



FINAL REPORT

Foundation Investigation Report

Highway 401/Moira River Bridge Replacement (Structure No. 11X-0162)

Belleville, Ontario

MTO GWP 4053-18-00, WP 4087-19-01, Agreement 4020-E-0012

Submitted to:

Ministry of Transportation Ontario

1355 John Counter Boulevard, Kingston, Ontario K7K 0E5

Submitted by:

Ottawa, Ontario, Canada K2M 2J1

CA0006099.3147 Moira

July 11, 2024

GEOCREs No.: 31C03-003

Latitude: 44.193610°

Longitude: -77.394210°



Distribution List

1 e-Copy - MTO Eastern Region

1 e-Copy - MTO Foundations Section

1 e-Copy - WSP Canada Inc.

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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 Highway 401 / Moira River Bridge (MTO Structure No. 11X-0162) (WP 4087-19-01) and associated retaining wall. In addition to the detailed design foundation scope, additional environmental soil sampling and laboratory testing were carried out to provide information for the development of an excess soil management plan for this project.

2.0 SITE DESCRIPTION AND GEOLOGY

2.1 Site Description

The Highway 401 / Moira River Bridge (Site No. 11X-0162) is located at about Station 11+550 on Highway 401 approximately 250 m west of the Highway 401 / Highway 37 interchange in Belleville, Ontario. The site location is shown in the key plan in Drawings 1 to 3.

At this location, Highway 401 is a divided highway with a six-lane cross-section with two eastbound and two westbound through lanes with paved shoulders, plus a speed change lane at the interchange ramps in both directions. The highway is divided by a median concrete highwall. Both steel beam guiderails and concrete barriers are present immediately adjacent to the overpass structure on both sides of the highway.

Based on existing drawings, the existing bridge was constructed in 1956 and consists of a three-span steel plate I-girder bridge with a total length of 78.9 m with individual span lengths of 22.7 m, 33.5 m, and 22.7 m. The bridge has an overall width of 36 m and carries six lanes of traffic on Highway 401 over the Moira River. The road grade on the bridge is approximately 4.5 m above the river channel.

Moira River flows from north to south connecting Stoco Lake to Lake Ontario with river flow controlled by upstream and downstream weir structures. At the time of field investigation, the Moira River water level was measured at about Elevation 91 m on November 22, 2022.

The natural terrain in the vicinity of the bridge is generally flat. Bedrock is exposed at various locations along the riverbanks and within and the flat, wide river channel. The lands north and south of the site are generally grass covered with some mature trees. There is a shopping centre to the northwest and a park located to the southwest of the crossing.

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

2.2 Regional Geology

As delineated in *The Physiography of Southern Ontario*¹, the proposed bridge 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.

3.0 INVESTIGATION PROCEDURES

3.1 2023 Investigation

The field work for this investigation was carried out between June 26 and July 27, 2023, and included advancing ten boreholes (MR-01, MR-02, MR-04 to MR-07, MR-09, MR-10, RW-05, and RW-06), along the general location of the proposed widening, structure and retaining wall alignments. Boreholes MRP-01 and MRP-02 were drilled in Moira River in the general location of the proposed centre pier. The borehole locations are shown on Drawings 1 to 3.

Due to site access restrictions and in-water work, a series of drilling companies and equipment were utilized to advance the boreholes for this investigation as follows: Boreholes MR-01, MR-04, RW-05 and RW-06 were advanced with a Diedrich D-50 LC rubber track-mounted drill rig. Boreholes MR-06, MR-07 and MR-09 were advanced with a CME 45 LC rubber track-mounted drill rig. Boreholes MRP-01 and MRP-02 were advanced with a limited access portable drill rig. The Diedrich D-50 LC, CME 45 LC and limited access portable drill rigs were supplied and operated by Marathon Underground Constructors Corporation of Greely, Ontario.

Boreholes MR-02 and MR-05 were advanced with a CME55 truck-mounted drill rig supplied and operated by CCC Geotechnical & Environmental Drilling Ltd. of Ottawa, Ontario.

Borehole MR-10 was advanced with a CME55 low clearance (LC) rubber track-mounted drill rig supplied and operated by George Downing Estate Drilling Ltd. of Hawkesbury, Ontario.

In-water support and equipment were supplied and operated by O.D.S Marine Construction Ltd. of Greely, Ontario.

Traffic control required to close the on-ramp, driving lanes and shoulders of Highway 401 in accordance with the Ontario Traffic Manual, Book 7, Temporary Conditions was provided by Steed and Evans of St. Jacobs, Ontario.

Soil samples were obtained using a 50 mm outer diameter split-spoon sampler in general accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). Soil samples were obtained at vertical sampling intervals of about 0.76 m. HQ or NQ-sized bedrock core samples were obtained using a rotary diamond drilling technique and a triple-tube core-barrel at all boreholes except Boreholes MR-05 and MR-10.

A piezometer was installed in Borehole MR-01, to observe the groundwater level at the site. The piezometer consists of a 24 mm outside diameter PVC tube with a 1.5 m long slotted screen. Well installation details are shown on the record for Borehole MR-01 provided in Appendix A. The monitoring well has been left in place to allow for monitoring of groundwater levels up to the time of construction. As part of the construction, the monitoring well will need to be decommissioned by qualified personnel in accordance with Ontario Regulation 903 (O.Reg. 903), as amended.

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

The boreholes without piezometers 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 O.Reg. 903, as amended. The site conditions were restored following the completion of the field work.

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.

In addition to the borehole investigation, environmental sampling, in-situ and laboratory testing was carried out at Boreholes RW-05, RW-06, MR-01 and MR-02 to provide information for the development of an excess soil management plan for this project. During drilling the collected soils samples from Boreholes RW-05, RW-06, MR-01 and MR-02 were field screened to measure headspace combustible and organic vapour concentrations using a portable RKI Eagle 2 gas monitoring instrument, calibrated to n-hexane for combustible gas measurements and to isobutylene for organic vapour measurement. The field headspace screening results are presented on the borehole records for Boreholes RW-05, RW-06, MR-01 and MR-02 in Appendix A. In addition to in-situ testing, four soil samples were submitted to AGAT Laboratories for environmental laboratory testing/analysis for metals/inorganics, PAHs, and PHCs/BTEX.

The borehole locations and elevations were surveyed by WSP 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, 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)			
MR-01	4895234.1 (44.193610°)	233319.3 (-77.394210°)	93.5	4.5	Bedrock cored
MR-02	4895191.9 (44.193240°)	233365.8 (-77.393620°)	94.9	5.4	Bedrock cored
MR-04	4895222.0 (44.193580°)	233311.9 (-77.394300°)	93.7	4.3	Bedrock cored
MR-05	4895195.7 (44.193272°)	233343.8 (-77.393904°)	95.1	2.7	Auger Refusal
MR-06	4895274.2 (44.193980°)	233424.8 (-77.392900°)	92.7	4.9	Bedrock cored
MR-07	4895259.9 (44.193850°)	233431.9 (-77.392810°)	92.4	4.7	Bedrock cored

Borehole	NAD83 CSRS CBNv6-2010.0 MTM Zone 9		Ground Surface Elevation (m)	Drilled Depths (m)	Comments
	Northing (m) (Latitude)	Easting (m) (Latitude)			
MR-09	4895275.8 (44.194000°)	233449.4 (-77.392590°)	92.6	4.5	Bedrock cored
MR-10	4895236.8 (44.193650°)	233468.2 (-77.392350°)	94.7	2.8	Auger Refusal
MRP-01	4895265.1 (44.193900°)	233381.0 (-77.393448°)	91.1	4.9	Bedrock cored
MRP-02	4895252.2 (44.193785°)	233385.2 (-77.393394°)	91.0	5.7	Bedrock cored
RW-05	4895228.6 (44.193550°)	233292.8 (-77.394540°)	94.1	4.6	Bedrock cored
RW-06	4895223.5 (44.193500°)	233242.4 (-77.395170°)	94.6	6.1	Bedrock cored
MR20-01 ¹	4895216.1 (44.19345°)	233339.6 (-77.39396°)	94.9	5.3	Bedrock cored
MR20-02 ¹	4895224.3 (44.19353°)	233466.7 (-77.39237°)	94.4	6.0	Bedrock cored

NOTE 1. Previous site investigation boreholes (GEOCREs No. 31C-311), see Section 3.4 for more information.

3.2 2023 Geophysical Investigation

In view of the challenges of accessing the existing pier locations within the river and the river bottom along the proposed pier location using conventional drilling equipment, WSP carried out additional investigations to provide appropriate information for the design of the proposed foundations.

The additional field investigations included the following:

- Shear wave velocity profiling carried out using the Multichannel Analysis of Surface Waves (MASW) geophysical technique. The MASW profiling was carried out on November 22, 2022, by WSP personnel. Shear wave velocity profiles were obtained along the proposed north-west approach embankment alignment abutments at the location shown in Drawing 1. A series of 24 low-frequency (4.5 Hz) geophones were laid out at 3 m intervals and an 8 kg sledgehammer and 40 kg drop weight were used as the seismic source.
- Ground Penetrating Radar (GPR) scanning within the river to obtain the bedrock surface elevations immediately adjacent to the two existing piers and along the proposed centre pier. The GPR survey was completed on water using a Sensors & Software Noggin GPR system with 250 MHz antennae attached to a boat in a 'free run' configuration with data sampling at approximately 0.02 m intervals. The GPR data were recorded digitally and transferred to a computer for subsequent data processing. The data were reviewed by the operator on site for quality control by means of the real-time visual display of data. To map the bedrock topography, GPR data was acquired along a series of seven south-east to north-west trending lines adjacent to the existing and proposed piers. Data was acquired at irregularly spaced intervals between the lines to obtain adequate coverage of the survey area. Positioning was recorded with a differential GPS system and GEODETIC coordinates were mapped. The locations of the GPR survey lines are shown on Figure 1 in Appendix F.

3.3 2023 Underwater Visual Survey

An underwater visual survey within Moira River was carried out to assess the depth of the bedrock surface and the weathering and fracturing of the exposed rock adjacent to the existing piers and along the proposed pier alignments. The survey was completed using a Deep Trekker DTG 3 Remote Operated Vehicle (ROV) with a video camera. The DTG 3 is a dual-thruster ROV with a 200 m tether and includes a primary 1,000 lumen light and two 1,000-lumen auxiliary lights on the front of the vehicle. A 4K Ultra HD low-light camera is mounted on a vertical axis, with real-time imagery projected on the controller and stored on an internal micro-SD card. All ROV video was reviewed in real time on the controller viewer during the field surveys and all collected video was reviewed in the office on a larger screen to identify potential features and targeted objects.

The key results of the existing conditions based on a review of the video visual survey are as follows:

- Moira River was shallow with water depths less than 1.0 m along the majority of the survey area, with a strong and fast river current.
- The existing piers and abutments appear to be founded directly on the bedrock surface or founded on a concrete leveling pad overlying bedrock.
- The bedrock surface elevation steps up along the pier alignments from north to south.
- There is little or no sediment or other overburden material overlying the bedrock along the existing bridge abutments and piers and the proposed pier location.
- Some bedrock surface weathering appears to be visible.
- North of the existing Highway 401 bridge within the proposed widening, fractured undulating bedrock is present.

3.4 2020 Preliminary Investigation

A preliminary Foundations investigation for the then proposed replacement option was carried out in 2020. The results of the previous study have been reviewed and used to augment the results of the current foundation investigation. The results of the previous investigations are contained in the following report:

- **MTO GEOCREs No. 31C-311:** “Preliminary Investigation and Design Report, Moira River Bridge Replacement, Highway 401 Widening EA. Site No. 11-162, Highway 401 Widening, Belleville, Ontario G.W.P. 4193-15-00” dated July 2021, prepared by Thurber Engineering Ltd.

A total of two boreholes were advanced at the site as part of the 2020 preliminary investigation. In particular, Boreholes MR20-01 and MR20-02 were advanced at the existing eastbound and westbound abutments, respectively. A copy of the Borehole Location and Soil Strata Drawing and borehole records used to supplement the 2023 investigation are provided for reference in Appendix C. The approximate borehole locations are shown in the Borehole Location and Soil Strata drawing from this GEOCREs report as provided in Appendix C.

4.0 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 Site Stratigraphy Overview

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 Record of Borehole and Drillhole sheets presented in Appendix A. The results of the in-situ field tests as presented in the borehole records and in Section 4.0 are uncorrected and are based on the use of an automatic hammer. The results of the geotechnical laboratory testing carried out during the investigation are presented on the borehole records and on Figures B1 to B4.

The borehole locations and the interpreted stratigraphic profile projected along the proposed overpass alignment are provided in Drawings 1 and 3.

Photographs of the core recovered from the underlying bedrock are shown on Figures A1 to A22, provided in Appendix A. The results of the environmental testing completed on select soil samples are provided in Appendix D.

The geophysical investigation results are presented in the Technical Memorandum provided in Appendix F and include the calculated shear wave velocity profiles measured from the field testing and a graphical representation of the shear wave velocity profiles with depth as well as the interpreted bedrock surface elevation profile.

The stratigraphic boundaries shown on the borehole and drillhole records and on the interpreted stratigraphic section in Drawings 1 and 3 are inferred from observations of the drilling progress and noncontinuous soil sampling and therefore, 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 generally consist of a topsoil or pavement structure (asphalt and pavement granular material) over embankment fill, overlying a glacial till, all underlain by limestone bedrock. This is generally consistent with the conditions encountered in the 2020 investigation.

A more detailed description of the overburdened soil and bedrock deposits encountered during the field investigation is provided in the following sections.

4.1.1 Surface Cover / Surficial Materials

Topsoil with thickness ranging between approximately 50 mm and 150 mm was encountered at the surface of Boreholes MR-01, MR-04, MR-07, MR-09, RW-05 and RW-06.

Asphaltic concrete with thickness ranging between approximately 140 mm and 250 mm was encountered at Boreholes MR-02, MR-05, MR-10, MR20-01 and MR20-02.

4.1.2 Fill

Fill consisting primarily of sand and gravel with varying amounts of silt and clay was encountered below the topsoil or asphalt at all boreholes advanced at the site except MRP-01, MRP-02, and MR-07. The top of this layer was encountered at elevations ranging from 92.5 m to 94.8 m. The thickness of this layer ranged from approximately 0.1 m to 2.7 m. The SPT N-values recorded in this layer range from 3 to 58 blows per 0.3 m of penetration but more typically 4 to 26 blows per 0.3 m, indicating a loose to compact state of compactness. Cobbles and boulders were noted in this layer.

The measured water content of eight samples of the fill ranged from 4% to 13%. The results of grain size analysis testing carried out on seven samples of this material are illustrated in Figure B1 in Appendix B. The results of Atterberg limits testing completed on two samples of the fill material indicate that this material has liquid limits of 30 and 44, plastic limits of 16 and 22, and plasticity indices of 15 and 22. The Atterberg limits analysis results are provided on Figure B2 in Appendix B and indicate the fines fraction of this fill layer consists of clayey silt (CL) to silty clay (CI).

4.1.3 Bedrock

The overburden soils are underlain by limestone bedrock.

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

Refusal on highly weathered bedrock occurred at all boreholes except Boreholes MR-02, MR20-01 and MR20-02. The thickness of this moderately to highly weathered zone ranged from 0.1 m to 0.7 m.

The bedrock surface elevations provided in Table 2 are referenced at the point in which the recovered bedrock core indicates competent bedrock below the moderately to highly weathered zone.

Bedrock mapping results are presented in the Technical Memorandum provided in Appendix F and include bedrock surface mapping and profile drawings along 3 lines surveyed during the Geophysical field work. The results have also been included in the bedrock surface profile on Drawings 1 to 3.

Table 2: Summary of Bedrock Surface Depths and Elevations

Borehole	Existing Ground Surface Elevation (m)	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)
MR-01	93.5	0.9	92.6
MR-02	94.9	2.5	92.4
MR-04	93.7	1.0	92.7
MR-06	92.7	0.5	92.2
MR-07	92.4	0.1	92.3
MR-09	92.6	0.5	92.1
MRP-01	91.1	0.7	90.4
MRP-02	91.0	1.0	90.0
RW-05	94.1	1.2	93.0
RW-06	95.0	1.7	93.3
MR20-01	94.9	2.3	92.6
MR20-02	94.4	2.9	91.5

Rock Quality Designation (RQD) values measured on the recovered limestone bedrock core samples range from about 13% to 100%, but more commonly 61% to 99% indicating a fair to excellent rock quality. The results of UCS testing carried out on nine bedrock core sample gave UCS values ranging from 62 MPa to 138 MPa, indicating strong to very strong bedrock; these results are provided on Figures B3 and B4 in Appendix B.

4.2 Groundwater Conditions

A piezometer was installed in Borehole MR-01 to measure the groundwater level at the site. The groundwater levels measured in the piezometer, and the open-hole water levels, are presented in Table 3 and Table 4 respectively.

The groundwater level was not measured in Boreholes MR-04, MR-06, MR-07, MR-09, MRP-01 and MRP-02 due to the introduction of water for wash boring and coring.

It is expected that the groundwater levels will be subject to fluctuations both seasonally and as a result of precipitation events.

Table 3: Summary of Groundwater Conditions

Borehole	Screened Interval	Ground Surface Elevation (m)	Depth to Groundwater Level (m)	Groundwater Elevation (m)	Date
MR-01	Limestone Bedrock	93.5	1.4	92.1	July 27, 2023
			1.7	91.8	February 16, 2024

Table 4: Summary of Open Borehole Groundwater Levels

Borehole	Ground Surface Elevation (m)	Depth to Groundwater Level (m)	Groundwater Elevation (m)	Date
MR-02	94.9	-	-	Borehole dry upon completion of drilling
MR-05	95.1	-	-	Borehole dry upon completion of drilling
MR-10	94.7	2.3	92.4	July 20, 2023
RW-05	94.1	0.3	93.8	July 24, 2023
RW-06	95.0	1.0	94.0	July 24, 2023
MR20-01	94.9	2.1	92.8	November 12, 2020
MR20-02	94.4	2.7	91.7	November 11, 2020

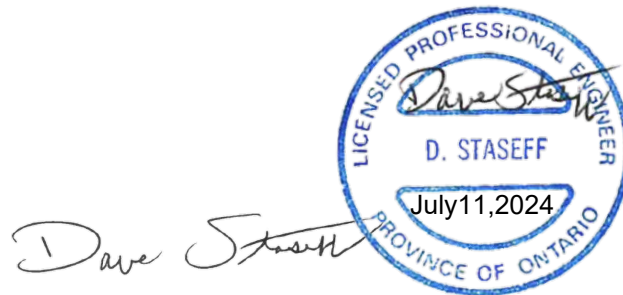
5.0 CLOSURE

This report was prepared by Ben Waechter, EIT and reviewed by Kenton Power, P.Eng., a senior geotechnical engineer with WSP. David Staseff, P.Eng., a Senior Principal Geotechnical Engineer and MTO Principal Foundations Contact for WSP conducted an independent technical and quality review of this report.

WSP Canada Inc.



