# Appendix A: Geotechnical Reports

# GEOTECHNICAL FACTUAL REPORT
# GRAND BANK, NL

(FFC File: 3087)

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# Preface

Department of Fisheries and Oceans (DFO) through Public Works and Government Services Canada (PWGSC) retained Fracflow Consultants Inc. to undertake a marine geotechnical site investigation at Grand Bank, NL. This investigation was conducted according to the pricing and stipulations outlined in the existing Standing Offer Contract (No. EA003-160505/001/PWD) between PWGSC and Fracflow Consultants Inc.

The proposed scope of work for the Grand Bank project consisted of drilling and sampling twenty-eight (28) geotechnical boreholes: eight (8) boreholes through the existing concrete wharf, and twenty (20) boreholes over the edge of the existing wharf. Based on results obtained from boreholes that were drilled at similar locations, three (3) boreholes over the edge of the wharf were omitted, and twenty-five (25) boreholes were completed. The scope of work also included collection of marine sediment samples at borehole locations selected by PWGSC. The field work was conducted between May 5 and 18, and May 26 and June 5, 2016.

The field work for these investigations utilized a Foremost Mobile B-47 geotechnical drill rig at the approximate locations specified by the project engineer. Some boreholes had to be moved slightly from the proposed locations to avoid infrastructure underneath and on the current wharf. Split-spoon sampling and Standard Penetration Tests (SPTs) were conducted using a NW/NQ diamond drill string in each borehole at the standard 1.5 m interval. Marine sediment sampling was conducted using a grab sampler and a HW/HQ diamond drill string and a 76 mm diameter split spoon. HW casing was used to drill access holes through the concrete deck of the wharf.

A visual inspection of the subsurface soil conditions encountered, based on the split-spoon samples that were recovered during the field program, was used to describe the soil conditions at the site. The end of hole elevations of the twenty-five (25) boreholes ranged from -4.17 m LNT in BH22 to -17.84 m LNT in BH10.

The overburden, based on the twenty-five (25) boreholes that were completed as part of this geotechnical investigation, can be summarized as a layer of varying amounts of sand and gravel with trace to some silt/clay from ocean bottom to bedrock. Overburden thicknesses range from 0.13 m in BH13 to 13.07 m in BH24. Bedrock or broken bedrock was encountered in twenty-five (25) boreholes at elevations ranging from 0.31 m LNT in BH22 to -12.47 m LNT in BH10. The thickness of the overburden and the depth to solid bedrock are shown on two contour maps and in cross section. Two (2) distinct bedrock types were recovered, a volcanic tuff from the northern end of the wharf, and a volcanic flow from the southern end of the wharf. Areas of highly fractured bedrock were encountered in the central section of the wharf (BH10 to BH13) and the southern end of the wharf (BH20, BH25 to BH28). Rock strength data from Point Load Tests and Brazilian tests on representative samples of the rock core show that the rock properties are highly variable with low tensile strength due to the pervasive microfracture network.

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# 1.0 INTRODUCTION

Department of Fisheries and Oceans (DFO) through Public Works and Government Services Canada (PWGSC) retained Fracflow Consultants Inc. to undertake a marine geotechnical site investigation at Grand Bank, NL. This investigation was conducted according to the pricing and stipulations outlined in the existing Standing Offer Contract (No. EA003-160505/001/PWD) between PWGSC and Fracflow Consultants Inc.

The proposed scope of work for the Grand Bank project consisted of drilling and sampling twenty-eight (28) geotechnical boreholes: eight (8) boreholes through the existing concrete wharf, and twenty (20) boreholes over the edge of the existing wharf. Based on results obtained from the drilled boreholes, three (3) boreholes over the edge of the wharf were omitted, and twenty-five (25) boreholes were completed. The scope of work also included collection of marine sediment samples at borehole locations selected by PWGSC. The field work was conducted between May 5 and 18, and May 26 and June 5, 2016.

The borehole and marine sediment sampling locations are shown on the site plan in **Figure 1.1**. A summary of the geotechnical field work conducted is shown in **Table 1.1**. A summary of the marine sediment sampling is shown in **Table 1.2**. All sediment samples were delivered to AGAT Laboratories in St. John's on behalf of DFO/PWGSC.

This report contains a factual presentation and full disclosure of all findings of the subsurface investigation. The following sections provide: (1) a description of the site and the general geology of the area; (2) a summary of the investigative procedures used; (3) a detailed description of the subsurface soil and rock conditions; and (4) a compilation of the bedrock and soil thickness in the form of contour maps and cross-sections. Appended to this report are the detailed geotechnical logs for each borehole and grain size analysis reports and related laboratory data for this current field investigation and the relevant logs from earlier borehole investigations by Fracflow.

Table 1.1 Summary of geotechnical investigations at Grand Bank, NL.

| Borehole ID | Overburden Drilled (m) | Bedrock Drilled (m) | Total Depth Drilled (m) | SPT & Split-spoon Samples Attempted | Split-spoon Samples Tested |
|---|---|---|---|---|---|
| **BH1** | 0.95 | 3.21 | 4.16 | 1 | 1 |
| **BH2** | 1.42 | 4.36 | 5.78 | 2 | 0 |
| **BH3** | 1.30 | 3.30 | 4.60 | 3 | 1 |
| **BH4** | 2.50 | 3.50 | 6.00 | 3 | 2 |
| **BH5** | 3.35 | 4.18 | 7.53 | 4 | 1 |
| **BH8** | 3.29 | 6.81 | 10.10 | 5 | 0 |
| **BH10** | 9.31 | 5.37 | 14.68 | 7 | 2 |
| **BH11** | 6.74 | 3.41 | 10.15 | 5 | 0 |
| **BH12** | 1.07 | 2.88 | 3.95 | 2 | 1 |
| **BH13** | 0.13 | 3.64 | 3.77 | 1 | 0 |
| **BH14** | 2.52 | 2.24 | 4.76 | 3 | 0 |
| **BH15** | 0.64 | 3.27 | 3.91 | 1 | 1 |
| **BH16** | 0.43 | 2.85 | 3.28 | 1 | 1 |
| **BH17** | 0.62 | 2.66 | 3.28 | 2 | 1 |
| **BH18** | 2.83 | 2.74 | 5.57 | 2 | 1 |
| **BH19** | 2.95 | 3.00 | 5.95 | 3 | 1 |
| **BH20** | 4.86 | 3.42 | 8.28 | 4 | 2 |
| **BH21** | 5.11 | 2.81 | 7.92 | 5 | 0 |
| **BH22** | 1.17 | 4.48 | 5.65 | 3 | 0 |
| **BH23** | 5.06 | 3.44 | 8.50 | 5 | 1 |
| **BH24** | 13.07 | 0.00 | 13.07 | 8 | 2 |
| **BH25** | 1.39 | 3.87 | 5.26 | 3 | 0 |
| **BH26** | 0.78 | 3.00 | 3.78 | 2 | 1 |
| **BH27** | 2.62 | 2.98 | 5.60 | 3 | 0 |
| **BH28** | 6.05 | 3.32 | 9.37 | 5 | 3 |
| **Total** | 80.12 | 84.73 | 164.85 | 83 | 22 |

Table 1.2 Summary of marine sediment sampling at Grand Bank, NL.

| Borehole No. | Depth to Harbour Bottom Relative to LNT (m) | Final sample/hole Depth Relative to LNT (m) | Split-spoon Samples Attempted | Sample ID's | Samples Submitted for Analysis |
|---|---|---|---|---|---|
| **BH2** | -3.02 | -3.86 | 1 | BH2-MS1-OB<br>BH2-MS1-0.0.7811z | 2 |
| **BH5** | -3.07 | -4.1 | 1 | BH5-MS1-OB<br>BH5-MS1-0-0.9144z | 2 |
| **BH10** | -3.16 | -3.62 | 1 | BH10-MS1-OB<br>BH10-MS1-0-1.176z | 2 |
| **BH13** | -1.82 | -2.06 | 1 | BH13-MS1-OB<br>BH13-MS1-0.0.343z | 2 |
| **BH16** | -4.09 | -4.94 | 1 | BH16-MS1-0-0.7366z | 1 |
| **BH19** | -3.45 | -4.87 | 1 | BH19-MS1-OB<br>BH19-MS1-0-0.9398z | 1 |

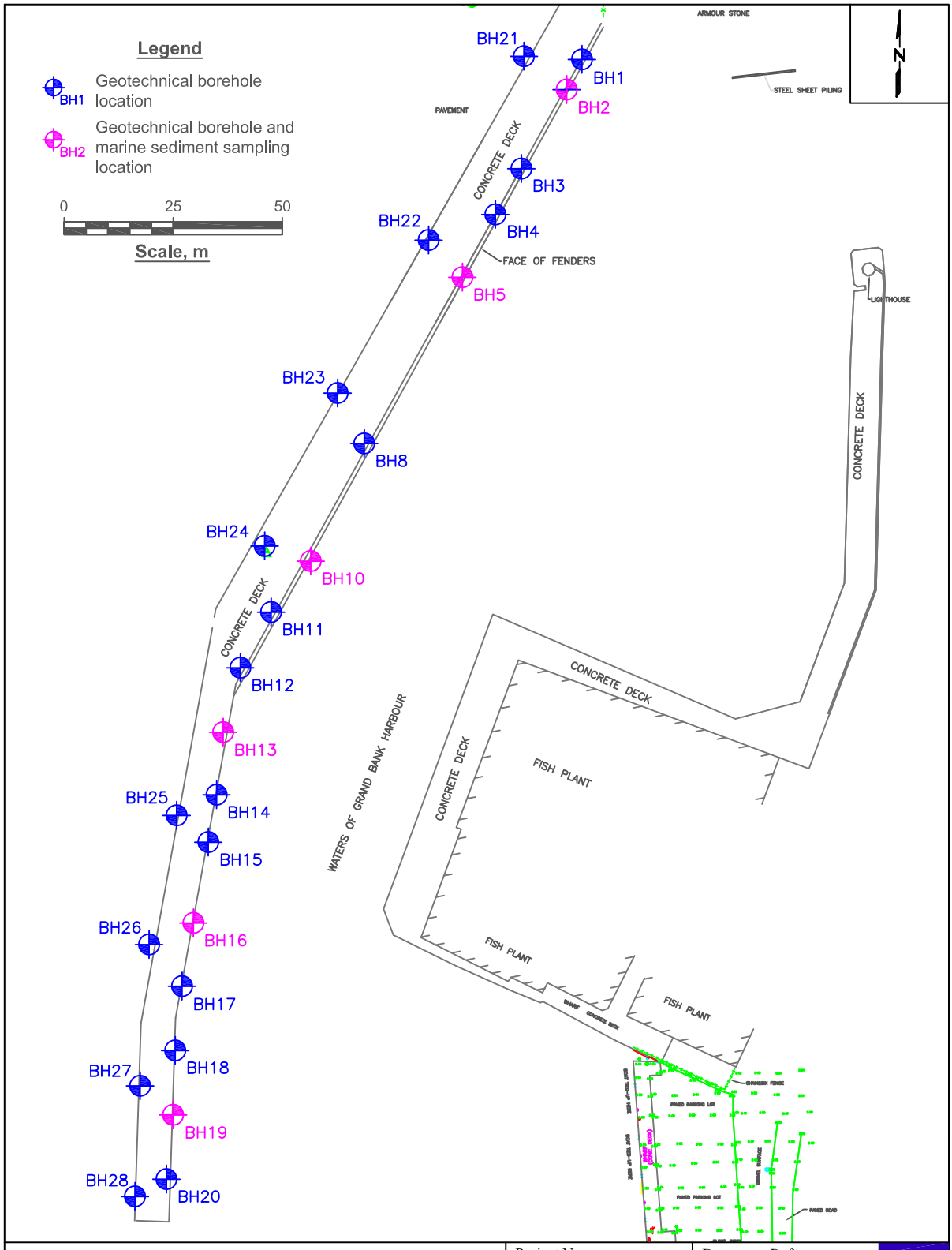


Figure 1.1 Location map of boreholes and marine sediment samples.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087 |
| Location: Grand Bank, NL | Date: June 2016 |

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# 2.0 SITE DESCRIPTION AND GENERAL GEOLOGY

The community of Grand Bank is located in Fortune Bay, on the southern tip of the Burin Peninsula. Overburden in the area is characterized by glacial till overlying bedrock (Batterson, 2007). Bedrock in the area consists of “rhyolitic ash - flow tuffs; flows and breccias; associated epliclastic rocks; minor unseparated mafic flows and tuffs; sericitic and chloritic schists” of the Marystown Group (O’Driscoll, 1995).

# 3.0 INVESTIGATIVE PROCEDURES

At the Grand Bank site, the project consisted of drilling and sampling twenty-five (25) boreholes and collecting marine sediment samples at six (6) of those borehole locations. The field work for these investigations utilized a Foremost Mobile B-47 at the locations shown in **Figure 1.1**. The field work was conducted between May 5 and 18, and May 26 and June 5, 2016. Due to the limited space on the wharf and the high traffic activity, a special light-weight platform had to be constructed to allow for rapid set-up and movement from hole to hole when drilling over the edge of the wharf or close to the edge of the wharf.

Overburden material was drilled using 'NW' (OD 88.9 mm, ID 76.2 mm) flush joint casing and "NQ" (OD 69.9 mm, ID 60.3 mm) diamond drill string. Soil samples were collected using a 51 mm OD, 610 mm long, split-spoon sampler. In conjunction with this split-spoon soil sampling, Standard Penetration Tests (SPTs) were performed to estimate relative soil densities. The standard procedure is to drive each split-spoon into the ground using a 63.5 kg weight falling a distance of 760 mm. The number of blows is recorded for each 150 mm the split-spoon is advanced. After the first 150 mm advance, a N-value is calculated as the sum of the blow counts required to drive the spoon an additional 300 mm (i.e., the sum of the second and third set of blow counts). The calculated N-value is a direct reflection of the relative density of the soil strata as defined in the Canadian Foundation Engineering Manual (Canadian Geotechnical Society, 1992).

Marine sediment samples for environmental analysis were collected at boreholes BH2, BH5, BH10, BH16, and BH19. Marine sediment samples at ocean bottom were collected using a grab sampler. Sediment samples were collected from ocean bottom to 1.0 m below ocean bottom or where the sampler encountered refusal, using a 76 mm diameter split spoon. Collection of the environmental samples followed the procedures that had been established by PWGSC. Samples were stored on ice before being submitted to AGAT Laboratories in St. John's for analysis.

Both the soil samples and rock cores were logged and labelled in the field immediately after collection. Soil samples were stored in moisture proof containers and rock cores were stored in wooden core boxes in the field. All soil and rock samples were returned to Fracflow's office and select soil samples collected during the investigation were tested. Soil testing in the laboratory consisted of standard mechanical sieve analyses and water content determinations that were performed according to ASTM standards as required. Brazilian Indirect Tension tests and Point Load Uniaxial Compression tests were conducted on selected core samples. The soil and rock core samples are stored by Fracflow for a two-year period.

# 4.0 SUBSURFACE CONDITIONS AND CHARACTERIZATION

Subsurface characterization is based on the field data collected from the twenty-five (25) vertical boreholes that were completed at this site. Data collection included split-spoon sampling while drilling in conjunction with the SPTs. A description of the soil profiles is provided below using both terminologies defined in the Unified Soil Classification System (USCS) and in the Canadian Foundation Engineering Manual (CFEM) (CGS, 1992). Photographs of the core recoveries from each borehole are provided in **Figure 4.1** through **Figure 4.8**. Detailed logs of the geological conditions at each borehole location are provided in **Appendix A**. **Appendix B** contains the grain size analysis information for each soil sample tested.

## 4.1 Soil Description

Twenty-two (22) soil samples were analysed in the lab using mechanical grain size analysis. The samples were generally characterized by CFEM as Sand and Gravel (or Sandy Gravel / Gravelly Sand) with trace Silt/Clay. The samples were generally characterized by USCS as poorly to well-graded sand or gravel (SW/GW, SP/GP) with varying amounts of silt (GW-GM, SP-SM).

Overburden thicknesses range from 0.13 m in BH13 to 13.07 m in BH24. Overburden is thinnest at the northern and southern ends of the wharf, and increase in thickness toward the middle of the wharf. The overburden can be described as a layer of sand and gravel with trace to some silt/clay.

## 4.2 Bedrock Description

The general description of bedrock in the area consists of “rhyolitic ash - flow tuffs; flows and breccias; associated epliclastic rocks; minor unseparated mafic flows and tuffs; sericitic and chloritic schists” of the Marystown Group (O’Driscoll, 1995).

Bedrock or highly fractured bedrock was encountered in all twenty-five (25) of the boreholes. Solid bedrock was not encountered in borehole BH24. Bedrock elevations ranged from 0.31 m LNT in BH22 to -12.47 m LNT in BH10. In the majority of boreholes, a layer of broken bedrock with lower recoveries was encountered before solid core was obtained.

Two (2) distinct bedrock types were encountered in the boreholes. At the northern end of the wharf (BH1 to BH5, BH8, and BH21 to BH23) bedrock was a volcanic tuff with Rock Quality Designations (RQDs) ranging from 0% to 84% (average of 21%). At the southern end of the wharf (BH10 to BH20, BH25 to BH28) bedrock was a volcanic flow with RQDs ranging from 0% to 83% (average of 17%). Very fractured bedrock was encountered in boreholes BH10, BH11, BH13, BH20, BH25, BH26, and BH28.

Brazilian Indirect Tension (Brazilian) tests and Point Load Uniaxial Compression (Point Load) tests were conducted on samples selected from each of the two (2) bedrock types. The results of the Brazilian tests and the Point Load tests are tabulated in **Table 4.1** and **Table 4.2** respectively. Results from the Brazilian tests and Point Load tests were grouped based on bedrock type: volcanic tuff (BH1 to BH5, BH8, and BH21 to BH23), and volcanic flow (BH10 to BH20, and BH25 to BH28).

Indirect Tensile Strength (ITS) of each sample was calculated from the Brazilian test data using the relationship (ASTM, 2008),

$$ITS = 2 \cdot P / \eth \cdot L \cdot D$$

where:
P = load at failure;
L = thickness of sample;
D = diameter of sample.

The mean, median, standard deviation, minimum, and maximum of the ITSs were determined for all samples and for each bedrock type:

| Group | Mean | Median | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| | MPa | MPa | MPa | MPa | MPa |
| All Samples | 10.2 | 9.6 | 4.5 | 3.4 | 19.1 |
| Volcanic tuff | 11.7 | 11 | 5.3 | 5.2 | 19.1 |
| Volcanic flow | 8.7 | 8.9 | 3.1 | 3.4 | 12.9 |

Histograms of the ITS results from the Brazilian tests are shown in **Figure 4.9**. The histograms are presented for all samples and by bedrock type. Samples from the volcanic flow have a slightly lower mean ITS than those from the volcanic tuff.

The Uncorrected Point Load Index ($I_s$), was calculated from the Point Load test data using the relationship (ASTM, 2008),

$$I_s = P / D_e^2$$

where:
P = load at failure;
$D_e$ = equivalent core diameter, D for diametral tests.

The Size Corrected Point Load Index ($I_{s(50)}$) was calculated by multiplying by a "Size Correction Factor F", obtained from the expression:

$$F = (D_e / 50)^{0.45}$$

The Uniaxial Compressive Strength (UCS) was then obtained from the expression:

$$UCS = K \cdot I_{s(50)}$$

where:
K = Generalized Index to Strength Conversion Factor.

For a mean core diameter of 47.5 mm, the Generalized Index to Strength Conversion Factor (K) was found to be 22.5.

The mean, median, standard deviation, minimum, and maximum of the UCSs were determined for all samples and for each bedrock type:

| Group No. | Mean | Median | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| | MPa | MPa | MPa | MPa | MPa |
| All Samples | 90.8 | 79.1 | 52.4 | 15.3 | 194.9 |
| Volcanic tuff | 103.3 | 112.5 | 44.4 | 15.8 | 166.6 |
| Volcanic flow | 78.3 | 60.9 | 58.6 | 15.3 | 194.9 |

Histograms of the UCSs obtained from the point load tests are shown in **Figure 4.10**. The histograms are presented for all all samples and by bedrock type. Samples from the volcanic tuff have a higher mean UCS than those from the volcanic flow.

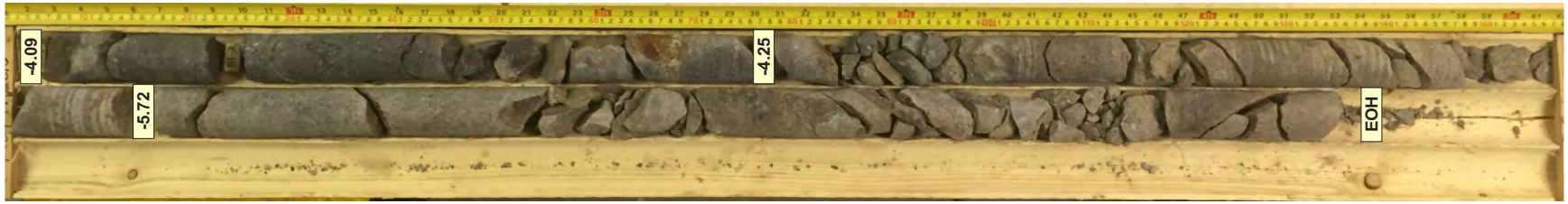
Table 4.1 Indirect tensile strength data from Brazilian tests,Grand Bank, NL.

| Sample I.D. | Approximate Elevation (m LNT) | Diameter (mm) | Thickness (mm) | Load (kN) | Indirect Tensile Strength (MPa) | Comments |
|---|---|---|---|---|---|---|
| BH1-BZ1 | -6.23 | 47.66 | 24.47 | 13.84 | **7.6** | No foliation. |
| BH4-BZ1 | -6.55 | 47.62 | 22.66 | 27.33 | **16.1** | Loading 90 degrees to foliation. |
| BH4-BZ2 | -8.96 | 47.62 | 24.64 | 22.60 | **12.3** | No foliation. |
| BH4-BZ3 | -8.99 | 47.64 | 24.88 | 27.76 | **14.9** | No foliation. |
| BH5-BZ1 | -10.30 | 47.75 | 23.67 | 10.22 | **5.8** | No foliation. |
| BH5-BZ2 | -11.29 | 47.77 | 22.51 | 10.62 | **6.3** | No foliation. |
| BH8-BZ1 | -9.85 | 47.64 | 24.67 | 34.84 | **18.9** | No foliation. |
| BH8-BZ2 | -12.35 | 47.65 | 23.47 | 14.26 | **8.1** | No foliation. |
| BH10-BZ1 | -15.09 | 47.35 | 21.93 | 13.64 | **8.4** | Loading 90 degrees to foliation. |
| BH12-BZ1 | -5.97 | 47.53 | 24.71 | 7.35 | **4.0** | No foliation. |
| BH13-BZ1 | -3.61 | 47.57 | 23.27 | 19.51 | **11.2** | No foliation. |
| BH14-BZ1 | -7.82 | 47.51 | 24.65 | 18.81 | **10.2** | No foliation. |
| BH15-BZ1 | -6.20 | 47.52 | 24.95 | 20.48 | **11.0** | Loading 90 degrees to foliation. |
| BH17-BZ1 | -6.47 | 47.38 | 24.84 | 23.66 | **12.8** | No foliation. |
| BH17-BZ2 | -6.50 | 47.40 | 25.71 | 24.72 | **12.9** | No foliation. |
| BH18-BZ1 | -7.75 | 47.67 | 24.53 | 13.34 | **7.3** | No foliation. |
| BH19-BZ1 | -9.15 | 47.58 | 23.22 | 12.70 | **7.3** | No foliation. |
| BH21-BZ1 | -2.33 | 47.26 | 24.39 | 17.72 | **9.8** | No foliation. |
| BH22-BZ1 | -1.99 | 47.49 | 24.38 | 34.70 | **19.1** | No foliation. |
| BH22-BZ2 | -2.52 | 47.52 | 23.99 | 30.56 | **17.1** | Loading 90 degrees to foliation. |
| BH23-BZ1 | -5.40 | 47.70 | 24.56 | 9.49 | **5.2** | Loading parallel to foliation. |
| BH26-BH1 | -2.26 | 47.58 | 23.02 | 5.89 | **3.4** | No foliation. |
| BH27-BZ1 | -5.30 | 47.68 | 24.23 | 17.10 | **9.4** | No foliation. |
| BH28-BZ1 | -7.84 | 47.62 | 23.43 | 11.30 | **6.4** | No foliation. |

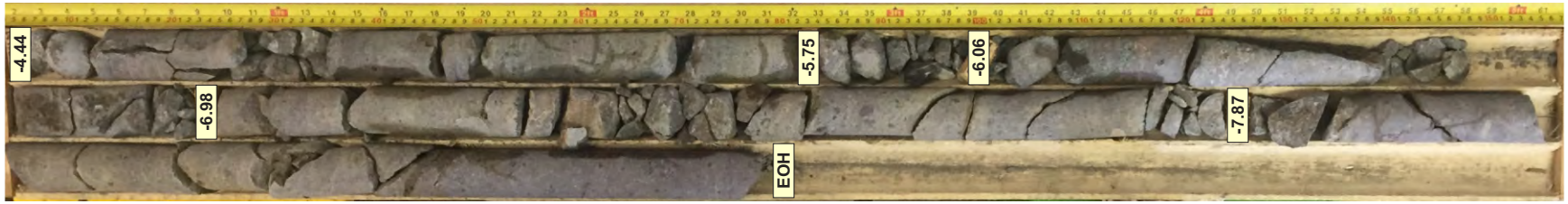
Table 4.2 Uniaxial compressive strength data from point load tests, Grand Bank, NL

| Sample ID | Approx-imate Elevation (m LNT) | Diameter (mm) | Length (mm) | Load at Failure (kN) | Strength Index -- | Corr. Strength Index -- | Uniaxial Comp. Strength MPa | Sample Description and Failure Mode |
|---|---|---|---|---|---|---|---|---|
| BH1-PL1 | -5.39 | 47.62 | 105.11 | 13.21 | 5.83 | 5.70 | **128.23** | Diametral test. |
| BH2-PL1 | -5.64 | 47.55 | 105.10 | 7.12 | 3.15 | 3.08 | **69.27** | Diametral test. |
| BH2-PL2 | -8.06 | 47.63 | 76.24 | 6.56 | 2.89 | 2.83 | **63.66** | Diametral test. |
| BH4-PL1 | -7.68 | 47.61 | 88.47 | 14.36 | 6.34 | 6.20 | **139.43** | Diametral test. |
| BH4-PL2 | -7.97 | 47.64 | 137.73 | 15.91 | 7.01 | 6.86 | **154.33** | Diametral test. Loading 90 degrees to fracture. |
| BH5-PL1 | -7.93 | 47.65 | 81.09 | 1.63 | 0.72 | 0.70 | **15.81** | Diametral test. |
| BH5-PL2 | -10.71 | 47.64 | 95.86 | 17.17 | 7.57 | 7.40 | **166.56** | Diametral test. |
| BH8-PL1 | -9.88 | 47.53 | 98.29 | 12.62 | 5.59 | 5.46 | **122.86** | Diametral test. |
| BH8-PL2 | -11.35 | 47.52 | 102.57 | 7.13 | 3.16 | 3.09 | **69.43** | Diametral test. |
| BH8-PL3 | -12.86 | 47.5 | 140.28 | 10.48 | 4.64 | 4.54 | **102.13** | Diametral test. |
| BH10-PL1 | -17.2 | 47.34 | 139.92 | 2.34 | 1.04 | 1.02 | **22.92** | Diametral test. |
| BH11-PL1 | -13.39 | 47.51 | 118.85 | 11.41 | 5.05 | 4.94 | **111.15** | Diametral test. Loading 90 degrees to fracture. |
| BH12-PL1 | -4.7 | 47.49 | 90.75 | 1.57 | 0.70 | 0.68 | **15.30** | Diametral test. |
| BH14-PL1 | -8.52 | 47.55 | 124.12 | 4.52 | 2.00 | 1.95 | **43.97** | Diametral test. |
| BH15-PL1 | -7.11 | 47.51 | 123.03 | 3.75 | 1.66 | 1.62 | **36.53** | Diametral test. |
| BH15-PL2 | -8.06 | 47.52 | 86.46 | 13.11 | 5.81 | 5.67 | **127.67** | Diametral test. |
| BH16-PL1 | -7.15 | 47.61 | 117.33 | 8.01 | 3.53 | 3.46 | **77.78** | Diametral test. |
| BH17-PL1 | -4.93 | 47.27 | 122.30 | 16.41 | 7.34 | 7.16 | **161.12** | Diametral test. |
| BH18-PL1 | -8.64 | 47.59 | 130.00 | 4.04 | 1.78 | 1.74 | **39.25** | Diametral test. |
| BH22-PL1 | -3.83 | 47.61 | 74.47 | 8.09 | 3.57 | 3.49 | **78.55** | Diametral test. Loading 90 degrees to fracture. |
| BH23-PL1 | -5.06 | 47.61 | 104.00 | 13.28 | 5.86 | 5.73 | **128.95** | Diametral test. |
| BH25-PL1 | -0.31 | 47.73 | 90.01 | 20.15 | 8.84 | 8.66 | **194.89** | Diametral test. |
| BH26-PL1 | -4.15 | 47.6 | 80.24 | 8.19 | 3.61 | 3.54 | **79.55** | Diametral test. Loading 90 degrees to fracture. |
| BH28-PL1 | -7.4 | 47.59 | 80.40 | 3.08 | 1.36 | 1.33 | **29.93** | Diametral test. |

**Hole ID: BH1**




**Hole ID: BH2**



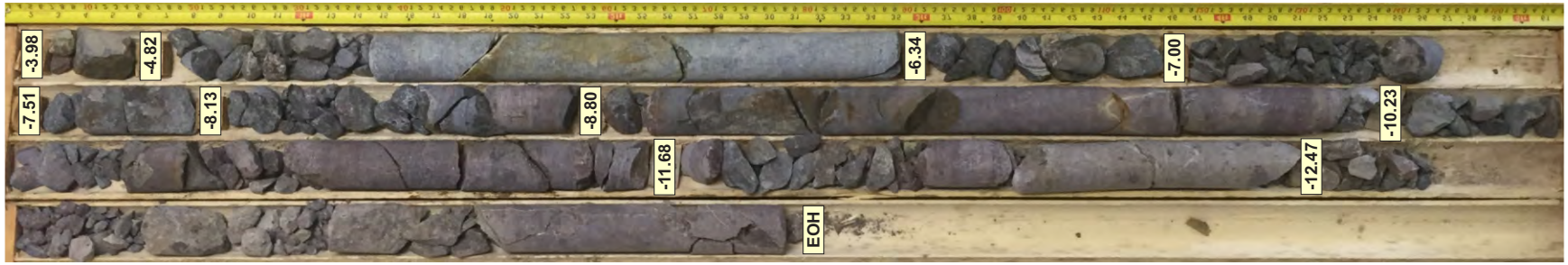

**Hole ID: BH3**


**Hole ID: BH4**


Figure 4.1 Photographs of core recovered during drilling from boreholes BH1, BH2, BH3, and BH4 (elevations shown in m LNT).

**Hole ID: BH5**

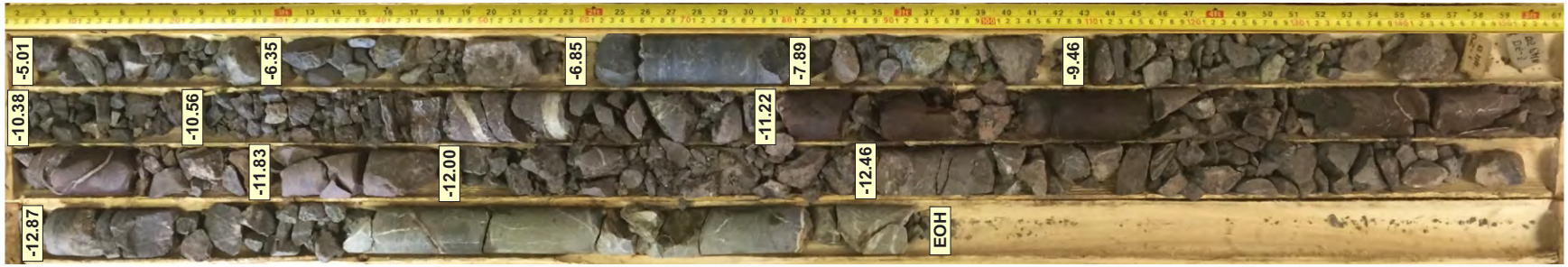

**Hole ID: BH8**




**Hole ID: BH10**


Figure 4.2 Photographs of core recovered during drilling from borehole BH5, BH8, and BH10 (elevations shown in m LNT).

**Hole ID: BH11**




**Hole ID: BH12**

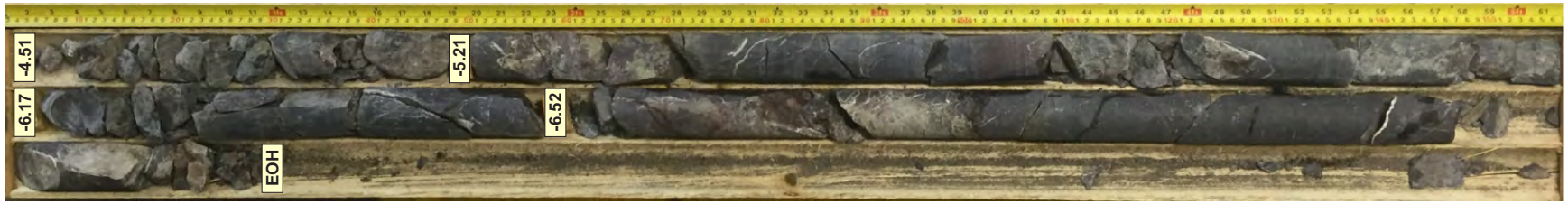

**Hole ID: BH13**


Figure 4.3 Photographs of core recovered during drilling from boreholes BH11, BH12, and BH13 (elevations shown in m LNT).

**Hole ID: BH14**


**Hole ID: BH15**


**Hole ID: BH16**




**Hole ID: BH17**

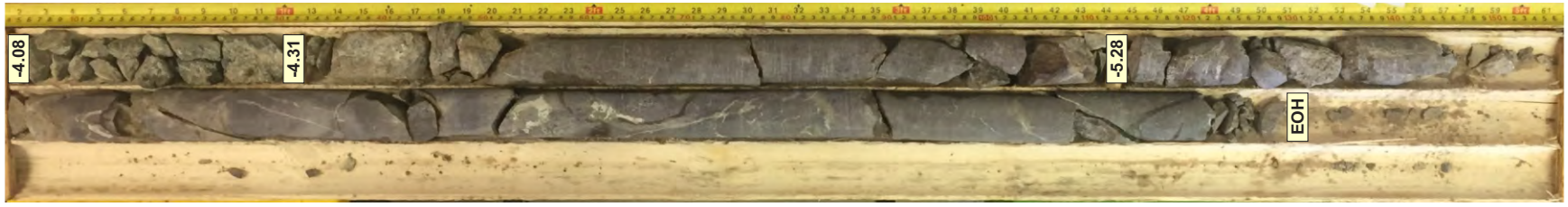
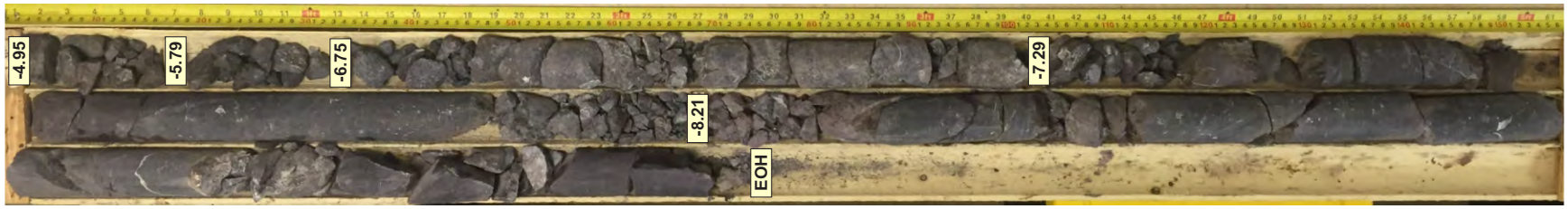



Figure 4.4 Photographs of core recovered during drilling from boreholes BH14, BH15, BH16, and BH17 (elevations shown in m LNT).

**Hole ID: BH18**

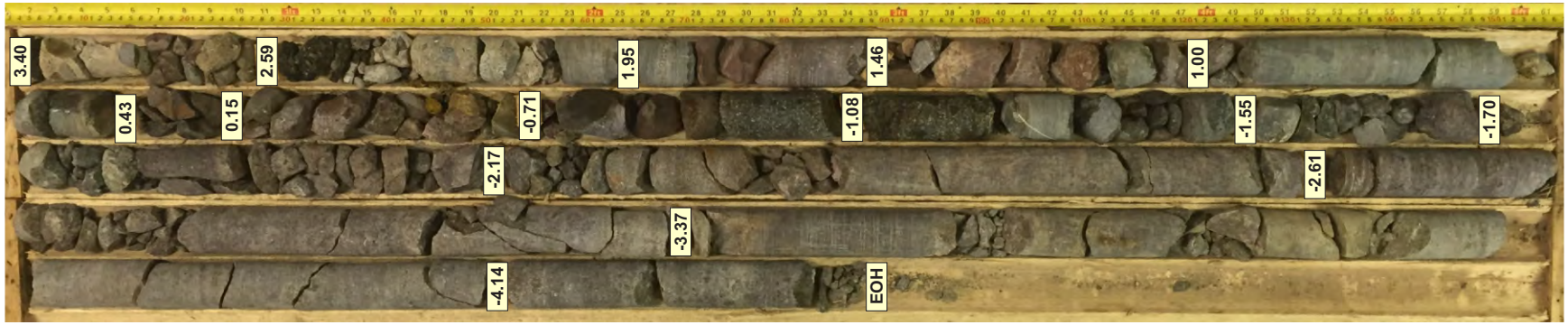



**Hole ID: BH19**


**Hole ID: BH20**


Figure 4.5 Photographs of core recovered during drilling from boreholes BH18, BH19, and BH20 (elevations shown in m LNT).

**Hole ID: BH21**




**Hole ID: BH22**


**Hole ID: BH23**

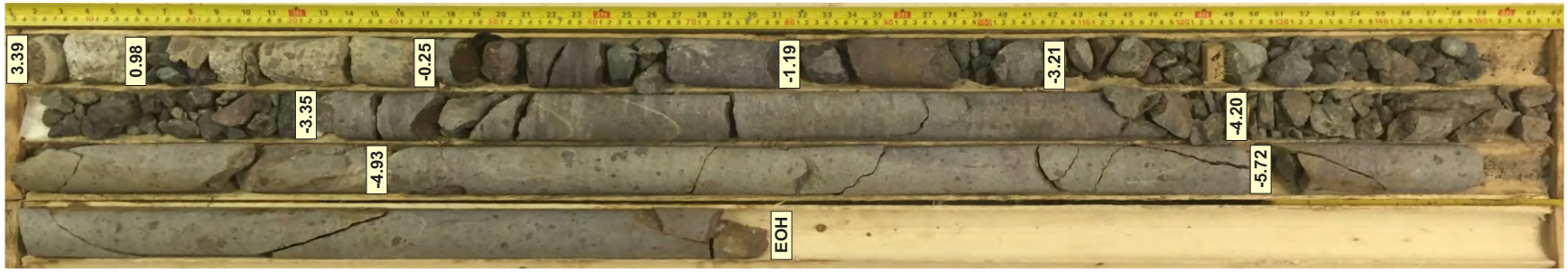
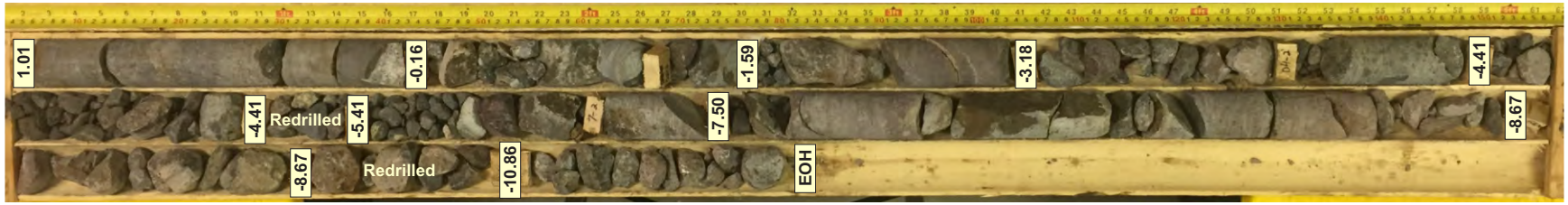
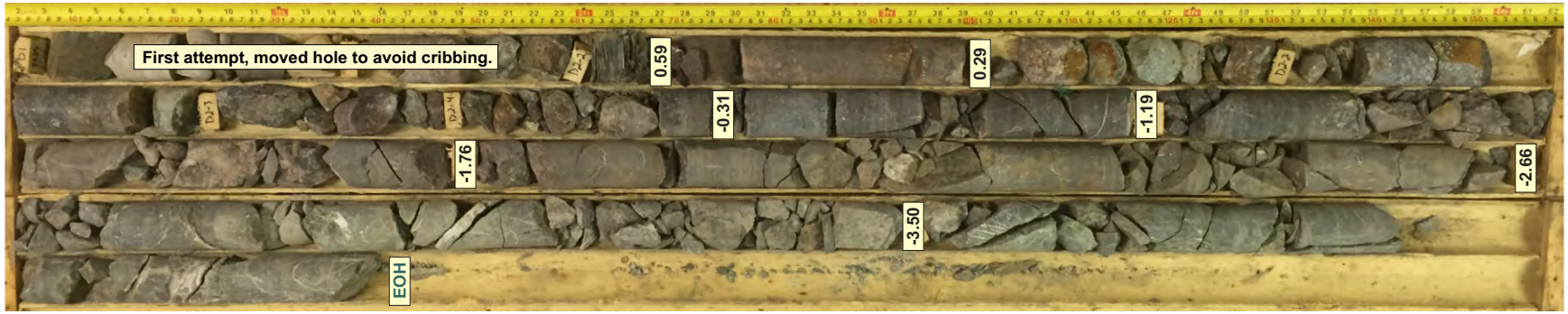



Figure 4.6 Photographs of core recovered during drilling from boreholes BH21, BH22, and BH23 (elevations shown in m LNT).

