FINAL REPORT

Foundation Investigation Report

Replacement of Structural Culvert 11X-0423/C0
Highway 401/Wallbridge-Loyalist Road Interchange, Belleville, Ontario
MTO GWP 4053-18-00; WP 4097-20-01; Agreement 4020-E-0012

Submitted to:

Ministry of Transportation Ontario
1355 John Counter Boulevard
Kingston, Ontario K7K 0E5

Submitted by:

WSP Canada Inc.
1931 Robertson Road, Ottawa, Ontario K2H 5B7

GEOCRES No.: 31C-318
Latitude: 44.178390°
Longitude: -77.449930°

20148061B (4200)-R4

August 22, 2024

Distribution List

1 e-copy: MTO Eastern Region

1 e-copy: MTO Foundations Section

1 e-copy: WSP Canada Inc.

Table of Contents

APPENDICES

1.0 INTRODUCTION

WSP Canada Inc. (WSP, formerly Golder Associates Ltd., amalgamated with WSP in 2023) has been retained by the Ministry of Transportation, Ontario (MTO) to support future procurement-ready design phases of the widening of Highway 401 through Belleville, Ontario as part of GWP 4053-18-00, delivered under MTO Agreement No. 4020-E-0012. The project limits extend from 1.2 km west of the Wallbridge-Loyalist Road interchange to 4.3 km east of the Highway 37 interchange. The overall project includes the replacement of six bridges, several structural and non-structural culverts, and operational improvements and reconfiguration of existing interchanges.

This report presents the results of the detailed foundation investigation carried out for the replacement of Culvert 11X-0423/C0 (WP 4097-20-01) located on the W-N/S Ramp in the southwest quadrant of the Highway 401 / Wallbridge-Loyalist Road interchange.

2.0 SITE DESCRIPTION AND GEOLOGY

2.1 Site Description

Culvert 11X-0423/C0 is located under the existing Highway 401 W-N/S Ramp to Wallbridge-Loyalist Road, in the southwest quadrant of the interchange approximately 250 m west of Wallbridge-Loyalist Road in Belleville. The site location is shown in Drawing 1.

At this location, Highway 401 has a four-lane cross-section with two eastbound and two westbound through lanes with paved shoulders separated by a concrete median wall. Steel beam guiderails are also present along both sides of the highway, in the vicinity of the underpass structure. The existing interchange includes a westbound onramp (existing N/S-E Ramp) and an eastbound offramp (existing W-N/S) at Wallbridge-Loyalist Road.

Wallbridge-Loyalist Road is an undivided road with a single travel lane in each direction. Steel beam guide rails are present along both sides of Wallbridge-Loyalist Road in the vicinity of the underpass structure.

The existing W-N/S Ramp has a rural cross-section with a single lane with paved and gravel shoulders. The lands north and south of the offramp are generally brush-covered with some mature trees. Farmland is located on the south and west sides of the offramp beyond the MTO right-of-way. The stormwater drainage in the area is to existing culverts and ditches.

Site photographs showing the general conditions of the site are presented in Appendix D.

2.2 Regional Geology

As delineated in *The Physiography of Southern Ontario*[1], the proposed culvert site lies within a physiographic region known as the Napanee Plain which is characterized as a flat-to-undulating plain of limestone of the Gull River and Bobcaygeon Formations overlain by glacially worked thin overburden deposits.

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

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out on October 4 and October 5, 2022, and included advancing three boreholes, numbered C-11 to C-13. Boreholes C-12 and C-13 were both located in the ditchline in the general location of the culvert outlet south of the ramp while Borehole C-11 was located near the proposed culvert inlet. The borehole locations are shown on Drawing 1.

The boreholes were advanced using portable rotary drilling equipment employing a full-weight (63.5 kg) hammer dropped from the Standard Penetration Test (SPT) height. The drilling equipment was supplied and operated by CCC Geotechnical & Environmental Drilling Ltd. (CCC) of Ottawa, Ontario.

Soil samples were obtained using a 50 mm outer diameter split-spoon sampler in general accordance with the SPT procedure (ASTM D1586[2]). Soil samples from the portable drilling equipment were obtained in continuous vertical increments of about 0.6 m. NQ-sized bedrock core samples were recovered at Borehole C-13 using a BW-size thin-wall core barrel.

A methane pocket was encountered during bedrock coring at Borehole C-13 at an approximate depth of 6.0 m (Elevation. 93.8 m). Methane concentrations above the lower explosive level (LEL) were measured at the site using an RKI Model GX-2012, 4-Gas Monitor. After discussion with MTO Foundations, as a safety precaution, no further bedrock coring was carried out at this site. Based on the methane encountered in this borehole and other boreholes near this site, it should be expected that methane could be encountered during excavation/construction activities at elevations near or within the bedrock, throughout the project limits.

Monitoring wells were installed at Boreholes C-11 and C-12, to observe the groundwater level at the site. The monitoring wells consist of a 52 mm outside diameter PVC tube with a 1.5 m long slotted screen. Installation details are shown on the borehole log for Boreholes C-11 and C-12 provided in Appendix A.

The boreholes without monitoring well were backfilled with bentonite within the bedrock, and bentonite mixed with soil cuttings within the overburden. The boreholes were backfilled in general accordance with the intent of Ontario Regulation (O.Reg.) 903, as amended. The site conditions were restored following the completion of the fieldwork. The monitoring wells have been left in place to allow for the monitoring of groundwater levels as part of the future design-build contract. As part of the construction, the monitoring wells will need to be decommissioned by qualified personnel in accordance with Ontario Regulation 903 (amended).

The field work was supervised on a full-time basis by members of WSP's technical staff who located the boreholes in the field, directed the drilling, sampling, and in-situ testing operations, and logged the boreholes. The soil and bedrock samples were identified in the field, placed in labelled containers, and transported to WSP's laboratory in Ottawa for further examination and testing. Index and classification tests consisting of water content determinations, grain size distribution analyses and Atterberg limits testing were carried out on selected soil samples and uniaxial compressive strength (UCS) testing was carried out on selected samples of the bedrock. The laboratory tests were carried out to MTO LS and/or ASTM Standards, as applicable at WSP's Ottawa laboratory.

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

Two soil samples were sent to Eurofins Environmental Testing Canada Inc. (Eurofins) for basic chemical analysis related to the potential corrosion of buried steel elements and sulfate attack on buried concrete elements (corrosion and sulphate attack).

The borehole locations and elevations were surveyed by WSP Golder using a Trimble R10 GPS unit having an accuracy of 0.1 m in vertical and 0.5 m in horizontal directions and referenced to the NAD83 CSRS CBNv6-2010.0 MTM Zone 9 geodetic datum. The borehole locations, including northing and easting coordinates as well as geographic coordinates, ground surface elevations, and drilled depths are summarized in Table 1.

Table 1: Summary of Borehole Locations

Borehole	NAD83 CSRS CBNv6-2010.0 MTM Zone 9		Ground Surface Elevation (m)	Drilled Depths (m)	Comments
	Northing (m) (Latitude)	Easting (m) (Latitude)			
C-11	4893592.2 (44.178390°)	228846.3 (-77.449930°)	100.3	3.8	Auger refusal
C-12	4893565.9 (44.178140°)	228843.7 (-77.449950°)	99.6	3.9	Auger refusal
C-13	4893558.3 (44.178070°)	228848.8 (-77.449890°)	99.8	6.5	Bedrock cored

4.0 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 General

The subsurface soil, bedrock and groundwater conditions encountered in the boreholes and the results of in-situ testing from the investigation are shown on the borehole and drillhole records presented in Appendix A. Photographs of the core recovered from the underlying bedrock at the boreholes are shown in Figures A1 and A2, provided in Appendix A. The results of the in-situ field tests as presented in the borehole records and in Section 4, are uncorrected and are based on the use of an automatic hammer for the SPT. The results of the geotechnical laboratory testing carried out during the investigation are presented on the borehole records as well as on Figures B1 to B5 in Appendix B. The results of the analytical testing completed on select soil samples are provided in Appendix C.

