FISHERIES AND OCEANS CANADA

AMHERSTBURG NAVIGATIONAL AIDS
GEOTECHNICAL INVESTIGATION

APRIL 1, 2019

FINAL

AMHERSTBURG NAVIGATIONAL AIDS

GEOTECHNICAL INVESTIGATION

FISHERIES AND OCEANS CANADA

FINAL

PROJECT NO.: 181-14155-00
DATE: APRIL 2019

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April 1, 2019

FINAL

FISHERIES AND OCEANS CANADA
520 Exmount Street
Sarnia, ON N7T 8B1

Attention: Laurence Long, Project Engineer

Subject: Amherstburg Navigational Aids, Geotechnical Investigation

Dear Sir:

We are pleased to submit our geotechnical investigation report for the above-noted project. A field investigation and laboratory testing program was conducted to assess soil and groundwater conditions at the site as input to design of the replacement of the current navigations aids, located along the Detroit River in Amherstburg, Ontario.

Included in this report are recommendations for foundation design, a site plan with borehole layout, and results from our field and laboratory investigation.

We trust that the report is straightforward and meets your current requirements.

Yours sincerely,

Pete Hynes. P.Eng.
Project Engineer, Environment

WSP ref.: 181-14155-00

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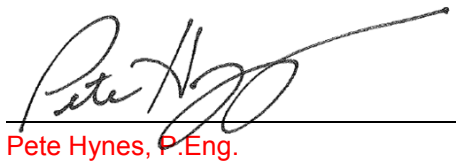

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April 1, 2019

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[1] Approval of this document is an administrative function indicating readiness for release and does not impart legal liability on to the Approver for any technical content contained herein. Technical accuracy and fit-for-purpose of this content is obtained through the review process. The Approver shall ensure the applicable review process has occurred prior to signing the document.

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1 INTRODUCTION

1.1 SITE DESCRIPTION

The subject towers are shown on the enclosed figures (**Figures 1 to 9).** Figure 1 illustrates the overall location of each of the eight (8) Site locations, while Figures 2 to 9 illustration the location of the individual boreholes with respect to existing site features. A total of eight (8) boreholes were completed at eight (8) navigational aids along the Detroit River, in the Town of Amherstburg, Ontario.

Boreholes BH18-01 and BH18-02 were located at the two navigational aids at the south-end of Bob-Lo Island, boreholes BH18-03 and BH18-04 were located on the island north of Bob-Lo Island. Borehole BH18-05 was located in between residential driveways north of the intersection of Sandwich Street North and St. Arnaud Street. Borehole BH18-06 was located at the navigational aid in the south-west corner of the Amherstburg Visitor Centre property. Borehole BH18-07 was located along Bob-Lo Island Boulevard near the Bob-Lo Island ferry loading area. Lastly, Borehole BH18-08 was located at the south end of the Canadian Coast Guard property

Table 1-1 (below) summarizes the borehole locations relative to the site towers with GPS coordinates.

Table 1-1: Borehole Locations

SITE	BOREHOLE ID	ZONE	EASTING	NORTHING
LL648	BH18-01	17T	324308	4659781
LL649	BH18-02	17T	324502	4660521
LL656	BH18-08	17T	325243	4662677
LL657	BH18-07	17T	325320	4662962
LL663	BH18-03	17T	324901	4664509
LL664	BH18-04	17T	324884	4664850
LL667	BH18-06	17T	325402	4664605
LL668	BH18-05	17T	325439	4664497

1.2 OBJECTIVES

The objectives of the geotechnical investigation were to evaluate subsurface conditions at the existing navigational aid tower locations as input to foundation design.

Information in this report is only valid for the borehole locations as described. Should the subject tower location or elevation be moved, WSP should be contacted to review our findings and the possible need for additional investigative work.

2 METHODOLOGY

2.1 SITE INVESTIGATION

The geotechnical site investigation included the drilling of borehole eight (8) boreholes described as boreholes BH18-01 to BH18-08, to a range of depths of approximately 6.1 to 15.4 m below grade surface (mBGS). The borehole locations are provided on the Borehole Location Plans (**Figures 2 to 9)**. The borehole logs are provided in **Appendix A**.

Field work was undertaken between December 13, 2018 to March 12, 2019 during three (3) site visits under the supervision of WSP technical staff.

The island boreholes, BH18-01 to BH18-04, and the main land borehole, BH18-05, were advanced using limited access drill equipment equipped with an SPT hammer. Soil samples were recovered continuously using a 51 mm outside diameter split-spoon sampler, driven in accordance with the SPT procedure (ASTM D1586). The results of the SPTs, in terms of N values are referred to in this report as consistency for cohesive soils and relative density for non-cohesive materials. Representative samples were recovered from the boreholes and placed in moisture proof bags and transported to our CCIL-certified laboratory for subsequent review by the project team and laboratory testing. The boreholes were checked for groundwater seepage and general stability prior to backfilling.

Boreholes BH18-06 to BH18-08 were advanced using a commercial track-mount drill rig equipped with continuous flight augers and SPT hammer. Soil samples were recovered at regular intervals while using a 51 mm outside diameter split-spoon sampler, driven in accordance with the SPT procedure (ASTM D1586). The results of the SPTs, in terms of N values are referred to in this report as consistency for cohesive soils and relative density for non-cohesive materials. Representative samples were recovered from the boreholes and placed in moisture proof bags and transported to our CCIL-certified laboratory for subsequent review by the project team and laboratory testing. The boreholes were checked for groundwater seepage and general stability prior to backfilling.

2.2 LABORATORY TESTING

Upon completion of drilling, recovered soil samples were transported to the WSP geotechnical laboratory for more detailed visual examination and engineering classifications by the Project Team. Selected laboratory soil testing was completed and comprised of:

- Sixteen (16) Particle Size Distribution Analyses (ASTM D422 and LS602);
- One (1) Atterberg Limit Test (ASTM D4318); and
- Fifty-nine (59) natural Moisture Content analyses (ASTM D2216).

Unless requested in advance, the soil samples from the investigation will be stored in our laboratory facility for a period of six (6) months after the issuance of the final report.

2.3 ANALYTICAL LABORATORY TESTING

In addition to the physical laboratory analysis, analytical laboratory testing (chemical analysis) was performed on eight (8) selected representative samples (one per borehole). The samples were submitted to SGS Laboratories (in Lakefield, ON) for corrosivity analysis using AWWA criteria. A copy of the corrosivity laboratory results is provided in **Appendix C.**

3 SUBSURFACE CONDITIONS

The subsurface soil profile at the island sites generally consisted of surficial topsoil over native sandy gravel and cobbles. The subsurface soil profile at the coast guard site generally consisted of surficial asphalt, over fill, over native sandy gravel and cobbles. The subsurface soil profile at the remaining main land sites consisted of surficial topsoil over native silt and clay deposits. Site specific soil units encountered in the boreholes are described as follows.

3.1 SITE LL648

Borehole BH18-01 was advanced at the site LL648 navigational aid tower to a depth of 9.1 mBGS and the following subsurface conditions were encountered.

3.1.1 TOPSOIL

A surficial layer of topsoil was encountered with a thickness of approximately 75 mm. The topsoil was observed in a generally moist, loose state. The topsoil was observed as dark brown and had a sandy silt texture, with a high organic content, as such it is expected to be devoid of structural engineering properties.

3.1.2 FILL

A layer of fill was encountered immediately beneath the topsoil, and extended to a depth of approximately 0.3 mBGS. The fill material consisted predominantly of sand and gravel with trace amounts of silt. The material was generally moist, based on field observations and a laboratory moisture content of 9%. This soil was generally observed in a compact in-situ state.

3.1.3 SANDY GRAVEL

A layer of light brown sandy gravel with cobbles was encountered beneath the fill material and extended to a depth of approximately 4.4 mBGS. Based on field observations and laboratory moisture contents ranging from 5 to 11%, this material was generally moist to wet. The sandy gravel material was observed in a compact to dense in-situ state.

Two (2) laboratory particle size distribution analysis of the sandy gravel material was completed on sample SS4 and SS6 from borehole BH18-01. The test results are attached in **Appendix B** and summarized as follows based on USCS:

- Gravel (greater than 4.75 mm size) 63%
- Sand (0.075 mm to 4.75 mm size) 33%
- Silt and Clay (less than 0.075 mm size) 4%

3.1.4 CLAYEY SILT AND COBBLES

A layer of light brown clayey silt and cobbles was encountered at a depth ranging from approximately 4.4 to 4.6 mBGS. The material contained trace amounts of sand and was observed in a compact in-situ state. This material was generally wet based on field observations.

3.1.5 COBBLES

A layer of light brown cobbles with sand and gravel was encountered at a depth of 4.6 mBGS and extended to the termination of the borehole at 9.1 mBGS. Based on field observations and laboratory moisture contents ranging from 10 to 13%, this material was generally wet. The cobble material was observed in a loose to dense in-situ state.

3.1.6 GROUNDWATER

Borehole cave in was measured upon completion of drilling and was encountered at a depth of approximately 1.7 mBGS. Although there was no groundwater seepage in the borehole, it is expected that the stable groundwater level at this site shall approximately reflect the water level in the Detroit River. Groundwater levels may vary and are subject to seasonal fluctuations in response to climatic weather events.

3.2 SITE LL649

Borehole BH18-02 was advanced at the site LL649 navigational aid tower to a depth of 7.5 mBGS upon refusal on a presumed boulder and the following subsurface conditions were encountered.

3.2.1 TOPSOIL

A surficial layer of topsoil was encountered with a thickness of approximately 75 mm. The topsoil was observed in a generally moist, loose state. The topsoil was observed as dark brown and had a sandy silt texture, with a high organic content, as such it is expected to be devoid of structural engineering properties.

3.2.2 SANDY GRAVEL

A layer of light brown sandy gravel with cobbles was encountered immediately beneath the topsoil, and extended to a depth of approximately 2.1 mBGS. Based on field observations and laboratory moisture contents ranging from 6 to 12%, this material was generally moist. The sandy gravel material was observed in a compact in-situ state.

One (1) laboratory particle size distribution analysis of the sandy gravel material was completed on sample SS3 from borehole BH18-02. The test results are attached in **Appendix B** and summarized as follows based on USCS:

- Gravel (greater than 4.75 mm size) 40%
- Sand (0.075 mm to 4.75 mm size) 34%
- Silt and Clay (less than 0.075 mm size) 16%

3.2.3 COBBLES

A layer of light brown cobbles with sand and gravel was encountered at a depth of 2.1 mBGS and extended to the full depth of the borehole at 9.1 mBGS. The material contained trace amounts of silt. Based on field observations and laboratory moisture contents ranging from 9 to 13%, this material was generally moist to wet. The cobble material was observed in a compact to dense in-situ state.

One (1) laboratory particle size distribution analysis of the cobble material was completed on sample SS5 from borehole BH18-02. The test results are attached in **Appendix B** and summarized as follows based on USCS:

- Gravel (greater than 4.75 mm size) 68%
- Sand (0.075 mm to 4.75 mm size) 28%
- Silt and Clay (less than 0.075 mm size) 4%

3.2.4 GROUNDWATER

Borehole groundwater was measured upon completion of drilling and was encountered at a depth of approximately 0.5 mBGS and borehole cave in was encountered at approximately 1.8 mBGS. It is expected that the stable groundwater level at this site shall approximately reflect the water level in the Detroit River and that groundwater levels may vary and are subject to seasonal fluctuations in response to climatic weather events.

3.3 SITE LL656

Borehole BH18-08 was advanced at the site LL656 navigational aid tower to a depth of 6.1 mBGS upon termination on presumed bedrock and the following subsurface conditions were encountered.

3.3.1 ASPHALT

A surficial layer of asphalt was encountered with a thickness of approximately 100 mm.

3.3.2 FILL

A layer of fill was encountered immediately beneath the asphalt, and extended to a depth of approximately 0.7 mBGS. The light brown fill material consisted predominantly of sand and gravel with trace amounts of silt. The material was generally moist, based on field observations and a laboratory moisture content of 12%. This soil was generally observed in a compact in-situ state.

3.3.3 COBBLES

A layer of light brown cobbles with sand and gravel was encountered at a depth of 0.7 mBGS and extended to the termination of the borehole at 6.1 mBGS. The material contained trace amounts of silt and clay. Based on field observations and laboratory moisture contents ranging from 12 to 21%, the material was generally wet. The cobble material was observed in a loose to very dense in-situ state.

Two (2) laboratory particle size distribution analysis of the cobble material was completed on sample SS3 and SS5 from borehole BH18-08. The test results are attached in **Appendix B** and summarized as follows based on USCS:

- Gravel (greater than 4.75 mm size) 28 to 65%
- Sand (0.075 mm to 4.75 mm size) 21 to 37%
- Silt and Clay (less than 0.075 mm size) 14 to 35%

3.3.4 GROUNDWATER

Borehole groundwater was measured upon completion of drilling and was encountered at a depth of approximately 0.9 mBGS and borehole cave in was encountered at approximately 1.1 mBGS. It is expected that the stable groundwater level at this site shall approximately reflect the water level in the Detroit River and that groundwater levels may vary and are subject to seasonal fluctuations in response to climatic weather events.

3.4 SITE LL657

Borehole BH18-07 was advanced at the site LL657 navigational aid tower to a depth of 10.7 mBGS upon termination on presumed bedrock and the following subsurface conditions were encountered.

3.4.1 TOPSOIL

A surficial layer of topsoil was encountered with a thickness of approximately 200 mm. The topsoil was observed in a generally moist, loose state. The topsoil was observed as dark brown and had a sandy silt texture, with a high organic content, as such it is expected to be devoid of structural engineering properties.

3.4.2 FILL

A layer of fill was encountered immediately beneath the topsoil, and extended to a depth of approximately 2.3 mBGS. The fill material was dark brown and consisted predominantly of sandy silt. The material contained trace amounts of clay and organic material (including rootlets). The material was generally moist to wet, based on field observations and laboratory moisture contents ranging from 19 to 42%. This soil was generally observed in a loose to compact in-situ state.

3.4.3 CLAYEY SILT

A layer of grey to dark grey clayey silt was encountered at a depth ranging from approximately 2.3 to 3.2 mBGS. The material contained trace amounts of sand and gravel, and was observed in a soft in-situ state. The material was generally APL to WTPL (About Plastic Limit to Wetter Than Plastic Limit) based on field observations and a laboratory moisture content of 28%.

A second layer of clayey silt was encountered at a depth of 8.9 mBGS and extended to the full depth of the borehole at 10.7 mBGS. The material contained some sand and trace amounts of gravel and was observed in stiff in-situ state. The materially was generally APL based on field observations and laboratory moisture contents ranging from 13 to 19%. The material contained saturated crushed rock upon termination of the borehole.

One (1) laboratory particle size distribution analysis of the clayey silt material was completed on sample SS3 from borehole BH18-07. The test results are attached in **Appendix B** and summarized as follows based on USCS:

- Gravel (greater than 4.75 mm size) 7%
- Sand (0.075 mm to 4.75 mm size) 24%
- Silt and Clay (less than 0.075 mm size) 69%

3.4.4 SANDY SILT TILL

A layer of brown to grey sandy silt till was encountered at a depth of 3.2 mBGS and extended to a depth of 8.9 mBGS. The material contained some clay to clayey and trace amounts of gravel. Based on field observations and laboratory moisture contents ranging from 11 to 13%, the material was generally moist. The sandy silt till material was observed in a dense to compact in-situ state.

One (1) laboratory particle size distribution analysis of the sandy silt till material was completed on sample SS5 from borehole BH18-07. The test results are attached in **Appendix B** and summarized as follows based on USCS:

- Gravel (greater than 4.75 mm size) 3%
- Sand (0.075 mm to 4.75 mm size) 23%
- Silt and Clay (less than 0.075 mm size) 82%

3.4.5 GROUNDWATER

Groundwater was measured upon completion of drilling in the open borehole and was encountered at a depth of approximately 3.0 mBGS. It is expected that the stable groundwater level at this site shall approximately reflect the water level in the Detroit River and that groundwater levels may vary and are subject to seasonal fluctuations in response to climatic weather events.

3.5 SITE LL663

Borehole BH18-03 was advanced at the site LL663 navigational aid tower to a depth of 6.1 mBGS and the following subsurface conditions were encountered.

3.5.1 TOPSOIL

A surficial layer of topsoil was encountered with a thickness of approximately 150 mm. The topsoil was observed in a generally moist, loose state. The topsoil was observed as dark brown and had a sandy silt texture, with a high organic content, as such it is expected to be devoid of structural engineering properties.

3.5.2 SANDY GRAVEL

A layer of light brown sandy gravel with cobbles was encountered directly beneath the topsoil and extended to the full depth of the borehole at approximately 6.1 mBGS. Based on field observations and laboratory moisture contents ranging from 11 to 20%, this material was generally moist to wet. The sandy gravel material was observed in a compact in-situ state.

Two (2) laboratory particle size distribution analysis of the sandy gravel material was completed on sample SS4 and SS5 from borehole BH18-03. The test results are attached in **Appendix B** and summarized as follows based on USCS:

- Gravel (greater than 4.75 mm size) 65 to 70%
- Sand (0.075 mm to 4.75 mm size) 24 to 29%
- Silt and Clay (less than 0.075 mm size) 6%

3.5.3 GROUNDWATER

Borehole groundwater was measured upon completion of drilling and was encountered at a depth of approximately 1.8 mBGS and borehole cave in was encountered at approximately 3.4 mBGS. It is expected that the stable groundwater level at this site shall approximately reflect the water level in the Detroit River and that groundwater levels may vary and are subject to seasonal fluctuations in response to climatic weather events.

3.6 SITE LL664

Borehole BH18-04 was advanced at the site LL664 navigational aid tower to a depth of 6.1 mBGS and the following subsurface conditions were encountered.

3.6.1 TOPSOIL

A surficial layer of topsoil was encountered with a thickness of approximately 175 mm. The topsoil was observed in a generally moist, loose state. The topsoil was observed as dark brown and had a sandy silt texture, with a high organic content, as such it is expected to be devoid of structural engineering properties.

3.6.2 SANDY GRAVEL

A layer of light brown sandy gravel with cobbles was encountered directly beneath the topsoil and extended to the full depth of the borehole at approximately 6.1 mBGS. Based on field observations and laboratory moisture contents ranging from 5 to 16%, this material was generally moist to wet. The sandy gravel material was observed in a loose to compact in-situ state.

Two (2) laboratory particle size distribution analysis of the sandy gravel material was completed on sample SS4 and SS5 from borehole BH18-04. The test results are attached in **Appendix B** and summarized as follows based on USCS:

- Gravel (greater than 4.75 mm size) 62 to 72%
- Sand (0.075 mm to 4.75 mm size) 27 to 35%
- Silt and Clay (less than 0.075 mm size) 1 to 3%

3.6.3 GROUNDWATER

Borehole groundwater was measured upon completion of drilling and was encountered at a depth of approximately 2.1 mBGS and borehole cave in was encountered at approximately 4.0 mBGS. It is expected that the stable groundwater level at this site shall approximately reflect the water level in the Detroit River and that groundwater levels may vary and are subject to seasonal fluctuations in response to climatic weather events.

3.7 SITE LL667

Borehole BH18-06 was advanced at the site LL667 navigational aid tower to a depth of 15.4 mBGS and the following subsurface conditions were encountered.

3.7.1 TOPSOIL

A surficial layer of topsoil was encountered with a thickness of approximately 75 mm. The topsoil was observed in a generally moist, loose state. The topsoil was observed as dark brown and had a sandy silt texture, with a high organic content, as such it is expected to be devoid of structural engineering properties.

3.7.2 SILTY CLAY

Directly beneath the topsoil a layer of silty clay was encountered and extended to a depth of approximately 1.7 mBGS. The material contained some sand and the material was generally Drier Than the Plastic Limit (DTPL), based on field observations and a laboratory moisture content of 24%. This soil was generally observed in a soft in-situ state.

One (1) laboratory particle size distribution analysis of the silty clay material was completed on sample AS1 from borehole BH18-06. The test results are attached in **Appendix B** and summarized as follows based on USCS:

- Gravel (greater than 4.75 mm size) 0%
- Sand (0.075 mm to 4.75 mm size) 14%
- Silt and Clay (less than 0.075 mm size) 86%

3.7.3 CLAYEY SILT

A layer of light brown, changing to grey with depth, clayey silt was encountered at a depth of approximately 1.7 mBGS extended to a depth of approximately 6.1 mBGS. The material contained some sand to sandy and trace amounts of gravel. Based on field observations and laboratory moisture contents ranging from 12 to 16%, this material was generally DTPL to APL. The clayey silt material was observed in a very stiff to hard in-situ state.

One (1) laboratory particle size distribution analysis of the clayey silt material was completed on sample AS3 from borehole BH18-06. The test results are attached in **Appendix B** and summarized as follows based on USCS:

- Gravel (greater than 4.75 mm size) 1%
- Sand (0.075 mm to 4.75 mm size) 24%
- Silt and Clay (less than 0.075 mm size) 75%

3.7.4 SILTY CLAY TILL

A layer of grey silty clay till was encountered at a depth ranging from approximately 6.1 mBGS to the full depth of the borehole at approximately 15.4 mBGS. The material contained varying amounts of sand and trace gravel. The material was observed in a very stiff to stiff in-situ state. The material was generally APL based on field observations.

3.7.5 GROUNDWATER

Groundwater was measured upon completion of drilling in the open borehole and was encountered at a depth of approximately 6.1 mBGS. It is expected that the stable groundwater level at this site shall approximately reflect the water level in the Detroit River and that groundwater levels may vary and are subject to seasonal fluctuations in response to climatic weather events.

3.8 SITE LL668

Borehole BH18-05 was advanced at the site LL668 navigational aid tower to a depth of 9.1 mBGS and the following subsurface conditions were encountered.

3.8.1 TOPSOIL

A surficial layer of topsoil was encountered with a thickness of approximately 150 mm. The topsoil was observed in a generally moist, loose state. The topsoil was observed as dark brown and had a sandy silt texture, with a high organic content, as such it is expected to be devoid of structural engineering properties.

3.8.2 FILL

Directly beneath the topsoil a layer of fill was encountered and extended to a depth of approximately 0.8 mBGS. The fill material was generally light to dark brown and consisted predominantly of sandy silt with trace amounts of organic material. The material was generally moist, based on field observations and a laboratory moisture content of 20%. This soil was generally observed in a loose in-situ state.

3.8.3 SILTY CLAY

A layer of brown, with some grey mottling, silty clay was encountered beneath the fill material and extended to a depth at approximately 3.0 mBGS. The silty clay material contained some sand and occasional gravel with some orange mottling throughout. Based on field observations and laboratory moisture contents ranging from 10 to 20%, this material was generally APL to WTPL. The sandy gravel material was observed in a stiff to hard in-situ state.

