



**Geotechnical Investigation
Waterloo West Side Employment
Lands**

Erb Street W and Wilmot Line
Waterloo, Ontario

August 16, 2018

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Sign-off Sheet

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Table of Contents

1.0	INTRODUCTION	1
2.0	PREVIOUS SITE INVESTIGATIONS	1
3.0	SITE DESCRIPTION	2
3.1	LOCATION AND CURRENT LAND USE.....	2
3.2	TOPOGRAPHY	2
3.3	REGIONAL GEOLOGY	2
4.0	PROPOSED DEVELOPMENT	2
4.1	OVERVIEW	2
5.0	METHOD OF INVESTIGATION	3
5.1	FIELD INVESTIGATION.....	3
5.2	BOREHOLE LOCATION AND ELEVATION SURVEY.....	3
5.3	GEOTECHNICAL LABORATORY TESTING PROGRAM.....	4
6.0	RESULTS OF INVESTIGATION	5
6.1	SUBSURFACE CONDITIONS.....	5
6.1.1	Frame of Reference & Overview	5
6.1.2	General Subsurface Stratigraphy	5
6.2	SOIL STRATIGRAPHY	5
6.2.1	Topsoil/Topsoil Fill	5
6.2.2	Fill 6	
6.2.3	Silt (ML)	6
6.2.4	Silty Clay (CL-ML)	6
6.2.5	Sandy Clay, Silty Clay, Sandy Silty Clay (CL, CL-ML) Till	6
6.2.6	Silty Sand (SM) Till.....	7
6.2.7	Sand, Silty Sand (SP, SP-SM)	8
6.3	GROUNDWATER CONDITIONS	8
6.4	ANALYTICAL CHEMISTRY RESULTS	9
6.4.1	Corrosion Analyses	9
6.4.2	Sulphates in Soil	10
7.0	DESIGN DISCUSSION & RECOMMENDATIONS	11
7.1	SUBSURFACE CONDITIONS OVERVIEW.....	11
7.2	GEOTECHNICAL CONSIDERATIONS AND CONSTRAINTS.....	11
7.3	GRADING AND EARTHWORKS.....	12
7.3.1	General	12
7.3.2	Erosion & Sediment Control and Regulatory Constraints	12
7.3.3	Sub-Excavation and Proof Rolling.....	12
7.3.4	Engineered Fill Placement	13
7.3.5	Subgrade Fill Placement	13
7.3.6	Adverse Weather Construction.....	13
7.4	SERVICING.....	14



GEOTECHNICAL INVESTIGATION - WATERLOO WEST SIDE EMPLOYMENT LANDS, ERB STREET W AND WILMOT LINE, WATERLOO, ONTARIO

7.4.1	General Servicing Overview	14
7.4.2	Excavations	14
7.4.3	Bedding	15
7.4.4	Trench Backfill	15
7.4.5	Municipal Infrastructure Backfilling	16
7.4.6	Dewatering	16
7.5	ROAD DESIGN AND CONSTRUCTION	16
7.6	BUILDING CONSTRUCTION	17
7.6.1	General Building Construction Overview	17
7.6.2	Foundations	17
7.6.3	Floor Slabs	18
7.7	SITE MATERIALS REUSE	18
7.7.1	Existing Fill	18
7.7.2	Topsoil	18
7.7.3	Silt, Clay, Clay Till	19
7.7.4	Sand, Silty Sand, and Sand Till	19
7.8	SURFACE WATER MANAGEMENT	19
7.8.1	Storm Water Management Facility	19
7.8.2	Estimates of Hydraulic Conductivity	20
8.0	CLOSURE	20

LIST OF TABLES

Table 5.1	Borehole Elevations and Coordinates	4
Table 5.2	Geotechnical Laboratory Testing Program	4
Table 6.1	Grain Size Distribution – FILL	6
Table 6.2	Grain Size Distribution – Sandy Clay, Silty Clay, Sandy Silty Clay (CL, CL-ML) Till	7
Table 6.3	Atterberg Limits Test Results – Sandy Clay, Silty Clay (CL, CL-ML) Till	7
Table 6.4	Grain Size Distribution – Silty Sand (SM) Till	8
Table 6.5	Groundwater Level Measurements	9
Table 6.6	Results of Chemical Analysis and ANSI/AWWA Soil Corrosivity Potential	10
Table 6.7	Results of Chemical Analysis for Soluble Sulphates	10
Table 7.1	Recommended Pavement Structures	16
Table 7.2	Geotechnical Bearing Resistances	17
Table 7.3	Summary of Peak Horizontal Ground Accelerations	18

LIST OF APPENDICES

APPENDIX A	A
A.1 Statement of General Conditions	A
APPENDIX B	B
B.1 Drawings	B
APPENDIX C	C
C.1 Symbols & Terms Used on Borehole Records	C



**GEOTECHNICAL INVESTIGATION - WATERLOO WEST SIDE EMPLOYMENT LANDS, ERB STREET W AND
WILMOT LINE, WATERLOO, ONTARIO**

C.2	Borehole Records.....	C
APPENDIX D		D
D.1	Laboratory Test Results	D
APPENDIX E		E
E.1	Analytical Corrosivity Test results	E
APPENDIX F		F
F.1	Seismic Hazard Calculation.....	F



Introduction

1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained by The City of Waterloo (Client) to carry out a geotechnical investigation for the subject lands currently known as the "Waterloo West Side Employment Lands (WWSEL)" (Site) located at the northeast corner of the Erb Street and Wilmot Line intersection in the City of Waterloo, Ontario.

The work was carried out in accordance with Stantec's scope of work issued on January 16, 2017.

The information provided in this report is specific to the scope of the investigation and the scope of the proposed development as discussed herein and should not be used for any application or purpose other than that stated herein. The scope of this report includes focusing on the geotechnical aspects of the project and does not include hydrogeological or environmental components. However, a hydrogeological investigation was carried out by Stantec in conjunction with this geotechnical investigation. The hydrogeological investigation report is provided under a separate cover.

Use of this report is subject to the Statement of General Conditions provided in **Appendix A**.

2.0 PREVIOUS SITE INVESTIGATIONS

Borehole information from previous site investigations available to Stantec at the time of this report were reviewed as general background information for consideration during the preparation of this report, which are as follows:

- 2004 investigation by CH2M Hill (Project 122843)
- 2010 investigation by CH2M Hill (Project Number Unknown)
- 2013 investigation by Stantec (Project 160321331)

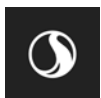
The 2004 investigation by CH2M Hill included four (4) boreholes with monitoring wells (MW04-1 to MW04-4) and six (6) boreholes without monitoring wells (BH04-1 to BH04-6).

The 2010 investigation by CH2M Hill included four (4) boreholes with monitoring wells (MW1-10 to MW4-10).

The 2013 investigation by Stantec included three (3) boreholes with monitoring wells (BH4-13, BH15-13, BH18-13) and twenty-one (21) boreholes without monitoring wells (BH1-13 to BH24-13, minus the three previously mentioned).

The borehole logs from the above listed investigations are included in **Appendix C**, and the locations of the boreholes are shown on the Borehole Location Plan in **Appendix B**.

It should be noted that there may be other previous investigations carried out by others not mentioned in this Subsection, however not provided to Stantec.



SITE DESCRIPTION

3.0 SITE DESCRIPTION

3.1 LOCATION AND CURRENT LAND USE

The Site is situated in the City of Waterloo, Ontario, on the north side of Erb Street West and on the east side of Wilmot Line as illustrated on the Site Location Plan on Drawing No. 1 in **Appendix B**. The Site is approximately 43 hectares (106 acres) in size and comprises an existing golf course, agricultural fields, an existing temporary storm water management (SWM) pond, a few small ponds, and some clusters of trees.

The Site is bordered to the north by Columbia Street West; to the south by Erb Street West and commercial properties; to the east by Hydro One corridor and agricultural fields; and, to the west by Wilmot Line and residential properties fronting onto Wilmot Line.

3.2 TOPOGRAPHY

Based on the topographical information on the Proposed Grading Plan, prepared by Stantec (Drawing C-400, Revision 0), the local surficial topography falls outwards from the highest point at the Site, which is a ridge (kame moraine) that extends from the southwest corner of the Site and ending near the centre of the overall property. There is a ground relief of up to about 20 m between borehole locations. The maximum difference in elevations at borehole locations is observed between the highest point on the ridge near the centre of the Site and the lowest point at the northeast corner of the Site.

Ground surface elevations at the borehole locations were surveyed by the Stantec Geomatics group. The borehole elevations and locations are provided on the Borehole Location Plan on Drawing No. 1 in **Appendix B** and on the Borehole Logs in **Appendix C**.

3.3 REGIONAL GEOLOGY

The physiology of Southern Ontario, by Chapman and Putman (1984), indicates that the site is situated within the physiographic region known as the Waterloo Hills. The Waterloo Hills has surficial geology that is "composed of sandy hills, some of them being ridges of sandy till while others are kame and kame moraines, with outwash sands occupying the intervening hollows".

In general, the surficial geology generally comprises clay to silt till from glaciolacustrine deposits.

4.0 PROPOSED DEVELOPMENT

4.1 OVERVIEW

Based on the Concept Plan, it is understood that the proposed plan of subdivision will include the extension of a collector road and two (2) new internal roadways serving approximately forty-three (43) hectares of business



METHOD OF INVESTIGATION

employment uses. The proposed development will also include a stormwater management pond, walkway blocks, a park block, and a servicing corridor.

5.0 METHOD OF INVESTIGATION

5.1 FIELD INVESTIGATION

Prior to commencing the field investigation, the various public utility companies were consulted to identify where public utilities crossed the property boundaries. In addition, a private locator was contracted to clear the boreholes of any private on-site services.

The fieldwork for the investigation was carried out between May 1 and 8, 2017. A total of seventeen (17) boreholes (BH01-17 to BH17-17) were advanced for this geotechnical investigation at the locations shown on the Borehole Location Plan, Drawing 1 in **Appendix B**.

The boreholes were advanced using a track mounted drill rig equipped with hollow-stem augers operated by a specialist drilling subcontractor. Stantec personnel recorded the subsoil and groundwater conditions encountered in the boreholes. The soil samples were recovered at regular 0.76 m and 1.52 m intervals using a 51 mm (outside diameter) split-tube sampler by conducting Standard Penetration Tests (SPTs) in accordance with the procedures outlined in ASTM specification D1586. Pocket penetrometer tests were performed on cohesive soil samples to determine approximate shear strengths. All soil samples recovered from the boreholes were placed in moisture-proof bags and returned to our laboratory for detailed geotechnical classification and testing as required.

Groundwater monitoring wells were installed in seven (7) boreholes (BH01-17, BH02-17, BH05-17, BH07-17, BH09-17, BH11-17, BH17-17), and the water levels were measured by Stantec personnel on May 17 and 18, 2017. The monitoring wells consisted of 50 mm inside diameter, Schedule 40 PVC pipe, with a No. 10 slot screen (0.01-inch slot) with a minimum screen length of 1.5 m. The annular space between the monitoring well pipe and surrounding geological formation was backfilled with well sand to the top of screen, with the remainder of the annular space being filled with a granular bentonite to prevent a hydraulic connection from occurring between the soil layers along the length of the casing.

The boreholes without monitoring wells were backfilled with a low-permeability mixture of granular bentonite and auger spoils in accordance with the requirements of the Ontario Ministry of the Environment and Climate Change (MOECC) Regulation 903/90 as amended 128/03.

5.2 BOREHOLE LOCATION AND ELEVATION SURVEY

The coordinates and elevations collected by Stantec's Geomatics division are provided in Table 5.1 below.



METHOD OF INVESTIGATION

Table 5.1 Borehole Elevations and Coordinates

Borehole Number	Elevation (m)	Easting (UTM)	Northing (UTM)
BH01-17	387.5	533731	4810907
BH02-17	391.3	533746	4810668
BH03-17	394.1	533811	4810569
BH04-17	386.3	533675	4810912
BH05-17	393.2	533435	4810718
BH06-17	396.0	533504	4810674
BH07-17	392.7	533708	4810475
BH08-17	396.5	533768	4810359
BH09-17	400.7	533835	4810232
BH10-17	396.9	533351	4810613
BH11-17	396.3	533406	4810463
BH12-17	406.3	533565	4810421
BH13-17	396.5	533579	4810290
BH14-17	406.1	533735	4810145
BH15-17	395.1	533246	4810605
BH16-17	392.0	533327	4810398
BH17-17	396.3	533536	4810207

The borehole locations are shown on the Borehole Location Plan Drawing No. 1 in **Appendix B**.

5.3 GEOTECHNICAL LABORATORY TESTING PROGRAM

All samples recovered from the geotechnical investigation were returned to Stantec's geotechnical and materials testing laboratory and were visually examined by a geotechnical specialist.

The scope of the geotechnical laboratory testing program is outlined below in Table 5.2.

Table 5.2 Geotechnical Laboratory Testing Program

Laboratory Test	Number of Samples Tested
ASTM D2216-10 – Natural Moisture Content	Selected 85 samples
ASTM D422-63 (2007) – Grain Size Distribution with Hydrometer	9
ASTM D4318-10 – Atterberg Limits	3

The results of the laboratory tests are discussed in the text of this report. The results of the moisture content tests are shown on the Borehole Records in **Appendix C**. The results of the grain size distribution tests and Atterberg Limits Tests are reported on the borehole records and are illustrated on the Figures 1, 2 and 3 in **Appendix D**.



RESULTS OF INVESTIGATION

Samples remaining after testing will be placed in storage for a period of three months after issue of this geotechnical report. After the storage period, the samples will be discarded.

6.0 RESULTS OF INVESTIGATION

6.1 SUBSURFACE CONDITIONS

6.1.1 Frame of Reference & Overview

The soils encountered in the boreholes and reported herein have been classified in accordance with the Unified Soil Classification System (USCS) as defined in ASTM D2487-11 and D2488-09a, with modifications consistent with the methods of the Ontario Ministry of Transportation (MTO).

The subsurface conditions encountered in the boreholes are presented in detail on the Borehole records provided in **Appendix C**. An explanation of the symbols and terms used to describe the Borehole Records is also included in **Appendix C**.

The stratigraphic boundaries shown on the borehole logs are inferred from non-continuous sampling and should be considered approximate only. Variations to the conditions reported and discussed herein must be anticipated.

6.1.2 General Subsurface Stratigraphy

In general, the subsurface stratigraphy encountered in the boreholes advanced on the subject property generally consisted of topsoil underlain by glacial till. The glacial till is comprised of predominantly clay till; however, silty sand till is present in some of the hills in the central and southern parts of the site. Sand layers were encountered in the glacial till in some areas. A sand deposit was also encountered below the lower limit of the glacial till in some of the deeper boreholes.

Bedrock was not encountered in the boreholes advanced for this investigation.

6.2 SOIL STRATIGRAPHY

The following sections summarize the soil strata encountered in all boreholes and completed for the current investigation.

6.2.1 Topsoil/Topsoil Fill

Topsoil or topsoil fill was encountered at the ground surface in all boreholes and extended to depths of 50 mm to 600 mm below the existing ground surface, with an average of approximately 250 mm.



RESULTS OF INVESTIGATION

6.2.2 Fill

Fill was encountered at surface in boreholes BH03-17, BH05-17, and BH16-17 and extended to depths between 1.5 m and 2.3 m below existing grade. The fill was heterogeneous and comprised silty sand, sandy silt, silty clay. Occasional rootlets and topsoil inclusions were encountered.

The N-values obtained from the SPTs advanced in the fill ranged from 2 to 9. The moisture content of the fill materials ranged from 13 to 33%, which is indicative of moist to wet moisture conditions.

The results of two (2) grain size analyses tests completed on samples of the fill material are shown below in Table 6.1 and shown on Figures No. 1 and 2, provided in **Appendix D**.

Table 6.1 Grain Size Distribution – FILL

Borehole	Sample	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH03-17	SS3	1.8	FILL	0	15	69	16
BH16-17	SS2	1.1	FILL	0	15	67	18

6.2.3 Silt (ML)

A stratum of silt was encountered below the topsoil in boreholes BH02-17 and BH04-17 and extended to depths of 0.8 m and 1.5 m below existing grade.

The N-values obtained from the SPTs advanced in this stratum ranged from 6 to 19, which are indicative of loose to compact compactness condition. The moisture content of this material ranged from 13 to 16%, which is indicative of moist to wet moisture conditions.

6.2.4 Silty Clay (CL-ML)

A stratum of silty clay was encountered below the topsoil in boreholes BH06-17 and BH10-17 and extended to a depth of 0.8 m below existing grade.

The N-values obtained from the SPTs advanced in this stratum ranged from 2 to 4. A pocket penetrometer result indicated an approximate shear strength of 30 kPa, which indicate the clay materials had a firm consistency.

The clay materials were described as about the plastic limit (APL) at the time of the fieldwork.

