



**Fracflow Consultants Inc.**  
 Environmental, Hydrogeological and  
 Geotechnical Engineering Consultants



**Government of Canada** **Gouvernement du Canada**

**Geotechnical Factual Report  
 Wabush Airport  
 Wabush, NL**

*(File 3145)*

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Submitted to:

Public Services & Procurement Canada  
 Real Property Branch  
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PROVINCE OF NEWFOUNDLAND



**PERMIT HOLDER  
 CLASS "A"**  
 This Permit Allows  
**FRACFLOW CONSULTANTS INC**

*[Signature]*

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To practice Professional Engineering  
 in Newfoundland and Labrador.  
 Permit No. as issued by APEGNL D0169  
 which is valid for the year 2019.

November 2019



## **Executive Summary**

Fracflow Consultants Inc. was retained by PWGSC to conduct a geotechnical site investigation at three areas around the airport buildings in Wabush, NL. This investigation was conducted according to the stipulations outlined in the current Standing Offer Contract (No. EA003-182945/001/PWD) between PWGSC and Fracflow Consultants Inc.

The proposed scope of work for the Wabush airport geotechnical investigation consisted of drilling/augering eight (8) boreholes at the location provided by PWGSC. The field work for this investigation was conducted between September 27 and 30, 2019. Split-spoon sampling and Standard Penetration Tests (SPTs) were conducted every 1.5 m during using hollow stem augers. A visual inspection of the subsurface soil conditions encountered, based on the split-spoon samples that were recovered during the field program, and the laboratory data for the collected overburden samples were used to describe the soil conditions at the site. The depths for the eight (8) boreholes ranged from 4.51 m to 6.71 m below ground surface (bgs) based on the end of the last standard penetration tests (SPT). Refusal was encountered at six (6) boreholes with a depth range from 1.43 mbgs to 6.69 mbgs. Dynamic Cone Penetration Test (DCPT) was conducted in five (5) boreholes where refusal was not encountered when the bottom of the boreholes reached about 6 mbgs. A stand-pipe was installed at each borehole location upon the completion of borehole and the water depth from the ground surface was also measured for each monitoring well. The final blow counts from the DCPTs in the five (5) boreholes ranged between 96 and 126 per 150 mm (6 inch). Refusals to SPTs and DCPTs were encountered on boulders or broken bedrock.

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## **1.0 INTRODUCTION, SCOPE AND SITE DESCRIPTION**

Fracflow Consultants Inc. was retained by PWGSC to conduct a geotechnical site investigation at three areas around the airport buildings (**Figure 1**) in Wabush, NL. This investigation was conducted according to the stipulations outlined in the current Standing Offer Contract (No. EA003-182945/001/PWD) between PWGSC and Fracflow Consultants Inc.

The proposed scope of work for the Wabush airport geotechnical investigation consisted of drilling/augering eight (8) boreholes at the location provided by PWGSC. The field work for this investigation was conducted between September 27 and 30, 2019. Split-spoon sampling and Standard Penetration Tests (SPTs) were conducted every 1.5 m during augering with hollow stem augers.

Visual inspections of the subsurface soil conditions encountered based on the split-spoon samples that were recovered during the field program were used to describe the soil conditions at the site. The depths for the eight (8) boreholes ranged from 4.51 m to 6.71 m below ground surface (bgs) based on the end of the last standard penetration tests (SPT). Refusal was encountered at six (6) boreholes with a depth range from 1.43 mbgs to 6.66 mbgs.

Dynamic Cone Penetration Test (DCPT) was conducted in five (5) boreholes at the end of the auger penetration and the final SPT in those boreholes. A summary of the field work that was conducted is provided in **Table 1.1** and **Table 1.2**. A stand-pipe was installed in each borehole on the completion of the borehole and water depth from the ground surface was also measured in each standpipe.

This report contains a factual presentation and full disclosure of all findings of the subsurface investigation at the project site during the field work. 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 is a site plan showing the borehole locations, the detailed geotechnical logs for each borehole and the grain size analysis reports.

Table 1.1 Summary of Geotechnical Investigations at Wabush airport, Wabush, NL.

<b>Borehole ID</b>	<b>Overburden Drilled/Tested (m)</b>	<b>Bedrock Drilled (m)</b>	<b>Total Depth Drilled (m)</b>	<b>Split-spoon Samples Attempted</b>	<b>Split-spoon Samples Tested</b>
<b>BH1</b>	6.67	--	6.06	5	1
<b>BH2</b>	6.66	--	6.15	4	1
<b>BH3</b>	6.69	--	6.08	5	1
<b>BH4</b>	6.52	--	6.00	5	1
<b>BH5</b>	6.58	--	5.97	5	2
<b>BH6</b>	4.51	--	4.51	4	1
<b>BH7</b>	5.35	--	5.35	5	1
<b>BH8</b>	6.71	--	6.10	5	2
<b>Totals</b>	49.70	--	46.23	38	10

Table 1.2 Summary of Dynamic Cone Penetration Test at Wabush airport, Wabush, NL.

<b>DCPT ID</b>	<b>DCPT Start Depth (m)</b>	<b>DCPT End Depth (m)</b>	<b>Tested Length (m)</b>	<b>Blow Counts of DCPT (Overlapped distance with SPT in brackets)</b>
<b>BH1PC</b>	6.23	6.56	0.33	(18 / 101 / 126)
<b>BH2PC</b>	6.43	6.71	0.28	(26) / 120
<b>BH3PC</b>	6.49	6.92	0.43	(6) / 72 / 110
<b>BH5PC</b>	6.52	6.95	0.43	(30) / 49 / 105
<b>BH8PC</b>	6.20	7.04	0.85	(3 / 5 / 30 / 47) / 61 / 96

## **2.0 SITE DESCRIPTION AND GENERAL GEOLOGY**

The Wabush airport is located approximately 1.9 km northeast of Wabush, NL. Overburden in the area of the Wabush airport is characterized as “Till and Other Surficial Deposits (Undifferentiated): Predominantly nonstratified, poorly sorted, silty to sandy diamiction, gravel, and sandy gravel; deposited either directly from ice or by meltout during ablation; includes glaciofluvial, glaciolacustrine, marine, and fluvial deposits of either minor areal extent or thin (< 2 m) and discontinuous” (Klassen, et al., 1992). The overburden encountered in the boreholes consisted mainly of ‘Silty/Clayey Sand, some Gravel’. The bedrock in the area consists of the Knob Lake Group (Lower Proterozoic) with pelitic schist and pelitic gneiss of Menihek Formation and meta-ironstone and quartzite of Sokoman Formation (Wardle et al., 1997; Rivers and Massey, 1985). Bedrock was not recovered from any of the boreholes since no coring was attempted.

### **3.0 INVESTIGATIVE PROCEDURES**

At the Wabush airport site, eight (8) boreholes were drilled using hollow stem augering and geotechnical soil samples collected at the locations where ground conditions permitted. Drilling/Augering and soil sampling were completed using a Mobile B-47 drill rig. The borehole/DCPT locations are shown on the site plan in **Appendix A** that was provided by PWGSC.

Overburden material was drilled/augered using hollow stem augers with a auger head of 216 mm OD. 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 (SPT) were performed to estimate relative soil densities. The standard procedure is to drive each SPT, 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).

In addition to borehole augering and sampling, five (5) Dynamic Cone Penetration Tests (DCPTs) were performed upon completion of augering by driving the pencone out of the end of the augers at the corresponding boreholes. During the driving of the pencone, the cone was driven into the ground using a 63.5 kg weight falling a distance of 760 mm and the number of blow counts recorded for each 150 mm the cone advanced. The cone was driven into the soil until practical refusal occurred (50 blows per 50 mm or equivalent).