Kenton Power, P.Eng.
Geotechnical Engineer



David Staseff, P.Eng.
MTO Principal Foundations Contact

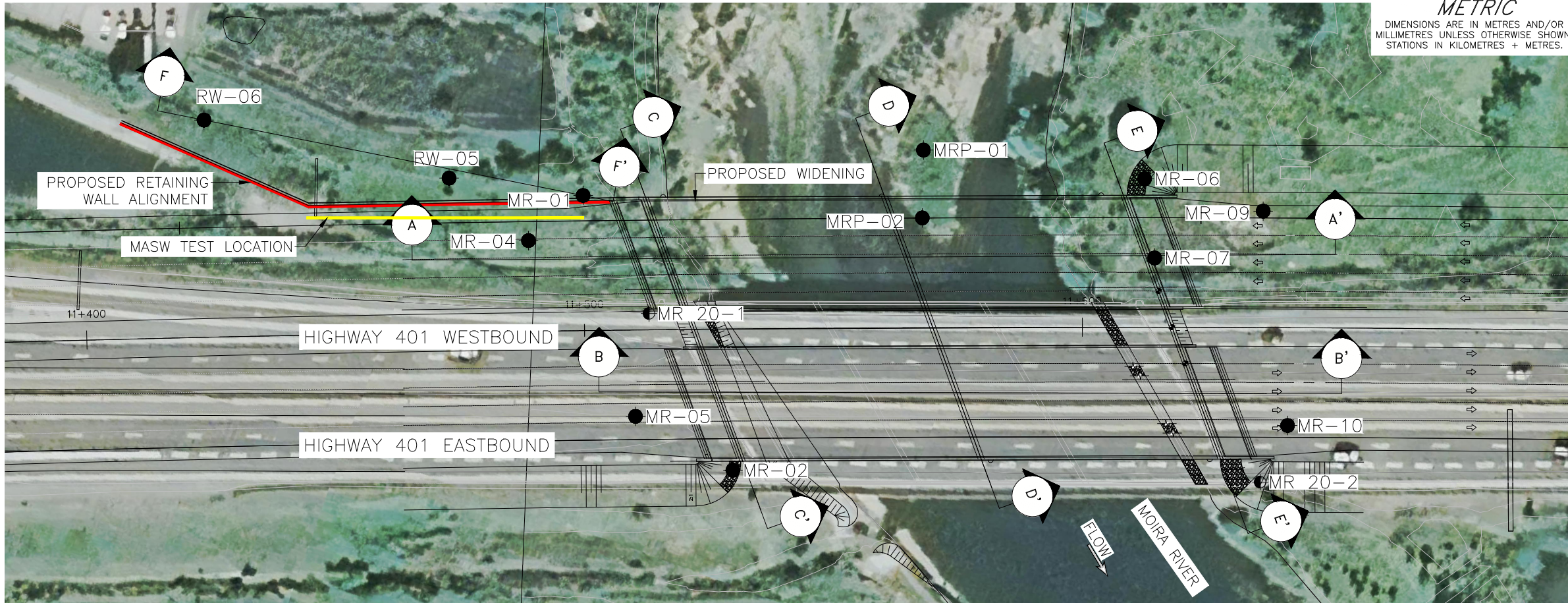
BW/KCP/DS/yj

[https://wsponlinecan.sharepoint.com/sites/ca-ca00060993147/shared documents/06. deliverables/moira river/2-final/gwp 4053-18-00 final fir moira river op & rw \(11-162\) 2024-06-28 \(ca0006099.3147\).docx](https://wsponlinecan.sharepoint.com/sites/ca-ca00060993147/shared%20documents/06.%20deliverables/moira%20river/2-final/gwp%204053-18-00%20final%20fir%20moira%20river%20op%20&%20rw%20(11-162)%202024-06-28%20(ca0006099.3147).docx)

DRAWINGS

Drawings 1 to 3

Borehole Locations and Soil Strata



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

CONT No. _____
GWP No. 4053-18-00



HIGHWAY 401 WIDENING
MOIRA RIVER BRIDGE
BOREHOLE LOCATIONS AND SOIL
STRATA

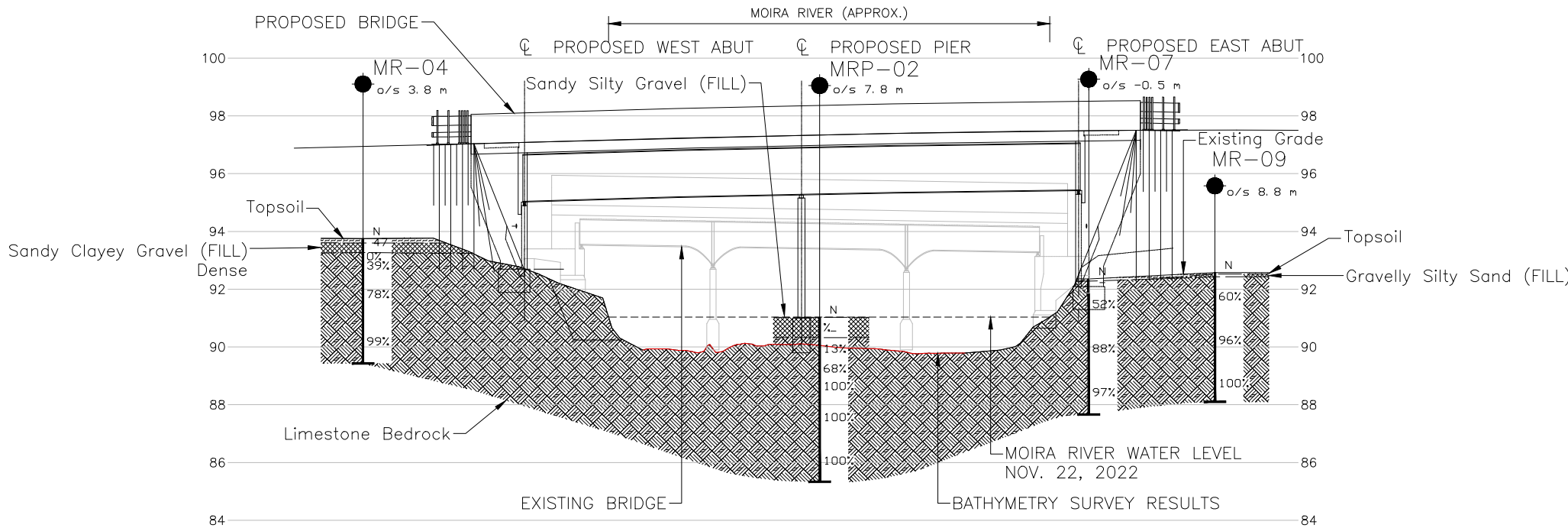
SHEET



KEY PLAN
SCALE
1 0 1 2 km

LEGEND

- Borehole - Current Investigation
- ⊕ Borehole - Previous Investigation GEOCREs No. 31C-311
- ⊥ 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)



BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
MR-01	93.5	4895234.1	233319.3
MR-02	94.9	4895191.9	233365.8
MR-04	93.7	4895222.0	233311.9
MR-05	95.1	4895195.7	233343.8
MR-06	92.7	4895274.2	233424.8
MR-07	92.4	4895259.9	233431.9
MR-09	92.6	4895275.9	233449.5
MR-10	94.7	4895236.8	233468.2
MR 20-1	94.9	4895216.1	233339.6
MR 20-2	94.4	4895224.3	233466.7
MRP-01	91.1	4895265.1	233381.0
MRP-02	91.0	4895252.2	233385.2
RW-05	94.1	4895228.6	233292.8
RW-06	94.6	4895223.5	233242.4

Structural Site Location: Latitude: 44.193610 Longitude: -77.394210

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.

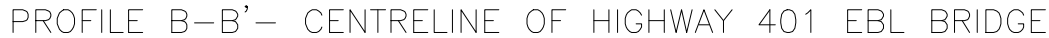
REFERENCES

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 by WSP file nos. S16M-01435-01-340-001GA.dwg and S16M-01435-01-340-002GA.dwg, received January 25, 2024.
Imagery source © 2023 Microsoft Corporation © Maxar © CNES (2023) Distribution Airbus DS

PROFILE A-A' - CENTRELINE OF HIGHWAY 401 WBL BRIDGE

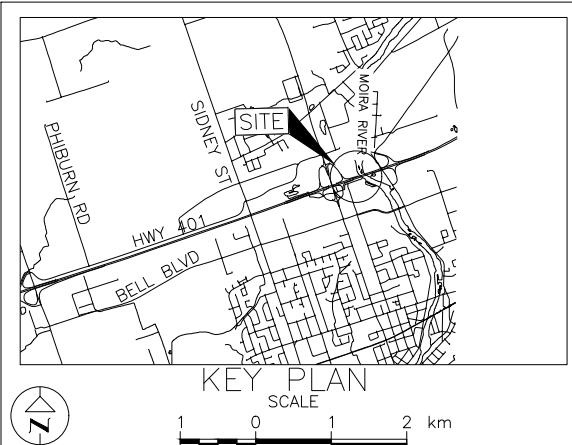


NO.	DATE	BY	REVISION
Geocres No. 31C03-003			
HWY. 401		PROJECT NO. CA0006099.3147	
SUBM'D. BW		DIST. EASTERN	
CHKD. KCP		DATE: 07/12/2024	
DRAWN: SA/DD		SITE: 11-162	
CHKD. KCP		APPD. DS	
		DWG. 1	









CONT No.
GWP No. 4053-18-00

SHEET



LEGEND

	Borehole – Current Investigation
	Previous Investigation GEOCREs No. 31C–311
	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 July 27, 2023
	WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
MR-01	93.5	4895234.1	233319.3
MR-02	94.9	4895191.9	233365.8
MR-05	95.1	4895195.7	233343.8
MR-10	94.7	4895236.8	233468.2
MR 20-1	94.9	4895216.1	233339.6

Structural Site Location: Latitude: 44.193610 Longitude: -77.394210

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.

NO.	DATE	BY	REVISION	
Geocres No. 31C03-003				
HWY. 401		PROJECT NO. CA0006099.3147		DIST. EASTERN
SUBM'D. BW	CHKD. KCP	DATE: 07/12/2024		SITE: 11X-0162
DRAWN: SA/DD	CHKD. KCP	APPD. DS		DWG. 2



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

CONT No. _____
GWP No. 4053-18-00

HIGHWAY 401 WIDENING
MOIRA RIVER BRIDGE

SOIL STRATA



KEY PLAN
SCALE 1 0 1 2 km

LEGEND

- Borehole - Current Investigation
- Previous Investigation GEOCREs No. 31C-311
- ⊥ 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 July 27, 2023
- ≡ WL upon completion of drilling

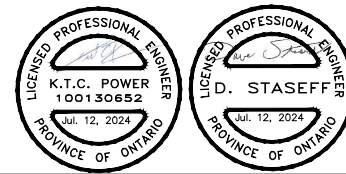
BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
MR-01	93.5	4895234.1	233319.3
MR-06	92.7	4895274.2	233424.8
MR-09	92.6	4895275.9	233449.5
MR 20-2	94.4	4895224.3	233466.7
MRP-01	91.1	4895265.1	233381.0
MRP-02	91.0	4895252.2	233385.2
RW-05	94.1	4895228.6	233292.8
RW-06	94.6	4895223.5	233242.4

Structural Site Location: Latitude: 44.193610 Longitude: -77.394210

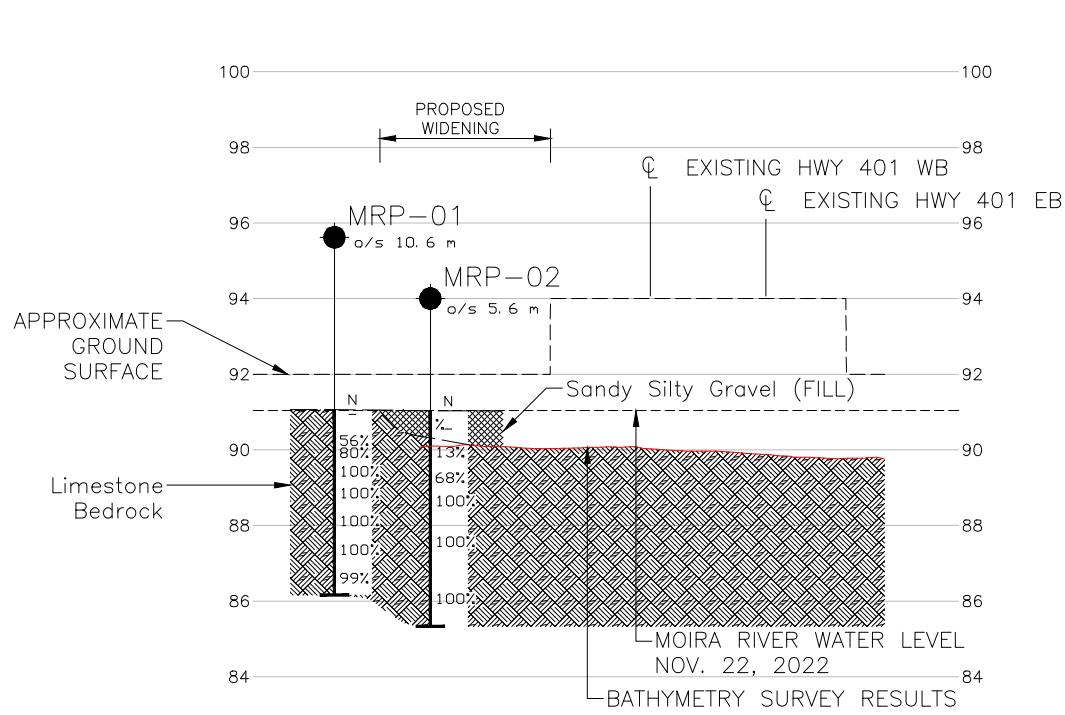
NOTES

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.

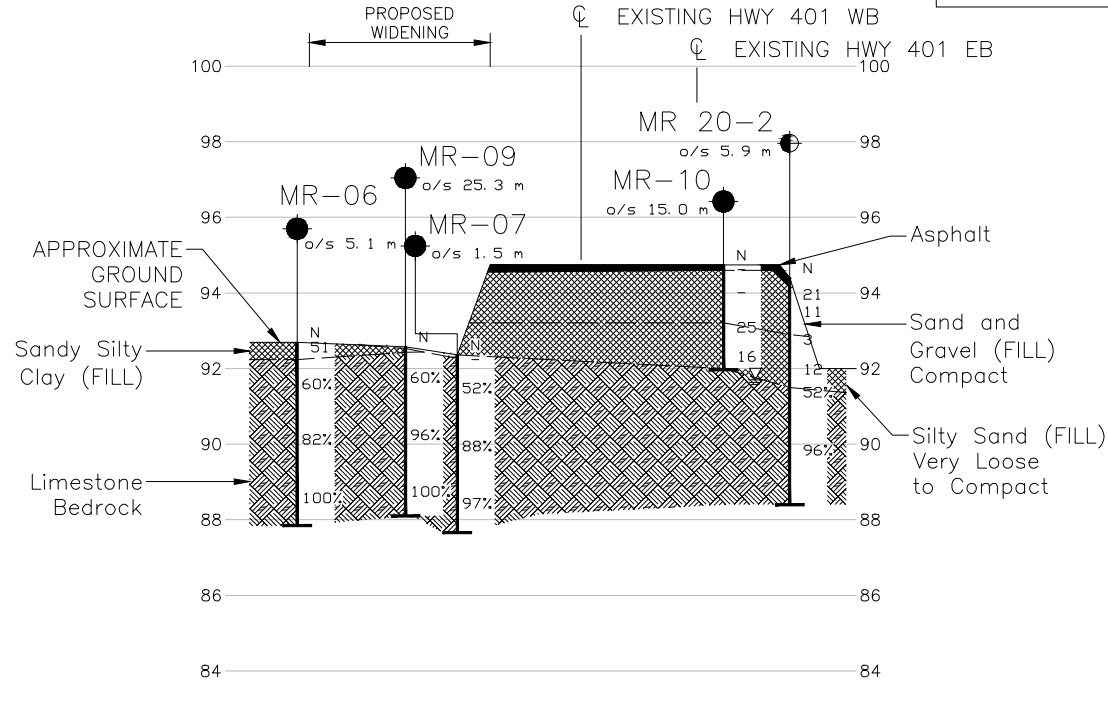
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.



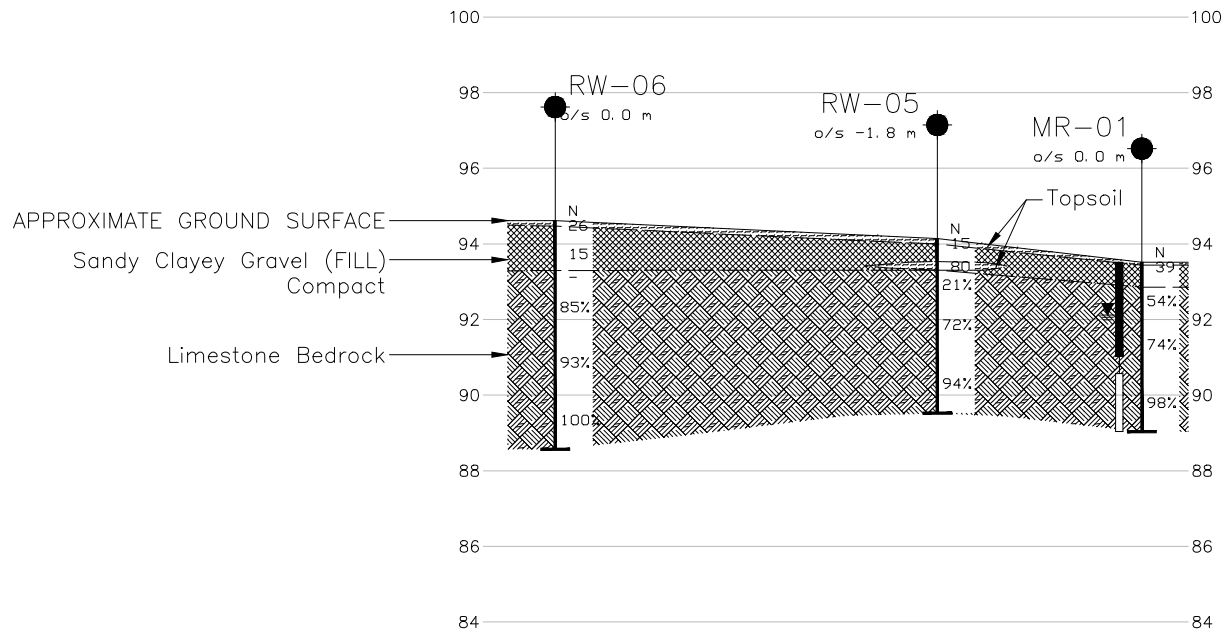
Geocres No. 31C03-003			
HWY. 401	PROJECT NO. CA0006099.3147		
SUBM'D. BW	CHKD. KCP	DATE: 07/12/2024	SITE: 11X-0162
DRAWN: SA/DD	CHKD. KCP	APPD. DS	DWG. 3



SECTION D-D' - CENTRE PIER



SECTION E-E' - EAST ABUTMENT



SECTION F-F' - PROPOSED RETAINING WALL



APPENDIX A

Borehole Records

Lists of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Records of Boreholes and Drill Holes

Bedrock Core Photographs, Figures A1 and A10

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>i.e.</i> , SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (<i>i.e.</i> , some sand)
≤ 10	trace (<i>i.e.</i> , trace fines)

1. Only applicable to components not described by Primary Group Name.

2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve friction (f_s) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

SAMPLES

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

SOIL TESTS

w	water content
PL, w_p	plastic limit
LL, w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D_R	relative density (specific gravity, G_s)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
Y	unit weight

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

COARSE-GRAINED SOILS

Compactness¹

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

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

2. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

FINE-GRAINED SOILS

Consistency

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

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

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

Field Moisture Condition

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

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

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

I. GENERAL

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

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)

σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
$C_{a(e)}$	secondary compression index
C_a	rate of secondary compression
$C_{a(e)}$	modified secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

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

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

Notes: 1
2

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

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING CLASSIFICATION

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

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery (TCR)

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

Dip with Respect to Core Axis

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

Description and Notes

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

Abbreviations

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

ISRM Intact Rock Material Strength Classification

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



PROJECT CA0006099.3147

RECORD OF BOREHOLE No MR-01

SHEET 1 OF 1

METRIC

G.W.P. 4053-18-00

LOCATION N 4895234.1; E 233319.3 MTM NAD 83 ZONE 9 (LAT. 44.193610; LONG. -77.394210)

ORIGINATED BY RI

DIST Eastern HWY 401

BOREHOLE TYPE Diedrich D-50 Rotary Drill-Wash Boring; NW Casing

COMPILED BY BW

DATUM Geodetic

DATE June 25, 2023

CHECKED BY KCP/LCC

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 (%)		
92.9	GROUND SURFACE																			
0.7	TOPSOIL (80 mm)		1	SS	39											56 28 (16)				
92.2	Sandy CLAYEY GRAVEL (GC), contains trace organic matter, rootlets, cobbles (FILL)		1	RC	REC 98%											RQD = 54%				
91.8	Dense Brown to dark brown Moist																			
1.1	Moderately weathered/fractured LIMESTONE (BEDROCK)		2	RC	REC 100%											RQD = 74%				
	LIMESTONE (BEDROCK)																			
	Bedrock cored from 0.7 m to 4.5 m		3	RC	REC 100%											RQD = 98%				
	For rock coring details see Record of Drillhole MR-01																			
88.4	END OF BOREHOLE																			
4.5	NOTES: 1. Water level in well measured at a depth of 1.4 m (Elev. 91.5 m) on July 27, 2023. 2. The following soil sample headspace vapour readings were obtained in the field: Sample HEX (ppm) IBL (ppm) 1 15 1 Background 15 0																			

GTA-MTO 001 S:\CLIENTS\MTOWHY_401_BELLEVILLE\02_DATA\GINT\HWY_401_BELLEVILLE.GPJ GAL-GTA.GDT 6/6/24

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon

[illegible]

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: KCP/LCC

STA-RCK 046 S:\CLIENTS\IMTO\HWY_401_BELLEVILLE\02_DATA\GINTHWY_401_BELLEVILLE.GPJ GAL-MISS.GDT 6/6/24



PROJECT CA0006099.3147

RECORD OF BOREHOLE No MR-02

SHEET 1 OF 1

METRIC

G.W.P. 4053-18-00

LOCATION N 4895191.9; E 233365.8 MTM NAD 83 ZONE 9 (LAT. 44.193240; LONG. -77.393620)

ORIGINATED BY DG

DIST Eastern HWY 401

BOREHOLE TYPE CME55 LC Power Auger 200 mm O.D; Hollow Stem Auger; HW Casing

COMPILED BY BW

DATUM Geodetic

DATE June 26, 2023

CHECKED BY KCP/LCC

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		
								20	40	60	80	100					
94.9	GROUND SURFACE																
0.0	ASPHALT (250 mm)																
0.3	Sandy GRAVEL (GP) contains cobbles and boulders (FILL) Brown		1	GS	-												
			2	GS	-												
			3	SS	10												
92.4			4	SS	50/0.03												
2.5	LIMESTONE (BEDROCK)		1	RC	REC 100%											RQD = 100%	
	Bedrock cored from 2.5 m to 5.4 m		2	RC	REC 100%											RQD = 88%	
	For rock coring details see Record of Drillhole MR-02		3	RC	REC 100%											RQD = 100%	
89.5	END OF BOREHOLE																
5.4	NOTE: 1. Borehole dry upon completion of drilling and prior to the introduction of water for wash boring and coring.																

