

Redox Potential	mV	85	N/A	8640030				170	N/A	8640030
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Inorganics

Soluble (20:1) Chloride (Cl-)	ug/g	<20	20	8642980				<20	20	8642980
Conductivity	umho/cm	181	2	8642849	182	2	8642849	148	2	8642849
Available (CaCl2) pH	pH	8.08		8643146				8.37		8643146
Soluble (20:1) Sulphate (SO4)	ug/g	35	20	8642987				45	20	8642987
Sulphide	mg/kg	21.9 (1)	0.5	8647012				68 (1)	5	8647012

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

N/A = Not Applicable

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



RESULTS OF ANALYSES OF SOIL

Bureau Veritas ID		VRE196	VRE197		
Sampling Date		2023/04/27 12:00	2023/04/27 12:00		
COC Number		903374-11-01	903374-11-01		
	UNITS	BH400-050-01-SS3	BH400-0501-01-SS3	RDL	QC Batch
Physical Testing					
Moisture-Subcontracted	%	28	21	0.30	8647043
RDL = Reportable Detection Limit					
QC Batch = Quality Control Batch					



TEST SUMMARY

Bureau Veritas ID: VRE196
Sample ID: BH400-050-01-SS3
Matrix: Soil

Collected: 2023/04/27
Shipped:
Received: 2023/04/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	8642980	2023/05/03	2023/05/03	Massarat Jan
Conductivity	AT	8642849	2023/05/03	2023/05/03	Gurparteek KAUR
Moisture (Subcontracted)	BAL	8647043	N/A	2023/05/03	Ashley Henderson
Sulphide in Soil	SPEC	8647012	N/A	2023/05/03	Princess Nicole Hernaez
pH CaCl2 EXTRACT	AT	8643146	2023/05/03	2023/05/03	Surinder Rai
Redox Potential	COND	8640030	2023/05/02	2023/05/02	Gurparteek KAUR
Resistivity of Soil		8635096	2023/05/04	2023/05/04	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	8642987	2023/05/03	2023/05/03	Massarat Jan

Bureau Veritas ID: VRE196 Dup
Sample ID: BH400-050-01-SS3
Matrix: Soil

Collected: 2023/04/27
Shipped:
Received: 2023/04/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	8642849	2023/05/03	2023/05/03	Gurparteek KAUR

Bureau Veritas ID: VRE197
Sample ID: BH400-0501-01-SS3
Matrix: Soil

Collected: 2023/04/27
Shipped:
Received: 2023/04/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	8642980	2023/05/03	2023/05/03	Massarat Jan
Conductivity	AT	8642849	2023/05/03	2023/05/03	Gurparteek KAUR
Moisture (Subcontracted)	BAL	8647043	N/A	2023/05/03	Ashley Henderson
Sulphide in Soil	SPEC	8647012	N/A	2023/05/03	Princess Nicole Hernaez
pH CaCl2 EXTRACT	AT	8643146	2023/05/03	2023/05/03	Surinder Rai
Redox Potential	COND	8640030	2023/05/02	2023/05/02	Gurparteek KAUR
Resistivity of Soil		8635096	2023/05/04	2023/05/04	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	8642987	2023/05/03	2023/05/03	Massarat Jan



GENERAL COMMENTS

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

Package 1	-1.0°C
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Results relate only to the items tested.



BUREAU
VERITAS

Bureau Veritas Job #: C3C0241

Report Date: 2023/05/04

QUALITY ASSURANCE REPORT

exp Services Inc

Client Project #: ADM-22000797-A0

Site Location: HWY 401 FROM VICTORIA TO NELSON AVE, ON

Sampler Initials: IB

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8640030	Redox Potential	2023/05/02			102	95 - 105			3.3	35
8642849	Conductivity	2023/05/03			99	90 - 110	<2	umho/cm	0.39	10
8642980	Soluble (20:1) Chloride (Cl-)	2023/05/03	112	70 - 130	91	70 - 130	<20	ug/g	NC	35
8642987	Soluble (20:1) Sulphate (SO4)	2023/05/03	NC	70 - 130	94	70 - 130	<20	ug/g	13	35
8643146	Available (CaCl2) pH	2023/05/03			100	97 - 103			1.6	N/A
8647012	Sulphide	2023/05/03	305 (1)	75 - 125	97	75 - 125	<0.5	mg/kg	NC	30
8647043	Moisture-Subcontracted	2023/05/03					<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)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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



