



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 9 CULVERT REPLACEMENT
LLOYDTOWN, ONTARIO
LATITUDE: 44.000164°, LONGITUDE: -79.727996°
W.P. 2148-20-00, CULVERT NO. CV-0074-0009-0004**

GEOCRES Number: 30M13-235

Report

to

Parsons

Date: April 22, 2021
File: 30652



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1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed Culvert No. CV-0074-0009-0004 replacement on Highway 9 in Lloydtown, 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 was retained by the Parsons Inc to carry out this foundation investigation under the MTO Assignment Number 2019-E-0081.

2. SITE DESCRIPTION

The existing culvert is located on Highway 9, approximately 20 m west of the centreline of 11th Line Road King in Lloydtown, Ontario. The existing culvert is an 800 mm diameter Corrugated Steel Pipe (CSP), approximately 34 m long, running in a general south-north direction. The approximate culvert invert is at approximate Elevation 274.28 m at the inlet (south) and 274.08 m at the outlet (north). The culvert allows the surface drainage to flow in a northerly direction beneath the highway. The highway embankment is approximately 3.0 to 3.2 m in height.

The lands surrounding the culvert site generally consist of agricultural areas with localized residential properties. The site topography is generally flat, with gentle cut slopes to the southeast of the site which are vegetated with grass and trees.

Based on published geological information, the general site area lies within the physiographic region known as the Schomberg Clay Plains. Varved clays overlying tills plains are anticipated.



3. INVESTIGATION PROCEDURES

The field investigation and field testing for this project was carried out on March 1st, 2021, and consisted of drilling and sampling two (2) boreholes, labeled Boreholes HWY9-01 and HWY9-02, to a depth of approximately 8.2 m (base Elevation 268.7 m and 268.9m, respectively). Boreholes HWY9-01 and HWY9-02 were drilled through the existing highway embankment on the eastbound and westbound granular shoulder lanes, respectively.

The approximate locations of the boreholes from the investigation are shown on the Borehole Locations and Soil Strata Drawing included in Appendix C.

Utility clearances were obtained prior to the start of drilling. The ground surface elevations for the boreholes were surveyed and provided to Thurber by Parsons. The coordinate system MTM NAD 83 was used for the boreholes.

A truck-mounted CME-75 drill rig was used to advance the boreholes using solid stem augers. Soil samples were obtained in the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

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

Completion details of the boreholes are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole Number	Borehole Depth / Base Elevation (m)	Completion Details
HWY9-01	8.2 / 268.7	Backfilled with bentonite holeplug to 0.6m, then sand and gravel cuttings to surface
HWY9-02	8.2 / 268.9	Backfilled with bentonite holeplug to 0.6m, then sand and gravel cuttings to surface

4. LABORATORY TESTING

All recovered soil samples were subjected to visual identification (VI) and to natural moisture



content determination. Selected samples were also subjected to grain size distribution analyses and Atterberg Limit testing, where appropriate. The results of this laboratory testing program are shown on the Record of Borehole sheets included in Appendix A and on the figures included in Appendix B.

In order to assess the potential for sulphate attack on concrete, as well as the potential for corrosion associated with the structure, a sample of the fill from Borehole HWY9-01 was submitted to AGAT Laboratories., a CALA accredited analytical laboratory in Mississauga, Ontario, for analytical testing of corrosivity parameters and sulphate content. The results of the analytical testing from the investigation are summarized in Section 6 and are presented in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. 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 C. A general 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, which was comprised of sand and gravel fill underlain by silty clay fill, which in turn was underlain by native silty clay. Descriptions of the individual strata are presented below.

5.1 Granular Fill

Granular fill consisting of silty sand and gravel was encountered at the surface of the granular shoulders. The thickness of the fill extended to a depth of 0.7 to 1.2 m (Elevation 276.2 m and 275.9 m).

SPT 'N' values in the granular fill were 26 blows and 58 blows for 0.3 m of penetration, indicating compact to very dense conditions. The measured moisture content in the fill ranged from 4 percent to 7 percent.



The results of grain size analyses conducted on selected samples of fills are illustrated on Figures B1 in Appendix B. The results are summarized as follows:

Soil Particle	Silty Sand and Gravel Fill
Gravel	22 to 26
Sand	62 to 64
Silt	12
Clay	4
Silt & Clay	10

5.2 Silty Clay Fill

Underlying the granular fill, dark brown silty clay fill which contained some sand, traces of gravel, and trace organics was encountered in both boreholes. Where fully penetrated, the silty clay fill was approximately 1.9 to 2.0 m thick and the base extended to depths of 2.6 and 3.2 m (Elevation 274.3 m and 273.9 m), respectively.

SPT 'N' values measured in the silty clay fill ranged from 7 blows to 29 blows for 0.3 m penetration, indicating firm to very stiff consistencies. The measured moisture content of the fill ranged from 10 percent to 27 percent.

