



THURBER ENGINEERING LTD.

**PRELIMINARY
FOUNDATION INVESTIGATION REPORT
HIGHWAY 17 TWINNING, RENFREW AREA
DOCHART CREEK CROSSINGS 21+340 EB AND 21+360 WB
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009**

Geocres No.: 31F-219

Report to:

Ministry of Transportation Ontario

Latitude: 45.440061
Longitude: -76.464160

December 2024
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) under Assignment No. 4018-E-0009 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 replacement of the three pipe culverts under the existing (proposed eastbound) embankment and the installation of a new structure for the new westbound embankment at Dochart Creek in the Township of McNab/Braeside within Renfrew County, Ontario.

This section of the report presents the factual findings obtained from historical foundation investigations available from the online Geocres Library and from the foundation investigation completed as part of the current study.

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.

Previous foundation investigation information from boreholes completed in 2005 for the proposed westbound structure was available under Geocres 31F-153 while information from boreholes completed in 2018 for the rehabilitation of eastbound culverts was available under Geocres 31F-204.

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 BACKGROUND

2.1 Site Description

The site is located on Highway 17 approximately 600 m west of the Highway 17 Scheel Drive Overpasses. The existing Highway 17 in this area consists of a transition zone from the two-lane undivided Highway 17 to the west and the previously twinned Highway 417 to the east. At the site, there is a single lane in each direction with paved shoulders separated by a central gore area. The existing road surface (proposed eastbound) is at approximate elevation 120.1 m. Based on profiles provided by MTO the proposed westbound lanes are to be at a similar elevation.

The land adjacent to the site typically consists of forests and agricultural fields. The terrain is relatively flat with shallow and exposed bedrock approximately 500 m east and west of the site.

Creek flow beneath existing Highway 17 is from the south to the north through three 43.5 m long, 2.75 m diameter structural plate, corrugated steel pipe (CSP) culverts installed on a skew to the highway. The center-to-center distance between the three culverts is approximately 4.4 m. The existing culvert inverts are at approximate elevation 115.2 m and 115.3 m at the south and north ends, respectively. During a site visit on April 27, 2020, the main Dochart Creek channel at the new westbound lanes was 2 m to 3 m wide and about 0.7 m deep. Near the north end of the existing culverts (outlet), the creek was 12 m wide and about 0.3 m deep. See Photo 4 in Appendix D to see the orientation of the creek and highway. The cover above the existing culverts is approximately 2.0 m.

The existing embankment side slopes did not show any visible signs of distress at the time of the investigation and were sloped at approximately 2H:1V. Along the westbound alignment approximately 40 m east of the creek, a rockfill stockpile approximately 6 m high was placed as part of the previous twinning project (See Appendix A and Photo 4 in Appendix D).

Photographs showing the existing conditions in the area of the creek 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 culvert 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.

A Physical Setting Report for the overall project prepared by ERIS and based on Ontario Geological Mapping Indicates that the underlying bedrock at the Dochart Creek site is typically carbonate meta-sedimentary rocks of the Grenville Province.



3 SITE INVESTIGATION AND FIELD TESTING

The current site investigation and field testing program was carried out in several phases between October 18th, 2019 and March 11, 2024. The field investigation consisted of advancing five boreholes identified as DOC19-1 through DOC19-4 and DOC23-1. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

Historical Boreholes 18-1 and 18-2 (Geocres 31F-204) were drilled by Thurber in June 2018 for the rehabilitation of the existing culverts. It was planned to replace the inlet portion of the three culverts; to date this work has not been completed. Historical Boreholes 29-416/C1S, 29-416/C1M and 29-416/C1N (Geocres 31F-153) were drilled east of the creek in May 2005 as part of the preliminary investigation for the proposed westbound structure. The five historical boreholes have been fully incorporated into this report.

The northing, easting and elevation of the 2019 and 2024 boreholes were surveyed by Thurber staff using a Trimble Catalyst DA1 antenna with centimeter accuracy and 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 (Geocres 31F-153, 31F-204 and Current Investigation)

Borehole No.	Drilled Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Termination Depth Below Ground Surface (m)	Comments
18-1	Highway 17 Eastbound Shoulder – west of creek	5 033 329.1 (45.439889)	307 562.1 (-76.464694)	120.2	15.8	-
18-2	Inlet of Eastbound Culverts	5 033 313.8 (45.439751)	307 569.7 (-76.464597)	116.0	11.4	Piezometer
29-416/C1M	Mid-point of Westbound Embankment	5 033 368.0 (45.440238)	307 640.0 (-76.463698)	116.1	5.8	Piezometer
29-416/C1N	Downstream of Westbound Embankment	5 033 368.8 (45.440245)	307 663.9 (-76.463393)	116.1	4.3	-
29-416/C1S	Upstream of Westbound Embankment	5 033 353.8 (45.440111)	307 622.7 (-76.463919)	116.5	5.5	-
DOC19-1	Outlet of Eastbound Culvert	5 033 341.8 (45.440003)	307 603.9 (-76.46416)	115.7	8.5	Well
DOC19-2	Upstream of Westbound Embankment	5 033 362.9 (45.440193)	307 604.7 (-76.464149)	116.1	11.2	-

Borehole No.	Drilled Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Termination Depth Below Ground Surface (m)	Comments
DOC19-3	Mid-point of Westbound Embankment	5 033 369.8 (45.440255)	307 638.7 (-76.463715)	116.2	9.5	-
DOC19-4	Downstream of Westbound Embankment	5 033 390.1 (45.440437)	307 640.6 (-76.46369)	115.5	7.8	Well
DOC23-1	Highway 17 Eastbound Shoulder – east of creek	5 033 319.6 (45.439803)	307 588.0 (-76.464363)	119.9	16.2	Well

For the 2018 investigation, the drilling for Borehole 18-2 was carried out using a portable drill rig using wash boring while Borehole 18-1 was drilled using a truck mounted CME 55 drill rig equipped with hollow stem augers and rotary diamond drilling equipment. The boreholes in the 2005 investigation were advanced using a track-mounted CME drill rig equipped with hollow stem augers. The 2019/2024 investigations utilized a track mounted CME 45 drill rig for offroad locations and a truck mounted CME 75 for an onroad location, both drills were equipped with hollow stem augers and rotary diamond drilling equipment.

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Relatively undisturbed, thin-walled tube samples were acquired by pushing hydraulically in Boreholes DOC19-2 and 29-416/C1M. Upon achieving auger refusal or SPT refusal, Boreholes 18-1 and DOC19-1 through DOC 19-4 were advanced into bedrock while collecting NQ core.

A 50 mm monitoring well was installed in Borehole DOC23-1. 38 mm monitoring wells were installed in Boreholes DOC19-1 and DOC19-4. During the previous investigations 25 mm diameter piezometers were installed in Borehole 18-2 and 29-416/C1M. The installation details are illustrated on the Record of Borehole sheets provided in Appendix B. The boreholes were backfilled in accordance with MOE requirements (O.Reg 903, as amended). The piezometers and monitoring wells installed as part of the current investigation 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 and bedrock 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 soil samples were subjected to grain size distribution analysis and Atterberg limits tests where appropriate. The testing was carried out to MTO and ASTM standards. One-dimensional consolidation testing was carried out on four thin-walled tube samples from DOC19-2 with incremental loading in accordance with ASTM D2435. Cohesive soils from the 2019/2020/2024 boreholes are described in accordance with the MTO Guideline for Foundation Engineering Services (GFES) Manual (April 2022) and the 4th Edition of the Canadian Foundation Engineering Manual. Terminology from the 2003 borehole information may vary from current practice.

All rock cores were photographed and their total core recovery (TCR), solid core recovery (SCR) and rock quality designation (RQD) were measured. Chemical analysis for determination of pH, conductivity, resistivity, sulphide, sulphate and chloride concentrations were carried out on one soil sample from each of DOC19-1, DOC19-4 and DOC23-1.

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.

Generally, the site was underlain by embankment fill overlying a native deposit of sensitive clayey silt to clay, over a glacial till deposit. The overburden soils are underlain by limestone bedrock.

5.1 Asphalt

An 80 mm and 110 mm thick layer of asphalt was observed at ground surface in Boreholes DOC23-1 and 18-1, respectively.

5.2 Fill

5.2.1 Sandy Gravel some Silt to Silty Sand with Gravel (Pavement Structure)

A fill layer ranging from sandy gravel some silt to silty sand with gravel was encountered beneath the asphalt surface in Boreholes 18-1 and DOC23-1. Occasional cobbles were observed in this layer. The top of this layer was encountered at elevations ranging from 119.8 m to 120.1 m and a layer thickness of 0.7 m to 1.4 m was observed. The SPT N-values were 34, 44 and 62; indicating a dense to very dense condition.



The moisture content of the samples tested ranged from 2 to 4%. The results of grain size analysis tests conducted on two samples of this material are summarized below and are illustrated on Figure C1 in Appendix C.

Table 5-1: Summary of Grain Size Distribution Testing

Soil Particle	Percentage (%)
Gravel	33 - 47
Sand	45 - 53
Silt	8 - 14
Clay	

5.2.2 Rock Fill with Sand Infill

Rock fill with sand infill was encountered within the core of the existing Highway 17 embankment beneath the pavement structure fill in Boreholes 18-1 and DOC23-1. The top of this layer was encountered at Elevations 118.7 m and 119.1 m and the layer had a thickness of 2.0 m and 2.2 m. The SPT N-values ranged from weight of hammer (WH) to 75; indicating a very loose to very dense condition but typically, compact to dense. Augering and tri-cone drilling techniques were used to advance through this layer in Borehole 18-1. Augering was used to advance through this layer in Borehole DOC23-1. Sample recovery was poor in both boreholes as boulders and cobbles were noted throughout this layer and the sand infill was likely washed away or lost into void space during drilling.

The moisture content of the samples tested typically ranged from 1 to 2%, although one sample near the bottom transition to clay was 18%.

5.2.3 Silty Clay with Sand to Clayey Sand some Gravel

A fill layer consisting of a mix of clay and granular fill material was encountered beneath the topsoil layer in Borehole 18-2 and below the rock fill layer in Borehole DOC23-1. Pieces of wood and rootlets were observed in this unit in Borehole 18-2. The top of this layer was encountered at Elevations 115.8 m and 116.9 m and had a layer thickness of 0.4 m and 1.6 m. The SPT N-values were 6 and 12; indicating a loose relative density or stiff consistency. The moisture content of two samples were 36 and 51%.

5.3 Topsoil

Topsoil with a thickness between 100 mm and 300 mm was noted at surface in all the off-road boreholes. The moisture content of two samples tested was 33 and 44%.

5.4 Clayey Silt to Clay (CL to CH)

A native deposit of clayey silt to clay was encountered in all boreholes. The top of the deposit was encountered at elevations ranging from 115.3 m to 116.7 m. The upper 0.5 m to 2.6 m of the deposit in Boreholes 18-1, 18-2, DOC19-1, DOC19-3, DOC19-4 and DOC23-1 was noted to be

a weathered crust. The total thickness of the deposit ranged from 2.9 m to 7.8 m with an underside elevation ranging from 107.6 m to 112.5 m.

SPT tests conducted in the layer gave N-values ranging from Weight of Hammer to 11. In situ shear vane test results indicated undrained shear strengths greater than 100 kPa in the crust and 25 kPa to 100 kPa below the crust indicating very stiff consistency in the crust and a firm to stiff consistency below. The measured sensitivity ranged from 3 to 21 indicating a medium sensitive to quick clay deposit (CFEM, 2006).

The moisture content of the samples tested ranged from 27 to 64%. The results of grain size analysis tests conducted on fourteen samples of this material are summarized below and are illustrated on Figures C2, C3 and C4 in Appendix C.

Table 5-2: Summary of Grain Size Distribution Testing

Soil Particle	Percentage (%)
Gravel	0 – 2
Sand	0 – 16
Silt	36 – 50
Clay	38 – 62

The results of Atterberg Limits testing carried out on fifteen samples of this material are summarized below and are illustrated on Figures C6, C7 and C8 in Appendix C. They indicate the material ranges from a clayey silt (CL) to clay of high plasticity (CH) but generally of intermediate plasticity (CI).

Table 5-3: Summary of Atterberg Limit Testing

Parameter	Value
Liquid Limit	29 – 59
Plastic Limit	16 – 25
Plasticity Index	13 – 37

It should be noted in accordance with the MTO Guideline for Foundation Engineering Services (April 2022) that where Atterberg limits tests indicate a CL material, the deposit should be described as “clayey silt”. The historical boreholes were completed prior to this version of the guideline and refer to CL material as “clay”.

The results of laboratory oedometer (one-dimensional consolidation) tests carried out on four relatively undisturbed clay samples obtained with thin-walled tube samples are presented in Appendix C and summarized below.

Table 5-4: Consolidation Test Results

Parameter	Results			
Borehole	DOC19-2	DOC19-2	DOC19-2	DOC19-2
Ground Surface Elevation, (m)	116.1	116.1	116.1	116.1
Approx. Groundwater Elevation, (m)	116.1	116.1	116.1	116.1
Sample	ST1	ST2	ST3	ST4
Sample Depth, (m)	1.2	1.8	2.4	3.0
Sample Elevation, (m)	114.9	114.3	113.7	113.1
Approx. Existing Effective Stress, P_0 , (kPa)	8	12	17	20
Moisture Content, (%)	54	52	49	55
Liquid Limit, (%)	51	42	39	37
Plastic Limit, (%)	21	20	22	20
Liquidity Index	1.1	1.45	1.59	2.06
Unit Weight, (kN/m ³)	16.5	16.5	17.0	16.6
Specific Gravity, G_s	2.790	2.790	2.790	2.790
Initial Void Ratio e_0	1.562	1.527	1.400	1.561
Pre-consolidation Pressure, P_c' , (kPa)	200	140	230	200
Over Consolidation Ratio, OCR	25.0	11.7	13.5	10.0
Compression Index, C_c	1.01	0.85	0.80	1.00
Recompression Index, C_r	0.043	0.032	0.060	0.068
Coefficient of consolidation, c_v (mm ² /s)	0.09	0.16	0.26	0.14
Coefficient of re-consolidation, c_{vr} (mm ² /s)	1.0	2.8	1.8	2.0

5.5 Glacial Till

A glacial till deposit ranging from sandy silt some clay and gravel to silty gravel with sand was encountered beneath the clayey silt to clay in all boreholes except 26-416/C1N. The top of this layer ranges from elevation 107.6 m to 112.5 m. The thickness of the layer ranges from 0.6 m to 3.0 m.

SPT tests conducted in this layer gave N-values ranging from 6 to 33, indicating a loose to dense relative density. N-values greater than 100 blows were encountered in a number of boreholes at the till/bedrock contact.

The moisture content of the samples tested ranged from 3 to 33%. The results of grain size analyses on six samples of the till are summarized below and are illustrated on Figure C5 in Appendix C. The results of Atterberg Limits testing completed on the fines of four of the samples indicated that the fines were non-plastic (ML).

Table 5-5: Summary of Grain Size Distribution Testing

Soil Particle	Percentage (%)	
Gravel	14 – 49	
Sand	37 – 50	
Silt	28 - 33	14 - 29
Clay	4 - 12	

5.6 Refusal and Bedrock

Split spoon refusal on inferred bedrock was encountered in the Borehole 18-2 at elevation 104.6 m. Auger refusal on inferred bedrock was encountered in Boreholes 29-416/C1S, 29-416/C1M and 29-416/C1N at elevations ranging from 110.3 m to 111.8 m. It is noted that refusal could also be due to cobbles and boulders in the till. Bedrock was proven by coring in Boreholes 18-1, DOC19-1, DOC19-2, DOC19-3, DOC19-4 and DOC23-1. The bedrock surface was encountered at varying elevations across the site indicating sloping bedrock conditions and a summary of the bedrock surface information is provided below:

Table 5-6: Summary of Bedrock Depth/Elevation

Borehole No.	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)
18-1	12.2	108.0
18-2	11.4*	104.6*
29-416/C1M	5.8*	110.3*
29-416/C1N	4.3*	111.8*
29-416/C1S	5.5*	111.0*
DOC19-1	5.3	110.4
DOC19-2	7.1	109.0
DOC19-3	6.4	109.8
DOC19-4	3.6	111.9
DOC23-1	13.1	106.8

Notes: * – Inferred, SPT or Auger refusal

The bedrock encountered within the cored boreholes consisted of slightly weathered to freshly weathered grey to black limestone. The bedrock in Borehole DOC19-3 was observed to be vuggy between elevation 107.9 m and 109.4 m and contain voids and a clay seam at approximate elevation 107.0 m.

The Total Core Recovery (TCR) measured on the recovered bedrock core ranged from 68 to 100%, the Solid Core Recovery (SCR) ranged from 62 to 100% and the Rock Quality Designation (RQD) ranged from 15 to 100%. Based on the measured RQD values, the bedrock is classified

as very poor to excellent quality (CFEM, 2006). Photographs of the bedrock core are provided in Appendix C.

The bedrock generally slopes downwards from north to south and east to west along the creek alignment.

