



THURBER ENGINEERING LTD.

**PRELIMINARY
FOUNDATION INVESTIGATION REPORT
HIGHWAY 17 TWINNING, RENFREW AREA
LITTLE HALLIDAY CREEK CULVERTS
STA.17+893 EBL AND WBL, HORTON TOWNSHIP
SITE NO. 29X-0405/C0
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009**

Geocres No.: 31F-228

Report to:

Ministry of Transportation Ontario

Latitude: 45.502924°
Longitude: -76.673744°

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 Highway 17/Halliday Creek crossing located near Station 17+893 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 west of the existing alignment at this location. The culvert currently present under the existing Highway 17 lanes will require replacement 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 both the new and replacement culverts near Station 17+893.

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 site is located on Highway 17 approximately 675 m north of the existing intersection with Bruce Street. For project purposes, Highway 17 is herein described as oriented north-south and Halliday Creek, east-west.

The existing Highway 17 in the vicinity of the site is an undivided highway with a westbound passing lane, gravel shoulders and a posted speed limit of 90 km/hr. Three-cable guiderails are present on both sides. The AADT for this existing section of Highway 17 near the site had a reported AADT of 12,300 in 2016.

The land adjacent to the site generally consists of agricultural fields with residential homes located approximately 100 m south of the existing highway. The terrain is relatively flat with slight downward slope towards the creek. Occasional trees and shrubs are present along the existing highway right-of-way and the creek.

The existing culvert is a 2.4 m diameter, 41.1 m long corrugated steel pipe (CSP) culvert. The cover above the existing culvert is approximately 2.5 m. The culvert facilitates the flow of Little Halliday Creek under the highway embankment from west to east and has an invert elevation of approximately 144.2 m. It is noted that the creek runs in a small incised valley which was noted to be approximately 2.5 m wide. There was approximately 0.35 m depth of water in the creek on April 27, 2021.

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

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 is comprised of calcitic carbonate metasedimentary bedrock including calcitic and siliceous marble.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field-testing program was carried multiple phases; May 11 to May 12, 2020, April 26, 2021 and May 14 to May 18, 2021. The field investigation consisted of advancing



6 boreholes identified as Boreholes CV-4, CV 5, CV-6, CV-24, N20-1 and N20-2. 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-4	Proposed EBL Culvert Inlet	5 040 358.9 (45.503018)	291 160.7 (-76.674536)	145.6	11.9
CV-5	Proposed EBL Embankment	5 040 353.2 (45.502967)	291 176.9 (-76.674329)	145.5	11.9
CV-6	Proposed EBL Culvert Outlet / Proposed WBL Culvert Inlet	5 040 346.9 (45.502911)	291 194.2 (-76.674107)	145.2	11.9
CV-24	Proposed WBL Culvert Outlet	5 040 356.6 (45.502999)	291 241.4 (-76.673503)	145.3	9.8
N20-1	Proposed WBL Existing Hwy 17	5 040 349.3 (45.502933)	291 226.9 (-76.673688)	149.0	15.8
N20-2	Proposed WBL Existing Hwy 17	5 040 344.3 (45.502888)	291 220.5 (-76.67377)	149.1	15.8

The investigation for on-road Boreholes N20-1 and N20-2 was carried out using a truck-mounted CME 55 drill rig equipped with HW rotary diamond drilling equipment. A track-mounted CME 45 drill rig equipped with hollow stem augers was used to carry out the off-road drilling for Boreholes CV-4, CV-5, CV-6 and CV-24.

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-4 and CV-24. 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...



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 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 ASTM D2487. Cohesive soils are described per current MTO protocols.

In general terms, beneath the pavement asphalt, embankment fill comprising sand with silt trace gravel to silty sand was encountered where boreholes were advanced from the existing Highway 17 roadway. Topsoil was encountered at the ground surface in the off-road boreholes. The native soils under the existing and proposed embankment comprised weathered clayey silt to silty clay crust underlain by clayey silt to silty clay. All boreholes were terminated in the clayey silt to silty clay deposit.

5.1 Embankment Fill

5.1.1 Asphalt

Asphalt ranging in thickness from 255 mm to 350 mm was encountered in on-road Boreholes N20-1 and N20-2.

5.1.2 Silty Sand to Sand with Silt, Trace Gravel (Fill)

A fill layer consisting of silty sand with gravel to silty sand trace gravel was encountered below the asphalt in Boreholes N20-1 and N20-1. The thickness of the layer ranges from 5.0 m to 5.2 m

with base depths ranging from 5.3 m to 5.6 m (base elevations ranging from 143.8 m to 143.4 m). The SPT N-values ranged from 3 to 85; indicating a very loose to very dense condition.

The moisture content of the samples tested ranged from 3% to 16%. The results of grain size analyses conducted on two samples of this fill material are summarized below and are illustrated on Figure C1 in Appendix C.

Summary of Grain Size Distribution Testing - Fill

Soil Particle	Percentage (%)
Gravel	2 – 14
Sand	75 – 82
Silt & Clay	11 – 16

5.2 Topsoil

A layer of topsoil was encountered at the ground surface in Boreholes CV-4, CV-5, CV-6 and CV-24. It is noted that several of the boreholes were located within farmland and the extent of the topsoil will reflect the dept of the tilled layer. The topsoil was observed to range in thickness from 200 mm to 460 mm in the four boreholes. One recorded moisture content of 45% was obtained. It should be noted that the topsoil thickness may vary between boreholes and in other areas of the site. This limited data should not be used for estimating topsoil stripping quantities.

5.3 Weathered Clayey Silt (CL) to Silty Clay (CI) Crust

A weathered crust layer consisting of grey-brown clayey silt to silty clay was encountered below the topsoil in Boreholes CV-4, CV-5, CV-6 and CV-24. The thickness of this layer ranged from 1.6 m to 2.1 m with base depths ranging from 2.1 m to 2.3 m (base elevations ranging from 143.5 m to 142.9 m).

SPT N-Values ranged from 1 to 4; indicating a stiff to very stiff condition.

The moisture content of the samples tested ranges from 29% to 49%. The results of grain size analyses conducted on four samples of the crust material are summarized below and are illustrated on Figure C2 in Appendix C.

Summary of Grain Size Distribution Testing – Weathered Crust

Soil Particle	Percentage (%)
Gravel	0
Sand	0 – 1
Silt	45 – 59
Clay	41 – 55

The results of Atterberg Limits testing carried out on four samples of this material are summarized below and are illustrated on Figure C5 in Appendix C. The laboratory results indicate that the material ranges from a clayey silt (CL) to a silty clay of intermediate plasticity (CI).

Summary of Atterberg Limit Testing – Weathered Crust

Parameter	Value
Liquid Limit	34 – 50
Plastic Limit	19 – 21
Plasticity Index	13 – 29

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

A native deposit of clayey silt to silty clay was encountered below the weathered crust in Boreholes CV-4, CV-5, CV-6 and CV-24, and below the fill in Boreholes N20-1 and N20-2. All boreholes were terminated in this deposit at base depths ranging from 9.8 m to 15.8 m (base elevations ranging from 135.5 m to 133.2 m). Sand partings were noted throughout this layer in Boreholes CV-5 and Borehole CV-6.