The results of grain size analyses conducted on a selected sample of the silty clay fill are illustrated on Figure B2 in Appendix B. The results are summarized as follows:

Soil Particle	Silty Clay Fill
Gravel	0
Sand	16
Silt	41
Clay	43

5.3 Silty Clay

Underlying the fills at both boreholes, brown silty clay, which contained some sand was encountered. Both boreholes were terminated within this native material.



SPT 'N' values recorded in the silty clay ranged from 7 blows to 26 blows per 0.3 m penetration, indicating firm to very stiff consistencies, typically stiff to very stiff. The measured moisture content of the fill ranged from 19 percent to 33 percent.

The results of grain size analyses conducted on selected sample of the silty clay are illustrated on Figure B3 in Appendix B. The results are summarized as follows:

Soil Particle	Silty Clay
Gravel	0
Sand	11 to 13
Silt	46 to 67
Clay	20 to 43

The results of Atterberg Limits Testing on the selected silty clay samples are presented in Figure B4, and summarized below.

Index Property	Value
Liquid Limit	38
Plastic Index	14 to 21

The results of the Atterberg Limits testing indicate that this deposit has typically medium plasticity with a group symbol of CI.

5.4 Groundwater Conditions

These groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling. A summary of the water level measurements is provided in Table 5.2 below:

Table 5.2 - Groundwater Measurements

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
HWY9-01	March 1, 2021	3.7	273.2	Open Borehole
HWY9-02	March 2, 2021	3.0	274.1	Open Borehole

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. CORROSIVITY AND SULPHATE TEST RESULTS

One sample of the silty clay fill was submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are shown in Table 6.1. The laboratory certificates of analysis are presented in Appendix B.

Table 6.1 - Analytical Test Results

Parameter	Units (soil)	Test Results
		Borehole HWY9-01 SS#4
		Silty Clay Fill
Chloride	µg/g	2420
Sulphate	µg/g	<20
pH	no unit	7.42
Conductivity	µS/cm	4.20
Resistivity (calculated)	ohms.cm	238
Redox Potential (average)	mV	448.7

7. MISCELLANEOUS

Thurber obtained subsurface utility clearances prior to drilling. The northing and easting coordinates and ground surface elevations were estimated based on a field survey conducted by Parsons Inc.

Drilltech Drilling Ltd of Newmarket, 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. George Azzopardi of Thurber. The overall supervision of the field program was conducted by Mr. Rod de Castro, P.Eng, of Thurber.

Geotechnical laboratory testing was carried out in Thurber's geotechnical laboratory. Analytical laboratory testing was carried out by AGAT Laboratories.

Interpretation of the field data and preparation of this report was carried out by Mr. Rod de Castro, P.Eng. The report was reviewed by Mr. Jason Lee, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



Thurber Engineering Ltd.

Rod de Castro, P.Eng.
Geotechnical Engineer



Jason Lee, P.Eng.
Principal, Senior Geotechnical Engineer



P.K. Chatterji, P.Eng., Ph.D.
Review Principal, Designated MTO Contact





Appendix A

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


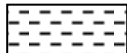



SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core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

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
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	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
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	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

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 HWY 9-01

1 OF 1

METRIC

W.P. 2148-20-00 LOCATION MTM NAD83-10: N 4 873 367.4 E 286 515.8 ORIGINATED BY GA
 HWY 9 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM MTM NAD83-10 DATE 2021.01.03 - 2021.01.03 LATITUDE LONGITUDE CHECKED BY RD

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									
								20 40 60 80 100									
276.9	GROUND SURFACE							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) W P W W L		GR SA SI CL		
0.0	Silty SAND and GRAVEL Very Dense Brown Moist (FILL)		1	SS	58		276								26 64 10 (SI+CL)		
276.2																	
0.7	Silty CLAY , trace sand, occasional gravel, trace organics Very Stiff to Stiff Dark Brown Wet (FILL)		2	SS	16			275								0 16 41 43	
			3	SS	10												
274.3			4	SS	7				274								
2.6	Silty CLAY , some sand Firm to Very Stiff Brown Wet																0 11 46 43
			5	SS	10												
										273							
			6	SS	16												
			7	SS	13	272											
						271											
			8	SS	12												
						270											
			9	SS	26	269											
268.7							269										
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN TO 8.2m AND WATER LEVEL AT 3.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, THEN SAND AND GRAVEL TO SURFACE.																

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HWY 9-02

1 OF 1

METRIC

W.P. 2148-20-00 LOCATION MTM NAD83-10: N 4 873 385.2 E 286 511.8 ORIGINATED BY GA
 HWY 9 BOREHOLE TYPE Soild Stem Augers COMPILED BY AN
 DATUM MTM NAD83-10 DATE 2021.01.03 - 2021.01.03 LATITUDE LONGITUDE CHECKED BY RD

