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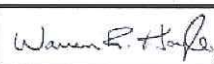
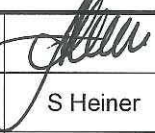

Milne Port Ore Dock No. 2 Factual Geotechnical Report

(286 Pages)

Report

Baffinland Iron Mines Corporation Mary River Expansion Project

2017 Milne Port Ore Dock No. 2 Geotechnical Factual Data Report

						
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This report contains the expression of the professional opinion of Hatch, based upon information available at the time of preparation. Hatch has conducted this investigation in accordance with the methodology outlined herein. It is important to note that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems, cannot guarantee their absence. The quality of the information, conclusions and estimates contained herein is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

Waiver, Release and Indemnification

To: Hatch Ltd. together with its affiliates, the "Consultant"

Re: 2017 Milne Ore Dock No. 2 Geotechnical Factual Data Report (and together with any subsequent revisions thereof, the "Report") dated October 03, 2017 prepared by the Consultant for Baffinland Iron Mines Corporation (the "Client"), in respect of the drilling, soil sampling at the proposed Ore Dock 2 and laboratory testing of samples.

The undersigned hereby:

(a) acknowledges that it wishes to receive a copy of the Report from the Client and that a condition precedent to the provision of the Report to the undersigned is that it sign and deliver to the Consultant this Waiver, Release and Indemnification; and

(b) irrevocably and unconditionally:

(i) waives, releases and disclaims any and all suits, actions, proceedings, claims and any other rights (whether in tort, contract or otherwise and whether past, present or future) that it has or may have against or in relation to the Consultant in respect of or in connection with the Report;

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(iii) agrees to indemnify, defend and hold harmless the Consultant from and in respect of any suits, actions, proceedings, claims, damages, costs and expenses suffered or incurred by the Consultant and which relate to or result from the use of the Report by the undersigned or the provision by the undersigned of the Report or any of the information set out in the Report to any third party; and

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Dated: [insert current date]

[INSERT NAME OF REPORT RECIPIENT]

By: _____

Name:

Title:

Table of Contents

1. Introduction.....	1
1.1 Previous Investigations.....	1
1.2 Pre-Investigation Activities.....	1
1.2.1 Safety Management Plan.....	1
1.2.2 Ice Thickness Assessment	1
2. Geotechnical Investigation	2
2.1 General	2
2.2 Sonic Borehole and CPTu Sounding Locations	2
2.3 Drilling and Sampling Methodology for Boreholes.....	3
2.4 Methodology for Performing Piezocone Soundings	5
2.5 Laboratory Testing.....	6
3. Results of Investigation	7
3.1 Milne Port Offshore Boreholes.....	7
3.1.2 Shallow Water Boreholes.....	8
3.1.3 Mid-Depth Boreholes	9
3.1.4 Deep Water Boreholes.....	10
3.1.5 Influence of Drilling Methods on SPT N-Values.....	10
3.2 Piezocone Sounding Results.....	11
3.3 Laboratory Test Results.....	12
4. Summary of Geotechnical Findings	13
5. References	14

List of Tables

Table 2-1: Milne Port Borehole Locations and Depths	3
Table 2-2: Milne Port CPTu Locations and Depths	3
Table 2-3: Laboratory Testing Standards from 2017 Investigation.....	6
Table 3-1 Summary of Material Encountered in Shallow Boreholes	9
Table 3-2: Summary of Materials Encountered in Mid-Depth Boreholes	9
Table 3-3 Summary of Materials Encountered in Deep Borehole	10
Table 3-4: Summary of Particle Size Distribution Testing	12
Table 3-5 Summary of Direct Shear Testing on Borehole Samples.....	13

List of Figures

Figure 1: 2017 Offshore Drilling Setup.....	4
Figure 2: Ramset Used for Pushing Cones Through the Seabed	5
Figure 3: Data Acquisition System For Piezocone Testing.....	6
Figure 4: Transition from Gravelly Sand to Silt in BH17-D002	7
Figure 5: Dark grey silt and sand encountered below 4.6 m in BH17-D001.....	7
Figure 6: Fine Sand From BH17-D003	8
Figure 7: Grey sand on from the sea bed, BH17-D001	8

Figure 8: Reddish brown sand encountered in BH17-D001	8
Figure 9: Gravelly Sand from BH17-D005	8
Figure 10: Sand from BH17-D006	10

Appendices:

Appendix A

Borehole Location Plan

Appendix B

Borehole Reports

Appendix C

Sample Photographs

Appendix D

Laboratory Test Reports

Appendix E

Geotechnical Investigation Job Hazard Analysis

Appendix F

ConeTec Report

Appendix G

Laboratory Certificate

Appendix H

Ice Thickness Assessment

Appendix I

Fence Diagrams

Appendix J

Influence of Drilling Method on Standard Penetration Testing

1. Introduction

Baffinland Iron Mines LP (BIM) currently operates the Mary River iron ore mine in Nunavut, Canada. BIM plans to increase the mine production to 12 Mtpa, shipping the output through the Milne Port. This will be achieved by upgrading the mine fleet, constructing a 105 km long rail line from the mine site to the port, building a new crushing and screening facility at the port, construction of larger ore stockpiles and building a secondary dock for ship loading.

Hatch Ltd. (Hatch) was retained by BIM to conduct geotechnical investigations for an additional ore dock (Ore Dock No. 2) at the Milne Port Site.

This report presents (i) sonic borehole data at the proposed Ore Dock No. 2 location including the visual observations and laboratory test results for particle size distribution and soil behavior type and (ii) piezocone penetration test (CPTu) data. In addition, sample photographs are appended providing visual records of the soil cores.

1.1 Previous Investigations

Geotechnical investigation programs have previously been conducted at the Mary River mine site, Steensby Inlet port structure, and the Milne Inlet port site, the Tote Road, as well as offshore investigations for Ore Dock No. 1 at Milne Port.

These previous programs were conducted in 2006, 2007, and 2008 by Knight Piésold Consulting Ltd. (Knight Piésold), in 2010 by AMEC Earth and Environmental (AMEC) in 2011 by Thurber Engineering (Thurber), and in 2013 and 2014 by Hatch.

For the 2013-2014 investigation, offshore boreholes were drilled at the Milne Port for Ore Dock No. 1. The soil thermal resistivity was tested, and a geophysical survey consisting of seismic refraction, seismic resonance, and Multichannel Analysis of Surface Waves were conducted. Information from the 2013-2014 investigation undertaken by Hatch for the Milne Port has been used in this report when relevant.

1.2 Pre-Investigation Activities

1.2.1 *Safety Management Plan*

Safety management was a key consideration during the planning process for the geotechnical investigations. A safety management plan was prepared by Hatch and reviewed and approved by BIM and Boart Longyear Ltd. (Boart Longyear). As part of the execution plan for the Milne Port Offshore Investigation, a Job Hazard Analysis (JHA); appended as Appendix E; was developed by Hatch and BIM and reviewed by Boart Longyear. All site personnel reviewed and signed off on the JHA. This JHA was reviewed on a periodic basis and updated when there were changes to the conditions or the work activities.

1.2.2 *Ice Thickness Assessment*

As required by the JHA, an ice assessment plan was prepared to test the thickness of the ice sheet and assess it before mobilizing equipment on the ice, to ensure the ice was sufficiently

strong to support the drill rig and associated equipment and personnel. The target thickness was more than 1.5 m of ice.

The ice thickness assessment consisted of auguring test holes through the ice on a grid pattern at the drilling location; 34 of the 46 planned auger holes were drilled to confirm the ice thickness. The 12 remaining holes were located mostly in an area of ground ice (full ice column to the seabed) and did not require detailed delineation as found during the ice auguring program. The test holes were augured using a 20 cm (8 in) diameter gas-powered auger operated by two Boart-Longyear workers. Once the hole was augured, a Hatch field engineer measured the thickness of the sea ice, the depth of freeboard as well as the height of the snow cover on the ice. The completed ice assessment and UTM Coordinates of the test holes can be found in Appendix H.

2. Geotechnical Investigation

2.1 General

The drilling supervision, material logging and sampling was carried out by Hatch Boart Longyear was selected as the drilling contractor and ConeTec Inc. (ConeTec) was selected as the contractor to perform piezocone penetration tests, (piezocone soundings). The Hatch field personnel and the contractor mobilized to the site on March 7, 2017. The field investigations for the Milne Port Ore Dock No. 2 offshore program were completed between March 8, 2017 and April 7, 2017.

A total of six boreholes were developed ranging from a depth of 24.4 m to 42.7 m below the sea bed. In addition, eight piezocone soundings were performed with depths ranging from 20.5 to 39.5 m.

Soil samples were collected on site and shipped to the Hatch geotechnical laboratory in Niagara Falls for additional visual examination. Representative samples were selected for further laboratory testing (See Section 2.5 for more detail).

This report provides information for the proposed Milne Port Ore Dock No. 2 seabed area approximately 300 m from the shoreline. Land based drilling was completed for the Milne Port infrastructure and results are presented in the report entitled, "2016 Milne Port Geotechnical Investigation Factual Data Report (H353034-1000-229-230-0002, Rev. 2, October 03, 2017)".

2.2 Sonic Borehole and CPTu Sounding Locations

The surveyed location of the sonic borehole and the borehole depths are provided in Table 2-1. The CPTu surveyed locations and total depths are summarized in Table 2-2. All coordinates are located within Zone 17 of the Universal Transverse Mercator (UTM) Grid. The horizontal datum for this project is the North American Datum 1983 (NAD 83). The as-built borehole location plan is provided in Appendix A.

In the naming convention, the prefix BH represents Borehole and CPT represents Piezocone sounding, while 17 refers to 2017, the year of the investigation. The first letter following the dash symbol (-) categorizes the borehole location as the proposed Ore Dock No. 2 (D).

Table 2-1: Milne Port Borehole Locations and Depths

Borehole Number	Easting (m)	Northing (m)	Depth (m)
BH17-D001	503,644	7,976,666	27.4
BH17-D002	503,764	7,976,680	27.4
BH17-D003	503,608	7,976,710	30.5
BH17-D004	503,701	7,976,728	42.7
BH17-D005	503,786	7,976,738	31.1
BH17-D006	503,678	7,976,797	24.4

Table 2-2: Milne Port CPTu Locations and Depths

Borehole Number	Easting (m)	Northing (m)	Depth (m)
CPT17-D001	503,607	7,976,718	32.8
CPT17-D002	503,705	7,976,728	39.5
CPT17-D003	503,785	7,976,758	30.4
CPT17-D004	503,646	7,976,768	32.1
CPT17-D005	503,736	7,976,781	25.1
CPT17-D006	503,808	7,976,808	20.6
CPT17-D007	503,767	7,976,684	30.2
CPT17-D008	503,636	7,976,651	30.0

2.3 Drilling and Sampling Methodology for Boreholes

The geotechnical boreholes were drilled using a BL100 Mini Sonic Drilling rig owned and operated by Boart Longyear. The boreholes were advanced using vibration of the drill string at a high frequency in addition to rotary motion, and pressure by the drilling head.

A 178 mm (7 in.) casing was lowered to approximately 3 m above the seabed and suspended using a collar seated on the ice around the borehole. A 152 mm (6 in.) casing was then lowered to the seabed surface and an HQ rod (89 mm OD) was used for the sonic drilling with seawater. Figure 1 shows the offshore drilling setup including the drilling rig, drill shack, survival shack, drilling rods/casings rack and a light tower. Other major equipment included a tracked utility vehicle, skid steer, generator sets, frost fighters and pickup trucks.



Figure 1: 2017 Offshore Drilling Setup

In order to collect soil samples, a 3 m drilling rod was advanced 1.5 m into the seabed for each run. The bottom 1.5 m was collected into a 4 in. split PVC pipe, and the top 1.5 m was collected in a second 4 in. split PVC pipe. Both samples from the 3 m run were inspected by the field supervisor.

The Hatch field supervisor documented the materials encountered, and determined in situ testing and sampling requirements. Samples were typically taken at 2 m to 4 m spacing. The description of soils as detailed in the geotechnical borehole reports are based on field visual classification and confirmatory laboratory testing in accordance with the explanatory notes included with these reports.

The detailed geotechnical borehole drilling reports are contained in the attached Appendix B and should be referenced for a complete description of soil materials and the in situ testing and sampling performed. Appendix B also contains a set of explanatory notes detailing terminology used in the borehole reports. Additional observations such as testing and sampling procedures, percent recovery, water loss/gain, and mechanical heating of samples were recorded, along with time of observation. Photographs of samples collected during the drilling investigation are contained in Appendix C.

2.4 Methodology for Performing Piezocone Soundings

The piezocone soundings were completed by ConeTec using the Boart Longyear drilling rig, CPTu equipment and a ramset (Figure 2). The piezocone soundings were undertaken as per ASTM D5778. The ramset used the hydraulic system of the drilling rig to push an instrumented cone under the seabed. The drilling rig was secured in place using heavy duty steel chains and titanium ice studs to prevent it from lifting.



Figure 2: Ramset used for Pushing Cones through the Seabed

The cone was pushed through the soil at 2.5 cm/s and data was collected electronically in real time by an onsite data acquisition system as shown in Figure 3. Tip resistance, sleeve friction and pore-water pressure was recorded at 2.5 cm intervals. The Soil Behaviour Type (SBT) chart by Robertson and Campanella (1986) was used to characterize the soil type i.e., Sand, Silty Sand, etc.



Figure 3: Data Acquisition System for Piezocone Testing

A total of 8 piezocone soundings were completed for the offshore investigation. Piezocone testing characterizes the soil based on its behaviour type as opposed to the particle size distribution. Soil behavior is deduced based on the friction ratio.

$$\text{Friction Ratio} = \frac{\text{Sleeve Friction}}{\text{Tip Resistance}} \times 100$$

According to Robertson and Campanella's SBT chart, finer grained soils tend to have a high friction ratio (i.e., high sleeve friction, low tip resistance) while coarser grained soils tend to have a lower friction ratio (i.e., low sleeve friction, high tip resistance). Overburden stress and pore-water pressure data can be used to correct soil classifications acquired from piezocone testing.

See Appendix F for detailed information regarding the CPTu test results.

2.5 Laboratory Testing

All soil samples were shipped to the Hatch geotechnical laboratory in Niagara Falls, a Canadian Council of Independent Laboratories (CCIL) certified laboratory (see Appendix G for the certification document). Discussion of the lab results is included in Section 3 of this report, with full laboratory test results in Appendix D.

Table 2-3: Laboratory Testing Standards from 2017 Investigation

Name	Standard
Standard Test Methods for Particle-Size Distribution of Soils Using Sieve Analysis	ASTM D6913
Standard Test Method for Particle Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis	ASTM D7928
Direct Shear Tests of Soils Under Consolidated Drained Conditions	ASTM D3080

3. Results of Investigation

3.1 Milne Port Offshore Boreholes

A total of six (6) boreholes were drilled offshore at Milne Port to support design of the proposed Ore Dock No. 2 at Milne Port. The boreholes were arranged into three categories based on the depth to seabed; the shallow water (closest to shoreline), the mid-depth holes, and the deep water (farthest from shoreline). Fence diagrams of select borehole sections are presented in Appendix I.

The materials encountered during the investigation typically consisted of silt and sand, sand or gravelly sand. In the shallow and deep boreholes these layers were found inter layered without a consistent trend of coarsening or fining with depth, when all the boreholes are considered. In general, it was noted that there was a tendency for coarser deposits to have a brown to reddish brown colour whereas finer deposits tended to be coloured grey to dark grey, see Figure 4.



Figure 4: Transition from Gravelly Sand to Silt in BH17-D002

The recorded elevations for the boreholes were determined from the surveyed drilling position on the sea ice and the depth to the sea bed; the depths noted refer to depth below the sea bed. Total drilling depths were corrected for the tidal effects.

3.1.1.1 *Silt and Sand*

A soil comprising a mix of silt and sand was encountered at the surface, where there was recovery, in the mid-depth boreholes. Layers of silt and sand were also noted in the mid-depth boreholes beneath the surface layer of sand, and also at depth. The silt and sand was noted to occur in either grey to dark grey, generally comprised of fine sand, see Figure 5, or a reddish brown, which tended to have coarse sand.



Figure 5: Dark Grey Silt and Sand Encountered Below 4.6 m in BH17-D001

3.1.1.2 *Sand*

Sand was encountered at surface in the shallow and deep borehole locations. The sand was typically fine to coarse grained when encountered in the upper 10 m of the boreholes, and tended to be finer at depth. Sand was generally light grey to brown. Sand was intersected for the full depth of the deep borehole BH17-D006. Examples of the sand encountered in the investigation are presented in Figure 6 through Figure 8.



Figure 6: Fine Sand from BH17-D003



Figure 7: Grey Sand from the Sea Bed, BH17-D001



Figure 8: Reddish Brown Sand Encountered in BH17-D001

3.1.1.3 *Gravelly Sand*

The gravelly sand layer (also referred to as Sand with Gravel in the borehole logs) was encountered in both shallow and one mid-depth borehole. Typically the gravelly sand was well graded, and where described the gravel was noted to be rounded to subangular. The gravelly sand was brown to reddish brown in most cases, as seen in Figure 9.



Figure 9: Gravelly Sand from BH17-D005

3.1.2 *Shallow Water Boreholes*

The two boreholes drilled in shallow water are BH17-D001 and BH17-D002. The recorded elevations are -2.38 m and -3.25 respectively. The materials encountered in these boreholes are summarized in Table 3-1. Generally BH17-D001 intersected alternating sand and gravelly sand below 7.6 m, and BH17-D002 encountered gravelly sand below 8.5 m.

Table 3-1: Summary of Material Encountered in Shallow Boreholes

Borehole Number	Depth Material Encountered		
	Silt and Sand	Sand	Gravelly Sand
BH17-D001	4.3 – 7.6	0 – 4.3; 9.7 – 17.1; 18.3 – 21.9; 24.4 – 27.4*	17.1 – 18.3; 22.9 – 24.4
BH17-D002	4.6 – 8.5	0 – 3.0; 12.8 – 13.7	8.5 – 12.8; 13.7 – 27.4

* Denotes termination depth

3.1.3 Mid-Depth Boreholes

BH17-D003, BH17-D004 and BH17-D005 were drilled at an elevation of -15.3 m, -16.6 m and -19.5 m, respectively. The materials intersected in these boreholes is summarized in Table 3-2.

Table 3-2: Summary of Materials Encountered in Mid-Depth Boreholes

Borehole Number	Depth Material Encountered		
	Silt and Sand or Silty Sand	Sand	Gravelly Sand
BH17-D003	3.0 – 6.1; 21.3 – 21.9; 27.4 – 30.5*	1.5 – 3.0; 6.1 – 9.1; 10.7 – 11.3; 22.9 – 23.5; 24.4 – 25.0; 25.9 – 27.4*	15.2 – 15.8; 16.8 – 17.4; 18.3 – 18.9;
BH17-D004	0 – 1.5; 3.0 – 4.6; 25.9 – 33.5	4.6 – 18.3; 19.8 – 25.9; 33.5 – 42.7*	
BH17-D005	0 – 2.1; 6.7 – 9.1; 19.3 – 21.3	12.2 – 15.2; 16.5 – 19.3; 21.3 – 31.1*	

* Denotes termination depth

Gravelly sand was encountered in BH17-D003 between 15.2 m and 18.9 m, core loss during the investigation prevented full definition of this strata. While drilling, soil samples were retrieved using a core barrel with a flapper bit to ensure good sample recovery. In BH17-D003, the flapper drilling bit was lost at a depth of 9.1 m below the seabed. This resulted in poor sample recovery. A Standard Penetration Test (SPT) was carried out every 1.5 m to recover split spoon samples. A replacement drill bit was used for drilling between a depth of 29.9 m to the end of borehole.

3.1.4 *Deep Water Boreholes*

The sole deep water borehole, BH17-D006, was located on the sea bed with a collar elevation of -29.8 m. Unlike the other boreholes, neither silty material or gravelly material was intersected, see Table 3-3. An example of the sand from BH17-D006 is presented in Figure 10.

Table 3-3: Summary of Materials Encountered in Deep Borehole

Borehole Number	Depth Material Encountered		
	Silt and Sand or Silty Sand	Sand	Gravelly Sand
BH17-D006	Not Encountered	0 – 24.4*	Not Encountered



Figure 10: Sand from BH17-D006

3.1.5 *Influence of Drilling Methods on SPT N-Values*

Various drilling methods have been used at the Milne Port Site to investigate the seabed subsurface conditions. The rotary wash boring (rotary) method was primarily used with sea water as the drilling fluid during the 2013 investigations associated with the Ore Dock No. 1. There were difficulties encountered during the borehole advancement including sand binding around the rods and heaving into the drill rods. As a result of these difficulties, New Zam D mud was added to the sea water in order to mitigate these issues. This was only partly successful, while there was an improvement in production, some SPT values were considered to be invalid due to soil disturbance.

During the 2014 investigations, bentonite was added to the New Zam D mud mixture. This combination appeared to stabilize the borehole conditions resulting in a more consistent SPT blow count.

In order to maximize drilling production, a Mini Sonic Drilling rig was selected in 2017. However, the sonic drilling method involves advancement of the casing in conjunction with the core barrel, as well as the use of sea water as the drilling fluid and there was concern that this drilling technique might cause soil disturbance prior to conducting SPT. Disturbance of the in-situ conditions would likely result in a lower SPT N-value than would have been measured without the disturbance. Figures provided in Appendix J show a comparison of N-Values recorded in 2013, 2014 and 2017.

In contrast, piezocone sounding do not require advancement of drill casing and a core barrel past the surface layer of the seabed, reducing the chances of disturbance of the in-situ conditions. Accordingly, piezocone testing was undertaken as part of the 2017 investigation in order to provide the in-situ density data to supplement the material classification and sample collection undertaken in the boreholes. Down hole seismic profiling was carried out at two boreholes locations.

3.2 Piezocone Sounding Results

The piezocone data attached in Appendix F provides a general interpretation of the tip resistance, sleeve friction and pore water pressure during each sounding. The piezocone sounding plots, provided by Conetec, include inferred phi and SPT values as well as inferred soil types based on the soils Soil Behaviour Type (SBT) chart. Soil samples were collected using the sonic core barrel and SPT split spoon to supplement and confirm piezocone test results with field classification and laboratory testing.

The piezocone test data requires further review by a qualified geotechnical engineer for selection of the design parameters and safety factors. A summary of the inferred materials, based on the SBT, from each of the piezocone soundings is presented below.

3.2.1.1 CPT17-D001

CPT17-D001 was performed at the BH17-D003 location. The SBT indicates a silty sand in the upper 12 m, changing to sand with trace to some gravel below 12 m depth.

3.2.1.2 CPT17-D002

CPT17-D002 was performed at the same location at BH17-D004. The SBT indicates silt and sand for the top 6 m, alternating layers of sand and silty sand between 6 m and 16 m, and sand below 16 m from the seabed surface.

3.2.1.3 CPT17-D003

CPT17-D003 was performed slightly north of BH17-D005. Based on the SBT the soil type is silt and sand at the top 5m and 19 m to 21 m below the seabed. Alternating bands of sand and silty sand are indicated between 5 m and 11 m below seabed. The soil behaves like sand 11 m to 19 m and from 21 m to the end of the borehole.

3.2.1.4 CPT17-D004, CPT17-D005 and CPT17-D006

CPT17-D004, CPT17-D005 and CPT17-D006 were drilled along a line slightly south of BH17-D006. The SBT indicates alternating layers of sand and silty sand for the top 10 to 15 m below the seabed. The CPTu testing showed a 1 m thick layer of sandy silt at a depth of 17 m and 27 m, respectively, below the seabed.

3.2.1.5 CPT17-D007

CPT17-D007 was performed at the same location as BH17-D002. Based on the SBT, the soil behaves as silty sand in the upper 10 m below the seabed and indicates gravelly sand 15 m below seabed.

3.2.1.6 CPT17-D008

CPT17-D008 was performed close to borehole BH17-D001. Based on the SBT, the top 7 m of the test location is predominantly silty sand. Soil behaviour indicates sand from 7 m to 13 m, and alternating layers of sand and gravelly sand 13 m below the seabed.

3.3 Laboratory Test Results

Laboratory testing on select soil samples was undertaken to confirm the site classification of the material. The results of the classification tests are presented in Table 3-4 with full laboratory results presented in Appendix D. Results of the classification tests are also presented on the borehole reports in Appendix B.

Table 3-4: Summary of Particle Size Distribution Testing

Borehole ID	Depth (m)	Sample	Percent Gravel	Percent Sand	Percent Fines
BH17-D001	0.90	DS1	3	89	8
	7.00	DS4	3	41	57
	14.50	DS9	1	95	4
	17.70	DS11	60	39	1
BH17-D002	0.00	DS1	5	91	4
	5.20	DS3	2	46	52
	8.50	DS5	31	67	1
	15.70	DS9	28	68	3
	17.50	DS10	27	66	8
	25.90	DS13	32	66	2
BH17-D003	5.20	DS2	3	40	57
	15.20	AS6	35	63	1
	21.30	AS9	5	56	39
	30.20	DS14	1	78	23
BH17-D004	7.60	AS5	2	94	4
	18.00	DS10	1	96	3
	29.30	DS16	2	49	49
	38.70	DS20	8	91	1
	42.10	DS21	0	98	2
BH17-D005	0.00	DS1	8	54	38
	7.00	DS3	10	55	35
	12.80	DS5	5	92	3
	21.00	DS9	1	41	58
	25.30	DS12	1	80	20
	28.00	DS13	0	96	4

Borehole ID	Depth (m)	Sample	Percent Gravel	Percent Sand	Percent Fines
BH17-D006	0.00	AS1	3	79	18
	2.10	DS2	0	99	1
	11.60	DS8	3	95	2
	15.80	DS11	0	82	18

Representative samples were selected for direct shear testing. Samples were remolded and compacted to in situ conditions. The inferred values of peak and residual internal friction angles, based on the direct shear testing, are presented. The test reports should be reviewed by a qualified engineer to select the appropriate design values based on these results and in consideration with the other information gathered during the investigations. The results of the direct shear testing are summarized with the Laboratory Test Reports in Appendix D.

Table 3-5: Summary of Direct Shear Testing on Borehole Samples

Borehole ID	Depth (m)	Sample	Peak ϕ	Residual ϕ
BH17-D003	5.2 – 5.5	DS2	34.6°	32.3°
BH17-D004	18.0 – 18.3	DS10	42.9°	31.6°
BH17-D005	0.0 – 0.3	DS1	39.4°	36.7°
BH17-D005	12.8 – 13.1	DS5	37.8°	31.9°
BH17-D005	30.5 – 31.1	DS14	35.9°	33.3°

4. Summary of Geotechnical Findings

A summary of geotechnical findings for the 2017 Ore Dock No. 2 investigations is provided below:

- The most common soil intersected in the investigations was a sand, varying from fine grained with trace to some silt, to fine to coarse grained with trace gravel.
- Layers of silt and sand were intersected in the shallow and mid-depth boreholes; gravelly sand was encountered in both shallow boreholes and one mid-depth borehole.
- The soil primarily consists of sand with trace silt and gravel. Layers of silt and sand were observed at a depth of 0 m, 4.6 m, 21 m and 26 m. Layers of sand and some gravel were observed in the shallow boreholes at various depths between 8 m and 25 m below seabed.
- There is a linear increase with depth in the pore water pressure, as measured by the piezocone soundings, indicating clean sand. This notwithstanding, interbedded silt was noted with in the sand sequence in several locations and layers of silt and sand were encountered.

- Seismic data indicates an increase in shear velocity with depth.
- No bedrock was encountered during the 2017 Ore Dock No. 2 investigation.
- No permafrost or frozen soils were encountered during the 2017 offshore investigation.

5. References

Hatch Ltd. H337697-0000-15-124-0004. Geotechnical Data Report –Infrastructure. April 5, 2012.

Hatch Ltd. H349000-1000-15-122-0001. Geotechnical Design Criteria. Aug 08, 2013.

Hatch Ltd. H349000-2200-15-124-0002. Milne Ore Dock Geotechnical Investigation Factual Report. Feb 21, 2014.

Hatch Ltd. H352034-1000-229-230-0002. 2016 Milne Port Geotechnical Investigation Factual Report.

Robertson, P.K., Campanella, R.G., Gillespie, D., and Greig, J., 1986. Use of Piezometer Cone data. In-Situ '86 Use of In-situ testing in Geotechnical Engineering, GSP 6, ASCE, Reston, VA, Specialty Publication, pp 1263-1280.

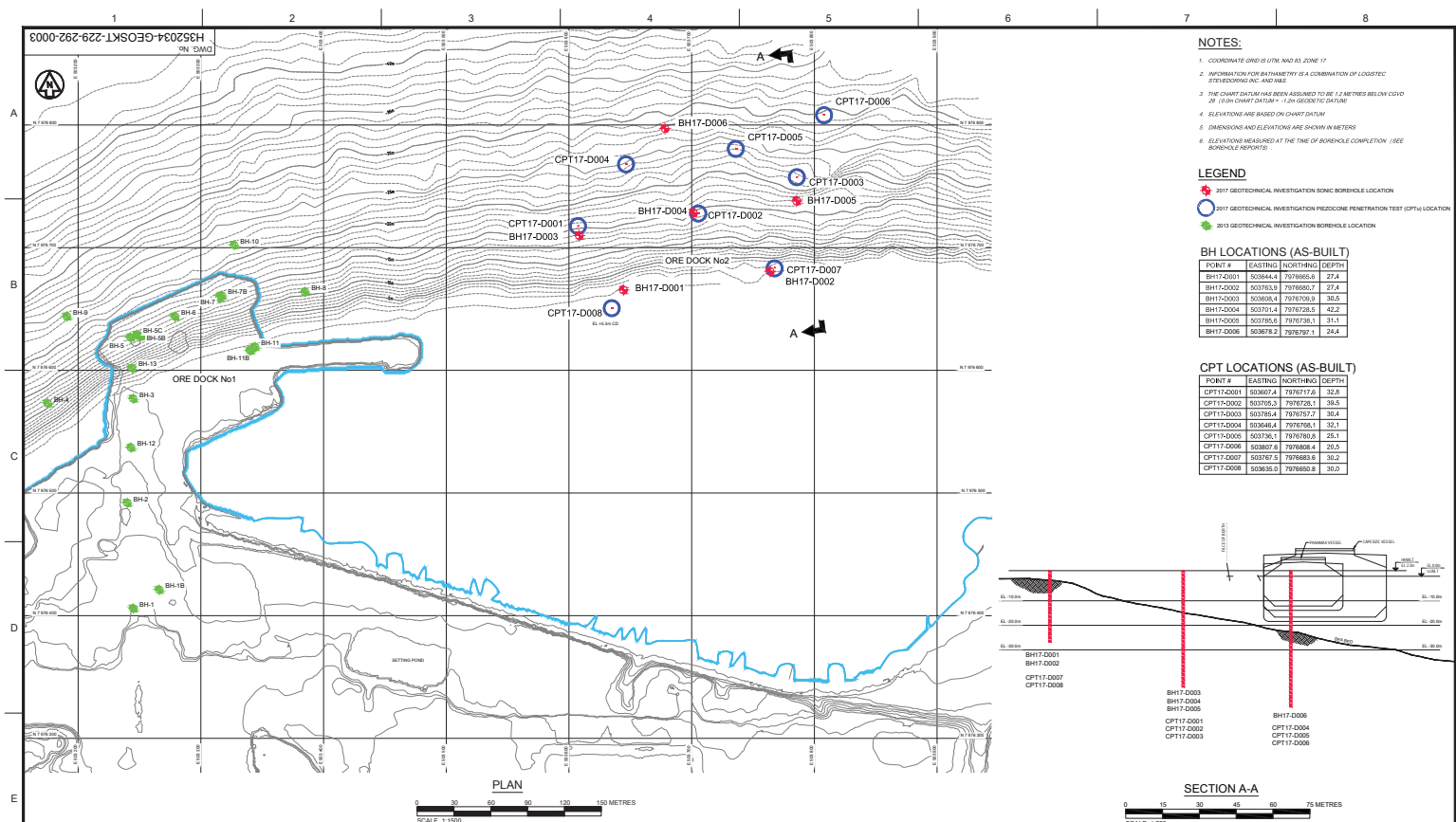
ASTM D5778 Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils.

Hatch Ltd. H349000-2200-015-124-0002. 2014 Milne Ore Dock Geotechnical Investigation Factual Report.

Youd et al., 1998 Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluations of Liquefaction Resistance of Soils, Journal of Geotechnical and Geoenvironmental Engineering, Salt Lake City, UT.

Appendix A

Borehole Location Plan



- NOTES:**
1. COORDINATE GRID IS UTM, NAD 83, ZONE 17
 2. INFORMATION FOR BATHYMETRY IS A COMBINATION OF LOGISTEC HYDROGRAPHIC DATA AND MMS
 3. THE CHART DATUM HAS BEEN ASSIGNED TO BE 1.2 METRES BELOW CGVD (B: 1984 CHART DATUM = 1.2M LOGISTEC DATUM)
 4. ELEVATIONS ARE BASED ON CHART DATUM
 5. DIMENSIONS AND ELEVATIONS ARE SHOWN IN METERS
 6. ELEVATIONS MEASURED AT THE TIME OF BOREHOLE COMPLETION (SEE BOREHOLE REPORTS)

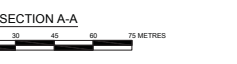
- LEGEND**
- 2017 GEOTECHNICAL INVESTIGATION SONIC BOREHOLE LOCATION
 - 2017 GEOTECHNICAL INVESTIGATION PREZONE PENETRATION TEST (CPT) LOCATION
 - 2010 GEOTECHNICAL INVESTIGATION BOREHOLE LOCATION

BH LOCATIONS (AS-BUILT)

POINT #	EASTING	NORTHING	DEPTH
BH17-D001	503644.4	797665.6	27.4
BH17-D002	503763.9	797665.7	27.4
BH17-D003	503684.1	797670.9	30.9
BH17-D004	503701.4	797678.5	42.2
BH17-D005	503785.6	797678.1	31.1
BH17-D006	503678.2	797670.1	24.4

CPT LOCATIONS (AS-BUILT)

POINT #	EASTING	NORTHING	DEPTH
CPT17-D001	503607.4	797677.6	32.8
CPT17-D002	503705.1	797678.1	34.5
CPT17-D003	503785.4	797677.7	30.4
CPT17-D004	503648.4	797678.1	32.1
CPT17-D005	503726.1	797678.5	28.1
CPT17-D006	503807.4	797688.4	29.5
CPT17-D007	503767.5	797683.6	30.2
CPT17-D008	503635.0	797665.0	30.0



DRAWING No.		DRAWING TITLE		REFERENCE DRAWINGS	
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Appendix B

Borehole Reports

General

Elevations

Elevations are referenced to datum indicated.

Depth

All depths are given in meters (feet) measured from the ground surface unless otherwise noted.

Sample Recovery

Indicates the length retained in millimeters (inches) in a split spoon sampler or percentage recovery of sample retained in the core barrel sampler.

Sample Number

Samples are numbered consecutively in the order in which they were obtained or attempted in the borehole.

Sample Type

The first letter describes the sampling method and the second, the shipping container.

Sampling Method

A – Split Tube	E – Auger
B – Thin Wall Tube	F – Wash
C – Piston Sampler	G – Shovel Grab Sample
D – Core Barrel	K – Slotted Sampler

Shipping Container

O – Tube	U – Not Recovered
P – Water Content Tin	X – Plastic & PVC Sleeve (Sonic)
Q – Jar	Y – Core Box
S – Plastic Bag	Z – Discarded

Abbreviations

N/A – Not applicable
N/E – Not encountered
N/O – Not observed

Soil

Soil Description, Label and Symbol

Soil description under the “Description” column conforms generally, but not rigorously, to the Unified Soils Classification System. For a given soil unit, defined by depth boundaries, the descriptive text constitutes the definitive soil unit description and takes precedence over both the brief label and the symbol used to graphically represent the soil unit.

Grain Size

Clay	<0.002 mm
Silt	0.002 – 0.075 mm
Sand	0.075 – 4.75 mm
Fine	0.075 – 0.42 mm
Medium	0.42 – 2.00 mm
Course	2.00 – 4.75 mm
Gravel	4.75 – 75 mm
Fine	4.75 – 19.00 mm
Coarse	19.00 – 75.00 mm
Cobbles	75 – 300 mm
Boulder	>300 mm

Relative Quantities

Term	Example	(%)
Trace	Trace sand	1 – 10
Some	Some sand	10 – 20
With (adjective)	With Sand (Sandy)	20 – 35
And	And sand	>35
Noun	Sand	>50

Standard Penetration Test (SPT)

The test is carried out in accordance with ASTM D-1586 and the ‘N’ value corresponds to the sum of the number of blows required by a 63.5-kg (140-lb) hammer, dropped 760 mm (30 in.), to drive a 50-mm (2-in.) diameter split tube sampler the second and third 150 mm (6 in.) of penetration.

Density (Granular Soils)

	N(SPT)
Very loose	0 – 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very dense	>50

Consistency (Cohesive Soils)

	N(SPT)
Very soft	<2
Soft	2 – 4
Firm	4 – 8
Stiff	8 – 15
Very stiff	15 – 30
Hard	>30

Plasticity/Compressibility

		Liquid Limit (%)
Low plasticity clays	Low compressibility silts	<30
Medium plasticity clays	Medium compressibility silts	30 – 50
High plasticity clays	High compressibility silts	>50

Dilatancy

None	- No visible change, during shaking or squeezing
Slow	- Water appears slowly on surface of specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	- Water appears quickly on the surface of specimen during shaking and disappears quickly upon squeezing.

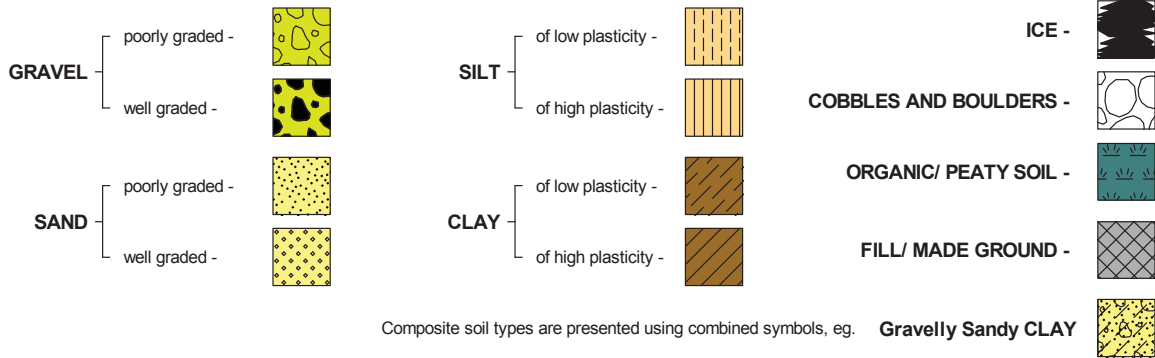
Sensitivity

Insensitive	<2
Low	2 – 4
Medium	4 – 8
High	8 – 16
Quick	>16

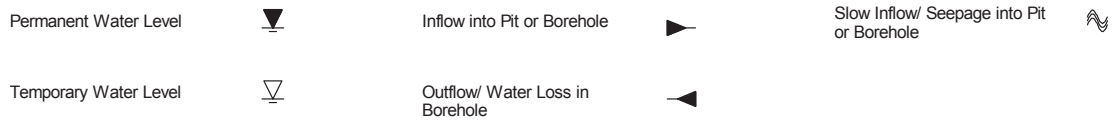
BASIS FOR SOIL DESCRIPTION

(Based on AS1726-1993 - Geotechnical Site Investigations, with modifications)

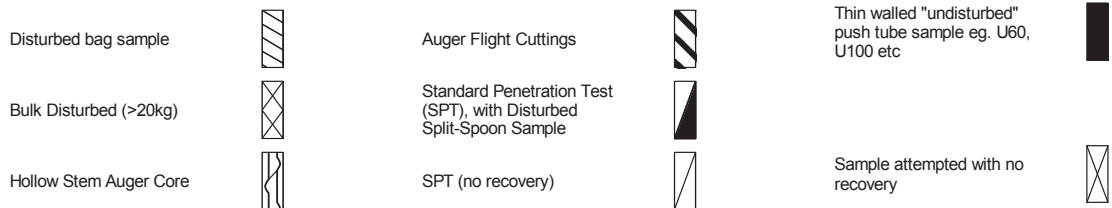
GRAPHIC SYMBOLS FOR SOILS



GROUNDWATER OBSERVATIONS



SAMPLE TYPES





BOREHOLE REPORT

BH17-D001

Sheet 1 of 6

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/31/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,644.4 m**Northing:** 7,976,665.6 m**Surface Elevation:** -2.38 m**Bottom Elevation:** -29.78 m**Total Depth:** 27.4 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-2.9	0.5				SAND, trace SILT, trace GRAVEL: Grey, medium grained, poorly graded sand; fine gravel										
	-3.4	1.0							DS1 taken from .90-1.20m.		3	89	8			
	-3.9	1.5														
	-4.4	2.0														
	-4.9	2.5														
	-5.4	3.0														
	-5.9	3.5														
	-6.4	4.0														
	-6.9	4.5				SILT and SAND, trace GRAVEL: Reddish brown, coarse grained sand, well graded, rounded to subangular gravel										
	-7.4	5.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D001

Sheet 2 of 6

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/31/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,644.4 m**Northing:** 7,976,665.6 m**Surface Elevation:** -2.38 m**Bottom Elevation:** -29.78 m**Total Depth:** 27.4 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-7.9	5.5				SILT and SAND, trace GRAVEL: Reddish brown, coarse grained sand, well graded, rounded to subangular gravel (<i>Continued</i>)			DS3 taken from 5.20-5.50m.							
	-8.4	6.0														
	-8.9	6.5														
	-9.4	7.0							DS4 taken from 7.00-7.30m.		3	41	57			
	-9.9	7.5														
	-10.4	8.0				No core recovered										
	-10.9	8.5														
	-11.4	9.0														
	-11.9	9.5						0%	AS5 taken from 9.10-9.70m. N= 2							
	-12.4	10.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D001

Sheet 3 of 6

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/31/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,644.4 m**Northing:** 7,976,665.6 m**Surface Elevation:** -2.38 m**Bottom Elevation:** -29.78 m**Total Depth:** 27.4 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-12.9	10.5				SAND, trace GRAVEL: Grey to light brown, fine to coarse grained sand; rounded to subrounded, well graded gravel (<i>Continued</i>)			DS6 taken from 10.10-10.40m.							
	-13.4	11.0														
	-13.9	11.5							DS7 taken from 11.30-11.60m.							
	-14.4	12.0														
	-14.9	12.5							DS8 taken from 12.50-12.80m.							
	-15.4	13.0														
	-15.9	13.5														
	-16.4	14.0														
	-16.9	14.5				SAND, trace SILT, trace GRAVEL: Grey to light brown, fine to medium grained sand; rounded			DS9 taken from 14.50-14.90m.		1	95	4			
	-17.4	15.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocene test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D001

Sheet 4 of 6

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/31/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,644.4 m**Northing:** 7,976,665.6 m**Surface Elevation:** -2.38 m**Bottom Elevation:** -29.78 m**Total Depth:** 27.4 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-17.9	15.5				SAND, trace GRAVEL: Fine to coarse grained sand; fine, rounded, poorly graded gravel		75%	AS10 taken from 15.20-15.80m. N= 3							
	-18.4	16.0														
	-18.9	16.5														
	-19.4	17.0														
	-19.9	17.5				GRAVEL with SAND and trace SILT: Light brown to reddish brown; rounded well graded gravel; fine to coarse grained sand										
	-20.4	18.0							DS11 taken from 17.70-18.30m.		60	39	1			
	-20.9	18.5				SAND, trace GRAVEL: Light brown to reddish brown, fine to coarse grained sand; rounded to subrounded gravel										
	-21.4	19.0														
	-21.9	19.5							DS12 taken from 19.20-19.50m.							
	-22.4	20.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D001

Sheet 5 of 6

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/31/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,644.4 m**Northing:** 7,976,665.6 m**Surface Elevation:** -2.38 m**Bottom Elevation:** -29.78 m**Total Depth:** 27.4 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-22.9	20.5				SAND, trace GRAVEL: Brownish Grey, fine to coarse grained sand; rounded to subrounded gravel (<i>Continued</i>)			DS13 taken from 20.40-20.70m.							
	-23.4	21.0														
	-23.9	21.5														
	-24.4	22.0				No core recovered										
	-24.9	22.5														
	-25.4	23.0				SAND, with GRAVEL: Grey to light brown, fine to coarse grained sand; rounded to subrounded, well graded gravel			AS14 taken from 21.30-21.90m. N= 9							
	-25.9	23.5														
	-26.4	24.0							DS15 taken from 23.50-23.80m.							
	-26.9	24.5				SAND, trace GRAVEL: Grey to light brown, fine to medium grained sand										
	-27.4	25.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D001

Sheet 6 of 6

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/31/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,644.4 m**Northing:** 7,976,665.6 m**Surface Elevation:** -2.38 m**Bottom Elevation:** -29.78 m**Total Depth:** 27.4 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						SAND, trace GRAVEL: Grey to light brown, fine to medium grained sand (Continued)			DS16 taken from 25.00-25.30m.							
						SAND, some SILT, trace GRAVEL: Light brown to dark grey, fine grained sand; rounded, poorly graded gravel			DS17 taken from 26.50-26.80m.							
						To Target Depth. Drillhole BH17-D001 terminated at 27.4m.										

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D002

Sheet 1 of 6

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/21/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,763.9 m**Northing:** 7,976,680.7 m**Surface Elevation:** -3.25 m**Bottom Elevation:** -30.65 m**Total Depth:** 27.4 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						SAND, trace GRAVEL, trace SILT: Grey, fine to coarse grained sand; poorly graded gravel			DS1 taken from .00-.30m.		5	91	4			
									DS2 taken from 2.00-2.20m.							
						No core recovered										
						SILT and SAND, trace GRAVEL: Grey, fine grained sand; fine gravel										

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D002

Sheet 2 of 6

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/21/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,763.9 m**Northing:** 7,976,680.7 m**Surface Elevation:** -3.25 m**Bottom Elevation:** -30.65 m**Total Depth:** 27.4 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-8.8	5.5				SILT and SAND, trace GRAVEL: Grey, fine grained sand; fine gravel (Continued)			DS3 taken from 5.20-5.50m.		2	46	52			
	-9.3	6.0														
	-9.8	6.5						50%	AS4 taken from 6.10-6.70m. N= 8							
	-10.3	7.0														
	-10.8	7.5														
	-11.3	8.0														
	-11.8	8.5														
	-12.3	9.0				SAND, with GRAVEL: Brown, fine to coarse grained sand; fine to coarse gravel			DS5 taken from 8.50-8.80m.		31	67	1			
	-12.8	9.5														
	-13.3	10.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D002

Sheet 3 of 6

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/21/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,763.9 m**Northing:** 7,976,680.7 m**Surface Elevation:** -3.25 m**Bottom Elevation:** -30.65 m**Total Depth:** 27.4 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-13.8	10.5				SAND, with GRAVEL: Brown, fine to coarse grained sand; fine to coarse gravel (<i>Continued</i>)										
	-14.3	11.0						100%	AS6 taken from 10.70-11.30m. N= 8							
	-14.8	11.5														
	-15.3	12.0							DS7 taken from 11.90-12.20m.							
	-15.8	12.5														
	-16.3	13.0				SAND: Grey, fine grained, poorly graded										
	-16.8	13.5														
	-17.3	14.0				SAND, with GRAVEL: Brown, fine to coarse grained, well graded sand; fine to coarse, well graded gravel			DS8 taken from 13.10-13.40m.							
	-17.8	14.5														
	-18.3	15.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D002

Sheet 4 of 6

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/21/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,763.9 m**Northing:** 7,976,680.7 m**Surface Elevation:** -3.25 m**Bottom Elevation:** -30.65 m**Total Depth:** 27.4 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-18.8	15.5				SAND, with GRAVEL: Brown, fine to coarse grained, well graded sand; fine to coarse, well graded gravel (Continued)										
	-19.3	16.0				SAND with GRAVEL, trace SILT: Brown, fine to coarse grained, well graded sand; fine well graded gravel			DS9 taken from 15.70-16.00m.		28	68	3			
	-19.8	16.5														
	-20.3	17.0														
	-20.8	17.5							DS10 taken from 17.50-17.80m.		27	66	8			
	-21.3	18.0														
	-21.8	18.5														
	-22.3	19.0														
	-22.8	19.5														
	-23.3	20.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D002

Sheet 5 of 6

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/21/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,763.9 m**Northing:** 7,976,680.7 m**Surface Elevation:** -3.25 m**Bottom Elevation:** -30.65 m**Total Depth:** 27.4 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-23.8	20.5				SAND with GRAVEL, trace SILT: Brown, fine to coarse grained, well graded sand; fine well graded gravel (Continued)			DS11 taken from 20.40-20.70m.							
	-24.3	21.0														
	-24.8	21.5														
	-25.3	22.0														
	-25.8	22.5														
	-26.3	23.0				SAND with GRAVEL, trace SILT: Light brown, fine to coarse grained sand, fine to coarse gravel			DS12 taken from 23.60-23.90m.							
	-26.8	23.5														
	-27.3	24.0														
	-27.8	24.5														
	-28.3	25.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D002

Sheet 6 of 6

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/21/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,763.9 m**Northing:** 7,976,680.7 m**Surface Elevation:** -3.25 m**Bottom Elevation:** -30.65 m**Total Depth:** 27.4 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-28.8	25.5				SAND with GRAVEL, trace SILT: Light brown, fine to coarse grained sand, fine to coarse gravel (<i>Continued</i>)										
	-29.3	26.0				SAND with GRAVEL, trace SILT: Fine to coarse grained sand, rounded gravel, poorly graded			DS13 taken from 25.90-26.70m.		32	66	2			
	-29.8	26.5														
	-30.3	27.0														
	-30.8	27.5				To Target Depth. Drillhole BH17-D002 terminated at 27.4m.										
	-31.3	28.0														
	-31.8	28.5														
	-32.3	29.0														
	-32.8	29.5														
	-33.3	30.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D003

Sheet 1 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/29/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,608.4 m**Northing:** 7,976,709.9 m**Surface Elevation:** -15.34 m**Bottom Elevation:** -45.84 m**Total Depth:** 30.5 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						No Core Recovered										
	-15.8	0.5														
	-16.3	1.0														
	-16.8	1.5				SAND, trace Silt: Grey, fine to coarse grained sand, loose, poorly graded		100%	AS1 taken from 1.50-2.10m. N= 1							
	-17.3	2.0														
	-17.8	2.5														
	-18.3	3.0				No core recovered										
	-18.8	3.5														
	-19.3	4.0														
	-19.8	4.5														
	-20.3	5.0				SILT and SAND, trace GRAVEL: Dark grey, black mottling, organics; fine grained sand; fine angular gravel										

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D003

Sheet 2 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/29/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,608.4 m**Northing:** 7,976,709.9 m**Surface Elevation:** -15.34 m**Bottom Elevation:** -45.84 m**Total Depth:** 30.5 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-20.8	5.5				SILT and SAND, trace GRAVEL: Dark grey, black mottling, organics; fine grained sand; fine angular gravel (Continued)			DS2 taken from 5.20-5.30m.		3	40	57			
	-21.3	6.0														
	-21.8	6.5				SAND, trace GRAVEL, trace COBBLES: Reddish brown, medium to coarse grained, poorly graded sand; angular gravel, and subrounded cobbles.										
	-22.3	7.0							DS3 taken from 7.00-7.30m.							
	-22.8	7.5														
	-23.3	8.0				SAND: Reddish brown, medium to coarse grained, poorly graded		0%	AS4 taken from 7.60-8.20m. N= 7							
	-23.8	8.5														
	-24.3	9.0														
	-24.8	9.5				No Core Recovered										
	-25.3	10.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D003

Sheet 3 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/29/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,608.4 m**Northing:** 7,976,709.9 m**Surface Elevation:** -15.34 m**Bottom Elevation:** -45.84 m**Total Depth:** 30.5 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						No Core Recovered (Continued)										
	-25.8	10.5														
	-26.3	11.0				SAND, trace Gravel: Grey, fine to medium grained sand, loose, poorly graded, subangular gravel		100%	AS5 taken from 10.70-11.30m. N= 9							
	-26.8	11.5				No Core Recovered										
	-27.3	12.0														
	-27.8	12.5						0%	taken from 12.20-12.80m. N= 8							
	-28.3	13.0														
	-28.8	13.5														
	-29.3	14.0						0%	taken from 13.70-14.30m. N= 4							
	-29.8	14.5														
	-30.3	15.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D003

Sheet 4 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/29/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,608.4 m**Northing:** 7,976,709.9 m**Surface Elevation:** -15.34 m**Bottom Elevation:** -45.84 m**Total Depth:** 30.5 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						No Core Recovered (Continued)										
	-30.8	15.5				Gravelly SAND, trace SILT: Reddish brown to grey, coarse to medium grained sand; rounded to subrounded gravel		50%	AS6 taken from 15.20-15.80m. N= 6		35	63	1			
	-31.3	16.0				No core recovered										
	-31.8	16.5														
	-32.3	17.0				SAND, with Gravel: Coarse grained sand; rounded to subangular coarse gravel, well graded		17%	AS7 taken from 16.80-17.40m. N= 10							
	-32.8	17.5				No Core Recovered										
	-33.3	18.0														
	-33.8	18.5				SAND, with Gravel: Coarse grained sand; coarse, rounded to subangular gravel		50%	AS8 taken from 18.30-18.90m. N= 9							
	-34.3	19.0				No Core Recovered										
	-34.8	19.5														
	-35.3	20.0						0%	taken from 19.80-20.40m. N= 5							

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D003

Sheet 5 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/29/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,608.4 m**Northing:** 7,976,709.9 m**Surface Elevation:** -15.34 m**Bottom Elevation:** -45.84 m**Total Depth:** 30.5 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						No Core Recovered (<i>Continued</i>)										
	-35.8	20.5														
	-36.3	21.0														
	-36.8	21.5				SILT and SAND, trace GRAVEL: Grey, medium to fine grained sand; fine grained, poorly graded gravel		50%	AS9 taken from 21.30-21.90m. N= 10		5	56	39			
	-37.3	22.0				No Core Recovered										
	-37.8	22.5														
	-38.3	23.0				SAND, trace GRAVEL: Grey to light brown, fine grained sand; poorly graded, rounded to subangular gravel		100%	AS10 taken from 22.90-23.50m. N= 35							
	-38.8	23.5				No Core Recovered										
	-39.3	24.0														
	-39.8	24.5				SAND, trace GRAVEL: Grey to light brown, fine to medium grained sand, rounded to subrounded, poorly graded gravel		50%	AS11 taken from 24.40-25.00m. N= 26							
	-40.3	25.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D003

Sheet 6 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/29/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,608.4 m**Northing:** 7,976,709.9 m**Surface Elevation:** -15.34 m**Bottom Elevation:** -45.84 m**Total Depth:** 30.5 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						No Core Recovered										
	-40.8	25.5														
	-41.3	26.0				SAND, trace GRAVEL: Grey to light brown, fine to medium grained sand; rounded, poorly graded gravel		50%	AS12 taken from 25.90-26.50m. N= 23							
	-41.8	26.5														
	-42.3	27.0														
	-42.8	27.5				SAND with SILT, trace GRAVEL: Grey to light brown, fine grained sand; rounded, poorly graded gravel										
	-43.3	28.0							DS13 taken from 28.00-28.30m.							
	-43.8	28.5														
	-44.3	29.0														
	-44.8	29.5														
	-45.3	30.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocene test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D003

Sheet 7 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/29/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,608.4 m**Northing:** 7,976,709.9 m**Surface Elevation:** -15.34 m**Bottom Elevation:** -45.84 m**Total Depth:** 30.5 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						SAND with SILT, trace GRAVEL: Grey to light brown, fine grained sand; rounded, poorly graded gravel (Continued)			DS14 taken from 30.20-30.50m.		1	76	23			
	-45.8	30.5				To Target Depth. Drillhole BH17-D003 terminated at 30.5m.										
	-46.3	31.0														
	-46.8	31.5														
	-47.3	32.0														
	-47.8	32.5														
	-48.3	33.0														
	-48.8	33.5														
	-49.3	34.0														
	-49.8	34.5														
	-50.3	35.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D004

Sheet 1 of 9

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/26/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,701.4 m**Northing:** 7,976,728.5 m**Surface Elevation:** -16.59 m**Bottom Elevation:** -59.29 m**Total Depth:** 42.7 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-17.1	0.5				SAND and SILT: Dark grey to black, fine grained sand, trace of organics, black mottling										
	-17.6	1.0							DS1 taken from .90-1.20m.							
	-18.1	1.5				No core recovered										
	-18.6	2.0														
	-19.1	2.5														
	-19.6	3.0				SAND and SILT, some GRAVEL: Dark grey, black mottling, fine grained sand; fine to coarse, rounded to subangular gravel			DS2 taken from 3.20-3.40m.							
	-20.1	3.5														
	-20.6	4.0														
	-21.1	4.5							DS3 taken from 4.30-4.60m.							
	-21.6	5.0				SAND, some SILT, some GRAVEL: Light brown, fine to coarse grained, well graded sand; multi-coloured, fine to coarse, rounded to subangular gravel			DS4 taken from 4.70-5.00m.							

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D004

Sheet 2 of 9

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/26/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,701.4 m**Northing:** 7,976,728.5 m**Surface Elevation:** -16.59 m**Bottom Elevation:** -59.29 m**Total Depth:** 42.7 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-22.1	5.5				SAND, some SILT, some GRAVEL: Light brown, fine to coarse grained, well graded sand; multi-coloured, fine to coarse, rounded to subangular gravel (Continued)										
	-22.6	6.0				SAND, trace GRAVEL, trace SILT: Brown, fine to coarse grained sand; multi-coloured, well graded, rounded to subrounded gravel										
	-23.1	6.5														
	-23.6	7.0														
	-24.1	7.5														
	-24.6	8.0				SAND, trace SILT, trace GRAVEL: Brown, coarse grained, poorly graded sand; multi-coloured, angular gravel		100%	AS5 taken from 7.60-8.20m. N= 6		2	94	4			
	-25.1	8.5														
	-25.6	9.0							DS6 taken from 8.80-9.10m.							
	-26.1	9.5														
	-26.6	10.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D004

Sheet 3 of 9

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/26/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,701.4 m**Northing:** 7,976,728.5 m**Surface Elevation:** -16.59 m**Bottom Elevation:** -59.29 m**Total Depth:** 42.7 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-27.1	10.5				SAND, trace SILT, trace GRAVEL: Brown, coarse grained, poorly graded sand; multi-coloured, angular gravel (Continued)										
	-27.6	11.0							DS7 taken from 11.00-11.30m.							
	-28.1	11.5														
	-28.6	12.0														
	-29.1	12.5														
	-29.6	13.0														
	-30.1	13.5														
	-30.6	14.0				SAND, trace GRAVEL, trace SILT: Reddish brown, medium to coarse grained sand; angular well graded gravel		100%	AS8 taken from 13.70-14.30m. N= 11							
	-31.1	14.5														
	-31.6	15.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D004

Sheet 4 of 9

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/26/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,701.4 m**Northing:** 7,976,728.5 m**Surface Elevation:** -16.59 m**Bottom Elevation:** -59.29 m**Total Depth:** 42.7 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-32.1	15.5				SAND, trace GRAVEL, trace SILT: Reddish brown, medium to coarse grained sand; angular well graded gravel (Continued)			DS9 taken from 15.50-15.80m.							
	-32.6	16.0														
	-33.1	16.5														
	-33.6	17.0														
	-34.1	17.5														
	-34.6	18.0							DS10 taken from 18.00-18.30m.		1	96	3			
	-35.1	18.5				No core recovered										
	-35.6	19.0														
	-36.1	19.5														
	-36.6	20.0						100%	AS11 taken from 19.80-20.40m. N= 35							

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



Sheet 5 of 9

Project No.: H352034

Datum: NAD83

Platform: Ice Surface

Rig Type/ Mounting: MiniSonic Rig

Date Logged: 3/26/2017

Driller: EB/SF

Hole Diameter (mm): 100

Date Reviewed:5/18/2017

Easting: 503,701.4 m

Northing: 7,976,728.5 m

Surface Elevation: -16.59 m

Bottom Elevation: -59.29 m

Total Depth: 42.7 m

Logged By: UK/AB

Reviewed By: WH/CH

[illegible]

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D004

Sheet 6 of 9

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/26/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,701.4 m**Northing:** 7,976,728.5 m**Surface Elevation:** -16.59 m**Bottom Elevation:** -59.29 m**Total Depth:** 42.7 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-42.1	25.5				SAND, trace SILT: Grey, fine grained, poorly graded sand (<i>Continued</i>)			DS13 taken from 25.00-25.30m.							
	-42.6	26.0				SILT and SAND, trace GRAVEL: Brown, fine to medium grained, well graded sand		100%	AS14 taken from 25.90-26.50m. N= 9							
	-43.1	26.5														
	-43.6	27.0														
	-44.1	27.5														
	-44.6	28.0														
	-45.1	28.5							DS15 taken from 28.30-28.60m.							
	-45.6	29.0														
	-46.1	29.5				SAND and SILT, trace GRAVEL: Brown, fine to coarse grained, well graded sand; multi-coloured, rounded gravel			DS16 taken from 29.30-29.60m.		2	49	49			
	-46.6	30.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D004

Sheet 7 of 9

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/26/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,701.4 m**Northing:** 7,976,728.5 m**Surface Elevation:** -16.59 m**Bottom Elevation:** -59.29 m**Total Depth:** 42.7 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-47.1	30.5				SAND and SILT, trace GRAVEL: Brown, fine to coarse grained, well graded sand; multi-coloured, rounded gravel (Continued)										
	-47.6	31.0														
	-48.1	31.5														
	-48.6	32.0														
	-49.1	32.5														
	-49.6	33.0														
	-50.1	33.5														
	-50.6	34.0				SAND, some GRAVEL: Brown, coarse grained poorly graded sand; multi-coloured, rounded to subangular gravel										
	-51.1	34.5														
	-51.6	35.0														

100%

AS17 taken from 32.00-32.60m.
N= 5

DS18 taken from 34.40-34.70m.

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D004

Sheet 8 of 9

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/26/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,701.4 m**Northing:** 7,976,728.5 m**Surface Elevation:** -16.59 m**Bottom Elevation:** -59.29 m**Total Depth:** 42.7 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-52.1	35.5				SAND, trace GRAVEL, trace SILT: Brown, coarse grained sand; poorly graded, fine, subangular gravel										
	-52.6	36.0														
	-53.1	36.5														
	-53.6	37.0				SAND, some SILT: Dark grey, fine grained, well graded sand										
	-54.1	37.5							DS19 taken from 37.20-37.50m.							
	-54.6	38.0														
	-55.1	38.5				SAND, trace Gravel, trace SILT: Brown, coarse grained sand; fine, multi-coloured, rounded to subangular, well graded gravel										
	-55.6	39.0							DS20 taken from 38.70-39.00m.		8	91	1			
	-56.1	39.5														
	-56.6	40.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D004

Sheet 9 of 9

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/26/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,701.4 m**Northing:** 7,976,728.5 m**Surface Elevation:** -16.59 m**Bottom Elevation:** -59.29 m**Total Depth:** 42.7 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-57.1	40.5				SAND, trace Gravel, trace SILT: Brown, coarse grained sand; fine, multi-coloured, rounded to subangular, well graded gravel (<i>Continued</i>)										
	-57.6	41.0														
	-58.1	41.5				SAND, trace SILT: Brown, coarse grained sand; well graded, multi-coloured gravel										
	-58.6	42.0														
	-59.1	42.5							DS21 taken from 42.10-42.40m.		0	98	2			
	-59.6	43.0				To Target Depth. Drillhole BH17-D004 terminated at 42.7m.										
	-60.1	43.5														
	-60.6	44.0														
	-61.1	44.5														
	-61.6	45.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D005

Sheet 1 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/24/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,785.6 m**Northing:** 7,976,738.1 m**Surface Elevation:** -19.50 m**Bottom Elevation:** -50.60 m**Total Depth:** 31.1 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						SILT and SAND, trace GRAVEL: Dark brown to black, fine to coarse grained sand; fine, poorly graded gravel			DS1 taken from .00-.30m.		8	54	38			
									AS2 taken from 1.50-2.10m.							
						No core recovered										

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



Sheet 2 of 7

Reviewed By:	WH/CH
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HATCHCANADA2015 DRAFT.GLB Log ICE BOREHOLE MR EXPANSION STUDY STAGE 2 - REV A.GPJ <<DrawingFile>> 25/05/2017 14:22

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D005

Sheet 3 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/24/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,785.6 m**Northing:** 7,976,738.1 m**Surface Elevation:** -19.50 m**Bottom Elevation:** -50.60 m**Total Depth:** 31.1 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						No core recovered (Continued)										
						SAND, trace GRAVEL, trace SILT: Grey, coarse grained, poorly graded, angular sand										
									DS5 taken from 12.80-13.10m.		5	92	3			
									DS6 taken from 14.30-14.50m.							

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D005

Sheet 4 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/24/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,785.6 m**Northing:** 7,976,738.1 m**Surface Elevation:** -19.50 m**Bottom Elevation:** -50.60 m**Total Depth:** 31.1 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						No core recovered										
	-35.0	15.5														
	-35.5	16.0														
	-36.0	16.5				SAND, some GRAVEL: Coarse grained sand; rounded to subangular coarse gravel			DS7 taken from 16.50-16.80m.							
	-36.5	17.0														
	-37.0	17.5														
	-37.5	18.0														
	-38.0	18.5				SAND, some SILT: Brown, fine grained, poorly graded										
	-38.5	19.0							DS8 taken from 18.90-19.20m.							
	-39.0	19.5				SILT and SAND, trace GRAVEL: Brown to Grey, medium to coarse grained, poorly graded sand; fine gravel										
	-39.5	20.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D005

Sheet 5 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/24/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,785.6 m**Northing:** 7,976,738.1 m**Surface Elevation:** -19.50 m**Bottom Elevation:** -50.60 m**Total Depth:** 31.1 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-40.0	20.5				SILT and SAND, trace GRAVEL: Brown to Grey, medium to coarse grained, poorly graded sand; fine gravel (Continued)										
	-40.5	21.0							DS9 taken from 21.00-21.30m.		1	41	58			
	-41.0	21.5				SAND, some SILT, trace GRAVEL: Light brown, fine to coarse grained sand, well graded, multi-coloured, rounded to subangular gravel										
	-41.5	22.0							DS10 taken from 21.90-22.30m.							
	-42.0	22.5														
	-42.5	23.0				SAND, some SILT: Light brown, well graded, medium to coarse grained sand										
	-43.0	23.5														
	-43.5	24.0				24.00 m to 24.40 m: Trace gravel, multi-coloured			DS11 taken from 24.10-24.40m.							
	-44.0	24.5														
	-44.5	25.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D005

Sheet 6 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/24/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,785.6 m**Northing:** 7,976,738.1 m**Surface Elevation:** -19.50 m**Bottom Elevation:** -50.60 m**Total Depth:** 31.1 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-45.0	25.5				SAND, some SILT: Light brown, well graded, medium to coarse grained sand (Continued)			DS12 taken from 25.30-25.60m.		1	80	20			
	-45.5	26.0														
	-46.0	26.5														
	-46.5	27.0														
	-47.0	27.5				SAND, trace SILT: Light brown, fine to coarse grained, well graded sand			DS13 taken from 28.00-28.30m.		0	96	4			
	-47.5	28.0														
	-48.0	28.5														
	-48.5	29.0														
	-49.0	29.5														
	-49.5	30.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D005

Sheet 7 of 7

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 3/24/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,785.6 m**Northing:** 7,976,738.1 m**Surface Elevation:** -19.50 m**Bottom Elevation:** -50.60 m**Total Depth:** 31.1 m**Logged By:** UK/AB**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-50.0	30.5				SAND, trace SILT: Light brown, fine to coarse grained, well graded sand (Continued)		100%	AS14 taken from 30.50-31.10m. N= 2							
	-50.5	31.0														
	-51.0	31.5				To Target Depth. Drillhole BH17-D005 terminated at 31.1m.										
	-51.5	32.0														
	-52.0	32.5														
	-52.5	33.0														
	-53.0	33.5														
	-53.5	34.0														
	-54.0	34.5														
	-54.5	35.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D006

Sheet 1 of 5

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 4/1/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,678.2 m**Northing:** 7,976,797.1 m**Surface Elevation:** -29.84 m**Bottom Elevation:** -54.24 m**Total Depth:** 24.4 m**Logged By:** UK/MR**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
	-30.3	0.5				SAND, some SILT, trace Gravel: Light brown to dark grey, fine grained sand; rounded gravel; organic silt		100%	AS1 taken from .00-.60m. N= 5		3	79	18			
	-30.8	1.0														
	-31.3	1.5														
	-31.8	2.0				SAND, trace SILT: Grey to light brown, fine to coarse grained, well graded sand			DS2 taken from 2.10-2.40m.		0	99	1			
	-32.3	2.5														
	-32.8	3.0														
	-33.3	3.5							DS3 taken from 3.70-4.00m.							
	-33.8	4.0														
	-34.3	4.5														
	-34.8	5.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D006

Sheet 2 of 5

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 4/1/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,678.2 m**Northing:** 7,976,797.1 m**Surface Elevation:** -29.84 m**Bottom Elevation:** -54.24 m**Total Depth:** 24.4 m**Logged By:** UK/MR**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						SAND, trace SILT: Grey to light brown, fine to coarse grained, well graded sand (Continued)										
	-35.3	5.5							DS4 taken from 5.50-5.80m.							
	-35.8	6.0				SAND, trace GRAVEL: Grey to light brown, fine to medium grained sand; rounded, well graded gravel		100%	AS5 taken from 6.10-6.70m. N= 4							
	-36.3	6.5														
	-36.8	7.0														
	-37.3	7.5				SAND, trace GRAVEL, trace SILT: Grey to light brown, fine to medium grained sand; rounded, poorly graded gravel										
	-37.8	8.0							DS6 taken from 7.90-8.20m.							
	-38.3	8.5														
	-38.8	9.0														
	-39.3	9.5														
	-39.8	10.0							DS7 taken from 9.80-10.10m.		3	95	2			

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



Sheet 3 of 5

Reviewed By: WH/CH

ATCHCANADA2015 DRAFT.GLB Log ICE BOREHOLE MR EXPANSION STUDY STAGE 2 - REV A.GPJ <<DrawingFile>> 25/05/2017 14:22

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D006

Sheet 4 of 5

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 4/1/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,678.2 m**Northing:** 7,976,797.1 m**Surface Elevation:** -29.84 m**Bottom Elevation:** -54.24 m**Total Depth:** 24.4 m**Logged By:** UK/MR**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						SAND, some SILT: Dark grey, fine to medium grained, poorly graded sand; organic silt										
	-45.3	15.5														
	-45.8	16.0							DS11 taken from 15.80-16.20m.		0	82	18			
	-46.3	16.5														
	-46.8	17.0														
	-47.3	17.5														
	-47.8	18.0							DS12 taken from 17.70-18.00m.							
	-48.3	18.5				SAND: Light brown, fine to medium grained										
	-48.8	19.0							DS13 taken from 18.90-19.20m.							
	-49.3	19.5														
	-49.8	20.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.



BOREHOLE REPORT

BH17-D006

Sheet 5 of 5

Client: Baffinland Iron Mines**Project No.:** H352034**Project:** Marry River Expansion Study Stage 2**Datum:** NAD83**Location:** Milne Port Ore Dock No.2**Platform:** Ice Surface**Contractor:** Boart Longyear**Rig Type/ Mounting:** MiniSonic Rig**Date Logged:** 4/1/2017**Driller:** EB/SF**Hole Diameter (mm):** 100**Date Reviewed:** 5/18/2017**Easting:** 503,678.2 m**Northing:** 7,976,797.1 m**Surface Elevation:** -29.84 m**Bottom Elevation:** -54.24 m**Total Depth:** 24.4 m**Logged By:** UK/MR**Reviewed By:** WH/CH

Water	Elevation (m)	Depth (m)	Method	Casing	Graphic Log	Soil Description TYPE; plasticity or particle characteristics (size, grading, shape, roundness), colour, structure, accessory components.	Frozen Soil Description	Consistency/ Density Sample Type	Additional Observations	Field Water Content	Percent Gravel	Percent Sand	Percent Fines	Liquid Limit	Plastic Index	Other Tests
						SAND: Light brown, fine to medium grained (Continued)										
	-50.3	20.5							DS14 taken from 20.40-20.70m.							
	-50.8	21.0														
	-51.3	21.5														
	-51.8	22.0				Thin silt seams below 22.0m			DS15 taken from 21.90-22.30m.							
	-52.3	22.5														
	-52.8	23.0														
	-53.3	23.5							DS16 taken from 23.50-23.80m.							
	-53.8	24.0														
	-54.3	24.5				To Target Depth. Drillhole BH17-D006 terminated at 24.4m.										
	-54.8	25.0														

Notes: SPT blow counts lower than expected due to disturbed zone around sonic drill bit. Refer to piezocone test data for undisturbed in-situ testing.

