



THURBER ENGINEERING LTD.

**PRELIMINARY
FOUNDATION INVESTIGATION REPORT
HIGHWAY 17 TWINNING, RENFREW AREA
LITTLE HALLIDAY CREEK TRIBUTARY CULVERTS
STA.17+570 EBL AND WBL, HORTON TOWNSHIP
SITE NO. 29X-0404/C0
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009**

Geocres No.: 31F-227

Report to:

Ministry of Transportation Ontario

Latitude: 45.505544°
Longitude: -76.675363°

July 2022
Thurber File No.: 24726



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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 in the Renfrew area.

This report addresses the unnamed Little Halliday Creek tributary crossing of Highway 17, located near Station 17+570 in Horton Township just west of Renfrew, Ontario. The existing Highway 17 alignment at this site will become the future Highway 17 westbound lanes and new eastbound lanes will be constructed to the southwest of the existing alignment. Rehabilitation or replacement of the culvert currently present under the existing Highway 17 lanes is proposed, while a new culvert will be required under the proposed eastbound lanes.

This section of the report presents the factual findings obtained from foundation investigations completed for the new and existing culvert structures at Station 17+570. Thurber carried out the investigation under Ministry of Transportation of Ontario (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 site is located on Highway 17 approximately one kilometre northwest of the existing intersection with Bruce Street. At the site, Highway 17 runs roughly north-south and the tributary



creek, east-west. However, the travelled lanes of Highway 17 will be described herein as eastbound and westbound to maintain continuity with convention of the overall highway.

The land adjacent to the site is generally flat-lying and consists of agricultural fields. Residential homes are located along Garden of Eden Road which runs roughly parallel to the existing highway, approximately 250 m west of the site. The terrain is relatively flat with a slight downward slope towards the tributary creek. Occasional trees and shrubs are present along the existing highway right-of-way and the tributary creek.

The existing Highway 17 in the vicinity of the site is an undivided highway with two travelled lanes and a westbound passing lane, gravel shoulders, and a posted speed limit of 90 km/hr. The AADT for this existing section of Highway 17 near the site had a reported AADT of 12,300 in 2016.

The existing culvert present beneath Highway 17 is a 1.8 m diameter, 33.7 m long corrugated steel pipe (CSP) culvert and has about 2.6 m of cover. The culvert facilitates the flow of the tributary creek under the highway embankment from east to west where it meets Little Halliday Creek. The existing culvert has an invert elevation of approximately 146.3 m. It is noted that the tributary runs in a small, incised valley which was noted to be approximately 1.0 m wide. The depth of water in the creek was approximately 0.2 m on April 27, 2021.

The embankment sides are sloped at approximately 2.5H:1V and did not show any visible signs of distress at the time of the investigation.

Photographs showing the existing conditions in the area of the site at the time of the field investigation are included in Appendix D for reference.

2.2 Site Geology

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 Clay Plains. The Ottawa Valley Clay Plains are characterized primarily by clay plains deposited by the Champlain Sea (Leda Clay) interrupted by ridges of rock or sand.

Ontario Geological Survey Map 2460 for Precambrian Geology for the Cobden Area suggests the bedrock comprises calcitic carbonate metasedimentary bedrock including calcitic and siliceous marble.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation was carried out between April 27, 2021 and May 14, 2021, as part of an overall field-testing program to address several project structures. The field investigation consisted of advancing four boreholes identified as Boreholes CV-1, CV-2, CV-3, and CV-28. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.



The locations and elevations of the boreholes were surveyed by Thurber with a Trimble Catalyst DA1 antenna with centimeter accuracy. The northing, easting and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A, the individual Record of Borehole sheets in Appendix B, and in Table 3-1 below. The site is located within MTM Zone 9.

Table 3-1: Borehole Summary

Borehole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
CV-1	Proposed Eastbound Lanes Culvert Outlet	5 040 609.4 (45.505270)	291 050.3 (-76.675956)	146.8	11.9
CV-2	Proposed Eastbound Lanes Embankment	5 040 622.6 (45.505389)	291 062.8 (-76.675796)	146.8	11.9
CV-3	Proposed Westbound Lanes Culvert Outlet / Proposed Eastbound Lanes Culvert Inlet	5 040 631.1 (45.505466)	291 074.8 (-76.675642)	146.9	11.9
CV-28	Proposed Westbound Lanes Culvert Inlet (Existing Hwy 17)	5 040 650.8 (45.505644)	291 113.9 (-76.675142)	147.0	5.8

A track-mounted CME 45 drill rig equipped with hollow stem augers was used to put down the boreholes at the site.

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). In situ vane shear testing was completed in cohesive soils with an MTO 'N' sized vane.

Monitoring wells, 50 mm in diameter, were installed in Boreholes CV-1 and CV-28. The installation details are illustrated on the respective Record of Borehole sheets provided in Appendix B. The boreholes were backfilled in accordance with MOE requirements (O.Reg 903, as amended). The monitoring wells will be decommissioned by Thurber, as outlined in the Hydrogeological Investigation and Design Report.

In addition, four pavement boreholes were advanced through the existing highway embankment nearby at Station 17+600 to depths ranging from 1.5 m to 2.1 m. The boreholes were drilled with a solid stem auger and representative samples acquired from the augers. In situ vane shear tests were carried out in cohesive deposits.



The drilling and sampling operations were supervised on a full-time basis by a member of Thurber's geotechnical staff. The drilling supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's Ottawa geotechnical 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 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 ASTM D2487. Cohesive soils are described per current MTO protocols.

In general, the site stratigraphy consists of embankment fill over native deposits of silty clay to clayey silt, weathered to a crust in the upper several metres. Topsoil was encountered at the ground surface at all off-road borehole locations. All boreholes were terminated in the silty clay to clayey silt deposit.

5.1 Embankment Material

An asphalt layer ranging in thickness from 220 mm to 360 mm was encountered at ground surface in three of the four pavement boreholes drilled at 17+600. Granular fill was observed in all four boreholes and extended to depths ranging from 0.9 m to 1.5 m below ground surface. The granular fill ranged from silty gravel with sand to poorly graded sand.

The moisture content of the two samples tested was 5% and 6%. The results of grain size analyses conducted on two samples of the embankment fill are summarized below.

Summary of Grain Size Distribution Testing – Embankment Fill

Soil Particle	Percentage (%)
Gravel	5 to 44
Sand	43 to 91
Silt and Clay	4 to 13

5.2 Topsoil

A layer of topsoil was encountered at the ground surface in all boreholes. It is noted that the boreholes were put down adjacent to farmland and the extent of the topsoil may reflect the depth of the tilled layer. The topsoil was observed to range in thickness from 300 mm, in the boreholes put down west of the existing Highway 17 alignment, to 610 mm, in Borehole CV-28 put down east of the existing Highway 17 alignment. One complete sample of topsoil obtained in Borehole CV-28 had a natural moisture content of 52%.

5.3 Weathered Silty Clay (CI) Crust

A deposit of silty clay weathered to a grey-brown crust was identified below the topsoil in Boreholes CV-1, CV-2, and CV-3 and three of the pavement boreholes. The thickness of this layer ranged from 1.2 m to 2.0 m with base depths ranging from 1.5 m to 2.3 m (base elevations ranging from 144.5 m to 145.4 m).

SPT N-values ranged from 2 to 3 blows per 0.3 m of penetration, indicating a stiff consistency.