**Hole ID: BH24**




**Hole ID: BH25**




**Hole ID: BH26**


Figure 4.7 Photographs of core recovered during drilling from boreholes BH24, BH25, and BH26 (elevations shown in m LNT).

**Hole ID: BH27**


**Hole ID: BH28**

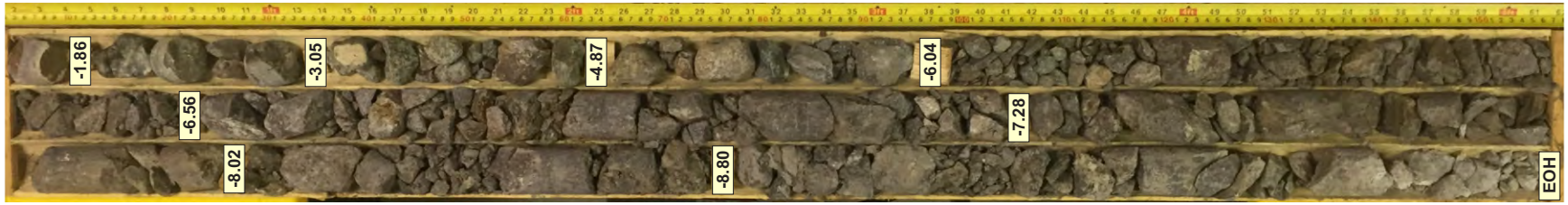



Figure 4.8 Photographs of core recovered during drilling from boreholes BH27 and BH28 (elevations shown in m LNT).

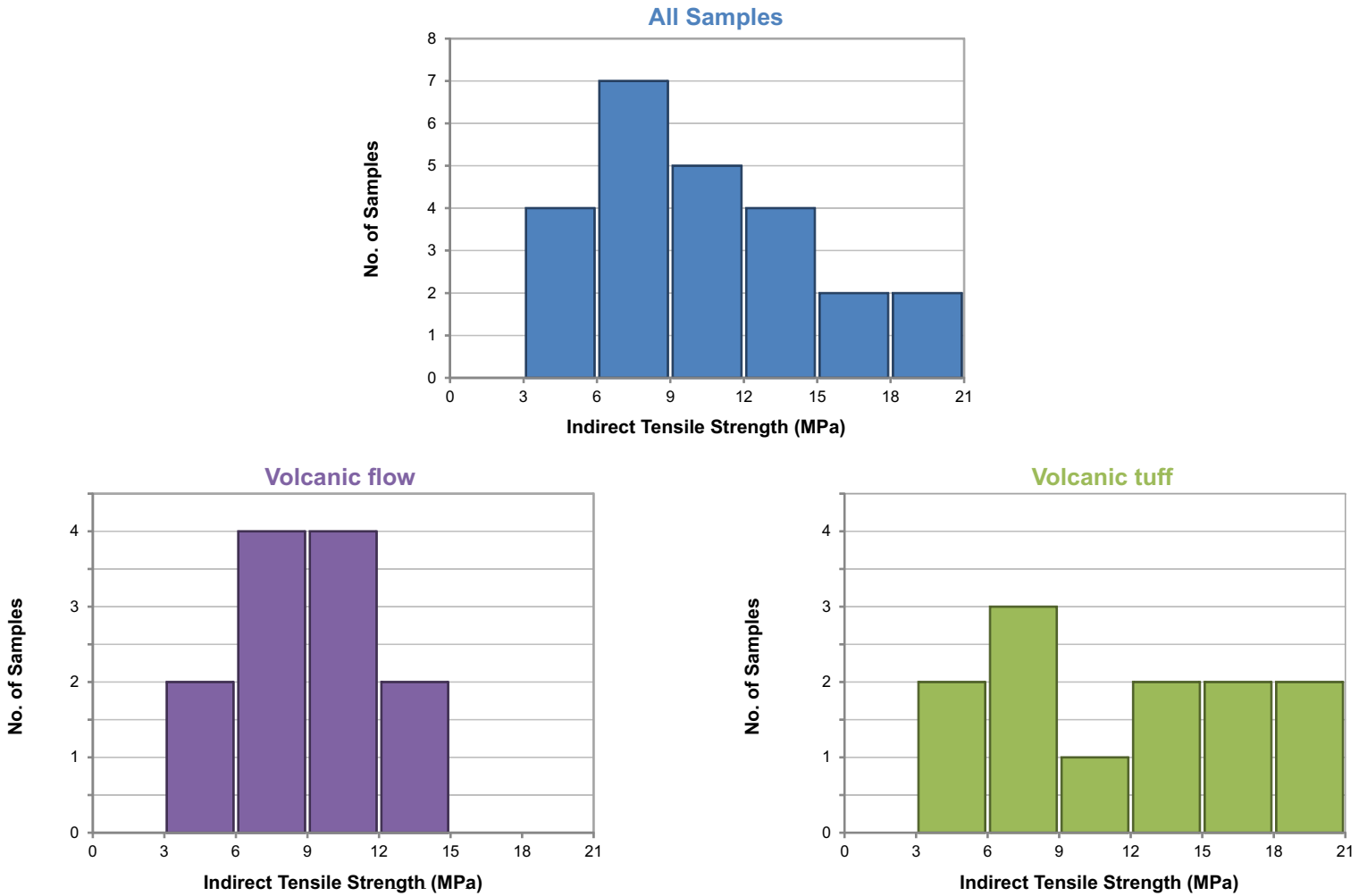



Figure 4.9 Histograms of indirect tensile strength data obtained from Brazilian tests, Grand Bank, NL.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087 |
| Location | Date |
| Grand Bank, NL | June 2016 |

FFC

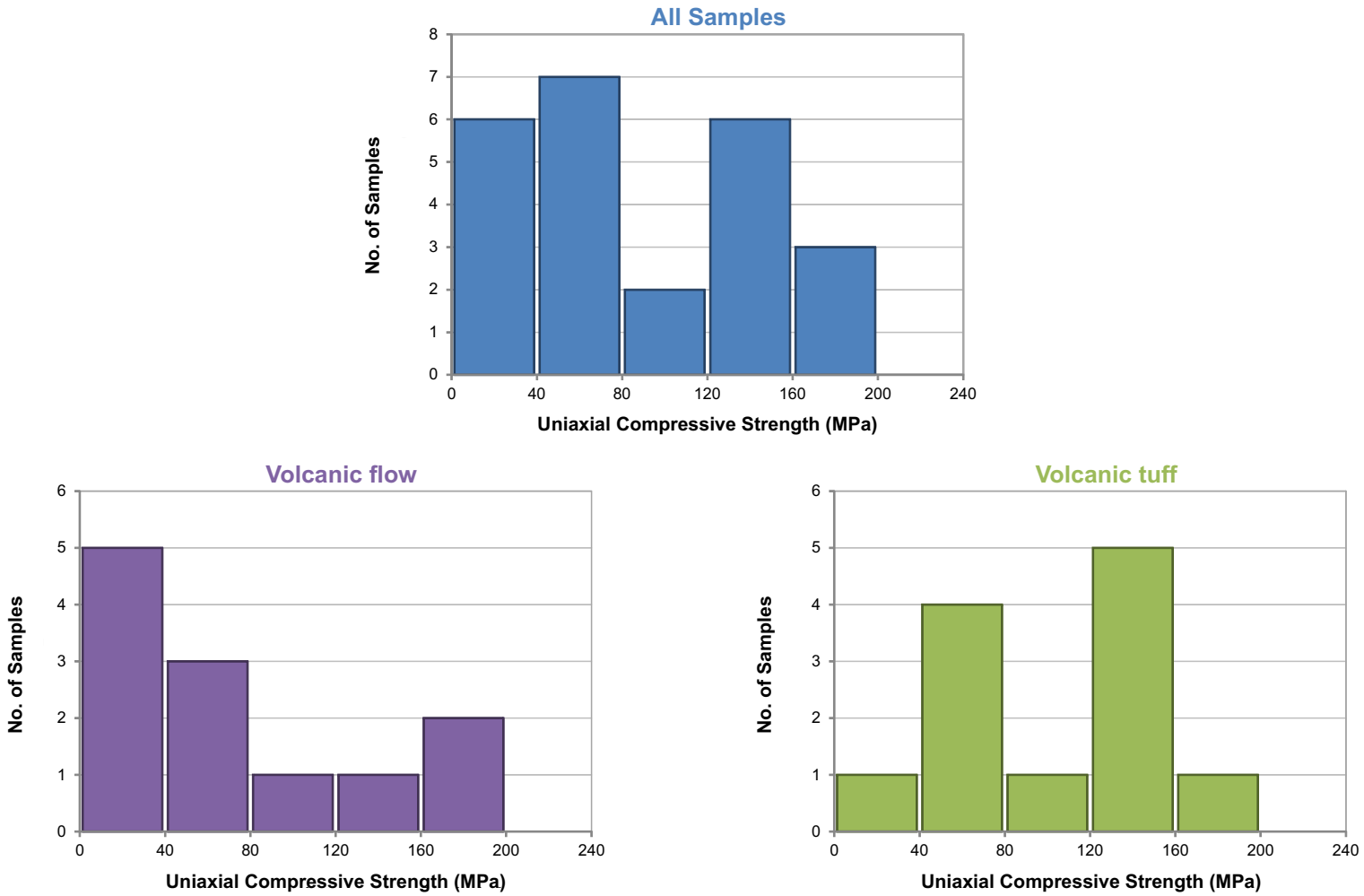



Figure 4.10 Histograms of uniaxial compressive strength data obtained from point load tests, Grand Bank, NL.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087 |
| Location | Date |
| Grand Bank, NL | June 2016 |

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# 5.0 SUBSURFACE PROFILE

Other areas of the current project site was investigated by Fracflow Consultants Inc. in 1999, 2001 and 2002. The geotechnical project in 1999 was focused on the area around the community stage (southeast side of the current project location). The drilling projects in 2001 were focussed approximately 100 m west of the current location. Boreholes drilled in 2002 were in a grid format that covered the west side of the current project location, with some overlap, and the north side of the existing fish plant. **Figure 5.1** shows all the boreholes from the previous projects. Borehole logs from these three (3) previous projects were combined with drilling data from the current site investigation to evaluate the subsurface condition of the site. Boreholes logs from the previous projects are provided in **Appendix C**.

Among the three previous projects, only six (6) boreholes drilled in 2002 were close to the wharf and considered to be overlap with the current project site proposed borehole plan. These boreholes are shown in **Figure 5.2** as boreholes with green symbols. These borehole data were combined with those from the current site investigation, allowing three (3) of the proposed boreholes for this current investigation to be deleted and not drilled. To compare the overburden thicknesses and bedrock elevations around the wharf, two (2) cross-sections along the edge of the wharf were constructed. The corresponding cross-section lines are shown in **Figure 5.2** as A-A' at the harbour side and B-B' at the land side of the wharf. The two cross-sections are provided in **Figures 5.3** and **5.4**, respectively. The boreholes along each cross-section line were projected to the closest cross-section line. A total of 30 boreholes were plotted on the two cross-sections. For comparison, the boreholes were divided into three groups; Group 1 - boreholes drilled on water approximately three (3) metres away from the wharf, Group 2 - boreholes drilled through the concrete deck along the wharf side, and Group 3 - boreholes drilled along the land side wharf. Group 1 includes the boreholes drilled in 2002, 325-BH1, 325-BH3, 325-BH4, 325-BH7, 325-BH8 and 325-BH10. Group 2 includes BH1 to BH5, BH8 and BH10 to BH20. Boreholes for Group 3 are BH21 to BH28 excluding BH24. The data are compiled in **Table 5.1**.

The overburden thickness from all available boreholes ranged from 0.13 m at BH13 to 9.31 m at BH10 with average thickness of 3.31 m. Because the bedrock was not encountered in BH24 (just highly fractured bedrock), the bedrock thickness was assumed to be greater than 13.07 m, but the bottom part of the overburden/boulder could be highly broken bedrock with low recovery values. Due to the uncertainty, BH24 was excluded from the basic statistics. The summary of overburden thickness data of each group is shown in the following table.

| ***Overburden Thickness*** | *Total* | *Group 1* | *Group 2* | *Group 3* |
|---|---|---|---|---|
| *Number of Boreholes* | 30 | 6 | 17 | 7 |
| *Minimum (m)* | 0.13 | 3.94 | 0.13 | 0.78 |
| *Maximum (m)* | 9.31 | 7.36 | 9.31 | 6.05 |
| *Average (m)* | 3.36 | 5.61 | 2.64 | 3.17 |
| *Ste. Dev. (m)* | 2.47 | 1.60 | 2.44 | 2.19 |

Boreholes on water (Group 1) showed the thickest average overburden. The average overburden thickness was lower at the edge of the water-along the edge of the wharf (Group 2) and then increased slightly as one moved toward the land (Group 3). The high standard deviations in Groups 2 and 3 indicated that the overburden thicknesses were highly variable in the corresponding group.

Bedrock from the current investigation was often recovered as highly broken bedrock with low recovery at the top portion of the bedrock in some boreholes. For those boreholes, the bedrock was divided into broken bedrock (light green) and bedrock (dark green) in the cross-sections. For the summary table below, the top of broken bedrock, if it was all that was encountered, was considered as the bedrock elevation.

| ***Bedrock Elevation*** | *Total* | *Group 1* | *Group 2* | *Group 3* |
|---|---|---|---|---|
| *Number of Boreholes* | 30 | 6 | 17 | 7 |
| *Shallowest (m LNT)* | +0.31 (above) | -8.47 | -2.0 | +0.31 (above) |
| *Deepest (m LNT)* | -13.17 | -13.17 | -12.47 | -6.04 |
| *Difference (m)* | 13.48 | 4.7 | 10.47 | 6.35 |
| *Average (m LNT)* | -6.09 | -10.89 | -6.01 | -2.16 |

The bedrock elevations from all available boreholes showed average elevation of - 6.0 m LNT with a range between +0.31 m LNT (above LNT) at BH22 and -13.17 m LNT (below LNT) at 325-BH10. Group 1 showed a deepest bedrock elevation with average of -10.89 m LNT. The bedrock elevation then becomes shallower as one moves toward the land (Group 2 to Group3). Note that the data from BH24 was removed from Group 3 since the bedrock was not encountered or not specified and only highly fractured bedrock was recovered. The deepest bedrock along the land-side (inside) of the wharf was -6.04 m. The difference between the shallowest and the deepest bedrock elevation was 10.47 m in Group 2 and decreased toward Group 1 and Group 3. This means the variation of the bedrock elevation was highest along the water-side (outside edge) of the wharf.

Contour maps for the overburden thickness and the bedrock elevation were constructed using the existing data and presented in **Figures 5.5** and **5.6**, respectively. Since the contour map was based on the limited number of boreholes along the wharf, they were only used for checking the overall data trend and not for an estimation of the overburden thickness and/or bedrock elevation at specific locations. Note that the lateral extension of the contours in the direction of the east side of the wharf was based on the previous borehole data. Because the data were clustered in each project location, the lateral extension of the contours should be updated with additional drilling data if necessary.

As shown in the cross-sections, the overburden was thickest around BH10 then thinned out toward each of the north and the south direction. Then the overburden was getting thicker toward the south end of the wharf. For bedrock elevation, most of the boreholes on water (325 boreholes) were close to or deeper than -10 m LNT. The bedrock elevation became shallower toward the inside of the wharf - the land side. The boreholes along the land-side wharf (BH21 to BH27) showed the bedrock elevations shallower than -3.5 m LNT.

Table 5.1 The overburden thickness and bedrock elevation data from all available boreholes (page 1 of 2).

| Year | Borehole ID | Easting m, UTM | Northing m, UTM | Water Surface - m LNT | Overburden Thickness m | Bedrock Elevation - m LNT |
|---|---|---|---|---|---|---|
| 1999 | GB-BH1 | 594841.62 | 5216997.23 | 1.70 | 0.38 | 2.08 |
| 1999 | GB-BH2 | 594844.18 | 5216981.62 | 3.55 | 1.42 | 4.97 |
| 1999 | GB-BH3 | 594854.28 | 5216981.90 | -2.44 | 5.84 | 3.40 |
| 1999 | GB-BH4 | 594844.98 | 5216956.32 | 1.38 | 0.30 | 1.69 |
| 1999 | GB-BH5 | 594840.09 | 5216929.47 | 0.29 | 0.36 | 0.64 |
| 1999 | GB-BH6 | 594838.43 | 5216915.81 | 0.80 | 0.23 | 1.02 |
| 1999 | GB-BH7 | 594827.92 | 5216931.68 | 1.63 | 2.03 | 3.66 |
| 2001 | #25b | 594950.34 | 5217137.45 | 2.17 | 1.05 | 3.22 |
| 2001 | #27 | 595045.77 | 5217194.32 | 4.24 | 1.67 | 5.91 |
| 2001 | #34 | 595018.55 | 5217133.89 | 2.76 | 1.96 | 4.72 |
| 2001 | #37 | 594986.73 | 5217100.16 | 1.43 | 3.21 | 4.64 |
| 2002 | 325-BH1 | 594830.82 | 5217218.20 | 4.53 | 3.94 | 8.47 |
| 2002 | 325-BH3 | 594819.91 | 5217200.56 | 5.47 | 4.10 | 9.57 |
| 2002 | 325-BH4 | 594810.97 | 5217182.66 | 5.30 | 6.80 | 12.10 |
| 2002 | 325-BH6 | 594877.63 | 5217145.89 | 1.58 | 1.92 | 3.50 |
| 2002 | 325-BH7 | 594801.30 | 5217165.27 | 5.50 | 4.47 | 9.97 |
| 2002 | 325-BH8 | 594790.86 | 5217148.10 | 5.06 | 6.99 | 12.05 |
| 2002 | 325-BH10 | 594781.19 | 5217130.81 | 5.81 | 7.36 | 13.17 |
| 2016 | BH1 | 594832.26 | 5217228.96 | 3.14 | 0.95 | 4.09 |
| 2016 | BH2 | 594828.75 | 5217222.03 | 3.02 | 1.42 | 4.44 |
| 2016 | BH3 | 594818.35 | 5217203.91 | 3.39 | 1.30 | 4.70 |
| 2016 | BH4 | 594812.39 | 5217193.40 | 3.48 | 2.50 | 5.98 |
| 2016 | BH5 | 594804.84 | 5217179.04 | 3.07 | 3.35 | 6.42 |
| 2016 | BH8 | 594782.32 | 5217140.92 | 3.05 | 3.29 | 6.34 |
| 2016 | BH10 | 594770.04 | 5217113.95 | 3.16 | 9.31 | 12.47 |
| 2016 | BH11 | 594760.96 | 5217102.28 | 3.64 | 6.74 | 10.38 |
| 2016 | BH12 | 594753.91 | 5217089.52 | 3.46 | 1.07 | 4.53 |
| 2016 | BH13 | 594749.96 | 5217074.73 | 1.87 | 0.13 | 2.00 |
| 2016 | BH14 | 594748.44 | 5217060.40 | 4.21 | 2.52 | 6.73 |

Table 5.1 The overburden thickness and bedrock elevation data from all available boreholes (page 2 of 2).

| Year | Borehole ID | Easting m, UTM | Northing m, UTM | Water Surface - m LNT | Overburden Thickness m | Bedrock Elevation - m LNT |
|---|---|---|---|---|---|---|
| 2016 | BH15 | 594746.55 | 5217049.55 | 4.33 | 0.64 | 4.97 |
| 2016 | BH16 | 594743.13 | 5217031.02 | 4.09 | 0.43 | 4.51 |
| 2016 | BH17 | 594740.51 | 5217016.51 | 3.47 | 0.62 | 4.08 |
| 2016 | BH18 | 594738.95 | 5217001.77 | 3.92 | 2.83 | 6.75 |
| 2016 | BH19 | 594738.48 | 5216987.01 | 3.45 | 2.95 | 6.41 |
| 2016 | BH20 | 594736.94 | 5216972.29 | 2.49 | 4.86 | 7.35 |
| 2016 | BH21 | 594818.94 | 5217229.67 | -3.40 | 5.11 | 1.70 |
| 2016 | BH22 | 594797.07 | 5217187.54 | -1.48 | 1.17 | -0.31 |
| 2016 | BH23 | 594776.21 | 5217152.47 | -1.72 | 5.06 | 3.35 |
| 2016 | BH25 | 594739.29 | 5217055.66 | -1.08 | 1.39 | 0.31 |
| 2016 | BH26 | 594732.97 | 5217026.06 | 0.46 | 0.78 | 1.24 |
| 2016 | BH27 | 594730.91 | 5216993.66 | 0.15 | 2.62 | 2.77 |
| 2016 | BH28 | 594729.71 | 5216968.33 | -0.01 | 6.05 | 6.04 |

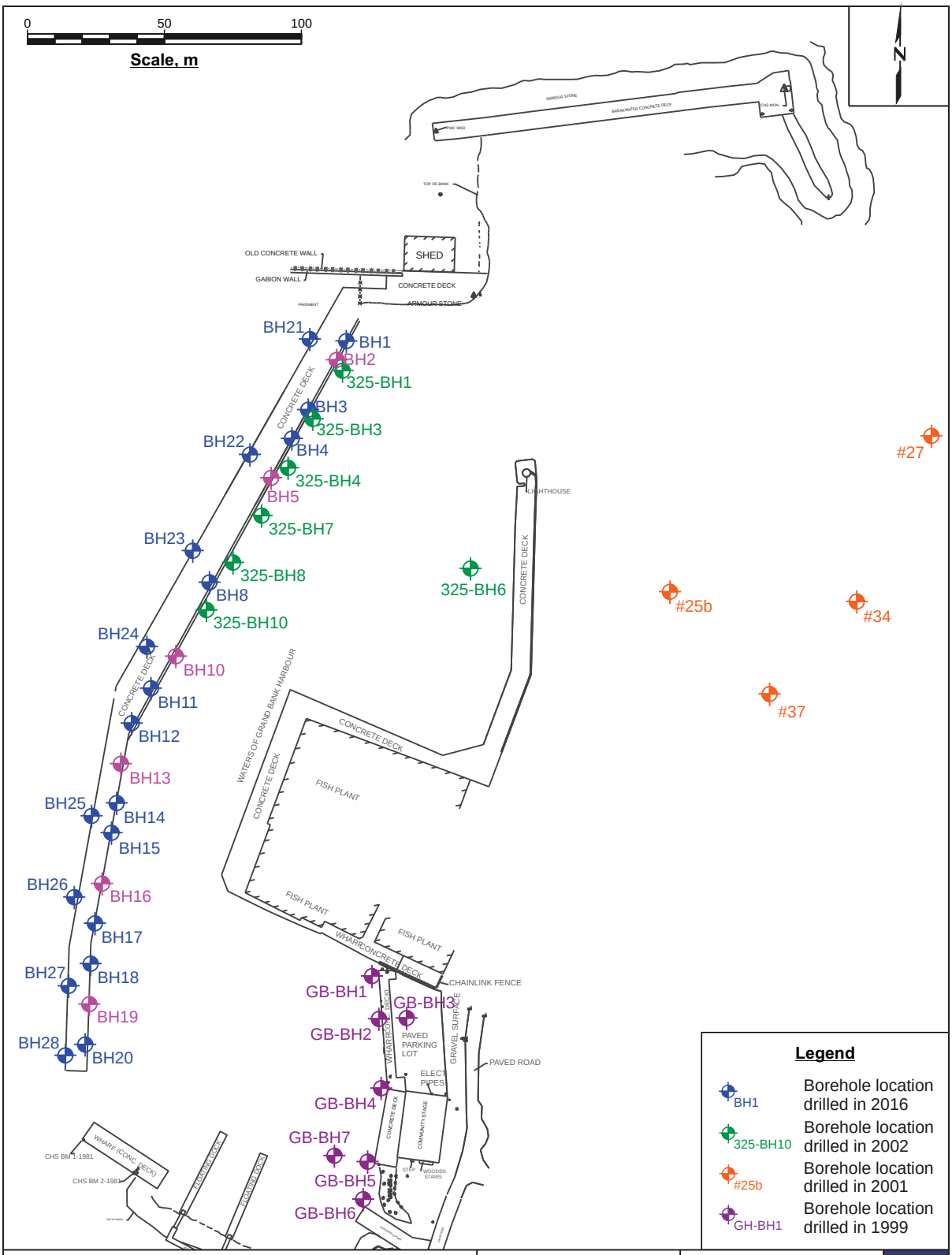


Figure 5.1 Available boreholes from the previous and current projects for a data set of the overburden thickness and bedrock elevation.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087 |
| **Location** | **Date** |
| Grand Bank, NL | June 2016 |

FFC

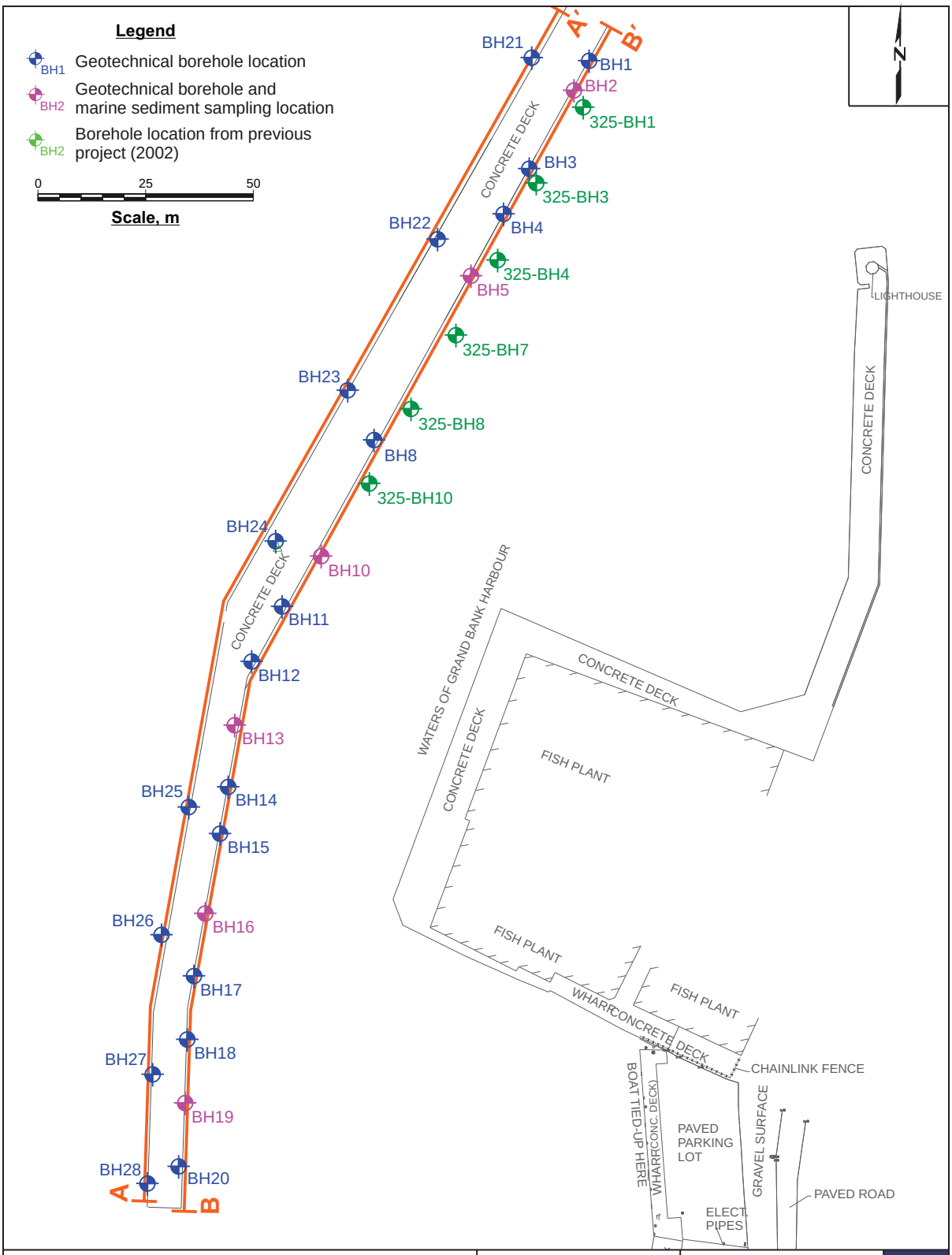


Figure 5.2 Boreholes used for subsurface profiling with two cross-section lines.

| | |
|---|---|
| Project No. 3087 | Document Reference FFC-NL-3087 |
| Location Grand Bank, NL | Date June 2016 |

FFC

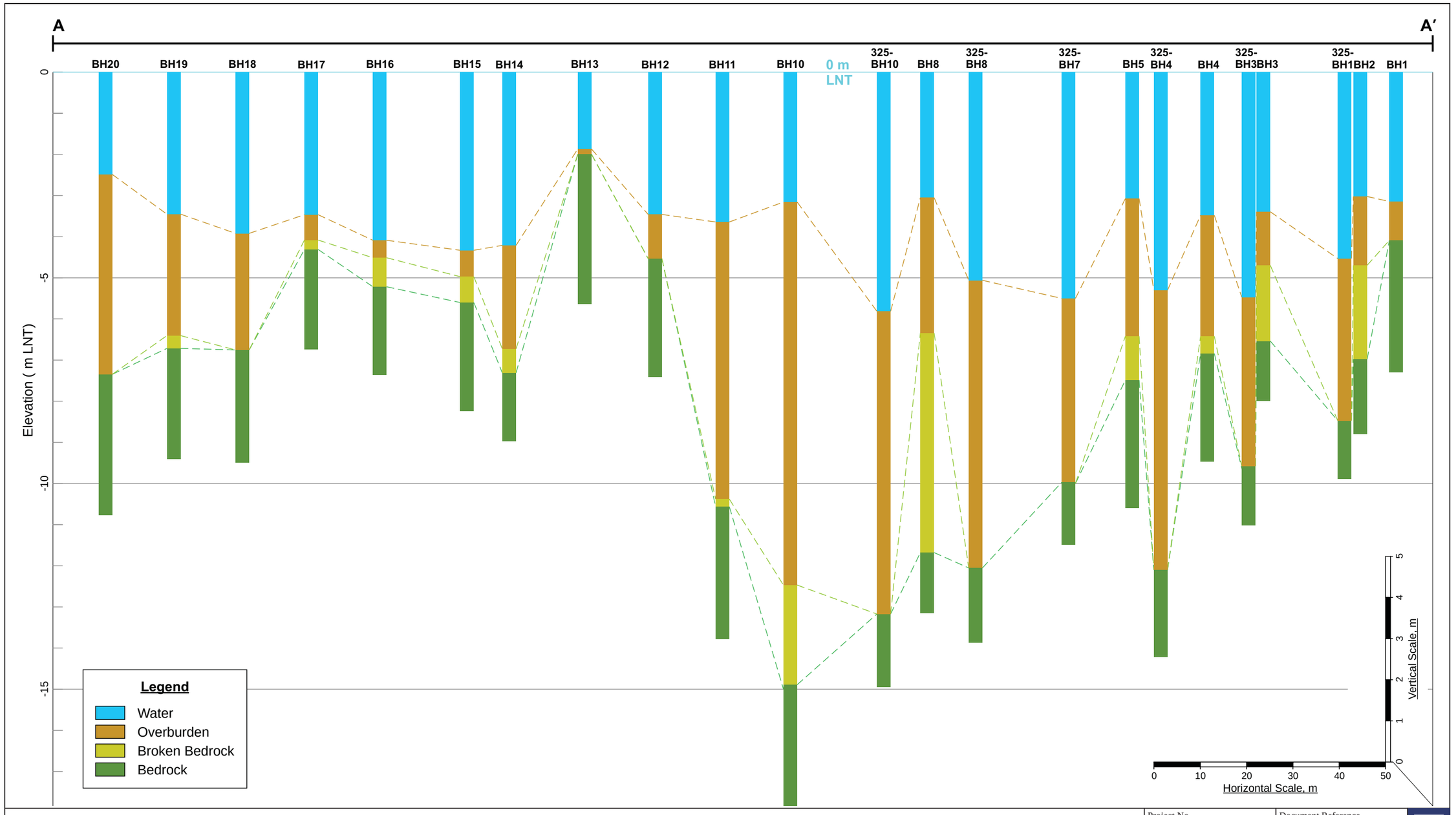


Figure 5.3 Cross-section showing the overburden thicknesses and the bedrock elevations of boreholes along A-A′.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087 |
| Location | Date |
| Grand Bank, NL | June 2016 |

FFC

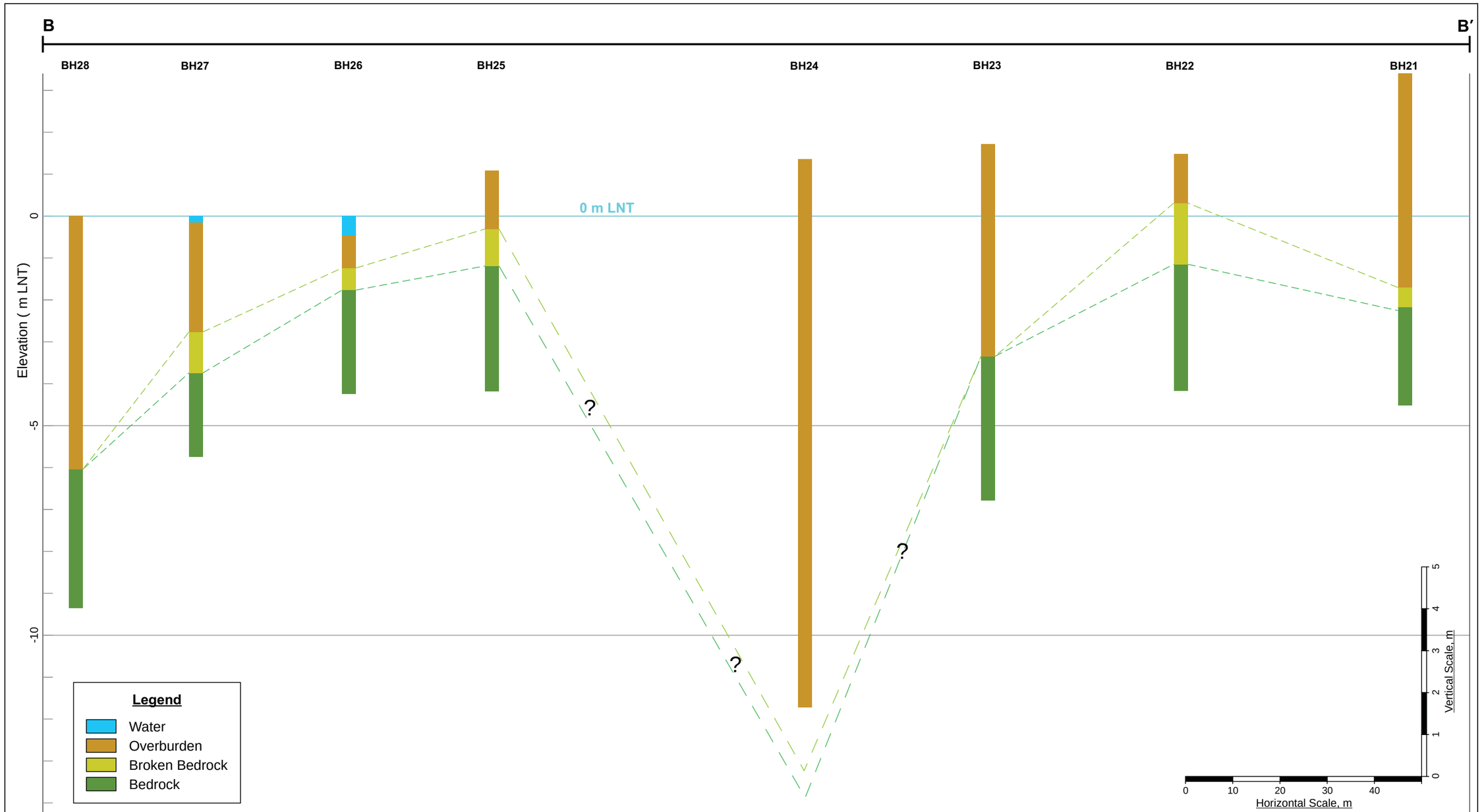


Figure 5.4 Cross-section showing the overburden thicknesses and the bedrock elevations of boreholes along B-B′.

| | |
|---|---|
| Project No. 3087 | Document Reference FFC-NL-3087 |
| Location Grand Bank, NL | Date June 2016 |

FFC

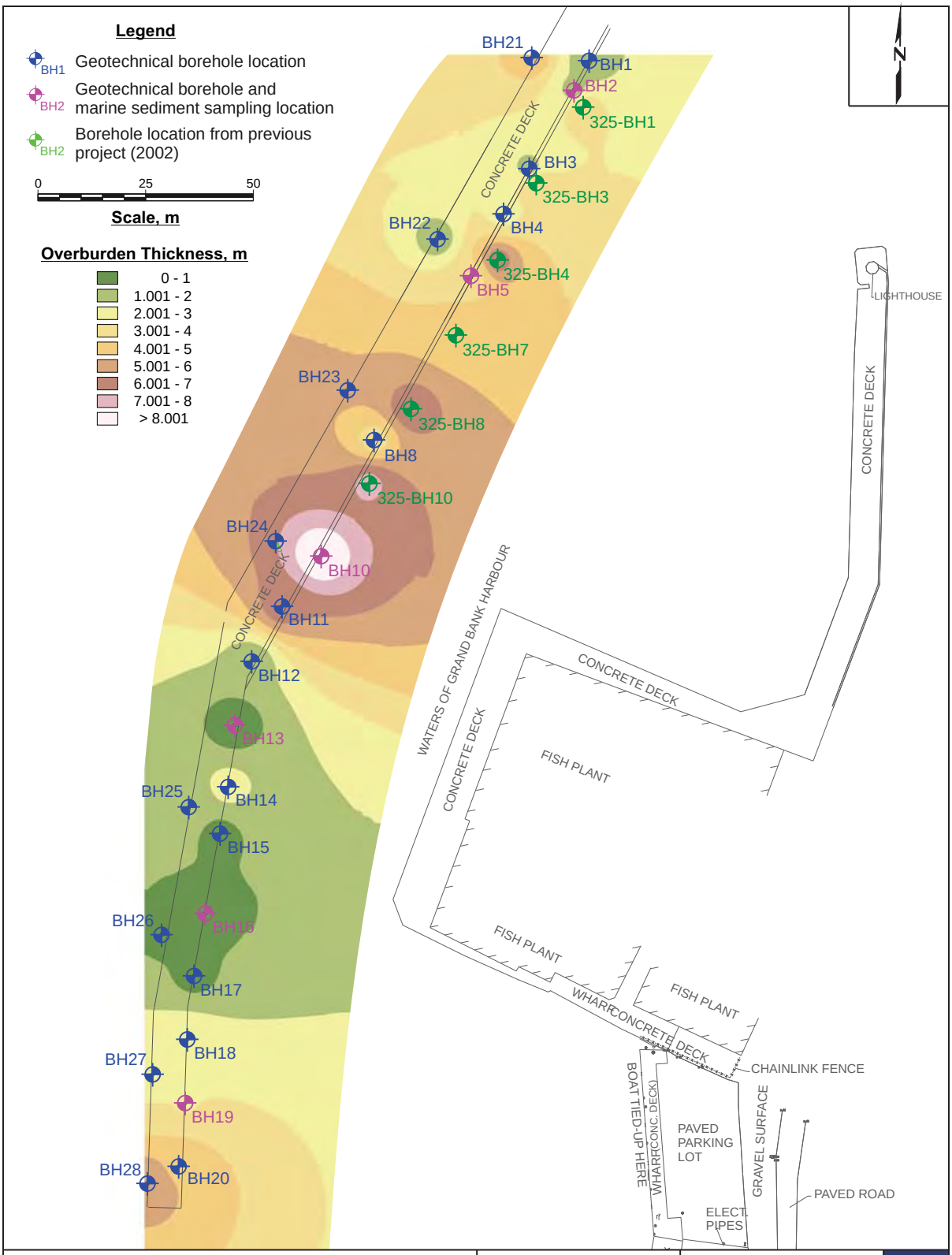


Figure 5.5 Contour map of the overburden thickness from the available boreholes.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087 |
| **Location** | **Date** |
| Grand Bank, NL | June 2016 |

FFC

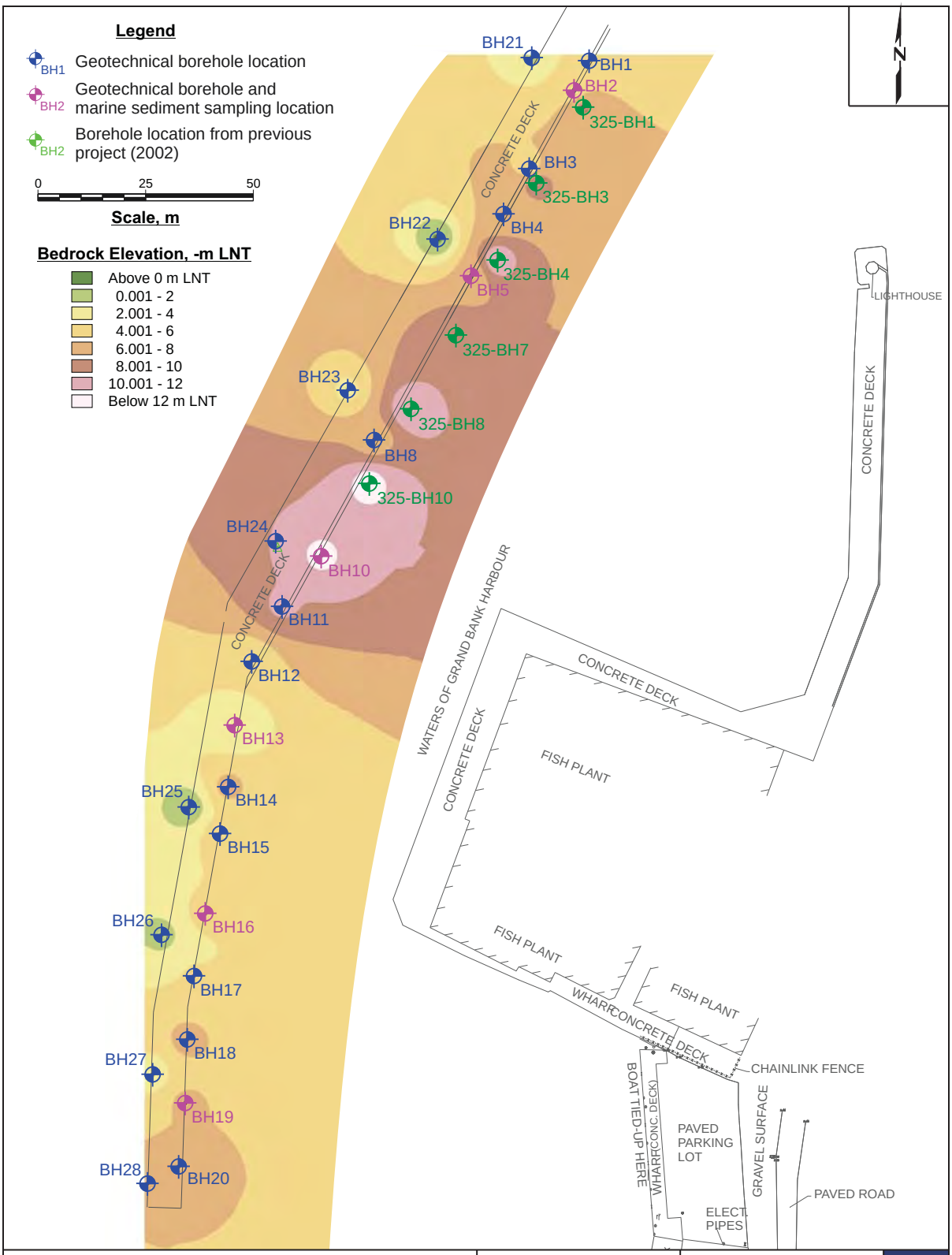


Figure 5.6 Contour map of the bedrock elevation from the available boreholes.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087 |
| **Location** | **Date** |
| Grand Bank, NL | June 2016 |