6.2.5 Sandy Clay, Silty Clay, Sandy Silty Clay (CL, CL-ML) Till

Strata of sandy clay, silty clay, or sandy silty clay till were encountered in all boreholes, except in BH14-17. The clay till were encountered below topsoil in boreholes BH01-17, BH07-17, BH09-17, BH11-17 to BH13-17, BH15-17; below fill in boreholes BH03-17, BH05-17, and BH16-17; below silt in boreholes BH02-17 and BH04-17; below clay in borehole BH06-17; below sand in boreholes BH08-17 and BH10-17; and, below sand till in boreholes BH14-17 and



GEOTECHNICAL INVESTIGATION - WATERLOO WEST SIDE EMPLOYMENT LANDS, ERB STREET W AND WILMOT LINE, WATERLOO, ONTARIO

RESULTS OF INVESTIGATION

BH17-17. The clay till extended below the borehole termination depths in the above-mentioned boreholes, except in boreholes BH06-17 and BH11-17, where the lower limit was encountered at depths of 6.1 to 10.6 m.

The N-values obtained from the SPTs advanced in these strata ranged from 4 to 35. Pocket penetrometer results indicated undrained shear strengths ranging between 25 kPa to greater than 200 kPa. Based on the N-values and pocket penetrometer results, the soil was assessed as being firm to hard, but generally very stiff with increasing depth. The moisture content of these materials ranged from 10 to 23%, which is indicative of drier than the plastic limit (DTPL) to wetter than the plastic limit (WTPL) moisture conditions.

The results of five (5) grain size analyses tests completed on samples of these soils are shown below in Table 6.2 and shown on Figures No. 1 and 2, provided in **Appendix D**.

Table 6.2 Grain Size Distribution – Sandy Clay, Silty Clay, Sandy Silty Clay (CL, CL-ML) Till

Borehole	Sample	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH01-17	SS7	6.4	Sandy Clay (CL) TILL	9	21	44	26
BH06-17	SS6	4.9	Sandy Silty CLAY (CL-ML) TILL	13	32	38	17
BH07-17	SS8	7.9	Sandy Silty Clay (CL) TILL	10	33	44	13
BH09-17	SS6	4.9	Sandy Clay (CL) TILL	5	19	48	28
BH17-17	SS5	3.4	Sandy Silty Clay (CL-ML) TILL	4	27	49	20

The results of three (3) Atterberg limits tests completed on samples of these soils are shown below in Table 6.3 and shown on Figure No. 3 in **Appendix D**.

Table 6.3 Atterberg Limits Test Results – Sandy Clay, Silty Clay (CL, CL-ML) Till

Borehole	Sample	Depth (m)	Description	Liquid Limit	Plastic Limit	Plasticity Index	Moisture Content (%)
BH01-17	SS7	6.4	Sandy Clay (CL) TILL	24	12	12	12
BH07-17	SS8	7.9	Sandy Silt (ML) TILL	15	11	4	11
BH17-17	SS5	3.4	Sandy Silty Clay (CL-ML) TILL	17	10	7	12

Based on the results of the testing referenced above, this soil is classified as Sandy Clay, Silty Clay, Sandy Silty Clay (CL, CL-ML) Till, in accordance with the USCS. For purposes of this report, this soil is referred to as Clay Till.

6.2.6 Silty Sand (SM) Till

A stratum of silty sand till was encountered in boreholes BH12-17, BH14-17, and BH17-17 below topsoil or clay till and had a thickness of 0.9 m to 2.9 m. The silty sand till extended to depths ranging between 1.5 m and 3.1 m below existing grade.



RESULTS OF INVESTIGATION

The N-values obtained from the SPTs advanced in this soil ranged from 4 to 29, which indicated that the soil was in a loose to compact compactness condition. The moisture content of these materials ranged from 6 to 22%, which is indicative of moist to wet moisture conditions.

The results of two (2) grain size analyses tests completed on samples of this soil are shown below in Table 6.4 and shown on Figure No. 2, provided in **Appendix D**.

Table 6.4 Grain Size Distribution – Silty Sand (SM) Till

Borehole	Sample	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH12-17	SS3	1.8	Silty Sand (SM) TILL	11	49	28	12
BH14-17	SS4	2.6	Silty Sand (SM) TILL	9	53	24	14

Based on the results of the testing referenced above, this soil is classified as Silty Sand (SM) Till, in accordance with the USCS. For purposes of this report, this soil is referred to as Sand Till.

6.2.7 Sand, Silty Sand (SP, SP-SM)

Strata of sand and silty sand were encountered beneath the topsoil in borehole BH08-14; beneath or interlayered within the clay till in boreholes BH04-17, BH09-17, BH11-17, and BH15-17; beneath the clay in borehole BH10-17; beneath the silt till in borehole BH06-17; and, beneath the sand till in borehole BH14-17. The sand strata extended to borehole termination depths in BH06-17, BH11-17, and BH14-17. The sand strata ranged in thickness from 0.7 m to 2.7 in boreholes BH04-17, BH08-17, BH09-17, BH10-17, and BH15-17.

The N-values obtained from the SPTs advanced in these strata ranged from 7 to 29, which indicated that the sand was in a loose to compact compactness condition. The moisture content of this material ranged from 3 to 17%, which is indicative of moist to wet moisture conditions.

Based on the visual observations of the samples from these strata, the soils are classified as Sand or Silty Sand (SP, SP-SM), in accordance with the USCS. For purposes of this report, this soil is referred to as Sand.

6.3 GROUNDWATER CONDITIONS

Free groundwater was measured in eight (8) of the open boreholes upon completion of drilling, in boreholes BH01-17, BH03-17 to BH06-17, BH08-17, BH09-17, BH13-17, BH15-17 to BH17-17 at depths ranging between 1.5 m and 11.0 m below existing grades. In general, the free groundwater noted in the boreholes were likely due to seepage from wet seams in the till, or from wet sand soils. The measured free groundwater elevations in the above open boreholes ranged from 381.4 m to 393.5 m. It should be noted that the boreholes did not remain open for a sufficient period for equilibration to occur.

50 mm diameter monitoring wells were installed in seven (7) boreholes (boreholes BH01-17, BH01-17, BH05-17, BH07-17, BH09-17, BH11-17, and BH17-17) to measure the static groundwater levels. Groundwater levels in the monitoring wells were measured at depths ranging between 1.1 and 10.1 m below existing grades, which correspond



RESULTS OF INVESTIGATION

to elevations ranging between 380.5 m and 395.2 m. The measured groundwater levels are presented in detail on the Borehole Records provided in **Appendix C** and summarized in the following Table 6.5.

Table 6.5 Groundwater Level Measurements

Borehole Number	Date of Measurement	Groundwater Level	
		Depth (m)	Elevation (m)
BH01-17	May 17, 2017	7.01	380.49
BH02-17	May 17, 2017	10.14	381.11
BH05-17	May 18, 2017	1.32	391.91
BH07-17	May 18, 2017	2.09	390.65
BH09-17	May 18, 2017	10.11	390.55
BH11-17	May 17, 2017	5.46	390.83
BH17-17	May 17, 2017	1.12	395.16

Fluctuations in the above stabilized groundwater levels should be anticipated throughout the various seasons.

6.4 ANALYTICAL CHEMISTRY RESULTS

6.4.1 Corrosion Analyses

Two (2) samples of the native soils were submitted to AGAT Laboratories in Mississauga, Ontario for analysis of resistivity, pH, redox potential, and concentrations of sulphides. The results of these tests can be used as an indicator of the corrosiveness of the soil.

The test results are summarized in Table 6.6 below with reference to the ANSI/AWWA Point Rating for the potential for corrosion of ductile iron pipe in contact with soil and groundwater. The moisture content conditions were assessed based on the results of the moisture content tests conducted as a component of the geotechnical testing program.



RESULTS OF INVESTIGATION

Table 6.6 Results of Chemical Analysis and ANSI/AWWA Soil Corrosivity Potential

Parameter	Sample Information			
Borehole No.	BH01-17		BH17-17	
Sample No.	SS3		SS3	
Median Depth (m)	1.8		1.8	
Sample Description	Sandy Clay Till		Sandy Silty Clay Till	
Parameter	Measured Values	ANSI / AWWA Point Rating	Measured Values	ANSI / AWWA Point Rating
Resistivity, (Ohm-cm)	4,420	0	8,850	0
pH	7.90	0	8.17	0
Redox Potential, (mV)	242	0	240	0
Sulphides, (%)	< 0.05	0	< 0.05	0
Moisture	Wet	2	Wet	2
Total ANSI / AWWA Points	2		2	

The ANSI/AWWA rating system considers a score of 10 points or more indicative of the potential for corrosion of buried steel (less than 10 points indicates no potential for corrosion of buried steel).

Based on the ANSI/AWWA rating system, the samples of the existing soil are considered non-corrosive.

It is noted that other factors may influence the corrosion potential, such as the application of deicing salts that leach into the soil, or the presence of stray electrical currents.

Copies of the results of the chemical analysis are included in **Appendix E** for reference.

6.4.2 Sulphates in Soil

Two (2) samples of the native soils were submitted to AGAT Laboratories for analysis of the concentration of soluble sulphates. The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater and can be used as a reference to select the appropriate cement type to be used in buried concrete applications. The results of the testing are shown in Table 6.7 below.

Table 6.7 Results of Chemical Analysis for Soluble Sulphates

Borehole No.	Sample No.	Median Depth of Sample (m)	Soluble Sulphates (µg/g)
BH01-17	SS3	1.8	125
BH17-17	SS3	1.8	3

Soluble sulphate concentrations less than 1000 µg/g generally indicate that a low degree of sulphate attack is expected for concrete in contact with soil and groundwater.



DESIGN DISCUSSION & RECOMMENDATIONS

The results of testing of the soil samples indicate that a low degree of sulphate attack is expected for concrete in contact with the respective soils.

In consideration of the results of the testing, Type GU Portland Cement would be suitable for use in buried concrete in contact with the materials indicated.

Copies of the results of the chemical analysis are included in **Appendix E** for reference.

7.0 DESIGN DISCUSSION & RECOMMENDATIONS

It should be noted that only limited design information which included the servicing concept plan by Stantec was available at the time of this report. No finalized design information such as finished grade elevations, location of building footprints, and underside of footing elevations were available at the time of this report.

7.1 SUBSURFACE CONDITIONS OVERVIEW

The subsurface conditions encountered in the boreholes advanced for the geotechnical investigation generally consisted of topsoil underlain by glacial till. The glacial till is comprised of predominantly clay till; however, silty sand till is present in some of the hills in the central and southern parts of the site. Sand layers were encountered in the glacial till in some areas. A sand deposit was also encountered below the lower limit of the glacial till in some of the deeper boreholes.

Groundwater was measured at depths of between 1.1 and 10.1 m below existing grades. Groundwater is typically perched in seams within the glacial till, or above the glacial till in sandy deposits.

Bedrock was not encountered in the boreholes advanced at the site for this investigation.

7.2 GEOTECHNICAL CONSIDERATIONS AND CONSTRAINTS

The following general development considerations and constraints are provided with respect to observations made during the preliminary investigation, the subsurface conditions encountered, and the intended scope of development:

- Free groundwater was observed at Elevations ranging between 381.5 m and 395.2 m within the monitoring wells. It is inferred that the free groundwater is typically perched in wet seams within the glacial till, or perched in sandy deposits above the glacial till;
- Existing fill was encountered in localized areas. The existing fill material is not suitable to remain below proposed building or pavement areas;
- Significant grading is anticipated to be needed in order to prepare the land for the proposed development. In general, the native soils will be suitable for re-use; however, the fine texture of the predominant native soils will make grading problematic in wet or cold weather;
- The native clayey soils can be blocky, and extra compactive effort including thin lifts and heavy sheepfoot packers will be needed to properly break down this soil for re-use as trench backfill in order to prevent post-construction settlements; and,
- Following grading and servicing, site specific geotechnical investigations are recommended for each block to aid in building design.



DESIGN DISCUSSION & RECOMMENDATIONS

Additional geotechnical comments, discussion, and recommendations are provided in the following sections with respect to the design and construction of the planned building.

7.3 GRADING AND EARTHWORKS

7.3.1 General

The proposed Grading Plan identifies the preliminary finished grading of the development. It is anticipated that significant grading operations will be undertaken. In general, the existing grades between the southwest corner and the centre of the site are the highest, with the lowest elevations at the northeast corner. There is an existing temporary SWM Pond along the east property edge; however, this pond will be decommissioned once a larger stormwater management block is constructed in the hydro corridor.

The program for grading and earthworks should be designed in advance, and carefully executed in consideration of the time of year of execution, prevailing weather conditions, construction storm-water management control, and associated issues and concerns, and the intended end-use of the subject property as described herein.

All fill materials imported to the subdivision must meet all applicable municipal, provincial, and federal guidelines and requirements associated with environmental characterization of the materials.

7.3.2 Erosion & Sediment Control and Regulatory Constraints

An erosion and sediment control plan should be developed and implemented prior to commencement of construction, to direct precipitation and ground surface runoff away from the areas of construction. Identification of an outfall/discharge location will be required for this purpose. All erosion sedimentation control should be conducted in accordance to the approved for construction design drawings.

7.3.3 Sub-Excavation and Proof Rolling

Existing fill was encountered in a number of localized areas, and additional areas of existing fill should be anticipated, particularly in the north end of site, where a golf course is currently located. All existing fill and topsoil must be removed from below proposed building and pavement areas.

Following stripping, sub-grade in areas of proposed fill are to be inspected by geotechnical personnel to ensure that all unsuitable materials are removed. Any soft clay till, loose silty sand, loose sand till, or disturbed areas identified during site preparation or during general construction activities, are to be removed and replaced with approved Engineered Fill, as referenced below.

The exposed sub-grade surface should be proof rolled and compacted across the entire area of the planned development. The proof rolling program should be undertaken using large, vibratory compaction equipment having a minimum static weight of 10 tonnes.



7.3.4 Engineered Fill Placement

Prior to engineered fill placement under proposed buildings areas, the existing fill material and unsuitable native soils must be removed from under the proposed building footprint plus a horizontal distance beyond the periphery sufficient to allow engineered fill pad construction. The engineered fill pad must extend horizontally 2 m beyond the edge of proposed footings, and then downwards and outwards at a slope of 1 horizontal to 1 vertical to competent soil. Geotechnical comments with respect to excavations re provided in Section 7.4.2.

Subsequent to completing the stripping and removal of topsoil and fill materials, the exposed native subgrade surfaces are expected to consist primarily of glacial till and sand soils. The exposed subgrade surface should be inspected to confirm the removal of any deleterious materials, organics, or loose/soft materials or wet zones. Where such materials are identified, they should be removed, and the areas backfilled with engineered fill in accordance with the recommendations provided below.

Engineered fill will need to be benched into any native slopes steeper than 2 horizontal to 1 vertical. The benching should be excavated with heights match engineered fill lift thicknesses of 300 mm.

Excavation in the native mineral soils should be straight forward using large tracked excavating equipment, or motor scrapers. Further comments with respect to reuse of this soil are provided below.

If imported fill materials are required for raising the grade on site, it is recommended that granular materials or materials with characteristics similar to the native soils on site (as described in this report) be imported for this purpose. Additional details with respect to materials recommended for use during periods of poor weather conditions are discussed below. Imported Granular 'B' (recommended) or OPSS SSM are recommended for use as engineered fill below buildings. Other soil types may also be suitable but must be tested and confirmed as acceptable by a geotechnical engineer prior to being imported to site.

All materials placed as engineered fill should be placed in 300 mm thick loose lifts. Each lift should be uniformly compacted to achieve a minimum of 100% of the material's Standard Proctor Maximum Dry Density (SPMDD).

7.3.5 Subgrade Fill Placement

Subgrade fill placement will also be required to raise grade under proposed roads and paved areas. The preparations of the subgrade prior to subgrade fill placement should be the same as for the engineered fill.

Any fill placed in paved areas should be placed in 300 mm thick loose lifts compacted to at least 95% SPMDD. The excavated native mineral soils should be suitable for reuse as subgrade fill placement, but moisture conditioning such as drying may be required.

7.3.6 Adverse Weather Construction

Additional precautions, effort, and measures may be required, when and where construction is undertaken during late fall, winter, and early spring when the temperature and climatic conditions have an adverse influence on the standard construction practices or during periods of inclement weather.



DESIGN DISCUSSION & RECOMMENDATIONS

With respect to all earthworks activities undertaken during the late fall through to late spring, when less-than-ideal construction conditions may prevail, the following comments are provided:

1. It is recommended that engineered fill under the buildings should comprise granular materials, such as imported Granular 'B' or OPSS SSM.
2. The intended area of fill should be clearly identified in the field prior to commencing the work.
3. Temporary ramps or roads for construction access must be constructed outside of the limits of intended fill.
4. Fill placement should be inspected by qualified field personnel on a full-time basis under the supervision of a geotechnical engineer, with the authority to stop the placement of fill at any time when conditions are considered to be unfavourable.
5. Imported materials that contain ice, snow, or any frozen material should not be accepted for use.
6. Overnight frost penetration may occur, even in granular fill materials, where precipitation and ground surface runoff pools and accumulates, and freezing temperatures exist. Any frozen materials must be removed prior to placing subsequent lifts of engineered fill. Breaking the frost in-situ is not considered acceptable.
7. It may be necessary to stop the placement of engineered fill during periods of cold, where ambient temperatures of -5°C or less, occur.

