FINAL REPORT

Foundation Investigation Report
Highway 129 - Vincent Creek Culvert Replacement
Structure No. 46-004C
Algoma District, Reaney Township
Ministry of Transportation, Ontario
GWP 411-00-00, WP 5291-13-01

Submitted to:

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18104216

February 26, 2019

GEOCRES NO: 41O-037

Distribution List

3 Copies and 1 PDF Copy: Ministry of Transportation, Ontario, North Bay (Northeastern Region)

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1 PDF Copy: Golder Associates Ltd.

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PART A

FOUNDATION INVESTIGATION REPORT
HIGHWAY 129 - VINCENT CREEK CULVERT REPLACEMENT
STRUCTURE NO. 46-004C
ALGOMA DISTRICT, REANEY TOWNSHIP
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 411-00-00, WP 5291-13-01

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Parsons Corporation (Parsons) on behalf of Ministry of Transportation, Ontario (MTO) to provide foundation engineering services associated with the replacement of the Vincent Creek Culvert (Structure No. 46-004C). The Vincent Creek Culvert is located in the Algoma District on Highway 129, approximately 33.7 km South of the Highway 101 and Highway 129 junction in Reaney Township. The key plan showing the general location of this section of Highway 129 is shown on Drawing 1.

The Terms of Reference (TOR) and Scope of Work for the Foundation Investigation are outlined in MTO's Request for Proposal, dated June 2018. Golder's proposal for foundation engineering services associated with replacement of the Vincent Creek Culvert is contained in Section 17.8 of Parson's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundations engineering services for this project, dated August, 2018.

2.0 SITE DESCRIPTION AND LOCAL GEOLOGY

In general, the topography of the site and surrounding area is undulating to rolling terrain beyond the creek. The area is surrounded by dense tree cover beyond the highway right-of-way.

Based on MTO's current General Arrangement (GA) dated March 2018, the existing culvert is a 20 m long, 3.6 m diameter corrugated steel pipe and the water level in the creek in September 2014 was reportedly at Elevation 442 m. Also based on MTO's GA, the existing culvert invert is approximately 441.4 m and 441.3 m at the west and east ends respectively. The existing embankment is about 4 m high relative to the creek bottom. Views at the culvert site are shown on Photographs 1 and 2, following the text of this report.

3.0 INVESTIGATION PROCEDURES

3.1 Previous Investigation

A foundation investigation was carried out at the Highway 129 Vincent Creek Culvert in 2015 by Peto MacCallum Ltd., (PML), GEOCRES 41O-16, comprised of the drilling of four boreholes (VC-1 to VC-4), at the locations shown on Drawing 1. A copy of the previous investigation Borehole Location and Soil Strata drawing (Drawing VC-1), Record of Boreholes and laboratory testing plots are included in Appendix A. The borehole locations, ground surface elevations and borehole depths presented on the borehole records are summarized below.

Borehole Number	MTM NAD83 Northing	MTM NAD83 Easting	Ground Surface Elevation (m)	Borehole Depth (m)
VC-1	5263599.2	364112.7	444.0	11.3
VC-2	5263586.3	364114.4	445.5	13.0
VC-3	5263590.8	364123.7	445.4	13.0
VC-4	5263579.5	364124.9	443.6	8.2

3.2 Current Investigation

The field work for the current investigation was carried out between September 26 and 28, 2018, during which time two boreholes (BH-1 and BH-2) were advanced at the locations shown on Drawing 1.

The boreholes were advanced from the existing roadway platform using a truck mount drill rig supplied and operated by Landcore Drilling (Landcore) of Chelmsford, Ontario. Traffic control was performed by Leroy Construction of Blind River, Ontario. All traffic control was performed in accordance with the Ontario Traffic Control Manual Book 7 – Temporary Conditions. The boreholes were advanced using NW casing and wash boring techniques. Where coring through cobbles and boulders or bedrock was required, an NQ-size core barrel was used. Soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm outer diameter split-spoon sampler operated by an automatic hammer, in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). The groundwater level in the open boreholes was observed during the drilling operations as described on the borehole records in Appendix B. The boreholes were backfilled upon completion in accordance with Ontario Regulation 903 Wells (as amended).

The field work for this investigation was supervised on a full-time basis by a member of Golder's staff, who located the boreholes in the field, cleared the site for buried services, directed the drilling and sampling operations, and logged the boreholes. The soil samples were identified in the field, placed in labelled containers, and transported to Golder's Sudbury Laboratory for further examination and laboratory testing. Laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Index and classification tests consisting of water content and grain size distribution were carried out on selected soil samples. An unconfined compression (UC) strength test was carried out on a specimen of the bedrock core obtained in Borehole BH-1.

The degree of weathering of the bedrock samples (i.e., fresh to slightly weathered) and the strength classification of the intact rock mass based on field identification (i.e., strong to very strong) are described in accordance with Table B.3 and Table B.6, respectively, of the International Society for Rock Mechanics (ISRM[1]) standard classification system. Classification of the rock mass quality of the bedrock with respect to the Rock Quality Designation (RQD) and Uniaxial Compressive Strength are described based on Table 3.10 and Table 3.5, respectively, of the Canadian Foundation Engineering Manual (CFEM, 2006[2]).

The borehole locations and elevations for this investigation were measured and surveyed by a member of our technical staff, referenced to the intersection of the centerline of Highway 129 and centerline of the culvert. The borehole locations (referenced to the MTM NAD83, Zone 13 co-ordinate system), ground surface elevations (referenced to Geodetic datum) and borehole depths are presented on the borehole records in Appendix B, and summarized below.

[1] International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech. Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

[2] Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

Borehole Number	MTM NAD83 Northing (Latitude)	MTM NAD83 Easting (Longitude)	Ground Surface Elevation (m)	Borehole Depth (m)
BH-1	5263576.5 (47.508701)	364116.1 (-83.212514)	445.4	18.3*
BH-2	5263600.4 (47.508915)	364122.0 (-83.212432)	445.3	15.4

* Includes 3.1 m of bedrock core

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS)[3] mapping, the Vincent Creek Culvert site is located within an outwash plain, valley train deposit consisting primarily of sand and gravel.

Based on geological mapping by the Ontario Ministry of Northern Development and Mines (MNDM)[4], the site is underlain by gneissic tonalite suite with minor supracrustal inclusions of the Superior Province.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes from the previous investigation, together with the results of in situ and laboratory testing are given on the Record of Borehole sheets contained in Appendix A. The detailed subsurface soil and groundwater conditions as encountered in the boreholes from the current investigation, together with the results of in situ and laboratory testing are given on the Record of Borehole sheets contained in Appendix B. The detailed results of the geotechnical laboratory testing for the previous investigation are contained in Appendix A and for the current investigation are combined in Appendix C. The results of the in-situ field tests (i.e., SPT 'N' values) as presented on the Record of Borehole sheets for the current investigation and in Section 4.2 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic profile shown on Drawings 1 and VC-1 (in Appendix A) 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. A summary of the subsurface conditions encountered in the boreholes advanced for the current and previous investigations is presented below.

[3] Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 410NW

[4] Ontario Ministry of Northern Development of Mines. Bedrock Geology of Ontario – East Central Sheet, Ontario Geological Survey – Map 2543

4.2.1 Soil Conditions

Deposit/Layer Description	Boreholes	Deposit Surface Elevation (m)	Deposit Thickness (m)	SPT N Values (Blows), Su Vanes (kPa) Compactness Condition/ Consistency	Laboratory Testing
(FILL) Asphalt over Sand and Gravel	VC-2, VC-3, BH-1, and BH-2	445.5 to 445.3	0.2 to 2.3	16 - 84, 39/0.15 **Compact**	n/a
(ROCK FILL) Cobble and Boulder Sizes	VC-2 , VC-3, BH-1, and BH-2	445.3 to 443.0	1.5 to 1.9	n/a, 27 **Compact**	n/a
(FILL) Sandy Gravel	BH-2	441.5	0.8	1 **Very Loose**	n/a
PEAT (fibrous/amorphous)	VC-1, VC-4 and BH-2	443.8, 443.6 and 440.7	0.1 to 0.9	n/a, WH Very Soft	w = 20% and 852%
Sand to Silty Sand, layers of peat	VC-1 to VC-4	443.7 to 442.8	3.2 to 3.8	WH to 37 **Very Loose to Dense**	w = 20% to 83% and 223% 1-MH (Fig. VC-GS-1 in App. A)
SILT to CLAYEY SILT to CLAYEY SILT with Sand	VC-1 to VC-4, and BH-2	440.3 to 439.0	1.4 to 2.1	WH to 13, Su = 12 kPa to 65 kPa **Very Soft to Stiff**	w = 19% - 42% 4-MH (Fig. VC-GS-2 in App. A) 4-ATT (Fig. C2 and Fig. VC-PC-1 in App. A) w_l = 20% - 29% w_p = 15% - 17% I_p = 5% - 12%