GTA-MTO 001 S:\CLIENTS\MTOWHY_401_BELLEVILLE\02_DATA\GINT\HWY_401_BELLEVILLE.GPJ GAL-GTA.GDT 6/6/24

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

PROJECT: CA0006099.3147

RECORD OF DRILLHOLE: MR-02

SHEET 1 OF 1

LOCATION: N 4895191.90 ;E 233365.83

DRILLING DATE: June 27, 2023

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 55-Truck

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY																		FEATURES	PIEZOMETER																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
						RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA					WEATH- ERING INDEX					Diametral Point Load Index (MPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
						TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja	J _{son}	W1	W2	W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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		Continued from Record of Borehole MR-02		92.44																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															

UCS=62 MPa

DEPTH SCALE

1 : 50



LOGGED: DG

CHECKED: KCP/LCC



PROJECT		RECORD OF BOREHOLE		No MR-04		SHEET 1 OF 1		METRIC															
G.W.P. 4053-18-00		LOCATION		N 4895222.0; E 233311.9 MTM NAD 83 ZONE 9 (LAT. 44.193580; LONG. -77.394300)		ORIGINATED BY		RI															
DIST Eastern HWY 401		BOREHOLE TYPE		Diedrich D-50 LC Rotary Drill-Wash Boring; NW Casing		COMPILED BY		BW															
DATUM Geodetic		DATE		June 25, 2023		CHECKED BY		KCP/LCC															
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																		
93.7	GROUND SURFACE																						
0.0	TOPSOIL (150 mm)																						
93.2	Sandy CLAYEY GRAVEL (GC), contains cobbles (FILL)		1	SS	47																		
0.5	Dense Dark brown Moist		1	RC	REC 32%																		
92.7	Highly weathered /fractured LIMESTONE (BEDROCK)		2	RC	REC 98%																		
1.1	LIMESTONE (BEDROCK)																						
	Bedrock cored from 0.5 m to 4.3 m		3	RC	REC 100%																		
	For rock coring details see Record of Drillhole MR-04																						
			4	RC	REC 100%																		
89.4	END OF BOREHOLE																						
4.3	NOTE: 1. Water level was not measured in borehole following completion of drilling due to introduction of water for wash boring and coring.																						

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon

www

LOGGED: RI

CHECKED: KCP/LCC



PROJECT		RECORD OF BOREHOLE				No MR-05		SHEET 1 OF 1		METRIC							
G.W.P. 4053-18-00		LOCATION N 4895195.7; E 233343.8 MTM NAD 83 ZONE 9 (LAT. 44.193272; LONG. -77.393904)				ORIGINATED BY DG											
DIST Eastern HWY 401		BOREHOLE TYPE CME55 LC Power Auger 200 mm O.D; Hollow Stem Auger				COMPILED BY BW											
DATUM Geodetic		DATE June 27, 2023				CHECKED BY KCP/LCC											
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									
95.1	GROUND SURFACE																
0.0	ASPHALT (250 mm)																
0.5	Gravelly SAND (SP) (FILL) Brown		1	GS	-												
	2		GS	-													
	3		GS	-													
93.6	Sandy GRAVEL (GP) contains cobbles and boulders (FILL) Brown																
1.5	Gravelly CLAYEY SAND (SC/GC), contains cobbles and boulders (FILL) Brown to dark brown Moist		4	SS	58												
	5		SS	56													
92.4	END OF BOREHOLE AUGER REFUSAL ON INFERRED BEDROCK																
2.7	NOTE: 1. Borehole dry upon completion of drilling.																



PROJECT		RECORD OF BOREHOLE		No MR-06		SHEET 1 OF 1		METRIC																						
G.W.P.		LOCATION		N 4895274.2; E 233424.8 MTM NAD 83 ZONE 9 (LAT. 44.193980; LONG. -77.392900)		ORIGINATED BY		RI																						
DIST		HWY		BOREHOLE TYPE		CME 45 LC Rotary Drill-Wash Boring; NW Casing		COMPILED BY		BW																				
DATUM		Geodetic		DATE		June 27, 2023		CHECKED BY		KCP/LCC																				
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)															
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20	40	60	80	100	W _p	W	W _L	γ	GR	SA	SI	CL									
92.7	0.0	GROUND SURFACE																												
92.2	0.6	Sandy SILTY CLAY (CL) , trace gravel, contains cobbles and organic matter (FILL) Brown to dark brown		1	SS	51																								
		Moderately weathered /fractured LIMESTONE (BEDROCK)		1	RC	REC 100%		92													RQD = 60%									
		Bedrock cored from 0.5 m to 5.0 m						91																						
		For rock coring details see Record of Drillhole MR-06		2	RC	REC 93%		90													RQD = 82%									
				3	RC	REC 100%		89													RQD = 100%									
87.9	4.9	END OF BOREHOLE						88																						
<p>NOTES:</p> <p>1. Water level was not measured in borehole following completion of drilling due to introduction of water for wash boring and coring.</p> <p>2. The following soil sample headspace vapour readings were obtained in the field:</p> <table border="1"><thead><tr><th>Sample</th><th>HEX (ppm)</th><th>IBL (ppm)</th></tr></thead><tbody><tr><td>1</td><td>15</td><td>1</td></tr><tr><td>Background</td><td>15</td><td>0</td></tr></tbody></table>																						Sample	HEX (ppm)	IBL (ppm)	1	15	1	Background	15	0
Sample	HEX (ppm)	IBL (ppm)																												
1	15	1																												
Background	15	0																												

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SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon

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CHECKED: KCP/LCC



PROJECT CA0006099.3147

RECORD OF BOREHOLE No MR-07

SHEET 1 OF 1

METRIC

G.W.P. 4053-18-00

LOCATION N 4895259.9; E 233431.9 MTM NAD 83 ZONE 9 (LAT. 44.193850; LONG. -77.392810)

ORIGINATED BY RI

DIST Eastern HWY 401

BOREHOLE TYPE CME 45 LC Rotary Drill-Wash Boring; NW Casing

COMPILED BY BW

DATUM Geodetic

DATE June 27, 2023

CHECKED BY KCP/LCC

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		
								20	40	60	80	100					
92.4	GROUND SURFACE																
0.0	TOPSOIL (90 mm)		1	GS	-												
92.0	Moderately weathered/fractured LIMESTONE (BEDROCK)																
0.4	LIMESTONE (BEDROCK)																
	Bedrock cored from 0.1 m to 4.7 m		1	RC	REC 88%											RQD = 52%	
	For rock coring details see Record of Drillhole MR-07		2	RC	REC 100%											RQD = 88%	
			3	RC	REC 100%											RQD = 97%	
87.7	END OF BOREHOLE																
4.7	NOTE: 1. Water level was not measured in borehole following completion of drilling due to introduction of water for wash boring and coring.																

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PROJECT: CA0006099.3147

RECORD OF DRILLHOLE: MR-07

SHEET 1 OF 1

LOCATION: N 4895259.87 ;E 233431.94

DRILLING DATE: June 27, 2023

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D-50 Rubber Track

DRILLING CONTRACTOR: Marathon

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY																FEATURES	PIEZOMETER																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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						TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jzon	W1	W2	W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: KCP/LCC

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PROJECT CA0006099.3147

RECORD OF BOREHOLE No MR-09

SHEET 1 OF 1

METRIC

G.W.P. 4053-18-00

LOCATION N 4895275.9; E 233449.5 MTM NAD 83 ZONE 9 (LAT. 44.194000; LONG. -77.392590)

ORIGINATED BY RI

DIST Eastern HWY 401

BOREHOLE TYPE CME 45 LC Rotary Drill-Wash Boring; NW Casing

COMPILED BY BW

DATUM Geodetic

DATE July 27, 2023

CHECKED BY KCP/LCC

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		
								20	40	60	80	100					
92.6	GROUND SURFACE																
0.0	TOPSOIL (50 mm)																
92.1	Gravelly SILTY SAND (SW-GW) (FILL)																
0.5	Brown Wet		1	RC	REC 96%											RQD = 60%	
	Slightly weathered LIMESTONE (BEDROCK)																
	LIMESTONE (BEDROCK)																
	Bedrock cored from 0.2 m to 4.5 m		2	RC	REC 100%											RQD = 96%	
	For rock coring details see Record of Drillhole MR-09																
			3	RC	REC 100%											RQD = 100%	
88.1	END OF BOREHOLE																
4.5	NOTE: 1. Water level was not measured in borehole following completion of drilling due to introduction of water for wash boring and coring.																

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SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon

[illegible]

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: KCP/LCC



PROJECT CA0006099.3147

RECORD OF BOREHOLE No MR-10

SHEET 1 OF 1

METRIC

G.W.P. 4053-18-00

LOCATION N 4895236.8; E 233468.2 MTM NAD 83 ZONE 9 (LAT. 44.193650; LONG. -77.392350)

ORIGINATED BY BW

DIST Eastern HWY 401

BOREHOLE TYPE CME55 LC Power Auger, 108 mm Hollow Stem Auger

COMPILED BY BW

DATUM Geodetic

DATE July 20, 2023

CHECKED BY KCP/LCC

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		
94.7	GROUND SURFACE																
0.0	ASPHALT (140 mm)																
0.1	SAND and gravel (SP/GW) (FILL)		1	AS	-												
94.1	Brown to grey Moist																
0.6	SAND (SP-SM), trace non-plastic fines (FILL) Brown Moist		2	AS	-												
93.2	CLAYEY SAND (SC/GC), contains asphalt fragments (FILL) Compact Grey-brown Moist to wet		3	SS	25												
1.5																	
			4A	SS	16												
91.9	END OF BOREHOLE AUGER REFUSAL ON INFERRED BEDROCK		4B														
2.8																	
	NOTES: 1. Water level was measured in the open borehole at a depth of 2.3 m (Elev. 92.4 m) following completion of drilling.																

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PROJECT

CA0006099.3147

RECORD OF BOREHOLE

No MRP-01

SHEET 1 OF 1

METRIC

G.W.P.

4053-18-00

LOCATION

N 4895265.1; E 233381.0 MTM NAD 83 ZONE 9 (LAT. 44.193900; LONG. -77.393448)

ORIGINATED BY

RI

DIST

Eastern

HWY

401

BOREHOLE TYPE

Fordia Explo Portable; Rotary Drill-Wash Boring; NW Casing

COMPILED BY

BW

DATUM

Geodetic

DATE

June 20, 2023

CHECKED BY

KCP/LCC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED									
91.1	GROUND SURFACE						20	40	60	80	100						
0.0	Mixture of Highly Weathered bedrock and Sandy SILTY GRAVEL (GM), contains organic matter and rootlets		1	GS	-												
90.4																	
0.7	LIMESTONE (BEDROCK)		1	RC	REC 84%											RQD = 56%	
	Bedrock cored from 0.7 m to 4.9 m		2	RC	REC 86%											RQD = 80%	
	For rock coring details see Record of Drillhole MRP-01		3	RC	REC 100%											RQD = 100%	
			4	RC	REC 100%											RQD = 100%	
			5	RC	REC 100%											RQD = 100%	
			6	RC	REC 100%											RQD = 100%	
			7	RC	REC 100%											RQD = 99%	
86.2	END OF BOREHOLE																
4.9	NOTE: 1. Water level was not measured in borehole following completion of drilling due to introduction of water for wash boring and coring.																

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PROJECT: CA0006099.3147

RECORD OF DRILLHOLE: MRP-01

SHEET 1 OF 1

LOCATION: N 4895265.12 ;E 233380.97

DRILLING DATE: June 20, 2023

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Fordia Explo Rig

DRILLING CONTRACTOR: Marathon

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY																FEATURES	PIEZOMETER																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: KCP/LCC

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PROJECT CA0006099.3147

RECORD OF BOREHOLE No MRP-02

SHEET 1 OF 1

METRIC

G.W.P. 4053-18-00

LOCATION N 4895252.2; E 233385.2 MTM NAD 83 ZONE 9 (LAT. 44.193785; LONG. -77.393394)

ORIGINATED BY RI

DIST Eastern HWY 401

BOREHOLE TYPE Fordia Explo Portable; Rotary Drill-Wash Boring; NW Casing

COMPILED BY BW

DATUM Geodetic

DATE June 18, 2023

CHECKED BY KCP/LCC

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		
91.0	GROUND SURFACE																
0.0	Sandy SILTY GRAVEL (GM) (FILL)		1	RC	REC 0%											RQD = 0%	
90.3	Slightly weathered LIMESTONE (BEDROCK)		2	RC	REC 90%											RQD = 13%	
90.0	LIMESTONE (BEDROCK)		3	RC	REC 100%											RQD = 68%	
1.0	Bedrock cored from 0.7 m to 5.7 m For rock coring details see Record of Drillhole MRP-02		4	RC	REC 100%											RQD = 100%	
			5	RC	REC 100%											RQD = 100%	
			6	RC	REC 100%											RQD = 100%	
85.3	END OF BOREHOLE																
5.7	NOTE: 1. Water level was not measured in borehole following completion of drilling due to introduction of water for wash boring and coring.																

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PROJECT: CA0006099.3147

RECORD OF DRILLHOLE: MRP-02

SHEET 1 OF 1

LOCATION: N 4895252.20 ;E 233385.21

DRILLING DATE: June 18, 2023

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Fordia Explo Rig

DRILLING CONTRACTOR: Marathon

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY																FEATURES	PIEZOMETER																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
						RECOVERY		R.Q.D. %	FRACT. INDEX PER	DISCONTINUITY DATA					WEATH- ERING INDEX					Diametral Point Load Index (MPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
						TOTAL CORE %	SOLID CORE %			DIP W/L CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jzon	W1	W2	W3	W4	W5		W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
0		Continued from Record of Borehole MRP-02		91.03																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: KCP/LCC

GTA-RCK 046 S:\CLIENTS\MT\HWY 401 BELLEVILLE\02 DATA\GINT\HWY 401 BELLEVILLE.GPJ GAL-MISS.GDT 6/6/24

[illegible]

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

[illegible]



PROJECT CA0006099.3147

RECORD OF BOREHOLE No RW-06

SHEET 1 OF 1

METRIC

G.W.P. 4053-18-00

LOCATION N 4895223.5; E 233242.4 MTM NAD 83 ZONE 9 (LAT. 44.193500; LONG. -77.395170)

ORIGINATED BY RI

DIST Eastern HWY 401

BOREHOLE TYPE Diedrich D-50 LC, Rotary Drill-Wash Boring; NW Casing

COMPILED BY BW

DATUM Geodetic

DATE June 24, 2023

CHECKED BY KCP/LCC

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		
								20	40	60	80	100					
94.6	GROUND SURFACE																
0.0	TOPSOIL (150 mm)																
0.2	Sandy CLAYEY GRAVEL (GC), trace organic matter (FILL)		1	SS	26											56 29 (15)	
93.8	Compact Brown Moist		2	SS	15												
93.3	Sandy SILTY GRAVEL (GM/GC), contains trace organic matter, cobbles (FILL)		3	SS	-												
1.6	Compact Brown Moist to wet																
	Moderately weathered LIMESTONE (BEDROCK)		1	RC	REC 100%											RQD = 85%	
	LIMESTONE (BEDROCK)																
	Bedrock cored from 1.6 m to 6.1 m																
	For rock coring details see Record of Drillhole RW-06		2	RC	REC 100%											RQD = 93%	
			3	RC	REC 100%											RQD = 100%	
88.6	END OF BOREHOLE																
6.1	NOTES: 1. Water level was not measured in borehole following completion of drilling due to introduction of water for wash boring and coring. 2. The following soil sample headspace vapour readings were obtained in the field: Sample HEX (ppm) IBL (ppm) 1 25 1 2 5 1 3 25 1 Background 20 0																

GTA-MTO 001 S:\CLIENTS\MTOWHY_401_BELLEVILLE\02_DATA\GINT\HWY_401_BELLEVILLE.GPJ GAL-GTA.GDT 6/6/24

MR-01 (Dry)

Core Box 1 to 2 of 2

Weathered/Fractured Bedrock

Elevation 92.6 m Top of "Sound" Bedrock



Elevation 89.0 m End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A1

MR-01 (Wet)
Core Box 1 to 2 of 2

Weathered/Fractured Bedrock

Elevation 92.6 m Top of "Sound" Bedrock



Elevation 89.0 m End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A2

MR-02 (Dry)
Core Box 1 of 1

Elevation 92.4 m Top of Bedrock



Elevation 89.5 m End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A3

MR-02 (Dry)
Core Box 1 of 1

Elevation 92.4 m Top of Bedrock



Elevation 89.5 m End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A4

MR-04 (Dry)
Core Box 1 to 2 of 2

Weathered/Fractured Bedrock

Elevation 92.7 m Top of "Sound" Bedrock



Elevation 89.4 m
End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A5

MR-04 (Wet)
Core Box 1 to 2 of 2

Weathered/Fractured Bedrock

Elevation 92.7 m Top of "Sound" Bedrock



Elevation 89.4 m
End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

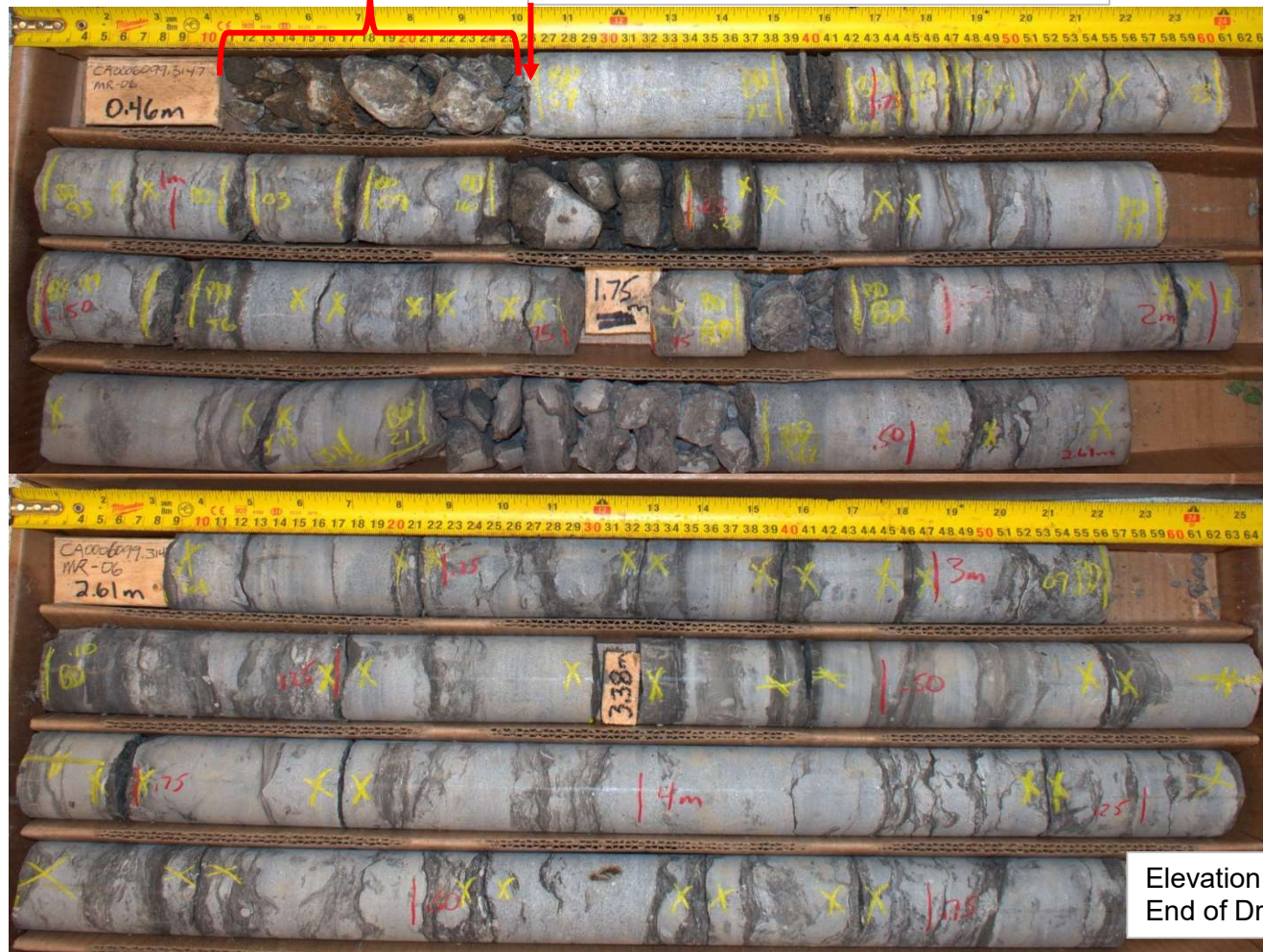
Figure A6

MR-06 (Dry)

Core Box 1 to 2 of 2

Weathered/Fractured Bedrock

Elevation 92.2 m Top of "Sound" Bedrock



Elevation 87.9 m
End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A7

MR-06 (Wet)
Core Box 1 to 2 of 2

Weathered/Fractured Bedrock

Elevation 92.2 m Top of "Sound" Bedrock



Elevation 87.9 m
End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A8

MR-07 (Dry)

Core Box 1 to 2 of 2

Weathered/Fractured Bedrock

Elevation 92.3 m Top of "Sound" Bedrock

Note 1.
Clayey
Sand Infill



Elevation 87.7 m
End of Drillhole

Note 1. Clayey Sand infill between 1.00 m and 1.02 m depth



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A9

MR-07 (Wet)

