



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 556 CULVERT REPLACEMENT AT STA 17+032
(TOWNSHIP OF DEROCHE)
REHABILITATION OF HIGHWAYS 556 & 532
DISTRICT OF ALGOMA, ONTARIO
ASSIGNMENT No.: 5020-E-0020
G.W.P. 5221-18-00**

LATITUDE: 46.731259°, LONGITUDE: -84.156367°

GEOCRES Number: 41K-122

Report

to

AECOM Canada Ltd.

Date: April 13, 2023
File: 31719



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PART A: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) at the site of a centreline culvert, located at STA 17+032 on Highway 556, in the Township of Deroche, District of Algoma, Ontario.

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

Thurber carried out the investigation as a subconsultant to AECOM Canada Ltd. (AECOM), under the Ministry of Transportation, Ontario (MTO) Assignment No. 5020-E-0020.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. SITE DESCRIPTION

The existing culvert is located on Highway 556, approximately 7.6 km west of the intersection with Highway 532 near Searchmont, Ontario. For project orientation purposes, Highway 556 is herein described as oriented east-west and the culvert is described as oriented north-south. Details of the existing culvert are as follows:



Township and Station	Culvert Size and Type	Length of Culvert (m)	Invert Elevation at Inlet (m)	Invert Elevation at Outlet (m)
Deroche 17+032	800 mm diameter CSP	39.13 m long	309.1 (south)	308.7 (north)

The existing culvert allows flow in a south to north direction under the approximately 7 m high embankment. The highway pavement surface is at approximately Elev. 315.4 m. The embankment slopes in the area of the culvert were sloped at approximately 2H:1V.

Based on visual observations, no signs of slope instability or erosion of the embankment were noted at the culvert site. At the time of investigation, ponded water was observed on the south side of the highway embankment at the culvert inlet, and the culvert inlet was submerged and not observable (see Photo 4 in Appendix A). The existing culvert outlet pipe was observed to be damaged, possibly partially crushed by a boulder. The south and north sides of the embankment at the toe of the slope were surrounded by thick, mixed forest. Site photographs can be found in Appendix A.

Highway 556 consists of two, 3.25 m wide, paved lanes and narrow partially paved shoulders. The alignment at the site is curved. The paved shoulders are narrow and are flanked by steel beam guiderails on both sides of the highway. Overhead utility lines are present on the south side of the highway. It is understood that the projected 2023 AADT for Highway 556 is 540. Granular entrances to rural properties are located less than 50 m to the east of the culvert.

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS) mapping, the site lies in an outwash plain and valley train and the primary materials are sandy and gravelly soils, and bedrock knobs and outcrops. The site topography in the immediate vicinity of the culvert is of low relief consisting of plains and gullies and the surrounding area is generally described as moderate relief of a cliffy volcanic rock signature.

Based on the OGS Map MRD126 titled "Bedrock Geology of Ontario", dated 2011, the underlying bedrock at the site consists of mafic to intermediate metavolcanic rocks.

3. INVESTIGATION PROCEDURES

The field investigation and testing for this project was carried out between August 17 and September 15, 2022, and consisted of drilling and sampling five boreholes, designated as Boreholes 17032-01 to 17032-05, to depths of between 5.1 m and 14.6 m (Elev. 306.4 m and 300.8 m). Boreholes 17032-02 to 17032-04 were advanced through the existing highway embankment, while Boreholes 17032-01 and 17032-05 were advanced near the toe of the



embankment near the existing outlet and inlet, respectively.

The Record of Borehole sheets for the boreholes are included in Appendix B.

Utility clearances were obtained prior to mobilization to the site. The as-drilled borehole elevations were surveyed in the field with a rod and level using a temporary benchmark identified as HCP 181 which is at an elevation of 314.95 m. The borehole co-ordinates were determined through off-set measurement from the highway centerline and existing culvert. The coordinate system MTM NAD 83, Zone 13 was used for the boreholes.

Boreholes 17032-02 to 17032-04 were drilled using a truck mounted CME 75 drill rig using wash boring technique with HW casing and NQ coring equipment, while Boreholes 17032-01 and 17032-05 were advanced with a portable drilling equipment also using wash boring technique but with BW casing and AW coring equipment. Soils samples were obtained at selected intervals using a split-spoon sampler in conjunction with Standard Penetration Testing (SPT) in general accordance with ASTM D1586. Soil sampling in Boreholes 17032-01 and 17032-05 employed the use of a manually lifted half-weight hammer and as such, a correction factor has been applied for the reported SPT N-values and thus, they are less reliable.

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

The rock cores were logged, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and Fracture Index (FI) were determined.

Groundwater conditions observed in open boreholes are not considered stabilized due to the introduction of water throughout the drilling operation. A piezometer was installed in Borehole 17032-01, which consisted of 32 mm diameter Schedule 40 PVC pipe with a 3 m slotted screen, enclosed in a column of filter sand to permit groundwater level monitoring. The piezometer installation details, groundwater level observations and water level readings are shown on the Record of Borehole sheets. The borehole completion details are summarized below:



Borehole	Depth and Elevation of Borehole Base (m)	Depth and Elevation of Piezometer Tip (m)	Northing and Easting MTM NAD83 Zone 13	Completion Details
17032-01	5.1 / 305.8	5.1 / 305.8	N 5 176 872.2 E 292 833.7	32 mm diameter PVC pipe with a 3 m long slotted screen.
17032-02	14.6 / 300.8	None Installed	N 5 176 873.3 E 292 861.0	Backfilled with bentonite holeplug and asphalt patch at surface.
17032-03	12.3 / 303.1	None Installed	N 5 176 864.4 E 292 843.1	Backfilled with bentonite holeplug and asphalt patch at surface.
17032-04	12.3 / 303.6	None Installed	N 5 176 861.1 E 292 846.2	Backfilled with bentonite holeplug and asphalt patch at surface.
17032-05	7.0 / 306.4	None Installed	N 5 176 855.2 E 292 852.3	Backfilled with bentonite holeplug to surface.

4. LABORATORY TESTING

All recovered soil samples were subjected to visual identification (VI) and natural moisture content determination. Selected samples were subjected to grain size distribution analyses (sieve and/or hydrometer). Unconfined compressive strength testing was carried out on a select bedrock core sample. The results of this testing program are summarized on the Record of Borehole sheets in Appendix B and are shown on the figures included in Appendix C.

Testing was carried out on a sample of the native soil to assess the potential for sulphate attack on buried concrete structures, as well as the potential for corrosion associated with buried steel elements of the structures. The results of the analytical testing are summarized in this report and presented in Appendix C.



5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix B. Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and on the Borehole Locations and Soil Strata Drawing included in Appendix D. A description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description and must be used for interpretation of the site conditions. It must be recognized and expected that soil conditions may vary between and beyond the borehole locations.

In general, the subsurface conditions encountered consisted of gravelly sand to sand and gravel embankment fill containing cobbles and boulders, underlain by native deposits of sand and silt and sand and gravel containing cobbles and boulders. The overburden material was underlain by greenschist bedrock.

5.1 Topsoil

A 100 mm thick layer of topsoil was encountered at ground surface at Borehole 17032-01 at the toe of the embankment. A moisture content of 108 percent was measured on a sample of the topsoil. The topsoil thickness may vary in other areas of the site.

5.2 Asphalt

Boreholes 17032-02 to 17032-04 were advanced through the paved portion of Highway 556, and the thickness of the asphalt was measured to be 60 mm at each borehole location.