Deposit/Layer Description	Boreholes	Deposit Surface Elevation (m)	Deposit Thickness (m)	SPT N Values (Blows), Su Vanes (kPa) / Compactness Condition/ Consistency	Laboratory Testing
Sandy SILT to SAND	VC-1 to VC-4, BH-1 and BH-2	442.4 to 437.6	>2.9 (VC-1 to VC-4 terminated in this deposit) to 10.3	2 – 32 / **Very Loose to Dense**	w = 15% - 24% 8-MH (Fig. C2 and Fig. VC-GS-3 in App. A) 1-M (Fig. C2)
SAND and GRAVEL and COBBLES	BH-1 & BH-2	432.0 & 431.6	1.8 & 1.7 (BH-2 terminated in this deposit)	24 – 26/0.05 / **Compact to Very Dense**	n/a

Where:
N = SPT 'N'-value; number of blows for 0.3 m of penetration
s_u = Undrained Shear Strength (kPa)
w = Natural Moisture Content (%)
MH = Combined sieve and hydrometer analysis
ATT = Atterberg Limits Testing
w_p = Plastic Limit (%)
w_l = Liquid Limit (%)
I_p = Plasticity Index (%)

4.2.2 Bedrock/Refusal

Bedrock was cored in Borehole BH-1 and the depth/elevation of the actual/inferred bedrock surface is presented below. Refusal to further split spoon advancement was encountered on inferred bedrock in Borehole BH-2.

Borehole No.	Depth to Bedrock Surface (Below Ground Surface) (m)	Bedrock Surface Elevation (Inferred) (m)	Refusal Condition (m)
BH-1	15.2	430.2	3.1 m length of bedrock core
BH-2	15.4	(429.9)	Split-Spoon

The retrieved bedrock core from Borehole BH-1 is described as fresh, fine to medium grained, grey gneiss. More detailed descriptions of the bedrock core are presented on the Record of Drillhole BH-1 in Appendix B, including data regarding the discontinuity frequency and type. A photograph of the bedrock core samples is shown on Figure C3 in Appendix C. The bedrock properties, as encountered in the cored borehole and the result of an unconfined compression (UC) test on a specimen of the bedrock core are summarized below. The detailed results of the UC test are presented in Table C1 in Appendix C.

Borehole No.	Total Core Recovery (TCR)	Rock Quality Designation (RQD)	Quality Classification (Table 3.10 of CFEM 2006[5])	UCS (MPa)	Strength Classification (Table 3.5 of CFEM 2006[3])
BH-1	100%	90% - 100%	Excellent	196	(R5) Very Strong

4.2.3 Groundwater Conditions

The unstabilized groundwater levels presented on the borehole records upon completion of drilling are summarized below; however, these are not considered representative of stabilized in situ groundwater conditions. Groundwater levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

Borehole No.	Depth to Unstabilized Groundwater Level (m)	Approximate Groundwater Elevation (m)
VC-1	0.7 (0.9*)	443.1
VC-2	2.0	443.5
VC-3	5.2	440.2
VC-4	0.8	442.8
BH-1	1.4	444.0
BH-2	1.3	444.0

* Below ice surface

5.0 CLOSURE

The field drilling program was carried out under the supervision of Ms. Kirsten Janssen, EIT. This Foundation Investigation Report was prepared by Ms. Kirsten Janssen, EIT, and the technical aspects were reviewed by Mr. André Bom, P.Eng., a geotechnical engineer and Associate of Golder. Mr. Jorge M.A. Costa, P.Eng., an MTO Foundations Designated Contact and Senior Consultant for Golder, conducted an independent quality control review and technical audit of this report.

[5] Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

Signature Page

Golder Associates Ltd.

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MTO Foundations Designated Contact, Senior Consultant

KJ/AB/JMAC/sb

https://golderassociates.sharepoint.com/sites/29404g/deliverables/foundations-vincent creek/3-final february xx, 2019/18104216-r-rev0-parsons vincent creek fir 26feb_19.docx

MINISTRY OF TRANSPORTATION, ONTARIO

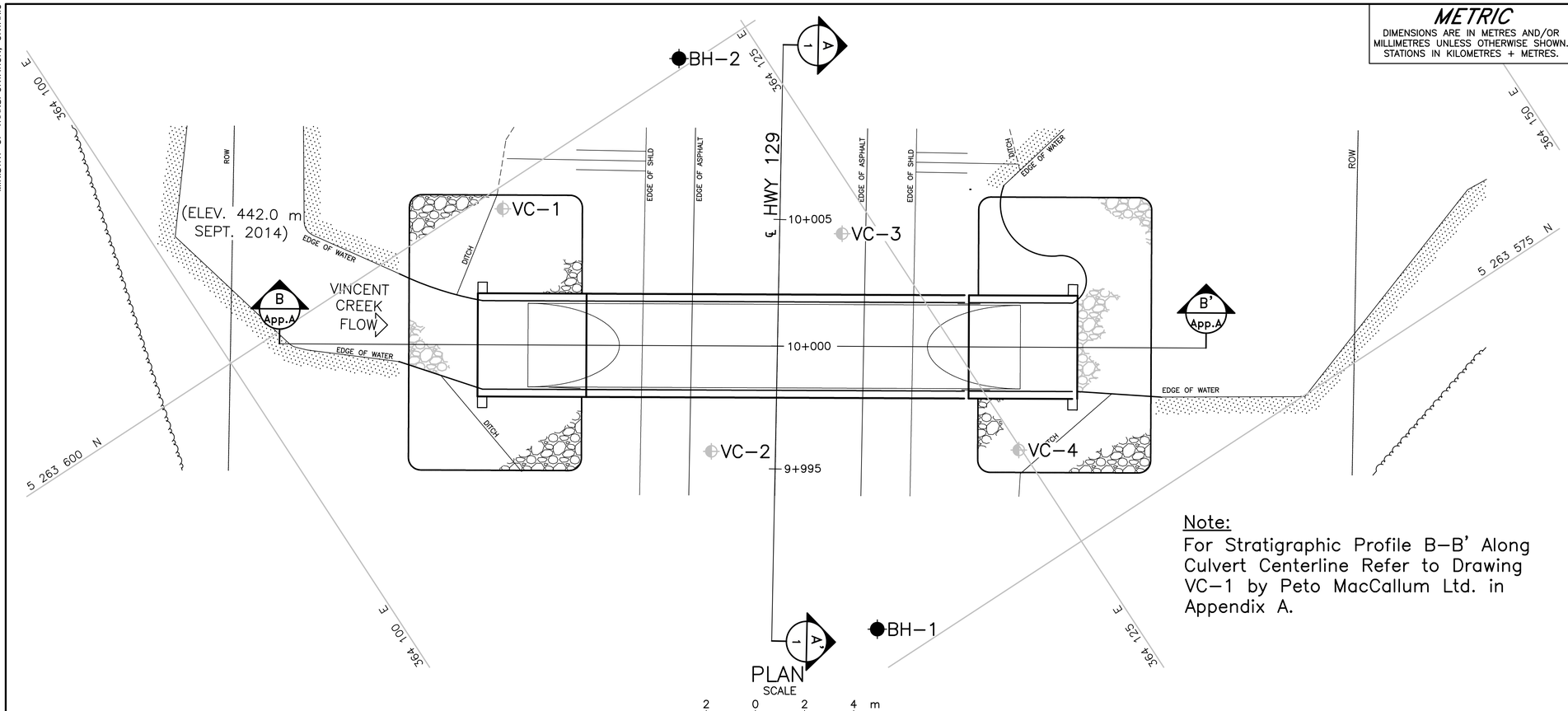
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 5291-13-01

HIGHWAY 129
VINCENT CREEK CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

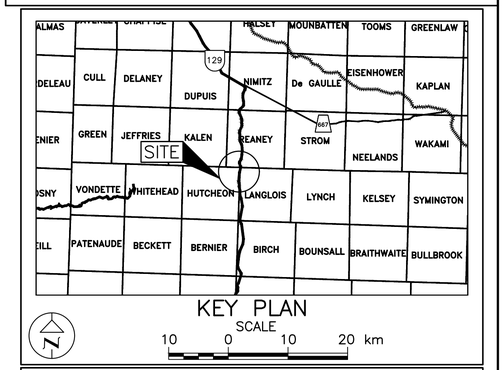
SHEET .

GOLDER



PLAN
SCALE
2 0 2 4 m

Note:
For Stratigraphic Profile B-B' Along Culvert Centerline Refer to Drawing VC-1 by Peto MacCallum Ltd. in Appendix A.



