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April 10, 2019 File: 64153.85

Novatech
240 Michael Cowpland Drive, Suite 200
Ottawa, Ontario
K2M 1P6

Attention: Mr. Mark Bissett, P.Eng. – Senior Project Manager

Re: Supplemental Geotechnical Investigation
Proposed Residential Subdivision
1055 Klondike Road
Ottawa, Ontario

This letter presents the results of a supplemental geotechnical investigation carried out for the proposed residential development located at 1055 Klondike Road in the City of Ottawa, Ontario. The purpose of the investigation was to supplement the existing subsurface information at the site by means of a limited number of boreholes and, based on the factual information obtained, to provide information regarding the grade raise restrictions within the site. Guidelines for the design of the buildings, roadways, and services within the proposed development are provided in the following documents prepared by GEMTEC Consulting Engineers and Geoscientists Ltd. (GEMTEC):

- "Preliminary Geotechnical Investigation, Proposed Residential Subdivision, 1055 Klondike, Ottawa, Ontario", dated April 13, 2017.
- "Geotechnical Investigation, Proposed Residential Subdivision, 1055 Klondike, Ottawa, Ontario", dated April 4, 2018.

This subsurface investigation was carried out in general accordance with our proposal dated February 21, 2019.

BACKGROUND

Plans are being prepared to develop a tract of land for residential purposes located at 1055 Klondike Road in the City of Ottawa, Ontario (see Key Plan, Figure 1). The proposed plans for the residential development will include duplex and townhouse blocks. It is understood that the existing grade will be raised by up to 4.5 metres along the ridge near the cul-de-sac at the northeast end of the internal roadway in order to construct the proposed development.

Previous Geotechnical Investigations by GEMTEC

The subsurface conditions encountered in the boreholes advanced as part of the previous geotechnical investigations carried out by GEMTEC consist of topsoil underlain by weathered silty clay crust, very stiff to firm grey silty clay and glacial till.

The approximate locations of the test holes previously advanced by GEMTEC are shown on the Borehole Location Plan, Figure 1. Copies of borehole logs from the previous investigations are provided in Attachment D for reference.

SUBSURFACE INVESTIGATION

The field work for this investigation was carried out on March 14, 2019. During that time, two (2) boreholes numbered 19-1 and 19-2, inclusive, were advanced at the site by George Downing Estate Drilling Ltd. to depths of 9.1 and 8.8 metres below existing grade, respectively (elevations 68.8 and 69.7 metres, geodetic datum). The soil stratigraphy was not logged in borehole 19-2. One (1) standpipe piezometer was installed and sealed in the overburden in borehole 19-2 to facilitate groundwater level measurements.

Standard penetration tests (SPT) were carried out in the boreholes and samples of the soils encountered were recovered using a 50 millimetre diameter split barrel sampler. Relatively undisturbed Shelby tube samples of the silty clay were obtained for consolidation testing.

The field work was observed throughout by a member of our engineering staff who directed the drilling operations and logged the samples and boreholes.

Following completion of the drilling, the soil samples were returned to our laboratory for examination by a geotechnical engineer.

The results of the boreholes are provided on the Record of Borehole sheets in Attachment A. The approximate locations and ground surface elevations of the boreholes from the current and previous investigations are shown on the Borehole Location Plan, Figure 1. The results of the laboratory classification tests on the soil samples are provided on the Plasticity chart in Attachment B. The results of consolidation testing carried out on undisturbed silty clay samples are provided in Attachment C.

The borehole locations were selected by GEMTEC and positioned on site relative to existing features. The ground surface elevations at the location of the boreholes were determined using a Trimble R10 global positioning system. The coordinates of the boreholes are referenced to NAD83 (CSRS) Epoch 2010, vertical network CGVD2013 and are considered to be accurate within the tolerance of the instrument.

SUBSURFACE CONDITIONS

General

As previously indicated, the soil and groundwater conditions identified in the boreholes are given on the Record of Borehole sheets in Attachment A. The borehole logs indicate the subsurface conditions at the specific test locations only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. The precision with which subsurface conditions are indicated depends on the method of drilling, the frequency and recovery of samples, the method of sampling, and the uniformity of the subsurface conditions. Subsurface conditions at other than the test locations may vary from the conditions encountered in the boreholes. 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 groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These conditions may vary seasonally or as a consequence of construction activities in the area.

The soil descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves judgement and GEMTEC does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The following presents an overview of the subsurface conditions encountered in the boreholes advanced during this supplemental investigation. It is noted that the soil stratigraphy was not logged in borehole 19-2.

Topsoil/Organic Material

A 0.2 metre thick surficial layer of topsoil composed of dark brown silty sand with organic material was encountered in borehole 19-1.

Silty Sand

A deposit of brown silty sand was encountered underlying the topsoil in borehole 19-1 at a depth of 0.2 metres below existing grade (elevation 77.8 metres, geodetic datum). The thickness of the silty sand is 2.0 metres.

Standard penetration tests carried out in the silty sand, gave N values of 7 blows per 0.3 metres of penetration, which reflect a loose consistency.

Silty Clay

The upper part of the silty clay encountered in borehole 19-1 is weathered and brown, and was encountered at a depth of 2.2 metres below existing grade (elevation 75.8 metres, geodetic

datum). Standard penetration tests carried out in the weathered silty clay gave N values ranging from 2 to 5 blows per 0.3 metres of penetration, which reflect a stiff to very stiff consistency. In situ vane shear strength tests carried out in the weathered silty clay gave shear strengths of 46 to 100 kilopascals, which indicate a firm to very stiff consistency. The weathered silty clay extends to a depth of 7.0 metres below existing grade (elevation 71.0 metres, geodetic datum). The water content of the weathered silty clay ranges from 45 to 49 percent.

The results of Atterberg limit testing carried out on a samples of the weathered silty clay are provided in Attachment B. The results are summarized in Table 1.

Table 1 – Summary of Atterberg Limit Test Results for Weathered Silty Clay

Borehole	Sample	Sample Depth (metres)	Water Content (%)	Liquid Limits (%)	Plastic Limits (%)	Plasticity Index
19-1	5	2.90 – 3.51	45.1	54.5	24.1	30.4
19-1	8	5.97 – 6.58	46.4	42.4	23.5	18.9

This testing indicates that sample 5 of weathered silty clay tested from borehole 19-1 has high plasticity, and sample 8 of weathered silty clay tested from borehole 19-1 has low plasticity. The water content of sample 5 is between the measured liquid and plastic limit values and the water content of sample 8 is greater than the liquid limit value.