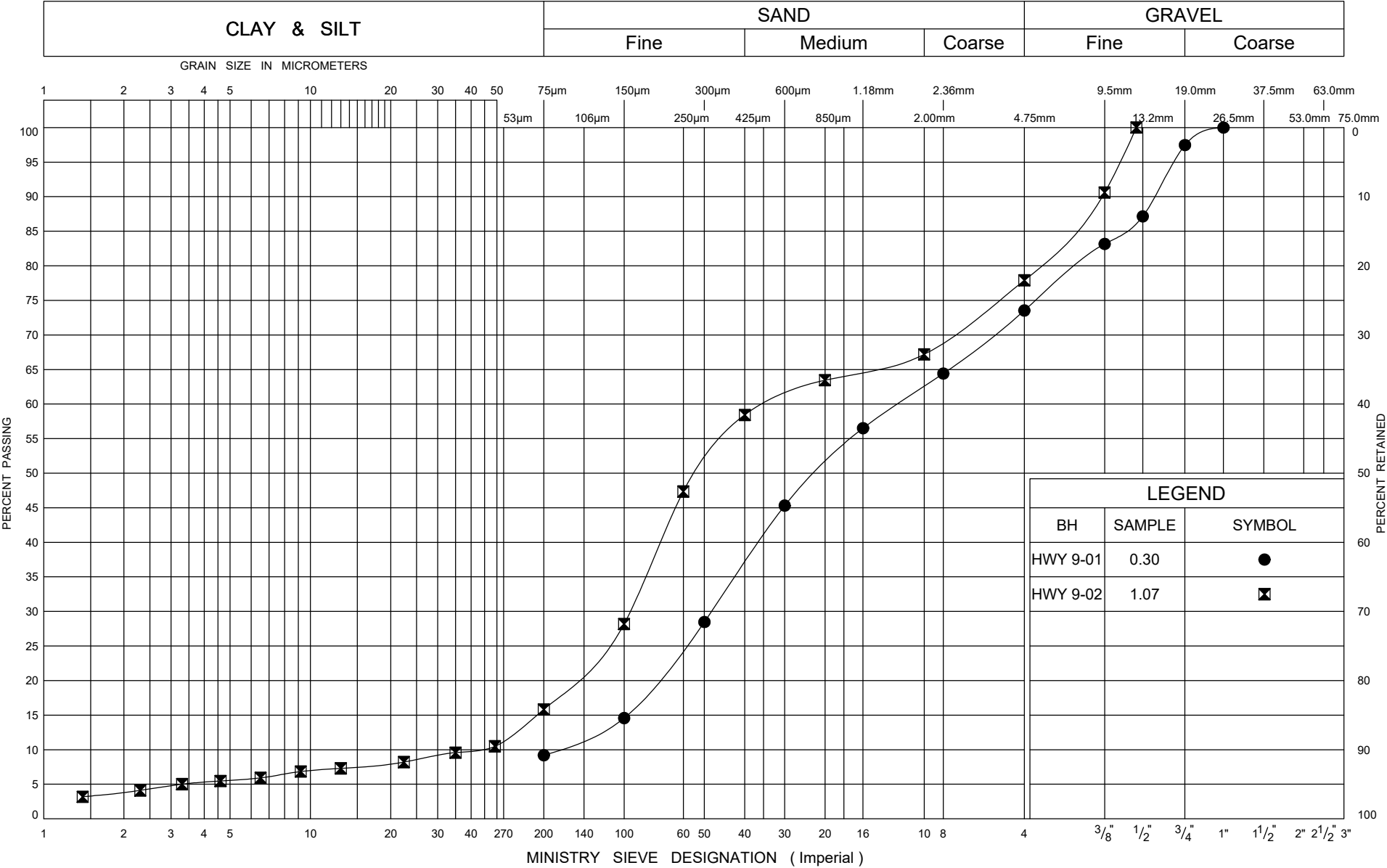
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100							20 40 60			
277.1	GROUND SURFACE							<div><div></div><div></div><div></div><div></div><div></div></div>										
0.0	Silty SAND AND GRAVEL , trace gravel Dense Brown Moist (FILL)		1	SS	46		277											
275.9			2	SS	26		276											22 62 12 4
1.2	Silty CLAY , some sand and gravel Stiff Dark Brown Moist (FILL)		3	SS	29		275											
			4	SS	9													
273.9							274											
3.2	Silty CLAY , occasional sand, some organics at 3.1 m Stiff to Very Stiff Brown Wet		5	SS	10													0 13 67 20
			6	SS	10		273											
			7	SS	15		272											
							271											
			8	SS	18		270											
			9	SS	21		269											
268.9																		
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN TO 8.2m AND WATER LEVEL AT 3.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, THEN SAND AND GRAVEL TO SURFACE.																	