SPT tests conducted within the cohesive unit gave N-values ranging from weight of hammer to 11. In situ shear vane tests indicated undrained shear strengths ranging from greater than 100 to 31 kPa with increasing depth indicating a very stiff to firm consistency. Sensitivity typically ranged from 1.8 to 9.5; the largest sensitivity reported was 22.5.

The moisture content of the samples tested ranged from 27 to 48%. The results of twelve grain size analysis tests conducted on samples of this material are summarized below and are illustrated on Figures C3 and C4 in Appendix C.

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

Soil Particle	Percentage (%)
Gravel	0 – 2
Sand	0 – 4
Silt	43 – 61
Clay	37 – 54

The results of Atterberg Limits testing carried out on ten samples of this material are summarized below and are illustrated on Figures C6 and C7 in Appendix C. The laboratory results indicate that the material ranges from a clayey silt of low plasticity (CL) to a silty clay of intermediate plasticity (CI).



Summary of Atterberg Limit Testing – Clayey Silt to Silty Clay

Parameter	Value
Liquid Limit	26 – 40
Plastic Limit	16 – 22
Plasticity Index	10 – 19

5.5 Groundwater

Monitoring wells with diameters of 50 mm were installed in Boreholes CV-4 and CV-24. 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-4	141.0	0.7	144.9	August 4, 2021
		1.0	144.6	September 22, 2021
		0.7	144.9	October 5, 2021
		0.8	144.8	October 20, 2021
		1.0	144.6	January 19, 2022
CV-24	140.7	0.4	144.9	August 4, 2021
		0.8	144.5	September 22, 2021
		0.2	145.1	October 5, 2021
		0.6	144.7	January 19, 2022

Water was observed while drilling at depths of 3.0 m and 3.8 m in Boreholes N20-1 and N20-2, respectively (elevations 146.0 m to 145.3 m, respectively).

On April 27, 2021, the water level in the creek was reported to be at elevation 144.8 m.

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 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 (µg/g)	Sulphate (µg/g)	Sulphide (%)	pH (-)	Resistivity (Ohm-cm)
CV-6	SS3	1.5 – 2.1	168	63	0.05	7.73	1,980

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 Nick Weil and 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 Fred Griffiths, P.Eng. The report was reviewed by P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



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

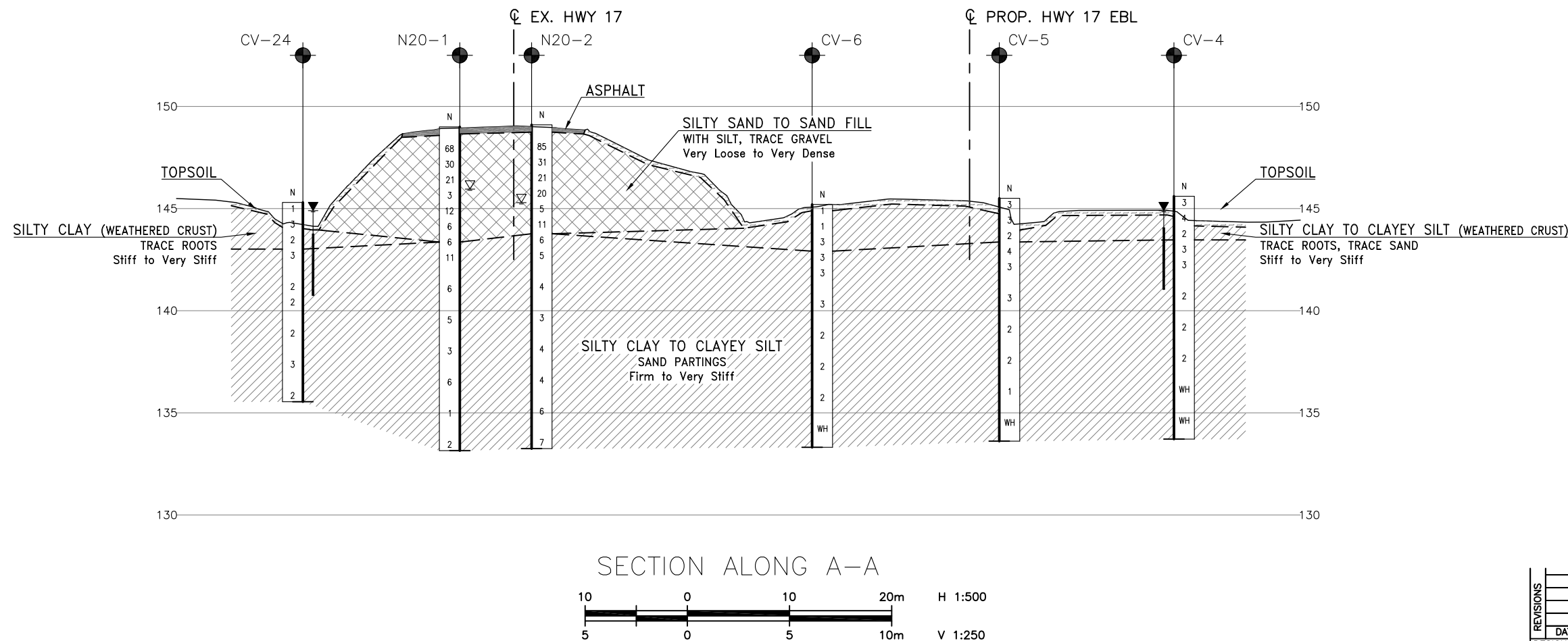
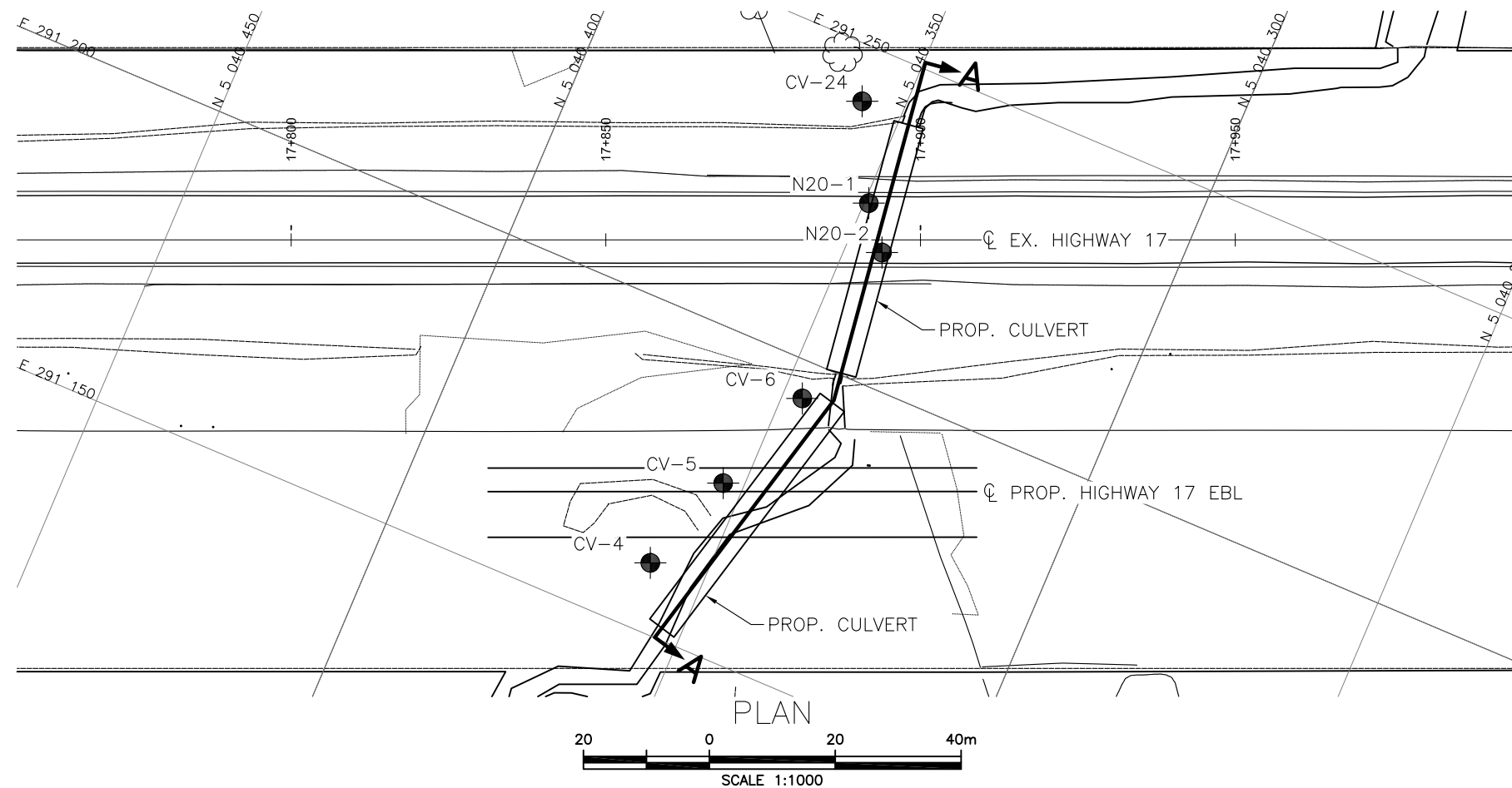