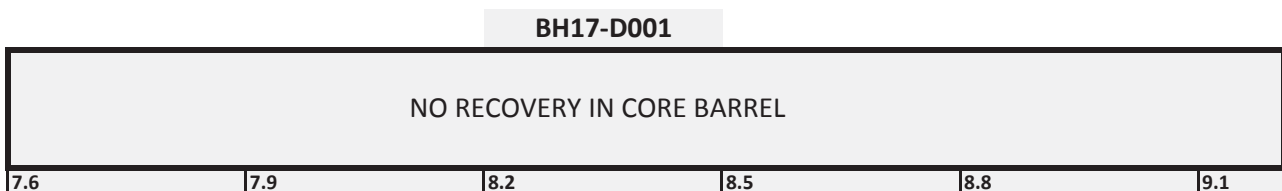
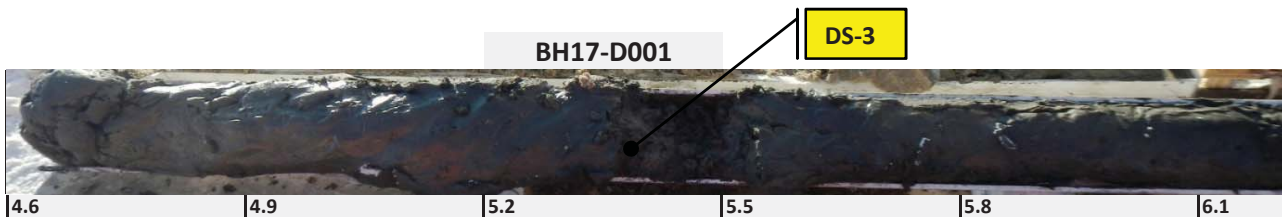
Appendix C

Sample Photographs

Sample Photographs

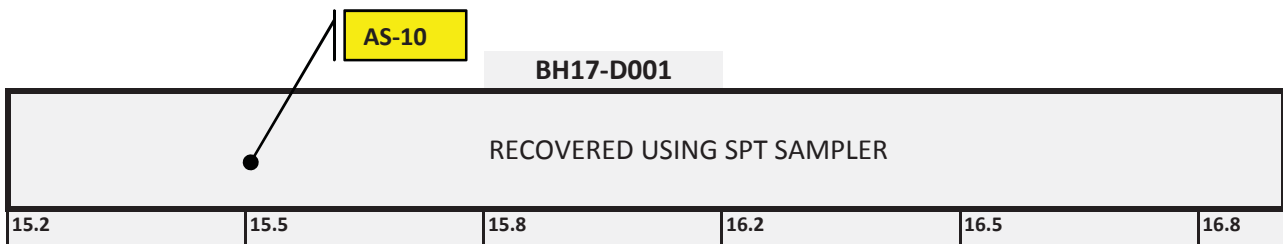
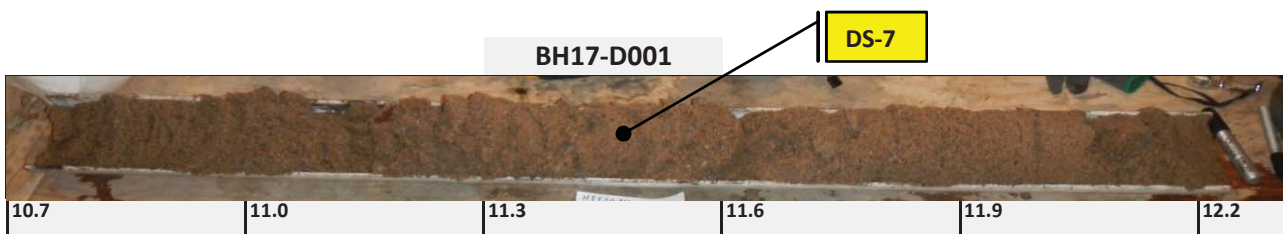
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 Location: 17 W 503644 7976665
 Completion Date: April 1, 2017

Mary River Expansion Study Stage 2
 2017 Geotechnical Investigation
 Baffinland Iron Mines



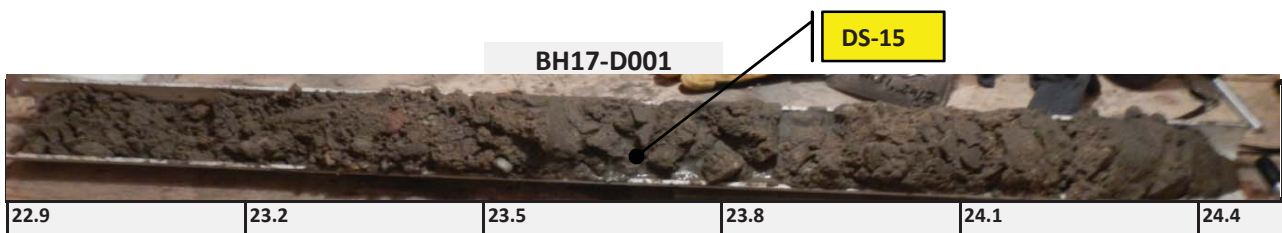
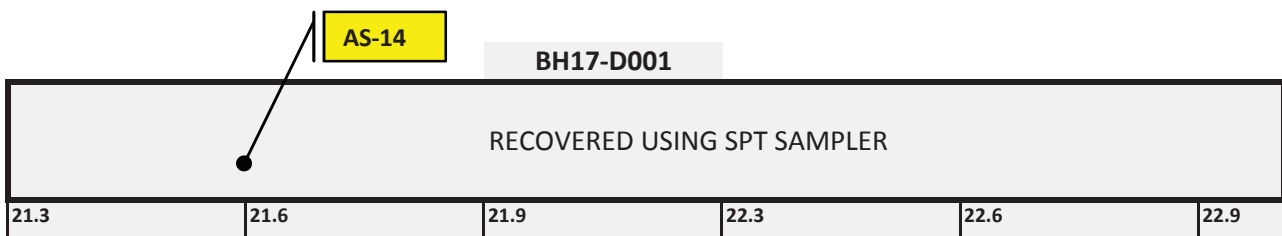
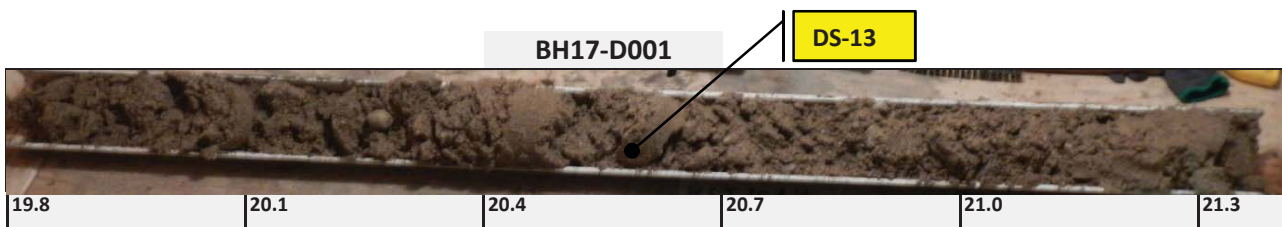
Sample Photographs

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Location:	17 W 503644 7976665	
Completion Date:	April 1, 2017	Baffinland Iron Mines



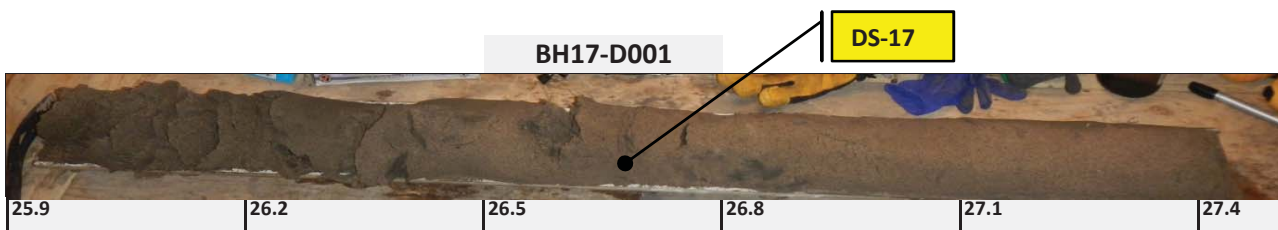
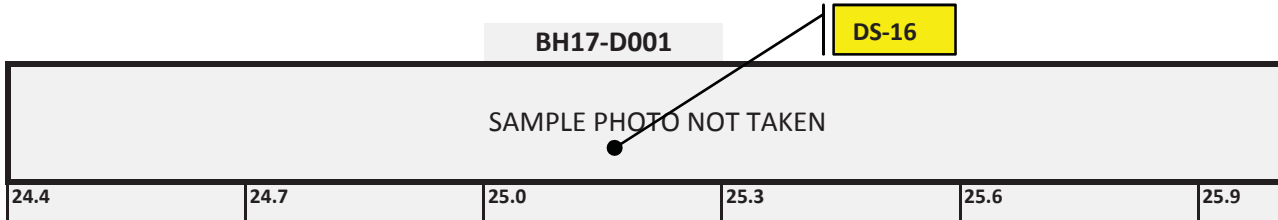
Sample Photographs

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Location:	17 W 503644 7976665	
Completion Date:	April 1, 2017	Baffinland Iron Mines



Sample Photographs

Borehole Name:	BH17-D001	Mary River Expansion Study Stage 2
Location:	17 W 503644 7976665	
Completion Date:	April 1, 2017	Baffinland Iron Mines



Sample Photographs

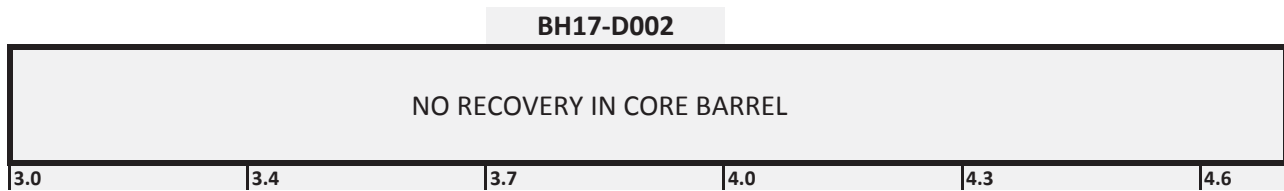
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Mary River Expansion Study Stage 2

Location: 17 W 503764 7976681

Completion Date: March 24, 2017

Baffinland Iron Mines



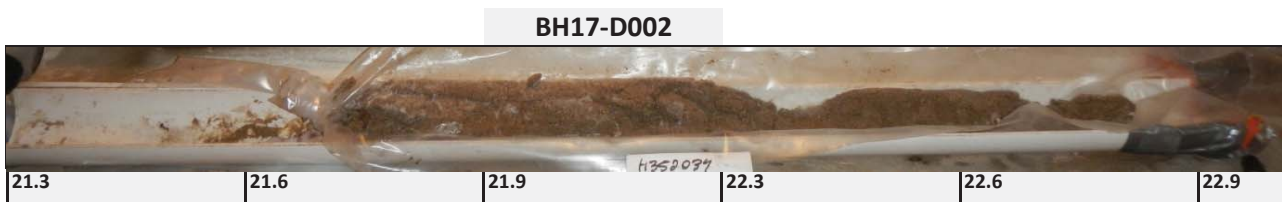
Sample Photographs

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Location:	17 W 503764 7976681	
Completion Date:	March 24, 2017	Baffinland Iron Mines



Sample Photographs

Borehole Name:	BH17-D002	Mary River Expansion Study Stage 2
Location:	17 W 503764 7976681	
Completion Date:	March 24, 2017	Baffinland Iron Mines



Sample Photographs

Borehole Name:	BH17-D002	Mary River Expansion Study Stage 2
Location:	17 W 503764 7976681	
Completion Date:	March 24, 2017	Baffinland Iron Mines

BH17-D002



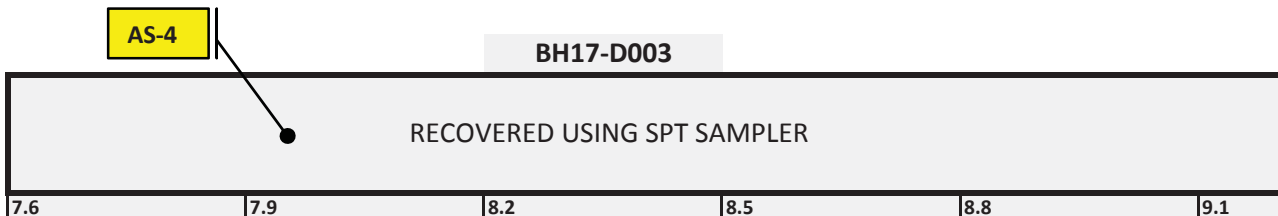
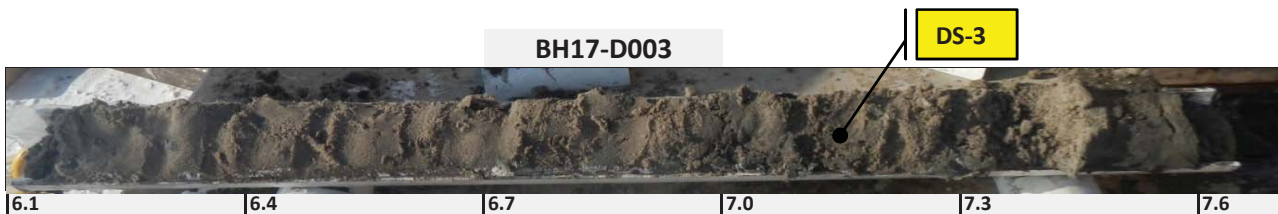
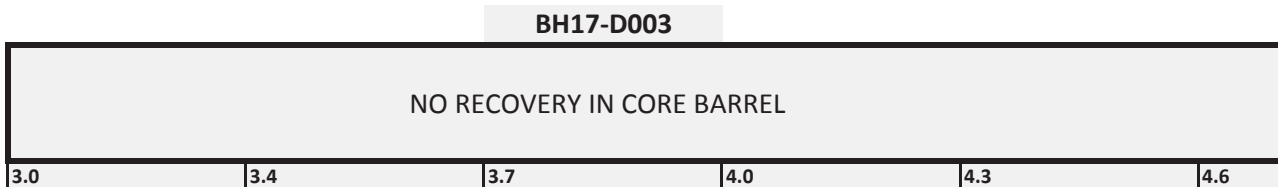
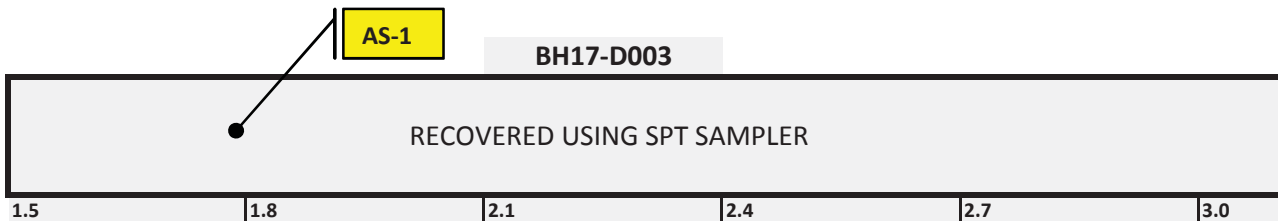
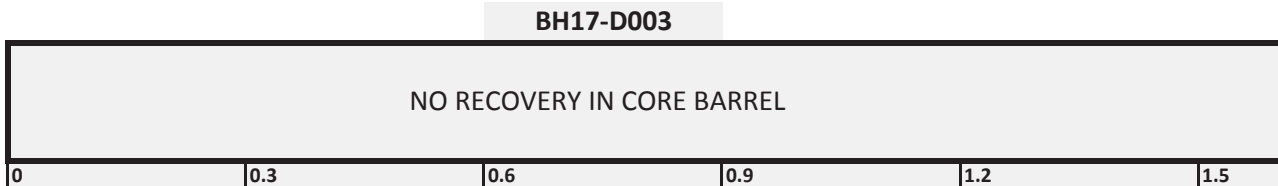
DS-13

BH17-D002



Sample Photographs

Borehole Name:	BH17-D003	Mary River Expansion Study Stage 2
Location:	17 W 503608 7976710	2017 Geotechnical Investigation
Completion Date:	March 31, 2017	Baffinland Iron Mines



Sample Photographs

Borehole Name:	BH17-D003	Mary River Expansion Study Stage 2
Location:	17 W 503608 7976710	
Completion Date:	March 31, 2017	Baffinland Iron Mines

BH17-D003

NO RECOVERY IN CORE BARREL

9.1	9.4	9.8	10.1	10.4	10.7
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AS-5

BH17-D003

RECOVERED USING SPT SAMPLER

10.7	11.0	11.3	11.6	11.9	12.2
------	------	------	------	------	------

BH17-D003

NO RECOVERY IN CORE BARREL

12.2	12.5	12.8	13.1	13.4	13.7
------	------	------	------	------	------

BH17-D003

NO RECOVERY IN CORE BARREL

13.7	14.0	14.3	14.6	14.9	15.2
------	------	------	------	------	------

AS-6

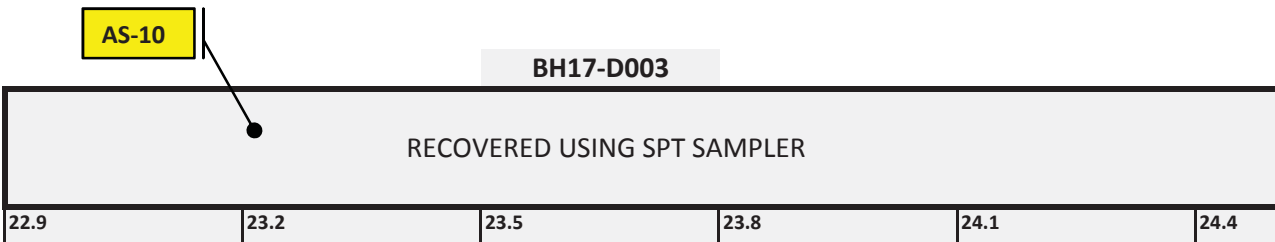
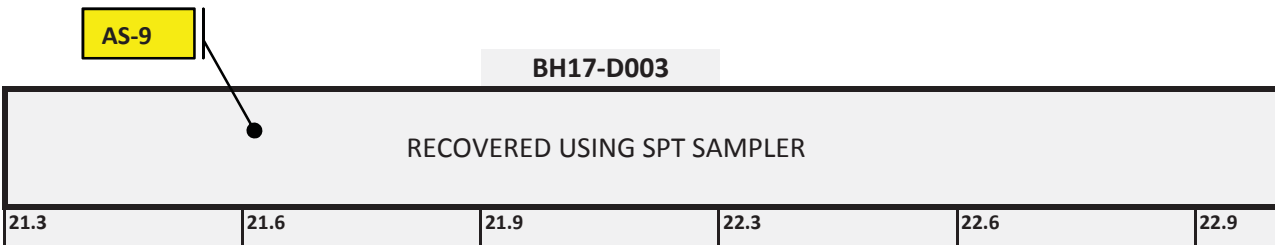
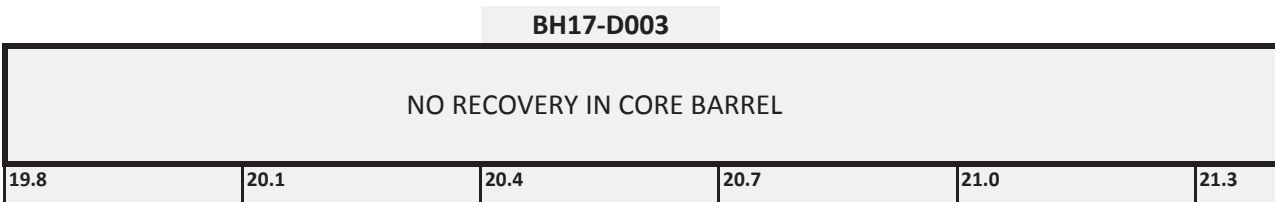
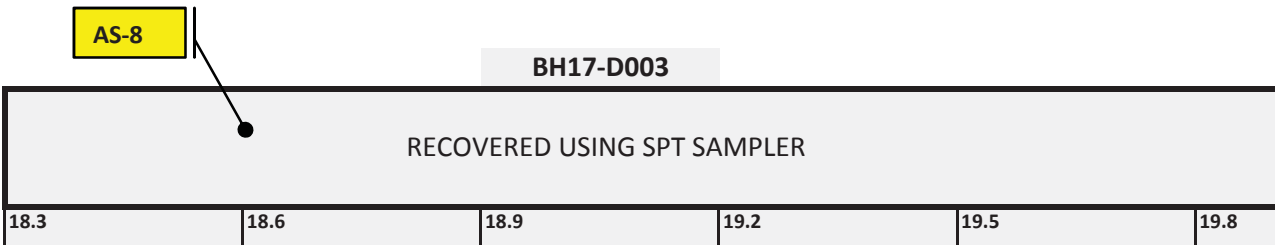
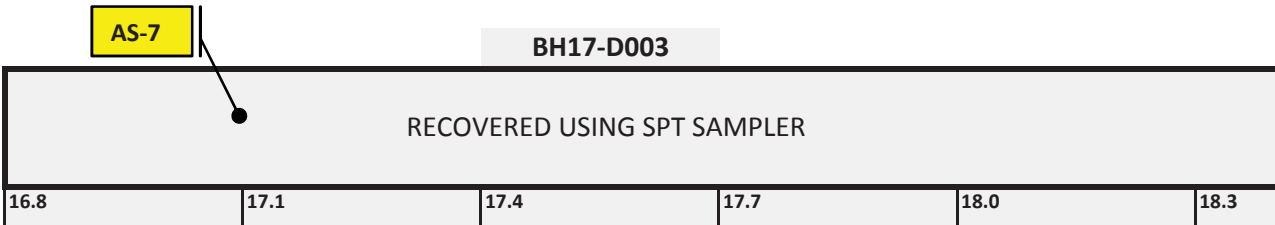
BH17-D003

RECOVERED USING SPT SAMPLER

15.2	15.5	15.8	16.2	16.5	16.8
------	------	------	------	------	------

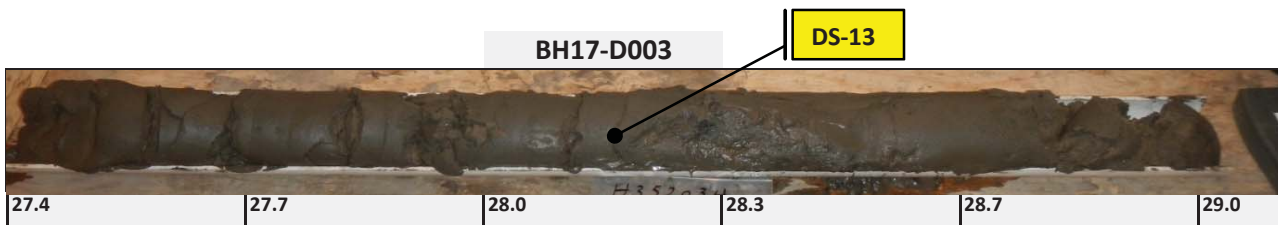
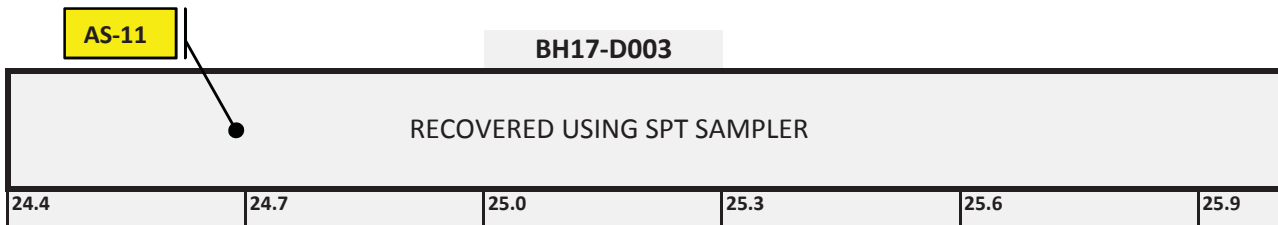
Sample Photographs

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Location:	17 W 503608 7976710	
Completion Date:	March 31, 2017	Baffinland Iron Mines



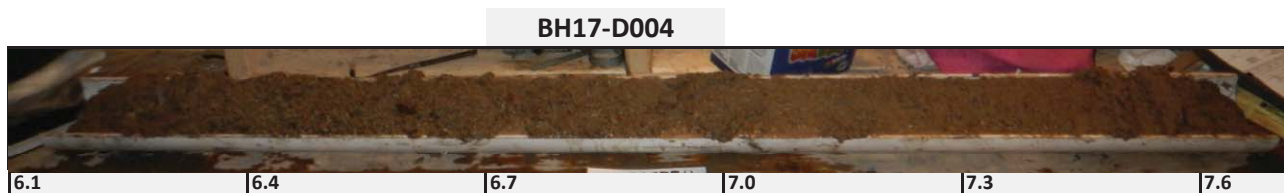
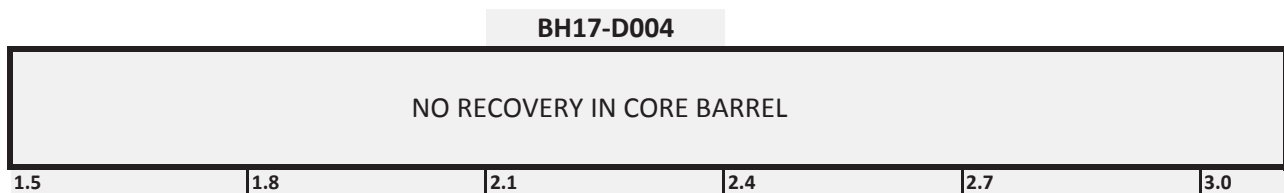
Sample Photographs

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Location:	17 W 503608 7976710	
Completion Date:	March 31, 2017	Baffinland Iron Mines



Sample Photographs

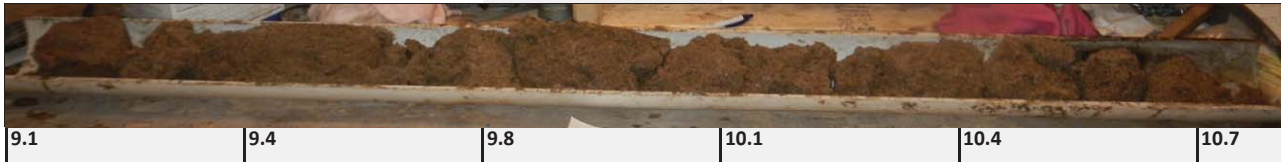
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Location:	17 W 503701 7976728	
Completion Date:	March 28, 2017	Baffinland Iron Mines



Sample Photographs

Borehole Name:	BH17-D004	Mary River Expansion Study Stage 2
Location:	17 W 503701 7976728	
Completion Date:	March 28, 2017	Baffinland Iron Mines

BH17-D004



DS-7

BH17-D004



BH17-D004



AS-8

BH17-D004



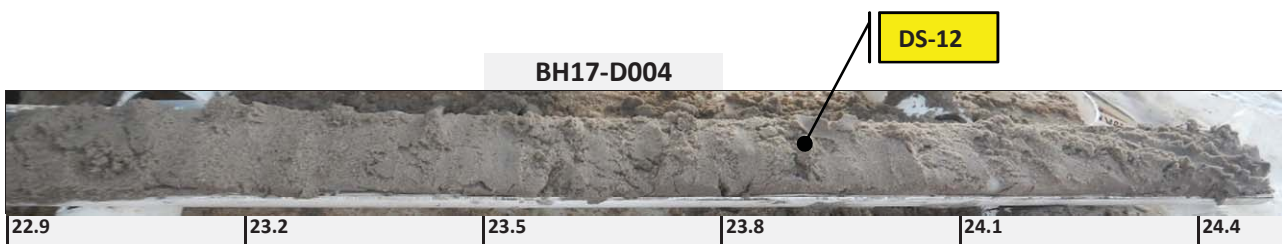
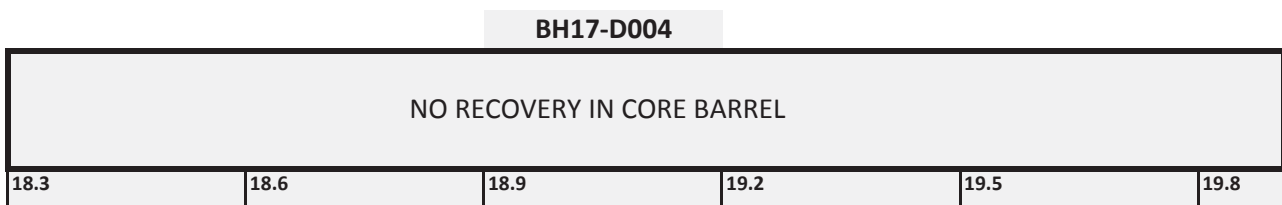
DS-9

BH17-D004



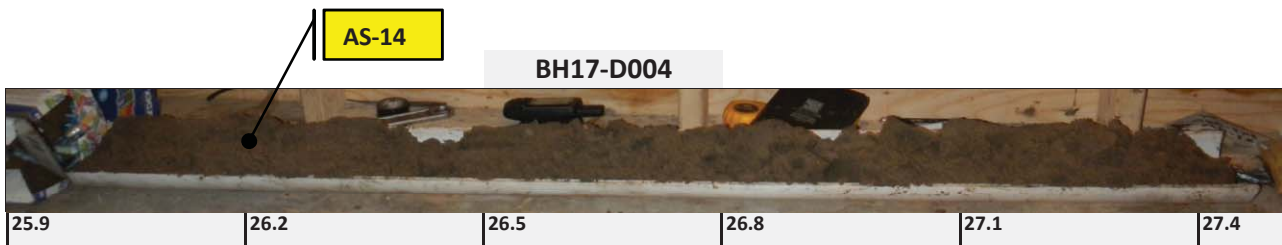
Sample Photographs

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Location:	17 W 503701 7976728	
Completion Date:	March 28, 2017	Baffinland Iron Mines



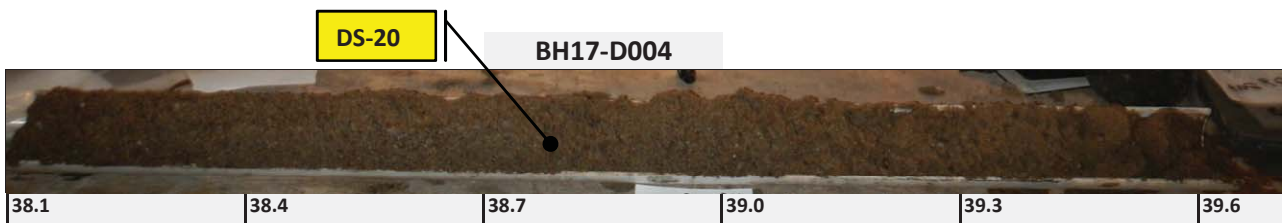
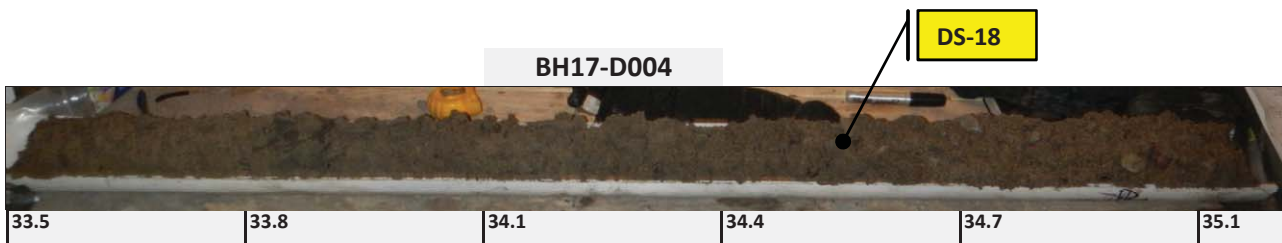
Sample Photographs

Borehole Name:	BH17-D004	Mary River Expansion Study Stage 2
Location:	17 W 503701 7976728	
Completion Date:	March 28, 2017	Baffinland Iron Mines



Sample Photographs

Borehole Name:	BH17-D004	Mary River Expansion Study Stage 2
Location:	17 W 503701 7976728	
Completion Date:	March 28, 2017	Baffinland Iron Mines



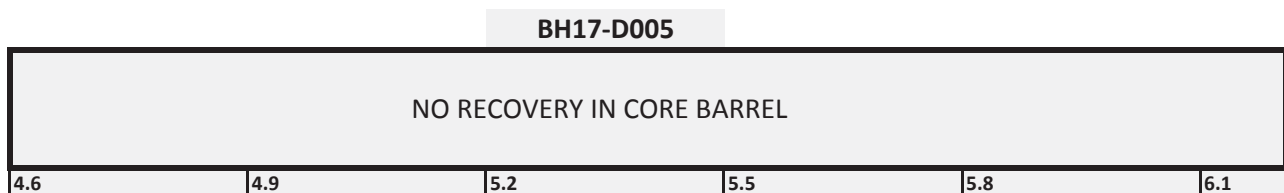
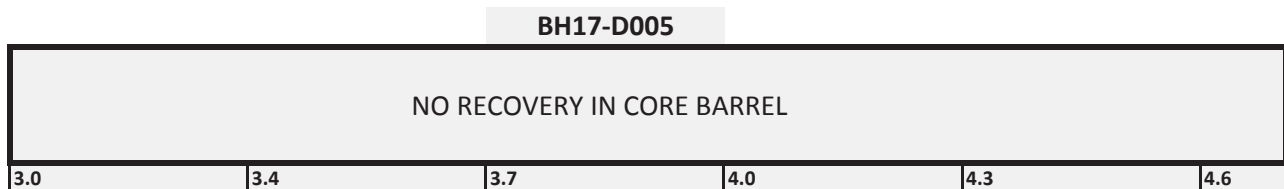
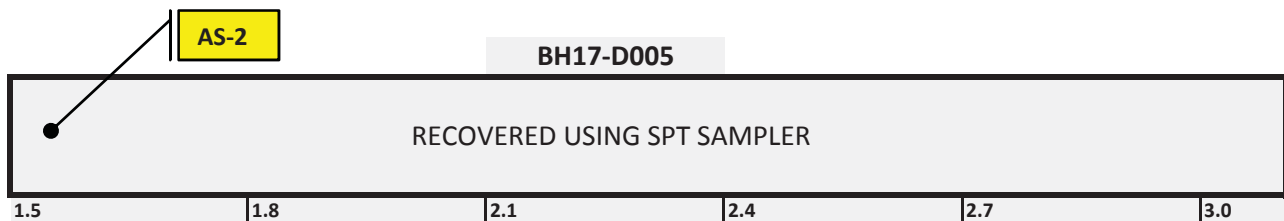
Sample Photographs

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Location:	17 W 503701 7976728	
Completion Date:	March 28, 2017	Baffinland Iron Mines



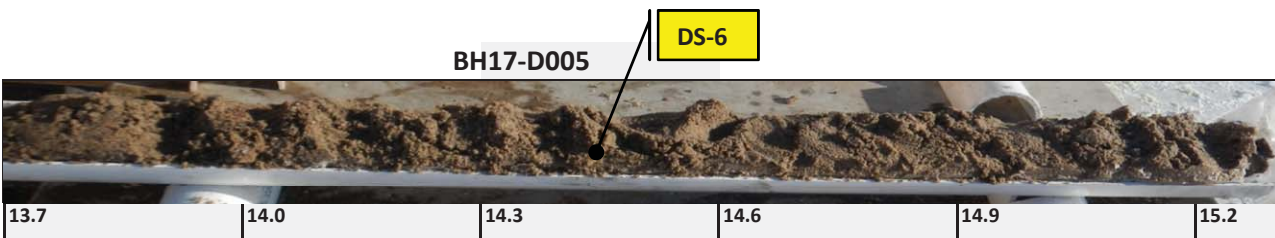
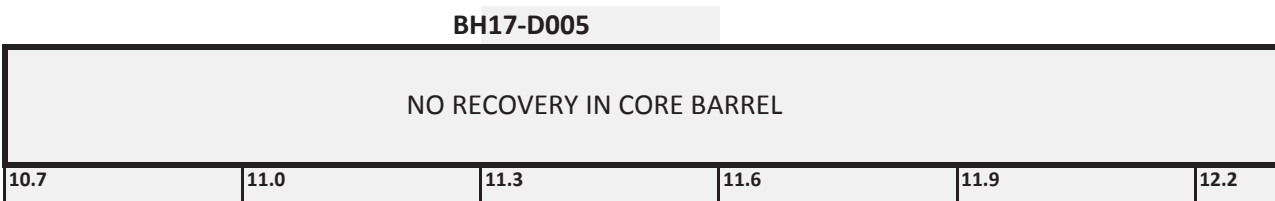
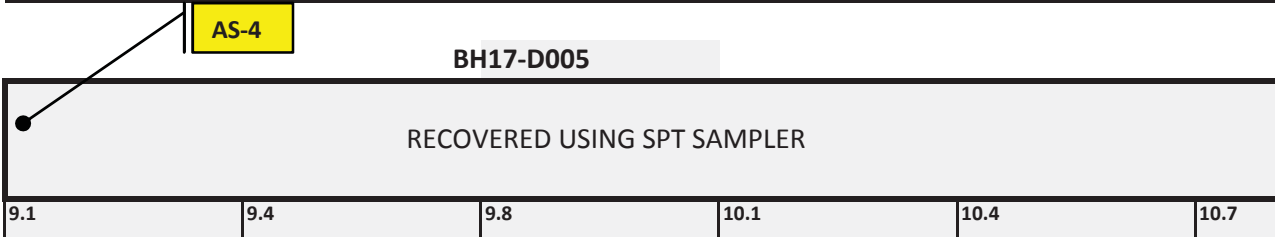
Sample Photographs

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Location:	17 W 503786 7976738	
Completion Date:	March 26, 2017	Baffinland Iron Mines



Sample Photographs

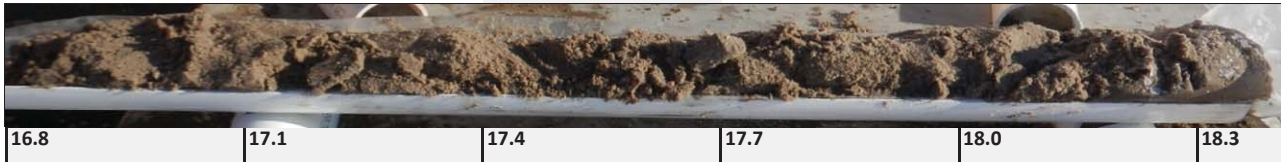
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 Location: 17 W 503786 7976738
 Completion Date: March 26, 2017 Baffinland Iron Mines



Sample Photographs

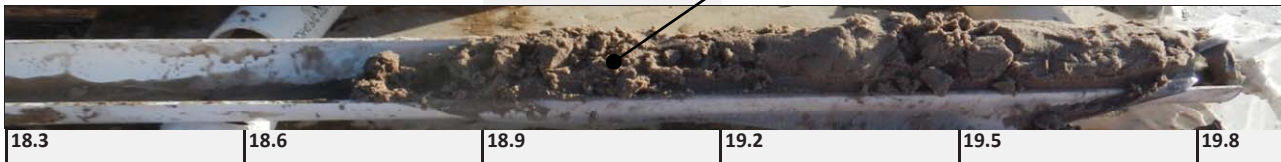
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Location:	17 W 503786 7976738	
Completion Date:	March 26, 2017	Baffinland Iron Mines

BH17-D005



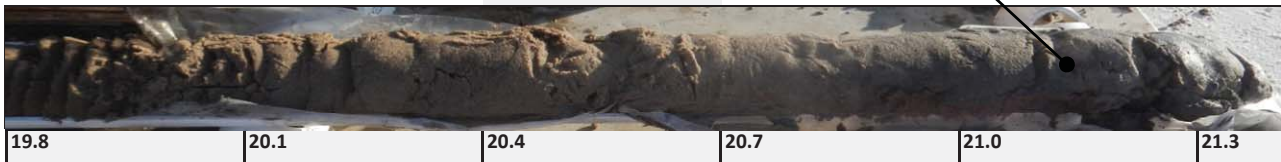
BH17-D005

DS-8



BH17-D005

DS-9



BH17-D005

DS-10



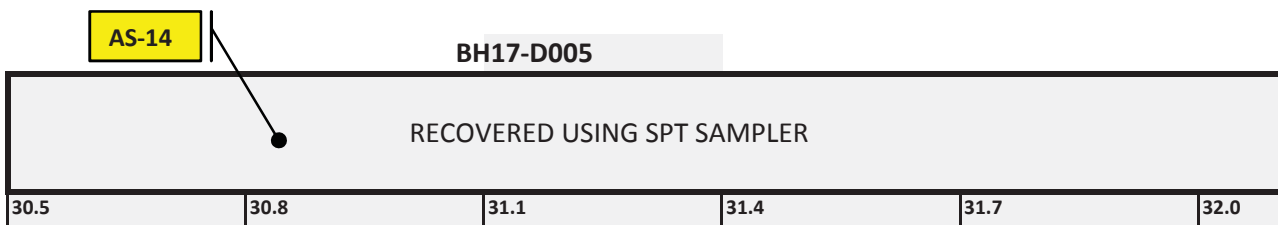
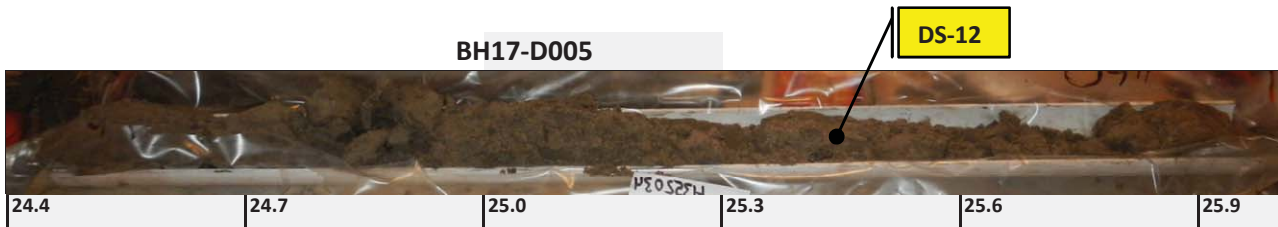
BH17-D005

DS-11



Sample Photographs

Borehole Name:	BH17-D005	Mary River Expansion Study Stage 2
Location:	17 W 503786 7976738	
Completion Date:	March 26, 2017	Baffinland Iron Mines



Sample Photographs

Borehole Name: BH17-D006

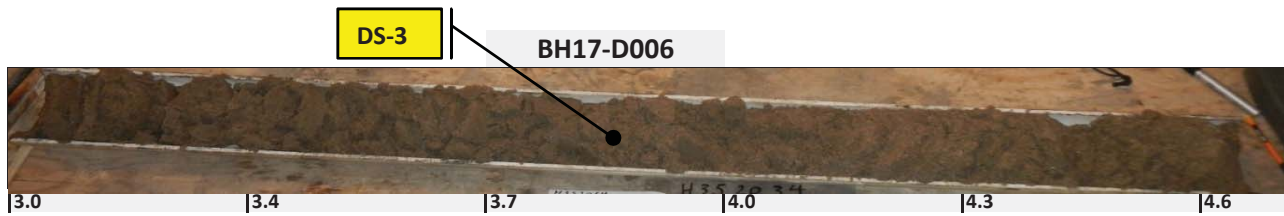
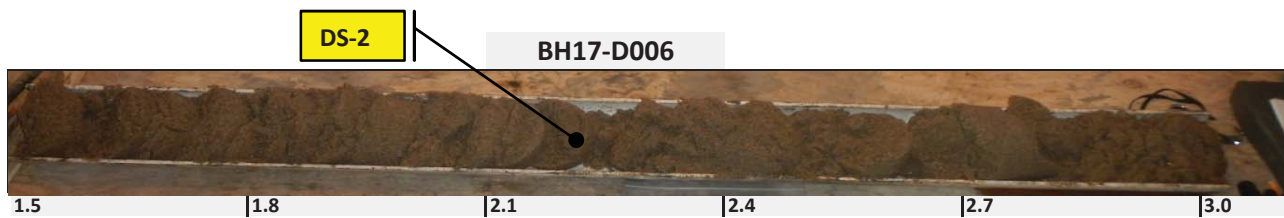
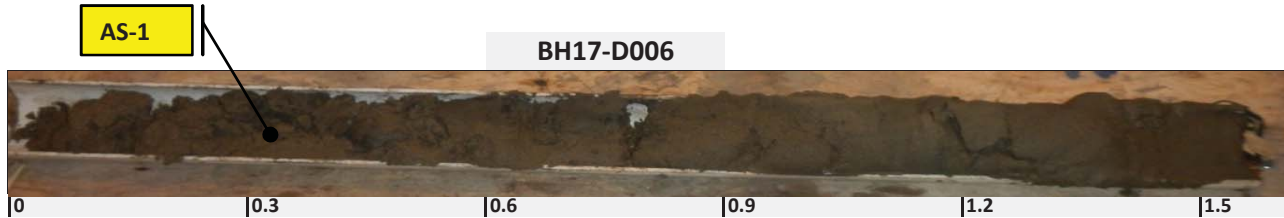
Location: 17 W 503678 7976797

Completion Date: April 2, 2017

Mary River Expansion Study Stage 2

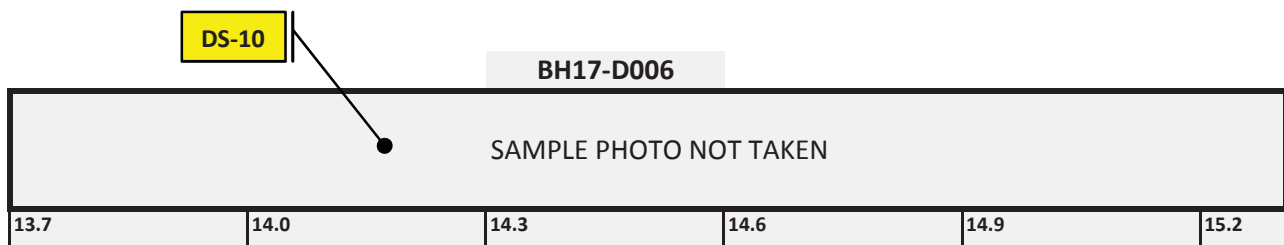
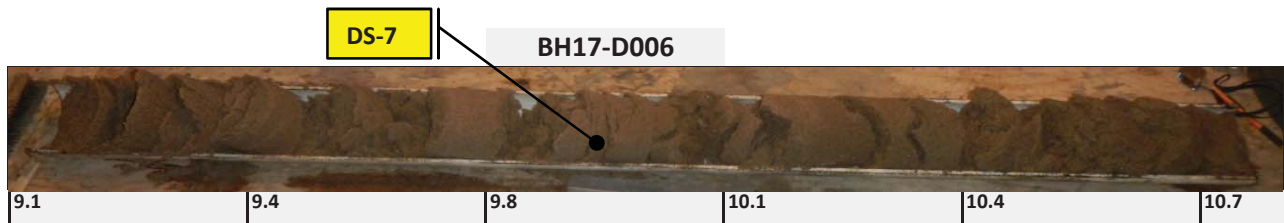
2017 Geotechnical Investigation

Baffinland Iron Mines



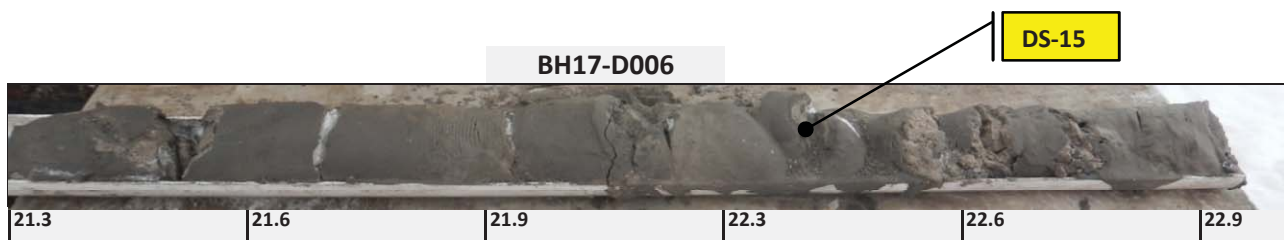
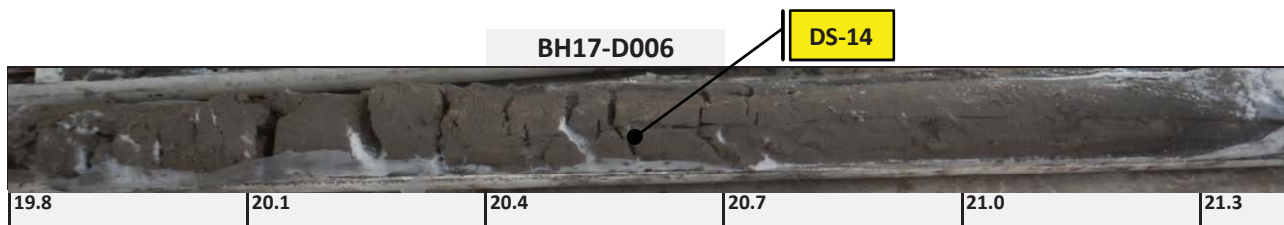
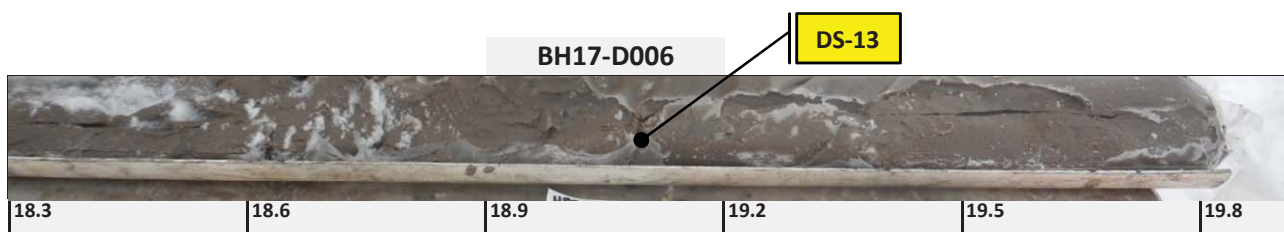
Sample Photographs

Borehole Name:	BH17-D006	Mary River Expansion Study Stage 2
Location:	17 W 503678 7976797	
Completion Date:	April 2, 2017	Baffinland Iron Mines



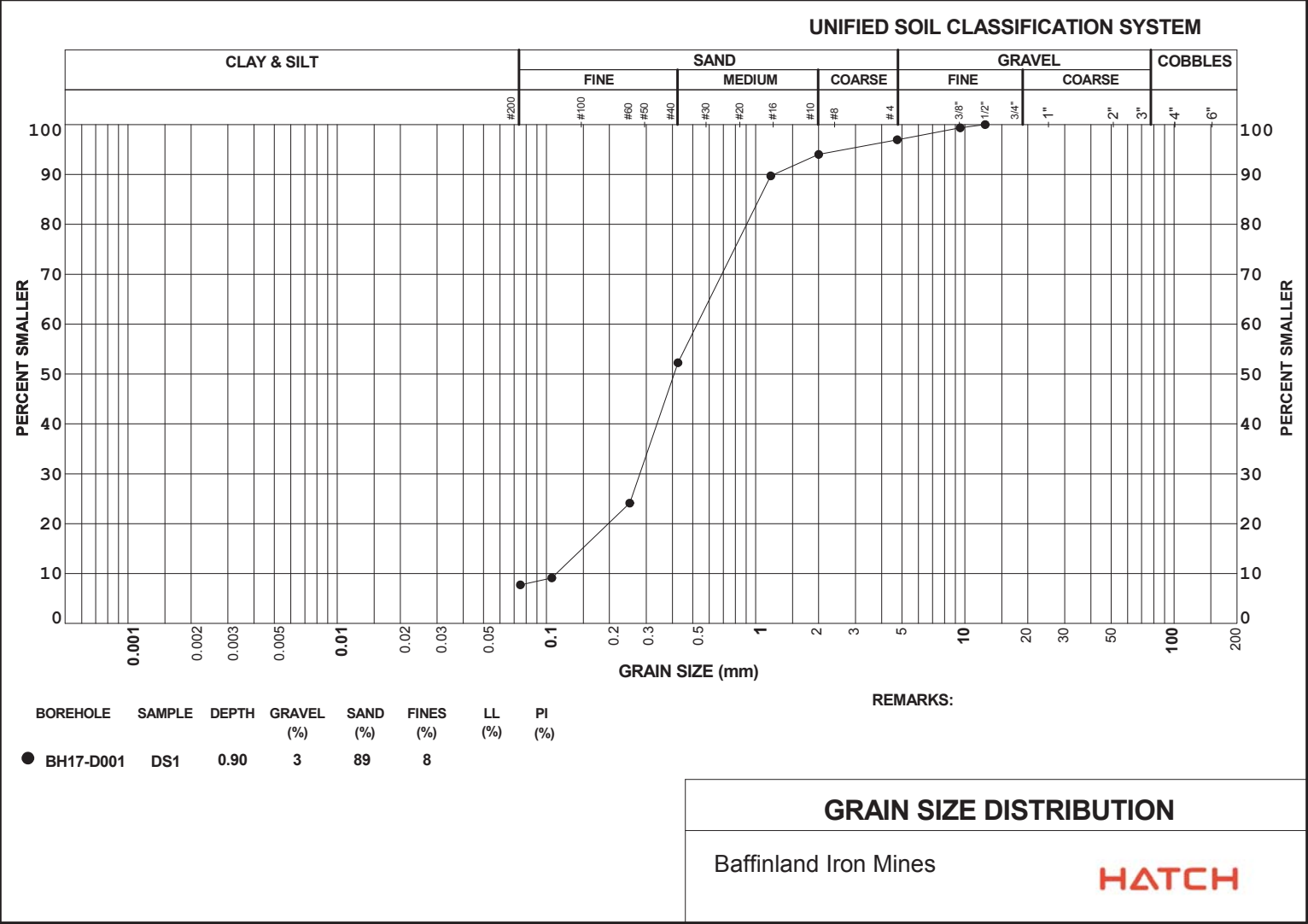
Sample Photographs

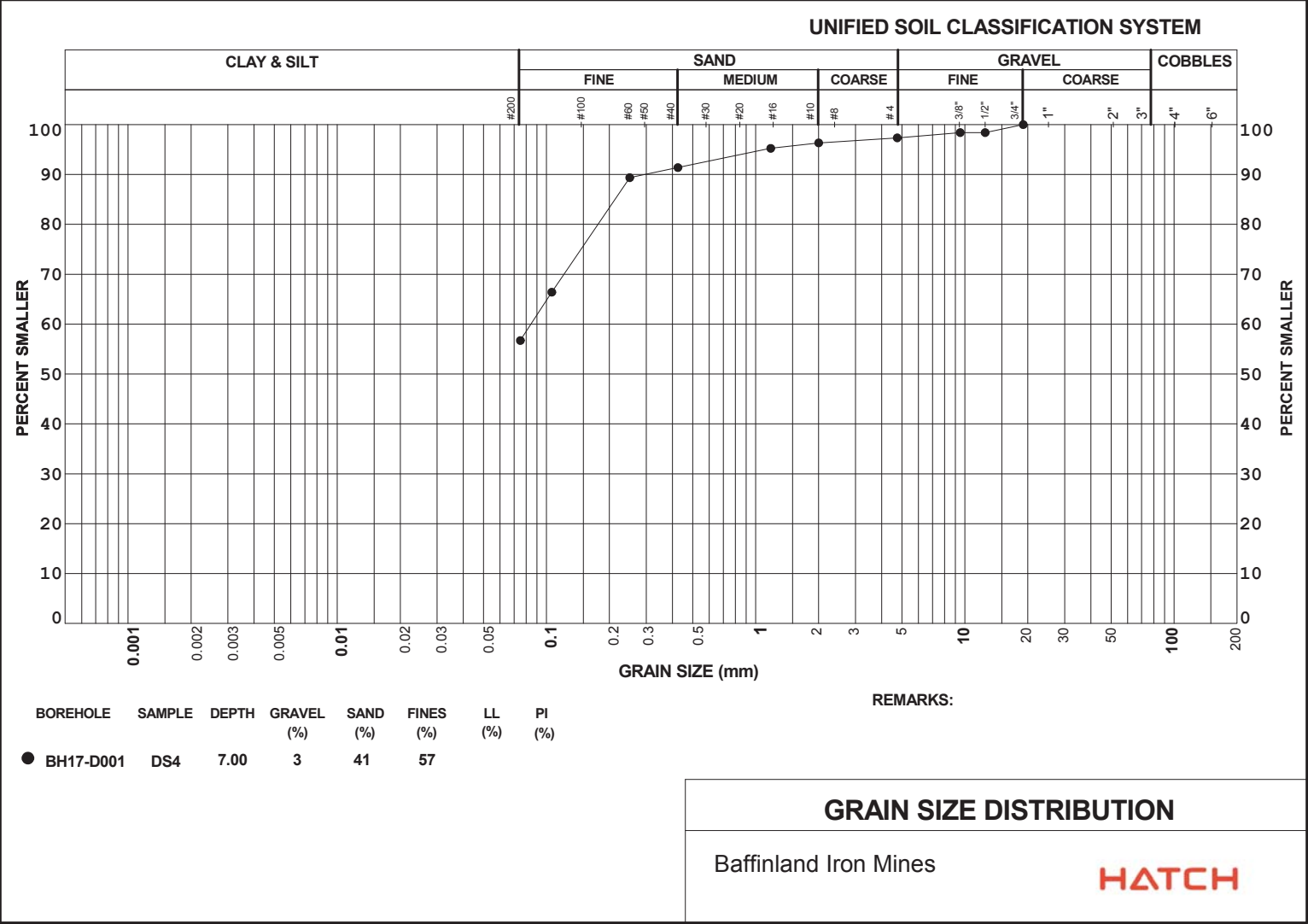
Borehole Name:	BH17-D006	Mary River Expansion Study Stage 2
Location:	17 W 503678 7976797	
Completion Date:	April 2, 2017	Baffinland Iron Mines

