



THURBER ENGINEERING LTD.

**PRELIMINARY
FOUNDATION INVESTIGATION REPORT
HIGHWAY 17 TWINNING, RENFREW AREA
CULVERT 23
HIGHWAY 17, STA. 10+993, MCNAB TOWNSHIP
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009**

Geocres No.: 31F07-004

Report to:

Ministry of Transportation Ontario

Latitude: 45.446140°
Longitude: -76.594334°

December 2024
Thurber File No.: 24726



TABLE OF CONTENTS

PART 1. FACTUAL INFORMATION

1	INTRODUCTION	1
2	SITE DESCRIPTION.....	1
2.1	General	1
2.2	Site Geology.....	2
3	SITE INVESTIGATION AND FIELD TESTING.....	3
4	LABORATORY TESTING	4
5	GENERAL DESCRIPTION OF SUBSURFACE CONDITIONS	4
5.1	Embankment Fill.....	4
5.1.1	Sand with Silt and Gravel Fill	4
5.1.2	Silty Sand Fill	5
5.2	Peat.....	5
5.3	Sand with Silt.....	5
5.4	Clayey Silt (CL)	6
5.5	Silty Sand (Glacial Till)	7
5.6	Bedrock.....	7
5.7	Groundwater.....	8
5.8	Analytical Testing	9
6	MISCELLANEOUS	9



APPENDICES

- | | |
|-------------|---|
| Appendix A. | Borehole Location Plan and Stratigraphic Drawings |
| Appendix B. | Record of Borehole Sheets |
| Appendix C. | Laboratory Testing |
| Appendix D. | Site Photographs |



**PRELIMINARY
FOUNDATION INVESTIGATION REPORT
HIGHWAY 17 TWINNING, RENFREW AREA
CULVERT 23
STA. 10+993, MCNAB TOWNSHIP
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009**

Geocres No.: 31F07-004

PART 1. FACTUAL INFORMATION

1 INTRODUCTION

Thurber Engineering Ltd. (Thurber) has been engaged by the Ministry of Transportation Ontario (MTO) to carry out Foundation Investigations to support the design of the Highway 17 Twinning Project which extends from Scheel Drive westerly to 3 km west of Bruce Street within the County of Renfrew, Ontario. Thurber carried out the investigation under Ministry of Transportation (MTO) Assignment No. 4018-E-0009.

This report addresses the proposed replacement of an existing CSPA culvert with a new structural culvert (29X-0409/C1) at about Sta. 10+993 on existing Highway 17 in McNab Township within Renfrew County, Ontario.

This section of the report presents the factual findings obtained from the foundation investigation conducted by Thurber as part of the current study. Thurber carried out the investigation under Ministry of Transportation (MTO) Assignment No. 4018-E-0009.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions.

It should be noted that the use of and reliance on Part 1 of the Report is governed by and limited to the terms and conditions set out in the Report and a reliance letter. The Preferred Proponent remains responsible to assess the need for additional investigations and to complete that work.

2 SITE DESCRIPTION

2.1 General

The culvert crosses Highway 17 approximately 750 m east of the intersection between Highway 17 and Goshen Road. For project purposes, Highway 17 is herein described as oriented east-west, and the culvert is described as oriented north-south.

In the area of the culvert, the existing Highway 17 is a two-lane highway and has a posted speed limit of 90 km/h. The highway profile near the culvert is relatively flat and the road surface is at



approximate elevation 159.7 m at the centerline. The culvert is located within an approximately 1.6 km long highway curve; the highway alignment continues to curve both east and west of the culvert site. The shoulders are partially paved and have a width of approximately 3.9 m in both directions. Traffic volumes for this section of Highway 17 is understood to have been 13,900 AADT in 2016.

The existing culvert near the site is a corrugated steel pipe arch (CSPA) culvert with an approximately 1.6 m horizontal span, 1.0 m vertical rise, and 34.8 m length. The culvert is skewed approximately 53° to the highway alignment. The culvert is reported to have a relatively flat gradient (approx. 0.2%) with the invert of the culvert at the outlet at approximately 157.2 m. The inlet of the culvert was not visible on July 26, 2024; ponded water on the inlet side was surveyed at elevation 158.4 m. The water level at the outlet was surveyed at elevation 158.0 m on the same day. The cover above the existing culvert is approximately 1.5 m at the highway centerline. The water flows through the culvert from south to north.

Embankment side slopes, in the vicinity of the culvert, are shallow and inclined at approximately 3H:1V to 6H:1V. The existing embankment side slopes at the culvert site did not show any visible signs of global instability at the time of the investigation.

The site is in a rural setting and the area directly adjacent to the highway is undeveloped and densely vegetated with coniferous and deciduous trees. The terrain along the ditch line is relatively rugged in the vicinity of the culvert site. A low-lying marsh dominated with grasses and ponded water located on both sides of the highway. Rock cuts are visible approximately 250 m east of the culvert. Overhead utility lines are not present.

Photographs of the project area are included in Appendix D. These photographs show the existing condition of the roadway embankment and the culvert at the time of the field investigation.

2.2 Site Geology

It is noted that Thurber completed a Foundation Investigation for the proposed Highway 17 culvert on the new west bound lanes at approximate Station 10+890 McNab. The results are presented in Geocres Report 31F-217.

According to Crins et al. 2009¹, the project area is described as Ecoregion 6E (Lake Simcoe-Rideau Ecoregion) within the Mixedwood Plains Ecozone. According to Wester et al. 2018², the ecoregion is subdivided into Ecodistrict 6E-16 (Pembroke Ecodistrict). The area is characterized by glaciolacustrine dominated landscape overlying a mix of Paleozoic to Precambrian bedrock.

Based on published geological information in *The Physiography of Southern Ontario* by Chapman and Putnam (1984), the site lies within the physiographic region known as the Ottawa Valley Shallow Till and Rock Ridges. Surficial mapping by Ontario Geological Survey (OGS) indicates

¹ <https://files.ontario.ca/mnrf-ecosystemspart1-accessible-july2018-en-2020-01-16.pdf>

² <https://files.ontario.ca/ecosystems-ontario-part2-03262019.pdf>



the site to be comprised of either coarse-textured glaciomarine deposits, organic deposits or Precambrian bedrock.

Ontario Geological Survey Map P.3784³ suggests the bedrock in the project area comprises felsic intrusive rocks, such as monzogranites to syenogranites.

3 SITE INVESTIGATION AND FIELD TESTING

The foundation investigation and field-testing program was carried out between March 06 and March 14, 2024, and consisted of one on-road borehole identified as SC23-2 and two off-road boreholes identified as SC23-1 and SC23-3. All of the boreholes were advanced with CME 75 drill rigs utilizing Hollow Stem Augers, NW casing and coring techniques in bedrock. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

A summary of the borehole coordinates, elevations, and termination depths is provided in Table 3-1. The locations and elevations of the boreholes were surveyed by Thurber with a Trimble Catalyst DA1 antenna with centimeter accuracy and were measured relative to BM HCP 102 (Elevation 129.023 m). Horizontal locations were measured by Thurber relative to existing site features. The elevations and borehole coordinates were reviewed and referenced to the survey data provided by MTO. The borehole coordinates and elevations are shown on the Borehole Location and Soil Strata drawing included in Appendix A and on the individual Record of Borehole sheets included in Appendix B. The borehole coordinates are referenced to MTM Zone 9.

