



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
TEMPORARY PROTECTION SYSTEM FOR HIGHWAY 556 CULVERT
REPLACEMENT AT STA 19+741 (TOWNSHIP OF VANKOUGHNET)
REHABILITATION OF HIGHWAYS 556 & 532
DISTRICT OF ALGOMA, ONTARIO
ASSIGNMENT No.: 5020-E-0020
G.W.P. 5221-18-00**

LATITUDE: 46.705997°, LONGITUDE: -84.237334°

GEOCRES Number: 41K-129

Report

to

AECOM Canada Ltd.

Date: May 5, 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) for a temporary protection system for the proposed replacement of a centreline culvert, located at STA 19+741 on Highway 556, in the Township of Vankoughnet, District of Algoma, Ontario.

The purpose of this investigation was to explore the subsurface conditions in the vicinity of the highway centreline near the culvert, 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 5.3 km east of the intersection with Highway 552 and approximately 15.8 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:

Client: AECOM

File No.: 31719

E file: <https://thurberengineering.sharepoint.com/sites/31719/Shared Documents/Reports & Memos/04 - Culvert 19+741 FIDR ->

TPS/TEL_31719_Hwy 556 Culvert 19+741 FIR Final.docx

Date: May 5, 2023

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Township and Station	Culvert Size and Type	Length of Culvert (m)	Invert Elevation at Inlet (m)	Invert Elevation at Outlet (m)
Vankoughnet 19+741	1000 mm dia. CSP	24.38 m long	286.5 (south)	285.4 (north)

The existing culvert allows flow in a south to north direction under the approximately 4.1 m high embankment cover over the existing culvert. Due to the steep terrain, the culvert features two concrete drop inlets, one along the ditch line and one along the toe of the earth cut. The highway pavement surface is at approximate Elev. 291.4 m. This section of highway is constructed partially in an earth/rock cut with the natural ground surface inclined downwards at approximately 2H:1V or flatter from north to south; however, the slopes immediately at the culvert outlet/toe of embankment is as steep as 0.5H:1V due to erosion.

Based on visual observations, no signs of slope instability of the highway embankment were noted near the inlet of the culvert site. The north side of the highway embankment, including the area of the culvert outlet, is generally surrounded by thick mixed forest. The culvert outlet was noted to be damaged / crushed and that the north ditch/toe of embankment shows evidence of erosion with visible cobbles and boulders in the exposed slope and along the surface of the ditch. Bedrock outcrops are visible on the south side of the highway approximately 150 m west of the site. Site photographs of the highway, drop inlets, and culvert outlet can be found in Appendix A.

Highway 556 consists of two, 3.25 m wide, paved lanes and narrow partially paved shoulders. The highway alignment in the immediate vicinity of the culvert is straight and rises from west to east. There is a guide rail along the north side of the highway. Overhead utility lines are present along the north side of the highway. It is understood that the projected 2023 AADT for Highway 556 is 540. A granular entrance to a rural property is located approximately 325 m west of the culvert.

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS) mapping, the site lies near an outwash plain and the primary materials are sandy and gravelly soils, with bedrock knobs and outcrops. The site topography in the immediate vicinity of the culvert is of 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 on November 4 and November 6, 2022, and consisted of drilling and sampling two boreholes through the highway embankment, designated as Boreholes 19741-01 to 19741-02, to depths of 10.4 m and 15.3 m (Elev. 281.7 m and 275.3 m), respectively. The locations of the boreholes are presented on the Record of Borehole sheets, included in Appendix B, and in the borehole location plan in Appendix D.

Utility clearances were obtained prior to mobilization to the site. The borehole co-ordinates were determined through off-set measurement from the highway centerline and existing culvert and as-drilled borehole elevations on the highway were obtained from the digital terrain model. The coordinate system MTM NAD 83, Zone 13 was used for the boreholes.

The boreholes were drilled using a truck-mounted CME 75 drill rig using wash boring technique with NW casing and NQ coring equipment. Soil samples were obtained at selected intervals using a split-spoon sampler in conjunction with Standard Penetration Testing (SPT) in general accordance with ASTM D1586.

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 core samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions observed in open boreholes are not considered stabilized due to the introduction of water throughout the drilling and coring operation.

The borehole completion details are summarized below:

Borehole	Depth and Elevation of Borehole Base (m)	Depth and Elevation of Well Tip (m)	Northing and Easting MTM NAD83 Zone 13	Completion Details
19741-01	10.4 / 281.7	None Installed	N 5 174 074.7 E 286 662.3	Backfilled with bentonite holeplug and asphalt patch at surface.
19741-02	15.3 / 275.3	None Installed	N 5 174 071.0 E 286 641.8	Backfilled with bentonite holeplug and asphalt patch at 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 hydrometer). 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 specimen of the silty sand fill to assess the potential for sulphate attack on buried concrete structures, as well as the potential for corrosion associated with buried steel elements. 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 embankment fill comprised of sand and gravel to silty sand, some gravel to gravelly, over embankment fill containing cobbles underlain by rockfill. The rockfill is in turn underlain by a native deposit of silty sand transitioning into a cobbles and boulders deposit.

5.1 Asphalt

Boreholes 19741-01 and 19741-02 were advanced through the paved portion of the Highway 556 embankment, and the asphalt was measured to be 50 mm thick.

