APPENDIX G -

REPORT AND GEOTECHNICAL MEMO

GEOTECHNICAL REPORT
LOT 16, GRAND BAY WEST ROAD
PORT AUX BASQUES, NL

(FFC File: 3098-02)

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PROVINCE OF NEWFOUNDLAND
PERMIT HOLDER
CLASS "A"
This Permit Allows
FRACFLOW CONSULTANTS INC.
To practice Professional Engineering
in Newfoundland and Labrador.
Permit No. as issued by APEGN D0169
which is valid for the year 2016.

December 2016

REGISTERED PROFESSIONAL ENGINEER
JOHN E. GALE
SIGNATURE
Dec 31, 2016
DATE
PROVINCE OF NEWFOUNDLAND

Executive Summary

Public Works and Government Services Canada (PWGSC) retained Fracflow Consultants Inc. to undertake a geotechnical site investigation on Lot 16, Grand Bay West Road, Port aux Basques, 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, and as outlined in the cost estimate.

Lot 16 is located down-gradient of existing buildings and the overall site is a gently sloping bog covered area. The down gradient edge of the property is bordered by scrub trees and the ground then slopes down approximately 6 to 8 m to a surface water body. A 10 to 12 m wide band at the front of the property, parallel to the paved road and also around the Town-owned water/wastewater service structure, has been covered by fill. The location that has been proposed for the MCTS building is undisturbed moss covered and water saturated bog.

The proposed scope of work for the Lot 16 project consisted of drilling or excavating and sampling at six (6) proposed locations. Due to the need to minimize damage to the site, five (5) test pits were excavated to approximately 3.0 to 3.5 m of depth or until the upper silty/clay layer had been penetrated, using a large mini-excavator on rubber tracks. This mini-excavator was supported by the upper bog layer and did not break through the organic layers to the underlying granular material. A larger excavator would have caused significant disturbance of the bog area. A borehole was drilled out on the bog area of the property using plywood sheets to support the drill rig. Geogrid, while available on site, was not required to ensure movement of the drill rig across the bog surface. This borehole was drilled to 7.57 m below ground surface with SPTs completed at every 0.75 m to provide both overburden samples and to provide bearing capacity data for comparison with the test pit logs. The proposed scope of work also included two (2) percolation tests. However, while the water table was below the bottom of the test pits, the surface water in the upper bog layer continued to drain into and pool in the test pits making it impossible to complete a percolation test. Grain size data were obtained for the different

overburden layers to provided the permeability data with which to assess the suitability of the site for construction of a septic tank system and drain field.

The field work was conducted between November 23 and 25, 2016. Samples were collected from the exposed walls of the test pits by hand and from the excavator bucket when the pits exceeded 1.4 m of depth. Borehole drilling was conducted using a Foremost Mobile B-47 geotechnical drill rig, with split-spoon sampling and Standard Penetration Tests (SPTs) using an NW/NQ diamond drill string. Split-spoon sampling was conducted in the boreholes at 0.76 m (2.5 feet) intervals - two (2) split spoons in each 1.5 m interval. A visual inspection of the subsurface soil conditions encountered, based on the split-spoon and test pit samples that were recovered during the field program, was used to describe the soil conditions at the site. The final depths of the test pits were approximately 3 m. The borehole was extended to 7.57 m below ground surface. Bedrock was not encountered in any of the test pit locations or in the borehole.

Overburden Characteristics from Test Pits

The overburden encountered at the majority of test pit locations consisted of a layer of root mat and decayed organic material ranging in thickness from 0.7 m to 1.0 m over a layer of silty sand with some clay or sand and silt with vary amounts of gravel and some rounded cobbles and boulders to depth. The samples collected from the silty sand/ silty clay layer were generally classified by CFEM as “Silty Sand, trace Gravel, trace Clay”, “Sand and Silt, some Gravel, trace Clay”, “Silty Gravelly Sand, trace Clay”, or “Silty/Clayey Sand, some Gravel”. Water levels were measured in the stand pipes installed in four (4) of the test pits (TP1, TP2, TP4, and TP5) and BH1 at depths ranging from 0.30 m to 2.76 m below ground surface. The top layer of organic material in each test pit was saturated, and the perched water at the surface drained into the test pits during excavation. The measured water levels in the stand pipes were impacted by the surface water seeping down through the disturbed overburden that was used to back-fill the test pits and the actual water table is deeper than the measured water levels.

Overburden Characteristics from Geotechnical Borehole.

The overburden encountered in borehole BH1 consisted of sand and gravel with small amounts of silt/clay from ground surface to 2.5 m below ground surface, overlying a thick layer of sand and silt/clay with varying amounts of gravel from 2.5 m below ground surface to final borehole depth (7.57 m below ground surface). Samples from the sand and silt/clay layer were generally classified by CFEM as "Silty/Clayey Sand, some Gravel", "Sand and Silt/Clay, some Gravel", and "Gravelly Sand and Silt/Clay". The water level in a standpipe, that was completed in this borehole, was 1.84 m below the ground surface on November 25, 2016, but this water level is assumed to have been impacted by the surface water that was pooled at the surface.

The N-Values from the SPT tests ranged from 1 over the first 0.6 m of depth, increasing to 3 between 1.0 and 1.5 m of depth and then increasing to 10 between 1.9 and 2.5 m of depth and greater than 39 from 2.7 m to the bottom of the borehole. Bearing capacities are estimated from the N-Values to be <50 kPa for the first 1.5 m of depth, then increasing to approximately 100 kPa between 1.9 and 2.5 m of depth and then increasing from 200 kPa to more than 300 kPa between 2.7 m and the bottom of the hole as shown by the N-Values in the borehole log.

Most of the overburden samples lack sufficient cohesion for completion of Atterberg Limit tests. The one sample, from the upper silty/clay layer for which the Atterberg Limit test could be completed gave a Liquid Limit of 14.6% and a Plastic Limit of 13.6% which gives a Plasticity Index of 1.0. This does not allow one to use the Atterberg Limits to classify the soil sample but does indicate that the sample has a high silt content.

General Overburden Characteristics and Properties

The proposed building site is covered by a layer of moss and vegetation that is water saturated and is approximately 0.5 m or greater in thickness. The moss layer is underlain by a compacted organic/peat layer which in turn is underlain by a grey, silty/clay layer that varies in thickness from 0.5 to 1.5 m thick. This upper layer is partially saturated or saturated and when disturbed has a very low angle of repose and flows. However, the test pits are stable over a period of minutes to hours but do tend to cave and collapse as the perched water comes into contact with the test pit walls as the water drains into the test pits. Large boulders are present at the base of the organic layer and in the upper granular layer. Below this grey silt/clay layer, a well graded brown granular layer continues to depth with minor changes in colour. This layer, while damp, is essentially unsaturated. The water table is considered to be deeper than 3.5 m over most of the property. However, the overall permeability of this layer is low since the surface water from the upper moss/bog layer drained into each test pit and pooled, making it impossible to conduct percolation tests as planned.

To assess the feasability of constructing an on-site septic system, hydraulic conductivities were calculated from the grain size distribution data of eight (8) samples using the Hazen method. Calculated hydraulic conductivities ranged from $<5.1\times10^{-8}$ m/s to $<1.3\times10^{-6}$ m/s. Due to the high percentage of fines in the overburden samples, the calculated hydraulic conductivity values are considered to be higher than the actual in-situ hydraulic conductivities.

The up-gradient buildings/properties have been placed on fill, which appear to have been placed directly on the bog surface. Surface water has pooled around the down-gradient edge of the fill on which these properties have been placed which adds to the surface water in the moss/bog layer over Lot 16. Stand pipes were installed in four (4) of the test pits and in the borehole. However, it is concluded that the water levels in the test pit stand pipes represent perched water table conditions. In addition, it is expected that the water level in the borehole stand pipe was also impacted by surface water or drill water. The stand pipes were left in place and measurement of the water levels in those stand pipes after the ground has frozen at depth will provide a more accurate measure of the depth to the water table below the perched water level.

Considerations for Site Development

If this site is developed for the MCTS building, the client should consider constructing three (3) subsurface drains from the down-gradient edge of the property up to the top up-gradient edge of the property at a depth of 3.0 to 4.0 m below the bog surface, or below the silty/clay layer to divert the surface water and to under-drain the site. These three (3) sub-surface drains should be completed using perforated pipe and filter fabric surrounded by crushed stone that extends to the surface. These three (3) sub-surface drains should be connected across the top or up-gradient edge of the property using a trench/drain that extends along the full top edge of the property. The steep drop to the surface water at the down-gradient side of the property and the extent of the drains will ensure the necessary drainage. Connections to those drains for the surface water on the up-gradient side of the property will ensure overall drainage.

If a septic system is constructed on this site, then the drain field has to be connected using large vertical drains to the granular sections below the grey silty/clay layer or at a depth of approximately 2 to 3 m. This connection can be provided by constructing several crushed stone filled test pits or a trench section to depth at the end of the septic drain field.

Site preparation for Lot 16 is expected to follow the same procedures that were used to prepare the building sites for the up-gradient properties. Removal of the highly compressible moss/bog layer would expose the silty/clay layer and working the site with heavy equipment would cause the silty/clay layer in the presence of water to lose cohesion and mobilize. Removal of both the organic layer and the upper grey silty/clay layer would require excessive excavation costs. One approach is to place a layer of Geotextile on top of the moss/bog and then place two (2) layers of Geogrid, with a 25 to 30 cm grid, on top of the Geotextile. Fill would then be placed on the Geogrid and compacted, or allowed to compact/settle, to the thickness required to support a slab-on-grade foundation with appropriate frost protection and under-drains. The bearing capacity of the overburden will support spread footings that are placed to 1.2 to 1.5 m of depth below the bottom of the organic layer or 2.5 m below ground surface with surface water control during construction. Bearing capacities increase with depth.

The second option, which is the recommended approach, is to first construct the site drains to divert the surface water and then advance the site preparation by excavating and removing the bog and organic layer in 5 to 10 m wide strips, followed by placement of fill to support the excavator as it is advanced. Given the low N-Values in the upper layers, it is recommended that a layer of Geotextile and a layer of Geogrid be placed on top of the exposed silty/clay granular layer before the fill is placed, especially since the upper part of the granular layer will be saturated and will flow when disturbed.

Summary

1. The ultimate and serviceable bearing capacities (>50 kPa) of the overburden increase with depth and are adequate to support spread footings at approximately 2.0 m below ground surface or approximately 1.2 m below the bottom of the organic layer.
2. There is a perched water table over the entire site formed by pooled surface runoff water from the up-gradient properties along the up-gradient edge of the property plus rainfall.
3. The actual water table is more than 2 m below ground surface and is expected to extend to more than 3 m of depth over much of the property. Water table conditions should be confirmed by measuring water levels in the stand pipes after the ground has frozen to depth and isolates the perched water table. Frost is expected to extend to a maximum of 1.2 m of depth in this location.
4. The large drop in elevation of 6 to 8 m at the down gradient edge of the property can be used to ensure site drainage by the construction of a well designed and properly constructed set of deep sub-horizontal drains.
5. A septic drain field can be constructed on this site as long as the drain field is connected by large vertical drains to the granular layers below the grey silty/clay layer that appears to extend across the entire site.
6. Design of a slab-on-grade foundation must take into account the highly compressible nature of the moss and decayed organic matter above the first granular layer if this layer is not removed.
7. Removal of the organic layer will require surface water control during construction since the upper granular layer tends to mobilize when disturbed in the presence of water. The cohesion for this upper soil layer is essentially zero when disturbed in the presence of water. The coefficients of lateral at rest, active and passive soil pressures for the upper

grey soil layer are a function of water content. For the worst case condition, where the soil is disturbed in the presence of water, the coefficients are equal to the unit weight times the depth.

8. The granular or coarse grained layer, below the grey silty/clay layer, has low to no cohesion with an estimated angle of internal friction, based on the test pit walls, of approximately 33 degrees.
9. The unit weight or density of the surface moss/peat/organic layer is estimated to range from 400 kg per cubic metre when dry to 800 and 1,200 kg per cubic metre when wet. The estimated soil density or unit weights, based on the published correlations between SPT values and unit weights varies from 1,100 to 1,600 kg per cubic metre near the surface (the second borehole split spoon) to between 1,760 and 2,080 kg per cubic metre at 1.5 m of depth and greater than 2,200 kg per cubic metre at depths greater than 2.0 m.

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1.0 INTRODUCTION

Public Works and Government Services Canada (PWGSC) retained Fracflow Consultants Inc. to undertake a geotechnical site investigation at Lot 16, Grand Bay West Road, Port aux Basques, 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 Lot 16 project consisted of drilling or excavating and sampling at six (6) proposed locations. Due to the need to minimize damage to the site, five (5) test pits were excavated to approximately 3.0 to 3.5 m of depth or until the upper silty/clay layer had been penetrated, using a large mini-excavator on rubber tracks. This mini-excavator was supported by the upper bog layer and did not break through the organic layers to the underlying granular material. A larger excavator would have caused significant disturbance of the bog area. A borehole was drilled out on the bog area of the property using plywood sheets to support the drill rig. Geogrid, while available on site, was not required to ensure movement of the drill rig across the bog surface. This borehole was drilled to 7.57 m below ground surface with SPTs completed at every 0.75 m to provide both overburden samples and to provide bearing capacity data for comparison with the test pit logs. The proposed scope of work also included two (2) percolation tests. However, while the water table was below the bottom of the test pits, the surface water in the upper bog layer continued to drain into and pool in the test pits making it impossible to complete a percolation test. Grain size data were obtained for the different overburden layers to provided the permeability data with which to assess the suitable of the site for construction of a septic tank system and drain field.

The field work was conducted between November 23 and 25, 2016. Samples were collected from the exposed walls of the test pits by hand and from the excavator bucket when the pits exceeded 1.4 m of depth. Borehole drilling was conducted using a Foremost Mobile B-47 geotechnical drill rig, with split-spoon sampling and Standard Penetration Tests (SPTs) using an

NW/NQ diamond drill string. Split-spoon sampling was conducted in the boreholes at 0.76 m (2.5 feet) intervals - two (2) split spoons in each 1.5 m interval. A visual inspection of the subsurface soil conditions encountered, based on the split-spoon and test pit samples that were recovered during the field program, was used to describe the soil conditions at the site. The final depths of the test pits were approximately 3 m. The borehole was extended to 7.57 m below ground surface. Bedrock was not encountered in any of the test pit locations or in the borehole. A summary of the field work that was conducted is provided in **Table 1.1** and **Table 1.2**.

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; and (3) a detailed description of the subsurface soil conditions. Appended to this report are the detailed geotechnical logs for each borehole, test pit logs, and the grain size analysis reports.

Table 1.1 Summary of borehole investigations at Lot 16, Grand Bay West Road, Port aux Basques, NL.

Borehole ID	Overburden Drilled (m)	Bedrock Drilled (m)	Total Depth Drilled (m)	SPT & Split-spoon Samples Attempted	Split-spoon Samples Tested
BH1	7.57	0.00	7.57	10	6
Total	7.57	0.00	7.57	10	6

Table 1.2 Summary of test pit investigations at Lot 16, Grand Bay West Road, Port aux Basques, NL.