Table 3-1: Borehole Summary

Borehole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
SC23-1	Near Inlet	5034014.1 (45.446019)	297424.8 (-76.594282)	158.7	12.8
SC7-2	Westbound Lane	5034021.8 (45.446088)	297421.5 (-76.594324)	159.6	16.2
SC7-3	Near Outlet	5034042.6 (45.446275)	297421.0 (-76.594331)	158.5	9.3

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in general accordance with ASTM D 1586. In-situ shear vane testing was carried out within the cohesive layers, where possible, using an MTO 'N' sized vane in general accordance with ASTM D 2573

A 50 mm diameter monitoring well was installed in each of Boreholes SC23-1 and SC23-3 to allow for measurements of the groundwater level after drilling. The details for the wells are illustrated on the respective Record of Borehole sheets provided in Appendix B. The monitoring

³ <http://www.geologyontario.mndm.gov.on.ca/mines/data/google/mrd126/doc.kml>



wells installed as part of the current investigation will be decommissioned by Thurber, as outlined in the Hydrogeological Investigation and Design Report.

Borehole SC23-2 was backfilled in accordance with MOE requirements (O.Reg 903, as amended).

The drilling and sampling operations were supervised on a full-time basis by a member of Thurber's technical staff. The drilling supervisor logged the boreholes and processed the recovered soil and rock samples for transport to Thurber's Ottawa laboratory for further examination and testing.

4 LABORATORY TESTING

Laboratory testing was selected in accordance with the current MTO Guideline for Foundation Engineering Services, Section 5. Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all retained soil samples. At least 25% of the recovered soil samples were subjected to testing for grain size distribution analysis and, where appropriate, Atterberg Limits in accordance with MTO and ASTM standards. Chemical analysis for determination of pH, conductivity, resistivity, sulphide, sulphate and chloride was carried out on a sample of the soil.

The results of the geotechnical tests are summarized on the Record of Borehole sheets included in Appendix B and all laboratory results are presented on the figures included in Appendix C.

5 GENERAL DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and the Borehole Location and Soil Strata Drawing included in Appendix A. A general description of the stratigraphy based on the conditions encountered in the boreholes is given in the following sections. However, the factual data presented on the Borehole Records takes precedence over the Soil Strata Drawing and the general description. It must be recognized that the soil and groundwater conditions may vary between and beyond borehole locations. Soil classification is in accordance with MTO Guideline for Foundation Engineering Services (GFES) Manual (April 2022) and the 4th Edition of the Canadian Foundation Engineering Manual.

In general, the encountered stratigraphy consists of sand with silt and gravel fill over native sand with silt over clayey silt, which is, in turn underlain by silty sand glacial till over bedrock. Peat was encountered below the ground surface in Borehole SC23-1.

5.1 Embankment Fill

5.1.1 Sand with Silt and Gravel Fill

A fill layer consisting of sand with silt and gravel was encountered at the ground surface in Borehole SC23-2. The thickness of the layer was 3.0 m (base elev. 156.6 m). The SPT N-values ranged from 10 to 52 blows, indicating a compact to very dense condition.



The moisture content of the samples tested ranged from 1 to 23% but typically less than 4%. The results of a grain size analysis conducted on a sample of this fill material are summarized below and are illustrated on Figure C1 in Appendix C.

Summary of Grain Size Distribution Testing – Sand with Silt and Gravel Fill

Soil Particle	Percentage (%)
Gravel	42
Sand	46
Silt & Clay	12

5.1.2 Silty Sand Fill

A fill layer consisting of silty sand with varying amounts of organics and wood fragments was encountered at the ground surface in Borehole SC23-3. The thickness of the layer was 1.8 m (base elev. 156.7 m). The SPT N-values ranged from 4 to 7, indicating a very loose to loose condition.

The moisture content of the samples tested were 40 and 43%.

5.2 Peat

A native deposit of fine fibrous to amorphous peat was encountered below the ground surface in Borehole SC23-1. The thickness of the layer was 2.1 m (base elev. 156.6 m). The SPT N-values ranged from 2 to 4 blows, indicating a very soft consistency.

The moisture content of a sample tested was 235%.

5.3 Sand with Silt

A native deposit of sand with silt containing varying amounts of organics was encountered beneath the peat in Borehole SC23-1, below the sand with silt and gravel fill in Borehole SC23-2, and below the silty sand fill in Borehole SC23-3. The thickness of the layer ranged from 0.5 to 1.1 m (base elev. 156.2 to 155.5 m). The SPT N-values ranged from 2 to 19 blows, indicating a very loose to compact relative density.

The moisture content of the samples tested ranged from 21 to 68%. The results of gradation analyses completed on two samples of the layer are illustrated in Figure C2 of Appendix C. The results of the tests are summarized below and on the Record of Borehole sheets in Appendix B.

Summary of Grain Size Distribution Testing – Sand with Silt

Soil Particle	Percentage (%)
Gravel	1
Sand	89 – 92
Silt & Clay	7 – 10

5.4 Clayey Silt (CL)

A native deposit of clayey silt was encountered below the sand with silt in all the boreholes. Sand partings and seams were encountered throughout the layer. The thickness of the layer ranged from 3.6 to 9.0 m (base elev. 152.6 to 146.5 m).

Where SPT was conducted within the layer, the N-values typically ranged from weight-of-hammer (WH) to 8 blows. Field vane tests were performed within this layer where possible. Undrained shear strengths were obtained and decreased with depth from greater than 100 kPa to 27 kPa. Remolded vane tests recorded sensitivities typically ranging from greater than 2 to 18, indicating that the clayey silt is medium sensitive to quick (CFEM, 2006). The layer is described as firm to very stiff in consistency based on N-values, undrained shear strength measurements, and tactile evaluations of strength.

The moisture content of the samples tested ranged from 18 to 47% but were typically greater than 27%. The results of grain size analysis tests conducted on six samples of this material are summarized in the table below and are illustrated in Figure C3 in Appendix C.

Summary of Grain Size Distribution Testing – Clayey Silt (CL)

Soil Particle	Percentage (%)
Gravel	0
Sand	2 – 5
Silt	53 – 70
Clay	26 – 42

The results of Atterberg Limits testing carried out on six samples of this material are summarized below and are illustrated in Figure C4 in Appendix C. The laboratory results indicate that the clayey silt is of low plasticity (CL).

Summary of Atterberg Limit Testing – Clayey Silt (CL)

Parameter	Value
Liquid Limit	25 – 34
Plastic Limit	16 – 21
Plasticity Index	8 – 15

5.5 Silty Sand (Glacial Till)

A layer of silty sand till was encountered below the clayey silt deposit in the Boreholes SC23-1 and SC23-2. Varying amounts of gravel were encountered in the layer. Though not fully penetrated in Borehole SC23-1, the layer thickness was proven to be at least 0.6 m thick (base elev. 146.5 to 145.9 m). SPT N-values ranged from 45 blows to refusal, indicating a dense to very dense relative density. Although not observed in the boreholes, it should be anticipated that cobbles and boulders are also present in the glacial till deposit.

The moisture content of the samples tested ranged from 7 to 27%. The results of gradation analyses completed on a sample of the layer are illustrated in Figure C5 of Appendix C. The results of the tests are summarized below and on the Record of Borehole sheets in Appendix B.

Summary of Grain Size Distribution Testing – Silty Sand (Glacial Till)

Soil Particle	Percentage (%)
Gravel	0
Sand	65
Silt	29
Clay	6

5.6 Bedrock

Bedrock was proven by coring in Boreholes SC23-2 and SC23-3. The depth to bedrock was 5.9 to 13.1 m (elevation 152.6 and 146.5 m). Borehole SC23-1 was terminated upon auger refusal on inferred bedrock. The bedrock surface appears to slope down from the culvert outlet to the inlet.

The bedrock encountered consisted of slightly weathered to fresh jointed, coarse grained, light pinkish red monzogranite. Photographs of the bedrock cores are provided in Appendix C. The rock core quality measurements are summarized in the Table 5-1.