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# 6.0 REFERENCES

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# *APPENDIX A*

## *Borehole Logs*

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH1*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 18, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Top of Wharf | 3.38 | | | | | | |
| 21 / 6 | | Harbour bottom (6.88 m below top of wharf). | -3.14 | | | | | | |
| 22 | | Split spoon sank 0.34 m into soft sediment under own weight before SPT. | -3.48 | | | | | | |
| 23 | | | | | | | | | |

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Fax: (709) 753-5101

Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH1

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 18, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 23 | | SPT: 1 / 3 / 2 / 10. CFEM: Gravelly Sand, some Silt/Clay. | -4.09 | SS | 1 | 5 | 33 | | ■ |
| 24 | | | | RC | -- | | 78 | 0 | |
| 25 | | | | | | | | | |
| 26 – 8 | | | | RC | -- | | 61 | 0 | |
| 27 | | | | | | | | | |
| 28 | | | | | | | | | |
| 29 | | | | | | | | | |
| 30 – 9 | | Bedrock: volcanic rock; tuff. | | | | | | | |
| 31 | | | | | | | | | |
| 32 | | | | RC | -- | | 76 | 18 | |
| 33 – 10 | | | | | | | | | |
| 34 | | | | | | | | | |
| 35 | | | -7.31 | | | | | | |
| 36 – 11 | | End of Borehole | | | | | | | |
| 37 | | | | | | | | | |
| 38 | | | | | | | | | |
| 39 | | | | | | | | | |
| 40 – 12 | | | | | | | | | |
| 41 | | | | | | | | | |
| 42 | | | | | | | | | |
| 43 – 13 | | | | | | | | | |
| 44 | | | | | | | | | |
| 45 | | | | | | | | | |
| 46 – 14 | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH2*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 27, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Top of Wharf | 3.39 | | | | | | |
| 21 / 6 | | Harbour bottom (6.41 m below top of wharf). | -3.02 | | | | | | |
| 21 / 6 | | Split spoon sank 0.12 m into soft sediment under own weight before SPT. | | | | | | | |
| 22 / 6 | | SPT: 1 / 7 / 5 / 4. Sand, some gravel. | | | | | 40 | | |

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Fax: (709) 753-5101

Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH2

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 27, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | | -3.79 | SS | 1 | 12 | 40 | |
| | | No recovery. | -4.24 | OB | -- | | 0 | |
| | | SPT: 10 / 52 for 0.05 m, bouncing (refusal). Rock in split spoon shoe. | -4.44 | SS | 2 | 52 | 13 | |
| 8 | | Broken bedrock: volcanic rock; tuff. | | RC | -- | | 50 | 18 |
| 9 | | | | RC | -- | | 42 | 0 |
| 10 | | | -6.98 | RC | -- | | 69 | 12 |
| 11 | | Bedrock: volcanic rock; tuff. | | RC | -- | | 100 | 12 |
| 12 | | | -8.8 | RC | -- | | 100 | 37 |
| 13 | | End of Borehole | | | | | | |
| 14 | | | | | | | | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

Fracflow Consultants Inc.
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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH3*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 8, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Top of Wharf | 3.34 | | | | | | |
| 22 / 6.74 | | Harbour bottom (6.74 m below top of wharf). | -3.39 | | | | | | |
| | | Split spoon sank 0.58 m into soft sediment under own weight before SPT. | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH3

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 8, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | | -3.97 | | | | | |
| | | SPT: 1 / 4 / 1 / 3.<br>Sand, some gravel. | | SS | 1 | 5 | 17 | |
| | | | -4.58 | | | | | |
| 8 | | SS2 overlapped with SS1 for 0.52 m.<br>SS2: "N" Value = 2; Recovery = 28%.<br>SPT: 3 / 1 / 1 / 4.<br>CFEM: Sand, some Silt/Clay, some Gravel. | | SS | 2 | 2 | 28 | |
| | | Broken bedrock: volcanic rock; tuff. | | RC | -- | | 60 | 19 |
| | | | -5.6 | | | | | |
| 9 | | SS3: "N" Value = 52; Recovery = 0%.<br>SPT: 52 for 0.05 m, bouncing (refusal).<br>No sample recovery. | | SS | 3 | 52 | 0 | |
| | | Broken bedrock: volcanic rock; tuff. | | RC | -- | | 65 | 0 |
| | | | -6.54 | | | | | |
| 10 | | Bedrock: volcanic rock; tuff. | | RC | -- | | 100 | 29 |
| | | | -7.99 | | | | | |
| | | End of Borehole | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH4*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 17, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft / m | | Top of Wharf | 3.38 | | | | | | |
| 0 / 0 | | | | | | | | | |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 / 1 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 / 2 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 / 3 | | | | | | | | | |
| 10 | | | | | | | | | |
| 11 | | | | | | | | | |
| 12 / 4 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |
| 15 / 5 | | | | | | | | | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 / 6 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | | | | | | | | |
| 21 | | | | | | | | | |
| 22 | | Harbour bottom (6.86 m below top of wharf). | -3.48 | | | | | | |
| 23 | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH4

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 17, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | Split spoon sank 0.39 m into soft sediment under own weight before SPT. | -3.87 | | | | | |
| | | SPT: 1 / 1 / 4 / 11 for 0.26 m.<br>CFEM: Sand, some Gravel, some Silt/Clay. | -4.58 | SS | 1 | 5 | 39 | |
| 8 | | SS2 overlapped with SS1 for 0.31 m.<br>SPT: 9 / 1 / 6 / 12.<br>Sand and gravel. | -4.89 | SS | 2 | 7 | 8 | |
| | | Overburden: gravel. | -5.82 | OB | -- | | 33 | |
| 9 | | SPT: 13 / 52 for 0.0 m, bouncing (refusal).<br>CFEM: Sandy Gravel, trace Silt/Clay. | | SS | 3 | 52 | 25 | |
| | | Broken bedrock: volcanic rock; tuff. | -6.84 | RC | -- | | 60 | 12 |
| 10 | | Bedrock: volcanic rock; tuff. | | RC | -- | | 90 | 61 |
| 11 | | | | RC | -- | | 100 | 53 |
| 12 | | | | RC | -- | | 92 | 0 |
| | | | -9.47 | | | | | |
| 13 | | End of Borehole | | | | | | |
| 14 | | | | | | | | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH5*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 27 - 28, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft / m | | Top of Wharf | 3.37 | | | | | | |
| 21 / 6 | | Harbour bottom (6.44 m below top of wharf). | -3.07 | | | | | | |
| 22 / 6 | | Split spoon sank 0.58 m into soft sediment under own weight before SPT. | -3.65 | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH5

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 27 - 28, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| 23 | | | | | | | | |
| 24 | | SPT: 4 / 6 / 5 / 15 for 0.19 m.<br>CFEM: Sand and Gravel, trace Silt/Clay. | | SS | 1 | 11 | 27 | |
| 25 | | | -4.3 | | | | | |
| 26 | | SPT: 4 / 9 / 52 for 0.13 m, bouncing (refusal).<br>Sand and gravel. | | SS | 2 | 61 | 18 | |
| 27 | 8 | | -4.73 | OB | -- | | 27 | |
| 28 | | Overburden: gravel and cobbles. | | | | | | |
| 29 | | | | OB | -- | | 60 | |
| 30 | 9 | | -5.81 | | | | | |
| 31 | | SPT: 15 / 13 / 5 / 5.<br>Gravel. | | SS | 3 | 18 | 10 | |
| 32 | | | -6.42 | | | | | |
| 33 | 10 | Broken bedrock: volcanic rock; tuff. | | RC | -- | | 45 | 0 |
| 34 | | | | RC | -- | | 43 | 0 |
| 35 | | | -7.32 | | | | | |
| 36 | 11 | SPT: 14 / 52 for 0.01 m, bouncing (refusal).<br>Rock in split spoon shoe. | -7.49 | SS | 4 | 52 | 15 | |
| 37 | | | | RC | -- | | 100 | 0 |
| 38 | | | | RC | -- | | 100 | 0 |
| 39 | 12 | | | RC | -- | | 100 | 0 |
| 40 | | | | | | | | |
| 41 | | Bedrock: volcanic rock; tuff. | | RC | -- | | 100 | 21 |
| 42 | | | | | | | | |
| 43 | 13 | | | RC | -- | | 100 | 41 |
| 44 | | | | | | | | |
| 45 | | | | | | | | |
| 46 | 14 | | -10.6 | | | | | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH8*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 31 - June 1, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft / m | | Top of Wharf | 3.41 | | | | | | |
| 21 / 6 | | Harbour bottom (6.46 m below top of wharf). | -3.05 | | | | | | |
| 22 | | Split spoon sank 0.26 m into soft sediment under own weight before SPT. | -3.31 | | | | 4 | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH8

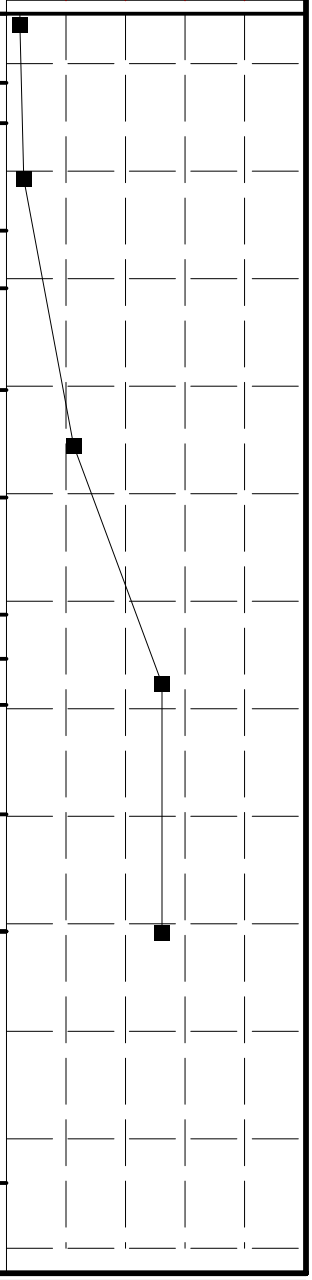
Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 31 - June 1, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| 23 | | SPT: 4 / 4 / 1 / 4 for 0.21 m. Gravel and sand. | | SS | 1 | 5 | 4 | |
| 24 | | | -3.98 | | | | | |
| | | Overburden: gravel. | -4.21 | OB | -- | | 11 | |
| 25 | | | | | | | | |
| 26 | 8 | SPT: 1 / 3 / 3 / 6. No sample recovery. | | SS | 2 | 6 | 0 | |
| 27 | | | -4.82 | | | | | |
| | | Overburden: gravel. | -5.15 | OB | -- | | 30 | |
| 28 | | | | | | | | |
| 29 | | Overburden: boulder (0.50 m cored length). | | OB | -- | | 80 | |
| 30 | 9 | | -5.72 | | | | | |
| 31 | | SPT: 5 / 7 / 16 / 6 for 0.16 m. Gravel (rock fragments). | | SS | 3 | 23 | 12 | |
| 32 | | | -6.34 | | | | | |
| 33 | 10 | Broken bedrock: volcanic rock; tuff. | | RC | -- | | 18 | 0 |
| 34 | | | | RC | -- | | 100 | 0 |
| | | | -7.25 | | | | | |
| 35 | | SPT: 7 / 52 for 0.10 m, bouncing (refusal). No sample recovery. | -7.51 | SS | 4 | 52 | 0 | |
| 36 | 11 | | | RC | -- | | 16 | 0 |
| 37 | | Broken bedrock: volcanic rock; tuff. | | | | | | |
| 38 | | | | | | | | |
| 39 | 12 | | | RC | -- | | 40 | 0 |
| | | | -8.8 | | | | | |
| 40 | | SS5: "N" Value = 52; Recovery = 0%. SPT: 52 for 0.0 m, bouncing (refusal). No sample recovery. | | | | | | |
| 41 | | | | | | | | |
| 42 | | | | RC | -- | | 52 | 21 |
| 43 | 13 | | | | | | | |
| 44 | | | | | | | | |
| 45 | | Broken bedrock: volcanic rock; tuff. | | | | | | |
| 46 | 14 | | | | | | | |

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH8

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 31 - June 1, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 15 | | | -11.7 | RC | -- | | 49 | 0 | |
| 16 | | Bedrock: volcanic rock. | | RC | -- | | 100 | 38 | |
| | | | | RC | -- | | 100 | 19 | |
| 17 | | End of Borehole | -13.2 | | | | | | |

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH10*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 30 - 31, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Top of Wharf | 3.42 | | | | | | |
| | | Concrete wharf deck. | 3.07 | | | | | | |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 / 1 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 / 2 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 / 3 | | | | | | | | | |
| 10 | | | | | | | | | |
| 11 | | | | | | | | | |
| 12 / 4 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |
| 15 / 5 | | | | | | | | | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 / 6 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | | | | | | | | |
| 21 | | Harbour bottom (6.58 m below top of wharf). | -3.16 | | | | | | |
| 22 | | Split spoon sank 0.38 m into soft sediment under own weight before SPT. | -3.53 | | | | | | |
| 23 | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH10

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 30 - 31, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| 23 | | | | | | | | |
| 24 | | SPT: 2 / 2 / 1 / 1 for 0.40 m (sank)<br>Sand, some gravel. | | SS | 1 | 3 | 13 | |
| 25 | | | -4.39 | | | | | |
| 26 – 8 | | No recovery. | | OB | -- | | 0 | |
| 27 | | | | | | | | |
| 28 | | | | | | | | |
| 29 | | | -5.63 | | | | | |
| 30 – 9 | | SPT: 5 / 12 / 8 / 9.<br>CFEM: Sand, some Gravel, trace Silt/Clay. | | SS | 2 | 20 | 25 | |
| 31 | | | -6.24 | | | | | |
| 32 | | No recovery. | | OB | -- | | 0 | |
| 33 – 10 | | | | | | | | |
| 34 | | | -7.14 | | | | | |
| 35 | | SPT: 8 / 14 / 13 / 12.<br>Sand and gravel. | | SS | 3 | 27 | 2 | |
| 36 – 11 | | | -7.75 | | | | | |
| 37 | | Overburden: gravel. | | OB | -- | | 14 | |
| 38 | | | | | | | | |
| 39 – 12 | | | -8.77 | | | | | |
| 40 | | SPT: 7 / 5 / 7 / 5.<br>No sample recovery. | | SS | 4 | 12 | 0 | |
| 41 | | | -9.38 | | | | | |
| 42 | | Overburden: gravel. | | OB | -- | | 17 | |
| 43 – 13 | | | | | | | | |
| 44 | | | -10.2 | | | | | |
| 45 | | SPT: 11 / 8 / 8 / 8.<br>Gravel, some sand. | | | | | 12 | |
| 46 – 14 | | | | | | | | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH10

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 30 - 31, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | | -10.8 | SS | 5 | 16 | 12 | |
| | | Overburden: gravel. | -11.8 | OB | -- | | 25 | |
| | | SPT: 9 / 52 for 0.05 m, bouncing (refusal).<br>CFEM: Sandy Gravel, trace Silt/Clay. | -12.1 | SS | 6 | 52 | 24 | |
| | | Overburden: gravel. | -12.5 | OB | -- | | 36 | |
| | | | | OB | -- | | 40 | |
| | | Broken bedrock: volcanic rock; flow. | | OB | -- | | 17 | |
| | | | | OB | -- | | 9 | |
| | | SS7: "N" Value = 52; Recovery = 0%.<br>SPT: 52 for 0.03 m, bouncing (refusal).<br>No sample recovery. | -14.9 | SS | 7 | 52 | 0 | |
| | | | | RC | -- | | 86 | 15 |
| | | | | RC | -- | | 100 | 0 |
| | | Bedrock: volcanic rock; flow. | | RC | -- | | 100 | 0 |
| | | | | | | | 100 | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH10*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 30 - 31, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| | | | -17.8 | RC | -- | | 100 | 0 | |
| | | End of Borehole | | | | | | | |

69 70 71 72 22 73 74 75 23 76 77 78 79 24 80 81 82 25 83 84 85 26 86 87 88 27 89 90 91 92 28

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH11*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 2, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Top of Wharf | 3.38 | | | | | | |
| | | Concrete wharf deck. | 3.04 | | | | | | |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 / 1 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 / 2 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 / 3 | | | | | | | | | |
| 10 | | | | | | | | | |
| 11 | | | | | | | | | |
| 12 / 4 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |
| 15 / 5 | | | | | | | | | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 / 6 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | | | | | | | | |
| 21 | | | | | | | | | |
| 22 | | | | | | | | | |
| 23 | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH11

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 2, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | Harbour bottom (7.77 m below top of wharf). | -4.39 | | | | | |
| 8 | | SPT: 2 / 3 / 3 / 3 for 0.17 m. Sand, some gravel. | -5.01 | SS | 1 | 6 | 41 | |
| 9 | | Overburden: gravel. | -5.74 | OB | -- | | 16 | |
| | | SPT: 16 / 39 / 14 / 6. Gravel. | -6.35 | SS | 2 | 53 | 15 | |
| 10 | | Overburden: gravel, cobble (0.13 m cored length). | | OB | -- | | 21 | |
| | | | -7.28 | OB | -- | | 54 | |
| 11 | | SPT: 11 / 12 / 9 / 4. Gravel and sand. | -7.89 | SS | 3 | 21 | 4 | |
| 12 | | Overburden: gravel. | -8.85 | OB | -- | | 15 | |
| | | SPT: 6 / 5 / 6 / 10. Gravel. | -9.46 | SS | 4 | 11 | 6 | |
| 13 | | Overburden: gravel. | -10.3 | OB | -- | | 24 | |
| 14 | | | -10.6 | RC | -- | | 65 | 0 |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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# Log of Borehole: BH11

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 2, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 46 | | SS5: "N" Value = 52; Recovery = 0%. SPT: 52 for 0.03 m, bouncing (refusal). No sample recovery. Broken bedrock: volcanic rock. | | RC | -- | | 84 | 0 | |
| 47 | | | | | | | | | |
| 48 | | | | RC | -- | | 100 | 0 | |
| 49 | 15 | | | | | | | | |
| 50 | | | | RC | -- | | 89 | 0 | |
| 51 | | Bedrock: volcanic rock; flow. | | RC | -- | | 83 | 0 | |
| 52 | | | | | | | | | |
| 53 | 16 | | | RC | -- | | 100 | 0 | |
| 54 | | | | | | | | | |
| 55 | | | | RC | -- | | 89 | 12 | |
| 56 | 17 | | -13.8 | | | | | | |
| 57 | | End of Borehole | | | | | | | |
| 58 | | | | | | | | | |
| 59 | 18 | | | | | | | | |
| 60 | | | | | | | | | |
| 61 | | | | | | | | | |
| 62 | 19 | | | | | | | | |
| 63 | | | | | | | | | |
| 64 | | | | | | | | | |
| 65 | | | | | | | | | |
| 66 | 20 | | | | | | | | |
| 67 | | | | | | | | | |
| 68 | | | | | | | | | |
| 69 | 21 | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH12*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 3, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Top of Wharf | 3.38 | | | | | | |
| | | Concrete wharf deck. | 3.03 | | | | | | |
| 22 / 6 | | Harbour bottom (6.84 m below top of wharf). | -3.46 | | | | | | |
| 23 | | Split spoon sank 0.20 m into soft sediment under own weight before SPT. | -3.66 | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH12

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 3, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 23 | | | | | | | | | |
| 24 | | SPT: 1 / 7 / 14 / 13.<br>Sand and gravel. | | SS | 1 | 21 | 37 | | |
| 25 | | | -4.27 | | | | | | |
| 26 8 | | SS2 overlapped SS1 for 0.08 m.<br>SPT: 14 / 32 / 52 for 0.04 m, bouncing (refusal).<br>CFEM: Gravel and Sand, trace Silt/Clay. | -4.53 | SS | 2 | 84 | 30 | | |
| 27 | | | | RC | -- | | 82 | 9 | |
| 28 | | | | | | | | | |
| 29 9 | | | | RC | -- | | 99 | 67 | |
| 30 | | | | | | | | | |
| 31 | | Bedrock: volcanic rock; flow. | | | | | | | |
| 32 | | | | RC | -- | | 98 | 40 | |
| 33 10 | | | | | | | | | |
| 34 | | | | RC | -- | | 100 | 55 | |
| 35 | | | -7.41 | | | | | | |
| 36 11 | | End of Borehole | | | | | | | |
| 37 | | | | | | | | | |
| 38 | | | | | | | | | |
| 39 12 | | | | | | | | | |
| 40 | | | | | | | | | |
| 41 | | | | | | | | | |
| 42 | | | | | | | | | |
| 43 13 | | | | | | | | | |
| 44 | | | | | | | | | |
| 45 | | | | | | | | | |
| 46 14 | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH13

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 4, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Top of Wharf | 3.39 | | | | | | |
| | | Concrete wharf deck. | 3.01 | | | | | | |
| 1 / | | | | | | | | | |
| 2 / | | | | | | | | | |
| 3 / 1 | | | | | | | | | |
| 4 / | | | | | | | | | |
| 5 / | | | | | | | | | |
| 6 / 2 | | | | | | | | | |
| 7 / | | | | | | | | | |
| 8 / | | | | | | | | | |
| 9 / | | | | | | | | | |
| 10 / 3 | | | | | | | | | |
| 11 / | | | | | | | | | |
| 12 / | | | | | | | | | |
| 13 / 4 | | | | | | | | | |
| 14 / | | | | | | | | | |
| 15 / | | | | | | | | | |
| 16 / 5 | | | | | | | | | |
| 17 / | | Harbour bottom (5.26 m below top of wharf). | -1.87 | | | | | | |
| | | SPT: 1 for 0.13 m / 52 for 0.0 m, bouncing (refusal). | | SS | 1 | 52 | 30 | | ■ |
| 18 / | | Sand and gravel. | | | | | | | |
| 19 / | | | | RC | -- | | 100 | 0 | |
| 20 / 6 | | | | | | | | | |
| 21 / | | | | RC | -- | | 98 | 0 | |
| 22 / | | | | | | | | | |
| 23 / | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH13

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 4, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 8 | | Bedrock: volcanic rock; flow. | | RC | -- | | 100 | 22 | |
| | | | | RC | -- | | 100 | 0 | |
| | | | | RC | -- | | 100 | 0 | |
| 9 | | | -5.64 | | | | | | |
| | | End of Borehole | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH14*

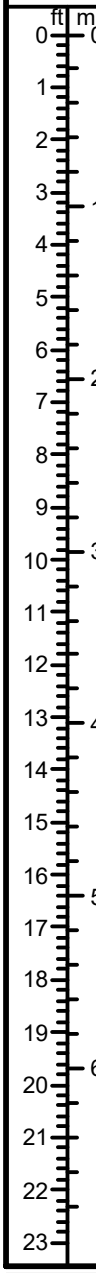
Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 3 - 4, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft / m | | Top of Wharf | 3.39 | | | | | | |





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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH14

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 3 - 4, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | Harbour bottom (7.60 m below top of wharf). | -4.21 | | | | | |
| 8 | | SPT: 11 / 26 / 9 / 8.<br>Wood fragments. | -4.82 | SS | 1 | 35 | 37 | |
| | | Overburden: gravel. | -5.74 | OB | -- | | 12 | |
| 9 | | SPT: 8 / 9 / 6 / 7.<br>Sand and gravel. | -6.34 | SS | 2 | 15 | 4 | |
| | | Overburden: gravel. | -6.73 | OB | -- | | 40 | |
| 10 | | Broken bedrock: volcanic rock; flow. | -7.25 | RC | -- | | 74 | 23 |
| | | SS3: "N" Value = 52; Recovery = 0%.<br>SPT: 52 for 0.05 m, bouncing (refusal).<br>No sample recovery. | | SS | 3 | 52 | 0 | |
| 11 | | | | RC | -- | | 100 | 49 |
| | | Bedrock: volcanic rock; flow. | | | | | | |
| 12 | | | | RC | -- | | 100 | 59 |
| | | | -8.97 | | | | | |
| | | End of Borehole | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH15*

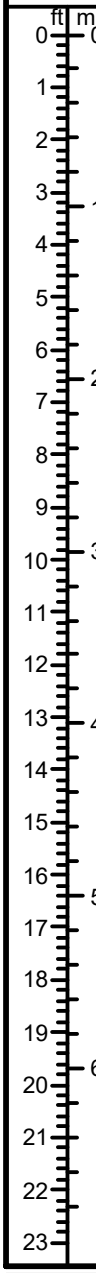
Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 4 - 5, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft / m | | Top of Wharf | 3.34 | | | | | | |





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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH15

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 4 - 5, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| | | Harbour bottom (7.67 m below top of wharf). | -4.33 | | | | | | |
| | | Split spoon sank 0.15 m into soft sediment under own weight before SPT. | | | | | | | |
| 8 | | SPT: 1 / 3 / 15 / 52 for 0.05 m, bouncing (refusal). | | SS | 1 | 18 | 17 | | |
| | | CFEM: Gravel, some Sand, trace Silt/Clay. | -4.97 | | | | | | |
| | | 0.15 m gravel overburden over broken bedrock. | | RC | -- | | 56 | 0 | |
| | | | -5.6 | | | | | | |
| 9 | | Bedrock: volcanic rock; flow. | | RC | -- | | 91 | 24 | |
| 10 | | | | RC | -- | | 100 | 45 | |
| 11 | | | | RC | -- | | 97 | 53 | |
| | | | -8.24 | | | | | | |
| 12 | | End of Borehole | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH16*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 28, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm |
| ft / m | | Top of Wharf | 3.34 | | | | | | 20 40 60 80 |
| 0 / 0 | | | | | | | | | |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 / 1 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 / 2 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 / 3 | | | | | | | | | |
| 10 | | | | | | | | | |
| 11 | | | | | | | | | |
| 12 / 4 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |
| 15 / 5 | | | | | | | | | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 / 6 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | | | | | | | | |
| 21 | | | | | | | | | |
| 22 | | | | | | | | | |
| 23 | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Lt.d

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH16

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 28, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 24 | | Harbour bottom (7.42 m below top of wharf). | -4.09 | | | | | | |
| | | Split spoon sank 0.24 m into soft sediment under own weight before SPT. | -4.32 | | | | | | |
| 25 | | SPT: 7 / 52 for 0.04 m, bouncing (refusal). | -4.51 | SS | 1 | 52 | 33 | | |
| 26 | 8 | CFEM: Gravel and Sand, some Silt/Clay. | | | | | | | |
| 27 | | Broken bedrock: volcanic rock; flow. | | RC | -- | | 38 | 0 | |
| 28 | | | -5.22 | | | | | | |
| 29 | 9 | | | | | | | | |
| 30 | | | | RC | -- | | 100 | 27 | |
| 31 | | Bedrock: volcanic rock; flow. | | | | | | | |
| 32 | | | | | | | | | |
| 33 | 10 | | | | | | | | |
| 34 | | | | RC | -- | | 100 | 83 | |
| 35 | | | -7.36 | | | | | | |
| 36 | 11 | End of Borehole | | | | | | | |
| 37 | | | | | | | | | |
| 38 | | | | | | | | | |
| 39 | 12 | | | | | | | | |
| 40 | | | | | | | | | |
| 41 | | | | | | | | | |
| 42 | | | | | | | | | |
| 43 | 13 | | | | | | | | |
| 44 | | | | | | | | | |
| 45 | | | | | | | | | |
| 46 | 14 | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Lt.d

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH17*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 29, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Top of Wharf | 3.31 | | | | | | |
| 22 / 6.78 | | Harbour bottom (6.78 m below top of wharf). | -3.47 | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH17

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 29, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| 23 | | SPT: 2 / 6 / 10 / 24.<br>CFEM: Gravel and Sand, trace Silt/Clay. | -4.08 | SS | 1 | 16 | 33 | |
| 24 | | Broken bedrock: volcanic rock; flow. | -4.29 | RC | -- | | 34 | 0 |
| 25 | | SS2: "N" Value = 52; Recovery - 0%.<br>SPT: 52 for 0.03 m, bouncing (refusal).<br>No sample recovery. | | | | | | |
| 26 | 8 | | | RC | -- | | 82 | 36 |
| 27 | | | | | | | | |
| 28 | | | | | | | | |
| 29 | | Bedrock: volcanic rock; flow. | | | | | | |
| 30 | 9 | | | | | | | |
| 31 | | | | RC | -- | | 100 | 42 |
| 32 | | | | | | | | |
| 33 | 10 | | -6.74 | | | | | |
| 34 | | End of Borehole | | | | | | |
| 35 | | | | | | | | |
| 36 | 11 | | | | | | | |
| 37 | | | | | | | | |
| 38 | | | | | | | | |
| 39 | 12 | | | | | | | |
| 40 | | | | | | | | |
| 41 | | | | | | | | |
| 42 | | | | | | | | |
| 43 | 13 | | | | | | | |
| 44 | | | | | | | | |
| 45 | | | | | | | | |
| 46 | 14 | | | | | | | |

SUBSURFACE PROFILE

SAMPLE

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH18*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 29, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm |
| ft / m | | | | | | | | | 20 40 60 80 |
| 0 / 0 | | Top of Wharf | 3.31 | | | | | | |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 / 1 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 / 2 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 / 3 | | | | | | | | | |
| 10 | | | | | | | | | |
| 11 | | | | | | | | | |
| 12 / 4 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |
| 15 / 5 | | | | | | | | | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 / 6 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | | | | | | | | |
| 21 | | | | | | | | | |
| 22 | | | | | | | | | |
| 23 | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH18

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 29, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | Harbour bottom (7.23 m below top of wharf). | -3.92 | | | | | |
| | | Split spoon sank 0.78 m into soft sediment under own weight before SPT. | -4.7 | | | | | |
| 8 | | SPT: 1 / 2 / 5 / 4 for 0.17 m. Sand, trace gravel. | -5.33 | SS | 1 | 7 | 44 | |
| | | Overburden: gravel. | -5.79 | RC | -- | | 41 | |
| 9 | | SPT: 17 / 52 for 0.04 m, bouncing (refusal). CFEM: Gravel and Sand, trace Silt/Clay. | -5.99 | SS | 2 | 52 | 32 | |
| | | Overburden: gravel. | -6.75 | RC | -- | | 16 | |
| 10 | | Bedrock: volcanic rock; flow. | | RC | -- | | 100 | 0 |
| 11 | | | | RC | -- | | 94 | 33 |
| 12 | | | | RC | -- | | 100 | 30 |
| 13 | | End of Borehole | -9.49 | | | | | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH19*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 28 - 29, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft / m | | Top of Wharf | 3.34 | | | | | | |
| 22 / 6.7 | | Harbour bottom (6.80 m below top of wharf). | -3.45 | | | | | | |
| 23 / 7 | | Split spoon sank 0.34 m into soft sediment under own weight before SPT. | -3.79 | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH19

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 28 - 29, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 23 | | | | | | | | | |
| 24 | | SPT: 3 / 4 / 4 / 3 for 0.22 m.<br>Sand, trace gravel. | | SS | 1 | 8 | 28 | | |
| 25 | | | -4.46 | | | | | | |
| 26 8 | | SS2 overlapped with SS1 for 0.11 m.<br>SPT: 1 / 2 / 3 / 1 for 0.19 m.<br>Sand, some gravel, some wood fragments. | | SS | 2 | 5 | 16 | | |
| 27 | | | -5 | | | | | | |
| 28 | | Overburden: wood fragments and gravel. | | OB | -- | | 27 | | |
| 29 9 | | | -5.79 | | | | | | |
| 30 | | SPT: 14 / 21 / 14 / 10.<br>CFEM: Gravel and Sand, trace Silt/Clay. | | SS | 3 | 35 | 12 | | |
| 31 | | | -6.41 | | | | | | |
| 32 | | Broken bedrock: volcanic rock; flow. | | RC | -- | | 64 | 0 | |
| 33 10 | | | -6.72 | | | | | | |
| 34 | | | | RC | -- | | 100 | 35 | |
| 35 | | | | | | | | | |
| 36 11 | | Bedrock: volcanic rock; flow. | | | | | | | |
| 37 | | | | | | | | | |
| 38 | | | | RC | -- | | 100 | 46 | |
| 39 12 | | | | | | | | | |
| 40 | | | | | | | | | |
| 41 | | | -9.41 | | | | | | |
| 42 | | End of Borehole | | | | | | | |
| 43 13 | | | | | | | | | |
| 44 | | | | | | | | | |
| 45 | | | | | | | | | |
| 46 14 | | | | | | | | | |

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH20*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 5, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Top of Wharf | 3.34 | | | | | | |
| | | Concrete wharf deck. | 3.03 | | | | | | |
| 19 / 6 | | Harbour bottom (5.83 m below top of wharf). | -2.49 | | | | | | |
| | | Split spoon sank 0.34 m into soft sediment under own weight before SPT. | -2.82 | | | | | | |
| 21 | | SPT: 1 for 0.61 m (sank).<br>CFEM: Gravelly Sand, some Silt/Clay. | -3.43 | SS | 1 | 1 | 46 | | |

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH20

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 5, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | Overburden: black fine sand. | -4.25 | OB | -- | | 16 | |
| | | SPT: 3 / 2 / 4 / 8.<br>Gravel and sand. | -4.86 | SS | 2 | 6 | 10 | |
| | | Overburden: gravel. | -5.8 | OB | -- | | 22 | |
| | | SPT: 11 / 8 / 8 / 10.<br>CFEM: Gravel and Sand, trace Silt/Clay. | -6.4 | SS | 3 | 16 | 17 | |
| | | Overburden: gravel. | -7.27 | OB | -- | | 10 | |
| | | SS4: "N" Value = 52; Recovery = 11%<br>SPT: 52 for 0.05 m, bouncing (refusal).<br>Rock in split spoon shoe. | | SS | 4 | 52 | 0 | |
| | | | | RC | -- | | 100 | 0 |
| | | | | RC | -- | | 68 | 0 |
| | | Bedrock: volcanic rock; flow. | | RC | -- | | 92 | 0 |
| | | | | RC | -- | | 100 | 0 |
| | | | -10.8 | RC | -- | | 100 | 0 |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH20

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: June 5, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 46 | | End of Borehole | | RC | -- | | 100 | 0 | |
| 47 | | | | | | | | | |
| 48 | | | | | | | | | |
| 49 | | | | | | | | | |
| 15 | | | | | | | | | |
| 50 | | | | | | | | | |
| 51 | | | | | | | | | |
| 52 | | | | | | | | | |
| 16 | | | | | | | | | |
| 53 | | | | | | | | | |
| 54 | | | | | | | | | |
| 55 | | | | | | | | | |
| 56 | | | | | | | | | |
| 17 | | | | | | | | | |
| 57 | | | | | | | | | |
| 58 | | | | | | | | | |
| 59 | | | | | | | | | |
| 18 | | | | | | | | | |
| 60 | | | | | | | | | |
| 61 | | | | | | | | | |
| 62 | | | | | | | | | |
| 19 | | | | | | | | | |
| 63 | | | | | | | | | |
| 64 | | | | | | | | | |
| 65 | | | | | | | | | |
| 20 | | | | | | | | | |
| 66 | | | | | | | | | |
| 67 | | | | | | | | | |
| 68 | | | | | | | | | |
| 69 | | | | | | | | | |
| 21 | | | | | | | | | |

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH21

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 6 - 7, 2016

| Depth below Top of Wharf (ft) | Depth below Top of Wharf (m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | | Top of Wharf | 3.4 | | | | | |
| | | | Concrete deck. | 3.2 | OB | -- | | 58 | |
| 1 | | | SPT: 13 / 10 / 5 / 7. Gravel. | | SS | 1 | 15 | 10 | |
| 2 | | | | 2.6 | | | | | |
| 3 | 1 | | Overburden: asphalt, concrete, and gravel. | | OB | -- | | 31 | |
| 4 | | | | 1.96 | | | | | |
| 5 | | | SPT: 16 / 52 for 0.05 m, bouncing (refusal). Wood fragments. | 1.74 | SS | 2 | 52 | 0 | |
| 6 | 2 | | Overburden: gravel and cobbles, boulder (0.23 m cored length). | | OB | -- | | 70 | |
| 9 | | | | 0.423 | | | | | |
| 10 | 3 | | SS3: "N" Value = 52; Recovery = 0%. SPT: 52 for 0.03 m, bouncing (refusal). No sample recovery. | | SS | 3 | 52 | 0 | |
| 11 | | | Overburden: gravel, boulder (0.20 m cored length). | | OB | -- | | 47 | |
| 13 | 4 | | | -1.05 | | | | | |
| 14 | | | SS4: "N" Value = 52; Recovery = 0%. SPT: 52 for 0.03 m, bouncing (refusal). No sample recovery. | | SS | 4 | 52 | 0 | |
| 15 | | | | | OB | -- | | 50 | |
| 16 | 5 | | Overburden: gravel. | -1.7 | OB | -- | | 67 | |
| 17 | | | Broken bedrock: volcanic rock; tuff. | | RC | -- | | 65 | 0 |
| 18 | | | | | | | | | |
| 19 | | | | | RC | -- | | 100 | 40 |
| | | | | -2.54 | | | | | |
| 20 | 6 | | SS5: "N" Value = 52; Recovery = 0%. SPT: 52 for 0.05 m, bouncing (refusal). No sample recovery. | | SS | 5 | 52 | 0 | |
| 21 | | | | | RC | -- | | 93 | 36 |
| 22 | | | | | | | | | |
| 23 | | | | | | | | | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80


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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH21

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 6 - 7, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 23 | | | | | | | | | |
| 24 | | Bedrock: volcanic rock; tuff. | | RC | -- | | 100 | 36 | |
| 25 | | | | RC | -- | | 100 | 96 | |
| 26 – 8 | | | -4.51 | | | | | | |
| 27 | | End of Borehole | | | | | | | |
| 28 | | | | | | | | | |
| 29 – 9 | | | | | | | | | |
| 30 | | | | | | | | | |
| 31 | | | | | | | | | |
| 32 | | | | | | | | | |
| 33 – 10 | | | | | | | | | |
| 34 | | | | | | | | | |
| 35 | | | | | | | | | |
| 36 – 11 | | | | | | | | | |
| 37 | | | | | | | | | |
| 38 | | | | | | | | | |
| 39 – 12 | | | | | | | | | |
| 40 | | | | | | | | | |
| 41 | | | | | | | | | |
| 42 | | | | | | | | | |
| 43 – 13 | | | | | | | | | |
| 44 | | | | | | | | | |
| 45 | | | | | | | | | |
| 46 – 14 | | | | | | | | | |

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH22

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 7, 2016

| Depth below Top of Wharf (ft) | Depth below Top of Wharf (m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | | Top of Wharf | 3.47 | | | | | |
| | | | Concrete deck. | 3.12 | | | | | |
| 6 | 2 | | Harbour bottom (1.99 m below top of wharf). | 1.48 | | | | | |
| | | | SPT: 14 / 52 for 0.03 m, bouncing (refusal). Sand and gravel. | 1.3 | SS | 1 | 52 | 29 | |
| | | | Overburden: concrete and webbing. | | OB | -- | | 47 | |
| 10 | 3 | | | 0.374 | SS | 2 | 52 | 20 | |
| | | | SS2: "N" Value = 52; Recovery = 20%. SPT: 52 for 0.05 m, bouncing (refusal). Rock in split spoon shoe. | | | | | | |
| | | | Broken bedrock: volcanic rock; tuff. | | OB | -- | | 68 | 10 |
| 15 | 4 | | | -1.09 | SS | 3 | 52 | 20 | |
| | | | SS3: "N" Value = 52; Recovery = 20%. SPT: 52 for 0.05 m, bouncing (refusal). Rock in split spoon shoe. | | RC | -- | | 100 | 0 |
| | | | | | RC | -- | | 99 | 47 |
| 20 | 6 | | Bedrock: volcanic rock; tuff. | | RC | -- | | 89 | 11 |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH22

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 7, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 23 | | | | RC | -- | | 89 | 11 | |
| 24 | | | | RC | -- | | 92 | 21 | |
| 25 | | | -4.17 | | | | | | |
| | | End of Borehole | | | | | | | |
| 26 (8) | | | | | | | | | |
| 27 | | | | | | | | | |
| 28 | | | | | | | | | |
| 29 | | | | | | | | | |
| 30 (9) | | | | | | | | | |
| 31 | | | | | | | | | |
| 32 | | | | | | | | | |
| 33 | | | | | | | | | |
| 34 (10) | | | | | | | | | |
| 35 | | | | | | | | | |
| 36 | | | | | | | | | |
| 37 | | | | | | | | | |
| 38 (11) | | | | | | | | | |
| 39 | | | | | | | | | |
| 40 | | | | | | | | | |
| 41 | | | | | | | | | |
| 42 (12) | | | | | | | | | |
| 43 | | | | | | | | | |
| 44 | | | | | | | | | |
| 45 | | | | | | | | | |
| 46 (13) | | | | | | | | | |
| 14 | | | | | | | | | |