Core Box 1 to 2 of 2

Weathered/Fractured Bedrock

Elevation 92.3 m Top of "Sound" Bedrock

Note 1.
Clayey
Sand Infill



Elevation 87.7 m
End of Drillhole

Note 1. Clayey Sand infill between 1.00 m and 1.02 m depth



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A10

MR-09 (Dry)
Core Box 1 to 2 of 2



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

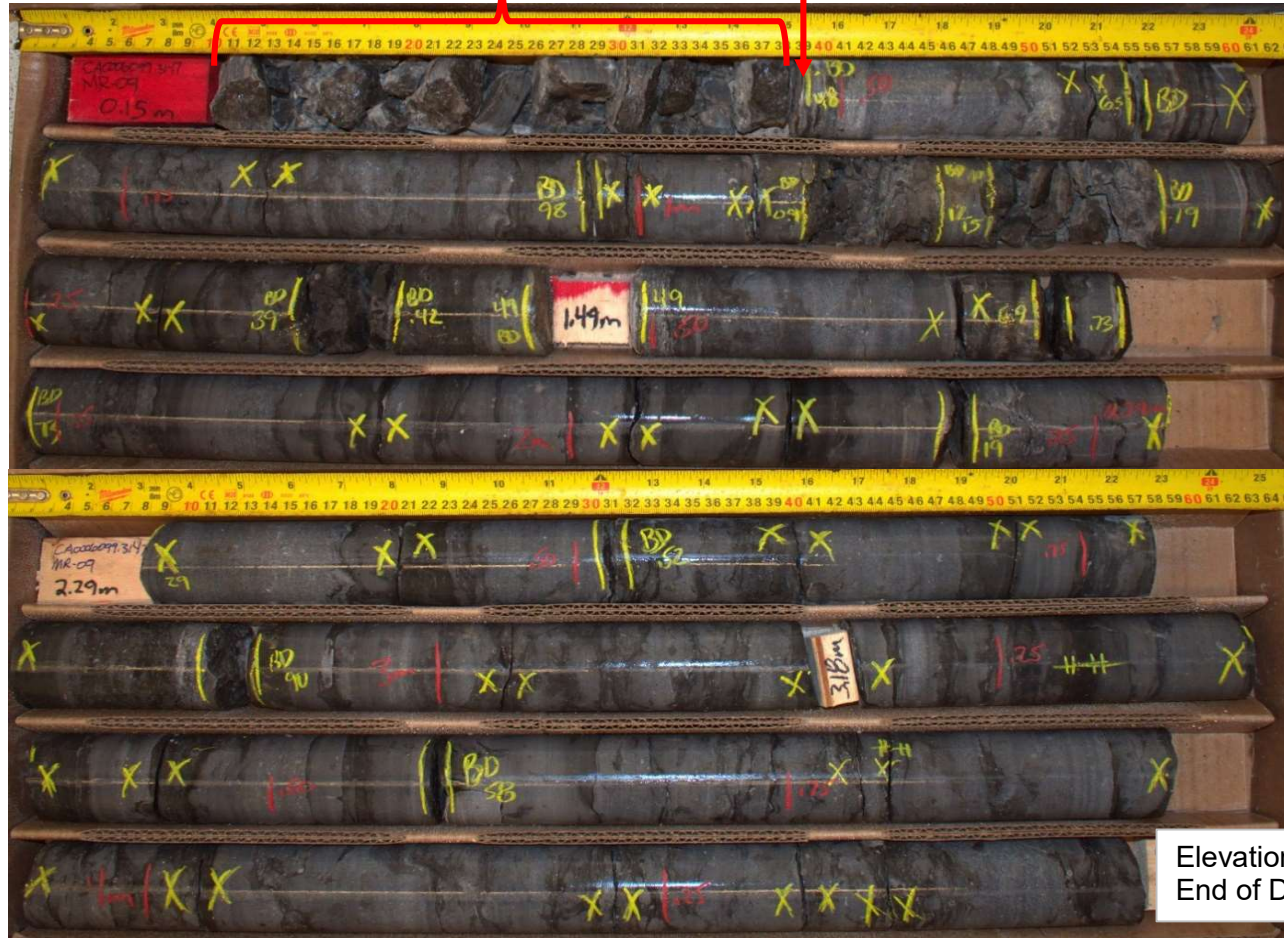
Figure A11

MR-09 (Wet)

Core Box 1 to 2 of 2

Weathered/Fractured Bedrock

Elevation 92.1 m Top of "Sound" Bedrock



Elevation 88.1 m
End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

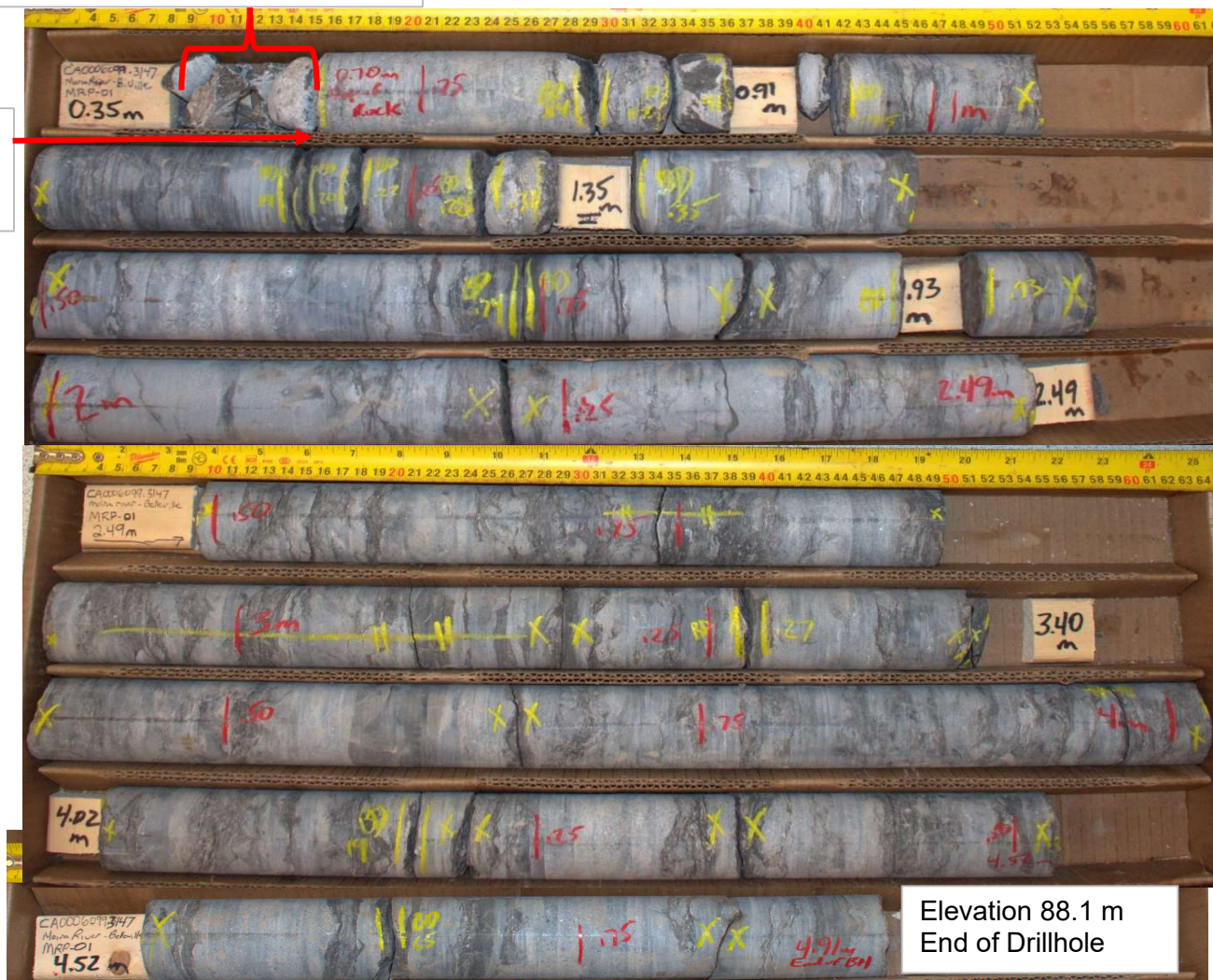
Figure A12

MRP-01 (Dry)

Core Box 1 to 3 of 3

Weathered/Fractured Bedrock

Elevation 90.4 m
Top of "Sound"
Bedrock



Elevation 88.1 m
End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

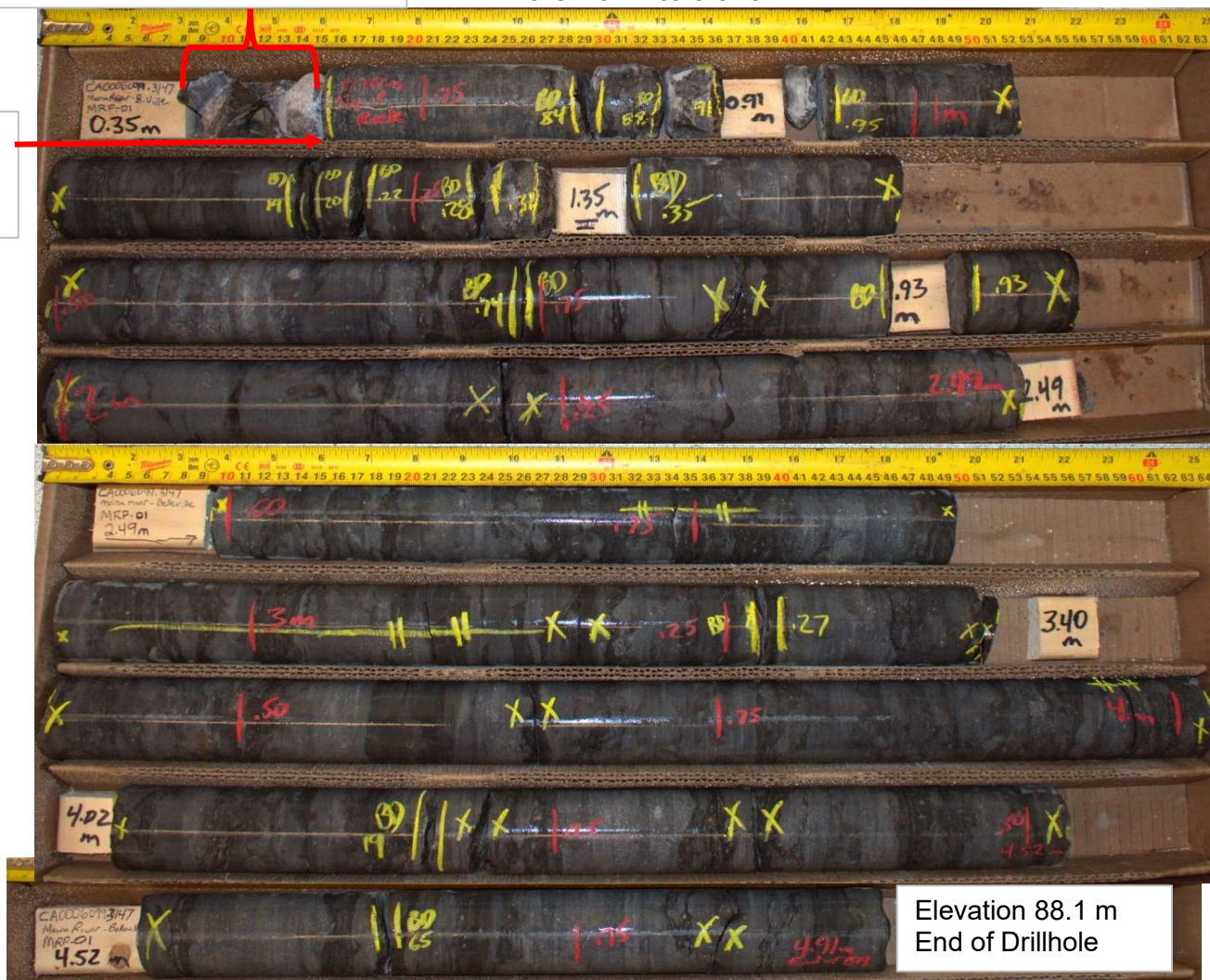
Figure A13

MRP-01 (Wet)

Core Box 1 to 3 of 3

Weathered/Fractured Bedrock

Elevation 90.4 m
Top of "Sound"
Bedrock



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

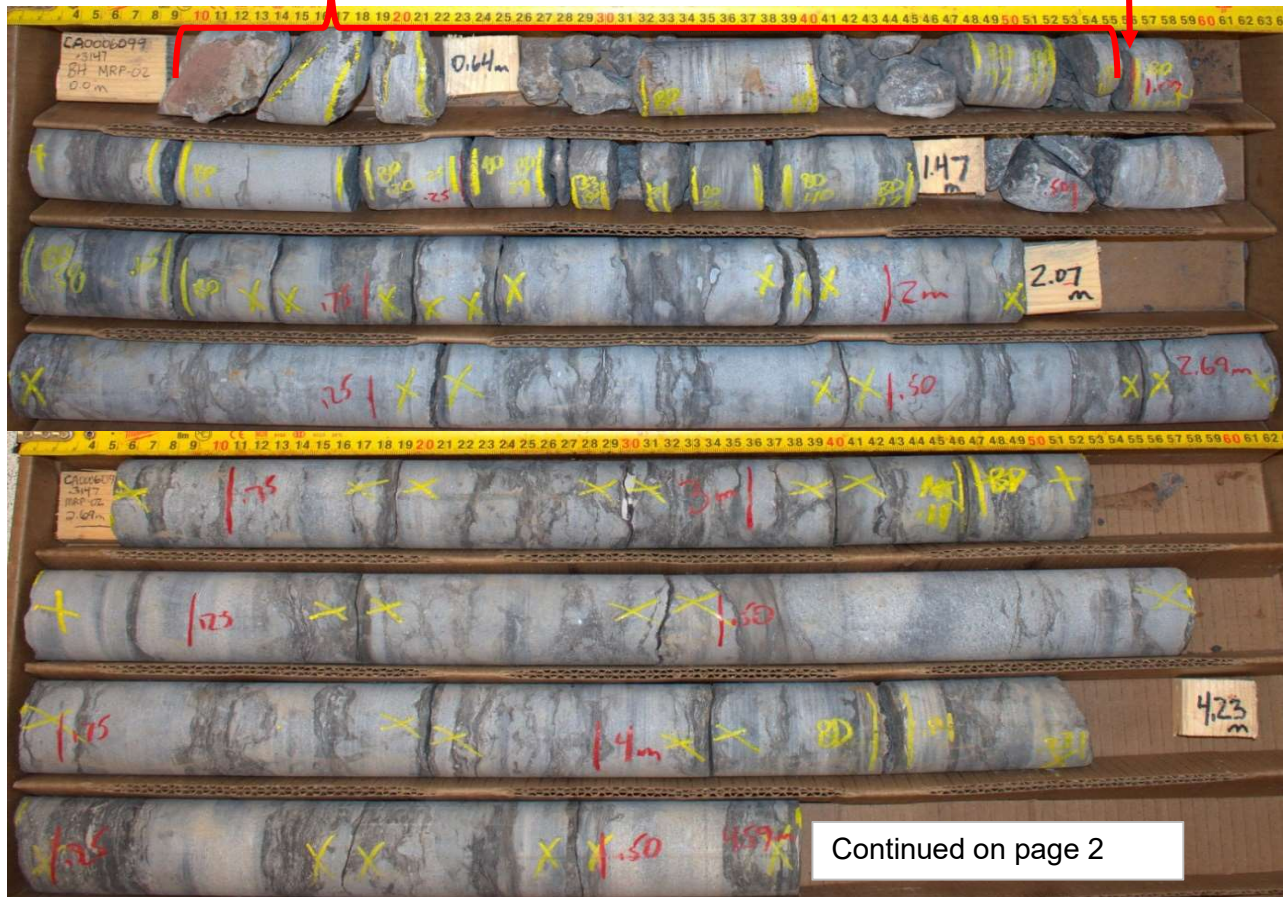
Review: LCC

Figure A14

Weathered/Fractured Bedrock

MRP-02 (Dry)
Core Box 1 to 2 of 3

Elevation 90.0 m
Top of "Sound" Bedrock



Continued on page 2



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A15

MRP-02 (Dry)
Core Box 3 to 3 of 3

Continued from page 1



Elevation 85.3 m
End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A16

Weathered/Fractured Bedrock

MRP-02 (Wet)
Core Box 1 to 2 of 3

Elevation 90.0 m
Top of "Sound" Bedrock



Continued on page 2



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A17

MRP-02 (Wet)
Core Box 3 to 3 of 3

Continued from page 1



Elevation 85.3 m
End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A18

RW-05 (Dry)
Core Box 1 to 2 of 2



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

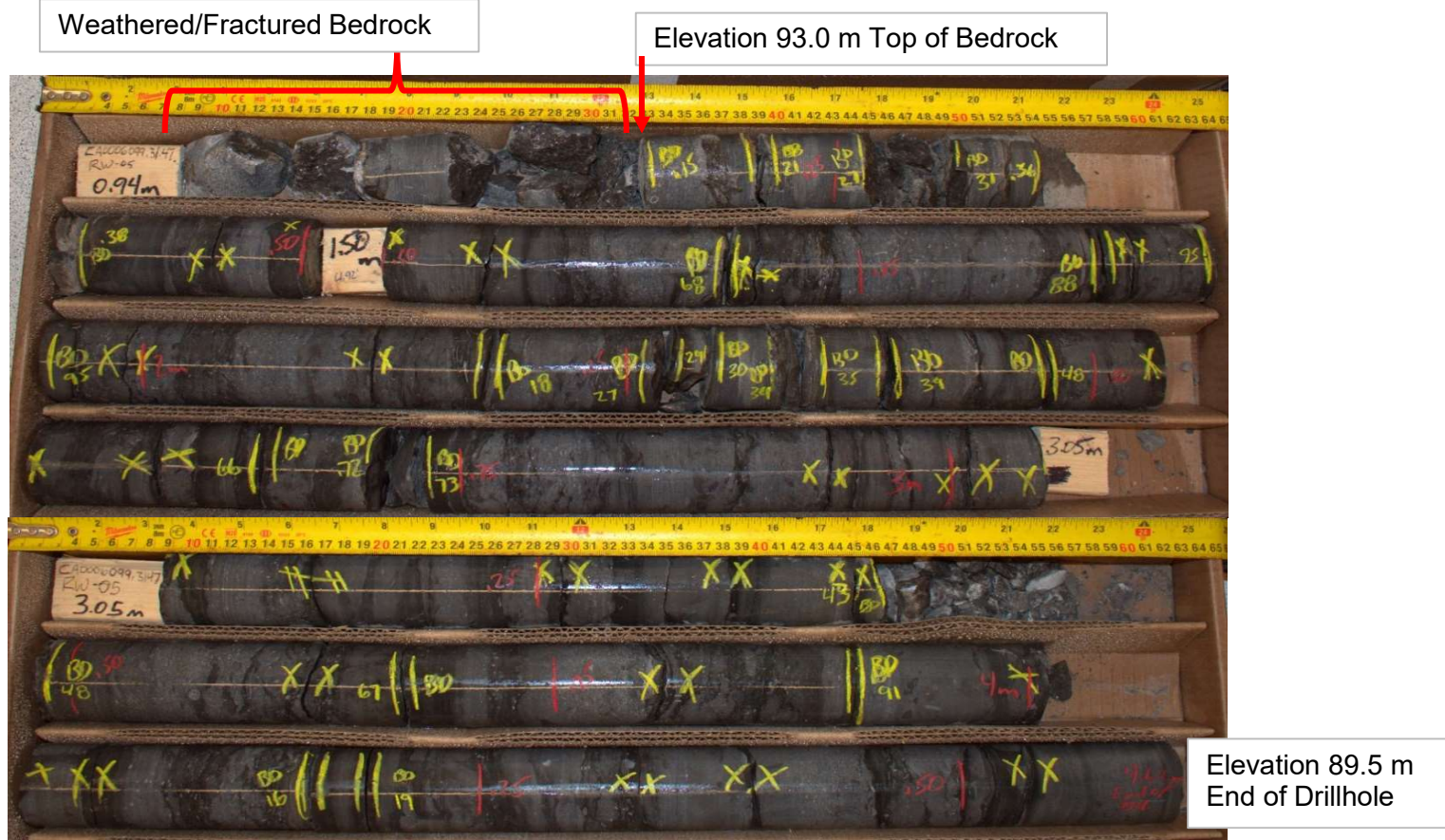
Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A19

RW-05 (Wet)
Core Box 1 to 2 of 2



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A20

RW-06 (Dry)
Core Box 1 to 3 of 3

Weathered/Fractured Bedrock

Elevation 93.3 m
Top of "Sound"
Bedrock



Elevation 88.6 m
End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A21

RW-06 (Wet)
Core Box 1 to 3 of 3

Weathered/Fractured Bedrock

Elevation 93.3 m
 Top of "Sound"
 Bedrock



Elevation 88.6 m
 End of Drillhole



Replacement of Bridge No. 11X-0162
GWP: 4053-18-00 WP: 4087-19-01

Highway 401 / Moira River Bridge
Belleville, Ontario

Project No. CA0006099.3147

Drawn: BW

Date: 2024-02-23

Checked: KCP

Review: LCC

Figure A22

APPENDIX B

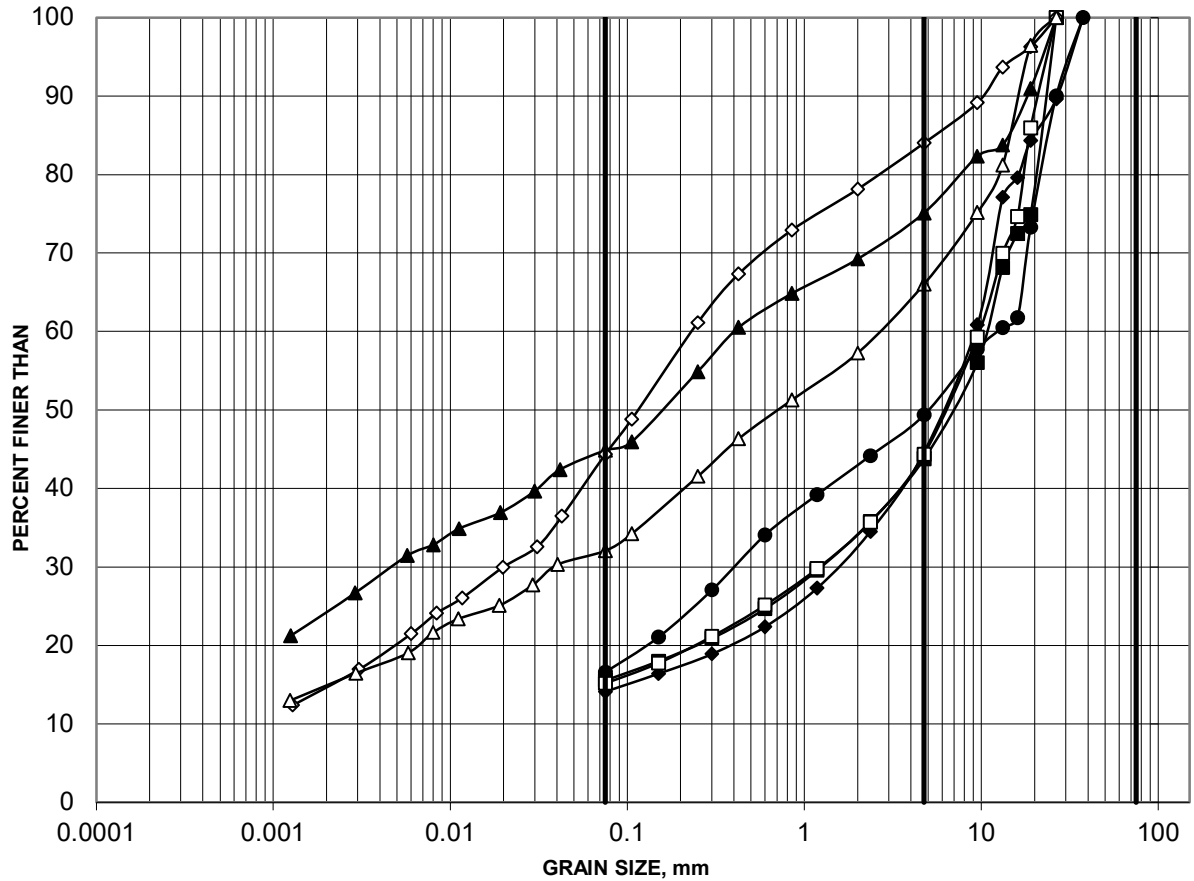
Geotechnical Laboratory Test Results

Figures B1 to B4

GRAIN SIZE DISTRIBUTION

FIGURE B1

Sandy CLAYEY GRAVEL (GC) to Gravelly CLAYEY SAND (SC/GC) (FILL)