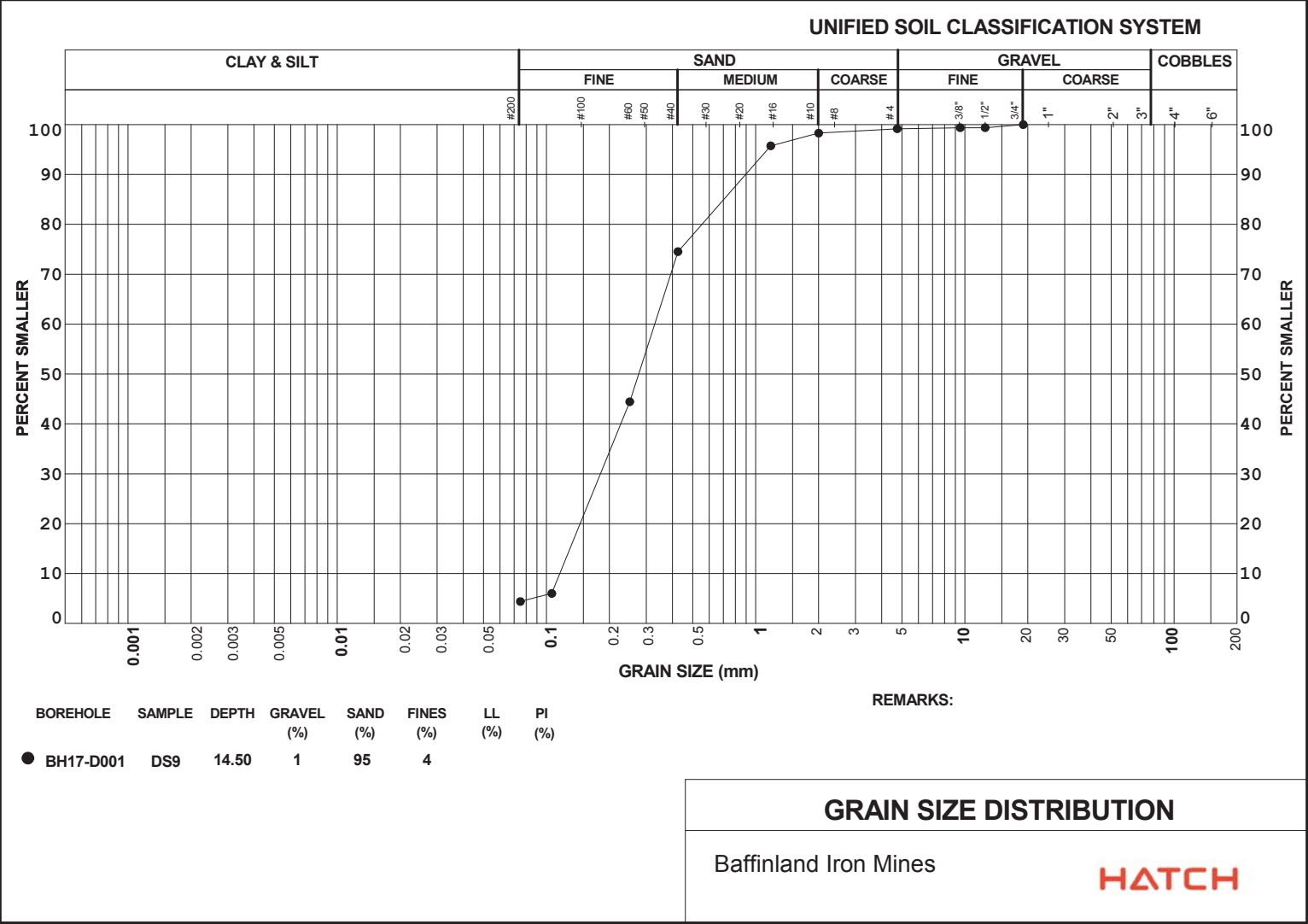


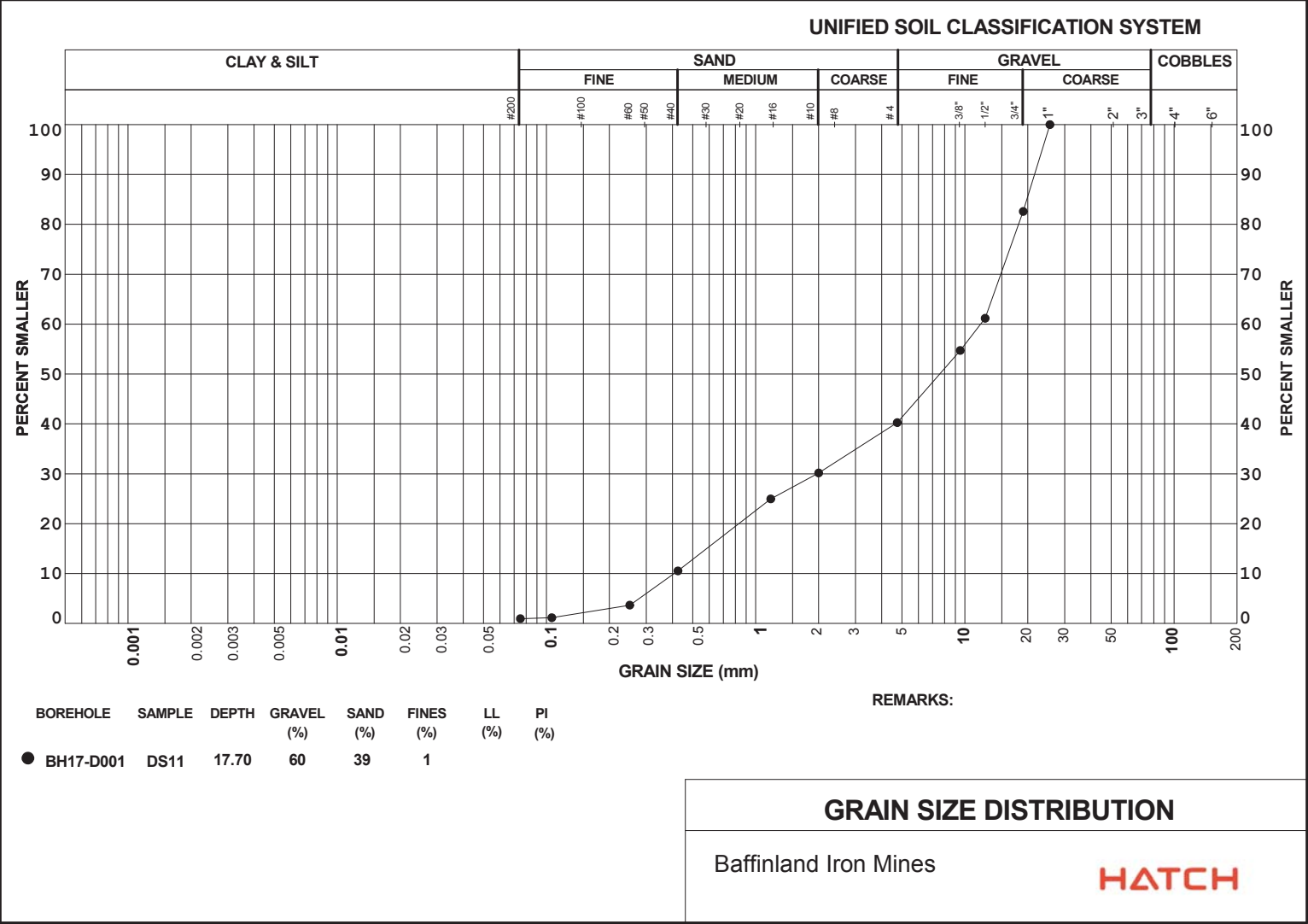
Appendix D

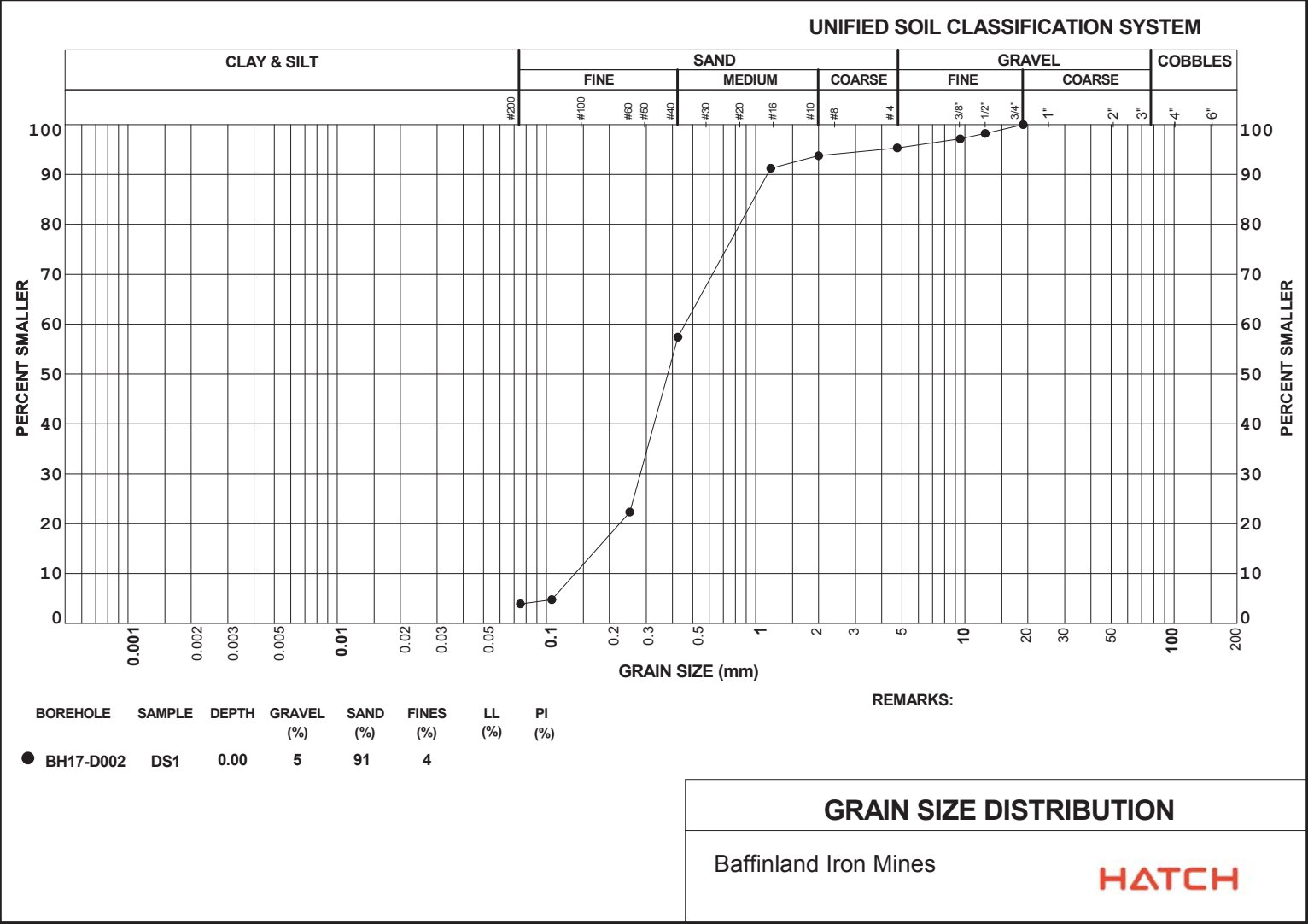
Laboratory Test Reports

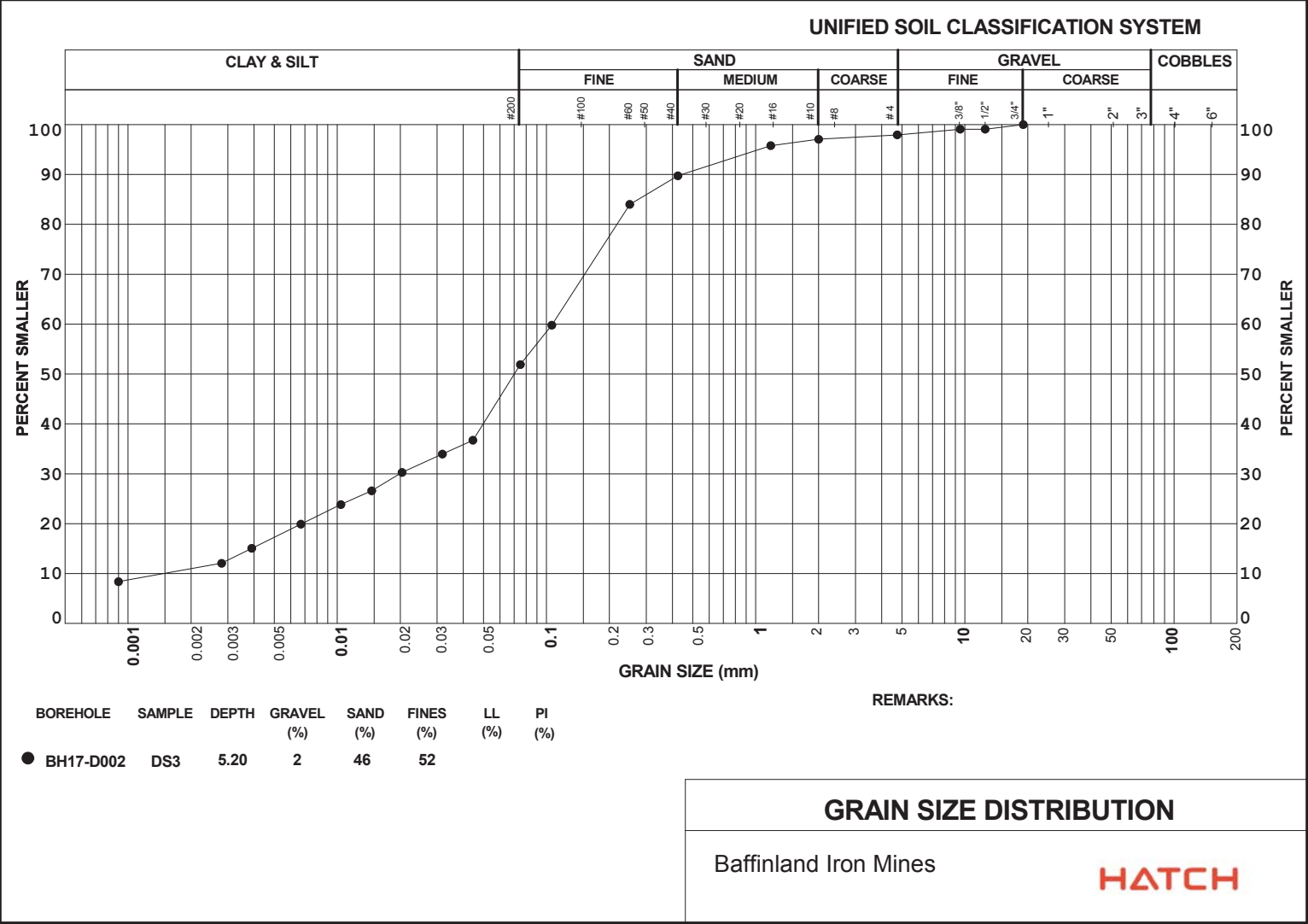


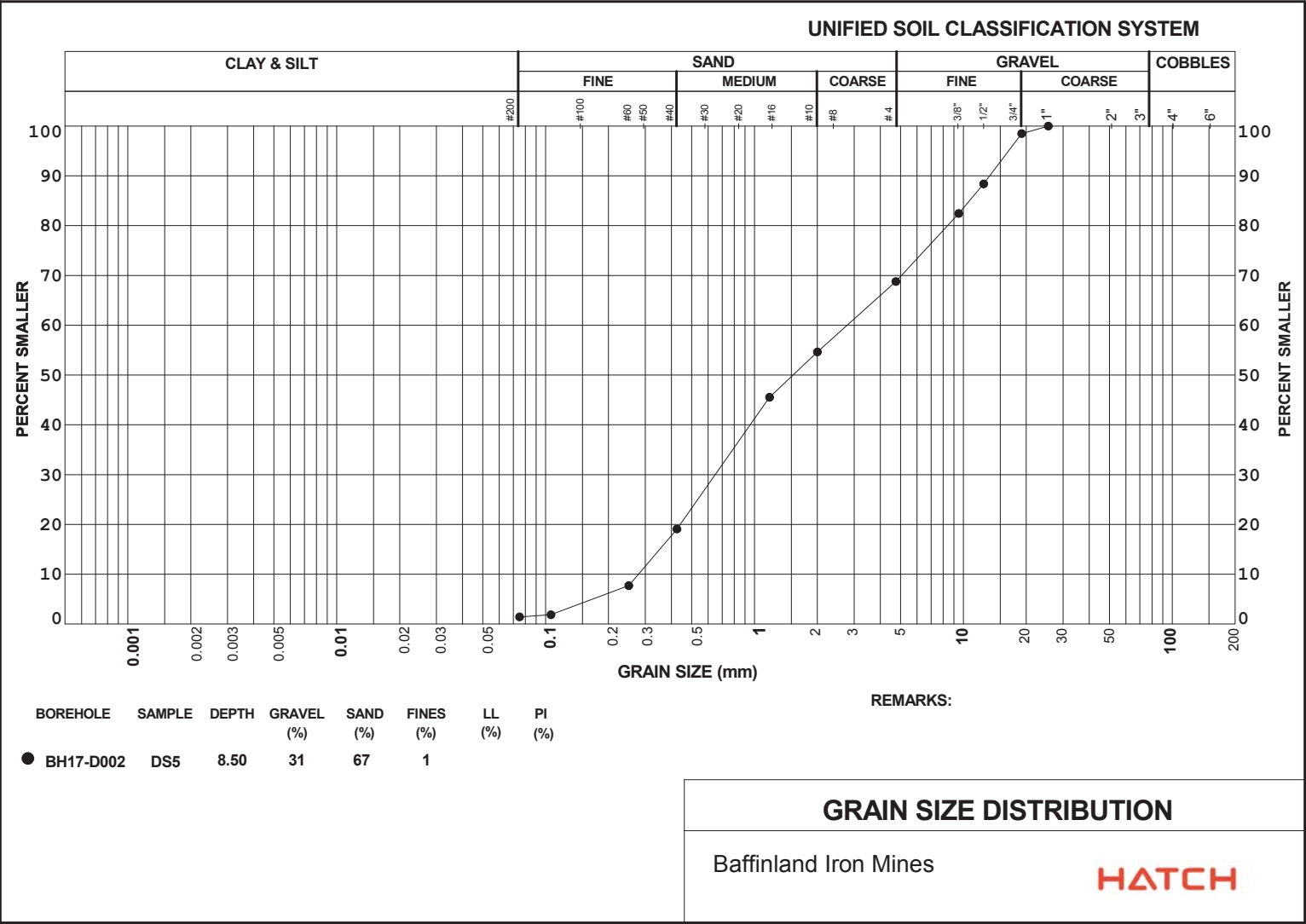


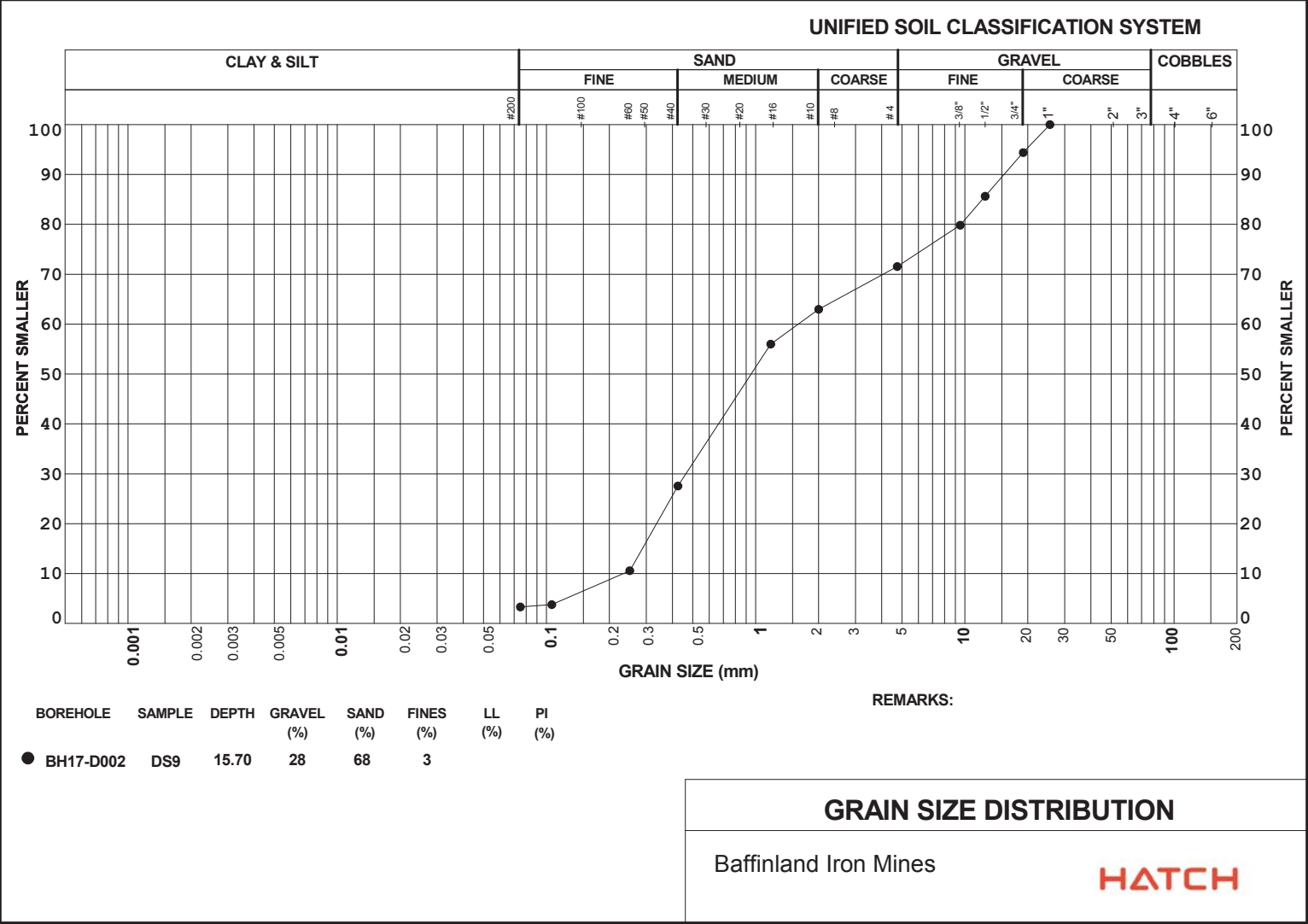


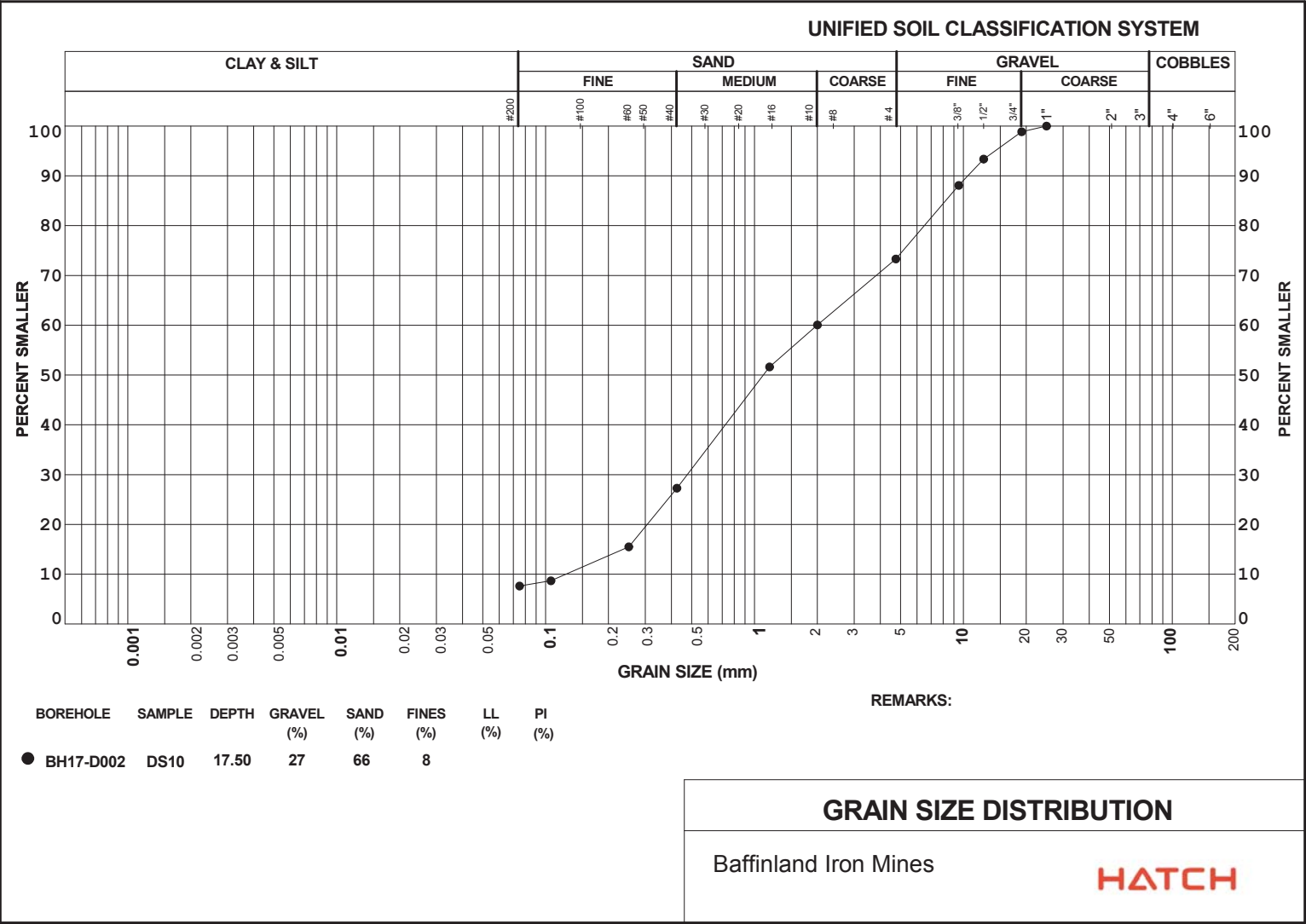


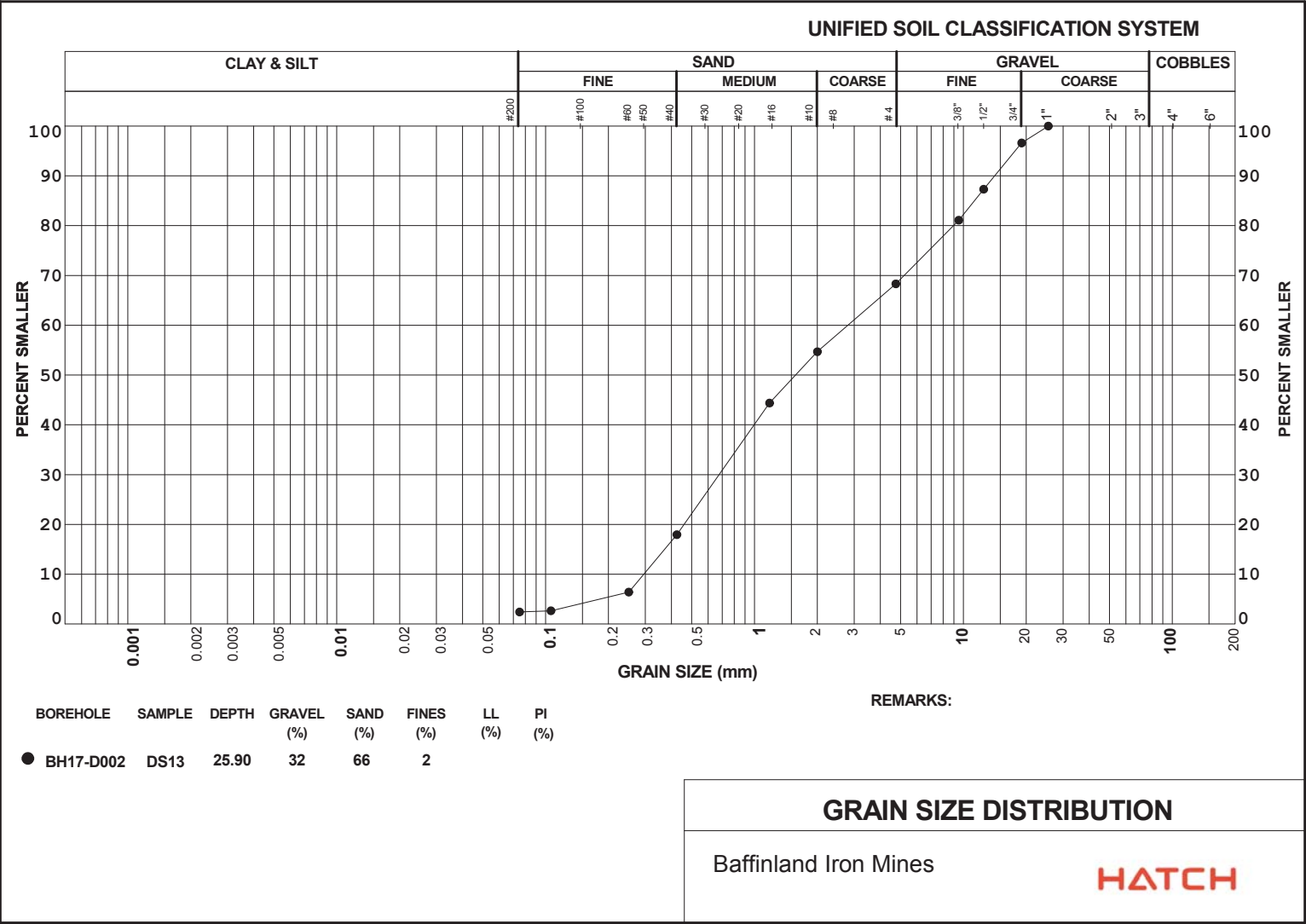


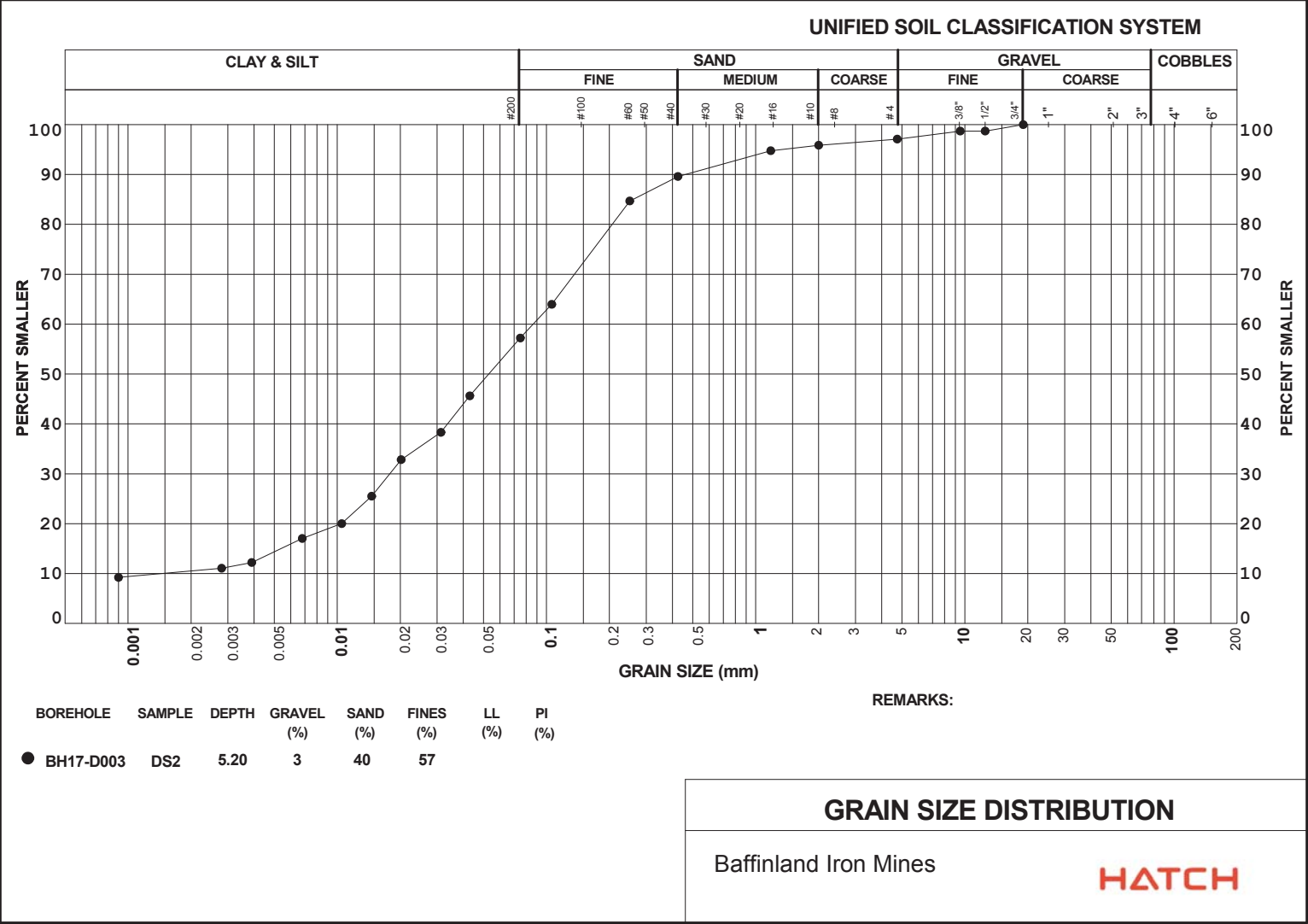


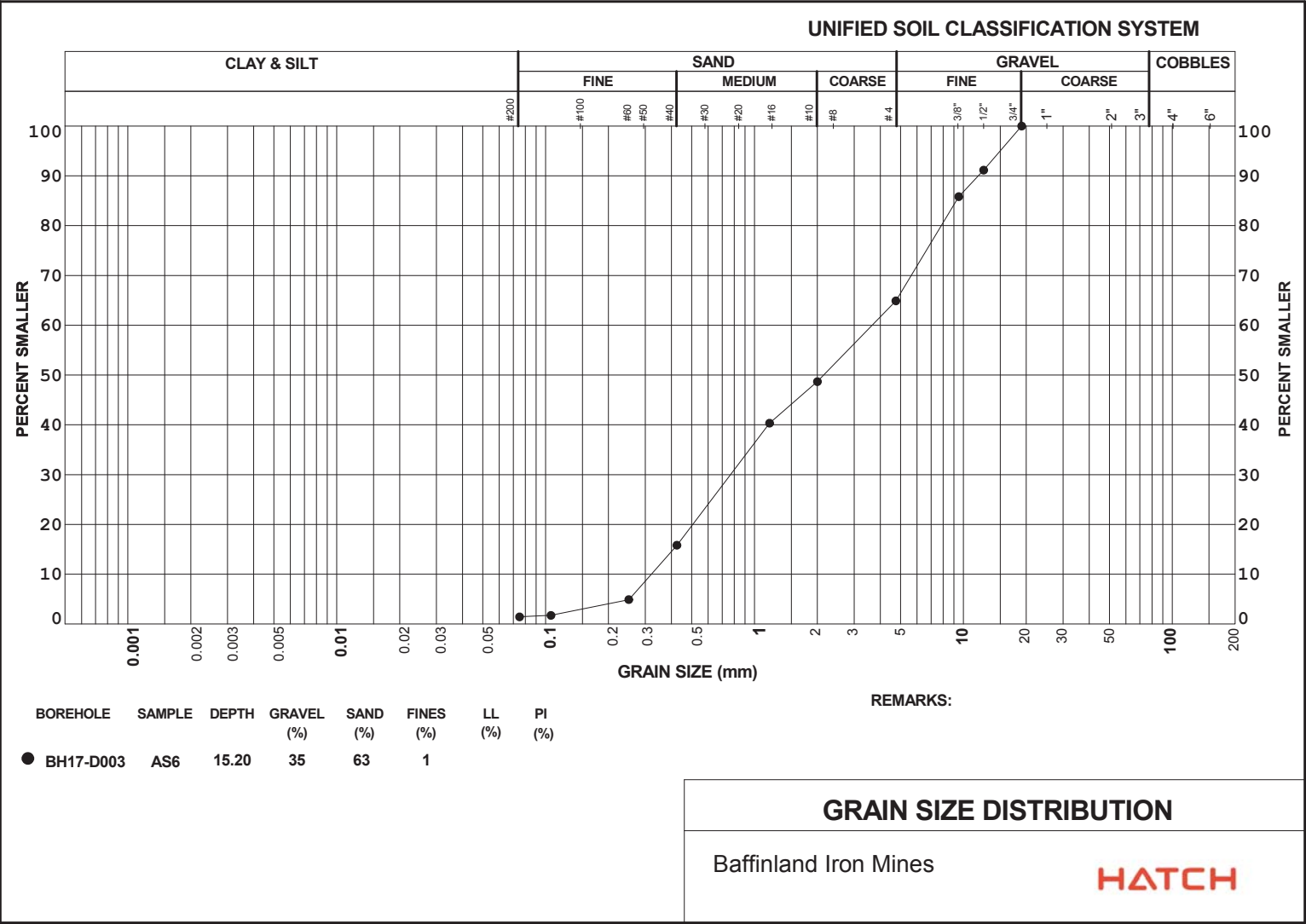


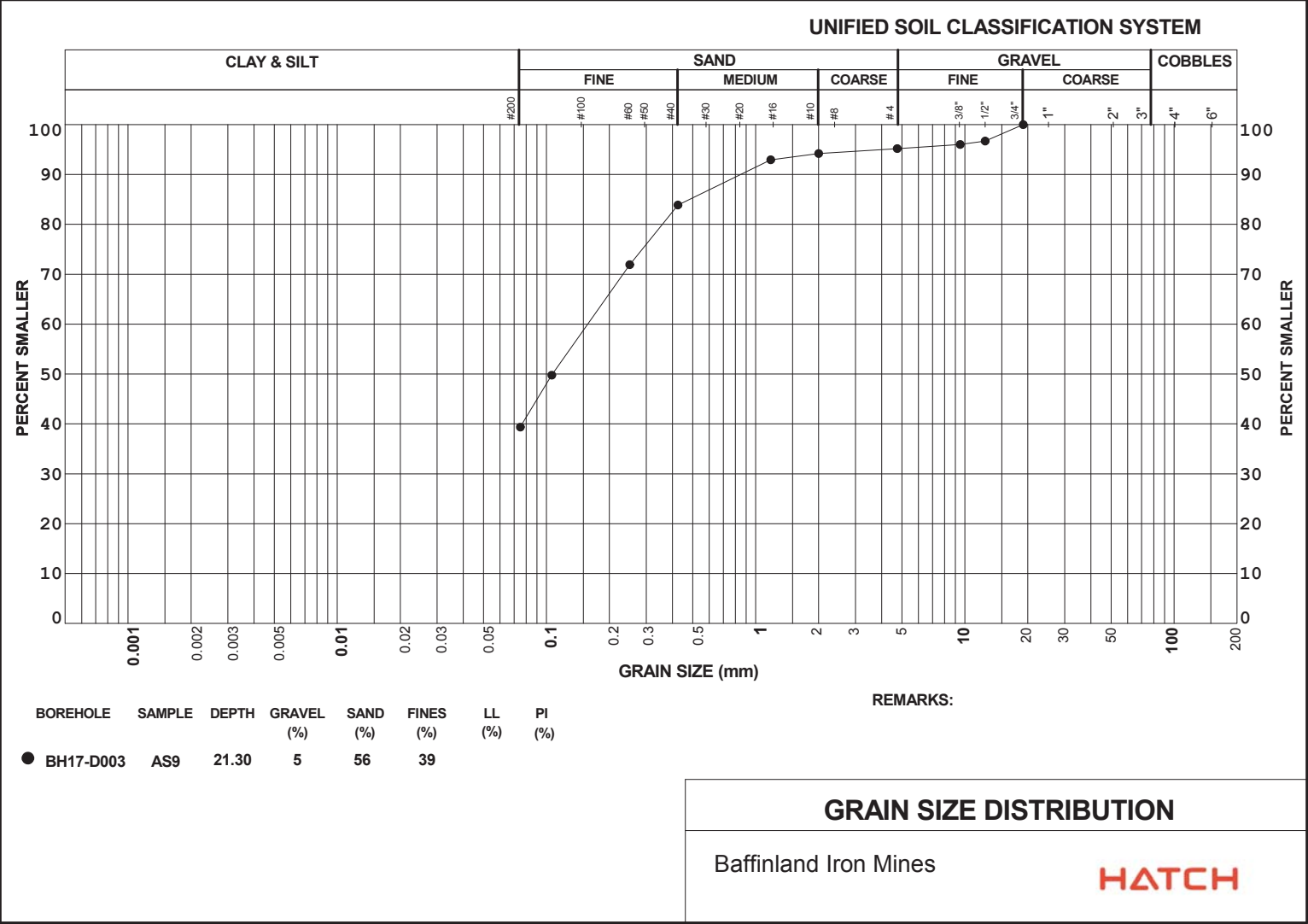


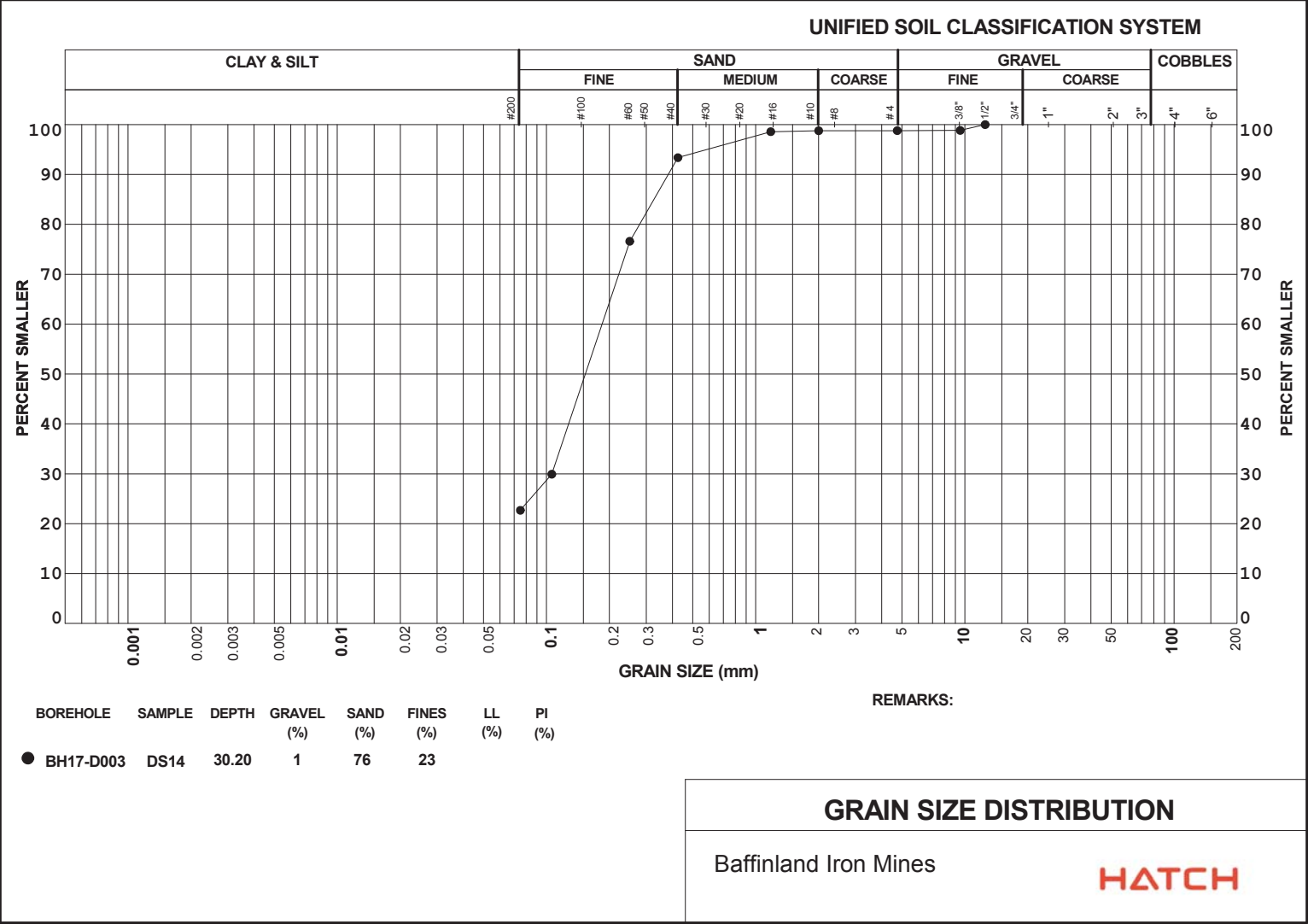


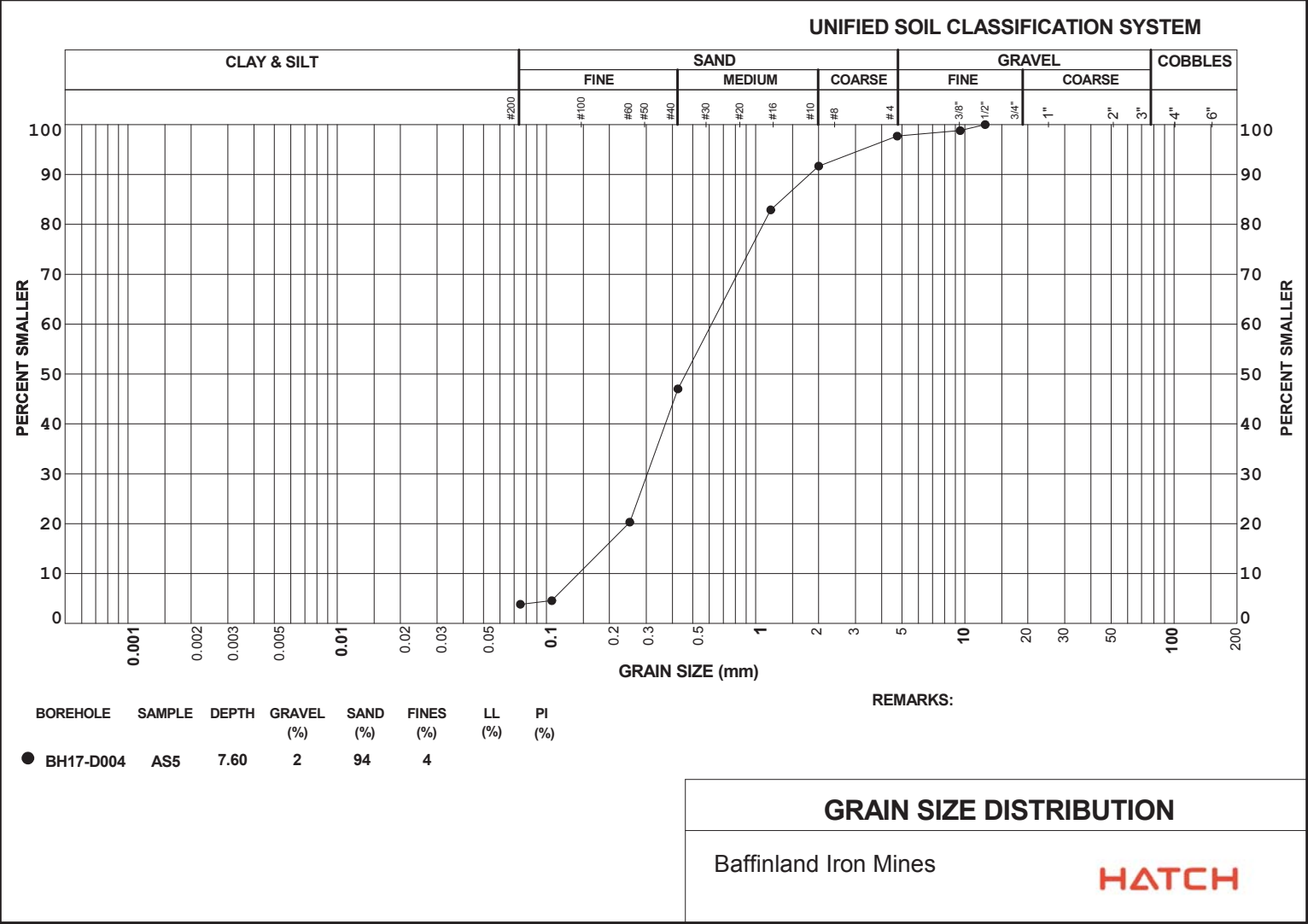


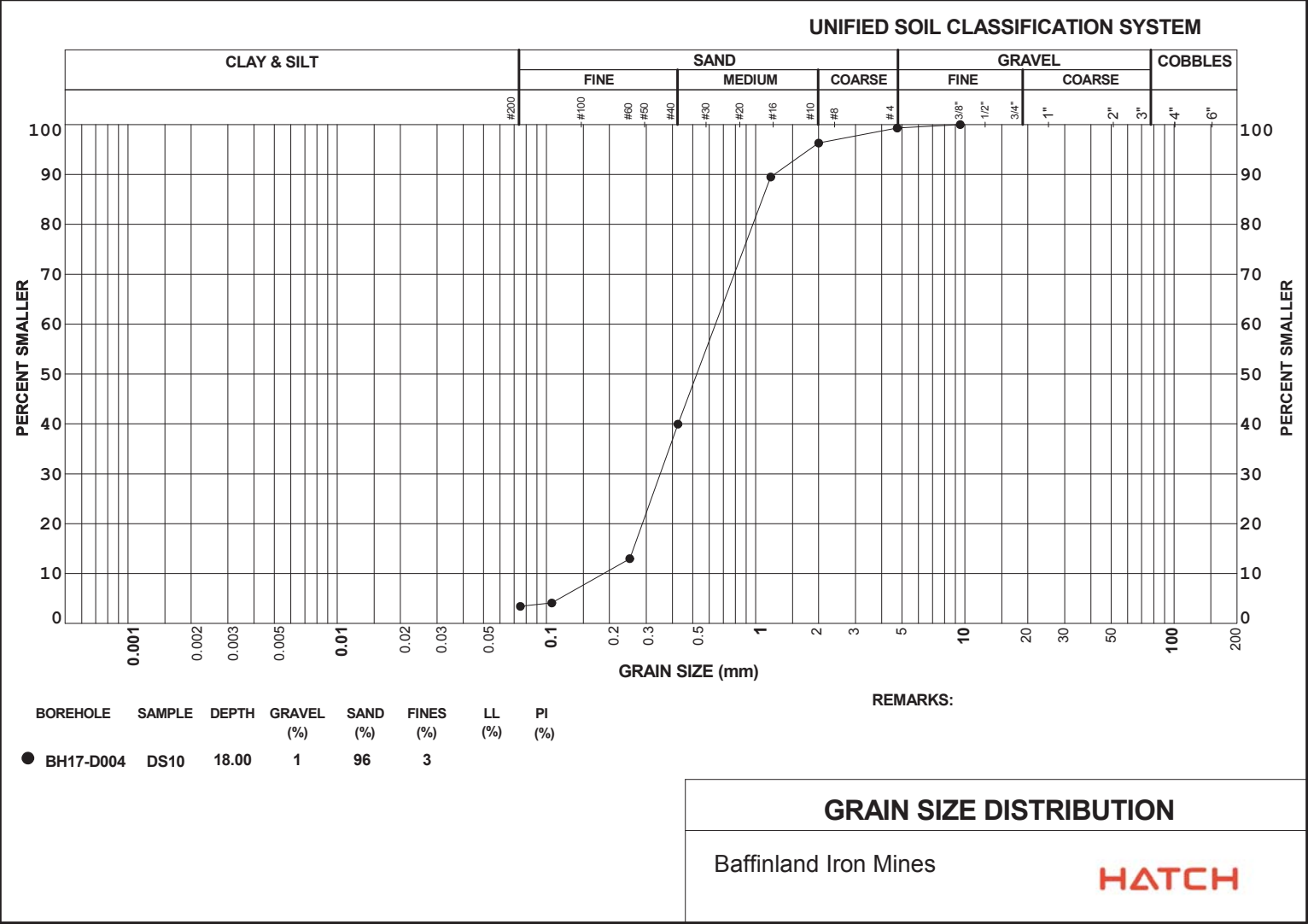


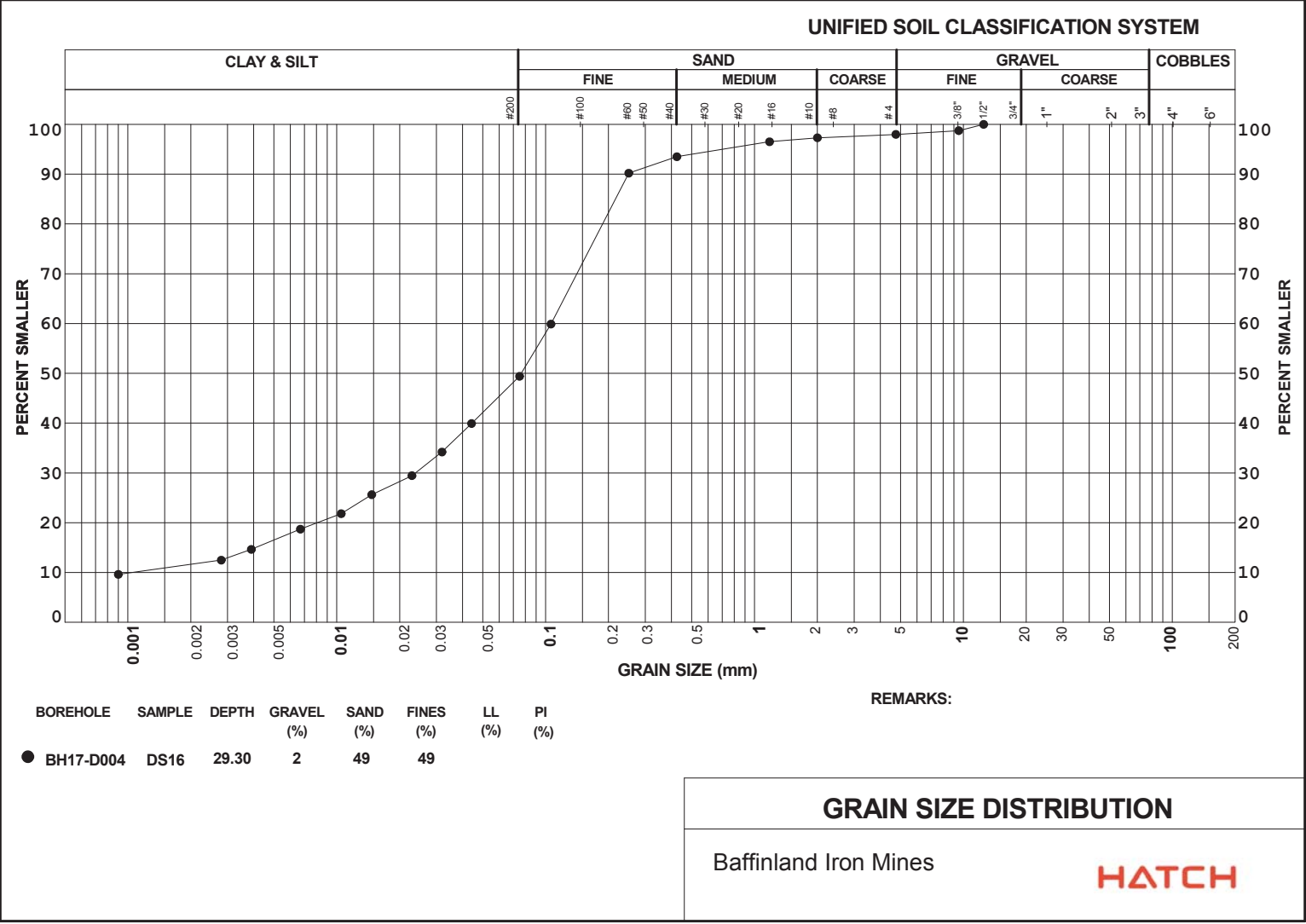


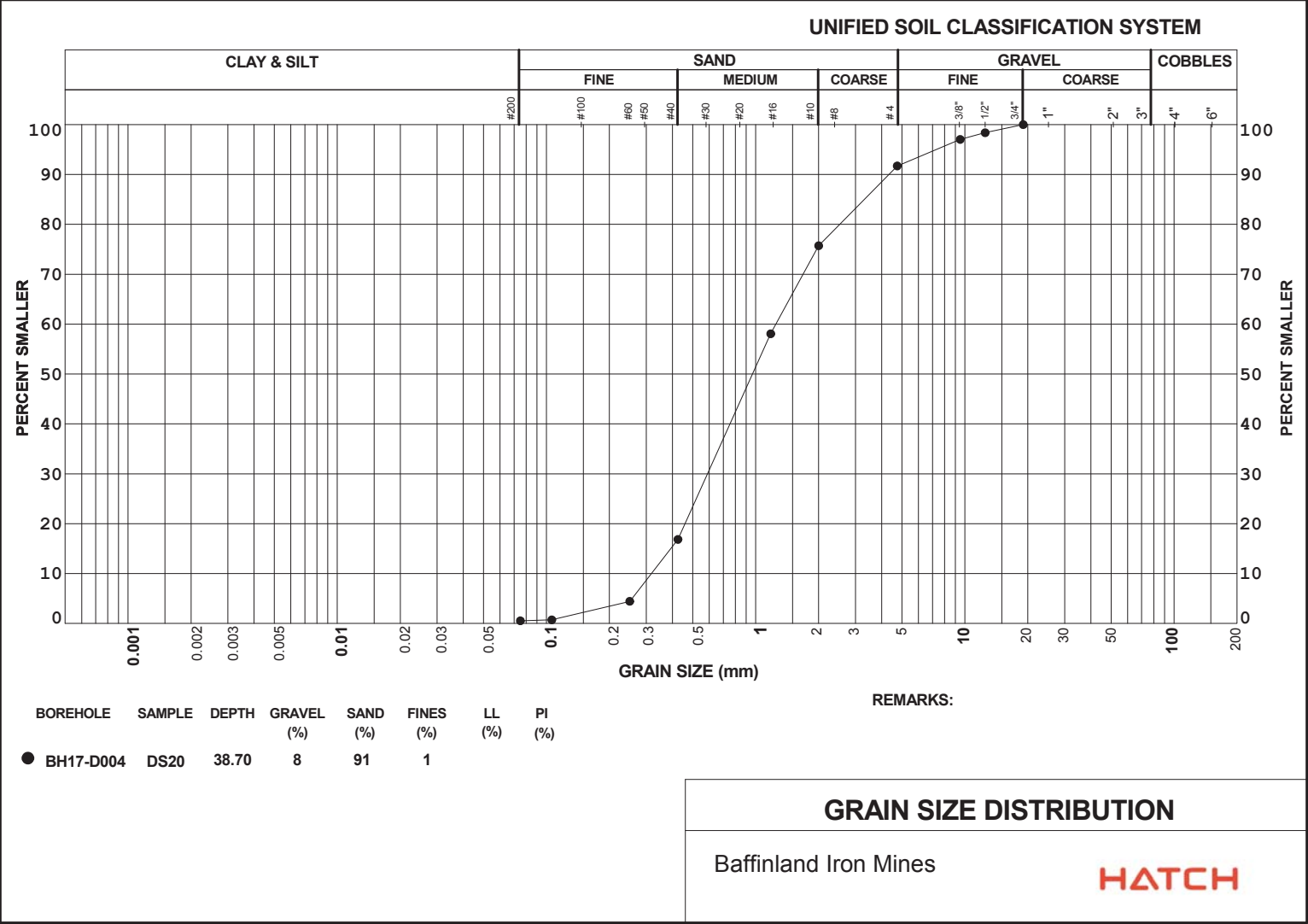


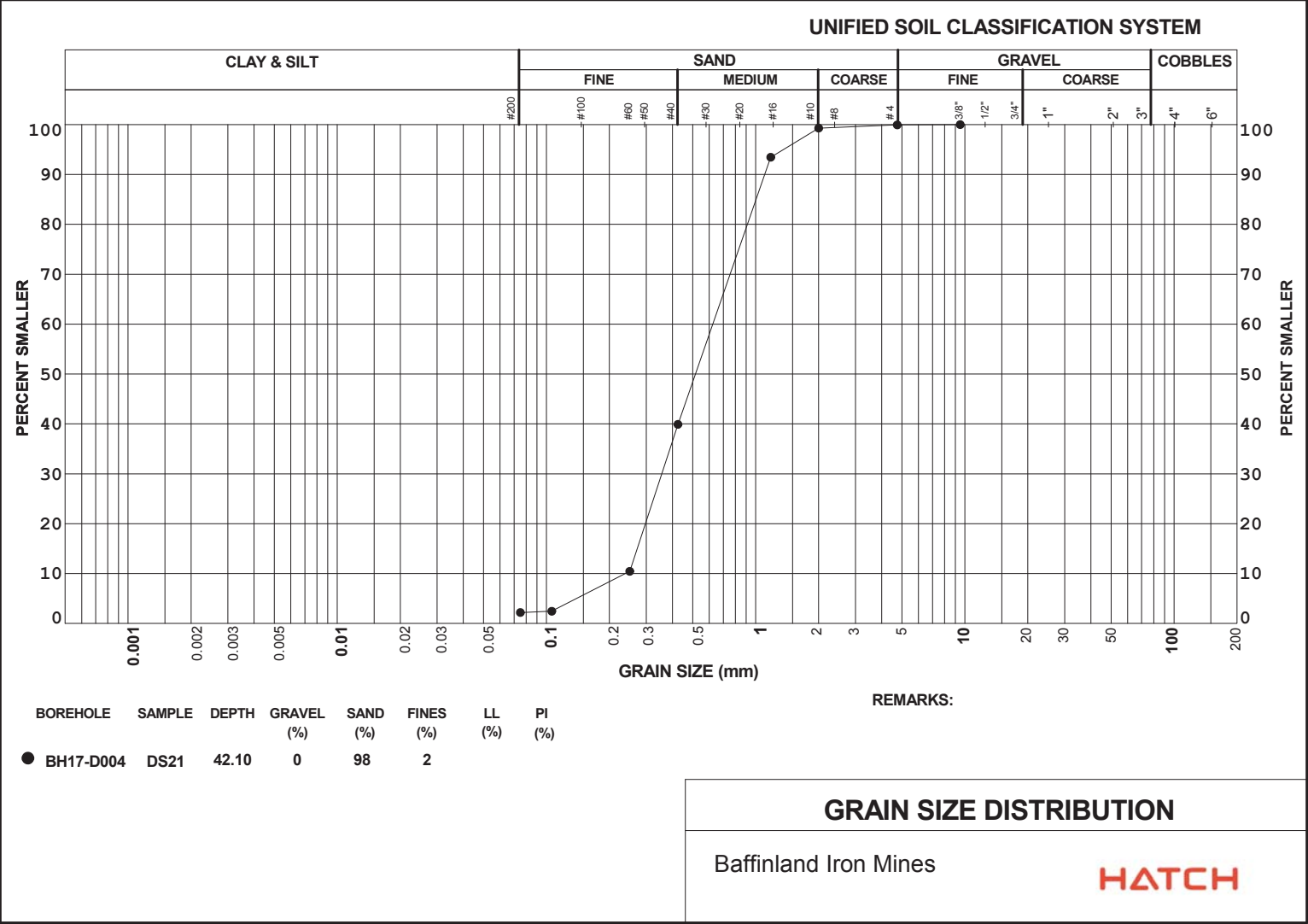


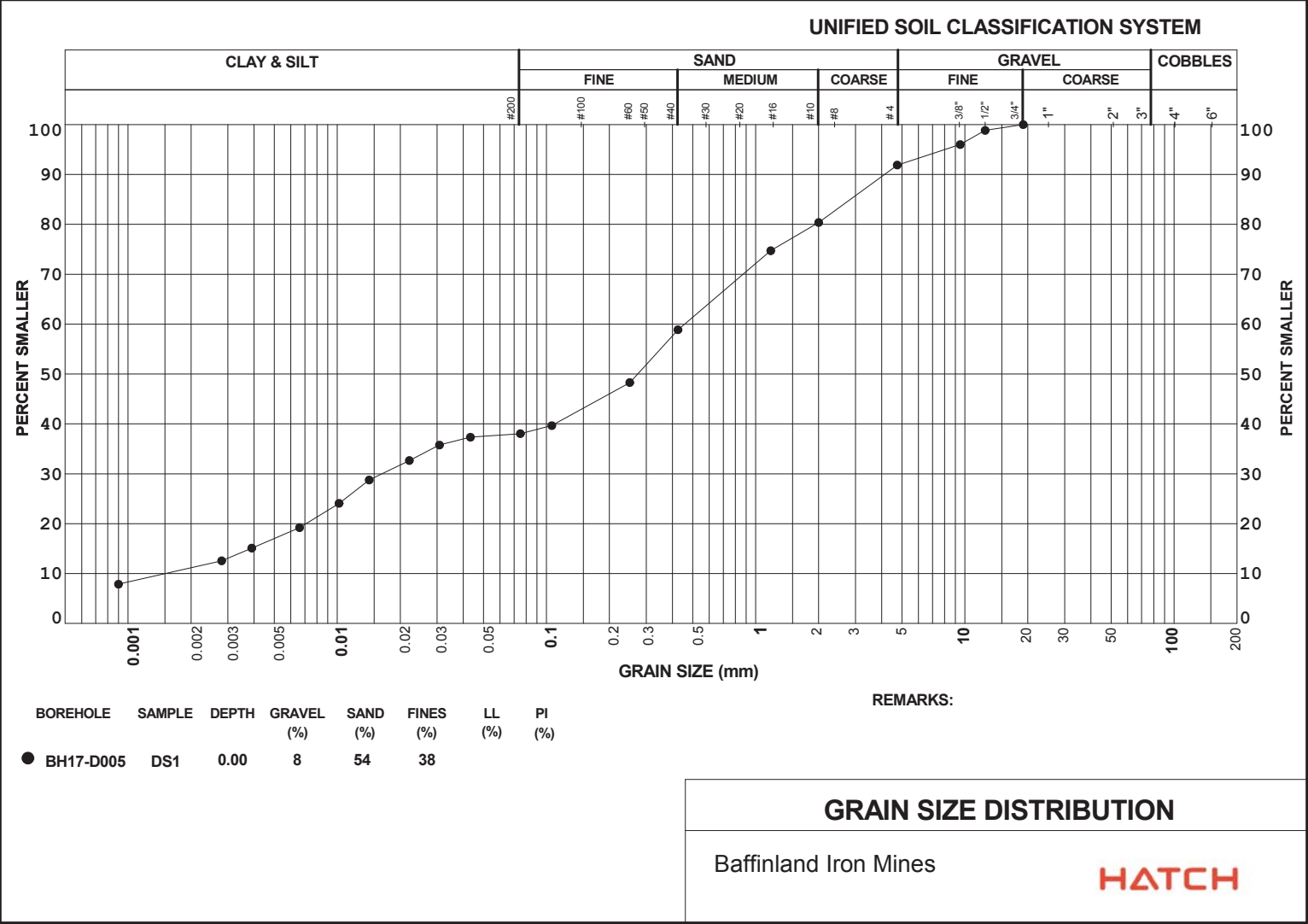


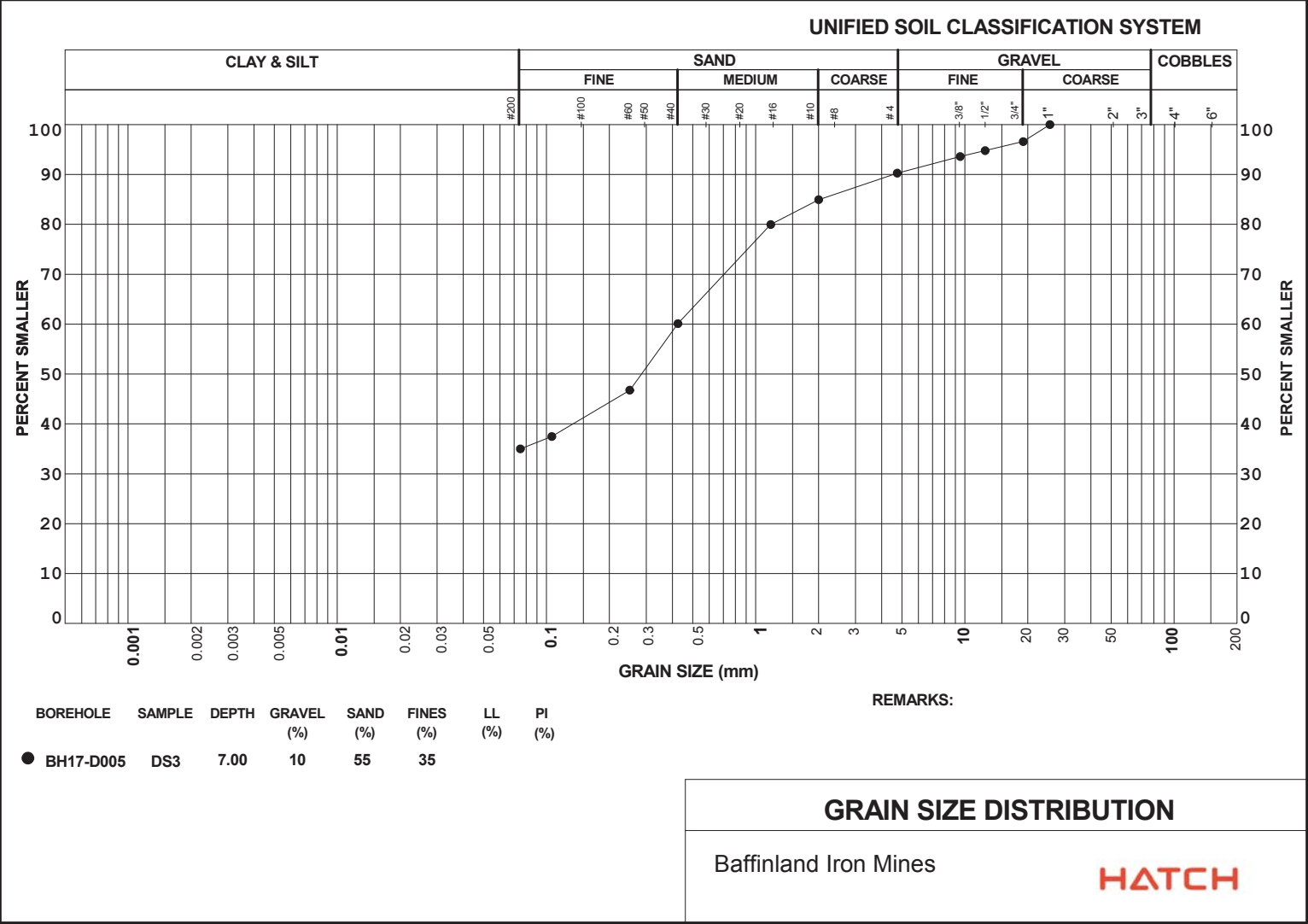


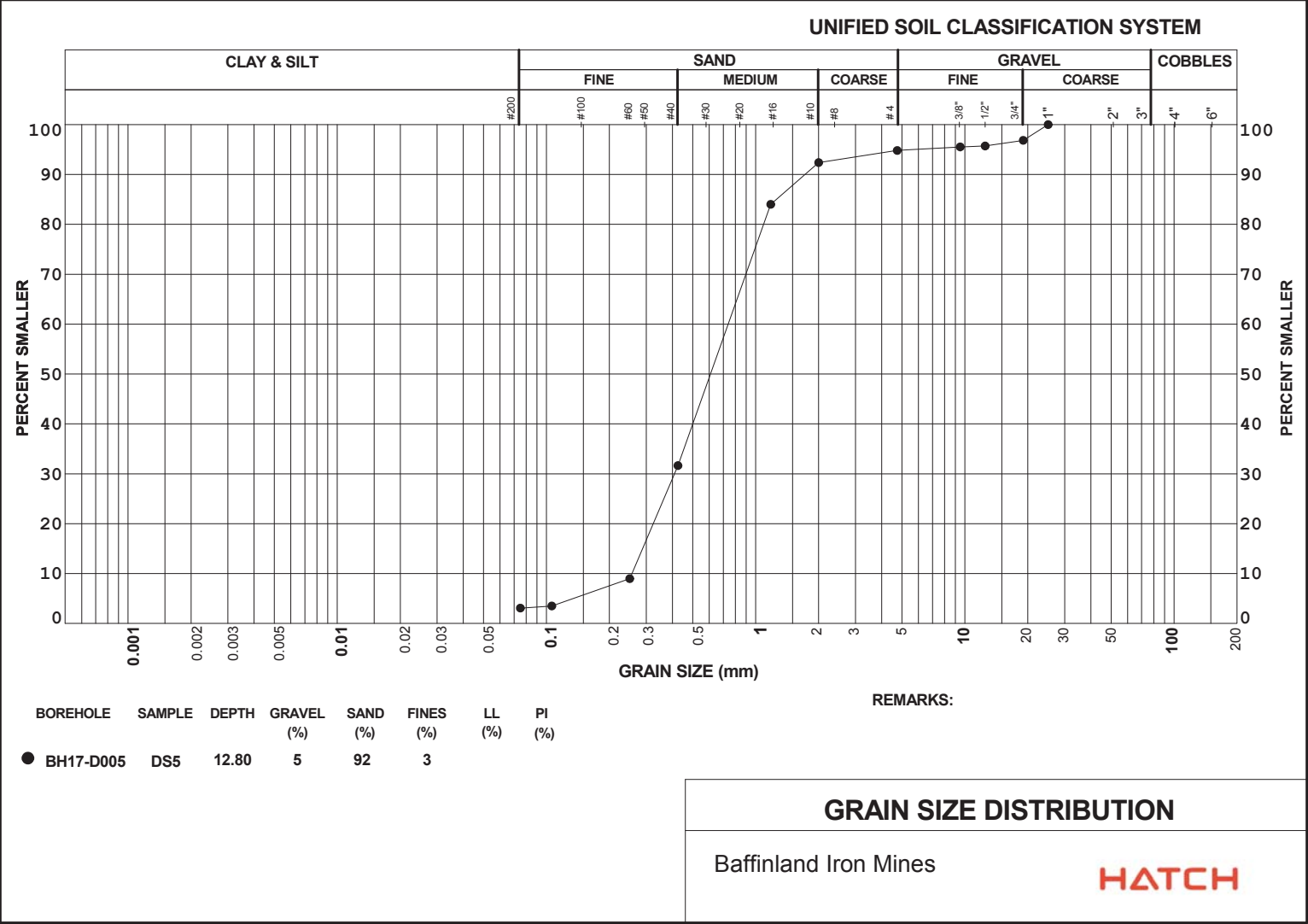


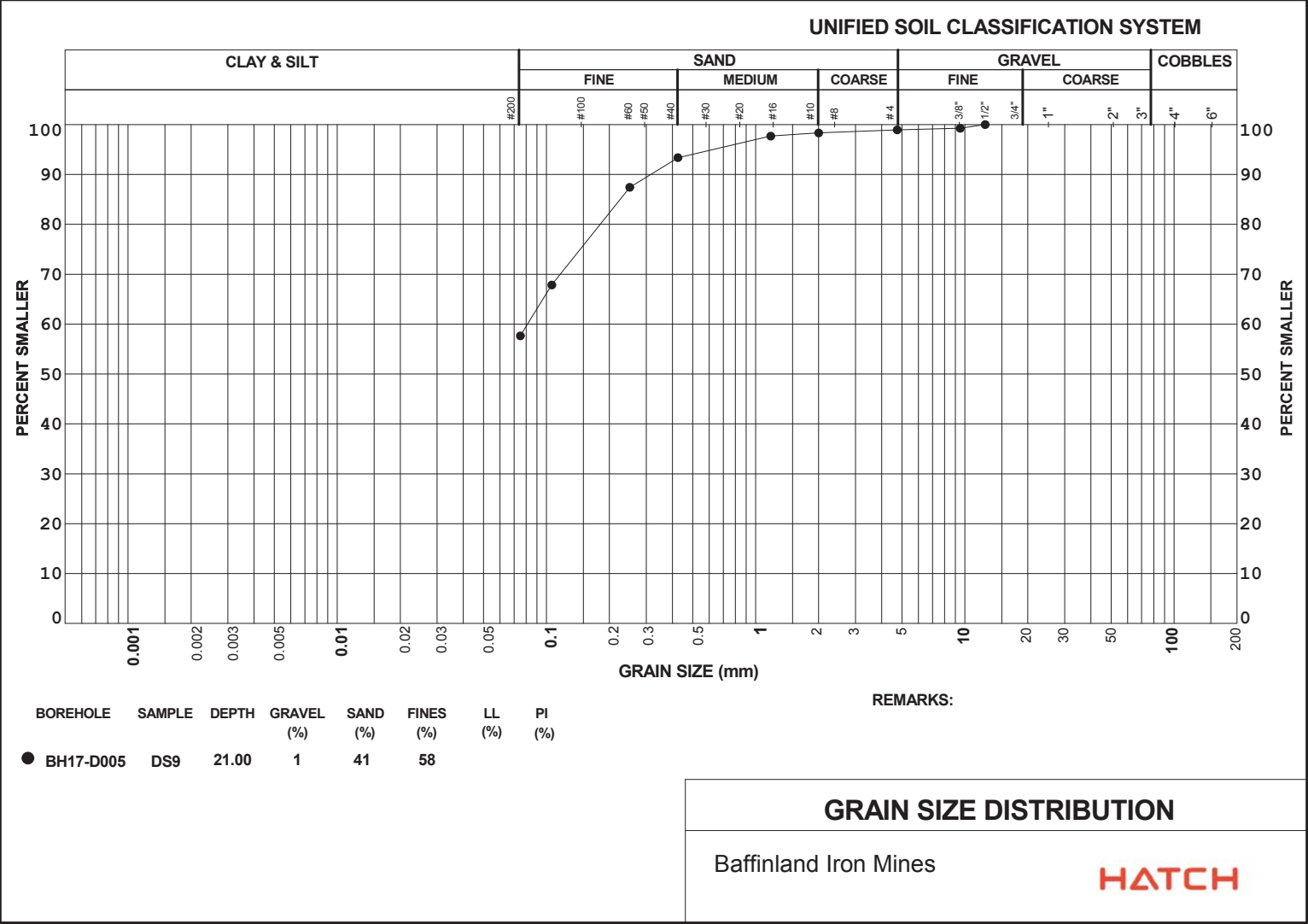


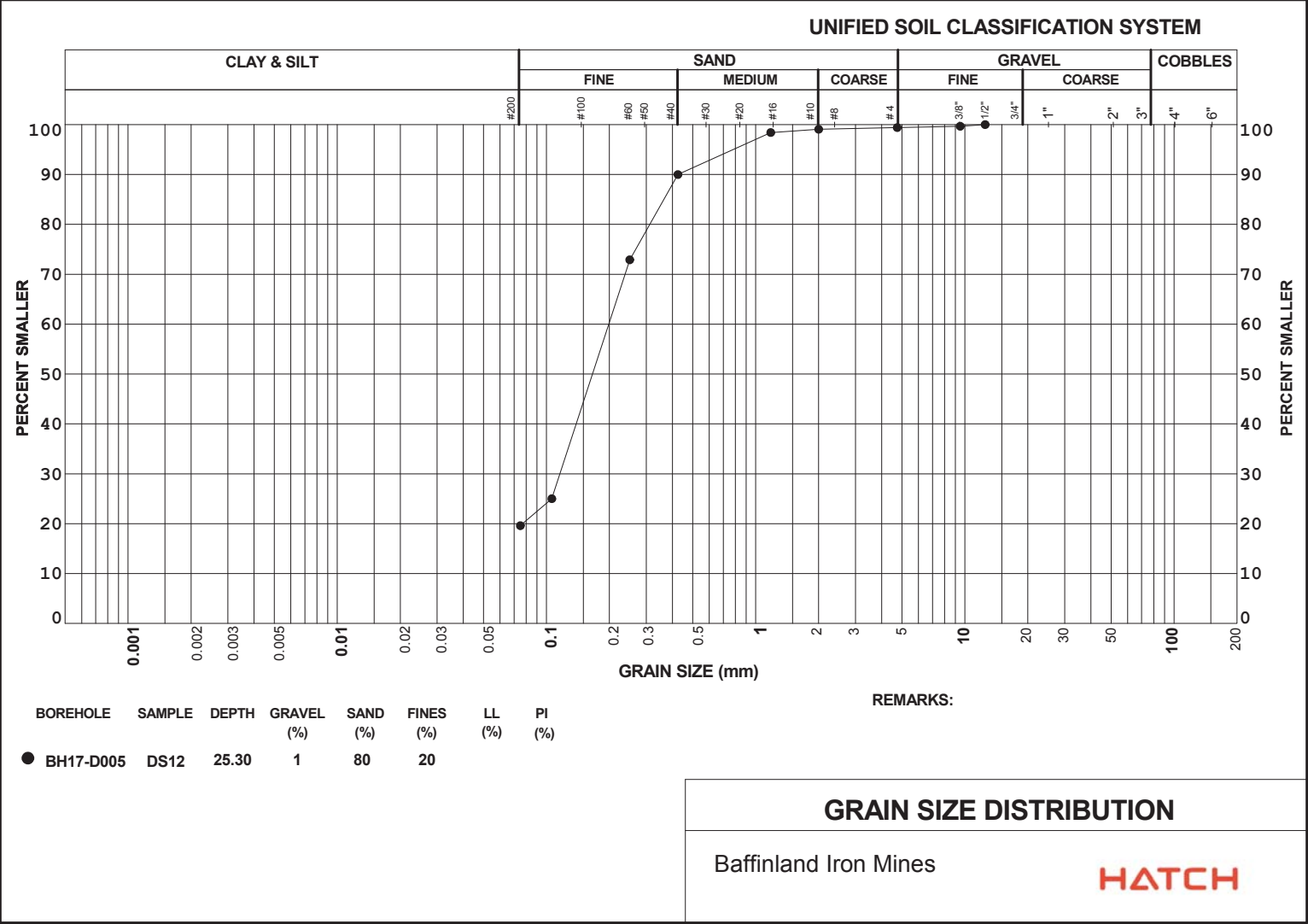


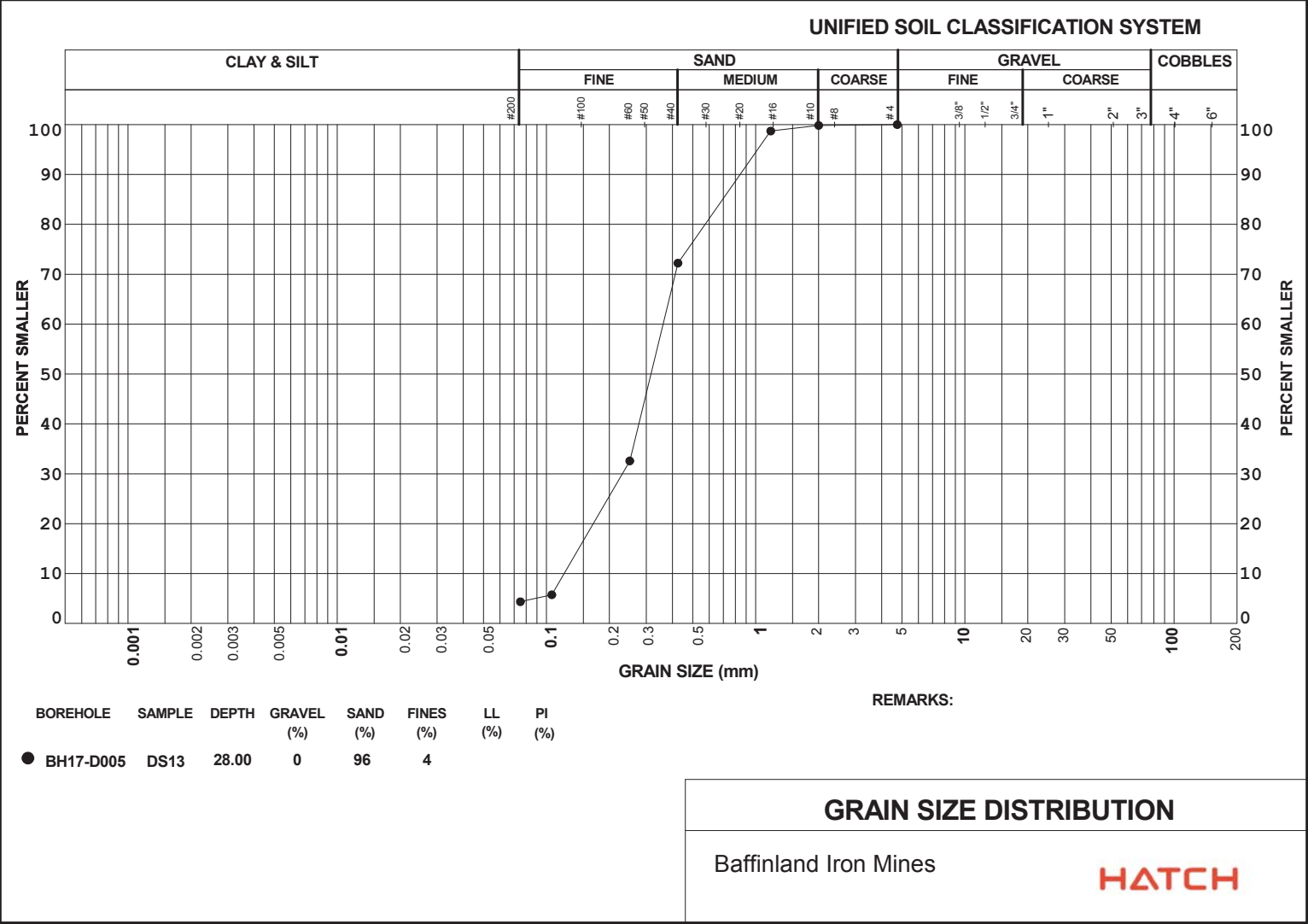


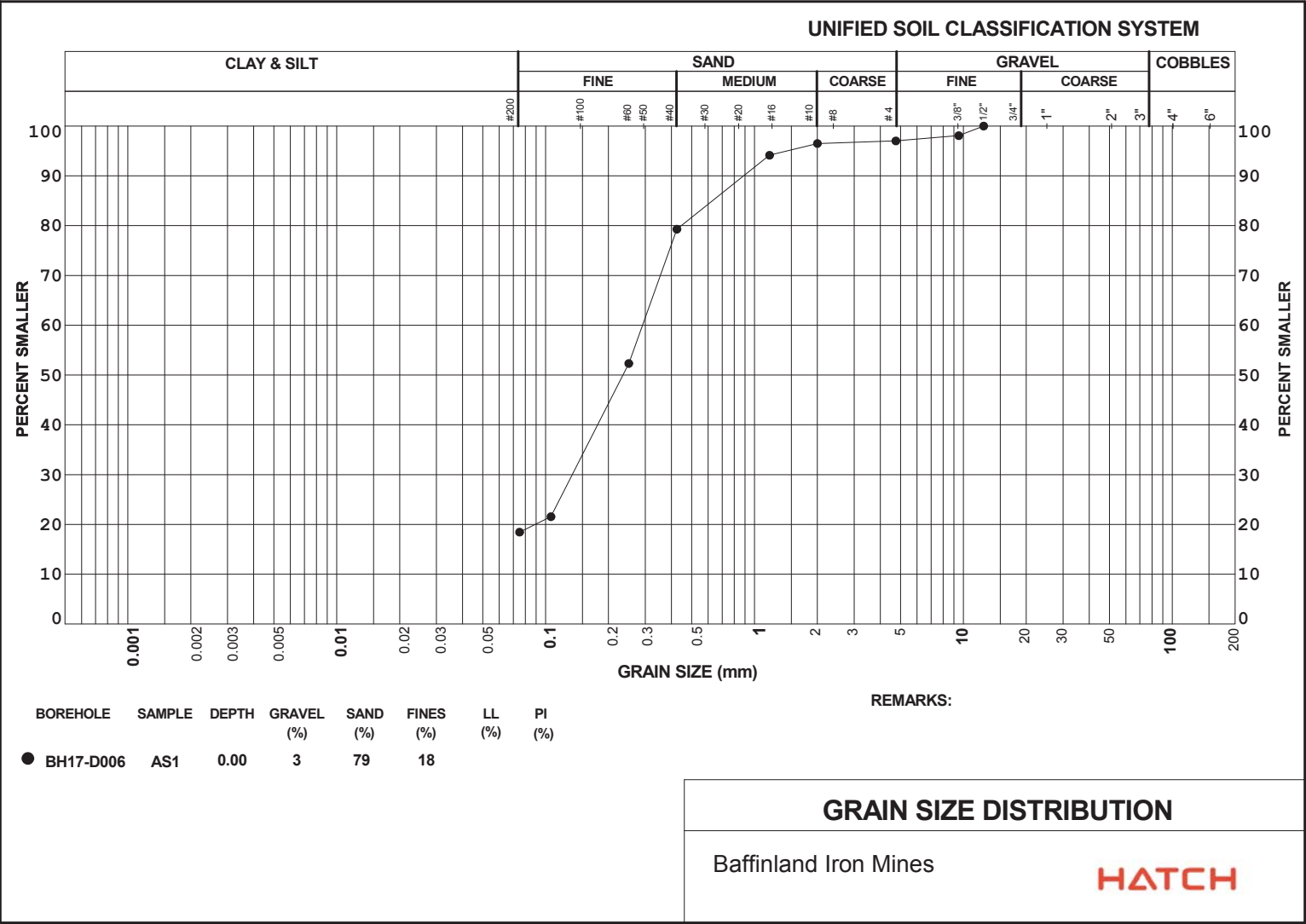


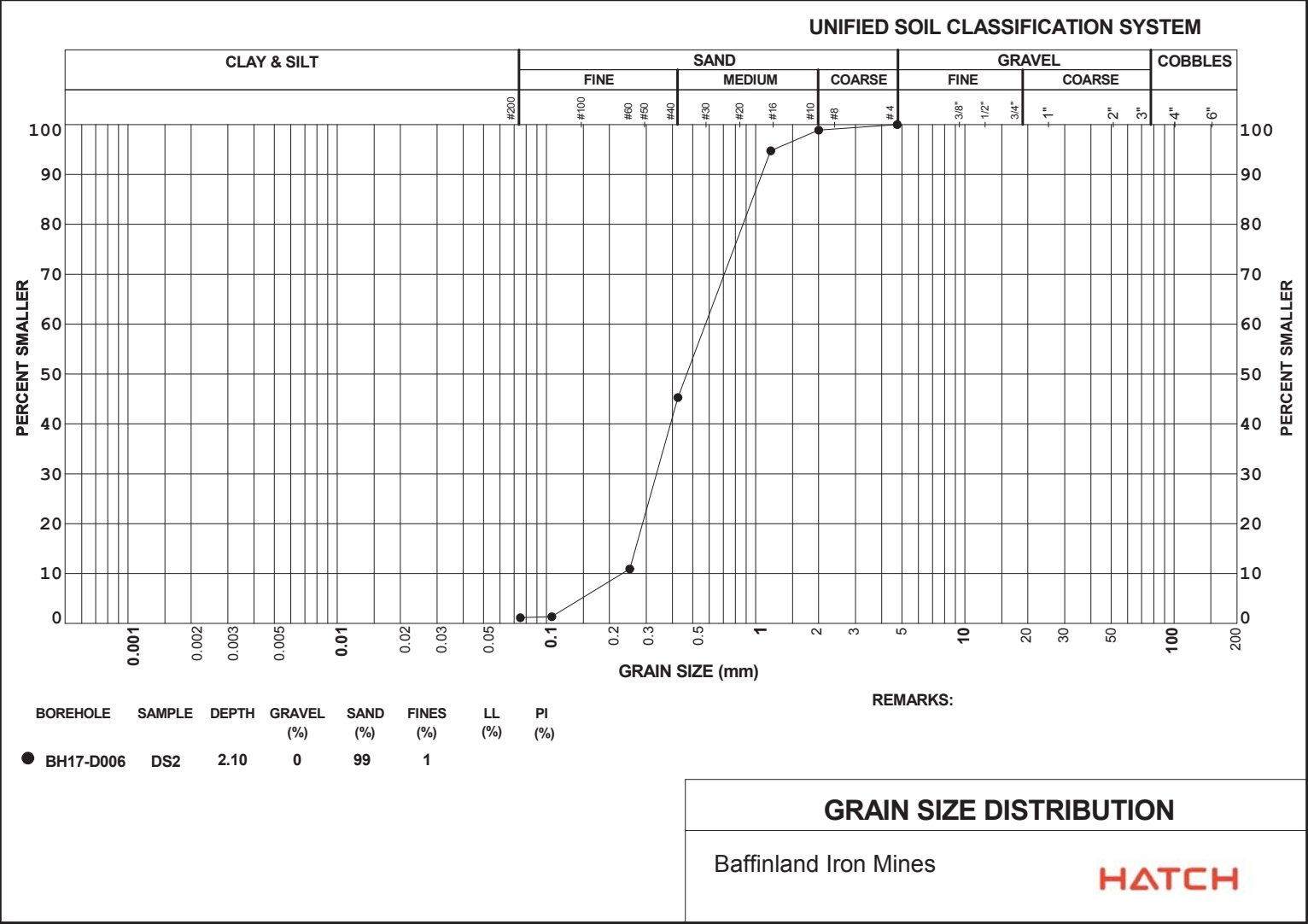


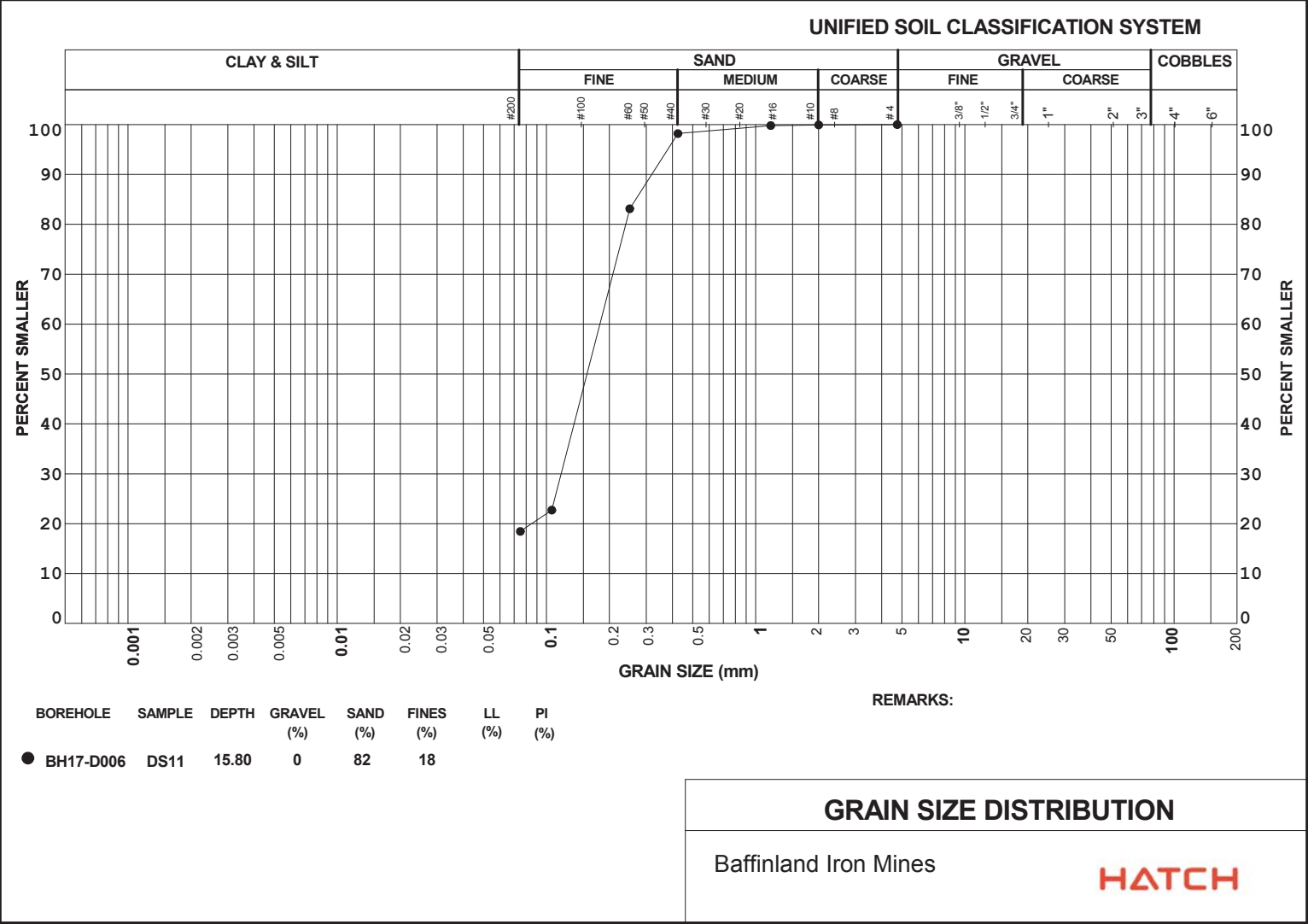












Direct Shear Test of Soils Under Consolidated Drained Conditions

ASTM D 3080/3080M- 11

Date: May 19, 2017

Baffinland Iron Mines

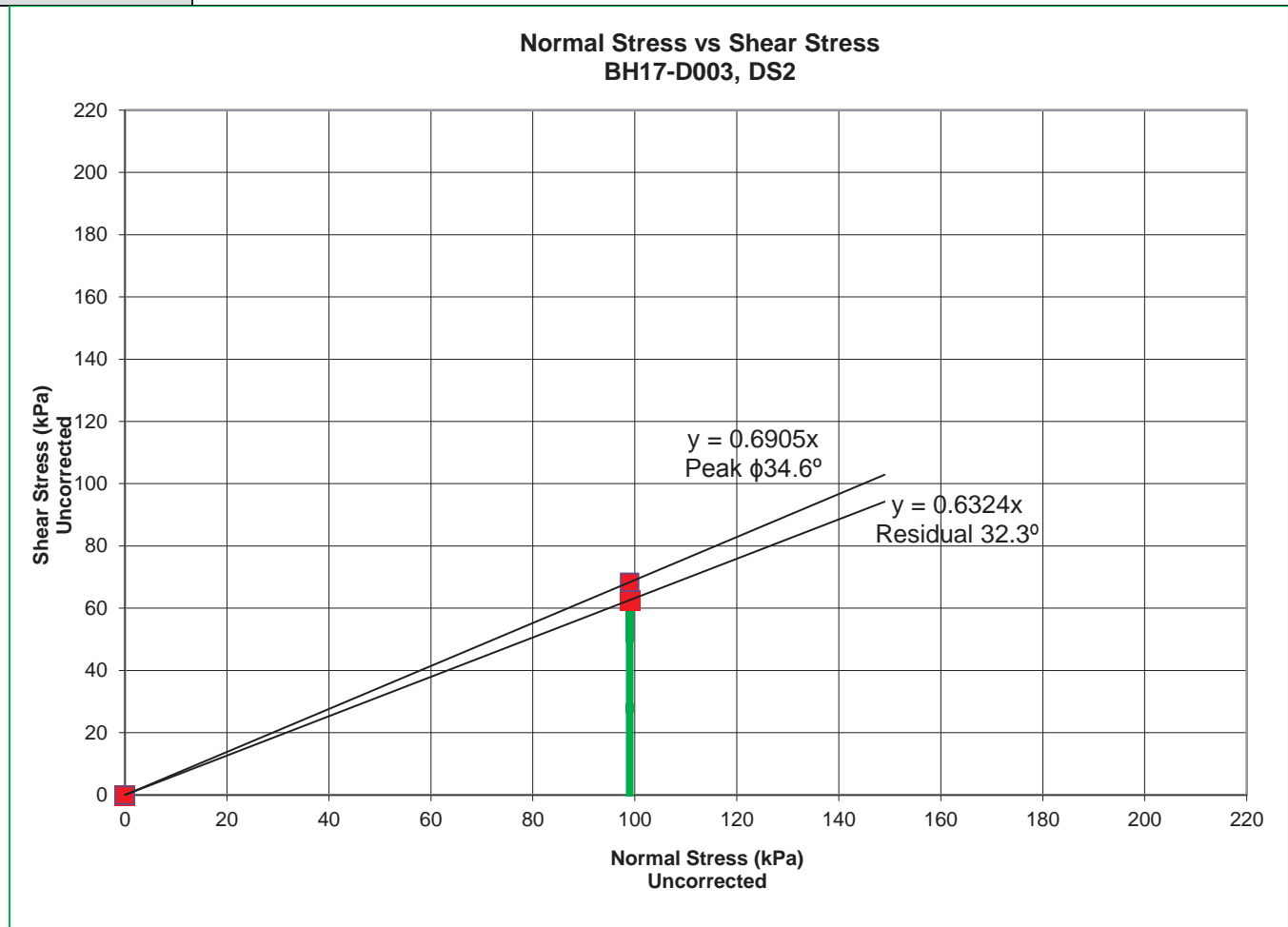
Project Number: H/352034

2275 Upper Middle Rd, Oakville Ont.

Project: Mary River Expansion Study
Stage 2

Attention: Matt Weaver

Sample	DS2 from 5.2 m to 5.5 m
Source	Milne Port Borehole BH17-D003



Comments:

Reported by: R.Serluca, Lab Tech, May 23, 2017

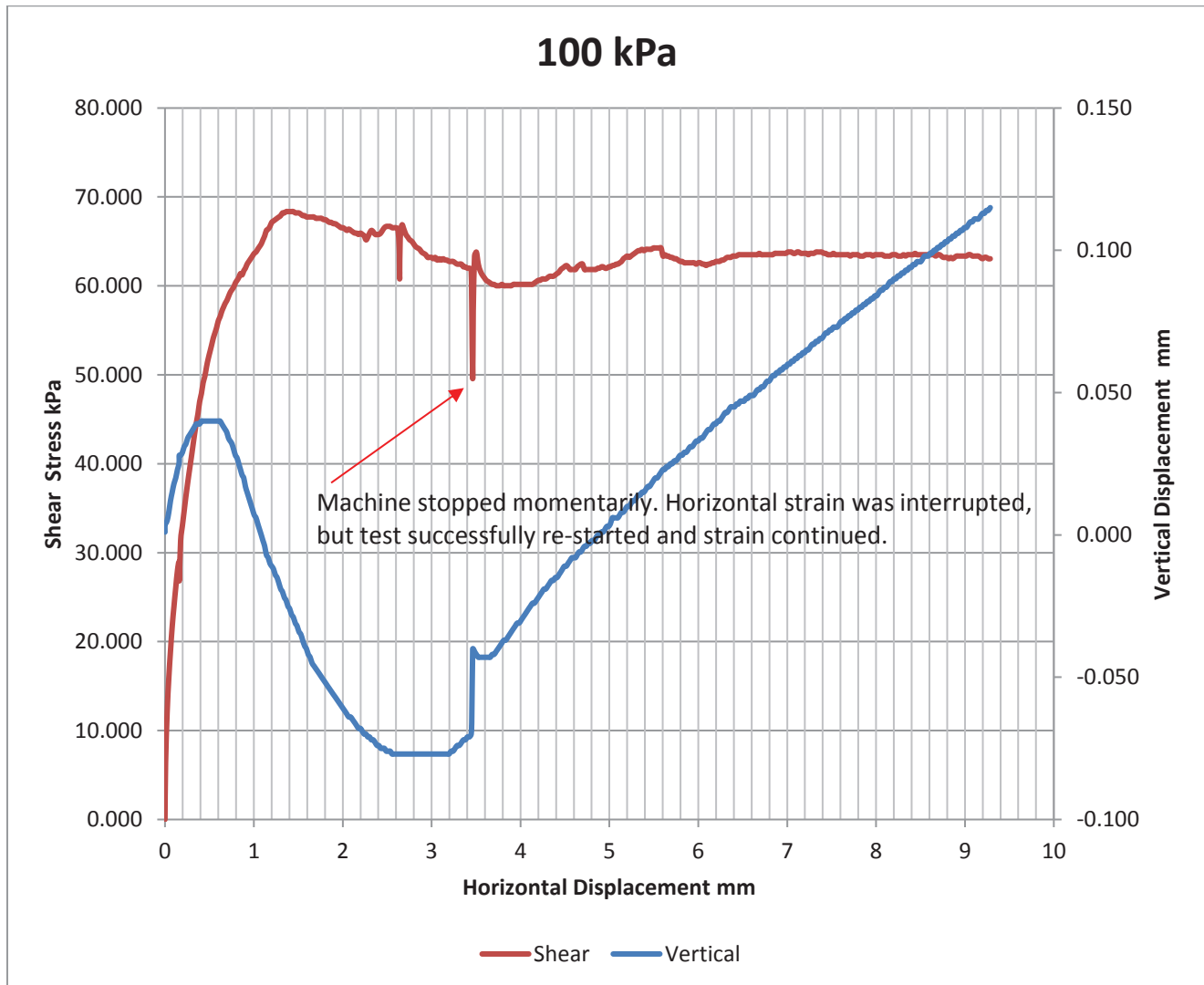
Name, Title, Date

Reviewed by: C. Hannon, May 2017

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

100 kPa Test	Before Test	After Consolidation	After Test
Length and Width (cm)	5.986	*****	5.986
Height (cm)	2.950	2.988	*****
Area (cm ²)	35.832	35.832	35.832
Volume (cm ³)	105.705	107.067	*****
Tare+Wet Samp. (gm)	2478.700	*****	*****
Tare (gm)	2247.300	*****	*****
Wet Weight (gm)	231.400	232.762	*****
Water Content (%)	12.176	*****	12.577
Tare	46.980	*****	47.780
Tare+ Wet Soil	164.630	*****	274.690
Tare+ Dry Soil	151.860	*****	249.340
Dry Weight (gm)	206.283	*****	*****
Dry Density (kg/m ³)	1951.500	*****	*****
Wet Density (kg/m ³)	2189.112	2173.989	*****
Specific Gravity (cm ³)	2.700		*****
Vol.of Solids (cm ³)	76.302	*****	*****
Void Ratio	1.385	*****	*****
Deg.of Saturation (%)	85.422	*****	*****
Height of Solids (cm)	2.13	*****	*****



TEST NOTES.

1. Test carried out as per ASTM D3080 remolded and compacted.
2. Test specimen was split from total sample, portion passing 4.75 mm sieve.
3. Test carried out on Shear Machine #1.
4. Shear Rate 0.0043 cm per minute.
5. Value for Specific Gravity is assumed.
6. Peak PHI values are based on highest shear stress to normal stress ratio achieved during the test.
7. Residual PHI was taken at 6 mm train for all 5 samples in test suite.
8. Test data not corrected for area change during shearing as per ASTM.

Direct Shear Test of Soils Under Consolidated Drained Conditions

ASTM D 3080/3080M- 11

Date: May 19, 2017

Baffinland Iron Mines

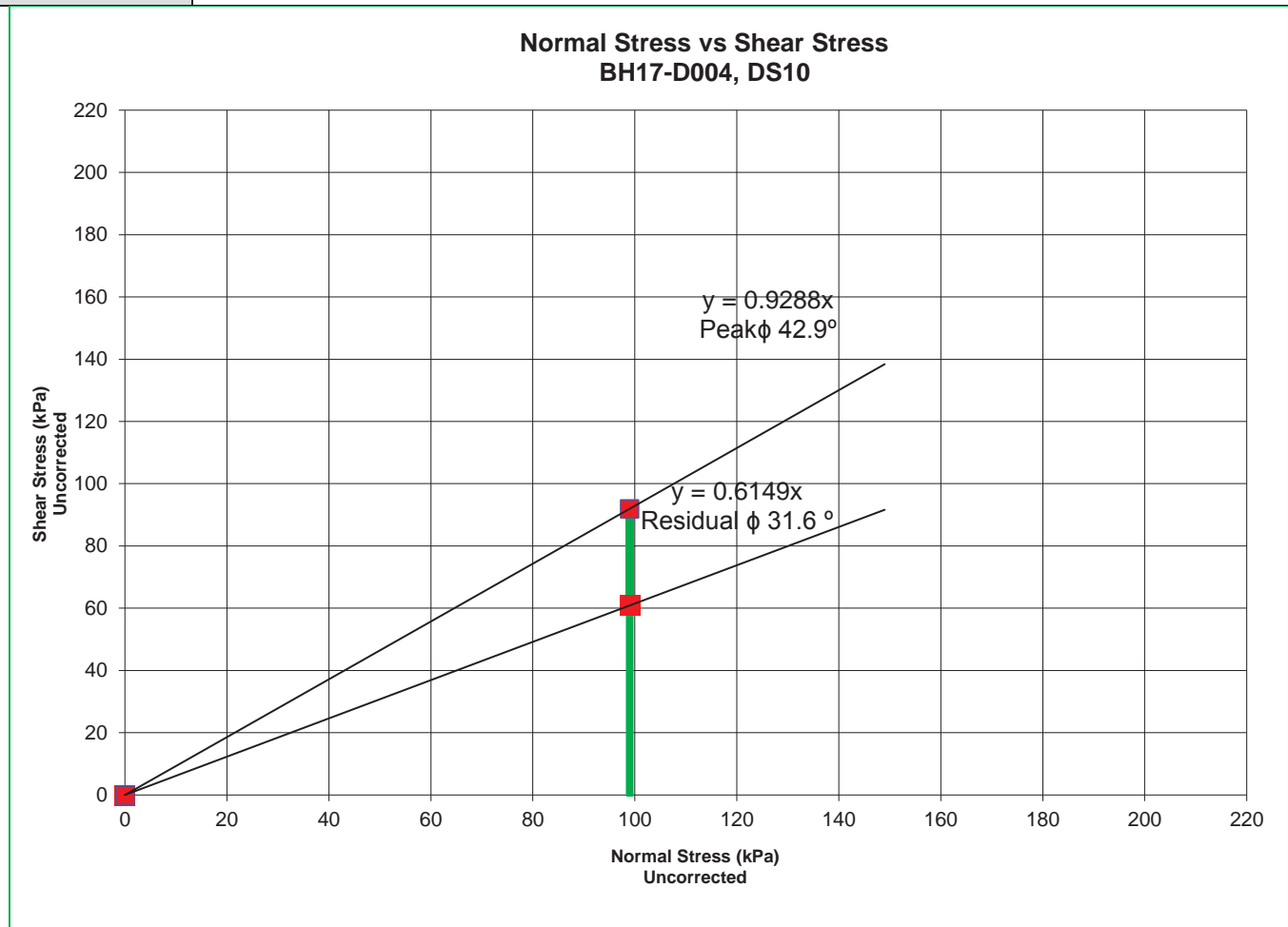
Project Number: H/352034

2275 Upper Middle Rd, Oakville Ont.

Project: Mary River Expansion Study
Stage 2

Attention: Matt Weaver

Sample	DS10 from 18.0 m to 18.3 m
Source	Milne Port Borehole BH17-D004



Comments:

Reported by: R.Serluca, Lab Tech, May 23, 2017

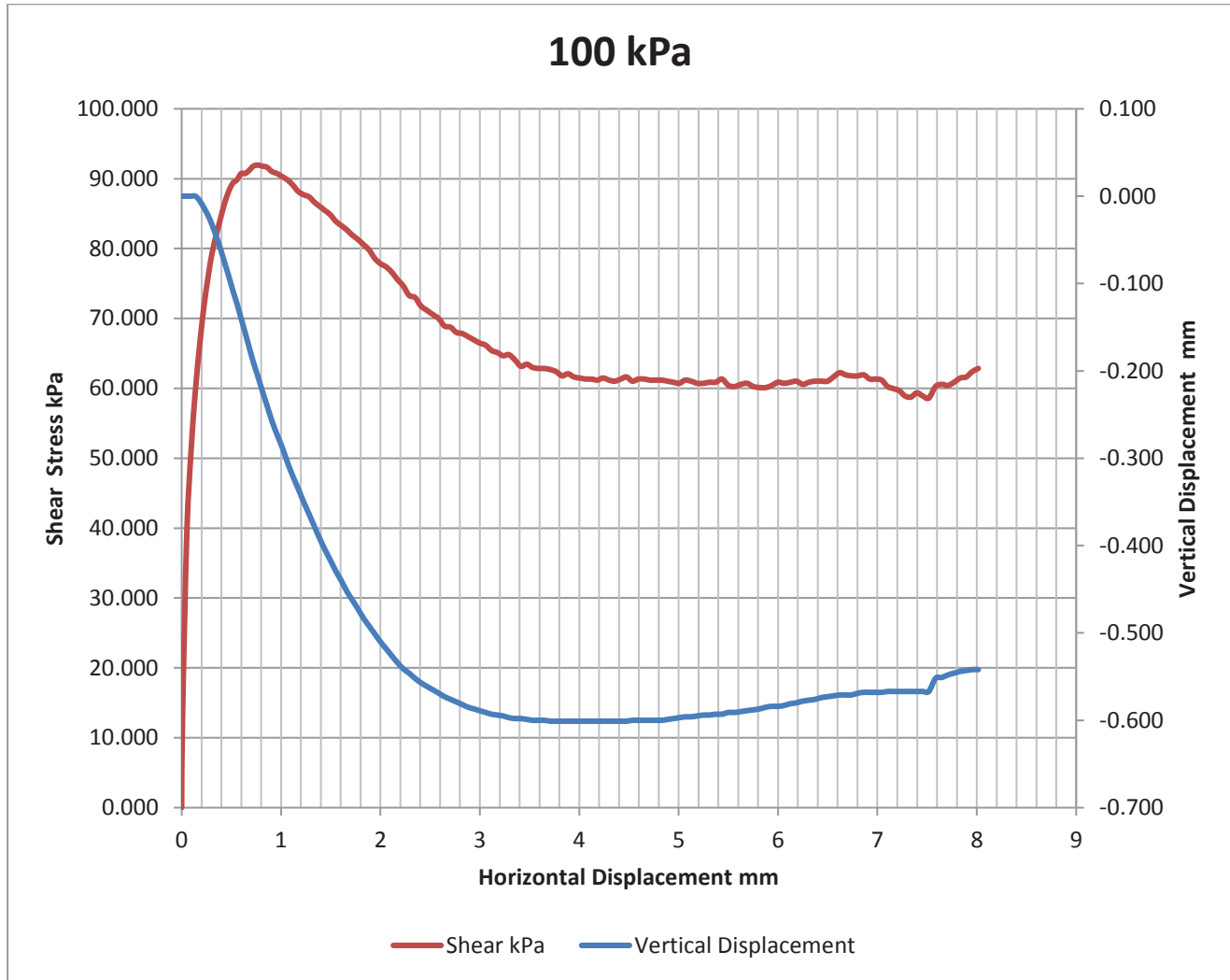
Name, Title, Date

Reviewed by: C. Hannon, May 2017

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

100 kPa Test	Before Test	After Consolidation	After Test
Length and Width (cm)	5.986	*****	5.986
Height (cm)	2.988	2.988	*****
Area (cm ²)	35.832	35.832	35.832
Volume (cm ³)	107.067	107.067	*****
Tare+Wet Samp. (gm)	2467.600	*****	*****
Tare (gm)	2243.100	*****	*****
Wet Weight (gm)	224.500	224.500	*****
Water Content (%)	15.532	*****	15.278
Tare	47.650	*****	47.650
Tare+ Wet Soil	99.420	*****	248.050
Tare+ Dry Soil	92.460	*****	221.490
Dry Weight (gm)	194.318	*****	*****
Dry Density (kg/m ³)	1814.927	*****	*****
Wet Density (kg/m ³)	2096.826	2096.826	*****
Specific Gravity (cm ³)	2.700		*****
Vol.of Solids (cm ³)	71.876	*****	*****
Void Ratio	1.490	*****	*****
Deg.of Saturation (%)	85.767	*****	*****
Height of Solids (cm)	2.01	*****	*****



TEST NOTES.

1. Test carried out as per ASTM D3080 remolded and compacted.
2. Test specimen was split from total sample, portion passing 4.75 mm sieve.
3. Test carried out on Shear Machine #1.
4. Shear Rate 0.0114 cm per minute.
5. Value for Specific Gravity is assumed.
6. Peak PHI values are based on highest shear stress to normal stress ratio achieved during the test.
7. Residual PHI was taken at 6 mm strain for all 5 samples in test suite.
8. Test data not corrected for area change during shearing as per ASTM.