Dr. P.K. Chatterji, P.Eng.
MTO Review Principal,
Senior Geotechnical Engineer

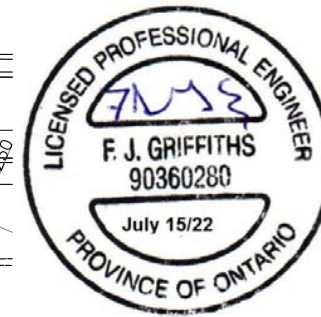




Appendix A.

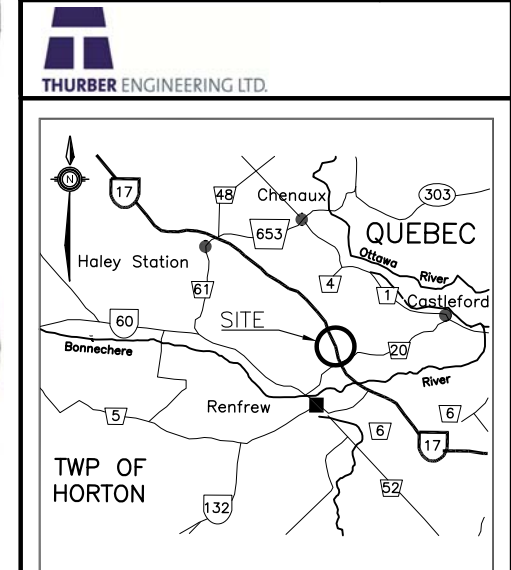
Borehole Location Plan and Stratigraphic Drawings







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



<p>CONT No</p> <p>WP No</p>	
<p>HIGHWAY 17 TWINNING CULVERT STA. 17+893</p>	<p>SHEET</p>
<p>BOREHOLE LOCATIONS AND SOIL STRATA</p>	



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

[illegible]

-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. Structural elements, surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 9.

GEOCRES No. 31F-228

REVISIONS									
	DATE	BY	DESCRIPTION						
DESIGN	DP	CHK	FG	CODE	LOAD	DATE		JUL 2022	
DRAWN	MFA	CHK	PKC	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).

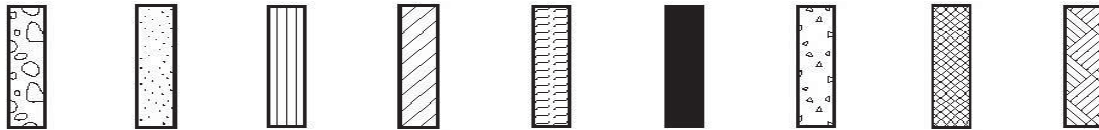
DYNAMIC CONE PENETRATION TEST (DCPT):

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 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 CV-24

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Culvert 17+893 MTM Zone 9: N 5 040 356.6 E 291 241.4 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.04.26 - 2021.04.26 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _P W W _L			
145.3	Ground Surface							20 40 60 80 100					
0.0	TOPSOIL (200 mm)							20 40 60 80 100					
0.2	SILTY CLAY (CI), trace roots Stiff to very stiff Grey-brown with yellow mottles (WEATHERED CRUST)		1	SS	1		145						
			2	SS	3								
							144						
			3	SS	2								
							143						
143.0			4	SS	3								
2.3	SILTY CLAY (CI) Firm to very stiff Grey						142						
			5	SS	2								
			6	SS	2								
			7	SS	2								
			8	SS	3								
							137						
			9	SS	2								
135.5													
9.8	End of Borehole												

Continued Next Page

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

ONTM14S 24726 CULVERT 17+893 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-23

RECORD OF BOREHOLE No CV-24

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Culvert 17+893 MTM Zone 9: N 5 040 356.6 E 291 241.4 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.04.26 - 2021.04.26 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									
	Continued From Previous Page																
	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 0.4 144.9																
	2021.09.22 0.8 144.5																
	2021.10.05 0.2 145.1																
	2022.01.19 0.6 144.7																

ONTMT4S 24726 CULVERT 17+893 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-23

RECORD OF BOREHOLE No CV-4

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Culvert 17+893 MTM Zone 9: N 5 040 358.9 E 291 160.7 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.05.18 - 2021.05.18 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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
145.6	Ground Surface							20 40 60 80 100		w _P w w _L				
0.0	TOPSOIL (300 mm)							○ UNCONFINED + FIELD VANE						
145.3			1	SS	3			● QUICK TRIAXIAL × LAB VANE						
0.3	SILTY CLAY (CI), trace roots Stiff to very stiff Grey-brown with yellow mottles (WEATHERED CRUST)													
			2	SS	4									
			3	SS	2								0 0 46 54	
143.5														
2.1	CLAYEY SILT (CL) Firm to very stiff Grey		4	SS	3									
			5	SS	3									
				6	SS	2								
				7	SS	2								0 0 48 52
			8	SS	2									
			9	SS	WH								0 0 48 52	

