

REPORT ON

Additional Geotechnical Investigation Program Capital Region Resource Recovery Centre (CRRRC) Ottawa, Ontario

Submitted to:

Taggart Miller Environmental Services

Submitted by:

Golder Associates Ltd.

1931 Robertson Road Ottawa, Ontario, K2H 5B7 Canada

+1 613 592 9600

1787048/400/4.4

June 2018

Distribution List

- 6 copies City of Ottawa
- 1 e-copy City of Ottawa
- 1 e-copy Golder
- 1 e-copy Taggart Miller Environmental Services
- 1 e-copy JLR



Table of Contents

1.0	INTRO	DUCTION1
2.0	DESCI	RIPTION OF PROJECT AND SITE1
	2.1	General1
	2.2	Previous Geotechnical Investigation2
	2.3	Test Fill Program
	2.4	Regional Seismicity
3.0	PROC	EDURE4
4.0	SUBS	URFACE CONDITIONS7
	4.1	General
	4.2	Overburden Summary
	4.2.1	Fill9
	4.2.2	Topsoil9
	4.2.3	Surficial Silty Sand9
	4.2.4	Silty Clay9
	4.2.5	Glacial Till12
	4.3	Bedrock
	4.4	Groundwater13
	4.5	Corrosion14
5.0	DISCU	ISSION14
	5.1	General14
	5.2	Site Grading15
	5.3	Seismic Site Class and Hazards16
	5.4	Building Foundations
	5.4.1	Overview16
	5.4.2	Pile Foundations17
	5.4.2.1	Axial Resistance
	5.4.2.2	Downdrag20
	5.4.2.3	Resistance to Lateral Loading-Driven Piles

	5.4.2.4	Resistance to Lateral Loading - Foundation Walls and Grade Beams
	5.4.2.5	Resistance to Lateral Loading - Structural Slabs21
	5.4.3	Raft Foundations
	5.4.4	Spread Footing22
	5.4.5	Slab on Grade24
	5.4.6	Surcharge and Pre-load Options24
	5.5	Retaining Wall, Foundation Wall and Grade Beam Backfill25
	5.6	Lateral Earth Pressures
	5.6.1	Static Lateral Earth Pressures
	5.6.2	Seismic Lateral Earth Pressures26
	5.7	Frost Protection
	5.8	Excavation and Shoring
	5.9	Site Servicing
	5.9.1	Pipelines
	5.9.2	Surface Ponds
	5.10	Pavements Design
	5.11	Trees
	5.12	Corrosion and Cement Type
6.0	ADDIT	IONAL CONSIDERATIONS
7.0	CLOSI	JRE
IMP	ORTAN	T INFORMATION AND LIMITATIONS OF THIS REPORT
TAE	BLES	
Tab	le 2.1: S	ummary of Test Fill Pad Construction Staging
Tab	le 3-1: S	ummary of Test Hole Locations - Current Investigation

- Table 3-2: Summary of Test Hole Locations Previous Investigation
- Table 4-1: Summary of Overburden Conditions
- Table 4-2: Summary of Oedometer Consolidation Tests
- Table 4-3: Summary of Cored Bedrock Boreholes
- Table 4-4: Summary of Ground Water Elevations in Monitoring Wells in the Current Study Area
- Table 4-5: Result of Basic Chemical Analyses
- Table 5-1: Seismic Hazard Values

- Table 5-2: Summary of Building Foundation Details
- Table 5-3: Pile Foundation Horizontal Subgrade Reaction Parameters
- Table 5-4: Reduction Factors for Pile Group Action under Lateral Loading
- Table 5-5: Unfactored Friction Coefficient for Slabs
- Table 5-6: Permissible Bearing Resistance and Grade Raises for Spread Footing Foundations
- Table 5-7: Static Lateral Earth Pressure Parameters
- Table 5-8: Seismic Lateral Earth Pressure Coefficients
- Table 5-9: Some Common Trees in Decreasing Order of Water Demand

FIGURES

- Figure 1 Site Grading Plan
- Figure 2 Test Hole Location Plan
- Figure 3 Bedrock Surface Contour Map
- Figure 4 Test Fill Pad Settlement Monitoring Results
- Figure 5 Summary of Undrained Shear Strength Profiles CPTs
- Figure 6 Summary of Undrained Shear Strength Profiles Boreholes
- Figure 7 Summary of Silty Clay Sensitivity Boreholes

APPENDICES

APPENDIX A

List of Abbreviations and Symbols Record of Boreholes – Current Investigation

APPENDIX B

Record of Boreholes - Previous Investigation

APPENDIX C

Cone Penetration Test (CPT) Results - Current Investigation

APPENDIX D Laboratory Testing Results on Soil Samples and Bedrock Cores

APPENDIX E Results of Chemical Analyses

APPENDIX F Correlation of Undrained Shear Strengths from CPT and Nilcon Vane Testing

APPENDIX G Photographs of Bedrock Core Samples

APPENDIX H Technical Memorandum – Results of VSP Testing

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out for the proposed buildings/facilities to be located at the north end of the Capital Region Resource Recovery Centre (CRRRC) site (Site), south of Highway 417 and west of Frontier Road in Ottawa, Ontario.

The purpose of the geotechnical investigation was to assess the general soil and groundwater conditions across the site. Based on an interpretation of the factual information obtained, along with existing data available for the site, engineering guidelines on developing this portion of the site, including (but not limited to) the feasible foundation systems (and associated design parameters) for the various proposed structures, the permissible grade raises as well as the various proposed infrastructure (i.e., pavements, site servicing) are provided. In addition, the geotechnical investigation was undertaken to meet the requirements for Site Plan Control approval and building permit applications for the various structures, where the level of investigation meets the requirements of City of Ottawa's "Geotechnical Investigation and Reporting Guidelines for Development Applications in the City of Ottawa".

The reader is referred to the "Important Information and Limitations of This Report", which follows the text but forms an integral part of this document.

2.0 DESCRIPTION OF PROJECT AND SITE

2.1 General

The proposed CRRRC Site is located east of Boundary Road, just southeast of the Highway 417/Boundary Road interchange, on Lots 22 through 25, Concession XI, in the former Township of Cumberland. The property is east of an existing industrial park, north of Devine Road and west of Frontier Road and totals approximately 192 hectares in area.

The land use surrounding the CRRRC Site is primarily a mixture of commercial/industrial and agricultural. The agricultural land use is found immediately east of the CRRRC Site, as well as to the southeast, south and southwest; however, areas of undeveloped (i.e., heavily vegetated) land generally exists between the CRRRC Site and the agricultural lands in these directions. The industrial land use is found to the west and northwest of the CRRRC Site. Residential development in the vicinity of the CRRRC Site is limited to some houses mixed in with the commercial/industrial uses along Boundary Road.

The area of the current investigation is located in the northern portion of the CRRRC Site, where numerous buildings/facilities are being proposed, and covers an area of about 55 hectares (see Site Grading Plan, Figure 1). The area is currently undeveloped and relatively flat with existing elevations varying from about 75.0 to 77.5 metres.

The proposed development shown on Figure 1 consists of numerous buildings and infrastructure including the following:

- Heavily loaded structures: The proposed C&D processing facility, materials recovery facility, leachate pretreatment building/geotube shelter (greenhouse), and secondary digester. These structures are expected to be heavily loaded and will likely need to be supported on deep/piled foundations with structural slabs;
- Moderately loaded structures: The proposed organic pre-processing building and maintenance garage. These structures are expected to be moderately loaded and will likely need to be supported on either deep/piled foundations or raft slab foundations;

- Lightly loaded buildings: The proposed administration building, scale houses, PHC soil storage building, and flare power generation building. These structures are expected to be relatively lightly loaded and could likely be supported on shallow spread footing foundations or raft foundations;
- Large pads for processing compost and PHC soils;
- A retaining wall for the clean load and small vehicle drop off area;
- Site servicing and surface water ponds; and,
- Road widening and pavement design for various access roadways within the facility.

2.2 Previous Geotechnical Investigation

Golder Associates Ltd. (Golder) completed an overall broad-scale geotechnical and hydrogeological investigation for the proposed CRRRC facility in 2013. The primary focus of that investigation was to assess the general characteristics of the subsurface conditions that underlie the CRRRC Site, provide geotechnical and hydrogeological input for the preliminary facility design, and to assist with the MOECC environmental permitting/approvals. The results of that investigations are summarized in the following report:

 "Volume III, Geology, Hydrogeology and Geotechnical Report Capital Region Resource Recovery Centre", dated December 2014 (Report No. 12-1125-0045/4500).

Based on the existing subsurface information, the subsurface conditions across the CRRRC Site consist of about 0.05 to 0.3 metres of topsoil/peat underlain by about 0.3 to 2.7 metres of surficial sand and silt, overlying between about 26 to 37 metres of compressible and soft silty clay. The upper 0.1 to 1.3 metres of the clay deposit at most locations has been weathered to a red brown crust and has a stiffer consistency. Within the upper portion of the underlying unweathered silty clay, to depths of about 2.7 to 5.5 metres below ground surface, a 0.1 to 0.6 metre thick continuous silty layer crosses the CRRRC Site. The unweathered silty clay generally has a soft consistency to about 9 to 10 metres depth, followed by a firm consistency to about 15 to 18 metres depth, and is stiff to very stiff below that. The silty clay is underlain by loose to very dense glacial till that ranges from about 2 to 9 metres in thickness. The bedrock surface (Carlsbad Formation limestone and shale) was encountered beneath the glacial till deposit at depths between about 33 and 41 metres.

2.3 Test Fill Program

A geotechnical test fill program was implemented in 2015 for the purposes of validating the compressibility of the underlying silty clay soils. The test fill program included construction of two test fill pads on the compressible silty clay soil within the northern portion of the CRRRC Site (see Figure 2) and monitoring of the test fill settlements. Monitoring the actual settlements due to fill placement provided additional data on the compressibility of the silty clay deposit underlying the CRRRC Site at a much larger scale than possible on laboratory specimens. The information obtained allowed for the refined assessment of the allowable grade raises for site development, refinement of numerical settlement models, and design of the preload/surcharge measures. The material used to construct the test fill pads was silty clay soil from nearby sources (i.e., 82 Range Road in Ottawa). The test fill pads were constructed in stages with side slopes of approximately 2 horizontal to 1 vertical (2H:1V) with square base dimensions of about 36.0 and 39.2 metres at Test Fill Pads 1 and 2, respectively. The following table indicates the maximum thicknesses of fill for each stage of test fill pad construction and the date of fill placement. At each stage the wet unit weight of the silty clay fill was measured at various locations across the newly placed fill. The average unit wet weight of each stage is summarized in the following table:

Embankment / Base Elevation (m)	Stage No.	Average Wet Unit Weight (kN/m³)	Lift Thickness (m)	Maximum Test Fill Pad Elevation (m) / Height (m)	Date of placing the fill
	1	17.4	0.5	76.70 / 0.50	February 4, 2015
	2	17.6	0.41	77.11 / 0.91	February 6, 2015
Test Fill Pad 1 / 76.20	3	17.6	0.54	77.65 / 1.45	February 9, 2015
70.20	4	17.3	0.05	77.70 / 1.50	February 11, 2015
	5	17.2	0.30	77.73 / 1.53	January 29, 2016
	1	18.4	0.40	76.55 / 0.40	December 15, 2014
	2	17.0	0.80	77.35 / 1.20	February 3, 2015
Test Fill Pad 2 / 76.15	3	17.9	0.38	77.73 / 1.58	February 5, 2015
70.15	4	19.2	0.54	78.27 / 2.12	February 10, 2015
	5	17.4	0.14	78.41 / 2.26	February 11, 2015

Table 2.1: Summary of Test Fill Pad Construction Staging

In each test fill pad, three settlement plates (SP) were installed within the fill. Baseline measurements were taken prior to the fill placement, and subsequently at periodic intervals of time after completion of the fill placement for Stage Nos.4 and 5 for Test Fill Pads 1 and 2, respectively.

The SP's were installed on the native soil below frost level, one in the center and two at 5 metres offset from the center of each test fill pad. Figure 4 provides a summary of the settlement monitoring results.

2.4 Regional Seismicity

As delineated in "*The Physiography of Southern Ontario*¹", this section of Highway 417 lies on the boundary of the minor physiographic regions known as the Ottawa Valley Clay Plain and the Russell and Prescott Sand plain, which lies within the major physiographic region of the Ottawa-St. Lawrence Lowland.

The Ottawa Valley Clay Plain region is characterized by relatively thick deposits of sensitive marine clay, silt and silty clay that were deposited within the Champlain Sea basin. These deposits, known as the Champlain Sea clay or Leda clay, overlie relatively thin, commonly reworked glacial till and glaciofluvial deposits, that in turn overlie bedrock². The Russell and Prescott Sand Plains are generally characterized by a sand mantle about 3 to 5 m thick overlying an extensive deposit of sensitive marine clay deposited within the Champlain Sea basin, underlain by glacial till and shale bedrock.

This region is underlain by a series of sedimentary rocks, consisting of sandstones, dolostones, limestones and shales that are, in turn, underlain at depth by bedrock of Carlsbad Formation.

The site falls within the Western Québec (WQ) seismic zone according to the Geological Survey of Canada. The WQ seismic zone constitutes a large area which encompasses the urban areas of Montreal, Ottawa-Hull and

¹Chapman, L. J. and Putnam, D. F., 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey. Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000. Ontario Ministry of Natural Resources.

² Belanger, J.R. "Urban Geology of Canada's National Capital Area", in *Urban Geology of Canadian Cities*, Geological Association of Canada Special Paper 42, Ed. P.F. Karrow and O.L. White, 1998.

Cornwall. Within the WQ seismic zone recent seismic activity has been concentrated in two subzones; one along the Ottawa River and another more active subzone along the Montreal-Maniwaki axis. The two major earthquakes in the WQ seismic zone includes the 1935 Témiscaming event which had a magnitude (i.e., a measure of the intensity of the earthquake) of 6.2, and the 1944 Cornwall-Massena event which had a magnitude of 5.6.

3.0 PROCEDURE

The fieldwork for the current investigation was carried out between December 18, 2017 and February 8, 2018. At that time, 40 test holes were advanced within the building/facility and infrastructure areas, as shown on the attached Test Hole Location Plan, Figure 2. The CRRRC Site investigation methodology applied during the current subsurface investigation is outlined below:

- Four boreholes were advanced along the proposed main access roadway at approximately 150 metre spacings to depths of about 4.3 to 4.9 metres below present ground surface. Six deep boreholes and eight very deep boreholes were also put down across the site. The deep boreholes were advanced through the overburden soils to depths of about 10 metres below the existing ground surface. The very deep boreholes were advanced through the overburden to the bedrock surface at depths of about 29.2 to 40.0 metres below the existing ground surface. The bedrock was then cored in the very deep boreholes an additional 1.6 to 3.4 metres using HQ-size coring equipment.
- The boreholes were advanced using a track-mounted continuous flight hollow-stem auger drill rig, supplied and operated by Forage Greenville Drilling of Ottawa, Ontario. Wash boring techniques were used to advance the very deep boreholes into bedrock. Standard penetration tests (SPTs) were carried out in the boreholes at regular intervals of depth and samples of the soils encountered were recovered using split spoon sampling equipment. In situ vane testing was carried out where possible in the cohesive deposits to assess the undrained shear strength of these soils. In addition, fifteen relatively undisturbed 73 millimetre diameter thin walled Shelby tube samples of the silty clay were obtained from the boreholes using a fixed piston sampler. The very deep boreholes were backfilled with bentonite-cement grout within the bedrock and bentonite mixed with soil cuttings in the overburden.
- Nilcon *in situ* vane profiles were completed at nine borehole locations within the study area. At these locations the boreholes were first drilled through the surficial silty sand and/or upper silty clay to depths of between about 1.0 and 2.1 metres, to reach the native unweathered silty clay. Below that depth, an electric Nilcon *in situ* vane testing apparatus was advanced, with measurements taken at either 0.5 or 1.0 metre depth intervals. This vane testing was carried out under conditions of a constant rate of rotation (consistent with ASTM D2573). The undrained shear strength of remoulded silty clay was also typically measured (to assess sensitivity of the clay) at approximately one of every three to five test intervals. The Nilcon vane testing was typically advanced to a depth of about 10 metres below the existing ground surface. In the remaining boreholes and at greater depths, in situ vane testing was completed using the MTO 'N' vane.
- Thirteen Cone Penetration Tests (CPTs) were advanced within the study area. The CPT consists of a probe with a cone shaped tip that is equipped with electronic sensing elements to continuously measure tip resistance and local side friction on a sleeve behind the tip, as well as pore water pressure (Type I). The cone is pushed at a constant rate into the ground using a drill rig (consistent with ASTM D5778-12). A continuous stratigraphic profile together with engineering properties, such as strength, behaviour stress history and density, can be interpreted from the results of the CPT. The CPTs were advanced through the upper silty clay to up to depths of about 10 metres. The CPTs were advanced using a drill rig supplied and operated by the Stratum CPT of Grenville, Quebec and the data obtained interpreted by Golder staff.

The field work was supervised by members of engineering staff who located the test holes in the field, directed the drilling, sampling, and in situ testing operations, and logged the test holes and took custody of the soil and bedrock samples retrieved. Upon completion of the drilling operations, samples of the soil and bedrock obtained in the boreholes were transported to our laboratory for future examination by the project engineer and for laboratory testing. The testing included water content determinations, Atterberg Limit testing, grain size distribution tests, and oedometer consolidation testing. Unconfined compressive strength (UCS) testing was also carried out on four samples of the bedrock core.

Four soil samples were selected and submitted to Eurofins Environment Testing for basic chemical analyses related to potential sulphate attack on buried concrete elements and corrosion of buried ferrous elements.

The test hole locations were selected, picketed, and surveyed in the field by Golder. The test hole locations and elevations were surveyed using a Trimble R8 Global Positioning System (GPS) unit. The test hole locations in Universal Transverse Mercator (UTM) NAD 83, Zone 18 ground surface elevations referenced to geodetic datum (CGVD28) and drilled depths are summarized in the following table. Northing and easting grid coordinates are also summarized below as well as shown on the Record of Borehole sheets.

Table 3-1: Summary of Test Hole Locations - Current Investigation

							ion Of e Type	
Test Hole Number	UTM ZONE 18 Northing (m)	UTM ZONE 18 Easting (m)	Ground Surface Elevation (m) (CGVD28)	Test hole Depth (m)	Very Deep Borehole	Deep Borehole	Nilcon Vane Test Hole	CPT Test Hole
17-01	5020936.4	465673.3	77.3	4.9		х		
17-02	5020989.8	465813.1	77.5	4.9		х		
17-03	5021042.5	465953.7	77.5	4.3		х		
17-04	5021108.2	466090.6	76.3	4.4		х		
17-05	5021093.1	465937.9	76.3	9.6		х	х	
17-06	5021145.7	465895.4	76.5	10.0				х
17-07	5021228.9	465864.4	76.3	32.5	Х			
17-08	5021301.7	465837.2	76.1	9.8		х	х	х
17-09	5021391.2	466055.7	76.6	33.1	Х			
17-10	5021315.6	466081.9	76.5	10.0				х
17-11	5021417.6	466129.1	76.6	10.0				х
17-12	5021345.5	466151.3	76.6	10.0			х	
17-13	5021450.3	466217.9	76.4	10.0			х	
17-14	5021390.9	466243.5	76.6	36.9	Х			
17-15	5021504.2	466348.8	76.0	10.0				х
17-16	5021443.0	466364.6	76.1	10.0				х
17-17	5021538.5	466440.9	76.3	38.5	Х			
17-18	5021496.1	466456.3	76.0	9.8		х	х	х
17-19	5021502.5	466517.0	76.0	10.0		х		
17-20	5021491.3	466569.2	76.0	10.0			х	

							ion Of e Type	
Test Hole Number	UTM ZONE 18 Northing (m)	UTM ZONE 18 Easting (m)	Ground Surface Elevation (m) (CGVD28)	Test hole Depth (m)	Very Deep Borehole	Deep Borehole	Nilcon Vane Test Hole	CPT Test Hole
17-21	5021375.1	466666.3	76.5	10.0	Х			
17-22	5021314.9	466705.5	76.5	39.9				х
17-23	5021218.7	466509.0	76.4	9.8	Х			
17-24	5021172.5	466473.4	76.0	9.7		х	х	Х
17-25	5021082.8	466539.8	76.3	10.0				х
17-26	5021036.3	466558.2	76.3	10.0	Х			-
17-27	5021055.7	466466.9	76.3	41.5			х	-
17-28	5021008.7	466486.9	76.0	10.0				х
17-29	5021029.1	466400.2	76.2	41.9	Х			
17-30	5020966.5	466404.0	76.0	10.0		Х	х	х
17-31	5020957.7	466330.6	76.0	10.0				х

In addition, eleven test holes were advanced within the current investigation area as part of the previous investigation in 2014. The locations of the previous test holes are shown on Figure 2. The northing and easting grid coordinates, ground surface elevation, and drilled depth are summarized in the table below as well as shown on the Record of Borehole sheets in Appendix B.

Table 3-2: Summary of Test Hole Locations - Previous Investigation

					Description Of Test Hole Type								
Test Hole Number	UTM ZONE 18 Northing (m)	UTM ZONE 18 Easting (m)	Ground Surface Elevation (m) (CGVD28)	Test hole Depth (m)	Very Deep Borehole	Deep Borehole	Nilcon Vane Test	CPT Test Hole	Monitoring Well	VSP	Direct Push	Shelby Tube	
12-3	5021578.5	466670.9	76.1/76.3	1.5/45.4	х	х	х	х	х		х	х	
12-4	5020872.7	466523.2	75.9/76.0	1.6/43.6	х	Х	Х	х	х		х	х	
13-5	5021083.2	466176.3	76.4/76.5	1.5/40.3	х	х	х	х	х				
13-8	5021436.7	466032.3	76.4	1.5/7.6		х		х	х				
13-9	5021536.1	466347.6	76.1	1.5/7.6		х		х	х				
13-10	5021244.4	466453.0	76.4/76.5	1.5/7.6		х		х	х				
13-11	5021059.0	466865.2	76.0	1.5		х		х	х				
13-12	5020785.0	466278.4	76.2/76.3	1.5/7.6		х		х	х				

					Description Of Test Hole Type								
Test Hole Number	UTM ZONE 18 Northing (m)	UTM ZONE 18 Easting (m)	Ground Surface Elevation (m) (CGVD28)	Test hole Depth (m)	Very Deep Borehole	Deep Borehole	Nilcon Vane Test	CPT Test Hole	Monitoring Well	VSP	Direct Push	Shelby Tube	
13-13	5021366.3	466752.5	76.2	1.5		х		х	х				
13-1 (A13-1)	5020863.8	465500.4	77.2	3.1		х							
13-2 (A13-2)	5020876.6	465535.5	77.5	3.1		х							

Vertical Seismic Profile (VSP) testing was completed as part of the previous investigation at the CRRRC Site in 2014. The results of that testing are summarized in a technical memorandum provided in Appendix H.

4.0 SUBSURFACE CONDITIONS

4.1 General

Information on the subsurface conditions is provided as follows:

- The subsurface conditions encountered in the boreholes along with the results of the in situ vane testing are shown on the Record of Borehole sheets in Appendix A. The results of the water content and Atterberg limit testing are also indicated on the Record of Borehole sheets.
- The Record of Borehole sheets from the previous 2014 investigation in area of the current investigation are provided in Appendix B.
- The CPT profiles for normalized cone resistance with an interpreted profile of the stratigraphy are provided in Appendix C.
- The results of grain size distribution testing carried out on selected soil samples are shown on Figures D1 to D3 provided in Appendix D.
- The results of Atterberg limit tests carried out on selected silty clay samples are shown on Figure D4 in Appendix D
- The results of oedometer consolidation tests on selected silty clay samples are provided on Figures D5 to D12 in Appendix D.
- The UCS test results on selected bedrock core samples are shown on Figure D13, also in Appendix D.
- The results of the basic chemical analyses are provided in Appendix E.
- A summary of the undrained shear strength profiles interpreted from the CPTs as well as the measured undrained shear strength from the Nilcon vane testing are provided on Figures 5 and 6, respectively.
- A summary of the sensitivity of the silty clay is provided on Figure 7.
- A summary of the undrained shear strength profiles interpreted from the CPTs based on correlation with the measured undrained shear strengths measured from the Nilcon vane testing are provided on Figures F1 to F13 in Appendix F.
- Photographs of the core recovered from underlying bedrock are shown in Appendix G.

The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from observations of drilling progress, non-continuous sampling and CPT measurements and, therefore, represent transitions between soil and rock types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the test hole locations. In general, the subsurface conditions on this site consist of topsoil/peat/fill underlain by a thin layer of surficial sand, overlying a thick deposit of compressible and soft silty clay. The silty clay is underlain by glacial till, followed by interbedded shale and limestone bedrock.

The following sections present a more detailed overview of the subsurface conditions on this site. In the following discussion, emphasis is placed on the subsurface conditions indicated in the boreholes from the present investigation. The relevant boreholes from 2014 investigations were, in some cases, advanced beyond the structure/facility footprints of the current investigation area. The results of relevant boreholes from the 2014 investigation area. The results of relevant boreholes from the 2014 investigation are referenced herein only in regard to the bedrock surface elevation and groundwater conditions.

4.2 Overburden Summary

The general overview of the overburden condition encountered in the boreholes from the additional geotechnical investigation on the site is summarized in the following table. In addition, a more detailed description is provided in the following sections.

Deposit/ Structure Description	Boreholes	Deposit/ Structure Thickness (m)	Deposit/ Structure Surface Elevation	N Values or Su Relative Density or	Laboratory Testing
Fill-Silty Sand and Clayey Silt, some gravel, contains organic matter	17-01 to 17-03	2.3 to 3.1	(m) 77.3 to 77.5	N= 2-37; Very loose to dense	w = 10 to 16%
Topsoil	17-05,17-08,17-09, 17-17, 17-18, 17-19, 17-21, 17-23, 17-24, 17-26, 17-29, and 17-30	0.08 to 0.3	76.0 to 76.6	-	-
Surficial Sand, Silty Sand, and Sandy Silt	17-04, 17-05, 17-07, 17-08, 17-09, 17-14, 17-17, 17-18, 17-19, 17-21, 17-23, 17-24, 17-26, 17-29,17-30	0.6 to 3.1	75.7 to 76.6	N= WH-18; Very loose to compact	w = 17 to 61% 4 - M (Fig. D1) 1 - CHEM (App. E)
Silty Clay to Clay	All deep 2 and very deep boreholes	1.8 to 34.7	76.0 to 73.5	Su=9 to >96 kPa (Figures 5 – 6) Very soft to stiff	w = 34 to 105% 18 – AT (Fig. D4) 8 – Oed (Fig.D5 to D12) 1 – CHEM (App. E)

Table 4-1: Summary of Overburden Conditions

Deposit/ Structure Description	Boreholes	Deposit/ Structure Thickness (m)	Deposit/ Structure Surface Elevation (m)	N Values or Su Relative Density or Consistency ¹	Laboratory Testing
Glacial Till	17-07, 17-09, 17-14, 17- 17, 17-21, 17-23, 17-26, 17-29	1.1 to 6.8	38.8 to 53.7	N= 11 to >50; Compact to very dense	w = 7% to 16% 3 - M (Fig. D3) 2 - CHEM (App. E)

Notes:

¹ = For the upper 10 metres of the clay deposit, the consistency results are representative of in situ Nilcon vane testing, where the lower 10 metres results are representative of the in situ N vane testing

² = The clay deposit was not fully penetrated in the deep boreholes

N = SPT 'N'-value; number of blows for 0.3 m of penetration; WH = Weight of hammer.

Su = Undrained shear Strength (kPa)

w = Natural Moisture Content (%)

AT = Atterberg limit testing

Oed = Oedometer Consolidation tests

M = Sieve analysis

CHEM = Basic Chemical Analyses

4.2.1 Fill

Fill exists at the ground surface at boreholes 17-01 to 17-03 advanced along the proposed main access roadway. The fill consists of silty sand, sandy silt and clayey silt, some gravel and contains organic matter. The fill was fully penetrated in these boreholes and varies from about 2.3 to 3.1 metres in thickness (i.e., elevations 74.2 to 75.2 metres). SPT 'N' values obtained within this material generally range from about 1 to 37 blows per 0.3 metres of penetration indicating a very loose to dense state of packing. The measured water content on selected samples of the fill ranges from approximately 10 to 16 percent.

4.2.2 Topsoil

Topsoil exists at ground surface at boreholes 17-05, 17-08, 17-09, 17-17, 17-18, 17-19, 17-21, 17-23, 17-24, 17-26, 17-29, and 17-30, with thicknesses of about 80 to 300 millimetres.

4.2.3 Surficial Silty Sand

Surficial silty sand was encountered at the ground surface or beneath the topsoil at all the boreholes with the exception of boreholes 17-01 to 17-03. This deposit extends to about 0.7 to 3.1 metres depth below the existing ground surface (i.e., elevations 73.5 to 75.8 metres). SPT 'N' values obtained within the silty sandy soils generally range from weight of hammer to 18 blows per 0.3 metres of penetration indicating a very loose to compact state of packing.

The measured natural water contents on selected samples of this deposit range from about 17 to 61 percent. The results of grain size distribution testing on four samples of this material are shown on Figure D1 in Appendix D.

4.2.4 Silty Clay

The fill and surficial silty sand are underlain by a thick deposit of sensitive silty clay to clay. The silty clay deposit was fully penetrated at all the very deep boreholes (17-07, 17-09, 17-14, 17-17, 17-21, 17-23, 17-26, and 17-29) and is about 21.8 to 34.7 metres in thickness, extending to about 22.6 to 37.5 metres depth below the existing ground surface (i.e., elevations 38.8 to 53.7 metres). At the deep boreholes (17-01, 17-02, 17-03, 17-04, 17-05,

17-08, 17-09, 17-18, 17-19, 17-24, and 17-30) the clay deposit was not fully penetrated but was proven to extend to depth up to about 9.1 metres below the ground surface.

The upper 0.6 metres to 1.1 metres of the silty clay at boreholes 17-01, 17-03, 17-05, 17-07, 17-08, 17-09, and 17-30 has been weathered to a red brown crust (referred to as 'weathered crust'). Layers and seams of silty sand, sand and clayey silt were also encountered within the weathered portion of the silty clay deposit. SPT 'N' values obtained within the weathered material generally range from weight of hammer to 5 blows per 0.3 metres of penetration indicating a stiff to firm consistency (based on local experience with correlations to undrained shear strength).

The measured natural water contents of selected samples of the weathered crust ranged from about 40 to 87 percent.

The silty clay below the surficial silty sand or weathered crust (where present) is unweathered. The results of *in situ* Nilcon vane testing in the upper 10 metres of this unweathered material gave undrained shear strengths ranging from about 9 to 50 kilopascals (kPa), generally increasing with depth. These results indicate a generally very soft to firm consistency to about 10 metres depth in the deposit. One higher undrained shear strength of 74 kPa was measured in borehole 17-08N within this deposit a depth of about 3 metres below the existing ground surface. However, this value likely reflects the presence of a sand and silt layer, rather than the stiffness of the silty clay. The results of the Nilcon vane testing are summarized on the Record of Borehole sheets in Appendix A as well as provided on Figure 6.

Undrained shear strength profiles of the upper 10 metres of silty clay have also been evaluated from the results of the CPTs, using the following equation:

$$S_u = (q_t - \sigma_{vo}) / N_{kt}$$

Where: S_u = Calculated undrained shear strength (kPa);

qt = Measured net tip resistance (kPa);

 σ_{vo} = Calculated total vertical stress (kPa);

N_{kt} = Correlation factor, a value of 15 to 20 was used based on correlations with Nilcon vane testing results.

The undrained shear strength profiles for the silty clay, interpreted from the results of the CPTs, as described above, are summarized on Figure 5. In general, the assumed N_{kt} correlation factors increase with depth. The interpreted undrained shear strength profiles from the CPTs along with the results of the Nilcon vane testing are also shown on Figures F1 to F13 in Appendix F. The CPT results indicate undrained shear strengths that are generally consistent with the *in situ* Nilcon vane testing results.

In situ shear vane testing carried out where possible in the very deep cored boreholes within this deposit measured undrained shear strengths of 9 to greater than 95 kPa, indicating generally a very soft to stiff consistency, generally increasing with depth. The higher undrained shear strengths within the upper portion of this deposit may reflect the presence of sand and silty layers.

The calculated sensitivity ratio, based on remoulded shear strengths of 1 to 36 kPa in this deposit, from range about 1 to 25, indicating a very sensitive material in accordance with the CFEM³.

³ Canadian Geotechnical Society., 2006. Canadian foundation Engineering Manual. Richmond, B.C., Fourth Edition.

The measured water contents of samples of the unweathered silty clay were between about 34 and 105 percent. However, more generally, the following observations are made:

- The water content above about 20 metre depth is typically in the range of 50 to 85 percent; and,
- The water content below about 20 metre depth is slightly less (i.e., typically in the range of 40 to 65 percent).

The results of Atterberg limit testing carried out on several samples of the unweathered silty clay gave plasticity index values generally ranging from about 25 to 59 percent and liquid limits values from about 41 to 85 percent. These results indicate an intermediate but more typically high plasticity deposit. These values are summarized on Figure D4 in Appendix D. The natural water content is generally at or above the measured liquid limit.

Oedometer consolidation testing was carried out on eight thin-walled Shelby tube samples of the unweathered silty clay. The results of that testing are provided on Figures D11 to D18 in Appendix D and are summarized in Table 4-2 below.

Borehole/ Sample Number	Sample Depth/Elevation (m)	Unit Weight (kN/m³)	σ _P ′ (kP)	Сс	Cr	eo	OCR	Wn (%)	WL %)	РІ (%)
17-05/3	2.4/73.9	14.2	65	4.45	0.0183	2.87	2.6	105	74	53
17-05/6	6.4/69.9	15.2	80	3.00	0.0166	2.24	1.7	82	60	40
17-08/5 ¹	5.0/71.1	17.3	60	0.72	0.0083	1.29	1.3	47	85	59
17-08/7	7.5/68.6	15.1	80	2.73	0.0100	2.24	1.4	81	67	41
17-19/7	6.2/69.8	16.0	67	1.32	0.0100	1.76	1.3	64	62	42
17-24/4	3.1/73.3	15.6	64	1.67	0.0066	1.93	1.9	70	51	35
17-30/5	4.7/71.3	15.7	65	1.17	0.0149	1.93	1.6	70	41	25
17-30/9	9.9/66.1	16.0	112	2.33	0.0050	1.78	1.5	64	70	47

Table 4-2: Summary of Oedometer Consolidation Tests

Notes:

¹ – Probability of a silty layer in sample

 $\sigma P'$ – Apparent preconsolidation pressure

 σ_{VO}' - Computed existing vertical effective stress

- Cc Compression index
- Cr Recompression index

eo. Initial void ratio

OCR - Overconsolidation ratio

Wn - Natural moisture content

WL - Liquid limit

PI - Plasticity index

A continuous layer of sandy silt to silty sand was encountered within the upper portion of the silty clay at depths between about 2.7 and 5.5 metres (referred to as the silty layer). This layer was observed both within the sampled boreholes as well as from the results of the CPTs and varies in thickness from about 0.1 to 0.6 metres. The results of grain size distribution testing carried out on one sample of this silty layer were shown on Figure D2 in Appendix D.

4.2.5 Glacial Till

A deposit of glacial till was encountered below the silty clay at the very deep borehole locations (17-07, 17-09, 17-14, 17-17, 17-21, 17-23, 17-26, 17-29) at depths between about 22.6 to 37.5 metres below the existing ground surface (i.e., elevations 38.8 to 53.7 metres). The till consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sandy silt with some clay. This deposit was fully penetrated to depths between about 29.4 and 40.5 metres below the existing ground surface with the thickness ranging from about 1.1 to 6.8 metres.

SPT 'N' values obtained within the glacial till generally range from 11 to greater than 50 blows per 0.3 metres of penetration indicating a compact to very dense state of packing. However, the higher SPT 'N' values encountered in the glacial till may reflect the presence of cobbles and boulders in the deposit.

The measured natural water content on selected samples of the glacial till ranges from approximately 7 to 16 percent. The results of grain size distribution testing carried out on three samples of this deposit are shown on Figure D3 in Appendix D. However, it should be noted that the samples were retrieved using a 35-millimetre inside diameter sampler and therefore the results do not reflect the boulder, cobble or full gravel content.

4.3 Bedrock

The bedrock encountered at site consists of the shaley member of the Carslbad formation consisting of grey to dark grey, thinly to medium bedded shale with dolomite, limestone and calcareous shale interbeds.

The bedrock surface was encountered at depths ranging from about 29.4 to 40.5 metres below the existing ground surface (i.e., elevations 46.9 to 35.6 metres) at the very deep boreholes (17-07, 17-09, 17-14, 17-17, 17-21, 17-23, 17-26, 17-29). These boreholes were advanced 1.6 to 3.4 metres into the bedrock using diamond drilling techniques.

Photos of the bedrock core obtained during the current investigation are provided on Figures G1 to G18 in Appendix G.

The following table summarizes the bedrock surface depths and elevations as encountered at the boreholes as part of the current and previous investigations.

Borehole Number	Ground Surface Elevation (m)	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)
17-07	76.3	29.4	46.9
17-09	76.6	30.0	46.6
17-14	76.6	35.3	41.3
17-17	76.3	35.1	41.2
17-21	76.1	40.5	35.7
17-23	76.5	37.8	38.7
17-26	76.3	38.6	37.7
17-29	76.2	40.0	36.2
12-3	76.2	39.8	36.4
12-4	75.9	37.8	38.1
13-5	76.5	34.2	42.3

Table 4-3: Summary of Cored Bedrock Boreholes

Surface elevation contours of the Carlsbad Formation bedrock within the study area using data from the current and 2014 investigations are shown on Figure 3.

Rock Quality Designation (RQD) values measured on the recovered bedrock core samples ranged from about 0 to 100 percent but more generally between 40 to 75 percent indicating a poor to good quality rock. The lowest RQD value was measured within the upper 0.35 metres of the bedrock in borehole 17-17. The result of four unconfined compressive strength tests on selected samples of the bedrock are presented on Figure D13 in Appendix D. The results range from about 97 to 229 MPa and indicate a strong to very strong bedrock.

4.4 Groundwater

Monitoring wells and standpipe piezometers were not installed as part of the current investigation. However, a groundwater level monitoring program was instituted within selected on-site boreholes as part of the previous investigations starting in January 2013. Reference should be made to the previous investigation (i.e., Report No. 12-1125-0045/4500/vol III) for details regarding the monitoring well installations and the groundwater level monitoring program. The initial and the most recent groundwater level measurement in the monitoring wells located within current investigation area are summarized in the table below.

					Grou	ndwater	Elevatio	n (m)		
Well Location	Ground Surface Elevation (m)	Material	09-Jan-13	29-Apr-13	17-May-13	06-Jul-15	02-Oct-15	20-Apr-16	26-Nov-16	20-Nov-17
12-3-3	76.2	Bedrock	-	74.48	74.46	74.6	74.59	74.63	74.5	74.67
12-3-4A	76.2	Glacial Till	74.6	74.5	74.5	74.7	74.7	74.8	74.6	74.8
12-3-4B	76.2	Deep Clay	75.8	75.4	75.4	75.3	75.3	75.3	75.3	75.3
12-3-5A	76.2	Middle Clay	frozen	75.5	75.5	75.4	75.4	75.5	75.3	75.5
12-3-5B	76.2	Shallow Clay with Silty Layer	75.6	75.8	75.8	75.8	75.8	75.9	75.7	75.9
12-3-6	76.3	Surficial Sand	75.9	75.8	75.7	75.7	75.6	75.9	76.0	76.0
12-4-3	75.9	Upper Bedrock	-	74.2	74.2	74.4	74.3	74.3	74.2	74.8
12-4-4A	75.9	Glacial Till	-	74.5	74.5	74.6	74.6	74.6	74.5	74.3
12-4-4B	75.9	Deep Clay	-	75.1	75.1	75.5	75.2	75.5	75.4	75.3
12-4-5A	75.9	Middle Clay	-	75.4	75.4	75.4	75.3	75.5	75.2	75.3
12-4-5B	75.9	Shallow Clay with Silty Layer	-	75.7	75.6	75.8	75.6	75.8	75.4	75.6
12-4-6	75.9	Surficial Sand	-	75.8	75.5	75.9	75.6	75.8	75.8	75.8
13-5-3	76.5	Bedrock	-			74.6	74.5	74.6	74.5	74.6
13-5-4A	76.4	Glacial Till	-	74.5	74.5	74.6	74.6	74.5	74.3	74.4
13-5-4B	76.4	Mid Clay	-	74.8	74.7	74.9	74.8	74.9	74.3	75.0
13-5-5	76.4	Shallow Clay with Silty Layer	-	76.1	75.9	75.7	75.6	76.1	75.8	76.1
13-5-6	76.5	Surficial Sand	-	76.0	75.4	75.4	75.7	76.2	75.7	76.3
13-8-2	76.4	Surficial Sand	-	76.4	76.2	75.6	75.6	-	-	-
13-8-3	76.4	Shallow Clay with Silty Layer	-	76.0	76.0	75.9	75.9	-	-	-
13-9-2	76.1	Surficial Sand	-	75.9	75.2	75.2	75.2	75.9	77.2	77.2
13-9-3	76.1	Shallow Clay with Silty Layer	-	75.8	75.6	75.6	75.4	75.9	77.1	77.1
13-10-2	76.4	Surficial Sand	-	75.9	75.3	75.4	75.5	76.0	77.5	77.5

Table 4-4: Summary of Ground Water Elevations in Monitoring Wells in the Current Study Area



				Groundwater Elevation (m)							
Well Location	Ground Surface Elevation (m)	Material	09-Jan-13	29-Apr-13	17-May-13	06-Jul-15	02-Oct-15	20-Apr-16	26-Nov-16	20-Nov-17	
13-10-3	76.5	Shallow Clay with Silty Layer	-	75.8	75.7	75.5	75.8	76.0	77.5	77.5	
13-11-2	76.0	Surficial Sand	-	75.9	75.6	75.4	75.3	-	-	-	
13-12-2	76.2	Surficial Sand	-	76.1	75.8	75.6	75.6	-	-	-	
13-12-3	76.3	Shallow Clay with Silty Layer	-	75.9	75.9	75.9	75.7	-	-	-	
13-13-2	76.2	Surficial Sand	-	75.8	75.7	75.6	75.5	-	-	-	

As indicated in the table above, the groundwater level varies between about elevations of 74.2 and 77.5 metres. It should be noted that the groundwater levels measurements were not limited to the table above and that a groundwater level monitoring program for on-site monitoring wells is being carried out to further characterize the long-term hydrogeological conditions present at the CRRRC Site. In addition, groundwater levels are expected to fluctuate seasonally. Higher and lower groundwater levels are expected during wet and dry periods of the year.

4.5 Corrosion

Samples of soil from boreholes 17-07, 17-26, and 17-29 were submitted to Eurofins Environment Testing for basic chemical analyses related to potential corrosion of buried steel elements and potential sulphate attack on buried concrete elements. The results of this testing are provided in Appendix E and are summarized below.

Borehole Number / Sample Number	Sample Depth (m)	Chloride (%)	SO₄ (%)	рН	Resistivity (Ohm-cm)	Material
17-07 / 18	25.9 - 26.5	0.015	0.09	8.8	813	Glacial Till
17-26 / 2	0.76 - 1.4	< 0.002	<0.01	8.8	12,500	Surficial Silty Sand
17-29 / 3	3.0 - 3.7	0.018	0.01	8.6	20,000	Silty Clay
17-29 / 20	35.1 - 35.7	0.157	0.04	9.0	5,880	Silty Clay

Table 4-5: Result of Basic Chemical Analyses

5.0 **DISCUSSION**

5.1 General

This section of the report provides engineering guidelines and recommendations on the geotechnical design aspects of the proposed buildings/facilities at the CRRRC Site to support an application to the City of Ottawa for Site Plan Control approval and building permit applications for the various structures. The recommendations are based on our interpretation of the factual data obtained from the test hole information advanced during the current subsurface investigation as well as the project requirements. The discussion and recommendations presented are intended to provide the building design team with sufficient information to assess the feasible foundation alternatives and to carry out the detail design of the foundations for the individual buildings/facilities. The results and guidelines presented herein are subject to the limitations in the "Important Information and Limitations of this Report" which follows the text of this report. The following guidelines are provided on the basis that the buildings/facilities will be designed in accordance with the 2012 Ontario Building Code (OBC).

5.2 Site Grading

The subsurface conditions on the site generally consist of topsoil/peat/ fill underlain by a thin layer of surficial sand, overlying a thick deposit of compressible sensitive very soft to stiff silty clay extending to at least 23 to 38 metres depth. The upper 0.6 to 1.1 metres of the silty clay deposit at some locations has been weathered to a red brown crust and has a stiff consistency. The underlying silty clay generally has a soft consistency to about 10 to 12 metres depth, followed by a firm consistency to about 16 to 19 metres depth, and is stiff below that.

The "soft to firm" grey silty clay has limited capacity to accept additional load from the weight of grade raise fill and from the foundations of the buildings/facilities without undergoing long-term consolidation settlements. Therefore, to leave sufficient remaining capacity for the silty clay to support these foundations, the thicknesses of grade raise fill will need to be limited to no more than about 1.0 metre based largely on the observations from the test fill program described in Section 2.3.

The results of test fill program indicate the following:

- Less than 25 milimetres of settlement for a 23 kPa loading placed over an area of 36 metres squared (i.e., Pad 1).
- Settlements expected to exceed 50 milimetres for a 28 kPa loading placed over an area of 36 metres squared (i.e., Pad 1).
- Settlements upwards of 120 milimetres for a 34 kPa loading placed over an area of about 39 metres squared (i.e., Pad 2).

The current grading plan shown on Figure 1 indicates grade raises generally consistent with the 1.0 restriction, with only a few areas requiring mitigation (e.g. EPS or surcharge) as outlined below. Grade raise fill should be sands or gravels with a unit weight not exceeding 18 kN/m³.

If the grading restriction given above cannot be accommodated, the following two options could be considered to lessen the applied load on the silty clay and limit the expected settlements:

- The additional required grade raising (above the limit given above) in some applications/locations on the CRRRC site could be accomplished using expanded polystyrene (EPS) light weight fill. Further discussion of this option is presented in Sections 5.4.3 and 5.4.4.
- The area could be pre-loaded/surcharged and allowed to settle in advance of structure construction. The subgrade settlements would need to be monitored to establish when sufficient settlements had occurred such that structure construction could proceed. To reduce the time required for the pre-loading, it is likely that a temporary surcharge above the existing grade would need to be considered, however in either case the pre-load time could be months or years in duration, but could be reduced with the use of wick drains. Some discussion of this option is presented in Section 5.4.6.

Additional geotechnical guidelines would need to be provided if any of the above options are selected.

As a general guideline regarding the site grading, the preparation for filling of the site should include stripping the topsoil and fill for predictable performance of structures and services. The topsoil is not suitable as engineered fill and should be stockpiled separately for re-use in landscaping applications only. In areas with no proposed structures, services, or roadways, the fill may be left in place provided some settlement of the ground surface following filling can be tolerated.

5.3 Seismic Site Class and Hazards

OBC 2012 requires the use of a time-averaged (harmonic) shear wave velocity (V_s) in the upper 30 metres for determining the appropriate seismic Site Class. The measured shear wave velocities are to be averaged over 30 metres immediately below the bottom of the basement, spread footing foundation or pile caps.

As part of the previous investigation at the CRRRC Site carried out by Golder in 2014, shear wave velocities were measured at two locations across the site. The results of that testing are summarized in technical memorandum provided in Appendix H.

The results indicate average shear wave velocities in the upper 30 metres of subsurface stratigraphy of less than 180 metres per second. In accordance with Section 4.1.8 of the OBC 2012 a Site Class E would be applicable for the seismic design of the buildings at the CRRRC Site. The Site is also underlain by more than 3 metres of clay meeting the criteria listed in Table 4.1.8.4.A of OBC 2012, further reinforcing the Site Class E designation.

In accordance with Table 1.2 of Supplementary Standard SB-1 of the OBC 2012 and based on the location of the Site, the reference Site Class C seismic hazard values modified to the site-specific seismic site classification (i.e., Site Class E) are summarized in the table below.

Seismic Hazard Values	2% Exceedance in 50 years (2,475 return period) (Site Class C)	2% Exceedance in 50 years (2,475 return period) (Site Class E)
PGA (g)	0.320	0.365
Sa (0.2) (g)	0.640	0.788
Sa (0.5) (g)	0.310	0.382
Sa (1.0) (g)	0.140	0.288
Sa (2.0) (g)	0.046	0.095
Sa (10.0) (g)	0.046	0.047

Table 5-1: Seismic Hazard Values

The soils on this site are not considered to be susceptible to liquefaction during seismic events.

5.4 Building Foundations

5.4.1 Overview

As discussed in the preceding section, the silty clay deposit has limited capacity to accept the combined load from site grading fill and foundation loads. Although the surficial sand layer was observed at most of the locations on the site and the upper portion of the silty clay deposit has been weathered to a stiff crust in some locations, the underlying unweathered portions of the deposit are compressible. For these subsurface conditions, the Serviceability Limit States (SLS) bearing resistances for the design of foundations is based on limiting the stress increases on the soft to firm, compressible, grey silty clay at depth to an acceptable level so that foundation settlements do not become excessive. The potential stress increase on the compressible unweathered silty clay is primarily affected by:

- The applied pressures on the foundations and the size (i.e., dimensions) of the footings;
- The thickness of the surficial sand and weathered crust below the underside of the foundations and above the compressible silty clay, through which the foundation loads are distributed;

- The amount of net surcharge in the vicinity of the foundations due to landscape fill, underslab fill, floor loads, etc.; and,
- The effects of groundwater lowering caused by this or other construction.

As indicated previously, it is understood that the overall site development will include the construction of several buildings subjected to various loading conditions. The building loads for the various structures are summarized in Table 5-2 below.

Building	Finished Floor Elevation (m)	Proposed Grade Raise (m)	Expected Floor Load (kPa)	Column Load (kN)	Raft Slab Load (kPa) (where an option)
Admin Building	77.50	1.1	< 5	-	~30
Materials Recovery Facility	77.40	0.9	< 25	1,600	N/A
C&D Processing Facility	77.40	1.4	<25	1,600	N/A
Maintenance Garage	76.90	1.0	< 15	-	-
Leachate Treatment Facility	77.00	1.0	< 7	-	-
In-Bound Scale Houses	77.35	1.1	< 5	-	~15
Out- Bound Scale Houses	77.70	0.6	< 5	-	~15
Secondary Scale Houses	77.15	1.0	< 5	-	~15
Truck Tire Wash Facility	76.65	0.5	< 5	-	-
Compost Processing Facility and Storage	77.10	0.9	~ 7	N/A	N/A
Organics Pre-Processing Facility	77.40	1.0	< 15	-	~50
Petroleum Hydrocarbon (PHC) Treatment and Storage Facility	76.90	1.0	~ 30	N/A	-
Clean Load & Small Vehicles Drop-off (Lower Level)	76.60	0.4	N/A	N/A	N/A

Table 5-2:	Summary	of	Building	Foundation	Details
	Cannary	<u> </u>	Banang	i ounduiton	Dotano

Further discussion of the foundation design alternatives is provided in the following sections.

5.4.2 Pile Foundations

It is considered that the heavily and moderately loaded structures will need to be supported on steel pipe piles or H-piles driven to refusal on the bedrock. A piled foundation would transfer the foundation loads through the silty clay and the compact to very dense glacial till deposit, and down to the bedrock surface which appears to range from about 35.7 to 46.9 metres elevation as shown on the bedrock surface contour map (Figure 3). The use of a

piled foundation would avoid the structures experiencing any significant total or differential settlement (for both static and seismic loading conditions).

A suitable pile type would be concrete filled steel pipe piles (closed-ended) or H-piles, with the piles end-bearing on bedrock.

A minimum 0.75 metre thick granular working mat should be provided for pile driving equipment to protect the subgrade. The granular pad should consist of 300 millimetres of OPSS Granular B Type II underlain by 450 millimetres of 150 millimetre minus crushed stone. The granular pad should also be underlain by a Class II nonwoven geotextile having an FOS not exceeding 100 microns placed on the subgrade, with overlaps of at least 0.5 metres between rolls.

5.4.2.1 Axial Resistance

As one possible design example, based on a 245 millimetres diameter close-ended steel pipe pile with a wall thickness of 12 millimetres driven to bedrock, an unfactored Ultimate Limit State (ULS) resistance of 2,200 kilonewtons can be developed based on prior PDA testing of similar piles on similar bedrock. The ULS unfactored resistance of a HP 310 x 110 pile driven to bedrock may be taken as 3,000 kilonewtons. In accordance with the 2012 OBC the ULS values given above should be factored using a resistance factor of either 0.4 or 0.5 if PDA testing is carried out or 0.6 with static load testing.

The ULS factored geotechnical resistance of the pile should equal or exceed the structural resistance if the piles are driven to the bedrock, and are installed using an appropriate set criteria and using a hammer of sufficient energy.

For piles end-bearing on or within the bedrock, Serviceability Limit States (SLS) conditions generally do not govern the design since the stresses required to induce 25 millimetres of movement (i.e., the typical SLS criteria) exceed those at ULS. Accordingly, the post-construction settlement of structural elements which derive their support from piles bearing on bedrock should be negligible.

Pipe piles should be equipped with a base plate having a thickness of at least 20 millimetres to limit damage to the pile tip during driving.

Due to their smaller cross section, H-piles might have more success in penetrating the glacial till and reaching the bedrock surface. Pipe piles offer the advantage of creating more lateral stiffness by infilling with concrete but will be more challenging to drive through cobbles/boulders in the glacial till compared to H-Piles, and their stiffness in flexure is less dependent on the direction of loading. However, the integrity of pipe piles following driving may be more readily inspected (by visual examination of the pile interiors) than for H-piles, and therefore damaged piles can be more easily identified.

To avoid reductions in vertical capacity the piles should be driven no closer than 2.5 diameters centre to centre.

The pile termination or set criteria will be dependent on the pile driving hammer type, helmet, selected pile, and length of pile; the criteria must therefore be established at the time of construction and after the piling equipment is known. All of these factors must be taken into consideration in establishing the driving criteria to ensure that the piles will have adequate capacity, but are also not overdriven and damaged. In this regard, it is a generally accepted practice to reduce the hammer energy after abrupt peaking is met on the bedrock surface, and then to gradually increase the energy over a series of blows to seat the pile. If battered piles are considered, the contractor will need to be careful in driving battered piles through the glacial till which consists of cobble/boulders. Therefore, the piles should be reinforced at the tip with standard bearing points to improve seating of the piles on

the bedrock and to reduce the potential for damage to the piles during driving through soils that contain boulders. However, it should be expected that some of the piles, both vertical and battered, will be out of allowable tolerance and require assessment.

Relaxation of the piles following the initial set could result from several processes, including:

- Softening of the shale bedrock into which the piles are driven;
- The dissipation of negative excess pore water pressures in the overburden material above the bedrock surface; and,
- The driving of adjacent piles.

Provision should therefore be made for restriking all of the piles at least once to confirm the design set and/or the permanence of the set and to check for upward displacement due to driving adjacent piles. Piles that do not meet the design set criteria on the first restrike should receive additional restriking until the design set is met. All restriking should be performed after 48 hours of the previous set.

Since the piles would be founded on shale bedrock, it is expected that several rounds of restriking could be required. The need for multiple restrikes could be reduced by using a lesser geotechnical capacity for the piles.

It is recommended that dynamic monitoring and capacity testing (known as PDA testing) be carried out (by the contractor) at an early stage in the piling operation to verify both the transferred energy from the pile driving equipment and the load carrying capacity of the piles. As a preliminary guideline, the specification should require that at least 10 percent of the piles be included in the dynamic testing program. CASE method estimates of the capacities should be provided for all piles tested. These estimates should be provided by means of a field report on the day of testing. As well, CAPWAP analyses should be carried out for at least one third of the piles tested, with the results provided no later than one week following testing. The final report should be stamped by a professional engineer licensed in the province of Ontario.

The purpose of the PDA testing will be to confirm that the contractor's proposed set criteria is appropriate and that the required pile geotechnical capacity is being achieved. It will therefore be necessary for the pile to have sufficient structural capacity to survive that testing, which could require a stronger pile section than would otherwise be required by the design loading.

The foundation and piling specifications should be reviewed by Golder prior to tender and the contractor's submission (i.e., shop drawings, equipment, procedures, and set criteria) should be reviewed by the geotechnical consultant prior to the start of piling. That submission should include a WEAP (Wave Equation Analysis of Piles) analysis of the driveability of the pile, to the design depth, using the contractor's selected hammer.

Vibration monitoring should be carried out during pile installation to ensure that the vibration levels at nearby existing structures, if present, are maintained below tolerable levels. A maximum peak particle velocity of 50 millimetres per second is recommended for structures.

Piling operations should be inspected on a full time basis by geotechnical personnel to monitor the pile locations and plumbness, initial sets, penetrations on restrike, and to check the integrity of the piles following installation.

5.4.2.2 Downdrag

Downdrag forces will also be applied to the piles as a result of consolidation settlement of the compressible silty clay layer due to the additional loading imposed from the 1.0 metre grade raise and apply negative skin friction to the pile shaft. The resulting unfactored downdrag loads may be taken as 160 kilonewtons for a 245 millimetre diameter pipe pile and 260 kilonewtons for a HP 310 x 110 pile.

5.4.2.3 Resistance to Lateral Loading-Driven Piles

Lateral loading could be resisted fully or partially by the use of battered piles sloped at 1 horizontal to 12 vertical (1H:12V).

The resistance to lateral loading could also be derived from the soil resistance in front of the piles, and it may be assumed that this resistance will be nearly the same for vertical and inclined piles.

The SLS lateral geotechnical response of the soil in front of the piles under lateral loading may be calculated using subgrade reaction theory where the coefficient of horizontal subgrade reaction, k_h, is based on the equation given below, as described by Terzaghi⁴

For cohesionless soils:

$$k_h = \frac{n_h z}{B}$$
 Where: n_h = the constant of horizontal subgrade reaction, as given below;
z = the depth (m); and,
B = the pile diameter/width (m).

For cohesive soils: (Terzaghi, 1955)

$$k_h = \frac{67 s_u}{B}$$
 Where: s_u = the undrained shear strength of the soil (kPa); and B = the pile diameter/width (m).

The constant of horizontal subgrade reaction depends on the soil type and soil density/consistency around the pile shaft. For the design of resistance to lateral loads, the values indicated in the table below may be used. The values provided are unfactored geotechnical parameters.

Range of Elevations to Bottom of Soil Layer ¹ (m)	Soil Type	n _h (kPa/m)	s _u (kPa)
Pile cap to 73.5	Very loose to compact surficial sand	1.3	-
66.0	Soft silty clay	-	15
61.0	Firm silty clay	-	30
38.8 to 53.7	Firm to stiff silty clay	-	50
35.7 to 46.9	Compact to very dense glacial till	4.4	-

Table 5-3: Pile Foundation Horizontal Subg	grade Reaction Parameters
--	---------------------------

Notes:

¹ The bottom of layer elevations is variable and therefore the most critical combination should be considered, or be evaluated on a location-bylocation basis using the nearest borehole record.

^{4 4}Terzaghi, K. "Elevation of Coefficient of Subgrade Reaction", Geotechnique, V.D. 5, No. 4, 1995, pp.297-326

Group action for lateral loading should be considered when the pile spacing in the direction of the loading is less than six to eight pile diameters. Group action can be evaluated by reducing the coefficient of lateral subgrade reaction or ULS resistance in the direction of loading by a reduction factor as follows:

Pile Spacing in Direction of Loading	Reduction
(d = Pile Diameter)	Factor
8d	1.0
6d	0.7
4d	0.4
3d	0.25

Table 5-4: Reduction Factors for Pile Group Action under Lateral Loading

The coefficient of horizontal subgrade reaction values calculated as described above may then be used to calculate the lateral deflection of the pile (i.e., the SLS response of the pile), taking into the account the soil-structure interaction.

For establishing the ULS factored *structural* resistance, the shear force and bending moment distribution in the piles under factored loading can be established using these same procedures and parameters for evaluating the SLS response of the pile.

The unfactored ULS static geotechnical resistance to lateral loading for a single pile can be taken as 100 kilonewtons for a 245 millimetres pipe pile and 320 kilonewtons for a HP 310 x 110 pile driven to refusal on bedrock.

The ULS resistance given above are unfactored values. In accordance with the 2012 OBC with a resistance factor of 0.5 should be applied in calculating horizontal resistance. The ULS lateral resistance of a pile group may be estimated as the sum of the individual resistances across the face of the pile group, perpendicular to the direction of the applied lateral force, adjusted for group action as indicated above.

5.4.2.4 Resistance to Lateral Loading - Foundation Walls and Grade Beams

Resistance to lateral loading can also be generated along buried structural elements such as foundation walls and grade beams, as their lateral displacement mobilizes passive resistances. However, soils exposed to freeze-thaw conditions (as discussed in Section 5.7) should not be relied upon to generate passive resistances. Further details related to passive resistances along buried elements is provided in Section 5.5.

5.4.2.5 Resistance to Lateral Loading - Structural Slabs

Resistance to lateral loading can also be generated by the friction between the base and the subgrade of foundation elements subjected to dead and sustained live loads. For structural slabs, the extent of loading will be materially offered by the degree to which the slab deflects and engages with the soil. It should be noted that in such cases any load applied may lead to stresses being transmitted to the underlying compressible silty clay at depth.

The following friction factors can be used in conjunction with dead and sustained live loads.

Table 5-5: Unfactored Friction Coefficient for Slabs

Interface and Loading Condition	Coefficient of Friction
Concrete – Granular A base	0.60
EPS	0.40

The values given above should be factored with a resistance factor of 0.8 as specified in the 2012 OBC.

5.4.3 Raft Foundations

It also considered that certain structures with relatively low floor loads could be supported on a raft slab foundation which would have at least 1.0 metre of EPS lightweight fill under and around the structures. For the Administration Building and Scale Houses, a raft foundation could be designed with a gross SLS bearing resistance of 35 kPa and a factored ULS bearing resistance of 50 kPa. The above SLS resistance should be consistent with total and differential settlements not exceeding about 50 and 25 millimetres.

The SLS resistance corresponds to a settlement resulting from consolidation of the silty clay. Consolidation of silty clay is a process which takes months or longer and, as such, results from sustained loading. Therefore, the foundation loads to be used in conjunction with the SLS resistance given above should be the full dead load plus sustained live load. The factored dead load plus full factored live load should be used in conjunction with the ULS factored bearing resistance.

The raft foundations will need to be sufficiently rigid so that the structure loads will be uniformly distributed over the entire structure footprint, which depends on the relative stiffness between the raft slab and the underlying subgrade. The distribution of the contact stress, the raft slab deflections, and the resulting forces and bending moments in the slab to be used in its structural design could be determined by structural analysis using a modulus of subgrade reaction, k_s, for the subgrade. It should be noted however that the modulus of subgrade reaction is not a fundamental soil property and its value depends, in part, on the size and shape of the loaded area. For the analysis of the contact stress distribution beneath a raft foundation, its value would depend on the size of the areas over which increased/concentrated contact stresses are anticipated (analogous to equivalent footings beneath the walls and columns) and the size of these areas is in turn related to the value the modulus of subgrade reaction, i.e., they are inter-related. Accordingly, the analysis of the raft slabs should ideally involve an iterative analysis between the determination of the contact stress distribution by the structural engineer and the geotechnical determination of the modulus of subgrade reaction value, until the two are consistent with each other.

The permissible SLS gross contact stress given above assumes a relatively uniform contact stress under the raft. Areas of higher contact stress could lead to localized overstressing of the silty clay with some resulting higher settlements and unanticipated raft slab deflections and forces. Given this requirement for a relatively uniform contact stress, the width of the loaded area will essentially be the width of an individual structure. The modulus of subgrade reaction may therefore be assumed to be 10 megapascals per metre for a raft slab underlain by EPS lightweight fill or native sand.

The raft should be designed not only to resist the forces and moments calculated in this manner, but should also be designed to resist the *hydrostatic uplift pressures* on the raft. A groundwater level at about 0.5 metres below the existing ground surface should be considered in that analysis.

The SLS resistance and corresponding settlement estimates are dependent upon the soil at or below founding level not being disturbed during construction. Where the subgrade consists of silty clay this material will be very sensitive to disturbance and should therefore be protected with a mud slab of lean concrete, which should be placed immediately following inspection and approval of the subgrade.

5.4.4 Spread Footing

It is considered that some of the more lightly loaded structures may generally be supported on spread footings founded on or within the native sand or silty clay, at depths of less than about 1.0 metre below the finished exterior grades. Shallow foundations at such depths would require insulation as describe in Section 5.7. Spread footing foundations at depths greater than 1.0 metre are not considered feasible.

As discussed in the preceding sections, the silty clay has limited capacity to accept the combined load from site grading fill and foundation loads. The bearing resistance for spread footing foundations at this site are therefore based on limiting the stress increases on the soft, compressible, grey silty clay to an acceptable level so that foundation settlements do not become excessive. Four important parameters in calculating the stress increase on the grey silty clay are:

- The thickness of soil below the underside of the footings and above the compressible silty clay;
- The size (dimensions) of the footings;
- The amount of surcharge in the vicinity of the foundation due to grade raise/landscape fill, underslab fill, floor loads, etc.; and,
- The effects of groundwater lowering caused by this or other construction (assumed to be about 0.5 metres).

The following table summarizes the permissible bearing resistance and grade raises for the Administration Building and Maintenance Garage. It should be noted that spread footing foundations at depths of 1.8 metres below finished grade and at other structures are not considered feasible.

Table 5-6: Permissible Bearing Resistance and Grade Raises for Spread Footing Foundations

Structure	SLS Bearing Resistance (kPa)	ULS Bearing Resistance (kPa)	Type of Footing	Corresponding Maximum Footing Width (metres)	Maximum Permissible Grade Raise (metres)
Administration	60	150	Pad	≤ 1.0	1.1
Building	60	150	Strip	≤ 0.5	1.1
Maintenance	50	150	Pad	≤ 1.0	1.0
Garage	35	150	Strip	≤ 0.5	1.0

Notes:

Requires insulation of footings for frost protection (see Section 5.7)

The above allowable bearing resistances are based on the criteria of limiting the stress level within the silty clay at an acceptable margin below the deposit's preconsolidation pressure. However, in assessing the needed level of margin, and noting that the total thickness of the clay deposit at this site is significant, it is considered that the post construction total and differential settlements of footings sized using the above permissible bearing resistances and grading restrictions should be less than about 40 and 20 millimetres, respectively, provided that the soil at or below founding level is not disturbed during construction. Further, the SLS resistances correspond to a settlement resulting from consolidation of the silty clay. Consolidation of the silty clay is a process which takes months or longer and, as such, results from sustained loading. Therefore, the foundation loads to be used in conjunction with the SLS resistances given above should be full dead load plus sustained live load. The factored dead load plus full factored live load should be used in conjunction with the ULS factored bearing resistances.

Where the surficial sand is exposed at footing/subgrade level, prior to construction of footings, the surface of the native sandy material should be proof-rolled to provide surficial densification of any loose or disturbed material.

The bearing resistance values given above could be increased by replacing some of the grade raise fill and native sand with EPS lightweight fill (e.g., 1.0 metre of EPS would increase the bearing values by about 20 kPa). Additional details on this option can be provided if needed.

5.4.5 Slab on Grade

Slab on grade are considered feasible where floor loads are less than 7 kPa. In preparation for construction of the floor slab, all loose, wet, and disturbed material (including all of the fill and topsoil) should be removed from within the building footprints.

Provision should be made for at least 150 millimetres of OPSS. Granular A to form the base of the floor slab. Any bulk fill required to raise the grade to the underside of the Granular A should consist of OPSS. Granular B Type II. The underslab fill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment.

To support slab design, a modulus of subgrade reaction of 10 megapascals per metre can be used.

Where floor loads exceed 7 kPa, structural slabs (i.e. supported on piles) or the use of surcharge, pre-load and/or lightweight fill can be considered. Further details on the latter option can be provided if needed.

5.4.6 Surcharge and Pre-load Options

In the area of the Compost Processing and Storage area, Petroleum Hydrocarbon (PHC) Soil Treatment Biopile area and the Clean Load and Small Vehicles Drop-off area, larger loads may lead to settlement that could impact the performance of these facilities. A description of these facilities is provided herein:

- Compost Processing and Storage area: A paved area with about 1.5 metres of grade raise is proposed. The facility covers an area of about 3.5 hectares and is expected to store about 20,400 tonnes of material in windrows which are about 3 to 4 metres high and 5 to 8 metres wide. Thus, the average loading in this area is expected to be less than about 5 kPa.
- 2) PHC Soil Treatment Biopile area: This area covers about 1,200 square metres and will be lined with a geomembrane. The biopiles will have a total volume of about 2,000 cubic metres, resulting in an average loading of up to about 50 kPa.
- 3) Clean Load and Small Vehicle Drop-Off area: This area covers a footprint of about 800 square metres with an initial grade raise of about 0.4 metres at the lower level, and a 1.8 metre grade raise at the upper level. The Drop-Off area is higher than the waste containers below. This area will also be paved and require a 1.5 metre high retaining wall at the western edge of the facility.

For the Compost Processing and Storage area where the loading is limited, pre-loading/surcharging is not considered necessary. Therefore, the pad can be constructed using the pavement structure given in Section 5.10 for parking areas.

For the PHC Soil Treatment Biopile area, the much higher fill and pad loadings will likely induce long-term consolidation settlements which may impact performance of the geomembrane barrier/drainage system. In this case, a surcharge and pre-load of the area would provide a reasonable option to improve performance. Without a surcharge and pre-load, settlements in the order of 800 to 900 millimetres can be expected over a 20 year period. The surcharge and pre-load should be 2.5 metres in height above the proposed finished grade and extend about 5 metres beyond the limit of the biopile footprint. The surcharge and pre-load should be monitored with 6 to 10 settlement plates over a period of 12 to 18 months. Following this, removal of the surcharge and pre-load can be undertaken to allow construction of the biopile cells. During biopile operations, further settlements are expected to range from about 30 to 90 millimetres over a 20 year period.

For the Clean Load and Small Vehicle Drop-Off area, the much higher fill loadings will likely induce long-term consolidation settlements that will affect performance of the facility and of the retaining wall. In this case, a surcharge and pre-load of the area would provide a reasonable option to improve performance. Without a pre-load and surcharge, settlements on the order of 500 to 600 millimetres can be expected over a 20 year period, impacting performance of the pad and retaining wall. The surcharge and pre-load should be 2.5 metres in height above the proposed finished grade and extend about 3 metres beyond the limit of the retaining wall and any fill areas exceeding a grade raise of 1.0 metre. The surcharge and pre-load should be monitored with 4 to 6 settlement plates over a period of 9 to 12 months. Following this, removal of the surcharge and pre-load can be undertaken as needed and 1.0 metre of EPS lightweight fill placed behind the retaining wall over a width of 4 metres to provide for acceptable performance of the pad and wall. Under these conditions, further settlements after the pre-load and surcharge should be less than 50 millimetres at the upper level, and less than 25 millimetres along the retaining wall foundation (lower level).

5.5 Retaining Wall, Foundation Wall and Grade Beam Backfill

The soils at this site are highly frost susceptible and should not be used as backfill against exterior unheated, or uninsulated foundation elements (e.g., pile caps, grade beams, and retaining walls). To avoid problems with frost adhesion and heaving, these foundation elements should either be backfilled with non-frost susceptible sand or sand and gravel conforming to the requirements for OPSS Granular B Type I or, alternatively, a bond break such as the Platon system sheeting on thermal insulation could be placed against the foundation walls and grade beams.

In areas where pavement or other hard surfacing will abut the proposed structures, differential frost heaving could occur between the granular fill and the adjacent areas. To reduce this differential heaving, the backfill adjacent to the wall should be placed to form a frost taper. The frost taper should be brought up to pavement subgrade level from 1.5 metres below finished exterior grade at a slope of 3 horizontal to 1 vertical, or flatter, away from the wall. The granular fill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment.

The pavement or hard surfacing could be expected to perform better in the long term if the granular backfill against the foundation walls is drained by means of a perforated pipe subdrain in a surround of 19 millimetre clear stone, fully wrapped in a geotextile, which leads by gravity drainage to a positive outlet.

5.6 Lateral Earth Pressures

The magnitude of the lateral earth pressures will depend on the type and method of placement of the backfill materials, the nature of the soils behind the backfill, the magnitude of surcharge including construction loadings, the freedom of lateral movement of the structure, and the drainage conditions behind the walls. Seismic (earthquake) loading must also be taken into account in the design.

It should be noted that all of the lateral earth pressure equations are given in an unfactored format and will need to be factored for ULS design purposes.

It should also be noted that the below lateral earth pressure equations assume that the foundation walls will be drained. If the walls are design to be water-tight, the walls will have to be designed to resist the additional hydro-static pressure.

5.6.1 Static Lateral Earth Pressures

The following guidelines and recommendations are provided regarding the lateral earth pressures for static (i.e., not earthquake) loading conditions. These lateral earth pressures assume that the ground above the wall will be flat, not sloping. If the inclination of the slope above the wall changes then new lateral earth pressures will need to be calculated. If the backfill materials consist of compacted sand or sand and gravel (OPSS Granular B Type I) then the following parameters (unfactored) may be used:

Table 5-7: Static Lateral Earth Pressure Parameters

Soil Unit Weight (kN/m3)	20
Yielding, Ka	0.33
Non- Yielding, K _o	0.50

- If the structure does not allow lateral yielding (i.e., restrained structure where the rotational or horizontal movement is not sufficient to mobilize an active earth pressure condition), at-rest earth pressures (plus any compaction surcharge) should be assumed for the foundation design. If the structure allows for lateral yielding, active earth pressures should be used in the foundation design.
- The lateral earth pressures may be taken as:

$$\sigma_h(z) = K (\gamma z + q)$$

Where: $\sigma_h(z)$ = Lateral earth pressure on the wall at depth z, kPa;

K = At-rest or active earth pressure coefficient;

- γ = Unit weight of retained soil;
- z = Depth below top of wall, metres; and
- q = Uniform surcharge at ground surface to account for traffic and equipment (not less than 15 kilopascals), plus any surcharge due to adjacent foundation loads.

5.6.2 Seismic Lateral Earth Pressures

Seismic (earthquake) loading must be taken into account in the design in accordance with OBC 2012. In this regard, the following should be included in the assessment of lateral earth pressures:

- Seismic loading will result in increased lateral earth pressures acting on the wall. The wall should be designed to withstand the combined lateral loading for the appropriate static pressure conditions given in Section 5.5.2, above, plus the earthquake-induced dynamic earth pressure.
- The following unfactored seismic active pressure coefficients (K_{AE}) for OPSS Granular B Type I may be used in design. It should be noted that these seismic earth pressure coefficients assume that the back of the wall is vertical and the ground surface behind the wall is flat. Where sloping backfill is present above the top of the wall, the lateral earth pressures under seismic loading conditions should be calculated by treating the weight of the backfill located above the top of the wall as a surcharge.

