



FOUNDATION INVESTIGATION REPORT

Highway 17, Station 12+754, Township of Aweres Culvert Replacement

Ministry of Transportation, Ontario GWP 5181-13-00

Submitted to:

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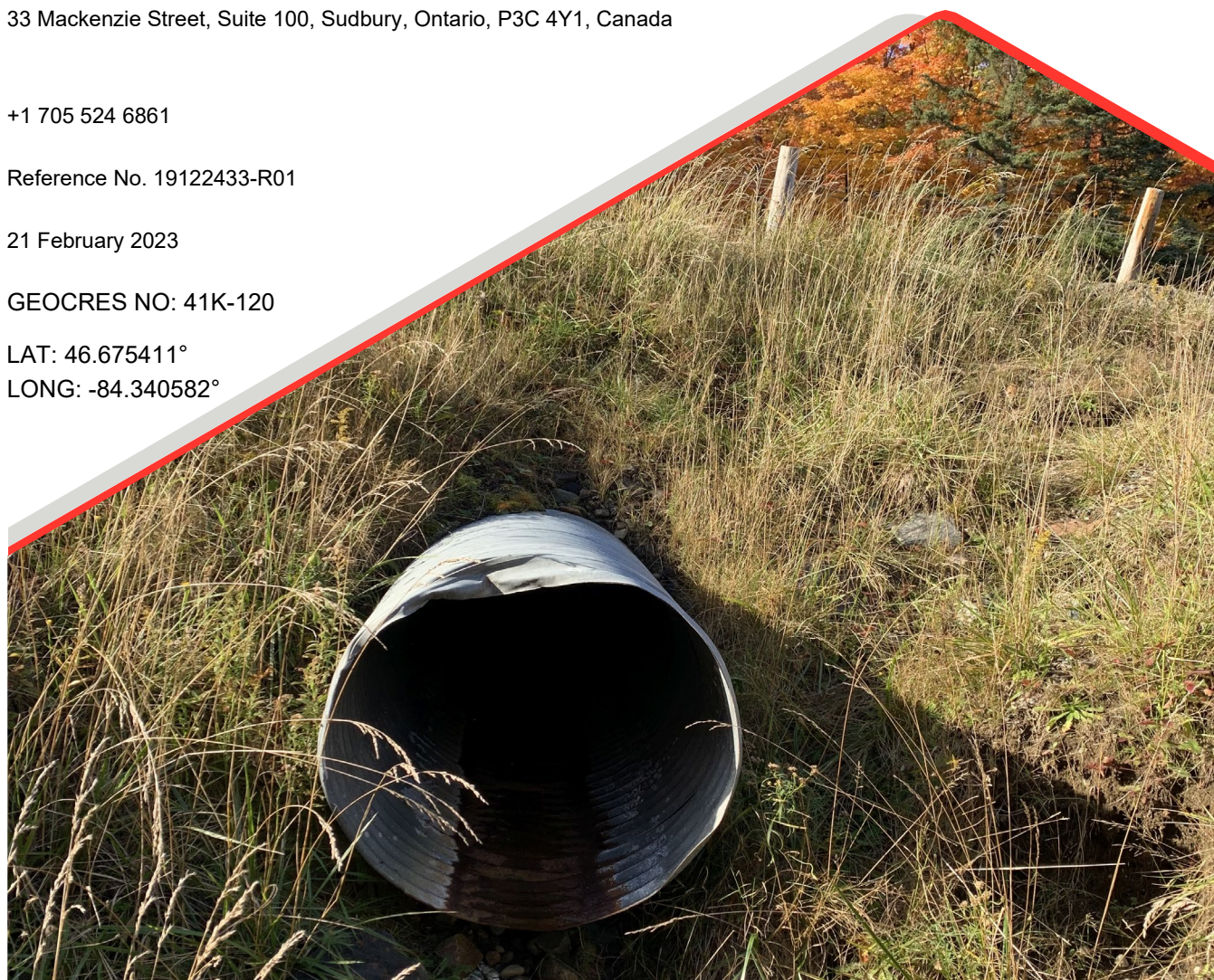
Reference No. 19122433-R01

21 February 2023

GEOCRES NO: 41K-120

LAT: 46.675411°

LONG: -84.340582°



Distribution List

1 PDF Copy: Ministry of Transportation, Ontario (NE Region)

1 PDF Copy: Ministry of Transportation, Ontario (Foundations)

1 PDF Copy: AECOM

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Table of Contents

1.0 INTRODUCTION	1
2.0 SITE DESCRIPTION	1
3.0 INVESTIGATION PROCEDURES	2
4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS.....	3
4.1 Regional Geology.....	3
4.2 Subsurface Conditions	3
4.2.1 Asphalt	3
4.2.2 Gravelly Sand (SP-SM) to Silty Sand (SM) Fill.....	3
4.2.3 Silty Sand (SM) to Sand and Gravel (SP).....	3
4.3 Groundwater Conditions	4
5.0 CLOSURE	4