One (1) laboratory particle size distribution analysis of the silty clay material was completed on sample SS2 from borehole BH18-05. The test results are attached in **Appendix B** and summarized as follows based on USCS:

- Gravel (greater than 4.75 mm size) 1%
- Sand (0.075 mm to 4.75 mm size) 24%
- Silt and Clay (less than 0.075 mm size) 75%

An Atterberg test was also complete on this sample. The test results are attached in **Appendix B** and summarized as follows:

- Liquid Limit 40%
- Plastic Limit 22%
- Plasticity Index 18%

3.8.4 CLAYEY SILT

A layer of brown, changing to grey with depth, sandy silt was encountered at a depth of approximately 3.0 mBGS and extended to the full depth of the borehole at approximately 9.1 mBGS. The clayey silt material contained some sand and occasional gravel with some orange mottling throughout. Based on field observations and laboratory moisture contents ranging from 10 to 20%, this material was generally APL to WTPL. The clayey silt material was observed in a very stiff to hard in-situ state.

One (1) laboratory particle size distribution analysis of the clayey silt material was completed on sample SS5 from borehole BH18-05. The test results are attached in **Appendix B** and summarized as follows based on USCS:

- Gravel (greater than 4.75 mm size) 2%
- Sand (0.075 mm to 4.75 mm size) 16%
- Silt and Clay (less than 0.075 mm size) 82%

3.8.5 GROUNDWATER

Borehole groundwater was measured upon completion of drilling and was encountered at a depth of approximately 1.8 mBGS and borehole cave in was encountered at approximately 2.6 mBGS. It is expected that the stable groundwater level at this site shall approximately reflect the water level in the Detroit River and that groundwater levels may vary and are subject to seasonal fluctuations in response to climatic weather events.

3.9 PRACTICAL REFUSAL

Practical refusal to further borehole advancement was encountered in boreholes BH18-06, BH18-07 and BH18-08 at depths of 15.4, 10.7, and 6.1 mBGS, respectively. The depth at which practical refusal was encountered was interpreted by WSP as being the depth of competent bedrock for the purpose of logging the boreholes. The bedrock in the vicinity general consists of limestone bedrock. Limestone bedrock typically exhibits a certain degree of weathering and fracturing in its upper zone, which can be partially penetrated through the advancement boreholes with drilling equipment. Borehole BH18-02 was terminated at 7.5 mBGS upon practical refusal on a presumed boulder.

3.10 SOIL CORROSIVITY

One (1) selected, representative soil sample from each borehole was submitted to a CALA- certified Laboratory for corrosivity analysis and the results are included as **Appendix C**. The samples were analysed for chloride, sulphate, and sulphide concentrations, pH, electrical conductivity/resistivity, and redox potential. Laboratory data was compared to the ANSI/AWWA corrosivity rating system (Attached in **Appendix C**) to determine the corrosive nature of the tested materials. A sample greater than 10 points is considered to represent a corrosive environment with respect to grey or cast iron alloys.

A summary of corrosivity analyses as per the ANSI/AWWA rating system is provided in Tables 3-1, 3-2 and 3-3 (next page).

Table 3-1: ANSI/AWWA Corrosivity Analysis (Boreholes BH18-01 to BH18-03)

PARAMETER	TEST RESULTS (BH18-01 SS4)	ANSI/AWWA POINT RATING	TEST RESULTS (BH18-02 SS4)	ANSI/AWWA POINT RATING	TEST RESULTS (BH18-03 SS3)	ANSI/AWWA POINT RATING
Resistivity (Ω-cm)	2940	0	2380	0	4910	0
pH	8.53	3	8.69	3	8.55	3
Redox Potential (mV)	232	0	229	0	370	0
Sulphide (%)	<0.02	0	0.03	2	0.02	2
Drainage	Fair	1	Fair	1	Fair	1
Total Points	-	4		6		6

Table 3-2: ANSI/AWWA Corrosivity Analysis (Boreholes BH18-04 to BH18-06)

PARAMETER	TEST RESULTS (BH18-04 SS4)	ANSI/AWWA POINT RATING	TEST RESULTS (BH18-05 SS5)	ANSI/AWWA POINT RATING	TEST RESULTS (BH18-06 AS2)	ANSI/AWWA POINT RATING
Resistivity (Ω-cm)	2710	0	3550	0	5420	0
pH	8.40	0	8.81	3	8.34	0
Redox Potential (mV)	240	0	232	0	257	0
Sulphide (%)	<0.02	0	0.02	2	<0.02	0
Drainage	Fair	1	Fair	1	Fair	1
Total Points		1	-	6		1

Table 3-3: ANSI/AWWA Corrosivity Analysis (Boreholes BH18-07 and BH18-08)

PARAMETER	TEST RESULTS (BH18-07 SS4)	ANSI/AWWA POINT RATING	TEST RESULTS (BH18-08) SS4	ANSI/AWWA POINT RATING
Resistivity (Ω-cm)	4130	0	7650	0
pH	8.40	0	8.66	3
Redox Potential (mV)	261	0	238	0
Sulphide (%)	<0.02	0	0.04	2
Drainage	Fair	1	Fair	1
Total Points		1		6

Based on the test results, corrosion conditions at the site do not appear to be significant. It is noted that there may be overriding factors in assessments of corrosion potential, such as the application and leaching of de-icing salts, and stray electrical currents. WSP recommends sacrificial anodes for protection of metallic fittings provided in the final design, to accommodate the anticipated corrosion of the material over the design life of the site.

Laboratory test results for water-soluble sulphate concentration ranged between 16 to 150 ug/g. Results were compared to Table 3 of CSA A23.1-09 to determine the risk of sulphate attack on cementitious materials. The recommended exposure class at the site is F-1, and type GU cement should be used.

4 RECOMMENDATIONS

4.1 GENERAL

The following recommendations for design and construction of the replacement of the existing navigation aid towers are based on the borehole information provided in Section 3. It is understood that the proposed towers will be designed and built as self-supporting towers (no guy wire system). The anticipated tower loading was also unknown at the time of reporting, however it is expected that the replacement navigational aid towers loadings shall be similar to those of the existing navigation aid towers. While we believe our findings are fairly representative, conditions may vary between and beyond the investigated locations. If significant differences in the subsurface conditions described above are found at a later time, WSP should be contacted immediately to revise our findings and recommendations, as necessary.

Recommendations are intended for Designers and are not intended as instructions to Contractors, who should perform their own investigations to confirm any conditions that may affect them. Recommendations in this report must not be used by third parties without the express written consent of WSP.

4.2 EXCAVATIONS

As a federal project, temporary excavations for the construction of underground structures and services must be carried out in accordance with the most recent version of the Canadian Occupational Health and Safety Regulation (SOR/86-304), whereas any excavations greater than 1.4 m, shall be sloped at a slope of 1:1 (Horizontal: Vertical) or flatter, without the use of appropriate reinforcement or shoring.

However, based on the soil conditions, it is recommended that excavations should be carried out in accordance with the most recent version (O. Reg. 123/08) of the Occupational Health and Safety Act (OHSA). For three (3) of the main land tower locations (sites LL756, LL667, and LL668) the soil consisted of silt, sand, and clay soils, while the remaining site soils generally consisted of consisted of cobbles with sand and gravel. Based on OHSA criteria, the site soils above the groundwater table may be considered a Type 3 soil, while site soils below the groundwater table should be considered a Type 4 soil.

Excavation sidewalls in a Type 3 soil should be sloped at a maximum of 1H:1V to the base of the excavation, while excavation sidewalls in a Type 4 soil should be sloped at a maximum of 3H:1V to the base of the excavation. Excavations should be protected from exposure to precipitation and associated ground surface runoff, and should be inspected regularly for signs of instability.

Excavations should be protected from exposure to precipitation and associated ground surface runoff, and should be inspected regularly for signs of instability. If localized instability is noted during excavation, or if wet conditions are encountered, side slopes should be flattened as required to maintain safe working conditions. If excavation side slopes cannot be achieved due to site confinement, shoring should be designed by a professional engineer licensed to practice in Ontario and installed. It is expected that any localized that is required could be completed with sheet piling.

4.3 DEWATERING

As noted above, groundwater seepage and/or borehole cave-in was encountered in all of the boreholes during the drilling operations. Any excavation below the river level shall encounter seepage. Saturated soils were observed through the investigation.

Advance dewatering systems may be required when excavations extend below the groundwater table. All dewatering shall be completed according to OPSS 518 and shall be completed using submersible pumps and sumps, well points or diversions as required.

Construction excavation dimensions (length, width and depths) as well as dewatering methods and techniques can greatly affect the volume of dewatering that will be required for excavation operations. If dewatering activities are to exceed 50,000 L/day the project would either need to be registered under the Environmental Sector and Registry (ESAR) program by the MOECP (for up to 400,000 L/day) or require a permit to take water (PTTW) (greater than 400,000 L/day). Both an EASR or a PTTW application should be done well in advance of construction, by a Qualified Person (QP), and consider the pumping rates, drawdown, water quality for discharge, ground effects, and monitoring requirements.

Further, due to the proximity of some of the Site to the Detroit River, cut-off walls may be required to minimize the inflow of groundwater into open excavations. Several cut-off methodologies exist including, but not limited to, sheet piling walls, slurry trench walls, caisson walls, mix-in-place barriers and artificial ground freezing.

It is strongly recommended that selected contractor(s), evaluate the groundwater conditions at each individual Site, and retain the services of a dewatering specialist to prepare a dewatering plan for each Site.

4.4 TOWER FOUNDATION

Provided that the tower loads are properly distributed it should be possible to support the proposed tower on a shallow footing foundation found on compact or firm native soils. Topsoil, frozen soil or otherwise deleterious material must be removed from below the foundation. Also, disturbance of the subsoil must be kept to a minimum; if deemed necessary by the Geotechnical Engineer, recompaction of disturbed material and or localized ground improvement may be required to provide a stable working surface.

For design purposes, **Table 4-1** (next page) demonstrates the recommended geotechnical resistance at factored Ultimate Limit States (ULS) and geotechnical reaction at Serviceability Limit States (SLS) bearing on the existing compact subsurface materials discussed in **Section 3**.

Table 4-1: Site Specific Bearing Capacities

SITE	SLS	ULS (FACTORED)
LL648	150 kPa	250 kPa
LL649	150 kPa	250 kPa
LL656	150 kPa	250 kPa
LL657 (< 3.2 mBGS) (See Note 1)	75 kPa	125 kPa
Engineered Fill (See Note 2)	150 kPa	250 kPa
LL663	150 kPa	225 kPa
LL664	150 kPa	250 kPa
LL667 (< 1.5 mBGS) (See Note 1)	75 kPa	125 kPa
(> 1.5 mBGS) (See Note 3)	150 kPa	250 kPa
LL668	150 kPa	225 kPa

Note 1: Generally, suitable compact native soils were encountered at the recommended frost protection depth. Special considerations need to be made for Navigational Aid Sites LL657 and LL667. At these Sites, looser, finer grained soils were encountered within the targeted bearing zone. Reduced bearing capacities have been provided in **Table 4-1** for the upper soil layers.

Note 2: For Navigational Site LL657, it is strongly recommended that the sandy silt and clayey silt layers be sub-excavated and replaced with engineered fill consisting of OPSS 1010 Granular B, compacted to 100% of standard Proctor density (ASTM D698). It is expected that subexcavation down to a depth of approximately 3.2 mBGS would be required.

Note 3: For Navigational Site LL667, it is strongly recommended that foundation be deepened to be founded at a depth of at least 1.5 mBGS on the very stiff to hard clayey silt.

Following preparation of the subgrade, it is recommended that an engineered bedding layer consisting of 300 mm (12 in.) of OPSS 1010 Granular A, compacted to 100% of standard Proctor density (ASTM D698), be placed to support the proposed footing. Alternately, a mud mat of lean concrete placed immediately after excavation may be necessary to preserve the integrity of the otherwise sensitive sand material at the foundation level.

As per CSA S37, a resistance factor, $\Phi = 0.75$ should be used in the design of self-supporting towers.

Foundation backfill should consist of an approved granular material, such as OPSS 1010 Granular B Type 1 or equivalent, placed in 300 mm maximum loose lifts and compacted to 98% of standard Proctor maximum dry density (SPMDD) as per ASTM D698 procedures.

The geotechnical reaction at SLS is based on a total allowable settlement of 25 mm and maximum differential settlement of 15 mm.

4.5 SEISMIC SITE CLASS

For the purposes of earthquake design, the information relevant to the geotechnical conditions is attributed by the "Site Class". Based on the explored soil properties and in accordance with Table 4.1.8.4.A of the National Building Code (2015), it is recommended that the Site Class 'D' (i.e. stiff soils) be used for design. Multichannel Analysis of Surface Waves (MASW) testing is required to justify higher classifications, and is beyond the scope of the current program.

4.6 FROST PENETRATION DEPTH

Based on Canadian Foundation Engineering Manual (CFEM 2016) and OPS Drawing 3090.101, the frost penetration depth for the Site is 1.0 mBGL. Therefore, foundation elements should be provided with at least 1.2 m of earth cover for frost protection, or an equivalent thickness of insulation installed according to manufacturer's specifications.

4.7 INSPECTIONS, MATERIAL TESTING AND LIMITATIONS OF THE REPORT

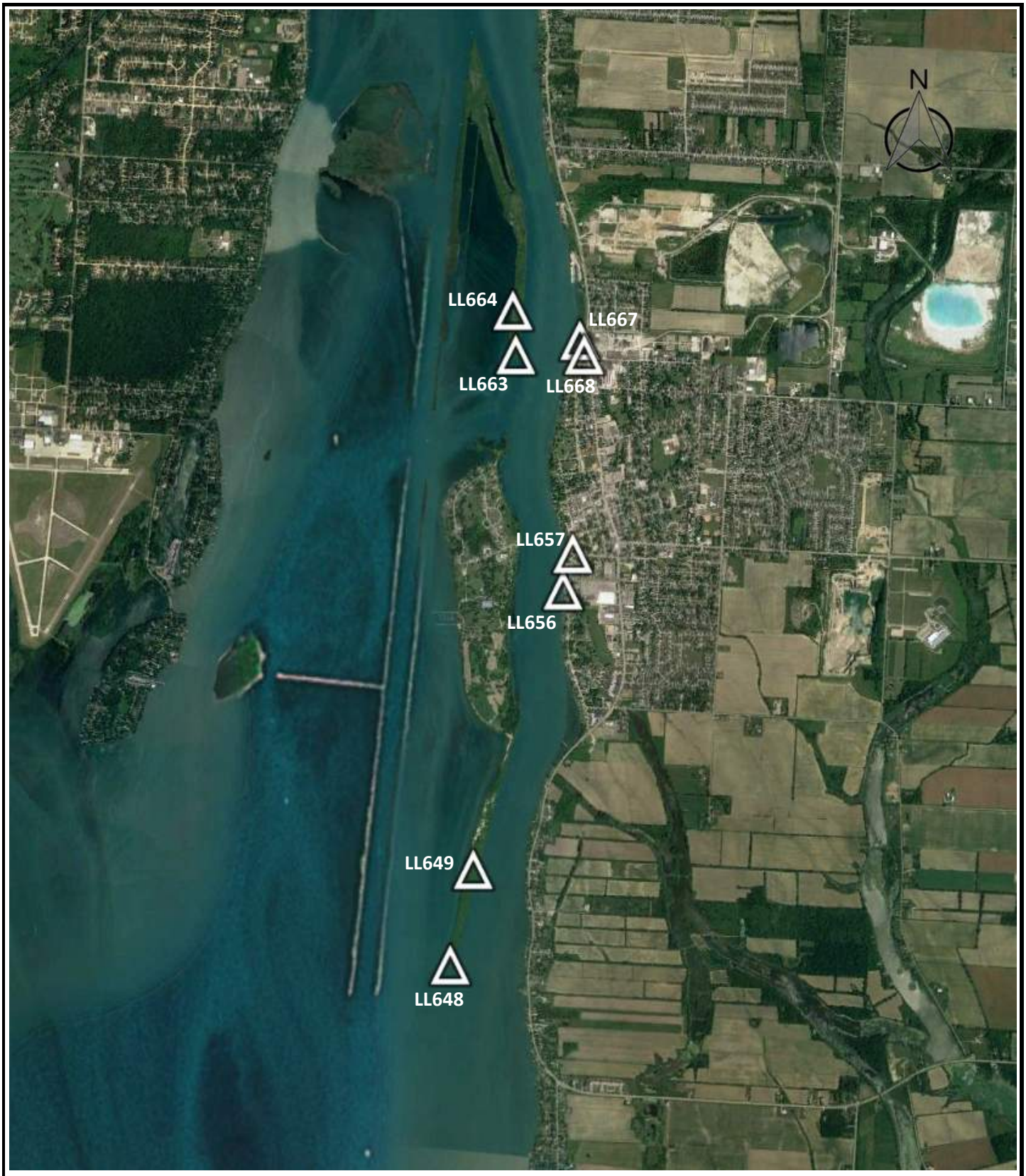
The data, conclusions and recommendations which are presented in this geotechnical report, and the quality thereof, are based on the scope of work authorized by Fisheries and Oceans Canada. While we believe the information to be representative of site conditions, subsurface conditions between and beyond the test locations may vary. If significant differences in the subsurface conditions described above are found, WSP should be contacted immediately to revise our findings and recommendations, if necessary.

The design recommendations provided in this report are intended for Designers and should not be construed as providing instructions to Contractors, who should form their own opinions about site conditions for tendering, construction procedures and general planning. WSP accepts no liability for use of or reliance on the report information by third parties, without express written consent. WSP should be contacted to review and comment on the overall design to confirm that the geotechnical requirements stated in this report are addressed. If WSP is not given the opportunity to review the design prior to commencing of work of the above recommendations we cannot be held liable for any misinterpretation of the recommendations.

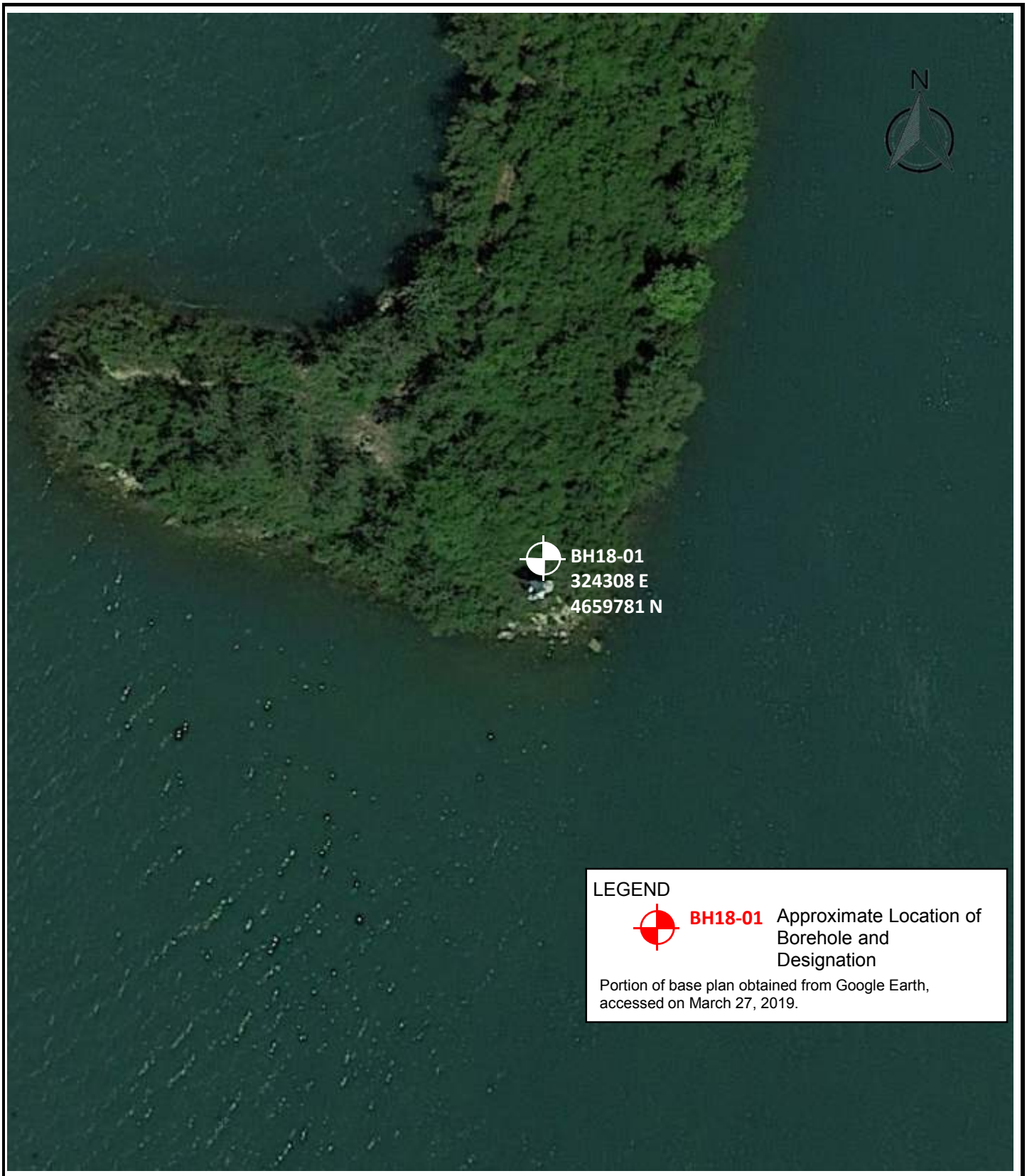
During construction, qualified personnel working under the direct supervision of the Geotechnical Engineer should be contacted to complete inspections of the subgrade, and granular fill compaction. Geotechnical inspections are critical during construction operations for quality control and assurance (QA/QC). Inspection and testing services should include verification of subgrade soil conditions below placed granular fills, monitoring of the placement of structural fill, and general testing of geotechnical materials including compaction testing of fill and concrete testing.

We trust that this report satisfies your requirements. Please contact WSP if you have any questions.