Test Pit ID	Overburden Excavated (m)	Refusal Condition	Samples Collected	Samples Tested
TP1	3.50	No refusal.	2	2
TP2	2.90	No refusal.	1	1
TP3	3.50	No refusal.	1	1
TP4	3.20	No refusal.	3	3
TP5	3.00	No refusal.	2	2
Total	16.10	--	9	9

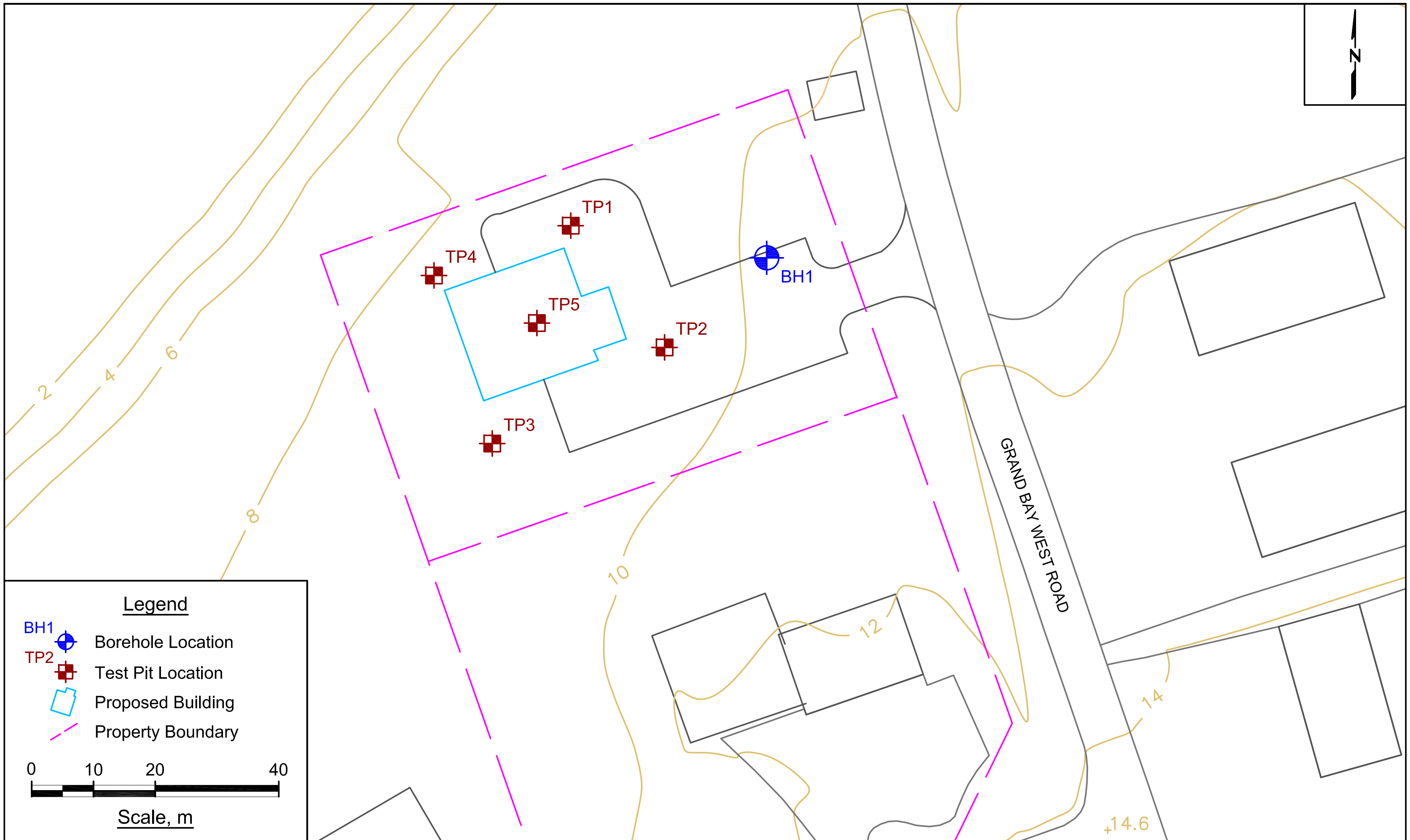

Figure 1.1 Site location map with borehole and test pit locations, Lot 16, Grand Bay West Road, Port aux Basques, NL.	Project No. 3098-02	Scale As Shown	FFC
	Location Port aux Basques, NL	Date December 2016	

2.0 SITE DESCRIPTION AND GENERAL GEOLOGY

The town of Port aux Basques is located on the south-western tip of the island of Newfoundland. The overburden in the area of Port aux Basques is classified as “Till deposits variably comprised of unsorted silty sand, clayey silt, gravel and boulders occurring as till plains, ridged morainal and eroded, dissected terrain” (Water Resources Division, 1986). Bedrock in the Lot 16 area is characterized by the Kelby Cove orthogneiss of the Gander Zone: “gneissic granitoid rock varying from hornblende- and biotite-bearing tonalite to biotite- and/or muscovite-bearing granite” (van Staal, 1996).

3.0 INVESTIGATIVE PROCEDURES

At the Lot 16 site, the project consisted of drilling and sampling one (1) borehole and excavating and sampling five (5) test pits. The borehole/test pit locations were located and marked in the field using a Topcon GRS-1 GPS unit.

At the borehole location, overburden material was drilled using an 'NW' (OD 88.9 mm, ID 76.2 mm) flush joint casing. 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 SPT and the 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 (CGS, 1992). Rock was drilled using a 'NQ' (OD 69.9 mm, ID 60.3 mm) diamond drill string, cored to approximately 1 m to 2 m depth. Standpipes were installed in both boreholes to measure water levels.

At the test pit locations, overburden material was excavated using a mini excavator. Soil samples were collected from the undisturbed side walls of the excavation by hand. Where the depth of excavation exceeded the safe entry depth, samples were collected from the excavator bucket. The test pits were logged and scaled photos of the test pits taken. Standpipes were installed, and the test pits were then backfilled and restored to original condition.

Both the soil samples and rock cores are logged and labelled in the field immediately after collection. Soil samples are stored in moisture proof containers and rock cores are stored in wooden core boxes in the field. All soil and rock samples are returned to Fracflow's office where any soil samples collected during the investigation are tested. Soil testing in the laboratory consists of standard mechanical sieve analyses, hydrometer tests and water content determinations that are performed according to ASTM standards as required. If clays are encountered and recovered, additional tests are performed to characterize the clay material. 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 borehole and five (5) test pits. A description of the soil profile is provided below using both terminologies defined in the Unified Soil Classification System (USCS) and in the Canadian Foundation Engineering Manual (CGS, 1992). Detailed logs of the geological conditions at each borehole and test pit location are provided in **Appendix A**. **Appendix B** contains the grain size analysis information for each soil sample tested. Calculations of hydraulic conductivity from grain size data using the Hazen method are shown in **Table 4.1**.

4.1 Overburden Description and Water Table Conditions

The overburden encountered in borehole BH1 consisted of a surface layer of moss and peat/organic material, underlain by sand and gravel with small amounts of silt/clay from ground surface to 2.5 m below ground surface, overlying a thick layer of sand and silt/clay with varying amounts of gravel from 2.5 m below ground surface to final borehole depth (7.55 m below ground surface). Samples from the sand and silt/clay layer were generally classified by CFEM as “Silty/Clayey Sand, some Gravel”, “Sand and Silt/Clay, some Gravel”, and “Gravelly Sand and Silt/Clay”.

The overburden encountered at the majority of test pit locations consisted of a layer of root mat and decayed organic material ranging in thickness from 0.7 m to 1.0 m over a layer of silty sand or sand and silt with vary amounts of gravel and some rounded cobbles and boulders to depth. The samples collected from the silty sand layer were generally classified by CFEM as “Silty Sand, trace Gravel, trace Clay”, “Sand and Silt, some Gravel, trace Clay”, “Silty Gravelly Sand, trace Clay”, or “Silty/Clayey Sand, some Gravel”.

N-Values from the SPT tests ranged from 1 over the first 0.6 m of depth in the organic layer, increasing to 3 between 1.0 and 1.5 m of depth in the first granular layer and then increasing to 10 between 1.9 and 2.5 m of depth and greater than 39 from 2.7 m to the bottom of the borehole. Bearing capacities are estimated from the N-Values to be <50 kPa for the first 1.5 m of depth, then increasing to approximately 100 kPa between 1.9 and 2.5 m of depth and then increasing from 200 kPa to more than 300 kPa between 2.7 m and the bottom of the hole as shown by the N-Values in the borehole log.

Most of the overburden samples lack sufficient cohesion for completion of Atterberg Limit tests. The one (1) sample, from the upper silty/clay layer for which the Atterberg Limit test could be completed gave a Liquid Limit of 14.6% and a Plastic Limit of 13.6% which gives a Plasticity Index of 1.0. This does not allow one to use Atterberg Limits to classify the soil sample but does indicate that the sample has a high silt content.

Water levels were measured in the standpipes installed in four (4) of the test pits (TP1, TP2, TP4, and TP5) and BH1 at depths ranging from 0.30 m to 2.76 m below ground surface. The top layer of organic material in each test pit was observed to be saturated, and a perched water table at surface was observed draining into the test pits during excavation.

Hydraulic conductivities were calculated from the grain size distribution data of eight (8) samples using the Hazen method, shown in **Table 4.1**. The Hazen method is applicable to sandy soils where d_{10} is between 0.1 mm and 3.0 mm. Due to the high amount of fines in the samples (d_{10} > 0.1 mm), calculated K values will be higher than the actual hydraulic conductivities. Calculated hydraulic conductivities ranged from $<5.1\times10^{-8}$ m/s to $<1.3\times10^{-6}$ m/s. Hydrometer analysis was not conducted on seven (7) of the samples, therefore d_{10} values were not available for those samples.

4.2 Bedrock Description

Bedrock was not encountered in the borehole or any of the test pits.

Table 4.1 Hydraulic conductivity calculation from the grain size distribution data using Hazen method.

Sample ID	*USCS Description*	*d 10*	*C (1)*	*K*		*C min*	*C max*	*K min*	*K max*
		cm	*--*	*cm/s*	*m/s*	*--*	*--*	*cm/s*	*cm/s*
L16-BH1-SS2	SM (Silty sand)	NA	d_{10} value not available.						
L16-BH1-SS3	SM (Silty sand with gravel)	NA	d_{10} value not available.						
L16-BH1-SS4	SM (Silty sand with gravel)	NA	d_{10} value not available.						
L16-BH1-SS5	SM (Silty sand with gravel)	NA	d_{10} value not available.						
L16-BH1-SS6	SM (Silty sand with gravel)	NA	d_{10} value not available.						
L16-BH1-SS7	SM (Silty sand)	NA	d_{10} value not available.						
*L16-TP1-2.1-1.1m**	SM (Silty sand)	0.00029	60	**5.05E-06**	**5.05E-08**	40	80	3.36E-06	6.73E-06
*L16-TP1-1.1-0.0m**	SM (Silty sand with gravel)	0.00115	60	**7.94E-05**	**7.94E-07**	40	80	5.29E-05	1.06E-04
*L16-TP2-1.5-0.0m**	SM (Silty sand)	0.001	60	**6.00E-05**	**6.00E-07**	40	80	4.00E-05	8.00E-05
*L16-TP3-2.0-0.0m**	SM (Silty sand)	0.00061	60	**2.23E-05**	**2.23E-07**	40	80	1.49E-05	2.98E-05
*L16-TP4-2.0-1.4m**	SM (Silty sand)	0.00087	60	**4.54E-05**	**4.54E-07**	40	80	3.03E-05	6.06E-05
*L16-TP4-1.4-0.5m**	SM (Silty sand with gravel)	0.00146	60	**1.28E-04**	**1.28E-06**	40	80	8.53E-05	1.71E-04
*L16-TP4-0.5-0.0m**	SM (Silty sand)	0.00092	60	**5.08E-05**	**5.08E-07**	40	80	3.39E-05	6.77E-05
*L16-TP5-0.7-0.8m**	SM (Silty sand)	0.00079	60	**3.74E-05**	**3.74E-07**	40	80	2.50E-05	4.99E-05
L16-TP5-0.8-0.0m	SM (Silty sand)	NA	d_{10} value not available.						

Notes: * Sample is fined grained (d_{10} < 0.10 mm). Actual hydraulic conductivity (K) will be less than calculated values.

(1) Table for coefficient C by Hazen (1911).

40 - 80 Very fine sand, poorly sorted
40 - 80 Fine sand with appreciable fines
80 - 120 Medium sand, well sorted
80 - 120 Coarse sand, poorly sorted
120 - 150 Coarse sand, well sorted, clean

5.0 GENERAL SITE CONDITIONS AND RECOMMENDATIONS

General Overburden Characteristics and Properties

The proposed building site is covered by a layer of moss and vegetation that is water saturated and is approximately 0.5 m to 1.0 m or greater in thickness. The moss layer is underlain by a compacted organic/peat layer which in turn is underlain by a grey, silty/clay layer that varies in thickness from 0.5 to 1.5 m thick. This upper granular layer is partially saturated or saturated and when disturbed has a very low angle of repose and flows. However, the test pits are stable over a period of minutes to hours but do tend to cave and collapse as the perched water comes into contact with the test pit walls as the water drains into the test pits. Large boulders are present at the base of the organic layer and in the upper granular layer. Below this grey silt/clay layer, a well-graded brown granular layer continues to depth with minor changes in colour. This layer, while moist, is essentially unsaturated. The water table is considered to be deeper than 3.5 m over most of the property. However, the overall permeability of this layer is low since the surface water from the upper moss/bog layer drained into each test pit and pooled, making it impossible to conduct percolation tests as planned.

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The up-gradient buildings/properties have been placed on fill, which appear to have been placed directly on the bog surface. Surface water has pooled around the down-gradient edge of the fill on which these properties have been placed which adds to the surface water in the moss/bog layer over Lot 16. Stand pipes were installed in four (4) of the test pits and in the borehole. However, it is concluded that the water levels in the test pit stand pipes represent perched water table conditions. In addition, it is expected that the water level in the borehole stand pipe was also impacted by surface water or drill water. The stand pipes were left in place and measurement of the water levels in those stand pipes after the ground has frozen at depth will provide a more accurate measure of the depth to the water table below the perched water level.

Considerations for Site Development

If this site is developed for the MCTS building, the client should consider constructing three (3) subsurface drains from the down-gradient edge of the property up to the top up-gradient edge of the property at a depth of 3.0 to 4.0 m below the bog surface, or below the silty/clay layer to divert the surface water and to under-drain the site. These three (3) sub-surface drains should be completed using perforated pipe and filter fabric surrounded by crushed stone that extends to the surface. These three (3) sub-surface drains should be connected across the top or up-gradient edge of the property using a trench/drain that extends along the full top edge of the property. The steep drop to the surface water at the down-gradient side of the property and the extent of the drains will ensure the necessary drainage. Connections to those drains for the surface water on the up-gradient side of the property will ensure overall drainage.

If a septic system is constructed on this site, then the drain field has to be connected using large vertical drains to the granular sections below the grey silty/clay layer or at a depth of approximately 2 to 3 m. This connection can be provided by constructing several crushed stone filled test pits or a trench section to depth at the end of the septic drain field.