5.3 Embankment Fill

Granular embankment fill ranging in composition from gravel and sand to silty sand, and containing cobbles and boulders was encountered beneath the topsoil in Borehole 17032-01, below the asphalt in Boreholes 17032-02 to 17032-04, and at the surface in Borehole 17032-05. Cobbles and boulders were encountered at varying depths throughout the embankment fill and were cored using an 'NQ' size rock core barrel. Photographs of the cobble cores are provided in Appendix C.

The embankment fill ranged in thickness from 3.2 m to 7.5 m and extended to depths of between 3.3 m and 7.6 m (Elev. 309.8 m and 307.6 m).



SPT 'N' values in the embankment fill ranged from 1 blow per 0.3 m penetration to 42 blows per 0.1 m of penetration (with typical values recorded between 5 to 48 blows per 0.3 m of penetration), indicating a loose to dense condition. The SPT 'N' values varied widely as a result of split-spoon refusal on cobbles and boulders, which were present throughout the fill. The measured moisture contents generally ranged from 3 percent to 23 percent.

The results of grain size analyses conducted on selected samples of the embankment fill are provided on the Record of Borehole sheets in Appendix B and plotted in Figures C-1A and C-1B of Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	4 to 56
Sand	36 to 80
Silt	15 to 40
Clay	2 to 4

5.4 Organic Silt

A 0.3 m thick deposit of organic silt, trace gravel and trace sand was encountered below the embankment fill in Boreholes 17032-03 at a depth of 7.6 m (Elev. 307.8 m). A buried layer of topsoil, 75 mm thick, was present beneath the fill in Borehole 17032-05 at a depth of 3.6 m (Elev. 309.8 m).

An SPT 'N' value recorded in the organic silt measured 11 blows per 0.3 m penetration, indicating a compact condition. The measured moisture and organic content from the sample of the organic silt was 73 percent and 9 percent, respectively.

5.5 Gravel and Sand to Silt

A heterogenous deposit of cohesionless soils ranging from gravel and sand to silt, some sand containing cobbles and boulders was encountered beneath the embankment fill at the borehole location except for Boreholes 17032-03 and 17032-05, where it was encountered beneath the organic silt and topsoil, respectively. The cohesionless deposit was encountered at depths of between 3.3 m and 7.9 m (Elev. 309.8 m and 307.5 m). Where fully penetrated, the cohesionless deposit was 0.7 m to 4.2 m thick and extended to depths of between 4.0 m and 11.3 m (Elev. 307.3 m and 304.6 m). Borehole 17032-03 was terminated within the cohesionless deposit at a depth of 12.3 m (Elev. 303.1 m), respectively.



SPT 'N' values in the cohesionless deposit ranged from 8 to 68 blows per 0.3 m penetration, indicating a loose to very dense condition. A SPT 'N' value of 60 blows per 0.15 m of penetration was measured on probable cobbles and boulders prior to termination. The measured moisture contents in the silt to sand and silt ranged from 8 percent to 25 percent.

The results of grain size analyses conducted on selected samples of the gravel and sand to silt are presented on Figure C-2A and C-2B in Appendix C and summarized as follows:

Soil Particle	Percentage (%)
Gravel	0 to 64
Sand	19 to 68
Silt	36 to 78
Clay	1 to 11

5.6 Cobbles and Boulders

A layer of cobbles and boulders was encountered underlying the gravel and sand to silt deposits in all borehole locations except in Borehole 17032-03. The cobbles and boulders were encountered at depths ranging from 4.0 m to 11.3 m (Elev. 307.3 m to 304.6 m). Particle sizes of the cobbles and boulders were measured up to 500 mm in the cored samples. Where fully penetrated in Borehole 17032-02, the layer of cobbles and boulders was 1.7 m thick and extended to a depth of 11.5 m (Elev. 303.9 m). Boreholes 17032-01, 17032-04, and 17032-05 were terminated with this layer.

5.7 Bedrock

In Borehole 17032-02, bedrock was encountered at a depth of 11.5 m (Elev. 303.9 m) and was proven by coring.

The bedrock consisted of slightly weathered to fresh greenschist with frequent quartz veining. The greenschist is fine to medium grained, laminated, and dark green to grey in colour. Photographs of the bedrock core can be found in Appendix C. The rock core quality parameters are summarized below:



Rock Core Quality Parameters	Range	Average
Total Core Recover (TCR), %	100	100
Solid Core Recover (SCR), %	27 to 67	50
Rock Quality Designation (RQD), %	27 to 63	48
Fractured Index (FI)	1 to 10	4

The Rock Quality Designation (RQD) varied from 27 percent to 63 percent indicating a rock mass of poor to fair quality. The results of the Unconfined Compressive Strength (UCS) testing carried out on a bedrock core sample from Borehole 17302-02 are presented in Appendix C and summarized below. Based on the test result, the bedrock is classified as very strong (R5).

Borehole Core	Depth and Elevation of Core Run (m)	Unconfined Compressive Strength (UCS) (MPa)	Term (Grade)
17032-02 Run #2	12.1 to 12.3 / 303.3 to 303.1	135	Very Strong (R5)

5.8 Groundwater Conditions

Details of the water level observed in the boreholes upon completion of drilling and in a piezometer installed in a borehole are presented on the record of boreholes and summarized below.

Borehole	Date of Measurement	Groundwater Level (m)		Remark
		Depth	Elevation	
17032-01	Sept. 2, 2022	1.7	309.2	Measurements from piezometer
	Sept. 14, 2022	2.0	308.9	
	Sept. 17, 2022	1.9	309.0	
	Sept. 22, 2022	1.9	309.0	
17032-02	-	-	-	Not measured. Note 1
17032-03	-	-	-	Not measured. Note 1
17032-04	Aug. 20, 2022	1.4	314	Not stabilized. Note 2.
17032-05	-	-	-	Not measured. Note 1

Note 1: Introduced water into borehole for drilling with wash boring methods and therefore, groundwater level was not measured upon completion of drilling.

Note 2: Introduced water into borehole for drilling with wash boring methods and therefore, groundwater level at time of measurement was not considered stabilized.

The water level in the ditch was surveyed at the time of the investigation and found to be at approximately Elev. 308.6 m near the culvert outlet. The ponded water near the inlet was found to be at approximately Elev. 310.9 m at the time of the investigation.



These groundwater levels are short-term observations and seasonal fluctuations of the groundwater levels are to be expected. In particular, the groundwater levels may be at a higher elevation during spring and after periods of significant or prolonged precipitation.

6. ANALYTICAL LABORATORY TESTING

One sample of the native sandy gravel was submitted for analytical testing for corrosivity analysis and sulphide content. The analytical test results for the soil are presented in Appendix C and are summarized below.

Borehole	17032-04
Sample	SS10B
Depth (m)	9.4 to 9.7
Elevation (m)	306.4
Sulphide (Na ₂ CO ₃) %	<0.04
Chloride (µg/g)	<5
Sulphate (µg/g)	<5
pH	6.89
Conductivity (µS/cm)	36
Resistivity (Ohm-cm)	27,400

7. MISCELLANEOUS

Downing Drilling Ltd. of Greely, Ontario, and Forage Fusion Drilling of Hawkesbury, Ontario supplied and operated the drilling, sampling, and in-situ testing equipment for the field investigation. The field investigation was supervised on a full-time basis by Messrs. Arman Hasan, M.Eng., and Ibrahim Khan, M.Eng. The overall management of the field program was conducted by Ms. Alysha Kobylinski, P.Eng.