The collected soil samples were logged and labelled in the field immediately after collection, and then stored in water tight glass jars in the field. All soil samples were returned to Fracflow's office where selected soil samples collected during the investigation are tested. Soil testing in the

laboratory consists of standard mechanical sieve analyses and water contents that are performed according to ASTM standards. The soil 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 eight (8) boreholes drilled/augered in conjunction with the Standard Penetration Test data and the five (5) Dynamic Cone Penetration Tests. 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 location are provided in **Appendix B**. **Appendix C** contains the grain size analysis information for each soil sample tested.

### **4.1 Soil Description**

Overburden in the area of the Wabush airport is mainly characterized as “Till and Other Surficial Deposits (Undifferentiated): Predominantly nonstratified, poorly sorted, silty to sandy diamiction, gravel, and sandy gravel; deposited either directly from ice or by meltout during ablation; includes glaciofluvial, glaciolacustrine, marine, and fluvial deposits of either minor areal extent or thin (< 2 m) and discontinuous” (Klassen, et al., 1992). The overburden encountered in the boreholes consisted mainly of sand with gravel or silty/clayey sand with gravel.

Ten (10) samples were analyzed in the lab using mechanical grain size analysis. Under the main category by *USCS*, Four (4) samples were classified as ‘SM (Silty sand with gravel) or SC (Clayey sand with gravel) or SC-SM (Silty, clayey sand with gravel)’, another four (4) samples as ‘SM (Silty sand) or SC (Clayey sand) or SC-SM (Silty, clayey sand)’, one (1) sample as ‘SP-SM (Poorly graded sand with silt and gravel) or SP-SC (Poorly graded sand with clay and gravel)’, and one (1) sample as ‘SP-SM (Poorly graded sand with silt) or SP-SC (Poorly graded sand with clay)’. By *CFEM*, five (5) samples are described as ‘Silty/Clayey Sand, some Gravel’ and the other samples are as ‘Silty/Clayey Gravelly Sand’, ‘Silty/Clayey Sand, trace Gravel’, ‘Gravelly, Silty/Clayey Sand’, ‘Gravelly Sand, trace Silt/Clay’, and ‘Sand, trace Silt/Clay’.

Refusal was encountered at the bottom of the boreholes in four (4) boreholes, BH2, BH4, BH6 and BH7. Two (2) boreholes, BH5 and BH8, SPT refusal was encountered on boulders or broken bedrock at shallower depths at 1.61 mbgs and 3.53 mbgs, respectively. Refusal was not encountered in two (2) boreholes, BH1 and BH3.

DCPTs were conducted in the five (5) boreholes, BH1, BH2, BH3 and BH5 and BH8, where refusal was not encountered when the bottom of the boreholes reached about 6 mbgs. The final blow counts for the DCPTs in the five (5) boreholes ranged between 96 and 126 per 150 mm (6 inches).

The summary of depths of each borehole is provided in **Table 1.1** and each DCPT in **Table 1.2**. Detailed information for each borehole and DCPT is contained in **Appendix B**. The summary of depths of each borehole is provided in **Table 1.1** and each DCPT in **Table 1.2** and the sieve analysis data are provided in **Appendix C**.

## **4.2 Bedrock Description**

Bedrock units in the area are under Knob Lake Group (Lower Proterozoic) with pelitic schist and pelitic gneiss of Menihek Formation and meta-ironstone and quartzite of Sokoman Formation (Wardle et al., 1997; Rivers and Massey, 1985). Bedrock was not recovered in the boreholes since no coring was conducted.

## **5.0 REFERENCES**

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

Klassen, R A; Paradis, S; Bolduc, A M; Thomas, R D, 1992. Glacial landforms and Deposits, Labrador, Newfoundland and eastern Québec. Geological Survey of Canada, "A" Series Map no. 1814A

Rivers, T. and Massey, N. 1985: Geology of the Wightman Lake area, Labrador -Quebec. Map 85-28. Scale: 1:100 000. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division

Wardle, R J, Gower, C F, Ryan, B, Nunn, G A G, James, D T and Kerr, A., 1997. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Map 97-07, 1997.

***APPENDIX A***

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***Borehole Location Maps***

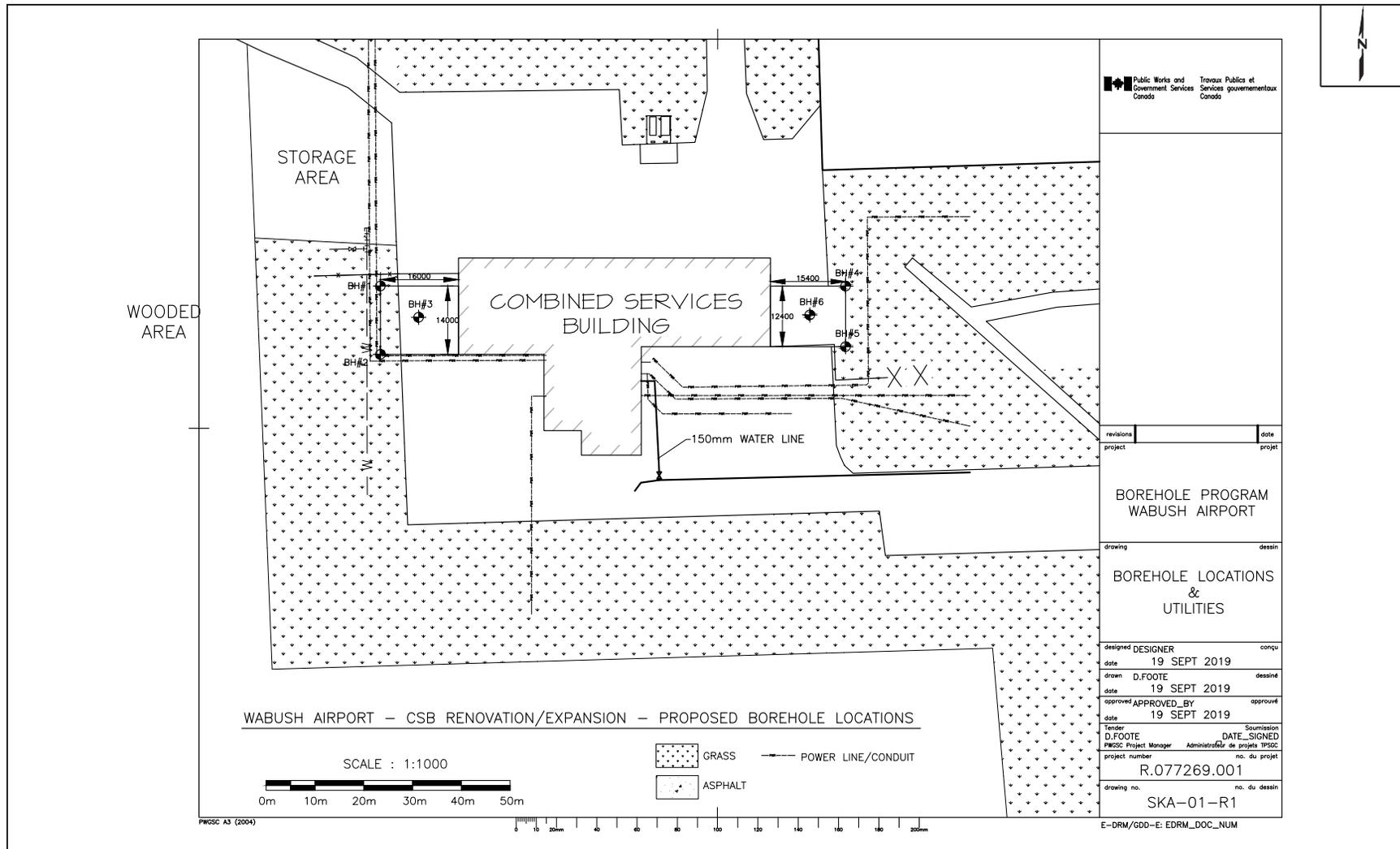


Figure 1 Borehole location map provided by PWGSC for BH1 to BH6 at the Wabush airport, Wabush, NL.