It should be noted that the placement of engineered fill materials during cold weather conditions requires extra effort beyond that typical when better climatic conditions prevail. At any time where conditions are deemed unfavourable, the engineered fill operation must be suspended. Any frost accumulating in placed silty/clayey fill must be removed prior to re-starting fill operations.

Appropriate scheduling of the work may also require specific consideration and revision from the typical adopted. The scope of work intended may have to be reduced or adjusted, and/or only select construction activities are undertaken during specific climatic conditions. The areas of planned engineered fill may have to be reduced on a daily basis, the extent of excavations may have to be limited, with all excavating and associated backfilling completed without delay.

7.4 SERVICING

7.4.1 General Servicing Overview

Following grading, the subdivision will be serviced to provide water and sewer services to the various lots and blocks. The Proposed Underground Servicing Plan, prepared by Stantec (Drawing C-100, Revision 0), for the development indicates that sewers will typically be at conventional depths below finished grade throughout the majority of the site but may be more than 6 m below finished grade in the north end of the site. The predominant soils expected to be encountered during servicing are clay till. Some seepage should be anticipated from wet sand seams within the clay till, and any localized saturated sandy deposits perched above the clay till.

7.4.2 Excavations

Temporary excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA).

The native soils encountered in the boreholes can be classified as a Type 2 soil. The excavation side slopes for a Type 2 soil may be near vertical in the bottom 1.2 m of excavation, above which the maximum inclination is 1:1



DESIGN DISCUSSION & RECOMMENDATIONS

(Horizontal: Vertical) from the base of excavation in accordance with the OSHA regulation, in accordance with the OSHA regulation.

Any soils encountered that extend below the groundwater level and exhibit seepage should be classified as Type 4 soil. The maximum excavation side slope for a Type 4 soil is 3:1 (Horizontal: Vertical) in accordance with the OSHA regulation, in accordance with the OSHA regulation.

The side slopes of the excavations in soils should be protected from exposure to precipitation and associated ground surface runoff, to prevent further softening and loss of strength of these fill materials and soils that could lead to additional sloughing and caving.

If space is restricted such that the side slopes cannot be safely cut back in accordance with the OSHA Regulation, or sloughing and cave-in are encountered in the excavation, the slopes should be flattened to achieve a stable configuration or temporary shoring must be provided.

Any seepage encountered during the proposed construction should be handled by pumping from sumps using conventional submersible pumps provided the excavations remain open for a short period of time, less than 48 hours.

If localized instability is noted during excavation or if wet conditions are encountered, the side slopes should be flattened to a stable configuration.

7.4.3 Bedding

Bedding for services should consist of OPSS Granular 'A' material. In general, a minimum of 150 mm of bedding and 300 mm of cover material is recommended.

The bedding and cover material should be compacted to achieve a minimum of 100% of the material's SPMD.

These recommendations should be confirmed with the pipe manufacturer and care must be taken to avoid incurring damage to the services. Pipe manufactures may have additional/alternative requirements that should be reviewed by the Designer and Contractor prior to installation of the services.

7.4.4 Trench Backfill

Backfill for sewer trenches may consist of the on-site native soils, subject to the constraints and limitations stated with respect to reuse of these soils. The use of imported Granular 'B' may also be considered for use as necessary to augment the available on-site materials.

All trench backfill placed should be placed in 300 mm thick loose lifts and compacted to a minimum of 98% SPMD for the full thickness of the backfill.

It should be noted that on-site clayey materials can be blocky, and extra care will be needed to break down the materials during backfilling. If the interlump voids are not broken down during the placement, then long-term settlement could occur. If blocky soils are noted in the backfill, the lift thicknesses should be reduced to 200 mm or thinner, and heavy sheepsfoot packers should be used.



DESIGN DISCUSSION & RECOMMENDATIONS

7.4.5 Municipal Infrastructure Backfilling

Where manholes and catch basins are required for the sewer or reinstatement of existing manholes and catch basins is required, these components should be constructed and backfilled in accordance with specifications outlined in OPSS 407: Construction Specification for Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation.

Settlements around manholes are common, and the settlements can be reduced by backfilling immediately around the manhole structure using OPSS Granular 'B' Type I material.

7.4.6 Dewatering

A hydrogeological investigation was completed in conjunction with the geotechnical investigation. Results of the hydrogeological investigation report are provided under separate cover for details related to groundwater and dewatering.

7.5 ROAD DESIGN AND CONSTRUCTION

Following are grading in accordance with the recommendations provided in the previous sections of this report, the site will be suitable for construction of municipal roads. The following pavement structures are recommended based on the anticipated subgrade conditions and City of Waterloo standards. For local roads, the recommended sub-base thickness has been increased from City Standards due to the silty/clayey nature of the soils.

Table 7.1 Recommended Pavement Structures

Material	Design Pavement Structure Thicknesses (mm)	
	Collector Road	Local Road
HL3 PG 64-28 Top course	40	40
HL8 PG 64-28 Base course	50	50
OPSS 1010 Granular 'A' Base	150	150
RWSSP 1010 Granular 'B' Type I Sub-base	500	400

These structures should provide a typical pavement service life, provided regular maintenance is carried out during the life cycle of the pavements. The above pavement structure recommendations are based on typical expected use along with anticipated subgrade conditions. It should be noted that no traffic data was provided to Stantec at the time of this design, and thus a detailed pavement design analyses was not carried out.

The base and sub-base materials should be compacted to a minimum of 100% SPMDD. The asphaltic concrete should be compacted to a minimum of 92% of Maximum Theoretical Relative Density (MTRD).



DESIGN DISCUSSION & RECOMMENDATIONS

Due to the poor drainage nature of the existing fill and native soils, pavement subdrains are recommended along the edges of road, below the curbs. The subdrains should comprise 100 mm diameter perforated corrugated pipe with filter sock bedded in concrete sand. The top of pipe should be below the lower limit of the granular subbase, and the subgrade below the subbase should slope towards the subdrains. The subdrains should outlet to a suitable frost-free outlet such as a catch basin.

7.6 BUILDING CONSTRUCTION

7.6.1 General Building Construction Overview

Following grading, servicing, and road construction, it is anticipated that commercial or industrial buildings will be constructed on the various lots and blocks. It is recommended that site-specific geotechnical investigations be undertaken to aid in the design of each building. The following provides preliminary input on building design following grading.

7.6.2 Foundations

The following geotechnical bearing resistances for factored Ultimate Limit States (ULS) and Serviceability Limit States (SLS) on Table 7.2 can be utilized for conventional shallow footings constructed on undisturbed native mineral soils or on approved engineered fill.

Table 7.2 Geotechnical Bearing Resistances

Factored ULS Bearing Resistance (kPa)	SLS Bearing Resistance (kPa)
225	150

The Ultimate Limits States (ULS) values provided above include a resistance factor of 0.5. The Serviceability Limits States (SLS) reaction values have been evaluated to provide a total settlement of 25 mm (or less) and differential settlement of 19 mm.

Some of the native soil deposits are suitable to provide higher bearing resistances. These higher bearing resistances (if applicable) should be determined through the geotechnical investigations for the individual lots or blocks.

The footings must be provided with a minimum of 1.2 m of soil cover for frost protection. Where construction is undertaken during winter conditions, the footing subgrade must be protected from freezing.

Foundation drainage is not required provided the buildings are constructed without basements, and exterior finished grades slope away from the buildings.

Foundation walls should be backfilled with free-draining granular material such as OPSS Granular 'B' Type 1. The exterior (perimeter) wall backfill should be placed in loose lifts having a maximum thickness of 300 mm. Each lift should be uniformly compacted using suitable compaction equipment for the purpose intended, to achieve a minimum of 95% of the material's SPMD.



DESIGN DISCUSSION & RECOMMENDATIONS

The National Building Code specifies that structures should be designed to withstand forces due to earthquake. For the purpose of earthquake design the relevant geotechnical information required based on the conditions at this site is the "Site Class".

For shallow spread or strip footing foundations, we recommend that Site Class D be applied to this site, in accordance with Table 4.1.8.4.A of the National Building Code (2010).

A copy of the NBC Seismic Hazard Calculation Data sheet prepared by Natural Resources Canada is provided in **Appendix F** for reference.

The peak horizontal ground acceleration (PGA) for various return periods based on the Natural Resource Canada values are summarized below in Table 7.3 for reference.

Table 7.3 Summary of Peak Horizontal Ground Accelerations

Return Period	Probability of Exceedance in 50 years	PGA (g)
100 yrs.	40%	0.0080
475 yrs.	10%	0.023
2500 yrs.	5%	0.037

7.6.3 Floor Slabs

Conventional slab-on-grade floors should be suitable for use for the proposed development provided the sub-grade is prepared as outlined in Section 7.3 above.

A layer of free-draining granular material such as OPSS Granular 'A', at least 200 mm thick, should be placed immediately beneath the slabs. This layer will act as a leveling course and as a moisture break under the floor slabs. This material should be compacted to achieve a minimum of 100% of the material's SPMDD.

7.7 SITE MATERIALS REUSE

7.7.1 Existing Fill

The existing fill materials (encountered in boreholes BH03-17, BH05-17, and BH16-17) will need to be sub-excavated from below proposed building and pavement areas. These soils can either be removed from site or re-used in landscaped areas. The excavated fill is not suitable for reuse as engineered fill, trench backfill, granular base and sub-base materials. Additional areas of localized fill should be anticipated, particularly in the north end of the site where a golf course is currently located.

7.7.2 Topsoil

The existing topsoil will need to be stripped from below proposed building and pavement areas. The topsoil can either be removed from site or re-used in landscaped areas. The excavated topsoil is not suitable for reuse as engineered fill, trench backfill, granular base and sub-base materials.



7.7.3 Silt, Clay, Clay Till

These soils may be considered for reuse as subgrade fill and engineered fill; however, the clayey materials could be difficult to work with, depending on their moisture levels, and the climatic conditions at the time of use. The results of the gradation analyses on these materials indicate that the soils consist of mainly of silt and clay size particles, with some to trace sand and gravel. The high in-situ moisture content and high percentage of clay and silt will make these soils difficult to handle, place, and compact, in any "less-than-ideal" weather conditions. Disturbance and loss of strength in the presence of excess moisture and/or construction traffic is a concern. It is recommended that reuse of this soil be limited to prevailing "dry" conditions and during favourable seasons.

The material can be blocky and will require breaking down during placement. It should be ensured that the material be placed in thin lifts and compacted using a sheepfoot roller. If these soils are placed without being sufficiently broken down or placed in thick lifts, interlump voids could occur which will cause long term settlement.

This material should be placed with moisture contents that are within +/- 2.0% of the optimum moisture content level. It is recommended that the material be approved at the time of placement by qualified geotechnical personnel. Due to the high in-situ moisture content of the silt or clay materials, scarifying and drying may be required prior to placement.

This material is assessed as having moderate to high frost susceptibility in accordance in accordance to Section 3.1.5 of the MTO's Pavement Design and Rehabilitation Manual.

This material should not be considered as free draining. Therefore, this soil should not be used as backfill in any application requiring the use of free draining material, such as for drainage layers, foundation wall backfill, service pipe bedding, or sub-base and base layers in pavements.

7.7.4 Sand, Silty Sand, and Sand Till

These soils are considered suitable for reuse as subgrade fill, engineered fill, and as backfill in trenches to the finished sub-grade level.

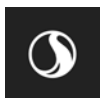
The material is assessed as having moderate frost susceptibility in accordance to Section 3.1.5 of the MTO's Pavement Design and Rehabilitation Manual.

This material should not be considered as free draining unless additional laboratory testing is carried out at the time of construction to confirm low levels of fines are present. Therefore, this soil should not be used as backfill in any application requiring the use of free draining material, such as for drainage layers, service pipe bedding, or sub-base and base layers in pavements.

7.8 SURFACE WATER MANAGEMENT

7.8.1 Storm Water Management Facility

The storm water management facility that will service the subdivision will be located in the hydro corridor, east of the northeast end of the subdivision. Stantec has previously conducted a geotechnical investigation for the storm water management facility, and we refer to our March 3, 2014 report under project number 160321331 for particulars.



CLOSURE

7.8.2 Estimates of Hydraulic Conductivity

For estimates of hydraulic conductivity of the predominant soil encountered at the site, please refer to the Hydrogeological Assessment report conducted under a separate cover by Stantec, Project No. 161413446.

8.0 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in **Appendix A**. It is the responsibility of The City of Waterloo who is identified as “the Client” within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report;
- Basis of the report;
- Standard of care;
- Interpretation of site conditions;
- Varying or unexpected site conditions; and,
- Planning, design or construction.

This report has been prepared by David Lee and reviewed by Jeff Dietz.

Respectfully Submitted,

STANTEC CONSULTING LTD.



APPENDICES

Appendix A

Appendix A

A.1 STATEMENT OF GENERAL CONDITIONS



STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or subsurface conditions are present upon becoming aware of such conditions.

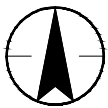
PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

Appendix B

Appendix B

B.1 DRAWINGS





JULY 2018
PROJECT No. 161413446



	BOREHOLE (2017 INVESTIGATION, STANTEC)
	BOREHOLE (2013 INVESTIGATION, STANTEC)
	BOREHOLE (2010 INVESTIGATION, CH2MHILL)
	BOREHOLE (2004 INVESTIGATION, CH2MHILL)
	GROUND SURFACE ELEVATION (m)

Client/Project

Drawing No.

Title

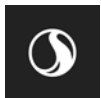
BOREHOLE LOCATION PLAN

Appendix C

Appendix C

C.1 SYMBOLS & TERMS USED ON BOREHOLE RECORDS

C.2 BOREHOLE RECORDS



SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

<i>Rootmat</i>	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
<i>Topsoil</i>	- mixture of soil and humus capable of supporting vegetative growth
<i>Peat</i>	- mixture of visible and invisible fragments of decayed organic matter
<i>Till</i>	- unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

<i>Desiccated</i>	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
<i>Fissured</i>	- having cracks, and hence a blocky structure
<i>Varved</i>	- composed of regular alternating layers of silt and clay
<i>Stratified</i>	- composed of alternating successions of different soil types, e.g. silt and sand
<i>Layer</i>	- > 75 mm in thickness
<i>Seam</i>	- 2 mm to 75 mm in thickness
<i>Parting</i>	- < 2 mm in thickness

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%
<i>Frequent</i>	> 20%

Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
<i>Very Loose</i>	<4
<i>Loose</i>	4-10
<i>Compact</i>	10-30
<i>Dense</i>	30-50
<i>Very Dense</i>	>50

Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
<i>Very Soft</i>	<0.25	<12.5	<2
<i>Soft</i>	0.25 - 0.5	12.5 - 25	2-4
<i>Firm</i>	0.5 - 1.0	25 - 50	4-8
<i>Stiff</i>	1.0 - 2.0	50 - 100	8-15
<i>Very Stiff</i>	2.0 - 4.0	100 - 200	15-30
<i>Hard</i>	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	Very Poor Quality
25-50	Poor Quality
50-75	Fair Quality
75-90	Good Quality
90-100	Excellent Quality

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	Crushed
Severely Fractured	Shattered or Very Blocky
Fractured	Blocky
Moderately Jointed	Sound
Intact	Very Sound

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	Extremely Wide	-
2000-6000	Very Wide	Very Thick
600-2000	Wide	Thick
200-600	Moderate	Medium
60-200	Close	Thin
20-60	Very Close	Very Thin
<20	Extremely Close	Laminated
<6	-	Thinly Laminated

Terminology describing rock strength:

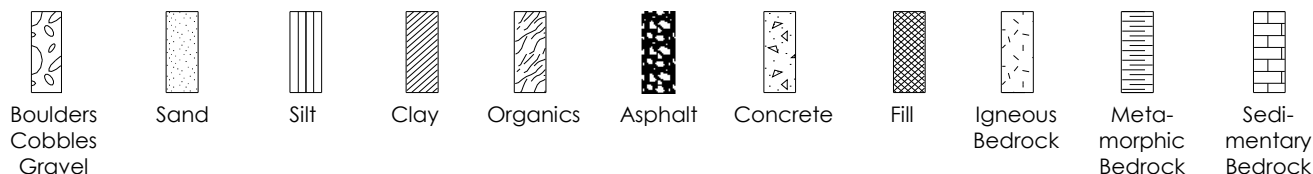
Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

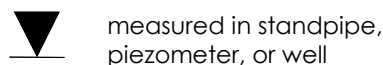
Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT



measured in standpipe, piezometer, or well



inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
y	Unit weight
G _s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q _u	Unconfined compression
I _p	Point Load Index (I _p on Borehole Record equals I _p (50) in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 3, 2017 WATER LEVEL May 17, 2017 TPC ELEVATION 388.42

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50 100 150 200											
WATER CONTENT & ATTERBERG LIMITS																W _p W W _L		DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼		STANDARD PENETRATION TEST, BLOWS/0.3m ●	
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		TOPSOIL 125 mm			1	SS	1	510 610	7	●	○	△									
		Stiff to very stiff sandy clay (CL)			2																
		TILL			3																
1		- trace gravel			4	SS	2	460 610	14	●			△								
	386.0	- APL-WTPL			5																
		- hard			6	SS	3	460 610	20	○	●						>>△				
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7					22																
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	379.9				24																
8		END OF BOREHOLE approximately 7.6 m below existing grade.			25																
					26																
					27																
					28																
9		Water noted in open borehole at approximately 6.1 m below existing grade. 50 mm monitoring well installed in borehole screened from approximately 6.1 m to 7.6 m below existing grade.			29																
					30																
					31																
					32																
10	Continued Next Page									☐ Field Vane Test, kPa ☒ Remoulded Vane Test, kPa ☐ Pocket Penetrometer Test, kPa											