5.2 Embankment Fill

Beneath the asphalt layer in both boreholes, the embankment fill consists of an upper granular layer of sand and gravel, trace silt, trace clay, to silty sand, some gravel to gravelly, trace clay, and a lower layer of rockfill. In Borehole 19741-01, a pocket of silty sand fill was encountered with in rockfill. Coring using an 'NQ' size rock core barrel was required to advance the boreholes



through the coarse gravels, and cobbles encountered in the granular embankment fill and through the rockfill. Photographs of the gravels, and cobbles recovered from the embankment fill are shown in the Core Box Photographs in Appendix C. From the recovered soil cores and observations of embankment fill cuttings, the particle size ranges from 15 mm gravels to cobbles up to about 190 mm.

The embankment fill extended to depths of 7.7 m and 6.7 m, corresponding to Elev. 284.4 m and 283.9 m, in Borehole 19741-01 and 19741-02, respectively.

The SPT 'N' values in the upper granular embankment fill ranged from 24 blows per 0.3 m of penetration 50 blows for 0.13 m of penetration, indicating a compact to very dense condition. In general, the SPT 'N' values in the rockfill ranged from 50 blows per 0.13 m of penetration to 50 blows per less than 0.1 m of penetration, indicating a very dense condition; however, a SPT 'N' value of 87 blows per 0.3 m of penetration was recorded in the pocket of silty sand fill in Borehole 19741-01. In general, the measured moisture contents ranged from 1 percent to 8 percent.

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

Soil Particle	Percentage (%)
Gravel	14 to 43
Sand	48 to 73
Silt	8 to 12
Clay	0 to 1

5.3 Silty Sand

A deposit of silty sand, trace to some gravel, containing possible cobbles and boulders was encountered below the embankment fill in both boreholes. In Borehole 19741-01, the silty sand deposit was 2.7 m thick and extends to a borehole termination of depth of 10.4 m (Elev. 281.7 m). In Borehole 19741-02, the silty sand deposit was 1.9 m thick and extends to a depth of 8.6 m (Elev. 282.0 m).

In general, the SPT 'N' values in the silty sand deposit ranged from 50 blows per 0.13 m of penetration 50 blows for 0.03 m of penetration, indicating a very dense condition. The high SPT 'N' values and split-spoon refusal is attributed to presence of coarse gravels, cobbles, and



boulders throughout the silty sand. The measured moisture contents in the deposit generally ranged between about 4 percent and 9 percent.

The results of grain size analyses conducted on samples of the silty sand deposit are provided on the Record of Borehole sheets in Appendix B and plotted in Figure C-2 of Appendix C. The results summarized as follows:

Soil Particle	Percentage (%)
Gravel	8 to 12
Sand	52 to 56
Silt	31 to 39
Clay	1

5.4 Cobbles and Boulders

In Borehole 19741-02, a 6.7 m thick layer of cobbles and boulders were encountered below the silty sand, which extends to a depth of 15.3 m (Elev. 275.3 m) prior to borehole termination. It should be noted that there were difficulty advancing the NW casing from a depth of 9.4 m to 10.4 m in Borehole 19741-01, and that it was possibly attributed to the deflection of the casing by an obstruction. Given the presence of cobbles and boulders below the silty sand deposit, it is possible that this obstruction was a boulder.

This deposit was penetrated using wash boring and NQ coring techniques. Photographs of the gravels, cobbles, and boulders recovered from this layer is shown in the Core Box Photographs in Appendix C. From the recovered soil cores, the particle size ranges from 20 mm gravels to boulders up to about 870 mm.

5.5 Groundwater Conditions

In general, water was introduced into the boreholes for drilling with wash boring methods and for coring and therefore, groundwater levels were not measured upon completion of drilling.

Water was measured to be at a depth of 3.1 m below the top of the drop inlet located along the ditch line (Elev. 286.9 m). The water at the outlet was found to be surficial at approximately Elev. 285.6 m at the time of the investigation and flowing downhill to a stream (as shown in Photograph 6 in Appendix A).



It should be noted that the groundwater levels may be at a higher elevation during spring and after periods of significant or prolonged precipitation.

6. ANALYTICAL LABORATORY TESTING

A sample of silty sand fill was submitted for analytical testing for corrosivity analysis. The analytical test results for the soil are presented in Appendix C and are summarized below.

Borehole	19741-01
Sample	SS 7
Depth (m)	4.9
Elevation (m)	287.2
Chloride (µg/g)	<10
Sulphate (µg/g)	<10
pH	6.69
Conductivity (µS/cm)	50
Resistivity (Ohm-cm)	20,100

7. MISCELLANEOUS

Marathon Drilling of Greely, 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 Mr. Ian Ross, B.A.Sc. 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 laboratories. Analytical laboratory testing was carried out by Paracel Laboratories Ltd., a CALA accredited analytical laboratory in Richmond Hill, Ontario.

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



Thurber Engineering Ltd.



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Review Principal,
Designated MTO Contact

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.