Project No. 3145	Document Reference FFC-NL-3145-001
Location Wabush, NL	Date November 2019



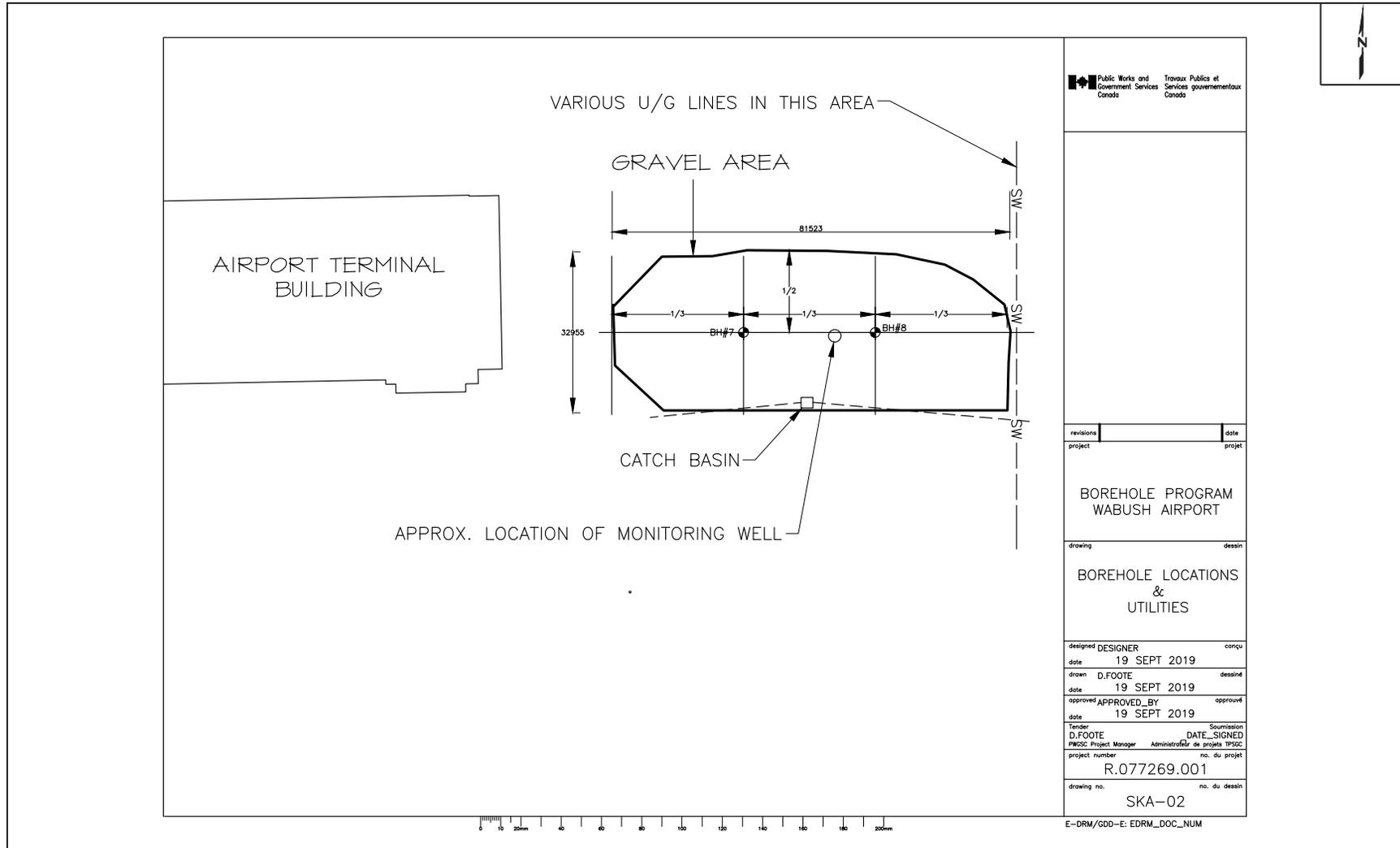


Figure 2 Borehole location map provided by PWGSC for BH7 and BH8 at the Wabush airport, Wabush, NL.

Project No. 3145	Document Reference FFC-NL-3145-001
Location Wabush, NL	Date November 2019



***APPENDIX B***

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***Borehole Logs***

Project: Geotechnical Investigation

# Log of Monitoring Well: BH1

Client: Public Services & Procurement Canada

Project No: 3145

Location: Wabush Airport, Wabush, NL

Date: September 27, 2019

SUBSURFACE PROFILE				SAMPLE				Standard Penetration Test "N" Value per 300 mm DCPT per 150 mm	Well Data	Well Description
Depth	Symbol	Geologic Description	Depth (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)			
0		Ground Surface (GS)	0							
1		Augering	-0.533	OB	-					Flush Mount at Ground Surface Riser SU 0.05 m bgs
3		SPT: 10 / 13 / 14 / 23 CFEM: Silty/Clayey Sand, trace Gravel	-1.14	SS	1	27	62			Native material packing from 0.05 m to 5.98 m
4		Augering	-1.5	OB	-					
6		SPT: 13 / 23 / 26 / 31 Brown silt and gravel	-2.11	SS	2	49	88			0.05 m dia. PVC riser from 0.05 m to 4.46 m
8		Augering	-3.01	OB	-					
11		SPT: 12 / 26 / 35 / 40 Brown gravel and sand	-3.62	SS	3	61	75			WL 4.52 m bgs (Sep. 30, 2019)
13		Augering	-4.51	OB	-					
16		SPT: 10 / 31 / 39 / 60 Brown sand and clay	-5.12	SS	4	70	92			0.05 m dia. PVC screen from 4.46 m to 5.98 m
18		Augering	-6.06	OB	-					
21		SPT: 14 / 46 / 52 / 96 Brown sand and clay	-6.67	SS	5	98	98			Pointed screw-on end cap at 5.98 m
22		DCPT: 18 / 101 / 126 for 0.03 m (Refusal) DCPT overlapped with the last SPT	-6.67							
24		End of Borehole								



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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Ground Surface

Sheet: 1 of 1

Project: Geotechnical Investigation

# Log of Monitoring Well: BH2

Client: Public Services & Procurement Canada

Project No: 3145

Location: Wabush Airport, Wabush, NL

Date: September 27 - 28, 2019

SUBSURFACE PROFILE				SAMPLE				Standard Penetration Test		Well Data	Well Description
Depth	Symbol	Geologic Description	Depth (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	Mod. TPH (mg/kg)	"N" Value per 300 mm DCPT per 150 mm		
0		Ground Surface (GS)	0								Flush Mount at Ground Surface
1		Augering		OB	-						Riser SU 0.05 m bgs
2		Augering		OB	-						Native material packing from 0.05 m to 6.06 m
3		SPT: 12 / 39 / 21 / 23 Brown/grey sand	-1.51	SS	1	60	83				
4		Augering		OB	-						
5		Augering		OB	-						
6		SPT: 72 for 0.03 m (Refusal) No recovery SS2: "N": Value = 72; Recovery = 0%	-3	SS	2	72	0				0.05 m dia. PVC riser from 0.05 m to 4.53 m
7		Augering		OB	-						
8		Augering		OB	-						
9		Augering		OB	-						
10		SPT: 10 / 25 / 39 / 42 Brown sand and clay	-4.59	SS	3	64	92				0.05 m dia. PVC screen from 4.53 m to 6.06 m
11		Augering		OB	-						WL 5.07 m bgs (Sep. 30, 2019)
12		Augering		OB	-						
13		Augering		OB	-						
14		Augering		OB	-						
15		SPT: 39 / 43 / 66 / 52 for 0.05 m (Refusal) CFEM: Gravelly Sand, trace Silt/Clay	-6.06	SS	4	109	85				Pointed screw-on end cap at 6.06 m
16		DCPT: 26 / 120 for 0.13 m (Refusal) DCPT overlapped 0.24 m with the last SPT	-6.96	SS	5	120					
17		End of Borehole									



