



REPORT

Foundation Investigation and Design Report

Nicolston Culvert Replacement / Rehabilitation (Site No. 30X-0678/C0)

Highway 89, Alliston, Simcoe County, Ontario

MTO G.W.P. 2022-22-00; W.P. 2014-23-01; Assignment 2022-E-0046

Submitted to:

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PART A

**FOUNDATION INVESTIGATION REPORT
NICOLSTON CULVERT REPLACEMENT / REHABILITATION
(SITE NO. 30X-0678/C0)
HIGHWAY 89, ALLISTON, SIMCOE COUNTY, ONTARIO
MTO G.W.P. 2022-22-00; W.P. 2014-23-01; ASSIGNMENT 2022-E-0046**

1.0 INTRODUCTION

WSP Canada Inc. (WSP) has been retained by the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the detail design of improvements to the Highway 89 / Essa 5th Line intersection, including widening of the Nottawasaga River bridge, and rehabilitation / replacement of the Nicolston Structural Culvert in Alliston, Ontario.

This report presents the results of the foundation investigation carried out for detail design of the Highway 89 Nicolston Structural Culvert (Site No. 30X-0678/C0). A separate report addresses the foundation investigation for the proposed widening of the Nottawasaga River bridge.

2.0 SITE DESCRIPTION

This section of Highway 89 is located between the towns of New Tecumseth and Cookstown, and between Essa 5th Line and Nottawasaga Resort Way. The culvert is located within the existing Highway 89 embankment that crosses over a ravine associated with a Nottawasaga River tributary watercourse. The location of the culvert site is shown on Drawing 1.

The area to the south of Highway 89, beyond the vegetated / wooded ravine, is occupied by mobile homes (i.e. the Rolling Acres Camp), as well as the Nottawasaga Resort located further east. The area to the north of Highway 89 consists of heavily vegetated / wooded ravine which leads up to the tableland which is currently used for agricultural purposes. There are some residential and/or small business properties on the north side of Highway 89, directly east of the ravine and culvert site.

The north slope of the Nottawasaga tributary ravine is considered an environmentally sensitive area. There is a permanent cut slope (up to about 10 m high) into the tableland that runs parallel to Highway 89 and adjacent to Essa 5th Line, approximately 30 m west of the culvert. There were previous surficial stability issues within the cut slope west of the site, as outlined in a previous Foundation Report¹ and technical memorandum issued to MTO and titled “*Permanent Remediation of Cut Slope Instabilities on Highway 89 near 5th Line, Essa Township, W.O. 2012-11010, GEOCRETS No. 31D-537*”, dated March 27, 2012. Based on observations of the cut slope during the current investigation, there was no obvious signs of instability or active erosion. The exiting conditions at the proposed locations of the temporary access roads are shown in Photographs 1 and 2 below.



Photograph 1 – North end of culvert (inlet), looking west



Photograph 2 – South end of culvert (outlet), looking northeast

¹ Golder Associates Ltd. 2009. *Foundation Investigation and Design Report: Highway 89 Nottawasaga River Bridge Rehabilitation/Widening & Retaining Wall and Cut Slope at Intersection of Essa 5th Line and Highway 89, Simcoe County, Ontario, G.W.P. 2503-04-00.*

Highway 89 runs in an east-west direction at this location, and the Nottawasaga River tributary (and culvert) generally runs northeast-southwest. The embankment side-slopes are generally covered with trees and shrubs, with increasing wooded area surrounding the Nottawasaga tributary watercourse, which drains into the Nottawasaga River approximately 275 m southwest of the culvert. The embankment at the location of the culvert is up to approximately 8 m high, with existing side slopes of about 2 horizontal to 1 vertical (2H:1V). There is an existing retaining wall (up to about 1.5 m high) at the crest of the embankment on the north side of Highway 89. The retaining wall was assessed as part of a separate study for this project and is considered to be performing satisfactorily with no signs of distortion or distress.

Based on observations during the field investigation and the site reconnaissance of the existing retaining wall discussed in WSP's retaining wall technical memorandum², the existing Highway 89 embankment side-slopes in the vicinity of the culvert inlet / outlet and proposed access roads appear to generally be performing adequately and visual signs of instability or active erosion were limited to some localized zones within the tributary watercourse channel near the headwall / wingwall at the inlet (north) side (see Photograph 3) and above the headwall at the outlet (south) side (see Photograph 4). Localized erosion of the natural drainage path leading from the Highway 89 ditch to the watercourse tributary, east of the retaining wall, was also observed (see Photograph 5). The majority of the embankment slope between the base of the retaining wall and the bottom of the embankment slope appeared to be stable and was heavily vegetated at the time of observation (see Photograph 6).



Photograph 3 – North culvert inlet, looking north (erosion near south/east side of culvert not shown) (Spring 2024)

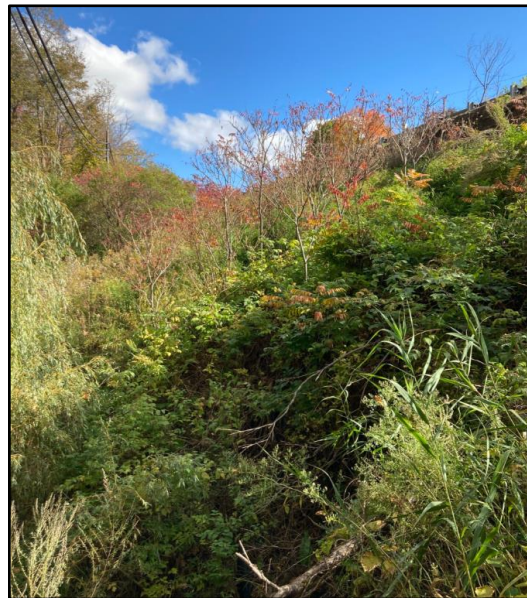


Photograph 4 – South culvert inlet, looking north (Fall 2024)

² WSP. 2024. *Foundation Desktop Study and Site Reconnaissance, Existing Retaining Wall Northeast of Nicolston Culvert, Highway 89, Alliston, Simcoe County, MTO Assignment No. 2022-E-0046*. Technical Memorandum dated March 2024.



Photograph 5 – Erosion east of the retaining wall, looking northwest (Spring 2024)



Photograph 6 – North embankment slope below retaining wall (Early Fall 2023)

Based on the current design drawings, the existing Nicolston Culvert is a 63 m long (measured along centreline) open footing concrete box culvert consisting of an original structure with extensions on both ends. The original section is 18 m long, while the north and south extensions are about 29 m and 16 m long, respectively. The original and south sections are skewed relative to the Highway 89 alignment at an angle of about 41°, and the north extension is “kinked” to follow the direction of the existing watercourse. The culvert sections have a span of about 3.65 m and a rise of about 1.9 m (relative to the top of the open footings). There are concrete wing walls present at both the north (inlet) and south (outlet) ends of the culvert. The natural watercourse bed (streambed) is shown to be near or slightly below the top of the open footings. The width and depth of the existing open footings are not known.

The dates of both the original construction and the extensions are unknown, however it is assumed that the original structure was constructed in the early 1960’s. There are no original design or construction drawings available for the existing culvert. The original culvert section is assumed to be a non-rigid frame while the extensions are assumed to be rigid frame structures. The embankment soil cover above the existing culvert is up to about 6 m thick and Highway 89 currently consists of one lane of traffic in each direction. Highway 89 will not be permanently widened at the culvert location as part of the current design and there is no proposed grade raise.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between April 15 and 23 and November 14 and 27, 2024, during which time a total of six boreholes (designated Boreholes BH24-03 to BH24-06, BH24-09 and BH24-10) were advanced at the locations shown on Drawing 1.

Boreholes BH24-03, BH24-04, BH24-09, and BH24-10 were advanced using 210 mm outside diameter (O.D.) hollow stem augers using a CME 75 truck-mounted drill supplied and operated by Atcost Drilling Inc. of Gormley, Ontario. Boreholes BH24-05 and BH24-06 were advanced using BW sized casing and wash boring techniques with portable equipment supplied and operated by OGS Inc. of Almonte, Ontario. Soil samples were generally obtained at 0.75 m and 1.5 m intervals of depth using a 50 mm O.D. split spoon sampler. The split spoon sampler

was driven with an automatic hammer in boreholes advanced with the truck mounted drill rigs in general accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586³). The split spoon sampler was driven with a full weight hammer lifted manually with assistance of a cathead and dropped from the SPT height in boreholes advanced with portable equipment. The split-spoon samplers used in the investigation generally limit the maximum particle size that can be sampled and tested to about 35 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension would not be sampled or represented in the grain size distributions. In-situ vane shear tests were carried out in cohesive soils for determination of undrained shear strengths in general accordance with the Standard Test Method for Field Vane Shear Test in Saturated Fine-Grained Soils (ASTM D2573⁴), using an MTO standard 'N'-size vane in boreholes advanced with the truck mount drill rig and an MTO standard 'B'-size vane in boreholes advanced with portable equipment. The boreholes were backfilled upon completion in general accordance with Ontario Regulation 903 Wells (as amended) and capped at the roadway surface using cold patch asphalt.

The water level was typically measured in the open boreholes (or inside the hollow stem augers or BW casing) during and after drilling operations. Standpipe piezometers were installed in Boreholes BH24-03 and BH24-04 and were screened within a silt/silty sand fill and clayey silt deposit, respectively. The installed piezometers consist of a 50 mm diameter PVC pipe, with a 1.5 m long slotted screen within a filter sand pack. The boreholes and annulus surrounding the piezometer pipe above the filter sand pack were backfilled to near ground surface with bentonite pellets in general accordance with Ontario Regulation 903 Wells (as amended)⁵. The monitoring wells were capped with flushmount casings.

The field work was monitored on a full-time basis by a member of WSP's engineering staff who located the boreholes in the field, directed the sampling and in-situ testing operations, logged the boreholes, and examined the soil samples. The soil samples were identified in the field, placed in labelled containers, and transported to WSP's laboratories in Mississauga and Whitby for further visual review and geotechnical laboratory testing. Index and classification testing consisting of natural moisture content, organic content, Atterberg limits and grain size distribution were conducted on selected samples. All laboratory tests were carried out in general accordance with MTO and / or ASTM Standards, as applicable.

Two soil samples obtained from Boreholes BH24-03 and BH24-04 were submitted to a specialist analytical laboratory (Bureau Veritas Laboratories of Mississauga, Ontario) under chain of custody procedures for testing of electrical conductivity / resistivity, pH, and chemical analysis of sulphate, sulphide and chloride content, to assess the potential for the soil to cause deterioration to buried concrete and corrosion to steel.

The borehole coordinates were surveyed in the field by WSP personnel using a Trimble Catalyst DA2 Global Positioning System (GPS) unit and the elevation was obtained from the digital terrain model (DTM) developed for the project. The locations given on the borehole records and shown on Drawing 1 are positioned relative to NAD 83 MTM (Zone 10) northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum (CGVD28 datum). The borehole locations, including the geographic (Latitude / Longitude) coordinates, the ground surface elevations, and borehole depths are summarized below.

³ ASTM D1586 Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soils.

⁴ ASTM D2573 Standard Test Method for Field Vane Strength Shear Test

⁵ Ontario Regulation 903 Wells (as amended)

Table 1: Summary of Boreholes

Borehole No.	NAD 83 MTM Northing (m) (Latitude, °)	NAD 83 MTM Easting (m) (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
BH24-03	4,891,998.5 (44.167577)	280,397.8 (-79.805134)	214.5	18.9
BH24-04	4,892,002.9 (44.167616)	280,382.3 (-79.805328)	214.2	18.9
BH24-05	4,891,977.2 (44.167385)	280,382.4 (-79.805326)	207.3	10.4
BH24-06	4,892,037.3 (44.167928)	280,443.4 (-79.804566)	209.8	9.8
BH24-09	4,891,999.0 (44.16758)	280,367.8 (-79.805509)	213.8	16.2
BH24-10	4,892,002.5 (44.167613)	280,413.3 (-79.80494)	215.0	16.2

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The site generally lies within the physiographic region known as the Simcoe Lowlands, between two sections of the region known as the Peterborough Drumlin Field, as delineated in *The Physiography of Southern Ontario*⁶.

Most of the Nottawasaga Basin was at one time part of the floor of Lake Algonquin and its surface beds are deltaic and lacustrine origin. Within the Nottawasaga Basin in the Alliston area where the culvert site is located, near the confluence of the Nottawasaga River and Boyne River are the Essa Flats⁷. The Essa Flats portion of the Basin comprises of a sandy loam soil. The surficial geology in the area adjacent to the Nottawasaga River are described as modern alluvial deposits consisting of clay, silt, sand, and gravel which may contain organics⁸.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes from the current investigation, including piezometer installation details and water level readings, and the results of the in-situ and laboratory tests, are provided on the borehole records in Appendix A. The results of the in-situ field tests (i.e., SPT “N”-values) as presented on the borehole records and in Section 4 are uncorrected. The detailed results of the geotechnical laboratory testing on soil samples are presented on the laboratory test figures in Appendix B. The results of the analytical testing are provided in Appendix C.

The stratigraphic boundaries shown on the borehole records and on the stratigraphic profile on Drawing 2 are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Variation in the stratigraphic boundaries between and beyond boreholes will exist and is to be expected.

⁶ Chapman, L. J. and Putnam, D. F. *The Physiography of Southern Ontario*, Ontario Geological Survey Special Volume 2, Third Edition, 1984. Accompanied by Map P.2715 Scale 1:600,000.

⁷ Ministry of Northern Development and Mines, Ontario. 1988. Aggregate resources inventory of Essa and Tosoronto Townships, Simcoe County, Southern Ontario; Ontario Geological Survey. Aggregate Resources Inventory Paper 113.

⁸ Ontario Geological Survey. 2010. Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release – Data 128 – Revised.

In general, the soil encountered at this site consists of embankment fill associated with the highway (i.e. surficial layer of asphalt underlain by cohesive and non-cohesive fill) above peat or an organic silt, underlain by a clayey silt to clay deposit underlain by a till deposit consisting predominantly of clayey silt-silt and sand. More detailed descriptions of the major soil layers encountered in the boreholes as well as a summary of laboratory results are provided in the following sections.

4.2.1 Asphalt

An approximately 45 mm to 180 mm thick layer of asphalt was encountered at ground surface in Boreholes BH24-03, BH24-04, BH24-09 and BH24-10, respectively.

4.2.2 Fill

A 3.5 m to 7.2 m thick layer of fill (cohesive and non-cohesive) was encountered below the asphalt in boreholes advanced through the road (BH24-03, BH24-04, BH24-09 and BH24-10) and a 1 m thick layer of silty sand fill was encountered at ground surface in Borehole BH24-05. The fill encountered in boreholes advanced through the road was primarily non-cohesive, consisting of sandy silt, silt and sand, silty sand, sand to gravelly sand, and sandy gravel. The cohesive fill consisted of clayey silt to sandy clayey silt. Trace organics were encountered throughout the fill soils in the majority of boreholes and trace asphalt fragments were encountered in the fill at Borehole BH24-03. The lower portion of the fill soils typically contained timber and wood fragments and/or shell fragments near the fill / native soil interface.

The SPT 'N'-values measured within the non-cohesive fill range from 0 blows to 46 blows per 0.3 m of penetration, indicating a very loose to dense state of compactness.

The SPT 'N'-values measured within the cohesive fill range from 2 to 8 blows per 0.3 m of penetration. In-situ field vane tests carried out within the cohesive fill measured shear strengths ranging from 48 kPa to 67 kPa with a calculated sensitivity between about 10 and 13. The combined SPT and field vane test results suggest that the deposit has a generally firm to stiff consistency.

Grain size distribution tests were carried out on six samples of the non-cohesive fill and the results are presented on Figure B1 in Appendix B. Atterberg limits testing was carried out on five samples of the non-cohesive fill. Four of the Atterberg limit tests measured the fines component of the non-cohesive fill as non-plastic. One Atterberg limits test taken on a fill sample containing organics from the lower portion of BH24-03 measured a liquid limit of about 27%, plastic limit of about 22%, and plasticity index of 5% (see Figure B2 in Appendix B) indicating the fines component of the fill is classified as a clayey silt-silt to silt or organic silt of low plasticity. A laboratory organic content test performed on the same sample from Borehole BH24-03 measured an organic content of about 5%.

A grain size distribution test carried out on one sample of the cohesive clayey silt fill is presented on Figure B3. An Atterberg limits test was carried out on one sample of the cohesive clayey silt fill and measured a liquid limit of about 33%, plastic limit of about 17%, and corresponding plasticity index of about 16%. The results of the Atterberg limits test are shown on the plasticity chart on Figure B4 and indicate the fill is classified as clayey silt of low plasticity.

The natural moisture content measured on samples of the non-cohesive fill range from 4% to 37%. The higher moisture contents can be attributed to the presence of organics and clayey interlayers. The natural moisture content measured on three samples of the cohesive fill range from 23% to 25%.

4.2.3 Organic Deposit – Peat (PT) / Organic Silt (OL)

A layer of peat (0.4 m thick) was encountered below the fill in Borehole BH24-09 at a depth of approximately 3.7 m below highway grade (Elevation 210.0 m). A 0.3 m thick layer of organic silt was encountered below the fill

in Borehole BH24-10 at a depth of 4.2 m below highway grade (Elevation 210.8 m). The organic silt deposit contains wood pieces.

A SPT 'N'-value measured at the interface between the peat and the underlying sandy silt deposit was 5 blows per 0.3 m of penetration, suggesting a firm consistency. The natural moisture content measured on a sample of the peat was about 120%. The organic content of a sample of peat was measured to be about 33%.

A SPT 'N'-value measured at the interface between the organic silt and the overlying sandy silt fill was 0 blows (weight of hammer) per 0.3 m of penetration, suggesting a very loose state of compactness. The natural moisture content measured on a sample of the organic silt was 44%.

4.2.4 Sandy Silt (ML)

A 0.4 m thick deposit of brown to grey sandy silt was encountered below the organic deposit in Boreholes BH24-09 and BH24-10, respectively. The deposit was encountered between Elevations 209.7 m and 210.5 m respectively.

The SPT 'N'-values measured within this deposit were 5 blows and 8 blows per 0.3 m of penetration, indicating a loose state of compactness.

The natural moisture content measured on two samples of the deposit was about 21% and 22%.

4.2.5 Clayey Silt (CL) to Clay (CH)

A native cohesive deposit consisting of clayey silt to clay with varying amounts of sand and gravel was encountered at ground surface in Borehole BH24-06, below the fill in Boreholes BH24-03 to BH24-05 and below the sandy silt deposit in Boreholes BH24-09 and BH24-10. The top of the clayey silt to clay deposit was encountered between Elevation 206.3 m and 210.1 m. Where the deposit was fully penetrated in two boreholes, it had a thickness of 8.8 m and 10.4 m. The deposit was penetrated for lengths between 9.4 m and 11.7 m in Boreholes BH24-03, BH24-05, BH24-06 and BH24-10 before the boreholes were terminated. The deposit contained pockets, laminations, and seams of gravel, sand and silt at various depths in Boreholes BH24-04, BH24-06, BH24-09, and BH24-10. In Borehole BH24-06 the deposit contained interlayers of organic silt and/or wood fragments from ground surface to a depth 3 m (Elevation 209.8 m to 206.8 m).