Geotechnical laboratory testing on soil samples was carried out in Thurber's geotechnical laboratory. Organic content testing on the organic silt and unconfined compression testing of the rock core was carried out by Stantec Consulting Ltd., in Ottawa, Ontario. Analytical laboratory testing was carried out by Paracel Laboratories Ltd., a CALA accredited analytical laboratory in Ottawa, Ontario.



Interpretation of the field data and preparation of this report was carried out by Messrs. Cory Zanatta, P.Eng., and Christopher Ng, P.Eng., respectively. The report was reviewed by Messrs. Fred Griffiths, P.Eng., and P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects at Thurber.

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STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

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The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

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5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

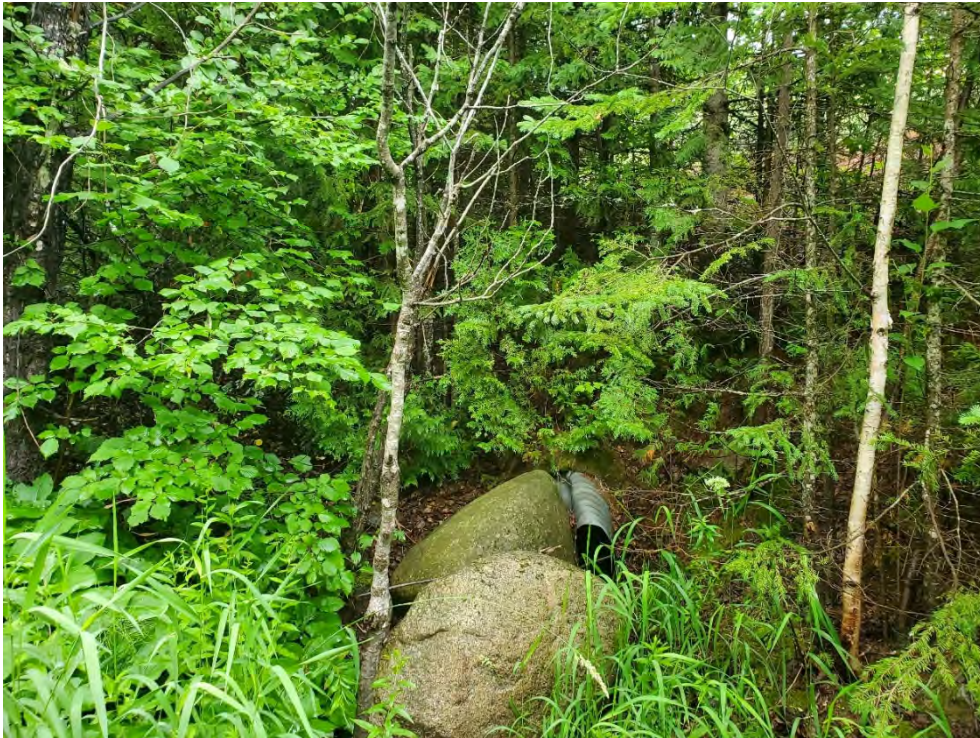
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The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.



Appendix A

Site Photographs



Photograph #1 – Culvert outlet facing South. Outlet at base of embankment slope surrounded by thick mixed forest (July, 2022).



Photograph #2 – Toe of embankment slope at culvert inlet facing West. Culvert visible in bottom left corner (July, 2022).



Photograph #3 – West view of culvert inlet embankment approximately 75 m North of culvert. (August, 2022)



Photograph #4 – South view of culvert inlet ponding at time of drilling investigation (August, 2022)



Photograph #5 – View looking east along Highway 556 at existing culvert location. (August, 2022)



Appendix B

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$


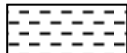



 Water Level
 C_{pen} Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	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	SILTS AND CLAYS W _L < 50%	ML	Inorganic silts and 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. (W _L < 30%).
		CI	Inorganic clays of medium plasticity, silty clays. (30% < W _L < 50%).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS W _L > 50%	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Very thinly bedded	20 to 60mm				
Laminated	6 to 20mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Thinly Laminated	Less than 6mm				

<u>TERMS</u>						
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty Can be peeled by a pocket knife, crumbles under firm blows of geological pick. Indented by thumbnail	
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750		
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150		
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen					
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.					

RECORD OF BOREHOLE No 17032-01

1 OF 1

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 176 872.2 E 292 833.7 ORIGINATED BY IK
DIST Algoma HWY 556 BOREHOLE TYPE Portable Drilling, Wash Boring, BW Casing Advance, AW Coring COMPILED BY AO
DATUM Geodetic DATE 2022.08.31 - 2022.09.02 LATITUDE 46.731317 LONGITUDE -84.156568 CHECKED BY CZ

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						
310.9	GROUND SURFACE													
0.0	TOPSOIL: (100 mm)													
0.1	Gravelly SAND , some silt, trace clay, containing cobbles and boulders Very Loose to Compact Brown to Grey Moist (FILL)		1	SS	5									
	No recovery from a depth of 1.2 m to 3.0 m		2	SS	4									
	Coring from a depth of 1.9 m to 2.4 m		3	SS	1									
			4	SS	42/0.10									
	Coring from a depth of 3.0 m to 3.4 m		1	AW	-									
			5	SS	28									
307.6			2	AW	-									
3.3	GRAVEL and SAND , some silt, containing cobbles and boulders Dense Grey Moist		6	SS	39									
306.9														
4.0	COBBLES and BOULDERS		3	AW	-									
305.8														
5.1	END OF BOREHOLE AT 5.1 m. Monitoring well installation consists of 31.8 mm diameter Schedule 40 PVC pipe with 1.5 m slotted screen. NOTES: 1. A half-weight hammer was used to advance the split-spoon sampler. The "N" values presented above have been adjusted to provide an estimate of the "N" value that would have been obtained with a standard hammer. 2. Borehole terminated at a depth of 5.1 m as a result of casing seizing within the cobbles and boulder layer from a depth of 4.0 m to 5.1 m. Hydraulic jacks were required to remove casing from borehole. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2022.09.02 1.7 309.2 2022.09.14 2.0 308.9 2022.09.17 1.9 309.0 2022.09.22 1.9 309.0													

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

RECORD OF BOREHOLE No 17032-02

1 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 176 873.3 E 292 861.0 ORIGINATED BY AH
DIST Algoma HWY 556 BOREHOLE TYPE CME 75, Wash Boring, HW Casing Advance, NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.08.18 - 2022.08.19 LATITUDE 46.731328 LONGITUDE -84.156211 CHECKED BY CZ

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		
315.4	GROUND SURFACE												
0.0	ASPHALT:(60 mm)												
0.1	SAND and GRAVEL , trace silt to Silty SAND , some gravel, containing cobbles and boulders Very Loose to Very Dense Greyish Brown Moist (FILL)		1	SS	103								
			2	SS	64								
	Coring of a 150 mm cobble at a depth of 1.4 m		1	NQ	-								
			3	SS	20								
			4	SS	8								
			5	SS	2								
			6	SS	8								
			7	SS	18								
309.8													
5.6	SILT , some sand, some clay, trace gravel Compact Brownish Grey Moist to Wet		8	SS	14								
308.2													
7.2	Sandy SILT , occasional silt seams Loose to Compact Brownish Grey Moist to Wet		9	SS	19								
			10	SS	8								
305.6													
9.8	COBBLES and BOULDERS particle												