The moisture content of the samples tested ranges from 32% to 59%. The results of grain size analyses conducted on three samples of the weathered silty clay crust are summarized below and two from the foundations boreholes are illustrated on Figure C1 in Appendix C.

Summary of Grain Size Distribution Testing – Weathered Silty Clay Crust

Soil Particle	Percentage (%)
Gravel	0
Sand	0 – 9
Silt	24 – 48
Clay	44 – 67

The results of Atterberg Limits testing carried out on three samples of this material are summarized below and two from the foundations boreholes are illustrated on Figure C4 in Appendix C. The laboratory results indicate that the material is a silty clay of intermediate plasticity (CI).



Summary of Atterberg Limit Testing – Weathered Silty Clay Crust

Parameter	Value
Liquid Limit	43 – 50
Plastic Limit	18 – 21
Plasticity Index	25 – 29

5.4 Silty Clay (CI) to Clayey Silt (CL)

Unweathered silty clay to clayey silt was encountered below the weathered crust in Boreholes CV-1, CV-2, and CV-3, and below the topsoil in Borehole CV-28. All boreholes were terminated in this deposit at base depths ranging from 5.8 m to 11.9 m (base elevations ranging from 134.9 m to 141.2 m). Sand partings were noted throughout this layer in Boreholes CV-1, CV-2, and CV-3.

SPTs conducted in this unit gave N-values ranging from weight of hammer to 3 blows per 0.3 m of penetration. In-situ shear vane tests indicated undrained shear strengths decreasing with increasing depth, ranging from greater than 100 to 41 kPa indicating a very stiff to firm consistency. Sensitivity values ranged from 4 to 18 but were generally between about 5 and 10.

The moisture content of the samples tested ranged from 26 to 52%. The results of nine grain size analysis tests conducted on samples of this material are summarized below and are illustrated on Figures C2 and C3 in Appendix C.

Summary of Grain Size Distribution Testing – Silty Clay to Clayey Silt

Soil Particle	Percentage (%)
Gravel	0
Sand	0 – 3
Silt	44 – 60
Clay	40 – 56

The results of Atterberg Limits testing carried out on five samples of this material are summarized below and are illustrated on Figure C5 in Appendix C. The laboratory results generally indicate that the material is a silty clay of intermediate plasticity (CI), with one test indicating a clayey silt of low plasticity (CL).

Summary of Atterberg Limit Testing – Silty Clay to Clayey Silt

Parameter	Value
Liquid Limit	25 – 47
Plastic Limit	17 – 22
Plasticity Index	8 – 28



5.5 Groundwater

Monitoring wells with diameters of 50 mm were installed in Boreholes CV-1 and CV-28. Groundwater levels recorded in the wells are presented in Table 5-1 below:

Table 5-1: Summary of Groundwater Levels

Borehole No.	Bottom of Screen Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Date of Measurement
CV-1	142.2	0.3	146.5	August 4, 2021
		0.3	146.5	September 22, 2021
		0.4	146.4	October 5, 2021
		0.4	146.4	October 22, 2021
		0.6	146.2	January 19, 2022
CV-28	142.4	0.1	146.9	August 4, 2021
		0.1	146.9	September 22, 2021
		0	147.0	October 5, 2021
		0.3	146.7	January 19, 2022

The creek water elevation was noted to be approximately 146.4 m on April 27, 2021.

These observations are considered short term and it should be noted that the groundwater level at the time of construction may be different and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation.

5.6 Analytical Testing

One sample of the native silty clay 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 5-2. Copies of the test results are provided in Appendix C.

Table 5-2: Results of Chemical Analysis

Borehole	Sample	Depth (m)	Chloride ($\mu\text{g/g}$)	Sulphate ($\mu\text{g/g}$)	Sulphide (%)	pH (-)	Resistivity (Ohm-cm)
CV-2	SS2	0.8 – 1.4	192	30	< 0.04	7.66	2,140



6 MISCELLANEOUS

Borehole locations were selected by Thurber relative to existing site features. The as-drilled locations and ground surface elevation of the boreholes were surveyed by Thurber following completion of the field program. The elevation survey was carried out with reference to geodetic elevation benchmarks provided by the MTO.

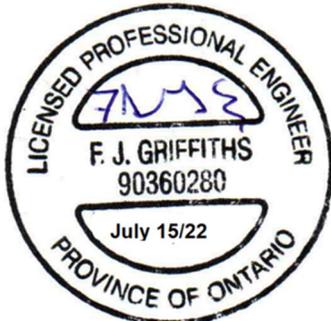
Marathon Underground of Greely, Ontario supplied and operated the drilling equipment and carried out the drilling, soil sampling, in-situ testing, monitoring well installation and borehole decommissioning. The field investigation was supervised on a full-time basis by Anderson de Oliveira of Thurber. Overall supervision of the investigation program was provided by Justin Gray, P.Eng.

Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa.

Overall project management and direction of the field program was provided by Fred Griffiths, P.Eng. Interpretation of the factual data and preparation of this report were carried out by Matt Kennedy, P.Eng. and Fred Griffiths, P.Eng. The report was reviewed by P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



