City of Niagara Falls

Geotechnical Investigation

Type of Document
Final

Project Name
2019-2020 Road Rehabilitation Program
Niagara Falls, ON

Project Number
HAM-00801646-A0

Prepared By:
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04.01.2019

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1 Introduction

EXP Services Inc. (EXP) was retained by the City of Niagara Falls (City) under the terms of the existing 2016-2018 Geotechnical Material Inspection and Testing Services contract to complete a pavement investigation for the proposed resurfacing of the 2019 road rehabilitation candidates as well as possible future segments, as listed below:

2019 Segments:

- Woodington Road between Woodgate Street and Woodfield Avenue
- Loring Crescent off Appleford Avenue

Possible Future Segments:

- Wedgewood Crescent off Wilinger Street
- Appleford Avenue between Casey Street and Harriman Street
- Sauterne Place off Fairway Road
- Fairway Road between Glengowan Crescent and Harriman Street
- Abbey Circle off Fairway Road
- Theresa Street off Portage Road to Hillcrest Crescent

Authorization to proceed with the geotechnical investigation was provided by Joe D'Agostino on behalf of the City of Niagara Falls (City). The purpose of this investigation was to determine the existing pavement structure makeup and layer thicknesses, as well as subsoil and groundwater conditions, by advancing auger holes at thirty-three (33) locations across the above list of roadways, and based on an assessment of the factual data, provide an engineering report containing general recommendations pertinent to the proposed construction.

The comments and recommendations given in this report are based on the assumption that the above described design concept will proceed into construction. If changes are made either in the design phase or during construction, this office must be retained to review these modifications. The result of this review may be a modification of our recommendations or the requirement of additional field or laboratory work to check whether the changes are acceptable from a geotechnical viewpoint.

2 Investigation Program

2.1 General Fieldwork

The fieldwork for the investigation was carried out on March 5 and 6, 2019. A total of thirty-three (33) boreholes were advanced by a drilling subcontractor under the full-time supervision of EXP staff. The boreholes were advanced to depths of up to 1.5 m below grade with a truck-mounted drill rig using continuous-flight auger equipment. Traffic control procedures in accordance with OTC Book 7 were implemented for the duration of the investigation. Prior to the commencement of drilling operations, underground services were located to minimize the risk of contacting any such services during the investigation.

Representative samples of the granular fill and subgrade material were recovered in the boreholes using the auger sampling method. The retained soil samples were logged in the field and then carefully packaged and transported to our Hamilton laboratory for detailed visual, textural and olfactory classification.

Groundwater levels within the boreholes were measured prior to backfilling. All boreholes were backfilled in accordance with O.Reg. 903 and capped with cold patch asphalt.

The boreholes were located by EXP in accessible areas on site, clear of underground services and overhead obstructions. The approximate locations of the boreholes are shown on the Borehole Location Plans (Dwg. Nos. 1 to 8 included in Appendix A).

3 Subsurface Conditions

In general, the pavement structure consisted of between 85 and 110 mm of asphaltic concrete overlying between 300 and 400 mm of granular fill. The granular typically consisted of crushed limestone but was noted to consist of recycled materials along Loring Crescent, Sauterne Place, and Abbey Circle. The underlying subgrade typically consisted of moist clayey silt or sandy silt materials. Details of the pavement structure and subgrade conditions encountered during the drilling program are summarized in Table 3-1 below.