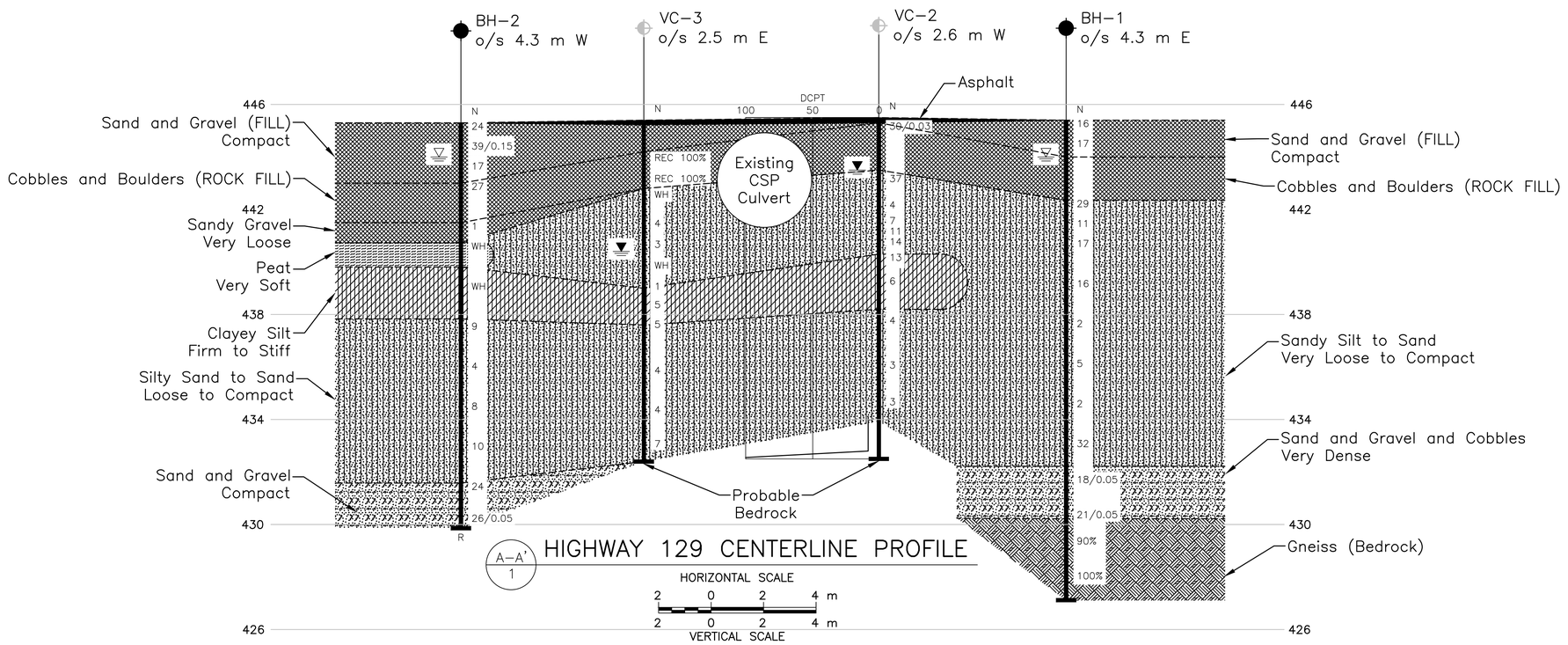
KEY PLAN
SCALE
10 0 10 20 km

LEGEND

- Borehole – Current Investigation
- Borehole – Previous Investigation 1
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% — Rock Quality Designation (RQD)
- REC — Recovery (%)
- R — Refusal
- WL in piezometer, measured on MMM DD, YYYY
- WL upon completion of drilling

BOREHOLE CO-ORDINATES (NAD83 MTM ZONE 13)

No.	ELEVATION	NORTHING	EASTING
BH-1	445.4	5263576.5	364116.1
BH-2	445.3	5263600.4	364122.0
VC-1	444.0	5263599.2	364112.7
VC-2	445.5	5263586.3	364114.4
VC-3	445.4	5263590.8	364123.7
VC-4	443.6	5263579.5	364124.9



A-A'
1
HIGHWAY 129 CENTERLINE PROFILE

HORIZONTAL SCALE
2 0 2 4 m
VERTICAL SCALE
2 0 2 4 m

LICENSED PROFESSIONAL ENGINEER J.M.A.COSTA Feb 14, 2019 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER A.J.K. BOM 100075715 Feb 14, 2019 PROVINCE OF ONTARIO

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 provided in digital format by MTO, drawing file nos. WP 5291-13-01 Site 46-004C – Vincent.dwg, received Oct 16, 2018.

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 410-037

HWY. 129	PROJECT NO. 18104216		DIST. .
SUBM'D. .	CHKD. KJ	DATE: 2/14/2019	SITE: 46-004/C
DRAWN: TR	CHKD. AB	APPD. JMAC	DWG. 1

PLOT DATE: February 21, 2019
FILENAME: S:\Clients\Ontario\Vincent_Creek_Culvert\VP_PROV\18104216\d0_PROV\1000\18104216-1000-BC-0001.dwg

Photograph 1: Vincent Creek Culvert – Hwy 129 – Reaney Twp., Outlet Facing South (taken September 26, 2018)

Photograph 2: Vincent Creek Culvert – Hwy 129 – Reaney Twp., Inlet Facing South (taken September 26, 2018)

APPENDIX A

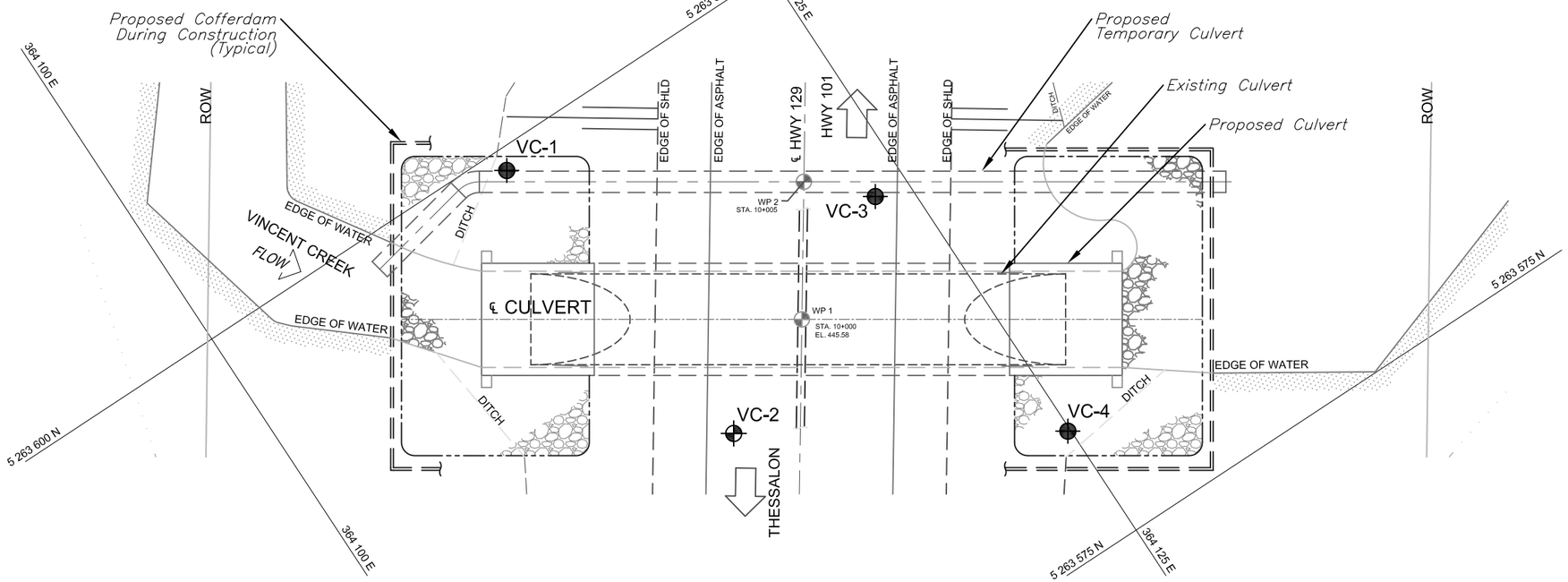
Foundation Drawing, Record of Boreholes and Laboratory Testing – Previous Investigation

CONT No XXXX-XXX
GWP No 5222-05-00
WP No 5291-13-01

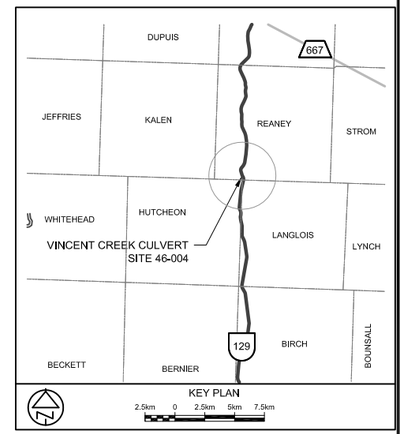
VINCENT CREEK CULVERT REPLACEMENT
HIGHWAY 129
STA. 10+000 REANEY TWP
BOREHOLE LOCATIONS AND SOIL STRATA