FIGURES

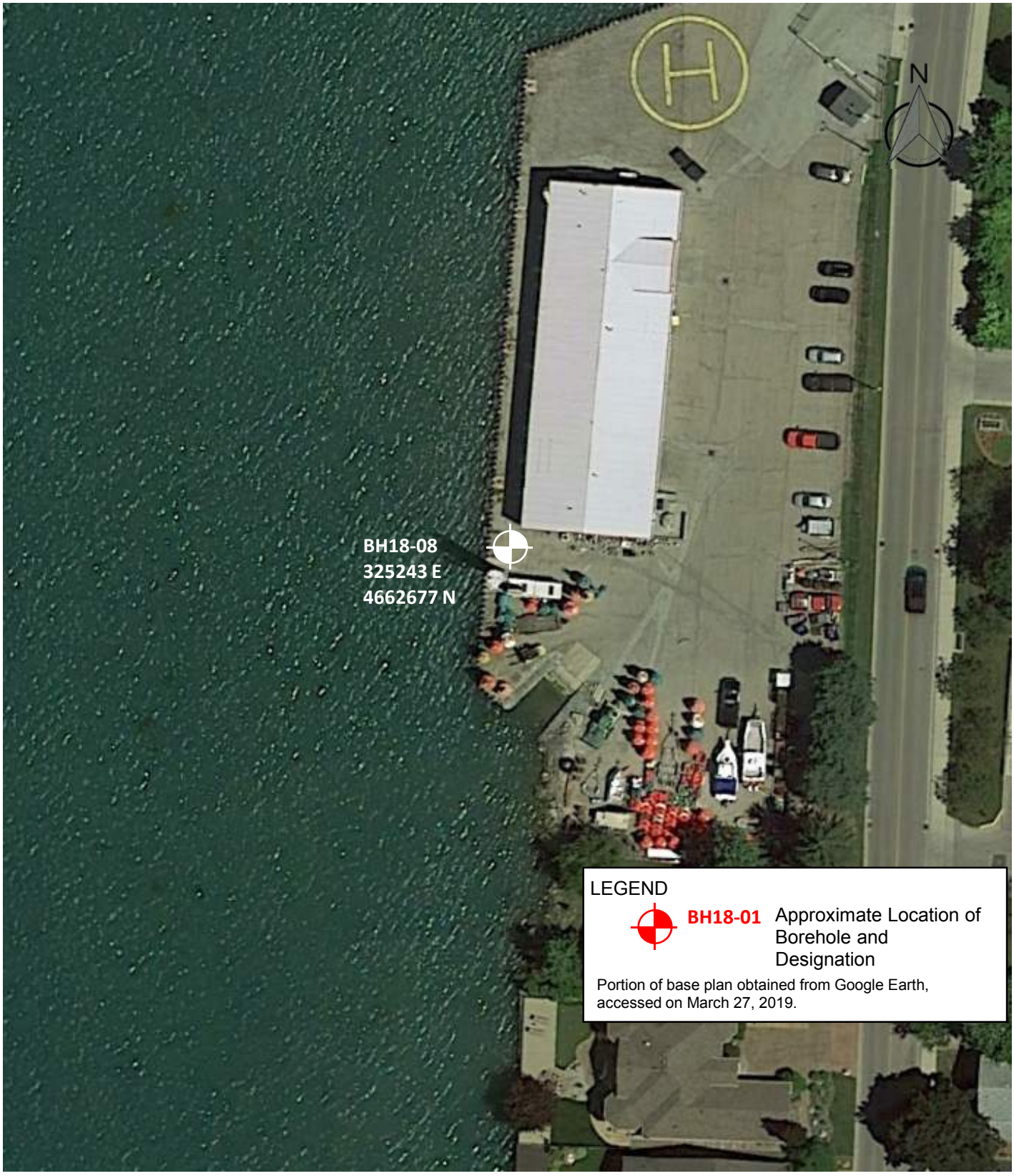


REF. NO.: 181-14155-00 F1	**SITE LOCATIONS PLAN**
DATE: MARCH, 2019	
PROJECT: 181-14155-00	GEOTECHNICAL INVESTIGATION AMHERSTBURG NAVIGATIONAL AIDS AMHERSTBURG, ON FOR: PWGSC
wsp	**FIGURE** **1**



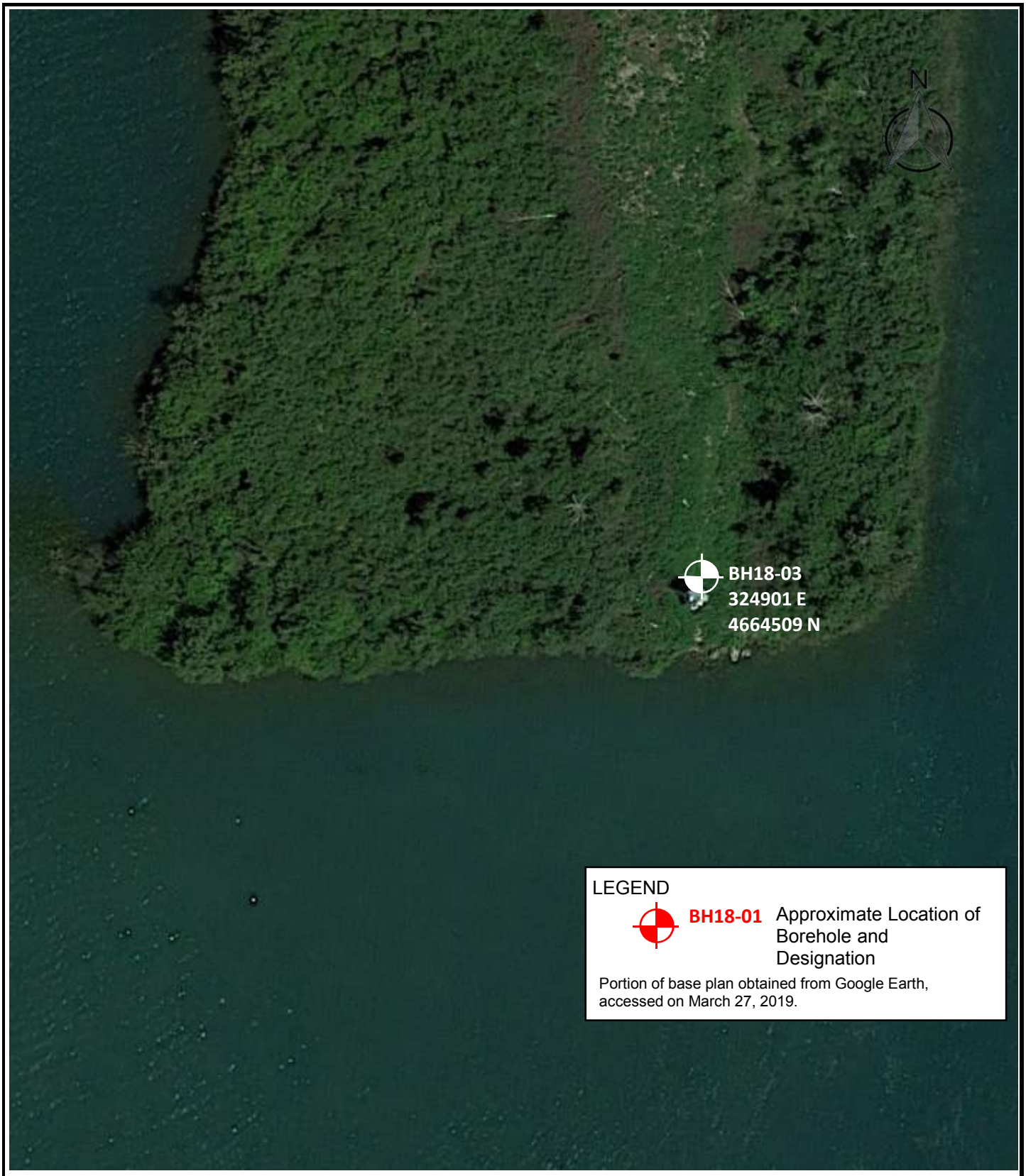
REF. NO.: 181-14155-00 F2	**LL648 - BOREHOLE LOCATION PLAN**
DATE: MARCH, 2019	
PROJECT: 181-14155-00	GEOTECHNICAL INVESTIGATION AMHERSTBURG NAVIGATIONAL AIDS AMHERSTBURG, ON FOR: PWGSC
wsp	**FIGURE** **2**

REF. NO.: 181-14155-00 F3	**LL649 - BOREHOLE LOCATION PLAN**
DATE: MARCH, 2019	
PROJECT: 181-14155-00	GEOTECHNICAL INVESTIGATION AMHERSTBURG NAVIGATIONAL AIDS AMHERSTBURG, ON FOR: PWGSC
wsp	**FIGURE** **3**

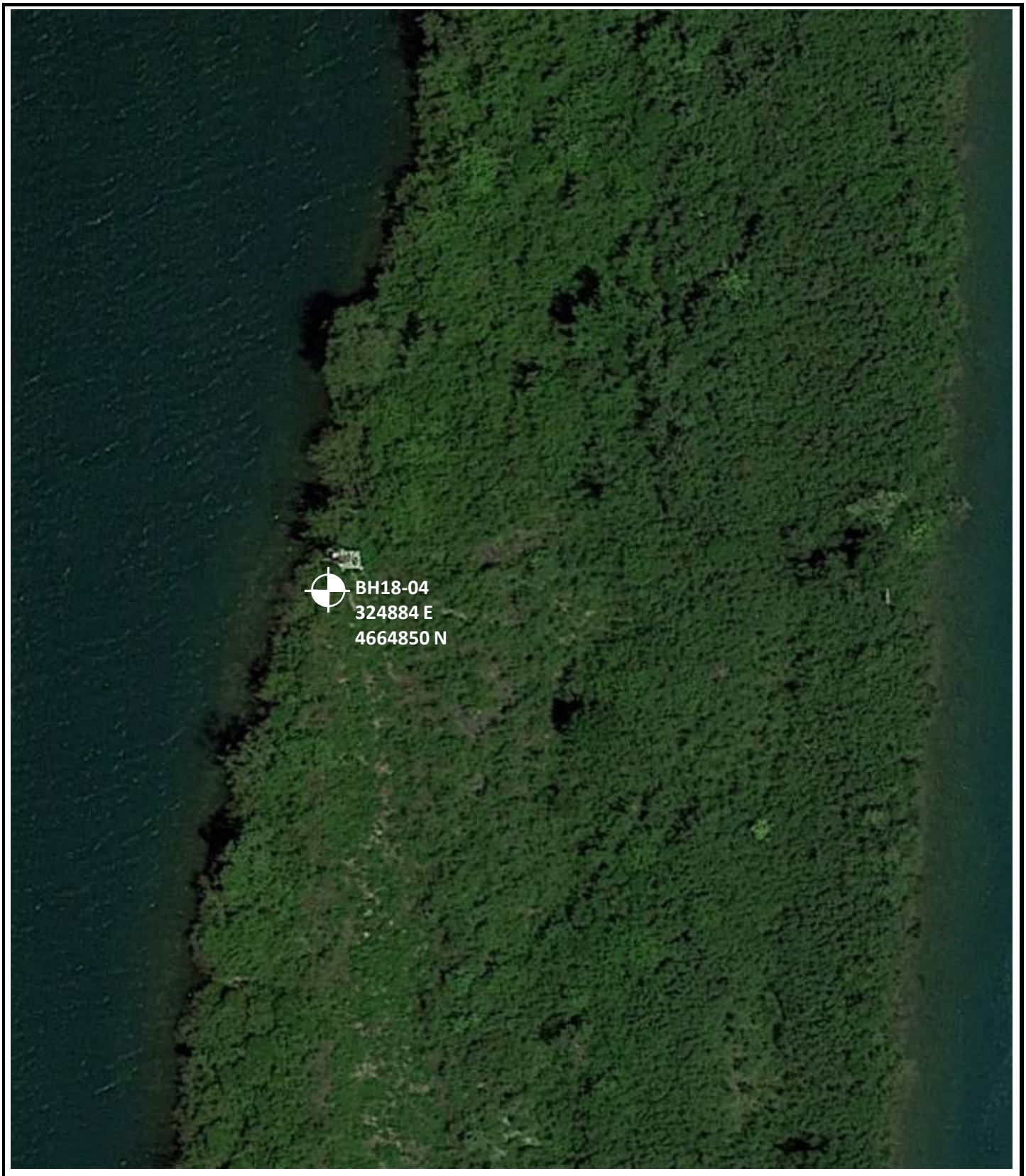


REF. NO.: 181-14155-00 F4	**LL656 - BOREHOLE LOCATION PLAN**
DATE: MARCH, 2019	
PROJECT: 181-14155-00	GEOTECHNICAL INVESTIGATION AMHERSTBURG NAVIGATIONAL AIDS AMHERSTBURG, ON FOR: PWGSC
wsp	**FIGURE** **4**

REF. NO.: 181-14155-00 F5	**LL657 - BOREHOLE LOCATION PLAN**
DATE: MARCH, 2019	
PROJECT: 181-14155-00	GEOTECHNICAL INVESTIGATION AMHERSTBURG NAVIGATIONAL AIDS AMHERSTBURG, ON FOR: PWGSC
wsp	**FIGURE** **5**



REF. NO.: 181-14155-00 F6	**LL663 - BOREHOLE LOCATION PLAN**
DATE: MARCH, 2019	
PROJECT: 181-14155-00	GEOTECHNICAL INVESTIGATION AMHERSTBURG NAVIGATIONAL AIDS AMHERSTBURG, ON FOR: PWGSC
wsp	**FIGURE** **6**



REF. NO.: 181-14155-00 F7	**LL664 - BOREHOLE LOCATION PLAN**
DATE: MARCH, 2019	
PROJECT: 181-14155-00	GEOTECHNICAL INVESTIGATION AMHERSTBURG NAVIGATIONAL AIDS AMHERSTBURG, ON FOR: PWGSC
wsp	**FIGURE** **7**

REF. NO.: 181-14155-00 F8	**LL667 - BOREHOLE LOCATION PLAN**
DATE: MARCH, 2019	
PROJECT: 181-14155-00	GEOTECHNICAL INVESTIGATION AMHERSTBURG NAVIGATIONAL AIDS AMHERSTBURG, ON FOR: PWGSC
wsp	**FIGURE** **8**

REF. NO.: 181-14155-00 F9	**LL668 - BOREHOLE LOCATION PLAN**
DATE: MARCH, 2019	
PROJECT: 181-14155-00	GEOTECHNICAL INVESTIGATION AMHERSTBURG NAVIGATIONAL AIDS AMHERSTBURG, ON FOR: PWGSC
wsp	**FIGURE** **9**

APPENDIX

A BOREHOLE LOGS

BOREHOLE LOG EXPLANATION FORM

This explanatory section provides the background to assist in the use of the borehole logs. Each of the headings used on the borehole log, is briefly explained.

DEPTH

This column gives the depth of interpreted geologic contacts in metres below ground surface.

STRATIGRAPHIC DESCRIPTION

This column gives a description of the soil based on a tactile examination of the samples and/or laboratory test results. Each stratum is described according to the following classification and terminology.

Soil Classification*		Terminology	Proportion
Silt & Clay	< 0.075 mm	"trace" (e.g. trace sand)	<10%
Sand	0.075 to 4.75 mm	"some" (e.g. some sand)	10% - 20%
Gravel	4.75 to 75 mm	adjective (e.g. sandy)	20% - 35%
Cobbles	75 to 300 mm	"and" (e.g. and sand)	35% - 50%
Boulders	>300 mm	noun (e.g. sand)	>50%

* Extension of USCS Classification system unless otherwise noted.

The use of the geologic term "till" implies that both disseminated coarser grained (sand, gravel, cobbles or boulders) particles and finer grained (silt and clay) particles may occur within the described matrix.

The compactness of cohesionless soils and the consistency of cohesive soils are defined by the following:

COHESIONLESS SOIL		COHESIVE SOIL	
Compactness	Standard Penetration Resistance "N", Blows / 0.3 m	Consistency	Standard Penetration Resistance "N", Blows / 0.3 m
Very Loose	0 to 4	Very Soft	0 to 2
Loose	4 to 10	Soft	2 to 4
Compact	10 to 30	Firm	4 to 8
Dense	30 to 50	Stiff	8 to 15
Very Dense	Over 50	Very Stiff	15 to 30
		Hard	Over 30

The moisture conditions of cohesionless and cohesive soils are defined as follows.

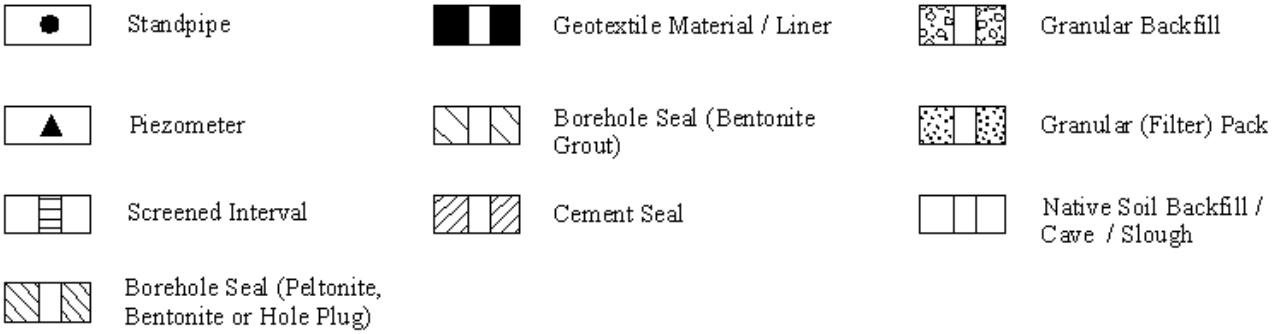
COHESIONLESS SOILS	COHESIVE SOILS		
Dry	DTPL	-	Drier Than Plastic Limit
Moist	APL	-	About Plastic Limit
Wet	WTPL	-	Wetter Than Plastic Limit
Saturated	MWTPL	-	Much Wetter Than Plastic Limit

STRATIGRAPHY

Symbols may be used to pictorially identify the interpreted stratigraphy of the soil and rock strata.

MONITOR DETAILS

This column shows the position and designation of standpipe and/or piezometer ground water monitors installed in the borehole. Also the water level may be shown for the date indicated.



Where monitors are placed in separate boreholes, these are shown individually in the "Monitor Details" column. Otherwise, monitors are in the same borehole. For further data regarding seals, screens, etc., the reader is referred to the summary of monitor details table.

SAMPLE

These columns describe the sample type and number, the "N" value, the water content, the percentage recovery, and Rock Quality Designation (RQD), of each sample obtained from the borehole where applicable. The information is recorded at the approximate depth at which the sample was obtained. The legend for sample type is explained below.

SS	=	Split Spoon	GS	=	Grab Sample
ST	=	Thin Walled Shelby Tube	CS	=	Channel Sample
AS	=	Auger Flight Sample	WS	=	Wash Sample
CC	=	Continuous Core	RC	=	Rock Core

$$\% \text{ Recovery} = \frac{\text{Length of Core Recovered Per Run}}{\text{Total Length of Run}} \times 100$$

Where rock drilling was carried out, the term RQD (Rock Quality Designation) is used. The RQD is an indirect measure of the number of fractures and soundness of the rock mass. It is obtained from the rock cores by summing the length of core recovered, counting only those pieces of sound core that are 100 mm or more in length. The RQD value is expressed as a percentage and is the ratio of the summed core lengths to the total length of core run. The classification based on the RQD value is given below.

RQD Classification	RQD (%)
Very poor quality	< 25
Poor quality	25 - 50
Fair quality	50 - 75
Good quality	75 - 90
Excellent quality	90 - 100

TEST DATA

The central section of the log provides graphs which are used to plot selected field and laboratory test results at the depth at which they were carried out. The plotting scales are shown at the head of the column.

Dynamic Penetration Resistance - The number of blows required to advance a 51 mm diameter, 60º steel cone fitted to the end of 45 mm OD drill rods, 0.3 m into the subsoil. The cone is driven with a 63.5 kg hammer over a fall of 750 mm.

Standard Penetration Resistance - Standard Penetration Test (SPT) "N" Value - The number of blows required to advance a 51 mm diameter standard split-spoon sampler 300 mm into the subsoil, driven by means of a 63.5 kg hammer falling freely a distance of 750 mm. In cases where the split spoon does not penetrate 300 mm, the number of blows over the distance of actual penetration in millimetres is shown as $\frac{xBlows}{mm}$

Water Content - The ratio of the mass of water to the mass of oven-dry solids in the soil expressed as a percentage.

W_P - Plastic Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

W_L - Liquid Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

REMARKS

The last column describes pertinent drilling details, field observations and/or provides an indication of other field or laboratory tests that were performed.

BOREHOLE NO. BH18-01

PROJECT NAME: AMHERSTBURG NAVIGATIONAL AIDS
PROJECT NO.: 181-14155-00
CLIENT: FISHERIES AND OCEANS CANADA
DATE COMPLETED: Dec 13, 2019
BOREHOLE TYPE: HOLLOW STEM AUGER/ SPLIT SPOON SAMPLER
SUPERVISOR: MN
GROUND ELEVATION: EXISTING GRADE AT EXISTING TOWER BASE
REVIEWER: PH

UTM CO-ORDINATES
UTM Zone: 17 NAD: 83
Easting: 324308
Northing: 4659781

DEPTH (m)	ELEV (mASL)	STRATIGRAPHIC DESCRIPTION	STRATIGRAPHY	MONITOR DETAILS	SAMPLE TYPE	N VALUE	% WATER	% RECOVERY	PID/TOV (ppm)	REMARKS
0.0										
0.1		TOPSOIL								
0.3		FILL: Light brown sand and gravel FILL, trace silt, moist, compact			SS1	11	9	43		
1.0		SANDY GRAVEL: Light brown SANDY GRAVEL, with cobbles, moist, compact to dense - Moist to wet			SS2	10	5	57		
2.0					SS3	11		14		Borehole caved at 1.7 m below ground surface upon completion of drilling.
					SS4	10	11	100		GSA SS4: Gravel: 63% Sand: 33% Silt & Clay: 4%
3.0					SS5	30	11	86		
4.0					SS6	18	9	93		GSA SS6: Gravel: 63% Sand: 33% Silt & Clay: 4%
4.4										
4.6		CLAYEY SILT AND COBBLES: Light brown to grey CLAYEY SILT AND COBBLES, trace sand, wet, dense			SS7	22	11	93		
5.0		COBBLES: Light brown COBBLES with sand and gravel, wet, loose to dense			SS8	21	10	93		
6.0					SS9	15	10	79		
7.0					SS10	4	13	93		
8.0					SS11	12		57		
9.0					SS12	32	10	93		
9.1		Borehole terminated at 9.1 m below ground surface in COBBLES.								
10.0										
11.0										
12.0										
13.0										
14.0										
15.0										
16.0										
17.0										

CONE PENETRATION "N" VALUE 10 20 30
SHEAR STRENGTH 10 20 30 40 — Intact (MaX) Cu — Remoulded Cu
WATER CONTENT % 15 30 45 W_P W_L

BOREHOLE NO. BH18-02

PROJECT NAME: AMHERSTBURG NAVIGATIONAL AIDS
PROJECT NO.: 181-14155-00
CLIENT: FISHERIES AND OCEANS CANADA
DATE COMPLETED: Dec 14, 2019
BOREHOLE TYPE: HOLLOW STEM AUGER/ SPLIT SPOON SAMPLER
SUPERVISOR: MN
GROUND ELEVATION: EXISTING GRADE AT EXISTING TOWER BASE
REVIEWER: PH

UTM CO-ORDINATES
UTM Zone: 17 NAD: 83
Easting: 324502
Northing: 4660521

DEPTH (m)	ELEV (mASL)	STRATIGRAPHIC DESCRIPTION	STRATIGRAPHY	MONITOR DETAILS	SAMPLE TYPE	N VALUE	% WATER	% RECOVERY	PID/TOV (ppm)
0.0									
0.1		TOPSOIL							
		SANDY GRAVEL: Light brown SANDY GRAVEL, with cobbles, moist, compact			SS1	19		68	
1.0					SS2	27		100	
2.0					SS3	11		86	
2.1		COBBLES: Light brown COBBLES with sand and gravel, moist to wet, compact to dense			SS4	12		86	
3.0		- Wet			SS5	39		100	
4.0					SS6	31		71	
5.0					SS7	21		64	
6.0		- Trace silt			SS8	21		64	
					SS9	14		79	
7.0					SS10	43		56	
7.5		Borehole terminated upon refusal at 7.5 m below ground surface on presumed boulder.							
8.0									
9.0									
10.0									
11.0									
12.0									
13.0									
14.0									
15.0									
16.0									
17.0									

CONE PENETRATION
"N" VALUE 10 20 30
SHEAR STRENGTH 10 20 30 40
Intact (MaX) Cu
Remoulded Cu

WATER CONTENT % 15 30 45
W_P W_L

43

REMARKS

Borehole caved at 1.8 m below surface and groundwater was at 0.5 m below surface upon completion of drilling.