Table 3-1: Borehole Summary

Street Name	Borehole No.	Borehole Location		Asphaltic Concrete Thickness (mm)	Granular Thickness (mm)	Subgrade and Groundwater Conditions
		Lane	Longitudinal Location*			
Wedgewood Crescent	BH-1	Northbound	In front of #2736	90	300	Clayey silt, brown, moist. Dry upon completion.
	BH-2	Northbound	In front of #2800	90	300	Clayey silt, brown, moist. Dry upon completion.
	BH-3	Northbound	In front of #2840	90	320	Clayey silt, brown, moist. Dry upon completion.
Woodington Road	BH-4	Eastbound**	In front of #7210	90	310	Clayey silt, brown, moist. Dry upon completion.
	BH-5	Eastbound	In front of #7160	85	330	Clayey silt, brown, moist. Dry upon completion.
	BH-6	Eastbound	In front of #7060	90	300	Clayey silt, brown, moist. Dry upon completion.
	BH-7	Eastbound	In front of #7020	90	500	Clayey silt, brown, moist. Dry upon completion.
Loring Crescent	BH-8	Eastbound	In front of #7134	80	300	Sandy silt, brown, moist. Dry upon completion.
	BH-9	Eastbound	In front of #7100	100	300	Sandy silt, brown, moist. Dry upon completion.
	BH-10	Eastbound	In front of #7067	90	330	Sandy silt, brown, moist. Dry upon completion.
Appleford Avenue	BH-11	Southbound**	In front of #3049	90	300	Sandy silt, brown, moist. Dry upon completion.
	BH-12	Southbound	In front of #3097	110	300	Sandy silt, brown, moist. Dry upon completion.
	BH-13	Southbound	In front of #3141	90	330	Sandy silt, brown, moist. Dry upon completion.
	BH-14	Southbound	In front of #3187	90	300	Sandy silt, brown, moist. Dry upon completion.
	BH-15	Southbound	In front of #3227	100	350	Sandy silt, brown, wet. Dry upon completion.
	BH-16	Southbound	In front of #3267	90	300	Sandy silt, brown, moist. Dry upon completion.

Street Name	Borehole No.	Borehole Location		Asphaltic Concrete Thickness (mm)	Granular Thickness (mm)	Subgrade and Groundwater Conditions
		Lane	Longitudinal Location*			
Sauterne Place	BH-17	Westbound	In front of #7141	85	300	Sandy silt, some clay, brown, moist. Dry upon completion.
	BH-18	Eastbound	In front of #7091	95	300	Sandy silt, some clay, brown, moist. Dry upon completion.
	BH-19	Westbound	In front of #7060	90	300	Sandy silt, some clay, brown, moist. Dry upon completion.
Fairway Road	BH-20	Northbound	In front of #7010	100	300	Sandy silt, some clay, brown, moist. Dry upon completion.
	BH-21	Southbound	In front of #3207	95	300	Sandy silt, some clay, brown, moist. Dry upon completion.
	BH-22	Southbound	In front of #3249	100	330	Sandy silt, some clay, brown, moist. Dry upon completion.
	BH-23	Northbound	In front of #3308	90	300	Sandy silt, some clay, brown, moist. Dry upon completion.
Abbey Circle	BH-24	Eastbound	In front of #7014	90	350	Silty sand, some gravel, brown, moist. Dry upon completion.
	BH-25	Eastbound	In front of #6986	90	330	Silty sand, some gravel, brown, moist. Dry upon completion.
	BH-26	Eastbound	In front of #6958	90	300	Silty sand, some gravel, brown, moist. Dry upon completion.
Theresa Street	BH-27	Westbound	In front of #6015	90	300	Sandy silt, brown, moist. Dry upon completion.
	BH-28	Westbound	In front of #5999	100	330	Sandy silt, brown, moist. Dry upon completion.
	BH-29	Westbound	In front of #5950	100	300	Sandy silt, brown, moist. Dry upon completion.
	BH-30	Eastbound	In front of #5870	95	320	Sandy silt, brown, moist. Dry upon completion.
	BH-31	Eastbound	In front of #5810	85	300	Sandy silt, brown, moist. Dry upon completion.
	BH-32	Westbound	In front of #5741	90	320	Sandy silt, brown, moist. Dry upon completion.

Street Name	Borehole No.	Borehole Location		Asphaltic Concrete Thickness (mm)	Granular Thickness (mm)	Subgrade and Groundwater Conditions
		Lane	Longitudinal Location*			
	BH-33	Eastbound	In front of #5698	90	330	Sandy silt, brown, moist. Dry upon completion.

*Longitudinal locations reference the municipal address on the subject street.

**Boreholes were advanced in the same lane due to presence of utilities in other lane.

Eight (8) sieve analyses were conducted on recovered samples of the granular fill materials. The samples did not meet the gradation requirements for Granular A as outlined in OPSS 1010, with all eight sieves being finer than the specifications. Two grain size analyses were also conducted on representative sample of the subgrade, which was found to consist of 8 to 22 percent clay, 70 to 72 percent silt, and 6 to 22 percent sand. Laboratory test results are included in Appendix B.