5.7 Groundwater Conditions

The water level in Dochart Creek was measured at an approximate elevation of 115.5 m on November 26th, 2019. One 50 mm diameter monitoring well (DOC23-1) and two 38 mm diameter monitoring wells (DOC19-1 and DOC19-4) were installed at the site during the current investigation. Two 25 mm diameter piezometers were installed in boreholes from the previous investigations. Artesian conditions were noted at different locations across the site during and upon completion of drilling in Borehole 18-2, DOC19-1 and DOC 19-4 originating from the glacial till layer. The non-stabilized artesian level in Borehole 18-2 was measured at least 0.6 m above the ground surface or elevation 116.6 m; the artesian flow was sealed at the source with bentonite pellets while decommissioning the borehole. Groundwater levels from wells and piezometers are presented below:

Table 5-7: Summary of Groundwater Levels

Borehole No.	Depth (mbgs)	Groundwater Elevation (m)	Date of Measurement	Notes
18-2	-0.6	116.6	June 26, 2018	25mm Standpipe Piezometer
29-416/C1M	0.0	116.1	June 1, 2005	25mm Standpipe Piezometer
	-0.8	116.9	April 21, 2020	
	-0.6	116.7	April 28, 2020	
	-1.0	117.1	May 4, 2020	
	-0.1	116.2	July 20, 2021	
DOC19-1	-0.9	116.6	November 26, 2019	38mm Monitoring Well
	> -1.3	>117.0	April 21, 2020	
	> -1.1	>116.8	April 28, 2020	
	-1.5	117.2	May 4, 2020	
	-0.7	116.4	July 20, 2021	
	-0.7	116.4	March 9, 2022	
DOC19-4	-0.2	115.7	November 26, 2019	38mm Monitoring Well
	-0.3	115.8	April 21, 2020	
	-0.1	115.6	April 28, 2020	
	-0.4	115.9	May 4, 2020	
	-0.1	115.6	March 9, 2022	
DOC23-1	3.9	116.1	March 20, 2024	50mm Monitoring Well
	3.8	116.1	April 9, 2024	

Borehole No.	Depth (mbgs)	Groundwater Elevation (m)	Date of Measurement	Notes
	3.8	116.1	May 1, 2024	
	3.8	116.1	June 27, 2024	
Creek Water Level	N/A	115.5	November 26, 2019	Creek near DOC19-1
Creek Water Level	N/A	116.44	N/A	2-yr Flow (from GA Drawing)

Note: Negative depth indicates above ground/artesian conditions

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.

5.8 Analytical Testing

Samples of the native soils were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate, sulphides, chloride concentrations, resistivity and electrical conductivity. The analysis results are summarized below and provided in Appendix C.

Table 5-8: Results of Chemical Analysis

Sample	Depth (m)	pH	Resistivity (Ohm-cm)	Chloride (µg/g)	Sulphate (µg/g)	Sulphide (%)	Conductivity µS/cm
18-2 SS3	1.5	7.8	1300	393	77	<0.02	770
DOC19-1 SS2	1.1	7.8	1170	439	53	0.10	852
DOC19-4SS1	0.3	7.5	2410	52	42	0.04	415
DOC23-1 SS7	4.9	7.1	600	682	29	0.01	1660



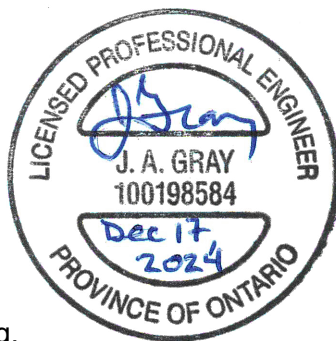
6 MISCELLANEOUS

Borehole locations were selected by Thurber relative to the proposed westbound centerline and to the existing culverts. 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.

For the 2019/2024 investigation, Marathon Drilling of Greely, Ontario and Eastern Ontario Diamond Drilling of Hawkesbury, Ontario supplied and operated the drilling equipment and carried out the drilling, soil sampling, in-situ testing, well installation and borehole decommissioning. The field investigation was supervised on a full-time basis by Mr. Michel Johnston and Mr. Darlan Amorim Pereira of Thurber. Overall supervision of the investigation program was provided by Mr. Justin Gray, P.Eng.

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

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



Justin Gray, P.Eng.
Geotechnical Engineer



Dr. Fred Griffiths, P.Eng.
Senior Associate

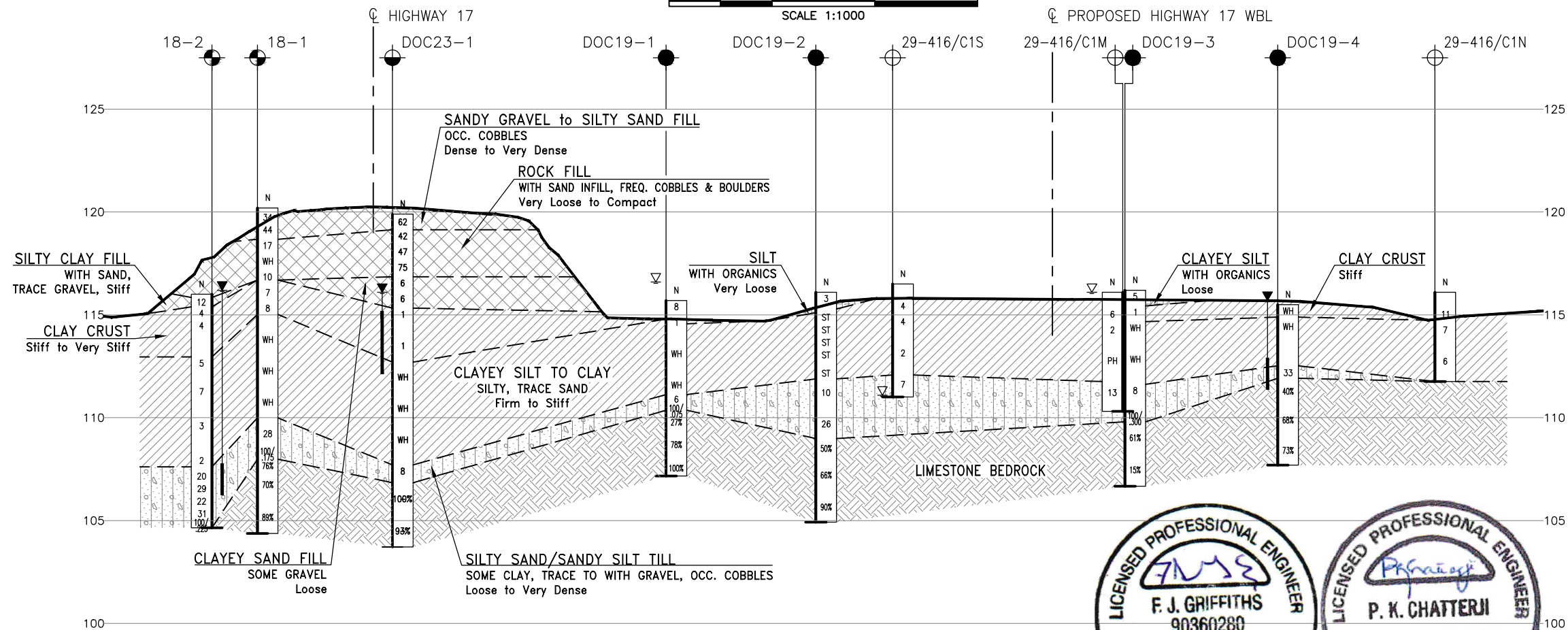
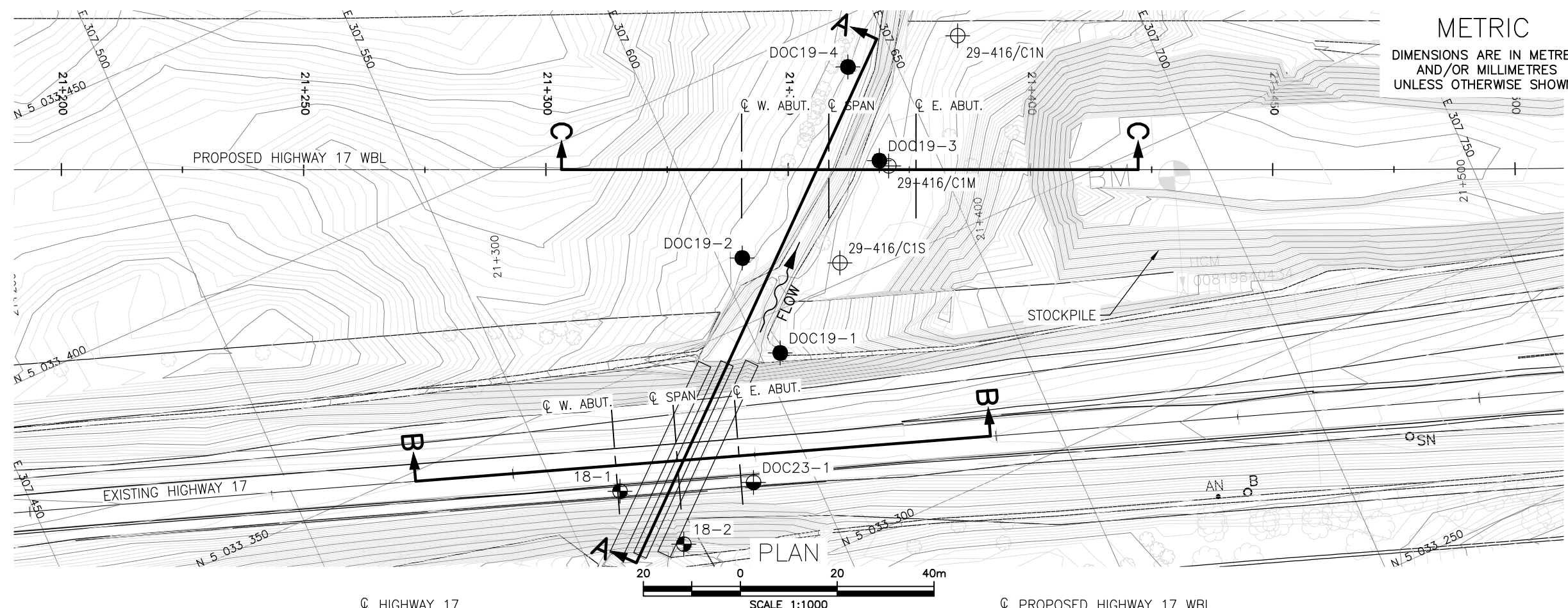


Dr. P.K. Chatterji, P.Eng.
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Appendix A.

Borehole Location Plan and Stratigraphic Drawings



SECTION A-A



H 1:500

V 1:250

CONT No
WP No 4068-09-00HIGHWAY 17 TWINNING
DOCHART CREEK
CULVERTS
BOREHOLE LOCATIONS AND SOIL STRATA

Ontario



KEYPLAN

LEGEND

	Borehole (2024 Investigation)
	Borehole (2019 Investigation)
	Borehole (2018 Investigation)
	Borehole (2005 Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

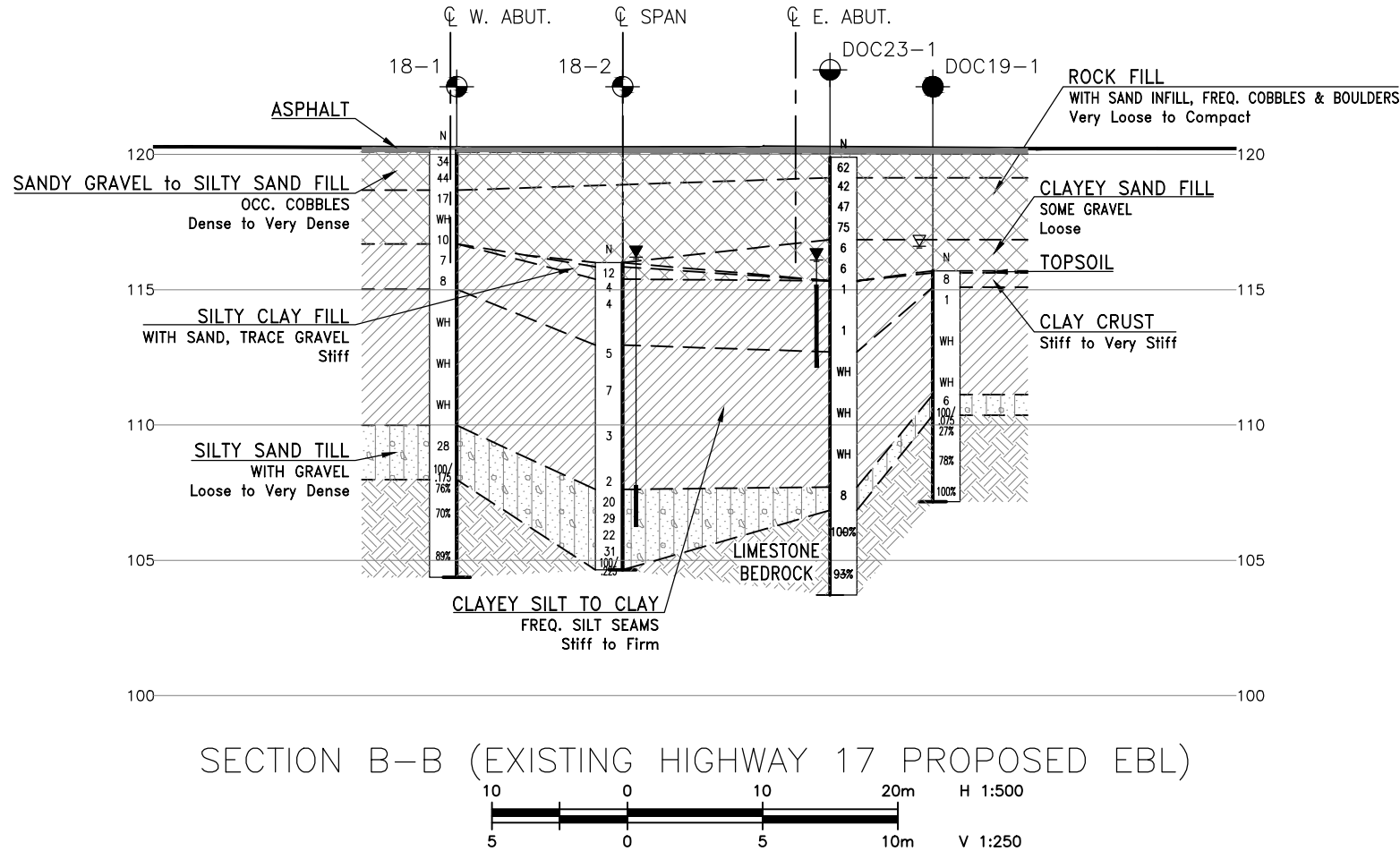
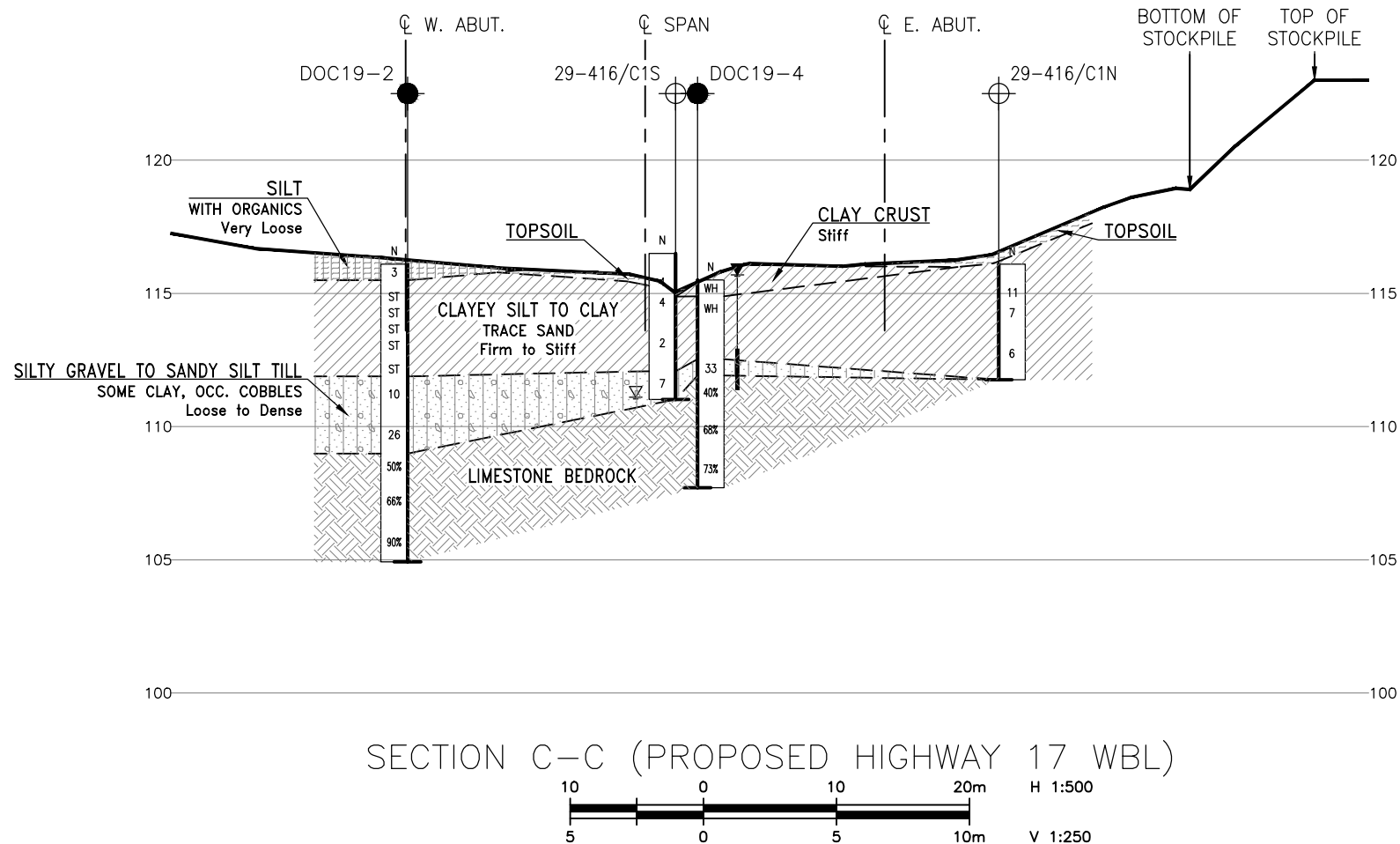
NO	ELEVATION	NORTHING	EASTING
18-1	120.2	5 033 329.1	307 562.1
18-2	116.0	5 033 313.8	307 569.7
29-416/C1M	116.1	5 033 368.0	307 640.0
29-416/C1N	116.1	5 033 386.8	307 663.9
29-416/C1S	116.5	5 033 353.8	307 622.7
DOC19-1	115.7	5 033 341.8	307 603.9
DOC19-2	116.1	5 033 362.9	307 604.7
DOC19-3	116.2	5 033 369.8	307 638.7
DOC19-4	115.5	5 033 390.1	307 640.6
DOC23-1	119.9	5 033 319.6	307 588.0

-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-219

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	JG	CHK -	CODE
DRAWN	MFA	CHK JG	SITE
LOAD	DATE	JUL 2024	
STRUCT	DWG	1	



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



CONT No
WP No 4068-09-00

HIGHWAY 17 TWINNING
DOCHART CREEK
CULVERTS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Ontario



KEYPLAN

LEGEND

	Borehole (2024 Investigation)
	Borehole (2019 Investigation)
	Borehole (2018 Investigation)
	Borehole (2005 Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
18-1	120.2	5 033 329.1	307 562.1
18-2	116.0	5 033 313.8	307 569.7
29-416/C1M	116.1	5 033 368.0	307 640.0
29-416/C1N	116.1	5 033 386.8	307 663.9
29-416/C1S	116.5	5 033 353.8	307 622.7
DOC19-1	115.7	5 033 341.8	307 603.9
DOC19-2	116.1	5 033 362.9	307 604.7
DOC19-3	116.2	5 033 369.8	307 638.7
DOC19-4	115.5	5 033 390.1	307 640.6
DOC23-1	119.9	5 033 319.6	307 588.0

-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.