Table 5-1: Bedrock Details

Parameter	Range
Total Core Recovery (TCR), %	93 – 100
Solid Core Recovery (SCR), %	33 – 94
Rock Quality Designation (RQD), %	53 – 90
Fracture Index (fractures per 0.3 m) ⁽¹⁾	0 – >10
Unconfined Compressive Strength (MPa)	104 – 128

Note: (1) Indicated as “FI” on Borehole Logs

The RQD values ranged from 53 to 90%, indicating a bedrock of fair to excellent quality (CFEM, 2023). The results of unconfined compressive strength tests (UCS) were 104 and 128 MPa, indicating that the tested samples of the bedrock are very strong (CFEM, 2023). The UCS test results are included in Appendix C.

5.7 Groundwater

Monitoring wells with diameters of 50 mm were installed in off-road Boreholes SC23-1 and SC23-3. Groundwater levels recorded in the wells are presented in Table 5-2.

Table 5-2: Summary of Groundwater Levels

Borehole No.	Bottom of Screen Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Date of Measurement
SC23-1	155.3	0.5	158.2	March 08, 2024
		0.4	158.3	April 09, 2024
		0.5	158.2	May 01, 2024
		0.6	158.1	June 07, 2024
		0.5	158.2	June 28, 2024
		0.6	158.1	July 12, 2024
		0.6	158.1	August 28, 2024
SC23-3	152.7	0.5	158.0	April 09, 2024
		0.6	157.9	May 01, 2024
		0.8	157.7	June 07, 2024
		0.7	157.8	June 28, 2024
		0.8	157.7	August 28, 2024

At the time of the field investigation frozen water was ponded near both inlet and outlet with both ends of the culvert visible (see Photos 1 and 2). However, during Thurber’s site visit on July 26, 2024, the culvert inlet was submerged (see Photo 3), and ponded water had a depth of approximately 0.8 m near the culvert outlet; the water surface was at approximate elevations of 158.4 and 158.0 m near the inlet and outlet, respectively.

These observations are considered short term as they were recorded at discrete times, and it should be noted that the groundwater level at the time of construction may be different. Seasonal



fluctuations of the groundwater level are to be expected. Furthermore, the groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation.

5.8 Analytical Testing

One sample of the native sand with silt was submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate, sulphide and chloride concentrations, resistivity, and conductivity. The analysis results are summarized in Table 5-3. Copies of the test results are provided in Appendix C.

Table 5-3: Results of Chemical Analysis

Borehole	Sample	Depth (m)	Chloride (µg/g)	Sulphate (µg/g)	Sulphide (%)	pH (-)	Resistivity (Ohm-cm)
SC23-2	SS5	3.0 – 3.6	175	2,080	0.83	6.91	510

6 MISCELLANEOUS

The borehole locations reflect existing site features and access constraints. The as-drilled locations and ground surface elevation were measured by Thurber following completion of the field program. George Downing Estate Drilling Ltd. of Hawkesbury, Ontario, supplied and operated the drill rigs used to drill, test, sample, and decommission the boreholes. Traffic control was performed in accordance with Ontario Book 7 and was provided by C&C Services of Renfrew, Ontario. The field investigation was supervised on a full-time basis by Mr. B. Coote, EIT, and Mr. D. Amorim Pereira, Geotechnical Technician. Overall supervision of the field investigation program was provided by Mr. J. Gray, P.Eng.

Routine geotechnical laboratory testing were completed by Thurber's laboratory in Ottawa. UCS testing were completed by Thurber's laboratory in Oakville. Analytical testing was completed by Paracel Laboratories Ltd. in Ottawa.



Interpretation of the factual data and preparation of this report was completed by I. Khan, EIT, and A. de Oliveira, P.Eng. The report was reviewed by Dr. F. Griffiths, P.Eng., and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundation Projects.

Thurber Engineering Ltd.
Report Prepared By:

Ibrahim Khan, EIT
Engineering Intern



Anderson de Oliveira, M.A.Sc., P.Eng.
Geotechnical Engineer



Dr. Fred Griffiths, P.Eng.
Principal, Senior Geotechnical Engineer

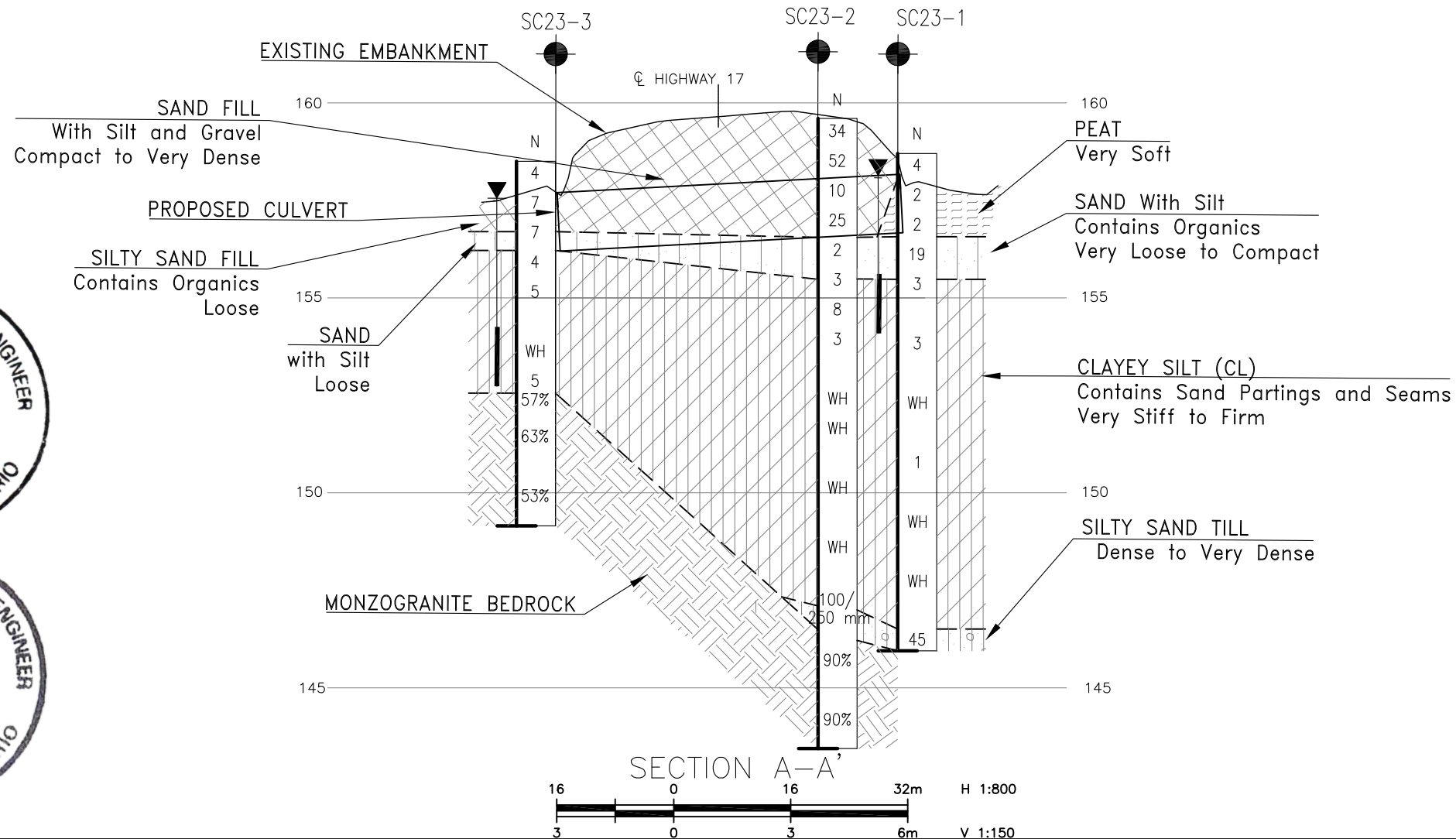
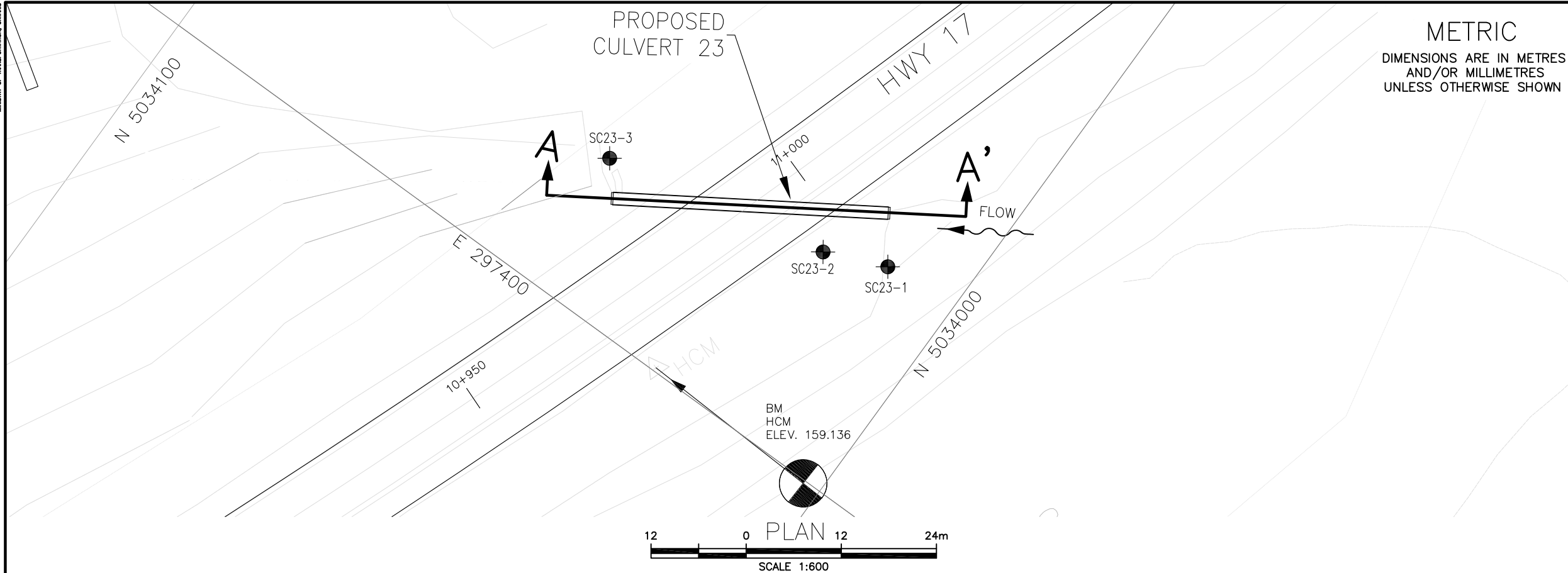