Continued Next Page

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

RECORD OF BOREHOLE No 17032-02

2 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 176 873.3 E 292 861.0 ORIGINATED BY AH
DIST Algoma HWY 556 BOREHOLE TYPE CME 75, Wash Boring, HW Casing Advance, NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.08.18 - 2022.08.19 LATITUDE 46.731328 LONGITUDE -84.156211 CHECKED BY CZ

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							WATER CONTENT (%)		
								20	40	60	80	100			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT
	Continued From Previous Page																
303.9	size between 100 mm and 330 mm Grey		2	NQ	-												
11.5	GREENSCHIST, frequent quartz veins, slightly weathered to fresh, fine to medium grained, laminated, rust colouration at joints Dark Greenish Grey		1	RUN	-								FI	RUN #1 TCR=100% SCR=27% RQD=27%			
			2	RUN	-										2		
				3	RUN	-									10		
															1		
300.8																	
14.6	END OF BOREHOLE AT 14.6 m. BOREHOLE BACKFILLED WITH BENTONITE, ASPHALT PATCH AT SURFACE.																

RECORD OF BOREHOLE No 17032-03

1 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 176 864.4 E 292 843.1 ORIGINATED BY AH
DIST Algoma HWY 556 BOREHOLE TYPE CME 75, Wash Boring, HW Casing Advance, NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.08.17 - 2022.08.18 LATITUDE 46.731247 LONGITUDE -84.156445 CHECKED BY CZ

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											
								<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div>				<div><div>PLASTIC LIMIT</div><div>NATURAL MOISTURE CONTENT</div><div>LIQUID LIMIT</div><div>W_P W W_L</div><div>WATER CONTENT (%)</div><div>204060</div></div>							
315.4	GROUND SURFACE																		
0.0	ASPHALT:(60 mm)																		
0.1	GRAVEL and SAND, trace non-plastic fines, containing cobbles and boulders Compact to Dense Greyish Brown Moist (FILL) Spoon refusal at a depth of 1.3 m		1	SS	48		315												
			2	SS	27														
							314												
			3	SS	43									56 36 8 (SI+CL)					
313.1	Cobbles encountered below a depth of 2.1 m		1	NQ	-		313												
2.3	Silty SAND, some gravel, trace clay, containing cobbles and boulders Compact to Very Loose Greyish Brown Moist to West (FILL)		4	SS	15									13 57 28 2					
			5	SS	15		312												
			6	SS	18														
			7	SS	2		311												
	Spoon refusal, no sample recovery Coring from a depth of 5.6 m to 7.0 m with particle size up to 500 mm		8	SS	4/0.150		310												
			2	NQ	-		309												
							308												
307.8	Void between a depth of 7.0 m and 7.6 m																		
7.6	ORGANIC SILT trace gravel, trace sand		9	SS	11		307							15 43 39 3					
307.5	Compact Black Wet																		
7.9	Silty SAND, some gravel, trace clay, to SILT and SAND, trace gravel, trace clay Compact Brown Moist to Wet		10	SS	19		306							6 36 56 2					

Continued Next Page

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

RECORD OF BOREHOLE No 17032-03

2 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 176 864.4 E 292 843.1 ORIGINATED BY AH
DIST Algoma HWY 556 BOREHOLE TYPE CME 75, Wash Boring, HW Casing Advance, NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.08.17 - 2022.08.18 LATITUDE 46.731247 LONGITUDE -84.156445 CHECKED BY CZ

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									
	Continued From Previous Page							20	40	60	80	100					
304.7							305										
10.7	Gravelly Silty SAND Dense to Very Dense Grey Moist to Wet		11	SS	44		304										34 48 18 (SI+CL)
303.1																	
12.3	END OF BOREHOLE AT 12.34 m. BOREHOLE BACKFILLED WITH BENTONITE, ASPHALT PATCH AT SURFACE.		12	SS	60/0.150												

RECORD OF BOREHOLE No 17032-04

1 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 176 861.1 E 292 846.2 ORIGINATED BY AH
DIST Algoma HWY 556 BOREHOLE TYPE CME 75, Wash Boring, HW Casing Advance, NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.08.19 - 2022.08.20 LATITUDE 46.731217 LONGITUDE -84.156404 CHECKED BY CZ

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											
315.9	GROUND SURFACE							20	40	60	80	100							
0.9	ASPHALT:(60 mm)																		
	GRAVEL and SAND trace non-plastic fines, to Gravelly SAND, containing cobbles and boulders Compact to Dense Greyish Brown Moist (FILL)		1	SS	117		315												52 38 10 (SI+CL)
	Coring from a depth of 1.4 m to 1.8 m		2	SS	54														
			1	NQ	-		314												
			3	SS	66														
			4	SS	33		313												
			5	SS	38														
	Coring from a depth of 3.7 m to 3.8 m		2	NQ	-		312												28 45 27 (SI+CL)
			6	SS	20														
	No sample recovery from a depth of 4.6 m to 5.2 m		7	SS	8		311												
							310												
			8	SS	6		309												
308.6																			
7.3	Silty SAND some gravel, trace clay, containing cobbles Very Dense Brown Moist		9	SS	68		308												17 37 41 5
							307												
306.5																			
9.4	Sandy GRAVEL, trace non-plastic fines Dense to Very Dense		10	SS	32		306												

Continued Next Page

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

METRIC

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	W P W W L												
	Continued From Previous Page																		
304.6	Grey Moist Coring from a depth of 9.8 m to 10.7 m		3	NQ	-														
11.3	COBBLESand BOULDERS Particle size up to 300 mm		11	SS	55														
303.6	Split-spoon refusal at a depth of 12.3 m		4	NQ	-														
12.3	END OF BOREHOLE AT 12.3 m. BOREHOLE BACKFILLED WITH BENTONITE, ASPHALT PATCH AT SURFACE.		12	SS	26/0.150														
NOTES: 1. Unstabilized water level in open borehole upon completion of drilling at a depth of 1.4 m below ground surface. Water introduced to borehole during drilling.																			

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 17032-05

1 OF 1

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 176 855.2 E 292 852.3 ORIGINATED BY IK
DIST Algoma HWY 556 BOREHOLE TYPE Portable Drilling, Wash Boring, BW Casing Advance, AW Coring COMPILED BY AN
DATUM Geodetic DATE 2022.09.13 - 2022.09.15 LATITUDE 46.731165 LONGITUDE -84.156324 CHECKED BY CN

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									
313.4	GROUND SURFACE							20	40	60	80	100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
0.0	SAND , some gravel, trace non-plastic fines, trace organics, containing cobbles and boulders Loose to Compact Brown Moist (FILL) Casing grinding on probably cobbles between a depth of 0.6 m and 1.2 m Coring from a depth of 1.2 m to 1.8 m		1	SS	5		313										16 80 4 (SI+CL)
			2	SS	14												
311.6			1	AW	-		312										
1.8	Silty SAND , trace gravel, trace clay Loose Grey Wet (FILL) Coring from a depth of 2.7 m to 3.0 m		3	SS	5		311										
			4	SS	42/0.150												
			2	AW	-												
			5	SS	6		310										4 54 40 2
309.8																	
309.9	TOPSOIL (75 mm)																
3.7	Silty SAND some gravel, Compact to Dense Brown Wet		6	SS	12		309										18 68 14 (SI+CL)
			7	SS	33												
308.5																	
4.9	SILT , some sand, trace clay Compact to Dense Brown To Grey Wet -Grey below a depth of 5.5 m		8	SS	29		308										0 20 78 2
			9	SS	35												
307.3																	
6.1	COBBLES and BOULDERS		3	AW	-		307										
306.4																	
7.0	END OF BOREHOLE AT 7.0 m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE NOTES: 1. A half-weight hammer was used to advance the split-spoon sampler. The "N" values presented above have been adjusted to provide an estimate of the "N" value that would have been obtained with a standard hammer. 2. Borehole terminated at a depth of 7.0 m as a result of casing seizing within the cobbles and boulder layer from a depth of 6.1 m to 7.0 m. Hydraulic jacks were required to remove casing from borehole.																