Continued Next Page

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

RECORD OF BOREHOLE No CV-4

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Culvert 17+893 MTM Zone 9: N 5 040 358.9 E 291 160.7 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.05.18 - 2021.05.18 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	WATER CONTENT (%)					
	Continued From Previous Page													
	CLAYEY SILT (CL) Firm to very stiff Grey													
133.7			10	SS	WH									
11.9	End of Borehole 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 0.7 144.9 2021.09.22 1.0 144.6 2021.10.05 0.7 144.9 2021.10.20 0.8 144.8 2022.01.19 0.6 144.7													



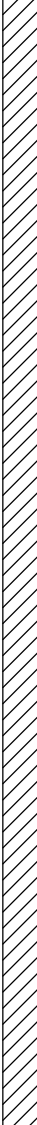
+³, ×³: Numbers refer to Sensitivity
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0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CV-5

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Culvert 17+893 MTM Zone 9: N 5 040 353.2 E 291 176.9 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.05.17 - 2021.05.18 CHECKED BY FG

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				
145.5	Ground Surface							20 40 60 80 100				
0.0	TOPSOIL (460 mm)		1	SS	3		145	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
145.0								20 40 60 80 100				
0.5	SILTY CLAY (CI), trace roots Stiff to very stiff Grey-brown with yellow mottles (WEATHERED CRUST)		2	SS	3		144	20 40 60 80 100				0 1 46 53
								20 40 60 80 100				
			3	SS	2			20 40 60 80 100				
143.4								20 40 60 80 100				
2.1	SILTY CLAY (CI) Contains sand partings Firm to very stiff Grey-brown		4	SS	4		143	20 40 60 80 100				
								20 40 60 80 100				
			5	SS	3		142	20 40 60 80 100				0 0 49 51
								20 40 60 80 100				
								20 40 60 80 100				
			6	SS	3		141	20 40 60 80 100				
								20 40 60 80 100				
								20 40 60 80 100				
			7	SS	2		140	20 40 60 80 100				
								20 40 60 80 100				
								20 40 60 80 100				
								20 40 60 80 100				
			8	SS	2		139	20 40 60 80 100				
								20 40 60 80 100				
								20 40 60 80 100				
								20 40 60 80 100				
								20 40 60 80 100				
								20 40 60 80 100				
			9	SS	1		138	20 40 60 80 100				
								20 40 60 80 100				
								20 40 60 80 100				
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+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CV-5

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Culvert 17+893 MTM Zone 9: N 5 040 353.2 E 291 176.9 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.05.17 - 2021.05.18 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page							20	40	60	80	100					
	SILTY CLAY (CI) Contains sand partings Firm to very stiff Grey-brown						135				2.8						0 2 52 46
			10	SS	WH		134				3.3						
133.6																	
11.9	End of Borehole																

RECORD OF BOREHOLE No CV-6

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Culvert 17+893 MTM Zone 9: N 5 040 346.9 E 291 194.2 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.05.14 - 2021.05.17 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 (%)								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		W P W W L								
								20 40 60 80 100		20 40 60								
145.2	Ground Surface						145											
0.0	TOPSOIL (300 mm)						145						○					
144.9			1	SS	1													
0.3	CLAYEY SILT (CL), trace roots, trace sand Stiff to very stiff Grey-brown with yellow mottles (WEATHERED CRUST)						144						○					
			2	SS	1									○				
			3	SS	3									┌─┐			0 0 59 41	
							143											
142.9	SILTY CLAY (CI) Contains sand partings Stiff to very stiff Grey-brown		4	SS	3								○					
2.3																		
			5	SS	3									○				
				6	SS		3								┌─┐	○		0 0 49 51
			7	SS	2									○				
			8	SS	2								┌─┐	○		0 0 46 54		

Continued Next Page

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

RECORD OF BOREHOLE No CV-6

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Culvert 17+893 MTM Zone 9: N 5 040 346.9 E 291 194.2 ORIGINATED BY AO
 HWY 17 BOREHOLE TYPE CME45 Trackmount, HSA COMPILED BY AO
 DATUM Geodetic DATE 2021.05.14 - 2021.05.17 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 80 100	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
	Continued From Previous Page						135									
	SILTY CLAY (CI) Contains sand partings Stiff to very stiff Grey-brown		10	SS	WH		134									
133.3																
11.9	End of Borehole															

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

RECORD OF BOREHOLE No N20-1

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Culvert 17+893 MTM Zone 9: N 5 040 349.3 E 291 226.9 ORIGINATED BY NW
 HWY 17 BOREHOLE TYPE CME55 Truckmount, HQ Casing COMPILED BY MW
 DATUM Geodetic DATE 2020.05.11 - 2020.05.11 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	W _P W W _L					
149.0	Pavement Surface						20 40 60 80 100							GR SA SI CL
0.0	ASPHALT (350 mm)													
148.6														
0.4	SILTY SAND to SAND with silt, trace gravel Very loose to very dense Brown Moist to Wet (FILL)		1	SS	68		148			○				
			2	SS	30		147			○				2 82 16 (SI+CL)
			3	SS	21					○				
			4	SS	3		146							
			5	SS	12		145							
			6	SS	6		144							
143.4			7	SS	6					○				
5.6	SILTY CLAY (CI) Stiff to very stiff Grey		8	SS	11		143			○				1 4 43 52
			9	SS	6		142							
			10	SS	5		141							
							140							
							139							

Continued Next Page

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

ONTMT4S 24726 CULVERT 17+893 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-23

RECORD OF BOREHOLE No N20-1

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Culvert 17+893 MTM Zone 9: N 5 040 349.3 E 291 226.9 ORIGINATED BY NW
 HWY 17 BOREHOLE TYPE CME55 Truckmount, HQ Casing COMPILED BY MW
 DATUM Geodetic DATE 2020.05.11 - 2020.05.11 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 (%)				
								○ UNCONFINED + FIELD VANE				w P w w L				
						● QUICK TRIAXIAL × LAB VANE										
	Continued From Previous Page						20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100			
133.2 15.8	SILTY CLAY (CI) Stiff to very stiff Grey															
			11	SS	3	138									0 2 61 37	
			12	SS	6	137										
			13	SS	1	135										
						13.3 +										
						22.5 +										
			14	SS	2											
	End of Borehole Water observed at 3.0m during drilling.															