Groundwater conditions were monitored in the open boreholes during and upon completion of the drilling operations. All boreholes were dry upon completion. The groundwater levels are not considered to have stabilized during the short term of the investigation but would be expected to be below the shallow depths of this investigation. Seasonal variations in the water table should be anticipated, with higher levels occurring during wet weather conditions (spring thaw and late fall) and lower levels occurring during dry weather conditions.

4 Road Construction

In general, the roadways were noted to be in fair condition with localized areas which were poor to very poor, with the exception of Wedgewood Crescent which was noted to be in poor condition throughout. Significant crack sealing was noted along all roadways with the exception of Woodington Road. In general, the encountered pavement structure did not meet the current City of Niagara Falls design standard for urban local roadways which consists of 120 mm of asphaltic concrete overlying 450 mm of Granular “A”. Additionally, based on the results of the eight (8) grain size analyses conducted on the granular materials, the granular fill encountered did not meet the requirements of OPSS 1010 for Granular “A” material.

Two options are presented for the roadway reconstruction projects. Option 1 involves full depth removal of the existing asphaltic concrete and granular fill and reconstruction of the pavement with new materials which meet the OPSS specifications. Some sub-excavation will be required to allow for placement of additional granular material and asphaltic concrete without raising the overall grade, which at present is limited to the elevations of the curbs. Given the fair condition of the majority of the roadways, Option 2 has been provided as a more economical option and involves the complete asphalt replacement and selective granular repair.

The City should consider the cost benefit of both options in relation to the service life of the pavement to decide which option is best suited for their purposes.

4.1 Option No. 1: Full Reconstruction

To meet the current City of Niagara Falls pavement design standard for granular base and asphaltic concrete thicknesses, a full depth reconstruction may be considered. If this is the chosen method of rehabilitation, then the following steps should be followed:

1. Remove and dispose of the asphalt.
2. If the grade raise is not an issue, add additional granular base material to meet the standard granular thickness of 450 mm. Otherwise, excavate to the required elevation of the subgrade and place 450 mm of Granular "A" material. Areas noted to contain organic subgrade materials should be sub-excavated to competent soil, free of organic and deleterious materials.
3. Install subdrains as required.
4. Construct concrete curb and gutter.
5. Place 80 mm of HL8 HS binder course asphalt compacted to min. 92% Maximum Relative Density (MRD) followed by 40 mm of HL3 HS surface course asphalt compacted to min. 92% MRD.

4.2 Option No. 2: Full Asphalt Removal or Mill and Pave with Localized Repairs

Since there are no major issues observed except in localized areas, the following method may be considered for rehabilitation of the subject roadways. Further, it is understood that the subject roadways are not typically subjected to heavy duty traffic and traffic volumes are limited, as such the current average pavement structure is considered adequate.

1. Remove and dispose of the entire thickness of asphalt.
2. Conduct localized full depth repairs in areas of noted subgrade failure and in areas where severe pavement distress is noted. Re-compact the granular surface in the presence of a geotechnical representative to identify additional areas of repair.
3. Add additional Granular A compacted to 100 percent SPMDD where required to allow for placement of at least 90 mm of hot mix asphalt
4. Install subdrains as required.
5. Conduct curb repairs.
6. Adjust manholes, utility accesses and catch basins.
7. Place 50 mm HL8 HS and 40 mm HL3 HS compacted to a minimum of 92% MRD to the required grade.

Alternatively, as a cost-saving measure in areas without significant pavement distresses, the upper approximately 50 mm of asphaltic concrete may be milled and disposed of instead of the full depth. A tack coat should then be applied on the milled surface before placing HL3 HS to the required grade, compacted a minimum of 92% MRD to the required grade. It is noted that this method is not recommended for Wedgewood Crescent or any other areas of severe pavement distress.

5 General Comments

The information presented in this report is based on a limited investigation designed to provide information to support an overall assessment of the current geotechnical conditions of the subject property. The conclusions presented in this report reflect site conditions existing at the time of the investigation.