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE



Appendix C

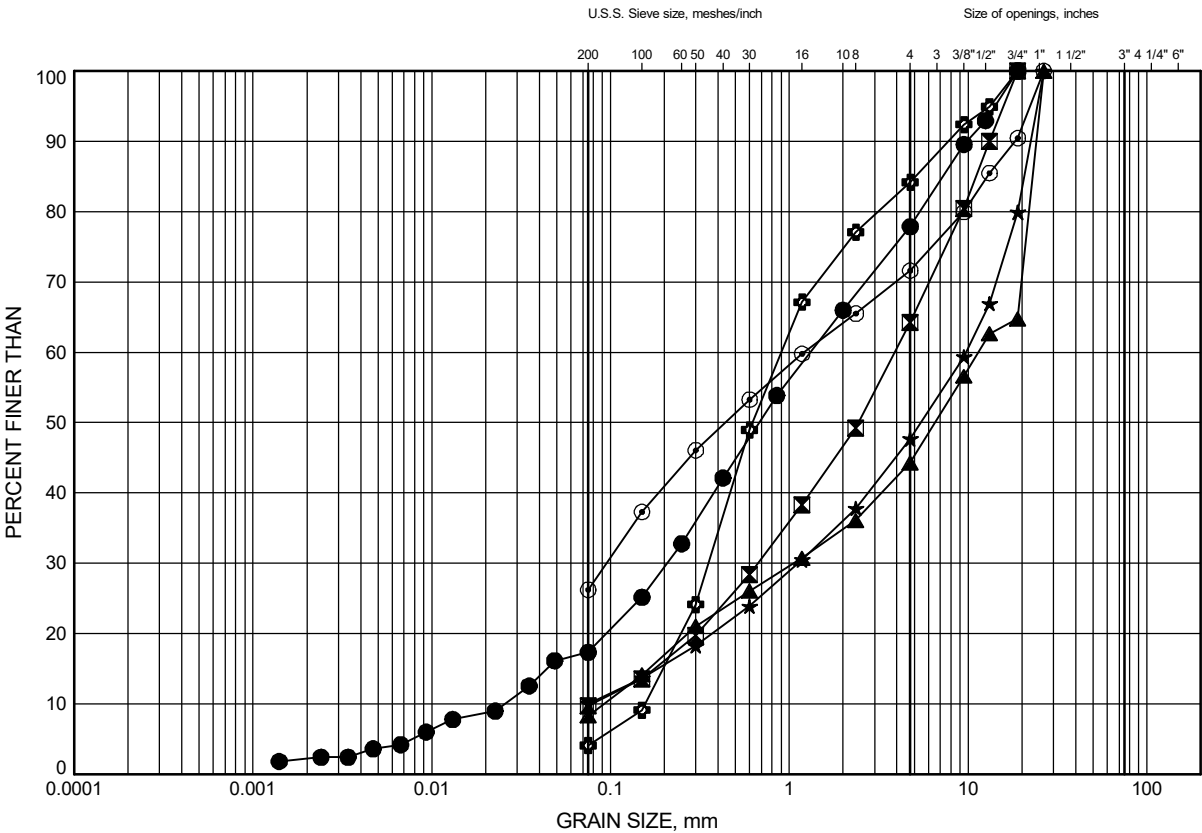
Geotechnical and Analytical Laboratory Test Results, and Core Photographs

Highway 556 Culvert Replacement at STA 17+032

GRAIN SIZE DISTRIBUTION

FIGURE C-1A

Gravel and Sand to Gravelly Silty Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17032-01	0.9	310.0
⊠	17032-02	0.5	314.9
▲	17032-03	1.8	313.6
★	17032-04	1.1	314.8
⊙	17032-04	4.1	311.8
⊕	17032-05	0.3	313.1

GRAIN SIZE DISTRIBUTION - THURBER MTO-31719.GPJ 22-11-4

Date November 2022
W.P. 5221-18-00



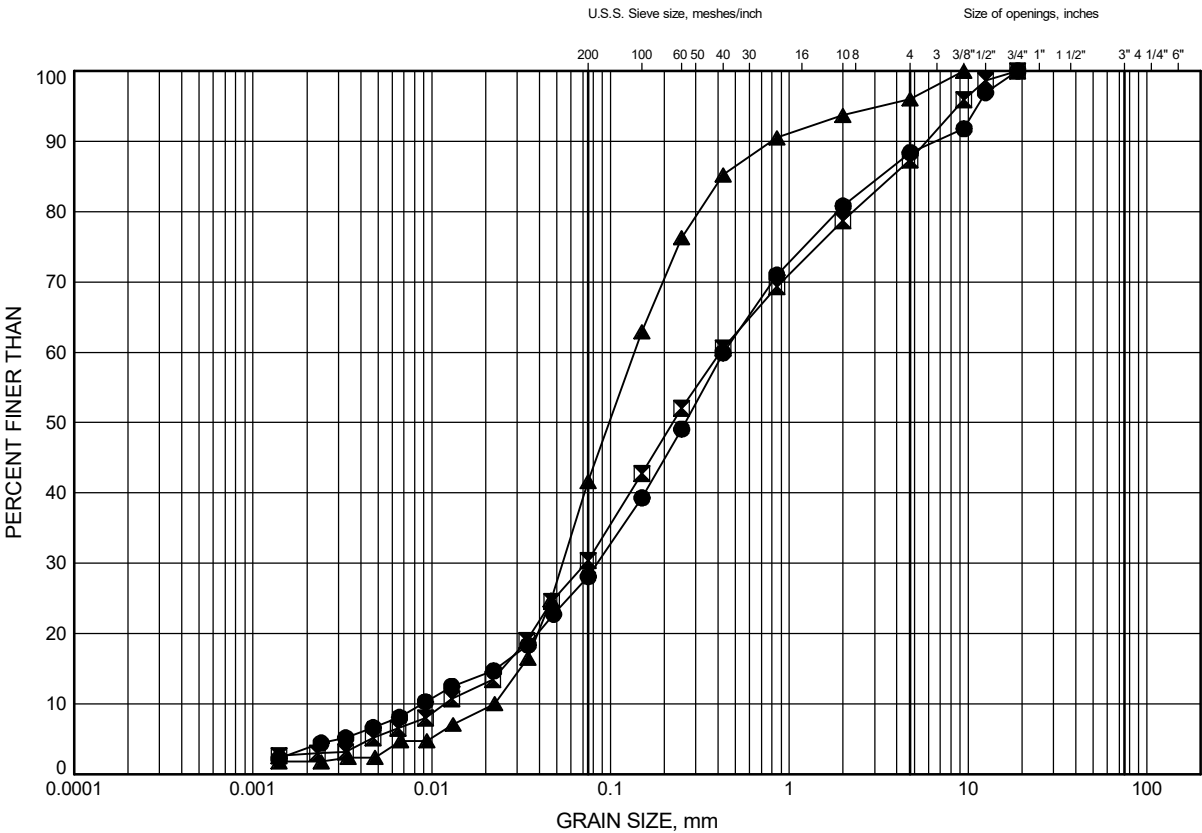
Prep'd CZ
Chkd. CN

Highway 556 Culvert Replacement at STA 17+032

GRAIN SIZE DISTRIBUTION

FIGURE C-1B

Sand to Silty Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17032-02	3.4	312.0
⊠	17032-03	2.6	312.8
▲	17032-05	3.4	310.0