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH23

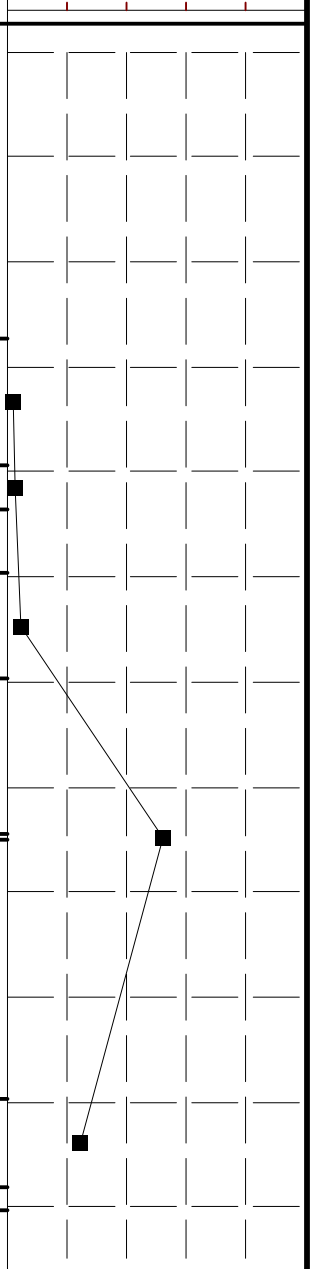
Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 9, 2016

| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| 0 / 0 | | Top of Wharf | 3.39 | | | | | |
| | | Concrete wharf deck. | 3.13 | | | | | |
| 5 / 1 | | Harbour bottom (1.67 m below top of wharf). | 1.72 | | | | | |
| 7 / 2 | | SPT: 1 / 1 / 1 / 1 for 0.28 m (sank). No sample recovery. Split spoon SS1 overlapped with split spoon SS2 for 0.41 m. | 0.979 | SS | 1 | 2 | 0 | |
| 8 | | SPT: 1 / 1 / 2 / 1 for 0.20 m (sank). No sample recovery. | 0.725 | SS | 2 | 3 | 0 | |
| 9 | | | 0.357 | OB | -- | | 0 | |
| 10 / 3 | | SPT: 2 / 2 / 3 / 2. Gravel. | -0.253 | SS | 3 | 5 | 12 | |
| 13 / 4 | | Overburden: gravel and cobbles. | -1.15 | OB | -- | | 44 | |
| 15 | | SS4: "N" Value = 52; Recovery = 0%. SPT: 52 for 0.04 m, bouncing (refusal). No sample recovery. | | SS | 4 | 52 | 0 | |
| 17 / 5 | | Overburden: gravel and cobbles. | -2.69 | OB | -- | | 4 | |
| 20 / 6 | | SPT: 8 / 10 / 15 / 52 for 0.06 m, bouncing (refusal). CFEM: Sandy Gravel, trace Silt/Clay. | -3.21 | SS | 5 | 25 | 20 | |
| 22 | | Overburden: gravel. | | RC | -- | | 81 | 0 |
| 23 | | | | | | | | |

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH23

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 9, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 8 | | Bedrock: volcanic rock; tuff. | | RC | -- | | 100 | 69 | |
| | | | | RC | -- | | 100 | 45 | |
| 9 | | | | RC | -- | | 100 | 84 | |
| | | | | RC | -- | | 90 | 57 | |
| 10 | | | -6.79 | | | | | | |
| | | End of Borehole | | | | | | | |
| 11 | | | | | | | | | |
| 12 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH24

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 10 - 11, 2016

| Depth below Top of Wharf (ft) | Depth below Top of Wharf (m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | | Top of Wharf | 3.47 | | | | | |
| | | | Concrete wharf deck. | 3.22 | | | | | |
| 7 | 2 | | Harbour bottom (2.46 m below top of wharf). | 1.36 | SS | 1 | 52 | 0 | |
| | | | SS1: "N" Value = 52; Recovery =0%.<br>SPT: 52 for 0.0 m, bouncing (refusal).<br>No sample recovery. | | OB | -- | | 67 | |
| | | | Overburden: boulder. | 0.467 | | | | | |
| 10 | 3 | | SPT: 7 / 11 / 12 / 12.<br>Rock in split spoon shoe. | -0.155 | SS | 2 | 23 | 4 | |
| 13 | 4 | | Overburden: gravel and cobbles. | -0.98 | OB | -- | | 18 | |
| 15 | | | SPT: 7 / 4 / 7 / 4.<br>Sand and gravel. | -1.59 | SS | 3 | 11 | 12 | |
| 17 | 5 | | Overburden: gravel and cobbles. | -2.54 | OB | -- | | 18 | |
| 20 | 6 | | SPT: 6 / 10 / 12 / 13.<br>CFEM: Sandy Gravel, trace Silt/Clay. | -3.18 | SS | 4 | 22 | 18 | |
| 22 | | | Overburden: gravel and cobbles. | | | | | 26 | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH24

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 10 - 11, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| | | | -3.8 | OB | -- | | 26 | | |
| | | SPT: 3 / 3 / 1 / 1.<br>Sand. | -4.41 | SS | 5 | 4 | 8 | | |
| 8 | | Overburden: gravel. | -4.8 | OB | -- | | 18 | | |
| | | SPT: 2 / 8 / 19 / 23.<br>CFEM: Sand, trace Silt/Clay, trace Gravel. | -5.41 | SS | 6 | 27 | 44 | | |
| 9 | | Overburden: gravel. | -7.15 | OB | -- | | 15 | | |
| | | SPT: 5 / 1 / 52 for 0.04 m, bouncing (refusal).<br>No sample recovery. | -7.49 | SS | 7 | 53 | 0 | | |
| 11 | | Overburden: cobbles and gravel. | | OB | -- | | 47 | | |
| 12 | | | | | | | | | |
| 13 | | | -10.3 | OB | -- | | 19 | | |
| 14 | | SPT: 8 / 7 / 8 / 11.<br>Rock in split spoon shoe, trace sand. | | | | | 4 | | |

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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH24

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 10 - 11, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| | | | -10.9 | SS | 8 | 15 | 4 | | |
| | | Overburden: gravel. | | OB | -- | | 16 | | |
| | | | -11.7 | | | | | | |
| | | End of Borehole | | | | | | | |

46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69

15 16 17 18 19 20 21

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH25

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 12, 2016

| Depth below Top of Wharf (ft) | Depth below Top of Wharf (m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | | Top of Wharf | 3.39 | | | | | |
| | | | Concrete deck. | 3.08 | | | | | |
| 7 | 2 | | Harbour bottom (2.31 m below top of wharf). | 1.08 | | | | | |
| | | | SPT: 3 / 3 / 15 / 52 for 0.04 m, bouncing (refusal). Gravel, some sand. | 0.588 | SS | 1 | 18 | 8 | |
| 10 | 3 | | Overburden: boulder. | 0.353 | OB | -- | | 100 | |
| | | | SS2: "N" Value = 52; Recovery = 100%. SPT: 52 for 0.06 m, bouncing (refusal). Gravel. | | SS | 2 | 52 | 100 | |
| | | | Overburden: gravel and cobbles. | -0.308 | OB | -- | | 65 | |
| 13 | 4 | | Broken bedrock: volcanic rock; flow. | | RC | -- | | 51 | 0 |
| | | | SS3: "N" Value = 52; Recovery = 0%. SPT: 52 for 0.04 m, bouncing (refusal). No sample recovery. | -1.15 | SS | 3 | 52 | 0 | |
| 16 | 5 | | | | RC | -- | | 100 | 0 |
| 18 | | | | | RC | -- | | 100 | 14 |
| 20 | 6 | | Bedrock: volcanic rock; flow. | | RC | -- | | 100 | 0 |

Standard Penetration Test "N" Value per 300 mm: 20, 40, 60, 80

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154 Major's Path
St. John's, NL A1A 5A1
Phone: (709) 739-7270
Fax: (709) 753-5101

Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH25

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 12, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| | | | | RC | -- | | 100 | 17 | |
| | | | -4.18 | | | | | | |
| | | End of Borehole | | | | | | | |


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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH26

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 13, 2016

| Depth below Top of Wharf (ft) | Depth below Top of Wharf (m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | | Top of Wharf | 3.33 | | | | | |
| | | | Concrete wharf deck. | 3.02 | | | | | |
| 12 | 3 | | Harbour bottom (3.79 m below top of wharf). | -0.463 | | | | | |
| 13 | 4 | | SPT: 1 / 1 / 52 for 0.13 m / 52 for 0.0 m, bouncing (refusal). CFEM: Sand and Gravel, trace Silt/Clay. | -0.895 | SS | 1 | 53 | 12 | |
| 14 | | | | -1.15 | | -- | | 0 | |
| 15 | 5 | | SS2: "N" Value = 52; Recovery = 14%. SPT: 52 for 0.09 m / 52 for 0.0 m, bouncing (refusal). Rock in split spoon shoe. | | SS | 2 | 52 | 14 | |
| 16 | | | | | RC | -- | | 100 | 0 |
| 18 | | | | | RC | -- | | 100 | 0 |
| 20 | 6 | | Bedrock: volcanic rock; flow. | | RC | -- | | 100 | 17 |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH26

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 13, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| | | | | RC | -- | | 95 | 0 | |
| | | | -4.24 | | | | | | |
| | | End of Borehole | | | | | | | |


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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

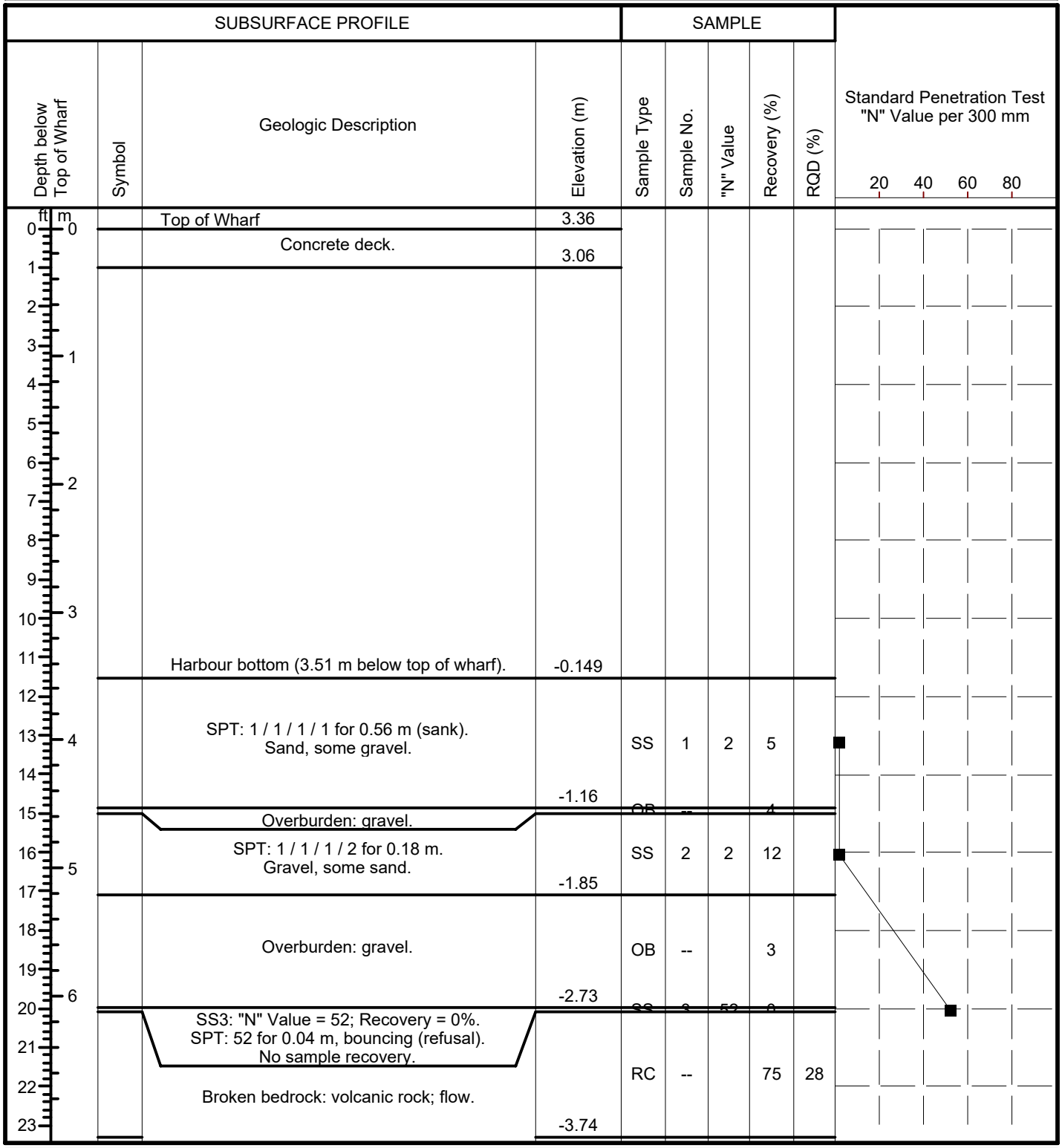
# Log of Borehole: BH27

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 13, 2016





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Drilling Method: NW casing / NQ coring

Datum: LNT

Driller: Formation Drilling Ltd.

Project: Marine Geotechnical Investigation

# Log of Borehole: BH27

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 13, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 23 | | | | RC | -- | | 75 | 28 | |
| 24 | | | | RC | -- | | 100 | 77 | |
| 25 | | | | | | | | | |
| 26 | | | | | | | | | |
| 8 | | Bedrock: volcanic rock; flow. | | | | | | | |
| 27 | | | | RC | -- | | 100 | 54 | |
| 28 | | | | | | | | | |
| 29 | | | | | | | | | |
| 9 | | | -5.74 | | | | | | |
| 30 | | End of Borehole | | | | | | | |
| 31 | | | | | | | | | |
| 32 | | | | | | | | | |
| 10 | | | | | | | | | |
| 33 | | | | | | | | | |
| 34 | | | | | | | | | |
| 35 | | | | | | | | | |
| 36 | | | | | | | | | |
| 11 | | | | | | | | | |
| 37 | | | | | | | | | |
| 38 | | | | | | | | | |
| 39 | | | | | | | | | |
| 12 | | | | | | | | | |
| 40 | | | | | | | | | |
| 41 | | | | | | | | | |
| 42 | | | | | | | | | |
| 13 | | | | | | | | | |
| 43 | | | | | | | | | |
| 44 | | | | | | | | | |
| 45 | | | | | | | | | |
| 46 | | | | | | | | | |
| 14 | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

Client: PWGSC

Location: Grand Bank, NL

# Log of Borehole: BH28

Project No: 3087

Date: May 14 - 15, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Top of Wharf | 3.37 | | | | | | |
| | | Concrete wharf deck. | 3.06 | | | | | | |
| 11 / 3 | | Harbour bottom (3.36 m below top of wharf). | 0.009 | | | | | | |
| | | SPT: 13 / 52 for 0.08 / 52 for 0.0 m, bouncing (refusal). CFEM: Sand and Gravel, trace Silt/Clay. | -0.22 | SS | 1 | 52 | 50 | | |
| 13 / 4 | | Overburden: gravel. | -1.25 | OB | -- | | 5 | | |
| 16 / 5 | | SPT: 2 / 1 / 2 / 1. Gravel, some sand. | -1.86 | SS | 2 | 3 | 2 | | |
| 18 / 6 | | Overburden: gravel. | -2.76 | OB | -- | | 13 | | |
| 20 | | SPT: 8 / 52 for 0.14 m / 52 for 0.0 m, bouncing (refusal). CFEM: Gravelly Sand, trace Silt/Clay. | -3.05 | SS | 3 | 52 | 35 | | |
| 23 | | Overburden: gravel. | | | | | 17 | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH28

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 14 - 15, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | | | OB | -- | | 17 | |
| | | | -4.26 | | | | | |
| 8 | | SPT: 11 / 11 / 13 / 9.<br>Gravel in split spoon shoe. | | SS | 4 | 24 | 4 | |
| | | | -4.87 | | | | | |
| | | Overburden: gravel. | | OB | -- | | 19 | |
| 9 | | | -5.77 | | | | | |
| | | SPT: 9 / 52 for 0.11 m / 52 for 0.0 m, bouncing (refusal).<br>CFEM: Gravelly Sand, trace Silt/Clay. | -6.04 | SS | 5 | 52 | 53 | |
| | | | | RC | -- | | 84 | 0 |
| 10 | | | | RC | -- | | 100 | 0 |
| | | Bedrock: volcanic rock; flow. | | RC | -- | | 94 | 0 |
| 12 | | | | RC | -- | | 82 | 0 |
| | | | | RC | -- | | 100 | 0 |
| | | | -9.36 | | | | | |
| 13 | | End of Borehole | | | | | | |
| 14 | | | | | | | | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

# *APPENDIX B*

## *Grain Size Analysis Reports*

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

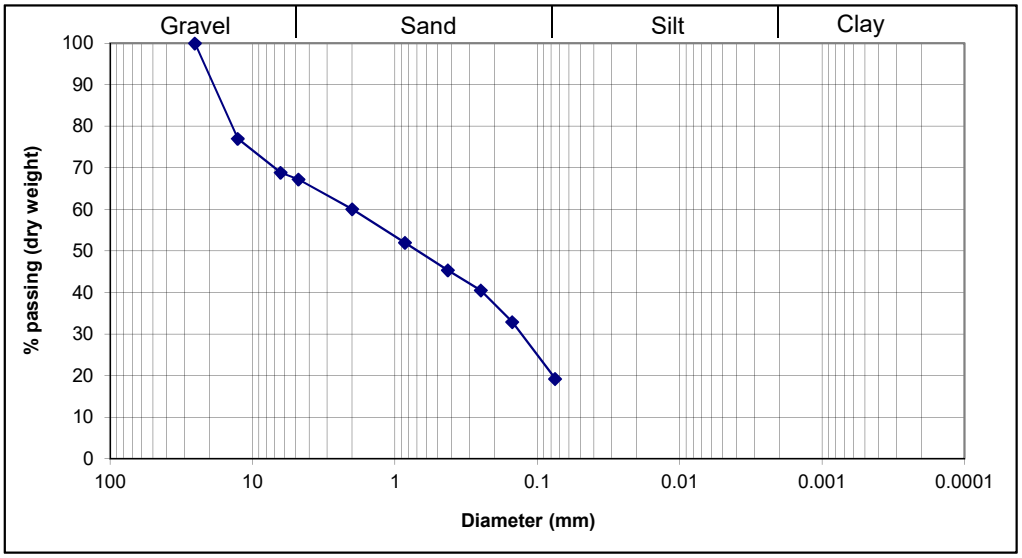
Sample No. : BH1-SS1

Depth below LNT : 3.48 m - 4.09 m

Sieve Analysis

Dry weight of sample (g) = 292.92

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 67.21 | 22.94 | 22.94 | 77.06 |
| 1/4" | 6.35 | 24.09 | 8.22 | 31.17 | 68.83 |
| 4 | 4.76 | 4.53 | 1.55 | 32.72 | 67.28 |
| 10 | 2.00 | 21.06 | 7.19 | 39.91 | 60.09 |
| 20 | 0.85 | 23.61 | 8.06 | 47.97 | 52.03 |
| 40 | 0.425 | 19.44 | 6.64 | 54.60 | 45.40 |
| 60 | 0.25 | 14.26 | 4.87 | 59.47 | 40.53 |
| 100 | 0.15 | 22.22 | 7.59 | 67.06 | 32.94 |
| 200 | 0.075 | 40.13 | 13.70 | 80.76 | 19.24 |
| pan | --- | 56.37 | 19.24 | 100.00 | --- |
| | | 292.92 | | | |




$D_{10}$ = NA

$D_{30}$ = 0.13

$D_{60}$ = 2

Cu = NA

Cc = NA

**USCS:** SM (Silty sand with gravel).

$R_{200}$ = 80.76

$R_4$ = 32.72

$R_4/R_{200}$ = 0.41

SF = 48.04

GF = 32.72

% Gravel = 32.72

% Sand = 48.04

% Silt & Clay = 19.24

% Clay = NA

**CFEM:** Gravelly Sand, some Silt/Clay.

**Moisture Content (%):** 59.97

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

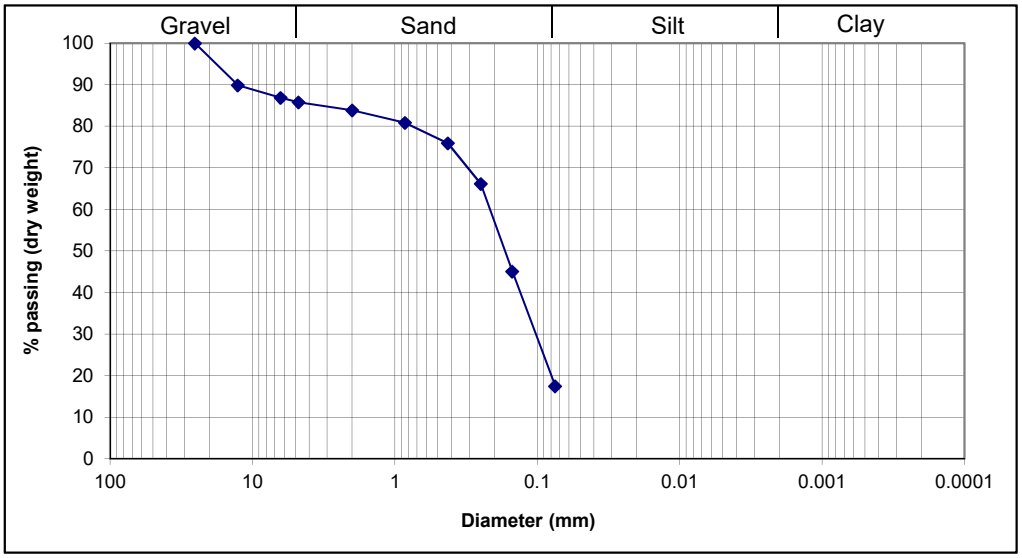
Sample No. : BH3-SS2

Depth below LNT : 4.06 m - 4.70 m

Sieve Analysis

Dry weight of sample (g) = 278.77

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 28.27 | 10.14 | 10.14 | 89.86 |
| 1/4" | 6.35 | 8.35 | 3.00 | 13.14 | 86.86 |
| 4 | 4.76 | 2.90 | 1.04 | 14.18 | 85.82 |
| 10 | 2.00 | 5.36 | 1.92 | 16.10 | 83.90 |
| 20 | 0.85 | 8.44 | 3.03 | 19.13 | 80.87 |
| 40 | 0.425 | 13.82 | 4.96 | 24.08 | 75.92 |
| 60 | 0.25 | 27.15 | 9.74 | 33.82 | 66.18 |
| 100 | 0.15 | 58.88 | 21.12 | 54.94 | 45.06 |
| 200 | 0.075 | 76.88 | 27.58 | 82.52 | 17.48 |
| pan | --- | 48.72 | 17.48 | 100.00 | --- |
| | | 278.77 | | | |




$D_{10}$ = NA

$D_{30}$ = 0.101

$D_{60}$ = 0.213

Cu = NA

Cc = NA

**USCS:** SM (Silty sand).

$R_{200}$ = 82.52

$R_4$ = 14.18

$R_4/R_{200}$ = 0.17

SF = 68.35

GF = 14.18

% Gravel = 14.18

% Sand = 68.35

% Silt & Clay = 17.48

% Clay = NA

**CFEM:** Sand, some Silt/Clay, some Gravel.

**Moisture Content (%):** 72.46

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

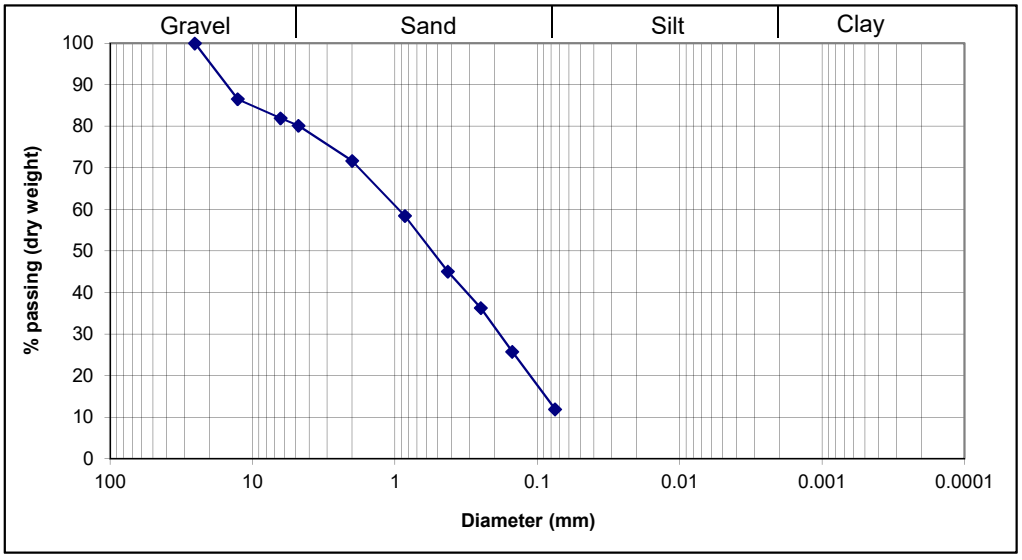
Sample No. : BH4-SS1

Depth below LNT : 3.87 m - 4.58 m

Sieve Analysis

Dry weight of sample (g) = 378.62

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 50.97 | 13.46 | 13.46 | 86.54 |
| 1/4" | 6.35 | 17.22 | 4.55 | 18.01 | 81.99 |
| 4 | 4.76 | 6.93 | 1.83 | 19.84 | 80.16 |
| 10 | 2.00 | 31.91 | 8.43 | 28.27 | 71.73 |
| 20 | 0.85 | 50.09 | 13.23 | 41.50 | 58.50 |
| 40 | 0.425 | 50.91 | 13.45 | 54.94 | 45.06 |
| 60 | 0.25 | 33.08 | 8.74 | 63.68 | 36.32 |
| 100 | 0.15 | 40.03 | 10.57 | 74.25 | 25.75 |
| 200 | 0.075 | 52.47 | 13.86 | 88.11 | 11.89 |
| pan | --- | 45.01 | 11.89 | 100.00 | --- |
| | | 378.62 | | | |




$D_{10}$ = NA

$D_{30}$ = 0.183

$D_{60}$ = 0.94

Cu = NA

Cc = NA

**USCS:** SP-SM (Poorly graded sand with silt and gravel).

$R_{200}$ = 88.11

$R_4$ = 19.84

$R_4/R_{200}$ = 0.23

SF = 68.27

GF = 19.84

% Gravel = 19.84

% Sand = 68.27

% Silt & Clay = 11.89

% Clay = NA

**CFEM:** Sand, some Gravel, some Silt/Clay.

**Moisture Content (%):** 52.07

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

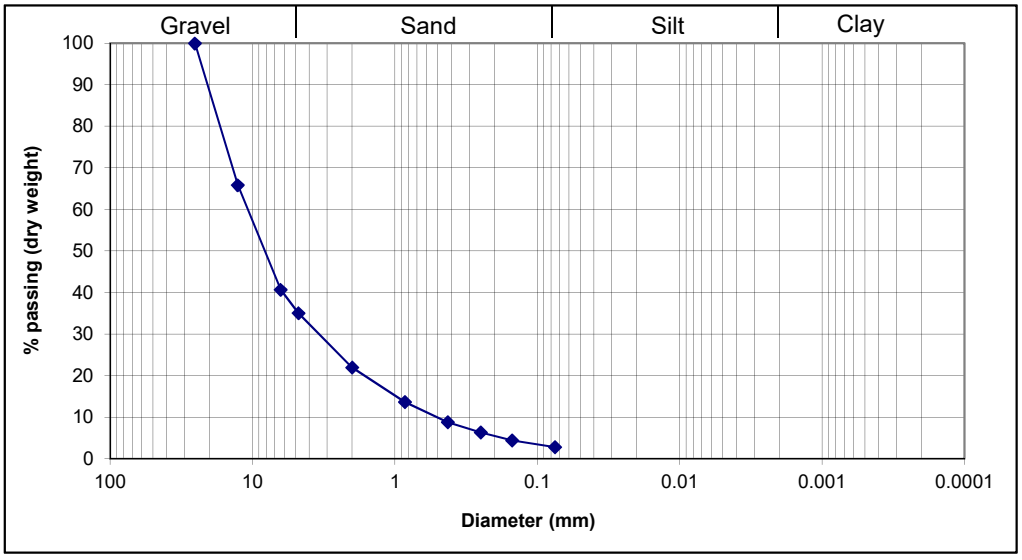
Sample No. : BH4-SS3

Depth below LNT : 5.82 m - 5.98 m

Sieve Analysis

Dry weight of sample (g) = 194.86

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 66.52 | 34.14 | 34.14 | 65.86 |
| 1/4" | 6.35 | 49.03 | 25.16 | 59.30 | 40.70 |
| 4 | 4.76 | 11.04 | 5.67 | 64.96 | 35.04 |
| 10 | 2.00 | 25.43 | 13.05 | 78.01 | 21.99 |
| 20 | 0.85 | 16.24 | 8.33 | 86.35 | 13.65 |
| 40 | 0.425 | 9.42 | 4.83 | 91.18 | 8.82 |
| 60 | 0.25 | 4.81 | 2.47 | 93.65 | 6.35 |
| 100 | 0.15 | 3.69 | 1.89 | 95.55 | 4.45 |
| 200 | 0.075 | 3.21 | 1.65 | 97.19 | 2.81 |
| pan | --- | 5.47 | 2.81 | 100.00 | --- |
| | | 194.86 | | | |




$D_{10}$ = 0.51

$D_{30}$ = 3.4

$D_{60}$ = 10.7

Cu = 20.98

Cc = 2.12

**USCS:** GW (Well-graded gravel with sand).

$R_{200}$ = 97.19

$R_4$ = 64.96

$R_4/R_{200}$ = 0.67

SF = 32.23

GF = 64.96

% Gravel = 64.96

% Sand = 32.23

% Silt & Clay = 2.81

% Clay = NA

**CFEM:** Sandy Gravel, trace Silt/Clay,

**Moisture Content (%):** 8.30

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

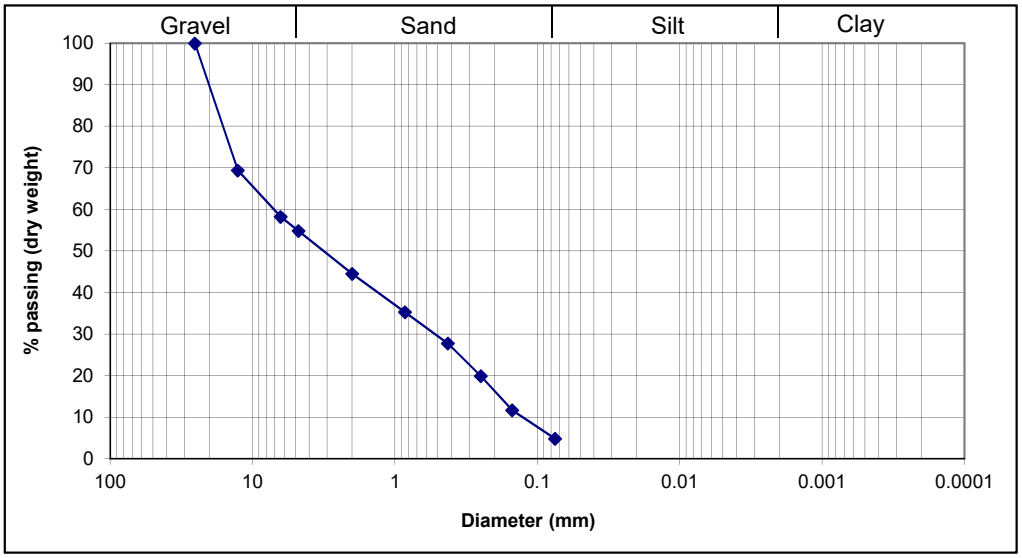
Sample No. : BH5-SS1

Depth below LNT : 3.65 m - 4.30 m

Sieve Analysis

Dry weight of sample (g) = 452.47

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 138.39 | 30.59 | 30.59 | 69.41 |
| 1/4" | 6.35 | 50.63 | 11.19 | 41.78 | 58.22 |
| 4 | 4.76 | 15.30 | 3.38 | 45.16 | 54.84 |
| 10 | 2.00 | 46.73 | 10.33 | 55.48 | 44.52 |
| 20 | 0.85 | 41.84 | 9.25 | 64.73 | 35.27 |
| 40 | 0.425 | 33.99 | 7.51 | 72.24 | 27.76 |
| 60 | 0.25 | 35.41 | 7.83 | 80.07 | 19.93 |
| 100 | 0.15 | 37.50 | 8.29 | 88.36 | 11.64 |
| 200 | 0.075 | 30.90 | 6.83 | 95.19 | 4.81 |
| pan | --- | 21.78 | 4.81 | 100.00 | --- |
| | | 452.47 | | | |




$D_{10}$ = 0.127

$D_{30}$ = 0.523

$D_{60}$ = 7.1

Cu = 55.91

Cc = 0.30

**USCS:** SP (Poorly graded sand with gravel).

$R_{200}$ = 95.19

$R_4$ = 45.16

$R_4/R_{200}$ = 0.47

SF = 50.03

GF = 45.16

% Gravel = 45.16

% Sand = 50.03

% Silt & Clay = 4.81

% Clay = NA

**CFEM:** Sand and Gravel, trace Silt/Clay.

**Moisture Content (%):** 23.31

GRAIN SIZE ANALYSIS

Depth below LNT :

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

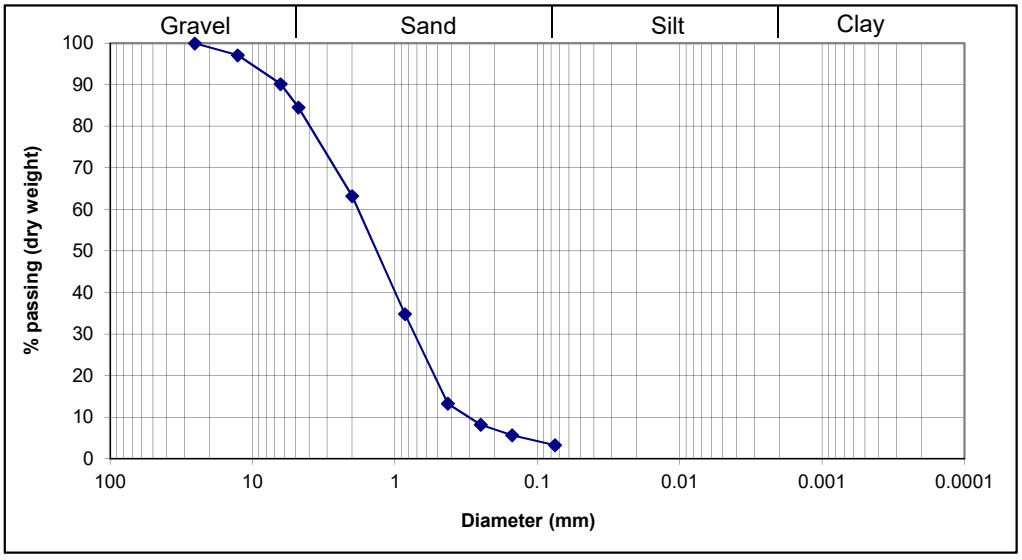
Sample No. : BH10-SS2

Depth below LNT : 5.63 m - 6.24 m

Sieve Analysis

Dry weight of sample (g) = 256.27

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 7.36 | 2.87 | 2.87 | 97.13 |
| 1/4" | 6.35 | 17.79 | 6.94 | 9.81 | 90.19 |
| 4 | 4.76 | 14.47 | 5.65 | 15.46 | 84.54 |
| 10 | 2.00 | 54.63 | 21.32 | 36.78 | 63.22 |
| 20 | 0.85 | 72.71 | 28.37 | 65.15 | 34.85 |
| 40 | 0.425 | 55.29 | 21.57 | 86.72 | 13.28 |
| 60 | 0.25 | 13.04 | 5.09 | 91.81 | 8.19 |
| 100 | 0.15 | 6.51 | 2.54 | 94.35 | 5.65 |
| 200 | 0.075 | 6.16 | 2.40 | 96.76 | 3.24 |
| pan | --- | 8.31 | 3.24 | 100.00 | --- |
| | | 256.27 | | | |




$D_{10}$ = 0.305

$D_{30}$ = 0.72

$D_{60}$ = 1.79

Cu = 5.87

Cc = 0.95

**USCS:** SP (Poorly graded sand with gravel).

$R_{200}$ = 96.76

$R_4$ = 15.46

$R_4/R_{200}$ = 0.16

SF = 81.30

GF = 15.46

% Gravel = 15.46

% Sand = 81.30

% Silt & Clay = 3.24

% Clay = NA

**CFEM:** Sand, some Gravel, trace Silt/Clay.

**Moisture Content (%):** 18.84

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

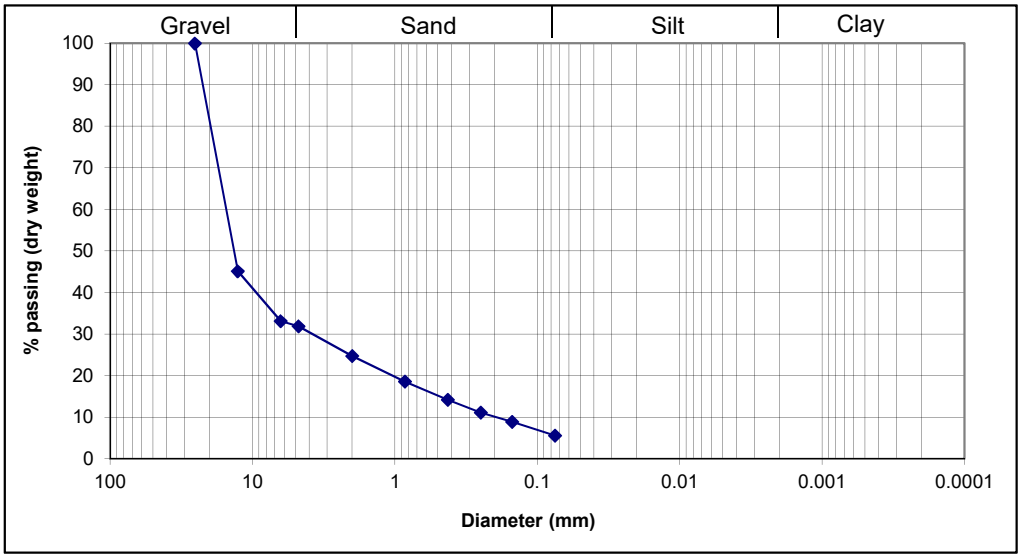
Sample No. : BH10-SS6

Depth below LNT : 11.84 m - 12.06 m

Sieve Analysis

Dry weight of sample (g) = 173.00

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 94.83 | 54.82 | 54.82 | 45.18 |
| 1/4" | 6.35 | 20.86 | 12.06 | 66.87 | 33.13 |
| 4 | 4.76 | 2.09 | 1.21 | 68.08 | 31.92 |
| 10 | 2.00 | 12.43 | 7.18 | 75.27 | 24.73 |
| 20 | 0.85 | 10.58 | 6.12 | 81.38 | 18.62 |
| 40 | 0.425 | 7.64 | 4.42 | 85.80 | 14.20 |
| 60 | 0.25 | 5.30 | 3.06 | 88.86 | 11.14 |
| 100 | 0.15 | 3.90 | 2.25 | 91.12 | 8.88 |
| 200 | 0.075 | 5.74 | 3.32 | 94.43 | 5.57 |
| pan | --- | 9.63 | 5.57 | 100.00 | --- |
| | | 173.00 | | | |




$D_{10}$ = 0.2

$D_{30}$ = 3.7

$D_{60}$ = 15.3

Cu = 76.50

Cc = 4.47

**USCS:** GP-GM (Poorly graded gravel with silt and sand).

$R_{200}$ = 94.43

$R_4$ = 68.08

$R_4/R_{200}$ = 0.72

SF = 26.35

GF = 68.08

% Gravel = 68.08

% Sand = 26.35

% Silt & Clay = 5.57

% Clay = NA

**CFEM:** Sandy Gravel, trace Silt/Clay.

**Moisture Content (%):** 15.22

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

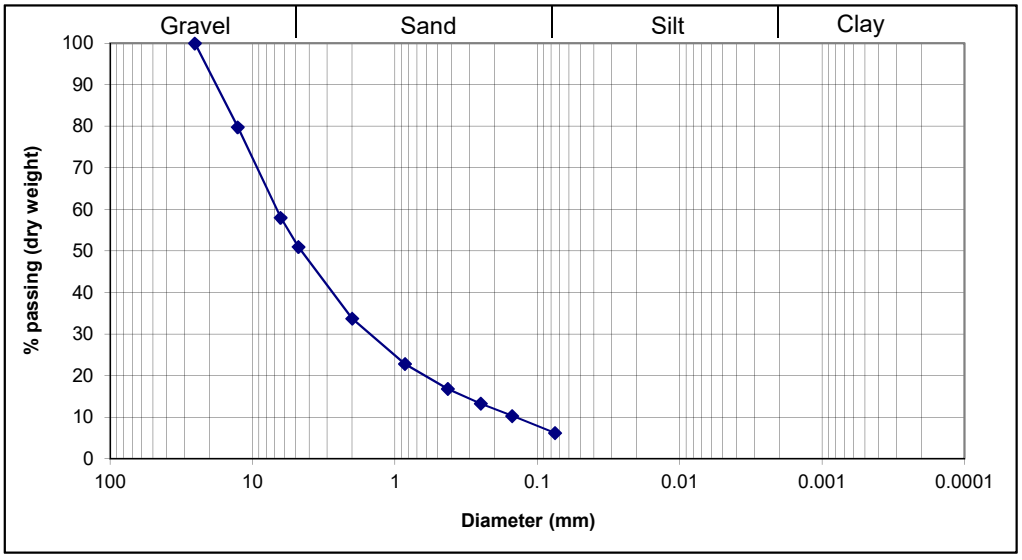
Sample No. : BH12-SS2

Depth below LNT : 4.19 m - 4.53 m

Sieve Analysis

Dry weight of sample (g) = 355.26

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 71.82 | 20.22 | 20.22 | 79.78 |
| 1/4" | 6.35 | 77.29 | 21.76 | 41.97 | 58.03 |
| 4 | 4.76 | 24.93 | 7.02 | 48.99 | 51.01 |
| 10 | 2.00 | 61.21 | 17.23 | 66.22 | 33.78 |
| 20 | 0.85 | 38.83 | 10.93 | 77.15 | 22.85 |
| 40 | 0.425 | 21.45 | 6.04 | 83.19 | 16.81 |
| 60 | 0.25 | 12.58 | 3.54 | 86.73 | 13.27 |
| 100 | 0.15 | 10.52 | 2.96 | 89.69 | 10.31 |
| 200 | 0.075 | 14.66 | 4.13 | 93.82 | 6.18 |
| pan | --- | 21.97 | 6.18 | 100.00 | --- |
| | | 355.26 | | | |