EXP Services Inc. should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, EXP Services Inc. will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

More specific information, with respect to the conditions between samples, or the lateral and vertical extent of materials, may become apparent during excavation operations. Consequently, during the future development of the property, conditions not observed during this investigation may become apparent; should this occur, EXP Services Inc. should be contacted to assess the situation and additional testing and reporting may be required. EXP Services Inc. has qualified personnel to provide assistance in regard to future geotechnical and environmental issues related to this property.

We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

EXP Services Inc.

LICENSED PROFESSIONAL ENGINEER
April 1/19
M. M. LIVECCHI
100189574
PROVINCE OF ONTARIO

Matt Livecchi, P.Eng.
Geotechnical Project Manager

Jeffrey Golder, P.Eng.
Manager, Hamilton Geotechnical Services

Appendix A – Drawings



EXP Services Inc.
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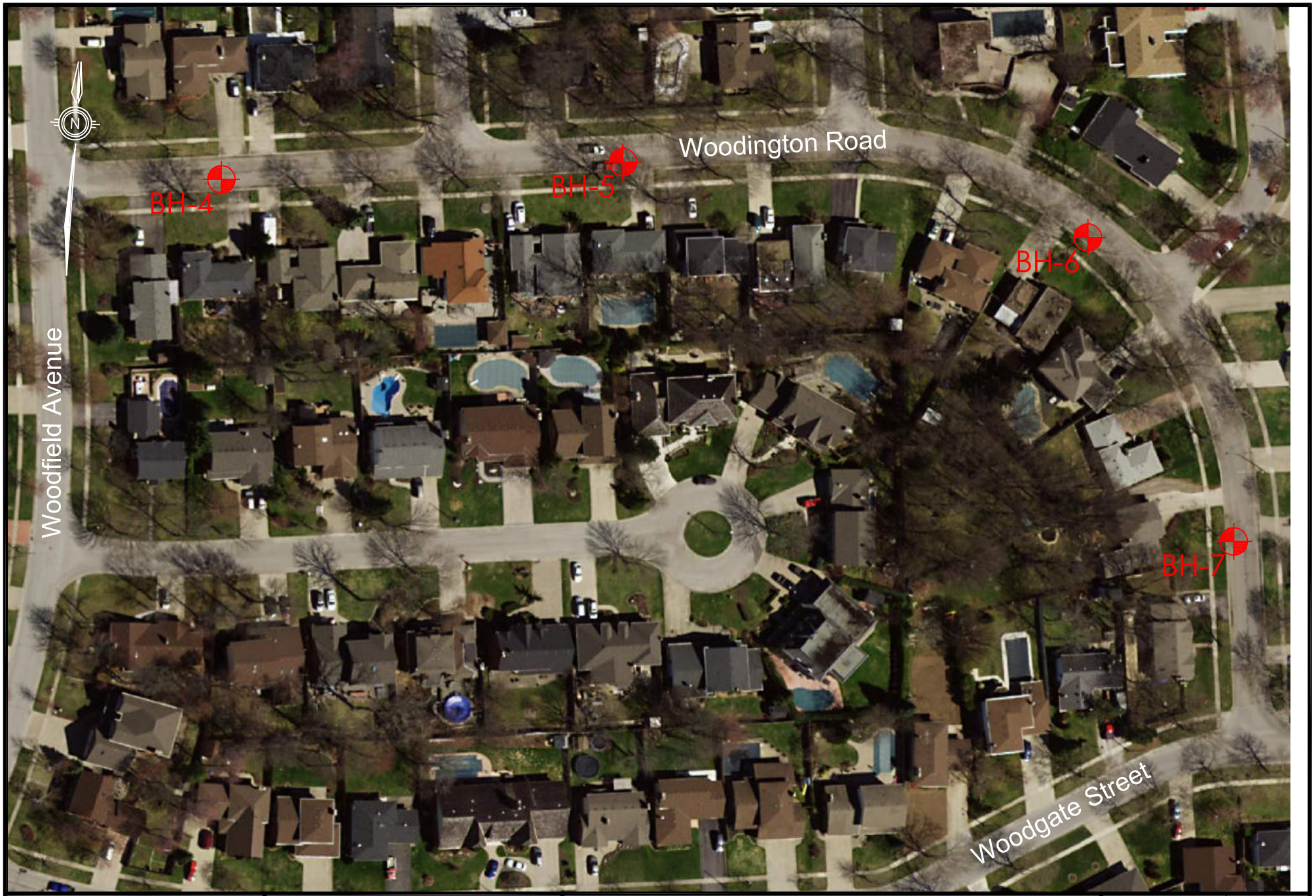
LEGEND:

APPROXIMATE BOREHOLE LOCATION

TITLE AND LOCATION:

BOREHOLE LOCATION PLAN
GEOTECHNICAL INVESTIGATION
PROPOSED 2019 - 2020 ROAD REHABILITATION PROGRAM
WEDGEWOOD CRESCENT, NIAGARA FALLS, ON

JOB NO.: HAM-00801646-A0	DRAWN BY: ML
SCALE: NTS	CHECKED BY: JG
DATE: March 2019	DWG NO.: 1



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LEGEND:

APPROXIMATE BOREHOLE LOCATION

TITLE AND LOCATION:

BOREHOLE LOCATION PLAN
GEOTECHNICAL INVESTIGATION
PROPOSED 2019 - 2020 ROAD REHABILITATION PROGRAM
WOODINGTON ROAD, NIAGARA FALLS, ON

JOB NO.: HAM-00801646-A0	DRAWN BY: ML
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LEGEND:

APPROXIMATE BOREHOLE LOCATION

TITLE AND LOCATION:

BOREHOLE LOCATION PLAN
GEOTECHNICAL INVESTIGATION
PROPOSED 2019 - 2020 ROAD REHABILITATION PROGRAM
LORING CRESCENT, NIAGARA FALLS, ON

JOB NO.: HAM-00801646-A0	DRAWN BY: ML
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LEGEND:

APPROXIMATE BOREHOLE LOCATION

TITLE AND LOCATION:

BOREHOLE LOCATION PLAN
GEOTECHNICAL INVESTIGATION
PROPOSED 2019 - 2020 ROAD REHABILITATION PROGRAM
APPLEFORD AVENUE, NIAGARA FALLS, ON

JOB NO.: HAM-00801646-A0	DRAWN BY: ML
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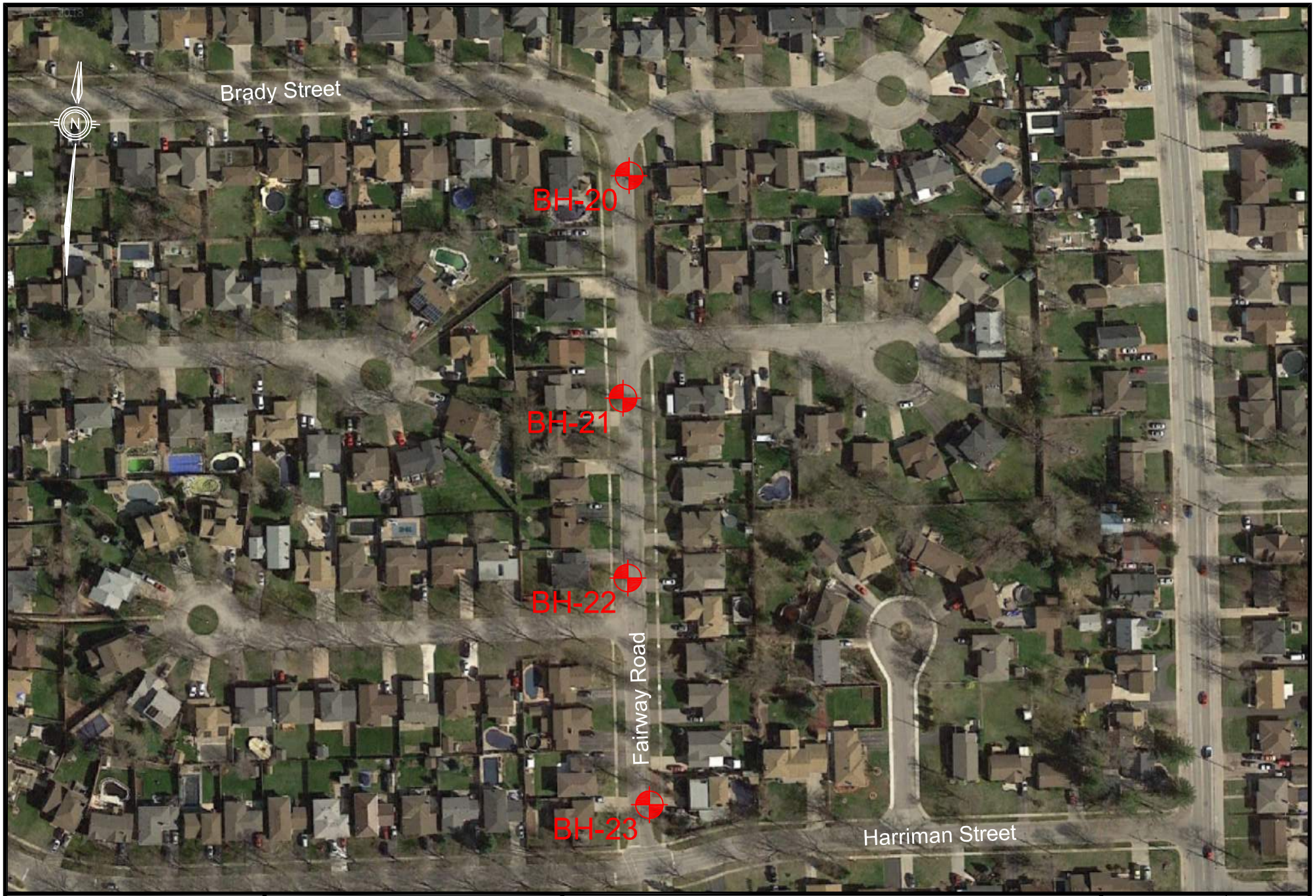
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APPROXIMATE BOREHOLE LOCATION

