Appendix H
Geotechnical Assessment

GEOTECHNICAL INVESTIGATION REPORT
Municipal Class Environmental Assessment
Phases 3 & 4 for
Barton Street and Fifty Road Improvements
Stoney Creek & Winona, Hamilton, Ontario

(City of Hamilton Contract Number: C3-01-16)

Wood Reference Number: TPB166053

Prepared for:

City of Hamilton
71 Main Street West, Hamilton, Ontario, L8P 4Y5

23 March 2020

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Prepared by:

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23 March 2020

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23 March 2020

City of Hamilton
71 Main Street West,
Hamilton, Ontario, L8P 4Y5

Attention: Ms. Melanie Anderton - Project Manager
Growth Management, City of Hamilton - Ontario

Dear Ms. Anderton:

RE: Geotechnical Investigation Report
Municipal Class Environmental Assessment Phases 3 & 4 for
Barton Street and Fifty Road Improvements
Stoney Creek and Winona, Hamilton, Ontario
City of Hamilton Contract No. C3-01-16, Ontario

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (hereinafter referred to as "Wood"), takes pleasure in submitting a digital copy of our Geotechnical Investigation Report for the abovementioned project. Wood will be glad to discuss any questions arising from this work.

We thank you for giving us this opportunity to be of service to you.

Yours truly,

Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited

Hoda Seddik., M. A. Sc., P. Eng.,
Consulting Engineer
Principal Pavement Engineer/Group Lead

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1.0 INTRODUCTION

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited ("Wood"), was retained by City of Hamilton ("the City") to conduct Municipal Class Environmental Assessment Phases 3 and 4 for Barton Street and Fifty Road Improvements ("project"). As part of the project, a geotechnical investigation is required to provide soil and groundwater information for design of various components of the project. This report presents the findings of the geotechnical investigation, while a desktop hydrogeological study is presented in a separate cover. The project site is shown in Figure Nos. 1A to 1D.

The purpose of the geotechnical investigation was to obtain information on the subsurface conditions by means of a limited number of boreholes at the investigated area, and based on the results of the investigation, to provide recommendations for widening / rehabilitation of Barton Street (from Fruitland Road to Fifty Road) and Fifty Road (from Highway 8 to South Service Road), a proposed grade separation for CNR crossing at Fifty Road and installation of underground utilities.

Authorization to proceed (Purchase Order 0000082501) was received on 8 June 2016. The geotechnical investigation was carried out as per Wood's Proposal No. TP63200-1606 (dated 24 February 2016) and the requirements provided in the City's Request for Proposals (Contract No. C3-01-16) and its subsequent Addenda). The fieldwork was carried out in June 2019 after receiving approval from the City to proceed with the geotechnical investigation.

The recommendations and comments provided hereinafter are based on factual information and are intended only for design. The number of boreholes may not be sufficient to determine all the factors that may affect construction methods and construction costs. Sub-surface soil and groundwater conditions between and beyond the boreholes may differ from those encountered at the borehole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation.

The possible construction conditions are also discussed, but only to the extent that they will likely influence design decisions. Construction methods discussed, however, express Wood's opinion only and are not intended to direct Contractors on how to carry out the construction. Contractors should be aware that the data and their interpretation presented in this report may not be sufficient to assess all the factors that may have an effect upon the construction.

The report is prepared with the conditions that the design and construction will be in accordance with all applicable standards, codes, regulations of authorities having jurisdiction, and carried out using good engineering practices. Further, the recommendations and opinions in this report are applicable only to the proposed project as described herein.

Once the details of the proposed works are finalized, on-going liaison with Wood is recommended during both the design and construction phases of the project to confirm that the recommendations in this report

are applicable and/or correctly interpreted and implemented. Also, any queries concerning the geotechnical aspects of the proposed project should be directed to Wood for further elaboration and/or clarification.

Limitations to Geotechnical Reports attached herein are an integral part of this report.

1.1 Project Description

As per the information provided in the RFP: *"[Hamilton TMP (2007)], The City of Hamilton is in the process of carrying out the Hamilton Transportation Master Plan (TMP) update of the 2007 document. Following the Municipal Class Environmental Assessment (EA) process, the TMP provides policies and strategies for Hamilton's transportation network over the next 30 years. The 2007 TMP recommended improvements to Barton Street and Fifty Road (see attached map). These road improvements were identified as a Schedule C Project. Phase 1 and 2 of the EA process were completed during the TMP work. [SCUBE TMP (2008)] In 2008, The Stoney Creek Urban Boundary Expansion (SCUBE) TMP was completed. The SCUBE TMP provided a transportation strategy that supported the addition of 223 hectares of land into the urban boundary. [Fifty Road and Canadian National Railway (CNR) Grade Separation Needs Assessment Study (2013)] The City completed a Grade Separation Needs Assessment (2013) for Fifty Road and CNR crossing. [Fruitland-Winona Secondary Plan (2014)] In May 2014, the City of Hamilton adopted the Fruitland Winona Secondary Plan (currently under appeal). The planning area included lands east of Fruitland Road, north of Highway No. 8, south of Barton Street (including Winona); and the lands east of Winona, north of Highway No. 8, south of the QEW, and west of the City limits. The purpose of the Fruitland-Winona Secondary Plan is to establish land uses, the transportation network, infrastructure requirements, and development standards to guide the development of lands located in the Fruitland-Winona Secondary Plan area for the next 20 years."*

With the above background and as the next step, the City required Phase 3 and 4 of the Municipal Class Environmental Assessment ("MCEA") for Barton Road and Fifty Road improvements (hereafter referred to as "project") to determine alternative design concepts for the preferred solution and to develop an Environmental Study Report and provide implementation strategies and phasing, the contract for which was awarded to Wood. This geotechnical investigation was carried out to obtain existing subsurface soil and pavement structure information to support the project.

In addition to widening of the road, installation of new underground utilities are planned, together with a grade separation for Fifty Road and CNR crossing, located on Fifty Road, about 420 m north of its intersection with Barton Street and just south of the ramp to South Service Road.

At the time of the investigation, both Barton Street and Fifty Road were 2-lane roads (one lane in each direction) with gravel shoulder (about 5.8 km total, i.e., 5.1 km of Barton Street and 0.7 km of Fifty Road) passing through residential / commercial / farmland areas. The road surface was similar to or slightly higher (less than 1 m) than surrounding ground surface.

The ground (road) elevations within the project limits (based on borehole locations) varied from about 87.0 m to 92.3 m, with undulating ground surface. Overall, the ground surface sloped down from west (Fruitland Road) to east (Fifty Road).

1.2 Geology

This area is located within the Ontario-Erie Lobe dominated by Halton Till of the Pleistocene with areas of exposed carbonate and clastic sedimentary bedrock that may be covered by a thin, discontinuous layer of drift. Based on Preliminary Map P.993, "Quaternary Geology, Grimsby Area" prepared by Ministry of Natural Resources Ontario, the surficial soil in the area is composed of Halton Till (clayey silt - clay till). The Halton Till within this area overlies siltstones, sandstone and limestone interbedded shale and shales of the Queenston Formation (Liberty, B.A., Feenstra, B.H. and Telford, P.G. 1976).

According to the Preliminary Map P.240, "Bedrock Topography Series, Grimsby Area", bedrock is close to ground surface or exposed.

2.0 INVESTIGATION PROCEDURE

Based on the requirements in the Request for Proposals and Wood's proposal, the following tasks were carried out for geotechnical investigation along Barton Street and Fifty Road:

- Visual pavement condition survey of existing road.
- Geotechnical investigation for road widening, underground utility services and a grade separation at CNR tracks by drilling a total of 41 boreholes, at various depths from about 1.5 m to 10.7 m, consisting of:
  - 32 boreholes along Barton Street (BH 01 to BH 40), excluding 8 boreholes (BH 02, BH 04, BH 14, BH 28, BH 30, BH 36, BH 38 and BH 40) which could not be drilled due to conflict with existing utilities and / or accessibility;
  - 8 boreholes (BH 41 to BH 48) along Fifty Road; and
  - 1 borehole (BH 49) for the grade separation (on Fifty Road).
- Laboratory testing for soil classification, soil corrosivity and soil chemical analyses.

2.1 Overall Investigation Approaches

Prior to drilling, the borehole locations were staked out on site by Wood and utility locate clearances were obtained for existing underground utilities. The final locations of the boreholes were slightly adjusted based on existing underground utilities and site conditions, where necessary. As noted above, eight boreholes could not be drilled due to conflict with utilities and / or accessibility.

The fieldwork was carried out between 18 and 24 June 2019. The borehole schedule is provided in Table 2.1, and as-drilled borehole locations are shown in Figure Nos. 1A to 1D.

Table 2.1: Borehole Schedule

Borehole No.	Location	Approximate GPS Coordinates (UTM/NAD 83)		Borehole Depth / Elevation			Investigation Purpose
				Depth Below Ground Surface	Ground Surface Elevation (1)	Bottom Elevation	
		Northing	Easting	(m)			
BH 01	Barton Street	4786265	605803	5.2	87.6	82.4	Utility installation and pavement
BH 02	Barton Street	*Could not be drilled due to existing utilities or inaccessibility*					
BH 03	Barton Street	4786207	606010	4.6	87.6	82.9	Utility installation and pavement
BH 04	Barton Street	*Could not be drilled due to existing utilities or inaccessibility*					
BH 05	Barton Street	4786121	606286	1.5	88.4	86.9	Pavement
BH 06	Barton Street	4786118	606287	1.5	88.1	86.6	Pavement
BH 07	Barton Street	4786072	606452	1.5	87.0	85.5	Pavement
BH 08	Barton Street	4786071	606451	1.5	87.2	85.7	Pavement
BH 09	Barton Street	4785981	06725	4.6	87.3	82.7	Pavement
BH 10	Barton Street	4785976	06721	1.5	87.2	85.7	Pavement
BH 11	Barton Street	4785897	606967	4.6	88.7	84.0	Utility installation and pavement
BH 12	Barton Street	4785900	606968	0.5 (terminated due to sewer)	88.7	88.2	Pavement
BH 13	Barton Street	4785851	607126	1.5	89.6	88.0	Pavement
BH 14	Barton Street	*Could not be drilled due to existing utilities or inaccessibility*					
BH 15	Barton Street	4785761	607431	1.5	90.0	88.5	Pavement
BH 16	Barton Street	4785756	607432	1.5	90.0	88.5	Pavement
BH 17	Barton Street	4785700	607650	4.6	88.8	84.2	Utility installation and pavement
BH 18	Barton Street	4785692	607646	1.5	88.7	87.2	Pavement
BH 19	Barton Street	4785614	607925	5.2	89.4	84.2	Utility installation and pavement
BH 20	Barton Street	4785610	607924	1.5	89.3	87.8	Pavement
BH 21	Barton Street	4785557	608166	1.5	89.1	87.6	Pavement
BH 22	Barton Street	4785554	608166	1.5	89.0	87.5	Pavement
BH 23	Barton Street	4785534	608328	1.5	88.7	87.2	Pavement
BH 24	Barton Street	4785530	608327	1.5	88.6	87.1	Pavement
BH 25	Barton Street	4785494	608581	5.2	87.9	82.8	Utility installation and pavement
BH 26	Barton Street	4785492	608580	1.5	87.8	86.3	Pavement

Borehole No.	Location	Approximate GPS Coordinates (UTM/NAD 83)		Borehole Depth / Elevation			Investigation Purpose
				Depth Below Ground Surface	Ground Surface Elevation [1]	Bottom Elevation	
		Northing	Easting	(m)			
BH 27	Barton Street	4785430	608982	5.2	88.4	83.2	Utility installation and pavement
BH 28	Barton Street	*Could not be drilled due to existing utilities or inaccessibility*					
BH 29	Barton Street	4785384	609138	1.5	90.3	88.8	Pavement
BH 30	Barton Street	*Could not be drilled due to existing utilities or inaccessibility*					
BH 31	Barton Street	4785327	609317	1.5	91.7	90.2	Pavement
BH 32	Barton Street	4785328	609320	1.5	91.7	90.2	Pavement
BH 33	Barton Street	4785249	609527	4.6	92.0	87.3	Utility installation and pavement
BH 34	Barton Street	4785244	609526	1.5	92.0	90.5	Pavement
BH 35	Barton Street	4785166	609796	4.6	92.1	87.4	Utility installation and pavement
BH 36	Barton Street	*Could not be drilled due to existing utilities or inaccessibility*					
BH 37	Barton Street	4785101	610013	1.5	92.2	90.7	Pavement
BH 38	Barton Street	*Could not be drilled due to existing utilities or inaccessibility*					
BH 39	Barton Street	*Could not be drilled due to existing utilities or inaccessibility*					
BH 40	Barton Street	4785040	610232	1.5	92.3	90.8	Pavement
BH 41	Fifty Road	4784889	610450	4.6	91.4	86.8	Utility installation and pavement
BH 42	Fifty Road	4784890	610446	1.5	91.3	89.8	Pavement
BH 43	Fifty Road	4785071	610501	1.5	91.3	89.8	Pavement
BH 44	Fifty Road	4785071	610503	0.9	91.3	90.4	Pavement
BH 45	Fifty Road	4785190	610532	1.5	91.3	89.8	Pavement
BH 46	Fifty Road	4785192	610531	1.5	90.4	88.9	Pavement
BH 47	Fifty Road	4785306	610568	4.7	88.9	84.2	Utility installation and pavement
BH 48	Fifty Road	4785306	610570	1.5	88.7	87.2	Pavement
BH 49	Fifty Road	4785400	610588	10.7	88.4	77.7	Grade separation, pavement and utility installation

[1] Elevations were taken from the topographic survey map prepared by Wood for the project.

The as-drilled borehole locations were obtained as northing and easting co-ordinates (UTM Coordinates, NAD 83) using a hand-held GPS unit, and are shown on the Record of Boreholes. Ground elevations at the borehole locations, as listed in Table 2.1, were estimated from the topographic survey prepared by Wood for the project and should not be used for any accurate measurements.

Traffic control during the investigation was provided by Four Aces Traffic Control Services Inc., Thorold, in accordance with Ontario Traffic Manual – Temporary Conditions (Book 7).

All boreholes were drilled using a truck-mounted drill rig, fitted with an automatic hammer, supplied and operated by Davis Drilling Ltd. of Milton, Ontario. The drilling activities were conducted under full-time oversight by Wood personnel, who also logged the soil types encountered during borehole advancement and collected soil samples. Soil samples were generally obtained almost-continuously via the Standard Penetration Test (SPT) method, as per ASTM D1586, using an automatic hammer. The SPT tests consisted of freely dropping a 63.5 kg (140 lb) hammer a vertical distance of 0.76 m (30 inches) to drive a 50 mm (2 inch) diameter O.D. split-barrel (split spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m (12 inches) was recorded as SPT 'N' values of the soil, which indicated the compactness of non-cohesive soils and / or implied (indirectly determined) the consistency of cohesive soils. The results of SPT are shown in the Record of Boreholes.

Groundwater depths in the boreholes, where encountered, were measured during drilling and upon completion of drilling. The measured groundwater depths, where applicable, are shown on the Record of Boreholes.

Upon completion of drilling, all boreholes were backfilled in accordance with the general requirements of Ministry of Environment (MOE) Ontario Regulation 903. The surficial asphaltic concrete at the borehole locations were repaired by cold patch asphalt.

A visual pavement condition survey of the existing road surface was carried out to evaluate the existing condition. Selected photographs showing the existing road condition are included in Appendix A.

Soil samples were transported to Wood's Laboratory for further review and laboratory testing (i.e., water content determination, grain size distribution analysis and Atterberg Limit test, where applicable). The soil conditions, groundwater levels, and the results of the in-situ and laboratory tests are presented on the corresponding Record of Boreholes. The laboratory test results are presented in Appendix B.

Upon recovery, all soil samples were screened to assess for evidence of potential contamination, which included visual inspections. Selected soil samples were transported to AGAT laboratories, an accredited CALA laboratory located in Mississauga, for soil chemical analysis and soil corrosivity tests. The Certificates of Analysis for the soil chemical analyses and soil corrosivity tests are included in Appendix C.

2.2 Pavement Investigation

2.2.1 Visual Condition Survey

Wood carried out a visual pavement condition survey of the existing road surface within the project area on December 2019 to identify any distresses. The identification and classification of the pavement distresses were carried out in accordance with MTO's "Flexible Pavement Condition Rating Manual – Guidelines for Municipalities", SP-022.

2.2.2 Borehole Investigation for Existing Pavement

A total of 40 boreholes (BH 01 to BH 48, excluding eight boreholes (BH 02, BH 04, BH 14, BH 28, BH 30, BH 36, BH 38 and BH 40, which could not be drilled due to presence of underground utility or inaccessibility), were drilled within the project limits to investigate the existing pavement structure. The details of the boreholes drilled at the project site are presented in Table 2.1 and shown on Figure Nos. 1A to 1D.

2.3 Geotechnical Investigation

2.3.1 Underground Utilities

The boreholes drilled for pavement investigation (Section 2.2.2) were also used for underground utility investigation, some of which were deepened to provide additional subsurface information.

Twelve (12) boreholes (BH 01, BH 03, BH 09, BH 11, BH 17, BH 19, BH 25, BH 27, BH 33, BH 35, BH 41 and BH 47) drilled for pavement investigation were deepened to depths varying from 4.6 m to 5.2 m to obtain additional subsurface information for underground utility installation, as listed in Table 2.1 and shown in Figure Nos. 1A to 1D.

2.3.2 Grade Separation

One (1) borehole (BH 49) was drilled to a depth of about 10.7 m at the location of the planned grade separation between Fifty Road and CNR tracks, as listed in Table 2.1 and shown in Figure No. 1D.

2.4 Hydrogeological Investigation

The project scope of work includes a desktop hydrogeological study, the findings of which are presented in a separate report prepared by Wood.

2.5 Laboratory Tests

Laboratory testing was performed on selected samples from boreholes, which included tests for soil characterization (natural water content determination, grain size distribution analysis and Atterberg Limit test) and soil chemical analysis for soil corrosivity, as listed below:

- Water content determination of all soil samples obtained from the boreholes;
- Grain size distribution analysis on fifteen (15) selected samples;
- Atterberg Limit test on six (6) selected samples;
- Soil corrosivity analysis of four (4) selected samples; and
- Soil chemical analysis as follows:
    - Metals and inorganics (6 tests);
    - PHC (F1-F4) with BTEX (2 tests);
    - TCLB (metals, VOC and B(a)P (2 tests).

2.6 Groundwater Level Measurement

Groundwater was not encountered in any of the boreholes at the time of drilling or upon completion of drilling.

3.0 SUBSURFACE SOIL CONDITIONS

The subsurface conditions observed at the 41 boreholes (BH 01 to BH 49, excluding BH 02, BH 04, BH 14, BH 28, BH 30, BH 36, BH 38 and BH 40) drilled for this project are described in this section. Eight boreholes, as listed in Table 2.1, could not be drilled due to the presence of existing utilities and / or inaccessibility. The boreholes were drilled to depths varying from 0.5 m to 10.7 m, as shown in Table 2.1. Soil stratigraphy along Barton Street is shown in Figure Nos. 2A and 2B, and along Fifty Road is shown in Figure No. 3.

The subsurface soil profile at the site consisted of surficial cover (asphaltic concrete or exposed sand and gravel fill) underlain by various fill soils (sand and gravel, silty clay and/or silty sand / sand / silt) overlying silty clay till and/or weathered shale which extended to the termination depths of the boreholes. Groundwater was not encountered in any of the boreholes during or upon completion of drilling.

The stratigraphic units and groundwater conditions are discussed in the following sections. Additional information is provided in the Record of Boreholes. The following summary is to assist the designers of the project with an understanding of the possible soil conditions at the investigated road section. It is to be noted that the soil and groundwater conditions could vary between and beyond the borehole locations.

3.1 Surficial Cover

At the borehole locations, the surficial cover consisted of asphaltic concrete or exposed sand and gravel fill (Section 3.2).

The thickness of the asphaltic concrete varied from about 95 mm to 470 mm along Barton Street. In the boreholes drilled along Fifty Road, it varied from about 110 mm to 135 mm.

3.2 Sand and Gravel Fill

Sand and gravel fill was encountered at all borehole locations, either at the ground surface or below asphaltic concrete, and extended to depths varying from about 0.2 m to the termination depth of some boreholes at 1.5 m (Elevations 85.5 m to 91.6 m) below ground / road surface.

SPT 'N' values measured with the sand and gravel fill varied from 11 to 61 blows per 0.3 m, and water contents measured in fill samples varied from about 1 % to 21 %.

Results of grain size distribution analyses carried out on nine sand and gravel fill samples are included in the Record of Boreholes and summarized in Table 3.1.

Table 3.1: Results of Grain Size Distribution Analyses
(Sand and Gravel Fill)

Borehole No.	Sample No.	Depth	Elevation	Grain Size Distribution				USCS Modified Group Symbol
				Gravel	Sand	Fines		
						Silt	Clay	
		(m)		(%)				
BH 05	SS 1	0.6	87.8	28	44	28		SM
BH 10	SS 1	0.3	86.9	44	38	18		SM
BH 15	SS 1	0.4	89.6	44	46	10		SP / SM
BH 20	SS 1	0.3	89.0	34	48	18		SM
BH 26	SS 1	0.1	87.7	41	47	12		SP / SM
BH 32	SS 1	0.3	91.4	31	49	20		SM
BH 39	SS 1	0.3	92.0	40	39	21		GM / SM
BH 43	SS 1	0.3	91.0	40	52	8		SP / SM
BH 48	SS 1	0.3	88.4	41	48	11		SP / SM

The grain size distribution plots, with respect to Granular A and Granular B (OPSS 1010) gradations, are presented in Figure Nos. B1 and B2 in Appendix B.

3.3 Silty Clay Fill

Silty clay fill was encountered below the sand and gravel fill in most of the boreholes or below silty sand / sand / silt fill (Section 3.4) in BH 27. It was not encountered within the drilled depths in Boreholes BH 03, BH 05, BH 07, BH 12, BH 16, BH 23 to BH 25, BH 29, BH 31, BH 32, BH 34, BH 35, BH 37 and BH 44 to BH 48, The silty clay fill, where encountered, extended to depths varying from about 0.6 m to 2.2 m (Elevations 86.2 m to 91.5 m) below the existing ground / road surface.

The silty clay fill was brown / red in colour and contained trace to some sand, trace gravel and trace organic matter. SPT 'N' values measured with the silty clay fill varied from 6 to 16 blows per 0.3 m, and water contents measured in fill samples varied from about 9 % to 40 %.

3.4 Silty Sand / Sand / Silt Fill

Silty sand / sand / silt fill was encountered below the sand and gravel fill in five boreholes (BH 09, BH 17, BH 19, BH 20 and BH 27), and extended to depths varying from about 0.9 m to termination depth of BH 20 at 1.5 m (Elevations 86.4 m to 88.3 m) below the existing ground / road surface.

The silty sand / sand / silt fill was generally grey / brown / red in colour and contained trace clay and gravel. SPT 'N' values measured with the silty sand / sand / silt fill varied from 7 to 26 blows per 0.3 m, and water contents measured in fill samples varied from about 12 % to 16 %.

3.5 Silty Clay Till

Silty clay till was encountered in all boreholes below the fill soils, except in boreholes that were terminated within the fill soils, i.e., BH 05, BH 07, BH 12, BH 16, BH 18, BH 20 to BH 22, BH 40 and BH 42 to BH 44. The silty clay till, where encountered, extended to depths varying from about 1.5 m to 5.2 m (Elevations 82.8 m to 90.7 m) below the existing ground / road surface. In a number of boreholes (BH 06, BH 08, BH 13, BH 15, BH 19, BH 22 to BH 32, BH 34, BH 37, BH 45, BH 46 and BH 48), the silty clay till extended to the borehole termination depths of 1.5 to 5.2 m.

The silty clay till was generally red / brown / grey in colour and contained trace to some sand and trace gravel. SPT 'N' values measured with the silty clay till varied from 9 to more than 50 blows per 0.3 m, implying stiff to hard consistency. The lower 'N' values (firm to stiff) were generally observed just below the fill soils, with the remaining generally in very stiff to hard consistency. Water contents measured in the till samples varied from about 5 % to 23 %.

Gradation analysis and Atterberg Limit test were carried out in six samples of the silty clay till, the results of which are presented in Table 3.2, and shown in the Records of Boreholes.

Table 3.2: Results of Grain Size Distribution Analysis and Atterberg Limit Test
(Silty Clay Till)

Borehole No.	Sample No.	Depth	Elevation	Grain Size Distribution				Atterberg Limit			USCS Modified Group Symbol
				Gravel	Sand	Fines					
						Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index	
		(m)		(%)							
BH 03	SS 3	1.8	85.8	2	3	70	25	26	17	9	CL
BH 11	SS 4	2.6	86.1	<1	7	74	19	24	18	6	CL
BH 19	SS 4	2.6	86.8	3	19	48	30	30	14	16	CL
BH 27	SS 5	3.4	85.0	6	19	49	26	27	17	10	CL
BH 35	SS 2	1.1	91.0	18	6	56	20	27	17	10	CL
BH 49	SS 5	3.3	85.1	<1	1	77	22	28	19	9	CL

The grain size distribution curves and plasticity chart are presented in Figure Nos. B3 and B4 in Appendix B.

3.6 Weathered Shale

Weathered shale, i.e., shale that could be augered through, was encountered below the silty clay till in a number of boreholes (BH 01, BH 03, BH 09 to BH 11, BH 17, BH 33, BH 35, BH 41, BH 47 and BH 49,) and extended to the termination depths of the boreholes varying from 1.5 m to 10.7 m (Elevations 77.7 m to 87.4 m). Borehole BH 49 was terminated due to auger refusal on possible sound shale at a depth of about 10.7 m (Elevation 77.7 m).

The weathered shale was red or grey in colour. SPT 'N' values measured with the weathered shale were all more than 50 blows per 0.3 m, implying hard consistency. Water contents measured in the shale samples varied from about 4 % to 9 %.

3.7 Groundwater

Groundwater was not encountered in any of the boreholes during or upon completion of boreholes.

It should be noted that the groundwater at the site would fluctuate seasonally and can be higher during the spring months, and in response to major weather events.

4.0 PAVEMENT INVESTIGATION AND DESIGN

The purpose of the geotechnical investigation was to obtain subsurface information and to provide geotechnical recommendations for road rehabilitation/re-surfacing and widening along Barton Street and Fifty Road in Stoney Creek and Winona, Ontario. The discussions and recommendations in the following sections are general in nature, as the details of the widening were not available at the time of this report.

The following discussions and recommendations are based on the available information and the subsurface information obtained from the boreholes and are intended for use by Design Engineers. In addition, Section 7 provides general considerations for design and construction.

4.1 Visual Pavement Condition Survey

On 25 February 2020, Wood completed a visual pavement condition survey of the existing road surface within the project area to identify any distresses. A summary of the pavement condition survey, including predominant surface defects, surface deformation and cracking, is tabulated in Table 4.1 and selected photographs showing the existing condition of the investigated road section are presented in Appendix A. Based on the pavement condition survey, the existing asphaltic concrete surface condition ranged from 'Fair to Poor' Condition.