DRAWINGS

Drawing 1 Borehole Locations and Soil Strata

PHOTOGRAPHS

Photographs 1 to 4

APPENDICES

APPENDIX A Record of Boreholes

Lists of Symbols and Abbreviations

Record of Boreholes 22-1 and 22-2

APPENDIX B Laboratory Test Results

Figure B-1 Grain Size Distribution – Gravelly SAND (SP-SM) to SILTY SANDY (SM) (Fill)

Figure B-2 Grain Size Distribution – Sandy SILT (ML) to Gravelly SILTY SAND (SM) to SAND and Gravel (SP)

1.0 INTRODUCTION

Golder Associates Ltd., a member of WSP (WSP Golder) has been retained by AECOM Canada Limited (AECOM) on behalf of the Ministry of Transportation, Ontario (MTO), to provide foundation engineering services related to the replacement of the culvert on Highway 17 at Station 12+754 in the Township of Aweres, approximately 6.2 km south of Goulais River. The Key Plan showing the general location of this section of Highway 17 and the location of the investigated area are shown in Drawing 1.

The purpose of this investigation is to establish the subsurface conditions at the culvert replacement through a foundation investigation consisting of boreholes and in-situ testing, with laboratory testing carried out on selected soil samples.

2.0 SITE DESCRIPTION

Based on the survey provided by AECOM, the existing culvert consists of an approximate 900 mm diameter by 32 m long corrugated steel pipe (CSP) culvert. The culvert inlet (west end) and outlet (east end) inverts are at Elevations 298.4 m and 296.6 m, respectively. The highway grade at the centerline is at approximately Elevation 300.9 m. The topography beyond the vicinity of the culvert is generally sloping downwards to the north – northeast and vegetated with trees and shrubs beyond the MTO right of way.

The average inclination of the east slope of the highway embankment at the culvert location is at about 2 Horizontal and 1 Vertical (2H:1V) and the west embankment slope is inclined at about 2.7H:1V. At the time of the field work, the embankment side slopes were generally grass covered. No signs of deep-seated embankment slope instability were observed in the vicinity of the culvert. The ground surface conditions at select locations of the culvert area are shown in Photographs 1 to 4.

3.0 INVESTIGATION PROCEDURES

Field work for the subsurface exploration was carried out on 23 and 24 August 2022, during which time two boreholes (Boreholes 22-1 and 22-2) were advanced at the approximate locations shown in Drawing 1. The boreholes were advanced using a track-mounted CME-55 drilling rig supplied and operated by Landcore Drilling of Sudbury, Ontario. Traffic control, where required, was performed in accordance with MTO's Ontario Traffic Control Manual Book 7 – Temporary Conditions.

The boreholes were advanced using 108 mm I.D. hollow-stem augers and HQ-casing with wash boring techniques. Soil samples were obtained in the boreholes at 0.75 m and 1.5 m intervals of depth using 50 mm outer diameter split-spoon samplers driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedures (ASTM D1586).

To measure a more stabilized groundwater level, a temporary standpipe piezometer was installed in Borehole 22-2 as described in the borehole records provided in Appendix A. The boreholes were backfilled in accordance with Ontario Regulation 903 (as amended) and were capped at the roadway surface using cold patch asphalt.

Field work was supervised on a full-time basis by a member of WSP Golder's technical staff who: located the boreholes in the field; arranged for the clearance of underground services; supervised the drilling and sampling operations; logged the boreholes; and examined the soil samples. The soil samples were identified in the field, placed in labelled containers, and transported to WSP Golder's geotechnical laboratory in Sudbury for further examination and laboratory testing. The laboratory testing included index and classification testing consisting of water content determinations and grain size distributions. The geotechnical laboratory testing was completed according to ASTM and MTO LS standards, as applicable.

The as-drilled borehole locations were measured relative to the highway centreline and chainage/station marked on the pavement at the culvert centreline by a member of our technical staff and converted into northing/easting coordinates on the base plan drawing provided by AECOM. The ground surface elevation at each borehole location was obtained from the topographic survey provided by AECOM. The northing and easting coordinates, ground surface elevations referenced to Geodetic datum, and borehole depths at each borehole location are presented on the borehole records in Appendix A and summarized below. The latitude/ longitude coordinates of the borehole locations are also shown on the borehole records.

Borehole Number	MTM NAD 83 Northing (m)	MTM NAD 83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
22-1	5170695.7	278755.5	301.4	14.3
22-2	5170705.9	278736.5	300.6	14.3

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS)¹ mapping, the culvert site is located in an area of bedrock knobs.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the summary results of in-situ and laboratory testing are given on the Record of Borehole sheets contained in Appendix A. The plotted results of the geotechnical laboratory testing are contained in Appendix B. The results of the in-situ field tests (i.e., SPT 'N'-values) as presented on the borehole records and discussed in Section 4.2, are uncorrected. The stratigraphic boundaries shown on the borehole records and on the interpreted stratigraphic profile shown in Drawing 1 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change.