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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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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 – Highway 556 near culvert location, facing East. Drop Inlet at ditch to the south. (Google Streetview imagery, August 2018)



Photograph #2 – Highway 556 near culvert location, facing West. Drop Inlet at ditch to the south. Rock outcrops visible on slope south of ditch near horizontal curve. (Google Streetview imagery, August 2018)



Photograph #3 – Safety grate over drop inlet at the culvert inlet located along ditch line. (November 2022)



Photograph #4 – Cobbles and boulders inside drop inlet located along ditch line. (November 2022)



Photograph #5 – Partially crushed culvert outlet, facing south. (November 2022)



Photograph #6 – Culvert outlet, surrounded by vegetation, facing east. (November 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
 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			

RECORD OF BOREHOLE No 19741-01

1 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 174 074.7 E 286 662.3 ORIGINATED BY IR
DIST Algoma HWY 556 BOREHOLE TYPE CME75, NW Casing Advance and Tricone, NQ Coring COMPILED BY AK
DATUM Geodetic DATE 2022.11.06 - 2022.11.06 LATITUDE 46.706010 LONGITUDE -84.237204 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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
								20 40 60 80 100					
292.1	GROUND SURFACE												
0.0	ASPHALT: (50 mm)		1	SS	50/0.127		292						
	SAND and GRAVEL, trace silt, trace clay to SILTY SAND some gravel, containing cobbles Dense to Very Dense Brown Wet (FILL)		2	SS	47		291						43 48 8 1
			3	SS	36		290						
	Cored between 2.4 m and 2.6 m		4	SS	48		289						
289.1	ROCKFILL, containing pockets of silty sand fill		5	SS	50/0.152		289						
3.0	Cored between 3.0 m and 3.7 m		1	NQ	-		288						
	Cored between 3.8 m and 4.3 m		6	SS	50/0.127		287						14 73 12 1
			2	NQ	-		286						
			3	NQ	-		285						
	No sample recovery from a depth of 6.1 m to 6.2 m		8	SS	50/0.100		284						
	Coring from a depth of 6.2 m to 6.3 m		4	NQ	-		283						12 56 31 1
284.4	SILTY SAND some gravel, trace clay, containing possible cobbles, and boulders Very Dense Grey		9	SS	50/0.100		284						
7.7			10	SS	50/0.127		283						
	Difficult casing advancement from a depth of 9.4 m to 10.4 m.		11	SS	50/0.127								

Continued Next Page

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

RECORD OF BOREHOLE No 19741-01

2 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 174 074.7 E 286 662.3 ORIGINATED BY IR
 DIST Algoma HWY 556 BOREHOLE TYPE CME75, NW Casing Advance and Tricone, NQ Coring COMPILED BY AK
 DATUM Geodetic DATE 2022.11.06 - 2022.11.06 LATITUDE 46.706010 LONGITUDE -84.237204 CHECKED BY CN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
	Continued From Previous Page						282	20	40	60	80	100	20	40	60	
281.7	<div><div>SILTY SAND some gravel, trace clay, containing possible cobbles, and boulders</div><div>Very Dense</div><div>Grey</div><div>No sample recovery from a depth of 10.3 m to 10.4 m</div><div>END OF BOREHOLE AT 10.4m. BOREHOLE BACKFILLED WITH BENTONITE AND PATCHED WITH SAND AND ASPHALT AT SURFACE.</div><div>NOTES:</div><div>1. The cored depth intervals and particle sizes of recovered rockfill are summarized as follows: Depth (m) Recovered 2.4 - 2.6 1 x 50 mm 3.0 - 3.7 1 x 190 mm, gravels between 20 mm and 50 mm 3.8 - 4.3 gravels between 15 mm and 40 mm 6.2 - 6.3 gravels between 20 mm and 65 mm</div><div>2. Drill string in borehole was noted to be sub-vertical at the depth of 10.4 m when attempts were made to advance borehole through obstruction by coring. It was also noted that there is a deflection of the drill string of the depth of 9.4 m, possibly from a cobble or boulder. As a result of the deflect, coring of the obstruction could not be carried out and therefore, the borehole was terminated.</div><div>3. Water level at a depth of 1.0 m below ground surface in open borehole upon removal of casing prior to abandonment, but is not considered representative of the natural groundwater level due to the introduction of water for casing advance</div></div>	12	SS	60/0.025												
10.4																

ONTMT4S2 2020LIBRARY(MTO) - COPY, GLB MTO-31719.GPJ 23/3/14

RECORD OF BOREHOLE No 19741-02

1 OF 3

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 174 071.0 E 286 641.8 ORIGINATED BY IR
DIST Algoma HWY 556 BOREHOLE TYPE CME75, NW Casing Advance and Tricone, NQ Coring COMPILED BY AK
DATUM Geodetic DATE 2022.11.04 - 2022.11.06 LATITUDE 46.705977 LONGITUDE -84.237472 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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
290.6	GROUND SURFACE												
0.0	ASPHALT: (50 mm)												
	SAND and GRAVEL, some silt Dense Brown Moist (FILL)		1	SS	47								
			2	SS	47								
289.1													
	Gravelly SAND, trace silt Compact Grey Wet (FILL)		3	SS	24								
	ROCKFILL		4	SS	50/0.10								
	Coring from a depth of 2.3 m to 3.1 m and from 3.1 m to 3.5 m		1	NQ	-								
			2	NQ	-								
	Coring from a depth of 3.5 m to 5.1 m												
			3	NQ	-								
	No sample recovery from a depth of 5.2 m to 5.4 m.		5	SS	50/0.10								
	Coring from a depth of 6.1 m to 6.6 m		6	SS	50/0.076								
			4	NQ	-								
283.9													
	SILTY SAND trace gravel, containing possible cobbles and boulders Very Dense Grey Wet												
			7	SS	50/0.127								
			8	SS	50/0.054								
	COBBLES and BOULDERS containing pockets of silty sand												
	No sample recovery from a depth of 8.5 m.		5	NQ	-								
	Coring from a depth of 8.8 m to 9.1 m												
			9	SS	50/0.127								