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- Field Vane Test, kPa
- Remoulded Vane Test, kPa
- △ Pocket Penetrometer Test, kPa

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 3, 2017 WATER LEVEL May 17, 2017 TPC ELEVATION 388.42

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50	100		150
	377.5	Water level measured at 7.0 m below existing grade on May 17, 2017			33								
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☐ Field Vane Test, kPa
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CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 3, 2017 WATER LEVEL May 17, 2017 TPC ELEVATION 392.21

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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- ☐ Field Vane Test, kPa
- ☒ Remoulded Vane Test, kPa
- ☐ Pocket Penetrometer Test, kPa

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 4, 2017 WATER LEVEL _____ TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
 Pocket Penetrometer Test, kPa

CLIENT City of Waterloo PROJECT No. 161413446
LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
DATES: BORING May 3, 2017 WATER LEVEL _____ TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 2, 2017 WATER LEVEL May 18, 2017 TPC ELEVATION 394.24

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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- ☐ Field Vane Test, kPa
- ☒ Remoulded Vane Test, kPa
- ☐ Pocket Penetrometer Test, kPa

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 2, 2017 WATER LEVEL May 18, 2017 TPC ELEVATION 394.24

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) / TCR(%) / SCR(%)	N-VALUE OR RQD(%)											
10	383.2	approximately 9.8 m below existing grade. Water noted in open borehole approximately 6.1 m below existing grade. 50 mm monitoring well installed in borehole screened from approximately 5.2 m to 6.7 m below existing grade. Water level measured at 1.3 m below existing grade on May 18, 2017.			33					WATER CONTENT & ATTERBERG LIMITS DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▽ STANDARD PENETRATION TEST, BLOWS/0.3m ● 10 20 30 40 50 60 70 80 90 100										
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CLIENT City of Waterloo

PROJECT No. 161413446

LOCATION Erb Street and Wilmot Line, Waterloo, Ontario

DATUM _____

DATES: BORING May 2, 2017

WATER LEVEL _____

TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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- Field Vane Test, kPa
- Remoulded Vane Test, kPa
- △ Pocket Penetrometer Test, kPa

[illegible]

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 4, 2017 WATER LEVEL May 18, 2017 TPC ELEVATION 393.62

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50 100 150 200											
										WATER CONTENT & ATTERBERG LIMITS DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m											
										10 20 30 40 50 60 70 80 90 100											
0	392.7	Tall Grass Field			0																
		TOPSOIL 600 mm			1	SS	1	330 610	5		●		○								
	392.1				2																
1		Firm to stiff, brown sandy clay (CL) TILL			3																
	391.7	- trace gravel			4	SS	2	380 610	9		●		○								
		- moist			5																
2		Stiff, brown silty clay (CL) TILL			6	SS	3	380 610	11		●	○			△						
		- some sand, trace gravel			7																
	390.5	- moist			8																
3		Very stiff, grey, sandy silty clay (CL-ML) TILL			9	SS	4	460 610	17		○	●			△						
		- trace gravel			10																
		- APL			11	SS	5	510 610	16		○	●			△						
4					12																
					13																
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8					26	SS	8	510 610	16		○	●									
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9					29																
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					31	SS	9	560 610	25		○	●				△					
	383.0				32																
10		END OF BOREHOLE																			
Continued Next Page										□ Field Vane Test, kPa ■ Remoulded Vane Test, kPa △ Pocket Penetrometer Test, kPa											

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- Field Vane Test, kPa
- Remoulded Vane Test, kPa
- △ Pocket Penetrometer Test, kPa

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 4, 2017 WATER LEVEL _____ TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50 100 150 200											
										WATER CONTENT & ATTERBERG LIMITS DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m											
										W _p W W _L											
0	396.5	Tall Grass Field			0																
	396.1	TOPSOIL 400 mm			1	SS	1	180 610	6												
1		Loose, brown silty SAND (SP-SM) - trace gravel - moist			2																
			3	SS	2	200 610	9														
	395.0				4																
2		Stiff to very stiff, brown, sandy clay (CL) TILL - trace gravel - APL-WTPL			5																
			6	SS	3	560 610	15														
					7																
3		Compact, brown silty SAND (SP) - some clay, trace gravel - wet			8	SS	4	460 610	16												
			9																		
	393.5				10																
4		Very stiff to hard, grey, sandy clay (CL) TILL - trace gravel - APL-WTPL			11	SS	5	380 610	18												
			12																		
	392.7				13																
5					14																
			15																		
					16	SS	6	460 610	17												
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					31	SS	9	460 610	35												
					32																
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- Field Vane Test, kPa
- Remoulded Vane Test, kPa
- △ Pocket Penetrometer Test, kPa

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 4, 2017 WATER LEVEL _____ TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) / TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50	100	
10	386.5				33							
					34							
					35							
11					36	SS	10	510 / 610	32			
					37							
					38							
					39							
12					40							
					41	SS	11	580 / 610	26			
	383.7				42							
13		END OF BOREHOLE approximately 12.8 m below existing grade.			43							
					44							
					45							
14		Water noted in open borehole approximately 8.8 m below existing grade.			46							
					47							
					48							
15					49							
					50							
					51							
16					52							
					53							
					54							
17					55							
					56							
					57							
18					58							
					59							
					60							
19					61							
					62							
					63							
					64							
20					65							

☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 5, 2017 WATER LEVEL May 18, 2017 TPC ELEVATION 401.55

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50	100	
10	390.7				33							
					34							
					35							
11					36	SS	10	560 610	31			
					37							
					38							
					39							
12					40							
					41	SS	11	580 610	28			
	387.9				42							
13		END OF BOREHOLE approximately 12.8 m below existing grade.			43							
					44							
					45							
14		Water noted in open borehole at approximately 11.0 m below existing grade. 50 mm monitoring well installed in borehole screened from approximately 10.7 m to 12.2 m below existing grade.			46							
					47							
					48							
15					49							
					50							
		Water measured at 10.1 m below existing grade on May 18, 2017.			51							
					52							
16					53							
					54							
					55							
17					56							
					57							
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18					59							
					60							
					61							
19					62							
					63							
					64							
20					65							

☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 1, 2017 WATER LEVEL _____ TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)											
0	396.9	Grass			0															
	396.6	TOPSOIL 300 mm			1	SS	1	610 / 610	2											
	396.1	Firm, brown silty CLAY (CL-ML) - trace sand and gravel - APL			2															
1		Compact, brown silty SAND (SP-SM) - trace clay - moist			3	SS	2	360 / 610	16											
	395.4				4															
2		Very stiff to hard, brown, sandy clay (CL) TILL - trace gravel - APL			5															
					6	SS	3	560 / 610	22											
					7															
					8															
					9	SS	4	530 / 610	28											
3	393.9	- stiff, grey - WTPL			10															
	393.3				11	SS	5	510 / 610	9											
4		END OF BOREHOLE approximately 3.7 m below existing grade.			12															
					13															
					14															
					15															
5		Borehole open and dry upon completion of drilling.			16															
					17															
					18															
					19															
6					20															
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					22															
7					23															
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☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING _____ WATER LEVEL May 17, 2017 TPC ELEVATION 397.13

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
 Pocket Penetrometer Test, kPa

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 4, 2017 WATER LEVEL _____ TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)											
0	406.3	Grass			0					50 100 150 200 WATER CONTENT & ATTERBERG LIMITS DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m W_p W W_L										
	405.9	TOPSOIL 300 mm			1	SS	1	560 / 610	4	10 20 30 40 50 60 70 80 90 100 11 49 28 12										
1		Firm, brown, sandy clay (CL) TILL - trace gravel - APL-WTPL			2															
					3	SS	2	560 / 610	5											
	404.7				4															
2		Loose to compact, brown, silty sand (SM) TILL - trace gravel - wet to moist			5															
					6	SS	3	460 / 610	9											
					7															
					8															
					9	SS	4	460 / 610	14											
3	403.2				10															
		Stiff, brown, sandy clay (CL) TILL - trace some gravel - APL			11	SS	5	430 / 610	16											
					12															
4					13															
					14															
					15															
5					16	SS	6	510 / 610	15											
					17															
					18															
					19															
6					20															
					21	SS	7	460 / 610	13											
	399.5				22															
7		END OF BOREHOLE approximately 6.7 m below existing grade.			23															
					24															
					25															
8		Borehole open and dry upon completion of drilling.			26															
					27															
					28															
					29															
9					30															
					31															
					32															
10																				

☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
 Pocket Penetrometer Test, kPa

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 4, 2017 WATER LEVEL _____ TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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☐ Field Vane Test, kPa
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CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 5, 2017 WATER LEVEL _____ TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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CLIENT City of Waterloo

 PROJECT No. 161413446

 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario

DATUM _____

 DATES: BORING May 1, 2017

WATER LEVEL _____

TPC ELEVATION _____

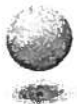
DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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- ☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

CLIENT City of Waterloo PROJECT No. 161413446
 LOCATION Erb Street and Wilmot Line, Waterloo, Ontario DATUM _____
 DATES: BORING May 8, 2017 WATER LEVEL May 17, 2017 TPC ELEVATION 397.22

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
 Pocket Penetrometer Test, kPa



CH2MHILL

RECORD OF MONITORING WELL: MW04-1

Location Coordinates:

Northing: 4810274 m

Easting: 533713 m

LOCATION: City of Waterloo: Scoped Subwatershed Study (307 & 314)

DRILLER: Atcost Soil Drilling Inc.

MOE WELL TAG #: A005260

DATED/DRILLED: January 14, 2004

TOP OF PIPE: 392.356 masl

GROUND ELEVATION: 391.70 masl

LOGGED BY: B Neck

DRILLING METHOD: CME 85 with 0.2-m dia. HSA

DEPTH (mbgs)	SAMPLES		SOIL DESCRIPTION	STRATA PLOT	MONITORING WELL DETAILS		⊕ ORGANIC VAPOUR READINGS PID (ppm)			
	Recovery (m)	TYPE			(masl) ELEV. DEPTH (mbgs)		25	50	75	100
			Topsoil (OL/OH): Dark brown topsoil, silt with fine sand, rootlets							
	0.46	SS 1	3		391.50					
			SILT with Sand (ML): SILT with fine sand, trace clay, moist, soft.		0.20					
		AUGER								
			SILT with Clay (CL/ML): Dark brown to black SILT with clay, moist, soft, small, orange oxidation spots, trace fine sand		390.94					
			Groundwater measured at 0.905 mbgs on Jan. 19/04.		0.76					
			Groundwater measured at 0.93 mbgs on Jan. 23/04.		390.80					
1	0.28	SS 2	5		0.91					
			Silty SAND (SM): Silty SAND, light brown, moist becoming wet at 1.8 mbgs, soft; at 2.0 mbgs increasing pebbles, trace fine gravel, at 2.13 mbgs trace coarse gravel, trace clay.		390.77					
					0.93					
		AUGER								
	0.38	SS 3	6		390.40					
					1.30					
		AUGER								
2			SILT (ML): Grey SILT trace fine sand and clay, moist, soft becoming firm, trace clasts; at 2.75 mbgs brown silt, trace clay and fine sand, moist (coarse sand with pebbles found in tip of split spoon).		389.41					
					2.29					
	0.29	SS 4	10							
		AUGER								
3			SILT TILL (ML): Grey SILT TILL, trace clay and fine sand, trace clasts, damp, grey throughout, firm.		388.65					
					3.05					
	0.38	SS 5	8							
		AUGER								
			CLAYEY SILT TILL (CL/ML): CLAYEY SILT TILL, hard, damp, trace clasts, grey, small oxidation spot noted, occasional blue clay streaks, trace sand.		387.89					
					3.81					
4	0.81	SS 6	14							
		AUGER								
			Borehole terminated at 4.57 mbgs.		387.13					
					4.57					
5										

**CH2MHILL****RECORD OF MONITORING WELL: MW04-2**

Location Coordinates:

Northing: 4810704 m

Easting: 533962 m

LOCATION: City of Waterloo: Scoped Subwatershed Study (307 & 314)

DRILLER: Atcost Soil Drilling Inc.

MOE WELL TAG #: A005260

DATE DRILLED: January 15, 2004

TOP OF PIPE: 377.834 masl

GROUND ELEVATION: 377.01 masl

LOGGED BY: B Neck

DRILLING METHOD: CME 85 with 0.15-m dia. SSA

DEPTH (mbgs)	SAMPLES		SOIL DESCRIPTION	STRATA PLOT	MONITORING WELL DETAILS		ORGANIC VAPOUR READINGS PID (ppm)			
	Recovery (m)	TYPE			ELEV (masl)	DEPTH (m)				
1	0.30	SS 1	Topsoil (OL/OH): Grassy surface, dark brown topsoil, sandy silt trace clay, rootlets, organics, trace pebbles, moist.		376.81	0.20				
			Sandy SILT (ML): Sandy SILT trace clay, moist, soft, brown.		376.62	0.39				
			Groundwater measured at 0.39 mbgs on Jan. 23/04. Groundwater measured at 0.4 mbgs on Jan. 19/04.		376.61	0.40				
2	0.3	SS 2	SILT with Sand (ML): Light brown SILT with fine sand, moist, soft; at 2.59 mbgs wet, dark brown with sand with gravel.		376.25	0.76				
			CLAYEY SILT TILL (CL/ML): CLAYEY SILT TILL, firm, tan mottling, clasts, moist to damp, with sand, trace gravel.		375.49	1.52				
			As above, tan mottling, damp, trace small clasts, trace fine sand.							
3	0.61	SS 4	As above, brown throughout, soft to firm, trace fine to medium grained sand.							
			As above, dark brown, soft to firm, large clasts, trace gravel.							
			As above, trace fine to medium sand.							
4	0.41	SS 6	As above, trace fine to medium sand.							
			As above, trace fine to medium sand.							
			As above, trace fine to medium sand.							
5	0.57	SS 7	As above, trace fine to medium sand.		371.83	5.18				
			Borehole terminated at 5.18 mbgs.							

ANDYMW2 122843.GPJ CG&S.GDT 2/5/04



Location Coordinates:

Northing: 4810260 m

Easting: 534063 m

LOCATION: City of Waterloo: Scoped Subwatershed Study (307 & 314)

DRILLER: Alcost Soil Drilling Inc.

MOE WELL TAG #: A005260

DATEDRILLED: January 15, 2004

TOP OF PIPE: 392.225 masl

GROUND ELEVATION: 391.520 masl

LOGGEDBY: B. Neck

DRILLING METHOD: CME 85 with 0.15-m dia. SSA

DEPTH (mbgs)	SAMPLES			SOIL DESCRIPTION	STRATA PLOT	MONITORING WELL DETAILS		ORGANIC VAPOUR READINGS PID (ppm)			
	Recovery (m)	TYPE	SPT (N-count)			ELEV. (masl)	DEPTH (mbgs)				
				Topsoil (OL/OH): Grassy surface, dark brown topsoil, sandy silt trace clay, rootlets, organics, moist, loose		391.32	0.20	Cement seal at surface to secure steel protective casing (above ground)			
	0.46	SS 1	3	Sandy SILT (ML): Sandy SILT with clay, moist, soft, dark brown.				Bentonite gravel seal			
		AUGER									
1						390.50	1.02	Silica sandpack No. 1			
	0.57	SS 2	3	CLAYEY SILT TILL (CL/ML): Brown to light grey CLAYEY SILT TILL, trace fine sand, speckled with tan mottling, moist, very soft.		390.33	1.20				
		AUGER		Groundwater measured at 1.195 mbgs on Jan. 19/04.		390.18	1.34				
				Groundwater measured at 1.34 mbgs on Jan. 23/04.		390.00	1.52	51 mm-dia. Schedule 40 PVC well riser pipe			
	0.23	SS 3	3	Sandy SILT (ML): Sandy SILT, trace clay, sporadic small pockets (<0.10 m thick) of peat and organics with silt, black, decomposition odour noted, wet.		389.69	1.83	51 mm-dia. machine slotted (10-slot) Schedule 40 PVC well screen			
		AUGER		CLAYEY SILT TILL (CL/ML): Brown to light grey CLAYEY SILT TILL, with fine sand, light tan mottling, moist, very soft.		389.23	2.29	0.15 m-diameter borehole (solid stem augers used for drilling)			
2				Unknown stratigraphy (sample unrecoverable). Inside of split spoon wet when retrieved.							
	0.03	SS 4	13			388.62	2.90				
		AUGER		CLAYEY SILT TILL (CL/ML): CLAYEY SILT TILL, trace sand, grey to brown in colour, some tan mottling, damp, firm.							
3						387.71	3.81				
	0.43	SS 5	12	Sandy SILT (ML): Sandy SILT trace clay, damp, brown, fine grained, firm.		386.95	4.57	Bentonite gravel seal at bottom of borehole.			
		AUGER		CLAYEY SILT TILL (CL/ML): CLAYEY SILT TILL, trace sand, brown, trace small clasts, damp, firm, hard.							
4						386.34	5.18				
	0.61	SS 6	12								
		AUGER									
5											
	0.61	SS 7	19								
		AUGER									
				Borehole terminated at 5.18 mbgs.							