The SPT 'N'-values measured within this deposit range from 0 blows (i.e., weight of hammer) to 10 blows per 0.3 m of penetration. In-situ field vane tests carried out within this deposit generally measured undrained shear strengths ranging from 26 kPa to 86 kPa with a calculated sensitivity between about 1 and 12. Several field vane tests achieved refusal of the testing equipment to penetrate the deposit due to the presence of gravel pockets. The combined SPT and field vane test results indicate that the deposit has a generally firm to stiff consistency.

Eight grain size distribution tests were carried out on samples of the clayey silt to clay deposit and the results are shown on Figure B5 in Appendix B.

Atterberg limits tests were carried out on 12 samples of the cohesive deposit and measured liquid limits between about 31% and 70%, plastic limits between about 17% and 22%, and corresponding plasticity indices between about 14% to 49%. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B6A/B in Appendix B and classify the cohesive deposit as clayey silt to clay of low to high plasticity.

The natural moisture content measured on 19 samples of the clayey silt to clay deposit were between about 18% and 47%. The organic content of a sample from the upper portion of the cohesive deposit containing organic silt interlayers in Borehole BH24-06 was measured to be about 4%.

4.2.6 Clayey Silt-Silt (CL-ML) - Till

A clayey silt-silt and sand (till) deposit was encountered underlying the cohesive clayey silt to clay deposit in Boreholes BH24-04 and BH24-09. The till deposit was encountered at Elevation 197.1 m and 200.5 m. Boreholes BH24-04 and BH24-09 were terminated within the clayey silt-silt till deposit after penetrating it for lengths of 1.8 m and 2.9 m, respectively.

The SPT 'N'-values measured within this deposit range from 6 blows to 10 blows per 0.3 m of penetration. Two in-situ field vane tests carried out within this deposit measured undrained shear strengths of approximately 67 kPa with a calculated sensitivity of about 3. The combined SPT and field vane test results suggest that the deposit has a stiff consistency.

Two grain size distribution tests were carried out on select samples of the clayey silt-silt till deposit and the results are shown on Figure B7 in Appendix B.

An Atterberg limits test carried out on two samples of the cohesive till deposit measured liquid limits of about 13% and 14%, plastic limits of about 9%, and corresponding plasticity indices of about 4% and 5%. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B8 in Appendix B and classify the till deposit as clayey silt-silt of low plasticity.

The natural moisture content measured on two samples of the clayey silt-silt till deposit was about 9% and 11%.

4.3 Groundwater Conditions

The water levels measured in the open boreholes and/or within the hollow stem augers or BW casing at the time of the investigation are shown on the borehole records in Appendix A and are not considered representative of the stabilized hydrostatic water levels at the site. Standpipe piezometers were installed in Boreholes BH24-03 and BH24-04 to allow monitoring of the stabilized hydrostatic groundwater level at this site. The groundwater levels recorded in the piezometers are shown on the borehole records in Appendix A and are summarized below.

Table 2: Summary of Piezometer Installation and Water Level Readings

Borehole No. (Piezometer)	Depth (Elevation) of Screen Interval (m)	Depth (bgs) to Water Level (m)	Water Level Elevation (m)	Date of Water Level Reading
BH24-03	6.1 – 7.6 (208.4 – 206.9)	4.0	210.5	August 26, 2024
		4.3	210.2	November 25, 2024
BH24-04	4.6 – 6.1 (209.6 – 208.1)	3.8	210.4	August 26, 2024
		3.9	210.3	November 27, 2024

The groundwater levels at this site will be subject to seasonal fluctuations and precipitation events; the water levels should be expected to be higher during the spring season or during and following periods of heavy precipitation and snow melt. Localized perched groundwater should also be anticipated above clayey zones within the fill soils.

4.4 Analytical Testing Results

Two soil samples were submitted for analysis of parameters used to assess the potential corrosivity of the site soil to steel and concrete. Detailed analytical test results are included in Appendix C and the test results are summarized below:

Table 3: Summary of Analytical Testing Results

Borehole No., Sample No.	pH	Resistivity (ohm-cm)	Electrical Conductivity (µmho/cm)	Soluble Chloride (µg/g)	Soluble Sulphate (µg/g)	Sulphide (mg/kg)	Redox Potential (mV)
BH24-03, Sa#9	7.74	1800	561	200	35	2.4	270
BH24-04, Sa#8	7.56	5200	192	<20 *	49	3.3	270

Note: * Less than reportable detection limit.

5.0 CLOSURE

This foundation investigation report was prepared by Farhana Jabin, P.Eng., and Madison Kennedy, P.Eng., both Geotechnical Engineers with WSP. Kevin Bentley, P.Eng. a Geotechnical Engineer with WSP and MTO Principal Foundations Contact conducted a technical and quality control review of the report.

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PART B

**FOUNDATION DESIGN REPORT
NICOLSTON CULVERT REPLACEMENT / REHABILITATION
(SITE NO. 30X-0678/C0)
HIGHWAY 89, ALLISTON, SIMCOE COUNTY, ONTARIO
MTO G.W.P. 2022-22-00; W.P. 2014-23-01; ASSIGNMENT 2022-E-0046**

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides foundation engineering design recommendations for the Nicolston Structural Culvert (Site No. 30X-0678/C0) located at Station 16+443 of Highway 89 in Alliston, Ontario. The recommendations herein are based on interpretation of the factual data obtained from the boreholes advanced during the current subsurface exploration. The discussion and recommendations presented are intended to provide the designers with information to assess feasible foundation alternatives for culvert replacement or rehabilitation, with open cut or trenchless methods.

The Foundation Design Report (Part B of this report), discussion and recommendations are intended for the use of the MTO and their designers and shall not be used or relied upon for any other purpose or by any other parties, including the construction contractor or design-build proponents. Contractors undertaking the work must make their own interpretation based on the data presented in the Foundation Investigation Report (Part A of this report). Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project and for which special provisions may be required in the Contract Documents. Those requiring information on aspects of construction must make their own interpretation of the data provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

6.2 Project Understanding

As part of this assignment, an assessment of both replacement and rehabilitation options for the Nicolston culvert were to be considered. Replacement options included open cut (i.e. full highway closure or staged construction) and rehabilitation options included lining the existing culvert with the possibility of adding a new relief culvert via trenchless method, if required.

Culvert replacement foundation options using open cut are discussed in Section 6.5. Based on the high fill embankment, property and watercourse constraints, and the requirement to keep Highway 89 open to traffic, open cut methods to replace the culvert were not considered practical or feasible.

Culvert lining (i.e. trenchless rehabilitation) is considered to be the preferred option by the design team based on the low impact to traffic and the use of a structural liner consisting of Glass Reinforced Plastic (GRP). The GRP liner is designed to provide adequate structural capacity and does not rely on any strength from the host pipe. The GRP liner also has adequate cross-section to meet the design hydraulic capacity requirements such that no relief culvert is required. The foundation recommendations for the culvert lining option are provided in Section 6.6. Although not considered to be required for the current proposed culvert design rehabilitation (lining) option, foundation recommendations for a trenchless installation for a new or future relief culvert are provided in Section 6.7 for information purposes.

From a geotechnical / foundation perspective, rehabilitation by lining the existing culvert is the preferred option given that there is reduced geotechnical related risk during construction and limited interruption to the existing highway traffic and watercourse compared to open cut or trenchless installation methods for a new or relief culvert (e.g. shafts in close proximity to highway and watercourse). To facilitate the lining operation, temporary access routes will need to be constructed from the Highway 89 grade to near the existing culvert inlet and outlet. Based on the design drawings, it is anticipated that the access routes / roads will be constructed east of the existing culvert. The investigation and design recommendations related to temporary construction works including the access routes / roads is included in separate foundation report.

Details of the existing culvert and proposed liner dimensions, inverts and associated embankment height are summarized in Table 4.

Table 4: Existing and Proposed Lined Culvert Details

Embankment Height (m) ²	Total Length along centreline (m)	Culvert Dimensions				Invert El. (m) ¹
		Existing		Lined		Upstream / Downstream
		Width ³ / Span (m)	Height ⁴ / Rise (m)	Width ³ / Span (m)	Height ⁴ / Rise (m)	
8	63	4.5 / 3.6	2.8 / 2.3	3.2 / 2.996	2.5 / 2.4	206.1 / 206.0

Notes:

1. Invert Elevation based on proposed liner invert elevation.
2. Relative to culvert liner invert.
3. Width – approximate dimension from outside edges of culvert or liner and grout.
4. Height – approximate dimension from tributary or liner bottom to top of culvert or liner and grout.
5. In general, dimensions are approximate and rounded to one decimal place.

6.3 General Foundation Design Context

6.3.1 Consequences and Site Understanding Classification

In accordance with Section 6.5 of the *Canadian Highway Bridge Design Code CAN/CSA S6-19* (CHBDC, 2019) and its *Commentary*, the culvert, liner and its foundation system may be classified as a geotechnical system design for applications along a transportation corridor with medium to large traffic volumes and/or with potential impacts on other transportation corridors, resulting in a “typical consequence level” associated with exceeding limit states design.

In addition, given the project-specific foundation investigation carried out at this site (as presented in the Foundation Investigation Report or Part A of this report), in comparison to the degree of site understanding in Section 6.5 of CHBDC (2019), the level of confidence for design is considered to be a “typical degree of site and prediction model understanding.” Accordingly, the appropriate corresponding ultimate limit state (ULS) and serviceability limit state (SLS) consequence factor, Ψ , and geotechnical factors ϕ_{gu} and ϕ_{gs} , from Tables 6.1 and 6.2 of the CHBDC (2019) have been used for design.

In addition, reference is made to the MTO Material Engineering Research Office (MERO) Memorandum #2020-01 (dated March 23, 2020) settlement and stability analyses, as applicable.

6.4 Seismic Design

6.4.1 Seismic Site Classification

The subsurface conditions for seismic site characterization were assessed based on the results of the field investigation and in situ testing. Based on the undrained shear strength, s_u , below the founding level, the site may be classified as Site Class E in accordance with Table 4.1 of the *CHBDC* (2019), in the absence of any geophysical testing.

The *CHBDC* (2019) states that the seismic hazard values associated with the design earthquakes should be those established for the National Building Code of Canada (NBCC) by the Geological Survey of Canada (GSC). The current seismic hazard maps (referred to as the 6th generation seismic hazard maps) were developed and made available for public use in 2020.

6.4.2 Spectral Response Values and Seismic Performance Category

In accordance with Section 4.4.3.1 of the 2019 CHBDC, the peak ground acceleration (PGA), peak ground velocity (PGV) and 5% damped spectral response acceleration ($S_a(T)$) values for Site Class E were obtained for

the culvert site using the NBCC website (earthquakescanada.nrcan.gc.ca) and are summarized below for use in the design, if applicable.

Table 5: Site Class E - Peak Ground Acceleration, Peak Ground Velocity, and Spectral Response

Seismic Hazard Values for Site Class D	10% Exceedance in 50 years (475-year return period)	5% Exceedance in 50 years (975-year return period)	2% Exceedance in 50 years (2,475 year return period)
PGA (g)	0.0623	0.0977	0.159
PGV (m/s)	0.0679	0.112	0.195
$S_a(0.2)$ (g)	0.111	0.173	0.28
$S_a(0.5)$ (g)	0.122	0.19	0.309
$S_a(1.0)$ (g)	0.0723	0.115	0.193
$S_a(2.0)$ (g)	0.0327	0.0543	0.0938
$S_a(5.0)$ (g)	0.0076	0.0135	0.025
$S_a(10.0)$ (g)	0.00237	0.00419	0.00771

6.5 Option#1 - Culvert Replacement using Open Cut

Temporary cut slopes up to 8.5 m high are required for open cut replacement. Temporary cuts would be made through the variable embankment fill containing very loose to soft zones and underlying firm clay deposits. Preliminary slope stability assessment indicates the cuts would need to be sloped at about 3H:1V to achieve a factor of safety of 1.16, if MTO accepts a “low consequence level” for design of the temporary cut slope. If a “typical consequence level” is used for design, temporary cut slopes shallower than 3H:1V would be required to achieve a greater factor of safety and is not considered practical. Given that full closure of Highway 89 is not permitted combined with the adjacent property and watercourse constraints, large volume of excavated soil and high cost of temporary protections systems up to 8.5 m high, it was determined that culvert replacement by open cut is not feasible at this site.

Although there is a low probability of culvert replacement using open cut methods, foundation recommendations are provided for both precast concrete segmental closed box culvert and open footing box culvert replacement options. The recommendations provided assume that the replacement culvert will be the same size and on the same alignment as the existing culvert.

6.5.1 Founding Elevations, Sub-excavation and Frost Protection Requirements

For a segmental precast closed box culvert, it is generally not considered necessary to found the culvert at or below the depth of frost penetration, as precast box structure segments are typically tolerant of small magnitudes of movement relative to freeze-thaw cycles, should these occur. Consideration should be given to sealing joints to adequately control water and soil infiltration at locations of high frost susceptibility. Any disturbed (loosened/softened) soils and organic materials, if encountered at the founding level, should be removed prior to placement of the bedding / leveling pad for the box culvert.

For an open footing culvert founded on shallow / strip footings, the founding level should be a minimum depth of 1.5 m (i.e. frost depth) below the lowest surrounding final grade, including below the tributary streambed to provide adequate protection against frost penetration (as interpreted from OPSD 3090.101 – Foundation Frost Penetration Depth for Southern Ontario). Consideration can be given to using insulation for frost protection in lieu of soil cover.

A summary of the recommended founding elevations and founding soils for the closed box and open footing culvert options are provided in Table 6, along with the subexcavation and frost protection requirements

Table 6: Culvert Replacement in Open Cut Options

Culvert Type	Approximate Invert / Streambed Elevation (m)	Proposed Founding Elevation (m)	Sub-excavation Requirements	Founding Stratum	Frost Protection Required
Segmental Pre-Cast Closed Box Culvert	206.1 / 206.0 (upstream / downstream)	205.4 / 205.3 (upstream / downstream)	About 0.7 m depth	Firm to Stiff Silty Clay to Clay	N/A
Open-Footing Box Culvert	206.1 / 206.0 (upstream / downstream)	204.6 / 204.5 (upstream / downstream)	N/A	Firm to Stiff Silty Clay to Clay	Yes (1.5 m of soil)

Notes:

1. The values for the closed box culvert have been provided assuming a culvert concrete base thickness of about 0.3 m and underlying combined bedding and leveling course thickness of 0.4 m.
2. Assumes open footings are founded at frost depth (1.5 m below ground surface / streambed).

It should be noted that the bedding layer thickness, levelling pad and actual culvert base thickness of the closed box culvert option would need to be confirmed and the recommendations checked and revised, as applicable.

6.5.2 Geotechnical Resistance

The closed box or open footing box culvert placed / constructed on properly prepared subgrade, at or below the founding elevations provided in Table 6, may be designed based on the factored geotechnical resistance at ultimate limit state (ULS) and serviceability limit state (SLS, for 25 mm of settlement) values provided in Table 7. These recommendations are based on the associated culvert width dimensions / footing size and the founding soils outlined in Table 7.

Table 7: Summary of Factored Geotechnical Resistance Values for Culvert Replacement in Open Cut

Culvert Type	Foundation Size	Founding Stratum	Factored Geotechnical Resistance at ULS (kPa)	Factored Geotechnical Resistance at SLS (kPa)
Precast Closed Box Culvert	3 m to 4 m wide	Compact granular bedding above firm to stiff clayey silt to clay	130	50
Open-Footing Box Culvert	0.8 m to 1 m wide	Firm to stiff clayey silt to clay	135	135

The factored geotechnical resistances are dependent on the culvert foundation width, founding soils / elevations, and embankment configuration and as such, the geotechnical resistances will need to be reviewed and revised as necessary if a culvert replacement using open cut method is selected as the preferred option.

The factored geotechnical resistances provided above are based on loading applied perpendicular to the surface of the bottom of the foundation. Where load is not applied perpendicular to the horizontal founding level / footings, inclination of the load should be taken into account as per CHBDC (2019).

6.5.3 Resistance to Lateral Loads / Sliding Resistance

Resistance to lateral forces / sliding resistance between the base of the precast concrete box culvert or cast-in-place strip footings and the subgrade should be calculated in accordance with Section 6.10.4 of CHBDC (2019). The following table provides the coefficient of friction ($\tan \delta$) between the base of the culvert/footing and potential interface materials at the culvert site.

Table 8: Coefficient of Friction for Lateral Resistance

Soil Type	Interface Material	Coefficient of Friction ($\tan \delta$)
New Compacted Granular Fill / Bedding (Granular 'A' or 'B' Type II)	Precast Concrete	0.45
	Cast-in-Place (Mass) Concrete	0.65
Firm to Stiff Silty Clay to Clay	Precast Concrete	0.25

Soil Type	Interface Material	Coefficient of Friction ($\tan \delta$)
	Cast-in-Place (Mass) Concrete	0.35

6.5.4 Subgrade Preparation, Culvert Bedding and Backfill

The placement of bedding, cover and backfill should be placed in general accordance with OPSS.PROV 912 (Precast Concrete Culverts with Spans Greater than 3.0 m) for precast closed box culverts, and as per OPSS.PROV 902 (Excavating and Backfilling – Structures) for open footing culverts.

The bedding, cover and backfill should be placed in lifts not exceeding 200 mm in loose thickness, and compacted to at least 95% of the Standard Proctor Maximum Dry Density (SPMDD) of the material as specified in OPSS.PROV 501 (*Compacting*). The differential height of backfill on each side of the culvert should not exceed 500 mm as per OPSS.PROV 902.

The backfill behind the culvert walls should consist of granular material meeting the OPSS .PROV 1010 (*Aggregates*) Granular 'A' or Granular 'B' Type I or II meeting the requirements of OPSS.PROV 912 and OPSS.PROV 902 for the precast box and open footing culvert, respectively. The granular backfill should be placed and compacted as per OPSS.PROV 501 (*Compacting*).

Backfill placement for reconstruction of the roadway embankments over the culvert should be carried out in general accordance with OPSS 208.010 (Benching of Earth Slopes) to integrate the existing embankment fill and new fill along the cut faces.

6.6 Option #2 - Culvert Rehabilitation - Lining Existing Culvert

Rehabilitating the existing culvert through the installation of a structural liner, such as a Glass Reinforced Plastic (GRP) liner, is being considered for the Nicolston Culvert. For this rehabilitation method the structural liner will be inserted into the existing structure, and the voids between the existing structure and the liner are filled with grout. To facilitate the culvert lining, a work area is required at the inlet and outlet, and a cofferdam and temporary flow passage will be required to complete the installation in the dry.

Design of the GRP liner should be in general accordance with the MTO Trenchless Technologies Design Guide – Pipe-Insert Liners (2017).