The borehole locations and the interpreted stratigraphic profile projected along the proposed culvert alignment are provided in Drawing 1. The stratigraphic boundaries shown on the borehole and drillhole records and on the interpreted stratigraphic section in Drawing 1 are inferred from observations of the drilling progress together with continuous soil sampling and may represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

At the borehole locations, the subsurface conditions consist of topsoil overlying very stiff clay over very stiff glacial till all underlain by limestone bedrock. A more detailed description of the overburdened soil deposits and bedrock geology conditions encountered during the field investigation is provided in the following sections.

4.1.1 Topsoil

Topsoil with thickness ranging between approximately 100 mm to 600 mm was encountered at the surface of all boreholes.

4.1.2 Clay (CH) to Silty Clay (CI)

A clay deposit was encountered beneath the surficial topsoil layer at all borehole locations.

The top of this layer was encountered at elevations ranging from 99.0 m to 100.2 m. The thickness of this layer ranges from about 1.2 m to 1.8 m. The SPT N-values recorded in this layer range from 6 to 45 blows per 0.3 m of penetration but more typically 9 to 18 blows per 0.3 m, indicating a generally very stiff consistency.

The results of grain size analysis testing carried out on three samples of this material are illustrated in Figure B1 in Appendix B. The results of Atterberg limits testing completed on three samples of the clay material indicate liquid limits ranging from 35 to 83, plastic limits ranging from 16 to 32, and plasticity indices ranging from 19 to 57, as shown on Figure B2 in Appendix B. These Atterberg limits testing results indicate a clay of high plasticity (CH) to a silty clay of intermediate plasticity (CI). The water contents of eleven tested samples of the clay crust range from 33% to 37% near or slightly above the plastic limit of the material.

4.1.3 Glacial Till

A glacial till deposit varying in composition from silt to sandy clayey silt to silty clay, containing cobbles and boulders, was encountered below the clay material at all boreholes. The top of this deposit was encountered between Elevations 97.7 m and 98.5 m. The thickness of this layer ranges from about 1.9 m to 2.1 m. The SPT N-values recorded in this layer range from 18 to greater than 100 blows per 0.3 m of penetration but more typically 20 to 33 indicating very stiff to hard consistency. Boreholes C-11 and C-12 were terminated in this layer. The higher blow counts (e.g., 100/120 mm) recorded in the till may have been influenced by the presence of cobbles or boulders within the till, rather than the consistency of the soil matrix.

The results of grain size analysis testing carried out on three samples of this material are provided in Figure B3 in Appendix B. The results of Atterberg limits testing completed on three samples of the till material indicate liquid limits ranging from 16 to 40, plastic limits ranging from 11 to 17, and plasticity indices ranging from 5 to 24, as shown in Figure B4 in Appendix B. These Atterberg limits testing results indicate clayey silt–silt (CL-ML) to a silty clay of intermediate plasticity (CI). The measured water content of three samples of the till ranged from 10% to 28%., below the plastic limit for the material near or slightly above the plastic limit of the material.

4.1.4 Limestone Bedrock

The overburden soils are underlain by limestone bedrock. NQ-sized bedrock core samples were recovered with a BW-size thin-wall core barrel at Borehole C-13.

A methane pocket was encountered during bedrock coring at Borehole C-13 at an approximate depth of 6.0 m (Elevation 93.8 m). Methane concentrations above the lower explosive level (LEL) were measured at the top of the borehole casing using an RKI Model GX-2012, 4-Gas Monitor. It should be expected that methane could be encountered within the bedrock if any protection system installation, excavation or other /construction activities extend to this level.

Table 2 summarizes the depths and the elevations of the bedrock surface as encountered at the borehole locations.

Table 2: Summary of Bedrock Surface Depths and Elevations

Borehole	Existing Ground Surface Elevation (m)	Depth to Bedrock Surface (m)	Bedrock Surface/Refusal Elevation (m)
C-11	100.3	3.8	96.5[2]
C-12	99.6	3.9	95.7[2]
C-13	99.8	4.1	95.7[1]

Note(s): 1. Bedrock surface elevation confirmed by bedrock coring.
2. Due to the presence of methane in the bedrock, after discussion with MTO Foundations Section, as a safety precaution bedrock coring was not carried out at Boreholes C-11 and C-12 and these boreholes were terminated at auger refusal.

Rock Quality Designation (RQD) values measured on the recovered limestone bedrock core samples range from about 60% to 100%, indicating fair to excellent rock quality. The results of UCS testing carried out on a single bedrock core sample gave a UCS value of 75 MPa, indicating strong bedrock; The results of UCS testing are provided on Figure B5 in Appendix B.

4.2 Groundwater Conditions

Monitoring wells were installed at Boreholes C-11 and C-12 to measure the groundwater level at the site. The groundwater levels measured in the monitoring wells are presented in Table 3.

It is expected that the groundwater levels will be subject to fluctuations both seasonally and as a result of precipitation events. In addition to the groundwater level as measured within the glacial till deposit, perched groundwater should be expected at the base of non-cohesive fills where encountered, atop the underlying lower-permeability native soils.

Table 3: Summary of Groundwater Conditions

Borehole	Screened Interval	Ground Surface Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Date
C-11	Glacial Till	100.3	0.2	100.1	December 14, 2022, and February 27, 2024
C-12	Glacial Till	99.6	0.6	99.0	December 14, 2022
			0.7	98.9	February 27, 2024

4.3 Analytical Laboratory Testing Results

Two soil samples were submitted to Eurofins for chemical testing/analysis related to the potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack). The test results are provided in Appendix C and are summarized in Table 4.

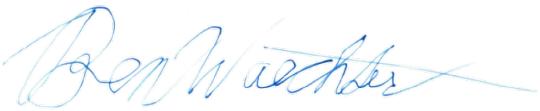
Table 4: Steel Corrosion and Sulphate Attack, Chemical Analysis

Borehole	Sample Depth (m)	Chloride (%)	Sulphate (%)	Electrical Conductivity (mS/cm)	pH	Resistivity (ohm-cm)
C-11	3.1-3.7	0.03	0.005	0.23	8.5	4,540
C-13	0.6-1.2	0.04	0.043	0.77	8.33	1,320

5.0 CLOSURE

This report was prepared by Ben Waechter, EIT, and reviewed by Kenton Power, P.Eng., a Senior Geotechnical Engineer with WSP. Lisa Coyne, P.Eng., a Geotechnical Engineering Fellow and MTO Principal Foundations Contact for WSP conducted an independent technical and quality review of this report.

WSP Canada Inc.