Table 5-8: Seismic Lateral Ea	arth Pressure Coefficients
-------------------------------	----------------------------

Wall Type	Design Earthquake	Site PGA for Site Class E	Seismic Active Pressure Coefficients, KAE
Yielding Wall	2,475 Yr	0.365 g	0.49
Non-Yielding Wall	2,475 Yr	0.365 g	0.68

The earthquake-induced dynamic pressure distribution, which is to be added to the static earth pressure distribution, is a linear distribution with maximum pressure at the top of the wall and minimum pressure at its toe (i.e., an inverted triangular pressure distribution). The total pressure distribution (static plus seismic) may be determined as follows:

 $\sigma_h(d) = K_a \gamma d + (K_{AE} - K_a) \gamma (H-d)$, yielding walls

 $\sigma_h(d) = K_o \gamma d + (K_{AE} - K_a) \gamma (H-d)$, non-yielding walls

- Where: $\sigma_h(d)$ is the (static plus seismic) lateral earth pressure at depth, d, (kPa);
 - K_a is the static active earth pressure coefficient;
 - K_o is the static at-rest earth pressure coefficient;
 - KAE is the seismic active earth pressure coefficient;
 - γ is the unit weight of the backfill soil (kN/m³), as given previously;
 - d is the depth below the top of the wall (m); and,
 - H is the total height of the wall (m).

Lateral passive resistance can be developed along buried foundation walls and grade beams that displace sufficiently. The following unfactored passive resistance would develop:

- For a 1.0 metre high wall or grade beam, 22 kilonewtons per metre;
- For a 2.0 metres high wall or grade beam, 102 kilonewtons per metre;
- For a 2.5 metres high wall or grade beam, 142 kilonewtons per metre; and,
- For a 3.0 metres high wall or grade beam, 232 kilonewtons per metre.

A geotechnical resistance factor of 0.5 should be used with the values above.

The wall deflection needed to mobilize these maximum passive lateral resistances is about 3 percent of the wall height. Deflection of about 1.3 percent of the wall height would be needed to develop 85 percent of the maximum passive resistance, with the passive resistances developing linearly over this range. The values provided herein assume that the walls and grade beams are backfilled with OPSS Granular B Type I.

5.7 Frost Protection

The soils at this site are considered to be frost susceptible and will expand/heave if allowed to freeze. All exterior perimeter foundation elements for buildings/facilities that are heated should be provided with a minimum of 1.5 metres of earth cover. However, the exterior and interior foundation elements (e.g., footings, pile caps, and grade beams) of the unheated buildings/facilities should be provided with a minimum of 1.8 metres of earth cover for frost protection purposes.

Rigid insulation could be considered as an alternative to the above earth cover requirements particularly where the slab subgrade will already need to be insulated, that insulation could be extended beneath the pile caps and grade beams to also insulate the subgrade beneath those foundation elements. Further details can be provided for the perimeter footings, if insulation of the subgrade is preferred alternative to earth cover.

5.8 Excavation and Shoring

Excavations depths of about 2 to 3 metres will be required for the construction of the foundations and servicing. The excavations will be made through the existing topsoil, fill, and surficial sand, where present, and into the underlying silty clay below the groundwater level. No unusual problems are anticipated in excavating in the overburden materials using conventional hydraulic excavating equipment. In accordance with the Occupational Health and Safety Act of Ontario (OHSA), the overburden soils below the water table (i.e., sand and soft silty clay) would generally be classified as Type 4 soils. Accordingly, side slopes in the short term in these soils should slopped at a minimum of 4 horizontal to 1 vertical (4H:1V).

Alternatively, the excavations could be carried out using steeper side slopes with all manual labour carried out within a fully braced, steel trench box for worker safety.

Stockpiling of soil beside the excavations made in the silty clay should be avoided; the weight of the stockpiled soil could lead to basal instability of braced excavations or slope instability for unsupported excavations. In addition, the shoring system should be designed to account for the additional surcharge loading from any adjacent any building foundations. Excavations will extend below the groundwater level and therefore ground water inflow into the excavations should be expected. It should be possible to handle the groundwater inflow into the excavation by pumping from well filtered sumps within the excavations. The rate of groundwater inflow from the silty clay is expected to be low, with moderate inflows occurring from the overlying fill and surficial sand. The actual rate of groundwater inflow to the excavations will depend on many factors including the contractor's schedule and rate of excavation, the size of the excavation, the number of working areas being excavated at one time, and the time of year at which the excavation is made. Also, there may be instances where volumes of precipitation, surface runoff and/or groundwater collects in an open excavation, and must be pumped out. The groundwater level should be lowered to at least 0.5 metres below the excavation level.

According to Ontario Regulation 63/16 and Ontario Regulation 387/04, a Permit to Take Water (PTTW) is required from the Ministry of the Environment and Climate Change (MOECC) if a volume of water greater than 400,000 L/day is pumped from the excavations. If the volume of water to be pumped will be less than 400,000 L/day, but more than 50,000 L/day, the water taking will not require a PTTW, but will need to be registered in the Environmental Activity and Sector Registry (EASR) as a prescribed activity.

Where the subgrade is found to be wet and sensitive to disturbance (i.e., for sandy soils below the water table or sensitive silty clay), consideration should be given to placing a mud slab of lean concrete over the subgrade (following inspection and approval by geotechnical personnel) to protect the subgrade from construction traffic. Surface water should be directed away from the excavation areas, to prevent ponding of water that could result in disturbance and weakening of the subgrade.

If the above open-cut excavation side slopes cannot be accommodated, then a shoring system would need to be considered. The excavation contractor should be made responsible for the detailed design of the shoring.

The shoring method(s) chosen to support the excavation sides must take into account the soil stratigraphy, the groundwater conditions, the methods adopted to manage the groundwater, the permissible ground movements associated with the excavation and construction of the shoring system, and potential impacts on adjacent

structures and utilities. The selection of the type of temporary shoring system, and the method of lateral restraint should be entirely the choice/responsibility of the contractor. The contractor should be required to submit the shoring system design, including details on the design lateral earth pressures, expected movements, and a monitoring plan, for review prior to the start of shoring construction.

Some unavoidable inward horizontal deformation and vertical settlement of the adjacent ground may occur as a result of excavation, installation of the shoring and deflection of the ground support system (including bending of the walls and compression of the struts).

The construction documents should not specify the specific shoring system that should be used, but rather the permissible deflection level (i.e., 'Performance Level') should be specified, in accordance with OPSS.MUNI 539. With the above design approach, it is considered that Performance Level 2 would be specified.

5.9 Site Servicing

5.9.1 Pipelines

It is expected that excavations for the installation of site services will extend to no more than 2 metres depth. These excavations will be made through the surficial fill, sand (where present), and into the underlying soft silty clay.

At least 150 millimetres of OPSS Granular A should be used as pipe bedding for sewer and water pipes. Where unavoidable disturbance to the subgrade surface does occur, it may be necessary to place a sub-bedding layer consisting of compacted OPSS Granular B Type II beneath the Granular A or to thicken the Granular A bedding. The bedding material should in all cases extend to the spring line of the pipe and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density. The use of clear crushed stone as a bedding layer should not be permitted anywhere on this project since fine particles from the sandy backfill materials or sandy soils on the trench walls could potentially migrate into the voids in the clear crushed stone and cause loss of lateral pipe support.

Cover material, from spring line of the pipe to at least 300 millimetres above the top of pipe, should consist of OPSS Granular A or Granular B Type I with a maximum particle size of 25 millimetres. The cover material should be compacted to at least 95 percent of the material's standard Proctor maximum dry density.

It should generally be possible to re-use surficial sandy soils or drier weather silty clay as trench backfill.

The high moisture content of the unweathered grey silty clay makes this soil difficult to handle and compact. If grey silty clay is excavated during installation of the site services, this material should be wasted or should only be used as backfill in the lower portion of the trenches to limit the amount of long term settlement of the roadway surface. If the grey silty clay is used in trenches under roadways, some long term settlement of the pavement surface should be expected. Where the trench will be covered with hard surfaced areas, the type of native material placed in the frost zone (between subgrade level and 1.8 metres depth) should match the soil exposed on the trench walls for frost heave compatibility. Trench backfill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

Impervious dykes or cut-offs should be constructed at 100 metre intervals in the service trenches to reduce groundwater lowering at the site due to the "french drain" effect of the granular bedding and surround for the service pipes. It is important that these barriers extend from trench wall to trench wall and that they fully penetrate the granular materials to the trench bottom. The dykes should be at least 1.5 metres wide and could be

constructed using relatively dry (i.e., compactable) grey brown silty clay from the weathered zone or beam concrete.

5.9.2 Surface Ponds

Several stormwater management ponds are proposed within the facility, with depths in the order of 2 to 3 metres. The excavations for the ponds will be through grade raise fill and surficial sand. As such, excavation side slopes of 4H: 1H should be used. Erosion protection of the excavated slopes should also be provided.

5.10 Pavements Design

Site access to the facility is proposed directly from Boundary Road approximately 1,130 metres south of Highway 417 and approximately 600 metres south of the Thunder Road.

In preparation for pavement construction, all topsoil, disturbed, or otherwise deleterious material (i.e., those materials containing organic material) should be removed from the roadway areas.

The existing fill, and any native subgrade within the proposed site access road way, should be proof rolled prior to the placement of new fill. The purpose of the proof rolling is to provide surficial densification of the existing subgrade and to identify any isolated areas of soft or loose subgrade soil, which would require subexcavation and replacement with suitable fill.

Sections requiring backfilling of existing ditches to the proposed subgrade level (i.e., following subexcavation of loose/soft soil) should be carried out using acceptable OPSS Select Subgrade Material (SSM). All fill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment.

The granular base and subbase should be compacted to 100 percent of the material's standard Proctor maximum dry density using suitable compaction equipment unless otherwise noted.

Below the pavement structure, frost compatibility must be maintained across any pavement tie-ins. The depth of frost penetration (from the profile grade) on this project should be 1.8 metres. This depth should be used when designing frost tapers in accordance with the OPSD 803 series. Transition zones should be treated in accordance with the applicable OPSD 205 series. The transition treatment depth, "t", should be taken as 1.8 metres and the depth of organic, leached and accumulated layers, "D_a", taken as 300 millimetres.

The subsoil should be inspected by qualified geotechnical personnel to make sure that there is no potential for differential frost heaving.

In preparation for the pavement structure for the new paved site access road the following pavement construction should be carried out:

- Remove all organic material and topsoil;
- Provide 150 millimetres (40+50+50) HMA;
 - 50 millimetres SP 12.5 FC 2, Traffic Category D, PGAC 64-34; and,
 - 100 (50+50) millimetres SP 19.0, Traffic Category D, PGAC 64-34.
- Provide 150 millimetres of new Granular A; and,

Provide 500 millimetres of new Granular B Type II.

If all or parts of the access road will be used as a gravel surfaced haul road during or after construction, the following pavement construction should be carried out:

- Remove all organic material and topsoil;
- Provide 200 millimetres of new Granular A, compacted to 100 percent of the material's standard Proctor maximum dry density (SPMDD);
- Provide 400 millimetres of upper subbase Granular B Type II compacted to 100 percent of the material's SPMDD;
- Provide a biaxial geogrid such as, Tensar BX1200 XMD, or equivalent; and,
- Provide 300 millimetres of lower subbase Granular B Type II compacted to 95 percent SPMDD. The lower subbase should be spread with dozer only and not compacted prior to placement of the geogrid.

The granular base and subbase for new construction should consist of OPSS Granular A and Granular B Type II, respectfully. Subgrade fill, if required could consist of SSM in accordance with OPSS.MUNI 1010.

The composition of the Hot Mix and Granular Conversion Factors should be as follows:

- Superpave 12.5 FC2 2.390 t/m³;
- Superpave 19.0 2.460 t/m³;
- Granular A 2.4 t/m^{3;} and,
- Granular B Type II 2.4 t/m³.

Based on the pavement profile at Boundary Road where it will intersect with the proposed site access roadway, there will be an approximately 1.8 metres difference in grade. Therefore, a 10H:1V taper for tie in of the granular materials will be required at this intersection.

5.11 Trees

The silty clay soils at this site are potentially sensitive to water depletion by trees of high water demand during periods of dry weather. When trees draw water from the silty clay, the silty clay undergoes shrinkage which can result in settlement of adjacent structures founded at shallow depth. Some restrictions could therefore need to be imposed on the planting of trees of higher water demand in close proximity to the foundations structures founded at shallow depth (i.e., shallow spread footings or shallow raft foundations). It is therefore recommended that trees with high water demand not be planted closer to any buildings with shallow foundations than the ultimate height of the tree. However, these restrictions do not apply to structures founded on deep pile foundations supported on bedrock.

The table below provides a list of common trees in decreasing order of water demand and, accordingly, decreasing risk of potential effects on structures.

Tree Species	List of Trees
	Poplar
	Alder
	Aspen
	Willow
	Elm
Broad Leaved Deciduous	Maple
	Birch
	Ash
	Beech
	Oak
Deciduous Conifer	Larch
	Spruce
Evergreen Conifers	Fir
	Pine

Table 5-9: Some Common Trees in Decreasing Order of Water Demand

5.12 Corrosion and Cement Type

Four samples of soil from boreholes 17-07, 17-26, and 17-29 were submitted to Eurofins Environment Testing for basic chemical analyses related to potential corrosion of buried steel elements and potential sulphate attack on buried concrete elements. The results of this testing are provided in Appendix E.

The results indicate that concrete made with Type GU Portland cement should be acceptable for substructures. The results also indicate a mild to very high potential for corrosion of exposed ferrous metals within the silty clay deposit and a high potential for corrosion of exposed ferrous metal within the glacial till deposit.

6.0 ADDITIONAL CONSIDERATIONS

The soils at this site are sensitive to disturbance from ponded water, construction traffic and frost.

Piling operations should be inspected on a full time basis by geotechnical personnel to monitor the pile locations and plumbness, initial sets, penetrations on restrike, and to check the integrity of the piles following installation.

All raft foundation bearing areas should be inspected by geotechnical personnel to ensure that a suitable subgrade has been reached and that it has been properly prepared. In order to avoid disturbance of the sensitive clay subgrade, it is recommended that the silty clay subgrade be protected by a mud slab of lean concrete as soon as each portion of the excavation has been completed and inspected.

All footing and subgrade areas should be inspected by experienced geotechnical personnel prior to filling or concreting to ensure that soil having adequate bearing capacity has been reached and that the bearing surfaces have been properly prepared.

The placing and compaction of engineered fill as well as sewer bedding and backfill should be inspected to ensure that the materials used conform to specifications from both a grading and compaction point of view.

Two test pads from previous investigation were constructed to about 2.5 metre height within the proposed building area. These test pads should be removed before construction.

Regardless of season, granular pads will be required to be constructed before any heavy equipment can be sent out to site. It is understood that the client is planning to do some pre-construction drainage improvements to better promote and manage the runoff, especially in the spring, which can render the site challenging to access.

It is recommended that the final shoring design be reviewed and accepted by a geotechnical engineer prior to construction and that periodic inspection of the shoring installation procedures be carried out to ensure compatibility with the building design.

At the time of the writing of this report, only conceptual details for the proposed structures were available. Golder should be retained to review the final drawings and specifications for this project prior to tendering to ensure that the guidelines in this report have been adequately interpreted.

7.0 CLOSURE

We trust that this report meets your current needs. If you have any questions, or if we may be of further assistance, please do not hesitate to contact the undersigned.

Signature Page

Golder Associates Ltd.



Shokouh Meshkinfar, EIT Junior Geotechnical Engineer-in-Training



Michael Snow, P.Eng. Principal, Senior Geotechnical Engineer

SM/SAT/MSS/mvrd https://golderassociates.sharepoint.com/sites/18733g/deliverables/phase 400 tsk 4.4 report/reports/1787048-400-4.4-rev0-final-crrrc geotechnical report-june 2018.docx

Golder and the G logo are trademarks of Golder Associates Corporation



IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client, <u>Taggart Miller Environmental Services.</u> The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then the client may authorize the use of this report for such purpose by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process, provided this report is not noted to be a draft or preliminary report, and is specifically relevant to the project for which the application is being made. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder cannot be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT (cont'd)

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

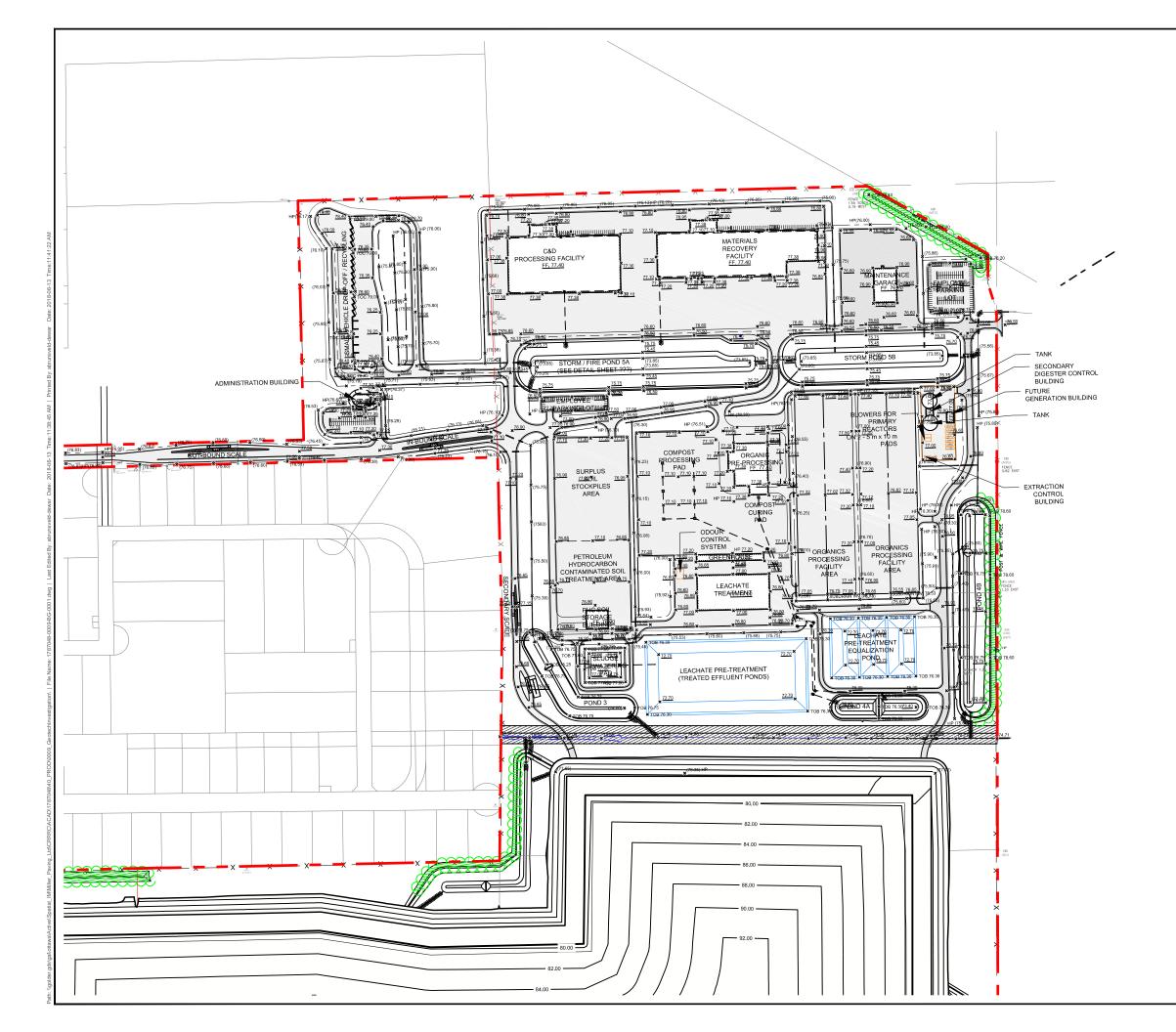
Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.



LEGEND	
P	ROPERTY BOUNDARY
E	EXISTING CONTOUR (0.25 m INTERVAL)
T	TERRACING (SLOPE AS INDICATED)
c	ОЛСН
——— 6	00 mmØ CULVERT OR AS NOTED
E	EXISTING CULVERT AS NOTED

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

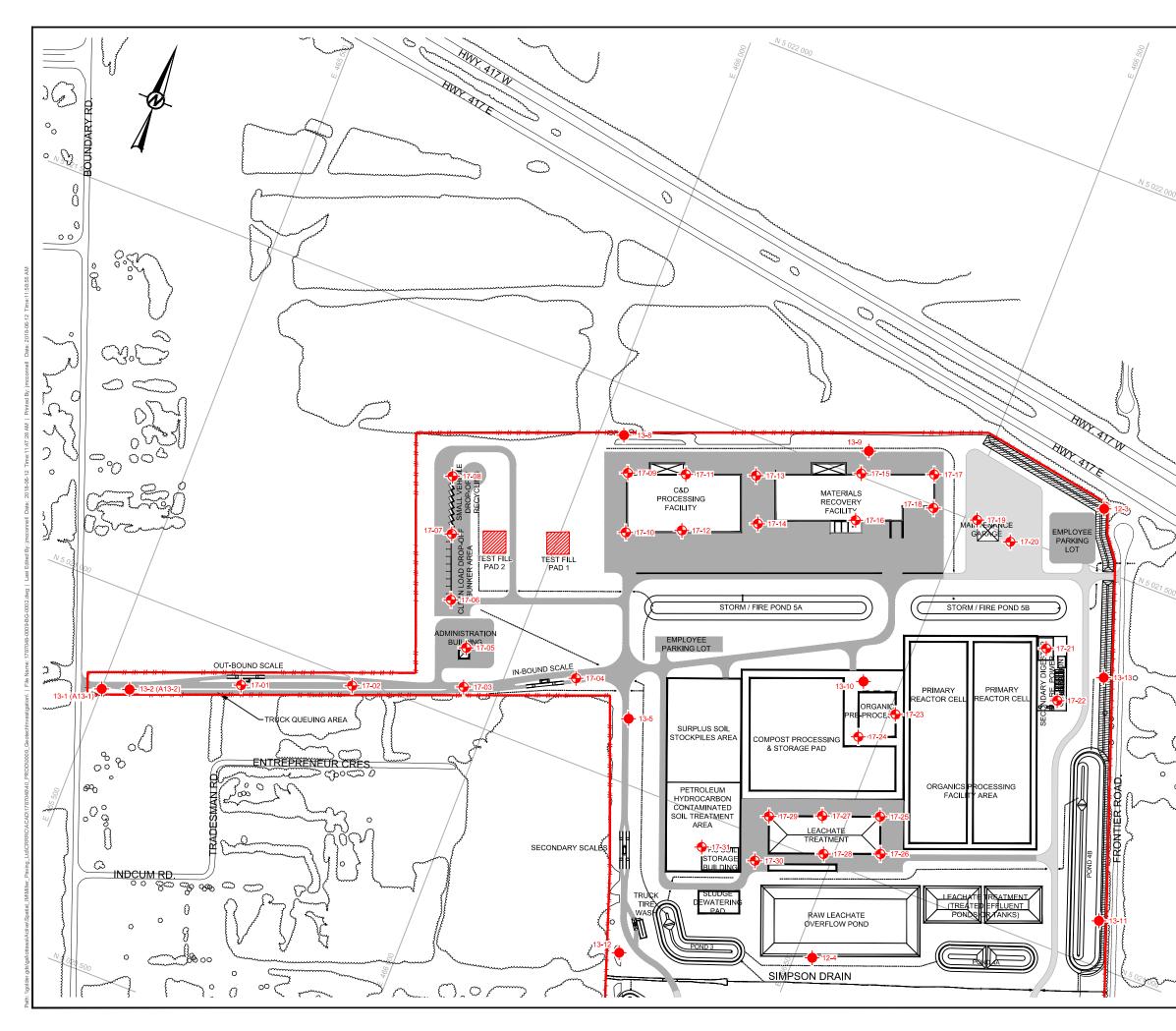


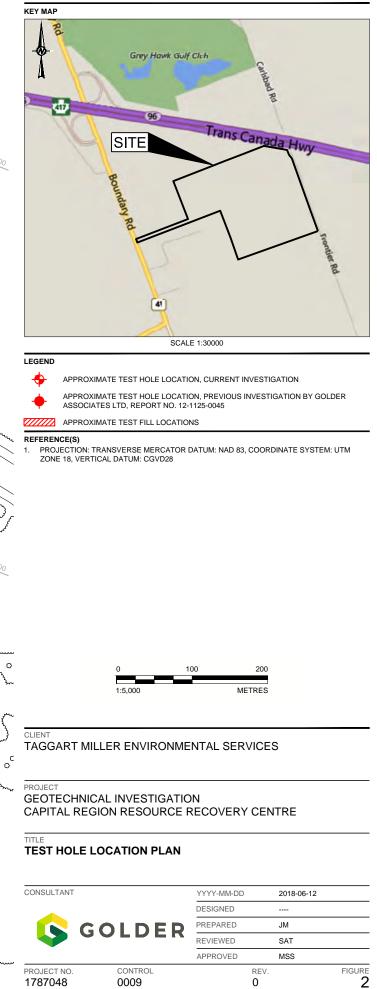
CLIENT TAGGART MILLER ENVIRONMENTAL SERVICES

PROJECT CAPITAL REGION RESOURCE RECOVERY CENTRE

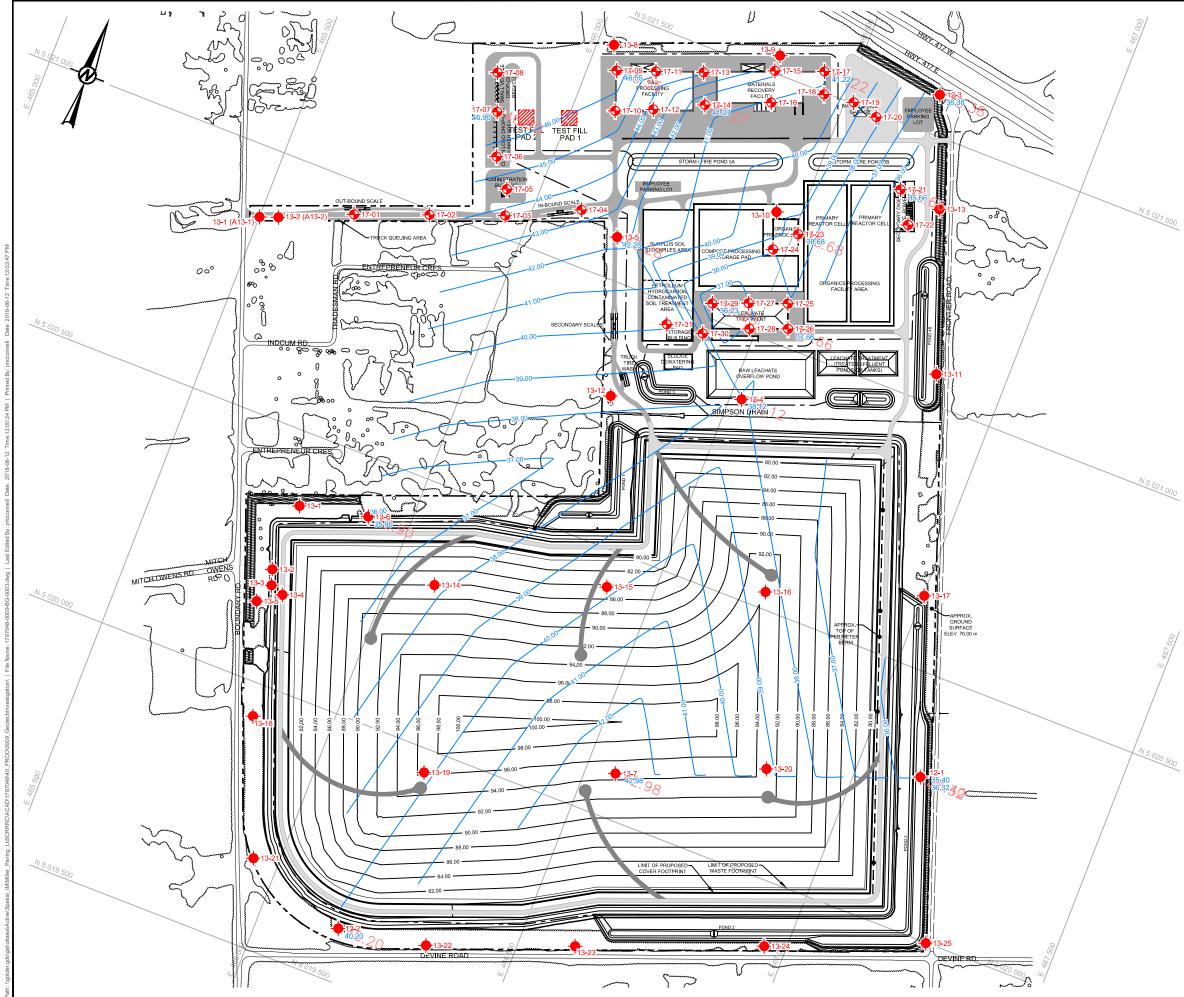
TITLE OVERALL SITE PLAN

CONSULTANT YYYY-MM-DD 2018-01-19 DESIGNED MK GOLDER PREPARED ABD REVIEWED SAT APPROVED MSS PROJECT NO. DRAWING CONTROL rev. 0 1787048 0009 1





..... IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FRO



LEGEND ÷

APPROXIMATE TEST HOLE LOCATION, CURRENT INVESTIGATION

APPROXIMATE TEST HOLE LOCATION, PREVIOUS INVESTIGATION BY GOLDER ASSOCIATES LTD, REPORT NO. 12-1125-0045

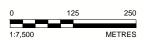
46.90 BEDROCK ELEVATION IN TEST HOLE, metres ABOVE SEA LEVEL

-39.00 INTERPRETED BEDROCK ELEVATION CONTOUR, metres ABOVE SEA LEVEL

APPROXIMATE TEST FILL LOCATIONS

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28



PROJECT

CLIENT TAGGART MILLER ENVIRONMENTAL SERVICES

GEOTECHNICAL INVESTIGATION CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

BEDROCK SURFACE CONTOUR PLAN

CONSULTANT GOLDER PROJECT NO. CONTROL 1787048 0009

YYYY-MM-DD		2018-06-12	
DESIGNED			
PREPARED		JM	
REVIEWED		SAT	
APPROVED		MSS	
	REV.		FIGURE
	0		3

Date (Month) 25-Aug-15 19-Aug-16 18-Sep-16 17-Mar-17 28-Mar-15 27-May-15 22-Mar-16 21-May-16 16-May-17 11-May-18 15-Jun-17 12-Mar-18 26-Feb-15 27-Apr-15 23-Nov-15 23-Dec-15 21-Feb-16 21-Apr-16 20-Jul-16 17-Nov-16 17-Dec-16 15-Jul-17 14-Aug-17 12-Nov-17 11-Apr-18 26-Jun-15 24-Sep-15 24-Oct-15 22-Jan-16 20-Jun-16 18-Oct-16 16-Jan-17 15-Feb-17 16-Apr-17 13-Sep-17 13-Oct-17 12-Dec-17 11-Jan-18 10-Feb-18 10-Jun-18 26-Jul-15 40 30 20 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 Settlement (mm) 009 -110 -120 -130 Notes: 1) H = 1.5 m (Equivalent to a 0.8 m grade raise and 5 kPa foor load or q = 23 kPa). **→**4 **→**5 **→**6 2) Test fill pad height increased to H=1.8 m on January 29, 2016 (equivalent to 1.1 m grade raise Pad 1 and 5 kPa floor load or q = 28). 21-May-16 21-Apr-16 14-Aug-17 12-Nov-17 27-Apr-15 27-May-15 12-Dec-17 11-May-18 28-Mar-15 25-Aug-15 24-Sep-15 23-Nov-15 23-Dec-15 21-Feb-16 22-Mar-16 20-Jul-16 19-Aug-16 17-Nov-16 17-Dec-16 17-Mar-17 16-Apr-17 16-May-17 11-Jan-18 12-Mar-18 26-Feb-15 26-Jun-15 24-Oct-15 22-Jan-16 20-Jun-16 18-Sep-16 18-Oct-16 15-Feb-17 13-Sep-17 13-Oct-17 10-Feb-18 11-Apr-18 10-Jun-18 26-Jul-15 15-Jun-17 16-Jan-17 15-Jul-17 40 30 20 -10 -20 -30 -50 -50 -50 -60 -70 -80 -90 -100 -110 Settlement (mm) -120 -130 Pad 2 **—**2 **—**3 Note : H = 2.3 m (Equivalent to a 1.3 m grade raise and 5 kPa foor load or q = 34 kPa **---**1 CRRRC TEST FILL PAD SETTLEMENT MONITORING RESULTS PHASE No. 400/4.4 ROJECT No 178704 SCALE: NTS REV ESIGN SM 24/04/20 Golder

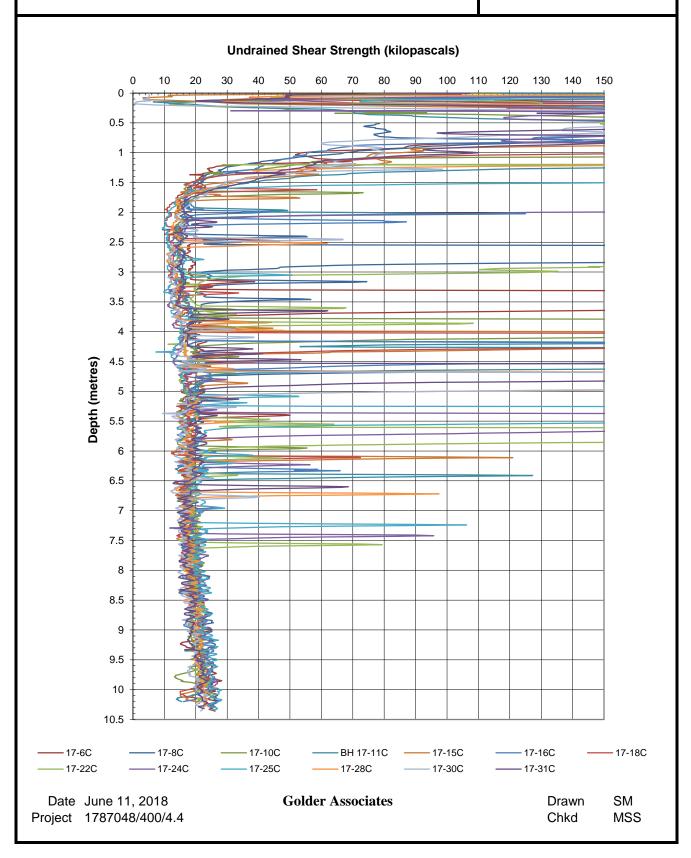
FIGURE 4

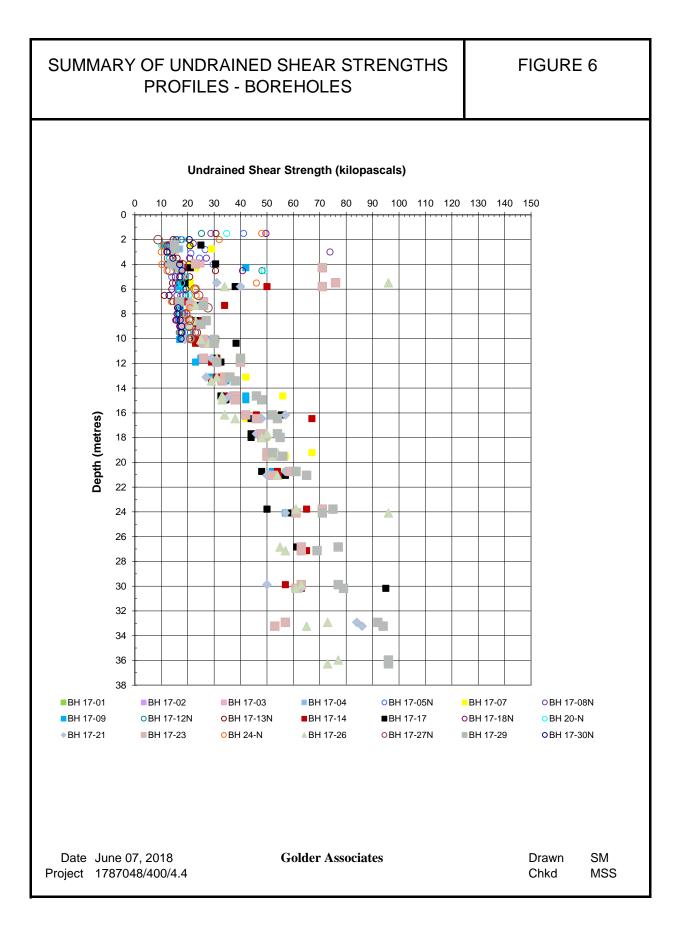
MSS

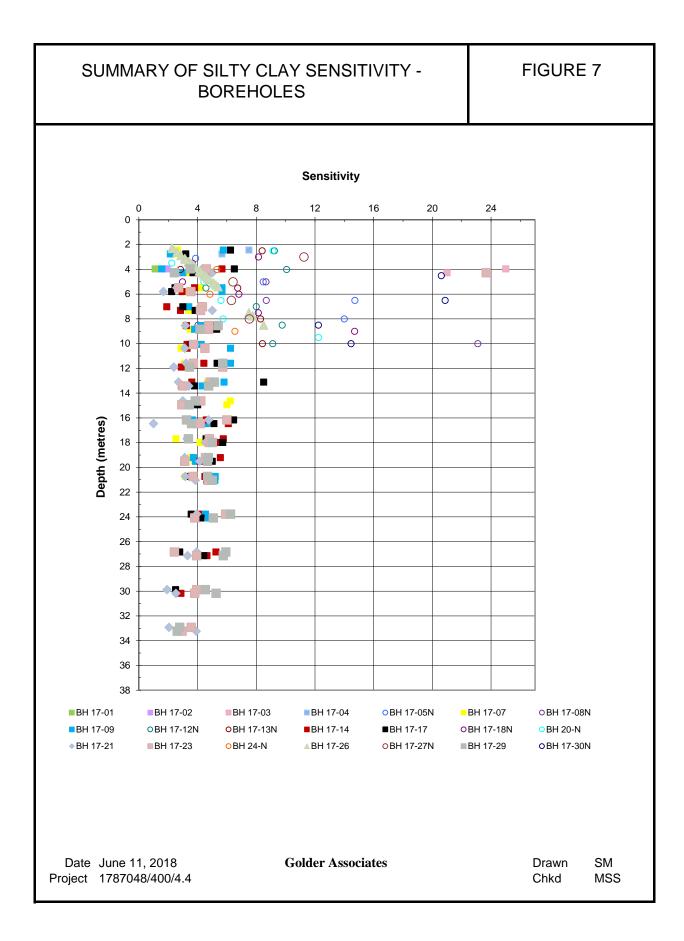
HECK REVIEW

FIGURE 5

SUMMARY OF UNDRAINED SHEAR STRENGTHS PROFILES - CPTS







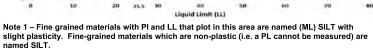
APPENDIX A

List of Abbreviations and Symbols Record of Boreholes – Current Investigation

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Туре	of Soil	Gradation or Plasticity	Cu	$u = \frac{D_{60}}{D_{10}}$		$Cc = \frac{(D)}{D_{10}}$	$(xD_{60})^2$	Organic Content	USCS Group Symbol	Group Name																					
		Gravels Gravels Gravels Signature Gravels Signature Gravels Signature Gravels		Poorly Graded		<4		≤1 or ≧	:3		GP	GRAVEL																					
(ss	5 mm)	ELS mass action 1	All Sauit All Sauit All All Sauit All All Sauit All All Sauit All All All All All All All All All Al	Well Graded		≥4		1 to 3	3		GW	GRAVEL																					
by ma	SOILS an 0.07	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with >12%	Below A Line			n/a]	GM	SILTY GRAVEL																					
INORGANIC (Organic Content s30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	c (>	fines (by mass)	Above A Line			n/a			≤30%	GC	CLAYEY GRAVEL																					
INOR	SE-GR ss is la) is um	Sands with ≤12%	Poorly Graded		<6		≤1 or 3	≥3	3078	SP	SAND																					
ganic (COAR: by ma	SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	fines (by mass)	Well Graded		≥6		1 to 3	3		SW	SAND																					
Ō	(>50%	SAN 50% by barse fr ller tha	Sands with >12%	Below A Line			n/a				SM	SILTY SAND																					
		sma c ()	fines (by mass)	Above A Line			n/a				SC	CLAYEY SAND																					
Organic						I	Field Indica	ators																									
or Inorganic	Soil Group	Туре	of Soil	Laboratory Tests	Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)	Organic Content	USCS Group Symbol	Primary Name																					
				Liquid Limit	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT																					
(ss	75 mm)		city ow)	<50	Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT																					
by ma	OILS an 0.01	SILTS SILTS below A-L on Plasti Chart bel	SILTS n-Plastic or PI	SILTS Bloctic or DI	SILTS Bloctic or DI	SILTS	SILTS	SILTS SILTS	SILTS	SILTS	SILTS SILTS	SILTS	SILTS n-Plastic or PI	SILTS D-Plastic or PI	SILTS n-Plastic or PI	SILTS n-Plastic or PI	SILTS D-Plastic or PI	SILTS D-Plastic or PI	SILTS D-Plastic or PI	SILTS Deplactic or PI	SILTS D-Plastic or PI	SILTS c or PI	SILTS (Non-Plastic or Pl and LL plot below A-Line on Plasticity Chart below)	or PI ow A-L Plastic		Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
aNIC ≤30%	VED S(-Plasti bel On		Liquid Limit	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	МН	CLAYEY SILT	
INORGANIC Content ≤30%	FINE-GRAINED SOILS mass is smaller than 0.	(Nor		≥50	None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	ОН	ORGANIC SILT																					
INORGANIC (Organic Content ≤30% by mass)	FINE by mas	(250% by mass is smaller than 0.075 mm) CLAYS SILTS and LL plot (Non-Plastic or Pl and LL	e on art	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0%	CL	SILTY CLAY																					
Ō	≥50% I		Plasticity Chart below)	Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium	to 30%	СІ	SILTY CLAY																					
			Plast	Liquid Limit ≥50	None	High	Shiny	<1 mm	High	(see Note 2)	СН	CLAY																					
S NIC	nic >30% iss)		mineral soil tures							30% to 75%		SILTY PEAT, SANDY PEAT																					
HIGHLY ORGANIC SOILS	(Organic Content >30% by mass)	may cor mineral so	nantly peat, ntain some pil, fibrous or nous peat							75% to 100%	PT	PEAT																					
40 30 10 10	Low	Plasticity		SILTY CLAY	CLAY CH CLAYEY 5 ORGANIC			a hyphen, For non-co the soil h transitiona gravel. For cohes liquid limit	for example, ohesive soils, as between I material b ive soils, the and plasticity	GP-GM, S the dual sy 5% and etween "c dual symb y index val	two symbols SW-SC and C ymbols must b 12% fines (i.a lean" and "di pol must be us ues plot in the ity Chart at lef	L-ML. ie used when e. to identify rty" sand or ed when the cL-ML area																					

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.



CLAYEY SILT ML

ORGANIC SILT OL

SILTY CLAY

a

SILTY CLAY-CLAYEY SILT, CL-ML

SILT ML (See Note 1)

Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

10

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	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)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (<i>i.e.</i> , SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

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.).

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_i), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); Nd: 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
- wн Sampler advanced by static weight of hammer
- Sampler advanced by weight of sampler and rod WR:

NON-COHESIVE (COHESIONLESS) SOILS

Compactness ²				
Term	SPT 'N' (blows/0.3m) ¹			
Very Loose	0 - 4			
Loose	4 to 10			
Compact	10 to 30			
Dense	30 to 50			
Very Dense	>50			

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.

2. Definition of compactness terms are based on SPT-N' ranges as provided in Terzaghi, Peck and Mesri (1996) and correspond to typical average N₆₀ values. Many factors affect the recorded SPT-N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), groundwater conditions, and grainsize. As such, the recorded SPT-'N' value(s) should be considered only an approximate guide to the compactness term. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction. Field Maint

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.			

5	Α	Μ	IP	L	E	s

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
FS	Foil sample
GS	Grab Sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
то	Thin-walled, open – note size
ТР	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

3012 12313	
w	water content
PL, w _p	plastic limit
LL, wL	liquid limit
С	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test1
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
М	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
SO4	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 aniso	tropically consolidated prior to shear are shown as CAD, CAU.

COHESIVE 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 1. effects; approximate only. SPT 'N' values should be considered ONLY an approximate guide to 2

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.

	Water Content
Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

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

I. /n x log ₁₀ g t	GENERAL 3.1416 natural logarithm of x x or log x, logarithm of x to base 10 acceleration due to gravity time	(a) W Wi or LL Wp or PL Ip or PI Ws IL Ic emax emin ID	Index Properties (continued) water content liquid limit plastic limit plasticity index = $(w_l - w_p)$ shrinkage limit liquidity index = $(w - w_p) / l_p$ consistency index = $(w_l - w) / l_p$ void ratio in loosest state void ratio in densest state density index = $(e_{max} - e) / (e_{max} - e_{min})$
II.	STRESS AND STRAIN		(formerly relative density)
γ Δ ε εν η υ σ σ΄ σ΄	shear strain change in, e.g. in stress: $\Delta \sigma$ linear strain volumetric strain coefficient of viscosity Poisson's ratio total stress effective stress ($\sigma' = \sigma - u$) initial effective overburden stress	(b) h q v i k	Hydraulic Properties hydraulic head or potential rate of flow velocity of flow hydraulic gradient hydraulic conductivity (coefficient of permeability) seepage force per unit volume
σ1, σ2, σ3	principal stress (major, intermediate, minor) mean stress or octahedral stress	(c) C _c	Consolidation (one-dimensional) compression index
σ _{oct} τ Ε G K	$= (\sigma_1 + \sigma_2 + \sigma_3)/3$ shear stress porewater pressure modulus of deformation shear modulus of deformation bulk modulus of compressibility	Cr Cs Cα mv Cv	(normally consolidated range) recompression index (over-consolidated range) swelling index secondary compression index coefficient of volume change coefficient of consolidation (vertical direction) coefficient of consolidation (horizontal
III. (2)	SOIL PROPERTIES	ch Tv U σ′p	direction) time factor (vertical direction) degree of consolidation pre-consolidation stress
(a) ρ(γ) ρd(γd) ρw(γw) ρs(γs) γ' D _R e n S	Index Properties bulk density (bulk unit weight)* dry density (dry unit weight) density (unit weight) of water density (unit weight) of solid particles unit weight of submerged soil $(\gamma' = \gamma - \gamma_w)$ relative density (specific gravity) of solid particles (D _R = ρ_s / ρ_w) (formerly G _s) void ratio porosity degree of saturation	ΟCR (d) ^{τ_p, τ_r φ' δ μ c' c_u, s_u p c' c_u, s_u p g u S_t}	over-consolidation ratio = σ'_p / σ'_{vo} Shear Strength peak and residual shear strength effective angle of internal friction angle of interface friction coefficient of friction = tan δ effective cohesion undrained shear strength ($\phi = 0$ analysis) mean total stress ($\sigma_1 + \sigma_3$)/2 mean effective stress ($\sigma'_1 + \sigma'_3$)/2 ($\sigma_1 - \sigma_3$)/2 or ($\sigma'_1 - \sigma'_3$)/2 compressive strength ($\sigma_1 - \sigma_3$) sensitivity
where	ty symbol is ρ . Unit weight symbol is $\gamma = \rho g$ (i.e. mass density multiplied by eration due to gravity)	Notes: 1 2	τ = c' + σ' tan φ' shear strength = (compressive strength)/2



RECORD OF BOREHOLE: 17-01

BORING DATE: December 18, 2017

SHEET 1 OF 1

DATUM: CGVD28

LOCATION: N 5020936.4 ;E 465673.3 SAMPLER HAMMER, 64kg; DROP, 760mm

J F	DOH-		SOIL PROFILE	-		SA	MPL		DYNAMIC PENETRA RESISTANCE, BLOV	``	k, cm			NG	PIEZOMETER
DEP IN SUALE METRES	BORING METHOD	D	ESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	түре	BLOWS/0.30m	20 40 I I SHEAR STRENGTH Cu, kPa	60 80 nat V. + Q - ● rem V. ⊕ U - C	WATER	10 ⁻⁵ 10 ⁻⁴ CONTENT PERC	10 ⁻³ ENT	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
1	BO	_		STR	(m)			BLC	20 40	60 80	20	40 60	80		
0		GROUND SURF	ACE .TY SAND, fine to		77.26								_		
		medium sand, plastic fines; b matter and clay	trace gravel, some low			1	ss	37							
1						2	ss	28							
2						3	ss	13							
	Power Auger	200 mm Diam. (Tollow Stern)				4	ss	2							
3					74.21										
		brown, contains	CLAY to CLAY; grey s silt seams 9 CRUST); cohesive,		3.05	5	ss	wн							
4		fine sand; grey	SAND to sandy SILT,		73.25 4.01 72.99				a -						
		(CI/CH) SILTY	CLAY to CLAY; grey with mottling, contains silt		4.27 72.38		ss	wн							
5		End of Borehol	e		4.88										
6															
7															
8															
9															
10															
DE	PTH	SCALE		1	<u> </u>	<u> </u>			GOL	DER					DGGED: DWM ECKED: SM

RECORD OF BOREHOLE: 17-02

BORING DATE: December 18, 2017

SHEET 1 OF 1

DATUM: CGVD28

LOCATION: N 5020989.8 ;E 465813.1 SAMPLER HAMMER, 64kg; DROP, 760mm

J.S.	BORING METHOD	SOIL PROFILE	⊢ I		SAM	PLES	DYNAMIC PENE RESISTANCE, B		Ì,	k,	IC CONDUC cm/s	2	ING ING	PIEZOMETER
METRES	G ME	DECODIDATION	STRATA PLOT	EV.	¥ ;	BLOWS/0.30m	20 40 SHEAR STRENG		80 + Q - ●	10 ⁻⁶	10 ⁻⁵ 1 I ER CONTEN	0 ⁻³ I NT	ADDITIONAL LAB. TESTING	OR STANDPIPE
Ξ	ORIN(DESCRIPTION	RAT¢	PTH (m)		OWS/0.	Cu, kPa	rem V. 6	₽ U- O				ADD LAB.	INSTALLATION
	ă			,	+	BL	20 40	60	80	20		80 	$\left \right $	
0		GROUND SURFACE FILL - (SM) SILTY SAND, some gravel;		77.46	+	+							$\left\{ \right\}$	
		FILL - (SM) SILTY SAND, some gravel; grey to blackish to brown, contains asphalt, organic matter and brick fragments; non-cohesive, moist, compact			1 5	SS 25				0				
1					2 5	SS 19				0				
2	ttam)	FILL - (ML) CLAYEY SILT and sandy SILT, some gravel; grey brown, contains organic matter; non-cohesive, moist, loose to very loose		75.9 <u>4</u> 1.52	3 5	SS 9				0				
	Power Auger				4 5	SS 3				0				
3	300 m	(CI/CH) SILTY CLAY to CLAY; grey brown, contains silt seams; cohesive, w>PL, soft		74.41 3.05	5 5	ss wh						0		
4							+							
		(SM/ML) SILTY SAND to sandy SILT, fine to medium sand; grey; non-cohesive, wet (CI/CH) SILTY CLAY to CLAY; grey with reddish brown mottling, contains silt seams; cohesive, w>PL, soft		7 <u>3.27</u> 4.19 4.27 72.58	6 5	SS WH								
5		seams; cohesive, w>PL, soft		4.88										
6														
7														
8														
9														
10														
DEI	PTH	SCALE					GO	LDF	R			 	LO	GGED: DWM

RECORD OF BOREHOLE: 17-03

BORING DATE: December 18, 2017

SHEET 1 OF 1

DATUM: CGVD28

LOCATION: N 5021042.5 ;E 465953.7 SAMPLER HAMMER, 64kg; DROP, 760mm

L L	ПНОВ	SOIL PROFILE		1	SA	MPLE					ION S/0.3m),		k, cm/s				AL NG	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE		20 HEAR S		i0 I NGTH	60 nat V.	80 + Q - ● ⊕ U - O	10 W/	L ATER C	ONTENT	I PERCE		ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
r I	BOR		STRA	(m)	N		BLOV	ц, кра 20		40	60	80	Wp 2		+0 (WI 80	LAI	
0		GROUND SURFACE		77.47															
		FILL - (SM) SILTY SAND, some gravel to gravelly, some low plastic fines; brown to black, contains organic matter; non-cohesive, moist, compact		0.00	1	SS 2	24												
1					2	SS 2	22												
2	ger ollow Stem)				3	SS 1	5												
2	200 mm Diam. (Hollow Stem)	(CI/CH) SILTY CLAY to CLAY; grey brown (WEATHERED CRUST), contains silt seams; cohesive, w>PL, stiff		75.19 2.28	4	SS	3												
3	2	(CI/CH) SILTY CLAY to CLAY; grey with reddish brown mottling, contains silt seams; cohesive, w>PL, soft		74.58 2.89															
					5	ss v													
4				73.20			•		+										
		End of Borehole		4.27															
5																			
6																			
7																			
8																			
9																			
10																			
DEF	PTH S	CALE						G	i O	L	DE	ER						LC	OGGED: DWM

RECORD OF BOREHOLE: 17-04

BORING DATE: December 18, 2017

SHEET 1 OF 1

DATUM: CGVD28

LOCATION: N 5021108.2 ;E 466090.6 SAMPLER HAMMER, 64kg; DROP, 760mm

ш		Ę	3	SOIL PROFILE			SA	MPL	ES	DYNA		BLOWS	ON /0.3m		HYDR	AULIC C k, cm/s	ONDUCT	IVITY,		0	
SCALI	METRES				OT.		~		m					30					0 ⁻³	ADDITIONAL LAB. TESTING	PIEZOMETER OR
TH S	ЛЕТК		≥ פ	DESCRIPTION	LA PL	ELEV.	NUMBER	TYPE	S/0.3				⊥ nat V. + rem V. ⊕		N	ATER C			NT	DITIO	STANDPIPE INSTALLATION
DEF	~				STRATA PLOT	DEPTH (m)	Ĩ	ŕ	BLOWS/0.30m						VV	р ——			WI	AD	
		-	-	GROUND SURFACE	ŝ				8		20	40	50 E	30	1	20 4	06	8 0	0		
-	0			(SP/SM) SAND to SILTY SAND, trace		76.30															
F				gravel; non-cohesive, wet, loose			1	SS	9							0					
Ē																					-
E																					-
-	1						2	SS	7							0					-
Ē								33	ľ												-
E						74.78															-
F			(jug	(CI/CH) SILTY CLAY to CLAY; grey brown, contains silt seams: cohesive,		1.52															-
Ē	0	Ļ.	ow Ste	w>PL, soft			3	SS	wн									0			-
E	2	- Auge	200 mm Diam. (Hollow Stem)				<u> </u>														
F		Power	Diam.							⊕ +											-
F			m 0																		-
E			8							⊕ +	-										-
F	3																				-
Ē							4	SS	wн												-
E																					-
F				(ML) condu CILT CILT and CLAVEV		72.49															-
F	4			(ML) sandy SILT, SILT and CLAYEY SILT, layered; grey; non-cohesive, wet,		3.01															-
E				very loose				SS	2												-
F				End of Borehole	34	71.88															-
Ē																					-
F	5																				-
F																					-
E																					-
F																					-
F	c																				-
E	6																				-
F																					-
F																					-
E																					-
F	7																				-
F																					-
E																					-
F																					-
-	8																				-
ZS																					-
2/18																					-
4/1																					-
GDT	9																				
-MIS.	Ĵ																				-
GAL																					-
GPJ																					-
048.0																					-
1787	10																				-
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS					<u> </u>	1	I	L			1	1	1	I	I	1					
-BHS	DE	PT	НS	CALE					C		GC	LI	DE	R						LC	DGGED: DWM
MIS	1:	50						<	V			_								CH	ECKED: SM

RECORD OF BOREHOLE: 17-05

BORING DATE: January 30, 2018

SHEET 1 OF 1

DATUM: CGVD28

LOCATION: N 5021093.1 ;E 465937.9 SAMPLER HAMMER, 64kg; DROP, 760mm

J.	гнор	SOIL PROFILE	1 - 1		SA	MPLE		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	k, cm/			ING	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION		ELEV. DEPTH (m)	NUMBER	ТҮРЕ	BLOWS/0.30m	20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q. • rem V. ⊕ U • O 20 40 60 80	WATER (10 ⁻³ ENT 1 WI 80	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
		GROUND SURFACE		76.35			-		20				
0	Τ	TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive, moist		0.00 0.08	1	SS	7						
		(SP/SM) SAND to SILTY SAND; brown; non-cohesive, moist, loose				33	<i>`</i>						
1		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silt seams		75.59 0.76									
ľ		(WEATHERED CRUST); cohesive, w>PL, stiff		75.0 <u>1</u>	2	SS	3						
		CI/CH) SILTY CLAY to CLAY; grey, contains silt seams; cohesive, w>PL, soft		1.34									
2				-									
					3	TP	PH				104.8	Рс	
				Ī									
3				-									
		(SM/ML) SILTY SAND to sandy SILT;		72.84 3.51	4	SS V	ΝН						
4		grey; non-cohesive, wet (CI/CH) SILTY CLAY to CLAY; grey, contains silt seams; cohesive, w>PL,		3.66									
ŕ		firm to soft											
	Boring			ŀ									
5	Wash Boring HW Casing				5	ss v	ΝR						
				F									
6				F	6	TP I	PH				0	с	
				-									
7													
ŕ													
				-									
8					7	ss v	ΝR						
				F									
9				╞									
				66.80	8	TPI	PH						
		End of Borehole		9.55									
10													
DE	PTH	SCALE							i	i		LOC	GGED: DG
DEI 1:		SCALE					P	GOLDER					GGED: DG CKED: SM

RECORD OF BOREHOLE: 17-05N

BORING DATE: January 11, 2018

SHEET 1 OF 2

DATUM: CGVD28

LOCATION: N 5021093.1 ;E 465937.9 SAMPLER HAMMER, 64kg; DROP, 760mm

	ДOH	SOIL PROFILE			SA	MPLE		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	≓ິ2 PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE	BLOWS/0.30m	20 40 60 80 SHEAR STRENGTH nat V. + Q - ● Cu, kPa rem V. ⊕ U - O	10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴ 10 ⁻³ WATER CONTENT PERCENT Wp	PIEZOMETER OR STANDPIPE INSTALLATION
\square	BC		STF	(m)			BL(20 40 60 80	20 40 60 80	
0 -	Power Auger 200 mm Diam. (H.S)	(CI/CH) SILTY CLAY to CLAY; grey brown, contains silt seams (WEATHERED CRUST); cohesive, w>PL, stiff		76.35 0.05 75.59 0.76 75.01	1		7			
2 3 4 5 6 7 8	Nilcon Vares Clutch	For soil stratigraphy refer to Record of Borehole 17-05		1.34			9	$\begin{array}{c} + \\ + \\ + \\ + \\ + \\ + \\ + \\ + \\ + \\ + $		
9 10 -		CONTINUED NEXT PAGE		66.35				► +		
DEF	PTH	SCALE			•			GOLDER		LOGGED: DG

RECORD OF BOREHOLE: 17-05N

BORING DATE: January 11, 2018

SHEET 2 OF 2

DATUM: CGVD28

LOCATION: N 5021093.1 ;E 465937.9 SAMPLER HAMMER, 64kg; DROP, 760mm

┟		Q	SOIL PROFILE			SAMF	PLES	DYNAMIC	PENETRATI	ON	<u>}</u>	HYDRAU k	LIC CO	NDUCTI	VITY,			
	METRES	BORING METHOD		LOT				RESISTAN		60.3m	^ر ,	10 ⁻⁶				3	ADDITIONAL LAB. TESTING	PIEZOMETER
Ē	METE	RING N	DESCRIPTION		LEV. EPTH		BLOWS/0.30m	SHEAR ST Cu, kPa	RENGTH	nat V. + rem V. ⊕	Q - ● U - O					T //	AB. TE	STANDPIPE INSTALLATION
ŭ	ā	BOI		STR	(m)	z	BLO	20	40	60 8	0	20	40				~ _	
-	10		CONTINUED FROM PREVIOUS PAGE End of Borehole		10.00	_												
-																		-
Ē																		-
-	11																	-
E																		-
Ē																		-
-																		-
-	12																	-
Ē																		-
Ē																		-
Ē	13																	-
Ē																		-
Ē																		-
-																		-
-	14																	
-																		-
Ē																		-
-	15																	-
Ē																		-
Ē																		-
-	16																	-
Ē																		-
Ē																		
Ē																		-
-	17																	
Ē																		-
Ē																		-
-	18																	-
SZ 2																		-
112/18																		
3DT 4	40																	-
-MIS.	19																	-
l GAL																		-
48.GP.																		-
17870	20																	-
\$ 001																		
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS			SCALE					G	OLI	DE	R							OGGED: DG
Σ	1:	50															UH	ECKED: SM

RECORD OF BOREHOLE: 17-07

BORING DATE: December 19-21, 2017

SHEET 1 OF 4

DATUM: CGVD28

LOCATION: N 5021228.9 ;E 465864.4 SAMPLER HAMMER, 64kg; DROP, 760mm

	ТНОВ	SOIL PROFILE			SAI	MPLES		PENETRA ICE, BLOW		λ,		AULIC C k, cm/s				₽g	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	ATA □	ELEV. EPTH (m)	NUMBER	TYPE BLOWS/0.30m	20 I SHEAR ST Cu, kPa	40 I RENGTH		80 - Q - ●	w	0 ⁻⁶ 1 ATER C	ONTENT	PERCE		L ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
_	B			(,		Ē	20	40	60	80					80	+	
0		GROUND SURFACE (SM) SILTY SAND, fine; grey brown,		76.29 0.00		+	+		+							+	
		contains organic matter; non-cohesive, moist, very loose			1	ss wi						0					
1		(CI/CH) SILTY CLAY to CLAY, trace sand; grey brown, contains silt layers and organic matter (rootlets) (WEATHERED CRUST); cohesive, w>PL, stiff		75.53 0.76	2	SS 3							Þ				
		(CI/CH) SILTY CLAY to CLAY; grey with reddish brown mottling, contains silt seams; cohesive, w>PL, soft to firm		74.7 <u>7</u> 1.52	3	ss wi	I				F			-90			
2				73.24			⊕ + ⊕ -	+									
		(ML) sandy SILT; grey; non-cohesive, wet, compact to loose		3.05 72.63	4	SS 10						0				м	
		(CI/CH) SILTY CLAY to CLAY; grey with reddish brown to black mottling, contains silt seams; cohesive, w>PL, soft		3.66			⊕ +										
4							⊕ +										
5	Wash Boring HW Casing				5	ss wi								0			
6	≥ -						⊕ + ⊕ +										
J				-	6	ss wi								¢			
7							⊕ +										
				-			⊕ +										
8					7	SS WF											
9							⊕ + ⊕ +										
3					8	ss wr									0		
10		CONTINUED NEXT PAGE			_				+						+	-	
DE	PTH	SCALE						OL	DF	P						LO	GGED: DWM

RECORD OF BOREHOLE: 17-07

LOCATION: N 5021228.9 ;E 465864.4

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: December 19-21, 2017

SHEET 2 OF 4

DATUM: CGVD28

J Z	ТНОВ	SOIL PROFILE		-	SA			DYNAMI RESISTA				λ,		k, cm/s				NG NG	PIEZOMETER
METRES	BORING METHOD	DECODENTION	STRATA PLOT	ELEV.	BER	_щ	BLOWS/0.30m	20 SHEAR S				80 - 0 - ●	10 W		0 ⁻⁵ 1 ONTEN	1	10 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
Ξ	ORIN	DESCRIPTION	'RATA	DEPTH (m)	NUMBER	TYPE	OWS	SHEAR S Cu, kPa		ſ	em V. €	9 ŭ- O	Wp				WI	ADD LAB.	INSTALLATION
_	ä		ST	()		$\left \cdot \right $	В	20	40) (60 	80	2	0 4	10	60	80	+ +	
10		CONTINUED FROM PREVIOUS PAGE (CI/CH) SILTY CLAY to CLAY; grey with						⊕ -	+										
		reddish brown to black mottling, contains silt seams; cohesive, w>PL, soft						⊕ +											
11				65.01	9	SS \	WR												
		(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams;		11.28															
		cohesive, w>PL, firm						⊕	+										
12								⊕	+										
					10	SS \	wн												
13								Ð		F									
										•									
								Ð	+										
14					11	SS \	WR									9			
		(CI/CH) SILTY CLAY to CLAY; grey with		61.97 14.32															
		black mottling, contains silt seams; cohesive, w>PL, stiff		61.51				⊕		+									
15	Wash Boring HW Casing	(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, firm		14.78				⊕		+									
-	Wash HW (cohesive, w>PL, firm																	
					12	SS N	WR												
16																			
								Ð		+									
								Ð	ŀ	ł									
17					13	SS	WR												
										+									
18								Ð		+									
				58.00															
		(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, stiff		18.29															
		conesive, w>PL, stiff			14	SS \	wR												
19																			
								⊕			+								
								⊕		+									
					15	ss v	WR												
20	_ L		_1111	1				+			+			<u> </u>	+		+	- -	
		I		1									I	L	1	1			
	PTH S 50	SCALE				Į	Þ	; G	0	L) E	R							GED: DWM CKED: SM

RECORD OF BOREHOLE: 17-07

LOCATION: N 5021228.9 ;E 465864.4

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: December 19-21, 2017

SHEET 3 OF 4

DATUM: CGVD28

щ		ДŎ	SOIL PROFILE		s	AMP	LES	DYNAMIC RESISTAI	PENE NCE, B	TRATIC	N 0.3m	$\overline{\boldsymbol{\lambda}}$	HYDR	AULIC C k, cm/s	ONDUCT	TIVITY,		٥	
DEPTH SCALE METRES		BORING METHOD		STRATA PLOT		10	BLOWS/0.30m	20	40	6	0 8		1	0 ⁻⁶ 1	0 ⁻⁵ 1	0 ⁻⁴ 1	0-3	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE
DEPTH MF		DRING	DESCRIPTION	ATA DEL	тн §	TYPE	0/S/Q	SHEAR S Cu, kPa	TRENG	STH n re	atV. + emV.⊕	Q - ● U - O	w w				NT WI	ADDI ^T LAB. T	INSTALLATION
Ĕ	+	В		N STR	" ~		BL(20	40	6	8 0	0					30		
- 2	0		CONTINUED FROM PREVIOUS PAGE (CI/CH) SILTY CLAY to CLAY; grey with		+	+	-		-+						0				
-			black mottling, contains silt seams; cohesive, w>PL, stiff		15	SS	WR												
-								e		+									
- 2	1																		-
								Ð		+									
Ē																			
-																			
- 2	2																		-
-				5	3.73														
-			(SM/ML) SILTY SAND to sandy SILT, some low plastic fines, some gravel to gravelly; grey, contains rock fragments		2.56														
- 2	3		gravelly; grey, contains rock fragments (GLACIAL TILL); non-cohesive, wet, dense to very dense																-
-					16	SS	39												
-																			
- 2	4																		-
-	a a la a	ging	,																
Ē	1 dech	Wasn Boring HW Casing			17	SS	54						0						
- 2	5																		-
-																			
-																			
- 2	6																		-
-					18	SS	87											CHEM	
E																			
- 2	7																		_
-	<i>`</i>																		
-																			
Ē					19	SS	50												
- 2	8					-													-
/18 Z(
4/12																			
S.GDT	9				20	ss	>50												-
AL-MI					6.90	1													
SPJ G			Borehole continued on RECORD OF DRILLHOLE 17-07	29	9.39														
37048.G																			
1 178																			
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS)EP	TH	SCALE					G	\mathbf{a}	I F		D							DGGED: DWM
9-SIM	: 5											R							ECKED: SM

			F: 1787048/400/4.4		REC	co	RD	0																					ET 4		
			N: N 5021228.9 ;E 465864.4 ION: -90° AZIMUTH:						DF	RILL	RIG:	LC	∃: D€ 55 TRAC]								L	JAT	JM: C	GVD2	8
DEPTH SCALE METRES			DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH <u>COLOUR</u>	SH VN CJ RI	ε % (iear ein onjuga	R.C	CO- OR- CL-	RACT. INDEX PER 0.25 m	t onal	le D	UN- ST - IR -	t. TYP	ating	URFACE	Slicke Smoo Roug Mech	ensid oth h	al Bre HY CON K	eak	NOTE abbrev of abb symbo ULIC TIVIT sec	: For : viation reviations. Js. VPoir Ii (f	additi s refe ions &	ad _{RM0}	t			
30	Rotary Drill	HQ Core	BEDROCK SURFACE Possible weathered rock, till infilling Slightly weathered to fresh, thinly to medium bedded, grey to dark grey, fine grained, slightly to non-porous SHALE, with limestone and calcareous shale interbeds CARLSBAD FORMATION - Broken core from 29.69 m to 30.00 m - Broken core from 30.59 m to 30.70 m - Broken core from 30.86 m to 30.88 m		46.90 29.39 29.52	1 2 3	100							0.0	5		σ								~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	4 00			S = 13	5.8 MPa	-
- - - - - - - - - - - - - - - - - - -			End of Drillhole		<u>43.83</u> 32.46																							_			-
- 35 - 35 - 36 - 36 - 36																															-
MIS-RCK 004 1787048.GPJ GAL-MISS.GDT 4/12/18 ZS 66 88 88 88 88 88 88 88 88 88 88 88 88 8																															-
DE WIS-RCK 007		 H S	CALE						(G	0	L	D	E	R	2	11			1			1			1			GED: KED:		

RECORD OF BOREHOLE: 17-08

BORING DATE: January 10, 2018

SHEET 1 OF 1

DATUM: CGVD28

LOCATION: N 5021301.7 ;E 465837.2 SAMPLER HAMMER, 64kg; DROP, 760mm

۳. F	тнор	SOIL PROFILE			SAN	MPLES	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	
METRES	BORING METHOD	DESCRIPTION		ELEV. DEPTH (m)	NUMBER	TYPE BLOWS/0.30m	20 40 60 80 SHEAR STRENGTH nat V. + Q - ● Cu, kPa rem V. ⊕ U - O	10 ⁶ 10 ⁵ 10 ⁴ 10 ³ WATER CONTENT PERCENT Wp ├─────────── W──── I WI 20 40 60 80	PIEZOMETER OR ELET GR INSTALLATION
		GROUND SURFACE		76.12			20 40 60 80	20 40 60 80	
0 -		TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive, moist (SM) SILTY SAND; brown; non-cohesive, moist, loose		0.00	1	SS 7			
1	Stem)	(CI/CH) SILTY CLAY to CLAY; grey brown, contains silt seams (WEATHERED CRUST); cohesive, w>PL, stiff		74.78	2	SS 2			
2	200 mm Diam. (Hollow	(CI/CH) SILTY CLAY to CLAY; grey with reddish brown mottling, contains silt		1.34	3	ss wh			
-	200 п			73.38					
3		(SP/SM) SAND to SILTY SAND, fine sand; grey; non-cohesive, wet, very loose		2.74	4	SS 2			
4		(CI/CH) SILTY CLAY to CLAY; grey with occasional reddish brown mottling, contains silt seams; cohesive, w>PL, soft		0.20					
					5	TP PH			С
5									
6					6	SS WH			
7	Wash Boring HW Casing								
					7	TP PH			c
8				_	8	SS WH			
9				-	9	ss wн			
10		End of Borehole		66.37 9.75					
DEF	PTH	SCALE	1 1	1			GOLDER		LOGGED: DG

RECORD OF BOREHOLE: 17-08N

BORING DATE: January 9, 2018

SHEET 1 OF 2

DATUM: CGVD28

LOCATION: N 5021301.7 ;E 465837.2 SAMPLER HAMMER, 64kg; DROP, 760mm

luary 9, 2018

бЩ.			F				ε	00	RATION DWS/0.3m	``		, cm/s		.4 .	0-3	I₹EI	PIEZOMETER
WEI	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.30m	20 40 SHEAR STRENGT Cu, kPa	60 80 H nat V. + C	<u>2</u> -●		ER CON	NTENT	PERCE	0 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
METRES	BORI		STRA	DEPTH (m)	₽	-	BLOW	20 40	60 80	J- ()	Wp ⊢ 20	40			WI 30	LAI	
		GROUND SURFACE		76.12											Ĺ		
0	Ê	TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive, moist		0.00 0.09													
	v Stem)	(SM) SILTY SAND; brown;			1	SS	7										
	Auger (Hollow	non-cohesive, moist, loose		75.57 0.55													
	Power Auger Diam. (Hollo	(CI/CH) SILTY CLAY to CLAY; grey brown, contains silt seams (WEATHERED CRUST); cohesive,		0.00													
1	200 mm Diam.	(WEATHERED CRUST); cohesive, w>PL, stiff				SS	2										
	200				2	33	2										
ŀ		For soil stratigraphy refer to Record of		74.77													
		Borehole 17-08						+									
2																	
								+									
3									+								
Ĭ																	
								⊕ +									
4								+									
								+									
5								⊕ +									
	Nilcon Vanes Clutch							+									
	Clutch																
6	ž							+									
7								+									
								+									
8								+									
								⊕ +									
9								+									
								+									
10				66.12				╾┛┰╶└							L		
'' [_	CONTINUED NEXT PAGE										Ī					
			•	•	•					<u> </u>	· · · ·				•		
DEF	РТН 8 60	SCALE				Q		GOI	DEF	₹							ogged: Dg Ecked: Sm

RECORD OF BOREHOLE: 17-08N

BORING DATE: January 9, 2018

SHEET 2 OF 2

DATUM: CGVD28

LOCATION: N 5021301.7 ;E 465837.2 SAMPLER HAMMER, 64kg; DROP, 760mm

	Q	SOIL PROFILE		SA	MPLE	S DYN	NAMIC PEN BISTANCE		ON \	<u>}</u> +	HYDRAULIC (k, cm/	CONDUCT	TIVITY,		(7)	
DEPTH SCALE METRES	BORING METHOD		LOT	L m					i0.511 i0 80	`			0-4 10	D ⁻³	ADDITIONAL LAB. TESTING	PIEZOMETER OR
PTH S	NG N	DESCRIPTION	STRATA PLOT (m) (m)		TYPE	SHE		NGTH r	at V. + C em V. ⊕ L		WATER				DDITIO	STANDPIPE INSTALLATION
DE	BOR		(m)	ן ב					i0 80		Wp			WI 0	LA	
- 10		CONTINUED FROM PREVIOUS PAGE	40.00													
-		End of Borehole	10.00	1												
E																-
-																
- - - 11																- -
-																-
Ē																-
E																-
- 12																-
-																-
-																-
-																-
- 13																-
E																-
-																:
-																-
- 14																-
E																-
E																-
E																-
- 15																-
Ę																-
-																-
F																:
- 16 - 16																
-																-
-																-
-																:
- 17 - 17																-
-																-
Ē																-
-																-
- 18																-
ZS																-
12/18																-
0T 4/																-
19 19 19																-
H H																-
- G																-
048.G																-
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		1														-
001	1											1				
DI BHS	EPTH	SCALE					GC		DEF	R						OGGED: DG
<u>б</u> М	50									-					CH	ECKED: SM