Site preparation for Lot 16 is expected to follow the same procedures that were used to prepare the building sites for the up-gradient properties. Removal of the highly compressible moss/bog layer will expose the silty/clay layer and working the site with heavy equipment will cause the silty/clay layer in the presence of water to lose cohesion and mobilize. Removal of both the organic layer and the upper grey silty/clay layer would require excessive excavation costs. One approach is to place a layer of Geotextile on top of the moss/bog and then place two (2) layers of Geogrid, with a 25 to 30 cm grid, on top of the Geotextile. Fill would then be placed on the Geogrid and compacted, or allowed to compact/settle, to the thickness required to support a slab-on-grade foundation with appropriate frost protection and under-drains. The bearing capacity of the overburden will support spread footings that are placed to 1.2 to 1.5 m of depth below the bottom of the organic layer with surface water control during construction. Bearing capacities increase with depth.

The second option, which is the recommended approach, is to first construct the site drains to divert the surface water and then advance the site preparation by excavating and removing the bog and organic layer in 5 to 10 m wide strips, followed by placement of fill to support the excavator as it is advanced. Based on the low N-values near the surface, it is recommended that a layer of geotextile and a layer of geogrid be placed on top of the exposed silty/clay granular layer before the fill is placed, especially since the upper part of the granular layer will be saturated and will flow when disturbed.

Summary

1. The ultimate and serviceable bearing capacities (>50 kPa) of the overburden increase with depth and are adequate to support spread footings at approximately 2.0 m below ground surface or approximately 1.2 m below the bottom of the organic layer.
2. There is a perched water table over the entire site formed by pooled surface runoff water from the up-gradient properties along the up-gradient edge of the property plus rainfall.
3. The actual water table is more than 2 m below ground surface and is expected to extend to more than 3 m of depth over much of the property. Water table conditions should be confirmed by measuring water levels in the stand pipes after the ground has frozen to depth and isolates the perched water table. Frost is expected to extend to a maximum of 1.2 m of depth in this location.
4. The large drop in elevation of 6 to 8 m at the down-gradient edge of the property can be used to ensure site drainage by the construction of a well designed and properly constructed set of deep sub-horizontal drains.

5. A septic drain field can be constructed on this site as long as the drain field is connected by large vertical drains to the granular layers below the grey silty/clay layer that appears to extend across the entire site.
6. Design of a slab on grade foundation must take into account the highly compressible nature of the moss and decayed organic matter above the first granular layer if this layer is not removed.
7. Removal of the organic layer will require surface water control during construction since the upper granular layer tends to mobilize when disturbed in the presence of water. The cohesion for this upper soil layer is essentially zero when disturbed in the presence of water. The coefficients of lateral at rest, active and passive soil pressures for the upper grey soil layer are a function of water content. For the worst case condition, where the soil is disturbed in the presence of water, the coefficients are equal to the unit weight times the depth.
8. The granular or coarse grained layer, below the grey silty/clay layer, has low to no cohesion with an estimated angle of internal friction, based on the test pit walls, of approximately 33 degrees.
9. The unit weight or density of the surface moss/peat/organic layer is estimated to range from 400 kg per cubic metre when dry to 800 and 1,200 kg per cubic metre when wet. The estimated soil density or unit weights, based on the published correlations between SPT values and unit weights varies from 1,100 to 1,600 kg per cubic metre near the surface (the second borehole split spoon) to between 1,760 and 2,080 kg per cubic metre at 1.5 m of depth and greater than 2,200 kg per cubic metre at depths greater than 2.0 m.
10. Frost is estimated to extend to 1.3 to 1.5 m of depth if the organic layer is removed.

6.0 REFERENCES

Canadian Geotechnical Society (CGS, 1992), *Canadian Foundation Engineering Manual, 3rd Edition*, Technical Committee on Foundations, 512 p.

Hydrogeology of The St. George's Bay Area, 1986, *Water Resources Report 2-8, Groundwater Series*, Department of Environment, Water Resources Division.

van Staal, C.R., Hall, L., Schofield, D., and Valverde, P., 1996, *Geology, Port aux Basques, Newfoundland (part of NTS 11-O/11)*, Geological Survey of Canada, Open File 3165.

APPENDIX A

Borehole and Test Pit Logs

Log of Borehole: L16-BH1

Project: Geotechnical Investigation

Client: Public Works Government Service Canada

Project No: 3098-02

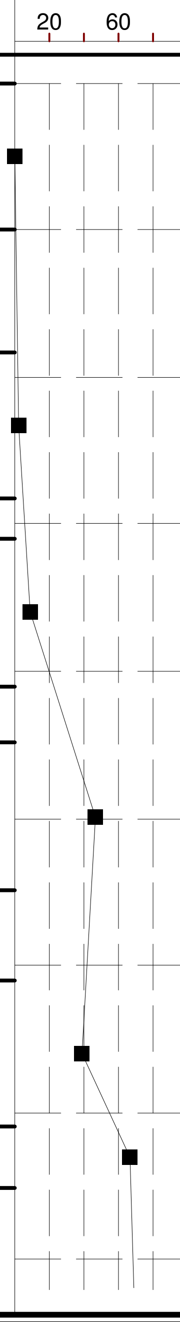
Location: Port aux Basques, NL

Date: November 25, 2016

Depth (m)	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	PID (ppm)
0	Ground Surface (GS)	10.7					
	SPT: 1 for 0.30 m / 1 / 3. Organic material with minor sand.	10.1	SS	1	1	4	
		9.6	OB	--			
	SPT: 2 / 2 / 1 / 1. CFEM: Sand and Silt/Clay, trace Gravel.	8.99	SS	2	3	17	
		8.82	OB	--			
	SPT: 4 / 3 / 7 / 13. CFEM: Gravelly Sand, some Silt/Clay.	8.22	SS	3	10	21	
		7.98	OB	--			
	SPT: 10 / 21 / 26 / 24. CFEM: Silty/Clayey Sand, some Gravel. Compact.	7.37	SS	4	47	38	
		7	OB	--			
	SPT: 12 / 16 / 23 / 33. CFEM: Sand and Silt/Clay, some Gravel. Compact.	6.39	SS	5	39	42	
	SPT: 16 / 15 for 0.10 m / 52 for 0.0 m, bouncing (refusal). CFEM: Gravelly Sand and Silt/Clay.	6.13	SS	6	67	90	

Depth scale: ft 0–16; m 0–5

Standard Penetration Test "N" Value per 300 mm



Well Data

Well Description

Standpipe installed

Water level 1.84 m below ground surface (Nov. 25, 2016)

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

Drilling Method: NW casing / NQ coring

Datum: Geodetic

Driller: Formation Drilling Ltd.

Sheet: 1 of 2

Log of Borehole: L16-BH1

Project: Geotechnical Investigation

Client: Public Works Government Service Canada

Location: Port aux Basques, NL

Project No: 3098-02

Date: November 25, 2016

SUBSURFACE PROFILE			SAMPLE							
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	PID (ppm)	Standard Penetration Test "N" Value per 300 mm (20, 60)	Well Data	Well Description
			5.41	OB	--						
		SPT: 32 / 20 for 0.05 m / 52 for 0.0 m, bouncing (refusal). CFEM: Sand and Silt/Clay, trace Gravel.	5.21	SS	7	72	100				
			4.85	OB	--						
6		SS8: "N" Value = 52; Recovery = 0%. SPT: 1 for 0.03 m / 52 for 0.0 m, bouncing (refusal). No sample recovery.		SS	8	52	0				
			3.99	OB	--						
7		SPT: 32 / 52 for 0.10 m / 52 for 0.0 m, bouncing (refusal). Grey-brown silt and gravel.	3.73	SS	9	52	80				
			3.28	OB	--						
8		SS10: "N" Value = 52; Recovery = 100%. SPT: 48 for 0.13 m / 52 for 0.0 m, bouncing (refusal). Grey silt/clay and gravel.	3.15	SS	10	52	100				
9		End of Borehole									

Depth scale (ft): 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32

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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical Investigation

Log of Test Pit: L16-TP1

Client: Public Works Government Services Canada

Project No: 3098-02

Location: Port aux Basques, NL

Date: November 24, 2016

SUBSURFACE PROFILE				SAMPLE			
Depth Below Surface (ft / m)	Symbol	Geologic Description	Elevation (m)	Soil Sample	Number	Notes/Sample Identification	Photos
ft 0 / m 0		Ground Surface	9.41				
0, 1, 2, 3		Saturated, root mat over black decayed organic material.	8.52			Water seeping into test pit from surface.	
3, 4, 5, 6 / 1		CFEM: Silty Sand, trace Gravel, trace Clay.	7.51	SS	1	Sample L16-TP1-2.1-1.1m collected.	
7, 8, 9 / 2		CFEM: Sand and Silt, some Gravel, trace Clay. Dry. Rounded boulders in test pit.	6.41	SS	2	Sample L16-TP1-1.1-0.0m collected. Water level 2.76 m below ground surface (Nov. 25, 2016).	
10, 11 / 3			5.91				
12		End of Test Pit					

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Excavation Method: Excavator

Datum: Geodetic

Sheet: 1 of 1

Log of Test Pit: L16-TP2

Project: Geotechnical Investigation

Client: Public Works Government Services Canada

Project No: 3098-02

Location: Port aux Basques, NL

Date: November 24, 2016

SUBSURFACE PROFILE				SAMPLE			
Depth Below Surface (ft / m)	Symbol	Geologic Description	Elevation (m)	Soil Sample	Number	Notes/Sample Identification	Photos
0 / 0		Ground Surface	10.1				
		Saturated, root mat.	9.82			Water level 0.30 m below ground surface (Nov. 25, 2016).	
		Saturated, black decayed organic material.	9.22				
		CFEM: Silty Sand, some Gravel, trace Clay. Rounded cobbles at base of test pit.	7.72	SS	1	Sample L16-TP2-1.5-0.0m collected.	
			7.22				
		End of Test Pit					

Depth scale: ft 0–12; m 0–3

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Excavation Method: Excavator

Datum: Geodetic

Sheet: 1 of 1

Log of Test Pit: L16-TP3

Project: Geotechnical Investigation

Client: Public Works Government Services Canada

Location: Port aux Basques, NL

Project No: 3098-02

Date: November 23, 2016

SUBSURFACE PROFILE				SAMPLE			
Depth Below Surface (ft / m)	Symbol	Geologic Description	Elevation (m)	Soil Sample	Number	Notes/Sample Identification	Photos
0 ft / 0 m		Ground Surface	9.61				
0–1 m		Saturated, root mat and decayed organic material. Large boulders.	8.61			Water seeping into test pit from surface. No water observed in standpipe.	
1–3 m		CFEM: Silty Sand, some Gravel, trace Clay. Saturated, compact.	6.61	SS	1	Sample L16-TP3-2.0-0.0m collected.	
3–3.5 m			6.11				
		End of Test Pit					

Depth scale: ft 0–12; m 0–3.

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Excavation Method: Excavator

Datum: Geodetic

Log of Test Pit: L16-TP4

Project: Geotechnical Investigation

Client: Public Works Government Services Canada

Project No: 3098-02

Location: Port aux Basques, NL

Date: November 24, 2016

SUBSURFACE PROFILE				SAMPLE			
Depth Below Surface	Symbol	Geologic Description	Elevation (m)	Soil Sample	Number	Notes/Sample Identification	Photos
ft 0 / m 0		Ground Surface	8.94				
		Saturated, root mat over black decayed organic material.	8.24			Water seeping into test pit from surface.	
		CFEM: Sand and Silt, trace Gravel, trace Clay.	7.64	SS	1	Sample L16-TP4-2.0-1.4m collected.	
		CFEM: Silty Gravelly Sand, trace Clay. Rounded cobbles in test pit.	6.74	SS	2	Sample L16-TP4-1.4-0.5m collected. Water level 1.85 m below ground surface (Nov. 25, 2016).	
		CFEM: Silty Sand, some Gravel, trace Clay. Rounded cobbles in test pit.	6.24	SS	3	Sample L16-TP4-0.5-0.0m collected.	
			5.74				
		End of Test Pit					

Depth scale: ft 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12; m 0, 1, 2, 3

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Excavation Method: Excavator

Datum: Geodetic

Sheet: 1 of 1

Project: Geotechnical Investigation

Log of Test Pit: L16-TP5

Client: Public Works Government Services Canada

Project No: 3098-02

Location: Port aux Basques, NL

Date: November 23, 2016

SUBSURFACE PROFILE				SAMPLE		
Depth Below Surface (ft / m)	Symbol	Geologic Description	Elevation (m)	Soil Sample	Number	Notes/Sample Identification
0 / 0		Ground Surface	9.53			
		Saturated, root mat and decayed organic material. Large slab-shaped boulders.	9.03			Water seeping into test pit from surface.
		Saturated, black decayed organic material, sticky.	8.73			
		CFEM: Silty Sand, trace Gravel, trace Clay. Compact.	7.84	SS	1	Sample L16-TP5-0.7-0.8m collected.
		CFEM: Silty/Clayey Sand, some Gravel. Dry. Rounded cobbles in test pit.	7.03	SS	2	Sample L16-TP5-0.8-0.0m collected. Water level 2.12 m below ground surface (Nov. 25, 2016).
			6.53			
		End of Test Pit				

Depth scale: ft 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12; m 0, 1, 2, 3

Photos

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Fax: (709) 739-5101

Excavation Method: Excavator

Datum: Geodetic

Sheet: 1 of 1

APPENDIX B

Grain Size Analysis Reports

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

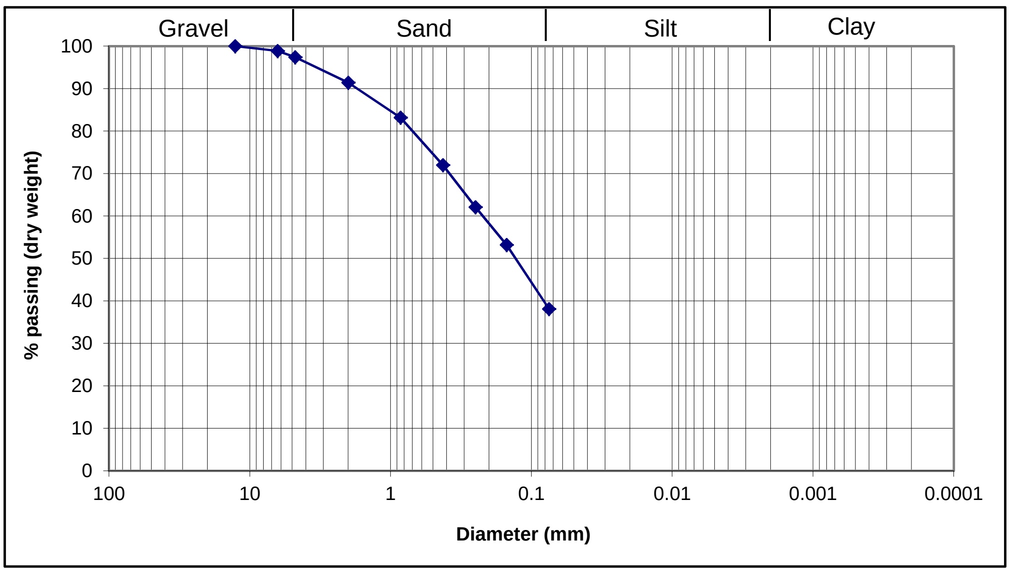
Sample No. : L16-BH1-SS2

Depth below GS: 1.1 m - 1.7 m

Sieve Analysis

Dry weight of sample (g) = 202.69

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	---	---		
1	25.4	---	---		
1/2"	12.7	0.00	0.00	0.00	100.00
1/4"	6.35	2.31	1.14	1.14	98.86
4	4.76	2.97	1.47	2.60	97.40
10	2.00	12.11	5.97	8.58	91.42
20	0.85	16.74	8.26	16.84	83.16
40	0.425	22.65	11.17	28.01	71.99
60	0.25	20.02	9.88	37.89	62.11
100	0.15	18.07	8.92	46.81	53.19
200	0.075	30.59	15.09	61.90	38.10
pan	---	77.23	38.10	100.00	---
		202.69			



D_{10} = NA

D_{30} = NA

D_{60} = 0.22

Cu = NA

Cc = NA

USCS: SM (Silty sand)?