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

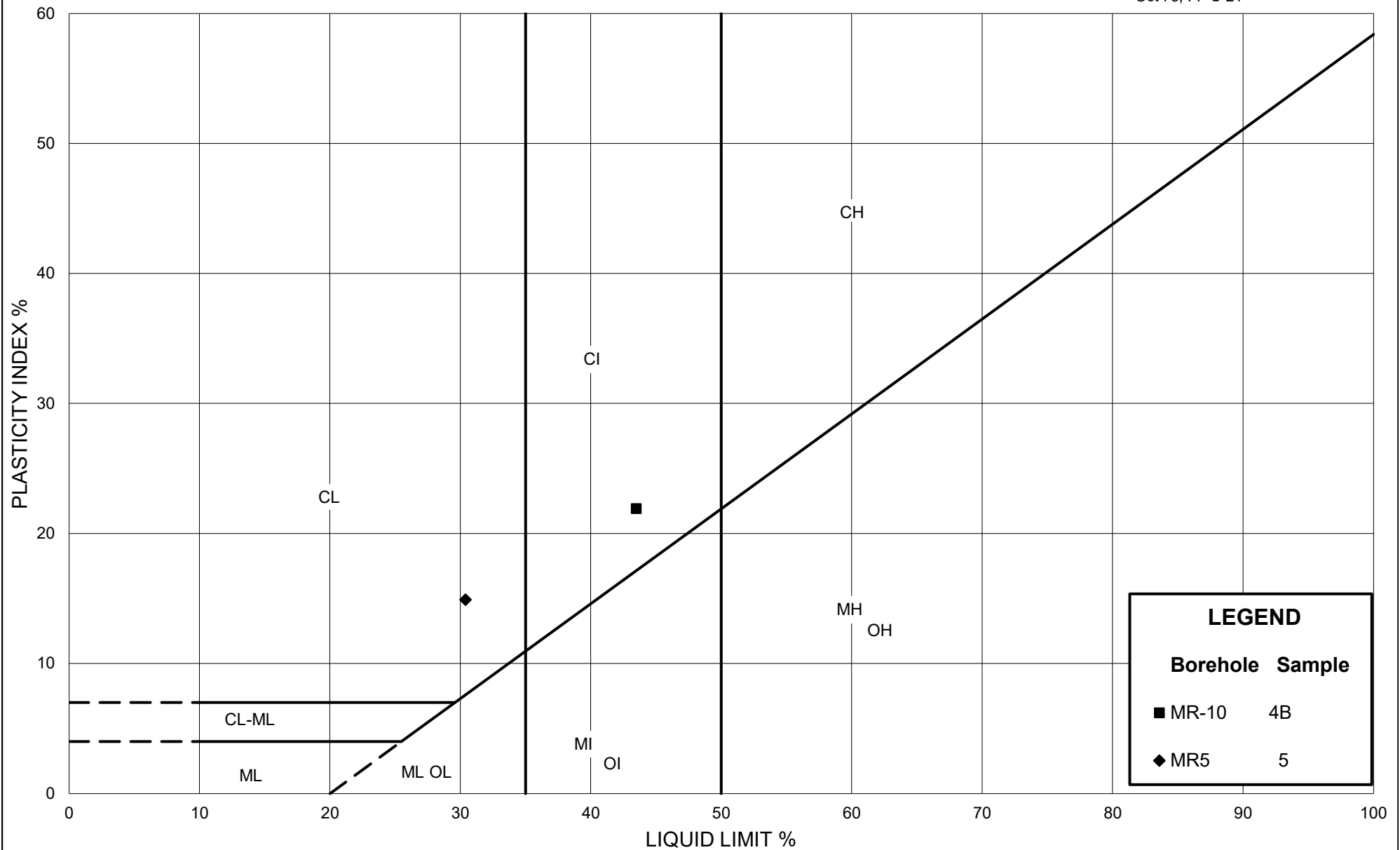
Borehole	Sample	Depth (m)	Constituents (%)			
			Gravel	Sand	Silt	Clay
MR-01	1	0.08-0.66	56	28	16	
MR-04	1	0.15-0.48	55	31	14	
MR-10	4B	2.59-2.77	25	30	21	24
RW-05	1	0.15-0.61	51	32	17	
RW-06	1	0.15-0.53	56	29	15	
MR-5	4	1.52-2.13	16	40	29	15
MR-5	5	2.29-2.74	34	34	17	15



Project: CA0006099.3147/2000

<https://wsponlinecan.sharepoint.com/Sites/Global-OttawaLab/Shared Documents/Active/CA0006099.3147/Phase 2000 Moira/figures/>

Created by: MI
Checked by: CW



Ontario

Ministry of Transportation

PLASTICITY CHART

CLAYEY SILT (CL) to SILTY CLAY (CI) - Fines Portion of Fill

Figure: B2

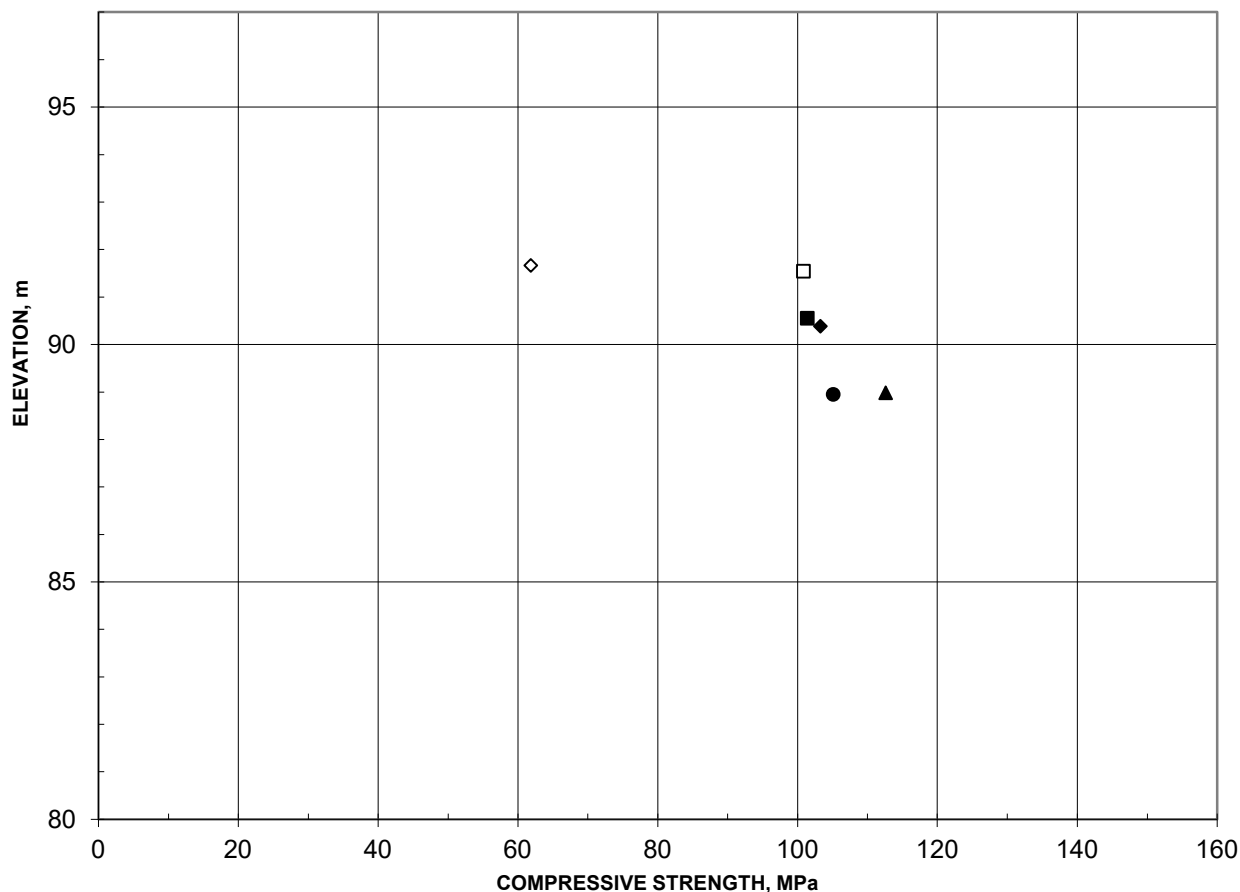
Project: CA0006099.3147/2000

Created By: MI

Checked By: CW

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

FIGURE B3



	Borehole	Depth (m)	L/D	Bulk Density (kg/m ³)	Lithology	UCS (MPa)	Failure Type
■	MR-01 RC1	1.5	2.6	2659	Limestone	101	1
◆	MR-04 RC1	1.7	2.3	2663	Limestone	103	1
▲	MR-06 RC1	1.9	2.3	2665	Limestone	113	1
●	MR-07 RC1	1.7	2.5	2674	Limestone	105	1
□	MR-09 RC1	0.6	2.3	2660	Limestone	101	1
◇	MR-02 RC1	3.2	2.3	2668	Limestone	62	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 cracking 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: CA0006099.3147

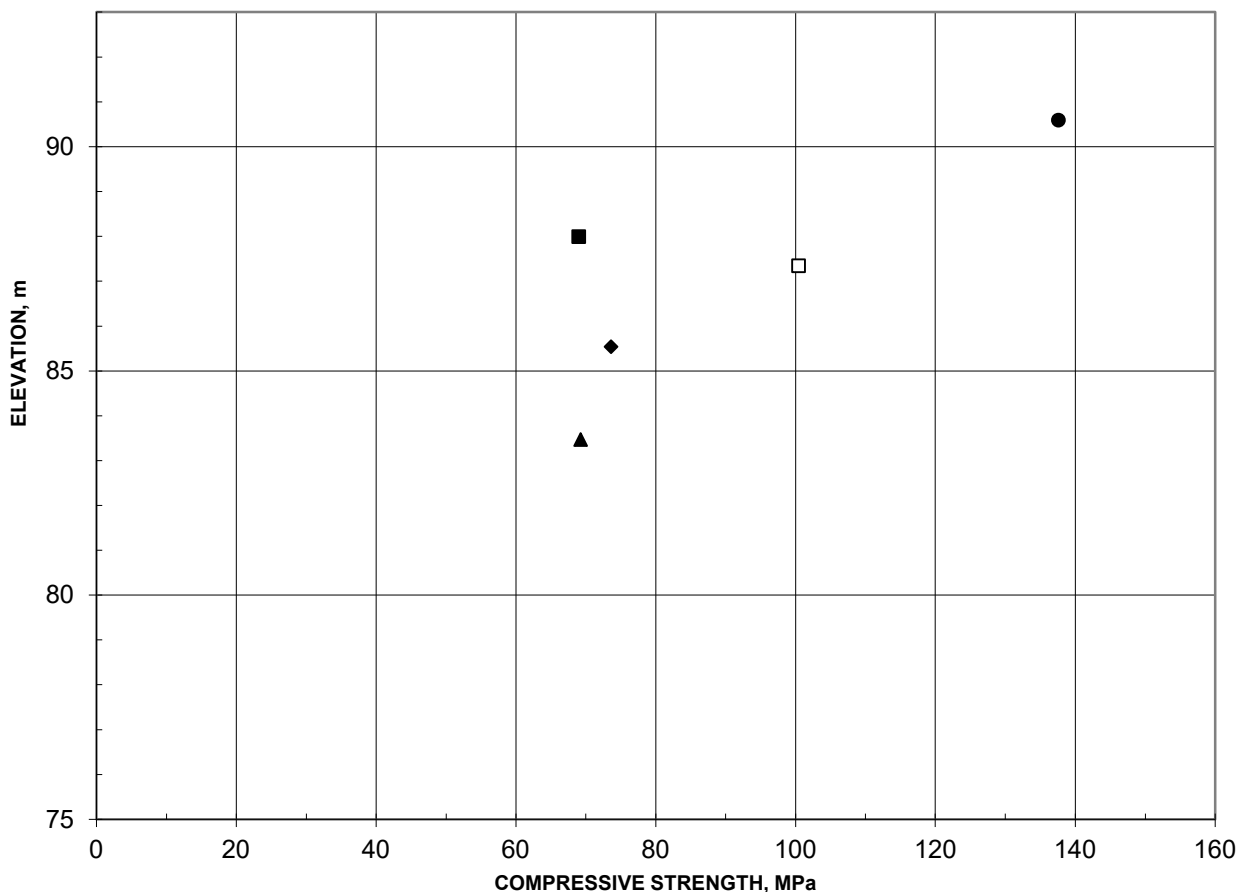
wsp

Created by: MI

Checked by: CW

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

FIGURE B4



Borehole	Depth (m)	L/D	Bulk Density (kg/m ³)	Lithology	UCS (MPa)	Failure Type
■ MRP-01 RC1	1.6	2.5	2687	Limestone	69	1
◆ MRP-02 RC1	2.8	2.5	2652	Limestone	74	1
▲ MRP-02 RC2	3.8	2.6	2648	Limestone	69	1
● RW-05 RC1	1.8	2.4	2689	Limestone	138	1
□ RW-06 RC1	3.7	2.4	2681	Limestone	100	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 cracking 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.

wsp

Project: CA0006099.3147

Created by: MI

Checked by: CW

APPENDIX C

**Results from 2020 Preliminary Investigation
GEOCRES No. 31C-311**

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

CONT No
WP No 4193-15-00

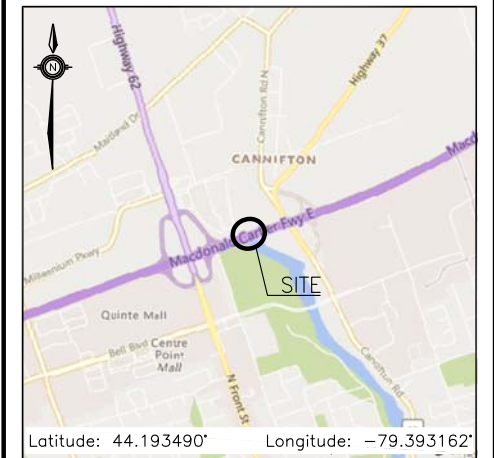


SHEET

HIGHWAY 401 WIDENING
MOIRA RIVER BRIDGE
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA








THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

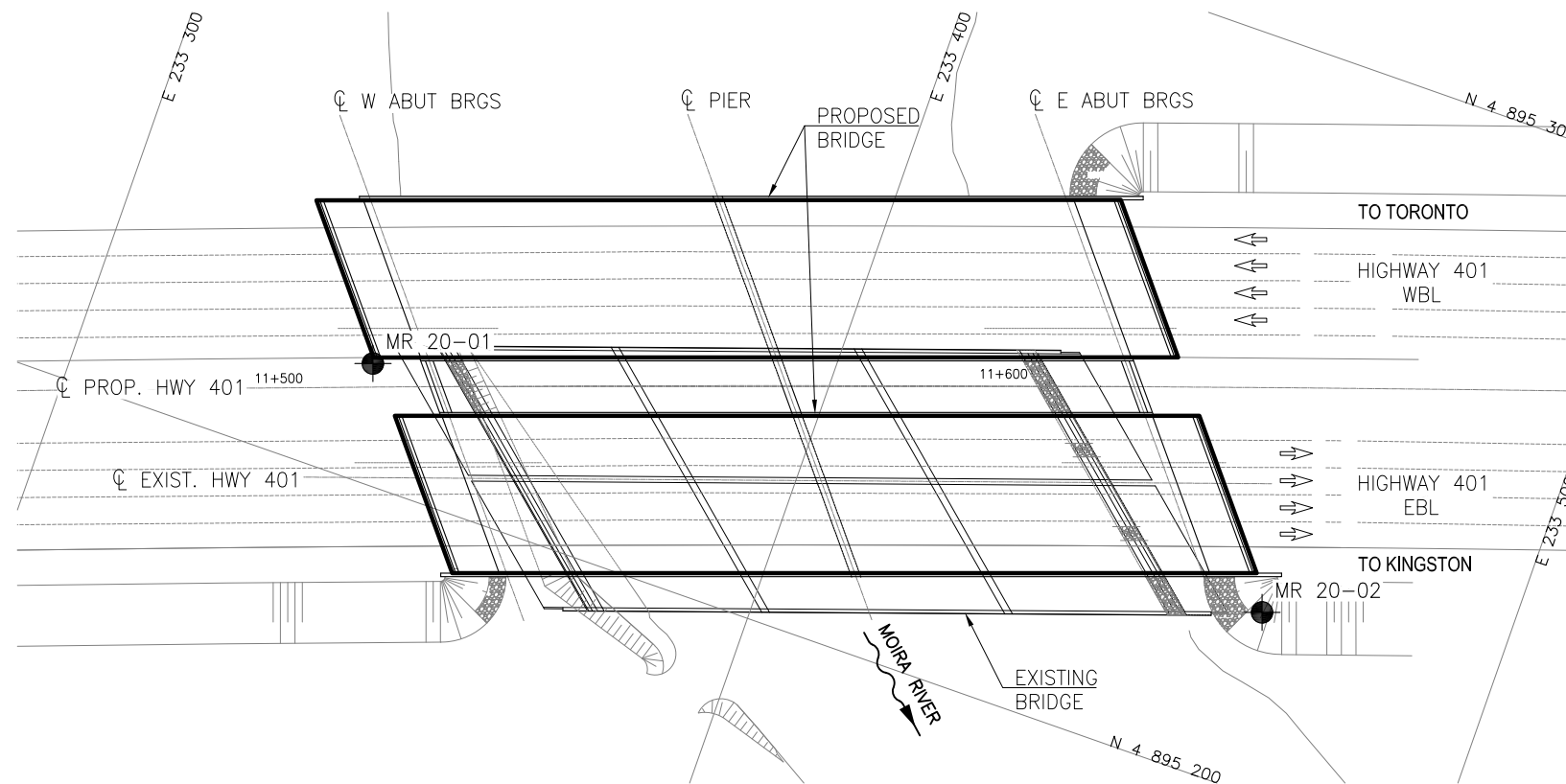
	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
MR 20-01	94.9	4 895 216.1	233 339.6
MR 20-02	94.4	4 895 224.3	233 466.7

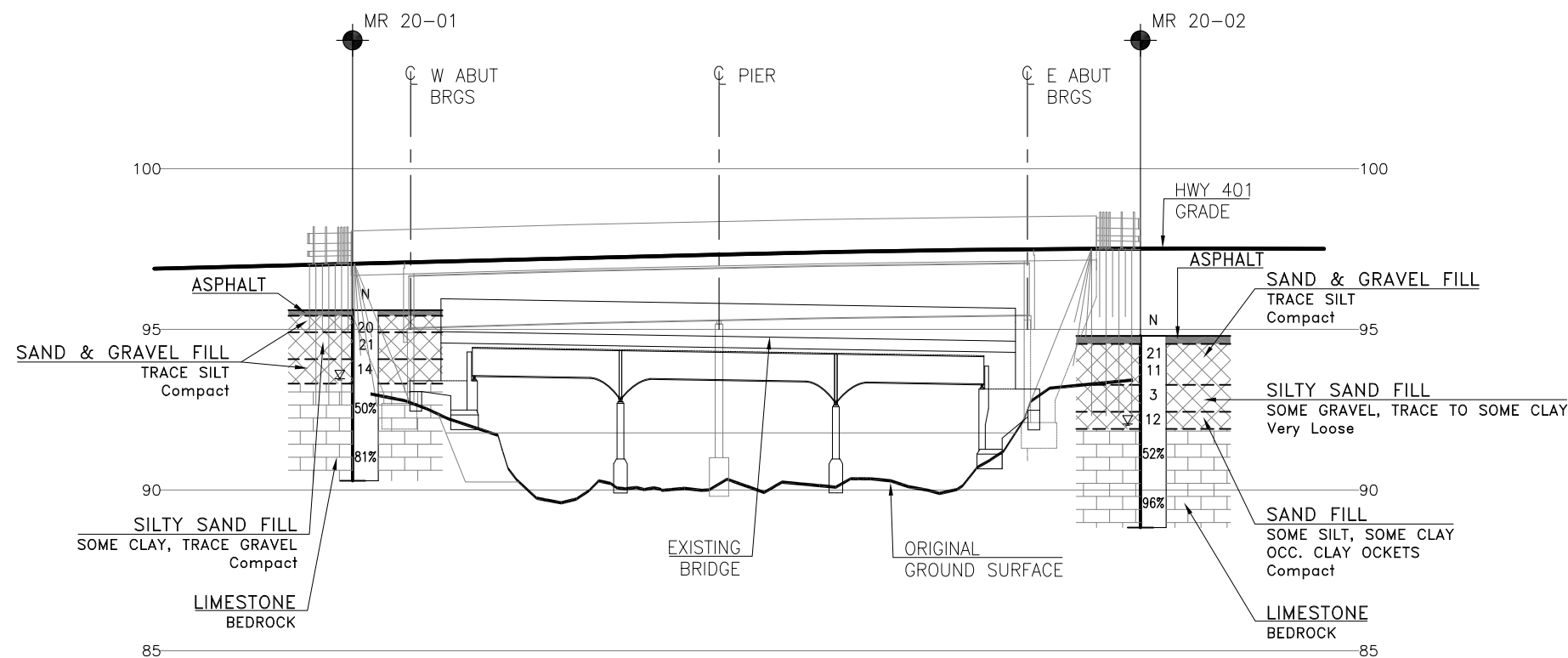
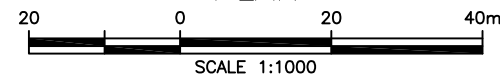
-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 9.