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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Ground Surface

Sheet: 1 of 1

Project: Geotechnical Investigation

# Log of Monitoring Well: BH3

Client: Public Services & Procurement Canada

Project No: 3145

Location: Wabush Airport, Wabush, NL

Date: September 27, 2019

SUBSURFACE PROFILE				SAMPLE				Standard Penetration Test "N" Value per 300 mm DCPT per 150 mm	Well Data	Well Description
Depth	Symbol	Geologic Description	Depth (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)			
0		Ground Surface (GS)	0							
1		Augering	-0.572	OB	-					Flush Mount at Ground Surface Riser SU 0.05 m bgs
3	1	SPT: 14 / 22 / 19 / 17 Brown sand, silt and gravel	-1.18	SS	1	41	75			Native material packing from 0.05 m to 5.99 m
4		Augering	-1.44	OB	-					
6	2	SPT: 21 / 20 / 17 / 18 Brown gravel and sand	-2.05	SS	2	37	71			0.05 m dia. PVC riser from 0.05 m to 4.47 m
7		Augering	-2.98	OB	-					
11	3	SPT: 13 / 29 / 28 / 29 Brown sand and clay	-3.59	SS	3	57	79			0.05 m dia. PVC screen from 4.47 m to 5.99 m
13	4	Augering	-4.53	OB	-					
16	5	SPT: 19 / 28 / 44 / 60 CFEM: Silty/Clayey Sand, some Gravel	-5.14	SS	4	72	100			WL 5.38 m bgs (Sep. 30, 2019)
18		Augering	-6.08	OB	-					
21	6	SPT: 50 / 68 / 75 / 78 Brown clay	-6.69	SS	5	143	87			Pointed screw-on end cap at 5.99 m
22		DCPT: 6 / 72 / 110 for 0.13 m (Refusal) DCPT overlapped 0.20 m with the last SPT	-6.91	PC	-	72				
23	7	End of Borehole								



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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Ground Surface

Sheet: 1 of 1

Project: Geotechnical Investigation

# Log of Monitoring Well: BH4

Client: Public Services & Procurement Canada

Project No: 3145

Location: Wabush Airport, Wabush, NL

Date: September 28, 2019

SUBSURFACE PROFILE				SAMPLE				Standard Penetration Test		Well Data	Well Description
Depth	Symbol	Geologic Description	Depth (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	Mod. TPH (mg/kg)	"N" Value per 300 mm DCPT per 150 mm		
0		Ground Surface (GS)	0								
1		Augering	-0.521	OB	-						Flush Mount at Ground Surface Riser SU 0.05 m bgs
2		SPT: 4 / 9 / 13 / 11 Brown sand, silt and gravel	-1.13	SS	1	22	88				Native material packing from 0.05 m to 5.86 m
3		Augering	-1.47	OB	-						
4		SPT: 5 / 10 / 11 / 40 CFEM: Silty/Clayey Sand, some Gravel	-2.08	SS	2	21	81				 WL 2.40 m bgs (Sep. 30, 2019)
5		Augering	-2.95	OB	-						
6		SPT: 52 for 0.03 m (Refusal) No recovery SS3: "N" Value = 52; Recovery = 0%	-2.95	SS	3	52	0				0.05 m dia. PVC riser from 0.05 m to 4.33 m
7		Augering	-4.44	OB	-						
8		SPT: 17 / 51 / 49 / 43 Brown sand and clay	-5.05	SS	4	100	88				0.05 m dia. PVC screen from 4.33 m to 5.86 m
9		Augering	-6	OB	-						
10		SPT: 37 / 27 / 33 / 52 for 0.06 m (Refusal) Brown sand and clay	-6.51	SS	5	60	99				Pointed screw-on end cap at 5.86 m
11		End of Borehole									



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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Ground Surface

Sheet: 1 of 1

Project: Geotechnical Investigation

# Log of Monitoring Well: BH5

Client: Public Services & Procurement Canada

Project No: 3145

Location: Wabush Airport, Wabush, NL

Date: September 28, 2019

SUBSURFACE PROFILE				SAMPLE				Standard Penetration Test "N" Value per 300 mm DCPT per 150 mm	Well Data	Well Description
Depth	Symbol	Geologic Description	Depth (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)			
0		Ground Surface (GS)	0							
1		Augering	-0.451	OB	-					Flush Mount at Ground Surface Riser SU 0.05 m bgs
2		SPT: 4 / 10 / 19 / 30 Brown/grey sand and silt	-1.06	SS	1	29	81			Native material packing from 0.05 m to 5.83 m
3		Augering	-1.43	OB	-					
4		SPT: 50 / 52 for 0.03 m (Refusal) Brown/Grey gravel and sand	-1.61	SS	2	52	86			0.05 m dia. PVC riser from 0.05 m to 4.31 m
5		Augering	-2.91	OB	-					
6		SPT: 13 / 37 / 36 / 38 Brown sand	-3.52	SS	3	73	100			WL 3.81 m bgs (Sep. 30, 2019)
7		Augering	-4.5	OB	-					
8		SPT: 35 / 32 / 34 / 34 CFEM: Silty/Clayey Gravelly Sand	-5.11	SS	4	66	96			0.05 m dia. PVC screen from 4.31 m to 5.83 m
9		Augering	-5.97	OB	-					
10		SPT: 21 / 30 / 37 / 35 CFEM: Silty/Clayey Sand, some Gravel	-6.58	SS	5	67	100			Pointed screw-on end cap at 5.83 m
11		DCPT: 30 / 49 / 105 for 0.13 m (Refusal) DCPT overlapped 0.06 m with the last SPT	-6.95	PC	-	30				
12		End of Borehole								



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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Ground Surface

Sheet: 1 of 1

Project: Geotechnical Investigation

# Log of Monitoring Well: BH6

Client: Public Services & Procurement Canada

Project No: 3145

Location: Wabush Airport, Wabush, NL

Date: September 28 - 29, 2019

SUBSURFACE PROFILE				SAMPLE				Standard Penetration Test		Well Data	Well Description
Depth	Symbol	Geologic Description	Depth (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	Mod. TPH (mg/kg)	"N" Value per 300 mm DCPT per 150 mm		
0		Ground Surface (GS)	0						20 60		
1		Augering	-0.622	OB	-						Flush Mount at Ground Surface Riser SU 0.05 m bgs
3	1	SPT: 20 / 28 / 34 / 25 Brown sand and gravel	-1.23	SS	1	62	83				0.05 m dia. PVC riser from 0.05 m to 2.79 m
4		Augering	-1.45	OB	-						
6	2	SPT: 11 / 20 / 25 / 22 CFEM: Silty/Clayey Sand, some Gravel	-2.06	SS	2	45	71				▼ WL 1.96 m bgs (Sep. 30, 2019)
8		Augering	-2.98	OB	-						Native material packing from 0.05 m to 4.32 m
11	3	SPT: 20 / 36 / 33 / 45 Brown sand and clay	-3.59	SS	3	69	92				0.05 m dia. PVC screen from 2.79 m to 4.32 m
13	4	Augering	-4.51	OB	-						Pointed screw-on end cap at 4.32 m
15		SPT: 52 for 0.00 m (Refusal) No recovery SS4: "N" Value = 52; Recovery = 0%									
17	5	End of Borehole									
18											
19											
20	6										
21											
22											
23	7										
24											