GEORES No. 31F-219

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	JG	CHK -	CODE
DRAWN	MFA	CHK JG	SITE
LOAD			
STRUCT			
DWG	2		
DATE	JUL 2024		



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).

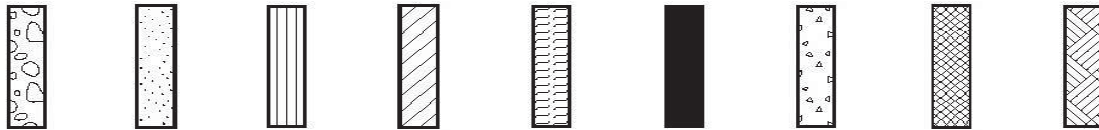
DYNAMIC CONE PENETRATION TEST (DCPT):

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

METRIC

[illegible]

DOUBLE LINE 24726 DOCHART CREEK.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No DOC19-2

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.440193°, Long: -76.46415°
Dochart Creek, MTM zone 9: N 5 033 362.9 E 307 604.7 ORIGINATED BY MJ
HWY 17 BOREHOLE TYPE CME45 Track Mount, HSA, NQ Coring COMPILED BY JG
DATUM Geodetic DATE 2019.10.18 - 2019.10.18 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					
116.1	Ground Surface							20 40 60 80 100					
0.0	200 mm Topsoil							20 40 60 80 100					
0.2	CLAY (Cl) stiff brown to grey		1	SS	3		116						
			1	ST			115						
			2	ST									
			3	ST			114						
			4	ST									
			5	ST			113						
111.9							112						
4.2	GRAVEL, silty with sand Compact Grey (TILL)		2	SS	10								
			3	SS	26								
109.0							109						
7.1	LIMESTONE BEDROCK Slightly Weathered Foliated Grey		1	RUN			108						
			2	RUN									

Continued Next Page

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

DOUBLE LINE 24726 DOCHART CREEK.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No DOC19-3

1 OF 1

METRIC

WP# 4068-09-00 LOCATION Lat: 45.440254°, Long: -76.463715°
Dochart Creek, MTM zone 9: N 5 033 369.8 E 307 638.7 ORIGINATED BY MJ
HWY 17 BOREHOLE TYPE CME45 Track Mount, HSA, NQ Coring COMPILED BY JG
DATUM Geodetic DATE 2019.10.21 - 2019.10.21 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				
116.2	Ground Surface							20 40 60 80 100		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		
0.0	300 mm Topsoil									W _P W W _L		
115.9			1	SS	5		116					
0.3	CLAY (Cl) crust Stiff Brown		2	SS	1		115					0 3 47 50
114.7												
1.5	CLAY (Cl) Firm to Stiff Grey		3	SS	WH		114					
			4	SS	WH		113					
							112					
111.6												
4.6	Silty SAND with gravel Loose Grey (TILL) -poor sample recovery		5	SS	8		111					
							110					
109.8			6	SS	100/ 300mm							
6.4	LIMESTONE BEDROCK Slightly Weathered Foliated Grey Fair to poor quality -vugs from 6.8 m to 7.2 m		1	RUN			109					RUN #1 TCR=95% SCR=90% RQD=61%
	-vugs from 7.9 m to 8.3 m						108					
	-voids/broken rock from 9.1 m to 9.3 m - 50 mm clay seam at 9.3 m		2	RUN			107					RUN #2 TCR=79% SCR=65% RQD=15%
106.7												
9.5	End of Borehole											

DOUBLE LINE 24726 DOCHART CREEK GPJ 2012TEMPLATE(MTO).GDT 12-16-24

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

RECORD OF BOREHOLE No DOC19-4

1 OF 1

METRIC

WP# 4068-09-00 LOCATION Lat: 45.440438°, Long: -76.46369°
Dochart Creek, MTM zone 9: N 5 033 390.1 E 307 640.6 ORIGINATED BY MJ
HWY 17 BOREHOLE TYPE CME45 Track Mount, HSA, NQ Coring COMPILED BY JG
DATUM Geodetic DATE 2019.10.18 - 2019.10.18 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										
115.5	Ground Surface							20	40	60	80	100						
0.0	100 mm TOPSOIL																	
0.1	CLAY (Cl) crust Stiff Brown		1	SS	WH		115											
114.9	CLAY (Cl) Firm to Stiff Grey		2	SS	WH		114											
0.6							113	8.0		9.3								
									7.0									
									4.8									
112.5	GRAVEL, silty with sand Dense Grey (TILL)		3	SS	33		112											
111.9	LIMESTONE BEDROCK Slightly Weathered to Fresh Grey to Grey-Black Poor to fair quality Broken from 3.6 m to 3.7 m		1	RUN			111											
3.6							110											
			2	RUN			109											
			3	RUN			108											
107.7	End of Borehole																	
7.8	1.0 m stickup on well WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2019.11.26 0.2 above g.s. 115.7 2020.04.21 0.3 above g.s. 115.8 2020.04.28 0.1 above g.s. 115.6 2020.05.04 0.4 above g.s. 115.9 2022.03.09 0.1 above g.s. 115.6																	

DOUBLE LINE 24726 DOCHART CREEK GPJ 2012TEMPLATE(MTO)GDT 12-16-24

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

RECORD OF BOREHOLE No DOC23-1

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.439803°, Long: -76.464363° Dochart Creek Bridge MTM Zone 9: N 5 033 319.6 E 307 588.0 ORIGINATED BY DAP
HWY 17 BOREHOLE TYPE CME 75 Truckmount / HSA / NW Casing / NQ Coring COMPILED BY RH/AO
DATUM Geodetic DATE 2024.03.11 - 2024.03.11 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						WATER CONTENT (%) PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L						
119.9	Paved Shoulder							20	40	60	80	100								
0.0	ASPHALT (80 mm)							20	40	60	80	100								
0.1	SILTY SAND with gravel very dense yellowish brown FILL		1	SS	62															
119.1	COBBLES and BOULDERS with greyish brown sand infills ROCKFILL		2	SS	42															
0.8			3	SS	47															
			4	SS	75															
116.9	CLAYEY SAND some gravel loose greyish brown FILL		5	SS	6															
3.0			6	SS	6															
115.3	SILTY CLAY (Cl) crust very stiff grey		7	SS	1															
4.6			8	SS	1															
112.7	SILTY CLAY (Cl) stiff grey		9	SS	WH															
7.2			10	SS	WH															

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
5
0
-5
-10
-15
-20
(%) STRAIN AT FAILURE

DOUBLE LINE 24726 DOCHART CREEK.GPJ 2012TEMPLATE(MTO).GDT 12-12-24

RECORD OF BOREHOLE No DOC23-1

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.439803°, Long: -76.464363° Dochart Creek Bridge MTM Zone 9: N 5 033 319.6 E 307 588.0 ORIGINATED BY DAP
HWY 17 BOREHOLE TYPE CME 75 Truckmount / HSA / NW Casing / NQ Coring COMPILED BY RH/AO
DATUM Geodetic DATE 2024.03.11 - 2024.03.11 CHECKED BY JG

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								
	Continued From Previous Page							20	40	60	80	100				
								○ UNCONFINED	+ FIELD VANE							
								● QUICK TRIAXIAL	× LAB VANE							
								20	40	60	80	100	20	40	60	
107.7	SILTY CLAY (CI) stiff grey															
			11	SS	WH		109							○		
							108			10.7 +						
										6.6 +						
12.2	SILTY SAND some gravel loose grey (TILL)		12	SS	8		107									14 41 33 12
106.8																
13.1	MARBLE BEDROCK slightly weathered to fresh jointed light to dark grey medium grained strong		1	RUN	-		106									RUN #1 TCR=100% SCR=75% RQD=100%
							105									
			2	RUN	-		104									RUN #2 TCR=100% SCR=90% RQD=93% UCS=93MPa
103.7																
16.2	End of Borehole															
	Monitoring Well installed: Schedule 40 PVC standpipe with 50-mm diameter and 3.0-m slotted screen. Flushmount cover installed at ground surface. Water Level Readings: DATE DEPTH (m) ELEV. (m) 2024/03/20 3.8 116.1 2024/04/09 3.8 116.1 2024/05/01 3.8 116.1 2024/06/27 3.8 116.1															

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

RECORD OF BOREHOLE No 18-1

1 OF 2

METRIC

GWP# 4076-13-00 LOCATION Lat: 45.4398887°, Long: -76.4646941° MTM Zone 9: N 5 033 329.1 E 307 562.1 ORIGINATED BY CM
 HWY 17 BOREHOLE TYPE HSA / HW casing COMPILED BY CM
 DATUM Geodetic DATE 2018.06.06 - 2018.06.07 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				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					
120.2								20 40 60 80 100					
0.0								20 40 60 80 100					
0.1	110 mm ASPHALT												
	Sandy gravel some silt, occasional cobbles Dense Grey Dry FILL		1	SS	34								
			2	SS	44								47 45 8 (SI+CL)
118.7													
1.5	Rock fill with sand infill - frequent cobbles and boulders Very loose to compact Brown ROCK FILL - borehole advanced by tri-cone from 1.5 m to 3.5 m		3	SS	17								
			4	SS	WH								
			5	SS	10								
116.7													
3.5	CLAY (CH) Crust - Slight mottling Very Stiff Grey to brown		6	SS	7								
			7	SS	8								0 8 43 49
115.0													
5.2	CLAY (CI) Stiff to firm Grey												
			8	SS	WH								0 0 48 52
			9	SS	WH								
			10	SS	WH								
				</									

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

DOUBLE_LINE DOCHART CREEK CULVERT.GPJ 2012TEMPLATE(MTO).GDT 6/7/18

RECORD OF BOREHOLE No 18-1

2 OF 2

METRIC

GWP# 4076-13-00 LOCATION Lat: 45.4398887°, Long: -76.4646941°
MTM Zone 9: N 5 033 329.1 E 307 562.1 ORIGINATED BY CM
HWY 17 BOREHOLE TYPE HSA / HW casing COMPILED BY CM
DATUM Geodetic DATE 2018.06.06 - 2018.06.07 CHECKED BY KP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				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					
								WATER CONTENT (%)					
	Continued From Previous Page						20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT			
110.0								W P	W	W L			
10.2	SILTY SAND (SM) with Gravel TILL Compact to very dense Grey		11	SS	28							17 47 30 6 Non-plastic	
108.0			12	SS	100/ 175mm								
12.2	LIMESTONE BEDROCK Slightly weathered to fresh Close joint spacing Fair to good quality Grey to black		1	RUN								RUN #1 TCR=100% SCR=100% RQD=76% RUN #2 TCR=91% SCR=81% RQD=70%	
			2	RUN									
			3	RUN								RUN #3 TCR=100% SCR=98% RQD=89%	
104.4													
15.8	End of Borehole												

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 18-2

2 OF 2

METRIC

GWP# 4076-13-00 LOCATION Lat: 45.4397509° Long: -76.464597° MTM Zone 9: N 5 033 313.8 E 307 569.7 ORIGINATED BY SOB
 HWY 17 BOREHOLE TYPE Portable - full weight hammer COMPILED BY CM
 DATUM Geodetic DATE 2018.06.06 - 2018.06.06 CHECKED BY KP

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					
	Continued From Previous Page		10	SS	22												
			11	SS	31												
104.6			12	SS	100/ 225mm		105										
11.4	End of Borehole on Inferred Bedrock Groundwater measured at least 0.6 m above existing grade or elevation 116.6 m on 2018-06-26																

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

RECORD OF BOREHOLE No 29-416/C1N

1 OF 1

METRIC

W.P. 647-92-01 LOCATION N 5 033 386.8 E 307 663.9 ORIGINATED BY SL
 HWY 17/ 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JL/HS
 DATUM Geodetic DATE 26.05.05 - 26.05.05 CHECKED BY MRA

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							
116.1								20 40 60 80 100							
0.0	TOPSOIL (250mm)						116								
115.8															
0.3	Silty CLAY , trace sand Stiff to Firm Brown Moist		1	SS	11		115								
			2	SS	7		114								
								30 +							
							113								
	Becoming Grey		3	SS	6										
							112								
111.8															
4.3	END OF BOREHOLE AT 4.34 m. AUGER REFUSAL AT 4.34 m ON PROBABLE BEDROCK OR BOULDERS. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE.														

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 29-416/C1M

1 OF 1

METRIC

W.P. 647-92-01 LOCATION N 5 033 368.0 E 307 640.0 ORIGINATED BY SL
 HWY 17/417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JL/HS
 DATUM Geodetic DATE 26.05.05 - 26.05.05 CHECKED BY MRA

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		WATER CONTENT (%) w _P w w _L				
116.1								20 40 60 80 100						
0.0	TOPSOIL (250mm)													
115.8														
0.3	Silty CLAY, trace sand Firm Brown Moist		1	SS	6									
	Becoming Grey		2	SS	2									0 2 47 51
			1	TW	PH									
111.8														
4.3	Sandy SILT, some clay and gravel Compact Grey Wet (TILL)		3	SS	13									
110.3														
5.8	END OF BOREHOLE AT 5.79 m. AUGER REFUSAL AT 5.79 m ON PROBABLE BEDROCK OR BOULDERS. Piezometer installation consists of 25 mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) 01/06/05 0.00													

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 29-416/C1S

1 OF 1

METRIC

W.P. 647-92-01 LOCATION N 5 033 353.8 E 307 622.7 ORIGINATED BY SL
 HWY 17/ 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JL/HS
 DATUM Geodetic DATE 26.05.05 - 26.05.05 CHECKED BY MRA

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							
116.5								20 40 60 80 100							
0.0	TOPSOIL (200mm)														
0.2	Silty CLAY Firm Brown Moist						116								
			1	SS	4										
							115								
			2	SS	4										
							114								
	Becoming Grey		3	SS	2		113								0 2 48 50
112.1															
4.4	Sandy SILT, some clay, trace gravel and cobbles Loose Grey Wet (TILL)		4	SS	7		112								
111.0															
5.5	END OF BOREHOLE AT 5.49 m. AUGER REFUSAL AT 5.49m. BOREHOLE OPEN TO 5.49 m AND WATER LEVEL AT 5.40 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE.														



Appendix C.
Laboratory Testing



Appendix C.1

Particle Size Analysis Figures

Atterberg Limit Test Results

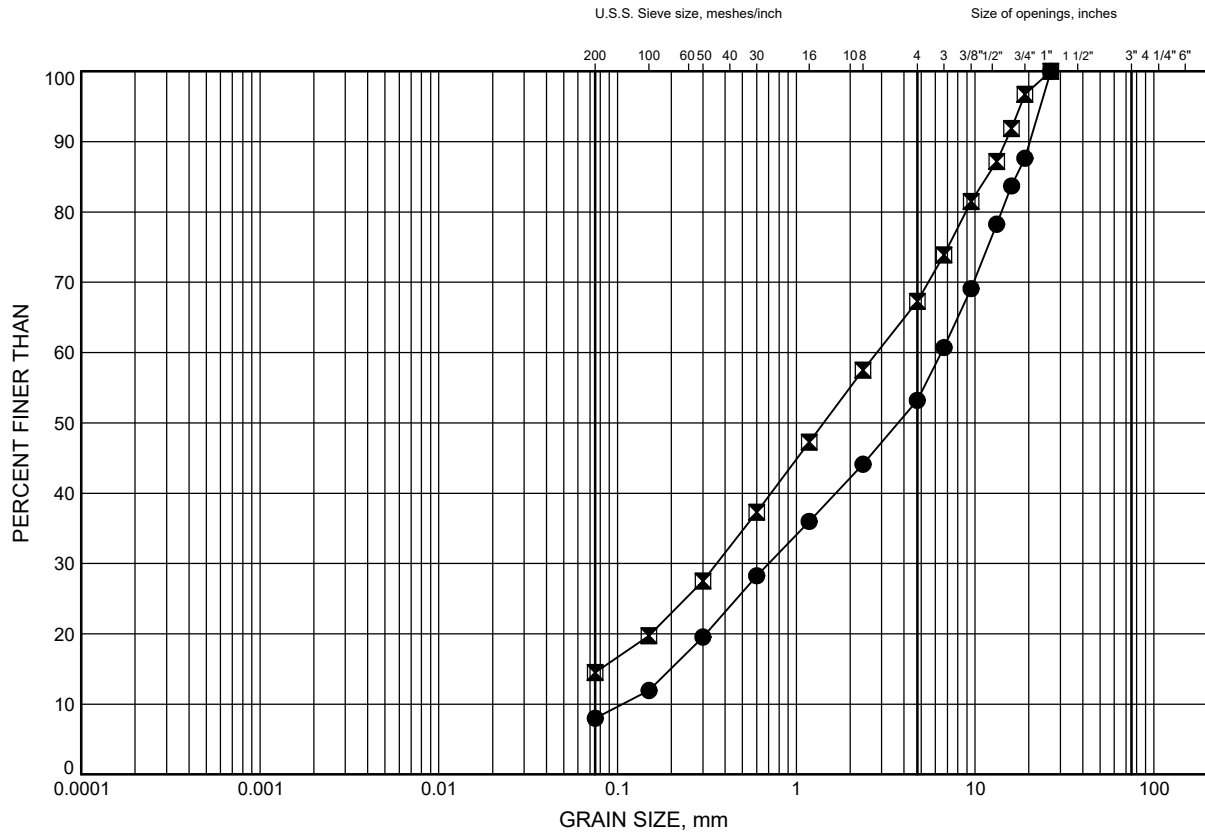
One-Dimensional Consolidation Test Results