Table 4.1: Existing Pavement Condition

	Predominant Distress	February 2020 Condition Rating
Barton Street		
1. Fruitland to McNeilly Rd. Approx. 2.6 km	• Ravelling & coarse aggregate loss – Moderate to Severe / Frequent. • Potholes Moderate / Few • Wheel Track Rutting/Distortion – Moderate / Frequent. • Longitudinal Cracking (single, multiple and alligator) – Moderate / Frequent. • Alligator Cracking – Moderate / Frequent / Extensive. • Centreline Cracking (single, multiple and alligator) – Moderate / Frequent. • Pavement Edge Cracking – Moderate / Intermittent with Potholes • Transverse Cracking (Half, Full and Multiple – Alligator Cracking – Moderate / Frequent to Extensive.	Fair to Poor Condition

Table 4.1: Existing Pavement Condition

Predominant Distress		February 2020 Condition Rating
2. McNeilly Rd to Fifty Rd. Approx. 2.5 km	• Ravelling & coarse aggregate loss – Moderate / Frequent. • Wheel Track Rutting/Distortion – Slight / Intermittent. • Longitudinal Cracking (single, multiple and alligator) – Moderate / Frequent to Extensive. • Alligator Cracking – Moderate / Frequent / Extensive. • Centreline Cracking (single, multiple and alligator) – Moderate / Frequent. • Pavement Edge Cracking – Moderate / Frequent. • Transverse Cracking (Half, Full and Multiple – Alligator Cracking – Moderate / Frequent.	Poor to Fair Condition
200 mm before Fifty Rd newly paved road.		
Fifty Road		
3. Barton St to Hwy 8 Approx. 0.80 km	• Ravelling & coarse aggregate loss – Slight / Intermittent. • Wheel Track Rutting/Distortion – Slight / Intermittent. • Longitudinal Cracking (single, multiple and alligator) – Moderate / Intermittent. • Centreline Cracking (single, multiple and alligator) – Moderate / Frequent. • Pavement Edge Cracking - Slight / Intermittent. • Transverse Cracking (single, multiple and alligator) – Moderate / Frequent	Fair to Poor Condition
From railway to QEW ~200 mm newly paved road.		

4.2 Subsurface Conditions

A total of 32 boreholes were drilled along Barton Street from Fruitland Road to Highway 8 (approx. 5.1 km) and 9 boreholes were drilled along Fifty Road from Highway 8 to South Service Road (approx. 0.8 km), Stoney Creek and Winona, Ontario. The soil profile consisted predominantly of existing asphaltic concrete pavement overlying fill soils (sand and gravel, silty clay, silty sand / sand / silt) underlain by silty clay till and / or weathered shale.

Additional information is provided in the Records of Boreholes. Results of the grain size distribution analyses carried out on the sand and gravel fill samples are included in the Record of Boreholes and summarized in Table 3.2. The grain size distribution plots, with respect to Granular A and Granular B (OPSS 1010) gradations, are presented in Figure Nos. B1 and B2 in Appendix B.

Groundwater was not encountered in any of the boreholes during or upon completion of drilling. It should be noted that the soil and groundwater conditions might vary between and beyond the borehole locations.

4.3 Pavement Adequacy and Composition

Two methods were used to assess the existing pavement structure. In-situ structure number ("SN") and in-situ Granular Base Equivalency ("GBE") were estimated from the borehole data using the equivalency factors for various material types, as shown in Table 4.2.

Table 4.2: Summary of Typical Structural Layer Coefficient

Material Type	Typical AASHTO-Ontario Structural Layer Coefficient (SLC), ai (mm) [1]		Granular Base Equivalency Factors
Rehabilitation	Drainage	Structural	
Existing HL	Acceptable 1.0	0.14 to 0.28	1.25
Existing Gran Base	Questionable 0.9	0.10 to 0.14	0.75
Existing Gran Sub-base	Inadequate 0.8 to 0.5	0.05 to 0.09	0.50
Existing Gran Base/Sub-base			0.625

[1] MTO Report MI-183 -. MTO Report MI-183 "Adaptation and Verification of AASHTO Pavement Design Parameters for Ontario Conditions" - Table 4-5.

Table 4.3 summarises the total average pavement structure thickness of the existing asphaltic concrete pavement, granular base and sub-base, as well as the average existing Structure Number 'SN' and 'GBE' before rehabilitation.

Table 4.3: Summary of Existing Pavement Structure

# of CBs @DL	Average Thickness (mm)		SN[1]	GBE	Predominant Subgrade
	HMA	Base/Subbase	(mm)		
Barton St from Fruitland Rd to Hwy 8 ~ 5.1 km					
Mainline BHs = 20	Range (95-470) mm Av. 224 mm	Range (30-1,370) mm Av. 395 mm	Range (45-169) mm Av. 74 mm	Range (309-1,069) mm Av. 526mm	Si(y) Cl Till, Tr Sa Si(y) Cl Till, Tr Sa & Gr Sa & Gr Si(y) Cl Till Si(y) Cl (Fill)
Shoulder BHs =12	-	Range (200-1,500) mm Av. 492 mm	-	-	
Fifty Rd from Hwy 8 to South Service Rd ~ 0.8 km					
Mainline BHs = 5	Range (110-135) mm Av. 125 mm	Range (365-590) mm Av. 525 mm	Range (58-80) mm Av. 74 mm	Range (395-519) mm Av. 484 mm	Si(y) Cl (Fill) Sa & Gr Si(y) Cl Till
Shoulder BHs = 4	-	Range (400-600) mm Av. 450 mm	-	-	

Notes: DL=Driving Lane

[1] For the existing SN calculations, the following parameters were used:

- Existing HMA coefficient, = 0.14;
- Existing granular base/subbase coefficient, and drainage = 0.12/0.9

4.4 Existing and Forecasted Traffic Data

The traffic data represented as Average Annual Daily Traffic ($AADT_{2020}$) in both directions was estimated by Wood Traffic Group as presented in Table 4.4 Equivalent single axle loads (ESALs) were calculated cumulatively over 20 years as described in the Ministry of Transportation Report "Procedures for Estimating Traffic Loads for Pavement Design, 1995".

Table 4.4: Traffic Data

Road Segment	Growth Rate (%)	$AADT_{2020}$ in Both Directions	Comm. Vehicles (%)	Design ESALs @ 20 Years	Traffic Category
Barton St from Fruitland Rd to Hwy 8 ~ 5.1 km					
Between Escarpment Dr & Lewis Rd	1.0%	3,990	8%	2,455,843	C
Between Lewis Rd & McNeilly Rd	1.0%	3,910	9%	2,707,428	
Between Glover Rd & McNeilly Rd	1.0%	4,820	12%	4,450,061	
Fifty Rd from Hwy 8 to South Service Rd ~ 0.8 km					
Between Hwy 8 & Barton St	3.5	6,090	6%	3,421,050	C

Notes:

- 2020 is the anticipated construction year.
- Growth rates were estimated based on historical data.
- Truck percentages were determined based on existing turning movement counts (TMCs).
- AADTs were rounded up to the nearest 10.
- Highest ESAL used for the Analysis.

4.5 Flexible Structural Pavement Design for Widening

After reviewing the field data and laboratory test results, the minimum pavement structural design for widening / rehabilitation of Barton Street (from Fruitland Road to Fifty Road) and Fifty Road (from Highway 8 to South Service Road) is presented in Table 4.5 as determined in accordance with the 1993 American Association of State Highway and Transportation Officials ('AASHTO') Guide for the Design of Pavement Structures using the Darwin Software Program.

The AASHTO Pavement Design is considered to be a function of estimated future traffic in both directions (ESALs), reliability (R) which is a function of road classification, overall standard deviation (S_o), resilient modulus (M_r), as well as initial and terminal serviceability (P_o, P_t). From these parameters, the structure number (SN) is calculated. The SN is defined in the AASHTO Guide as a number, which provides a measure of the pavement strength and thickness needed to avoid overstressing the subgrade.

The following design parameters were chosen to calculate the required structure number for the design of flexible pavement using the AASHTO method, as described in the Ministry of Transportation Materials Information Report MI-183 *"Adaptation and Verification of AASHTO Pavement Design Parameters for Ontario Conditions".*

- Initial serviceability, P_i = 4.5;
- Terminal serviceability, P_t = 2.5;
- Reliability level, R = 90 percent.
- Overall standard of deviation, S_o = 0.49;
- Subgrade Resilient Modulus, (kPa) M_r = 30,000

Table 4.5: Recommended Minimum Structural Pavement Design

Road	ESALs	AASHTO Design for 20 Years					Recommended HMA & PGAC		Traffic Category
		HMA	Gran A	Gran B Type II	Design SN Req'	Total Pavt Thickness	Marshall		
							SP 12.5FC2 Surface Course	SP 19 Binder Course	
		Thickness (mm)							
Barton St ~5.1 km	4.5 X 10^6	165	150 or 450 mm of Gran A	300	130	615	SP 40 mm PGAC 64-28	55 mm+70 mm PGAC 58-28	C
Fifty Rd ~0.8 km	3.5 X 10^6	155	150 or 450 mm of Gran A	300	126	605	SP 40 mm PGAC 64-28	55 mm+ 60 mm PGAC 58-28	

Notes:

Pavement shall be placed over approved subgrade.

Granular A: Compaction as per OPSS Form 1010 (100% SPMDD).

4.6 Rehabilitation Strategies

The selected rehabilitation strategy was based on Wood's geotechnical/pavement investigation and analysis, including a visual pavement condition assessment, subgrade condition, and calculated ESALs. Consideration was also given to user delay, cost and/or disruption of traffic and an anticipated construction year of 2020. Proposed rehabilitation strategy for Barton Street and Fifty Road is presented in Table 4.6 as follows:

Partial Depth Reconstruction (PDR)

The visual pavement condition of both Barton Street and Fifty Road was rated in "Fair to Poor" condition. Partial depth re-construction is recommended, which involves excavating to a total depth of 315 mm for Barton Street and to a depth of 305 mm for Fifty Road to accommodate the pavement design in Table 4.6.

This strategy will improve drainage and the structural capacity of the pavement and it will have lower maintenance cost over the pavement service life of 13-16 years. In addition, it will not change the existing vertical profiles.

4.7 Recommended Construction Features for Pavement

4.7.1 Rehabilitation Strategies

Table 4.6 presents the proposed strategy which is partial depth reconstruction.

Table 4.6: Proposed Rehabilitation Strategy

Road Section	Pavement Condition	Rehabilitation Strategy	Urban / Rural
Barton Street from Fruitland Road to Fifty Road	Fair to Poor Condition	Excavate to depth of 315 mm including HMA and existing granular, proof roll, compact, add 150 mm of granular A compact, and resurface with 165 mm of HMA. o 40 mm of SP12.5FC2 o 55 mm + 70 mm of SP 19 o 150 mm Granular A *(No raise in grade)*	U
Fifty Road from Highway 8 to South Service Road		Excavate to depth of 305 mm including HMA and existing granular, proof roll, compact, add 150 mm of granular A compact, and resurface with 155 mm of HMA. o 40 mm of SP12.5FC2 o 55 mm + 60 mm of SP 19 o 150 mm Granular A *(No raise in grade)*	

4.7.2 Widening of Barton Street and Fifty Road

Pavement recommendations for widening are presented in Table 4.7, including hot mix type, lift thickness, and PGAC type making up the recommended asphalt thickness, as well as the traffic category, in accordance with OPSS 1151. The granular thicknesses of the widening given in the table is a minimum thickness and should match the adjacent existing pavement granular thickness to promote positive lateral drainage. Also, the thicknesses can be increased depending on grading requirements.

Full depth excavation, as required and commencing from the existing edge of pavement, will be required to accommodate the proposed design thickness. The excavated granular materials from the shoulder can be re-used as fill material for subgrade for the widening/embankment, provided it is not contaminated. New Granular B Type II subbase should be added and compacted, followed by new Granular A base material. Both base and subbase can vary in thickness to match the adjacent existing pavement granular in order to

promote positive lateral drainage. The Granular A base course should be compacted and overlain with 2 lifts of SP19.0 mm binder course, and 1 lift of SP12.5 FC2 surface course, as per Table 4.7. Installation of subdrain is recommended, if lateral drainage of the existing subgrade is not possible.

Table 4.7: Pavement Design for Widening

Pavement Components / Road Section	Barton Street from Fruitland Road to Fifty Road	Fifty Road from Highway 8 to South Service Road
SP12.5FC2/ PGAC 64-28 - Traffic Category C	40 mm	40 mm
SP 19.0 / PGAC 58-28 - Traffic Category C	55 mm	55 mm
SP 19.0 / PGAC 58-28 - Traffic Category C	70 mm	60 mm
Granular A	150 mm	150 mm
Granular B Type II (1)	300+mm	300+mm
Total Pavement Structure	615 mm	605 mm

Notes:
(1) The granular thicknesses of the widening given in the table is a minimum thickness and should match the adjacent existing pavement granular thickness to promote positive lateral drainage. Also, the thicknesses can be increased depending on grading requirements.

4.7.3 Subgrade / Road Base Preparation and Compaction

The pavement structural design recommended for roads is applicable, provided the subgrade is prepared under dry weather conditions, proof-rolled with a heavy rubber-tired vehicle (such as loaded dump truck) in the presence of a geotechnical consultant. Any loose, soft or unstable areas, if detected during proof-rolling, must be sub-excavated, replaced with approved granular materials and compacted. Any additional engineered fill, if required, should be placed in thin layers not exceeding 200 mm and compacted to a minimum of 98 % of Standard Proctor Maximum Dry Density (SPMDD). Granular materials should be placed in thin layers, not exceeding approximately 200 mm, within ± 2 % of its optimum moisture content, and thoroughly compacted to a minimum of 100 % of SPMDD.

The subgrade should be provided with adequate drainage. If wet weather conditions prevail at the time of construction, adjustments to this design may be required, i.e., if the subgrade becomes excessively wet or rutted during construction activities, additional sub-base material may be required. The need for additional sub-base material is best determined during construction.

All granular base and sub-base materials must be compacted to at least 100% of SPMDD.

4.7.4 Drainage

It is recommended that adequate drainage be provided both laterally and longitudinally along the length of the project.

To meet the design requirements for the pavement life, the road subgrade and granular courses should be well drained at all times. This can be accomplished by ensuring proper grading of the subgrade and positive lateral drainage of the granular base daylighting at the ditch. Alternatively, full-length perforated subdrain pipes of 150 mm diameter should be installed along both sides of the road, below the roadbed level and drain to suitable outlets for effective drainage, in accordance with OPSD 216.021. The sub-drainpipes should be wrapped in suitable non-woven geotextile surrounded by a minimum drainage zone of 19 mm size clear stone of minimum 150 mm thickness. A minimum slope of 2 % should be maintained across the paved sections (finished road surface) to ensure proper surface drainage. New pavement should slope towards the gutter/ditch.

5.0 UNDERGROUND UTILITY INSTALLATION

The geotechnical investigation program was carried out to obtain subsurface conditions and provide recommendations for installation of new underground utility services, including associated manholes / catch basins. As the details of new underground utilities are not available at the time of preparing this report, the following discussion and recommendation are general in nature. In addition, Section 7 provides general considerations for design and construction.

5.1 Subsurface Conditions

All boreholes drilled for the project have been considered in this section for installing new underground utilities and associated manholes / catch basins. One borehole (BH 49) was drilled for the proposed grade separation and Boreholes BH 41 and BH 47 were drilled along Fifty Road (about 0.7 km within project limits), while the rest were drilled along Barton Street (about 5.1 km within project limits). Soil stratigraphy along Barton Street is shown in Figure Nos. 2A and 2B, and along Fifty Road is shown in Figure No. 3.

Overall, the project site consisted of surficial cover (asphaltic concrete or exposed sand and gravel fill) underlain by various fill soils (sand and gravel, silty clay and/or silty sand / sand / silt) overlying silty clay till and/or weathered shale.

Groundwater was not encountered in any of the boreholes at the time of drilling or upon completion of drilling.

Subsurface and groundwater conditions are described in Section 3.0.

5.2 Discussions and Recommendations for Underground Utility Installation

As per the information available, the planned Barton Street and Fifty Road improvements within the project limits will include new underground utilities (sewers, watermain, etc.) and associated manholes and catch basins, the details of which were not available at the time of this report. Existing utilities should be protected and taken into consideration for design and construction of new underground utilities and road widening.

The ground (road) elevations within the project limits (based on borehole locations) varied from about 87.0 m to 92.3 m, with undulating ground surface. Overall, the ground surface sloped up from west to east along Barton Street and from north to south along Fifty Road.

Recommendations and discussions for excavation and installation of underground utilities and associated manholes / catch basins, are provided in the following sections.

5.2.1 Founding Subgrade Conditions

The results of the investigation, which comprised 10 boreholes along Barton Street and 3 boreholes along Fifty Road, indicated that the soil profile predominantly consisted of fill soils (sand and gravel, silty clay, silty sand / sand / silt) underlain by silty clay till and weathered shale. The silty clay till was encountered at depths ranging from about 0.7 m to 2.2 m (Elevations 86.2 m to 91.3 m) below the existing ground level (road surface). Weathered shale (which could be augered through) was encountered at the majority of the borehole locations (10 out of 13 boreholes) at depths ranging from about 2.2 m to 4.9 m (Elevations 83.5 m to 89.6 m) below the existing ground level (road surface).

The silty clay till, which was firm to hard, and the hard weathered shale should be generally competent to support underground utilities and associated manholes/catch basins. If necessary, they can be founded on competent existing fill soils after being proof-rolled, inspected and approved by a geotechnical engineer. Existing incompetent fill soils (e.g., not compactable, mixed with organic matter, soft, etc.) encountered at the founding level should be sub-excavated and backfilled with compacted soil as recommended in Section 6.3 (Engineered Fill).

For manholes and catch basins founded on the silty clay till or weathered shale, if required, a Geotechnical Reaction at Serviceability Limit State (SLS) of 100 to 150 kPa and a factored Geotechnical Resistance at Ultimate Limit State (factored ULS) of 150 to 225 kPa may be used, which should be verified by a geotechnical engineer during construction. Under the SLS bearing values, settlements of up to 25 mm may take place.

The frost penetration depth for the project area should be considered as 1.2 m.

Groundwater was not measured in the boreholes during or upon completion of the boreholes. As such groundwater may not be present within the excavation depths. However, perched water in sandy / silty pocket and / or water from surface runoff will require dewatering during excavation. As the excavation will

generally be in clayey soils, groundwater seepage, if any, into the excavation is likely to be slow and a properly filtered sump and pump system, or gravity drainage, may be used for dewatering excavation.

General discussions regarding excavation and dewatering are provided in Section 7.4. Wood's hydrogeological desktop study, which is submitted under a separate cover, should be considered for dewatering requirements.

Trench excavation, pipe bedding and anti-seepage collar considerations are discussed in following sections.

General discussions provided in Section 6.0 should also be considered for design and construction.

5.2.2 Trench Excavation

Trench excavation should be carried out as per the Ontario's Occupational Health and Safety (OH&S) Regulations for Construction Projects. The soil types for excavation are provided in Section 7.4. Based on the soils encountered in the boreholes, the sideslopes of excavations should be 1H:1V for Type 2 and Type 3 soils, provided excavations are properly dewatered and underground utilities are installed and backfilled within a reasonable short period of time. Provisions should be made for dewatering, as noted in Section 7.4. Trenching should be in accordance with OPSS 401 (Construction Specification for Trenching, Backfilling and Compacting).

5.2.3 Bedding

Bedding for underground pipes should be placed in accordance with the design requirements and current OPS specifications, OPSD 802.10 for flexible pipes and OPSD 802.30, 802.31 and 802.32 for rigid pipes. It is recommended that a minimum of 150 mm thick bedding material (Class 'B' Type or better) be placed below the pipe invert. The thickness of the bedding may, however, have to be increased depending on the pipe diameter, or if wet or weak subgrade conditions are encountered. If the subgrade is weak, it should be sub-excavated and replaced with engineered fill to support the pipes and allow the use of Class 'B' Type bedding. If weak subgrade is encountered and cannot totally be removed, Class 'A' Type bedding (e.g., minimum 100 mm thick lean concrete) should be used to provide a workable surface and support the pipes.

For the areas to be filled, the fill soils should first be placed approximately to finished grade and subsequently excavated to install underground pipes in order to prevent pipe settlement due to overburden loads.

Should the pipes be installed in soft clay soils, the joints should be restrained from movements and the backfill around the pipes should be properly compacted in order to prevent long-term movements. A layer of geotextile (Terrafix 270R or equivalent) should be placed between the soft clayey soils and the granular bedding/backfill in order to prevent soil migration.

The possibility of underground pipe movements in soft clayey soils, after installation, should be considered in the design and construction of underground pipes.

Construction of underground pipes should be carried out in accordance with the relevant OPSS 410 (Construction Specification for Pipe Sewer Installation in Open Cut), or other relevant applicable municipal / regional standards.

5.2.4 Anti-Seepage Collars

Anti-seepage collars are recommended for pipes installed under groundwater table in silty / sandy soils to prevent erosion of the silty / sandy soils around the pipes. Although groundwater was not encountered in the boreholes drilled, long-term groundwater could be present and anti-seepage collars should be installed in silty / sandy soils which support underground pipes.

The anti-seepage collar, if required, should follow the Region's standards / specifications.

5.2.5 Soil Corrosivity

To assess the soil aggressiveness to concrete and steel / embedded metallic structures, three (3) soil samples were submitted to AGAT Laboratories for determination of pH, chloride, sulphate, electrical conductivity, resistivity and Redox Potential.

Summarized corrosivity test results are provided in Table 5.1. The corrosivity test results and laboratory Certificate of Analyses are included in Appendix C.

Table 5.1: Summary of Soil Corrosivity Test Results

Sample ID	Chloride (µg/g)	Sulphate (µg/g)	pH	Electrical Conductivity (mS/cm)	Resistivity (ohm-cm)	Redox Potential (mV)	Sulfide (%)
BH 9, SS 4	26	70	8.28	0.24	4170	293	293
BH 25, SS 4	227	4740	8.31	3.51	285	268	268
BH 35, SS 3	310	49	8.13	0.70	1420	294	294

The measured soil resistivity values can be considered as "very high" for 285 ohm-cm , "high" for 1420 ohm-cm and "moderate" for 4170 ohm-cm, with respect to exposed metallic structures, based on ASTM STP 1000, Corrosion Testing and Evaluation - Table 3 (Corrosivity for Uncoated Steel). From the measured acidity (pH) of 7.87 to 8.31 of soil samples, corrosivity potential is considered "low to moderate".

In accordance with Table 3 of CSA A23.1-14, no additional requirement is specified for sulphate content below 0.10 % (1,000 µg/g) with respect to concrete. In one sample (BH 25, SS4), a sulphate content of 4740 µg/g was measured, which is considered as exposure class S-2 ("severe"). The remaining two samples were

below 1000 µg/g, for which, in accordance with Table 6 of CSA A23.1-14, Type GU Portland cement can be used based on the water-soluble sulphate contents measured in soils.

The chloride content measured in the samples were 26 to 227 µg/g. As per ASTM STP 1013 (Effects of Soil Characteristics on Corrosion – "*chloride appears to be the main factor in increased soil corrosivity with levels in excess of 0.01 % (100 (µg/g) considered indicative of accelerated corrosion*".

A corrosion specialist should be retained, if necessary, to review the analysis results and provide relevant recommendation.

6.0 GEOTECHNICAL INVESTIGATION FOR GRADE SEPARATION

The geotechnical investigation program for the planned grade separation between Fifty Road and CNR tracks (refer to Figure No. 1D) consisted of one (1) borehole (BH 49) to obtain subsurface conditions. Proposed grade separation detail was not available at the time of this report.

6.1 Subsurface Conditions

Based on the soil conditions observed in Borehole BH 49, the subsurface profile at grade separation locations generally consisted of fill soils (sand and gravel and silty clay) underlain by silty clay till overlying weathered shale.

The stratigraphic units and groundwater conditions encountered at the borehole location are discussed in the following sections and presented in the Record of Boreholes. The following summary is to assist the designers of the project with an understanding of the soil conditions encountered at the planned grade separation location. The soil and groundwater conditions might vary beyond the borehole location.

6.1.1 Surficial Cover and Fill Soils

Asphaltic Concrete: The borehole was drilled through the existing road, where the asphaltic concrete thickness was about 125 mm.

Sand and Gravel Fill: Sand and gravel fill was encountered below the asphaltic concrete and extended to a depth of about 0.7 m (Elevation 87.7 m) below ground surface.

Silty Clay Fill: Silty clay fill was encountered below the sand and gravel fill and extended to a depth of about 1.8 m (Elevation 86.5 m) below ground surface. Two SPT 'N' values measured within the fill were 6 and 11 blows per 0.3 m, and two water contents measured in the fill samples were 11 % and 24 %.

6.1.2 Silty Clay Till

Silty clay till was encountered underlying the fill soils and extended to depth of 4.9 m (Elevation 83.5 m) below the existing ground surface.

The silty clay till was red / brown in colour and contained trace sand and gravel. SPT 'N' values measured within the till varied from 37 to more than 50 blows per 0.3 m, implying hard consistency. Water contents measured in the till varied from 8 % to 12 %.

Gradation and Atterberg Limit tests were carried out in one sample of the silty clay till in BH 49, the results of which are presented in Table 3.2, and shown in the Record of Boreholes. The grain size distribution curve and plasticity chart are presented in Figure Nos. B3 and B4 in Appendix B.

6.1.3 Weathered Shale

Red / grey weathered shale, which could be augered through, was encountered below the silty clay till and extended to the termination depth of the borehole at 10.7 m (Elevation 77.7 m) below existing ground surface. The borehole was terminated due to auger refusal on possible sound shale.

SPT 'N'-values measured in the weathered shale were all greater than 50 blows per 0.3 m, implying hard consistency.

6.1.4 Groundwater Conditions

Groundwater was not encountered in the boreholes during or upon completion of drilling. It should be noted that the groundwater could fluctuate seasonally and can be expected to be somewhat higher during the spring months and in response to major weather events.

6.2 Discussions and Recommendations for Grade Separation

The purpose of the geotechnical investigation was to obtain subsurface information and to provide geotechnical recommendations with respect to the planned grade separation between Fifty Road and CNR tracks about 420 m north of Barton Street and just south of the ramp to South Service Road.

The subsurface soil encountered in the borehole (BH 49) drilled at the grade separation location consisted of fill soils (sand and gravel, silty clay) overlying hard silty clay till, which was underlain by weathered shale. At the borehole location, the silty clay till was encountered at a depth of about 2.2 m (Elevation 86.2 m) below ground surface, and weathered shale was encountered at a depth of about 4.9 m (Elevation 83.5 m). Groundwater was not encountered in the borehole.

As the detail of the planned work was not available at the time of preparation of this report, general considerations for grade separation are presented the following sections. In addition, Section 7 provides general considerations for design and construction.

6.2.1 Foundation

Based on the borehole drilled in the vicinity of grade separation, geotechnical reaction at Serviceability Limit State (SLS) and geotechnical resistance at Ultimate Limit State (ULS) values provided in Table 6.1 may be used for design.

Table 6.1: Recommended ULS / SLS Bearing Values for Grade Separation Structure

Borehole No.	Founding Stratum	Depth Below Existing Grade (m)	Elevation (m)	Geotechnical Reaction at SLS (kPa)	Factored Geotechnical Resistance at ULS[(1)] (kPa)
BH 49	Fill	Above 2.2 (±)	Above 86.2 (±)	not recommended	not recommended
	Hard silty clay till	2.2 to 4.9 (±)	86.2 to 83.5 (±)	200	300
	Hard weathered shale	Below 4.9 (±)	Below 89.7 (±)	300	450

[(1)] A resistance factor of Φ = 0.5 has been applied to the ULS values provided.