**CH2MHILL****RECORD OF MONITORING WELL: MW04-4**

Location Coordinates:

Northing: 4810459 m

Easting: 533186 m

LOCATION: City of Waterloo: Scoped Subwatershed Study (307 & 314)

DRILLER: Atcost Soil Drilling Inc

MOE WELL TAG #: A005260

DATE DRILLED: January 16, 2004

TOP OF PIPE: 395.329 masl

GROUND ELEVATION: 394.5 masl

LOGGED BY: B Neck

DRILLING METHOD: CME 85 with 0.15 m dia SSA

DEPTH (m,gs)	SAMPLES		SOIL DESCRIPTION	STRATA PLOT	(masl) ELFV. DEPTH (m,gs)	MONITORING WELL DETAILS		ORGANIC VAPOR READINGS PID (ppm)			
	Recovery (m)	TYPE						25	50	75	100
			Topsoil (OL/OH): Dark brown topsoil, silt with fine sand, rootlets								
			Sandy SILT (ML): Brown sandy SILT with clay, tan mottling, moist to wet, very soft Groundwater measured at 0.245 mbgs on Jan. 19/04 Groundwater measured at 0.25 mbgs on Jan. 23/04		394.30 0.20 394.26 0.25 394.25 0.25		Cement seal at surface Bentonite gravel seal				
1			As above, wet				Silica sandpack No. 1 51 mm-dia. Schedule 40 PVC well riser pipe				
			CLAYEY SILT TILL (CL/ML): Grey with brown CLAYEY SILT TILL trace sand, wet, very soft		392.98 1.52		51 mm-dia. machine slotted (10-slot) Schedule 40 PVC well screen				
2			Silty SAND (SM): Brown, silty SAND trace clay, moist to wet.		392.37 2.13		0.15 m-diameter borehole (solid stem augers used for drilling)				
	AUGER										
3			As above with pebbles								
			CLAYEY SILT TILL (CL/ML): CLAYEY SILT TILL, with coarse sand, soft to firm, grey to dark brown, moist.		390.23 4.27						
4			Borehole terminated at 4.57 mbgs.		389.93 4.57						
5											

ANDYMW2 122843.GPJ CG&S.GDT 2/5/04

Location Coordinates:

Northing: 4810084 m

Easting: 533789 m

LOCATION: City of Waterloo: Scoped Subwatershed Study (307 & 314)

DRILLER: Atcost Soil Drilling Inc.

MOE WELL TAG #

DATE DRILLED: January 14, 2004

TOP OF PIPE: masl

GROUND ELEVATION: 400.492 masl

LOGGEDBY: B.Neck

DRILLING METHOD: CME 85 with 0.15-m dia. SSA

DEPTH (mbgs)	SAMPLES			SOIL DESCRIPTION	STRATA PLOT	MONITORING WELL DETAILS		⊕ ORGANIC VAPOUR READINGS PID (ppm)						
	Recovery (m)	TYPE	SPT (N-count)			ELEV. DEPTH (mbgs)		25	50	75	100			
	0.43	SS 1	2	Topsoil (OL/OH): Corn stubble at surface, dark brown topsoil, sandy silt, rootlets, soft.			Bentonite gravel seal at top of borehole							
		AUGER		Sandy SILT (ML): Sandy SILT, brown to dark brown, soft, trace rootlets, occasional worm holes, moist.		400.03 0.46								
1	0.45	SS 2	12	SILT TILL (ML): SILT TILL with clasts, firm, brown, damp, trace sand		399.52 0.97	Backfilled with clean auger cuttings.							
		AUGER		CLAYEY SILT TILL (CL/ML): CLAYEY SILT TILL, hard, damp, tan mottling, grey to brown, trace gravel.		399.32 1.17								
	0.61	SS 3	27	As above, brown with tan mottling, some grey, orange oxidation at approximately 1.63 mbgs										
2		AUGER		As above, at 1.94 mbgs, trace medium gravel, some orange oxidation spots, trace medium sand pockets										
	0.61	SS 4	30	As above with clasts.										
		AUGER		Becoming dark brown at 2.59 mbgs, trace coarse sand pockets (black), small orange oxidation spots, damp.										
3	0.61	SS 5	21	As above, some blue clay streaks, damp, hard, some small oxidation spots at 3.05 mbgs.			0.15-m diameter borehole (solid stem augers used for drilling)							
		AUGER												
4	0.61	SS 6	17											
		AUGER		As above, dark brown, damp, hard.										
5	0.61	SS 7	19				Bentonite gravel seal at bottom of borehole.							
		AUGER		As above, trace medium gravel, damp.										
	0.61	SS 8	20											
6				Borehole terminated at 5.94 mbgs.		394.55 5.94								



CH2MHILL

RECORD OF BOREHOLE:

BH04-2

Location Coordinates:

Northing: 4810005 m

Easting: 533530 m

LOCATION: City of Waterloo, Scoped Subwatershed Study (307 & 314)

DRILLER: Atcost Soil Drilling Inc.

MOE WELL TAG #

DATE DRILLED: January 14, 2004

TOP OFFPIPE: mast

GROUND ELEVATION: 396.576 masl

LOGGED BY: B.Neck

DRILLING METHOD: CME 85 with 0.15-m dia. SSA

DEPTH (mbgs)	SAMPLES			SOIL DESCRIPTION	STRATA PLOT	(masl) ELEV. DEPTH (mbgs)	MONITORING WELL DETAILS	ORGANIC VAPOUR READINGS PID (ppm)			
	Recovery(m)	TYPE	SPT (N-count)					25	50	75	100
1	0.43	SS 1	5	Topsoil (OL/OH): Corn stubble at surface, dark brown topsoil, sandy silt, rootlets, soft, rootlets.		396.38	Bentonite gravel seal at top of borehole				
				Sandy SILT (ML): Sandy SILT, brown, soft, trace pebbles damp		0.20					
1		AUGER									
	0.57	SS 2	3	PEAT (OL/OH): Pocket of PEAT and organics with sand and silt, black to dark brown, soft, moist		395.54	Backfilled with clean auger cuttings.				
				SAND and SILT (SW-SM): Reddish brown SAND and SILT trace clay, moist, soft		395.44					
1		AUGER									
				Sandy SILT (ML): Sandy SILT, trace clay, brown, soft, trace pebbles, moist		395.33					
2				CLAYEY SILT TILL (CL/ML): CLAYEY SILT TILL, clasts, trace coarse gravel, damp to moist, firm to hard, tan mottling, grey to brown in colour		395.06					
	0.56	SS 3	13			1.52					
2		AUGER									
3	0.61	SS 4	18	As above, at 2.64 mbgs a pocket of black and tan medium to coarse sand			0.15-m diameter borehole (solid stem augers used for drilling)				
		AUGER									
3	0.51	SS 5	14	As above with a thin orange oxidation layer at 3.28 mbgs. No mottling below 3.28 mbgs, moist, fewer clasts, hard, dark brown							
		AUGER		As above with thin orange oxidation layer.							
4	0.25	SS 6	>50	Split spoon refusal at 4.18 mbgs (likely a boulder). Auger to 4.57 mbgs			Bentonite gravel seal at bottom of borehole				
		AUGER									
5	0.61	SS 7	21	Silty SAND (SM): Silty SAND, brown, hard, fine to medium textured, grey to black coarse sand pockets, damp, compact to dense, trace clay		391.75					
				Sandy SILT TILL (ML): Sandy SILT TILL, trace clay, clasts, firm, small grey moisture pockets, brown grading to dark brown, generally damp		4.83					
5		AUGER		As above, dark brown, firm, moist to wet zone at 5.54 mbgs (25 mm-thick)		391.60					
						4.98					
6	0.56	SS 8	14								
				Borehole terminated at 5.94 mbgs.		390.64					
						5.94					

ANDYBH2 122B43.GPJ CG&S.GDT 2/5/04



Location Coordinates:

Northing 4810567 m

Easting 533408 m

LOCATION: City of Waterloo: Scoped Subwatershed Study (307 & 314)

DRILLER: Alcost Soil Drilling Inc.

MOE WELL TAG #

DATEDRILLED: January 15, 2004

TOP OF PIPE: masl

GROUND ELEVATION: 393.962 masl

LOGGEDBY: B.Neck

DRILLING METHOD: CME 85 with 0.15-m dia. SSA

DEPTH (mbgs)	SAMPLES		SOIL DESCRIPTION	STRATA PLOT	ELEV. DEPTH (mbgs)	MONITORING WELL DETAILS	ORGANIC VAPOUR READINGS PID (ppm)			
	Recovery (m)	TYPE					25	50	75	100
1	0.39	SS 1	3		393.76	Bentonite gravel seal at top of borehole.				
					0.20					
1	0.58	SS 2	6		393.20	Backfilled with clean auger cuttings.				
					0.76					
2	0.51	SS 3	17		392.16	0.15-m diameter borehole (solid stem augers used for drilling).				
					1.80					
3	0.56	SS 4	18		391.15					
					2.81					
4	0.58	SS 5	16		390.91					
					3.05					
5	0.61	SS 7	9			Bentonite gravel seal at bottom of borehole.				
6	0.61	SS 8	9		388.02					
					5.94					



CH2MHILL

RECORD OF BOREHOLE:

BH04-4

Location Coordinates:

Northing: 4810559 m

Easting: 533814 m

LOCATION: City of Waterloo, Scoped Subwatershed Study (307 & 314)

DRILLER: Atcost Soil Drilling Inc.

MOE WELL TAG #:

DATEDRILLED: January 15, 2004

TOP OF PIPE: masl

GROUND ELEVATION: 382.783 masl

LOGGEDBY: B.Neck

DRILLING METHOD: CME 85 with 0.15-m dia. SSA

DEPTH (mbgs)	SAMPLES			SOIL DESCRIPTION	STRATA PLOT	(masl) ELEV. DEPTH (mbgs)	MONITORING WELL DETAILS		ORGANIC VAPOR READINGS (ppm)			
	Recovery (m)	TYPE	SPT (N-count)						25	50	75	100
				Topsoil (OL/OH): Dark brown topsoil layer, sandy silt, rootlets, soft				Bentonite gravel seal at top of borehole				
	0.36	SS 1	3	Sandy SILT (ML): Dark brown to brown sandy SILT, damp, loose.		382.48 0.30						
		AUGER		As above, with fine gravel, no rootlets, fine to medium grained.				Backfilled with clean auger cuttings				
	0.30	SS 2	4									
		AUGER										
	0.56	SS 3	5	Silty SAND (SM): Wet silty SAND, trace fine gravel, fine to medium grained, brown, loose.		381.26 1.52						
		AUGER										
	0.47	SS 4	15	As above, brown layers visible in silty sand (approx. 1 cm thick), moist to wet, compact, no gravel.								
		AUGER										
	0.61	SS 5	22	Sandy SILT (ML): Fine sandy SILT, brown, damp, firm to hard, trace fine gravel and clay.		379.48 3.30						
		AUGER										
	0.45	SS 6	24	Silty SAND (SM): Moist to wet silty SAND, medium to coarse grained, compact to dense, brown, trace gravel and clay.		378.97 3.81						
		AUGER										
	0.45	SS 7	35									
		AUGER										
	0.41	SS 8	32	Sandy SILT (ML): Silty sand from above grading into sandy SILT, fine to coarse sand, brown, moist, firm to hard, trace clay.		377.80 4.98						
		AUGER										
				Borehole terminated at 5.94 mbgs.		376.84 5.94		Bentonite gravel seal at bottom of borehole.				

ANDYBH2 122843.GPJ CG&S.GDT 2/5/04



Location Coordinates:

Northing: 4810042 m

Easting: 534144 m

LOCATION: City of Waterloo: Scoped Subwatershed Study (307 & 314)

DRILLER: Atcost Soil Drilling Inc.

MOE WELL TAG #:

DATEDRILLED: January 15, 2004

TOP OF PIPE: masl

GROUND ELEVATION: 391.518 masl

LOGGEDBY: B.Neck

DRILLING METHOD: CME 85 with 0.15-m dia. SSA

DEPTH (mbgs)	SAMPLES			SOIL DESCRIPTION	STRATA PLOT	ELEV. DEPTH (mbgs)	MONITORING WELL DETAILS		ORGANIC VAPOUR READINGS PID (ppm)			
	Recovery(m)	TYPE	SPT (N-count)						25	50	75	100
1	0.27	SS 1	3	Topsoil (OL/OH): Corn stubble at surface. Dark brown topsoil layer, fine grained sandy silt trace clay, trace gravel, some small rootlets, soft.		391.32	Bentonite gravel seal at top of borehole					
				Silty SAND (SM): Fine silty SAND, trace clay, trace fine to medium grained, trace fine gravel, some small rootlets, brown, loose.		0.20						
		AUGER		As above, faint tan mottling, damp, loose.			Backfilled with clean auger cuttings					
	0.61	SS 2	2									
		AUGER										
	0.38	SS 3	13	SILT and SAND (SW-SM): Layered SILT and SAND, compact, moist to damp, fine grained, brown, trace clay. Wet silt and sand layer from 1.69 mbgs to 1.73 mbgs.		390.00						
		AUGER										
	0.56	SS 4	16									
		AUGER										
	0.55	SS 5	27	Sandy SILT (ML): Fine grained sandy SILT, brown, damp, crumbly (drier than plastic limit), trace clay, hard.		388.47						
		AUGER										
	0.61	SS 6	27	As above.								
		AUGER										
	0.61	SS 7	21									
		AUGER										
	0.61	SS 8	40	Silty SAND (SM): Damp silty SAND, brown, trace clay, fine grained, dense.		386.19						
		AUGER										
				Borehole terminated at 5.94 mbgs.		385.58						
						5.94	Bentonite gravel seal at bottom of borehole					

2/5/04

J CG8

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CH2MHILL

RECORD OF BOREHOLE:

BH04-6

Location Coordinates:

Northing: 4810142 m

Easting: 533407 m

LOCATION: City of Waterloo: Scoped Subwatershed Study (307 & 314)

DRILLER: Atcost Soil Drilling Inc.

MOE WELL TAG #

DATE DRILLED: January 16, 2004

TOP OF PIPE: masl

GROUND ELEVATION: 396.781 masl

LOGGED BY: B.Neck

DRILLING METHOD: CME 85 with 0.15-m dia. SSA

DEPTH (mbgs)	SAMPLES		SOIL DESCRIPTION	STRATA PLOT	MONITORING WELL DETAILS		ORGANIC VAPOUR READINGS (ppm)			
	Recovery (m)	TYPE			ELEV DEPTH (mbgs)		25	50	75	100
1	0.43	SS 1 2	<u>Topsoil (OL/OH)</u> : Grassy surface, dark brown topsoil layer, sandy silt, rootlets, soft, moist to damp		396.58					
		AUGER	<u>SILT with Clay (MH)</u> : Brown damp to moist SILT with clay, trace sand, soft		0.20					
1	0.45	SS 2 12	<u>CLAYEY SILT TILL (CL/ML)</u> : Brown CLAYEY SILT TILL, damp, drier than plastic limit, soft to firm, trace fine to coarse sand, small clasts		396.02					
		AUGER			0.76					
2	0.61	SS 3 27	Wet from 1.66 mbgs to 1.71 mbgs. Fine sand layer.							
		AUGER	Wet from 2.07 mbgs to 2.09 mbgs. Fine sand layer.							
3	0.61	SS 4 30	As above, becoming hard.		394.16					
		AUGER	<u>SAND (SW)</u> : Fine to medium clean sand, brown, well-graded, dense, damp, trace silt.		2.62					
4	0.61	SS 5 21	As above, dry to damp.							
		AUGER	As above, few brown and grey fine sand seams.							
5	0.61	SS 6 17	As above.							
		AUGER								
5	0.61	SS 7 19	As above, medium to coarse sand.							
		AUGER								
6	0.61	SS 8 20			390.68					
			Borehole terminated at 6.10 mbgs.		6.10					

ANDYBH2 122843.GPJ CG&S.GDT 2/5/04

TABLE 8-1
Groundwater Elevations
Phase II Investigation
Hergott Farm, Waterloo, ON

Well ID	Reference Elevation	Water Level	Groundwater Elevation
	Top of Pipe	mbgs	mAMSL
MW1-10	393.22	2.07	391.15
MW2-10	396.44	5.06	391.38
MW3-10	395.36	4.66	390.7
MW4-10	389.19	3.14	386.05
MW4-01	392.36	1.04	391.32