Highway 17 Twinning

GRAIN SIZE DISTRIBUTION

FIGURE C1

Pavement Structure FOS



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-1	1.07	119.12
⊠	DOC23-1	0.38	119.52

Date July 2024
Project 4068-09-00



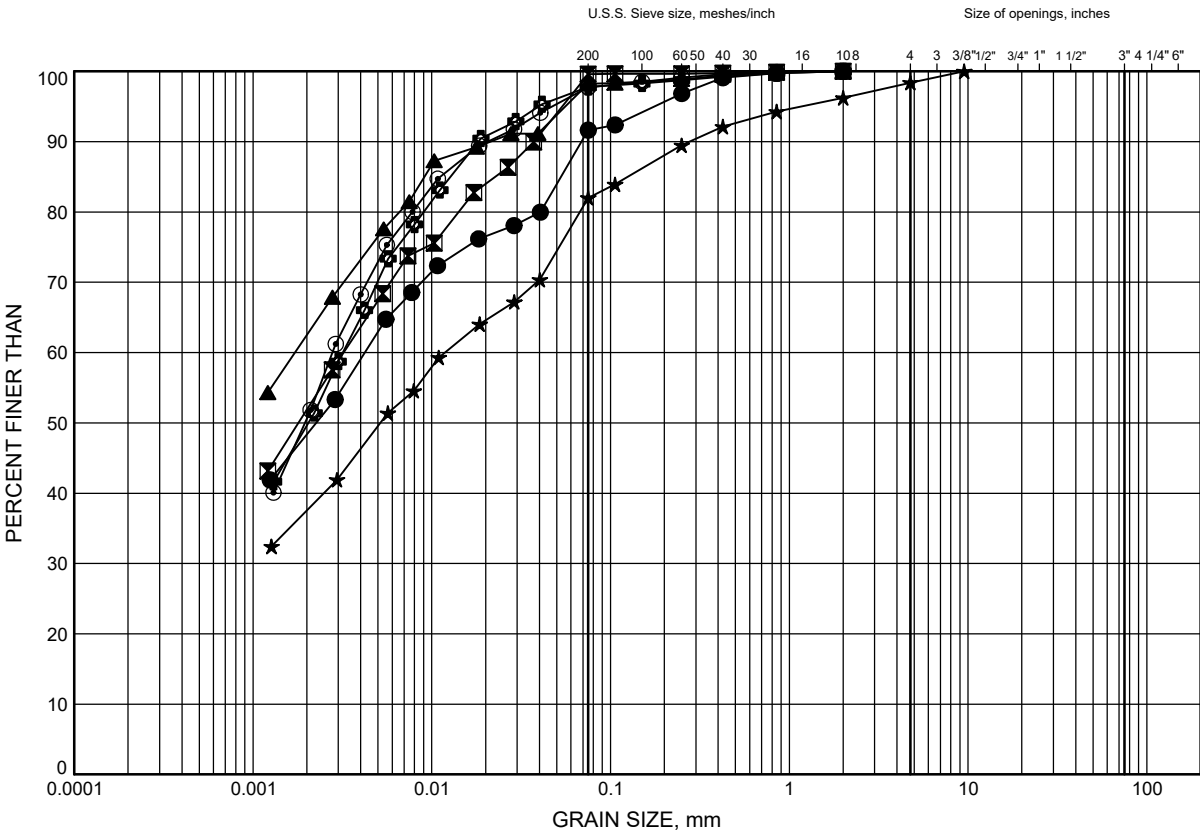
Prep'd JG
Chkd. FG

Highway 17 Twinning

GRAIN SIZE DISTRIBUTION

FIGURE C2

Clayey SILT to CLAY (CL-CH)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-1	4.88	115.31
⊠	18-1	6.40	113.78
▲	18-2	0.91	115.09
★	18-2	8.08	107.92
⊙	29-416/C1M	1.83	114.27
⊕	29-416/C1S	3.35	113.15

Date July 2024

Project 4068-09-00



Prep'd JG

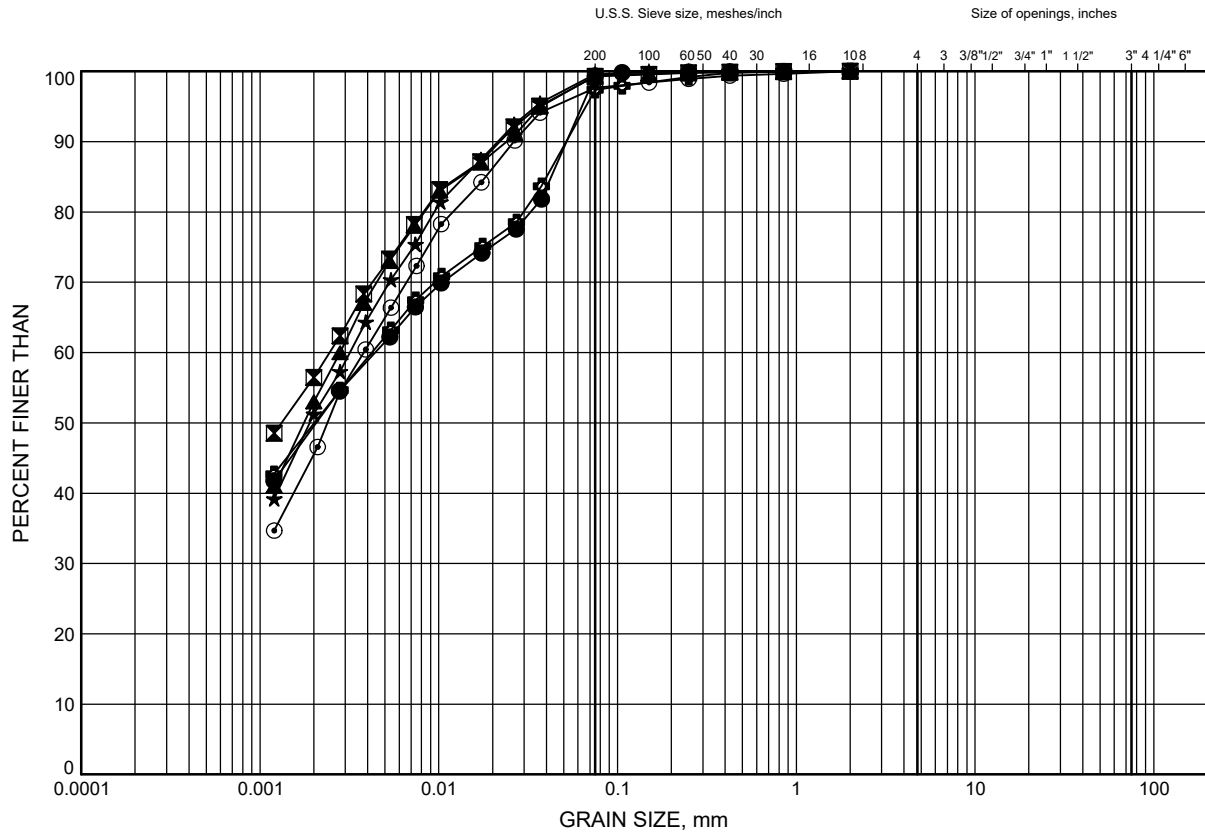
Chkd. FG

Highway 17 Twinning

GRAIN SIZE DISTRIBUTION

FIGURE C3

Clayey SILT to CLAY (CL-CH)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	DOC19-1	2.59	113.11
⊠	DOC19-2	1.22	114.88
▲	DOC19-2	1.83	114.27
★	DOC19-2	2.44	113.66
⊙	DOC19-2	3.05	113.05
⊕	DOC19-3	1.07	115.13

Date July 2024
Project 4068-09-00



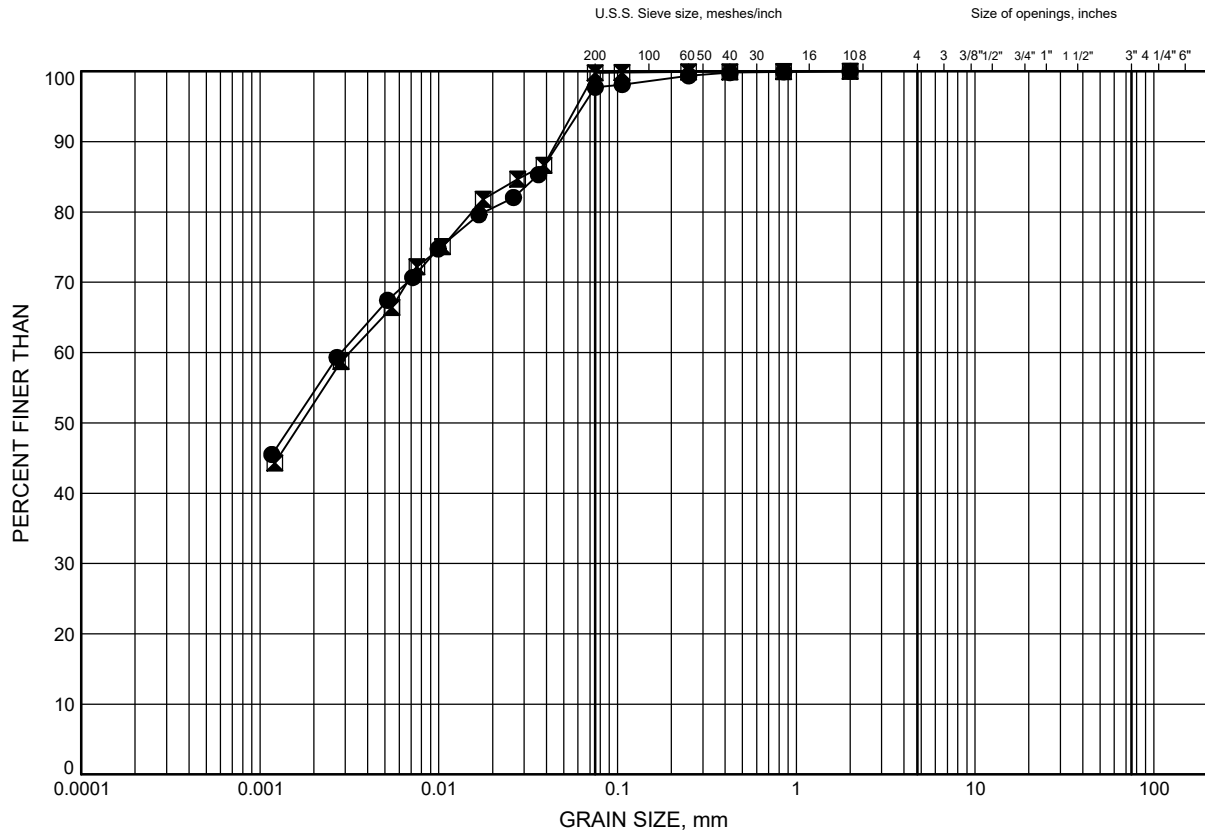
Prep'd JG
Chkd. FG

Highway 17 Twinning

GRAIN SIZE DISTRIBUTION

FIGURE C4

Clayey SILT to CLAY (CLAY CH)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	DOC19-4	1.07	114.43
⊠	DOC23-1	6.40	113.50

Date July 2024
Project 4068-09-00



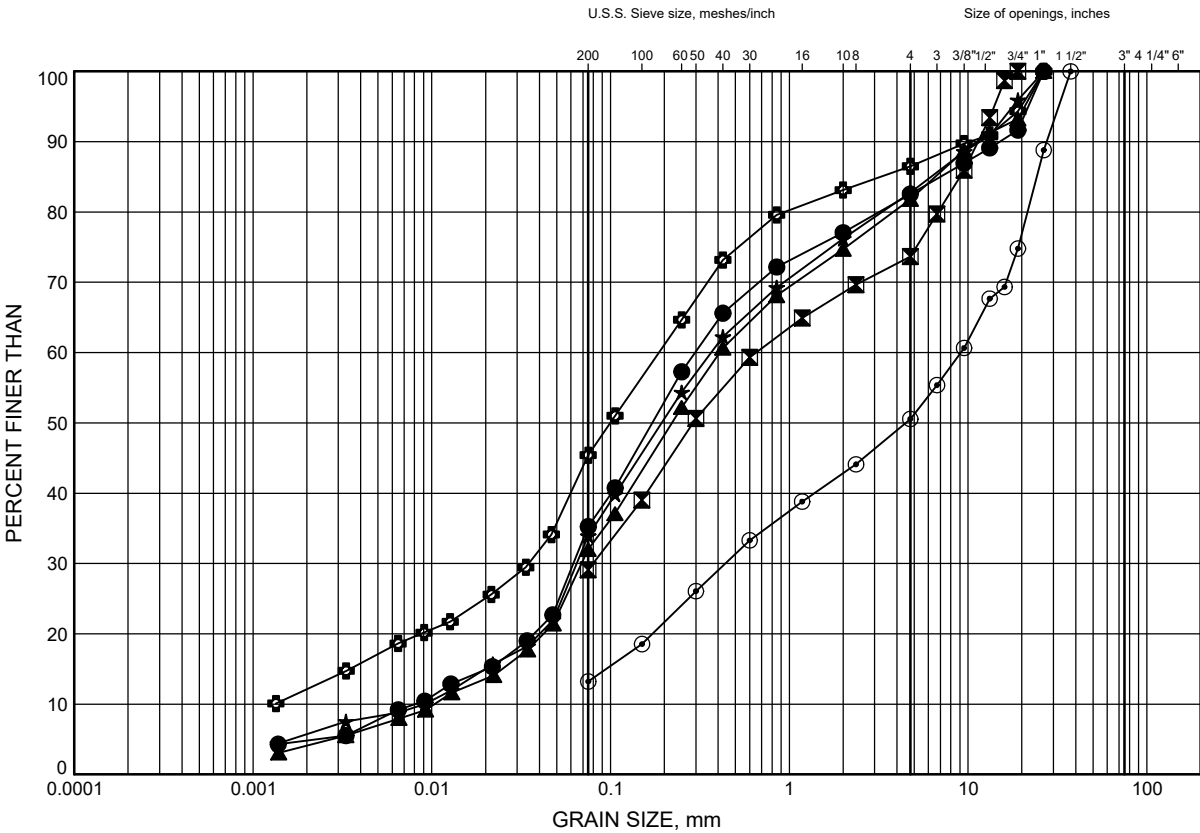
Prep'd JG
Chkd. FG

Highway 17 Twinning

GRAIN SIZE DISTRIBUTION

FIGURE C5

Glacial TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-1	10.97	109.21
⊠	18-2	9.45	106.55
▲	18-2	10.67	105.33
★	DOC19-1	4.88	110.82
⊙	DOC19-2	6.40	109.70
⊗	DOC23-1	12.50	107.40

Date July 2024
Project 4068-09-00

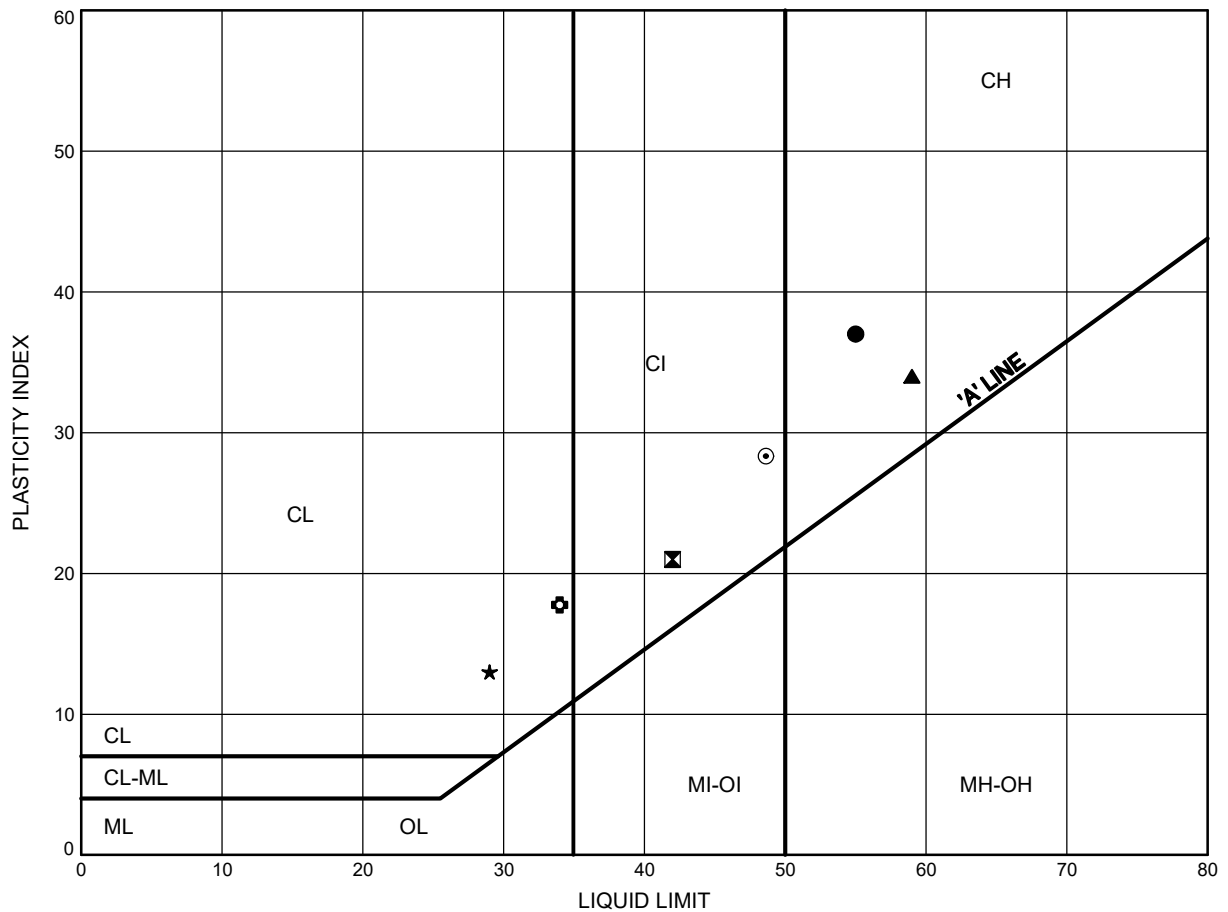


Prep'd JG
Chkd. FG

Highway 17 Twinning ATTERBERG LIMITS TEST RESULTS

FIGURE C6

Clayey SILT to CLAY (CL to CH)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-1	4.88	115.31
⊠	18-1	6.40	113.78
▲	18-2	0.91	115.09
★	18-2	8.08	107.92
⊙	29-416/C1M	1.83	114.27
⊕	29-416/C1N	3.35	112.75