Direct Shear Test of Soils Under Consolidated Drained Conditions

ASTM D 3080/3080M- 11

Date: May 29, 2017

Baffinland Iron Mines

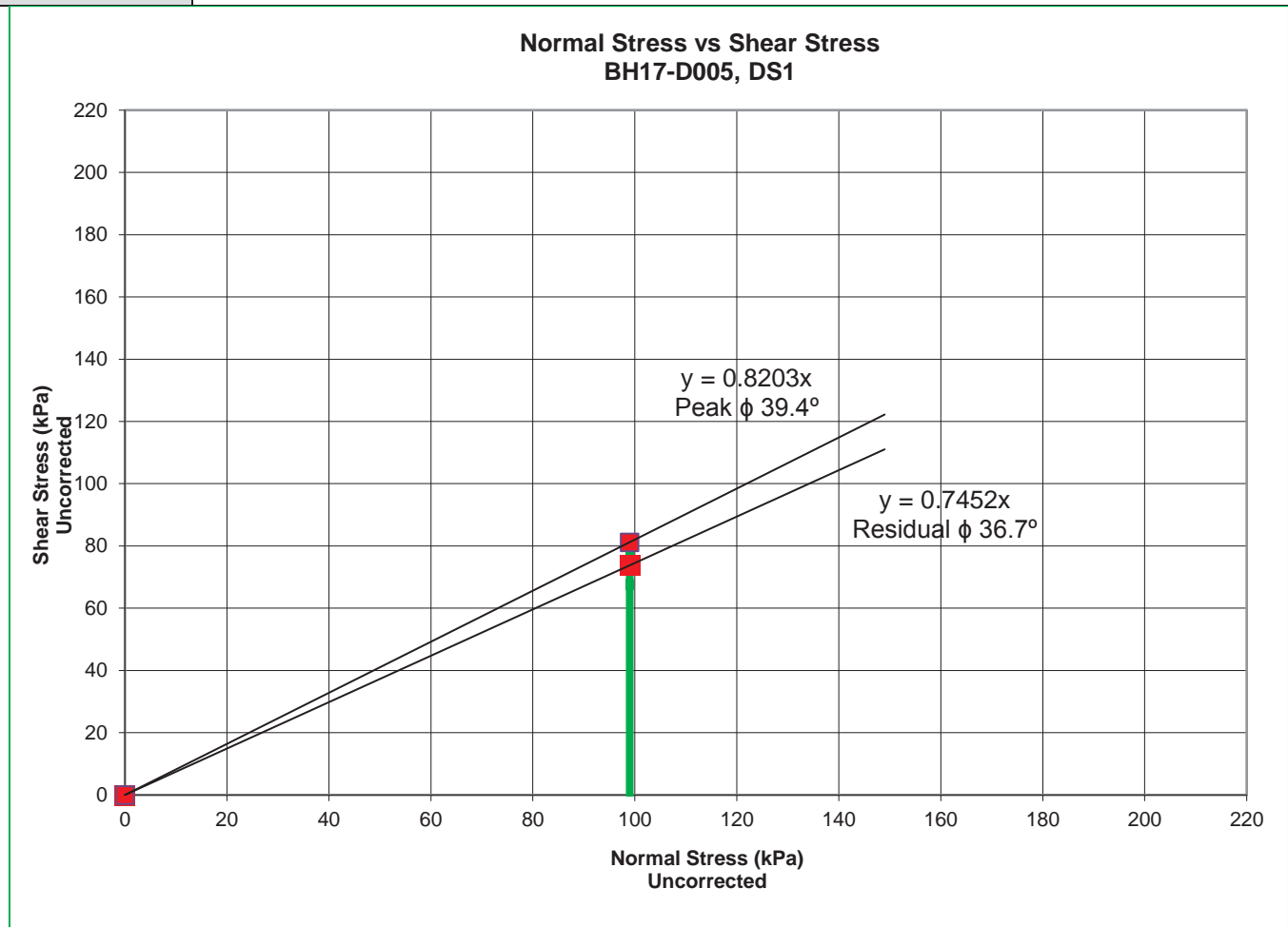
Project Number: H/352034

2275 Upper Middle Rd, Oakville Ont.

Project: Mary River Expansion Study
Stage 2

Attention: Matt Weaver

Sample	DS1 from 0.0 m to 0.3 m
Source	Milne Port Borehole BH17-D005



Comments:

Reported by: R.Serluca, Lab Tech, May 23, 2017

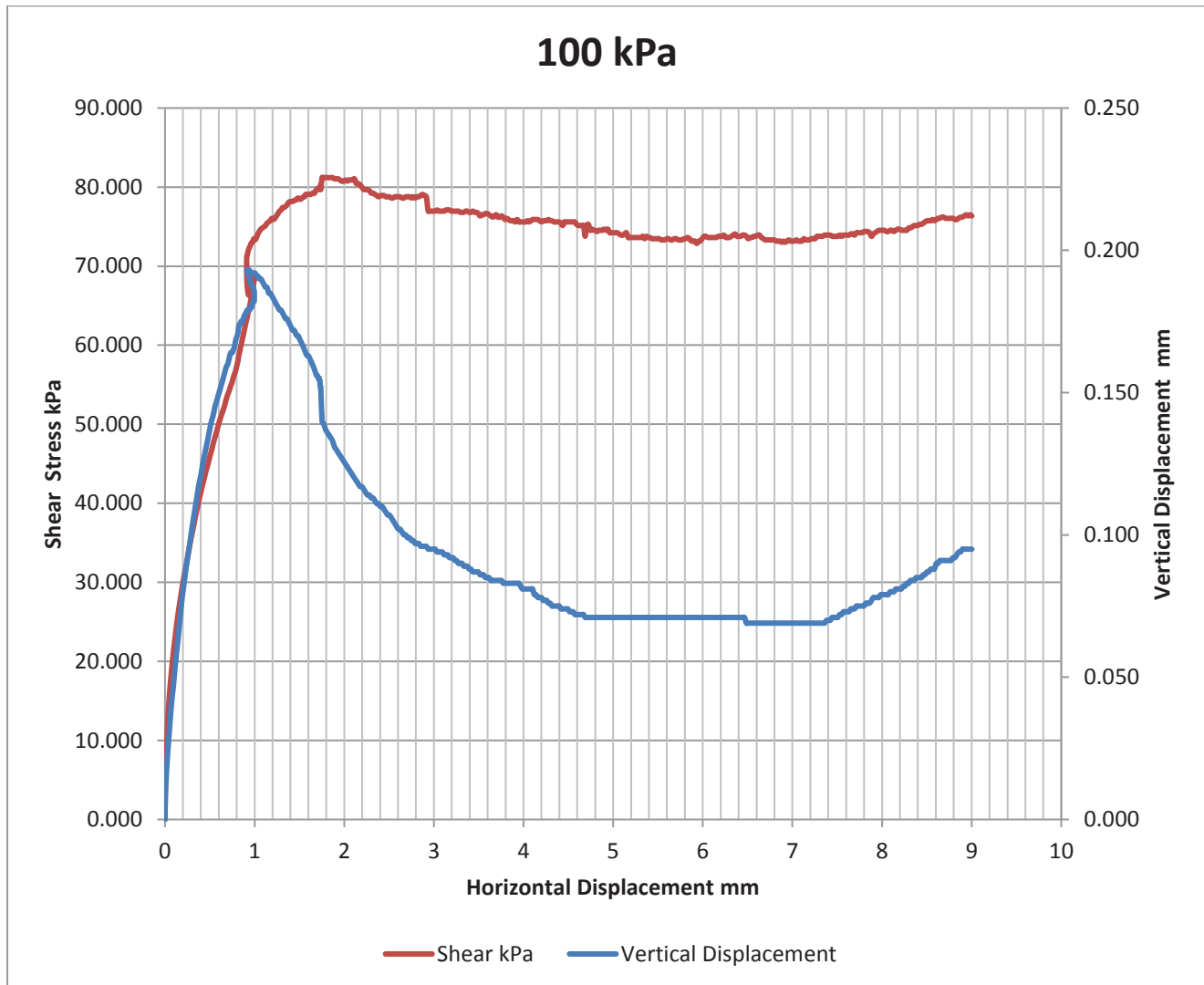
Name, Title, Date

Reviewed by: C. Hannon, May 2017

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

100 kPa Test	Before Test	After Consolidation	After Test
Length and Width (cm)	5.986	*****	5.986
Height (cm)	2.950	2.796	*****
Area (cm ²)	35.832	35.832	35.832
Volume (cm ³)	105.705	100.183	*****
Tare+Wet Samp. (gm)	2479.200	*****	*****
Tare (gm)	2246.000	*****	*****
Wet Weight (gm)	233.200	227.678	*****
Water Content (%)	13.106	*****	15.508
Tare	48.180	*****	48.640
Tare+ Wet Soil	166.840	*****	273.880
Tare+ Dry Soil	153.090	*****	243.640
Dry Weight (gm)	206.177	*****	*****
Dry Density (kg/m ³)	1950.499	*****	*****
Wet Density (kg/m ³)	2206.140	2272.618	*****
Specific Gravity (cm ³)	2.700		*****
Vol.of Solids (cm ³)	76.263	*****	*****
Void Ratio	1.386	*****	*****
Deg.of Saturation (%)	91.782	*****	*****
Height of Solids (cm)	2.13	*****	*****



TEST NOTES.

1. Test carried out as per ASTM D3080 remolded and compacted.
2. Test specimen was split from total sample, portion passing 4.75 mm sieve.
3. Test carried out on Shear Machine #1.
4. Shear Rate 0.0043 cm per minute.
5. Value for Specific Gravity is assumed.
6. Peak PHI values are based on highest shear stress to normal stress ratio achieved during the test.
7. Residual PHI was taken at 6 mm strain for all 5 samples in test suite.
8. Test data not corrected for area change during shearing as per ASTM.

Direct Shear Test of Soils Under Consolidated Drained Conditions

ASTM D 3080/3080M- 11

Date: June 1, 2017

Baffinland Iron Mines

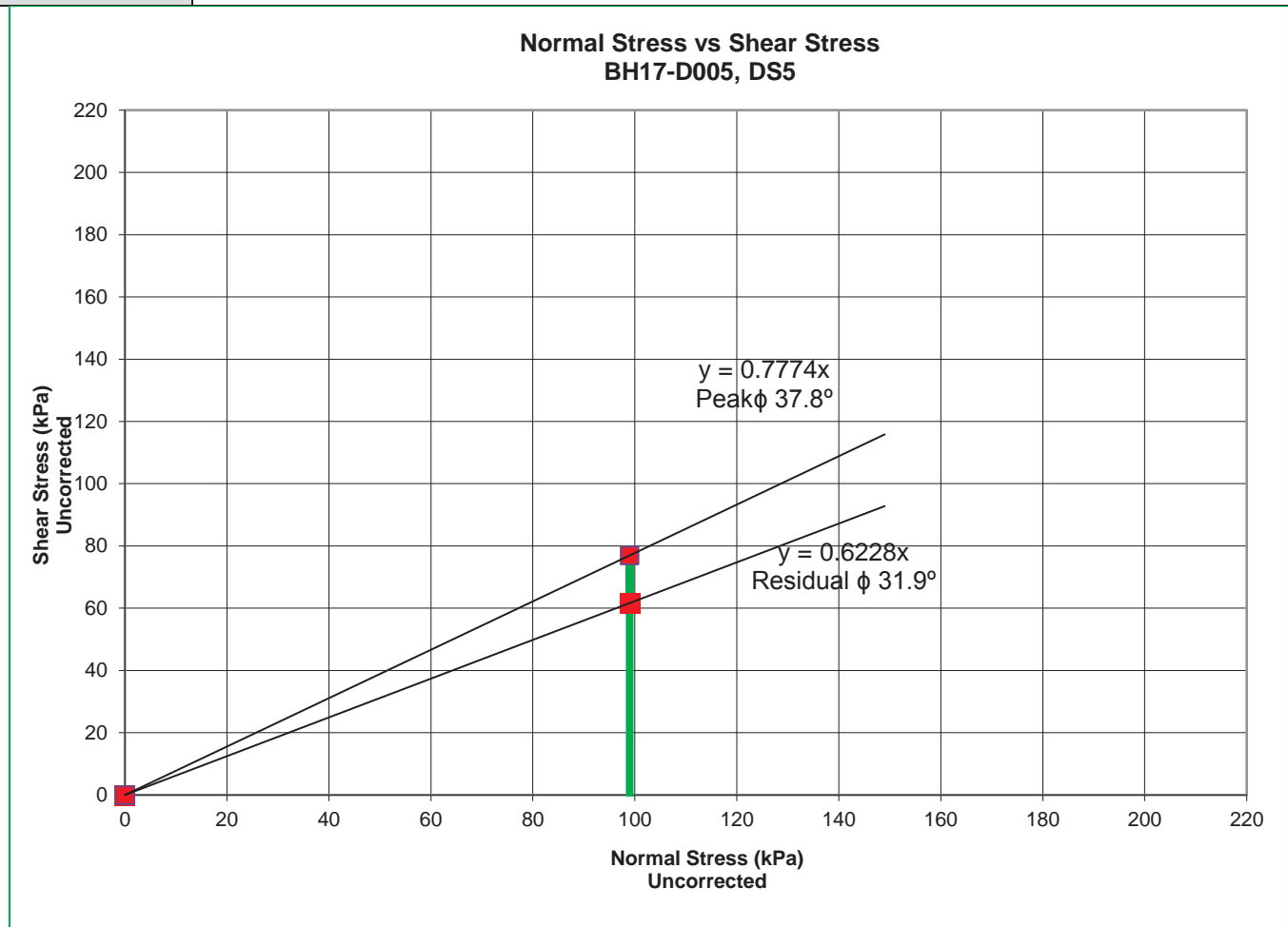
Project Number: H/352034

2275 Upper Middle Rd, Oakville Ont.

Project: Mary River Expansion Study
Stage 2

Attention: Matt Weaver

Sample	DS5 from 12.8 m to 13.1 m
Source	Milne Port Borehole BH17-D005



Comments:

Reported by: R.Serluca, Lab Tech, May 23, 2017

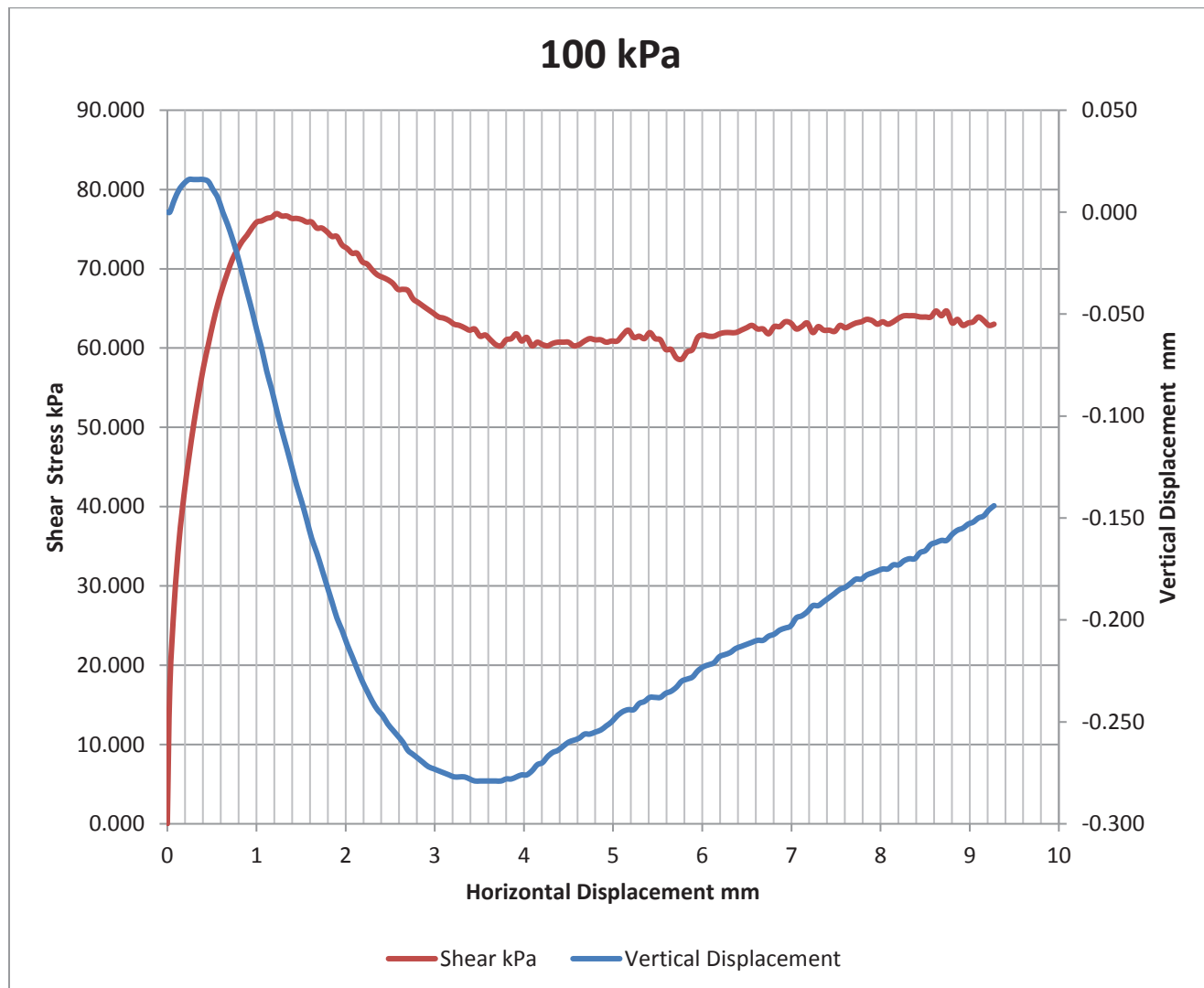
Name, Title, Date

Reviewed by: C. Hannon, May 2017

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

100 kPa Test	Before Test	After Consolidation	After Test
Length and Width (cm)	5.986	*****	5.986
Height (cm)	2.950	2.887	*****
Area (cm ²)	35.832	35.832	35.832
Volume (cm ³)	105.705	103.448	*****
Tare+Wet Samp. (gm)	2443.500	*****	*****
Tare (gm)	2247.200	*****	*****
Wet Weight (gm)	196.300	194.043	*****
Water Content (%)	7.175	*****	17.599
Tare	47.680	*****	46.970
Tare+ Wet Soil	146.570	*****	238.080
Tare+ Dry Soil	139.950	*****	209.480
Dry Weight (gm)	183.159	*****	*****
Dry Density (kg/m ³)	1732.738	*****	*****
Wet Density (kg/m ³)	1857.055	1875.758	*****
Specific Gravity (cm ³)	2.700		*****
Vol.of Solids (cm ³)	67.749	*****	*****
Void Ratio	1.560	*****	*****
Deg.of Saturation (%)	34.621	*****	*****
Height of Solids (cm)	1.89	*****	*****



TEST NOTES.

1. Test carried out as per ASTM D3080 remolded and compacted.
2. Test specimen was split from total sample, portion passing 4.75 mm sieve.
3. Test carried out on Shear Machine #1.
4. Shear Rate 0.0117 cm per minute.
5. Value for Specific Gravity is assumed.
6. Peak PHI values are based on highest shear stress to normal stress ratio achieved during the test.
7. Residual PHI was taken at 6 mm strain for all 5 samples in test suite.
8. Test data not corrected for area change during shearing as per ASTM.

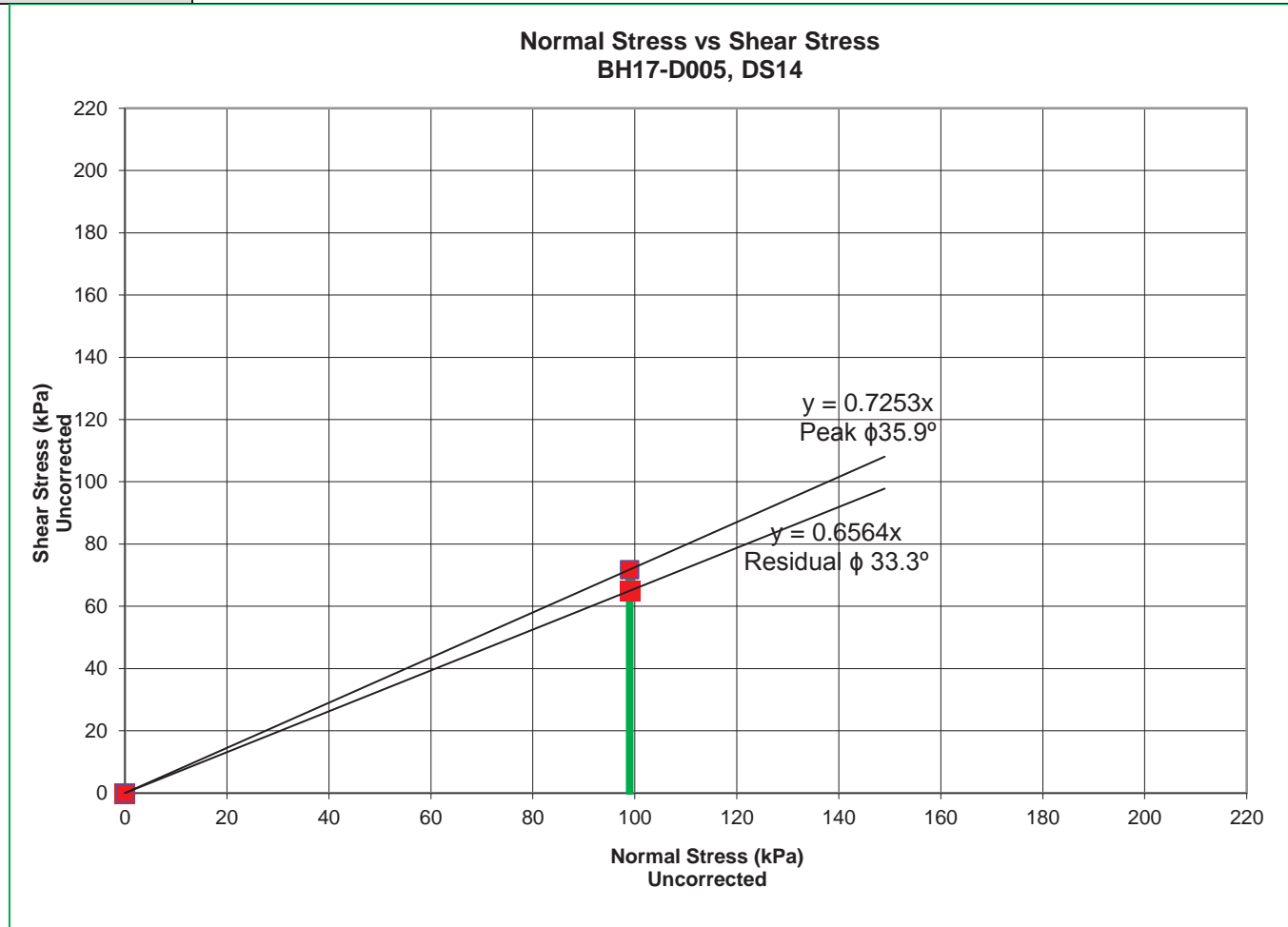
Direct Shear Test of Soils Under Consolidated Drained Conditions

ASTM D 3080/3080M- 11

Date: May 31, 2017
Project Number: H/352034
Project: Mary River Expansion Study Stage 2

Baffinland Iron Mines
2275 Upper Middle Rd, Oakville Ont.
Attention: Matt Weaver

Sample	DS14 from 30.5 m to 31.1 m
Source	Milne Port Borehole BH17-D005



Comments:

Reported by: R.Serluca, Lab Tech, May 23, 2017

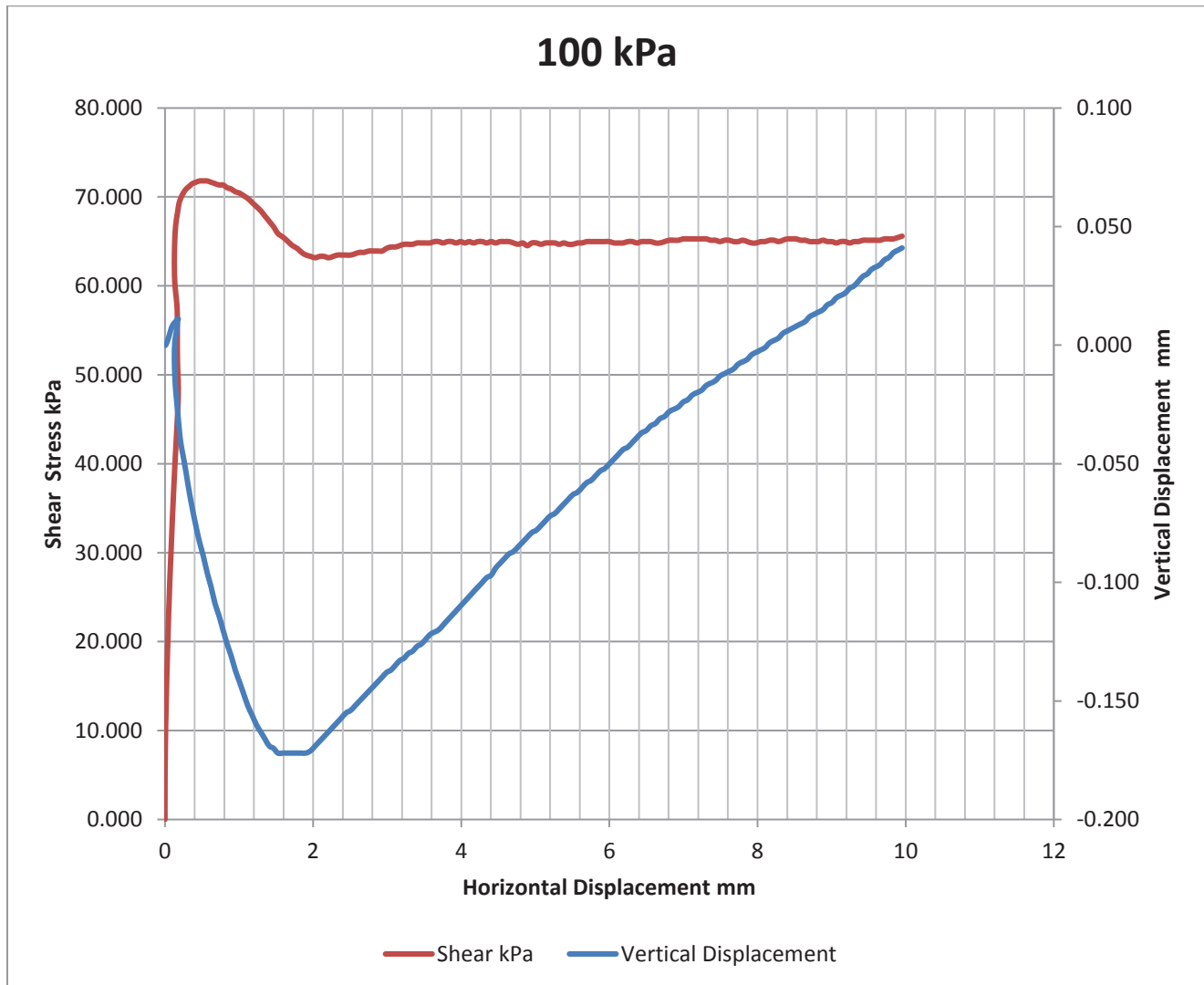
Name, Title, Date

Reviewed by: C. Hannon, May 2017

Name, Title, Date

Notice: the test data given herein pertain to the sample provided, and may not be applicable to material from other production zones/periods. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

100 kPa Test	Before Test	After Consolidation	After Test
Length and Width (cm)	5.986	*****	5.986
Height (cm)	2.950	2.913	*****
Area (cm ²)	35.832	35.832	35.832
Volume (cm ³)	105.705	104.368	*****
Tare+Wet Samp. (gm)	2463.000	*****	*****
Tare (gm)	2246.700	*****	*****
Wet Weight (gm)	216.300	214.963	*****
Water Content (%)	10.557	*****	15.945
Tare	47.070	*****	47.290
Tare+ Wet Soil	117.760	*****	254.170
Tare+ Dry Soil	111.010	*****	225.720
Dry Weight (gm)	195.646	*****	*****
Dry Density (kg/m ³)	1850.869	*****	*****
Wet Density (kg/m ³)	2046.261	2059.660	*****
Specific Gravity (cm ³)	2.700		*****
Vol.of Solids (cm ³)	72.367	*****	*****
Void Ratio	1.461	*****	*****
Deg.of Saturation (%)	61.954	*****	*****
Height of Solids (cm)	2.02	*****	*****



TEST NOTES.

1. Test carried out as per ASTM D3080 remolded and compacted.
2. Test specimen was split from total sample, portion passing 4.75 mm sieve.
3. Test carried out on Shear Machine #1.
4. Shear Rate 0.0116 cm per minute.
5. Value for Specific Gravity is assumed.
6. Peak PHI values are based on highest shear stress to normal stress ratio achieved during the test.
7. Residual PHI was taken at 6 mm strain for all 5 samples in test suite.
8. Test data not corrected for area change during shearing as per ASTM.

Appendix E

Geotechnical Investigation Job Hazard Analysis



1. Introduction

A geotechnical field investigation is underway to gather subsurface data for the 12 Mtpa mine expansion prefeasibility study, which includes an offshore (on ice) investigation for the proposed Ore Dock No. 2. This job hazard analysis (JHA) presents an assessment of the hazards and control measures to reduce the likelihood or consequence of the hazards in order to carry out the offshore investigation program. There are a total of 10 proposed boreholes for the dock area including 5 sonic boreholes and 5 Piezocone (CPTu) test holes.



Baffinland Iron Mines Corporation - Mary River Project - ERP
Job Hazard Analysis Form

Job Hazard Analysis Form

PROJECT/TASK: ZG003 Geotechnical Marine Drilling Milne Inlet				Department: Projects Boart Longyear				JOB No.: ZG003			
SUPERVISOR: Emile Beauchamp				LOCATION: Future Ore Dock Milne Inlet				DATE: March 12 ,2017			
JOB STEP Break the job into steps. Listing work which may be hazardous.	HAZARDS List the hazard or type of harm identified with each step.	Inherent			CONTROL MEASURE List the necessary control measures to be followed to eliminate/reduce the identified hazards.	Residual			ACTION Person who will ensure this happens		
		Consequence	Likelihood	Risk Ranking		Consequence	Likelihood	Risk Ranking			
1. Pre-job JHA Review.	Missing critical items on the JHA that can lead to an incident	3	2	5	Conduct a pre-job JHA review with Safety and critical team members All workers will have the opportunity to identify changes needed Any changes will be added to this document	1	1	2	Marlon Coakley/Warren Hoyle		
2. Workers to complete FLRA card in the field at location prior to starting work.	Additional hazards in the area that may not have been identified on the JHA and daily changes that may pose additional danger to the health and safety of workers, the environment and property	3	3	6	Look at immediate work area for hazards that may exist, not identified on the JHA. Have other workers in the group sign off on the FLHA	1	1	2	All workers		
3. Load Weights – The number and types of vehicles and equipment and their maximum gross weights	Not knowing load calculations will run the risk of breaking through the ice.	5	3	8	All equipment and material shall have posted GVW or gross equipment weight or maximum pull back loads available for use with load-ice thickness tables and shall follow the Ice Safety Plan. Refer to Attachment B for minimum ice thickness required for the drilling operations and Attachment C for further guidelines regarding Ice Safety	4	2	6	Warren Hoyle		



4. General Site	<p>Ice Conditions – Slip falls</p> <p>Ice Conditions – Adequate load bearing capacity</p> <p>Inadequate lighting</p> <p>Interaction with a Polar Bear</p> <p>Cold</p> <p>Whiteout conditions</p> <p>Emergency Procedures</p>	3	2	5	<p>Construct a working platform for outside of drill shack to store drill steel and allow the use of salt</p> <p>Use of traction aids on work boots will be required for work on ice surfaces.</p> <p>Apply salt to drill shack decks</p> <p>Engineered Assessment of minimum ice thickness as referenced in Attachment B for ice thickness required for the drilling operations and Attachment C for further guidelines regarding Ice Safety</p> <p>Place delineators in the snow marking access from the drilling location to the shoreline</p> <p>Existing Baffinland procedure "Safely Working On Fresh And Salt Water Ice" shall be followed</p> <p>Polar Bear Monitor will be available at all times</p> <p>Employees will have appropriate PPE including clothing available for safely working in -40 C and windy conditions</p> <p>Worksite location is approximately 300 meters from the shoreline. No work will be conducted in whiteout conditions and a safety shelter will be available immediately adjacent to the work area</p> <p>Site emergency procedures will be provided and reviewed at site</p>	2	1	3	All Crew
-----------------	--	---	---	---	---	---	---	---	----------



5. Working around water and sea ice	Water may appear to be completely frozen over, but not enough to support persons	5	1	6	Ice thickness to be assessed before walking on ice as per BIM Policy. Initial ice profiling will be conducted with an ice auger	2	1	3	Marlon Coakley/Warren Hoyle
	Falling in water	5	1	6	Floatation suit will be used for the initial ice profiling using an ice auger. Survival Bag (sleeping bag) will be available to reduce the risk of hyperthermia				
	Equipment breaking through ice	4	2	6	Follow the BIM Working On Ice Procedure (BAF-PH1-320-PRO-005, Rev 0, March 1, 2016)				
	Workers unaware of potential dangerous conditions	3	1	4	All workers will be required to complete the Alberta Working Safely on Ice Procedure online training				
6. Drill testing for ice thickness	Water may appear to be completely frozen over, but not enough to support persons. Large ice cracks or crevices Falling in water Strains/Sprains Slipping on ice Drilling ice with power auger Changes in ice conditions	3	4	7	Traction aids will be used for any ice work Ice thickness to be assessed before walking on ice Floatation suits will be worn by workers while ice auguring, the worker is to be tethered to a primary rescue worker at a distance of 30m Snow must be removed at the hole location so ice can be examined for quality as described in the Ice field guide. Hand shovelling may be necessary If crevices/ cracks greater than 50% of the ice thickness are present, repairs must be made if there is risk of falling through ice into deep water	2	2	4	Warren Hoyle / Marlon Coakley



					<p>Ice thickness for a person to walk on must be a minimum 13 cm. STOP all work if this condition is not met and return to shore.</p> <p>Be aware when using power ice auger that auger bit could bind or jam, have secure footing and grip on auger</p> <p>The ice auger hole spacing will be 20 m along the centreline access and the grid established in the designated work area. Secondary test holes will be augured at 10 m spacing within 250 m of the shoreline, if required based on the variable ice thickness</p> <p>Complete daily inspections of ice surfaces and record on ice log inspection sheet</p>				
7. Access from Land to Sea Ice Snow removal equipment, drill rig and access vehicles are to be used for borehole access	<p>Long distances to walk</p> <p>Exposure to cold</p> <p>White Out conditions</p> <p>Risk of falling under sea ice along the shoreline</p>	4	1	5	<p>Proper warm winter wear to be used</p> <p>Sat phones and digital radio use.</p> <p>Rig mats to be used to bridge over the fractured ice transition area if the transition between sea ice and shoreline needs leveling</p> <p>Buddy system is important to verify presence of frost bite or other cold related concerns</p> <p>Vehicle operators and passengers are not to wear seat belts when working on ice</p>	1	1	2	All workers



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8. Refueling of equipment	Fuel spills Regulatory or social impacts Spills into water bodies	3	2	5	Use of duck ponds with any refueling Have sufficient spill cleanup supplies on hand to respond to potential spills Maximize space between refueling vehicle	3	1	4	All workers
9. Extreme weather exposure when working outdoors or driving to and from the Borehole Location	Stranded work crew in white out conditions Cold emergencies or cold injuries Mechanical equipment failure	4	2	6	BIM has a procedure that is designed for white out conditions – it would be announced on the radio An emergency shelter to be used when in the Marine Drilling areas Emergency Shelter: Heated wooden shack (7' 8" by 7' 8") set on platform with skis Crews to radio from Hatch leads Buddy system to watch out for fellow workers who may not realize they are developing frost bite Workers to dress in arctic gear and layered clothing Proper PPE required Equipment check list Review Tidal charts on a daily basis Workers to take warm up breaks to stay warm and alert At toolbox review weather forecast with crew and prepare accordingly	2	1	3	All workers



10. Chemical handling- No unusual chemicals other than equipment needs are anticipated to be used.	Spills, leaks Chemical splash Chemical exposure	2	2	4	All products to be stored in secondary containment MSDS to be supplied to BIM for review MSDS books to be accessible at the work front MSDS training and WHMIS training completed before arriving to site PPE will be followed as per MSDS recommendations as well as first aid and environmental responses Spills response training and supplies to be kept with the equipment	1	1	2	Boat Longyear
11. Waste management and Wildlife Encounters	Risk of wildlife encounters due to improper waste controls Regulatory non compliance	3	2	5	Crews will collect waste daily and transport it back to camp Crews will follow BIM waste management guidelines No placing or storing of food in the back of pickup trucks Secure all small tools and PPE as they may carry away small articles from the site	2	2	4	All workers
12. Ecological and Cultural sensitive areas	Risk of causing damage to archeological areas Destroying vegetation Sensitive wildlife and marine life areas Regulatory and reputation damage	3	3	6	Crews have been instructed that there will be NO entry to the area east of the sealift ramp Crews are not to build or alter any inukshuk's or other rock formations on the tundra Permits will be required for the work	2	2	4	All personnel



13. Assemble Drill on skid platform skid and construct four walls and roofs	General hazards associated with drill assembly Inadequate communication between Boart Longyear and Site Services / mobile equipment operators	2	2	4	FLRA to be complete by Boart Longyear supervisor prior to executing work Boart Longyear Drilling operations SOPs to be followed including Boart Longyear Procedure 4001	1	1	2	Warren Hoyle / Marlon Coakley
14. Auguring holes in ice for sonic drilling and CPT work	Large ice cracks or crevices Falling in water Strains/Sprains Slipping on ice Drilling ice with power auger Changes in ice conditions	3	3	6	Wear traction aids for any ice work PFDs to be worn by workers while ice auguring during the sonic drilling and CPT operations Snow must be removed at the hole location so ice can be examined for quality. Hand shovelling may be necessary Be aware when using power ice auger that auger bit could bind or jam, have secure footing and grip on auger Complete daily inspections of ice surfaces and record on ice log inspection sheet All holes must be marked using an orange spray paint Any hole in ice over 30 cm in diameter must have a physical barrier around the hole	3	2	5	
15. Working around rotating equipment	Entanglement injuries	3	2	5	All equipment guards to be in place and in good working condition No loose clothing or drawstrings that can get pulled into rotating equipment Long hair must be contained to prevent entanglement into rotating equipment	2	1	3	All workers



					If any maintenance is required then energy isolation procedures to be followed				
16. Isolation of energy sources	Potential energy release that causes injury	3	2	5	All crews will follow the BIM Zero Energy State (ZES) procedure Crews to be given the BIM ZES training on site and fully understand the BIM requirements	1	1	2	Boart Longyear Crews BIM H&S
17. Working on equipment	Slip and trip hazards around railings, stairs and uneven ground.	2	2	4	Rails are installed around deck and to be properly maintained in good condition Stairs to be used on equipment A head cage will be used to reduce chance of contact with the rotating head Estops to be in good working order and easily accessible FLRA to be completed daily to review hazards All crews will follow the BIM Zero Energy State (ZES) procedure	1	1	2	Boart Longyear crew
18. Ice monitoring during drilling activities	Excessive deflection in ice	4	3	7	Hatch geotechs crew will monitor ice conditions during drilling including cracks around the work area, monitor freeboard in drilled holes for signs of ice deflection	2	2	4	All crew



19. Spotter activities	Equipment could come in contact with Spotter	4	2	6	Spotter to maintain eye contact with driver Spotter to review FLRA Agreed hand signals to be used with drivers in conjunction with BIM spotter procedure Agreed hand signals will be documented on the FLRA Drivers to immediately stop if the Spotter is out of eye contact	1	1	2	Boart Longyear crew
20. Manual lifting	Pinch point, back injuries, muscle and joint sprains and strains	2	3	5	Work in pairs, FLRA reviews Work with a buddy on heavy or awkward lifts Use proper lifting techniques 100 pound pipes to be handled by two workers	1	1	2	All crew
21. Working with pressure systems	Pressurized water and hydraulic fluids are used on drill and support equipment	3	2	5	Pre operational inspection Follow all safe work procedures. ZES when maintenance is required.	1	1	2	Boart Longyear crew
22. Falling objects	Potential exists for falling of drill rod and casing falling from overhead	3	2	5	Rigging and slinging training required when working with suspended loads and overhead hazards Perform FLRA	1	1	2	Boart Longyear Hatch Geotec EHS techs
23. High noise and vibration areas on the rigs	Hearing damage	2	2	4	Hearing protection is required by use of ear plugs or muffs.	2	1	3	Boart Longyear Hatch Geotec EHS techs



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24. Housekeeping	Potential exists for poor housekeeping causing slip/trips and other hazards	3	2	5	Daily site assessments and toolbox meetings by drillers and site supervisors BIM EHS techs to perform daily inspections	2	2	4	All Crew
25. Fatigue	Potential exists for crew fatigue	2	2	4	Fit for duty confirmation required for all employees, daily FLRA reviews Micro breaks to stretch Proper rest during off shift period	1	1	2	All Crew
26. Working at night or 24 hour darkness	Higher risk of injury due to poor visibility	3	3	6	Hi-vis work gear to be used Use of flashlight and headlamp Workers to stay within 10 meters (30 feet) of the worksites at any time Use of wobble lights and light tower Emergency shelter	1	1	2	All Crew
27. Hot work - welding	Fire risk Burn injuries Welders Flash	2	2	4	Hot work training Use of hot work permits and JHA for any Hot Work Fire Watch required Proper PPE Welding training required	1	1	2	Boart Longyear crew



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28. Rescue Plan	<p>Rough terrain</p> <p>Further injuries to casualty during transit.</p> <p>Snow storm, white out conditions.</p> <p>Darkness</p>	3	3	6	<p>The track unit will be used to pull the survival shack (survival shack is 7' 8" x 7' 8" square) on platform with skis.</p> <p>When an incident has occurred, the Geotechnical Engineer must call a Code 1.</p> <p>Provide first aid treatment to the injured person until MRT arrives on site</p> <p>MRT will be dispatched to the location. MRT will transport the casualty.</p> <p>Visibility (whiteout conditions) will hinder rescue time, rescuers will have to wait out the storm, or until the whiteout conditions have subsided.</p>	2	2	4	Marlon Coakley/ Warren Hoyle
29. Cleanup and Demob	<p>Unfrozen open holes</p> <p>Complacency</p>	3	3	6	<p>All drill holes must be filled in with water and snow upon completion of drilling operations</p> <p>A Hatch site representative will confirm safe conditions upon demob</p> <p>All debris must be removed from ice surface and disposed off site per waste management plan</p> <p>BIM safety and environment representatives to attend a post project closeout inspection to document the completion of the clean-up</p>	2	2	4	Boart Longyear



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Comments:



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Score	CONSEQUENCE		
	People	Plant	Environment
5 – Very High/ Catastrophic	Multiple Fatalities.	Greater than \$10 Million Loss	Catastrophe, destruction of sensitive environment, worldwide attention. Likely EPA prosecution. More than 30 days delay.
4 – High/ Major	Fatality or Permanent Disabilities.	\$1 Million to \$10 Million Loss	Disaster, high levels of media attention, high cost of clean-up. Offsite environmental harm; more than 10 days delay.
3 – Moderate	Major Injuries – Incapacitations or requiring time of work.	\$100 Thousand to \$1 Million Loss	Major spills, onsite release, substantial environmental nuisance, more than 1 day delay. (Leads to additional resources call out i.e. SES).
2 – Low/ Minor	Significant Injuries – Medical Treatments, non-permanent injury.	\$10 Thousand to \$100 Thousand Loss	Significant spills. (Leads to a call out of Site Emergency Response Group).
1 – Very Low/ Insignificant	Minor Injuries – First Aid Treatments (cuts/bruises).	Less than \$10 Thousand Loss	Low environmental impact. Minor Spills less than 80 Litres.

Score	LIKELIHOOD
5 – Almost Certain	The event is expected to occur in most circumstances. Likely to occur frequently - More than 1 per year.
4 – Likely/ Probable	The event will probably occur in most circumstances. Likely to occur several times – 1 per year.
3 – Moderate/ Occasional	The event should occur at some time. Likely to occur at some time – 1 per 5 years.
2 – Remote/ Unlikely	The event could occur at some time. Unlikely but possible. 1 per 10 years.
1 – Rare/ Very Unlikely	The event may occur only in exceptional circumstances. Assumed it may not be experienced. 1 per 100 years.

Job Hazard Analysis Attendees: Darryl Finlay, Marlon Coakley, Warren Hoyle, Usman Khan, Alex Boissonneault

	Name	Signature	Date
Written by:	Marlon Coakley		Mar 20/2017
Reviewed by:	Warren Hoyle (Hatch)		March 30, 2017
	Darryl Finlay (BIM Safety Coordinator)		March 20, 2017

Risk Rating = Consequence + Likelihood						Risk Rating - Definitions		
Consequence	Risk Rating					Risk Rating	Definitions	Action Required
5	6	7	8	9	10	8 - 10	Intolerable	Task not to start till the risk is eliminated or reduced. Bring to the immediate attention of management. Formal assessment required. MUST reduce the risk as a matter of priority.
4	5	6	7	8	9	7	High	Bring to the immediate attention of management. Task not to start till the risk is eliminated or reduced. Further Assessment required. MUST reduce the risk as a matter of priority.
3	4	5	6	7	8	6	Significant Risk	Bring to the attention of supervision. Review risks and ensure that they are reduced to as low as reasonably practicable. To be dealt with as soon as possible, preferably before the task commences. Introduce some form of hardware to control risk.
2	3	4	5	6	7	5	Moderate Risk	Needs to be controlled but not necessarily immediately, an action plan to control the risk should be drawn up. Review effectiveness of controls. Ensure responsibilities for



						control are specified.
1	2	3	4	5	6	2-4 Low Risk If practical reduce the risk. Ensure personnel are competent to do the task. Manage by routing procedure. Monitor for change
	1	2	3	4	5	A JHA considers a variety of activities/tasks involved in a job scope and analyses the key hazards (sources of harm) and their consequences (types of harm) eg. Sources of harm – lifting a heavy pipe - manual handling. Types of harm – Back strain.
	Likelihood					
Main Points – On how to write a JHA. 1. Define the task – what is to be done. 2. Review previous JHA if any – have we done it before? 3. Identify the steps – what is to be done. 4. Identify the hazards of each step. 5. Identify who or what could be harmed. 6. Give the task a risk rating – Consequence + Frequency 7. Develop solutions to eliminate or control hazards in each step. 8. Review the risk rating after the control system has been implemented. 9. If risk rating unacceptable review the solutions till risk rating acceptable. 10. Agree who will implement the control system. 11. Document the JHA and discuss with the relevant personnel.						Hierarchy of Hazard Management – Control Measures These steps outline what should be planned for when deciding what control measures are to be put in place. Whenever possible the highest step should be used first and then progress down the list. 1. Eliminate the hazard. 2. Substitution. 3. Reducing the frequency of a hazardous task. 4. Enclosing the hazard. 5. Additional procedures. 6. Additional supervision. 7. Additional training. 8. Instructions / information. 9. Some personal protective equipment.



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Worker / Visitor review	Signature
Warren Hoyle	Warren Hoyle March 19/2017
Marlon Coakley	Marlon Coakley March 19/2017
Usman Khan	Usman Khan
Alex Boissonneault	Alex Boissonneault March 19, 2017
Emile Beauchamp	Emile Beauchamp March 19/2017
Samuel Flynn	Samuel Flynn March 19/2017
Ruben Gross	Ruben Gross March 19/2017
Justin Gross	Justin Gross March 19/2017
Chris Entz	Chris Entz March 19/2017
Doug Roach	
Robbie Jordan	


Enclosed:

Attachment A – BIM Working on Ice Procedure
Attachment B – On Ice Platform for Geotechnical Drilling
Attachment C – Best Practice for Building and Working Safely on Ice Covers in Alberta
Attachment D – Ice Thickness Assessment
Attachment E – Ice Assessment Drawing



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Attachment A – BIM Working on Ice Procedure

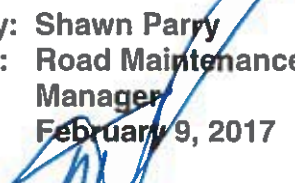
	Working On Ice Procedure	Issue Date: February 6, 2017 Rev.: 0	Page 1 of 12
	Road Maintenance Department	Document #: BAF-PH1-320-PRO-0055	

Baffinland Iron Mines Corporation

Working on Ice Procedure

BAF-PH1-320-PRO-0055

Rev 0

Prepared By: Shawn Parry
 Department: Road Maintenance
 Title: Manager
 Date: February 9, 2017
 Signature: 

Approved By: Sylvain Proulx
 Title: Chief Operating Officer
 Date: February 9, 2017
 Signature: 

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	Working On Ice Procedure	Issue Date: February 6, 2017 Rev.: 0	Page 2 of 12
	Road Maintenance Department	Document #: BAF-PH1-320-PRO-0055	

DOCUMENT REVISION RECORD

Issue Date MM/DD/YY	Revision	Prepared By	Approved By	Issue Purpose
01/19/17	1	S.P.	R.G.	use

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	Working On Ice Procedure	Issue Date: February 6, 2017 Rev.: 0	Page 3 of 12
	Road Maintenance Department	Document #: BAF-PH1-320-PRO-0055	

TABLE OF CONTENTS

1	PURPOSE AND SCOPE	4
2	Definitions	4
2.1	Baffinland Classifications for Working on Ice	4
3	RESPONSIBILITIES	4
3.1	Chief Operating Officer or General Manager, Operations	4
3.2	Department Manager/Superintendent.....	4
3.3	Department Supervisor.....	4
3.4	Worker	5
3.5	Safety Superintendent or Coordinator.....	5
3.6	Mine Rescue Team Trainer or Delegate	5
4	PROTOCOL	6
4.1	Class A Job	6
4.2	Class B Job	7
4.3	Class C Job	7
5	Golds Ice Weight Bearing Capacity Formula	7
5.1	Working on Ice frozen to the bottom (River, Lake – etc.)	8
6	Working on Ice JHA and Work Planning Meeting	8
7	MEASURING AND RECORDING ICE THICKNESS.....	9
7.1	Test Hole Spacing	10
8	REFERENCES AND RECORDS.....	10

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	Working On Ice Procedure	Issue Date: February 6, 2017 Rev.: 0	Page 4 of 12
	Road Maintenance Department	Document #: BAF-PH1-320-PRO-0055	

1 PURPOSE AND SCOPE

Baffinland Iron Mines Corporation is committed to taking the necessary steps to ensure that work performed on ice of lakes, rivers, streams or the ocean is conducted in a safe, efficient and environmentally compliant manner.

This procedure is not intended to provide instructions for large scale ice operations such as ice road construction and operation. For large scale ice operations, refer to "Best Practice for Building and Working Safely on Ice Covers in Alberta (Work Safe Alberta)".

2 DEFINITIONS

2.1 BAFFINLAND CLASSIFICATIONS FOR WORKING ON ICE

Class A Job – The ice is between 15 centimetres and 38 centimetres thick and the load weight, including people on the ice will be 4,536 kilograms or less.

Class B Job – The ice is more than 38 centimetres thick and the load weight, including people, is greater than 4,536 kilograms but less than 63,000 kilograms.

Class C Job – The job requirements cannot be met by either Class A or B guidelines.

See section 4, Protocols for a discussion of Class A, B and C requirements.

3 RESPONSIBILITIES

The following roles have specific accountabilities that must be met to ensure that any work on ice is conducted in a safe and environmentally responsible manner.

3.1 CHIEF OPERATING OFFICER OR GENERAL MANAGER, OPERATIONS

The Chief Operating Officer or General Manager, Operations must review and approve any Class C job for working on ice.

3.2 DEPARTMENT MANAGER/SUPERINTENDENT

The Department Manager and Superintendent are responsible to ensure their department supervisors are aware of and comply with this procedure. The manager and superintendent are also responsible to validate the terms and conditions of the JHA are implemented.

3.3 DEPARTMENT SUPERVISOR

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	Working On Ice Procedure	Issue Date: February 6, 2017 Rev.: 0	Page 5 of 12
	Road Maintenance Department	Document #: BAF-PH1-320-PRO-0055	

The Supervisor is responsible for supervising the work/tasks in accordance with this procedure and the terms and conditions of the JHA. Specifically, the supervisor is responsible for:

- Notify the department manager and superintendent of the requirement to work on ice and send each a copy of the completed JHA.
- Ensure a geographically specific JHA is completed and implemented, prior to starting work.
- Notify the MRT Trainer and have them participate in the JHA.
- Ensuring that workers have reviewed and understand the JHA, prior to starting work.
- Supervise the work and act as the main point of contact for workers working on ice.

3.4 WORKER

The worker, is responsible for the following:


- Review, sign and comply with the terms and conditions of the JHA.
- Promptly reporting to their supervisor, any safety concerns or incidents that occur while working on ice.

3.5 SAFETY SUPERINTENDENT OR COORDINATOR

The Safety Superintendent or Coordinator will facilitate the working on ice JHA process.

3.6 MINE RESCUE TEAM TRAINER OR DELEGATE

The Mine Rescue Team Trainer or delegate is responsible to work with the supervisor to develop the rescue plan component of the JHA.

	Working On Ice Procedure	Issue Date: February 6, 2017 Rev.: 0	Page 6 of 12
	Road Maintenance Department	Document #: BAF-PH1-320-PRO-0055	

4 PROTOCOL

4.1 CLASS A JOB

The following table provides requirements for performing work on ice under Class A conditions.
The JHA must meet the following conditions;

Equipment Example	Weight (kilograms)	Minimum Ice Thickness (centimetres)	Ice Integrity
1 or 2 people and their tools and equipment	Up to 272	15	Solid ice that is free of cracks, water and slush
Snowmobile and rider	Up to 363	20	Solid ice that is free of cracks, water and slush
2 snowmobiles and riders	Up to 726	25	Solid ice that is free of cracks, water and slush
Pickup truck or other mobile equipment, cargo and driver/passengers	Up to 4536	38	Solid ice that is free of cracks, water and slush

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	Working On Ice Procedure	Issue Date: February 6, 2017 Rev.: 0	Page 7 of 12
	Road Maintenance Department	Document #: BAF-PH1-320-PRO-0055	

4.2 CLASS B JOB

The ice is greater than 38 centimetres thick and the load weight, including people, is greater than 4536 kilograms but less than 63, 000 kilograms.

Ice Thickness Calculation	Weight and Ice Thickness	Ice Integrity
The Golds formula found in Section 5 must be applied to calculate the safe ice thickness. The calculation, including safe ice thickness must be documented in or attached to the working on ice JHA.	The combined weight of the load, including equipment and people is greater than 4536 kilograms but less than 63, 000 kilograms and the ice is 38 centimetres thick or greater	Solid ice that is free of cracks, water and slush

4.3 CLASS C JOB

The job requirements cannot be met by either Class A or B guidelines. The assistance of a professional engineer recognized as an authority on ice covers, must be consulted and their guidance documented in or attached to, the JHA.

5 GOLDS ICE WEIGHT BEARING CAPACITY FORMULA

GOLD'S FORMULA


All guidelines currently in use in Canada are based on a technical paper published by Dr. Lorne Gold in 1971 entitled "Use of Ice Covers for Transportation". Gold's Formula is;

$$P = A \times h^2$$

Where:

- P is the allowable load in kilograms
- A is a parameter that depends on the strength of the ice
- h is the effective thickness of good quality ice (cm)

Gold suggested a range of A-values for lake ice that corresponds to a range of safe ice thicknesses for a given load or a range of acceptable loads for a given ice thickness. Baffinland has adopted Golds "Tolerable Risk" value for ice quality, therefore the A value in Golds formula will be four (4) when calculating ice thickness for a Baffinland Class B job.

	Working On Ice Procedure	Issue Date: February 6, 2017 Rev.: 0	Page 8 of 12
	Road Maintenance Department	Document #: BAF-PH1-320-PRO-0055	

Gold's formula A value of 4 is most commonly used for normal operations with moving vehicles. When equipment will be working in the same spot (stationary) for more than 2 hours, the value for A in Golds formula, must be reduced to two (2).

Two examples using the Golds Formula for a Class B job:

What is the weight capacity of good quality ice that is 60 cm thick?

$$\text{Capacity (in Kgs)} = A \times h^2$$

$$\text{Capacity (in Kgs)} = 4 \times (60 \times 60)$$

$$\text{Capacity (in Kgs)} = 4 \times 3600$$

$$\text{Capacity} = 14400 \text{ Kgs}$$

The weight bearing capacity of good quality ice that is 60 cm thick is up to 14400 kilograms.

What is the weight bearing capacity of good quality ice that is 60 cm thick and the load will be stationary for 2 hours or more?

$$\text{Capacity (in Kgs)} = A \times h^2$$

$$\text{Capacity (in Kgs)} = 2 \times (60 \times 60)$$

$$\text{Capacity (in Kgs)} = 2 \times 3600$$

$$\text{Capacity} = 7200 \text{ Kgs}$$

7,200 kgs is the weight bearing capacity of good quality ice that is 60 cm thick and the load will be stationary for 2 hours or more.

5.1 WORKING ON ICE FROZEN TO THE BOTTOM (RIVER, LAKE – ETC.)

When ice thickness measurements determine the ice has frozen to the bottom in the area of travel and work, the ice may be considered as safe provided the ice quality is routinely monitored and remains solid and free of slush and water.

6 WORKING ON ICE JHA AND WORK PLANNING MEETING

Working on ice may be divided into two parts;


1. initial measurement of ice thickness
2. working on the ice

Both parts require a JHA.

A work planning meeting must be held prior to any work on ice. This meeting will be based on review of the completed JHA. All individuals participating in the work must present and review their work instructions, roles and responsibilities. The following points will be covered

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	Working On Ice Procedure	Issue Date: February 6, 2017 Rev.: 0	Page 9 of 12
	Road Maintenance Department	Document #: BAF-PH1-320-PRO-0055	

in the JHA and will be covered as part of the topics of discussion during the “planning meeting”:

- A description of the work to be done – with sufficient detail for individuals to understand their role
- Potential hazards associated with the work
- Personal safety equipment
- Specific safety procedures for working on ice
- Rescue procedures and necessary equipment
- Individual job tasks
- Communications and hand signals to be used
- Load (i.e. equipment, personnel) weight and distribution on ice during work
- Ice assessment – thickness and condition

JHA safety and emergency response considerations;

- Measuring ice thickness should always be a two person operation.
- Initial ice measurement must be done with a PFD and the lead tester on a tether to the second person who is a safe distance behind.
- Self-recovery is not the primary means of rescue, it’s the second person and the tether.
- The MRT will provide a backup rescue plan.

7 MEASURING AND RECORDING ICE THICKNESS

The task of ice thickness measurements may be the subject of a separate JHA or may be included in the working on ice JHA.

Ice thickness is the primary measurement required to determine the safe working load that can be put on the ice (allowable load bearing capacity). Manual measurements are made by cutting a hole in the ice cover with an auger, a saw or an ice chisel and then directly measuring the ice thickness. Measurements are made in a prescribed spacing or pattern to provide sufficient coverage and verify the thickness of the ice cover.

It must be mentioned that in all cases of manual ice thickness measurements it is the absolute minimum thickness measured in all holes that must be used. Not an average or any other measurement.

It is imperative that a systematic procedure be implemented to document all ice thickness measurements. Measurement locations should be taken either with a Global Positioning System (GPS) receiver or marked with stakes, or other reliable system so that these locations can be tracked in future measurements or identified for repairs. This information is a key element in the monitoring control plan.

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	Working On Ice Procedure	Issue Date: February 6, 2017 Rev.: 0	Page 10 of 12
	Road Maintenance Department	Document #: BAF-PH1-320-PRO-0055	

These records are vital to reconcile any ice failures that may occur. These records must be maintained in a log that is specific to recording ice thickness. See Appendix #1 - Ice Thickness Measurement Log

Suitable equipment and personal protective equipment (PPE) must be prescribed for the work. Initial testing should be conducted by at least two trained crew members travelling separately over the ice. The work could be carried out by travelling:

- On foot, by snowmobile or by amphibious vehicle.
- While testing, the crew should also be checking the ice for cracks and noting the snow load.
- If vehicles are used, two separate vehicles must be used at all times and must be separated at safe distance unless ice conditions are known.

7.1 TEST HOLE SPACING

Rivers

If GPR is used, test holes are only required for calibration and for mapping of thin areas. Recommend 30 meters between test holes along alternate edges. Look for thin areas caused by river current.

Lakes

If GPR is used, test holes are only required for calibration. If within 250 metres of shore: 30 meters between test holes along centre line. If more than 250 metres from shore: 250 metres between test holes along centre line

Note – these recommendations indicate normal test hole spacing. Good judgement based on field experience must be used when varying from these recommendations. In thin ice areas the suggested spacing should be reduced to determine their extent and severity.

8 REFERENCES AND RECORDS

- Baffinland Job Hazard Analysis Procedure BAF-PH1-810-PRO-0016r1
- Baffinland Iron Mines Corporation– Emergency Response Plan (BAF-PH1-830-P16-0007)
- Best Practice for Building and Working Safely on Ice Covers in Alberta (Work Safe Alberta)
- NWT Transportations Guide to Ice Road Construction

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	Working On Ice Procedure	Issue Date: February 6, 2017 Rev.: 0	Page 11 of 12
	Road Maintenance Department	Document #: BAF-PH1-320-PRO-0055	

Appendix #1 Ice Thickness Measurement Log

Date:		Location:	
Completed by:		Signature:	
Weather Conditions, including temperature:			
Test Hole #	Ice Thickness	Notes on test hole – clear solid ice cracking, water – etc.	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
Names of other participants		Signature of other participants	

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	Road Maintenance Department	Document #: BAF-PH1-320-PRO-0055	

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Baffinland Iron Mines Corporation - Mary River Project - ERP
Job Hazard Analysis Form

Attachment B – On Ice Platform for Geotechnical Drilling

On-Ice Platforms for Geotechnical Drilling at Steensby Island

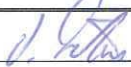
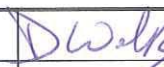
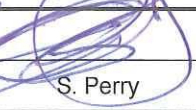

2013-04-09	0	Approved for Use				
DATE	REV.	STATUS	PREPARED BY	CHECKED BY	APPROVED BY	APPROVED BY

Table of Contents

1. Purpose	1
2. Scope	1
3. Roles and Responsibilities	1
3.1 Construction Manager	1
3.2 Contractor's Line Managers	1
3.3 Site Health and Safety Manager	1
3.4 Supervisors	1
3.5 Employees	2
4. Definitions	2
4.1 Solid Ice	2
4.2 Sea Ice	2
4.3 Rafted Ice or Raft Ice	2
4.4 Ice Platform	2
4.5 Rig Mat	2
4.6 Drill Rig	2
5. Procedure	3
5.1 Specific Requirements for Ice Platforms	3
6. References	3

List of Appendices

Appendix A

Illustrations

Appendix B

Consideration of Bearing Capacity of Ice for Geotechnical Drilling Program

1. Purpose

- 1.1 This Procedure identifies minimum safe work practices for the set-up and maintenance of on-ice platforms to be used to support geotechnical drill rigs for near shore work at Steensby Island.

NOTE: This Procedure does not replace safe work procedures for working on ice.

2. Scope

- 2.1 This Procedure applies to all locations where on-ice platforms are required for near shore work at Steensby Island.

3. Roles and Responsibilities

3.1 Construction Manager

- 3.1.1 The Construction Manager shall be accountable for ensuring full implementation and compliance with the requirements of this Procedure.

3.2 Contractor's Line Managers

- 3.2.1 Contractor's Line Managers shall have the following accountabilities:
- Conduct risk assessments for tasks associated with this Procedure and ensure the implementation of controls
 - Ensure equipment is used and processes are applied in accordance with this Procedure

3.3 Site Health and Safety Manager

- 3.3.1 The Site Health and Safety Manager shall have the following accountabilities:
- Audit and monitor compliance with this Procedure
 - Identify remedial corrective actions required to meet this Procedure

3.4 Supervisors

- 3.4.1 Supervisors shall have the following accountabilities:
- Ensure the application of this Procedure
 - Responsibility for details of construction of the platforms
 - Ensure that a JHA/FLRA is developed for tasks associated with this Procedure

- Ensure that employees review and sign the JHA/FLRA prior to task commencement
- Responsibility for removal of the ice platforms

3.5 Employees

3.5.1 All employees shall have the following accountabilities:

- Ensure they follow this Procedure
- Ensure that JHA/FLRA developed for tasks associated with this Procedure are followed

4. Definitions

4.1 Solid Ice

4.1.1 Stable sheet of solid ice, thickness adequate to safely support the operation. The solid ice may be subject to movement due to tides.

4.2 Sea Ice

4.2.1 Sea ice is any form of ice that is found at sea and has originated from the freezing of sea water.

4.3 Rafted Ice or Raft Ice

4.3.1 Ice in cakes or sheets overlapping or piled on one another. This is a body of near shore ice segments fused together and formed during fall freeze-up. The surface of suitable rafted ice should be reasonably flat and elevation at or near high tide. This rafted ice is a stable entity. Rafted ice that moves with the tides shall be regarded as unstable.

4.4 Ice Platform

4.4.1 A platform constructed on the rafted ice by flooding with salt water and including embedded rig mats.

4.5 Rig Mat

4.5.1 A portable platform used to support equipment used in construction and resource based activity including drill rigs.

4.6 Drill Rig

4.6.1 A track mounted drill rig used for geotechnical investigations.

5. Procedure

5.1 Specific Requirements for Ice Platforms

- 5.1.1 The rafted ice must be stable and fused to act as a homogeneous mass. Appropriate ice profiling and/or direct measurement of ice thickness is required.
- 5.1.2 Do not attempt to construct an ice platform in locations where sea ice is pushed up onto the rafted ice to a height exceeding 2 m.
- 5.1.3 The solid ice adjacent to the ice platform must be stable during tidal influence and capable of safely supporting the gravity loads imposed by the operation, including at the edge of the ice sheet. Appropriate ice profiling and/or direct measurement of ice thickness is required.
- 5.1.4 The zone of discontinuity between the solid and rafted ice must not be open water at any time and must be sufficiently narrow so that the rig mats will safely support the movement of equipment and personnel across this zone. No work is to be performed over this zone of discontinuity. Appropriate ice profiling and/or direct measurement of ice thickness is required.
- 5.1.5 The ice platform shall be constructed by alternate overlapping layers of rig mats and flooding with salt water until a suitable work space is created over the rafted ice. Profile the ice with an ice profiler or measure ice thickness using a mechanical ice auger prior to any flooding.
- 5.1.6 The rig mats shall be constructed of steel frames and timber cross beams. The rig mats shall be strong enough to bridge across the zone of discontinuity. Note that the attached sketch is conceptual only. The number of rig mats must be determined on site. It is anticipated that the number of available rig mats will not be more than six.
- 5.1.7 The rig mats shall be adequately connected by mechanical means to be determined at site.
- 5.1.8 The platform must be sufficiently long and wide to permit a clearance of at least two metres on each side of the equipment and supplies.
- 5.1.9 The platforms must be removed by means established by the supervisor.

6. References

Nunavut General Safety Regulations, R.R.N.W.T. 1990.

Nunavut Mine Health and Safety Regulations, R-125-95.

Safe Work Procedure – Working on Ice (HS-SWP-092).

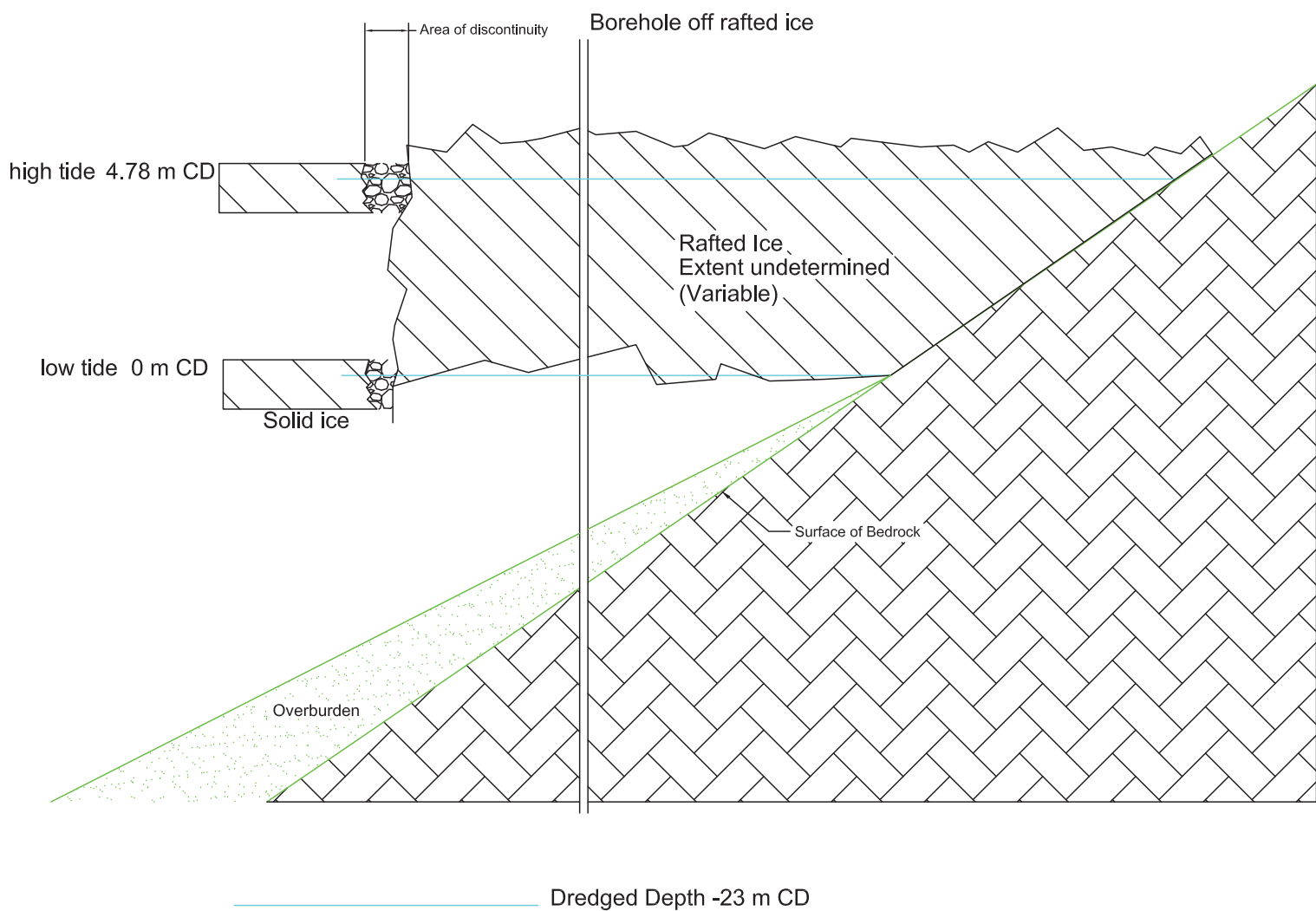
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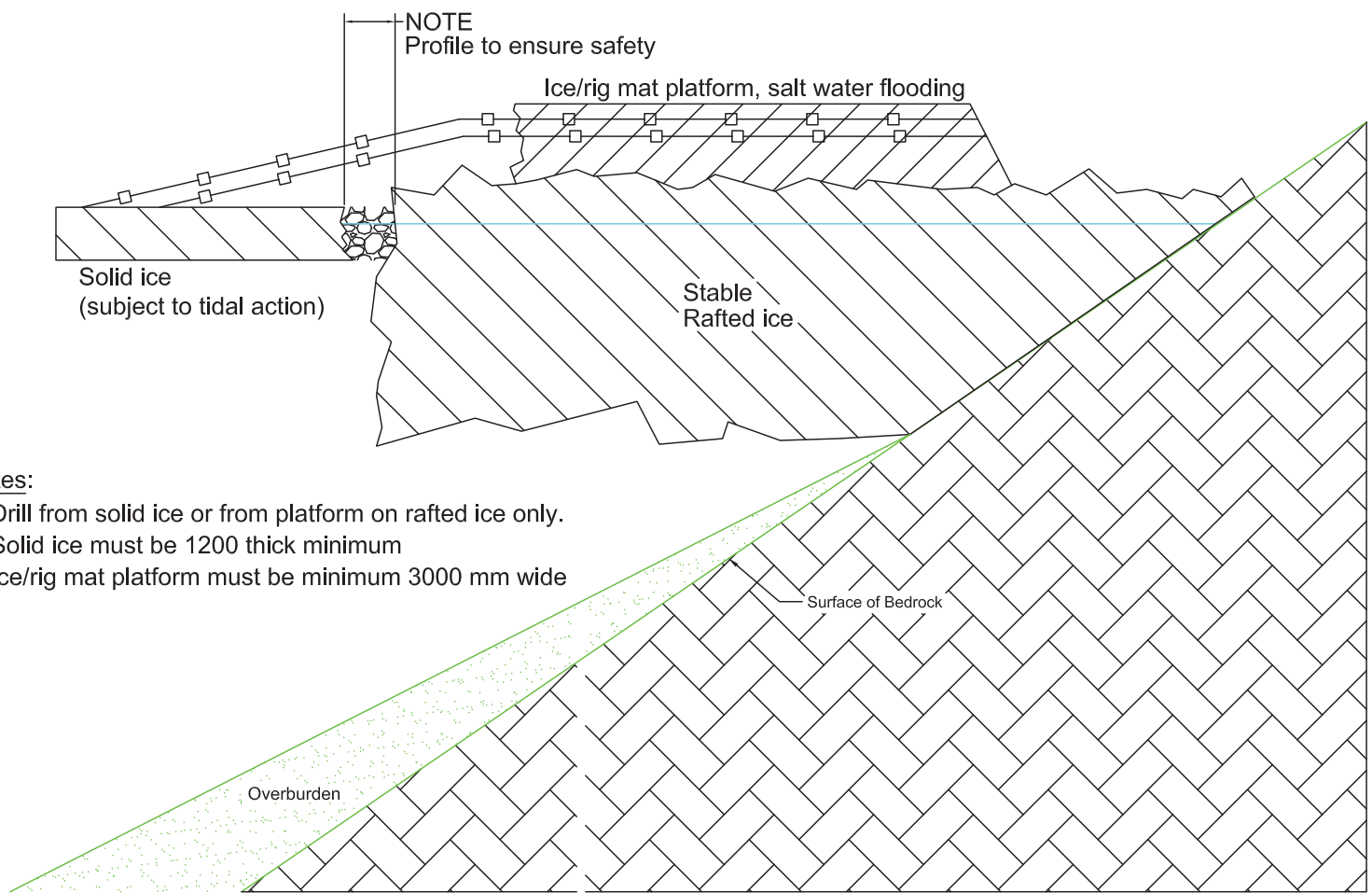
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Appendix A

Illustrations



ORE DOCK
NEARSHORE CROSS SECTION



Notes:

1. Drill from solid ice or from platform on rafted ice only.
2. Solid ice must be 1200 thick minimum
3. Ice/rig mat platform must be minimum 3000 mm wide

ORE DOCK
ICE PLATFORM CONCEPT

Appendix B

Consideration of Bearing Capacity of Ice for Geotechnical Drilling Program

Project Memo

December 14, 2011

TO: K. Skebo

FROM: B. Gill

cc: S. Hinchberger
R. MacCrimmon**Baffinland Iron Mines Corporation**
Mary River Project**Consideration of Bearing Capacity of Ice for Geotechnical Drilling Program****1. Introduction**

The purpose of this note is to consider the ice features that may affect the execution of a planned geotechnical drilling program in a safe and effective manner. The program will be conducted during April and May in the proposed mine and marine facilities areas of the Baffinland project on northern Baffin Island. This note addresses primarily the bearing capacity of the ice cover for supporting the drilling program vehicles and equipment.

1.1 Air Temperatures and Ice Thickness

The air temperatures over the period from 1971 to 2000 for Hall Beach to the southwest and Pond Inlet to the northeast for April and May are as follows:

Table 1-1: Air Temperatures

	Hall Beach		Pond Inlet	
	April	May	April	May
Daily Average	-20.4	-9.0	-22.1	-9.9
Daily Maximum	-15.2	-4.8	-17.7	-5.8
Daily Minimum	-25.6	-13.2	-26.5	-13.9

Thus it is seen that the air temperature is well below freezing for the period and ice will continue to grow. Ice thickness data for Hall Beach show that in most years, the thickness reaches to 2 m or greater by May. The minimum thickness for May over 50 years is approximately 1.5 m. This is a significant thickness that is capable of supporting very heavy loads.

1.2 The Bearing Capacity of Ice

The guidelines in Canada for determining safe working loads for operations on ice are based on work by Dr. L. Gold of the National Research Council (see for example, "A Field Guide to Ice Construction Safety" by NWT Department of Transportation, November, 2007 and "Best Practice for Building and Working Safely on Ice Covers in Alberta by Work Safe Alberta, Government of Alberta, October, 2009). Dr. Gold published his paper "Use of Ice Covers for Transportation" in 1971. His formula, which says that the safe working load is a function of the ice thickness squared, is $P = Ah^2$ where A is a parameter that is related to the ice strength and h is the ice

If you disagree with any information contained herein, please advise immediately.

H337697-3100-12-220-0002, Rev. A

Page 1



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thickness. The value of A may vary depending on the degree of risk one is willing to take and the offsetting precautionary and response measures that are implemented in a given case. For the current case in which the ice thickness is large, the ice is static, and the equipment loads are relatively modest in relation to the ice bearing capacity, one could assume a low risk factor, and the subsequent calculated minimum ice thickness for the planned equipment weight would be relatively high, but still well below the thickness in April and May. In the Alberta and NWT documents referred to above, the former document uses a range of values for 'A' from 3.5 to 7 and suggests hazard control measures appropriate to each level, whereas the latter document uses a single value of 4 for 'A'. Both of these documents are concerned with freshwater lake and river ice.

Using a value of 4 for 'A' and an ice thickness of 200 cm results in an allowable load of 160 tonnes or more than 12 times the weight of a Cat 950 loader. The ratio would be presumably even greater in the case of a drill rig. In the same manner, the minimum (freshwater) ice thickness that a stationary or slowly moving 950 loader weighing about 13,000 kg would require is 57 cm.

The allowable load in the case of sea ice would be less than that for an equivalent thickness of freshwater ice because of the lower strength (under the same temperature conditions) that results from brine inclusions in the sea ice. A reasonable understanding of this derating can be obtained by comparing the flexural strengths of the two types of ice. For a salinity of 8 ppt (parts per thousand) for arctic sea ice at an average ice temperature of -20 deg C, the resulting flexural strength is about 65 percent of the strength of freshwater ice at the same temperature. The minimum sea ice thickness for a 950 loader would then be about 70 cm. This is 35 percent of the expected ice thickness at the project site during the drilling period.

The rate of movement of the equipment is not expected to be a significant factor, unlike in the case of transport vehicles moving at speed on ice covers over relatively shallow water. The speeds in the present case will not be sufficient to cause any dynamic effects that could lead to a magnification in deflection of the ice cover. According to field studies reported in the above-referenced Alberta Government document, a vehicle would have to travel at 50 km/h over ice 1 m thick in 15 m of water to cause such effects.

1.3 Potential Hazard Control

As noted, the large ice thickness in relation to the minimums required to safely carry the loads and the static nature of the ice cover in the present case mean that this is a low-risk operation in terms of potential ice bearing problems. An appropriate hazard control procedure would entail prior ice measurements to confirm the anticipated thickness in the working areas, measurements thereafter if any uncertainties exist with respect to ice thickness, monitoring the ice quality (e.g. cracks, effects of warming, water on the ice, etc), and checking for deflection of the ice cover as time of equipment in one location increases (this can be done by observing the water level in boreholes).

An overall ice safety plan should be implemented, including orientation and instruction for employees and contractors and routine daily observations to ensure rules of working on an ice cover are followed.

BG:vl

Internal Memo

H352034

March 18, 2017

To: Warren Hoyle

From: Usman Khan

cc: Marlon Coakley
Alex Boissonneault
Sean Hinchberger
Tyler Bruce
Sven Heiner

Baffinland Iron Mines Mary River Expansion Study Stage 2

Minimum Ice Thickness for Offshore Drilling at Milne Port 2017

1. Introduction

Hatch Ltd. (Hatch) was retained by Baffinland Iron Mines to conduct an offshore, on-ice, geotechnical drilling investigation at the Milne Port Site. This investigation is scheduled for the period of mid to late March 2017. In order to mitigate risk relating to ice breakthrough, the investigation team reviewed ice strength evaluation completed for a similar offshore investigation at the Steensby site in 2011.

2. Allowable Ice Loading

2.1 Moving Loads

The 2011 evaluation of ice thickness utilized Gold's formula to calculate the allowable weight for a variable ice thickness. Gold's formula is based on literature that utilizes data collected from ice breakthroughs and forms an empirical relationship to predict the allowable bearing capacity of ice.

$$P = Ah^2$$

P = Allowable load in kilograms

A = Constant which depends on the quality of the ice, the geometry of the load and the factor of safety appropriate

h = Effective thickness of the ice in centimeters

Further literature review suggests using a value of 4 as a conservative estimate for freshwater ice. Government of Alberta and Northwest territories both recommend using a factor of 4.

It is noted that a factor of 4 is used for freshwater ice and does not account for the reduction of flexural strength in sea ice due to the presence of brine. A reduction factor of 0.65 is applied per Hatch project memo entitled, "On-Ice Platforms for Geotechnical Drilling at Steensby Island" (Document # H349000-HS-SWP-165).