Ben Waechter, EIT
Geotechnical Engineer-in-training

Kenton Power, P.Eng.
Senior Geotechnical Engineer

Lisa Coyne, P.Eng.
MTO Principal Designated Contract

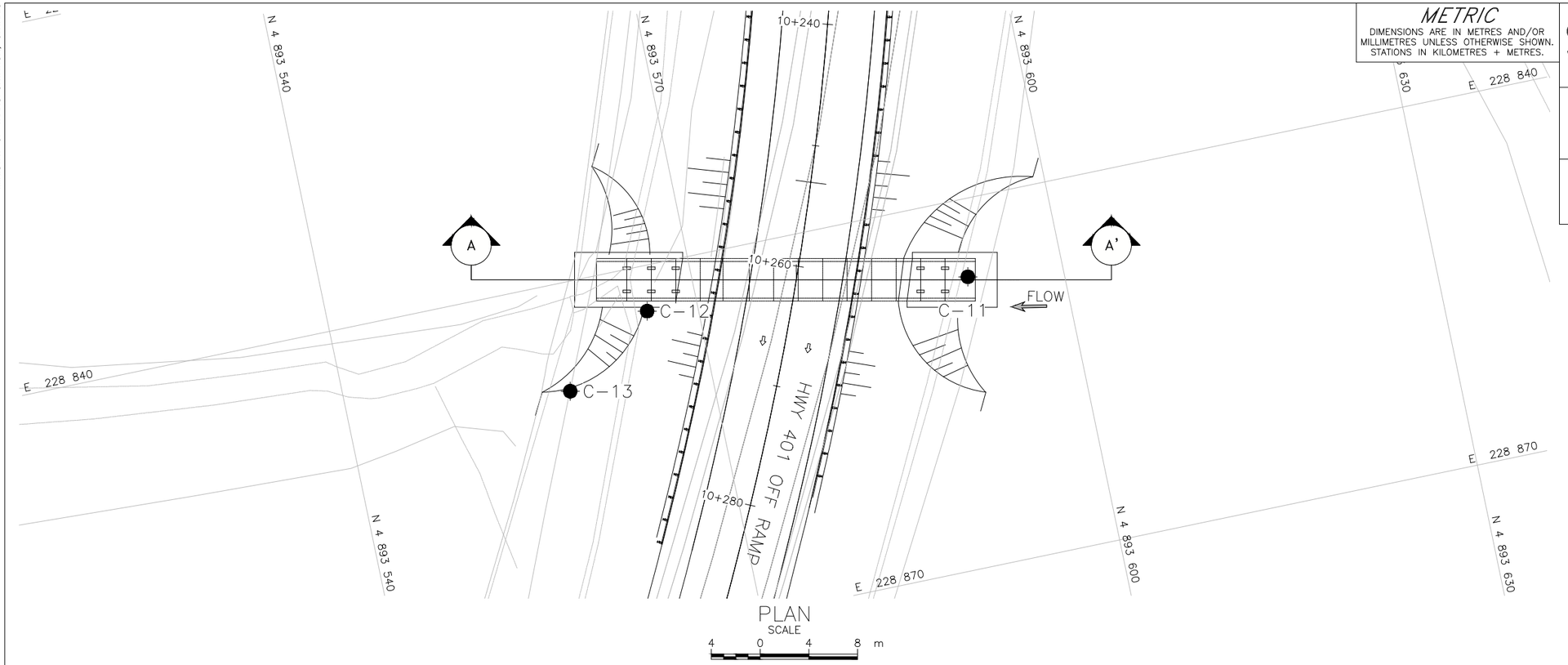
BW/KCP/LCC/yj

https://wsponline.sharepoint.com/sites/gld-152692/project files/6 deliverables/03-culvert r4/2-final/gwp 4053-18-00 rev0 fir culvert 11x-0423 (20148061b-r4) 2024-08-13.docx

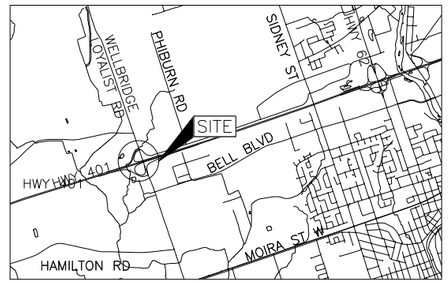
DRAWING

Drawing 1 – Borehole Locations and Soil Strata

MINISTRY OF TRANSPORTATION, ONTARIO



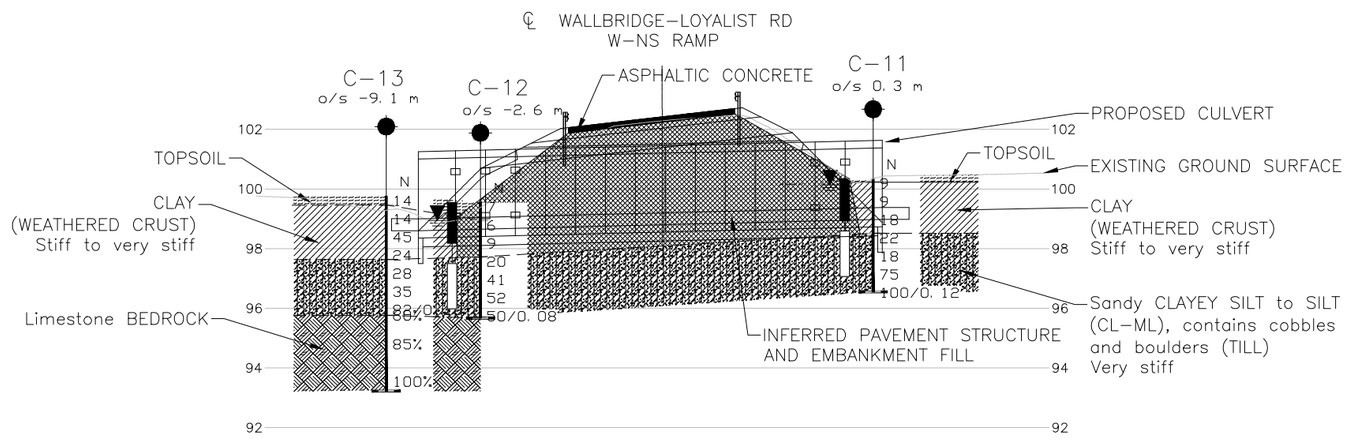
PLAN
SCALE
4 0 4 8 m



KEY PLAN
SCALE
1 0 1 2 km

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% — Rock Quality Designation (RQD)
- WL in piezometer, measured on February 27, 2024



PROFILE A–A'
SCALE
4 0 4 8 m
SCALE
2 0 2 4 m

BOREHOLE CO–ORDINATES NAD83 (CSRS) MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
C–11	100.3	4893592.2	228846.3
C–12	99.6	4893565.9	228843.7
C–13	99.8	4893558.3	228848.8

Structural Site Location: Latitude: 44.178390 Longitude: **-77.449930**

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 Procurement–Ready Design Documents.

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

REFERENCE

Base plans provided in digital format by MTO, drawing file nos 3216057_EP.dwg and 3216057_Hwy 401 _8 Lanes Design_ACAD.dwg, received Oct. 13 2022.
General arrangement provided in digital format by WSP, drawing file no. S16M–01435–01–355–001GA.dwg, received April 11, 2024.
Basemaping provided in digital format by WSP, drawing file no. 221–08798–00–XB1.dwg, received May 3, 2024.
Alignment provided in digital format by WSP, file no. Alignment Export – Hwy 401 & WBLR Ramps.xml, received May 8, 2024.