RECORD OF BOREHOLE: 17-09

BORING DATE: January 3-9, 2018

SHEET 1 OF 5

DATUM: CGVD28

LOCATION: N 5021391.2 ;E 466055.7 SAMPLER HAMMER, 64kg; DROP, 760mm

	ТНОВ	SOIL PROFILE			SA	MPLE		DYNAMIC PENETRA RESISTANCE, BLO		Ì,		k, cm/s				NG NG	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION		ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	20 40 HEAR STRENGTH Cu, kPa	nat V. + rem V. ⊕	U- O	w w	↓ /ATER C p		PERCE	WI	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
+	ш	GROUND SURFACE	Ś	(,		i	ā	20 40	60 8	30	2				0		
0	\top	TOPSOIL - (SM) SILTY SAND; black;		76.56 0.00		\vdash	+										
		non-cohesive, wet (SM) SILTY SAND; grey brown;		76.26 0.30	1	SS	2					0				м	
		non-cohesive, moist, very loose															
		(CI/CH) SILTY CLAY to CLAY; grey		75.80 0.76													
1		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silt seams and organic matter (roots) (WEATHERED CRUST);			2	SS	2							0			
		cohesive, w>PL, stiff to firm															
				ŀ													
		(CI/CH) SILTY CLAY to CLAY; grey with		74.7 <u>3</u> 1.83	3	ss v	νн							c			
2		reddish brown mottling, contains silt seams; cohesive, w>PL, very soft to soft		1.00													
		Souris, Concerve, WAT L, VELY SUIL IU SUIL		ſ													
							⊕	+									
								⊕ +									
3				╞													
					4	ss v	VR								þ		
				ſ													
4								⊕+									
		- Possible silt layer						⊕ +									
				╞													
	sing				5	ss v	νн										
5	Wash Boring HW Casing																
	≤			ſ													
							⊕	+									
							⊕	+									
6				ļ													
					6	ss v	VH							0			
					5												
				f													
7							e	→ +									
							€	+									
				ļ													
					7	ss v	VR										
8					'	33 1											
				F													
							€	+									
							e	» +									
9				ļ													
					8	SS V	٧K										
10		CONTINUED NEXT PAGE		66.56			- -	-+	-+	<u> </u>	+		+		+	·	
											I	I	I	I	I		
DEF	TH S	CALE				Ň	5	GOL	DE	R						LC	GGED: DWM

RECORD OF BOREHOLE: 17-09

BORING DATE: January 3-9, 2018

SHEET 2 OF 5

DATUM: CGVD28

LOCATION: N 5021391.2 ;E 466055.7 SAMPLER HAMMER, 64kg; DROP, 760mm

, y o o, 2010

	DOH-	SOIL PROFILE		-	SA	MPL		DYNAMIC PE RESISTANC	NETRA E, BLOV	TION VS/0.3m)		, cm/s				RGA	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE	BLOWS/0.30m	20 J SHEAR STR Cu, kPa	40 I ENGTH	60 I nat V. rem V.	80			NTENT	PERCE		ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
2	BOR		STRA	(m)	P		BLOV	20 20	40	<u>60</u>	80	Wp ⊢ 20	4(0 ^W		WI 80	ĽP №	
10		CONTINUED FROM PREVIOUS PAGE (CI/CH) SILTY CLAY to CLAY; grey with	XXX	10.00				⊕ +										
		reddish brown to black mottling, contains silt seams; cohesive, w>PL, soft to firm		10.00														
								⊕ +										
11					9	SS	WR								0			
								⊕ +										
12								⊕ +										
		(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams:		64.37 12.19														
		black mottling, contains silt seams; cohesive, w>PL, firm			10	SS	WR											
40						$\left \right $												
13								⊕ +										
								⊕ -	-									
14					11	SS	WR											
								Ð	+									
15	Wash Boring HW Casing							Ð	+									
	Was																	
					12	SS	WR											
10																		
16								⊕	+									
								Ð	+									
17					13	SS	WR								0			
18																		
				58.27														
		(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, stiff		18.29	14	SS	WR											
		, ,																
19								Ð	4									
								⊕		+								
								Ψ		T								
20	_L				15	ss	WR	+	-	-+		├ -	-+			+	––	
		CONTINUED NEXT PAGE																
DEF	PTH S	SCALE					C	G) L	DE	ER							ogged: DWM Ecked: SM

RECORD OF BOREHOLE: 17-09

BORING DATE: January 3-9, 2018

SHEET 3 OF 5

DATUM: CGVD28

LOCATION: N 5021391.2 ;E 466055.7 SAMPLER HAMMER, 64kg; DROP, 760mm

ц Д	DOH	SOIL PROFILE			SA	AMPL	_	DYNAMIC PE RESISTANCE			Ì,		k, cm/s				RGAL	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION		ELEV.	NUMBER	TYPE	BLOWS/0.30m		40 NGTH		30 · Q - ●			0 ⁻⁵ 1 I ONTENT	1	10 ⁻³ ENT	ADDITIONAL LAB. TESTING	
.≥	BORIN		TRAT,	DEPTH (m)	NUM	≿	SMOT	SHEAR STRE Cu, kPa				Wp	• I	—0 ^W		WI	ADI LAB.	INSTALLATION
	-	CONTINUED FROM PREVIOUS PAGE					ш	20	40	<u>60 8</u>	30	2	0 4	ιο e	50	80	+	
20		(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, stiff			15	ss	WR											
		cohesive, w>PL, stiff				-												
								Ð	+									
21								Ð		+								
22																		
23]_												
					16	SS	WR								10			
						1												
24								Ð	+									
								Ð		+								
	ing																	
25	Wash Boring HW Casing																	
	> _																	
26																		
					17	SS	1						С					
				49.89														
		(SM/ML) SILTY SAND to sandy SILT, some low plastic fines, some gravel to		26.67	18	SS	55											
27		some low plastic fines, some gravel to gravelly; grey, contains rock fragments and cobbles (GLACIAL TILL); non-cohesive, wet, very dense																
28																		
					19	SS	56											
29					20													
					20	SS	~5U											
					21	ss	>50											
30		CONTINUED NEXT PAGE	-9112	46.55		+-	-	+	-	+	 		<u> </u>	+		+	-	
															I			
DEI		SCALE					Ç	GC) L	DE	R							ogged: DWM Ecked: SM

RECORD OF BOREHOLE: 17-09

BORING DATE: January 3-9, 2018

SHEET 4 OF 5

DATUM: CGVD28

LOCATION: N 5021391.2 ;E 466055.7 SAMPLER HAMMER, 64kg; DROP, 760mm

	9	SOIL PROFILE			SA	MPLE	ES	DYNAMIC PE RESISTANCE		DN)	HYDRA		NDUCT	IVITY,			
DEPTH SCALE METRES	BORING METHOD		TO.								⁰ ``	10	k, cm/s ⁶ 10) ⁻⁵ 1(D ⁻⁴ 10	Q ⁻³	ADDITIONAL LAB. TESTING	PIEZOMETER OR
PTH S METR	M DN	DESCRIPTION	TA PL	ELEV.	NUMBER	TYPE	/S/0.3	SHEAR STRE Cu, kPa				WA	ATER CO	ONTENT	PERCE		BDITIO	STANDPIPE INSTALLATION
DEI	BORI		STRATA PLOT	DEPTH (m)	INN	-	BLOWS/0.30m			60 8		Wp 20	→ → 4			WI 80	LAE	
20		CONTINUED FROM PREVIOUS PAGE					_	20	40 (<u>, 4</u>	5 0				
— 30 —		Borehole continued on RECORD OF DRILLHOLE 17-09		30.01														-
-																		-
E																		-
È																		-
- 31																		
-																		-
Ē																		-
-																		-
— 32 _																		
F																		-
Ē																		-
F																		-
- 33 -																		
-																		
Ē																		-
- - - 34																		-
- 34																		-
_																		-
-																		-
- - - 35																		-
-																		-
-																		-
E																		-
- - 36																		-
Ē																		-
-																		-
Ē																		-
- 37																		-
Ē																		-
F																		-
E																		-
- 38																		-
																		-
12/18																		-
1 4/-																		=
- 39 - 39																		
AL-M																		-
P. G.																		-
148.G	1																	-
40																		_
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS 0 01 01 01 01 01 01 01 01 01 01 01 01 01	1																	
SH8-	EPTH S	SCALE					Ċ	GC) L [ΣE	R							DGGED: DWM
SW 1:	50						V										CH	ECKED: SM

			T: 1787048/400/4.4		RE	СС	RD) ()											IEET				
			N: N 5021391.2 ;E 466055.7 TON: -90° AZIMUTH:						I	DRI	LL I	RIG:	LC			-				8 e Dril	ling										DA	TUN	1: C	GVE	028	
DEPTH SCALE METRES		DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR	S VEIC 2 VEIC	HR- N - J - REC	Joint Faul Shea Vein Conj OVE	ar jugat RY OLID	R.C	CC OR CL	- Bec - Foli - Cor - Orth - Cle - Cle INDE PEI	nogo avag CT.		Ir	IR -	- Ste - Irre SCOI	nar ved dulating pped gular NTINUI	F N TY DA		Slicke	ensid ith	al Bre	eak DRA	NOT abbre of ab symb	E: Fo eviatio brevia iols.	roker ons re ations liame oint L Inde (MPa	itiona ifer to : &	al o list					
		DRII	BEDROCK SURFACE	λs	46.55		FLUSH	8	0RE %	6 CO	0RE %	2		0.25 500	m				s ľ	YPE AN DESC	ID SUR RIPTIC	FACE	Jcon	Jr Ja							-¥ AVG.					
- - - - - - - - - -			Slightly weathered to fresh, thinly to medium bedded, grey to dark grey, fine grained, slightly to non-porous SHALE, with limestone and calcareous shale interbeds CARLSBAD FORMATION		30.01		1	100																												
- - - - - - - - - - - - - - - - - - -	Rotary Drill	HQ Core	- Silt seam from 30.15 m to 30.24 m - Silt seam from 31.03 m to 31.08 m			2		100																												
- - - - 33					43.42	3		100																												
- 34 - 35 - 35 - 36 - 36 - 37			End of Drillhole		33.14																															
- 38 - 39 - 40 DE 1:																																				
DE 1:			CALE			<u> </u>			 	G	; (C	L	D)	E	R	2					- 1				1			. 1) GGE			M	

RECORD OF BOREHOLE: 17-12N

BORING DATE: January 17, 2018

SHEET 1 OF 2

DATUM: CGVD28

LOCATION: N 5021345.5 ;E 466151.3 SAMPLER HAMMER, 64kg; DROP, 760mm

, 2010

S S S	ETHOD	SOIL PROFILE	1					DYNAMIC PEI RESISTANCE 20			ر ۵	HYDRAUL k, 10 ⁻⁶	cm/s 10 ⁻⁵		Υ, 10 ⁻³	NAL	PIEZOMETER OR
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	. =	TYPE	BLOWS/0.30m	SHEAR STRE Cu, kPa	_			WAT	ER CONT			ADDITIONAL LAB. TESTING	STANDPIPE INSTALLATION
1	BO		STR	(m)		\square	BLC	20	40	60 8	0	20	40	60	80	<u> </u>	
0		GROUND SURFACE		76.57			\square									+ $+$	
	Stem)	brown; non-cohesive, moist		76.34		SS	6										
	uger Iollow	(SM) SILTY SAND; brown; non-cohesive, wet, loose (CI/CH) SILTY CLAY to CLAY; grey brown, contains silt seams (WEATHERED CRUST): cohesive, w>PL, stiff		75.96		33	U										
	Power Auger	E (CI/CH) SILTY CLAY to CLAY; grey		0.61													
1	P	WEATHERED CRUST): cohesive,			2	ss	3										
, i	200	w>PL, stiff		75.32													
				1.25				+									
2								+									
-																	
							đ	→ +									
							ľ										
3								+									
3								'									
								+									
								、 _									
4							đ	→ +									
									+								
5								1									
	es																
	Nilcon Vanes Clutch	Internet					ľ	⊕ +									
	ZIIC C																
6								+									
								+									
7							ŧ	₽ +									
								+									
8								+									
							đ	₽ +									
9								+									
								+									
10	_1_	CONTINUED NEXT PAGE		66.57		+ -	-	►-+		+	<u> </u>	-	-+-	· _ - ·	-+	- -	
				1	I											<u> </u>	
DE	РТН	ISCALE				ľ	D	GC) L	DE	R					LOC	GGED: DG

RECORD OF BOREHOLE: 17-12N

BORING DATE: January 17, 2018

SHEET 2 OF 2

DATUM: CGVD28

LOCATION: N 5021345.5 ;E 466151.3 SAMPLER HAMMER, 64kg; DROP, 760mm

	9	SOIL PROFILE		SA	MPLES	DYNA	MIC PEN STANCE,	ETRATIO)N	>	HYDRA		NDUCT	IVITY,		(1)	
DEPTH SCALE METRES	BORING METHOD		LOT	æ	E C				0.3m 0 80	,``	10	k, cm/s ⁶ 10	o ⁵ 10)-4 10	D-3	ADDITIONAL LAB. TESTING	PIEZOMETER OR
PTH 8	NG N	DESCRIPTION	STRATA PLOT (m) (m)	NUMBER	TYPE BI OWS/0 30m	SHEA Cu. kF		IGTH r	at V. + em V. ⊕				DNTENT	PERCE	NT	DDITIO	STANDPIPE INSTALLATION
DE	BOR		(m)	z					0 80		Wp 20				WI 0	LA	
- 10		CONTINUED FROM PREVIOUS PAGE	10.00														
-		End of Borehole	10.00														
Ē																	-
Ē																	-
- 11																	_
Ē																	-
F																	-
E																	-
- - 12	:																-
Ē																	-
Ē																	:
E																	-
- - 13																	-
F																	:
Ē																	-
-																	-
- 14 -																	-
Ē																	-
F																	-
Ē																	-
- 15 -																	-
Ē																	-
È																	-
-																	-
- 16 -																	-
F																	-
Ē																	-
-																	-
- 17 - -																	
E																	-
Ē																	-
- - - 18																	-
-																	-
1 1 1																	-
4/12																	-
L GD 19																	-
L-MIS																	-
L GA																	-
8.GP																	-
+0187 - 1 50																	-
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0																	
D BHS C	EPTH	SCALE					G O	Г	DE	P						LC	OGGED: DG
M	: 50															CH	ECKED: SM

RECORD OF BOREHOLE: 17-13N

BORING DATE: January 17, 2018

SHEET 1 OF 2

DATUM: CGVD28

LOCATION: N 5021450.3 ;E 466217.9 SAMPLER HAMMER, 64kg; DROP, 760mm

METRES	BORING METHOD		SOIL PROFILE		1	S/	AMPL		DYNAMIC PENE RESISTANCE, I			ζ.		k, cm/s				ING	PIEZOMETER
TRE	ME			STRATA PLOT	ELEV.	ËR		BLOWS/0.30m	20 4				10 ⁻⁶				10 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
Ξ	SNIS		DESCRIPTION	ATA	DEPTH	NUMBER	TYPE	WS/(SHEAR STREN Cu, kPa	GTH	nat V. + rem V. ⊕	Q - ● U - O	WA			PERCE		ADDI: AB. T	INSTALLATION
	BOF			STR/	(m)	Ĭ		BLO	20 4			80	Wp 20	4			WI 80	□	
		+	GROUND SURFACE		76.43			-	20 4				20	4	. (
0		2	TOPSOIL - (SM) SILTY SAND: dark	EEE	0.00						1						1		
		ste	brown; non-cohesive, moist (SM) SILTY SAND; brown;	- Trī	76.20 0.23	1	ss	4			1								
	Power Auger	mm Diam. (Hollow	non-cohesive, wet, very loose								1								
	ver A	E.			75.67		1												
	6 B	iii u	(CI/CH) SILTY CLAY to CLAY; grey brown, contains silt seams (WEATHERED CRUST); cohesive,		0.76		SS	3											
1		81	(WEATHERED CRUST); cohesive,			-		0											
		-	w>PL, stiff		75.21														
									+										
2									+		1								
											1								
									€ +										
											1								
											1								
3									+		1								
											1								
									+										
											1								
											1								
4									⊕ +		1								
											1								
									+										
											1								
_																			
5									T		1								
	ş																		
	Nilcon Vanes	ţ							⊕ +										
	licon	Clutch																	
6	z								+										
Ŭ									'										
									+										
7									+		1								
·																			
											1								
									+		1								
8									⊕ +		1								
											1								
									+		1								
											1								
9									+		1								
											1								
									+										
											1								
10		_			66.43		╞╺┥	_	+_		+	<u> </u>				<u> </u>	+	-	
			CONTINUED NEXT PAGE																
		H SC	CALE						GO	L	DE	R							DGGED: DG
1:	50																	CH	ECKED: SM

RECORD OF BOREHOLE: 17-13N

BORING DATE: January 17, 2018

SHEET 2 OF 2

DATUM: CGVD28

LOCATION: N 5021450.3 ;E 466217.9 SAMPLER HAMMER, 64kg; DROP, 760mm

	0	SOIL PROFILE			AMPL	FS	DYNAMIC RESISTAN	PENETR	ATION	<u>۱</u>	HYDRAU k	LIC CO	NDUCTI	IVITY,			
DEPTH SCALE METRES	BORING METHOD		5		-	_	RESISTAN 20	NCE, BLC 40		80	10 ⁻⁶				0 ⁻³	ADDITIONAL LAB. TESTING	PIEZOMETER OR
TH S	M D	DESCRIPTION			TYPE	S/0.30			H nat V rem V. 6		TAW	TER CO	NTENT	PERCE		DITIO . TES	STANDPIPE
DEP	BORIN		STRATA PLOT) dd g	™ 5	F	BLOWS/0.30m					vvp -					AD	
-		CONTINUED FROM PREVIOUS PAGE	<i>w</i>	+		ш	20	40	60	80	20	40	60	8 (0		
10)	End of Borehole	10	.00													
F																	-
Ē																	-
- 11																	
- "																	-
Ē																	-
Ē																	-
- 12	2																-
Ē																	-
Ē																	-
F																	-
- - 13 -	3																-
Ē																	-
F																	2
Ē																	-
14 - -	1																-
E																	-
F																	-
- 15	5																-
Ē																	-
-																	-
E																	-
- - 16	6																
E																	-
F																	-
Ē																	-
- 17 -	7																-
-																	
F																	-
- - - 18	3																-
-																	-
2/18																	-
T 4/1																	-
- 19 - 19	9																-
AL-M																	-
Б -																	-
048.G																	-
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS)																-
s 001			<u> </u>								I – – – –				I		
C BH.		SCALE				Ç	G	OL	. D E	R							DGGED: DG ECKED: SM
Σ	: 50															CHI	LONED. SIVI

RECORD OF BOREHOLE: 17-14

BORING DATE: January 10-16, 2018

SHEET 1 OF 5

DATUM: CGVD28

LOCATION: N 5021390.9 ;E 466243.5 SAMPLER HAMMER, 64kg; DROP, 760mm

	ЦОН		SOIL PROFILE			s/	AMPL	_	DYNAMIC PE RESISTANCE	NETRA , BLOW	FION 'S/0.3m	Z,		k, cm/s		TIVITY,		RG₽	PIEZOMETER
METRES	BORING METHOD			STRATA PLOT	ELEV.	ER	ω	BLOWS/0.30m		40		80				1	10 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
Ψ	EING		DESCRIPTION	ATA	DEPTH		TYPE	WS/0	SHEAR STRE Cu, kPa	NGTH	nat V rem V. 6	- Q-● ● U- O					ENT WI	ADDI AB. T	INSTALLATION
1	C a			STR	(m)			BLC	20	40	60	80					80	<u> </u>	
0			GROUND SURFACE	4. 1	76.60														
J			(SM) SILTY SAND; brown; non-cohesive, wet, very loose to loose	鼎	0.00	1													
					1	1	SS	4											
						_	-												
1						2	SS	3						0				м	
						3	SS	9											
2																			
				丨		\vdash	-												
						4	SS	РН											
3			(CI/CH) SILTY CLAY to CLAY; grey with		. 73.55	-	-												
			reddish brown to black mottling, contains silt seams; cohesive, w>PL, soft			5	SS	WR							0				
4									⊕ +										
									⊕ +										
						\vdash													
	oring	sing				6	SS	WR											
5	Wash Boring	HW Casing																	
	\$	-				_													
									⊕ +										
									Ð	+									
6						\vdash													
						7	SS	WR											
						'													
							1												
7									⊕ +										
									⊕ +										
							-												
8						8	SS	WR											
						\vdash	-												
									⊕ +										
									⊕ +										
9																			
						9	SS	WR											
						\vdash	-												
10	L l	└┝		_12224	4	<u> </u>	+-	-	+		+		+		+	<u> </u> .	+	-	
			GON TINDED NEXT PAGE																
DE	PTł	HSC	CALE						GC)L	DE	R						LC	OGGED: DWM
1:	50						4											CH	ECKED: SM

RECORD OF BOREHOLE: 17-14

LOCATION: N 5021390.9 ;E 466243.5

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 10-16, 2018

SHEET 2 OF 5

DATUM: CGVD28

1	DOH	SOIL PROFILE		r	SA			NAMIC PE SISTANCE		'ION S/0.3m	Ì,		k, cm/s				RG	PIEZOMETER
METRES	BORING METHOD		STRATA PLOT	ELEV.	3ER	ш.	SH Cu,		40		BO	10 ⁻⁶				0 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
. H	DRING	DESCRIPTION	RATA	DEPTH	NUMBER	TYPE	Cu,	EAR STRE kPa	INGTH	nat V. + rem V. €	- u- ● 9 U- O		TER CO				ADD ABD	INSTALLATION
-	BC			(m)	- -			20	40	60	80	20				30		
10		CONTINUED FROM PREVIOUS PAGE (CI/CH) SILTY CLAY to CLAY; grey with				\vdash	•	+								-	+	
		reddish brown to black mottling, contains silt seams; cohesive, w>PL, soft																
		,					Ð	+										
		(CI/CH) SILTY CLAY to CLAY; grey with		65.94 10.66														
11		(CI/CH) SILTY CLAY to CLAY; grey with reddish brown to black mottling, contains silt seams; cohesive, w>PL, firm			10	ss v	/R					+		-	0			
							Ð	+										
12							€	+										
					-													
					11	ss v	/R											
13							⊕											
							€	+										
					\vdash													
14					12	ss v	/R											
							⊕	+										
	ing																	
15	Wash Boring HW Casing						€) +										
	≤ [⊥]					1												
					13	ss v	/R											
					<u> </u>	$\left \right $												
16							€		+									
							4			+								
		- Possible silt layer						,										
						1												
17					14	ss v	/R									9		
					<u> </u>	$\left \right $												
							⊕		+									
18							⊕		+									
10																		
						1												
					15	ss v	/R											
19		(CI/CH) SILTY CLAY to CLAY; grey with		57.7 <u>1</u> 18.89	-	$\left \right $												
		(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, stiff					•		+									
								Ð	+									
20				L	16	ss v		-+		<u> </u>	L	-			L	↓	_	
		CONTINUED NEXT PAGE																
רי		CALE						~ ~		- -	_							GGED: DWM
	50							GC	L	υE	К							ECKED: SM

RECORD OF BOREHOLE: 17-14

BORING DATE: January 10-16, 2018

SHEET 3 OF 5

DATUM: CGVD28

LOCATION: N 5021390.9 ;E 466243.5 SAMPLER HAMMER, 64kg; DROP, 760mm

, L	гнор	SOIL PROFILE		SA	MPLES		PENETRATION CE, BLOWS/0.3	· · ·	HYDRAULIC CONDUCTIVI k, cm/s	TY,	
METRES	BORING METHOD	DESCRIPTION	(m)	FI≧	TYPE BLOWS/0.30m	20 I SHEAR ST Cu, kPa	40 60 RENGTH nat rem	80 V. + Q - ● V. ⊕ U - O	10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴ WATER CONTENT PE Wp		PIEZOMETER OR STANDPIPE INSTALLATION
-	В	CONTINUED FROM PREVIOUS PAGE		<u> </u>		20	40 60	80	20 40 60	80	
20 -		C(VCH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, stiff		16	ss w	₹ ⊕	+ +				
22 23											
24				17	ss w	₹ ⊕	4	- +			
25	Wash Boring HW Casing										
26 27				18	SS 2	Φ	+				
28						Ŧ					
29				19	ss w						
30	_L	CONTINUED NEXT PAGE	_		╞┥╴		+-		++++++++++-	-+	
DEF	PTH S	CALE					OLD	FP			LOGGED: DWM

RECORD OF BOREHOLE: 17-14

LOCATION: N 5021390.9 ;E 466243.5

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 10-16, 2018

SHEET 4 OF 5

DATUM: CGVD28

IS IS	ETHOD	SOIL PROFILE	L.			MPLES	RESISTANC			30 \	HYDRAUL k, 10 ⁻⁶	IC CONDI cm/s 10 ⁻⁵	JCTIVITY, 10 ⁻⁴	10-3	NAL TING	PIEZOMETER OR
METRES	BORING METHOD	DESCRIPTION		ELEV. DEPTH (m)	NUMBER	TYPE BLOWS/0.30m	SHEAR STF Cu, kPa	RENGTH	nat V. + rem V. ⊕	1	WATI	ER CONTE	ENT PERC	ENT	ADDITIONAL LAB. TESTING	STANDPIPE INSTALLATION
30		CONTINUED FROM PREVIOUS PAGE														
31		(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, stiff					₽		+							
32	Wash Boring HW Casing	(SM/ML) SILTY SAND to sandy SILT, some low plastic fines, some gravel to gravelly; grey, contains cobbles (GLACIAL TILL); non-cohesive, wet, very dense		45.05 31.55	20	SS 6										
33					21	SS 5					0				м	
34					22	SS 5										
				42.11	23	SS >5	D									
35	HQ Core	COBBLES and BOULDERS	000000000000000000000000000000000000000	34.49		RC D										
36		Borehole continued on RECORD OF DRILLHOLE 17-14	<u>)</u> 70	41.27 35.33												
37																
38																
39																
40																
DEF	TH S	CALE	<u> </u>				G	DL	DE	R	•		1			GGED: DWM ECKED: SM

			T: 1787048/400/4.4		RE	CC	ORD	0																		HEET 5 OF 5
			N: N 5021390.9 ;E 466243.5 10N: -90° AZIMUTH:						D	RILI	LRI	G: L	C 55		-			2018 ille Drill	ng						DA	ATUM: CGVD28
DEPTH SCALE METRES		DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH <u>COLOUR</u>	S⊢ VN CJ R TO CŎ	I - J T - F HR- S N - V I - C RECO NTAL RE %	ihear (ein Conjug VER VER SOL	gate Y .ID E %	C O C R.Q.D.	PE 0.25	ntact nogor avage CT. EX R E	e I Angle		IN-U T-S R-In DISCO Pw.r.t. ORE VXIS	lanar urved ndulating tepped regular ONTINUIT	K SM Ro MB	ensio	al Br HY CON	eak (DRA IDUC	: For a viation: reviations ols.	additio s refer ons &	nal to list	
- - - - - - - - - - - - - - - - - - -	Rotary Drill		BEDROCK SURFACE Slightly weathered to fresh, thinly to medium bedded, grey to dark grey, fine grained, slightly to non-porous SHALE, with limestone and calcareous shale interbeds CARLSBAD FORMATION - Clay mud seams from 35.37 m to 35.46 m - Broken core from 35.63 m to 35.71 m		41.27 35.33 39.72 36.88	1	Ę		28			8848			3380	0	888				11		5	4 0		
- 37 - - - - - - - - - - - - - - - - - - -																										
- 39 																										
- 41 - 41 	:																									
MIS-RCK 004 1787048.GPJ GAL-MISS.GDT 4/12/18 ZS 1 1 2 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4																										
MIS-RCK 004 1787048.GF			CALE							G	C) L	 - C			R										DGGED: DWM ECKED: SM

RECORD OF BOREHOLE: 17-17

LOCATION: N 5021538.5 ;E 466440.9

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 17-19, 2018

SHEET 1 OF 5

DATUM: CGVD28

5	тнор	SOIL PROFILE	F	1	SA	MPLE		DYNAMIC PENET RESISTANCE, BL		``		cm/s				ING	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE	BLOWS/0.30m	20 40 I I SHEAR STRENGT Cu, kPa	60 TH nat V. rem V	80		10 ⁻⁵ ER CON	ITENT	PERCE		ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
	BORI		STRA	(m)	R		BLOW	20 40	60	80	Wp ⊢ 20	40			WI 80	LAE	
		GROUND SURFACE	1	76.32				20 40			20		0				
0		TOPSOIL - (SM) SILTY SAND; brown; \non-cohesive, moist		0.00													
		(SM/ML) SILTY SAND to sandy SILT;			1	SS	6										
		brown; non-cohesive, moist to wet, loose															
1					2	SS	6										
					-		Ŭ										
		(CI/CH) SILTY CLAY to CLAY; grey		74.65													
		brown, contains silt seams; cohesive, w>PL, soft to firm			3	SS	5							0			
2																	
								⊕ +									
								⊕ +									
3																	
					4	SS N	WR										
						~											
						1											
4								⊕ +									
								⊕ +									
								ΨT									
		(CI/CH/ML) SILTY CLAY to CLAY and		71.75 4.57													
	boring asing	sandy SILT, layered; grey brown; cohesive, w>PL, stiff			5	ss	8										
5	Wash Boring HW Casing			71.14													
	≤	(CI/CH) SILTY CLAY to CLAY; grey with reddish brown to black mottling, contains		5.18													
		reddish brown to black mottling, contains silt seams; cohesive, w>PL, soft to firm						⊕ +									
								⊕ +									
6																	
					6	SS N	WR							0			
7																	
'								⊕ +									
								⊕ +									
					7	SS N	WE										
8					[′]		vv rK										
		(CI/CH) SILTY CLAY to CLAY; grey with		68.09 8.23													
		(CI/CH) SILTY CLAY to CLAY; grey with reddish brown to black mottling, contains silt seams; cohesive, w>PL, firm to stiff						⊕ +									
9								⊕ +									
					8	ss v	WR										
10				1											⊥		
10		CONTINUED NEXT PAGE															
	отн с	SCALE															GED: DWM
וביט	50							GOI		: K							CKED: SM

RECORD OF BOREHOLE: 17-17

BORING DATE: January 17-19, 2018

SHEET 2 OF 5

DATUM: CGVD28

LOCATION: N 5021538.5 ;E 466440.9 SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

» ALE	rhod	SOIL PROFILE	F		S/	MPL			IC PENET			λ,		k, cm/s				NG NG	PIEZOMETER
DEP IN SUALE METRES	BORING METHOD	DE0021771011	STRATA PLOT	ELEV.	BER	Щ	BLOWS/0.30m	20 SHEAR				80	10 WA		0 ⁻⁵ 1 L ONTENT	1	10 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
- ME	ORIN(DESCRIPTION	RATA	DEPTH (m)	NUMBER	түре	OWS.	Cu, kPa	R STRENG	re	m V. €	⇒ ŭ- Ŏ	Wp				WI	ADD LAB.	INSTALLATION
	ă		ST	(11)	<u> </u>		BL	20	0 40	60)	80	20				80	+	
10		CONTINUED FROM PREVIOUS PAGE (CI/CH) SILTY CLAY to CLAY; grey with			-			Ð	+			-						+ +	
		(CI/CH) SILTY CLAY to CLAY; grey with reddish brown to black mottling, contains silt seams; cohesive, w>PL, firm to stiff						⊕											
								Ψ	Ť										
11					9	SS	WR												
								•											
								⊕	+										
12								⊕	+										
					<u> </u>														
					10	SS	WR												
13																			
								⊕	+										
								⊕	+										
14					11	SS	WR												
								⊕	+										
15	Wash Boring HW Casing							⊕	+										
	Wash																		
					12	SS	WD												
16																			
								⊕		+									
								⊕	+	-									
17					13	SS	WD									0			
						33	VVIX												
								⊕	+	-									
18								⊕	+	-									
							14/5												
					14	SS	vvR												
· 19						1													
								⊕		+									
								⊕		+									
- 20	_L	L		1	15	ss	WR		-	+	·						+	_ -	
		CONTINUED NEXT PAGE																	
	рти (SCALE									、 –	F							GGED: DWM
1:								j C	GO	ւլ	ιF	ĸ							CKED: SM

RECORD OF BOREHOLE: 17-17

BORING DATE: January 17-19, 2018

SHEET 3 OF 5

DATUM: CGVD28

LOCATION: N 5021538.5 ;E 466440.9 SAMPLER HAMMER, 64kg; DROP, 760mm

andary 17-13, 2010

ъ Н Е	тнор	SOIL PROFILE	F	_	SA	MPLES		MIC PENI TANCE,			λ,		, cm/s			ING	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE BLOWS/0.30m	SHEAI Cu. kP	R STREN			Q - ● U - O		ER CON	ITENT P	ERCENT	B. TEX	OR STANDPIPE INSTALLATION
ż	BOR		STRA	(m)	٦٢	BLOV	2	<u>0 4</u>			10	Wp H 20	40	-O ^W 60	WI 80		
20		CONTINUED FROM PREVIOUS PAGE	7000														
-		(CI/CH) SILTY CLAY to CLAY; grey with reddish brown to black mottling, contains silt seams; cohesive, w>PL, firm to stiff			15	ss w	₹ ⊕		+								
21							Ð		+								
23					16	ss w	₹ ⊕		+								
24 25	Wash Boring HW Casing						Ð		+								
26	Was				17	ss w	٦										
27							Ф	⊕		+							
28																	
29					18	ss w	२	Ð		+							
30		CONTINUED NEXT PAGE		+						+		t -	+-	-	+		
DEF	PTH S	CALE	1	1				GO	Lſ	DE	R	<u> </u>	I	[DGGED: DWM ECKED: SM

RECORD OF BOREHOLE: 17-17

BORING DATE: January 17-19, 2018

SHEET 4 OF 5

DATUM: CGVD28

LOCATION: N 5021538.5 ;E 466440.9 SAMPLER HAMMER, 64kg; DROP, 760mm

4	ЪН	SOIL PROFILE	1.		34	MPLE		NAMIC PENETRA	VS/0.3m	Ν.	k,	cm/s		/ITY,	₽₽	PIEZOMETER
METRES	BORING METHOD		STRATA PLOT		Ч			20 40	60	80	10 ⁻⁶	10-5			ADDITIONAL LAB. TESTING	OR STANDPIPE
E E	SING	DESCRIPTION	ATA F	ELEV. DEPTH	NUMBER	TYPE		EAR STRENGTH kPa	nat V. rem V.	+ Q-● ⊕ U-O		ER CON	ITENT F	PERCENT	B. TI	INSTALLATION
ž	BOF		STR∕	(m)	R	-) K				Wp H		-0 ^W	WI		
		CONTINUED FROM PREVIOUS PAGE	0				-	20 40	60	80	20	40	60	80		
30		(CI/CH) SILTY CLAY to CLAY; grey with				\vdash		+ +	_				-+			
		reddish brown to black mottling, contains silt seams; cohesive, w>PL, firm to stiff								>96+						
31																
32																
				44.01								b				
	Wash Boring HW Casing	(ML-CI) CLAYEY SILT and SILTY CLAY, layered; grey; cohesive, w>PL, stiff	HH	32.31	19	SS	2					P				
	W Ca	ayereu, grey, coriesive, w>PL, Stiff		1												
	≥ ĭ		HH													
33				1												
			III													
				42.79												
		(SM/ML) SILTY SAND to sandy SILT,		33.53												
		some low plastic fines, some gravel to gravelly; grey, contains shale fragments			20	SS	29									
34		(GLACIAL TILL); non-cohesive, wet, compact to very dense														
35			<u>fill</u>	41.27												
		Borehole continued on RECORD OF DRILLHOLE 17-17		35.05												
36																
37																
38																
39																
40																
								GOL								
DEI	-IH S	SCALE				Ľ		GOL	DF	- P					LC	OGGED: DWM

PF	soj	ECI	Г: 1787048/400/4.4		RE	СС	ORD	0	ΓI	DF	RIL	Lŀ	10	LE			17	7-1	7										SH	IEET	5 0	F 5	
			N: N 5021538.5 ;E 466440.9 ION: -90° AZIMUTH:						DR	ILL	RIG:	LC			-														DA	ATUN	1: C0	GVD28	3
	_			0			RIN	JN	- Joi - Fau	nt	NG (BD-	TRAC Beddir Foliati	ng	R: (PL	- Pla	anar urved	rilling	PO-	Polis	shed	dod				Broke						
DEPTH SCALE METRES		חעוררוואפ עברסעה	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH <u>COLOUR</u>	SHI VN CJ	R- She - Vei - Coi ECOV	ear n njuga	R.C	CO- OR- CL -	Contai Orthog Cleava RACT. NDEX PER 0.25 m	ct gonal age B Ar	ngle	UN ST IR	I- Un - Ste - Inn SCC w.r.t. RE	ndulati epped egular DNTIN	i r		Rou Mec	n Jr J	cal B H CO	IYDR NDU K, cr	abb of a c syn	neviat abbrev nbols. IC [/ITY]	or add ions re iations Diame Oint L Inde (MP)	efer to s & etral .oad ex a)	o list				
_			BEDROCK SURFACE Slightly weathered to fresh, thinly to		41.27 35.05																												
-			medium bedded, grey to dark grey, fine grained, slightly to non-porous SHALE, with limestone and calcareous shale interbeds			1	100				-																						
- - - 36			CARLSBAD FORMATION																														
	=		- Broken/lost core from 35.40 m to 35.82 m - Broken core from 35.75 m to 35.82 m			2	100																										
- - - - 37	Rotary Drill	NQ Core	- Weathered/broken core from 36.70 m to 36.81 m																														
- - - - 38						3	100																										
-																																	
			End of Drillhole		37.85 38.47			T																									
- - - 39																																	
Ē																																	
- - 40 -																																	
-																																	
- - - 41																																	
-																																	
- - 42 -																																	
- 43 SZ -																																	
1 1 1																																	
TOD:0																																	
AL-MIS																																	
GPJG																																	
1 1 820421																																	
MIS-RCK 004 1787048.GPJ GAL-MISS.GDT 4/12/18 ZS 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	L EPT	нs	CALE	<u> </u>					للل ۲) (Ш О		D	E	III F	.⊤ 1														OGGE	ED: [DWM	
<u>∽</u> ∎ 1:	50						Ý				_	_	_			•													CHE	ECKE	ED: S	SM	

RECORD OF BOREHOLE: 17-18

BORING DATE: January 19, 2018

SHEET 1 OF 1

DATUM: CGVD28

LOCATION: N 5021496.1 ;E 466456.3 SAMPLER HAMMER, 64kg; DROP, 760mm

	ПОН	SOIL PROFILE			SA	MPLE		DYNAMIC PENETRA RESISTANCE, BLOV	TION /S/0.3m) L	HYDRAU k	LIC CON , cm/s	DUCTIVIT	Ύ,	او ب	PIEZOMETER
METRES	BORING METHOD		STRATA PLOT		н.		BLOWS/0.30m	20 40		80	10 ⁻⁶	10-5	10-4	10-3	ADDITIONAL LAB. TESTING	OR STANDPIPE
MET	SNG	DESCRIPTION	TA F	ELEV. DEPTH	NUMBER	TYPE	NS/0	SHEAR STRENGTH Cu, kPa	nat V. + rem V. 4	- Q- ●) U- ∩	WAT				DDIT B. TE	STANDPIPE INSTALLATION
	BOR		٦TRA	(m)	Ŋ		arov				vvp -		-0 ^W			
	-	GROUND SURFACE	0			++		20 40	60	80	20	40	60	80	+	
0		TOPSOIL - (SM) SILTY SAND; dark	EEE	76.01 0.00		++	+		-						+	
		brown; non-cohesive, moist		75.71 0.30		SS	5									
		(SM) SILTY SAND; brown; non-cohesive, moist to wet, loose		0.30			Ĭ									
						-										
					2	SS	6									
1					-		Ŭ									
				74.49												
		(CI/CH) SILTY CLAY to CLAY; grey with reddish brown mottling, contains silt seams; cohesive, w>PL, soft		1.52												
		seams; cohesive, w>PL, soft			3	SS	1									
2																
3					-											
					4	ss v	νн									
					-											
4																
					5	TP F	ΡΗ									
	Wash Boring HW Casing															
5	V Cat															
Ŭ	š ≤															
6																
						1										
					6	ss v	νн									
					-	1										
7																
					_											
8					7	TP F	ч									
9																
						1										
					8	ss v	νн									
				66.00												
ŀ		End of Borehole		66.26 9.75		1										
10																
										-						
DEI	PTH S	SCALE				ľ	\mathbf{b}	GOL	DE	R						GGED: DG
1:5	50														CHE	CKED: SM

RECORD OF BOREHOLE: 17-18N

BORING DATE: January 18, 2018

SHEET 1 OF 2

DATUM: CGVD28

LOCATION: N 5021496.1 ;E 466456.3 SAMPLER HAMMER, 64kg; DROP, 760mm

y 10, 2010

	DOH.		SOIL PROFILE	1.		SA	MPL		DYNAMIC PI RESISTANC	E, BLOW	ION S/0.3m	Ì,	HYDRAL I	k, cm/s				RGA	PIEZOMETER
METRES	BORING METHOD			STRATA PLOT	ELEV.	R	ш	BLOWS/0.30m	20	40		80	10 ⁻⁶				10 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
W	RING		DESCRIPTION	ATA	DEPTH	NUMBER	ТҮРЕ)/S//C	SHEAR STR Cu, kPa	ENGTH	nat V. + rem V. €	- Q - ● 9 U - O	WA ⁻ Wp I	TER CO		PERCI	ENT WI	ADDI ⁻ AB. T	INSTALLATION
1	BO	_		STF	(m)			BLC	20	40	60	80	20				80	L.	
0	 	-	GROUND SURFACE		76.01					_	_						-		
	er	200 mm Diam. (H.S)	For soil stratigraphy refer to Record of Borehole 17-18		0.00							1							
	Power Auger	Diam.																	
	Powe	m																	
		200																	
1																			
										>50+									
												1							
2									+			1							
									+			1							
												1							
3									€ +			1							
												1							
												1							
									T T										
4									+										
												1							
										+		1							
												1							
5									\oplus +										
	nes											1							
	Nilcon Vanes	Clutch							+			1							
	Ĭ											1							
6									⊕ +			1							
									-										
									-			1							
												1							
7									+			1							
												1							
									⊕ +			1							
												1							
8									+										
												1							
									+			1							
												1							
9									€ +										
5												1							
												1							
									†			1							
10			CONTINUED NEXT PAGE		66.01		+ -	-	⊢ - +-·	-	+		-	+			+	-	
												1							
DE	PTH	H S(CALE					Ċ	G	ΣL	DE	R						LC	OGGED: DG
1:	50						<	V										CHI	ECKED: SM

RECORD OF BOREHOLE: 17-18N

BORING DATE: January 18, 2018

SHEET 2 OF 2

DATUM: CGVD28

LOCATION: N 5021496.1 ;E 466456.3 SAMPLER HAMMER, 64kg; DROP, 760mm

\vdash			SOIL PROFILE		SA	MPLE	s	DYNAM RESIST	IC PEN	ETRATIO	ON	<u>۱</u>	HYDRA	AULIC CO	ONDUCT	IVITY,			
CALE	METRES	BORING METHOD		5				RESIST				ы ^х ,	10	k, cm/s			0 ⁻³	ADDITIONAL LAB. TESTING	PIEZOMETER OR
TH S(IETRE	IG ME	DESCRIPTION	STRATA PLOT (m) (m)		ТҮРЕ	BLOWS/0.30m	SHEAR Cu, kPa										DITIO TES	STANDPIPE INSTALLATION
DEP	Σ	SORIN	DEGONITION	LA DEPTH	¹ N	≿	DW	Cu, kPa		r	em V. 🕀	U - O	Wp					ADI	INSTALLATION
				S S	-		Ē	20	4	06	8 0	0	2	0 4	06	<u>ع 0</u>	30		
-	10		CONTINUED FROM PREVIOUS PAGE End of Borehole	10.00	,														
F																			
E																			
F																			
F	11																		
F																			
E																			
F																			-
F	12																		-
F																			-
E																			-
Ē																			
F	13																		
Ē																			
F																			
Ē																			-
F	14																		-
E																			
E																			
-																			
-	15																		-
-																			-
Ē																			-
-	16																		:
F	16																		-
E																			
-																			-
E	17																		-
-	"																		
-																			
-																			
E	18																		
- S																			-
/18 2																			
4/12																			
GDT	19																		-
-MIS																			
I GA																			
8.GP																			
8704	20																		-
11																			
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS	DEI	PTH S	SCALE					; C	· ~			Р						LC	DGGED: DG
AIS-B	1:										ノロ	ĸ							ECKED: SM
2																			

RECORD OF BOREHOLE: 17-19

BORING DATE: January 19, 2018

SHEET 1 OF 1

DATUM: CGVD28

LOCATION: N 5021502.5 ;E 466517.0 SAMPLER HAMMER, 64kg; DROP, 760mm

			SOIL PROFILE		1	SA	MPLE		DYNAMIC PENETRAT RESISTANCE, BLOW		Ì,		, cm/s				<u>N</u> G NG	PIEZOMETER
METRES	BORING METHOD		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.30m	20 40 SHEAR STRENGTH	nat V	80 ⊦ Q-●	10 ⁻⁶ WAT	10 ⁻⁵			0 ⁻³	I ADDITIONAL LAB. TESTING	OR STANDPIPE
j∑ J	30RIN		DESCRIPTION	TRAT/	DEPTH (m)	NUM	∠	FOWS	Cu, kPa	rem V. 6	ÐU-O	Wp H		OW		WI	ADI LAB.	INSTALLATION
		•	GROUND SURFACE	ەن ا			$\left \right $	ш	20 40	60	80	20	40	6	0	80	+	
0		+	TOPSOIL - (SM) SILTY SAND; dark		75.98													
		ŀ	brown; non-cohesive, moist (SM/ML) SILTY SAND to sandy SILT;		75.73 0.25	1	SS	5										
			brown; non-cohesive, moist to wet, loose															
1						2	SS	7										
			(CI/CH) SILTY CLAY to CLAY: grey		74.46													
			(CI/CH) SILTY CLAY to CLAY; grey brown and reddish brown, contains silt seams; cohesive, w>PL, firm		74.15	3	SS	2										
2		ſ	(CI/CH) SILTY CLAY to CLAY; grey, contains silt seams; cohesive, w>PL,		1.83	ľ		-										
			very soft to soft															
						4	TP I	PH										
3																		
4						_												
						5	SS V	νH										
		┢	(SM/ML) sandy SILT to SILTY SAND;		71.56													
	Wash Boring	asing	brown; non-cohesive, wet (CI/CH) SILTY CLAY to CLAY; grey,		71.26 4.72													
5	Wash	HWC	(CI/CH) SILTY CLAY to CLAY; grey, contains silt seams; cohesive, w>PL, soft			6	SS V	ΝН										
6						7	TP I	РН							ю		с	
7																		
8						8	SS V	ΝН										
9																		
							1											
						9	TP	PH										
		+	End of Borehole		66.28 9.70				+									
10																		
DE	PTH	H S	CALE						GOL		D						LO	GGED: DG
1::	50								, G OL		. 17						CHE	CKED: SM

RECORD OF BOREHOLE: 17-20N

BORING DATE: January 18, 2018

SHEET 1 OF 2

DATUM: CGVD28

LOCATION: N 5021491.3 ;E 466569.2 SAMPLER HAMMER, 64kg; DROP, 760mm

ary 10, 2010

METRES	тнор	SOIL PROFILE			SA	MPL	_	DYNAMIC PENETRA RESISTANCE, BLOW	· · · ·	HYDRAULIC (k, cm/			ING	PIEZOMETER
ETRE:	BORING METHOD	DESCRIPTION		ELEV.	NUMBER	TYPE	BLOWS/0.30m	20 40 I I SHEAR STRENGTH	60 80		10 ⁻⁵ 10 ⁻⁴	10 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
Σ	BORIN		TRAT	DEPTH (m)	NUM		SMOT	SHEAR STRENGTH Cu, kPa		vvp		- WI	ADI LAB.	INSTALLATION
	-	GROUND SURFACE	s s	76.03		$\left \right $	B	20 40	60 80	20	40 60	80	+ +	
0	f.S.			0.00										
	Power Auger 200 mm Diam. (H.S)													
	ower nm Di													
	200-													
1														
								+						
2								+						
								€ +						
3								+						
								⊕ +						
4								+						
								>49+						
5								⊕ +						
	S													
	Nilcon Vanes Clutch							+						
	SII0													
6								+						
-														
								⊕ +						
								W T						
7														
'								+						
								+						
8								⊕ +						
								+						
9								+						
								⊕ +						
10	_	CONTINUED NEXT PAGE	+	66.03		╞╺┥	-	+	+	+	+ -	-+	- -	
DEF	PTH S	SCALE					C	GOL	DER				LO	GGED: DG

RECORD OF BOREHOLE: 17-20N

BORING DATE: January 18, 2018

SHEET 2 OF 2

DATUM: CGVD28

LOCATION: N 5021491.3 ;E 466569.2 SAMPLER HAMMER, 64kg; DROP, 760mm

y 10, 2010

		_ 1				~ ·		- 0	DYNAMIC	PEN	ETRATIO	ON	<u>\</u>	HYDR		ONDUCT				
DEPTH SCALE METRES			SOIL PROFILE			SA	MPLE		DYNAMIC RESISTA				N,		k, cm/s				ING	PIEZOMETER
1 SC/ TRES		ME		STRATA PLOT	ELEV.	ER	ш	BLOWS/0.30m	20	4		6 8 1	30		0 ⁻⁶ 1		1	0-3	ADDITIONAL LAB. TESTING	OR STANDPIPE
AET.			DESCRIPTION	ATA -	DEPTH	NUMBER	ТҮРЕ	WS/0	SHEAR S Cu, kPa	STREN	GTH r	ıat V. + em V. ⊕	Q - ● U - O	W			PERCE		AB. T	INSTALLATION
ā				STR.	(m)	ĨŽ		BLO	20	4			30	VV				90 30	<u>ر</u> ۹	
			CONTINUED FROM PREVIOUS PAGE																	
- 10)		End of Borehole		10.00															
E																				
E																				
F																				
- 11																				
F																				-
E																				-
E																				
E																				
- 12 -	2																			-
F																				
F																				
E																				
- 13	3																			-
-																				-
F																				
F																				-
E																				
- 14	i I																			-
E																				
F																				-
F																				-
- - 15																				
	°																			
E																				
F																				-
Ē																				
- 16	5																			-
E																				-
E																				
E.																				
F																				
- 17 -	′																			-
E																				-
E																				
F																				-
- 18	3																			-
SI-																				
18																				
4/12																				
L L L																				-
0 19 S	9																			-
AL-N																				
0 -																				
8.GP																				-
3104 20 20)																			_
178																				
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS	-												•				•			
Нарадија Нарадиј Нарадиј Нарадиј Нарадиј Нарадиј Нарадиј Нарадиј Нарадиј Нарадиј Нарадиј Нара Нарадиј Нара Нара Нара Нара Нара Нара Нара Нар	EPT	HS	CALE						G	0	LD)E	R							DGGED: DG
S ₩	: 50						<	V		-		_	-						CH	ECKED: SM

RECORD OF BOREHOLE: 17-21

LOCATION: N 5021375.1 ;E 466666.3

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 24-29, 2018

SHEET 1 OF 6

DATUM: CGVD28

J F	DOH-	SOIL PR		<u> </u>		SAN	MPLE:		YNAMIC ESISTAN		ATION WS/0.3m	· ` \	HYDRA	k, cm/s				NG	PIEZOMETER
METRES	BORING METHOD			STRATA PLOT	LEV.	BER	TYPE	100.00			60 I nat V	80 + Q-•	10 W/	0 ⁻⁶ 10			10 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
ME	ORING	DESCRIPTION		RATA	EPTH (m)	NUMBER	TYPE		u, kPa	RENGIE	rem V	⊕ U- O						ADD LAB.	INSTALLATION
	B(,	_	ā		20	40	60	80	20	0 4	10 (50	80		
0		GROUND SURFACE TOPSOIL - (SM) SILTY SAN	ID; brown;	333	76.14 0.00	-	-	-									-		
		non-cohesive, moist (SM) SILTY SAND; grey brow	wn;		0.15	1	ss	6)					
		non-cohesive, wet, loose to c	compact																
					┝														
1						2	SS 1	4											
					⊢														
						3	SS 1	0					0						
2																			
		(CI/CH) SILTY CLAY to CLA	Y; grey with		73.86 2.28	_													
		(CI/CH) SILTY CLAY to CLA' reddish brown mottling, conta seams; cohesive, w>PL, stiff	ains siit			4	ss	2									\$		
3		(CI/CH) SILTY CLAY to CLA reddish brown to black mottli	Y; grey with		73.09 3.05	\neg													
		silt seams; cohesive, w>PL,	soft			5	ss w	/R								+1			
					┝														
4								⊕	+										
								⊕	+										
								Ű											
	6	0			Γ														
5	Wash Boring					6	ss w	/R											
	Was	I (CI/CH) SILTY CLAY TO CLA	Y; grey with		70.96 5.18	_													
		reddish brown to black mottli silt seams; cohesive, w>PL,	ng, contains firm						⊕	+									
									⊕	Ļ									
6					70.04														
		(CI/CH) SILTY CLAY to CLA reddish brown to black mottli	ng, contains		6.10	7	ss w	(D											
		silt seams; cohesive, w>PL,	SOIL			'	55 M	r.											
7								⊕	+										
								⊕	+										
					-														
						8	ss w	/R											
8																			
								€											
9								Ð	+										
					╞	\neg													
						9	ss w	/R								0			
					┝	-													
10						-+		- -	-+-		-+-		+				+	-	
															I	1			
	РТН 50	ISCALE							G	OL	D	- R							GGED: DWM ECKED: SM

RECORD OF BOREHOLE: 17-21

BORING DATE: January 24-29, 2018

SHEET 2 OF 6

DATUM: CGVD28

LOCATION: N 5021375.1 ;E 4666666.3 SAMPLER HAMMER, 64kg; DROP, 760mm

N L	BORING METHOD	SOIL PROFILE	F	1		MPLE				ATION NS/0.3m	λ,	HYDRA			?	ING ING	PIEZOMETER
METRES	G ME	DECODIDITION	STRATA PLOT	ELEV.	BER	E	BLOWS/0.30m	20 LEAR STR	40 L RENGTH	60 nat V.	80 + Q - ●	10 WA		0 ⁻⁴	10 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
E E	ORIN(DESCRIPTION	RATA	DEPTH (m)		TYPE		, kPa		rem V.	+ Q-● ⊕ U-O	Wp			WI	ADD LAB.	INSTALLATION
	ă			(11)		i	<u></u>	20	40	60	80	20			80	+	
10	$\neg \uparrow$	CONTINUED FROM PREVIOUS PAGE (CI/CH) SILTY CLAY to CLAY; grey with			-	\vdash	•	+	_	_						+ +	
		reddish brown to black mottling, contains silt seams; cohesive, w>PL, soft					•	+									
							ľ										
11					10	ss v	/R										
							€	, +									
12								⊕ +									
					11	ss v	/R										
					\vdash												
13							€	→ +									
							4		+								
14					10												
14					12	SS V	VK										
								€	+								
15	Wash Boring HW Casing						•	Ð	+								
	WasI			60.90 15.24													
		(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, firm to stiff				ss v	/R										
16																	
								€		+							
								⊕	+								
					\vdash												
17					14	ss v	/R								0		
								_									
								⊕	+								
18							•	Ð	+	•							
					15	ss v	/R										
40					<u> </u>												
19								Ð	+								
								⊕		+							
20				4	16	ss v						<u> _ </u>	 L		<u> </u>	_ _	
		CONTINUED NEXT PAGE															
									<u>~ -</u>		· n					10	GGED: DWM
DEI 1:4		CALE						G		DE	: K						GGED: DWM CKED: SM

RECORD OF BOREHOLE: 17-21

LOCATION: N 5021375.1 ;E 466666.3

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 24-29, 2018

SHEET 3 OF 6

DATUM: CGVD28

L.	ТНОВ	SOIL PROFILE			MPLE		DYNAMIC PEN RESISTANCE,			<u>``</u>	HYDRA 10		ONDUC ⁻ 0 ⁻⁵ 1		10 ⁻³	NAL	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	ELEV. DEPTH	NUMBER	TYPE		20 4 I SHEAR STREN Cu, kPa		60 80 hat V. + em V. ⊕		w	ATER C		I PERCE		ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
·	BC		(m)	-	ā	BL	20 4	0 (<u>80 80</u>)	2				80		
20 -		CONTINUED FROM PREVIOUS PAGE (CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, firm to stiff		16	ss w	/R	Ð	+									
22							Φ	+									
23		(CI-CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, stiff	53.28 22.86	17	ss w	/R											
24							⊕	+	+								
25	Wash Boring HW Casing																
26				18	ss w	/R						 		4			
27							⊕		+								
28																	
29				19	ss v	/R											
30	_L					_ -	+ •								+	- -	
DEF 1 : {		CALE					GO	LI	DE	R							gged: DWM Cked: SM

RECORD OF BOREHOLE: 17-21

BORING DATE: January 24-29, 2018

SHEET 4 OF 6

DATUM: CGVD28

LOCATION: N 5021375.1 ;E 4666666.3 SAMPLER HAMMER, 64kg; DROP, 760mm

luary 24-23, 2010

DEP IN SUALE METRES	<u>۳</u>		5				DYNAMIC PEN RESISTANCE,			<u>```</u>		k, cm/s	5 40-4	40-3	INAL	PIEZOMETER
1 3	BORING METHOD	DESCRIPTION	(m)	Ή≧	түре	BLOWS/0.30m	20 4 SHEAR STREM Cu, kPa	1		B0 - Q - ● - U - O	10 		NTENT P	PERCENT	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
<u>'</u>	BG		(m)			BLC	20 4	10	60	80	20					
30		CONTINUED FROM PREVIOUS PAGE (CI-CH) SILTY CLAY to CLAY; grey with		+	+	\vdash	•		+							
31		black mottling, contains silt seams; cohesive, w>PL, stiff					U									
32				20	ss	WR										
33								€		+						
							₽			+						
34																
	asing															
35	wasn Boring HW Casing			21	ss	WR						0	,			
36																
37		(ML-SM) SILTY SAND and sandy SILT, some low plastic fines, some gravel to gravelly; grey, contains rock fragments (GLACIAL TILL); wet, compact to very	39.4 36.7	¹¹ /3 22	SS	11					0					
		dense														
38																
				23	SS	31					0				м	
39																
40				24	ss	80		_	_−			+		+-		
	TH S	CALE					GO				I					GGED: DWM

		T: 1787048/400/4.4		RE	CC	DR	D						7-21						HEET 5 OF 6
		DN: N 5021375.1 ;E 466666.3 R HAMMER, 64kg; DROP, 760mm						BC	iring e	DATE: 、	lanuary	24-29, 2	2018	PEI	NETRA	ΓΙΟΝ ΤΕ	EST HAN		ATUM: CGVD28 64kg; DROP, 760mm
CALE ES	ЕТНОD	SOIL PROFILE	10			MPL		DYNAM RESIS	FANCE,	ETRATIC BLOWS/ 0 6	0.3m	, 0 10		AULIC C k, cm/s			0 ⁻³	NAL	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	түре	BLOWS/0.30m		R STREN	GTH n re	at V. + em V.⊕		w w			PERCE	NT	ADDITIONAL LAB. TESTING	STANDPIPE
- 40	ging	CONTINUED FROM PREVIOUS PAGE								0 0									-
	HW Casing	Borehole continued on RECORD OF		35.66 40.48															-
- - - 41		DRILLHOLE 17-21																	-
-																			-
-																			-
- 42 - - -																			
-																			-
- 43 - -																			
-																			-
- 44 - 44																			-
- - 45 -																			-
-																			-
- - 46 -																			
-																			-
- - - 47																			-
																			-
- - - - 48																			-
-																			-
5DT 4/12/																			
49 9-1-1-1 9-1-1-1																			
48.GPJ G																			
01 17870																			
ц.	EPTH S 50	SCALE							60	LC	DE	R							DGGED: DWM ECKED: SM

٦

PR	RO.	IECT	T: 1787048/400/4.4		RE	СС	RD	0	F١	DF	RIL	LI	HO	LE	Ξ:		17	7-21	I								S	HEET 6 OF 6
			N: N 5021375.1 ;E 4666666.3 ION: -90° AZIMUTH:						DF	ILL	RIG:	LC			-				ing								D	ATUM: CGVD28
ш		OKD		00			<u>COLOUR</u> % RETURN	SHI	- Joi - Fai R- Sh	nt ult ear		BD FO CC	- Bedd - Foliat - Conta	ling tion act		PL CI UI	Pl U- Ci N- Ui	anar urved	PC K SN	- Poli - Slic I- Sm	kensi ooth	ded		NOTE	: For	additi	Rock	
DEPTH SCALE METRES		DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	HSU	CJ	E % C	njuga	R.C	CL 2.D.	- Ortho - Cleav FRACT INDE2 PER 0.25 n	/āge Г. К В/	Angle		T - St t - Irr	tepped regular ONTINUI	Ro ME	CE .	chani	-COI	reak YDR/ NDU(K, cm	symb	Dis. TPoir			
41	Rotary Drill		BEDROCK SURFACE Slightly weathered to fresh, thinly to medium bedded, grey to dark grey, fine grained, slightly to non-porous SHALE, with limestone and calcareous shale interbeds CARLSBAD FORMATION - Broken core from 40.61 m to 40.63 m - Possible mud seams from 40.80 m to 40.82 m - Possible mud seams from 41.70 m to 41.72 m - Broken core from 41.92 m to 41.95 m - Weathered/broken core from 42.01 m to 42.07 m - Broken core from 42.66 m to 42.96 m		35.66	2	100		24			24			550													UCS = 97.4 MPa
- 43 			End of Drillhole		<u>32.73</u> 43.41	3	100																					
- 46 - 47 - 47																												
MIS-RCK 004 1787048.GPU GAL-MISS.GDT 4/12/18 ZS 66 412 11 11 11 11 11 11 11 11 11 11 11 11 1																												
DE 1 :			CALE				\$		LII C) G	0	L	D	E		Ⅲ २												OGGED: DWM IECKED: SM

RECORD OF BOREHOLE: 17-23

BORING DATE: January 30-February 6, 2018

SHEET 1 OF 5

DATUM: CGVD28

LOCATION: N 5021218.7 ;E 466509.0 SAMPLER HAMMER, 64kg; DROP, 760mm

7.1	£	SOIL PROFILE	1.		SA	MPL		DYNAMIC PENET RESISTANCE, BL	OWS/0.3m		k,	IC CONDUC cm/s	,	μŞ	PIEZOMETER
METRES	BORING METHOD		STRATA PLOT	ELEV.	ER		BLOWS/0.30m	20 40		o `	10 ⁻⁶		10 ⁻⁴ 10 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
Ξ	RING	DESCRIPTION	ATA	DEPTH	NUMBER	TYPE)/S/(SHEAR STRENG Cu, kPa	TH nat V. + rem V. ⊕	Q - ● U - O				ADDI ⁻ AB. T	INSTALLATION
ر	BO		STR	(m)	z		BLC	20 40	60 8	0	20		60 80	نـ `	
0		GROUND SURFACE		76.50											
-		TOPSOIL - (ML) sandy SILT; brown; non-cohesive, moist		0.00 0.15											
		(SM) SILTY SAND; grey brown; cohesive, moist to wet, loose to compact			1	SS	6				φ				
1					2	SS	14								
						1									
					3	SS	5				0			м	
2			剧												
		(CI/CH) SILTY CLAY to CLAY; grey		73.91 2.59	4	SS	2								
		brown, contains silt seams; cohesive, w>PL, soft to stiff													
3						$\left \right $									
					5	ss	wн								
4								⊕ +							
								⊕	+						
						$\left \right $									
	oring				6	ss	WR								
5	Wash Boring HW Casing														
	< ⁺														
								Ð	+						
								€	+						
6		(CI/CH) SILTY CLAY to CLAY: arey with		70.4 <u>0</u> 6.10											
		(CI/CH) SILTY CLAY to CLAY; grey with reddish brown to black mottling, contains silt seams; cohesive, w>PL, firm		0.10	7	SS	WP								
		on oouno, ooncore, were, iiiiii			ľ										
						1									
7								⊕ +							
								⊕ +							
8					8	SS	WR				+		0		
								⊕ +							
								⊕ +							
9					L										
					9	SS	WR								
						$\left \right $									
10	_L		_1222			╞╺┥	-	+_	+		+	-+	· +	-	
DE	PTH S	CALE					C	GO	LDE	R				LC	OGGED: DWM

RECORD OF BOREHOLE: 17-23

LOCATION: N 5021218.7 ;E 466509.0

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 30-February 6, 2018

SHEET 2 OF 5

DATUM: CGVD28

DEPTH SCALE METRES	тнор	SOIL PROFILE	_		MPLES		MIC PENE STANCE, E			λ,	HYDRAU k				-3	-ING	PIEZOMETER
IETRE.	BORING METHOD	DESCRIPTION	OJA ELEV.	NUMBER	TYPE BLOWS/0.30m	SHEA	20 40 R STREN Pa			80 - Q - ●	10 ⁻⁶ WAT	ER CON	TENT F	PERCEN		ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
≤ز د	BORIN		DEPTH (m)	NN N		Cu, kF					VVPF		OW	v	VI	AD LAB	INGTALLATION
_	_	CONTINUED FROM PREVIOUS PAGE	,,				20 40	U	60	80	20	40	60	80	J		
10		(CI/CH) SILTY CLAY to CLAY: arev with				Ð	+										
		reddish brown to black mottling, contains silt seams; cohesive, w>PL, firm				⊕	+										
					ss w												
11				10	55 W	~											
						⊕	+										
12						⊕		-									
12																	
				11	ss w	2											
13																	
						Ð	+										
						⊕	+										
14				12	ss w	٦											
						⊕	4										
	bring	Buis															
15	Wash Boring	HW Casing				•											
	5	-															
				13	ss w	٦							0				
10				<u> </u>													
16						⊕		+									
						⊕		+									
17					ss w												
				14	55 W	~											
						⊕		+									
18						⊕		+									
		(CI/CH) SILTY CLAY to CLAY: grey with	58.2 <u>1</u> 18.29														
		(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, firm to stiff		15	ss w	٦											
19																	
						•		+									
						e		+									
20			鼅	16	ss w	·			<u> </u>								
		CONTINUED NEXT PAGE															
DE	PTH	1 SCALE					GΟ	ī		D						LO	GGED: DWM
1:							30	L		R							CKED: SM

RECORD OF BOREHOLE: 17-23

LOCATION: N 5021218.7 ;E 466509.0

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 30-February 6, 2018

SHEET 3 OF 5

DATUM: CGVD28

J.	BORING METHOD	SOIL PROFILE		S	AMPL	_	DYNAMIC PE RESISTANCE			ζ,		cm/s			ING	PIEZOMETER
METRES	G ME		STRATA PLOT (m) dad	V. H	Щ	BLOWS/0.30m	20 SHEAR STRE		80 80		10 ⁻⁶	10 ⁻⁵ R CONTE		10 ⁻³	I ADDITIONAL LAB. TESTING	OR STANDPIPE
ΞΨ	CRINC	DESCRIPTION	DEP (m	FH S	TYPE	OWS,	SHEAR STRE Cu, kPa	rionn l	rem V. ⊕	ũ-Ō	WATE Wp H				ADD LAB	INSTALLATION
	ă			<u> </u>		В	20	<u>40 6</u>	50 80)	20	40	60	80	+ +	
20		CONTINUED FROM PREVIOUS PAGE (CI/CH) SILTY CLAY to CLAY; grey with		+									_		+	
		black mottling, contains silt seams; cohesive, w>PL, firm to stiff			SS	WR										
		(CI/CH) SILTY CLAY to CLAY; grey with	56 20	42	-											
		(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, stiff					Ð	-	+							
21							Ð	+								
							Ŭ									
22																
23																
				17	SS	WR										
					_											
							Ð		+							
24																
							Ð		†							
	6 B															
25	Wash Boring HW Casing															
	Was															
26																
				18	SS	WR										
							Ð									
27									+							
							Φ		+							
28																
29				\vdash	-											
				19	SS	wR										
30	_L	CONTINUED NEXT PAGE	_64244		+-	-			+			-+-	_	+	- -	
	отц о	CALE						· · ·			I					GED: DWM
	50 50					¢	GC) L [JE	R						GED: DWM CKED: SM

RECORD OF BOREHOLE: 17-23

LOCATION: N 5021218.7 ;E 466509.0

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 30-February 6, 2018

SHEET 4 OF 5

DATUM: CGVD28

l l	BORING METHOD	SOIL PROFILE	- L-	1	SA	MPLES	DYNAMIC P RESISTANC			R.	HYDRAU					AL	PIEZOMETER
METRES	MET		STRATA PLOT	ELEV/	ER	TYPE BLOWS/0.30m	20	40		80	10'				0-3	ADDITIONAL LAB. TESTING	OR STANDPIPE
ΞΨ	RING	DESCRIPTION	ATA	ELEV. DEPTH (m)	UMB.	TYPE WS/0.3	SHEAR STF Cu, kPa	RENGTH	nat V. + rem V. ∉	- Q - ● 9 U - O	WA			PERCE		VDDI VB. T	INSTALLATION
ž	BOF		STR/	(m)	ž	BLO	20	40		80	Wp 20				WI 30		
		CONTINUED FROM PREVIOUS PAGE		1							20	4	- (Ĭ		
30		(CI/CH) SILTY CLAY to CLAY: grev with					•			1							
		black mottling, contains silt seams; cohesive, w>PL, stiff					Ψ		T								
31																	
32																	
					20	SS WF	1						C				
										1							
33							Ð		+	1							
							Ð	+		1							
	۵.									1							
	Wash Boring HW Casing									1							
34	Wash HW C									1							
										1							
		(SM-ML) sandy SILT to SILTY SAND,		42.06 34.44													
		some low plastic fines, some gravel to gravelly; grey, contains rock fragments and cobbles (GLACIAL TILL);								1							
35		and cobbles (GLACIAL TILL); non-cohesive, wet, compact to dense								1							
55		non concerve, wer, compact to delise		Ś													
					21	SS 16					0						
										1							
										1							
36										1							
				×													
										1							
			11b	Ś	<u> </u>					1							
				1	22	SS 34				1							
37																	
										1							
										1							
				38.68						1							
38		Borehole continued on RECORD OF DRILLHOLE 17-23		37.82						1							
50		DINILLI IVLL 17-20															
										1							
										1							
										1							
39										1							
										1							
										1							
40																	
										1							
DFF	PTH S	CALE						<u> </u>		Р						10	DGGED: DWM
							G	JL	νE	К						СН	

F	RO	JEC.	T: 1787048/400/4.4		REG	CO	RD	0	F	D	RII	LL	.HO	C	E		1	17	-23								:	SHI	EET 5 OF 5	
			n: N 5021218.7 ;E 466509.0 FION: -90° AZIMUTH:						DF	RILL	RIC	3: L	C 55						uary 6, 2 e Drillin								I	DA	TUM: CGVD28	
DEPTH SCALE METRES		DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH <u>COLOUR</u>	SHF VN CJ	Ξ% (iear in injug	/ R ID 1%	C	PE 0.2	CT.	t onal	le D	ST - IR -		nar ved dulating pped gular NTINUITY YPE AND S DESCRIF	Slicke Smoo Rougl	enside ith h	I Bre HY CON K	eak DRA DUC , cm/	NOTE abbre of abb symbo	E: For viation revia ols. Poi Poi (addit ns ref tions	-C	st		
- - 3 -	8		BEDROCK SURFACE Slightly weathered to fresh, thinly to medium bedded, grey to dark grey, fine grained, slightly to non-porous SHALE, with limestone and calcareous shale		38.68 37.82	1	100																					L	JCS = 229.3 MPa	
- - - - - - - - - - -	6 Detect Drill		 CARLSBAD FORMATION Broken core from 38.27 m to 38.32 m Broken core from 38.40 m to 38.52 m Broken core from 38.62 m to 38.66 m 			2	100																							
- 4 - 4 - 4			End of Drillhole		36.58 39.92																									
- - - - - - - - - - - - -	2																													
- - - - - - - - -	3																													
- 4 - 4 																														
3DT 4/12/18 ZS	6																													
MIS-RCK 004 1787048.GPJ GAL-MISS.GDT 4/12/18 ZS	7																													
MIS-RCK 0(DEP : 5		CALE						0	3	0		. [)	E	R	2												GGED: DWM CKED: SM	

RECORD OF BOREHOLE: 17-24

BORING DATE: January 25, 2018

SHEET 1 OF 1

DATUM: CGVD28

LOCATION: N 5021172.5 ;E 466473.4 SAMPLER HAMMER, 64kg; DROP, 760mm

Ш Д	DOH		SOIL PROFILE	1.		SA		_	DYNAMIC PENETRA RESISTANCE, BLOV	TION /S/0.3m	Ì.	HYDRAU k	ILIC CO k, cm/s	NDUCT	IVITY,		ĘĘ	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD			STRATA PLOT		К		BLOWS/0.30m	20 40	60	80	10 ⁻⁶				0 ⁻³	ADDITIONAL LAB. TESTING	OR
Ξ	SING		DESCRIPTION	ATA F	ELEV. DEPTH	NUMBER	TYPE	NS/0	SHEAR STRENGTH Cu, kPa	nat V. rem V.	+ Q-● ∌ U- O			NTENT			DDI TDU	INSTALLATION
i	BOF			STR/	(m)	۲	ľ	BLO	20 40	60	80	Wp H 20	40			WI 30		
\neg		+	GROUND SURFACE		76.44		\mathbf{T}				1	20		. 0	~ (Ĭ		
0		╡	TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive, moist		0.00		1			1								
		╞	(SM) SILTY SAND; brown;	222	76.14	1	SS	4										
			non-cohesive, moist to wet, very loose to loose															
			loose															
1						2	SS	6										
						3	SS	3										
2					74.31													
		ſ	(CI/CH) SILTY CLAY to CLAY; grey brown, contains silt seams; cohesive, w>PL, very soft to soft		2.13													
			w>PL, very soft to soft															
3						4	TP	PH						_	0		с	
5						1	[r.a						'	0		Ĭ	
							1											
4																		
						5	SS	wн										
	oring	sing																
5	Wash Boring	W Ca.																
	ž	τ																
					70.95													
			(SM/ML) SILTY SAND to sandy SILT; grey; non-cohesive, wet	T	5.49													
			(CI/CH) SILTY CLAY to CLAY; grey with reddish brown mottling, contains silt		5.00	6	SS	3										
6			seams; cohesive, w>PL, soft				-											
7							1											
						7	TP	PH										
							-											
8																		
9																		
							1											
						8	SS	wн										
					66.69													
		1	End of Borehole		9.75		1											
10					1													
				1			1											
DE	PTH	H S	CALE					Ċ	GOL	DF	R						LC	GGED: DG
1:	50						<	V									CHE	ECKED: SM