The subsurface conditions will vary between and beyond the borehole locations; however, the factual data presented on the Record of Borehole sheets governs any interpretation of the site conditions. A summary description of the soil deposits and groundwater conditions encountered in the boreholes is provided below. It should be noted that the interpreted stratigraphy shown in Drawing 1 is a simplification of the subsurface conditions.

4.2.1 Asphalt

A 180 mm to 200 mm thick layer of asphalt was encountered along Highway 17 at ground surface in Boreholes 22-1 and 22-2.

4.2.2 Gravelly Sand (SP-SM) to Silty Sand (SM) Fill

A 3.6 m and 2.8 m thick layer of fill, consisting of gravelly sand to silty sand was encountered below the asphalt in the boreholes. The top of the fill deposit was encountered at Elevation 301.2 m and 300.4 m in Boreholes 22-1 and 22-2, respectively.

The SPT 'N'-values measured within the fill generally range from 16 blows to 74 blows per 0.3 m of penetration, indicating a compact to very dense compactness condition. Split-spoon refusal was encountered at 3.1 m depth in Borehole 22-1 and at 0.3 m depth in Borehole 22-2, suggesting the potential for obstructions (e.g., cobbles) within the fill.

Grain size distribution testing was carried out on two samples of the fill and the results are presented in Figure B-1 in Appendix B. The natural water content measured on two samples of the fill are 7 percent and 10 percent.

4.2.3 Silty Sand (SM) to Sand and Gravel (SP)

A native granular stratum consisting of silty sand, to gravelly silty sand, to sand, to sand and gravel was encountered below the fill in Boreholes 22-1 and 22-2 at Elevation 297.6 m. Boreholes 22-1 and 22-2 were terminated within this deposit after advancing to a total depth of 14.3 m. Cobbles of approximately 75 mm in diameter were encountered below 3.1 m depth in Borehole 22-2.

¹ Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 41KNE.

The SPT 'N'-values measured within the granular deposit range from 17 blows to 112 blows per 0.3 m of penetration indicating a compact to very dense compactness condition. In Borehole 22-2, two SPT tests encountered refusal after 0.1 m of penetration, further suggesting obstructions (e.g., cobbles) within the granular deposit.

The natural moisture content measured on select samples of the granular deposit range between approximately 11 percent and 16 percent.

Grain size distribution testing was carried out on five samples of the deposit and the results are presented on Figure B-2 in Appendix B.

4.3 Groundwater Conditions

The groundwater levels measured in the piezometer installed in Borehole 22-2 are summarized below. Groundwater and creek water levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

Borehole Number	Depth to Groundwater Level (m)	Approximate Groundwater Elevation (m)	Notes
22-2	9.1	291.5	Piezometer (23 August 2022)
	8.4	292.2	Piezometer (25 August 2022)

5.0 CLOSURE

The field drilling program was carried out under the supervision of Mr. Hayden Buchanan, under the overall direction of Mr. Matthew Thibeault, P.Eng. This Foundation Investigation Report was prepared by Mr. Tibor Berecz, P.Eng. and reviewed by Mr. Paul Dittrich, P.Eng., an MTO Foundations Designated Contact with WSP Golder, who conducted an independent quality control review of this report.

Signature Page

Golder Associates Ltd.