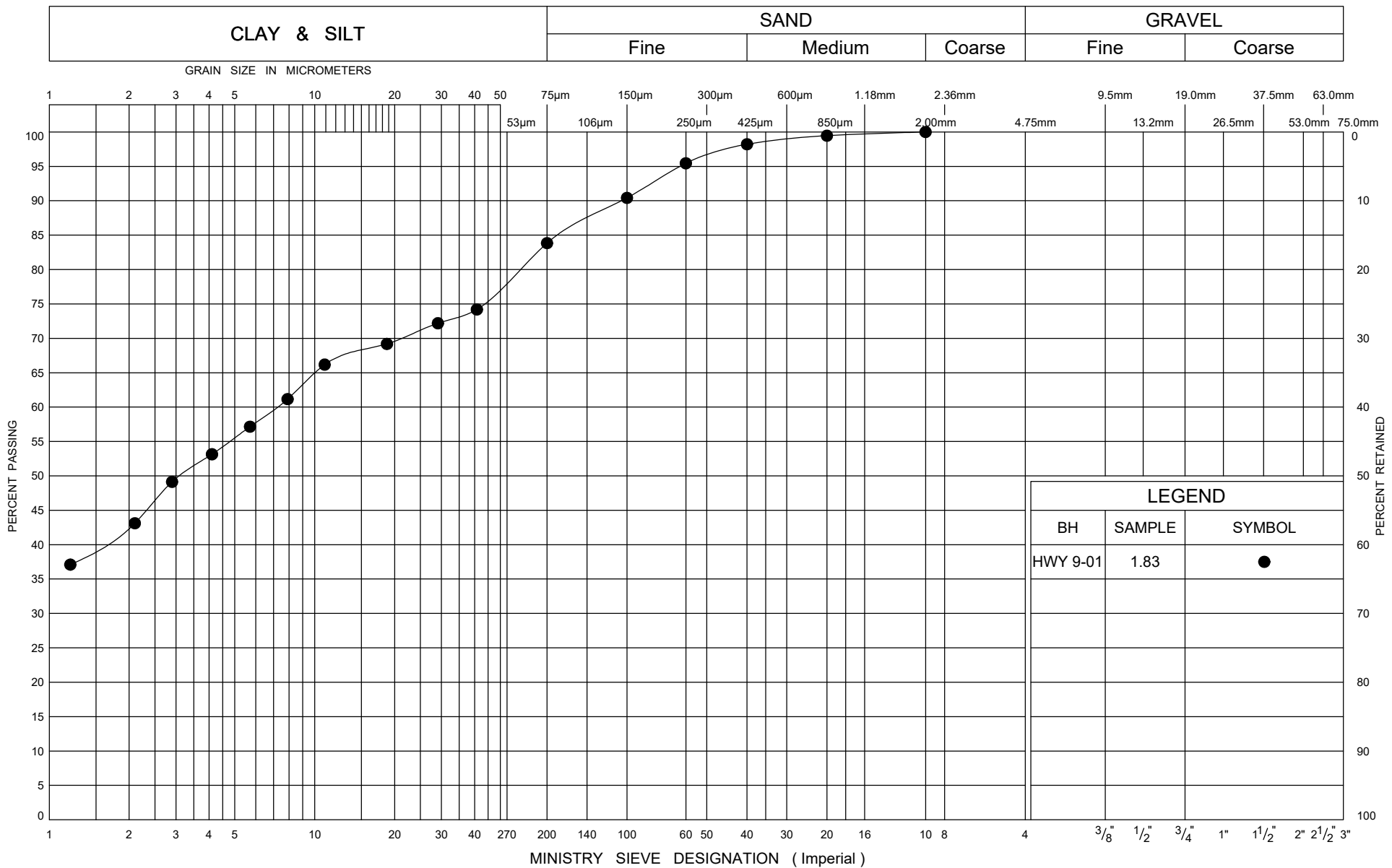
+³, ×³: Numbers refer to Sensitivity
 20
15
10
5
0
(%) STRAIN AT FAILURE