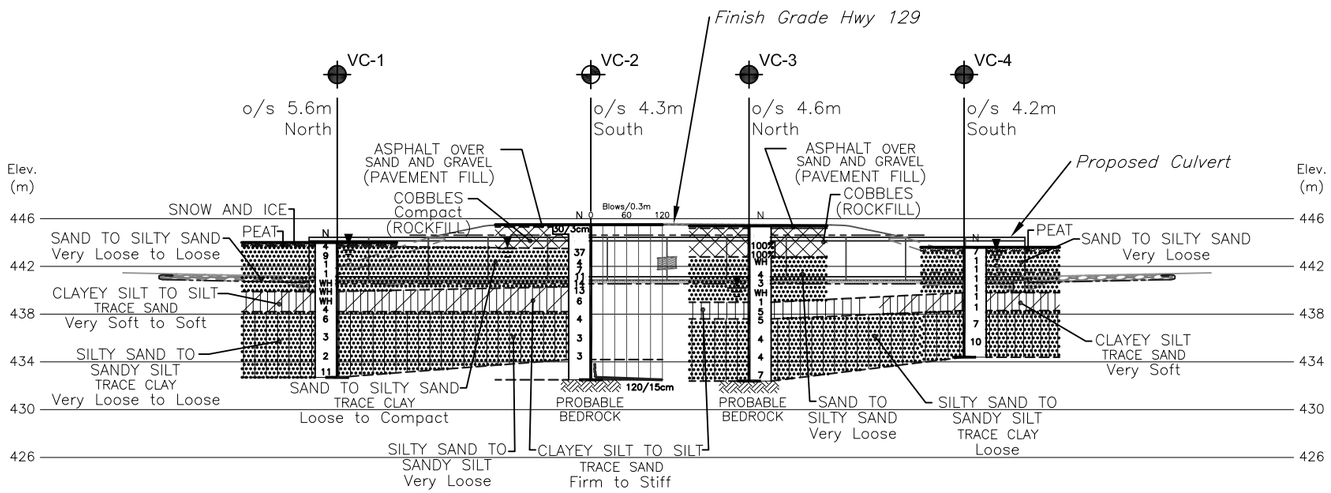
SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



PLAN
SCALE
2.5 0 2.5 5m





PROFILE ALONG CENTRELINE VINCENT CREEK CULVERT

SCALE
HORIZONTAL
2.5 0 2.5 5m
VERTICAL
5 0 5 10m

LEGEND	
Borehole	
Cone	
Borehole and Cone	
N	Blows/0.3m (Std. Pen Test, 475 J/blow)
CONE	Blows/0.3m (60 Cone, 475 J/blow)
WL at time of investigation Jan. 2015	
Head ARTESIAN WATER Encountered	
PIEZOMETER	

BH No	ELEVATION	NORTHINGS	EASTINGS
VC-1	444.0	5 263 599.2	364 112.7
VC-2	445.5	5 263 586.3	364 114.4
VC-3	445.4	5 263 590.8	364 123.7
VC-4	443.6	5 263 579.5	364 124.9

NOTES:

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE LOGS.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
3. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

LICENSED PROFESSIONAL ENGINEER M. VASAVITHASAN 0420 PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER C.M.P. Nascimento 104 PROVINCE OF ONTARIO

REF AECOM Drawing: 60333079-P60.dwg dated June 2015

— NOTE —
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 410-16

HWY No	129			DIST	SAULT ST. MARIE
SUBM'D	NA	CHECKED	MKh	DATE	OCT. 04, 2016
DRAWN	NA	CHECKED	MV	APPROVED	CN
SITE	46-004/C				
DWG	VC-1				

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No VC-1 1 of 1 METRIC

G.W.P. 5222-05-00 LOCATION Vincent Creek Coords: 5 263 599.2 N; 364 112.7 E ORIGINATED BY F.P.

DIST Algoma HWY 129 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY M.Kh.

DATUM Geodetic DATE January 9 and 11, 2015 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
444.0	Ground Surface										
443.8 / 0.2	Snow and ice										
443.7 / 0.3	Peat, coarse fibrous Dark brown		1	SS	4	▽*					
	Sand, layers of peat fine fibrous to amorphous Very loose Dark Wet to loose brown		2	SS	9	▼*	443				
			3	SS	1		442				
			4	SS	1		441				
			5	SS	WH**						
439.9			6	SS	WH		440				
4.1	Clayey silt, trace sand Very soft Grey Wet to soft		7	SS	WH		439				0 9 65 26
438.2			8	SS	4		438				
5.8	Silty sand to sandy silt trace clay Very loose Grey Wet to compact		9	SS	6		437				0 52 42 6
			10	SS	3		436				
			11	SS	2		435				
432.7			12	SS	11		434				
11.3	End of borehole						433				

* 2015 01 09 & 11

▽ Water level observed during drilling

▼ Water level measured on completion

WH** denotes penetration due to weight of hammer and rods

NOTE Borehole caved in at 0.9m

ON MTO_VER3 NEW LOGO 14TF038.GPJ ON_MOT.GDT 05/07/2016 8:38:42 AM

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE 20 15 5 10

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No VC-2 1 of 2 METRIC

G.W.P. 5222-05-00 LOCATION Vincent Creek Coords: 5 263 586.3 N; 364 114.4 E ORIGINATED BY F.P.

DIST Algoma HWY 129 BOREHOLE TYPE C.F.H.S.A. + Casing and Dynamic Cone Penetration Test COMPILED BY M.Kh.

DATUM Geodetic DATE December 13, 2014 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
445.5	Ground Surface										
445.3 / 0.2	180mm Asphalt over sand and gravel (PAVEMENT FILL)		1	AS	30/3cm		445				Top 0.3m is frozen
	cobbles and boulders compact (ROCKFILL)						444				
443.5						▽* ▼*					
2.0	Sand to silty sand trace clay, trace gravel Loose to dense Grey Wet		2	SS	37		443				
			3	SS	4		442				
			4	SS	7						
			5	SS	11		441				0 63 35 2 ***
440.3			6	SS	14						
5.2	Clayey silt to silt with sand Firm to stiff Grey Wet		7	SS	13		440				
			8	SS	6		439				0 27 71 2
438.2											
7.3	Silty sand to sandy silt Very loose Grey Wet		9	SS	4**		438				
			10	SS	3**		437				
							436				
			11	SS	3**		435				
434.2											
11.3	End of borehole Switch to dynamic cone penetration at 11.3m Probable sandy silt Very loose						434				
432.5							433	120/15cm			
13.0	End of dynamic cone penetration test Probable bedrock Sample 1: Sampler bouncing										

Cont'd

ON MTO_VER3 NEW LOGO 14TF038.GPJ ON_MOT.GDT 05/07/2016 8:38:43 AM

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No VC-2 2 of 2 METRIC

G.W.P. 5222-05-00 LOCATION Vincent Creek Coords: 5 263 586.3 N; 364 114.4 E ORIGINATED BY F.P.

DIST Algoma HWY 129 BOREHOLE TYPE C.F.H.S.A. + Casing and Dynamic Cone Penetration Test COMPILED BY M.Kh.

DATUM Geodetic DATE December 13, 2014 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
430.5											

* 2014 12 13

▽ Water level observed during drilling

▼ Water level measured on completion

** denotes possible hydraulic disturbance during drilling

*** Combined samples of SS5 & SS6

C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers

+7, ×5: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No VC-3 1 of 2 METRIC

G.W.P. 5222-05-00 LOCATION Vincent Creek Coords: 5 263 590.8 N; 364 123.7 E ORIGINATED BY F.P.

DIST Algoma HWY 129 BOREHOLE TYPE Continuous Flight Hollow Stem Augers and casing COMPILED BY M.Kh.

DATUM Geodetic DATE December 14, 2014 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
445.4	Ground Surface										
0.0	180mm Asphalt over sand and gravel						445				
444.7	(PAVEMENT FILL)										
0.7	cobbles and boulders										
	(ROCKFILL)										
	1.5m boulder penetrated		1	RC	REC 100%		444				
			2	RC	REC 100%		443				
442.8											
2.6	Sand to silty sand layers of peat, fine fibrous		3	SS	WH**						
	Very loose Moist						442				
			4	SS	4						
			5	SS	3		441			151	
	organics					▽* ▼*					
	Brown Moist										
	clay seams		6	SS	WH		440		○		
	wet										
439.0			7	SS	1		439				
6.4	Silt to clayey silt trace sand			FV				+3			
	Firm Grey Moist		8	SS	5				H ○		0 8 75 17
437.6							438				
7.8	Silty sand to sandy silt trace clay		9	SS	5				○		
	Loose Grey Wet						437				
			10	SS	4		436		○		0 76 23 1
							435				
			11	SS	4				○		
	silt seams						434				
			12	SS	7		433		○		0 7 90 3
432.4											
13.0	End of borehole										
	Probable bedrock										
	Cont'd										

ON MTO_VER3 NEW LOGO 14TF038.GPJ ON_MOT.GDT 18/07/2016 3:05:04 PM

+7 , ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE (20 / 15 / 10 / 5)

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No VC-3 2 of 2 METRIC

G.W.P. 5222-05-00 LOCATION Vincent Creek Coords: 5 263 590.8 N; 364 123.7 E ORIGINATED BY F.P.