Tibor Berecz, P.Eng.
Geotechnical Engineer



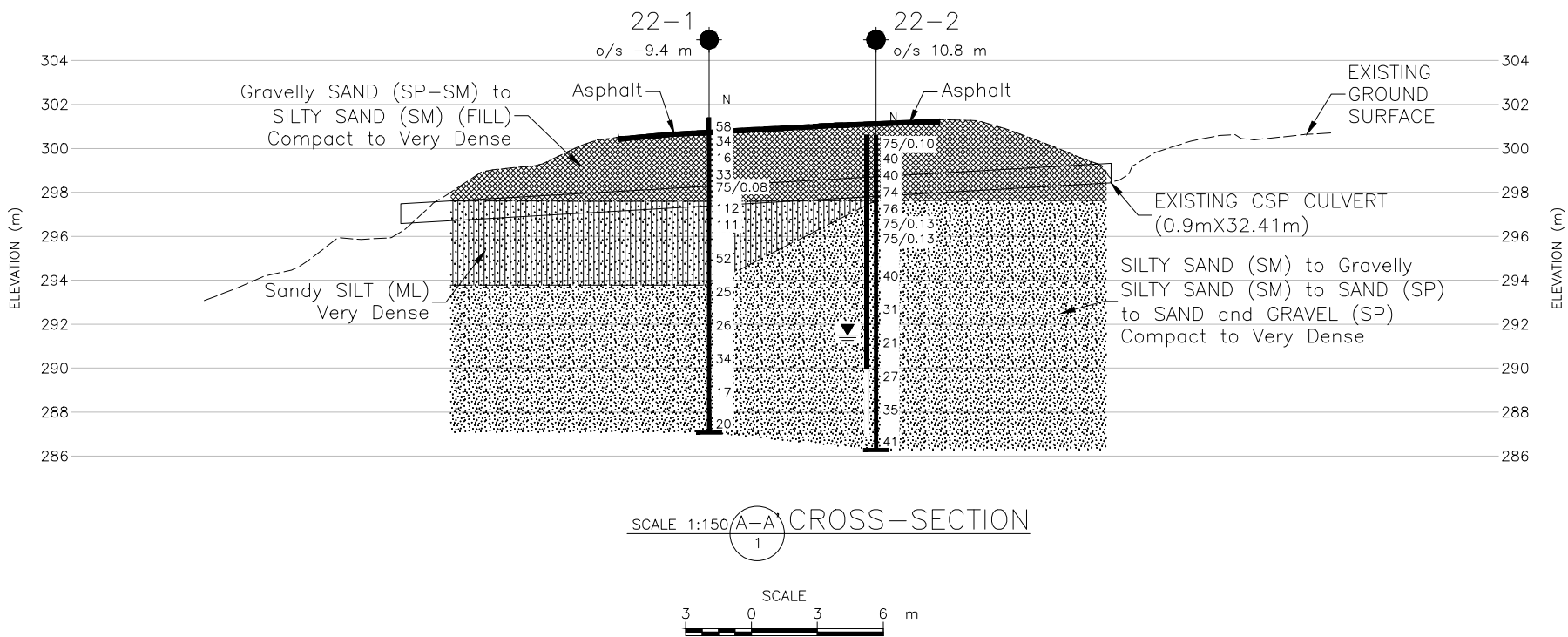
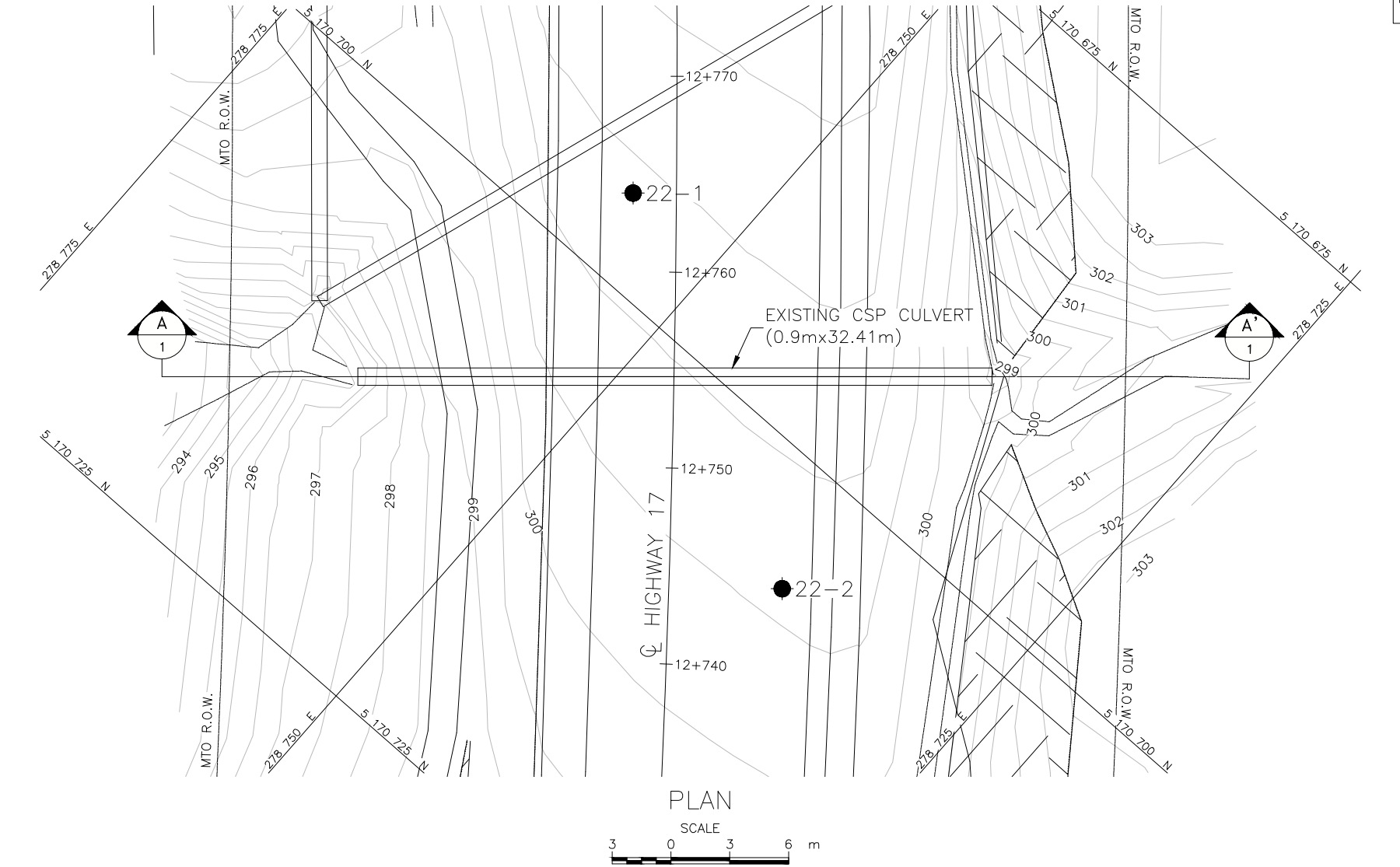
Matthew Thibeault, P.Eng.
Senior Geotechnical Engineer