Below the weathered zone, the silty clay is grey in colour. In situ vane shear strength tests carried out in the grey silty clay gave shear strengths of 51 to 73 kilopascals, which indicate a stiff consistency. The water content of the grey silty clay is about 39 percent. The grey silty clay extends to a depth of 9.1 metres below existing grade (elevation 68.8 metres, geodetic).

The results of an Atterberg limit test carried out on a sample of the grey silty clay are provided in Attachment B. The results are summarized in Table 2.

Table 2 – Summary of Atterberg Limit Test Results for Grey Silty Clay

Borehole	Sample	Sample Depth (metres)	Water Content (%)	Liquid Limits (%)	Plastic Limits (%)	Plasticity Index
19-1	10	8.38 – 8.99	39.1	31.2	17.3	13.9

This testing indicates that sample 10 of grey silty has low plasticity. The water content of the sample tested is greater than the liquid limit value.

Groundwater Levels

The groundwater levels measured in the well screens installed in boreholes 19-2, 18-1 and 18-5 on March 22, 2019 are summarized in Table 2.

Table 2 – Groundwater Depth and Elevation

Borehole	Groundwater Depth Below Existing Ground Surface (metres)	Groundwater Elevation (metres, geodetic datum)
19-1	6.7	71.9
18-1	2.2	75.5
18-5	Dry	

The groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

GEOTECHNICAL RECOMMENDATIONS

Site Grade Raise Restrictions

The site is underlain by deposits of sensitive silty clay, which have a limited capacity to support loads imposed by grade raise fill material, pavement structures and foundations for the buildings. The placement of fill material must therefore be carefully controlled so that the stress imposed by the fill material does not result in excessive consolidation of the grey silty clay deposit. The settlement response of the silty clay deposit to the increase in stress caused by fill material and groundwater lowering is influenced by variables such as the existing effective overburden pressure, the past pre-consolidation pressure for the silty clay, the compressibility characteristics of the silty clay, and the presence or absence of drainage paths, etc. It is well established that the settlement response of silty clay deposits can be significant when the stress increase is at or near the difference between the preconsolidation pressure (P_c) and the existing overburden stress (σ_{vo}').

Based on the results of the vane shear strength test carried out in the boreholes, in conjunction with the oedometer consolidation test results, the following grade raise restrictions could be used for design purposes (refer to Figure 1):

- Within the low lying area at the bottom of the slope (i.e., where the existing ground surface elevation is less than 72.0 metres), a grade raise fill restriction of 6.0 metres could be used (i.e., grade raise up to an elevation of 78.0 metres).

- In areas along the midsection of the slope (i.e., where the existing ground surface elevation is between 72.0 and 75.0 metres), a grade raise fill restriction of 4.0 metres could be used (i.e., grade raise up to an elevation of 79.0 metres).
- In areas near the top of the slope (i.e., where the existing ground surface elevation is between 75.0 and 78.0 metres), a grade raise fill restriction of 2.0 metres could be used (i.e., grade raise up to an elevation of 80.0 metres).

The grade raise restriction for the site has been calculated in order to limit the total settlement of the ground to about 25 millimetres in the long term. For design purposes, we have made the following assumptions:

- The groundwater lowering due to the development at this site will be at most 0.5 metres. As such, it is important to install seepage barriers along the service trenches, as indicated in our geotechnical report titled: "Geotechnical Investigation, Proposed Residential Subdivision, 1055 Klondike Road, Ottawa, Ontario" dated April 4, 2018, to reduce the potential for groundwater level lowering.

- The unit weight of the grade raise fill material used in the vicinity of the structures is not greater than 22 kilonewtons per cubic metre. The engineered fill should consist of granular material meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type II and should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density.

Expanded polystyrene (EPS) blocks, which are specifically manufactured for this purpose, could be used to make up the additional depth of grade raise. As a minimum, the EPS should extend at least 2.4 metres beyond the entire perimeter of the foundations and within garages and porches, where necessary. EPS blocks could also be used below the roadways. Additional information regarding the use of EPS blocks could be provided as the design progresses.

We recommend that the placement of the grade raise fill material be carried out well in advance of construction (i.e., 6 months or more), where possible, in order to minimize the amount of post construction total and differential settlement. Further, the use of steel reinforcement in the foundations will reduce the risk of cracking where the thickness of grade raise fill will vary significantly across the footprint of a dwelling.

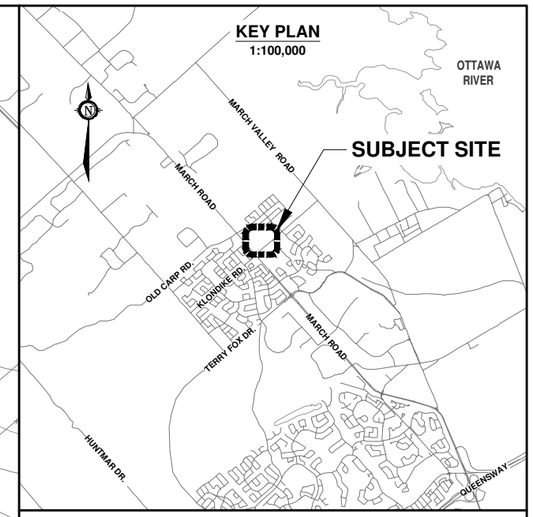
It is recommended that the grading plans be reviewed by the geotechnical engineer as the design progresses to ensure that the guidelines provided in this report have been interpreted as intended.

The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed excavations do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design. The subgrade surfaces for the site services and roadways should be inspected by experienced geotechnical personnel to ensure that suitable materials have been reached and properly prepared. The placing and compaction of earth fill and imported granular materials should be inspected to ensure that the materials used conform to the grading and compaction specifications. In accordance with Section 4.2.2.2 of the Ontario Building Code (2017), full time inspection will be required if compacted granular material is required below any spread footing foundations.

We trust this letter provides sufficient information for your present purposes. If you have any questions concerning this report, please do not hesitate to contact our office.

Kelsey Holkestad, B.Eng., E.I.T.