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

CONT No.
WP No. 4097–20–01

HIGHWAY 401 WIDENING
REPLACEMENT OF CULVERT 11X–0423/C0
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

wsp

LICENSED PROFESSIONAL ENGINEER L.L.C. COYNE Aug. 23, 2024 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER K.T.C. POWER 100130652 Aug. 23, 2024 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 31C–318

HWY. 401	PROJECT NO. 20148061B		DIST. EASTERN
SUBM'D. BW	CHKD. KCP	DATE: 8/23/2024	SITE: 11X–0423/C0
DRAWN: ZS	CHKD. KCP	APPD. LCC	DWG. 1

PLOT DATE: August 23, 2024
FILENAME: S:\Clients\MTO\Hwy_401_Belleville\06_PROJ\20148061B\X6_PROD\0003_Culvert_RA\20148061B-0003-BD-0001.dwg

APPENDIX A

Borehole Records and Bedrock Core Photographs

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

PARTICLE SIZES OF CONSTITUENTS

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

MODIFIERS FOR SECONDARY COMPONENTS[1,2]

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

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

PENETRATION RESISTANCE

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

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

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

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

SAMPLES

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

SOIL TESTS

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

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

COARSE-GRAINED SOILS

Compactness[1]

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

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 grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.
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.

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

I. GENERAL

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
$C_{\alpha(e)}$	secondary compression index
C_α	rate of secondary compression
$C_{\alpha(\varepsilon)}$	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 δ
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

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

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING CLASSIFICATION

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

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery (TCR)

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

Dip with Respect to Core Axis

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

Description and Notes

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

Abbreviations

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

ISRM Intact Rock Material Strength Classification

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

PROJECT 20148061B

RECORD OF BOREHOLE No C-11

SHEET 1 OF 1

METRIC

G.W.P. 4053-18-00 LOCATION N 4893592.2; E 228846.3 MTM NAD 83 ZONE 9 (LAT. 44.178390; LONG. -77.449930) ORIGINATED BY BW

DIST Eastern HWY 401 BOREHOLE TYPE Portable Rotary Drilling Equipment with Full Weight Hammer COMPILED BY NV

DATUM Geodetic DATE October 5, 2022 CHECKED BY KCP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
100.3	GROUND SURFACE										
0.0 / 0.1	TOPSOIL Dark brown Moist										
	CLAY (CH), highly fissured (WEATHERED CRUST) Stiff to very stiff Brown w>PL		1	SS	9		100				
			2	SS	9						0 3 29 68
			3	SS	18		99				
98.5 / 1.8	Sandy CLAYEY SILT to SILT (CL-ML), contains cobbles and boulders (TILL) Very stiff Brown W<PL		4	SS	22		98				
			5	SS	18						9 40 36 15
			6	SS	75		97				
96.5			7	SS	100/0.12						
3.8	END OF BOREHOLE Auger refusal on inferred bedrock										

NOTE:

1. Water level measured in monitoring well:

Date	Depth (m)	Elev. (m)
14-Dec-22	0.2	101.1
27-Feb-24	0.2	101.1

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

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

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401_BELLEVILLE\02_DATA\GINT\HWY_401_BELLEVILLE.GPJ GAL-GTA.GDT 8/23/24

PROJECT 20148061B

RECORD OF BOREHOLE No C-12

SHEET 1 OF 1

METRIC

G.W.P. 4053-18-00 LOCATION N 4893565.9; E 228843.7 MTM NAD 83 ZONE 9 (LAT. 44.178140; LONG. -77.449950) ORIGINATED BY BW

DIST Eastern HWY 401 BOREHOLE TYPE Portable Rotary Drilling Equipment with Full Weight Hammer COMPILED BY GS

DATUM Geodetic DATE October 5, 2022 CHECKED BY KCP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.6	GROUND SURFACE										
0.0 / 99.0	TOPSOIL Dark brown Moist		1	SS	7		99				
0.6 / 97.8	SILTY CLAY (Cl), highly fissured (WEATHERED CRUST) Stiff to very stiff Brown w>PL		2	SS	6						
			3	SS	9		98		o		2 16 36 46
1.8 / 95.7	Sandy CLAYEY SILT (CL), contains cobbles and boulders (TILL) Very stiff to hard Brown w>PL		4	SS	20						
			5	SS	41		97				
			6	SS	52				o		14 31 29 26
			7	SS	50/0.08		96				
3.9	END OF BOREHOLE Auger refusal on inferred bedrock										

NOTE:

1. Water level measured in monitoring well:

Date	Depth (m)	Elev. (m)
14-Dec-22	0.6	99
27-Feb-24	0.7	98.9

+3, ×3: Numbers refer to Sensitivity

○3% STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401_BELLEVILLE\02_DATA\GINT\HWY_401_BELLEVILLE.GPJ GAL-GTA.GDT 8/23/24

PROJECT 20148061B

RECORD OF BOREHOLE No C-13

SHEET 1 OF 2

METRIC

G.W.P. 4053-18-00 LOCATION N 4893558.3; E 228848.8 MTM NAD 83 ZONE 9 (LAT. 44.178070; LONG. -77.449890) ORIGINATED BY BW

DIST Eastern HWY 401 BOREHOLE TYPE Portable Rotary Drilling Equipment with Full Weight Hammer COMPILED BY GS

DATUM Geodetic DATE October 4, 2022 CHECKED BY KCP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.8	GROUND SURFACE										
0.0 / 99.5	TOPSOIL Dark brown Moist		1	SS	14						
0.3	CLAY (CH), highly fissured (WEATHERED CRUST) Very stiff to hard Brown w>PL		2	SS	14		99				
			3	SS	45						1 6 24 69
97.7							98				
2.1	SILTY CLAY (CI) (TILL) Very stiff Brown w>PL		4	SS	24						
			5	SS	28		97				
			6	SS	35						4 15 33 48
95.8			7	SS	82/0.18		96				
4.0	LIMESTONE (BEDROCK) Bedrock cored from 4.0 m to 6.5 m Highly weathered Bedrock from 4.0 to 4.1 m For rock coring details see Record of Drillhole C-13		1	RC	REC 98%						RQD = 60%
			2	RC	REC 100%		95				RQD = 85%
93.3			3	RC	REC 100%		94				RQD = 100%
6.5	END OF BOREHOLE NOTE(S) 1. A methane pocket was encountered during bedrock coring at an approximate depth of 6.0 m (Elev. 93.8 m). Methane concentrations above the lower explosive level were measured										

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

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401_BELLEVILLE\02_DATA\GINT\HWY_401_BELLEVILLE.GPJ GAL-GTA.GDT 8/23/24

PROJECT: 20148061B

RECORD OF DRILLHOLE: C-13

SHEET 2 OF 2

LOCATION: N 4893558.34 ;E 228848.84

DRILLING DATE: October 4, 2022

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable

DRILLING CONTRACTOR: CCC

NOTE:
For abbreviations, symbols and descriptions refer to
LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jcon	WEATH-ERING INDEX	Diametral Point Load Index (MPa)	FEATURES	PIEZOMETER
		Continued from Record of Borehole C-13.		95.76															
4		Highly weathered Bedrock		4.00															
		Fresh to slightly weathered, medium bedded to thinly laminated, light to dark grey banded black, fine to medium grained, non to slightly porous, fair to excellent quality, strong, LIMESTONE with shale partings		4.10	1													BC/LC	
5	Rotary Drill / NQ Coring				2														UCS = 75 MPa
6		- Clay infill from 6.19 m to 6.20 m - Methane pocket encountered with concentrations above the lower explosive limit		93.22	3														
		END OF DRILLHOLE		6.54															
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			