R_{200} = 61.90

R_4 = 2.60

R_4/R_{200} = 0.04

SF = 59.29

GF = 2.60

% Gravel = 2.60

% Sand = 59.29

% Silt & Clay = 38.10

% Clay = NA

CFEM: Sand and Silt/Clay, trace Gravel

Moisture Content (%): 15.37

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

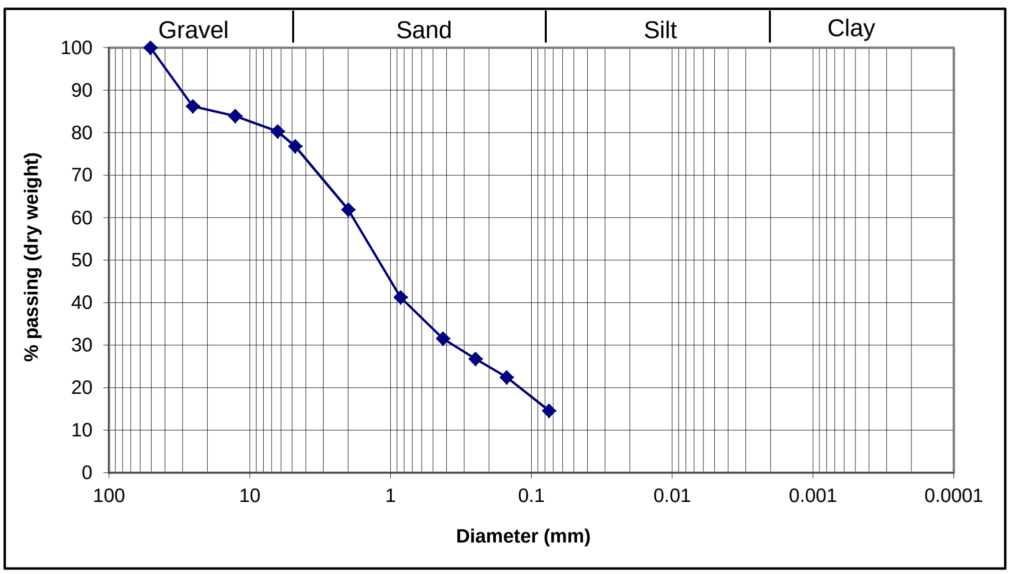
Sample No. : L16-BH1-SS3

Depth below GS: 1.9 m - 2.5 m

Sieve Analysis

Dry weight of sample (g) = 303.29

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	0.00	0.00	0.00	100.00
1	25.4	41.81	13.79	13.79	86.21
1/2"	12.7	6.99	2.30	16.09	83.91
1/4"	6.35	10.89	3.59	19.68	80.32
4	4.76	10.65	3.51	23.19	76.81
10	2.00	45.15	14.89	38.08	61.92
20	0.85	62.63	20.65	58.73	41.27
40	0.425	29.43	9.70	68.43	31.57
60	0.25	14.45	4.76	73.20	26.80
100	0.15	13.15	4.34	77.53	22.47
200	0.075	23.84	7.86	85.39	14.61
pan	---	44.30	14.61	100.00	---
		303.29			



D_{10} = NA

D_{30} = 0.35

D_{60} = 1.85

Cu = NA

Cc = NA

USCS: SM (Silty sand with gravel)?

R_{200} = 85.39

R_4 = 23.19

R_4/R_{200} = 0.27

SF = 62.20

GF = 23.19

% Gravel = 23.19

% Sand = 62.20

% Silt & Clay = 14.61

% Clay = NA

CFEM: Gravelly Sand, some Silt/Clay

Moisture Content (%): 12.05

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

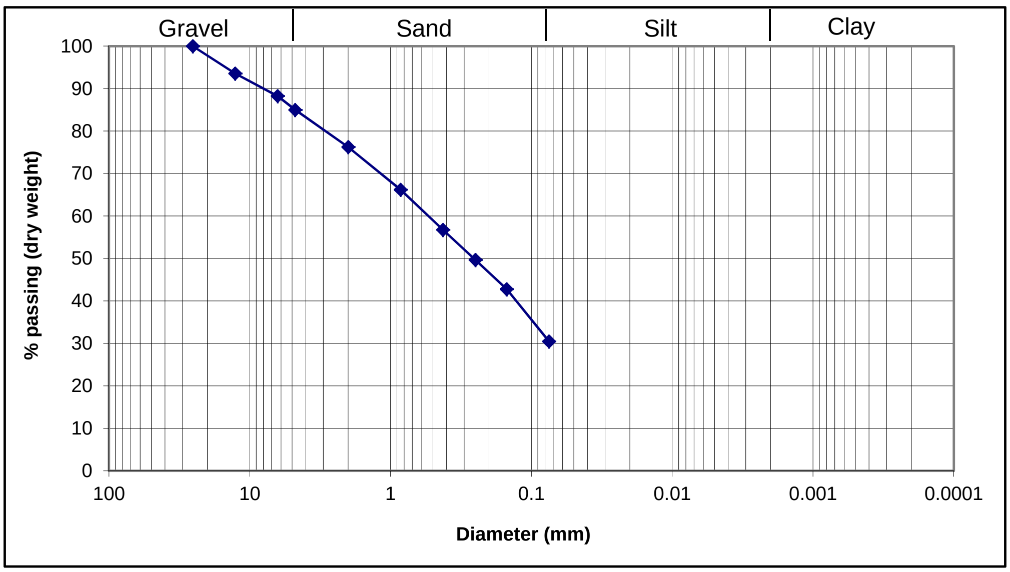
Sample No. : L16-BH1-SS4

Depth below GS: 2.7 m - 3.3 m

Sieve Analysis

Dry weight of sample (g) = 247.66

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	---	---		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	15.96	6.44	6.44	93.56
1/4"	6.35	13.16	5.31	11.76	88.24
4	4.76	8.04	3.25	15.00	85.00
10	2.00	21.70	8.76	23.77	76.23
20	0.85	24.83	10.03	33.79	66.21
40	0.425	23.42	9.46	43.25	56.75
60	0.25	17.57	7.09	50.34	49.66
100	0.15	17.02	6.87	57.22	42.78
200	0.075	30.53	12.33	69.54	30.46
pan	---	75.43	30.46	100.00	---
		247.66			



D_{10} = NA

D_{30} = NA

D_{60} = 0.55

Cu = NA

Cc = NA

USCS: SM (Silty sand with gravel)?

R_{200} = 69.54

R_4 = 15.00

R_4/R_{200} = 0.22

SF = 54.54

GF = 15.00

% Gravel = 15.00

% Sand = 54.54

% Silt & Clay = 30.46

% Clay = NA

CFEM: Silty/Clayey Sand, some Gravel

Moisture Content (%): 11.18

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

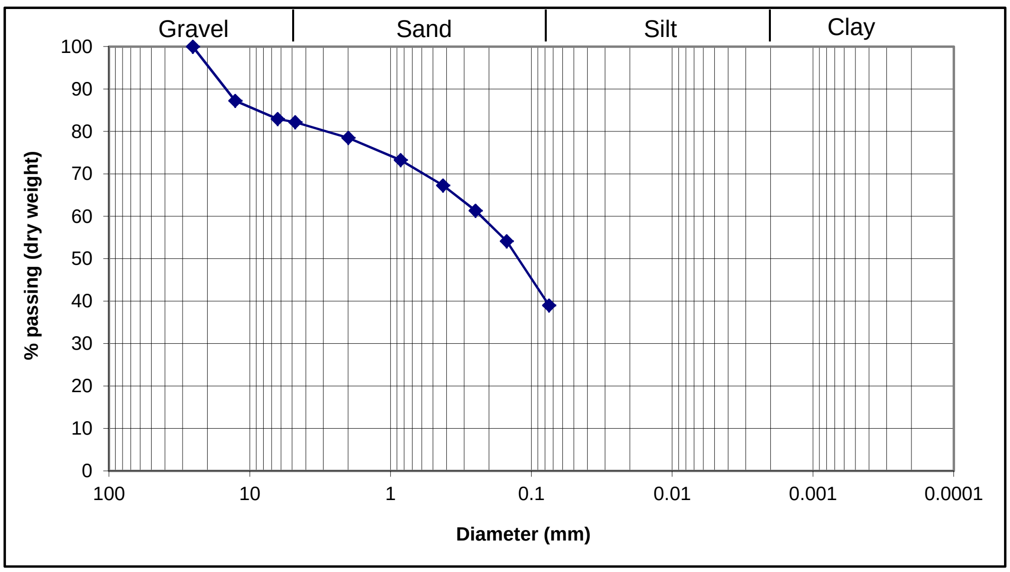
Sample No. : L16-BH1-SS5

Depth below LNT: 3.7 m - 4.3 m

Sieve Analysis

Dry weight of sample (g) = 199.93

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	---	---		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	25.51	12.76	12.76	87.24
1/4"	6.35	8.56	4.28	17.04	82.96
4	4.76	1.52	0.76	17.80	82.20
10	2.00	7.39	3.70	21.50	78.50
20	0.85	10.46	5.23	26.73	73.27
40	0.425	11.93	5.97	32.70	67.30
60	0.25	11.90	5.95	38.65	61.35
100	0.15	14.38	7.19	45.84	54.16
200	0.075	30.24	15.13	60.97	39.03
pan	---	78.04	39.03	100.00	---
		199.93			



D_{10} = NA

D_{30} = NA

D_{60} = 0.23

Cu = NA

Cc = NA

USCS: SM (Silty sand with gravel)?

R_{200} = 60.97

R_4 = 17.80

R_4/R_{200} = 0.29

SF = 43.17

GF = 17.80

% Gravel = 17.80

% Sand = 43.17

% Silt & Clay = 39.03

% Clay = NA

CFEM: Sand and Silt/Clay, some Gravel

Moisture Content (%): 10.69

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

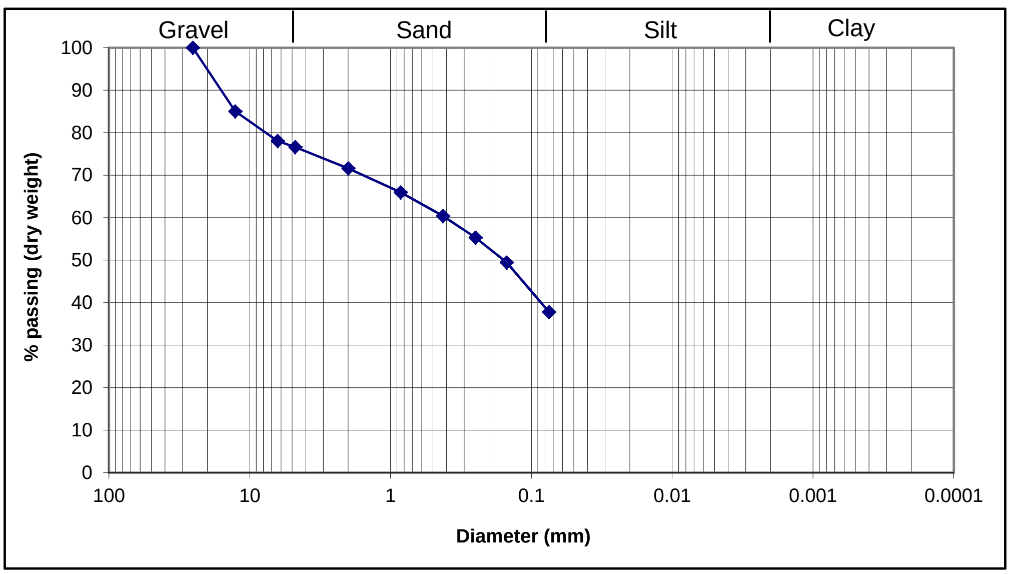
Sample No. : L16-BH1-SS6

Depth below GS: 4.3 m - 4.9 m

Sieve Analysis

Dry weight of sample (g) = 235.10

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	---	---		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	35.18	14.96	14.96	85.04
1/4"	6.35	16.43	6.99	21.95	78.05
4	4.76	3.34	1.42	23.37	76.63
10	2.00	11.81	5.02	28.40	71.60
20	0.85	13.23	5.63	34.02	65.98
40	0.425	13.11	5.58	39.60	60.40
60	0.25	11.92	5.07	44.67	55.33
100	0.15	13.74	5.84	50.51	49.49
200	0.075	27.42	11.66	62.18	37.82
pan	---	88.92	37.82	100.00	---
		235.10			



D_{10} = NA

D_{30} = NA

D_{60} = 0.42

Cu = NA

Cc = NA

USCS: SM (Silty sand with gravel)?

R_{200} = 62.18

R_4 = 23.37

R_4/R_{200} = 0.38

SF = 38.80

GF = 23.37

% Gravel = 23.37

% Sand = 38.80

% Silt & Clay = 37.82

% Clay = NA

CFEM: Gravelly Sand and Silt/Clay

Moisture Content (%): 11.57

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

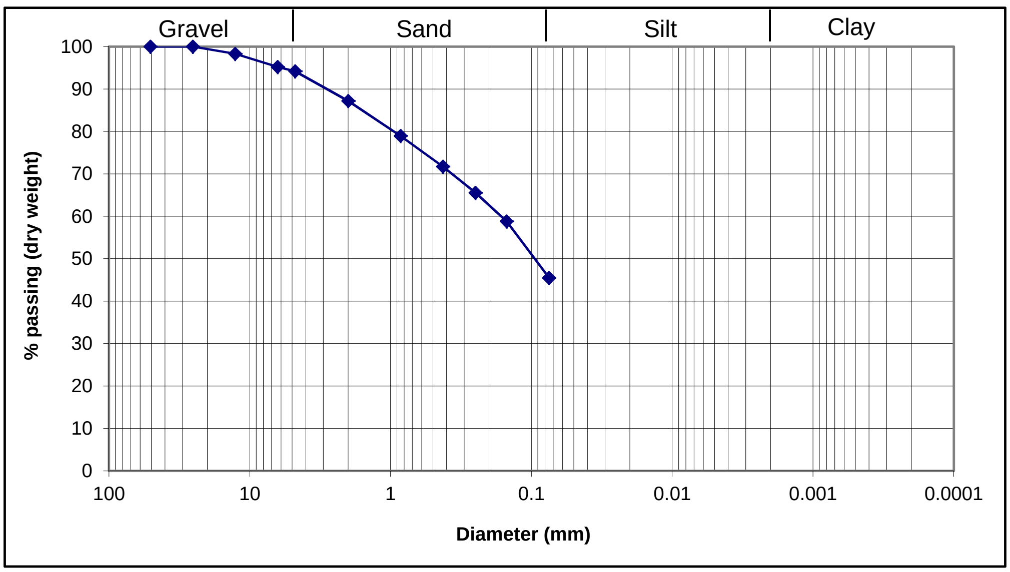
Sample No. : L16-BH1-SS7

Depth below GS: 5.3 m - 5.9 m

Sieve Analysis

Dry weight of sample (g) = 194.70

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	0.00	0.00	0.00	100.00
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	3.30	1.69	1.69	98.31
1/4"	6.35	6.00	3.08	4.78	95.22
4	4.76	2.02	1.04	5.81	94.19
10	2.00	13.58	6.97	12.79	87.21
20	0.85	16.10	8.27	21.06	78.94
40	0.425	14.07	7.23	28.28	71.72
60	0.25	11.98	6.15	34.44	65.56
100	0.15	13.15	6.75	41.19	58.81
200	0.075	25.93	13.32	54.51	45.49
pan	---	88.57	45.49	100.00	---
		194.70			



D_{10} = NA

D_{30} = NA

D_{60} = 0.165

Cu = NA

Cc = NA

USCS: SM (Silty sand)?