6.6.1 Foundations

According to the design drawings, the GRP liner will be designed to resist all structural loads over the design life of the culvert and will not rely on any structural capacity from the existing (host) culvert.

From a foundations perspective, it is recommended that the existing host pipe be suitably cleaned and the existing streambed be cleared of debris (e.g. logs, cobbles, obstructions) including organics or deleterious material to expose a competent subgrade. Based on the closest borehole information, it is anticipated that the competent subgrade will consist of loose to compact silt and sand fill and/or native generally firm to stiff clayey silt to clay soil. Temporary flow diversion of the existing watercourse will be needed to allow for clearing and temporary subexcavation of any organics and deleterious materials to design subgrade, as discussed in Section 6.12. Based on the design drawings, clearing / temporary subexcavation up to about 400 mm deep may be required along the streambed, followed by installation of a temporary support system on the subgrade for placement of the GRP liner, followed by grouting of the annulus and placement of riverstone / granulars above the liner invert to match existing streambed level.

It is noted that the founding level of the existing open footings of the existing host culvert are not known. Although not anticipated, if clearing / temporary subexcavation operations extend more than 400 mm below existing

streambed or below the bottom of the existing footings, temporary bracing or lateral support of the existing culvert may be required. The requirement to provide temporary bracing or support should be assessed by the structural engineer. During temporary subexcavation / clearing operations and until the GRP liner is installed, grouted, and streambed restored, consideration should be given to monitoring the performance of the existing culvert (host) pipe and top of footings and any temporary supports (if needed).

6.6.2 Settlement

The installation of the liner and associated grout will increase the load on the underlying native firm to stiff clayey silt to clay deposit. Assuming there is no grade raise or embankment widening, the additional load from the new liner and grout within the annulus is anticipated to be negligible. Given that a portion of the additional load will likely be distributed to the host pipe and existing open footings, settlement of the new liner / host pipe system is anticipated to be less than 20 mm with differential settlement estimated to be less than 10 mm.

6.7 Option #3 - Culvert Rehabilitation – Lining Existing Culvert and Trenchless Installation of Relief Culvert

This option is similar to Option#2, however, if the liner design reduces the hydraulic capacity of the existing culvert such that a new relief culvert is required, the following sections provide feasible trenchless options for installation of a smaller diameter relief culvert. The current design indicates that a relief culvert is not needed. However, if required, it is assumed the size (diameter) of the relief culvert will be less than 1.2 m and will be located on the east side of the existing culvert. It is also assumed that the length of the new trenchless installation will be approximately 50 m in length, and that the crossing will have similar invert elevations to the existing culvert.

6.7.1 Trenchless Installation Methods

Based on the site conditions and assumed alignment and diameter of the potential new relief culvert, the feasible trenchless methods considered herein include horizontal auger boring (i.e. “Jack and Bore”), pipe ramming, and microtunneling. In brief, these trenchless methods involve the following:

Pipe Ramming: Pipe ramming using a pneumatic tool to hammer a steel pipe or casing into the ground. The pipe is almost always driven “open” to thereby direct the soil into the pipe interior instead of compacting it outside the pipe. The leading edge of the pipe typically has a small overcut to reduce friction between the casing and soil. Soil/pipe friction reduction can also be achieved with lubrication, and different types of bentonite and/or polymers can be used for this purpose. Typically, there is limited ability to steer the casing during ramming unless more advanced techniques are used such as the pilot-tube method. Depending on the length of the installation, the soils inside the pipe can be removed during or after the installation by auguring, compressed air, or water jetting. Pipe ramming methods are also better suited for penetrating through/displacing potential obstructions, such as wood pieces, cobbles and small boulders in comparison to jack and bore installation method, though this method can still be obstructed by obstructions depending on their size, number, and their positions relative to the pipe leading edge and diameter. Partial or full removal of materials from within the pipe, to facilitate driving, should not be carried out if the ground through which the pipe is being driven consists of saturated granular soils (i.e. silt, sand, gravel) or very soft clays. As with traditional jack and bore methods, flowing or heaving ground conditions and/or operating the cleanout augers beyond, at or near the leading edge of the casing can result in significant ground losses, excessive surface settlement and, in some cases, sinkholes that could propagate to the surface.

Horizontal Auger Boring – “Jack-and-Bore”: In Ontario, a traditional “jack and bore” operation involves pushing a steel pipe (casing) horizontally into the ground by jacking while simultaneously cutting the ground with an auger head operating near the leading end of the steel pipe. The spoil is generally removed from within the casing using an auger boring machine. Jacking (sending) and receiving pits are required. Typically, there is limited ability to

steer the casing during jacking unless more advanced techniques are used such as the pilot-tube method. Jack and bore may not be feasible in bouldery soils (e.g. glacial till containing cobbles and boulders) or soils containing significant obstructions (construction debris, logs or buried lumber). In some cases, contractors will advance augers ahead of the casing or not provide sufficient “soil plug” within the casing which can lead to high risks for ground losses leading to settlement and/or sinkholes at the ground surface. This method is also considered to be a higher risk option than pipe ramming in running or flowing ground (dry or saturated sand and silt) where uncontrolled loss of soil and overexcavation may occur.

In some cases, traditional “jack and bore” equipment is supplemented with a specialized rotating cutting head, sometimes referred to as a “small boring unit”. These cutting heads are welded to the lead end of steel casings, can sometimes include limited alignment adjustments capabilities, and can be fitted with more specialized cutting tools such as rock disc cutters. In ideal ground conditions (e.g. hard glacial till, weathered rock), the small boring heads can be advantageous. However, these systems are not well suited to and should not be used in saturated and potentially flowing ground conditions. Further, these systems should not be confused with microtunnelling systems that operate using very different principles of ground support.

Microtunnelling: Microtunnelling is a method of installing pipes behind a steerable remote controlled shielded microtunnel boring machine (MTBM) that is pressurized with a bentonitic fluid to balance earth and water pressures and reduce the risk of ground losses. The process is essentially remotely controlled pipe jacking where all operations are controlled from the surface, cuttings are removed by the circulating slurry and the necessity for personnel to enter the bore is eliminated. Typically, ground loss and associated settlements can be controlled well with this method, if the face pressure and cutting tools are appropriate for the ground and are maintained over the length of the drive. The pipe / casing is typically installed in sections while the bore is being advanced.

Overcut should be minimized by selection of a casing diameter which is similar to that of the shield and cutterhead. If over excavation occurs, the annulus between the outside of the pipe and the ground should be immediately filled with bentonite slurry of an appropriate viscosity. The slurry should be appropriately formulated, using suitable additives, if necessary, for the anticipated ground conditions. A seal will be required to close the annular space between the wall of the entry / exit shaft and the shield and pipes to retain soil behind the temporary shoring and stop backflow of slurry into the pits.

Microtunnelling can be fully obstructed if sufficient number and / or sizes of cobbles and boulders or similar obstructions are encountered due to the lack of access to the face and the smaller diameter of the equipment precluding manual removal of obstructions from the face. As such, the selected cutting tools and methods should be compatible with the anticipated site soils. Obstructions typically cannot be cleared or ingested by the machine and the alignment will have to be either abandoned or a rescue shaft advanced to free the MTBM and remove the obstruction.

6.7.2 Comparison of Trenchless Methods and Preferred Alternative

The feasibility of the trenchless installation methods described in the previous section, along with advantages, disadvantages, and risks associated with each option are provided in Table 10, following the text of this report. From a geotechnical perspective, the preferred alternative is pipe ramming using a pilot tube provided that some horizontal and vertical misalignment may occur during construction and can be accommodated / tolerated in the design. Alternatively, microtunnelling is considered the most suitable option for the trenchless installation as it is able to provide improved alignment control, steering and earth pressure balance (compared to the other options) in the variable / mixed face soil conditions anticipated along the tunnel horizon. The presence of wood and timber fragments near the fill / native soil interface may result in challenging conditions for any proposed new trenchless installation, thus, the lining of the existing culvert is preferred.

Although not anticipated, if trenchless installation of a relief culvert is required, a non-standard special provision for feasible trenchless installation methods will need to be prepared and included in the contract package.

6.7.3 Subsurface Conditions and Tunnelman's Ground Classification

The anticipated soil strata along the tunnel horizon may be classified based on Terzaghi's Tunnelman's Ground Classification System as modified by Heuer (1974). The System is commonly used to describe the potential behaviour of an unsupported tunnel face during excavation. This System uses qualitative "stand-up time" criteria to classify the ground into six principal categories: firm, slow ravelling, fast ravelling, squeezing, running (also including 'cohesive-running' to describe material that has some stand-up time before running), flowing and swelling. This System also differentiates the ground behaviour above and below the groundwater table. Therefore, this Ground Classification System has been adopted to provide an objective evaluation of the anticipated ground behaviour during trenchless installations.

The subsurface soil and groundwater conditions encountered along the proposed tunnel horizon (taken as about one tunnel diameter above and below the proposed tunnel path) are summarized in the table below. The correlating soil classification, as per the modified version of Terzaghi's Tunnelman's Classification, are also provided.

Table 9: Subsurface Conditions along Tunnel Horizon and Tunnelman's Ground Classification

Assumed Tunnel Horizon, Elevation (m)	Relevant Boreholes	Groundwater Level, Elevation (m)	Soil Along Tunnel Horizon	Terzaghi's Soil Classification
205 to 209	24-03, 24-04, 24-05, 24-06	210.1 to 210.4	Very Loose to Compact Silt (ML) and Sand to Silty Sand (SM) Fill, contains timber and wood fragments Soft to Firm Clayey Silt (CL) Fill, trace organics and shell fragments Firm to Stiff Clayey Silt (CL) to Silty Clay (CI) to Clay (CH), variable sand content, contains wood fragments and organic silt interlayers	Running or Flowing Firm to fast ravelling Firm to Squeezing to fast ravelling

6.7.4 Settlement and Monitoring

If trenchless installation of a relief culvert is required, a settlement assessment should be carried out to estimate the magnitude of settlement at the highway ground surface and any nearby utilities based on the preferred trenchless method, design alignment and profile, and culvert / tunnel diameter selected.

Additionally, a site-specific settlement instrumentation and monitoring plan will be required. The plan should meet the requirements outlined in Appendix E (*Appendix: Settlement Monitoring Guidelines – Tunneling*) of the most recent *Ontario Ministry of Transportation (MTO), Guidelines for Foundation Engineering Services* document.

6.7.5 Trenchless Construction Considerations

6.7.5.1 Entry and Exit Shafts

Due to the limited space at the toe of the embankment and proximity to the watercourse, it is anticipated that excavation into the existing embankment and temporary protection systems will be required at the entry and exit shafts. A general discussion on temporary excavations, temporary protection systems, and groundwater / surface water control are provided in Section 6.12. If trenchless installation of a relief culvert is required, additional site-specific design recommendations for the shafts can be provided when more details are known.

6.7.5.2 Existing Utilities

There are two existing buried utilities which are located within the embankment and would cross over the new trenchless crossing. There is an Enbridge Gas pipeline, as well as a Rogers high priority telecommunications line which are both located on the south side of Highway 89 within the south embankment slope. The location and depth of the utilities will need to be confirmed in order to assess impacts of trenchless operations. The utility owners will need to be contacted and settlement tolerances identified such that mitigation measures can be implemented, as required.

There are also aerial utility lines located on the north embankment slope which may impact the location of potential shafts and trenchless operations. Temporary relocation of the aerial lines will need to be considered if trenchless installation of the relief culvert is required.

6.7.5.3 Obstructions

Obstructions such as wood fragments / pieces, including pieces of timber were encountered within the fill and near the fill / native interface in Boreholes BH24-03, BH24-05, BH24-06, BH24-09 and BH24-10. If a new relief culvert is needed, it is likely that the profile would be near the fill / native soil interface with a high potential for encountering wood / timber pieces, which could include buried logs / roots if the tunnel is located along the previous alignment / width of the watercourse channel. The presence of such obstructions will need to be included in a special provision to alert the tunnelling contractor if trenchless installation of a new relief culvert is actually required.

6.8 Embankment

There is no proposed permanent embankment widening or grade raise in the vicinity of the culvert. For the culvert lining option, there is no anticipated impact (temporary cut or fill) to the existing embankment other than the construction of temporary access routes to the inlet and outlet. Foundation investigation and discussion on geotechnical aspects of the temporary works related to construction, including the access roads, is included in a separate FIDR. Any embankment reinstatement and engineered fill placement must be in accordance with OPSS.PROV 206 (*Grading*) and OPSS.PROV 902, as applicable.

6.9 Erosion Protection

There are existing concrete headwalls / wingwalls at the culvert inlet and outlet location. We understand the headwalls / wingwalls are performing satisfactorily and are to remain in place if the culvert is to be replaced or lined. If a new relief culvert is required, provisions should be made for scour and erosion protection at the new relief culvert inlet and outlet location and any associated watercourse realignment. A design check of erosion protection measures at the inlet and outlet of the existing and for any new relief culvert should be performed by the hydraulic design engineer. At the inlet and outlet of the culvert, sub-excavation for the liner should extend into the native clayey silt to clay deposit. The grout in the annulus between the culvert and the liner, and below the liner, should be low permeability to reduce the risk of water flowing below and around the liner.

It is noted that active erosion was observed within the watercourse channel, likely during peak flow and high water level conditions. At the time of our investigation, water flow through the culvert was minimal and was slightly above the tributary creek bed. At the culvert inlet, evidence of erosion near the limit of the wingwalls (i.e. at the interface between the watercourse top of bank and highway embankment toe) was observed. There was no undercutting or active erosion of the existing embankment observed, however, it is likely that erosion could progress into the embankment over time. As a result, it is recommended that erosion protection (e.g. armour stone or rip-rap) be provided beyond the limits of the existing wingwalls, as discussed below.

6.9.1 Armour Stone Protection

Armour stone erosion protection is proposed adjacent to the existing concrete wing walls at the northeast, northwest, and southeast location to reinstate locally eroded areas as part of the rehabilitation of the culvert. Based on the design drawings, the individual armour stone blocks are each approximately 1 m in width and length and range from 0.5 m to 1 m in height. At all proposed armour stone locations, the exposed armour stone face (i.e. equivalent to a vertical wall face) is less than 2 m high (equivalent to 2 levels of block) and less than 3 m wide (3 blocks wide). The base / founding level of the armour stones is about El. 208 m on the south side and ranges from about El. 207 m to 208.5 m on the north side. Based on the existing borehole information and design drawings, it is anticipated that the foundation soils below the armour stone consists of a combination of existing retaining wall backfill (likely granular material), very loose to loose sand and silt fill, and the native firm to stiff clayey silt to clay. Given the relatively light load of the armour stone protection system (maximum 2 m high) and the fact that the stones are generally reinstating the previous ground level where soil erosion has occurred, the founding soils have essentially been preloaded and are considered to be competent to support the proposed armour stone configurations.

Generally, the existing eroded grade where the armour stones are to be placed adjacent to the existing wing wall are to be stripped / subexcavated to remove sediments, organics or loosened / softened areas to create a flat level subgrade surface. Existing rip-rap that may be present within the channel may be temporarily removed and reinstated in front of the armour stone blocks after construction. The temporary cuts for subexcavation are anticipated to be less than 1 m deep and are to be “stepped” at 2H:1V to follow the proposed ground surface in front of the armour stones near the northwest wing wall location. Any overexcavation can be brought back up to design subgrade using engineered fill. Temporary excavations will be less than 3 m wide (i.e. the maximum length of the armour stone system near the northwest wing wall). Following subexcavation, a granular levelling pad is to be placed followed by placement of the armour stones.

A minimum 150 mm thick granular pad/levelling layer is recommended below the armour stones. The levelling pad and any engineered fill / backfill below or behind the armour stone walls should consist of OPSS.PROV 1010 Granular A or Granular B Type II soil. A geotextile is recommended between the existing soil or granular backfill and the back of the armour stone system to mitigate loss of fine particles through the joints / gaps between the armour stones. The geotextile should extend across the gap between the edge of the armour stones and existing wing walls.

Given that the exposed armour stone block face ranges from 0.5 m to 2 m high during construction, with an average permanent exposed height of about 1.5 m, and the fact that the blocks are 1 m thick, the local stability of the gravity armour block system is considered to be suitable. Also, given the fact that the length of the armour stone block systems are limited to 2 m to 3 m at each location and are located directly adjacent to the concrete wing walls, the global stability of the embankments are not considered to be significantly impacted during and/or after construction. It is important to note that surface water must be diverted away from the excavation for the armour stone protection systems at all times. Given that the armour stone protection systems are located at areas where previous erosion has occurred along natural drainage paths, it is anticipated that groundwater seepage will also be encountered during excavations. Temporary dewatering and diversion of shallow groundwater will likely be required and could consist of temporary trenches, sumps or counterfort drains installed within the existing embankment above and/or adjacent to the temporary excavations. If sufficient dewatering and surface water diversion is not provided, localized instability of the temporary cut slopes may occur with a risk that this could propagate and lead to global instability concerns within the existing embankments.

Given the variability of the fill and native subgrade soil, some settlement of the armour stone blocks is anticipated. Generally, the single and double layer armour stone systems are considered tolerable to settlements and frost movements of the foundation and surrounding soils. The armour stone face should be battered / angled, or the top layer of the blocks offset, to allow for some differential settlement / movement to occur and reduce the risk of tilting / overturning.

6.10 Lateral Earth Pressure for Design

The lateral earth pressures acting on the structural culvert walls and any associated concrete headwalls/retaining walls will depend on the type and method of placement of the backfill material, the nature of the soils behind the backfill, the magnitude of surcharge including construction loadings, the freedom of lateral movement of the structure, and the drainage conditions behind the walls.

The following recommendations are made concerning the design of any new or rehabilitated culvert walls. These design recommendations and parameters assume level backfill and ground surface behind the walls. Where there is sloping ground behind the walls, the coefficient of lateral earth pressure must be adjusted to account for the slope.

- Free draining granular fill meeting the specifications of OPSS.PROV 1010 (*Aggregates*) Granular 'A' or Granular 'B' Type II should be used as backfill behind the culvert walls, and on top of the culvert for a thickness of not less than 300 mm. Backfill should be placed in a maximum of 200 mm loose lift thickness and compacted. Longitudinal drains or weep holes, where applicable, should be installed to provide positive drainage of the granular backfill. Compaction (including type of equipment, target densities, etc.) should be carried out in accordance with OPSS.PROV 501 (*Compacting*).
- For restrained walls (e.g. box culvert), granular fill should be placed in a zone with the width equal to at least 1.5 m behind the back of the wall (in accordance with Figure C6.31(a) of the *Commentary* to the CHBDC (2019)). For unrestrained walls (e.g. open footing culvert), fill should be placed within the wedge shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical (1.5H:1V) extending up and back from the rear face of the footing or pile cap (in accordance with Figure C6.31(B) of the *Commentary* to the CHBDC (2019)).

If the culvert structure does not allow for lateral yielding, at-rest earth pressures should be assumed for the foundation design. If the culvert structure allows for lateral yielding, active earth pressures should be used in the foundation design. The movement required to allow active pressures to develop within the backfill, and there by assume an unrestrained structure for design, should be calculated in accordance with Section C6.12.1 and Table C6.12 of the *Commentary* to the CHBDC (2019).