DEPTH SCALE

1 : 50

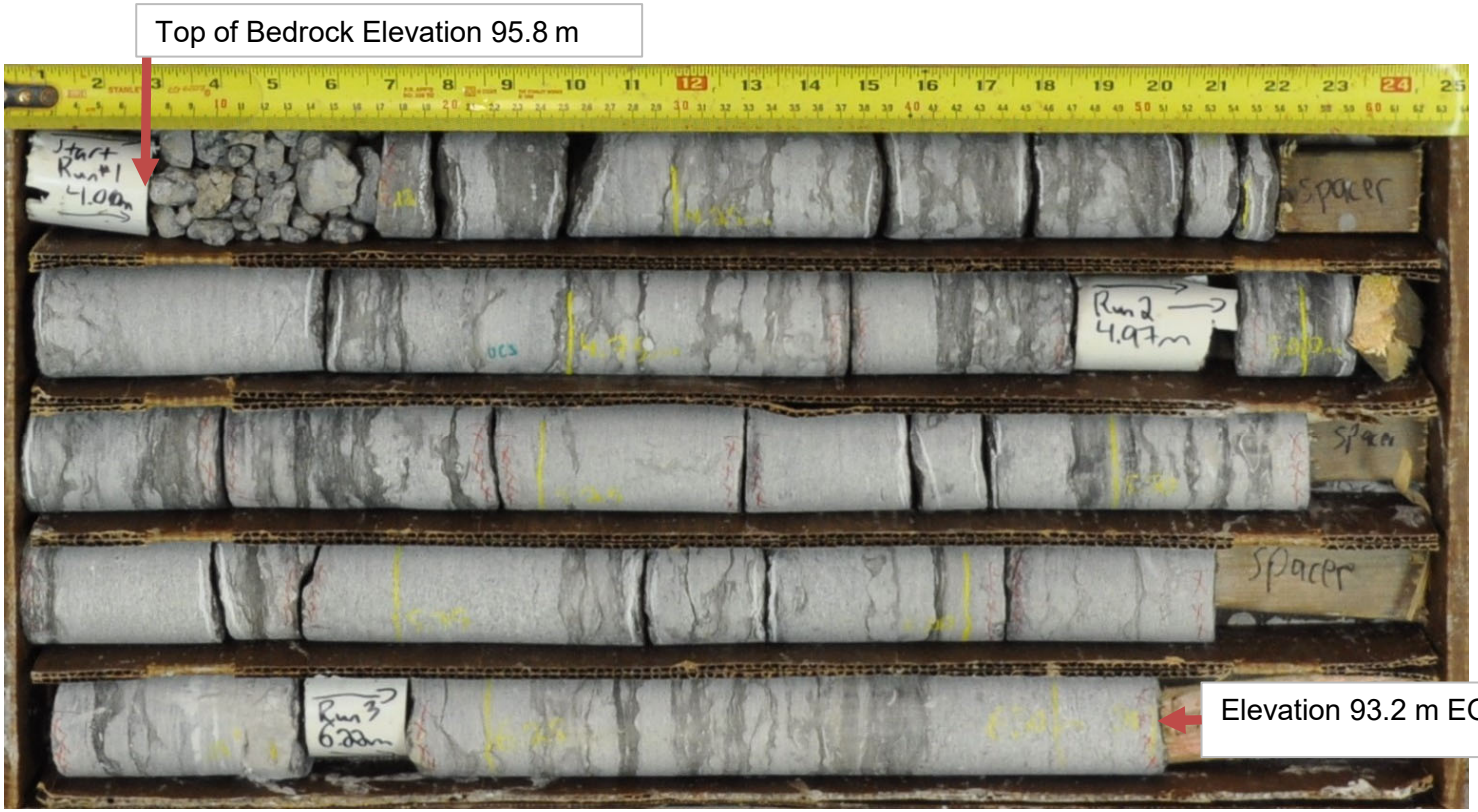
LOGGED: BW

CHECKED: KCP

GTA-RCK 046 S:\CLIENTS\MTO\HWY_401_BELLEVILLE\02_DATA\GINT\HWY_401_BELLEVILLE.GPJ GAL-MISS.GDT 8/23/24

BH C-13 (Dry)

Core Box 1 & 2 of 2



Note:

1. A methane pocket was encountered during bedrock coring at Borehole C-13 at an approximately depth of 6.0 m; Elevation. 93.8 m. Methane concentrations above the lower explosive level (LEL) were measured at the site using an RKI Model GX-2012, 4-Gas Monitor.

wsp	**Foundations Investigation** **Replacement of Structural Culvert 11X-0423/CO** **GWP 4053-18-00; WP 4097-20-01** **Highway 401, Belleville, Ontario**	Project No. 20148061B Drawn: BW Date: 2022-11-06 Checked: KCP Review: LCC	**Figure A1**

BH C-13 (Wet)

Core Box 1 & 2 of 2

Note:

1. A methane pocket was encountered during bedrock coring at Borehole C-13 at an approximately depth of 6.0 m; Elevation. 93.8 m. Methane concentrations above the lower explosive level (LEL) were measured at the site using an RKI Model GX-2012, 4-Gas Monitor.

wsp	**Foundations Investigation** **Replacement of Structural Culvert 11X-0423/CO** **GWP 4053-18-00; WP 4097-20-01** **Highway 401, Belleville, Ontario**	Project No. 20148061B Drawn: BW Date: 2022-11-06 Checked: KCP Review: LCC	**Figure A2**