Fracflow Consultants Inc.  
154 Major's Path  
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Fax: (709) 753-5101

Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Ground Surface

Sheet: 1 of 1

Project: Geotechnical Investigation

# Log of Monitoring Well: BH7

Client: Public Services & Procurement Canada

Project No: 3145

Location: Wabush Airport, Wabush, NL

Date: September 29, 2019

SUBSURFACE PROFILE				SAMPLE				Standard Penetration Test "N" Value per 300 mm DCPT per 150 mm 20 60	Well Data	Well Description
Depth	Symbol	Geologic Description	Depth (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)			
0		Ground Surface (GS)	0							
1		Augering	-0.584	OB	-					Flush Mount at Ground Surface Riser SU 0.05 m bgs
3	1	SPT: 12 / 24 / 33 / 28 Brown/grey sand and silt	-1.19	SS	1	57	71			Native material packing from 0.05 m to 4.95 m
4		Augering	-1.49	OB	-					
6	2	SPT: 14 / 10 / 10 / 7 Brown/grey gravel and sand	-2.1	SS	2	20	50			0.05 m dia. PVC riser from 0.05 m to 3.43 m
8		Augering		OB	-					
10	3	SPT: 6 / 14 / 10 / 16 Brown sand	-3.06	SS	3	24	25			WL 2.77 m bgs (Sep. 30, 2019)
13	4	Augering		OB	-					0.05 m dia. PVC screen from 3.43 m to 4.95 m
15		SPT: 14 / 26 / 98 / 52 for 0.06 m (Refusal)		SS	4	124	30			
16	5	CFEM: Gravelly, Silty/Clayey Sand	-5.07							Pointed screw-on end cap at 4.95 m
17		Augering	-5.35	OB	-					
18		SPT: 52 for 0.00 m (Refusal) No recovery								
19		SS5: "N" Value = 52; Recovery = 0%								
20	6	End of Borehole								
21										
22										
23	7									
24										



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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Ground Surface

Sheet: 1 of 1

Project: Geotechnical Investigation

# Log of Monitoring Well: BH8

Client: Public Services & Procurement Canada

Project No: 3145

Location: Wabush Airport, Wabush, NL

Date: September 29, 2019

SUBSURFACE PROFILE				SAMPLE				Standard Penetration Test "N" Value per 300 mm DCPT per 150 mm 20 60	Well Data	Well Description
Depth	Symbol	Geologic Description	Depth (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)			
0		Ground Surface (GS)	0							
1		Augering	-0.705	OB	-					Flush Mount at Ground Surface Riser SU 0.05 m bgs
3	1	SPT: 15 / 18 / 120 / 18 Brown sand	-1.31	SS	1	38	25			Native material packing from 0.05 m to 5.95 m
4		Augering		OB	-					
5		SPT: 7 / 11 / 13 / 12 CFEM: Sand, trace Silty/Clay	-2.06	SS	2	24	67			WL 2.33 m bgs (Sep. 30, 2019)
6	2	Augering		OB	-					
10	3	SPT: 9 / 20 / 31 / 52 for 0.08 m (Refusal) Brown sand and clay	-3.53	SS	3	51	38			0.05 m dia. PVC riser from 0.05 m to 4.43 m
13	4	Augering		OB	-					
16	5	SPT: 11 / 28 / 38 / 41 Brown sand and clay	-5.11	SS	4	66	83			0.05 m dia. PVC screen from 4.43 m to 5.95 m
18		Augering		OB	-					
21	6	SPT: 16 / 22 / 26 / 46 CFEM: Silty/Clayey Sand, some Gravel	-6.71	SS	5	48	71			Pointed screw-on end cap at 5.95 m
22		DCPT: 3 / 5 / 30 / 47		PC	-	47				
23	7	/ 61 / 96 for 0.09 m (Refusal) DCPT overlapped 0.51 m with the last SPT	-7.05	PC	-	61				
24		End of Borehole		PC	-	96				



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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Ground Surface

Sheet: 1 of 1

***APPENDIX C***

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***Grain Size Analysis***



## GRAIN SIZE ANALYSIS

Project : 3145 - Wabush, NL

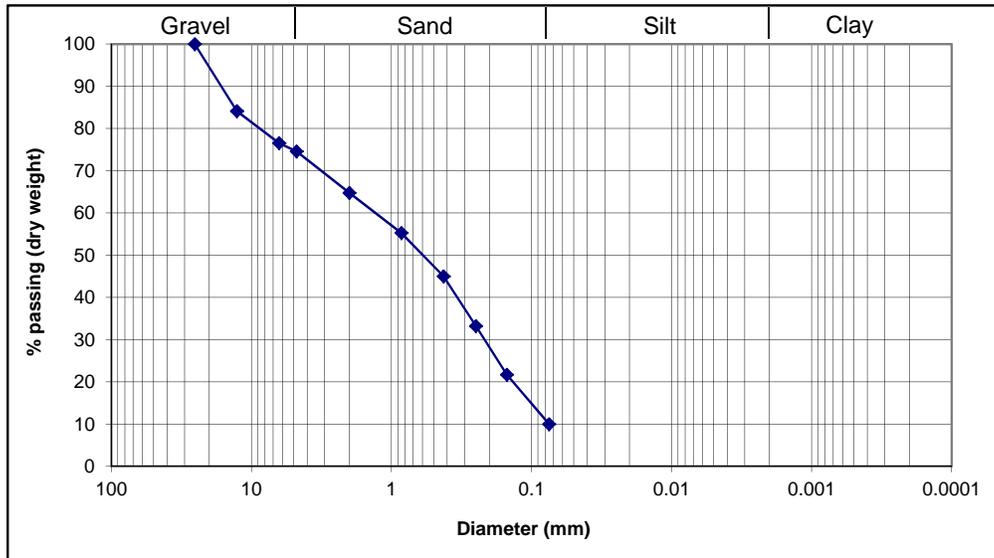
Sample No. : 3145-BH2-SS4

Depth below GS : 6.15 m - 6.66 m

Sieve Analysis

Dry weight of sample (g) = 184.88

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	29.36	15.88	15.88	84.12
1/4"	6.35	14.03	7.59	23.47	76.53
4	4.76	3.59	1.94	25.41	74.59
10	2.00	18.13	9.81	35.22	64.78
20	0.85	17.59	9.51	44.73	55.27
40	0.425	18.98	10.27	55.00	45.00
60	0.25	21.76	11.77	66.77	33.23
100	0.15	21.34	11.54	78.31	21.69
200	0.075	21.63	11.70	90.01	9.99
pan	---	18.47	9.99	100.00	---
		184.88			



$$D_{10} = 0.075$$

$$D_{30} = 0.22$$

$$D_{60} = 1.3$$

$$Cu = 17.33$$

$$Cc = 0.50$$

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

or SP-SC (Poorly graded sand with clay and gravel)