DIST Algoma HWY 129 BOREHOLE TYPE Continuous Flight Hollow Stem Augers and casing COMPILED BY M.Kh.

DATUM Geodetic DATE December 14, 2014 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH 430.4	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL

* 2014 12 14

▽ Water level observed during drilling

▼ Water level measured on completion

WH** denotes penetration due to weight of hammer and rods

+7, ×5: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No VC-4 1 of 1 METRIC

G.W.P. 5222-05-00 LOCATION Vincent Creek Coords: 5 263 579.5 N; 364 124.9 E ORIGINATED BY F.P.

DIST Algoma HWY 129 BOREHOLE TYPE Tripod + Casing COMPILED BY M.Kh.

DATUM Geodetic DATE January 14, 2015 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
443.6	Ground Surface										
0.0 / 443.3	Peat, fine fibrous Dark brown		1	SS	7	▽*			852		
0.3	Sand to silty sand organics layers of fine fibrous peat Very loose Brown Wet		2	SS	1	▼*	443				
			3	SS	1		442				
	amorphous peat layers		4	SS	1		441		223		
439.8			5	SS	1		440				
3.8	Clayey silt, trace sand Very soft Grey Wet		6	SS	1						0 2 64 34
				FV			439	+3			
	some clay		7	SS	1						
438.3							438				
5.3	Silty sand to sandy silt trace clay Loose Brown Wet to compact		8	SS	7		437				0 42 51 7
			9	SS	10		436				
435.4											
8.2	End of borehole										

* 2015 01 14

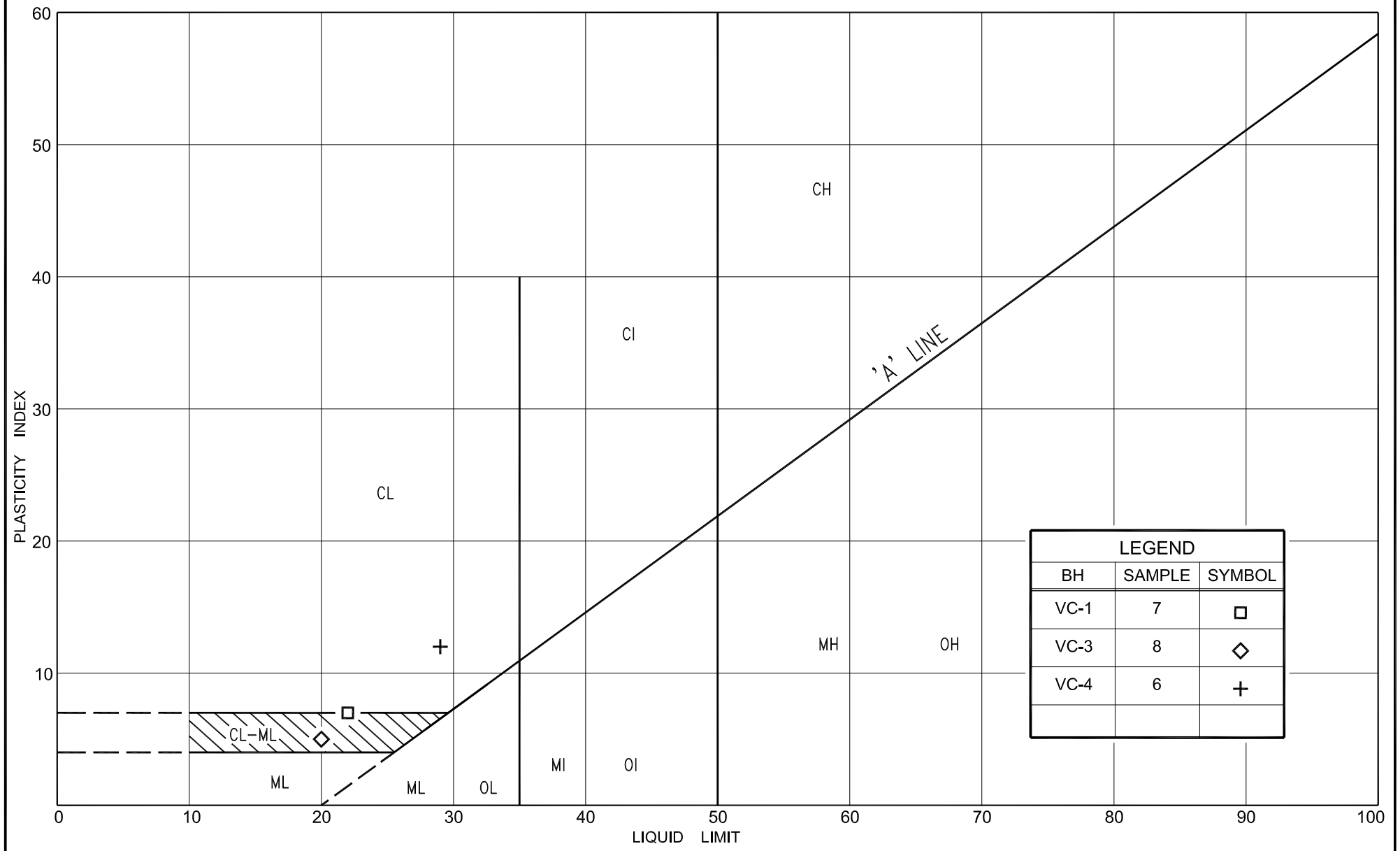
▽ Water level observed during drilling

▼ Water level measured on completion

NOTE: Borehole caved in at 1.5m

+7, ×5: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

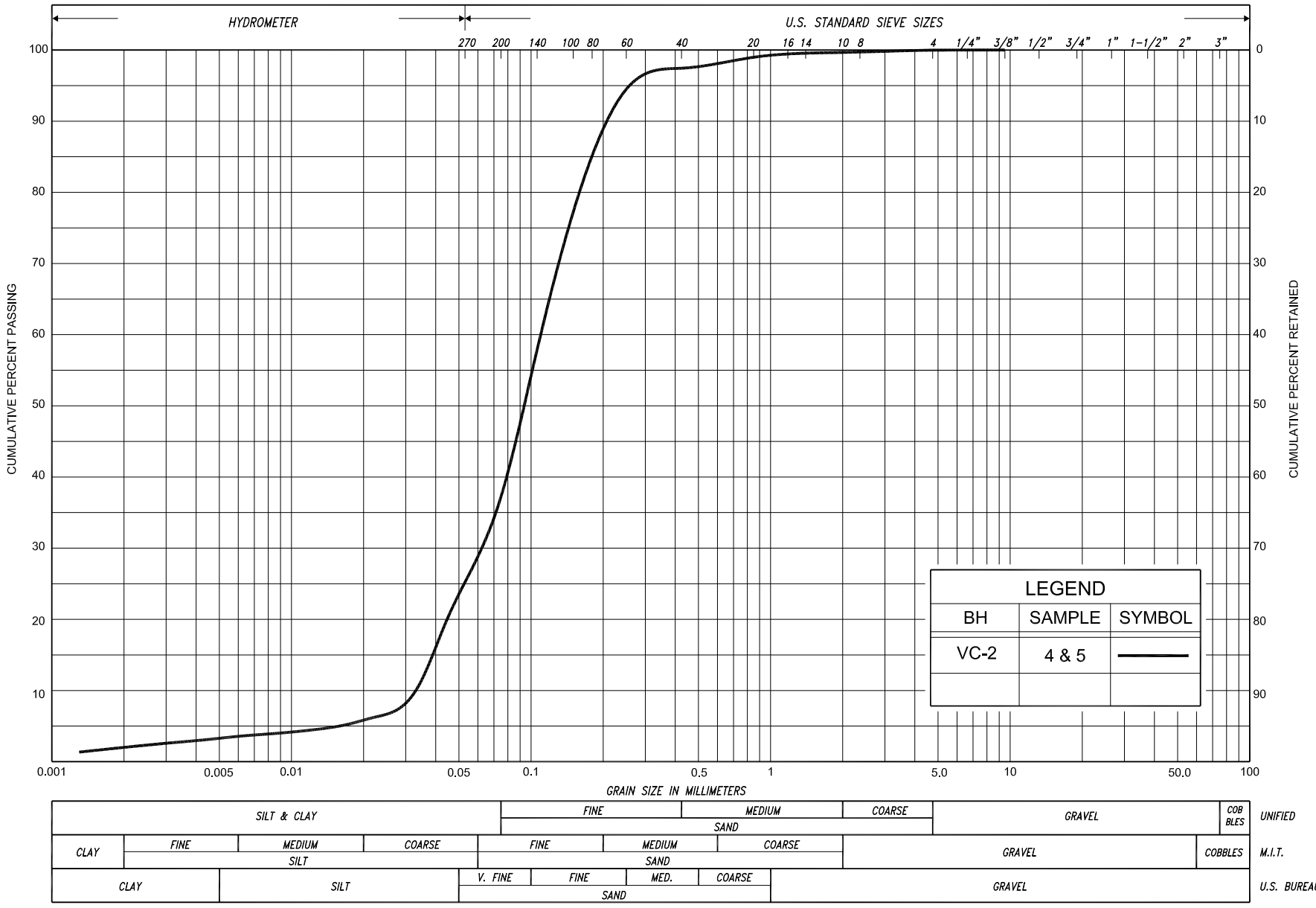


Ontario

PLASTICITY CHART

SILT TO CLAYEY SILT, trace to with sand (CL-ML to CL)