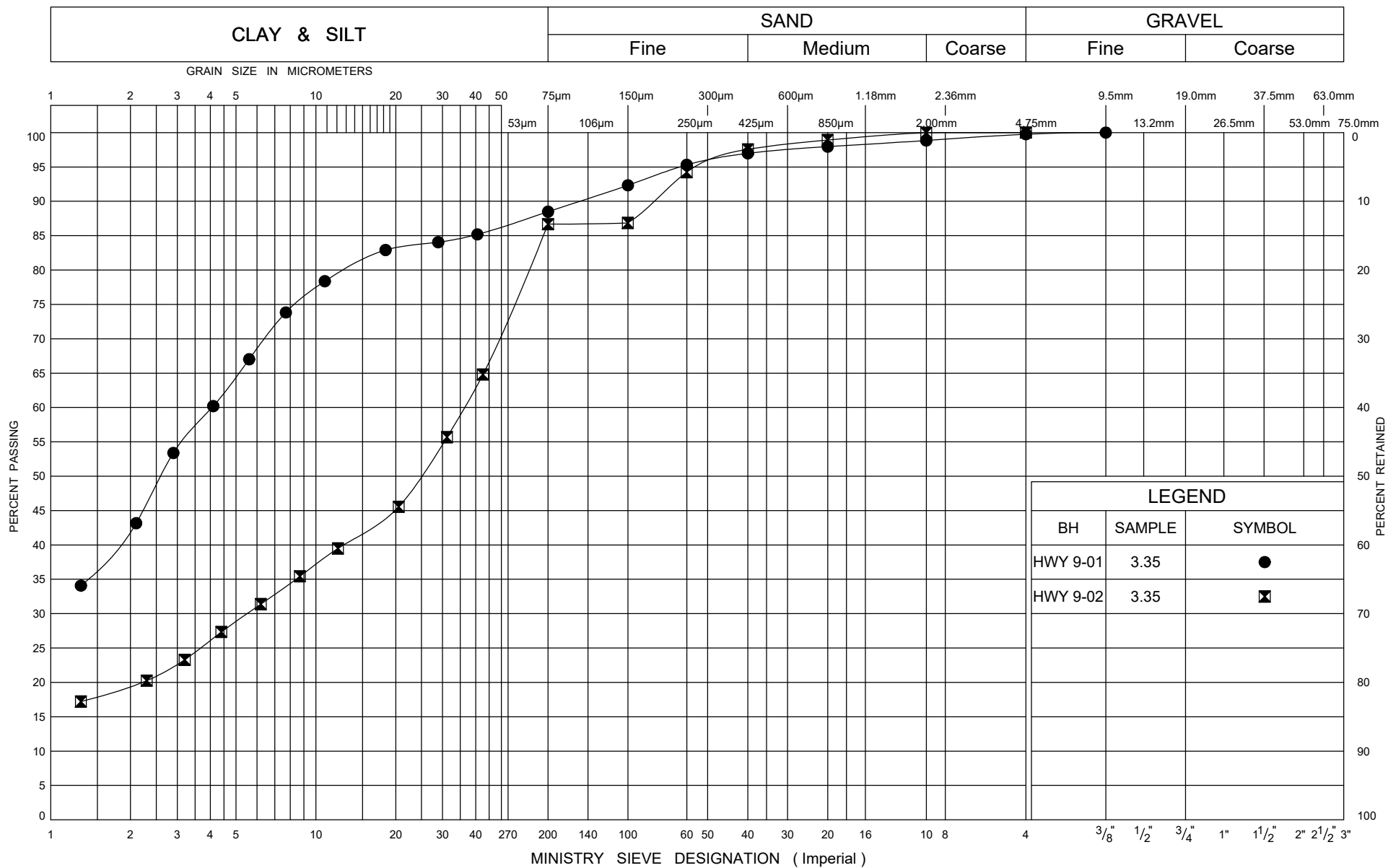


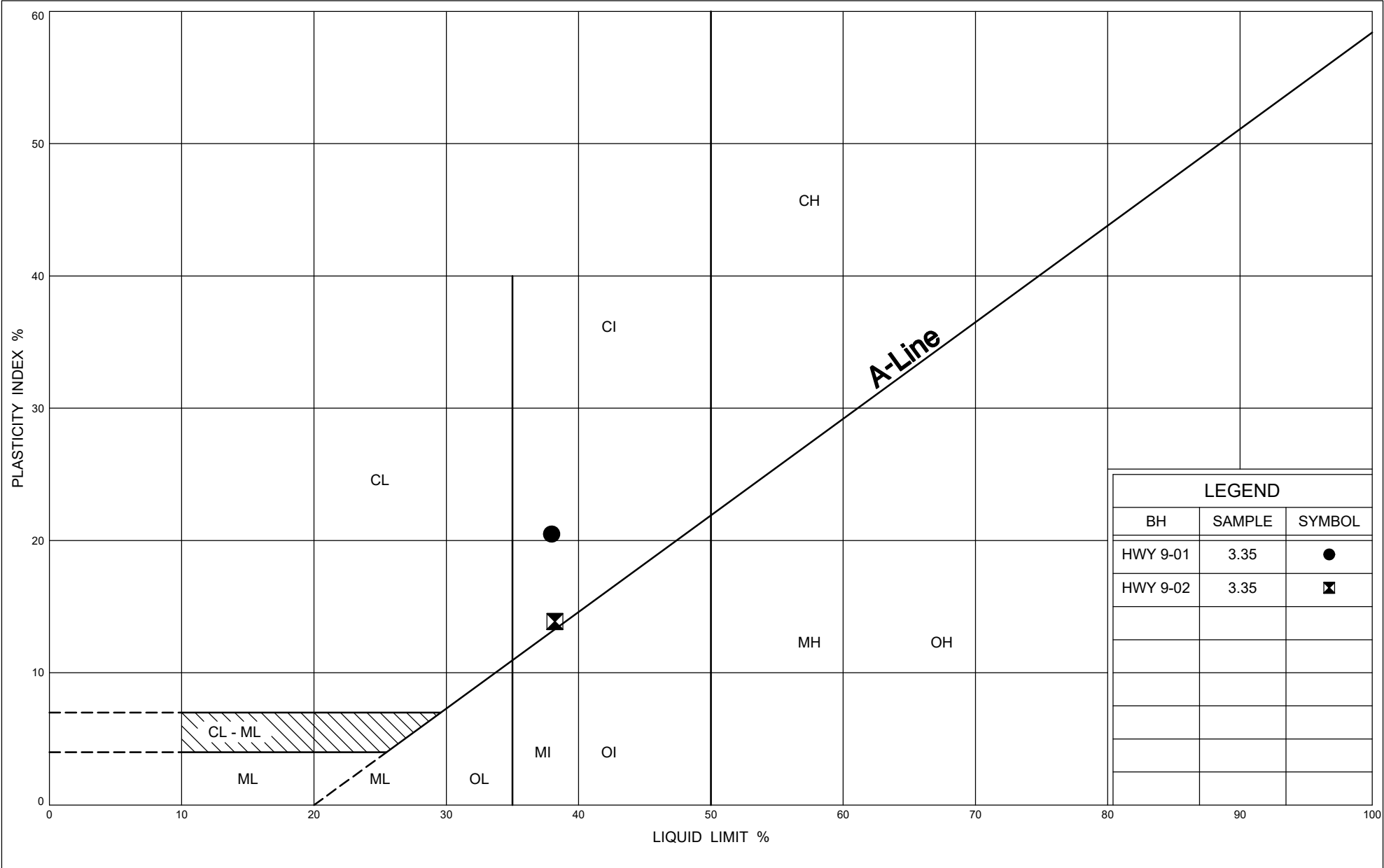
Appendix B

Geotechnical and Analytical Laboratory Test Results









CLIENT NAME: THURBER ENGINEERING LTD
SUITE 103, 2010 WINSTON PARK DRIVE
OAKVILLE, ON L6H5R7
(905) 829-8666

ATTENTION TO: Rod de Castro

PROJECT: Highway 9 Culvert Replacement

AGAT WORK ORDER: 21T719152

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

DATE REPORTED: Mar 15, 2021

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days following analysis, unless expressly agreed otherwise in writing. Please contact your Client Project Manager if you require additional sample storage time.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
- This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
- The test results reported herewith relate only to the samples as received by the laboratory.
- Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.
- All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 21T719152

PROJECT: Highway 9 Culvert Replacement

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE: York Region, ON

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

Corrosivity Package

DATE RECEIVED: 2021-03-08

DATE REPORTED: 2021-03-15

SAMPLE DESCRIPTION: HWY9-01, SS-4 (7 1/2-9 1/2)				
SAMPLE TYPE: Soil				
DATE SAMPLED: 2021-03-01 22:00				
Parameter	Unit	G / S	RDL	2193011
Chloride (2:1)	µg/g		20	2420
Sulphate (2:1)	µg/g		20	<20
pH (2:1)	pH Units		NA	7.42
Electrical Conductivity (2:1)	mS/cm		0.005	4.20
Resistivity (2:1) (Calculated)	ohm.cm		1	238
Redox Potential 1	mV		NA	458.9
Redox Potential 2	mV		NA	445.2
Redox Potential 3	mV		NA	442.1

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

2193011 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter. Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results. Redox potential measurement in soil is quite variable and non reproducible due in part, to the general heterogeneity of a given soil. It is also related to the introduction of increased oxygen into the sample after extraction. The interpretation of soil redox potential should be considered in terms of its general range rather than as an absolute measurement.

Dilution required, RDL has been increased accordingly.