Table 2-1: Maximum Allowable Load On Sea Ice

Ice Thickness (cm)	Load (kg)	Load (lb)		Ice Thickness (cm)	Load (kg)	Load (lb)
5	60	150		105	28,660	63,200
10	260	580		110	31,460	69,360
15	580	1,290		115	34,380	75,810
20	1,040	2,300		120	37,440	82,550
25	1,620	3,590		125	40,620	89,570
30	2,340	5,160		130	43,940	96,880
35	3,180	7,030		135	47,380	104,470
40	4,160	9,180		140	50,960	112,350
45	5,260	11,610		145	54,660	120,520
50	6,500	14,340		150	58,500	128,980
55	7,860	17,340		155	62,460	137,720
60	9,360	20,640		160	66,560	146,740
65	10,980	24,220		165	70,780	156,060
70	12,740	28,090		170	75,140	165,660
75	14,620	32,250		175	79,620	175,550
80	16,640	36,690		180	84,240	185,720
85	18,780	41,420		185	88,980	196,180
90	21,060	46,430		190	93,860	206,930
95	23,460	51,740		195	98,860	217,970
100	26,000	57,330		200	104,000	229,290

2.2 Static Loads

Gold's formula is adequate for calculating the allowable bearing capacity for moving loads on ice but it does not propose a relationship between allowable loads and ice thickness for static loads. To ensure ice safety for a static load operation, a literature review was completed. It was concluded that the deflection in ice must be monitored throughout the drilling operation and loading must be removed in case of excessive deflections. Ice cover should not exceed the freeboard elevation to ensure safety of the drilling crew.

3. Monitoring During Drilling Activities

A hole will be augured through ice within 5 m of the point of maximum load. The depth of water in the hole will be monitored throughout the duration of the drilling investigation at each borehole location. Drilling will be terminated if sea water is observed flowing through the top of the augured hole. Ref 3 provides further details regarding the bearing capacity of ice covers under static loads.

4. References

1. W, Gold. L. (n.d.). Field study on the load bearing capacity of ice covers. National Research Council Canada, 61(5), 3-7. Retrieved March 18, 2017, from <http://nparc.cisti-icist.nrc-cnrc.gc.ca/eng/view/object/?id=e7d278d9-808a-4959-b9f7-27320d757afd>
2. KINGERYW, . D., KCLICKD, . W., DYKINSJ., E. Sea ice engineering summary report- Project ICEWAY. U.S. Naval Civ. Eng. Lab.Port Hueneme, Calif., Tech. Rep. R-189.
3. Frederking, R. M. W., and L. W. Gold. "The Bearing Capacity of Ice Covers under Static Loads." Canadian Journal of Civil Engineering 3.2 (1976): 288-93. Web Accessed March 18, 2017.

UK:UK

Attachment(s)/Enclosure

Appendix F

ConeTec Report

PRESENTATION OF SITE INVESTIGATION RESULTS

Milne Port Expansion

Prepared for:

Baffinland Iron Mines Corporation

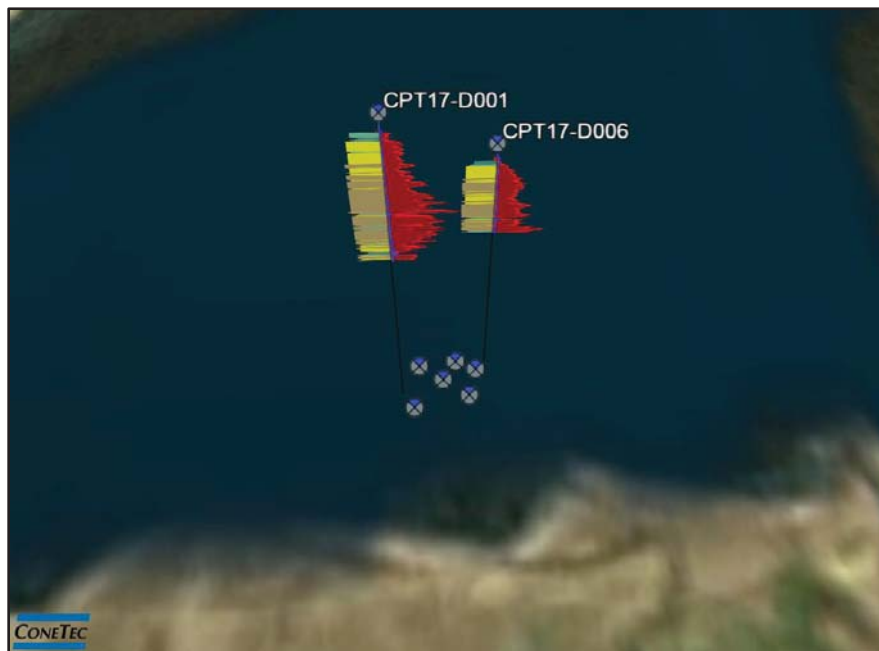
ConeTec Job No: 17-05010

Project Start Date: 22-Mar-2017

Project End Date: 09-Apr-2017

Report Date: 13-Apr-2017

Revised Date: 21-Apr-2017



Prepared by:

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www.conetecdataservices.com



Introduction

The enclosed report presents the results of the site investigation program conducted by ConeTec Investigations Ltd. for Baffinland Iron Mines Corporation at Milne Inlet, Baffin Island, Nunavut. The program consisted of six cone penetration tests (CPT) and two seismic cone penetration tests (SCPT) carried out under the direction of Hatch Ltd.

Project Information

Project	
Client	Baffinland Iron Mines Corporation
Project	Milne Port Expansion
ConeTec project number	17-05010

A map from Google earth including the CPT and SCPT test locations is presented below.



Rig Description	Deployment System	Test Type
Boart LS100	Portable	CPT, SCPT

Coordinates		
Test Type	Collection Method	EPSG Number
CPT, SCPT	ConeTec Trimble Survey (RTK)	26917

Cone Penetration Test (CPT)	
Depth reference	Depths are referenced to the existing mudline at the time of each test.
Tip and sleeve data offset	0.1 meter This has been accounted for in the CPT data files.
Additional plots	Advanced CPT plots with I_c , Φ , and $N1(60)$ and SCPT plots have been included.

Cone Penetrometers Used for this Project						
Cone Description	Cone Number	Cross Sectional Area (cm ²)	Sleeve Area (cm ²)	Tip Capacity (bar)	Sleeve Capacity (bar)	Pore Pressure Capacity (psi)
338:T1500F15U500	338	15	225	1500	15	500
374:T1500F15U500	374	15	225	1500	15	500
The CPT summary indicates which cone was used for each sounding.						

Interpretation Tables	
Additional information	<p>The Soil Behaviour Type (SBT) classification chart (Robertson et al., 1986 presented by Lunne, Robertson and Powell, 1997) was used to classify the soil for this project. A detailed set of calculated CPT parameters were generated and are provided in Excel format files in the release folder. The calculated CPT parameters are based on values of corrected tip (q_t), sleeve friction (f_s) and pore pressure (u_2).</p> <p>Soils were classified as either drained or undrained based on the Soil Behaviour Type (SBT) classification chart (Robertson et al., 1986 presented by Lunne, Robertson and Powell, 1997). Calculations for both drained and undrained parameters were included for materials that classified as silt (zone 6).</p>

Survey	
Tidal Fluctuations	As requested by Hatch Ltd., a survey grid was setup to monitor ice movement due to tidal fluctuation throughout the drill program. The grid was laid out around the proposed drilling area using six survey points in a 200m by 100m grid. ½ inch steel pins was installed at each point by drilling out a section of ice and freezing the rod in place. The pins were surveyed repeatedly throughout a 12-hour period to determine if the ebb and flow of the tide was moving the ice laterally. After installation they were then surveyed every couple of days.
Surveying Methodology	Due to the lack of compatibility with the onsite base station, a second base station broadcasting in the 450MHz band had to be setup to support the drill program surveying. An observed control point was surveyed in by the BIM

	surveyor onsite in datum NAD83 using an ellipsoid model. Our base station was permanently setup over the surveyed point with a vertical offset of 1.32m to the bottom of the R8 base. An existing control point, KM002, was surveyed for quality control. A second control point, PRJCNTRL, was surveyed in to allow for easy quality control when restarting the base station.
Depth Control	Significant tidal fluctuations between two and seven feet were observed on the ice throughout the drill program. Constant monitoring of the elevation of the ice was required while conducting the cone penetration tests (CPTs) to ensure the depth was correct throughout the sounding. At the beginning of the CPT, the Northing, Easting, and Elevation of the sounding was recorded along with a dip tape measurement to the sea floor. The dip tape measurement was subtracted from the ice elevation to get the sea floor elevation. Throughout the CPT, the elevation of ice was monitored and compared to the initial measurement to get an accurate depth at the end of every meter.
Ice Cracks and Survey Grid	There were large cracks in the ice near the drilling pad. They appeared to open and close as the tide went up and down. The Northing and Easting coordinates of the grid were surveyed using a continuous topo. The survey grid coordinates are not presented as part of this report.

Limitations

This report has been prepared for the exclusive use of Baffinland Iron Mines Corporation (Client) and Hatch Ltd. for the project titled “Milne Port Expansion”. The report’s contents may not be relied upon by any other party without the express written permission of ConeTec Investigations Ltd. (ConeTec). ConeTec has provided site investigation services, prepared the factual data reporting, and provided geotechnical parameter calculations consistent with current best practices. No other warranty, expressed or implied, is made.

The information presented in the report document and the accompanying data set pertain to the specific project, site conditions and objectives described to ConeTec by the Client and Hatch Ltd. In order to properly understand the factual data, assumptions and calculations, reference must be made to the documents provided and their accompanying data sets, in their entirety.

The cone penetration tests (CPTu) are conducted using an integrated electronic piezocone penetrometer and data acquisition system manufactured by Adara Systems Ltd. of Richmond, British Columbia, Canada.

ConeTec's piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and a geophone sensor for recording seismic signals. All signals are amplified down hole within the cone body and the analog signals are sent to the surface through a shielded cable.

ConeTec penetrometers are manufactured with various tip, friction and pore pressure capacities in both 10 cm² and 15 cm² tip base area configurations in order to maximize signal resolution for various soil conditions. The specific piezocone used for each test is described in the CPT summary table presented in the first Appendix. The 15 cm² penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 10 cm² piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross sectional area (typically 44 mm diameter over a length of 32 mm with tapered leading and trailing edges) located at a distance of 585 mm above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a 60 degree apex angle.

All ConeTec piezocones can record pore pressure at various locations. Unless otherwise noted, the pore pressure filter is located directly behind the cone tip in the "u₂" position (ASTM Type 2). The filter is 6 mm thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current ASTM D5778 standard. ConeTec's calibration criteria also meets or exceeds those of the current ASTM D5778 standard. An illustration of the piezocone penetrometer is presented in Figure CPTu.

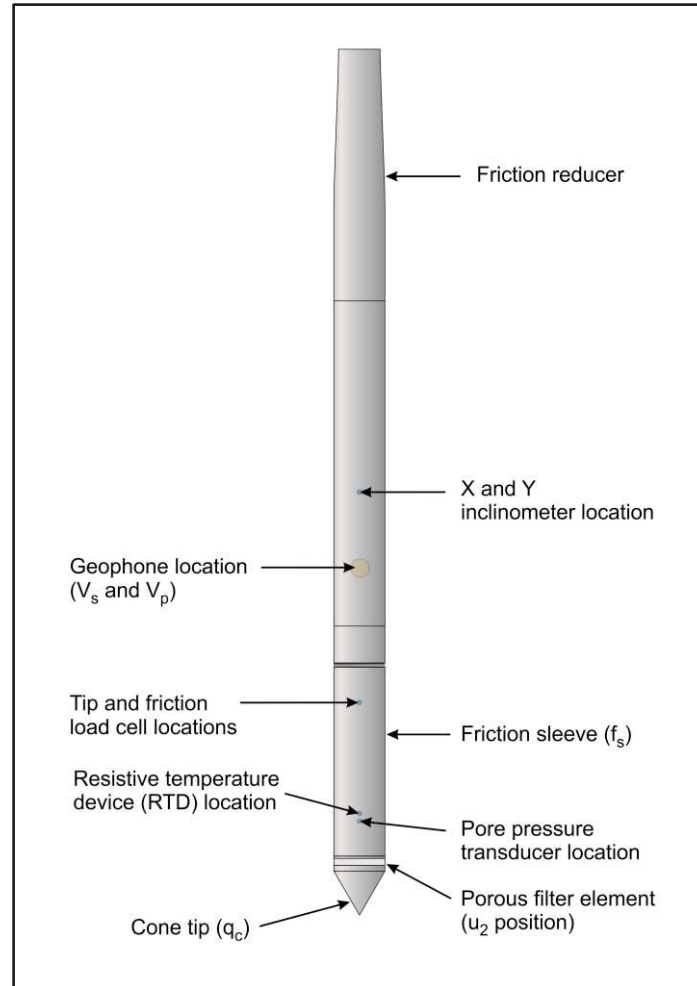


Figure CPTu. Piezocone Penetrometer (15 cm²)

The ConeTec data acquisition systems consist of a Windows based computer and a signal conditioner and power supply interface box with a 16 bit (or greater) analog to digital (A/D) converter. The data is recorded at fixed depth increments using a depth wheel attached to the push cylinders or by using a spring loaded rubber depth wheel that is held against the cone rods. The typical recording intervals are either 2.5 cm or 5.0 cm depending on project requirements; custom recording intervals are possible. The system displays the CPTu data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected tip resistance (q_c)
- Sleeve friction (f_s)
- Dynamic pore pressure (u)
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

All testing is performed in accordance to ConeTec's CPT operating procedures which are in general accordance with the current ASTM D5778 standard.

Prior to the start of a CPTu sounding a suitable cone is selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with either glycerine or silicone oil and the baseline readings are recorded with the cone hanging freely in a vertical position.

The CPTu is conducted at a steady rate of 2 cm/s, within acceptable tolerances. Typically one meter length rods with an outer diameter of 1.5 inches are added to advance the cone to the sounding termination depth. After cone retraction final baselines are recorded.

Additional information pertaining to ConeTec's cone penetration testing procedures:

- Each filter is saturated in silicone oil or glycerine under vacuum pressure prior to use
- Recorded baselines are checked with an independent multi-meter
- Baseline readings are compared to previous readings
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs, excessive inclination occurs, equipment damage is likely to take place, or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with ASTM standards

The interpretation of piezocone data for this report is based on the corrected tip resistance (q_t), sleeve friction (f_s) and pore water pressure (u). The interpretation of soil type is based on the correlations developed by Robertson (1990) and Robertson (2009). It should be noted that it is not always possible to accurately identify a soil type based on these parameters. In these situations, experience, judgment and an assessment of other parameters may be used to infer soil behaviour type.

The recorded tip resistance (q_c) is the total force acting on the piezocone tip divided by its base area. The tip resistance is corrected for pore pressure effects and termed corrected tip resistance (q_t) according to the following expression presented in Robertson et al, 1986:

$$q_t = q_c + (1-a) \cdot u_2$$

where: q_t is the corrected tip resistance

q_c is the recorded tip resistance

u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)

a is the Net Area Ratio for the piezocone (0.8 for ConeTec probes)

The sleeve friction (f_s) is the frictional force on the sleeve divided by its surface area. As all ConeTec piezocones have equal end area friction sleeves, pore pressure corrections to the sleeve data are not required.

The dynamic pore pressure (u) is a measure of the pore pressures generated during cone penetration. To record equilibrium pore pressure, the penetration must be stopped to allow the dynamic pore pressures to stabilize. The rate at which this occurs is predominantly a function of the permeability of the soil and the diameter of the cone.

The friction ratio (R_f) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high

friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

A summary of the CPTu soundings along with test details and individual plots are provided in the appendices. A set of interpretation files were generated for each sounding based on published correlations and are provided in Excel format in the data release folder. Information regarding the interpretation methods used is also included in the data release folder.

For additional information on CPTu interpretations, refer to Robertson et al. (1986), Lunne et al. (1997), Robertson (2009), Mayne (2013, 2014) and Mayne and Peuchen (2012).

Shear wave velocity testing is performed in conjunction with the piezocone penetration test (SCPTu) in order to collect interval velocities. For some projects seismic compression wave (V_p) velocity is also determined.

ConeTec's piezocone penetrometers are manufactured with a horizontally active geophone (28 hertz) that is rigidly mounted in the body of the cone penetrometer, 0.2 meters behind the cone tip.

Shear waves are typically generated by using an impact hammer horizontally striking a beam that is held in place by a normal load. In some instances an auger source or an imbedded impulsive source maybe used for both shear waves and compression waves. The hammer and beam act as a contact trigger that triggers the recording of the seismic wave traces. For impulsive devices an accelerometer trigger may be used. The traces are recorded using an up-hole integrated digital oscilloscope which is part of the SCPTu data acquisition system. An illustration of the shear wave testing configuration is presented in Figure SCPTu-1.

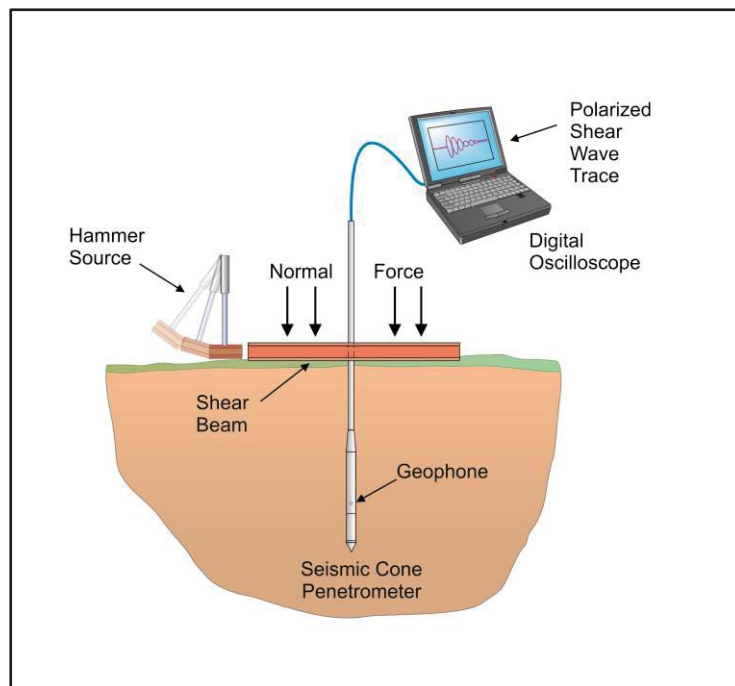


Figure SCPTu-1. Illustration of the SCPTu system

All testing is performed in accordance to ConeTec's SCPTu operating procedures.

Prior to the start of a SCPTu sounding, the procedures described in the Cone Penetration Test section are followed. In addition, the active axis of the geophone is aligned parallel to the beam (or source) and the horizontal offset between the cone and the source is measured and recorded.

Prior to recording seismic waves at each test depth, cone penetration is stopped and the rods are decoupled from the rig to avoid transmission of rig energy down the rods. Multiple wave traces are recorded for quality control purposes. After reviewing wave traces for consistency the cone is pushed to the next test depth (typically one meter intervals or as requested by the client). Figure SCPTu-2 presents an illustration of a SCPTu test.

For additional information on seismic cone penetration testing refer to Robertson et.al. (1986).

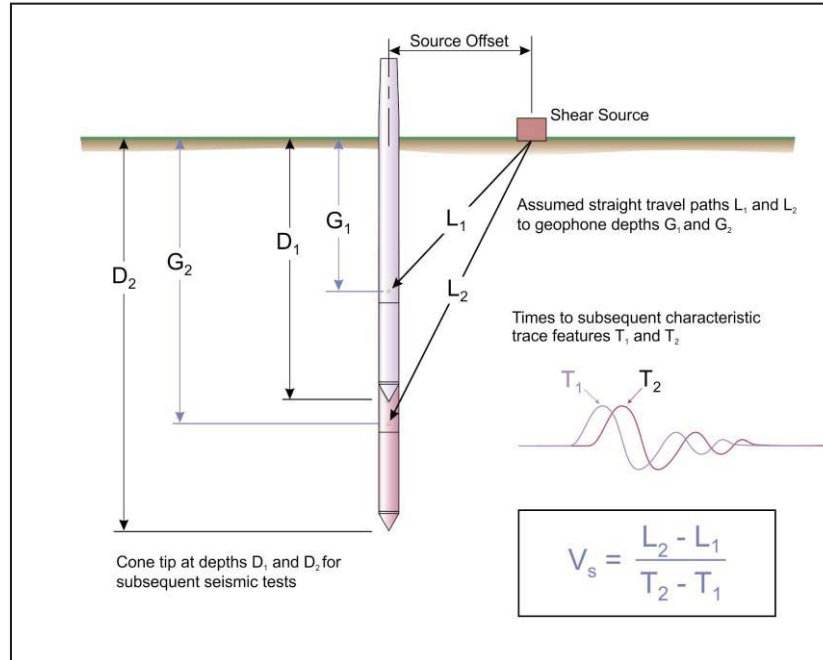


Figure SCPTu-2. Illustration of a seismic cone penetration test

Calculation of the interval velocities are performed by visually picking a common feature (e.g. the first characteristic peak, trough, or crossover) on all of the recorded wave sets and taking the difference in ray path divided by the time difference between subsequent features. Ray path is defined as the straight line distance from the seismic source to the geophone, accounting for beam offset, source depth and geophone offset from the cone tip.

The average shear wave velocity to a depth of 30 meters (V_{s30}) has been calculated and provided for all applicable soundings using an equation presented in Crow et al., 2012.

$$V_{s30} = \frac{\text{total thickness of all layers (30m)}}{\sum(\text{layer traveltimes})}$$

The layer travel times refers to the travel times propagating in the vertical direction, not the measured travel times from an offset source.

Tabular results and SCPTu plots are presented in the relevant appendix.

The cone penetration test is halted at specific depths to carry out pore pressure dissipation (PPD) tests, shown in Figure PPD-1. For each dissipation test the cone and rods are decoupled from the rig and the data acquisition system measures and records the variation of the pore pressure (u) with time (t).

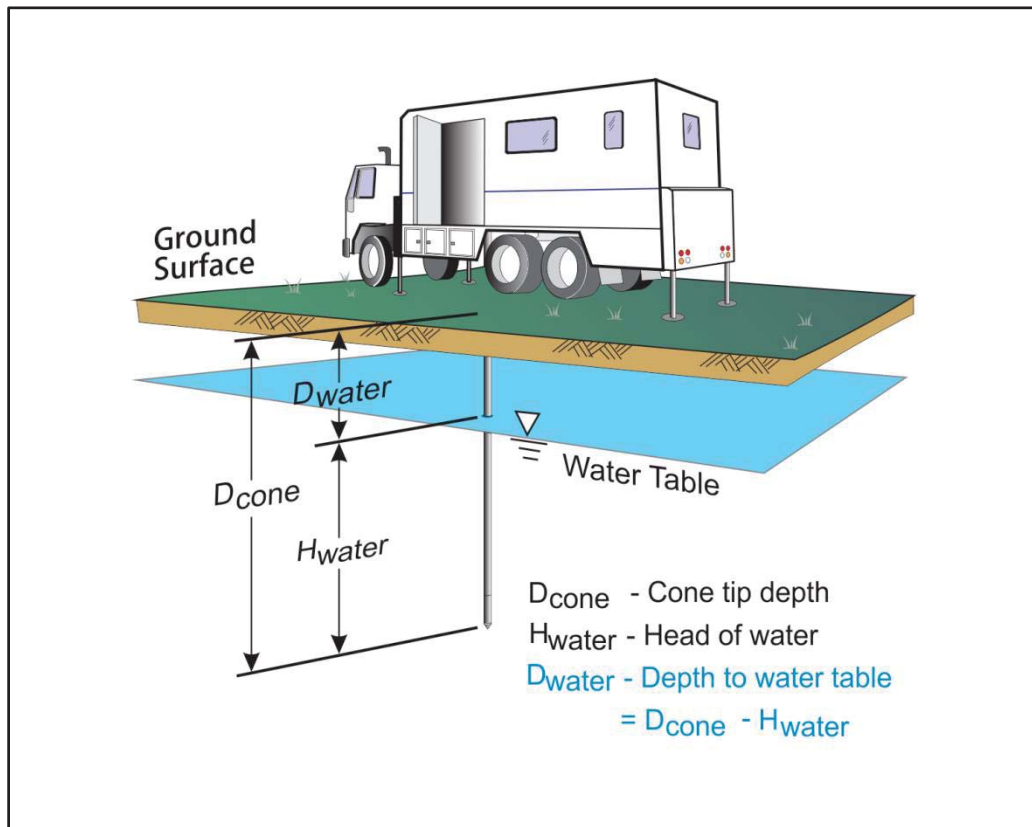


Figure PPD-1. Pore pressure dissipation test setup

Pore pressure dissipation data can be interpreted to provide estimates of ground water conditions, permeability, consolidation characteristics and soil behaviour.

The typical shapes of dissipation curves shown in Figure PPD-2 are very useful in assessing soil type, drainage, in situ pore pressure and soil properties. A flat curve that stabilizes quickly is typical of a freely draining sand. Undrained soils such as clays will typically show positive excess pore pressure and have long dissipation times. Dilative soils will often exhibit dynamic pore pressures below equilibrium that then rise over time. Overconsolidated fine-grained soils will often exhibit an initial dilatory response where there is an initial rise in pore pressure before reaching a peak and dissipating.

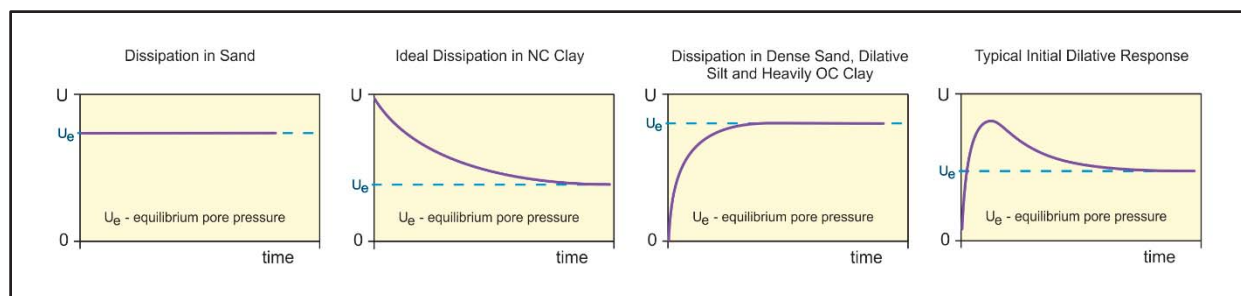


Figure PPD-2. Pore pressure dissipation curve examples

In order to interpret the equilibrium pore pressure (u_{eq}) and the apparent phreatic surface, the pore pressure should be monitored until such time as there is no variation in pore pressure with time as shown for each curve of Figure PPD-2.

In fine grained deposits the point at which 100% of the excess pore pressure has dissipated is known as t_{100} . In some cases this can take an excessive amount of time and it may be impractical to take the dissipation to t_{100} . A theoretical analysis of pore pressure dissipations by Teh and Houlsby (1991) showed that a single curve relating degree of dissipation versus theoretical time factor (T^*) may be used to calculate the coefficient of consolidation (c_h) at various degrees of dissipation resulting in the expression for c_h shown below.

$$c_h = \frac{T^* \cdot a^2 \cdot \sqrt{I_r}}{t}$$

Where:

- T^* is the dimensionless time factor (Table Time Factor)
- a is the radius of the cone
- I_r is the rigidity index
- t is the time at the degree of consolidation

Table Time Factor. T^* versus degree of dissipation (Teh and Houlsby, 1991)

Degree of Dissipation (%)	20	30	40	50	60	70	80
$T^* (u_2)$	0.038	0.078	0.142	0.245	0.439	0.804	1.60

The coefficient of consolidation is typically analyzed using the time (t_{50}) corresponding to a degree of dissipation of 50% (u_{50}). In order to determine t_{50} , dissipation tests must be taken to a pressure less than u_{50} . The u_{50} value is half way between the initial maximum pore pressure and the equilibrium pore pressure value, known as u_{100} . To estimate u_{50} , both the initial maximum pore pressure and u_{100} must be known or estimated. Other degrees of dissipations may be considered, particularly for extremely long dissipations.

At any specific degree of dissipation the equilibrium pore pressure (u at t_{100}) must be estimated at the depth of interest. The equilibrium value may be determined from one or more sources such as measuring the value directly (u_{100}), estimating it from other dissipations in the same profile, estimating the phreatic surface and assuming hydrostatic conditions, from nearby soundings, from client provided information, from site observations and/or past experience, or from other site instrumentation.

For calculations of c_h (Teh and Houlsby, 1991), t_{50} values are estimated from the corresponding pore pressure dissipation curve and a rigidity index (I_r) is assumed. For curves having an initial dilatory response in which an initial rise in pore pressure occurs before reaching a peak, the relative time from the peak value is used in determining t_{50} . In cases where the time to peak is excessive, t_{50} values are not calculated.

Due to possible inherent uncertainties in estimating I_r , the equilibrium pore pressure and the effect of an initial dilatory response on calculating t_{50} , other methods should be applied to confirm the results for c_h .

Additional published methods for estimating the coefficient of consolidation from a piezocone test are described in Burns and Mayne (1998, 2002), Jones and Van Zyl (1981), Robertson et al. (1992) and Sully et al. (1999).

A summary of the pore pressure dissipation tests and dissipation plots are presented in the relevant appendix.

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REFERENCES

Teh, C.I., and Houlsby, G.T., 1991, "An analytical study of the cone penetration test in clay", *Geotechnique*, 41(1): 17-34.

The following appendices listed below are included in the report:

- Cone Penetration Test Summary and Standard Cone Penetration Test Plots
- Advanced Cone Penetration Test Plots with I_c , Φ , and $N1(60)$
- Seismic Cone Penetration Test Tabular Results
- Seismic Cone Penetration Test Plots
- Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots

Cone Penetration Test Summary and Standard Cone Penetration Test Plots



Job No: 17-05010
Client: Baffinland Iron Mines Corporation
Project: Milne Port Expansion
Start Date: 03-Apr-2017
End Date: 07-Apr-2017

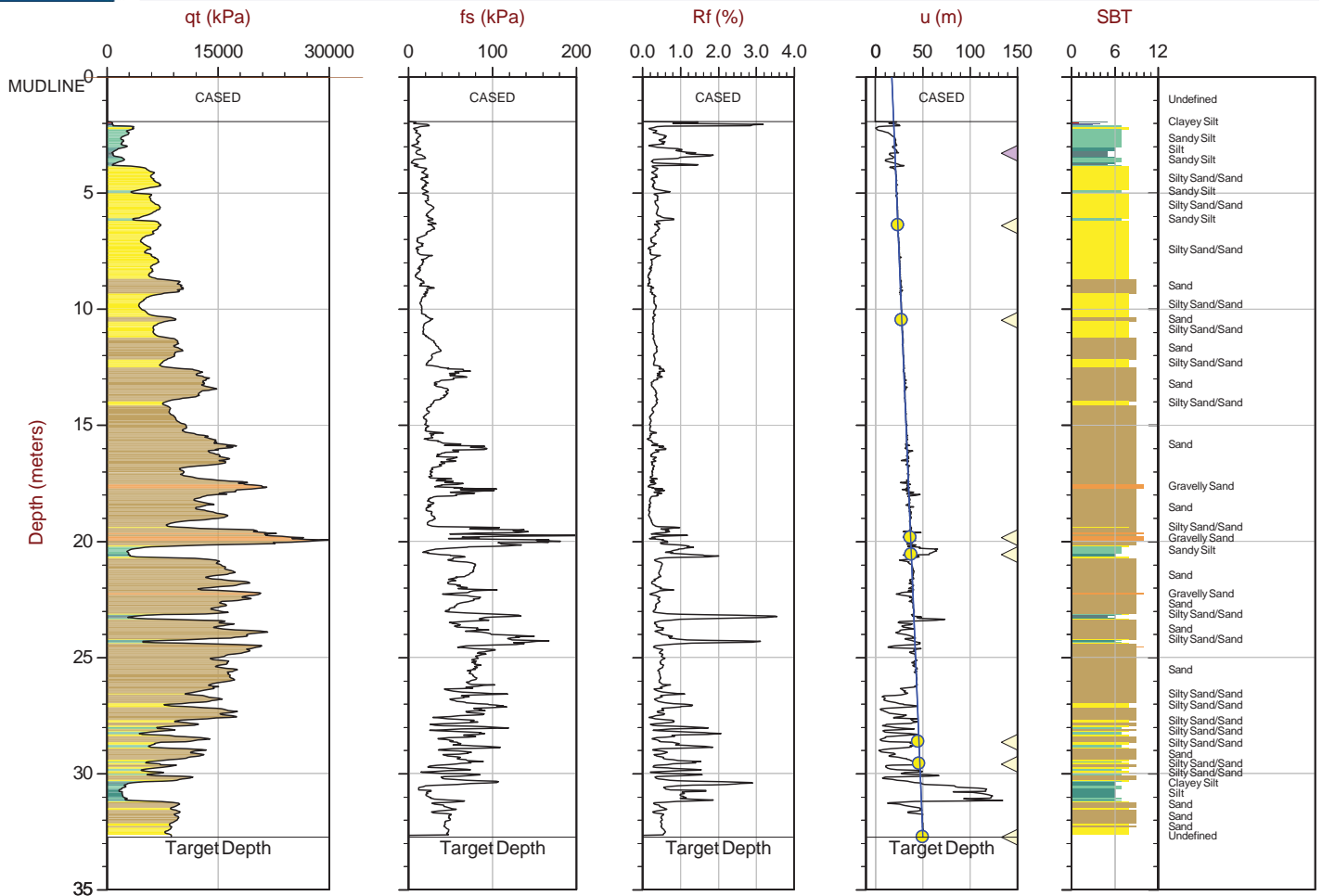
CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Assumed Phreatic Surface ¹ (m)	Final Depth ² (m)	Northing ³ (m)	Easting (m)	Elevation (m)	Refer to Notation Number
CPT17-D001	17-05010_CPD001	05-Apr-2017	338:T1500F15U500	-17.6	32.750	7976717.62	503607.38	-16.97	
SCPT17-D002	17-05010_SPD002	05-Apr-2017	338:T1500F15U500	-16.9	39.475	7976728.05	503705.30	-16.12	
CPT17-D003	17-05010_CPD003	06-Apr-2017	338:T1500F15U500	-23.2	30.425	7976757.71	503785.39	-22.68	
SCPT17-D004	17-05010_SPD004	04-Apr-2017	338:T1500F15U500	-27.3	32.050	7976768.10	503646.44	-26.59	
CPT17-D005	17-05010_CPD005	03-Apr-2017	338:T1500F15U500	-26.0	25.125	7976780.84	503736.09	-24.98	
CPT17-D006	17-05010_CPD006	06-Apr-2017	374:T1500F15U500	-32.0	20.575	7976808.43	503807.55	-31.32	
CPT17-D007	17-05010_CPD007	07-Apr-2017	374:T1500F15U501	-4.7	30.200	7976683.63	503767.46	-4.23	
CPT17-D008	17-05010_CPD008	07-Apr-2017	374:T1500F15U502	-1.4	30.000	7976650.76	503635.99	-1.80	

1. The assumed phreatic surface was based on pore pressure dissipation tests. Hydrostatic conditions were assumed for the interpretation tables.

2. Depth is referenced from the mudline at the time of testing.

3. Coordinates and elevations were acquired using ConeTec Trimble Survey in datum NAD 83 / UTM Zone 17 North. Elevation is of the mudline at the time of testing.



Max Depth: 32.750 m / 107.45 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
● Equilibrium Pore Pressure (Ueq)

File: 17-05010_CPD001.COR
Unit Wt: SBT (R&C1986)

SBT: [Robertson and Campanella, 1986](#)
Coords: [UTM17N](#)N:7976717.62mE:503607.38m Elev:-16.97m

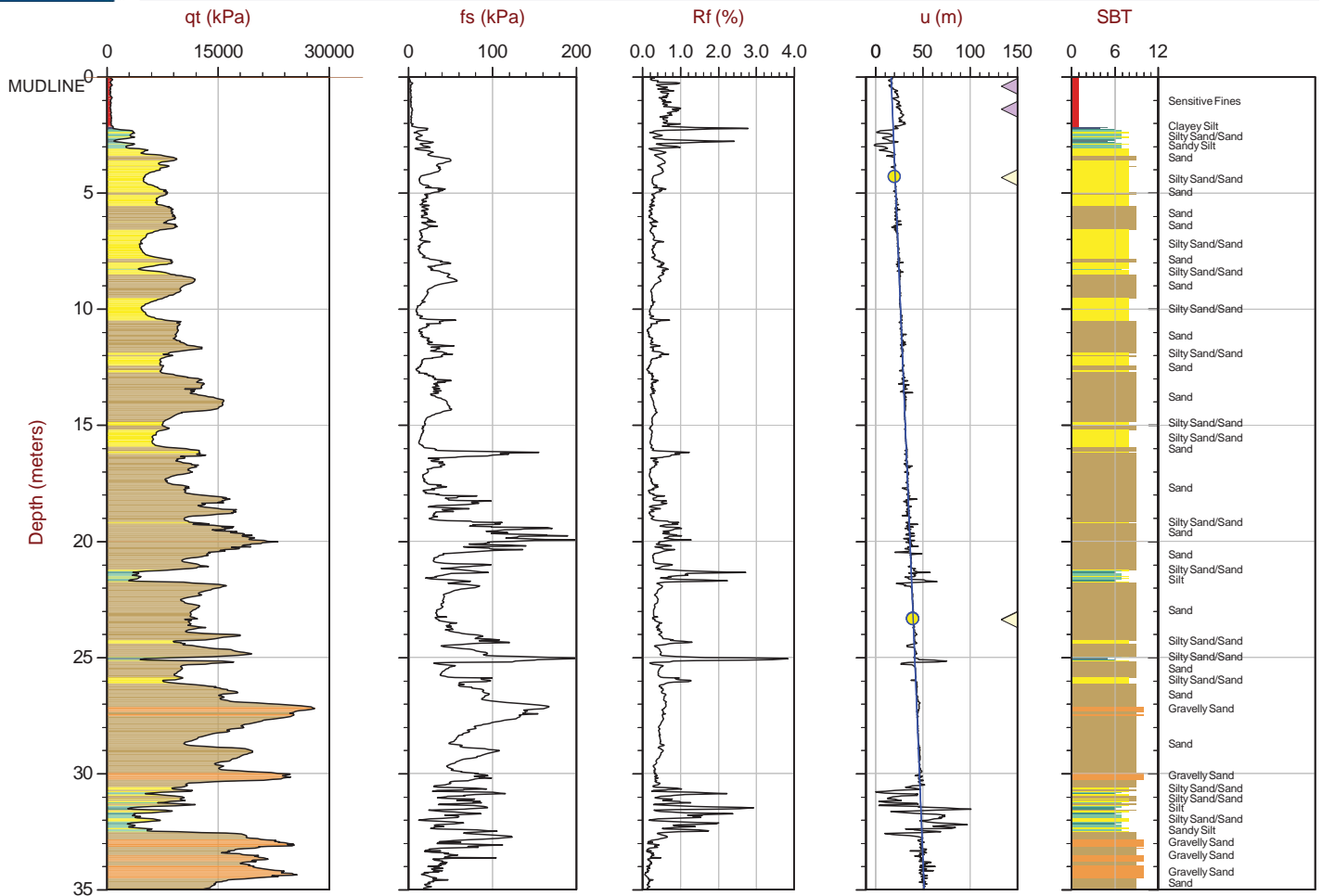
 Dissipation, U_{eq} not achieved
 Dissipation, U_{eq} achieved
 Hydrostatic Line



Baffinland

Job No: 17-05010
Date: 2017-04-05 20:44
Site: Milne Port Expansion

Sounding: SCPT17-D002
Cone: 338:T1500F15U500



MaxDepth: 39.475 m / 129.51 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
● Equilibrium Pore Pressure (Ueq)

File: 17-05010_SPD002.COR
Unit Wt: SBT (R&C1986)

SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976728.05m E: 503705.30m Elev: -16.12m

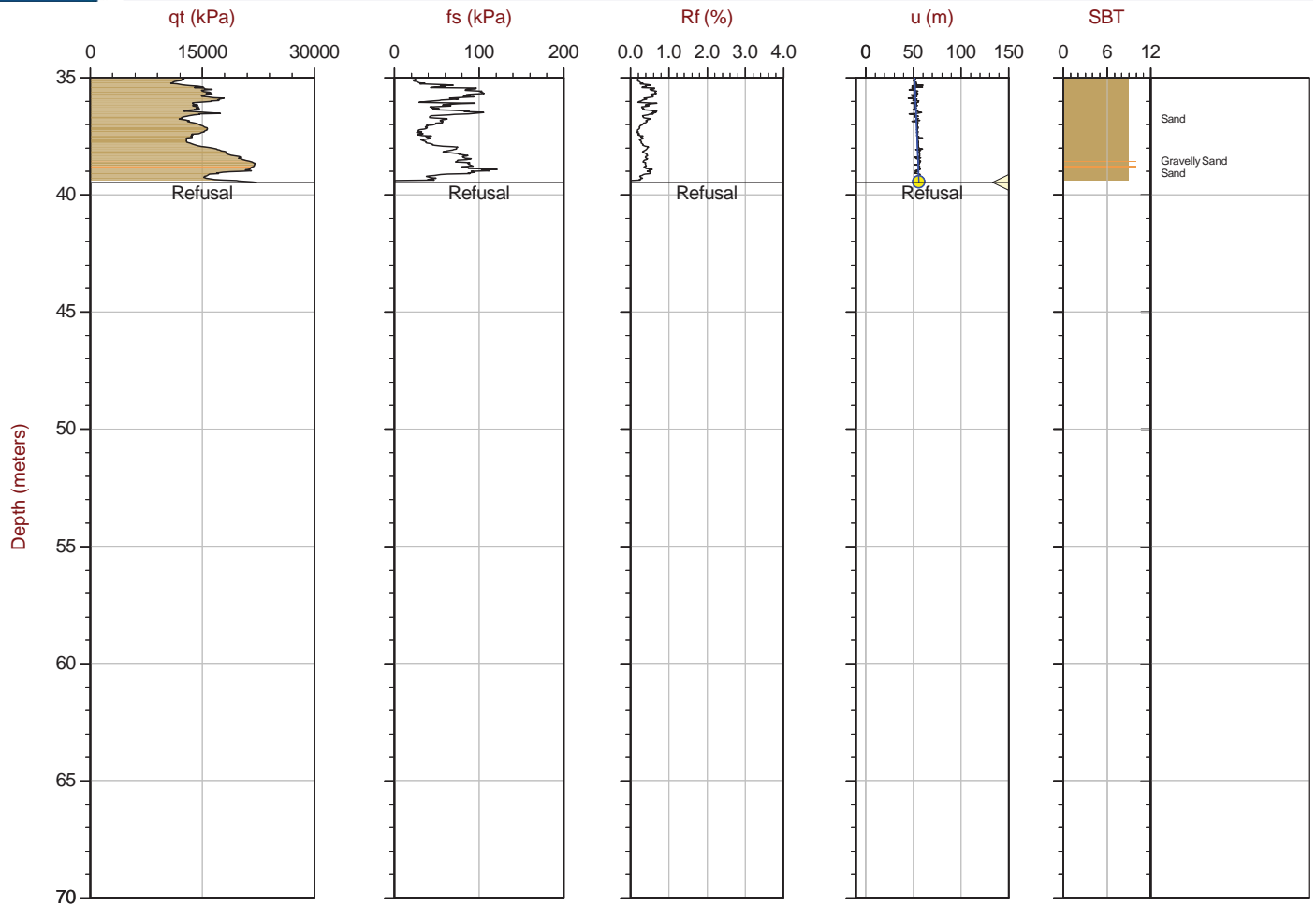
△ Dissipation, Ueq not achieved △ Dissipation, Ueq achieved — Hydrostatic Line



Baffinland

Job No: 17-05010
Date: 2017-04-05 20:44
Site: Milne Port Expansion

Sounding: SCPT17-D002
Cone: 338:T1500F15U500



MaxDepth: 39.475 m / 129.51 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
● Equilibrium Pore Pressure (Ueq)

File: 17-05010_SPD002.COR
Unit Wt: SBT (R&C1986)

SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976728.05m E: 503705.30m Elev: -16.12m

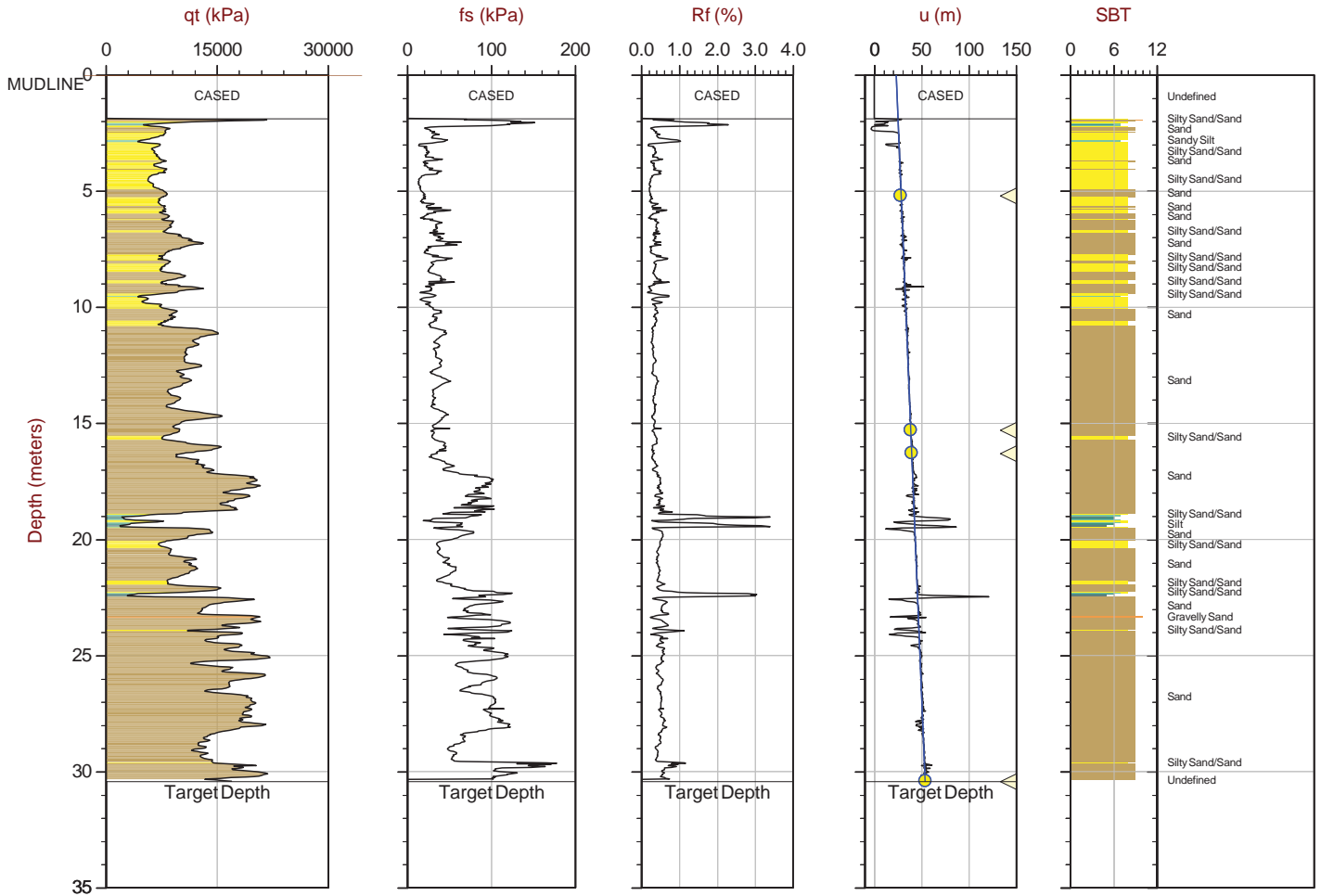
◀ Dissipation, Ueq not achieved ▶ Dissipation, Ueq achieved — Hydrostatic Line



Baffinland

Job No: 17-05010
Date: 2017-04-06 13:34
Site: Milne Port Expansion

Sounding: CPT17-D003
Cone: 338:T1500F15U500

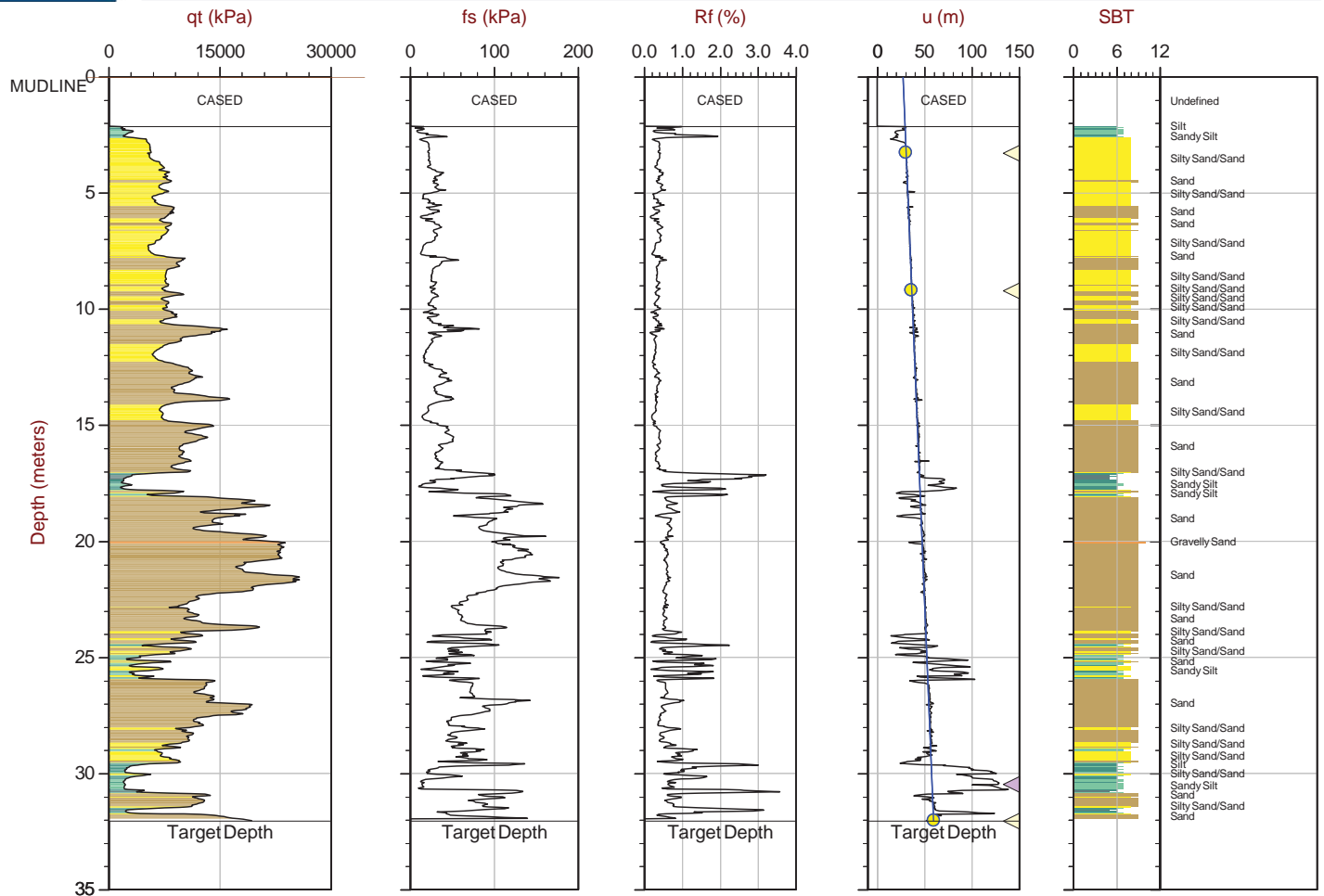


MaxDepth: 30.425 m / 99.82 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
● Equilibrium Pore Pressure (Ueq)

File: 17-05010_CPD003.COR
Unit Wt: SBT (R&C1986)

SBT: Robertson and Campanella, 1986
Coords: UTM17N: 797675.71m E: 503785.39m Elev: -22.68m

◀ Dissipation, Ueq not achieved ▶ Dissipation, Ueq achieved — Hydrostatic Line



Max Depth: 32.050 m / 105.15 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
● Equilibrium Pore Pressure (Ueq)

File: 17-05010_SPD004.COR
Unit Wt: SBT (R&C1986)

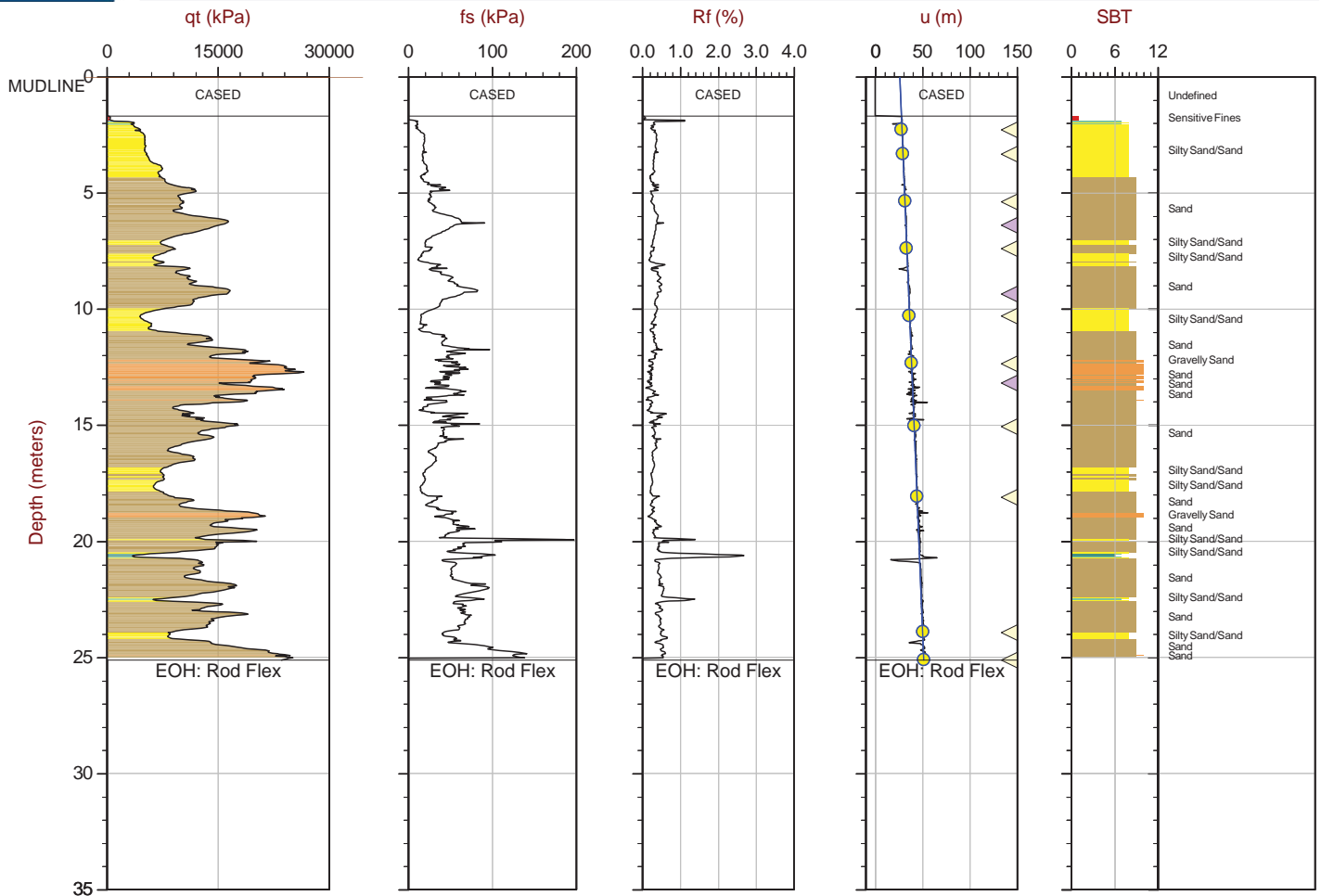
SBT: [Robertson and Campanella, 1986](#)
 Coords: [UTM17N](#)N:7976768.10mE:503646.44m Elev:-26.59m

- Equilibrium Pore Pressure (U_{eq})

◀ Dissipation, U_{eq} not achieved

◀ Dissipation, U_{eq} achieved

— Hydrostatic Line

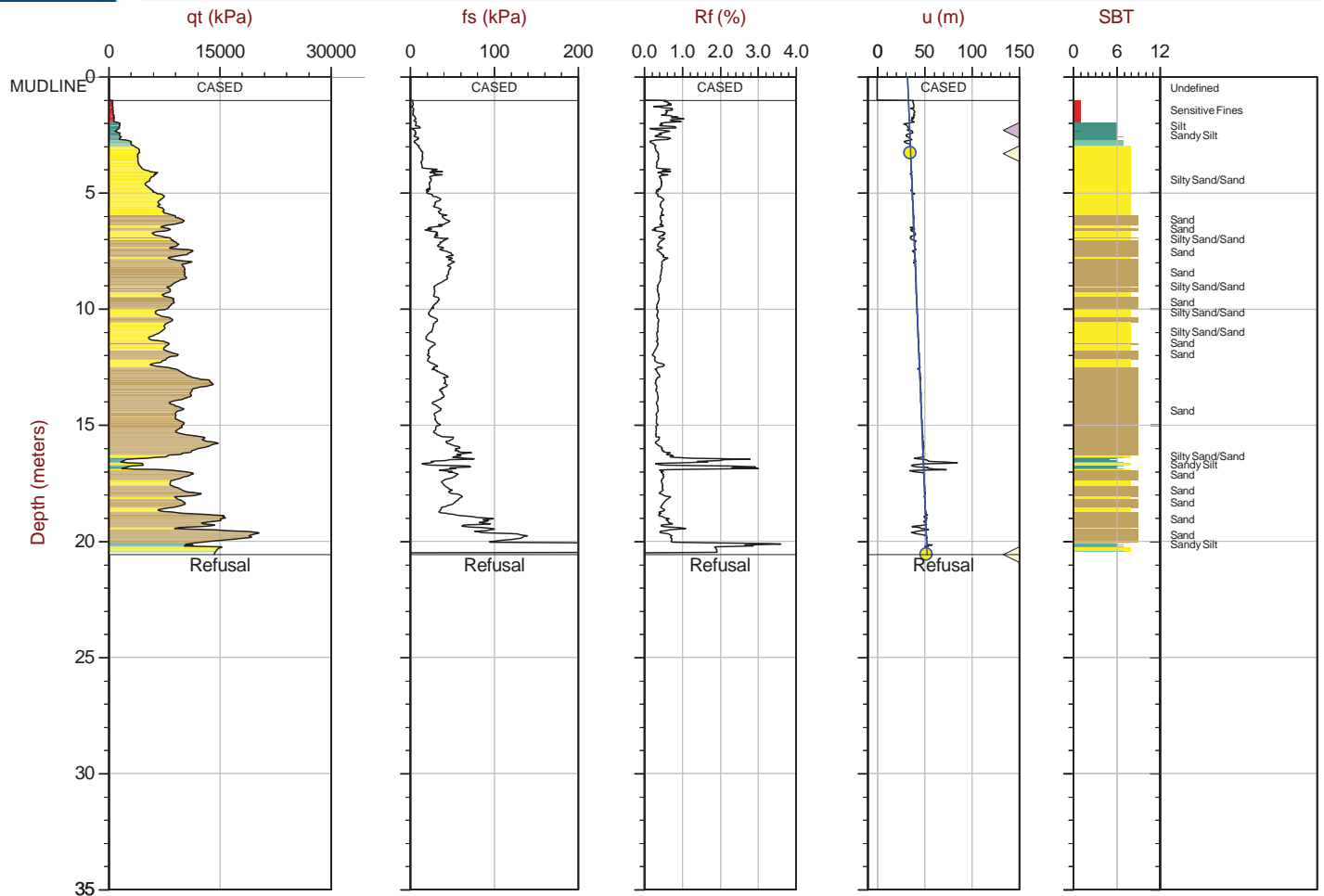


Max Depth: 25.125 m / 82.43 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
● Equilibrium Pore Pressure (Ueq)

File: 17-05010_CPD005.COR
Unit Wt: SBT (R&C1986)

SBT: [Robertson and Campanella, 1986](#)
 Coords: [UTM17N](#):7976780.84m [E](#):503736.09m Elev: -24.98m

 Dissipation, U_{eq} not achieved
 Dissipation, U_{eq} achieved
 Hydrostatic Line



Max Depth: 20.575 m / 67.50 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
● Equilibrium Pore Pressure (Ueq)

File: 17-05010_CPD006.COR
Unit Wt: SBT (R&C1986)

SBT: [Robertson and Campanella, 1986](#)
 Coords: [UTM17N N:7976808.43m E:503807.55m Elev:-31.32m](#)

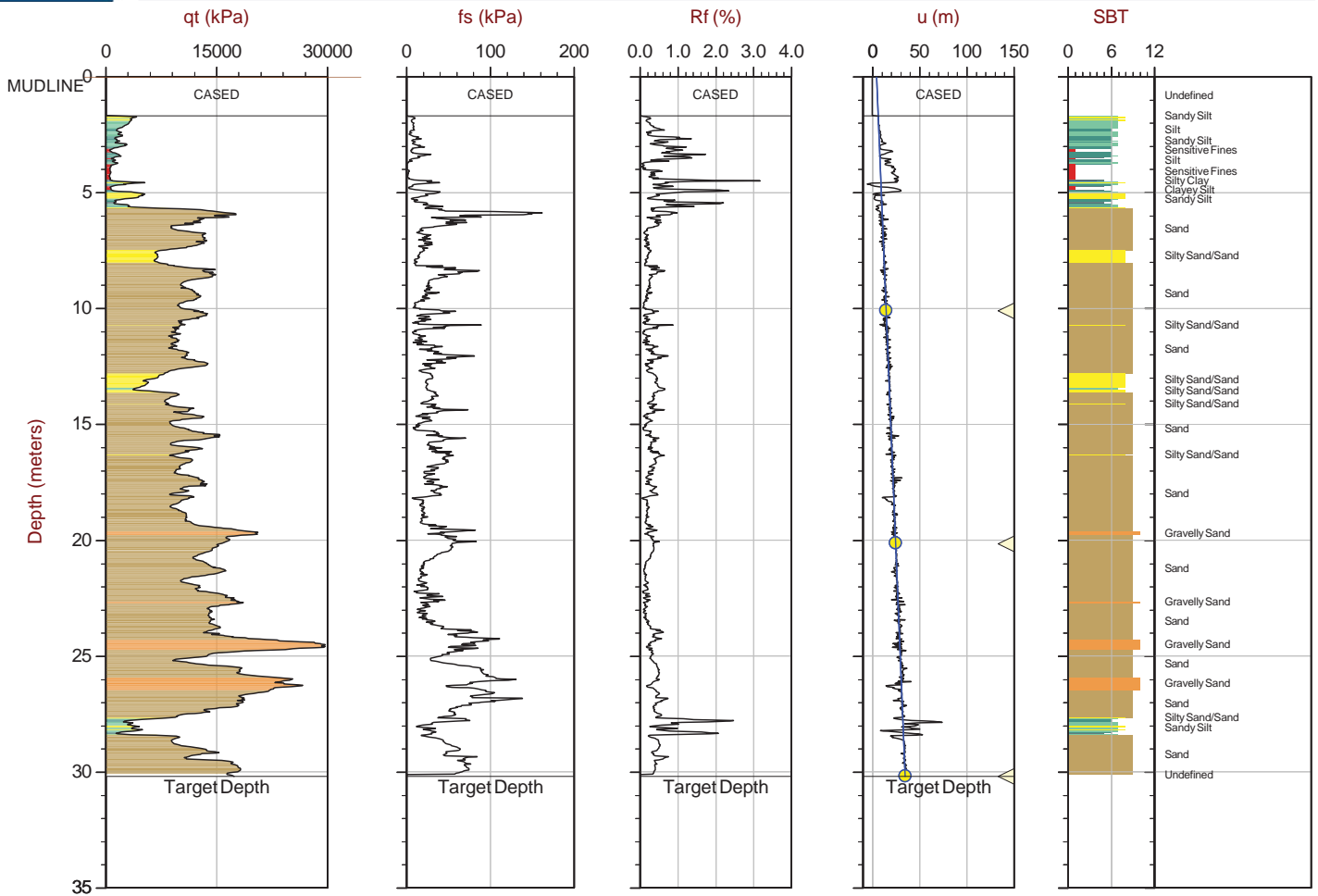
 Dissipation, U_{eq} not achieved
 Dissipation, U_{eq} achieved
 Hydrostatic Line



Baffinland

Job No: 17-05010
Date: 2017-04-07 11:27
Site: Milne Port Expansion

Sounding: CPT17-D007
Cone: 374:T1500F15U500



MaxDepth: 30.200 m / 99.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
● Equilibrium Pore Pressure (Ueq)

File: 17-05010_CPD007.COR
Unit Wt: SBT (R&C1986)

◀ Dissipation, Ueq not achieved

◀ Dissipation, Ueq achieved

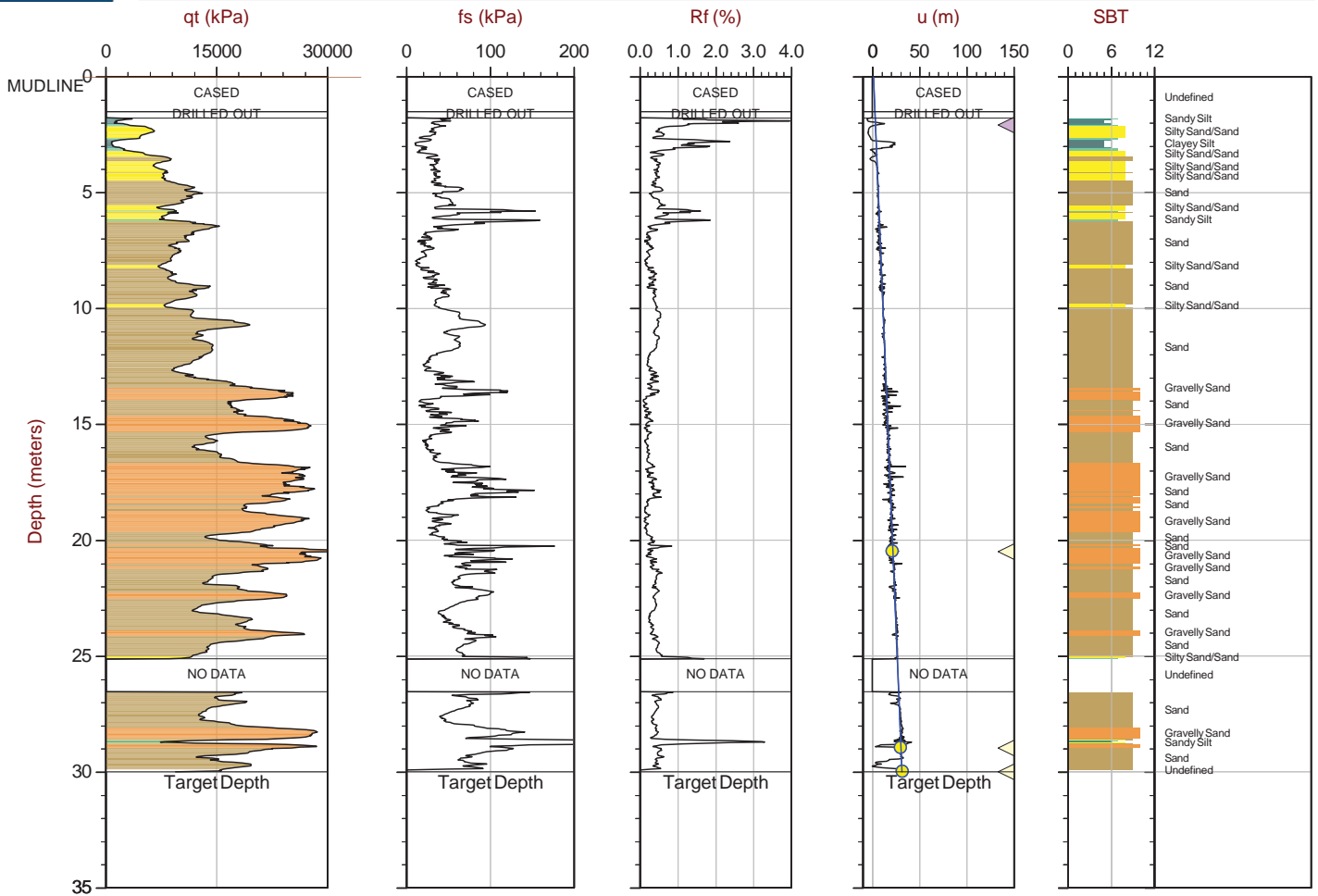
— Hydrostatic Line



Baffinland

Job No: 17-05010
Date: 2017-04-07 16:47
Site: Milne Port Expansion

Sounding: CPT17-D008
Cone: 374:T1500F15U500



MaxDepth: 30.000 m / 98.42 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
● Equilibrium Pore Pressure (Ueq)

File: 17-05010_CPD008.COR
Unit Wt: SBT (R&C1986)

SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976650.76m E: 503635.99m Elev: -1.80m

◀ Dissipation, Ueq not achieved ▶ Dissipation, Ueq achieved — Hydrostatic Line

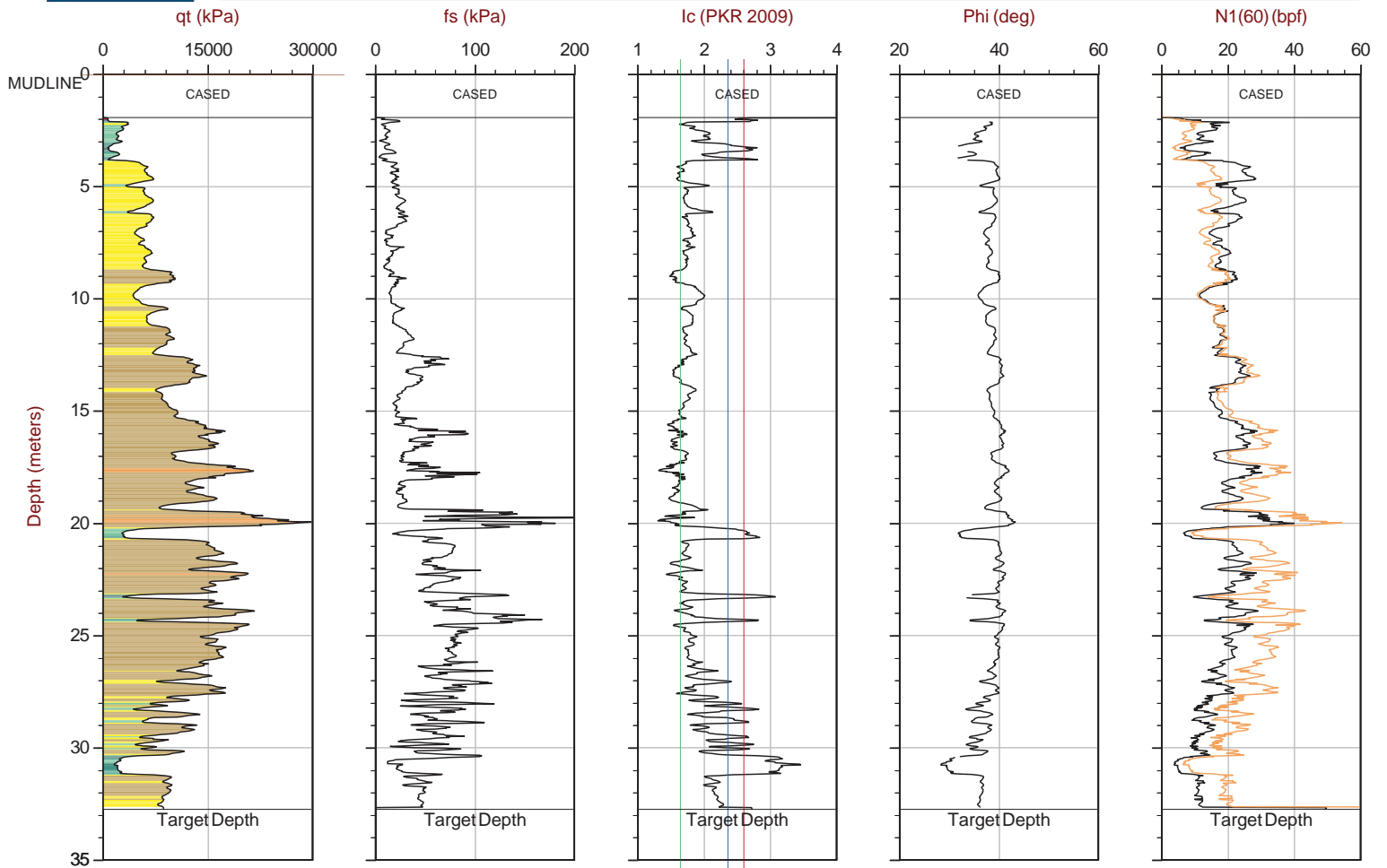
Advanced Cone Penetration Test Plots with I_c , Φ , and $N_{1(60)}$



Baffinland

Job No: 17-05010
Date: 2017-04-05 09:17
Site: Milne Port Expansion

Sounding: CPT17-D001
Cone: 338:T1500F15U500



MaxDepth: 32.750 m / 107.45 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
— N(60) (bpf)

File: 17-05010_CPD001.COR
Unit Wt: SBT (R&C1986)

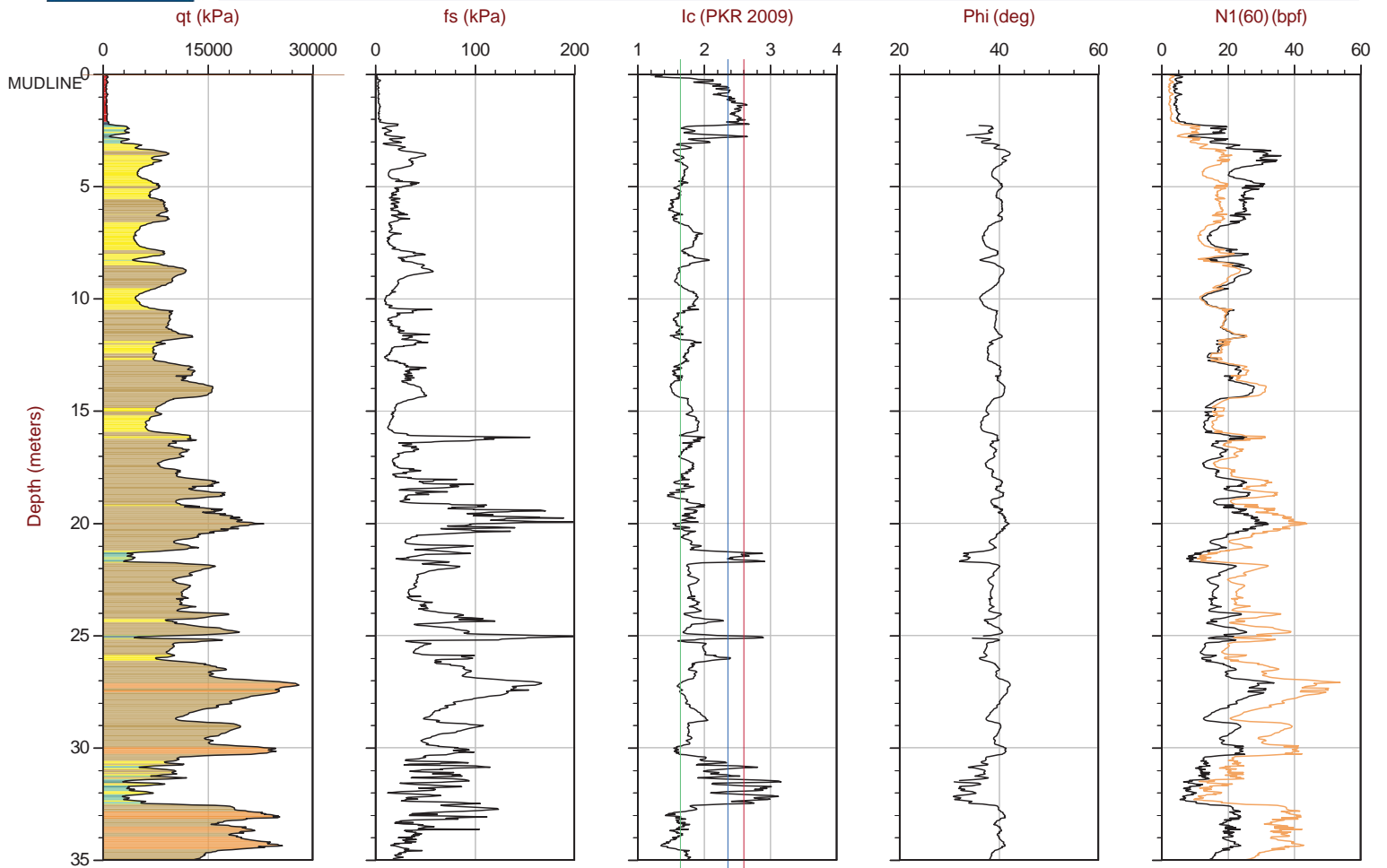
SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976717.62m E: 503607.38m Elev: -16.97m



Baffinland

Job No: 17-05010
Date: 2017-04-05 20:44
Site: Milne Port Expansion

Sounding: SCPT17-D002
Cone: 338:T1500F15U500



MaxDepth: 39.475 m / 129.51 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
— N(60) (bpf)

File: 17-05010_SPD002.COR
Unit Wt: SBT (R&C1986)

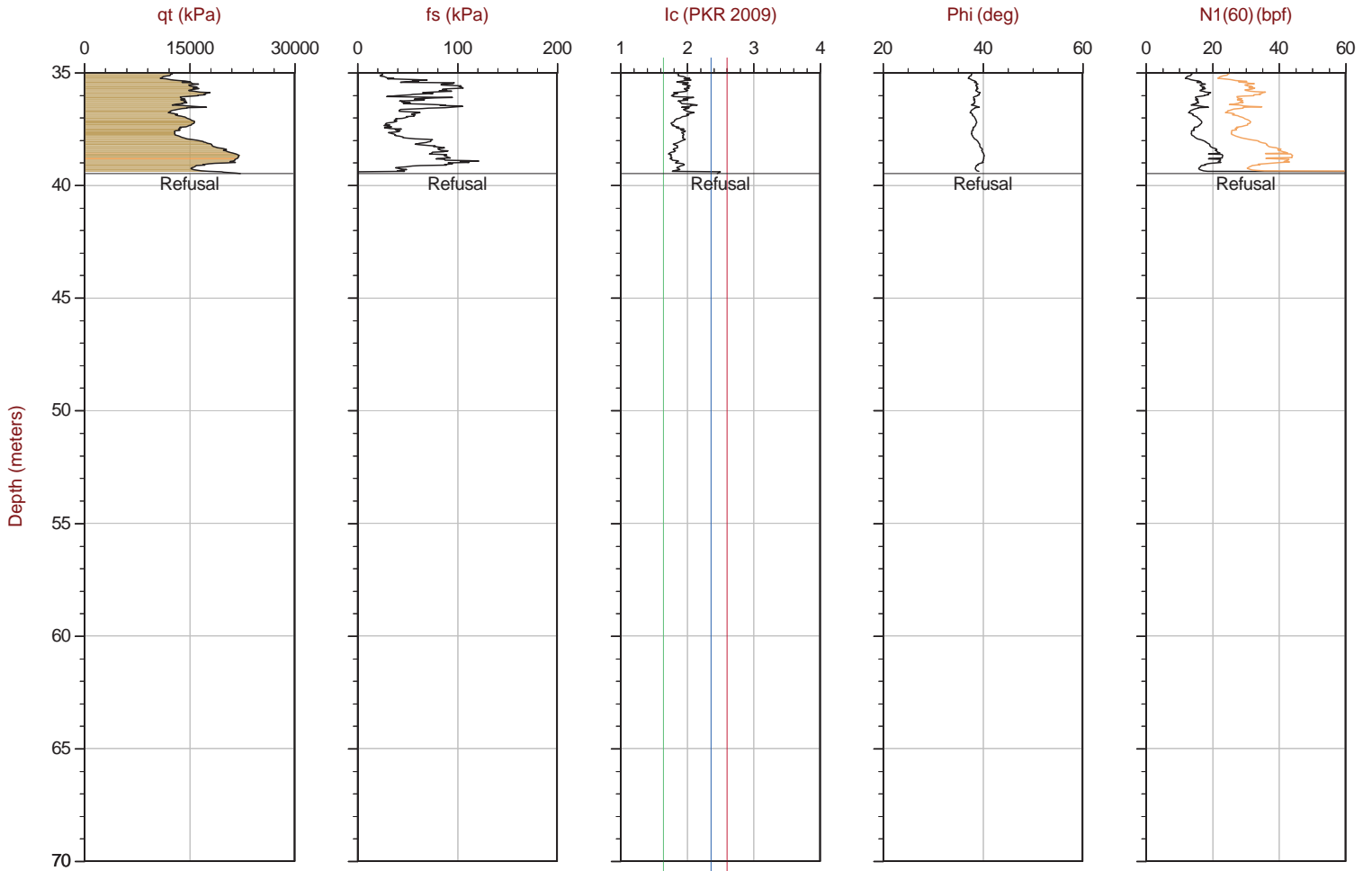
SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976728.05m E: 503705.30m Elev: -16.12m



Baffinland

Job No: 17-05010
Date: 2017-04-05 20:44
Site: Milne Port Expansion

Sounding: SCPT17-D002
Cone: 338:T1500F15U500



MaxDepth: 39.475 m / 129.51 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
— N(60) (bpf)

File: 17-05010_SPD002.COR
Unit Wt: SBT (R&C1986)