The geotechnical pressure values provided in Table 6.1 are intended to assess the feasibility and sizes of footings and are for vertical loads (no inclination) without load eccentricity. Under the SLS pressures, foundation settlements could be up to 25 mm (total) and 20 mm (differential). Detail foundation analysis should be carried out, if necessary, to confirm SLS/ULS and corresponding settlements.

The design frost depth penetration is 1.2 m. All foundations should be covered by at least 1.2 m deep soil or equivalent synthetic thermal insulation.

Groundwater was not observed in the borehole during or upon completion of drilling. Findings of Wood's hydrogeological desktop study, which is submitted under a separate cover, should be considered for design.

General recommendations related to excavation and dewatering are presented in Section 7.4.

6.2.2 Soil Parameters for Design

The unfactored soil parameters listed in Table 6.2 may be used for design. It should be noted that these parameters are based on published information and/or semi-empirical/theoretical relationships. These parameters are conservative and should be verified by additional field / laboratory testing, if more representative parameters are required.

Table 6.2: Unfactored Static Soil Parameters for Design

Material	Total Stress Analysis		Effective Stress Analysis		Earth Pressure Coefficients[1]			Bulk Unit Weight (kN/m^3)	Coefficient of Friction between Concrete and Soil
	C (kPa)	Φ (deg)	c' (kPa)	Φ' (deg)	Active K_a	At-Rest K_o	Passive K_p		
Hard silty clay till	100	0	0	30[2]	0.33	0.50	3.0	20	0.4
Weathered Shale[3]	200	0	0	35	0.27	1.0[4]	3.7	22	0.4

[1] Values based on semi-empirical relationships. For SLS, K_p values should be reduced to 1/3 of indicated value to limit lateral movement.
[2] Normally-consolidated range.
[3] Parameters for weathered shale are possibly conservative, depending on the degree of weathering.
[4] Due to potential swelling of shale.

6.2.3 Earthquake Considerations

Based on the soil conditions observed in the borehole (maximum drill depth of 10.7 m below ground) and in conformance with the criteria in Table 4.1 (Section 4.4.3.2 – Seismic Properties) of Canadian Highway Bridge Design Code S6-14 ("CHBDC"), the project site may be classified as Site Class C ("Very dense soil to soft rock").

The design values of site coefficients F(T), F(PGA) and F(PGV) should conform to Tables 4.2 to 4.9 (Section 4.4.3.3 – Site Coefficients) of CHBDC, and the design spectral acceleration, S(T) should be determined as per Section 4.4.3.4 (Design Spectral Acceleration and Displacement Values) of CHBDC.

6.2.4 Backfill for Structure

Backfill materials behind structures (e.g., abutments, retaining / wing wall, etc.) should consist of non-frost susceptible, free-draining granular materials in accordance with OPSS (i.e., Granular 'A' or Granular 'B'). Such backfill should be compacted to at least 95 % SPMDD (Standard Proctor Maximum Dry Density). Free-draining backfill materials and drain pipes / weep holes, etc., should be used to prevent hydrostatic pressure build-up.

Backfill, backfill transition and cover for structure, if applicable, should conform to Ontario Provincial Standard Drawing (OPSD) 3101.150 (*Walls, Abutment, Backfill, Minimum Granular Requirement*) or applicable City standard.

Engineered fill is discussed in Section 7.3, and excavation and dewatering during construction are discussed in Section 7.4.

6.2.5 Soil Corrosivity

To assess the soil aggressiveness to concrete and steel / embedded metallic structures, one (1) soil sample was submitted to AGAT Laboratories for determination of pH, chloride, sulphate, electrical conductivity, resistivity, Redox Potential and sulfide.

Summarized corrosivity test results in one sample in BH 49 are provided in Table 6.3. The corrosivity test results and laboratory Certificate of Analyses are included in Appendix C.

Table 6.3: Summary of Soil Corrosivity Test Results

Sample ID	Chloride (µg/g)	Sulphate (µg/g)	pH	Electrical Conductivity (mS/cm)	Resistivity (ohm-cm)	Redox Potential (mV)	Sulfide (%)
BH 49, SS 4	582	252	7.87	1.38	725	228	228

The measured soil resistivity values of 725 ohm-cm can be considered as “very high” for exposed metallic structures, based on ASTM STP 1000, Corrosion Testing and Evaluation - Table 3 (Corrosivity for Uncoated Steel). From the measured acidity (pH) of 7.87 in one soil sample, corrosivity potential is considered “low”.

In accordance with Table 3 of CSA A23.1-14, no additional requirement is specified for sulphate content below 0.10 % (1,000 µg/g) with respect to concrete. As such, based on the measured sulphate content of 252 µg/g and in accordance with Table 6 of CSA A23.1-14, Type GU Portland cement can be used.

The chloride content measured in the sample was 582 µg/g. As per ASTM STP 1013 (Effects of Soil Characteristics on Corrosion – “*chloride appears to be the main factor in increased soil corrosivity with levels in excess of 0.01 % (100 µg/g) considered indicative of accelerated corrosion*”.

A corrosion specialist should be retained, if necessary, to review the analysis results and provide relevant recommendation.

7.0 GENERAL CONSIDERATIONS FOR DESIGN AND CONSTRUCTION

7.1 Site Preparation

Site preparation will generally include stripping of topsoil / asphalt, excavation to subgrade, proof-rolling, repairing soft spots (if encountered), and backfilling (if necessary) with engineered fill (Section 7.3).

Subgrade preparation of pavement is discussed in Section 4.7.3. Any loose, soft or unstable areas in the exposed subgrade should be sub-excavated and replaced with approved fill and compacted (Section 7.3). Lean concrete may be used to backfill sub-excavated areas.

Excavation should be carried out with a temporary slope of 1H:1V or flatter (Section 7.4). If one lane of road is to be maintained during construction, a roadway shoring protection system may be required (Section 7.3).

7.2 Embankment Widening

Based on the existing site condition, road widening will generally involve fill sections along the investigation limits, with slope heights less than 1 m. The embankment required for road widening should be constructed with compacted engineered fill at 2H:1V (or flatter) side slopes. High embankment (fill or cut) may be required for construction of the grade separation structure. If a steeper than 2H:1V slope is required or if the height of the embankment / cut slope is greater than 4.5 m, slope stability analysis should be carried out to assess stability of the planned slope.

Widening of the road will require, as a minimum, stripping the existing ground surface cover (topsoil, asphaltic concrete, vegetation cover, surficial fill soils, etc.) from the area required for road widening. Grading, backfilling and compacting should follow OPSS 206 (Construction Specification for Grading), OPSS 401 (Construction Specification for Trenching, Backfilling and Compacting), OPSS 501 (Construction Specification for Compacting), and / or the City's requirements.

Backfilling, if required, for site grading (e.g., for subgrade raise, replacement of soft soil) should be placed as engineered fill. Engineered fill should be prepared according to the City's standards / contract specifications. Guidelines for engineered fill are included in Section 7.3.

The fill soils used for embankment widening should consist of approved clean fill (e.g., Select Subgrade Materials, Granular B - OPSS 1010, etc.).

7.3 Engineered Fill

Engineered fill, where required, may be used to backfill excavated areas, backfill around manholes and behind structures, replace soft/incompetent soils, and / or raise grades. Engineered fill for backfill of excavated areas should be placed after stripping existing fill soils, any soils containing excessive organic matter and otherwise unsuitable soils.

Engineered fill can be prepared by placing fill soil and compacted as per OPSS.MUNI 501 (*Construction Specification for Compacting*) and/or applicable City standards. Alternatively, engineered fill should be placed in loose layers not exceeding 200 mm. The water content of the fill should be within ± 2 % of its optimum moisture content (OMC) at the time of its placement, and it should be thoroughly compacted to a minimum of 98 % of Standard Proctor Maximum Dry Density (SPMDD) in general and to 100 % SMPDD below footings.

Fill soils should consist of inorganic soils and should not be frozen during backfilling and compaction. Full-time geotechnical inspection and quality control (by means of frequent field density and laboratory testing) are necessary for the construction of a certifiable engineered fill. The compaction procedures and quality control should be overseen by a geotechnical engineer.

7.4 Excavations and Dewatering During Construction

All excavations should be carried out in accordance with the Ontario's Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects (O. Reg. 213/91). The soils to be excavated can be classified as follows:

All fill soils	Type 3
Firm to stiff silty clay till	Type 3
Very stiff to hard silty clay till / weathered shale	Type 2

Accordingly, a bank slope of 1H:1V is required for excavations in accordance with the OHSA. For Type 2 soils, a 1.2 m high vertical cut at the bottom of excavation may generally be constructed. However, under groundwater table, a 1.2 m high vertical cut may not be stable and flatter slopes may be required. Near the ground surface, occasional 3H:1V or flatter slopes may be required due to loose/soft surficial soils. If open cut cannot be carried out, a temporary shoring system may be used to limit the extent of excavation. General consideration for temporary shoring is provided in Section 7.3.

Trenching should be carried out in accordance with OPSS 401 (Construction Specification for Trenching, Backfilling and Compacting).

Stockpiles, materials or any heavy equipment should be kept at least the same horizontal distance as the depth of the excavation from the upper edge of the excavation to prevent slope instability. All surface drainage should be directed away from any open excavations and trenches.

Based on observations at the borehole locations and potential excavation depth, normal excavation equipment should be suitable for excavation. The terms describing the compactness (very loose, loose, compact, dense, very dense) or consistency (very soft, soft, firm, stiff, very stiff, hard) of soil strata give an indication of the effort needed for excavation. Hard till soils and weathered shale will likely require additional effort for excavation (e.g., heavy excavator, rippers, impact hammer, etc.). It should be noted that

cobbles / boulders can be encountered in the soils and weathered shale. Therefore, removal of cobbles / boulders should be planned.

Based on the soil and groundwater conditions at the borehole locations, dewatering effort within excavated areas should not be significant. In the clayey soils, groundwater seepage into the excavation, if encountered, is likely to be slow. Nevertheless, a properly filtered sump and pump system or gravity drainage may be required for dewatering. The number of sumps and pumps may have to be increased if high water flow rates are encountered during construction.

The founding subgrade for structures (abutments / wing walls) will likely consist of till soils / weathered shale. The use of lean concrete mud mat or granular layer may be warranted where founding surfaces are to be exposed for extended period, especially if the work is carried out during wet weather. Care should also be exercised to minimize disturbance to the final subgrade during excavation.

It is recommended that qualified geotechnical personnel be present during excavation to review the conditions of the subgrade for supporting structures / utilities.

7.5 Temporary shoring

Temporary shoring (roadway protection) may be required for vertical excavation, if necessary, during construction of the grade separation structure and/or underground utilities. This can be accomplished using soldier piles with lagging (trench box or similar) in order to support the sides of the excavation. Temporary shoring design and construction should comply with OPSS.MUNI 539 (*Construction Specification for Temporary Protection Systems*), or applicable City standard.

The temporary shoring system should be designed to resist the lateral earth, surcharge and hydrostatic pressures which could occur during construction. Bracings should be installed within the shoring system to minimize movements of the soils. The temporary shoring system should be designed in accordance with the latest editions of Canadian Foundation Engineering Manual's (CFEM) and Canadian Highway Bridge Design Code (CHBDC), together with the requirements of the Ontario Health and Safety Regulations, as applicable.

The shoring system should be designed and approved by a professional engineer. Soil parameters provided in Section 6.2.2 may be considered for design.

7.6 Suitability of Existing Soils for Use as Engineered Fill

The excavated soils should be suitable for being reused as engineered fill, provided they can be properly compacted and are environmentally acceptable. Fill soils containing construction debris (or similar) and organic matter should not be reused. Soils that are too wet to compact will require additional processing (e.g., drying). Cobbles and boulders (larger than 100 mm in size), if any, should be discarded by mechanical means (e.g., sieving) or manual removal.

8.0 ENVIRONMENTAL SOIL QUALITY

8.1 Methodology

An environmental soil screening and laboratory analysis program was carried out in conjunction with the geotechnical investigation to provide a preliminary characterization of the soil at the Site for potential environmental impact and for potential future management of excess soil.

No Phase I or II Environmental Site Assessment (ESA) reports have been provided to Wood for the Site.

It is assumed that a Record of Site Condition, (RSC) as per Ontario Regulation 153/04 Records of Site Condition, Part XV.1 of the Environmental Protection Act (EPA), as amended (*O. Reg. 153/04*, as amended) is not required for the Site at this time. Due to the limited scope of work, further environmental assessment would be required in the event that an RSC is required.

8.2 Sample Selection for Analyses

The analyses were conducted using the soil samples obtained from the geotechnical boreholes which were drilled between 19 June and 24 June 2019.

Six (6) soil samples were collected from the boreholes (BH1, BH11, BH15, BH23, BH35 and BH41) and submitted for analysis of metals and inorganics. Two samples from BH11 and BH23 were also submitted for benzene, toluene, ethylbenzene and xylenes (collectively referred to as BTEX) and petroleum hydrocarbon (PHC) fractions F1 to F4.

Two (2) soil samples, identified as BH1 TCLP and BH41 TCLP, were analyzed as per toxicity characteristic leaching procedure (TCLP) specified in *O. Reg. 347*, as amended, Schedule 4 Leachate Criteria for metals and inorganics, volatile organic compounds (VOCs) and benzo(a)pyrene.

The soil samples were submitted to AGAT Laboratory located in Mississauga, Ontario.

8.3 Soil Assessment Criteria

Results were evaluated with respect to the *"Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act"*, Ministry of the Environment, Conservation and Parks (MECP), 15 April 2011, Table 1 Full Depth Background Site Condition Standards (SCS) for Residential/Parkland/Institutional/Industrial/Commerical/Community Property Use (Table 1 SCS).

TCLP analyses results were compared to Schedule 4 Leachate Quality Criteria (as outlined by the *"Registration Guidance Manual for Generators of Liquid Industrial and Hazardous Waste"*, October 2000) to determine if the waste would be considered leachate toxic for soil disposal purposes.

Results of the analyses are summarized in the following sections.

8.4 Chemical Analysis Results

8.4.1 Metals and Inorganics

The results of the metals and inorganic parameter analyses are summarized in the laboratory certificate of analysis in Appendix C. Six (6) soil samples were submitted for metals and inorganics including BH1 SS3 (1.5 – 2.1 m), BH11 SS2 (0.7 – 1.4 m), BH15 AS1 (0.25 – 0.45 m), BH23 SS2 (0.9 – 1.5 m), BH35 SS2 (0.8 – 1.4 m)and BH41 SS3 (1.5 – 2.1 m). As noted on the laboratory certificate of analysis, the samples met the Table 1 SCS with the exception of barium in BH35 SS2 (295 micrograms per gram [µg/g] vs 220 µg/g), electrical conductivity (EC) in five (5) of the six (6) samples and sodium adsorption ratio (SAR) in all (6) soil samples.

Soil demonstrating exceedances of the Table 1 SCS only can remain on-Site or can be disposed of at a clean fill site licensed to accept soil meeting the Table 1 SCS other than for EC and SAR, provided that the soil is buried more than 1.5 m below final grade.

8.4.2 Petroleum Hydrocarbons and BTEX

The results of the PHC F1 to F4 and BTEX analyses are summarized in the laboratory certificate of analysis in Appendix C. Two (2) soil samples, identified as BH11 SS2 (0.8 – 1.4 m) and BH23 SS2 (0.9 – 1.5 m), were analysed for PHC F1 to F4 and BTEX and met the Table 1 SCS.

8.4.3 TCLP Leachate Analyses

The analytical results for the two (2) soil samples (BH1 TCLP and BH41 TCLP) submitted for leachate analyses as per *O. Reg. 347*, amended, are provided on the laboratory certificate of analysis in Appendix C. Results of the analyses demonstrated concentrations that were below applicable Schedule 4 Leachate Quality Criteria for these parameters analyzed indicating that dry soils would be classified as non-hazardous for the purposes of disposal at an MECP approved disposal or soil treatment facility.

8.5 Summary

This characterization was based on Wood's understanding of site conditions and available information at the time of the geotechnical investigation. Phase I and Phase II ESAs have not been conducted by Wood for the Site and Wood does not warrant that the analytical schedule addresses all of the potential environmental issues at the Site. The soil chemical analyses results are preliminary and not intended to provide a complete assessment of all soil conditions at the Site. Further assessment and/or chemical analyses would be considered appropriate depending on the soil management option selected and/or receiver's requirements. As noted above, it is assumed that an RSC is not required for the Site at this time. The scope of work as described, will not address all of the requirements of *O. Reg. 153/04* and

supplementary work may be required in the event that an RSC is required in the future. Further assessment and/or chemical analyses may be needed depending on the soil management options and/or receiver's requirements that would be specified in a Fill Management Plan authored by a Qualified Person, as defined under *O. Reg. 153/04*, as amended.

9.0 CLOSURE

The sub-soil information and recommendations contained in this report should be used solely for the purpose of geotechnical assessment of the project.

This geotechnical investigation report was prepared by Shami Malla, M.Civ.Eng., P.Eng., Erica Tudo, B.Sc. and Hoda Seddik, M.A.Sc., P.Eng., and reviewed by Patrick Shriner, P.Geo., and Prapote Boonsinsuk, Ph.D., P.Eng.

Limitations To Geotechnical Reports are integral parts of this report.

Sincerely,
Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited

Hoda Seddik, M.A.Sc., P.Eng. Consulting Engineer / Principal Pavement Engineer	Shami Malla, M.Civ.Eng, P.Eng. Senior Geotechnical Engineer

LIMITATIONS TO GEOTECHNICAL REPORTS

1. The work performed in the preparation of this report and the conclusions presented herein are subject to the following:

   a) The contract between Wood and the Client, including any subsequent written amendment or Change Order dully signed by the parties (hereinafter together referred as the "Contract");

   b) Any and all time, budgetary, access and/or site disturbance, risk management preferences, constraints or restrictions as described in the contract, in this report, or in any subsequent communication sent by Wood to the Client in connection to the Contract; and

   c) The limitations stated herein.

2. Standard of care: Wood has prepared this report in a manner consistent with the level of skill and are ordinarily exercised by reputable members of Wood's profession, practicing in the same or similar locality at the time of performance, and subject to the time limits and physical constraints applicable to the scope of work, and terms and conditions for this assignment. No other warranty, guaranty, or representation, expressed or implied, is made or intended in this report, or in any other communication (oral or written) related to this project. The same are specifically disclaimed, including the implied warranties of merchantability and fitness for a particular purpose.

3. Limited locations: The information contained in this report is restricted to the site and structures evaluated by Wood and to the topics specifically discussed in it, and is not applicable to any other aspects, areas or locations.

4. Information utilized: The information, conclusions and estimates contained in this report are based exclusively on: i) information available at the time of preparation, ii) the accuracy and completeness of data supplied by the Client or by third parties as instructed by the Client, and iii) the assumptions, conditions and qualifications/limitations set forth in this report.

5. Accuracy of information: No attempt has been made to verify the accuracy of any information provided by the Client or third parties, except as specifically stated in this report (hereinafter "Supplied Data"). Wood cannot be held responsible for any loss or damage, of either contractual or extra-contractual nature, resulting from conclusions that are based upon reliance on the Supplied Data.

6. Report interpretation: This report must be read and interpreted in its entirety, as some sections could be inaccurately interpreted when taken individually or out-of-context. The contents of this report are based upon the conditions known and information provided as of the date of preparation. The text of the final version of this report supersedes any other previous versions produced by Wood.

7. No legal representations: Wood makes no representations whatsoever concerning the legal significance of its findings, or as to other legal matters touched on in this report, including but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect to regulatory compliance issues, regulatory statutes are subject to interpretation and change. Such interpretations and regulatory changes should be reviewed with legal counsel.

8. Decrease in property value: Wood shall not be responsible for any decrease, real or perceived, of the property or site's value or failure to complete a transaction, as a consequence of the information contained in this report.

9. No third party reliance: This report is for the sole use of the party to whom it is addressed unless expressly stated otherwise in the report or Contract. Any use or reproduction which any third party makes of the report, in whole or in part, or any reliance thereon or decisions made based on any information or conclusions in the report is the sole responsibility of such third party. Wood does not represent or warrant the accuracy, completeness, merchantability, fitness for purpose or usefulness of this document, or any information contained in this document, for use or consideration by any third party. Wood accepts no responsibility whatsoever for damages or loss of any nature or kind suffered by any such third party as a result of actions taken or not taken or decisions made in reliance on this report or anything set out therein. including without limitation, any indirect, special, incidental, punitive or consequential loss, liability or damage of any kind.

10. Assumptions: Where design recommendations are given in this report, they apply only if the project contemplated by the Client is constructed substantially in accordance with the details stated in this report. It is the sole responsibility of the Client to provide to Wood changes made in the project, including but not limited to, details in the design, conditions, engineering or construction that could in any manner whatsoever impact the validity of the recommendations made in the report. Wood shall be entitled to additional compensation from Client to review and assess the effect of such changes to the project.

11. Time dependence: If the project contemplated by the Client is not undertaken within a period of 18 months following the submission of this report, or within the time frame understood by Wood to be contemplated by the Client at the commencement of Wood's assignment, and/or, if any changes are made, for example, to the elevation, design or nature of any development on the site, its size and configuration, the location of any development on the site and its orientation, the use of the site, performance criteria and the location of any physical infrastructure, the conclusions and recommendations presented herein should not be considered valid unless the impact of the said changes is evaluated by Wood, and the conclusions of the report are amended or are validated in writing accordingly.

    Advancements in the practice of geotechnical engineering, engineering geology and hydrogeology and changes in applicable regulations, standards, codes or criteria could impact the contents of the report, in which case, a supplementary report may be required. The requirements for such a review remain the sole responsibility of the Client or their agents.

    Wood will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

12. Limitations of visual inspections: Where conclusions and recommendations are given based on a visual inspection conducted by Wood, they relate only to the natural or man-made structures, slopes, etc. inspected at the time the site visit was performed. These conclusions cannot and are not extended to include those portions of the site or structures, which were not reasonably available, in Wood's opinion, for direct observation.

13. Limitations of site investigations: Site exploration identifies specific subsurface conditions only at those points from which samples have been taken and only at the time of the site investigation. Site investigation programs are a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions.

    The data derived from the site investigation program and subsequent laboratory testing are interpreted by trained personnel and extrapolated across the site to form an inferred geological representation and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite this investigation, conditions between and beyond the borehole/test hole locations may differ from those encountered at the borehole/test hole locations and the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

    Final sub-surface/bore/profile logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Customarily, only the final bore/profile logs are included in geotechnical engineering reports.

    Bedrock, soil properties and groundwater conditions can be significantly altered by environmental remediation and/or construction activities such as the use of heavy equipment or machinery, excavation, blasting, pile-driving or draining or other activities conducted either directly on site or on adjacent terrain. These properties can also be indirectly affected by exposure to unfavorable natural events or weather conditions, including freezing, drought, precipitation and snowmelt.

    During construction, excavation is frequently undertaken which exposes the actual subsurface and groundwater conditions between and beyond the test locations, which may differ from those encountered at the test locations. It is recommended practice that Wood be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered at the test locations, that construction work has no negative impact on the geotechnical aspects of the design, to adjust recommendations in accordance with conditions as additional site information is gained and to deal quickly with geotechnical considerations if they arise.

    Interpretations and recommendations presented herein may not be valid if an adequate level of review or inspection by Wood is not provided during construction.

14. Factors that may affect construction methods, costs and scheduling: The performance of rock and soil materials during construction is greatly influenced by the means and methods of construction. Where comments are made relating to possible methods of construction, construction costs, construction techniques, sequencing, equipment or scheduling, they are intended only for

the guidance of the project design professionals, and those responsible for construction monitoring. The number of test holes may not be sufficient to determine the local underground conditions between test locations that may affect construction costs, construction techniques, sequencing, equipment, scheduling, operational planning, etc.

Any contractors bidding on or undertaking the works should draw their own conclusions as to how the subsurface and groundwater conditions may affect their work, based on their own investigations and interpretations of the factual soil data, groundwater observations, and other factual information.

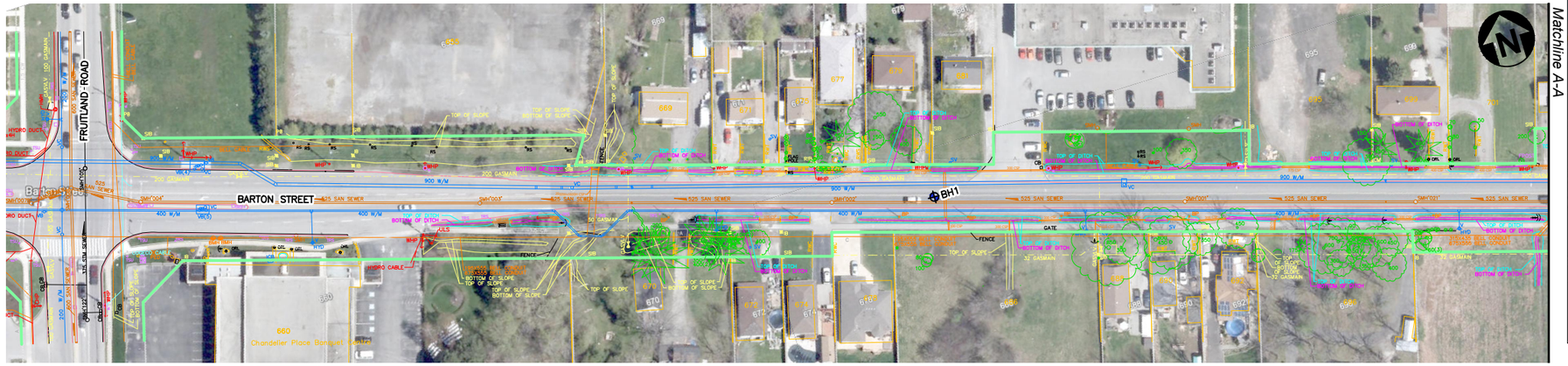
15. Groundwater and Dewatering: Wood will accept no responsibility for the effects of drainage and/or dewatering measures if Wood has not been specifically consulted and involved in the design and monitoring of the drainage and/or dewatering system.