John Cholewa, Ph.D., P.Eng.
Senior Geotechnical Engineer



LEGEND

- **BOREHOLE LOCATION IN PLAN** (current investigation by GEMTEC)
- **BOREHOLE WITH MONITORING WELL** (current investigation by GEMTEC)
- **BOREHOLE LOCATION IN PLAN** (previous investigation by GEMTEC, 2018)
- **BOREHOLE LOCATION IN PLAN** (previous investigation by Houle Chevrier Engineering Ltd., 2017)

BH # — BOREHOLE ID

XX.XX — GROUND SURFACE ELEVATION, IN METRES GEODETIC DATUM

Scale 1:1000

0 20 40 60m

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Client	Project
NOVATECH	64153.85

Location: KLONDIKE ROAD, OTTAWA, ON

Drwn by	Chkd by	
P.C.	K.H.	BOREHOLE LOCATION PLAN

Date	Rev.	
APRIL 2019	0	**FIGURE 1**

ATTACHMENT A

List of Abbreviations and Terminology
Record of Borehole Sheets

ABBREVIATIONS AND TERMINOLOGY USED ON RECORDS OF BOREHOLES AND TEST PITS

SAMPLE TYPES	
AS	Auger sample
CA	Casing sample
CS	Chunk sample
BS	Borros piston sample
GS	Grab sample
MS	Manual sample
RC	Rock core
SS	Split spoon sampler
ST	Slotted tube
TO	Thin-walled open shelby tube
TP	Thin-walled piston shelby tube
WS	Wash sample

SOIL TESTS	
w	Water content
PL, w_p	Plastic limit
LL, w_L	Liquid limit
C	Consolidation (oedometer) test
D_R	Relative density
DS	Direct shear test
G_S	Specific gravity
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	Organic content test
UC	Unconfined compression test
γ	Unit weight

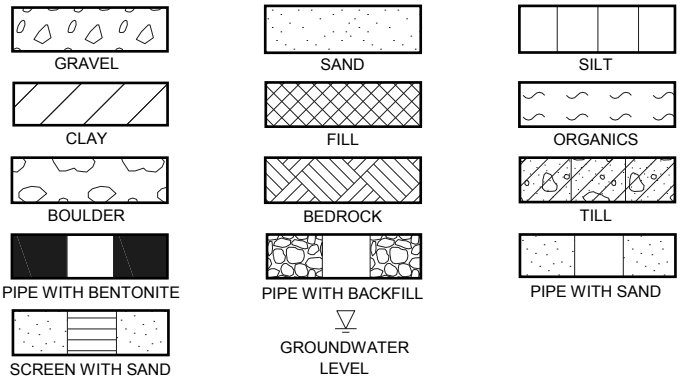
PENETRATION RESISTANCE

Standard Penetration Resistance, N
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 millimetres (30 in.) required to drive a 50 mm split spoon sampler for a distance of 300 mm (12 in.). For split spoon samples where less than 300 mm of penetration was achieved, the number of blows is reported over the sampler penetration in mm.

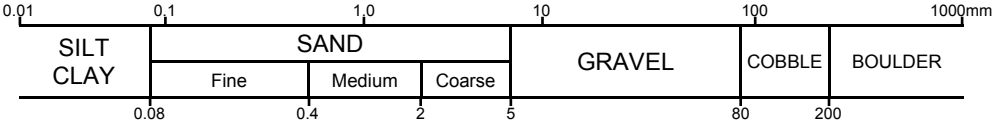
Dynamic Penetration Resistance
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive a 50 mm (2 in.) diameter 60° cone attached to 'A' size drill rods for a distance of 300 mm (12 in.).

WH	Sampler advanced by static weight of hammer and drill rods
WR	Sampler advanced by static weight of drill rods
PH	Sampler advanced by hydraulic pressure from drill rig
PM	Sampler advanced by manual pressure

COHESIONLESS SOIL Compactness		COHESIVE SOIL Consistency	
SPT N-Values	**Description**	**Cu, kPa**	**Description**
0-4	Very Loose	0-12	Very Soft
4-10	Loose	12-25	Soft
10-30	Compact	25-50	Firm
30-50	Dense	50-100	Stiff
>50	Very Dense	100-200	Very Stiff
		>200	Hard

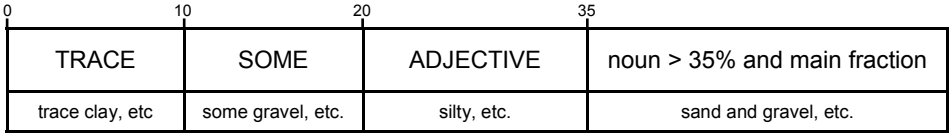


GRAIN SIZE



DESCRIPTIVE TERMINOLOGY

(Based on the CANFEM 4th Edition)



RECORD OF BOREHOLE 19-1

CLIENT: Novatech
PROJECT: 1055 Kondike Road
JOB#: 64153.85
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Mar 14 2019

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE (N), BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, Hollow Stem Auger (210mm OD)	Ground Surface		77.98							
		Dark brown silty sand with organic material (TOPSOIL)		77.8 / 0.2	1A, 1B	SS		3			
		Loose, brown SILTY SAND									
1					2	SS		7			
					3	SS		7			
2				75.8							
		Stiff to very stiff, brown silty clay (WEATHERED CRUST)		2.2	4	SS		4			
3					5	SS		5			
4					6	SS		2			Backfilled with auger cuttings
5					7	TO					
6					8	SS		2			
7				71.0	9	TO					
		Stiff, grey SILTY CLAY		7.0							
8											
					10	TO					
9				68.8							
		End of Borehole Refusal on inferred Bedrock		9.1							
10											
11											
12											
13											
14											
15											

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE (N), BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL, ⊕ REMOULDED
WATER CONTENT, %: W_P, W, W_L
10 20 30 40 50 60 70 80 90

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LOGGED: BWW
CHECKED: GD

GEO - BOREHOLE LOG 64153.85_GNT_V01_2019-03-15.GPJ GEMTEC 2018.GDT 10/4/19

RECORD OF BOREHOLE 19-2

CLIENT: Novatech
PROJECT: 1055 Kondike Road
JOB#: 64153.85
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Mar 14 2019

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE (N), BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger / Hollow Stem Auger (210mm OD)	Ground Surface		78.55					10 20 30 40 50 60 70 80 90		
		Soil stratigraphy not logged									Backfilled with auger cuttings
1											
2											
3											
4											Bentonite seal
5											
6											
7											Filter sand 50 millimetre diameter PVC screen
8											
				69.7							
9		End of Borehole		8.8							
10											
11											
12											
13											
14											
15											