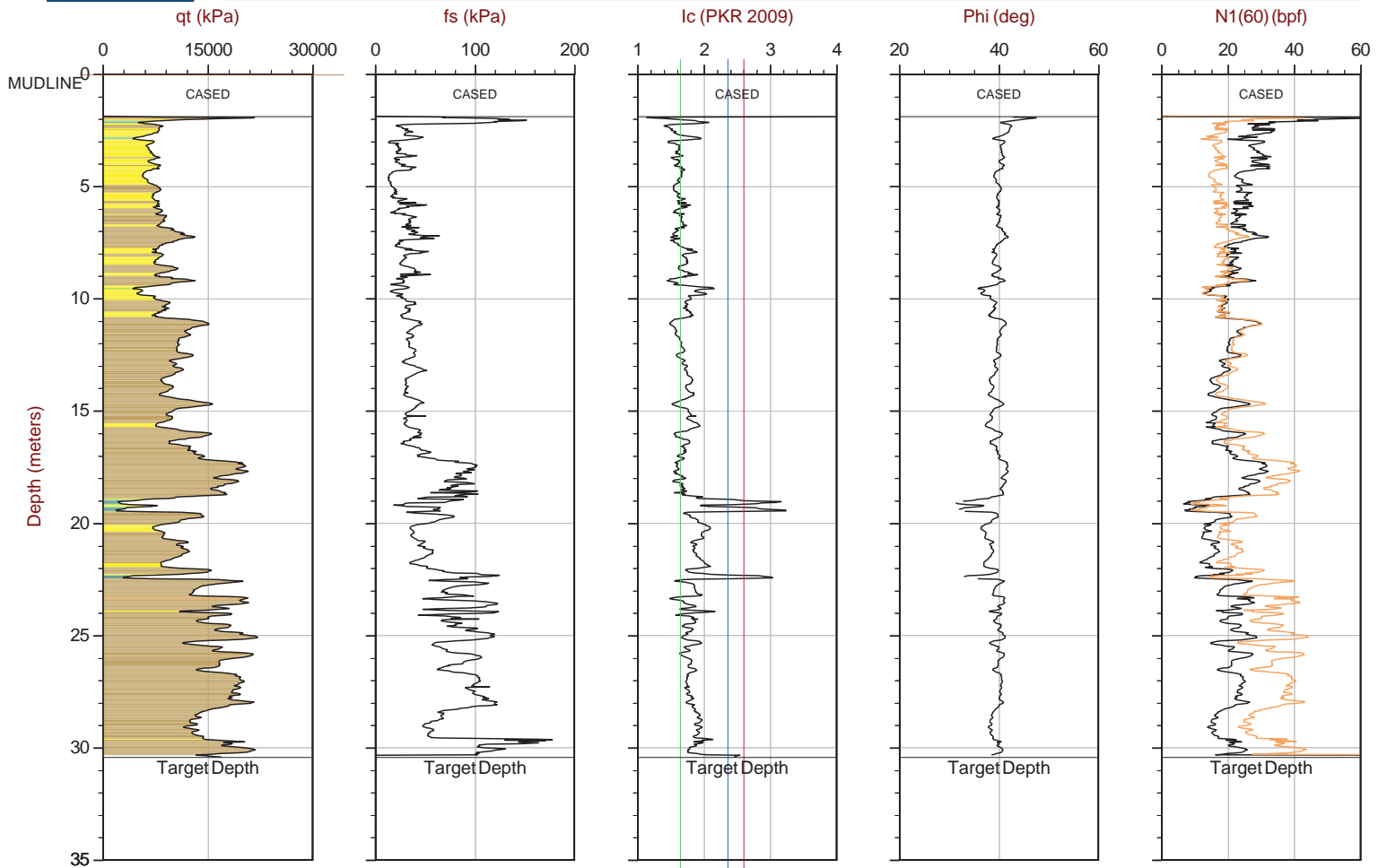
SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976728.05m E: 503705.30m Elev: -16.12m



Baffinland

Job No: 17-05010
Date: 2017-04-06 13:34
Site: Milne Port Expansion

Sounding: CPT17-D003
Cone: 338:T1500F15U500



MaxDepth: 30.425 m / 99.82 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
— N(60) (bpf)

File: 17-05010_CPD003.COR
Unit Wt: SBT (R&C1986)

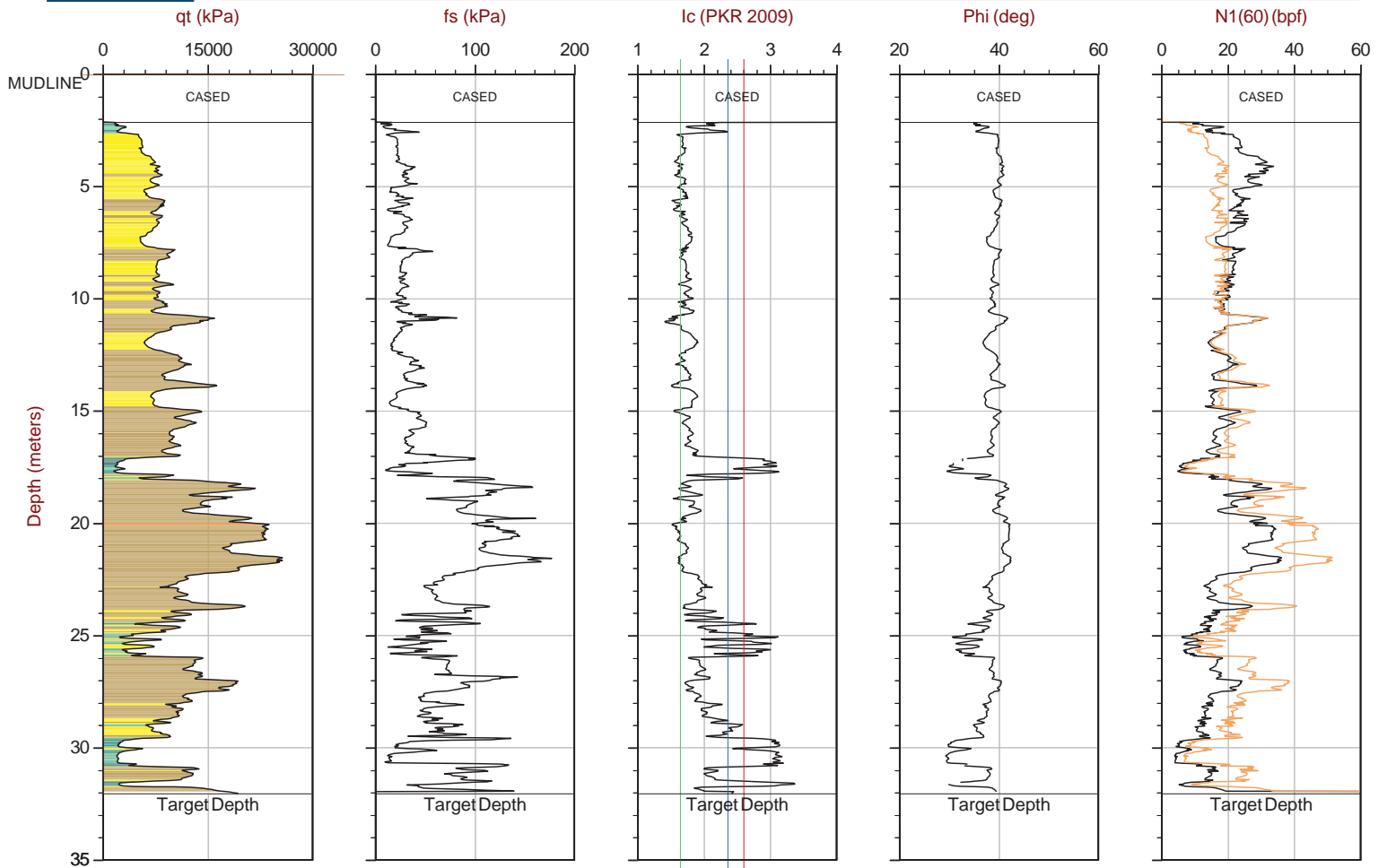
SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976757.71m E: 503785.39m Elev: -22.68m



Baffinland

Job No: 17-05010
Date: 2017-04-04 16:44
Site: Milne Port Expansion

Sounding: SCPT17-D004
Cone: 338:T1500F15U500



MaxDepth: 32.050 m / 105.15 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
— N(60) (bpf)

File: 17-05010_SPD004.COR
Unit Wt: SBT (R&C1986)

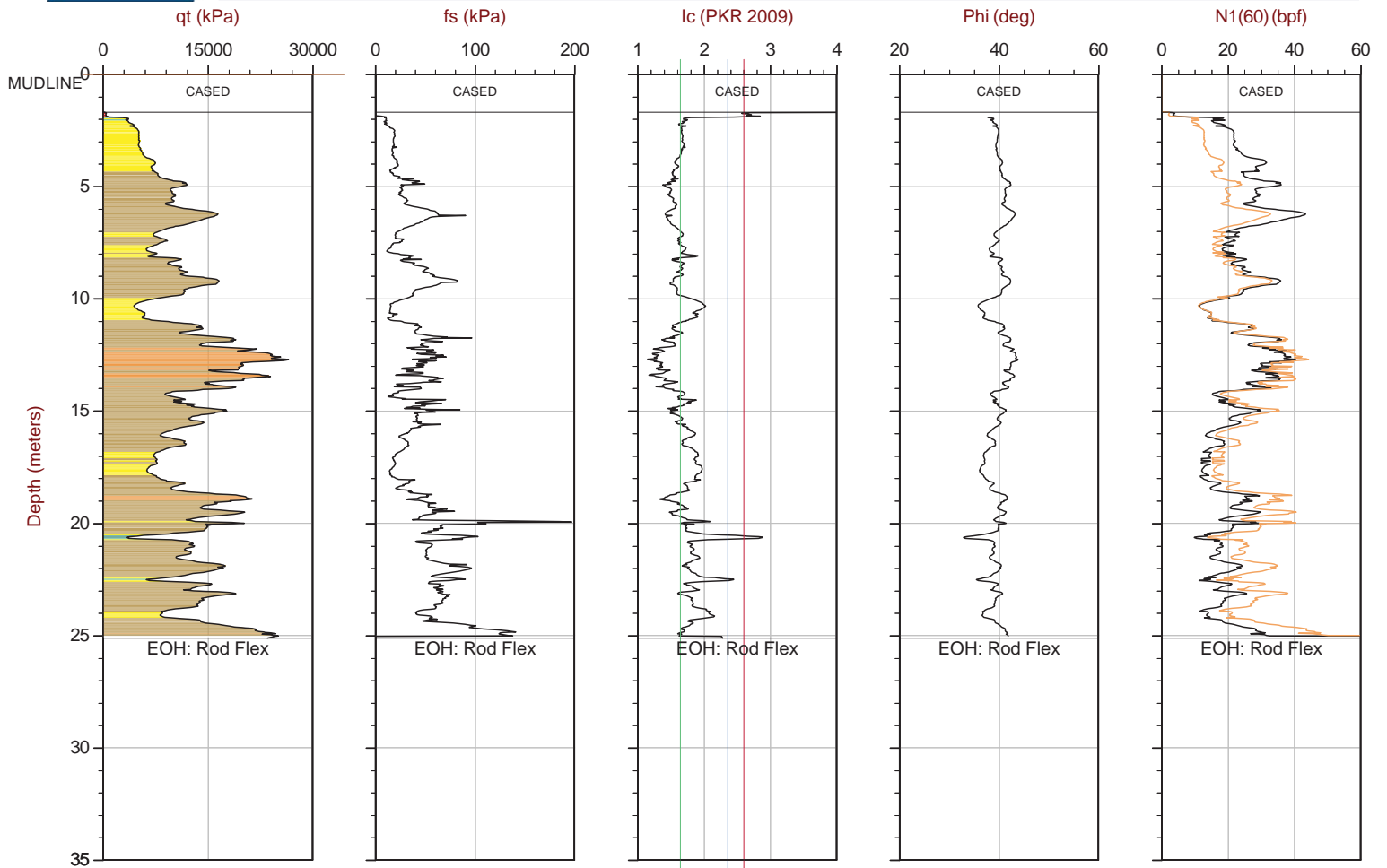
SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976768.10m E: 503646.44m Elev: -26.59m



Baffinland

Job No: 17-05010
Date: 2017-04-03 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500



MaxDepth: 25.125 m / 82.43 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
— N(60) (bpf)

File: 17-05010_CPD005.COR
Unit Wt: SBT (R&C1986)

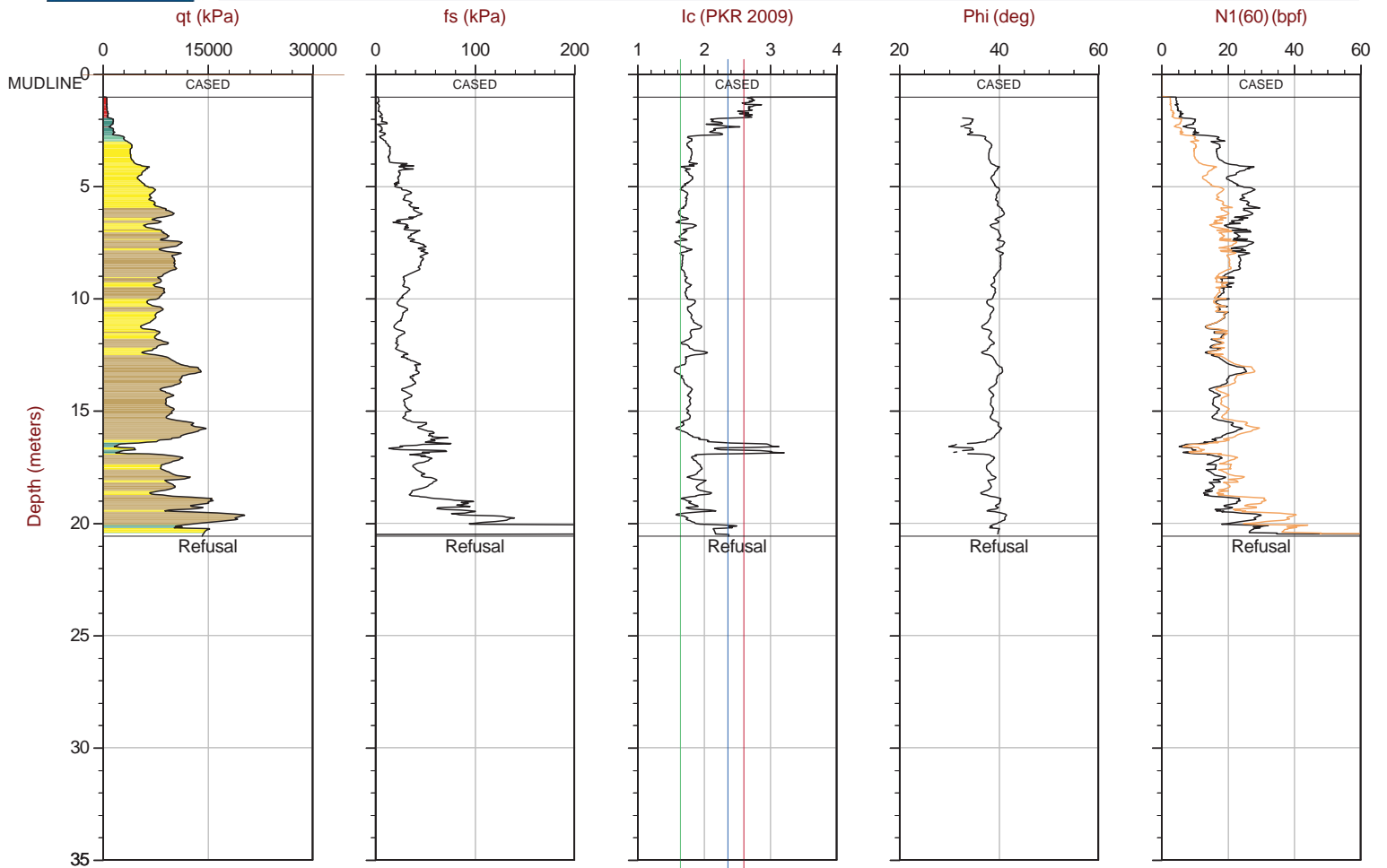
SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976780.84m E: 503736.09m Elev: -24.98m



Baffinland

Job No: 17-05010
Date: 2017-04-06 23:59
Site: Milne Port Expansion

Sounding: CPT17-D006
Cone: 374:T1500F15U500



MaxDepth: 20.575 m / 67.50 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
— N(60) (bpf)

File: 17-05010_CPD006.COR
Unit Wt: SBT (R&C1986)

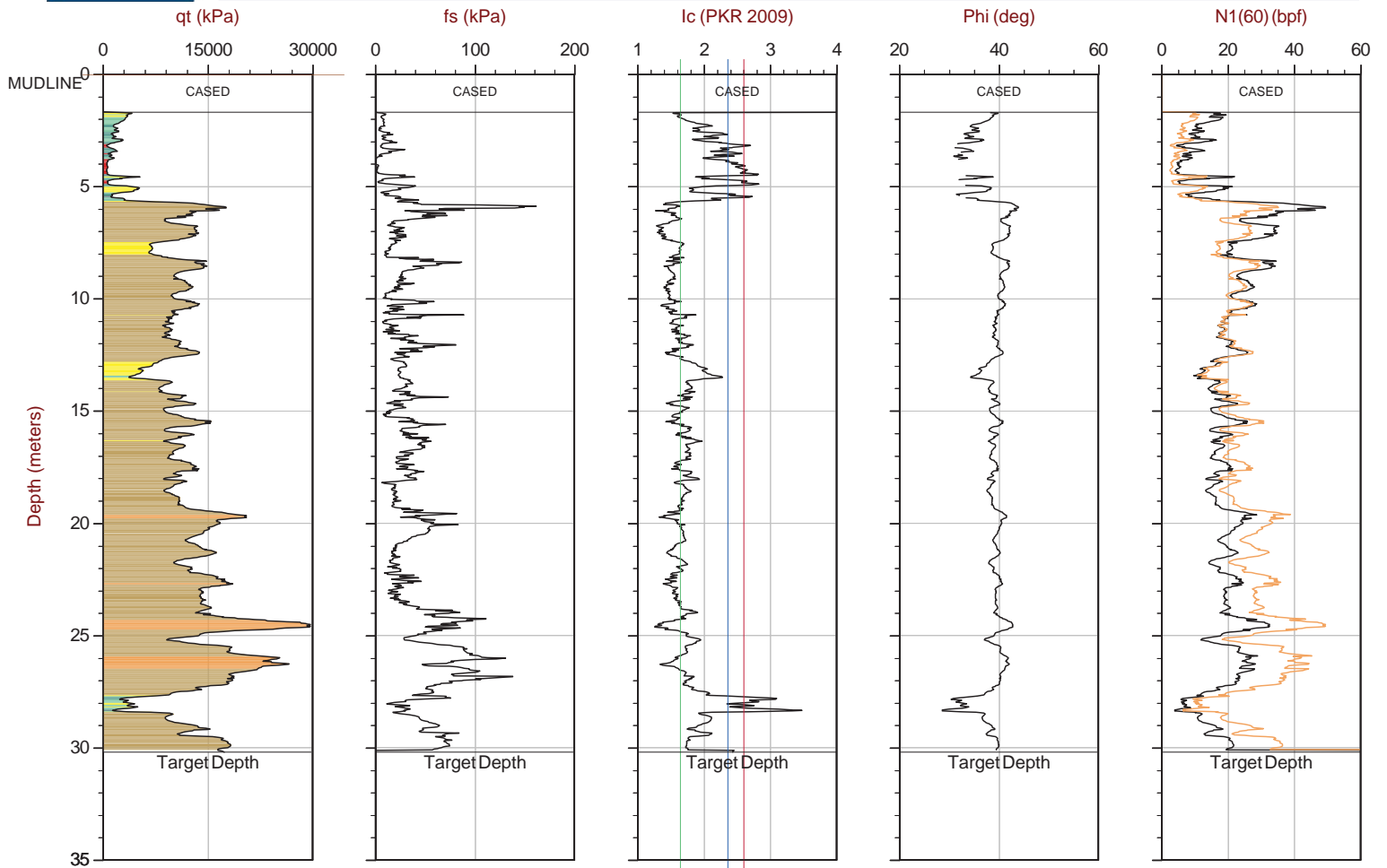
SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976808.43m E: 503807.55m Elev: -31.32m



Baffinland

Job No: 17-05010
Date: 2017-04-07 11:27
Site: Milne Port Expansion

Sounding: CPT17-D007
Cone: 374:T1500F15U500



MaxDepth: 30.200 m / 99.08 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
— N(60) (bpf)

File: 17-05010_CPD007.COR
Unit Wt: SBT (R&C1986)

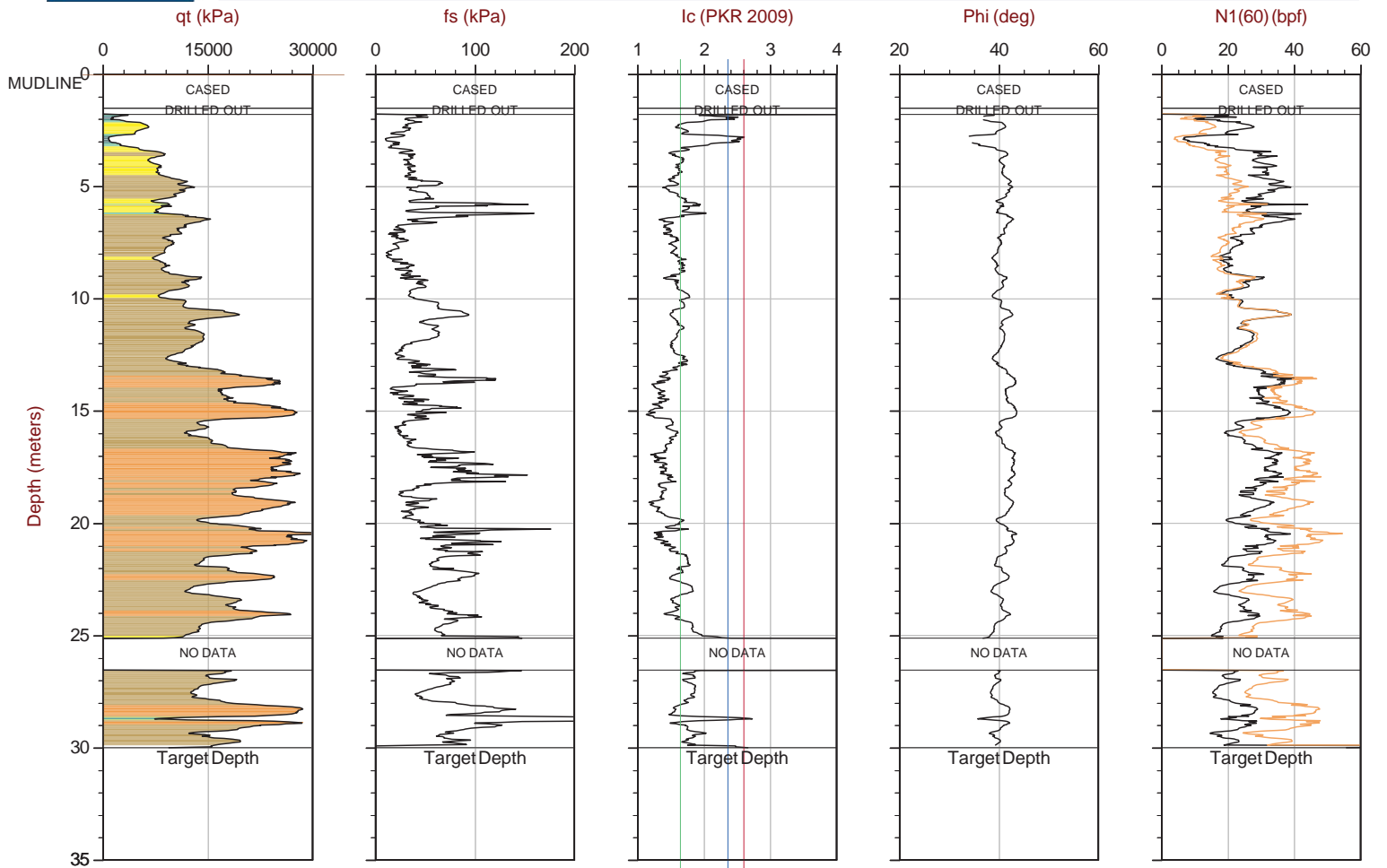
SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976683.63m E: 503767.46m Elev: -4.23m



Baffinland

Job No: 17-05010
Date: 2017-04-07 16:47
Site: Milne Port Expansion

Sounding: CPT17-D008
Cone: 374:T1500F15U500



MaxDepth: 30.000 m / 98.42 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
N(60) (bpf)

File: 17-05010_CPD008.COR
Unit Wt: SBT (R&C1986)

SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976650.76m E: 503635.99m Elev: -1.80m

Seismic Cone Penetration Test Tabular Results



Job No: 17-05010
Client: Baffinland Iron Mines Corporation
Project: Milne Port Expansion
Sounding ID: SCPT17-D002
Date: 05-Apr-2017

Seismic Source: Auto-seismic
Source Offset (m): 4.30
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPT_u SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
3.38	3.18	5.35			
5.38	5.18	6.73	1.38	8.94	155
6.35	6.15	7.50	0.77	4.62	167
7.40	7.20	8.39	0.88	5.00	177
8.38	8.18	9.24	0.86	4.38	195
9.40	9.20	10.16	0.91	5.21	175
10.38	10.18	11.05	0.90	4.78	187
11.38	11.18	11.98	0.93	5.35	173
12.40	12.20	12.94	0.96	4.82	198
13.43	13.23	13.91	0.98	4.81	203
14.43	14.23	14.87	0.95	4.70	203
15.43	15.23	15.83	0.96	4.39	219
16.43	16.23	16.79	0.96	4.40	219
17.40	17.20	17.73	0.94	4.13	228
18.45	18.25	18.75	1.02	4.54	225
19.40	19.20	19.68	0.93	3.87	239
20.35	20.15	20.60	0.93	3.91	238
21.35	21.15	21.58	0.98	4.50	217
22.35	22.15	22.56	0.98	4.44	221
23.35	23.15	23.55	0.98	4.67	210
24.27	24.07	24.45	0.91	4.13	219
25.30	25.10	25.47	1.01	4.00	254
26.27	26.07	26.42	0.96	3.80	252



Job No: 17-05010
Client: Baffinland Iron Mines Corporation
Project: Milne Port Expansion
Sounding ID: SCPT17-D002
Date: 05-Apr-2017

Seismic Source: Auto-seismic
Source Offset (m): 4.30
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPT_u SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
27.32	27.12	27.46	1.04	4.08	254
28.38	28.18	28.51	1.05	3.93	267
29.43	29.23	29.54	1.04	4.08	254
30.40	30.20	30.50	0.96	3.54	271
31.40	31.20	31.49	0.99	3.55	279
32.38	32.18	32.47	0.97	3.59	270
33.38	33.18	33.46	0.99	3.56	279
34.40	34.20	34.47	1.01	3.63	279
35.40	35.20	35.46	0.99	3.60	276
36.40	36.20	36.45	0.99	3.75	265
37.40	37.20	37.45	0.99	3.87	257
38.40	38.20	38.44	0.99	3.81	261
39.40	39.20	39.44	0.99	3.81	261



Job No: 17-05010
Client: Baffinland Iron Mines Corporation
Project: Milne Port Expansion
Sounding ID: SCPT17-D004
Date: 04-Apr-2017

Seismic Source: Auto-seismic
Source Offset (m): 3.40
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPT_u SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
4.30	4.10	5.33			
5.30	5.10	6.13	0.80	4.48	179
6.20	6.00	6.90	0.77	3.86	198
7.20	7.00	7.78	0.89	3.86	229
8.20	8.00	8.69	0.91	4.17	218
9.20	9.00	9.62	0.93	4.33	214
10.95	10.75	11.27	1.65	7.11	233
11.93	11.73	12.21	0.94	3.87	243
12.93	12.73	13.18	0.96	4.33	223
13.95	13.75	14.16	0.99	4.10	241
14.88	14.68	15.07	0.90	3.75	241
15.88	15.68	16.04	0.98	4.50	217
16.88	16.68	17.02	0.98	4.05	242
17.85	17.65	17.97	0.95	4.80	198
18.85	18.65	18.96	0.98	3.75	262
19.88	19.68	19.97	1.01	4.21	241
20.90	20.70	20.98	1.01	3.94	255
21.82	21.62	21.89	0.91	3.18	286
22.82	22.62	22.87	0.99	3.63	272
23.85	23.65	23.89	1.02	4.39	232
24.80	24.60	24.83	0.94	3.63	259
25.80	25.60	25.82	0.99	4.09	242
26.80	26.60	26.82	0.99	3.63	273



Job No: 17-05010
Client: Baffinland Iron Mines Corporation
Project: Milne Port Expansion
Sounding ID: SCPT17-D004
Date: 04-Apr-2017

Seismic Source: Auto-seismic
Source Offset (m): 3.40
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPT_u SHEAR WAVE VELOCITY TEST RESULTS - V_s

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
27.82	27.62	27.83	1.01	3.63	278
28.82	28.62	28.82	0.99	3.94	252
29.82	29.62	29.81	0.99	3.79	262
30.77	30.57	30.76	0.94	3.48	271
31.80	31.60	31.78	1.02	3.79	270
32.05	31.85	32.03	0.25	0.91	274

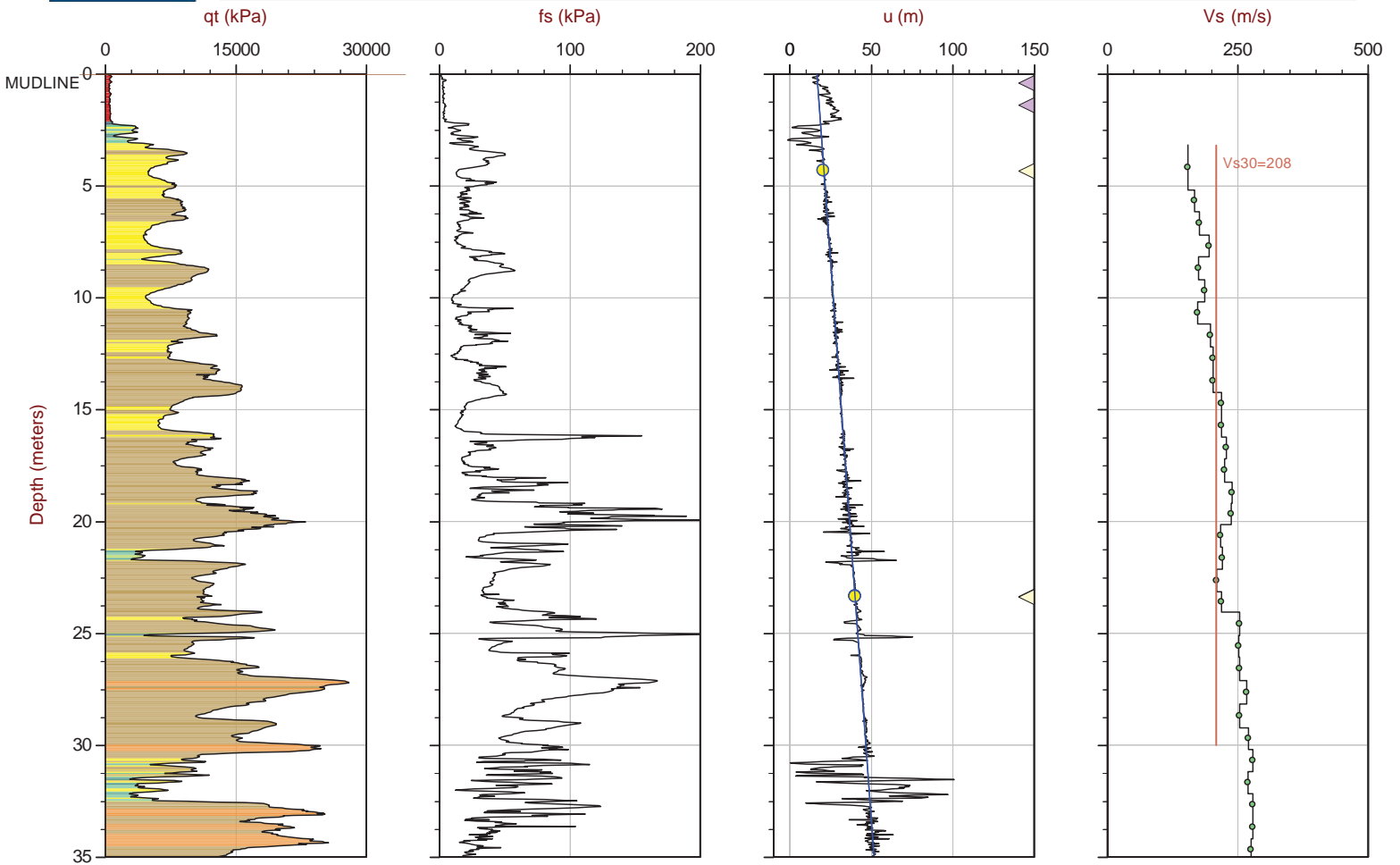
Seismic Cone Penetration Test Plots



Baffinland

Job No: 17-05010
Date: 2017-04-05 20:44
Site: Milne Port Expansion

Sounding: SCPT17-D002
Cone: 338:T1500F15U500



MaxDepth: 39.475 m / 129.51 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
● Equilibrium Pore Pressure (Ueq)

File: 17-05010_SPD002.COR
Unit Wt: SBT (R&C1986)
▲ Dissipation, Ueq not achieved

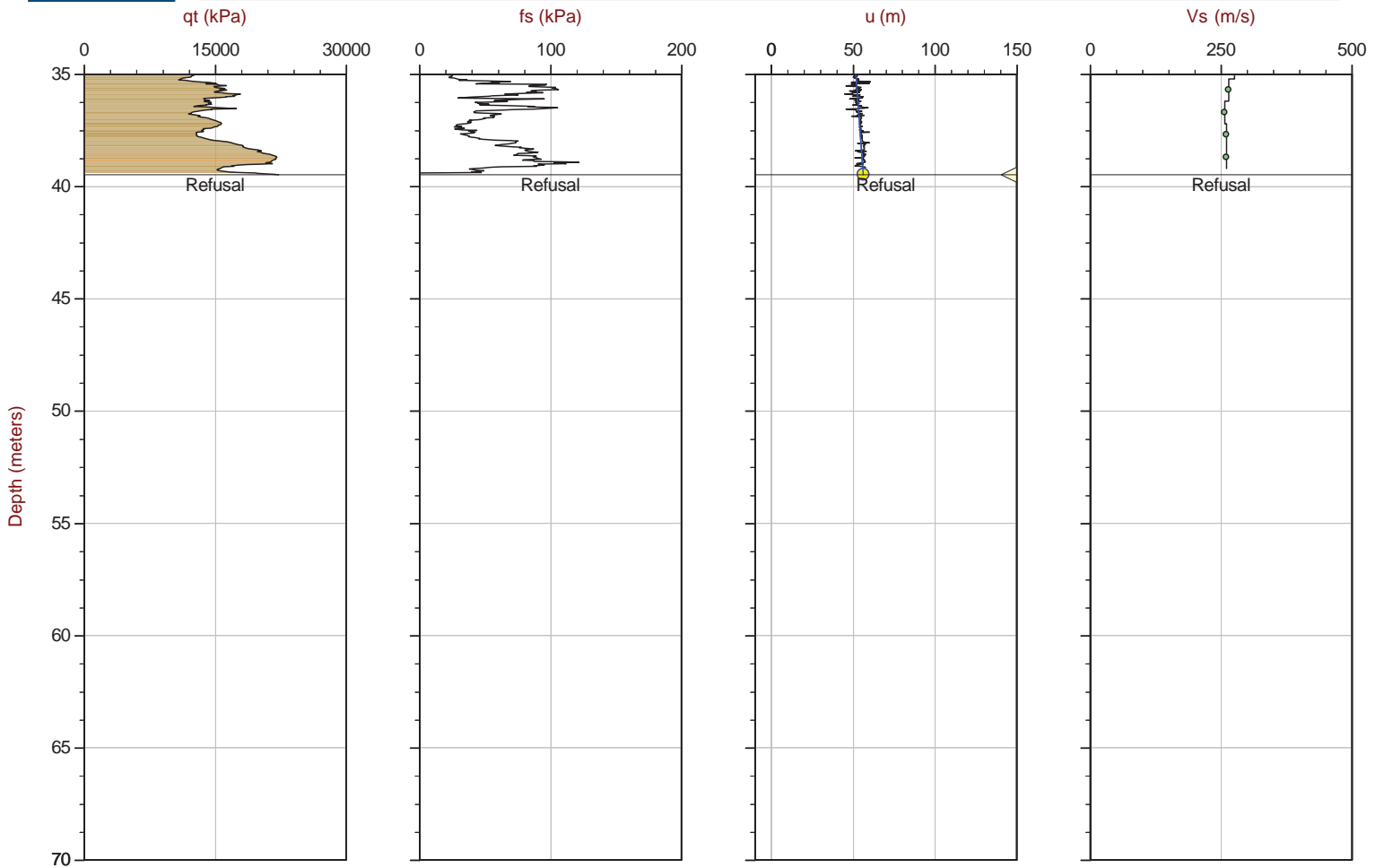
SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976728.05m E: 503705.30m Elev: -16.12m
▲ Dissipation, Ueq achieved — Hydrostatic Line



Baffinland

Job No: 17-05010
Date: 2017-04-05 20:44
Site: Milne Port Expansion

Sounding: SCPT17-D002
Cone: 338:T1500F15U500



MaxDepth: 39.475 m / 129.51 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 17-05010_SPD002.COR
Unit Wt: SBT (R&C1986)

SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976728.05m E: 503705.30m Elev: -16.12m

● Equilibrium Pore Pressure (Ueq)

◀ Dissipation, Ueq not achieved

◀ Dissipation, Ueq achieved

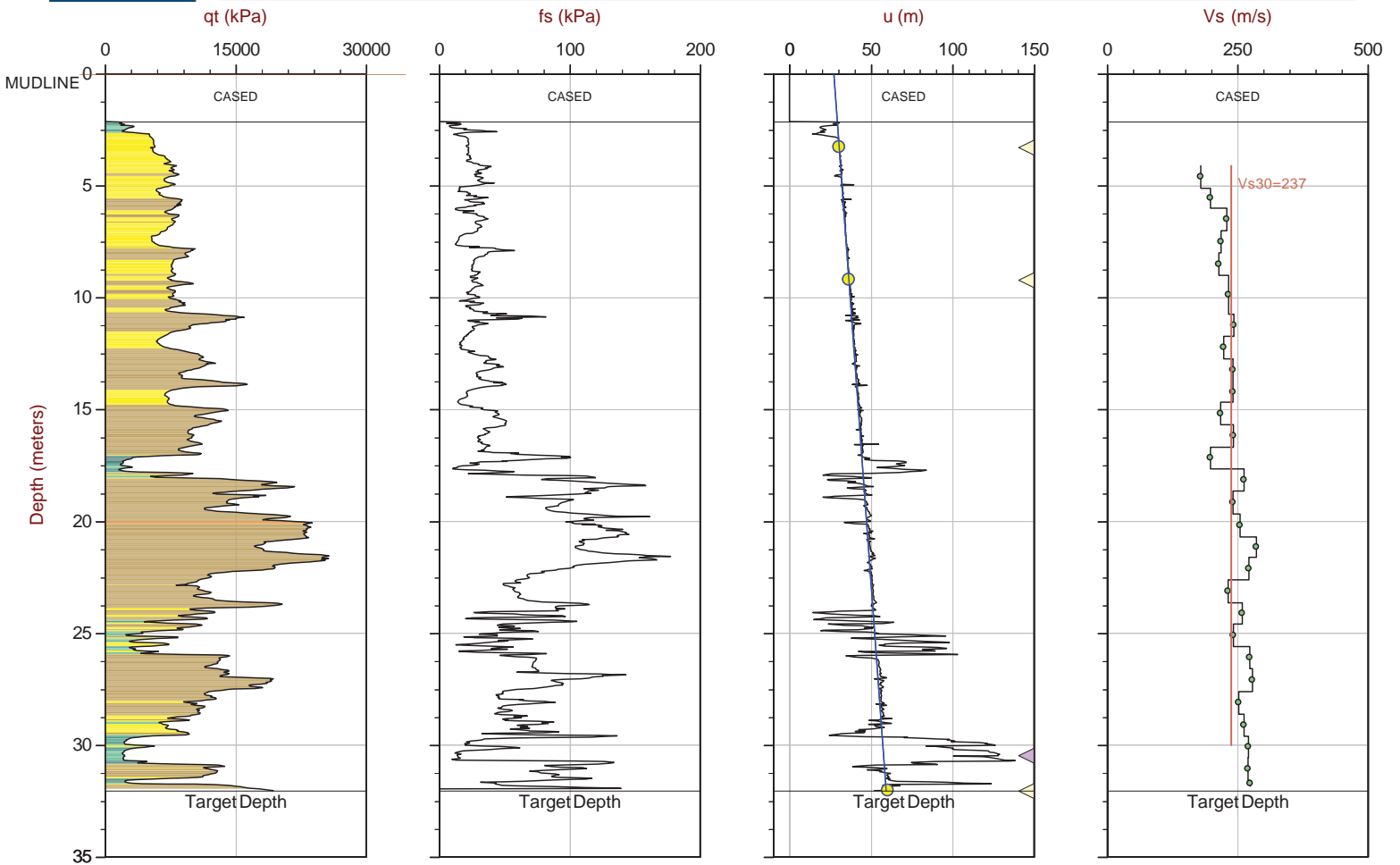
— Hydrostatic Line



Baffinland

Job No: 17-05010
Date: 2017-04-04 16:44
Site: Milne Port Expansion

Sounding: SCPT17-D004
Cone: 338:T1500F15U500



MaxDepth: 32.050 m / 105.15 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
● Equilibrium Pore Pressure (Ueq)

File: 17-05010_SPD004.COR
Unit Wt: SBT (R&C1986)
◀ Dissipation, Ueq not achieved

SBT: Robertson and Campanella, 1986
Coords: UTM17N: 7976768.10m E: 503646.44m Elev: -26.59m
◀ Dissipation, Ueq achieved — Hydrostatic Line

Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots



Job No: 17-05010
Client: Baffinland Iron Mines Corporation
Project: Milne Port Expansion
Start Date: 03-Apr-2017
End Date: 07-Apr-2017

CPT_u PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm ²)	Duration (s)	Test Depth (m)	Estimated Equilibrium Pore Pressure U _{eq} (m)	Calculated Phreatic Surface (m)
CPT17-D001	17-05010_CPD001	15	260	3.275	Not Achieved	
CPT17-D001	17-05010_CPD001	15	95	6.400	24.0	-17.6
CPT17-D001	17-05010_CPD001	15	300	10.475	28.1	-17.6
CPT17-D001	17-05010_CPD001	15	100	19.850	37.5	-17.6
CPT17-D001	17-05010_CPD001	15	400	20.575	38.5	-17.9
CPT17-D001	17-05010_CPD001	15	95	28.650	45.6	-16.9
CPT17-D001	17-05010_CPD001	15	150	29.600	46.7	-17.1
CPT17-D001	17-05010_CPD001	15	400	32.750	50.4	-17.7
SCPT17-D002	17-05010_SPD002	15	105	0.400	Not Achieved	
SCPT17-D002	17-05010_SPD002	15	110	1.375	Not Achieved	
SCPT17-D002	17-05010_SPD002	15	150	4.325	20.7	-16.4
SCPT17-D002	17-05010_SPD002	15	600	23.350	40.2	-16.9
SCPT17-D002	17-05010_SPD002	15	275	23.375	40.4	-17.0
SCPT17-D002	17-05010_SPD002	15	200	39.475	56.6	-17.1
CPT17-D003	17-05010_CPD003	15	110	5.200	28.2	-23.0
CPT17-D003	17-05010_CPD003	15	400	15.300	38.5	-23.2
CPT17-D003	17-05010_CPD003	15	105	16.300	39.6	-23.3
CPT17-D003	17-05010_CPD003	15	1200	30.425	54.1	-23.7
SCPT17-D004	17-05010_SPD004	15	95	3.275	30.4	-27.1
SCPT17-D004	17-05010_SPD004	15	300	9.200	36.5	-27.3
SCPT17-D004	17-05010_SPD004	15	600	30.475	Not Achieved	
SCPT17-D004	17-05010_SPD004	15	300	32.050	60.3	-28.2
CPT17-D005	17-05010_CPD005	15	1340	2.275	28.3	-26.0
CPT17-D005	17-05010_CPD005	15	110	3.325	29.5	-26.2
CPT17-D005	17-05010_CPD005	15	95	5.375	31.8	-26.4
CPT17-D005	17-05010_CPD005	15	145	6.375	Not Achieved	
CPT17-D005	17-05010_CPD005	15	110	7.400	33.5	-26.1
CPT17-D005	17-05010_CPD005	15	125	9.350	Not Achieved	
CPT17-D005	17-05010_CPD005	15	300	10.300	36.5	-26.2



Job No: 17-05010
 Client: Baffinland Iron Mines Corporation
 Project: Milne Port Expansion
 Start Date: 03-Apr-2017
 End Date: 07-Apr-2017

CPT_u PORE PRESSURE DISSIPATION SUMMARY

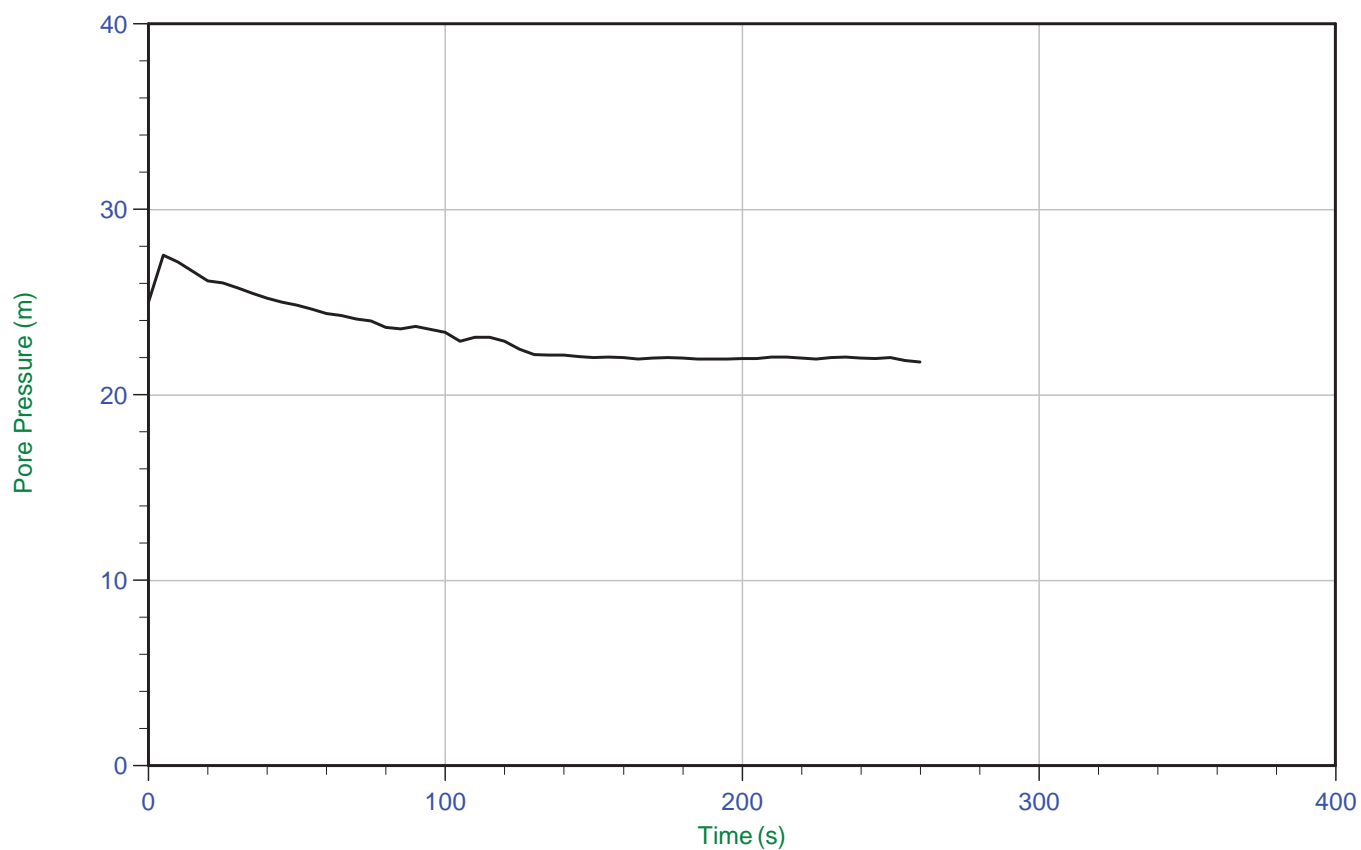
Sounding ID	File Name	Cone Area (cm ²)	Duration (s)	Test Depth (m)	Estimated Equilibrium Pore Pressure U _{eq} (m)	Calculated Phreatic Surface (m)
CPT17-D005	17-05010_CPD005	15	1460	12.350	38.8	-26.4
CPT17-D005	17-05010_CPD005	15	275	13.175	Not Achieved	
CPT17-D005	17-05010_CPD005	15	305	15.050	41.7	-26.6
CPT17-D005	17-05010_CPD005	15	165	18.100	44.7	-26.6
CPT17-D005	17-05010_CPD005	15	130	23.925	50.7	-26.8
CPT17-D005	17-05010_CPD005	15	300	25.125	51.9	-26.8
CPT17-D006	17-05010_CPD006	15	105	2.300	Not Achieved	
CPT17-D006	17-05010_CPD006	15	2100	3.300	35.3	-32.0
CPT17-D006	17-05010_CPD006	15	300	20.575	52.4	-31.8
CPT17-D007	17-05010_CPD007	15	200	10.100	14.8	-4.7
CPT17-D007	17-05010_CPD007	15	200	20.150	25.1	-5.0
CPT17-D007	17-05010_CPD007	15	200	30.200	35.5	-5.3
CPT17-D008	17-05010_CPD008	15	180	2.075	Not Achieved	
CPT17-D008	17-05010_CPD008	15	200	20.500	21.9	-1.4
CPT17-D008	17-05010_CPD008	15	120	28.975	30.4	-1.4
CPT17-D008	17-05010_CPD008	15	405	30.000	32.2	-2.2



Baffinland

Job No: 17-05010
Date: 04/05/2017 09:17
Site: Milne Port Expansion

Sounding: CPT17-D001
Cone: 338:T1500F15U500 Area=15 cm²



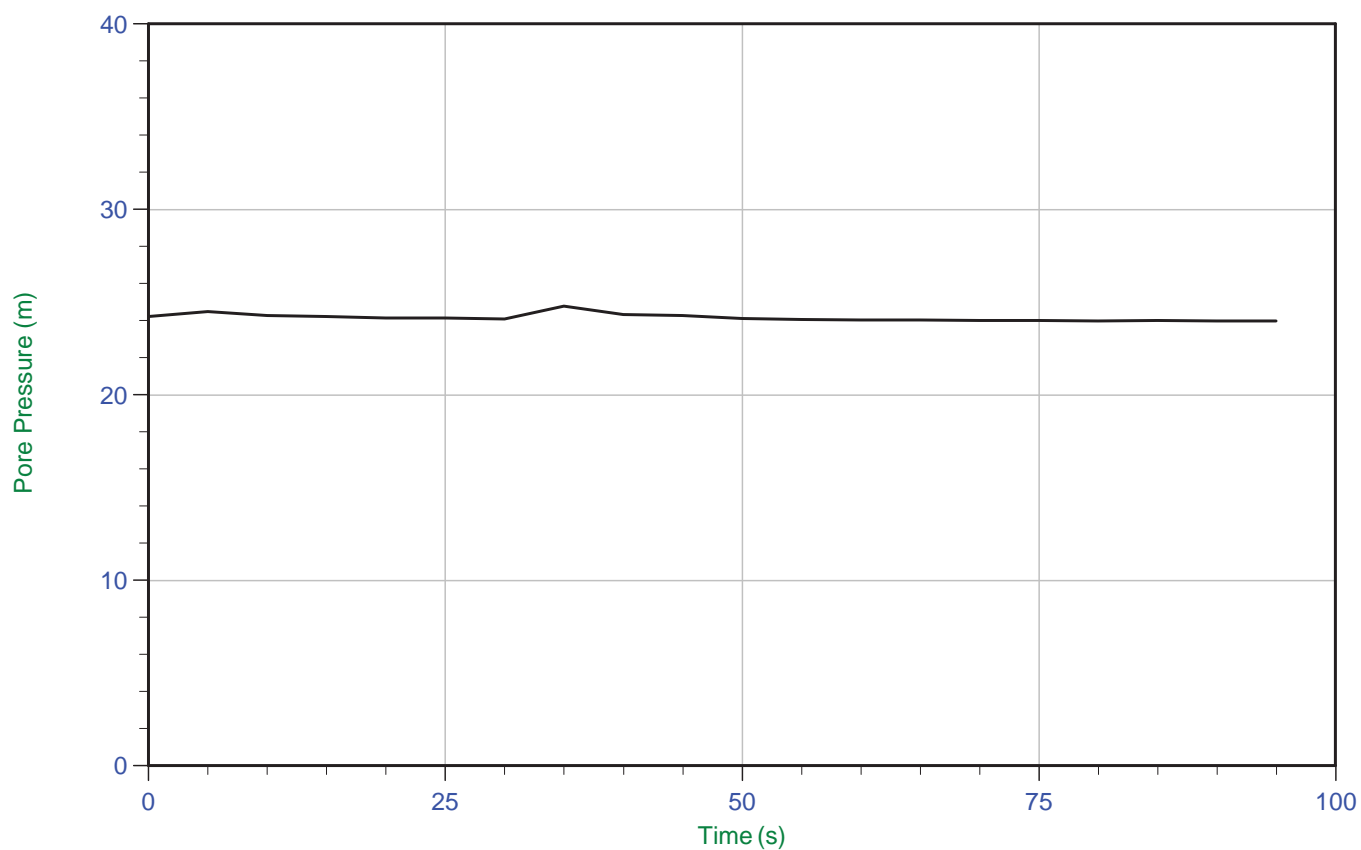
Trace Summary: Filename: 17-05010_CPD001.PPF U Min: 21.8 m
Depth: 3.275 m / 10.745 ft U Max: 27.5 m
Duration: 260.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 09:17
Site: Milne Port Expansion

Sounding: CPT17-D001
Cone: 338:T1500F15U500 Area=15 cm²



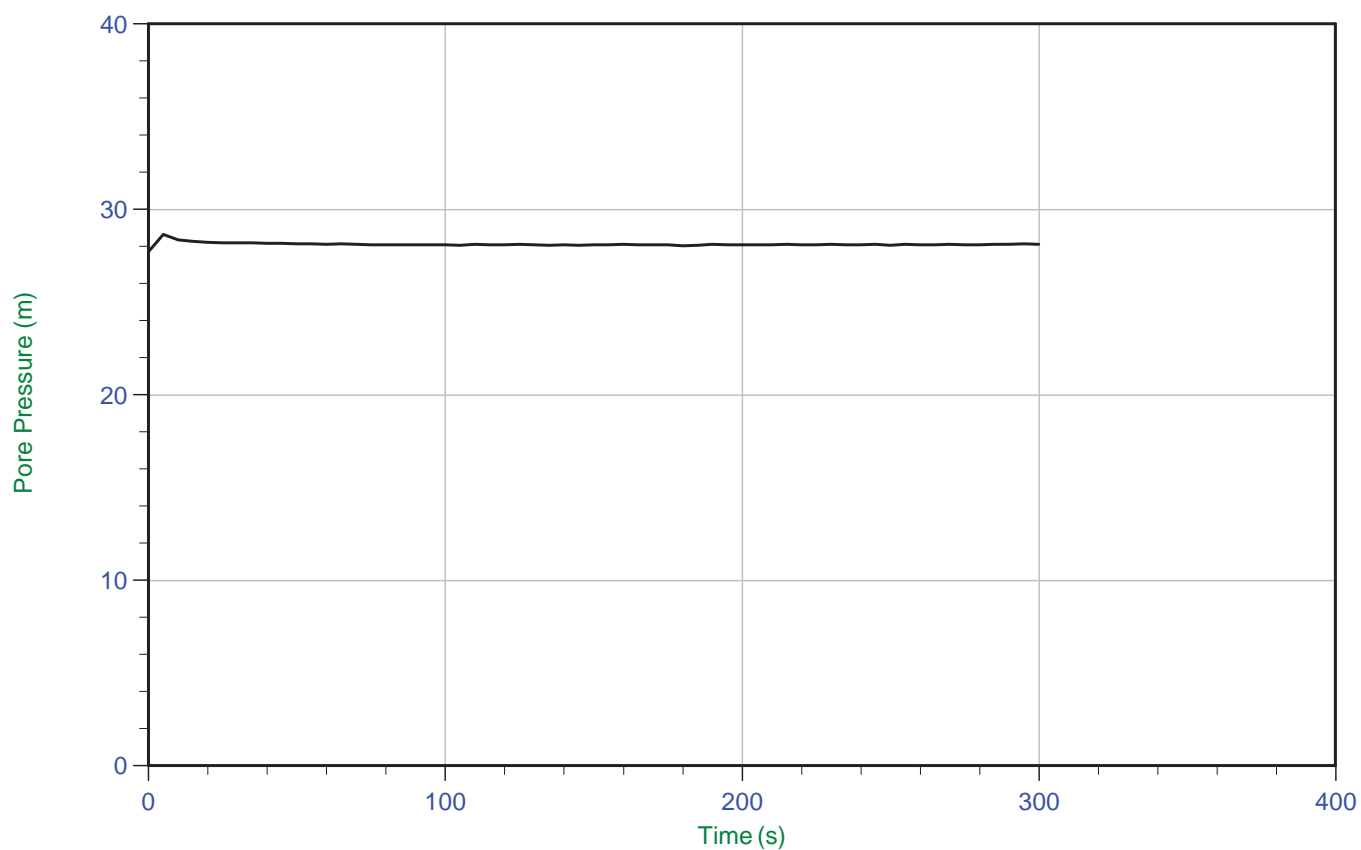
Trace Summary: Filename: 17-05010_CPD001.PPF U Min: 24.0 m WT: -17.600 m / -57.742 ft
 Depth: 6.400 m / 20.997 ft U Max: 24.8 m Ueq: 24.0 m
 Duration: 95.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 09:17
Site: Milne Port Expansion

Sounding: CPT17-D001
Cone: 338:T1500F15U500 Area=15 cm²



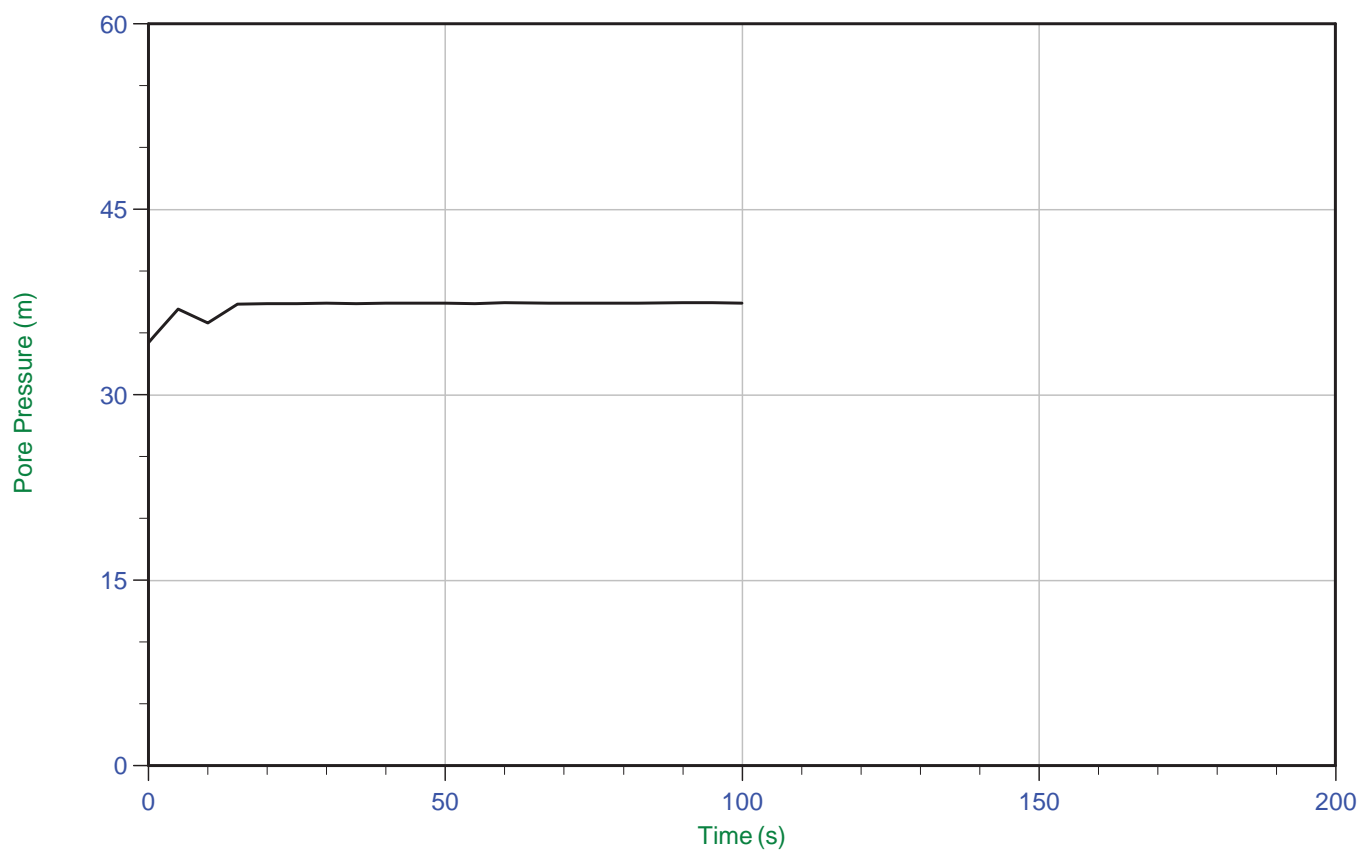
Trace Summary: Filename: 17-05010_CPD001.PPF U Min: 27.7 m WT: -17.646 m / -57.893 ft
 Depth: 10.475 m / 34.366 ft U Max: 28.6 m Ueq: 28.1 m
 Duration: 300.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 09:17
Site: Milne Port Expansion

Sounding: CPT17-D001
Cone: 338:T1500F15U500 Area=15 cm²



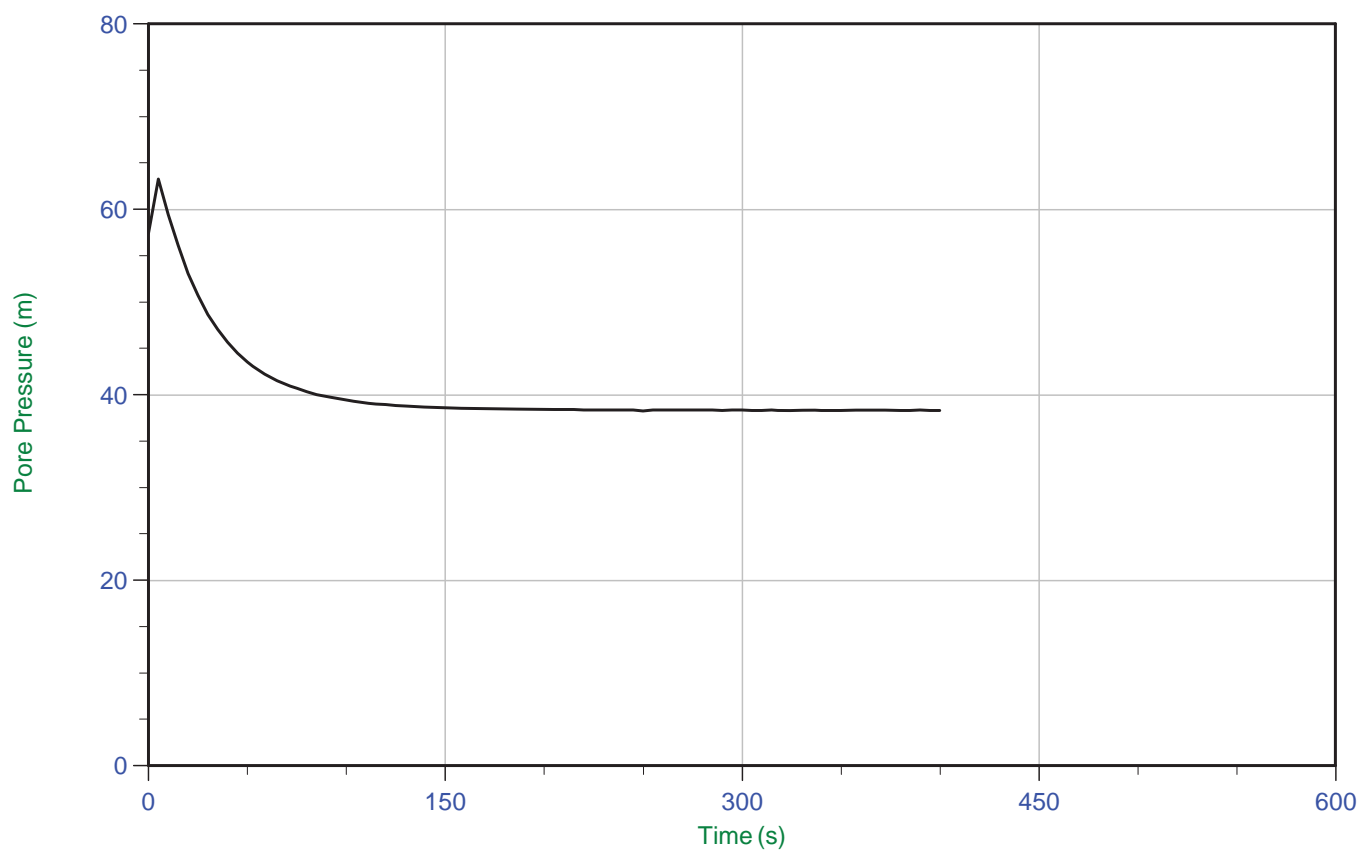
Trace Summary: Filename: 17-05010_CPD001.PPF U Min: 34.2 m WT: -17.605 m / -57.758 ft
Depth: 19.850 m / 65.124 ft U Max: 37.5 m Ueq: 37.5 m
Duration: 100.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 09:17
Site: Milne Port Expansion

Sounding: CPT17-D001
Cone: 338:T1500F15U500 Area=15 cm²



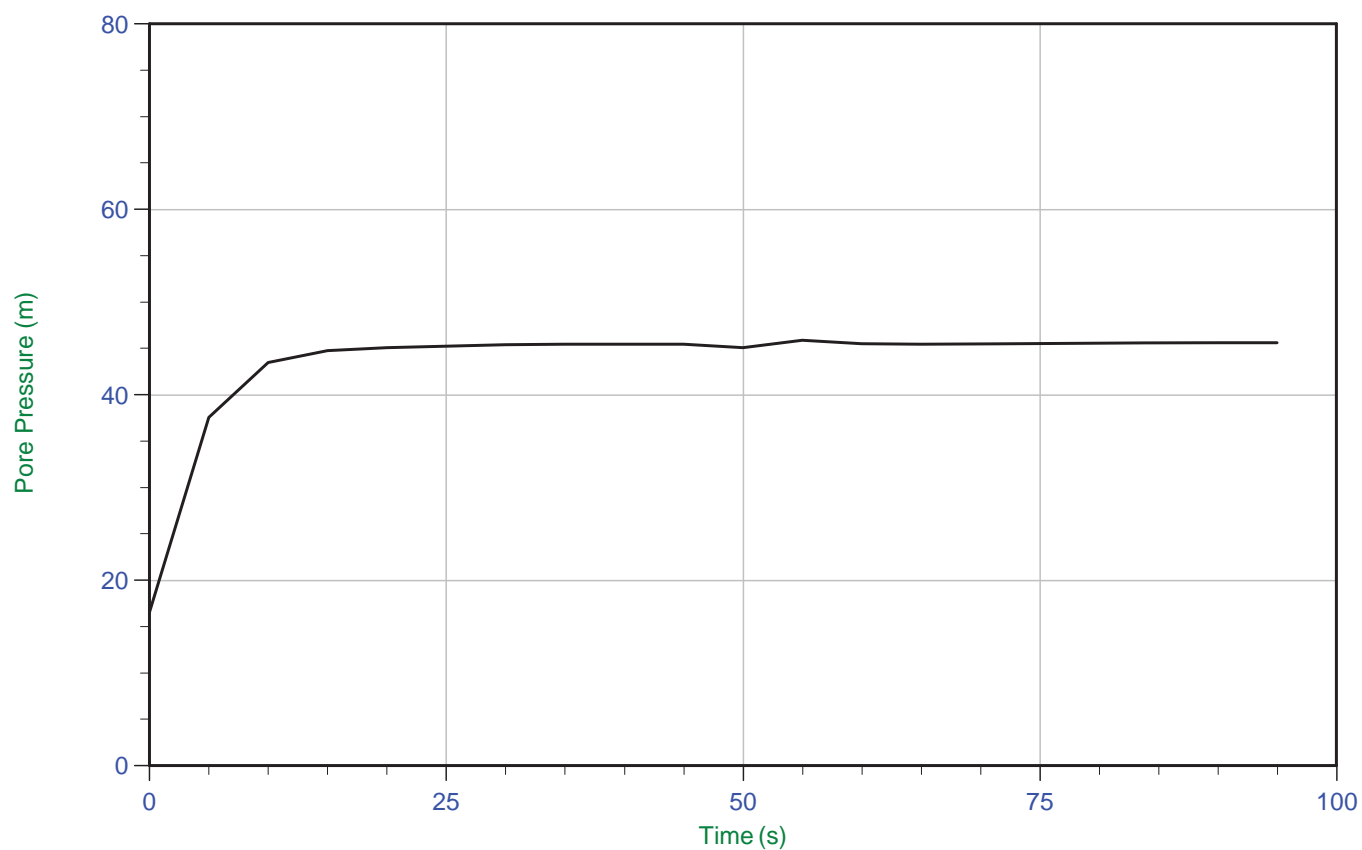
Trace Summary: Filename: 17-05010_CPD001.PPF U Min: 38.3 m WT: -17.890 m / -58.694 ft
Depth: 20.575 m / 67.502 ft U Max: 63.3 m Ueq: 38.5 m
Duration: 400.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 09:17
Site: Milne Port Expansion

Sounding: CPT17-D001
Cone: 338:T1500F15U500 Area=15 cm²



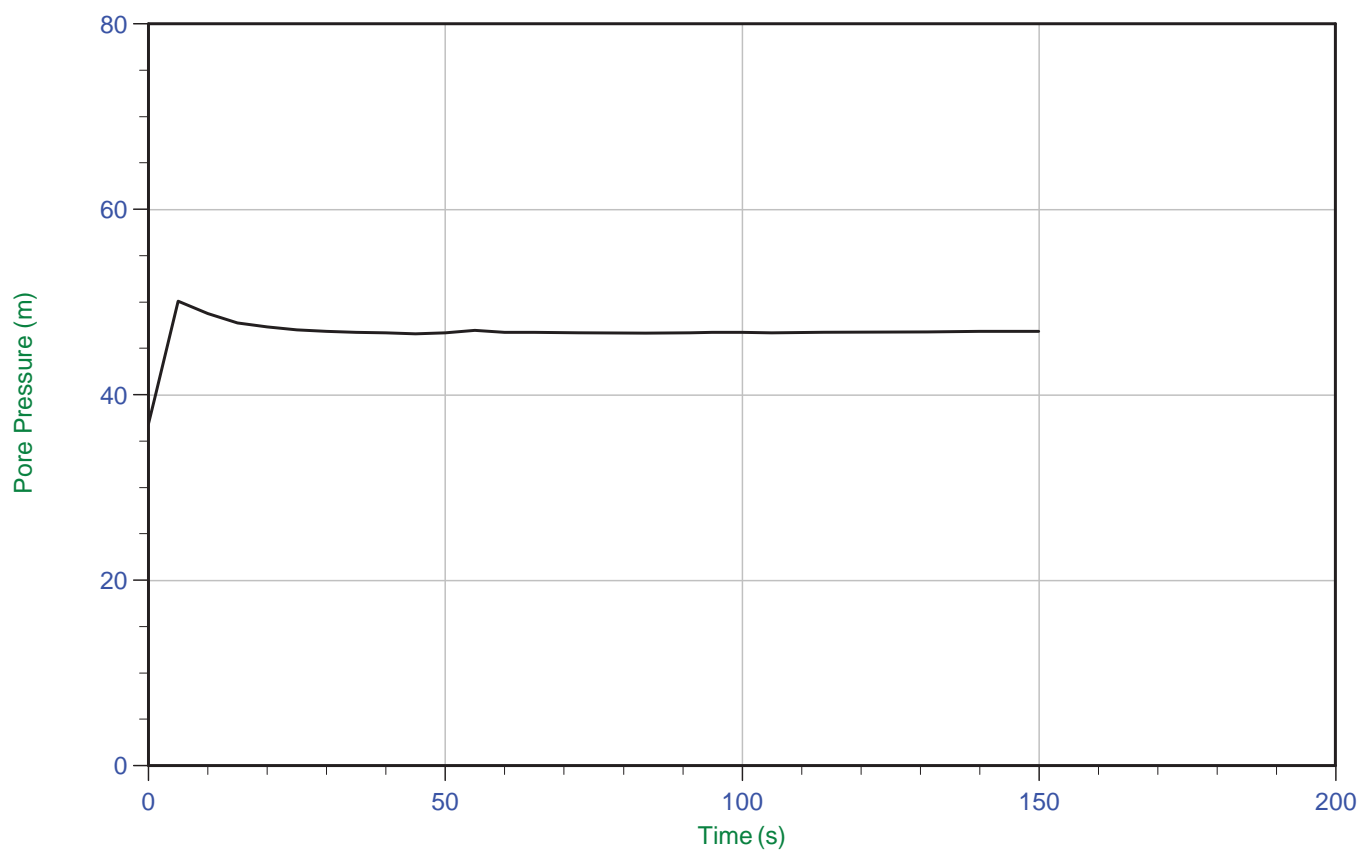
Trace Summary: Filename: 17-05010_CPD001.PPF U Min: 16.6 m WT: -16.926 m / -55.531 ft
Depth: 28.650 m / 93.995 ft U Max: 45.9 m Ueq: 45.6 m
Duration: 95.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 09:17
Site: Milne Port Expansion

Sounding: CPT17-D001
Cone: 338:T1500F15U500 Area=15 cm²



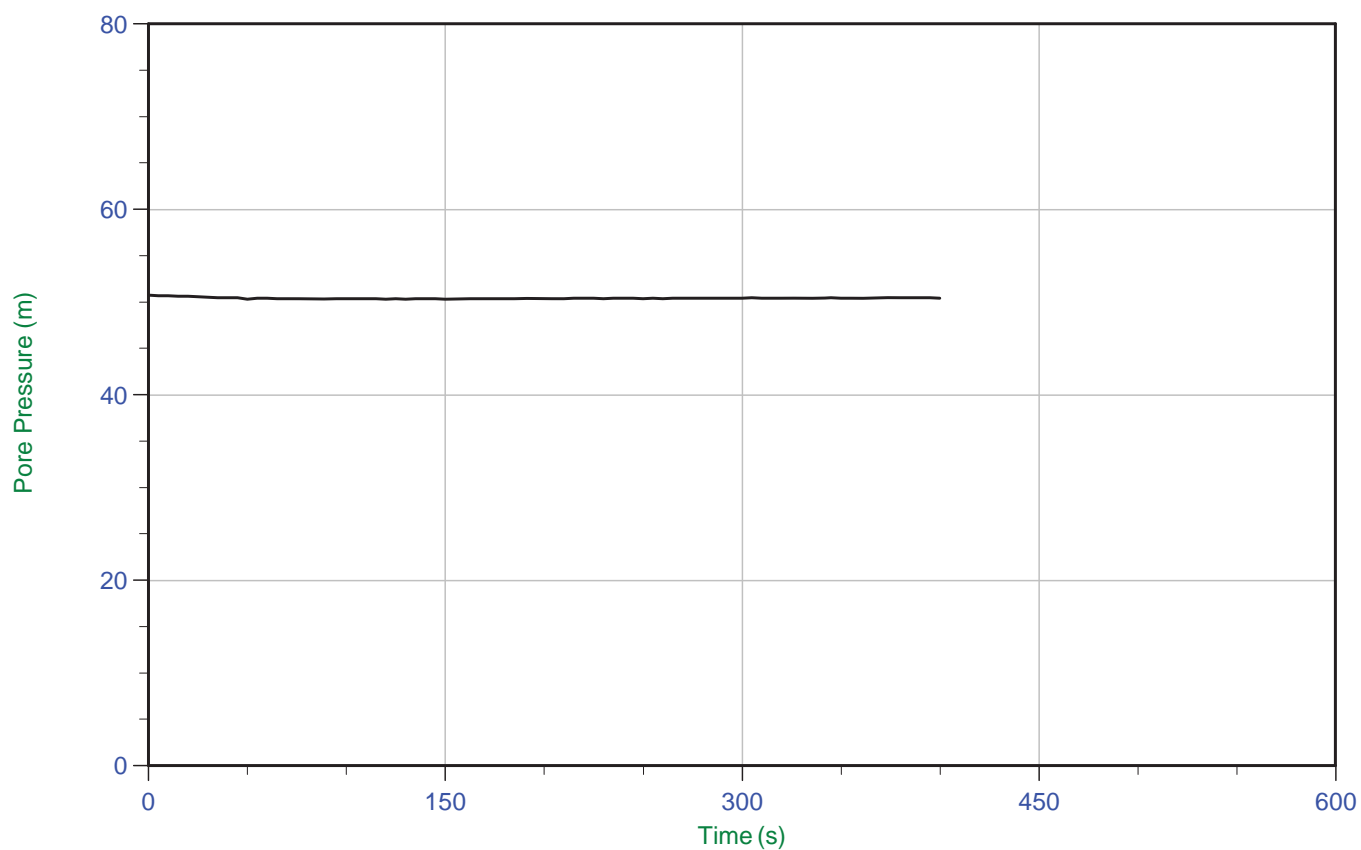
Trace Summary: Filename: 17-05010_CPD001.PPF U Min: 36.9 m WT: -17.107 m / -56.125 ft
Depth: 29.600 m / 97.112 ft U Max: 50.1 m Ueq: 46.7 m
Duration: 150.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 09:17
Site: Milne Port Expansion

Sounding: CPT17-D001
Cone: 338:T1500F15U500 Area=15 cm²



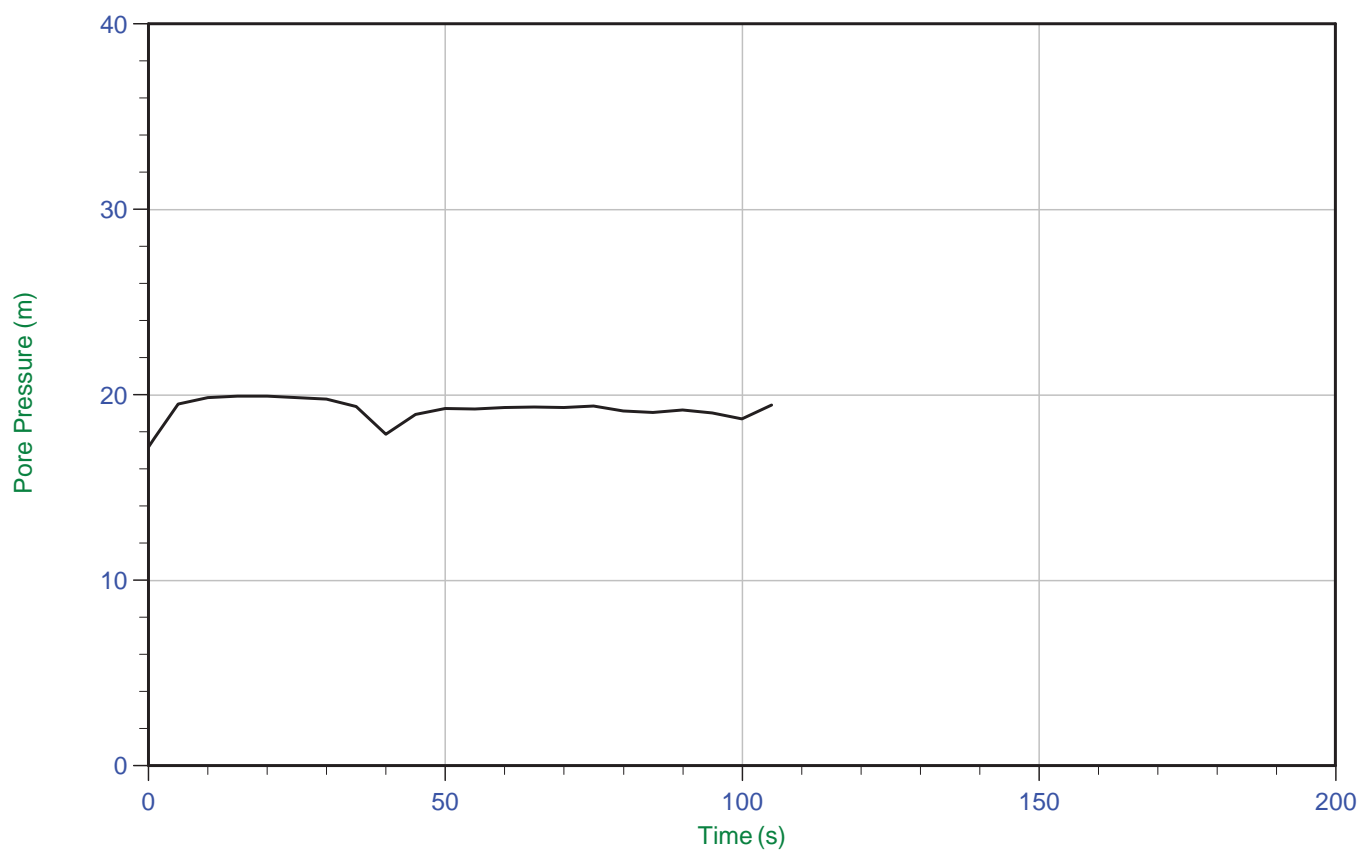
Trace Summary: Filename: 17-05010_CPD001.PPF U Min: 50.3 m WT: -17.674 m / -57.985 ft
Depth: 32.750 m / 107.446 ft U Max: 50.7 m Ueq: 50.4 m
Duration: 400.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 20:44
Site: Milne Port Expansion