GEOCRES No. 31C-311



PLAN



PROFILE ALONG C HIGHWAY 401



REVISIONS								
	DATE	BY	DESCRIPTION					
DESIGN	RPR	CHK	SKP	CODE	LOAD	DATE	JUL 2021	
DRAWN	AN	CHK	RPR	SITE 11-162	STRUCT	DWG 1		

RECORD OF BOREHOLE No MR 20-01

1 OF 1

METRIC

W.P. 4193-15-00 LOCATION Moira River Bridge, MTM NAD83-9 N 4 895 216.1 E 233 339.6 ORIGINATED BY GA
DIST Eastern HWY 401 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2020.11.12 - 2020.11.12 LATITUDE 44.193447 LONGITUDE -77.393956 CHECKED BY RPR

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				WATER CONTENT (%)								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
94.9	GROUND SURFACE						20	40	60	80	100						GR	SA	SI	CL
0.0	ASPHALT: (175mm)																			
0.2	SAND and GRAVEL Compact		1	SS	20															
94.2	Brown																			
0.7	Moist (FILL)		2	SS	21															
93.4	Silty SAND, some clay, trace gravel Compact Dark Brown to Brown																			
1.5	Moist (FILL)																			
92.6	SAND and GRAVEL, trace silt Compact Brown		3	SS	14															
2.3	Moist (FILL) Coring started at 2.3m																			
	LIMESTONE, highly to moderately weathered, grey to dark grey, with shale interbeds, laminated, horizontally bedded: (Simcoe Group)		1	RUN																
	Highly fractured zone from 2.30m to 2.44m																			
	Horizontal fractures at 2.44m, 2.52m, 2.59m, 2.60m, 2.64m, 2.78m, 2.84m, 3.05m, 3.23m, 3.24m, 3.52m and 3.62m																			
	Moderately weathered		2	RUN																
	Shale interbeds: 2.57m - 2.59m (20mm) 2.81m - 2.83m (20mm) 2.96m - 2.97m (10mm) 3.21m - 3.23m (20mm) 3.93m - 3.95m (20mm) 4.26m - 4.27m (10mm) 4.41m - 4.43m (10mm) 4.72m - 4.73m (10mm) 4.75m - 4.80m (50mm) 5.17m - 5.22 m (50mm) Horizontal fractures at 3.81m, 3.85m, 3.87m, 4.38m, 4.75m, 4.80m, 4.85m, 5.25m and 5.26m																			
89.6	END OF BOREHOLE AT 5.3m. BOREHOLE OPEN TO 5.3m AND WATER LEVEL AT 2.1m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, CONCRETE TO 0.2m, THEN ASPHALT COLD PATCH TO SURFACE.																			
5.3																				

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

APPENDIX D

Results of Environmental Analysis

CLIENT NAME: WSP CANADA INC.**1931 ROBERTSON ROAD
OTTAWA, ON K2H5B7
(613) 592-9600****ATTENTION TO: Ben Waechter/Kenton Power****PROJECT: CA0006099.3147****AGAT WORK ORDER: 23P052203****SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer****TRACE ORGANICS REVIEWED BY: Neli Popnikolova, Senior Chemist****DATE REPORTED: Aug 04, 2023****PAGES (INCLUDING COVER): 12****VERSION*: 1**

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
- This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
- The test results reported herewith relate only to the samples as received by the laboratory.
- Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.
- All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.
- For environmental samples in the Province of Quebec: The analysis is performed on and results apply to samples as received. A temperature above 6°C upon receipt, as indicated in the Sample Reception Notification (SRN), could indicate the integrity of the samples has been compromised if the delay between sampling and submission to the laboratory could not be minimized.



Certificate of Analysis

AGAT WORK ORDER: 23P052203

PROJECT: CA0006099.3147

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

SAMPLING SITE: Belleville WLB & M. River

ATTENTION TO: Ben Waechter/Kenton Power

SAMPLED BY: Rob Ireland / Ben Waechter

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2023-07-28

DATE REPORTED: 2023-08-04

		SAMPLE DESCRIPTION:		RW-06	RW-05	WL-2 SA2	MR-01	MR-06
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2023-07-24 11:30	2023-07-24 14:30	2023-07-25 11:30	2023-07-25 09:30	2023-07-27 11:30
Parameter	Unit	G / S	RDL	5178220	5178222	5178223	5178224	5178225
Antimony	µg/g		0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g		1	2	8	2	7	20
Barium	µg/g		2.0	108	358	170	333	638
Beryllium	µg/g		0.5	<0.5	0.9	0.5	0.8	1.3
Boron	µg/g		5	11	19	14	24	18
Boron (Hot Water Soluble)	µg/g		0.10	0.28	0.51	0.20	0.40	0.23
Cadmium	µg/g		0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g		5	19	32	0	32	44
Cobalt	µg/g		0.8	6.3	14.8	3.2	12.8	13.5
Copper	µg/g		1.0	16.1	15.4	4.3	17.1	13.8
Lead	µg/g		1	21	28	7	44	19
Molybdenum	µg/g		0.5	<0.5	0.7	0.9	0.7	1.4
Nickel	µg/g		1	10	26	2	22	29
Selenium	µg/g		0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Silver	µg/g		0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Thallium	µg/g		0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Uranium	µg/g		0.50	0.54	0.56	2.55	0.57	1.90
Vanadium	µg/g		2.0	22.0	37.9	11.1	38.4	63.4
Zinc	µg/g		5	45	65	18	70	129
Chromium, Hexavalent	µg/g		0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide, WAD	µg/g		0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g		0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity (2:1)	mS/cm		0.005	0.151	0.356	0.839	0.278	0.128
Sodium Adsorption Ratio (2:1) (Calc.)	N/A		N/A	0.257	2.75	4.52	1.99	0.317
pH, 2:1 CaCl2 Extraction	pH Units		NA	6.99	7.01	9.13	7.47	7.11

Certified By:



Ben Waechter



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 23P052203

PROJECT: CA0006099.3147

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CLIENT NAME: WSP CANADA INC.

SAMPLING SITE: Belleville WLB & M. River

ATTENTION TO: Ben Waechter/Kenton Power

SAMPLED BY: Rob Ireland / Ben Waechter

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2023-07-28

DATE REPORTED: 2023-08-04

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

5178220-5178225 EC was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl₂ extract prepared at 2:1 ratio. SAR is a calculated parameter.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



Nivine Basly



Certificate of Analysis

AGAT WORK ORDER: 23P052203

PROJECT: CA0006099.3147

5835 COOPERS AVENUE
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CLIENT NAME: WSP CANADA INC.

SAMPLING SITE: Belleville WLB & M. River

ATTENTION TO: Ben Waechter/Kenton Power

SAMPLED BY: Rob Ireland / Ben Waechter

O. Reg. 153(511) - PAHs (Soil)

DATE RECEIVED: 2023-07-28

DATE REPORTED: 2023-08-04

SAMPLE DESCRIPTION:				RW-06	RW-05	WL-2 SA2	MR-01	MR-06
SAMPLE TYPE:				Soil	Soil	Soil	Soil	Soil
DATE SAMPLED:				2023-07-24 11:30	2023-07-24 14:30	2023-07-25 11:30	2023-07-25 09:30	2023-07-27 11:30
Parameter	Unit	G / S	RDL	5178220	5178222	5178223	5178224	5178225
Naphthalene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthylene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluorene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phenanthrene	µg/g		0.05	0.42	<0.05	<0.05	<0.05	<0.05
Anthracene	µg/g		0.05	0.07	<0.05	<0.05	<0.05	<0.05
Fluoranthene	µg/g		0.05	0.56	<0.05	<0.05	<0.05	<0.05
Pyrene	µg/g		0.05	0.43	<0.05	<0.05	<0.05	<0.05
Benz(a)anthracene	µg/g		0.05	0.07	<0.05	<0.05	<0.05	<0.05
Chrysene	µg/g		0.05	0.12	<0.05	<0.05	<0.05	<0.05
Benzo(b)fluoranthene	µg/g		0.05	0.09	<0.05	<0.05	<0.05	<0.05
Benzo(k)fluoranthene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(a)pyrene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Indeno(1,2,3-cd)pyrene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenz(a,h)anthracene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1 and 2 Methyl naphthalene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Moisture Content	%		0.1	7.0	24.3	9.8	25.6	24.8
Surrogate	Unit	Acceptable Limits						
Naphthalene-d8	%	50-140		75	70	75	85	80
Acridine-d9	%	50-140		85	80	75	75	75
Terphenyl-d14	%	50-140		75	80	95	75	90

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

5178220-5178225 Results are based on the dry weight of the soil.

Note: The result for Benzo(b)Fluoranthene is the total of the Benzo(b)&j)Fluoranthene isomers because the isomers co-elute on the GC column.
2- and 1-Methyl Naphthalene is a calculated parameter. The calculated value is the sum of 2-Methyl Naphthalene and 1-Methyl Naphthalene.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

N Popmukolof



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 23P052203

PROJECT: CA0006099.3147

5835 COOPERS AVENUE
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CLIENT NAME: WSP CANADA INC.

SAMPLING SITE: Belleville WLB & M. River

ATTENTION TO: Ben Waechter/Kenton Power

SAMPLED BY: Rob Ireland / Ben Waechter

O. Reg. 153(511) - PHCs F1 - F4 (with PAHs) (Soil)

DATE RECEIVED: 2023-07-28

DATE REPORTED: 2023-08-04

		SAMPLE DESCRIPTION:		RW-06	RW-05	WL-2 SA2	MR-01	MR-06
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2023-07-24 11:30	2023-07-24 14:30	2023-07-25 11:30	2023-07-25 09:30	2023-07-27 11:30
Parameter	Unit	G / S	RDL	5178220	5178222	5178223	5178224	5178225
Benzene	µg/g		0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Toluene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ethylbenzene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
m & p-Xylene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
o-Xylene	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylenes (Total)	µg/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
F1 (C6 - C10)	µg/g	5	<5	<5	<5	<5	<5	<5
F1 (C6 to C10) minus BTEX	µg/g	5	<5	<5	<5	<5	<5	<5
F2 (C10 to C16)	µg/g	10	<10	<10	<10	<10	<10	<10
F2 (C10 to C16) minus Naphthalene	µg/g	10	<10	<10	<10	<10	<10	<10
F3 (C16 to C34)	µg/g	50	<50	<50	<50	<50	<50	<50
F3 (C16 to C34) minus PAHs	µg/g	50	<50	<50	<50	<50	<50	<50
F4 (C34 to C50)	µg/g	50	<50	<50	<50	<50	<50	<50
Gravimetric Heavy Hydrocarbons	µg/g	50	NA	NA	NA	NA	NA	NA
Moisture Content	%	0.1	7.0	24.3	9.8	25.6	24.8	
Surrogate	Unit	Acceptable Limits						
Toluene-d8	% Recovery	60-140	106	103	95	96	90	
Terphenyl	%	60-140	62	75	70	62	76	

Certified By:

N Popmukolof



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 23P052203

PROJECT: CA0006099.3147

5835 COOPERS AVENUE
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CLIENT NAME: WSP CANADA INC.

SAMPLING SITE: Belleville WLB & M. River

ATTENTION TO: Ben Waechter/Kenton Power

SAMPLED BY: Rob Ireland / Ben Waechter

O. Reg. 153(511) - PHCs F1 - F4 (with PAHs) (Soil)

DATE RECEIVED: 2023-07-28

DATE REPORTED: 2023-08-04

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

5178220-5178225 Results are based on sample dry weight.

The C6-C10 fraction is calculated using toluene response factor.

Xylenes total is a calculated parameter. The calculated value is the sum of m&p-Xylene and o-Xylene.

C6-C10 (F1 minus BTEX) is a calculated parameter. The calculated value is F1 minus BTEX.

The calculated parameters are non-accredited. The parameters that are components of the calculation are accredited.

The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.

Gravimetric Heavy Hydrocarbons are not included in the Total C16-C50 and are only determined if the chromatogram of the C34 - C50 hydrocarbons indicates that hydrocarbons >C50 are present.

The chromatogram has returned to baseline by the retention time of nC50.

Total C6 - C50 results are corrected for BTEX and PAH contributions.

C>10 - C16 (F2- Naphthalene) is a calculated parameter. The calculated value is F2 - Naphthalene.

C>16 - C34 (F3-PAH) is a calculated parameter. The calculated value is F3-PAH (PAH: sum of Phenanthrene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene,

Fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-c,d)pyrene and Pyrene).

This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.

nC10, nC16 and nC34 response factors are within 10% of their average.

C50 response factor is within 70% of nC10 + nC16 + nC34 average.

Linearity is within 15%.

Extraction and holding times were met for this sample.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Quality Assurance

CLIENT NAME: WSP CANADA INC.

PROJECT: CA0006099.3147

SAMPLING SITE: Belleville WLB & M. River

AGAT WORK ORDER: 23P052203

ATTENTION TO: Ben Waechter/Kenton Power

SAMPLED BY: Rob Ireland / Ben Waechter

Soil Analysis

RPT Date: Aug 04, 2023			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - Metals & Inorganics (Soil)															
Antimony	5180330		<0.8	<0.8	NA	< 0.8	114%	70%	130%	99%	80%	120%	80%	70%	130%
Arsenic	5180330		3	3	NA	< 1	110%	70%	130%	86%	80%	120%	89%	70%	130%
Barium	5180330		60.3	58.0	3.9%	< 2.0	105%	70%	130%	102%	80%	120%	98%	70%	130%
Beryllium	5180330		<0.5	<0.5	NA	< 0.5	119%	70%	130%	116%	80%	120%	117%	70%	130%
Boron	5180330		7	7	NA	< 5	92%	70%	130%	113%	80%	120%	107%	70%	130%
Boron (Hot Water Soluble)	5182048		0.33	0.32	NA	< 0.10	103%	60%	140%	99%	70%	130%	106%	60%	140%
Cadmium	5180330		<0.5	<0.5	NA	< 0.5	89%	70%	130%	111%	80%	120%	107%	70%	130%
Chromium	5180330		17	16	NA	< 5	106%	70%	130%	105%	80%	120%	109%	70%	130%
Cobalt	5180330		4.5	4.6	2.2%	< 0.8	102%	70%	130%	106%	80%	120%	105%	70%	130%
Copper	5180330		10.8	10.5	2.8%	< 1.0	98%	70%	130%	103%	80%	120%	103%	70%	130%
Lead	5180330		19	18	5.4%	< 1	107%	70%	130%	103%	80%	120%	98%	70%	130%
Molybdenum	5180330		0.9	<0.5	NA	< 0.5	118%	70%	130%	111%	80%	120%	108%	70%	130%
Nickel	5180330		9	9	0.0%	< 1	102%	70%	130%	102%	80%	120%	103%	70%	130%
Selenium	5180330		<0.8	<0.8	NA	< 0.8	101%	70%	130%	101%	80%	120%	104%	70%	130%
Silver	5180330		<0.5	<0.5	NA	< 0.5	105%	70%	130%	110%	80%	120%	102%	70%	130%
Thallium	5180330		<0.5	<0.5	NA	< 0.5	103%	70%	130%	98%	80%	120%	97%	70%	130%
Uranium	5180330		0.56	0.53	NA	< 0.50	108%	70%	130%	100%	80%	120%	99%	70%	130%
Vanadium	5180330		26.3	25.7	2.3%	< 2.0	106%	70%	130%	106%	80%	120%	106%	70%	130%
Zinc	5180330		56	56	0.0%	< 5	105%	70%	130%	105%	80%	120%	102%	70%	130%
Chromium, Hexavalent	5178225	5178225	<0.2	<0.2	NA	< 0.2	109%	70%	130%	110%	80%	120%	90%	70%	130%
Cyanide, WAD	5179547		<0.040	<0.040	NA	< 0.040	86%	70%	130%	105%	80%	120%	107%	70%	130%
Mercury	5180330		<0.10	<0.10	NA	< 0.10	106%	70%	130%	99%	80%	120%	108%	70%	130%
Electrical Conductivity (2:1)	5180313		0.177	0.177	0.0%	< 0.005	111%	80%	120%						
Sodium Adsorption Ratio (2:1) (Calc.)	5180313		0.268	0.270	0.7%	NA									
pH, 2:1 CaCl2 Extraction	5174597		6.43	6.66	3.5%	NA	101%	80%	120%						

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Duplicate NA: results are under 5X the RDL and will not be calculated.

Certified By:


Nivine Basily



Quality Assurance

CLIENT NAME: WSP CANADA INC.

PROJECT: CA0006099.3147

SAMPLING SITE: Belleville WLB & M. River

AGAT WORK ORDER: 23P052203

ATTENTION TO: Ben Waechter/Kenton Power

SAMPLED BY: Rob Ireland / Ben Waechter

Trace Organics Analysis

RPT Date: Aug 04, 2023			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

O. Reg. 153(511) - PHCs F1 - F4 (with PAHs) (Soil)

Benzene	5177700		<0.02	<0.02	NA	< 0.02	77%	60%	140%	87%	60%	140%	84%	60%	140%
Toluene	5177700		<0.05	<0.05	NA	< 0.05	88%	60%	140%	101%	60%	140%	119%	60%	140%
Ethylbenzene	5177700		<0.05	<0.05	NA	< 0.05	106%	60%	140%	110%	60%	140%	116%	60%	140%
m & p-Xylene	5177700		<0.05	<0.05	NA	< 0.05	102%	60%	140%	94%	60%	140%	96%	60%	140%
o-Xylene	5177700		<0.05	<0.05	NA	< 0.05	102%	60%	140%	103%	60%	140%	108%	60%	140%
F1 (C6 - C10)	5177700		<5	<5	NA	< 5	109%	60%	140%	109%	60%	140%	82%	60%	140%
F2 (C10 to C16)	5176405		<10	<10	NA	< 10	94%	60%	140%	91%	60%	140%	95%	60%	140%
F3 (C16 to C34)	5176405		<50	<50	NA	< 50	105%	60%	140%	98%	60%	140%	96%	60%	140%
F4 (C34 to C50)	5176405		<50	<50	NA	< 50	88%	60%	140%	105%	60%	140%	113%	60%	140%

O. Reg. 153(511) - PAHs (Soil)

Naphthalene	5174618		<0.05	<0.05	NA	< 0.05	110%	50%	140%	88%	50%	140%	83%	50%	140%
Acenaphthylene	5174618		<0.05	<0.05	NA	< 0.05	117%	50%	140%	80%	50%	140%	83%	50%	140%
Acenaphthene	5174618		<0.05	<0.05	NA	< 0.05	108%	50%	140%	103%	50%	140%	83%	50%	140%
Fluorene	5174618		<0.05	<0.05	NA	< 0.05	93%	50%	140%	88%	50%	140%	93%	50%	140%
Phenanthrene	5174618		<0.05	<0.05	NA	< 0.05	111%	50%	140%	95%	50%	140%	108%	50%	140%
Anthracene	5174618		<0.05	<0.05	NA	< 0.05	101%	50%	140%	73%	50%	140%	80%	50%	140%
Fluoranthene	5174618		<0.05	<0.05	NA	< 0.05	86%	50%	140%	80%	50%	140%	75%	50%	140%
Pyrene	5174618		<0.05	<0.05	NA	< 0.05	81%	50%	140%	78%	50%	140%	105%	50%	140%
Benz(a)anthracene	5174618		<0.05	<0.05	NA	< 0.05	118%	50%	140%	78%	50%	140%	80%	50%	140%
Chrysene	5174618		<0.05	<0.05	NA	< 0.05	110%	50%	140%	85%	50%	140%	90%	50%	140%
Benzo(b)fluoranthene	5174618		<0.05	<0.05	NA	< 0.05	84%	50%	140%	95%	50%	140%	93%	50%	140%
Benzo(k)fluoranthene	5174618		<0.05	<0.05	NA	< 0.05	101%	50%	140%	85%	50%	140%	80%	50%	140%
Benzo(a)pyrene	5174618		<0.05	<0.05	NA	< 0.05	102%	50%	140%	108%	50%	140%	110%	50%	140%
Indeno(1,2,3-cd)pyrene	5174618		<0.05	<0.05	NA	< 0.05	105%	50%	140%	85%	50%	140%	100%	50%	140%
Dibenz(a,h)anthracene	5174618		<0.05	<0.05	NA	< 0.05	114%	50%	140%	105%	50%	140%	93%	50%	140%
Benzo(g,h,i)perylene	5174618		<0.05	<0.05	NA	< 0.05	95%	50%	140%	110%	50%	140%	108%	50%	140%

Comments: When the average of the sample and duplicate results is less than 5x the RDL, the Relative Percent Difference (RPD) will be indicated as Not Applicable (NA).