Dr. P.K. Chatterji, P.Eng.
Designated Principal Contact,
Principal, Senior Geotechnical Engineer



Appendix A.

Borehole Location Plan and Stratigraphic Drawings



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

CONT No	(
GWP No 4068-09-00	



HIGHWAY 17 TWINNING
 STA. 10+993, MCNAB TOWNSHIP
 CULVERT 23
 BOREHOLE LOCATION PLAN AND SOIL STRATA






SHEET
1

Ontario 



KEYPLAN

LEGEND

	Borehole
	Historic Borehole
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level Upon Completion of Drilling
	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
SC23-1	158.7	5 034 014.1	297 424.8
SC23-2	159.6	5 034 021.8	297 421.5
SC23-3	158.5	5 034 042.6	297 421.0

-NOTES-

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

GEOCRES No. 31F07-004

REVISIONS								
	DATE	BY			DESCRIPTION			
DESIGN	AO	CHK	—	CODE	LOAD	DATE	NOV 2024	
DRAWN	RH	CHK	FG	SITE	STRUCT	DWG	1	

FILENAME: H:\Drafting\24000\24726\Culvert 23\TED-24726-BHPP-Culvert 23.dwg
PLOTDATE: 12/17/2024 11:09 AM



Appendix B.
Record of Borehole Sheets



SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

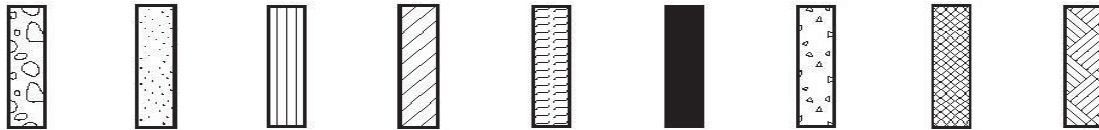
DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.



STRATA PLOT:

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel

Sand

Silt

Clay

Organics

Asphalt

Concrete

Fill

Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT “N” Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L = Liquid Limit



EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structures are preserved.

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

RECORD OF BOREHOLE No SC23-1

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.446019°, Long: -76.594282°
Culvert 23, McNab Township; MTM z9: N 5 034 014.1 E 297 424.8 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY AO
DATUM Geodetic DATE 2024.03.07 - 2024.03.07 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
158.7	Frozen Ground Surface						20 40 60 80 100	○ UNCONFINED + FIELD VANE	W _p W W _L					
0.0	AMORPHOUS PEAT to FINE FIBROUS PEAT very soft black		1	SS	4			● QUICK TRIAXIAL × LAB VANE						
			2	SS	2							235		
156.6			3	SS	2									
2.1	SAND with silt contains organics compact grey		4	SS	19									1 92 7 (SI+CL)
155.5														
3.2	CLAYEY SILT (CL) contains sand partings and seams very stiff to firm grey		5	SS	3									
			6	SS	3									
			7	SS	WH									
			8	SS	1									0 5 61 34
			9	SS	WH									

Continued Next Page



+³, ×³: Numbers refer to
Sensitivity 20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SC23-1

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.446019°, Long: -76.594282°
Culvert 23, McNab Township; MTM z9: N 5 034 014.1 E 297 424.8 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY AO
DATUM Geodetic DATE 2024.03.07 - 2024.03.07 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							PLASTIC LIMIT w _P w w _L NATURAL MOISTURE CONTENT WATER CONTENT (%)	LIQUID LIMIT					
	Continued From Previous Page							20	40	60	80	100									
	CLAYEY SILT (CL) contains sand partings and seams firm grey								5.0 +												
			10	SS	WH			148													
								147		8.0 +											
146.5																					
12.2	SILTY SAND (SM) dense greyish brown GLACIAL TILL		11	SS	45															0 65 29 6	
145.9																					
12.8	End of Borehole Auger Refusal on inferred bedrock Monitoring Well installed: Schedule 40 PVC standpipe with 50-mm diameter and 1.5-m slotted screen. Stick-up cover installed at ground surface. Water Level Readings: DATE DEPTH (m) ELEV. (m) 2024/03/08 0.5 158.2 2024/04/09 0.4 158.3 2024/05/01 0.5 158.2 2024/06/07 0.6 158.1 2024/06/28 0.5 158.2 2024/07/12 0.6 158.1 2024/08/28 0.6 158.1																				