6.11 Corrosion Assessment and Protection

Soil corrosivity may affect the concrete and/or steel elements (e.g. reinforcing steel) of foundations or related structures buried in the soil. The long-term performance and durability of the foundations are directly related to their respective corrosion resistance. Generally, the corrosivity potential of a structure can be assessed based on the soil resistivity / electrical conductivity, hydrogen ion concentration (pH), and salts (chloride and sulphate) concentrations. The analytical results for the soil samples submitted for testing are summarized in Section 4.4 and the analytical laboratory test reports are included in Appendix C.

6.11.1.1 Potential for Sulphate Attack

The analytical results were compared to CSA A23.1-24 Table 3 ("*Additional requirements for concrete subjected to sulphate attack*") for potential sulphate attack on concrete. The sulphate concentrations in the tested samples range from 35 to 49 µg/g and are below the exposure class of S-3 (Moderate). Therefore, based on the samples

tested, when the designer is selecting the exposure class for the structure, the effects of sulphates may not need to be considered.

6.11.1.2 Potential for Corrosion

The test results indicate a pH ranging from 7.56 to 7.74 and a resistivity ranging from 1,800 to 5,200 ohm-cm. According to the Gravity Pipe Design Guidelines (MTO, 2014), the pH is not considered detrimental to concrete durability. However, the resistivity indicates that the soil corrosiveness ranges from Low ($6,000 \text{ ohm-cm} > R > 4,500 \text{ ohm-cm}$) to Severe ($R < 2,000 \text{ ohm-cm}$), as per Table 3.2 of the Gravity Pipe Design Guidelines (MTO, 2014), and appropriate corrosion protection should be applied to the foundation element / materials. Further, given that the foundations are located adjacent to the highway shoulder and will be exposed to de-icing salt, consideration should be given to selection of a “C” type exposure class as defined by CSA A23.1 Table 1.

These recommendations are provided as guidance only; the designer should take the results of laboratory testing into consideration for selecting appropriate materials and corrosion susceptibility for design service of the structure material type, grout, and foundations and determine the appropriate exposure class and ensure that all aspects of CSA A23.1 Section 4.1.1 “Durability Requirements” are followed.

6.12 Construction Considerations

6.12.1 Temporary Excavations

In general, temporary excavations may be carried out using open cut methods. All temporary excavation work should be carried out in accordance with the Occupational Health and Safety Act and Regulations (OSHA), and in general accordance with OPSS.PROV 206 (Grading) and OPSS 902 (Excavating and Backfilling – Structures), as applicable.

The non-cohesive and cohesive fill are classified as Type 3 soils above the groundwater level and Type 4 soils below the groundwater level. Similarly, the firm to stiff clayey silt to clay deposit is classified as Type 3 and Type 4 above and below the groundwater level, respectively.

Temporary excavations (i.e. those which are open for a relatively short time period) should be made with side slopes no steeper than 1 horizontal to 1 vertical (1H:1V) for Type 3 soils, and no steeper than 3 horizontal to 1 vertical (3H:1V) for Type 4 soils.

6.12.2 Temporary Protection Systems

Due to the proximity of the watercourse and property limits, the use of temporary protection systems / shoring will likely be required to facilitate the construction of access routes from the highway down to the existing culvert inlet and outlet locations (for lining option), construction of entry / exit pits (for relief culvert option, if required), or to facilitate staged construction for the open cut option.

The temporary support systems should be designed and constructed in accordance with OPSS. PROV 539 (*Temporary Protection Systems*) and Special Provision 105S09. The lateral movement of the temporary protection system should meet Performance Level 2 as specified in OPSS.PROV 539, provided that any utilities, if present, can tolerate this magnitude of deformation. Where temporary protection systems are required adjacent to Highway 89, monitoring of the protection system is required as per OPSS.PROV 539 (*Temporary Protection Systems*).

A sheet pile wall and/or soldier pile and timber lagging wall or equivalent are considered feasible for the temporary protection systems at this site. The Contractor will need to be prepared to penetrate / remove any obstructions such as wood / timber pieces encountered in the fill and upper portion of the clayey silt to clay soils as indicated in

the Foundation Investigation Report. Further discussion on geotechnical parameters for temporary works is provided in a separate FIDR for this project.

6.12.3 Groundwater / Surface Water Control

The groundwater levels measured in monitoring wells installed within the embankment indicate a groundwater elevation of between 210.5 m and 210.2 m (November 2024), suggesting an elevated or perched groundwater level within the embankment fill. At the time of the investigation, flowing water was observed at the culvert inlet / outlet but was less than 0.3 m deep and is estimated to be at about Elevation 206.5 m to 207.0 m (November 2024). Based on observations of the tributary water level and measurements of groundwater in the embankment fill, it is anticipated that groundwater will be above the base of the excavation for any new culverts and the culvert liner.

For the purpose of this section, only the culvert liner rehabilitation option is being considered. If a culvert replacement using open cut or new relief culvert with entry / exit shafts is required, additional dewatering requirements may apply depending on actual design details.

For the culvert lining option, subexcavation / removal of sediments and debris within the existing streambed and installation of the culvert liner and grout is required to be carried out in the dry. As a result, the existing watercourse will need to be cut-off and/or diverted with appropriate dewatering measures in place to facilitate construction.

Consideration can be given to using a sheet pile cut-off wall or cofferdam to control surface water and groundwater. The sheet piles would need to be driven to a sufficient depth into the native clayey silt to clay deposit to provide cut-off and act as a cantilever system. Alternatively, sand bags and/or a bladder cofferdam system could be considered, however, additional measures may be needed to provide cut-off below the sand bags / bladder cofferdam to create a seal with the underlying clayey deposit. Cofferdams should be constructed in general accordance with OPSS.PROV 539 (Temporary Protection Systems) as applicable. In addition, surface water runoff should be directed away from the culvert and lining operations during excavation and liner installation at all times.

Flow diversion and dewatering operations must be carried out in accordance with OPSS.PROV 902 (Excavating and Backfilling – Structures), Special Provision No. 109S61, and OPSS.PROV 517 (Dewatering and Temporary Flow Passage System) as amended by Special Provision 517F01. The “fill-ins” for SP517F01 must indicate the groundwater should be lowered a minimum of 0.3 m below the base of the excavation for the liner and any support system needed prior to excavation, a preconstruction survey is not applicable, and a design engineer is required for both temporary flow passage system and dewatering system.

In general, water taking in excess of 50,000 L/day are regulated by the Ministry of Environment, Conservation and Parks (MECP). Certain takings of groundwater and stormwater for construction dewatering purposes with a combined total of less than 400,000 L/day qualify for self-regulation on the MECP Environmental Activity and Sector Registry (EASR). Registry on EASR replaces the need to obtain a PTTW for water taking purposes and a Section 53 approval for discharge of water to the environment. A “Water Taking Plan” and a “Discharge Plan” are required by the MECP if water is taken in accordance with an EASR. In all cases, discharge under the EASR must be in accordance with a Discharge Plan (to be developed by a qualified professional). The Contractor will be responsible for obtaining any required discharge approval in accordance with an EASR. A category 3 PTTW would be required for water taking in excess of 400,00 L/day.

For the culvert liner option, it is not anticipated that a PTTW will be required to facilitate the lining of the existing culvert at this site, however, an EASR may be required if the conditions outlined in Section 4.2(3) Subsection 34

of O.Reg. 387/04 are not met. If the surface water from the tributary is controlled and sufficiently cut-off, it is anticipated that dewatering of the groundwater should be able to be controlled through ditching, pits, and pumping from properly filtered sumps. If the existing culvert open footings are not deep enough to provide cut-off from seepage of the perched groundwater above the culvert, more elaborate dewatering measures may be required which could include more frequent pits / pumps and/or a series of shallow well-points along the culvert liner footprint.

6.12.4 Decommissioning of Monitoring Wells

Two groundwater monitoring wells were installed (Boreholes BH24-03 and BH24-04) to permit monitoring of the groundwater levels at the site.

Ontario Regulation (O.Reg) 903 amended by O.Reg. 128/03 of the Ontario Resources Act requires that monitoring wells are properly abandoned/decommissioned by qualified personnel.

It is recommended that the decommissioning of the monitoring wells be carried out as part of the construction activities at the site to allow for water level measurements taken prior to and during construction associated with the culvert lining, as required. A sample NSSP for the decommissioning of the groundwater monitoring wells has been included in Appendix D.

7.0 CLOSURE

This foundation design report was prepared by Madison Kennedy, P.Eng., a Geotechnical Engineer with WSP. Kevin Bentley, P.Eng. a Geotechnical Engineer with WSP and MTO Principal Foundations Contact conducted a technical and quality control review of the report.

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Geotechnical Engineer

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MCK/KJB/al

[https://wsponlinecan.sharepoint.com/sites/ca-ca00203320247/shared documents/05. technical/foundations/5 - reporting/5 - rpt culvert/3-final/ca0020332.0247_fid_rev0_hwy89-nicolston culvert_18mar25.docx](https://wsponlinecan.sharepoint.com/sites/ca-ca00203320247/shared%20documents/05.%20technical/foundations/5%20-%20reporting/5%20-%20rpt%20culvert/3-final/ca0020332.0247_fid_rev0_hwy89-nicolston%20culvert_18mar25.docx)

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ASTM International

- | | |
|------------|---|
| ASTM D1586 | Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soils. |
| ASTM D2573 | Standard Test Method for Field Vane Strength Shear Test |

Ministry of Transportation, Ontario

- MTO Gravity Pipe Design Guidelines, Circular Culverts and Storm Sewers, April 2014.
- MTO Trenchless Technologies Design Guide – Pipe-Inert Liners, September 2017
- Ontario Ministry of Transportation (MTO), Guidelines for Foundation Engineering Services
- Provincial Engineering Memorandum #20201, Material Engineering and Research Office (MERO), March 23, 2020

Ontario Provisional Standard Drawing:

- | | |
|---------------|--|
| OPSD 3090.101 | Foundation Frost Penetration Depths for Southern Ontario |
| OPSD 208.010 | Benching of Earth Slopes |

Ontario Provincial Standard Specifications (OPSS)

OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 517	Construction Specification for Dewatering and Temporary Flow Passage System OPSS.
OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS.PROV 902	Construction Specification for Excavating and Backfilling – Structures
OPSS.PROV 912	Construction Specification for Precast Concrete Culverts with Spans Greater than 3.0 m
OPSS.PROV 1010	Material Specifications for Aggregates – Base Subbase, Select Subgrade, and Backfill Material

Special Provision

Special Provision 105S09	Amendment to OPSS 539, November 2014
Special Provision 109S61	Amendment to OPSS 902, November 2019 – Dewatering and Protection Systems
Special Provision 517F01	Amendment to OPSS 517, November 2023 – Dewatering System and Temporary Flow Passage System

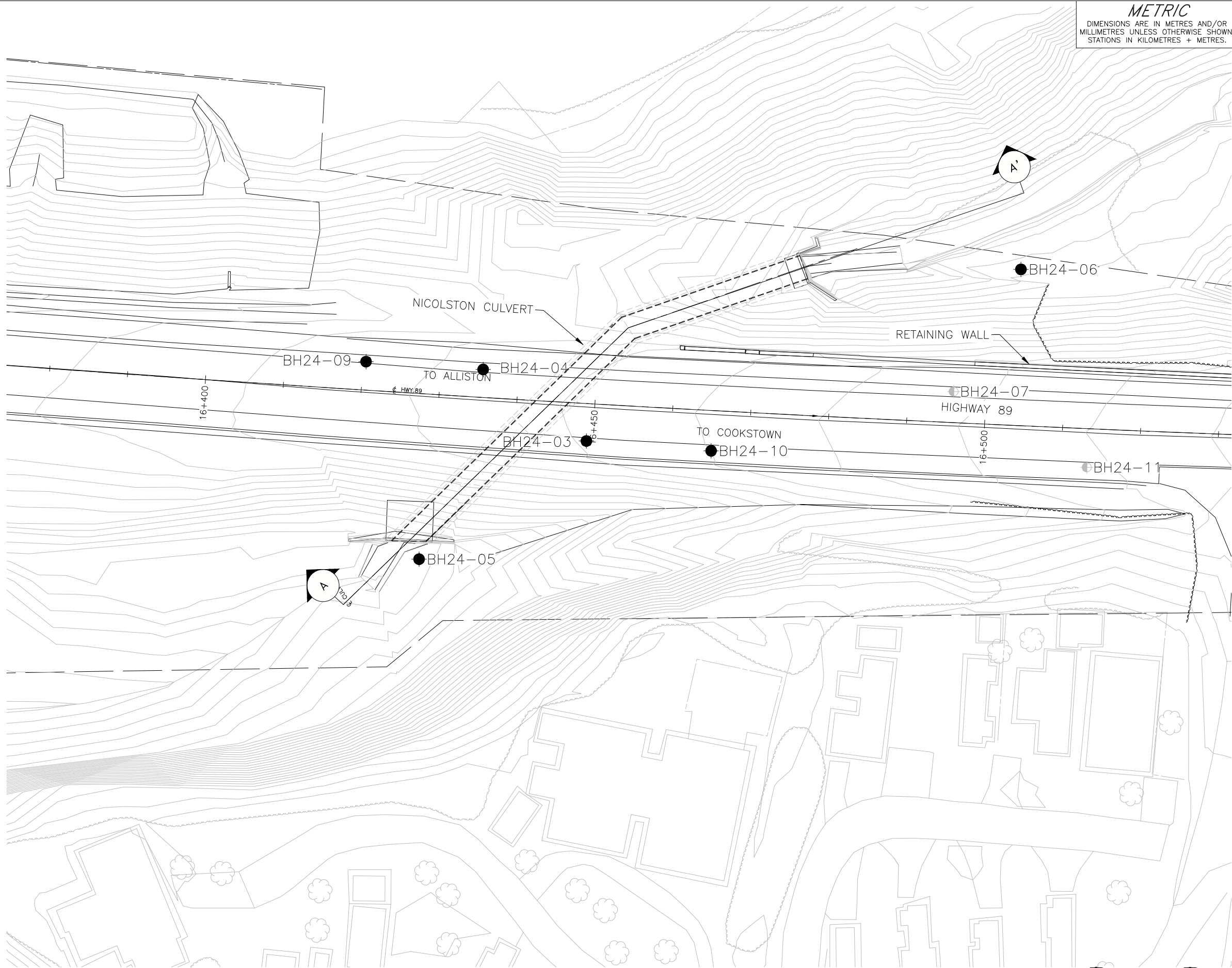
Ontario Regulations

Ontario Regulation 213	Construction Projects (as amended)
Ontario Regulation 903	Wells (as amended)
Ontario Regulation 337/04	Water Taking and Transfer

Table 10: Comparison of Trenchless Methods for New Relief Culvert

Method	Feasibility	Advantages	Disadvantages	Risk/Consequence
Jack-and-Bore	Marginally Feasible	<p>Widely used and conventional method.</p> <p>The line and grade can be maintained with moderate accuracy, especially if pilot tube is incorporated.</p> <p>Reduced level of vibration compared to pipe ramming.</p> <p>Suitable for anticipated 50 m long crossing.</p> <p>Suitable for anticipated diameter up to 1.5 m.</p> <p>Comparable cost to pipe ramming and less expensive than Microtunnelling.</p>	<p>Dewatering required (likely by horizontal drainage lances/pipes from start and end shafts and from surface) to lower groundwater within tunnel horizon in the saturated non-cohesive fills.</p> <p>Large work area with thrust block required for jacking pit, with limited space due to property and presence of watercourse.</p> <p>Augers may not be able to penetrate obstructions such as logs / large branches / timber</p>	<p>Groundwater above tunnel horizon and presence of non-cohesive granular fill within tunnel horizon leads to high to very high risk of ground loss due to flowing silts and sands</p> <p>Dewatering may be challenging and if lowered to below tunnel horizon, there is still moderate risk of ground loss due to running of very loose silts and sands; risk can be reduced by maintaining a soil "plug" in casing.</p> <p>Presence of obstructions such as large logs or timbers may hinder penetration and result in abandonment of bore.</p>
Pipe Ramming	Feasible	<p>Widely used and conventional method.</p> <p>The line and grade can likely be maintained with moderate accuracy if major obstructions are not encountered, especially if pilot tube is incorporated.</p> <p>May be able to penetrate or "swallow" obstructions such as logs / branches or small pieces of lumber which are typical near fill / native interface (depends on diameter)</p> <p>Smaller entry pit and no thrust block required as compared to jack and bore or microtunnelling.</p> <p>Suitable for anticipated 50 m long crossing.</p> <p>Suitable for anticipated diameter up to 1.5 m.</p> <p>Likely least expensive option or comparable to jack and bore.</p>	<p>Dewatering may not be required or efforts reduced compared to jack and bore if profile is raised and soil maintained inside casing during ramming.</p> <p>Higher noise levels than jack and bore or micro tunnelling, and may require permit.</p> <p>Limited steering capability if diverted offline by obstruction, unless pilot tube used.</p>	<p>Removal of soils within casing may be required during advancement (depending on size of casing and ramming force) which increases risk of flowing soils through casing which could lead to settlements.</p> <p>Presence of obstructions such as large logs or timbers may hinder penetration and result in abandonment of bore.</p> <p>Higher vibrations may cause settlements and/or impact adjacent overlying utilities.</p>

Method	Feasibility	Advantages	Disadvantages	Risk/Consequence
Microtunnelling	Feasible	<p>MTBM can provide slurry pressure balance / tunnel face support which reduces potential for ground loss and settlement.</p> <p>Steerable with high accuracy for line and grade.</p> <p>Dewatering not required for tunnel, shafts only.</p>	<p>No person access to face and if obstruction (e.g. logs, branches or timbers) halts bore, it will likely clog the machine and bore will need to be abandoned. A rescue shaft will be needed to free MTBM.</p> <p>Requires largest work area at entry and exit shaft due to the large amount of supporting equipment (slurry separation plant) and launch / retrieval of MTBM.</p> <p>Most expensive option.</p>	<p>If obstructions such as logs / large branches or debris is encountered there is a high risk of not completing installation and abandonment of bore.</p> <p>Low risk of ground loss or settlements due to slurry pressure balance system.</p> <p>Significant amount of grading and possible temporary protection systems required for large work area, which may require temporary limited interest property and additional environmental protection measures near the tributary.</p>



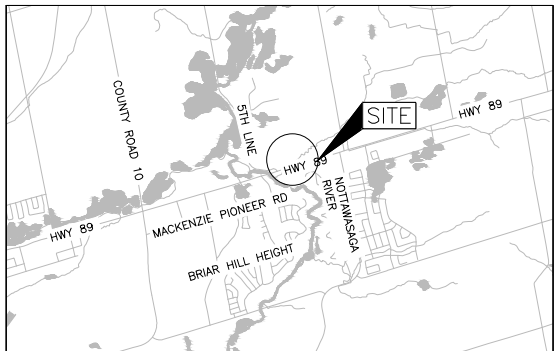
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MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 2014-23-01

HIGHWAY 89
NICOLSTON CULVERT
BOREHOLE LOCATIONS PLAN



SHEET



KEY PLAN

SCALE



LEGEND

● Borehole - Current Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BH24-03	214.5	4891998.5	280397.8
BH24-04	214.2	4892002.9	280382.3
BH24-05	207.3	4891977.3	280382.4
BH24-06	209.8	4892037.3	280443.4
BH24-09	213.8	4891999.0	280367.8
BH24-10	215.0	4892002.5	280413.3

NOTES

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

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

REFERENCE

Base plans provided in digital format by WSP, drawing file no. BC-785-89-1.dwg, received September 26, 2024.
GA provided in digital format by WSP, drawing file no. CA0020332.0247 Culvert - General Arrangement.dwg, received September 26, 2024.
Retaining Wall provided in digital format by WSP, drawing file no. B-785-89-1.dwg, received on October 10, 2024.