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MTO Foundations Designated Contact, Senior Principal

TB/MT/JPD/ca

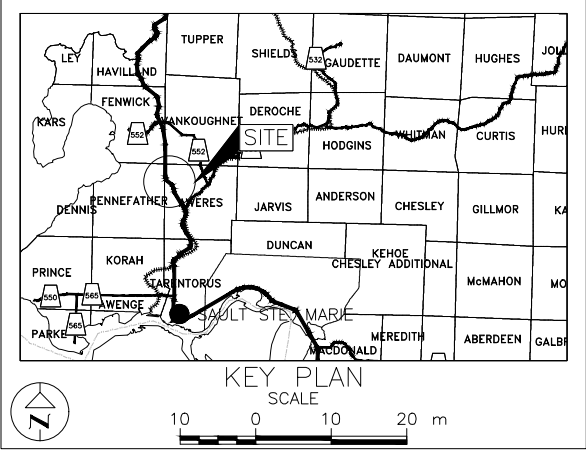
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METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5181-13-00

HIGHWAY 17
CULVERT AT STATION 12+754
BOREHOLE LOCATION AND SOIL STRATA



- LEGEND
- Borehole - Current Investigation
 - Seal
 - Piezometer
 - N Standard Penetration Test Value
 - 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
 - WL in piezometer, measured on August 25, 2022



BOREHOLE CO-ORDINATES (NAD 83 MTM ZONE 13)			
No.	ELEVATION	NORTHING	EASTING
22-1	301.4	5170695.7	278755.5
22-2	300.6	5170705.9	278736.5

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plans and topography provided in digital format by AECOM LTD., drawing file no. GWP 5181-13-00 Base Plan.dwg, Survey dated NOVEMBER 2019; Received SEPTEMBER 19, 2022.

NO.	DATE	BY	REVISION
Geocres No. 41K-120			
HWY. 17	PROJECT NO. 19122433		DIST. .
SUBM'D.	CHKD. TB	DATE: 02/21/2023	SITE: .
DRAWN: TR	CHKD. MT	APPD. JPD	DWG. 1



Photograph 1: Existing CSP culvert outlet (October 2022)



Photograph 2: Existing CSP culvert inlet (October 2022)



Photograph 3: Highway 17, looking northwest (October 2022)



Photograph 4: Highway 17, looking southeast (October 2022)

APPENDIX A

Record of Boreholes

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

MINISTRY OF TRANSPORTATION, ONTARIO

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>200	>8
COBBLES	Not Applicable	75 to 200	3 to 8
GRAVEL	Coarse	19 to 75	0.75 to 3
	Fine	4.75 to 19	(4) to 0.75
	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
FINES	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY COMPONENTS^{1,2}

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component (<i>i.e.</i> , SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (<i>i.e.</i> , some sand)
≤ 10	trace (<i>i.e.</i> , trace fines)

1. Only applicable to components not described by Primary Group Name.

2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (*q_t*), porewater pressure (*u*) and sleeve friction (*f_s*) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

SOIL TESTS

w	water content
PL, w _p	plastic limit
LL, w _L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G _s)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
Y	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

COARSE-GRAINED SOILS

Compactness¹

Term	SPT 'N' (blows/0.3m) ²
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

- Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grain size. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.
- SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

FINE-GRAINED SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' ^{1,2} (blows/0.3m)
Very Soft	< 12	0 to 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	> 200	> 30

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
- SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)

σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_L or LL	liquid limit
w_P or PL	plastic limit
I_P or PI	plasticity index $= (w_L - w_P)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index $= (w - w_P) / I_P$
I_C	consistency index $= (w_L - w) / I_P$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
$C_{a(e)}$	secondary compression index
C_a	rate of secondary compression
$C_{a(e)}$	modified secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
c'	effective cohesion
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q or q'	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ .
where $\gamma = \rho \cdot g$ (i.e., mass density multiplied by
acceleration due to gravity)

Notes: 1
2

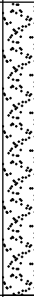
$\tau = c' + \sigma' \tan \phi'$
shear strength = (compressive strength)/2

PROJECT 19122433		RECORD OF BOREHOLE No. 22-1				1 OF 2 METRIC								
G.W.P. 5181-13-00		LOCATION N 5170695.7; E 278755.5 NAD83 MTM ZONE 13 (LAT. 46.675359; LONG. -84.340421)				ORIGINATED BY HB								
DIST _____ HWY 17		BOREHOLE TYPE CME 55 Trackmount, HQ Casing				COMPILED BY TR								
DATUM GEODETIC		DATE August 24, 2022				CHECKED BY MT								
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						
301.4	GROUND SURFACE													
0.0	ASPHALT (200 mm)													
0.2	Gravelly SAND (SP-SM) to SILTY SAND (SM), some silt (FILL) Compact to very dense Brown Moist		1	SS	58	301								
			2	SS	34									
						300								
			3	SS	16									
			4	SS	33	299								
	- Split-spoon refusal encountered in Sample 5, suggesting potential obstructions (e.g. cobbles).		5	SS	75/0.08									
						298								
297.6	Sandy SILT (ML), trace gravel, trace clay Very dense Grey to brown Wet		6	SS	112									
3.8			7	SS	111	297								
						296								
			8	SS	52	295								
293.8	SAND (SP) to SAND and Gravel (SP), trace silt Compact to dense Brown to brown grey Wet		9	SS	25	294								
7.6						293								
			10	SS	26	292								
			11	SS	34	291								
						290								

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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PROJECT 19122433		RECORD OF BOREHOLE No. 22-1				2 OF 2 METRIC										
G.W.P. 5181-13-00		LOCATION N 5170695.7; E 278755.5 NAD83 MTM ZONE 13 (LAT. 46.675359; LONG. -84.340421)				ORIGINATED BY HB										
DIST _____ HWY 17		BOREHOLE TYPE CME 55 Trackmount, HQ Casing				COMPILED BY TR										
DATUM GEODETIC		DATE August 24, 2022				CHECKED BY MT										
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 ---															
287.1	SAND (SP) to SAND and Gravel (SP), trace silt Compact to dense Brown to brown grey Wet		12	SS	17		289									
							288									
14.3	END OF BOREHOLE		13	SS	20											

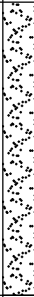
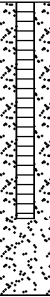
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PROJECT 19122433		RECORD OF BOREHOLE No. 22-2		1 OF 2 METRIC													
G.W.P. 5181-13-00		LOCATION N 5170705.9; E 278736.5 NAD83 MTM ZONE 13 (LAT. 46.675451; LONG. -84.340671)		ORIGINATED BY HB													
DIST _____ HWY 17		BOREHOLE TYPE CME 55 Trackmount, HQ Casing		COMPILED BY TR													
DATUM GEODETIC		DATE August 23, 2022		CHECKED BY MT													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	γ	GR	SA	SI	CL
300.6	GROUND SURFACE																
0.0	ASPHALT (180 mm)																
0.2	Gravelly SAND (SP) to SILTY SAND (SM) (FILL) Dense to very dense Brown Moist - Split-spoon refusal encountered in Sample 1, suggesting potential obstructions (e.g. cobbles).		1	SS	75/0.10		300										
			2	SS	40		299										
			3	SS	40		298										
			4	SS	74		297										
297.6	SILTY SAND (SM) to Gravelly SILTY SAND (SM), trace silt Compact to very dense Brown Wet - Cobbles up to 75 mm in diameter were encountered below 3.1 m depth. - Split-spoon refusal encountered in Sample 6, suggesting potential obstructions (e.g. cobbles). - Split-spoon refusal encountered in Sample 7, suggesting potential obstructions (e.g. cobbles).		5	SS	76		296										
3.0			6	SS	75/0.13		295										
			7	SS	75/0.13		294										
			8	SS	40		293										
			9	SS	31		292										
			10	SS	21		291										
			11	SS	27		290										
							289										