$$R_{200} = 90.01$$

$$R_4 = 25.41$$

$$R_4/R_{200} = 0.28$$

$$SF = 64.60$$

$$GF = 25.41$$

$$\% \text{ Gravel} = 25.41$$

$$\% \text{ Sand} = 64.60$$

$$\% \text{ Silt \& Clay} = 9.99$$

$$\% \text{ Clay} = \text{NA}$$

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

**Moisture Content (%):** 9.95

## GRAIN SIZE ANALYSIS

Project : 3145 - Wabush, NL

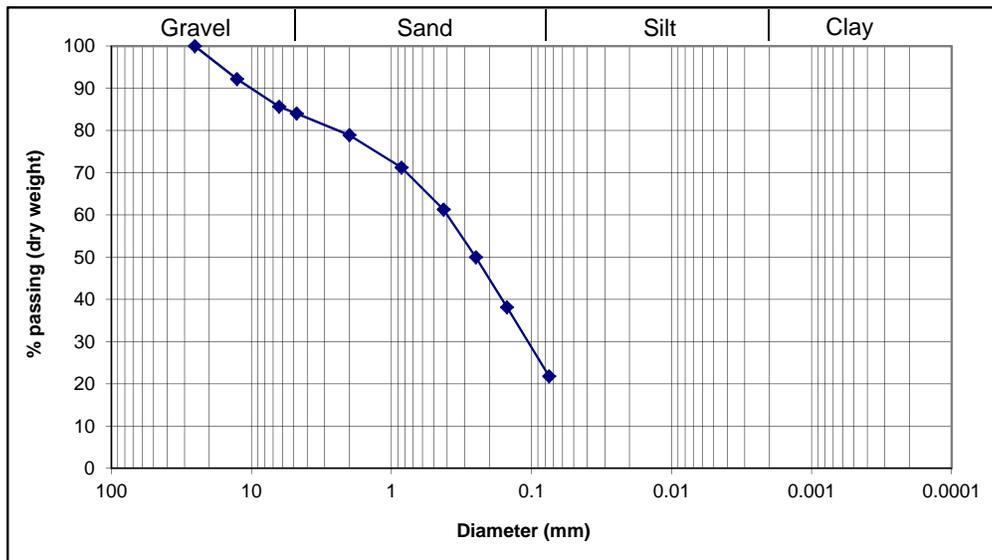
Sample No. : 3145-BH3-SS4

Depth below GS : 4.53 m - 5.14 m

Sieve Analysis

Dry weight of sample (g) = 202.08

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	15.78	7.81	7.81	92.19
1/4"	6.35	13.18	6.52	14.33	85.67
4	4.76	3.30	1.63	15.96	84.04
10	2.00	10.37	5.13	21.10	78.90
20	0.85	15.45	7.65	28.74	71.26
40	0.425	20.13	9.96	38.70	61.30
60	0.25	22.84	11.30	50.00	50.00
100	0.15	23.90	11.83	61.83	38.17
200	0.075	33.07	16.36	78.20	21.80
pan	---	44.06	21.80	100.00	---
		202.08			



$D_{10} = \text{NA}$   
 $D_{30} = 0.105$                        $C_u = \text{NA}$   
 $D_{60} = 0.4$                                $C_c = \text{NA}$

**USCS:** SM (Silty sand with gravel) or SC (Clayey sand with gravel)  
 or SC-SM (Silty, clayey sand with gravel)

$R_{200} = 78.20$	% Gravel = 15.96
$R_4 = 15.96$	% Sand = 62.23
$R_4/R_{200} = 0.20$	% Silt & Clay = 21.80
SF = 62.23	% Clay = NA
GF = 15.96	<b>CFEM:</b> Silty/Clayey Sand, some Gravel

**Moisture Content (%): 8.11**

## GRAIN SIZE ANALYSIS

Project : 3145 - Wabush, NL

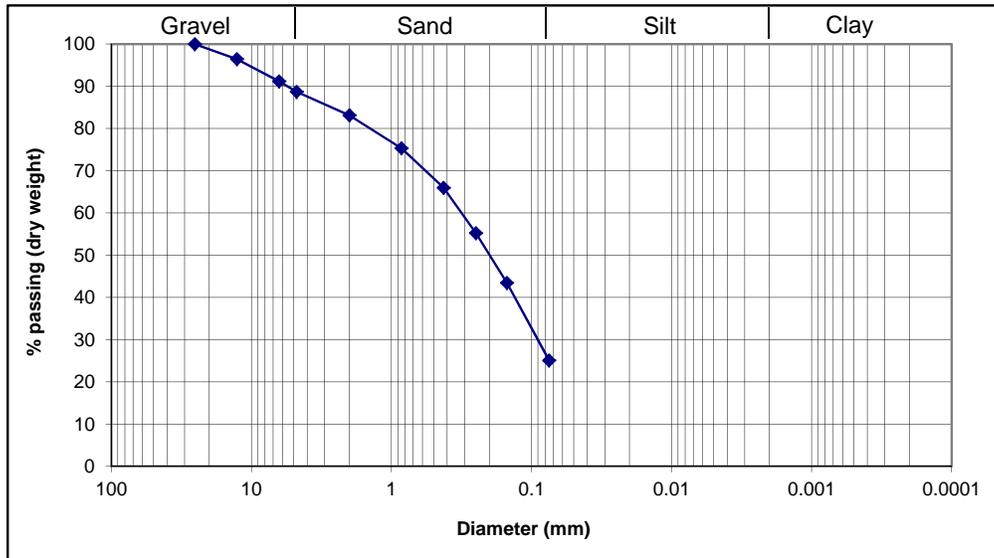
Sample No. : 3145-BH4-SS2

Depth below GS : 1.47 m - 2.08 m

Sieve Analysis

Dry weight of sample (g) = 178.97

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	6.36	3.55	3.55	96.45
1/4"	6.35	9.42	5.26	8.82	91.18
4	4.76	4.41	2.46	11.28	88.72
10	2.00	10.02	5.60	16.88	83.12
20	0.85	13.92	7.78	24.66	75.34
40	0.425	16.76	9.36	34.02	65.98
60	0.25	19.19	10.72	44.74	55.26
100	0.15	21.09	11.78	56.53	43.47
200	0.075	32.90	18.38	74.91	25.09
pan	---	44.90	25.09	100.00	---
		178.97			