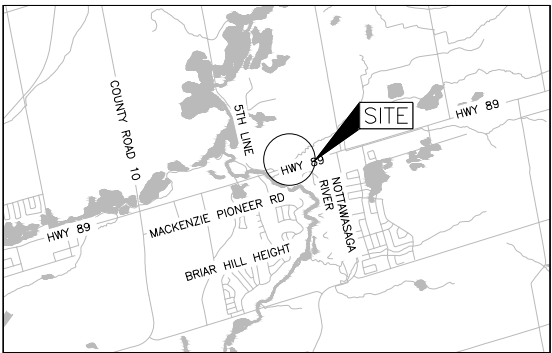
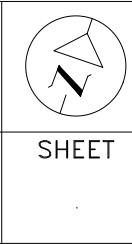
NO.	DATE	BY	REVISION
Geocres No. 31D04-009			
HWY. HWY 89		PROJECT NO. CA0020332.0247	
SUBM'D. MCK		DATE: 3/18/2025	
DRAWN: SA		SITE: 30X-0678/CO	
CHKD. FJ		APPD. KJB	
CHKD. MCK		DWG. 1	

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

CONT No.
WP No. 2014-23-01

HIGHWAY 89
NICOLSTON CULVERT

SOIL STRATA



KEY PLAN
SCALE
1 0 1 2 km

LEGEND

- Borehole - Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer
- WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BH24-03	214.5	4891998.5	280397.8
BH24-04	214.2	4892002.9	280382.3
BH24-05	207.3	4891977.3	280382.4
BH24-06	209.8	4892037.3	280443.4

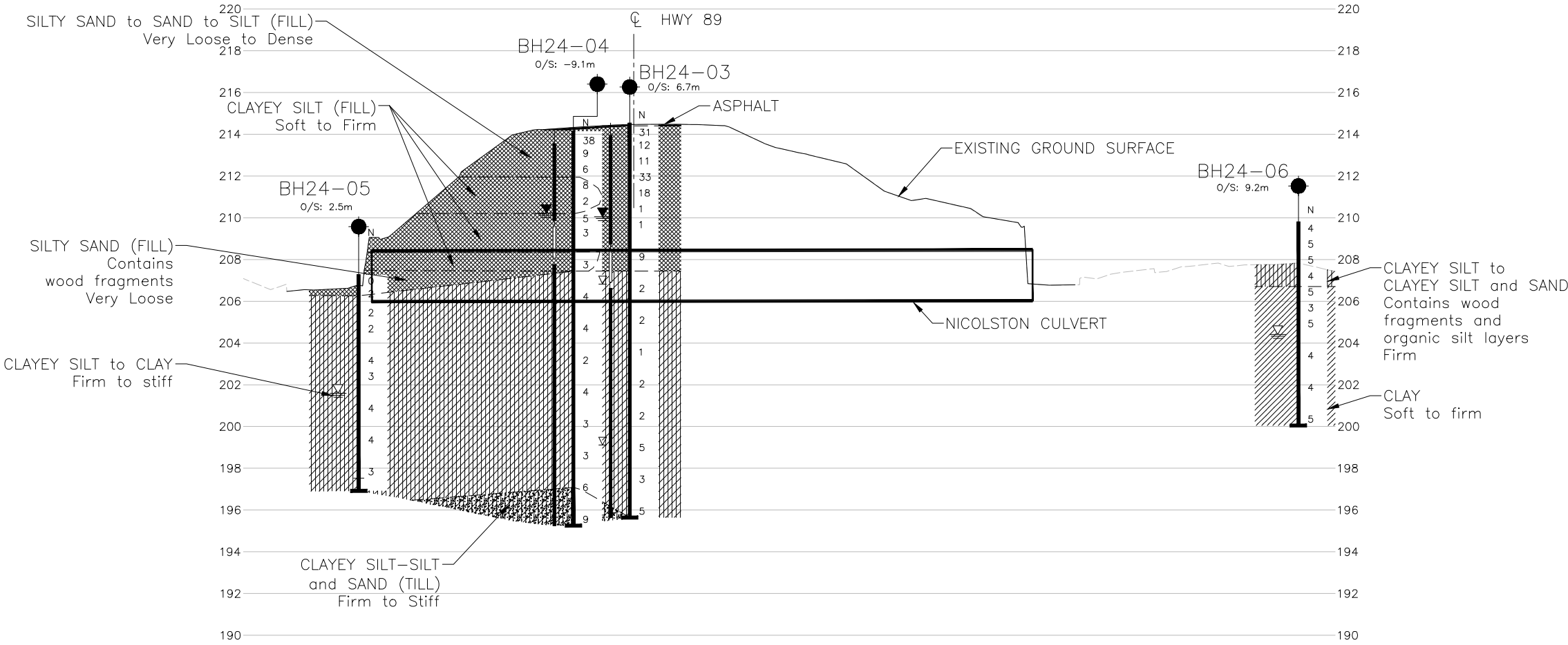
NOTES

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

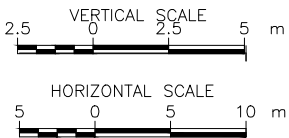
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plans provided in digital format by WSP, drawing file no. BC-785-89-1.dwg, received September 26, 2024.
GA provided in digital format b WSP, drawing file no. CA0020332.0247
Culvert - General Arrangement.dwg, received September 26, 2024.



PROFILE A-A'



NO.	DATE	BY	REVISION
Geocres No. 31D04-009			
HWY. 89		PROJECT NO. CA0020332.0247	
SUBM'D. MCK		CHKD. FJ	DATE: 3/4/2025
DRAWN: SA		CHKD. MCK	APPD. KJB
		DIST. .	
		SITE: 30X-0678/CO	
		DWG. 2	

APPENDIX A

RECORD OF BOREHOLES

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

MINISTRY OF TRANSPORTATION, ONTARIO

PARTICLE SIZES OF CONSTITUENTS

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

MODIFIERS FOR SECONDARY COMPONENTS^{1,2}

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

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

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

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Cone Penetration Test (CPT)

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

Dynamic Cone Penetration Resistance (DCPT); N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

SAMPLES

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

SOIL TESTS

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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
$C_{a(e)}$	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

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

METRIC

CHECKED BY MCK

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y kN/m³					REMARKS	
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	N° VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L		GR	SA	SI	CL		
								Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined	20	40	60	80	100	NP Nonplastic	20							40
0.0	ASPHALT (45 mm)																					
214.4 0.1	SILTY SAND (SM) and gravel, (FILL) Dense Brown		1A	SS	31																	
214.1 0.5	Moist SILTY SAND (SM), trace gravel, trace organics, containing asphalt fragments, (FILL) Dense to compact Brown Moist		1B																			
			2	SS	12																	
213.1 1.4	Sandy SILT (ML), trace gravel, trace organics, containing clayey silt pockets (FILL) Compact Brown Moist - 1.5 to 2.1 m: occasional clay pockets - 2.3 to 2.6 m: observed low plasticity			3	SS	11																
212.0 2.6	Gravelly SAND (SP), trace fines, (FILL) Dense Brown			4A	SS	33																
211.6 3.0	Moist SILT (ML) and sand, trace clay, trace gravel, (FILL) Compact to very loose Brown Moist to wet - 3.8 m: becoming wet below a depth of 3.8 m			4B																		
				5	SS	18																
				6	SS	1																
				7	SS	1																
			8A	SS	9																	
	- 6.1 to 6.4 m: Timber and wood fragments encountered in split spoon - 6.4 to 6.7 m: containing trace organics		8B																			
207.4 7.2	CLAY (CH) to CLAYEY SILT (CL), trace sand Firm to stiff Grey Wet																					
				9	SS	2																
			10	SS	2																	



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

METRIC

ORIGINATED BY KR

COMPILED BY MTI

CHECKED BY MCK

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y kN/m³	GR	SA	SI	CL	REMARKS	
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	N° VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL							
								Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined	20	40	60	80	100	W _p	W							W _i
														NP Nonplastic								-----○-----
								20	40	60												
CLAY (CH) to CLAYEY SILT (CL), trace sand Firm to stiff Grey Wet							204															
			11	SS	1			⊕		X												
			12	SS	2			⊕		X												
			13	SS	2											○						
			14	SS	5			⊕		X												

PROJECT CA0020332.0247

RECORD OF BOREHOLE No. BH24-04

Sheet 1 of 2

METRIC

G.W.P. 2022-E-0046

LOCATION N 4892002.9; E 280382.3 NAD83 / MTM Zone 10 (LAT. 44.167616; LONG. -79.805328)

ORIGINATED BY KR

DIST Central HWY 89

BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers

COMPILED BY MTI

DATUM Surface Elevation:214.2 m

DATE Apr 16, 2024 - Apr 18, 2024

CHECKED BY MCK

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y kN/m³	GR	SA	SI	CL	REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL						
								Field Vane	Remoulded	Pocket Pen	Quick Triaxial	Unconfined	W _p	W	W _L						
0.0	ASPHALT (170 mm)						20	40	60	80	100	20	40	60							
214.0 0.2	Gravelly SILTY SAND (SM) to SAND (SP-SM), some gravel (FILL) Loose to dense Brown, oxidation staining Moist		1A	SS	38																
			1B																		
213.2				2A																	
0.9	SILTY SAND (SM) to Sandy SILT (ML), containing clayey silt pockets (FILL) Loose Brown Moist - 1.8 m: becoming wet below 1.8 m		2B	SS	9																
			3	SS	6																
211.9																					
2.2	Sandy CLAYEY SILT (CL), trace gravel, (FILL) Soft to firm Grey, oxidation staining Moist - 3.0 m: becoming wet below 3.0 m		4	SS	8																
					5	SS	2														
210.2																					
4.0	SILTY SAND (SM), trace clay, containing clayey silt pockets to a depth of 4.42 m, (FILL) Loose to very loose Brown Wet - 4.6 m: trace organics below a depth of 4.6 m		6	SS	5																
					7	SS	3														
208.5																					
5.6	CLAYEY SILT (CL), trace sand, trace gravel, trace organics, trace shell fragments, (FILL) Soft Grey, greenish-yellow to blueish-grey staining Wet		8	SS	3																
207.4																					
6.7	SILTY CLAY (CI), trace sand Firm to stiff Grey Moist to wet																				
					9	SS	4														
			10	SS	4																

Continued on Next Page

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

PROJECT CA0020332.0247

RECORD OF BOREHOLE No. BH24-04

Sheet 2 of 2

METRIC

G.W.P. 2022-E-0046

LOCATION N 4892002.9; E 280382.3 NAD83 / MTM Zone 10 (LAT. 44.167616; LONG. -79.805328)

ORIGINATED BY KR

DIST Central HWY 89

BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers

COMPILED BY MTI

DATUM Surface Elevation:214.2 m

DATE Apr 16, 2024 - Apr 18, 2024

CHECKED BY MCK

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y kN/m³	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL						
								Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined					W _p	W	W _i						
													NP Nonplastic								
							20	40	60	80	100	20	40	60							
	SILTY CLAY (CI), trace sand Firm to stiff Grey Moist to wet 																				

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

PROJECTCA0020332.0247

G.W.P.2022-E-0046

DISTCentral

DATUMSurface Elevation:207.3 m

LOCATIONN 4891977.2; E 280382.4 NAD83 / MTM Zone 10 (LAT. 44.167385; LONG. -79.805326)

BOREHOLE TYPEWashboring, BW Casing; Portable Equipment

DATENov 26, 2024 - Nov 27, 2024

RECORD OF BOREHOLENo. BH24-05



Sheet 1 of 2

METRIC

ORIGINATED BYAM

COMPILED BYMTI

CHECKED BYMCK

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT	GR	SA	SI	CL	REMARKS	
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL							
								Field Vane	Remoulded	Pocket Pen	Quick Triaxial	Unconfined	W _p	W	W _L							
								20	40	60	80	100		20	40	60						
0.0	SILTY SAND (SM), some clay, trace gravel, trace organics containing wood fragments (FILL) Very Loose Grey Wet		1	SS	0		207								○		NP		1	49	34	16
206.3			2A	SS	2										○							
1.0	CLAY (CH) Soft to firm Grey Moist to wet		2B				206								○							
			3	SS	2																	
			4	SS	2																	
							204	⊕	×													
								⊕	×													
			5	SS	4																	
							203								⊕							
			6	SS	3																	
							202	⊕	×													
								⊕	×													
			7	SS	4																	
							200	⊕	×													
			8	SS	4																	
							199								⊕							
								⊕	×													
								⊕	×													
			9	SS	3		198															

Continued on Next Page

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

METRIC

AM

MTI

MCK

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

METRIC

ORIGINATED BY AM

COMPILED BY MTI

CHECKED BY MCK

[illegible]

1. Water level measured at a depth of 5.2 mbgs (Elev. 204.6 m) upon completion of drilling.

⁺, x³ : Numbers refer to Sensitivity o^{3%} STRAIN AT FAILURE

PROJECT CA0020332.0247

RECORD OF BOREHOLE No. BH24-09

Sheet 1 of 2

METRIC

G.W.P. 2022-E-0046

LOCATION N 4891999; E 280367.8 NAD83 / MTM Zone 10 (LAT. 44.16758; LONG. -79.805509)

ORIGINATED BY KR

DIST Central HWY 89

BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers

COMPILED BY MTI

DATUM Surface Elevation:213.8 m

DATE Apr 18, 2024 - Apr 22, 2024

CHECKED BY MCK

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y kN/m³	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa) Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined					PL W _p	NMC W	LL W _L						
							20	40	60	80	100	20	40	60							
0.0	ASPHALT (180 mm)																				
213.6 0.2	SILTY SAND (SM), some gravel to gravelly, (FILL) Dense Brown Moist		1A	SS	46																
			1B																		
212.9			2A																		
0.9	Sandy SILT (ML), trace gravel, (FILL) Compact Brown Moist		2B	SS	13																
212.1			3A																		
1.7	CLAYEY SILT (CL), trace sand, trace gravel, trace organics (FILL) Stiff Brown Moist		3B	SS	4																
				4	SS	3															
210.6																					
3.2	Sandy SILT (ML), trace clay, trace organics, wood pieces, (FILL) Very loose Brown, blackish spots		5	SS	2																
210.0																					
3.7	Wet Peat (PT) Firm																				
209.7	Black Wet		6A	SS	5																
4.1			6B																		
209.3	Sandy SILT (ML), trace organics, Loose Brown, oxidation staining and blackish staining Wet																				
4.5																					
	CLAY (CH) to CLAYEY SILT (CL), trace sand, trace gravel Firm to stiff Brown Wet		7	SS	10																
	- 6.1 m: becoming grey and wet below a depth of 6.1 m		8	SS	5																

Continued on Next Page

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

METRIC

KR

MTI

MCK

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

PROJECT CA0020332.0247

RECORD OF BOREHOLE No. BH24-10

Sheet 1 of 2

METRIC

G.W.P. 2022-E-0046

LOCATION N 4892002.5; E 280413.3 NAD83 / MTM Zone 10 (LAT. 44.167613; LONG. -79.80494)

ORIGINATED BY KR

DIST Central HWY 89

BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers

COMPILED BY MTI

DATUM Surface Elevation:215.0 m

DATE Apr 22, 2024 - Apr 23, 2024

CHECKED BY MCK

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT					REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L		GR	SA	SI	CL	
								Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined													
0.0	ASPHALT (70 mm)							20 40 60 80 100					20 40 60								
214.9 0.1	Gravelly SILTY SAND (SM) (FILL) Dense Brown Moist		1	SS	40																
214.2																					
0.8	Sandy GRAVEL (GP-GM), trace to some fines, (FILL) Compact Grey Moist		2	SS	11		214														
213.6																					
1.4	Sandy SILT (ML) trace gravel, (FILL) Very loose to compact Brown and grey Moist to wet		3	SS	10		213										2	25	68	5	
	- 2.3 m: becoming wet below a depth of 2.3 m - 2.3 m: containing trace organics and silty clay pockets between a depth of 2.3 m and 2.9 m		4	SS	29		212														
	- 3.0 to 3.7 m: containing wood fragments between a depth of 3.0 m and 3.7 m		5	SS	1																
210.8			6A	SS	0		211														
4.2	ORGANIC SILT (OL), containing wood pieces		6B																		
210.5	Very loose																				
4.5	Blackish grey																				
210.1	Wet		7A																		
4.9	Sandy SILT (ML), trace clay, trace organics, Loose		7B	SS	8		210														
	Grey																				
	Wet																				
	CLAYEY SILT (CL) to SILTY CLAY (CI), trace sand, trace gravel		8	SS	7		209										0	9	38	53	
	Firm to stiff																				
	Grey		9	SS	6		208														
	Wet																				
			10	SS	4																
			11	SS	6		207														
			12	SS	2		206														
			13	SS	1																
	- 9.9 m: containing silt seams below a depth of 9.9 m																				