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
19/03/22	6.7 ▽	71.9

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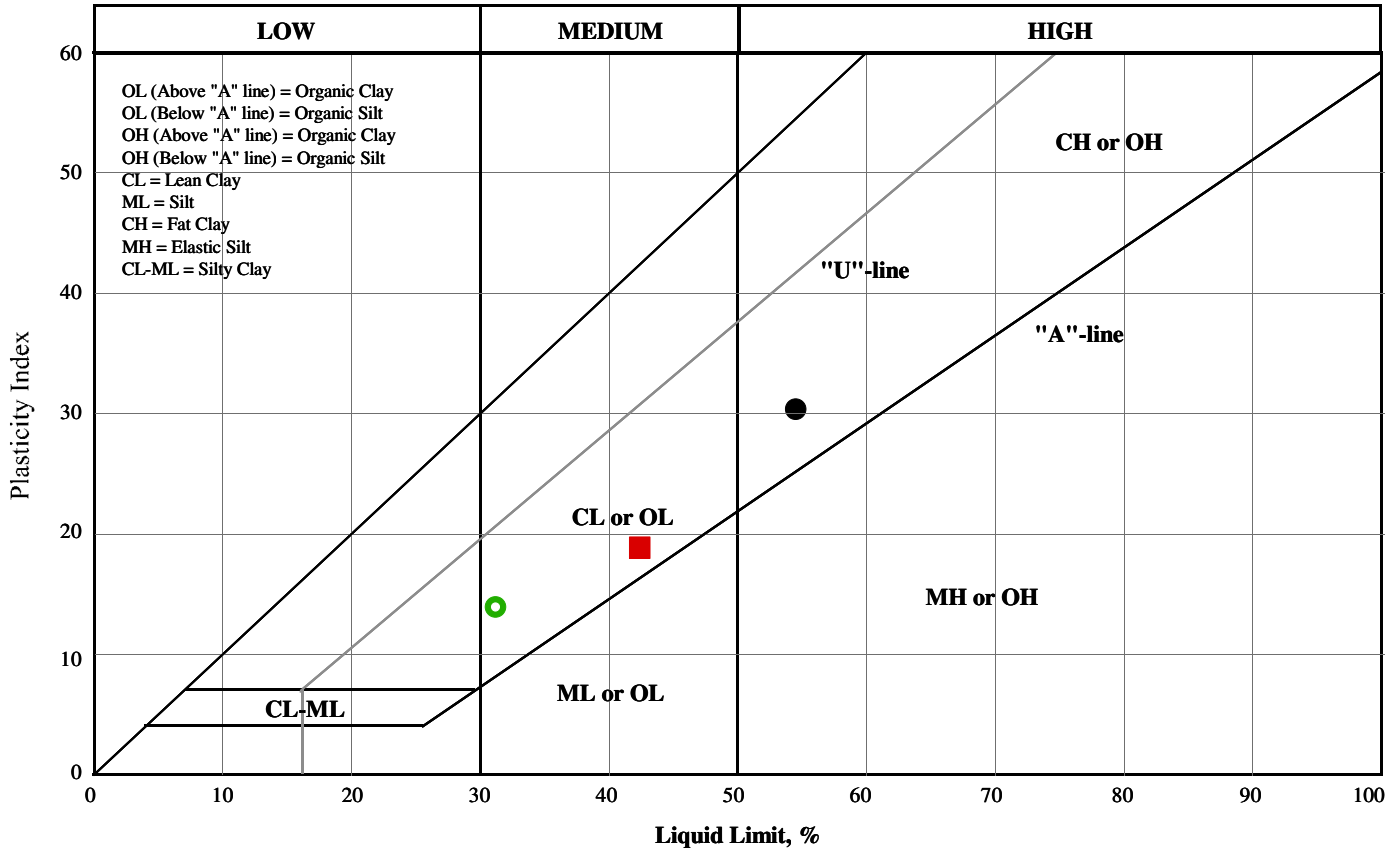
LOGGED: BWW
CHECKED: GD

GEO - BOREHOLE LOG 64153.85_GNT_V01_2019-03-15.GPJ GEMTEC 2018.GDT 10/4/19

ATTACHMENT B

Results of Laboratory Testing
Plasticity Chart

GEMTEC Consulting Engineers and Scientists	Client: Novatech Project: Geotechnical Investigation - 1055 Klondike Road Project #: 6415385	Plasticity Chart