VALIDATION SIGNATURE PAGE

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

Cristina Carriere, Senior Scientific Specialist

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

Suwan (Sze Yeung) Fock, B.Sc., Scientific Specialist

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Bureau Veritas
6740 Campbell Road, Mississauga, Ontario Canada L5N 2L8 Tel: (905) 817-5700 Toll-free: 800-563-6266 Fax: (905) 817-5777 www.bvna.com

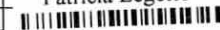
CHAIN OF CUSTODY RECORD

Page of

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:	
Company Name: #17488 exp Services Inc		Company Name: Nimesh Tamrakar		Quotation #: C20328	
Attention: Accounts Payable		Attention: Nimesh Tamrakar		P.O. #:	
Address: 1595 Clark Blvd		Address:		Project: ADM-22000797-A0	
Brampton ON L6T 4V1				Project Name:	
Tel: (905) 793-9800 Fax: (905) 793-0641		Tel: (905) 796-3200 Ext: 3026 Fax:		Site #:	
Email: AP@exp.com; Karen.Burke@exp.com		Email: Nimesh.Tamrakar@exp.com		Sampled By:	

28-Apr-23 11:47

Patricia Legette



C3C0241

RUK ENV-1105

er #:

ager:

gette

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY				ANALYSIS REQUESTED (PLEASE BE SPECIFIC)												Turnaround Time (TAT) Required: Please provide advance notice for rush projects									
Regulation 153 (2011) <input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Medium/Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> For RSC <input type="checkbox"/> Table <input type="checkbox"/>				Other Regulations <input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> Reg 558 <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> MISA Municipality <input type="checkbox"/> PWQO <input type="checkbox"/> Reg 406 Table <input type="checkbox"/> Other				Special Instructions				Field Filtered (please circle): Metals / Hg / Cr VI <i>consistency</i>												Regular (Standard) TAT: (will be applied if Rush TAT is not specified): Standard TAT = 5-7 Working days for most tests. Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details. Job Specific Rush TAT (if applies to entire submission) Date Required: Time Required: Rush Confirmation Number: (call lab for #)	
Include Criteria on Certificate of Analysis (Y/N)?																# of Bottles		Comments							
Sample Barcode Label		Sample (Location) Identification		Date Sampled		Time Sampled		Matrix																	
1		BH 400-050-01-SS3		APR 27/23		12:00																			
2		BH 400-0501-01-SS3		APR 27/23		12:00																			
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									

* RELINQUISHED BY: (Signature/Print)		Date: (YY/MM/DD)		Time		RECEIVED BY: (Signature/Print)		Date: (YY/MM/DD)		Time		# jars used and not submitted		Laboratory Use Only		Custody Seal		Yes		No	
Ivon Barup		APR 28/23		12:00		[Signature]		APR 29/23		11:47				Time Sensitive		Temperature (°C) on Reel		Present			
																-11-11-1		Intact			

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/COC-TERMS-AND-CONDITIONS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/CHAIN-CUSTODY-FORMS-COCS.

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

White: Bureau Veritas Yellow: Client



Your Project #: Campobello job# C3C0241

Attention: Patricia Legette

BUREAU VERITAS
CAMPOBELLO
6740 CAMPOBELLO ROAD
MISSISSAUGA, ON
CANADA L5N 2L8

Report Date: 2023/05/04

Report #: R3331578

Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C329984

Received: 2023/05/02, 11:00

Sample Matrix: Soil
Samples Received: 2

Analyses	Date		Date Analyzed	Laboratory Method	Analytical Method
	Quantity	Extracted			
Moisture	2	N/A	2023/05/03	AB SOP-00002	CCME PHC-CWS m
Sulphide	2	2023/05/02	2023/05/03	AB SOP-00080	EPA9030B/SM4500S2-DF

Remarks:

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

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

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

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

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.