FIG No.	VC-PC-1
HWY:	129
G.W.P. No.	5222-05-00

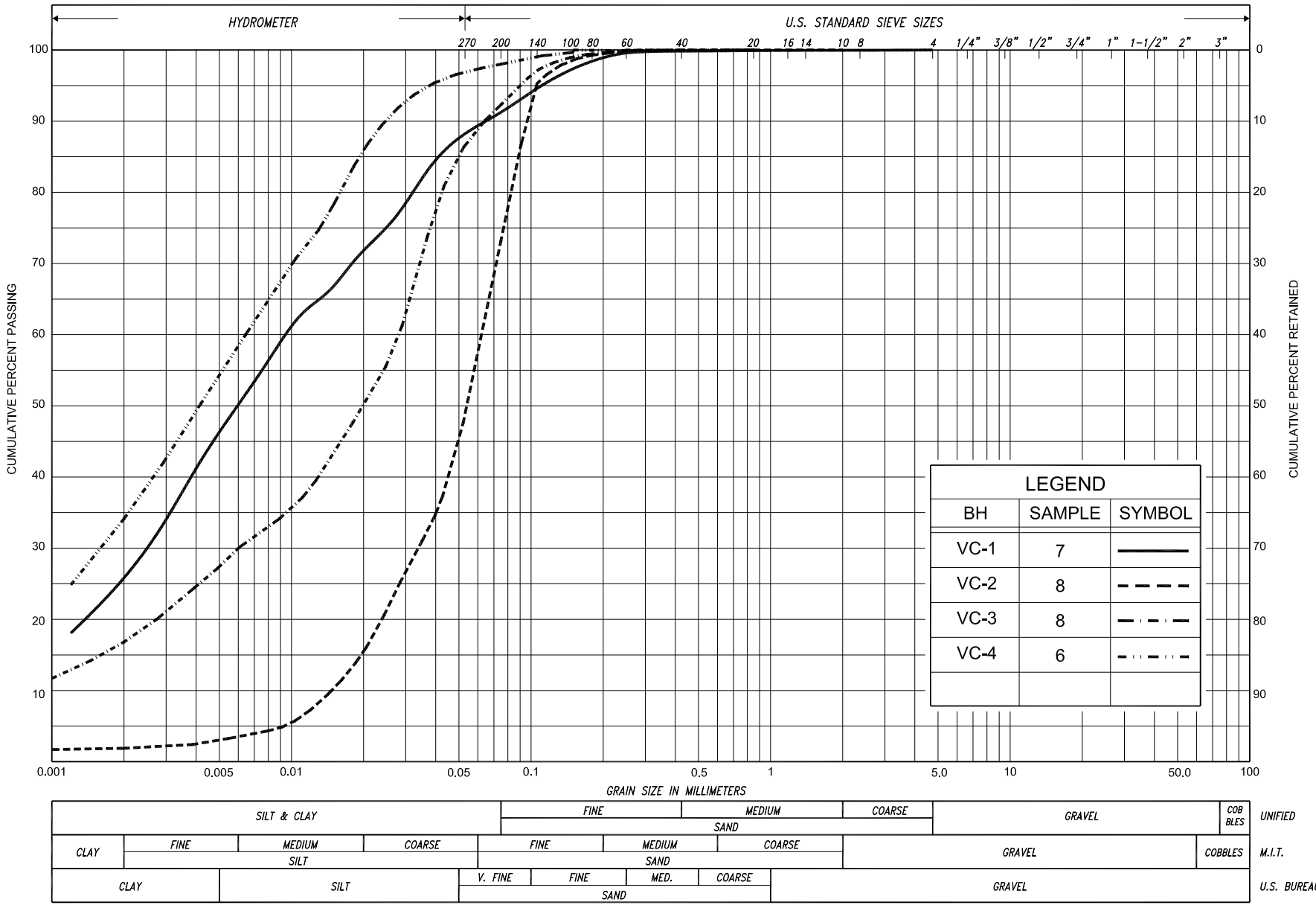


Ontario

GRAIN SIZE DISTRIBUTION

SAND TO SILTY SAND, trace clay

FIG No.	VC-GS-1
HWY:	129
G.W.P. No.	5222-05-00

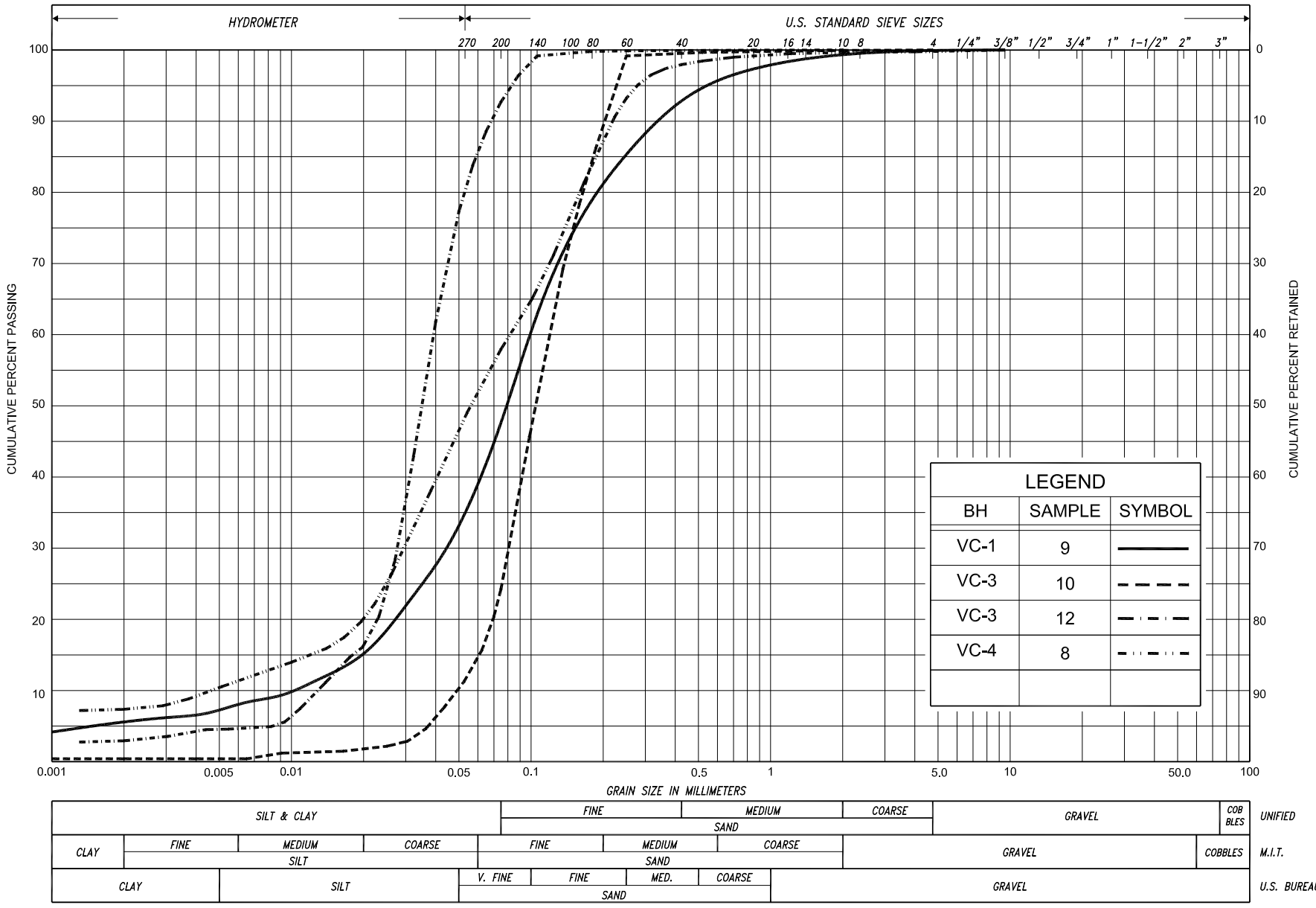


Ontario

GRAIN SIZE DISTRIBUTION

SILT TO CLAYEY SILT, trace to with sand (CL-ML)