Date July 2024
Project 4068-09-00



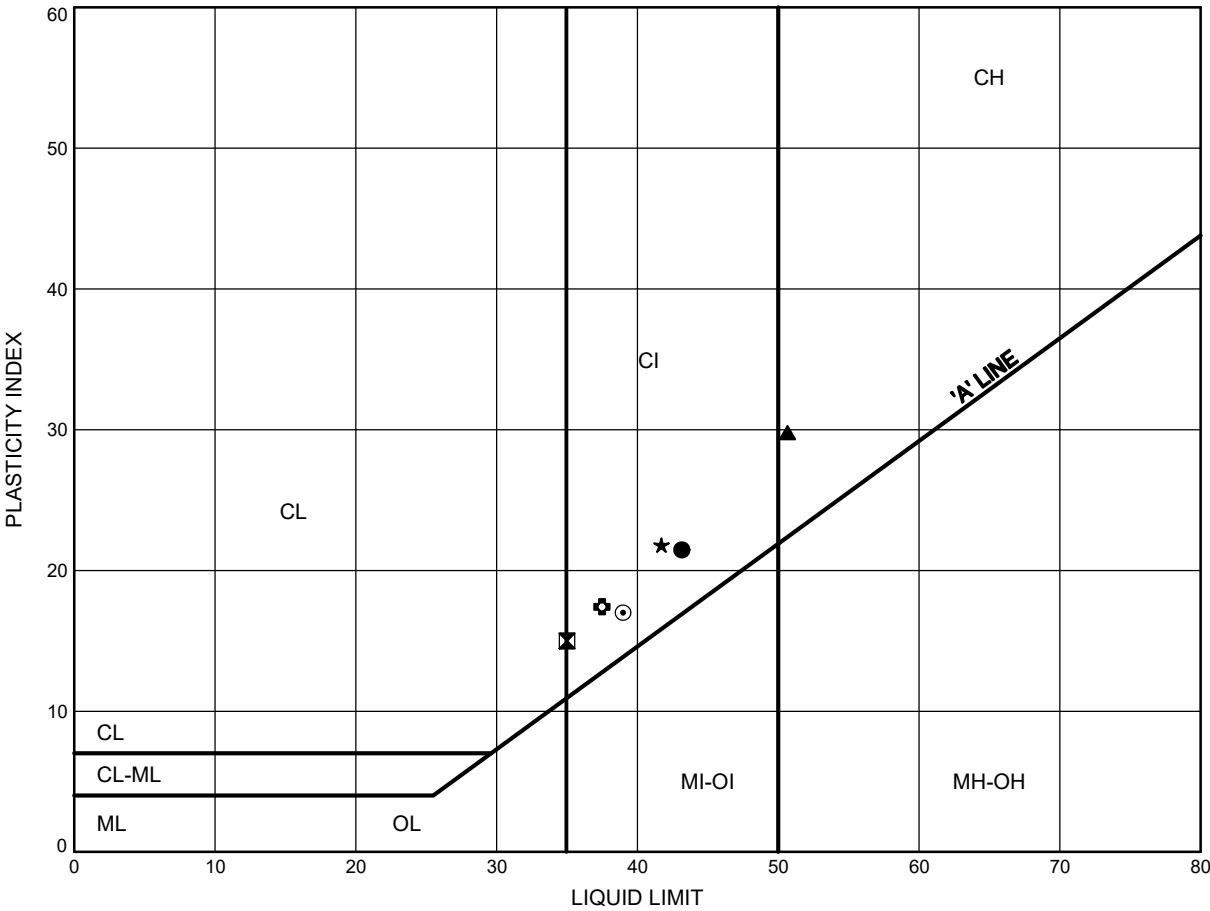
Prep'd JG
Chkd. FG

Highway 17 Twinning

ATTERBERG LIMITS TEST RESULTS

FIGURE C7

Clayey SILT to CLAY (CL to CH)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	29-416/C1S	3.35	113.15
⊠	DOC19-1	2.59	113.11
▲	DOC19-2	1.22	114.88
★	DOC19-2	1.83	114.27
⊙	DOC19-2	2.44	113.66
⊕	DOC19-2	3.05	113.05

Date July 2024
Project 4068-09-00

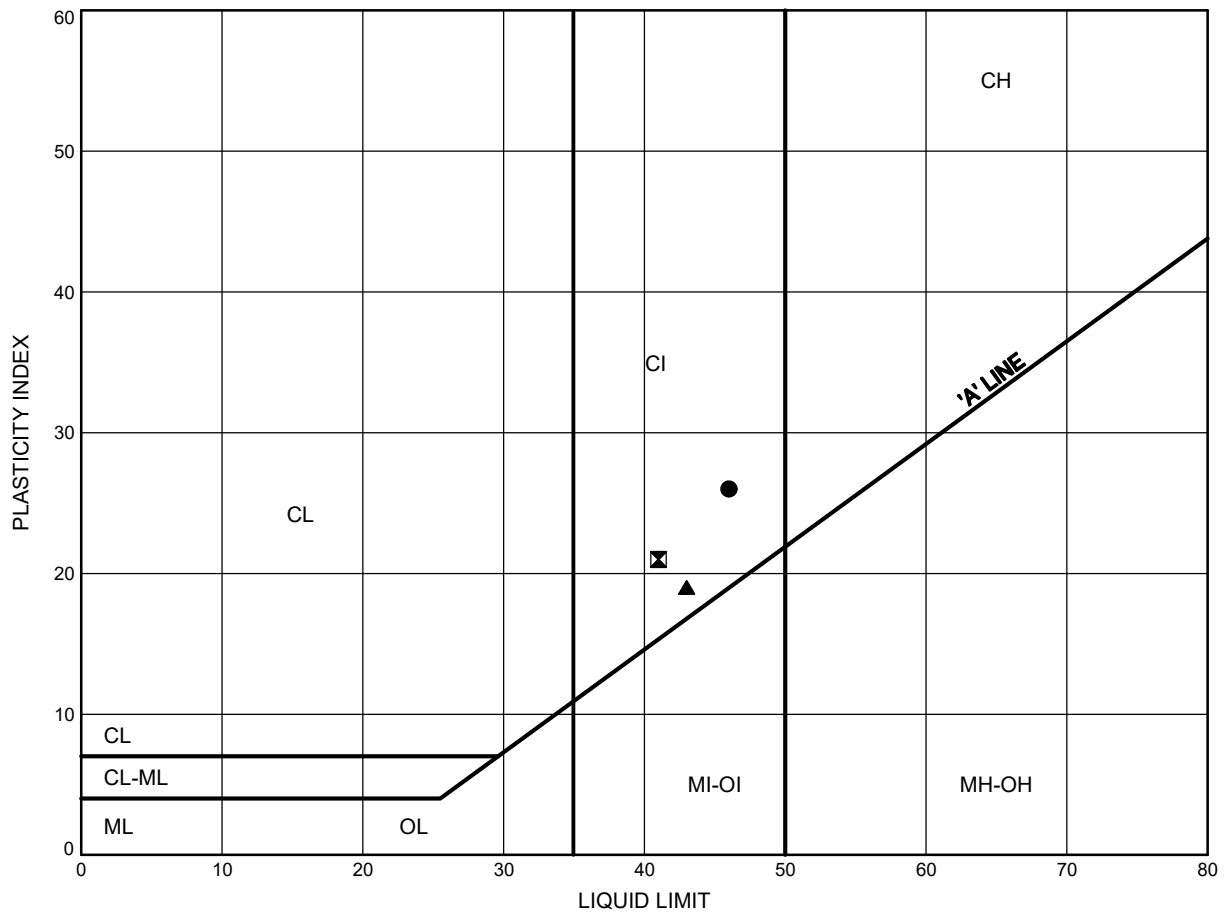


Prep'd JG
Chkd. FG

Highway 17 Twinning ATTERBERG LIMITS TEST RESULTS

FIGURE C8

Clayey SILT to CLAY (CL to CH)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	DOC19-3	1.07	115.13
⊠	DOC19-4	1.07	114.43
▲	DOC23-1	6.40	113.50

Date July 2024
Project 4068-09-00

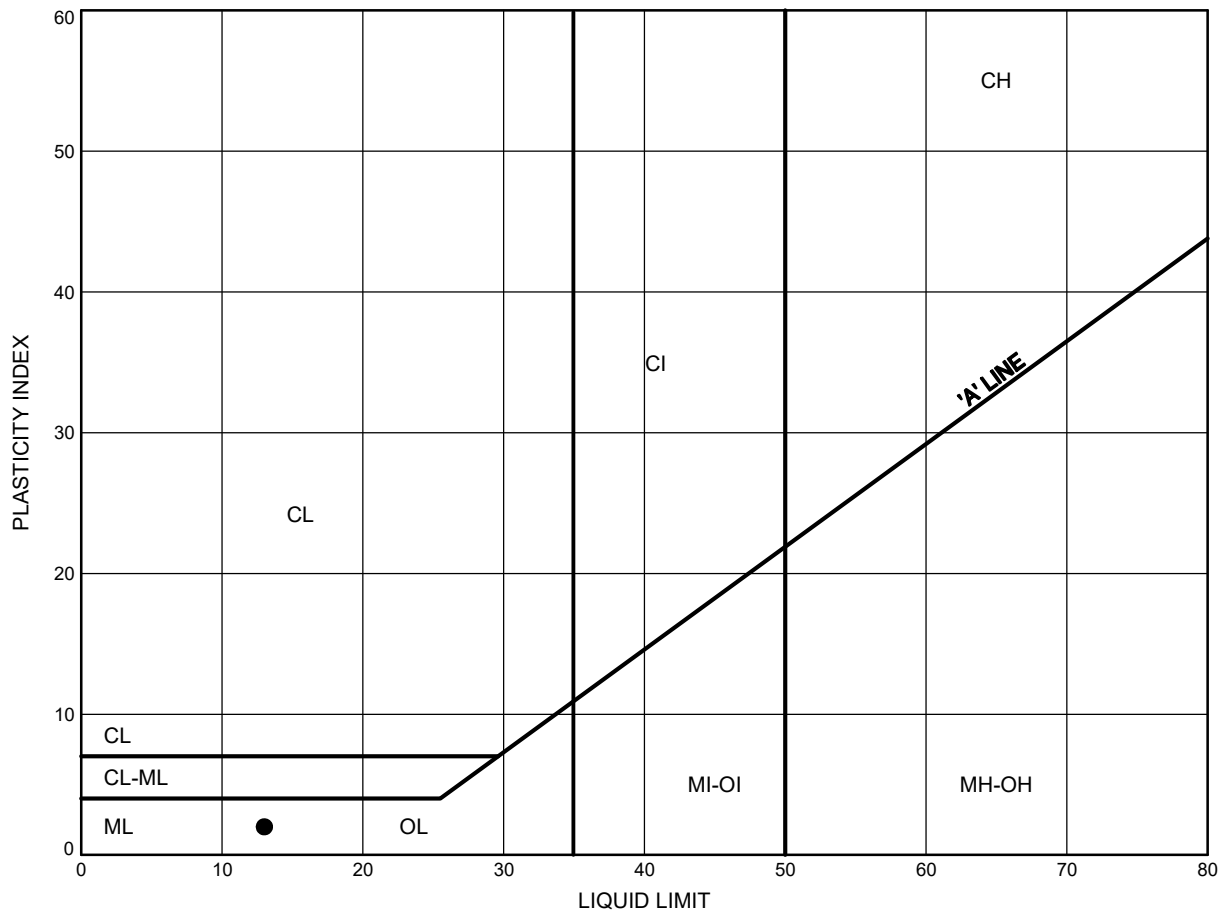


Prep'd JG
Chkd. FG

Highway 17 Twinning
ATTERBERG LIMITS TEST RESULTS

FIGURE C9

Glacial TILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	DOC23-1	12.50	107.40

Date July 2024
Project 4068-09-00



Prep'd JG
Chkd. FG

Consolidation Test Report

CLIENT: **Thurber Engineering (Ottawa)**

FILE NUMBER: **24726**

PROJECT: **Highway 17 Twinning - Renfrew**

REPORT DATE: **January 17, 2020**

TEST DATES: **November 20, 2019 - December 01, 2019**

SAMPLE: **DOC 19-2 ST1 3'-5'**
Silty clay, trace sand, grey, moist.
LL=51, PL=21, I_p = 30.

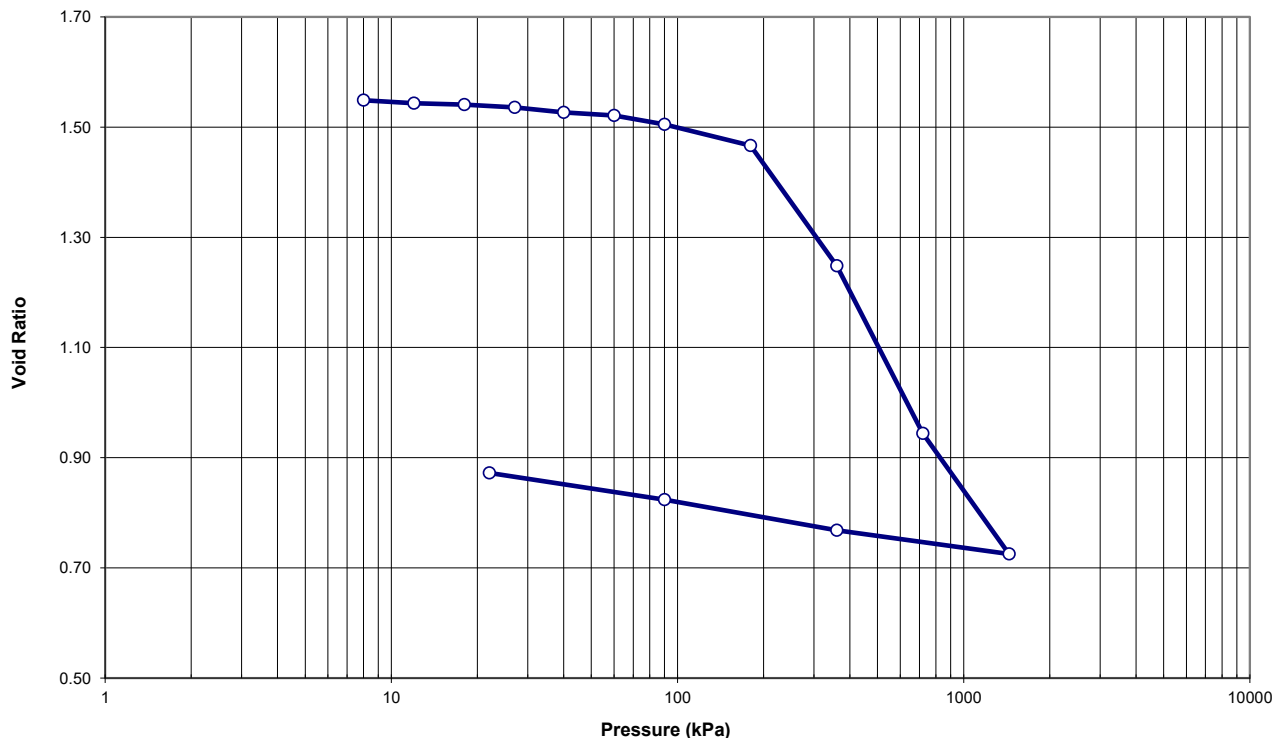
PROCEDURE: Test carried out in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-11, method B

	<u>Start of Test</u>	<u>End of Test</u>
Wet Dens. (kg/m ³)	1679.0	1974.2
Dry Dens. (kg/m ³)	1088.8	1489.9
Moisture Cont. (%)	54.2	32.5
Void Ratio	1.562	0.872
Saturation (%)	96.8	

Note: A Specific Gravity (Gs) of 2.79 was obtained for the void ratio and saturation calculations.

Void Ratio vs. Pressure

Project #: 24726
 Client: Thurber Engineering (Ottawa)
 Project Name: Highway 17 Twinning - Renfrew
 Sample: DOC 19-2 ST1 3'-5'



Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

DOC 19-2 ST1 3'-5'

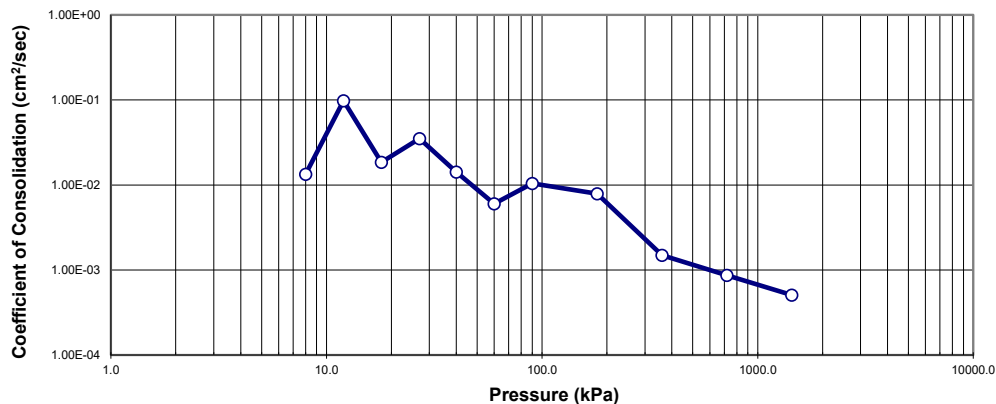
TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer.