GRAIN SIZE DISTRIBUTION - THURBER MTO-31719.GPJ 22-11-4

Date November 2022

W.P. 5221-18-00



Prep'd CZ

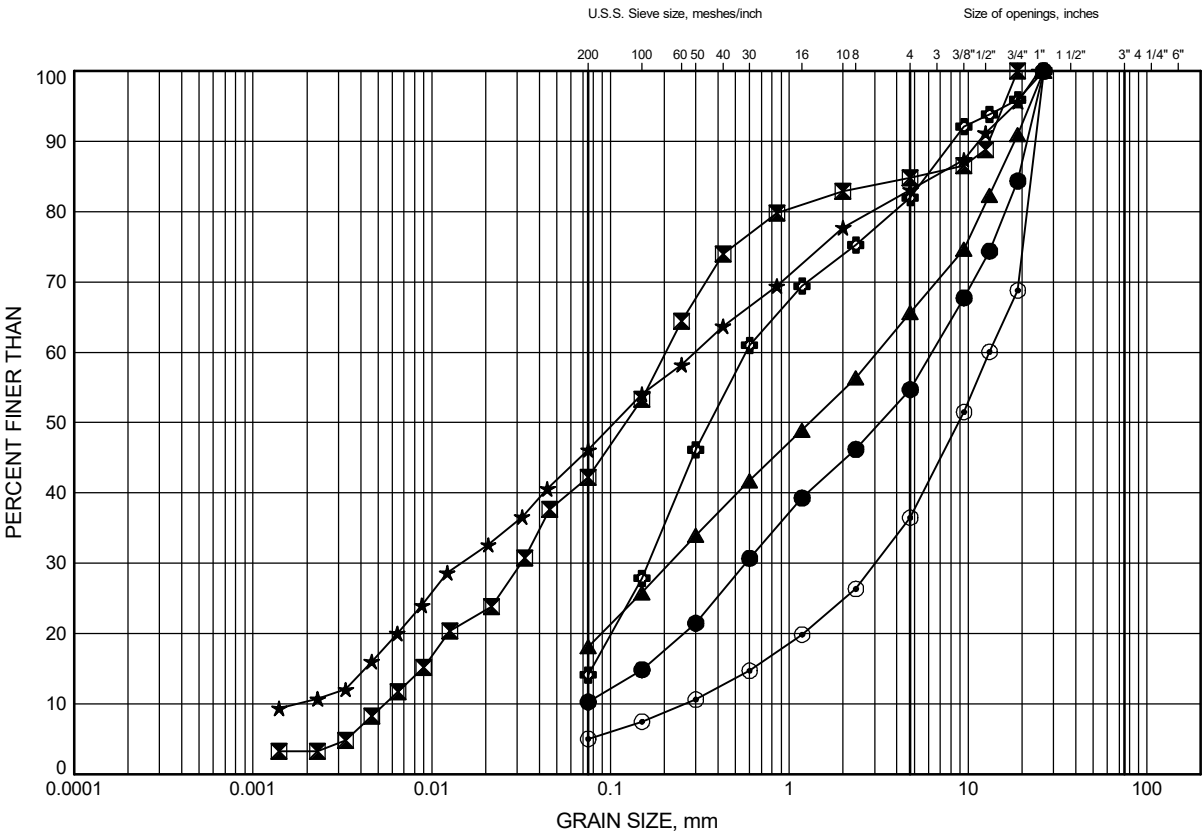
Chkd. CN

Highway 556 Culvert Replacement at STA 17+032

GRAIN SIZE DISTRIBUTION

FIGURE C-2A

Sandy Gravel to Silty Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17032-01	3.7	307.2
⊠	17032-03	7.7	307.7
▲	17032-03	11.1	304.3
★	17032-04	7.9	308.0
⊙	17032-04	11.0	304.9
⊕	17032-05	4.0	309.4

GRAIN SIZE DISTRIBUTION - THURBER MTO-31719.GPJ 22-11-4

Date November 2022
W.P. 5221-18-00



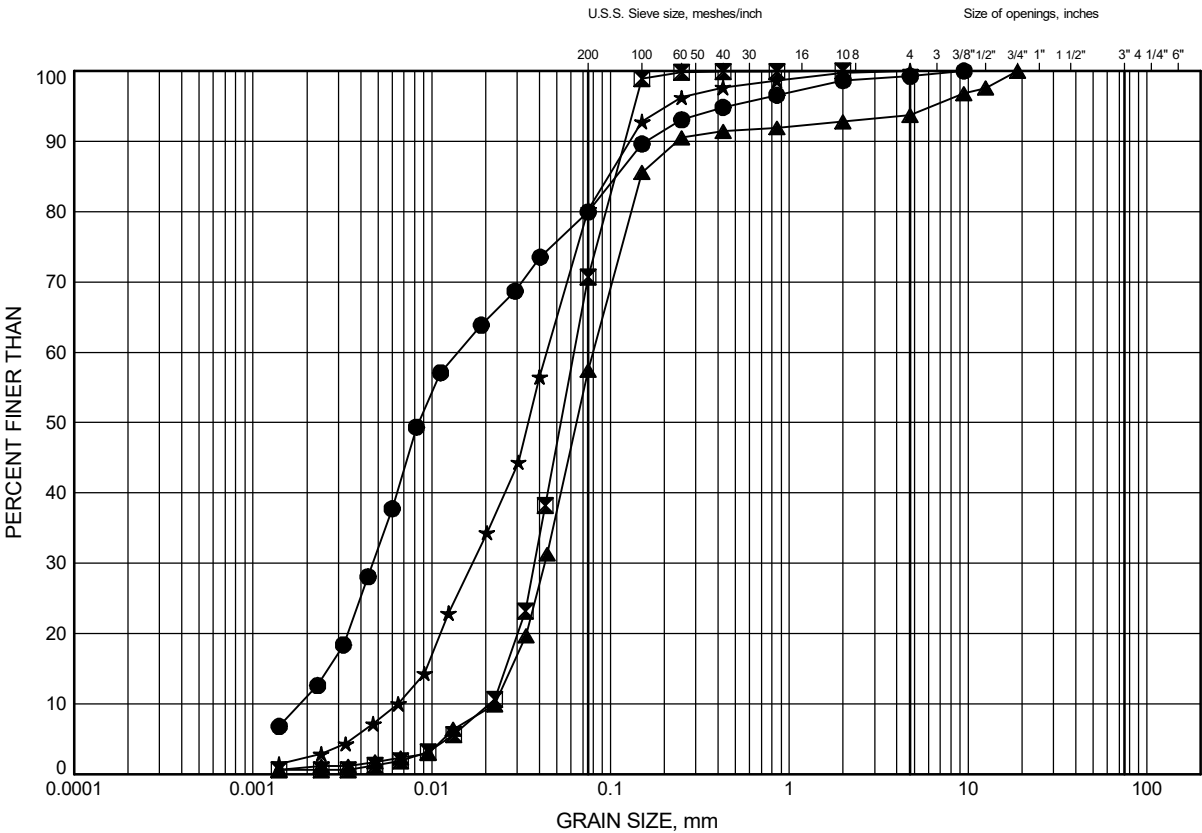
Prep'd CZ
Chkd. CN

Highway 556 Culvert Replacement at STA 17+032

GRAIN SIZE DISTRIBUTION

FIGURE C-2B

SILT and SAND to Sandy Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17032-02	6.4	309.0
⊠	17032-02	9.4	306.0
▲	17032-03	9.4	306.0
★	17032-05	5.2	308.2