ONTMT4S 24726 CULVERT 17+893 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-23

RECORD OF BOREHOLE No N20-2

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Culvert 17+893 MTM Zone 9: N 5 040 344.3 E 291 220.5 ORIGINATED BY NW
 HWY 17 BOREHOLE TYPE CME55 Truckmount, HQ Casing COMPILED BY MW
 DATUM Geodetic DATE 2020.05.12 - 2020.05.12 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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	W _P W W _L	WATER CONTENT (%)			GR		SA	SI	CL	
149.1	Pavement Surface																	
0.0 148.8	ASPHALT (255 mm)						149											
0.3	SILTY SAND to SAND with silt, trace gravel Compact Brown Moist (FILL)		1	SS	85		148											
			2	SS	31		147											
			3	SS	21		146											
			4	SS	20		145											
			5	SS	5		144											
			6	SS	11		143											
			7	SS	6		142											
			8	SS	5		141											
			9	SS	4		140											
			10	SS	3													
143.8	CLAYEY SILT (CL) to SILTY CLAY (CI) Stiff to very stiff Grey																	
5.3			7	SS	6													
			8	SS	5													
			9	SS	4													

Continued Next Page

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


ONTMT4S 24726 CULVERT 17+893 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-23

RECORD OF BOREHOLE No N20-2

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Culvert 17+893 MTM Zone 9: N 5 040 344.3 E 291 220.5 ORIGINATED BY NW
 HWY 17 BOREHOLE TYPE CME55 Truckmount, HQ Casing COMPILED BY MW
 DATUM Geodetic DATE 2020.05.12 - 2020.05.12 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									WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
	Continued From Previous Page						20 40 60 80 100												
133.3 15.8	CLAYEY SILT (CL) to SILTY CLAY (CI) Stiff to very stiff Grey					139										0 2 61 37			
			11	SS	4	138													
			12	SS	4	137													
			13	SS	6	136													
			14	SS	7	135													
						134													
	End of Borehole Water observed at 3.8m during drilling.																		

ONTMT4S 24726 CULVERT 17+893 GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-23



Appendix C.

Laboratory Testing

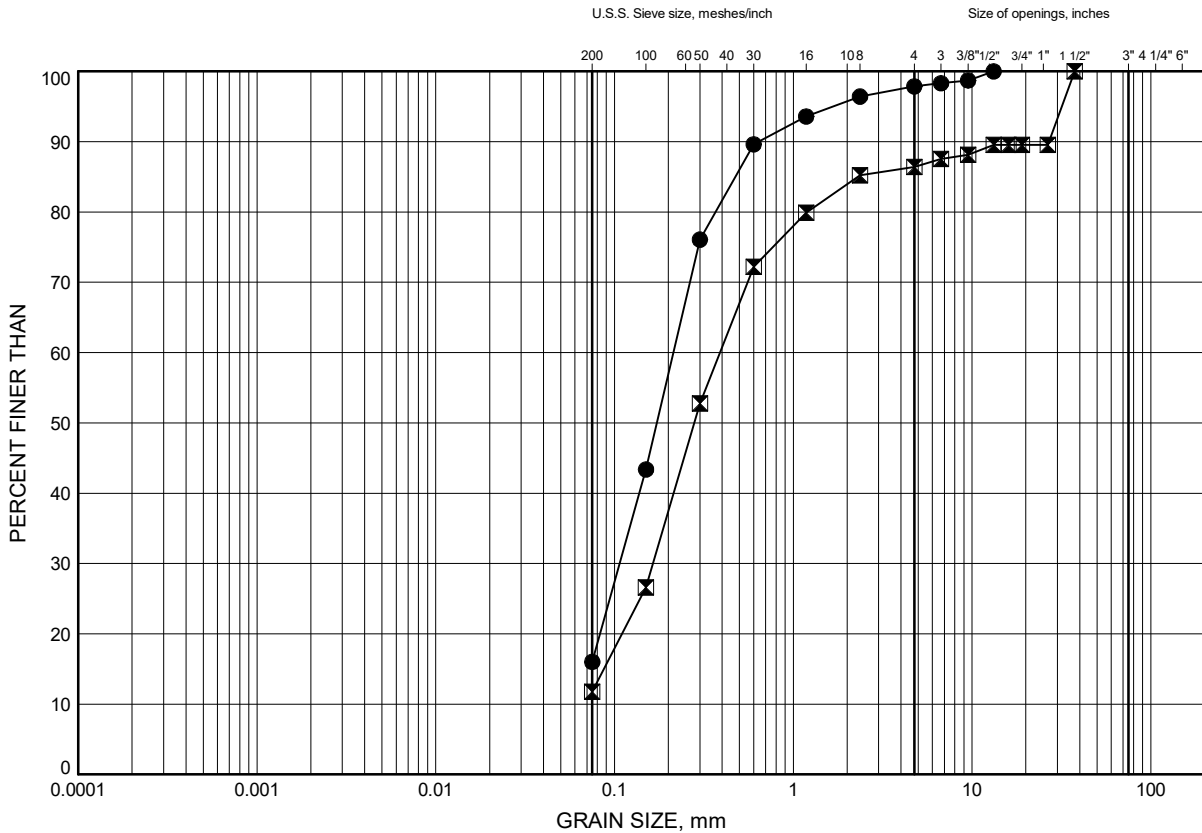


Appendix C.1
Particle Size Analysis Figures
Atterberg Limit Test Results

Highway 17 Twinning GRAIN SIZE DISTRIBUTION

FIGURE C1

Silty Sand to Silty Sand with Silt, Trace Gravel (Fill)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	N20-1	1.8	147.2
⊠	N20-2	2.6	146.5