Matt Kennedy, M.Sc. (Eng.), P.Eng.
Senior Geotechnical Engineer



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

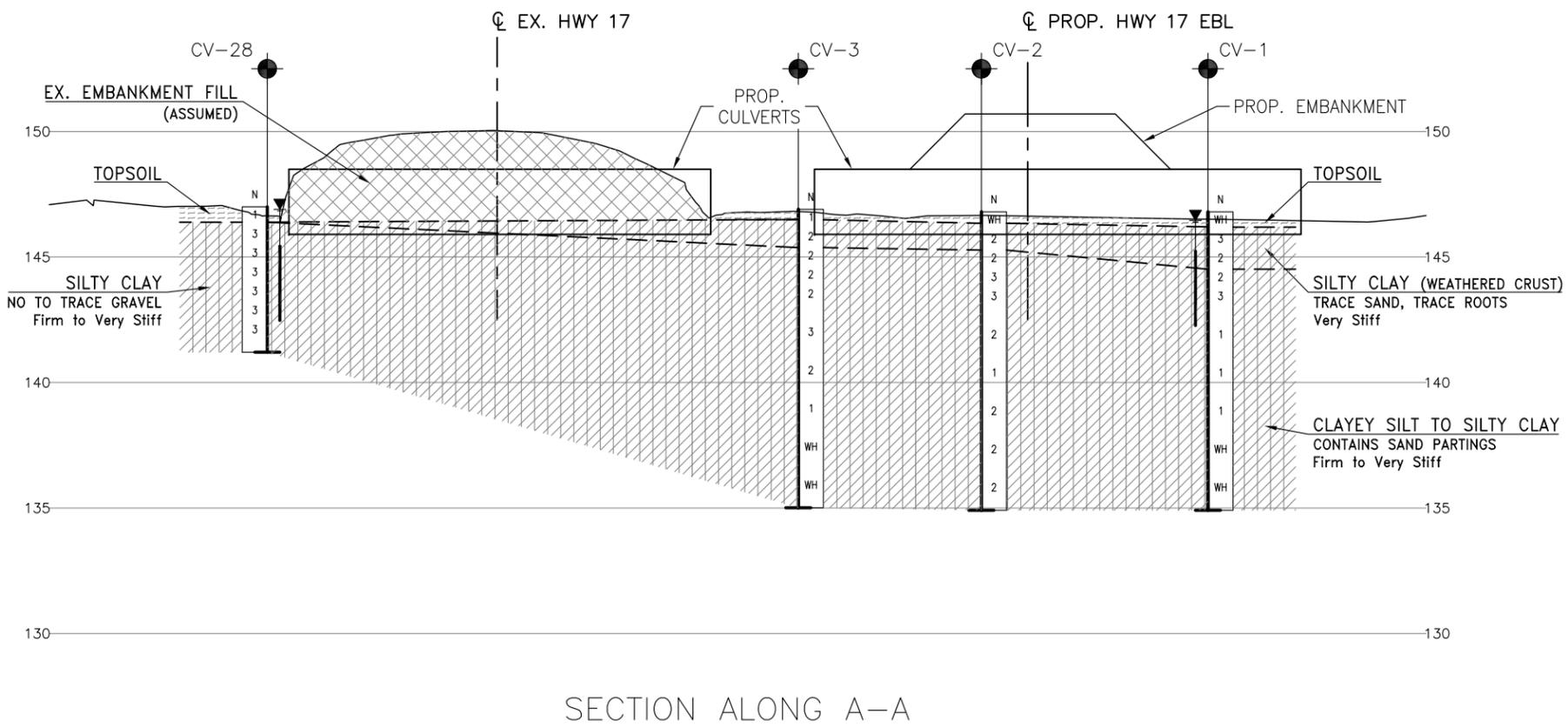
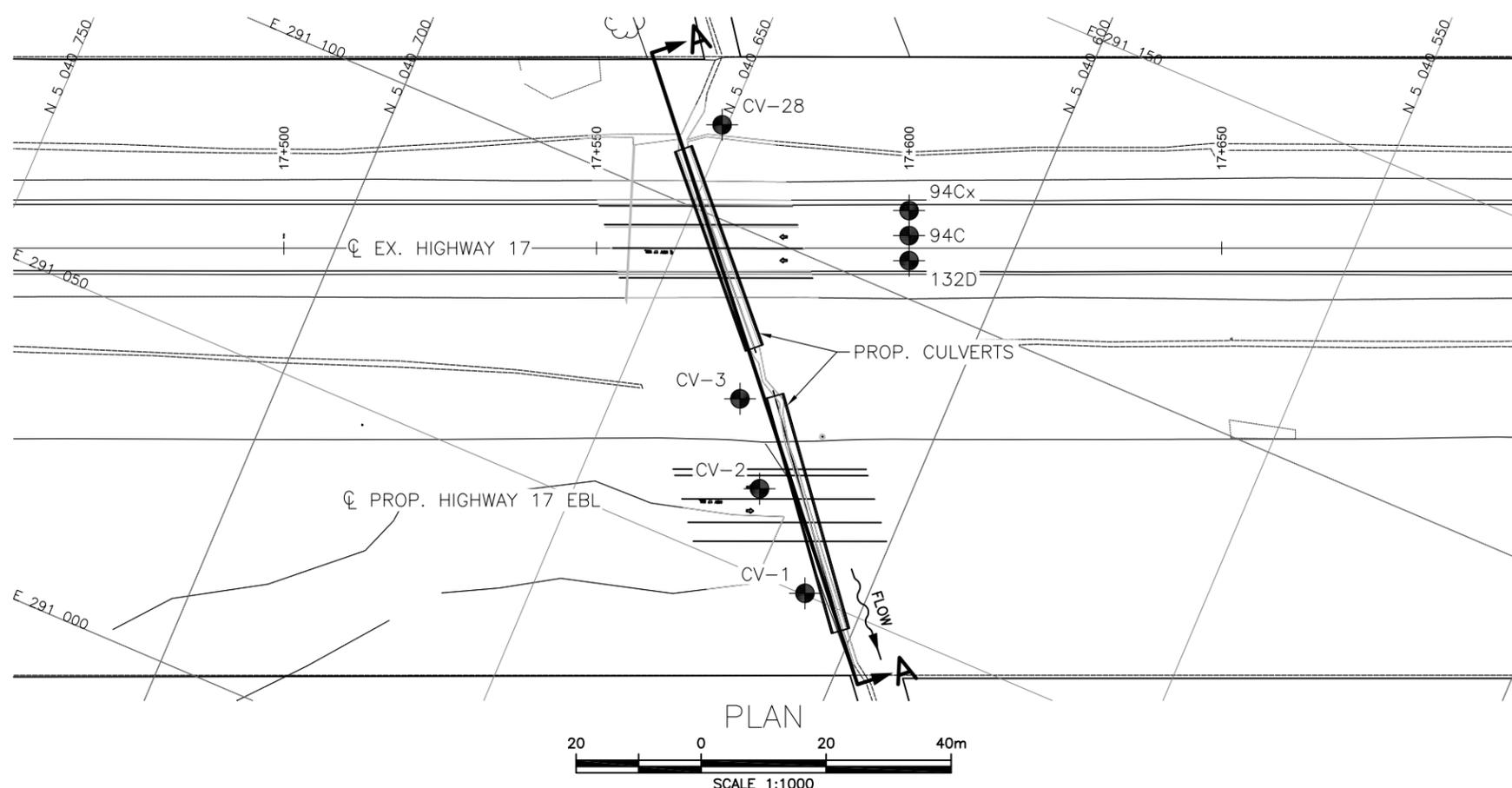


Dr. P.K. Chatterji, P.Eng.
MTO Review Principal,
Senior Geotechnical Engineer



Appendix A.

Borehole Location Plan and Stratigraphic Drawings



SECTION ALONG A-A
 H 1:500
 V 1:250

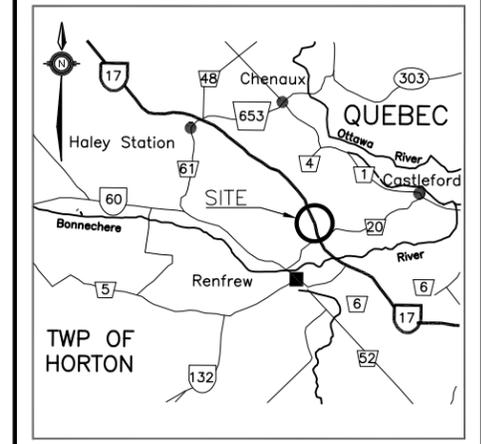
METRIC
 DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES
 UNLESS OTHERWISE SHOWN



CONT No
 WP No
 HIGHWAY 17 TWINNING
 CULVERT STA. 17+570
 BOREHOLE LOCATIONS AND SOIL STRATA



SHEET



KEYPLAN
 LEGEND

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

NO	ELEVATION	NORTHING	EASTING
CV-1	146.8	5 040 609.4	291 050.3
CV-2	146.8	5 040 622.6	291 062.8
CV-28	147.0	5 040 650.8	291 113.9
CV-3	146.9	5 040 631.1	291 074.8
132D	149.7	5 040 614.8	291 105.6
94C	149.7	5 040 616.4	291 109.3
94Cx	149.7	5 040 617.9	291 113.0

-NOTES-

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

GEOCREs No. 31F-227

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	MJK	CHK	PKC	CODE	LOAD	DATE	JUL 2022
DRAWN	MFA	CHK	MJK	SITE	STRUCT	DWG	1



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).