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SC23-2

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.446088°, Long: -76.594324° Culvert 23, McNab Township; MTM z9: N 5 034 021.8 E 297 421.5 ORIGINATED BY DAP
 HWY 17 BOREHOLE TYPE CME 75 Truckmount / HSA / NW Casing / NQ Coring COMPILED BY AO
 DATUM Geodetic DATE 2024.03.13 - 2024.03.14 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
159.6	Ground Surface							20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
0.0	SAND with silt and gravel compact to very dense yellowish brown FILL		1	SS	34				○ UNCONFINED	+ FIELD VANE			GR SA SI CL
			2	SS	52				● QUICK TRIAXIAL	× LAB VANE			
			3	SS	10				WATER CONTENT (%)				
			4	SS	25								
156.6													
3.0	SAND with silt contains organics very loose brown		5	SS	2								
			6	SS	3								
155.5													
4.1	CLAYEY SILT (CL) contains sand partings and seams very stiff to firm grey		7	SS	8								
			8	SS	3								
			9	SS	WH								
			10	SS	WH								
			11	SS	WH								

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
15
10
5
0 (%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No SC23-3

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.446275°, Long: -76.594331° Culvert 23, McNab Township; MTM z9: N 5 034 042.6 E 297 421.0 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA / NW Casing / NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2024.03.06 - 2024.03.06 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
158.5	Ground Surface							20 40 60 80 100		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
0.0	SILTY SAND contains organics and wood fragments loose dark brown FILL		1	SS	4			20 40 60 80 100					
			2	SS	7								
156.7			3	SS	7								
1.8	SAND with silt loose grey												1 89 10 (SI+CL)
156.2			4	SS	4								0 2 57 41
2.3	CLAYEY SILT (CL) contains sand partings and seams very stiff to firm grey		5	SS	5								
			6	SS	WH								0 2 59 39
			7	SS	5								
152.6													FI
5.9	MONZOGRANITE BEDROCK slightly weathered to fresh jointed light pinkish red coarse grained very strong		1	RUN	-								2 7 RUN #1 TCR=100% SCR=64% RQD=57% UCS=104MPa
			2	RUN	-								>10 1 0 2 6 1 RUN #2 TCR=93% SCR=73% RQD=63%
			3	RUN	-								4 >10 RUN #3 TCR=100% SCR=62% RQD=53%
149.2													3
9.3	End of Borehole												
	Monitoring Well installed: Schedule 40 PVC standpipe with												

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

SOIL PROFILE						SAMPLES																						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)																	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	w _P w w _L	γ																		
	50-mm diameter and 3.0-m slotted screen. Stick-up cover installed at ground surface.							20 40 60 80 100	20 40 60	kN/m ³	GR SA SI CL																	
	Water Level Readings: <table border="1"><thead><tr><th>DATE</th><th>DEPTH (m)</th><th>ELEV. (m)</th></tr></thead><tbody><tr><td>2024/04/09</td><td>0.5</td><td>158.0</td></tr><tr><td>2024/05/01</td><td>0.6</td><td>157.9</td></tr><tr><td>2024/06/07</td><td>0.8</td><td>157.7</td></tr><tr><td>2024/06/28</td><td>0.7</td><td>157.8</td></tr><tr><td>2024/08/28</td><td>0.8</td><td>157.7</td></tr></tbody></table>	DATE	DEPTH (m)	ELEV. (m)	2024/04/09	0.5	158.0	2024/05/01	0.6	157.9	2024/06/07	0.8	157.7	2024/06/28	0.7	157.8	2024/08/28	0.8	157.7									
DATE	DEPTH (m)	ELEV. (m)																										
2024/04/09	0.5	158.0																										
2024/05/01	0.6	157.9																										
2024/06/07	0.8	157.7																										
2024/06/28	0.7	157.8																										
2024/08/28	0.8	157.7																										



Appendix C.

Laboratory Testing



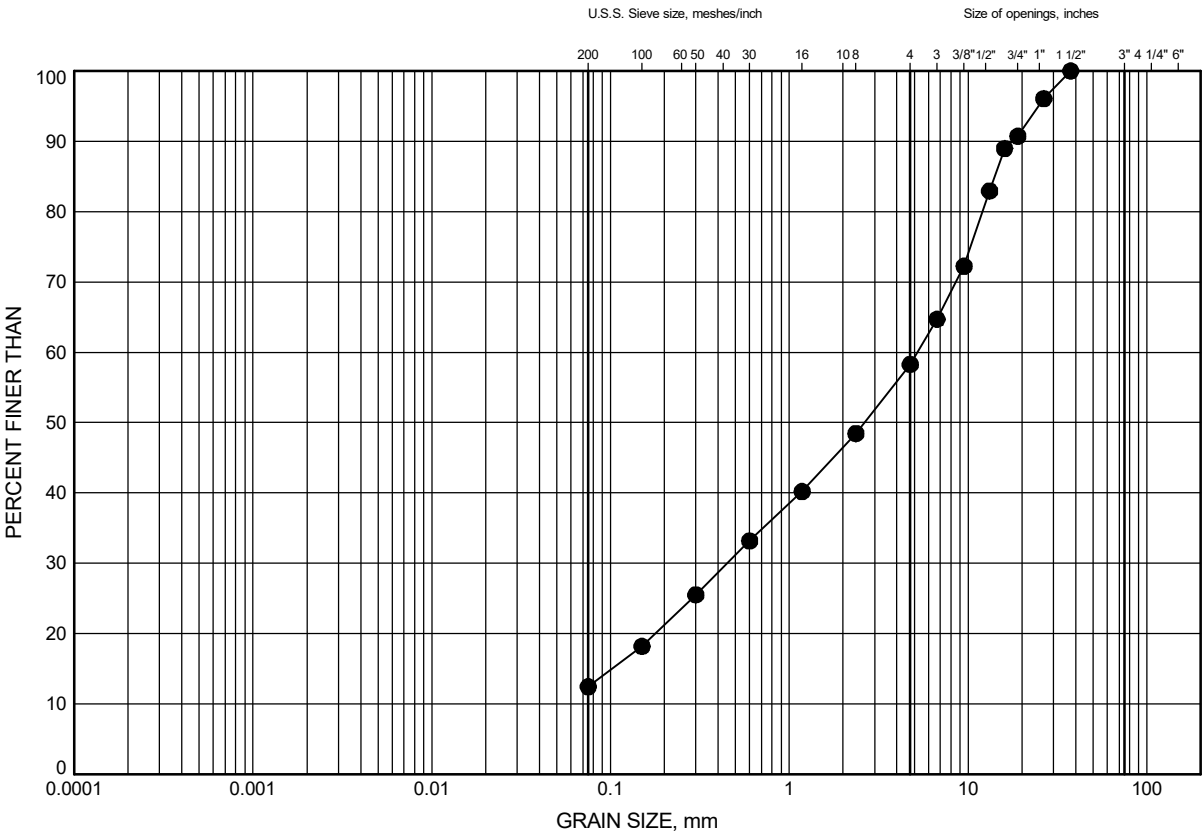
Appendix C.1
Particle Size Analysis Figures
Atterberg Limit Test Results
Unconfined Compressive Strength Testing Results
Rock Core Photos