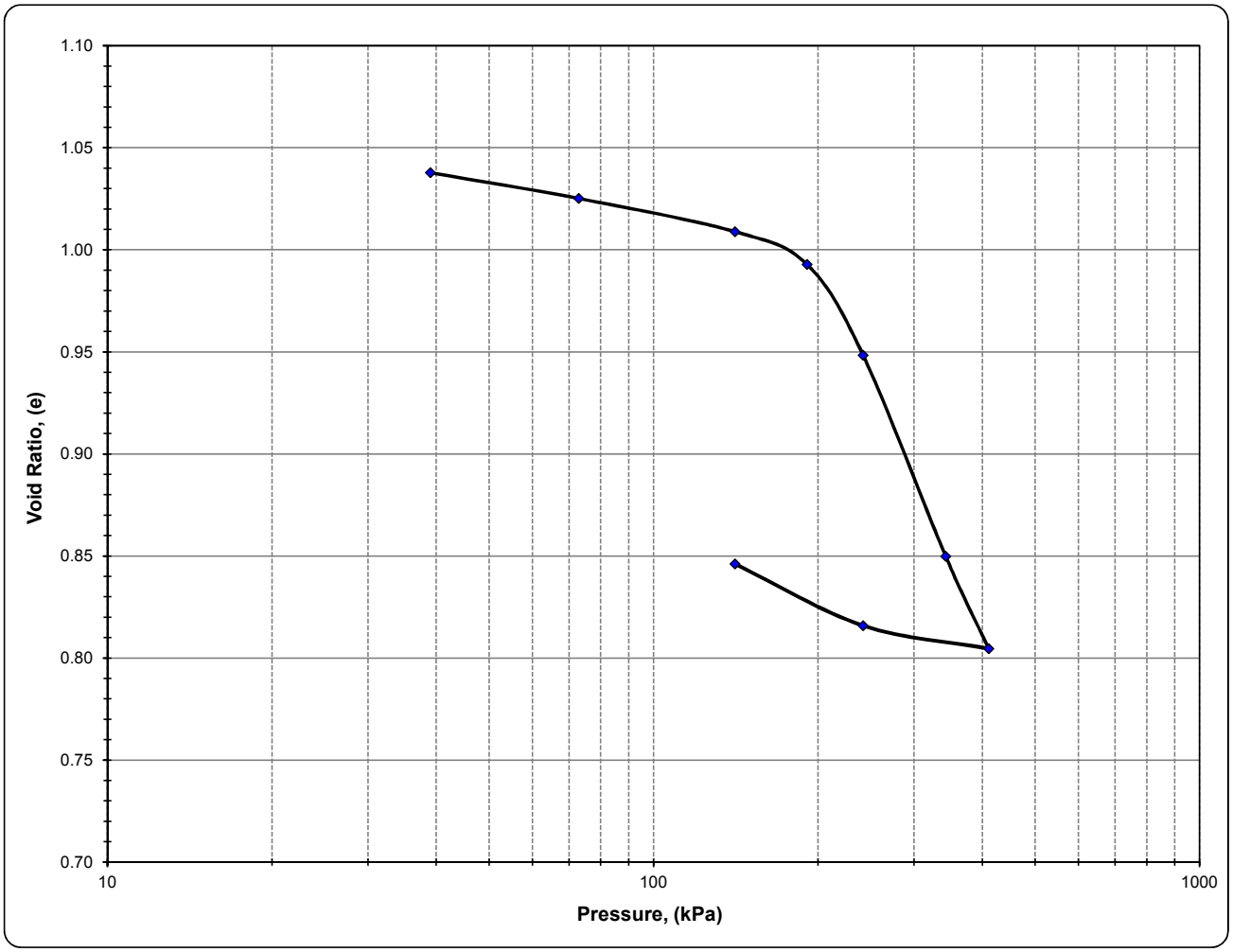


Symbol	Description	Sample Number	Depth	Date Sampled	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	Weathered Silty Clay	05	2.90 - 3.51	Apr 3, 2019	54.5	24.1	30.4	☐	45.07
■	Weathered Silty Clay	08	5.97 - 6.58	Apr 3, 2019	42.4	23.5	18.9	☐	46.40
○	Grey Silty Clay	10	8.38 - 8.99	Apr 3, 2019	31.2	17.3	13.9	☐	39.13

ATTACHMENT C

Results of Consolidation Testing
Figures C1 to C3

CONSOLIDATION ANALYSIS	FIGURE C1



Borehole	Sample	Depth (m)
19-1	SA9 TOP	6.7 to 6.9

Determined Properties:

W	38	percent

Test Results:

C_r	0.05	
C_c	0.65	
σ'_p	200	kPa

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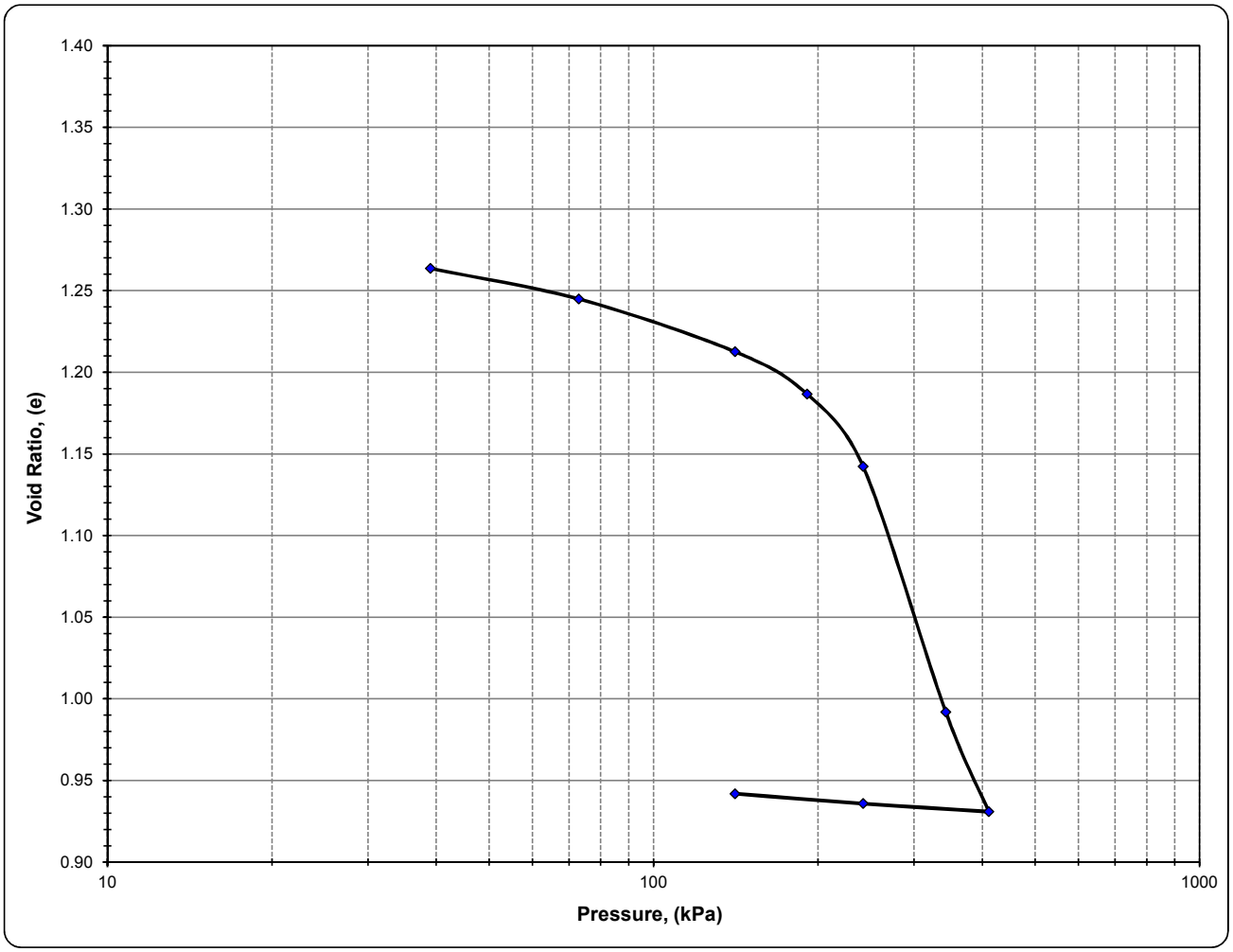
Date: April 2019
Project: 64153.85

CONSOLIDATION ANALYSIS	FIGURE C2



Borehole	Sample	Depth (m)
19-1	SA9 MID	6.9 to 7.1

Determined Properties:			Test Results:		
W	46	percent	C_r	0.02	
			C_c	0.99	
			σ'_p	208	kPa