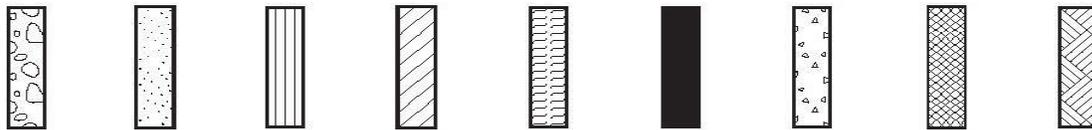
DYNAMIC CONE PENETRATION TEST (DCPT):

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 or 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 CV-1

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.50527°, Long: -76.675956°
 Culvert 17+570 MTM Zone 9: N 5 040 609.4 E 291 050.3 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.05.13 - 2021.05.14 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
146.8	Ground Surface														
0.0	TOP SOIL (300 mm)														
146.5			1	SS	WH										
0.3	SILTY CLAY Trace roots Grey-brown with yellow mottles Very stiff Homogeneous structure [WEATHERED CRUST]		2	SS	3										0 0 48 52
			3	SS	2										
144.5			4	SS	2										
2.3	CLAYEY SILT to SILTY CLAY Contains sand partings Grey-brown to grey Firm to very stiff Homogeneous structure		5	SS	3										0 3 55 42
			6	SS	1										
			7	SS	1										
			8	SS	1										0 0 48 52
			9	SS	WH										

DOUBLE LINE 24726 CULVERT 17+570 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Continued Next Page

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

RECORD OF BOREHOLE No CV-1

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.50527°, Long: -76.675956°
Culvert 17+570 MTM Zone 9: N 5 040 609.4 E 291 050.3 ORIGINATED BY AO
HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
DATUM Geodetic DATE 2021.05.13 - 2021.05.14 CHECKED BY FG

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 (%) GR SA SI CL																	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)																
134.9	<p>Continued From Previous Page</p> <p>CLAYEY SILT to SILTY CLAY Contains sand partings Grey-brown to grey Firm to very stiff Homogeneous structure</p>		10	SS	WH		136																										
135							135																										
11.9	<p>End of Borehole</p> <p>Monitoring well installation consists of 50-mm diameter Schedule 40 PVC pipe with a 3-m slotted screen</p> <table border="1"> <tr> <th>DATE</th> <th>DEPTH (m)</th> <th>ELEV. (m)</th> </tr> <tr> <td>2021.08.04</td> <td>0.3</td> <td>146.5</td> </tr> <tr> <td>2021.09.22</td> <td>0.3</td> <td>146.5</td> </tr> <tr> <td>2021.10.05</td> <td>0.4</td> <td>146.4</td> </tr> <tr> <td>2021.10.22</td> <td>0.4</td> <td>146.4</td> </tr> <tr> <td>2022.01.19</td> <td>0.6</td> <td>146.4</td> </tr> </table>	DATE	DEPTH (m)	ELEV. (m)	2021.08.04	0.3	146.5	2021.09.22	0.3	146.5	2021.10.05	0.4	146.4	2021.10.22	0.4	146.4	2022.01.19	0.6	146.4														
DATE	DEPTH (m)	ELEV. (m)																															
2021.08.04	0.3	146.5																															
2021.09.22	0.3	146.5																															
2021.10.05	0.4	146.4																															
2021.10.22	0.4	146.4																															
2022.01.19	0.6	146.4																															

DOUBLE LINE 24726 CULVERT 17+570 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

RECORD OF BOREHOLE No CV-2

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.505389°, Long: -76.675796°
Culvert 17+570 MTM Zone 9: N 5 040 622.6 E 291 062.8 ORIGINATED BY AO
HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
DATUM Geodetic DATE 2021.05.13 - 2021.05.13 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
146.8	Ground Surface														
0.0	TOP SOIL (300 mm)														
146.5			1	SS	WH							o			
0.3	SILTY CLAY Trace sand Trace roots Grey-brown with yellow mottles Very stiff Homogeneous structure [WEATHERED CRUST]		2	SS	2							o			
145.3			3	SS	2							o			0 0 52 48
1.5	SILTY CLAY Contains sand partings Grey-brown to grey Firm to very stiff Homogeneous structure		4	SS	3							o			
			5	SS	3							o			
			6	SS	2							o			0 0 51 49
			7	SS	1							o			
			8	SS	2							o			
			9	SS	2							o			0 1 58 41

DOUBLE LINE 24726 CULVERT 17+570 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Continued Next Page

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

RECORD OF BOREHOLE No CV-2

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.505389°, Long: -76.675796°
Culvert 17+570 MTM Zone 9: N 5 040 622.6 E 291 062.8 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.05.13 - 2021.05.13 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
134.9	Continued From Previous Page SILTY CLAY Contains sand partings Grey-brown to grey Firm to very stiff Homogeneous structure		10	SS	2		136								
135							135								
11.9	End of Borehole														

DOUBLE LINE 24726 CULVERT 17+570 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

RECORD OF BOREHOLE No CV-3

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.505466°, Long: -76.675642° Culvert 17+570 MTM Zone 9: N 5 040 631.1 E 291 074.8 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.05.12 - 2021.05.13 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
146.9	Ground Surface														
0.0	TOP SOIL (300 mm)														
146.6			1	SS	1										
0.3	SILTY CLAY Trace sand Trace roots Grey with yellow mottles Very stiff Homogeneous structure [WEATHERED CRUST]		2	SS	2										0 9 47 44
145.4			3	SS	2										
1.5	CLAYEY SILT to SILTY CLAY Contains sand partings Grey Firm to very stiff Homogeneous structure		4	SS	2										0 0 50 50
			5	SS	2										
			6	SS	3										
			7	SS	2										0 0 60 40
			8	SS	1										
			9	SS	WH										

DOUBLE LINE 24726 CULVERT 17+570 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Continued Next Page

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

RECORD OF BOREHOLE No CV-3

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.505466°, Long: -76.675642°
Culvert 17+570 MTM Zone 9: N 5 040 631.1 E 291 074.8 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.05.12 - 2021.05.13 CHECKED BY FG

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				W P W W L 20 40 60						
Continued From Previous Page																
135.0	CLAYEY SILT to SILTY CLAY Contains sand partings Grey Firm to very stiff Homogeneous structure		10	SS	WH		136									
11.9	End of Borehole															

DOUBLE LINE 24726 CULVERT 17+570 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

RECORD OF BOREHOLE No CV-28

1 OF 1

METRIC

WP# 4068-09-00 LOCATION Lat: 45.505644°, Long: -76.675142° Culvert 17+570 MTM Zone 9: N 5 040 650.8 E 291 113.9 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.04.27 - 2021.04.27 CHECKED BY FG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
						20	40	60	80	100	20	40	60	GR	SA	SI	CL	
147.0	Ground Surface																	
0.0	TOP SOIL (610 mm)	1	SS	1														
146.4	SILTY CLAY No to trace gravel Grey Firm to very stiff Homogeneous structure	2	SS	3										0	0	49	51	
0.6		3	SS	3														
		4	SS	3														
		5	SS	3														
		6	SS	3											0	0	44	56
		7	SS	3														
141.2		End of Borehole																
5.8	Monitoring well installation consists of 50-mm diameter Schedule 40 PVC pipe with a 3-m slotted screen DATE DEPTH (m) ELEV. (m) 2021.08.04 0.1 146.9 2021.09.22 0.1 146.9 2021.10.05 0.0 147.0 2022.01.19 0.3 146.7																	

DOUBLE LINE 24726 CULVERT 17+570 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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