R_{200} = 54.51

R_4 = 5.81

R_4/R_{200} = 0.11

SF = 48.70

GF = 5.81

% Gravel = 5.81

% Sand = 48.70

% Silt & Clay = 45.49

% Clay = NA

CFEM: Sand and Silt/Clay, trace Gravel

Moisture Content (%): 12.18

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

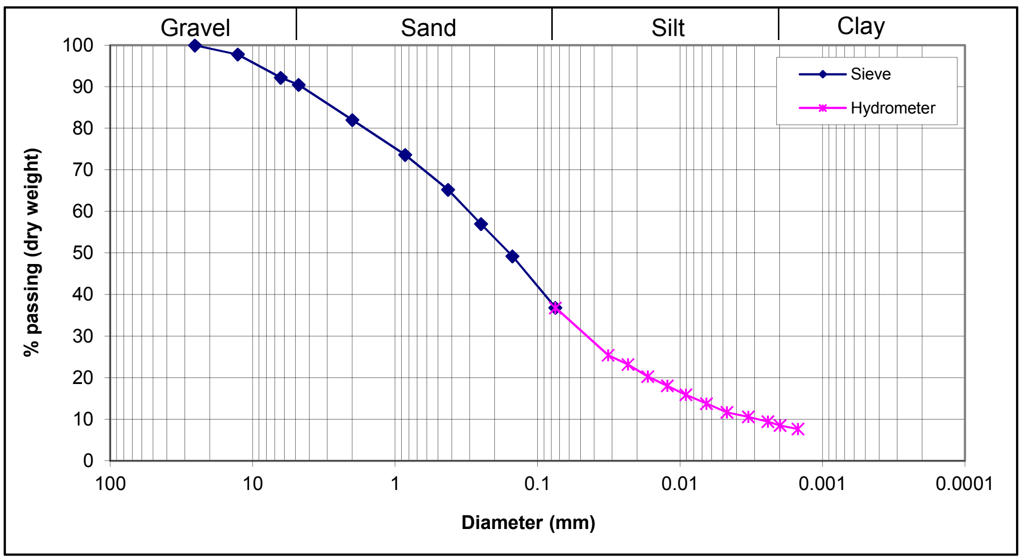
Sample No. : L16-TP1-2.1-1.1m

Depth below GS : 0.9 m - 1.9 m

Sieve Analysis

Dry weight of sample (g) = 161.61

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	---	---		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	3.59	2.22	2.22	97.78
1/4"	6.35	8.99	5.56	7.78	92.22
4	4.76	2.76	1.71	9.49	90.51
10	2.00	13.69	8.47	17.96	82.04
20	0.85	13.55	8.38	26.35	73.65
40	0.425	13.59	8.41	34.76	65.24
60	0.25	13.26	8.20	42.96	57.04
100	0.15	12.66	7.83	50.80	49.20
200	0.075	19.98	12.36	63.16	36.84
pan	---	59.54	36.84	100.00	---
		161.61			



D_{10} = 0.0029

D_{30} = 0.045

D_{60} = 0.3

Cu = 103.45

Cc = 2.33

USCS: SM (Silty sand)

R_{200} = 63.16

R_4 = 9.49

R_4/R_{200} = 0.15

SF = 53.67

GF = 9.49

% Gravel = 9.49

% Sand = 53.67

% Silt = 28.29

% Clay = 8.55

CFEM: Silty Sand, trace Gravel, trace Clay

Moisture Content (%): 13.84

GRAIN SIZE ANALYSIS-HYDROMETER

Project No. : 3098-02

Location of Project : Port aux Basques, NL, Grand Bay Road

Sample No. : L16-TP1-2.1-1.1m

Description of Soil : silty/clayey sand, trace gravel

Sample Depth : 0.9 m - 1.9 m

Tested By : IL / JR

Test Date : December 12, 2016

Hydrometer Analysis

Hydrometer Type: 152H

Zero Correction : 7

Meniscus Correction: 1

Dispersing Agent: $NaPO_4$

Amount Used: 4% @ 125 ml

G_s of Solids: 2.65

C.F. a : 1.0 (From Table 6-2)

Mass of Soil (g): 50

Control Sieve No. : 200

% finer than #200 from sieve analysis : 36.84

	1	2	3	5	4	6	7	8	9	10	11	12	13
Date	Time of reading	Elapsed Time, t(min.)	Temp. (^oC)	Act. Hyd. Reading, R_a	Temp. Corr. Factor, C_T(6-3)	Corr. Hyd. Reading, R_c	Actual % Finer	Adjusted % Finer	Hyd. corr. for meniscus, R	L (cm) {table 6-5}	L/t	K {table 6-4}	D (mm)
12/12/16	10:10	0	---	---	---	---	---	36.84	---	---	---	---	0.075
12/12/16	10:12	2	13	43	-1.5	34.5	69.0	25.4	44	9.10	4.550E+00	1.50E-02	3.200E-02
12/12/16	10:14	4	13	40	-1.5	31.5	63.0	23.2	41	9.60	2.400E+00	1.50E-02	2.324E-02
12/12/16	10:18	8	13	36	-1.5	27.5	55.0	20.3	37	10.20	1.267E+00	1.50E-02	1.688E-02
12/12/16	10:26	16	13	33	-1.5	24.5	49.0	18.1	34	10.70	6.688E-01	1.50E-02	1.227E-02
12/12/16	10:40	30	13.5	30	-1.4	21.6	43.2	15.9	31	11.20	3.733E-01	1.49E-02	9.104E-03
12/12/16	11:10	60	14	27	-1.3	18.7	37.4	13.8	28	11.70	1.950E-01	1.48E-02	6.536E-03
12/12/16	12:10	120	14.5	24	-1.2	15.8	31.6	11.6	25	12.20	1.017E-01	1.47E-02	4.687E-03
12/12/16	14:10	240	15	22.5	-1.1	14.4	28.8	10.6	23.5	12.45	5.188E-02	1.46E-02	3.325E-03
12/12/16	18:00	470	14.5	21	-1.2	12.8	25.6	9.4	22	12.70	2.702E-02	1.47E-02	2.416E-03
12/12/16	22:22	732	13	20	-1.5	11.5	23.0	8.5	21	12.90	1.763E-02	1.50E-02	1.992E-03
12/13/16	8:25	1335	12.5	19	-1.6	10.4	20.8	7.7	20	13.00	9.735E-03	1.51E-02	1.490E-03

ATTERBERG LIMITS

Project No. : 3098-02

Sample No. : L16-TP1-2.1-1.1m

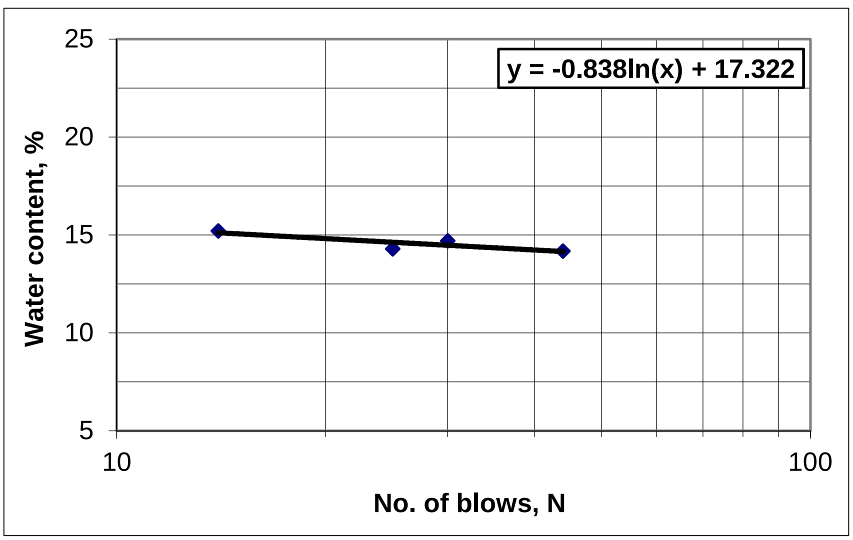
Location of Project : Port aux Basques, NL
Grand Bay Road

Test Date : December 14, 2016

Liquid Limit

Can no.	1	2	3	4
Mass of can, g	1.34	1.32	1.36	1.32
Mass of wet soil + can, g	38.92	36.51	31.42	30.39
Mass of dry soil + can, g	33.96	32.11	27.57	26.78
Mass of dry soil, g	32.62	30.79	26.21	25.46
Mass of moisture, g	4.96	4.4	3.85	3.61
Water content, %	15.2	14.3	14.7	14.2
No. of blows, N	14	25	30	44

No. of blows	**25**
Water content @ 25 counts	**14.6**



Liquid Limit : 14.6
Plastic Limit : 13.6
Plasticity Index : 1.0

Plastic Limit

Can no.	1	2	3
Mass of can, g	1.36	1.35	1.32
Mass of wet soil + can, g	7.6	16.65	17.81
Mass of dry soil + can, g	6.86	14.79	15.84
Mass of dry soil, g	5.5	13.44	14.52
Mass of moisture, g	0.74	1.86	1.97
Water content, %	13.5	13.8	13.6

Average Water Content, % 13.6

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

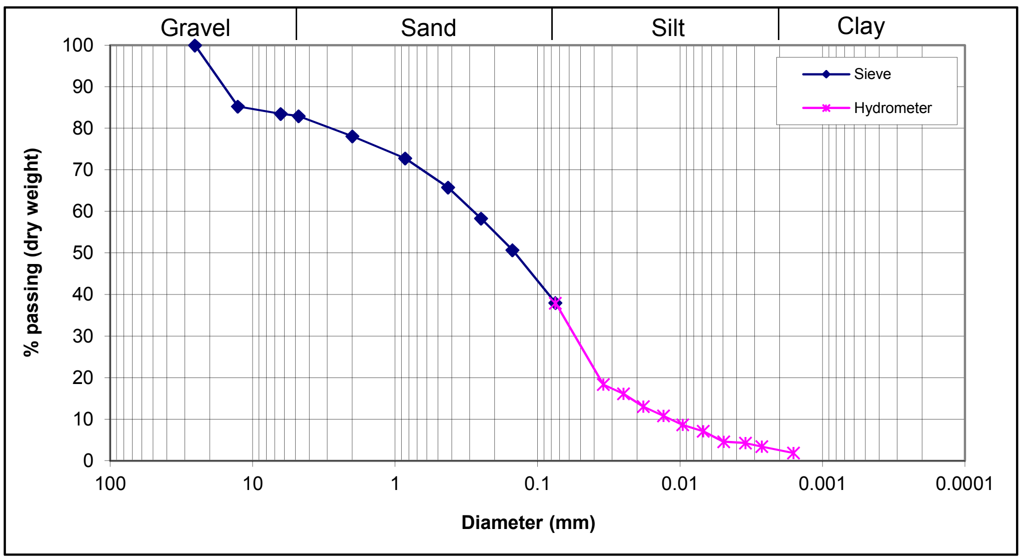
Sample No. : L16-TP1-1.1-0.0m

Depth below GS : 1.9 m - 3.0 m

Sieve Analysis

Dry weight of sample (g) = 194.64

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	28.63	14.71	14.71	85.29
1/4"	6.35	3.52	1.81	16.52	83.48
4	4.76	0.96	0.49	17.01	82.99
10	2.00	9.45	4.86	21.87	78.13
20	0.85	10.38	5.33	27.20	72.80
40	0.425	13.58	6.98	34.18	65.82
60	0.25	14.55	7.48	41.65	58.35
100	0.15	14.88	7.64	49.30	50.70
200	0.075	24.73	12.71	62.00	38.00
pan	---	73.96	38.00	100.00	---
		194.64			



D_{10} = 0.0115

D_{30} = 0.0545

D_{60} = 0.28

Cu = 24.35

Cc = 0.92

USCS: SM (Silty sand with gravel)

R_{200} = 62.00

R_4 = 17.01

R_4/R_{200} = 0.27

SF = 44.99

GF = 17.01

% Gravel = 17.01

% Sand = 44.99

% Silt = 35.45

% Clay = 2.55

CFEM: Sand and Silt, some Gravel, trace Clay

Moisture Content (%): 10.17

GRAIN SIZE ANALYSIS-HYDROMETER

Project No. : 3098-02

Location of Project : Port aux Basques, NL, Grand Bay Road

Sample No. : L16-TP1-1.1-0.0m

Description of Soil : sand and silt/clay, some gravel

Sample Depth : 1.9 m - 3.0 m

Tested By : IL

Test Date : December 13, 2016

Hydrometer Analysis

Hydrometer Type: 152H

Zero Correction : 6.5

Meniscus Correction: 1

Dispersing Agent: $NaPO_4$

Amount Used: 4% @ 125 ml

G_s of Solids: 2.65

C.F. a : 1.0 (From Table 6-2)

Mass of Soil (g): 50

Control Sieve No. : 200

% finer than #200 from sieve analysis : 38.00

	1	2	3	5	4	6	7	8	9	10	11	12	13
Date	Time of reading	Elapsed Time, t(min.)	Temp. (°C)	Act. Hyd. Reading, R_a	Temp. Corr. Factor, C_T(6-3)	Corr. Hyd. Reading, R_c	Actual % Finer	Adjusted % Finer	Hyd. corr. for meniscus, R	L (cm) {table 6-5}	L/t	K {table 6-4}	D (mm)
12/13/16	11:00	0	---	---	---	---	---	38.00	---	---	---	---	0.075
12/13/16	11:02	2	14	32	-1.3	24.2	48.4	18.4	33	10.90	5.450E+00	1.48E-02	3.455E-02
12/13/16	11:04	4	14	29	-1.3	21.2	42.4	16.1	30	11.40	2.850E+00	1.48E-02	2.499E-02
12/13/16	11:08	8	14	25	-1.3	17.2	34.4	13.1	26	12.00	1.500E+00	1.48E-02	1.813E-02
12/13/16	11:16	16	14	22	-1.3	14.2	28.4	10.8	23	12.50	7.813E-01	1.48E-02	1.308E-02
12/13/16	11:30	30	15	19	-1.1	11.4	22.8	8.7	20	13.00	4.333E-01	1.46E-02	9.611E-03
12/13/16	12:00	60	15	17	-1.1	9.4	18.8	7.1	18	13.30	2.217E-01	1.46E-02	6.874E-03
12/13/16	13:00	120	15.5	13.5	-1	6	12.0	4.6	14.5	13.90	1.158E-01	1.45E-02	4.935E-03
12/13/16	15:00	240	16	13	-0.9	5.6	11.2	4.3	14	14.00	5.833E-02	1.44E-02	3.478E-03
12/13/16	18:00	420	15.5	12	-1	4.5	9.0	3.4	13	14.20	3.381E-02	1.45E-02	2.666E-03
12/14/16	8:09	1269	13	10.5	-1.5	2.5	5.0	1.9	11.5	14.40	1.135E-02	1.50E-02	1.598E-03