Date August 2021
WP# 4068-09-00

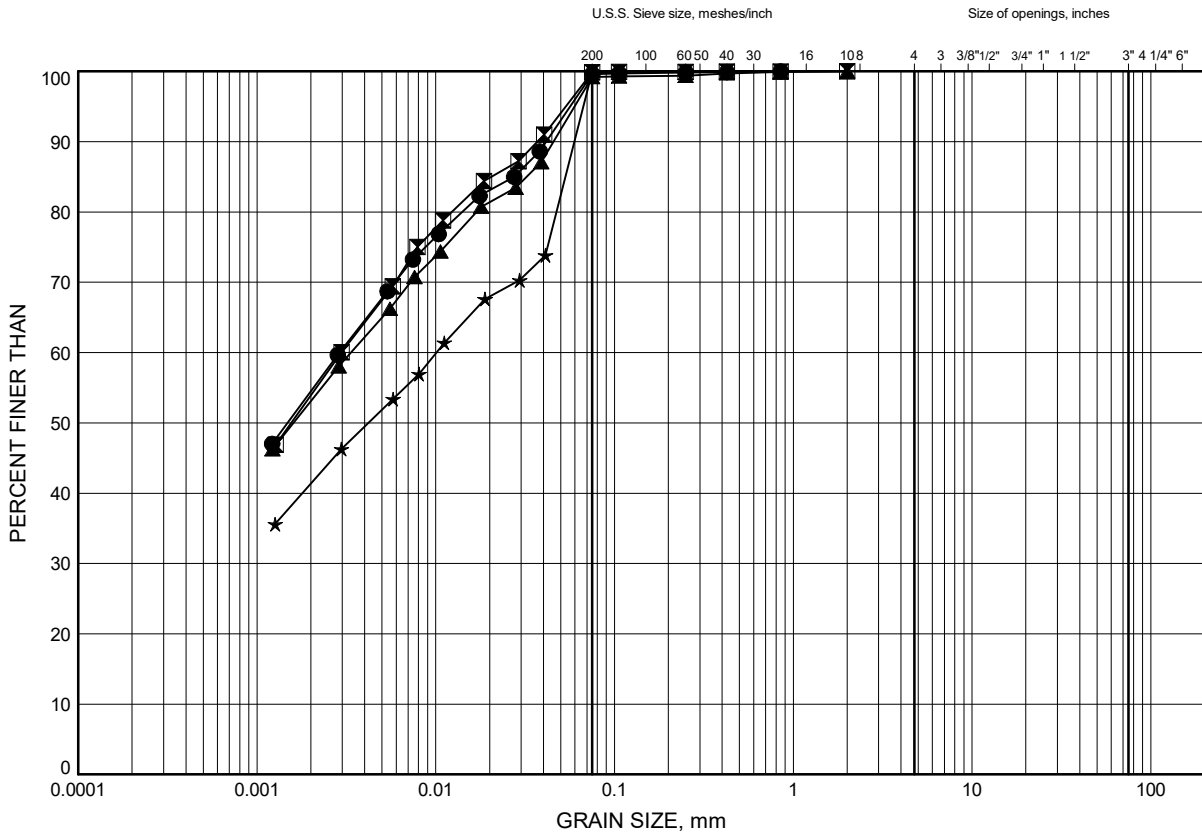


Prep'd DP
Chkd. FG

Highway 17 Twinning GRAIN SIZE DISTRIBUTION

FIGURE C2

Weathered Clayey Silt (CL) to Silty Clay (CI) Crust



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CV-24	1.1	144.2
⊠	CV-4	1.8	143.8
▲	CV-5	0.9	144.6
★	CV-6	1.8	143.4

Date August 2021
WP# 4068-09-00

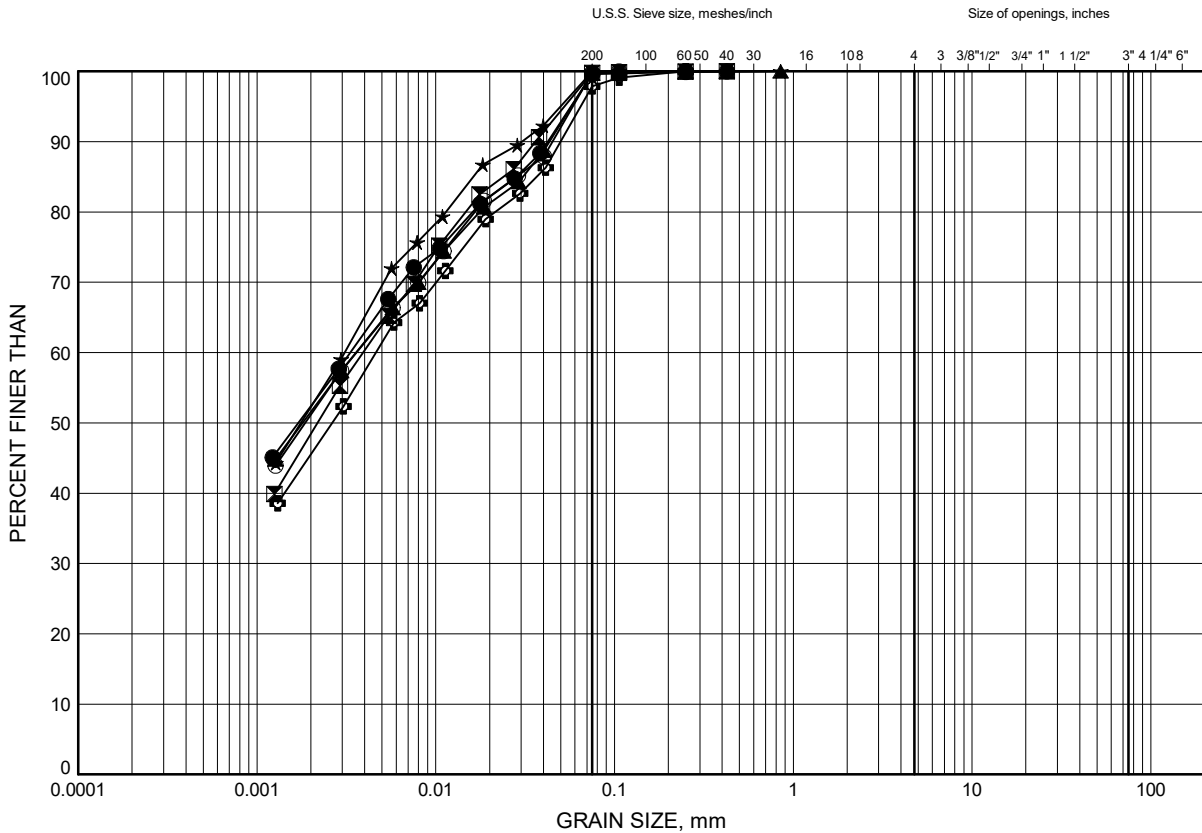


Prep'd DP
Chkd. FG

Highway 17 Twinning GRAIN SIZE DISTRIBUTION

FIGURE C3

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-24	4.1	141.2
⊠	CV-24	7.9	137.4
▲	CV-4	6.4	139.2
★	CV-4	9.4	136.2
⊙	CV-5	3.4	142.1
⊕	CV-5	11.0	134.5