RECORD OF BOREHOLE: 17-24N

BORING DATE: January 25, 2018

SHEET 1 OF 2

DATUM: CGVD28

LOCATION: N 5021172.5 ;E 466473.4 SAMPLER HAMMER, 64kg; DROP, 760mm

Ļ	ПОН		SOIL PROFILE	1.	ı —	SA	AMPL		DYNAMIC PENE RESISTANCE, E	ETRATIO BLOWS	DN 10.3m	\mathbf{x}	HYDRAU k	LIC CO , cm/s	NDUCT	IVITY,		Ę,	PIEZOMETER
METRES	BORING METHOD			STRATA PLOT	ELEV.	ER		BLOWS/0.30m	20 4			0	10 ⁻⁶	10			0-3	ADDITIONAL LAB. TESTING	OR
Ξ	RING		DESCRIPTION	ATA	DEPTH	NUMBER	TYPE	WS/C	SHEAR STREN Cu, kPa	GTH r r	iat V. + em V. ⊕	Q - ● U - O	WAT Wp H	ER CO	NTENT	PERCE	NT WI	ADDI AB. T	INSTALLATION
נ	BOI			STR	(m)	z		BLO	20 4	0 6	0 8	0	20	40			90	Ľ`	
0			COUND SURFACE		76.44														
	-e		r soil stratigraphy refer to Record of rehole 17-24		0.00														
	Power Auger	Diam.																	
	Powe	E C																	
		200																	
1																			
									>	48+									
2									+										
									+										
3									+										
Ŭ																			
									+										
4									⊕ +										
									+										
5									+										
	sər																		
	Nilcon Vanes	Clutch							>4	6+									
	NII																		
6									⊕ +										
-																			
									+										
7									+										
									+										
8									+										
9									⊕ +										
5																			
									+										
10			CONTINUED NEXT PAGE		66.44		+-	1-	⊢ − +−−		+		<u> </u> — − −	-+			+	-	
			CONTROLD NEXT FAGE																
DE	PTH	I SCAL	E					7	GO	I F) F	P						LC	DGGED: DG
1:	50							V				•						СН	ECKED: SM

RECORD OF BOREHOLE: 17-24N

BORING DATE: January 25, 2018

SHEET 2 OF 2

DATUM: CGVD28

LOCATION: N 5021172.5 ;E 466473.4 SAMPLER HAMMER, 64kg; DROP, 760mm

		1					DVNANIO			<u> </u>			'N/IT\/			
ш Т.,	BORING METHOD	SOIL PROFILE		8	AMPI	-	DYNAMIC PE RESISTANC		0N 5/0.3m	2		ONDUCT			RgF	PIEZOMETER
I SCA	MET		PLO1			. 30m	20			0	10) ⁻⁵ 1(ESTII	OR STANDPIPE
DEPTH SCALE METRES	RING	DESCRIPTION	STRATA PLOT	тн З	TYPE	BLOWS/0.30m	SHEAR STR Cu, kPa	ENGTH	nat V. + rem V.⊕	Q - ● U - O	W/		PERCE		ADDITIONAL LAB. TESTING	INSTALLATION
	BOI		STR (r	n) Z		BLO	20	40	60 8	0	20			80	~ _	
- 10		CONTINUED FROM PREVIOUS PAGE														
-		End of Borehole	1	0.00												
F																
E																
E .																
- 11 -																-
E																
E .																
F																
- 12																-
F																
F																
E																
- 13																-
E																
E																
F																
- - 14																-
- 14																
F																
-																-
E																
- 15 -																-
-																-
E																
Ē																
- 16																-
-																
E																
E																
- 17																
Ē																
E																
F																
- - - 18																-
-																
- N																
4/12/																
101-																
9.5 - 19																-
2 - 2 -																
0282 20																_
1						<u> </u>										
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS 0 01 01 01 01 01 01 01 01 01 01 01 01 01	EPTH	SCALE					G	יור		D					LC)GGED: DG
	50									Г						ECKED: SM
<																

RECORD OF BOREHOLE: 17-26

LOCATION: N 5021036.3 ;E 466558.2

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: February 8-13, 2018

SHEET 1 OF 5

DATUM: CGVD28

L S S S	ТНОВ	SOIL PROFILE	F					DYNAMIC PEN RESISTANCE,			<u>``</u> `		k, cm/s			0-3	AL	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	. =	ТҮРЕ	BLOWS/0.30m	20 SHEAR STREM Cu, kPa	40 I NGTH	1	80 - Q - ● → U - O	w	ATER C	I ONTENT	PERCE		I ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
i	BOF		STR/	(m)	ž	ľ	BLO		40		80		p			WI BO	L⊳ ⊳	
0		GROUND SURFACE TOPSOIL - (SM) SILTY SAND; brown;		76.26						_							+	
		non-cohesive, moist (SM) SILTY SAND; brown; non-cohesive, wet, compact to very loose		0.15	1	SS	11							0			м	
1					2	ss	8										CHEM	
2					3	ss	18						0					
				73.42		ss	wн											
3		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silt seams; w>PL, soft		2.84	5	ss	1						 		0			
4								€ +										
								€ +										
5	Wash Boring HW Casing				6	SS	WR								0			
6		- Possible silt layer		70.16				⊕ +			>96+							
		(CI/CH) SILTY CLAY to CLAY; grey with reddish brown to black mottling, contains silt seams; cohesive, w>PL, soft to firm		6.10	7	ss	WR											
7								⊕ + ⊕ +										
8					8	ss	WR								0			
								⊕ + ⊕ +										
9					9	ss	WR											
10		CONTINUED NEXT PAGE					_									+		
DEF	PTH S	CALE			•			GO		DF	R	•					LO	GGED: DWM

RECORD OF BOREHOLE: 17-26

LOCATION: N 5021036.3 ;E 466558.2

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: February 8-13, 2018

SHEET 2 OF 5

DATUM: CGVD28

"ЧГ	тнор	SOIL PROFILE		S	AMPLE		DYNAMIC F RESISTANO			ζ,		k, cm/s				ING	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT (m) (m)	HUMBER	ТҮРЕ	BLOWS/0.30m	20 SHEAR STE	40 RENGTH	60 nat V.	80 + Q- ●	10 ⁻⁶	³ 10 ⁻ TER CO			10 ⁻³ ENT	ADDITIONAL LAB. TESTING	
ر 5	BORIN		(m)	MUM	∣≻∣	SMOL	SHEAR STI Cu, kPa				vvp	I	-0 ^W		WI	ADI LAB.	INSTALLATION
_	-	CONTINUED FROM PREVIOUS PAGE		+	+	ш	20	40	60	80	20	40) 6	0	80	+	
10		(CI/CH) SILTY CLAY to CLAY; grey with					⊕ +										
		reddish brown to black mottling, contains silt seams; cohesive, w>PL, soft to firm					⊕ +										
					$\left \right $												
11				10	SS	WR											
							⊕ +										
12			64.0	17			⊕ +	-									
		CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, firm	12.1		1												
		cohesive, w>PL, firm		11	SS	WR											
				\vdash	$\left \right $												
13							⊕ +	+									
							⊕ +										
					$\left \right $												
14				12	SS	WR									0		
							Ð	+									
	sring																
15	Wash Boring HW Casing						Ð	+									
					1												
				13	SS	WR											
16				\vdash	1												
							⊕	+									
							⊕	+									
				-	$\left \right $												
17				14	SS	WR											
		(CI/CH) SILTY CLAY to CLAY: arev with	58.8		$\left \right $												
		(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, firm to stiff					Ð	+									
18							Ð	+									
				15	SS	WR											
19																	
							Ð		+								
							Ð	+	•								
20				16	ss	WR	- + -				↓			<u> </u>	<u> </u>	- -	
		CONTINUED NEXT PAGE															
DE	PTH S	SCALE					C .	OL		D						LO	GGED: DWM
1:	50					V				- N						CHE	CKED: SM

RECORD OF BOREHOLE: 17-26

LOCATION: N 5021036.3 ;E 466558.2

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: February 8-13, 2018

SHEET 3 OF 5

DATUM: CGVD28

METRES	BORING METHOD	SOIL PROFILE	L		SA	MPLE		DYNAMIC PEN RESISTANCE			Ì,				TIVITY,		NG AL	PIEZOMETER
TRE	3 ME		STRATA PLOT	ELEV.	ĔR	اس	BLOWS/0.30m				80					10 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
¥	RING	DESCRIPTION	łata	DEPTH	NUMBER	TYPE	/SMC	SHEAR STRE Cu, kPa	NGIH	rem V. 6	⊢ Q-● ₽ U-O			ONTEN [®]			ADDI AB.	INSTALLATION
ʻ	BC		STF	(m)			BLC	20	40	60	80					80		
20	_	CONTINUED FROM PREVIOUS PAGE (CI/CH) SILTY CLAY to CLAY; grey with							-						<u> </u>		+	
		black mottling, contains silt seams; cohesive, w>PL, firm to stiff			16	SS	WR						H		1	0		
		(CI/CH) SILTY CLAY to CLAY; grey with		55.8 <u>4</u> 20.42						1								
		(CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, stiff						Ð		↓								
21									.									
								Ð	+	1								
22																		
22																		
~																		
23					17	ss	WR											
								Ð		†								
24											>96+							
-	Boring																	
25	Wash Boring HW Casing																	
	-																	
26					19	SS	WD											
					10	33	vvrt											
								⊕	+									
27								Ð		+								
28																		
					L													
29																		
					19	SS	WR											
								Ð		+								
30		CONTINUED NEXT PAGE	_nxk	1		╞╺┤	-			+	-			+		+	- -	
			1	1					· · ·			I	I	1	1	1	<u> </u>	
	PTH S 50	SCALE				Ĵ		GC) L	DE	: R						LO CHE	GGED: DWM

RECORD OF BOREHOLE: 17-26

LOCATION: N 5021036.3 ;E 466558.2

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: February 8-13, 2018

SHEET 4 OF 5

DATUM: CGVD28

u ۲	ЦНОВ	SOIL PROFILE		SA	MPLES	DYNAMIC PENETR RESISTANCE, BLO	``	HYDRAULIC CONDUCTIVITY k, cm/s	, NG NG	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	TCTTA PLOT (m) (m)	. =	TYPE BLOWS/0.30m	20 40 I I SHEAR STRENGTH Cu, kPa	60 80 I nat V. + Q - ● rem V. ⊕ U - O	10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴	150	OR STANDPIPE INSTALLATION
ž	BOF		(m)	ך ד	BLOV	20 40	<u>60 80</u>	Wp H OW 20 40 60		
30 -		CONTINUED FROM PREVIOUS PAGE (CI/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, stiff				⊕	+			
32				20	SS WF	⊕	+ +	C		
34	Wash Boring HW Casing			21	SS WF			p		
36			38.77 0000 37.49			⊕	+			
38		(SM) gravelly SILTY SAND, some low plastic fines; grey (GLACIAL TILL); non-cohesive, wet, very dense	37.49 37.66 38.60	22	- SS 56			0	м	
39 40		Borehole continued on RECORD OF DRILLHOLE 17-26	38.60							
DEF 1:5		CALE				GOL	DER			.ogged: DWM HECKED: SM

		ECT: 1787048/400/4.4		RE	СС	RD	0																				HEET 5 OF 5 ATUM: CGVD28
		.TION: N 5021036.3 ;E 466558.2 NATION: -90° AZIMUTH:						DR	ILL I	RIG:	LC	55					Drillin	g								DF	ATUM: CGVD28
DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH <u>COLOUR</u>	SHF VN CJ	- Joir - Fau R- She - Vei - Cor	ear n njugal	te R O I	CO- OR- CL - D. I	Beddi Foliati Conta Ortho Cleav RACT NDEX PER	ict gona age	l Angle	UN- ST - IR - DIS DIP w COF	- Step - Irreg SCON	Ilating	K - SM- Ro - MB- DATA	Rougi Mech	ensid	HY CON K	ak s DRAU DUCT	NOTE: abbrevi of abbr symbol JLIC TIVITY sec	Diarr Point Inc	ddition refer ns &	to list	
- - - - - - - - - - -		BEDROCK SURFACE Slightly weathered to fresh, thinly to medium bedded, grey to dark grey, fine grained, slightly to non-porous SHALE, with limestone and calcareous shale interbeds CARLSBAD FORMATION - Broken core from 38.96 m to 39.00 m		37.66		100	80		8848		50	0.25 m		270		38	DESCRIF				10	10	100		4 0	AVG.	
- 40 	Rotary Drill	NQ Core		34.81	2	100-75																					
- - - - - - - - - - - - - - - - - - -	<u> </u>	End of Drillhole		41.45																							
- - - - - - - - - - - - - - - - - - -																											
- - - - - - 46 - -																											
DE 1:		H SCALE						C	5 (ЭI	L	D	E	: F	2												DGGED: DWM ECKED: SM

RECORD OF BOREHOLE: 17-27N

BORING DATE: January 26, 2018

SHEET 1 OF 2

DATUM: CGVD28

LOCATION: N 5021055.7 ;E 466466.9 SAMPLER HAMMER, 64kg; DROP, 760mm

	DOH-	SOIL PROFILE	L		SA	AMPL	_	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	≓월 PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	түре	BLOWS/0.30m	20 40 60 80 SHEAR STRENGTH nat V. + Q - ● Cu, kPa rem V. ⊕ U - O	10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴ 10 ⁻³ WATER CONTENT PERCENT Wp	PIEZOMETER OR STANDPIPE INSTALLATION
1	BO		STR	(m)			BLC	20 40 60 80	20 40 60 80	
0	-	GROUND SURFACE TOPSOIL - (SM) SILTY SAND; dark	222	76.26 0.00						
	v Stem)	brown; non-cohesive, wet		75.96	1	SS	6			
	Power Auger 200 mm Diam. (Hollow	(SM) SILTY SAND; brown; non-cohesive, wet, loose to compact		0.30	2	_				
1	2001			75.04 1.22						
2								+		
3								+		
								+		
4								+		
5								⊕ +		
	Nilcon Vanes Clutch									
6								+ ⊕ +		
7								+		
8								+ • •		
								+		
9										
10		CONTINUED NEXT PAGE		66.26		-		+		
DEI	PTH S	SCALE						GOLDER		LOGGED: DG

RECORD OF BOREHOLE: 17-27N

BORING DATE: January 26, 2018

SHEET 2 OF 2

DATUM: CGVD28

LOCATION: N 5021055.7 ;E 466466.9 SAMPLER HAMMER, 64kg; DROP, 760mm

		SOIL PROFILE		SVI	IPLES	DYNAMIC PEN	ETRATION \	HYDRAULIC CONDUCTIVITY,	<u> </u>
DEPTH SCALE METRES	BORING METHOD		5			DYNAMIC PEN RESISTANCE,	· · · ·	k, cm/s 10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴ 10 ⁻³	PIEZOMETER OR STANDPIPE INSTALLATION
TH S(IG ME		TOTA PLOT (m) (m)	NUMBER	BLOWS/0.30m		IO 60 80 I I I IGTH nat V. + Q - ● rem V. ⊕ U - O		
M DEP.	ORIN		LAT DEPTH (m)	NUN		Cu, kPa	rem V. 🕀 U - Ō	Wp I WI	
			ົດ ⁽⁾		B	20 4	0 60 80	20 40 60 80	
— 10 -	-	CONTINUED FROM PREVIOUS PAGE End of Borehole	10.00						
-									
-									
F									
- 11									
-									
E									
-									
- 12	2								-
-									
F									:
Ē									
- 13									-
Ē									
-									
-									
- 14									-
Ē									
-									
-									
- - - 15	;								
-									
-									
-									
- 16	;								
-									
-									
-									
- - 17									
F "									
-									
-									
- - 18									
-	,								
18 Z 									
4/12/									
0 19 SIV - SIV -	'								
GAL-									:
GPJ									
7048.									:
- 20 - 20	΄								
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS							<u> </u>		4 • • • • • • • • • • • • • • • • • • •
Ha-s		HSCALE			X	S G O	LDER		LOGGED: DG
<u>≆</u> 1	: 50					-			CHECKED: SM

RECORD OF BOREHOLE: 17-29

BORING DATE: January 30-February 5, 2018

SHEET 1 OF 5

DATUM: CGVD28

LOCATION: N 5021029.1 ;E 466400.2 SAMPLER HAMMER, 64kg; DROP, 760mm

LI L	ДОН	SOIL PROFILE	<u> </u>		s,	AMPL		DYNAM RESIST	IC PENE ANCE, E	ETRAT	10N S/0.3m	Ì.	HYDRA	k, cm/s		FIVITY,		NG	PIEZOMETER
METRES	BORING METHOD		STRATA PLOT		, H		BLOWS/0.30m	20				80	1(10 ⁻³	ADDITIONAL LAB. TESTING	OR
ME	RING	DESCRIPTION	ATA F	ELEV DEPT	НŠ	TYPE	WS/C	SHEAR Cu, kPa	STREN	GTH	nat V rem V. €	⊢ Q-● ₽ U-O					ENT WI	ADDI AB. T	INSTALLATION
1	BOI		STR	(m)	Ī		BLO	20) 4(0	60	80	2 Wp			60	80	Ľ`]	
0		GROUND SURFACE		76.2															
v		TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive, moist		0.0				T	T										
		(SP/SM) SAND to SILTY SAND; grey brown; non-cohesive, wet, compact to		0.2															
		very loose																	
						1													
1					1	SS	13												
						-													
					2	SS	1									6			
2				. 74.1												Ĭ			
		(CI/CH) SILTY CLAY to CLAY; grey v reddish brown mottling, contains silt	ith	2.1		1													
		seams; cohesive, w>PL, soft						+											
								+											
								т											
3						1													
					3	SS	WR										102.2	оснем	
4								⊕ +											
								⊕ +											
	ę	D																	
5	Wash Boring				4	SS	WН										0		
	Was			71.0 5.1 70.8	58	-								0					
		sand; grey; non-cohesive, wet (CI/CH) SILTY CLAY to CLAY; grey v reddish brown mottling, contains silt	ith	5.3		SS	1												
		reddish brown mottling, contains silt seams; cohesive, w>PL, soft																	
6																			
5					-														
					6	SS	wн												
				ĺ															
7		(CL/CH) SILTY CLAY to CLAY; grey	vith	69.2 7.0				+											
		black mottling, contains silt seams; cohesive, w>PL, firm							+										
8					7	SS	WR												
					-	-													
								⊕	+										
9								⊕	+										
3						-													
					8	SS	WR												
				Į															
				Į		1													
10	┝┕	CONTINUED NEXT PAGE	^***/	14 — -	1-	+ -	-	+			+	-	†		+		+		
	I				_										<u> </u>	1			
DE	PTH	H SCALE					Ċ		G O	L	DE	R						LC	DGGED: DG
1:	50					<	\mathbf{V}											CH	ECKED: SM

RECORD OF BOREHOLE: 17-29

LOCATION: N 5021029.1 ;E 466400.2

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 30-February 5, 2018

SHEET 2 OF 5

DATUM: CGVD28

L N	тнор	SOIL PROFILE					DYNAMIC RESISTAN				, ر		AULIC C k, cm/s			10-3		PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT , and		TYPE	BLOWS/0.30m	20 SHEAR ST Cu, kPa	40 IRENG				w	I ATER C	I ONTEN	r Perce		ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
נ ו	BOR		(m DED		 -	BLOV	Cu, кра 20	40				VV VV	p			WI 80	LAI	
10		CONTINUED FROM PREVIOUS PAGE (CL/CH) SILTY CLAY to CLAY: grey with						+										
		(CL/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, firm																
								+										
					1													
11				9	SS	WR												
				\vdash	+													
							Φ	ł										
12							0	+										
				\vdash	+													
				10	SS	WR												
				\vdash	+													
13							⊕	+										
							Ð	+										
					$\left \right $													
14				11	SS	WR												
							⊕		+									
	Boring asing						Ð		+									
15	Wash Boring HW Casing						-											
				12	SS	WR												
			60	0.36									ľ					
16		(CL/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, stiff	15	5.85														
		CONCORC, WALL, SUIT					•		+									
							Ð		+									
17																		
				13	SS	WŔ												
					1													
							Ð		+									
18							Ð		+									
				14	SS	WR												
19				\vdash	+													
							Ð		+									
							⊕		+									
				15	ss	WR												
20		CONTINUED NEXT PAGE		-1-	\dagger	-	+-		+				<u> </u>	†		†	- -	
		CALE						~			r	•			•			
DEI 1:{		CALE					j G	O	LĽ) E	R							GGED: DG CKED: SM

RECORD OF BOREHOLE: 17-29

LOCATION: N 5021029.1 ;E 466400.2

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 30-February 5, 2018

SHEET 3 OF 5

DATUM: CGVD28

۳ ۲	BORING METHOD	SOIL PROFILE	 –		SA	MPL		DYNAMIC PE RESISTANCE			Ì,	HYDRA					ING	PIEZOMETER
METRES	D ME		STRATA PLOT	ELEV.	3ER	щ	BLOWS/0.30m				0	10	10 ATER C			10 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
ĽΨ	JRING	DESCRIPTION	RATA	DEPTH	NUMBER	TYPE	/SMC	SHEAR STRE Cu, kPa	HIUM	rem V. ⊕	U- 0	W/A WD					ADD -AB.	INSTALLATION
1	BC		STF	(m)	2		BLC	20	40	60 8	0	20				80		
20		CONTINUED FROM PREVIOUS PAGE (CL/CH) SILTY CLAY to CLAY; grey with															+	
		black mottling, contains silt seams; cohesive, w>PL, stiff			15	SS	WR											
		cohesive, w>PL, stiff																
								Ð										
								Ψ		ľ								
21								Ð		+								
22																		
23]												
					16	SS	WR											
						-												
								Ð		+								
24																		
								Ð		+								
25	Boring																	
20	Wash Boring																	
26																		
					17	SS	νvΗ											
						1												
								Ð		+								
27								Ð		+								
								Ĩ		'								
28																		
29						1												
					18	SS	WR											
30						╞-	_			++	<u> </u>	<u> </u>		┞	––	+	- -	
		CONTINUED NEXT PAGE																
DE	ΡТΗ	SCALE						GC	11		D						LO	GGED: DG
1:						k					R							CKED: SM

RECORD OF BOREHOLE: 17-29

LOCATION: N 5021029.1 ;E 466400.2

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 30-February 5, 2018

SHEET 4 OF 5

DATUM: CGVD28

ļ	ЦОН	SOIL PROFILE	1.	1	SA	MPLE		DYNAMIC PENE RESISTANCE, E	BLOWS	0.3m	Ì,		AULIC CO k, cm/s		iivilT,		RG₽	PIEZOMETER
METRES	BORING METHOD		STRATA PLOT		R		BLOWS/0.30m	20 40		1	i0	10			1	10 ⁻³	ADDITIONAL LAB. TESTING	OR STANDPIPE
Ξ	SING	DESCRIPTION	TA F	ELEV. DEPTH	NUMBER	TYPE	NS/C	SHEAR STREN Cu, kPa	GTH r	at V. + em V. ⊕	Q - ● U - O		ATER C				DDI B. T	INSTALLATION
ž	BOR		3TRA	(m)	لح ا												[₽¤]	
			0					20 40	J 6	8008	0	2	0 4	0 6	50	80	+	
30		CONTINUED FROM PREVIOUS PAGE (CL/CH) SILTY CLAY to CLAY; grey with				\vdash	+								-		+	
		(CL/CH) SILTY CLAY to CLAY; grey with black mottling, contains silt seams; cohesive, w>PL, stiff						Ð		-	+							
		conesive, w>PL, sum																
31																		
32																		
52																		
					19	ss v	VR								0			
								⊕			+							
33								-										
								⊕			+							
34				1														
	Wash Boring HW Casing																	
35	W Ca																	
	Ϋ́																	
					20	SS V	v r1										CHEM	
36											>96+							
											>96+							
				39.51		1							0					
		(SM/ML) SILTY SAND to sandy SILT, some gravel to gravely, some low plastic fines; grey (GLACIAL TILL); non-cohesive, wet, dense to very dense		36.70	21	SS 3	35											
37		plastic fines; grey (GLACIAL TILL);										0						
		non-conesive, wet, dense to very dense																
					22	SS >	·50											
38																		
				1														
39																		
40		Borehole continued on RECORD OF	-rand	36.23 39.98														
		DRILLHOLE 17-26																
- -											-							0050 50
DEF	PTH S	CALE				Ň	5	GO	IΓ	\mathbf{F}	R						LO	GGED: DG

LC	C	ATIO	Г: 1787048/400/4.4 N: N 5021029.1 ;E 466400.2 'ION: -90° AZIMUTH:		RE	cc	R) C	D)RIL)RIL	LINC	G: (ATE: CME	Ja 75	anua	ary 3	30-F	ebr	7-29 ruary 5, 3											ET 5 OF UM: CG\	
DEPTH SCALE METRES		DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	ELLISH COLOUR	8월 10 2 2 8 8월 1 2 2 8 8	D LT - F HR- S N - V J - C RECC DTAL RE % 898	loint Fault Shear Zonju DVER	gate RY LID RE %		BD - E FO - F CO - (OR - (CL - (FF D. IN F 0.	eddi oliat	ing ion act gona rage	I	PL CL UN ST IR	- Pla J- Cu J- Cu - Str - Str - Im ISCC	ille Drillir lanar urved ndulating tepped egular DNTINUITY TYPE AND : DESCRI	PO- K - SM- Ro- MB- (DATA	Slick Smc Rou Mec	ensid oth gh hanic	al Br HY CON	eak	NOTE abbre of abb symbo ULIC TIVIT	E: For viatio previa ols. Dia Dia Dia	r addit ons ref ations) AV	st		
- 40			BEDROCK SURFACE		36.23				\prod					Ш	Ш	\prod	Ш	\prod					Π		П		\square				_
- 40 	Botary Drill	HQ Core	Slightly weathered to fresh, thinly to medium bedded, grey to dark grey, fine grained, slightly to non-porous SHALE, with limestone and calcareous shale interbeds CARLSBAD FORMATION		39.98	2																									
- 42 - 43 - 43 - 43 - 43 - 43 - 44 - 44 - 45 - 45 - 45 - 45 - 45 - 46 - 46 - 46			End of Drillhole		<u>34.27</u> 41.94																										
- 47 - 47 - 47 - 47 - 48																															
K 004 1787048.GPJ GAL-MISS.GDT 4/12/18 ZS																															
ID WIS-RCk	EP [.] : 50		CALE							G	С		LI	D	E	•	R													gged: Dg Cked: SM	

RECORD OF BOREHOLE: 17-30

BORING DATE: January 28, 2018

SHEET 1 OF 2

DATUM: CGVD28

LOCATION: N 5020966.5 ;E 466404.0 SAMPLER HAMMER, 64kg; DROP, 760mm

u Z	DOH.	SOIL PROFILE	1. 1	8	SAMP		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	국 일 PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	PT PE	LEV.	ТҮРЕ	BLOWS/0.30m	20 40 60 80 SHEAR STRENGTH nat V. + Q - ● Cu, kPa rem V. ⊕ U - O	10 ⁶ 10 ⁵ 10 ⁴ 10 ³ WATER CONTENT PERCENT Wp	PIEZOMETER OR STANDPIPE INSTALLATION
	BC			(,		BL(20 40 60 80	20 40 60 80	
0		GROUND SURFACE TOPSOIL - (SM) SILTY SAND; dark		75.99 0.00	+				
		brown; non-cohesive, moist (SM) SILTY SAND; brown;		75.69 0.30 1	ss	6 4			
		non-cohesive, moist to wet, very loose			4				
				75.08 0.91 2	SS	5 5			
1		(CL/CH) SILTY CLAY to CLAY; grey brown, contains silt seams (WEATHERED CRUST); cohesive,		0.01					
		w>PL, stiff							
		(CL/CH) SILTY CLAY to CLAY; grey with reddish brown mottling, contains silt		74.31					
2		reddish brown mottling, contains silt seams; cohesive, w>PL, soft		3	SS	5 2			
					1				
3				\vdash	\neg				
				4	ss	wн			
				\vdash	-				
4									
				\vdash	\dashv				
	sring king			5	TP	PH			с
5	Wash Boring HW Casing			\vdash	1				
	> ⁺	(SM/ML) SILTY SAND to sandy SILT,		70.59	-				
		fine sand; grey; non-cohesive, wet		5.40 70.38 5.61 6	SS	wн			
6		(CL/CH) SILTY CLAY to CLAY; grey with reddish brown mottling, contains silt seams; cohesive, w>PL, soft		\vdash	_				
-									
7				7	00	WR			
					33				
8									
U									
				\vdash	\neg				
				8	SS	WR			
9				\vdash	-				
					1				
				9	TP	PH			с
10		CONTINUED NEXT PAGE		<u>65</u> .98	+-		+		
	оти с	GCALE							LOGGED: DG
1:							GOLDER		CHECKED: SM

RECORD OF BOREHOLE: 17-30

BORING DATE: January 28, 2018

SHEET 2 OF 2

DATUM: CGVD28

LOCATION: N 5020966.5 ;E 466404.0 SAMPLER HAMMER, 64kg; DROP, 760mm

	F	SOIL PROFILE		SA	MPLES	DYNA		TRATION LOWS/0.3m	}	HYDRAUL	IC CONDUCT	IVITY,	(7)	
DEPTH SCALE METRES	AFT HC	O SOIL PROFILE U DESCRIPTION	ГОТ	2	m0%		20 40		80	к, 10 ⁻⁶		D ⁻⁴ 10 ⁻³	ADDITIONAL LAB. TESTING	PIEZOMETER OR
PTH 8	UN D	DESCRIPTION	(m)	NUMBER	TYPE BLOWS/0.30m	SHEA Cu. kF	R STRENG	TH nat V. rem V.		WATI	ER CONTENT	PERCENT	DDIT(C	STANDPIPE INSTALLATION
DE	ROR	BOR	(m) (m)	אר		2	20 40		80	Wp⊢ 20	40 6	WI 80	[≥≥]	
- 10		CONTINUED FROM PREVIOUS PAGE												
Ē		End of Borehole	10.01											
Ē														-
Ē														
- 11														
-														-
F														-
E														-
- 12	2													
Ē														-
-														
E														-
- 13	3													
-														-
Ē														-
-														-
- 14 - 14	ı													-
Ē														
Ę														-
-														
15 -	5													
Ē														-
-														-
Ē														-
- 16	5													
-														-
Ē														-
-														-
- 17 -	,													
-														
Ē														-
- 19	,													-
— 18 – ဟု –	,													-
/18 Z														-
4/12														-
LOD: 19	,													-
SIMS														:
I GAL														-
8.GP														
- 20 840-														
17														
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS	EPTH	TH SCALE					20	LDE	D				L	OGGED: DG
HISH	: 50								-					IECKED: SM

RECORD OF BOREHOLE: 17-30N

BORING DATE: January 28, 2018

SHEET 1 OF 2

DATUM: CGVD28

LOCATION: N 5020966.5 ;E 466404.0 SAMPLER HAMMER, 64kg; DROP, 760mm

	DOH.	SOIL PROFILE			S/	AMPL	_	DYNAMIC PEN RESISTANCE,	ETRATI BLOWS	ON /0.3m	λ,	HYDRAL				NG	PIEZOMETER
METRES	BORING METHOD		STRATA PLOT	ELEV.	Я		BLOWS/0.30m				80	10 ⁻⁶			0-3	ADDITIONAL LAB. TESTING	OR
Ψ	RING	DESCRIPTION	ATA	DEPTH	NUMBER	TYPE)/S/(C	SHEAR STREM Cu, kPa	IGTH I	nat V. + rem V. €	- Q - ● 9 U - O	WA ⁻ Wp	TER CC	PERCE	NT WI	ADDI AB. T	INSTALLATION
J	BO		STR	(m)	ľ		BLC	20 4	40 (60	80	20			80	Ľ`	
0		GROUND SURFACE		75.99													
	Power Auger	For soil stratigraphy refer to Record of Borehole 17-30		0.00													
	r Auge																
	Power Auger																
	200																
1																	
2								+									
								+									
3								+									
Ŭ																	
								_									
								+									
4								+									
								⊕ +									
5								+									
	nes																
	Nilcon Vanes Clutch																
	ĨZ																
6								+									
								⊕ ⊥									
								⊕ +									
7																	
								+									
8								+									
								⊕ +									
9								+									
ŕ																	
								1									
				65.00													
10		CONTINUED NEXT PAGE		65.99		+ -		Ð − +† − −		+	·	├ ──	+	 <u> </u>	+	-	
DE	PTH	SCALE					C	GO		DΕ	R						DGGED: DG
1:	50					<										CH	ECKED: SM

RECORD OF BOREHOLE: 17-30N

BORING DATE: January 28, 2018

SHEET 2 OF 2

DATUM: CGVD28

LOCATION: N 5020966.5 ;E 466404.0 SAMPLER HAMMER, 64kg; DROP, 760mm

	6	9 SOIL PROFILE		0/	MPL	FS	DYNAMIC PE RESISTANCE	NETRATIO	NC	1	HYDRAU k	JLIC CC	NDUCT	IVITY,			
DEPTH SCALE METRES	ICHT	O SOIL PROFILE	5	-						ί,	k 10 ⁻⁶				∩ ⁻³	ADDITIONAL LAB. TESTING	PIEZOMETER OR
TH SC ETRE	IG MF	ଅ ଅଧି DESCRIPTION	STRATA PLOT (m) (m)		TYPE	BLOWS/0.30m	20 J SHEAR STRI Cu, kPa		60 80 hat V. +	, Q - ●	1					TES	STANDPIPE INSTALLATION
M DEP.	ORIN		LEAT (m)		₽	LOWS					Wp H				WI	ADI LAB.	INSTALLATION
		CONTINUED FROM PREVIOUS PAGE		+		B	20	40 6	50 80)	20	40) 60	08	0		
- 10 -		End of Borehole	10.00					_									
-																	
-																	
Ē																	
- 11	1																-
E																	
E																	:
Ē																	
- 12	2																-
E																	
Ē																	:
Ē																	
- 13	3																-
Ē																	
F																	
-																	-
- 14	1																-
Ē																	
F																	
-																	
- 15	5																-
Ē																	-
F																	
E																	
- 16	5																-
F																	
E																	
E -																	
- 17 -	7																-
F																	
Ē																	
F.																	
- 18	3																-
18 - Z																	
4/12/																	
0 – 19 SIV-	1																
GAL																	:
GPJ																	-
31048 - 20																	- -
1178																	_
MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 4/12/18 ZS										-	· · · · ·				•		
-B-SI D	EPTH : 50	TH SCALE			Z		G) [[)E	R							DGGED: DG ECKED: SM
ΣĽ																	

APPENDIX B

Record of Boreholes - Previous Investigation

PROJECT:	12-1125-0045

BORING METHOD DEPTH SCALE METRES

0

3

4

5

6

7

8

10

11

12

13

14

15

1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

Electric Nilcon 9

Power Auger

2

RECORD OF BOREHOLE: 12-3-2

BORING DATE: November 27-28, 2012

SHEET 1 OF 3

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

LOCATION:	N 5021570	.68 ;E 466665.61
INCLINATIO	N: -90°	AZIMUTH:
SAMPLER H	AMMER, 64	kg; DROP, 760mm

	R HAMMER, 64Kg; DROP, 760mm				= 0		AMIC PE				HYDR				:51 HA	IVIIVIER,	64kg; DROP, 760mm	
	SOIL PROFILE	1	SA	AMPL	-	RESI	STANCE	, BLOW	/S/0.3m	Ì,		k, cm/s	3			ING	PIEZOMETER	
		STRATA PLOT	ELEV.	ËR	μ	BLOWS/0.3m		20	40	60	80		1		1	0 ⁻²	ADDITIONAL LAB. TESTING	OR STANDPIPE
	DESCRIPTION	RATA	DEPTH	NUMBER	TYPE	OWS	Cu, kł	AR STRE Pa	NGTH	nat v. rem V.	+ Q-● ⊕ U-○						ADDI AB.	INSTALLATION
2		STF	(m)	2		B		20	40	60	80					30		
	GROUND SURFACE		76.24															
em)	TOPSOIL Loose to compact grey brown to grey SILTY SAND, trace clay	ĪĪ	0.00		50 DO	9												
200 mm Diam. (Hollow Stem)	SILTY SAND, trace clay			-	-													
(Holl			75.10	2	50 DO	10							0				мн	
Diam	Grey SANDY SILT, trace clay		1.14 74.72	1														-
0 mm	Soft grey and red brown CLAY to SILTY		1.52		50													
20	CLAY, with silt seams			3	50 DO	WН												
																		-
							+											
							+											
							⊕	+										-
	Grey SILT, trace clay		71.36 4.88	1				+										-
	Grey SILTY SAND		5.03 5.15															
	Soft grey and red brown CLAY to SILTY CLAY, with black staining and silt seams																	
							-	÷										
			69.84															-
	Grey SILT Soft grey and red brown CLAY to SILTY		6.46															
	CLAY, with black staining Grey SILT		69.35 6.95	-			⊕	+										
	Soft grey and red brown CLAY to SILTY																	-
	CLAY, with black staining and clayey silt seams																	
								+										
	Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining		67.65 8.59															
	SILTY CLAY, with black staining							+										
							⊕	+										
								+										
								+										
							⊕	+										
								+										-
																		1
-		XXX	4	┣-	+-		<u>⊢</u> – ·	+	+	+-		+	<u> </u>	+	-	+	-	
	CONTINUED NEXT PAGE																	

CRRRC-SOIL DEPTH SCALE 1:75



PRO	OJEC.	T: 12-1125-0045		RE	CO	R	D	DF	BOR	REH	OLE:	: 1	2-3-	2				SI	HEET 2 OF 3
		N: N 5021570.68 ;E 466665.61 FION: -90° AZIMUTH:						B	DRING I	DATE:	Novemb	er 27-2	8, 2012					D	ATUM: Geodetic
		R HAMMER, 64kg; DROP, 760mm															EST HAI	MMER,	64kg; DROP, 760m
u N F	тнор	SOIL PROFILE	F		SA	MPLE		RESIS	MIC PEN TANCE,	BLOW	S/0.3m	Ì,		k, cm/				ING	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	ТҮРЕ	BLOWS/0.3m		1	10 I NGTH	60 8 nat V. + rem V. ⊕	Q - • U - ○	v	ATER C	10 ⁻⁶ 1 CONTENT	I F PERCI	10 ⁻² ENT	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATIO
د د	BO		STR	(m)	z		BLO	:	20 4	10	60 E	0					80		
15		CONTINUED FROM PREVIOUS PAGE Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining							+										
		g																	
16									>41	+									
17											+								
18											+								
19								⊕			+								
20											+								
21											+								
22											+								
	Electric Nilcon																		
	Electric	Stiff grey and red brown CLAY to SILTY CLAY, with black staining		53.63 22.61															
23																			
- 24											-	+							
												117							
25													t						
		Grey CLAYEY SILT, some sand		50.58 25.66								>113							
26		Very stiff grey CLAY to SILTY CLAY, with black staining		50.24 26.00								2113	t						
27		Grey SILTY fine SAND		49.05															
		Grey SANDY SILT, some clay Very stiff grey CLAY to SILTY CLAY,		27.30															
28		with black staining									>76+								
29																			
30	_L						-		+	<u> </u>	+		<u> </u>		+		+		
		CONTINUED NEXT PAGE								 									

		T: 12-1125-0045		REC	co	RD	OF E	BOR	EHC	DLE:	1:	2-3-2				HEET 3 OF 3
IN	CLINA	DN: N 5021570.68 ;E 466665.61 TION: -90° AZIMUTH:					BO	RING D	ATE: 1	Novemb	er 27-28	3, 2012	DENET			ATUM: Geodetic
ш		R HAMMER, 64kg; DROP, 760mm SOIL PROFILE			SAN	IPLES	DYNAM		TRATIC	N 0.0)	HYDRAU		-51 HAN		64kg; DROP, 760mm
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE BLOWS/0.3m		STREN) 6 GTH n re	0 8 at V. + em V. ⊕	Q - ● U - ○	10 ⁻⁸ WAT	cm/s 10 ⁻⁶ ER CONTE	10 ⁻² ENT WI 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
30 	Electric Nilcon	CONTINUED FROM PREVIOUS PAGE Brown SILTY SAND Very stiff grey CLAY to SILTY CLAY, with black staining End of Borehole		45.94 30.33 45.11 31.13						>76+						
- 32		Note: Soil stratigraphy inferred from various soil sampling methods and CPT.														
- 34 - 35 - 35																
- 36 - 37 - 37																
- 38 - 38 - 39 - 39																
40																
41																
		I SCALE						Ø	As	olde	r ites	ı		1		DGGED: DG ECKED: SAT

PROJECT:	12-1125-0045

12-3-3 **RECORD OF BOREHOLE:**

BORING DATE: December 3-5, 2012

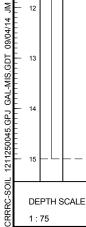
SHEET 1 OF 3

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

LOCATION:	N 5021578	.47 ;E 466670.90
INCLINATIO	N: -90°	AZIMUTH:
SAMPLER H	AMMER, 64	kg; DROP, 760mm

Bit Market Bit Status Sourt PROPILE Sourt PROPILE Sourt Propile Prop	
OP OP P P2 P2 </td <td>TED</td>	TED
OROUND SURFACE W TopSQL W	
OROUND SURFACE Orona P Zul Early and the provide state in the pro	PE
ORCUMO SURFACE D Tag Zu Go with a set of the set of	IUN
0 IOPSOL 22 00 0.00 1 IOPSOL 22 0.00 0.00 1 IOPSOL 0.00 0.00 0.00 1 IOPSOL 0.00 0.00 0.00 1 IOPSOL 1.00 0.00 0.00 2 IOPSOL 1.00 0.00 0.00 3 IOPSOL 1.00 1.00 0.00 2 IOPSOL 1.00 1.00 1.00 2 IOPSOL 1.00 1.00 1.00 2 IOPSOL 1.00 1.00 1.00 3 IOPSOL IOPSOL 1.00 1.00 3 IOPSOL IOPSOL IOPSOL IOPSOL 4 IOPSOL IOPSOL IOPSOL	
1 10-850L 22 0.02 1 1 17.530L 17.53 2 1 7.53 3 1 7.13 4 1 7.13 5 1 7.13 6 1 7.13 7 1 1 1 1 1 1 1 1 2 1 1 2 1 1 3 1 1 4 1 1 5 1 1 5 1 1 7 1 1 8 1 1 1 1 1 1 1 1 2 1 1 3 1 1 4 1 1 5 1 1 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 <td< td=""><td></td></td<>	
Love B comparing give provinting grey Suff of eye and red brown CLAY to SLITY CLAY, with silt seams	
1 Grey SANDY SILT, trace clay 7 700 2 1 1 70 3 1 1 70 4 Grey SILT, trace clay 1 70 5 1 1 70 6 1 70 6 1 70 7 100 9 1 100 8 1 100 9 1 100 10 1 100 11 1 100	
2 Grey SANDY SILT, trace clay 1 1/1 3 Grey SiLT, trace clay 1 1/2 4 1 1/2 1 5 Grey SiLT, trace clay 1 1/2 6 Crey SiLT, trace clay 1 1/2 7 Grey SiLT, trace clay 1 1/2 6 Grey SiLT, trace clay 1 1/2 7 Grey SiLT, trace clay 1 1/2 8 Grey SiLT, trace clay 1 1/2 9 Soft grey and red brown CLAY to SiLTY 1/2 1/2 9 Soft to stiff grey and grey brown CLAY to SiLTY 1/2 9 Soft to stiff grey and grey brown CLAY to SiLTY 1/2 9 Soft to stiff grey and grey brown CLAY to SiLTY<	
2 Grey SANDY SULT, trace clay 1.14 3 Grey SulT, trace clay 1.17 4 1 17 6 Grey SulT, trace clay 1.17 7 Grey SulT, trace clay 1.17 6 Grey SulT, trace clay 1.17 7 Grey SulT, trace clay 1.17 6 Grey SulT, trace clay 1.17 7 Grey SulT, trace clay 1.17 6 Grey SulT, trace clay 1.17 10 Grey SulT, trace clay 1.17 11 Grey SulT, trace clay 1.17 12 Grey SulT, trace clay 1.17 13 Grey SulT, trace clay 1.17 14 Grey SulT, trace clay 1.17 15 Grey SulT, trace clay 1.17 16 Soft grey and red brown CLAY to SulTY 1.17 17 Batterine Grey SulT 1.17 18 Grey SulT, trace clay 1.17 19 Soft grey and grey brown CLAY to SulTY 1.17 10	
2 Cary, with site seams 4 Cary SILT, trace clay 5 Cary, with site seams 4 Cary SILT, trace clay 7 Table 6 Cary SILT, trace clay 7 Cary, with black staining and sit seams 7 Cary, with black staining and site seams 8 Cary SILT, trace clay 7 Cary, with black staining and site seams 9 Soft grey and red brown CLAY to SILTY 1 Cary, with black staining and clayy site 9 Soft to stiff grey and grey brown CLAY to SILTY 1 Soft to stiff grey and grey bro	
2	
2	
3 4 6 6 7 7 8 7 9 9 10 11 11 11 11 11 11 11 11 11	
3 4 6 6 7 7 8 7 9 9 10 11 11 11 11 11 11 11 11 11	
4 - <td></td>	
4 - <td></td>	
5 6 7 6 7 10 9 10 10 10 10 10 10 10 10	
5 6 7 6 7 10 9 10 10 10 10 10 10 10 10	
6 7 Grey SILT, Trace clay, 7 1.58 6 5.15 5.15 5.15 7 Grey SILT SAND 5.15 8 2 73 9 Grey SILT Grey and red brown CLAY to SILTY 6.48 9 Grey SILT 6.48 9 Grey SILT 6.48 9 Soft grey and red brown CLAY to SILTY 6.48 9 Grey SILT 6.48 9 Soft grey and red brown CLAY to SILTY 6.48 9 Soft grey and red brown CLAY to SILTY 6.38 9 Soft grey and red brown CLAY to SILTY 6.38 9 Soft to stiff grey and red brown CLAY to SILTY 6.38 9 Soft to stiff grey and grey brown CLAY to SILTY 8.59 10 Soft to stiff grey and grey brown CLAY to SILTY 8.59	
5 Grey SILT, trace clay, 7, 13, 4 4.88 Grey SILTY SAND 5.15 2 Soft grey and red brown CLAY to SILTY 6.46 CAY, with black staining 6.46 Soft grey and red brown CLAY to SILTY 6.43 Crey SILT 6.46 Soft grey and red brown CLAY to SILTY 6.45 Crey SILT 6.46 Crey SILT 6.45 Soft grey and red brown CLAY to SILTY 6.45 Soft to stiff grey and grey brown CLAY to SILTY 6.45 Soft to stiff grey and grey brown CLAY to SILTY 6.45 Soft to stiff grey and grey brown CLAY to SILTY 6.45 Soft to stiff grey and grey brown CLAY to SILTY 8.59 Soft to stiff grey and grey brown CLAY to SILTY 8.59	
5 Grey SILT tace clay 4.88 Crey SILTY SAND 5.15 Soft grey and red brown CLAY to SILTY 6.46 Grey SILT 6.47 Carey SILT 6.46 Grey SILT 6.46 Grey SILT 6.47 Soft grey and red brown CLAY to SILTY 6.46 Grey SILT 6.47 Soft grey and red brown CLAY to SILTY 6.46 Grey SILT 6.47 Grey SILT 6.46 Grey SILT 6.47 Soft to stiff grey and grey brown CLAY to SILTY 8.59 SILTY CLAY, with black staining 8.59 Grey SILTY CLAY, with black staining 8.59	
5 Grey SILT tace clay 4.88 Crey SILTY SAND 5.15 Soft grey and red brown CLAY to SILTY 6.46 Grey SILT 6.47 Carey SILT 6.46 Grey SILT 6.46 Grey SILT 6.47 Soft grey and red brown CLAY to SILTY 6.46 Grey SILT 6.47 Soft grey and red brown CLAY to SILTY 6.46 Grey SILT 6.47 Grey SILT 6.46 Grey SILT 6.47 Soft to stiff grey and grey brown CLAY to SILTY 8.59 SILTY CLAY, with black staining 8.59 Grey SILTY CLAY, with black staining 8.59	
5 Grey SILT tace clay 4.88 Crey SILTY SAND 5.15 Soft grey and red brown CLAY to SILTY 6.46 Grey SILT 6.47 Carey SILT 6.46 Grey SILT 6.46 Grey SILT 6.47 Soft grey and red brown CLAY to SILTY 6.46 Grey SILT 6.47 Soft grey and red brown CLAY to SILTY 6.46 Grey SILT 6.47 Grey SILT 6.46 Grey SILT 6.47 Soft to stiff grey and grey brown CLAY to SILTY 8.59 SILTY CLAY, with black staining 8.59 Grey SILTY CLAY, with black staining 8.59	
Soft grey and red brown CLAY to SILTY CLAY, with black staining and silt seams Grey SILT Soft grey and red brown CLAY to SILTY CLAY, with black staining and clayey silt Grey SILT Soft pey and grey brown CLAY to SILTY CLAY, with black staining and clayey silt Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining Grey SILT Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining Grey SILT Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining Grey SILT Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining Grey SILT SILTY CLAY, with black staining Grey SILT Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining SILTY CLAY, with black staining Grey SILT SILTY CLAY, with black staining SILTY CLAY, SILTY	
Transformed and the state of th	
Transformed and the state of th	-
Provide stating 00.82 Original Soft Grey And red brown CLAY to SILTY 0.46 Original Soft Grey And red brown CLAY to SILTY 0.85 Original Soft Grey And red brown CLAY to SILTY 0.85 Original Soft Grey And Grey Down CLAY to SILTY 0.85 Soft to Stiff Grey and Grey Down CLAY to SILTY 0.85 Soft to Stiff Grey and Grey Down CLAY to SILTY 0.85 Soft to Stiff Grey and Grey Down CLAY to SILTY 0.85	
7 Orey SiLT 6.46 Soft grey and red brown CLAY to SiLTY 6.36 0 Orey SiLT Soft to stiff grey and grey brown CLAY to SiLTY Soft to stiff grey and grey brown CLAY to SiLTY Soft to stiff grey and grey brown CLAY to SiLTY Soft to stiff grey and grey brown CLAY to SiLTY Soft to stiff grey and grey brown CLAY to SiLTY CLAY, with black staining	
7 Or grey and red brown CLAY to SILTY CLAY, with black staining 69.33 9 Soft grey and red brown CLAY to SILTY CLAY, with black staining and clayey silt seams 6.95 9 Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining 67.63 8 Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining 67.63	
Image: Solid construction 0.55 Image: Solid construction 0.55 Image: Solid construction 0.55 Image: Solid construction 0.763 Image: Solid construction 0.763 <	
9 Soft to stiff grey and grey brown CLAY to SLTY 0 Soft to stiff grey and grey brown CLAY to SLTY 1 Soft to stiff grey and grey brown CLAY to SLTY	
8 Soft to stiff grey and grey brown CLAY to 9 SiLTY CLAY, with black staining	
8 67.63 9 Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining 10 8.59	
8 Soft to stiff grey and grey brown CLAY to 9 SiLTY CLAY, with black staining	
9 Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining 8.59 0 Image: Silt of the stiff grey and grey brown CLAY to SILTY CLAY, with black staining 8.59 1 Image: Silt of the stiff grey and grey brown CLAY to SILTY CLAY, with black staining 8.59	
9 Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining 8.59 0 Image: Silt of the stiff grey and grey brown CLAY to SILTY CLAY, with black staining 8.59 1 Image: Silt of the stiff grey and grey brown CLAY to SILTY CLAY, with black staining 8.59	-
	-
аларанананананананананананананананананан	
3 73 PH	
з 73 _{ТР} РН	
3 73 PH	
₅┝└╞╼╾╾╾╾╾╾╾╾╾╾╾╼╡╨┫╼╼╞╞┼┥╼╞╴╾┽╾╼┝╼╶┽╾╼┝╼╶┽╾╼┝╼╶┽╼╼┝╼┥╾╾╾╸╸	



CONTINUED NEXT PAGE

_	ER HAMMER, 64kg; DROP, 760mm SOIL PROFILE		SAN	IPLE:	DYNAMIC PE	NETRAT	ION	<u>}</u>	HYDRA		ONDUCT		 , 64kg; DROP, 760n
BORING METHOD	DESCRIPTION	STRATA PLOT (m) (m)	NUMBER		RESISTANCE 20 SHEAR STRE Cu, kPa 20	40 INGTH	60 8	Q - ● U - ○		ATER CO	D ⁻⁶ 1 ONTENT	0 ⁻⁴ 10 ⁻² PERCENT WI 50 80	PIEZOMETEF OR STANDPIPE INSTALLATIO
15 16 17 18 19 19 19 19 10 11 10 11 10 12 13 14 14 14 15 16 17 16 17 17 18 18 19 19 19 19 19 10 10 10 10 10 10 10 10 10 10	CONTINUED FROM PREVIOUS PAGE Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining	53.61 22.61		73 P TP P									Bentonite-Cernent Grout
24 25 26 27 28 29 30	Grey CLAYEY SILT, some sand Very stiff grey CLAY to SILTY CLAY, with black staining Grey SILTY fine SAND Grey SANDY SILT, some clay Very stiff grey CLAY to SILTY CLAY, with black staining	50.56 25.66 50.22 26.00 49.03 27.30		73 P						F		9	

RECORD OF BOREHOLE: 12-3-3

BORING DATE: December 3-5, 2012

SHEET 3 OF 3

DATUM: Geodetic

LOCATION: N 5021578.47 ;E 466670.90 INCLINATION: -90° AZIMUTH: ---

ц	IOD	SOIL PROFILE			SA	MPL	ES	DYNAMIC PENETR RESISTANCE, BLO	ATION		HYDRAULIC k, cn	CONDUCTIVITY, n/s	ט	
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	20 40 SHEAR STRENGT Cu, kPa 20 40	60 80	, • •	10 ⁻⁸	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
30		CONTINUED FROM PREVIOUS PAGE	~~~~											
31		Brown SILTY SAND Very stiff grey CLAY to SILTY CLAY, with black staining		<u>45.92</u> 30.33										
32	Wash Boring HW Casing	Very stiff grey SILTY CLAY, some sand Very stiff grey and red CLAY to SILTY CLAY		44.37 31.85 32.10										
33		Compact to very dense grey SILTY SAND to SANDY SILT, some gravel, trace to some clay, with cobbles and boulders (GLACIAL TILL)		<u>43.15</u> 33.07	7	50 DO	6							
34														
35					8	50 DO	20							Bentonite-Cement Grout
30					9	50 DO	21							
36					<u> </u>	50 DO	44							
	ore						55 97							
37	Rotary Drill HQ Core					50 DO	88				0		мн	
38						50 DO	>50							
					15	50 DO	90							
39					16	50 DO	90							Peltonite
40		Borehole continued on RECORD OF DRILLHOLE 12-3-3		36.38										
41		Note: Soil stratigraphy inferred from various soil sampling methods and CPT.												
42														
43														_
44														
45														
DE	PTH S	CALE			<u> </u>			Â	Golder				L	OGGED: DG

														SHEET 1 OF 3										
		on: N 5021578.47 ;E 466670.90						C	DRILI	L RIG	: C	ME	55	,									Ľ	DATUM: Geodetic
			1		<u> </u>		J	N - Joir	nt		BD-	Bedd	ing	OR: Marathon Dril PL - Planar CU- Curved	PC)- Pol	lishe	ł	E	BR	- Bro	ken Ro	ick	
DEPTH SCALE METRES	DRILLING RECORD		SYMBOLIC LOG	ELEV.	No	URN	s v	LT - Fau H - She N - Veii J - Cor	ear in		CO- OR-	Foliat Conta Ortho Clear	ict gonal	UN- Undulating	SN RC	- Slid A- Sm D- Ro	100th ugh		2	abbrev of abb	viation	additional s refer to ons &	l b list	NOTEO
EPTH S METR	TING	DESCRIPTION	MBOL	DEPTH (m)	RUN No.	FLUSH RETURN		COVER	ID F	R.Q.D.	FR/	ACT.)IP w.r. CORE	DISCONTINUITY DA	ATA			HYI CONI	DRAULI DUCTIV cm/sec	IC /ITY	V	/EATH- ERING INDEX		NOTES
	DRII		S			FLL	CORE ଛଞ୍ଚ	E % COR	ε%	2668	0.2	25m	AXIS	DESCRIPTION	CE	Jcon	Jr Ja		29 1 1 1 1			× 43	W6	
- 40		BEDROCK SURFACE CARLSBAD FORMATION, 39.84 m to 45.42 m Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible SHALE, CALCAREOUS SHALE, SHALEY LIMESTONE and LIMESTONE with occasional bioclastic limestone beds.		36.38 39.84 39.86 36.23 39.99										• JN.,										Peltonite
-			+ + + + + + + + + + + + + + + + + + +	<u>36.06</u> 40.16 <u>35.93</u> 40.29									•	· JN., JN., JN.,										Silica Sand
- 41	Rotary Drill HO Core			35.09									•	VN,,										
		CONTINUED NEXT PAGE		41.13 34.98 41.24									•	VN.,										63 mm Diam. PVC #10 Slot Screen
	PTH	SCALE	1	I	L					Á				1 1		1				<u> </u>			لــــــــــــــــــــــــــــــــــــ	LOGGED: DG
1:	10									V	7	≓ G As	r Ul (500	der ciates										HECKED: SAT

PI	ROJE	CT: 12-1125-0045		RE	CC	R	D	OF	D	RI	LL	_H	0	LE	E: 12-3-3	3						:	SHEET 2 OF 3
		ION: N 5021578.47 ;E 466670.90								LLINO					ember 3-5, 2012							I	DATUM: Geodetic
IN	CLIN	ATION: -90° AZIMUTH:													OR: Marathon Dril	lling							
¶LE ℃	DRILING RECORD		DOG			z	F	N - Jo LT - Fa SH - Sh	ault hear		FC CC	D-Ber D-Fol D-Co	liatior ntact	n	PL - Planar CU- Curved UN- Undulating	K - SM-	Polish Slicke Smool	nside th	ed No	DTE: F	or ad	en Rock Iditional refer to list 15 &	
DEPTH SCALE METRES	LG RF	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH	RUN No.	FLUSH RETURN	С	N - Ve J - Co COVE	onjug		CL	R- Ort Cle RACT	an [°]	onai	ST - Stepped IR - Irregular DISCONTINUITY D/		Rough Mecha		I Break sy IYDRAULIC	mbols.		EATH- RING	NOTES
DEP			SYME	(m)	Ř	FLUSH	TOT/ CORE	AL SO	OLID DRE %	R.Q.E %	C	NDEX PER 0.25m		9 w.r.t. ORE XIS		`e	on Jr .		NDUCTIVI K, cm/sec		IN	IDEX	
		CONTINUED FROM PREVIOUS PAGE					808	68 24	20400	884	2	8 <u>29</u>	08	388			+	1		>	. > >	W5 W5 W6	
	Rotary Drill	CARLSBAD FORMATION, 39.84 m to 45.42 m Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible SHALE, CALCAREOUS SHALE, SHALEY LIMESTONE and LIMESTONE with occasional bioclastic limestone beds.		34.28 41.94 42.12 34.02 42.20 42.20 42.62	2										JN.,								63 mm Diam. PVC #10 Slot Screen
117	۴I						$\left + \right $	╞┿┛┿		┛┤┼	$\left \right $	- +	$\left \right $	4	+	-+	- -	+	- - +	\cdot	+	+	%H%]_
			<u> </u>								III S												
	EPTH 10	SCALE								G		A	Go ss	old oc	ler iates								logged: Dg Hecked: Sat

		T: 12-1125-0045		REC	CC	R	D	0							E: 12-3-	3									SHEET 3 OF 3
		0N: N 5021578.47 ;E 466670.90 TION: -90° AZIMUTH:									_ING _ RIG				cember 3-5, 2012										DATUM: Geodetic
			-					IN -	DF				NTF		FOR: Marathon Dri PL - Planar	-	- Poli	shod			BR	- Br	oken	Rock	1
S	DRILLING RECORD		DOG		ġ	Z		FLT - SH -	Fault Shea Vein	t ar		FO- CO-	Folia Cont Ortho	tion act	CU- Curved UN- Undulating	K SM	- Poli - Slic I- Smo I- Rou	kensi both	ided		NOT	E: For eviatio	additi	onal er to list	
DEPTH SCALE METRES	NG RE	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH	RUN No.	FLUSH RETURN	(CJ -	Conji VERY	ugate	e R.Q.D.	CL -	Clea ACT.	ī	IR - Irregular DISCONTINUITY D/	MB	- Med	chani		reak RAUL	symb	ools.	WEA		NOTES
DEP	DRILLI		SYM	(m)		FLUSF	TOT COR	E %	SOLIE CORE 889	D %	8848 %	P 0.2	ER 25m	DIP w.r CORE AXIS	TYPE AND SURFAC	CE	Jcon J	Ir Ja	Κ,		с		INDE	5 S S S	
- 44 - 44 	Rolary Drill HQ Core	CONTINUED FROM PREVIOUS PAGE CARLSBAD FORMATION, 39.84 m to 45.42 m Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible SHALE, CALCAREOUS SHALE, SHALEY LIMESTONE and LIMESTONE with occasional bloclastic limestone beds.		32.07 44.15 44.17 44.17 44.17 44.53 31.69 44.53 31.54 44.59 31.54 44.72								-			• VN.,										63 mm Diam. PVC #10 Slot Screen
CRRRC-ROCK 1211250045.GPJ GAL-MISS.GDT 09/04/14 JM		End of Drillhole		31.06 45.16 30.85 45.37 30.80 45.42																					Silica Sand
RC-ROC	EPTH S	SCALE			•	•		1		(Á		•	ioi	der ciates					<u>, </u>	-	•			LOGGED: DG
ਸ਼ੂ ਹ	10										V	1	As	<u>so</u>	ciates									C	HECKED: SAT

RECORD OF BOREHOLE: 12-3-4

LOCATION: N 5021576.05 ;E 466672.49 INCLINATION: -90° AZIMUTH: ---

BORING DATE: December 11-14, 2012

SHEET 1 OF 3 DATUM: Geodetic

Open Product OWARD Strangenet Data Note: 1 Products of the Not	ES		SOIL PROFILE	1	r +		MPL		DYNAMIC PENETR RESISTANCE, BLO 20 40		30	HYDRAUL k, 10 ⁻⁸	IC COND cm/s 10 ⁻⁶	UCTIVIT	Y, 10 ⁻²	NAL TING	PIEZOMETER OR
Construct Date			DESCRIPTION	RATA PLC	ELEV.	NUMBER	TYPE	OWS/0.3	SHEAR STRENGTH	nat V. +	Q - ●	WATE	R CONT	ENT PE	RCENT	ADDITIO -AB. TES	STANDPIPE
O Torseout Pacetor Lang 1 Torseout 100 100 3 1 100 100 1 Cony SANDY SLLT taxae clay 100 100 1 Soft goe and of them CLAY to SLTY 100 100 2 Cony SANDY SLT taxae clay 100 100 2 Soft goe and of them CLAY to SLTY 100 100 2 Cony SANDY SLT taxae clay 100 100 2 Cony SANDY SLT taxae clay 100 100 2 Cony SANDY SLT taxae clay 100 100 2 Cony SLT taxae clay 100 100 2 Cony SLT SAND 100 100 3 Cony SLT SAND 100 100 1 Cony SLT SAND 100	, <u> </u>	4		STF	(m)	-		BL	20 40	60	30						
1 Image: Compact age you how to give you have to gi	0	_		222												_	
	 1 2 3 4 5 6 7 buog type of the second seco	HW Casing	Loose to compact grey brown to grey SILTY SAND, trace clay Grey SANDY SILT, trace clay Soft grey and red brown CLAY to SILTY CLAY, with silt seams Grey SILT, trace clay Grey SILTY SAND Soft grey and red brown CLAY to SILTY CLAY, with black staining and silt seams Grey SILT Soft grey and red brown CLAY to SILTY CLAY, with black staining Grey SILT Soft grey and red brown CLAY to SILTY CLAY, with black staining Grey SILT Soft grey and red brown CLAY to SILTY CLAY, with black staining and clayey silt seams Soft to stiff grey and grey brown CLAY to		0.20 75.09 1.14 74.71 1.52 71.35 4.88 5.03 5.15 69.83 6.46 69.83 6.46 69.34 6.95												Bentonite-Cerment
	15 —	_						_					-+-		_ +		

RECORD OF BOREHOLE: 12-3-4

LOCATION: N 5021576.05 ;E 466672.49 INCLINATION: -90° AZIMUTH: ---

BORING DATE: December 11-14, 2012

SHEET 2 OF 3

ш Т.	DOH.	SOIL PROFILE	1		SA	MPL		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m K, cm/s	
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	ТҮРЕ	BLOWS/0.3m		PIEZOMETER OR STANDPIPE INSTALLATION
15 16 17 18 19 20		CONTINUED FROM PREVIOUS PAGE Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining							B.
· 21 · 22 · 23	Wash Boring HW Casing	Stiff grey and red brown CLAY to SILTY CLAY, with black staining		53.62 22.61					Bentonite-Cement Grout
25 26 27 28		Grey CLAYEY SILT, some sand Very stiff grey CLAY to SILTY CLAY, with black staining Grey SILTY fine SAND Grey SANDY SILT, some clay Very stiff grey CLAY to SILTY CLAY, with black staining		50.57 25.66 50.23 26.00 49.04 27.30					Peltonite Silica Sand
29 30		— — — — — — — — — — — — — — — — — — —							25 mm Diam. PVC

RECORD OF BOREHOLE: 12-3-4

LOCATION: N 5021576.05 ;E 466672.49 INCLINATION: -90° AZIMUTH: ---

BORING DATE: December 11-14, 2012

SHEET 3 OF 3

ц	ДОН	SOIL PROFILE	1		SA	MPLE	s	DYNAMIC PENETRA RESISTANCE, BLOV		HYDRAULIC CONDUCTIVITY, k, cm/s	글일	PIEZOMETER
TRES	MET		PLOT		Я		0.3m	20 40	60 80	10 ⁻⁸ 10 ⁻⁶ 10 ⁻⁴ 10 ⁻²		OR
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE		SHEAR STRENGTH Cu, kPa	nat V. + Q - ● rem V. ⊕ U - ○	WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	INSTALLATION
נ	BO		STR	(m)	z		BL(20 40	60 80	20 40 60 80		
30	_	CONTINUED FROM PREVIOUS PAGE										'B'
31		Brown SILTY SAND Very stiff grey CLAY to SILTY CLAY, with black staining		<u>45.93</u> 30.33							Silic	a Sand
32		Very stiff grey SILTY CLAY, some sand Very stiff grey and red CLAY to SILTY CLAY		44.38 31.85 32.10								
33		Compact to very dense grey SILTY SAND to SANDY SILT, some gravel, trace to some clay, with cobbles and boulders (GLACIAL TILL)		43.16 33.07							Pelt	onite
34	Wash Boring HW Casing											
35 36											Silic	a Sand
37											38 n #10	nm Diam. PVC Slot Screen 'A'
38												
39		End of Borehole Note: Soil stratigraphy inferred from various soil sampling methods and CPT.		37.52 38.71							Silic	a Sand
40												
41												
42												
43												
44												
42 43 44 45 DEF 1:7	PTH S	CALE							Golder		LOGG	ED: DG

RECORD OF BOREHOLE: 12-3-5

BORING DATE: December 7, 2012

SHEET 1 OF 2

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

LOCATION: N 50215	577.15 ;E 466668.45
INCLINATION: -90°	AZIMUTH:
SAMPLER HAMMER,	64kg; DROP, 760mm

щ	OD	SOIL PROFILE			SA	MPL	ES	DYNAMIC PEN RESISTANCE,	ETRAT	10N S/0.3m	ì	HYDR/	AULIC C k, cm/s	ONDUCTI	VITY,		<u>ں</u>	
DEPTH SCALE METRES	BORING METHOD		STRATA PLOT		с		.3m		10		80	1	0 ⁻⁸ 1	D ⁻⁶ 10 ⁻¹	4 10	0-2	ADDITIONAL LAB. TESTING	PIEZOMETER OR
	U U Z	DESCRIPTION	ΓA PI	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STREM	IGTH	nat V. +	Q - •	w	ATER C	ONTENT F		NT	ЕЩ.	STANDPIPE INSTALLATION
	ORII		T RA1	DEPTH (m)	Ň	F	ΓOΜ	Cu, kPa		rem V. ∉	• U- ()	W	⊳ —— I	W		WI	LAB	
	â		ST	(,			B	20 4	10	60	80	2	20 4	0 60	8	30		
0		GROUND SURFACE		76.23														'E
Ŭ		TOPSOIL	822	0.00														Protective Casing
		Loose to compact grey brown to grey SILTY SAND, trace clay		0.20														
1				75.09														
		Grey SANDY SILT, trace clay		1.14														
				74.71														
		Soft grey and red brown CLAY to SILTY CLAY, with silt seams		1.52														
2																		Bentonite Seal
3																		
4																		
4																		Silica Sand
				71.35														
5		Grey SILT, trace clay		4.88														32 mm Diam. PVC #10 Slot Screen 'B'
		Grey SILTY SAND		4.88 5.03 5.15														
		Soft grey and red brown CLAY to SILTY CLAY, with black staining and silt seams			1	73 TP	PH									40		
						TP												Silica Sand
6																		Z
				69.83														
		Grey SILT		6.46														
_	Power Auger 200 mm Diam. (Hollow Stem)	Soft grey and red brown CLAY to SILTY CLAY, with black staining		69.34														
7	low l	Grey SILT		6.95														
	² ower Auger Diam. (Hollo	Soft grey and red brown CLAY to SILTY CLAY, with black staining and clayey silt																
	ower Diam.	seams																
8																		
	200																	
				67.64														
		Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining		8.59														
9																		
10																		Bentonite Seal
10																		
11																		
12																		
13																		
13																		
				j l														📕
14																		Silica Sand
																		25 mm Diam. PVC
																		#10 Slot Screen 'A'
15	_ L		_1/2/1	1		$\vdash \dashv$	-	+	<u> </u>	+		+		+ -		+		×
		CONTINUED NEXT PAGE																
								4	ŝ									
DE	PTH	SCALE							A	Golde ssoci	er						L	OGGED: DG
	75							V	T٨		otoc						СН	ECKED: SAT



PR	OJEC	T: 12-1125-0045		REC	C	R	D	OF BO	REHO	DLE:	12	2-3-{	5				SI	HEET 2 OF 2
		DN: N 5021577.15 ;E 466668.45 TION: -90° AZIMUTH:						BORING	DATE:	Decemb	er 7, 20′	12					D	ATUM: Geodetic
	MPLE	R HAMMER, 64kg; DROP, 760mm														ST HAN	/MER,	64kg; DROP, 760mm
CALE	тнор	SOIL PROFILE	L.			MPL		DYNAMIC PE RESISTANCI			<i>,</i> ,	10	k, cm/s			0-2	NAL TING	PIEZOMETER OR
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE	BLOWS/0.3m	20 SHEAR STRI Cu, kPa	ENGTH r		Q - ●	W	ATER C		PERCE	1	ADDITIONAL LAB. TESTING	STANDPIPE INSTALLATION
Ω	BOI		STR	(m)	z		BLO	20	40 6	i0 8	0	2				80	<u>د ۲</u>	'B' 'A'
15 	Power Auger	CONTINUED FROM PREVIOUS PAGE Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining		60.43	2	73 TP	РН								-9			25 mm Diam. PVC #10 Slot Screen 'A' Silica Sand
- 16		End of Borehole Note:		15.80														
- - - - - - - - - - - - - - - - - - -		Soil stratigraphy inferred from various soil sampling methods and CPT.																
- - - - - - - - - -																		
- - - - - - - -																		
20																		
21																		
22																		
- 24																		
- 25																		
26																		
27																		
28																		
28																		
		SCALE	<u> </u>						D As	Golde	r							DGGED: DG ECKED: SAT

RECORD OF BOREHOLE: 12-3-6

LOCATION: N 5021574.40 ;E 466669.89 INCLINATION: -90° AZIMUTH: ---

BORING DATE: December 7, 2012

SHEET 1 OF 1

П	T	ПОН	SOIL PROFILE			SA	MPL	ES	DYNAMIC PEI RESISTANCE	NETRATI , BLOWS	ON 6/0.3m		HYDRAL	JLIC CO k, cm/s	ONDUCT	IVITY,		IG IC	PIEZOMETER
DEPTH SCALE METRES		BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	BER	TYPE	S/0.3m	20 SHEAR STRE			Q - ●	10 ⁻⁸ WA ⁻		D ⁻⁶ 10 DNTENT		0 ⁻²	ADDITIONAL LAB. TESTING	OR STANDPIPE
DEP		BORIN	DESCRIPTION	STRAT/	DEPTH (m)	MUN	Σ	BLOWS/0.3m	SHEAR STRE Cu, kPa 20			Ū-Ō			—0 ^W		WI 0	ADC LAB.	INSTALLATION
- (0	_	GROUND SURFACE		76.27				20	40			20	4	0 0	0 0			MON. WEL
		Power Auger 200 mm Diam. (HS)	TOPSOIL Loose to compact grey brown to grey SILTY SAND, trace clay		0.00 0.20 75.13														Protective Casing Bentonite Seal Silica Sand 50 mm Diam. PVC #10 Slot Screen
-	"	200-	Grey SANDY SILT, trace clay End of Borehole		73.13 1.14 74.75 1.52				-										#10 Slot Screen
	2		Note: Soil stratigraphy inferred from various soil sampling methods and CPT.		1.52														
	3																		-
	4																		-
	5																		-
	6																		-
	7																		-
	8																		-
	9																		-
- - - - - - - - - - - - - - - - - - -	0																		-
- - - - - - - - - - - - - - - - - - -	1																		-
	2																		-
11 09/04/14	3																		-
	4																		-
211250045.GP																			-
$\overline{2}$)EP : 7		SCALE						G	D	Golde	r							DGGED: DG ECKED: SAT