Highway 17 twinning, Culvert 23, Sta. 10+993

GRAIN SIZE DISTRIBUTION

FIGURE C1

FILL: Sand with Silt and Gravel



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC23-2	0.3	159.3

GRAIN SIZE DISTRIBUTION - THURBER CULVERT 23 GINT LOGS.GPJ 7-31-24

Date July 2024
GWP# 4018-E-0009



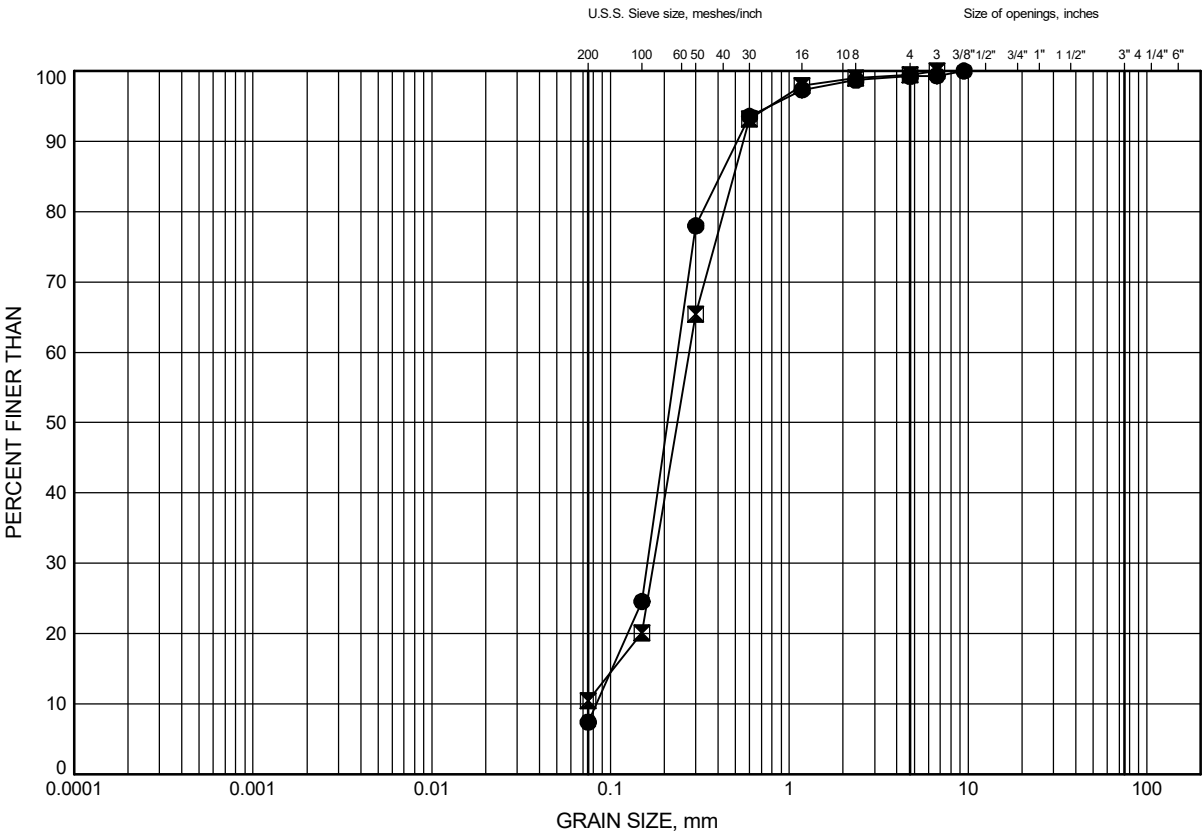
Prep'd RH
Chkd. AO

Highway 17 twinning, Culvert 23, Sta. 10+993

GRAIN SIZE DISTRIBUTION

FIGURE C2

Sand with Silt



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC23-1	2.6	156.1
⊠	SC23-3	2.0	156.5

GRAIN SIZE DISTRIBUTION - THURBER CULVERT 23 GINT LOGS.GPJ 7-31-24

Date July 2024
GWP# 4018-E-0009



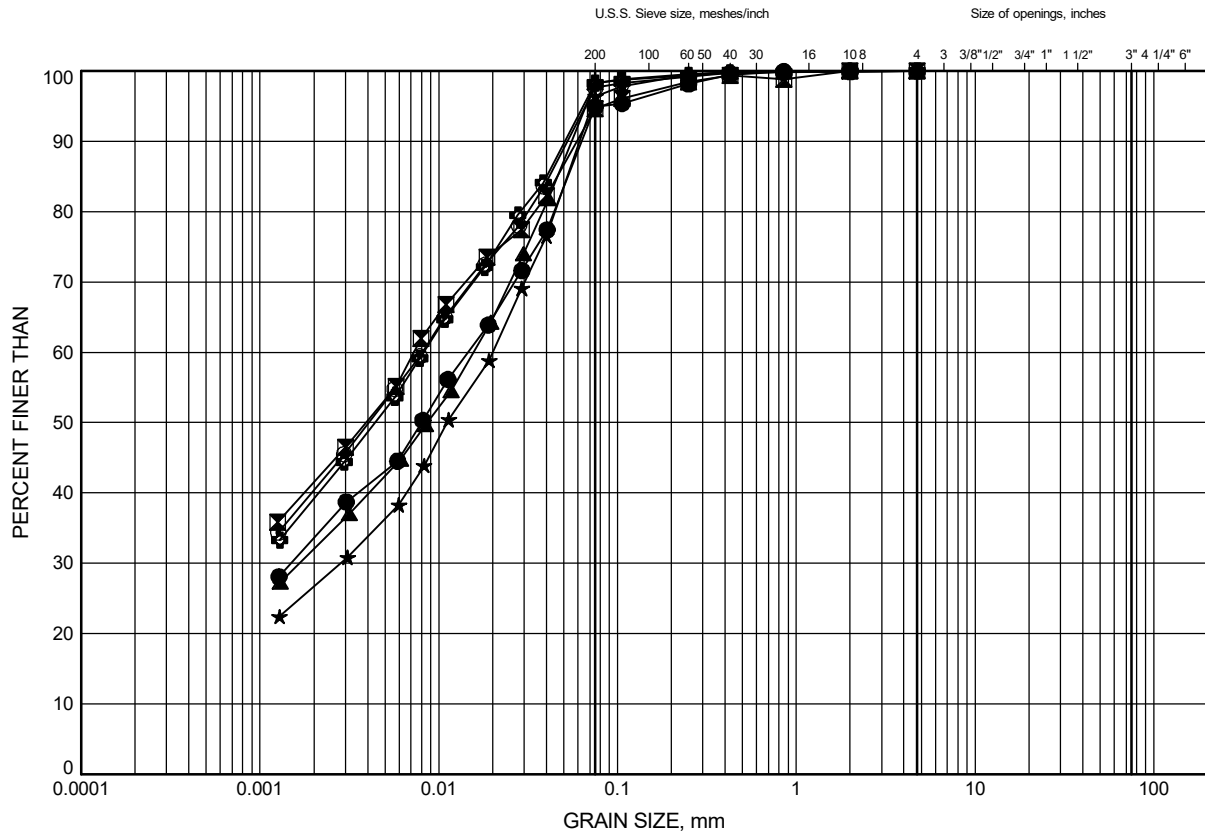
Prep'd RH
Chkd. AO

Highway 17 twinning, Culvert 23, Sta. 10+993

GRAIN SIZE DISTRIBUTION

FIGURE C3

Clayey Silt (CL)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC23-1	7.9	150.8
⊠	SC23-2	4.9	154.7
▲	SC23-2	7.9	151.7
★	SC23-2	12.3	147.3
⊙	SC23-3	2.6	155.9
⊕	SC23-3	4.9	153.6