Date August 2021
WP# 4068-09-00

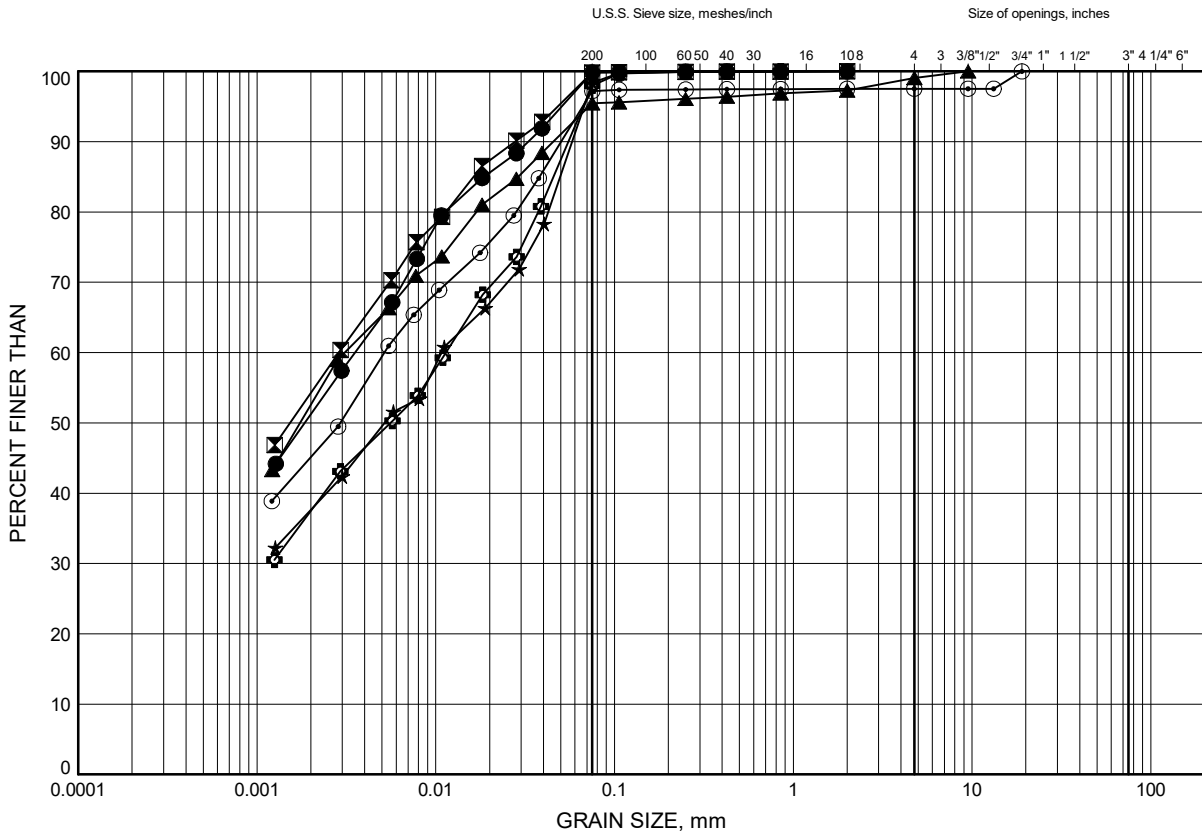


Prep'd DP
Chkd. FG

Highway 17 Twinning GRAIN SIZE DISTRIBUTION

FIGURE C4

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-6	4.9	140.3
⊠	CV-6	7.9	137.3
▲	N20-1	5.8	143.2
★	N20-1	11.0	138.0
⊙	N20-2	7.9	141.2
⊕	N20-2	12.5	136.6

Date August 2021
WP# 4068-09-00

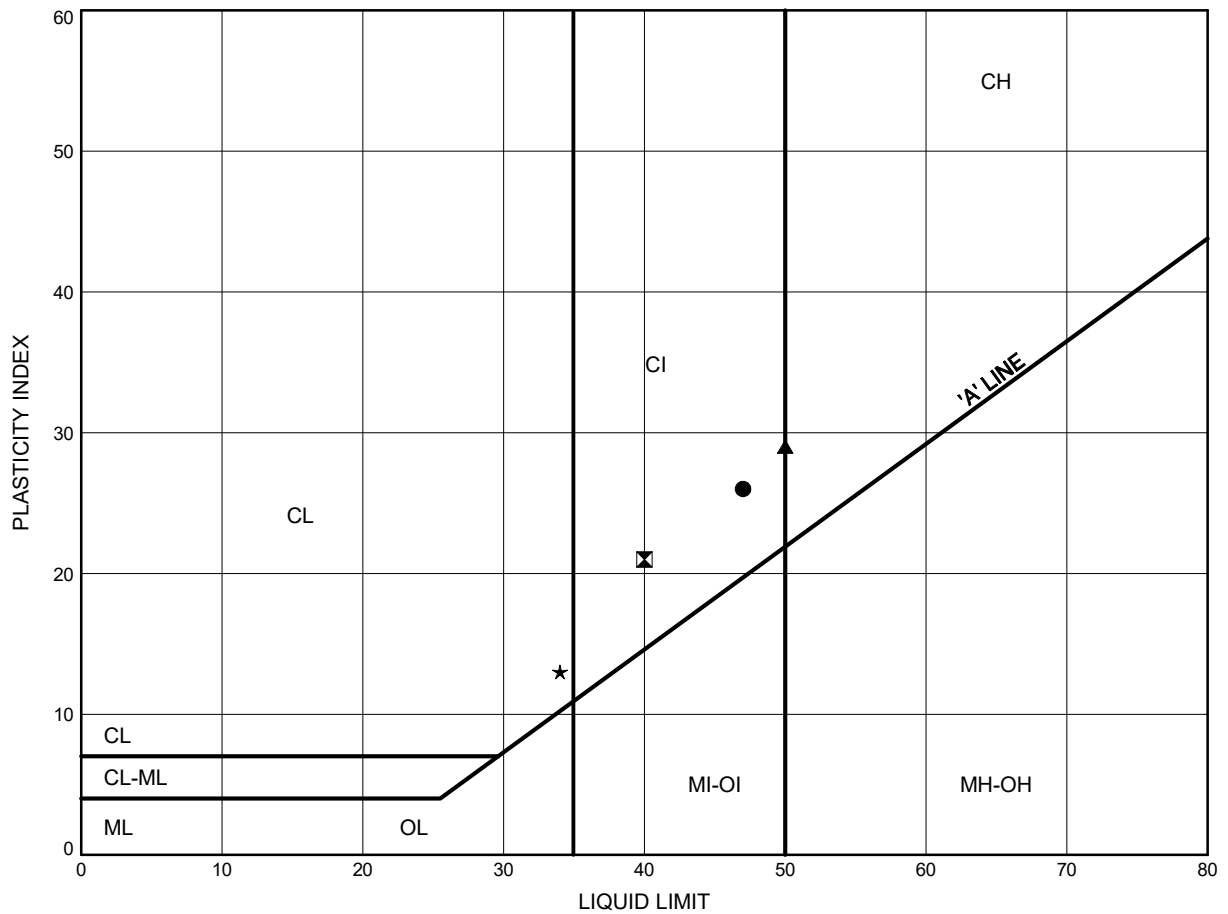


Prep'd DP
Chkd. FG

Highway 17 Twinning ATTERBERG LIMITS TEST RESULTS

FIGURE C5

Weathered Clayey Silt (CL) to Silty Clay (CI) Crust



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CV-24	1.1	144.2
⊠	CV-4	1.8	143.8
▲	CV-5	1.1	144.4
★	CV-6	1.8	143.4