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 19741-02

2 OF 3

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 174 071.0 E 286 641.8 ORIGINATED BY IR
DIST Algoma HWY 556 BOREHOLE TYPE CME75, NW Casing Advance and Tricone, NQ Coring COMPILED BY AK
DATUM Geodetic DATE 2022.11.04 - 2022.11.06 LATITUDE 46.705977 LONGITUDE -84.237472 CHECKED BY CN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page							20	40	60	80	100					
	Cobbles, and Boulders, containing pockets of silty sand																
	No sample recovery from a depth of 10.6 m.		10	SS	50/0.053		280										
							279										
			11	SS	50/0.053												
	Coring from a depth of 12.5 m to 13.6 m						278										
			6	NQ	-												
							277										
	Coring from a depth of 14.1 m to 14.2 m		7	NQ	-								○				
							276										
275.3	Coring from a depth of 15.2 m to 15.3 m																
15.3	END OF BOREHOLE AT 15.2 m. BOREHOLE BACKFILLED WITH BENTONITE AND PATCHED WITH SAND AND ASPHALT AT SURFACE.		8	NQ	-												
NOTES: 1. The cored depth intervals and particle sizes of recovered rockfill, gravels, cobbles, and boulders are summarized as follows: Depth (m) Recovered 2.3 - 3.1 gravels between 30 mm and 50 mm 3.1 - 3.5 gravels between 20 mm and 50 mm 3.5 - 5.1 1 x 75 mm, gravels between 20 mm and 50 mm 6.1 - 6.6 1 x 70 mm, gravels between 20 mm and 50 mm 8.8 - 9.1 1 x 355 mm, gravels between 30 mm and 50 mm 12.5 - 13.6 1 x 870 mm, 1 x 140 mm, 1 x 50 mm 14.1 - 14.2 2 x 30 mm 15.2 - 15.3 1 x 50 mm 2. Water level at a depth of 1.0 m below ground surface in open borehole upon removal of casing prior to abandonment, but is not																	

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 19741-02

3 OF 3

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 174 071.0 E 286 641.8 ORIGINATED BY IR
DIST Algoma HWY 556 BOREHOLE TYPE CME75, NW Casing Advance and Tricone, NQ Coring COMPILED BY AK
DATUM Geodetic DATE 2022.11.04 - 2022.11.06 LATITUDE 46.705977 LONGITUDE -84.237472 CHECKED BY CN

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 considered representative of the natural groundwater level due to the introduction of water for casing advance.																