Certified By:

N Popmukohof

Method Summary

CLIENT NAME: WSP CANADA INC.

PROJECT: CA0006099.3147

SAMPLING SITE: Belleville WLB & M. River

AGAT WORK ORDER: 23P052203

ATTENTION TO: Ben Waechter/Kenton Power

SAMPLED BY: Rob Ireland / Ben Waechter

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Antimony	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Arsenic	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Barium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Beryllium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Boron	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	modified from EPA 6010D and MSA PART 3, CH 21	ICP/OES
Cadmium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Chromium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Cobalt	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Copper	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Lead	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Molybdenum	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Nickel	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Selenium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Silver	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Thallium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Uranium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Vanadium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Zinc	MET 93 -6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Chromium, Hexavalent	INOR-93-6068	modified from EPA 3060 and EPA 7196	SPECTROPHOTOMETER
Cyanide, WAD	INOR-93-6052	modified from ON MOECC E3015, SM 4500-CN- I, G-387	SEGMENTED FLOW ANALYSIS
Mercury	MET-93-6103	modified from EPA 7471B and SM 3112 B	ICP-MS
Electrical Conductivity (2:1)	INOR-93-6075	modified from MSA PART 3, CH 14 and SM 2510 B	PC TITRATE
Sodium Adsorption Ratio (2:1) (Calc.)	INOR-93-6007	modified from EPA 6010D & Analytical Protocol	ICP/OES
pH, 2:1 CaCl ₂ Extraction	INOR-93-6075	modified from EPA 9045D, MCKEAGUE 3.11 E3137	PC TITRATE



Method Summary

CLIENT NAME: WSP CANADA INC.

PROJECT: CA0006099.3147

SAMPLING SITE: Belleville WLB & M. River

AGAT WORK ORDER: 23P052203

ATTENTION TO: Ben Waechter/Kenton Power

SAMPLED BY: Rob Ireland / Ben Waechter

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Naphthalene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Acenaphthylene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Acenaphthene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Fluorene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Phenanthrene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Anthracene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Fluoranthene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Pyrene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Benz(a)anthracene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Chrysene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Benzo(b)fluoranthene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Benzo(k)fluoranthene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Benzo(a)pyrene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Indeno(1,2,3-cd)pyrene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Dibenz(a,h)anthracene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Benzo(g,h,i)perylene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
1 and 2 Methylnaphthalene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Naphthalene-d8	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Acridine-d9	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Terphenyl-d14	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Moisture Content	VOL-91-5009	modified from CCME Tier 1 Method	BALANCE
Benzene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
Toluene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
Ethylbenzene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
m & p-Xylene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
o-Xylene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
Xylenes (Total)	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
F1 (C6 - C10)	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/FID
F1 (C6 to C10) minus BTEX	VOL-91-5009	modified from CCME Tier 1 Method	P&T GC/FID
Toluene-d8	VOL-91-5009	modified from EPA SW-846 5030C & 8260D	(P&T)GC/MS
F2 (C10 to C16)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
F2 (C10 to C16) minus Naphthalene	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
F3 (C16 to C34)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID

Method Summary

CLIENT NAME: WSP CANADA INC.

AGAT WORK ORDER: 23P052203

PROJECT: CA0006099.3147

ATTENTION TO: Ben Waechter/Kenton Power

SAMPLING SITE: Belleville WLB & M. River

SAMPLED BY: Rob Ireland / Ben Waechter

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
F3 (C16 to C34) minus PAHs	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
F4 (C34 to C50)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
Gravimetric Heavy Hydrocarbons	VOL-91-5009	modified from CCME Tier 1 Method	BALANCE
Terphenyl	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:
 Company: WSP Canada
 Contact: Ben Waechter / Kenton Powers
 Address: 1931 Robertson Rd.
 Ottawa, Ont. K2H 5B7
 Phone: 613-592-9600 Fax: 613-592-9601
 Reports to be sent to:
 1. Email: ben.waechter@wsp.com
 2. Email: kenton.powers@wsp.com

Project Information:
 Project: CA 0006099.3147
 Site Location: Bellefonte - WL3 W & M. River
 Sampled By: Rob Ireland / Ben Waechter
 AGAT Quote #: _____ PO: _____

Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☒ No ☐

Company: WSP Canada

Contact: ~~Joe~~ Julie Ethridge

Address: 300-2611 Queensview Drive, Ottawa

Email: capayables.invoice@wsp.com

Regulatory Requirements:

(Please check all applicable boxes)

<input type="checkbox"/> Regulation 153/04	<input checked="" type="checkbox"/> Regulation 406	<input type="checkbox"/> Sewer Use <input type="checkbox"/> Sanitary <input type="checkbox"/> Storm
Table <u>Indicate One</u>	Table <u>Indicate One</u>	<u>Region</u>
<input checked="" type="checkbox"/> Ind/Com	<input type="checkbox"/> Regulation 558	<input type="checkbox"/> Prov. Water Quality Objectives (PWQO)
<input type="checkbox"/> Res/Park	<input type="checkbox"/> CCME	<input type="checkbox"/> Other
<input type="checkbox"/> Agriculture		
Soil Texture (Check One)		
<input checked="" type="checkbox"/> Coarse		
<input type="checkbox"/> Fine		
		<u>Indicate One</u>

Is this submission for a
Record of Site Condition?

Report Guideline on Certificate of Analysis

Sample Matrix Legend

GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

[illegible]

Samples Relinquished By (Print Name and Sign): <i>Bob Ireland</i>	Date <i>July 28/23</i>	Time <i>08:35</i>	Samples Received By (Print Name and Sign): <i>Randy Jones</i>	Date <i>July 28/23</i>	Time <i>835</i>
Samples Relinquished By (Print Name and Sign): <i>[Signature]</i>	Date <i>July 28/23</i>	Time <i>1600</i>	Samples Received By (Print Name and Sign): <i>[Signature]</i>	Date <i>July 29/2023</i>	Time <i>10:10 am</i>
Samples Relinquished By (Print Name and Sign): <i>[Signature]</i>	Date	Time	Samples Received By (Print Name and Sign): <i>[Signature]</i>	Date	Time
			Page <u>1</u> of <u>1</u>		
			No: T-145524		

Laboratory Use Only

Work Order #: 23P052203

Cooler Quantity: 1

Arrival Temperatures: 6.2 | 5.3 | 5.6
4.4 | 3.7 | 4.6

Custody Seal Intact: ☐ Yes ☐ No ☒ N/A

Notes: ice - 1 bagged ice

Turnaround Time (TAT) Required:

Regular TAT  5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM

APPENDIX E

Site Photographs



Photograph 1: Looking west across the Moira River along the proposed overpass alignment towards the existing Moira River Bridge west approach embankment side slope; June 18, 2023



Photograph 2: Looking east across the Moira River along the proposed overpass alignment towards the existing Moira River Bridge east approach embankment side slope; February 20, 2024



Photograph 3: Looking north towards bedrock outcrop at the location of Boreholes MRP-01 and MRP-02; June 18, 2023



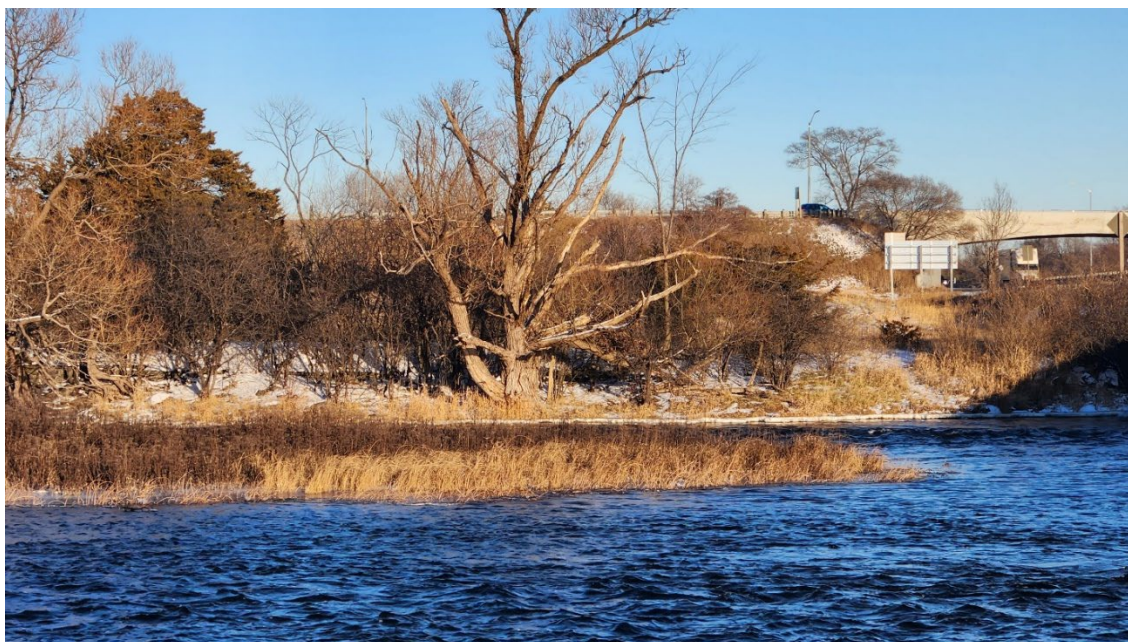
Photograph 4: Looking south from Borehole MRP-02 towards the existing Moira River Bridge; June 18, 2023



Photograph 5: Looking north from MRP-01 towards MRP-02 on the existing bedrock outcrop in the Moira River; June 18, 2023



Photograph 6: Looking east across the Moira River along the proposed overpass alignment towards the bedrock outcrop and Boreholes MRP-01 and MRP-02; February 20, 2024



Photograph 7: Looking east along location of proposed east abutment (Boreholes MR-6, MR-7, and MR-9); February 20, 2024



Photograph 8: looking west along location of proposed retaining wall towards Borehole RW-06; June 24, 2023



Photograph 9: Looking east along location of proposed retaining wall towards Borehole RW-05; June 24, 2023

APPENDIX F

Results of the 2023 Geophysical Investigation



TECHNICAL MEMORANDUM

DATE March 1, 2024

Project No. 20148061B-06000

TO

Ministry of Transportation of Ontario

FROM Alex Bilson Darko / Christopher Phillips

EMAIL alex.bilson.darko@wsp.com /
christopher.phillips@wsp.com

GEOPHYSICAL INVESTIGATION AT MOIRA RIVER, ONTARIO

This memorandum presents results of a geophysical investigation completed at two locations at the proposed Highway 401 widening site in Belleville, Ontario. The objective of the investigation was to assist with mapping the bedrock depth and obtaining shear wave velocity measurements for seismic site classification purposes at the Moira River crossing.

Methodology

WSP Golder used two different geophysical methodologies to meet the objectives of this investigation. Each method is further detailed in the following sub-sections.

Ground Penetrating Radar

A typical ground penetrating radar (GPR) system consists of two antennae (transmitter and receiver), a control console and a computer for real-time, graphic display and data recording. In reflection profiling mode, the antennae, separated a fixed distance, are moved stepwise along the survey line and readings are taken at discrete intervals. At each step, pulses of radar frequency electromagnetic energy (megahertz range) are transmitted, and reflections received from subsurface horizons. Subsurface reflections occur at horizons where there is an abrupt change in the material's dielectric permittivity such as at the interface between saturated and unsaturated materials (water table), stratigraphic horizons, and interfaces between natural and man-made materials. The amplitude of received radar energy is recorded as a function of time, processed in real-time for display purposes and the raw data recorded digitally for later processing and presentation.

A key aspect to interpretation of the GPR profiles is to have control at several locations within the survey area. Although it is generally reasonable to provide preliminary interpretations of collected data, it is necessary to confirm GPR interpretations with data from intrusive investigations such as boreholes and core holes.

GPR antennae, whether shielded or unshielded, can pick up spurious air-wave reflections from objects at surface proximal to the survey line such as buildings and overhead structures and wires. These air wave events are, in general, distinct in their shape and frequency content as observed on reflection profiles and can usually be identified with confidence on the GPR sections during interpretation.

Multichannel Analysis of Surface Waves

The Multichannel Analysis of Surface Waves (MASW) method measures variations in surface-wave velocity with increasing distance and wavelength and can be used to infer the rock/soil types, stratigraphy and soil conditions. A typical MASW survey requires a seismic source, to generate surface-waves, and a minimum of two geophone receivers, to measure the ground response at some distance from the source. Surface-waves are a special type of seismic wave whose propagation is confined to the near surface medium.

The depth of penetration of a surface-wave into a medium is directly proportional to its wavelength. In a non-homogeneous medium surface-waves are dispersive, i.e., each wavelength has a characteristic velocity owing to the subsurface heterogeneities within the depth interval that particular wavelength of surface-wave propagates through. The relationship between surface-wave velocity and wavelength is used to obtain the shear-wave velocity and attenuation profile of the medium with increasing depth.

The seismic source used can be either active or passive, depending on the application and location of the survey. Examples of active sources include explosives, weight-drops, sledge-hammer and vibrating pads. Examples of passive sources are road traffic, micro-tremors and water-wave action (in near-shore environments).

The geophone receivers measure the wave-train associated with the surface-wave travelling from a seismic source at different distances from the source. The participation of surface-waves with different wavelengths can be determined from the wave-train by transforming the wave-train results into the frequency domain. The surface-wave velocity profile with respect to wavelength (called the 'dispersion curve') is determined by the delay in wave propagation measured between the geophone receivers. The dispersion curve is then matched to a theoretical dispersion curve using an iterative forward-modelling procedure. The result is a shear-wave velocity profile of the tested medium with depth, which can be used to estimate the dynamic shear modulus of the medium as a function of depth.

Field Work

The geophysical data were acquired on November 22nd, 2022, by personnel from Golder's Mississauga office. Data was acquired at two separate locations; an MASW survey was carried on land at the north-west bank and a GPR survey on the river in the vicinity of the existing and proposed new piers. The locations of all geophysical data are shown on Figure 1. Data were acquired where access permitted given the shallow bedrock depth at various sections of the river. The details of the data acquired with each geophysical method are in the following sub-sections.

Ground Penetrating Radar

The GPR survey was completed on water using a Sensors & Software Noggin GPR system with 250 MHz antennae attached to a boat in a 'free run' configuration with data sampling at approximately 0.02 metre intervals. The GPR data were recorded digitally and transferred to a computer for subsequent data processing. The data were reviewed by the operator on site for quality control by means of the real-time visual display of data. GPR signal quality and effective depth of penetration varied across the site. Depth of penetration was approximately 2 metres below water surface (mbws).

To map the bedrock topography, GPR data were acquired along a series of south-east to north-west trending lines adjacent to the existing and proposed piers. Data was acquired at irregularly spaced intervals between the

lines to obtain adequate coverage of the survey area. Positioning was recorded with a differential GPS system and presented in NAD83 Zone 18N UTM coordinates. A total of 7 lines were surveyed.

Multichannel Analysis of Surface Waves

For the MASW survey on land, a series of 24 low frequency (4.5 Hz) geophones were laid out at 2-metre intervals. An 8-kilogram (kg) sledgehammer and 40 kg seismic weight drop were used as seismic sources for this investigation. Seismic records were collected with seismic sources located 5 and 8 metres from and collinear to the geophone array. An example of an active seismic record collected at the site is shown in Plate 1 below.

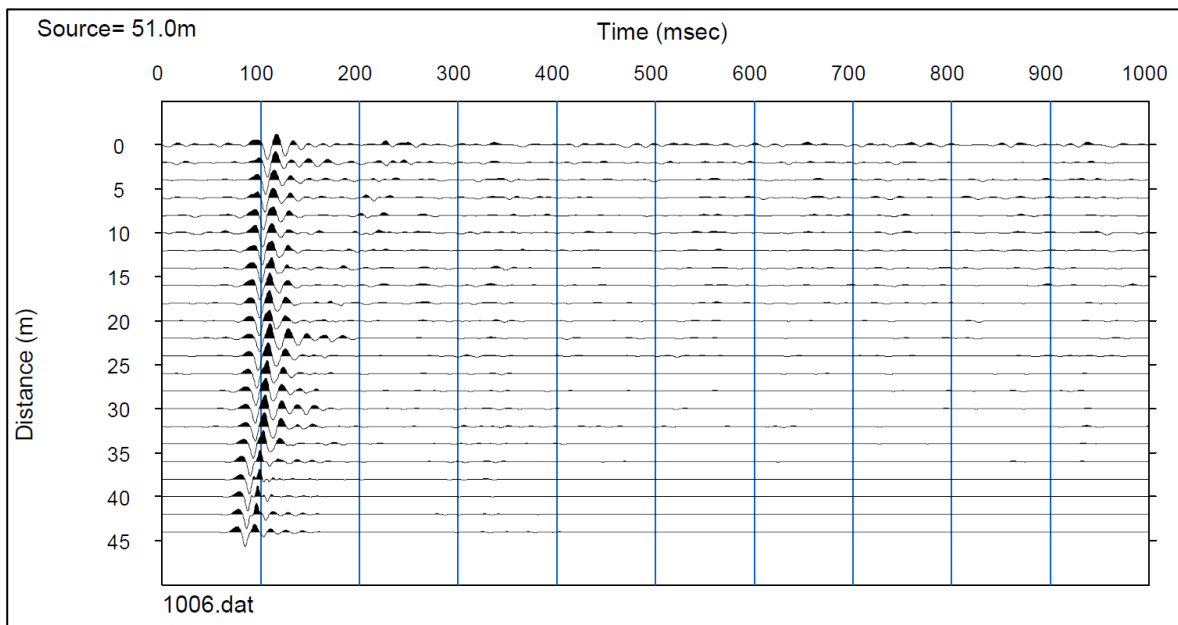


Plate 1: Typical seismic record collected for the MASW Line.

Data Processing and Interpretation

The geophysical data acquired during this investigation were processed with industry standard best practices with details for each method in the following sub-sections.

Ground Penetrating Radar

To map the bedrock topography, the GPR data collected were analyzed with the ReflexW software package (Sandmeier). GPR data is most often presented as cross-sections showing energy reflections with respect to time. A GPR velocity of 0.033 and 0.1 metres/nanosecond corresponding to water and soil velocities respectively, were used to calculate depth. These velocities are consistent with values for water and soils encountered at similar sites.

Data processing consisted of the following:

- Temporal and spatial smoothing (3-point running average filters);
- 'Dewow' to remove low frequency saturation;
- Added GPS positioning (X and Y) to the data traces; and,
- Application of a spreading exponential compensation gain.

The received GPR signal strength is strongly attenuated when travelling through conductive materials such as fine silts or clays. The depth of investigation of a GPR system is strongly affected by the electrical conductivity of the materials it travels through (the greater the conductivity, the shallower the depth of penetration).

River-bottom and bedrock interfaces are displayed within the GPR data as a continuous reflector that mimics the actual horizon. Overall, the interface between water and river-bottom sediments appears sharp and well defined. This is a result of the significant dielectric property contrast between these two media which creates a strong reflection from the GPR transmitter signal.

Plate 2 is a typical GPR profile from this investigation showing the features in the data and interpreted bedrock interface. The interpretation of the GPR data for the objective of mapping the bedrock topography was based on identifying a sub-horizontal reflector along each GPR profile. The bedrock reflector was interpreted without any ground-truthing data. Previous work at this site indicated that the bedrock surface was quite shallow with a thin veneer of sediments overlying it on the river. A high-frequency reflector that barely separated from the river-bottom reflector was interpreted on all GPR profiles. A multiple of the river-bottom was evident on all profiles.

The reflecting horizons interpreted as the top of bedrock reflector were picked in every GPR profile and gridded using the Surfer software package (Golden Software) to produce a contour map shown in Figure 2. The GPR test results along the existing and proposed pier alignments are presented in Figure 3 as 2D cross-sections showing the variation in bedrock depth along each line. The north-west limit of the proposed pier line extends to the region where data collection was restricted due to shallow water conditions. Thus, section C-D (in Figure 3) is truncated towards north-west to reflect the extent of the data collected. Adequate data coverage was obtained along sections A-B and E-F adjacent to the existing piers.

The interpreted depth to top of bedrock ranged from 0.8 to 2.1 mbws for this site with an average interpreted bedrock depth of 1.22 mbws. Generally, the river-bottom and bedrock were shallower towards north-west of the existing and proposed piers.