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

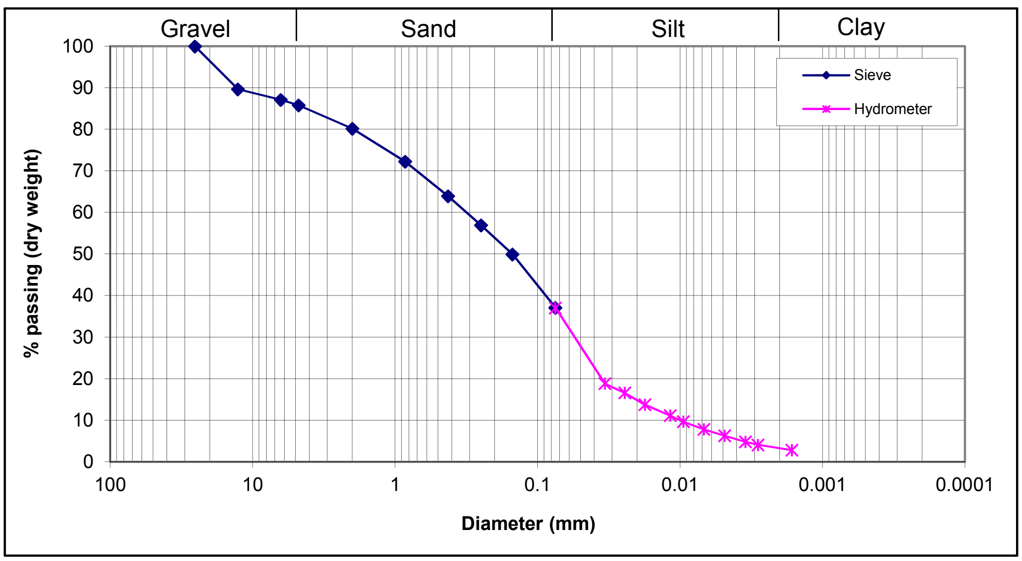
Sample No. : L16-TP2-1.5-0.0m

Depth below GS : 0.9 m - 2.4 m

Sieve Analysis

Dry weight of sample (g) = 169.93

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	---	---		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	17.61	10.36	10.36	89.64
1/4"	6.35	4.31	2.54	12.90	87.10
4	4.76	2.18	1.28	14.18	85.82
10	2.00	9.53	5.61	19.79	80.21
20	0.85	13.49	7.94	27.73	72.27
40	0.425	14.14	8.32	36.05	63.95
60	0.25	11.98	7.05	43.10	56.90
100	0.15	11.88	6.99	50.09	49.91
200	0.075	21.79	12.82	62.91	37.09
pan	---	63.02	37.09	100.00	---
		169.93			



D_{10} = 0.01

D_{30} = 0.0545

D_{60} = 0.315

Cu = 31.50

Cc = 0.94

USCS: SM (Silty sand)

R_{200} = 62.91

R_4 = 14.18

R_4/R_{200} = 0.23

SF = 48.73

GF = 14.18

% Gravel = 14.18

% Sand = 48.73

% Silt = 33.74

% Clay = 3.35

CFEM: Silty Sand, some Gravel, trace Clay

Moisture Content (%): 14.11

GRAIN SIZE ANALYSIS-HYDROMETER

Project No. : 3098-02

Location of Project : Port aux Basques, NL, Grand Bay Road

Sample No. : L16-TP2-1.5-0.0m

Description of Soil : silty/clayey sand, some gravel

Sample Depth : 0.9 m - 2.4 m

Tested By : IL

Test Date : December 13, 2016

Hydrometer Analysis

Hydrometer Type: 152H

Zero Correction : 6.5

Meniscus Correction: 1

Dispersing Agent: $NaPO_4$

Amount Used: 4% @ 125 ml

G_s of Solids: 2.65

C.F. a : 1.0 (From Table 6-2)

Mass of Soil (g): 50

Control Sieve No. : 200

% finer than #200 from sieve analysis : 37.09

	1	2	3	5	4	6	7	8	9	10	11	12	13
Date	Time of reading	Elapsed Time, t(min.)	Temp. (^oC)	Act. Hyd. Reading, R_a	Temp. Corr. Factor, C_T(6-3)	Corr. Hyd. Reading, R_c	Actual % Finer	Adjusted % Finer	Hyd. corr. for meniscus, R	L (cm) {table 6-5}	L/t	K {table 6-4}	D (mm)
12/13/16	11:58	0	---	---	---	---	---	37.09	---	---	---	---	0.075
12/13/16	12:00	2	15	33	-1.1	25.4	50.8	18.8	34	10.70	5.350E+00	1.46E-02	3.377E-02
12/13/16	12:02	4	15	30	-1.1	22.4	44.8	16.6	31	11.20	2.800E+00	1.46E-02	2.443E-02
12/13/16	12:06	8	15.5	26	-1	18.5	37.0	13.7	27	11.90	1.488E+00	1.45E-02	1.768E-02
12/13/16	12:17	19	15.5	22.5	-1	15	30.0	11.1	23.5	12.45	6.553E-01	1.45E-02	1.174E-02
12/13/16	12:28	30	15.5	20.5	-1	13	26.0	9.6	21.5	12.80	4.267E-01	1.45E-02	9.471E-03
12/13/16	12:58	60	15.5	18	-1	10.5	21.0	7.8	19	13.20	2.200E-01	1.45E-02	6.801E-03
12/13/16	13:58	120	15.5	16	-1	8.5	17.0	6.3	17	13.50	1.125E-01	1.45E-02	4.863E-03
12/13/16	15:58	240	15.5	14	-1	6.5	13.0	4.8	15	13.80	5.750E-02	1.45E-02	3.477E-03
12/13/16	18:02	364	15.5	13	-1	5.5	11.0	4.1	14	14.00	3.846E-02	1.45E-02	2.844E-03
12/14/16	8:10	1212	12	12	-1.7	3.8	7.6	2.8	13	14.20	1.172E-02	1.52E-02	1.645E-03

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

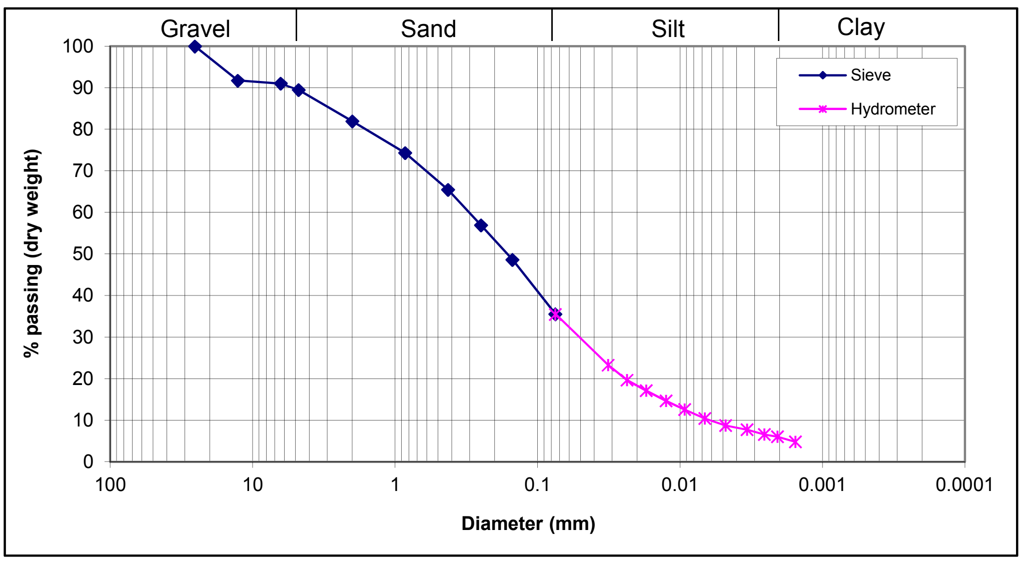
Sample No. : L16-TP3-2.0-0.0m

Depth below GS : 1.0 m - 3.0 m

Sieve Analysis

Dry weight of sample (g) = 183.19

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	---	---		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	15.14	8.26	8.26	91.74
1/4"	6.35	1.34	0.73	9.00	91.00
4	4.76	2.78	1.52	10.51	89.49
10	2.00	13.74	7.50	18.01	81.99
20	0.85	13.98	7.63	25.65	74.35
40	0.425	16.28	8.89	34.53	65.47
60	0.25	15.69	8.56	43.10	56.90
100	0.15	15.18	8.29	51.38	48.62
200	0.075	23.92	13.06	64.44	35.56
pan	---	65.14	35.56	100.00	---
		183.19			



D_{10} = 0.0061

D_{30} = 0.0505

D_{60} = 0.3

Cu = 49.18

Cc = 1.39

USCS: SM (Silty sand)

R_{200} = 64.44

R_4 = 10.51

R_4/R_{200} = 0.16

SF = 53.93

GF = 10.51

% Gravel = 10.51

% Sand = 53.93

% Silt = 29.66

% Clay = 5.90

CFEM: Silty Sand, some Gravel, trace Clay

Moisture Content (%): 11.85

GRAIN SIZE ANALYSIS-HYDROMETER

Project No. : 3098-02

Location of Project : Port aux Basques, NL, Grand Bay Road

Sample No. : L16-TP3-2.0-0.0m

Description of Soil : silty/clayey sand, some gravel

Sample Depth : 1.0 m - 3.0 m

Tested By : IL / JR

Test Date : December 12, 2016

Hydrometer Analysis

Hydrometer Type: 152H

Zero Correction : 7

Meniscus Correction: 1

Dispersing Agent: $NaPO_4$

Amount Used: 4% @ 125 ml

G_s of Solids: 2.65

C.F. a : 1.0 (From Table 6-2)

Mass of Soil (g): 50

Control Sieve No. : 200

% finer than #200 from sieve analysis : 35.56

	1	2	3	5	4	6	7	8	9	10	11	12	13
Date	Time of reading	Elapsed Time, t(min.)	Temp. (^oC)	Act. Hyd. Reading, R_a	Temp. Corr. Factor, C_T(6-3)	Corr. Hyd. Reading, R_c	Actual % Finer	Adjusted % Finer	Hyd. corr. for meniscus, R	L (cm) {table 6-5}	L/t	K {table 6-4}	D (mm)
12/12/16	10:46	0	---	---	---	---	---	35.56	---	---	---	---	0.075
12/12/16	10:48	2	14	41	-1.3	32.7	65.4	23.3	42	9.40	4.700E+00	1.48E-02	3.209E-02
12/12/16	10:50	4	14	36	-1.3	27.7	55.4	19.7	37	10.20	2.550E+00	1.48E-02	2.363E-02
12/12/16	10:54	8	13.5	32.5	-1.4	24.1	48.2	17.1	33.5	10.80	1.350E+00	1.49E-02	1.731E-02
12/12/16	11:02	16	13.5	29	-1.4	20.6	41.2	14.7	30	11.40	7.125E-01	1.49E-02	1.258E-02
12/12/16	11:16	30	14	26	-1.3	17.7	35.4	12.6	27	11.90	3.967E-01	1.48E-02	9.321E-03
12/12/16	11:46	60	14	23	-1.3	14.7	29.4	10.5	24	12.40	2.067E-01	1.48E-02	6.728E-03
12/12/16	12:46	120	14.5	20.5	-1.2	12.3	24.6	8.7	21.5	12.80	1.067E-01	1.47E-02	4.801E-03
12/12/16	14:46	240	15	19	-1.1	10.9	21.8	7.8	20	13.00	5.417E-02	1.46E-02	3.398E-03
12/12/16	18:02	436	14.5	17.5	-1.2	9.3	18.6	6.6	18.5	13.25	3.039E-02	1.47E-02	2.563E-03
12/12/16	22:24	698	13	17	-1.5	8.5	17.0	6.0	18	13.30	1.905E-02	1.50E-02	2.071E-03
12/13/16	8:27	1300	12	15.5	-1.7	6.8	13.6	4.8	16.5	13.60	1.046E-02	1.52E-02	1.554E-03

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

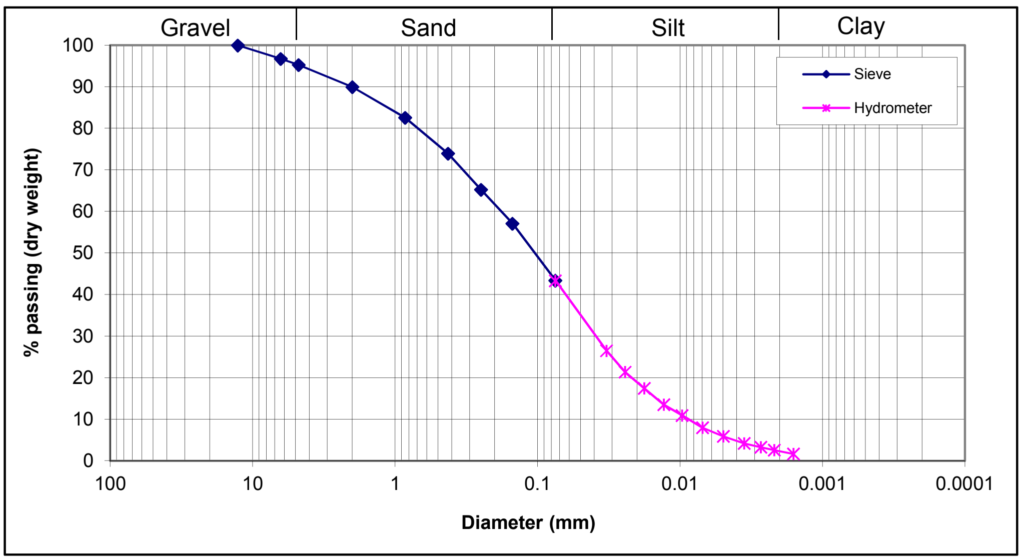
Sample No. : L16-TP4-2.0-1.4m

Depth below GS : 0.7 m - 1.3 m

Sieve Analysis

Dry weight of sample (g) = 170.28

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	---	---		
1	25.4	---	---		
1/2"	12.7	0.00	0.00	0.00	100.00
1/4"	6.35	5.57	3.27	3.27	96.73
4	4.76	2.52	1.48	4.75	95.25
10	2.00	8.95	5.26	10.01	89.99
20	0.85	12.68	7.45	17.45	82.55
40	0.425	14.67	8.62	26.07	73.93
60	0.25	14.73	8.65	34.72	65.28
100	0.15	13.90	8.16	42.88	57.12
200	0.075	23.36	13.72	56.60	43.40
pan	---	73.90	43.40	100.00	---
		170.28			