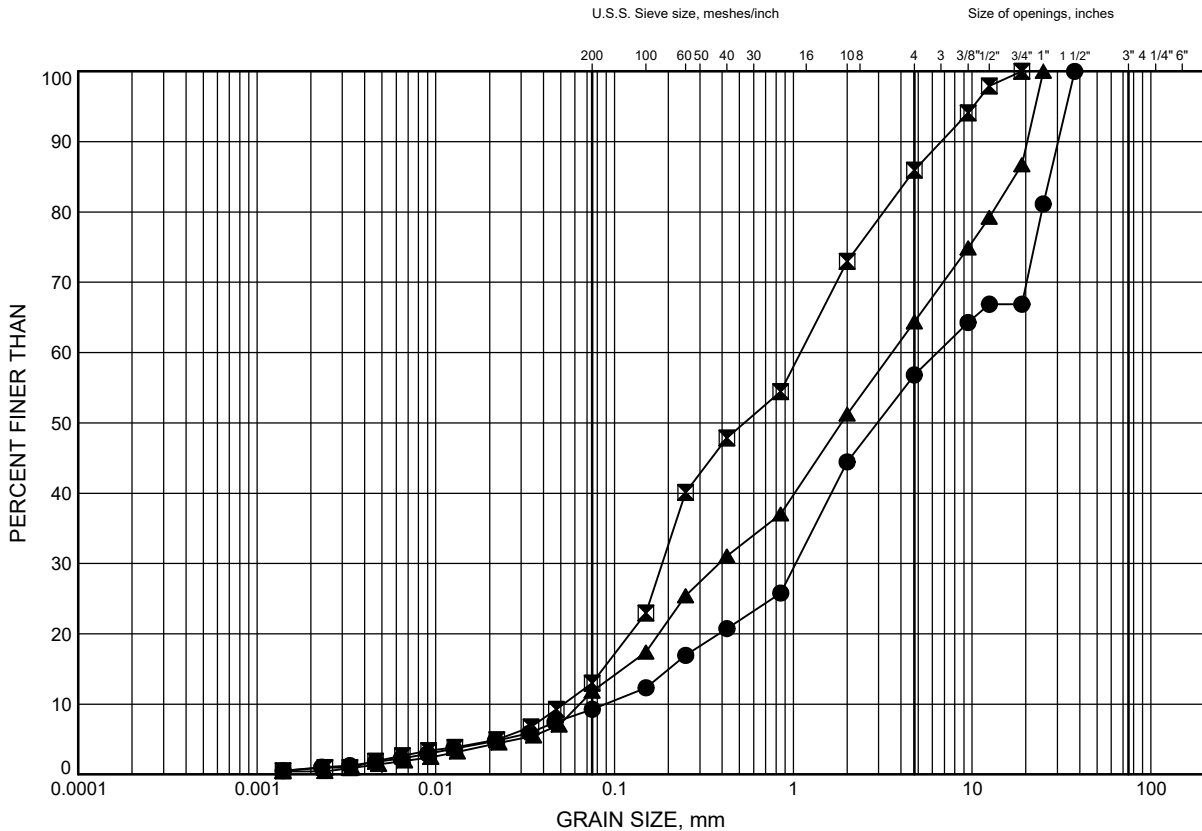


Appendix C

Geotechnical and Analytical Laboratory Test Results, and Core Photographs

GRAIN SIZE DISTRIBUTION

SAND and GRAVEL 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)
●	19741-01	1.1	291.0
⊠	19741-01	4.9	287.2
▲	19741-02	1.1	289.6

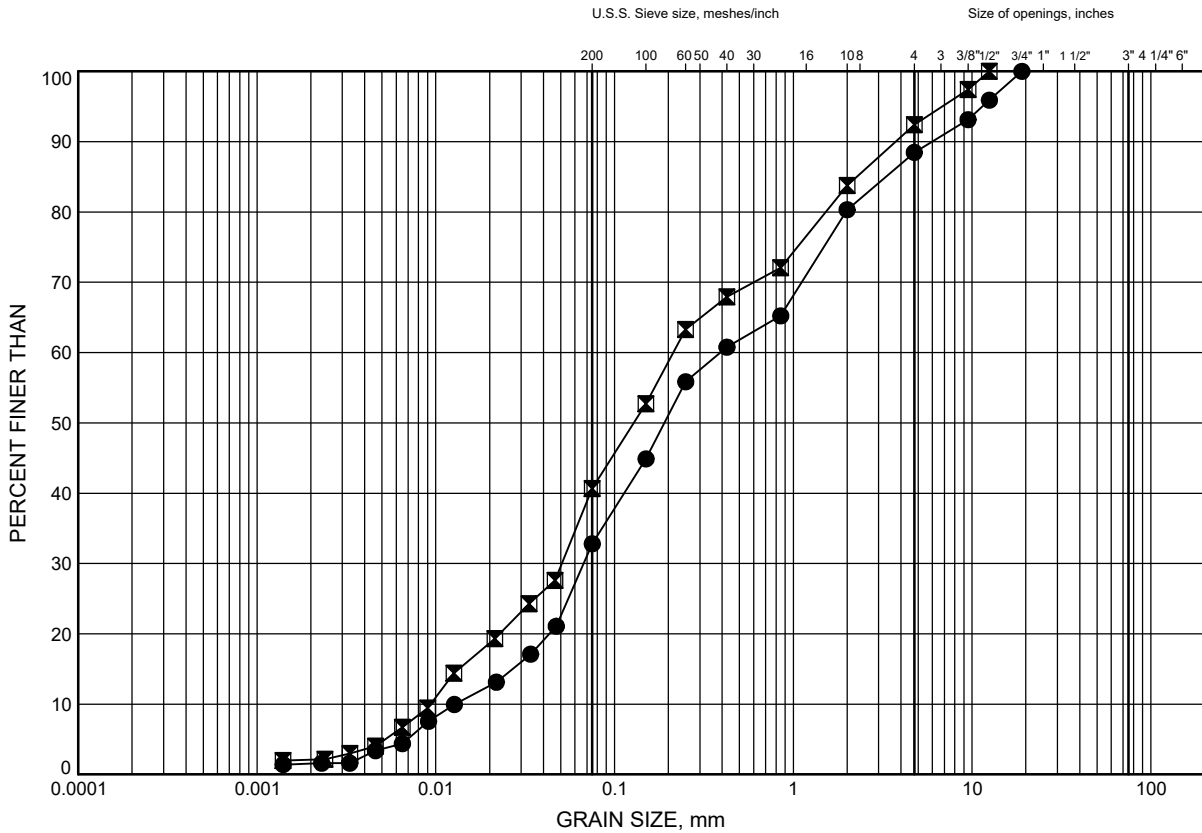
Date February 2023
W.P. 5221-18-00



Prep'd AN
Chkd. AK

GRAIN SIZE DISTRIBUTION

Silty SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19741-01	8.4	283.7
⊠	19741-02	9.8	280.8

Date February 2023

W.P. 5221-18-00



Prep'd AN

Chkd. AK

Certificate of Analysis

Thurber Engineering Ltd. (Pickering)

1795 Ironstone Manor, Unit 1
Pickering, ON L1W 3W9
Attn: Ali Rajaei

Client PO:
Project: 31719/10
Custody:

Report Date: 10-Feb-2023
Order Date: 3-Feb-2023

Order #: 2306047

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

Paracel ID	Client ID
2306047-01	19741-01 / SS#7
2306047-02	14495-01 / SS#3

Approved By:

Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis

Report Date: 10-Feb-2023

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 3-Feb-2023

Client PO:

Project Description: 31719/10

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	7-Feb-23	7-Feb-23
Conductivity	MOE E3138 - probe @25 °C, water ext	7-Feb-23	7-Feb-23
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	8-Feb-23	8-Feb-23
Resistivity	EPA 120.1 - probe, water extraction	7-Feb-23	7-Feb-23
Solids, %	CWS Tier 1 - Gravimetric	6-Feb-23	7-Feb-23