TITLE AND LOCATION:

BOREHOLE LOCATION PLAN
GEOTECHNICAL INVESTIGATION
PROPOSED 2019 - 2020 ROAD REHABILITATION PROGRAM
SAUTERNE PLACE, NIAGARA FALLS, ON

JOB NO.: HAM-00801646-A0	DRAWN BY: ML
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LEGEND:

APPROXIMATE BOREHOLE LOCATION

TITLE AND LOCATION:

BOREHOLE LOCATION PLAN
GEOTECHNICAL INVESTIGATION
PROPOSED 2019 - 2020 ROAD REHABILITATION PROGRAM
FAIRWAY ROAD, NIAGARA FALLS, ON

JOB NO.: HAM-00801646-A0	DRAWN BY: ML
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LEGEND:

APPROXIMATE BOREHOLE LOCATION

TITLE AND LOCATION:

BOREHOLE LOCATION PLAN
GEOTECHNICAL INVESTIGATION
PROPOSED 2019 - 2020 ROAD REHABILITATION PROGRAM
ABBEY CIRCLE, NIAGARA FALLS, ON

JOB NO.: HAM-00801646-A0	DRAWN BY: ML
SCALE: NTS	CHECKED BY: JG
DATE: March 2019	DWG NO.: 7



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LEGEND:

APPROXIMATE BOREHOLE LOCATION

TITLE AND LOCATION:

BOREHOLE LOCATION PLAN
GEOTECHNICAL INVESTIGATION
PROPOSED 2019 - 2020 ROAD REHABILITATION PROGRAM
THERESA STREET, NIAGARA FALLS, ON

JOB NO.: HAM-00801646-A0	DRAWN BY: ML
SCALE: NTS	CHECKED BY: JG
DATE: March 2019	DWG NO.: 8

Appendix B – Laboratory Test Results

ISSMFE SOIL CLASSIFICATION SYSTEM

CLAY	SILT			SAND			GRAVEL			Cobbles
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (Imperial)

1 3 5 10 30 50 75 #200 #100 #50 #16 #4 3/8" ½" ¾" 3"

PERCENT PASSING

100 90 80 70 60 50 40 30 20 10 0

0.001 0.01 0.1 1 10 100

GRAIN SIZE (MM)

OPSS 1010 Granular A Specifications Limits

OPSS 1010 Granular B Type I Specifications Limits

LEGEND

STREET	SAMPLE	SYMBOL
Wedgwood Crescent	BH-3	
Woodington Road	BH-4	
Loring Crescent	BH-10	
Appleford Avenue	BH-15	

exp.