Your Project #: Campobello job# C3C0241

Attention: Patricia Legette

BUREAU VERITAS
CAMPOBELLO
6740 CAMPOBELLO ROAD
MISSISSAUGA, ON
CANADA L5N 2L8

Report Date: 2023/05/04

Report #: R3331578

Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C329984

Received: 2023/05/02, 11:00

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Customer Solutions, Western Canada Customer Experience Team
Email: customersolutionswest@bvlabs.com
Phone# (403) 291-3077

=====

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

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RESULTS OF CHEMICAL ANALYSES OF SOIL

Bureau Veritas ID		BPO906		BPO908		
Sampling Date		2023/04/27 12:00		2023/04/27 12:00		
	UNITS	BH400-050-01-SS3	RDL	BH400-0501-01-SS3	RDL	QC Batch
Misc. Inorganics						
Sulphide	mg/kg	21.9 (1)	0.5	68 (1)	5	A949891
RDL = Reportable Detection Limit						
(1) Sample contained greater than 10% headspace at time of extraction.						



BUREAU
VERITAS

Bureau Veritas Job #: C329984

Report Date: 2023/05/04

BUREAU VERITAS

Client Project #: Campobello job# C3C0241

Sampler Initials: IB

PHYSICAL TESTING (SOIL)

Bureau Veritas ID		BPO906	BPO908		
Sampling Date		2023/04/27 12:00	2023/04/27 12:00		
	UNITS	BH400-050-01-SS3	BH400-0501-01-SS3	RDL	QC Batch
Physical Properties					
Moisture	%	28	21	0.30	A950729
RDL = Reportable Detection Limit					



BUREAU
VERITAS

Bureau Veritas Job #: C329984

Report Date: 2023/05/04

BUREAU VERITAS

Client Project #: Campobello job# C3C0241

Sampler Initials: IB

TEST SUMMARY

Bureau Veritas ID: BPO906
Sample ID: BH400-050-01-SS3
Matrix: Soil

Collected: 2023/04/27
Shipped:
Received: 2023/05/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL	A950729	N/A	2023/05/03	Ashley Henderson
Sulphide	SPEC	A949891	2023/05/02	2023/05/03	Princess Nicole Hernaez

Bureau Veritas ID: BPO908
Sample ID: BH400-0501-01-SS3
Matrix: Soil

Collected: 2023/04/27
Shipped:
Received: 2023/05/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL	A950729	N/A	2023/05/03	Ashley Henderson
Sulphide	SPEC	A949891	2023/05/02	2023/05/03	Princess Nicole Hernaez



**BUREAU
VERITAS**

Bureau Veritas Job #: C329984

Report Date: 2023/05/04

BUREAU VERITAS

Client Project #: Campobello job# C3C0241

Sampler Initials: IB

GENERAL COMMENTS

Results relate only to the items tested.



BUREAU
VERITAS

Bureau Veritas Job #: C329984

Report Date: 2023/05/04

QUALITY ASSURANCE REPORT

BUREAU VERITAS

Client Project #: Campobello job# C3C0241

Sampler Initials: IB

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
A949891	Sulphide	2023/05/03	305 (1)	75 - 125	97	75 - 125	<0.5	mg/kg	NC	30
A950729	Moisture	2023/05/03					<0.30	%	4.1	20

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

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NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference $\leq 2 \times \text{RDL}$).

(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 #: C329984

Report Date: 2023/05/04

BUREAU VERITAS

Client Project #: Campobello job# C3C0241

Sampler Initials: IB

VALIDATION SIGNATURE PAGE

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

Suwan (Sze Yeung) Fock, B.Sc., Scientific Specialist

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

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