GSA SS3:
Gravel: 40%
Sand: 34%
Silt & Clay: 16%

Borehole moved 2.0 m Northwest due to hammer refusal on rock.
GSA SS5:
Gravel: 68%
Sand: 28%
Silt & Clay: 4%

WSP GEOTECH (METRIC) WITH UTM AND MASL 181-14155-00_DRAFTLOGS.GPJ WSP_ENV_V1.GDT 3/29/19

BOREHOLE NO. BH18-03

PROJECT NAME: AMHERSTBURG NAVIGATIONAL AIDS
PROJECT NO.: 181-14155-00
CLIENT: FISHERIES AND OCEANS CANADA
DATE COMPLETED: Feb 14, 2019
BOREHOLE TYPE: HOLLOW STEM AUGER/ SPLIT SPOON SAMPLER
SUPERVISOR: MN
GROUND ELEVATION: EXISTING GRADE AT EXISTING TOWER BASE
REVIEWER: PH

UTM CO-ORDINATES
UTM Zone: 17 NAD: 83
Easting: 324884
Northing: 4664850

DEPTH (m)	ELEV (mASL)	STRATIGRAPHIC DESCRIPTION	STRATIGRAPHY	MONITOR DETAILS	SAMPLE TYPE	N VALUE	% WATER	% RECOVERY	PID/TOV (ppm)
0.0									
0.2		TOPSOIL							
		SANDY GRAVEL: Light brown SANDY GRAVEL, with cobbles, trace silt, moist, compact			SS1	26	13	87	
1.0					SS2	17	11	60	
		- Crushed rock with cobbles, some sandy gravel			SS3	18		20	
2.0		- Moist to wet			SS4	28	14	93	
3.0					SS5	13	16	100	
4.0					SS6	23	20	20	
5.0					SS7	16	18	100	
6.0					SS8	12	16	100	
6.1		Borehole terminated at 6.1 m below ground surface in SANDY GRAVEL.							
7.0									
8.0									
9.0									
10.0									
11.0									
12.0									
13.0									
14.0									
15.0									
16.0									
17.0									

CONE PENETRATION
"N" VALUE 10 20 30
SHEAR STRENGTH 10 20 30 40
Intact (MaX) Cu
Remoulded Cu

WATER CONTENT % 15 30 45
W_P W_L

REMARKS

Borehole caved at 3.4 m below surface and groundwater was at 1.8 m below surface upon completion of drilling.

GSA SS4:
Gravel: 70%
Sand: 24%
Silt & Clay: 6%

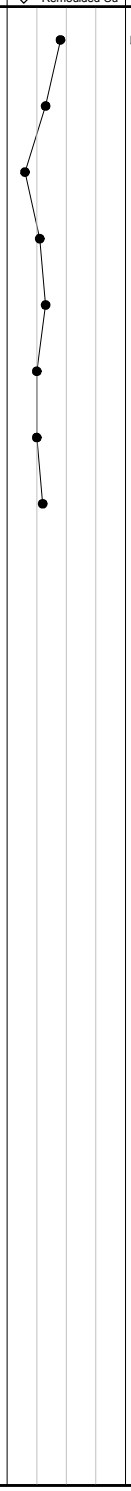
GSA SS5:
Gravel: 65%
Sand: 29%
Silt & Clay: 6%

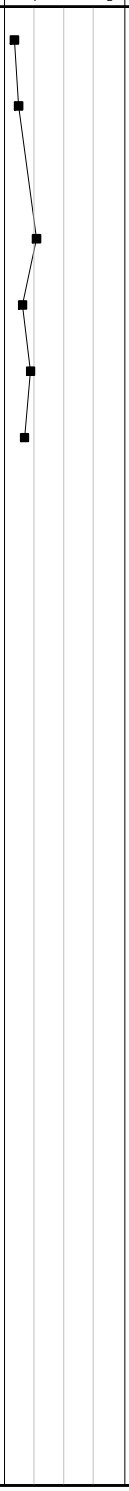
BOREHOLE NO. BH18-04

PROJECT NAME: AMHERSTBURG NAVIGATIONAL AIDS
PROJECT NO.: 181-14155-00
CLIENT: FISHERIES AND OCEANS CANADA
DATE COMPLETED: Feb 15, 2019
BOREHOLE TYPE: HOLLOW STEM AUGER/ SPLIT SPOON SAMPLER
SUPERVISOR: MN
GROUND ELEVATION: EXISTING GRADE AT EXISTING TOWER BASE
REVIEWER: PH

UTM CO-ORDINATES
UTM Zone: 17 NAD: 83
Easting: 325439
Northing: 4664497

DEPTH (m)	ELEV (mASL)	STRATIGRAPHIC DESCRIPTION	STRATIGRAPHY	MONITOR DETAILS	SAMPLE TYPE	N VALUE	% WATER	% RECOVERY	PID/TOV (ppm)
0.0		TOPSOIL							
0.2		SANDY GRAVEL: Light brown SANDY GRAVEL, with cobbles, moist, loose to compact			SS1	18	5	73	
1.0					SS2	13	7	57	
		- Wet			SS3	6		13	
2.0					SS4	11	16	50	
3.0		- Moist			SS5	13	9	100	
4.0					SS6	10	13	100	
5.0					SS7	10	10	80	
6.0					SS8	12		100	
6.1		Borehole terminated at 6.1 m below ground surface in SANDY GRAVEL.							
7.0									
8.0									
9.0									
10.0									
11.0									
12.0									
13.0									
14.0									
15.0									
16.0									
17.0									





REMARKS

Borehole caved at 4.0 m below surface and groundwater was at 2.1 m below surface upon completion of drilling.

GSA SS4:
Gravel: 62%
Sand: 35%
Silt & Clay: 3%

GSA SS5:
Gravel: 72%
Sand: 27%
Silt & Clay: 1%

BOREHOLE NO. BH18-05

PROJECT NAME: AMHERSTBURG NAVIGATIONAL AIDS
PROJECT NO.: 181-14155-00
CLIENT: FISHERIES AND OCEANS CANADA
DATE COMPLETED: Feb 12, 2019
BOREHOLE TYPE: HOLLOW STEM AUGER/ SPLIT SPOON SAMPLER
SUPERVISOR: MN
GROUND ELEVATION: EXISTING GRADE AT EXISTING TOWER BASE
REVIEWER: PH

UTM CO-ORDINATES
UTM Zone: 17 NAD: 83
Easting: 324901
Northing: 4664509

DEPTH (m)	ELEV (mASL)	STRATIGRAPHIC DESCRIPTION	STRATIGRAPHY	MONITOR DETAILS	SAMPLE TYPE	N VALUE	% WATER	% RECOVERY	PID/TOV (ppm)	CONE PENETRATION "N" VALUE / SHEAR STRENGTH (Intact (MaX) Cu, Remoulded Cu)	WATER CONTENT % (W_P, W_L)	REMARKS
0.0		TOPSOIL										
0.2		FILL: Light / dark brown sandy silt FILL, trace organics, moist, loose			SS1	6	19	40				
0.8		SILTY CLAY Brown SILTY CLAY, some sand, occasional gravel, APL to WTPL, stiff to hard - Some grey			SS2	10	20	43				GSA SS2: Gravel: 61% Sand: 24% Silt & Clay: 75%
1.0												
2.0		- Orangey brown mottling			SS3	29	14	70				AL SS2: Liquid Limit: 40% Plastic Limit: 22% Plasticity Index: 18% Borehole caved at 2.6 m below surface and groundwater was at 1.8 m below surface upon completion of drilling.
3.0					SS4	64	13	60		64		
3.0		CLAYEY SILT: Brown to grey CLAYEY SILT, some sand, occasional gravel, APL to WTPL, very stiff to hard			SS5	50	13	60		50		GSA SS4: Gravel: 2% Sand: 16% Silt & Clay: 82%
4.0					SS6	30	14	53				
5.0					SS7	30	10	33				
6.0		- Orange mottling			SS8	15	17	43				
7.0					SS9	37	14	60				
8.0					SS10	36	15	73				
9.0					SS11	23	18	17				
9.1		Borehole terminated at 9.1 m below ground surface in SANDY SILT.			SS12	19		100				
10.0												
11.0												
12.0												
13.0												
14.0												
15.0												
16.0												
17.0												

BOREHOLE NO. BH18-06

PROJECT NAME: AMHERSTBURG NAVIGATIONAL AIDS
PROJECT NO.: 181-14155-00
CLIENT: FISHERIES AND OCEANS CANADA
DATE COMPLETED: Mar 11, 2019
BOREHOLE TYPE: HOLLOW STEM AUGER/ SPLIT SPOON SAMPLER
SUPERVISOR: MN
GROUND ELEVATION: EXISTING GRADE AT EXISTING TOWER BASE
REVIEWER: PH

UTM CO-ORDINATES
UTM Zone: 17 NAD: 83
Easting: 325402
Northing: 4664605

DEPTH (m)	ELEV (mASL)	STRATIGRAPHIC DESCRIPTION	STRATIGRAPHY	MONITOR DETAILS	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE % WATER	SAMPLE % RECOVERY	PID/TOV (ppm)	REMARKS
0.0		TOPSOIL:								
0.8										
1.0		SILTY CLAY: Brown with grey mottling SILTY CLAY, some sand, DTPL, soft			AS1 SS1	9	24	89		GSA AS1: Sand: 14% Silt & Clay: 86%
					AS2		16			
1.7					SS2	15		89		
2.0		CLAYEY SILT: Light brown to grey CLAYEY SILT, some sand to sandy, trace gravel, DTPL to APL, very stiff to hard								GSA AS2: Gravel: 1% Sand: 24% Silt & Clay: 75%
					SS3	21		100		
3.0					AS3		12			
					SS4	32		100		Groundwater in open borehole at 6.1 m below ground surface upon completion of drilling.
4.0										
					SS5	21		100		
5.0										
6.0										
6.1		SILTY CLAY TILL: Grey SILTY CLAY TILL, trace to some sand, trace gravel, APL, very stiff to stiff			SS6	17		100		
7.0										
					SS7	13		100		
8.0										
9.0					SS8	9		100		
10.0										
11.0					SS9	9		100		
12.0										
					SS10	13		100		
13.0										
14.0										
15.0										
15.4		Borehole terminated at 15.4 m below ground surface in SILTY CLAY TILL.			SS11	50/ 25mm		100		
16.0										
17.0										

CONE PENETRATION
"N" VALUE 10 20 30
SHEAR STRENGTH 10 20 30 40
Intact (MaX) Cu
Remoulded Cu

WATER CONTENT % 15 30 45
W_P W_L

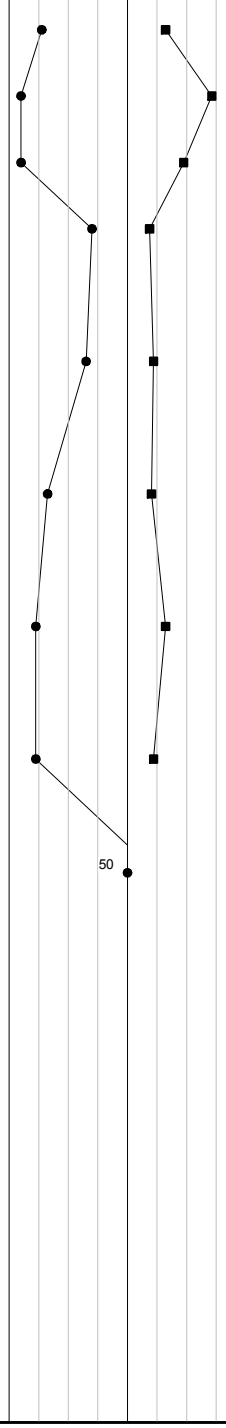
BOREHOLE NO. BH18-07

PROJECT NAME: AMHERSTBURG NAVIGATIONAL AIDS
PROJECT NO.: 181-14155-00
CLIENT: FISHERIES AND OCEANS CANADA
DATE COMPLETED: Mar 12, 2019
BOREHOLE TYPE: HOLLOW STEM AUGER/ SPLIT SPOON SAMPLER
SUPERVISOR: MN
GROUND ELEVATION: EXISTING GRADE AT EXISTING TOWER BASE
REVIEWER: PH

UTM CO-ORDINATES
UTM Zone: 17 NAD: 83
Easting: 325320
Northing: 4662962

DEPTH (m)	ELEV (mASL)	STRATIGRAPHIC DESCRIPTION	STRATIGRAPHY	MONITOR DETAILS	SAMPLE TYPE	N VALUE	% WATER	% RECOVERY	PID/TOV (ppm)	REMARKS
0.0		TOPSOIL								
0.2		SANDY SILT: Dark brown SANDY SILT, trace organics, trace rootets, moist to wet, loose to compact			SS1	11	19	100		
1.0		- trace clay			SS2	4	42	89		
2.0										
2.3		CLAYEY SILT: Grey to dark grey CLAYEY SILT, some sand, trace gravel, APL to WTPL, soft to firm			SS3	4	28	78		GSA SS3: Gravel: 7% Sand: 24% Silt & Clay: 69% Groundwater in open borehole at 3.0 m below surface upon completion of drilling.
3.0										
3.2		SANDY SILT TILL: Brown mottled grey SANDY SILT TILL, trace gravel, some clay to clayey, occasional cobbles, moist, compact			SS4	28	11	100		
4.0										
5.0					SS5	26	13	100		GSA SS5: Gravel: 3% Sand: 23% Silt & Clay: 82%
6.0		- Grey			SS6	13	12	100		
7.0										
7.9		CLAYEY SILT: Grey CLAYEY SILT, trace sand, trace gravel, APL, stiff			SS7	9	19	100		
9.0					SS8	9	13	100		
10.0										
10.7		- Crushed rock (weathered bedrock), saturated			SS9	50/ 25mm		100		
11.0		Borehole terminated upon refusal at 10.7 m below ground surface on presumed BEDROCK.								
12.0										
13.0										
14.0										
15.0										
16.0										
17.0										

CONE PENETRATION "N" VALUE 10 20 30
SHEAR STRENGTH 10 20 30 40 — Intact (MaX) Cu — Remoulded Cu
WATER CONTENT % 15 30 45 — W_P W_L



BOREHOLE NO. BH18-08

PROJECT NAME: AMHERSTBURG NAVIGATIONAL AIDS
PROJECT NO.: 181-14155-00
CLIENT: FISHERIES AND OCEANS CANADA
DATE COMPLETED: Mar 12, 2019
BOREHOLE TYPE: HOLLOW STEM AUGER/ SPLIT SPOON SAMPLER
SUPERVISOR: MN
GROUND ELEVATION: EXISTING GRADE AT EXISTING TOWER BASE
REVIEWER: PH

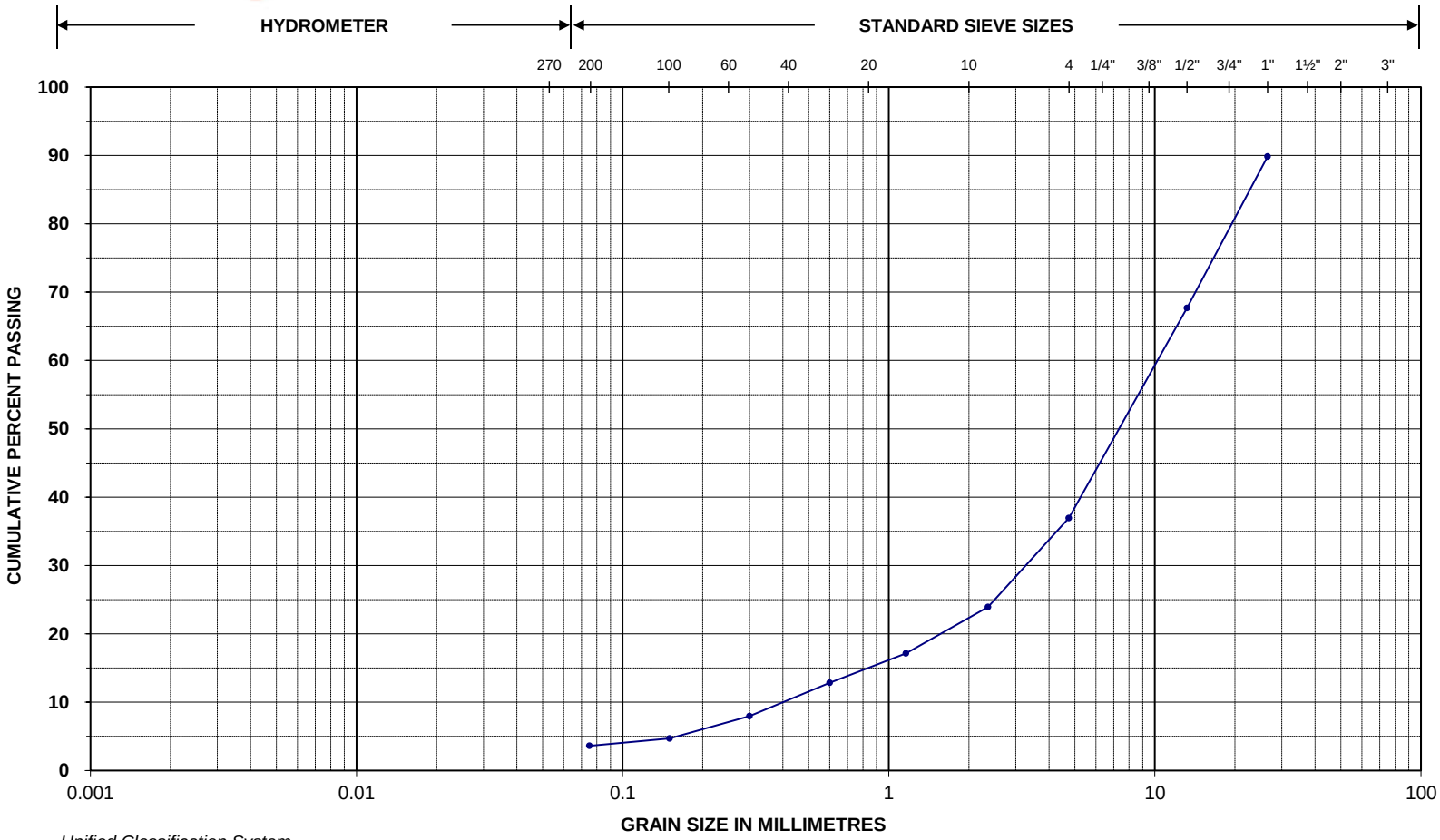
UTM CO-ORDINATES
UTM Zone: 17 NAD: 83
Easting: 325243
Northing: 4662677

DEPTH (m)	ELEV (mASL)	STRATIGRAPHIC DESCRIPTION	STRATIGRAPHY	MONITOR DETAILS	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE % WATER	SAMPLE % RECOVERY	PID/TOV (ppm)	CONE PENETRATION "N" VALUE / SHEAR STRENGTH (Intact (MaX) Cu, Remoulded Cu)	WATER CONTENT % (W_P, W_L)	REMARKS
0.0												
0.1		ASPHALT										
		FILL: Light brown sand and gravel FILL, trace silt, moist			AS1		12					
0.7												
1.0		COBBLES: Light brown COBBLES with sand and gravel, trace silt, wet, loose to compact			SS2	18	12	22				Borehole caved at 1.1 m below surface and groundwater was at 0.9 m below surface upon completion of drilling.
					SS3	12	20	22				GSA SS3 Gravel: 65% Sand: 21% Silt & Clay: 14%
2.0					SS4	13		56				
3.0		- Trace clay			SS5	7	21	22				GSA SS5: Gravel: 28% Sand: 37% Silt & Clay: 35%
4.0												
5.0					SS6	50/ 25mm	18	100		50		
6.0												
6.1		Borehole terminated upon refusal at 6.1 m below ground surface on presumed BEDROCK.			SS7	50/ 25mm		100		50		
7.0												
8.0												
9.0												
10.0												
11.0												
12.0												
13.0												
14.0												
15.0												
16.0												
17.0												