$D_{10}$ = 0.14

$D_{30}$ = 1.48

$D_{60}$ = 6.75

Cu = 48.21

Cc = 2.32

**USCS:** GW-GM (Well-graded gravel with silt and sand).

$R_{200}$ = 93.82

$R_4$ = 48.99

$R_4/R_{200}$ = 0.52

SF = 44.83

GF = 48.99

% Gravel = 48.99

% Sand = 44.83

% Silt & Clay = 6.18

% Clay = NA

**CFEM:** Gravel and Sand, trace Silt/Clay.

**Moisture Content (%):** 8.19

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

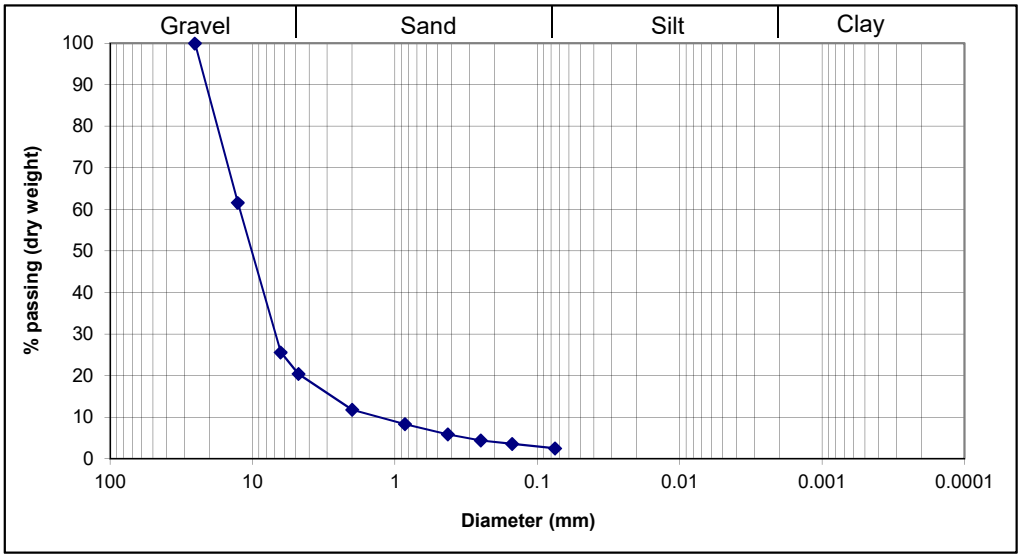
Sample No. : BH15-SS1

Depth below LNT : 4.45 m - 4.97 m

Sieve Analysis

Dry weight of sample (g) = 193.17

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 74.08 | 38.35 | 38.35 | 61.65 |
| 1/4" | 6.35 | 69.57 | 36.01 | 74.36 | 25.64 |
| 4 | 4.76 | 10.02 | 5.19 | 79.55 | 20.45 |
| 10 | 2.00 | 16.72 | 8.66 | 88.21 | 11.79 |
| 20 | 0.85 | 6.69 | 3.46 | 91.67 | 8.33 |
| 40 | 0.425 | 4.74 | 2.45 | 94.12 | 5.88 |
| 60 | 0.25 | 2.85 | 1.48 | 95.60 | 4.40 |
| 100 | 0.15 | 1.57 | 0.81 | 96.41 | 3.59 |
| 200 | 0.075 | 2.05 | 1.06 | 97.47 | 2.53 |
| pan | --- | 4.88 | 2.53 | 100.00 | --- |
| | | 193.17 | | | |




$D_{10}$ = 1.255

$D_{30}$ = 6.85

$D_{60}$ = 12.32

Cu = 9.82

Cc = 3.03

**USCS:** GP (Poorly graded gravel with sand).

$R_{200}$ = 97.47

$R_4$ = 79.55

$R_4/R_{200}$ = 0.82

SF = 17.92

GF = 79.55

% Gravel = 79.55

% Sand = 17.92

% Silt & Clay = 2.53

% Clay = NA

**CFEM:** Gravel, some Sand, trace Silt/Clay

**Moisture Content (%):** 9.44

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

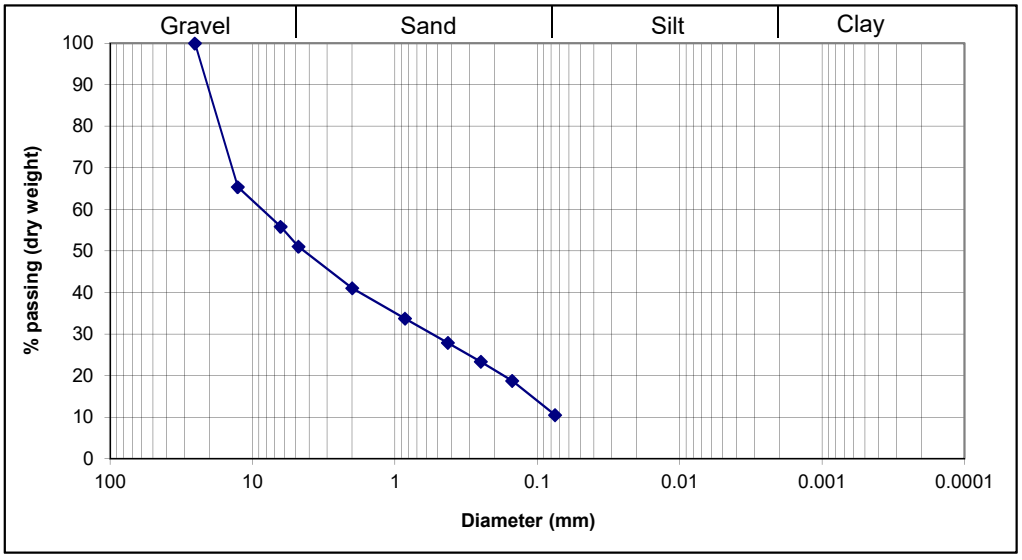
Sample No. : BH16-SS1

Depth below LNT : 4.32 m - 4.51 m

Sieve Analysis

Dry weight of sample (g) = 122.92

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 42.57 | 34.63 | 34.63 | 65.37 |
| 1/4" | 6.35 | 11.73 | 9.54 | 44.18 | 55.82 |
| 4 | 4.76 | 5.81 | 4.73 | 48.90 | 51.10 |
| 10 | 2.00 | 12.32 | 10.02 | 58.92 | 41.08 |
| 20 | 0.85 | 8.95 | 7.28 | 66.21 | 33.79 |
| 40 | 0.425 | 7.27 | 5.91 | 72.12 | 27.88 |
| 60 | 0.25 | 5.57 | 4.53 | 76.65 | 23.35 |
| 100 | 0.15 | 5.67 | 4.61 | 81.26 | 18.74 |
| 200 | 0.075 | 10.11 | 8.22 | 89.49 | 10.51 |
| pan | --- | 12.92 | 10.51 | 100.00 | --- |
| | | 122.92 | | | |




$D_{10}$ = 0.074

$D_{30}$ = 0.546

$D_{60}$ = 8.58

Cu = 115.95

Cc = 0.47

**USCS:** GP-GM (Poorly graded gravel with silt and sand).

$R_{200}$ = 89.49

$R_4$ = 48.90

$R_4/R_{200}$ = 0.55

SF = 40.59

GF = 48.90

% Gravel = 48.90

% Sand = 40.59

% Silt & Clay = 10.51

% Clay = NA

**CFEM:** Gravel and Sand, some Silt/Clay

**Moisture Content (%):** 40.54

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

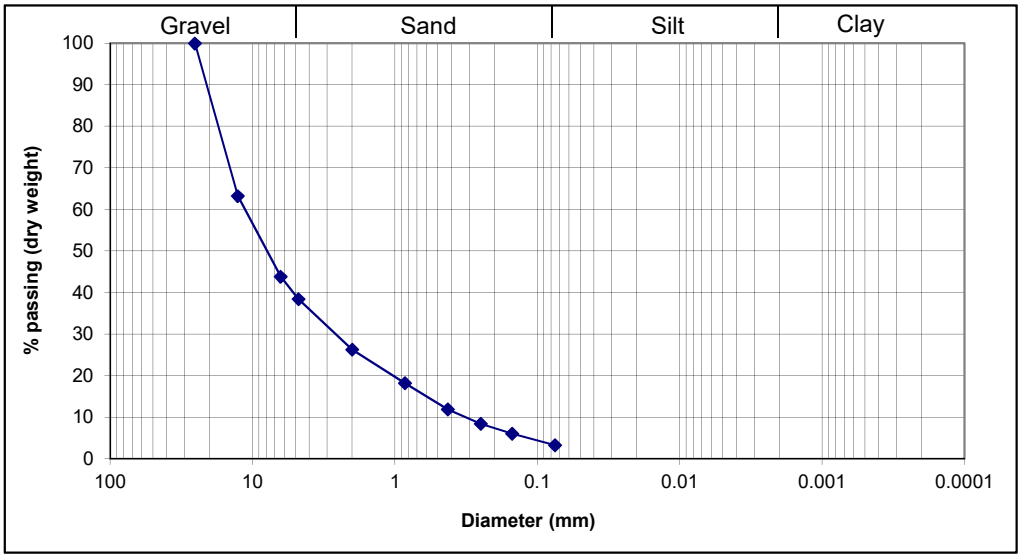
Sample No. : BH17-SS1

Depth below LNT : 3.47 m - 4.08 m

Sieve Analysis

Dry weight of sample (g) = 588.59

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 216.52 | 36.79 | 36.79 | 63.21 |
| 1/4" | 6.35 | 114.18 | 19.40 | 56.19 | 43.81 |
| 4 | 4.76 | 31.56 | 5.36 | 61.55 | 38.45 |
| 10 | 2.00 | 71.64 | 12.17 | 73.72 | 26.28 |
| 20 | 0.85 | 47.68 | 8.10 | 81.82 | 18.18 |
| 40 | 0.425 | 36.96 | 6.28 | 88.10 | 11.90 |
| 60 | 0.25 | 20.56 | 3.49 | 91.59 | 8.41 |
| 100 | 0.15 | 13.87 | 2.36 | 93.95 | 6.05 |
| 200 | 0.075 | 16.18 | 2.75 | 96.70 | 3.30 |
| pan | --- | 19.44 | 3.30 | 100.00 | --- |
| | | 588.59 | | | |




$D_{10}$ = 0.32

$D_{30}$ = 2.6

$D_{60}$ = 11.25

Cu = 35.16

Cc = 1.88

**USCS:** GW (Well-graded gravel with sand).

$R_{200}$ = 96.70

$R_4$ = 61.55

$R_4/R_{200}$ = 0.64

SF = 35.15

GF = 61.55

% Gravel = 61.55

% Sand = 35.15

% Silt & Clay = 3.30

% Clay = NA

**CFEM:** Gravel and Sand, trace Silt/Clay.

**Moisture Content (%):** 13.64

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

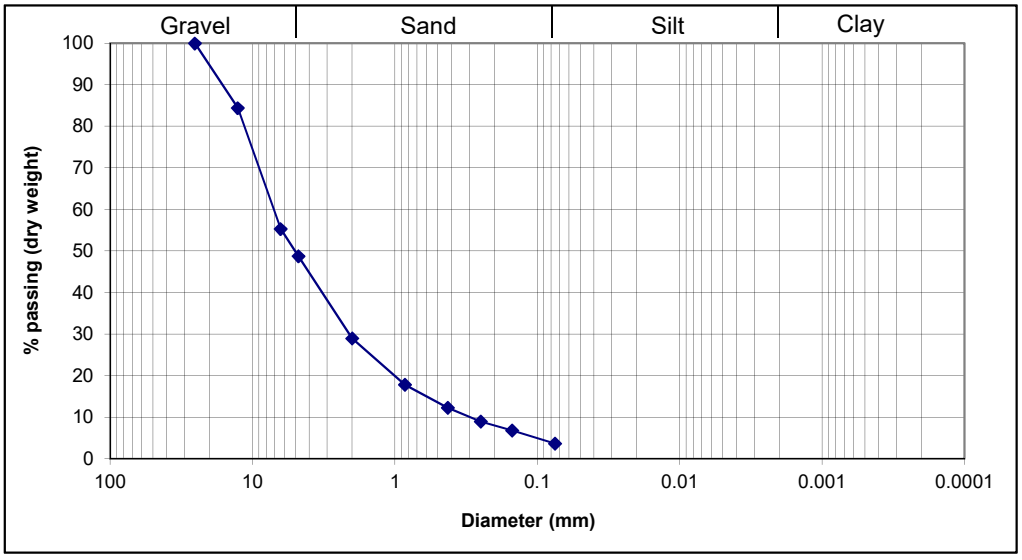
Sample No. : BH18-SS2

Depth below LNT : 5.79 m - 5.99 m

Sieve Analysis

Dry weight of sample (g) = 326.98

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 50.92 | 15.57 | 15.57 | 84.43 |
| 1/4" | 6.35 | 95.26 | 29.13 | 44.71 | 55.29 |
| 4 | 4.76 | 21.27 | 6.50 | 51.21 | 48.79 |
| 10 | 2.00 | 64.79 | 19.81 | 71.03 | 28.97 |
| 20 | 0.85 | 36.46 | 11.15 | 82.18 | 17.82 |
| 40 | 0.425 | 18.19 | 5.56 | 87.74 | 12.26 |
| 60 | 0.25 | 10.77 | 3.29 | 91.03 | 8.97 |
| 100 | 0.15 | 6.94 | 2.12 | 93.16 | 6.84 |
| 200 | 0.075 | 10.33 | 3.16 | 96.31 | 3.69 |
| pan | --- | 12.05 | 3.69 | 100.00 | --- |
| | | 326.98 | | | |




$D_{10}$ = 0.3

$D_{30}$ = 2.09

$D_{60}$ = 7.01

Cu = 23.37

Cc = 2.08

**USCS:** GW (Well-graded gravel with sand).

$R_{200}$ = 96.31

$R_4$ = 51.21

$R_4/R_{200}$ = 0.53

SF = 45.10

GF = 51.21

% Gravel = 51.21

% Sand = 45.10

% Silt & Clay = 3.69

% Clay = NA

**CFEM:** Gravel and Sand, trace Silt/Clay.

**Moisture Content (%):** 9.33

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

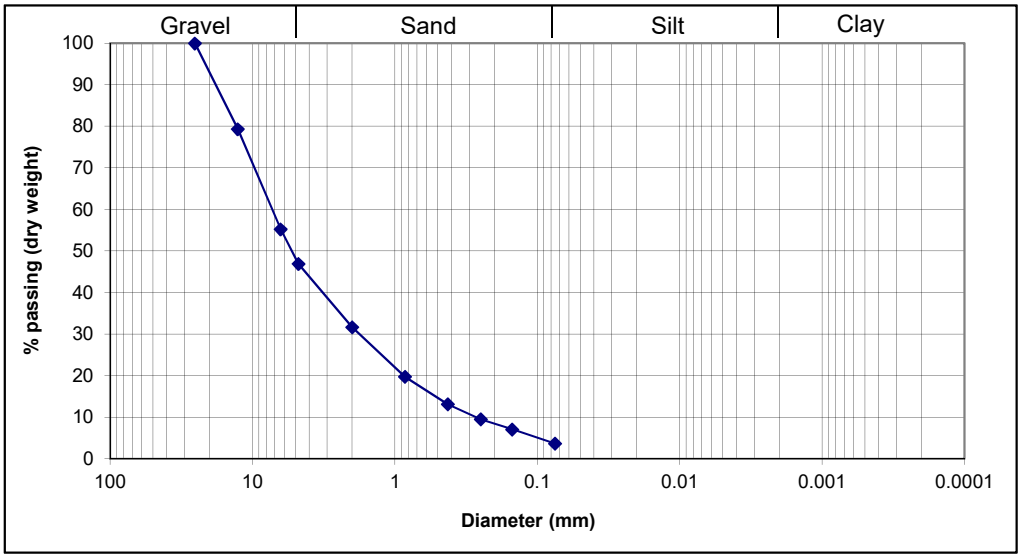
Sample No. : BH19-SS3

Depth below LNT : 5.80 m - 6.41 m

Sieve Analysis

Dry weight of sample (g) = 296.06

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 61.23 | 20.68 | 20.68 | 79.32 |
| 1/4" | 6.35 | 71.19 | 24.05 | 44.73 | 55.27 |
| 4 | 4.76 | 24.70 | 8.34 | 53.07 | 46.93 |
| 10 | 2.00 | 45.08 | 15.23 | 68.30 | 31.70 |
| 20 | 0.85 | 35.37 | 11.95 | 80.24 | 19.76 |
| 40 | 0.425 | 19.65 | 6.64 | 86.88 | 13.12 |
| 60 | 0.25 | 10.65 | 3.60 | 90.48 | 9.52 |
| 100 | 0.15 | 7.23 | 2.44 | 92.92 | 7.08 |
| 200 | 0.075 | 10.20 | 3.45 | 96.37 | 3.63 |
| pan | --- | 10.76 | 3.63 | 100.00 | --- |
| | | 296.06 | | | |




$D_{10}$ = 0.266

$D_{30}$ = 1.755

$D_{60}$ = 7.25

Cu = 27.26

Cc = 1.60

**USCS:** GW (Well-graded gravel with sand).

$R_{200}$ = 96.37

$R_4$ = 53.07

$R_4/R_{200}$ = 0.55

SF = 43.30

GF = 53.07

% Gravel = 53.07

% Sand = 43.30

% Silt & Clay = 3.63

% Clay = NA

**CFEM:** Gravel and Sand, trace Silt/Clay.

**Moisture Content (%):** 10.00

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

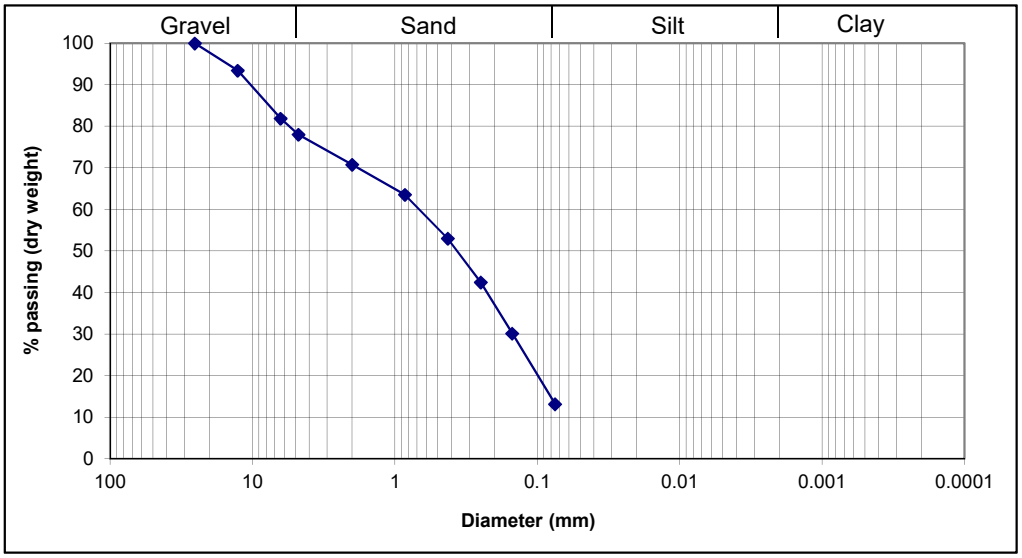
Sample No. : BH20-SS1

Depth below LNT : 2.82 m - 3.43 m

Sieve Analysis

Dry weight of sample (g) = 223.71

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 14.67 | 6.56 | 6.56 | 93.44 |
| 1/4" | 6.35 | 25.83 | 11.55 | 18.10 | 81.90 |
| 4 | 4.76 | 8.65 | 3.87 | 21.97 | 78.03 |
| 10 | 2.00 | 16.19 | 7.24 | 29.21 | 70.79 |
| 20 | 0.85 | 16.11 | 7.20 | 36.41 | 63.59 |
| 40 | 0.425 | 23.63 | 10.56 | 46.97 | 53.03 |
| 60 | 0.25 | 23.69 | 10.59 | 57.56 | 42.44 |
| 100 | 0.15 | 27.52 | 12.30 | 69.86 | 30.14 |
| 200 | 0.075 | 38.08 | 17.02 | 86.88 | 13.12 |
| pan | --- | 29.34 | 13.12 | 100.00 | --- |
| | | 223.71 | | | |




$D_{10}$ = NA

$D_{30}$ = 0.15

$D_{60}$ = 0.67

Cu = NA

Cc = NA

**USCS:** SM (Silty sand with gravel).

$R_{200}$ = 86.88

$R_4$ = 21.97

$R_4/R_{200}$ = 0.25

SF = 64.91

GF = 21.97

% Gravel = 21.97

% Sand = 64.91

% Silt & Clay = 13.12

% Clay = NA

**CFEM:** Gravelly Sand, some Silt/Clay.

**Moisture Content (%):** 76.22

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

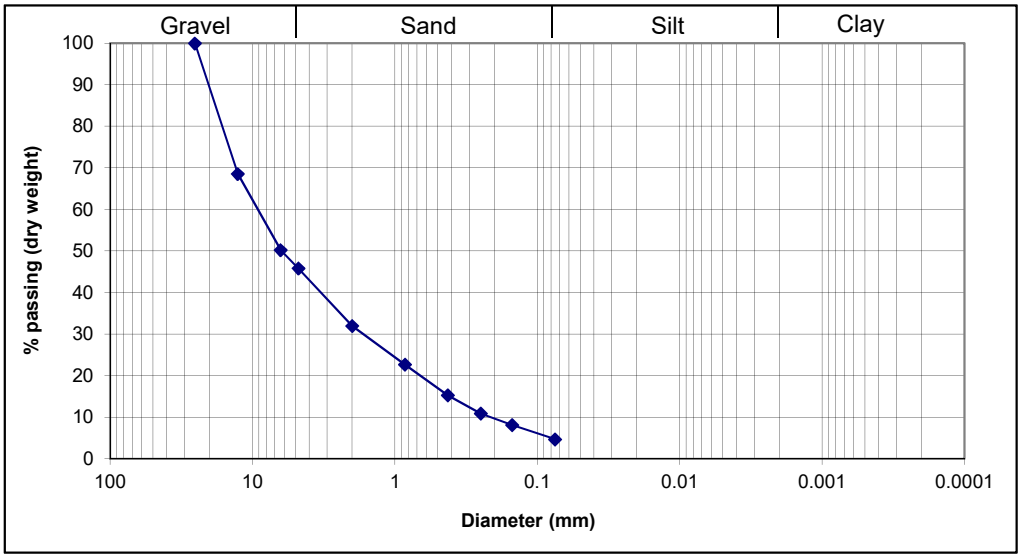
Sample No. : BH20-SS3

Depth below LNT : 5.80 m - 6.41 m

Sieve Analysis

Dry weight of sample (g) = 252.55

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 79.36 | 31.42 | 31.42 | 68.58 |
| 1/4" | 6.35 | 46.23 | 18.31 | 49.73 | 50.27 |
| 4 | 4.76 | 11.21 | 4.44 | 54.17 | 45.83 |
| 10 | 2.00 | 34.88 | 13.81 | 67.98 | 32.02 |
| 20 | 0.85 | 23.54 | 9.32 | 77.30 | 22.70 |
| 40 | 0.425 | 18.78 | 7.44 | 84.74 | 15.26 |
| 60 | 0.25 | 11.05 | 4.38 | 89.11 | 10.89 |
| 100 | 0.15 | 7.01 | 2.78 | 91.89 | 8.11 |
| 200 | 0.075 | 8.62 | 3.41 | 95.30 | 4.70 |
| pan | --- | 11.87 | 4.70 | 100.00 | --- |
| | | 252.55 | | | |




$D_{10}$ = 0.215

$D_{30}$ = 1.65

$D_{60}$ = 9.2

Cu = 42.79

Cc = 1.38

**USCS:** GW (Well-graded gravel with sand).

$R_{200}$ = 95.30

$R_4$ = 54.17

$R_4/R_{200}$ = 0.57

SF = 41.13

GF = 54.17

% Gravel = 54.17

% Sand = 41.13

% Silt & Clay = 4.70

% Clay = NA

**CFEM:** Gravel and Sand, trace Silt/Clay.

**Moisture Content (%):** 9.08

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

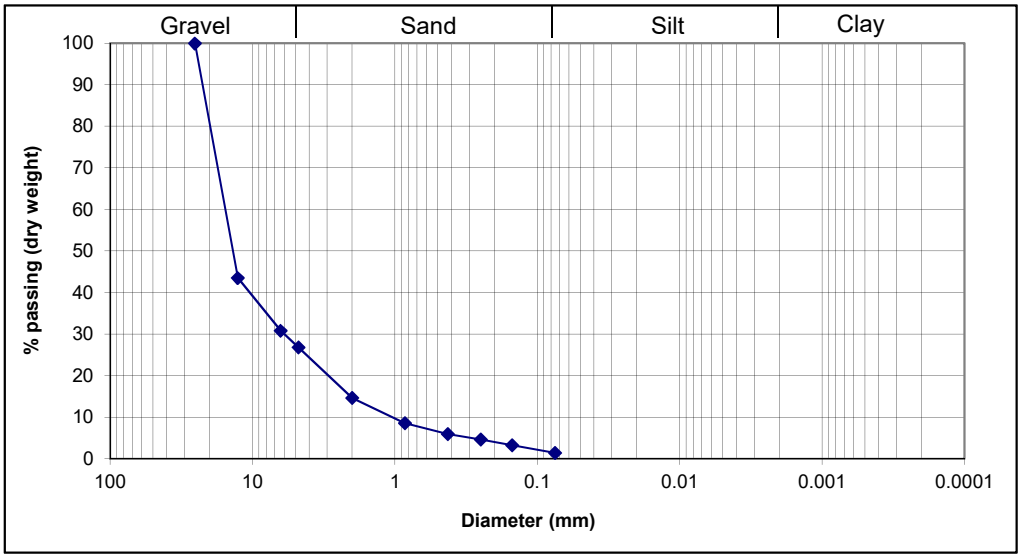
Sample No. : BH23-SS5

Depth below LNT : 2.69 m - 3.21 m

Sieve Analysis

Dry weight of sample (g) = 301.04

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 170.06 | 56.49 | 56.49 | 43.51 |
| 1/4" | 6.35 | 38.14 | 12.67 | 69.16 | 30.84 |
| 4 | 4.76 | 12.13 | 4.03 | 73.19 | 26.81 |
| 10 | 2.00 | 36.51 | 12.13 | 85.32 | 14.68 |
| 20 | 0.85 | 18.41 | 6.12 | 91.43 | 8.57 |
| 40 | 0.425 | 7.85 | 2.61 | 94.04 | 5.96 |
| 60 | 0.25 | 3.92 | 1.30 | 95.34 | 4.66 |
| 100 | 0.15 | 4.22 | 1.40 | 96.74 | 3.26 |
| 200 | 0.075 | 5.49 | 1.82 | 98.57 | 1.43 |
| pan | --- | 4.31 | 1.43 | 100.00 | --- |
| | | 301.04 | | | |




$D_{10}$ = 1.04

$D_{30}$ = 5.95

$D_{60}$ = 15.6

Cu = 15.00

Cc = 2.18

**USCS:** GW (Well-graded gravel with sand).

$R_{200}$ = 98.57

$R_4$ = 73.19

$R_4/R_{200}$ = 0.74

SF = 25.38

GF = 73.19

% Gravel = 73.19

% Sand = 25.38

% Silt & Clay = 1.43

% Clay = NA

**CFEM:** Sandy Gravel, trace Silt/Clay.

**Moisture Content (%):** 6.65

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

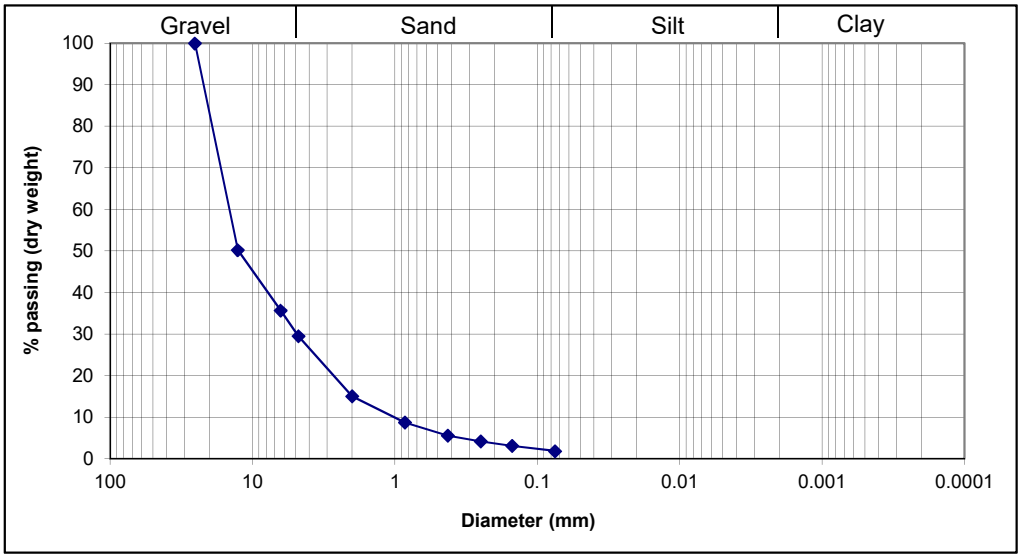
Sample No. : BH24-SS4

Depth below LNT : 2.54 m - 3.18 m

Sieve Analysis

Dry weight of sample (g) = 217.10

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 107.99 | 49.74 | 49.74 | 50.26 |
| 1/4" | 6.35 | 31.66 | 14.58 | 64.33 | 35.67 |
| 4 | 4.76 | 13.35 | 6.15 | 70.47 | 29.53 |
| 10 | 2.00 | 31.48 | 14.50 | 84.97 | 15.03 |
| 20 | 0.85 | 13.66 | 6.29 | 91.27 | 8.73 |
| 40 | 0.425 | 6.91 | 3.18 | 94.45 | 5.55 |
| 60 | 0.25 | 2.99 | 1.38 | 95.83 | 4.17 |
| 100 | 0.15 | 2.35 | 1.08 | 96.91 | 3.09 |
| 200 | 0.075 | 2.70 | 1.24 | 98.15 | 1.85 |
| pan | --- | 4.01 | 1.85 | 100.00 | --- |
| | | 217.10 | | | |




$D_{10}$ = 1.04

$D_{30}$ = 4.79

$D_{60}$ = 14.5

Cu = 13.94

Cc = 1.52

**USCS:** GW (Well-graded gravel with sand).

$R_{200}$ = 98.15

$R_4$ = 70.47

$R_4/R_{200}$ = 0.72

SF = 27.68

GF = 70.47

% Gravel = 70.47

% Sand = 27.68

% Silt & Clay = 1.85

% Clay = NA

**CFEM:** Sandy Gravel, trace Silt/Clay.

**Moisture Content (%):** 8.36

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

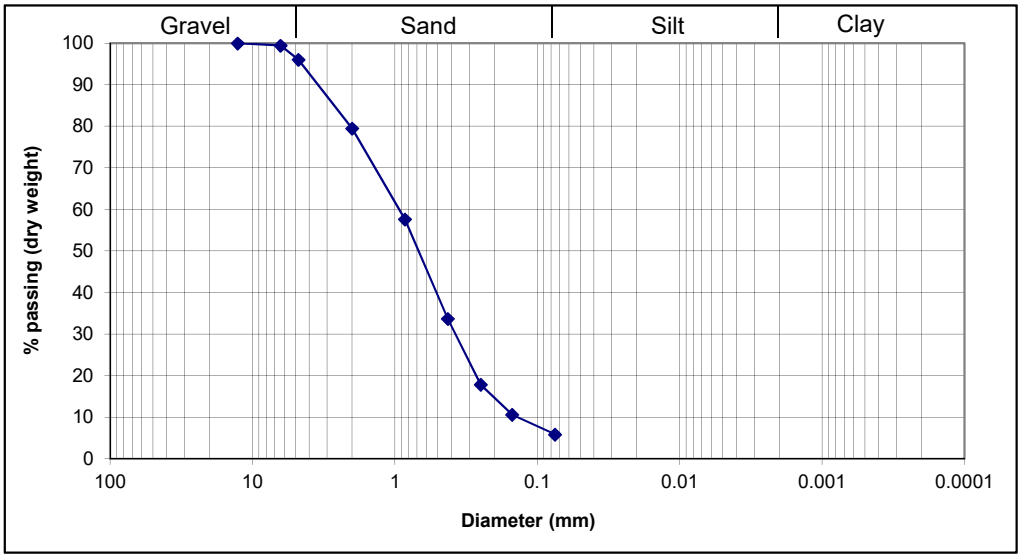
Sample No. : BH24-SS6

Depth below LNT : 4.80 m - 5.41 m

Sieve Analysis

Dry weight of sample (g) = 260.01

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | | | |
| 1/2" | 12.7 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/4" | 6.35 | 1.56 | 0.60 | 0.60 | 99.40 |
| 4 | 4.76 | 8.74 | 3.36 | 3.96 | 96.04 |
| 10 | 2.00 | 43.03 | 16.55 | 20.51 | 79.49 |
| 20 | 0.85 | 56.84 | 21.86 | 42.37 | 57.63 |
| 40 | 0.425 | 62.35 | 23.98 | 66.35 | 33.65 |
| 60 | 0.25 | 41.17 | 15.83 | 82.19 | 17.81 |
| 100 | 0.15 | 18.81 | 7.23 | 89.42 | 10.58 |
| 200 | 0.075 | 12.30 | 4.73 | 94.15 | 5.85 |
| pan | --- | 15.21 | 5.85 | 100.00 | --- |
| | | 260.01 | | | |




$D_{10}$ = 0.137

$D_{30}$ = 0.375

$D_{60}$ = 0.93

Cu = 6.79

Cc = 1.10

**USCS:** SW (Well-graded sand)

$R_{200}$ = 94.15

$R_4$ = 3.96

$R_4/R_{200}$ = 0.04

SF = 90.19

GF = 3.96

% Gravel = 3.96

% Sand = 90.19

% Silt & Clay = 5.85

% Clay = NA

**CFEM:** Sand, trace Silt/Clay, trace Gravel.

**Moisture Content (%):** 22.11

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

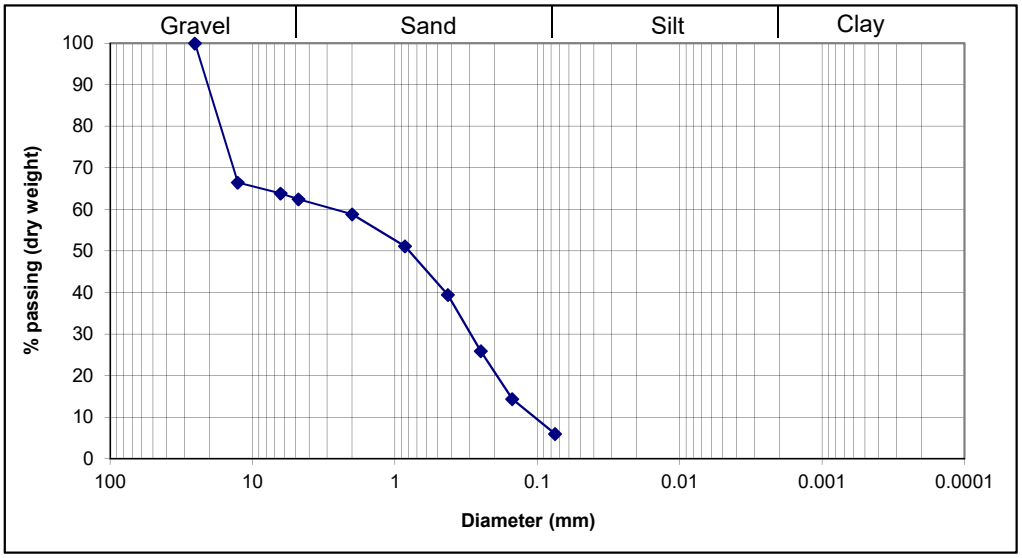
Sample No. : BH26-SS1

Depth below LNT : 0.46 m - 0.90 m

Sieve Analysis

Dry weight of sample (g) = 190.26

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 63.80 | 33.53 | 33.53 | 66.47 |
| 1/4" | 6.35 | 4.95 | 2.60 | 36.13 | 63.87 |
| 4 | 4.76 | 2.66 | 1.40 | 37.53 | 62.47 |
| 10 | 2.00 | 6.86 | 3.61 | 41.14 | 58.86 |
| 20 | 0.85 | 14.64 | 7.69 | 48.83 | 51.17 |
| 40 | 0.425 | 22.28 | 11.71 | 60.54 | 39.46 |
| 60 | 0.25 | 25.73 | 13.52 | 74.07 | 25.93 |
| 100 | 0.15 | 22.07 | 11.60 | 85.67 | 14.33 |
| 200 | 0.075 | 15.97 | 8.39 | 94.06 | 5.94 |
| pan | --- | 11.30 | 5.94 | 100.00 | --- |
| | | 190.26 | | | |




$D_{10}$ = 0.106

$D_{30}$ = 0.289

$D_{60}$ = 2.75

Cu = 25.94

Cc = 0.29

**USCS:** SP-SM (Poorly graded sand with silt and gravel).

$R_{200}$ = 94.06

$R_4$ = 37.53

$R_4/R_{200}$ = 0.40

SF = 56.53

GF = 37.53

% Gravel = 37.53

% Sand = 56.53

% Silt & Clay = 5.94

% Clay = NA

**CFEM:** Sand and Gravel, trace Silt/Clay.

**Moisture Content (%):** 32.05

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

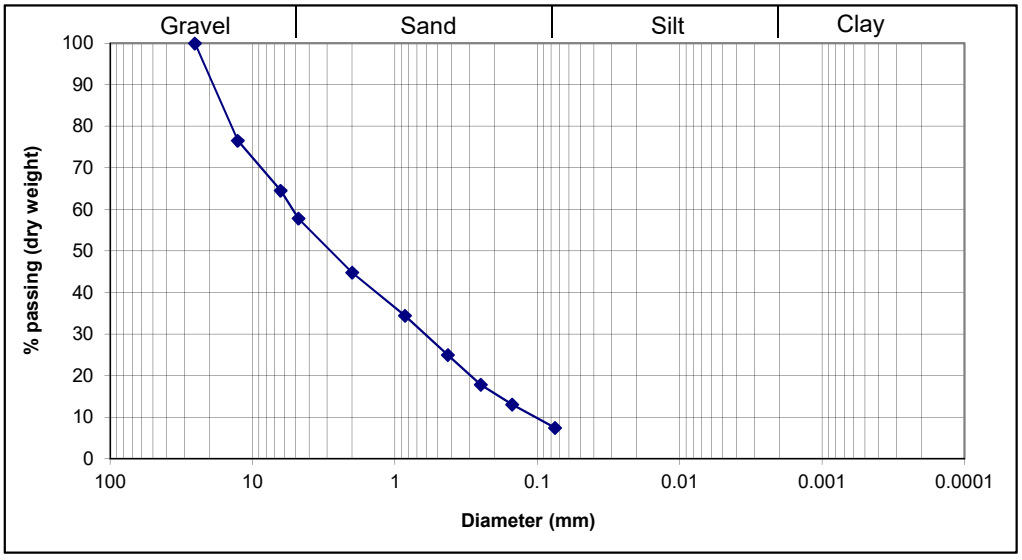
Sample No. : BH28-SS1

Depth below LNT : -0.01 m - 0.22 m

Sieve Analysis

Dry weight of sample (g) = 299.04

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 70.02 | 23.41 | 23.41 | 76.59 |
| 1/4" | 6.35 | 36.03 | 12.05 | 35.46 | 64.54 |
| 4 | 4.76 | 19.93 | 6.66 | 42.13 | 57.87 |
| 10 | 2.00 | 38.92 | 13.01 | 55.14 | 44.86 |
| 20 | 0.85 | 31.09 | 10.40 | 65.54 | 34.46 |
| 40 | 0.425 | 28.32 | 9.47 | 75.01 | 24.99 |
| 60 | 0.25 | 21.35 | 7.14 | 82.15 | 17.85 |
| 100 | 0.15 | 14.44 | 4.83 | 86.98 | 13.02 |
| 200 | 0.075 | 16.68 | 5.58 | 92.56 | 7.44 |
| pan | --- | 22.26 | 7.44 | 100.00 | --- |
| | | 299.04 | | | |




$D_{10}$ = 0.101

$D_{30}$ = 0.615

$D_{60}$ = 5.21

Cu = 51.58

Cc = 0.72

**USCS:** SP-SM (Poorly graded sand with silt and gravel).

$R_{200}$ = 92.56

$R_4$ = 42.13

$R_4/R_{200}$ = 0.46

SF = 50.43

GF = 42.13

% Gravel = 42.13

% Sand = 50.43

% Silt & Clay = 7.44

% Clay = NA

**CFEM:** Sand and Gravel, trace Silt/Clay

**Moisture Content (%):** 12.76

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

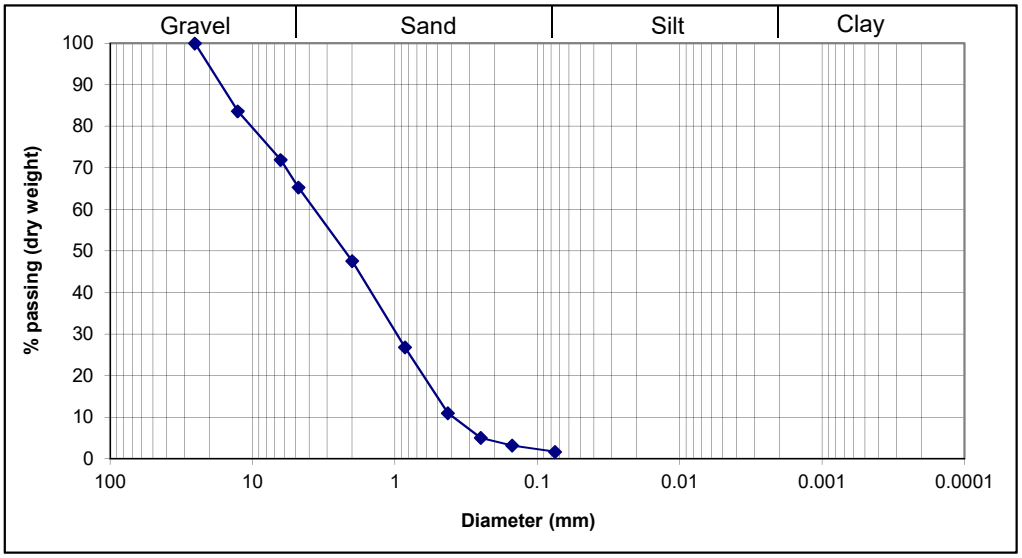
Sample No. : BH28-SS3

Depth below LNT : 2.76 m - 3.05 m

Sieve Analysis

Dry weight of sample (g) = 139.69

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 22.82 | 16.34 | 16.34 | 83.66 |
| 1/4" | 6.35 | 16.35 | 11.70 | 28.04 | 71.96 |
| 4 | 4.76 | 9.27 | 6.64 | 34.68 | 65.32 |
| 10 | 2.00 | 24.76 | 17.72 | 52.40 | 47.60 |
| 20 | 0.85 | 29.05 | 20.80 | 73.20 | 26.80 |
| 40 | 0.425 | 22.06 | 15.79 | 88.99 | 11.01 |
| 60 | 0.25 | 8.32 | 5.96 | 94.95 | 5.05 |
| 100 | 0.15 | 2.63 | 1.88 | 96.83 | 3.17 |
| 200 | 0.075 | 2.07 | 1.48 | 98.31 | 1.69 |
| pan | --- | 2.36 | 1.69 | 100.00 | --- |
| | | 139.69 | | | |