Notes:

mAMSL *metres above mean sea level*

mbgs *metres below ground surface*

**CH2MHILL****RECORD OF PIEZOMETER:****MW1-10**

Location Coordinates: Northing: 4810575 m Easting: 533715 m

LOCATION: Hergott Farm

TOP OF PIPE: 393.22 masl

DRILLER: Strata Soil Sampling

DATE DRILLED: February 1, 2010

GROUND ELEVATION: 392.05 masl

DRILLING METHOD: Geoprobe 7822DT w/ HSA

LOGGED BY: J. Divell

DEPTH (ft/bgs)	SAMPLES			SOIL DESCRIPTION	STRATA PLOT	(masl) ELEV. DEPTH (mbgs)	PIEZOMETER DETAILS	O pH SCREENING MEASUREMENT			
	Recovery (%)	TYPE	SPT (N-count)					6	7	8	9
							⊕ ORGANIC VAPOUR READINGS PID (cpm)				
								10	20	30	40
1				Fill: Loose, light brown sandy silt with medium diameter sub-angular gravel, frozen. Sandy silt and organics, dark brown/black, moist.			Concrete. Monument.				
2						391.44 0.61	Bentonite.				
3	60"	DP1		Very moist.							
4			MW1+Dip1	Wet.			Sand.				
5				Stiff, clayey silt with saturated sand seams throughout, interbedded.			10' screen, tip at 15' bgs.				
6			MW1+Dip2								
7											
8	60"	DP2									
9											
10				Saturated, APL							
11											
12				Sandy Clay: Firm to stiff, grey sandy clay, some silt, low plasticity, moist.		388.54 3.51					
13											
14				Clay with sand, trace silt, moist							
15						387.48 4.57					
				End of Borehole at 15' bgs							

DOW MW (FT) 398761.GPJ CG4S.GDT 2/12/10

**CH2MHILL****RECORD OF PIEZOMETER:****MW2-10**

Location Coordinates: Northing: 4810601 m Easting: 533655 m

LOCATION: Hergott Farm

TOP OF PIPE: 396.44 masl

DRILLER: Strata Soil Sampling

DATEDRILLED: February 1, 2010

GROUND ELEVATION: 395.7 masl

DRILLING METHOD: Geoprobe 7822DT w/ HSA

LOGGEDBY: J. Divell

DEPTH (ftbgs)	SAMPLES			SOIL DESCRIPTION	STRATA PLOT	ELEV. DEPTH (mbgs)	PIEZOMETER DETAILS		O pH SCREENING MEASUREMENT			
	Recovery (%)	TYPE	SPT (N-count)						6	7	8	9
									⊕ ORGANIC VAPOUR READINGS PID (ppm)			
									10	20	30	40
1	11"	DP1	Fill: Grass cover overlying dark brown topsoil, some sand and silt, trace organic litter, frozen.		395.09 0.61	Concrete. Monument						
			Very soft.			Bentonite.						
2			Silt: Firm, brown clayey silt, some fine sand, moist, non plastic.									
3												
4							Sand.					
5			Silt Till: Stiff, brown sandy clay, trace small diameter sub-angular gravel, very moist, weathered with horizontal fracturing.		394.18 1.52	10' screen, tip at 15' bgs.						
6												
7												
8	53"	DP2	Vertical sand seams, trace rootlets, wet, low plasticity.									
9		MW2										
10												
11			Uniform, very stiff, silt clay and fine sand, saturated pockets, wet, low plasticity.									
12												
13	56"	DP3										
14												
15			End of Borehole at 15' bgs		391.13 4.57							

DOW MW (FT): 398761.GPJ CG&S.GDT 2/12/10

**CH2MHILL****RECORD OF PIEZOMETER:****MW3-10**

Location Coordinates: Northing 4810526 m Easting 533839 m

LOCATION: Hergott Farm

TOP OF PIPE: 395.36 masl

DRILLER: Strata Soil Sampling

DATEDRILLED: February 1, 2010

GROUND ELEVATION: 394.68 masl

DRILLING METHOD: Geoprobe 7822DT w/ HSA

LOGGEDBY: J. Divell

DEPTH (ft/bgs)	SAMPLES		SOIL DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m/bgs)	PIEZOMETER DETAILS	pH SCREENING MEASUREMENT			
	Recovery (%)	TYPE					6	7	8	9
	SPT (N-count)						ORGANIC VAPOUR READINGS PID (ppm)			
							10	20	30	40
1			Fill: Brown sandy silt and topsoil, frozen.			Concrete. Monument.				
2			Dark brown silt, sand, and organics, frozen.			Bentonite.				
3			Sandy silt and medium diameter angular gravel, moist.							
4			Sandy Silt: Firm, brown sandy silt, fine sand, moist.		393.77 0.91					
5										
6			Clayey Silt Till: Firm to stiff, brown clayey silt, trace to some fine sand, large diameter gravel in structure, moist to very moist, low plasticity.		393.00 1.68					
7										
8			Medium grained sand seams in structure, very moist.							
9										
10			Sandy Silt: Brown sandy silt, medium sand, interbedded, very moist.		391.63 3.05					
11										
12			Wet with saturated pockets.							
13										
14			Silty Clay: Stiff, grey silty clay, moist, non plastic.		390.41 4.27					
15			End of Borehole at 15' bgs		390.11 4.57					

DOW MW (FT) 398761.GPJ CG&S.GDT 2/12/10

**CH2MHILL****RECORD OF PIEZOMETER:****MW4-10**

Location Coordinates: Northing: 4810685 m Easting: 533738 m

LOCATION: Hergott Farm

TOP OF PIPE: 389.19 masl

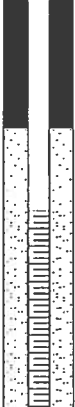
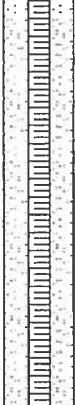
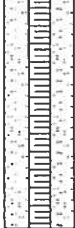
DRILLER: Strata Soil Sampling

DATE DRILLED: February 1, 2010

GROUND ELEVATION: 388.37 masl

DRILLING METHOD: Geoprobe 7822DT w/ HSA

LOGGED BY: J. Divell

DEPTH (ft/bgs)	SAMPLES			SOIL DESCRIPTION	STRATA PLOT	(masl) ELEV . DEPTH (mbgs)	PIEZOMETER DETAILS		O pH SCREENING MEASUREMENT				⊕ ORGANIC VAPOUR READINGS PID (ppm)				
	Recovery (%)	TYPE	SPT (N-count)						6	7	8	9					
1	51"	DP1		Fill; Hard, brown sandy silt and topsoil, frozen.		387.61 0.76		Concrete Monument.									
2				Soft, rootlets, silt with organics, some sand, moist.				Bentonite.									
3				Silt; Firm, dark brown silt, trace to some sand, moist, non plastic.													
4	57"	DP2						Sand.									
5				Very moist, medium plasticity.				10' screen, tip at 15' bgs.									
6																	
7	56"	DP3		Wet with sand seams, horizontal fracturing, weathered.		384.56 3.81											
8				Trace large diameter sub-angular gravel, wet.													
9																	
10						383.80 4.57											
11		Saturated, highly plastic.															
12																	
13				Clayey Silt; Stiff, brown clayey silt, trace sand seams, medium sand, moist, non plastic.													
14																	
15				End of Borehole at 15' bgs													

DOW MW (FT) 388761.GPJ CG&S GDT 2/12/10

CLIENT West Waterloo Retail LP

PROJECT No. 160321331

LOCATION 930 Erb Street Waterloo, Ontario

DATUM _____ Geodetic

DATES: BORING September 19, 2013

WATER LEVEL

TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%)
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
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										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
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										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
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										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										
										WATER CONTENT & ATTERBERG LIMITS										
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m										
										STANDARD PENETRATION TEST, BLOWS/0.3m										



Stantec

BOREHOLE RECORD

N: 4 811 081 E: 533 770

BH2-13

CLIENT West Waterloo Retail LP

PROJECT No. 160321331

LOCATION 930 Erb Street Waterloo, Ontario

DATUM Geodetic

DATES: BORING September 20, 2103

WATER LEVEL

TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50	100	
0	376.6	Farm field no crops			0							
	376.3	300 mm TOPSOIL			1	AS	1		-			
1		FILL: brown clayey silt some sand trace topsoil			2							
					3							
					4	SS	2	360 610	11			
2					5							
	374.3	Very stiff brown to grey silty CLAY (CL-ML) - moist to wet			6	SS	3	380 610	9			
					7							
					8	SS	4	430 610	15			
3					9							
					10							
					11	SS	5	510 610	17			
4					12							
					13							
					14	SS	6	460 610	17			
5					15							
					16	SS	7	430 610	21			
6					17							
					18							
					19							
7					20							
					21	SS	8	510 610	23			
8					22							
					23							
					24							
					25							
	368.4	End of Borehole			26	SS	9	610 610	17			
9					27							
		Groundwater level inferred in open borehole on completion of drilling			28							
10					29							
					30							
					31							
					32							
					33							
					34							
					35							
					36							
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					40							
					41							
					42							
					43							
					44							
					45							

☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa



Stantec

BOREHOLE RECORD

N: 4 810 989 E: 533 845

BH3-13

CLIENT West Waterloo Retail LP

PROJECT No. 160321331

LOCATION 930 Erb Street Waterloo, Ontario

DATUM Geodetic

DATES: BORING September 18, 2103

WATER LEVEL

TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50	100	
0	378.4	Farm field no crops			0							
	378.1	300 mm TOPSOIL			1	SS	1	0.0 / 610	4			
1		Very stiff brown to grey silty CLAY (CL-ML) with sand - moist to wet			2							
					3	SS	2	410 / 610	22			
2					4							
					5							
3					6	SS	3	330 / 610	23			
					7							
4					8	SS	4	480 / 610	20			
					9							
5		- grey			10							
					11	SS	5	460 / 610	27			
6					12							
					13							
7					14	SS	6	380 / 610	14			
					15							
8					16	SS	7	460 / 610	15			
					17							
9					18							
					19							
10					20							
					21	SS	8	0.0 / 610	23			
11					22							
					23							
12					24							
					25							
13					26	SS	9	510 / 610	27			
					27							
14		End of Borehole			28							
		No groundwater present in open borehole on completion of drilling			29							
					30							
					31							
					32							
					33							
					34							
					35							
					36							
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					43							
					44							
					45							

☐ Field Vane Test, kPa
☐ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

**Stantec****BOREHOLE RECORD**

N: 4 811 034 E: 533 729

BH4-13CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING September 19, 2103WATER LEVEL October 8, 2013TPC ELEVATION 379.71

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)											REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50 100 150 200																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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- ☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

**Stantec****BOREHOLE RECORD**

N: 4 810 986 E: 533 782

BH5-13CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING September 19, 2103

WATER LEVEL _____

TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50 100 150 200 WATER CONTENT & ATTERBERG LIMITS W_p W W_L DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼ STANDARD PENETRATION TEST, BLOWS/0.3m ● REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SL CL										
0	379.5	Brush and grass			0					10	20	30	40	50	60	70	80	90	100	
		150 mm TOPSOIL			1	AS	1		-	○										
1		Stiff brown to grey silty CLAY (CL-ML) with sand			2															
		- moist to wet			3															
					4	SS	2	360 610	11	●									△	
2		- grey			5															
					6	SS	3	410 610	15	●									△	
					7															
					8															
					9	SS	4	380 610	17	○●									△	
3					10															
					11	SS	5	510 610	11	●									△	
					12															
4					13															
					14	SS	6	530 610	17	○●									△	
					15															
5					16	SS	7	510 610	12	●									△	
					17															
6					18															
					19															
					20															
					21	SS	8	610 610	15	●									△	
7					22															
					23															
					24															
					25															
8	371.3	End of Borehole			26	SS	9	610 610	21	○●									△	
					27															
9		No groundwater present in open borehole on completion of drilling			28															
					29															
					30															
					31															
10					32															
					33															
					34															
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13					42															
					43															
					44															
14					45															

- ☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

**Stantec****BOREHOLE RECORD**

N: 4 811 059 E: 533 683

BH6-13CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING September 19, 2103

WATER LEVEL _____

TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50	100	
0	382.0	Brush and grass			0							
	381.8	225 mm TOPSOIL			1	AS	1		-			
1		FILL: brown clayey silt some sand trace topsoil			2							
					3							
					4	SS	2	300 610	6	•		
2					5							
					6	SS	3	230 610	5	•		
					7							
					8	SS	4	300 610	6	•		
3					9							
					10							
					11	SS	5	250 610	2	•		
4					12							
					13							
					14	SS	6	100 610	2	•		
5	377.4	Very loose to compact brown silty SAND (SM) - wet			15							
					16	SS	7	410 610	2	•		
6					17							
					18							
					19							
7	375.6	Very stiff brown silty CLAY (CL-ML)			20							
					21	SS	8	610 610	13	•		
8					22							
					23							
					24							
					25							
9	372.9	Compact brown silty SAND (SM) - damp			26	SS	9	460 610	31		•	
	372.3				27							
10		End of Borehole			28							
		Borehole caved to a depth of 6.7 m			29							
11					30							
					31	SS	10	510 610	18		•	
12					32							
					33							
13					34							
					35							
					36							
					37							
					38							
					39							
					40							
					41							
					42							
					43							
					44							
14					45							

☐ Field Vane Test, kPa
☐ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa



BOREHOLE RECORD

N: 4 810 953 E: 533 770

BH7-13

CLIENT West Waterloo Retail LP

PROJECT No. 160321331

LOCATION 930 Erb Street Waterloo, Ontario

DATUM Geodetic

DATES: BORING September 18, 2103

WATER LEVEL

TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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0	383.2	Farm field no crops			0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										

- ☐ Field Vane Test, kPa
- ☐ Remoulded Vane Test, kPa
- ☐ Pocket Penetrometer Test, kPa

**Stantec****BOREHOLE RECORD**

N: 4 810 847 E: 533 870

BH8-13CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING September 18, 2103

WATER LEVEL _____

TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50	100	
0	380.5	Farm field no crops			0							
	380.2	300 mm TOPSOIL			1	SS	1	150 610	12			
1		Very stiff brown to grey silty CLAY (CL-ML) - moist to wet			2							
					3	SS	2	360 610	7			
2					4							
					5							
3					6	SS	3	380 610	16			
					7							
4					8	SS	4	480 610	18			
					9							
5					10							
					11	SS	5	380 610	24			
6					12							
					13	SS	6	560 610	21			
7					14							
					15							
8					16	SS	7	360 610	20			
					17							
9					18							
					19							
10					20							
					21	SS	8	480 610	29			
11					22							
					23							
12					24							
	372.9	Dense brown sandy SILT (ML) - damp			25							
13					26	SS	9	460 610	39			
					27							
14					28							
					29							
15					30							
					31	SS	10	510 610	27			
16					32							
					33							
17					34							
					35							
18					36	SS	11	510 610	35			
	369.2	End of Borehole			37							
19					38							
					39							
20					40							
					41							
21					42							
					43							
22					44							
					45							

☐ Field Vane Test, kPa
☐ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

**Stantec****BOREHOLE RECORD**

N: 4 810 552 E: 534 151

BH9-13CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING September 18, 2103

WATER LEVEL _____

TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)											
0	389.9	Farm field no crops			0					50 100 150 200 WATER CONTENT & ATTERBERG LIMITS W_p W I_L DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼ STANDARD PENETRATION TEST, BLOWS/0.3m ●										
	389.6	225 mm TOPSOIL			1	SS	1	150 610	8	●	○									
1		Very stiff brown to grey silty CLAY (CL-ML) with sand - moist to wet			2															
					3	SS	2	380 610	13	○	●									
2					4															
					5															
					6	SS	3	460 610	19		○	●								
3		- grey			7															
					8	SS	4	430 610	22		○	●								
					9															
					10															
					11	SS	5	460 610	21			●								
4					12															
					13															
					14	SS	6	410 610	25		○	●								
5					15															
					16	SS	7	510 610	22		○	●								
6					17															
					18															
					19															
					20															
	383.1				21	SS	8	480 610	23		○	●								
7		End of Borehole			22															
		No groundwater present in open borehole on completion of drilling			23															
8					24															
					25															
9					26															
					27															
					28															
10					29															
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☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

**Stantec****BOREHOLE RECORD**

N: 4 810 741 E: 533 876

BH10-13CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING September 18, 2013

WATER LEVEL _____

TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50	100	
0	388.8	Farm field no crops			0							
	388.5	250 mm TOPSOIL			1	SS	1	150 610	8			
1		Very stiff brown silty CLAY (CL-ML) - moist to wet			2							
					3	SS	2	380 610	13			
2					4							
					5							
					6	SS	3	460 610	19			
3					7							
					8							
					9	SS	4	430 610	22			
4					10							
					11	SS	5	460 610	21			
5					12							
					13							
					14	SS	6	410 610	25			
6					15							
					16	SS	7	510 610	22			
7					17							
					18							
					19							
8	382.7	Compact brown SAND (SM) - damp			20							
					21	SS	8	480 610	23			
9					22							
					23							
					24							
10					25							
					26	SS	9	460 610	24			
11	380.6	End of Borehole			27							
					28							
12		No groundwater present in open borehole on completion of drilling			29							
					30							
13					31							
					32							
14					33							
					34							
					35							
					36							
					37							
					38							
					39							
					40							
					41							
					42							
					43							
					44							
					45							