APPENDIX

B PHYSICAL LABORATORY DATA

PARTICLE SIZE DISTRIBUTION



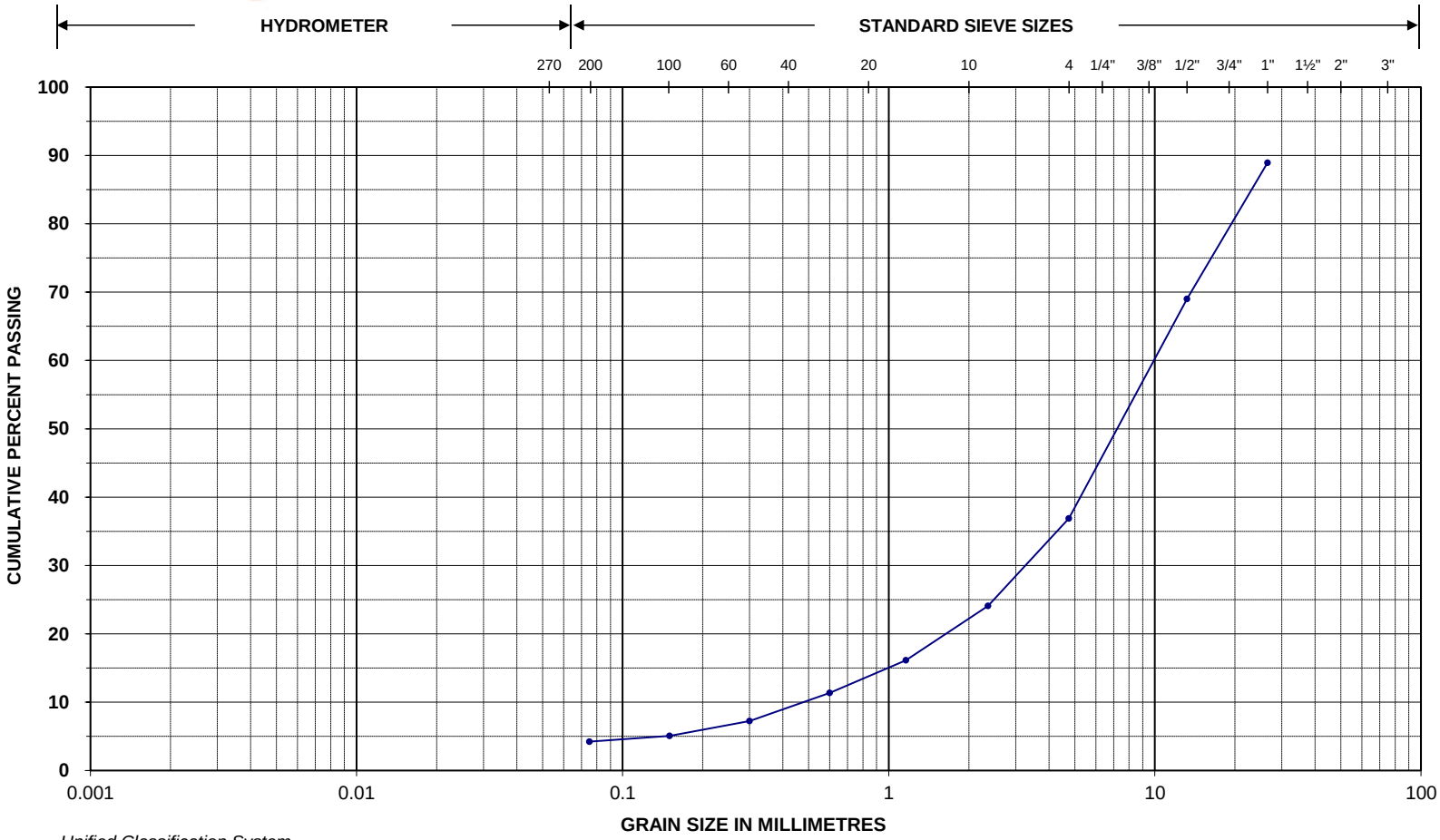
Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name:	Amherstburg Navigation Aids	**Project No.:**	181-14155-00
Location ID.:	BH18-01	**Sample No./Depth:**	SS4

Sieve Size	% Passing Coarse	**Sieve Size**	% Passing Fine
37.5 mm	100.0	**1.16 mm**	17.1
26.5 mm	89.8	**0.60 mm**	12.8
13.2 mm	67.7	**0.30 mm**	8.0
4.75 mm	36.9	**0.15 mm**	4.7
2.36 mm	23.9	**0.075 mm**	3.6

PARTICLE SIZE DISTRIBUTION



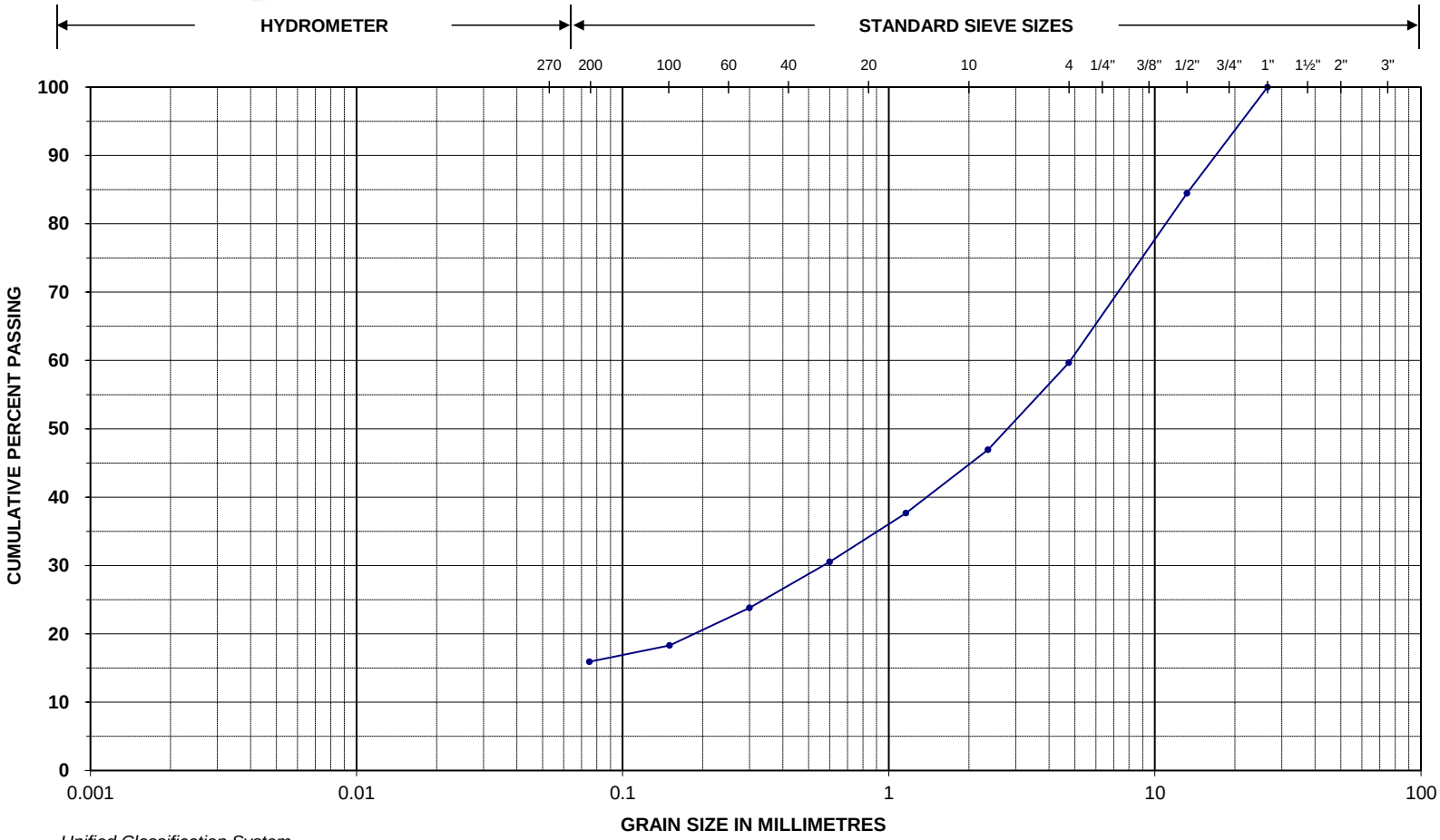
Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name:	Amherstburg Navigation Aids	**Project No.:**	181-14155-00
Location ID.:	BH18-01	**Sample No./Depth:**	SS6

Sieve Size	% Passing Coarse	**Sieve Size**	% Passing Fine
37.5 mm	100.0	**1.16 mm**	16.2
26.5 mm	88.9	**0.60 mm**	11.3
13.2 mm	69.0	**0.30 mm**	7.2
4.75 mm	36.9	**0.15 mm**	5.1
2.36 mm	24.1	**0.075 mm**	4.2

PARTICLE SIZE DISTRIBUTION



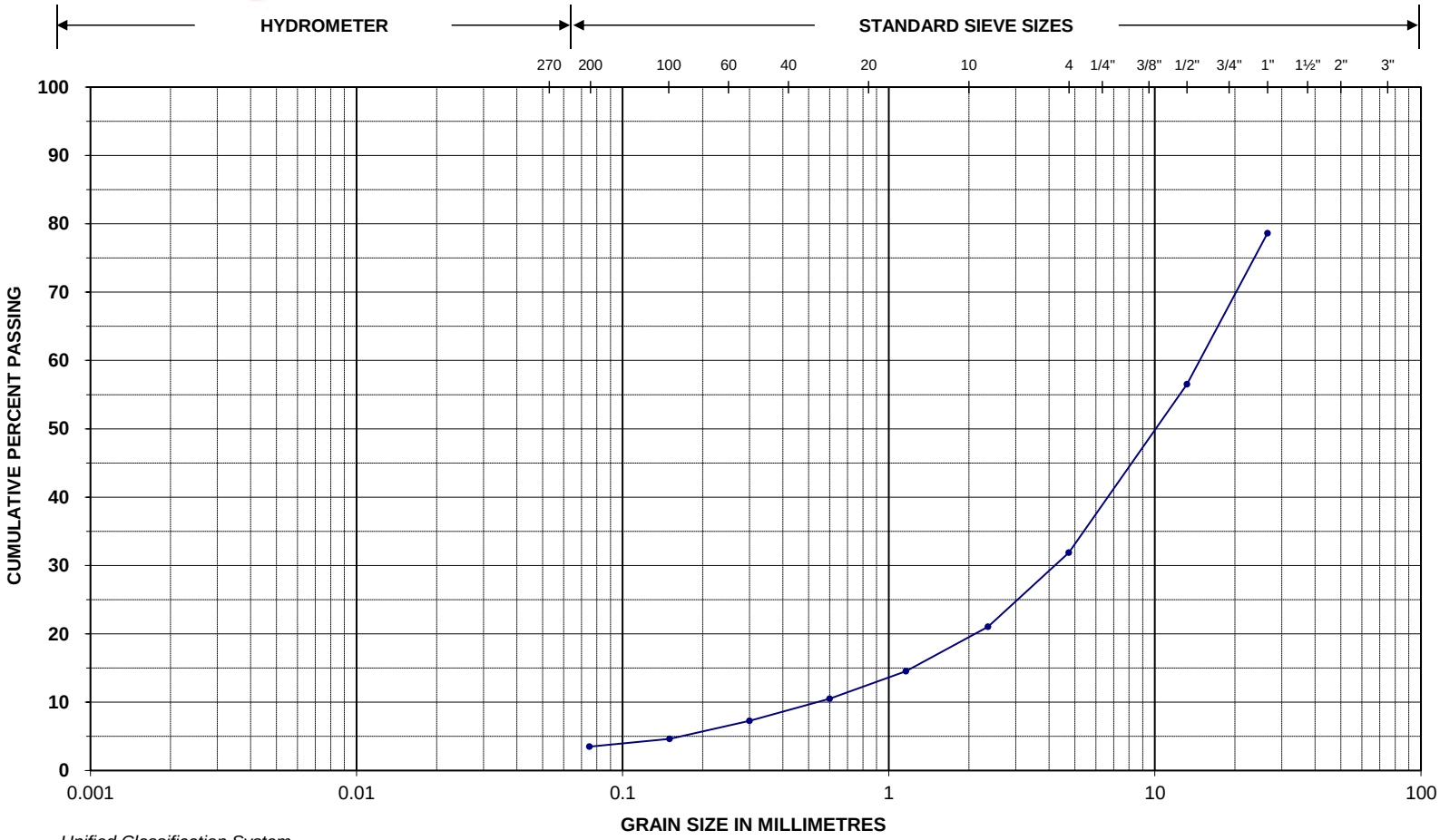
Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name:	Amhersetburg Navigation Aids	**Project No.:**	181-14155-00
Location ID.:	BH18-02	**Sample No./Depth:**	SS3

Sieve Size	% Passing Coarse	**Sieve Size**	% Passing Fine
37.5 mm	100.0	**1.16 mm**	37.7
26.5 mm	100.0	**0.60 mm**	30.5
13.2 mm	84.5	**0.30 mm**	23.8
4.75 mm	59.7	**0.15 mm**	18.3
2.36 mm	46.9	**0.075 mm**	15.9

PARTICLE SIZE DISTRIBUTION



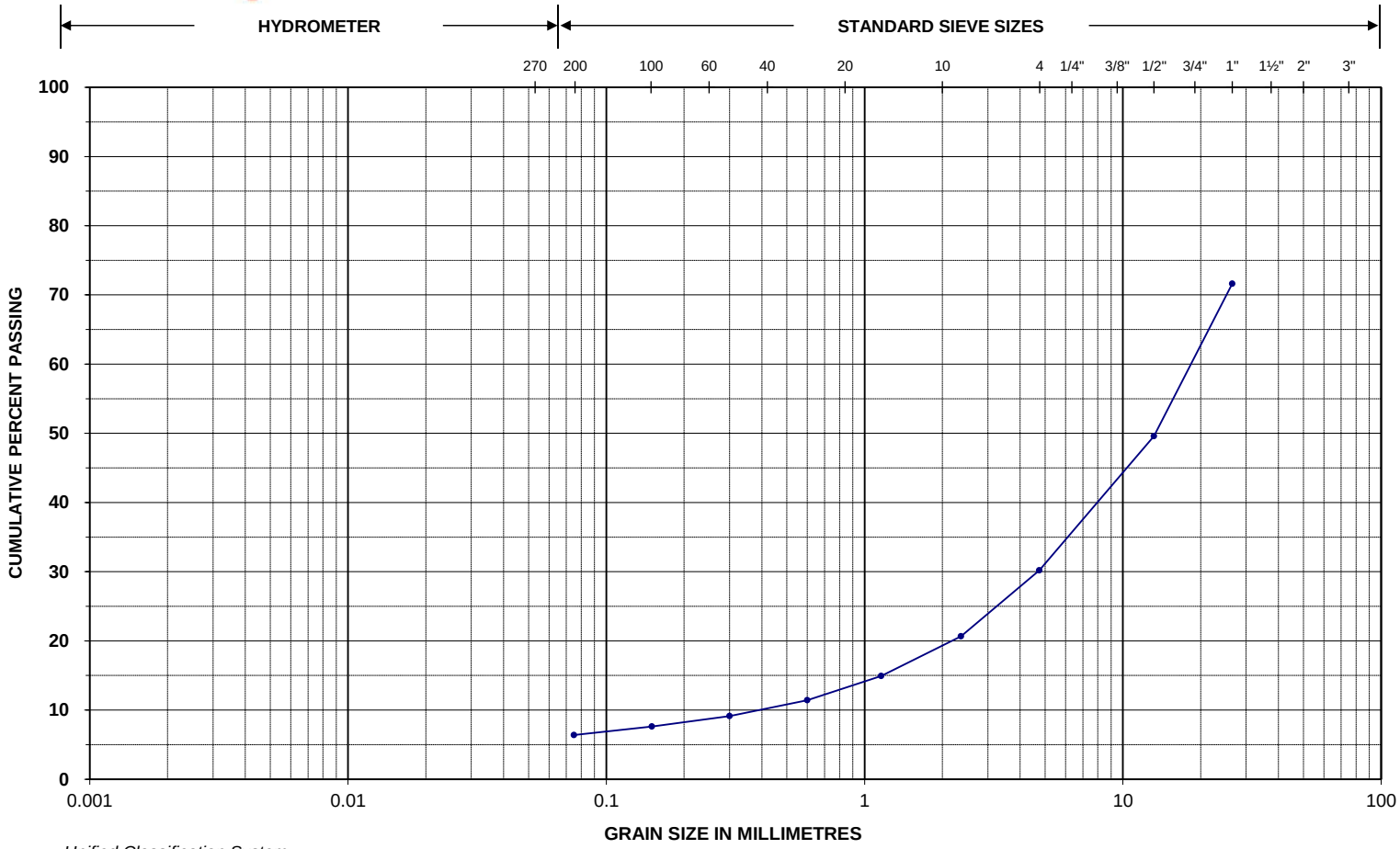
Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name:	Amherstburg Navigation Aids	**Project No.:**	181-14155-00
Location ID.:	BH18-02	**Sample No./Depth:**	SS5

Sieve Size	% Passing Coarse	**Sieve Size**	% Passing Fine
37.5 mm	100.0	**1.16 mm**	14.5
26.5 mm	78.6	**0.60 mm**	10.5
13.2 mm	56.5	**0.30 mm**	7.3
4.75 mm	31.9	**0.15 mm**	4.6
2.36 mm	21.0	**0.075 mm**	3.5

PARTICLE SIZE DISTRIBUTION



Unified Classification System

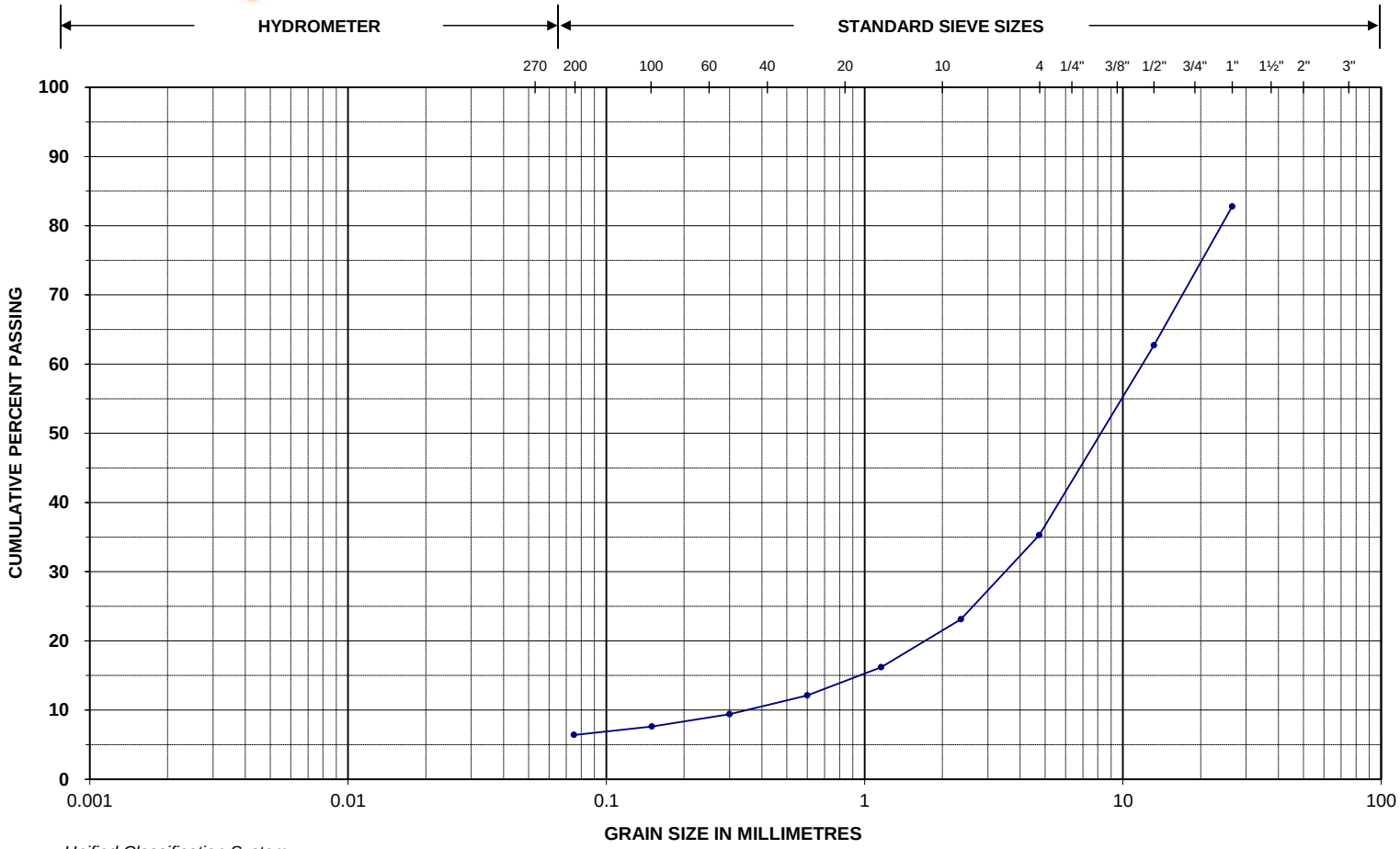
SILT AND CLAY	SAND	GRAVEL

Project Name: Amherstburg Navigation Aids **Project No.:** 181-14155-00

Location ID.: BH18-03 **Sample No./Depth:** SS4

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine
37.5 mm	100.0	**1.16 mm**	14.9
26.5 mm	71.6	**0.60 mm**	11.4
13.2 mm	49.6	**0.30 mm**	9.1
4.75 mm	30.2	**0.15 mm**	7.6
2.36 mm	20.7	**0.075 mm**	6.4

PARTICLE SIZE DISTRIBUTION



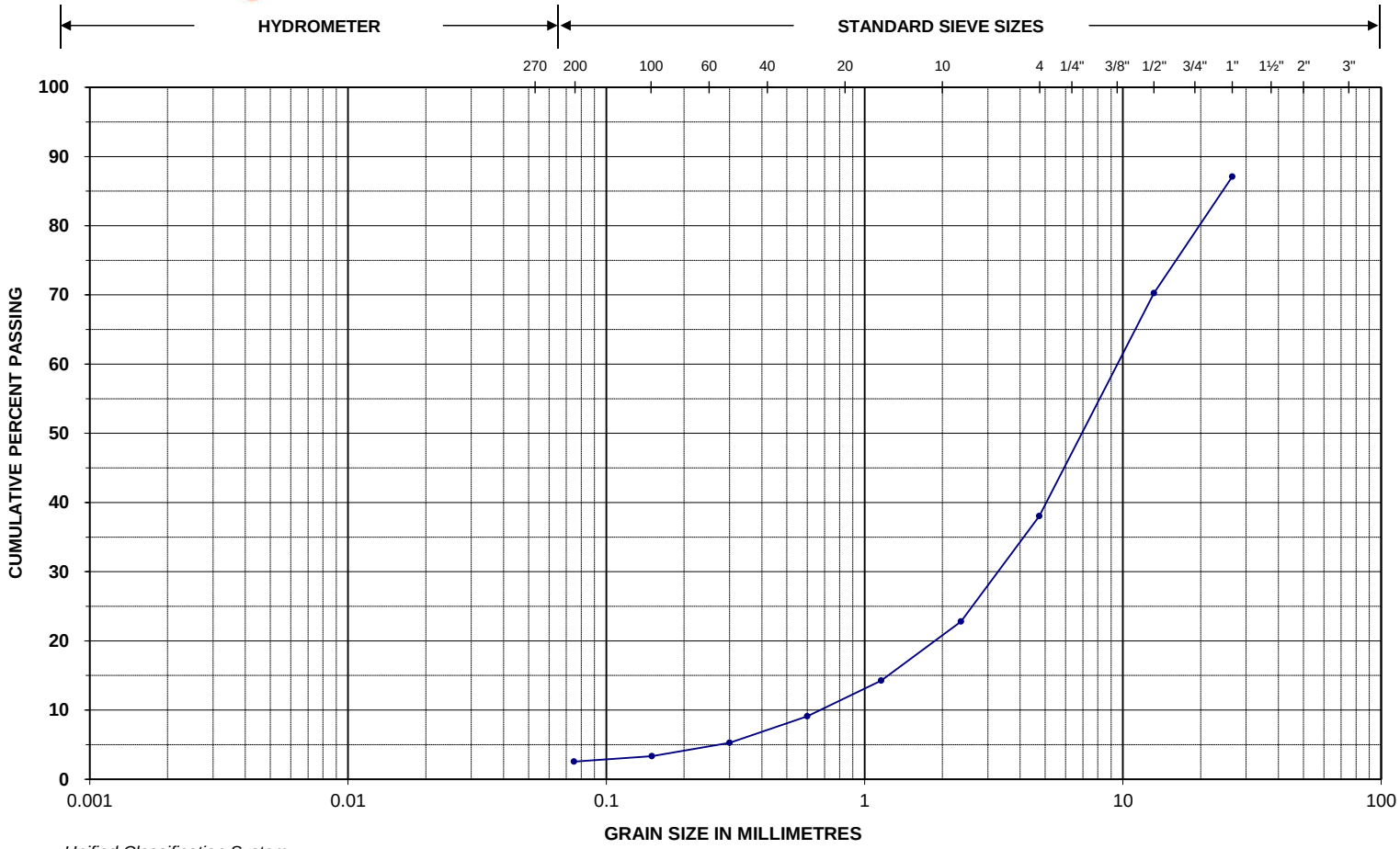
Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name:	Amherstburg Navigation Aids	**Project No.:**	181-14155-00
Location ID.:	BH18-03	**Sample No./Depth:**	SS5