Continued Next Page

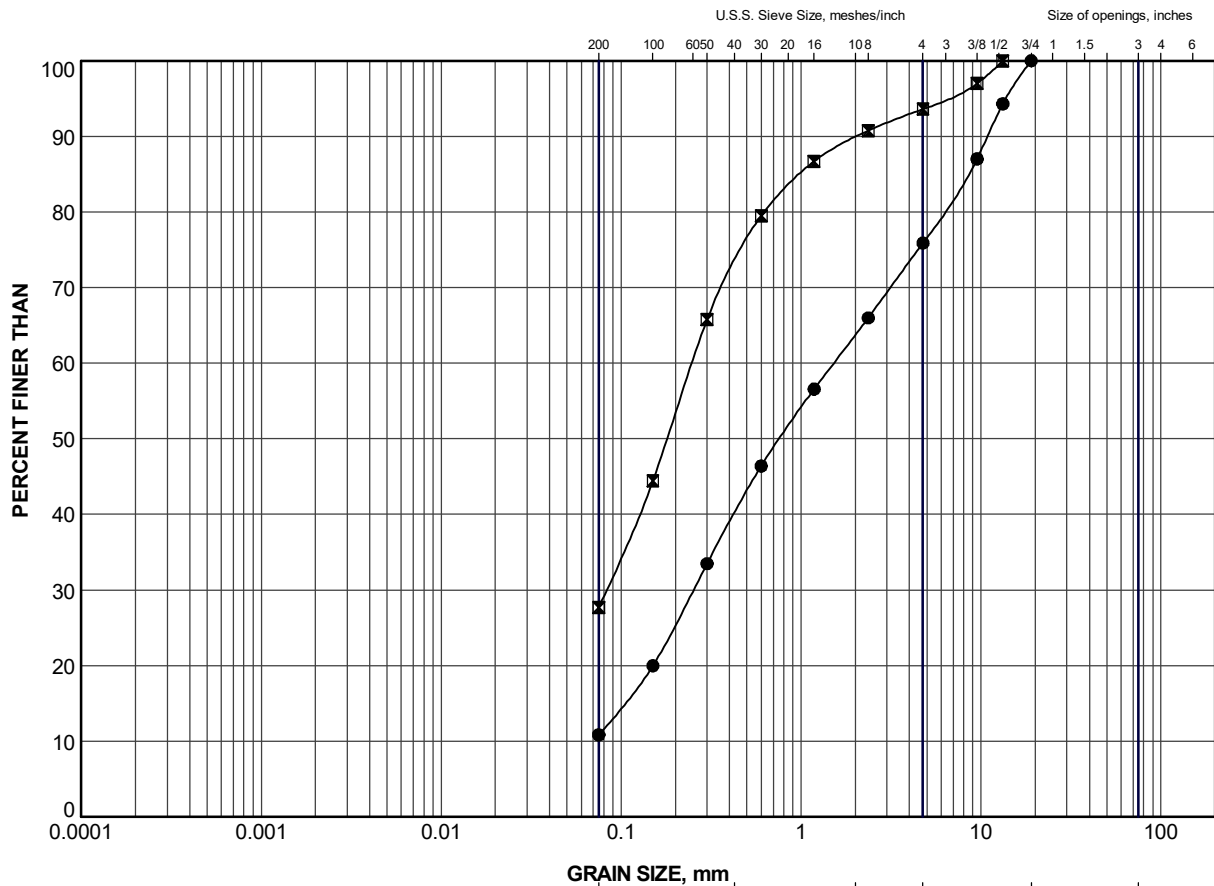
+ 3, X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

SUD-MTO 001 R:\SUBBURY\SIM\CLIENTS\IMTO\HWY17&552\02_DATAGINT\19122433\19122433.GPJ GAL-MISS.GDT 11/15/22 TR

PROJECT 19122433		RECORD OF BOREHOLE No. 22-2				2 OF 2 METRIC												
G.W.P. 5181-13-00		LOCATION N 5170705.9; E 278736.5 NAD83 MTM ZONE 13 (LAT. 46.675451; LONG. -84.340671)				ORIGINATED BY HB												
DIST _____ HWY 17		BOREHOLE TYPE CME 55 Trackmount, HQ Casing				COMPILED BY TR												
DATUM GEODETIC		DATE August 23, 2022				CHECKED BY MT												
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									WATER CONTENT (%)	
	--- CONTINUED FROM PREVIOUS PAGE ---						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					20 40 60 20 40 60				GR SA SI CL		
286.3	SILTY SAND (SM) to Gravelly SILTY SAND (SM), trace silt Compact to very dense Brown Wet		12	SS	35		288									o		22 64 (14)
287																		
14.3	END OF BOREHOLE NOTE: 1. Water level measured in piezometer at a depth of 8.4 m below ground surface (Elev. 292.2 m) on August 25, 2022.																	