☐ Field Vane Test, kPa
☐ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa



N: 4 810 691 E: 533 922

BH11-13

PROJECT No. 160321331

DATUM _____ Geodetic

TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	WATER CONTENT & ATTERBERG LIMITS											
										50100150200 W_p W I_L											
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼											
										STANDARD PENETRATION TEST, BLOWS/0.3m ●											
0	389.5	Brush and grass			0					10	20	30	40	50	60	70	80	90	100		
	389.2	300 mm TOPSOIL			1	SS	1	430 610	9	●											
		Stiff to very stiff brown CLAY (CL) with sand			2																
1						3															
						4	SS	2	380 610	10	●	○				△					
						5															
2						6	SS	3	200 610	10	●	○				△					
						7															
						8															
						9	SS	4	380 610	22		○	●				△				
3						10															
						11	SS	5	0.0 610	13		●									
						12															
4						13															
						14	SS	6	480 610	15		○	●						△		
						15															
5						16	SS	7	560 610	15		○	●					△			
				17																	
				18																	
6	383.4	Compact brown silty SAND (SM)			19																
	382.8				20																
				21	SS	8	560 610	16		●	●										
7		End of Borehole			22																
		No groundwater present in open borehole on completion of drilling			23																
					24																
					25																
					26																
					27																
					28																
					29																
					30																
					31																
10					32																
					33																
					34																
					35																
11					36																
					37																
					38																
12					39																
			40																		
			41																		
13			42																		
			43																		
			44																		
14					45																

Field Vane Test, kPa

Remoulded Vane Test, kPa

Pocket Penetrometer Test, kPa

**Stantec****BOREHOLE RECORD**

N: 4 810 635 E: 533 970

BH12-13

CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING August 27, 2013

WATER LEVEL _____

TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)				REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) / TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50 100 150 200				
0	388.7	Brush and grass			0									
	388.3	350 mm TOPSOIL			1	SS	1	250 / 610	8					
1		Stiff to very stiff brown to grey CLAY (CL) with sand			2									
					3	SS	2	460 / 610	6					
					4									
2					5									
					6	SS	3	610 / 610	9					
					7									
		- grey			8	SS	4	610 / 610	15					
3					9									
					10									
					11	SS	5	610 / 610	17					
					12									
4					13	SS	6	610 / 610	20					
					14									
					15									
5					16	SS	7	0.0 / 610	13					
					17									
					18									
6					19									
					20									
	382.0				21	SS	8	410 / 610	29					
7		End of Borehole			22									
					23									
					24									
8		Groundwater level inferred in open borehole on completion of drilling			25									
					26									
					27									
9					28									
					29									
					30									
10					31									
					32									
					33									
					34									
11					35									
					36									
					37									
					38									
12					39									
					40									
					41									
13					42									
					43									
					44									
14					45									

☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

**Stantec****BOREHOLE RECORD**

N: 4 810 554 E: 534 032

BH13-13CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING August 27, 2013

WATER LEVEL _____

TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50	100	
0	389.6	Brush and grass			0							
	389.2	300 mm TOPSOIL			1	SS	1	430 610	9			
1		Stiff to very stiff brown CLAY (CL) with sand			2							
	388.0	Very loose black PEAT			3	SS	2	180 610	5			
2		Stiff to very stiff brown CLAY (CL) with sand			4							
					5							
					6	SS	3	230 610	10			
					7							
					8	SS	4	430 610	8			
					9							
					10							
					11	SS	5	410 610	8			
					12							
					13							
					14	SS	6	460 610	19			
					15							
					16	SS	7	510 610	18			
					17							
					18							
					19							
					20							
	382.8	End of Borehole			21	SS	8	610 610	24			
7					22							
		Groundwater level inferred in open borehole on completion of drilling			23							
8					24							
					25							
					26							
					27							
					28							
					29							
					30							
					31							
					32							
10					33							
					34							
					35							
					36							
					37							
					38							
					39							
					40							
					41							
					42							
					43							
					44							
					45							

☐ Field Vane Test, kPa
☐ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa



BOREHOLE RECORD

N: 4 810 454 E: 533 960

BH15-13

CLIENT West Waterloo Retail LP

PROJECT No. 160321331

LOCATION 930 Erb Street Waterloo, Ontario

DATUM Geodetic

DATES: BORING August 27, 2013

WATER LEVEL October 8, 2013

TPC ELEVATION 395.66

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)									
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50 100 150 200									
										WATER CONTENT & ATTERBERG LIMITS W_p W I_L									
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m									
										STANDARD PENETRATION TEST, BLOWS/0.3m									
										REMARKS & GRAIN SIZE DISTRIBUTION (%)									
										GR SA SL CL									
0	394.9	Brush and grass			0														
	394.5	300 mm TOPSOIL			1	SS	1	100 610	10										
		Stiff to very stiff brown to grey			2														
1		CLAY (CL) with sand			3	SS	2	410 610	13										
					4														
					5														
2					6	SS	3	560 610	19										
					7														
					8	SS	4	610 610	19										
3					9														
					10														
					11	SS	5	460 610	19										
4					12														
					13														
					14	SS	6	560 610	11										
5					15														
					16	SS	7	410 610	15										
					17														
6		- grey			18														
					19														
					20														
					21	SS	8	610 610	22										
7					22														
					23														
					24														
8					25														
					26	SS	9	610 610	15										
					27														
9					28														
					29														
					30														
					31	SS	10	610 610	18										
10					32														
					33														
					34														
					35														
11	383.6				36	SS	11	510 610	23										
		End of Borehole			37														
12		Groundwater monitoring well installed with a screen from approximately 7.6 m to 10.7 m			38														
					39														
					40														
13		Groundwater level measure at a depth of approximately 6.5 m below grade on October 8, 2013			41														
					42														
14					43														
					44														
					45														

☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

**Stantec****BOREHOLE RECORD**

N: 4 810 391 E: 533 827

BH16-13CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING August 22, 2013

WATER LEVEL _____

TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SL CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50	100	
0	397.3	Brush and grass			0							
	397.0	300 mm TOPSOIL			1	SS	1	51 610	9			
		Very stiff brown CLAY (CL) with sand			2							
1					3	SS	2	410 610	20			
					4							
					5							
2					6	SS	3	380 610	32			
					7							
					8	SS	4	610 610	27			
3					9							
					10							
					11	SS	5	610 610	23			
4				12								
				13								
				14	SS	6	610 610	19				
5				15								
				16	SS	7	610 610	23				
6				17								
				18								
7				19								
				20								
				21	SS	8	610 610	22				
8				22								
				23								
				24								
				25								
9				26	SS	9	560 610	20				
				27								
10				28								
				29								
				30								
	387.6			31	SS	10	610 610	28				
11		End of Borehole		32								
		No groundwater present in open borehole on completion of drilling		33								
12				34								
				35								
				36								
13				37								
				38								
				39								
				40								
				41								
				42								
				43								
				44								
14				45								

☐ Field Vane Test, kPa
☐ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

CLIENT West Waterloo Retail LP

PROJECT No. 160321331

LOCATION 930 Erb Street Waterloo, Ontario

DATUM _____ Geodetic

DATES: BORING August 22, 2013

WATER LEVEL

TPC ELEVATION

[illegible]

**Stantec****BOREHOLE RECORD**

N: 4 810 495 E: 533 751

BH18-13CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING August 22, 2013WATER LEVEL October 8, 2013TPC ELEVATION 392.78

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
						TYPE	NUMBER	RECOVERY (mm) / TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50100150200																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
						WATER CONTENT & ATTERBERG LIMITS					DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m						STANDARD PENETRATION TEST, BLOWS/0.3m						REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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0	392.0	Brush and grass			0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

- ☐ Field Vane Test, kPa
☐ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

**Stantec****BOREHOLE RECORD**

N: 4 810 518 E: 533 896

BH19-13

CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING August 26, 2013

WATER LEVEL

TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50 100 150 200 WATER CONTENT & ATTERBERG LIMITS W_p W W_L DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ∇ STANDARD PENETRATION TEST, BLOWS/0.3m $\bullet$ REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL										
0	395.5	Brush and grass			0															
	395.2	300 mm TOPSOIL			1	SS	1	130 610	9											
1		Very stiff brown to grey CLAY (CL) with sand			2															
					3	SS	2	610 610	17											
2					4															
					5															
					6	SS	3	560 610	22											
3					7															
					8	SS	4	610 610	24											
					9															
4		- grey			10															
					11	SS	5	610 610	25											
					12															
					13															
					14	SS	6	610 610	12											
5					15															
					16	SS	7	380 610	14											
					17															
6					18															
					19															
					20															
					21	SS	8	460 610	17											
7					22															
					23															
					24															
8					25															
					26	SS	9	610 610	19											
					27															
9					28															
					29															
					30															
					31	SS	10	610 610	22											
10					32															
					33															
					34															
					35															
11					36	SS	11	610 610	22											
	384.2	End of Borehole			37															
12		No groundwater present in open borehole on completion of drilling			38															
					39															
					40															
13					41															
					42															
					43															
14					44															
					45															

- ☐ Field Vane Test, kPa
☐ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa



BOREHOLE RECORD

N: 4 810 443 E: 533 626

BH20-13

SHEET 1 of 2

CLIENT West Waterloo Retail LP

PROJECT No. 160321331

LOCATION 930 Erb Street Waterloo, Ontario

DATUM Geodetic

DATES: BORING August 22, 2013

WATER LEVEL

TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
						TYPE	NUMBER	RECOVERY (mm) / TCR(%) / SCR(%)	N-VALUE OR RQD(%)												
										WATER CONTENT & ATTERBERG LIMITS											
										DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m											
										STANDARD PENETRATION TEST, BLOWS/0.3m											
										10 20 30 40 50 60 70 80 90 100											
0	405.8	Brush and grass			0																
	405.5	250 mm TOPSOIL			1	SS	1	51 / 610	5	●	○										
		Loose brown silty SAND (SM)			2																
1					3	SS	2	430 / 610	5	●	○										
					4																
					5																
2					6	SS	3	460 / 610	7	●	○										
	403.5				7																
		Very stiff brown to grey CLAY (CL) with sand			8	SS	4	560 / 610	22		○	●									
3					9																
					10																
					11	SS	5	560 / 610	23		○	●									
					12																
4					13	SS	6	610 / 610	19			●									
					14																
					15																
5					16	SS	7	560 / 610	26			○	●								
					17																
					18																
6					19																
					20																
					21	SS	8	610 / 610	9	●		○	△								
7					22																
					23																
					24																
8		- grey			25																
					26	SS	9	610 / 610	15		●	○			△						
					27																
					28																
9					29																
					30																
					31	SS	10	560 / 610	23		○	●								△	
10					32																
					33																
	395.1				34																
		Very dense brown silty SAND (SM)			35																
11					36	SS	11	460 / 610	47	○					●						
					37																
12					38																
					39																
					40																
13					41	SS	12	530 / 610	93	○										●	0 67 32
					42																
					43																
					44																
14					45																

☐ Field Vane Test, kPa
☐ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

**Stantec****BOREHOLE RECORD**

N: 4 810 443 E: 533 626

BH20-13

SHEET 2 of 2

CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING August 22, 2013

WATER LEVEL _____

TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50	100	
14	391.8	Very dense brown silty SAND (SM)			46	SS	13	460 610	56	○	●	
47												
48												
49												
50												
15					51	SS	14	460 610	44	○	●	
16	390.0	End of Borehole			52							
53												
54												
55												
56												
57												
58												
59												
60												
61												
62												
63												
64												
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88												
89												
90												
91												

☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa



BOREHOLE RECORD

N: 4 810 164 E: 533 877

BH21-13

CLIENT West Waterloo Retail LP

PROJECT No. 160321331

LOCATION 930 Erb Street Waterloo, Ontario

DATUM Geodetic

DATES: BORING August 23, 2013

WATER LEVEL

TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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- ☐ Field Vane Test, kPa
- ☐ Remoulded Vane Test, kPa
- ☐ Pocket Penetrometer Test, kPa

**Stantec****BOREHOLE RECORD**

N: 4 810 260 E: 533 672

BH22-13CLIENT West Waterloo Retail LPPROJECT No. 160321331LOCATION 930 Erb Street Waterloo, OntarioDATUM GeodeticDATES: BORING August 23, 2013

WATER LEVEL _____

TPC ELEVATION _____

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50 100 150 200 WATER CONTENT & ATTERBERG LIMITS W_p W I_L DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼ STANDARD PENETRATION TEST, BLOWS/0.3m ● REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL										
0	405.5	Brush and grass			0					10	20	30	40	50	60	70	80	90	100	
	405.2	300 mm TOPSOIL			1	SS	1	230 610	7	●										
1		Very stiff brown to grey CLAY (CL) with sand			2															
					3	SS	2	610 610	21		●									△
					4															
2					5															
					6	SS	3	510 610	21		●									△
					7															
					8	SS	4	610 610	16		●									△
3					9															
					10															
					11	SS	5	610 610	16		●									△
					12															
4					13															
					14	SS	6	460 610	14		●		△							
					15															
5		- grey			16	SS	7	510 610	12		●			△						
					17															
					18															
6					19															
					20															
					21	SS	8	460 610	19		●				△					
7					22															
					23															
					24															
8					25															
					26	SS	9	610 610	16		●				△					
					27															
9					28															
					29															
					30															
					31	SS	10	610 610	25			●								△
10					32															
					33															
					34															
11					35															
					36	SS	11	610 610	36				●							△
					37															
12					38															
					39															
					40															
					41	SS	12	610 610	38					●						△
13	392.7	End of Borehole No Groundwater present in open borehole on completion of drilling			42															
					43															
					44															
14					45															

- ☐ Field Vane Test, kPa
☒ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

CLIENT West Waterloo Retail LP

PROJECT No. 160321331

LOCATION 930 Erb Street Waterloo, Ontario

DATUM _____ Geodetic

DATES: BORING August 23, 2013

WATER LEVEL

TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)											REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	WATER CONTENT & ATTERBERG LIMITS DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m											
0	398.3	Brush and grass			0																
	398.0	300 mm TOPSOIL			1	SS	1	130 610	5												
1		Stiff to very stiff brown CLAY (CL) with sand			2																
					3	SS	2	380 610	12												
2					4																
					5																
					6	SS	3	610 610	20												
3					7																
					8	SS	4	610 610	16												
4					9																
					10																
					11	SS	5	610 610	14												
5					12																
					13																
					14	SS	6	610 610	13												
6					15																
					16																
					17	SS	7	610 610	16												
7					18																
					19																
					20																
					21	SS	8	610 610	13												
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					26	SS	9	610 610	11												
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13					43																
					44																
14					45																



BOREHOLE RECORD

N: 4 810 115 E: 533 587

BH24-13

CLIENT West Waterloo Retail LP

PROJECT No. 160321331

LOCATION 930 Erb Street Waterloo, Ontario

DATUM Geodetic

DATES: BORING August 23, 2013

WATER LEVEL

TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%)
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	50 100 150 200										
										WATER CONTENT & ATTERBERG LIMITS DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m										
										10	20	30	40	50	60	70	80	90	100	
0	401.7	Brush and grass			0															
	401.4	300 mm TOPSOIL			1	SS	1	460 610	5	●	○									
		Stiff brown sandy silty CLAY (CL-ML)			2															
1					3	SS	2	560 610	18	○	●									
					4															
					5															
2					6	SS	3	560 610	14	●	○									1 38 46 15
					7															
					8	SS	4	610 610	14	○	●									
					9															
3					10															
					11	SS	5	560 610	15	○	●									
					12															
4					13	SS	6	610 610	13	●										
					14															
					15															
5					16	SS	7	610 610	16	●	○									
					17															
					18															
6					19															
					20															
					21	SS	8	610 610	12	●										
					22															
7					23															
					24															
					25															
8	393.5	End of Borehole			26	SS	9	610 610	14	○	●									
					27															
9		No groundwater present in open borehole on completion of drilling			28															
					29															
					30															
10					31															
					32															
					33															
					34															
11					35															
					36															
					37															
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13					41															
					42															
					43															
					44															
14					45															

Field Vane Test, kPa
Remoulded Vane Test, kPa
Pocket Penetrometer Test, kPa

- ☐ Field Vane Test, kPa
- ☐ Remoulded Vane Test, kPa
- ☐ Pocket Penetrometer Test, kPa