TWINNING OF HIGHWAY 17 - PART 1B FROM 1 KM WEST OF MILLER / ANDERSON RD TO 3KM WEST OF BRUCE ST COUNTY OF RENFREW

<p>94Cx Station 17+600 6m LT CL D 0</p> <p>0- 220 Asph</p> <p>220- 1 Br Sa and Gr Tr Si Moist</p> <p>1- 1.8 Br Si(y) Cl Tr Sa Moist *</p> <p style="padding-left: 150px;">w @ 1.4m = 32%</p> <p style="padding-left: 100px;">Percent Passing 4.75 mm = 100%</p> <p style="padding-left: 150px;">75 µm = 91%</p> <p style="padding-left: 150px;">5 µm = 67%</p> <p style="padding-left: 100px;">Frost Susceptibility = LSFH</p> <p style="padding-left: 150px;">W_L = 50%</p> <p style="padding-left: 150px;">W_P = 21%</p> <p style="padding-left: 150px;">P_I = 28%</p> <p style="padding-left: 100px;">MTC Soil Classification = CI</p> <p>Existing WB Lane 2. Partially Paved OSH Asphalt Thickness = 75mm. Firm @ 2.1 m PH</p>	<p>92Cx Station 18+000 2m LT CL D 0</p> <p>0- 275 Asph</p> <p>275- 750 Br Sa and Gr Tr Si Moist</p> <p>750- 1.5 Br Sa W Gr Tr Si Moist</p> <p style="padding-left: 100px;">Existing WB Lane 1 PH</p> <p>92C Station 18+000 1.5m LT CL D 0</p> <p>0- 225 Asph</p> <p>225- 650 Br Sa and Gr Tr Si Moist</p> <p>650- 1.5 Br Sa W Gr Tr Si Occ Cob Moist</p> <p style="padding-left: 100px;">Existing WB Lane 2. Partially Paved OSH Asphalt Thickness = 55mm PH</p> <p>134D Station 18+000 2m RT CL D 0</p> <p>0- 350 Asph</p> <p>350- 600 Br Sa and Gr Tr Si Moist</p> <p>600- 1.5 Br Sa Tr Si Moist</p> <p style="padding-left: 100px;">Existing EB Lane. Partially Paved OSH Asphalt Thickness = 90mm PH</p> <p>136D Station 18+300 2m RT CL D 0</p> <p>0- 340 Asph</p> <p>340- 600 Br Sa and Gr Tr Si Moist</p> <p>600- 1.5 Br Sa Tr Si Moist</p> <p style="padding-left: 100px;">Existing EB Lane. Partially Paved OSH Asphalt Thickness = 80mm PH</p> <p>99B Station 18+400 11m LT CL D-0.2</p> <p>0- 400 Br Sa and Gr Tr Si Moist</p> <p>400- 1.6 Br Sa Some Gr Tr Si Occ Cob Moist</p> <p>1.6- Gry Sa(y) Si Moist</p> <p style="padding-left: 100px;">Existing WB OSH. Firm @ 1.7 m PH</p>
<p>94C Station 17+600 2m LT CL D 0</p> <p>0- 360 Asph</p> <p>360- 1 Br Sa and Gr Tr Si Moist</p> <p>1- 1.3 Br Sa W Gr Tr Si Moist</p> <p>1.3- 1.8 Br Si(y) Cl Moist</p> <p style="padding-left: 100px;">Existing WB Lane. Firm @ 2.0 m PH</p>	<p>99Cx Station 18+400 2m LT CL D 0</p> <p>0- 330 Asph</p> <p>330- 850 Br Sa and Gr Tr Si Moist *</p> <p>850- 1.5 Br Sa W Gr Tr Si Moist *</p> <p style="padding-left: 100px;">Existing WB Lane PH</p>
<p>132D Station 17+600 2m RT CL D 0</p> <p>0- 350 Asph</p> <p>350- 700 Br Sa and Gr Some Si Moist *</p> <p style="padding-left: 150px;">w @ 0.5m = 6%</p> <p style="padding-left: 100px;">Percent Passing 4.75 mm = 56%</p> <p style="padding-left: 150px;">75 µm = 13%</p> <p>700- 1.5 Br Sa Tr Si Tr Gr Moist *</p> <p style="padding-left: 150px;">w @ 1.1m = 5%</p> <p style="padding-left: 100px;">Percent Passing 4.75 mm = 95%</p> <p style="padding-left: 150px;">75 µm = 4%</p> <p style="padding-left: 100px;">Existing EB Lane PH</p>	<p>90C Station 18+400 1.5m LT CL D 0</p> <p>0- 300 Asph</p> <p>300- 500 Br Sa and Gr Tr Si Moist</p> <p>500- 1.5 Br Sa W Gr Tr Si Occ Cob Moist</p> <p style="padding-left: 100px;">Existing WB Lane 2 PH</p>
<p>93Cx Station 17+800 2m LT CL D 0</p> <p>0- 320 Asph</p> <p>320- 770 Br Sa and Gr Tr Si Moist</p> <p>770- 2 Br Si(y) Cl Moist</p> <p style="padding-left: 100px;">Existing WB Lane PH</p>	
<p>92B Station 18+000 8m LT CL D-0.2</p> <p>0- 350 Br Sa and Gr Tr Si Moist</p> <p>350- 1.5 Br Sa W Gr Tr Si Occ Cob Moist</p> <p style="padding-left: 100px;">Existing WB OSH PH</p>	

Note: Boreholes offsets referenced from staked centreline.