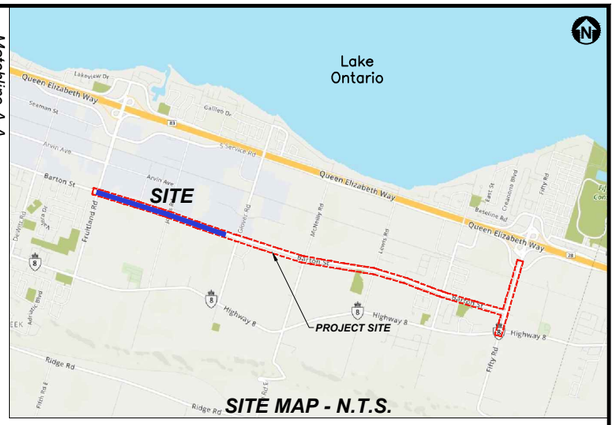
16. Environmental and Hazardous Materials Aspects: Unless otherwise stated, the information contained in this report in no way reflects on the environmental aspects of this project, since this aspect is beyond the Scope of Work and the Contract. Unless expressly included in the Scope of Work, this report specifically excludes the identification or interpretation of environmental conditions such as contamination, hazardous materials, wild life conditions, rare plants or archeology conditions that may affect use or design at the site. This report specifically excludes the investigation, detection, prevention or assessment of conditions that can contribute to moisture, mould or other microbial contaminant growth and/or other moisture related deterioration, such as corrosion, decay, rot in buildings or their surroundings. Any statements in this report or on the boring logs regarding odours, colours, and unusual or suspicious items or conditions are strictly for informational purposes

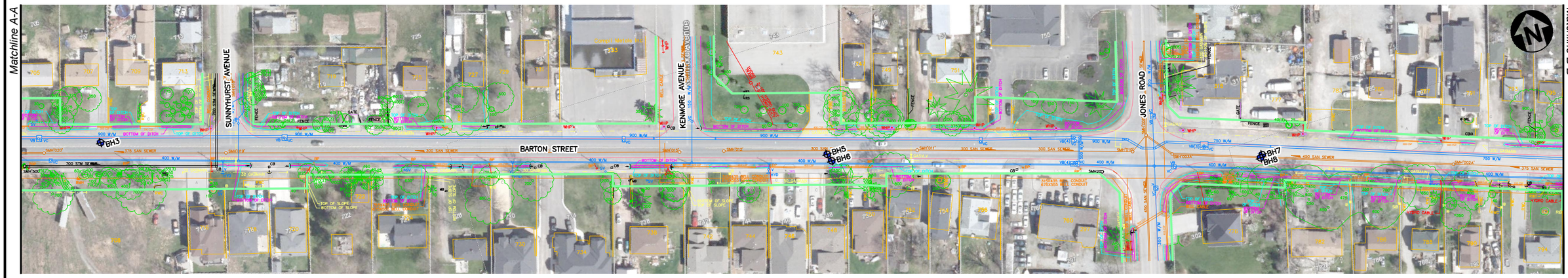
17. Sample Disposal: Wood will dispose of all uncontaminated soil and rock samples after 30 days following the release of the final geotechnical report. Should the Client request that the samples be retained for a longer time, the Client will be billed for such storage at an agreed upon rate. Contaminated samples of soil, rock or groundwater are the property of the Client, and the Client will be responsible for the proper disposal of these samples, unless previously arranged for with Wood or a third party.

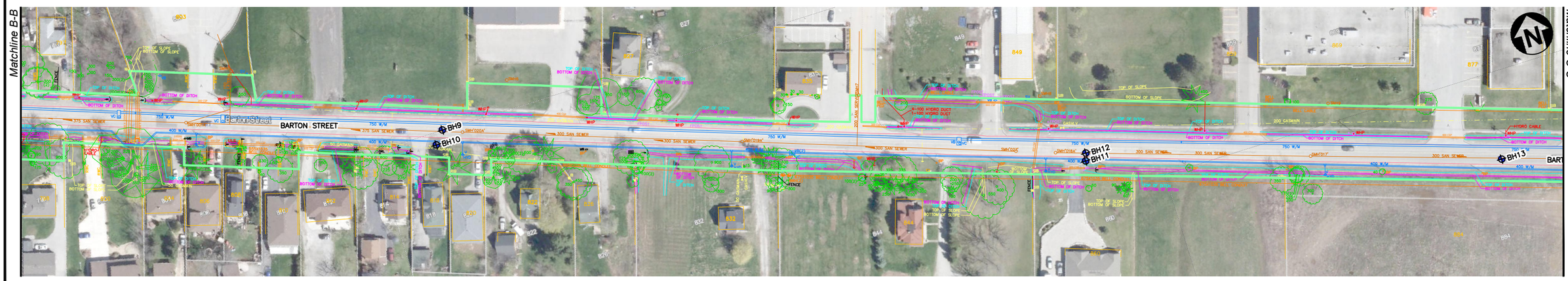
Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited

FIGURES









LEGEND

BOREHOLE LOCATION

0 25 50 75m

APPROXIMATE SCALE

CLIENT LOGO

Hamilton

CLIENT:

CITY OF HAMILTON

Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited
50 Vogell Road, Units 3 & 4, Richmond Hill, Ontario, L4B 3K6

wood.

DWN BY:	KW
CHK'D BY:	HS
DATUM:	NAD83
PROJECTION:	UTM Zone 17T
SCALE:	AS SHOWN

TITLE

SITE AND BOREHOLE LOCATION PLAN

PROJECT

GEOTECHNICAL INVESTIGATION

MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT
PHASES 3 AND 4 FOR BARTON STREET AND FIFTY ROAD IMPROVEMENTS
CITY OF HAMILTON, ONTARIO

DATE:	MARCH 2020
PROJECT NO:	TPB166053
RFSQ NO:	-
CONTRACT NO.:	C3-01-16
FIGURE No.	1A

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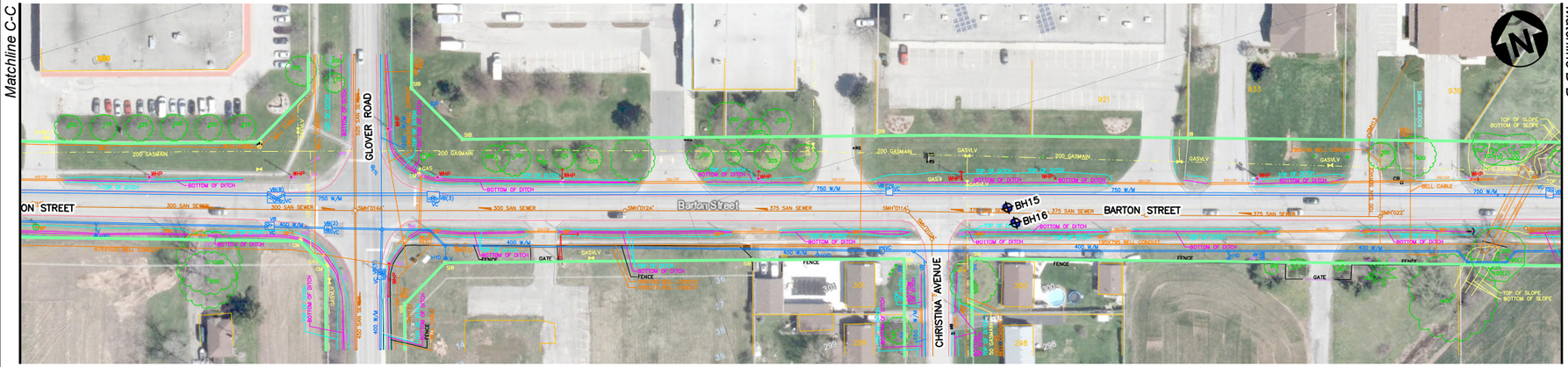

SITE MAP - N.T.S.

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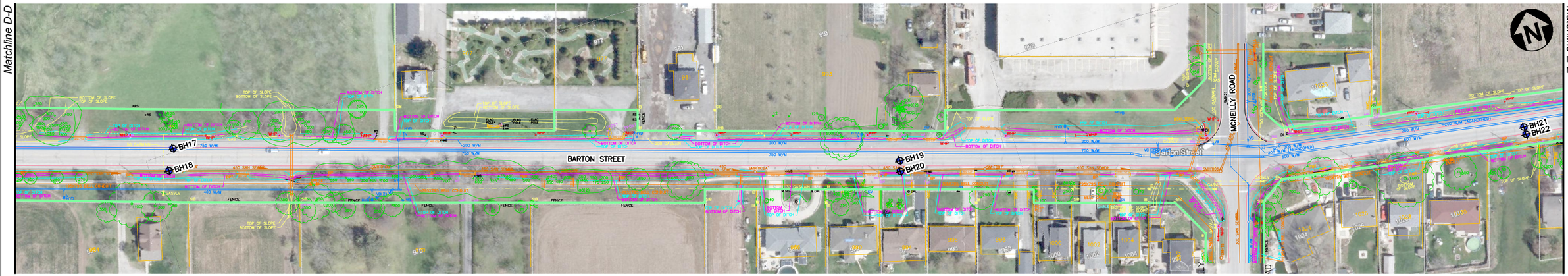

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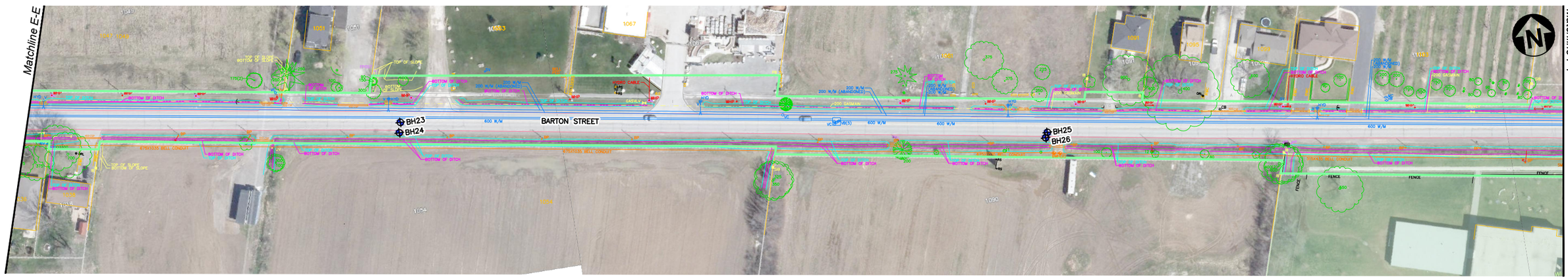


LEGEND

BOREHOLE LOCATION

0 25 50 75m

APPROXIMATE SCALE

CLIENT LOGO

Hamilton

CLIENT:

CITY OF HAMILTON

Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited
50 Vogell Road, Units 3 & 4, Richmond Hill, Ontario, L4B 3K6

wood.

DWN BY:	KW
CHK'D BY:	HS
DATUM:	NAD83
PROJECTION:	UTM Zone 17T
SCALE:	AS SHOWN

TITLE

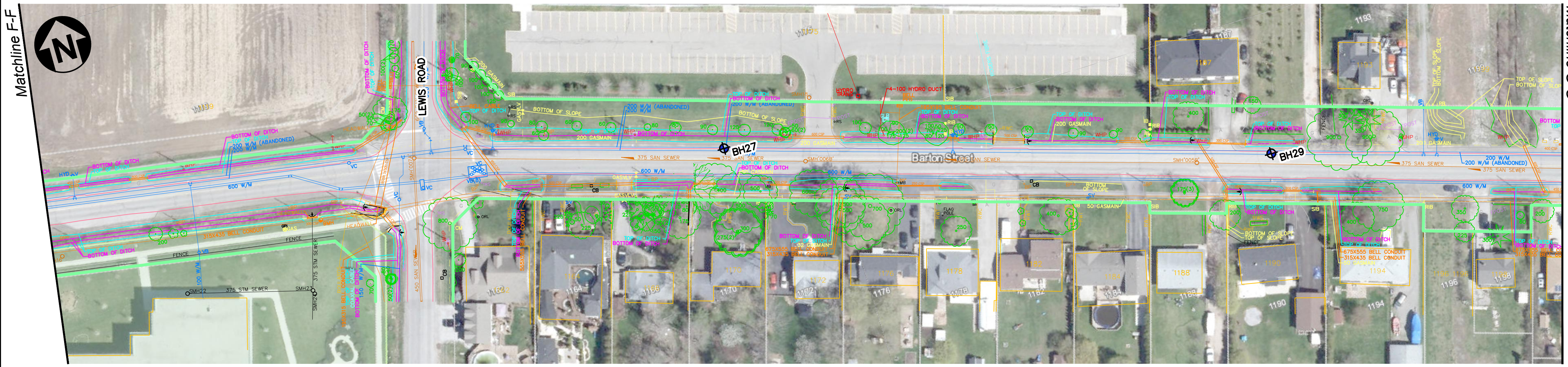
SITE AND BOREHOLE LOCATION PLAN

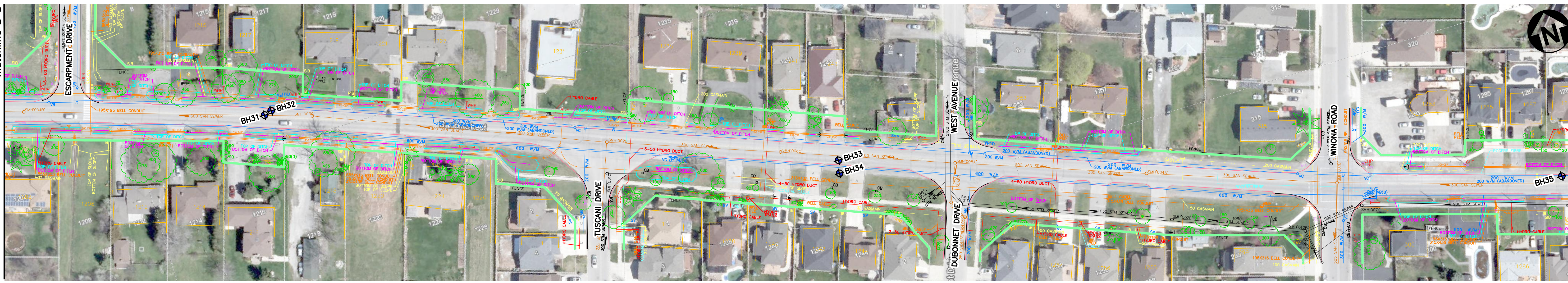
PROJECT

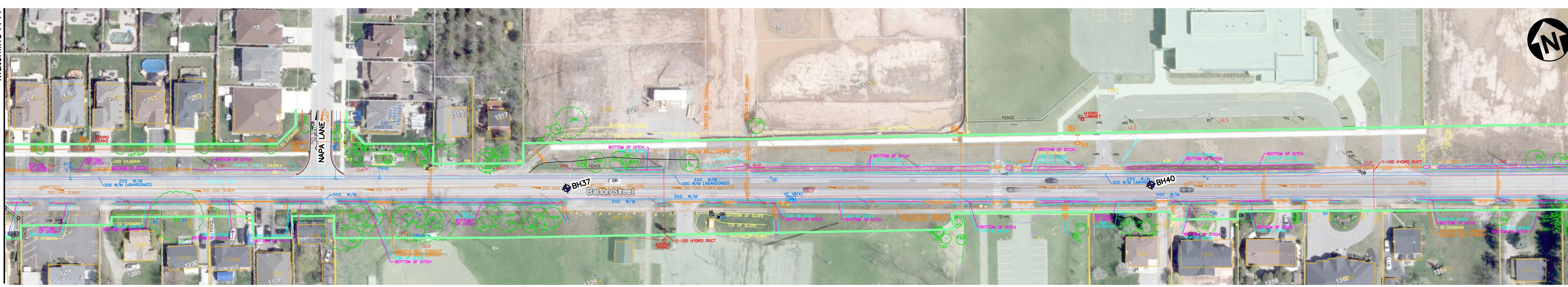
GEOTECHNICAL INVESTIGATION
MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT
PHASES 3 AND 4 FOR BARTON STREET AND FIFTY ROAD IMPROVEMENTS
CITY OF HAMILTON, ONTARIO

DATE:	MARCH 2020
PROJECT NO:	TPB166053
RFSQ NO:	-
CONTRACT NO.:	C3-01-16
FIGURE No.	1B

Z:\Projects\2019\# – TPB – Burlington Projects\# (2016) TPB166053 – Barton – Fifty Road\Drawings\TPB166053_08Jan2020_Site_and_BH_Location_Plan.dwg – BH Plan – Mar. 19, 2020 10:05am – kent.wong







LEGEND

BOREHOLE LOCATION

0 25 50 75m
APPROXIMATE SCALE

CLIENT LOGO

Hamilton

CLIENT:

CITY OF HAMILTON

Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited
50 Vogell Road, Units 3 & 4, Richmond Hill, Ontario, L4B 3K6

wood.

DWN BY:	KW
CHK'D BY:	HS
DATUM:	NAD83
PROJECTION:	UTM Zone 17T
SCALE:	AS SHOWN

TITLE

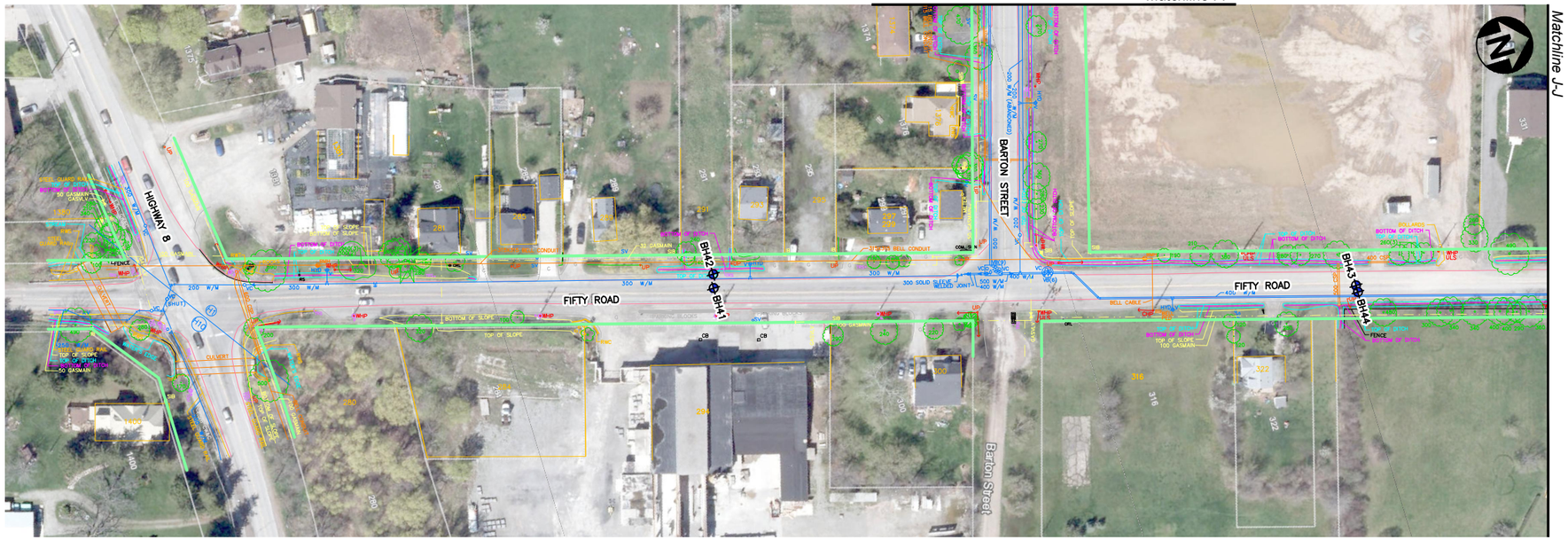
SITE AND BOREHOLE LOCATION PLAN

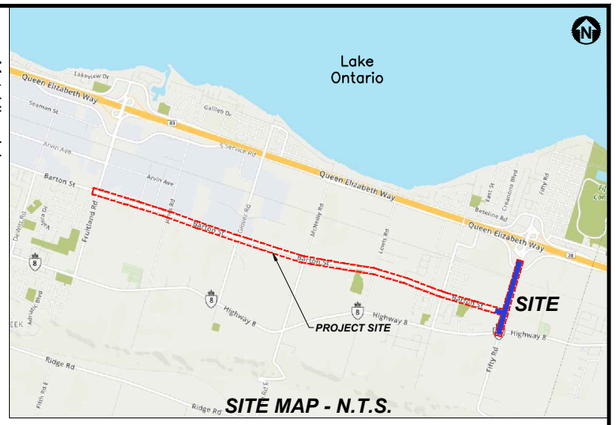
PROJECT

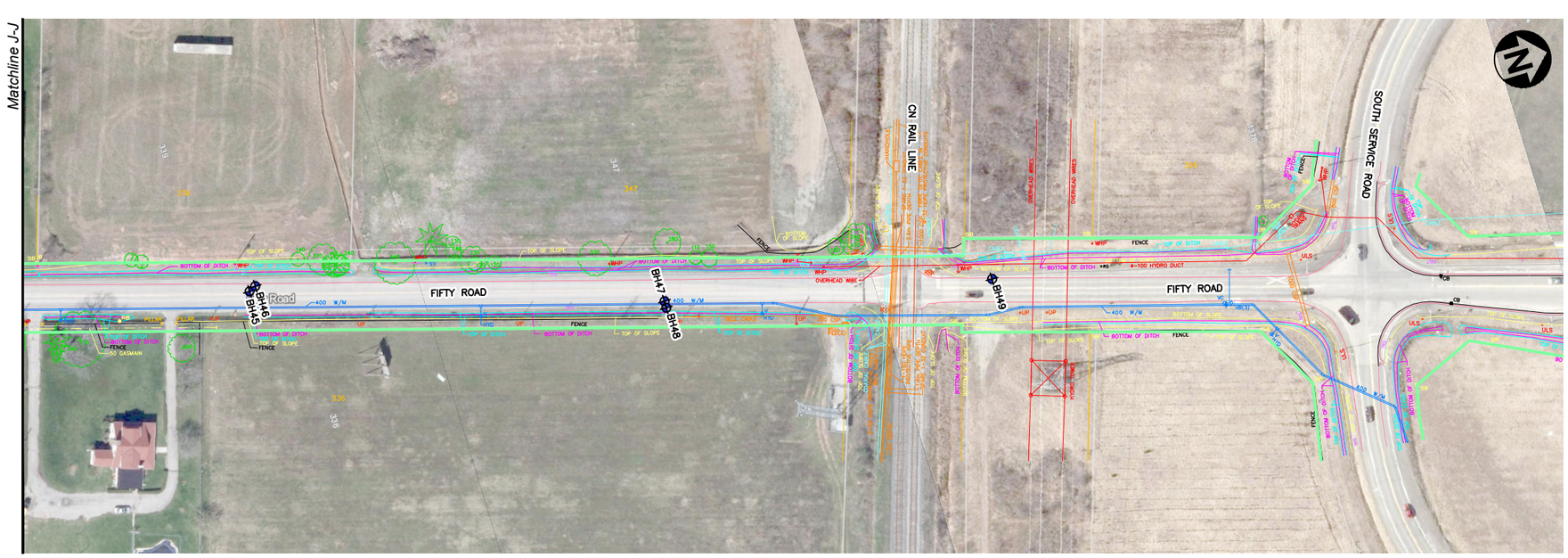
GEOTECHNICAL INVESTIGATION
MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT
PHASES 3 AND 4 FOR BARTON STREET AND FIFTY ROAD IMPROVEMENTS
CITY OF HAMILTON, ONTARIO

DATE:	MARCH 2020
PROJECT NO:	TPB166053
RFSQ NO:	-
CONTRACT NO.:	C3-01-16
FIGURE No.	1C

Z:\Projects\2019\# – TPB – Burlington Projects\# (2016) TPB166053 – Barton – Fifty Road\Drawings\TPB166053_19Mar2020_Site_and_BH_Location_Plan.dwg – BH Plan – Mar. 20, 2020 5:39pm – kent.wong







LEGEND

BOREHOLE LOCATION

0 25 50 75m

APPROXIMATE SCALE

CLIENT LOGO

Hamilton

CLIENT:

CITY OF HAMILTON

Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited
50 Vogell Road, Units 3 & 4, Richmond Hill, Ontario, L4B 3K6

wood.

DWN BY:	KW
CHK'D BY:	HS
DATUM:	NAD83
PROJECTION:	UTM Zone 17T
SCALE:	AS SHOWN

TITLE

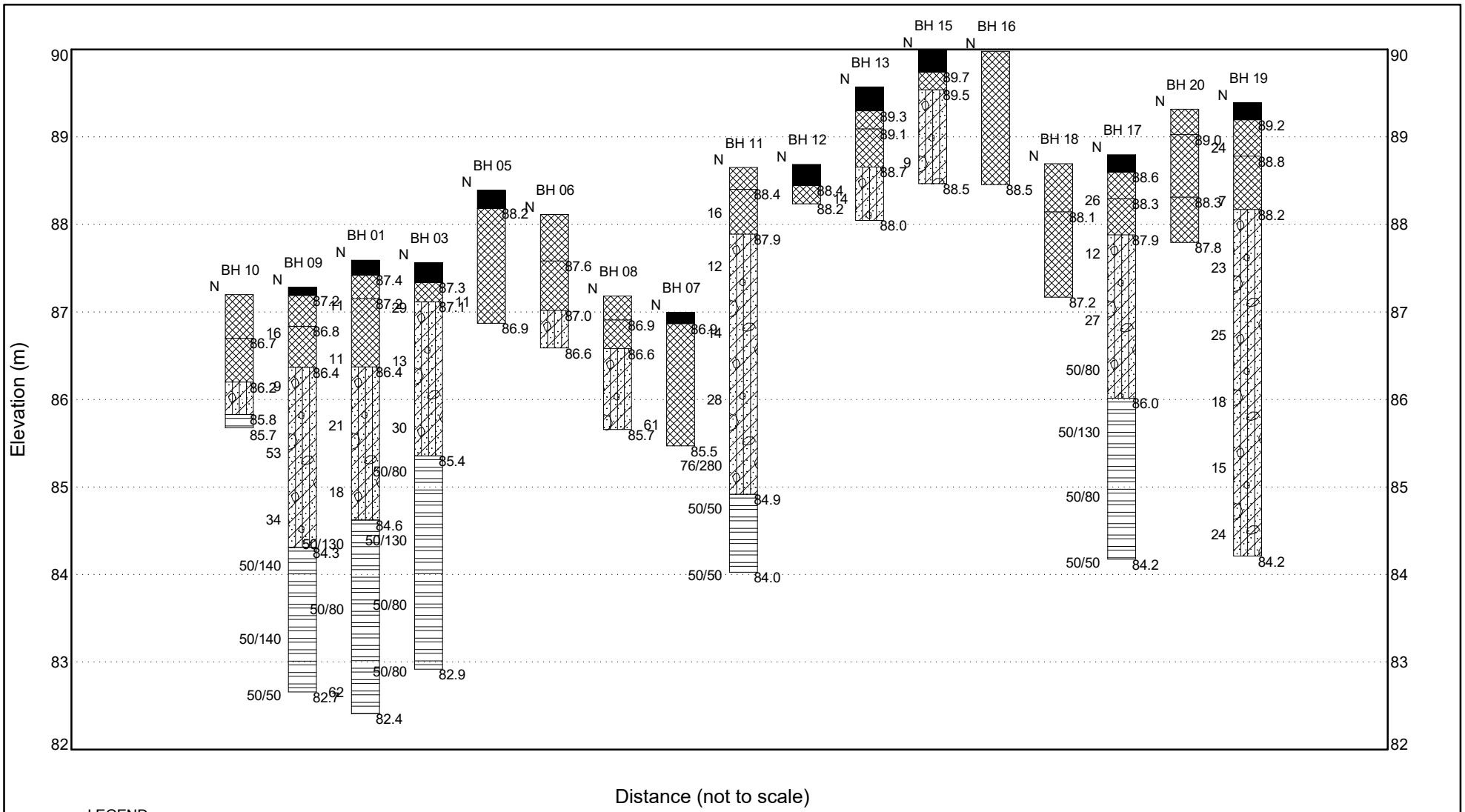
SITE AND BOREHOLE LOCATION PLAN

PROJECT

GEOTECHNICAL INVESTIGATION
MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT
PHASES 3 AND 4 FOR BARTON STREET AND FIFTY ROAD IMPROVEMENTS
CITY OF HAMILTON, ONTARIO