APPENDIX B

Laboratory Test Results

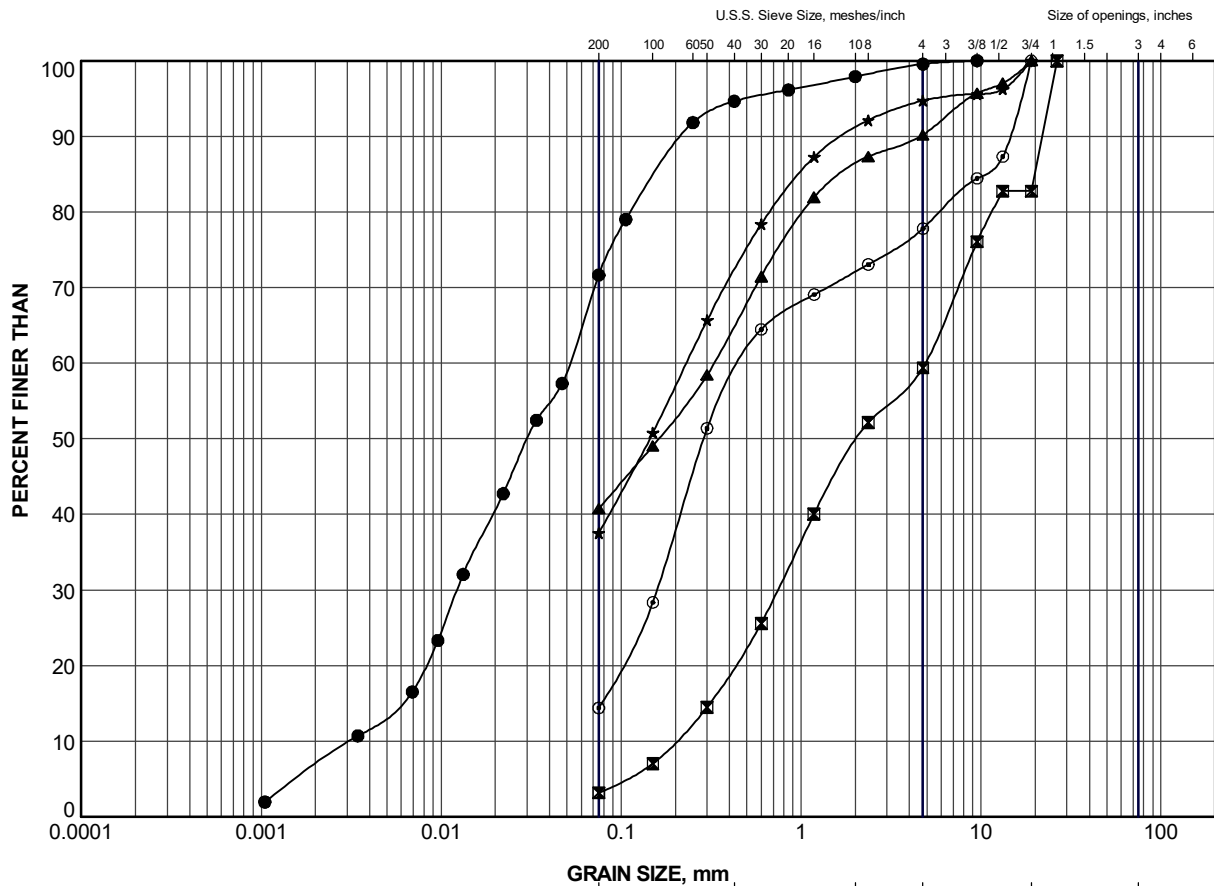


CLAY AND SILT	SAND SIZE, mm			GRAVEL SIZE, mm		Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	22-1	3	299.6
×	22-2	3	298.8

PROJECT						HIGHWAY 17 CULVERT AT STATION 12+754 TOWNSHIP OF AWERES					
TITLE						GRAIN SIZE DISTRIBUTION Gravelly SAND (SP-SM) to SILTY SAND (SM) (FILL)					
						PROJECT No. 19122433			FILE No. 19122433.GPJ		
						DRAWN	TR	Nov 2022	SCALE	N/A	REV.
						CHECK	TB	Nov 2022	FIGURE B-1		
						APPR	MT	Nov 2022			
SUDBURY, ONTARIO											



CLAY AND SILT	SAND SIZE, mm			GRAVEL SIZE, mm		Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	22-1	6	297.3
⊠	22-1	10	292.0
▲	22-2	5	297.3
★	22-2	8	294.2
⊙	22-2	12	288.1

PROJECT						HIGHWAY 17 CULVERT AT STATION 12+754 TOWNSHIP OF AWERES					
TITLE						GRAIN SIZE DISTRIBUTION Sandy SILT (ML) to Gravelly SILTY SAND (SM) to SAND and Gravel (SP)					
PROJECT No.			19122433			FILE No.			19122433.GPJ		
DRAWN	TR	Nov 2022	SCALE	N/A	REV.						
CHECK	TB	Nov 2022									
APPR	MT	Nov 2022									
						FIGURE B-2					
SUDBURY, ONTARIO											



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