Appendix C.
Laboratory Testing

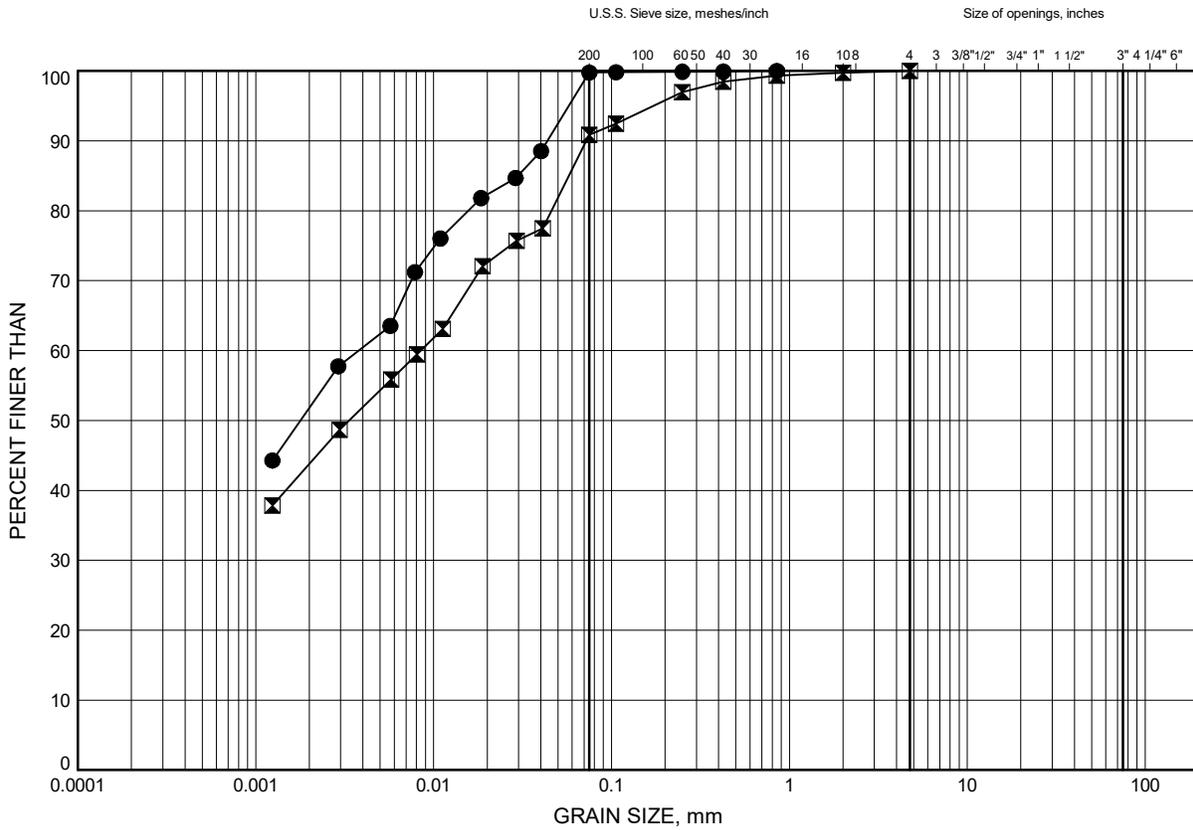


Appendix C.1
Particle Size Analysis Figures
Atterberg Limit Test Results

Highway 17 Twinning GRAIN SIZE DISTRIBUTION

FIGURE C1

Weathered Silty Clay (Cl) Crust



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CV-1	1.1	145.7
⊠	CV-3	1.1	145.8

Date August 2021
 WP# 4068-09-00

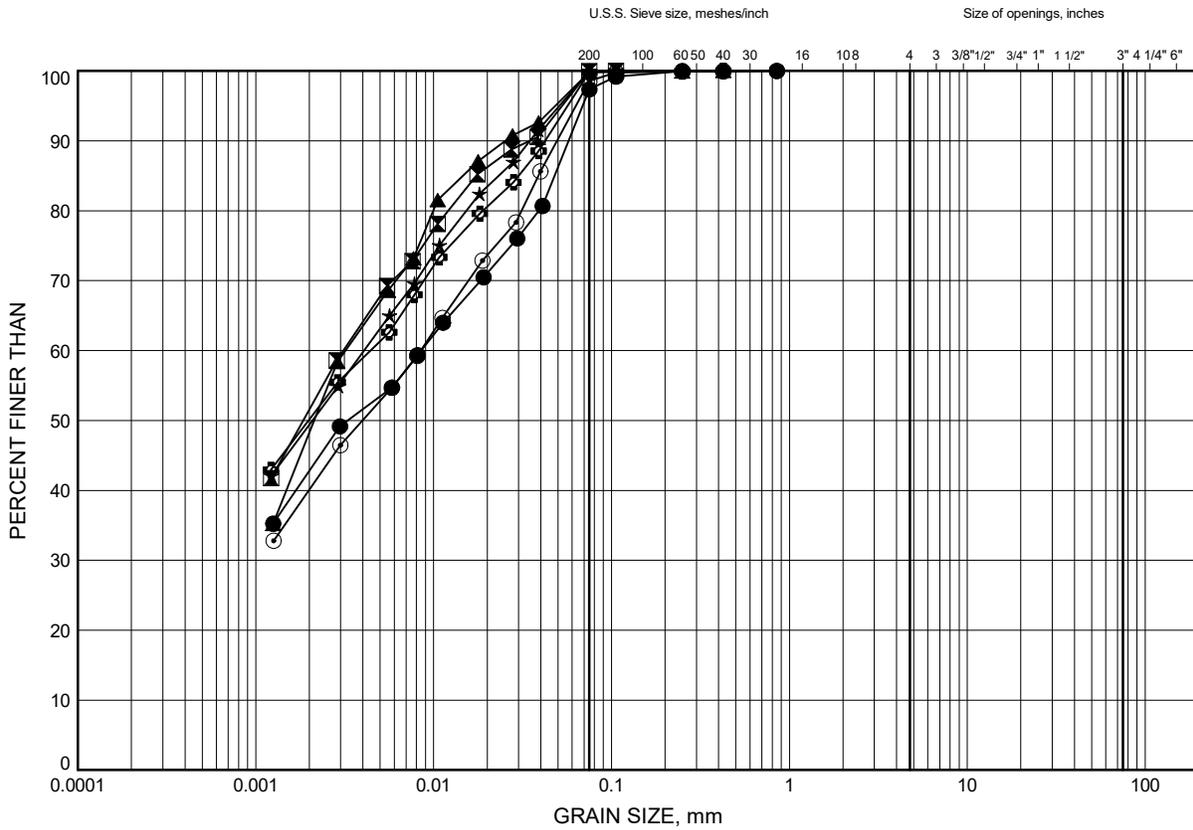


Prep'd MJK
 Chkd. FG

Highway 17 Twinning GRAIN SIZE DISTRIBUTION

FIGURE C2

Clayey Silt (CL) to Silty Clay (CI)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CV-1	3.4	143.4
⊠	CV-1	7.9	138.9
▲	CV-2	1.8	145.0
★	CV-2	4.9	141.9
⊙	CV-2	9.4	137.4
⊕	CV-3	2.6	144.3