DATE:	MARCH 2020
PROJECT NO:	TPB166053
RFSQ NO:	-
CONTRACT NO.:	C3-01-16
FIGURE No.	1D

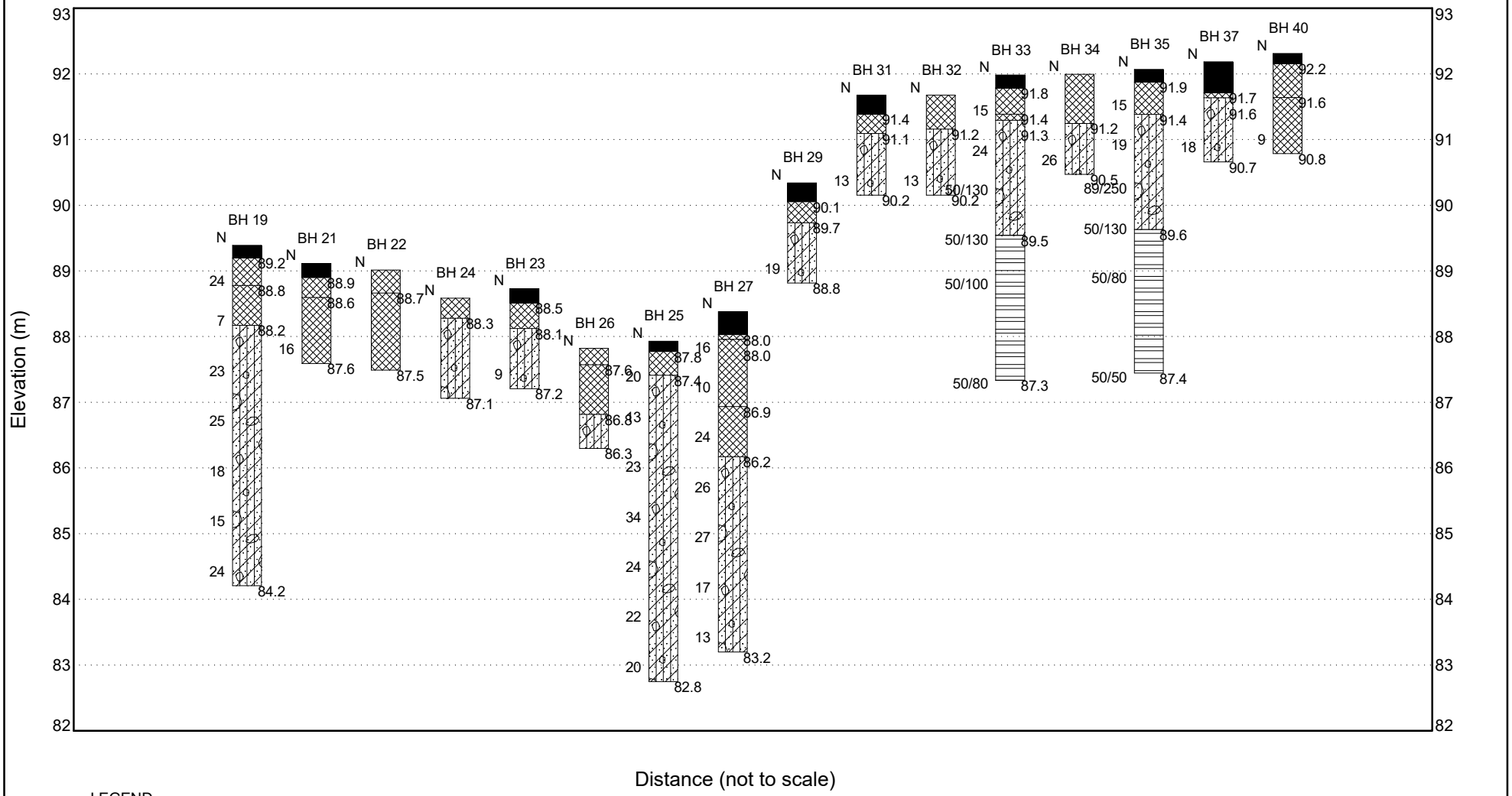
Z:\Projects\2019\# – TPB – Burlington Projects\# (2016) TPB166053 – Barton – Fifty Road\Drawings\TPB166053_08Jan2020_Site_and_BH_Location_Plan.dwg – BH Plan – Mar. 19, 2020 10:09am – kent.wong



STRATIGRAPHY ALONG BARTON STREET

Geotechnical Investigation,
MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements
Stoney Creek and Winona, Hamilton

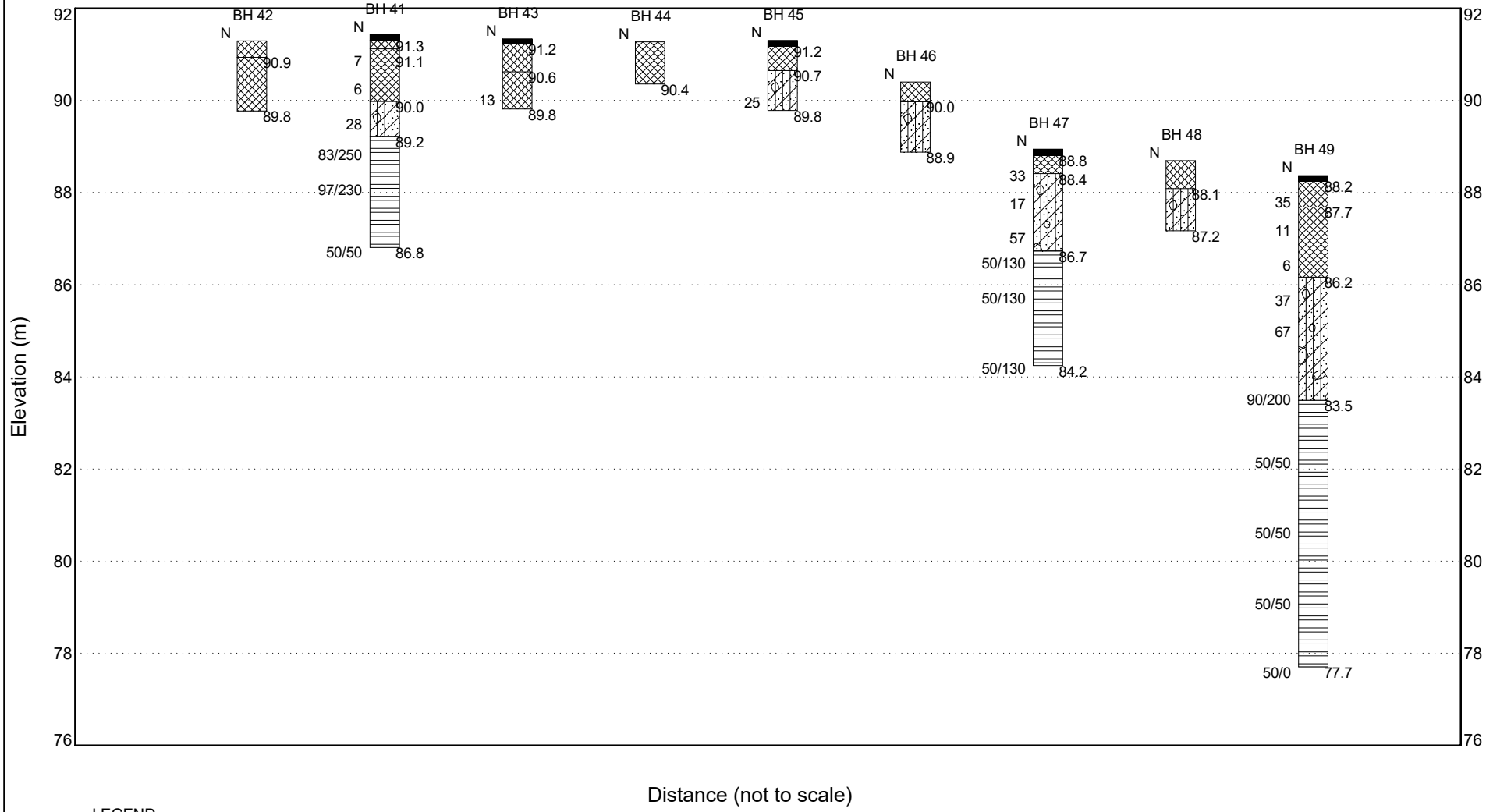
JOB NO.	DATE	Figure
TPB166053	Mar 2020	2A



STRATIGRAPHY ALONG BARTON STREET

Geotechnical Investigation,
MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements
Stoney Creek and Winona, Hamilton

JOB NO.	DATE	Figure
TPB166053	Mar 2020	2B



LEGEND

Water Level

Asphalt

Fill

Silty Clay Till

Weathered Shale

STRATIGRAPHY ALONG FIFTY ROAD

Geotechnical Investigation,
MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements
Stoney Creek and Winona, Hamilton

JOB NO.	DATE	Figure
TPB166053	Mar 2020	3

RECORD OF BOREHOLES

Explanation of Borehole Logs

Record of Boreholes of BH 01 to BH 49
(excluding BH 02, BH 04, BH 14, BH 28, BH 30, BH 36, BH 38 and BH 40)

EXPLANATION OF BOREHOLE LOG

This form describes some of the information provided on the borehole logs, which is based primarily on examination of the recovered samples, and the results of the field and laboratory tests. Additional description of the soil/rock encountered is given in the accompanying geotechnical report.

GENERAL INFORMATION

Project details, borehole number, location coordinates and type of drilling equipment used are given at the top of the borehole log.

SOIL LITHOLOGY

Elevation and Depth

This column gives the elevation and depth of inferred geologic layers. The elevation is referred to the datum shown in the Description column.

Lithology Plot

This column presents a graphic depiction of the soil and rock stratigraphy encountered within the borehole.

Description

This column gives a description of the soil stratums, based on visual and tactile examination of the samples augmented with field and laboratory test results. Each stratum is described according to the *Modified Unified Soil Classification System*.

The compactness condition of cohesionless soils (SPT) and the consistency of cohesive soils (undrained shear strength) are defined as follows *(Ref. Canadian Foundation Engineering Manual)*:

Compactness of Cohesionless Soils	SPT N-Value
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

Consistency of Cohesive Soils	Undrained Shear Strength kPa	Undrained Shear Strength psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very stiff	100 to 200	2000 to 4000
Hard	Over 200	Over 4000

Soil Sampling

Sample types are abbreviated as follows:

SS	Split Spoon	TW	Thin Wall Open (Pushed)	RC	Rock Core
AS	Auger Sample	TP	Thin Wall Piston (Pushed)	WS	Washed Sample

Additional information provided in this section includes sample numbering, sample recovery and numerical testing results.

Field and Laboratory Testing

Results of field testing (e.g., SPT, pocket penetrometer, and vane testing) and laboratory testing (e.g., natural moisture content, and limits) executed on the recovered samples are plotted in this section.

Instrumentation Installation

Instrumentation installations (monitoring wells, piezometers, inclinometers, etc.) are plotted in this section. Water levels, if measured during fieldwork, are also plotted. These water levels may or may not be representative of the static groundwater level depending on the nature of soil stratum where the piezometer tips are located, the time elapsed from installation to reading and other applicable factors.

Comments

This column is used to describe non-standard situations or notes of interest.

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MODIFIED * UNIFIED CLASSIFICATION SYSTEM FOR SOILS
*The soil of each stratum is described using the Unified Soil Classification System (Technical Memorandum 36-357 prepared by Waterways Experiment Station, Vicksburg, Mississippi, Corps of Engineers, U.S Army. Vol. 1 March 1953.) modified slightly so that an inorganic clay of "medium plasticity" is recognized.

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75mm	CLEAN GRAVELS (TRACE OR NO FINES)	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY GRAVELS (WITH SOME OR MORE FINES)	GM	SILTY GRAVELS, GRAVEL-SAND- SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I LESS THAN 4
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE OR P.I MORE THAN 7
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75mm	CLEAN SANDS (TRACE OR NO FINES)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3
			SP	POORLY GRADED GRAVELS, GRAVEL- SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY SANDS (WITH SOME OR MORE FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I LESS THAN 4
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE OR P.I MORE THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 50$	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)
		$W_L > 50$	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 30$	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS	
		$30 < W_L < 50$	CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	
		$W_L > 50$	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
	ORGANIC SLITS & CLAYS BELOW "A" LINE	$W_L < 50$	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	WHENEVER THE NATURE OF THE FINES CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER "F", E.G SF IS A MIXTURE OF SAND WITH SILT OR CLAY
		$W_L > 50$	OH	ORGANIC CLAYS OF HIGH PLASTICITY	
HIGH ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE

SOIL COMPONENTS

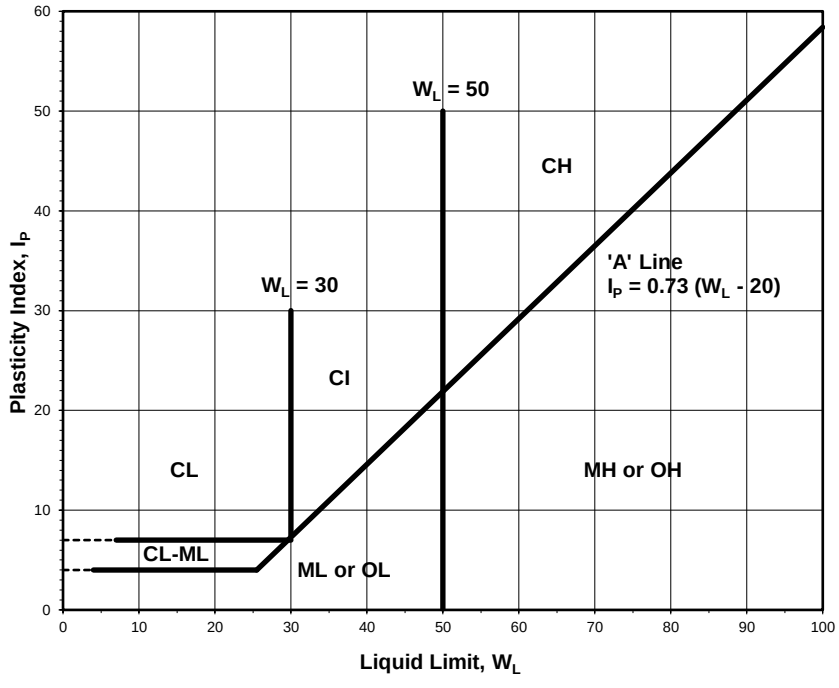
FRACTION	U.S STANDARD SIEVE SIZE		
GRAVEL	COARSE	PASSING	RETAINED
		76 mm	19 mm
	FINE	19 mm	4.75 mm
SAND	COARSE	4.75 mm	2.00 mm
	MEDIUM	2.00 mm	425 µm
	FINE	425 µm	75 µm
FINES (SILT OR CLAY BASED ON PLASTICITY)		75 µm	

DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
PERCENT	DESCRIPTOR
35-50	AND
20-35	Y/EY
10-20	SOME
1-10	TRACE

OVERSIZED MATERIAL

ROUNDED OR SUBROUNDED: COBBLES 76 mm TO 200 mm BOULDERS > 200 mm	NOT ROUNDED: ROCK FRAGMENTS > 76 mm ROCKS > 0.76 CUBIC METRE IN VOLUME

Plasticity Chart for Soil Passing 425 Micron Sieve



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Note 1: Soils are classified and described according to their engineering properties and behaviour.
Note 2: The modifying adjectives used to define the actual or estimated percentage range by weight of minor components are consistent with the Canadian Foundation Engineering Manual.

RECORD OF BOREHOLE No. BH 01

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4786265 E: 605803	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 20, 2019 Date Completed: Jun 20, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 87.6 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION
	about 170 mm Asphalt	87.4										
	Sand and Gravel FILL	0.2	SS	1	13	11				2		
		87.2						87				
	brown/grey Silty Clay FILL trace sand, trace gravel	0.4	SS	2	50	11	1			9		
		86.4										
	red SILTY CLAY TILL trace sand very stiff	1.2						86				
			SS	3	58	21	2			9		
			SS	4	58	18		85		8		
		84.6					3					
	red WEATHERED SHALE moist	3.0	SS	5	100	50 / 130mm			50 / 130 mm	8		
	cobbles/boulders							84				
			SS	6	100	50 / 80mm	4		50 / 80 mm	8		
								83				
			SS	7	83	62	5			8		
		82.4										
	END OF BOREHOLE	5.2										

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 03

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4786207 E: 606010	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 20, 2019 Date Completed: Jun 20, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 87.6 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	PenetrationTesting ○ SPT □ PPT ● DCPT MTO Vane* △ Intact ▲ Remould Nilcon Vane* ◇ Intact ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8 △ COV (ppm) □ TOV (ppm) 100 200 300 400 W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	about 230 mm Asphalt	87.3													
	Sand and Gravel FILL	0.2 87.1													
	red SILTY CLAY TILL trace sand, trace gravel stiff to very stiff	0.5	SS	1	63	29		87		18					
			SS	2	63	13	1			13					
			SS	3	79	30		86		11		2	3	70	25
		85.4					2								
	red WEATHERED SHALE moist cobbles/boulders	2.2	SS	4	100	50 / 80mm		85	50 / 80 mm	5					
			SS	5	100	50 / 130mm	3		50 / 130 mm	6					
			SS	6	100	50 / 80mm		84	50 / 80 mm	5					
							4								
		82.9	SS	7	100	50 / 80mm		83	50 / 80 mm	4					
	END OF BOREHOLE	4.6													

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 05

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4786121 E: 606286	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019 Date Completed: Jun 21, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 88.4 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	about 210 mm Asphalt	88.2													
	Sand and Gravel FILL	0.2													
			AS	1		NA		88		7		28	44		(28)
			SS	2	100	11	1		○	4					
		86.9						87							
	END OF BOREHOLE	1.5													

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 06

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4786118 E: 606287	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019	Date Completed: Jun 21, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 88.1 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	PenetrationTesting ○ SPT □ PPT ● DCPT MTO Vane* △ Intact ▲ Remould Nilcon Vane* ◇ Intact ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8 △ COV (ppm) □ TOV (ppm) 100 200 300 400 W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Sand and Gravel FILL	87.6						88				
	red/grey **Silty Clay FILL**	0.5 87.0					1	87				
	red **SILTY CLAY TILL**	1.1 86.6	AS	1		NA				○ 28		
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 07

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4786072 E: 606452	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019 Date Completed: Jun 21, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 87.0 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	about 130 mm Asphalt	86.9										
	Sand and Gravel FILL	0.1	AS	1		NA						
			SS	2	100	61	1	86	○	○ 11		
		85.5										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 08

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4786071 E: 606451	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019	Date Completed: Jun 21, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 87.2 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	Sand and Gravel FILL	86.9					0	87				
	grey **Silty Clay FILL**	0.3 86.6					1	86				
	red **SILTY CLAY TILL**	0.6 85.7										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 09

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785981 E:606725	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019 Date Completed: Jun 21, 2019	Revision No.:	0, 3/17/20

Geodetic Ground Surface Elevation: 87.3 m

Lithology Plot	DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (SPT, PPT, DCPT); MTO Vane* (Intact, Remould); Nilcon Vane* (Intact, Remould); * Undrained Shear Strength (kPa)	LAB TESTING: Soil Vapour Reading (COV (LEL), TOV (LEL)); COV (ppm), TOV (ppm); W_P, W, W_L; Plastic, Liquid	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	about 95 mm Asphalt	87.2										
	Sand and Gravel FILL	0.1										
		86.8	SS	1	75	16		87		14		
	brown Silty Sand / Sand FILL trace clay, trace gravel moist	0.4										
		86.4	SS	2	83	9	1			19		
	red SILTY CLAY TILL trace sand stiff to hard	0.9						86				
			SS	3	58	53	2			10		
			SS	4	67	34		85		10		
		84.3					3					
	red WEATHERED SHALE moist	3.0	SS	5	91	50 / 140mm			50 / 140 mm	7		
	cobbles/boulders							84				
			SS	6	96	50 / 140mm	4		50 / 140 mm	9		
								83				
		82.7	SS	7	100	50 / 50mm			50 / 50 mm			
	END OF BOREHOLE	4.6										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 10

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785976 E:606721	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019 Date Completed: Jun 21, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	Geodetic Ground Surface Elevation: 87.2 m														
	Sand and Gravel FILL														
		86.7	AS	1		NA		87		6		44	38		(18)
	grey/red Silty Clay FILL	0.5													
		86.2					1								
	red/grey SILTY CLAY TILL	1.0	AS	2		NA		86		17					
		85.8													
	red WEATHERED SHALE	1.4 85.7													
	END OF BOREHOLE	1.5													

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 11

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785897 E: 606967	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019 Date Completed: Jun 21, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 88.7 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	PenetrationTesting ○ SPT □ PPT ● DCPT MTO Vane* △ Intact ▲ Remould Nilcon Vane* ◇ Intact ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8 △ COV (ppm) □ TOV (ppm) 100 200 300 400 W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	Sand and Gravel FILL	88.4													
	brown **Silty Clay FILL**	0.2	SS	1	58	16			○	○ 10					
		87.9						88							
	red/brown **SILTY CLAY TILL** trace sand stiff to hard	0.8	SS	2	67	12	1		○	○ 17					
			SS	3	71	14		87	○	○ 15					
			SS	4	83	28	2		○	○■● 13		<1	7	74	19
			SS	5	74	76 / 280mm	3	86		○ 76 280 mm ○ 11					
	cobbles/boulders	84.9													
	red **WEATHERED SHALE** moist	3.7	SS	6	50	50 / 50mm		85	○ 50 50 mm						
	cobbles/boulders						4								
		84.0	SS	7	0	50 / 50mm			○ 50 50 mm						
	END OF BOREHOLE	4.6													

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 12

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785900 E: 606968	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019	Date Completed: Jun 21, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 88.7 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	about 240 mm Asphalt										
	88.4										
	Sand and Gravel FILL 0.2										
	88.2										
	END OF BOREHOLE 0.5 Borehole terminated due to presence of Sanitary sewer										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 13

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785851 E: 607126	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019 Date Completed: Jun 21, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 89.6 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	about 270 mm Asphalt											
		89.3										
	Sand and Gravel FILL	0.3										
		89.1										
	grey Silty Clay FILL	0.5						89				
		88.7										
	red SILTY CLAY TILL trace sand stiff	0.9	SS	1	100	14	1		○	○ 17		
		88.0										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 15

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785761 E: 607431	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019 Date Completed: Jun 21, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 90.0 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	PenetrationTesting: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L; Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	about 250 mm Asphalt	89.7													
	Sand and Gravel FILL	0.2 89.5	AS	1		NA						44	46		(10)
	red SILTY CLAY TILL trace sand stiff	0.5													
			SS	2	100	9	1	89	○	○ 13					
	END OF BOREHOLE	88.5 1.5													

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

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Scale: 1 : 37

RECORD OF BOREHOLE No. BH 16

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785756 E: 607432	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019	Date Completed: Jun 21, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 90.0 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L; Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	Sand and Gravel FILL										
		AS	1		NA				3		
						1	89				
	88.5										
	END OF BOREHOLE 1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 17

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785700 E: 607650	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019 Date Completed: Jun 21, 2019	Revision No.:	0, 3/17/20

Lithology Plot	DESCRIPTION	Elev.	Depth	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	Field Testing	Lab Testing	Instrumentation Installation	Comments & Grain Size Distribution (%)
	Geodetic Ground Surface Elevation: 88.8 m										GR SA SI CL
	about 200 mm Asphalt	88.6									
	Sand and Gravel FILL	0.2									
		88.3		SS	1	54	26		12		
	grey/brown/red Sand FILL trace to some silt, trace gravel, trace clay moist	0.5									
		87.9									
	grey/red SILTY CLAY TILL trace sand stiff to hard	0.9	1	SS	2	83	12		14		
				SS	3	88	27		13		
	cobbles/boulders		2	SS	4	100	50 / 80mm	50 / 80 mm	8		
		86.0									
	red WEATHERED SHALE moist	2.8	3	SS	5	100	50 / 130mm	50 / 130 mm	9		
	cobbles/boulders		4	SS	6	100	50 / 80mm	50 / 80 mm			
		84.2		SS	7	0	50 / 50mm	50 / 50 mm			
	END OF BOREHOLE	4.6									

Elevation (m): 88, 87, 86, 85

Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80

Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400

W_P W W_L; Plastic Liquid 20 40 60 80

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 18

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785692 E: 607646	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 21, 2019 Date Completed: Jun 21, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 88.7 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	grey **Sand and Gravel FILL**	88.1										
	grey **Silty Clay FILL** trace sand	0.5					1	88				
		87.2										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 19

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785614 E: 607925	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 24, 2019 Date Completed: Jun 24, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 89.4 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	PenetrationTesting: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	about 195 mm Asphalt	89.2													
	Sand and Gravel FILL	0.2	SS	1	42	24		89	○	1					
		88.8													
	brown Silty Sand FILL moist	0.6	SS	2	83	7	1		○	16					
		88.2						88							
	grey/brown SILTY CLAY TILL trace to some sand, trace gravel stiff to very stiff	1.2	SS	3	92	23	2		○	13					
			SS	4	100	25		87	○	13		3	19	48	30
			SS	5	100	18	3	86	○	13					
			SS	6	96	15	4	85	○	12					
			SS	7	96	24	5		○	11					
		84.2													
	END OF BOREHOLE	5.2													

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 20

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785610 E: 607924	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 24, 2019 Date Completed: Jun 24, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 89.3 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L; Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	Sand and Gravel FILL														
		89.0													
	brown **Silty Clay FILL** with cobbles	0.3	AS	1		NA		89		○ 3		34	48		(18)
		88.3					1								
	light brown **Silty Sand FILL** trace clay moist	1.0	AS	2		NA		88		○ 16					
		87.8													
	END OF BOREHOLE	1.5													

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 21

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785557 E: 608166	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 24, 2019 Date Completed: Jun 24, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 89.1 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	about 220 mm Asphalt	88.9										
	Sand and Gravel FILL ---	0.2										
	asphalt pieces	88.6										
	brown/grey Silty Clay FILL some sand, trace gravel	0.5						89				
			SS	1	100	16	1	88	○	○ 13		
		87.6										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 22

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785554 E: 608166	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 24, 2019 Date Completed: Jun 24, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 89.0 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	Sand and Gravel FILL											
		88.7	AS	1		NA				○2		
	brown **Silty Clay FILL** some sand, trace gravel	0.4										
			AS	2		NA	1	88		○17		
		87.5										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 23

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785534 E: 608328	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 24, 2019	Date Completed: Jun 24, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 88.7 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L; Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	about 220 mm Asphalt	88.5										
	Sand and Gravel FILL	0.2	AS	1		NA				2		
		88.1						88				
	brown SILTY CLAY TILL trace sand stiff	0.6					1					
			SS	2	100	9			○	15		
		87.2										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 24

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785530 E: 608327	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 24, 2019	Date Completed: Jun 24, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 88.6 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Sand and Gravel FILL	88.3										
	grey/brown **SILTY CLAY TILL** trace sand, trace gravel	0.3						88				
			AS	1		NA	1			○ 19		
		87.1										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 25

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785494 E: 608581	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 24, 2019 Date Completed: Jun 24, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 87.9 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	about 160 mm Asphalt	87.8										
	Sand and Gravel FILL	0.2										
		87.4	SS	1	67	20			○	○ 14		
	grey SILTY CLAY TILL trace sand, trace gravel stiff to hard	0.5	SS	2	83	13	1	87	○	○ 14		
			SS	3	100	23	2	86	○	○ 14		
			SS	4	100	34			○	○ 12		
			SS	5	100	24	3	85	○	○ 12		
			SS	6	92	22	4	84	○	○ 12		
			SS	7	100	20	5	83	○	○ 11		
		82.8										
	END OF BOREHOLE	5.2										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 26