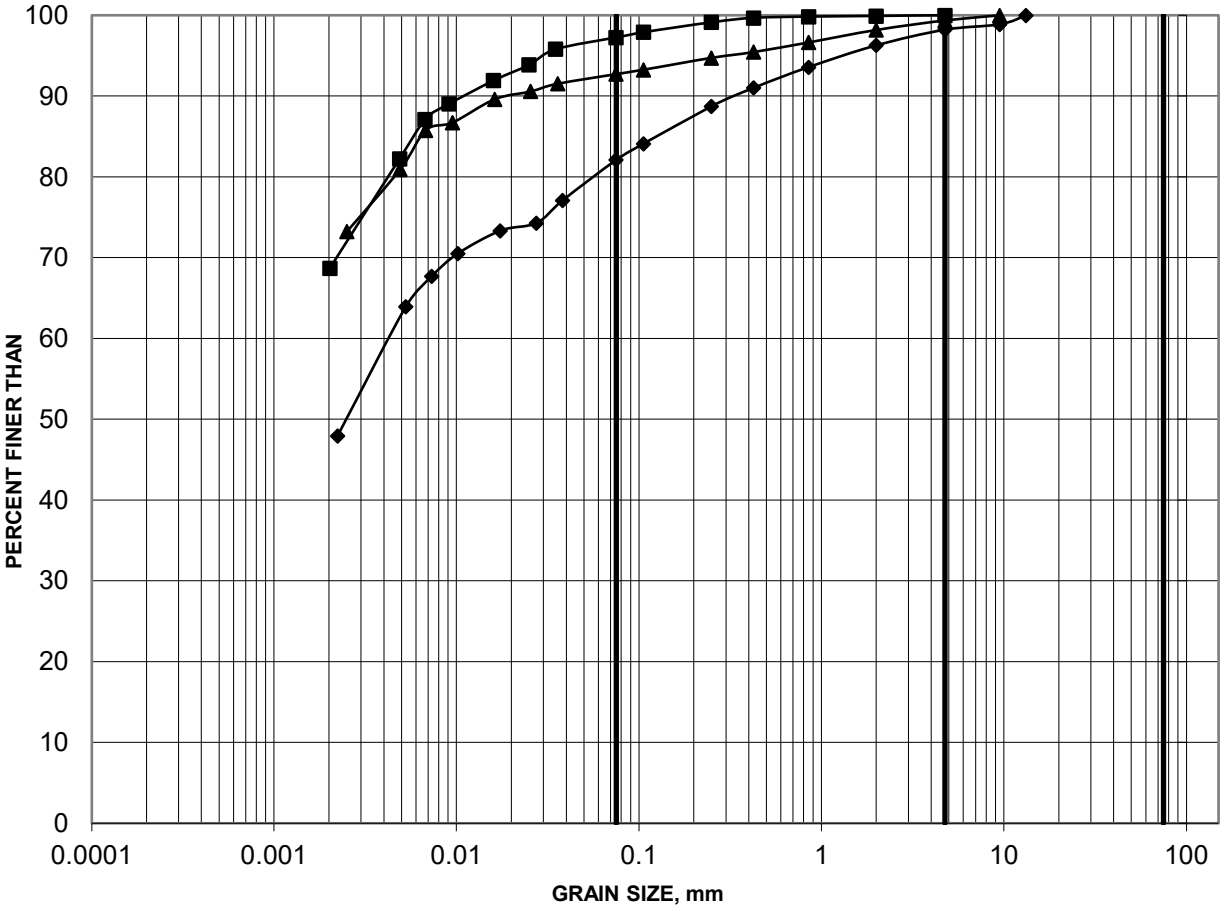
APPENDIX B

Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE B1

ENTER TITLE HERE

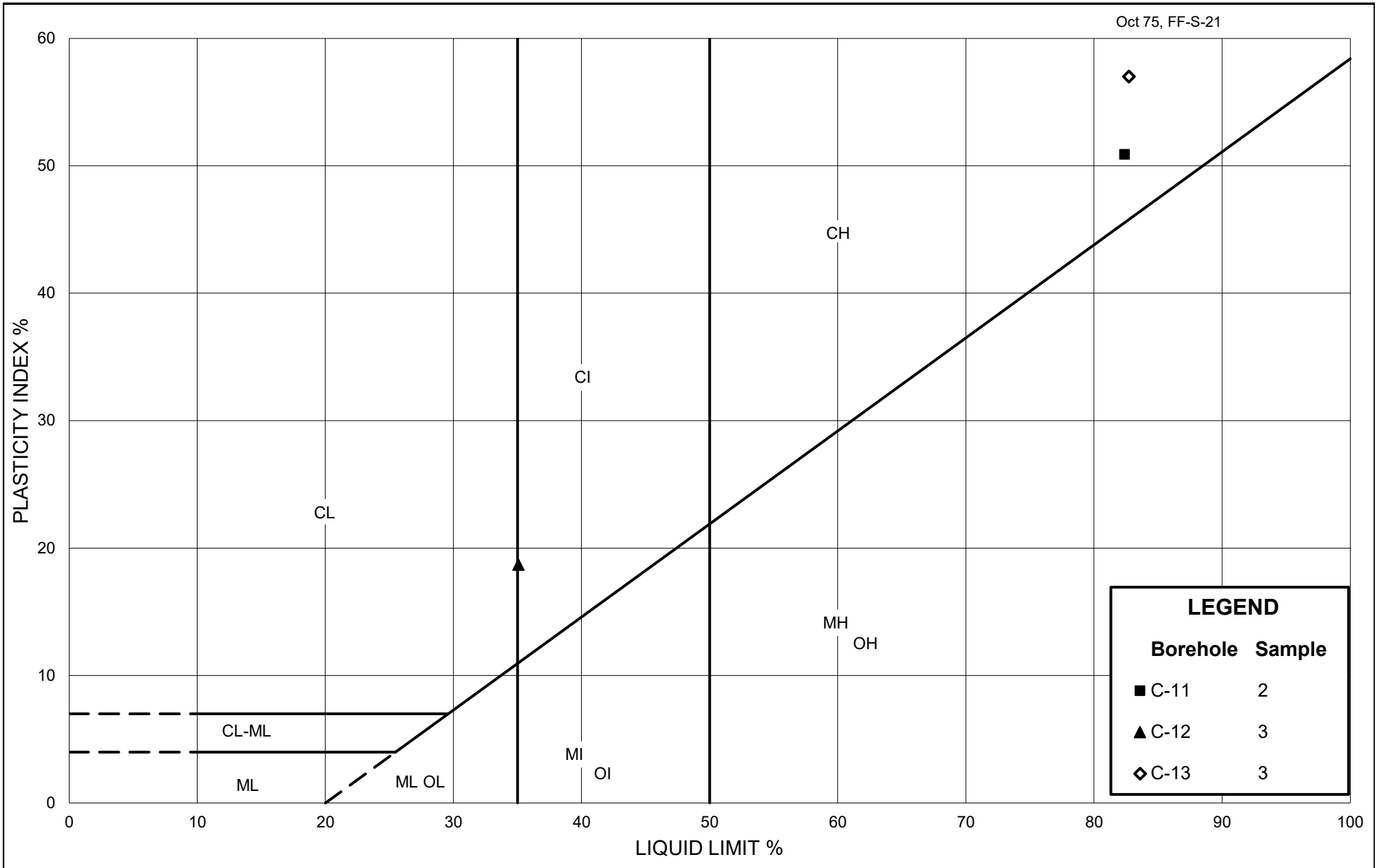


Borehole	Sample	Depth (m)
C-11	2	0.61-1.22
C-12	3	1.22-1.83
C-13	3	1.22-1.83

Project: 20148061B/4200

https://golderassociates.sharepoint.com/sites/35409g/Shared Documents/Active/2020/20148061B/figures/

Created by:	KCP
Checked by:	CW



Ministry of Transportation

Ontario

PLASTICITY CHART

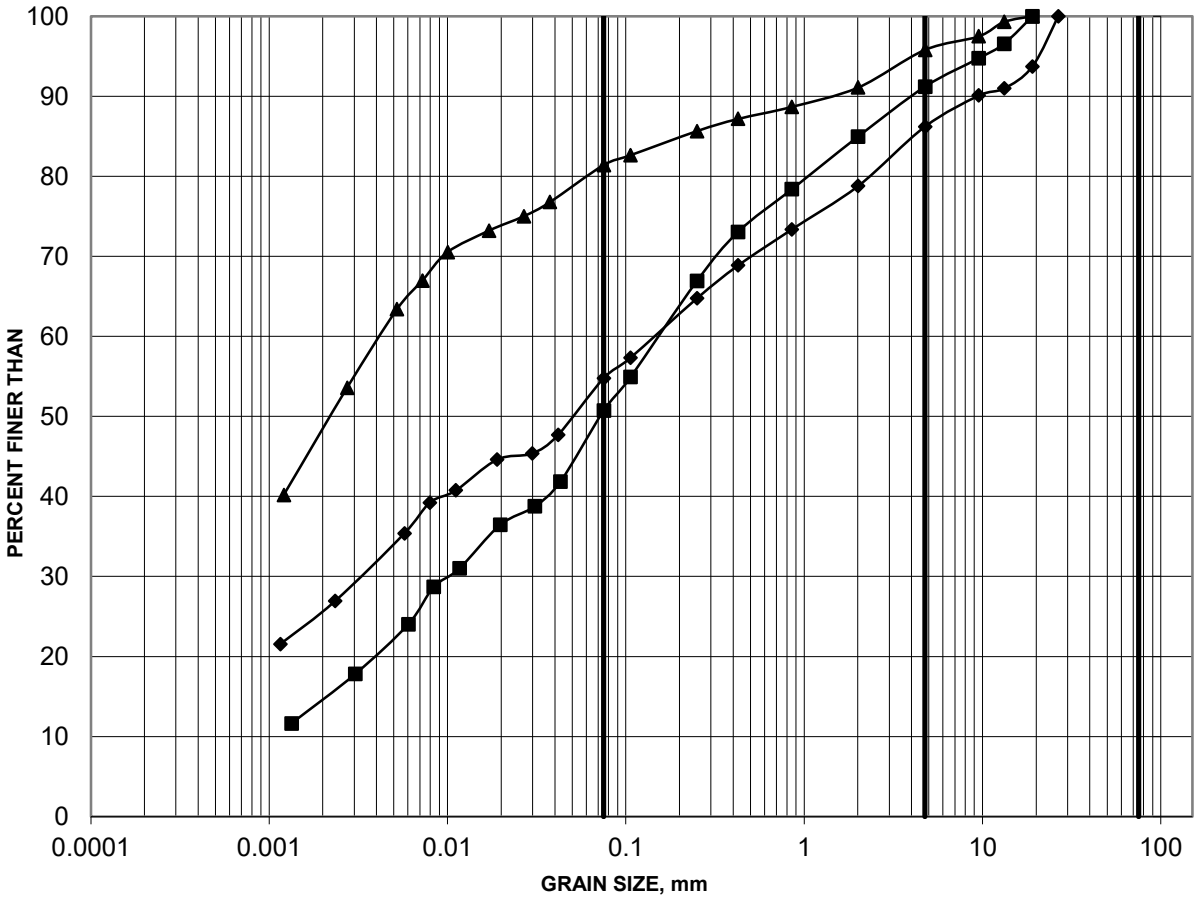
CLAY (CH) TO SILTY CLAY (CI)