Continued on Next Page

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

METRIC

KR

MTI

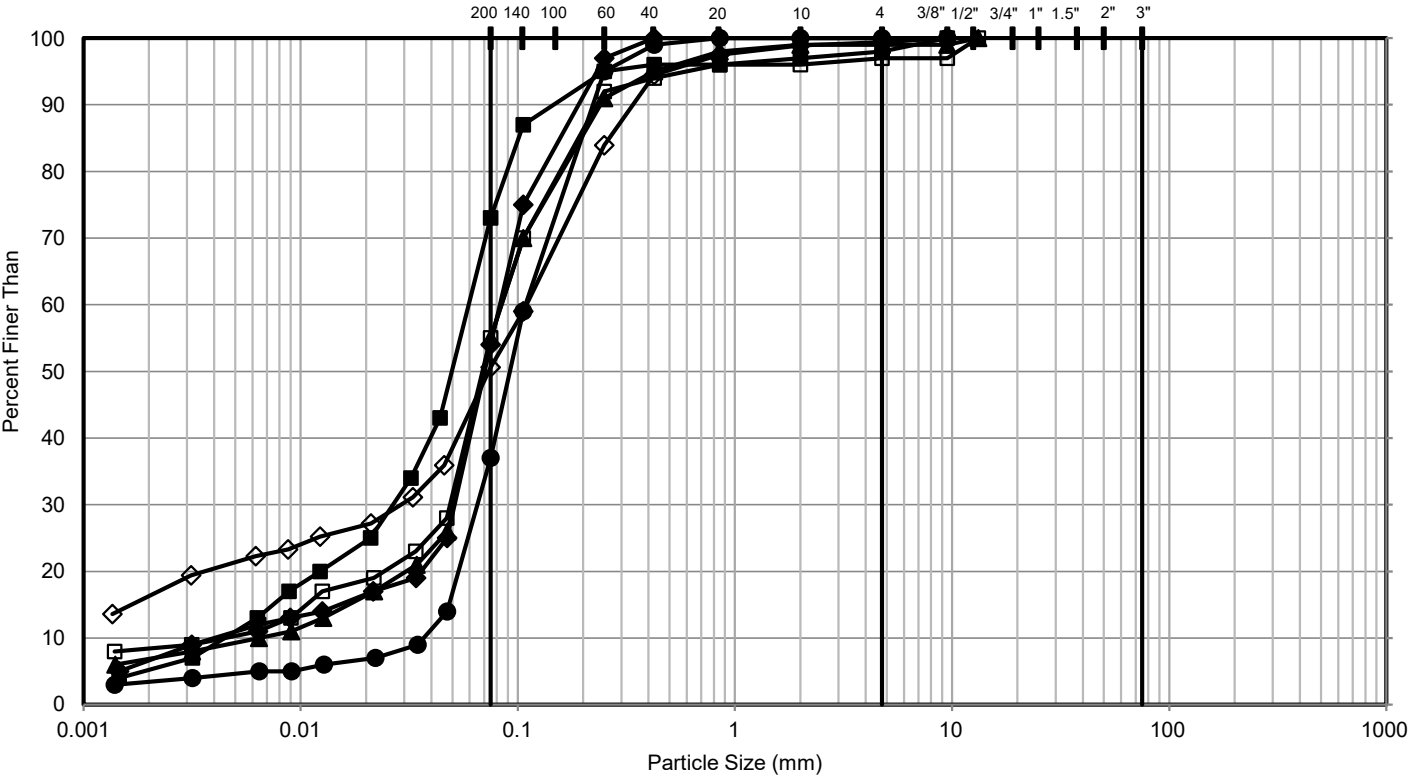
MCK

+³, x³ : Numbers refer to Sensitivity o^{30%} STRAIN AT FAILURE

APPENDIX B

LABORATORY TEST RESULTS

GRAIN SIZE DISTRIBUTION



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

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH24-10	3	1.5 - 2.1	213.5 to 212.9
◆	BH24-10	5	3.0 - 3.7	212.0 to 211.3
▲	BH24-03	6	3.8 - 4.4	210.7 to 210.1
●	BH24-04	7	4.6 - 5.2	209.6 to 209.0
□	BH24-03	8B	6.4 - 6.7	208.1 to 207.8
◇	BH24-05	1	0.0 - 0.6	207.3 to 206.7

CLIENT

Ministry of Transportation, Ontario

CONSULTANT



YYYY-MM-DD 2024-10-21

DESIGNED

-

PREPARED

FJ

REVIEWED

MCK

APPROVED

KJB

PROJECT

Nicolston Culvert Replacement/Rehabilitation (Site No. 30X-0678/CO), Highway 89, Alliston, Simcoe County, ON., MTO W.P. 2014-23-01; Assignment 2022-E-0046

TITLE

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

PROJECT NO.

CA0020332.0247

CONTROL

0

REV.

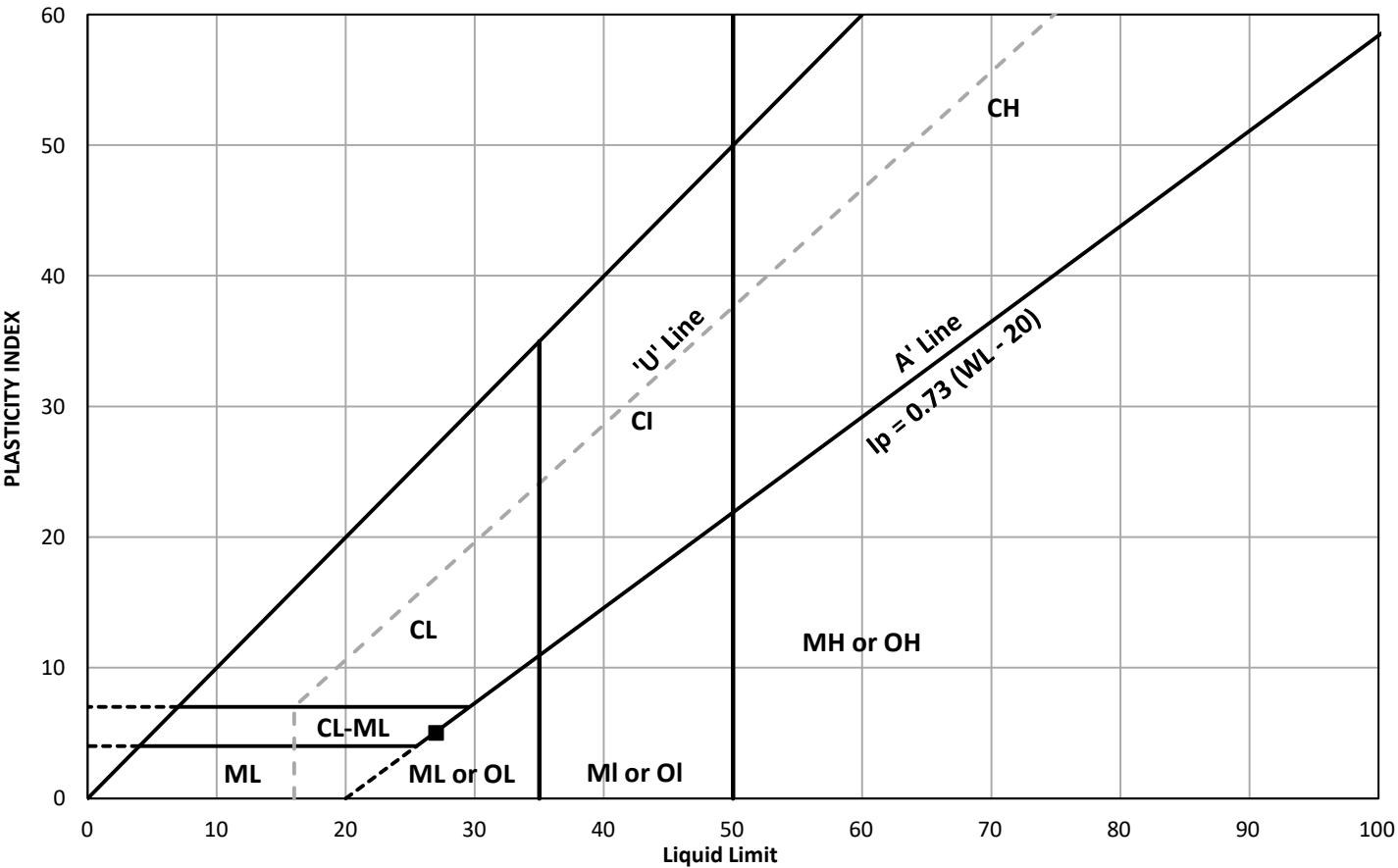
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FIGURE

B1

PATH: https://wsponlinecan.sharepoint.com/sites/CA-CA00203320247/Shared Documents/05. Technical/Foundations/05. Reporting/5 - RPT Culvert/Appendix B-Lab Figures | FILE NAME: Atterberg Output MTO - Culvert.xlsm

PLASTICITY CHART




	Sample Location	Sample / Specimen Number	Depth (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	BH24-03	8B	6.4 - 6.7	26.7	27	22	5	0.94

CLIENT

Ministry of Transportation, Ontario

CONSULTANT



YYYY-MM-DD

2024-10-21

DESIGNED

-

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KJB

PROJECT

Nicolston Culvert Replacement/Rehabilitation (Site No. 30X-0678/CO)
Highway 89, Alliston, Simcoe County, ON.,
MTO W.P. 2014-23-01; Assignment 2022-E-0046

TITLE

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

PROJECT NO.

CA0020332.0247

CONTROL

0

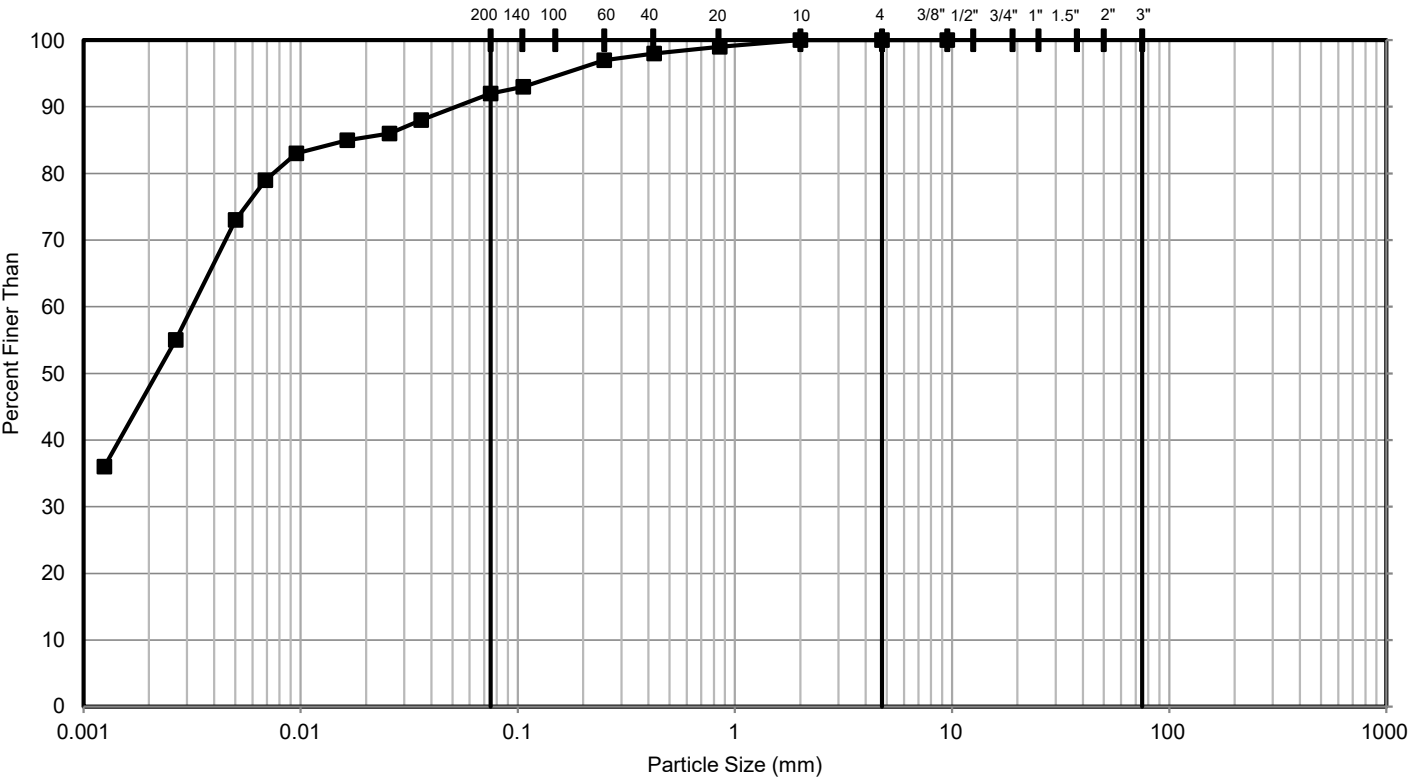
REV.

0

FIGURE

B2

GRAIN SIZE DISTRIBUTION



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

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH24-09	4	2.4 - 2.9	211.3 to 210.9

CLIENT

Ministry of Transportation, Ontario

CONSULTANT



YYYY-MM-DD 2024-10-21

DESIGNED

-

PREPARED

FJ

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MCK

APPROVED

KJB

PROJECT

Nicolston Culvert Replacement/Rehabilitation (Site No. 30X-0678/CO), Highway 89, Alliston, Simcoe County, ON., MTO W.P. 2014-23-01; Assignment 2022-E-0046

TITLE

CLAYEY SILT (CL) - FILL

PROJECT NO.

CA0020332.0247

CONTROL

0

REV.

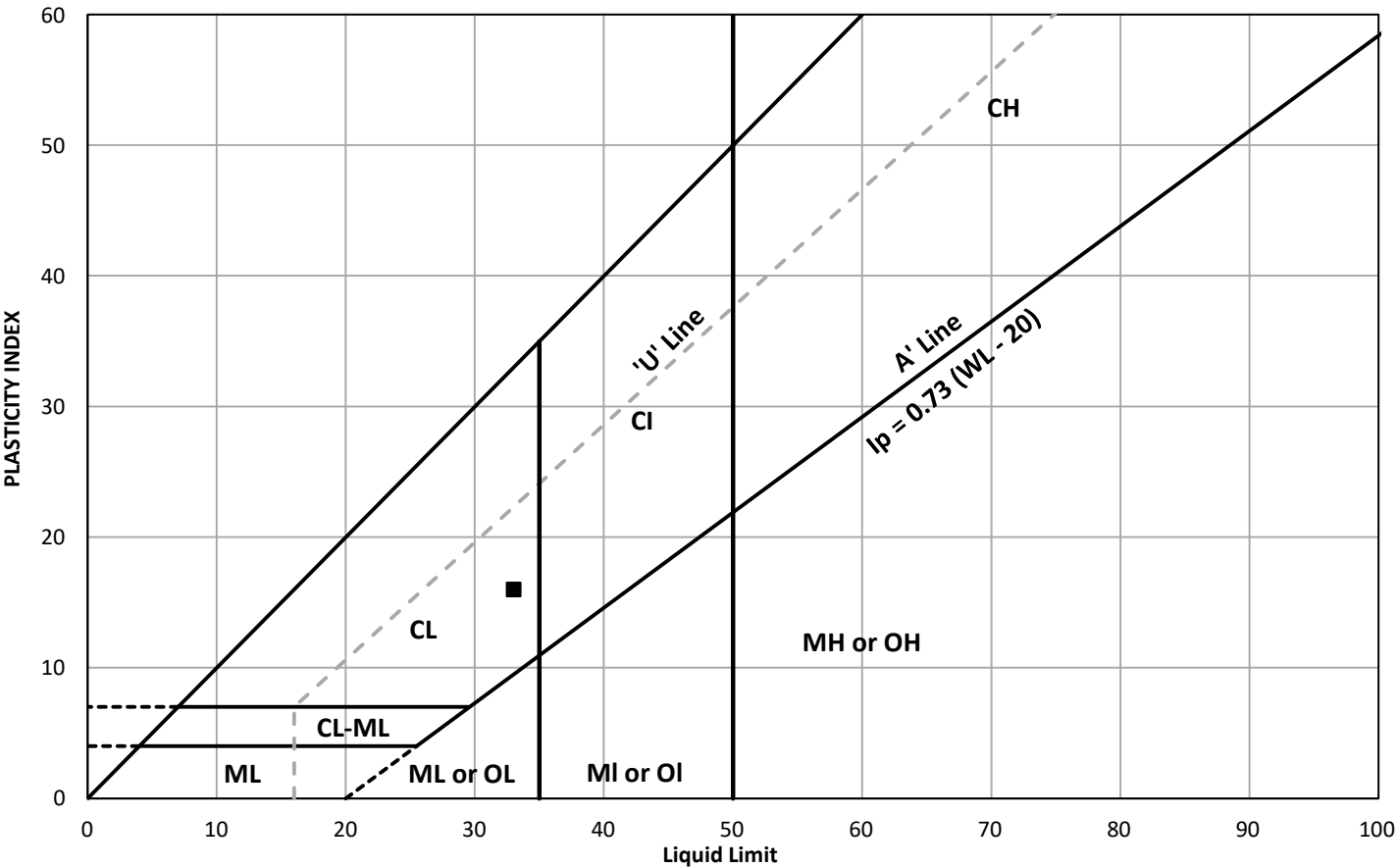
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FIGURE

B3

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PLASTICITY CHART




	Sample Location	Sample / Specimen Number	Depth (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	BH24-09	4	2.4 - 2.9	25.4	33	17	16	0.53

CLIENT

Ministry of Transportation, Ontario

CONSULTANT



YYYY-MM-DD

2024-10-21

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PROJECT

Nicolston Culvert Replacement/Rehabilitation (Site No. 30X-0678/CO)
Highway 89, Alliston, Simcoe County, ON.,
MTO W.P. 2014-23-01; Assignment 2022-E-0046

TITLE

CLAYEY SILT (CL) - FILL

PROJECT NO.

CA0020332.0247

CONTROL

0

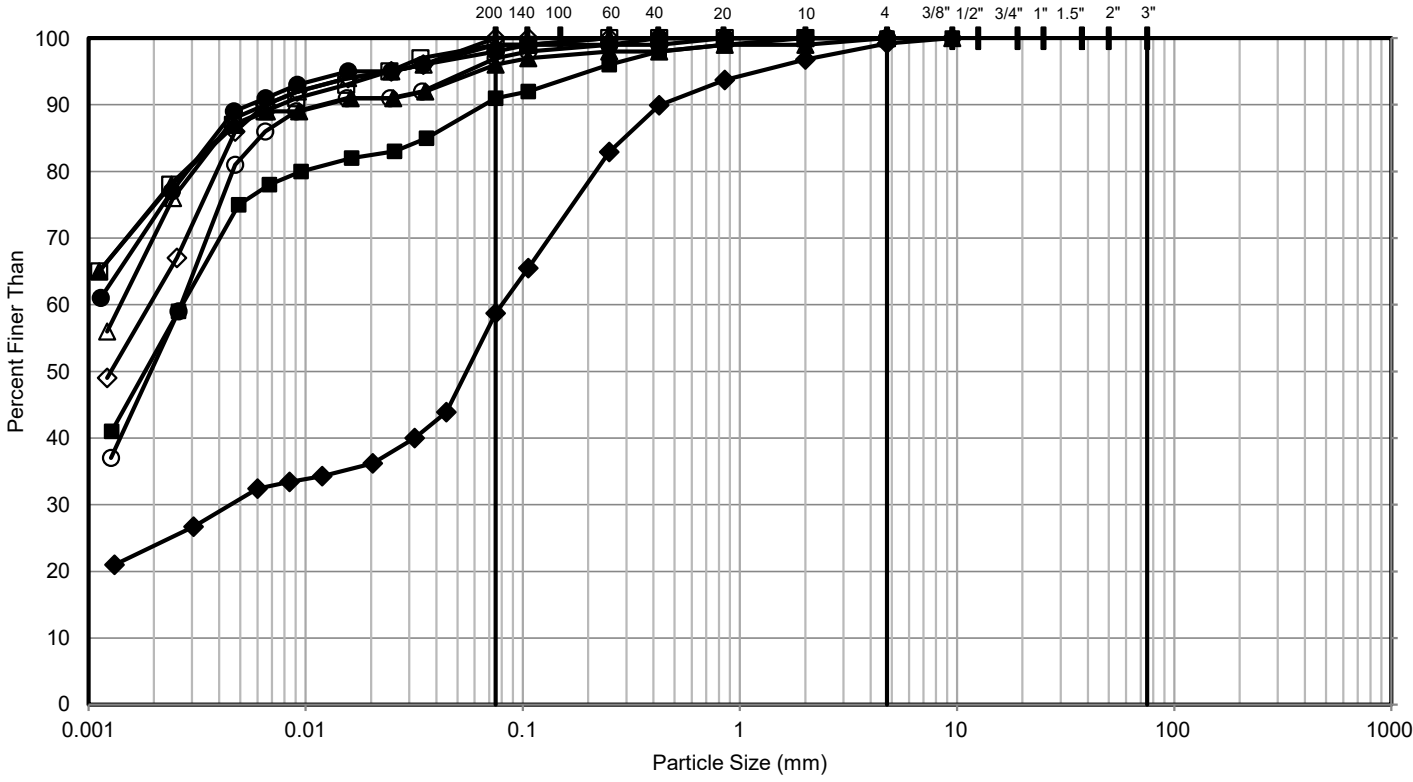
REV.