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785492 E: 608580	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 24, 2019 Date Completed: Jun 24, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 87.8 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	PenetrationTesting ○ SPT □ PPT ● DCPT MTO Vane* △ Intact ▲ Remould Nilcon Vane* ◇ Intact ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8 △ COV (ppm) □ TOV (ppm) 100 200 300 400 W_P W W_L Plastic Liquid 20 40 60 80		INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	Sand and Gravel FILL	87.6	AS	1		NA				○3			41	47	(12)	
	grey **Silty Clay FILL** trace sand, trace gravel	0.2 86.8						87								
	brown **SILTY CLAY TILL** trace sand, trace gravel	1.0 86.3	AS	2		NA	1			○18						
	END OF BOREHOLE	1.5														

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 27

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785430 E: 608982	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 19, 2019 Date Completed: Jun 19, 2019	Revision No.:	0, 3/17/20

Geodetic Ground Surface Elevation: 88.4 m

Lithology Plot	DESCRIPTION	Elev.	Depth	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Field Testing: Penetration Testing (SPT ○, PPT □, DCPT ●)	Field Testing: MTO Vane* (Intact △, Remould ▲)	Field Testing: Nilcon Vane* (Intact ◇, Remould ◆)	Lab Testing: Soil Vapour Reading COV (LEL) ▲	Lab Testing: TOV (LEL) ■	Lab Testing: COV (ppm) △	Lab Testing: TOV (ppm) □	Lab Testing: W_P	Lab Testing: W	Lab Testing: W_L	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
	about 350 mm Asphalt	88.0																						
	Sand and Gravel FILL	88.0	0.4	SS	1	29	16	1	88	○					13									
	brown Silt FILL some sand, trace clay, trace gravel			SS	2	63	10			○					16									
	grey Silty Clay FILL trace sand, trace gravel	86.9	1.4	SS	3	17	24	2	87	○					15									
	brown SILTY CLAY TILL trace to some sand, trace gravel stiff to very stiff	86.2	2.2	SS	4	75	26	3	86	○					14									
				SS	5	100	27		85	○					14						6	19	49	26
				SS	6	83	17	4	84	○					12									
				SS	7	71	13	5		○					12									
	END OF BOREHOLE	83.2	5.2																					

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 29

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785384 E: 609138	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 19, 2019	Date Completed: Jun 19, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 90.3 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L; Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	about 290 mm Asphalt	90.1										
	Sand and Gravel FILL	0.3	AS	1		NA		90		○3		
		89.7										
	brown/red SILTY CLAY TILL very stiff	0.6										
			SS	2	100	19	1	89	○	○12		
		88.8										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 31

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785327 E: 609317	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 19, 2019	Date Completed: Jun 19, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 91.7 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	PenetrationTesting ○ SPT □ PPT ● DCPT MTO Vane* △ Intact ▲ Remould Nilcon Vane* ◇ Intact ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8 △ COV (ppm) □ TOV (ppm) 100 200 300 400 W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	about 290 mm Asphalt	91.4										
	Sand and Gravel FILL	0.3 91.1										
	red SILTY CLAY TILL trace sand, trace gravel stiff	0.6						91				
			SS	1	100	13	1		○	○ 13		
		90.2										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 32

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785328 E: 609320	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 19, 2019	Date Completed: Jun 19, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 91.7 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L; Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	Sand and Gravel FILL														
		91.2	AS	1		NA				4		31	49		(20)
	brown/red **SILTY CLAY TILL** trace sand stiff	0.5						91							
			SS	2	100	13	1			14					
		90.2													
	END OF BOREHOLE	1.5													

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 33

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785249 E: 609527	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 19, 2019 Date Completed: Jun 19, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 92.0 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L; Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	about 195 mm Asphalt	91.8										
	Sand and Gravel FILL	0.2	SS	1	50	15			○ 50	○ 25		
		91.4										
	grey	90.6										
	Silty Clay FILL trace sand	0.7										
	red/grey SILTY CLAY TILL trace sand very stiff to hard		SS	2	50	24	1	91	○ 50	○ 16		
	cobbles/boulders		SS	3	100	50 / 130mm			○ 50 130 mm	○ 9		
		89.5					2	90				
	red WEATHERED SHALE moist	2.4	SS	4	100	50 / 130mm			○ 50 130 mm	○ 6		
	cobbles/boulders		SS	5	100	50 / 100mm	3	89	○ 50 100 mm	○ 5		
		87.3					4	88				
	END OF BOREHOLE	4.6	SS	6	100	50 / 80mm			○ 50 80 mm	○ 6		

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 34

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785244 E: 609526	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 19, 2019	Date Completed: Jun 19, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 92.0 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L; Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Sand and Gravel FILL											
			AS	1		NA				○4		
		91.2										
	red	0.7										
	SILTY CLAY TILL very stiff						1	91				
			SS	2	100	26			○	○9		
		90.5										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 35

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785166 E: 609796	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 19, 2019 Date Completed: Jun 19, 2019	Revision No.:	0, 3/17/20

Geodetic Ground Surface Elevation: 92.1 m

Depth (m)	Elevation (m)	Description	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	Field Testing	Lab Testing	Instrumentation Installation	GR	SA	SI	CL
		about 135 mm Asphalt											
0.2	91.9	Sand and Gravel FILL	SS	1	58	15		21					
0.7	91.4	red/grey SILTY CLAY TILL trace sand, some gravel very stiff to hard	SS	2	79	19		10		18	6	56	20
		cobbles/boulders	SS	3	81	89 / 250mm		8					
2.4	89.6	red WEATHERED SHALE moist	SS	4	100	50 / 130mm	50 / 130 mm	5					
		cobbles/boulders	SS	5	100	50 / 80mm	50 / 80 mm	6					
4.6	87.4	END OF BOREHOLE	SS	6	0	50 / 50mm	50 / 50 mm						

Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80

Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L; Plastic Liquid 20 40 60 80

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 37

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785101 E: 610013	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 19, 2019	Date Completed: Jun 19, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 92.2 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	PenetrationTesting ○ SPT □ PPT ● DCPT MTO Vane* △ Intact ▲ Remould Nilcon Vane* ◇ Intact ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8 △ COV (ppm) □ TOV (ppm) 100 200 300 400 W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	about 470 mm Asphalt	91.7										
	Sand and Gravel FILL	90.6 0.5	AS	1		NA		92		4		
	red SILTY CLAY TILL	0.5					1					
			SS	2	100	18		91		13		
		90.7										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 40

wood.

Project Number:	TPB166053	Drilling Location:	Barton Street, N: 4785040 E: 610232	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 19, 2019 Date Completed: Jun 19, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 92.3 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	about 150 mm Asphalt	92.2										
	Sand and Gravel FILL	0.2	AS	1		NA		92		9		40 39 (21)
		91.6										
	red Silty Clay FILL trace sand	0.7	SS	2	100	9	1	91		17		
		90.8										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 41

wood.

Project Number:	TPB166053	Drilling Location:	Fifty Road, N: 4784889 E: 610450	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 18, 2019 Date Completed: Jun 18, 2019	Revision No.:	0, 3/17/20

Geodetic Ground Surface Elevation: 91.4 m

Lithology Plot	DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Undrained Shear Strength (kPa)	LAB TESTING: Soil Vapour Reading / Plastic & Liquid Limits	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	about 125 mm Asphalt	91.3										
	Sand and Gravel FILL	0.1										
		91.1										
	grey/brown Silty Clay FILL trace to some sand, trace gravel	0.3	SS	1	42	7		91		29		
			SS	2	58	6	1			40		
		90.0						90				
	red/grey SILTY CLAY TILL trace sand, trace gravel very stiff	1.4	SS	3	71	28				9		
		89.2					2					
	red/grey WEATHERED SHALE moist	2.2	SS	4	75	83 / 250mm		89	83 250 mm	7		
	cobbles/boulders											
			SS	5	80	97 / 230mm	3			97 230mm		
								88				
							4					
		86.8						87				
	END OF BOREHOLE	4.6	SS	6	0	50 / 50mm			50 50 mm			

▽ No freestanding groundwater measured in open borehole on completion of drilling.

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Scale: 1 : 37

RECORD OF BOREHOLE No. BH 42

wood.

Project Number:	TPB166053	Drilling Location:	Fifty Road, N: 4784890 E: 610446	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 18, 2019	Date Completed: Jun 18, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 91.3 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	grey **Sand and Gravel FILL** moist 90.9										
	brown 0.4 **Silty Clay FILL** some sand and gravel						91				
		AS	1		NA	1			○ 26		
	89.8						90				
	END OF BOREHOLE 1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 43

wood.

Project Number:	TPB166053	Drilling Location:	Fifty Road, N: 4785071 E: 610501	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 18, 2019	Date Completed: Jun 18, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 91.3 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	about 110 mm Asphalt	91.2													
	grey Sand and Gravel FILL moist	0.1	AS	1		NA		91		3		40	52		(8)
		90.6													
	brown/red Silty Clay FILL trace sand	0.7	SS	2	100	13	1	90	○	10					
		89.8													
	END OF BOREHOLE	1.5													

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 44

wood.

Project Number:	TPB166053	Drilling Location:	Fifty Road, N: 4785071 E: 610503	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 18, 2019	Date Completed: Jun 18, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 91.3 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	grey **Sand and Gravel FILL** --- some clay, trace cobbles						91				
	90.4 **END OF BOREHOLE** 0.9										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 45

wood.

Project Number:	TPB166053	Drilling Location:	Fifty Road, N: 4785190 E: 610532	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 18, 2019 Date Completed: Jun 18, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 91.3 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	about 130 mm Asphalt	91.2										
	grey Sand and Gravel FILL moist	0.1	AS	1		NA		91		5		
		90.7										
	red SILTY CLAY TILL very stiff	0.7	SS	2	100	25	1	90		11		
		89.8										
	END OF BOREHOLE	1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 46

wood.

Project Number:	TPB166053	Drilling Location:	Fifty Road, N: 4785192 E: 610531	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 18, 2019 Date Completed: Jun 18, 2019	Revision No.:	0, 3/17/20

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 90.4 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	grey **Sand and Gravel FILL** 90.0										
	red 0.4 **SILTY CLAY TILL**					1	90 89				
	88.9 **END OF BOREHOLE** 1.5										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

RECORD OF BOREHOLE No. BH 47

wood.

Project Number:	TPB166053	Drilling Location:	Fifty Road, N: 4785306 E: 610568	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 18, 2019	Date Completed: Jun 18, 2019	Revision No.: 0, 3/17/20

Geodetic Ground Surface Elevation: 88.9 m

Lithology Plot	DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Penetration Testing (○ SPT □ PPT ● DCPT); MTO Vane* (△ Intact ▲ Remould); Nilcon Vane* (◇ Intact ◆ Remould); * Undrained Shear Strength (kPa) 20 40 60 80	LAB TESTING: Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L; Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	about 135 mm Asphalt	88.8										
	grey	0.1										
	Sand and Gravel FILL moist		SS	1	71	33						
		88.4										
	red/grey	0.5										
	SILTY CLAY TILL trace sand very stiff to hard		SS	2	67	17	1	88		18 14		
			SS	3	78	57	2	87		8		
		86.7										
	grey/red	2.2										
	WEATHERED SHALE moist		SS	4	80	50 / 130mm			50 / 130 mm	6		
	cobbles/boulders						3	86				
			SS	5	100	50 / 130mm			50 / 130 mm	6		
		84.2	SS	6	100	50 / 130mm	4	85	50 / 130 mm	6		
	END OF BOREHOLE	4.7										

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 48

wood.

Project Number:	TPB166053	Drilling Location:	Fifty Road, N: 4785306 E: 610570	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 18, 2019	Date Completed: Jun 18, 2019	Revision No.: 0, 3/17/20

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 88.7 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L; Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	grey **Sand and Gravel FILL**														
			AS	1		NA				○7		41	48		(11)
		88.1													
	red **SILTY CLAY TILL** trace sand, trace gravel	0.6						88							
							1								
			AS	2		NA				○23					
		87.2													
	END OF BOREHOLE	1.5													

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 37

RECORD OF BOREHOLE No. BH 49

wood.

Project Number:	TPB166053	Drilling Location:	Fifty Road, N: 4785400 E: 610588	Logged by:	TH
Project Client:	City of Hamilton	Drilling Method:	150 mm Solid Stem Augers	Compiled by:	TH/PR
Project Name:	Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements	Drilling Machine:	Truck Mounted Drill	Reviewed by:	HS/SM
Project Location:	Stoney Creek and Winona, Hamilton	Date Started:	Jun 18, 2019 Date Completed: Jun 18, 2019	Revision No.:	0, 3/17/20

Geodetic Ground Surface Elevation: 88.4 m

Lithology Plot	DESCRIPTION	Elevation	Depth	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
	about 125 mm Asphalt	88.2	0											
	Sand and Gravel FILL	0.1		SS	1	75	35		3					
		87.7	1											
	brown/grey Silty Clay FILL trace to some sand, trace gravel, trace organics	0.7		SS	2	33	11		11					
			2	SS	3	42	6		24					
		86.2												
	red/brown SILTY CLAY TILL trace sand hard	2.2		SS	4	67	37		12					
			3	SS	5	67	67		12		<1	1	77	22
			4	SS	6	71	90 / 200mm		90 200 mm					
	cobbles/boulders	83.5												
	red/grey WEATHERED SHALE moist cobbles/boulders	4.9	5											
			6	SS	7	100	50 / 50mm		50 50 mm					
			7											

Penetration Testing: ○ SPT □ PPT ● DCPT
MTO Vane*: △ Intact ▲ Remould
Nilcon Vane*: ◇ Intact ◆ Remould
* Undrained Shear Strength (kPa) 20 40 60 80

Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8
△ COV (ppm) □ TOV (ppm) 100 200 300 400
W_P W W_L Plastic Liquid 20 40 60 80

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▽ No freestanding groundwater measured in open borehole on completion of drilling.

Scale: 1 : 37

Continued on Next Page

RECORD OF BOREHOLE No. BH 49

Project Number: **TPB166053**

Project Name: **Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements**

Project Location: **Stoney Creek and Winona, Hamilton**

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) □ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	red/grey **WEATHERED SHALE** moist						81							
	cobbles/boulders	SS	8	100	50 / 50mm			50 / 50 mm						
						8	80							
						9								
		SS	9	100	50 / 50mm		79	50 / 50 mm						
						10								
							78							
	77.7													
	END OF BOREHOLE 10.7 Borehole terminated due to auger refusal on Inferred bedrock	SS	10		50 / 0mm			50 / 0 mm						

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 37

APPENDIX A

Photographs of Pavement Condition On 25 February 2020

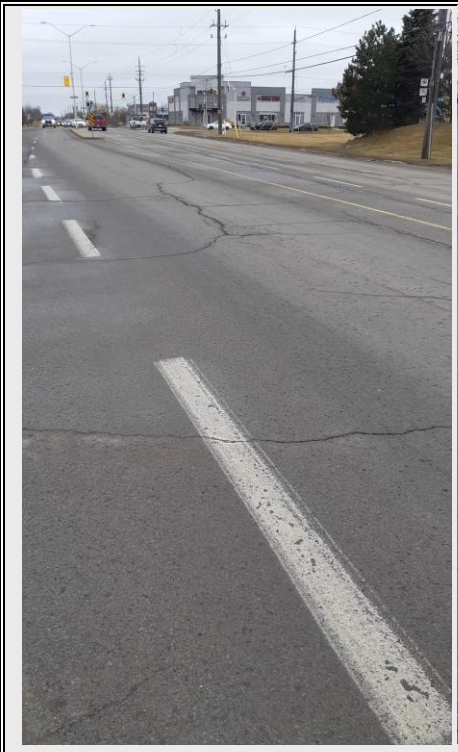
APPENDIX A - PHOTOS OFPAVEMENT CONDITION SURVEY

PROJECT NO. TPB166053 - (City of Hamilton Contract Number: C3-01-16)

PROJECT Geotechnical Investigation for for Barton Street and Fifty Road Improvements

LOCATION Stoney Creek & Winona, Hamilton, Ontario

ENCLOSURE 1

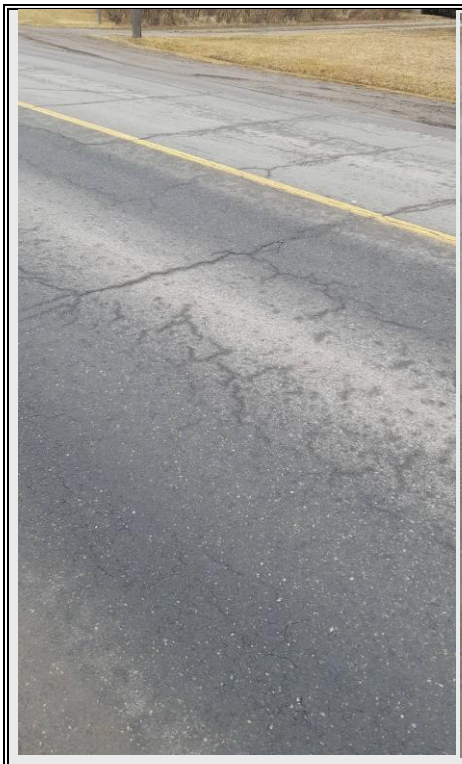


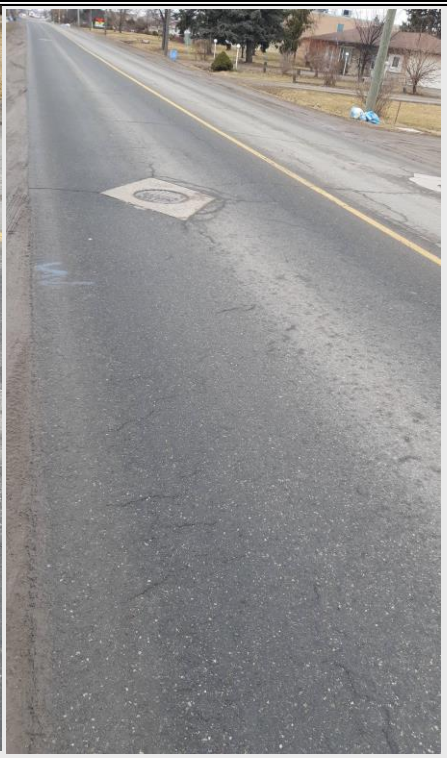
PHOTOGRAPH	1

Barton Street

from Fruitland to McNeilly Rd ~ 2.6 km

Fair to Poor Condition





PHOTOGRAPH	2

Barton Street

from Fruitland to McNeilly Rd ~ 2.6 km

Poor to Fair Condition

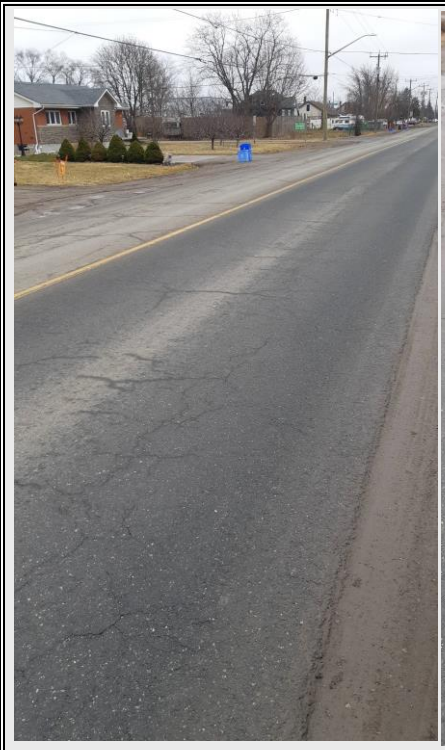
APPENDIX A - PHOTOS OF PAVEMENT CONDITION SURVEY

PROJECT NO. TPB166053 - (City of Hamilton Contract Number: C3-01-16)

PROJECT Geotechnical Investigation for for Barton Street and Fifty Road Improvements

LOCATION Stoney Creek & Winona, Hamilton, Ontario

ENCLOSURE 2



PHOTOGRAPH	3

Barton Street

from Fruitland to McNeilly Rd
~ 2.6 km

Fairly Poor Condition

PHOTOGRAPH	4

Barton Street

from Fruitland to McNeilly Rd
~ 2.6 km

Fair to Poor Condition

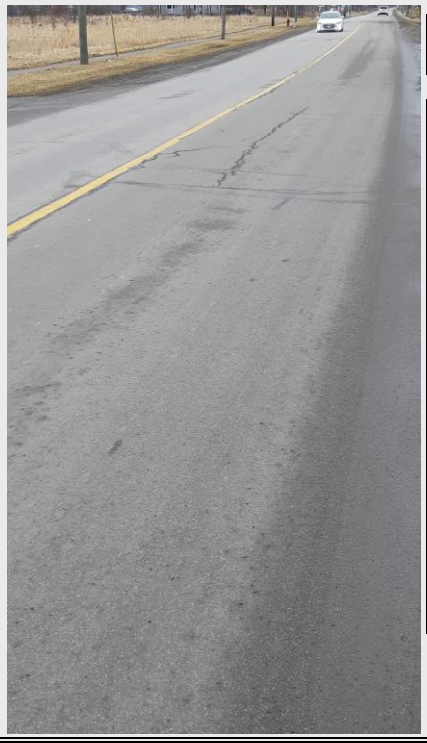
APPENDIX A - PHOTOS OF PAVEMENT CONDITION SURVEY

PROJECT NO. TPB166053 - (City of Hamilton Contract Number: C3-01-16)

PROJECT Geotechnical Investigation for for Barton Street and Fifty Road Improvements

LOCATION Stoney Creek & Winona, Hamilton, Ontario

ENCLOSURE 3



PHOTOGRAPH	5

Barton Street

from McNeilly Rd to Fifty Rd.
~ 2.5 km

Poor to Fair Condition

PHOTOGRAPH	6

Barton Street

from McNeilly Rd to Fifty Rd.
~ 2.5 km

Poor to Fairly Poor Condition

APPENDIX A - PHOTOS OF PAVEMENT CONDITION SURVEY

PROJECT NO. TPB166053 - (City of Hamilton Contract Number: C3-01-16)

PROJECT Geotechnical Investigation for for Barton Street and Fifty Road Improvements

LOCATION Stoney Creek & Winona, Hamilton, Ontario

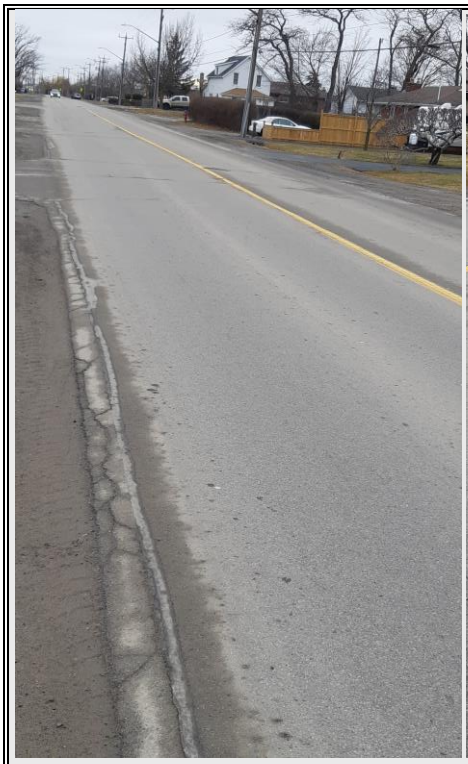
ENCLOSURE 4

PHOTOGRAPH	7

Barton Street

from McNeilly Rd to Fifty Rd.
~ 2.5 km

Poor to Fair Condition



PHOTOGRAPH	8

Barton Street

from McNeilly Rd to Fifty Rd.
~ 2.5 km

Fair to Poor Condition

APPENDIX A - PHOTOS OF PAVEMENT CONDITION SURVEY

PROJECT NO. TPB166053 - (City of Hamilton Contract Number: C3-01-16)

PROJECT Geotechnical Investigation for for Barton Street and Fifty Road Improvements

LOCATION Stoney Creek & Winona, Hamilton, Ontario

ENCLOSURE 5

PHOTOGRAPH	9

Fifty Road

from Hwy 8 to South Service Rd ~ 0.80 km

Fair to Poor Condition

PHOTOGRAPH	10

Fifty Road

from Hwy 8 to South Service Rd ~ 0.80 km

Fair Condition

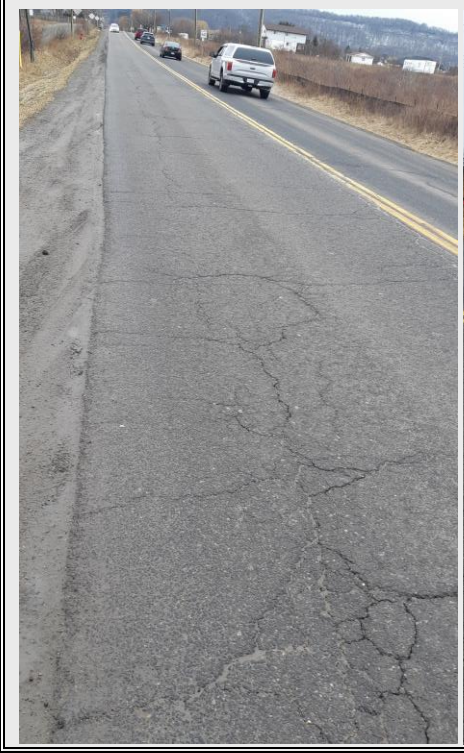
APPENDIX A - PHOTOS OF PAVEMENT CONDITION SURVEY

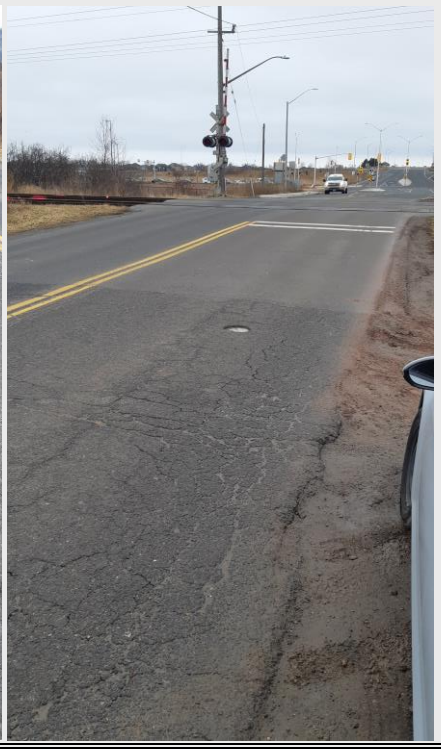
PROJECT NO. TPB166053 - (City of Hamilton Contract Number: C3-01-16)

PROJECT Geotechnical Investigation for for Barton Street and Fifty Road Improvements