2193012 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter. Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results. Redox potential measurement in soil is quite variable and non reproducible due in part, to the general heterogeneity of a given soil. It is also related to the introduction of increased oxygen into the sample after extraction. The interpretation of soil redox potential should be considered in terms of its general range rather than as an absolute measurement.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



Nivine Basly

Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD PROJECT:

Highway 9 Culvert Replacement SAMPLING SITE: York

Region, ON

AGAT WORK ORDER: 21T719152

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

Soil Analysis

RPT Date: Mar 15, 2021			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE	
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper

Corrosivity Package

Chloride (2:1)	2197917		53	53	0.0%	< 2	91%	70%	130%	104%	80%	120%	107%	70%	130%
Sulphate (2:1)	2197917		7	7	NA	< 2	94%	70%	130%	102%	80%	120%	104%	70%	130%
pH (2:1)	2193011	2193011	7.42	7.40	0.3%	NA	100%	90%	110%						
Electrical Conductivity (2:1)	2193011	2193011	4.20	4.36	3.7%	< 0.005	110%	80%	120%						
Redox Potential 1	1						100%	90%	110%						

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Duplicate NA: results are under 5X the RDL and will not be calculated.

Certified By:


Nivine Basily

Method Summary

CLIENT NAME: THURBER ENGINEERING LTD PROJECT:

Highway 9 Culvert Replacement SAMPLING SITE: York

Region, ON

AGAT WORK ORDER: 21T719152

ATTENTION TO: Rod de Castro

SAMPLED BY: GA

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	modified from MSA PART 3, CH 14 and SM 2510 B	EC METER
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B, SSA #5 Part 3	CALCULATION
Redox Potential 1	INOR-93-6066	modified G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	modified G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	modified G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE



5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Company: Thorben Engineering Ltd
Contact: Rod de Castro
Address: 103 - 2010 Winston Churchill Park Drive
Oakville ON L6W 5R7
Phone: 905 829 8666 Fax: _____
Reports to be sent to:
1. Email: rodcastro@thorben.ca
2. Email: _____

Project: Highway 9 & Highway 12 Culvert Replacement
 Site Location: Hudson York Region & Durham Region, ON
 Sampled By: GA
 AGAT Quote #: _____ PO: _____
 Please note: If quotation number is not provided, client will be billed full price for analysis.