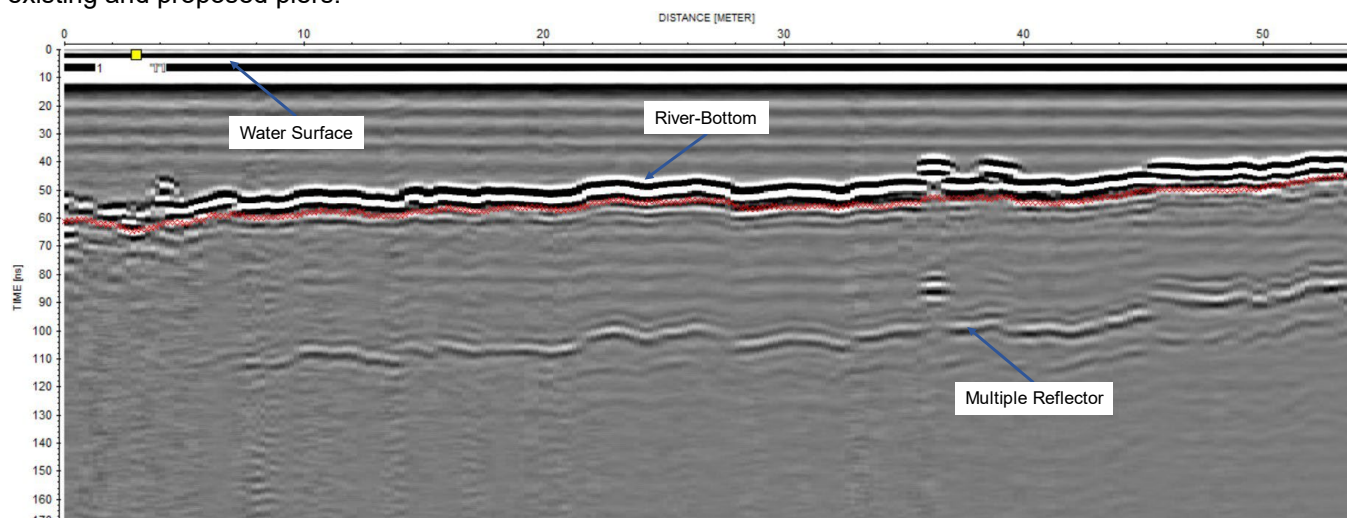


Plate 2: GPR survey line 2 showing interpreted bedrock interface (red).

Multichannel Analysis of Surface Waves

The processing of the MASW test results consisted of the following main steps:

- 1) Transformation of the time domain data into the frequency domain using a Fast-Fourier Transform (FFT) for each source location;
- 2) Calculation of the phase for each frequency component;
- 3) Linear regression to calculate phase velocity for each frequency component;
- 4) Filtering of the calculated phase velocities based on the Pearson correlation coefficient (r^2) between the data and the linear regression best fit line used to calculate phase velocity;
- 5) Generation of the dispersion curve by combining calculated phase velocities for each shot location of a single MASW test; and
- 6) Generation of the stiffness profile, through forward iterative modelling and matching of model data to the field collected dispersion curve.

Processing of the MASW data was completed using the SeisImager/SW software package (Geometrics). The calculated phase velocities for a seismic shot point were combined and the dispersion curve generated by choosing the minimum phase velocity calculated for each frequency component as shown on Plate 3. Shear-wave velocity profiles were generated through inverse modelling to best fit the calculated fundamental mode dispersion curves.

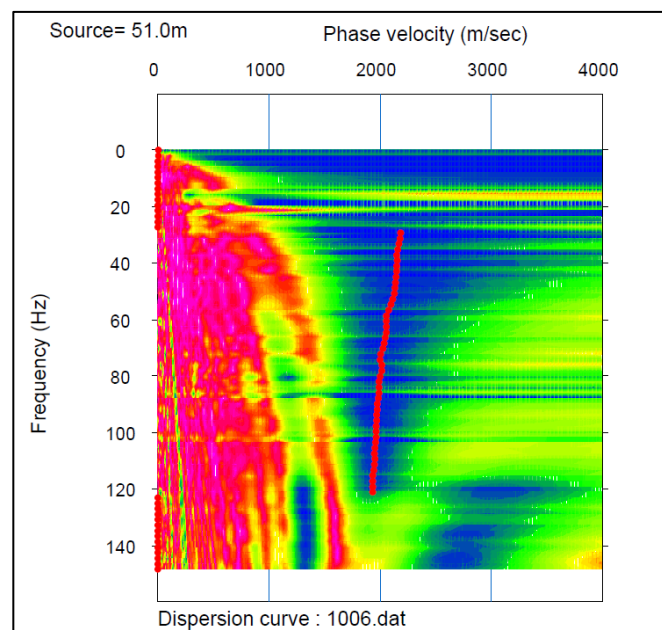


Plate 3: MASW Dispersion Curve Picks (red dots) for the MASW Line.

The minimum measured surface-wave frequency with sufficient signal-to-noise ratio to accurately measure phase velocity was approximately 30 Hz for the MASW Line. The MASW test results are tabulated in Table 1 and

presented graphically on Plate 4, which present the calculated shear-wave velocity profiles measured from the MASW line. There is a good correlation between the field collected and model calculated dispersion curves, with a root mean squared error of less than 5%.

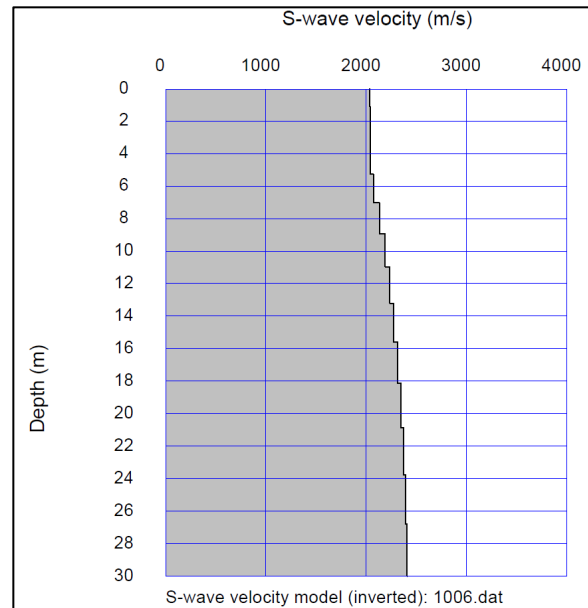


Plate 4: MASW Modelled Shear-Wave Velocity Depth profile.

Table 1: Shear-Wave Velocity Profile MASW Line.

Model Layer (mbgs)		Layer Thickness (m)	Shear Wave Velocity (m/s)	Shear Wave Travel Time Through Layer (s)
Top	Bottom			
0	1.1	1.1	2038	0.00054
1.1	2.3	1.2	2039	0.000588
2.3	3.7	1.4	2041	0.000686
3.7	5.3	1.6	2045	0.000783
5.3	7.0	1.7	2074	0.00082
7.0	8.9	1.9	2138	0.000889
8.9	11.0	2.1	2195	0.000957
11.0	13.2	2.2	2235	0.000984
13.2	15.6	2.4	2277	0.001054
15.6	18.1	2.5	2316	0.00108
18.1	20.9	2.8	2349	0.001192
20.9	23.7	2.8	2375	0.001179
23.7	26.8	3.1	2394	0.001295
26.8	30.0	3.2	2409	0.001328
Vs Average to 30 mbgs (m/s)				2243

To calculate the average shear-wave velocity as required by the National Building Code of Canada (NBC), 2020 (NBC2020), the results were modelled to 30 metres below ground surface (mbgs). The time-average shear-wave velocity (V_{s30}) for the MASW line was 2243 m/s.

Summary of Results

The geophysical investigation completed at this site used two methods to meet the project objectives.

A GPR survey was completed on water to map the bedrock profile at a reconnaissance level and a contour map of depth to bedrock was generated. In general, the bedrock depth is shallow towards north-west of the existing and proposed piers.

An MASW survey was completed on land to obtain shear wave velocity measurements for the purpose of seismic site classification. The time-average shear-wave velocity (V_{s30}) for the MASW line was 2243 m/s, corresponding to seismic Site Class A, based solely on the measured seismic velocity of the ground according to NBC2020.

Any follow-up intrusive investigation should reference the Figures in this report.

Limitations of Use

The geophysical interpretation presented in this report is based on the use of geophysical surveying techniques. As with any geophysical method, interpretation presented in this report should be confirmed by intrusive methods (boreholes, test pits, etc.).

Assumptions made in the geophysical interpretation have been stated, where applicable, throughout the report.

This geophysical survey was carried out in a manner consistent with the level of care and skill normally exercised by other members of the engineering and science professions currently practising under similar conditions, subject to the time limits and financial and physical constraints applicable to the services provided. This report provides a professional opinion and therefore no warranty is either expressed, implied, or made as to the conclusions, advice, and recommendations offered.

Any use of the information within this report made by a third party, or any reliance on, or decisions to be made based on it, are the sole responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this letter.

Closure

We trust that this memorandum meets your current needs. If you have any questions or require further clarification, please contact the undersigned.

WSP Canada Inc.



Alex Bilson Darko, MSc
Geophysicist III, Experienced
ABD/CRP/rk

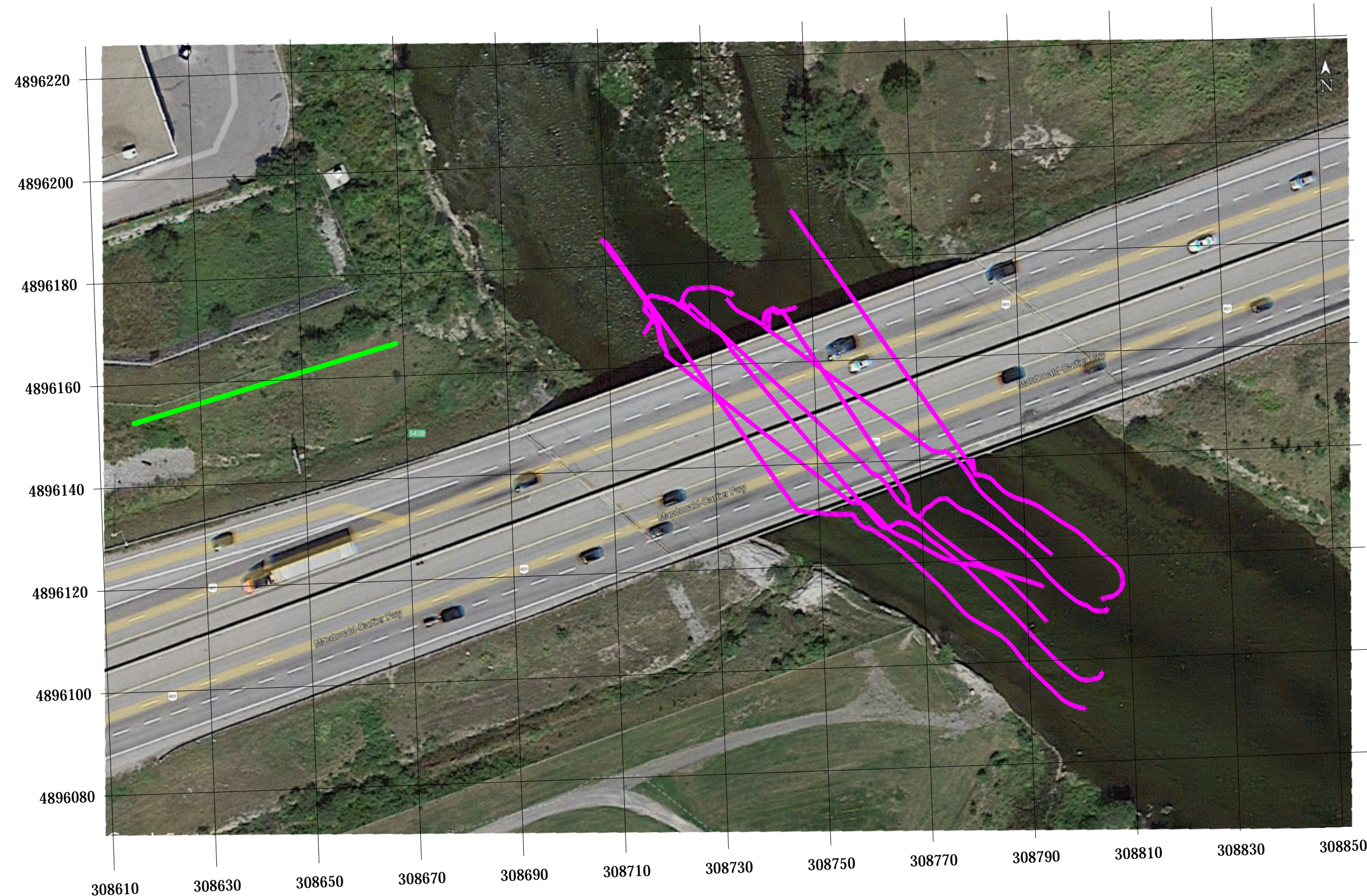


Christopher Phillips, MSc, PGeo
Geophysicist VII, Senior Principal

Attachments: Figures 1 to 3


FIGURES

FIGURES 1 TO 3

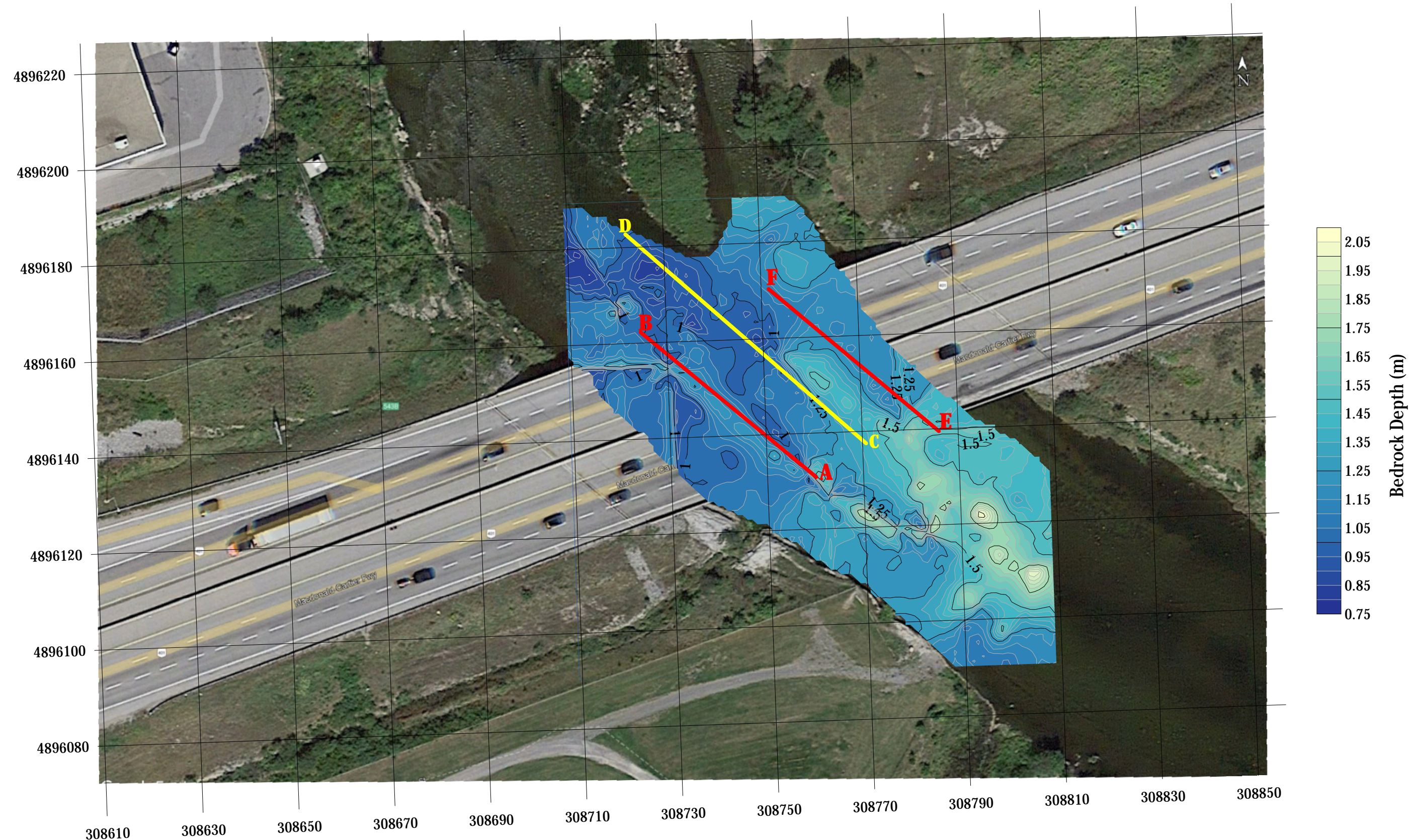


- Legend**
- MASW Survey Line
 - GPR Survey Line

- Notes**
1. This figure is to be analyzed in conjunction with accompanying report.
 2. Geophysical data referenced to NAD83 UTM Zone 18N.
 3. Aerial photograph (GoogleMaps™) may exhibit stretching and/or uneven scaling.


CLIENT MINISTRY OF TRANSPORTATION OF ONTARIO		PROJECT HIGHWAY 401 SIX LANE EXPANSION, BELLEVILLE, ON	
CONSULTANT 	YYYY-MM-DD	2022-12-02	
	PREPARED	ABD	
	DESIGN	ABD	
	REVIEW	PG	
	APPROVED	CP	
TITLE GEOPHYSICAL DATA COLLECTION LOCATIONS		PROJECT No. 20148061B	Phase 06000
		Rev. A	Figure 1

1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

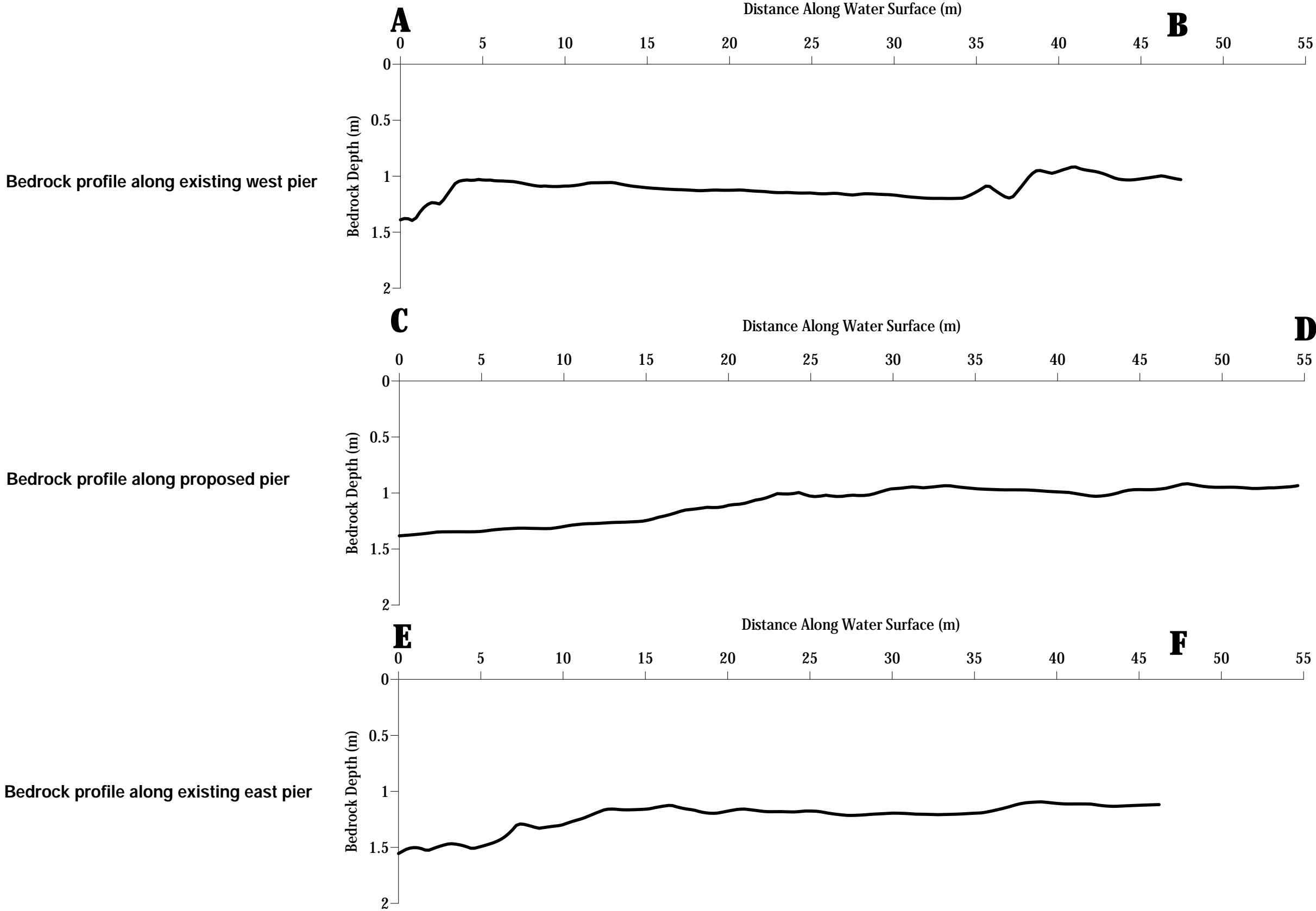


- Legend**
- Line adjacent to existing pier
 - Line adjacent to proposed pier

- Notes**
1. This figure is to be analyzed in conjunction with accompanying report.
 2. Geophysical data referenced to NAD83 UTM Zone 18N.
 3. Aerial photograph (GoogleMaps™) may exhibit stretching and/or uneven scaling.

CLIENT MINISTRY OF TRANSPORTATION OF ONTARIO		PROJECT HIGHWAY 401 SIX LANE EXPANSION, BELLEVILLE, ON	
CONSULTANT 	YYYY-MM-DD	2022-12-02	
	PREPARED	ABD	
	DESIGN	ABD	
	REVIEW	PG	
	APPROVED	CP	
TITLE GPR INTERPRETED BEDROCK DEPTH		PROJECT No. 20148061B	Phase 06000
		Rev. A	Figure 2

1" IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B




Legend

— Interpreted bedrock depth

Notes

1. This figure is to be analyzed in conjunction with accompanying report.
2. Geophysical data referenced to NAD83 UTM Zone 18N.

CLIENT MINISTRY OF TRANSPORTATION OF ONTARIO		PROJECT HIGHWAY 401 SIX LANE EXPANSION, BELLEVILLE, ON	
CONSULTANT 	YYYY-MM-DD	2022-12-02	
	PREPARED	ABD	
	DESIGN	ABD	
	REVIEW	PG	
	APPROVED	CP	
PROJECT No. 20148061B		Phase 06000	Rev. A
		Figure 3	

1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