$D_{10} = \text{NA}$

$D_{30} = 0.09$

$D_{60} = 0.32$

$C_u = \text{NA}$

$C_c = \text{NA}$

**USCS:** SM (Silty sand) or SC (Clayey sand) or SC-SM (Silty, clayey sand)

$R_{200} = 74.91$

$R_4 = 11.28$

$R_4/R_{200} = 0.15$

SF = 63.63

GF = 11.28

% Gravel = 11.28

% Sand = 63.63

% Silt & Clay = 25.09

% Clay = NA

**CFEM:** Silty/Clayey Sand, some Gravel

**Moisture Content (%):** 10.97

## GRAIN SIZE ANALYSIS

Project : 3145 - Wabush, NL

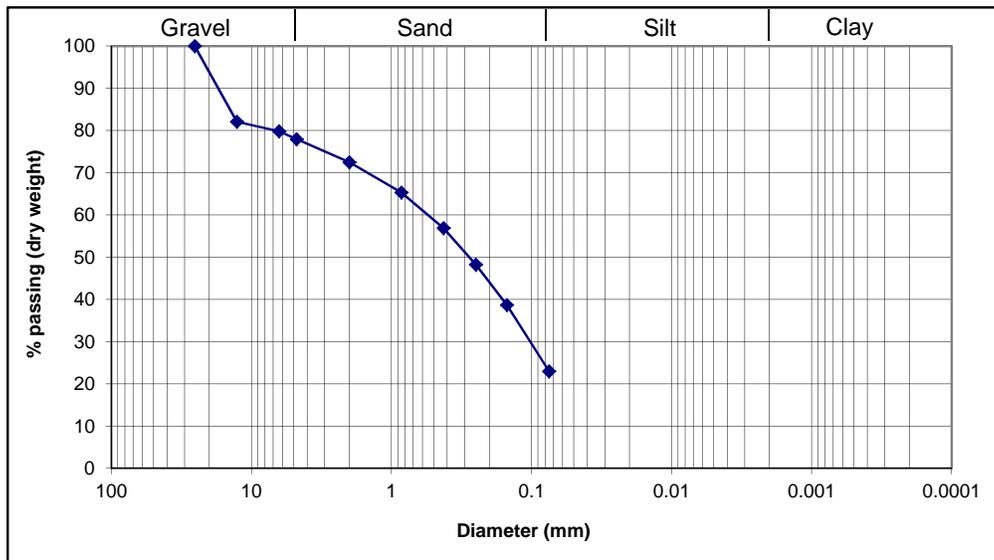
Sample No. : 3145-BH5-SS4

Depth below GS : 4.50 m - 5.11 m

Sieve Analysis

Dry weight of sample (g) = 258.62

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	46.36	17.93	17.93	82.07
1/4"	6.35	5.81	2.25	20.17	79.83
4	4.76	4.83	1.87	22.04	77.96
10	2.00	14.13	5.46	27.50	72.50
20	0.85	18.54	7.17	34.67	65.33
40	0.425	21.84	8.44	43.12	56.88
60	0.25	22.33	8.63	51.75	48.25
100	0.15	24.72	9.56	61.31	38.69
200	0.075	40.65	15.72	77.03	22.97
pan	---	59.41	22.97	100.00	---
		258.62			



$D_{10} = \text{NA}$

$D_{30} = 0.1$

$D_{60} = 0.55$

$C_u = \text{NA}$

$C_c = \text{NA}$

**USCS:** SM (Silty sand with gravel) or SC (Clayey sand with gravel)  
or SC-SM (Silty, clayey sand with gravel)

$R_{200} = 77.03$

$R_4 = 22.04$

$R_4/R_{200} = 0.29$

SF = 54.99

GF = 22.04

% Gravel = 22.04

% Sand = 54.99

% Silt & Clay = 22.97

% Clay = NA

**CFEM:** Silty/Clayey Gravelly Sand

**Moisture Content (%):** 8.26



## GRAIN SIZE ANALYSIS

Project : 3145 - Wabush, NL

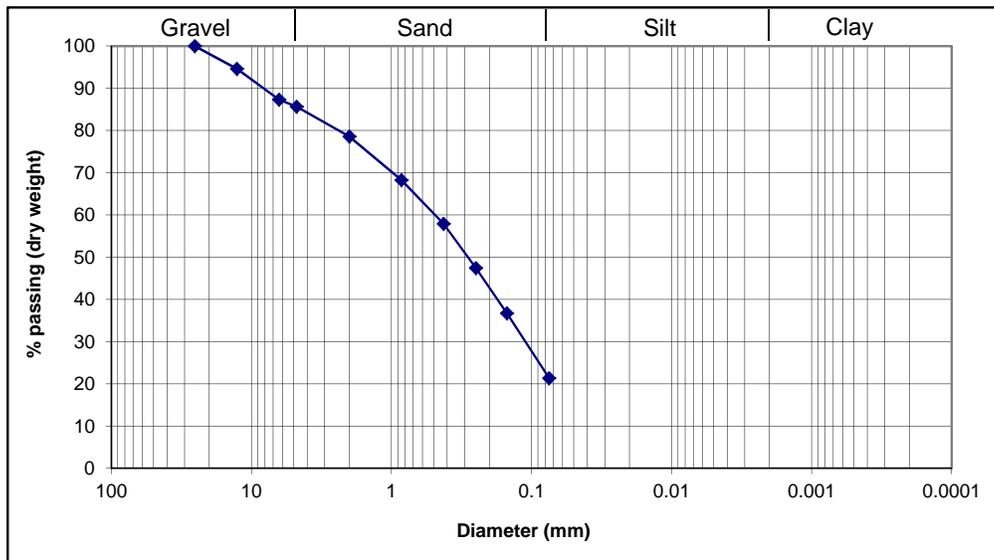
Sample No. : 3145-BH6-SS2

Depth below GS : 1.45 m - 2.06 m

Sieve Analysis

Dry weight of sample (g) = 202.87

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	10.89	5.37	5.37	94.63
1/4"	6.35	14.85	7.32	12.69	87.31
4	4.76	3.39	1.67	14.36	85.64
10	2.00	14.32	7.06	21.42	78.58
20	0.85	20.92	10.31	31.73	68.27
40	0.425	20.97	10.34	42.07	57.93
60	0.25	21.28	10.49	52.56	47.44
100	0.15	21.77	10.73	63.29	36.71
200	0.075	31.11	15.33	78.62	21.38
pan	---	43.37	21.38	100.00	---
		202.87			



$D_{10} = \text{NA}$

$D_{30} = 0.11$

$D_{60} = 0.49$

$C_u = \text{NA}$

$C_c = \text{NA}$

**USCS:** SM (Silty sand) or SC (Clayey sand) or SC-SM (Silty, clayey sand)

$R_{200} = 78.62$

$R_4 = 14.36$

$R_4/R_{200} = 0.18$

SF = 64.26

GF = 14.36

% Gravel = 14.36

% Sand = 64.26

% Silt & Clay = 21.38

% Clay = NA

**CFEM:** Silty/Clayey Sand, some Gravel

**Moisture Content (%):** 9.34

## GRAIN SIZE ANALYSIS

Project : 3145 - Wabush, NL

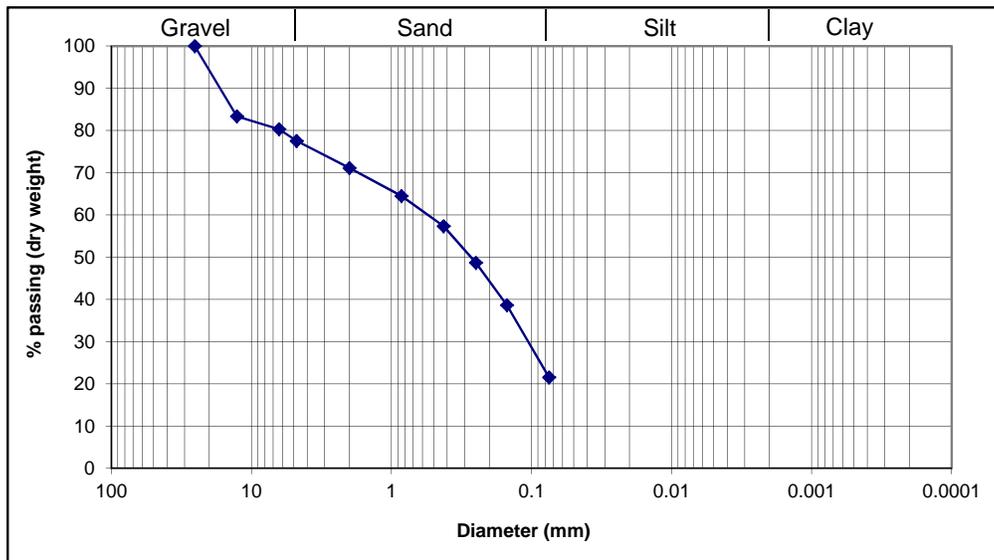
Sample No. : 3145-BH7-SS4

Depth below GS : 4.55 m - 5.07 m

Sieve Analysis

Dry weight of sample (g) = 185.89

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	30.92	16.63	16.63	83.37
1/4"	6.35	5.70	3.07	19.70	80.30
4	4.76	5.13	2.76	22.46	77.54
10	2.00	11.91	6.41	28.87	71.13
20	0.85	12.32	6.63	35.49	64.51
40	0.425	13.27	7.14	42.63	57.37
60	0.25	16.10	8.66	51.29	48.71
100	0.15	18.73	10.08	61.37	38.63
200	0.075	31.77	17.09	78.46	21.54
pan	---	40.04	21.54	100.00	---
		185.89			