Certificate of Analysis

Report Date: 10-Feb-2023

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 3-Feb-2023

Client PO:

Project Description: 31719/10

Client ID:	19741-01 / SS#7	14495-01 / SS#3	-	-
Sample Date:	06-Nov-22 09:00	01-Nov-22 09:00	-	-
Sample ID:	2306047-01	2306047-02	-	-
MDL/Units	Soil	Soil	-	-

Physical Characteristics

% Solids	0.1 % by Wt.	94.6	96.8	-	-
----------	--------------	------	------	---	---

General Inorganics

Conductivity	5 uS/cm	50 [1]	367 [1]	-	-
pH	0.05 pH Units	6.69 [1]	6.32 [1]	-	-
Resistivity	0.10 Ohm.m	201 [1]	27.3 [1]	-	-

Anions

Chloride	10 ug/g dry	<10 [1]	143 [1]	-	-
Sulphate	10 ug/g dry	<10 [1]	20 [1]	-	-

Certificate of Analysis

Report Date: 10-Feb-2023

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 3-Feb-2023

Client PO:

Project Description: 31719/10

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%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	0.10	Ohm.m						

Certificate of Analysis

Report Date: 10-Feb-2023

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 3-Feb-2023

Client PO:

Project Description: 31719/10

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	21.0	10	ug/g	22.0			4.6	35	
Sulphate	10.5	10	ug/g	11.7			11.0	35	
General Inorganics									
Conductivity	127	5	uS/cm	130			2.4	5	
pH	7.53	0.05	pH Units	7.55			0.3	2.3	
Resistivity	78.7	0.10	Ohm.m	76.9			2.4	20	
Physical Characteristics									
% Solids	94.5	0.1	% by Wt.	94.6			0.1	25	

Certificate of Analysis

Report Date: 10-Feb-2023

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 3-Feb-2023

Client PO:

Project Description: 31719/10

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	120	10	ug/g	22.0	98.1	82-118			
Sulphate	112	10	ug/g	11.7	101	80-120			

Certificate of Analysis

Report Date: 10-Feb-2023

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 3-Feb-2023

Client PO:

Project Description: 31719/10

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

Sample - One or more parameter received past hold time - Conductivity, Chloride, Sulphate, Sulphide

*Applies to samples: 19741-01 / SS#7, 14495-01 / SS#3****Sample Qualifiers :***

- 1 : Holding time had been exceeded upon receipt of the sample at the laboratory or prior to the analysis being requested.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

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

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.

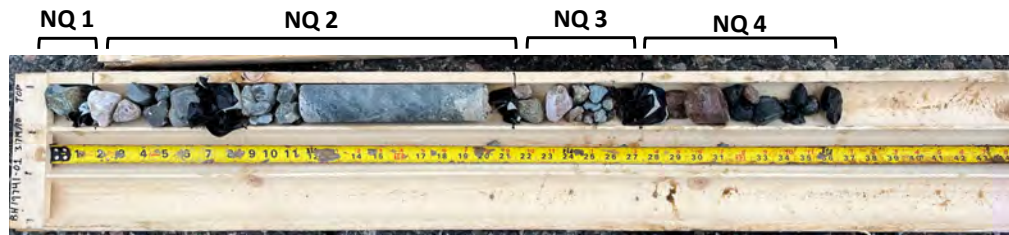
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.



Client Name: Thurber Engineering Ltd.	Project Ref:	Page <u> </u> of <u> </u>
Contact Name: Ali Rajaei	Quote #:	
Address: 1815 IRONSTONE MANOR SUITE 11, PICKERING, ON, L1W 3W9	PO #: 31719/10	Turnaround Time <input type="checkbox"/> 1 day <input type="checkbox"/> 3 day <input type="checkbox"/> 2 day <input checked="" type="checkbox"/> Regular
Telephone: 416-575-9069	E-mail: ARAJAEI@THURBER.CA CC: AKOBYLINSKI@THURBER.CA	
Date Required: <u> </u>		

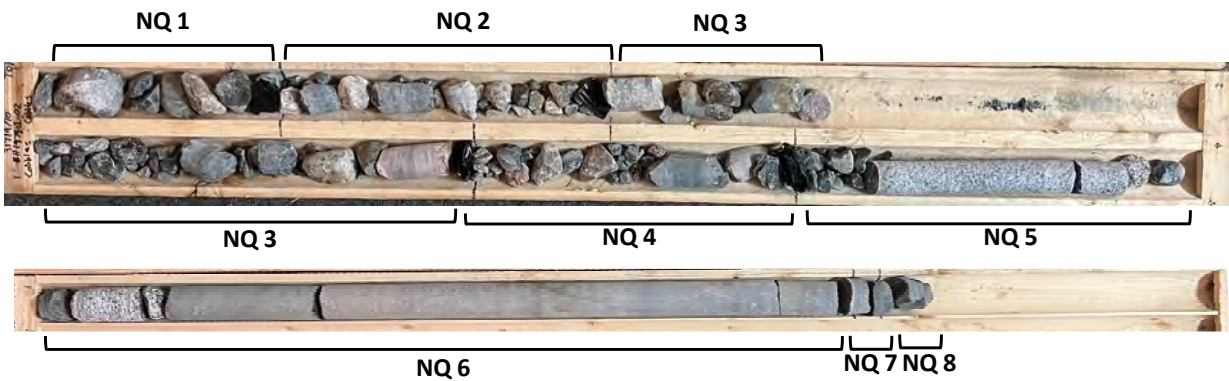
<input type="checkbox"/> REG 153/04 <input type="checkbox"/> REG 406/19 Other Regulation		Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)		Required Analysis														
<input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <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 <u> </u> 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: <u> </u> <input type="checkbox"/> Other: <u> </u>	Matrix	Air Volume	# of Containers	Sample Taken Date Time		PH	Resistivity	Chloride	Sulphide	Sulphate	Conductivity						
Sample ID/Location Name																		
1	19741-01 / SS#7	soil		1	Nov 8 / 22		✓	✓	✓	✓	✓	✓						
2	14495-01 / SS #3	soil		1	Nov 1 / 22		✓	✓	✓	✓	✓	✓						
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