Date August 2021
 WP# 4068-09-00

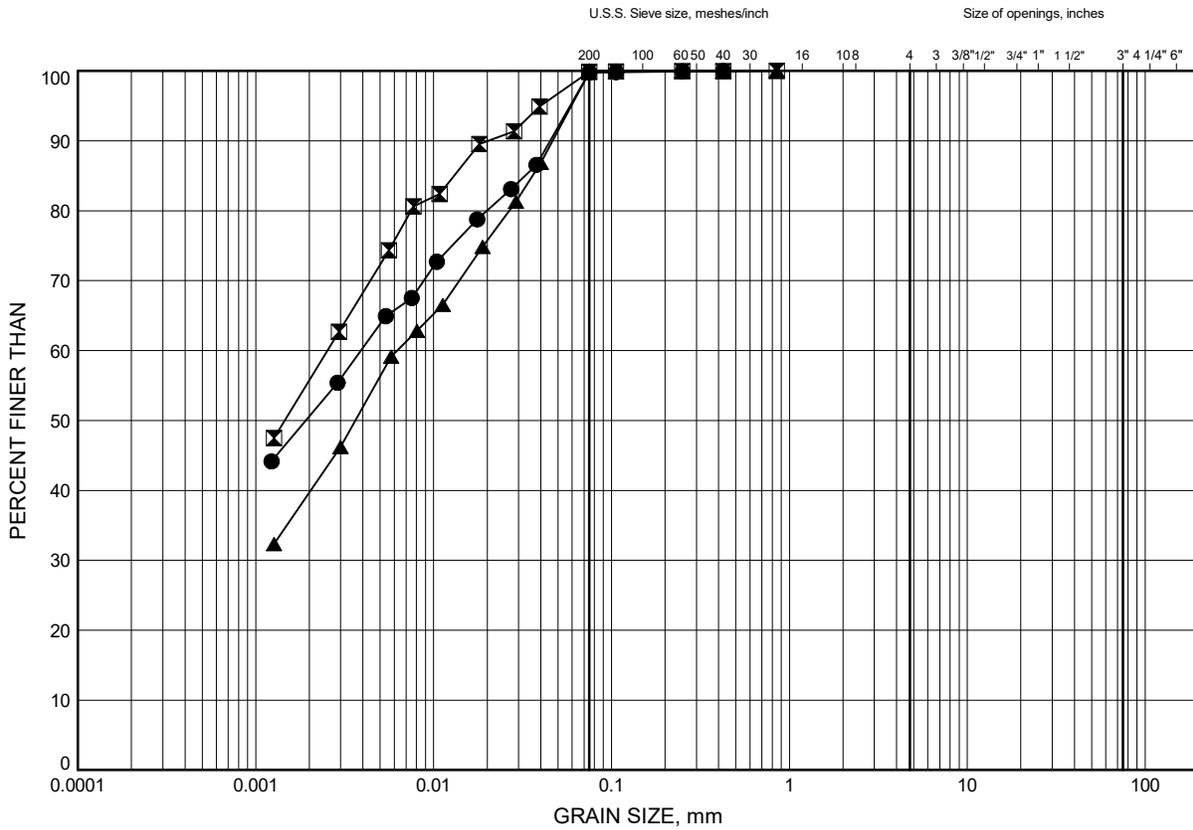


Prep'd MJK
 Chkd. FG

Highway 17 Twinning GRAIN SIZE DISTRIBUTION

FIGURE C3

Silty Clay (CI)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CV-28	1.1	145.9
⊠	CV-28	4.1	142.9
▲	CV-3	6.4	140.5

Date August 2021
 WP# 4068-09-00

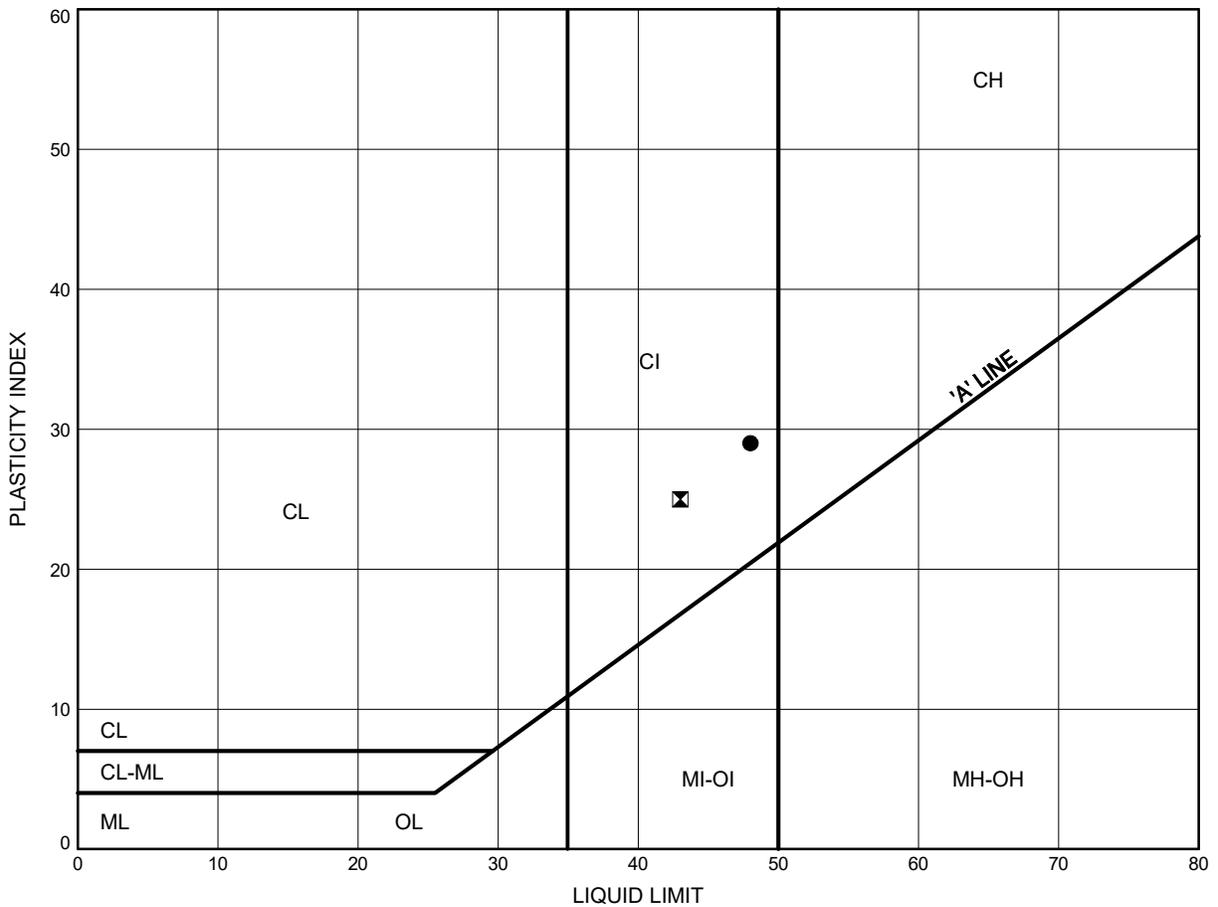


Prep'd MJK
 Chkd. FG

Highway 17 Twinning
ATTERBERG LIMITS TEST RESULTS

FIGURE C4

Weathered Silty Clay (CI) Crust



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CV-1	1.1	145.7
⊠	CV-3	1.1	145.8

THURBALT 24726 CULVERT 17+570 GINT.GPJ 30/8/21

Date .. August 2021 ..
 WP# .. 4068-09-00 ..