$D_{10}$ = 0.385

$D_{30}$ = 0.966

$D_{60}$ = 3.65

Cu = 9.48

Cc = 0.66

**USCS:** SP (Poorly graded sand with gravel).

$R_{200}$ = 98.31

$R_4$ = 34.68

$R_4/R_{200}$ = 0.35

SF = 63.63

GF = 34.68

% Gravel = 34.68

% Sand = 63.63

% Silt & Clay = 1.69

% Clay = NA

**CFEM:** Gravelly Sand, trace Silt/Clay.

**Moisture Content (%):** 32.64

GRAIN SIZE ANALYSIS

Project : 3087 - Grand Bank, NL

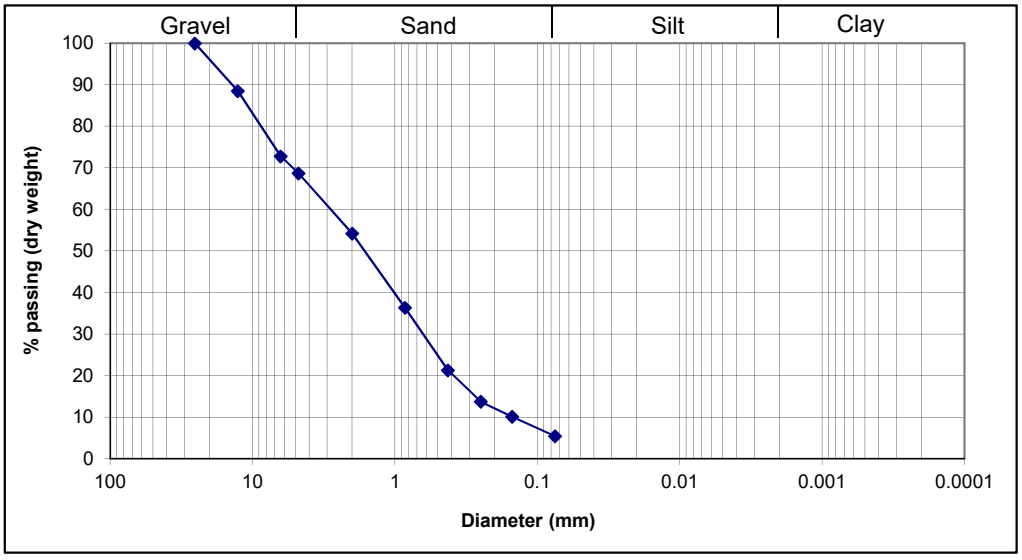
Sample No. : BH28-SS5

Depth below LNT : 5.77 m - 6.04 m

Sieve Analysis

Dry weight of sample (g) = 344.60

| Sieve | Opening (mm) | Retained (g) | % Retained | Cumulative % Ret. | % Passing |
|---|---|---|---|---|---|
| 2 | 50.8 | 0.00 | | | |
| 1 | 25.4 | 0.00 | 0.00 | 0.00 | 100.00 |
| 1/2" | 12.7 | 39.61 | 11.49 | 11.49 | 88.51 |
| 1/4" | 6.35 | 54.24 | 15.74 | 27.23 | 72.77 |
| 4 | 4.76 | 13.89 | 4.03 | 31.27 | 68.73 |
| 10 | 2.00 | 49.95 | 14.50 | 45.76 | 54.24 |
| 20 | 0.85 | 61.66 | 17.89 | 63.65 | 36.35 |
| 40 | 0.425 | 51.75 | 15.02 | 78.67 | 21.33 |
| 60 | 0.25 | 26.26 | 7.62 | 86.29 | 13.71 |
| 100 | 0.15 | 12.39 | 3.60 | 89.89 | 10.11 |
| 200 | 0.075 | 16.05 | 4.66 | 94.54 | 5.46 |
| pan | --- | 18.80 | 5.46 | 100.00 | --- |
| | | 344.60 | | | |




$D_{10}$ = 0.149

$D_{30}$ = 0.633

$D_{60}$ = 2.82

Cu = 18.93

Cc = 0.95

**USCS:** SP-SM (Poorly graded sand with silt and gravel).

$R_{200}$ = 94.54

$R_4$ = 31.27

$R_4/R_{200}$ = 0.33

SF = 63.28

GF = 31.27

% Gravel = 31.27

% Sand = 63.28

% Silt & Clay = 5.46

% Clay = NA

**CFEM:** Gravelly Sand, trace Silt/Clay.

**Moisture Content (%):** 15.70

# *APPENDIX C*

***Selected Borehole Logs from the Previous Projects (1999, 2001, 2002)***

Project: Geotechnical Investigation

# Log of Borehole GB-BH1

Location: Grand Bank, NF

Client: Public Works/ Gov't Services Canada

Date: 17/08/99

Drilling Supervisor: C. Richards

Project No: 241

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below LNT (m) | Symbol | Geologic Description | Elevation (LNT) | Type | Number | "N" Value | Recovery % | RQD % | Standard Penetration Test "N" Value per 300 mm (10 30 50 70 90) |
| 0 | | LNT | 0 | | | | | | |
| 1 | | Water | -1.7 | | | | | | |
| 2 | | 50 mm of loose black organics with gravel underlain by very dense, dark grey to light brown sandy gravel with a trace of silt. Note: USCS for SS1: GW- Well- graded gravel with sand. | -2.08 | SS | 1 | 68 | 100 | - | |
| | | | | RC | 2 | - | 100 | 0 | |
| | | | | RC | 3 | - | 75 | 0 | |
| | | | | RC | 4 | - | 100 | 0 | |
| 3 | | | | RC | 5 | - | 62 | 0 | |
| | | | | RC | 6 | - | 82 | 0 | |
| | | | | RC | 7 | - | 60 | 0 | |
| 4 | | Extremely fractured mafic to felsic volcanic flows (rhyolite). BEDROCK. | | RC | 8 | - | 100 | 0 | |
| | | | | RC | 9 | - | 82 | 26 | |
| 5 | | | | RC | 10 | - | 95 | 0 | |
| | | | -5.23 | RC | 11 | - | 100 | 79 | |
| | | End of Borehole | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |

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St. John's, NF A1A 5A1
Phone: (709) 739-7270
Fax: (709) 753-5101

Drill Method: BW/BQ Casing/ Coring

Driller: Zenith Drilling and Exploration

Datum: LNT

Checked by:

Sheet: 1 of 1

Project: Geotechnical Investigation

Location: Grand Bank, NF

Client: Public Works/ Gov't Services Canada

Drilling Supervisor: C. Richards

# Log of Borehole GB-BH2

Date: 17/08/99

Project No: 241

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below LNT (m) | Symbol | Geologic Description | Elevation (LNT) | Type | Number | "N" Value | Recovery % | RQD % | Standard Penetration Test "N" Value per 300 mm (10 30 50 70 90) |
| 0 | | LNT | 0 | | | | | | |
| 1 | | Water | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | -3.55 | | | | | | |
| 4 | | Very loose, black organics with gravelly sand. Note: USCS for SS1: Well- graded gravel with sand. Blow counts for SS1: 0 for 150mm/1 for 375mm/ 1 for 75mm | -4.16 | SS | 1 | NA | 8 | | |
| | | | | RC | 2 | - | 100 | 0 | |
| 5 | | Rounded gravel and cobbles. | -4.97 | RC | 3 | - | 40 | 9 | |
| 6 | | Extremely fractured mafic to felsic volcanic flows (rhyolite). BEDROCK. | | RC | 4 | - | 100 | 58 | |
| 7 | | | | RC | 5 | - | 100 | 20 | |
| 8 | | | -8.07 | | | | | | |
| 9 | | End of Borehole | | | | | | | |

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Drill Method: BW/BQ Casing/ Coring

Driller: Zenith Drilling and Exploration

Datum: LNT

Checked by:

Sheet: 1 of 1

Project: Geotechnical Investigation

# Log of Borehole GB-BH3

Location: Grand Bank, NF

Client: Public Works/ Gov't Services Canada  Date: 18/08/99

Drilling Supervisor: C. Richards  Project No: 241

| Depth below Surface (m) | Symbol | Geologic Description | Elevation (LNT) | Type | Number | "N" Value | Recovery % | RQD % |
|---|---|---|---|---|---|---|---|---|
| | | **SUBSURFACE PROFILE** | | **SAMPLE** | | | | |
| 0 | | Ground Surface | 2.44 | | | | | |
| | | Compact, coarse sand and gravel. Note: USCS for SS1: SW- Well- graded sand with gravel. | | SS | 1 | 12 | 8 | - |
| 1 | | Large wood chunks in samples. | | | | | | |
| | | | | SS | 2 | NA | 29 | - |
| 2 | | USCS for SS2: GW- Well- graded gravel with sand. | 0 | | | | | |
| 3 | | Coarse sand with some gravel. Note: USCS for SS3: SP- Poorly graded sand with gravel. | | SS | 3 | 10 | 4 | - |
| 4 | | | | RC | 4 | - | 26 | 0 |
| | | | | RC | 5 | - | 65 | 0 |
| 5 | | | | RC | 6 | - | 86 | 0 |
| | | | -3.4 | RC | 7 | - | 44 | 0 |
| 6 | | | | RC | 8 | - | 100 | 38 |
| 7 | | Extremely fractured mafic to felsic volcanic flows (rhyolite). BEDROCK. | | RC | 9 | - | 74 | 0 |
| 8 | | | | RC | 10 | - | 100 | 0 |
| | | | -6.4 | RC | 11 | - | 80 | 40 |
| 9 | | End of Borehole | | | | | | |

Standard Penetration Test
"N" Value per 300 mm
10 30 50 70 90

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Drill Method: BW/BQ Casing/ Coring

Driller: Zenith Drilling and Exploration

Datum: LNT

Checked by:

Sheet: 1 of 1

Project: Geotechnical Investigation

Location: Grand Bank, NF

Client: Public Works/ Gov't Services Canada

Drilling Supervisor: C. Richards

# Log of Borehole GB-BH4

Date: 15/08/99

Project No: 241

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below LNT (m) | Symbol | Geologic Description | Elevation (LNT) | Type | Number | "N" Value | Recovery % | RQD % | Standard Penetration Test "N" Value per 300 mm (10 30 50 70 90) |
| 0 | | LNT | 0 | | | | | | |
| | | Water | -1.38 | | | | | | |
| | | Coarse, grey to black gravel and sand with some organics. Note: USCS for SS1: GW-Well graded gravel with sand. Blow counts for SS1: 5/16/Refusal | -1.69 | SS | 1 | NA | 33 | - | |
| 2 | | | | RC | 2 | - | 83 | 0 | |
| | | | | RC | 3 | - | 67 | 0 | |
| 3 | | Extremely fractured mafic to felsic volcanic flows (rhyolite). BEDROCK. | | RC | 4 | - | 76 | 64 | |
| 4 | | | -4.43 | RC | 5 | - | 26 | 0 | |
| | | End of Borehole | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |

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Drill Method: BW/BQ Casing/ Coring

Driller: Zenith Drilling and Exploration

Datum: LNT

Checked by:

Sheet: 1 of 1

Project: Geotechnical Investigation

# Log of Borehole GB-BH5

Location: Grand Bank, NF

Client: Public Works/ Gov't Services Canada  Date: 15/08/99

Drilling Supervisor: C. Richards  Project No: 241

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below LNT (m) | Symbol | Geologic Description | Elevation (LNT) | Type | Number | "N" Value | Recovery % | RQD % | Standard Penetration Test "N" Value per 300 mm (10 30 50 70 90) |
| 0 | | LNT | 0 | | | | | | |
| | | Water | -0.287 | | | | | | |
| | | Dark brown cobbles and gravel with some silt and organics, grading to light brown sand and gravel with some silt. Note: USCS for SS1: GP-GM- Poorly graded gravel with silt and sand. Blow counts for SS1: 3/5/Refusal @ 355mm | -0.643 | SS | 1 | NA | 64 | | |
| | | | | RC | 2 | - | 100 | 0 | |
| 1 | | | | RC | 3 | - | 95 | 64 | |
| | | | | RC | 4 | - | 77 | 16 | |
| 2 | | | | RC | 5 | - | 6 | 0 | |
| | | Extremely fractured mafic to felsic volcanic flows (rhyolite). BEDROCK. | | RC | 6 | - | 91 | 23 | |
| 3 | | | -3.82 | RC | 7 | - | 100 | 0 | |
| 4 | | End of Borehole | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |

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Drill Method: BW/BQ Casing/ Coring

Driller: Zenith Drilling and Exploration

Datum: LNT

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Sheet: 1 of 1

Project: Geotechnical Investigation

Location: Grand Bank, NF

Client: Public Works/ Gov't Services Canada

Drilling Supervisor: C. Richards

# Log of Borehole GB-BH6

Date: 16/08/99

Project No: 241

| Depth below LNT (m) | Symbol | Geologic Description | Elevation (LNT) | Sample Type | Sample Number | "N" Value | Recovery % | RQD % |
|---|---|---|---|---|---|---|---|---|
| 0 | | LNT | 0 | | | | | |
| | | Water | -0.796 | | | | | |
| 1 | | Dark brown to black organics with some gravel and sand. Note: USCS for SS1: GP- Poorly graded gravel with sand. Blow counts for SS1: 9/refusal @ 230mm | | SS | 1 | NA | 56 | |
| | | | | RC | 2 | - | 78 | 0 |
| | | | | RC | 3 | - | 89 | 21 |
| 2 | | | | RC | 4 | - | 100 | 40 |
| 3 | | Extremely fractured mafic to felsic volcanic flows (rhyolite). BEDROCK. | | RC | 5 | - | 98 | 68 |
| 4 | | | -4.17 | | | | | |
| | | End of Borehole | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |

Standard Penetration Test "N" Value per 300 mm

10 30 50 70 90

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Drill Method: BW/BQ Casing/ Coring

Driller: Zenith Drilling and Exploration

Datum: LNT

Checked by:

Sheet: 1 of 1

Project: Geotechnical Investigation

# Log of Borehole GB-BH7

Location: Grand Bank, NF

Client: Public Works/ Gov't Services Canada  Date: 16/08/99

Drilling Supervisor: C. Richards  Project No: 241

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below LNT (m) | Symbol | Geologic Description | Elevation (LNT) | Type | Number | "N" Value | Recovery % | RQD % | Standard Penetration Test "N" Value per 300 mm (10 30 50 70 90) |
| 0 | | LNT | 0 | | | | | | |
| 1 | | Water | -1.62 | | | | | | |
| 2 | | Loose, wet gravel and sand. Some organic material. | | SS | 1 | 6 | 0 | | ■ |
| 3 | | Note: Unable to take split spoon sample at 3.12 m due to loose sands piping up into casing- unable to get undisturbed sample. | -3.66 | | | | | | |
| 4 | | Extremely fractured mafic to felsic volcanic flows (rhyolite). BEDROCK. | | RC | 2 | - | 100 | 0 | |
| | | | | RC | 3 | - | 58 | 0 | |
| 5 | | | | RC | 4 | - | 68 | 0 | |
| | | | | RC | 5 | - | 100 | 0 | |
| 6 | | | | RC | 6 | - | 79 | 0 | |
| | | | -6.73 | RC | 7 | - | 100 | 0 | |
| 7 | | End of Borehole | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |

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Drill Method: BW/BQ Casing/ Coring

Driller: Zenith Drilling and Exploration

Datum: LNT

Checked by:

Sheet: 1 of 1

Project: Geotechnical Investigation

Location: Grand Bank, NF

Client: Grand Bank Harbour Authority

Drilling Supervisor: Ian Osmond

# Log of Borehole 25b

Date: May 25, 2001

Project No: 310

| Depth Below LNT (m) | Symbol | Geologic Description | Elevation (m LNT) | Type | Number | "N" Value | Recovery % | RQD % |
|---|---|---|---|---|---|---|---|---|
| | | 0 m LNT | 0 | | | | | |
| 2 | | Ground Surface | -2.17 | | | | | |
| | | ( See DCPT 25 ) | -2.92 | | | | | |
| 3 | | Rubble / Cobbles | -3.22 | | | | | |
| 4 | | Bedrock, Red and Black volcanic rock, highly fractured | -4.21 | RC | 1 | | 29 | 100 |
| 5 | | Bedrock, Red to Black volcanic rock | -5.18 | RC | 2 | | 61 | 100 |
| 6 | | Bedrock, Red to Red volcanic rock, highly fractured | -6.92 | RC | 3 | | 100 | 0 |
| 7 | | End of Borehole | | | | | | |

SUBSURFACE PROFILE

SAMPLE

Standard Penetration Test "N" Value per 300 mm

10 30 50 70 90

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Drill Method: Core Drilling

Driller: Zenith Drilling

Datum: 0 m LNT

Checked by: SM

Sheet: 1 of 1

Project: Geotechnical Investigation

Location: Grand Bank, NF

Client: Grand Bank Harbour Authority

Drilling Supervisor: Scott Preston

# Log of Borehole 27

Date: May 27, 2001

Project No: 310

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth Below LNT (m) | Symbol | Geologic Description | Elevation (m LNT) | Type | Number | "N" Value | Recovery % | RQD % | Standard Penetration Test "N" Value per 300 mm (10 30 50 70 90) |
| 0 | | 0 m LNT | 0 | | | | | | |
| 4 | | Ground Surface | -4.24 | | | | | | |
| 5 | | Cobbles | -5.91 | RC | 1 | | 0 | 0 | |
| 6 | | Bedrock, Red and black volcanic rock | | RC | 2 | | 81 | 0 | |
| 7 | | | | RC | 3 | | 100 | 100 | |
| 8 | | End of Borehole | -7.89 | | | | | | |

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Drill Method: Core Drilling

Driller: Zenith Drilling

Datum: 0 m LNT

Checked by: SM

Sheet: 1 of 1

Project: Geotechnical Investigation

Location: Grand Bank, NF

Client: Grand Bank Harbour Authority

Drilling Supervisor: Scott Preston

# Log of Borehole 34

Date: May 27 , 2001

Project No: 310

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth Below LNT (m) | Symbol | Geologic Description | Elevation (m LNT) | Type | Number | "N" Value | Recovery % | RQD % | Standard Penetration Test "N" Value per 300 mm (10 30 50 70 90) |
| 0 | | 0 m LNT | 0 | | | | | | |
| | | Ground Surface | -2.76 | | | | | | |
| 3 | | Cobbles | | RC | 1 | | 38 | 0 | |
| | | | -4.72 | | | | | | |
| 5 | | Bedrock, Red to black volcanics | | RC | 2 | | 90 | 24 | |
| | | | -6.41 | | | | | | |
| | | End of Borehole | | | | | | | |
| 7 | | | | | | | | | |

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Phone: (709) 739-7270
Fax: (709) 753-5101

Drill Method: Core Drilling, NQ

Driller: Zenith Drilling

Datum: 0 m LNT

Checked by: SM

Sheet: 1 of 1

Project: Geotechnical Investigation

Location: Grand Bank, NF

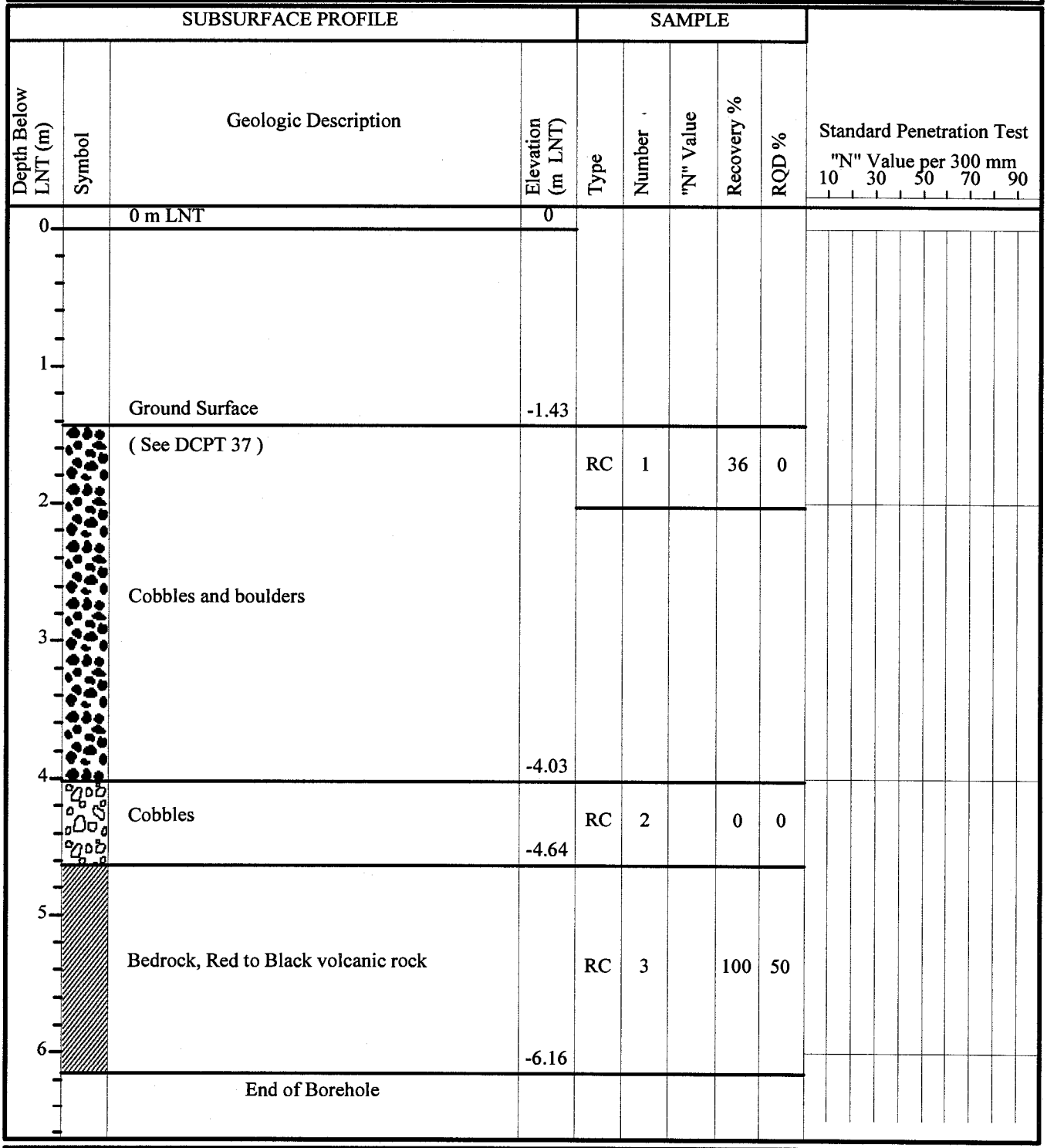
Client: Grand Bank Harbour Authority

Drilling Supervisor: Scott Preston

# Log of Borehole 37

Date: May 29, 2001

Project No: 310





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Phone: (709) 739-7270
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Drill Method: Core Drilling, NQ

Driller: Zenith Drilling

Datum: 0 m LNT

Checked by: SM

Sheet: 1 of 1

Project: Geotechnical Investigation

Location: Grand Bank, NF

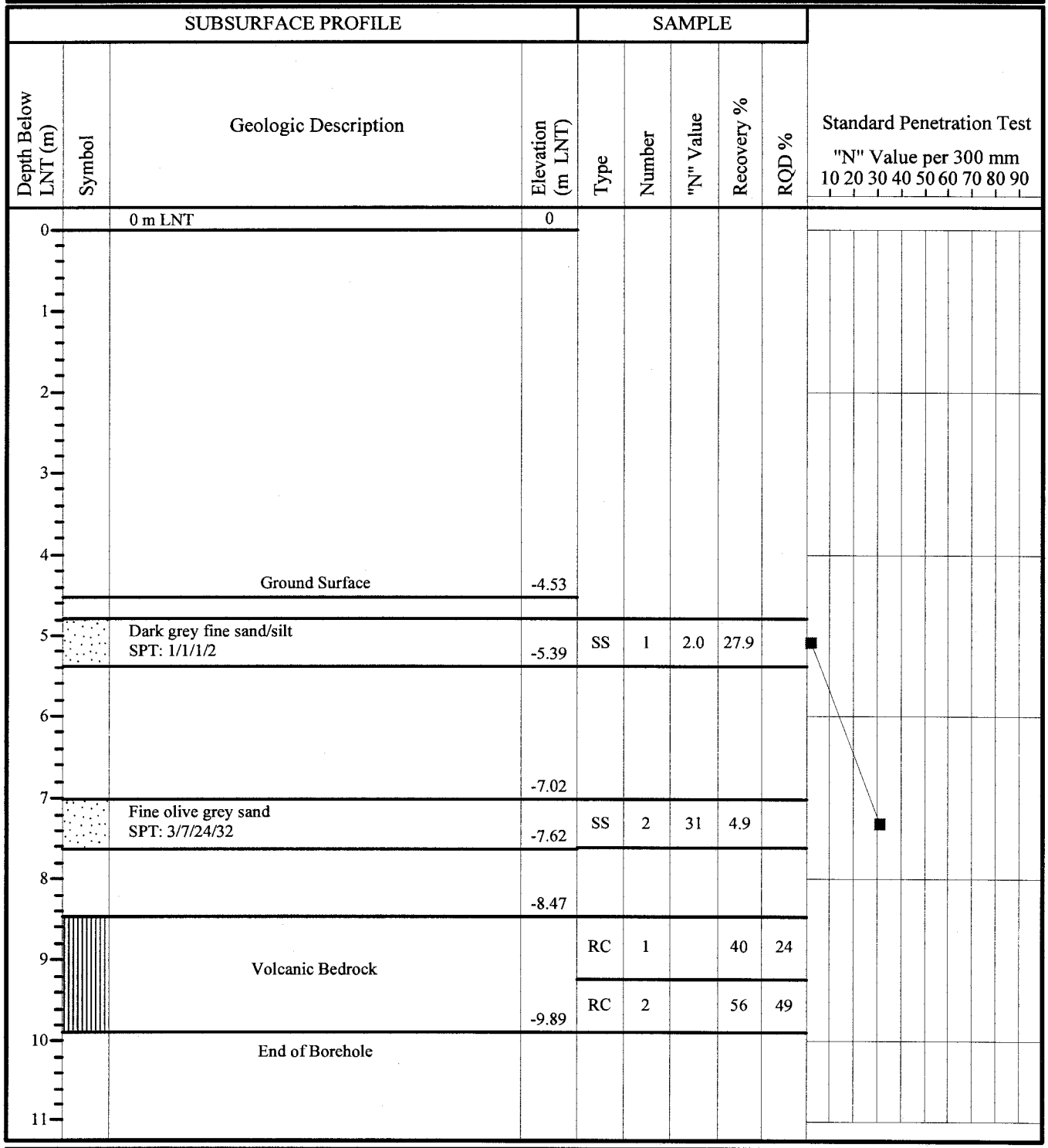
Client: BAE - NEWPLAN GROUP LIMITED

Drilling Supervisor: Marcia Parsons

# Log of Borehole: BH1

Date: May 6, 2002

Project No: 325





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154 Major's Path
St. John's, NF A1A 5A1
Phone: (709) 739-7270
Fax: (709) 753-5101


Drill Method: NW/NQ Casing/Coring

Driller: Zenith Drilling

Datum: 0 m LNT

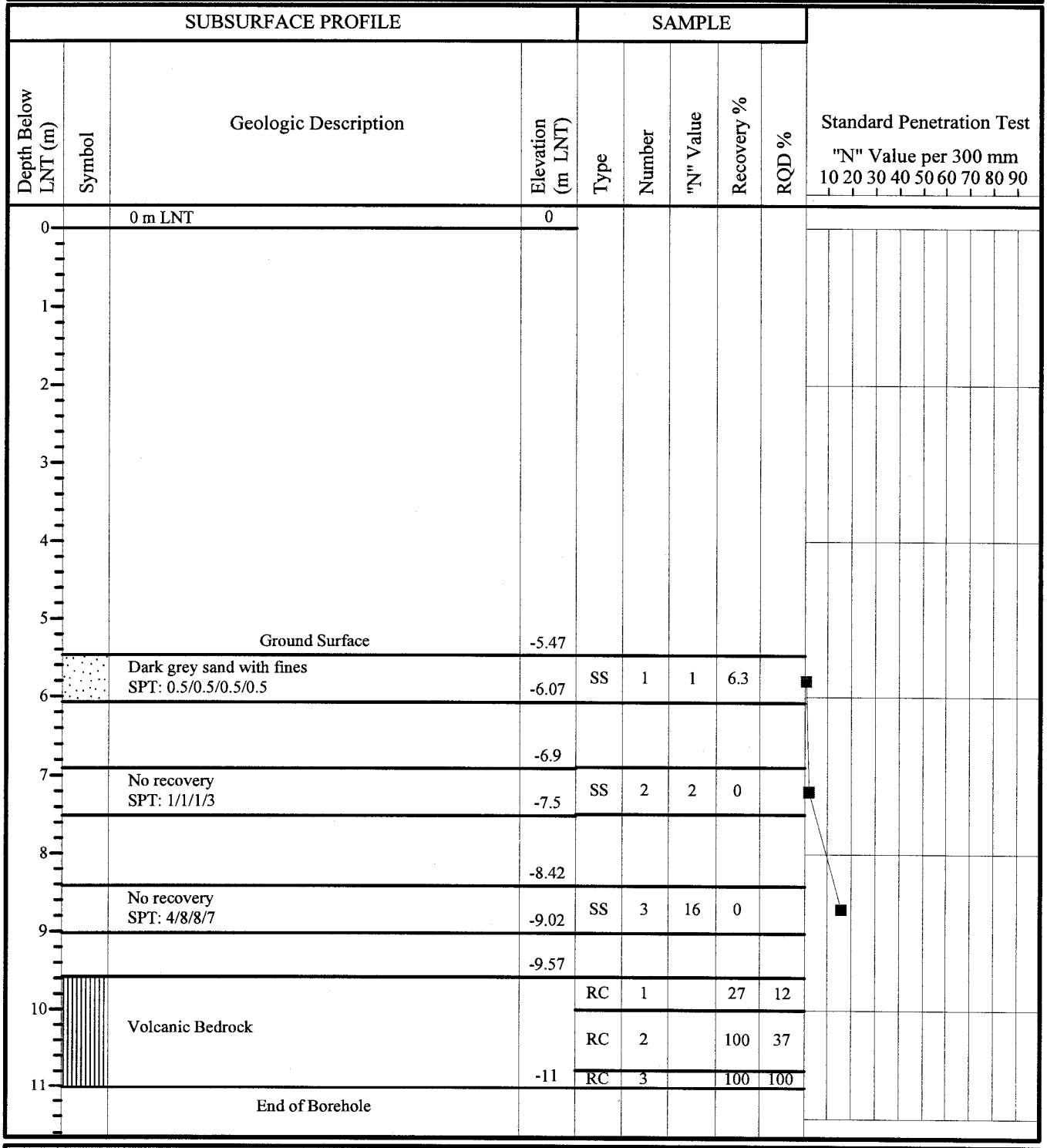
Checked by: JRG

Sheet: 1 of 1

Project: Geotechnical Investigation
Location: Grand Bank, NF
Client: BAE - NEWPLAN GROUP LIMITED
Drilling Supervisor: Marcia Parsons

# Log of Borehole: BH3

Date: May 2, 2002
Project No: 325





Fracflow Consultants
154 Major's Path
St. John's, NF A1A 5A1
Phone: (709) 739-7270
Fax: (709) 753-5101


Drill Method: NW/NQ Casing/Coring
Driller: Zenith Drilling

Datum: 0 m LNT
Checked by:
Sheet: 1 of 1

Project: Geotechnical Investigation
Location: Grand Bank, NF
Client: BAE - NEWPLAN GROUP LIMITED
Drilling Supervisor: Marcia Parsons

# Log of Borehole: BH4

Date: May 1, 2002
Project No: 325

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth Below LNT (m) | Symbol | Geologic Description | Elevation (m LNT) | Type | Number | "N" Value | Recovery % | RQD % | Standard Penetration Test "N" Value per 300 mm (10 20 30 40 50 60 70 80 90) |
| 0 | | 0 m LNT | 0 | | | | | | |
| 5 | | Ground Surface | -5.3 | | | | | | |
| 6 | | Dark grey sand with fines<br>SPT: 4/13/50/Refusal | -5.91 | SS | 1 | 63.0 | 8.3 | | |
| 7 | | | -7.45 | | | | | | |
| 8 | | Olive grey sand with fines<br>SPT: 4/3/5/4 | -8.04 | SS | 2 | 8.0 | 37.7 | | |
| 9 | | | -8.84 | | | | | | |
| 10 | | Olive grey organic matter<br>SPT: 1.5/1.5/1/1 | -9.42 | SS | 3 | 2.6 | 49.2 | | |
| 11 | | | -10.6 | | | | | | |
| 12 | | Olive grey sand with fines<br>SPT: 8/8/7/9 | -11.2 | SS | 4 | 15.0 | 32.8 | | |
| 13 | | Volcanic Bedrock | -12.1 | RC | 1 | | 20 | 14 | |
| 14 | | | | RC | 2 | | 52 | 0 | |
| 15 | | End of Borehole | -14.2 | RC | 3 | | 100 | 54 | |

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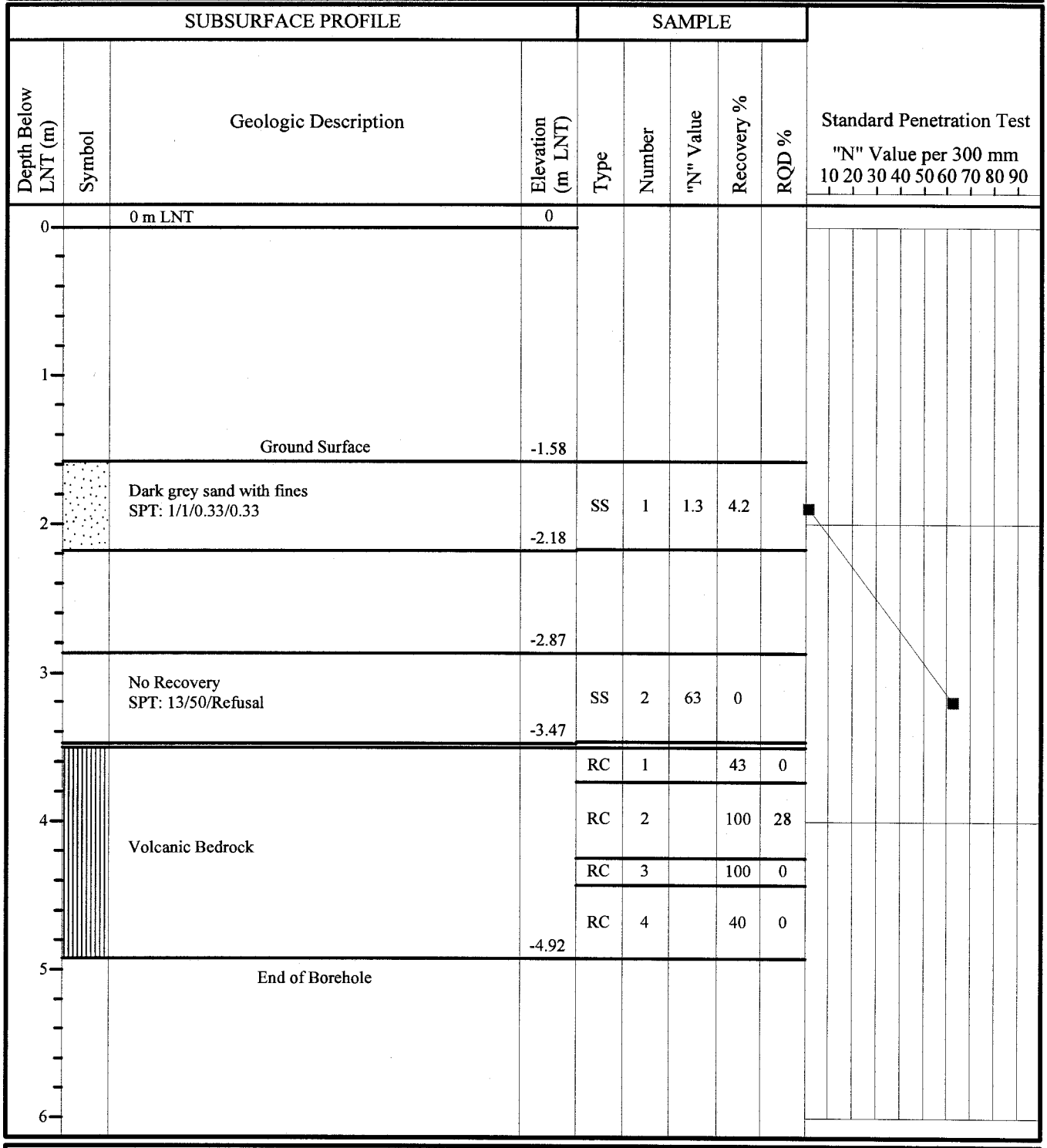
Drill Method: NW/NQ Casing/Coring
Driller: Zenith Drilling

Datum: 0 m LNT
Checked by:
Sheet: 1 of 1

Project: Geotechnical Investigation
Location: Grand Bank, NF
Client: BAE - NEWPLAN GROUP LIMITED
Drilling Supervisor: Marcia Parsons

# Log of Borehole: BH6

Date: April 30, 2002
Project No: 325





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Phone: (709) 739-7270
Fax: (709) 753-5101


Drill Method: NW/NQ Casing/Coring
Driller: Zenith Drilling

Datum: 0 m LNT
Checked by:
Sheet: 1 of 1

Project: Geotechnical Investigation
Location: Grand Bank, NF
Client: BAE - NEWPLAN GROUP LIMITED
Drilling Supervisor: Marcia Parsons

# Log of Borehole: BH7

Date: May 1, 2002
Project No: 325

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth Below LNT (m) | Symbol | Geologic Description | Elevation (m LNT) | Type | Number | "N" Value | Recovery % | RQD % | Standard Penetration Test "N" Value per 300 mm 10 20 30 40 50 60 70 80 90 |
| 0 | | 0 m LNT | 0 | | | | | | |
| 5 | | Ground Surface | -5.5 | | | | | | |
| 6 | | Dark grey silt<br>SPT: 1/1/3/5 | -6.17 | SS | 1 | 4 | 12.5 | | |
| | | | -6.67 | | | | | | |
| 7 | | Dark grey silt<br>SPT: 6/5/1/2 | -7.27 | SS | 2 | 6 | 4.2 | | |
| 9 | | | -9.44 | | | | | | |
| 10 | | Olive grey sand with fines<br>SPT: 10/4/26/50 | -9.97 | SS | 3 | 30 | 39.3 | | |
| 11 | | Volcanic Bedrock | | RC | 1 | | 18 | 18 | |
| | | | -11.5 | RC | 2 | | 67 | 67 | |
| 12 | | End of Borehole | | | | | | | |

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Fax: (709) 753-5101

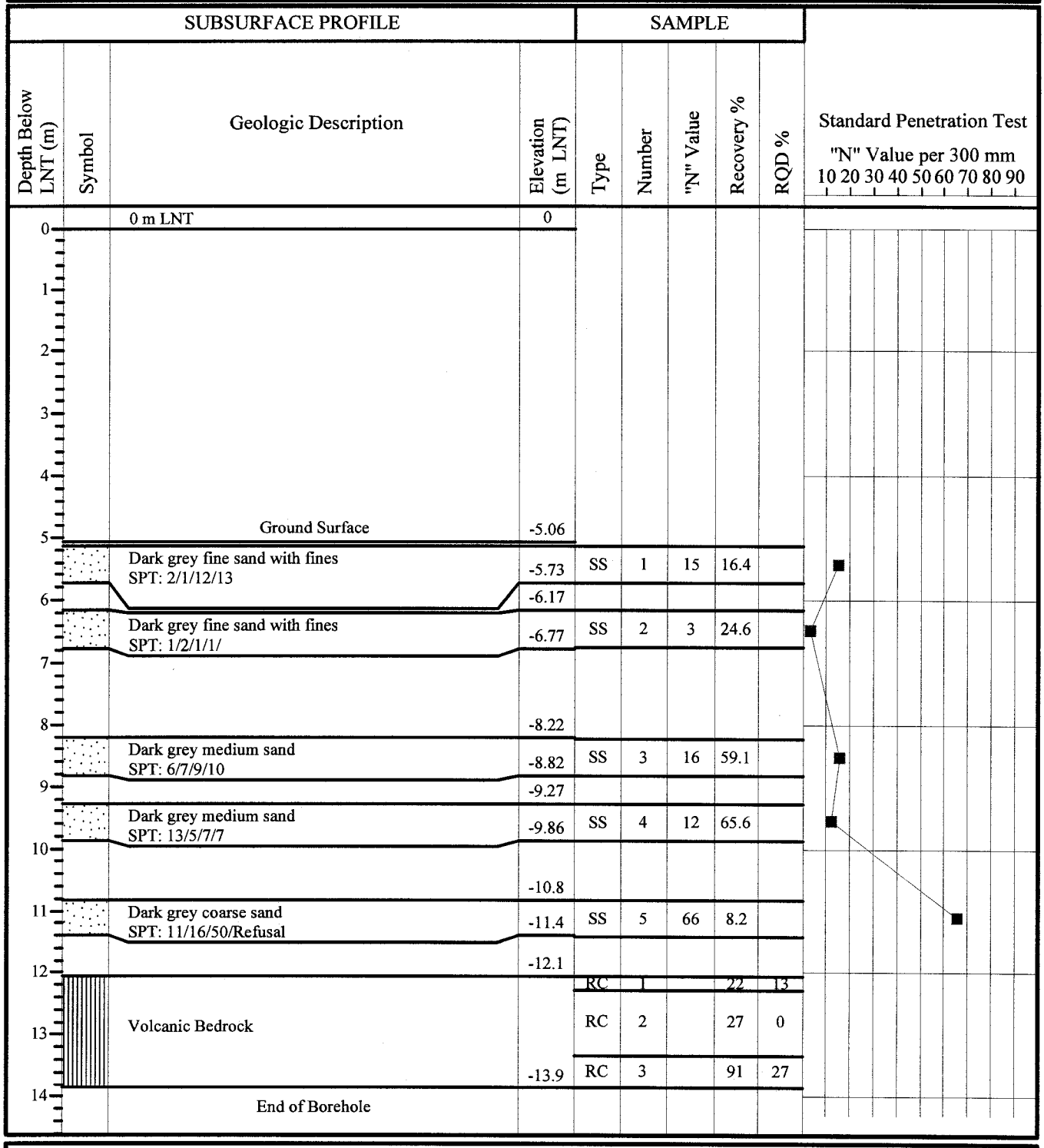
Drill Method: NW/NQ Casing/Coring
Driller: Zenith Drilling

Datum: 0 m LNT
Checked by:
Sheet: 1 of 1

Project: Geotechnical Investigation
Location: Grand Bank, NF
Client: BAE - NEWPLAN GROUP LIMITED
Drilling Supervisor: Marcia Parsons

# Log of Borehole: BH8

Date: May 5, 2002
Project No: 325





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Fax: (709) 753-5101


Drill Method: NW/NQ Casing/Coring
Driller: Zenith Drilling

Datum: 0 m LNT
Checked by:
Sheet: 1 of 1

Project: Geotechnical Investigation
Location: Grand Bank, NF
Client: BAE - NEWPLAN GROUP LIMITED
Drilling Supervisor: Marcia Parsons

# Log of Borehole: BH10

Date: May 7, 2002
Project No: 325

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth Below LNT (m) | Symbol | Geologic Description | Elevation (m LNT) | Type | Number | "N" Value | Recovery % | RQD % | Standard Penetration Test "N" Value per 300 mm 10 20 30 40 50 60 70 80 90 |
| 0 | | 0 m LNT | 0 | | | | | | |
| 5 | | Ground Surface | -5.81 | | | | | | |
| 6 | | | -6.3 | | | | | | |
| 7 | | Dark grey sand with fines SPT: 1/2/1/2 | -6.9 | SS | 1 | 3 | 16 | | |
| | | | -7.74 | | | | | | |
| 8 | | Olive grey sand with fines SPT: 10/2/5/7 | -8.34 | SS | 2 | 7 | 36 | | |
| 9 | | | -9.82 | | | | | | |
| 10 | | Olive grey sand SPT: 12/13/17/21 | -10.4 | SS | 3 | 30 | 95 | | |
| 11 | | | -11.4 | | | | | | |
| 12 | | Coarse gravel SPT: 5/5/3/4 | -12 | SS | 4 | 8 | 0 | | |
| 13 | | | -13.1 | | | | | | |
| | | No recovery SPT: 50/Refusal | | RC | 1 | | 46 | 46 | |
| 14 | | Volcanic Bedrock | | RC | 2 | | 35 | 13 | |
| 15 | | | -14.9 | | | | | | |
| | | End of Borehole | | | | | | | |

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Drill Method: NW/NQ Casing/Coring
Driller: Zenith Drilling

Datum: 0 m LNT
Checked by:
Sheet: 1 of 1

# GEOTECHNICAL FACTUAL REPORT
# GRAND BANK, NL

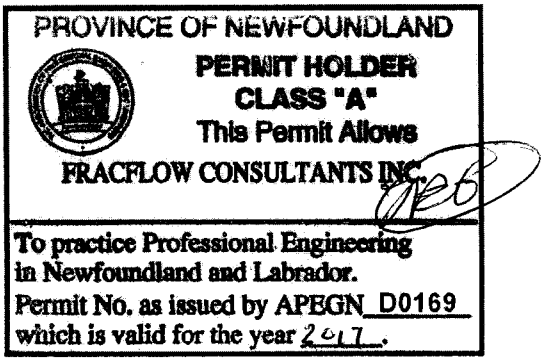
(FFC File: 3087)

Prepared by:

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL
A1A 5A1

Submitted to:

Public Works and Government Services Canada
7th Floor, John Cabot Building
P.O. Box 4600
St. John's, NL A1C 5T2




January 2017

# Preface

Public Works and Government Services Canada (PWGSC) retained Fracflow Consultants Inc. to undertake an additional marine geotechnical site investigation at Grand Bank, NL. This investigation was conducted according to the pricing and stipulations outlined in the existing Standing Offer Contract (No. EA003-160505/001/PWD) between Public Works and Government Services Canada (PWGSC) and Fracflow Consultants Inc.