$D_{10} = \text{NA}$

$D_{30} = 0.105$

$D_{60} = 0.55$

$C_u = \text{NA}$

$C_c = \text{NA}$

**USCS:** SM (Silty sand with gravel) or SC (Clayey sand with gravel)  
or SC-SM (Silty, clayey sand with gravel)

$R_{200} = 78.46$

$R_4 = 22.46$

$R_4/R_{200} = 0.29$

SF = 56.00

GF = 22.46

% Gravel = 22.46

% Sand = 56.00

% Silt & Clay = 21.54

% Clay = NA

**CFEM:** Gravelly, Silty/Clayey Sand

**Moisture Content (%):** 12.54

## GRAIN SIZE ANALYSIS

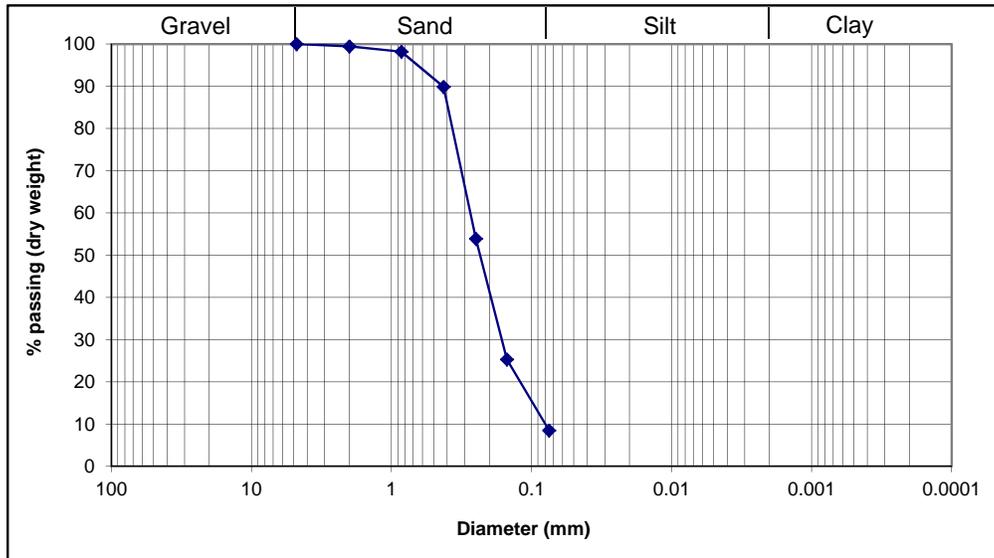
Project : 3145 - Wabush, NL

Sample No. : 3145-BH8-SS2  
Depth below GS : 1.45 m - 2.06 m

Sieve Analysis

Dry weight of sample (g) = 185.07

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	--	--		
1	25.4	--	--		
1/2"	12.7	--	--		
1/4"	6.35	--	--		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	1.03	0.56	0.56	99.44
20	0.85	2.31	1.25	1.80	98.20
40	0.425	15.43	8.34	10.14	89.86
60	0.25	66.55	35.96	46.10	53.90
100	0.15	52.91	28.59	74.69	25.31
200	0.075	31.11	16.81	91.50	8.50
pan	---	15.73	8.50	100.00	---
		185.07			



$$D_{10} = 0.08$$

$$D_{30} = 0.16$$

$$D_{60} = 0.28$$

$$Cu = 3.50$$

$$Cc = 1.14$$

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

or SP-SC (Poorly graded sand with clay)

$$R_{200} = 91.50$$

$$R_4 = 0.00$$

$$R_4/R_{200} = 0.00$$

$$SF = 91.50$$

$$GF = 0.00$$

$$\% \text{ Gravel} = 0.00$$

$$\% \text{ Sand} = 91.50$$

$$\% \text{ Silt \& Clay} = 8.50$$

$$\% \text{ Clay} = \text{NA}$$

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

**Moisture Content (%):** 8.20

## GRAIN SIZE ANALYSIS

Project : 3145 - Wabush, NL

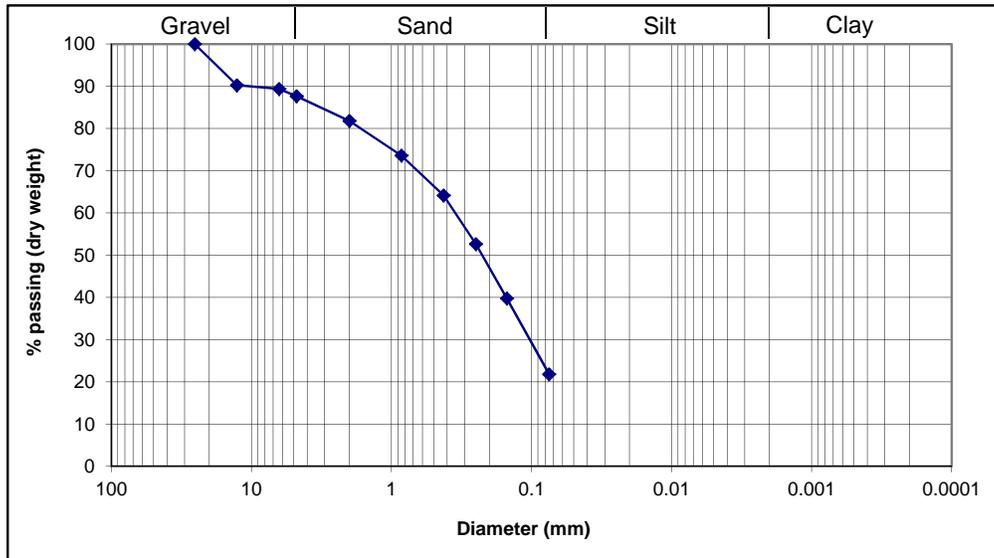
Sample No. : 3145-BH8-SS5

Depth below GS : 6.10 m - 6.71 m

Sieve Analysis

Dry weight of sample (g) = 178.83

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	17.42	9.74	9.74	90.26
1/4"	6.35	1.55	0.87	10.61	89.39
4	4.76	3.13	1.75	12.36	87.64
10	2.00	10.42	5.83	18.18	81.82
20	0.85	14.68	8.21	26.39	73.61
40	0.425	16.87	9.43	35.83	64.17
60	0.25	20.60	11.52	47.35	52.65
100	0.15	23.03	12.88	60.22	39.78
200	0.075	32.09	17.94	78.17	21.83
pan	---	39.04	21.83	100.00	---
		178.83			



$D_{10} = \text{NA}$

$D_{30} = 0.105$

$D_{60} = 0.35$

$C_u = \text{NA}$

$C_c = \text{NA}$

**USCS:** SM (Silty sand) or SC (Clayey sand) or SC-SM (Silty, clayey sand)

$R_{200} = 78.17$

$R_4 = 12.36$

$R_4/R_{200} = 0.16$

SF = 65.81

GF = 12.36

% Gravel = 12.36

% Sand = 65.81

% Silt & Clay = 21.83

% Clay = NA

**CFEM:** Silty/Clayey Sand, some Gravel

**Moisture Content (%):** 12.32