GRAIN SIZE DISTRIBUTION - THURBER MTO-31719.GPJ 22-11-4

Date November 2022
W.P. 5221-18-00



Prep'd CZ
Chkd. CN



Stantec Consulting Ltd.
2781 Lancaster Rd, Suite 100 A&B, Ottawa ON K1B 1A7

September 19, 2022
File: 122410864

Client: Thurber Engineering, File #31719

**Reference: ASTM-D2974 Organic Content & D2216 Moisture Content
Highway 556 & 532**

The following table summarizes one Moisture & Organic Content result.

Source	Depth	Moisture Content (%)	Organic Content (%)
17032-03 SS9A	25'-26'	63.2	9.2

Sincerely,

Stantec Consulting Ltd.

Brian Prevost
Laboratory Supervisor
Tel: 613-738-6075
Fax: 613-722-2799
brian.prevost@stantec.com



Stantec Consulting Ltd.
2781 Lancaster Rd, Suite 100 A&B, Ottawa ON K1B 1A7

September 19, 2022
File: 122410864

Client: Thurber Engineering, File #31719

**Reference: ASTM D7012, Method C, Unconfined Compressive Strength of Intact Rock Core
Highway 556 & 532**

The following table summarizes unconfined compressive strength results for one intact rock core.

Location	Sample Depth	Compressive Strength (MPa)	Description of Break
1703-02 Run-2	39'8"-40'6"	135.4	Well-formed cones at both ends

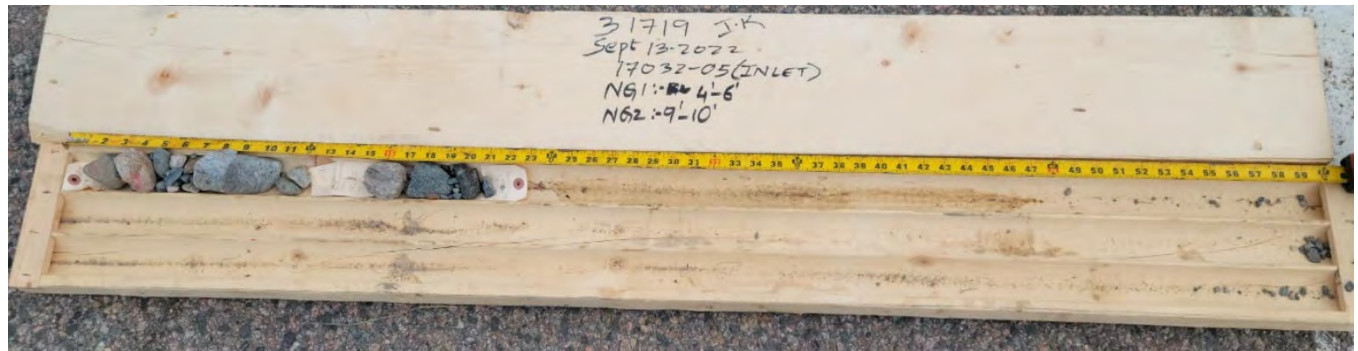
Sincerely,

Stantec Consulting Ltd.

Brian Prevost
Laboratory Supervisor
Tel: 613-738-6075
Fax: 613-722-2799
brian.prevost@stantec.com



Photograph #5 – Rock Coring Runs 1, 2, and 3 of Borehole 17032-02



Photograph #6 – NQ 1 and NQ 2 Cores of cobbles in Borehole 17032-05

Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104

Ottawa, ON K1B4S5

Attn: Alysha Kobylnski

Client PO:

Project: 31719 Hwys 556 & 532

Custody:

Report Date: 8-Sep-2022

Order Date: 1-Sep-2022

Order #: 2236448

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

Paracel ID	Client ID
2236448-01	17032-04 SS10B (31'-32')
2236448-02	21258-04 SS9A (25'-26')

Approved By:



Milan Ralitsch, PhD

Senior Technical Manager

Certificate of Analysis

Report Date: 08-Sep-2022

Client: Thurber Engineering Ltd.

Order Date: 1-Sep-2022

Client PO:

Project Description: 31719 Hwys 556 & 532

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	7-Sep-22	9-Jul-22
Conductivity	MOE E3138 - probe @25 °C, water ext	7-Sep-22	7-Sep-22
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	6-Sep-22	7-Sep-22
Resistivity	EPA 120.1 - probe, water extraction	7-Sep-22	7-Sep-22
Solids, %	Gravimetric, calculation	6-Sep-22	7-Sep-22

Certificate of Analysis

Report Date: 08-Sep-2022

Client: Thurber Engineering Ltd.

Order Date: 1-Sep-2022

Client PO:

Project Description: 31719 Hwys 556 & 532

Summary of Criteria Exceedances

(If this page is blank then there are no exceedances)

Only those criteria that a sample exceeds will be highlighted in red

Regulatory Comparison:

Paracel Laboratories has provided regulatory guidelines on this report for informational purposes only and makes no representations or warranties that the data is accurate or reflects the current regulatory values. The user is advised to consult with the appropriate official regulations to evaluate compliance. Sample results that are highlighted have exceeded the selected regulatory limit. Calculated uncertainty estimations have not been applied for determining regulatory exceedances.

Sample	Analyte	MDL / Units	Result	-	-
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Certificate of Analysis

Report Date: 08-Sep-2022

Client: Thurber Engineering Ltd.

Order Date: 1-Sep-2022

Client PO:

Project Description: 31719 Hwys 556 & 532

Client ID:	17032-04 SS10B (31'-32')	21258-04 SS9A (25'-26')	-	-	
Sample Date:	19-Aug-22 09:00	21-Aug-22 09:00	-	-	-
Sample ID:	2236448-01	2236448-02	-	-	-
Matrix:	Soil	Soil	-	-	-
MDL/Units					

Physical Characteristics

% Solids	0.1 % by Wt.	82.9	78.2	-	-	-	-
----------	--------------	------	------	---	---	---	---

General Inorganics

Conductivity	5 uS/cm	36	1140	-	-	-	-
pH	0.05 pH Units	6.89	6.54	-	-	-	-
Resistivity	0.1 Ohm.m	274	8.75	-	-	-	-

Anions

Chloride	5 ug/g	<5	752	-	-	-	-
Sulphate	5 ug/g	<5	54	-	-	-	-

Certificate of Analysis

Report Date: 08-Sep-2022

Client: Thurber Engineering Ltd.

Order Date: 1-Sep-2022

Client PO:

Project Description: 31719 Hwys 556 & 532

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%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: 08-Sep-2022

Client: Thurber Engineering Ltd.