0

FIGURE

B4

GRAIN SIZE DISTRIBUTION



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

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH24-10	8	5.3 - 5.9	209.7 to 209.1
◆	BH24-06	3	1.5 - 2.1	208.3 to 207.7
▲	BH24-09	8	6.1 - 6.7	207.7 to 207.1
●	BH24-04	9	7.6 - 8.2	206.5 to 205.9
□	BH24-03	10	9.1 - 9.8	205.4 to 204.8
◇	BH24-04	11	10.7 - 11.3	203.5 to 202.9
△	BH24-10	18	15.2 - 15.9	199.8 to 199.2
○	BH24-03	15	16.8 - 17.4	197.8 to 197.2

CLIENT

Ministry of Transportation, Ontario

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PROJECT

Nicolston Culvert Replacement/Rehabilitation (Site No. 30X-0678/CO), Highway 89, Alliston, Simcoe County, ON., MTO W.P. 2014-23-01; Assignment 2022-E-0046

TITLE

CLAYEY SILT (CL) to CLAY (CH)

PROJECT NO.

CA0020332.0247

CONTROL

0

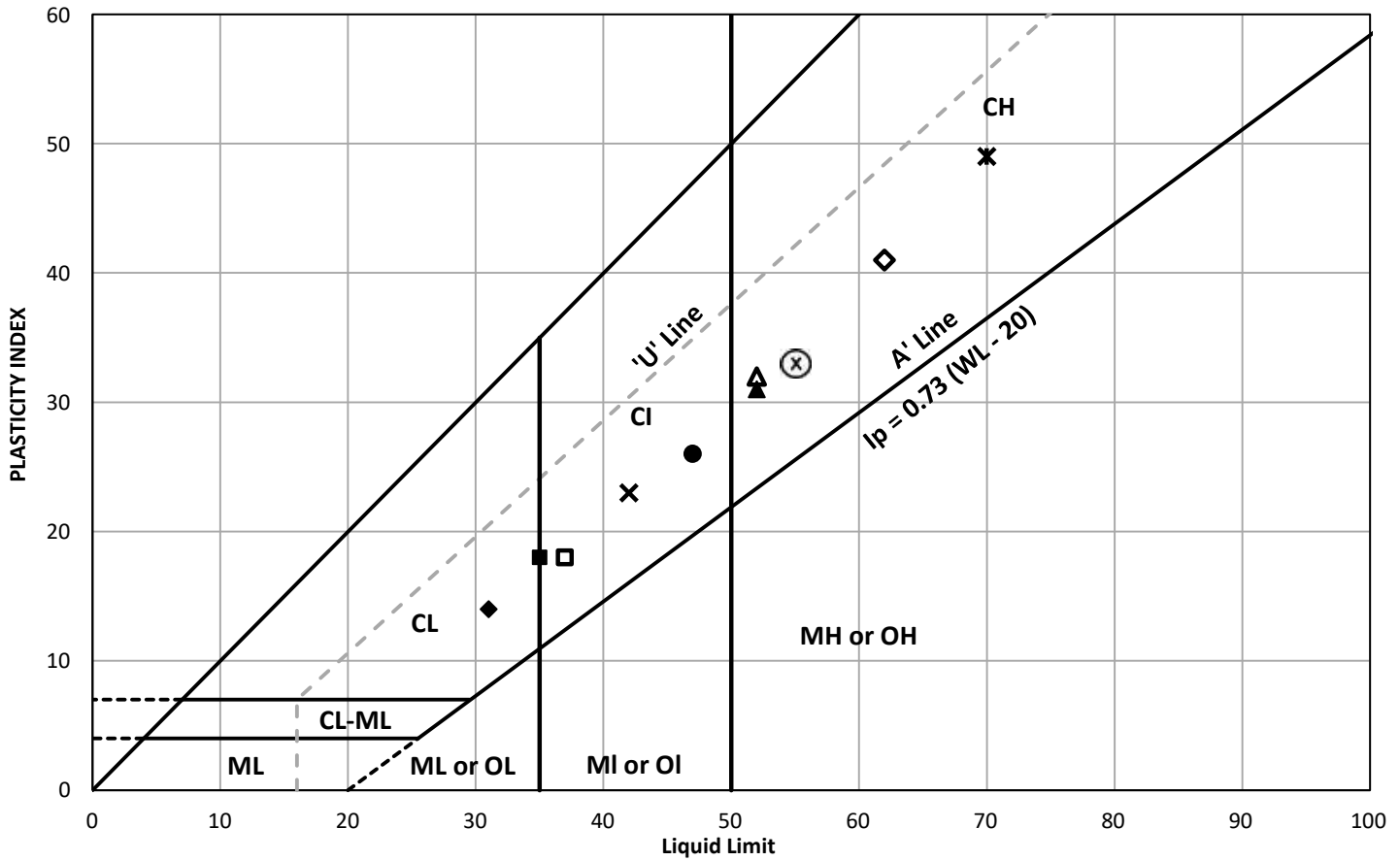
REV.

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FIGURE

B5

PLASTICITY CHART



	Sample Location	Sample / Specimen Number	Depth (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	BH24-10	8	5.3 - 5.9	24.2	35	17	18	0.40
◆	BH24-06	3	1.5 - 2.1	47.3	31	17	14	2.16
▲	BH24-09	8	6.1 - 6.7	35.7	52	21	31	0.47
●	BH24-04	9	7.6 - 8.2	32.4	47	21	26	0.44
*	BH24-06	6	3.8 - 4.4	42.1	70	21	49	0.43
⊗	BH24-03	10	9.1 - 9.8	42.3	55	22	33	0.62
□	BH24-04	11	10.7 - 11.3	27	37	19	18	0.44
◇	BH24-05	5	3.8 - 4.4	42.6	62	21	41	0.53
△	BH24-06	10	9.1 - 9.8	32.7	52	20	32	0.40
×	BH24-10	18	15.2 - 15.9	36.6	42	19	23	0.77

CLIENT

Ministry of Transportation, Ontario

CONSULTANT



YYYY-MM-DD	2024-10-21
DESIGNED	-
PREPARED	FJ
REVIEWED	MCK
APPROVED	KJB

PROJECT

Nicolston Culvert Replacement/Rehabilitation (Site No. 30X-0678/CO)
Highway 89, Alliston, Simcoe County, ON.,
MTO W.P. 2014-23-01; Assignment 2022-E-0046

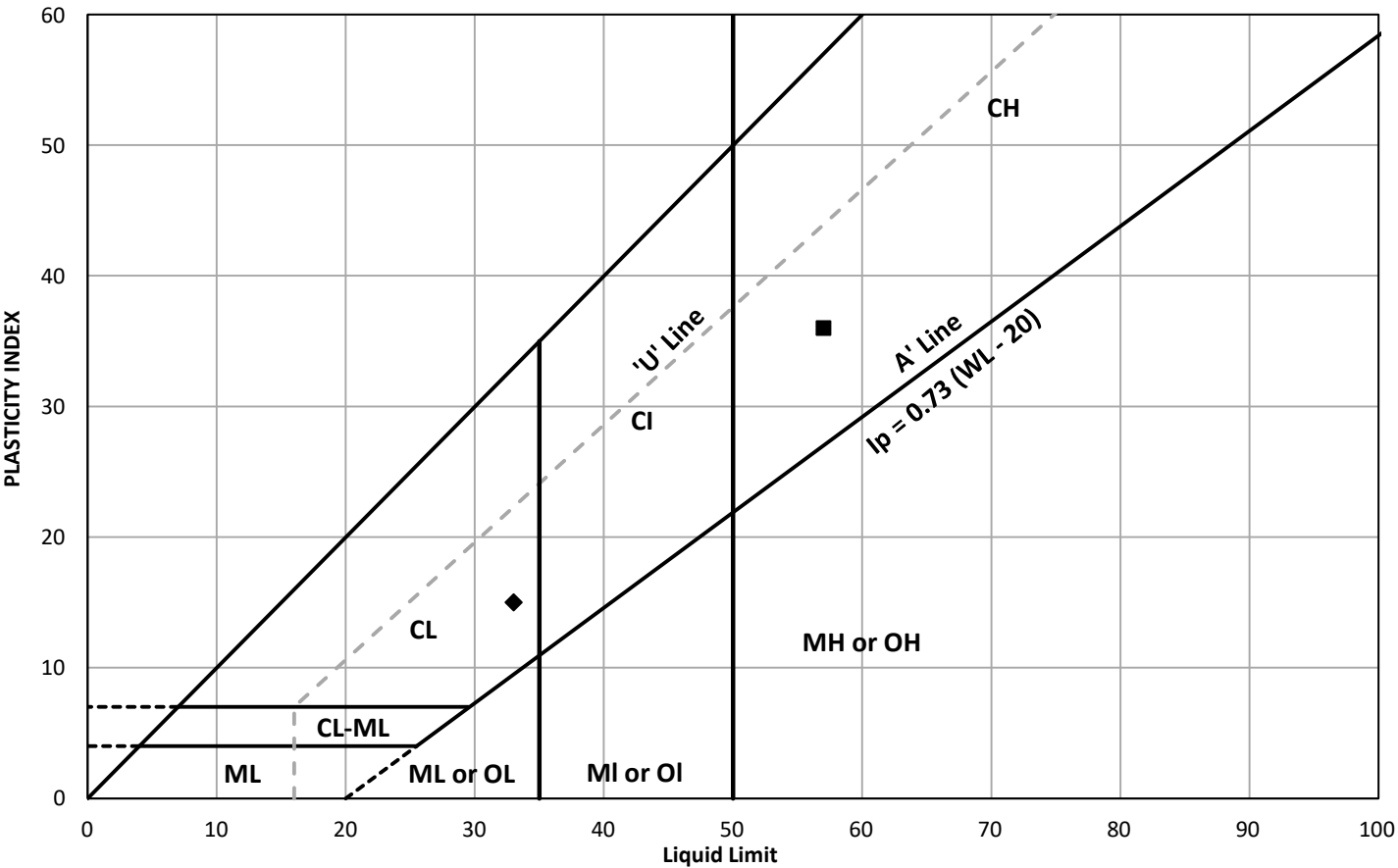
TITLE

CLAYEY SILT (CL) to CLAY (CH)

PROJECT NO.	CONTROL	REV.	FIGURE
CA0020332.0247	0	0	B6A

PATH: https://wsporlinecan.sharepoint.com/sites/CA-CA00203320247/Shared Documents/05. Technical/Foundations/5 - Reporting/5 - RPT Culvert/Appendix B-Lab Figures | FILE NAME: Atterberg Output MTO - Culvert.xlsm

PLASTICITY CHART




	Sample Location	Sample / Specimen Number	Depth (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	BH24-05	8	7.6 - 8.2	40.5	57	21	36	0.54
◆	BH24-03	15	16.8 - 17.4	28.4	33	18	15	0.69

CLIENT

Ministry of Transportation, Ontario

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YYYY-MM-DD

2024-10-21

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PROJECT

Nicolston Culvert Replacement/Rehabilitation (Site No. 30X-0678/CO)
Highway 89, Alliston, Simcoe County, ON.,
MTO W.P. 2014-23-01; Assignment 2022-E-0046

TITLE

CLAYEY SILT (CL) to CLAY (CH)

PROJECT NO.

CA0020332.0247

CONTROL

0

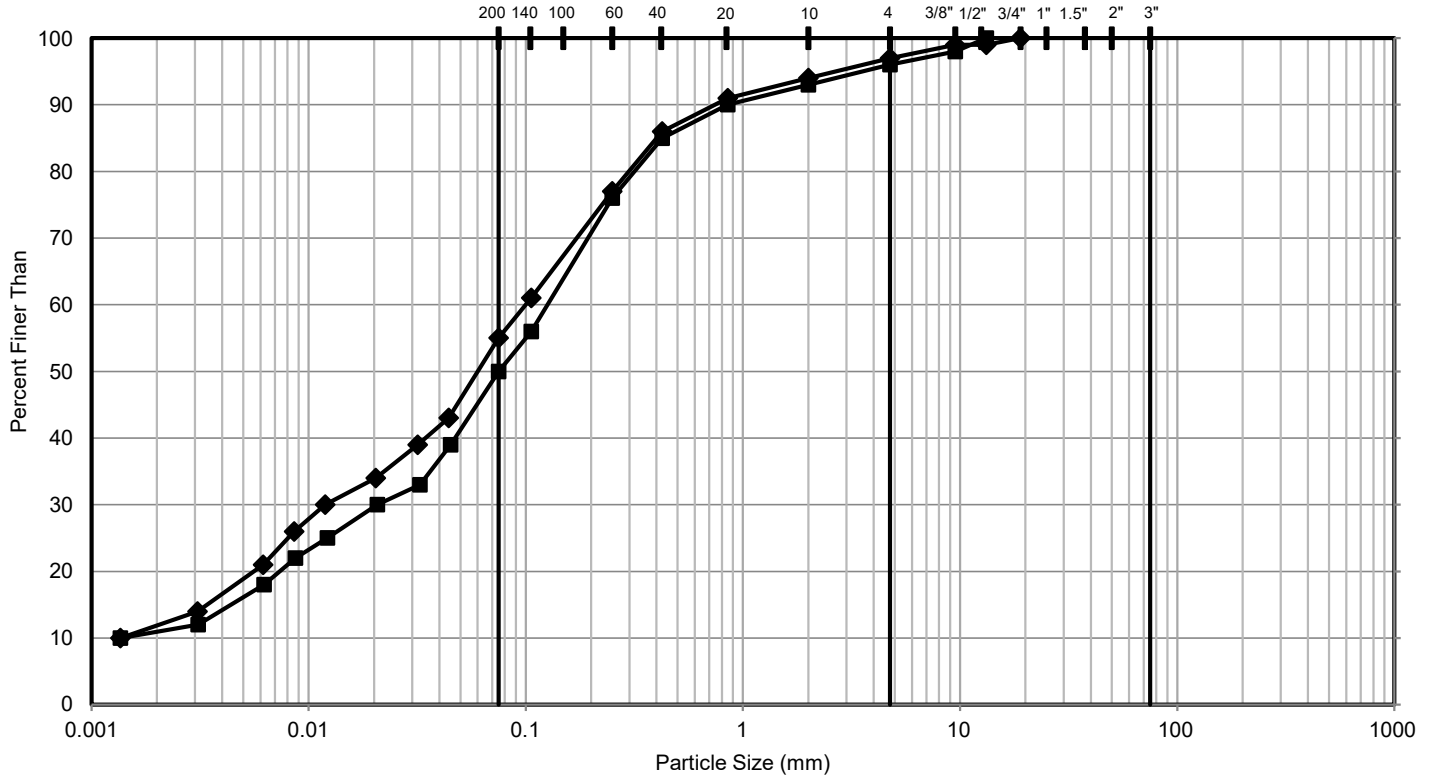
REV.

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FIGURE

B6B

GRAIN SIZE DISTRIBUTION



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

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH24-04	16	18.3 - 18.9	195.9 to 195.3
◆	BH24-09	13	13.7 - 14.3	200.1 to 199.5

CLIENT

Ministry of Transportation, Ontario

CONSULTANT



YYYY-MM-DD 2024-10-21

DESIGNED

-

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REVIEWED

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APPROVED

KJB

PROJECT

Nicolston Culvert Replacement/Rehabilitation (Site No. 30X-0678/CO), Highway 89, Alliston, Simcoe County, ON., MTO W.P. 2014-23-01; Assignment 2022-E-0046

TITLE

CLAYEY SILT - SILT (CL-ML) - TILL

PROJECT NO.

CA0020332.0247

CONTROL

0

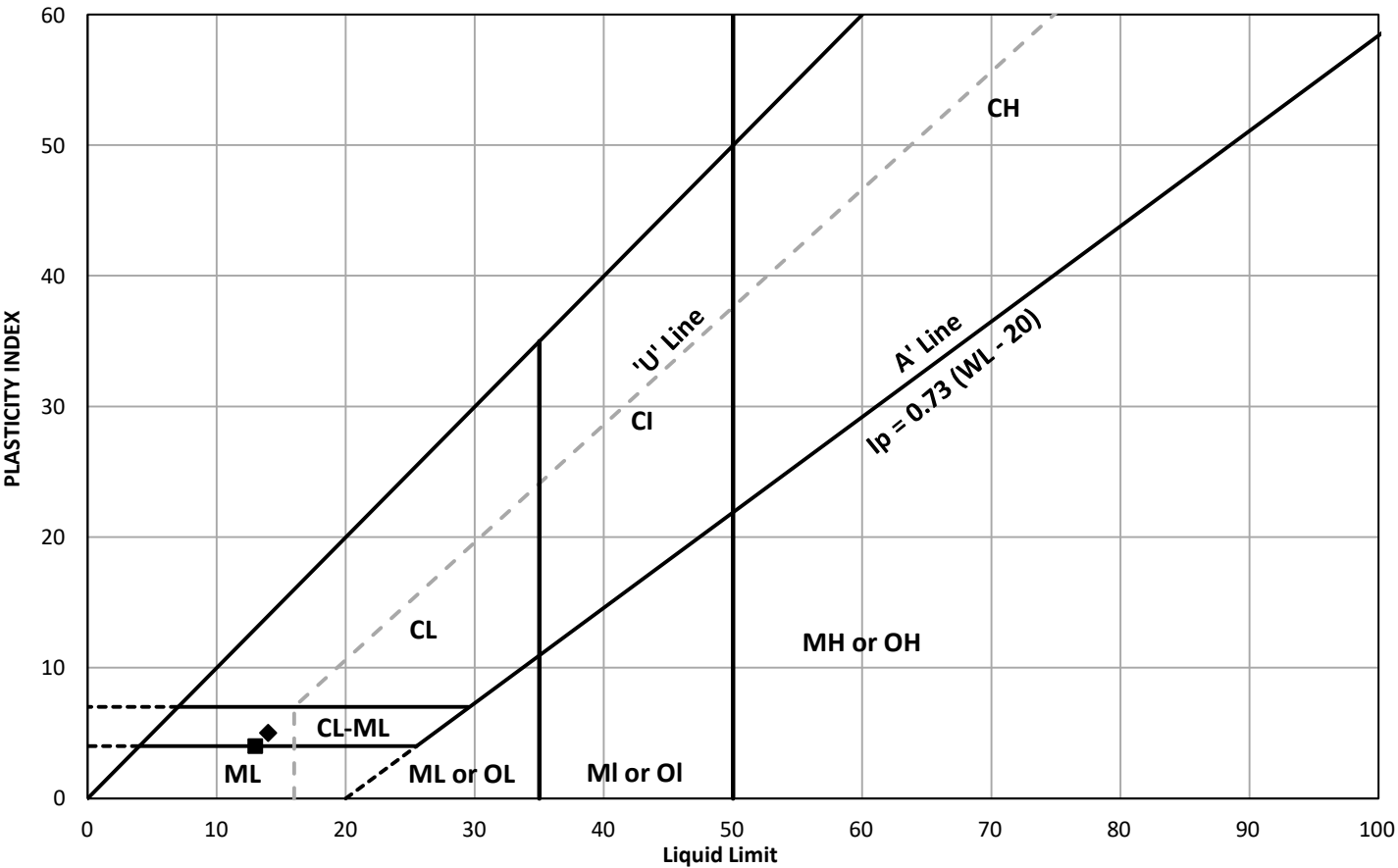
REV.