FIG No.	VC-GS-2
HWY:	129
G.W.P. No.	5222-05-00



Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND TO SANDY SILT, trace clay

FIG No.	VC-GS-3
HWY:	129
G.W.P. No.	5222-05-00

APPENDIX B

Record of Boreholes – Current Investigation

LIST OF SYMBOLS

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
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_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

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

(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 = $(w_l - w_p)$
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_α	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 = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c'	effective cohesion
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	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. 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.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; 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, 60º 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

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Compactness Condition	N Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency

	c_u, s_u kPa	c_u, s_u psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
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
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	field vane (LV-laboratory vane test)
γ	unit weight

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

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

GOLDER

RECORD OF BOREHOLE No BH-1

1 OF 2 **METRIC**

PROJECT 18104216
W.P. 5291-13-01
DIST ____ HWY 129
DATUM GEODETIC
LOCATION N 5263576.5; E 364116.1 NAD83 MTM ZONE 13 (LAT. 47.508701; LONG. -83.212514)
BOREHOLE TYPE NW Casing, Wash Boring and NQ Coring
DATE September 26 and 27, 2018
ORIGINATED BY KJ
COMPILED BY TR/KJ
CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
445.4	GROUND SURFACE										
0.0	Sand and gravel (FILL) Compact Brown Moist		1	SS	16		445				
			2	SS	17						
444.0						▽	444				
1.4	Cobbles and boulders (ROCK FILL)			NQ			443				
442.3											
3.1	Sandy SILT to SAND Very loose to dense Grey Wet		3	SS	29		442				
			4	SS	11				○		4 78 16 2
			5	SS	17		441				
			6	SS	16		440				
			7	SS	2		439				
			8	SS	5		438		○		0 23 75 2
			9	SS	2		437				
							436				
							435				
							434				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No BH-1

2 OF 2 **METRIC**

PROJECT 18104216
W.P. 5291-13-01
DIST HWY 129
DATUM GEODETIC
LOCATION N 5263576.5; E 364116.1 NAD83 MTM ZONE 13 (LAT. 47.508701; LONG. -83.212514)
BOREHOLE TYPE NW Casing, Wash Boring and NQ Coring
DATE September 26 and 27, 2018
ORIGINATED BY KJ
COMPILED BY TR/KJ
CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Sandy SILT to SAND Very loose to dense Grey Wet		10	SS	32		433		○		5 65 25 5
432.0											
13.4	SAND and GRAVEL and COBBLES, trace silt Very dense Grey Wet		11	SS	18/0.05		432				
430.2			12	SS	21/0.05		431				
15.2	GNEISS (BEDROCK) Bedrock cored from 15.2 m to 18.3 m depth. For coring details see Record of Drillhole BH-1.		1	RC	REC 100%		430				RQD = 90%
							429				
			2	RC	REC 100%		428				RQD = 100%
427.1											
18.3	END OF BOREHOLE Note: 1. Water level inside casing at a depth of 1.4 m (Elev. 444.0 m) below ground surface upon completion of coring bedrock.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF DRILLHOLE: BH-1

PROJECT: 18104216
LOCATION: N 5263576.5; E 364116.1
NAD83 MTM ZONE 13 (LAT. 47.508701; LONG. -83.212514)
INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 27, 2018
DRILL RIG: Truck Mount
DRILLING CONTRACTOR: Landcore Drilling

SHEET 1 OF 1
DATUM: GEODETIC

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		GROUND SURFACE		430.2																
16	NW / NQ Coring	GNEISS Fine to medium grained Very strong Grey Fresh		15.2	1	Grey 100							BR JNSTRo JNSTRo JNSTRo JNSTRo							UCS = 196 MPa
17					2	Grey 100							JNSTSM JNCURo JNCURo JNPLSM JNPLSM							
18				427.1									JNPLSM							
		END OF DRILLHOLE		18.3																
19																				
20																				
21																				
22																				
23																				
24																				
25																				
26																				
27																				

DEPTH SCALE
1 : 60

GOLDER

LOGGED: KJ
CHECKED: AB

SUD-MTO-RCK S:\CLIENTS\PARSONS\VINCENT_CREEK_CULVERT\02_DATA\GINT\18104216.GPJ GAL-MISS.GDT 10-31-18 TR

GOLDER

RECORD OF BOREHOLE No BH-2

1 OF 2 **METRIC**

PROJECT 18104216
W.P. 5291-13-01
DIST ____ HWY 129
DATUM GEODETIC
LOCATION N 5263600.4; E 364122.0 NAD83 MTM ZONE 13 (LAT. 47.508915; LONG. -83.212432)
BOREHOLE TYPE NW Casing, Wash Boring and NQ Coring
DATE September 27 and 28, 2018
ORIGINATED BY KJ
COMPILED BY TR/KJ
CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
445.3	GROUND SURFACE								
0.0	Sand and gravel (FILL) Compact Brown Moist		1	SS	24		445		
			2	SS	39/0.15				
	- Auger grinding on inferred cobbles.					▽	444		
			3	SS	17				
443.0							443		
2.3	Cobbles and boulders (ROCK FILL) Compact		4	SS	27				
				NQ			442		
441.5									
3.8	Sandy gravel (FILL) Very loose Grey Wet		5	SS	1		441		
440.7									
4.6	PEAT (amorphous) Very soft Brown to black Wet		6	SS	WH		440		
439.8									
5.5	CLAYEY SILT Firm to stiff Grey Wet		7	SS	WH		439		
437.8							438		
7.5	Silty SAND to SAND Loose to compact Grey Wet		8	SS	9				7 84 (9)
							437		
			9	SS	4		436		1 84 13 2
							435		
			10	SS	8				
							434		

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

Continued Next Page

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

RECORD OF BOREHOLE No BH-2

2 OF 2 **METRIC**

PROJECT 18104216

W.P. 5291-13-01 LOCATION N 5263600.4; E 364122.0 NAD83 MTM ZONE 13 (LAT. 47.508915; LONG. -83.212432) ORIGINATED BY KJ

DIST HWY 129 BOREHOLE TYPE NW Casing, Wash Boring and NQ Coring COMPILED BY TR/KJ

DATUM GEODETIC DATE September 27 and 28, 2018 CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Silty SAND to SAND Loose to compact Grey Wet		11	SS	10		433				
431.6							432				
13.7	SAND and GRAVEL Compact Grey Wet		12	SS	24		431				
429.9			13	SS	26/0.05		430				
15.4	END OF BOREHOLE Split spoon refusal Note: 1. Water level inside casing at a depth of 1.3 m (Elev. 444.0 m) below ground surface upon completion of drilling.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

APPENDIX C

Laboratory Test Results – Current Investigation

Golder Associates Ltd.
33 Mackenzie Street
Sudbury, Ontario, Canada P3C 4Y1
Telephone: (705) 524-6861
Fax: (705) 524-1984

TABLE C1: SUMMARY OF ROCK CORE TEST DATA

PROJECT NO.: **18104216/2002**
PROJECT NAME: **MTO/5017-E-0021,22,23/NE LVR**
TYPE OF UNIT: **Rock Core**
TESTED BY: **JM**
DATE TESTED: **October 10, 2018**