GRAIN SIZE DISTRIBUTION

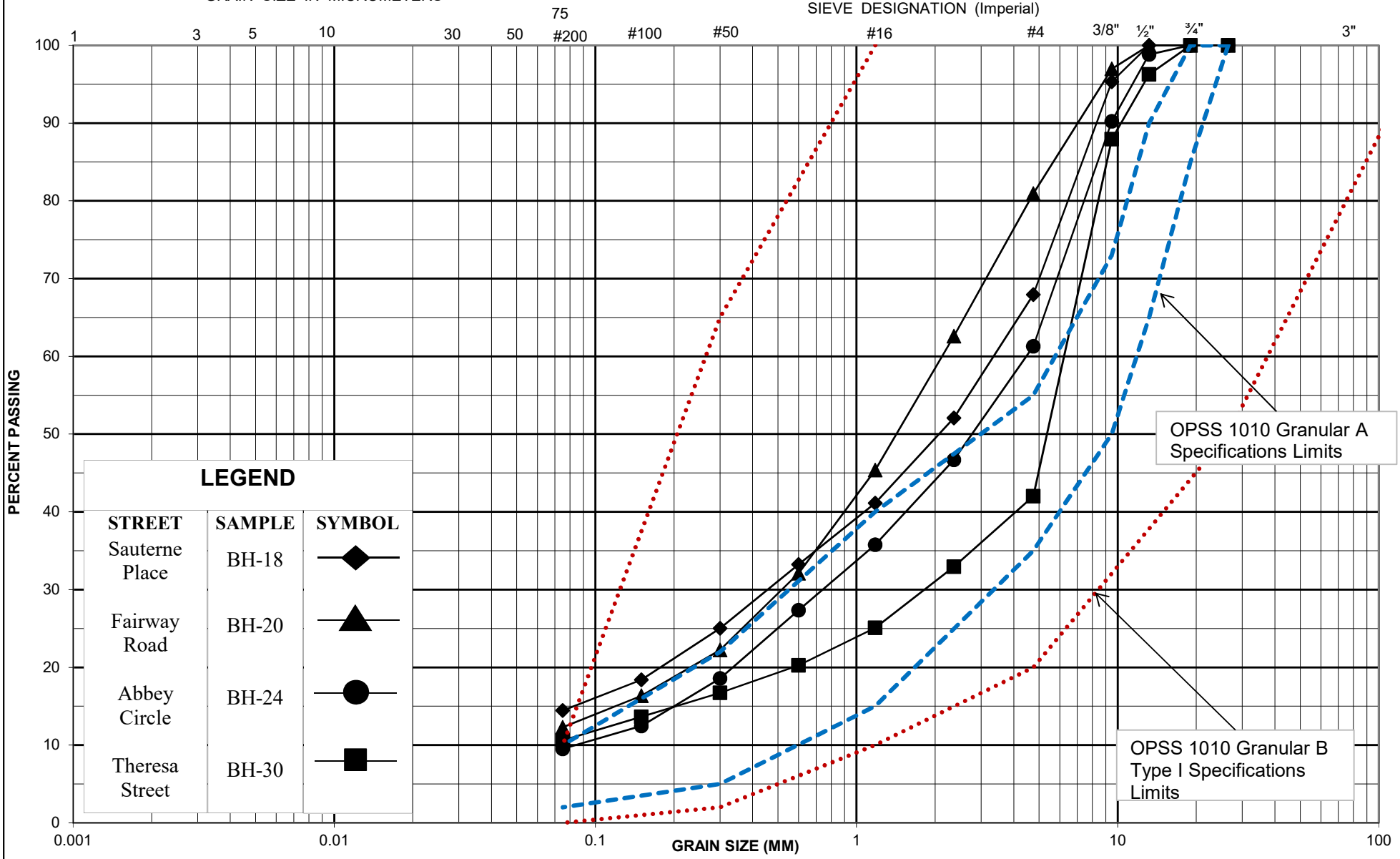
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PROJECT No.	HAM-00801646-A0
DATE:	March 2019

ISSMFE SOIL CLASSIFICATION SYSTEM

CLAY	SILT			SAND			GRAVEL			Cobbles
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (Imperial)