Company: _____
Contact: _____
Address: _____
Email: _____

<input type="checkbox"/> Regulation 153/04	<input type="checkbox"/> Sewer Use	<input type="checkbox"/> Regulation 558
Table _____ Indicate One	<input type="checkbox"/> Sanitary	<input type="checkbox"/> CCME
<input type="checkbox"/> Ind./Corn	<input type="checkbox"/> Storm	<input type="checkbox"/> Prov. Water Quality Objectives (PWO)
<input type="checkbox"/> Res./Park		<input type="checkbox"/> Other _____
<input type="checkbox"/> Agriculture		
Soil Texture (Check One)	Region _____ Indicate One	
<input type="checkbox"/> Coarse	<input type="checkbox"/> MISA	
<input type="checkbox"/> Fine		

☐ Yes ☒ No☐ Yes ☒ No

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Field Filtered - Metals, Hg, CrVI

O. Reg 153

Metals and Inorganics

☐ All Metals ☐ 153 Metals (excl. Hydrides)
☐ Hydride Metals ☐ 153 Metals (Incl. Hydrides)

ORPs: ☐ B-HWS ☐ Cl ☐ CN
☐ C⁶⁺ ☐ EC ☐ FOC ☐ Hg

Full Metals Scan

Regulation/Custom Metals

Nutrients: ☐ TP ☐ NH₃ ☐ TKN
☐ NO₃ ☐ NO₂ ☐ NO₃+NO₂

VOC ☐ BTEX ☐ THM ☐

PHCs F1 - F4

ABNS

PAHS

PCBs: ☐ Total ☐ Aroclors

Organochlorine Pesticides

TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs

Sewer Use

Community Package

Potentially Hazardous or High Concentration (Y/N)

[illegible]

Samples Relinquished By (Print Name and Sign): Roi de Castro <i>R-C</i>	Date: Mar 8/21	Time:	Samples Received By (Print Name and Sign):	Date:	Time:	Page <u>1</u> of <u>1</u>
Samples Relinquished By (Print Name and Sign):	Date:	Time:	John Chrysosha <i>[Signature]</i>	Mar 8	11:20	
Samples Relinquished By (Print Name and Sign): <i>[Signature]</i>	Date:	Time:	John Chrysosha <i>[Signature]</i>	Mar 8	4:20	

Nº: **T 104071**

Work Order #: 21T719152

Cooler Quantity: _____

Arrival Temperatures: 10.4 | 10.6 | 10.4
8.8 | 9 | 8.6

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes: no ice

Regular TAT ☒ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

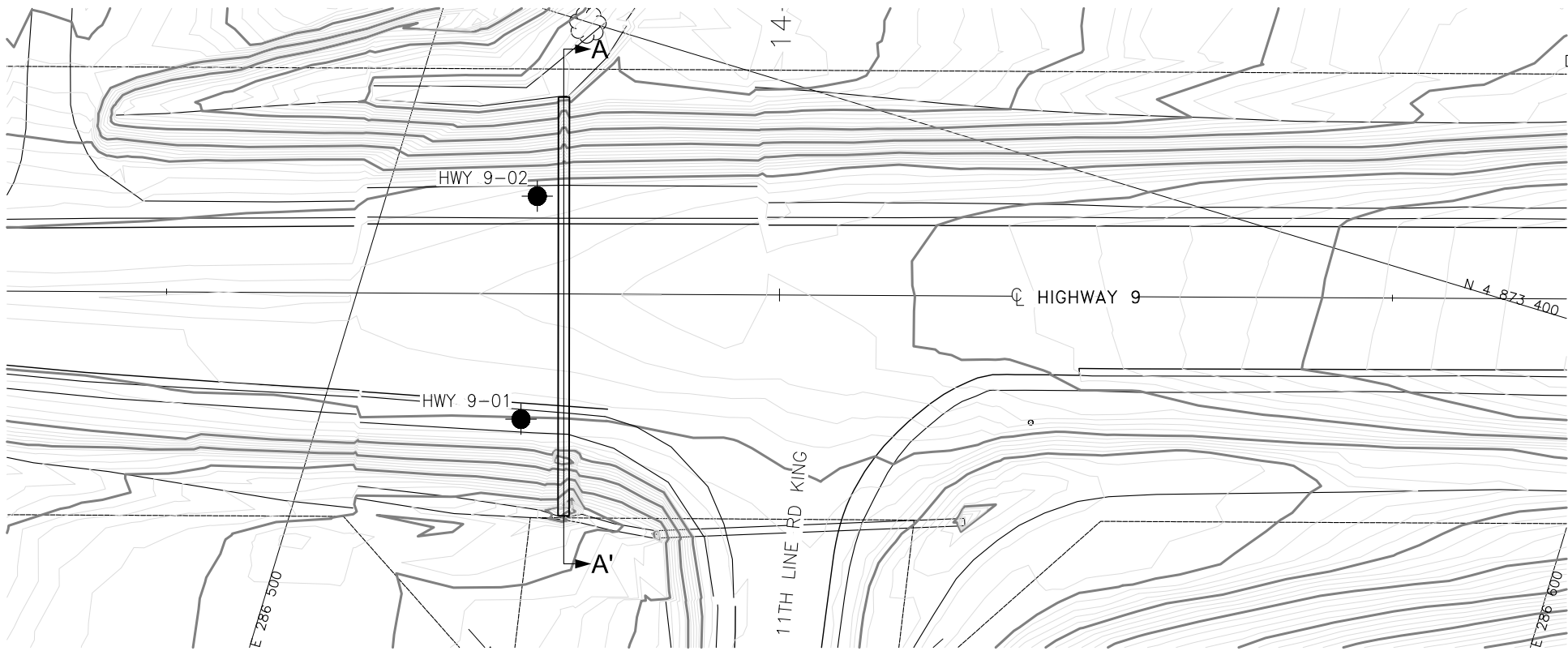
**TAT is exclusive of weekends and statutory holidays*