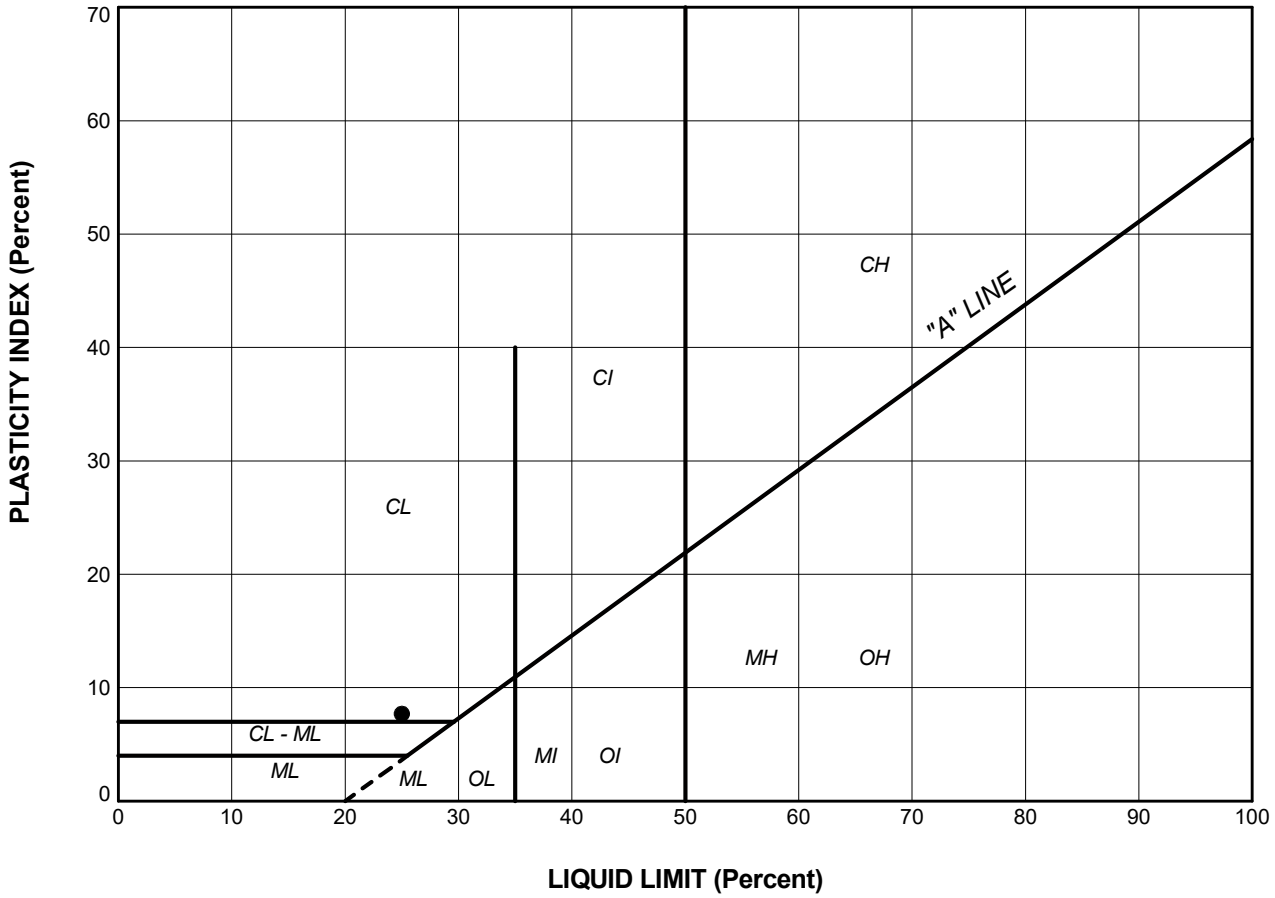
GOLDER LAB NUMBER	**S1298**				
BOREHOLE NUMBER:	**BH-1**				
SAMPLE NUMBER:	**N/A**				
DEPTH OF TESTED CORE	50.5'				
LENGTH AS CUT (mm)	102.6				
DIAMETER (mm)	47.6				
DENSITY (kg/m3)	2628				
COMPRESSIVE STRENGTH (KN)	348.2				
CORRECTED STRENGTH (MPa)	**195.6**				
TYPE OF FRACTURE	**1**				

Type of Fracture

1 2 3 4 5 6

COMMENTS:

Input by: KJ
Reviewed by: AB



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	BH-2	7	25.0	17.3	7.7

PROJECT

HIGHWAY 129
Vincent Creek Culvert

TITLE

PLASTICITY CHART

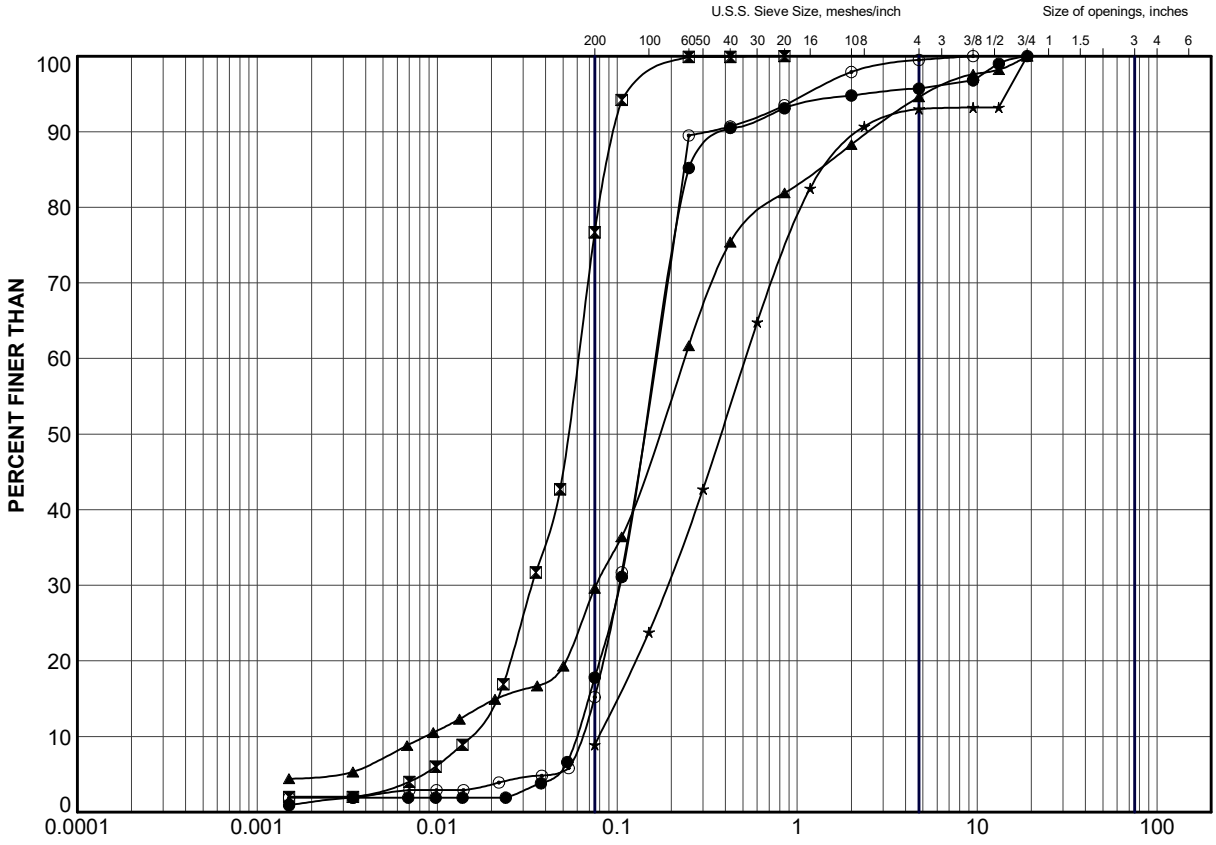
CLAYEY SILT

GOLDER

SUDBURY, ONTARIO

PROJECT No.		18104216	FILE No.	18104216.GPJ
DRAWN	TR	Oct 2018	SCALE N/A	REV.
CHECK	AB	Oct 2018		
APPR	AB	Oct 2018	**FIGURE C1**	

SUD-MTO PL GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-1	4	441.3
⊠	BH-1	7	437.5
▲	BH-1	10	432.9
★	BH-2	8	437.4
⊙	BH-2	9	435.9

PROJECT

HIGHWAY 129
Vincent Creek Culvert

TITLE

GRAIN SIZE DISTRIBUTION

Sandy SILT to SAND

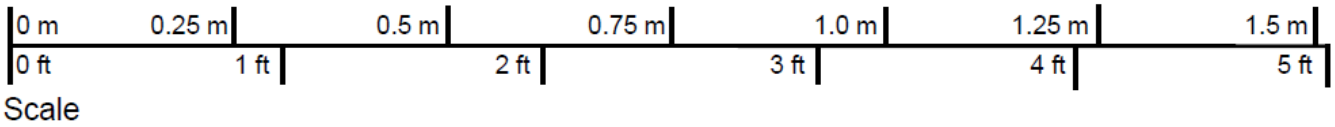
GOLDER
SUDBURY, ONTARIO

PROJECT No.		18104216	FILE No.	18104216.GPJ
DRAWN	TR	Oct 2018	SCALE N/A	REV.
CHECK	AB	Oct 2018		
APPR	AB	Oct 2018	FIGURE	C2

SUD-MTO GSD_GLDR_LDN.GDT

Borehole BH-1

Box 1: 15.2 m – 18.3 m



Scale

PROJECT

Vincent Creek Culvert (Structure No. 46-004/C)
Hwy 129, Reaney Twp., Ontario

TITLE

Bedrock Core Photograph

GOLDER

PROJECT No. 18104216			FILE No. ----		
DESIGN	KJ	Oct. 18	SCALE NTS		REV.
CADD	-- --				
CHECK	KJ		**FIGURE C3**		
REVIEW	AB				

REVISION DATE: May 1 BY: AD Project: 1894411

golder.com