The proposed scope of work for the Grand Bank project consisted of drilling six (6) additional inclined geotechnical boreholes angled into the bedrock on the land side of the wharf, in order to define the overburden and bedrock conditions below the buildings adjacent to the current wharf. The field work was conducted between January 12 and 20, 2017.

The field work for these investigations utilized a Foremost Mobile B-47 geotechnical drill rig at the approximate locations specified by the project engineer. Several boreholes had to be moved slightly from the proposed locations to avoid infrastructure underneath and on the current wharf. Based on the findings from the first six (6) boreholes, two (2) additional inclined boreholes were drilled.

A visual inspection of the subsurface soil conditions encountered, based on recovery from the core tube during drilling, was used to describe the soil conditions at the site. The end of hole depths (along the inclined hole) of the eight (8) boreholes ranged from 5.06 m below the top of wharf in INCL5 to 15.65 m below the top of wharf in INCL9.

Overburden in the area of the eight (8) inclined boreholes drilled can be described as gravel, cobbles, and boulders from ocean bottom to bedrock. Based on previous investigations conducted by Fracflow, the overburden can be assumed to include sand and varying amounts of silt/clay as well as the gravel/cobbles/boulders. Overburden thicknesses range from 10.33 m in INCL8 to 1.40 m in INCL10. Overburden is thinnest at the northern and southern ends of this section of the wharf, and increase in thickness toward the middle of the wharf. Bedrock or highly fractured bedrock was encountered in all eight (8) of the boreholes. Depth to bedrock along the inclined hole ranged from 3.81 m below the top of wharf in INCL5 to 11.70 m below the top of wharf in INCL8. In the majority of boreholes, a layer of broken bedrock with lower recoveries was encountered before solid core was obtained. Bedrock encountered in the eight (8) boreholes was a volcanic tuff with Rock Quality Designations (RQDs) ranging from 0% to 60% and recoveries ranging from 19% to 100%. Very fractured bedrock was encountered in boreholes INCL9 and INCL11. Rock strength data from Point Load Tests and Brazilian Tests on representative samples of the rock core show that the rock properties are highly variable with low tensile strength due to the pervasive microfracture network in some of the bedrock that was cored.

Cross sections were developed at the first six (6) borehole locations showing the current construction of the wharf and adjacent buildings, and the location of overburden and bedrock in

relation to the current wharf. These cross sections were constructed by migrating existing nearby borehole data into the plane of each section.

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# 1.0 INTRODUCTION

Public Works and Government Services Canada (PWGSC) retained Fracflow Consultants Inc. to undertake an additional marine geotechnical site investigation at Grand Bank, NL. This investigation was conducted according to the pricing and stipulations outlined in the existing Standing Offer Contract (No. EA003-160505/001/PWD) between Public Works and Government Services Canada (PWGSC) and Fracflow Consultants Inc.

The proposed scope of work for the Grand Bank project consisted of drilling six (6) additional inclined geotechnical boreholes angled into the bedrock on the land side of the wharf, in order to define the overburden and bedrock conditions below the buildings adjacent to the current wharf. Based on the findings from the first six (6) boreholes, two (2) additional inclined boreholes were drilled. The field work was conducted between January 12 and 20, 2017.

The borehole locations from the current scope of work are shown on the site plan in **Figure 1.1**. **Figure 1.2** shows all borehole locations from work completed during the current investigation, as well as nearby boreholes from the May/June 2016 (FFC, 2016a) and August 2016 (FFC, 2016b) investigations. A summary of the geotechnical field work conducted in January 2016 is shown in **Table 1.1**.

This report contains a factual presentation and full disclosure of all findings of the subsurface investigation. The following sections provide: (1) a description of the site and the general geology of the area; (2) a summary of the investigative procedures used; (3) a detailed description of the subsurface conditions, and; (4) local cross sections for six (6) locations where the inclined holes were drilled, showing overburden and bedrock conditions plus wharf conditions. Appended to this report are the detailed geotechnical logs for each borehole and, for completeness, the relevant logs from earlier borehole investigations by Fracflow.

Table 1.1 Summary of additional geotechnical investigations at Grand Bank, NL.

| Borehole ID | Overburden Drilled (m) | Bedrock Drilled (m) | Total Depth Drilled (m) | Borehole Plunge (degrees from horizontal) |
|---|---|---|---|---|
| **INCL4** | 3.94 | 1.49 | 5.43 | 74 |
| **INCL5** | 2.22 | 1.25 | 3.47 | 70 |
| **INCL6** | 4.09 | 2.60 | 6.69 | 72 |
| **INCL7** | 5.19 | 4.75 | 9.94 | 71 |
| **INCL8** | 10.33 | 1.11 | 11.44 | 73 |
| **INCL9** | 5.61 | 7.27 | 12.88 | 58 |
| **INCL10** | 1.40 | 1.99 | 3.39 | 80 |
| **INCL11** | 3.35 | 0.74 | 4.09 | 46 |
| **Total** | 36.13 | 21.20 | 57.33 | -- |

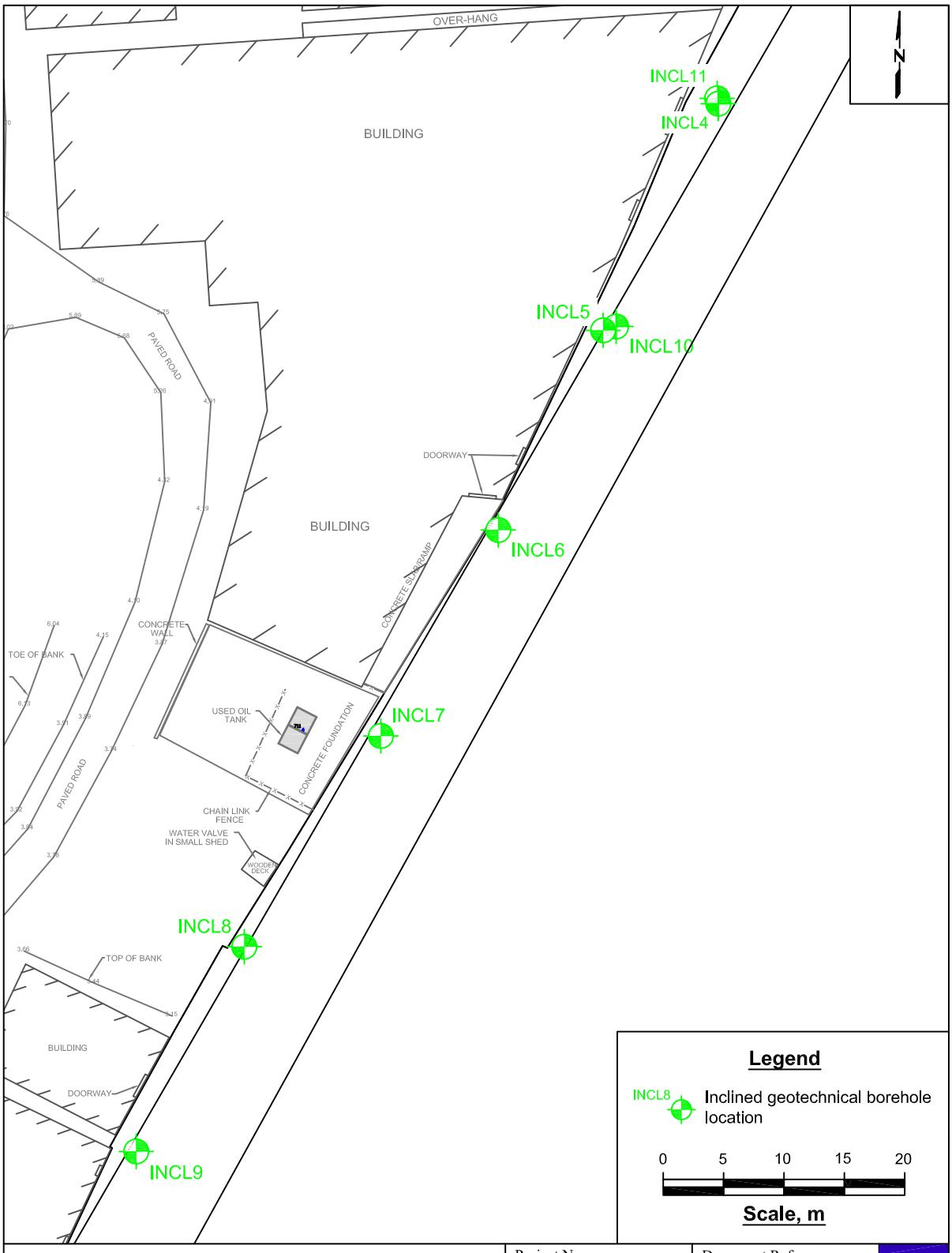



Figure 1.1 Borehole location map, January 2017 site investigation.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087-03 |
| Location | Date |
| Grand Bank, NL | January 2017 |

FFC

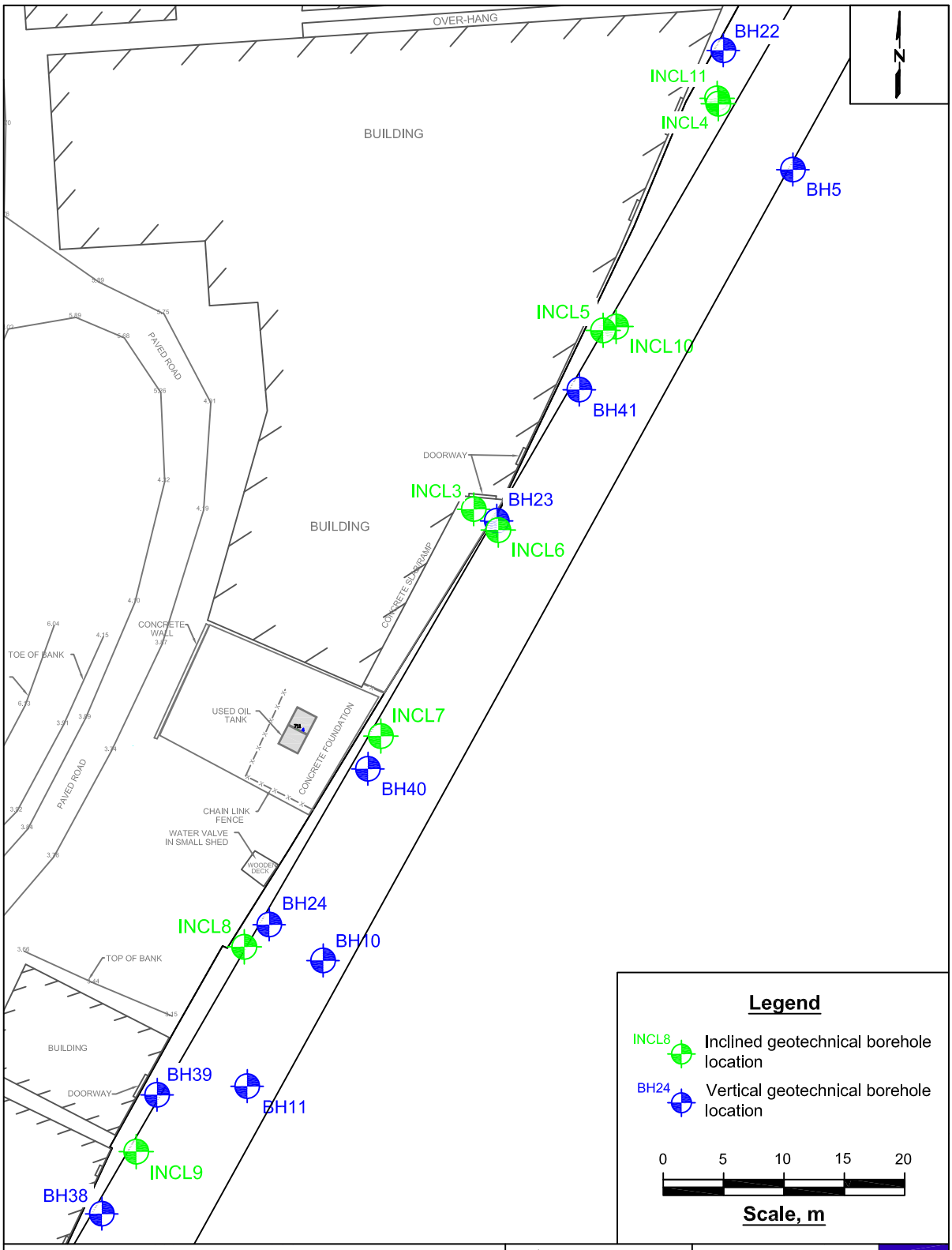



Figure 1.2 Borehole location map, May/June 2016, August 2016 and January 2017 site investigations.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087-03 |
| Location | Date |
| Grand Bank, NL | January 2017 |

FFC

# 2.0 SITE DESCRIPTION AND GENERAL GEOLOGY

The community of Grand Bank is located in Fortune Bay, on the southern tip of the Burin Peninsula. Overburden in the area is characterized by glacial till overlying bedrock (Batterson, 2007). Bedrock in the area consists of “rhyolitic ash - flow tuffs; flows and breccias; associated epliclastic rocks; minor unseparated mafic flows and tuffs; sericitic and chloritic schists” of the Marystown Group (O’Driscoll, 1995).

# 3.0 INVESTIGATIVE PROCEDURES

At the Grand Bank site, the project consisted of drilling an additional six (6) inclined geotechnical boreholes (INCL4 to INCL9) angled into the bedrock on the land side of the wharf, in order to define the overburden and bedrock conditions below the buildings adjacent to the current wharf. Based on the findings from the first six (6) boreholes, two (2) additional inclined boreholes (INCL10 and INCL11) were drilled to further define the overburden and bedrock conditions. The field work for these investigations utilized a Foremost Mobile B-47 mounted on a trailer at the locations shown in **Figure 1.1**. **Figure 1.2** shows all borehole locations completed during the current field program, and the May/June 2016 (FFC, 2016a) and August 2016 (FFC, 2016b) field programs. The current field program work was conducted between January 12 and 20, 2017.

Overburden and bedrock material were drilled using 'NW' (OD 88.9 mm, ID 76.2 mm) flush joint casing and "NQ" (OD 69.9 mm, ID 60.3 mm) diamond drill string. Soil samples were collected in borehole INCL4 using a 51 mm OD, 610 mm long, split-spoon sampler, driven by a 63.5 kg weight. Standard Penetration Tests (SPTs) were conducted, but N-values were not calculated due to the inclination of the borehole.

Both the soil samples and rock cores were logged and labelled in the field immediately after collection. Soil samples were stored in moisture proof containers and rock cores were stored in wooden core boxes in the field. All soil and rock samples were returned to Fracflow's office. Laboratory soil testing was not conducted due to limited sample. Brazilian Indirect Tension tests and Point Load Tests to determine Uniaxial Compressive Strengths were conducted on selected core samples. The soil and rock core samples are stored by Fracflow for a two-year period.

# 4.0 SUBSURFACE CONDITIONS AND CHARACTERIZATION

Subsurface characterization is based on the field data collected from the additional eight (8) geotechnical boreholes that were completed at this site during the January 2017 field program. A description of the soil profile is limited to a description of core tube recovery as split spoon samples were not collected from most of the inclined boreholes. Photographs of the core recoveries from each borehole are provided in **Figure 4.1** through **Figure 4.3**. Detailed logs of the geological conditions at each borehole location from the current site investigation are provided in **Appendix A**. Note that the geotechnical logs are presented as depth or length along the inclined borehole. **Appendix B** contains the relevant detailed borehole logs from the May/June 2016 (FFC, 2016a) and August 2016 (FFC, 2016b) site investigations.

## 4.1 Soil Description

Overburden in the area of the eight (8) inclined boreholes drilled can be described as gravel, cobbles, and boulders from ocean bottom to bedrock. Based on previous investigations conducted by Fracflow, the overburden can be assumed to include sand and varying amounts of silt/clay as well as the gravel/cobbles/boulders mentioned above (FFC, 2016b).

Overburden thicknesses range from 10.33 m in INCL8 to 1.40 m in INCL10. Overburden is thinnest at the northern and southern ends of the wharf, and increase in thickness toward the middle of the wharf.

## 4.2 Bedrock Description

The general description of bedrock in the area consists of “rhyolitic ash - flow tuffs; flows and breccias; associated epliclastic rocks; minor unseparated mafic flows and tuffs; sericitic and chloritic schists” of the Marystown Group (O’Driscoll, 1995).

Bedrock or highly fractured bedrock was encountered in all eight (8) of the boreholes. Depth to bedrock along the inclined hole ranged from 3.81 m in INCL5 to 11.70 m in INCL8. In the majority of boreholes, a layer of broken bedrock with lower recoveries was encountered before solid core was obtained.

Bedrock encountered in the eight (8) boreholes was a volcanic tuff with Rock Quality Designations (RQDs) ranging from 0% to 60% and recoveries ranging from 19% to 100%. Very fractured bedrock was encountered in boreholes INCL9 and INCL11.

Brazilian Indirect Tension (Brazilian) tests and Point Load Tests to determine Uniaxial Compressive Strengths were conducted on samples selected from boreholes INCL4 to INCL8

and INCL10. The results of the Brazilian tests and the Point Load tests are tabulated in **Table 4.1** and **Table 4.2** respectively.

Indirect Tensile Strength (ITS) of each sample was calculated from the Brazilian test data using the relationship (ASTM, 2008b),

$$ITS = 2 \cdot P / \pi \cdot L \cdot D$$

where:
P = load at failure;
L = thickness of sample;
D = diameter of sample.

The mean, median, standard deviation, minimum, and maximum of the ITSs were determined for all samples:

| Brazilian Test Group | No. Samples | Mean MPa | Median MPa | Standard Deviation MPa | Minimum MPa | Maximum MPa |
|---|---|---|---|---|---|---|
| All Samples | 17 | 12.5 | 13.2 | 3.4 | 4.3 | 18.9 |

The Uncorrected Point Load Index ($I_s$), was calculated from the Point Load test data using the relationship (ASTM, 2008a),

$$I_s = P / D_e^2$$

where:
P = load at failure;
$D_e$ = equivalent core diameter, D for diametral tests.

The Size Corrected Point Load Index ($I_{s(50)}$) was calculated by multiplying by a "Size Correction Factor F", obtained from the expression:

$$F = (D_e / 50)^{0.45}$$

The Uniaxial Compressive Strength (UCS) was then obtained from the expression:

$$UCS = K \cdot I_{s(50)}$$

where:
K = Generalized Index to Strength Conversion Factor.

For a mean core diameter of 47.5 mm, the Generalized Index to Strength Conversion Factor (K) was found to be 22.5.

The mean, median, standard deviation, minimum, and maximum of the UCSs were determined for all samples:

| Point Load Test Group | No. Samples | Mean MPa | Median MPa | Standard Deviation MPa | Minimum MPa | Maximum MPa |
|---|---|---|---|---|---|---|
| All Samples | 16 | 105.3 | 114.9 | 58.0 | 11.4 | 198.5 |

Table 4.1 Indirect tensile strength data from Brazilian tests, Grand Bank, NL.

| Sample I.D. | Approx. Depth m | Diameter mm | Thickness mm | Load at Failure kN | Indirect Tensile Strength MPa | Comments |
|---|---|---|---|---|---|---|
| INCL4-BZ1 | 6.43 | 47.19 | 23.69 | 35.18 | **14.3** | No foliation |
| INCL4-BZ2 | 7.09 | 47.30 | 23.57 | 17.05 | **9.7** | No foliation |
| INCL4-BZ3 | 7.11 | 47.30 | 22.63 | 24.80 | **14.7** | No foliation |
| INCL5-BZ2 | 4.18 | 47.51 | 23.81 | 19.30 | **10.9** | No foliation |
| INCL6-BZ1 | 6.91 | 47.60 | 23.93 | 7.62 | **4.3** | Loading 45° to fracture |
| INCL6-BZ2 | 7.22 | 47.56 | 24.19 | 19.28 | **10.7** | No foliation |
| INCL6-BZ3 | 7.85 | 47.61 | 23.25 | 26.35 | **15.1** | No foliation |
| INCL6-BZ4 | 7.87 | 47.61 | 24.06 | 24.46 | **13.6** | No foliation |
| INCL7-BZ1 | 10.91 | 47.63 | 23.35 | 17.65 | **10.1** | No foliation |
| INCL7-BZ2 | 10.93 | 47.62 | 23.70 | 22.72 | **12.8** | No foliation |
| INCL7-BZ3 | 11.71 | 47.70 | 23.17 | 22.99 | **13.2** | Loading 90° to fracture |
| INCL8-BZ1 | 12.15 | 47.67 | 26.62 | 31.32 | **15.7** | No foliation |
| INCL8-BZ2 | 12.31 | 47.67 | 24.48 | 34.69 | **18.9** | No foliation |
| INCL8-BZ3 | 12.56 | 47.67 | 23.98 | 24.49 | **13.6** | No foliation |
| INCL10-BZ1 | 4.50 | 47.56 | 26.94 | 15.52 | **7.7** | Loading 0° to fracture |
| INCL10-BZ2 | 4.97 | 47.66 | 25.38 | 22.70 | **11.9** | No foliation |
| INCL10-BZ3 | 5.67 | 47.72 | 24.36 | 28.12 | **15.4** | Loading 90° to fracture |

Table 4.2 Uniaxial compressive strength data from point load tests, Grand Bank, NL.

| Sample I.D. | Approx. Depth m | Diameter mm | Length mm | Load at Failure kN | Strength Index -- | Corrected Strength Index -- | Uniaxial Comp. Strength MPa | Comments |
|---|---|---|---|---|---|---|---|---|
| INCL4-PL2 | 6.98 | 47.29 | 103.6 | 11.41 | 5.10 | 4.98 | **112.0** | No foliation |
| INCL4-PL3 | 7.21 | 47.36 | 65.7 | 20.28 | 9.04 | 8.82 | **198.5** | No foliation |
| INCL5-PL1 | 4.26 | 47.52 | 69.8 | 16.50 | 7.31 | 7.14 | **160.7** | No foliation |
| INCL5-PL2 | 4.26 | 47.52 | 111.9 | 12.69 | 5.62 | 5.49 | **123.6** | Loading 45° to fracture |
| INCL5-PL3 | 4.94 | 47.56 | 90.8 | 1.17 | 0.52 | 0.51 | **11.4** | No foliation |
| INCL6-PL1 | 5.92 | 47.53 | 100.9 | 14.80 | 6.55 | 6.40 | **144.1** | No foliation |
| INCL6-PL2 | 6.46 | 47.57 | 83.3 | 1.45 | 0.64 | 0.63 | **14.1** | No foliation |
| INCL6-PL3 | 7.33 | 47.57 | 100.4 | 12.13 | 5.36 | 5.24 | **117.9** | No foliation |
| INCL7-PL1 | 10.70 | 47.64 | 81.5 | 7.58 | 3.34 | 3.27 | **73.5** | No foliation |
| INCL7-PL3 | 11.19 | 47.64 | 88.2 | 5.98 | 2.63 | 2.58 | **58.0** | No foliation |
| INCL8-PL1 | 12.05 | 47.48 | 95.8 | 16.84 | 7.47 | 7.30 | **164.2** | No foliation |
| INCL8-PL2 | 12.81 | 47.68 | 74.7 | 14.54 | 6.40 | 6.26 | **140.9** | No foliation |
| INCL8-PL3 | 12.90 | 47.69 | 87.7 | 17.70 | 7.78 | 7.62 | **171.4** | Loading 45° to fracture |
| INCL10-PL1 | 5.05 | 47.64 | 87.9 | 4.80 | 2.11 | 2.07 | **46.6** | No foliation |
| INCL10-PL2 | 5.70 | 47.67 | 87.0 | 4.56 | 2.01 | 1.96 | **44.2** | No foliation |
| INCL10-PL3 | 6.09 | 47.67 | 67.8 | 10.75 | 4.73 | 4.63 | **104.2** | No foliation |

**Hole ID: INCL4**


**Hole ID: INCL5**


**Hole ID: INCL6**


**Hole ID: INCL7**

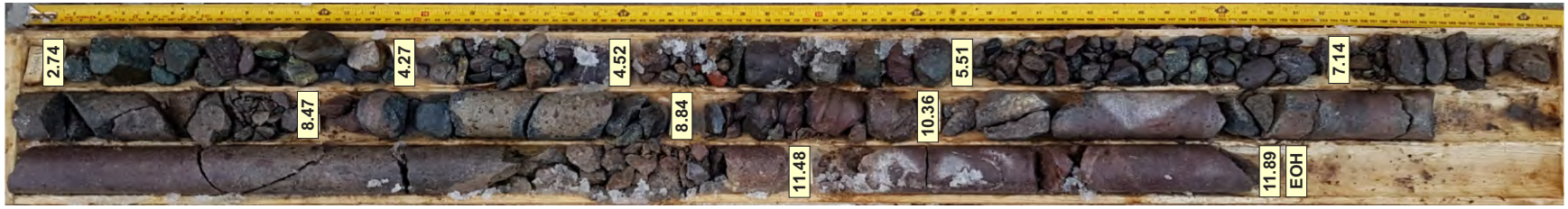



Figure 4.1 Photographs of core recovered during drilling from inclined boreholes INCL4 to INCL7 (depths shown as metres along inclined hole).

**Hole ID: INCL8**


**Hole ID: INCL9**


Figure 4.2 Photographs of core recovered during drilling from inclined boreholes INCL8 and INCL9 (depths shown as metres along inclined hole).

**Hole ID: INCL10**


**Hole ID: INCL11**

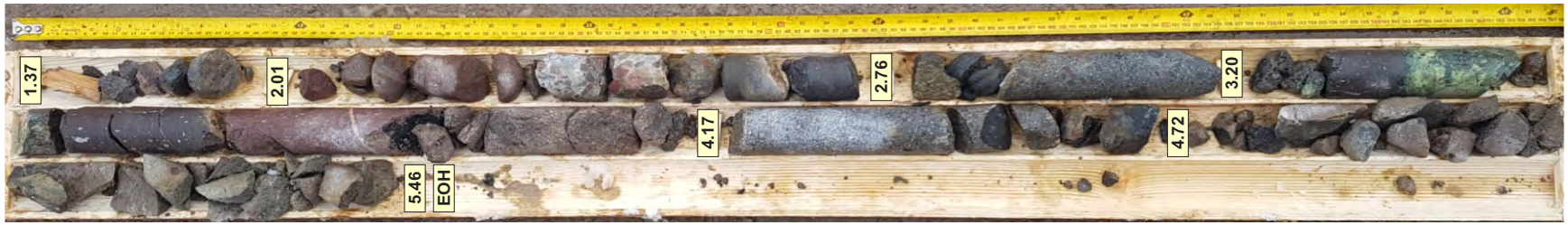



Figure 4.3 Photographs of core recovered during drilling from inclined boreholes INCL10 and INCL11 (depths shown as metres along inclined hole).

# 5.0 SUBSURFACE PROFILE

Cross sections perpendicular to the current wharf were developed for the six (6) original borehole locations using data collected from boreholes drilled during the January 2017, August 2016, and May/June 2016 investigations. The cross sections are shown in **Figure 5.1** to **Figure 5.6** and show the approximate current wharf and building construction, and the inferred location of overburden and bedrock at each location. Overburden and bedrock generally slope steeply away from beneath the current wharf and adjacent buildings, with depth to bedrock increasing in the area of INCL7 to INCL9. The data for each cross section has been supplemented by migrating nearby borehole data into each vertical cross section.

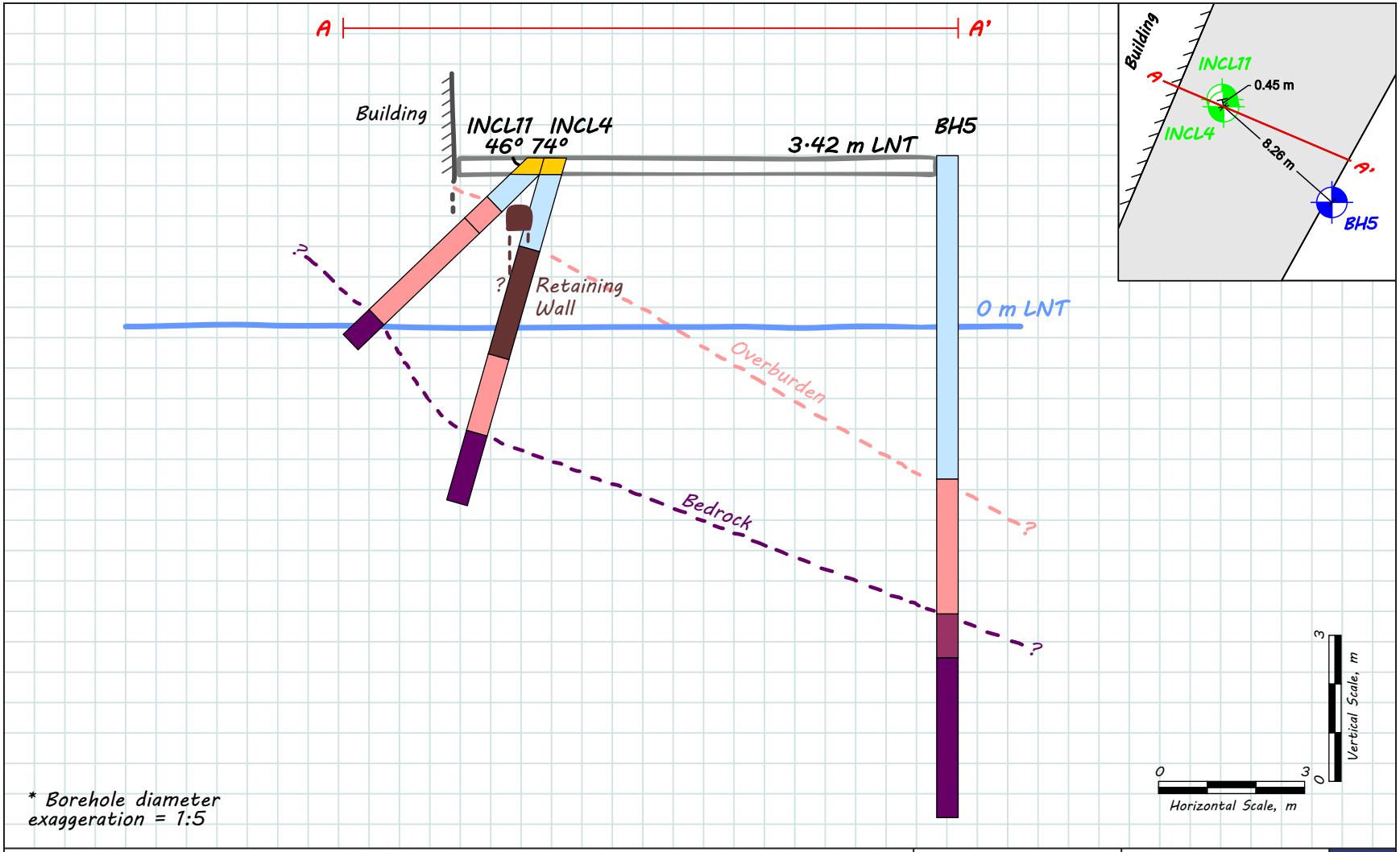
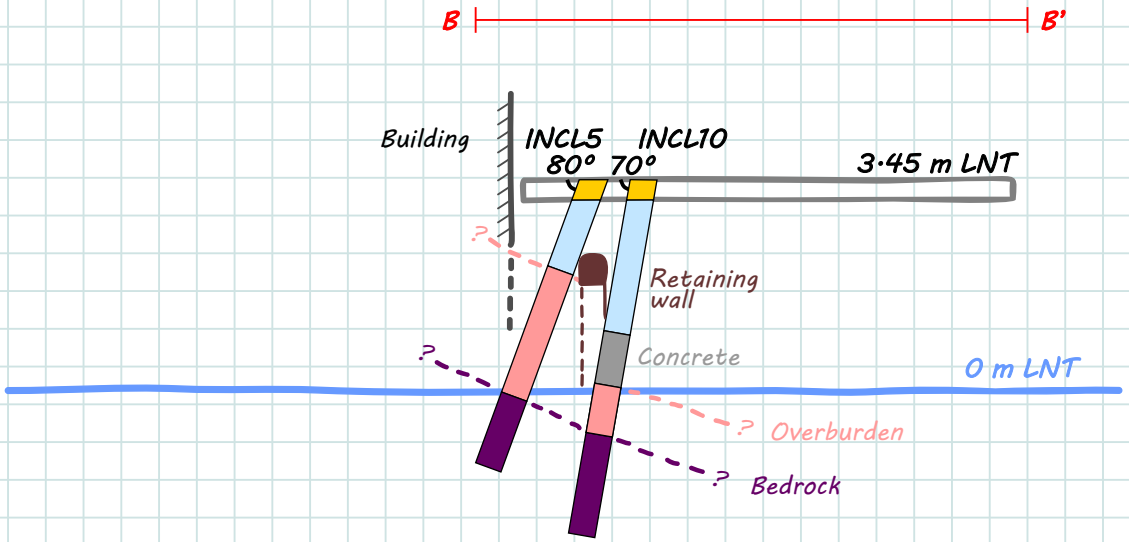
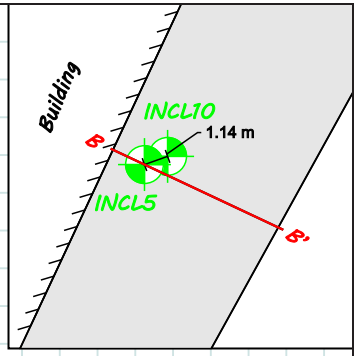


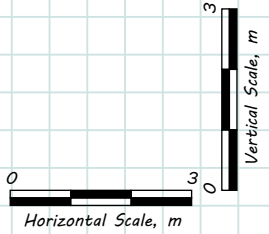

Figure 5.1 Cross section of the existing wharf and boreholes at borehole location INCL4.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087-03 |
| Location | Date |
| Grand Bank, NL | January 2017 |

FFC




* Borehole diameter exaggeration = 1:5

Figure 5.2 Cross section of the existing wharf and boreholes at borehole location INCL5.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087-03 |
| Location | Date |
| Grand Bank, NL | January 2017 |

FFC

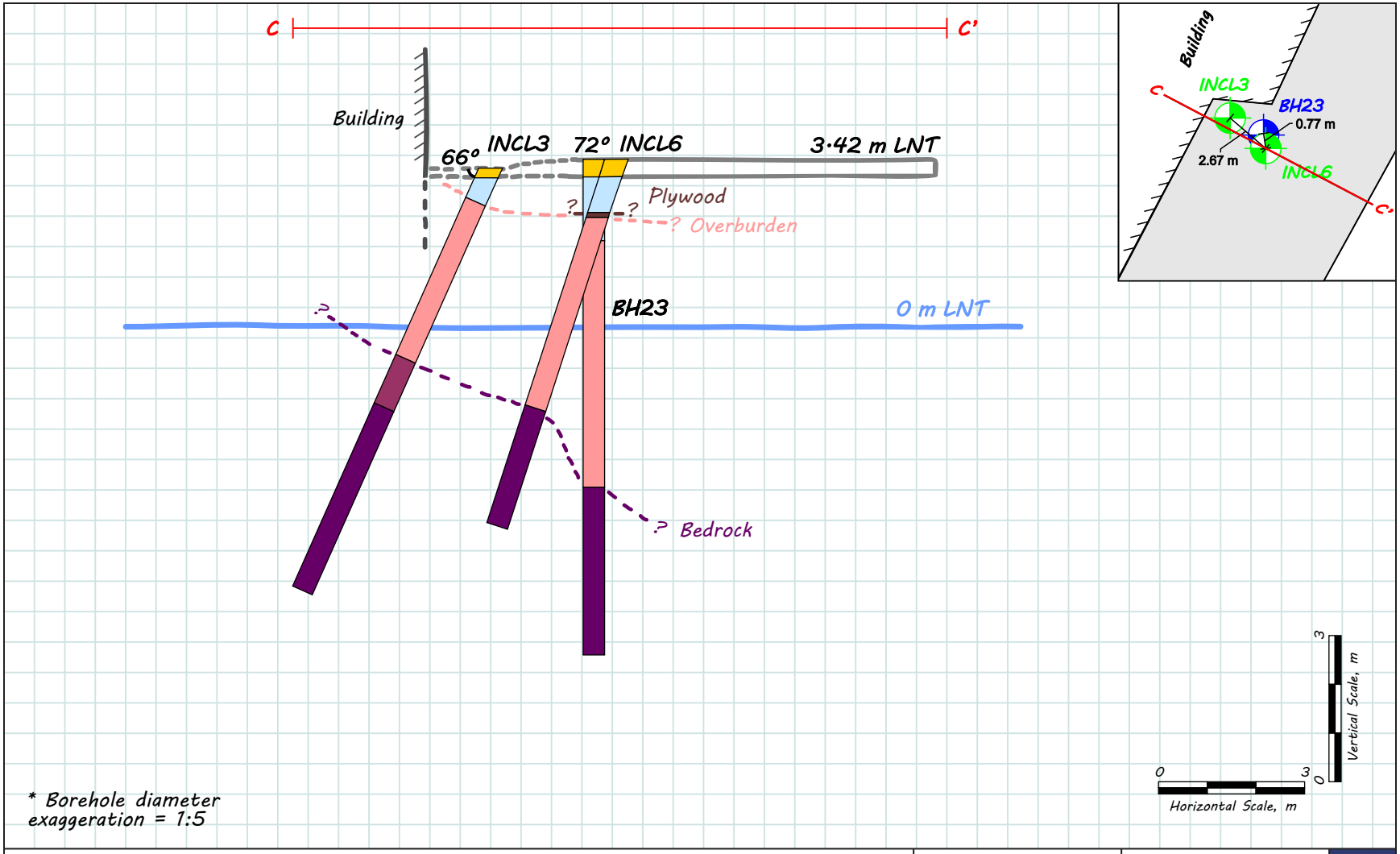



Figure 5.3 Cross section of the existing wharf and boreholes at borehole location INCL6.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087-03 |
| Location | Date |
| Grand Bank, NL | January 2017 |