Figure:	B2
Project:	20148061B/4200
Created By: KCP	Checked By: CW

GRAIN SIZE DISTRIBUTION

FIGURE B3

GLACIAL TILL



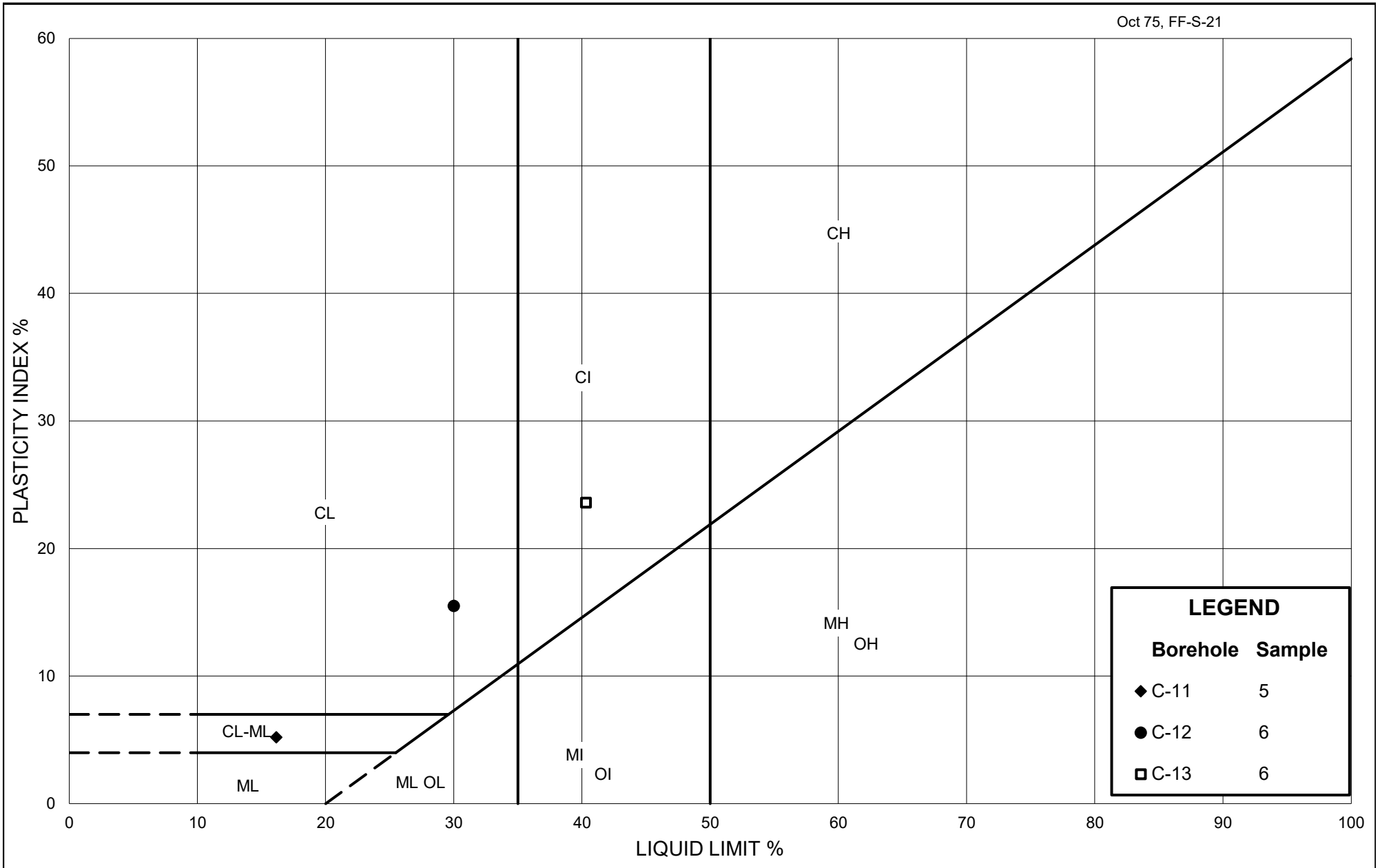
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

	Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
■	C-11	5	2.44-3.05	9	40	36	15
◆	C-12	6	3.05-3.66	14	31	29	26
▲	C-13	6	3.05-3.66	4	15	33	48

Project: 20148061B/4200

Created by: KCP
Checked by: CW

https://golderassociates.sharepoint.com/sites/35409g/Shared Documents/Active/2020/20148061B/figures/