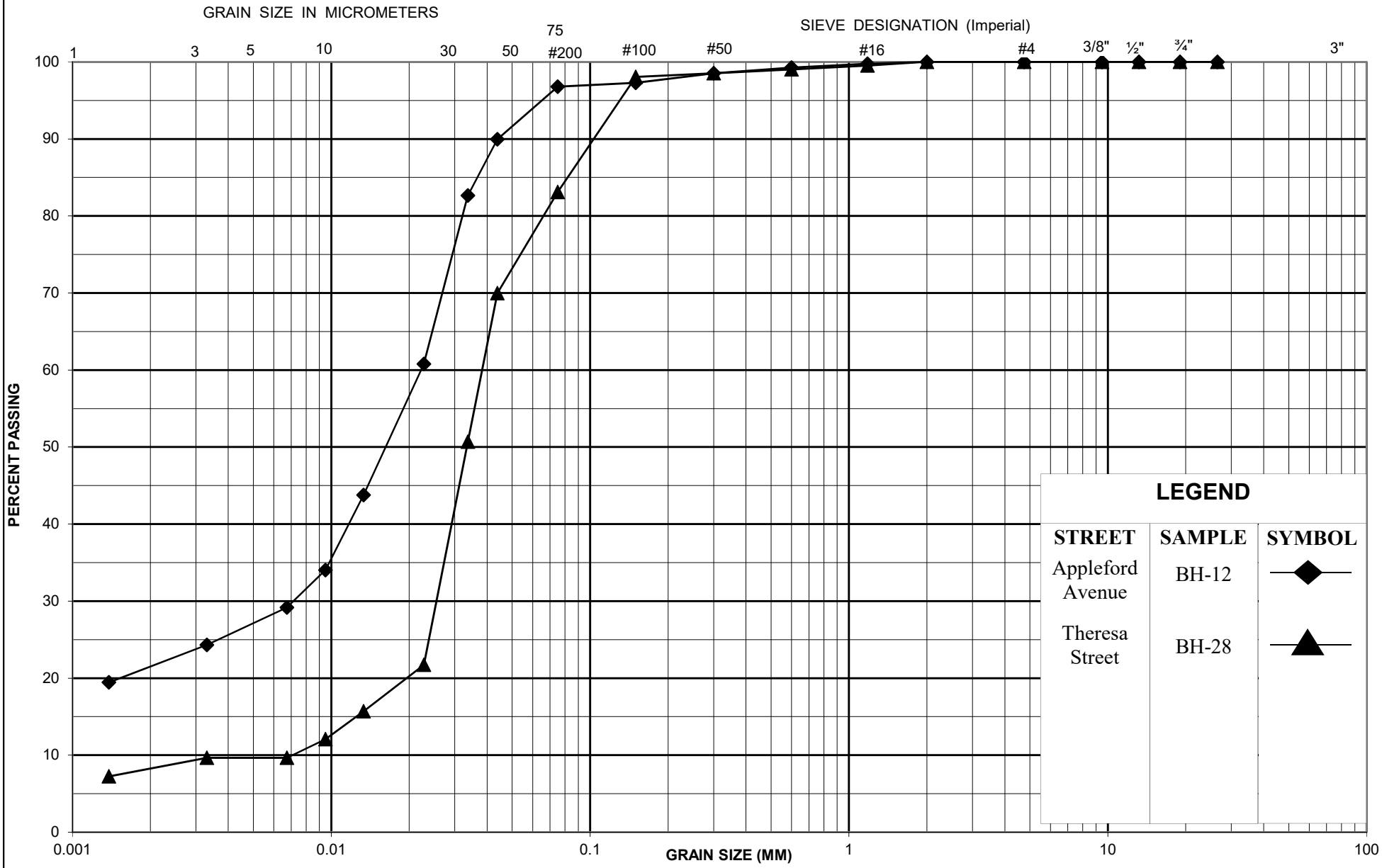
exp.

GRAIN SIZE DISTRIBUTION

DRAWING No.	B2
PROJECT No.	HAM-00801646-A0
DATE:	March 2019

ISSMFE SOIL CLASSIFICATION SYSTEM

CLAY	SILT			SAND			GRAVEL			Cobbles
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	



GRAIN SIZE DISTRIBUTION

DRAWING NO.:	B3
PROJECT NO.:	HAM-00801646-A0
DATE:	MARCH 2019