RECORD OF BOREHOLE: 12-3-7

LOCATION: N 5021565.88 ;E 466661.37 INCLINATION: -90° AZIMUTH: ---

BORING DATE: March 11, 2013

SHEET 1 OF 3

0 OHLES 0 MELKES 0 MELKE	DESCRIPTION GROUND SURFACE TOPSOIL Loose to compact grey brown to grey SILTY SAND, trace clay Grey SANDY SILT, trace clay Soft grey and red brown CLAY to SILTY CLAY, with silt seams	STRATA PLOT	ELEV. DEPTH (m) 76.09 0.00 0.20 74.95 1.14 74.57 1.52	IWON 1	TYPE BLOWS/0.3m	20 SHEAR STR Cu, kPa 20	40 ENGTH 40	nat V. + rem V. ⊕	30 Q - ● U - ○ 30	10 ⁻⁸ WA ⁻ Wp 1 20					LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	GROUND SURFACE TOPSOIL Loose to compact grey brown to grey SILTY SAND, trace clay Grey SANDY SILT, trace clay Soft grey and red brown CLAY to SILTY	STRATA F	DEPTH (m) 76.09 0.00 0.20 74.95 1.14 74.57	1		Cu, kPa		rem V. €	U- O	Wp	I	-O ^W			LAB. TI	
0	TOPSOIL Loose to compact grey brown to grey SILTY SAND, trace clay Grey SANDY SILT, trace clay Soft grey and red brown CLAY to SILTY	STRA	(m) 76.09 0.00 0.20 74.95 1.14 74.57	1			40									
0	TOPSOIL Loose to compact grey brown to grey SILTY SAND, trace clay Grey SANDY SILT, trace clay Soft grey and red brown CLAY to SILTY	S miles and set of the	0.00 0.20 74.95 1.14 74.57	1		20	40	60 8	50	20	40	6(<u>080 u</u>	<u>, </u>	+	
1 2 3 4 5 6 6 7 7	TOPSOIL Loose to compact grey brown to grey SILTY SAND, trace clay Grey SANDY SILT, trace clay Soft grey and red brown CLAY to SILTY		0.00 0.20 74.95 1.14 74.57	1	53 mm -						1			1		
2 3 4 5 6 7	SILTY SAND, trace clay Grey SANDY SILT, trace clay Soft grey and red brown CLAY to SILTY		74.95 1.14 74.57	1	53 mm -				1						+	
2 3 4 5 6 7	Grey SANDY SILT, trace clay Soft grey and red brown CLAY to SILTY		1.14 74.57		mm -											
2 3 4 5 6 7	Soft grey and red brown CLAY to SILTY		1.14 74.57		1 UDH										н	
3 4 5 6 7	Soft grey and red brown CLAY to SILTY		74.57											M		
3 4 5 6 7			14.57	1	+											
3 4 5 6 7	CLAY, with silt seams		1 1.52	1										м	1H	
3 4 5 6 7				2	53 mm -											
4		1/1/		2	TUBE											
4														м	пн	
4					+											
6	1															
6				3	53 mm -					⊩				6		
6					TUBE											
6																
6			1		1											
6			71.21	1	53									N	н	
7	Grey SILT, trace clay Grey SILTY SAND	拋	4.88 5.03 5.15	4	mm - TUBE											
7	Soft grey and red brown CLAY to SILTY CLAY, with black staining and silt seams		0.10													
7	CLAT, with black staining and slit seams			L												
	Grey SILT		69.69 6.46	-	53 mm -											
	Soft grey and red brown CLAY to SILTY CLAY, with black staining		69.20	l v	mm - TUBE							-	0			
probe	Grey SILT	M	6.95													
	Soft grey and red brown CLAY to SILTY CLAY, with black staining and clayey silt			-	+											
Geo	seams															
8				6	53 mm -											
			67.50		TUBE											
	Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining		8.59													
9	SILTY CLAT, with black staining				1											
					50											
				7	53 mm - TUBE							¢	o			
10																
			1													
11					53											
				8	mm - TUBE											
12			1	\vdash	$\left \right $											
				9	53 mm - TUBE								0			
13					TUBE											
					1											
14			1		5											
				10	53 mm - TUBE											
15			1													
	(1	1	1 1 7				+	<u> </u>	+ -	+		+	· — — I—		
· I	CONTINUED NEXT PAGE									-	+		+			
DEPTH S								Golde								GED: KE

	DOH-	SOIL PROFILE		1	SA	MPLI		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	,	HYDRAULIC CONDU k, cm/s		AL NG	PIEZOMETE
	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	20 40 60 SHEAR STRENGTH nat V. Cu, kPa rem V 20 40 60	80 + Q - ● . ⊕ U - ○ 80	10 ⁻⁸ 10 ⁻⁶ WATER CONTE Wp I	10 ⁻⁴ 10 ⁻² ENT PERCENT W 60 80	ADDITIONAL LAB. TESTING	OR STANDPIPI INSTALLATIO
15		CONTINUED FROM PREVIOUS PAGE Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining			11	53 mm TUBE	_				0		
17					12	53 mm TUBE	-						
19					13	53 mm TUBE	-				o		
20					14	53 mm TUBE	-						
22	Geoprobe	Stiff grey and red brown CLAY to SILTY CLAY, with black staining		53.48 22.61	15	53 mm TUBE	-				0		
23		CLAY, with black staining			16	53 mm TUBE	-						
25		Grey CLAYEY SILT, some sand		<u>50.43</u> 25.66	17	53 mm TUBE	-						
26		Very stiff grey CLAY to SILTY CLAY, with black staining Grey SILTY fine SAND		50.09 26.00 48.90 27.30	18	38 mm TUBE	-				0		
28		Grey SANDY SILT, some clay Very stiff grey CLAY to SILTY CLAY, with black staining		21.30	19	38 mm TUBE	-						
29					20	38 mm TUBE	-				•		

RECORD OF BOREHOLE: 12-3-7

LOCATION: N 5021565.88 ;E 466661.37 INCLINATION: -90° AZIMUTH: ---

BORING DATE: March 11, 2013

SHEET 3 OF 3

	DOH.	SOIL PROFILE	1.		SA	MPLES	DYNAMIC PENET RESISTANCE, BL	CATION OWS/0.3m	Ì,	k, ci		RGA	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE BLOWS/0.3m	20 40 SHEAR STRENGT Cu, kPa 20 40	60 H nat V. rem V. 60	80 + Q - ● ⊕ U - ○ 80	10 ⁻⁸ WATEF Wp	10 ⁻⁶ 10 ⁻¹ R CONTENT F	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
30		CONTINUED FROM PREVIOUS PAGE			20								
31	þe	Brown SILTY SAND Very stiff grey CLAY to SILTY CLAY, with black staining		45.79 30.33	21	38 mm - TUBE							
32	Geoprobe	Very stiff grey SILTY CLAY, some sand Very stiff grey and red CLAY to SILTY CLAY		44.24 31.85 32.10	22	38 mm - TUBE					o		
33 34		Compact to very dense grey SILTY SAND to SANDY SILT, some gravel, trace to some clay, with cobbles and boulders (GLACIAL TILL)		43.02 33.07 33.28									
35		Note: Soil stratigraphy inferred from various soil sampling methods and CPT.											
36													
37													
38													
39													
40													
41													
42													
43													
44													
45													
DEF	PTH S	GCALE					Â	Gole		•		 LO	GGED: KE

RECORD OF BOREHOLE: 12-3-7-1

LOCATION: N 5021565.89 ;E 466667.46 INCLINATION: -90° AZIMUTH: ---

BORING DATE: March 11, 2013

SHEET 1 OF 1

y I	ПОН	SOIL PROFILE	-		SA	MPL	ES	DYNAMIC PENETRAT RESISTANCE, BLOWS	/0.3m	k, cm	CONDUCTIVI 1/s	1,	έŕ	PIEZOMETER
METRES	BORING METHOD		JUOT		Ř).3m		60 80 [`]	10-8	10 ⁻⁶ 10 ⁻⁴	10 ⁻²	ADDITIONAL LAB. TESTING	OR
MET	SING	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat V. + Q - ● rem V. ⊕ U - O		CONTENT PE		DDIT B. TE	INSTALLATION
	BOR		STRA	(m)	Ъ	[]	BLO			Wp	W	- WI		
		GROUND SURFACE	0)	76.00				20 40	80 80	20	40 60	80	+	
0		TOPSOIL	ESS	76.06 0.00									+	
		Loose to compact grey brown to grey SILTY SAND, trace clay		0.20		53								
					1	mm TUBE	-							
1				74.92										
		Grey SANDY SILT, trace clay		1.14 74.54										
		Soft grey and red brown CLAY to SILTY		1.52										
2		CLAY, with silt seams			2	53 mm								
					2	TUBE	-							
3														
3														
					3	53 mm								
						TUBE								
4	e													
	Geoprobe													
	ő			71.18										
5		Grey SILT, trace clay Grey SILTY SAND		4.88 5.03 5.15	4	53 mm	-							
		Soft grey and red brown CLAY to SILTY CLAY, with black staining and silt seams		5.15		TUBE								
		CLAY, with black staining and silt seams												
6														
		Grey SILT		69.66		53								
		Soft grey and red brown CLAY to SILTY		6.46 69.17	5	53 mm TUBE	-							
7		CLAY, with black staining Grey SILT	XX	6.95										
		Soft grey and red brown CLAY to SILTY												
		CLAY, with black staining and clayey silt seams												
8						53 mm								
					6	mm TUBE	-							
		Soft to stiff grey and grey brown CLAY to		67.47 8.59 67.15										
9		Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining End of Borehole		67.15 8.91										
		Note: Soil stratigraphy inferred from various												
10		soil sampling methods and CPT.												
11														
12														
12														
10														
13														
14														
15														
DEF	PTH S	SCALE							Golder sociates				LOC	GED: WAM
									folder				_00	

PROJECT:	12-1125-0045

DEPTH SCALE METRES

0

2

3

4

5

6

7

8

9

10

11

12

13

14

15

1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

RECORD OF BOREHOLE: 12-4-2

BORING DATE: January 23-28, 2013

SHEET 1 OF 3

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

LOCATION:	N 50208	68.09 ;E 466519.28
INCLINATIO	N: -90°	AZIMUTH:
SAMPLER H	AMMER,	64kg; DROP, 760mm

R
E DN
-
-
_
-
-
-
-
-
-
-
-
1
-
1
-
-
-
-
-
-
-
1
-
- 1
-
1
-
-
1
1

CRRRC-SOIL DEPTH SCALE 1:75



PROJECT: 12-1125-0045

12-4-2 **RECORD OF BOREHOLE:**

BORING DATE: January 23-28, 2013

SHEET 2 OF 3

DATUM: Geodetic

LOCATION: N 5020868.09 ;E 466519.28 INCLINATION: -90° AZIMUTH: ---

		ER HAMMER, 64kg; DROP, 760mm													PE	NETRA	TION TE	ST HAN	MMER,	64kg; DROP, 760mm	
щ	DD	SOIL PROFILE			SÆ	AMPL	ES	DYNA RESIS	VIC PEN TANCE,	NETRAT	TION	l 3m	ì	HYDR/	AULIC C k, cm/s	ONDUC	FIVITY,		ı۵		
DEPTH SCALE METRES	BORING METHOD		LOT		Ř		.3m	2	0	40	60	8	0	1(0 ⁻⁸ 1	0 ⁻⁶ 1	0-4 1	0 ⁻²	ADDITIONAL LAB. TESTING	PIEZOMETER OR	
EPTH	SING	DESCRIPTION	STRATA PLOT	ELEV. DEPTH		TYPE	BLOWS/0.3m	SHEAF Cu, kP	R STREI a	NGTH	nat ren	t V. + n V. ⊕	Q - ● U - O			ONTEN	PERCE		DDIT B. TE	STANDPIPE INSTALLATION	
ä	BOF		STR/	(m)	ž		BLO			40	60		0		o			WI 60	ΑJ		
- 15		CONTINUED FROM PREVIOUS PAGE																			
		Firm to stiff grey and red CLAY to SILTY CLAY, with black staining																			
-																					
									>4	3+											
-																					
-																					
- 17 -										+											
-																					
— 18 _											+										
Ē																					
_ 19											+										
-																					
-																					
- 20 -											+	F									
-																				-	
Ē																					
21											+	F									
-																				-	
- - 22											>68	⁸ +								-	
Ē	Electric Nilcon																				
-	lectric			53.16 22.76	<u>;</u>																
- 23	"	Stiff grey to dark grey CLAY to SILTY CLAY, with black staining		22.70								+									
-																				-	
-																					
24								+			+										
- 25													+								
Ē																					
-																					
- 26 -												+									
-																					
Ē																					
- 27												+									
Ē																					
- 28										+	.										
Ē																					
Ē																					
29																					
Ē																					
E																					
- 30	\vdash	F	-rxxt	4	F-	+ -			+	·	+					+		+			

CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM DEPTH SCALE 1 : 75

CONTINUED NEXT PAGE



PROJECT:	12-1125-0045

CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

45

1 : 75

DEPTH SCALE

RECORD OF BOREHOLE: 12-4-2

BORING DATE: January 23-28, 2013

SHEET 3 OF 3

DATUM: Geodetic

LOCATION: N 5020868.09 ;E 466519.28

		TION: -90° AZIMUTH:						BORING DA	JE: J	January	23-28, 2	2013			DA	TOM. Geodelic
SAM	MPLE	R HAMMER, 64kg; DROP, 760mm													HAMMER, 6	i4kg; DROP, 760mm
2	тнор	SOIL PROFILE	⊢			MPLE		DYNAMIC PENE RESISTANCE, B			Ľ,	HYDRAULIC k, ci	m/s		ING	PIEZOMETER
	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	ТҮРЕ	BLOWS/0.3m	20 40 	STH n re	uat V. + em V.⊕	Q - • U - O	10 ⁻⁸ WATEF Wp		0 ⁻⁴ 10 ⁻² I PERCENT WI 60 80	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
30	_	CONTINUED FROM PREVIOUS PAGE Stiff grey to dark grey CLAX to SILTX														
31	Electric Nilcon	Stiff grey to dark grey CLAY to SILTY CLAY, with black staining														
33				42.12												
4		End of Borehole Note:		33.80												-
35		 Soil stratigraphy inferred from various soil sampling methods and CPT. Vane pushed to 33.8 m depth. 														
36																
37																
18																
9																
0																
1																
2																
3																
44																



RECORD OF BOREHOLE: 12-4-3

BORING DATE: January 31 - February 15, 2013

SHEET 1 OF 3

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

LOCATION: N 5020872.72 ;E 466523.18 INCLINATION: -90° AZIMUTH: ---SAMPLER HAMMER, 64kg; DROP, 760mm

	SA		= 0												
			ES		VIC PEN TANCE,			l'	HYDRA	AULIC C k, cm/s	ONDUCT	IVITY,		μų	PIEZOMETER
ELEV. DEPTH	NUMBER	TYPE	-OWS/0.3m	SHEAF		1			W	ATER C	i	PERCE	NT	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
(11)			BI	2	20 4	40	60	80	2	0 4	0 6	50 E	30		
75.92															
0.00 75.62															Protective Casing
0.30															
75.22 0.70															Bentonite Seal
74.70															-
1.22															
	DEPTH (m) 75.92 0.00 75.62 0.30 75.22 0.70 74.70	(m) - 75.92 0.00 75.62 0.30 75.22 0.70 74.70	75.92 0.00 75.62 0.30 75.22 0.70 74.70	(m) 2 3 75.92 0 0.00 75.62 0.30 75.22 0.70 74.70	(m) 2 m 2 75.92	(m) 2 2 20 2 75.92 0.00 75.62 0.00 0.00 75.62 0.00 0.00 75.22 0.70 0.74.70 0 0	2 a 20 40 75.92 0 </td <td>2 a 20 40 60 75.92 0.00</td> <td>2 a 20 40 60 80 75.92 0.00</td> <td>2 a 20 40 60 80 2 75.92 0.00</td> <td>mining mining <thmining< <="" td=""><td>(m) 2 m 20 40 60 80 20 40 6 75.92 0.00 0</td><td>(m) 2 m 20 40 60 80 20 40 60 8 75.92 0.00 0.0</td><td>2 2 40 60 80 20 40 60 80 75.92 0.00 75.62 0.00 <t< td=""><td>0 0 20 40 60 80 20 40 60 80 75.92 0.30 0.00 0</td></t<></td></thmining<></td>	2 a 20 40 60 75.92 0.00	2 a 20 40 60 80 75.92 0.00	2 a 20 40 60 80 2 75.92 0.00	mining mining <thmining< <="" td=""><td>(m) 2 m 20 40 60 80 20 40 6 75.92 0.00 0</td><td>(m) 2 m 20 40 60 80 20 40 60 8 75.92 0.00 0.0</td><td>2 2 40 60 80 20 40 60 80 75.92 0.00 75.62 0.00 <t< td=""><td>0 0 20 40 60 80 20 40 60 80 75.92 0.30 0.00 0</td></t<></td></thmining<>	(m) 2 m 20 40 60 80 20 40 6 75.92 0.00 0	(m) 2 m 20 40 60 80 20 40 60 8 75.92 0.00 0.0	2 2 40 60 80 20 40 60 80 75.92 0.00 75.62 0.00 <t< td=""><td>0 0 20 40 60 80 20 40 60 80 75.92 0.30 0.00 0</td></t<>	0 0 20 40 60 80 20 40 60 80 75.92 0.30 0.00 0

щ	DD	SOIL PROFILE			SAN	/PLE	s	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	.0	
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m		10 ⁻⁸ 10 ⁻⁶ 10 ⁻⁴ 10 ⁻² ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
DEP	BORIN		STRAT	DEPTH (m)	NN		BLOW	Cu, kPa rem V. ⊕ U - C 20 40 60 80	Wp → W I WI 20 40 60 80	AD	INGTALLATION
0		GROUND SURFACE	ਵਵ	75.92						<u> </u>	Protective Casing
		Grey brown SANDY SILT, trace clay,		0.00 75.62 0.30							_
1		with black staining Red brown SILTY CLAY, with silty sand seams (Weathered Crust)		75.22							Bentonite Seal
		Soft red grey CLAY to SILTY CLAY, with silty sand and silt seams		74.70 1.22							
2											
2											
				72.95							
3		Red grey and grey CLAY to SILTY CLAY, with silt seams		2.97	1	73 TP F	эн				
				-							
4											
				71.20							
5		Grey SILTY SAND, trace clay, with black staining		4.72							
		Grey SILT, some sand Soft red grey and grey CLAY to SILTY CLAY, with black staining and silt seams		5.18							
6		CLAY, with black staining and slit seams									
-											
7	oring	Grey SILT, some sand		68.76 7.26	2	73 TP F	ън				
	Wash Boring	Soft to firm red grey and grey CLAY to SILTY CLAY, with black staining		-							
8											Bentonite-Cement
											Grout
9											
10											
11					3	73 TP F	эн				
12											
13											
				62.36 13.56							
14		Firm to stiff grey and red CLAY to SILTY CLAY, with black staining		13.00							
15							_				
13		CONTINUED NEXT PAGE									
DE	PTH	SCALE								Ľ	OGGED: DG
1:								Golder)		IECKED: SAT

LOC/ INCL SAMI	ATIO INAT PLEF	T: 12-1125-0045 N: N 5020872.72 ;E 466523.18 FION: -90° AZIMUTH: R HAMMER, 64kg; DROP, 760mm	R				OF BORING I	DATE:	January	31 - Fel	bruary 15,	PENET	RATION 1		D	HEET 2 OF 3 ATUM: Geodetic 64kg; DROP, 760mm
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE	STRATA PLOT (m) (m) (m) (m) (m) (m) (m) (m) (m) (m)	T .	AMPL 3d	BLOWS/0.3m	SHEAR STREI Cu, kPa	HO E NGTH r r	50 8	U - O	10 ⁸	x, cm/s 10 ⁻⁶ FER CONT		10 ⁻²	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
15 17 17 18 19 19 19 19 19 19 19 19 19 19 19 19 19	HW Casing	CONTINUED FROM PREVIOUS PAGE Firm to stiff grey and red CLAY to SILTY CLAY, with black staining Stiff grey to dark grey CLAY to SILTY CLAY, with black staining CONTINUED NEXT PAGE			73 TP	PH										Bentonite-Cement Grout
DEP		CALE	<u> </u>			1	(Golde	r	1					 DGGED: DG ECKED: SAT

PROJECT:	12-1125-0045

RECORD OF BOREHOLE: 12-4-3

LOCATION: N 5020872.72 ;E 466523.18 INCLINATION: -90° AZIMUTH: ---SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 31 - February 15, 2013

SHEET 3 OF 3

No. PROFILE NAME IN PROVIDE IN TAXABLE IN PROVIDE IN TAXABLE IN PROVIDE IN TAXABLE IN PROVIDE IN TAXABLE IN PROVIDE INTERCONTENT PROVID INTERCONTENT	<u>н</u>	ДQ	SOIL PROFILE			SA	MPL	ES	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	ם ב	PIEZOMETER
	RES	METH		LOT		н		.3m			IONA	OR
Image: constraint of the	E H	RING	DESCRIPTION	ATA F		JMBE	ТҮРЕ	WS/0	SHEAR STRENGTH nat V. + Q - Cu, kPa rem V. ⊕ U -	• WATER CONTENT PERCENT	AB. TI	
30 Soft grey to dark grey CLAY to BLTY 31 1 32 T 33 T 34 T 35 T 36 T 37 T 38 T 39 T 31 T 32 T 33 T 34 T 35 T 36 T 37 T 38 T 39 T 39 T 30 T 31 T 32 T 33 T 34 T 35 T 36 T 37 T 38 T 39 T 30 T 30 T 30 T 31 T 32 T 33 T 34 T 35 T 36 T 37 T 38 T 39 T 39 T 30 T	ž	BOF		STR/		ž		BLC		wp wi	∠ >	
31 0 0 0 0 1 32 0 0 0 1 0 0 1 33 0<			Stiff grey to dark grey CLAY to SILTY			7	73 TP	WR				
38 39 37 30 38 Borehole continued on RECORD OF DRILHOLE 12.4.3 39 Borehole continued on RECORD OF DRILHOLE 12.4.3 30 1.5.12 DRILHOLE 12.4.3 30 1.5.12 DRILHOLE 12.4.3 41 1.5.12 Dased on 12.4.2 42 1.5.12 Dased on 12.4.2 43 1.5.12 Dased on 12.4.2	33	Vash Boring HW Casing	Dense grey SILTY SAND, some gravel, trace clay (GLACIAL TILL)			-						Bentonite-Cement Grout
38 Borehole continued on RECORD OF DRILLHOLE 12-4-3 Note: 1. Soil statigraphy inferred from valous soil sampling methods and CPT. 39 2. Soil statigraphy from 0.0 m to 33.8 m based on 12-4-2 40 41 42 43	35 36	∧										Glui
	39		DRILLHOLE 12-4-3 Note: 1. Soil stratigraphy inferred from various soil sampling methods and CPT. 2. Soil stratigraphy from 0.0 m to 33.8 m		38.12							
	41											
	42											
44	43											
45												

		N: N 5020872.72 ;E 466523.18 ON: -90° AZIMUTH:							DR	RILL	RIG	: Cl	ME	55	-	31 - February Marathon Dr		2013	•						[DATUM: Geodetic
METRES DRILLING RECORD		DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	FI S V C	H - 1 J - 1 COV	Fault Shear Vein Conju	gate R.		BD-I FO-I OR-I CL-I FRA IND PE 0.2	Foliat Conta Ortho Clear CCT. DEX ER 5m	ion ict gonal	t.	PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular DISCONTINUITY E TYPE AND SURFA DESCRIPTION	K SN RC ME)- Polis - Slick I- Smc J- Rou B- Mec	kensi ooth gh hanio	ded al Bre HYDR	AULIC AULIC) TY	For ad ations eviation s. WE	EATH RING	al to list	NOTES
38		BEDROCK SURFACE CARLSBAD FORMATION, 37.80 m to 43.61 m Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible SHALE, CALCAREOUS SHALE, SHALE, LIMESTONE and LIMESTONE with occasional bioclastic limestone beds.		38.12 37.80 38.08 37.84 37.99 37.93 37.94 37.98 38.01	-																					Bentonite-Cement Grout
				37.79 38.13 37.74 38.18																						Bentonite Seal
66 Rotary Drill	HQ Core			37.37 38.55 37.32 38.60 37.19 38.73 37.10 38.82 37.00 38.82 37.00 38.92 36.95 38.97 36.89	-											BD,PL,SM BD,IR,SM BD,PL,SM		12 1 16 1. 12 1	51							Silica Sand
				36.89 39.03 36.83 39.09 36.68 39.24 39.29 36.59 39.29 36.59 39.33 39.33 36.55 39.57 39.57 36.66 39.57 39.57 39.67 39.67 39.67 39.70 36.16 39.70	2											BD,PL,SM		12 1	1 1							63 mm Diam. PVC #10 Slot Screen
		CONTINUED NEXT PAGE						+							-	r tes							+			

		N: N 5020872.72 ;E 466523.18 ION: -90° AZIMUTH:						[DRII	LL RI	G: (CME	55		y 31 - February 1 8: Marathon Drill		013				DATUM: Geode	etic
METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	FL SH VN C.	% COF	ult ear in njug: RY	ate R.Q.E %	FO- CO- OR- CL- FR D. IN P 0.1	- Bedo - Folia - Conto - Ortho - Clea RACT. IDEX PER 25m 25m	tion act ogona	.r.t. E S	PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular DISCONTINUITY DA TYPE AND SURFACE DESCRIPTION	K - SM- RO- MB- TA	Polishe Slicker Smootl Rough Mecha	nical Bre HYDR CONDU K, cr	NOT	INDEX	NOTE	ES
40		CONTINUED FROM PREVIOUS PAGE CARLSBAD FORMATION, 37.80 m to 43.61 m Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible SHALE, CALCAREOUS SHALE, SHALE, LIMESTONE and LIMESTONE with occasional bioclastic limestone beds.		36.06 39.86 36.01 39.91 39.94 35.92 40.00	2									•	BD,PL,SM JN,PL,SM JN,PL,SM							
Rotary Driti	HQ Core			<u>35.25</u> 40.67 40.70																	63 mm Diam. P #10 Slot Screen	
41				34.84 41.08 34.78 41.14 41.17 34.70 41.22 41.24 41.24 41.30	- 3									•	BD,PL,SM BD,CU,SM		12 1 1 1					
DEPI		CONTINUED NEXT PAGE		<u>34.29</u> 41.63 <u>34.21</u> 41.71 41.74								As									LOGGED: DG	

F	PROJ	DJECT: 12-1125-0045		RE	co	R	DC	DF I	DF	RIL	LH	OLI	E: 12-4-	.3						ę	SHEET 3 OF 3
		ATION: N 5020872.72 ;E 466523.18									DATE : CMI		uary 31 - February	/ 15, 2	013					I	DATUM: Geodetic
		-		1	_		JN	- Joint T - Fault			CON BD-Be FO-Fo		OR: Marathon Di PL - Planar CU- Curved	PO-	Polisł	ed	BF	- Bro	ken R	ock	
DEPTH SCALE METRES		DESCRIPTION	C LOG	ELEV.	ю.	IRN	SH VN	- Shea - Vein	ar		CO- Co OR- Or	ntact hogonal	UN- Undulating ST - Stepped	K - SM- RO-	Slicke Smoo Roug	nsideo th n	d NO abb of a	TE: For a reviation bbreviati	addition	a	
PTH S			SYMBOLIC LOG	DEPTH (m)	RUN No.	FLUSH RETURN	CJ REC TOTAL	OVERY		R.Q.D.	FRACT		IR - Irregular DISCONTINUITY I	DATA	Mech	-COM	Break syn DRAULIC	Y V	VEATH	1 -	NOTES
DE		DRIL	SYI	(11)		FLUS	CORE %	% CORE		2608 2408	PER 0.25m		TYPE AND SURFA DESCRIPTION	VCE J	con Jr		c, cm/sec 0, 7, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,		NDEX S ≸ 5		
_)	34.07 41.85 34.00 41.92																	
4 - -	2			33.87								•	BD,PL,SM		12 1	1					
-	Rotary Drill	HQ Core		33.54 42.38 33.50 42.42 33.21 42.42 33.21 42.71 33.14 42.78 33.08 42.84																	63 mm Diam. PVC #10 Slot Screen
	3	End of Drillhole		42.87 42.90 32.86 43.06 43.06 43.26 43.26 43.24 43.24 43.24 43.24 43.24 43.40 32.55 43.37 43.40	4							•	BD,PL,SM		12 1	1					
																					-
יין בי בי)EPT : 10	PTH SCALE 0								Î	X	Golo ssoc	ler iates								logged: Dg Hecked: Sat

RECORD OF BOREHOLE: 12-4-4

LOCATION: N 5020875.53 ;E 466521.56 INCLINATION: -90° AZIMUTH: ---

BORING DATE: February 22-25, 2013

SHEET 1 OF 3

Ц	Ð		SOIL PROFILE			SA	MPL	ES	DYNAMIC PENE RESISTANCE, E	BLOW	ION 5/0.3m	,		LIC CC	NDUCT	VITY,		ں ب	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD			LOT	$ \neg$	ъ		.3m	20 40			80	10 ⁻⁸	10	⁵⁶ 10	-4 10	0 ⁻²	ADDITIONAL LAB. TESTING	OR
	U U U		DESCRIPTION	IA PI	ELEV.	MBEI	TYPE	/S/0.	SHEAR STREN	GTH	nat V	+ Q- •	WAT		ONTENT		NT	ΕË.	STANDPIPE INSTALLATION
 - -	ORI			STRATA PLOT	DEPTH (m)	NUMBER	F	BLOWS/0.3m	Cu, kPa		rem V. 6	₿ U- Ó	Wp H		W	I \	WI	AD	OINEEAHON
	ä			ST	(111)			B	20 40)	60	80	20	4			0		
0			GROUND SURFACE TOPSOIL		75.88						_								'E Protective Casing
			Grey brown SANDY SILT, trace clay,		0.00 75.58 0.30														
			with black staining		75.18														Bentonite Seal
			Red brown SILTY CLAY, with silty sand seams (Weathered Crust)		0.70														
1					74.66														
			Soft red grey CLAY to SILTY CLAY, with silty sand and silt seams		1.22														
2																			
3			Red grey and grey CLAY to SILTY CLAY, with silt seams		72.91 2.97														
			CLAY, with silt seams																
4																			
		Ļ	Grey SILTY SAND, trace clay, with black		71.16														
5		- \s	staining	柵	4.72														
			Grey SILT, some sand Soft red grey and grey CLAY to SILTY		5.18														
			CLAY, with black staining and silt seams																
6																			
7																			
'	ring	<u>e</u> t (Grey SILT, some sand		68.72 7.26														
	Wash Boring	Cas	Soft to firm red grey and grey CLAY to SILTY CLAY, with black staining		7.26														
	Wa:	Ĩ,	OILT I OLAT, WILL DIAUN SIGILIIN																Bentonite-Cement
8																			Grout
9																			
10																			
11																			
12																			
13																			
		┢	Firm to stiff grey and red CLAY to SILTY		62.32 13.56														
14			Firm to stiff grey and red CLAY to SILTY CLAY, with black staining																
15	μL	_ _						_			↓	_							
			CONTINUED NEXT PAGE																
DF	рт⊢	180	ALE						Á	¥.								10	OGGED: DG/DWM
00		. 00	<i>"</i>								Gold	er ates							

		CT: 12-1125-0045 ON: N 5020875.53 ;E 466521.56	RE	CC	R	D		TE: February						HEET 2 OF 3 ATUM: Geodetic
IN		TION: -90° AZIMUTH:						-	0, ,					
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE	(m) (m) (m) (m) (m) (m)	IBER	TYPE	BLOWS/0.3m	DYNAMIC PENE RESISTANCE, BI 20 40 	60 8 TH nat V. + rem V. ⊕	U- O	WATER C	ONDUCTIVIT 0 ⁻⁶ 10 ⁻⁴ 	10 ⁻²	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
15 16 17 18 19 10 17 18 19 10 10 10 10 10 10 10 10 10 10	Wash Boring HW Casing	CONTINUED FROM PREVIOUS PAGE Firm to stiff grey and red CLAY to SILTY CLAY, with black staining Stiff grey to dark grey CLAY to SILTY CLAY, with black staining CONTINUED NEXT PAGE												Bentonite-Cement Grout Bentonite Seal Silica Sand 25 mm Diam. PVC #10 Slot Screen 'B' Silica Sand Bentonite Seal
				1									 	
ר DE צעער 1:	PTH : 75	SCALE					<u> </u>	Golde	er ates					DGGED: DG/DWM ECKED: SAT

PROJECT:	12-1125-0045

RECORD OF BOREHOLE: 12-4-4

LOCATION: N 5020875.53 ;E 466521.56 INCLINATION: -90° AZIMUTH: ---

BORING DATE: February 22-25, 2013

SHEET 3 OF 3

		DO	SOIL PROFILE			SA	MPL	ES	DYNAMIC PEI RESISTANCE		ON)	HYDRAULIC C k, cm/s	ONDUC	TIVITY,			
DEPTH SCALE METRES		BORING METHOD		5				E				30			Q ⁻⁴ 1	0-2	ADDITIONAL LAB. TESTING	PIEZOMETER OR
H SC		3 ME		STRATA PLOT	ELEV.	NUMBER	ш	BLOWS/0.3m		1							UES.	STANDPIPE
EPT ME		RINC	DESCRIPTION	ATA	DEPTH	M	түре	MS	SHEAR STRE Cu, kPa	NGIN	rem V. \oplus	Ū- Ö	WATERC			WI	ABD.	INSTALLATION
		BO		STR	(m)	z		BLO	20	40	60 8	30	20 Wp			30	ר	
			CONTINUED FROM PREVIOUS PAGE						20	1			20					'B' 'A'
30	-	Г	Stiff grey to dark grey CLAY to SILTY	177														
E			CLAY, with black staining														ſ	
E																	ſ	
-																	ſ	
— 31 —																	1	
E																	1	
E																	1	
32																	1	
Ē																	1	Bentonite Seal
Ē																	1	Demonite ocu
																	1	
33	Soring	asing															1	
-	Wash Boring	HW Casing															1	
Ē	×	T			42.12 33.76												1	
- 34			Dense grey SILTY SAND, some gravel, trace clay (GLACIAL TILL)		33.70												1	
E																	1	
E																	1	
F ar					×.												1	Silica Sand
- 35 -	'																1	
_																	1	
-																	1	32 mm Diam. PVC
- 36																	1	#10 Slot Screen 'A'
_					×												1	
-					39.23												1	
			End of Borehole		36.65												1	
- 37 -			Note:														1	
Ē			Soil stratigraphy inferred from various soil sampling methods and CPT.														1	
-																	1	
38																	1	-
E																	1	
Ē																	1	
- 39																	1	
- 39																	1	
E																	1	
Ē																	1	
40																	1	
_																	1	
_																	1	
																	1	
_ *'																	1	
-																	1	
_																	1	
42																	1	
-																	1	
_					1													
- 43					1													
43					1													
-					1													
_																		
44																		
-																		
-					1													
					1													
- 45																	1	-
	1				I	L	I	1			<u> </u>	I		I				L
D	EPT	тнs	CALE								Golde	> P					LC	OGGED: DG/DWM
- 42 - 43 - 43 - 44 - 44 - 45 - 1 - 1	: 75								V	J A	SOCI	ates					СН	ECKED: SAT
L									-									

RECORD OF BOREHOLE: 12-4-5

LOCATION: N 5020871.62 ;E 466520.35 INCLINATION: -90° AZIMUTH: ---

BORING DATE: February 26, 2013

SHEET 1 OF 2 DATUM: Geodetic

л н С	гнор	SOIL PROFILE	1 -	1	SA	MPLE		DYNAMIC P RESISTANC	E, BLO	ATION WS/0.3m),		k, cm/s				AL NG	PIEZOMETER
UEPTIN SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	ТҮРЕ	BLOWS/0.3m	20 SHEAR STF Cu, kPa				Wp	TER CO		PERCE	WI	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
	_	GROUND SURFACE	0	75.90			_	20	40	60	80	20	4	06	50	80		'B'
0		TOPSOIL Grey brown SANDY SILT, trace clay, with black staining Red brown SILTY CLAY, with silty sand seams (Weathered Crust) Soft red grey CLAY to SILTY CLAY, with silty sand and silt seams		76.80 75.60 0.30 75.20 0.70 74.68 1.22														Protective Casing Bentonite Seal
3 4		Red grey and grey CLAY to SILTY CLAY, with silt seams		72.93 2.97														Silica Sand
5		Grey SILTY SAND, trace clay, with black staining Grey SILT, some sand Soft red grey and grey CLAY to SILTY		71.18 4.72 4.95 5.18														32 mm Diam. PVC 4 #10 Slot Screen 'B'
6		Soft red grey and grey CLAY to SILTY CLAY, with black staining and silt seams																Silica Sand
7 8 9 10 11	Wash Boring HW Casing	Soft to firm red grey and grey CLAY to		68.74														Bentonite-Cement Grout
13 14 15		Firm to stiff grey and red CLAY to SILTY CLAY, with black staining		62.34 13.56														Bentonite Seal Silica Sand 25 mm Diam. PVC #10 Slot Screen 'A'
				•		·					I	•						
DE	PTH S	SCALE							¥۵`,	Col	ler tiates						LC	DGGED: DG

RECORD OF BOREHOLE: 12-4-5

LOCATION: N 5020871.62 ;E 466520.35 INCLINATION: -90° AZIMUTH: ---

BORING DATE: February 26, 2013

SHEET 2 OF 2

ALE	гнор	SOIL PROFILE		1	SA	MPL	-	DYNAMIC P RESISTANC			```		k, cm/s			ING .	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	түре	BLOWS/0.3m	20 SHEAR STF Cu, kPa		nat V rem V. 6		vvp	ATER C			ADDIT LAB. TE	OR STANDPIPE INSTALLATION
- 15 	Wash Boring HW Casing	CONTINUED FROM PREVIOUS PAGE Firm to stiff grey and red CLAY to SILTY CLAY, with black staining	G	59.75				20	40	60	80	2		40 (60 80	<u>, </u>	25 mm Diam. PVC #10 Slot Screen 'A' Silica Sand
- - - - - - - - - - - - - - - - - - -		End of Borehole Note: Soil stratigraphy inferred from various soil sampling methods and CPT.		16.15													Silica Sano (<u>M.)</u>
- - - - - - - - - - - - - - - - - - -																	
20																	
21																	
- 22 - 22 - 23																	
 24																	
25																	
26																	
28																	
27 28 29 29 29 29 29 20 29 20 29 20 20 20 20 20 20 20 20 20 20 20 20 20																	
DE		SCALE			<u> </u>			(Ĵ.	Gold	er			<u> </u>			.ogged: Dg Hecked: Sat

RECORD OF BOREHOLE: 12-4-6

LOCATION: N 5020874.33 ;E 466518.97 INCLINATION: -90° AZIMUTH: ---

BORING DATE: February 27, 2013

SHEET 1 OF 1

ш		DD	SOIL PROFILE			SA	MPLE	s	DYNAMIC PE RESISTANC	ENETRATIO	DN /0.3m)	HYDRA	ULIC Co k, cm/s	ONDUCT	IVITY,		ں _י	
DEPTH SCALE	TRES	BORING METHOD		PLOT	ELEV.	ËR	ш	ʻ0.3m	20	40 6	60 E	30	10	^{r8} 1	0 ⁻⁶ 10		0-2	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE
DEPTH	ME	ORING	DESCRIPTION	STRATA PLOT	DEPTH (m)		TYPE	BLOWS/0.3m	SHEAR STR Cu, kPa	ENGTH r	nat V. + em V.⊕	Q - ● U - ○	W/ Wp				NT WI	ADDI ⁻ LAB. T	INSTALLATION
		â	GROUND SURFACE	ST	75.89		-	Ē	20	40 6	60 E	30	2) 4	0 6	8 0	0		MON. WELI
	0 -	Wash Boring HW Casing	Soft red grey CLAY to SILTY CLAY, with silty sand and silt seams End of Borehole Note:		0.00 75.59 0.30 75.19 0.70 74.67 1.22 74.31 1.58														Protective Casing Bentonite Seal Silica Sand 50 mm Diam. PVC #10 Slot Screen
	3		Soil stratigraphy inferred from various soil sampling methods and CPT.																
-	5																		
	6																		
	8																		
	10																		
-	11																		
[09/04/14 JM	12																		
GAL-MIS.GI	13																		
-SOIL 12112500	15																		
CRRRC	DEF 1:7		SCALE							D As	folde socia	er ates							DGGED: DG ECKED: SAT

RECORD OF BOREHOLE: 12-4-7

LOCATION: N 5020849.96 ;E 466535.91 INCLINATION: -90° AZIMUTH: ---

BORING DATE: April 2-3, 2013

SHEET 1 OF 3

ц 	ПОН	SOIL PROFILE	1.	1	SA	MPLI		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	Ì.	HYDR/	k, cm/s		IVITY,		RG	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	20 40 60 	80 - Q - ● → U - ○	w		0 ⁻⁶ 10 ONTENT	PERCE	0 ⁻² NT WI	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
-	В		STI	(m)			Ы	20 40 60	80					30		
0	-	GROUND SURFACE TOPSOIL	2	75.95							<u> </u>				\vdash	
			<u> 222</u>	0.00 75.65												
		Grey brown SANDY SILT, trace clay, with black staining		0.30 75.25		53										
		Red brown SILTY CLAY, with silty sand		0.70	1	53 mm TUBE	-								мн	
1		seams (Weathered Crust)		74.73							0					
		Soft red grey CLAY to SILTY CLAY, with silty sand and silt seams		1.22		+										
2						53 mm										
					2	TUBE	-									
3				72.98		$\left \right $										
5		Red grey and grey CLAY to SILTY CLAY, with silt seams		2.97												
				1		53 mm										
					3	mm TUBE	-									
4				1												
					-											
		Grey SILTY SAND, trace clay, with black	<u>III</u>	71.23											мн	
5		staining	ШŤ	4.95	,	53 mm TUBE										
		Grey SILT, some sand Soft red grey and grey CLAY to SILTY		5.18	4	TUBE	-									
		Soft red grey and grey CLAY to SILTY CLAY, with black staining and silt seams														
6						$\left \right $										
						53 mm										
_					5	TUBE	-							0		
7	φ	Grey SILT, some sand		68.79												
	Geoprobe	Soft to firm red grey and grey CLAY to SILTY CLAY, with black staining		7.26		$\left \right $										
	ð	SILTY CLAY, with black staining														
8						53										
					6	53 mm TUBE	-				-		-D			
9						+										
					7	53 mm										
10					ľ	TUBE	-									
				1	-	+										
14																
11					8	53 mm								0		
				1		тиве	-							ĭ		
12				1	-											
					9	53 mm	_									
13				1	۱	TUBE										
				1												
		Firm to stiff grey and red CLAY to SILTY CLAY, with black staining		62.39 13.56	-											
14		CLAY, with black staining		1												
					10	53 mm	-							6		
				1		TUBE								ĭ		
15				1	– -	\top	_			1		1		T		
			1								<u> </u>					
DE	PTH S	SCALE						Gold							LO	GGED: DG
								Lafer Gold	er							

PR	OJEC	T: 12-1125-0045	RE	CO	RD	OF BO	REHOLE	: 12	-4-7			SHE	ET 2 OF 3
		DN: N 5020849.96 ;E 466535.91 TION: -90° AZIMUTH:				BORING	DATE: April 2-3	3, 2013				DAT	UM: Geodetic
	Q	SOIL PROFILE		SA	MPLES	DYNAMIC PE	NETRATION E, BLOWS/0.3m)	HYDRAULIC C k, cm/s	ONDUCTIVI	ΓY,		
DEPTH SCALE METRES	BORING METHOD		10	~ ~	3m	20		80		s 10 ⁻⁶ 10 ⁻⁴	10 ⁻²	ADDITIONAL LAB. TESTING	PIEZOMETER OR
EPTH (SING N	DESCRIPTION	STRATA PLOT (m) (m)		TYPE BLOWS/0.3m	SHEAR STRE Cu, kPa	ENGTH nat V. + rem V. ∉	- Q - ● 9 U - O		ONTENT PE		B. TE	STANDPIPE INSTALLATION
DE	BOF		(m)	ž	BLO	20		80	Wp 	40 60	WI 80		
- 15		CONTINUED FROM PREVIOUS PAGE Firm to stiff grey and red CLAY to SILTY											
		CLAY, with black staining											
				11	53 mm - UBE								
- 16					UBE								
-													
17					-								
				12	53 mm - UBE						0		
- 18													
				13	53 mm - UBE								
— 19					UBE								
- 20													
				14	53 mm - UBE						0		
- 21													
				15	53 mm -								
- 22	pe			15	UBE								
	Geoprobe		53.1										
- 23		Stiff grey to dark grey CLAY to SILTY CLAY, with black staining	22.7										
				16	53 mm - UBE					0	,		
- 24													
					53								
- 25				17	mm - UBE								
- 26													
				18	53 mm - UBE					0			
- 27													
				\mathbb{H}									
					53								
27 28 29 30 DE 1:				19	mm - UBE								
- 29					53								
				20	mm - TUBE					0			
- 30	μL	L		. -		┣━┩━-	_			+ -	_+	_ -	
		CONTINUED NEXT PAGE											
DE	PTH S	SCALE				6	B AGold Associ	er				LOC	GGED: DG
1:	75						Associ	ates				CHE	CKED: SAT

Р	ROJE	CT: 12-1125-0045		RE	CC	R	D	of Bor	REHO	OLE:	: 12	2-4-7	7			SF	IEET 3 OF 3
		ON: N 5020849.96 ;E 466535.91 TION: -90° AZIMUTH:						BORING	DATE:	April 2-3	, 2013					DA	ATUM: Geodetic
TE	ПОН	SOIL PROFILE	1.	1	SA	MPL	ES	DYNAMIC PE RESISTANCE	NETRATI	ON /0.3m		HYDR/	AULIC CO k, cm/s	ONDUCT	IVITY,	 NG	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	ТҮРЕ	BLOWS/0.3m	SHEAR STRE Cu, kPa	NGTH	⊥ nat V. + rem V. ⊕	Q - ● U - ○	W	ATER C	0 ⁻⁶ 10 ONTENT 	PERCE	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
30 	,	CONTINUED FROM PREVIOUS PAGE		45.62	20		-										
		End of Borehole Note:		30.33													
- 31		Soil stratigraphy inferred from various soil sampling methods and CPT.															_
- 32	2																-
- - - 33	3																- - - -
- 34	L L																
- 35	5																
- 36 	5																-
- - - 37	,																_
- - - 38	3																
- 39																	
	,																
- 40)																
- 41 - 41	I																_
WC 42	2																
DT 09/04/1	3																
L-MIS.G																	
4 PD GD GA	•																
1250045.																	
1121 10 11 121	5																
μ Έ	EPTH : 75	SCALE						G	D As	Golde Socia	er ates						DGGED: DG ECKED: SAT

PROJECT:	12-1125-0045

BORING METHOD DEPTH SCALE METRES

Power Auger 200 mm Diam. (HS)

0

1

2

3

4

5

6

7

8 Electric Nilcon

9

10

12

13

14

15

1:75

DEPTH SCALE

_ 11

CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

RECORD OF BOREHOLE: 13-5-2

SHEET 1 OF 3

LOGGED: DG CHECKED: SAT

LOCATION:	N 5021087	.76 ;E 466180	.49
INCLINATIO	N: -90°	AZIMUTH:	
SAMPLER H	AMMER. 64	ka: DROP. 76	i0mr

	0N: N 5021087.76 ;E 466180.49 TION: -90° AZIMUTH:						BC)ring e	DATE:	February	/ 28 - Ma	arch 1, 2	2013				DA	ATUM: Geodetic	
	R HAMMER, 64kg; DROP, 760mm												PE	NETRAT	ION TE	ST HAN	MER,	64kg; DROP, 760mm	
	SOIL PROFILE			SA	MPL	.ES	DYNAM RESIS	/IC PEN TANCE,	ETRAT	ON \$/0.3m	$\overline{\boldsymbol{\lambda}}$	HYDRA	AULIC CO k, cm/s			-		PIEZOMETER	-
	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Cu, kPa	R STREN a	IGTH	⊥ nat V. + rem V. ⊕	U- O	W. Wr	•) ⁻⁴ 1(PERCEN	NT MI	ADDITIONAL LAB. TESTING	STANDPIPE INSTALLATION	
	GROUND SURFACE	S		\vdash	<u> </u>	-	2	0 4	0	60 8	0	2	0 4	06	08	0			_
	TOPSOIL	EEE	76.43	-															_
(ou)-	Loose brown to grey brown SAND, some silt		0.00 76.13 0.30	1	50 DO	5													-
				2	50 DO	10													-
			74.00	3	50 DO	6													-
	Soft CLAY to SILTY CLAY		74.60 1.83																-
							+												-
							+												-
							+												-
			72.16				+												-
	Compact grey SAND		4.27					>	49 +										-
	Soft CLAY to SILTY CLAY		4.88				⊕ +												-
							-	-											-
							+												-
								+											-
							€ +												-
							+												
																			-
							-	-											
			65.43																
	Firm CLAY to SILTY CLAY		11.00					+											
																			Ξ

+

 $^{+}$

 $^{+}$

40

HGolder Associates

X

CONTINUED NEXT PAGE

PROJECT:	12-1125-0045

RECORD OF BOREHOLE: 13-5-2

BORING DATE: February 28 - March 1, 2013

SHEET 2 OF 3

DATUM: Geodetic

LOCATION: N 5021087.76 ;E 466180.49 INCLINATION: -90° AZIMUTH: ---SAMPLER HAMMER, 64kg; DROP, 760mm

	PENETRATION TEST H	AMMER,	64kg; DROP, 760mm
~	HYDRAULIC CONDUCTIVITY, k, cm/s	NG	PIEZOMETER

4	ПОН	SOIL PROFILE			S/	AMPL		DYNA RESIS	VIC PEN TANCE,	ETRAT BLOWS	ION 6/0.3m	ì	HYDRAU k	LIC CO , cm/s	NDUC	FIVITY,		وب	PIEZOMETER
METRES	BORING METHOD		STRATA PLOT	 	н.		J.3m	2	20 4	10	60 8	80	10 ⁻⁸	10	⁻⁶ 1	0-4	10 ⁻²	ADDITIONAL LAB. TESTING	OR STANDPIPE
	RING	DESCRIPTION	ATA F	ELEV DEPT		TYPE	BLOWS/0.3m	SHEAF Cu, kP	R STREM a	IGTH	nat V. + rem V. ⊕	Q - O				PERCI		AB. TI	INSTALLATION
ž	BOF		STR/	(m)	Įž		BLC					80	Wp H 20				80		
15		CONTINUED FROM PREVIOUS PAGE							40										
15		Firm CLAY to SILTY CLAY																	
16										Ļ									
17									>43	3									
18				58.4	3			Ð		+									
		Stiff CLAY to SILTY CLAY		18.0															
19										-	+								
20											+								
21											+								
22	_										+								
	Electric Nilcon																		
	ectric																		
23											>74+								
24											+								
25											+								
26											+								
27																			
28												ľ							
~																			
29												+							
~																			
30				1		1	-		[— —		1	+	-	+			†		
		I		1	1	1			 	i i i i i i i i i i i i i i i i i i i	1	1				1			
DEF	PTH S	SCALE							ß		لمام	314						LC	GGED: DG
1:7	'5								V	T A	Golde Ssocia	ates						CHE	ECKED: SAT

PF	PROJECT: 12-1125-0045 RECORD OF BOREHOLE: 13-5-2 SHEET 3 OF 3																		
IN	CLINA	DN: N 5021087.76 ;E 466180.49 TION: -90° AZIMUTH:						B	ORING I	DATE:	Februar	y 28 - M	larch 1, 2						ATUM: Geodetic
SA	-	R HAMMER, 64kg; DROP, 760mm SOIL PROFILE			64	MPLI	- 0	DYNA		IETRATIO	ON	<u> </u>	HYDR				EST HA	1	64kg; DROP, 760mm
ES	BORING METHOD	SUL PROFILE	OT							IETRATIO BLOWS		во		k, cm/s	6		10 ⁻²	ADDITIONAL LAB. TESTING	PIEZOMETER OR
DEPTH SCALE METRES	RING M	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE	BLOWS/0.3m		R STRE	⊥ NGTH r	nat V. +	1	N	/ATER C	ONTENT	I F PERCE	ENT	DDITIC	STANDPIPE
DE	BOF		STR/	(m)	ž		BLO					80	W		₩ 40€		80	∠ ⊲	
30		CONTINUED FROM PREVIOUS PAGE Stiff CLAY to SILTY CLAY																	
-																			
- 31																			
Ē																			
- 32																			
- 32																			
-																			
— 33 -																			
	5																		
- 34 -	Electric Nilcon																		
-	Ē																		
- - 35																			
-																			
- 36																			
- 37																			
-																			
- 38																			
		End of Borehole		38.23 38.20															
- 39		Note: 1. Soil stratigraphy inferred from various soil compliant methods and CDT																	
- 39		soil sampling methods and CPT. 2. Vane pushed to 38.20 m depth. 3. Different stratigraphy relative to																	
		boreholes 13-5-3 and 13-5-4.																	
- 40 -																			
Ē																			
41																			
₹ + 42																			
1111																			
0 L L L L L L L L L L L L L L L L L L L																			
MIS.(
045.GF																			
45																			
CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14. JM 																			
S S DE	EPTH	SCALE							A		كملط	2P						L	DGGED: DG
1 :	75								V	7 As		ates						CH	ECKED: SAT

PROJECT:	12-1125-0045

RECORD OF BOREHOLE: 13-5-3

SHEET 1 OF 3

	ą	SOIL PROFILE		,	SAI	MPLE	S	DYNAMIC PENETRA RESISTANCE, BLO	TION VS/0.3m) l	HYDRAULIC CONDUCTIVITY, k, cm/s	<u>ہ</u> ۔	
	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	20 40 SHEAR STRENGTH Cu, kPa 20 40	60 80	Q - ● U - ○	10 ⁻⁸ 10 ⁻⁶ 10 ⁻⁴ 10 ⁻² WATER CONTENT PERCENT	BDITIO	PIEZOMETE OR STANDPIPE INSTALLATIO
0		GROUND SURFACE		76.51									MC Protective Casing
1		TOPSOIL Loose brown to grey brown SAND, some silt		0.00 76.21 0.30									
2		Soft CLAY to SILTY CLAY		74.68									Bentonite Seal
3		Compact grey SAND		72.24									
		Soft CLAY to SILTY CLAY		71.63									
6 7 8 9	Wash Boring NW Casing												Bentonite-Cement Grout
11				65.51 11.00									
12													
14													
		CONTINUED NEXT PAGE											

PR	OJEC	T: 12-1125-0045	RE	CO	RD	OF I	BOR	EHC	DLE:	1	3-5-3				S	HEET 2 OF 3	
		DN: N 5021083.24 ;E 466176.27 TION: -90° AZIMUTH:				BC	ORING E	DATE: 、	lune 14-	18, 201	3				D	ATUM: Geodetic	
SA		R HAMMER, 64kg; DROP, 760mm		-				ETRATIC			HYDRAUL			EST HAN	MMER,	64kg; DROP, 760	mm
CALE	BORING METHOD	SOIL PROFILE	5		PLES	RESIS	TANCE,	BLOWS/	0.3m) ,	HYDRAUL k, 0 10 ⁻⁸	cm/s		0-2	NAL	PIEZOMETE	R
DEPTH SCALE METRES	ING MI	DESCRIPTION	STRATA PLOT (m) (m)	NUMBER	BLOWS/0.3m		RSTREN	IGTH n		Q - ●	WATE	R CONTEN	IT PERCE	INT	ADDITIONAL LAB. TESTING	STANDPIPI	
DE	BOR		(m)	'	BLO			0 6			Wp ⊢ 20	⊖ ^V 40		WI BO	L A		
15		CONTINUED FROM PREVIOUS PAGE Firm CLAY to SILTY CLAY		+	_											MC	DN. WELL
CRRRC-Soll 1211250045.GPJ GALMIS.GDT 904/14 JM 1 0 6 8 2 7 9 9 1 0 6 8 2 7 9 9 1 1 1 1 1 1 1 1 1 1 0 6 8 2 5 5 1 <t< th=""><th>Wash Boring NW Casing</th><th>Stiff CLAY to SILTY CLAY</th><th><u>-98.5</u> 18.0</th><th>1</th><th>50 >100</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>Bentonite-Cement Grout</th><th></th></t<>	Wash Boring NW Casing	Stiff CLAY to SILTY CLAY	<u>-98.5</u> 18.0	1	50 >100											Bentonite-Cement Grout	
06 06												_+		†			v///A
DE CKRRC-SOI DE		SCALE					Ø	D As	olde socia	r ites						DGGED: DWM ECKED: SAT	

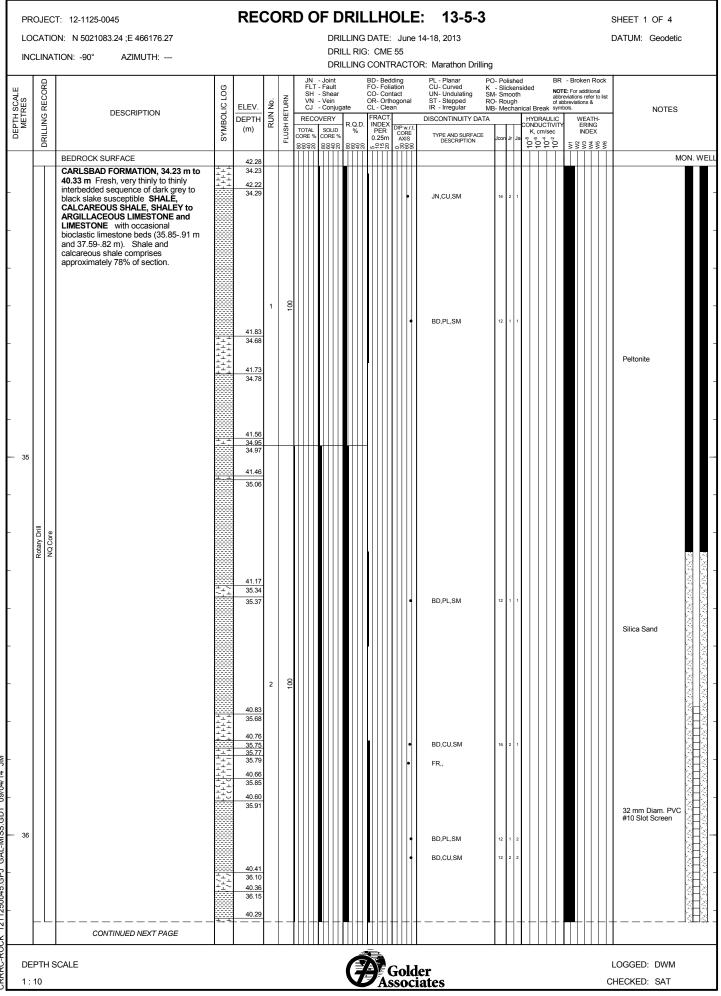
LOCATION: N 5021083.24 ;E 466176.27

RECORD OF BOREHOLE: 13-5-3

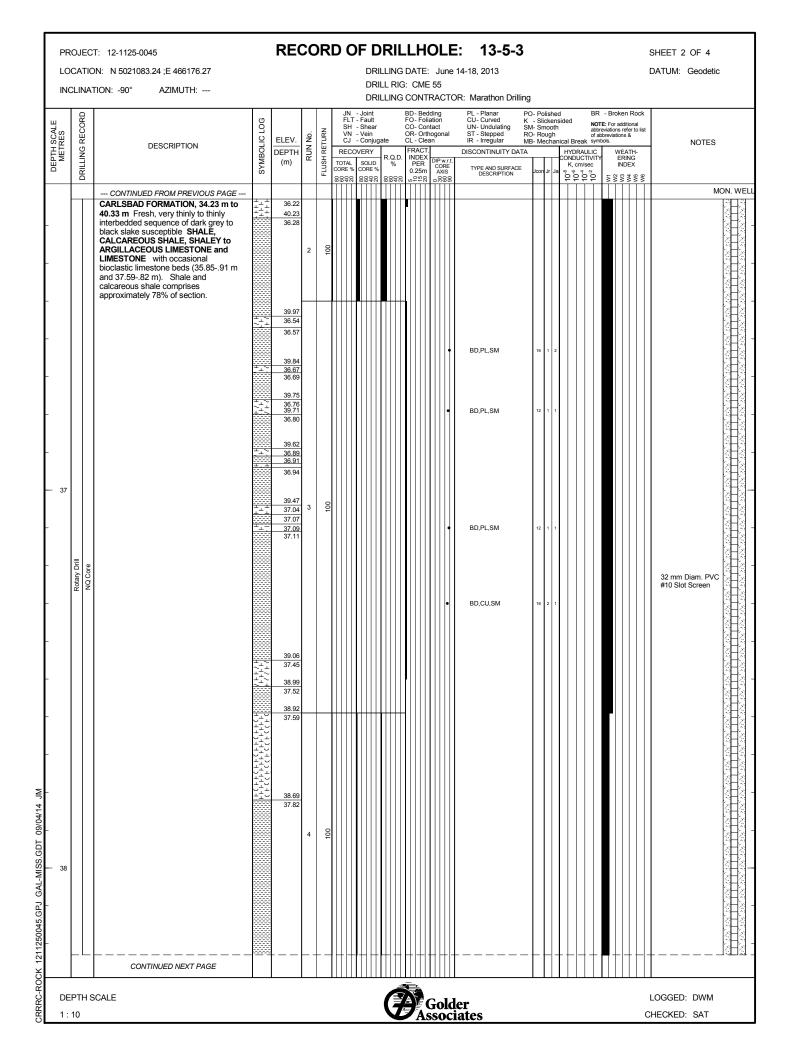
BORING DATE: June 14-18, 2013

SHEET 3 OF 3

		NTION: -90° AZIMUTH: ER HAMMER, 64kg; DROP, 760mm										MMER,	, 64kg; DROP, 760mm
Ц	日	SOIL PROFILE			SA	MPL	ES	DYNAMIC PENETRA RESISTANCE, BLOW	TION \ VS/0.3m \	HYDRAULIC CONDUC k, cm/s	TIVITY,	μų	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD		STRATA PLOT		н		3m	20 40	60 80	10 ⁻⁸ 10 ⁻⁶ 1	0-4 10-2	ADDITIONAL LAB. TESTING	OR STANDPIPE
MET	RING	DESCRIPTION	ATA F	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat V. + Q - ● rem V. ⊕ U - ○	WATER CONTEN		B. H	INSTALLATION
DE	BOR		STR/	(m)	z	_	BLO	20 40	60 80	Wp	WI 60 80	∠ A	
								20 40	80 80	20 40 1			MON. WEL
- 30 - 31 - 32 - 33	Wash Boring NW Casing	CONTINUED FROM PREVIOUS PAGE Compact to very dense grey SILTY SAND and SANDY SILT, some gravel, trace clay (GLACIAL TILL)			2 3 4	50 DO 50 DO 50 DO	94						Bentonite-Cement Grout
- - 34		COBBLES Borehole continued on RECORD OF DRILLHOLE 12-5-3		42.45 34.06									Peltonite
35		Note: 1. Soil stratigraphy inferred from various soil sampling methods and CPT. 2. Different stratigraphy relative to borehole 13-5-2.											-
- - 36 -													-
37													
- - 38 -													
- - - - - - - - - - - - - -													
- 40													
- - 41													
10.000001 45													
		SCALE											OGGED: DWM
1:	75								Golder Associates				ECKED: SAT



CRRRC-ROCK 1211250045.GPJ GAL-MISS.GDT 09/04/14 JM



PROJECT:	: 12-1125-0045	REC	OR	DC)F I	DR	ILL	_HC	DLE	E: 13-5-3	3						SHEET 3 OF 4
	N: N 5021083.24 ;E 466176.27					rilli Rill F				14-18, 2013							DATUM: Geodetic
INCLINATI	ON: -90° AZIMUTH:				DI	RILLI	NG C	ONTF	RACTO	DR: Marathon Drill	-						
DEPTH SCALE METRES DRILLING RECORD	DESCRIPTION	SXMBOLIC LOG DEDLH (m)	RUN No. FLUSH RETURN	FLT SH VN CJ	- Joint - Fault - Shea - Vein - Conj	t ar jugate	CC OF CL F	D-Bedo D-Folia D-Cont R-Ortho -Clea RACT.	act ogonal	PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular DISCONTINUITY DA	K - SM- RO- MB-	Polishe Slicker Smootl Rough Mecha	nsided h nical Br	NO	FE: For ad reviations bbreviation bols.	en Rock Iditional refer to list ns & EATH- RING	NOTES
DEPT		(m)	FLUSH	TOTAL CORE %	SOLII CORE	D 9	% C	NDEX PER).25m	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION		on Jr J	K, c		IN	IDEX	
	CONTINUED FROM PREVIOUS PAGE			24688	886	888	24 K	5 ²²	-888						333	W5 W5 W6	MON. WELL
-	CARLSBAD FORMATION, 34.23 m to 40.33 m Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible SHALE, SHALEY to ARGILLACEOUS SHALE, SHALEY to ARGILLACEOUS LIMESTONE and LIMESTONE with occasional bioclastic limestone beds (35.85-91 m and 37.59-82 m). Shale and calcareous shale comprises approximately 78% of section.	$\begin{array}{c} 37.76\\ -1.1\\ -2.1\\ -38.75\\ -37.71\\ +1\\ -37.71\\ -38.80$	5 00						•	BD,PL,SM BD,PL,SM BD,PL,SM		16 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1					32 mm Diam. PVC #10 Slot Screen
ž v							 5	_]≥									<u> </u>
안 DEPTH SC	CALE					(Ð	As	Fold soc	ler iates							Logged: DWM Hecked: Sat

PF	PROJECT: 12-1125-0045 RECORD OF DRILLHOLE: 13-5-3 s								
		DN: N 5021083.24 ;E 466176.27	DRILLING DATE: June 14-18, 2013 DRILL RIG: CME 55	DATUM: Geodetic					
IN	CLINA	TION: -90° AZIMUTH:	DRILLING CONTRACTOR: Marathon Drilling						
DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION							
		CONTINUED FROM PREVIOUS PAGE		MON. WELL					
- 41	Rdiary Drill NQ Core NQ Core	CONTINUED FROM PREVIOUS PAGE		Image: Silica Sand Image: Si					
CKRKG-ROCK 1211250045.GPJ GAL-MISS.GDJ 09/04/14 JM =									
דיין דיין דיין דיין דיין דיין דיין דיין	EPTH \$: 10	SCALE	Golder	LOGGED: DWM CHECKED: SAT					

PROJECT:	12-1125-0045

1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

CRRRC-SOIL

RECORD OF BOREHOLE: 13-5-4

BORING DATE: March 4-5, 2013

SHEET 1 OF 3

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

LOCATION:	N 5021083	3.81 ;E 466178	.65
INCLINATIO	N: -90°	AZIMUTH:	
SAMPLER H	AMMER, 6	4kg; DROP, 76	0mm

ш	4	0D	SOIL PROFILE			SA	MPL	ES	DYNAMIC PE RESISTANCE	NETRATI	ON 5/0.3m	ì	HYDRA	AULIC Co k, cm/s	ONDUCT	IVITY,		. ت		
DEPTH SCALE METRES		BORING METHOD		LOT		ж		3m	20			0	10) ⁻⁶ 10)-4 1(0-2	ADDITIONAL LAB. TESTING	PIEZOMETER OR	
METH	0	ואפ	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	түре	BLOWS/0.3m	SHEAR STRE Cu, kPa	NGTH	nat V. +	Q - ●			ONTENT			DDITI B. TE	STANDPIPE INSTALLATION	
DE		вок		STRA	(m)	R	F	BLOV							W			LAI		
			GROUND SURFACE	0,	76.43				20	40	<u>60 8</u>	0	2	0 4	06	0 8	0		'B' 'A'	-
- 0			TOPSOIL		0.00 76.13														Protective Casing	
-			Loose brown to grey brown SILTY SAND		0.30															
- 0																				
- 1																				
_																				-
2			Grey SILTY CLAY, with black staining		74.60 1.83															
2																				
-																				-
- 3																				-
																				-
-																				-
- 4																				-
-			Compact grey SAND		72.16 4.27															111
-					71.55	1	50 DO	14												-
4			Grey SILTY CLAY, with black staining		4.88															-
-																				-
-																				-
- 6																				-
6																				-
-																				-
- 7	þ	g																	Bentonite Seal	-
	Wash Boring	HW Casing																		
_		HW																		-
- 8																				-
-																				-
- 9																				-
						2	50 DO	WR												Ξ
-							00													-
- 10																				_
_																				-
_																				-
11																				-
-																				-
-																				-
- 12																				-
-																				-
_																				
- 13																				-
-																				-
- 14																				-
11 12 13 14 14 14 15 15 15 15 15 15 15 15 15 15 15 15 15																			Silica Sand	1111
-																			25 mm Diam, PVC	-
- 15	L	L						_			<u> </u>	L					L		25 mm Diam. PVC	
			CONTINUED NEXT PAGE																	
										Ξ.		-					-			1
DE 1:			SCALE						(Golde Ssocia	r							DGGED: DG ECKED: SAT	
1.	10								×	- A	SUCI	ucs						01	LUNED. JAI	

Set Set DESCRIPTION Set Set Market of Link Letters Market of Li	SAM	NPLE	R HAMMER, 64kg; DROP, 760mm											PEN	NETRA	TION TES	T HAMMER	R, 64kg; DROP, 760m
		ПОР	SOIL PROFILE			SAM	PLES	DYN RES	AMIC PE	NETRAT	ION 5/0.3m		HYDRA	AULIC CO k, cm/s	ONDUCT	IVITY,	ĢĻ	PIEZOMETER
0 coversion seque seques seque seques seque seque seque seques seque seque seque seques seque se	METRES	BORING MET	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	BLOWS/0.3m	SHE Cu, I	AR STRE Pa	INGTH	nat V. + rem V. ⊕	Q - ● U - O	W. Wr	ATER CO				OR STANDPIPE INSTALLATION
10 1	15	_																'E
29 4 50 61 Silica Sand	17 18 19 20 21 22 23 24 25 26 27	Wash Boring HW Casing	Compact to very dense grey SILTY SAND and SANDY SILT, some gravel,				50											Silica Sand
						4 5	50 50 50 50 50 53											38 mm Diam. PVC

RECORD OF BOREHOLE: 13-5-4

BORING DATE: March 4-5, 2013

SHEET 3 OF 3

DATUM: Geodetic

LOCATION: I	N 5021083.	81 ;E 4661	78.65
INCLINATION	-90°	AZIMUTI	H:
			760m

ORING	DATE:	March 4-5,	201

	ş	SOIL PROFILE			SA	MPL	ES.	RESIST	IC PENE ^T ANCE, BI	OWS	/0.3m	ζ.	HYDRA	k, cm/s	UNDUC			⊵ بـ	PIEZOMETER
METRES	BORING METHOD		LOT		ĸ		.3m	20				30	10			0-4	10 ⁻²	ADDITIONAL LAB. TESTING	OR
MEI	ING I	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE	BLOWS/0.3m	SHEAR Cu, kPa	STRENG	TH r	natV.+ emV⊄	Q - ● U - O	W			T PERCE		B. TE	STANDPIPE INSTALLATION
	BOR		TRA	(m)	R		BLO/						VVp				WI	LAL	
		CONTINUED FROM PREVIOUS PAGE	S				-	20	40	e	50 8 	30	2	U 4	10	60	80	-	'B' 'A'
30	_	Compact to yery dense grey SILTV	92			50													L P
	Wash Boring HW Casing	Compact to very dense grey SILTY SAND and SANDY SILT, some gravel, trace clay (GLACIAL TILL)			6	50 DO	96												38 mm Diam. PVC #10 Slot Screen 'A'
	/ash [
31	< 1 ⁺			45.34															
		End of Borehole		31.09															
		Note: 1. Soil stratigraphy inferred from various																	
32		soil sampling methods and CPT.																	
		2. Different stratigraphy relative to borehole 13-5-2.																	
33																			
34																			
35																			
36																			
37																			
88																			
39																			
10																			
11																			
12																			
3																			
4																			
42 43 44 45 DEI 1 : 5																			
										±.		er ates							

RECORD OF BOREHOLE: 13-5-5

LOCATION: N 5021081.04 ;E 466176.45 INCLINATION: -90° AZIMUTH: ---

BORING DATE: March 6, 2013

SHEET 1 OF 1

ш	į	ДQ	SOIL PROFILE			SA	MPLE	s	DYNAMIC PENE RESISTANCE, B	TRATIC	N).3m	2	HYDRAULIC k, cr	CONDUC	CTIVITY,		U	
DEPTH SCAL	METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	20 40 SHEAR STRENG Cu, kPa	60	0 8				IT PERCE	0 ⁻² NT WI	LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		8		S			_	В	20 40	60	8 (0	20	40	<u>60 8</u>	0	_	
F	0		GROUND SURFACE TOPSOIL	222	76.38		_										_	MON. WELI Protective Casing
	1		Loose brown to grey brown SILTY SAND		0.00 76.08 0.30													
	2 3	Power Auger 200 mm Diam. (Hollow Stem)	Grey SILTY CLAY, with black staining		74.55													Bentonite Seal
-	4		Compact grey SAND		72.11 4.27 71.50													Silica Sand
	5		Grey SILTY CLAY, with black staining		4.88												:	50 mm Diam. PVC #10 Slot Screen
-	6		End of Borehole		70.28 6.10													Silica Sand
CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM	7 8 9 10 11 12 13 14 15		Note: Soil stratigraphy inferred from various soil sampling methods and CPT.															
CRRRC-SOIL	DE		ISCALE	I	<u> </u>	I	[Ć	G	olde	r ites	<u> </u>					DGGED: DG ECKED: SAT

RECORD OF BOREHOLE: 13-5-6

LOCATION: N 5021081.45 ;E 466178.88 INCLINATION: -90° AZIMUTH: ---

BORING DATE: March 6, 2013

SHEET 1 OF 1

			SOIL PROFILE			SA	MPL	ES	DYNAMIC PE RESISTANCE		DN /0.3m		HYDR/	AULIC C k, cm/s	ONDUC	TIVITY,		(0	
DEPTH SCALE METRES		BORING METHOD		LOT		ж.		3m	20	40 6	60 E	10				0 ⁻⁴ 1	0-2	ADDITIONAL LAB. TESTING	PIEZOMETER OR
DEPTH		RING	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	IUMBE	TYPE	BLOWS/0.3m	SHEAR STRE Cu, kPa	NGTH r	nat V. + em V. ⊕	Q - ● U - ○	W			F PERCE	NT WI	ADDIT AB. TE	STANDPIPE INSTALLATION
				STR	(m)	z		BLO	20	40 6	60 E	0	2				30		
0			GROUND SURFACE TOPSOIL	222	76.45 0.00 76.15														MON. WEL Protective Casing Bentonite Seal
Ē	ger	200 mm Diam. (HS)	Loose brown to grey brown SILTY SAND		76.15 0.30														Silica Sand
Ē	wer Au	m Diar																	50 mm Diam. PVC
Ē	Po	200 m																	#10 Slot Screen (유민종)
-			End of Borehole	শৱস	74.93														
- 2			Note: Soil stratigraphy inferred from various soil sampling methods and CPT.																-
-			soil sampling methods and CPT.																
3																			-
-																			
Ē																			
- 4																			
Ē																			
- 5 -																			
Ē																			
- 6																			
-																			
-																			
- 7																			-
-																			
- 8																			-
-																			
- 9																			
-																			
Ē																			
10 																			-
Ē																			
- 11																			-
-																			
= ≤ - 12																			
114																			
0/60																			
LOD:																			_
9 - 14																			
045.G																			
112500																			_
IL 12																			
CRRRC-SOIL 1211250045.6PJ GAL-MIS.GDT 09/04/14 JM	EPT	тнs	CALE							D As	1.11							L	DGGED: DG
L CRRF	: 75								4	D As	TOIDE SOCIA	r ates							ECKED: SAT