Ministry of Transportation

Ontario

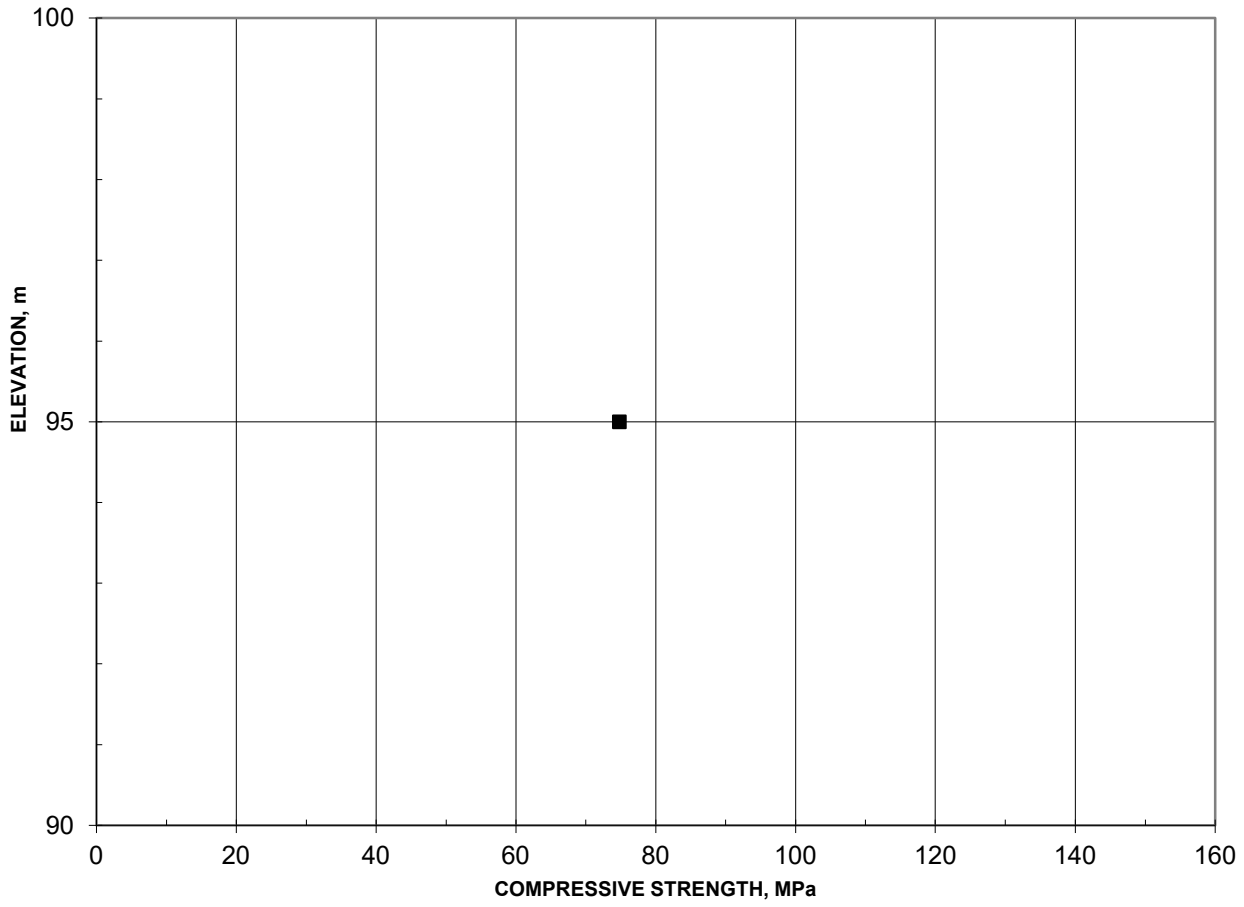
PLASTICITY CHART

GLACIAL TILL

Figure:	B4
Project:	20148061B/4200
Created By: KCP	Checked By: CW

ASTM D7012 - Method C
UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORE
SUMMARY OF LABORATORY TEST RESULTS

FIGURE B5



Borehole	Depth (m)	L/D	Bulk Density (kg/m^3)	Lithology	UCS (MPa)	Failure Type
BHC-13 RC1	4.8	2.3	2661	Limestone	75	1

Notes:

Failure Types

1. Well formed cones on both ends
2. Well formed cones on one end, vertical cracks through cap
3. Columnar vertical craking through both ends
4. Diagonal fracture with no cracking through ends
5. Side fractures at top or bottom
6. Side fractures at both sides of top or bottom

Remarks

- Cores tested in vertical direction.
- Cores tested in air-dry condition.
- Time to failure > 2 and < 15 minutes.

Project: 20148061B

Created by:	KCP
Checked by:	CW

APPENDIX C

Analytical Laboratory Testing Results

Certificate of Analysis

Client: Golder Associates Ltd (Ottawa)
1931 Robertson Road,
Ottawa, Ontario
.
Attention: Mr. Kenton Power
PO#:
Invoice to: Golder Associates Ltd

Report Number: 1990084
Date Submitted: 2022-11-17
Date Reported: 2022-11-24
Project: 20148061B MTO Belleville
COC #: 902953

Dear Kenton Power:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:

APPROVAL: _____
Emma-Dawn Ferguson, Chemist

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise indicated.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: https://directory.cala.ca/.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is licensed by the Ontario Ministry of the Environment, Conservation, and Parks (MECP) for specific tests in drinking water (license #2318). A copy of the license is available upon request.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by the Ontario Ministry of Agriculture, Food, and Rural Affairs for specific tests in agricultural soils.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Certificate of Analysis

eurofins | Environment Testing

Client: Golder Associates Ltd (Ottawa)
1931 Robertson Road,
Ottawa, Ontario
.
Attention: Mr. Kenton Power
PO#:
Invoice to: Golder Associates Ltd

Report Number: 1990084
Date Submitted: 2022-11-17
Date Reported: 2022-11-24
Project: 20148061B MTO Belleville
COC #: 902953

				Lab I.D.	1663118	1663119	1663120	1663121
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Type				
				Sampling Date	2022-10-21	2022-10-25	2022-10-26	2022-10-27
				Sample I.D.	H62-02 SA4 7.5'-9.5'	CNR-05 SA6 12.5'-14.5'	CNR-06 SA3 5'-7'	SS-04 SA2 2.5'-4.5'
Group	**Analyte**	**MRL**	**Units**	**Guideline**				
Anions	SO4	0.01	%		0.02	0.03	0.03	0.02
Cl in Concrete	Cl	0.002	%		0.025	0.016	0.024	0.046
General Chemistry	Electrical Conductivity	0.05	mS/cm		0.59	0.43	0.78	1.00
	pH	2.00			8.87	8.82	8.91	8.80
	Resistivity	1	ohm-cm		1724	2381	1300	1010

				Lab I.D.	1663122	1663123	1663124	1663125
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Type				
				Sampling Date	2022-10-27	2022-10-05	2022-10-04	2022-10-23
				Sample I.D.	SS-05 SA5 10'-12'	C-11 SA6 10'-12'	C-13 SA2 2'-4'	C-15 SA3 5'-7'
Group	**Analyte**	**MRL**	**Units**	**Guideline**				
Anions	SO4	0.01	%		0.04	0.03	0.04	0.04
Cl in Concrete	Cl	0.002	%		0.061	0.005	0.043	0.025
General Chemistry	Electrical Conductivity	0.05	mS/cm		1.38	0.23	0.77	0.75
	pH	2.00			9.22	8.50	8.33	8.81
	Resistivity	1	ohm-cm		725	4540	1320	1350

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

eurofins | Environment Testing

Certificate of Analysis

Client: Golder Associates Ltd (Ottawa)
1931 Robertson Road,
Ottawa, Ontario
.
Attention: Mr. Kenton Power
PO#:
Invoice to: Golder Associates Ltd

Report Number: 1990084
Date Submitted: 2022-11-17
Date Reported: 2022-11-24
Project: 20148061B MTO Belleville
COC #: 902953

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 433754 **Analysis/Extraction Date** 2022-11-23 **Analyst** AET **Method** C CSA A23.2-4B			
Chloride	<0.002 %	97	80-120
Run No 433839 **Analysis/Extraction Date** 2022-11-24 **Analyst** IP **Method** AG SOIL			
SO4	<0.01 %	105	70-130
Run No 433849 **Analysis/Extraction Date** 2022-11-24 **Analyst** MW **Method** Cond-Soil			
Electrical Conductivity	<0.05 mS/cm	99	90-110
pH	6.81	99	90-110
Resistivity			

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

APPENDIX D

Site Photographs

Photograph 1: Looking southeast along the Highway 401 W-N/S Ramp from Borehole C-11 (July 7, 2022)

Photograph 2: Looking west from Borehole C-13 (July 7, 2022)

Photograph 3: Looking northeast from Borehole C-12 along proposed culvert alignment (July 7, 2022)

wsp.com