D_{10} = 0.0087

D_{30} = 0.0395

D_{60} = 0.18

Cu = 20.69

Cc = 1.00

USCS: SM (Silty sand)

R_{200} = 56.60

R_4 = 4.75

R_4/R_{200} = 0.08

SF = 51.85

GF = 4.75

% Gravel = 4.75

% Sand = 51.85

% Silt = 41.10

% Clay = 2.30

CFEM: Sand and Silt, trace Gravel, trace Clay

Moisture Content (%): 17.46

GRAIN SIZE ANALYSIS-HYDROMETER

Project No. : 3098-02

Location of Project : Port aux Basques, NL, Grand Bay Road

Sample No. : L16-TP4-2.0-1.4m

Description of Soil : sand and silt/clay, trace gravel

Sample Depth : 0.7 m - 1.3 m

Tested By : IL / JR

Test Date : December 12, 2016

Hydrometer Analysis

Hydrometer Type: 152H

Zero Correction : 7

Meniscus Correction: 1

Dispersing Agent: $NaPO_4$

Amount Used: 4% @ 125 ml

G_s of Solids: 2.65

C.F. a : 1.0 (From Table 6-2)

Mass of Soil (g): 50.01

Control Sieve No. : 200

% finer than #200 from sieve analysis : 43.40

	1	2	3	5	4	6	7	8	9	10	11	12	13
Date	Time of reading	Elapsed Time, t(min.)	Temp. (^oC)	Act. Hyd. Reading, R_a	Temp. Corr. Factor, C_T(6-3)	Corr. Hyd. Reading, R_c	Actual % Finer	Adjusted % Finer	Hyd. corr. for meniscus, R	L (cm) {table 6-5}	L/t	K {table 6-4}	D (mm)
12/12/16	11:10	0	---	---	---	---	---	43.40	---	---	---	---	0.075
12/12/16	11:12	2	13.5	39	-1.4	30.6	61.2	26.6	40	9.70	4.850E+00	1.49E-02	3.281E-02
12/12/16	11:14	4	13.5	33	-1.4	24.6	49.2	21.3	34	10.70	2.675E+00	1.49E-02	2.437E-02
12/12/16	11:18	8	13.5	28.5	-1.4	20.1	40.2	17.4	29.5	11.45	1.431E+00	1.49E-02	1.783E-02
12/12/16	11:26	16	13.5	24	-1.4	15.6	31.2	13.5	25	12.20	7.625E-01	1.49E-02	1.301E-02
12/12/16	11:40	30	13.5	21	-1.4	12.6	25.2	10.9	22	12.70	4.233E-01	1.49E-02	9.695E-03
12/12/16	12:10	60	14	17.5	-1.3	9.2	18.4	8.0	18.5	13.25	2.208E-01	1.48E-02	6.955E-03
12/12/16	13:10	120	14.5	15	-1.2	6.8	13.6	5.9	16	13.70	1.142E-01	1.47E-02	4.967E-03
12/12/16	15:10	240	14.5	13	-1.2	4.8	9.6	4.2	14	14.00	5.833E-02	1.47E-02	3.550E-03
12/12/16	18:05	415	14.5	12	-1.2	3.8	7.6	3.3	13	14.20	3.422E-02	1.47E-02	2.719E-03
12/12/16	22:25	675	13	11.5	-1.5	3	6.0	2.6	12.5	14.25	2.111E-02	1.50E-02	2.179E-03
12/13/16	8:27	1277	12.5	10.5	-1.6	1.9	3.8	1.6	11.5	14.40	1.128E-02	1.51E-02	1.603E-03

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

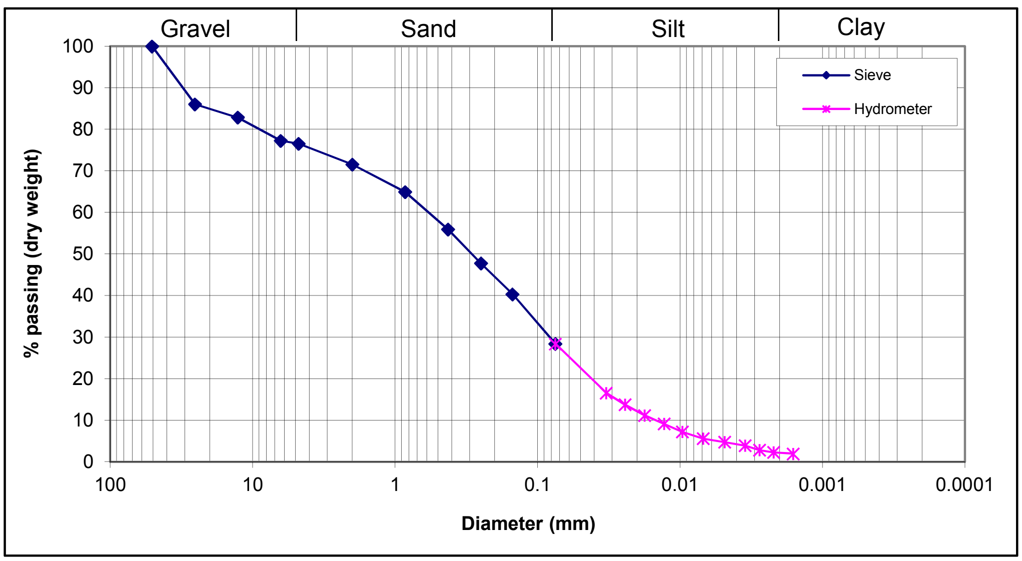
Sample No. : L16-TP4-1.4-0.5m

Depth below GS : 1.3 m - 2.2 m

Sieve Analysis

Dry weight of sample (g) = 204.69

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	0.00	0.00	0.00	100.00
1	25.4	28.56	13.95	13.95	86.05
1/2"	12.7	6.56	3.20	17.16	82.84
1/4"	6.35	11.39	5.56	22.72	77.28
4	4.76	1.48	0.72	23.45	76.55
10	2.00	10.15	4.96	28.40	71.60
20	0.85	13.70	6.69	35.10	64.90
40	0.425	18.32	8.95	44.05	55.95
60	0.25	16.69	8.15	52.20	47.80
100	0.15	15.27	7.46	59.66	40.34
200	0.075	24.55	11.99	71.65	28.35
pan	---	58.02	28.35	100.00	---
		204.69			



D_{10} = 0.0146

D_{30} = 0.0825

D_{60} = 0.585

Cu = 40.07

Cc = 0.80

USCS: SM (Silty sand with gravel)

R_{200} = 71.65

R_4 = 23.45

R_4/R_{200} = 0.33

SF = 48.21

GF = 23.45

% Gravel = 23.45

% Sand = 48.21

% Silt = 26.15

% Clay = 2.20

CFEM: Silty Gravelly Sand, trace Clay

Moisture Content (%): 16.99

GRAIN SIZE ANALYSIS-HYDROMETER

Project No. : 3098-02

Location of Project : Port aux Basques, NL, Grand Bay Road

Sample No. : L16-TP4-1.4-0.5m

Description of Soil : silty/clayey gravelly sand

Sample Depth : 1.3 m - 2.2 m

Tested By : IL / JR

Test Date : December 12, 2016

Hydrometer Analysis

Hydrometer Type: 152H

Zero Correction : 7

Meniscus Correction: 1

Dispersing Agent: $NaPO_4$

Amount Used: 4% @ 125 ml

G_s of Solids: 2.65

C.F. a : 1.0 (From Table 6-2)

Mass of Soil (g): 50.01

Control Sieve No. : 200

% finer than #200 from sieve analysis : 28.35

	1	2	3	5	4	6	7	8	9	10	11	12	13
Date	Time of reading	Elapsed Time, t(min.)	Temp. (^oC)	Act. Hyd. Reading, R_a	Temp. Corr. Factor, C_T(6-3)	Corr. Hyd. Reading, R_c	Actual % Finer	Adjusted % Finer	Hyd. corr. for meniscus, R	L (cm) {table 6-5}	L/t	K {table 6-4}	D (mm)
12/12/16	11:39	0	---	---	---	---	---	28.35	---	---	---	---	0.075
12/12/16	11:41	2	14	37.5	-1.3	29.2	58.4	16.6	38.5	10.00	5.000E+00	1.48E-02	3.309E-02
12/12/16	11:43	4	14	32.5	-1.3	24.2	48.4	13.7	33.5	10.80	2.700E+00	1.48E-02	2.432E-02
12/12/16	11:47	8	14	28	-1.3	19.7	39.4	11.2	29	11.50	1.438E+00	1.48E-02	1.774E-02
12/12/16	11:55	16	13.5	24.5	-1.4	16.1	32.2	9.1	25.5	12.10	7.563E-01	1.49E-02	1.296E-02
12/12/16	12:09	30	14	21	-1.3	12.7	25.4	7.2	22	12.70	4.233E-01	1.48E-02	9.629E-03
12/12/16	12:39	60	14.5	18	-1.2	9.8	19.6	5.6	19	13.20	2.200E-01	1.47E-02	6.895E-03
12/12/16	13:39	120	15	16.5	-1.1	8.4	16.8	4.8	17.5	13.40	1.117E-01	1.46E-02	4.879E-03
12/12/16	15:39	240	15	15	-1.1	6.9	13.8	3.9	16	13.70	5.708E-02	1.46E-02	3.488E-03
12/12/16	18:06	387	15	13	-1.1	4.9	9.8	2.8	14	14.00	3.618E-02	1.46E-02	2.777E-03
12/12/16	22:28	649	13	12.5	-1.5	4	8.0	2.3	13.5	14.10	2.173E-02	1.50E-02	2.211E-03
12/13/16	8:28	1249	12.5	12	-1.6	3.4	6.8	1.9	13	14.20	1.136E-02	1.51E-02	1.610E-03

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

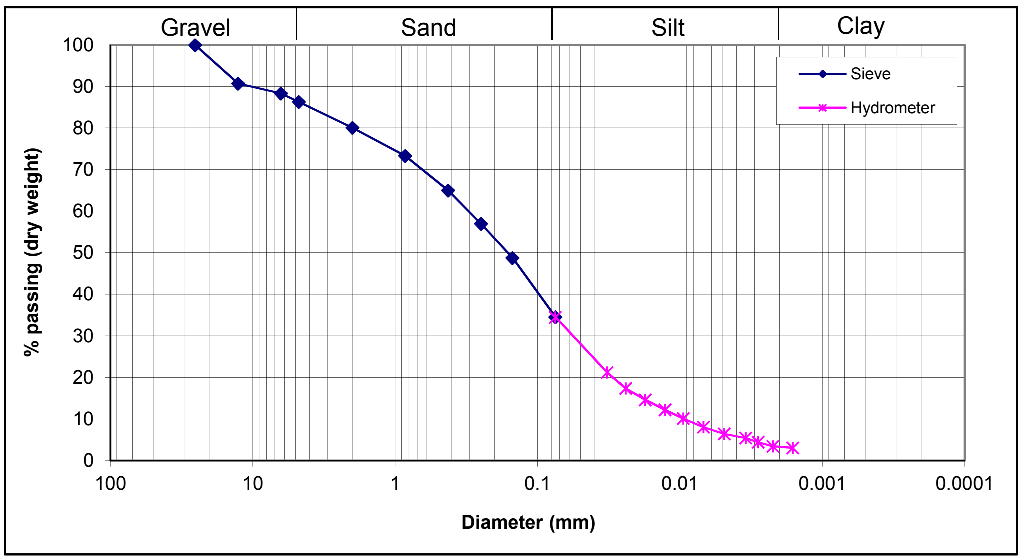
Sample No. : L16-TP4-0.5-0.0m

Depth below GS : 2.2 m - 2.7 m

Sieve Analysis

Dry weight of sample (g) = 186.88

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	---	---		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	17.32	9.27	9.27	90.73
1/4"	6.35	4.51	2.41	11.68	88.32
4	4.76	3.75	2.01	13.69	86.31
10	2.00	11.65	6.23	19.92	80.08
20	0.85	12.61	6.75	26.67	73.33
40	0.425	15.48	8.28	34.95	65.05
60	0.25	15.02	8.04	42.99	57.01
100	0.15	15.39	8.24	51.23	48.77
200	0.075	26.67	14.27	65.50	34.50
pan	---	64.48	34.50	100.00	---
		186.88			



D_{10} = 0.0092

D_{30} = 0.056

D_{60} = 0.3

Cu = 32.61

Cc = 1.14

USCS: SM (Silty sand)

R_{200} = 65.50

R_4 = 13.69

R_4/R_{200} = 0.21

SF = 51.81

GF = 13.69

% Gravel = 13.69

% Sand = 51.81

% Silt = 31.15

% Clay = 3.35

CFEM: Silty Sand, some Gravel, trace Clay

Moisture Content (%): 12.08

GRAIN SIZE ANALYSIS-HYDROMETER

Project No. : 3098-02

Location of Project : Port aux Basques, NL, Grand Bay Road

Sample No. : L16-TP4-0.5-0.0m

Description of Soil : silty/clayey sand, some gravel

Sample Depth : 2.2 m - 2.7 m

Tested By : IL / JR

Test Date : December 12, 2016

Hydrometer Analysis

Hydrometer Type: 152H

Zero Correction : 7

Meniscus Correction: 1

Dispersing Agent: $NaPO_4$

Amount Used: 4% @ 125 ml

G_s of Solids: 2.65

C.F. a : 1.0 (From Table 6-2)

Mass of Soil (g): 50

Control Sieve No. : 200

% finer than #200 from sieve analysis : 34.50

	1	2	3	5	4	6	7	8	9	10	11	12	13
Date	Time of reading	Elapsed Time, t(min.)	Temp. (^oC)	Act. Hyd. Reading, R_a	Temp. Corr. Factor, C_T(6-3)	Corr. Hyd. Reading, R_c	Actual % Finer	Adjusted % Finer	Hyd. corr. for meniscus, R	L (cm) {table 6-5}	L/t	K {table 6-4}	D (mm)
12/12/16	12:03	0	---	---	---	---	---	34.50	---	---	---	---	0.075
12/12/16	12:05	2	14	39	-1.3	30.7	61.4	21.2	40	9.70	4.850E+00	1.48E-02	3.259E-02
12/12/16	12:07	4	14	33.5	-1.3	25.2	50.4	17.4	34.5	10.60	2.650E+00	1.48E-02	2.409E-02
12/12/16	12:11	8	14	29.5	-1.3	21.2	42.4	14.6	30.5	11.30	1.413E+00	1.48E-02	1.759E-02
12/12/16	12:19	16	14	26	-1.3	17.7	35.4	12.2	27	11.90	7.438E-01	1.48E-02	1.276E-02
12/12/16	12:33	30	14	23	-1.3	14.7	29.4	10.1	24	12.40	4.133E-01	1.48E-02	9.515E-03
12/12/16	13:03	60	14	20	-1.3	11.7	23.4	8.1	21	12.90	2.150E-01	1.48E-02	6.862E-03
12/12/16	14:03	120	14.5	17.5	-1.2	9.3	18.6	6.4	18.5	13.25	1.104E-01	1.47E-02	4.885E-03
12/12/16	16:03	240	15	16	-1.1	7.9	15.8	5.5	17	13.50	5.625E-02	1.46E-02	3.463E-03
12/12/16	18:08	365	15	14.5	-1.1	6.4	12.8	4.4	15.5	13.75	3.767E-02	1.46E-02	2.834E-03
12/12/16	22:30	627	13	13.5	-1.5	5	10.0	3.5	14.5	13.90	2.217E-02	1.50E-02	2.233E-03
12/13/16	8:29	1226	12.5	13	-1.6	4.4	8.8	3.0	14	14.00	1.142E-02	1.51E-02	1.614E-03