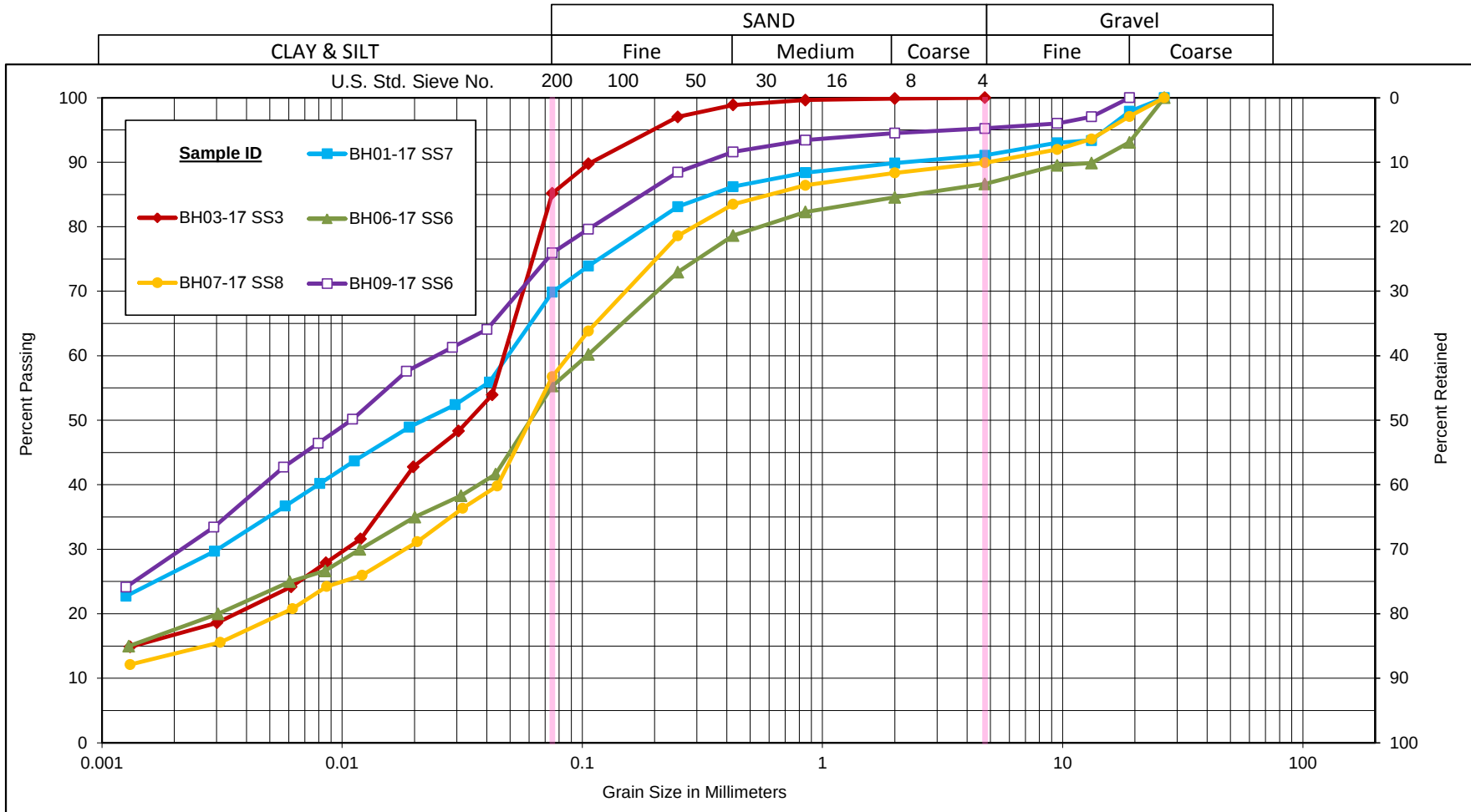
Appendix D

Appendix D

D.1 LABORATORY TEST RESULTS



Unified Soil Classification System



Sample ID	Depth (m)	% Gravel	% Sand	% Silt	% Clay
BH01-17 SS7	6.1-6.7	9.0	21.1	43.9	26.0
BH03-17 SS3	1.5-2.1	0.0	14.8	69.2	16.0
BH06-17 SS6	4.6-5.2	13.0	31.7	38.3	17.0
BH07-17 SS8	7.6-8.2	10.0	33.2	43.8	13.0
BH09-17 SS6	4.6-5.2	5.0	19.0	48.0	28.0

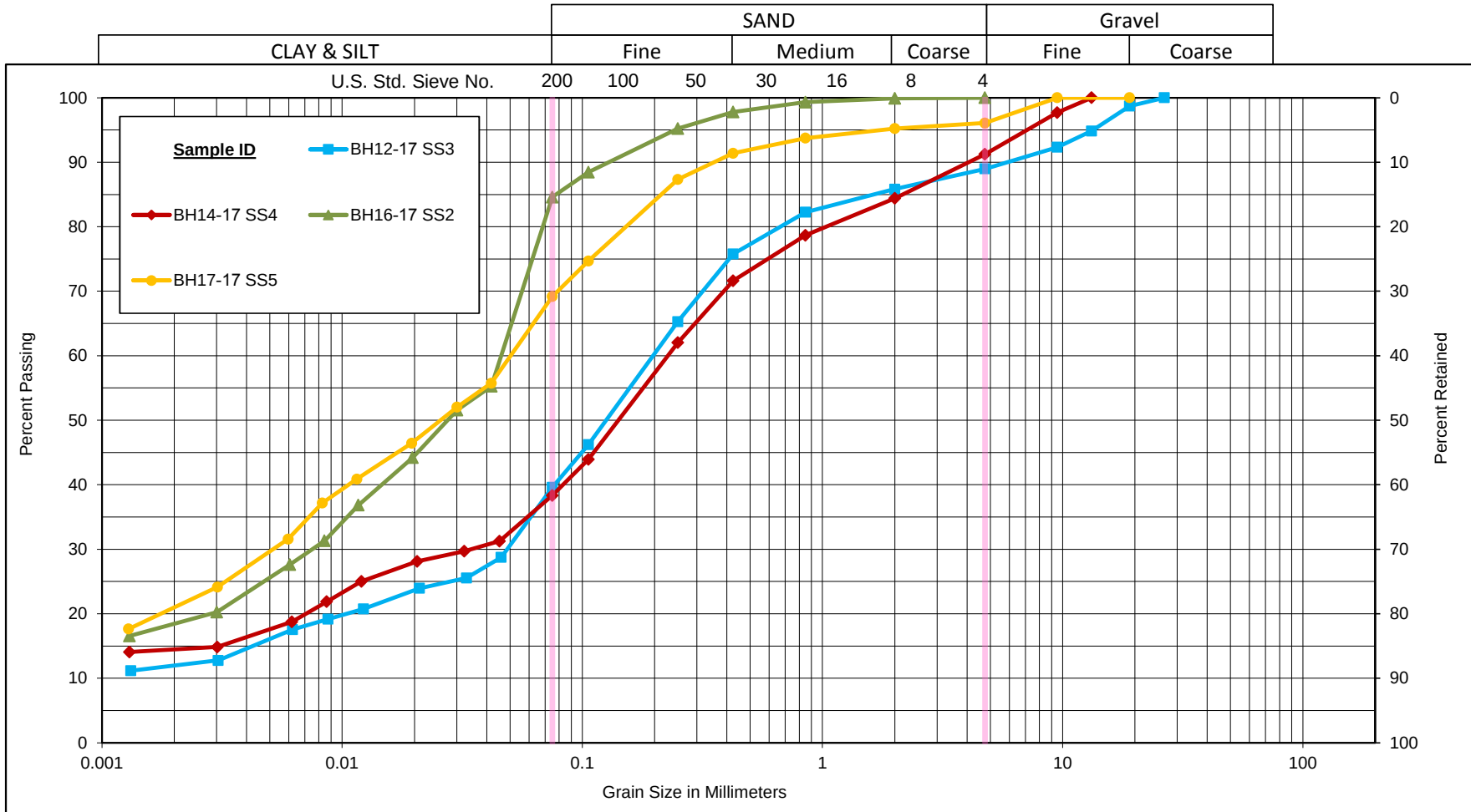


GRAIN SIZE DISTRIBUTION

Figure No. 1

Project No. 161413446.805

Unified Soil Classification System



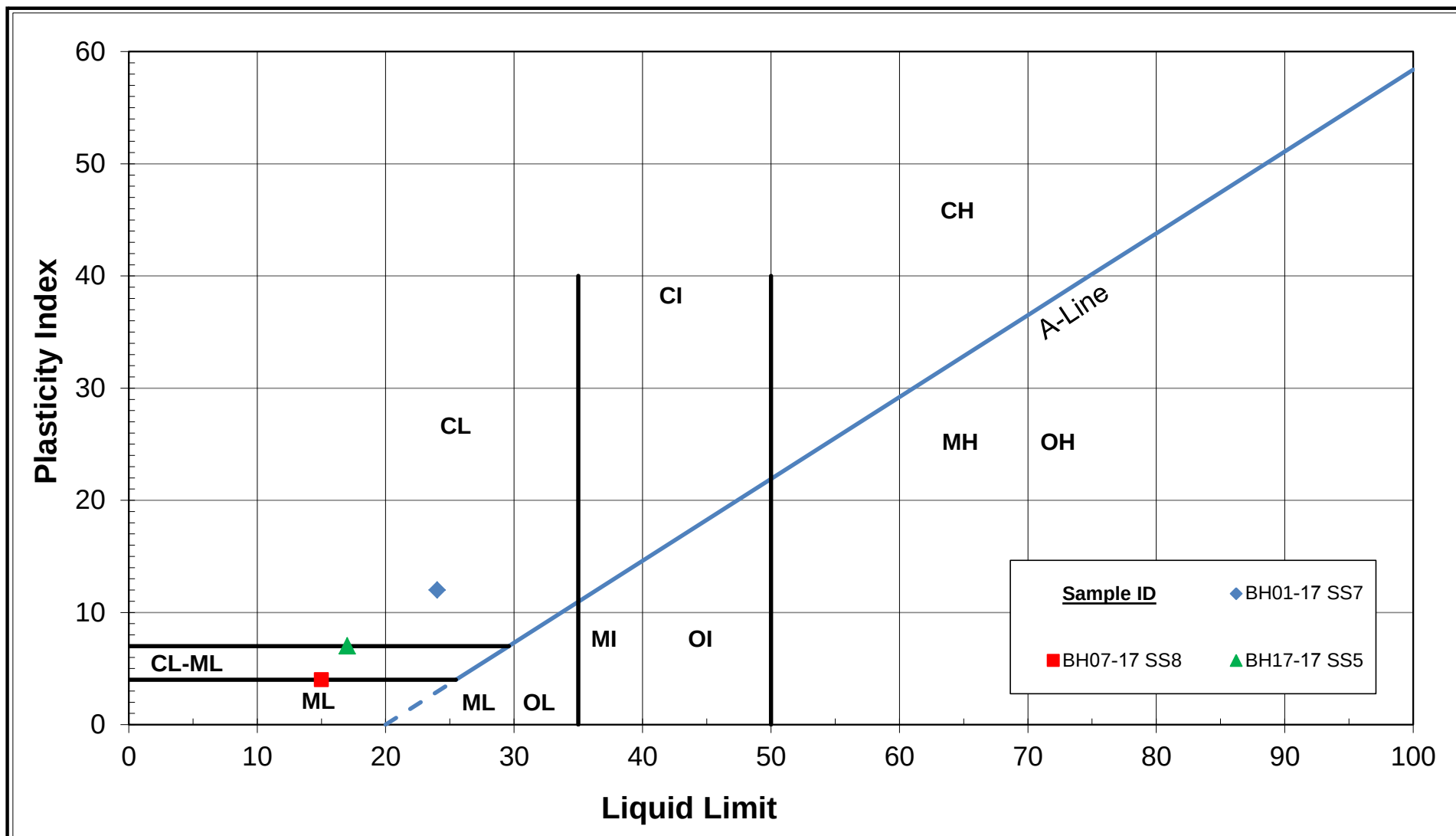
Sample ID	Depth (m)	% Gravel	% Sand	% Silt	% Clay
BH12-17 SS3	1.5-2.1	11.0	49.4	27.6	12.0
BH14-17 SS4	2.3-2.9	9.0	52.7	24.3	14.0
BH16-17 SS2	0.8-1.4	0.0	15.4	66.6	18.0
BH17-17 SS5	3.0-3.7	4.0	26.8	49.2	20.0



GRAIN SIZE DISTRIBUTION

Figure No. 2

Project No. 161413446.805



Appendix E

Appendix E

E.1 ANALYTICAL CORROSIVITY TEST RESULTS



**CLIENT NAME: STANTEC CONSULTING LTD
100 - 300 HAGEY BOULEVARD
WATERLOO, ON N2L0A4
(519) 579-4410**

ATTENTION TO: Jeff Dietz

PROJECT: Waterloo West Side Employment Lands

AGAT WORK ORDER: 17T214556

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: May 19, 2017

PAGES (INCLUDING COVER): 5

VERSION*: 1

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

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Member of: Association of Professional Engineers and Geoscientists of Alberta
(APEGA)
Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

Page 1 of 5

*Results relate only to the items tested and to all the items tested
All reportable information as specified by ISO 17025:2005 is available from AGAT Laboratories upon request*



Certificate of Analysis

AGAT WORK ORDER: 17T214556

PROJECT: Waterloo West Side Employment Lands

ATTENTION TO: Jeff Dietz

SAMPLED BY:RS

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

CLIENT NAME: STANTEC CONSULTING LTD

SAMPLING SITE:Waterloo

Corrosivity Package

DATE RECEIVED: 2017-05-10

DATE REPORTED: 2017-05-19

		SAMPLE DESCRIPTION:		BH01-17	BH17-17
		SAMPLE TYPE:		Sample 3	Sample 3
		DATE SAMPLED:		Soil	Soil
				2017-05-03	2017-05-03
Parameter	Unit	G / S	RDL	8384435	8384441
*Sulphide	%		0.05	<0.05	<0.05
Chloride (2:1)	µg/g		2	5	11
Sulphate (2:1)	µg/g		2	125	3
pH (2:1)	pH Units		NA	7.90	8.17
Electrical Conductivity (2:1)	mS/cm		0.005	0.226	0.113
Resistivity (2:1)	ohm.cm		1	4420	8850
Redox Potential (2:1)	mV		5	242	240

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

8384435-8384441 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

*Sulphide analyzed at AGAT Vancouver

Certified By:

Amanjot Bhela

Quality Assurance

CLIENT NAME: STANTEC CONSULTING LTD

AGAT WORK ORDER: 17T214556

PROJECT: Waterloo West Side Employment Lands

ATTENTION TO: Jeff Dietz

SAMPLING SITE: Waterloo

SAMPLED BY: RS

Soil Analysis

RPT Date: May 19, 2017

DUPLICATE

REFERENCE MATERIAL

METHOD BLANK SPIKE

MATRIX SPIKE

PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Corrosivity Package

*Sulphide	8386576		<0.05	<0.05	NA	< 0.05	95%	80%	120%						
Chloride (2:1)	8377583		443	451	1.8%	< 2	100%	80%	120%	101%	80%	120%	105%	70%	130%
Sulphate (2:1)	8377583		15400	15900	3.3%	< 2	97%	80%	120%	101%	80%	120%	103%	70%	130%
pH (2:1)	8384435		7.90	7.96	0.8%	NA	101%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	8384435 8384435		0.226	0.224	0.9%	< 0.005	95%	90%	110%	NA			NA		
Redox Potential (2:1)	8386372		238	233	2.3%	< 5	101%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By:

Amanjot Bhela

Method Summary

CLIENT NAME: STANTEC CONSULTING LTD

AGAT WORK ORDER: 17T214556

PROJECT: Waterloo West Side Employment Lands

ATTENTION TO: Jeff Dietz

SAMPLING SITE:Waterloo

SAMPLED BY:RS

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
*Sulphide	INOR-181-6027	modified from ASTM E1915-11	COMBUSTION
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE

Appendix F

Appendix F

F.1 SEISMIC HAZARD CALCULATION



2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

July 11, 2017

Site: 43.4478 N, 80.5858 W User File Reference: Waterloo West Side Employment Lands

Requested by: , Stantec Consulting Ltd.

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	Sa(0.2)	Sa(0.3)	Sa(0.5)	Sa(1.0)	Sa(2.0)	Sa(5.0)	Sa(10.0)	PGA (g)	PGV (m/s)
0.094	0.125	0.116	0.095	0.074	0.044	0.022	0.0054	0.0023	0.070	0.060

Notes. Spectral ($S_a(T)$, where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s . Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. *These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.*

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.0093	0.033	0.054
Sa(0.1)	0.015	0.047	0.076
Sa(0.2)	0.016	0.047	0.072
Sa(0.3)	0.014	0.040	0.060
Sa(0.5)	0.011	0.033	0.048
Sa(1.0)	0.0055	0.019	0.029
Sa(2.0)	0.0023	0.0089	0.014
Sa(5.0)	0.0005	0.0019	0.0034
Sa(10.0)	0.0004	0.0009	0.0014
PGA	0.0080	0.026	0.042
PGV	0.0066	0.023	0.037

References

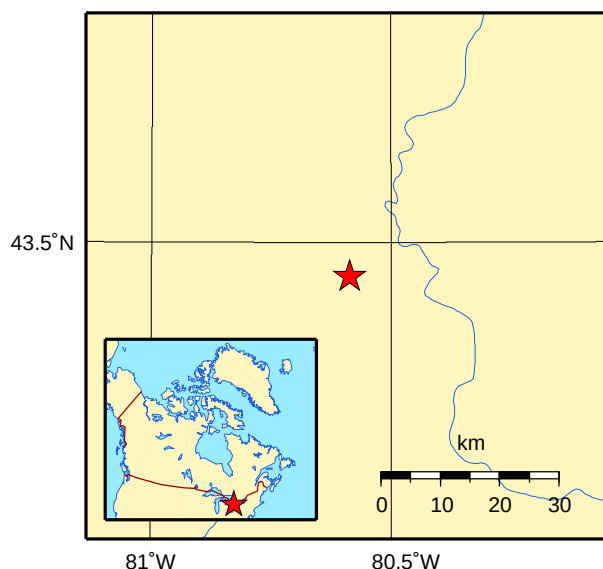
National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

Aussi disponible en français



Natural Resources
Canada

Ressources naturelles
Canada