RECORD OF BOREHOLE: 13-8-2

LOCATION: N 5021436.71 ;E 466032.27 INCLINATION: -90° AZIMUTH: ---

BORING DATE: April 9, 2013

SHEET 1 OF 1

			SOIL PROFILE			SA	MP	LES	DYNAMIC PE RESISTANC		ON	<u>}</u>	HYDRA		ONDUCT	TIVITY,			
DEPTH SCALE METRES		BORING METHOD		LOT		ц		.3m	20			30	10	k, cm/s ¹⁸ 1		0 ⁻⁴ 10)-2	ADDITIONAL LAB. TESTING	PIEZOMETER OR
DEPTH		RING	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE	BLOWS/0.3m	SHEAR STR Cu, kPa	ENGTH	nat V. + em V.⊕	Q - ● U - O	W/ Wn			PERCEN	NT MI	ADDIT AB. TE	STANDPIPE INSTALLATION
		2 2 2	GROUND SURFACE	STF	(m)	2		В	20	40	50 E	30	20			60 80			
0	-		TOPSOIL	EEE	76.41	-													Protective Casing
	Geoprobe		Grey to grey brown SILTY SAND to SANDY SILT		0.20		53 mm TUB	nl -											Bentonite Seal Silica Sand
- 1	Ğ		Grey brown CLAYEY SILT, some sand Grey brown SILTY SAND to SANDY \SILT, trace gravel Red brown SILTY CLAY, with silt seams		1.01 75.11			,											32 mm Diam. PVC #10 Slot Screen
2			(Weathered Crust) End of Borehole Note:																
- 3			Soil stratigraphy inferred from various soil sampling methods and CPT.																
- 4																			_
5																			
- 6																			
- 7																			
8																			
- - - 9																			_
- 10																			-
-																			
- 11																			
WD 12																			
170060 LQ																			_
AL-MIS.G																			
145.GPJ 6																			
- 12112500 1 1 12																			
*	EPT : 75		CALE	I	1	1	<u> </u>			D As	Folde	er			1				DGGED: DG ECKED: SAT

RECORD OF BOREHOLE: 13-8-3

LOCATION: N 5021438.32 ;E 466036.25 INCLINATION: -90° AZIMUTH: ---

BORING DATE: April 9, 2013

SHEET 1 OF 1

<u> </u>	호	SOIL PROFILE			SA		_0	YNAMIC PENETRATION	k, cm/s	μġ	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	20 40 60 80 HEAR STRENGTH nat V. + Q - Q u, kPa rem V. ⊕ U - C 20 40 60 80	10 ⁻⁸ 10 ⁻⁶ 10 ⁻⁴ 10 ⁻² WATER CONTENT PERCENT Wp	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
		GROUND SURFACE		76.43							
0		TOPSOIL Grev to grev brown SILTY SAND to		0.00		T					Protective Casing
		Grey to grey brown SILTY SAND to SANDY SILT				53					
1		Grey brown CLAYEY SILT, some sand		75.52	1	53 mm TUBE	-				
		Grey brown SILTY SAND to SANDY SILT, trace gravel		1.01 75.13 1.30							
		Red brown SILTY CLAY, with silt and silty sand seams (Weathered Crust)		74.54							
2		Red grey and grey CLAY to SILTY CLAY		1.89		53					Bentonite Seal
					2	mm TUBE	-				
3											
	pe					53					
4	Geoprobe				3	53 mm TUBE	-				
		Grey SILT		72.24 4.23 4.37 71.76							Silica Sand
		Red grey SILTY CLAY Grey SILTY SAND, trace clay		71.76						МН	1 2 2
5		Red grey to grey CLAY to SILTY CLAY, with black staining and silt seams				53					
					4	53 mm TUBE	-				32 mm Diam. PVC
6											32 mm Diam. PVC #10 Slot Screen
0											
						53					Silica Sand
7					5	53 mm TUBE	-				
				60.04							Cave
		End of Borehole	<u>exxk</u>	68.81 7.62							
8		Note: Soil stratigraphy inferred from various									
		Soil stratigraphy inferred from various soil sampling methods and CPT.									
9											
10											
11											
''											
12											
13											
14											
15											
הרו		CALE						Golder			OGGED: DG

RECORD OF BOREHOLE: 13-9-2

LOCATION: N 5021532.90 ;E 466350.22 INCLINATION: -90° AZIMUTH: ---

BORING DATE: March 20, 2013

SHEET 1 OF 1

	Τ.							F 0	DYNAMIC F	ENETR		1	<u> </u>	HYDR		CON	JUCT	IVITY.			
DEPTH SCALE METRES		BORING METHOD	SOIL PROFILE	Ц			MPL	-	DYNAMIC F RESISTAN				Ľ,		k, cm	ı/s			0-2	ADDITIONAL LAB. TESTING	PIEZOMETER
ETRE.		U ME		STRATA PLOT	ELEV.	NUMBER	Ы	BLOWS/0.3m	20 SHEAR ST	40 I RENGTH	60 H nat		0 Q - ●			10 ⁻⁶	10 	PERCE	0 ⁻²	TEST	OR STANDPIPE
DEPT			DESCRIPTION	RATA	DEPTH (m)	MUM	TYPE	SWO	SHEAR ST Cu, kPa		rer	n V. ⊕	Ŭ- O						wi	ADD LAB.	INSTALLATION
	1	ă		ST				B	20	40	60	8	0	2	20	40	6	<u>ع</u> 0	30		
_ 0			GROUND SURFACE	222	76.05 0.00 0.12	╞				_						+					Protective Casing Bentonite Seal
Ē			Grey brown to brown SILTY SAND, trace clay		0.12																Silica Sand
Ē	Geoprobe		otty			1	53 mm TUBE	-												мн	
— 1 _	Ğ				74.82																32 mm Diam. PVC #10 Slot Screen
Ē		Ц	Red brown SILTY CLAY, with black staining (Weathered Crust)		1.23 74.53 1.52																<u>a-a</u>
Ē,			End of Borehole		1.52																
- 2			Note: Soil stratigraphy inferred from various																		-
Ē			Soil stratigraphy inferred from various soil sampling methods and CPT.																		
- - 3																					-
Ē																					
Ē																					
- 4																					-
E																					
Ē																					
5 																					-
Ē																					
- 6																					
Ē																					
Ē																					
- 7																					-
Ē																					
Ē																					
- 8																					-
Ē																					
Ē																					
- 9	1																				-
Ē																					
- 10																					-
Ē																					
Ē																					
- 11																					-
Ē																					
Ē																					
₹12 #																					-
04/12																					
T 09,																					
LOD:0																					-
																					-
5.GP																					
5004																					
CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM																					-
တို့ DE	EPT	гн s	CALE									41-	er ates							L	OGGED: KE
1 :	: 75									D	≡ u Ass	orae ocia	ates								ECKED: SAT

RECORD OF BOREHOLE: 13-9-3

LOCATION: N 5021536.14 ;E 466347.26 INCLINATION: -90° AZIMUTH: ---

BORING DATE: March 20, 2013

SHEET 1 OF 1

	ДОН	SOIL PROFILE			SAI	MPLE	ES	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	βŁ	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE	BLOWS/0.3m	20 40 60 80 SHEAR STRENGTH nat V. + Q - ● Cu, kPa rem V. ⊕ U - ○	10 ⁻⁸ 10 ⁻⁶ 10 ⁻⁴ 10 ⁻² WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
2	BOR		STRA	(m)	Z		BLO	20 40 60 80	Wp ├───── <mark>W</mark> WI 20 40 60 80	[¤⊴]	
0		GROUND SURFACE		76.08							
1		TOPSOIL Grey brown to brown SILTY SAND, trace clay		0.00	1	53 mm TUBE	-				Protective Casing
		Red brown SILTY CLAY, with black staining and sand seams (Weathered Crust)		74.85							
2 3		Red grey CLAY to SILTY CLAY, with silt seams		1.93	2	53 mm TUBE	-				Bentonite Seal
4	Geoprobe	Grey SILTY SAND		71.79	3	53 mm TUBE	-				Silica Sand
5		Red grey SILTY CLAY Grey SILTY SAND, with black staining Red grey to grey CLAY to SILTY CLAY - Grey silt layer from 4.95 m to 5.00 m - Grey silt layer from 5.41 m to 5.46 m		71.36 4.72	4	53 mm TUBE	-				
6		Grey SILT Red grey to grey SILTY CLAY, with silt		69.83 6.35							32 mm Diam. PVC #10 Slot Screen
7		seams - Grey silt layer from 6.79 m to 6.82 m			5	53 mm TUBE	-				Silica Sand
		End of Borehole		68.46 7.62							
8 9		Note: Soil stratigraphy inferred from various soil sampling methods and CPT.									
10											
11											
12											
13											
14											
DEF	РТН S	SCALE	<u> </u>					Golder			OGGED: KE

RECORD OF BOREHOLE: 13-10-2

LOCATION: N 5021245.94 ;E 466456.29 INCLINATION: -90° AZIMUTH: ---

BORING DATE: March 14, 2013

SHEET 1 OF 1

S	ТНОВ	SOIL PROFILE	STRATA PLOT		AMPL	1	DYNAMIC PENETRA RESISTANCE, BLOV		HYDRAULIC CONDU k, cm/s		AAL ING	PIEZOMETER OR STANDPIPE INSTALLATION	
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION		ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	20 40 SHEAR STRENGTH Cu, kPa	60 80 I nat V. + Q - ● rem V. ⊕ U - ○	10 ⁸ 10 ⁶ WATER CONTE Wp	w wi		
 		GROUND SURFACE	0	76.41	-		+	20 40	60 80	20 40	60 80		
- 0		TOPSOIL		0.00	1								Protective Casing Bentonite Seal
- - - - - - - - - -	Geoprobe	Grey brown to grey SAND, trace silt		74.89	1	53 mm TUBI	-						Silica Sand 32 mm Diam. PVC #10 Slot Screen
Ē		End of Borehole		1.52									
2		Note: Soil stratigraphy inferred from various soil sampling methods and CPT.											
3													-
- 4 4 													
- 5 													-
6													-
- 7													
- 8 - 8 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1													
- 9													
- 10 - 10													
- 11 - 11 													
- 12 - 12													-
13													
- 14													
- 15													.
12 13 14 14 15 DE		SCALE						<u> </u>	Golder				ogged: dg Iecked: sat

RECORD OF BOREHOLE: 13-10-3

LOCATION: N 5021244.40 ;E 466452.99 INCLINATION: -90° AZIMUTH: ---

BORING DATE: March 13, 2013

SHEET 1 OF 1

Ц	Ŗ	SOIL PROFILE			SA	MPL	ES	DYNAMIC PENETRATION	k, cm/s	_ <u>0</u>	
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	түре	BLOWS/0.3m	20 40 60 80 SHEAR STRENGTH nat V. + Q - ● Cu, kPa rem V. ⊕ U - ○	10 ⁸ 10 ⁶ 10 ⁻⁴ 10 ⁻²	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
5	BOR		STRA	(m)	Ŋ		BLO	20 40 60 80	Wp H WI 20 40 60 80	LA	
		GROUND SURFACE		76.46							
0				0.00							Protective Casing
1		Grey brown to grey SAND, trace silt			1.	53 mm TUBE	-			МН	
2		Grey brown SAND, trace to some silt		74.08	2	53 mm TUBE	-				Bentonite Seal
3		Red grey to grey CLAY to SILTY CLAY, with black staining		73.75 2.71							
4	Geoprobe	- Grey silt layer from 3.30 m to 3.33 m - Grey silt layer from 3.58 m to 3.63 m			3	53 mm TUBE	-				Silica Sand
5					4	53 mm FUBE	-				32 mm Diam. PVC #10 Slot Screen
6		- Grey silt layer from 5.77 m to 5.80 m Grey SILTY SAND, with black staining Grey SILT, some sand to CLAYEY SILT		70.59 5.87 70.31 6.15 70.01							
7		Red grey to grey CLAY to SILTY CLAY, with black staining - Clayey silt layer from 6.81 m to 6.83 m - Clayey silt layer from 7.11 m to 7.14 m		6.45	5	53 mm TUBE	-				Silica Sand
8		- Clayey silt layer from 7.32 m to 7.34 m End of Borehole		68.84 7.62							
9		Note: Soil stratigraphy inferred from various soil sampling methods and CPT.									
10											
11											
12											
13											
14											
15											
DE	PTHS	SCALE		-				Golder			OGGED: KE

RECORD OF BOREHOLE: 13-11-2

LOCATION: N 5021059.00 ;E 466865.18 INCLINATION: -90° AZIMUTH: ---

BORING DATE: March 21, 2013

SHEET 1 OF 1 DATUM: Geodetic

																		-	1
щ	1	BORING METHOD	SOIL PROFILE			SA	MPLE	s	DYNAMIC PENET RESISTANCE, BL	RATIO	N).3m	l'	HYDRAU	ULIC C k, cm/s	ONDUC	TIVITY,		μ	PIEZOMETER
DEPTH SCALE METRES	ļ	É		-OT		r			20 40	60		0	10				10 ⁻²	ADDITIONAL LAB. TESTING	OR
AETH (202	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	ABEF	TYPE	.0/2	SHEAR STRENG Cu, kPa	TH na	at V. +	Q - ●	WA			T PERCE		ШЩ.	STANDPIPE INSTALLATION
DEP				LAT C	DEPTH (m)	ŊN	F	Š	Cu, kPa	re	m V. ⊕	U - O	Wp	H	W		WI	LAB LAB	IN THE THOM
		<u> </u>		ST	(11)			n	20 40	60	8	0	20	4	0	60	80		
— o			GROUND SURFACE		76.03														Protective Casing
Ē			TOPSOIL (0.00 m - 0.05 m) Grey brown to grey SAND, trace to		0:09														Protective Casing Bentonite Seal
Ē	pe		some silt				53												Silica Sand
Ē.	Geoprobe					1	53 mm FUBE	-											32 mm Diam. PVC
- 1 -	0																		32 mm Diam. PVC #10 Slot Screen
Ē					74.51														
Ē			End of Borehole		1.52														
- 2			Note: Soil stratigraphy inferred from various																-
E			Soil stratigraphy inferred from various soil sampling methods and CPT.																
F																			
- 3																			-
E																			
Ē																			
- 4																			
Ē																			
E																			
Ē																			
- 5																			-
Ē																			
E																			
- 6																			-
Ē																			
Ē																			
- 7																			-
Ē																			
Ē																			
- 8																			
E																			
E																			
- 9																			_
Ē																			
Ē																			
Ē.,																			
10 																			-
E																			
E																			
- 11 -																			-
Ē																			
Ē																			
₹ <u>1</u> 2																			-
4/14																			
0/60																			
L 13																			-
E.G																			
AL-N																			
																			-
GP																			
004£																			
1125 11																			-
12.																			
CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM		1							Â							1		•	
DE DE			CALE							G	olde ocia	r							OGGED: KE
ස් ර	: 75									Ass	ocia	ates						CH	ECKED: SAT

RECORD OF BOREHOLE: 13-12-2

LOCATION: N 5020785.00 ;E 466278.43 INCLINATION: -90° AZIMUTH: ---

BORING DATE: April 10, 2013

SHEET 1 OF 1 DATUM: Geodetic

L N N	THOL	SOIL PROFILE	Ŀ	1	-	AMPL	1	DYNAMIC PENETRA RESISTANCE, BLO	1	HYDRAULIC k, cm				PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	MBER	TYPE	BLOWS/0.3m	20 40 I I SHEAR STRENGTH Cu, kPa	60 80 nat V. + Q - ● rem V ⊕ U - ○	WATER	10 ⁻⁶ 10 ⁻⁴ CONTENT P	PERCENT	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
2	BORI		STRA	(m)	' ₹	-	BLOV	20 40	60 80	vvp	0 60 ⊖W		LAF	
0		GROUND SURFACE TOPSOIL	===	76.1	9									Protective Casing
1	Geoprobe	Grey brown to red brown SILTY SAND, trace gravel		0.0 75.8 0.3	1	53 mm TUBI	-							Bentonite Seal Silica Sand
		Red brown SILTY CLAY (Weathered Crust) End of Borehole		75.00 1.11 74.6 1.5	9									#10 Slot Screen
2		Note: Soil stratigraphy inferred from various soil sampling methods and CPT.												
3														
4														
5														
6														
7														
8														
0														
9														
10														
11														
12														
13														
14														
12 13 14 15 DE 1 :														

RECORD OF BOREHOLE: 13-12-3

LOCATION: N 5020781.01 ;E 466283.81 INCLINATION: -90° AZIMUTH: ---

BORING DATE: April 10, 2013

SHEET 1 OF 1

DATUM: Geodetic

	ПОН	SOIL PROFILE			SA	MPLE	S	DYNAMIC PENETRATION	HYDRAULIC CONDUCTIVITY, k, cm/s	ې ب	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	түре	BLOWS/0.3m	20 40 60 80 `` SHEAR STRENGTH nat V. + Q - ● Cu, kPa rem V. ⊕ U - ○	10 ⁻⁸ 10 ⁻⁶ 10 ⁻⁴ 10 ⁻² WATER CONTENT PERCENT Wp I → ^W WI	ADDITIONAL LAB. TESTING	STANDPIPE INSTALLATION
	8	GROUND SURFACE	S	(,		+	ш	20 40 60 80	20 40 60 80		
0		TOPSOIL	EEE	76.27 0.00 75.97		+				+	Protective Casing
1		Grey brown to red brown SILTY SAND, trace gravel		0.30	1	53 mm TUBE	-				
·		Red brown SILTY CLAY (Weathered Crust)		75.08 1.19 74.75							
2		Red grey to grey CLAY to SILTY CLAY, with clayey silt and silt seams		1.52	2	53 mm FUBE	-				Bentonite Seal
	Geoprobe			71.49	3	53 mm TUBE	-				Silica Sand
5		Grey SILT, trace sand and clay		4.78 70.88	4	53 mm	-			мн	
6		Red grey to grey CLAY to SILTY CLAY, with silt seams		5.39		TUBE					32 mm Diam. PVC #10 Slot Screen
7		Grey SILT		69.21	5	53 mm TUBE	-				Silica Sand
		Red grey to grey SILTY CLAY, with silt seams End of Borehole		7.16 68.65 7.62							Cave
8 9		Note: Soil stratigraphy inferred from various soil sampling methods and CPT.									
10											
11											
12											
13											
14											
15											
DEI	PTHS	SCALE						Golder		L	OGGED: DG

RECORD OF BOREHOLE: 13-13-2

LOCATION: N 5021366.28 ;E 466752.54 INCLINATION: -90° AZIMUTH: ---

BORING DATE: March 13, 2013

SHEET 1 OF 1

DATUM: Geodetic

	ш		0	SOIL PROFILE			SA	MPL	ES	DYNAMIC PEN RESISTANCE,		ON /0.3m	<u>}</u>	HYDR	AULIC C k, cm/s		TIVITY,		. (1)	
O O Part O Part O Part	SCAL		METH		LOT		н.).3m	20 4	0	50			0 ⁻⁸ 1	10 ⁻⁶ 1			TIONAL	OR
O O Part O Part O Part	EPTH		RING	DESCRIPTION	ATA F	ELEV. DEPTH	IUMBE	ТҮРЕ	0/S/MC	SHEAR STREN Cu, kPa	IGTH	nat V. + rem V. ∉	- Q - O	W					ADDIT AB. TE	INSTALLATION
0 TOPSION: 200 minutes 200 minutes 100			BO		STR	(m)	z		BLO	20 4	0 (50	80							
a a b a b a b a b <td>-</td> <td>0</td> <td></td> <td></td> <td>zzz</td> <td>76.21</td> <td>_</td> <td></td> <td>Protective Casing</td>	-	0			zzz	76.21	_													Protective Casing
	E		Φ			0.12														
	-		seoprot				1	53 mm TUBE	-											32 mm Diam PVC
Find of forwhete 130 3 Sold statignaly information matrices and SPT. 4 Sold statignaly information matrices and SPT. 5 Sold statignaly information matrices and SPT. 6 Sold statignaly information matrices and SPT. 7 Sold statignaly information matrices and SPT. 8 Sold statignaly information matrices and SPT. 9 Sold statignaly information matrices and SPT. 10 Sold statignaly information matrices and SPT. 11 Sold statignaly information matrices and SPT. 12 Sold statignaly information matrices and SPT. 13 Sold statignaly information matrices and SPT. 14 Sold statignaly information matrices and SPT.	Ē	1																	мн	#10 Slot Screen
		-		End of Borehole	19. J.S.	1.52														
	-	2		Note: Soil stratigraphy inferred from various																-
	-			soil sampling methods and CPT.																
		3																		
	Ē																			-
	-																			
		4																		
	-																			-
	-	5																		
	Ē																			
	-	6																		-
	Ē	7																		
	Ē																			
		8																		-
	Ē																			
	-	9																		_
	Ē																			
	1	0																		
	-																			
	Ē.																			
	Ē	1																		
12 13 13 14 14 14 14 14 14 14 14 14 15 15 15 16 17 17 16 17 <	-																			
DEPTH SCALE	₹ 1	2																		-
DEPTH SCALE	9/04/1																			
DEPTH SCALE		3																		
DEPTH SCALE	MIS.G																			
DEPTH SCALE	- GAL	4																		
DEPTH SCALE LOGGED: KE	CGPJ	*																		
DEPTH SCALE	25004																			
DEPTH SCALE LOGGED: KE	1211	5																		-
LOGGED: KE	SOIL				1	I	L	<u> </u>	1		Ś.	1	1	I	1	1	1	1		
CHECKED: SAT	1 I			GUALE						G		Gold	er ates							DGGED: KE ECKED: SAT

	/IPLE	TION: -90° AZIMUTH: R HAMMER, 64kg; DROP, 760mm						HEADSPACE			IP	PE HYDRAULIC (STHAN	IMER,	64kg; DROP, 760	mm
MEIKES	BORING METHOD	SOIL PROFILE	STRATA PLOT	ELEV. DEPTH (m)	NUMBER		BLOWS/0.3m	CONCENTRA ND = Not Dete 100 HEADSPACE VAPOUR CO [%LEL] ND =	TIONS [P ected 200 3 COMBUS NCENTRA	PM] 00 4 TIBLE TIONS	00 □	k, cm/s 10 ⁻⁶ WATER (s 10 ⁻⁵ 10 CONTENT) ⁻⁴ 1		ADDITIONAL LAB. TESTING	PIEZOMETI OR STANDPIF INSTALLATI	E
	Ш	GROUND SURFACE	ST	77.22			8	20	40	30 8	30	20	40 6	8 0	0		M	ON.
0 -		Compact dark brown to black SILTY SAND, trace gravel and shale fragments		0.00	1 :	ss	15	¢									Flush Mount Casing Bentonite Seal Silica Sand 7	
1	er low Stem)	Compact brown SILTY fine SAND		76.46 0.76	2	ss	15	Ð										
2	Power Auger 200 mm Diam. (Hollow Stem)	Brown SILTY CLAY, trace thin silty sand seams (Weathered Crust)		75.70	3	ss	3	θ									32 mm Diam. PVC #10 Slot Screen	
	5	Grey brown SILTY CLAY		74.93 2.29	4 \$	ss I	РН	Ð									Silica Sand	200,200,200,200
3.		End of Borehole		74.17 3.05													W.L. in Screen at	
																	W.L. in Screen at Elev. 76.564 on June 7, 2013	
4																		
5																		
6																		
7																		
8																		
- 1																		
9												1 1						

		CT: 12-1125-0045/8100 ON: See Site Plan	RE	COF	RD (OF	BOREHOLE:		(A13-2)	HEET 1 OF 1 ATUM: Geodetic
INC	CLINA	ATION: -90° AZIMUTH: ER HAMMER, 64kg; DROP, 760mm					BORING DATE: June	5, 2013		, 64kg; DROP, 760mm
		SOIL PROFILE			SAMP	LES	HEADSPACE ORGANIC VAP	OUR	HYDRAULIC CONDUCTIVITY,	_
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	_ <u> </u>	ELEV. DEPTH (m)	NUMBER	33	CONCENTRATIONS [PPM] ND = Not Detected 100 200 300 HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATION: [%LEL] ND = Not Detected 20 40 60			PIEZOMETER OR STANDPIPE INSTALLATION
- 0		GROUND SURFACE		77.48						MON. WEI
- - - - - - - - - - - - - - 1	Stem)	Compact brown to black sandy clayey silt, trace gravel, shale fragments, and organic matter (FILL)		0.00	1 SS	11	θ			Bentonite Seal
-	Power Auger Diam (Hollow	Loose brown SILTY fine SAND		76.11 1.37						
- - - - 2	Power Auger 200 mm Diam (Hollow Stem)	Brown SILTY CLAY (Weathered Crust)		75.65 1.83	3 SS 3A SS		⊕ ⊕			32 mm Diam. PVC #10 Slot Screen
- - - - - - - - - - 3		Grey brown SILTY CLAY		75.20 2.28 74.43	4 SS	5 1	Ð			Silica Sand
										W.L. in Screen at Elev. 78.60 on June 7, 2013
- - - - - - - - - - - - - - - - - - -	PTH	SCALE					Gold			OGGED: DWM

APPENDIX C

Cone Penetration Test (CPT) Results - Current Investigation

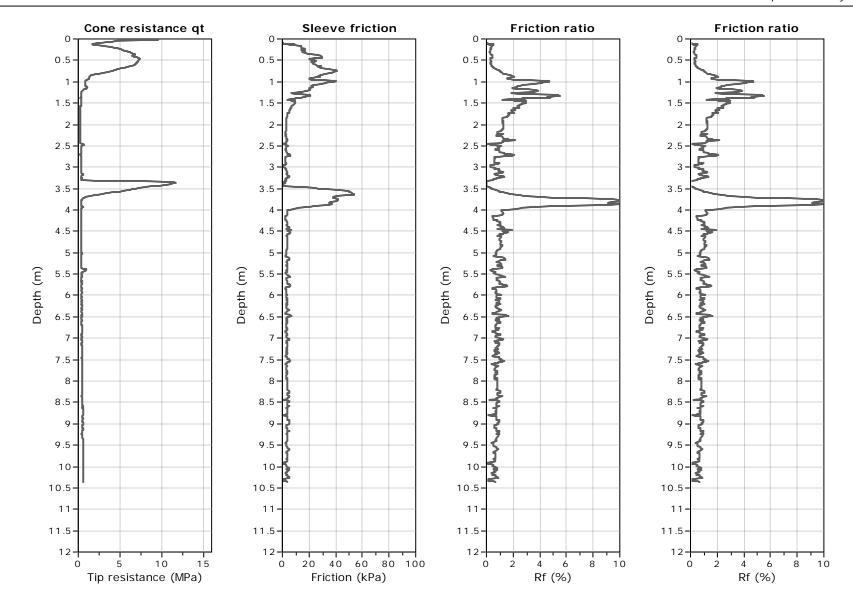
Golder Associates Ltd. Golder Associates CRRRC - 1787048-400-4.4 Project:

Location: Ottawa, ON, Canada

www.golder.com

Total depth: 10.36 m, Date: 03/01/2018 Cone Type: I-CFTXYP20-10 Cone Operator: M. Roy - Stratum CPT

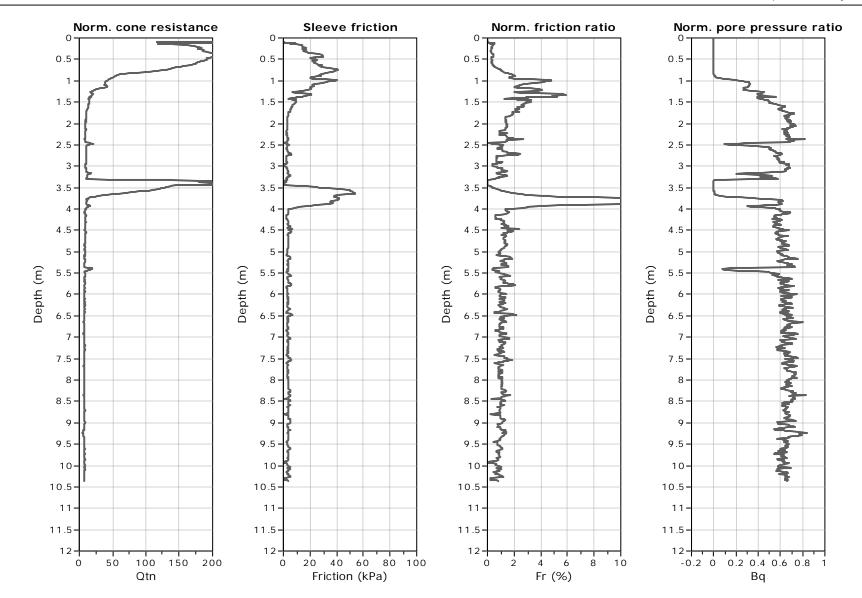
CPT17-06_RevA



Golder Associates Ltd. www.golder.com Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

CPT17-06_RevA Total depth: 10.36 m, Date: 03/01/2018 Cone Type: I-CFTXYP20-10 Cone Operator: M. Roy - Stratum CPT

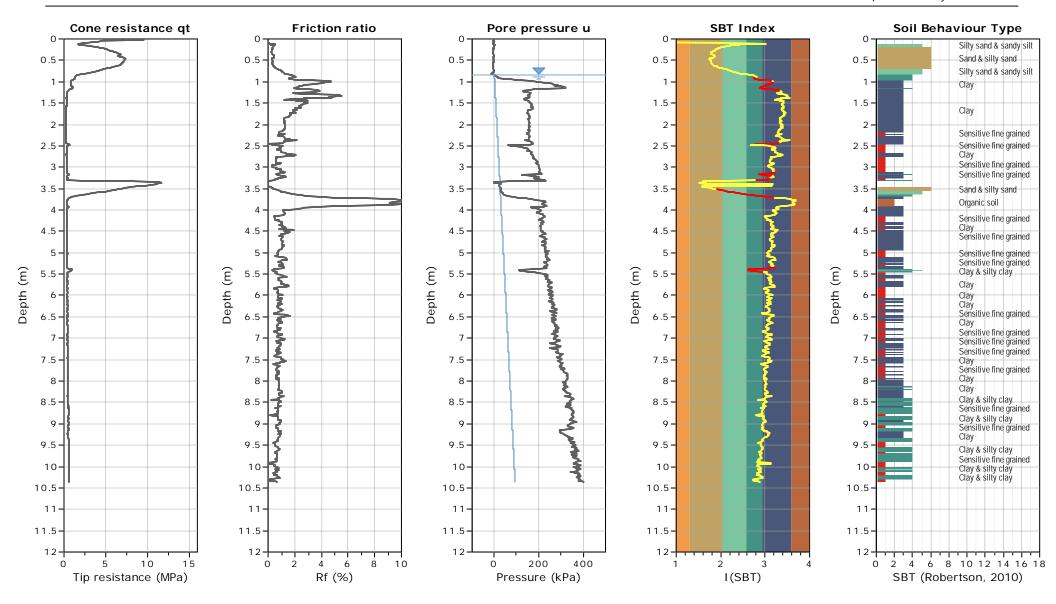


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:56 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt



Location: Ottawa, ON, Canada

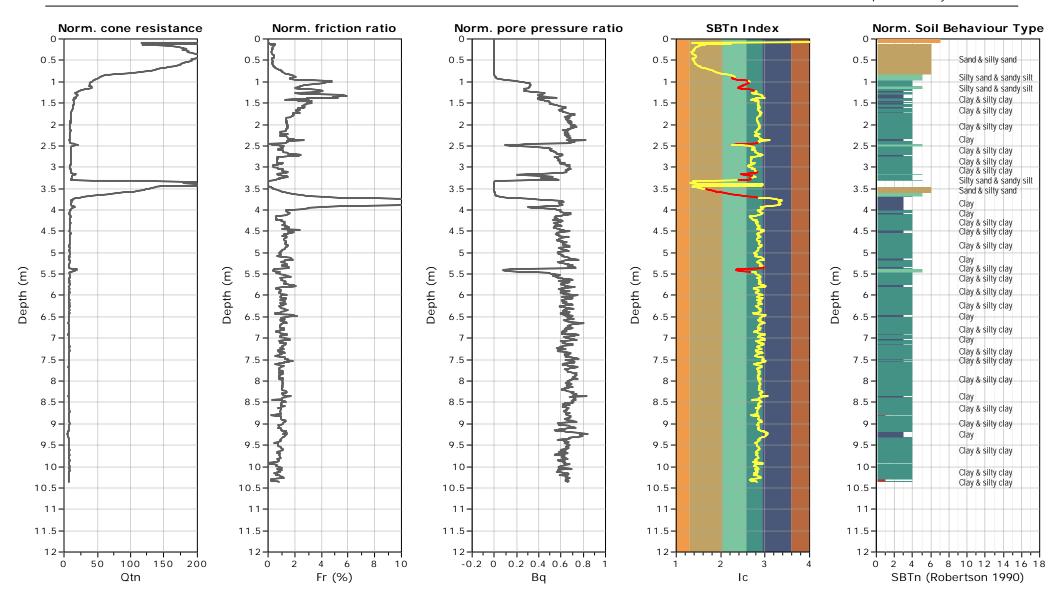
CPT17-06_RevA





CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

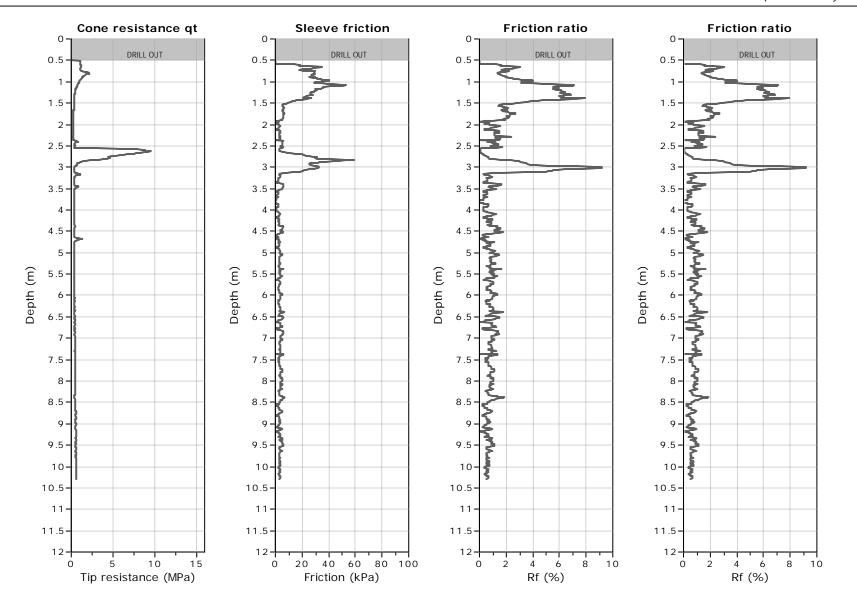


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:56 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

CPT17-06_RevA

Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

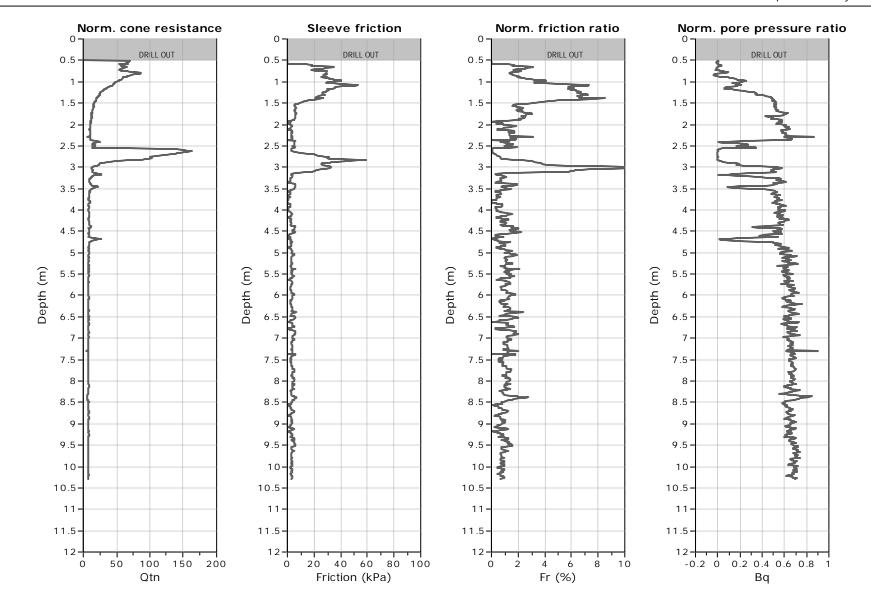


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:57 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

CPT17-08_RevA

Golder Associates Ltd. www.golder.com Project: CRRRC - 1787048-400-4.4 Location: Ottawa, ON, Canada

CPT17-08_RevA

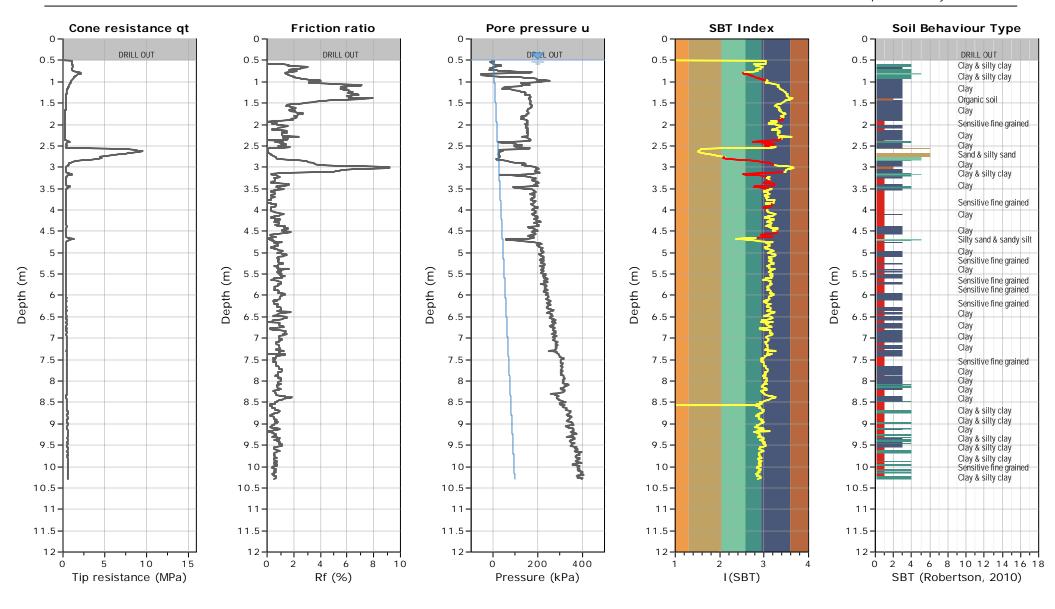


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:57 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt



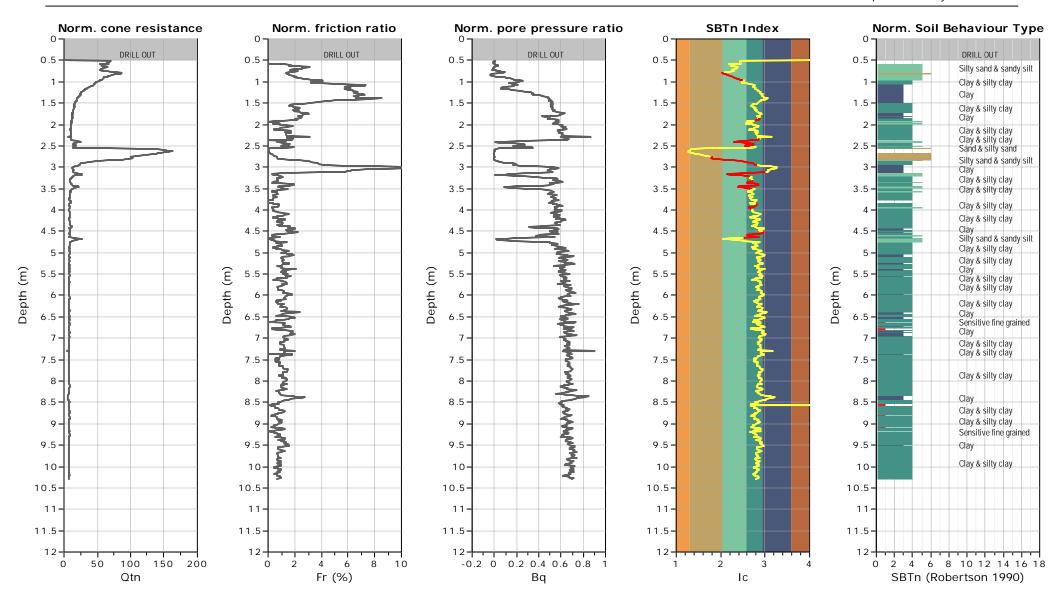
Location: Ottawa, ON, Canada

CPT17-08_RevA





Location: Ottawa, ON, Canada



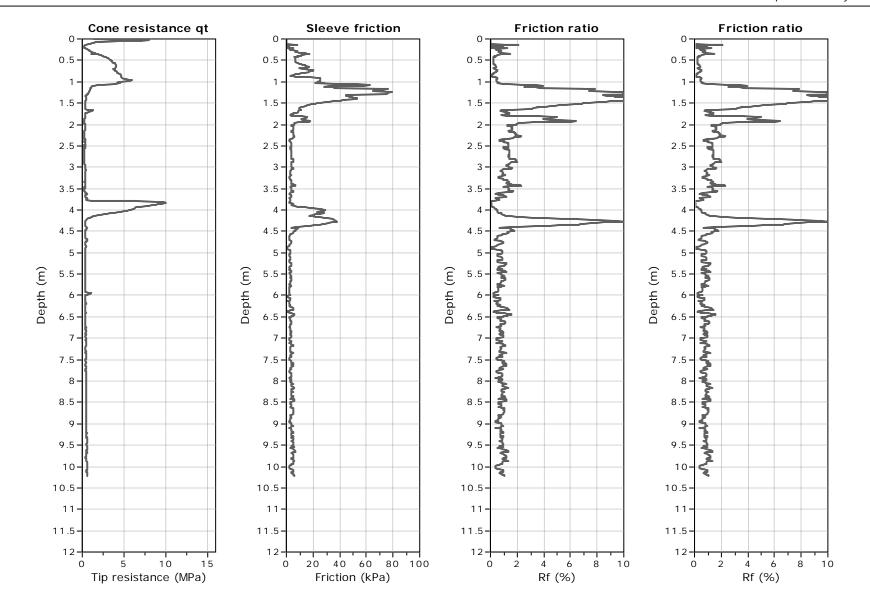
CPT17-08_RevA

Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

CPT17-10_RevA Total depth: 10.22 m, Date: 03/01/2018

Cone Type: I-CFXYP20-10 171029 Cone Operator: M. Roy - Stratum CPT

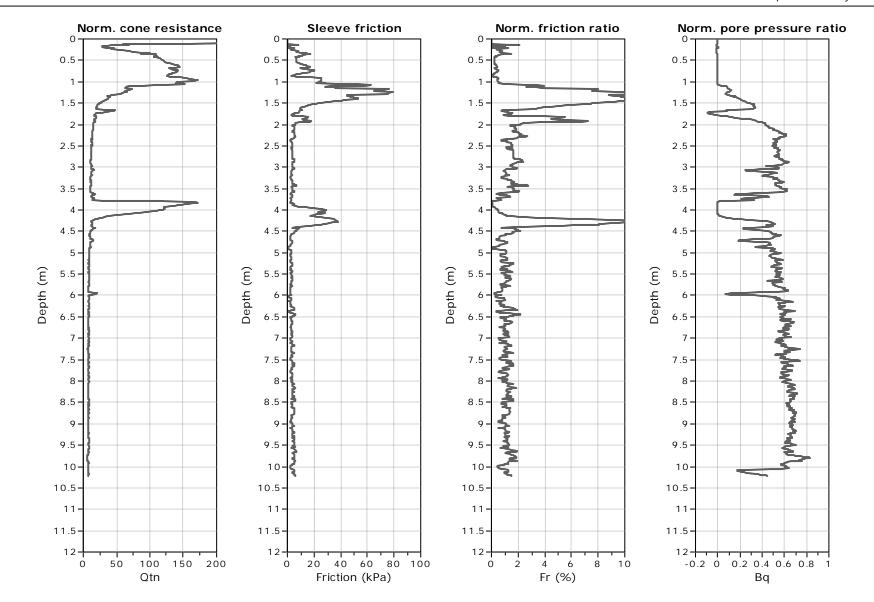


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:57 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt Golder Associates Ltd. www.golder.com Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

CPT17-10_RevA

Total depth: 10.22 m, Date: 03/01/2018 Cone Type: I-CFXYP20-10 171029 Cone Operator: M. Roy - Stratum CPT

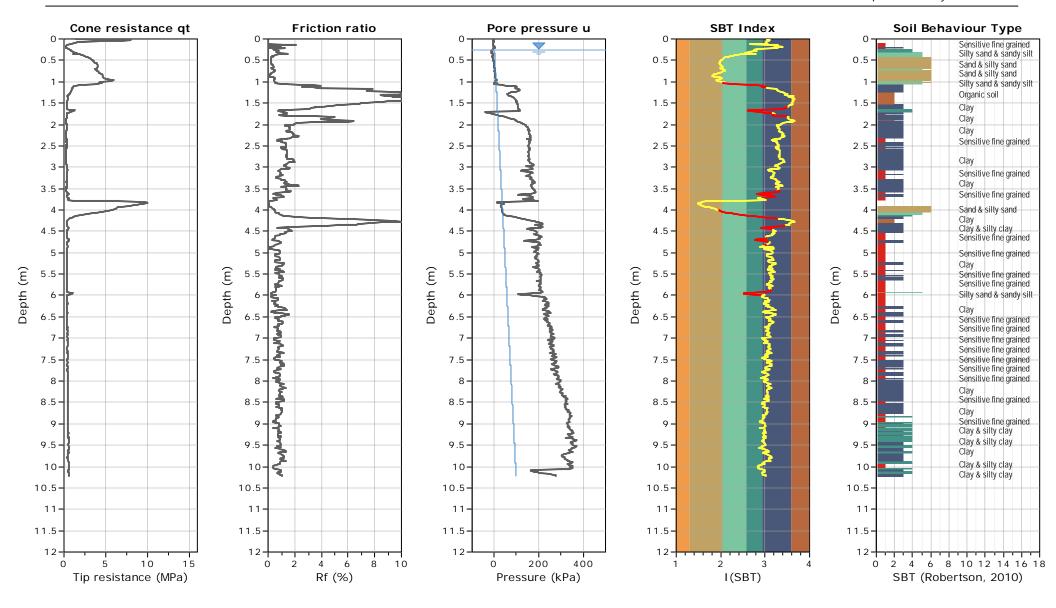


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:57 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt



Location: Ottawa, ON, Canada

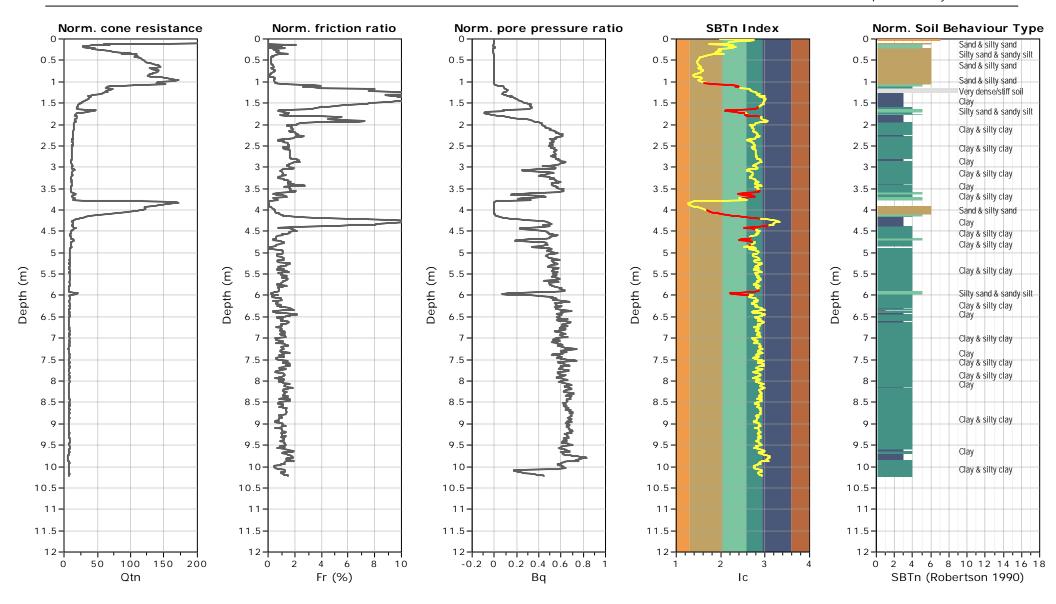
CPT17-10_RevA





Location: Ottawa, ON, Canada

CPT17-10_RevA

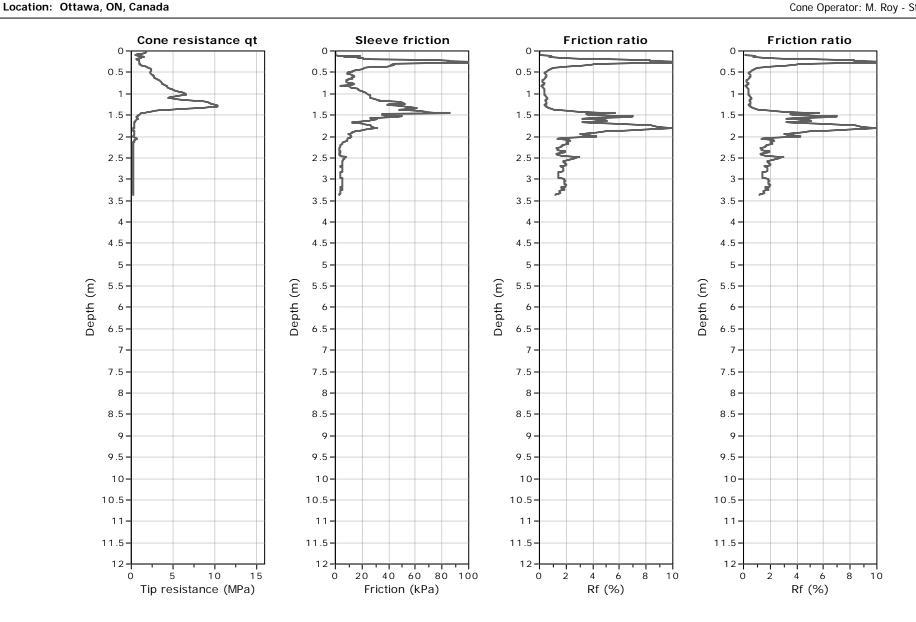


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:58 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt



CPT17-11_RevA

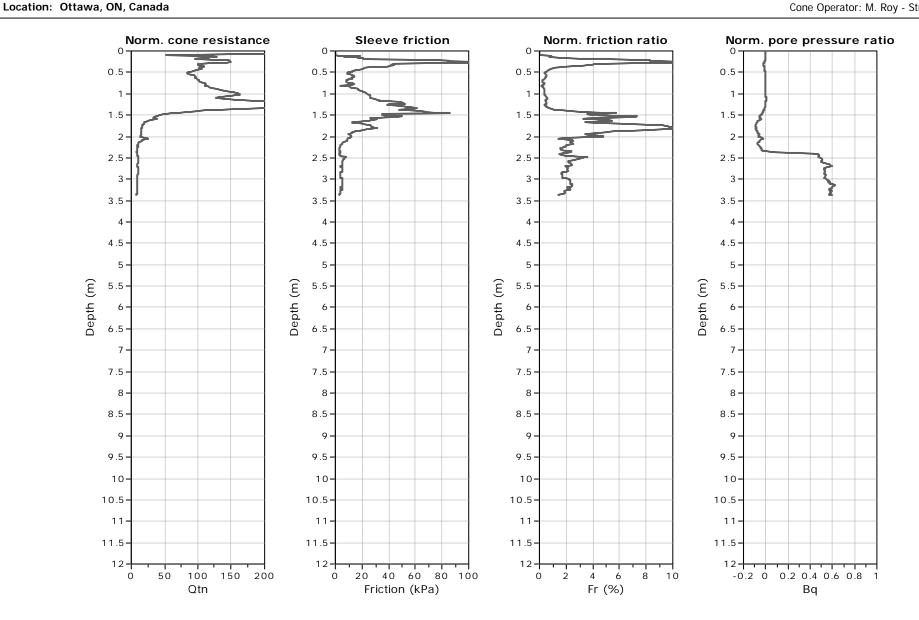
Total depth: 3.38 m, Date: 03/01/2018 Cone Type: I-CFXYP20-10 171029 Cone Operator: M. Roy - Stratum CPT



CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:58 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt



CPT17-11_RevA

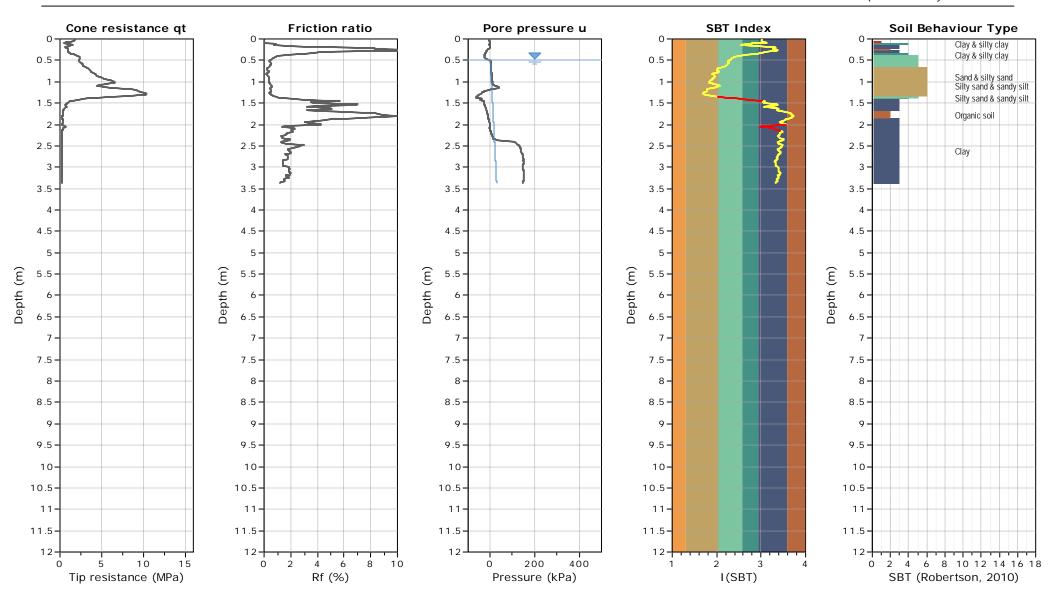


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:58 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt



Location: Ottawa, ON, Canada

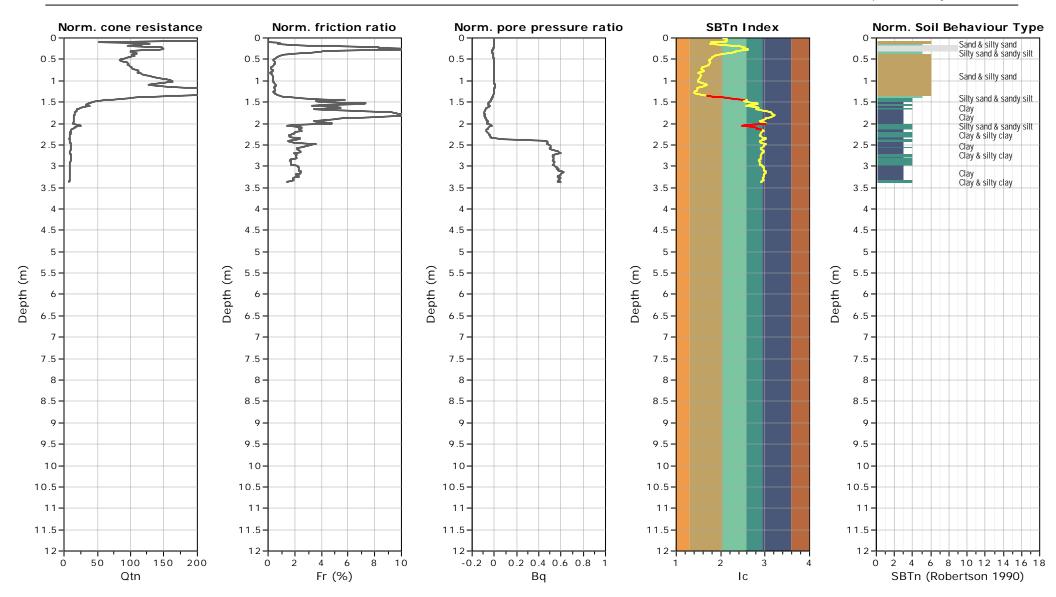
CPT17-11_RevA





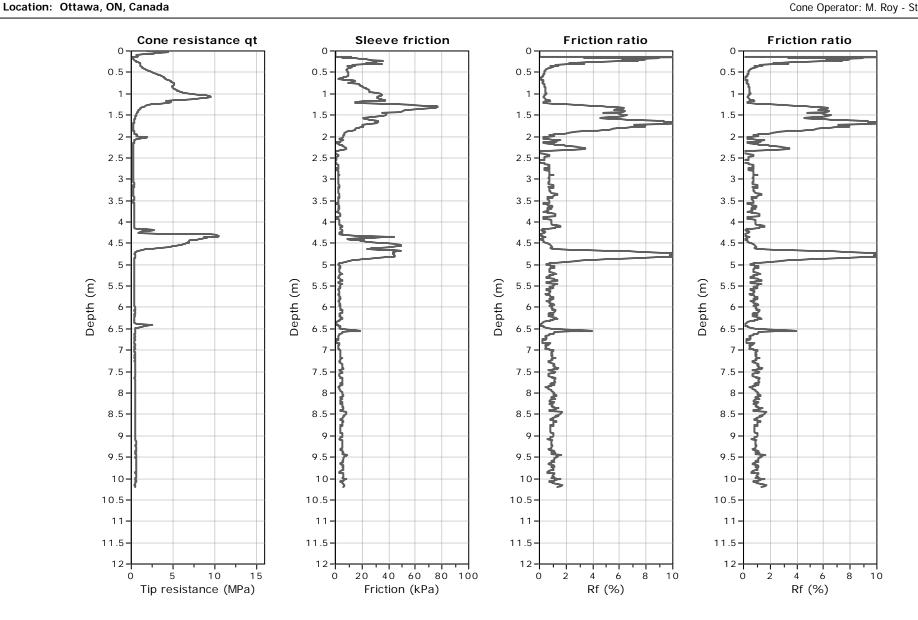
Location: Ottawa, ON, Canada

CPT17-11_RevA





CPT17-11R_RevA



CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:58 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

Project: CRRRC - 1787048-400-4.4

0.

1.

2.

3 -

0.5

1.5

2.5

3.5

4

5

6

7.

8 -

9-

9.5-

10-

10.5-

11-11.5-

12

Ó

50

100

Qtn

150 200

4.5

5.5

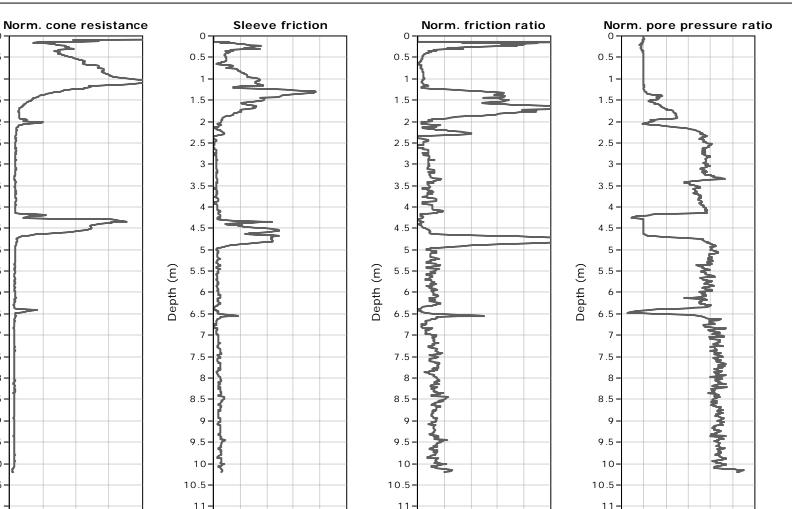
6.5

7.5

8.5

Depth (m)

Location: Ottawa, ON, Canada



11.5-

12-

0 2

11.5-

8 10

4 6

Fr (%)

12-

-0.2 0 0.2 0.4 0.6 0.8 1

Bq

Total depth: 10.20 m, Date: 03/01/2018 Cone Type: I-CFXYP20-10 171029

CPT17-11R_RevA

Cone Operator: M. Roy - Stratum CPT

11.5-

12

0

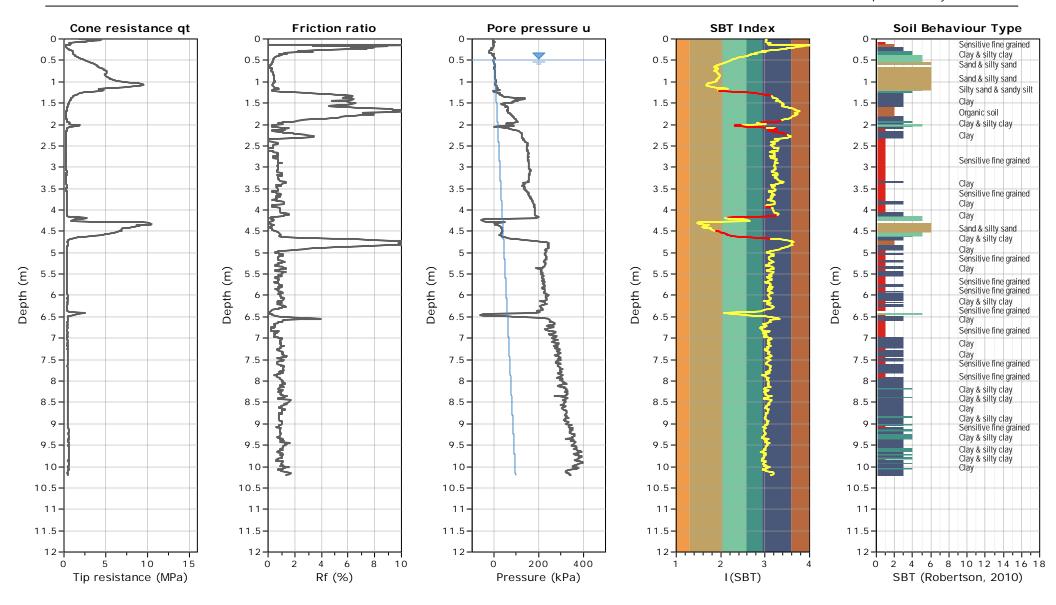
20 40 60 80 100

Friction (kPa)



Location: Ottawa, ON, Canada

CPT17-11R_RevA

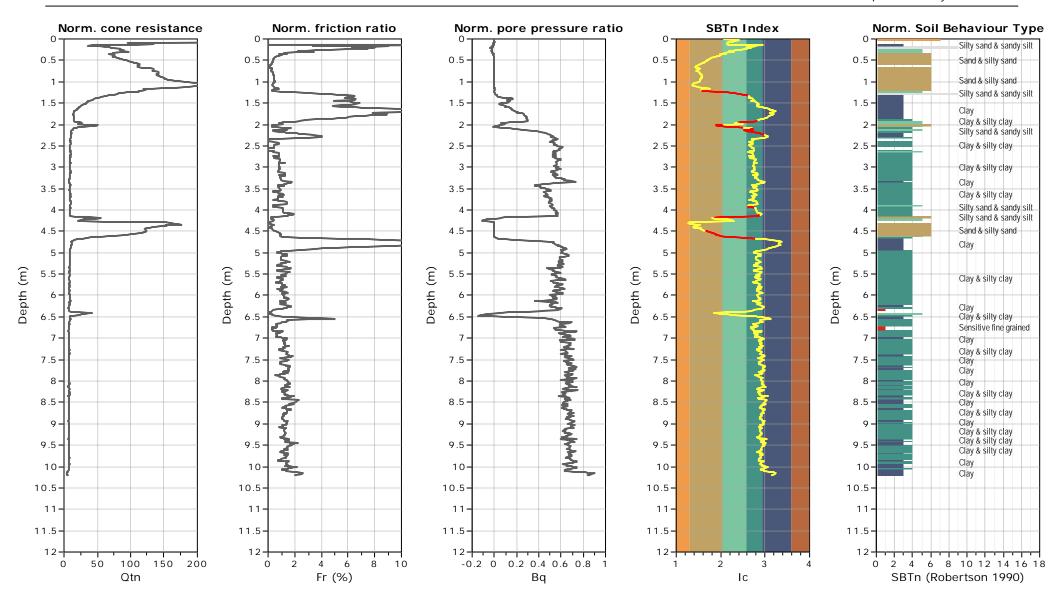




Location: Ottawa, ON, Canada

CPT17-11R_RevA

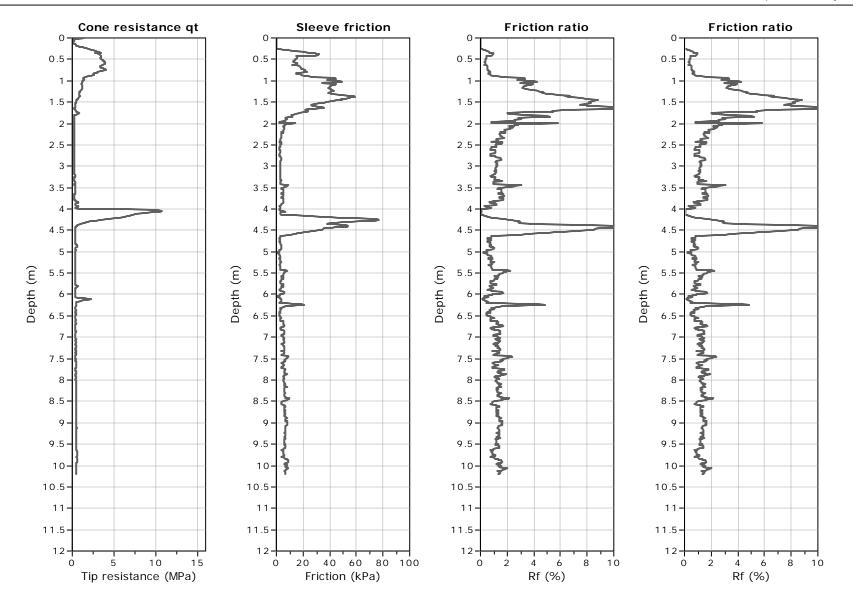
Total depth: 10.20 m, Date: 03/01/2018 Cone Type: I-CFXYP20-10 171029 Cone Operator: M. Roy - Stratum CPT



CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:59 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada



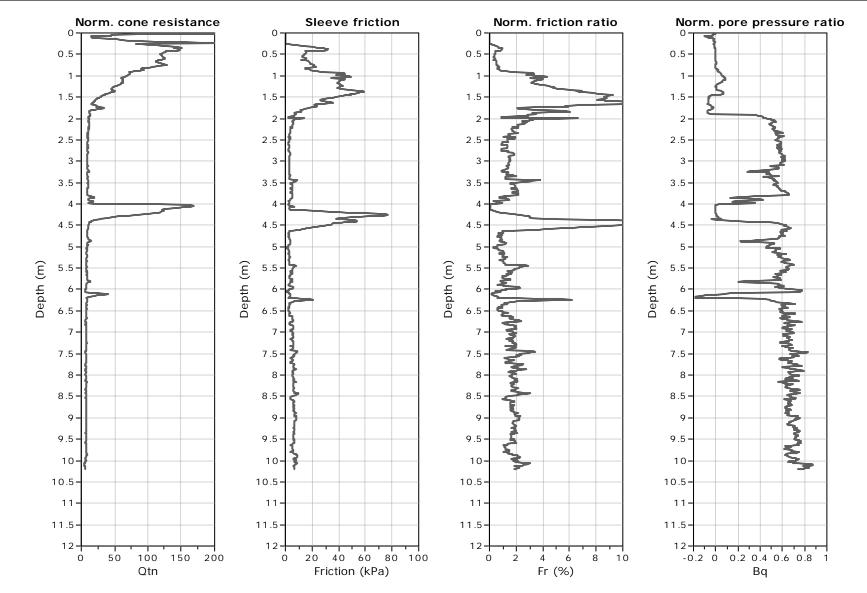
CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:59 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

CPT17-15_RevA

Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

Total depth: 10.20 m, Date: 03/01/2018 Cone Type: I-CFXYP20-10 171029 Cone Operator: M. Roy - Stratum CPT



CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:40:59 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

CPT17-15_RevA



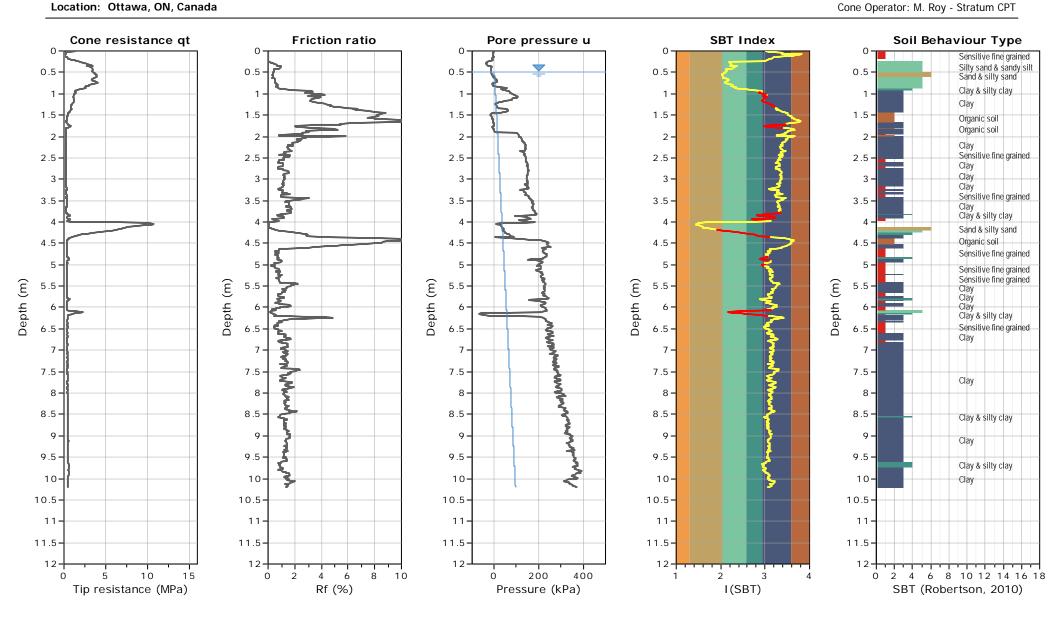
CPT17-15_RevA

Total depth: 10.20 m, Date: 03/01/2018

Cone Type: I-CFXYP20-10 171029

CRRRC - 1787048-400-4.4 Project:

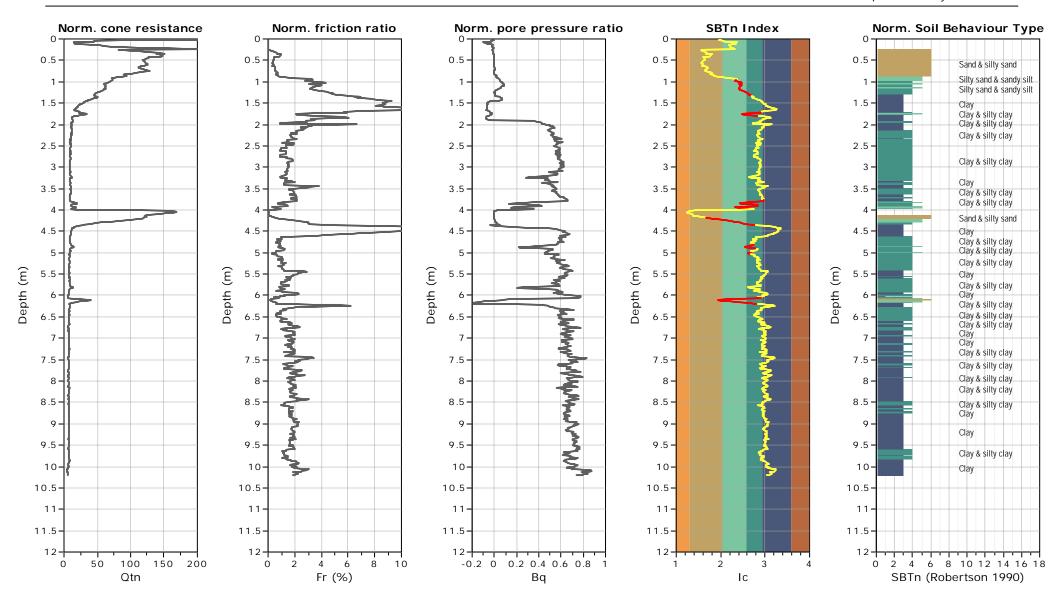
Location: Ottawa, ON, Canada





Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

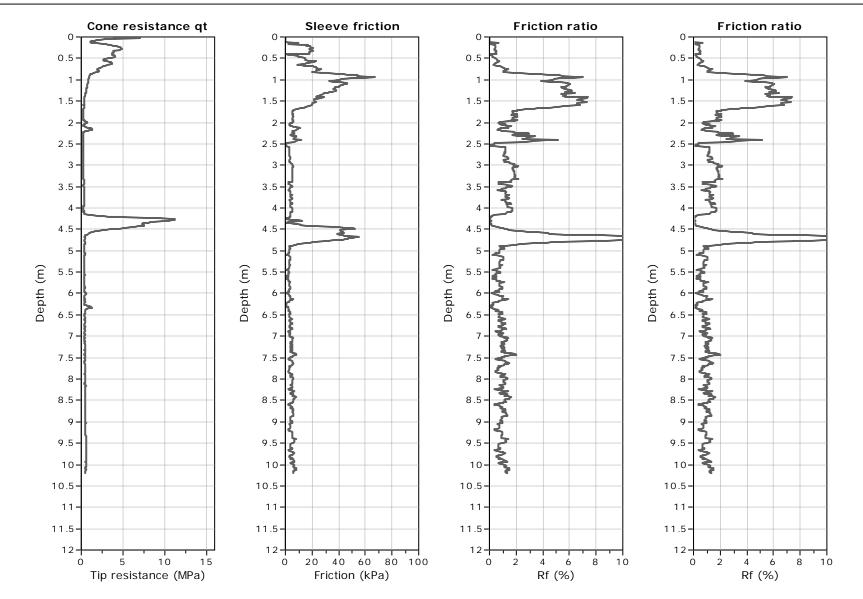


CPT17-15_RevA

Golder Associates Ltd. www.golder.com Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

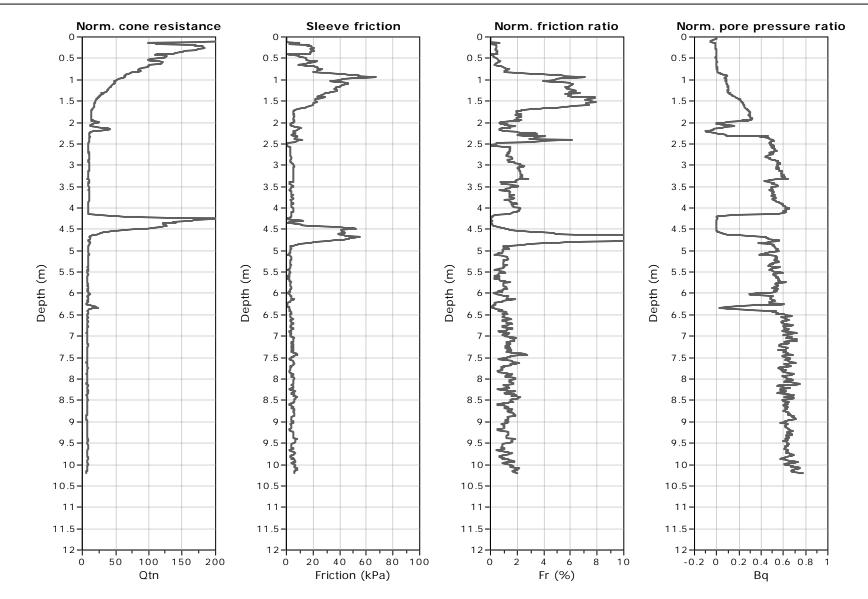
CPT17-16_RevA Total depth: 10.20 m, Date: 03/01/2018 Cone Type: Uknown Cone Operator: Uknown