Sieve Size	% Passing Coarse	**Sieve Size**	% Passing Fine
37.5 mm	100.0	**1.16 mm**	16.2
26.5 mm	82.8	**0.60 mm**	12.1
13.2 mm	62.7	**0.30 mm**	9.4
4.75 mm	35.3	**0.15 mm**	7.6
2.36 mm	23.1	**0.075 mm**	6.4

PARTICLE SIZE DISTRIBUTION



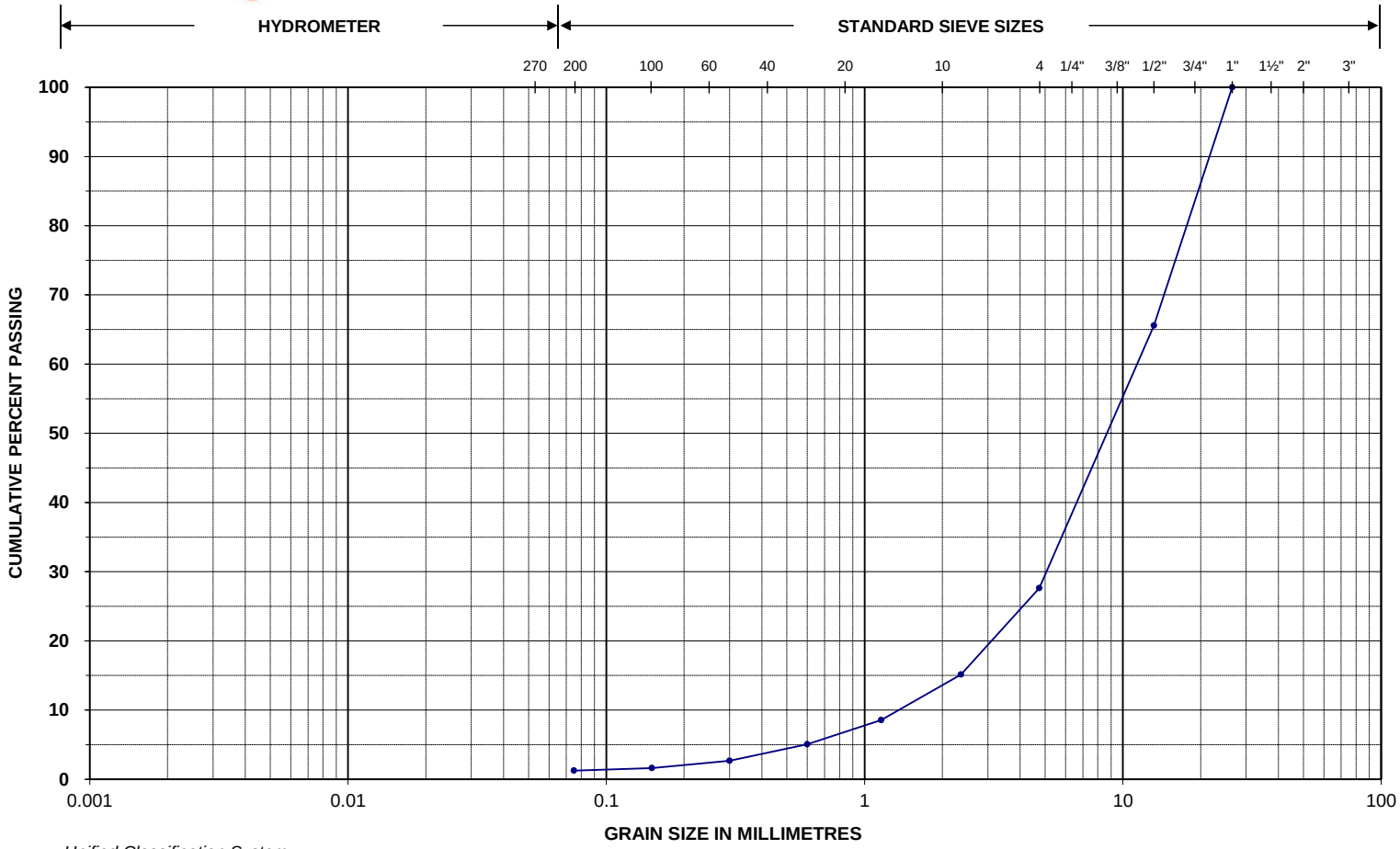
Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name: Amherstburg Navigation Aids
Project No.: 181-14155-00
Location ID.: BH18-04
Sample No./Depth: SS4

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine
37.5 mm	100.0	**1.16 mm**	14.3
26.5 mm	87.1	**0.60 mm**	9.1
13.2 mm	70.3	**0.30 mm**	5.3
4.75 mm	38.0	**0.15 mm**	3.3
2.36 mm	22.8	**0.075 mm**	2.5

PARTICLE SIZE DISTRIBUTION



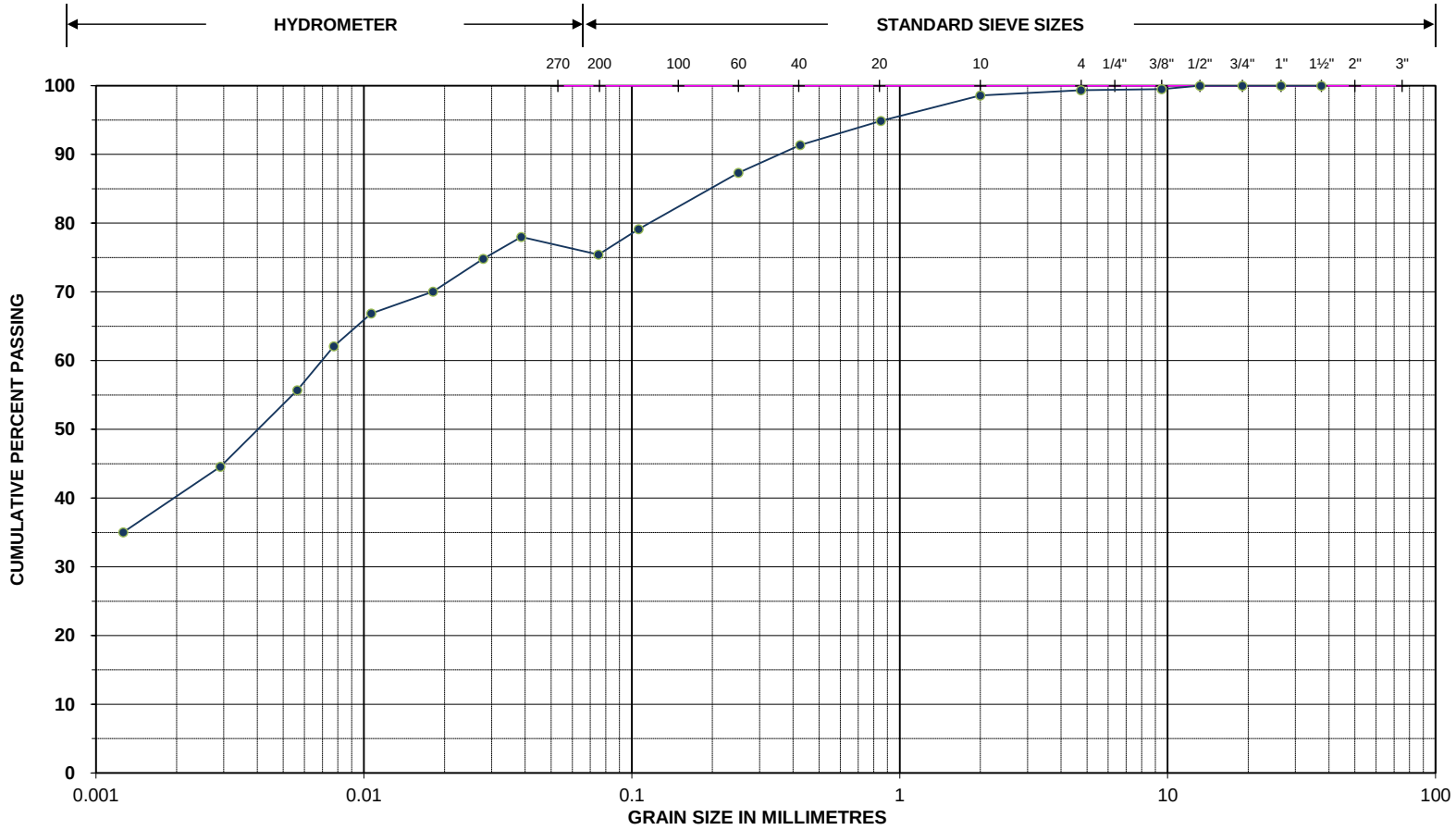
Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name:	Amherstburg Navigation Aids	**Project No.:**	181-14155-00
Location ID.:	BH18-04	**Sample No./Depth:**	SS5

Sieve Size	% Passing Coarse	**Sieve Size**	% Passing Fine
37.5 mm	100.0	**1.16 mm**	8.5
26.5 mm	100.0	**0.60 mm**	5.1
13.2 mm	65.6	**0.30 mm**	2.7
4.75 mm	27.6	**0.15 mm**	1.6
2.36 mm	15.1	**0.075 mm**	1.2

PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name: Amherstburg Navigation Aids **Project No.:** 181-14155-00

Location ID.: BH18-05 **Sample No./Depth:** SS2

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine	Hydrometer (mm)	% Passing
37.5 mm	100.0	**2.00 mm**	98.6	**0.039**	78.0
26.5 mm	100.0	**0.850 mm**	94.9	**0.018**	70.0
19.0 mm	100.0	**0.425 mm**	91.3	**0.008**	62.1
13.2 mm	100.0	**0.250 mm**	87.3	**0.003**	44.6
9.50 mm	99.5	**0.106 mm**	79.1	**0.001**	35.0
4.75 mm	99.3	**0.075 mm**	75.4		

ATTERBERG LIMITS

ASTM D4318

Date:	25-Feb-19	Job No.:	181-14155-00
Project Name:	Amherstburg Navigation Aids	Tech.:	NLO
Borehole/Sample No.:	BH18-05 / SS2		

Liquid Limit Test

Number of Shocks	35	25	18
Tin No.	FRED	A3	SH
Tin + Wet soil	35.4	36.8	35.7
Tin + Dry soil	33.4	34.4	33.5
Wt. of Water	2.0	2.4	2.2
Wt. of Tin	28.2	28.3	28.2
Wt. of Dry Soil	5.2	6.0	5.3
Water Content	38	40	42

Plastic Limit Test

Tin No.	KC10	LK11
Tin + Wet soil	27.0	34.4
Tin + Dry soil	25.8	33.3
Wt. of Water	1.3	1.1
Wt. of Tin	20.0	28.1
Wt. of Dry Soil	5.8	5.1
Water Content	22	22

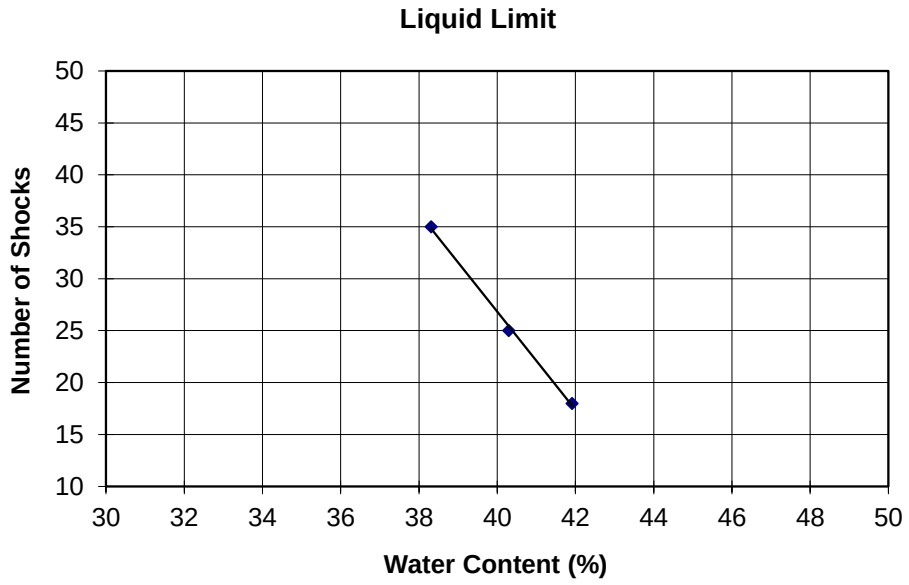
Natural Water Content

2L
79.6
69.9
9.8
16.9
53.0
18.5

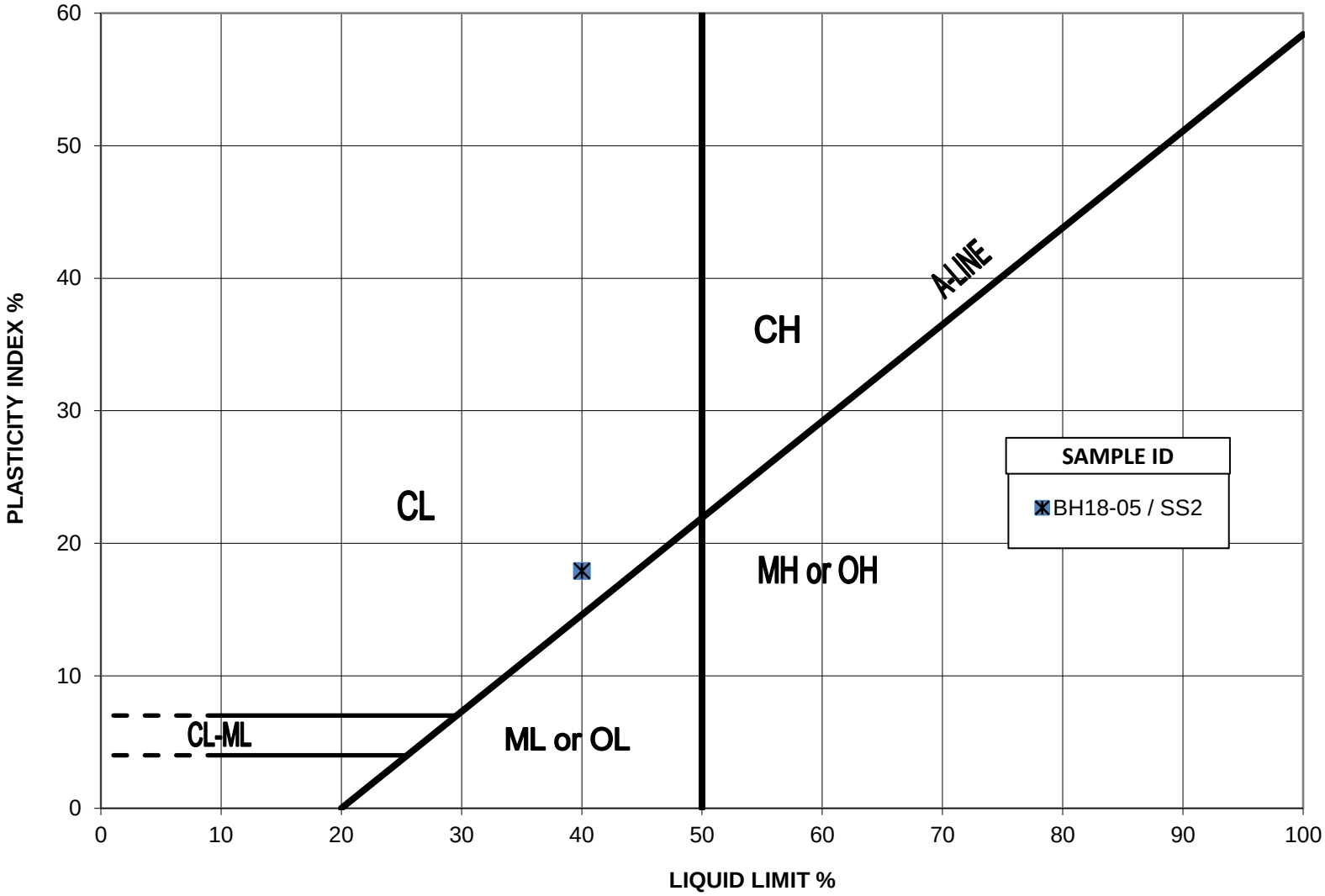
Liquid Limit, (W_L)	40
Plastic Limit, (WP)	22
Plasticity Index ($I_P=W_L-W_P$)	18
Natural Water Content, W	18
Liquidity Index ($I_L=W-W_P/W_L-W_P$)	0

Control Results

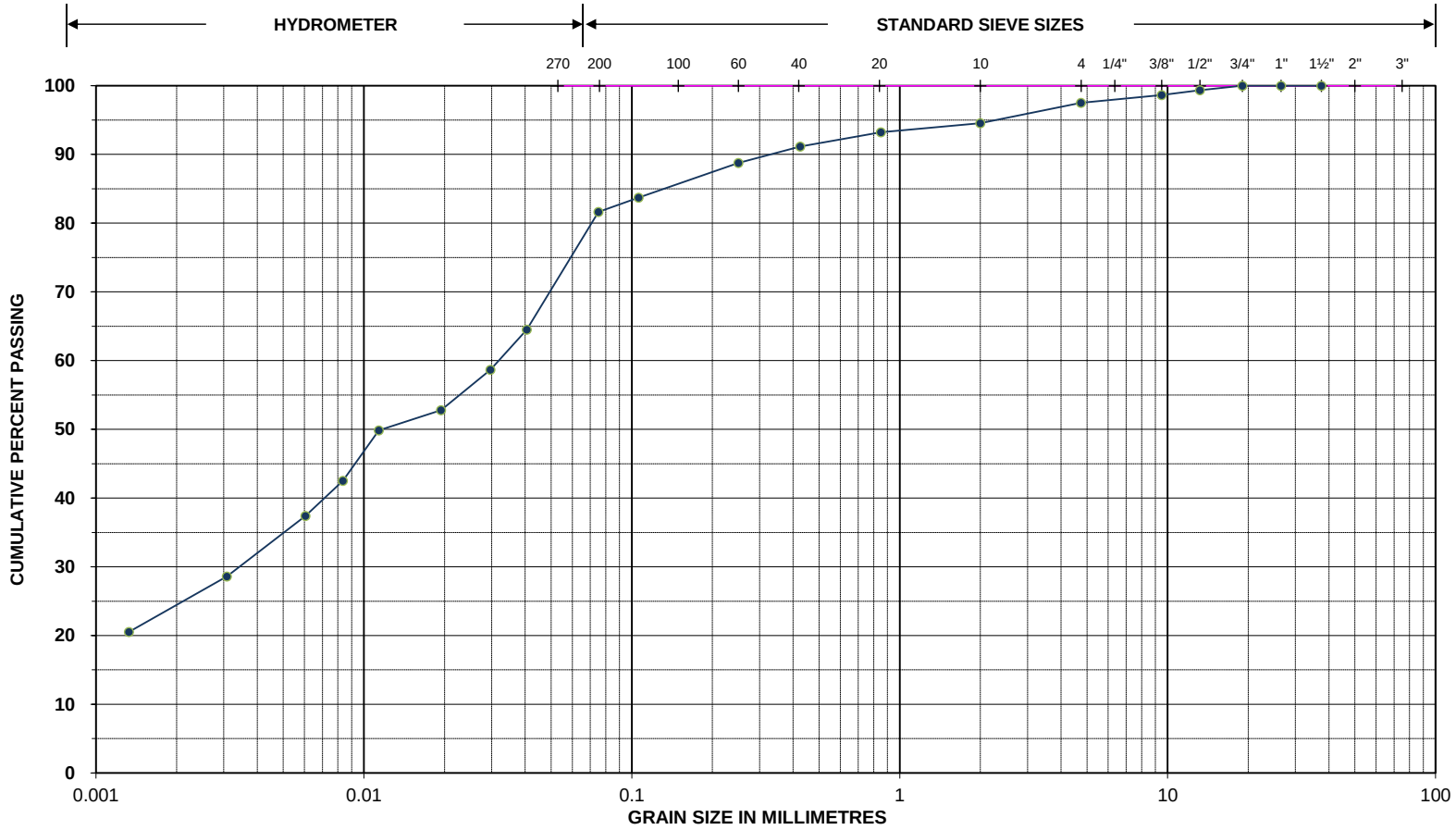
Liquid Limit, (W_L)	30
Plastic Limit, (WP)	19
Plasticity Index ($I_P=W_L-W_P$)	11