Sounding: SCPT17-D002
Cone: 338:T1500F15U500 Area=15 cm²



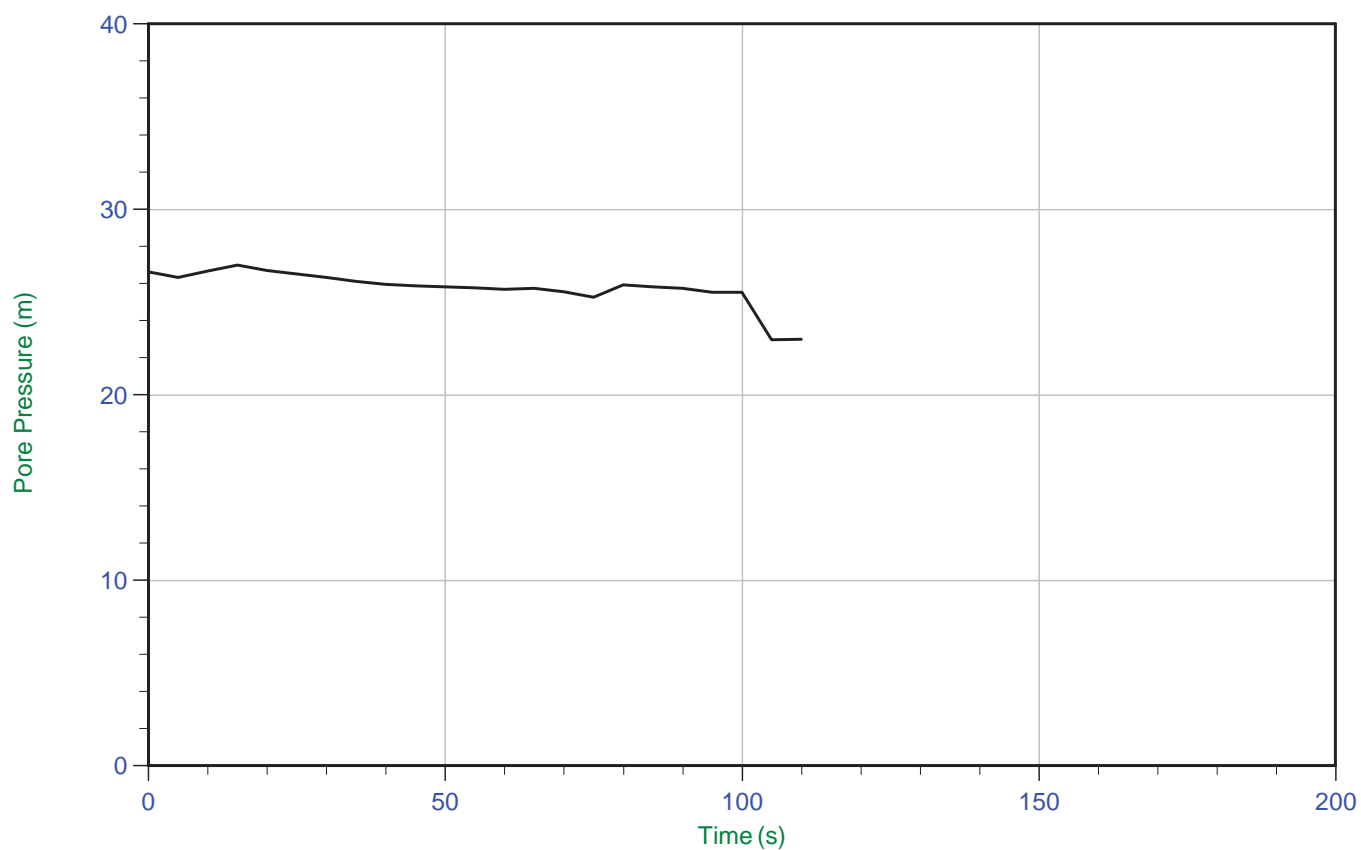
Trace Summary: Filename: 17-05010_SPD002.PPF U Min: 17.2 m
 Depth: 0.400 m / 1.312 ft U Max: 19.9 m
 Duration: 105.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 20:44
Site: Milne Port Expansion

Sounding: SCPT17-D002
Cone: 338:T1500F15U500 Area=15 cm²



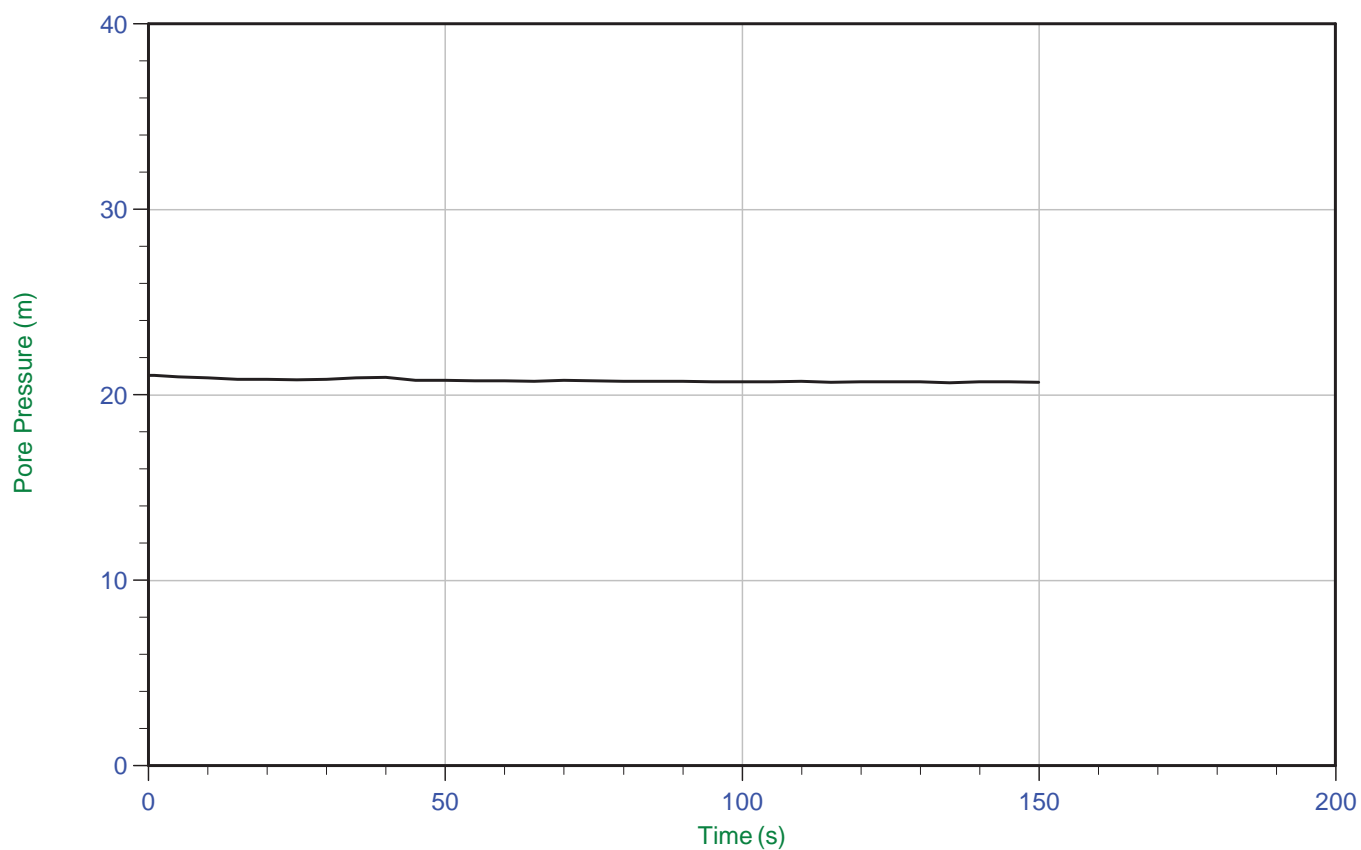
Trace Summary: Filename: 17-05010_SPD002.PPF U Min: 23.0 m
Depth: 1.375 m / 4.511 ft U Max: 27.0 m
Duration: 110.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 20:44
Site: Milne Port Expansion

Sounding: SCPT17-D002
Cone: 338:T1500F15U500 Area=15 cm²



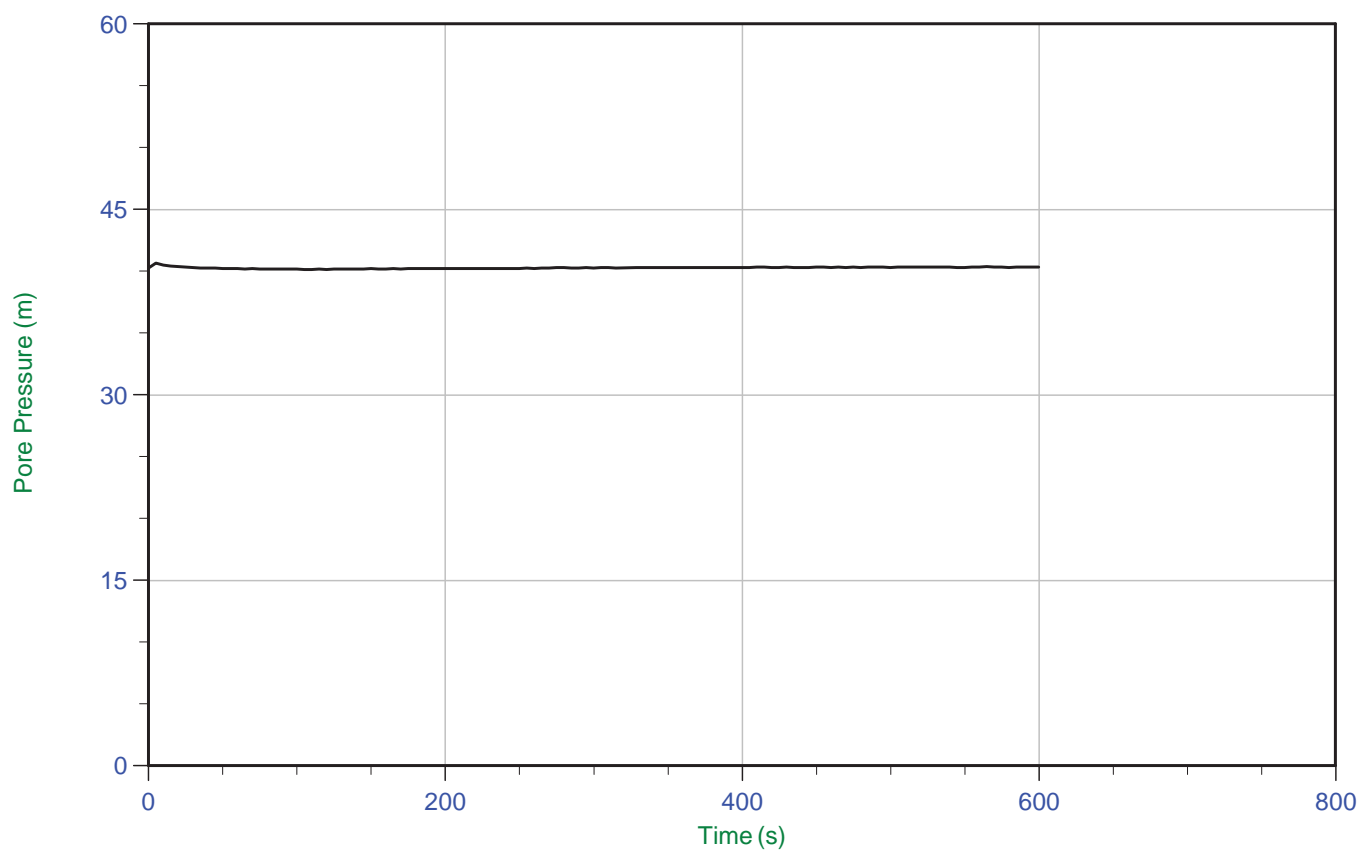
Trace Summary: Filename: 17-05010_SPD002.PPF U Min: 20.7 m WT: -16.362 m / -53.680 ft
 Depth: 4.325 m / 14.189 ft U Max: 21.1 m Ueq: 20.7 m
 Duration: 150.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 20:44
Site: Milne Port Expansion

Sounding: SCPT17-D002
Cone: 338:T1500F15U500 Area=15 cm²



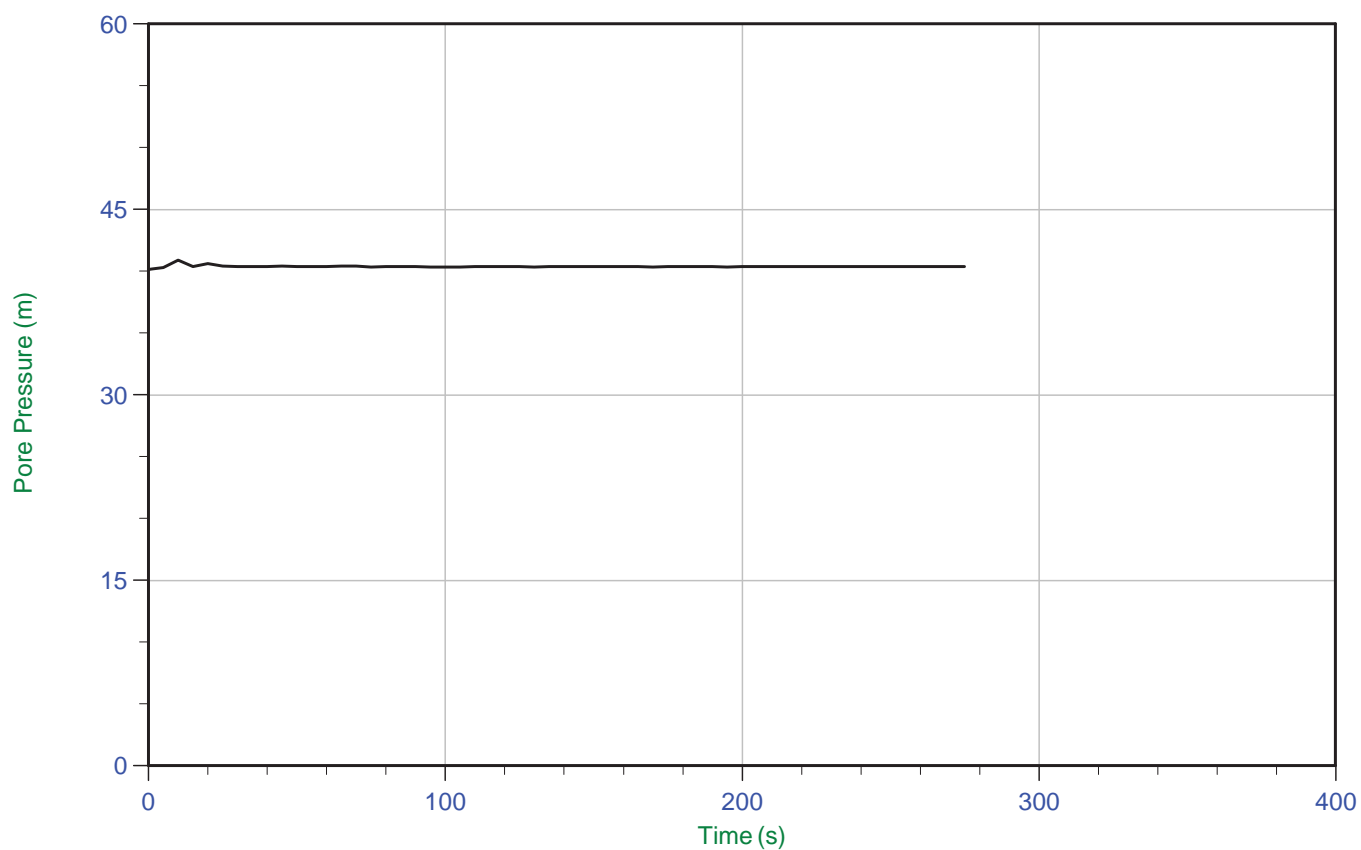
Trace Summary: Filename: 17-05010_SPD002.PPF U Min: 40.1 m WT: -16.892 m / -55.419 ft
 Depth: 23.350 m / 76.607 ft U Max: 40.6 m Ueq: 40.2 m
 Duration: 600.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 20:44
Site: Milne Port Expansion

Sounding: SCPT17-D002
Cone: 338:T1500F15U500 Area=15 cm²



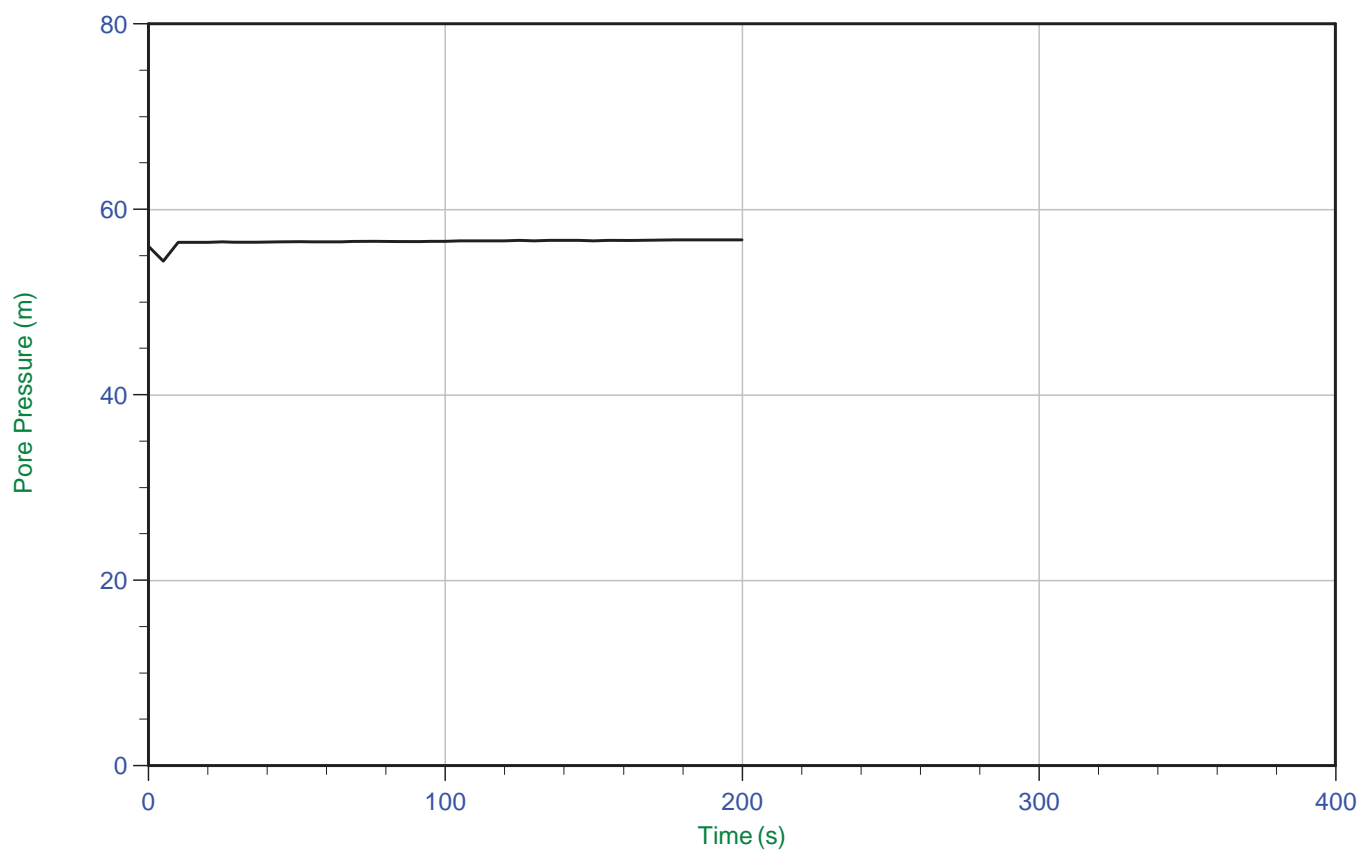
Trace Summary: Filename: 17-05010_SPD002.PPF U Min: 40.2 m WT: -16.989 m / -55.738 ft
 Depth: 23.375 m / 76.689 ft U Max: 40.9 m Ueq: 40.4 m
 Duration: 275.0 s



Baffinland

Job No: 17-05010
Date: 04/05/2017 20:44
Site: Milne Port Expansion

Sounding: SCPT17-D002
Cone: 338:T1500F15U500 Area=15 cm²



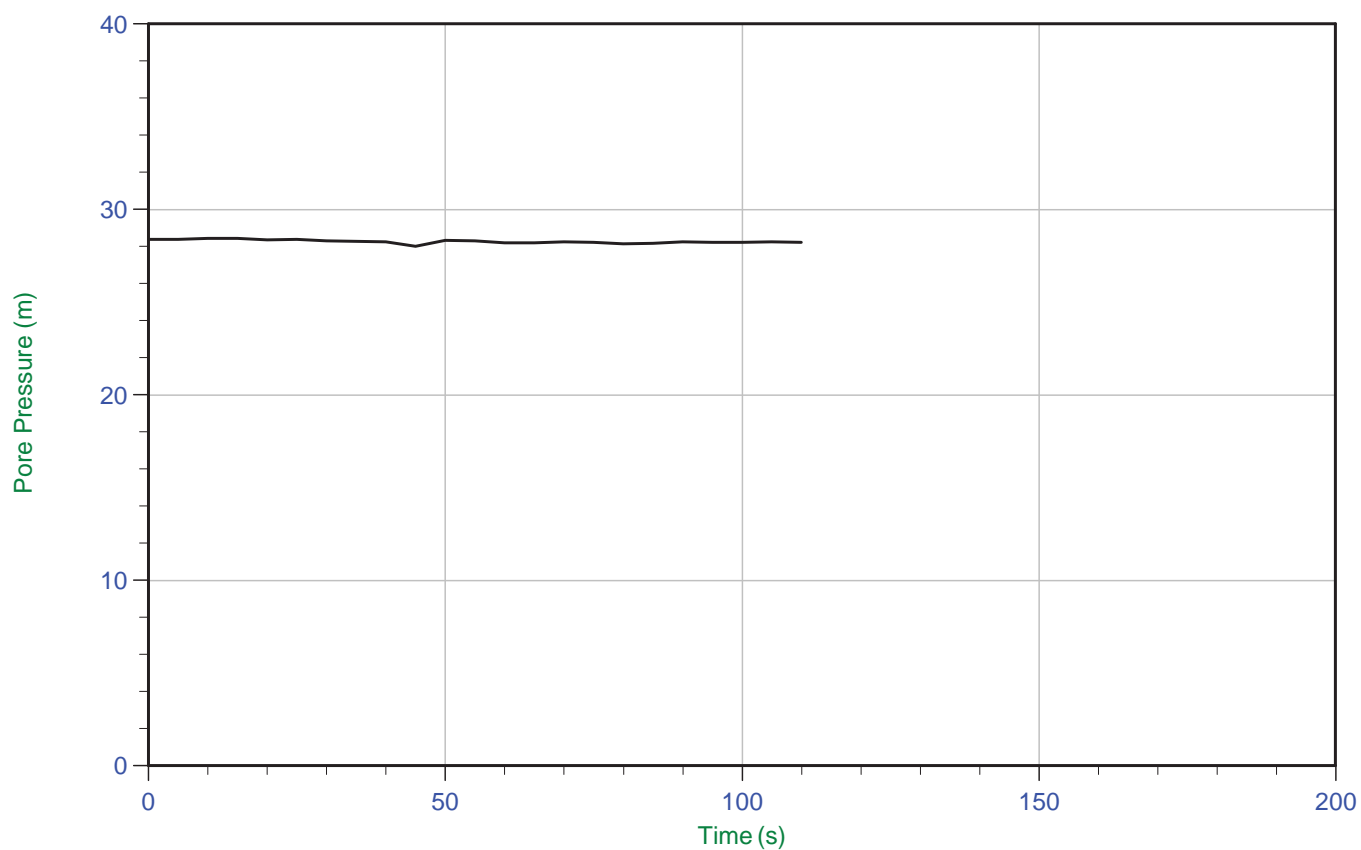
Trace Summary: Filename: 17-05010_SPD002.PPF U Min: 54.4 m WT: -17.091 m / -56.072 ft
Depth: 39.475 m / 129.510 ft U Max: 56.7 m Ueq: 56.6 m
Duration: 200.0 s



Baffinland

Job No: 17-05010
Date: 04/06/2017 13:34
Site: Milne Port Expansion

Sounding: CPT17-D003
Cone: 338:T1500F15U500 Area=15 cm²



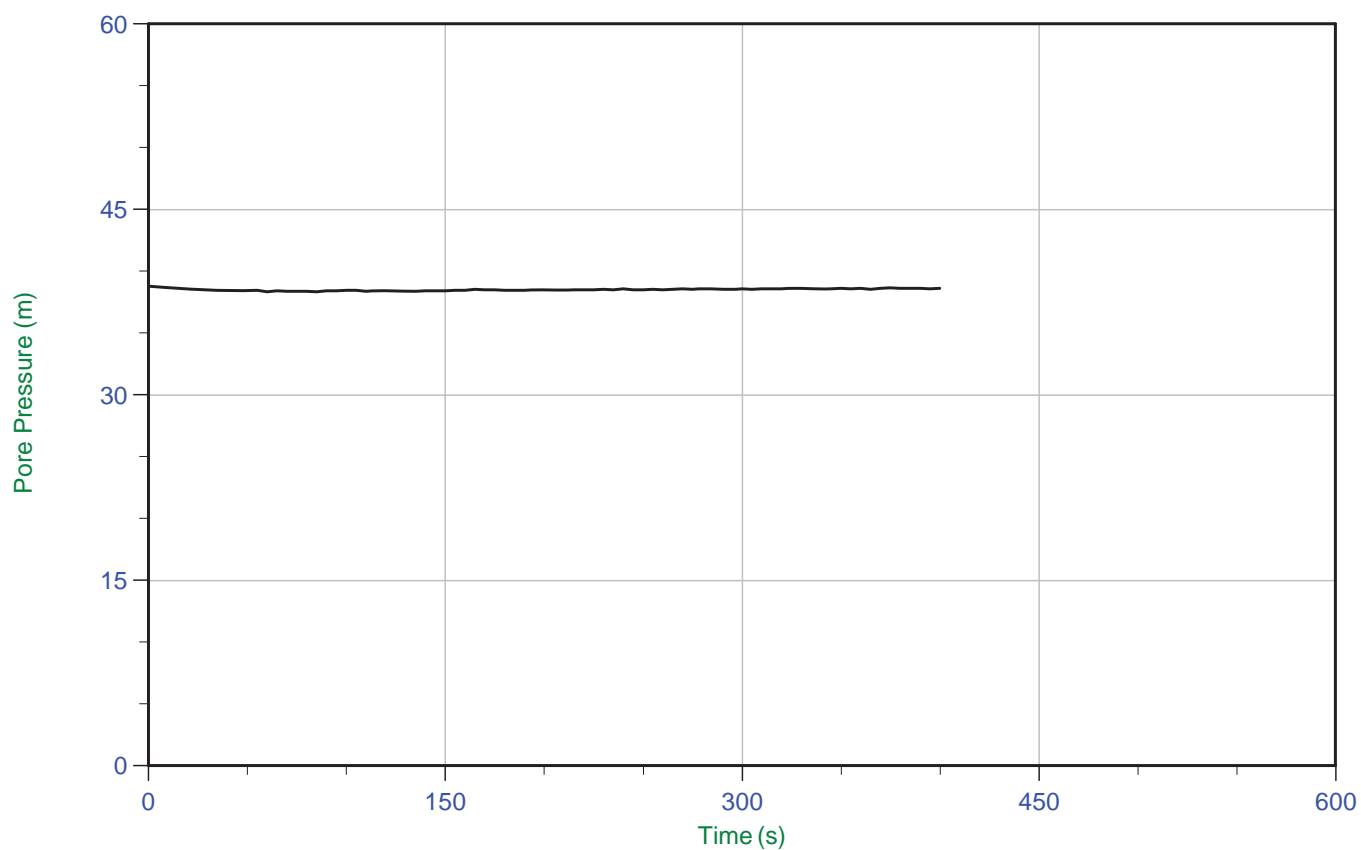
Trace Summary: Filename: 17-05010_CPD003.PPF U Min: 28.0 m WT: -23.002 m / -75.465 ft
 Depth: 5.200 m / 17.060 ft U Max: 28.4 m Ueq: 28.2 m
 Duration: 110.0 s



Baffinland

Job No: 17-05010
Date: 04/06/2017 13:34
Site: Milne Port Expansion

Sounding: CPT17-D003
Cone: 338:T1500F15U500 Area=15 cm²



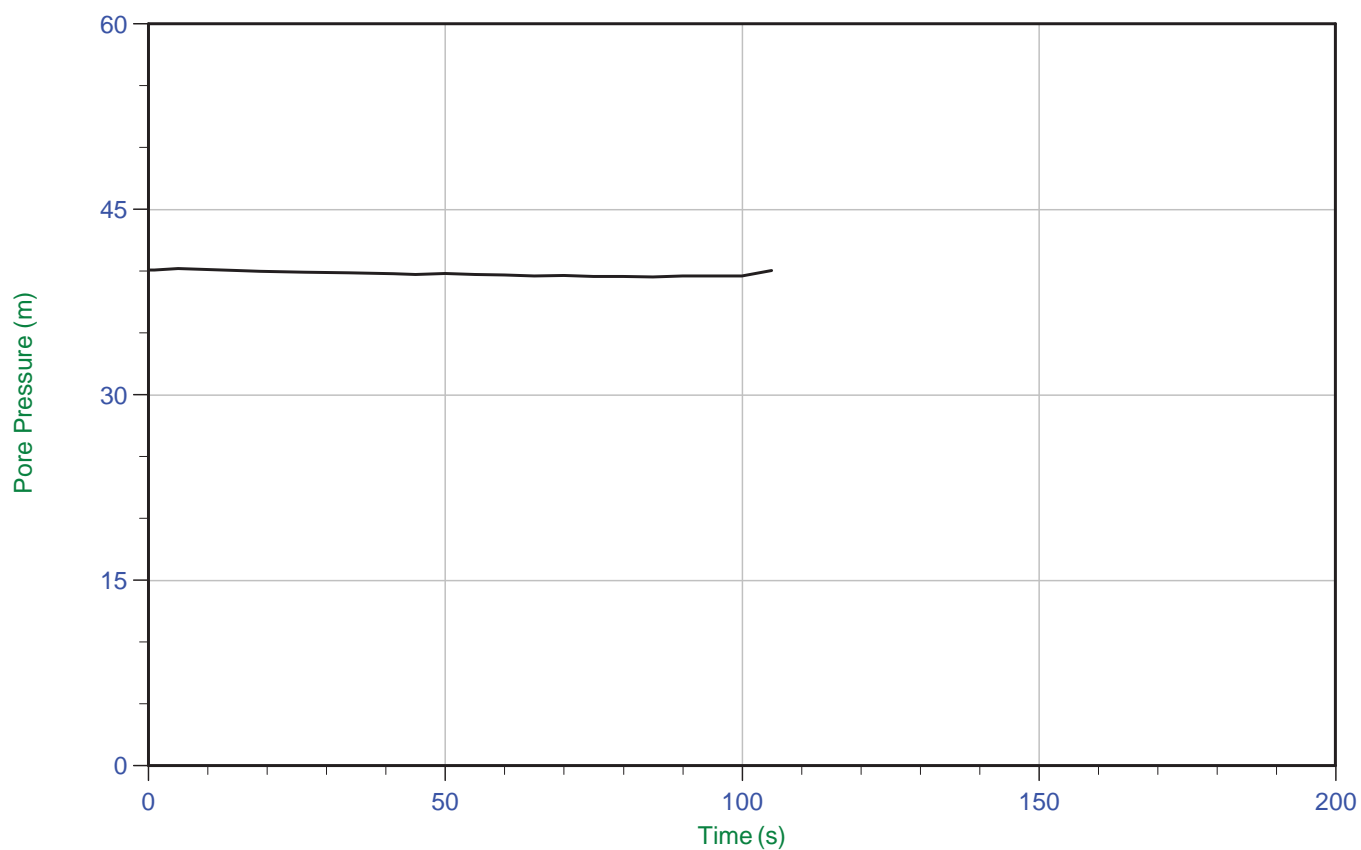
Trace Summary: Filename: 17-05010_CPD003.PPF U Min: 38.3 m WT: -23.245 m / -76.262 ft
 Depth: 15.300 m / 50.196 ft U Max: 38.8 m Ueq: 38.5 m
 Duration: 400.0 s



Baffinland

Job No: 17-05010
Date: 04/06/2017 13:34
Site: Milne Port Expansion

Sounding: CPT17-D003
Cone: 338:T1500F15U500 Area=15 cm²



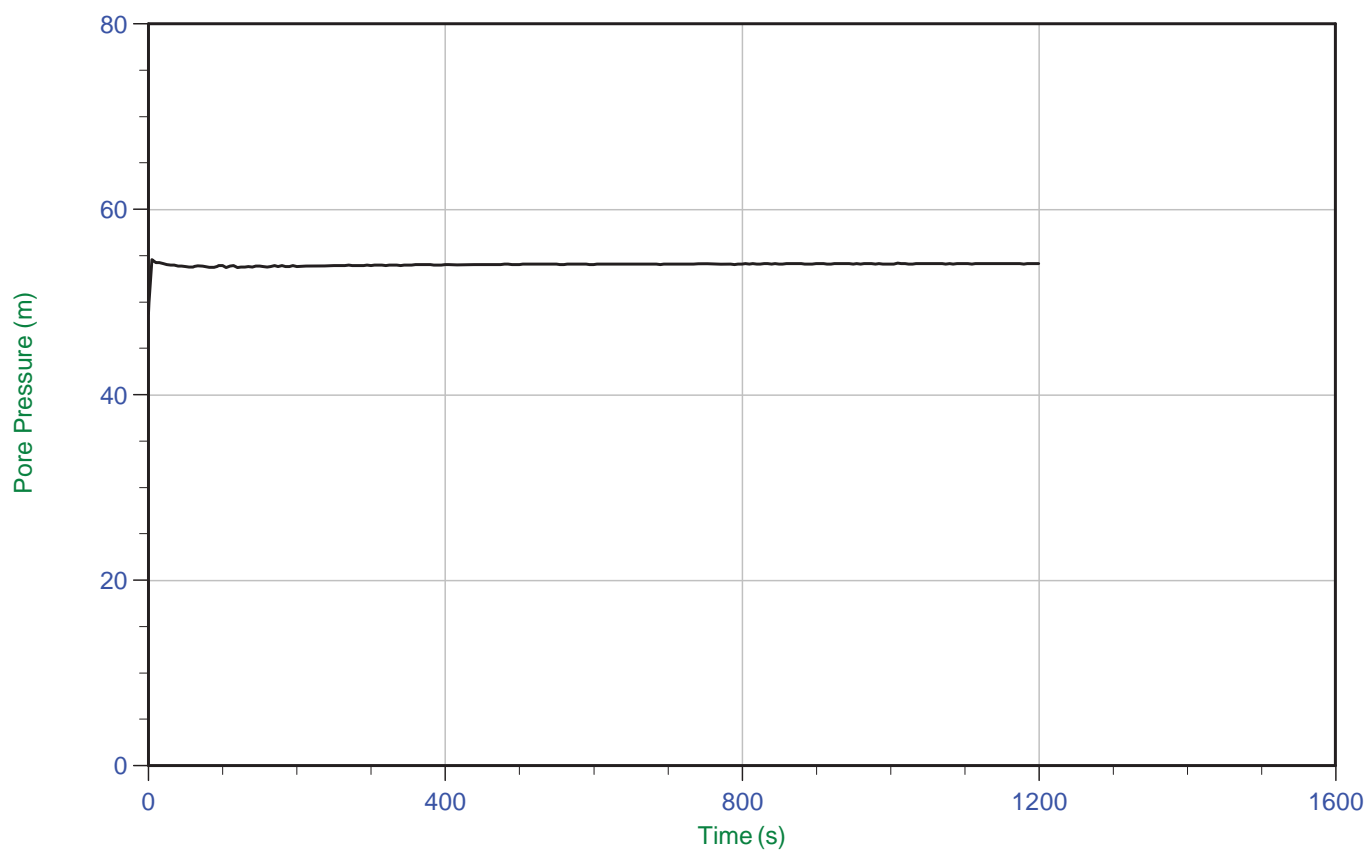
Trace Summary: Filename: 17-05010_CPD003.PPF U Min: 39.5 m WT: -23.336 m / -76.561 ft
 Depth: 16.300 m / 53.477 ft U Max: 40.2 m Ueq: 39.6 m
 Duration: 105.0 s



Baffinland

Job No: 17-05010
Date: 04/06/2017 13:34
Site: Milne Port Expansion

Sounding: CPT17-D003
Cone: 338:T1500F15U500 Area=15 cm²



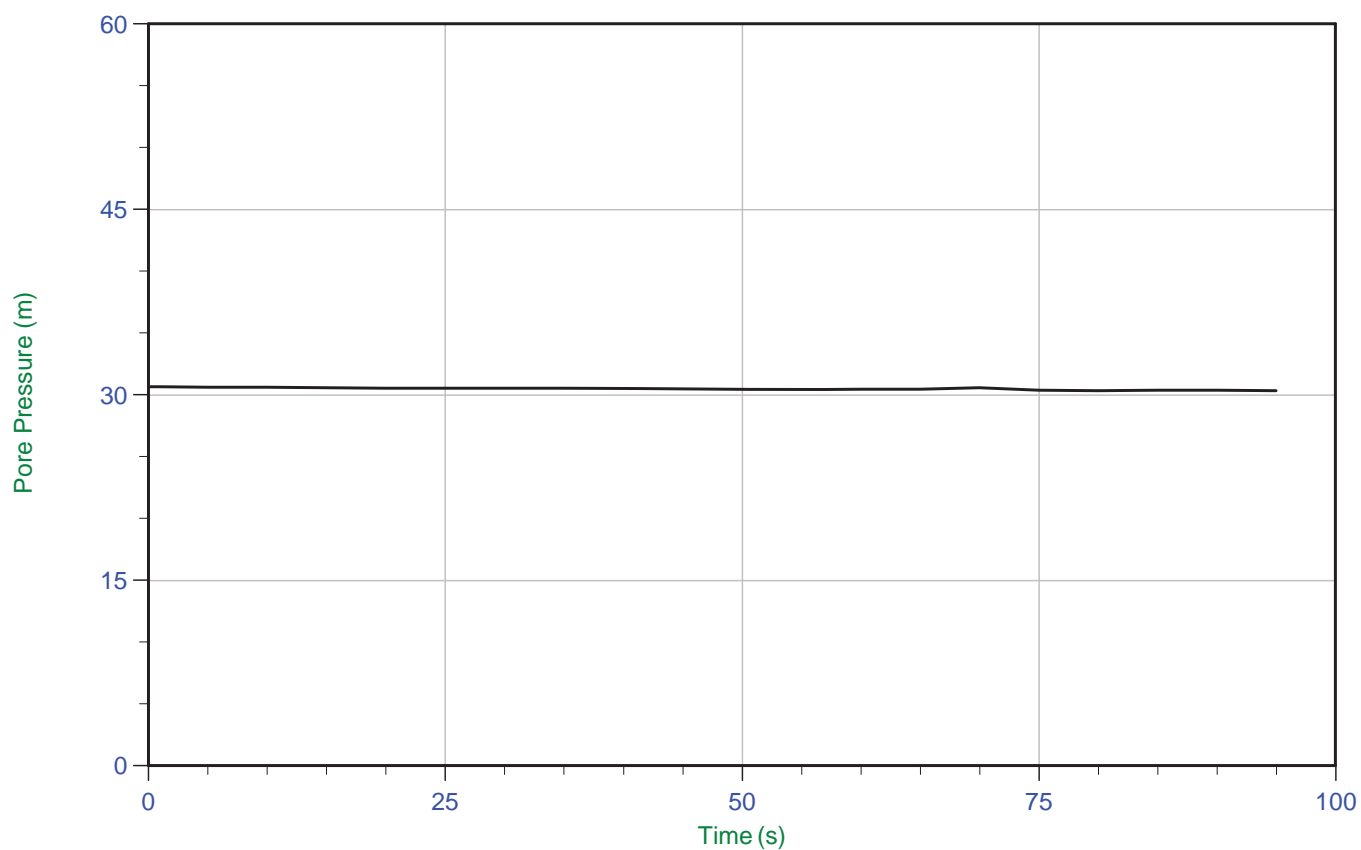
Trace Summary: Filename: 17-05010_CPD003.PPF U Min: 48.8 m WT: -23.716 m / -77.807 ft
 Depth: 30.425 m / 99.818 ft U Max: 54.6 m Ueq: 54.1 m
 Duration: 1200.0 s



Baffinland

Job No: 17-05010
Date: 04/04/2017 16:44
Site: Milne Port Expansion

Sounding: SCPT17-D004
Cone: 338:T1500F15U500 Area=15 cm²



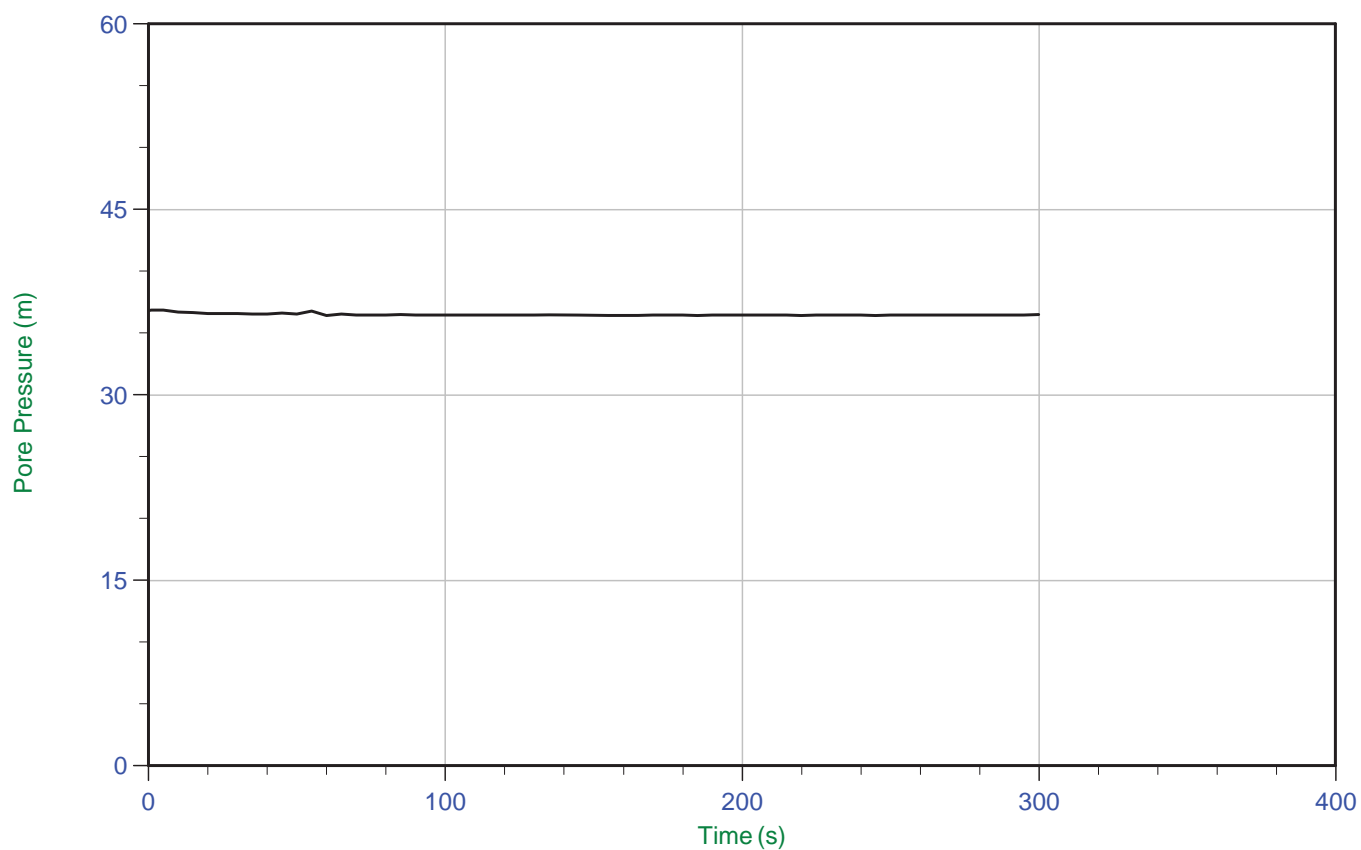
Trace Summary: Filename: 17-05010_SPD004.PPF U Min: 30.3 m WT: -27.149 m / -89.070 ft
 Depth: 3.275 m / 10.745 ft U Max: 30.7 m Ueq: 30.4 m
 Duration: 95.0 s



Baffinland

Job No: 17-05010
Date: 04/04/2017 16:44
Site: Milne Port Expansion

Sounding: SCPT17-D004
Cone: 338:T1500F15U500 Area=15 cm²



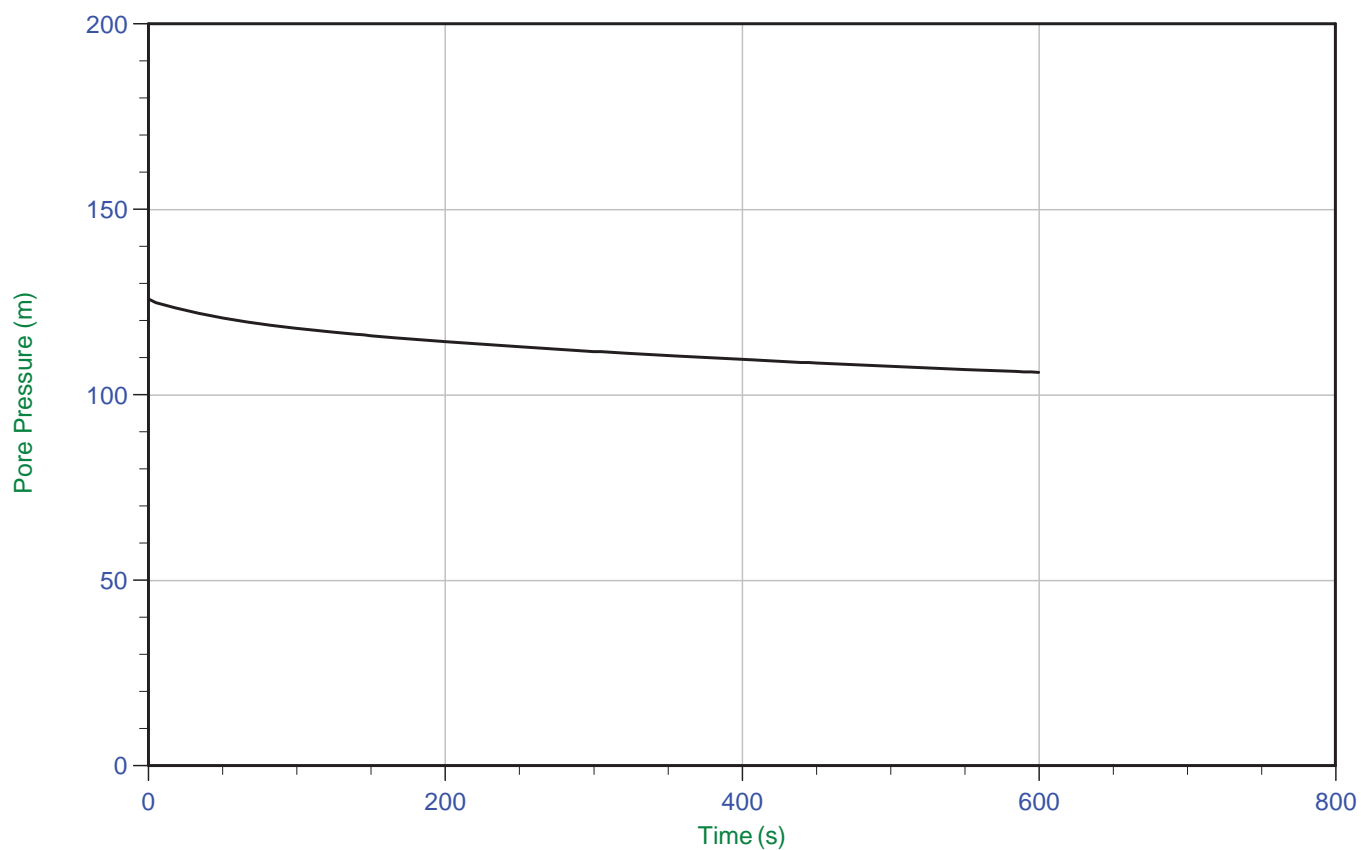
Trace Summary: Filename: 17-05010_SPD004.PPF U Min: 36.4 m WT: -27.285 m / -89.517 ft
Depth: 9.200 m / 30.183 ft U Max: 36.9 m Ueq: 36.5 m
Duration: 300.0 s



Baffinland

Job No: 17-05010
Date: 04/04/2017 16:44
Site: Milne Port Expansion

Sounding: SCPT17-D004
Cone: 338:T1500F15U500 Area=15 cm²



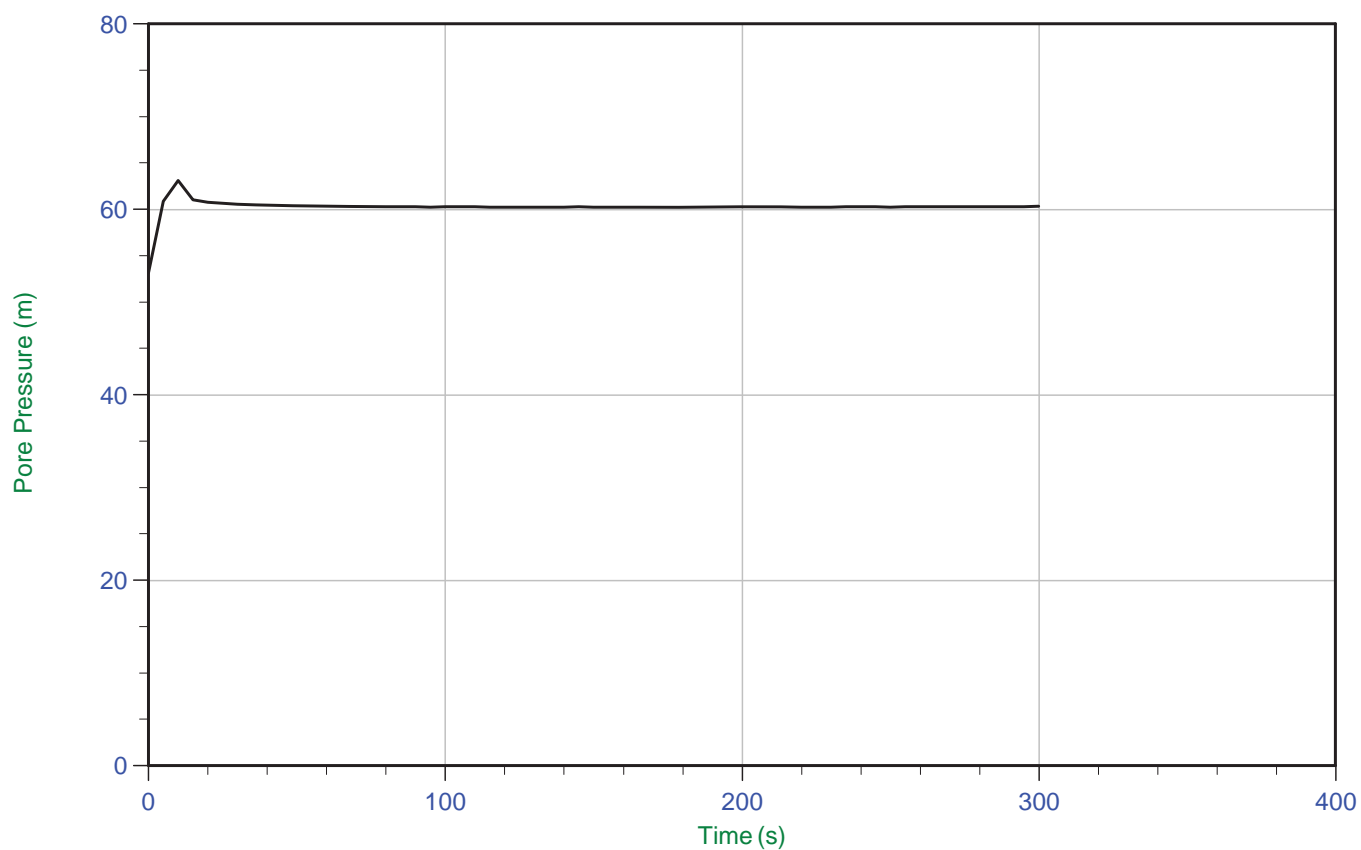
Trace Summary: Filename: 17-05010_SPD004.PPF U Min: 106.1 m
Depth: 30.475 m / 99.982 ft U Max: 125.8 m
Duration: 600.0 s



Baffinland

Job No: 17-05010
Date: 04/04/2017 16:44
Site: Milne Port Expansion

Sounding: SCPT17-D004
Cone: 338:T1500F15U500 Area=15 cm²



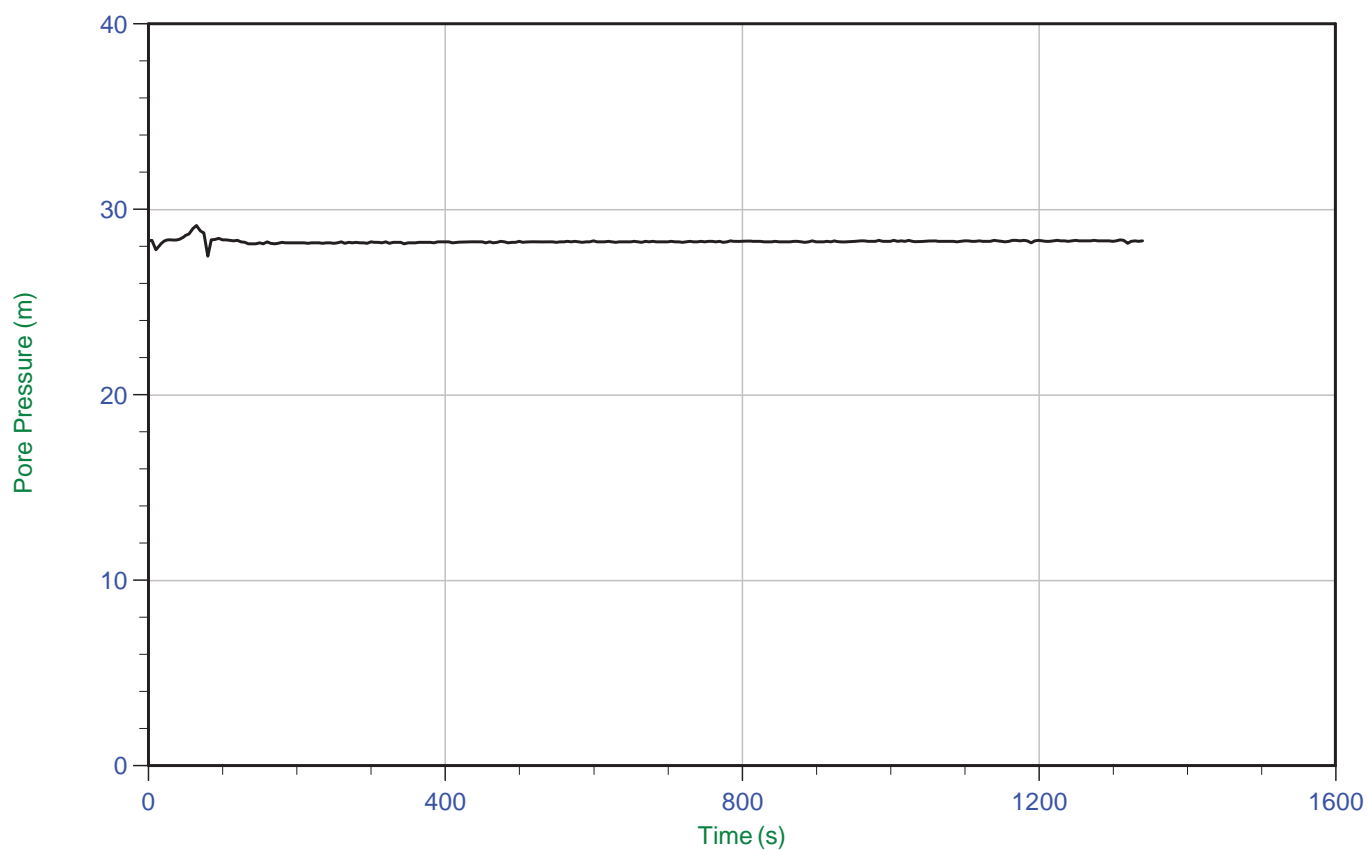
Trace Summary: Filename: 17-05010_SPD004.PPF U Min: 53.2 m WT: -28.233 m / -92.627 ft
 Depth: 32.050 m / 105.150 ft U Max: 63.1 m Ueq: 60.3 m
 Duration: 300.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



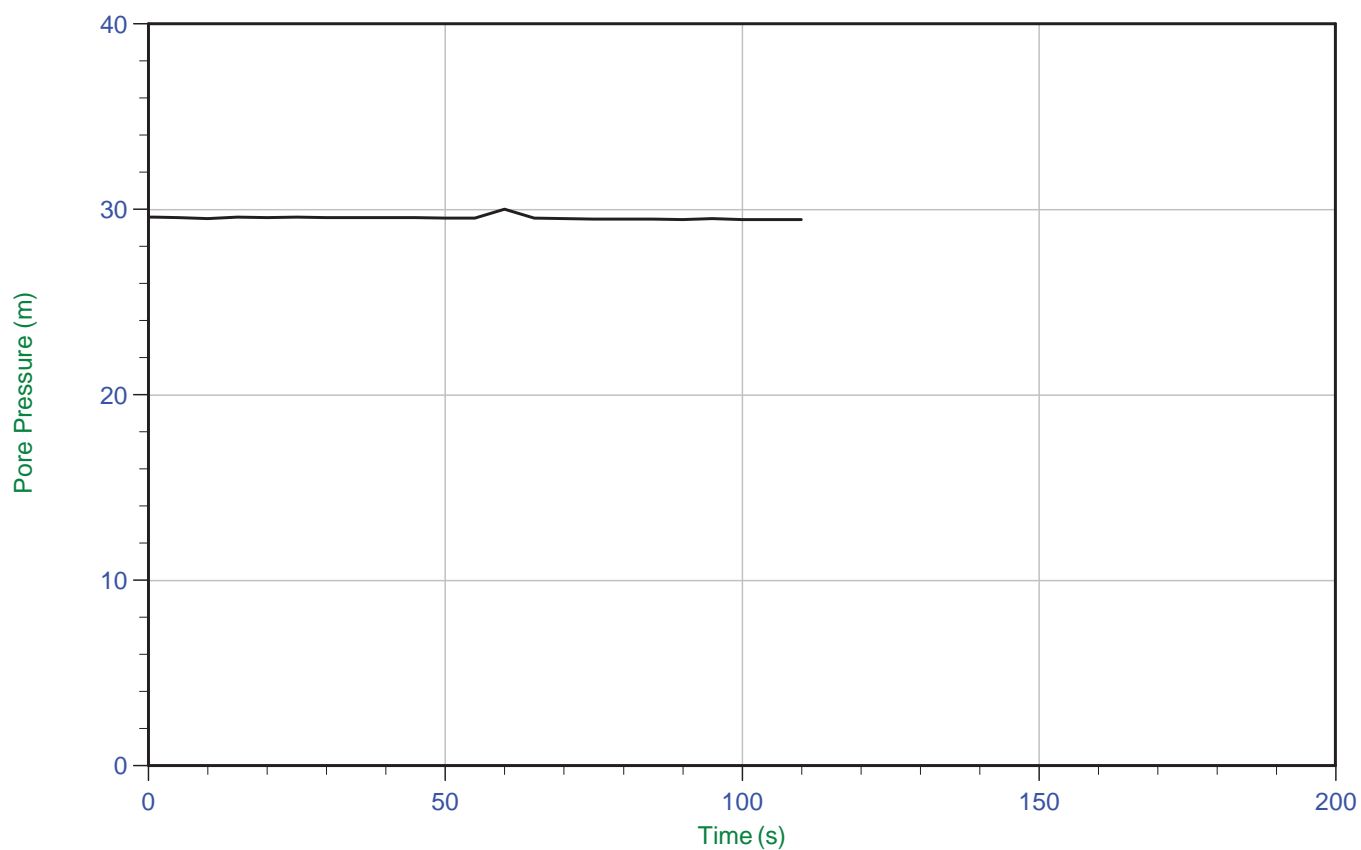
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 27.5 m WT: -26.008 m / -85.327 ft
Depth: 2.275 m / 7.464 ft U Max: 29.1 m Ueq: 28.3 m
Duration: 1340.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



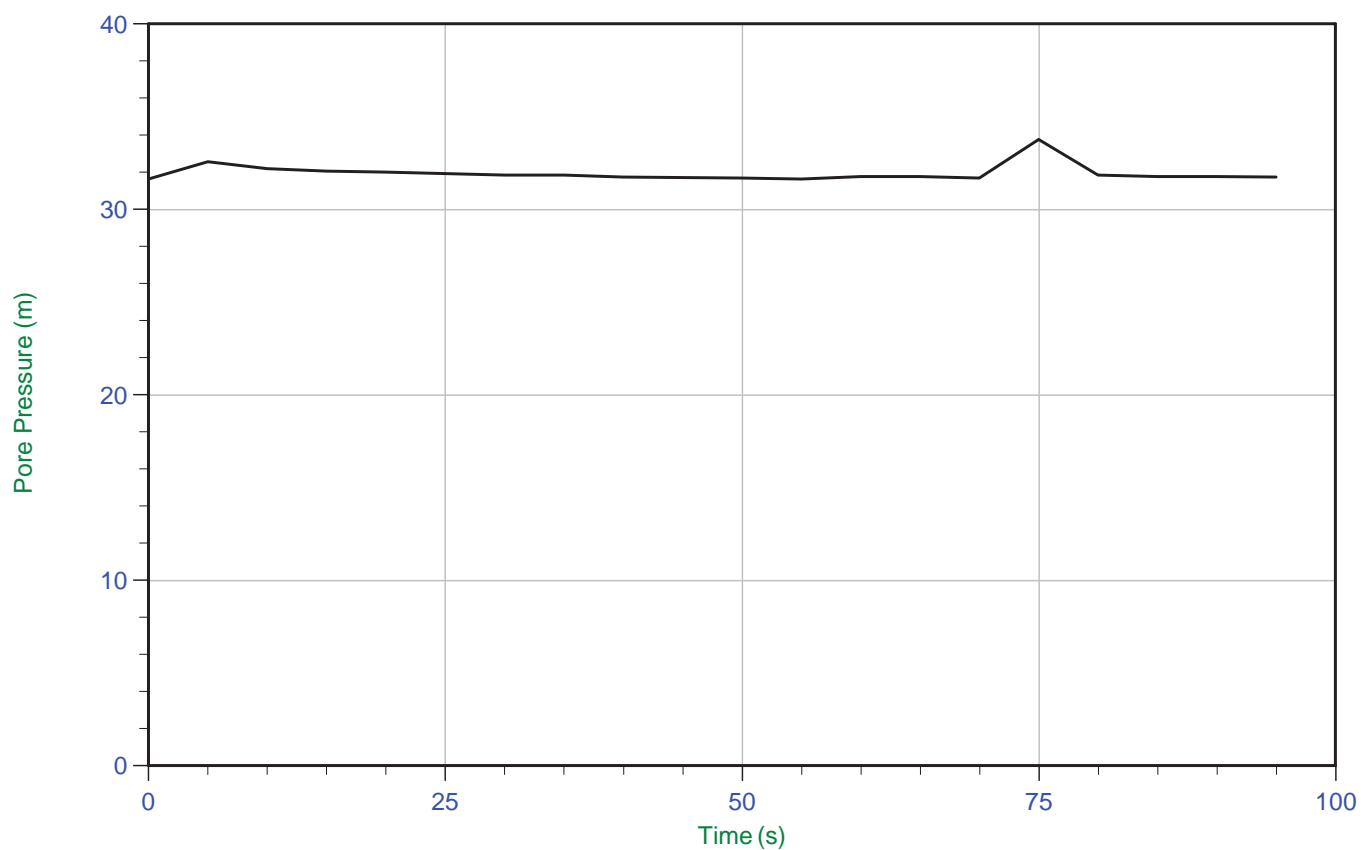
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 29.4 m WT: -26.170 m / -85.859 ft
 Depth: 3.325 m / 10.909 ft U Max: 30.0 m Ueq: 29.5 m
 Duration: 110.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



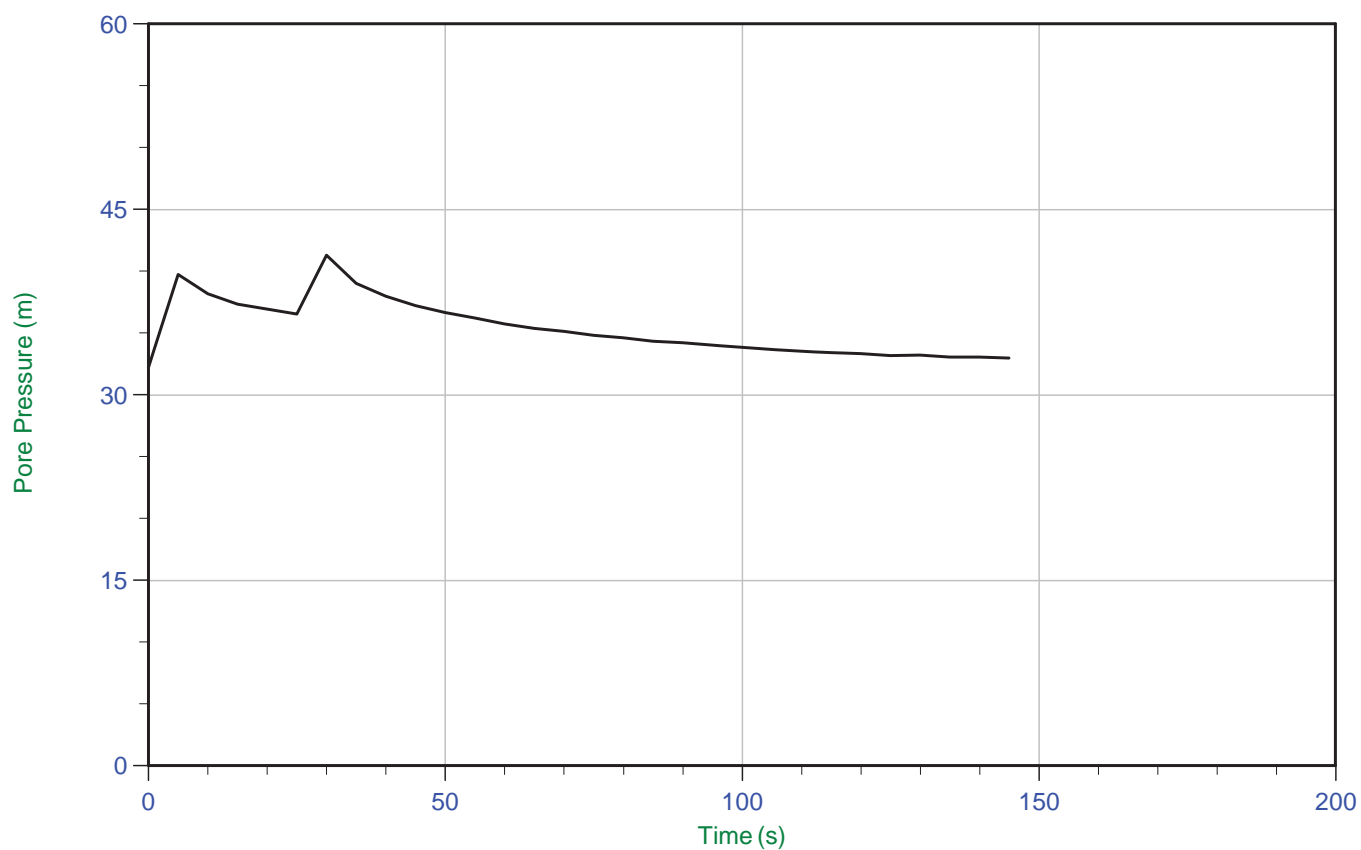
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 31.6 m WT: -26.383 m / -86.557 ft
 Depth: 5.375 m / 17.634 ft U Max: 33.8 m Ueq: 31.8 m
 Duration: 95.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



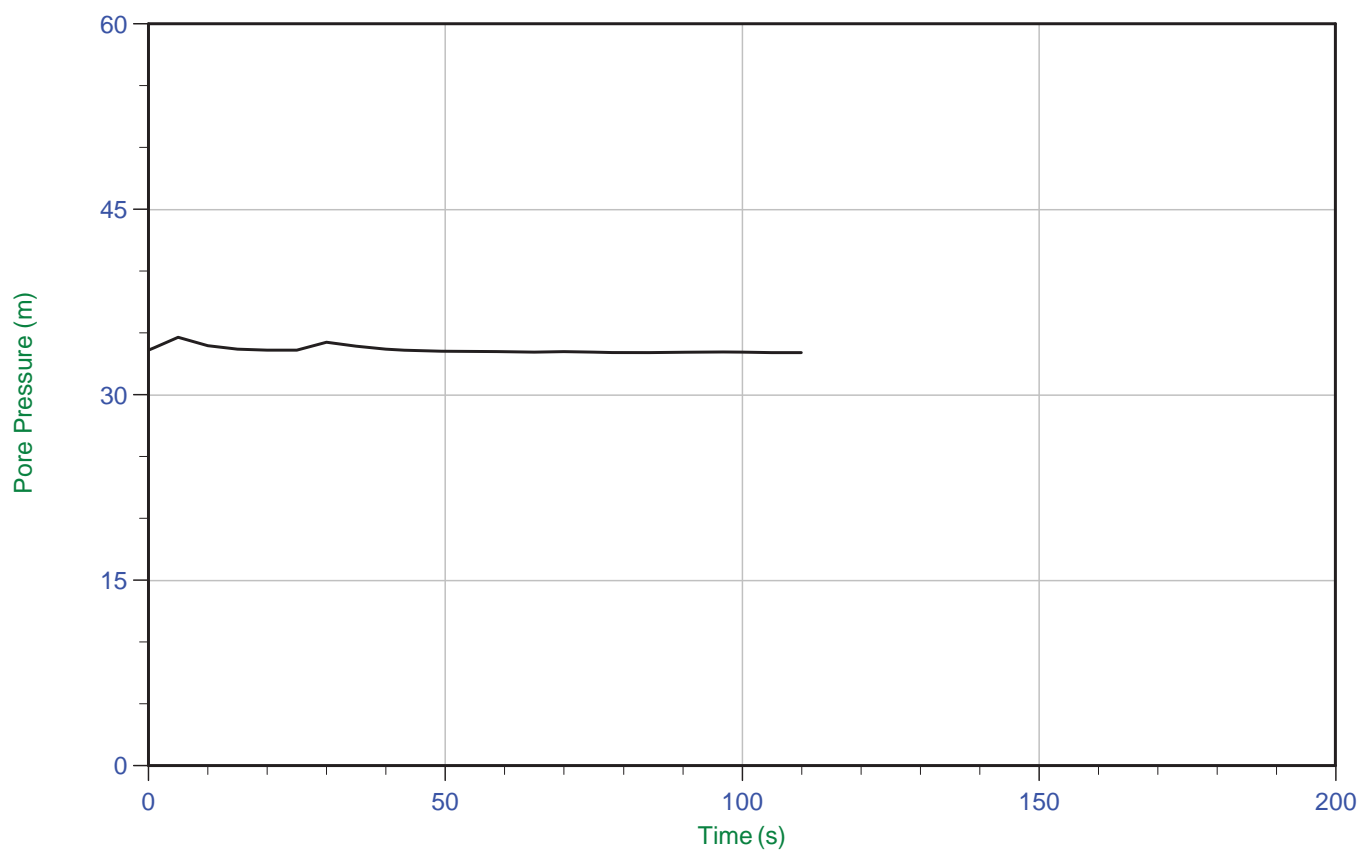
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 32.2 m
Depth: 6.375 m / 20.915 ft U Max: 41.3 m
Duration: 145.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



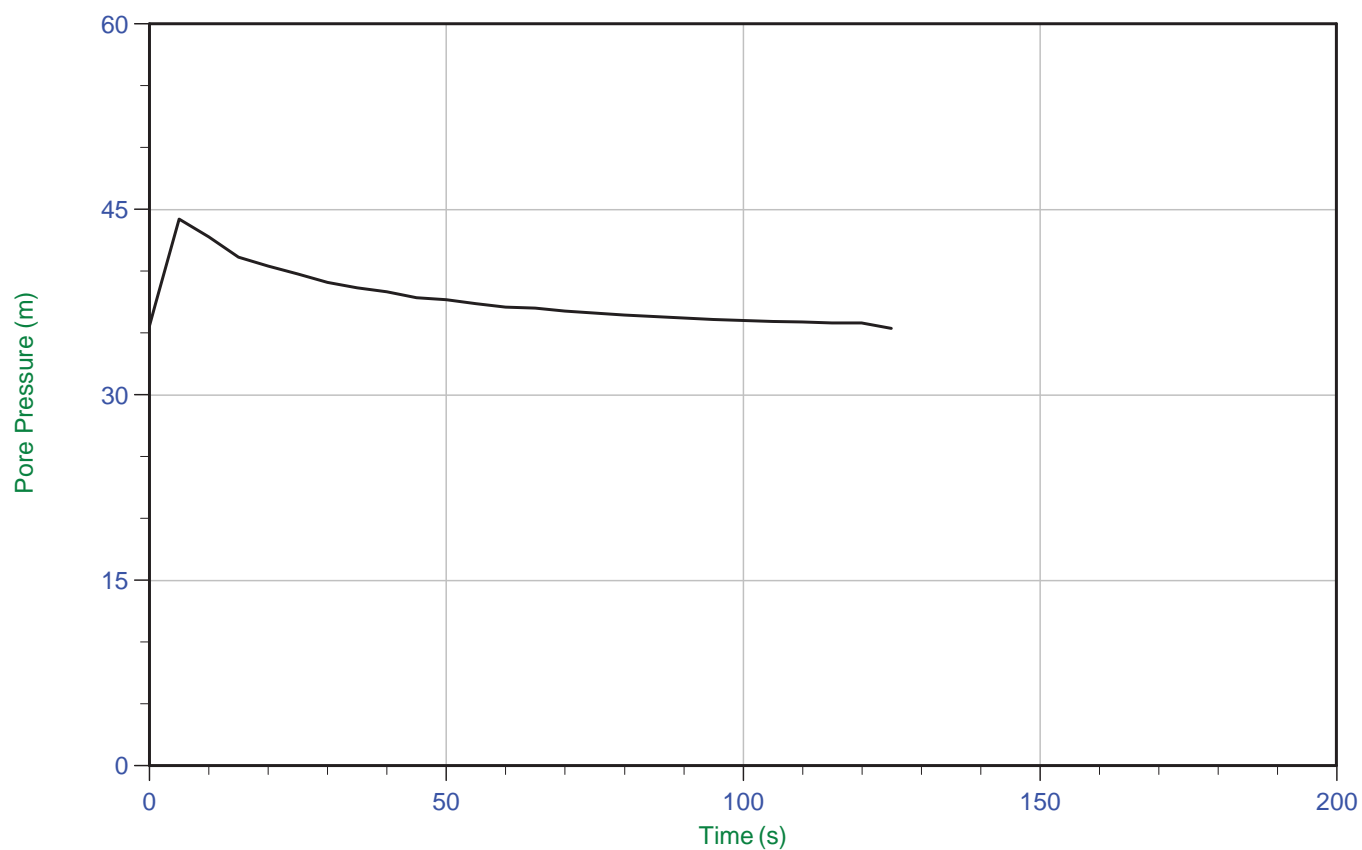
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 33.4 m WT: -26.055 m / -85.481 ft
 Depth: 7.400 m / 24.278 ft U Max: 34.6 m Ueq: 33.5 m
 Duration: 110.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



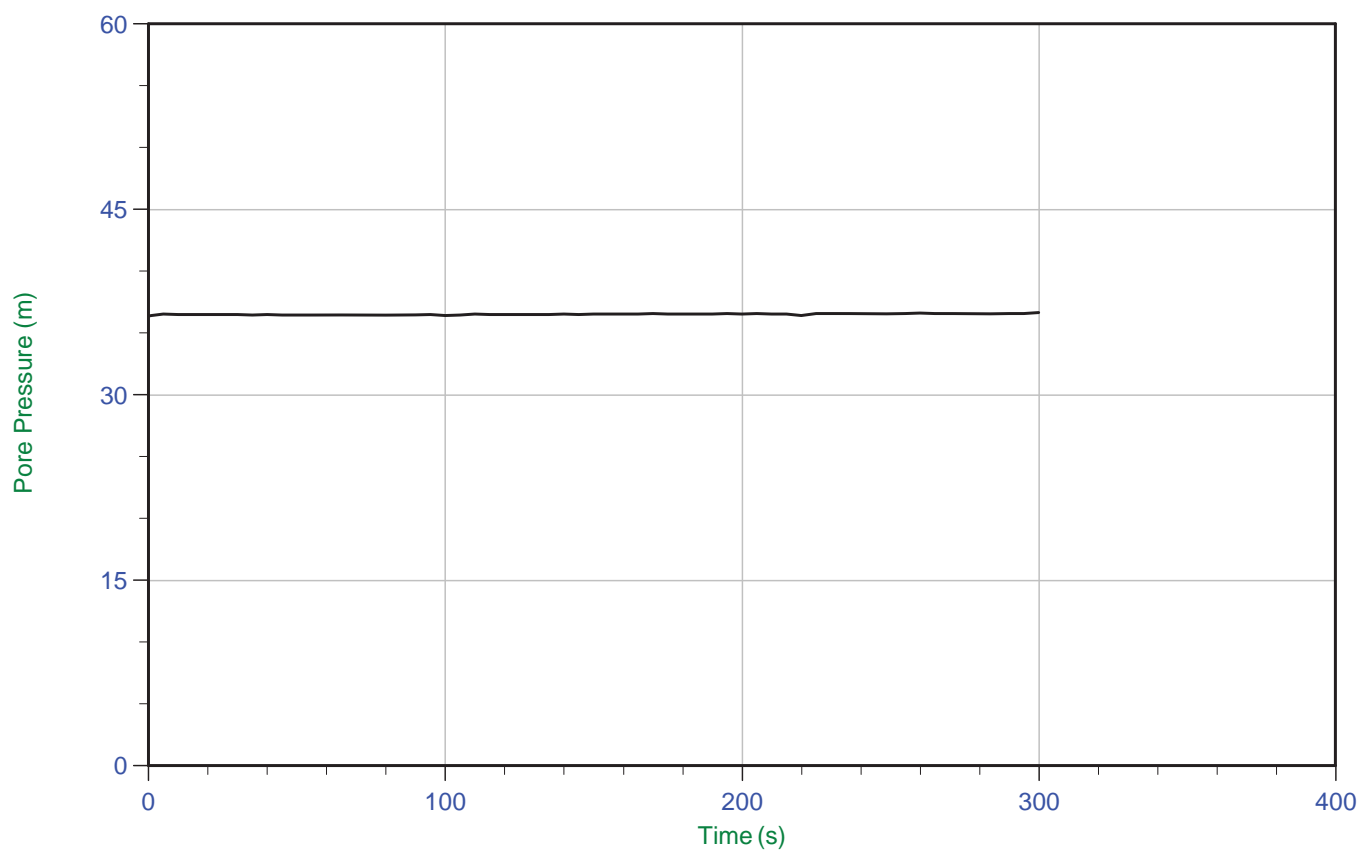
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 35.4 m
 Depth: 9.350 m / 30.675 ft U Max: 44.2 m
 Duration: 125.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



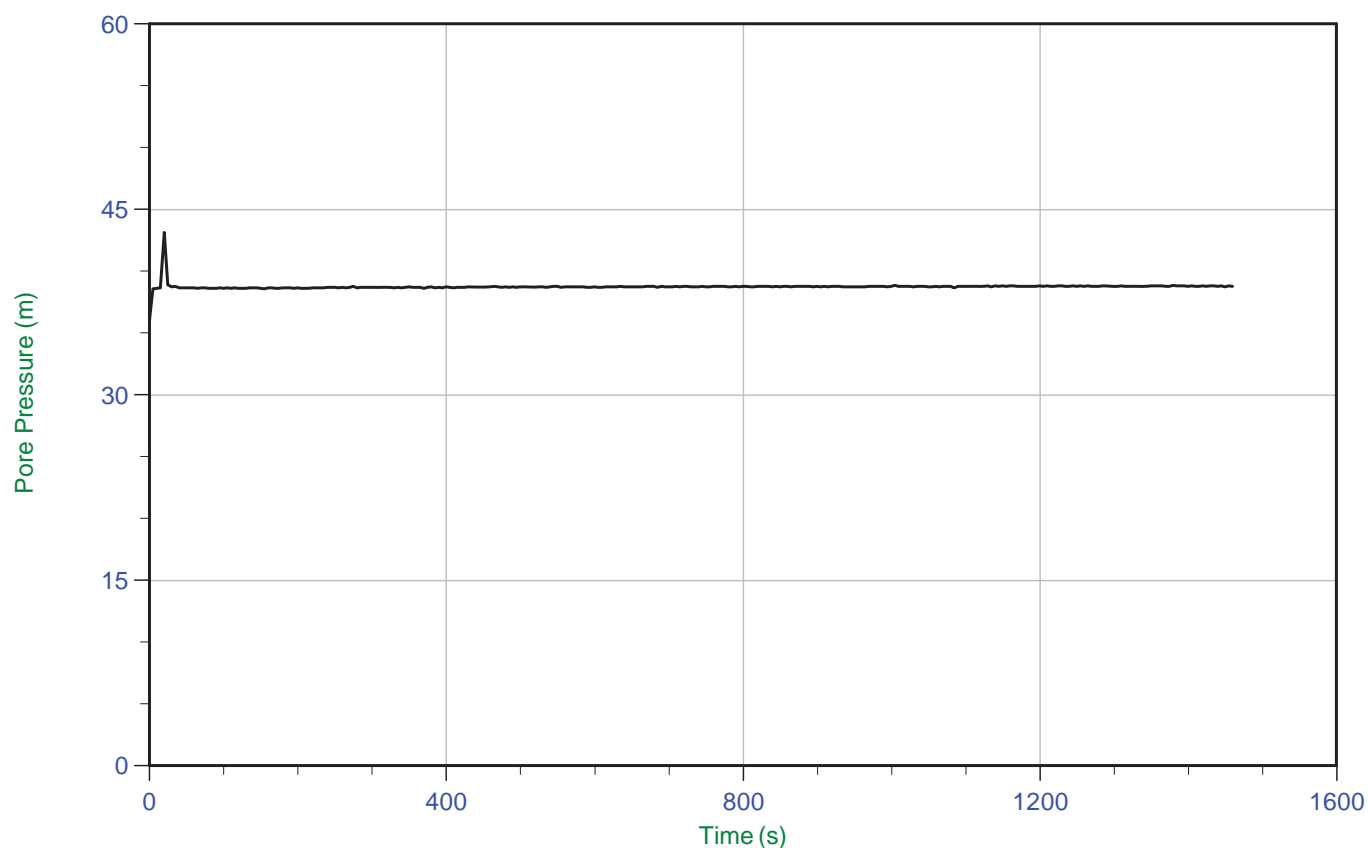
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 36.4 m WT: -26.185 m / -85.908 ft
 Depth: 10.300 m / 33.792 ft U Max: 36.6 m Ueq: 36.5 m
 Duration: 300.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