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

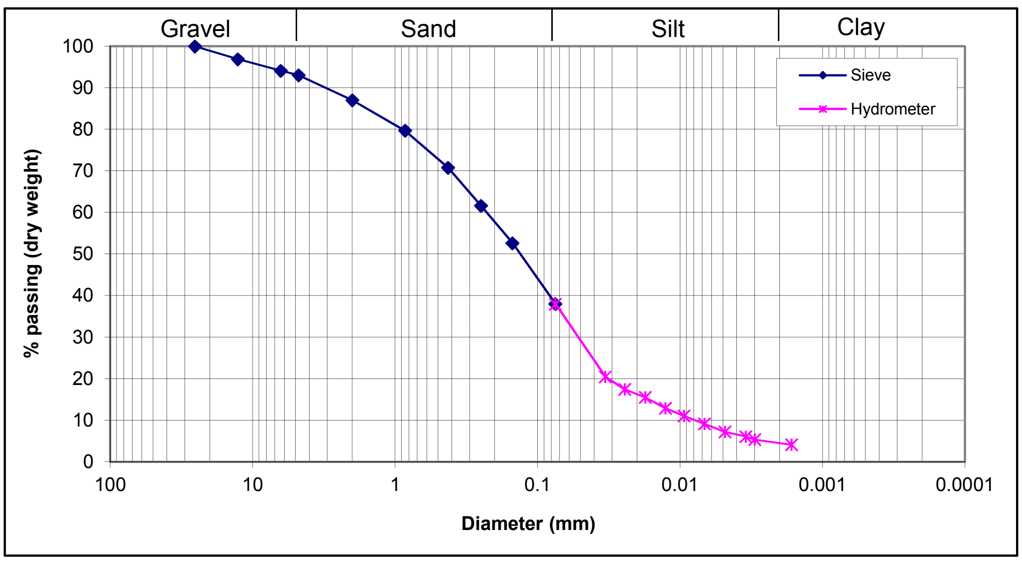
Sample No. : L16-TP5-0.7-0.8m

Depth below GS : 0.8 m - 1.7 m

Sieve Analysis

Dry weight of sample (g) = 183.34

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	---	---		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	5.73	3.13	3.13	96.87
1/4"	6.35	5.07	2.77	5.89	94.11
4	4.76	1.99	1.09	6.98	93.02
10	2.00	11.00	6.00	12.98	87.02
20	0.85	13.46	7.34	20.32	79.68
40	0.425	16.32	8.90	29.22	70.78
60	0.25	16.76	9.14	38.36	61.64
100	0.15	16.58	9.04	47.40	52.60
200	0.075	26.74	14.58	61.99	38.01
pan	---	69.69	38.01	100.00	---
		183.34			



D_{10} = 0.0079

D_{30} = 0.052

D_{60} = 0.229

Cu = 28.99

Cc = 1.49

USCS: SM (Silty sand)

R_{200} = 61.99

R_4 = 6.98

R_4/R_{200} = 0.11

SF = 55.01

GF = 6.98

% Gravel = 6.98

% Sand = 55.01

% Silt = 33.51

% Clay = 4.50

CFEM: Silty Sand, trace Gravel, trace Clay

Moisture Content (%): 13.88

GRAIN SIZE ANALYSIS-HYDROMETER

Project No. : 3098-02

Location of Project : Port aux Basques, NL, Grand Bay Road

Sample No. : L16-TP5-0.7-0.8m

Description of Soil : silty sand, trace gravel, trace clay

Sample Depth : 0.8 m - 1.7 m

Tested By : IL

Test Date : December 13, 2016

Hydrometer Analysis

Hydrometer Type: 152H

Zero Correction : 6

Meniscus Correction: 1

Dispersing Agent: $NaPO_4$

Amount Used: 4% @ 125 ml

G_s of Solids: 2.65

C.F. a : 1.0 (From Table 6-2)

Mass of Soil (g): 50

Control Sieve No. : 200

% finer than #200 from sieve analysis : 38.01

	1	2	3	5	4	6	7	8	9	10	11	12	13
Date	Time of reading	Elapsed Time, t(min.)	Temp. (^oC)	Act. Hyd. Reading, R_a	Temp. Corr. Factor, C_T(6-3)	Corr. Hyd. Reading, R_c	Actual % Finer	Adjusted % Finer	Hyd. corr. for meniscus, R	L (cm) {table 6-5}	L/t	K {table 6-4}	D (mm)
12/13/16	12:39	0	---	---	---	---	---	38.01	---	---	---	---	0.075
12/13/16	12:41	2	15	34	-1.1	26.9	53.8	20.5	35	10.50	5.250E+00	1.46E-02	3.345E-02
12/13/16	12:43	4	15	30	-1.1	22.9	45.8	17.4	31	11.20	2.800E+00	1.46E-02	2.443E-02
12/13/16	12:47	8	15	27.5	-1.1	20.4	40.8	15.5	28.5	11.60	1.450E+00	1.46E-02	1.758E-02
12/13/16	12:55	16	15.5	24	-1	17	34.0	12.9	25	12.20	7.625E-01	1.45E-02	1.266E-02
12/13/16	13:09	30	15.5	21.5	-1	14.5	29.0	11.0	22.5	12.60	4.200E-01	1.45E-02	9.397E-03
12/13/16	13:39	60	15.5	19	-1	12	24.0	9.1	20	13.00	2.167E-01	1.45E-02	6.749E-03
12/13/16	14:39	120	15.5	16.5	-1	9.5	19.0	7.2	17.5	13.40	1.117E-01	1.45E-02	4.845E-03
12/13/16	16:39	240	15.5	15	-1	8	16.0	6.1	16	13.70	5.708E-02	1.45E-02	3.464E-03
12/13/16	18:04	325	15.5	14	-1	7	14.0	5.3	15	13.80	4.246E-02	1.45E-02	2.988E-03
12/14/16	8:10	1171	12.5	13	-1.6	5.4	10.8	4.1	14	14.00	1.195E-02	1.51E-02	1.651E-03

GRAIN SIZE ANALYSIS

Project : 3098-02 - Grand Bay Road, Port aux Basques, NL

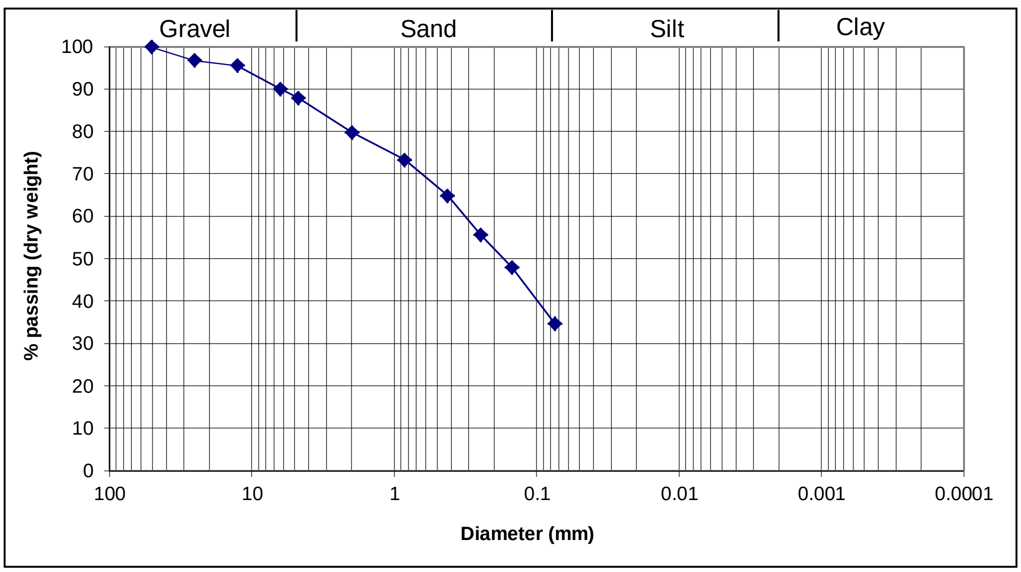
Sample No. : L16-TP5-0.8-0.0m

Depth below GS : 1.7 m - 2.5 m

Sieve Analysis

Dry weight of sample (g) = 178.26

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	0.00	0.00	0.00	100.00
1	25.4	5.65	3.17	3.17	96.83
1/2"	12.7	2.19	1.23	4.40	95.60
1/4"	6.35	9.78	5.49	9.88	90.12
4	4.76	3.77	2.12	12.00	88.00
10	2.00	14.59	8.18	20.18	79.82
20	0.85	11.42	6.41	26.59	73.41
40	0.425	15.12	8.48	35.07	64.93
60	0.25	16.39	9.19	44.27	55.73
100	0.15	13.68	7.67	51.94	48.06
200	0.075	23.80	13.35	65.29	34.71
pan	---	61.87	34.71	100.00	---
		178.26			



D_{10} = NA

D_{30} = NA

D_{60} = 0.32

Cu = NA

Cc = NA

USCS: SM (Silty sand)?

R_{200} = 65.29

R_4 = 12.00

R_4/R_{200} = 0.18

SF = 53.29

GF = 12.00

% Gravel = 12.00

% Sand = 53.29

% Silt & Clay = 34.71

% Clay = NA

CFEM: Silty/Clayey Sand, some Gravel

Moisture Content (%): 13.07

Memo

To: Ian Golding

From: Kevin Penney

cc: Ian Osmond

Date: May 31, 2017

Re. Marine Communications Traffic Centre
Lot 16, Grand Bay West Road, Port aux Basques

1. Introduction

This technical memo is to address geotechnical concerns for the proposed infrastructure for Lot 16, Grand Bay West Road, Port aux Basques.

A geotechnical investigation was conducted by Fracflow Consults Inc. (Fracflow) in December of 2016 for this site and proposed infrastructure. Within that report the following recommendations were made:

- Installation of three (3) sub grade drainage channels prior to construction; and
- Geotextile and geogrid installation on native soils before placement of required fill (Fracflow Consultants Inc., 2016).

2. Alternative Recommendations

Based on the information gathered by Amec Foster Wheeler in a review of the Fracflow report, alternate recommendations can also be considered for construction.

It is recommended that the subgrade excavation for the foundation be taken to a competent, non-saturated, unweathered, native material and backfilled using engineered fill (rockfill) to construct a rock mattress. It is recommended that a geotechnical engineer be onsite to inspect the subgrade material before the placement of any rockfill. If weak/soft spots are encountered, addition rockfill can be used to stabilize the area. If surficial water enters the excavation and disturbs material, that material can be removed and replaced with rockfill. Additional excavation may be required in areas of the prior test pit excavations.

The water encountered during the geotechnical investigation was identified as surface water (Fracflow Consultants Inc., 2016). The groundwater table was considered to be deeper than 3.5

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m as noted in the report (Fracflow Consultants Inc., 2016). Should surface water pose a concern it can be controlled with shallow ditching around the perimeter of the site. If during the excavation for placement of the rockfill of the foundation groundwater is encountered, then the sub grade drainage channels may be required. It is recommended that if required the drainage channels be located away from the footprint of the building.

It is our understanding there will be no basement in the building and the foundation will be either a slab on grade with a frost wall to the required depth, or, a thickened slab.

3. Additional Comments

3.1 Fill for Site Grading

Engineered fill should be a well graded, granular material such as sand and gravel or well graded rockfill from a quarry source. The maximum allowable particle diameter is 100 mm with a maximum fines (minus 0.075 mm) content of 8 percent. All engineered fill should be approved by the site engineer and placed and compacted under controlled conditions using procedures such as the following:

I. The area extent of engineered fill should be controlled by proper surveying techniques to ensure that the top of the engineered fill extends a minimum of 2.5 m beyond the perimeter of the structures to be supported. A maximum slope of 1V:1H (45º) constructed from engineered fill is to be maintained outside of this 2.5 m perimeter. This slope should not be confused with any embankment slopes which should be 1V:2H or flatter.

II. The area to receive the engineered fill should be stripped of any topsoil, organic matter, fill and other compressible, weak and deleterious materials. After stripping, the entire area should be inspected and approved by a Geotechnical Engineer. Spongy, wet or soft/loose spots should be sub-excavated to stable subgrade and replaced with compactable approved soil, compatible with subgrade conditions, as directed by a Geotechnical Engineer.

III. The fill material should be placed in thin layers ranging from 200 mm to 300 mm in thickness, depending on the compaction equipment used. Oversize particles (cobbles and boulders) larger than 100 mm should be discarded, and each fill layer should be uniformly compacted with heavy compactors, suitable for the type of fill used, to at least 100 percent of its Standard Proctor Maximum Dry Density (SPMDD) within the building envelope and 98 percent in the parking lot and roadways.

IV. Full-time geotechnical inspection and quality control (by means of frequent field density and laboratory testing) are necessary for the construction of a certifiable engineered fill. The compaction procedure and efficiency should be closely monitored by a Geotechnical Engineer.

V. The engineered fill should not be frozen and should be placed at moisture content within 2 percent of the optimum value for compaction. The engineered fill should not be placed during winter months when freezing ambient temperatures occur persistently or intermittently.

Based on the review of the Fracflow report, it is anticipated that onsite soils will not be suitable for reuse as engineered fill and should be disposed of either off site or incorporated into landscape areas. All materials to be used as engineered fill should be approved by the geotechnical engineer prior to placement. An allowable bearing capacity for footings installed on engineered fill or competent undisturbed native soil is 100 kPa.

Backfill material used around foundation walls should be free of deleterious material, free draining and classed as non-frost susceptible to reduce the potential effects of adfreeze. Maximum particle size should not exceed 100 mm. The granular backfill should be capped with a less permeable material and graded to promote positive drainage away from the building.

3.2 Excavation and Construction Dewatering

It is expected that excavations will be required for the foundation elements and for any underground utility installations. Conventional unsupported excavations are expected to be feasible where the groundwater table is below the bottom of the excavation. Based on previous studies, groundwater was assumed to be deeper than 3.5 m (Fracflow Consultants Inc., 2016). Any seepage from surficial runoff into the excavations can likely be dewatered using perimeter trenches, sumps, and pumps within the excavation. All excavations should be carried out in accordance with applicable occupational health and safety rules and regulations or a stricter set of rules and regulations if required by the Owner.

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4. CLOSURE

The recommendations were developed from a desktop study of available information and are in accordance with industry standard practices. Amec Foster Wheeler did not conduct addition investigations or perform a site visit. These recommendations are for site conditions during the initial investigation carried out by Fracflow Consultants Inc. If the conditions change at the time of construction, addition investigations may be required.

Yours sincerely,

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References

Fracflow Consultants Inc. (2016). *Geotechnical Report, Lot 16, Grand Bay West Road, Port aux Basques, NL.*