Atterberg Limits Plasticity Chart
Amherstburg Navigation Aids
181-14155-00



PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

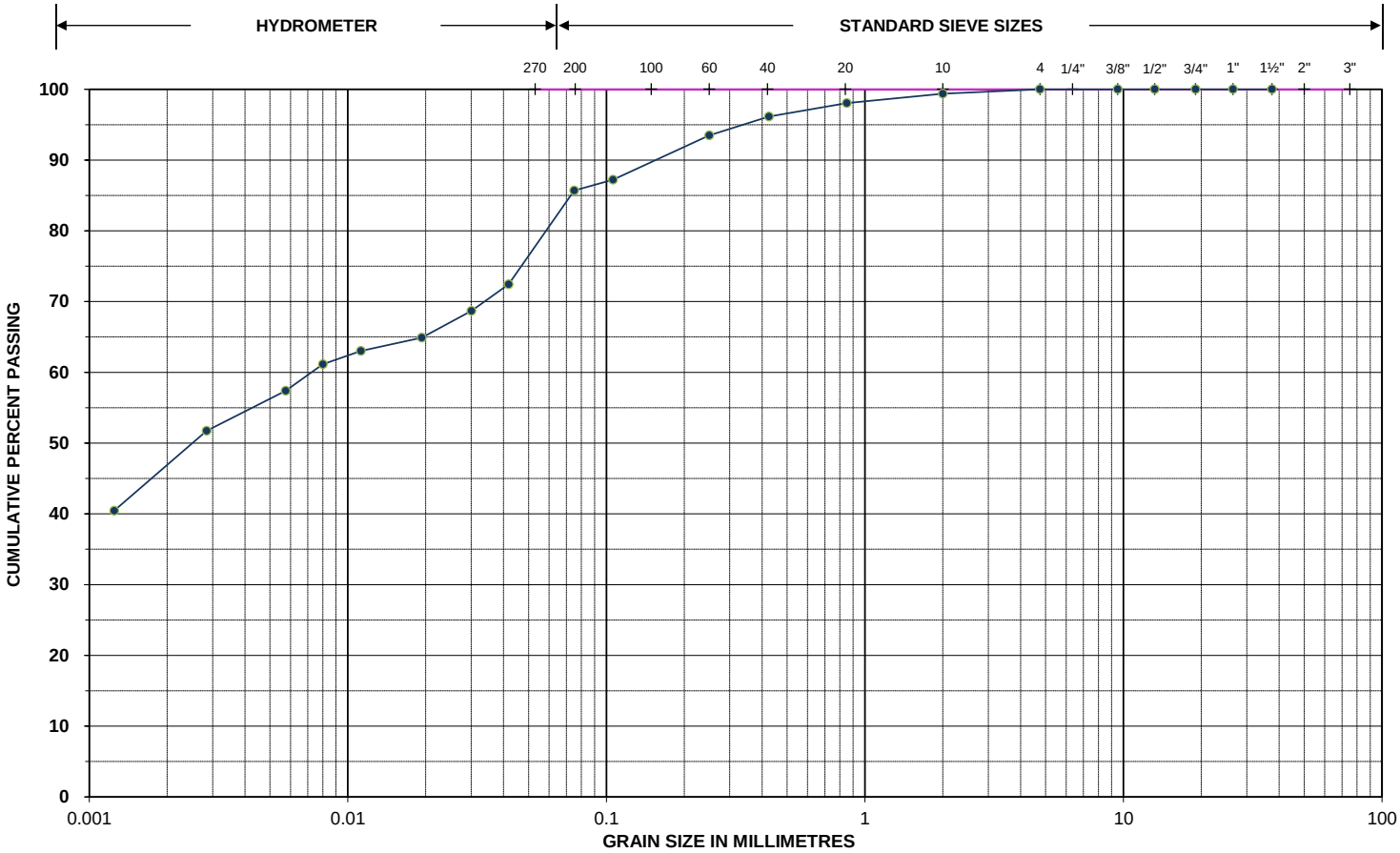
SILT AND CLAY	SAND	GRAVEL

Project Name: Amherstburg Navigation Aids **Project No.:** 181-14155-00

Location ID.: BH18-05 **Sample No./Depth:** SS5

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine	Hydrometer (mm)	% Passing
37.5 mm	100.0	**2.00 mm**	94.5	**0.041**	64.5
26.5 mm	100.0	**0.850 mm**	93.2	**0.019**	52.8
19.0 mm	100.0	**0.425 mm**	91.1	**0.008**	42.5
13.2 mm	99.3	**0.250 mm**	88.8	**0.003**	28.6
9.50 mm	98.7	**0.106 mm**	83.7	**0.001**	20.5
4.75 mm	97.5	**0.075 mm**	81.6		

PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

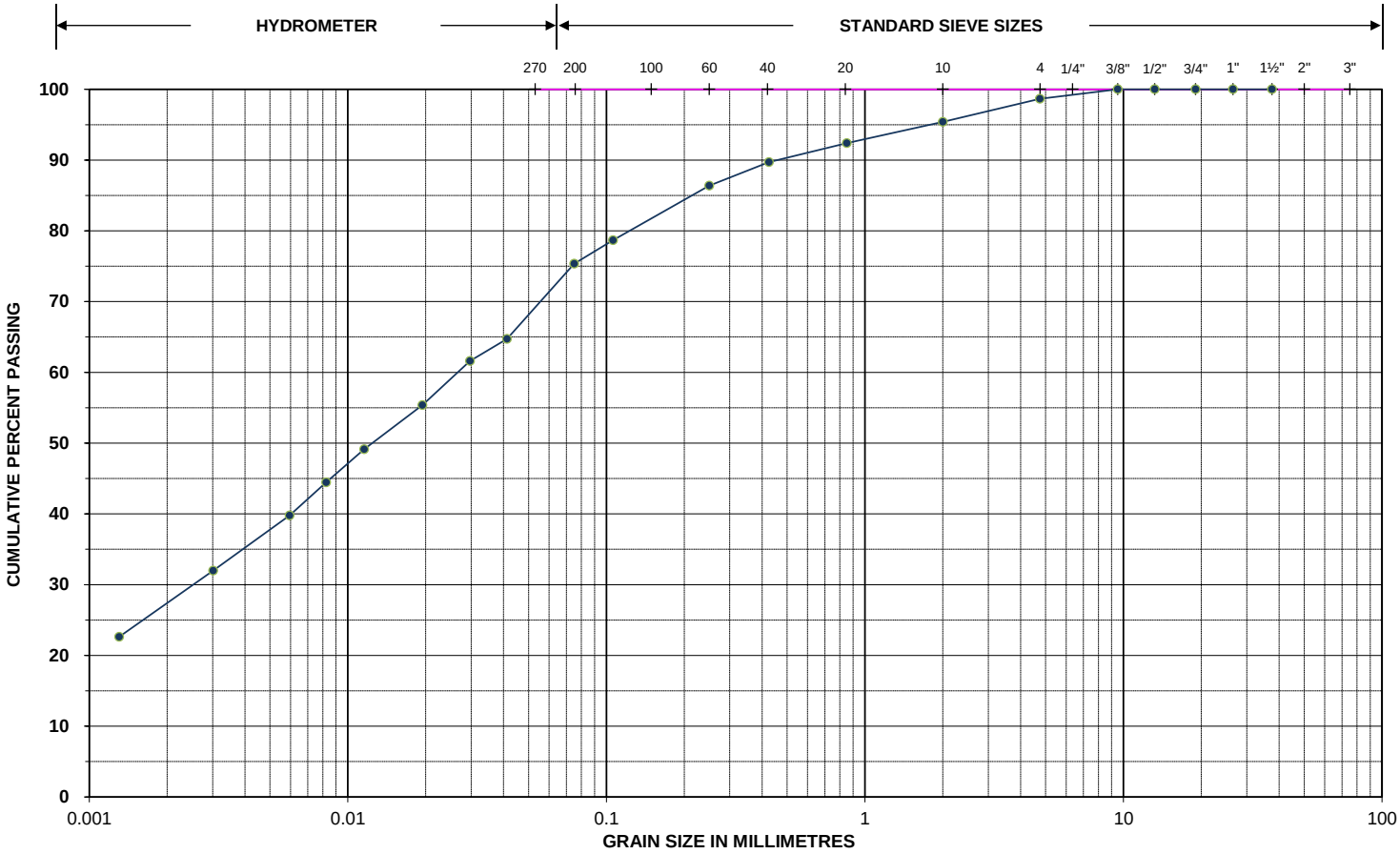
SILT AND CLAY	SAND	GRAVEL

Project Name: Amherstburg Navigation Aids **Project No.:** 181-14155-00

Location ID.: BH18-06 **Sample No./Depth:** AS1

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine	Hydrometer (mm)	% Passing
37.5 mm	100.0	**2.00 mm**	99.4	**0.042**	72.4
26.5 mm	100.0	**0.850 mm**	98.1	**0.019**	64.9
19.0 mm	100.0	**0.425 mm**	96.2	**0.008**	61.1
13.2 mm	100.0	**0.250 mm**	93.5	**0.003**	51.7
9.50 mm	100.0	**0.106 mm**	87.2	**0.001**	40.5
4.75 mm	100.0	**0.075 mm**	85.7		

PARTICLE SIZE DISTRIBUTION ASTM D422



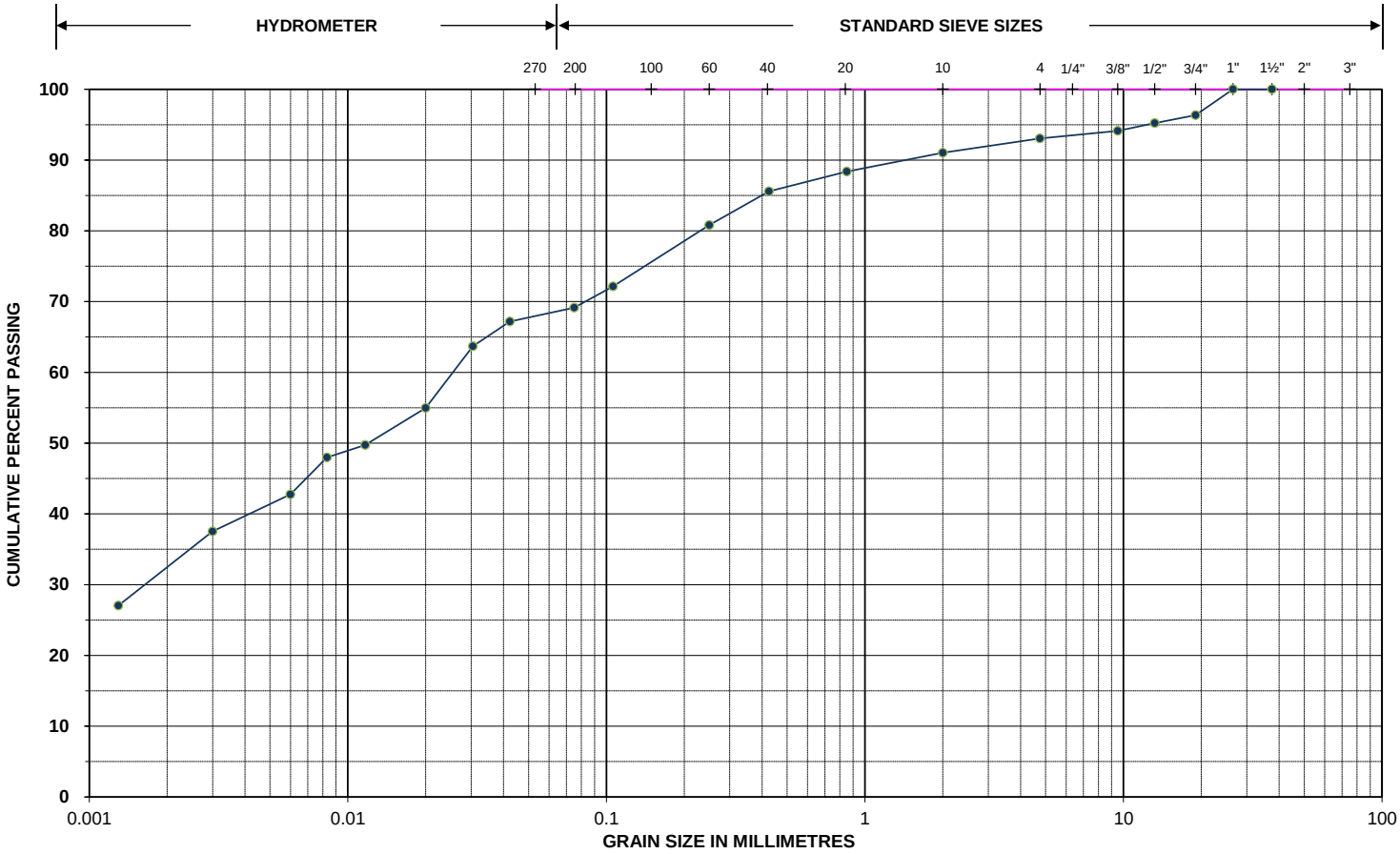
Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name:	Amherstburg Navigation Aids	**Project No.:**	181-14155-00
Location ID.:	BH18-06	**Sample No./Depth:**	AS3

Sieve Size	% Passing Coarse	**Sieve Size**	% Passing Fine	Hydrometer (mm)	% Passing
37.5 mm	100.0	**2.00 mm**	95.4	**0.041**	64.7
26.5 mm	100.0	**0.850 mm**	92.4	**0.019**	55.4
19.0 mm	100.0	**0.425 mm**	89.7	**0.008**	44.5
13.2 mm	100.0	**0.250 mm**	86.4	**0.003**	32.0
9.50 mm	100.0	**0.106 mm**	78.7	**0.001**	22.6
4.75 mm	98.7	**0.075 mm**	75.3		

PARTICLE SIZE DISTRIBUTION ASTM D422



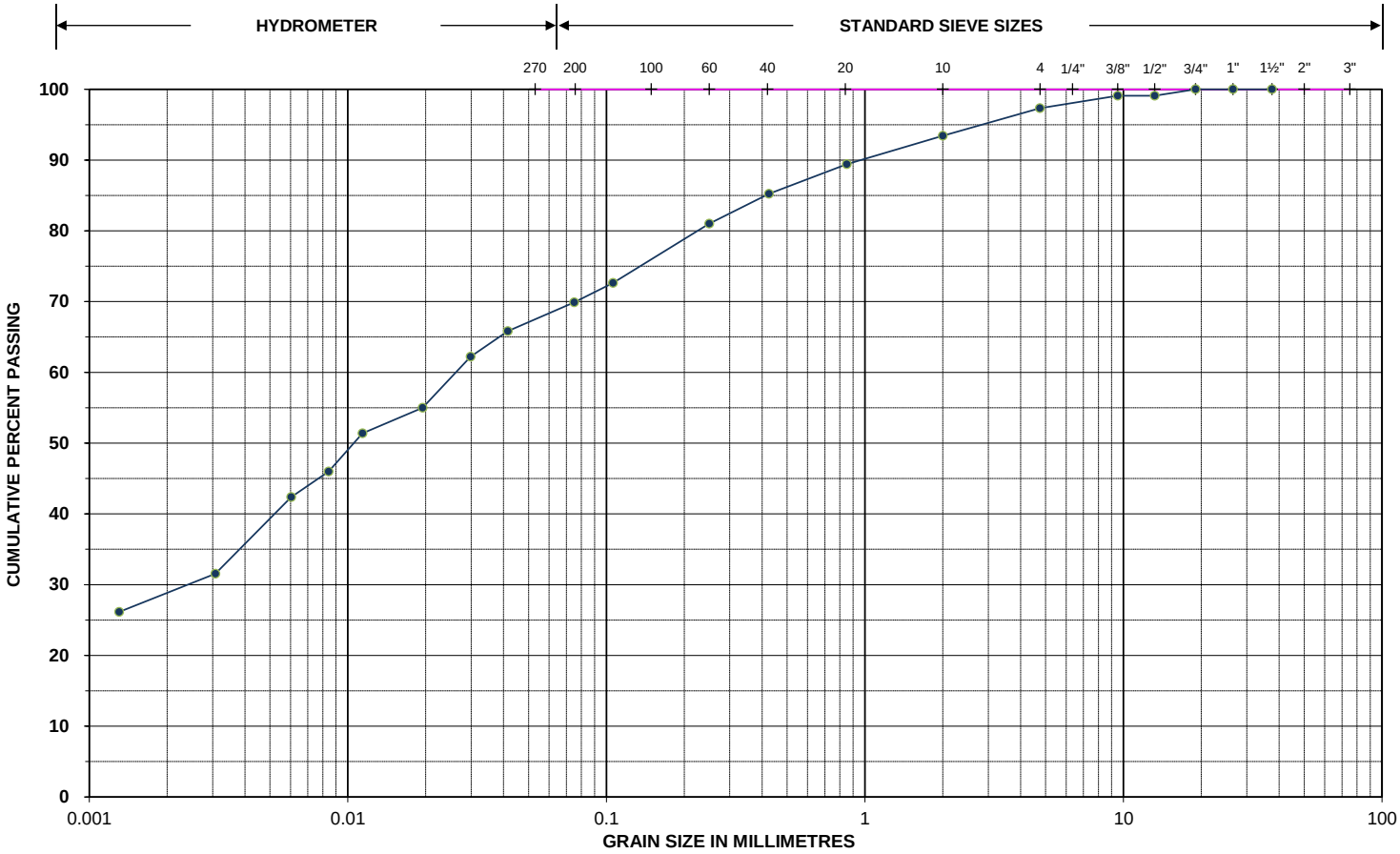
Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name:	Amherstburg Navigation Aids	**Project No.:**	181-14155-00
Location ID.:	BH18-07	**Sample No./Depth:**	SS3

Sieve Size	% Passing Coarse	**Sieve Size**	% Passing Fine	Hydrometer (mm)	% Passing
37.5 mm	100.0	**2.00 mm**	91.0	**0.042**	67.2
26.5 mm	100.0	**0.850 mm**	88.4	**0.020**	55.0
19.0 mm	96.4	**0.425 mm**	85.6	**0.008**	48.0
13.2 mm	95.2	**0.250 mm**	80.8	**0.003**	37.5
9.50 mm	94.1	**0.106 mm**	72.1	**0.001**	27.0
4.75 mm	93.0	**0.075 mm**	69.1		

PARTICLE SIZE DISTRIBUTION ASTM D422



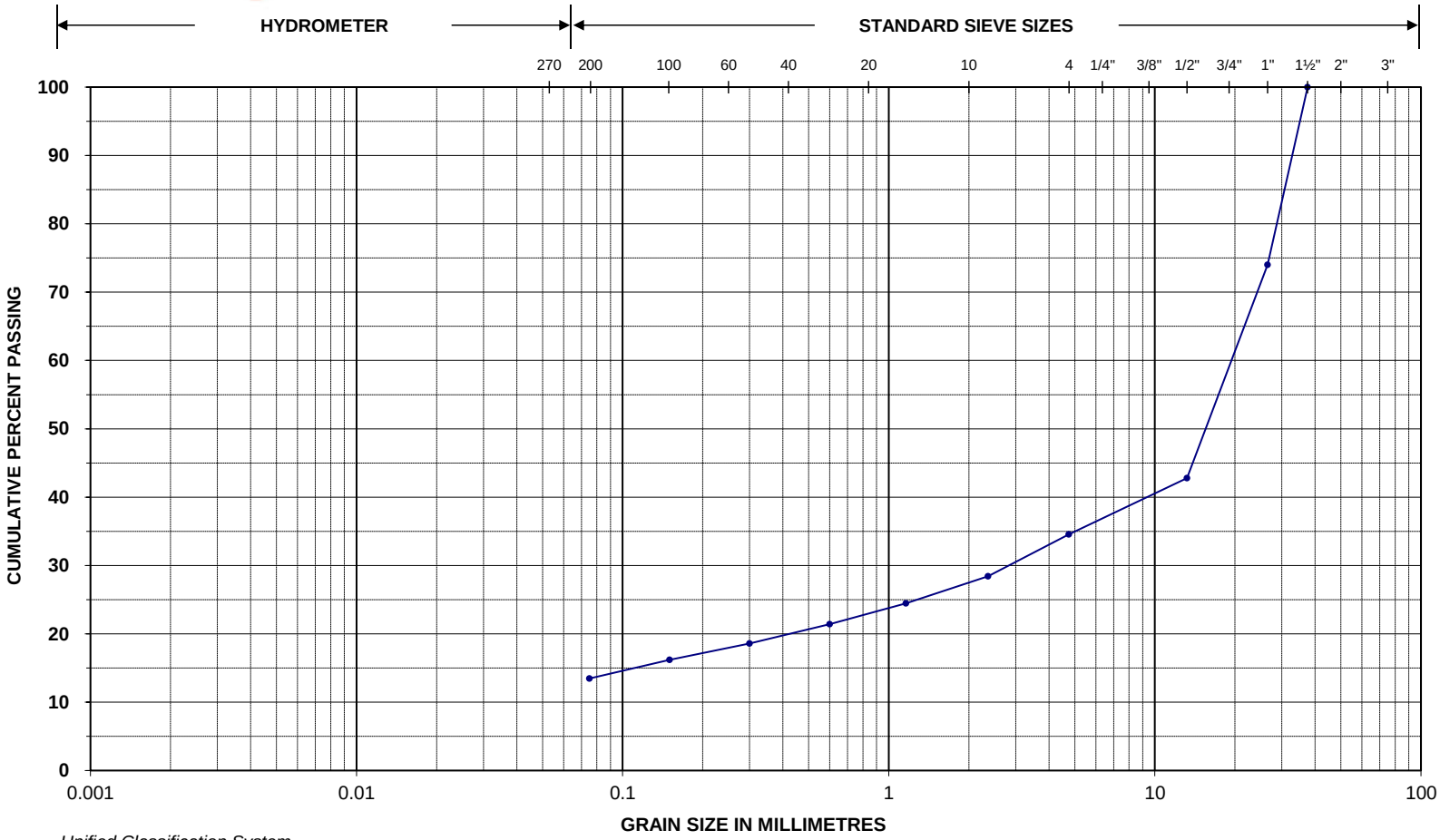
Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name:	Amherstburg Navigation Aids	**Project No.:**	181-14155-00
Location ID.:	BH18-07	**Sample No./Depth:**	SS5

Sieve Size	% Passing Coarse	**Sieve Size**	% Passing Fine	Hydrometer (mm)	% Passing
37.5 mm	100.0	**2.00 mm**	93.4	**0.042**	65.8
26.5 mm	100.0	**0.850 mm**	89.4	**0.019**	55.0
19.0 mm	100.0	**0.425 mm**	85.2	**0.008**	46.0
13.2 mm	99.1	**0.250 mm**	81.0	**0.003**	31.6
9.50 mm	99.1	**0.106 mm**	72.6	**0.001**	26.1
4.75 mm	97.3	**0.075 mm**	69.9		