Order Date: 1-Sep-2022

Client PO:

Project Description: 31719 Hwys 556 & 532

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	127	5	ug/g	123			2.9	20	
Sulphate	62.9	5	ug/g	62.2			1.1	20	
General Inorganics									
Conductivity	567	5	uS/cm	569			0.3	5	
pH	6.74	0.05	pH Units	6.68			0.9	10	
Resistivity	17.6	0.10	Ohm.m	17.6			0.3	20	
Physical Characteristics									
% Solids	93.8	0.1	% by Wt.	94.1			0.3	25	

Certificate of Analysis

Report Date: 08-Sep-2022

Client: Thurber Engineering Ltd.

Order Date: 1-Sep-2022

Client PO:

Project Description: 31719 Hwys 556 & 532

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	228	5	ug/g	123	105	82-118			
Sulphate	163	5	ug/g	62.2	100	80-120			

Certificate of Analysis

Report Date: 08-Sep-2022

Client: Thurber Engineering Ltd.

Order Date: 1-Sep-2022

Client PO:

Project Description: 31719 Hwys 556 & 532

Qualifier Notes:**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.



Parcel Order Number
(Lab Use Only)

2236448

Chain Of Custody
(Lab Use Only)

Client Name: Thurber Engineering	Project Ref: 31719 Hwy 556 & 532	Page 1 of 1
Contact Name: Alysha Kobylinski	Quote #:	Turnaround Time <input type="checkbox"/> 1 day <input type="checkbox"/> 3 day <input type="checkbox"/> 2 day <input checked="" type="checkbox"/> Regular
Address: 104 - 2460 Lancaster Rd Ottawa, ON K1B 4S5	PO #:	
Telephone: 226-748-9593	E-mail: akobylinski@thurber.ca	
Date Required:		

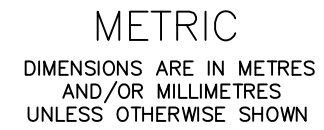
<input type="checkbox"/> REG 153/04 <input type="checkbox"/> REG 406/19		Other Regulation	Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)		Required Analysis									
<input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> Table _____ For RSC: <input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> REG 558 <input type="checkbox"/> PWQO <input type="checkbox"/> CCME <input type="checkbox"/> MISA <input type="checkbox"/> SU - Sani <input type="checkbox"/> SU - Storm Mun: _____ <input type="checkbox"/> Other: _____													
Sample ID/Location Name		Matrix	Air Volume	# of Containers	Sample Taken		pH	Resistivity	chloride	sulphide	sulphate	Conductivity		
					Date	Time								
1	17032-04 SS10B (31'-32')	S		1	Aug 19, 22		✓	✓	✓	✓	✓	✓		
2	21258-04 SS9A (25'-26')	S		1	Aug 21, 22		✓	✓	✓	✓	✓	✓		
3														
4														
5														
6														
7														
8														
9														
10														

Comments:			Method of Delivery:	
Relinquished By (Sign): <i>A. Oliveira</i>	Received By Driver/Depot:	Received By Lab: <i>Mehmet</i>	Verified By: <i>Walk in</i>	
Relinquished By (Print): Anderson de Oliveira	Date/Time:	Date/Time: Sept 1/22 17:00	Date/Time: SEP 20/22 11:11	
Date/Time: Sep 01, 2022 @ 16:53	Temperature: °C	Temperature: 23.1 °C	pH Verified: <input type="checkbox"/> By: NA	



Appendix D

Borehole Locations and Soil Strata Drawing



CONT No
WP No 5221-18-00






HIGHWAY 556
STA 17+032
CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

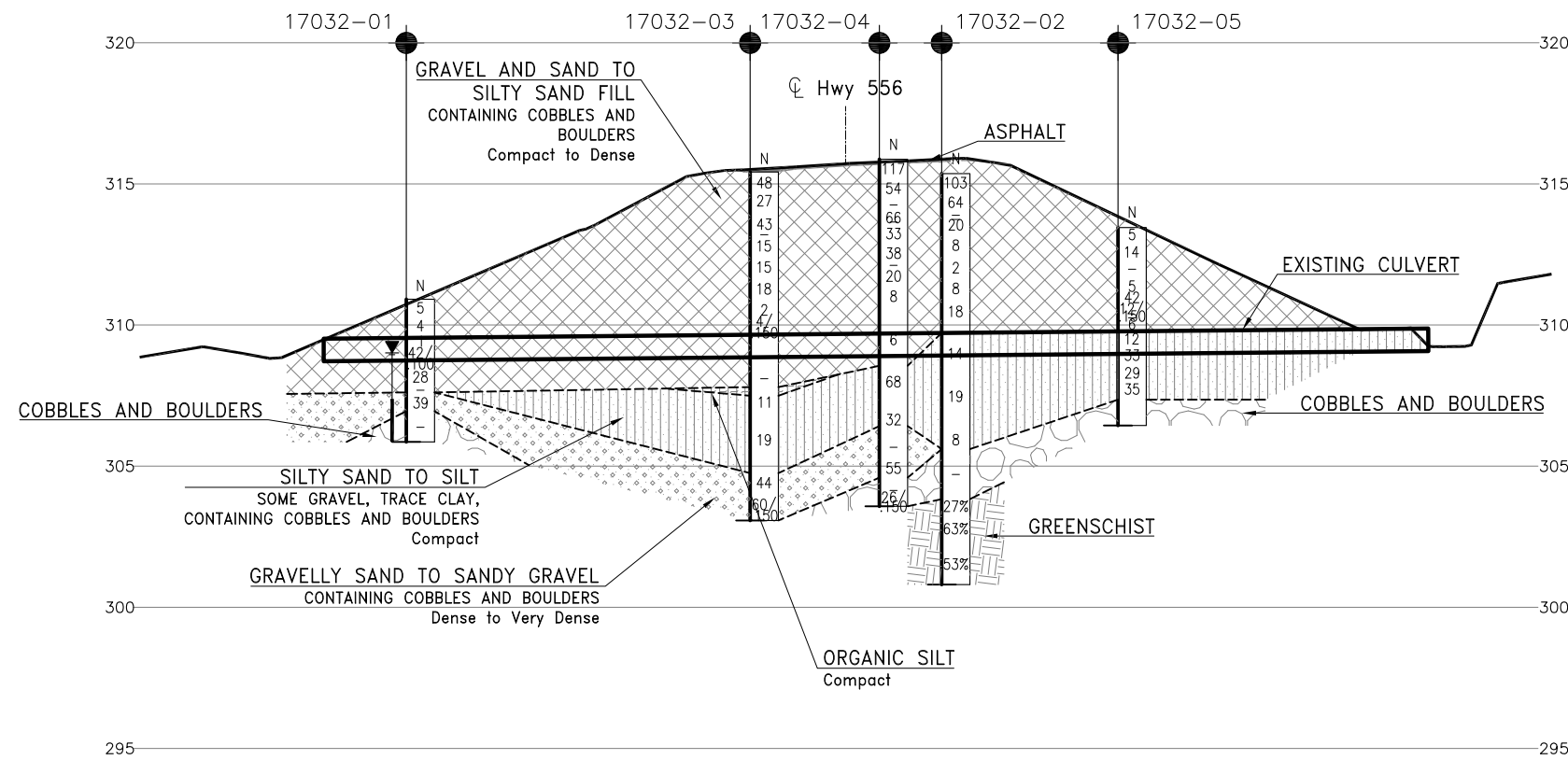
	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

[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. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 41K-122



SECTION ALONG CULVERT

[illegible]