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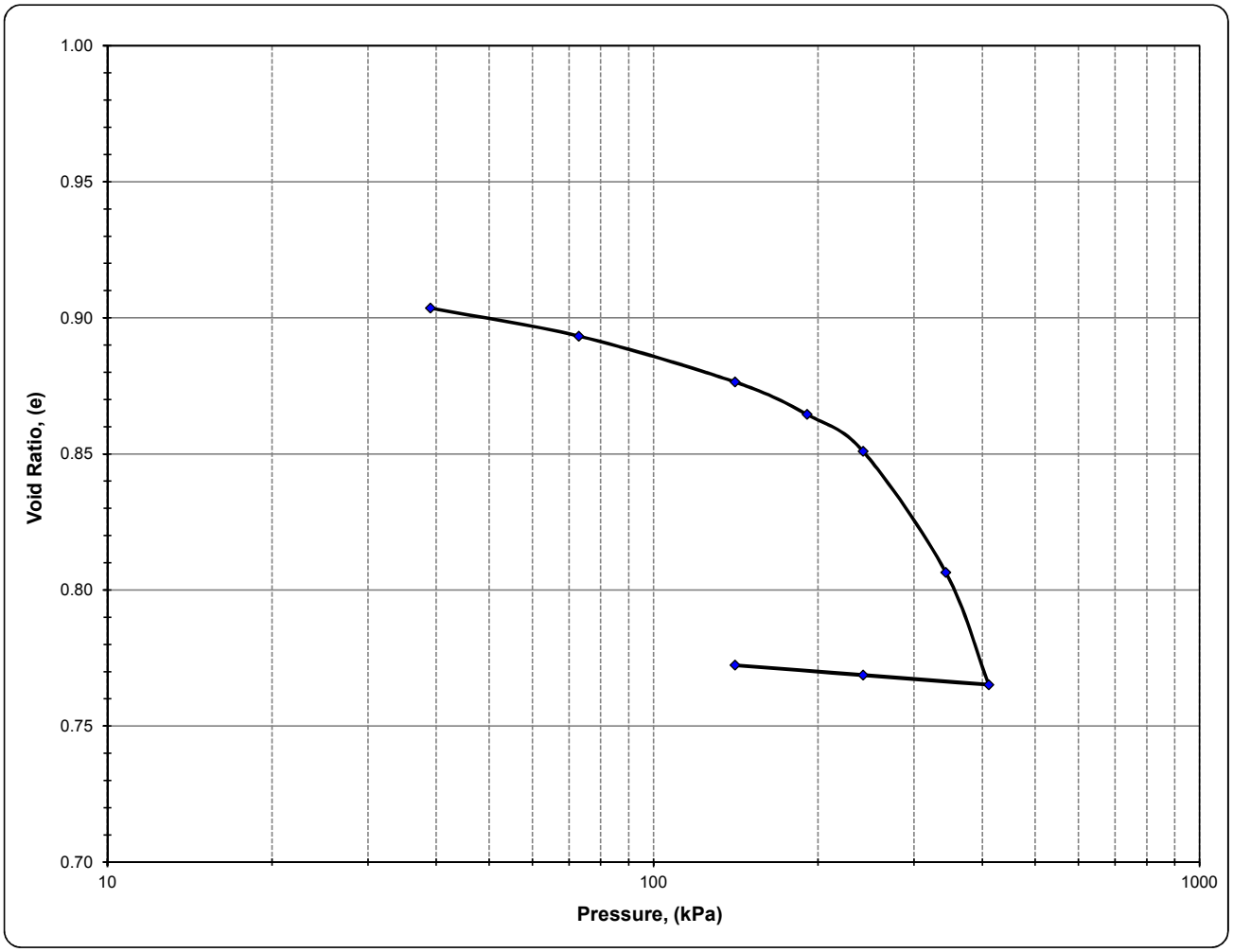
Date: April 2019
Project: 64153.85

CONSOLIDATION ANALYSIS	FIGURE C3



Borehole	Sample	Depth (m)
19-1	SA10 TOP	8.4 to 8.7

Determined Properties:

W	35	percent

Test Results:

C_r	0.02	
C_c	0.52	
σ'_p	280	kPa

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Consulting Engineers and Scientists

Date: April 2019
Project: 64153.85

ATTACHMENT D

Previous Investigations by GEMTEC
Record of Borehole Sheets

RECORD OF BOREHOLE 18-1

CLIENT:
PROJECT:
JOB#:
LOCATION: See Borehole Location Plan, Figure 2

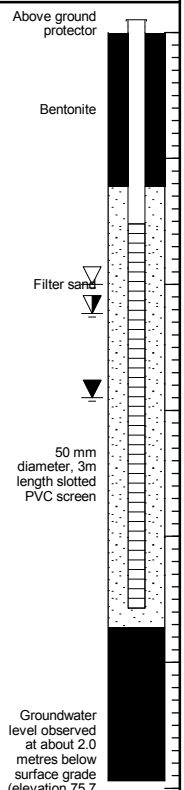
SHEET: 1 OF 1
DATUM: Geodetic
BORING DATE: Mar 9 2018

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	150 mm Diameter Power Auger	Ground Surface		77.69				
		Dark brown silty sand, some organic material (TOPSOIL)		77.38	1	50 D.O.		4
				0.31				
1		Brown SILT and SAND			2	50 D.O.		4
2					3	50 D.O.		6
				75.40				
		Very stiff to stiff, grey brown SILT and CLAY (WEATHERED CRUST)		2.29	4	50 D.O.		5
3					5	50 D.O.		5
4					6	50 D.O.		3
5					7	50 D.O.		4
					8	50 D.O.		3
				71.75				
6		End of borehole		5.94				
7								
8								
9								
10								
11								
12								

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, % W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING: PHCs and BTEX

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
18-03-15	2.0	75.7
18-05-14	2.9	74.8
19-03-22	2.2	75.5

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Consulting Engineers and Scientists

LOGGED: AN
CHECKED:

GEO - BOREHOLE LOG 6415385_BOREHOLE LOGS_GNT_V01_2018-03-14.GPJ GEMTEC 2018.GDT 4-9-19

RECORD OF BOREHOLE 18-2

CLIENT:
PROJECT:
JOB#:
LOCATION: See Borehole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: Geodetic
BORING DATE: Mar 8 2018