FFC

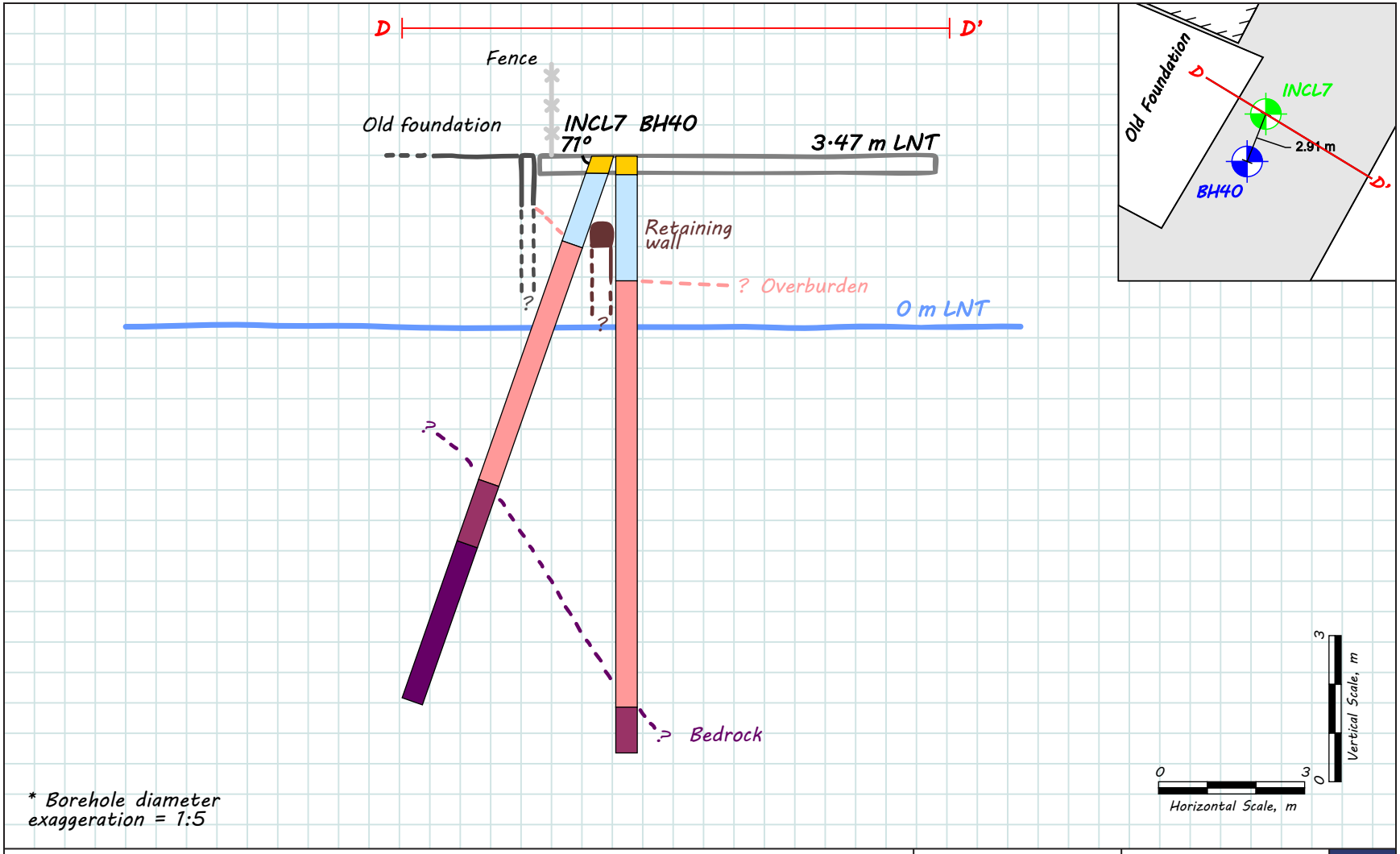



Figure 5.4 Cross section of the existing wharf and boreholes at borehole location INCL7.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087-03 |
| Location | Date |
| Grand Bank, NL | January 2017 |

FFC

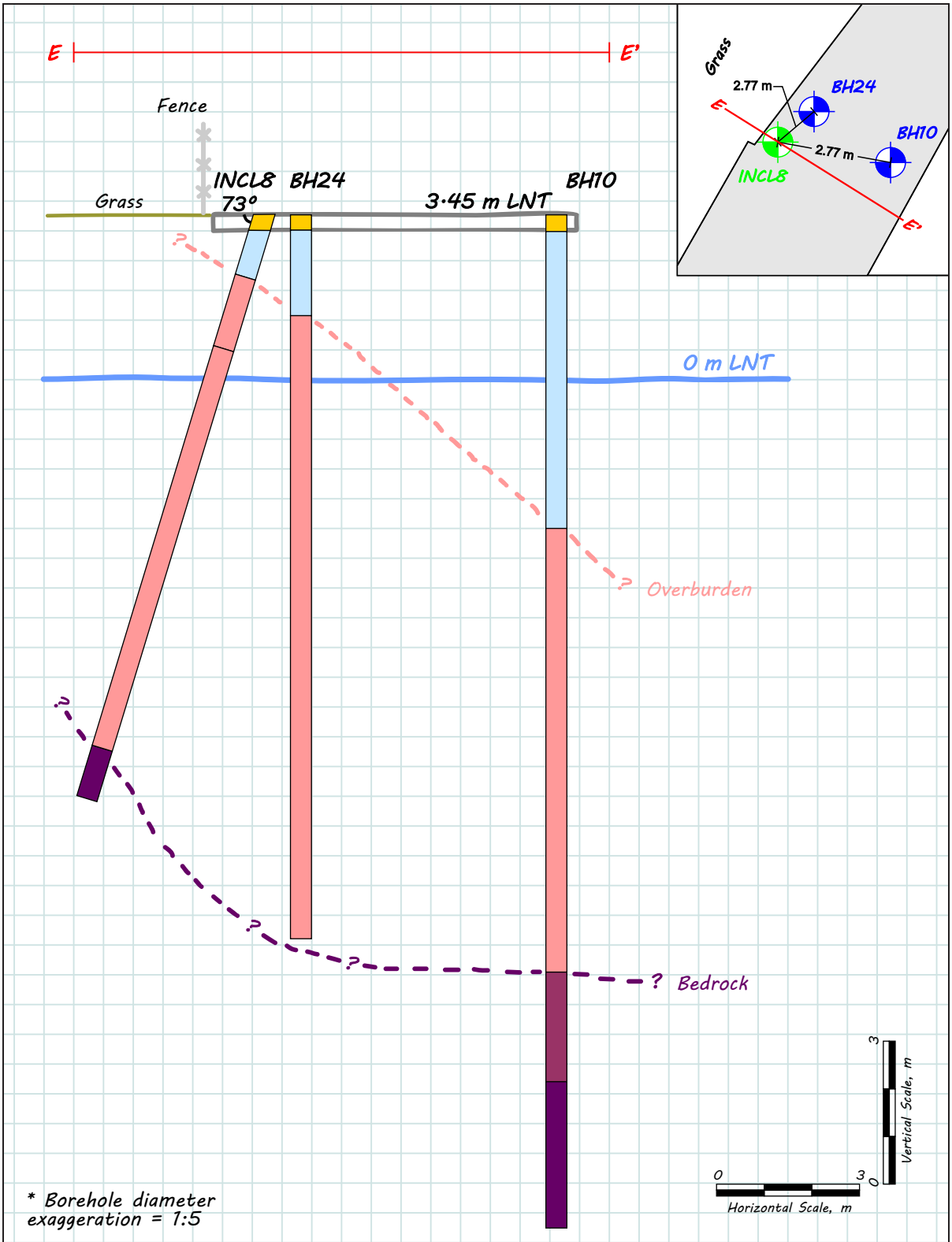



Figure 5.5 Cross section of the existing wharf and boreholes at borehole location INCL8.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087-03 |
| Location | Date |
| Grand Bank, NL | January 2017 |

FFC

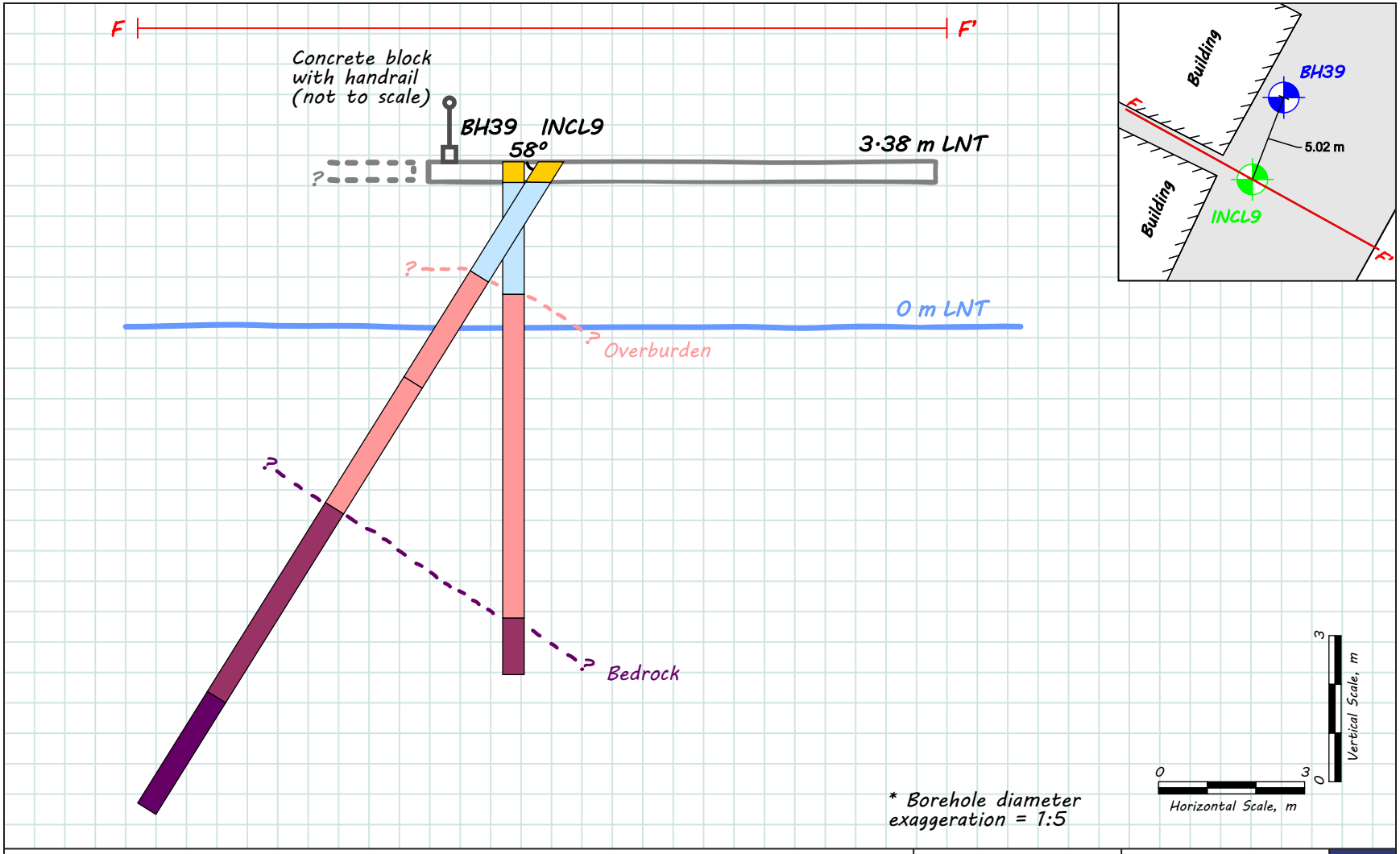



Figure 5.6 Cross section of the existing wharf and boreholes at borehole location INCL9.

| Project No. | Document Reference |
|---|---|
| 3087 | FFC-NL-3087-03 |
| Location | Date |
| Grand Bank, NL | January 2017 |

FFC

# 6.0 REFERENCES

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ASTM, 2008b, *Standard Test Method for Splitting Tensile Strength of Intact Rock Core Specimens*, Designation D3967-08, ASTM International.

Batterson, M.J. and Taylor, D.M., 2007, *Map 2007-16 Surficial Geology of the Grand Bank map sheet (NTS 1M/04)*, Geological Survey, Department of Natural Resources, Government of Newfoundland and Labrador.

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O'Driscoll, C.F., 1995. *Map 95-16 Mineral Occurance Map Belleoram / St. Lawrence Newfoundland*, Geological Survey, Department of Natural Resources, Government of Newfoundland and Labrador.

# *APPENDIX A*

*Borehole Logs - January 2017 Investigation*

Project: Marine Geotechnical Investigation

# *Log of Inclined Borehole: INCL4*

Client: Public Works Government Services Canada

Project No: 3087

Location: Grand Bank, NL

Date: January 14, 2017

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| | | Ground Surface | 0 | | | | | | |
| | | Concrete wharf deck. | -0.356 | | | | | | |
| | | | -1.94 | | | | | | |
| | | | | OB | -- | | | | |
| | | | | OB | -- | | | | |
| | | Drilling through wood, possibly retaining wall | | OB | -- | | | | |
| | | | -4.25 | | | | | | |
| | | SPT: 5 / 2 for 0.46 m, sank<br>SPT values can not be used to determine "N" Value due to inclination of borehole<br>Wood and gravel | -4.94 | SS | 1 | NA | 6 | | |
| | | Gravel | -5.8 | OB | -- | | 22 | | |
| | | SS2: Recovery = 0%.<br>SPT: 52 for 0.08 m, bouncing (refusal).<br>SPT values can not be used to determine "N" Value due to inclination of borehole<br>No recovery. | | SS | 2 | NA | 0 | | |
| | | | | RC | -- | | 98 | 55 | |
| | | Bedrock: volcanic tuff | -7.37 | RC | -- | | 89 | 42 | |
| | | End of Borehole | | | | | | | |

ft: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33

m: 0 1 2 3 4 5 6 7 8 9 10


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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Borehole Plunge: 74 degrees

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Inclined Borehole: INCL5*

Client: Public Works Government Services Canada

Project No: 3087

Location: Grand Bank, NL

Date: January 15, 2017

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft / m | | Ground Surface | 0 | | | | | | |
| | | Concrete wharf deck | -0.356 | | | | | | |
| | | | -1.59 | | | | | | |
| | | Boulders | | OB | -- | | 36 | | |
| | | | | OB | -- | | 31 | | |
| | | | -3.81 | | | | | | |
| | | Bedrock: volcanic tuff | | RC | -- | | 100 | 30 | |
| | | | | RC | -- | | 100 | 14 | |
| | | | -5.05 | | | | | | |
| | | End of Borehole | | | | | | | |


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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Borehole Plunge: 70 degrees

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Inclined Borehole: INCL6

Client: Public Works Government Services Canada

Project No: 3087

Location: Grand Bank, NL

Date: January 15-16, 2017

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft m | | Ground Surface | 0 | | | | | | |
| | | Concrete wharf deck | -0.356 | | | | | | |
| | | | -1.22 | | | | | | |
| | | | | OB | -- | | | | |
| | | Drilling through wood, possibly retaining wall | | OB | -- | | | | |
| | | | -2.44 | | | | | | |
| | | Boulder | -2.74 | OB | -- | | 58 | | |
| | | Boulder and gravel | | OB | -- | | 56 | | |
| | | | -4.01 | | | | | | |
| | | Gravel | | OB | -- | | 33 | | |
| | | | -5.31 | | | | | | |
| | | | | RC | -- | | 75 | 10 | |
| | | Bedrock: volcanic tuff | | RC | -- | | 100 | 17 | |
| | | | | RC | -- | | 100 | 60 | |
| | | | -7.91 | | | | | | |
| | | End of Borehole | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Borehole Plunge: 72 degrees

Datum: LNT

Sheet: 1 of 1

Project: Marine Geotechnical Investigation

# *Log of Inclined Borehole: INCL7*

Client: Public Works Government Services Canada

Project No: 3087

Location: Grand Bank, NL

Date: January 17, 2017

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft m | | Ground Surface | 0 | | | | | | |
| | | Concrete wharf deck | -0.381 | | | | | | |
| | | | -1.95 | | | | | | |
| | | | | OB | -- | | 0 | | |
| | | | | OB | -- | | 22 | | |
| | | Gravel | | OB | -- | | 65 | | |
| | | | | OB | -- | | 25 | | |
| | | | | OB | -- | | 21 | | |
| | | | -7.14 | | | | | | |
| | | | | RC | -- | | 32 | 0 | |
| | | Broken bedrock: volcanic tuff | | RC | -- | | 90 | 0 | |
| | | | | | | | 24 | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Borehole Plunge: 71 degrees

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Inclined Borehole: INCL7*

Client: Public Works Government Services Canada

Project No: 3087

Location: Grand Bank, NL

Date: January 17, 2017

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 33 | | | -10.4 | RC | -- | | 24 | 0 | |
| 34 | | | | | | | | | |
| 35 | | | | | | | | | |
| 36 | 11 | Bedrock: volcanic tuff | | RC | -- | | 100 | 30 | |
| 37 | | | | | | | | | |
| 38 | | | -11.9 | RC | -- | | 100 | 58 | |
| 39 | 12 | End of Borehole | | | | | | | |
| 40 | | | | | | | | | |
| 41 | | | | | | | | | |
| 42 | | | | | | | | | |
| 43 | 13 | | | | | | | | |
| 44 | | | | | | | | | |
| 45 | | | | | | | | | |
| 46 | 14 | | | | | | | | |
| 47 | | | | | | | | | |
| 48 | | | | | | | | | |
| 49 | 15 | | | | | | | | |
| 50 | | | | | | | | | |
| 51 | | | | | | | | | |
| 52 | 16 | | | | | | | | |
| 53 | | | | | | | | | |
| 54 | | | | | | | | | |
| 55 | | | | | | | | | |
| 56 | 17 | | | | | | | | |
| 57 | | | | | | | | | |
| 58 | | | | | | | | | |
| 59 | 18 | | | | | | | | |
| 60 | | | | | | | | | |
| 61 | | | | | | | | | |
| 62 | 19 | | | | | | | | |
| 63 | | | | | | | | | |
| 64 | | | | | | | | | |
| 65 | 20 | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Borehole Plunge: 71 degrees

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Inclined Borehole: INCL8*

Client: Public Works Government Services Canada

Project No: 3087

Location: Grand Bank, NL

Date: January 18, 2017

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft / m | | Ground Surface | 0 | | | | | | |
| | | Concrete wharf deck | -0.394 | | | | | | |
| | | | -1.37 | | | | | | |
| | | Cobbles | -1.98 | OB | -- | | 70 | | |
| | | Cobbles and gravel | -2.93 | OB | -- | | 43 | | |
| | | Gravel and cobbles | | OB | -- | | 23 | | |
| | | | | OB | -- | | 34 | | |
| | | | -5.98 | OB | -- | | 34 | | |
| | | Gravel | -6.67 | OB | -- | | 41 | | |
| | | No recovery | | OB | -- | | 0 | | |
| | | | | OB | -- | | 0 | | |
| | | | | | | | 0 | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Borehole Plunge: 73 degrees

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Inclined Borehole: INCL8*

Client: Public Works Government Services Canada

Project No: 3087

Location: Grand Bank, NL

Date: January 18, 2017

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| | | | -10.6 | OB | -- | | 0 | | |
| 11 | | Boulder and cobbles | -11.7 | OB | -- | | 50 | | |
| 12 | | Bedrock: volcanic tuff | | RC | -- | | 100 | 60 | |
| | | | -12.8 | RC | -- | | 100 | 44 | |
| 13 | | End of Borehole | | | | | | | |
| 14 | | | | | | | | | |
| 15 | | | | | | | | | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Borehole Plunge: 73 degrees

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Inclined Borehole: INCL9*

Client: Public Works Government Services Canada

Project No: 3087

Location: Grand Bank, NL

Date: January 12-13, 2017

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft / m | | Ground Surface | 0 | | | | | | |
| | | Concrete wharf deck | -0.483 | | | | | | |
| | | | -2.77 | | | | | | |
| | | | | OB | -- | | | | |
| | | Boulders | | OB | -- | | 82 | | |
| | | | | OB | -- | | 58 | | |
| | | | -5.33 | OB | -- | | 78 | | |
| | | | | OB | -- | | 20 | | |
| | | Gravel | | OB | -- | | 25 | | |
| | | | -8.38 | | | | | | |
| | | | | RC | -- | | 19 | 0 | |
| | | | | RC | -- | | 46 | 0 | |


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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Borehole Plunge: 58 degrees

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Inclined Borehole: INCL9*

Client: Public Works Government Services Canada

Project No: 3087

Location: Grand Bank, NL

Date: January 12-13, 2017

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 33 | | | | RC | -- | | 75 | 0 | |
| 34 | | | | | | | | | |
| 35 | | | | | | | | | |
| 36 | 11 | | | RC | -- | | 60 | 0 | |
| 37 | | Broken bedrock: volcanic tuff | | | | | | | |
| 38 | | | | | | | | | |
| 39 | | | | | | | | | |
| 40 | 12 | | | RC | -- | | 23 | 0 | |
| 41 | | | | | | | | | |
| 42 | | | -13 | | | | | | |
| 43 | 13 | | | RC | -- | | 100 | 0 | |
| 44 | | | | | | | | | |
| 45 | | | | RC | -- | | 100 | 11 | |
| 46 | 14 | Bedrock: volcanic tuff | | | | | | | |
| 47 | | | | | | | | | |
| 48 | | | | | | | | | |
| 49 | 15 | | | RC | -- | | 100 | 15 | |
| 50 | | | | | | | | | |
| 51 | | | -15.7 | | | | | | |
| 52 | 16 | End of Borehole | | | | | | | |
| 53 | | | | | | | | | |
| 54 | | | | | | | | | |
| 55 | | | | | | | | | |
| 56 | 17 | | | | | | | | |
| 57 | | | | | | | | | |
| 58 | | | | | | | | | |
| 59 | 18 | | | | | | | | |
| 60 | | | | | | | | | |
| 61 | | | | | | | | | |
| 62 | 19 | | | | | | | | |
| 63 | | | | | | | | | |
| 64 | | | | | | | | | |
| 65 | 20 | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Borehole Plunge: 58 degrees

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Inclined Borehole: INCL10*

Client: Public Works Government Services Canada

Project No: 3087

Location: Grand Bank, NL

Date: January 19, 2017

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft m | | Ground Surface | 0 | | | | | | |
| | | Concrete wharf deck | -0.356 | | | | | | |
| | | | -2.57 | | | | | | |
| | | Concrete | -3.45 | OB | -- | | 100 | | |
| | | Wood and cobble | -3.97 | OB | -- | | 49 | | |
| | | Broken bedrock: volcanic tuff | -4.45 | RC | -- | | 100 | | |
| | | Bedrock: volcanic tuff | -5.97 | RC | -- | | 100 | | |
| | | End of Borehole | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Borehole Plunge: 80 degrees

Datum: LNT

Sheet: 1 of 1

Project: Marine Geotechnical Investigation

# Log of Inclined Borehole: INCL11

Client: Public Works Government Services Canada

Project No: 3087

Location: Grand Bank, NL

Date: January 20, 2017

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft m | | Ground Surface | 0 | | | | | | |
| | | Concrete wharf deck | -0.356 | | | | | | |
| | | | -1.37 | | | | | | |
| | | Gravel and piece of wood | -2.01 | OB | -- | | 36 | | |
| | | Gravel and concrete | -2.76 | OB | -- | | 61 | | |
| | | Boulders | | OB | -- | | 63 | | |
| | | | | OB | -- | | 97 | | |
| | | | -4.72 | OB | -- | | 75 | | |
| | | Broken bedrock: volcanic tuff | -5.46 | RC | -- | | 88 | 0 | |
| | | End of Borehole | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Borehole Plunge: 46 degrees

Datum: LNT

Sheet: 1 of 1

# *APPENDIX B*

*Select Borehole Logs - May/June 2016 and August 2016 Investigations*

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH5*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 27 - 28, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Top of Wharf | 3.37 | | | | | | |
| 21 / 6.44 | | Harbour bottom (6.44 m below top of wharf). | -3.07 | | | | | | |
| | | Split spoon sank 0.58 m into soft sediment under own weight before SPT. | | | | | | | |
| 23 | | | -3.65 | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH5

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 27 - 28, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| 23 | | | | | | | | |
| 24 | | SPT: 4 / 6 / 5 / 15 for 0.19 m.<br>CFEM: Sand and Gravel, trace Silt/Clay. | | SS | 1 | 11 | 27 | |
| 25 | | | -4.3 | | | | | |
| 26 | | SPT: 4 / 9 / 52 for 0.13 m, bouncing (refusal).<br>Sand and gravel. | | SS | 2 | 61 | 18 | |
| 27 | 8 | | -4.73 | OB | -- | | 27 | |
| 28 | | Overburden: gravel and cobbles. | | | | | | |
| 29 | | | | OB | -- | | 60 | |
| 30 | 9 | | -5.81 | | | | | |
| 31 | | SPT: 15 / 13 / 5 / 5.<br>Gravel. | | SS | 3 | 18 | 10 | |
| 32 | | | -6.42 | | | | | |
| 33 | 10 | Broken bedrock: volcanic rock; tuff. | | RC | -- | | 45 | 0 |
| 34 | | | | RC | -- | | 43 | 0 |
| 35 | | | -7.32 | | | | | |
| 36 | 11 | SPT: 14 / 52 for 0.01 m, bouncing (refusal).<br>Rock in split spoon shoe. | -7.49 | SS | 4 | 52 | 15 | |
| 37 | | | | RC | -- | | 100 | 0 |
| 38 | | | | RC | -- | | 100 | 0 |
| 39 | 12 | | | RC | -- | | 100 | 0 |
| 40 | | | | | | | | |
| 41 | | Bedrock: volcanic rock; tuff. | | RC | -- | | 100 | 21 |
| 42 | | | | | | | | |
| 43 | 13 | | | RC | -- | | 100 | 41 |
| 44 | | | | | | | | |
| 45 | | | | | | | | |
| 46 | 14 | | -10.6 | | | | | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH10*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 30 - 31, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| ft / m | | Top of Wharf | 3.42 | | | | | | |
| | | Concrete wharf deck. | 3.07 | | | | | | |
| | | Harbour bottom (6.58 m below top of wharf). | -3.16 | | | | | | |
| | | Split spoon sank 0.38 m into soft sediment under own weight before SPT. | -3.53 | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH10*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 30 - 31, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | SUBSURFACE PROFILE | | SAMPLE | | | | |
| 23 | | | | | | | | |
| 24 | | SPT: 2 / 2 / 1 / 1 for 0.40 m (sank)<br>Sand, some gravel. | | SS | 1 | 3 | 13 | |
| 25 | | | -4.39 | | | | | |
| 26 – 8 | | No recovery. | | OB | -- | | 0 | |
| 27 | | | | | | | | |
| 28 | | | | | | | | |
| 29 | | | -5.63 | | | | | |
| 30 – 9 | | SPT: 5 / 12 / 8 / 9.<br>CFEM: Sand, some Gravel, trace Silt/Clay. | | SS | 2 | 20 | 25 | |
| 31 | | | -6.24 | | | | | |
| 32 | | No recovery. | | OB | -- | | 0 | |
| 33 – 10 | | | | | | | | |
| 34 | | | -7.14 | | | | | |
| 35 | | SPT: 8 / 14 / 13 / 12.<br>Sand and gravel. | | SS | 3 | 27 | 2 | |
| 36 – 11 | | | -7.75 | | | | | |
| 37 | | Overburden: gravel. | | OB | -- | | 14 | |
| 38 | | | | | | | | |
| 39 – 12 | | | -8.77 | | | | | |
| 40 | | SPT: 7 / 5 / 7 / 5.<br>No sample recovery. | | SS | 4 | 12 | 0 | |
| 41 | | | -9.38 | | | | | |
| 42 | | Overburden: gravel. | | OB | -- | | 17 | |
| 43 – 13 | | | -10.2 | | | | | |
| 44 | | | | | | | | |
| 45 | | SPT: 11 / 8 / 8 / 8.<br>Gravel, some sand. | | | | | 12 | |
| 46 – 14 | | | | | | | | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH10

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 30 - 31, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | | -10.8 | SS | 5 | 16 | 12 | |
| | | Overburden: gravel. | -11.8 | OB | -- | | 25 | |
| | | SPT: 9 / 52 for 0.05 m, bouncing (refusal). CFEM: Sandy Gravel, trace Silt/Clay. | -12.1 | SS | 6 | 52 | 24 | |
| | | Overburden: gravel. | -12.5 | OB | -- | | 36 | |
| | | | | OB | -- | | 40 | |
| | | Broken bedrock: volcanic rock; flow. | | OB | -- | | 17 | |
| | | | | OB | -- | | 9 | |
| | | SS7: "N" Value = 52; Recovery = 0%. SPT: 52 for 0.03 m, bouncing (refusal). No sample recovery. | -14.9 | SS | 7 | 52 | 0 | |
| | | | | RC | -- | | 86 | 15 |
| | | | | RC | -- | | 100 | 0 |
| | | Bedrock: volcanic rock; flow. | | RC | -- | | 100 | 0 |
| | | | | | | | 100 | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH10*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 30 - 31, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| | | | -17.8 | RC | -- | | 100 | 0 | |
| | | End of Borehole | | | | | | | |

69 70 71 72 22 73 74 75 23 76 77 78 79 24 80 81 82 25 83 84 85 26 86 87 88 27 89 90 91 92 28

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH23

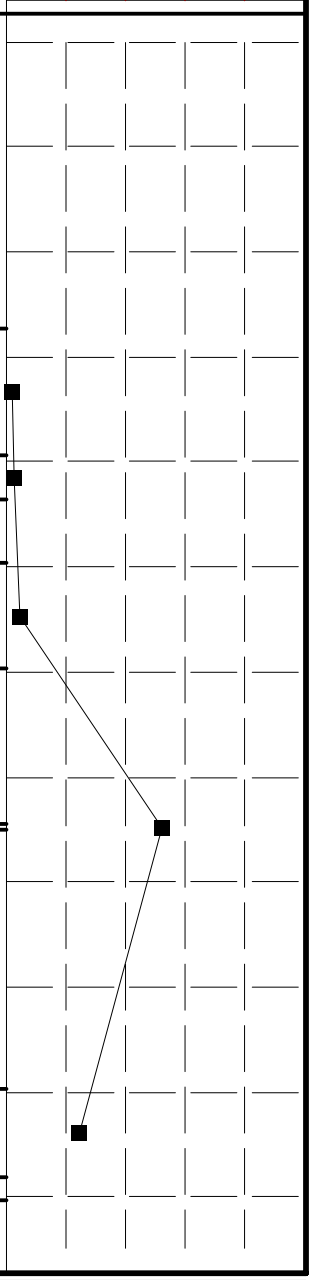
Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 9, 2016

| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| 0 / 0 | | Top of Wharf | 3.39 | | | | | |
| | | Concrete wharf deck. | 3.13 | | | | | |
| 5 / 1.72 | | Harbour bottom (1.67 m below top of wharf). | 1.72 | | | | | |
| 7 / 2 | | SPT: 1 / 1 / 1 / 1 for 0.28 m (sank). No sample recovery. Split spoon SS1 overlapped with split spoon SS2 for 0.41 m. | 0.979 | SS | 1 | 2 | 0 | |
| 8 | | SPT: 1 / 1 / 2 / 1 for 0.20 m (sank). No sample recovery. | 0.725 | SS | 2 | 3 | 0 | |
| 9 / 3 | | | 0.357 | OB | -- | | 0 | |
| 11 | | SPT: 2 / 2 / 3 / 2. Gravel. | -0.253 | SS | 3 | 5 | 12 | |
| 13 / 4 | | Overburden: gravel and cobbles. | -1.15 | OB | -- | | 44 | |
| 15 | | SS4: "N" Value = 52; Recovery = 0%. SPT: 52 for 0.04 m, bouncing (refusal). No sample recovery. | | SS | 4 | 52 | 0 | |
| 17 / 5 | | Overburden: gravel and cobbles. | -2.69 | OB | -- | | 4 | |
| 20 / 6 | | SPT: 8 / 10 / 15 / 52 for 0.06 m, bouncing (refusal). CFEM: Sandy Gravel, trace Silt/Clay. | -3.21 | SS | 5 | 25 | 20 | |
| 22 | | Overburden: gravel. | | RC | -- | | 81 | 0 |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH23*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 9, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 8 | | Bedrock: volcanic rock; tuff. | | RC | -- | | 100 | 69 | |
| | | | | RC | -- | | 100 | 45 | |
| 9 | | | | RC | -- | | 100 | 84 | |
| | | | | RC | -- | | 90 | 57 | |
| 10 | | | -6.79 | | | | | | |
| | | End of Borehole | | | | | | | |
| 11 | | | | | | | | | |
| 12 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH24

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 10 - 11, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Top of Wharf | 3.47 | | | | | | |
| | | Concrete wharf deck. | 3.22 | | | | | | |
| 2 / 1 | | Harbour bottom (2.46 m below top of wharf). | 1.36 | SS | 1 | 52 | 0 | | |
| | | SS1: "N" Value = 52; Recovery =0%.<br>SPT: 52 for 0.0 m, bouncing (refusal).<br>No sample recovery. | | OB | -- | | 67 | | |
| | | Overburden: boulder. | 0.467 | | | | | | |
| 3 | | SPT: 7 / 11 / 12 / 12.<br>Rock in split spoon shoe. | -0.155 | SS | 2 | 23 | 4 | | |
| 4 | | Overburden: gravel and cobbles. | -0.98 | OB | -- | | 18 | | |
| 5 | | SPT: 7 / 4 / 7 / 4.<br>Sand and gravel. | -1.59 | SS | 3 | 11 | 12 | | |
| | | Overburden: gravel and cobbles. | -2.54 | OB | -- | | 18 | | |
| 6 | | SPT: 6 / 10 / 12 / 13.<br>CFEM: Sandy Gravel, trace Silt/Clay. | -3.18 | SS | 4 | 22 | 18 | | |
| 23 | | Overburden: gravel and cobbles. | | | | | 26 | | |

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH24

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 10 - 11, 2016

| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | | -3.8 | OB | -- | | 26 | |
| | | SPT: 3 / 3 / 1 / 1.<br>Sand. | -4.41 | SS | 5 | 4 | 8 | |
| 8 | | Overburden: gravel. | -4.8 | OB | -- | | 18 | |
| | | SPT: 2 / 8 / 19 / 23.<br>CFEM: Sand, trace Silt/Clay, trace Gravel. | -5.41 | SS | 6 | 27 | 44 | |
| 9 | | Overburden: gravel. | -7.15 | OB | -- | | 15 | |
| | | SPT: 5 / 1 / 52 for 0.04 m, bouncing (refusal).<br>No sample recovery. | -7.49 | SS | 7 | 53 | 0 | |
| 11 | | Overburden: cobbles and gravel. | | OB | -- | | 47 | |
| 12 | | | | | | | | |
| 13 | | | -10.3 | OB | -- | | 19 | |
| 14 | | SPT: 8 / 7 / 8 / 11.<br>Rock in split spoon shoe, trace sand. | | | | | 4 | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH24

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: May 10 - 11, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth below Top of Wharf | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| | | | -10.9 | SS | 8 | 15 | 4 | | |
| | | Overburden: gravel. | | OB | -- | | 16 | | |
| | | | -11.7 | | | | | | |
| | | End of Borehole | | | | | | | |


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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH39*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: August 22-23, 2016

| Depth below Ground Surface (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| 0 / 0 | | Ground Surface | 3.42 | | | | | |
| | | Concrete deck. | 3.07 | | | | | |
| | | Harbour bottom (0.70 m LNT). | 0.699 | | | | | |
| 10 / 3 | | SPT: 8 / 8 / 8 / 12 for 0.20 m.<br>Gravel. | 0.038 | SS | 1 | 16 | 15 | |
| 13 / 4 | | Gravel and cobbles. | -1.12 | OB | -- | | 67 | |
| 16 / 5 | | SPT: 17 / 9 / 4 / 6.<br>Fine sand. | -1.73 | SS | 2 | 13 | 10 | |
| 18 / 6 | | Wood fragments and gravel. | -2.66 | OB | -- | | 40 | |
| 23 / 7 | | Broken rock. | -4.19 | OB | -- | | 11 | 0 |
| 26 | | SPT: 7 / 6 / 6 / 9.<br>CFEM: Sandy Gravel, trace Silt/Clay. | | | | | 10 | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH39*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: August 22-23, 2016

| Depth below Ground Surface | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | | -4.8 | SS | 3 | 12 | 10 | |
| 9 | | Broken rock. | -5.71 | OB | -- | | 28 | 0 |
| | | SPT: 20 / 52 for 0.08 m, bouncing (refusal). | -5.94 | SS | 4 | 52 | 0 | |
| | | CFEM: Gravel and Sand, trace Silt/Clay. | | | | | | |
| 10 | | Broken bedrock: volcanic flow. | -7.1 | OB | -- | | 53 | 0 |
| | | End of Borehole | | | | | | |

SUBSURFACE PROFILE

SAMPLE

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

11 12 13 14 15

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: BH40*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: August 21-22, 2016

| Depth below Ground Surface (ft / m) | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| 0 / 0 | | Ground Surface | 3.46 | | | | | |
| | | Concrete deck. | 3.11 | | | | | |
| | | Harbour bottom (0.90 m LNT). | 0.897 | | | | | |
| | | SPT: 3 / 1 / 52 for 0.04 m, bouncing (refusal). Concrete. | 0.554 | SS | 1 | 53 | 19 | |
| | | Gravel and cobbles. | -1.12 | OB | -- | | 64 | |
| | | SPT: 10 / 11 / 14 / 11. Medium sand. | -1.73 | SS | 2 | 25 | 15 | |
| | | Gravel and cobbles. | | OB | -- | | 25 | |
| | | | | OB | -- | | 23 | |
| | | | -4.17 | | | | | |
| 26 / 8 | | SPT: 12 / 10 / 6 / 3. CFEM: Gravelly Sand, trace Silt/Clay. | | | | | 15 | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# Log of Borehole: BH40

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: August 21-22, 2016

| Depth below Ground Surface | Symbol | Geologic Description | Elevation (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) |
|---|---|---|---|---|---|---|---|---|
| | | | -4.78 | SS | 3 | 16 | 15 | |
| | | Gravel. | -5.09 | OB | -- | | 62 | |
| | | Split spoon conducted in up-coning sand. SPT: 20 / 33 / 52 for 0.05 m, bouncing (refusal). CFEM: Sand, trace Silt/Clay. | -5.44 | SS | 4 | 85 | 43 | |
| | | No recovery. | -7.24 | OB | -- | | 0 | |
| | | SPT: 32 / 21 / 9 / 4. CFEM: Sandy Gravel, trace Silt/Clay. | -7.85 | SS | 5 | 30 | 13 | |
| | | Broken bedrock: volcanic flow. | | OB | -- | | 39 | 0 |
| | | SPT: 52 for 0.03 m, bouncing (refusal). No sample recovery. | | | | | | |
| | | End of Borehole | | | | | | |

Standard Penetration Test "N" Value per 300 mm

20 40 60 80

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Marine Geotechnical Investigation

# *Log of Borehole: INCL3*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: August 18-19, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length (ft / m) | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 0 / 0 | | Ground Surface | | | | | | | |
| | | Concrete deck. | | | | | | | |
| 3 / 1 | | Gravel and cobbles. | | OB | -- | | 25 | | |
| 10 / 3 | | Gravel. | | OB | -- | | 39 | | |
| | | Gravel. | | OB | -- | | 51 | | |
| 13 / 4 | | Gravel and cobbles over bedrock. | | OB | -- | | 75 | 50 | |
| 16 / 5 | | Broken bedrock: volcanic tuff. | | RC | -- | | 83 | 0 | |
| 19 / 6 | | Bedrock: volcanic tuff. | | RC | -- | | 100 | 46 | |
| 22 | | | | RC | -- | | 100 | 77 | |
| 23 / 7 | | | | RC | -- | | 100 | 67 | |
| 26 | | | | | | | | | |

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL A1A 5A1
Phone: (709) 739-7270
Fax: (709) 753-5101

Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: Ground Surface

Project: Marine Geotechnical Investigation

# *Log of Borehole: INCL3*

Client: PWGSC

Project No: 3087

Location: Grand Bank, NL

Date: August 18-19, 2016

| SUBSURFACE PROFILE | | | | SAMPLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Symbol | Geologic Description | Length (m) | Sample Type | Sample No. | "N" Value | Recovery (%) | RQD (%) | Standard Penetration Test "N" Value per 300 mm (20 40 60 80) |
| 27 | | | | RC | -- | | 100 | 15 | |
| 28 | | | | | | | | | |
| 29 | | | | | | | | | |
| 9 | | | | | | | | | |
| 30 | | | | RC | -- | | 100 | 47 | |
| 31 | | | | | | | | | |
| 32 | | End of Borehole | | | | | | | |
| 33 | | | | | | | | | |
| 10 | | | | | | | | | |
| 34 | | | | | | | | | |
| 35 | | | | | | | | | |
| 36 | | | | | | | | | |
| 11 | | | | | | | | | |
| 37 | | | | | | | | | |
| 38 | | | | | | | | | |
| 39 | | | | | | | | | |
| 12 | | | | | | | | | |
| 40 | | | | | | | | | |
| 41 | | | | | | | | | |
| 42 | | | | | | | | | |
| 13 | | | | | | | | | |
| 43 | | | | | | | | | |
| 44 | | | | | | | | | |
| 45 | | | | | | | | | |
| 14 | | | | | | | | | |
| 46 | | | | | | | | | |
| 47 | | | | | | | | | |
| 48 | | | | | | | | | |
| 49 | | | | | | | | | |
| 15 | | | | | | | | | |
| 50 | | | | | | | | | |
| 51 | | | | | | | | | |
| 52 | | | | | | | | | |

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