Date August 2021
 WP# 4068-09-00

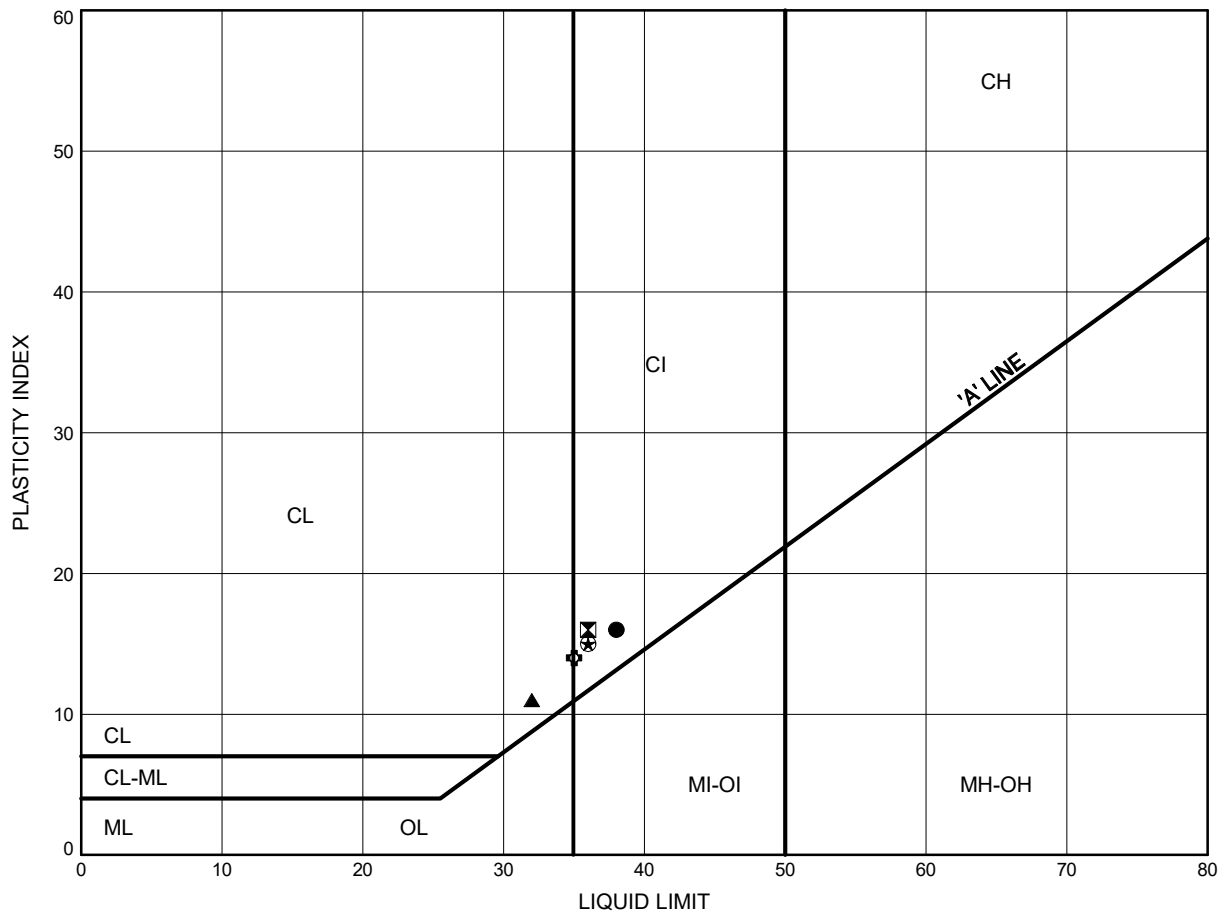


Prep'd DP
 Chkd. FG

Highway 17 Twinning ATTERBERG LIMITS TEST RESULTS

FIGURE C6

Clayey Silt (CL) to Silty Clay (CI)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CV-24	4.1	141.2
⊠	CV-24	7.9	137.4
▲	CV-4	6.4	139.2
★	CV-5	3.4	142.1
⊙	CV-6	4.9	140.3
⊕	CV-6	7.9	137.3

Date August 2021
 WP# 4068-09-00

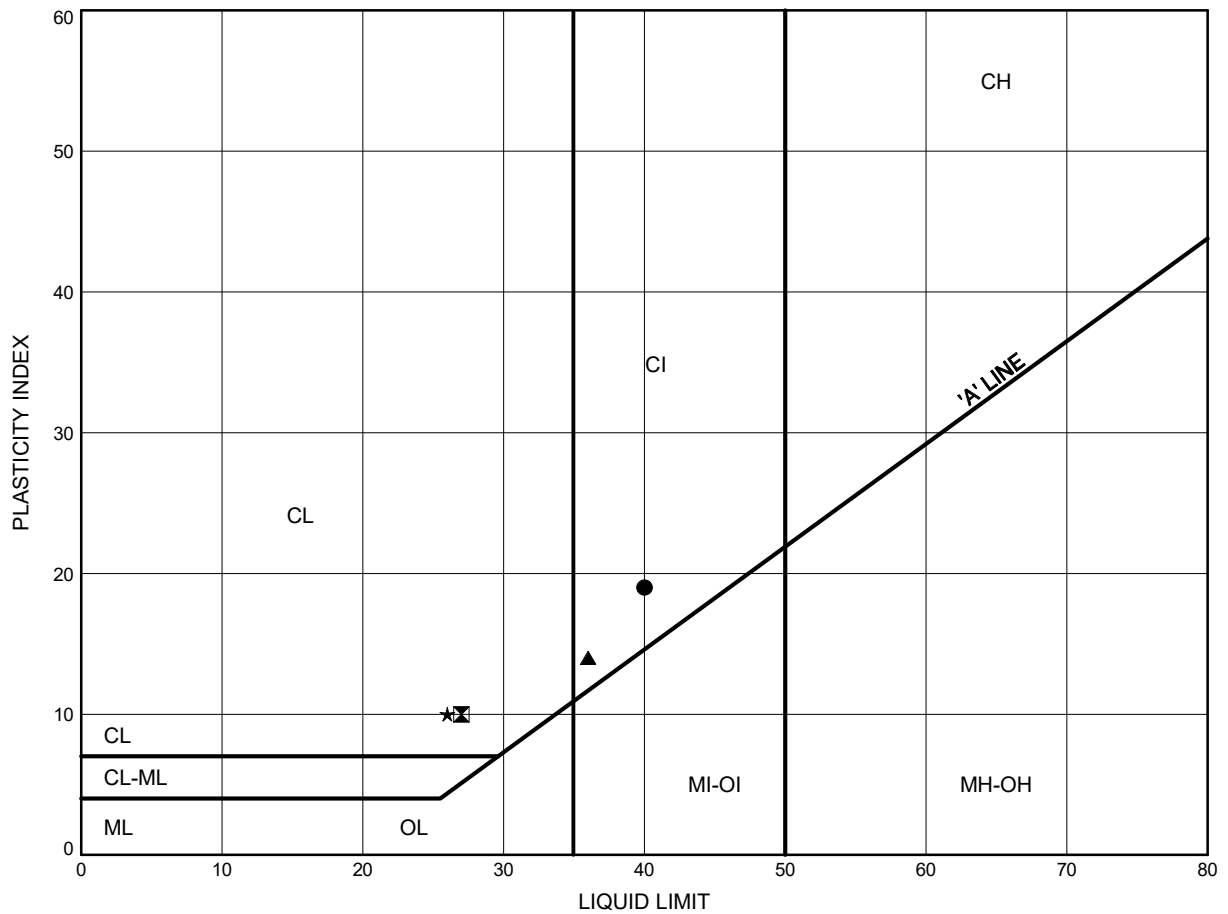


Prep'd DP
 Chkd. FG

Highway 17 Twinning ATTERBERG LIMITS TEST RESULTS

FIGURE C7

Clayey Silt (CL) to Silty Clay (CI)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	N20-1	5.8	143.2
⊠	N20-1	11.0	138.0
▲	N20-2	7.9	141.2
★	N20-2	12.5	136.6

Date August 2021
 WP# 4068-09-00



Prep'd DP
 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:

Paracel 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	-	-
General Inorganics						
Conductivity	5 uS/cm		458	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

Client: Thurber Engineering Ltd.

Client PO: 24726

Report Date: 21-May-2021

Order Date: 17-May-2021

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

Paracel Laboratories

Attn : Dale Robertson

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

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

27-May-2021

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 (Na ₂ CO ₃) %
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. Culvert inlet looking south-east; proposed EBL to south (2021/04/27)
Note: residential properties to south of culvert.



Photo 2. Culvert outlet looking north-east (2021/04/27)



Photo 3. Culvert inlet (2021/04/27)



Photo 4. Culvert outlet (2021/04/27)



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