LOCATION Stoney Creek & Winona, Hamilton, Ontario

ENCLOSURE 6



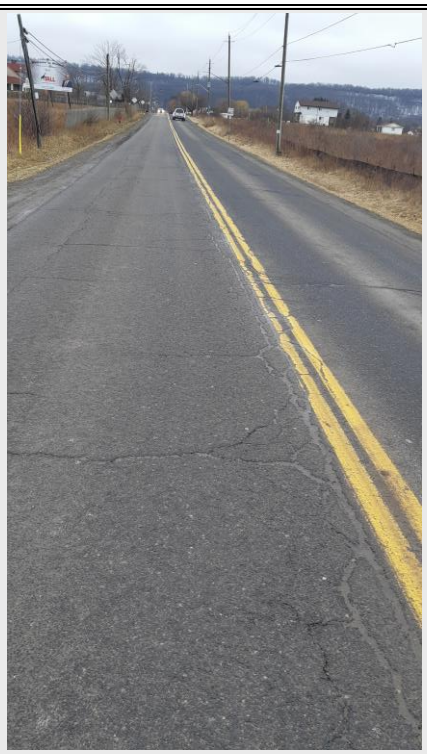


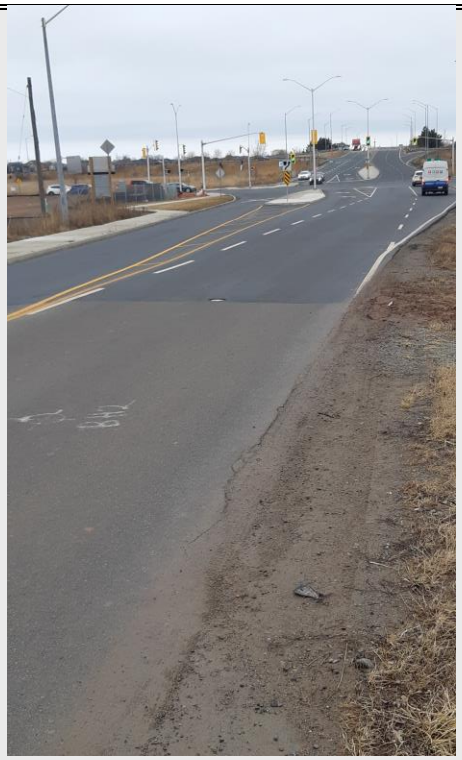
PHOTOGRAPH	11

Fifty Road

from Hwy 8 to South Service Rd ~ 0.80 km

Fairly Poor to Poor Condition





PHOTOGRAPH	12

Fifty Road

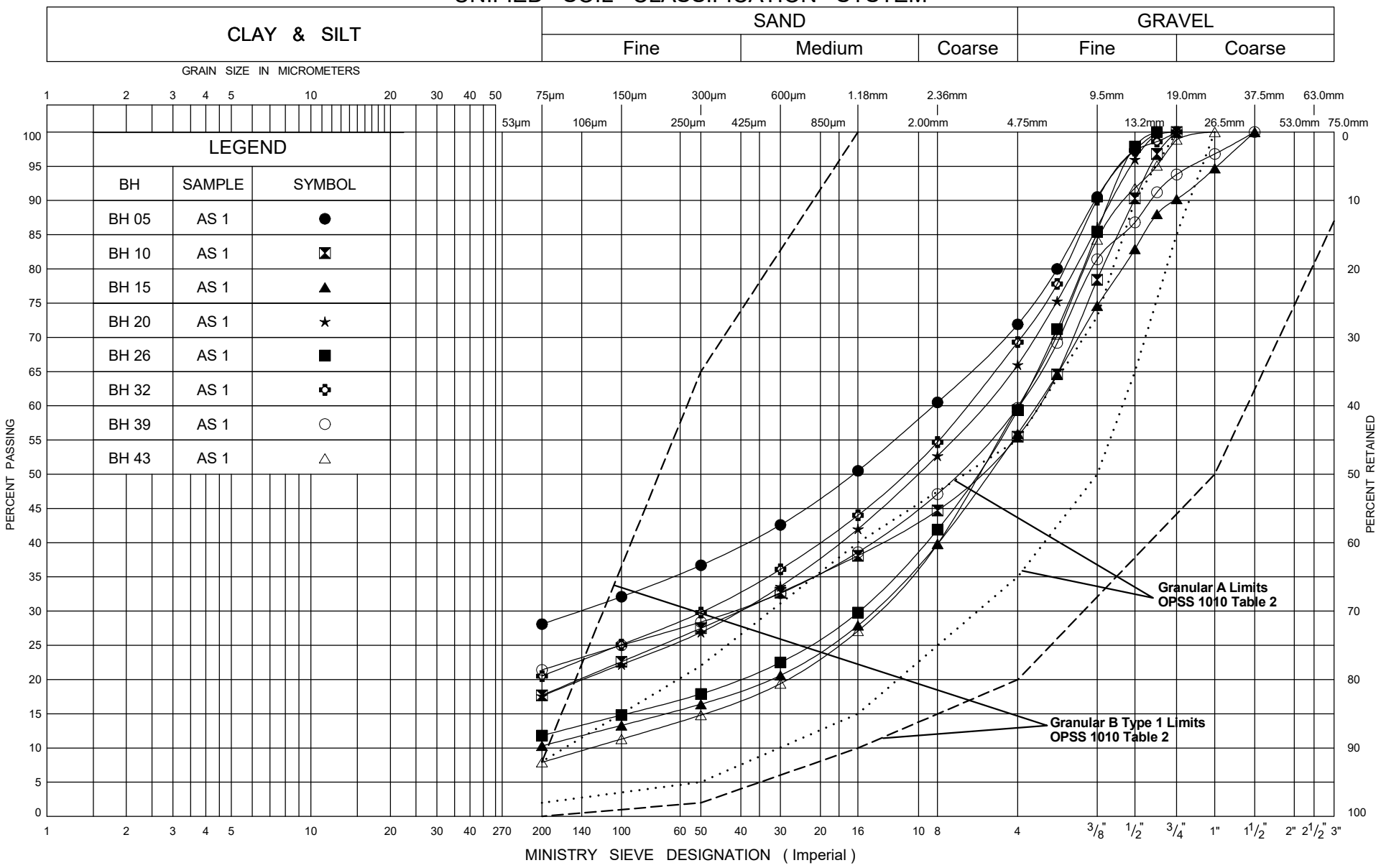
from Hwy 8 to South Service Rd ~ 0.80 km

Fair Condition
Railway to QEW ~200 mm
Newly paved road.

APPENDIX B

Soil Laboratory Test Results

UNIFIED SOIL CLASSIFICATION SYSTEM



wood.

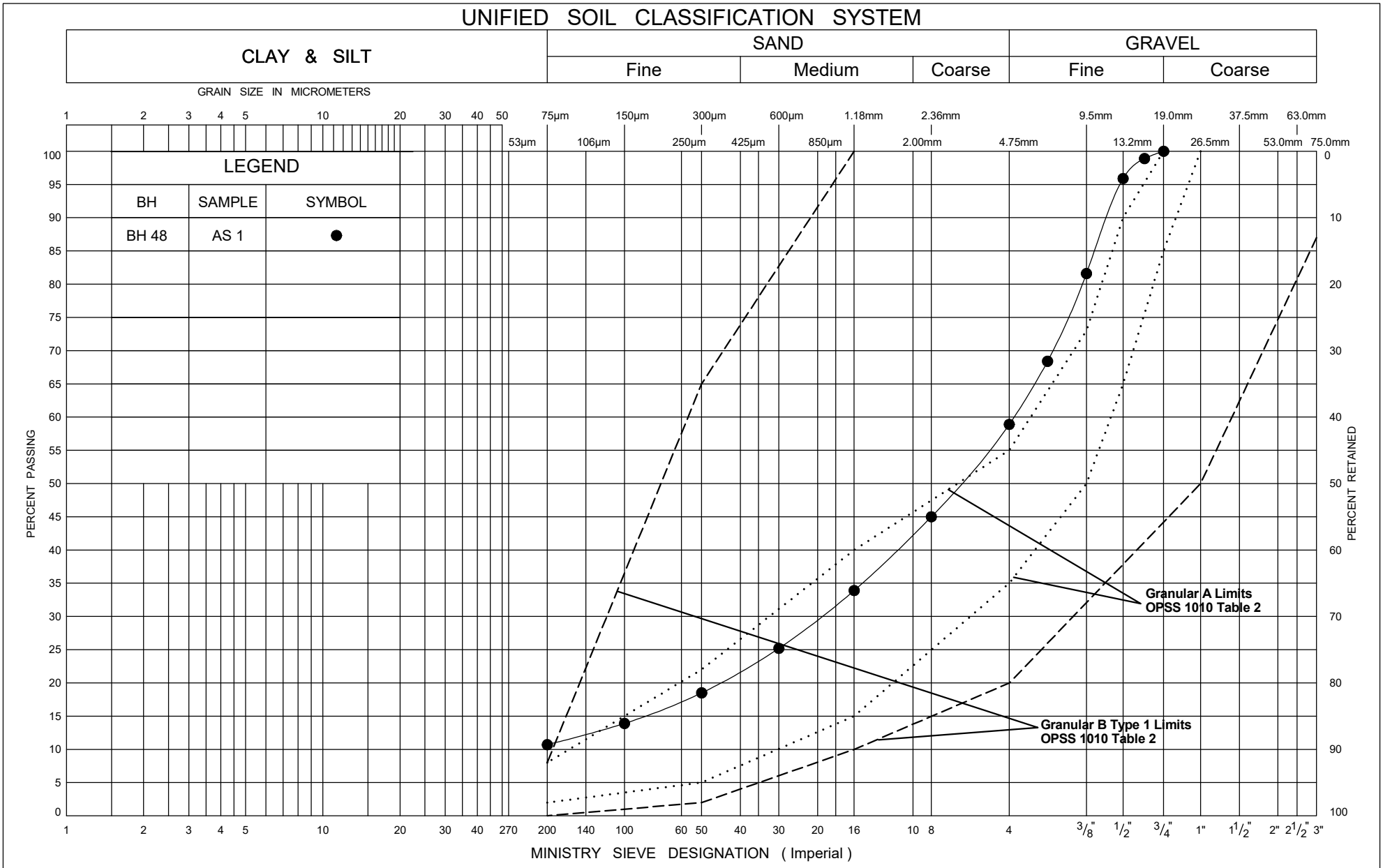
GRAIN SIZE DISTRIBUTION

Sand and Gravel FILL

Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements
Stoney Creek and Winona, Hamilton

TPB166053

Figure No. B1



wood.

GRAIN SIZE DISTRIBUTION

Sand and Gravel FILL

Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements
Stoney Creek and Winona, Hamilton

TPB166053

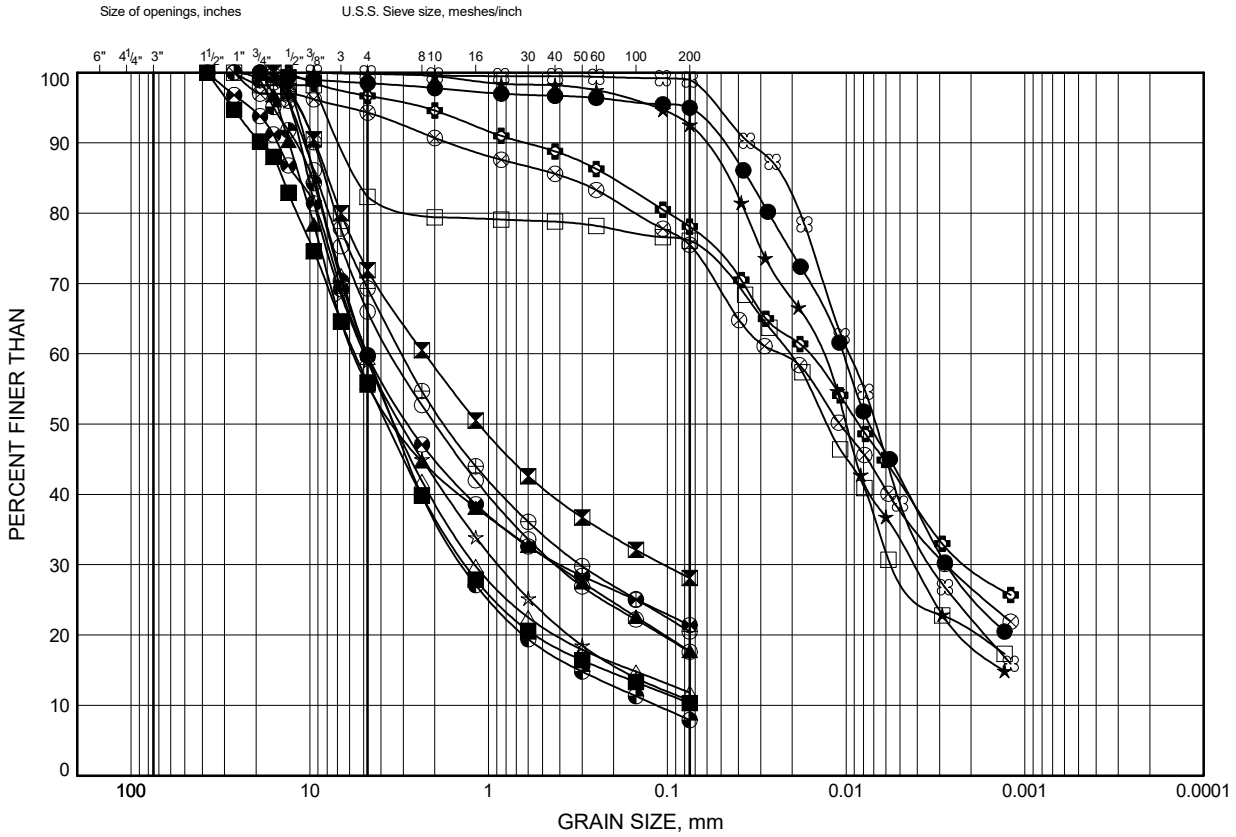
Figure No. B2

wood.

Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements

GRAIN SIZE DISTRIBUTION

FIGURE No. B3



COBBLE SIZE	GRAVEL		SAND			FINE GRAINED
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)	ELEVATION (m)
●	BH 03	SS 3	1.8	85.7
⊠	BH 05	AS 1	0.9	87.5
▲	BH 10	AS 1	0.3	86.9
★	BH 11	SS 4	2.6	86.1
■	BH 15	AS 1	0.3	89.7
✿	BH 19	SS 4	2.6	86.8
○	BH 20	AS 1	0.3	89.0
△	BH 26	AS 1	0.2	87.7
⊗	BH 27	SS 5	3.4	85.0
⊕	BH 32	AS 1	0.2	91.5
□	BH 35	SS 2	1.1	91.0
◓	BH 39	AS 1	0.2	92.1
◔	BH 43	AS 1	0.2	91.1
☆	BH 48	AS 1	0.2	88.5
✿	BH 49	SS 5	3.3	85.1

Date January 2020

Project TPB166053

Prep'd .....

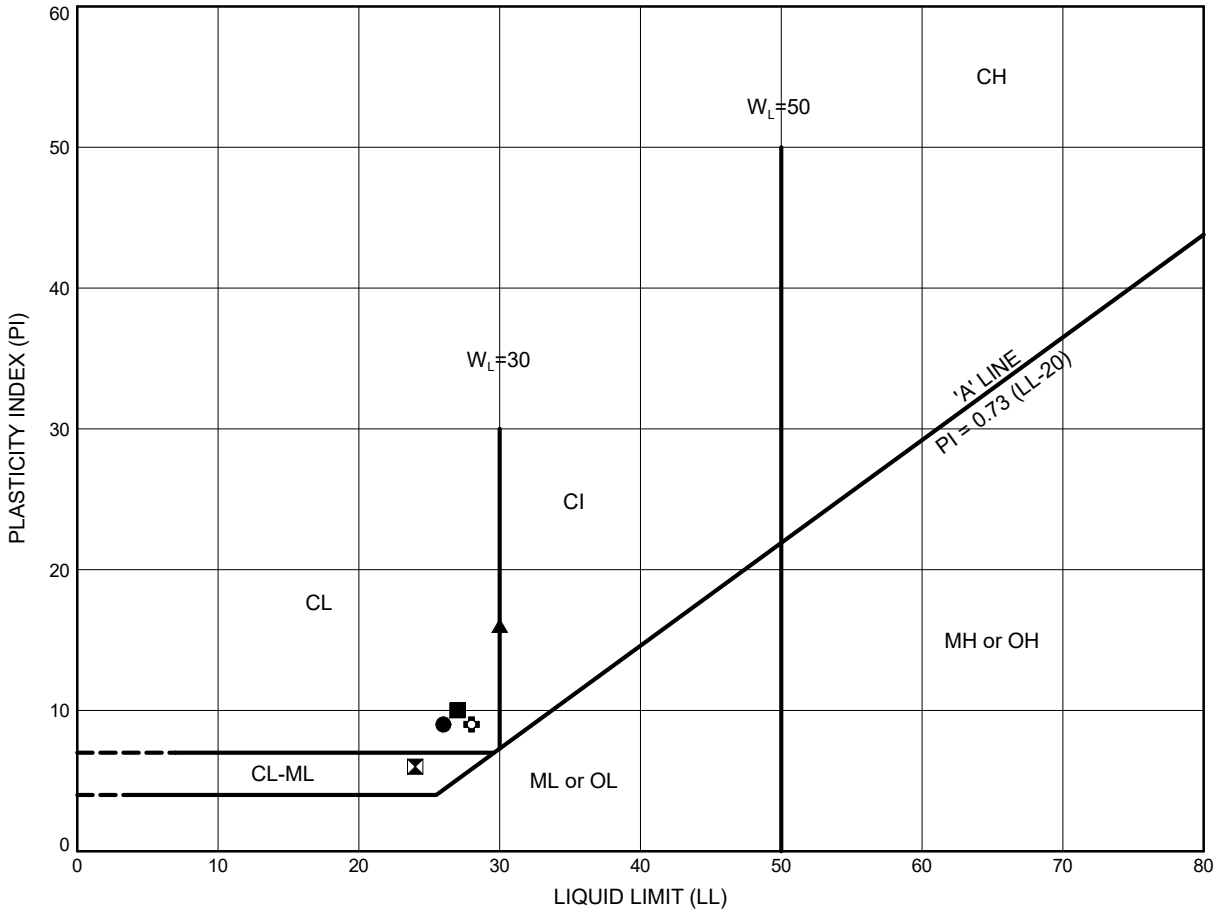
Chkd. .....

wood.

Geotechnical Investigation, MCEA Phases 3 & 4 Barton Street and Fifty Road Improvements

ATTERBERG LIMIT TEST RESULTS
SILTY CLAY TILL

FIGURE No. B4



SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)	ELEVATION (m)	LL	PL	PI
●	BH 03	SS 3	1.8	85.7	26	17	9
⊠	BH 11	SS 4	2.6	86.1	24	18	6
▲	BH 19	SS 4	2.6	86.8	30	14	16
★	BH 27	SS 5	3.4	85.0	27	17	10
■	BH 35	SS 2	1.1	91.0	27	17	10
✿	BH 49	SS 5	3.3	85.1	28	19	9

Date January 2020

Project TPB166053

Prep'd KH

Chkd.

APPENDIX C

Certificates of Analyses

AGAT Laboratories

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

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS
3450 HARVESTER ROAD, SUITE 100
BURLINGTON, ON L7N 3W5
(905) 335-2353

ATTENTION TO: Hoda Seddik

PROJECT: TPB166053.1702.10

AGAT WORK ORDER: 19H485384

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

TRACE ORGANICS REVIEWED BY: Neli Popnikolova, Senior Chemist

DATE REPORTED: Jul 08, 2019

PAGES (INCLUDING COVER): 14

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

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FAX (905)712-5122
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Certificate of Analysis

AGAT WORK ORDER: 19H485384

PROJECT: TPB166053.1702.10

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS

ATTENTION TO: Hoda Seddik

SAMPLING SITE:Barton St/Fifty Rd

SAMPLED BY:Thomas Horvat

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2019-06-27

DATE REPORTED: 2019-07-08

		SAMPLE DESCRIPTION:		BH11 SS2	BH15 AS1	BH23 SS2	BH35 SS2	BH41 SS3	BH1 SS3
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2019-06-21	2019-06-21	2019-06-24	2019-06-19	2019-06-19	2019-06-20
Parameter	Unit	G / S	RDL	308405	308406	308419	308426	308428	308429
Antimony	µg/g	1.3	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	7	7	7	4	4	4
Barium	µg/g	220	2	180	78	150	295	67	175
Beryllium	µg/g	2.5	0.5	0.9	1.0	0.8	0.7	0.7	0.8
Boron	µg/g	36	5	19	13	6	18	18	23
Boron (Hot Water Soluble)	µg/g	NA	0.10	0.40	0.30	0.31	0.20	0.18	1.66
Cadmium	µg/g	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	70	2	26	27	27	22	21	23
Cobalt	µg/g	21	0.5	19.2	17.5	15.7	14.9	14.5	15.7
Copper	µg/g	92	1	8	7	32	7	7	8
Lead	µg/g	120	1	10	9	19	8	7	9
Molybdenum	µg/g	2	0.5	1.4	1.0	0.5	0.7	0.6	1.1
Nickel	µg/g	82	1	41	35	32	33	31	33
Selenium	µg/g	1.5	0.4	<0.4	<0.4	0.5	<0.4	<0.4	<0.4
Silver	µg/g	0.5	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	µg/g	2.5	0.5	0.6	0.7	0.9	0.6	0.6	0.7
Vanadium	µg/g	86	1	31	37	41	32	31	31
Zinc	µg/g	290	5	72	72	78	61	59	64
Chromium VI	µg/g	0.66	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	µg/g	0.051	0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g	0.27	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm	0.57	0.005	0.757	3.38	1.07	0.929	0.539	2.13
Sodium Adsorption Ratio	NA	2.4	NA	3.71	21.0	16.9	3.03	6.12	8.02
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.53	7.44	7.45	7.47	7.67	7.75

Certified By: Vivine Basily

AGAT Laboratories

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FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 19H485384

PROJECT: TPB166053.1702.10

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS

ATTENTION TO: Hoda Seddik

SAMPLING SITE:Barton St/Fifty Rd

SAMPLED BY:Thomas Horvat

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2019-06-27

DATE REPORTED: 2019-07-08

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

308405-308429 EC was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio. SAR is a calculated parameter.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Vivine Basily

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Certificate of Analysis

AGAT WORK ORDER: 19H485384

PROJECT: TPB166053.1702.10

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS

ATTENTION TO: Hoda Seddik

SAMPLING SITE:Barton St/Fifty Rd

SAMPLED BY:Thomas Horvat

O. Reg. 558 Metals and Inorganics

DATE RECEIVED: 2019-06-27

DATE REPORTED: 2019-07-08

		SAMPLE DESCRIPTION:		BH1 TCLP	BH41 TCLP
		SAMPLE TYPE:		Soil	Soil
		DATE SAMPLED:		2019-06-20	2019-06-19
Parameter	Unit	G / S	RDL	308376	308427
Arsenic Leachate	mg/L	2.5	0.010	<0.010	<0.010
Barium Leachate	mg/L	100	0.100	0.585	0.852
Boron Leachate	mg/L	500	0.050	0.116	0.064
Cadmium Leachate	mg/L	0.5	0.010	<0.010	<0.010
Chromium Leachate	mg/L	5	0.010	<0.010	<0.010
Lead Leachate	mg/L	5	0.010	<0.010	<0.010
Mercury Leachate	mg/L	0.1	0.01	<0.01	<0.01
Selenium Leachate	mg/L	1	0.010	<0.010	<0.010
Silver Leachate	mg/L	5	0.010	<0.010	<0.010
Uranium Leachate	mg/L	10	0.050	<0.050	<0.050
Fluoride Leachate	mg/L	150	0.05	0.35	0.09
Cyanide Leachate	mg/L	20	0.05	<0.05	<0.05
(Nitrate + Nitrite) as N Leachate	mg/L	1000	0.70	<0.70	<0.70

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to O. Reg. 558 - Schedule IV Leachate Quality Criteria
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Vivine Basily

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 19H485384

PROJECT: TPB166053.1702.10

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS

ATTENTION TO: Hoda Seddik

SAMPLING SITE:Barton St/Fifty Rd

SAMPLED BY:Thomas Horvat

O. Reg. 153(511) - PHCs F1 - F4 (Soil)

DATE RECEIVED: 2019-06-27

DATE REPORTED: 2019-07-08

		SAMPLE DESCRIPTION:		BH11 SS2	BH23 SS2
		SAMPLE TYPE:		Soil	Soil
		DATE SAMPLED:		2019-06-21	2019-06-24
Parameter	Unit	G / S	RDL	308405	308419
Benzene	µg/g	0.02	0.02	<0.02	<0.02
Toluene	µg/g	0.2	0.05	<0.05	<0.05
Ethylbenzene	µg/g	0.05	0.05	<0.05	<0.05
Xylene Mixture	µg/g	0.05	0.05	<0.05	<0.05
F1 (C6 to C10)	µg/g	25	5	<5	<5
F1 (C6 to C10) minus BTEX	µg/g	25	5	<5	<5
F2 (C10 to C16)	µg/g	10	10	<10	<10
F3 (C16 to C34)	µg/g	240	50	<50	<50
F4 (C34 to C50)	µg/g	120	50	<50	<50
Gravimetric Heavy Hydrocarbons	µg/g	120	50	NA	NA
Moisture Content	%		0.1	12.6	13.2
Surrogate	Unit	Acceptable Limits			
Terphenyl	%	60-140		68	100

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

308405-308419 Results are based on sample dry weight.
The C6-C10 fraction is calculated using Toluene response factor.
Xylenes is a calculated parameter. The calculated value is the sum of m&p-Xylene and o-Xylene.
C6–C10 (F1 minus BTEX) is a calculated parameter. The calculated value is F1 minus BTEX.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16-C50 and are only determined if the chromatogram of the C34 - C50 hydrocarbons indicates that hydrocarbons >C50 are present.
The chromatogram has returned to baseline by the retention time of nC50.
Total C6 - C50 results are corrected for BTEX contribution.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 + nC16 + nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.
Fractions 1-4 are quantified with the contribution of PAHs. Under Ontario Regulation 153, results are considered valid without determining the PAH contribution if not requested by the client.
Quality Control Data is available upon request.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: NPopowich

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Certificate of Analysis

AGAT WORK ORDER: 19H485384

PROJECT: TPB166053.1702.10

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS

ATTENTION TO: Hoda Seddik

SAMPLING SITE:Barton St/Fifty Rd

SAMPLED BY:Thomas Horvat

O. Reg. 558 - Benzo(a) pyrene

DATE RECEIVED: 2019-06-27

DATE REPORTED: 2019-07-08

				SAMPLE DESCRIPTION:	BH1 TCLP	BH41 TCLP
				SAMPLE TYPE:	Soil	Soil
				DATE SAMPLED:	2019-06-20	2019-06-19
Parameter	Unit	G / S	RDL		308376	308427
Benzo(a)pyrene	mg/L	0.001	0.001		<0.001	<0.001

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to O. Reg. 558 - Schedule IV Leachate Quality Criteria
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

308376-308427 The sample was leached according to Regulation 558 protocol. Analysis was performed on the leachate.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: N Popowkolof

AGAT Laboratories
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Certificate of Analysis

AGAT WORK ORDER: 19H485384

PROJECT: TPB166053.1702.10

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS

ATTENTION TO: Hoda Seddik

SAMPLING SITE:Barton St/Fifty Rd

SAMPLED BY:Thomas Horvat

O. Reg. 558 - VOCs

DATE RECEIVED: 2019-06-27

DATE REPORTED: 2019-07-08

		SAMPLE DESCRIPTION:		BH1 TCLP	BH41 TCLP
		SAMPLE TYPE:		Soil	Soil
		DATE SAMPLED:		2019-06-20	2019-06-19
Parameter	Unit	G / S	RDL	308376	308427
Vinyl Chloride	mg/L	0.2	0.030	<0.030	<0.030
1,1 Dichloroethene	mg/L	1.4	0.020	<0.020	<0.020
Dichloromethane	mg/L	5.0	0.030	<0.030	<0.030
Methyl Ethyl Ketone	mg/L	200	0.090	<0.090	<0.090
Chloroform	mg/L	10.0	0.020	<0.020	<0.020
1,2-Dichloroethane	mg/L	0.5	0.020	<0.020	<0.020
Carbon Tetrachloride	mg/L	0.5	0.020	<0.020	<0.020
Benzene	mg/L	0.5	0.020	<0.020	<0.020
Trichloroethene	mg/L	5.0	0.020	<0.020	<0.020
Tetrachloroethene	mg/L	3.0	0.050	<0.050	<0.050
Chlorobenzene	mg/L	8.0	0.010	<0.010	<0.010
1,2-Dichlorobenzene	mg/L	20.0	0.010	<0.010	<0.010
1,4-Dichlorobenzene	mg/L	0.5	0.010	<0.010	<0.010
Surrogate	Unit	Acceptable Limits			
Toluene-d8	% Recovery	60-130		101	99