Golder Associates Ltd. www.golder.com Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

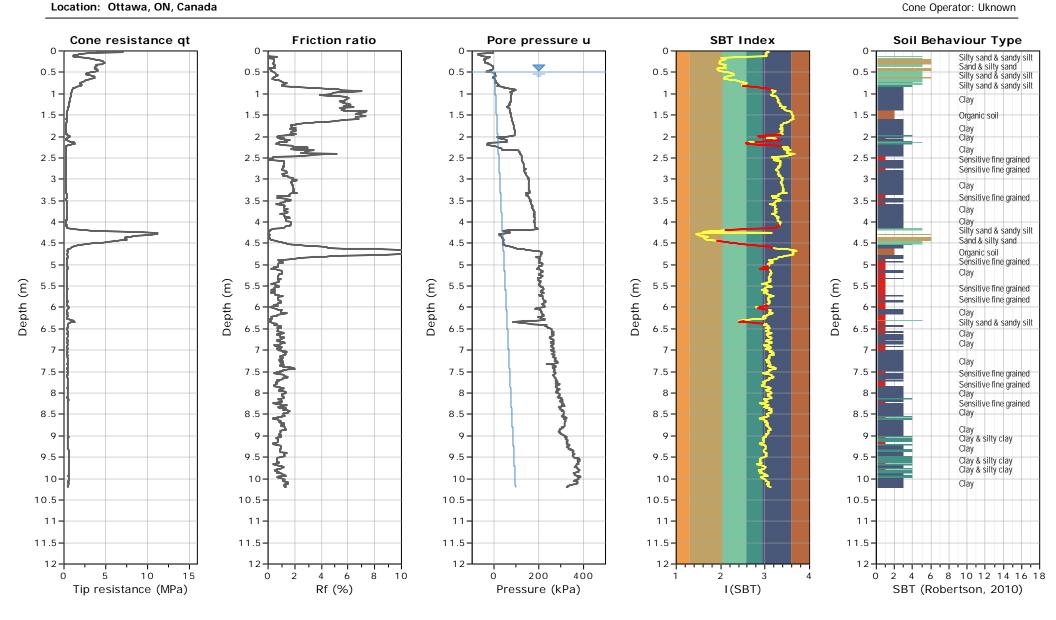
CPT17-16_RevA Total depth: 10.20 m, Date: 03/01/2018 Cone Type: Uknown Cone Operator: Uknown





CPT17-16_RevA

Total depth: 10.20 m, Date: 03/01/2018 Cone Type: Uknown Cone Operator: Uknown

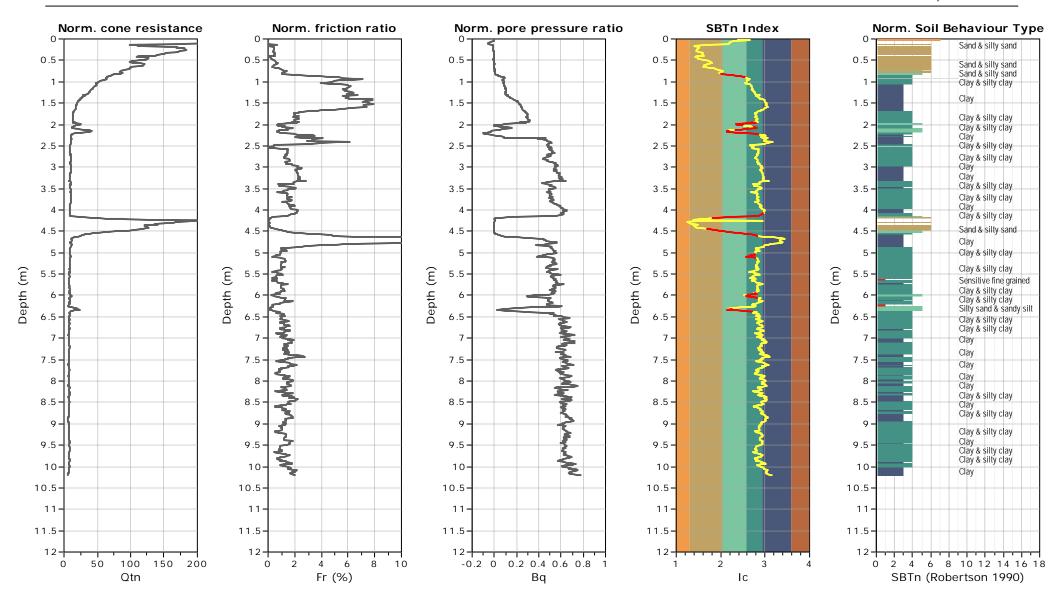




Location: Ottawa, ON, Canada

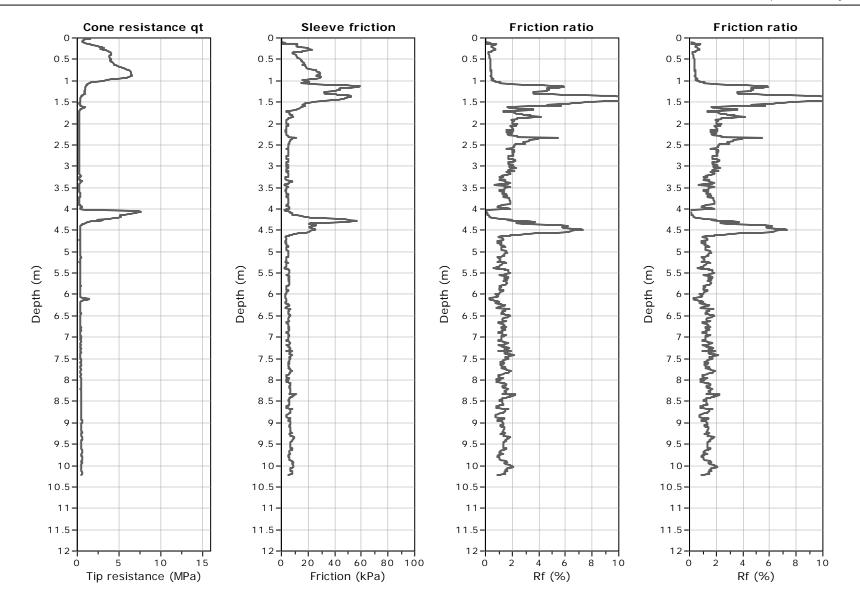
CPT17-16_RevA

Total depth: 10.20 m, Date: 03/01/2018 Cone Type: Uknown Cone Operator: Uknown



Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

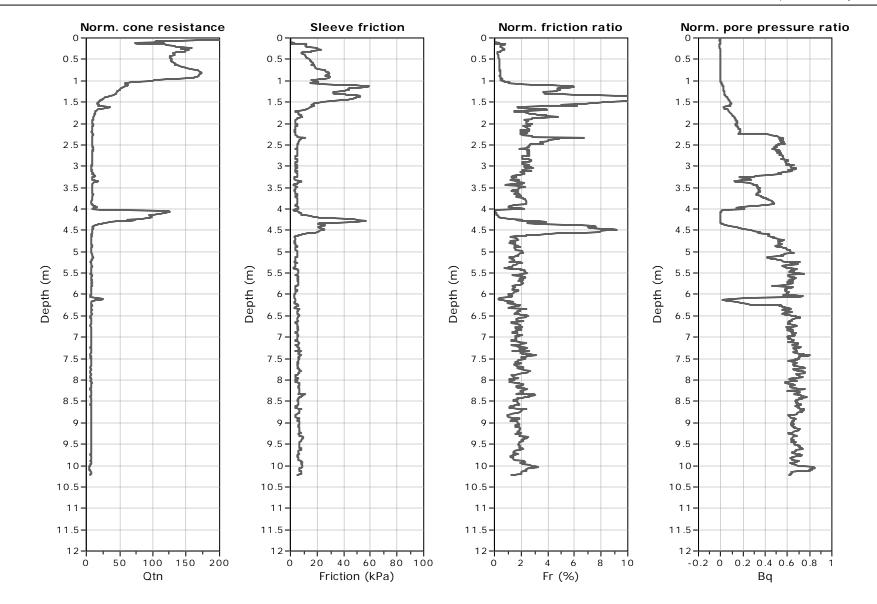


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:01 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

Total depth: 10.23 m, Date: 03/01/2018 Cone Type: I-CFXYP20-10 171029 Cone Operator: M. Roy - Stratum CPT

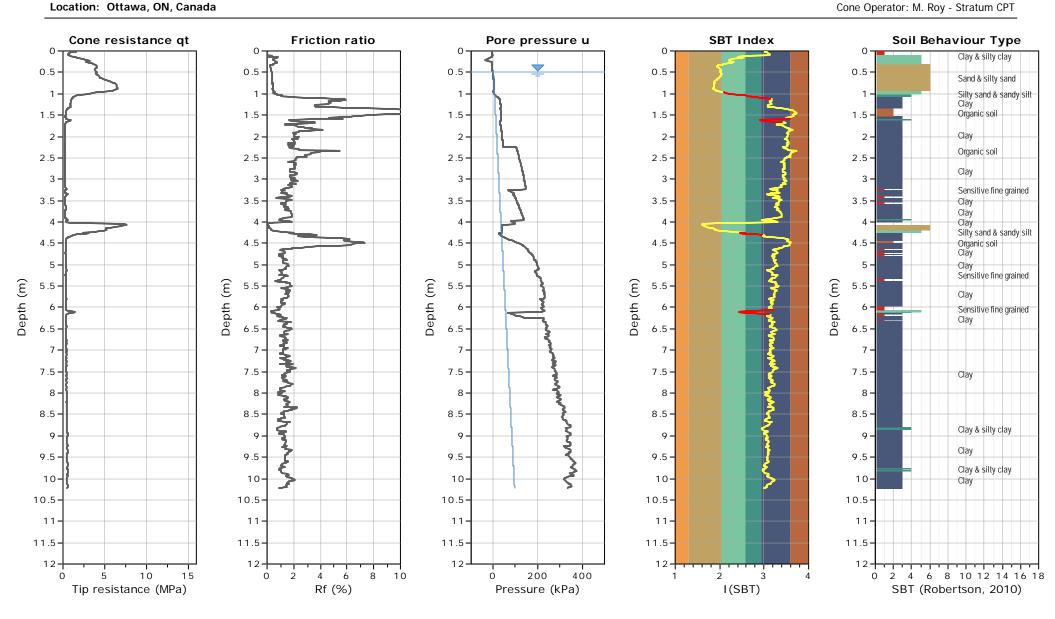


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:01 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

CPT17-18_RevA



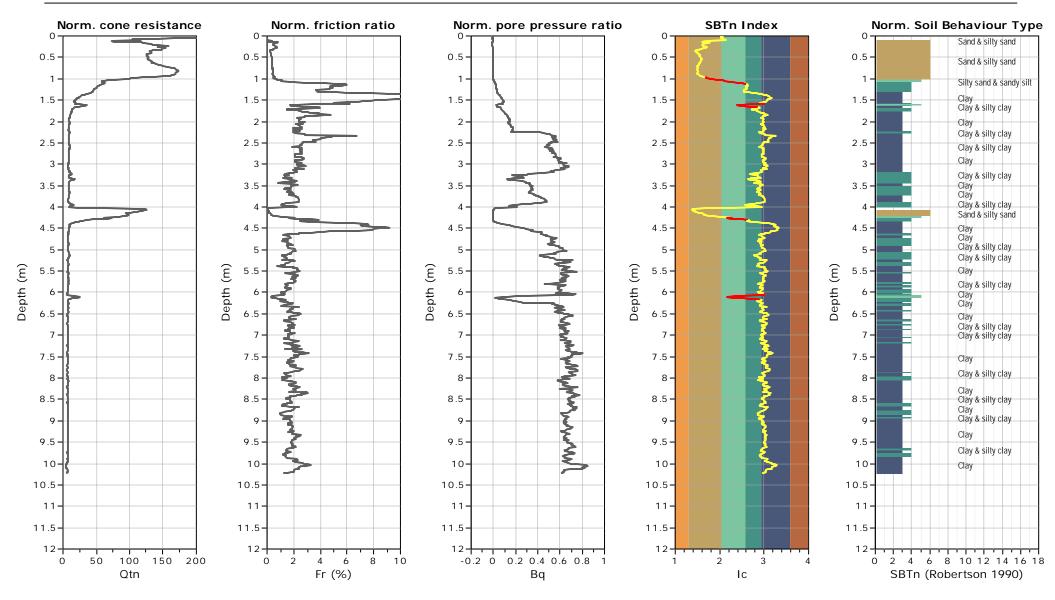
CPT17-18_RevA





Project: CRRRC - 1/8/048-400-4

Location: Ottawa, ON, Canada



CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:01 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

CPT17-18_RevA

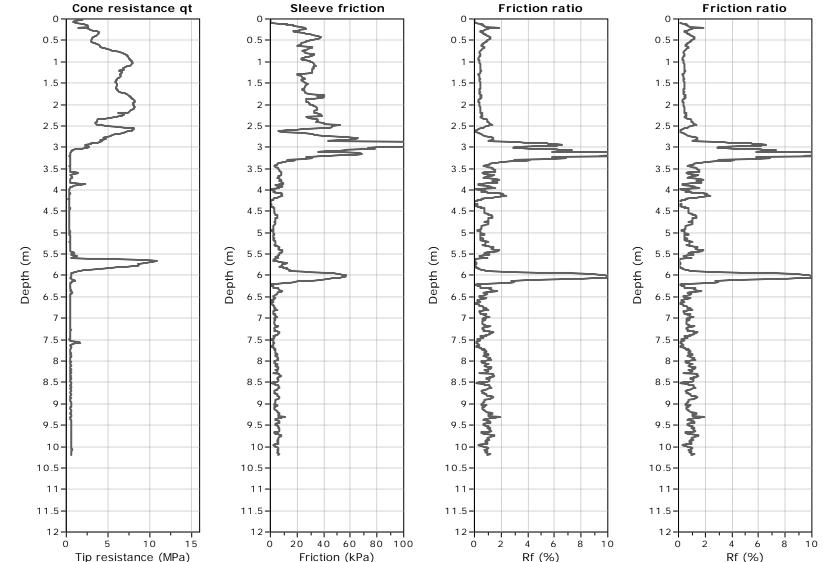
Golder Associates Ltd. Golder www.golder.com CRRRC - 1787048-400-4.4 Project:

Location: Ottawa, ON, Canada

CPT17-22_RevA

Cone Operator: M. Roy - Stratum CPT

Total depth: 10.20 m, Date: 04/01/2018 Cone Type: I-CFXYP20-10 171029 **Friction ratio**



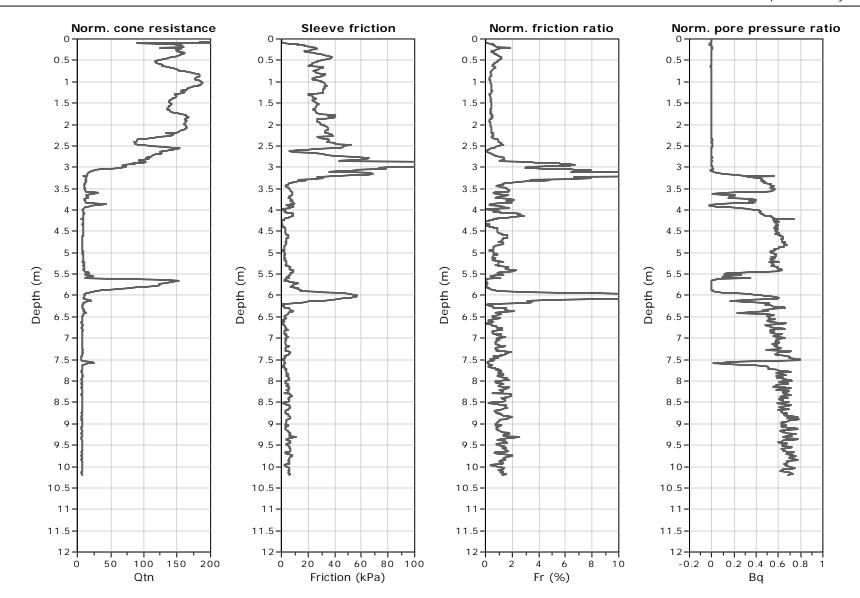
CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:02 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

Golder Associates Ltd. www.golder.com Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

Total depth: 10.20 m, Date: 04/01/2018 Cone Type: I-CFXYP20-10 171029 Cone Operator: M. Roy - Stratum CPT

CPT17-22_RevA

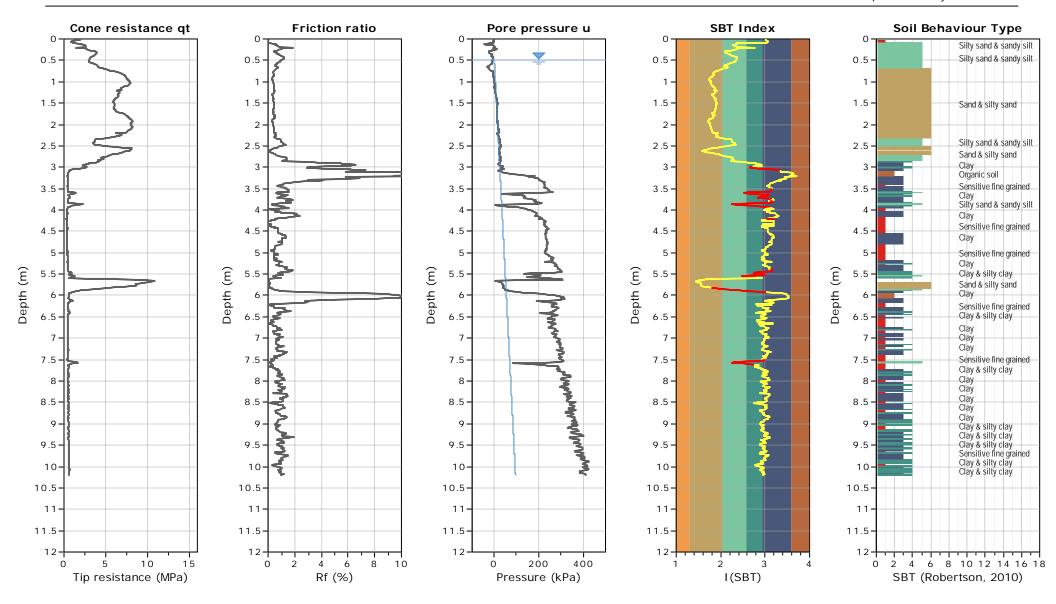


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:02 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt



Location: Ottawa, ON, Canada

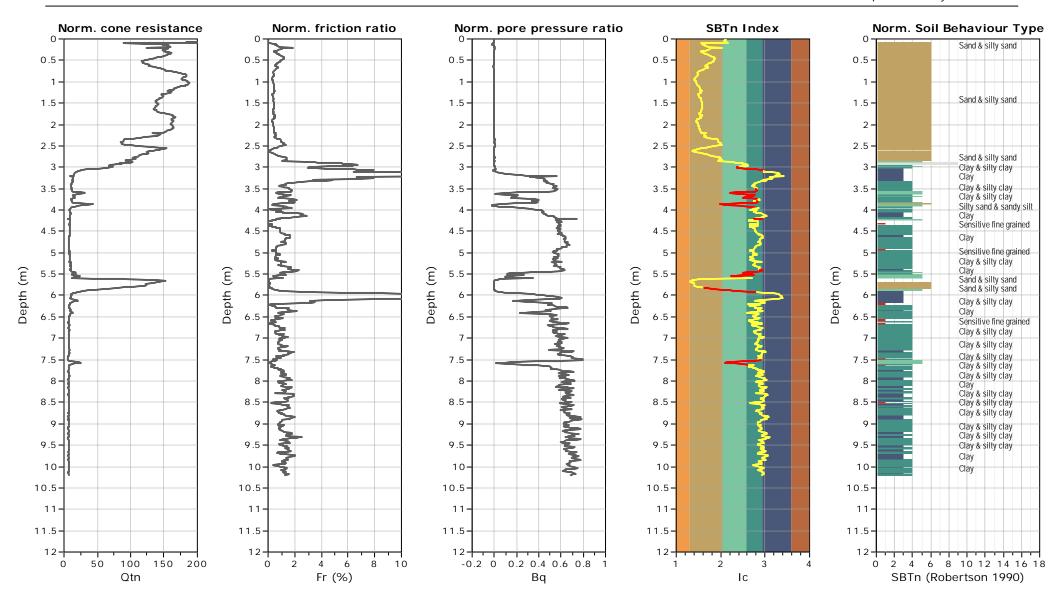
CPT17-22_RevA





Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada



CPT17-22_RevA

0

1

2 -

3 -

4 -

5.

6

7.

8 -

9.

9.5-

10-

11-

12

Ó

5

10

Tip resistance (MPa)

15

11.5-

10.5

1.5

2.5

3.5

4.5.

5.5

6.5

7.5

8.5

Depth (m)

0.5

Cone resistance qt

Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

Total depth: 10.29 m, Date: 04/01/2018 Cone Type: I-CFXYP20-10 171029 Cone Operator: M. Roy - Stratum CPT

10.

11-

12-

0

2

6

4

Rf (%)

8 10

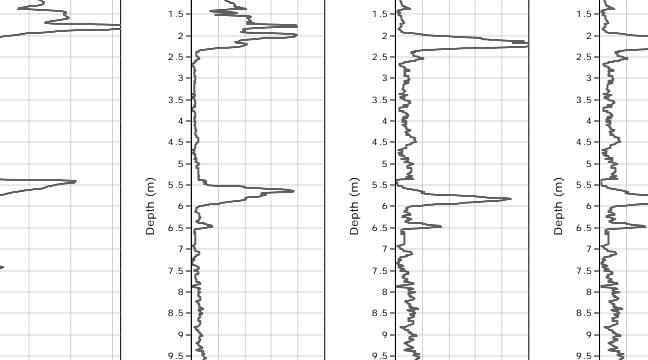
10.5

11.5-

8 10

4 6

Rf (%)



0

0.5

1

10-

10.5-

11.5-

11.

12-

0 2

Sleeve friction

0

1

0.5

CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:02 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

10-

10.5

11.5-

12

Ó

20 40 60 80 100

Friction (kPa)

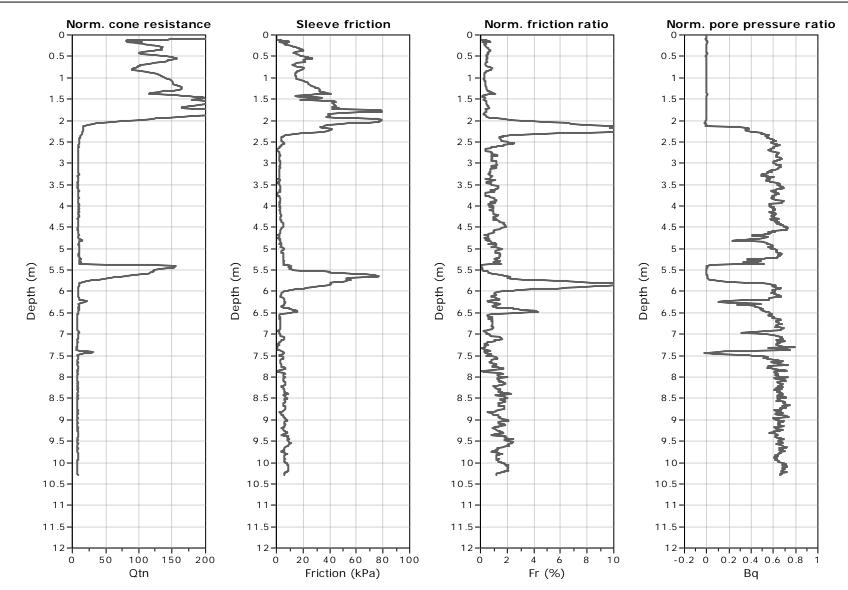
11

CPT17-24_RevA

CP117-24_Re

Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada



CPT17-24_RevA Total depth: 10.29 m, Date: 04/01/2018 Cone Type: I-CFXYP20-10 171029

Cone Type: I-CFXYP20-10 171029 Cone Operator: M. Roy - Stratum CPT

CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:03 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt



CPT17-24_RevA

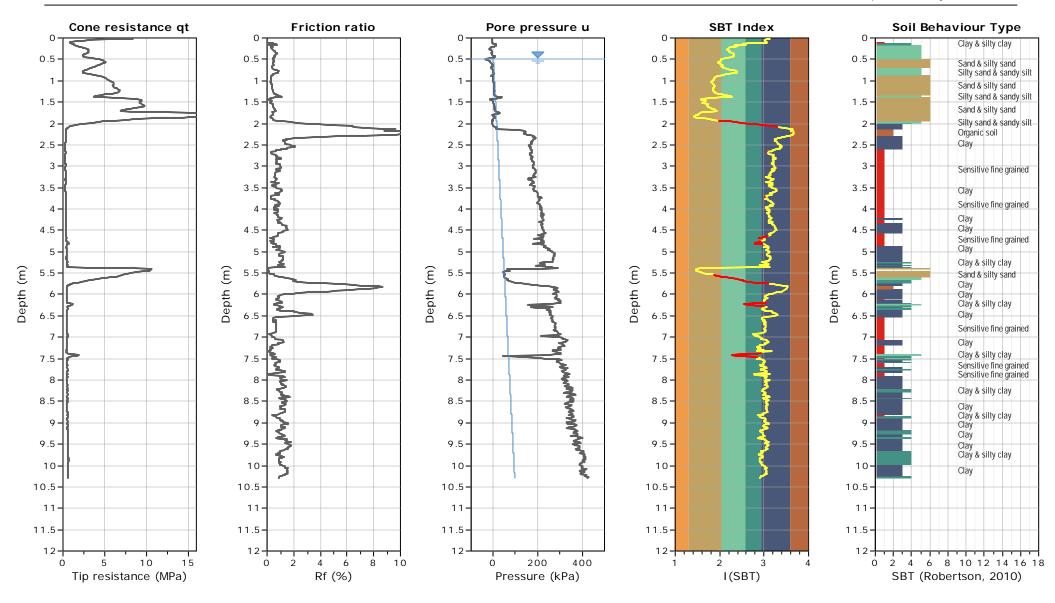
Total depth: 10.29 m, Date: 04/01/2018

Cone Type: I-CFXYP20-10 171029

Cone Operator: M. Roy - Stratum CPT

Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada





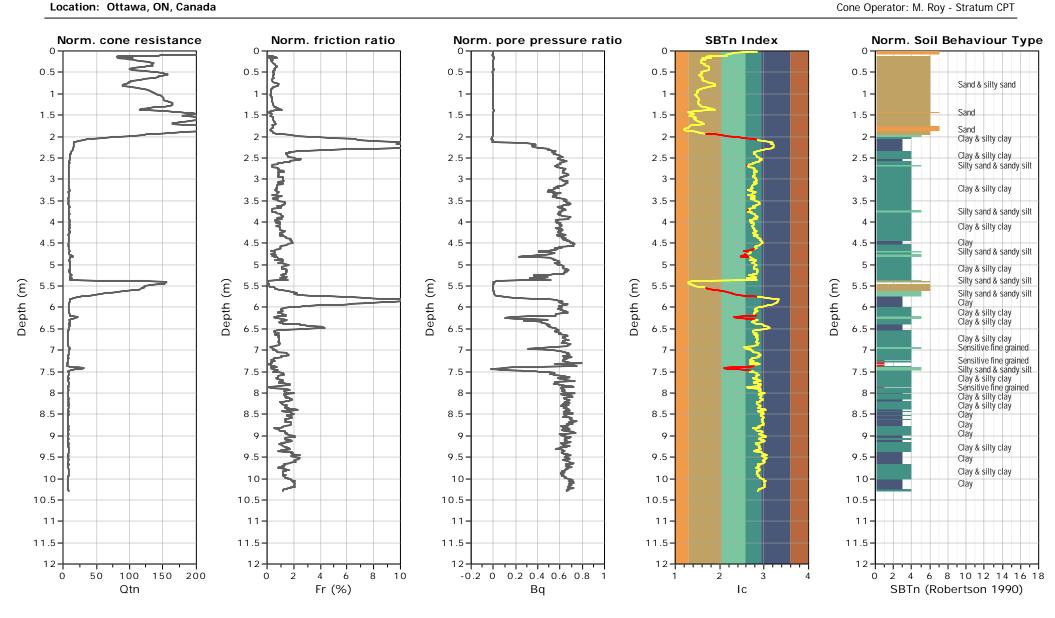
CPT17-24_RevA

Total depth: 10.29 m, Date: 04/01/2018

Cone Type: I-CFXYP20-10 171029

CRRRC - 1787048-400-4.4 Project:

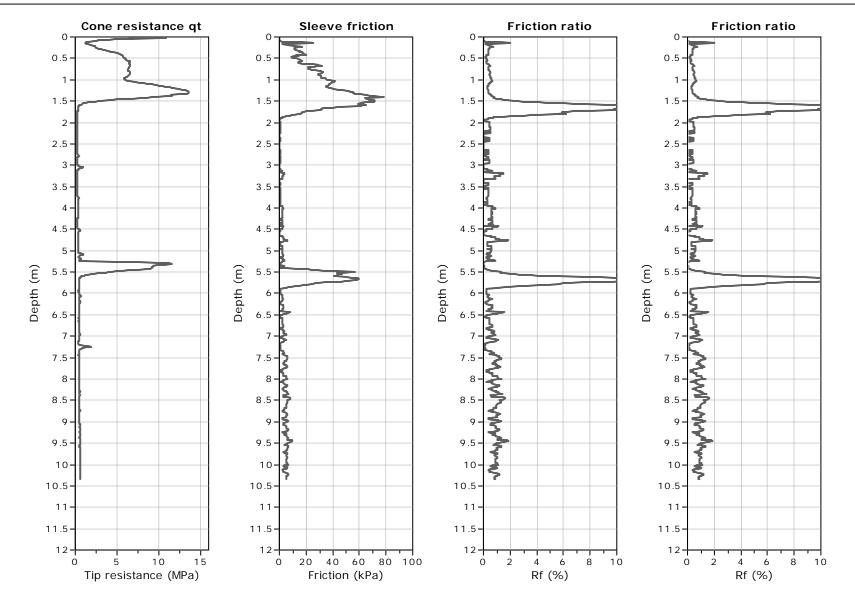
Location: Ottawa, ON, Canada



Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

CPT17-25_RevA Total depth: 10.34 m, Date: 04/01/2018 Cone Type: Uknown Cone Operator: Uknown

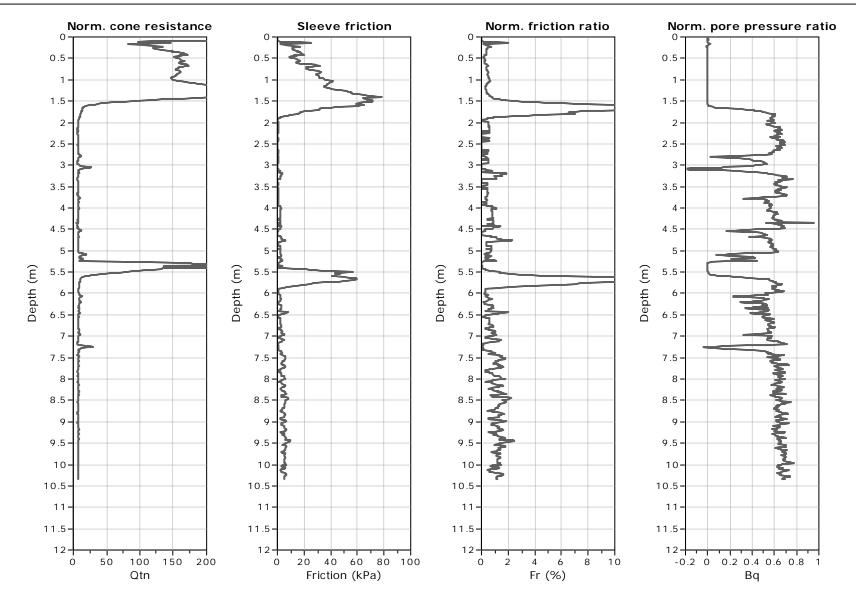


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:03 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

Golder Associates Ltd. www.golder.com Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

CPT17-25_RevA Total depth: 10.34 m, Date: 04/01/2018 Cone Type: Uknown Cone Operator: Uknown



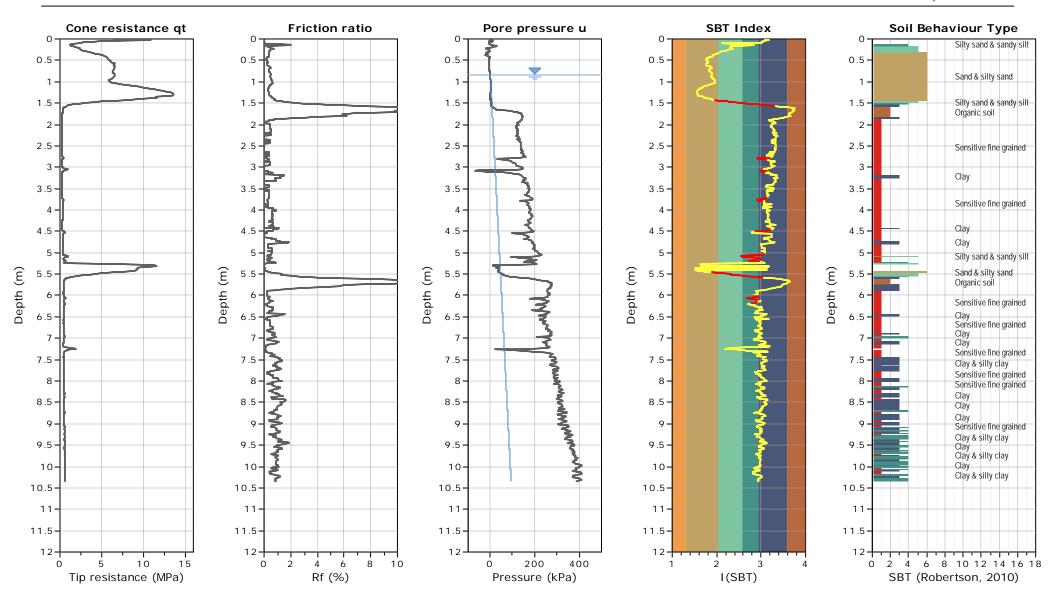
CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:03 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt



Location: Ottawa, ON, Canada

CPT17-25_RevA

Total depth: 10.34 m, Date: 04/01/2018 Cone Type: Uknown Cone Operator: Uknown

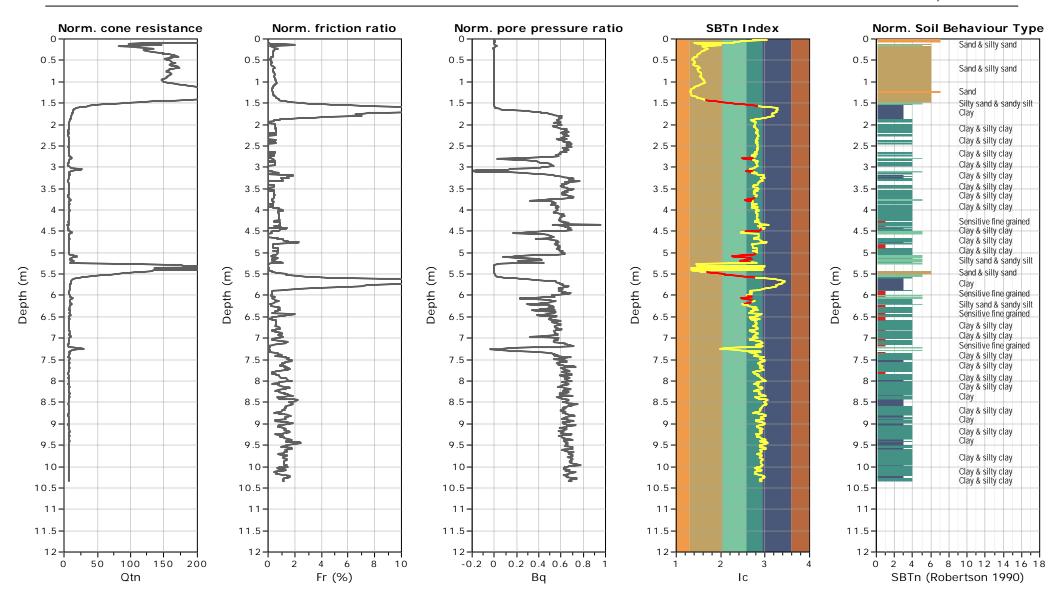




Location: Ottawa, ON, Canada

CPT17-25_RevA

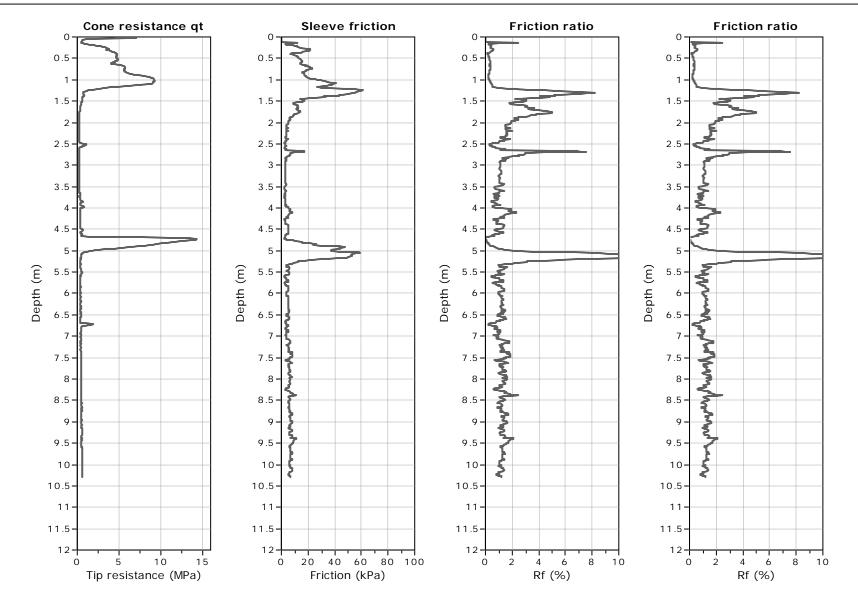
Total depth: 10.34 m, Date: 04/01/2018 Cone Type: Uknown Cone Operator: Uknown



Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

Total depth: 10.29 m, Date: 04/01/2018 Cone Type: I-CFXYP20-10 171029 Cone Operator: M. Roy - Stratum CPT

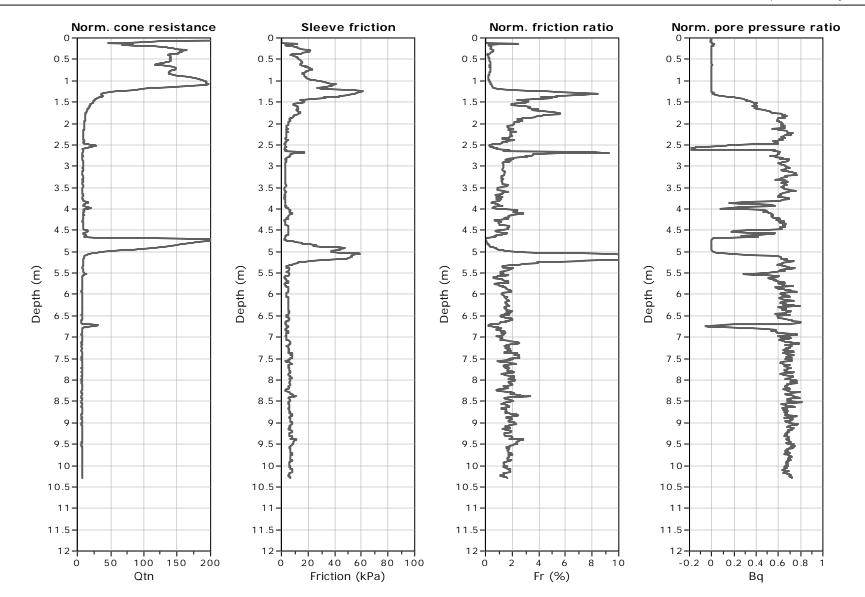


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:04 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

CPT17-28_RevA

Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

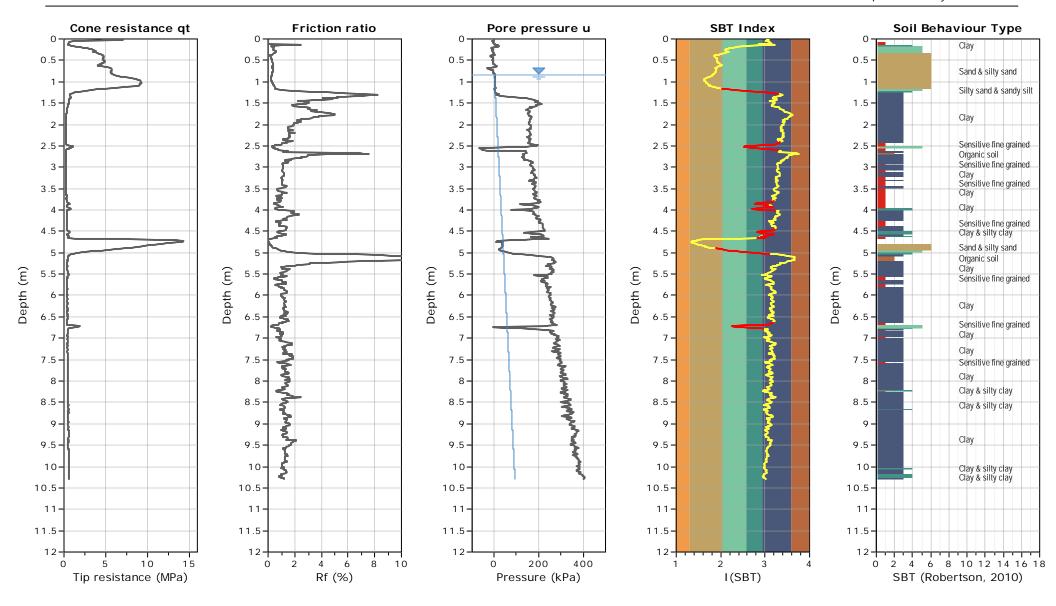


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:04 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt



Location: Ottawa, ON, Canada

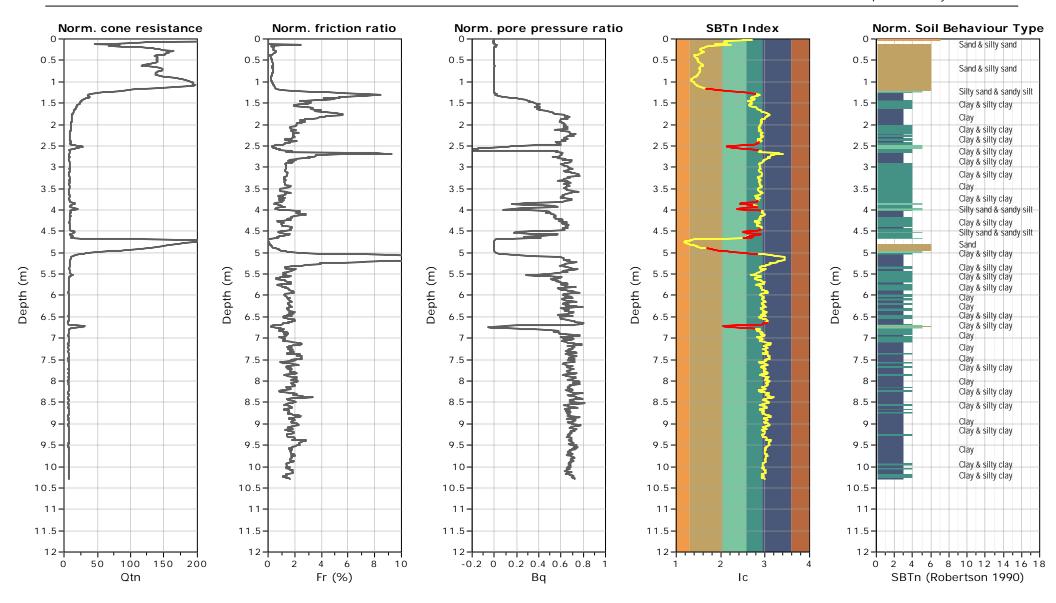
CPT17-28_RevA





Location: Ottawa, ON, Canada

CPT17-28_RevA



Golder Associates Ltd. www.golder.com Project: CRRRC - 1787048-400-4.4

0.

0.5

1.5

2.5

3.5

4.5

5.5

Depth (m)

1

2 -

3 -

4 -

5.

6.

Cone resistance qt

Location: Ottawa, ON, Canada

CPT17-30_RevA Total depth: 10.36 m, Date: 04/01/2018 Cone Type: I-CFXYP20-10 171029 Cone Operator: M. Roy - Stratum CPT

Friction ratio

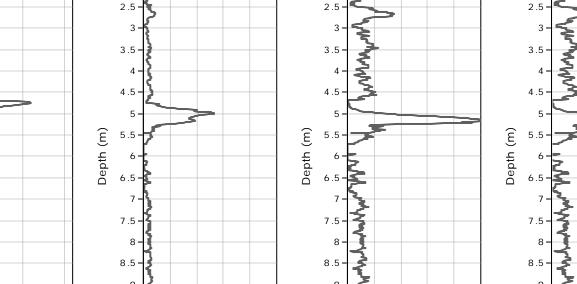
0

1

2

0.5

1.5



Friction ratio

0

0.5

1.5

1

2

Sleeve friction

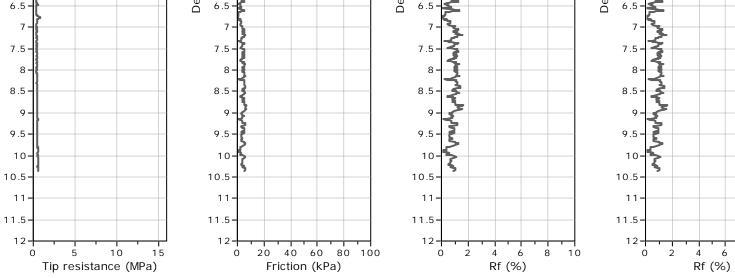
0

1

2.

0.5

1.5



CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:05 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

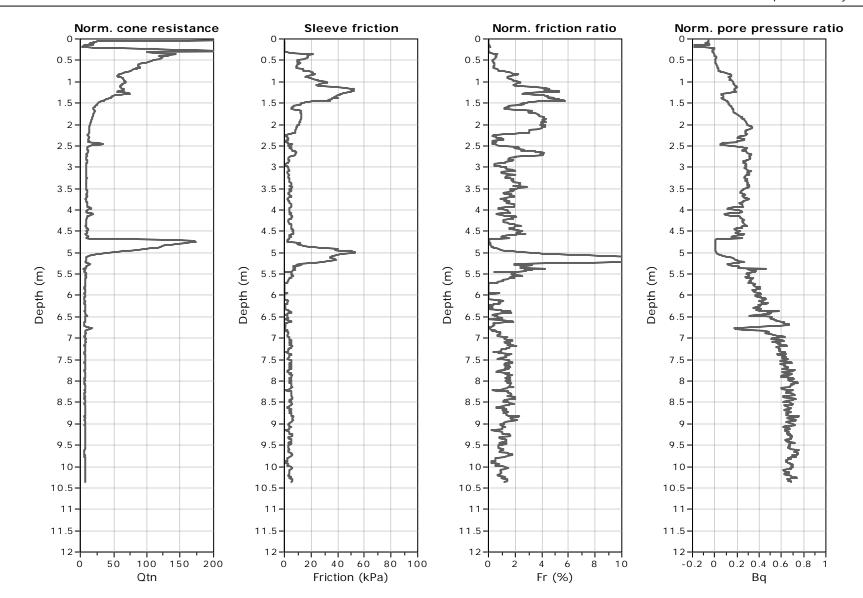
8 10

Golder Associates Ltd. www.golder.com Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

CPT17-30_RevA

Total depth: 10.36 m, Date: 04/01/2018 Cone Type: I-CFXYP20-10 171029 Cone Operator: M. Roy - Stratum CPT

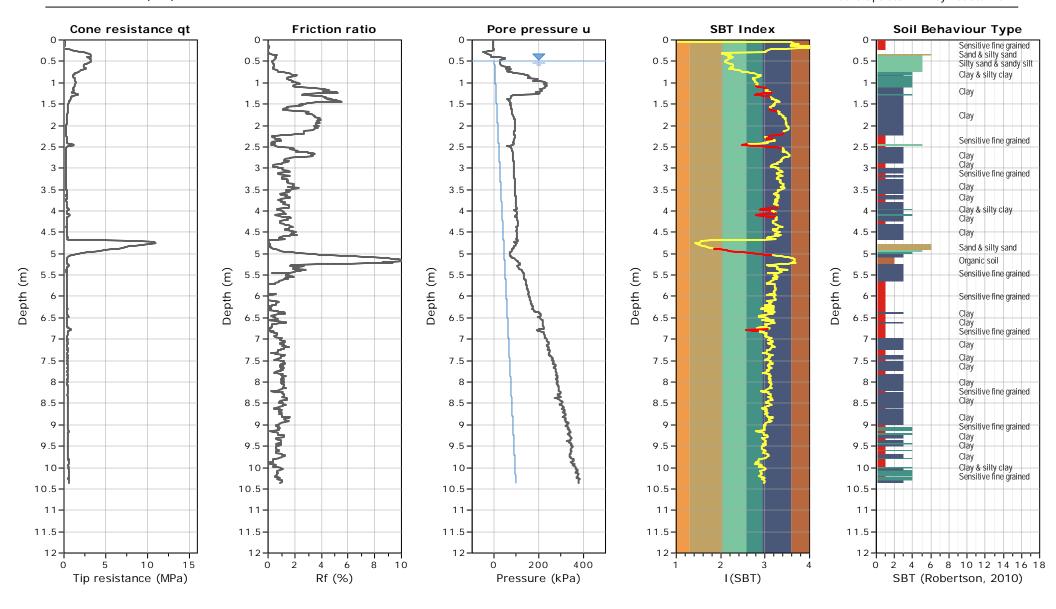


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:05 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt



Location: Ottawa, ON, Canada

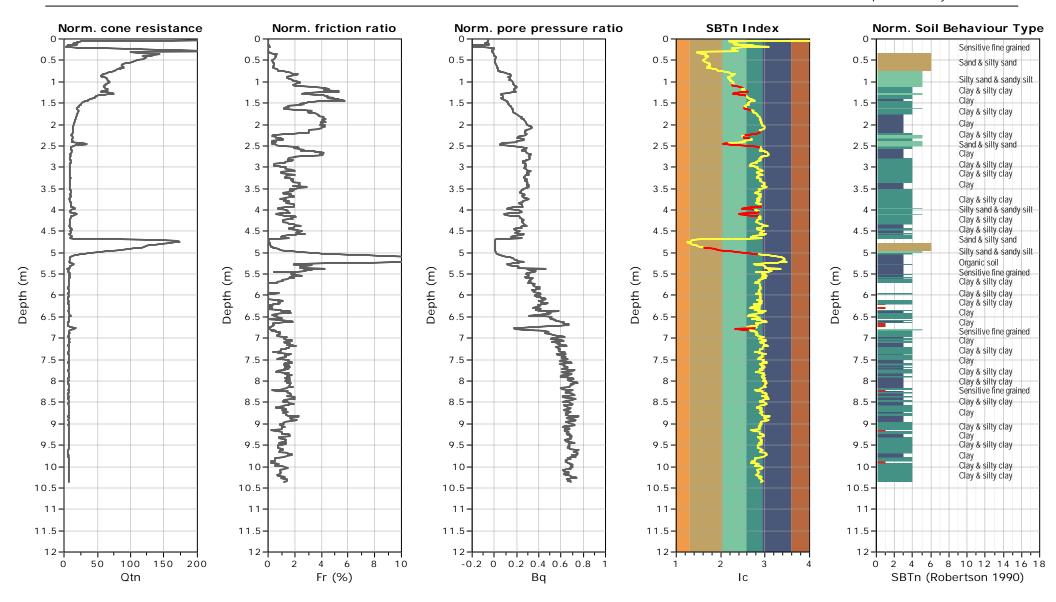
CPT17-30_RevA





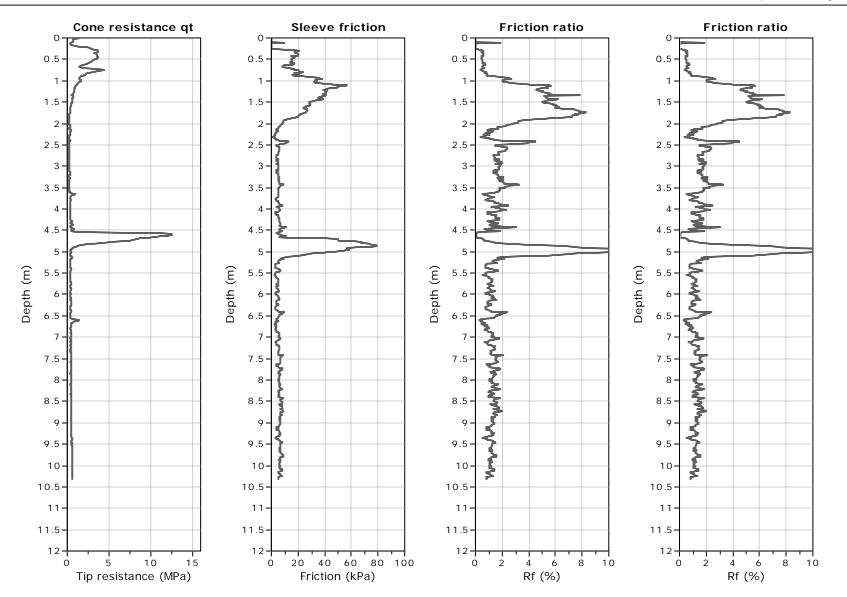
Location: Ottawa, ON, Canada

CPT17-30_RevA



Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada



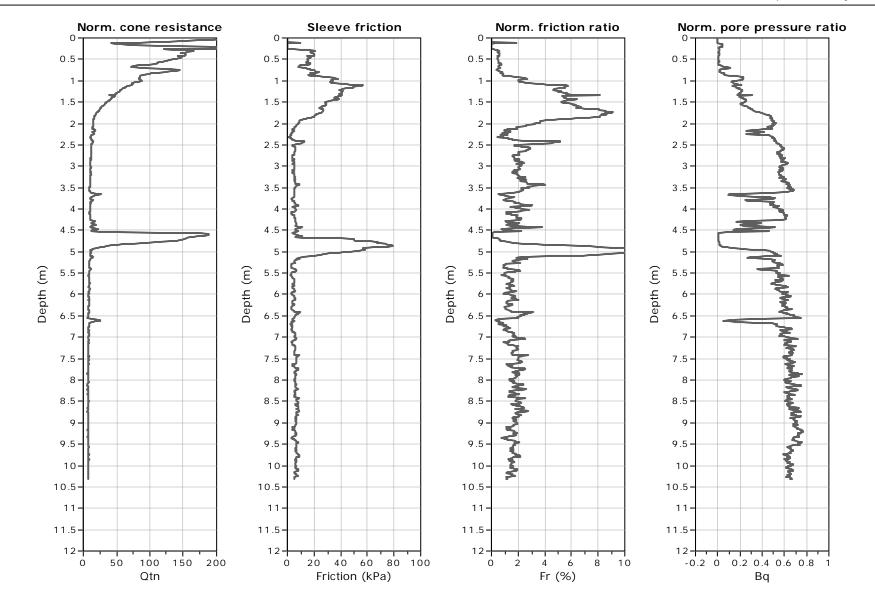
CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:06 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt

CPT17-31_RevA

Project: CRRRC - 1787048-400-4.4

Location: Ottawa, ON, Canada

CPT17-31_RevA

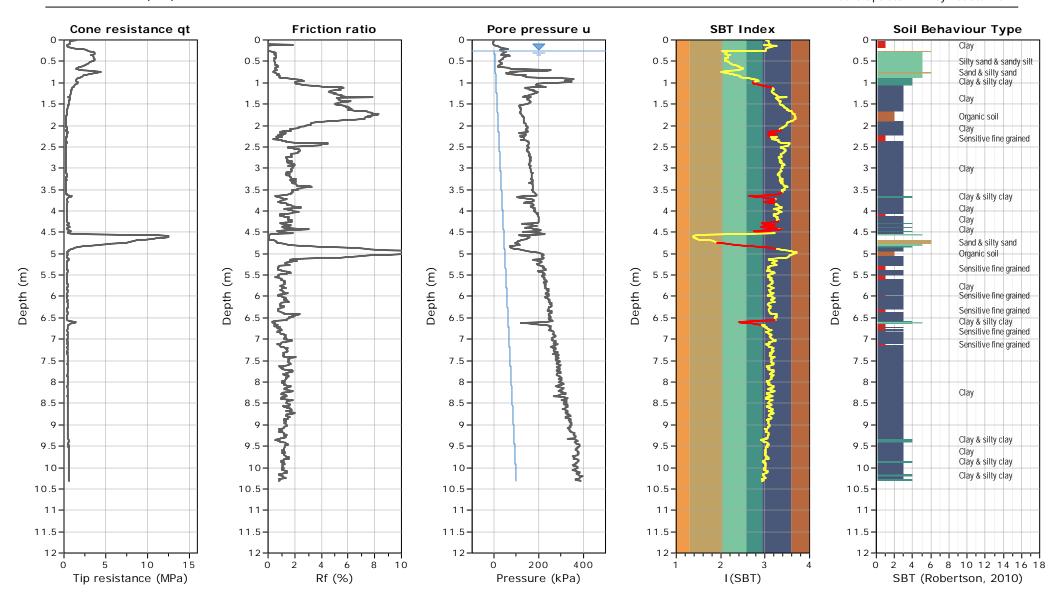


CPeT-IT v.2.0.1.12 - CPTU data presentation & interpretation software - Report created on: 26/01/2018, 3:41:06 PM Project file: C:\Users\JBrunswickwerner\Desktop\Ottawa CPT\CRRRC_Ottawa_20JAN2018.cpt



Location: Ottawa, ON, Canada

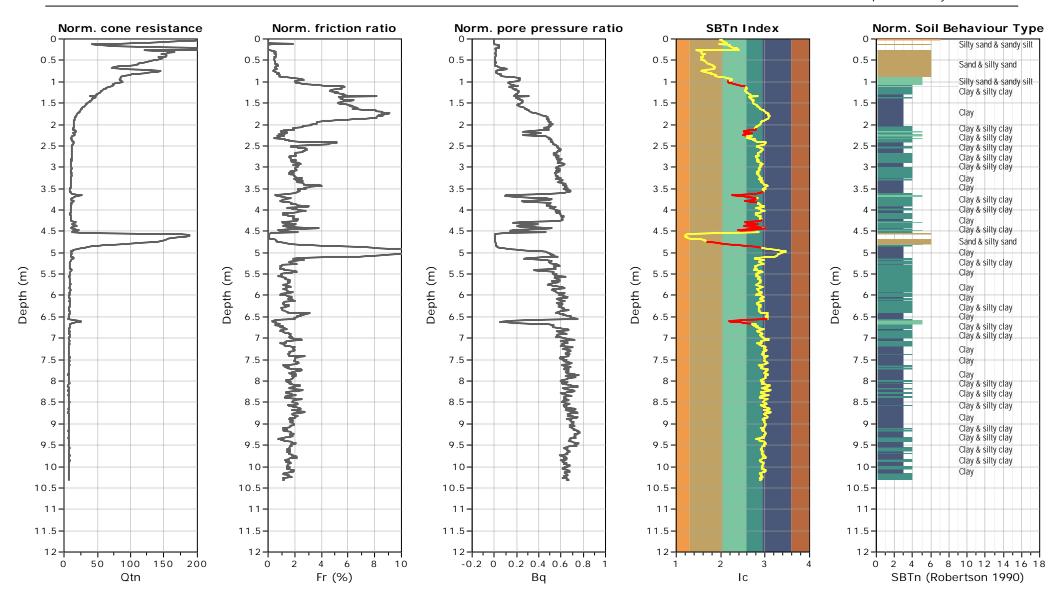
CPT17-31_RevA





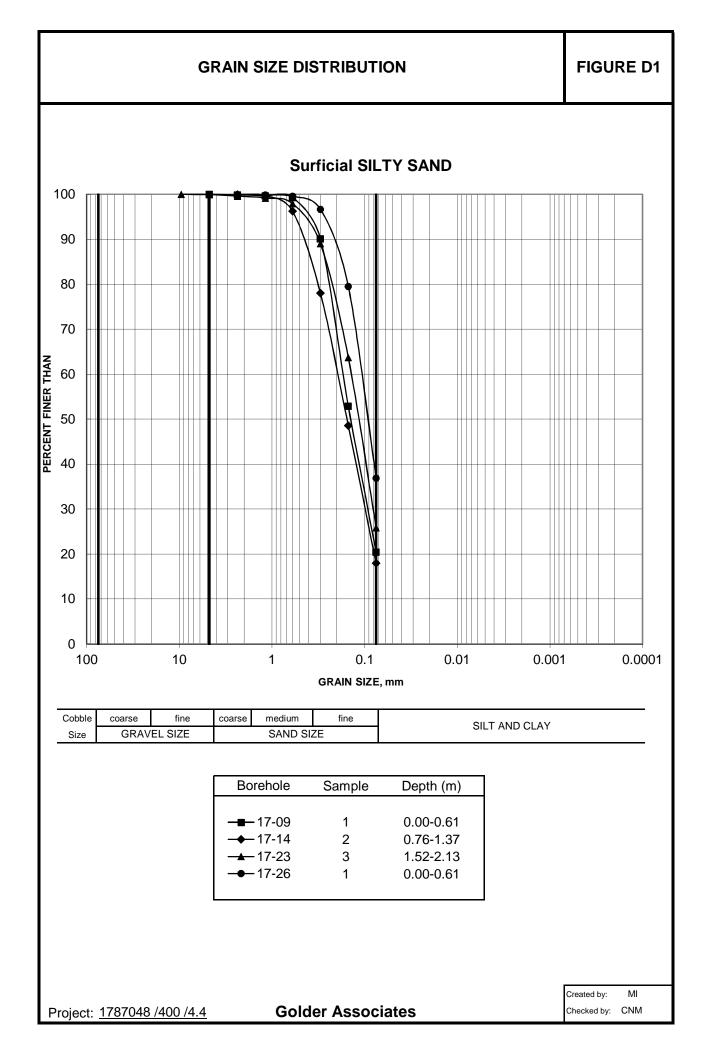
Location: Ottawa, ON, Canada

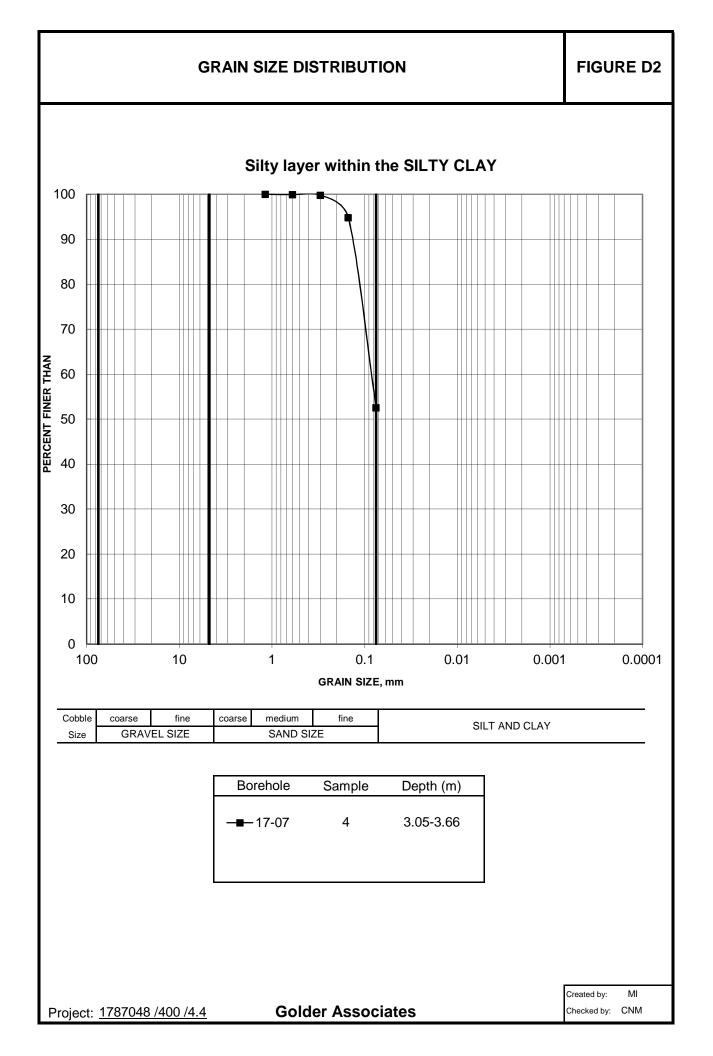
CPT17-31_RevA

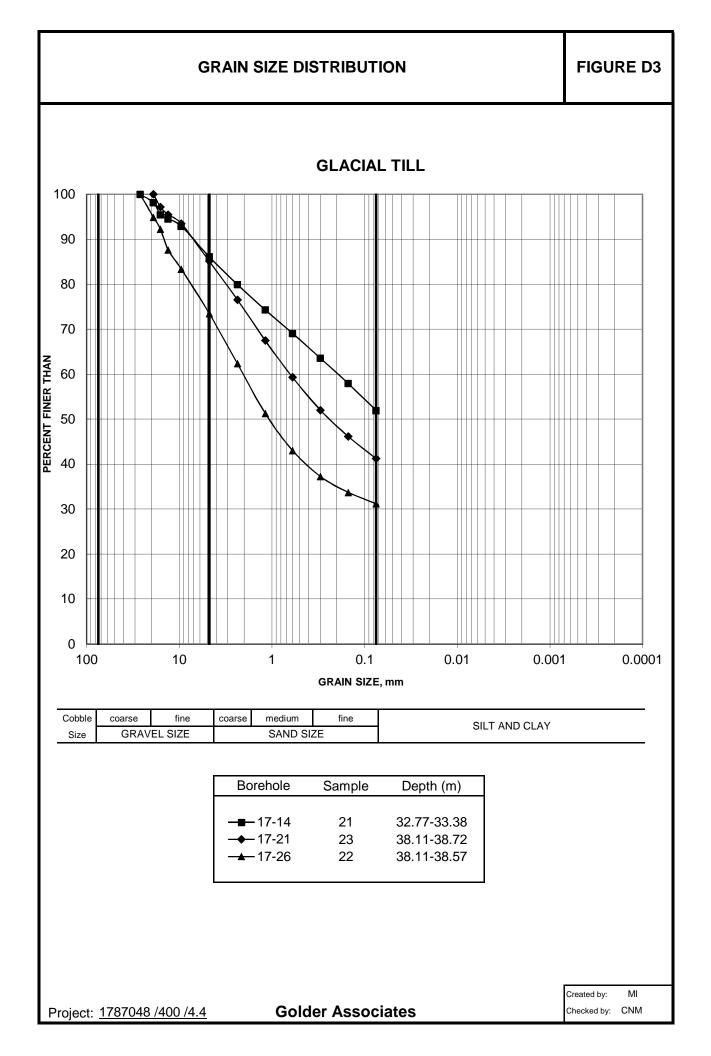


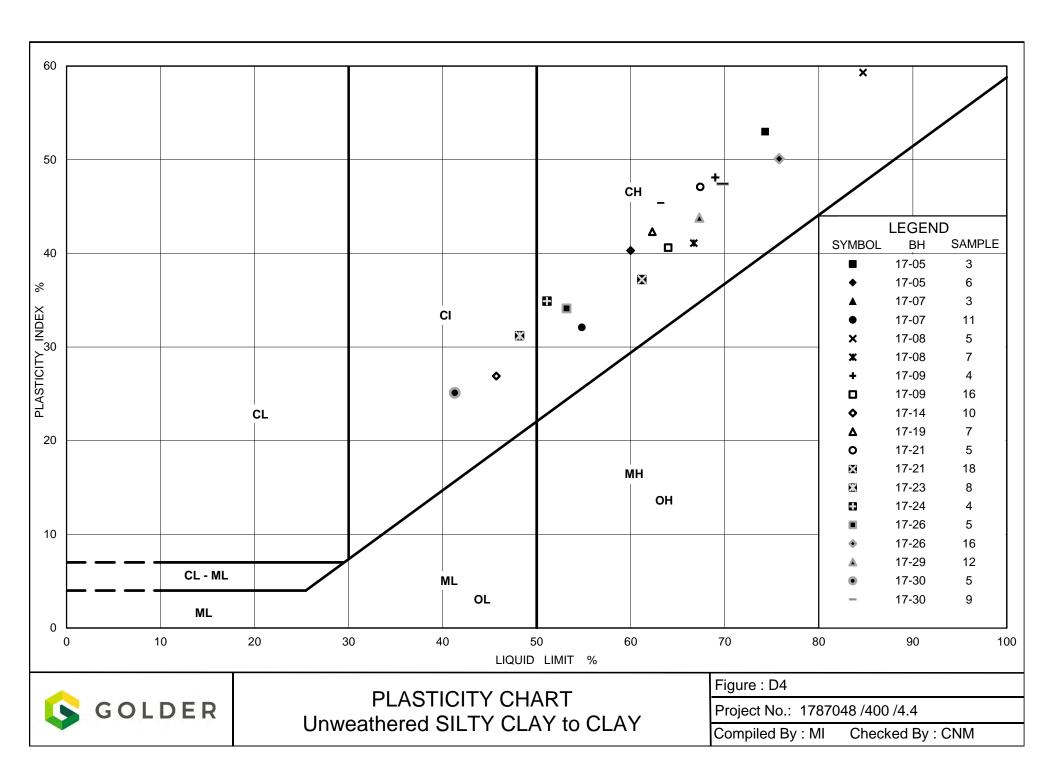
APPENDIX D

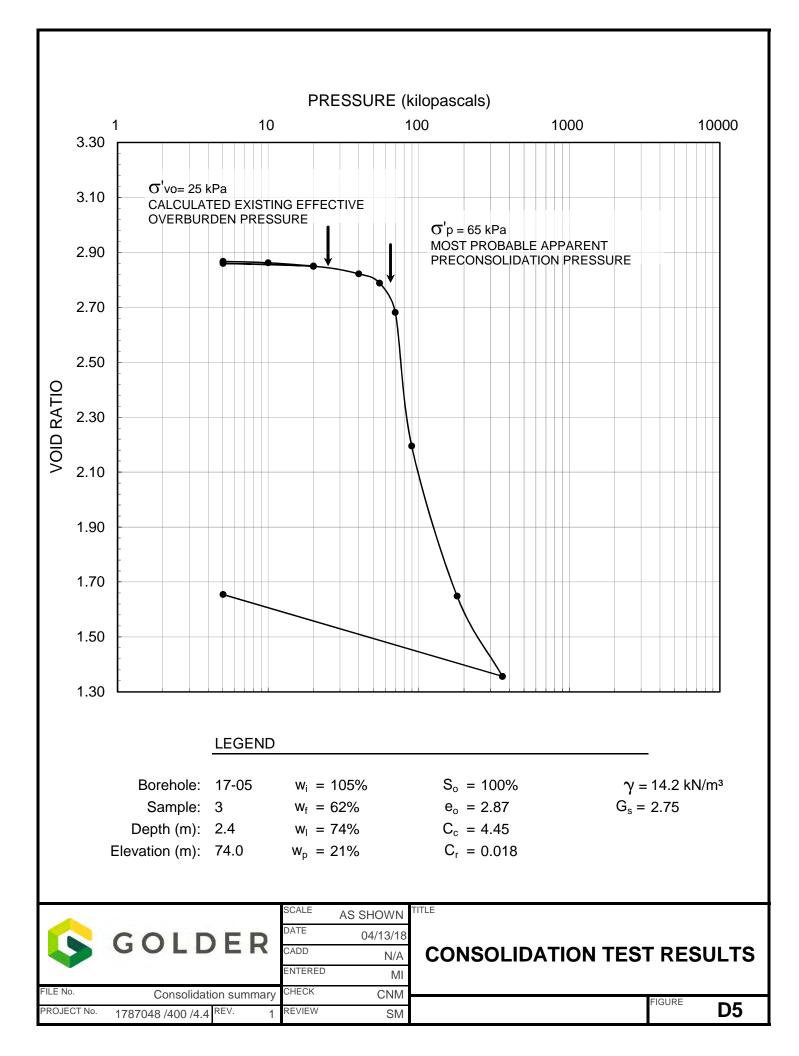
Laboratory Testing Results on Soil Samples and Bedrock Cores