LOADING: A seating load of 8 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied after 100% primary consolidation was reached at each load increment.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. H. (mm)	Avg. H. (mm)	D ₉₀ (mm)	t ₉₀ (min)	c _v (cm ² /s)	Void Ratio	m _v (m ² /kN)	k (cm/s)
0.0	25.400					1.562		
8.0	25.268	25.334	-0.033	1.69	1.34E-02	1.549	6.49E-04	8.55E-07
12.0	25.215	25.242	-0.015	0.23	9.77E-02	1.543	5.23E-04	5.01E-06
18.0	25.188	25.201	-0.012	1.21	1.85E-02	1.541	1.82E-04	3.32E-07
27.0	25.141	25.164	-0.029	0.64	3.50E-02	1.536	2.05E-04	7.04E-07
40.0	25.050	25.096	-0.041	1.56	1.42E-02	1.527	2.78E-04	3.88E-07
60.0	24.992	25.021	-0.047	3.69	6.00E-03	1.521	1.16E-04	6.83E-08
90.0	24.835	24.913	-0.065	2.10	1.04E-02	1.505	2.10E-04	2.15E-07
180.0	24.454	24.645	-0.230	2.72	7.88E-03	1.467	1.70E-04	1.31E-07
360.0	22.287	23.371	-1.340	12.96	1.49E-03	1.248	4.92E-04	7.19E-08
720.0	19.274	20.780	-2.065	17.64	8.65E-04	0.944	3.75E-04	3.18E-08
1440.0	17.103	18.188	-1.670	23.04	5.07E-04	0.725	1.56E-04	7.78E-09
360.0	17.527	17.315				0.768		
90.0	18.080	17.803				0.824		
22.0	18.562	18.321				0.872		

Coefficient of Consolidation vs. Pressure



Notes: C_v and k calculated using t₉₀ values

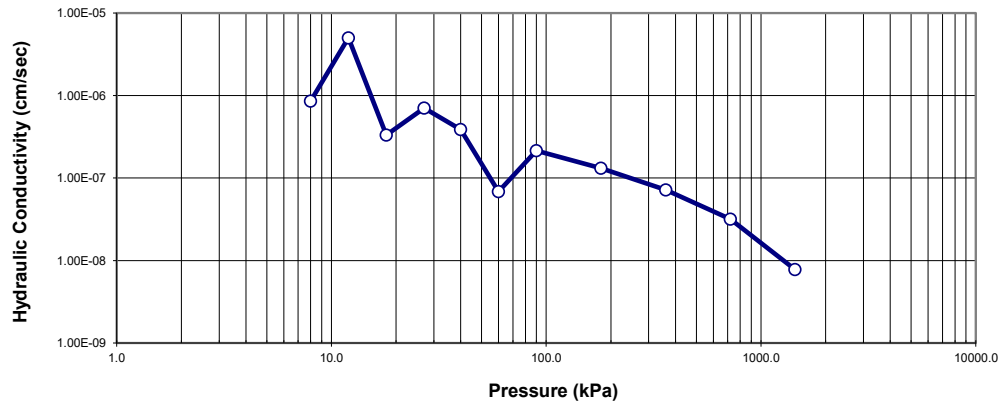
Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

DOC 19-2 ST1 3'-5'

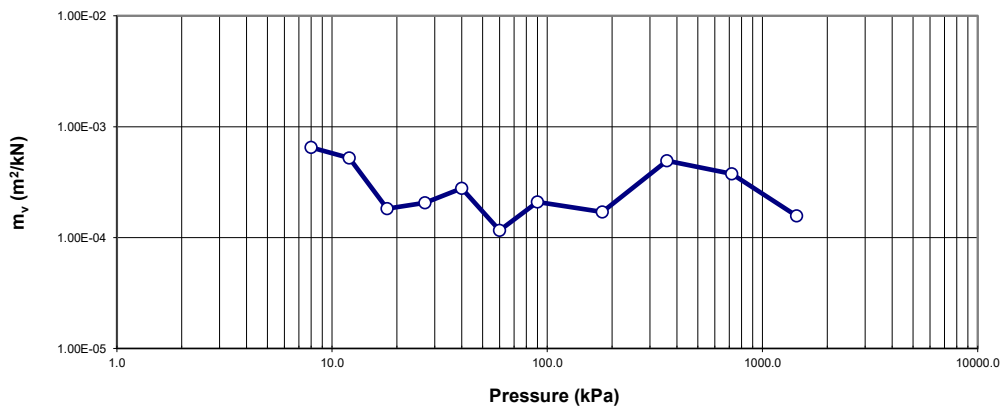
Hydraulic Conductivity vs. Pressure

Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: DOC 19-2 ST1 3'-5'



m_v vs. Pressure

Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: DOC 19-2 ST1 3'-5'



Consolidation Test Report

CLIENT: **Thurber Engineering (Ottawa)**

FILE NUMBER: **24726**

PROJECT: **Highway 17 Twinning - Renfrew**

REPORT DATE: **January 17, 2020**

TEST DATES: **November 20, 2019 - November 30, 2019**

SAMPLE: **DOC 19-2 ST2 5'-7'**
Silty clay, trace sand, grey, moist.
LL=42, PL=20, $I_p = 22$.

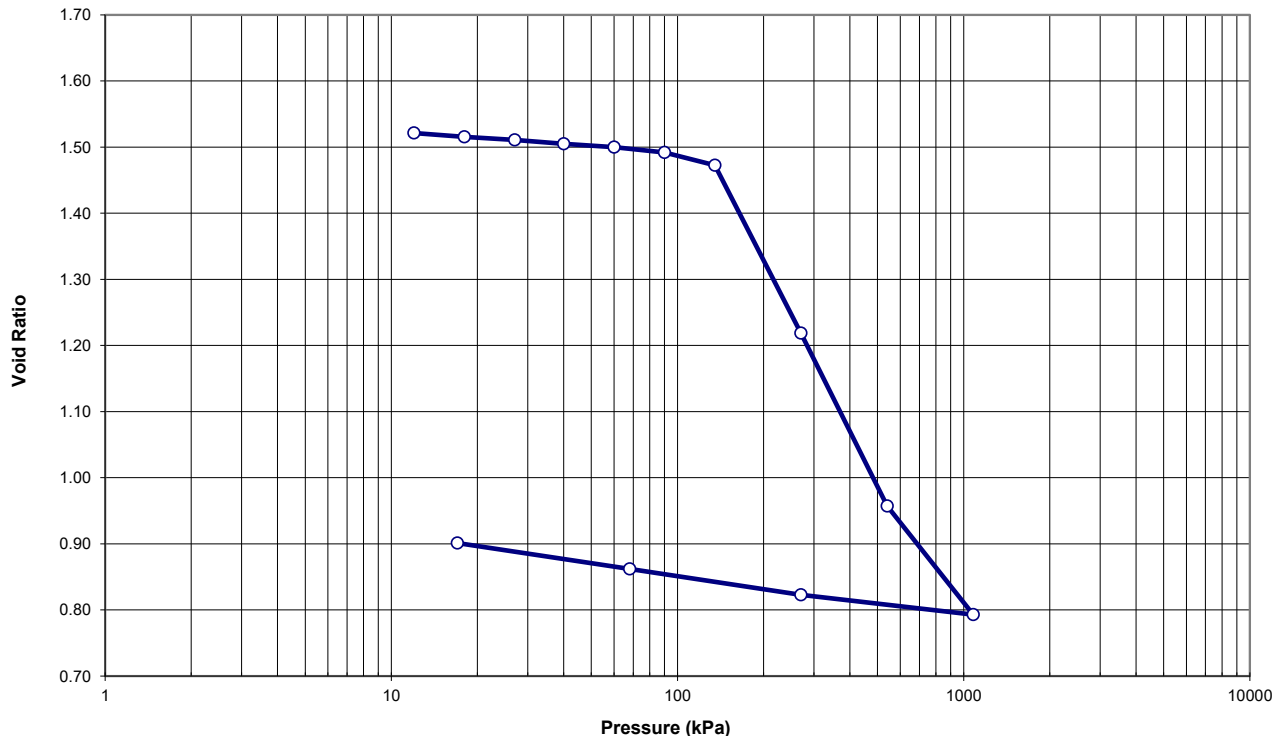
PROCEDURE: Test carried out in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-11, method B

	<u>Start of Test</u>	<u>End of Test</u>
Wet Dens. (kg/m ³)	1681.0	1944.8
Dry Dens. (kg/m ³)	1105.7	1469.5
Moisture Cont. (%)	52.0	32.3
Void Ratio	1.527	0.901
Saturation (%)	95.2	

Note: A Specific Gravity (Gs) of 2.79 was obtained for the void ratio and saturation calculations.

Void Ratio vs. Pressure

Project #: 24726
 Client: Thurber Engineering (Ottawa)
 Project Name: Highway 17 Twinning - Renfrew
 Sample: DOC 19-2 ST2 5'-7'



Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

DOC 19-2 ST2 5'-7'

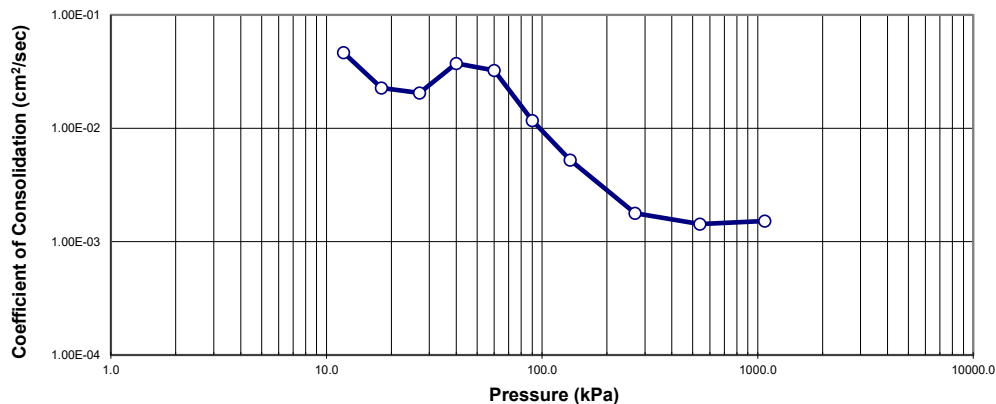
TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer.

LOADING: A seating load of 12 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied after 100% primary consolidation was reached at each load increment.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. H. (mm)	Avg. H. (mm)	D ₉₀ (mm)	t ₉₀ (min)	c _v (cm ² /s)	Void Ratio	m _v (m ² /kN)	k (cm/s)
0.0	25.400					1.527		
12.0	25.343	25.372	-0.023	0.49	4.64E-02	1.521	1.87E-04	8.50E-07
18.0	25.284	25.314	-0.032	1.00	2.26E-02	1.515	3.87E-04	8.60E-07
27.0	25.238	25.261	-0.035	1.10	2.05E-02	1.511	2.03E-04	4.07E-07
40.0	25.181	25.209	-0.023	0.60	3.74E-02	1.505	1.75E-04	6.40E-07
60.0	25.130	25.156	-0.038	0.69	3.25E-02	1.500	1.00E-04	3.19E-07
90.0	25.047	25.089	-0.052	1.90	1.17E-02	1.492	1.10E-04	1.26E-07
135.0	24.852	24.950	-0.103	4.20	5.23E-03	1.472	1.74E-04	8.91E-08
270.0	22.303	23.577	-1.080	11.02	1.78E-03	1.219	7.60E-04	1.33E-07
540.0	19.673	20.988	-1.800	10.89	1.43E-03	0.957	4.37E-04	6.12E-08
1080.0	18.021	18.847	-1.110	8.24	1.52E-03	0.793	1.56E-04	2.32E-08
270.0	18.324	18.173				0.823		
68.0	18.715	18.520				0.862		
17.0	19.112	18.913				0.901		

Coefficient of Consolidation vs. Pressure



Notes: C_v and k calculated using t₉₀ values

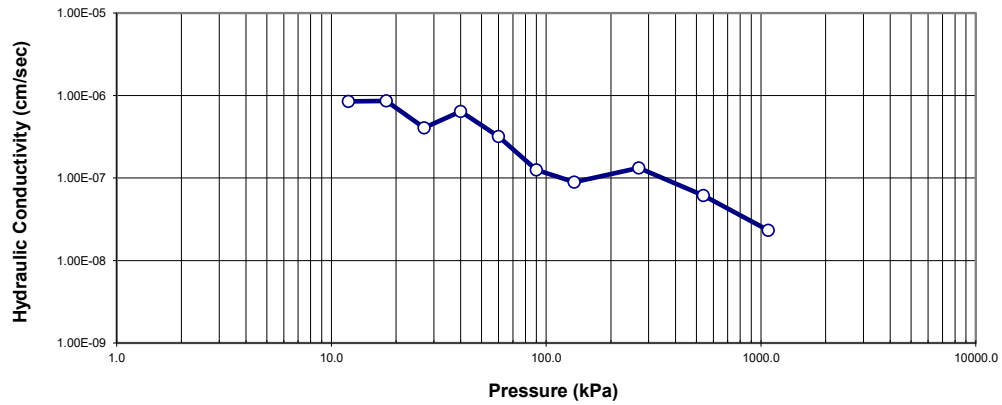
Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

DOC 19-2 ST2 5'-7'

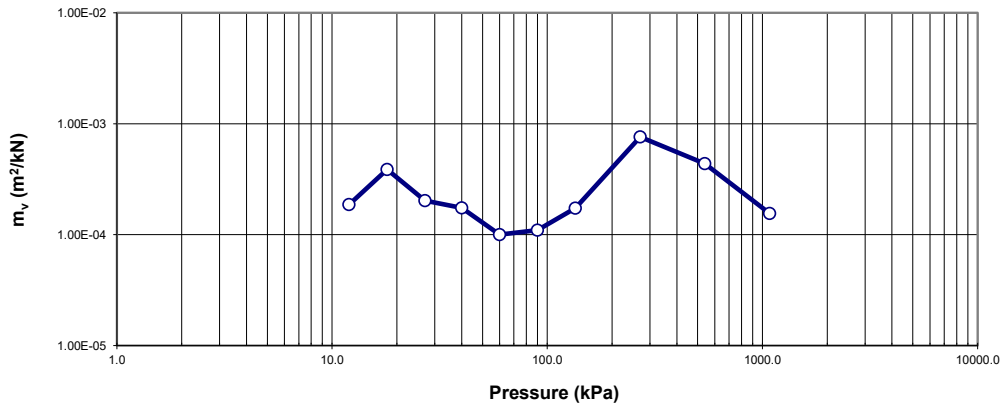
Hydraulic Conductivity vs. Pressure

Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: DOC 19-2 ST2 5'-7'



m_v vs. Pressure

Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: DOC 19-2 ST2 5'-7'



Consolidation Test Report

CLIENT: **Thurber Engineering (Ottawa)**

FILE NUMBER: **24726**

PROJECT: **Highway 17 Twinning - Renfrew**

REPORT DATE: **January 17, 2020**

TEST DATES: **December 18, 2020 - December 29, 2020**

SAMPLE: **DOC 19-2 ST3 7'-9'**
Silty clay, trace sand, grey, moist.
LL=39, PL=22, $I_p = 17$.

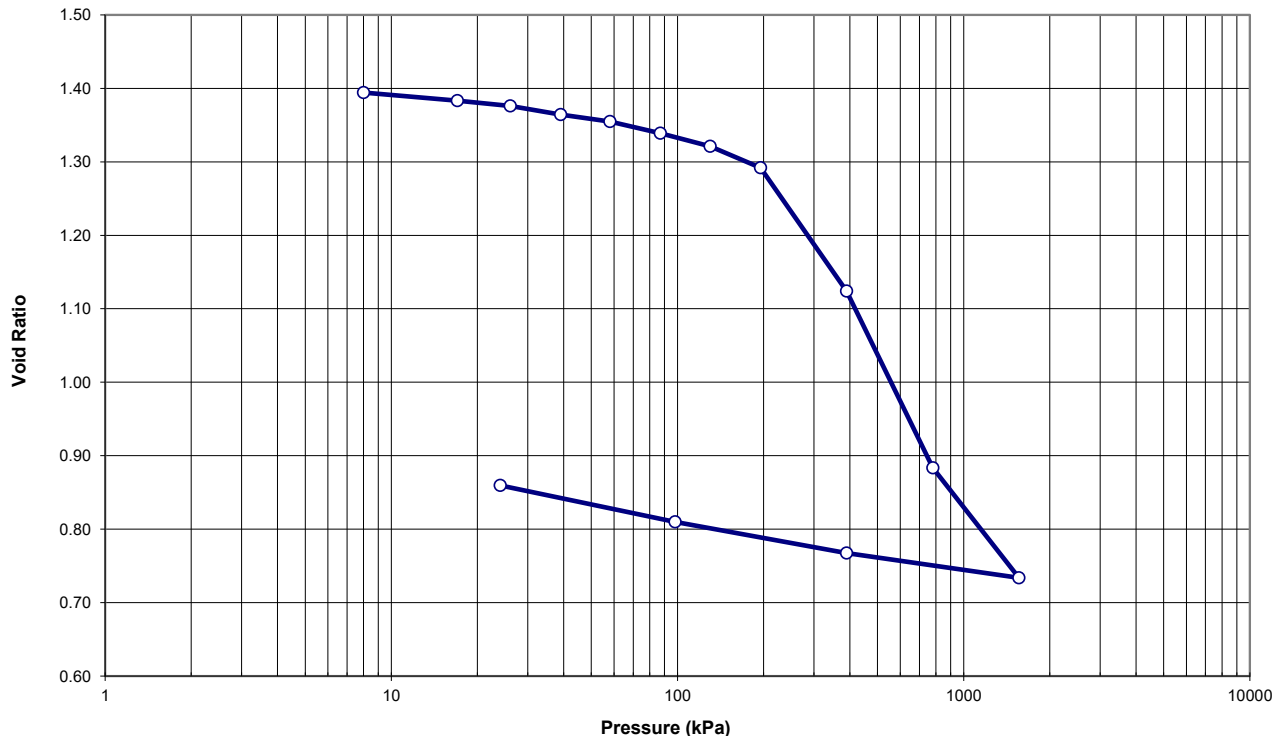
PROCEDURE: Test carried out in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-11, method B

	<u>Start of Test</u>	<u>End of Test</u>
Wet Dens. (kg/m ³)	1730.6	1979.3
Dry Dens. (kg/m ³)	1163.9	1502.1
Moisture Cont. (%)	48.7	31.8
Void Ratio	1.400	0.860
Saturation (%)	97.2	

Note: A Specific Gravity (Gs) of 2.79 was obtained for the void ratio and saturation calculations.