Comments:		Method of Delivery: Rubbex	
Relinquished By (Sign): <u> </u>	Received By Driver/Depot: <u> </u>	Received at Lab: <u> </u>	Verified By: <u> </u>
Relinquished By (Print): A. Rajaei	Date/Time: 03-FEB-23, 13:00	Date/Time: Feb 4/23 14:50	Date/Time: Feb 6/23 12:24
Date/Time: Feb 2, 2023	Temperature: 13.5 °C	Temperature: 4.4 °C	pH Verified: <input type="checkbox"/> By: <u> </u>



Borehole 19741-01 - Cored Rockfill

NQ 1 – 2.4 m – 2.6 m
NQ 2 – 3.0 m – 3.7 m
NQ 3 – 3.8 m – 4.3 m
NQ 2 – 6.2 m – 6.3 m



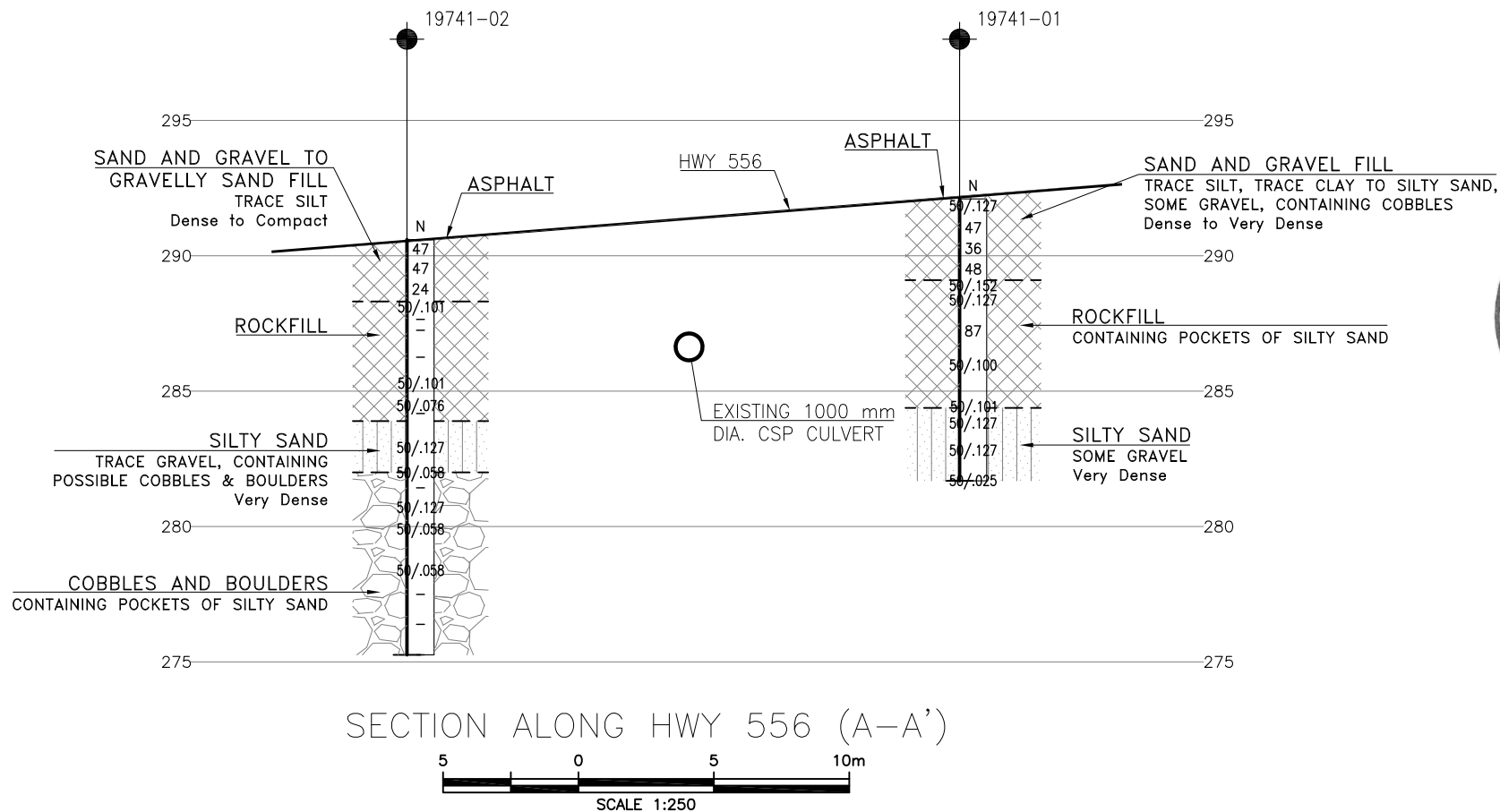
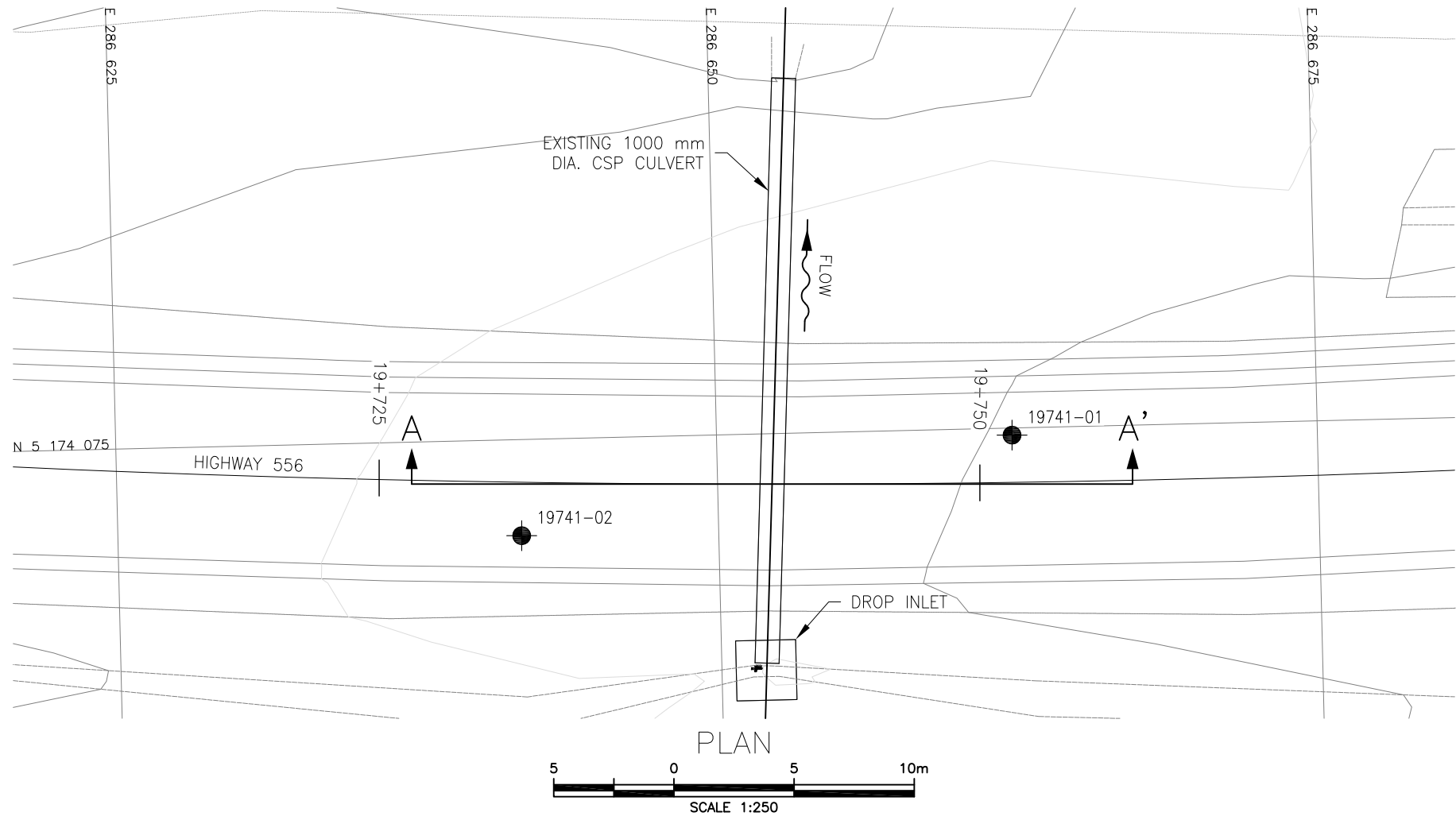
Borehole 19741-02 - Cored Rock Fill, Gravel, Cobbles, and Boulders

NQ 1 – 2.3 m – 3.1 m
NQ 2 – 3.1 m – 3.5 m
NQ 3 – 3.5 m – 5.1 m
NQ 4 – 6.1 m – 6.6 m
NQ 5 – 8.8 m – 9.1 m
NQ 6 – 12.5 m – 13.6 m
NQ 7 – 14.2 m – 14.2 m
NQ 8 – 15.3 m – 15.3 m



Appendix D

Borehole Locations and Soil Strata Drawing



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

CONT No
WP No 5221-18-00

HIGHWAY 556
STATION 19+741
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

NO	ELEVATION	NORTHING	EASTING
19741-01	292.1	5 174 074.7	286 662.3
19741-02	290.6	5 174 071.0	286 641.8

-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. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 13.

GEOCRES No. 41K-129



REVISIONS	DATE	BY	DESCRIPTION

DESIGN	AK	CHK	PKC	CODE	LOAD	DATE	MAY 2023
DRAWN	AN	CHK	AK	SITE	STRUCT	DWG	1