Date July 2024

GWP# 4018-E-0009



Prep'd RH

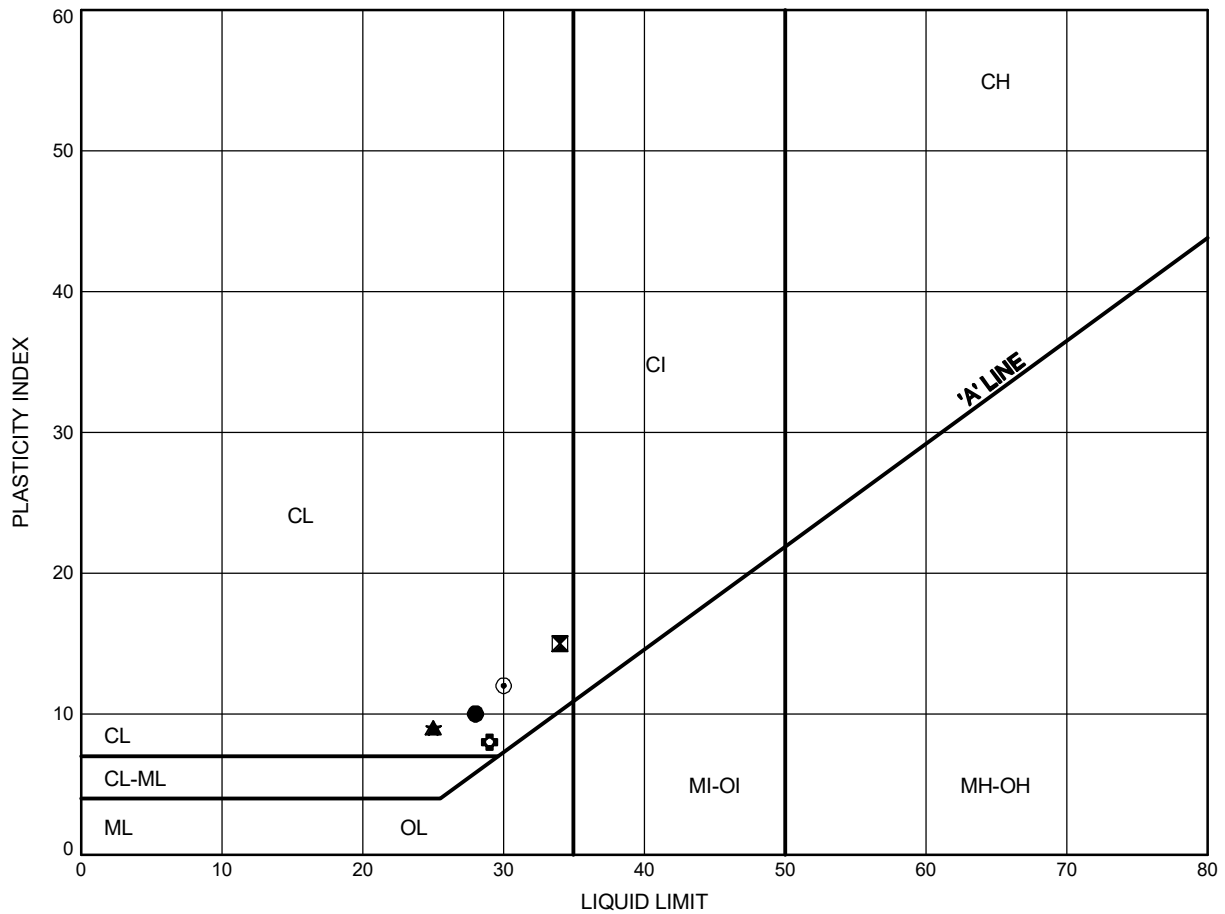
Chkd. AO

Highway 17 twinning, Culvert 23, Sta. 10+993

ATTERBERG LIMITS TEST RESULTS

FIGURE C4

Clayey Silt (CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC23-1	7.9	150.8
⊠	SC23-2	4.9	154.7
▲	SC23-2	7.9	151.7
★	SC23-2	12.3	147.3
⊙	SC23-3	2.6	155.9
⊕	SC23-3	4.9	153.6

Date July 2024

GWP# 4018-E-0009



Prep'd RH

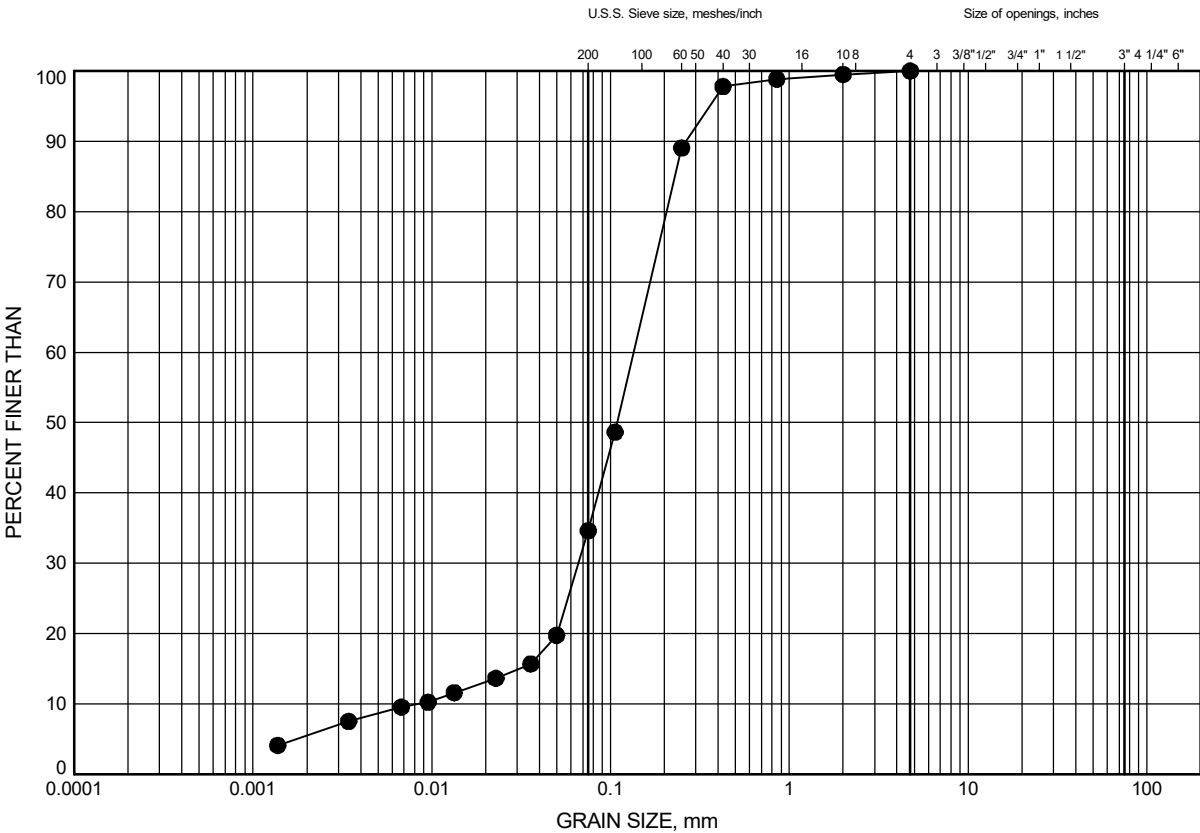
Chkd. AO

Highway 17 twinning, Culvert 23, Sta. 10+993

GRAIN SIZE DISTRIBUTION

FIGURE C5

Silty Sand (Glacial Till)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC23-1	12.4	146.3

GRAIN SIZE DISTRIBUTION - THURBER CULVERT 23 GINT LOGS.GPJ 7-31-24

Date July 2024
GWP# 4018-E-0009



Prep'd RH
Chkd. AO

UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

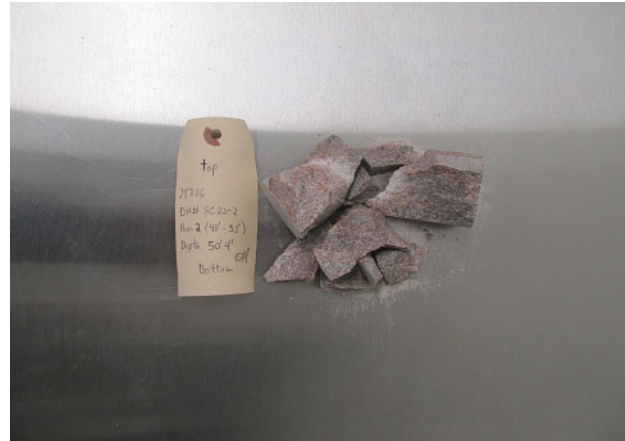
CLIENT:	Thurber Engineering (Ottawa)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 Twinning - Renfrew	REPORT DATE:	1-Aug-24
BOREHOLE No.:	SC23-2	TEST DATE:	9-May-24
SAMPLE No.:	Run 2		
SAMPLE DEPTH:	15.34 m		
DESCRIPTION:	Granite		