PARTICLE SIZE DISTRIBUTION



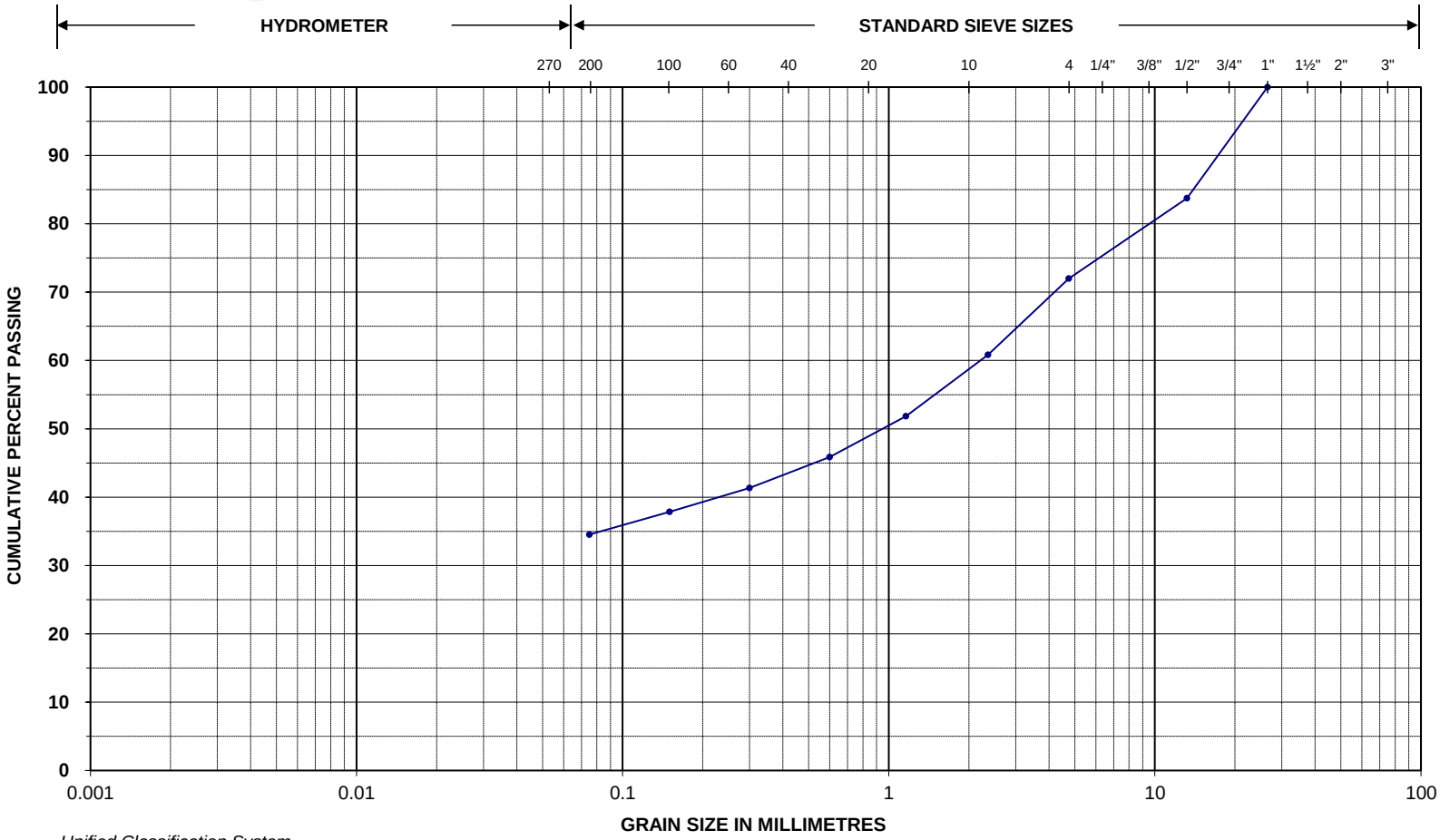
Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name:	Amherstburg Navigation Aids	**Project No.:**	181-14155-00
Location ID.:	BH18-08	**Sample No./Depth:**	SS3

Sieve Size	% Passing Coarse	**Sieve Size**	% Passing Fine
37.5 mm	100.0	**1.16 mm**	24.5
26.5 mm	74.0	**0.60 mm**	21.4
13.2 mm	42.8	**0.30 mm**	18.6
4.75 mm	34.6	**0.15 mm**	16.2
2.36 mm	28.4	**0.075 mm**	13.5

PARTICLE SIZE DISTRIBUTION



Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name:	Amherstburg Navigation Aids	**Project No.:**	181-14155-00
Location ID.:	BH18-08	**Sample No./Depth:**	SS5 / SS6

Sieve Size	% Passing Coarse	**Sieve Size**	% Passing Fine
37.5 mm	100.0	**1.16 mm**	51.8
26.5 mm	100.0	**0.60 mm**	45.9
13.2 mm	83.7	**0.30 mm**	41.3
4.75 mm	72.0	**0.15 mm**	37.9
2.36 mm	60.8	**0.075 mm**	34.5

APPENDIX

C CORROSIVITY LABORATORY DATA

FINAL REPORT

CA14534-FEB19 R1

181-14155-00, Amhertsburg, ON

Prepared for

WSP Canada Group Limited

FINAL REPORT

First Page

CLIENT DETAILS

Client	WSP Canada Group Limited
Address	294 Rink St. Peterborough, ON K9J 2K2. Canada
Contact	Pete Hynes
Telephone	705.743.6850
Facsimile	
Email	Peter.hynes@wsp.com
Project	181-14155-00, Amhertsburg, ON
Order Number	
Samples	Soil (5)

LABORATORY DETAILS

Project Specialist	Brad Moore Hon. B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2000
Facsimile	705-652-6365
Email	
SGS Reference	CA14534-FEB19
Received	02/21/2019
Approved	03/05/2019
Report Number	CA14534-FEB19 R1
Date Reported	03/05/2019

COMMENTS

Temperature of Sample upon Receipt: 6 degrees C
Cooling Agent Present: yes
Custody Seal Present: no

Chain of Custody Number: 006368

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Brad Moore Hon. B.Sc

TABLE OF CONTENTS

Client: WSP Canada Group Limited
Project: 181-14155-00, Amhertsburg, ON
Project Manager: Pete Hynes
Samplers: Mike Nieukirk

PACKAGE: **- Corrosivity Index** (SOIL)

			Sample Number	5	6	7	8	9
			Sample Name	BH 18-01 SS4	BH 18-02 SS4	BH 18-03 SS3	BH 18-04 SS4	BH 18-05 SS5
			Sample Matrix	Soil	Soil	Soil	Soil	Soil
			Sample Date	12/12/2018	13/12/2018	12/02/2019	14/02/2019	14/02/2019
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**
Corrosivity Index								
Corrosivity Index	none	1		5	9.5	7.5	2	7.5
Soil Redox Potential	mV	-		232	229	370	240	232
Sulphide	%	0.02		< 0.02	0.03	0.02	< 0.02	0.02
pH	pH Units	0.05		8.53	8.69	8.55	8.40	8.81
Resistivity (calculated)	ohms.cm	-9999		2940	2380	4910	2710	3550

PACKAGE: **- General Chemistry** (SOIL)

			Sample Number	5	6	7	8	9
			Sample Name	BH 18-01 SS4	BH 18-02 SS4	BH 18-03 SS3	BH 18-04 SS4	BH 18-05 SS5
			Sample Matrix	Soil	Soil	Soil	Soil	Soil
			Sample Date	12/12/2018	13/12/2018	12/02/2019	14/02/2019	14/02/2019
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**
General Chemistry								
Conductivity	uS/cm	2		340	421	204	369	282

PACKAGE: **- Metals and Inorganics** (SOIL)

			Sample Number	5	6	7	8	9
			Sample Name	BH 18-01 SS4	BH 18-02 SS4	BH 18-03 SS3	BH 18-04 SS4	BH 18-05 SS5
			Sample Matrix	Soil	Soil	Soil	Soil	Soil
			Sample Date	12/12/2018	13/12/2018	12/02/2019	14/02/2019	14/02/2019
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics								
Moisture Content	%	0.1		7.4	5.9	15.6	9.4	7.7
Sulphate	µg/g	0.4		150	110	16	99	50

Client: WSP Canada Group Limited

Project: 181-14155-00, Amhertsburg, ON

Project Manager: Pete Hynes

Samplers: Mike Nieukirk

PACKAGE: **- Other (ORP)** (SOIL)

Sample Number	5	6	7	8	9	
Sample Name	BH 18-01 SS4	BH 18-02 SS4	BH 18-03 SS3	BH 18-04 SS4	BH 18-05 SS5	
Sample Matrix	Soil	Soil	Soil	Soil	Soil	
Sample Date	12/12/2018	13/12/2018	12/02/2019	14/02/2019	14/02/2019	
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**	**Result**
Other (ORP)							
Chloride	µg/g	0.4	13	11	4.7	11	7.0

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0313-FEB19	µg/g	0.4	<0.4	1	20	95	80	120	101	75	125
Sulphate	DIO0313-FEB19	µg/g	0.4	<0.4	0	20	94	80	120	94	75	125
Chloride	DIO0366-FEB19	µg/g	0.4	<0.4	3	20	103	80	120	100	75	125
Sulphate	DIO0366-FEB19	µg/g	0.4	<0.4	19	20	98	80	120	93	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	ECS0035-FEB19	%	0.02	<0.02	10	20	120	80	120			
Sulphide	ECS0041-FEB19	%	0.02	<0.02	ND	20	119	80	120			

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0331-FEB19	pH Units	0.05	NA	1		99			NA		

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates 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.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.
RL Reporting Limit.
↑ Reporting limit raised.
↓ Reporting limit lowered.
NA The sample was not analysed for this analyte
ND Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

-- End of Analytical Report --

SGS Request for Laboratory Services and CHAIN OF CUSTODY

No: 006368

Page 1 of 1

Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

Laboratory Information Section - Lab use only

Received By: K Hitherton
Received Date (mm/dd/yyyy): 02/21/19 (mm\dd\yy)
Received Time: 18:45
Received By (signature): K Hitherton
Custody Seal Present: ☐ NO
Custody Seal Intact: ☐ NO
Cooling Agent Present: ☑ Ice
Temperature Upon Receipt (°C): 6x3
LAB LIMS #: CA14534-Feb 19

REPORT INFORMATION

Company: WSP Canada Inc.
Contact: Pete Hynes
Address: 294 Rinlr St. Suite 103
Peterborough, ON
Phone: 705-743-6850
Email: Peter.Hynes@wsp.com
Email:

INVOICE INFORMATION

☑ (same as Report Information)
Company:
Contact:
Address:
Phone:
Email:

PROJECT INFORMATION

Quotation #: 181-14155-00
P.O. #:
Project #: 181-14155-00
Site Location/ID: Amherstsburg, ON

TURNAROUND TIME (TAT) REQUIRED

☑ Regular TAT (5-7days)

TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:
Rush Confirmation ID:

REGULATIONS

Regulation 153/04:
☑ Table 1 ☐ R/P/I
☐ Table 2 ☐ I/C/C
☐ Table 3 ☐ A/O
☐ Table ____
Soil Texture: ☐ Coarse ☐ Medium ☐ Fine

Other Regulations:
☐ Reg 347/558 (3 Day min TAT)
☐ PWQO ☐ MMER
☐ CCME ☐ Other:
☐ MISA

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality:

NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	Metals & Inorganics	PAH ☐ ABN ☐ SVOC(all) ☐	PCB Total ☐ Aroclor ☐	PHC F1-F4 ☐ VOC ☐ BTEX ☐ BTEX/F1 ☐ F2-F4 ☐	VOC ☐ BTEX ☐ THM ☐	Pesticides OC ☐ OP ☐	TCLP M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit. ☐	Water Pkg Gen. ☐ Ext. ☐	Sewer Use:	Corrosivity Pkg.					COMMENTS:
1	BH18-01 SS4	Dec. 12/18	✓	1	S											X					
2	BH18-02 SS4	Dec. 13/19	✓	1	S											X					
3	BH18-03 SS3	Feb 12/19	✓	1	S											X					
4	BH18-04 SS4	Feb. 14/19	✓	1	S											X					
5	BH18-05 SS5	Feb. 15/19	✓	1	S											X					
6																					
7																					
8																					
9																					
10																					
11																					
12																					

Observations/Comments/Special Instructions

Sampled By (NAME): Mike Niewkirk
Signature:
Date: 02/21/19 (mm/dd/yy)

Relinquished by (NAME): Mike Niewkirk
Signature:
Date: 02/21/19 (mm/dd/yy)

Pink Copy - Client
Yellow & White Copy - SGS

Revision #: 1.1
Date of Issue: 04 April, 2018

Request for Laboratory Services and CHAIN OF CUSTODY

SGS Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

No: 008368 Page 1 of 1

Laboratory Information Section - Lab use only

Received By: K Hitherton
Received Date (mm/dd/yyyy): 02/21/19 (mm\dd\yy)
Received Time: 18:45
Received By (signature): K Hitherton
Custody Seal Present: ☐ NO
Custody Seal Intact: ☐ NO
Cooling Agent Present: ☑ Ice
Temperature Upon Receipt (°C): 6x3
LAB LIMS #: CA14534-Feb 19

REPORT INFORMATION

Company: WSP Canada Inc.
Contact: Pete Hynes
Address: 294 Rink St. Suite 103 Peterborough, ON
Phone: 705-743-6850
Email: Peter.Hynes@wsp.com
Email:

INVOICE INFORMATION

☑ (same as Report Information)
Company:
Contact:
Address:
Phone:
Email:

PROJECT INFORMATION

Quotation #: 181-14155-00
P.O. #:
Project #: 181-14155-00
Site Location/ID: Amherstsburg, ON

TURNAROUND TIME (TAT) REQUIRED

☑ Regular TAT (5-7days)
TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day
RUSH TAT (Additional Charges May Apply): ☐ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days
PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION
Specify Due Date:
Rush Confirmation ID:

REGULATIONS

Regulation 153/04: ☑ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ____ ☐ R/P/I ☐ I/C/C ☐ A/O
Soil Texture: ☐ Coarse ☐ Medium ☐ Fine
Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☐ PWQO ☐ MMER ☐ CCME ☐ Other: ☐ MISA
Sewer By-Law: ☐ Sanitary ☐ Storm Municipality:

NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	Metals & Inorganics	PAH ☐ ABN ☐ SVOC(all) ☐	PCB Total ☐ Aroclor ☐	PHC F1-F4 ☐ BTEX ☐ BTEX/F1 ☐ VOC ☐ F2-F4 ☐	VOC ☐ BTEX ☐ THM ☐	Pesticides OC ☐ OP ☐	TCLP M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit. ☐	Water Pkg Gen. ☐ Ext. ☐	Sewer Use:	Corrosivity Pkg.					COMMENTS:
1	BH18-01 SS4	Dec. 12/18		1	Soil											X					
2	BH18-02 SS4	Dec. 13/19		1	Soil											X					
3	BH18-03 SS3	Feb 12/19		1	Soil											X					
4	BH18-04 SS4	Feb. 14/19		1	Soil											X					
5	BH18-05 SS5	Feb. 15/19		1	Soil											X					
6																					
7																					
8																					
9																					
10																					
11																					
12																					

Observations/Comments/Special Instructions

Sampled By (NAME): Mike Niestrik	Signature:	Date: 02/21/19 (mm/dd/yy)	Pink Copy - Client
Relinquished by (NAME): Mike Niestrik	Signature:	Date: 02/21/19 (mm/dd/yy)	Yellow & White Copy - SGS

Revision #: 1.1
Date of Issue: 04 April, 2018

Moore, Brad (Lakefield)

From: Hynes, Pete <Peter.Hynes@wsp.com>
Sent: Friday, February 22, 2019 11:10 AM
To: Moore, Brad (Lakefield)
Cc: Nieukirk, Mike
Subject: RE: 181-14155-00 limited sample

I will have my guy look into if we have any left. Hold off doing anything right now.

Pete Hynes, P.Eng.
Project Engineer
Environment

wsp

T+ 1 705-743-6850
D+ 1 705-270-0172

294 Rink Street, Suite 103
Peterborough, Ontario,
K9J 2K2 Canada

wsp.com

From: Moore, Brad (Lakefield) [mailto:brad.moore@sgs.com]
Sent: Friday, February 22, 2019 11:08 AM
To: Hynes, Pete <Peter.Hynes@wsp.com>
Subject: 181-14155-00 limited sample

Good morning Pete,

Please see the attached CofC submitted with your samples yesterday. If has been brought to my attention that the samples are primarily stones and since stones are removed for some of the analysis, this leaves us with very limited sample. One solution would be for us to have the samples crushed prior to analysis. Given that these are not regulated parameters, how would you like for us to proceed with analysis?

Regards,

Brad Moore, Hon.B.Sc.,
Environment, Health & Safety
Project Specialist

SGS Canada Inc.
Phone: +1 705-652-2143
Mobile: +1 705-559-9095

E-mail: brad.moore@sgs.com

FINAL REPORT

CA14439-MAR19 R1

181-14155-00, Amherstburg, ON

Prepared for

WSP Canada Inc.

FINAL REPORT

First Page

CLIENT DETAILS

Client	WSP Canada Inc.
Address	294 Rink St. Peterborough, ON K9J 2K2. Canada
Contact	Mike Nieukirk
Telephone	705.761-0128
Facsimile	
Email	michael.nieukirk@wsp.com
Project	181-14155-00, Amherstburg, ON
Order Number	
Samples	Soil (3)

LABORATORY DETAILS

Project Specialist	Brad Moore Hon. B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2000
Facsimile	705-652-6365
Email	
SGS Reference	CA14439-MAR19
Received	03/15/2019
Approved	03/21/2019
Report Number	CA14439-MAR19 R1
Date Reported	03/21/2019

COMMENTS

Temperature of Sample upon Receipt: 6 degrees C
Cooling Agent Present:Yes
Custody Seal Present:No

Chain of Custody Number:NA

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Brad Moore Hon. B.Sc

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Client: WSP Canada Inc.

Project: 181-14155-00, Amherstburg, ON

Project Manager: Mike Nieukirk

Samplers: Mike N

PACKAGE: **REG153 - Corrosivity Index** (SOIL)

Sample Number			5	6	7
Sample Name			BH18-07 SS4	BH18-06 AS2	BH18-08 SS4
Sample Matrix			Soil	Soil	Soil
Sample Date			11/03/2019	12/03/2019	12/03/2019
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**
Corrosivity Index						
Corrosivity Index	none	1		1	1	7.5
Soil Redox Potential	mV	-		261	257	238
Sulphide	%	0.02		< 0.02	< 0.02	0.04
pH	pH Units	0.05		8.40	8.34	8.66
Resistivity (calculated)	ohms.cm	-9999		4130	5420	7650

PACKAGE: **REG153 - General Chemistry** (SOIL)

Sample Number			5	6	7
Sample Name			BH18-07 SS4	BH18-06 AS2	BH18-08 SS4
Sample Matrix			Soil	Soil	Soil
Sample Date			11/03/2019	12/03/2019	12/03/2019
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**
General Chemistry						
Conductivity	uS/cm	2		242	184	131

PACKAGE: **REG153 - Metals and Inorganics** (SOIL)

Sample Number			5	6	7
Sample Name			BH18-07 SS4	BH18-06 AS2	BH18-08 SS4
Sample Matrix			Soil	Soil	Soil
Sample Date			11/03/2019	12/03/2019	12/03/2019
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**
Metals and Inorganics						
Moisture Content	%	0.1		10.8	13.9	18.3
Sulphate	µg/g	0.4		28	9.7	24

Client: WSP Canada Inc.

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PACKAGE: **REG153 - Other (ORP)** (SOIL)

Sample Number	5	6	7
Sample Name	BH18-07 SS4	BH18-06 AS2	BH18-08 SS4
Sample Matrix	Soil	Soil	Soil
Sample Date	11/03/2019	12/03/2019	12/03/2019

Parameter	Units	RL		Result	Result	Result
Other (ORP)						
Chloride	µg/g	0.4		34	6.0	13

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0262-MAR19	µg/g	0.4	<0.4	12	20	95	80	120	114	75	125
Sulphate	DIO0262-MAR19	µg/g	0.4	<0.4	0	20	94	80	120	102	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	ECS0021-MAR19	%	0.02	<0.02	6	20	119	80	120			

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0281-MAR19	uS/cm	2	< 2	1	10	100	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0276-MAR19	pH Units	0.05	NA	1		101			NA		

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates 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.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS	Insufficient sample for analysis.
RL	Reporting Limit.
↑	Reporting limit raised.
↓	Reporting limit lowered.
NA	The sample was not analysed for this analyte
ND	Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

-- End of Analytical Report --

SGS

Request for Laboratory Services and CHAIN OF CUSTODY

No:

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SGS Environment, Health and Safety
- Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Toll Free: 877-747-7658 Fax: 705-652-6365
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361 Web: www.ca.sgs.com

Received By: Breanne Curry
Received Date: 03\15\19 (mm\dd\yy)
Received Time: 16 : 00 am / pm (circle)

Laboratory Information Section - Lab use only
Received By (signature):
Custody Seal Present: Y / N (circle)
Custody Seal Intact: Y / N
Cooling Agent Present: Y / N Type: Ice
Temperature Upon Receipt (°C) 6x3

LAB LIMS #: CA14439-Mar19

REPORT INFORMATION

Company: WSP Canada Inc.
Contact: Michael Niewkirk
Address: 294 Rinks Street Suite 103
Peterborough, ON K9J 2K2
Phone: 705-761-0129
Fax:
Email: michael.niewkirk@wsp.com

INVOICE INFORMATION

☒ (same as Report Information)
Company:
Contact:
Address:
Phone:
Email:

PROJECT INFORMATION

Quotation #: 181-14155-00
P.O. #:
Project #: 181-14155-00
Site Location/ID: Amherstburg, ON

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days)
TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 3pm or on weekends : TAT begins the next business day

RUSH TAT (Additional Charges May Apply) ☐ 1 Day ☐ 2 Days ☐ 3-4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date: Rush Confirmation ID:

REGULATIONS

Regulation 153 (2011):
☒ Table 1 ☐ Res/Park ☐ Soil Texture:
☐ Table 2 ☐ Ind/Com ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ Medium
☐ Table ____ ☐ Fine

Other Regulations:
☐ Reg 347/558 (3 Day min TAT)
☐ PWQO ☐ MMER
☐ CCME ☐ Other:
☐ MISA

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality:

DRINKING WATER SAMPLES (POTABLE WATER FOR HUMAN CONSUMPTION) MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	X Corrosivity Phys.	COMMENTS: Field Filtered (F) Preserved (P)
1	BH18-07 SS4	Mar.11/19	✓	1	S	X	
2	BH18-06 AS2	Mar.12/19	✓	1	S	X	
3	BH18-08 SS4	Mar.12/19	✓	1	S	X	
4							
5							
6							
7							
8							
9							
10							

Observations/Comments/Special Instructions

Sampled By (NAME): Mike Niewkirk	**Signature:**	Date: 03 / 15 / 19 (mm/dd/yy)	Pink Copy - Client
Relinquished by (NAME): Mike Niewkirk	**Signature:**	Date: 03 / 15 / 19 (mm/dd/yy)	Yellow & White Copy - SGS