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to O. Reg. 558 - Schedule IV Leachate Quality Criteria
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

308376-308427 Sample was prepared using Regulation 558 protocol and a zero headspace extractor.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 19H485384

PROJECT: TPB166053.1702.10

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CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS

ATTENTION TO: Hoda Seddik

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
308405	BH11 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	mS/cm	0.57	0.757
308405	BH11 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	NA	2.4	3.71
308406	BH15 AS1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	mS/cm	0.57	3.38
308406	BH15 AS1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	NA	2.4	21.0
308419	BH23 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	mS/cm	0.57	1.07
308419	BH23 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	NA	2.4	16.9
308426	BH35 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Barium	µg/g	220	295
308426	BH35 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	mS/cm	0.57	0.929
308426	BH35 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	NA	2.4	3.03
308428	BH41 SS3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	NA	2.4	6.12
308429	BH1 SS3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	mS/cm	0.57	2.13
308429	BH1 SS3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	NA	2.4	8.02

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Quality Assurance

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS

AGAT WORK ORDER: 19H485384

PROJECT: TPB166053.1702.10

ATTENTION TO: Hoda Seddik

SAMPLING SITE:Barton St/Fifty Rd

SAMPLED BY:Thomas Horvat

Soil Analysis

RPT Date: Jul 08, 2019			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
O. Reg. 558 Metals and Inorganics															
Arsenic Leachate	313901		<0.010	<0.010	NA	< 0.010	104%	90%	110%	107%	80%	120%	113%	70%	130%
Barium Leachate	313901		0.608	0.637	4.7%	< 0.100	103%	90%	110%	107%	80%	120%	108%	70%	130%
Boron Leachate	313901		<0.050	<0.050	NA	< 0.050	103%	90%	110%	103%	80%	120%	90%	70%	130%
Cadmium Leachate	313901		<0.010	<0.010	NA	< 0.010	99%	90%	110%	100%	80%	120%	97%	70%	130%
Chromium Leachate	313901		<0.010	<0.010	NA	< 0.010	101%	90%	110%	111%	80%	120%	101%	70%	130%
Lead Leachate	313901		<0.010	<0.010	NA	< 0.010	101%	90%	110%	111%	80%	120%	97%	70%	130%
Mercury Leachate	313901		<0.01	<0.01	NA	< 0.01	98%	90%	110%	95%	80%	120%	85%	70%	130%
Selenium Leachate	313901		<0.010	<0.010	NA	< 0.010	99%	90%	110%	104%	80%	120%	111%	70%	130%
Silver Leachate	313901		<0.010	<0.010	NA	< 0.010	97%	90%	110%	107%	80%	120%	97%	70%	130%
Uranium Leachate	313901		<0.050	<0.050	NA	< 0.050	95%	90%	110%	99%	80%	120%	89%	70%	130%
Fluoride Leachate	313901		0.26	0.26	0.0%	< 0.05	102%	90%	110%	107%	90%	110%	102%	70%	130%
Cyanide Leachate	313901		<0.05	<0.05	NA	< 0.05	102%	90%	110%	93%	90%	110%	103%	70%	130%
(Nitrate + Nitrite) as N Leachate	313901		<0.70	<0.70	NA	< 0.70	98%	80%	120%	96%	80%	120%	101%	70%	130%
O. Reg. 153(511) - Metals & Inorganics (Soil)															
Antimony	308405	308405	<0.8	<0.8	NA	< 0.8	126%	70%	130%	100%	80%	120%	71%	70%	130%
Arsenic	308405	308405	7	7	0.0%	< 1	108%	70%	130%	103%	80%	120%	98%	70%	130%
Barium	308405	308405	180	184	2.2%	< 2	105%	70%	130%	98%	80%	120%	82%	70%	130%
Beryllium	308405	308405	0.9	0.9	NA	< 0.5	76%	70%	130%	103%	80%	120%	88%	70%	130%
Boron	308405	308405	19	19	NA	< 5	80%	70%	130%	95%	80%	120%	94%	70%	130%
Boron (Hot Water Soluble)	308405	308405	0.40	0.41	NA	< 0.10	99%	60%	140%	114%	70%	130%	104%	60%	140%
Cadmium	308405	308405	<0.5	<0.5	NA	< 0.5	106%	70%	130%	104%	80%	120%	104%	70%	130%
Chromium	308405	308405	26	25	3.9%	< 2	86%	70%	130%	100%	80%	120%	88%	70%	130%
Cobalt	308405	308405	19.2	18.7	2.6%	< 0.5	107%	70%	130%	117%	80%	120%	107%	70%	130%
Copper	308405	308405	8	8	0.0%	< 1	88%	70%	130%	102%	80%	120%	90%	70%	130%
Lead	308405	308405	10	10	0.0%	< 1	105%	70%	130%	114%	80%	120%	109%	70%	130%
Molybdenum	308405	308405	1.4	1.4	NA	< 0.5	106%	70%	130%	109%	80%	120%	101%	70%	130%
Nickel	308405	308405	41	39	5.0%	< 1	104%	70%	130%	113%	80%	120%	99%	70%	130%
Selenium	308405	308405	<0.4	<0.4	NA	< 0.4	106%	70%	130%	108%	80%	120%	99%	70%	130%
Silver	308405	308405	<0.2	<0.2	NA	< 0.2	104%	70%	130%	103%	80%	120%	98%	70%	130%
Thallium	308405	308405	<0.4	<0.4	NA	< 0.4	122%	70%	130%	101%	80%	120%	99%	70%	130%
Uranium	308405	308405	0.6	0.6	NA	< 0.5	113%	70%	130%	101%	80%	120%	103%	70%	130%
Vanadium	308405	308405	31	30	3.3%	< 1	101%	70%	130%	112%	80%	120%	94%	70%	130%
Zinc	308405	308405	72	70	2.8%	< 5	87%	70%	130%	104%	80%	120%	101%	70%	130%
Chromium VI	308405	308405	<0.2	<0.2	NA	< 0.2	111%	70%	130%	104%	80%	120%	108%	70%	130%
Cyanide	316590		<0.040	<0.040	NA	< 0.040	91%	70%	130%	99%	80%	120%	114%	70%	130%
Mercury	308405	308405	<0.10	<0.10	NA	< 0.10	103%	70%	130%	110%	80%	120%	111%	70%	130%
Electrical Conductivity	308405	308405	0.757	0.760	0.4%	< 0.005	101%	90%	110%						
Sodium Adsorption Ratio	308405	308405	3.71	3.73	0.5%	NA									

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Quality Assurance

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS

AGAT WORK ORDER: 19H485384

PROJECT: TPB166053.1702.10

ATTENTION TO: Hoda Seddik

SAMPLING SITE:Barton St/Fifty Rd

SAMPLED BY:Thomas Horvat

Soil Analysis (Continued)

RPT Date: Jul 08, 2019			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
pH, 2:1 CaCl2 Extraction	308405	308405	7.53	7.61	1.1%	NA	101%	80%	120%						

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
pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Certified By: Nivine Basily

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CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS

AGAT WORK ORDER: 19H485384

PROJECT: TPB166053.1702.10

ATTENTION TO: Hoda Seddik

SAMPLING SITE:Barton St/Fifty Rd

SAMPLED BY:Thomas Horvat

Trace Organics Analysis

RPT Date: Jul 08, 2019			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
O. Reg. 558 - VOCs															
Vinyl Chloride	307313	307313	< 0.030	< 0.030	NA	< 0.030	101%	60%	140%	100%	60%	140%	NA	60%	140%
1,1 Dichloroethene	307313	307313	< 0.020	< 0.020	NA	< 0.020	100%	70%	130%	99%	70%	130%	NA	60%	140%
Dichloromethane	307313	307313	< 0.030	< 0.030	NA	< 0.030	98%	70%	130%	97%	70%	130%	NA	60%	140%
Methyl Ethyl Ketone	307313	307313	< 0.090	< 0.090	NA	< 0.090	102%	70%	130%	94%	70%	130%	NA	60%	140%
Chloroform	307313	307313	< 0.020	< 0.020	NA	< 0.020	100%	70%	130%	91%	70%	130%	NA	60%	140%
1,2-Dichloroethane	307313	307313	< 0.020	< 0.020	NA	< 0.020	98%	70%	130%	98%	70%	130%	NA	60%	140%
Carbon Tetrachloride	307313	307313	< 0.020	< 0.020	NA	< 0.020	98%	70%	130%	96%	70%	130%	NA	60%	140%
Benzene	307313	307313	< 0.020	< 0.020	NA	< 0.020	96%	70%	130%	100%	70%	130%	NA	60%	140%
Trichloroethene	307313	307313	< 0.020	< 0.020	NA	< 0.020	101%	70%	130%	99%	70%	130%	NA	60%	140%
Tetrachloroethene	307313	307313	< 0.050	< 0.050	NA	< 0.050	96%	70%	130%	97%	70%	130%	NA	60%	140%
Chlorobenzene	307313	307313	< 0.010	< 0.010	NA	< 0.010	97%	70%	130%	96%	70%	130%	NA	60%	140%
1,2-Dichlorobenzene	307313	307313	< 0.010	< 0.010	NA	< 0.010	95%	70%	130%	101%	70%	130%	NA	60%	140%
1,4-Dichlorobenzene	307313	307313	< 0.010	< 0.010	NA	< 0.010	100%	70%	130%	99%	70%	130%	NA	60%	140%
O. Reg. 558 - Benzo(a) pyrene															
Benzo(a)pyrene	309277		< 0.001	< 0.001	NA	< 0.001	112%	70%	130%	100%	70%	130%	NA	70%	130%
O. Reg. 153(511) - PHCs F1 - F4 (Soil)															
Benzene	310132		< 0.02	< 0.02	NA	< 0.02	110%	60%	130%	102%	60%	130%	83%	60%	130%
Toluene	310132		< 0.05	< 0.05	NA	< 0.05	112%	60%	130%	102%	60%	130%	82%	60%	130%
Ethylbenzene	310132		< 0.05	< 0.05	NA	< 0.05	112%	60%	130%	100%	60%	130%	80%	60%	130%
Xylene Mixture	310132		< 0.05	< 0.05	NA	< 0.05	111%	60%	130%	103%	60%	130%	83%	60%	130%
F1 (C6 to C10)	310132		< 5	< 5	NA	< 5	97%	60%	130%	97%	85%	115%	85%	70%	130%
F2 (C10 to C16)	311190		< 10	< 10	NA	< 10	93%	60%	130%	82%	80%	120%	81%	70%	130%
F3 (C16 to C34)	311190		< 50	< 50	NA	< 50	93%	60%	130%	81%	80%	120%	87%	70%	130%
F4 (C34 to C50)	311190		< 50	< 50	NA	< 50	91%	60%	130%	98%	80%	120%	109%	70%	130%

Comments: When the average of the sample and duplicate results is less than 5x the RDL, the Relative Percent Difference (RPD) will be indicated as Not Applicable (NA).

Certified By: N Popowkolof

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Method Summary

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS

AGAT WORK ORDER: 19H485384

PROJECT: TPB166053.1702.10

ATTENTION TO: Hoda Seddik

SAMPLING SITE:Barton St/Fifty Rd

SAMPLED BY:Thomas Horvat

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Antimony	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Barium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	EPA SW 846 6010C; MSA, Part 3, Ch.21	ICP/OES
Cadmium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Copper	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Lead	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Nickel	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Selenium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Silver	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Thallium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Uranium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Zinc	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium VI	INOR-93-6029	SM 3500 B; MSA Part 3, Ch. 25	SPECTROPHOTOMETER
Cyanide	INOR-93-6052	MOE CN-3015 & E 3009 A;SM 4500 CN	TECHNICON AUTO ANALYZER
Mercury	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Electrical Conductivity	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES
pH, 2:1 CaCl2 Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Arsenic Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Barium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Boron Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Cadmium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Chromium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Lead Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Mercury Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Selenium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Silver Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Uranium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Fluoride Leachate	INOR-93-6018	EPA SW-846-1311 & SM4500-F- C	ION SELECTIVE ELECTRODE
Cyanide Leachate	INOR-93-6052	EPA SW-846-1311 & MOE 3015 & SM 4500 CN- I	TECHNICON AUTO ANALYZER
(Nitrate + Nitrite) as N Leachate	INOR-93-6053	EPA SW 846-1311 & SM 4500 - NO3- I	LACHAT FIA

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Method Summary

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS

AGAT WORK ORDER: 19H485384

PROJECT: TPB166053.1702.10

ATTENTION TO: Hoda Seddik

SAMPLING SITE:Barton St/Fifty Rd

SAMPLED BY:Thomas Horvat

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
Toluene	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
Ethylbenzene	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
Xylene Mixture	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
F1 (C6 to C10)	VOL-91-5009	CCME Tier 1 Method	P&T GC/FID
F1 (C6 to C10) minus BTEX	VOL-91-5009	CCME Tier 1 Method	P&T GC/FID
F2 (C10 to C16)	VOL-91-5009	CCME Tier 1 Method	GC/FID
F3 (C16 to C34)	VOL-91-5009	CCME Tier 1 Method	GC/FID
F4 (C34 to C50)	VOL-91-5009	CCME Tier 1 Method	GC/FID
Gravimetric Heavy Hydrocarbons	VOL-91-5009	CCME Tier 1 Method	BALANCE
Moisture Content	VOL-91-5009	CCME Tier 1 Method	BALANCE
Terphenyl	VOL-91-5009		GC/FID
Benzo(a)pyrene	ORG-91-5105	EPA SW846 3540 & 8270	GC/MS
Vinyl Chloride	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
1,1 Dichloroethene	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
Dichloromethane	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
Methyl Ethyl Ketone	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
Chloroform	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
1,2-Dichloroethane	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
Carbon Tetrachloride	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
Benzene	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
Trichloroethene	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
Tetrachloroethene	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
Chlorobenzene	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
1,2-Dichlorobenzene	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
1,4-Dichlorobenzene	VOL-91-5001	EPA SW-846 5030C & 8260D	(P&T)GC/MS
Toluene-d8	VOL-91-5001	EPA SW-846 5230B & 8260	(P&T)GC/MS

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only

Work Order #: 19H485384

Cooler Quantity: LG cooler

Arrival Temperatures: 8.9 | 9.0 | 9.2
7.1 | 7 | 6.9

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes: ON ICE

Report Information:

Company: Wood PLC
Contact: Hoda Seddik
Address: 3450 Harvester Road. Suite 100
Burlington, Ontario L7N 3W5
Phone: 905-335-2353 Fax:
Reports to be sent to:
1. Email: Tracey.Schram2@woodplc.com
2. Email: Hoda.Seddik@woodplc.com

Regulatory Requirements: ☐ No Regulatory Requirement

(Please check all applicable boxes)

☑ Regulation 153/04
Table 1 *Indicate One*
☐ Ind/Com
☑ Res/Park
☐ Agriculture
Soil Texture *(Check One)*
☑ Coarse
☐ Fine

☐ Sewer Use
☐ Sanitary
☐ Storm
Region *Indicate One*
☐ MISA

☐ Regulation 558
☐ CCME
☐ Prov. Water Quality Objectives (PWQO)
☐ Other
Indicate One

Is this submission for a **Record of Site Condition?** ☐ Yes ☐ No

Report Guideline on *Certificate of Analysis* ☐ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: TPB166053.1702.10
Site Location: Barton St/ Fifty Rd.
Sampled By: Thomas Horvat
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☑ No ☐

Company: Wood PLC
Contact: Hoda Seddik
Address: 3450 Harvester Rd
Email: Hoda.Seddik@woodplc.com

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	O. Reg 153: Metals and Inorganics	All Metals / 153 Metals (excl. Hydrides)	Hydride Metals / 153 Metals (Incl. Hydrides)	ORPs: B-HWS, Cl, CN, Cr^{6+}, EC, FOC, Hg, pH, SAR	Full Metals Scan	Regulation/Custom Metals	Nutrients: TP, NH_3, TKN, NO_3, NO_2, NO_3+NO_2	Volatiles: VOC, BTEX, THM	PHCs F1 - F4	ABNs	PAHs	PCBs: Total, Aroclors	Organochlorine Pesticides	TCLP: M&I, VOCs, ABNs, B(a)P, PCBs	Sewer Use	Potentially Hazardous or High Concentration (Y/N)
BH1 TCLP	June20	11:30	3	S																✓		
BH11 SS2	June21	12:00	3	S			✓							✓	✓							
BH15 AS1	June21	2:30	1	S			✓															
BH23 SS2	June24	11:00	3	S			✓							✓	✓							
BH35 SS2	June19	11:30	1	S			✓															
BH41 TCLP	June19	4:00	3	S																✓		
BH41 SS3	June14	4:00	1	S			✓															
BH1 SS3	June20	10:30	1	S			✓															

Governed By MSSA MIS-016

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
Thomas Horvat	June 27/19	11:55am	Daniella Jaic	June27/19	11:55am
Daniella Jaic	June 27/19	3:35pm	John Chypyha	June27	3:20
			John Chypyha	June27	5:00

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Document ID: DW-78-1511-016

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Date Issued: March 22, 2019

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

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE
3450 Harvester Road, Suite 100
Burlington, ON L7N 3W5

ATTENTION TO: Tracey Schranz

PROJECT: TPB166053

AGAT WORK ORDER: 19T513754

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Supervisor

DATE REPORTED: Sep 10, 2019

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.

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

Certificate of Analysis

AGAT WORK ORDER: 19T513754

PROJECT: TPB166053

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE

ATTENTION TO: Tracey Schranz

SAMPLING SITE:

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2019-09-04

DATE REPORTED: 2019-09-10

		SAMPLE DESCRIPTION:		BH9 SS4		BH25 SS4		BH35 SS3		BH49 SS4
		SAMPLE TYPE:		Soil		Soil		Soil		Soil
		DATE SAMPLED:		2019-06-21		2019-06-24		2019-06-19		2019-06-18
Parameter	Unit	G / S	RDL	497231	RDL	497232	RDL	497233	RDL	497234
Chloride (2:1)	µg/g		2	26	8	227	2	310	4	582
Sulphate (2:1)	µg/g		2	70	16	4740	2	49	4	252
pH (2:1)	pH Units		NA	8.28	NA	8.31	NA	8.13	NA	7.87
Electrical Conductivity (2:1)	mS/cm		0.005	0.240	0.005	3.51	0.005	0.702	0.005	1.38
Resistivity (2:1) (Calculated)	ohm.cm		1	4170	1	285	1	1420	1	725
Redox Potential 1	mV		NA	292	NA	268	NA	293	NA	228
Redox Potential 2	mV		NA	293	NA	267	NA	294	NA	227
Redox Potential 3	mV		NA	292	NA	268	NA	293	NA	227

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

497231-497234 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.
PI note: Redox Potential is not an accredited parameter.
Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.
Elevated RDL indicates the degree of sample dilution prior to the analysis in order to keep analytes within the calibration range of the instrument and to reduce matrix interference.
Samples were received and analyzed beyond recommended hold times.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Amanjot Bhela

CHARTERED AMANJOT BHELA CHEMIST

AGAT Laboratories

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MISSISSAUGA, ONTARIO
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Quality Assurance

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE

AGAT WORK ORDER: 19T513754

PROJECT: TPB166053

ATTENTION TO: Tracey Schranz

SAMPLING SITE:

SAMPLED BY:

Soil Analysis

RPT Date: Sep 10, 2019			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															
Chloride (2:1)	509951		4	3	NA	< 2	110%	80%	120%	109%	80%	120%	107%	70%	130%
Sulphate (2:1)	509951		7	7	NA	< 2	106%	80%	120%	106%	80%	120%	105%	70%	130%
pH (2:1)	497231	497231	8.28	8.30	0.2%	NA	100%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	497231	497231	0.240	0.239	0.4%	< 0.005	99%	90%	110%	NA			NA		
Redox Potential 1	1						107%	90%	110%						

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
pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Certified By:

Amanjot Bhela

CHARTERED CHEMIST AMANJOT BHELA — ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

AGAT Laboratories
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Method Summary

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE

AGAT WORK ORDER: 19T513754

PROJECT: TPB166053

ATTENTION TO: Tracey Schranz

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
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) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential 1	INOR-93-6066	G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only
Work Order #: 19T513754

Cooler Quantity:
Arrival Temperatures: 2.9 | 2.8 | 2.9 / 2 | 1.9 | 1.8
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes: ice

Report Information:
Company: Wood
Contact: Tracey Schranz
Address: 3450 Harvester Rd Suite 100, Burlington, ON L7N 3W5
Phone: 905 335 2353 Fax:
Reports to be sent to:
1. Email: Tracey.Schranz@woodplc.com
2. Email: Hoda.Seddik@woodplc.com

Regulatory Requirements:
☐ No Regulatory Requirement
(Please check all applicable boxes)

☐ Regulation 153/04
Table (Indicate One) ☐ Ind/Com ☐ Res/Park ☐ Agriculture
Soil Texture (Check One) ☐ Coarse ☐ Fine

☐ Sewer Use ☐ Sanitary ☐ Storm
Region (Indicate One) ☐ MISA

☐ Regulation 558 ☐ CCME ☐ Prov. Water Quality Objectives (PWQO) ☐ Other
(Indicate One)

Turnaround Time (TAT) Required:
Regular TAT ☑ 5 to 7 Business Days
Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day
OR Date Required (Rush Surcharges May Apply):
Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*
For 'Same Day' analysis, please contact your AGAT CPM

Project Information:
Project: TPB166053
Site Location: Barton St. Stoney Creek
Sampled By: Thomas Horvat
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Is this submission for a **Record of Site Condition?** ☐ Yes ☐ No

Report Guideline on *Certificate of Analysis* ☐ Yes ☐ No

Invoice Information:
Bill To Same: Yes ☐ No ☐
Company: Wood Plc.
Contact: Hoda Seddik
Address: 3450 Harvester Rd. Burlington, ON L7N 3W5
Email: Hoda.Seddik@woodplc.com.

Sample Matrix Legend
B Biota
GW Ground Water
O Oil
P Paint
S Soil
SD Sediment
SW Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	O. Reg 153: Metals and Inorganics (☐ All Metals ☐ 153 Metals (excl. Hydrides) ☐ Hydride Metals ☐ 153 Metals (incl. Hydrides))	O. Reg 153: ORPs: ☐ B-HWS ☐ Cl ☐ CN ☐ Cr^{6+} ☐ EC ☐ FOC ☐ Hg ☐ pH ☐ SAR	Full Metals Scan	Regulation/Custom Metals	Nutrients: ☐ TP ☐ NH_3 ☐ TKN ☐ NO_3 ☐ NO_2 ☐ NO_3+NO_2	Volatiles: ☐ VOC ☐ BTEX ☐ THM	PHCs F1 - F4	ABNs	PAHs	PCBs: ☐ Total ☐ Aroclors	Organochlorine Pesticides	TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	Sewer Use	Corrosivity Package				Potentially Hazardous or High Concentration (Y/N)
BH9 SS4	June 21	11:00am	1	S																		X				
BH25 SS4	June 24	3:00pm	1	S																		X				
BH35 SS3	June 19	2:00pm	1	S																		X				
BH49 SS4	June 18	10:00am	1	S																		X				
Governed By: MSSA MIS-016																										

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
[signature]	Sept 3, 19	3:00			
[signature]			John Chypyha	Sept 4	12:42
[signature]			John Chypyha	Sept 4	4:35

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Document ID: DW-78-1511.016

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AGAT Laboratories

5623 McADAM ROAD
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CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE
3450 Harvester Road, Suite 100
Burlington, ON L7N 3W5

ATTENTION TO: Tracey Schranz

PROJECT: 19T513754

AGAT WORK ORDER: 19T515632

SOLID ANALYSIS REVIEWED BY: Sherin Moussa, Senior Technician

DATE REPORTED: Sep 11, 2019

PAGES (INCLUDING COVER): 5

Should you require any information regarding this analysis please contact your client services representative at (905) 501-9998

*NOTES

All samples are stored at no charge for 90 days. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

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MISSISSAUGA, ONTARIO
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TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 19T515632

PROJECT: 19T513754

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE

ATTENTION TO: Tracey Schranz

(201-042) Sulfide

DATE SAMPLED: Sep 09, 2019 | DATE RECEIVED: Sep 10, 2019 | DATE REPORTED: Sep 11, 2019 | SAMPLE TYPE: Other

Analyte:	Sulfide
Unit:	%
Sample ID (AGAT ID) RDL:	0.05
BH9 SS4 (511795)	<0.05
BH25 SS4 (511796)	<0.05
BH35 SS3 (511797)	<0.05
BH49 SS4 (511798)	<0.05

Comments: RDL - Reported Detection Limit

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Sherin Moussa

AGAT Laboratories

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MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
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http://www.agatlabs.com

Quality Assurance - Replicate

AGAT WORK ORDER: 19T515632

PROJECT: 19T513754

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE

ATTENTION TO: Tracey Schranz

(201-042) Sulfide

	REPLICATE #1				REPLICATE #2				REPLICATE #3							
Parameter	Sample ID	Original	Replicate	RPD	Sample ID	Original	Replicate	RPD	Sample ID	Original	Replicate	RPD				
S	511795	0.028	0.028	0.0%	511796	0.136	0.148	8.5%	511798	0.030	0.03	0.0%				
Sulfate	511795	< 0.01	<0.01	0.0%	511796	0.12	0.13	8.0%	511798	< 0.01	<0.01	0.0%				
Sulfide	511795	< 0.05	<0.05	0.0%	511796	< 0.05	<0.05	0.0%	511798	< 0.05	<0.05	0.0%				

AGAT Laboratories

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FAX (905)501-0589
http://www.agatlabs.com

Quality Assurance - Certified Reference materials

AGAT WORK ORDER: 19T515632

PROJECT: 19T513754

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE

ATTENTION TO: Tracey Schranz

(201-042) Sulfide

	CRM #1				CRM #2				CRM #3							
Parameter	Expect	Actual	Recovery	Limits	Expect	Actual	Recovery	Limits	Expect	Actual	Recovery	Limits				
S	0.8	0.8	100%	90% - 110%	0.8	0.81	101%	90% - 110%	0.8	0.8	100%	90% - 110%				
Sulfate	0.01	0.01	100%	90% - 110%	0.01	0.01	100%	90% - 110%	0.01	0.01	100%	90% - 110%				
Sulfide	0.8	0.79	98%	90% - 110%	0.8	0.8	100%	90% - 110%	0.8	0.79	98%	90% - 110%				

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http://www.agatlabs.com

Method Summary

CLIENT NAME: WOOD ENVIRONMENT & INFRASTRUCTURE

AGAT WORK ORDER: 19T515632

PROJECT: 19T513754

ATTENTION TO: Tracey Schranz

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Solid Analysis			
Sulfide	MIN-200-12037		LECO