Void Ratio vs. Pressure

Project #: 24726
 Client: Thurber Engineering (Ottawa)
 Project Name: Highway 17 Twinning - Renfrew
 Sample: DOC 19-2 ST3 7'-9'



Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

DOC 19-2 ST3 7'-9'

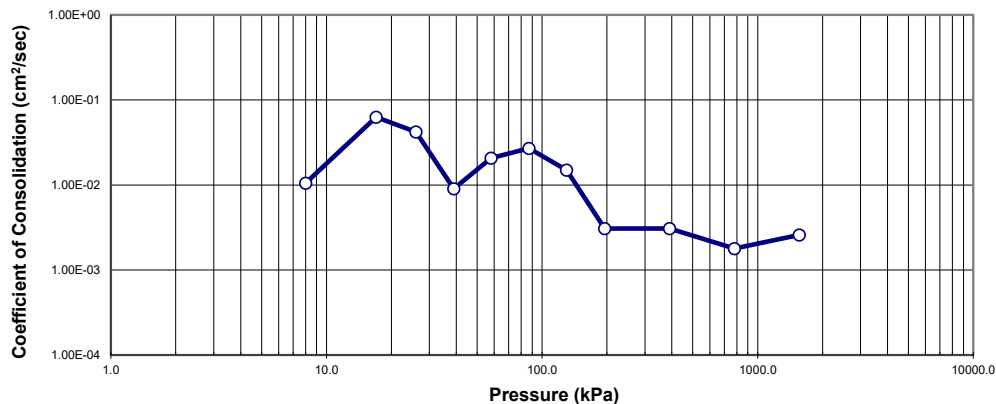
TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer.

LOADING: A seating load of 8.0 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied after 100% primary consolidation was reached at each load increment.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. H. (mm)	Avg. H. (mm)	D ₉₀ (mm)	t ₉₀ (min)	c _v (cm ² /s)	Void Ratio	m _v (m ² /kN)	k (cm/s)
0.0	25.400					1.400		
8.0	25.340	25.370	-0.025	2.16	1.05E-02	1.394	2.96E-04	3.06E-07
17.0	25.223	25.281	-0.068	0.36	6.27E-02	1.383	5.13E-04	3.16E-06
26.0	25.147	25.185	-0.038	0.53	4.21E-02	1.376	3.35E-04	1.38E-06
39.0	25.024	25.085	-0.079	2.46	9.02E-03	1.364	3.75E-04	3.31E-07
58.0	24.922	24.973	-0.073	1.06	2.08E-02	1.355	2.15E-04	4.37E-07
87.0	24.756	24.839	-0.092	0.81	2.69E-02	1.339	2.31E-04	6.08E-07
130.0	24.567	24.661	-0.090	1.44	1.49E-02	1.321	1.77E-04	2.60E-07
195.0	24.257	24.412	-0.138	6.86	3.07E-03	1.292	1.94E-04	5.83E-08
390.0	22.479	23.368	-0.652	6.30	3.06E-03	1.124	3.76E-04	1.13E-07
780.0	19.932	21.205	-1.735	8.88	1.79E-03	0.883	2.90E-04	5.10E-08
1560.0	18.348	19.140	-1.020	5.02	2.58E-03	0.734	1.02E-04	2.58E-08
390.0	18.704	18.526				0.767		
98.0	19.153	18.928				0.810		
24.0	19.680	19.416				0.860		

Coefficient of Consolidation vs. Pressure



Notes: C_v and k calculated using t₉₀ values

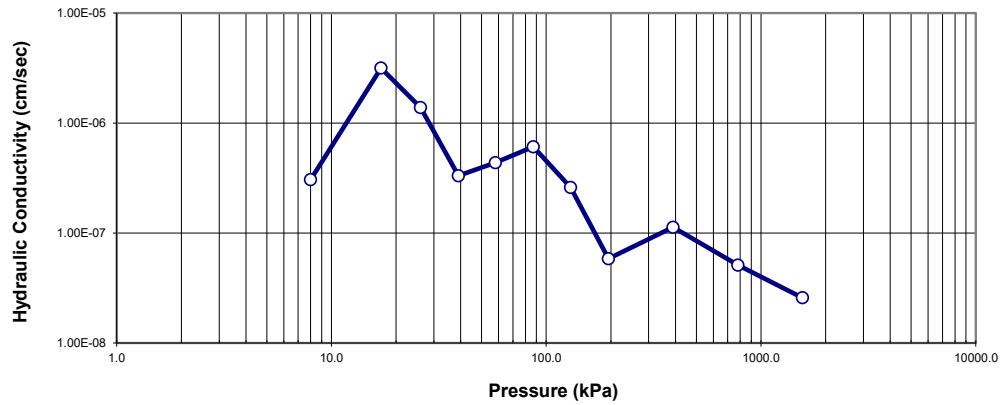
Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

DOC 19-2 ST3 7'-9'

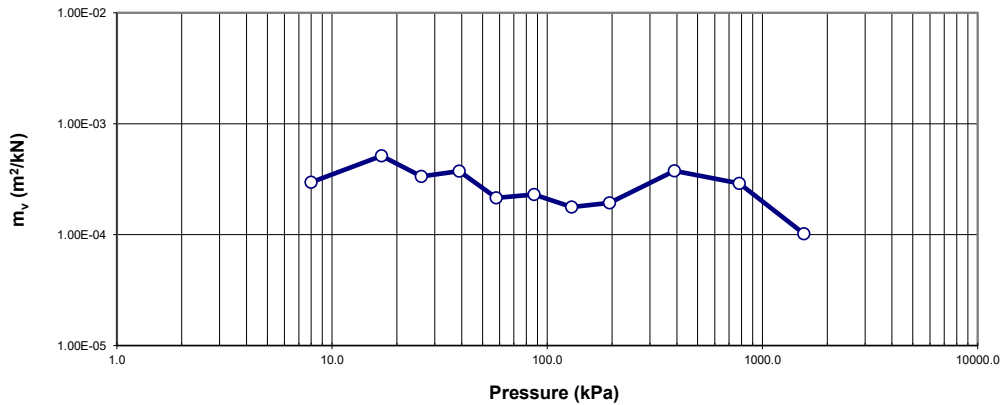
Hydraulic Conductivity vs. Pressure

Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: DOC 19-2 ST3 7'-9'



m_v vs. Pressure

Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: DOC 19-2 ST3 7'-9'



Consolidation Test Report

CLIENT: **Thurber Engineering (Ottawa)**

FILE NUMBER: **24726**

PROJECT: **Highway 17 Twinning - Renfrew**

REPORT DATE: **January 17, 2020**

TEST DATES: **December 18, 2020 - December 29, 2020**

SAMPLE: **DOC 19-2 ST4 9'-11'**
Silty clay, trace sand, grey, moist.
LL=37, PL=20, $I_p = 17$.

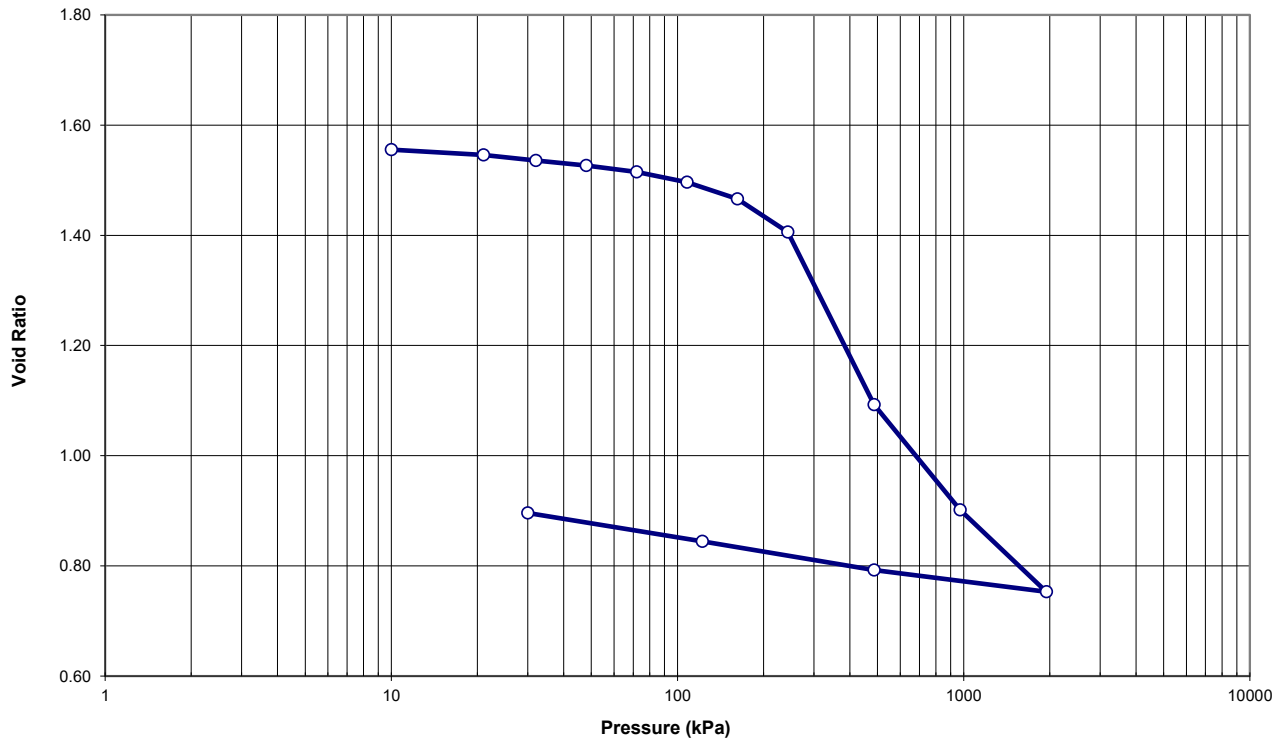
PROCEDURE: Test carried out in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-11, method B

	<u>Start of Test</u>	<u>End of Test</u>
Wet Dens. (kg/m ³)	1694.8	1956.3
Dry Dens. (kg/m ³)	1090.9	1473.3
Moisture Cont. (%)	55.4	32.8
Void Ratio	1.561	0.896
Saturation (%)	99.1	

Note: A Specific Gravity (Gs) of 2.79 was obtained for the void ratio and saturation calculations.

Void Ratio vs. Pressure

Project #: 24726
 Client: Thurber Engineering (Ottawa)
 Project Name: Highway 17 Twinning - Renfrew
 Sample: DOC 19-2 ST4 9'-11'



Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

DOC 19-2 ST4 9'-11'

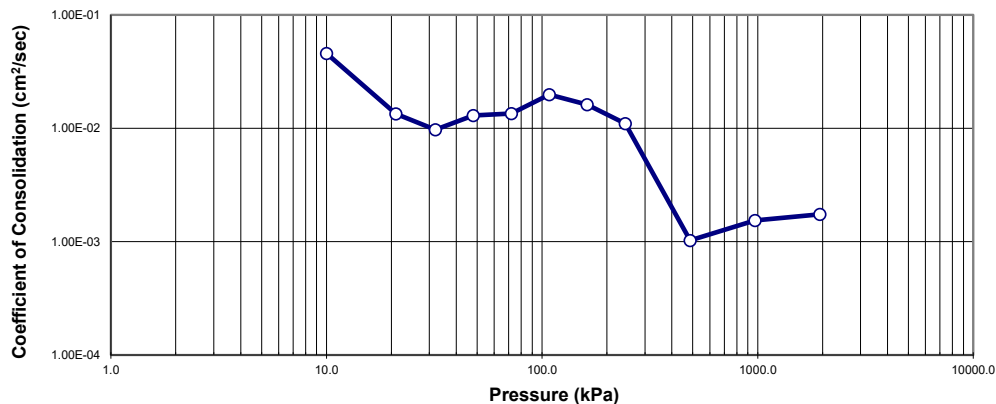
TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer.

LOADING: A seating load of 10 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied after a constant load increment duration of 24 hours. Load increment durations were reduced when swelling was apparent.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. H. (mm)	Avg. H. (mm)	D ₉₀ (mm)	t ₉₀ (min)	c _v (cm ² /s)	Void Ratio	m _v (m ² /kN)	k (cm/s)
0.0	25.400					1.561		
10.0	25.345	25.372	-0.025	0.50	4.58E-02	1.555	2.17E-04	9.73E-07
21.0	25.252	25.298	-0.056	1.69	1.34E-02	1.546	3.35E-04	4.40E-07
32.0	25.147	25.199	-0.076	2.31	9.71E-03	1.535	3.77E-04	3.59E-07
48.0	25.058	25.103	-0.058	1.72	1.30E-02	1.527	2.20E-04	2.80E-07
72.0	24.943	25.001	-0.056	1.64	1.35E-02	1.515	1.91E-04	2.53E-07
108.0	24.761	24.852	-0.079	1.10	1.98E-02	1.497	2.03E-04	3.95E-07
162.0	24.456	24.608	-0.103	1.32	1.62E-02	1.466	2.28E-04	3.62E-07
243.0	23.860	24.158	-0.153	1.88	1.10E-02	1.406	3.01E-04	3.24E-07
486.0	20.756	22.308	-1.920	17.14	1.03E-03	1.093	5.35E-04	5.39E-08
972.0	18.860	19.808	-1.250	9.00	1.54E-03	0.902	1.88E-04	2.84E-08
1944.0	17.387	18.124	-0.600	6.66	1.74E-03	0.753	8.03E-05	1.37E-08
486.0	17.776	17.582				0.792		
122.0	18.294	18.035				0.844		
30.0	18.808	18.551				0.896		

Coefficient of Consolidation vs. Pressure



Notes: C_v and k calculated using t₉₀ values

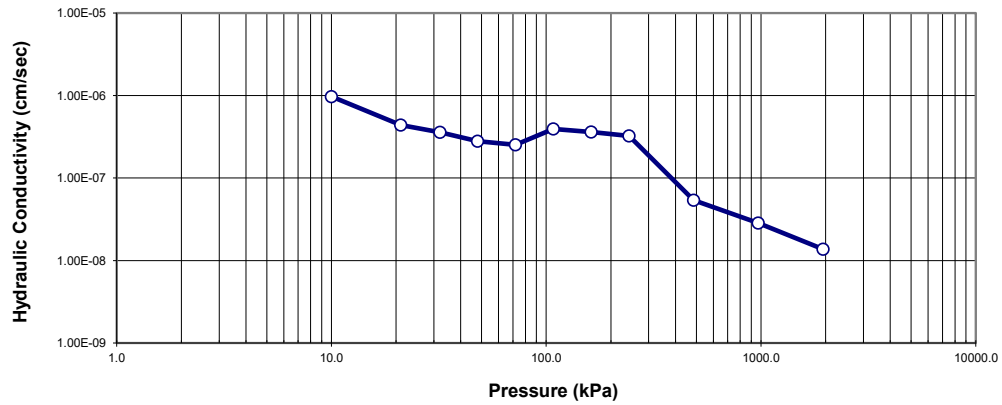
Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

DOC 19-2 ST4 9'-11'

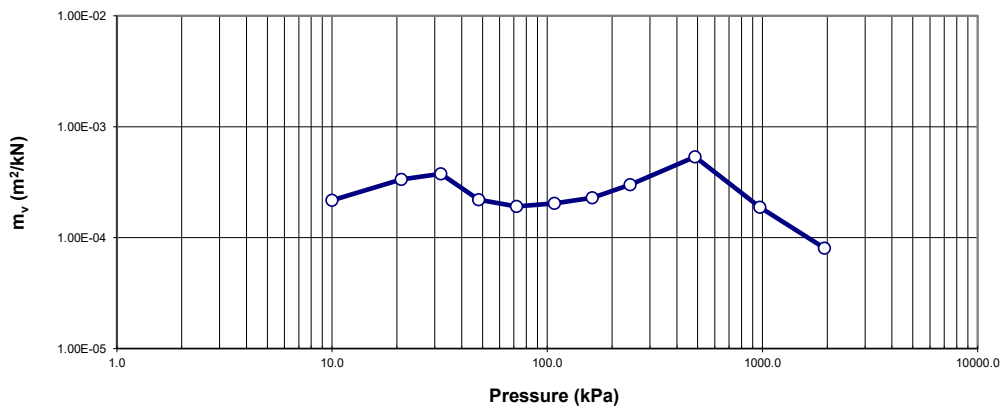
Hydraulic Conductivity vs. Pressure

Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: DOC 19-2 ST4 9'-11'



m_v vs. Pressure

Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: DOC 19-2 ST4 9'-11'





Appendix C.2

Analytical Testing Results

Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104
Ottawa, ON K1B 4S5
Attn: Paul Carnaffan

Client PO:
Project: 24726 Hwy 17 Twinning, Dochart
Custody: 49178

Report Date: 30-Oct-2019
Order Date: 24-Oct-2019

Order #: 1943587

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

Paracel ID	Client ID
1943587-01	SS2/DOC 19-1, 2'6"-4'6"
1943587-02	SS1/DOC 19-4, 0'-2'