For 'Same Day' analysis, please contact your AGAT CPM

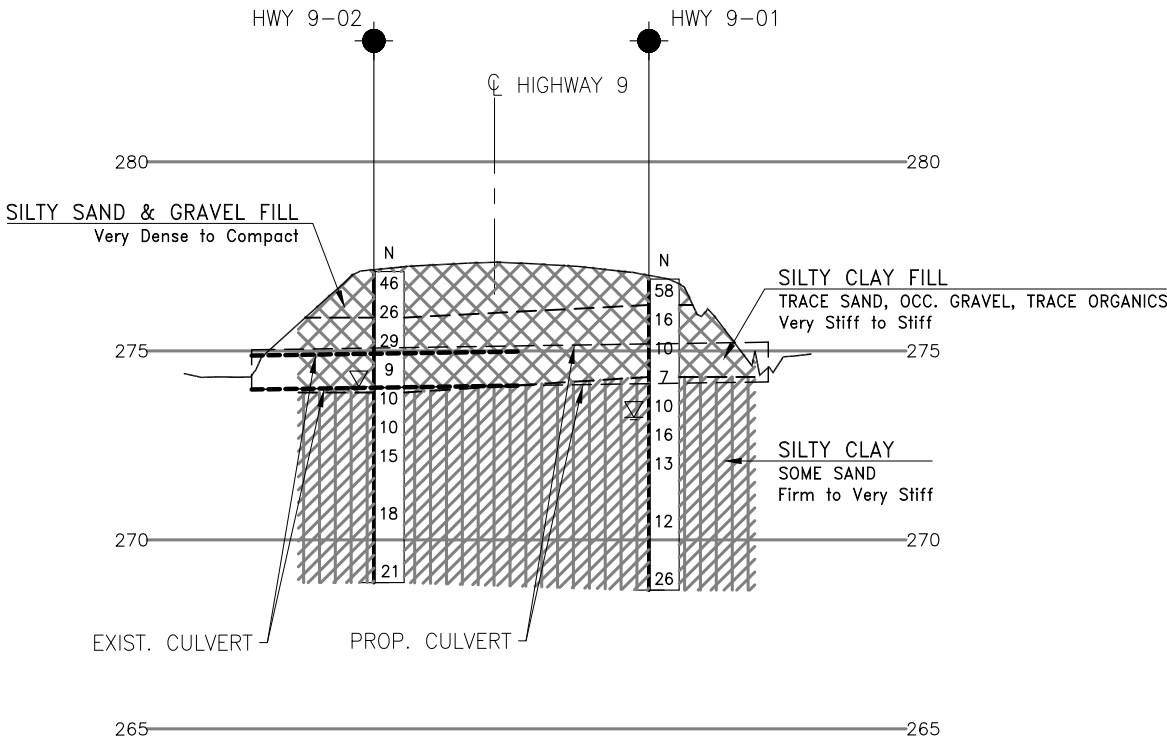


Appendix C

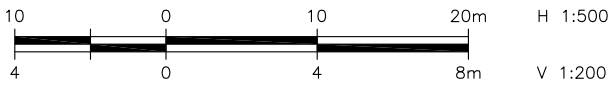
Borehole Locations and Soil Strata Drawing



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



SECTION ALONG A-A'



CONT No
WP No 2148-20-00

HIGHWAY 9
CULVERT REPLACEMENT

BOREHOLE LOCATIONS AND SOIL STRATA



SHEET



THURBER ENGINEERING LTD.



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
HWY 9-01	276.9	4 873 367.4	286 515.8
HWY 9-02	277.1	4 873 385.2	286 511.8

-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 10.

GEOCRES No. 30M13-235

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	RD	CHK	CODE
DRAWN	AN	CHK RD	SITE
			LOAD
			STRUCT
			DWG 1
			DATE MAR 2021