Avg. Height (cm):	9.5	Weight (g):	434.0
Avg. Diameter (cm):	4.7	Wet Density (kg/m ³):	2,633
H. to Dia. Ratio**:	2:1	Dry Density (kg/m ³):	2,633
Cross Sectional Area (cm ²):	17.35	Moisture Content* (%):	N/A
Sample Volume (cm ³):	164.82		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	0.250 MPa/s
MAXIMUM COMPRESSIVE LOAD:	223.2 kN
UNCONFINED COMPRESSIVE STRENGTH:	128.6 MPa

Note: * The moisture content was obtained before the test.
 ** Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: GF
 REVIEWED BY: WM

UCS SC23-2 Run 2

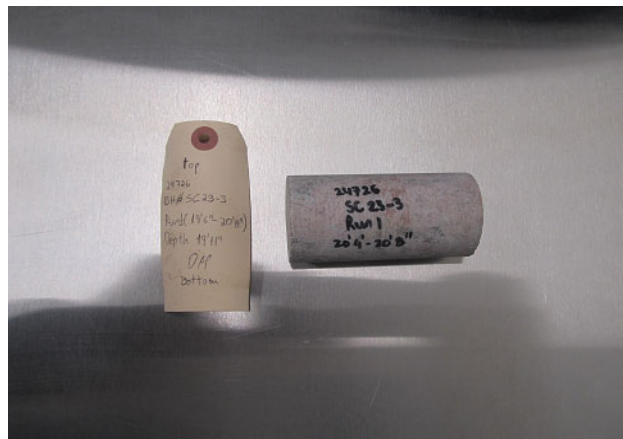
UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

CLIENT:	Thurber Engineering (Ottawa)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 Twinning - Renfrew	REPORT DATE:	1-Aug-24
BOREHOLE No.:	SC23-3	TEST DATE:	9-May-24
SAMPLE No.:	Run 1		
SAMPLE DEPTH:	6.07 m		
DESCRIPTION:	Granite		

Avg. Height (cm):	9.6	Weight (g):	436.1
Avg. Diameter (cm):	4.7	Wet Density (kg/m ³):	2,618
H. to Dia. Ratio**:	2:1	Dry Density (kg/m ³):	2,618
Cross Sectional Area (cm ²):	17.35	Moisture Content* (%):	N/A
Sample Volume (cm ³):	166.55		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	0.250 MPa/s
MAXIMUM COMPRESSIVE LOAD:	181.2 kN
UNCONFINED COMPRESSIVE STRENGTH:	104.4 MPa

Note: * The moisture content was obtained before the test.
 ** Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: GF
 REVIEWED BY: WM

UCS SC23-3 Run 1

Borehole SC23-2
Run 1 and 2
Depth 13.1 to 16.2 m
Elevation 146.5 to 143.4 m
Dry Sample



Borehole SC23-2
Run 1 and 2
Depth 13.1 to 16.2 m
Elevation 146.5 to 143.4 m
Wet Sample



Borehole SC23-3
Run 1, 2, and 3
Depth 5.9 to 9.3 m
Elevation 152.6 to 149.2 m
Dry Sample

Run 1 Start
elev. 152.6 m

Run 1 End
elev. 152.2 m

Run 2 Start
elev. 152.2 m



Run 2 End
elev. 150.7 m

Run 3 Start
elev. 150.7 m



Run 3 End
elev. 149.2 m

Borehole SC23-3
Run 1, 2, and 3
Depth 5.9 to 9.3 m
Elevation 152.6 to 149.2 m
Wet Sample

Run 1 Start
elev. 152.6 m

Run 1 End
elev. 152.2 m

Run 2 Start
elev. 152.2 m



Run 2 End
elev. 150.7 m

Run 3 Start
elev. 150.7 m



Run 3 End
elev. 149.2 m



Appendix C.2

Analytical Testing Results

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

	Client ID:	SC18-3 SS3A 5'-6'3"	SC23-2 SS5 10'-12'	DOC23-1 SS7, 15'-17'	OBR23-1 SS16 48'-50'		
	Sample Date:	11-Mar-24 09:00	13-Mar-24 09:00	11-Mar-24 09:00	27-Mar-24 09:00	-	-
	Sample ID:	2415421-01	2415421-02	2415421-03	2415421-04		
	Matrix:	Soil	Soil	Soil	Soil		
	MDL/Units						
Physical Characteristics							
% Solids	0.1 % by Wt.	87.8	62.4	62.0	87.9	-	-
General Inorganics							
Conductivity	5 uS/cm	108 [1]	1950 [2]	1660 [1]	100	-	-
pH	0.05 pH Units	7.32 [1]	6.91 [2]	7.12 [1]	7.37	-	-
Resistivity	0.1 Ohm.m	92.9 [1]	5.1 [2]	6.0 [1]	100	-	-
Anions							
Chloride	10 ug/g	10 [1]	175 [1]	682 [1]	<10	-	-
Sulphate	10 ug/g	<10 [1]	2080 [1]	29 [1]	<10	-	-

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

Qualifier Notes:**Login Qualifiers :**

Sample - One or more parameter received past hold time - Conductivity, chloride, pH, resistivity, and sulphate.

Applies to Samples: SC18-3 SS3A 5'-6'3", DOC23-1 SS7, 15'-17'

Sample Qualifiers :

- 1: Holding time had been exceeded upon receipt of the sample at the laboratory or prior to the analysis being requested.
- 2: This analysis was conducted after the accepted holding time had been exceeded.

Sample Data Revisions:

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

Soil results are reported on a dry weight basis unless otherwise noted.

Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

Any use of these results implies your agreement that our total liability in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

Paracel Laboratories

Attn : Dale Robertson

300-2319 St.Laurent Blvd.
Ottawa, ON
K1G 4K6, Canada

Phone: 613-731-9577
Fax: 613-731-9064

19-April-2024

Date Rec. : 16 April 2024
LR Report: CA12714-APR24
Reference: Project#: 2415421

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	Sulphide (Na ₂ CO ₃) %
1: Analysis Start Date		19-Apr-24
2: Analysis Start Time		13:06
3: Analysis Completed Date		19-Apr-24
4: Analysis Completed Time		13:12
5: RL		0.01
6: SC18-3 SC3A 5' 6"	11-Mar-24	< 0.01
7: SC23-2 SS5 10'-12'	13-Mar-24	0.83
8: DCC23-1 SC7, 15' 17"	11-Mar-24	0.01
9: OBR23-1 SS16 48'-50'	27-Mar-24	< 0.01
10: DON24-2 SC4 10' 12"	09-Apr-24	< 0.01
11: NCC20-2 SC2A 2'6" 3'3"	02-Apr-24	< 0.01
12: SC10-1 SS2B 3'-4"	21-Mar-24	< 0.01
13: SC10-4 SC2 2'6" 4'6"	04-Apr-24	< 0.01

RL - SGS Reporting Limit

Note: Samples taken March 11 and 13th were past the 28 day holding time for Sulphide analysis when received; result may be unreliable. Processed past holding time as per client's instructions.

Kimberley Didsbury
Project Specialist,
Environment, Health & Safety



Appendix D.

Site Photographs



Photo 1. Looking west along frozen ponded water and culvert inlet (March 5, 2024)



Photo 2. Looking east along north embankment and culvert outlet (May 01, 2024)



Photo 3. Looking west along ponded water near culvert inlet (July 26, 2024)



Photo 4. Looking east along Highway 17 eastbound (June 26, 2024)