Approved By:



Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 30-Oct-2019

Order Date: 24-Oct-2019

Project Description: 24726 Hwy 17 Twinning, Dochart

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	29-Oct-19	30-Oct-19
Conductivity	MOE E3138 - probe @25 °C, water ext	28-Oct-19	28-Oct-19
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	28-Oct-19	28-Oct-19
Resistivity	EPA 120.1 - probe, water extraction	28-Oct-19	28-Oct-19
Solids, %	Gravimetric, calculation	25-Oct-19	25-Oct-19

Certificate of Analysis
 Client: Thurber Engineering Ltd.
 Client PO:

Report Date: 30-Oct-2019

Order Date: 24-Oct-2019

Project Description: 24726 Hwy 17 Twinning, Dochart

Client ID:	SS2/DOC 19-1, 2'6"-4'6"	SS1/DOC 19-4, 0'-2'	-	-
Sample Date:	21-Oct-19 09:00	18-Oct-19 09:00	-	-
Sample ID:	1943587-01	1943587-02	-	-
MDL/Units	Soil	Soil	-	-

Physical Characteristics

% Solids	0.1 % by Wt.	73.9	56.7	-	-
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General Inorganics

Conductivity	5 uS/cm	852	415	-	-
pH	0.05 pH Units	7.76	7.48	-	-
Resistivity	0.10 Ohm.m	11.7	24.1	-	-

Anions

Chloride	5 ug/g dry	439	52	-	-
Sulphate	5 ug/g dry	53	42	-	-

Certificate of Analysis
 Client: **Thurber Engineering Ltd.**
 Client PO:

Report Date: 30-Oct-2019

Order Date: 24-Oct-2019

Project Description: 24726 Hwy 17 Twinning, Dochart

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
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 30-Oct-2019

Order Date: 24-Oct-2019

Project Description: 24726 Hwy 17 Twinning, Dochart

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	417	5	ug/g dry	439			5.2	20	
Sulphate	51.1	5	ug/g dry	52.8			3.3	20	
General Inorganics									
Conductivity	200	5	uS/cm	203			1.4	5	
pH	7.52	0.05	pH Units	7.62			1.3	2.3	
Resistivity	50.0	0.10	Ohm.m	49.3			1.4	20	
Physical Characteristics									
% Solids	77.2	0.1	% by Wt.	77.5			0.4	25	

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 30-Oct-2019

Order Date: 24-Oct-2019

Project Description: 24726 Hwy 17 Twinning, Dochart

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	528	5	ug/g	439	88.6	82-118			
Sulphate	163	5	ug/g	52.8	110	80-120			

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 30-Oct-2019

Order Date: 24-Oct-2019

Project Description: 24726 Hwy 17 Twinning, Dochart

Qualifier Notes:***Login Qualifiers :***

Container(s) - Bottle and COC sample ID don't match -

*Applies to samples: SS1/DOC 19-4, 0'-2'***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.

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: Paul Carnaffan

Tel: (613) 247-2121
Fax: (613) 247-2185

Paracel Report No **1943587**
Client Project(s): **24726 Hwy 17 Twinning, Dochart**
Client PO:
Reference: **Standing Offer**
CoC Number: **49178**

Order Date: 24-Oct-19
Report Date: 23-Dec-19

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
1943587-01	SS2/DOC 19-1, 2'6"-4'6"	Sulphide, solid
1943587-02	SS1/DOC 19-4, 0'-2'	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

23-December-2019

Date Rec. : 19 December 2019
LR Report: CA12696-DEC19
Reference: Project#:1943587

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	Sulphide %
1: Analysis Start Date		23-Dec-19
2: Analysis Start Time		12:07
3: Analysis Completed Date		23-Dec-19
4: Analysis Completed Time		13:28
5: QC - Blank		< 0.02
6: QC - STD % Recovery		115%
7: QC - DUP % RPD		48%
8: RL		0.02
9: SS2/DOC 19-1, 2'6"-4'6"	21-Oct-19	0.10
10: SS1/DOC 19-4, 0'-2'	18-Oct-19	0.04

RL - SGS Reporting Limit

Note: Samples were received past the 14 day holding time; results may be unreliable.

Kimberley Didsbury
Project Specialist,
Environment, Health & Safety

Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104

Ottawa, ON K1B 4S5

Attn: Justin Gray

Client PO: Highway 17 Renfrew, Various Sites

Project: 24726 task 700.706a

Custody:

Report Date: 18-Apr-2024

Order Date: 12-Apr-2024

Order #: 2415421

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

Paracel ID	Client ID
2415421-01	SC18-3 SS3A 5'-6'3"
2415421-02	SC23-2 SS5 10'-12'
2415421-03	DOC23-1 SS7, 15'-17'
2415421-04	OBR23-1 SS16 48'-50'
2415421-05	BON24-2 SS4 10'-12'
2415421-06	NSC20-2 SS2A 2'6"-3'3"
2415421-07	SC10-1 SS2B 3'-4'
2415421-08	SC10-4 SS2 2'6"-4'6"

Approved By:

Mark Foto

Mark Foto, M.Sc.

Lab Supervisor

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	15-Apr-24	15-Apr-24
Conductivity	MOE E3138 - probe @25 °C, water ext	15-Apr-24	15-Apr-24
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	15-Apr-24	15-Apr-24
Resistivity	EPA 120.1 - probe, water extraction	15-Apr-24	15-Apr-24
Solids, %	CWS Tier 1 - Gravimetric	15-Apr-24	16-Apr-24

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

Client ID:	SC18-3 SS3A 5'-6'3"	SC23-2 SS5 10'-12'	DOC23-1 SS7, 15'-17'	OBR23-1 SS16 48'-50'	
Sample Date:	11-Mar-24 09:00	13-Mar-24 09:00	11-Mar-24 09:00	27-Mar-24 09:00	-
Sample ID:	2415421-01	2415421-02	2415421-03	2415421-04	-
Matrix:	Soil	Soil	Soil	Soil	
MDL/Units					

Physical Characteristics

% Solids	0.1 % by Wt.	84.8	62.4	68.0	87.9	-	-
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General Inorganics

Conductivity	5 uS/cm	108 [1]	1950 [2]	1660 [1]	100	-	-
pH	0.05 pH Units	7.32 [1]	6.91 [2]	7.12 [1]	7.37	-	-
Resistivity	0.1 Ohm.m	92.9 [1]	5.1 [2]	6.0 [1]	100	-	-

Anions

Chloride	10 ug/g	10 [1]	175 [1]	682 [1]	<10	-	-
Sulphate	10 ug/g	<10 [1]	2080 [1]	29 [1]	<10	-	-

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

Client ID:	BON24-2 SS4 10'-12'	NSC20-2 SS2A 2'6"-3'3"	SC10-1 SS2B 3'-4'	SC10-4 SS2 2'6"-4'6"	
Sample Date:	09-Apr-24 09:00	02-Apr-24 09:00	21-Mar-24 09:00	04-Apr-24 09:00	-
Sample ID:	2415421-05	2415421-06	2415421-07	2415421-08	-
Matrix:	Soil	Soil	Soil	Soil	
MDL/Units					

Physical Characteristics

% Solids	0.1 % by Wt.	72.6	69.1	73.2	77.5	-	-
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General Inorganics

Conductivity	5 uS/cm	286	203	316	247	-	-
pH	0.05 pH Units	6.79	6.65	6.95	6.84	-	-
Resistivity	0.1 Ohm.m	35.0	49.2	31.6	40.5	-	-

Anions

Chloride	10 ug/g	12	37	97	27	-	-
Sulphate	10 ug/g	24	21	44	<10	-	-

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions								
Chloride	ND	10	ug/g					
Sulphate	ND	10	ug/g					
General Inorganics								
Conductivity	ND	5	uS/cm					
Resistivity	ND	0.1	Ohm.m					

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	10.1	10	ug/g	10.1			0.3	35	
Sulphate	ND	10	ug/g	ND			NC	35	
General Inorganics									
Conductivity	1040	5	uS/cm	1050			1.1	5	
pH	7.44	0.05	pH Units	7.46			0.3	2.3	
Resistivity	8.98	0.1	Ohm.m	9.51			5.7	20	
Physical Characteristics									
% Solids	84.9	0.1	% by Wt.	84.7			0.2	25	

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	110	10	ug/g	10.1	99.4	82-118			
Sulphate	106	10	ug/g	ND	106	80-120			

Certificate of Analysis

Report Date: 18-Apr-2024

Client: Thurber Engineering Ltd.

Order Date: 12-Apr-2024

Client PO: Highway 17 Renfrew, Various Sites

Project Description: 24726 task 700.706a

Qualifier Notes:**Login Qualifiers :**

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

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

Sample Qualifiers :

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

Sample Data Revisions:

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

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

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

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

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

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

Subcontracted Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104

Ottawa, ON K1B 4S5

Attn: Justin Gray

Paracel Report No. **2415421**

Client Project(s): **24726 task 700.706a**

Client PO: **Highway 17 Renfrew, Various Sites**

Reference: **#24-079 Standing Offer**

Order Date: 12-Apr-24

Report Date: 19-Apr-24

CoC Number:

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
2415421-01	SC18-3 SS3A 5'-6'3"	Sulphide, solid
2415421-02	SC23-2 SS5 10'-12'	Sulphide, solid
2415421-03	DOC23-1 SS7, 15'-17'	Sulphide, solid
2415421-04	OBR23-1 SS16 48'-50'	Sulphide, solid
2415421-05	BON24-2 SS4 10'-12'	Sulphide, solid
2415421-06	NSC20-2 SS2A 2'6"-3'3"	Sulphide, solid
2415421-07	SC10-1 SS2B 3'-4'	Sulphide, solid
2415421-08	SC10-4 SS2 2'6"-4'6"	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

19-April-2024

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

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	Sulphide (Na ₂ CO ₃) %
1: Analysis Start Date		19-Apr-24
2: Analysis Start Time		13:06
3: Analysis Completed Date		19-Apr-24
4: Analysis Completed Time		13:12
5: RL		0.01
6: SC18-3 SS3A 5'-6'3"	11-Mar-24	< 0.01
7: SC23-2 SS5 10'-12'	13-Mar-24	0.83
8: DOC23-1 SS7, 15'-17'	11-Mar-24	0.01
9: OBR23-1 SS16 48'-50'	27-Mar-24	< 0.01
10: BON24-2 SS4 10'-12'	09-Apr-24	< 0.01
11: NSC20-2 SS2A 2'6"-3'3"	02-Apr-24	< 0.01
12: SC10-1 SS2B 3'-4"	21-Mar-24	< 0.01
13: SC10-4 SS2 2'6"- 4'6"	04-Apr-24	< 0.01

RL - SGS Reporting Limit

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

Kimberley Didsbury
Project Specialist,
Environment, Health & Safety



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.

Lakefield - Ontario - KOL 2H0

Phone: 705-652-2000 FAX: 705-652-6365

LR Report :

CA12714-APR24

Quality Control Report

Inorganic Analysis													
Parameter	Reporting Limit	Unit	Method Blank	Duplicate				LCS / Spike Blank			Matrix Spike / Reference Material		
				Result 1	Result 2	RPD	Acceptance Criteria	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
									Low	High		Low	High
Carbon/Sulphur - QCBatchID: ECS0068-APR24													
Sulphide (Na2CO3)	0.01	%	< 0.01										

Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Unit 107
Ottawa, ON K1B4S5
Attn: Kenton Power

Client PO:
Project: 22912 Dochart Creek
Custody: 39855

Report Date: 26-Jun-2018
Order Date: 21-Jun-2018

Order #: 1825667

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

Paracel ID	Client ID
1825667-01	18-2 SS3 (4'-6')

Approved By:



Dale Robertson, BSc
Laboratory Director

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 26-Jun-2018

Order Date: 21-Jun-2018

Project Description: 22912 Dochart Creek

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	26-Jun-18	26-Jun-18
Conductivity	MOE E3138 - probe @25 °C, water ext	26-Jun-18	26-Jun-18
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	26-Jun-18	26-Jun-18
Resistivity	EPA 120.1 - probe, water extraction	26-Jun-18	26-Jun-18
Solids, %	Gravimetric, calculation	26-Jun-18	26-Jun-18

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 26-Jun-2018

Order Date: 21-Jun-2018

Project Description: 22912 Dochart Creek

Client ID:	18-2 SS3 (4'-6')	-	-	-
Sample Date:	06/06/2018 12:38	-	-	-
Sample ID:	1825667-01	-	-	-
MDL/Units	Soil	-	-	-

Physical Characteristics

% Solids	0.1 % by Wt.	65.0	-	-	-
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General Inorganics

Conductivity	5 uS/cm	770	-	-	-
pH	0.05 pH Units	7.83	-	-	-
Resistivity	0.10 Ohm.m	13.0	-	-	-

Anions

Chloride	5 ug/g dry	393	-	-	-
Sulphate	5 ug/g dry	77	-	-	-

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 26-Jun-2018

Order Date: 21-Jun-2018

Project Description: 22912 Dochart Creek

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	16000	0.10	Ohm.m						

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 26-Jun-2018

Order Date: 21-Jun-2018

Project Description: 22912 Dochart Creek

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	42.2	5	ug/g dry	42.0			0.6	20	
Sulphate	33.5	5	ug/g dry	33.7			0.4	20	
General Inorganics									
Conductivity	381	5	uS/cm	397			4.3	6.2	
pH	7.72	0.05	pH Units	7.64			1.0	10	
Resistivity	26.3	0.10	Ohm.m	25.2			4.3	20	
Physical Characteristics									
% Solids	71.0	0.1	% by Wt.	63.9			10.5	25	

Certificate of Analysis
 Client: Thurber Engineering Ltd.
 Client PO:

Report Date: 26-Jun-2018

Order Date: 21-Jun-2018

Project Description: 22912 Dochart Creek

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	138	5	ug/g	42.0	96.0	78-113			
Sulphate	141	5	ug/g	33.7	108	78-111			

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 26-Jun-2018
Order Date: 21-Jun-2018
Project Description: 22912 Dochart Creek

Qualifier Notes:

Login Qualifiers :

Container(s) - Bottle and COC sample ID don't match -
Applies to samples: 18-2 SS3 (4'-6')

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.

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, Unit 107

Ottawa, ON K1B4S5

Attn: Kenton Power

Tel: (613) 247-2121

Fax: (613) 247-2185

Paracel Report No **1825667**

Client Project(s): **22912 Dochart Creek**

Client PO:

Order Date: 21-Jun-18

Report Date: 05-Jul-18

Reference: **Standing Offer**

CoC Number: **39855**

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
1825667-01	18-2 SS3 (4'-6')	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,

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

05-July-2018

Date Rec. : 26 June 2018
LR Report: CA12858-JUN18
Reference: Project#:1825667

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	Sulphide %
1: Analysis Start Date		05-Jul-18
2: Analysis Start Time		10:43
3: Analysis Completed Date		05-Jul-18
4: Analysis Completed Time		13:06
5: QC - Blank		<0.02
6: QC - STD % Recovery		85%
7: QC - DUP % RPD		11%
8: RL		0.02
9: 18-2 SS3 (4'-6')	21-Jun-18	< 0.02

RL - SGS Reporting Limit

Kimberley Didsbury
Project Specialist
Environmental Services, Analytical



Appendix C.3

Bedrock Core Photographs

Borehole DOC19-1
Run 1 to 3 (of 3)
Elevation 110.4 m to 107.2 m

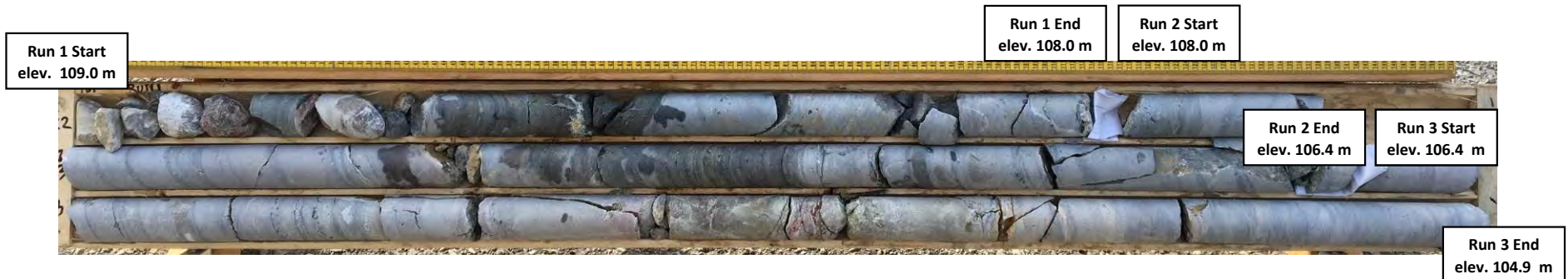


THURBER ENGINEERING LTD.

Foundation Investigation
HWY 17 Twinning (Dochart Creek)
Renfrew, Ontario

WP: 4068-09-00
Project No.: 24726

Borehole DOC19-2
Run 1 to 3 (of 3)
Elevation 109.0 m to 104.9 m



THURBER ENGINEERING LTD.

Foundation Investigation
HWY 17 Twinning (Dochart Creek)
Renfrew, Ontario

WP: 4068-09-00
Project No.: 24726

Borehole DOC19-3
Run 1 to 2 (of 2)
Elevation 109.0 m to 106.7 m



Borehole DOC19-4
Run 1 to 3 (of 3)
Elevation 109.0 m to 104.9 m



Borehole DOC23-1
Run 1 and 2
Depth 13.1 to 16.2 m
Elevation 106.8 to 103.7 m





Appendix D.

Site Photographs



**Photo 1. Looking South towards outlets of existing culverts
(2019/11/26)**



**Photo 2. Looking North from existing embankment towards proposed westbound
(2019/06/24)**



**Photo 3. Looking East along existing roadway
(2018/05/22)**



**Photo 4. Google Earth image showing variable creek width at North end of culvert
and stockpile North East of the existing culverts, along the proposed Highway 17
westbound alignment.
(Imagery Date 2020/04/27)**