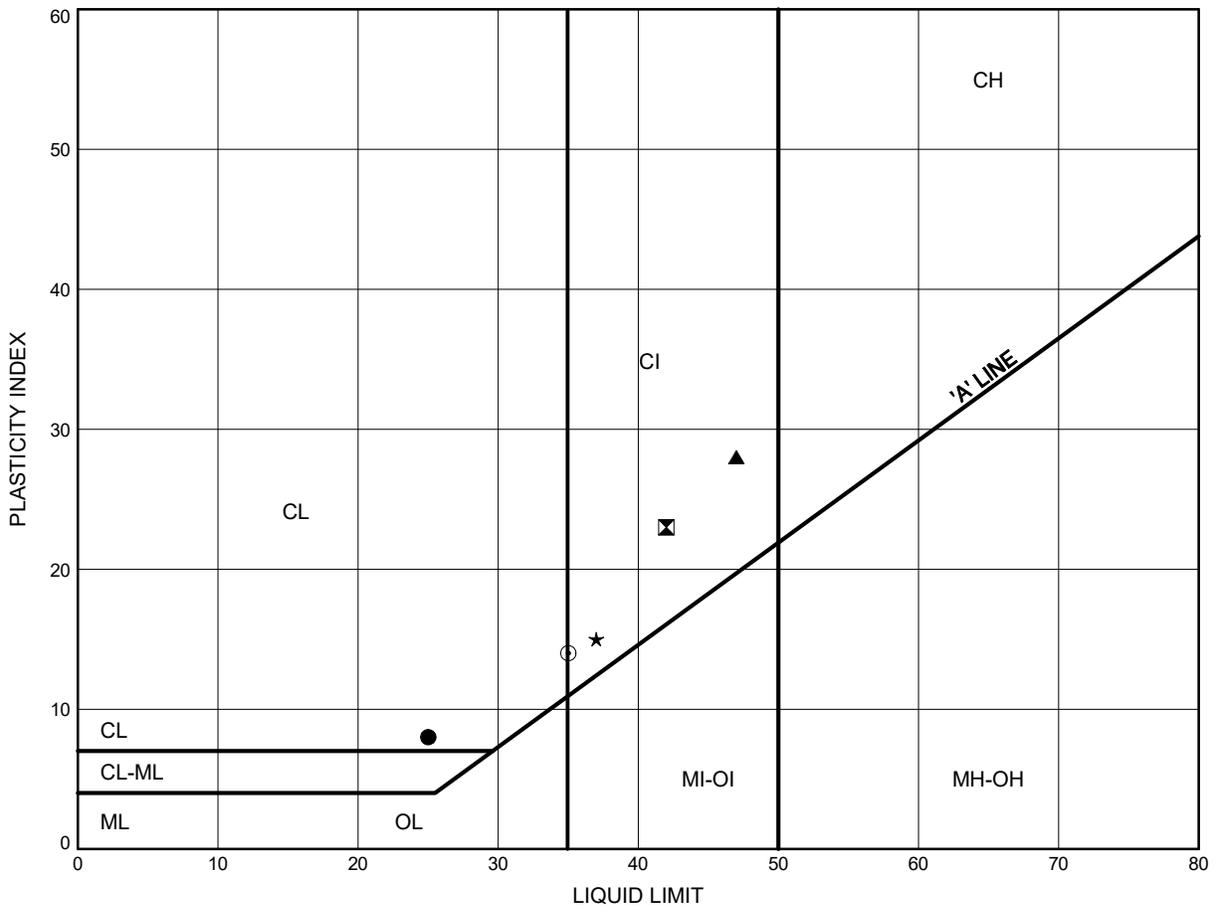


Prep'd .. MJK ..
 Chkd. .. FG ..

Highway 17 Twinning
ATTERBERG LIMITS TEST RESULTS

FIGURE C5

Clayey Silt (CL) to Silty Clay (CI)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CV-1	3.4	143.4
⊠	CV-2	1.8	145.0
▲	CV-28	1.1	145.9
★	CV-28	4.1	142.9
⊙	CV-3	2.6	144.3

Date August 2021
 WP# 4068-09-00



Prep'd MJK
 Chkd. FG



Appendix C.2
Analytical Testing Results

Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104
Ottawa, ON K1B 4S5
Attn: Justin Gray

Client PO: 24726
Project: Culverts 17+570 and 17+893
Custody: 48670

Report Date: 21-May-2021
Order Date: 17-May-2021

Order #: 2121164

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Parcel ID	Client ID
2121164-01	CV2 SS2 2'6"-4'6"
2121164-02	CV6 SS3 5'-7'

Approved By:



Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis

Report Date: 21-May-2021

Client: **Thurber Engineering Ltd.**

Order Date: 17-May-2021

Client PO: 24726

Project Description: **Culverts 17+570 and 17+893**

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	21-May-21	21-May-21
Conductivity	MOE E3138 - probe @25 °C, water ext	20-May-21	21-May-21
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	18-May-21	19-May-21
Resistivity	EPA 120.1 - probe, water extraction	20-May-21	21-May-21
Solids, %	Gravimetric, calculation	18-May-21	19-May-21

Certificate of Analysis

Report Date: 21-May-2021

Client: Thurber Engineering Ltd.

Order Date: 17-May-2021

Client PO: 24726

Project Description: Culverts 17+570 and 17+893

Client ID:	CV2 SS2 2'6"-4'6"	CV6 SS3 5'-7'	-	-
Sample Date:	13-May-21 09:00	14-May-21 14:00	-	-
Sample ID:	2121164-01	2121164-02	-	-
MDL/Units	Soil	Soil	-	-

Physical Characteristics

% Solids	0.1 % by Wt.	67.3	70.5	-	-
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General Inorganics

Conductivity	5 uS/cm	468	504	-	-
pH	0.05 pH Units	7.66	7.73	-	-
Resistivity	0.10 Ohm.m	21.4	19.8	-	-

Anions

Chloride	5 ug/g dry	192	168	-	-
Sulphate	5 ug/g dry	30	63	-	-

Certificate of Analysis

Report Date: 21-May-2021

Client: Thurber Engineering Ltd.

Order Date: 17-May-2021

Client PO: 24726

Project Description: Culverts 17+570 and 17+893

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	5	ug/g						
Sulphate	ND	5	ug/g						
General Inorganics									
Conductivity	ND	5	uS/cm						
Resistivity	ND	0.10	Ohm.m						

Certificate of Analysis

Report Date: 21-May-2021

Client: Thurber Engineering Ltd.

Order Date: 17-May-2021

Client PO: 24726

Project Description: Culverts 17+570 and 17+893

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	53.7	5	ug/g dry	51.6			4.1	20	
Sulphate	79.3	5	ug/g dry	77.9			1.8	20	
General Inorganics									
Conductivity	467	5	uS/cm	468			0.2	5	
pH	7.20	0.05	pH Units	7.23			0.4	2.3	
Resistivity	21.4	0.10	Ohm.m	21.4			0.2	20	
Physical Characteristics									
% Solids	93.4	0.1	% by Wt.	94.2			0.9	25	

Certificate of Analysis

Report Date: 21-May-2021

Client: Thurber Engineering Ltd.

Order Date: 17-May-2021

Client PO: 24726

Project Description: Culverts 17+570 and 17+893

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	142	5	ug/g	51.6	90.2	82-118			
Sulphate	165	5	ug/g	77.9	87.0	80-120			

Certificate of Analysis

Report Date: 21-May-2021

Client: Thurber Engineering Ltd.

Order Date: 17-May-2021

Client PO: 24726

Project Description: Culverts 17+570 and 17+893

Qualifier Notes:

None

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 when the units are denoted with 'dry'.

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

Subcontracted Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104
Ottawa, ON K1B 4S5

Attn: Justin Gray

Tel: (613) 408-6795

Fax: (613) 247-2185

Paracel Report No **2121164**
Client Project(s): **Culverts 17+570 and 17+893**
Client PO: **24726**
Reference: **Standing Offer**
CoC Number: **48670**

Order Date: 17-May-21

Report Date: 21-May-21

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor's report is attached

Paracel ID	Client ID	Analysis
2121164-01	CV2 SS2 2'6"-4'6"	Sulphide, solid
2121164-02	CV6 SS3 5'-7'	Sulphide, solid



SGS Canada Inc.

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

27-May-2021

Paracel Laboratories

Attn : Dale Robertson

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

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

Date Rec. : 19 May 2021
LR Report: CA13681-MAY21
Reference: Project#: 2121164

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	Sulphide (Na2CO3) %
1: Analysis Start Date		26-May-21
2: Analysis Start Time		15:06
3: Analysis Completed Date		26-May-21
4: Analysis Completed Time		17:03
5: QC - Blank		< 0.04
6: QC - STD % Recovery		111%
7: QC - DUP % RPD		ND
8: RL		0.02
9: CV2 SS2 2'6"-4'6"	13-May-21 09:00	< 0.04
10: CV6 SS3 5'-7'	14-May-21 14:00	0.05

RL - SGS Reporting Limit
ND - Not Detected

Kimberley Didsbury
Project Specialist,
Environment, Health & Safety



Appendix D.
Site Photographs



Photo 1. Existing embankment, westbound lanes, looking north at culvert inlet (2021/04/27)



Photo 2. Existing culvert inlet, looking northwest (2021/04/27)



Photo 3. Existing culvert outlet, looking west towards location of proposed eastbound lanes (2021/04/27)



Photo 4. Existing culvert outlet, looking west (2021/04/27)



Photo 5. Highway 17 looking northwest (2021/04/27)