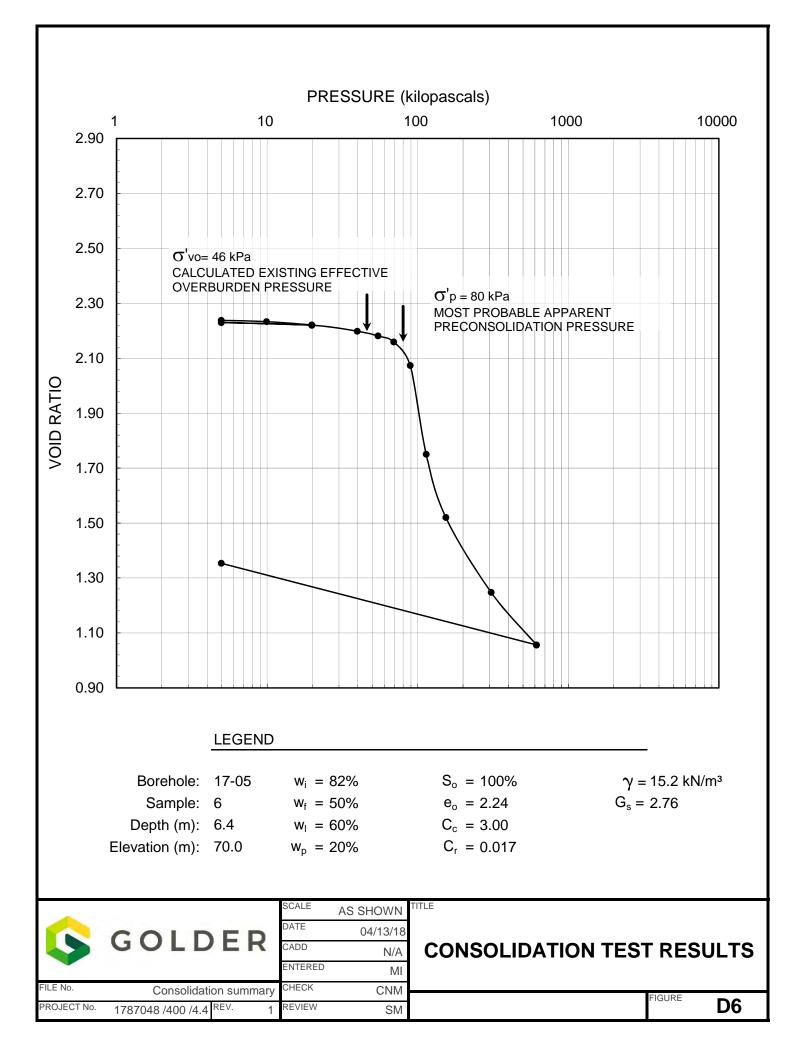


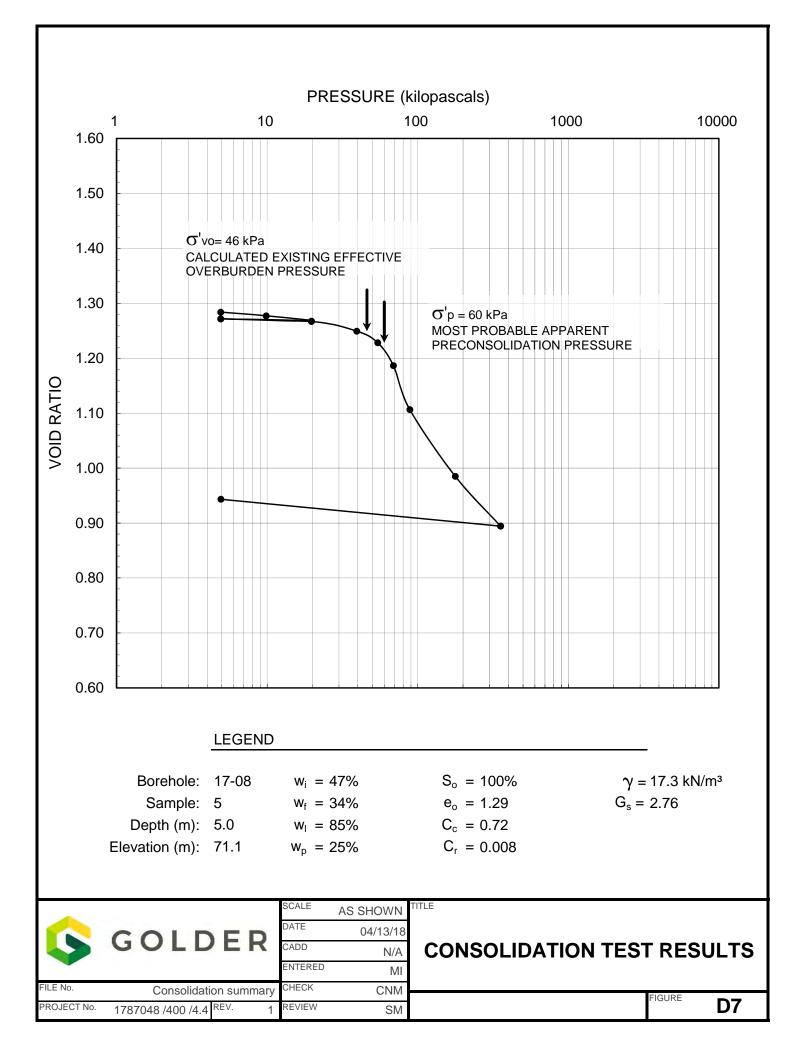


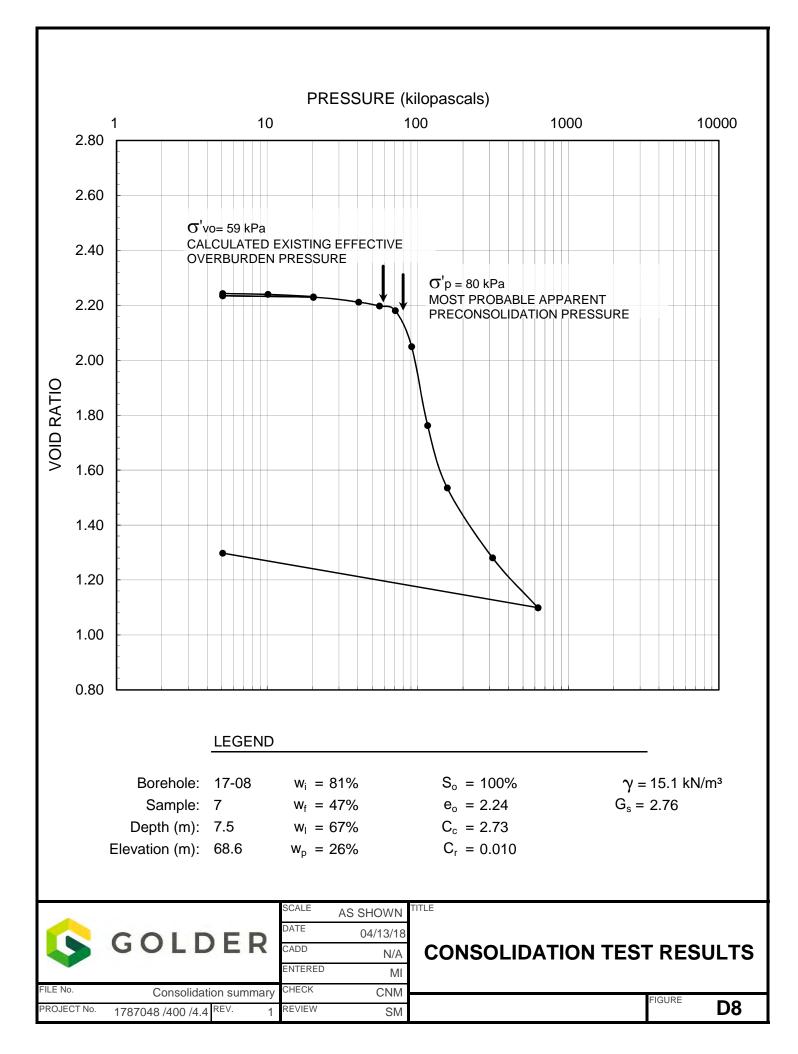


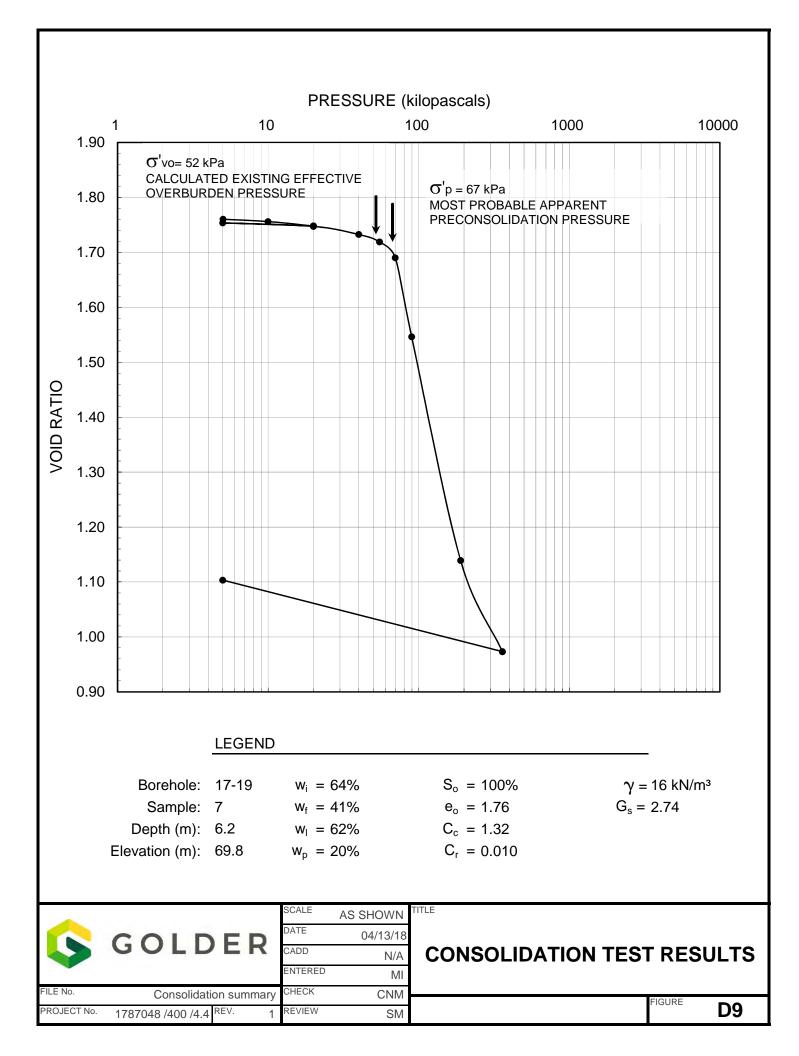


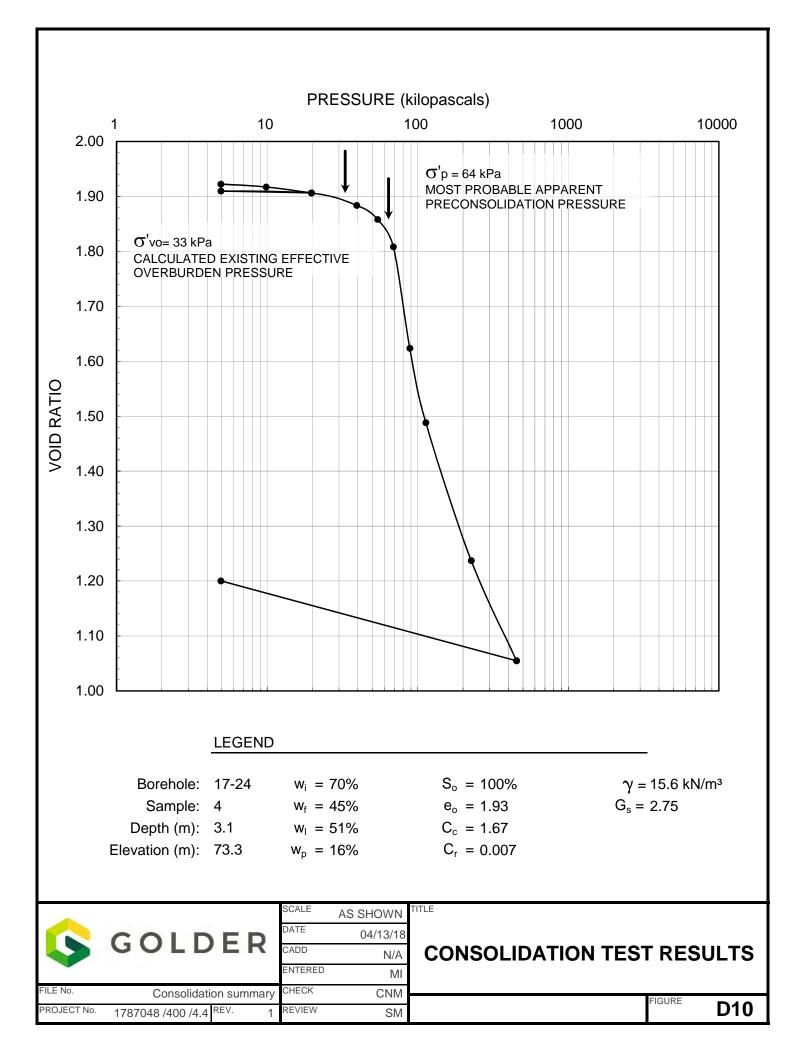


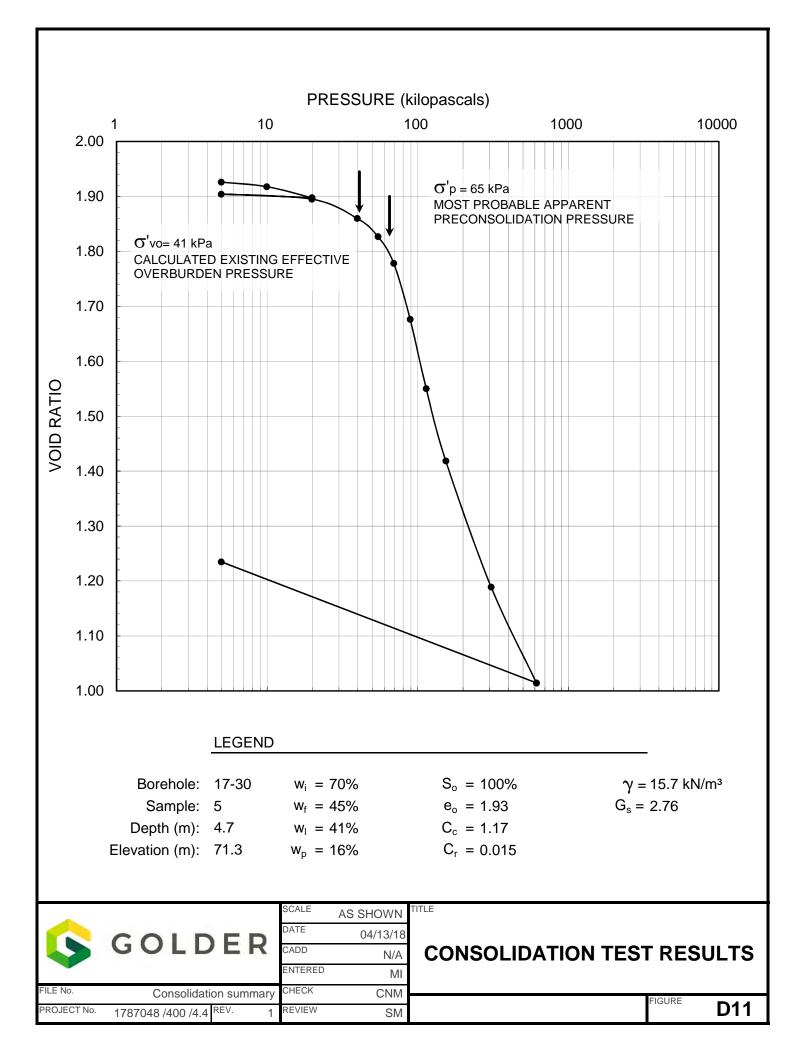


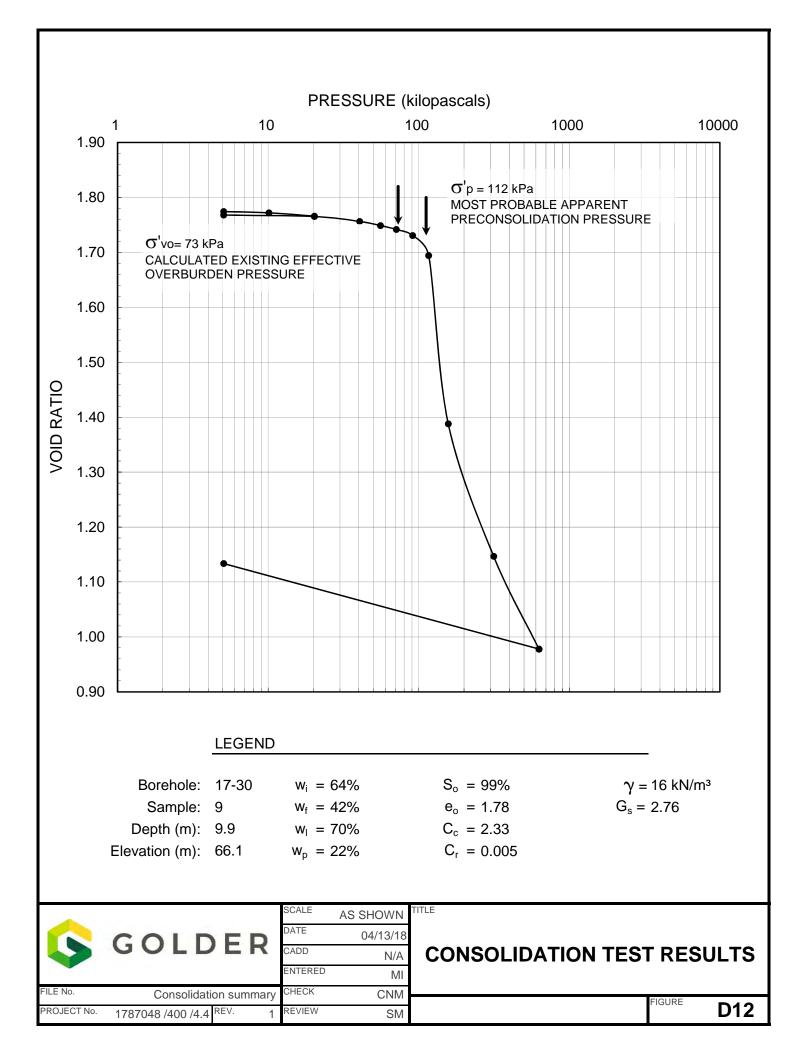












Golder Associates Ltd. 1931 Robertson Road Ottawa, Ontario K2H 5B7



UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORE

Project: CRRRC - Post EA Approval Activities

Project No.: 1787048 /400 /4.4

Date: March 9, 2018

Location(s): See Table Below

Bore Hole No.	Depth (m)	Date Tested	Core Size	Diameter (mm)	Density (kg/m³)	Compressive Strength (MPa)	Failure Mode
17-07	31.06-31.24	Mar 1/18	HQ	60.6	2675	135.8	
17-14	35.72-35.94	Mar 1/18	HQ	60.8	2677	110.9	
17-21	42.69-42.85	Mar 1/18	HQ	60.9	2713	97.4	
17-23	37.82-38.00	Mar 1/18	HQ	60.6	2676	229.3	

REMARKS : - Cores tested in vertical direction.

- Cores tested in air-dry condition.
- Specimen ends prepared with high-strength plaster, but un-restrained.
- L/D ratio's between 2.2:1 and 2.5:1
- Time to failure > 2 and < 15 minutes.

TESTING WAS CARRIED OUT IN GENERAL ACCORDANCE WITH ASTM D7012 - Method C

SIGNED:

C.N.Mangione P.Eng.

APPENDIX E

Results of Chemical Analyses



Certificate of Analysis

Environment Testing

Client:	Golder Associates Ltd. (Ottawa)
	1931 Robertson Road
	Ottawa, ON
	K2H 5B7
Attention:	Ms. Susan Trickey
PO#:	
Invoice to:	Golder Associates Ltd. (Ottawa)

🛟 eurofins

Report Number:	1802569
Date Submitted:	2018-02-22
Date Reported:	2018-02-27
Project:	1787048
COC #:	188724

				Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.	1346173 Soil 2018-01-30 17-7 Sa18/85-87	1346174 Soil 2018-02-08 17-26 Sa2/2.5-4.5	1346175 Soil 2018-02-08 17-29 Sa3/10-12	1346176 Soil 2018-02-08 17-29 Sa20/115-117
Group	Analyte	MRL	Units	Guideline				
Agri Soil	рН	2.00			8.76	8.84	8.58	8.98
	SO4	0.01	%		0.09	<0.01	0.01	0.04
General Chemistry	Cl	0.002	%		0.015	<0.002	0.018	0.157
	Electrical Conductivity	0.05	mS/cm		1.23	0.08	<0.05	0.17
	Resistivity	1	ohm-cm		813	12500	20000	5880

Guideline =

* = Guideline Exceedence

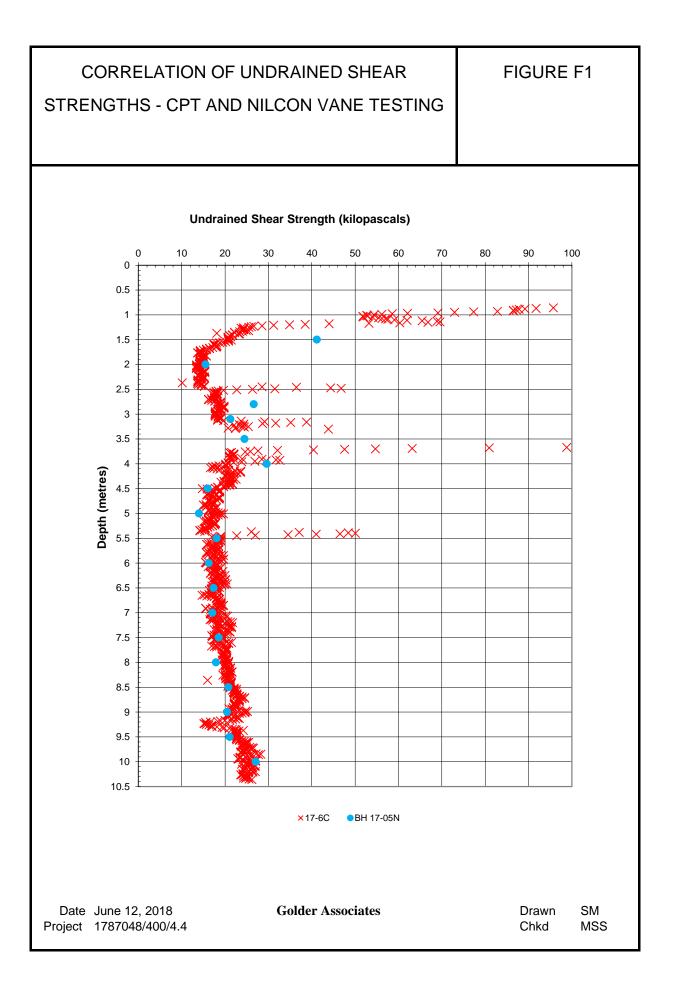
Results relate only to the parameters tested on the samples submitted. Methods references and/or additional QA/QC information available on request.

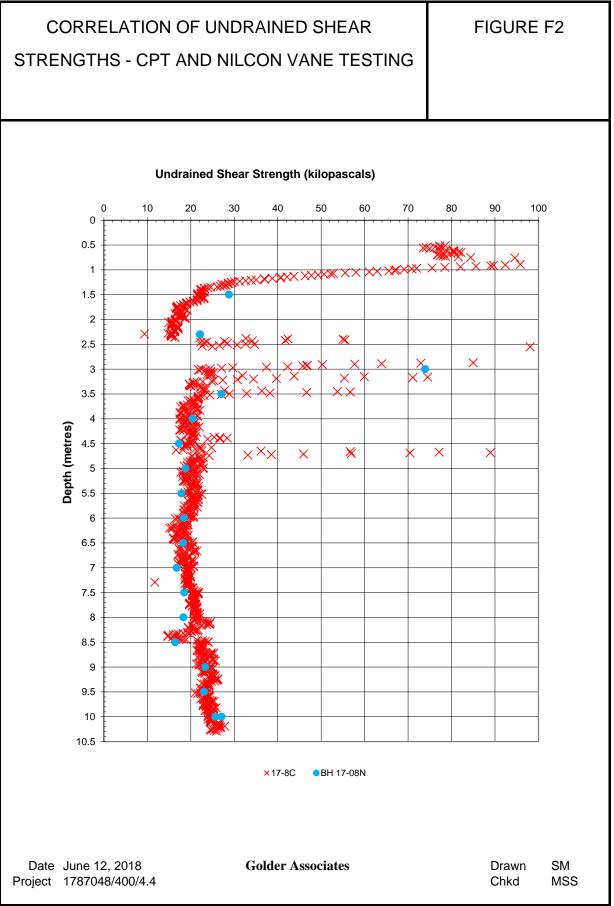
MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

APPENDIX F

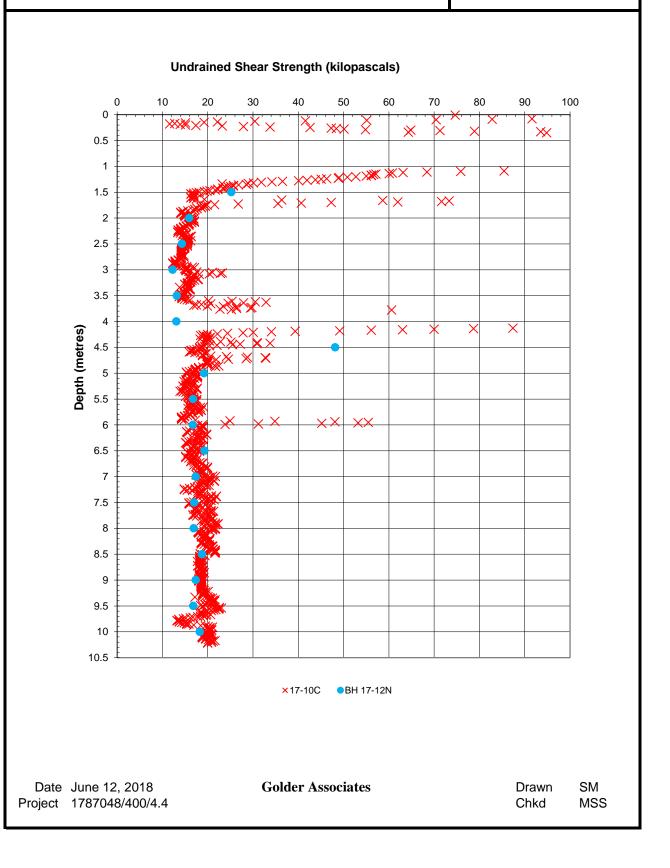
Correlation of Undrained Shear Strengths from CPT and Nilcon Vane Testing

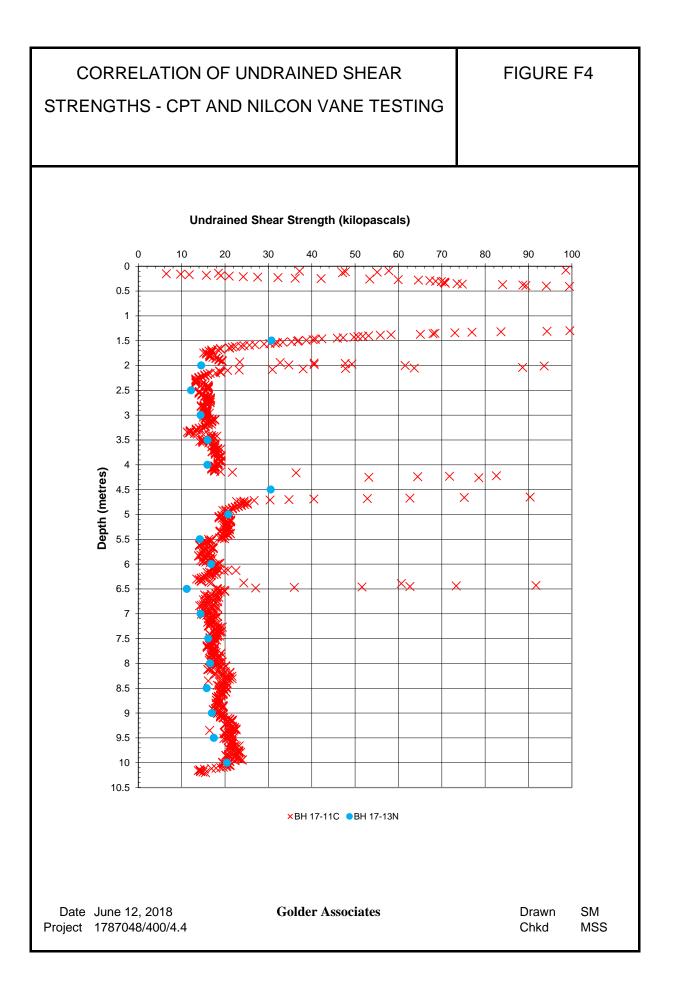


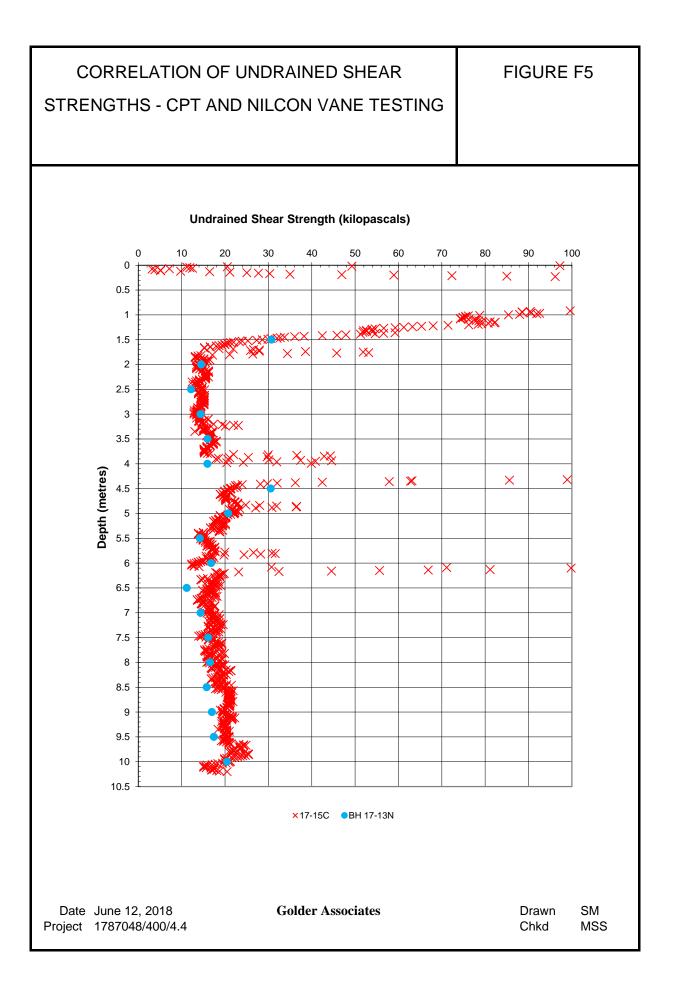


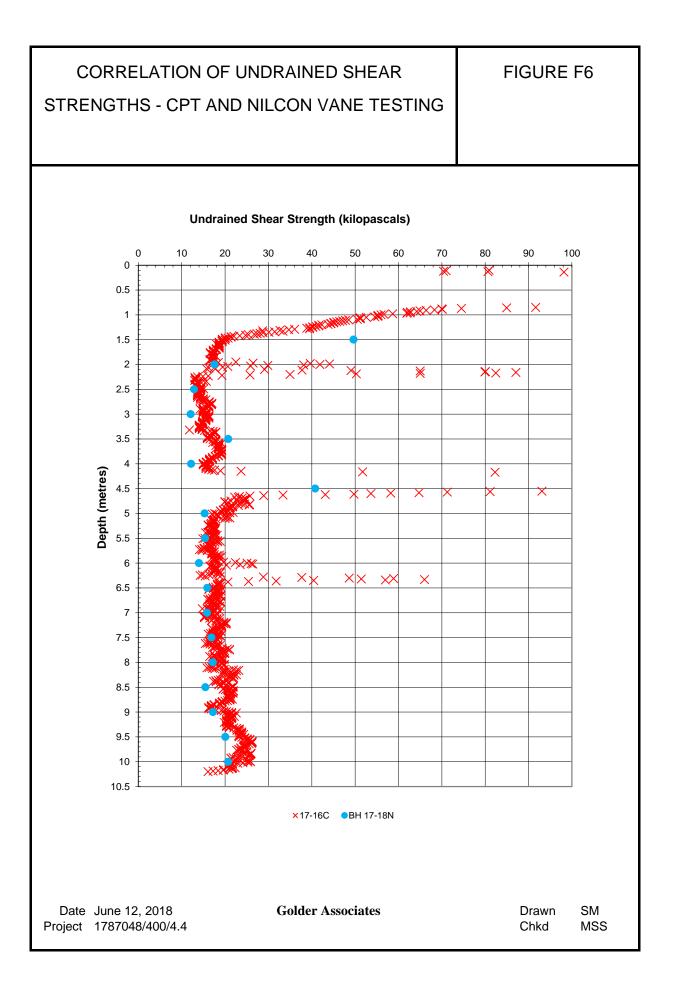


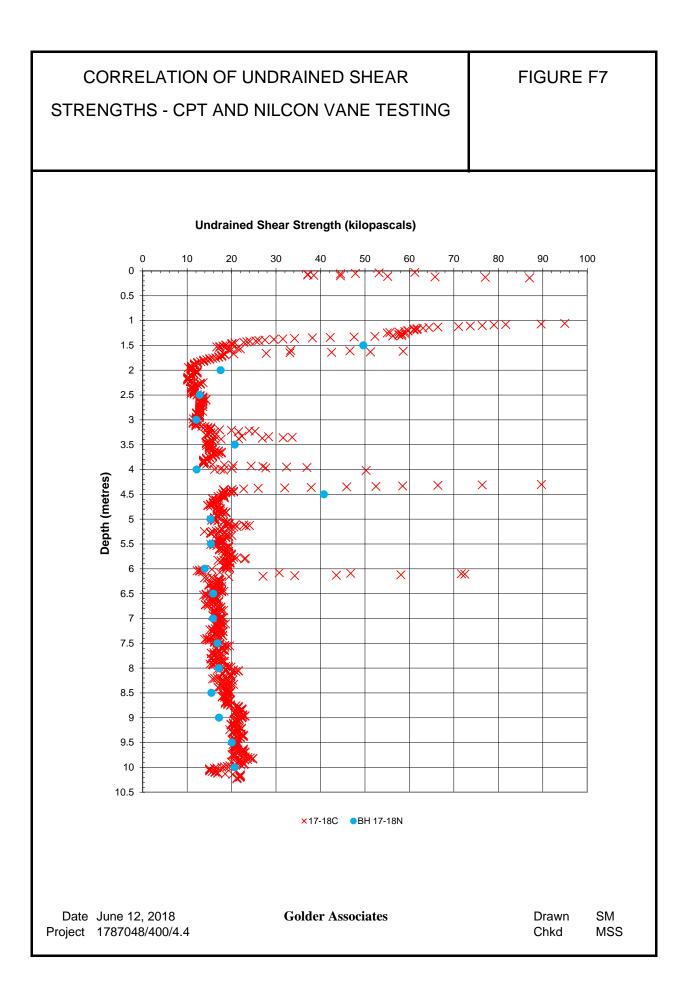
STRENGTHS - CPT AND NILCON VANE TESTING

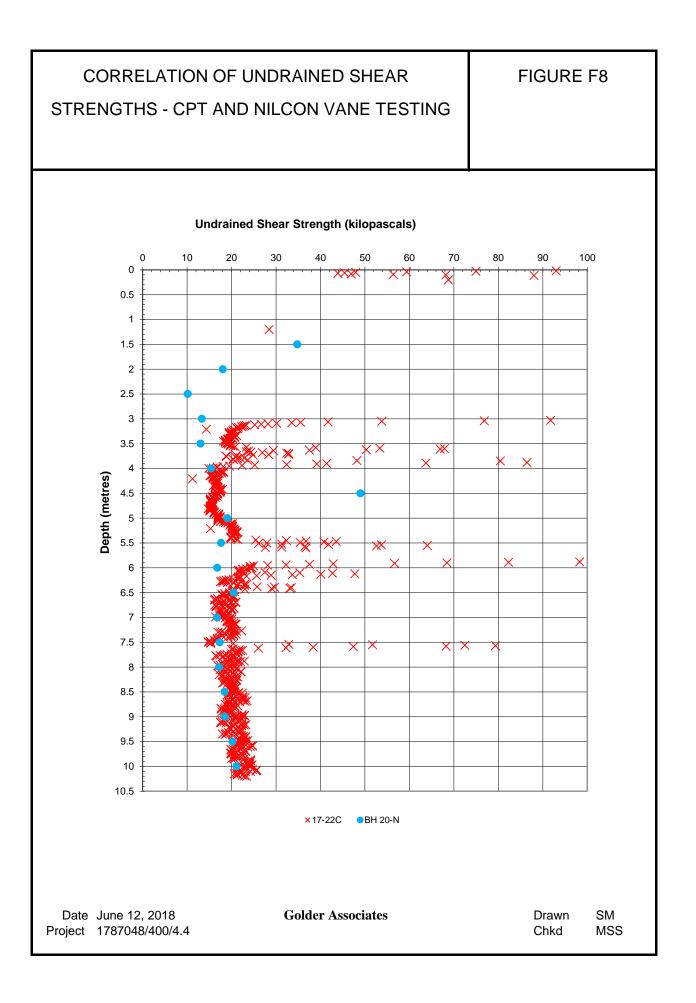


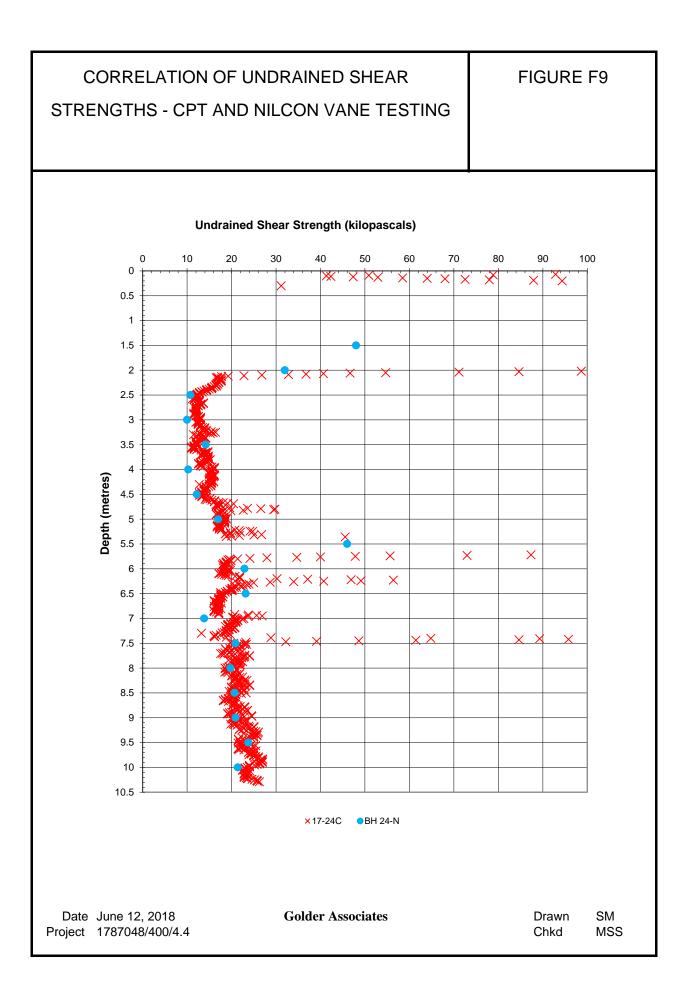


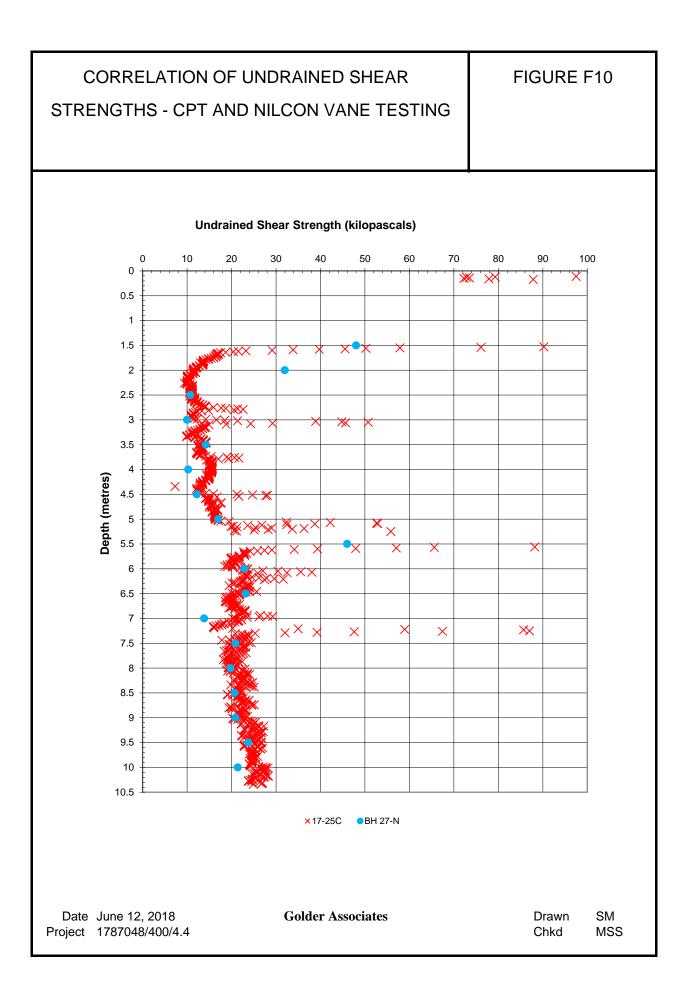


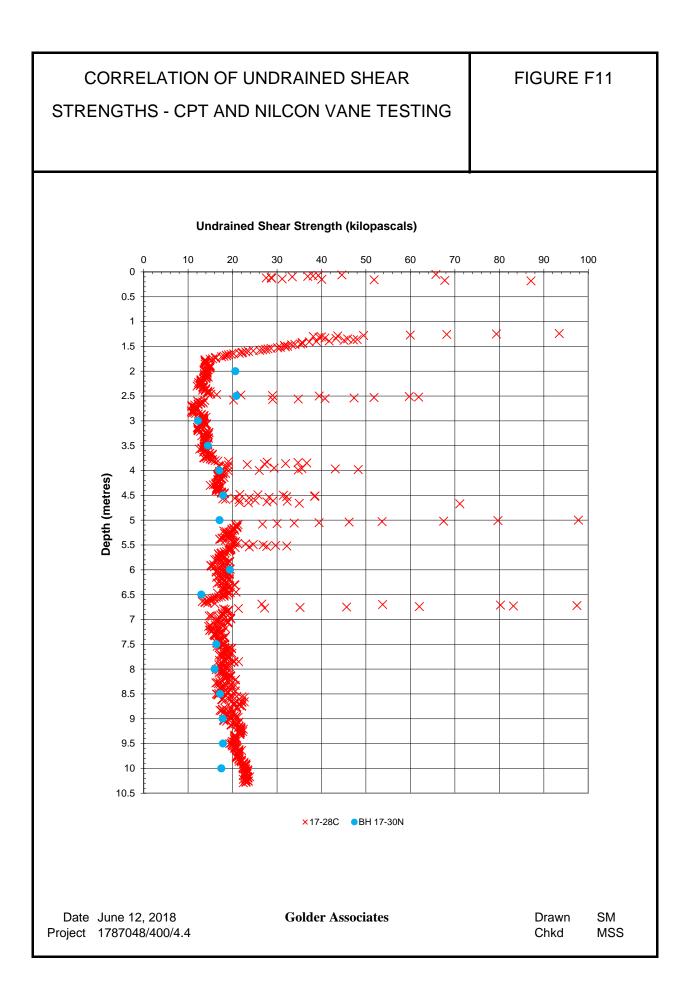


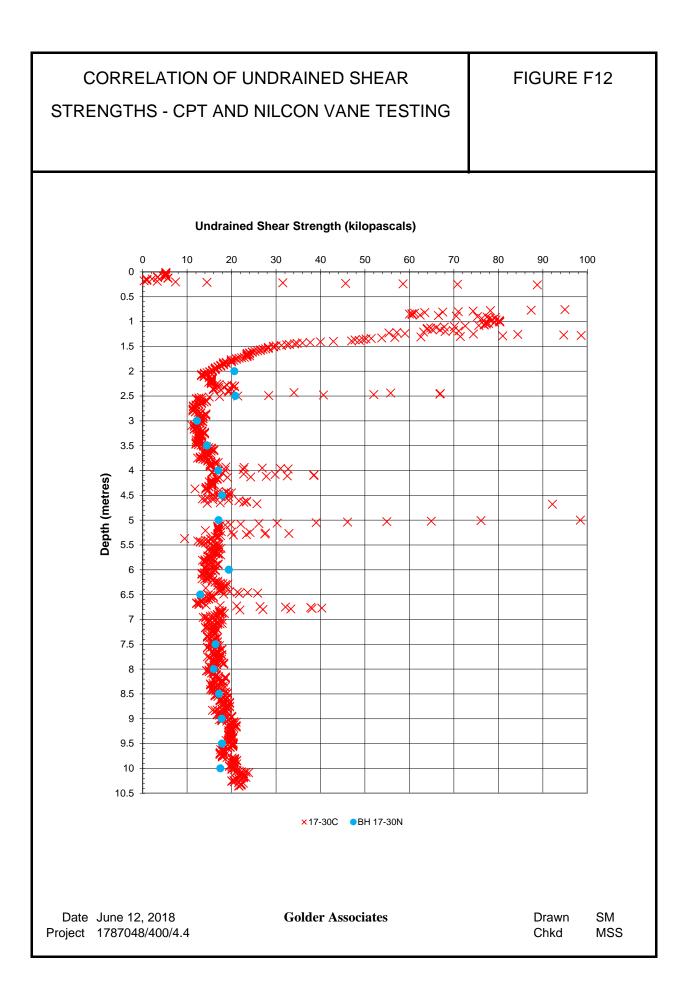


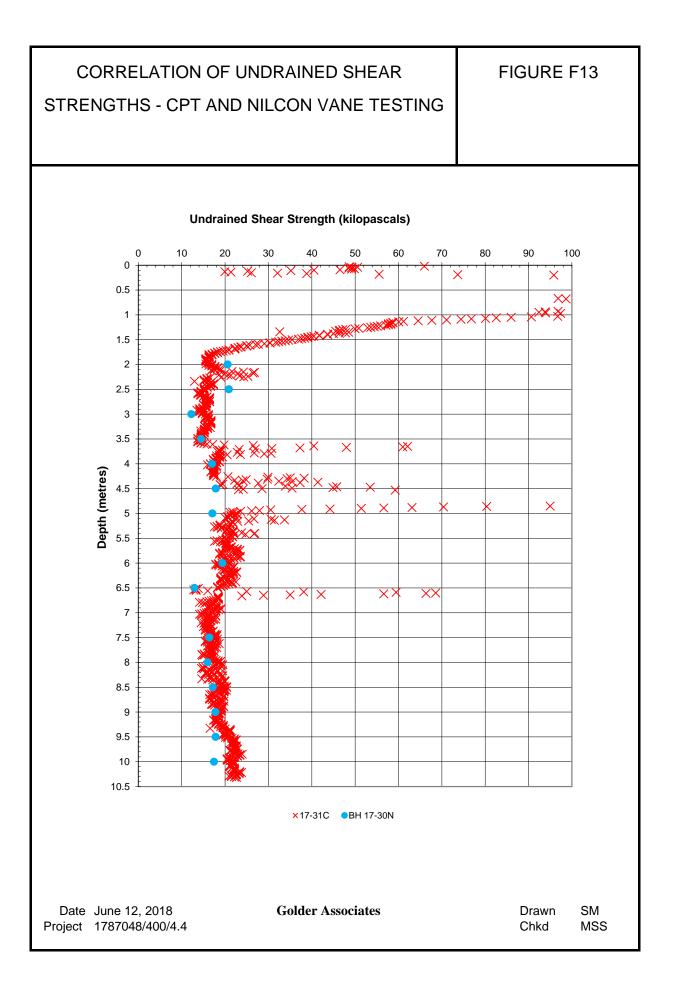












APPENDIX G

Photographs of Bedrock Core Samples



Path: \\golderassociates.sharepoint.com@SSL\DavWWWRoofsites118733g\Deliverables\Phase 400 Tsk 4.4 Report\Reports\Appendix G\17-7 Core Photos Plate.xisx | File: 17-7 Core Phot BH 17-07 (Dry) Cored Length of 29.39 to 32.41 metres Core Box 1 to 1 of 1 29.39 m Top of bedrock 32.41 m * * End of Hole is 32.46 m CLIENT PROJECT TAGGART MILLER ENVIRONMENTAL SERVICES CRRRC SITE CONSULTANT TITLE DD/MM/YYYY 05/04/2018 BOREHOLE 17-07 (DRY) PREPARED SM CORE PHOTOGRAPHS DESIGN SM REVIEW PHASE Rev. PROJECT No. FIGURE APPROVED G1 MSS 1787048 400/4.4 0

BH 17-07 (Wet) Cored Length of 29.39 to 32.41 metres Core Box 1 to 1 of 1

29.39 m Top of bedrock



32.41 m *

* End of Hole is 32.46 m

	GART MILLER ENVIRON	MENTAL SER	VICES	PROJECT CRRRC SITE			
CONSU	ILTANT	DD/MM/YYYY	05/04/2018	TITLE			
-		PREPARED	SM	BOREHOLE CORE PHOT			
	GOLDER	DESIGN	SM		OGINALITS		
5	GOLDER	REVIEW		PROJECT No.	PHASE	Rev.	FIGURE
		APPROVED	MSS	1787048	400/4 4	0	G2

BH 17-09 (Dry) Cored Length of 30.01 to 32.86 metres Core Box 1 to 1 of 2 30.01 m Top of bedrock 32.86 m CLIENT PROJECT TAGGART MILLER ENVIRONMENTAL SERVICES CRRRC SITE CONSULTANT TITLE DD/MM/YYYY 05/04/2018 BOREHOLE 17-09 (DRY) PREPARED SM **CORE PHOTOGRAPHS** DESIGN SM REVIEW PROJECT No. PHASE FIGURE Rev. APPROVED G3 MSS 1787048 400/4.4 0

BH 17-09 (Dry) Cored Length of 32.86 to 33.14 metres Core Box 2 to 2 of 2

32.86 m



TAGGART MILLER ENVIRONM	VICES	PROJECT CRRRC SITE	E			
CONSULTANT	DD/MM/YYYY	05/04/2018				
	PREPARED	SM	— BOREHOLE — CORE PHOT	· · ·		
SOLDER.	DESIGN	SM		OGINALING		
JOULDER	REVIEW		PROJECT No.	PHASE	Rev.	FI
	APPROVED	MSS	1787048	400/4.4	0	

BH 17-09 (Wet) Cored Length of 30.01 to 32.86 metres Core Box 1 to 1 of 2

30.01 m Top of bedrock



32.86 m

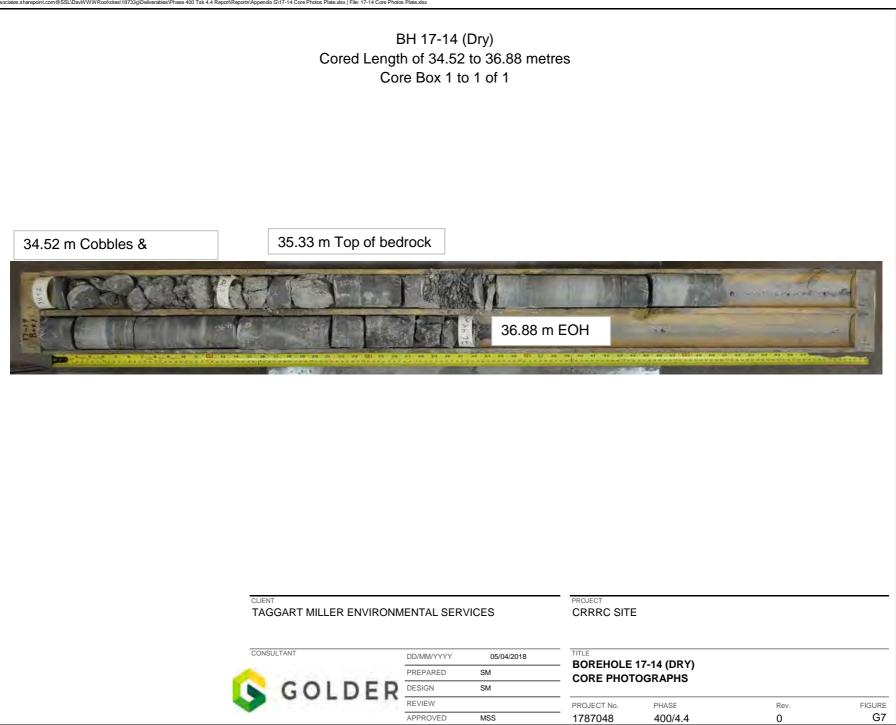
	ग GGART MILLER ENVIRONM	PROJECT CRRRC SITE	1				
CONS	SULTANT	DD/MM/YYYY	05/04/2018		17-00 (W/ET)		
		PREPARED	SM	CORE PHOT	· · ·		
	COLDED	DESIGN	SM		OGINALITS		
6	GOLDER	REVIEW		PROJECT No.	PHASE	Rev.	FIGURE
		APPROVED	MSS	1787048	400/4.4	0	G5

BH 17-09 (Wet) Cored Length of 32.86 to 33.14 metres Core Box 2 to 2 of 2





	GART MILLER ENVIRONM	PROJECT CRRRC SITE	Ē				
CONSI	ULTANT	DD/MM/YYYY	05/04/2018		47.00 (MET)		
-		PREPARED	SM	BOREHOLE CORE PHOT	· ·		
~	COLDED	DESIGN	SM		UGINALIIS		
5	GOLDER	REVIEW		PROJECT No.	PHASE	Rev.	FIGURE
		APPROVED	MSS	1787048	400/4.4	0	G6





	Cored	BH 17-17 (Dry) I Length of 35.05 to 38.47 m Core Box 1 to 2 of 2	netres	
35.05 m Top of bedrock				
	CLIENT TAGGART MILLER EN	NVIRONMENTAL SERVICES	PROJECT CRRRC SITE TITLE BOREHOLE 17-17 (DRY)	

Path: \\golderassociates.sharepoint.com@SSL\DavWWWRoot\sites\18733g\Deliverables\Phase 400 Tsk 4.4 Report\Reports\Appendix G\17-17 Core Photos Plate.xlsx | File: 17-17 Core Photos Plate.xlsx

=_--_ . _ 1



BH 17-21 (Dry) Cored Length of 40.48 to 43.41 metres Core Box 1 to 1 of 1

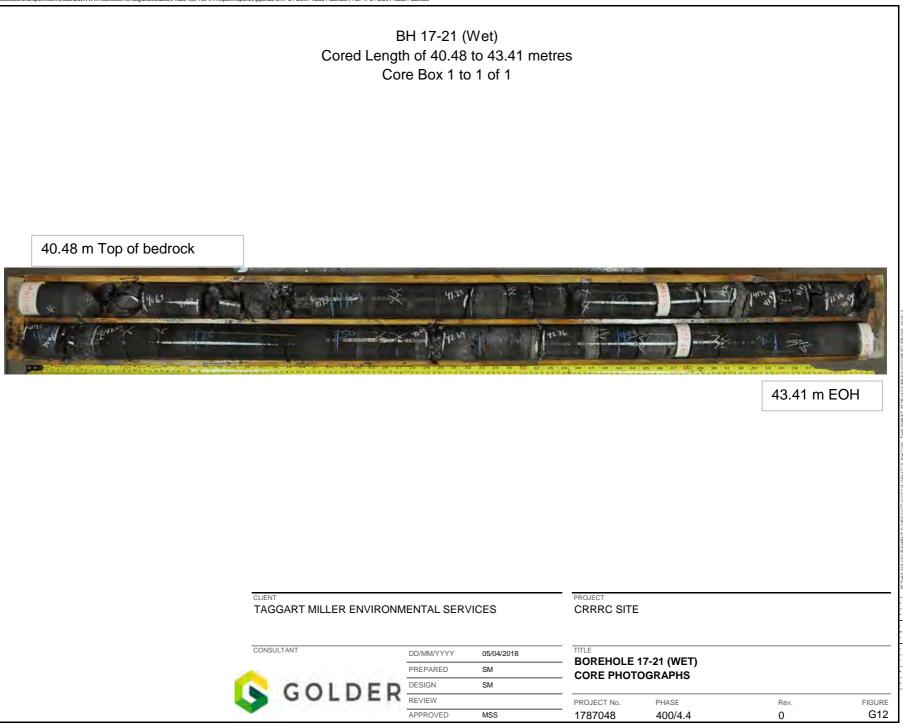
40.48 m Top of bedrock



43.41 m EOH

FIGURE

	GART MILLER ENVIRONI	MENTAL SER	PROJECT CRRRC SITE			
CONS	JLTANT	DD/MM/YYYY	05/04/2018	TITLE BOREHOLE	17-21 (DRV)	
-		PREPARED	SM	CORE PHOT	· · ·	
	GOLDER	DESIGN	SM		ooka no	
	OOLDLIN	REVIEW		PROJECT No.	PHASE	Rev.
		APPROVED	MSS	1787048	400/4.4	0



BH 17-23 (Dry) Cored Length of 37.49 to 39.92 metres Core Box 1 to 1 of 1

37.49 m Top of bedrock



39.92 m EOH

CLIENT TAGGART MILLER ENVIRONM	IENTAL SER	VICES	PROJECT CRRRC SITE	E		
CONSULTANT	DD/MM/YYYY	05/04/2018		47.00 (DDV)		
12.42	PREPARED	SM	 BOREHOLE 17-23 (DRY) CORE PHOTOGRAPHS 			
GOLDER	DESIGN	SM		OGINALITS		
COLDER	REVIEW		PROJECT No.	PHASE	Rev.	FIGUF
	APPROVED	MSS	1787048	400/4.4	0	G1:

BH 17-23 (Wet) Cored Length of 37.49 to 39.92 metres Core Box 1 to 1 of 1 37.49 m Top of bedrock 1.4 41814 Series managements 39.92 m EOH CLIENT PROJECT TAGGART MILLER ENVIRONMENTAL SERVICES CRRRC SITE CONSULTANT TITLE DD/MM/YYYY 05/04/2018 BOREHOLE 17-23 (WET) PREPARED SM **CORE PHOTOGRAPHS** DESIGN SM R E GO REVIEW

APPROVED

MSS

PROJECT No.

1787048

PHASE

400/4.4

FIGURE

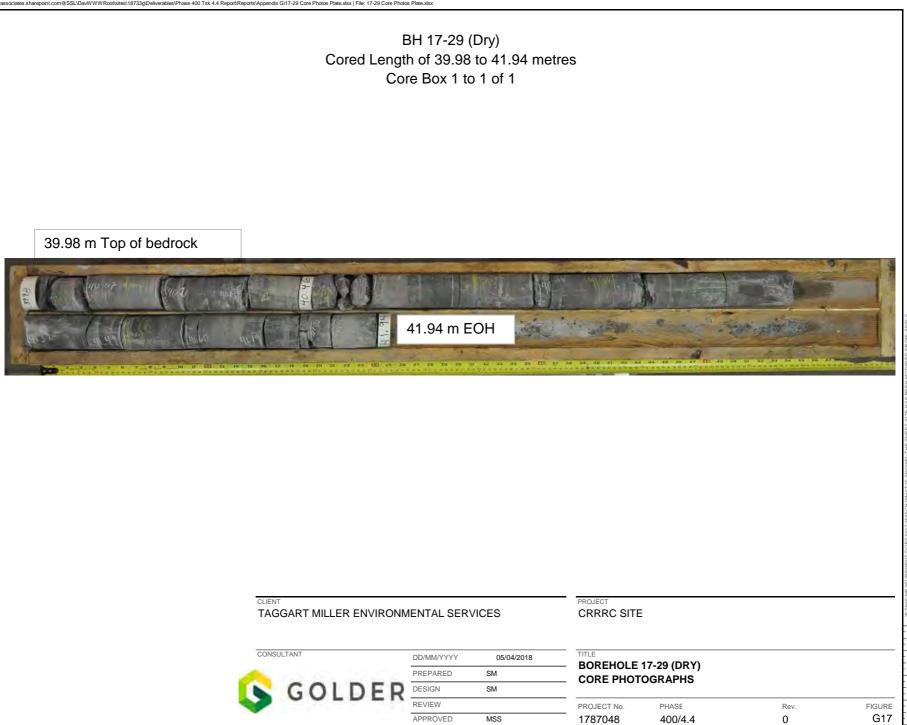
G14

Rev.

0









APPENDIX H

Technical Memorandum – Results of VSP Testing





TECHNICAL MEMORANDUM

DATE March 2013

PROJECT No. 12-1125-0045

VSP TEST RESULTS – CRRRC SITE, OTTAWA, ONTARIO

This memorandum presents the results of the vertical seismic profile (VSP) testing performed at the Capital Region Resource Recovery Centre (CRRRC) Site (Site) located in the eastern portion of the City of Ottawa. VSP testing was completed in BH-12-2-3 and BH-12-3-3 on February 20 and 21, 2013. Both boreholes were cased with a PVC pipe grouted in place, which extended above ground surface. Borehole BH-12-2-3 consists of about 36.7 metres of overburden overlying limestone bedrock. The overburden consists of approximately 34.6 metres of clay to silty clay overlying about 2.2 metres of sand and silt. Borehole BH-12-3-3 consists of approximately 39.8 metres of overburden overlying shale bedrock. The overburden consists of about 34.1 metres of clay to silty clay overlying about 5.7 metres of sand to sandy silt.

Methodology

For the VSP method, seismic energy is generated at the ground surface by an active seismic source and recorded by a geophone located in a nearby borehole at a known depth (Figure 1). The methodology can be applied using an active seismic source that produces either compression or shear waves. The time required for the energy to travel from the source to the receiver (geophone) provides a measurement of the average compression or shear wave seismic velocity of the medium between the source and the receiver. Data obtained from different geophone depths are used to calculate a detailed vertical seismic velocity profile of the subsurface in the immediate vicinity of the test borehole.

The high resolution results of a VSP survey are often used for earthquake engineering site classification, as per the National Building Code of Canada, 2010.

Field Work

The field work was completed on February 20th and 21st, 2013, by personnel from the Golder Ottawa offices.

Both compression and shear wave seismic sources were measured using a source located in close vicinity to the borehole. The seismic source for the compression wave test consisted of a 9.9 kilogram sledge hammer vertically impacted on a metal plate, located 2 metres from the borehole. The seismic source for the shear wave test consisted of a 3.0 metres long, 150 millimetres by 150 millimetres wooden beam, weighted down by a vehicle and horizontally struck with a 9.9 kilogram sledge hammer on alternate ends of the beam to induce polarized shear waves. The shear sources were located 2 metres from the borehole. Test measurements started at ground surface and were recorded in the borehole with a 3-component receiver spaced at 1-metre intervals below the ground surface, to a maximum depth of the borehole (40.2 metres in borehole BH-12-2-3 and 44.3 metres in borehole BH-12-3-3).



The seismic records collected for each source location were stacked a minimum of ten times to minimize the effects of ambient background seismic noise on the collected data. The data was sampled at 0.020833 millisecond intervals and a total time window of 0.341 seconds was collected for each seismic shot.

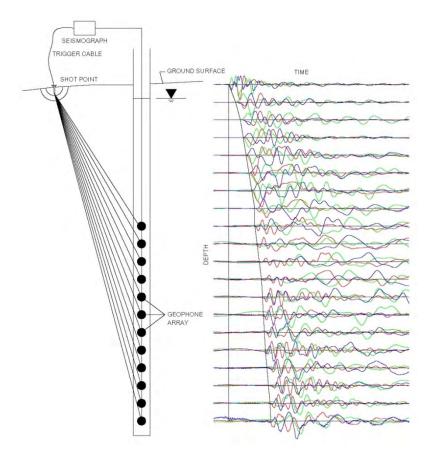


Figure 1: Example of Layout and resulting time traces from a VSP survey

Data Processing

Processing of the VSP test results consisted of the following main steps:

- 1) Combination of seismic records to present seismic traces for all depth intervals on a single plot for each seismic source and for each component;
- 2) Low Pass Filtering of data to remove spurious high frequency noise;
- 3) First break picking of the compression and shear wave arrivals; and,
- 4) Calculation of the average compression and shear wave velocity to each tested depth interval.

Processing of the VSP data was completed using the SeisImager/SW software package (Geometrics Inc.). The seismic records are presented on the following four plots and show the first break picks of the compression wave and shear wave arrivals for both boreholes overlaid on the seismic waveform traces recorded at the different geophone depths (Figures 2 to 5). The arrivals were picked on the vertical component for the compression source and on the two horizontal components for the shear source.



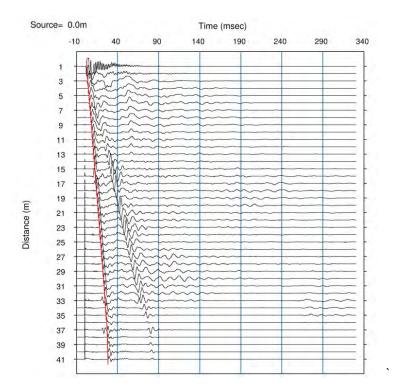


Figure 2: BH-12-2-3, first break picking of compression wave arrivals (red) along the seismic traces recorded at each receiver depth

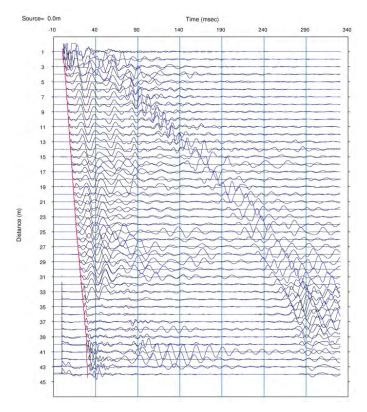


Figure 3: BH-12-3-3, first break picking of compression wave arrivals (red) along the seismic traces recorded at each receiver depth



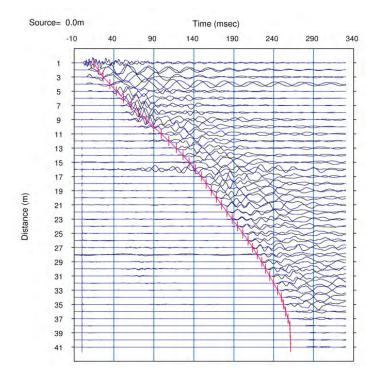


Figure 4: BH-12-2-3, first break picking of shear wave arrivals (red) along the seismic traces recorded at each receiver depth

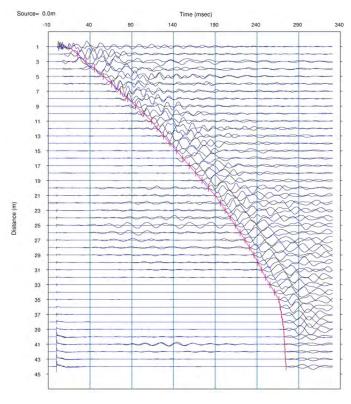


Figure 5: BH-12-3-3, first break picking of shear wave arrivals (red) along the seismic traces recorded at each receiver depth



Results

The VSP results are summarized in Table 1 for BH-12-2-3 and Table 2 for BH-12-3-3. The shear wave and compression wave layer velocities, at the field collected one-metre intervals, were calculated by best fitting a theoretical travel time model to the field data collected at either half or one metre intervals. The depths presented on the tables are relative to ground surface.

The estimated dynamic engineering moduli, based on the calculated wave velocities, are also presented on Table 1 and 2. The engineering moduli were calculated using an estimated bulk density, based on the borehole log, but a more detailed geotechnical investigation would be necessary to determine a more exact density for each layer. For the topsoil down to a depth of approximately 36 metres in BH-12-2-3 and 38 metres in BH-12-3-3, a bulk density of 1,750 kg/m³ was estimated. Further down, to a depth of the bottom of the hole, the bulk density for the bedrock was estimated at 2,300 kg/m³.

The first layer of both boreholes is likely frozen, which is why a relatively high velocity is measured for both the compressional and shear wave velocity.

The average shear wave velocity from ground surface to a depth of 30 metres was measured to be 117 m/s for BH-12-2-3 and 112 m/s for BH-12-3-3.

Closure

We trust that these results meet your current needs. If you have any questions or require clarification, please contact the undersigned at your convenience.

Yours truly,

GOLDER ASSOCIATES LTD.

Stephane Sol, Ph.D. Geophysics Group

Brian Byerley, M. Sc., P. Eng. Senior Hydrogeologist, Principal

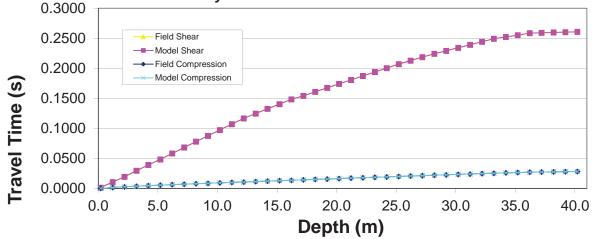
SS/PF/BTB/sg n:\active\2012\1125 - environmental and civil engineering\12-1125-0045 crrrc ea eastern on\phase 4500_final_easr\vol 3 - g h&g\appendices\appendices\appendix k\12-1125-0045 vsp techmemo final.docx

Attachments: Tables 1 and 2



Layer Depth (m)					Dynamic Engineering Properties			
_		Compressional	Shear Wave	Estimated Bulk Density	Poissons	Shear Modulus	Deformation Modulus	Bulk Modulus
Тор	Bottom	Wave (m/s)	(m/s)	(kg/m ³)	Ratio	(MPa)	(MPa)	(MPa)
0.0	0.2	872	138	1750	0.49	33	99	1286
0.0	1.2	747	110	1750	0.49	21	63	948
1.2	2.2	820	113	1750	0.49	22	67	1147
2.2	3.2	985	99	1750	0.49	17 19	51 57	1675
3.2	4.2	1115	104	1750	0.50	. 🜩	-	2150
4.2	5.2	1210	108	1750	0.50	20	61	2535
5.2	6.2	1260	99	1750	0.50	17	51	2755
6.2	7.2	1230	102	1750	0.50	18	54	2623
7.2	8.2	1345	102	1750	0.50	18	55	3142
8.2	9.2	1350	104	1750	0.50	19	57	3164
9.2	10.2	1370	103	1750	0.50	19	56	3260
10.2	11.2	1380	103	1750	0.50	19	56	3308
11.2	12.2	1390	105	1750	0.50	19	58	3355
12.2	13.2	1390	122	1750	0.50	26	78	3346
13.2	14.2	1390	125	1750	0.50	27	82	3345
14.2	15.2	1400	130	1750	0.50	30	88	3391
15.2	16.2	1400	128	1750	0.50	29	86	3392
16.2	17.2	1400	165	1750	0.49	48	142	3366
17.2	18.2	1400	150	1750	0.49	39	118	3378
18.2	19.2	1420	152	1750	0.49	40	121	3475
19.2	20.2	1410	152	1750	0.49	40	121	3425
20.2	21.2	1405	152	1750	0.49	40	121	3401
21.2	22.2	1400	152	1750	0.49	40	121	3376
22.2	23.2	1410	152	1750	0.49	40	121	3425
23.2	24.2	1490	152	1750	0.49	40	121	3831
24.2	25.2	1450	150	1750	0.49	39	118	3627
25.2	26.2	1450	170	1750	0.49	51	151	3612
26.2	27.2	1430	175	1750	0.49	54	160	3507
27.2	28.2	1350	180	1750	0.49	57	169	3114
28.2	29.2	1520	200	1750	0.49	70	209	3950
29.2	30.2	1520	200	1750	0.49	70	209	3950
30.2	31.2	1520	200	1750	0.49	70	209	3950
31.2	32.2	1520	200	1750	0.49	70	209	3950
32.2	33.2	1520	200	1750	0.49	70	209	3950
33.2	34.2	1520	340	1750	0.47	202	596	3773
34.2	35.2	1520	320	1750	0.48	179	529	3804
35.2	36.2	1900	300	1750	0.49	158	468	6108
36.2	37.2	3700	1900	2300	0.32	8303	21935	20416
37.2	38.2	3700	1900	2300	0.32	8303	21935	20416
38.2	39.2	3700	1900	2300	0.32	8303	21935	20416
39.2	40.2	3700	1900	2300	0.32	8303	21935	20416

Wave Velocity - Field Collected vs. Modelled Data



<u>Notes</u>

1. Depth Presented relative to ground surface.

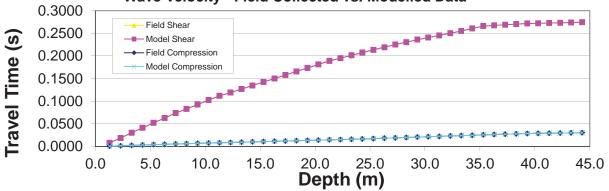
2. This Table to be analyzed in conjunction with the accompanying report.

Golder Associates

TABLE 2 SHEAR WAVE VELOCITY PROFILE AT BH 12-3-3

Layer Depth (m)					Dynamic Engineering Properties				
				Estimated		Shear	Deformation		
		Compressional	Shear Wave	Bulk Density	Poissons	Modulus	Modulus	Bulk Modulus	
Тор	Bottom	Wave (m/s)	(m/s)	(kg/m ³)	Ratio	(MPa)	(MPa)	(MPa)	
0.0	1.3	2385	165	1750	0.50	48	143	9891	
0.0	2.3	1110	92	1750	0.50	15	44	2136	
2.3	3.3	1020	88	1750	0.50	14	41	1803	
3.3	4.3	1022	90	1750	0.50	14	42	1809	
4.3	5.3	1260	92	1750	0.50	15	44	2759	
5.3	6.3	1480	93	1750	0.50	15	45	3813	
6.3	7.3	1500	93	1750	0.50	15	45	3917	
7.3	8.3	1520	108	1750	0.50	20	61	4016	
8.3	9.3	1530	103	1750	0.50	19	56	4072	
9.3	10.3	1550	103	1750	0.50	19	56	4180	
10.3	11.3	1550	103	1750	0.50	19	56	4180	
11.3	12.3	1560	145	1750	0.50	37	110	4210	
12.3	13.3	1560	125	1750	0.50	27	82	4222	
13.3	14.3	1340	130	1750	0.50	30	88	3103	
14.3	15.3	1550	130	1750	0.50	30	89	4165	
15.3	16.3	1600	128	1750	0.50	29	86	4442	
16.3	17.3	1550	128	1750	0.50	29	86	4166	
17.3	18.3	1600	128	1750	0.50	29	86	4442	
18.3	19.3	1600	130	1750	0.50	30	89	4441	
19.3	20.3	1580	130	1750	0.50	30	89	4329	
20.3	21.3	1580	125	1750	0.50	27	82	4332	
21.3	22.3	1580	165	1750	0.49	48	142	4305	
22.3	23.3	1580	165	1750	0.49	48	142	4305	
23.3	24.3	1400	165	1750	0.49	48	142	3366	
24.3	25.3	1250	165	1750	0.49	48	142	2671	
25.3	26.3	1280	170	1750	0.49	51	151	2800	
26.3	27.3	1250	170	1750	0.49	51	151	2667	
27.3	28.3	1150	185	1750	0.49	60	178	2235	
28.3	29.3	1250	185	1750	0.49	60	178	2655	
29.3	30.3	1200	210	1750	0.48	77	229	2417	
30.3	31.3	1200	215	1750	0.48	81	240	2412	
31.3	32.3	1250	215	1750	0.48	81	240	2627	
32.3	33.3	1200	190	1750	0.49	63	188	2436	
33.3	34.3	1220	185	1750	0.49	60	178	2525	
34.3	35.3	1220	190	1750	0.49	63	188	2520	
35.3	36.3	1220	650	1750	0.30	739	1925	1619	
36.3	37.3	1250	680	1750	0.29	809	2087	1655	
37.3	38.3	1260	680	2300	0.29	1064	2754	2233	
38.3	39.3	1500	800	1750	0.30	1120	2915	2444	
39.3	40.3	3000	1800	2300	0.22	7452	18164	10764	
40.3	41.3	3100	1900	2300	0.20	8303	19913	11032	
41.3	42.3	3200	1800	2300	0.27	7452	18907	13616	
42.3	43.3	3200	1800	2300	0.27	7452	18907	13616	
43.3	44.3	3200	1800	2300	0.27	7452	18907	13616	

Wave Velocity - Field Collected vs. Modelled Data



<u>Notes</u> 1. Depth Presented relative to ground surface.

2. This Table to be analyzed in conjunction with the accompanying report.



golder.com