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FIGURE

B7

PLASTICITY CHART




	Sample Location	Sample / Specimen Number	Depth (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	BH24-04	16	18.3 - 18.9	9.3	13	9	4	0.08
◆	BH24-09	13	13.7 - 14.3	10.7	14	9	5	0.34

CLIENT

Ministry of Transportation, Ontario

CONSULTANT



YYYY-MM-DD

2024-10-21

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MCK

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KJB

PROJECT

Nicolston Culvert Replacement/Rehabilitation (Site No. 30X-0678/CO)
Highway 89, Alliston, Simcoe County, ON.,
MTO W.P. 2014-23-01; Assignment 2022-E-0046

TITLE

CLAYEY SILT - SILT (CL-ML) - TILL

PROJECT NO.

CA0020332.0247

CONTROL

0

REV.

0

FIGURE

B8

APPENDIX C

ANALYTICAL TEST RESULTS



Your Project #: CA0020332.0247, TASK 900.910
Site Location: ALLISTON, ONTARIO
Your C.O.C. #: N/A

Attention: Madison Kennedy

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

Report Date: 2024/05/03
Report #: R8134623
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C4C4317

Received: 2024/04/25, 14:52

Sample Matrix: Soil
Samples Received: 9

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	9	2024/04/30	2024/05/01	CAM SOP-00463	MOE E3013 m
Conductivity	9	2024/04/30	2024/04/30	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 2)	9	N/A	2024/05/01	AB SOP-00002	CCME PHC-CWS m
Sulphide in Soil (1)	9	N/A	2024/04/30	AB SOP-00080	EPA9030B/SM4500S2-DF
pH CaCl2 EXTRACT	9	2024/04/29	2024/04/29	CAM SOP-00413	EPA 9045 D m
Redox Potential (3)	9	2024/05/02	2024/05/03	CAM SOP-00421	SM 24 2580 B
Resistivity of Soil	9	2024/04/26	2024/04/30	CAM SOP-00414	SM 24 2510 m
Sulphate (20:1 Extract)	9	2024/04/30	2024/05/01	CAM SOP-00464	MOE E3013 m

Remarks:

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

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

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

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

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

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

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

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

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

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



Your Project #: CA0020332.0247, TASK 900.910
Site Location: ALLISTON, ONTARIO
Your C.O.C. #: N/A

Attention: Madison Kennedy

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

Report Date: 2024/05/03
Report #: R8134623
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C4C4317

Received: 2024/04/25, 14:52

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

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:

Ankita Bhalla, Project Manager

Email: Ankita.Bhalla@bureauveritas.com

Phone# (905) 817-5700

=====

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

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.



**BUREAU
VERITAS**

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		YZU407		YZU408	YZU409			YZU409	
Sampling Date		2024/04/09		2024/04/10	2024/04/10			2024/04/10	
COC Number		N/A		N/A	N/A			N/A	
	UNITS	BH24-01 SA-5	RDL	BH24-01 SA-9	BH24-01 SA-12	RDL	QC Batch	BH24-01 SA-12 Lab-Dup	QC Batch
Calculated Parameters									
Resistivity	ohm-cm	410		870	4100		9358051		
CONVENTIONALS									
Redox Potential	mV	270	N/A	270	270	N/A	9368559	270	9368559
Inorganics									
Soluble (20:1) Chloride (Cl-)	ug/g	1400	40	550	21	20	9364082		
Conductivity	umho/cm	2470	2	1160	244	2	9364027		
Available (CaCl2) pH	pH	7.76		7.86	7.85		9361710		
Soluble (20:1) Sulphate (SO4)	ug/g	94	20	83	79	20	9364092		
Sulphide	mg/kg	3.2 (1)	0.5	1.5 (1)	1.8 (1)	0.5	9365692		
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable (1) Extracted past method specified hold time									



BUREAU
VERITAS

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		YZU410	YZU411			YZU411		
Sampling Date		2024/04/08	2024/04/08			2024/04/08		
COC Number		N/A	N/A			N/A		
	UNITS	BH24-02 SA-2+3	BH24-02 SA-05	RDL	QC Batch	BH24-02 SA-05 Lab-Dup	RDL	QC Batch

Calculated Parameters								
Resistivity	ohm-cm	1200	2400		9358051			
CONVENTIONALS								
Redox Potential	mV	270	270	N/A	9368559			
Inorganics								
Soluble (20:1) Chloride (Cl-)	ug/g	330	100	20	9364082	110	20	9364082
Conductivity	umho/cm	843	420	2	9364027			
Available (CaCl2) pH	pH	8.05	7.96		9361710			
Soluble (20:1) Sulphate (SO4)	ug/g	40	24	20	9364092	24	20	9364092
Sulphide	mg/kg	1.8 (1)	0.9 (1)	0.5	9365692			
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable (1) Extracted past method specified hold time								

Bureau Veritas ID		YZU412		YZU413		YZU414		
Sampling Date		2024/04/08		2024/04/09		2024/04/15		
COC Number		N/A		N/A		N/A		
	UNITS	BH24-02 SA-10	QC Batch	BH24-02 SA-12	QC Batch	BH24-03 SA-9	RDL	QC Batch

Calculated Parameters								
Resistivity	ohm-cm	3500	9358051	4100	9358051	1800		9358051
CONVENTIONALS								
Redox Potential	mV	270	9368559	270	9368559	270	N/A	9368559
Inorganics								
Soluble (20:1) Chloride (Cl-)	ug/g	80	9364082	64	9364082	200	20	9364082
Conductivity	umho/cm	284	9364027	246	9364027	561	2	9364027
Available (CaCl2) pH	pH	7.92	9361710	7.90	9361722	7.74		9361710
Soluble (20:1) Sulphate (SO4)	ug/g	34	9364092	31	9364092	35	20	9364092
Sulphide	mg/kg	1.6 (1)	9365692	1.1 (1)	9365692	2.4 (1)	0.5	9365692
RDL = Reportable Detection Limit QC Batch = Quality Control Batch N/A = Not Applicable (1) Extracted past method specified hold time								



BUREAU
VERITAS

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		YZU414			YZU415		
Sampling Date		2024/04/15			2024/04/16		
COC Number		N/A			N/A		
	UNITS	BH24-03 SA-9 Lab-Dup	RDL	QC Batch	BH24-04 SA-8	RDL	QC Batch
Calculated Parameters							
Resistivity	ohm-cm				5200		9358051
CONVENTIONALS							
Redox Potential	mV				270	N/A	9368559
Inorganics							
Soluble (20:1) Chloride (Cl-)	ug/g				<20	20	9364082
Conductivity	umho/cm	564	2	9364027	192	2	9364027
Available (CaCl2) pH	pH				7.56		9361722
Soluble (20:1) Sulphate (SO4)	ug/g				49	20	9364092
Sulphide	mg/kg				3.3	0.5	9365692
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable							



**BUREAU
VERITAS**

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

RESULTS OF ANALYSES OF SOIL

Bureau Veritas ID		YZU407	YZU408	YZU408	YZU409	YZU410	YZU411		
Sampling Date		2024/04/09	2024/04/10	2024/04/10	2024/04/10	2024/04/08	2024/04/08		
COC Number		N/A	N/A	N/A	N/A	N/A	N/A		
	UNITS	BH24-01 SA-5	BH24-01 SA-9	BH24-01 SA-9 Lab-Dup	BH24-01 SA-12	BH24-02 SA-2+3	BH24-02 SA-05	RDL	QC Batch

Physical Testing

Moisture-Subcontracted	%	16	15	16	17	5.4	6.7	0.30	9368179
------------------------	---	----	----	----	----	-----	-----	------	---------

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

Bureau Veritas ID		YZU412	YZU413	YZU414	YZU415		
Sampling Date		2024/04/08	2024/04/09	2024/04/15	2024/04/16		
COC Number		N/A	N/A	N/A	N/A		
	UNITS	BH24-02 SA-10	BH24-02 SA-12	BH24-03 SA-9	BH24-04 SA-8	RDL	QC Batch

Physical Testing

Moisture-Subcontracted	%	17	15	30	21	0.30	9368179
------------------------	---	----	----	----	----	------	---------

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch



**BUREAU
VERITAS**

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

TEST SUMMARY

Bureau Veritas ID: YZU407
Sample ID: BH24-01 SA-5
Matrix: Soil

Collected: 2024/04/09
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU408
Sample ID: BH24-01 SA-9
Matrix: Soil

Collected: 2024/04/10
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU408 Dup
Sample ID: BH24-01 SA-9
Matrix: Soil

Collected: 2024/04/10
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson

Bureau Veritas ID: YZU409
Sample ID: BH24-01 SA-12
Matrix: Soil

Collected: 2024/04/10
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu



BUREAU
VERITAS

Bureau Veritas Job #: C4C4317
Report Date: 2024/05/03

WSP Canada Inc.
Client Project #: CA0020332.0247, TASK 900.910
Site Location: ALLISTON, ONTARIO
Sampler Initials: MTI

TEST SUMMARY

Bureau Veritas ID: YZU409 Dup
Sample ID: BH24-01 SA-12
Matrix: Soil

Collected: 2024/04/10
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR

Bureau Veritas ID: YZU410
Sample ID: BH24-02 SA-2+3
Matrix: Soil

Collected: 2024/04/08
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU411
Sample ID: BH24-02 SA-05
Matrix: Soil

Collected: 2024/04/08
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU411 Dup
Sample ID: BH24-02 SA-05
Matrix: Soil

Collected: 2024/04/08
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU412
Sample ID: BH24-02 SA-10
Matrix: Soil

Collected: 2024/04/08
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR



Bureau Veritas Job #: C4C4317
Report Date: 2024/05/03

WSP Canada Inc.
Client Project #: CA0020332.0247, TASK 900.910
Site Location: ALLISTON, ONTARIO
Sampler Initials: MTI

TEST SUMMARY

Bureau Veritas ID: YZU412
Sample ID: BH24-02 SA-10
Matrix: Soil

Collected: 2024/04/08
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurparteek KAUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU413
Sample ID: BH24-02 SA-12
Matrix: Soil

Collected: 2024/04/09
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurparteek KAUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361722	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurparteek KAUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU414
Sample ID: BH24-03 SA-9
Matrix: Soil

Collected: 2024/04/15
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurparteek KAUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurparteek KAUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU414 Dup
Sample ID: BH24-03 SA-9
Matrix: Soil

Collected: 2024/04/15
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurparteek KAUR



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VERITAS

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

TEST SUMMARY

Bureau Veritas ID: YZU415
Sample ID: BH24-04 SA-8
Matrix: Soil

Collected: 2024/04/16
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361722	2024/04/29	2024/04/29	Taslima Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu



GENERAL COMMENTS

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

Package 1	3.3°C
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Results relate only to the items tested.



BUREAU
VERITAS

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

QUALITY ASSURANCE REPORT

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
9361710	Available (CaCl ₂) pH	2024/04/29			100	97 - 103			0.44	N/A
9361722	Available (CaCl ₂) pH	2024/04/29			100	97 - 103			0.11	N/A
9364027	Conductivity	2024/04/30			102	90 - 110	<2	umho/cm	0.55	10
9364082	Soluble (20:1) Chloride (Cl ⁻)	2024/05/01	NC	70 - 130	86	70 - 130	<20	ug/g	6.5	35
9364092	Soluble (20:1) Sulphate (SO ₄)	2024/05/01	91	70 - 130	90	70 - 130	<20	ug/g	0.52	35
9365692	Sulphide	2024/04/30	86	75 - 125	101	75 - 125	<0.5	mg/kg	24	30
9368179	Moisture-Subcontracted	2024/05/01					<0.30	%	3.2	20
9368559	Redox Potential	2024/05/03			103	95 - 105			0.50	35

N/A = Not Applicable

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

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

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

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

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



BUREAU
VERITAS

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

VALIDATION SIGNATURE PAGE

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

Cristina Carriere, Senior Scientific Specialist

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

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

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.



NONT-2024-04-2573

3110 Road, Mississauga, Ontario L5N 2L8
7-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
31/6

WORK ORDER**CHAIN OF CUSTODY RECORD**

Page 1 of 1

Invoice Information		Report Information (if differs from invoice)		Project Information (where applicable)		Turnaround Time (TAT) Required									
Company Name:	WSP Canada Inc	Company Name:	WSP Canada Inc	Quotation #:		<input checked="" type="checkbox"/> Regular TAT (5-7 days) Most analyses									
Contact Name:	Canada Accounts Payable	Contact Name:	Madison Kennedy	P.O. #/ AFE#:	CA0020332.0247, task 900.910	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS									
Address:	6925 Century Ave. Suite 400 600	Address:	6925 Century Ave. Suite 400 600	Project #:		Rush TAT (Surcharges will be applied)									
	Mississauga, ON		Mississauga, ON L5N 7K2	Site Location:	Alliston, Ontario	<input type="checkbox"/> 1 Day	<input type="checkbox"/> 2 Days <input type="checkbox"/> 3-4 Days								
Phone:	905-567-4444 Fax: 905-567-6561	Phone:	289-838-4008 778-278-5156 Fax: 905-567-6561	Site #:		Date Required:									
Email:	CAPayablesInvoice@wsp.com	Email:	muhammad.irshad@wsp.com; madison.kennedy@wsp.com	Site Location Province:	Ontario	Rush Confirmation #:									
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY				Sampled By:	MTI + KR										
Regulation 153		Other Regulations		Analysis Requested				LABORATORY USE ONLY							
<input checked="" type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/ Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Lomm <input type="checkbox"/> Loarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/ Other <input type="checkbox"/> Table _____ FOR RSC (PLEASE CIRCLE) Y / N		<input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> MISA <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> PWQU Region _____ <input type="checkbox"/> Other (Specify) _____ <input type="checkbox"/> REG 558 (MIN. 3 DAY TAT REQUIRED) <input type="checkbox"/> REG 406 Table _____						CUSTODY SEAL Y / N							
Include Criteria on Certificate of Analysis: Y / N								Present Intact							
SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS								COOLING MEDIA PRESENT: <input checked="" type="checkbox"/> Y / <input type="checkbox"/> N							
SAMPLE IDENTIFICATION		DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / CrVI	BTEX/ PHC F1	PHCs F2 - F4	VOCs	REG 153 METALS & INORGANICS	REG 153 ICPMS METALS	REG 153 METALS (Hg, Cr VI, ICPMS Metals, HWS - B)	Corrosivity Package (+ Sulphide)	HOLD- DO NOT ANALYZE	COMMENTS
1	BH24-01 SA-5	2024-04-09	PM	SOIL	2										2 Jars (250 mL and 120 mL)
2	BH24-01 SA-9	2024-04-10	AM	SOIL	2										2 Jars (250 mL and 120 mL)
3	BH24-01 SA-12	2024-04-10	AM	SOIL	2										2 Jars (250 mL and 120 mL)
4	BH24-02 SA-2+3	2024-04-08	AM	SOIL	2										2 Jars (250 mL and 120 mL)
5	BH24-02 SA-05	2024-04-08	AM	SOIL	2										2 Jars (250 mL and 120 mL)
6	BH24-02 SA-10	2024-04-08	PM	SOIL	2										2 Jars (250 mL and 120 mL)
7	BH24-02 SA-12	2024-04-09	AM	SOIL	2										2 Jars (250 mL and 120 mL)
8	BH24-03 SA-9	2024-04-15	PM	SOIL	2										2 Jars (250 mL and 120 mL)
9	BH24-04 SA-8	2024-04-16	PM	SOIL	2										2 Jars (250 mL and 120 mL)
10															
RELINQUISHED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)		DATE: (YYYY/MM/DD)		TIME: (HH:MM)		BV JOB #					
M. Talha Irshad		2024-04-25	7:50 PM	[Signature]		2024/04/25		19:52							

APPENDIX D

**NON-STANDARD SPECIAL
PROVISIONS**

WELL DECOMMISSIONING - Item No.

Non-Standard Special Provision

Well Decommissioning

Standpipe piezometers were installed in boreholes as part of the Foundation Investigation for the culvert replacement/rehabilitation. The standpipe piezometers installed as part of the Foundation Investigation are listed below; additional information regarding installation details and location are found within the Foundation Investigation Reports.

Monitoring well information is provided below.

Standpipe Piezometer Identification	Approximate Location		PVC Pipe and Screen Diameter / Borehole Diameter	Depth (below ground surface) to Tip of Well Screen
	Northing (m) (Latitude, °)	Easting (m) (Longitude, °)		
BH24-03	4,891,998.5 (44.167577)	280,397.8 (-79.805134)	50 mm / 210 mm	7.6 m
BH24-04	4,892,002.9 (44.167616)	280,382.3 (-79.805328)	50 mm / 210 mm	6.1 m

The standpipe piezometers are registered as Well Tag Number A372993. The registered owner is the Ministry of Transportation, Ontario.

The standpipe piezometers have been left in place to allow for monitoring of the groundwater levels during construction.

As part of the construction activities a Licensed Well Contractor shall properly decommission the standpipe piezometers after completion of the bridge widening construction and culvert rehabilitation works. The abandonment method for each standpipe piezometer must satisfy the minimum requirements of Ontario Regulation 903 Wells, as amended under the Ontario Water Resources Act. The Contractor must follow the abandonment process and reporting requirements in accordance with O.Reg. 903, as amended. In addition, the Contractor shall provide a written record of the decommissioning procedure to the Contract Administrator. The record shall include plugging material used, depth of plugging material and limit of PVC standpipe/screen removal.

Measure of Payment

For measurement purposes, a count shall be made of the number of standpipe piezometers decommissioned.

Basis of Payment

Payment at the contract price for this tender item shall be full compensation of all labour, equipment and materials for completion of the work.