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m; DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED); WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		78.38							
		Brown sandy silt with organic material (TOPSOIL)		78.13							
				0.25	1	50 D.O.		4			
		Grey brown SILT and SAND									
1				77.34							
				1.04	2	50 D.O.		7			
		Brown, fine to medium grained SAND, trace to some silt, layered with grey brown SILTY SAND									
					3	50 D.O.		5			
2				76.27							
				2.11							
		Very stiff to stiff, grey brown SILT and CLAY (WEATHERED CRUST)			4	50 D.O.		4			
3											
					5	50 D.O.		3			
4					6	50 D.O.		3			
					7	50 D.O.		7			
5	150 mm Diameter Power Auger			73.20							Borehole backfilled with auger cuttings
				5.18							
		Very stiff to stiff, grey SILTY CLAY									
6											
					8	50 D.O.		2			
7											
					9	50 D.O.		2			
8											
9				69.24							
				9.14							
		Compact, grey sand and silt, trace to some clay, some gravel and cobbles (GLACIAL TILL)			10	50 D.O.		15			
10					11	50 D.O.		27			Soil becomes saturated at about 2.3 metres below ground surface.
				68.17							
		Sampler refusal End of borehole		10.21							
11											
12											

GEO - BOREHOLE LOG 6415385_BOREHOLE LOGS_GNT_V01_2018-03-14.GPJ GEMTEC 2018.GDT 4-9-19

GEMTEC
Consulting Engineers and Scientists

LOGGED: AN
CHECKED:

RECORD OF BOREHOLE 18-3

CLIENT:
PROJECT:
JOB#:
LOCATION: See Borehole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: Geodetic
BORING DATE: Mar 9 2018

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	150 mm Diameter Power Auger	Ground Surface		78.79				
		Grey, crushed sand and gravel, trace silt (DRIVEWAY MATERIAL)		78.64 / 0.15	1	50 D.O.		46
		Dark brown and brown silty sand, some gravel, and organic material (FILL MATERIAL)		77.88 / 0.91	2	50 D.O.		7
1		Brown SILT and SAND			3	50 D.O.		7
2				76.30 / 2.49	4	50 D.O.		5
		Brown, fine to medium grained SAND, trace to some silt		75.74 / 3.05	5	50 D.O.		4
3		Very stiff to stiff, grey brown SILT and CLAY (WEATHERED CRUST)			6	50 D.O.		3
4					7	50 D.O.		4
5					8	50 D.O.		3
6					9	50 D.O.		2
7					10	50 D.O.		
		Stiff, grey Silty Clay		71.16 / 7.63	11	50 D.O.		1
8		End of borehole		70.56 / 8.23				
9								
10								
11								
12								

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, % — W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING: PHCs and BTEX with duplicate

PIEZOMETER OR STANDPIPE INSTALLATION

Above ground protector
Bentonite
Auger cuttings
Bentonite
Filter sand
50 mm diameter, 3m length slotted PVC screen
Groundwater level observed at about 6.3 metres below surface grade (elevation 72.5 metres, geodetic datum) on March 15, 2018.

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
18-03-15	6.3	72.5
18-05-14	6.8	72.0
18-07-27	7.6	71.2

GEMTEC
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LOGGED: AN
CHECKED:

GEO - BOREHOLE LOG 6415385_BOREHOLE LOGS_GNT_V01_2018-03-14.GPJ GEMTEC 2018.GDT 4-9-19

RECORD OF BOREHOLE 18-4

CLIENT:
PROJECT:
JOB#:
LOCATION: See Borehole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: Geodetic
BORING DATE: Mar 8 2018

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	150 mm Diameter Power Auger	Ground Surface		77.61				
		Dark brown silty sand / sandy silt, some organic material (TOPSOIL)		77.43 / 0.18	1	50 D.O.		3
		Brown SILT and SAND, trace roots						
1					2	50 D.O.		7
		Brown, fine to medium grained SAND, trace to some silt		76.49 / 1.12				
2					3	50 D.O.		10
				75.48 / 2.13				
		Very stiff, grey brown SILT and CLAY (WEATHERED CRUST)			4	50 D.O.		4
3					5	50 D.O.		4
4					6	50 D.O.		2
					7	50 D.O.		2
5								
6				71.51 / 6.10				
		Stiff, grey SILTY CLAY			8	50 D.O.		W.H.
7								
8					9	50 D.O.		1
				69.23 / 8.38				
		Grey sand and silt, some gravel, possible cobbles (GLACIAL TILL)		69.05 / 8.56	10	50 D.O.		50 for 0.1m
		Auger refusal on possible bedrock End of borehole						
9								
10								
11								
12								

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Borehole backfilled with auger cuttings

Soil becomes saturated at about 2.3 metres below ground surface.

GEMTEC
Consulting Engineers and Scientists

LOGGED: AN
CHECKED:

GEO - BOREHOLE LOG 6415385_BOREHOLE LOGS_GNT_V01_2018-03-14.GPJ GEMTEC 2018.GDT 4-9-19

RECORD OF BOREHOLE 18-5

CLIENT:
PROJECT:
JOB#:
LOCATION: See Borehole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: Geodetic
BORING DATE: Mar 8 2018

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m; DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED); WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	150 mm Diameter Power Auger	Ground Surface		77.80							Above ground protector
		Grey brown silty clay, with dark brown pockets, some organic material (FILL MATERIAL)			1	50 D.O.		8	●		Bentonite
1					2	50 D.O.		5	●		
2					3	50 D.O.		3	●		Filter sand
					4	50 D.O.		4	●		
3				74.55							
		Brown silty sand, trace wood		3.25	5	50 D.O.		5	●		
4					6	50 D.O.		8	●		50 mm diameter, 3m length slotted PVC screen
				73.08							
		Very stiff to stiff, grey brown SILT and CLAY (WEATHERED CRUST)		4.72	7	50 D.O.		12	●		
5					8	50 D.O.		5	●	PHCs and VOCs	
6					9	50 D.O.		3	●		
7					10	50 D.O.		2	●		
				70.06	11	50 D.O.		50 for 0.13m			Well observed to be dry on March 22, 2019.
8		Auger refusal on possible bedrock End of borehole		7.74					⊕		
9											
10											
11											
12											

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
18-03-15	5.5 ▽	72.3
18-05-14	5.9 ▼	71.9
18-07-27	6.7 ▼	71.1

GEMTEC
Consulting Engineers and Scientists

LOGGED: AN
CHECKED:

GEO - BOREHOLE LOG 6415385_BOREHOLE LOGS_GNT_V01_2018-03-14.GPJ GEMTEC 2018.GDT 4-9-19

RECORD OF BOREHOLE 17-1

PROJECT: 60616.46

LOCATION: See Borehole Location Plan, Figure 2

BORING DATE: March 27, 2017

SHEET 1 OF 1

DATUM: Geodetic

SPT HAMMER: 63.5 kg; drop 0.76 metres

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat. V - +, rem. V - ⊕, Q -●, U -○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-5} 10^{-4} 10^{-3} 10^{-2}) / WATER CONTENT, PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, 200 mm Diameter Hollow Stem	Ground Surface		78.30							
		Dark brown silty sand (TOPSOIL)		78.15 / 0.15	1	50 D.O.	8				Backfilled with soil cuttings
1		Brown fine to coarse grained SAND, some silt			2	50 D.O.	9				
2					3	50 D.O.	10				
				76.01 / 2.29							
		Very stiff, grey brown SILTY CLAY (Weathered crust)			4	50 D.O.	4				
3					5	50 D.O.	4				
				74.49 / 3.81							
4		Very stiff to firm, grey SILTY CLAY			6	50 D.O.	4				
5					7	50 D.O.	4				
6					8	50 D.O.	3				
					9	50 D.O.	2				
7					10	50 D.O.	1				
8											
					11	50 D.O.	1				
9											
		End of Borehole		68.70 / 9.60							
10											

DEPTH SCALE

1 to 50

Houle Chevrier Engineering

LOGGED: M.L.

CHECKED:

BOREHOLE LOG GINT LOGS MARCH 28 2017.GPJ HOULE CHEVRIER 2015.GDT 30/3/17

RECORD OF BOREHOLE 17-2

PROJECT: 60616.46

LOCATION: See Borehole Location Plan, Figure 2

BORING DATE: March 27, 2017

SHEET 1 OF 1

DATUM: Geodetic

SPT HAMMER: 63.5 kg; drop 0.76 metres

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
0	Power Auger 200 mm Diameter Hollow Stem	Ground Surface		78.43			
		Dark brown silty sand (TOPSOIL)		78.28 / 0.15			
		Brown fine to coarse grained SAND			1	50 D.O.	4
1					2	50 D.O.	6
					3	50 D.O.	6
2				75.84 / 2.59	4	50 D.O.	5
		Very stiff, grey brown SILTY CLAY (Weathered crust)					
3					5	50 D.O.	4
				74.62 / 3.81			
4		Very stiff to firm, grey SILTY CLAY			6	50 D.O.	4
					7	50 D.O.	3
5					8	50 D.O.	3
6					9	50 D.O.	2
7							
8					10	50 D.O.	1
9							
		End of Borehole		68.83 / 9.60			
10							

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

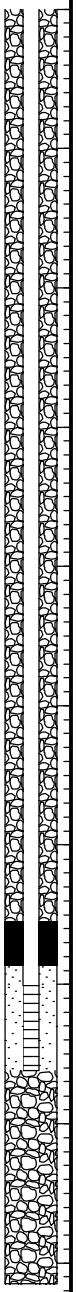
SHEAR STRENGTH Cu, kPa: 20 40 60 80 — nat. V - + Q -● — rem. V - ⊕ U -○

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-5} 10^{-4} 10^{-3} 10^{-2}

WATER CONTENT, PERCENT: Wp — W — Wl; 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 to 50

Houle Chevrier Engineering

LOGGED: M.L.

CHECKED:

BOREHOLE LOG GINT LOGS MARCH 28 2017.GPJ HOULE CHEVRIER 2015.GDT 30/3/17

PROJECT: 60616.46

RECORD OF BOREHOLE 17-3

SHEET 1 OF 1

LOCATION: See Borehole Location Plan, Figure 2

DATUM: Geodetic

BORING DATE: March 27, 2017

SPT HAMMER: 63.5 kg; drop 0.76 metres

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat. V - +, rem. V - ⊕, Q -●, U -○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-5} 10^{-4} 10^{-3} 10^{-2}) / WATER CONTENT, PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger 200 mm Diameter Hollow Stem	Ground Surface		72.74							
		Dark brown silty sand (TOPSOIL)		72.59							
		Very stiff, grey brown SILTY CLAY (Weathered crust)		0.15	1	50 D.O.	7				
1					2	50 D.O.	11				
2					3	50 D.O.	7				
					4	50 D.O.	6				
3					5	50 D.O.	4				
				68.74	6	50 D.O.	>50 for 75 mm				
4		Brown silty sand, some clay with small gravel (Glacial Till)		4.00							
		End of Borehole Practical Auger Refusal		4.07							Bentonite seal Filter Sand 25 mm Diameter, 0.6 metres long well screen
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 to 50

Houle Chevrier Engineering

LOGGED: M.L.

CHECKED:

BOREHOLE LOG GINT LOGS MARCH 28 2017.GPJ HOULE CHEVRIER 2015.GDT 30/3/17

PROJECT: 60616.46

RECORD OF BOREHOLE 17-4

SHEET 1 OF 1

LOCATION: See Borehole Location Plan, Figure 2

DATUM: Geodetic

BORING DATE: March 27, 2017

SPT HAMMER: 63.5 kg; drop 0.76 metres

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (20 40 60 80) nat. V - + Q -● rem. V - ⊕ U -○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-5} 10^{-4} 10^{-3} 10^{-2}) / WATER CONTENT, PERCENT (Wp W Wl; 20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger 200 mm Diameter Hollow Stem	Ground Surface		78.14							
		Dark brown silty sand (TOPSOIL)		78.04 / 0.10							
		Brown fine to coarse grained SAND			1	50 D.O.	4				Backfilled with soil cuttings
1					2	50 D.O.	8				
					3	50 D.O.	12				
2				75.70 / 2.44							
		Very stiff, grey brown SILTY CLAY (Weathered crust)			4	50 D.O.	7				
3					5	50 D.O.	5				
				74.33 / 3.81							
4		Very stiff to firm, grey SILTY CLAY			6	50 D.O.	6				
					7	50 D.O.	3				
5					8	50 D.O.	3				
6					9	50 D.O.	3				
7								⊕ +			
								⊕ +			
					10	50 D.O.	1				
8								⊕ +			
		End of Borehole Practical Auger Refusal		69.68 / 8.46							
9											
10											

DEPTH SCALE

1 to 50

Houle Chevrier Engineering

LOGGED: M.L.

CHECKED:

BOREHOLE LOG GINT LOGS MARCH 28 2017.GPJ HOULE CHEVRIER 2015.GDT 30/3/17