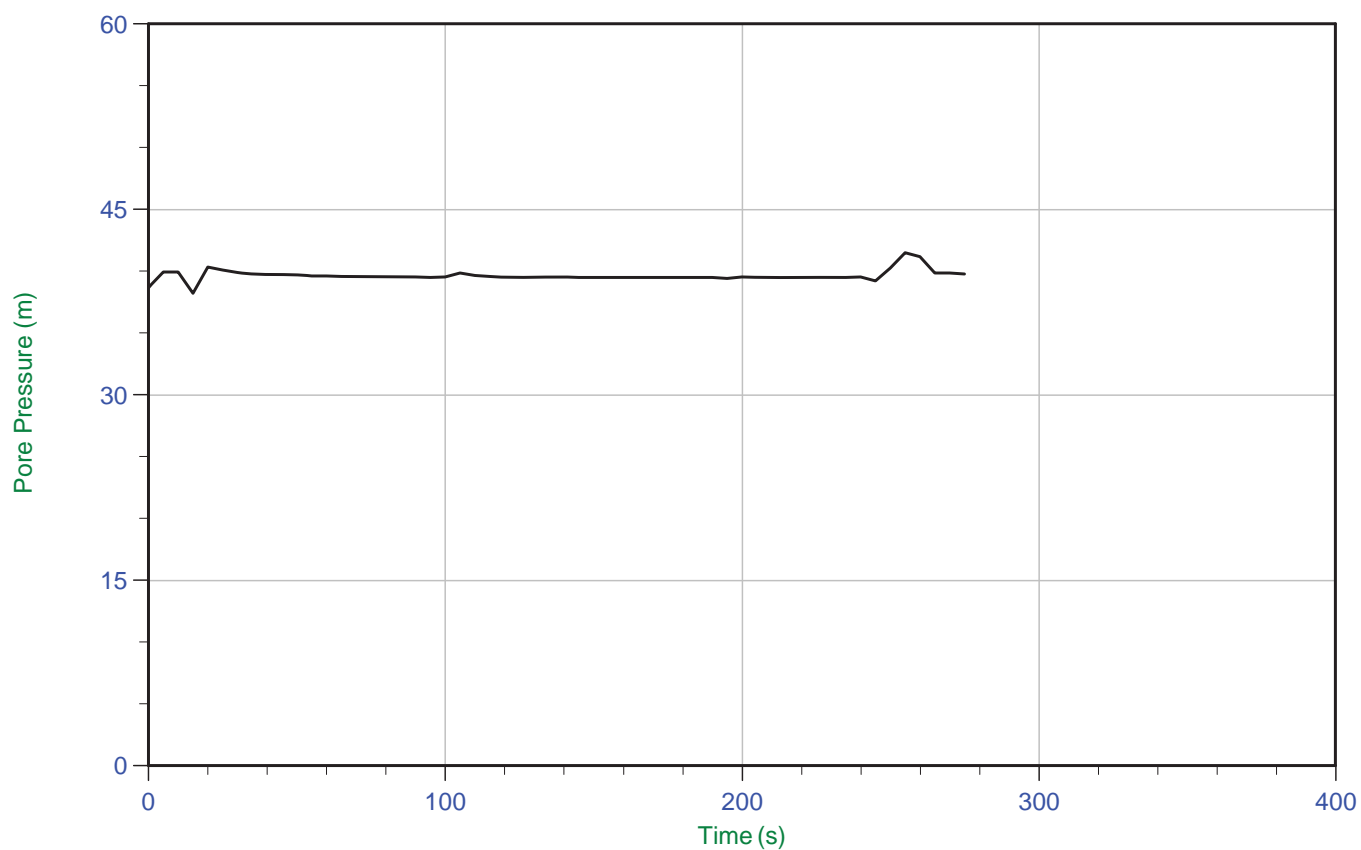
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 35.9 m WT: -26.438 m / -86.738 ft
 Depth: 12.350 m / 40.518 ft U Max: 43.1 m Ueq: 38.8 m
 Duration: 1460.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



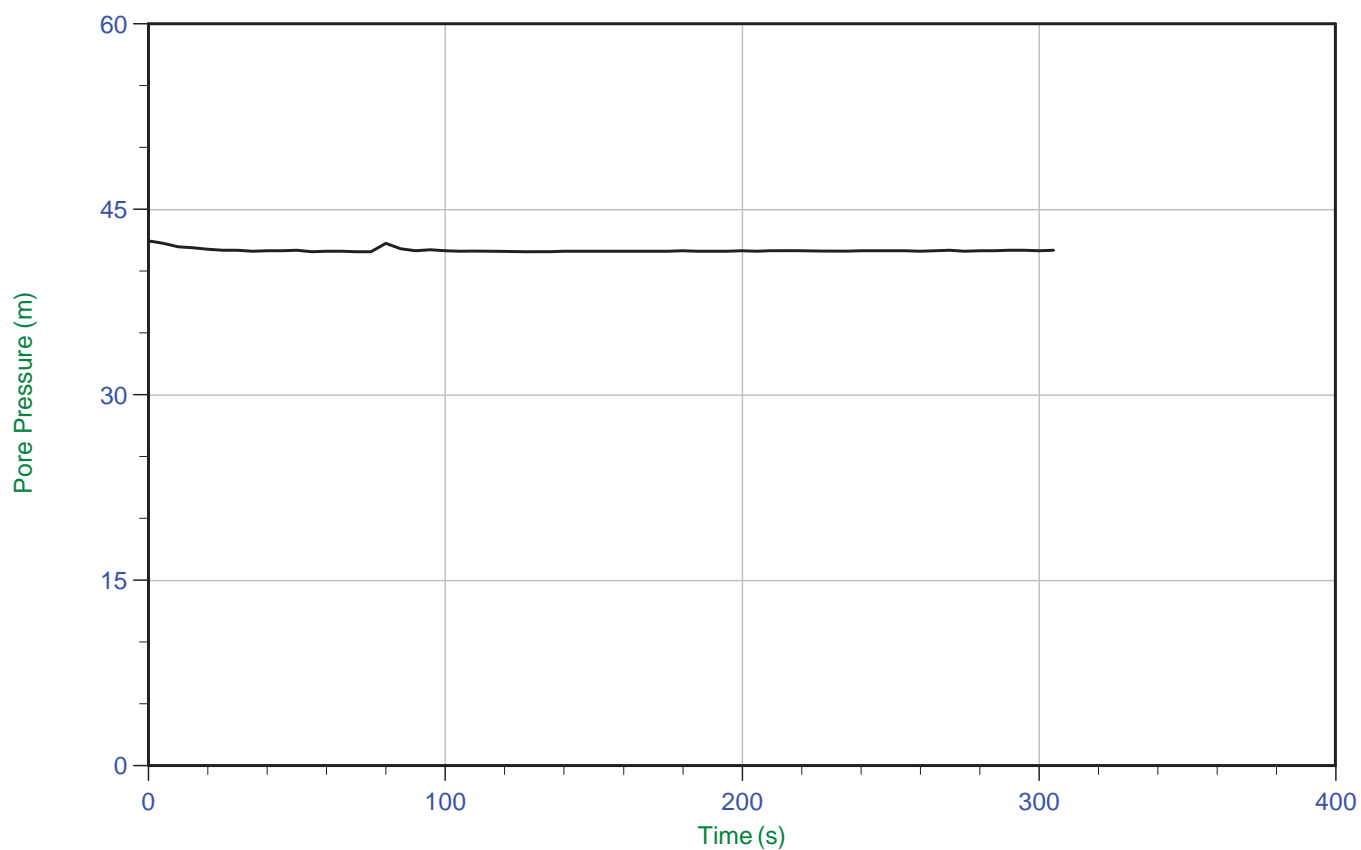
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 38.2 m
Depth: 13.175 m / 43.225 ft U Max: 41.5 m
Duration: 275.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



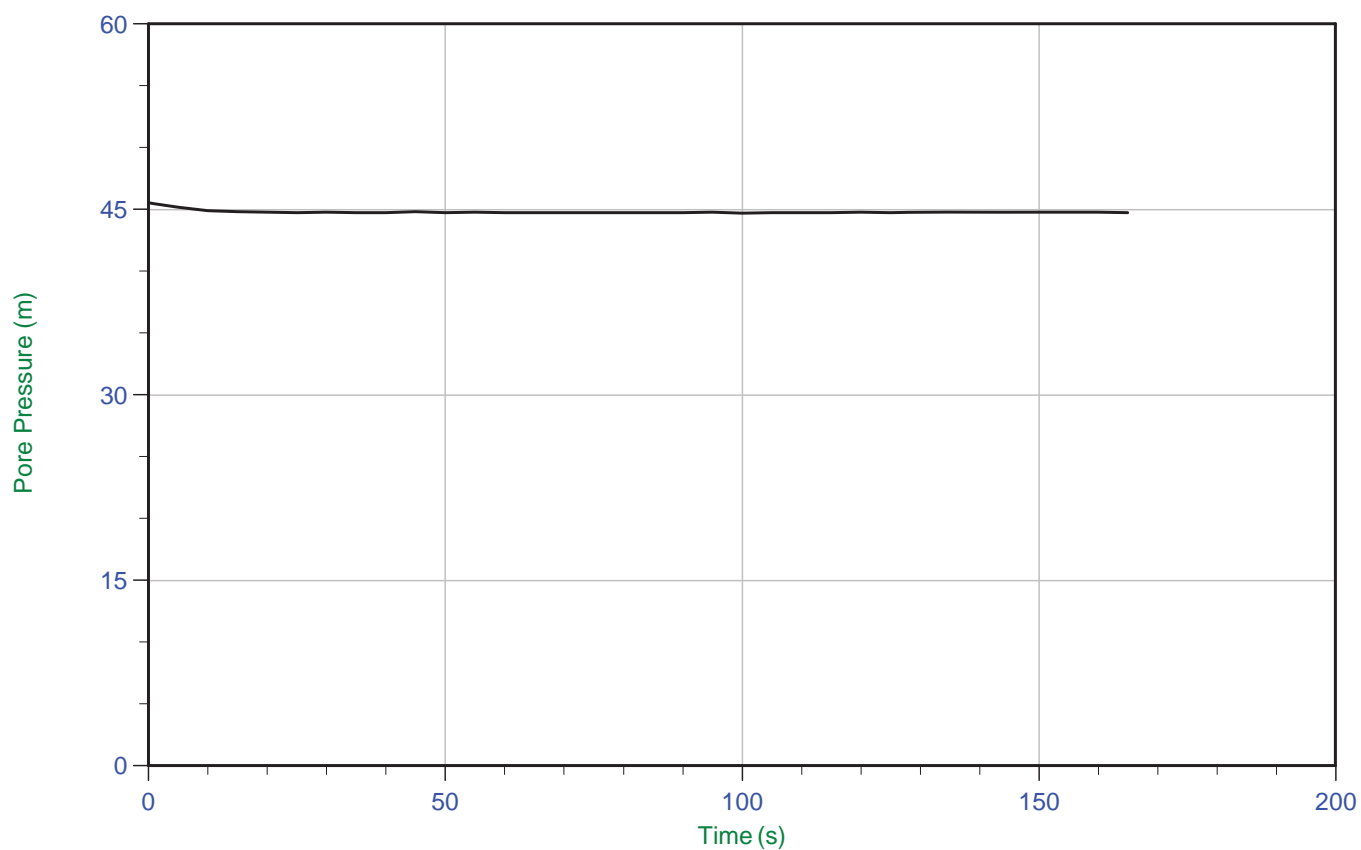
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 41.6 m WT: -26.647 m / -87.423 ft
 Depth: 15.050 m / 49.376 ft U Max: 42.4 m Ueq: 41.7 m
 Duration: 305.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



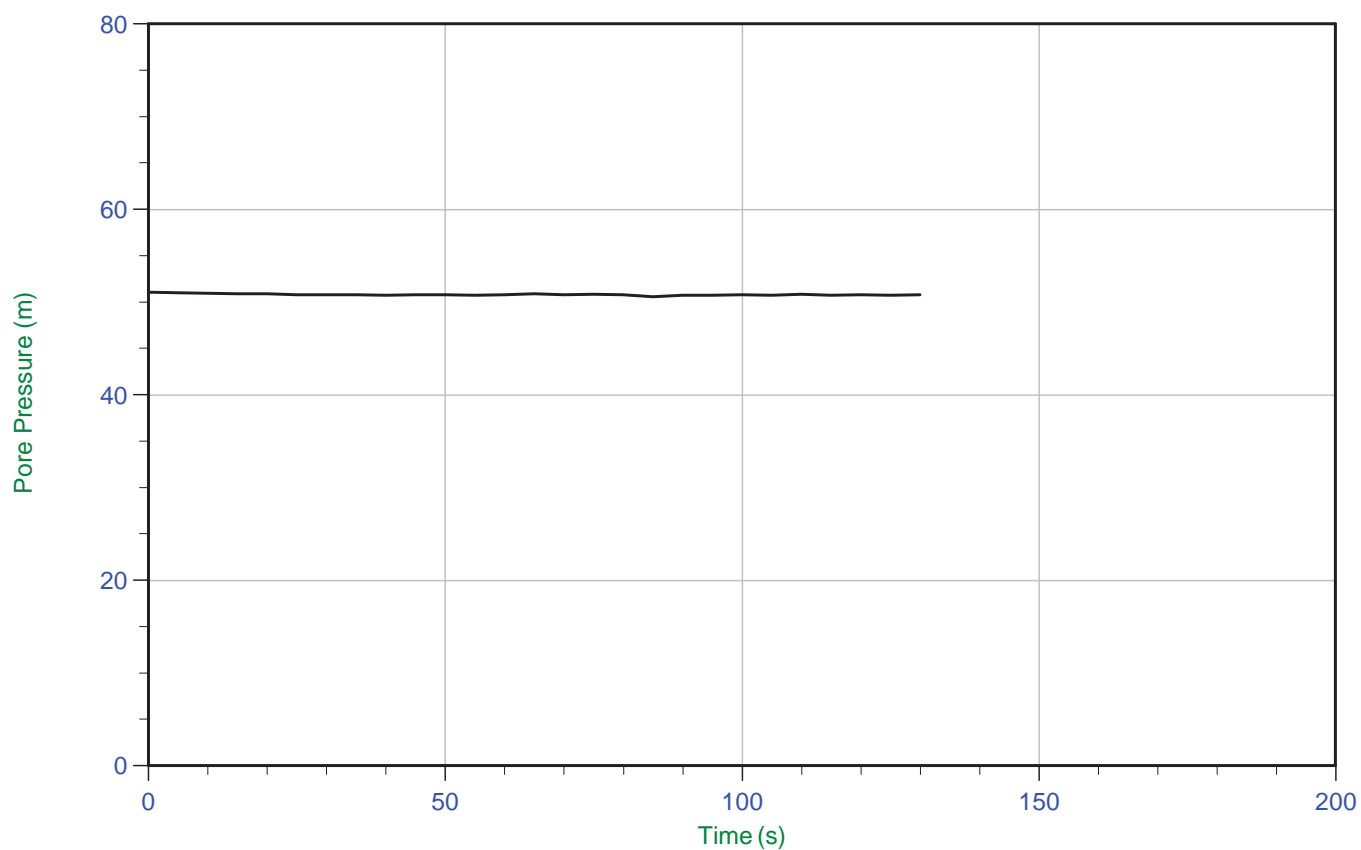
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 44.7 m WT: -26.627 m / -87.358 ft
 Depth: 18.100 m / 59.382 ft U Max: 45.5 m Ueq: 44.7 m
 Duration: 165.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



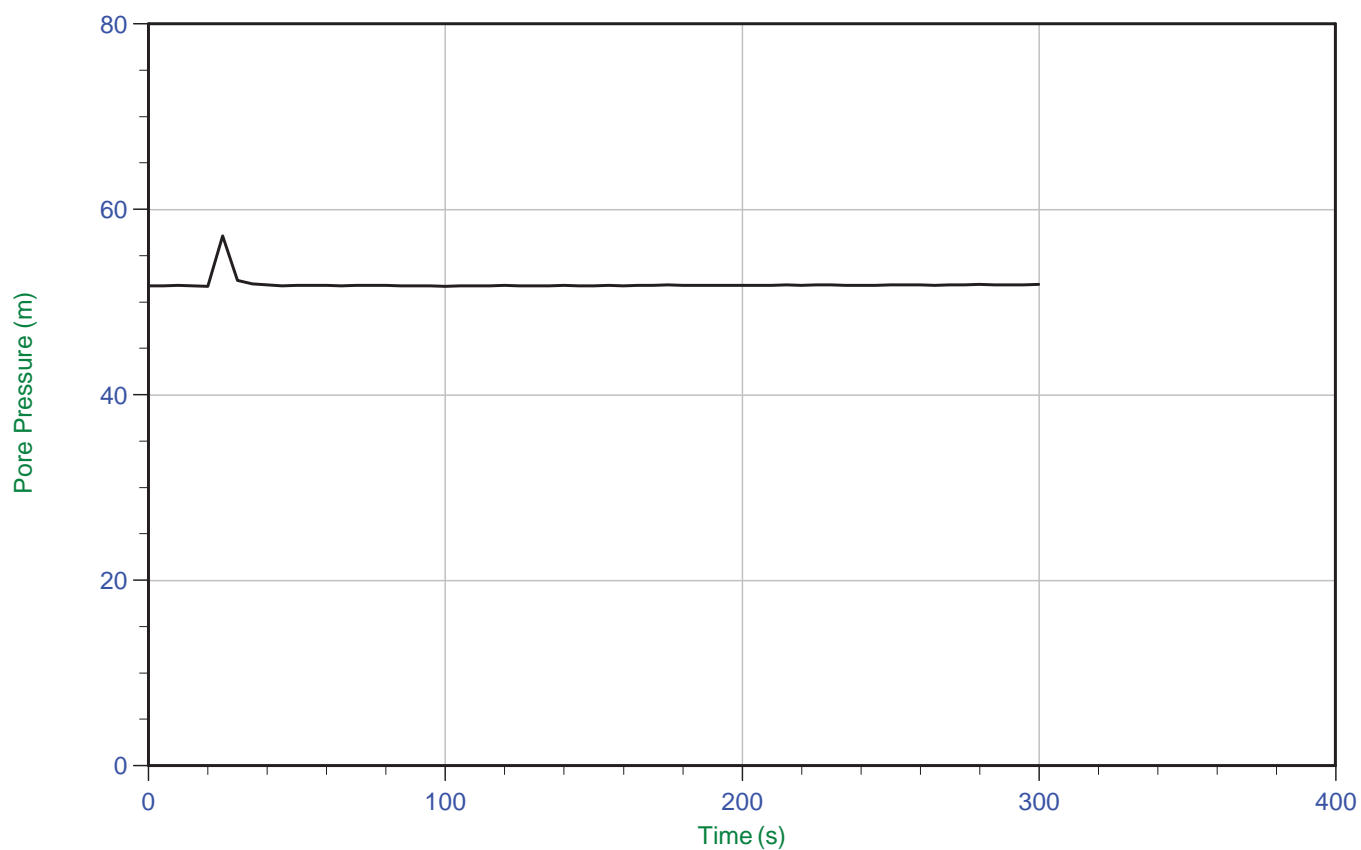
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 50.6 m WT: -26.822 m / -87.998 ft
Depth: 23.925 m / 78.493 ft U Max: 51.1 m Ueq: 50.7 m
Duration: 130.0 s



Baffinland

Job No: 17-05010
Date: 04/03/2017 02:19
Site: Milne Port Expansion

Sounding: CPT17-D005
Cone: 338:T1500F15U500 Area=15 cm²



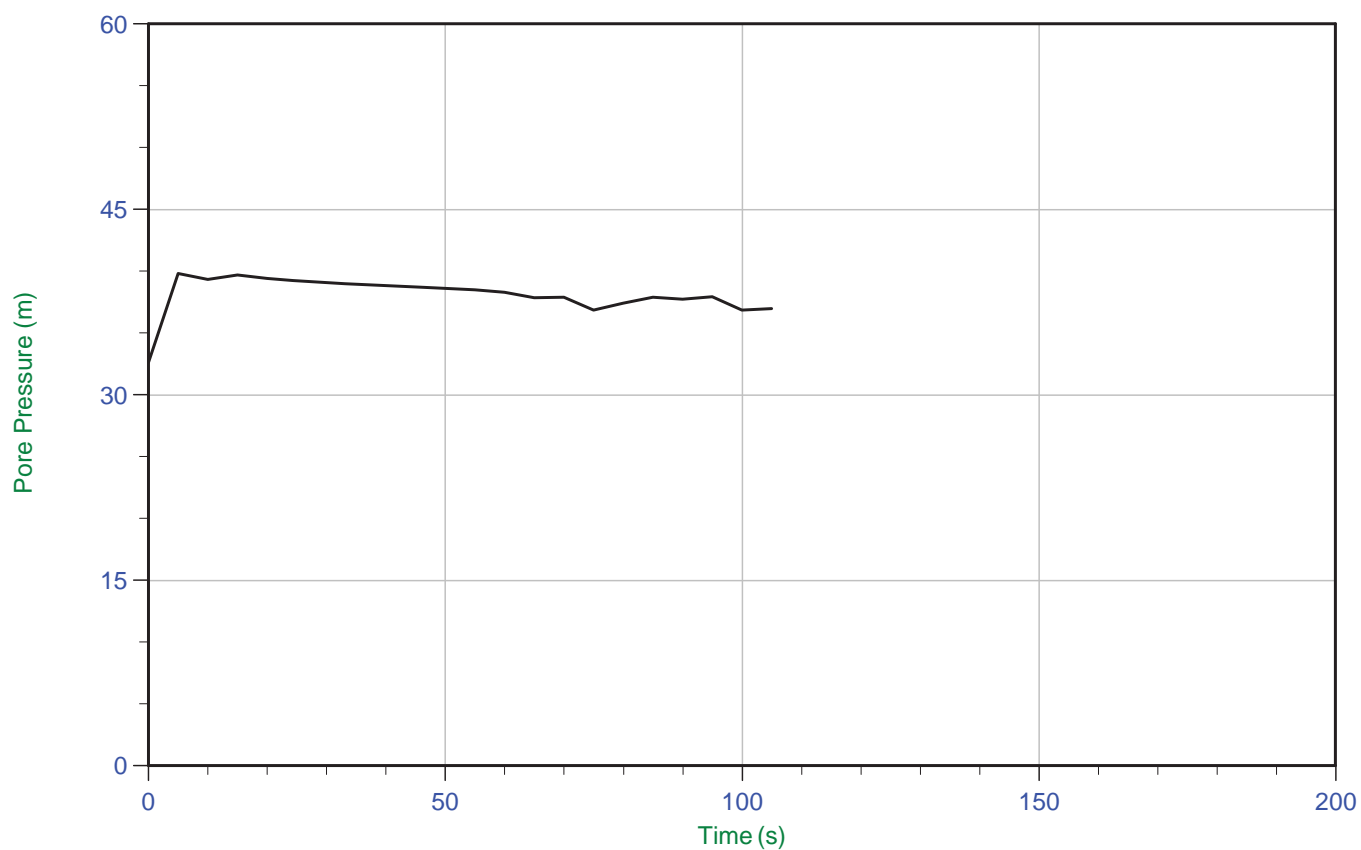
Trace Summary: Filename: 17-05010_CPD005.PPF U Min: 51.7 m WT: -26.754 m / -87.775 ft
 Depth: 25.125 m / 82.430 ft U Max: 57.2 m Ueq: 51.9 m
 Duration: 300.0 s



Baffinland

Job No: 17-05010
Date: 04/06/2017 23:59
Site: Milne Port Expansion

Sounding: CPT17-D006
Cone: 374:T1500F15U500 Area=15 cm²



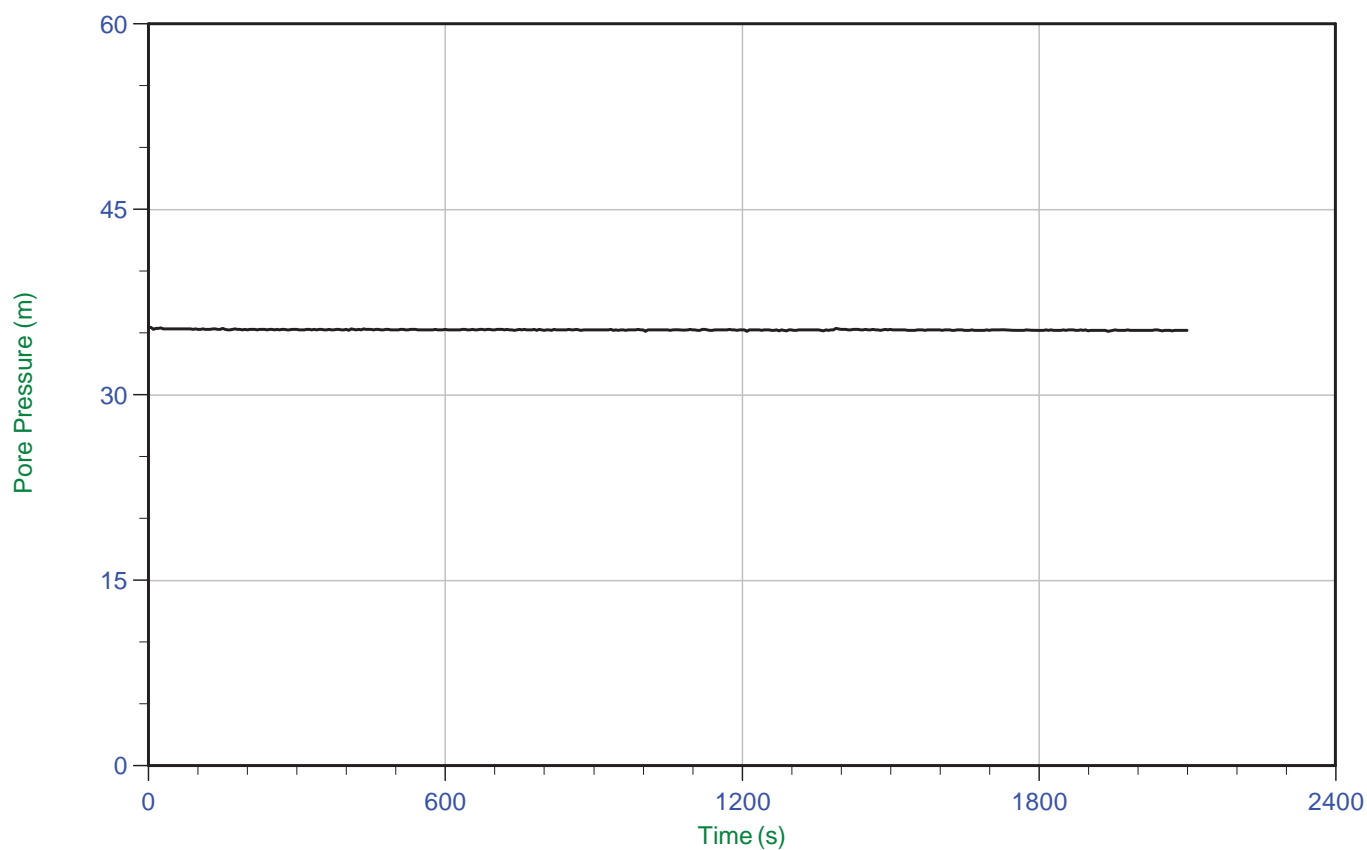
Trace Summary: Filename: 17-05010_CPD006.PPF U Min: 32.6 m
Depth: 2.300 m / 7.546 ft U Max: 39.8 m
Duration: 105.0 s



Baffinland

Job No: 17-05010
Date: 04/06/2017 23:59
Site: Milne Port Expansion

Sounding: CPT17-D006
Cone: 374:T1500F15U500 Area=15 cm²



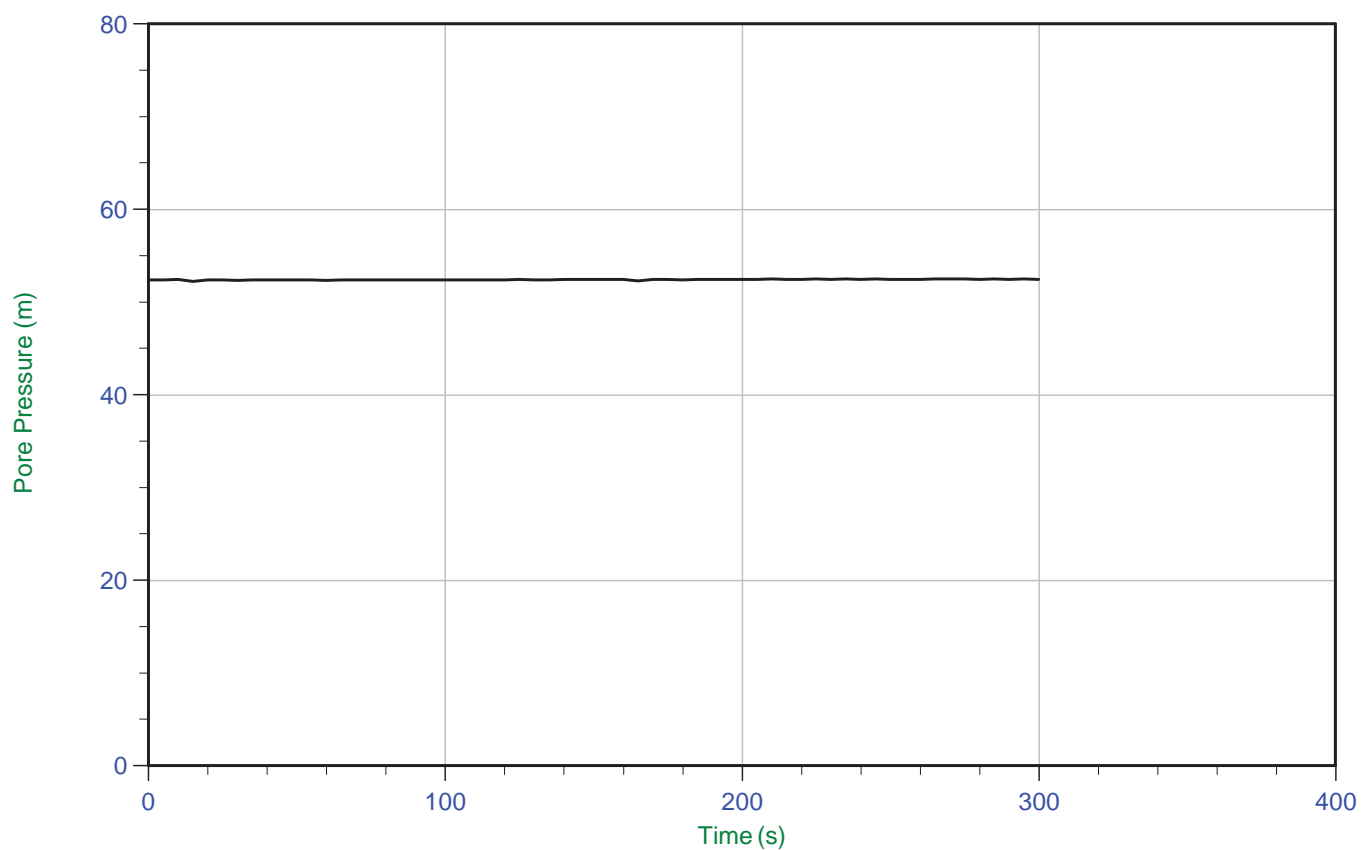
Trace Summary: Filename: 17-05010_CPD006.PPF U Min: 35.1 m WT: -31.973 m / -104.897 ft
 Depth: 3.300 m / 10.827 ft U Max: 35.4 m Ueq: 35.3 m
 Duration: 2100.0 s



Baffinland

Job No: 17-05010
Date: 04/06/2017 23:59
Site: Milne Port Expansion

Sounding: CPT17-D006
Cone: 374:T1500F15U500 Area=15 cm²



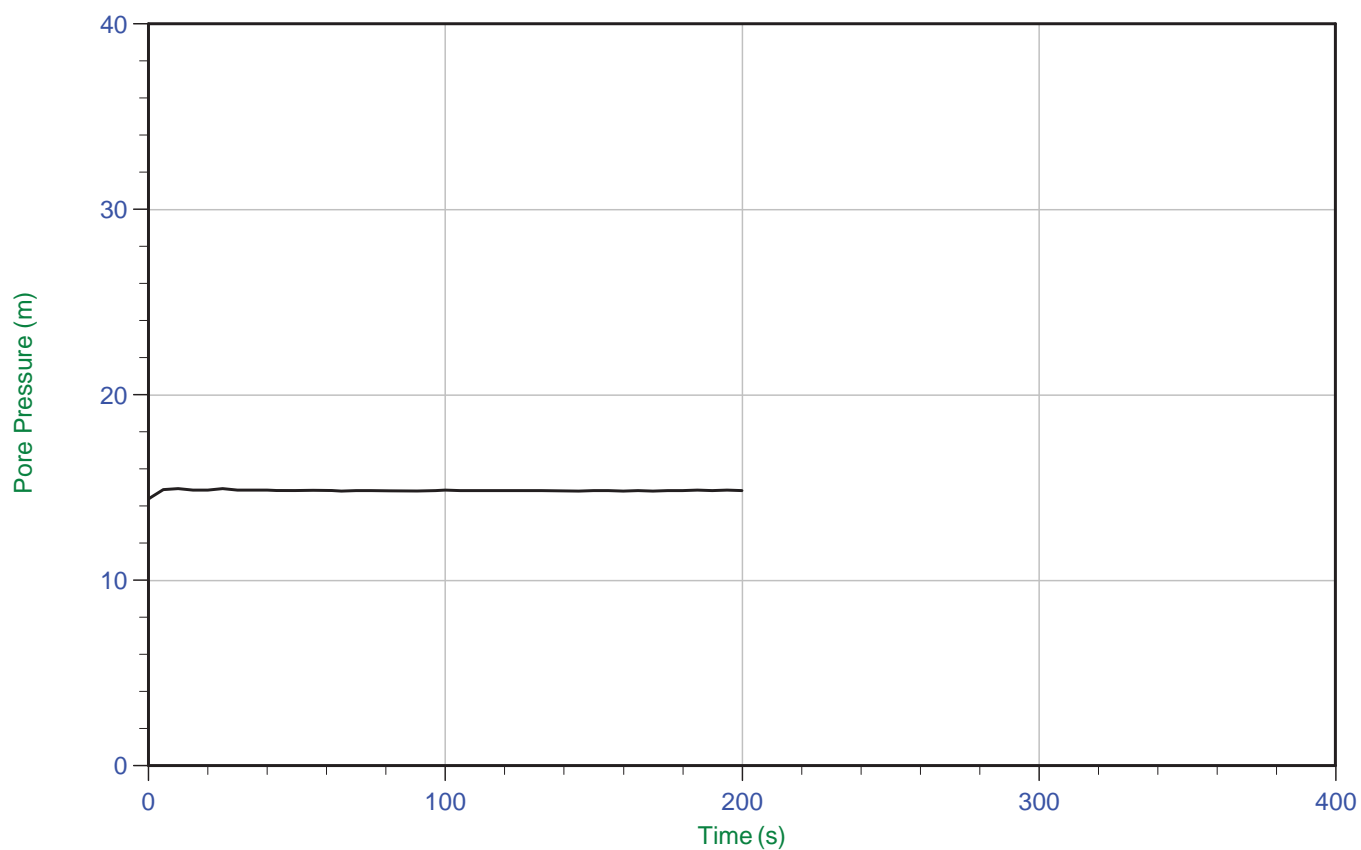
Trace Summary: Filename: 17-05010_CPD006.PPF U Min: 52.2 m WT: -31.789 m / -104.293 ft
 Depth: 20.575 m / 67.502 ft U Max: 52.5 m Ueq: 52.4 m
 Duration: 300.0 s



Baffinland

Job No: 17-05010
Date: 04/07/2017 11:27
Site: Milne Port Expansion

Sounding: CPT17-D007
Cone: 374:T1500F15U500 Area=15 cm²



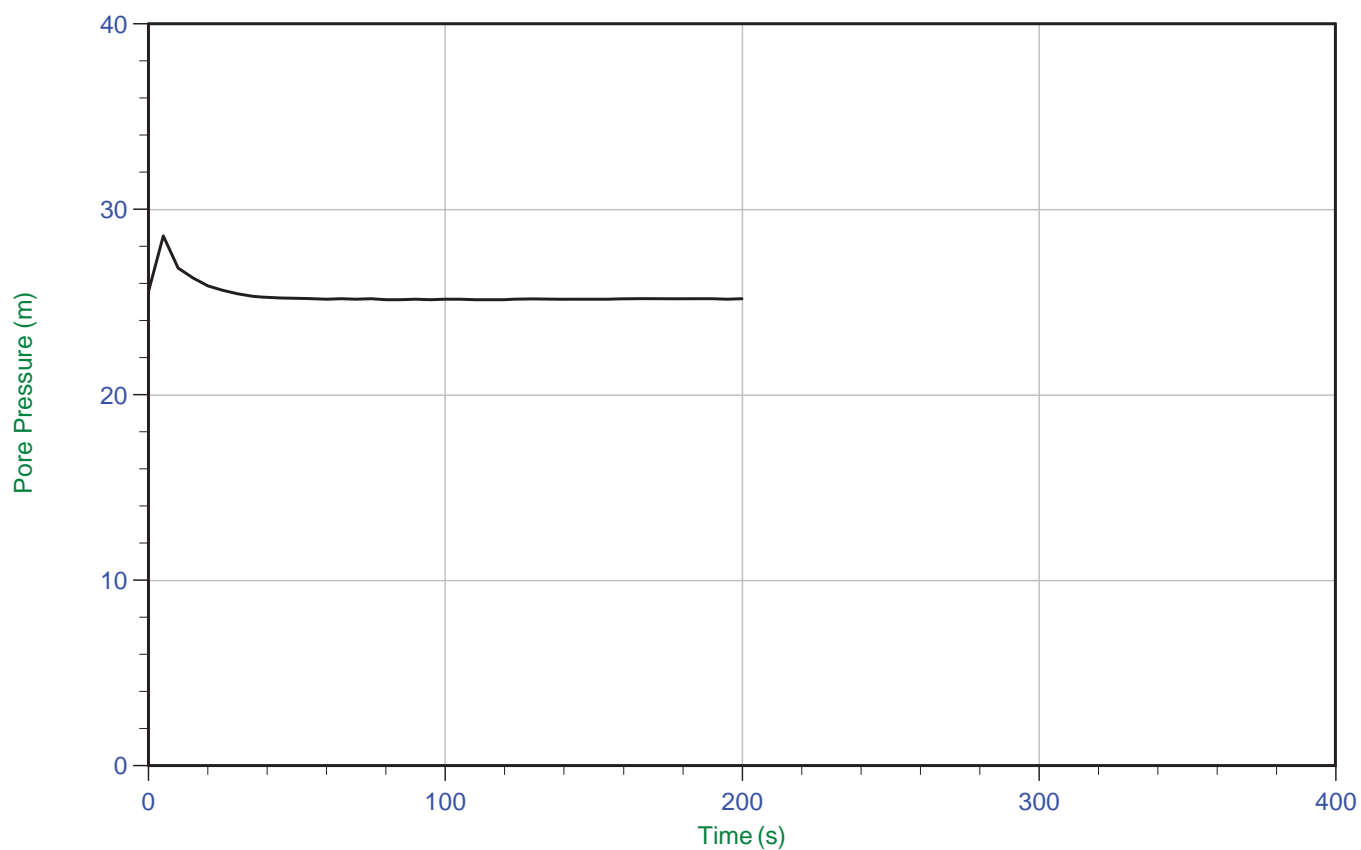
Trace Summary: Filename: 17-05010_CPD007.PPF U Min: 14.4 m WT: -4.688 m / -15.380 ft
 Depth: 10.100 m / 33.136 ft U Max: 15.0 m Ueq: 14.8 m
 Duration: 200.0 s



Baffinland

Job No: 17-05010
Date: 04/07/2017 11:27
Site: Milne Port Expansion

Sounding: CPT17-D007
Cone: 374:T1500F15U500 Area=15 cm²



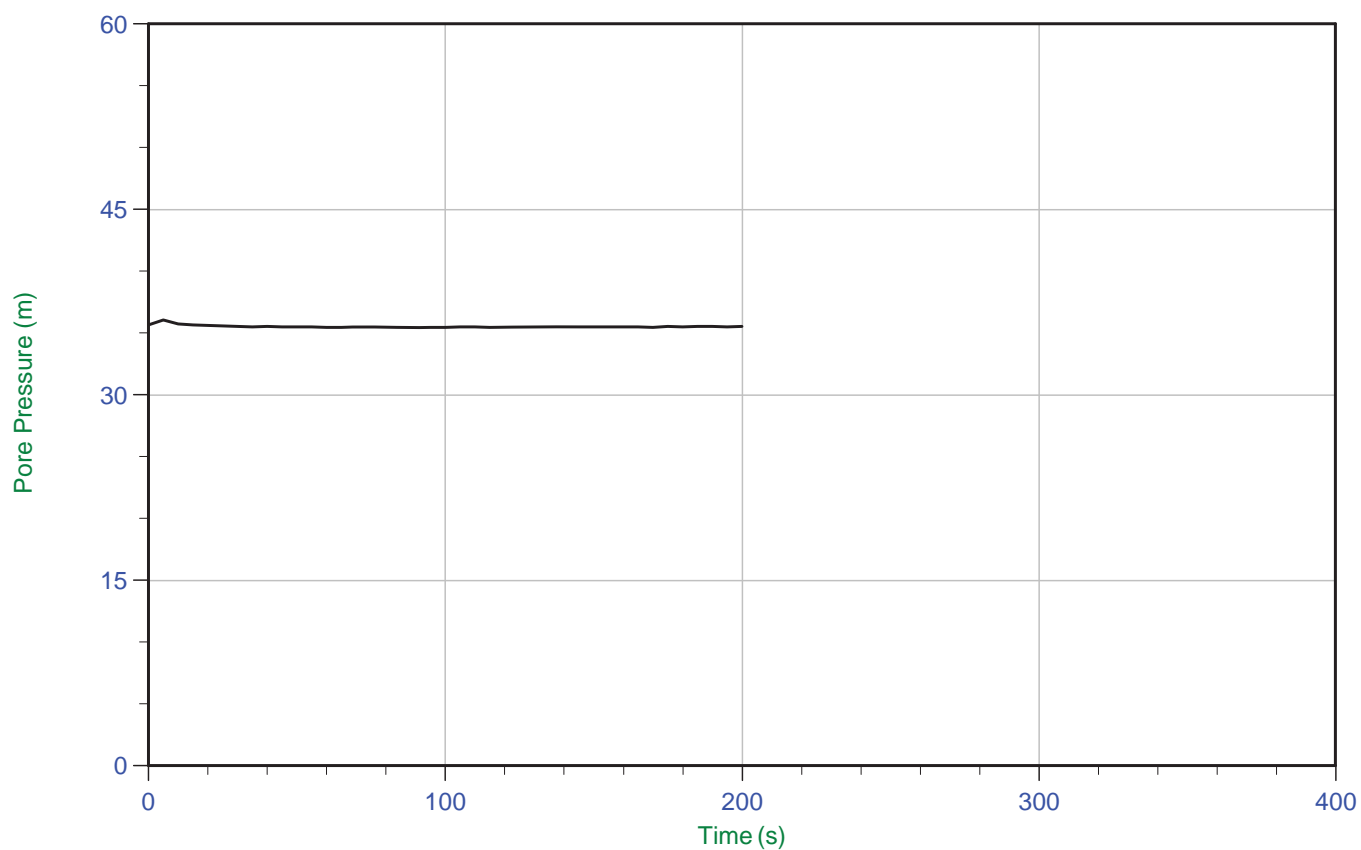
Trace Summary: Filename: 17-05010_CPD007.PPF U Min: 25.1 m WT: -4.981 m / -16.342 ft
Depth: 20.150 m / 66.108 ft U Max: 28.6 m Ueq: 25.1 m
Duration: 200.0 s



Baffinland

Job No: 17-05010
Date: 04/07/2017 11:27
Site: Milne Port Expansion

Sounding: CPT17-D007
Cone: 374:T1500F15U500 Area=15 cm²



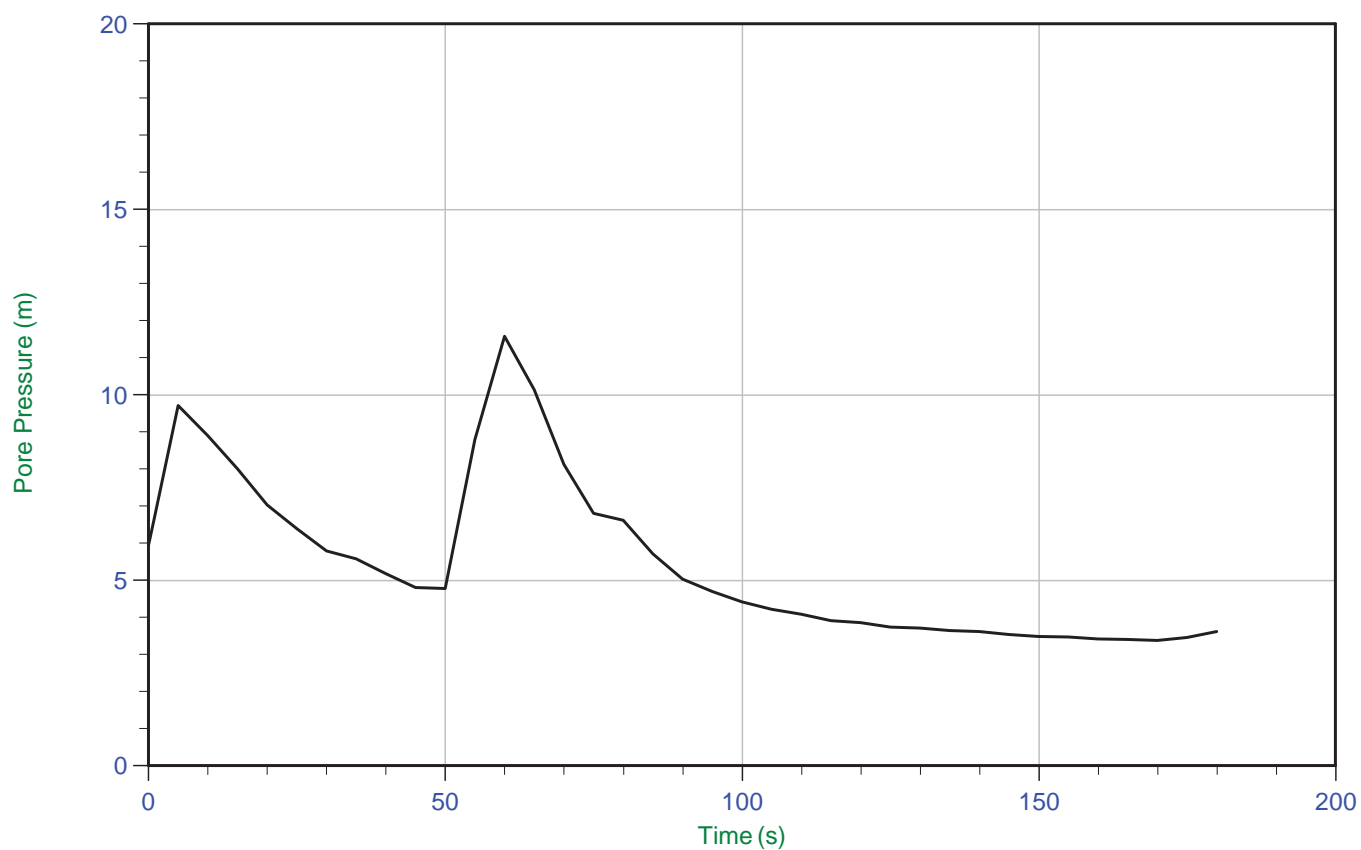
Trace Summary: Filename: 17-05010_CPD007.PPF U Min: 35.5 m WT: -5.315 m / -17.437 ft
 Depth: 30.200 m / 99.080 ft U Max: 36.0 m Ueq: 35.5 m
 Duration: 200.0 s



Baffinland

Job No: 17-05010
Date: 04/07/2017 16:47
Site: Milne Port Expansion

Sounding: CPT17-D008
Cone: 374:T1500F15U500 Area=15 cm²



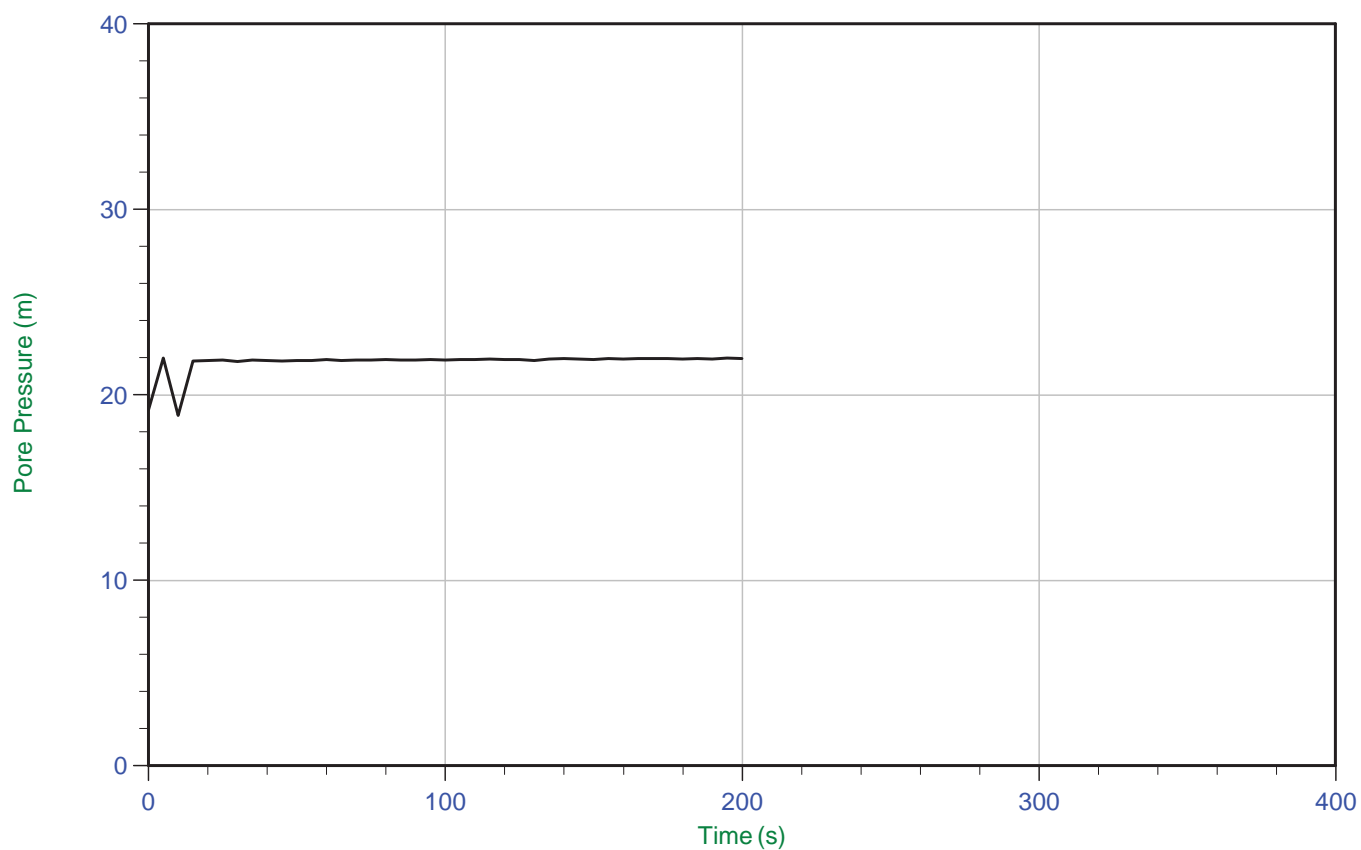
Trace Summary: Filename: 17-05010_CPD008.PPF U Min: 3.4 m
 Depth: 2.075 m / 6.808 ft U Max: 11.6 m
 Duration: 180.0 s



Baffinland

Job No: 17-05010
Date: 04/07/2017 16:47
Site: Milne Port Expansion

Sounding: CPT17-D008
Cone: 374:T1500F15U500 Area=15 cm²



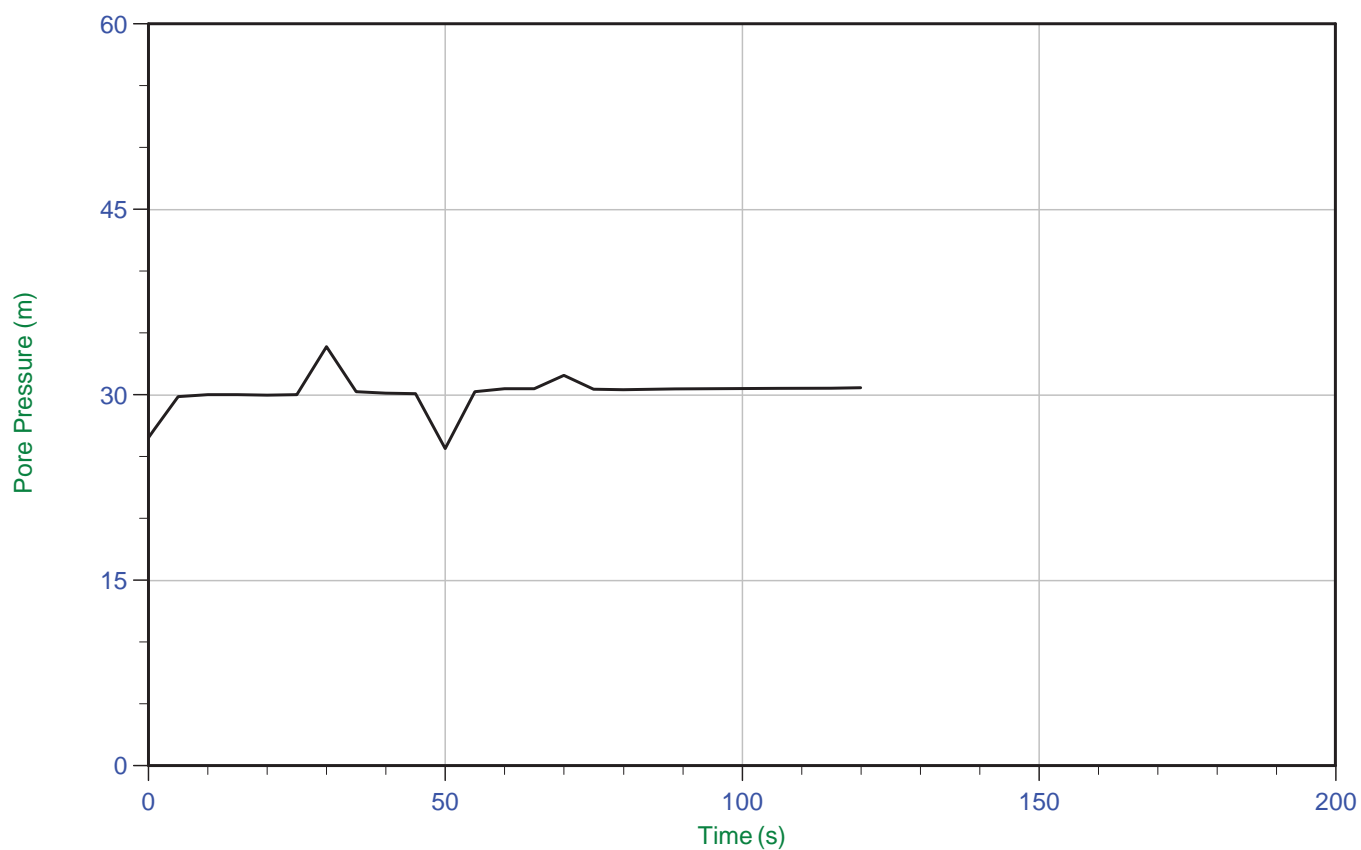
Trace Summary: Filename: 17-05010_CPD008.PPF U Min: 18.9 m WT: -1.399 m / -4.590 ft
Depth: 20.500 m / 67.256 ft U Max: 22.0 m Ueq: 21.9 m
Duration: 200.0 s



Baffinland

Job No: 17-05010
Date: 04/07/2017 16:47
Site: Milne Port Expansion

Sounding: CPT17-D008
Cone: 374:T1500F15U500 Area=15 cm²



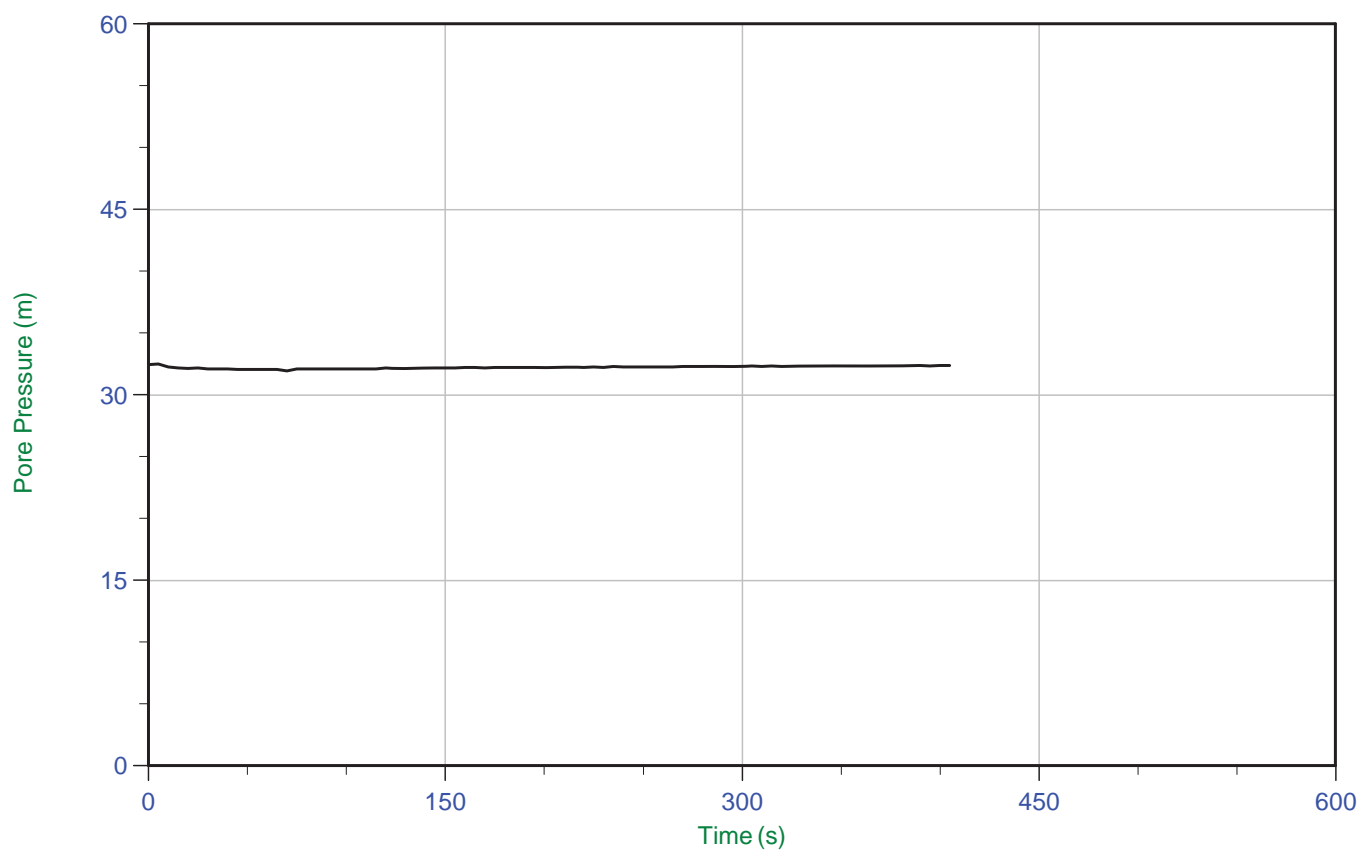
Trace Summary: Filename: 17-05010_CPD008.PPF U Min: 25.6 m WT: -1.449 m / -4.754 ft
 Depth: 28.975 m / 95.061 ft U Max: 33.9 m Ueq: 30.4 m
 Duration: 120.0 s



Baffinland

Job No: 17-05010
Date: 04/07/2017 16:47
Site: Milne Port Expansion

Sounding: CPT17-D008
Cone: 374:T1500F15U500 Area=15 cm²



Trace Summary: Filename: 17-05010_CPD008.PPF U Min: 32.0 m WT: -2.242 m / -7.356 ft
Depth: 30.000 m / 98.424 ft U Max: 32.5 m Ueq: 32.2 m
Duration: 405.0 s

Appendix G

Laboratory Certificate



Canadian Council of Independent Laboratories

CERTIFICATE OF CONFORMANCE

AGGREGATE LABORATORY CERTIFICATION

This is to certify that

Hatch

Located at:

Niagara Falls ON

Has met the Standardization and Interlaboratory Testing Requirements of the
CCIL/OSSGA AGGREGATE LABORATORY CERTIFICATION PROGRAM
and has qualified under the following categories and test methods:

AGGREGATE QUALITY CONTROL LABORATORY (TYPE C)

LS-600/C-702; LS-601/C-117; LS-602/C-136; LS-607; LS-608; LS-621

AGGREGATE PHYSICAL PROPERTY LABORATORY (TYPE D)

LS-623/D698; LS-702/D422; LS-703,704/D4318; LS-705/D854; LS-709/D2434

GIB MCINTEE, P. ENG.

CHAIRMAN, CERTIFICATION PROGRAM ADMINISTRATION COMMITTEE

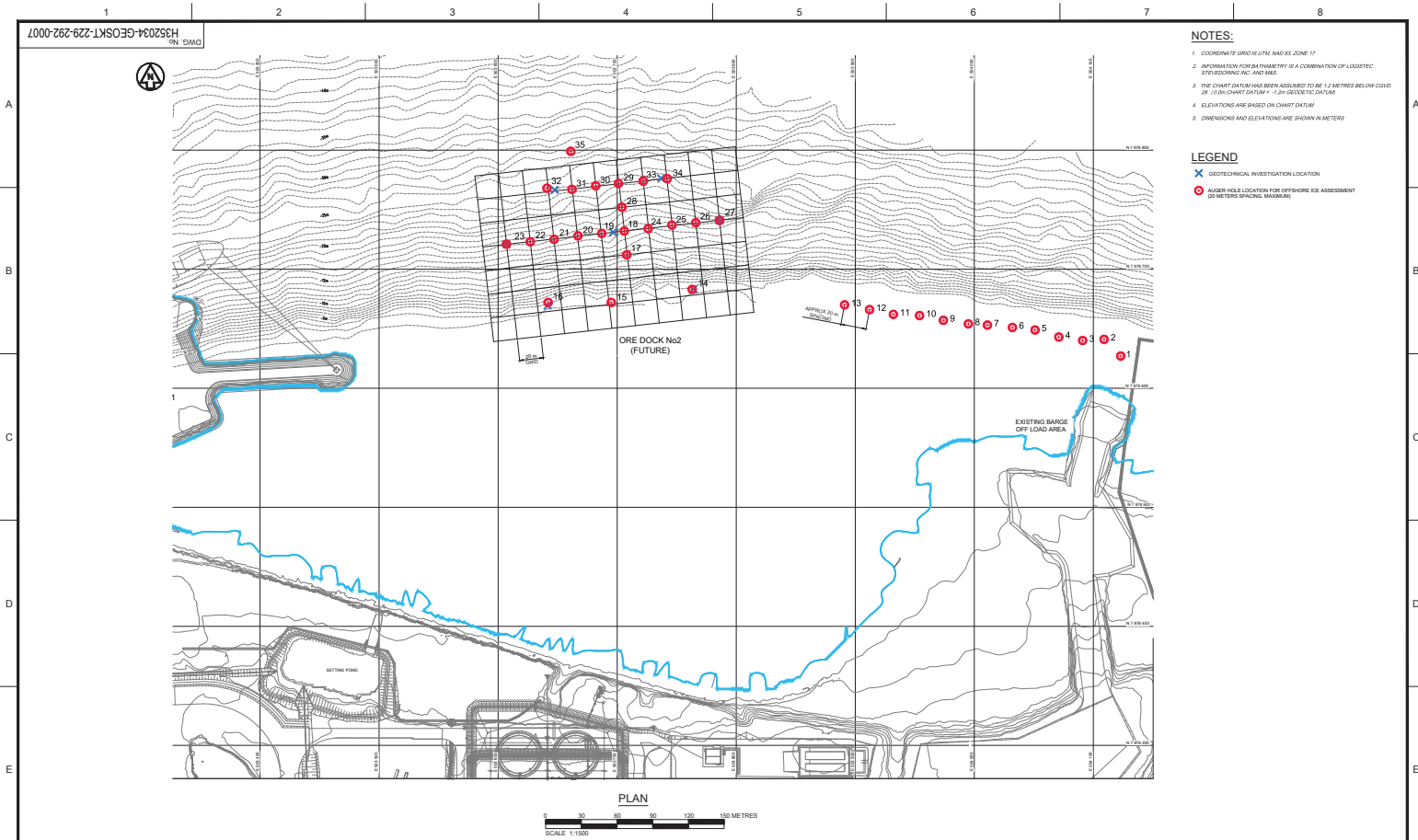
May 1, 2016 - April 30, 2017

Date

GORDON H. LEAMAN, P. ENG.
PRESIDENT

Appendix H

Ice Thickness Assessment



DRAWING No.		DRAWING TITLE	REFERENCE DRAWINGS		DRAWING No.		DRAWING TITLE	REFERENCE DRAWINGS	
1			2		3			4	
5			6		7			8	

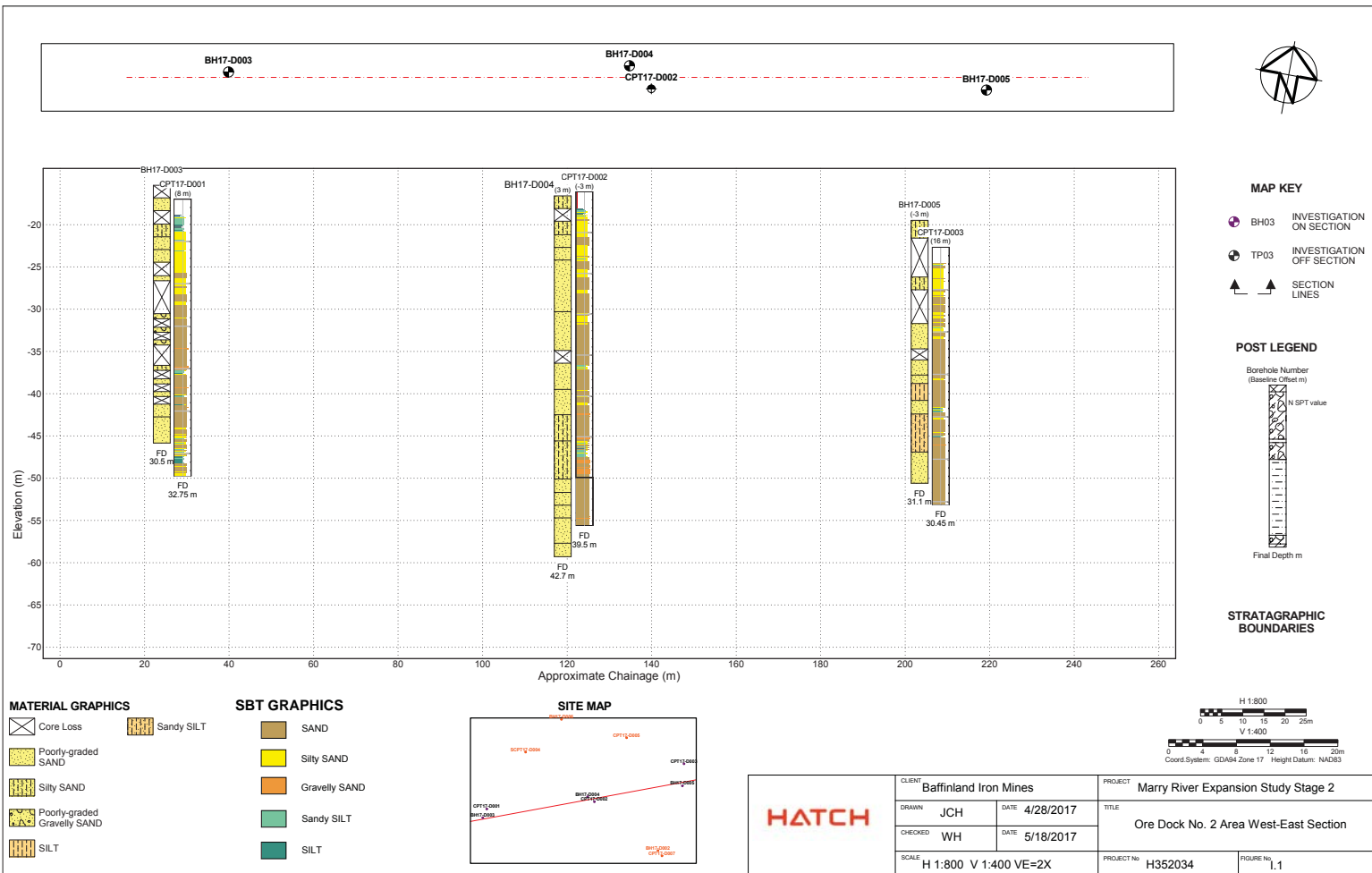
DATE		SIGNATURE		ENG REG NUMBER		REVISION DATE		ORIGINAL DATE	
REGISTERED PROFESSIONAL		No.		DESCRIPTION	BY	CHKD	DATE	ROLE	NAME
REVISIONS		DRAWING APPROVAL STATUS:		CLIENT REVIEW		DATE		SCALE	
1:50,000		DWG. No.		H352034-GEOSKT-229-292-0007		REV		B	

HATCH		BAFFINLAND	
DRAFTSPERSON: O PARKES		HR	
DE SIGNER		NR	
CHECKER		DATE	
DESIGN COORD: W HOYLE		DATE	
RESP. ENG		DATE	
LEAD ENG: S HINCHENGER		DATE	
ENG. MANAGER		DATE	
PROJ. MANAGER: S HEINER		DATE	

DESIGN SHOWN IS A HATCH CONCEPT DESIGN		CONTRACTOR TO PROVIDE HIS OWN DESIGN	
BAFFINLAND EXPANSION 12 MTPA MINE OPTION		PRE FEASIBILITY STUDY	
PORT SITE - ORE DOCK No. 2		OFF SHORE ICE ASSESSMENT	
AUGER HOLE LOCATIONS		REV	
H352034-GEOSKT-229-292-0007		B	

Appendix I

Fence Diagrams

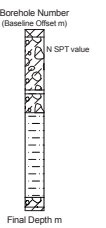




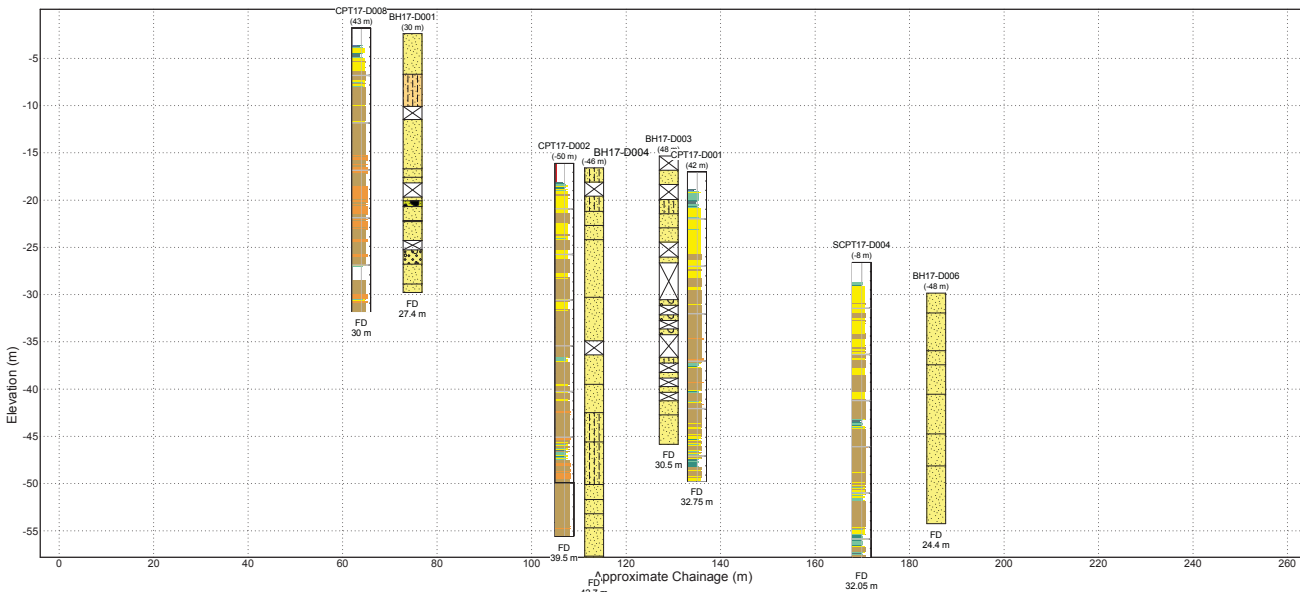
MAP KEY

- BH03 INVESTIGATION ON SECTION
- TP03 INVESTIGATION OFF SECTION
- SECTION LINES

POST LEGEND



STRATAGRAPHIC BOUNDARIES



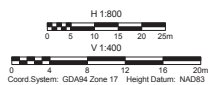
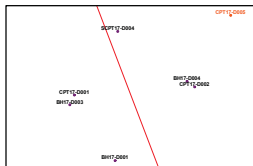
MATERIAL GRAPHICS

- Poorly-graded SAND
- Silty SAND
- Sandy SILT
- Poorly-graded Gravelly SAND
- Core Loss
- Well-graded Sandy GRAVEL
- Well-graded Gravelly SAND

SBT GRAPHICS

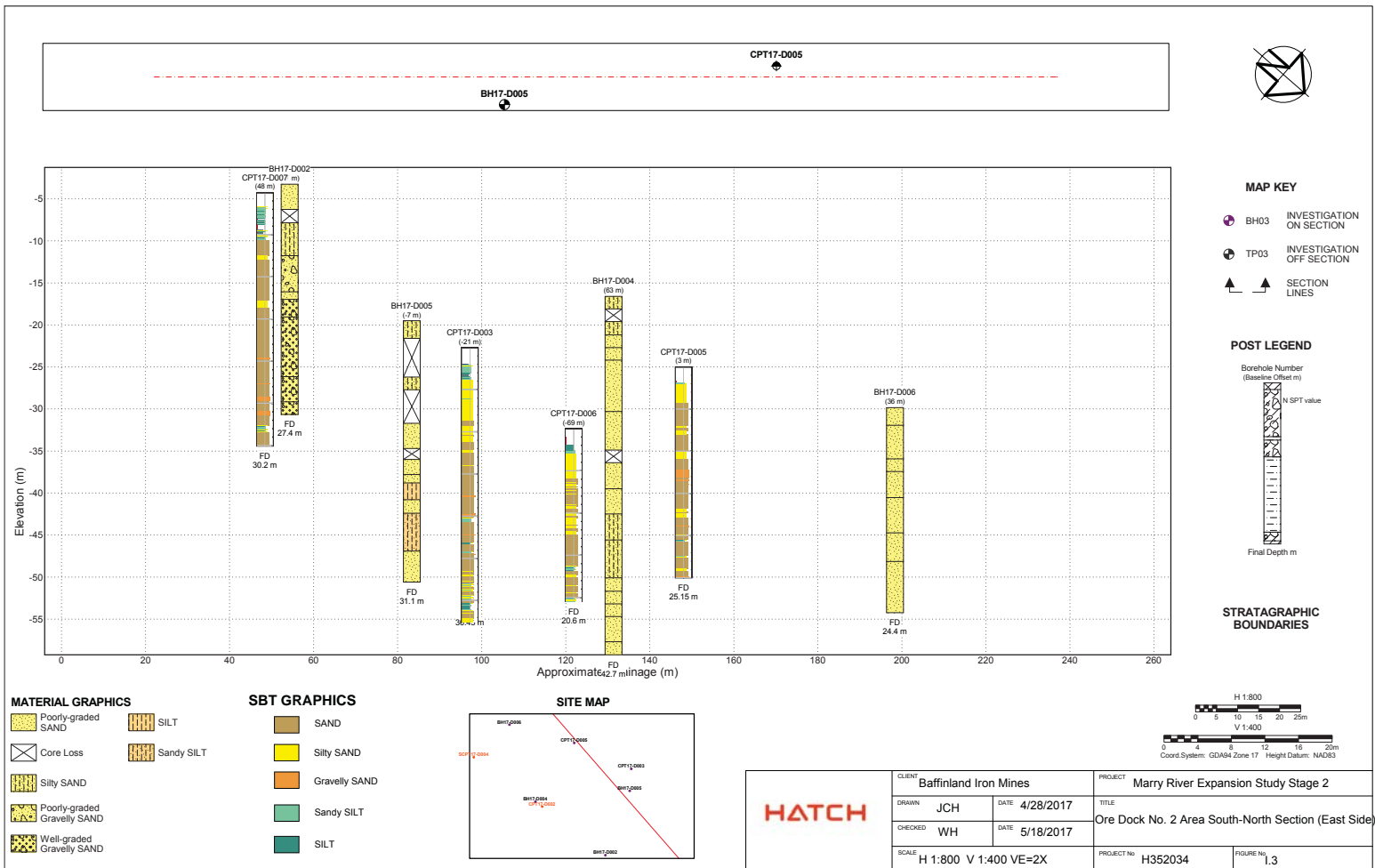
- SAND
- Silty SAND
- Gravelly SAND
- Sandy SILT
- SILT

SITE MAP



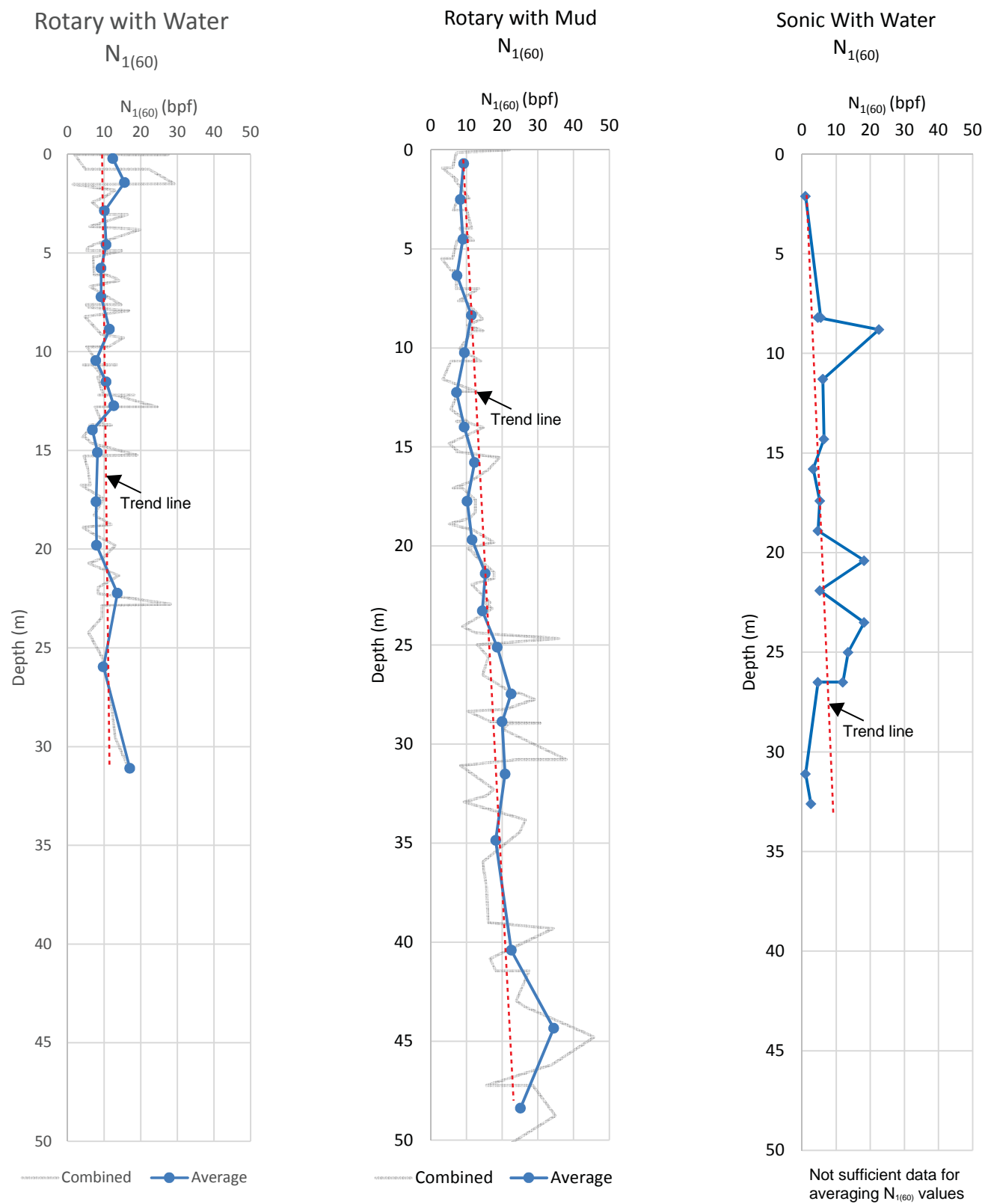
HATCH

CLIENT Baffinland Iron Mines		PROJECT Marry River Expansion Study Stage 2	
DRAWN JCH	DATE 4/28/2017	TITLE Ore Dock No. 2 Area South-North Section (West Side)	
CHECKED WH	DATE 5/18/2017		
SCALE H 1:800 V 1:400 VE=2X		PROJECT No H352034	FIGURE No 1.2



Appendix J

Influence of Drilling Method on Standard Penetration Testing



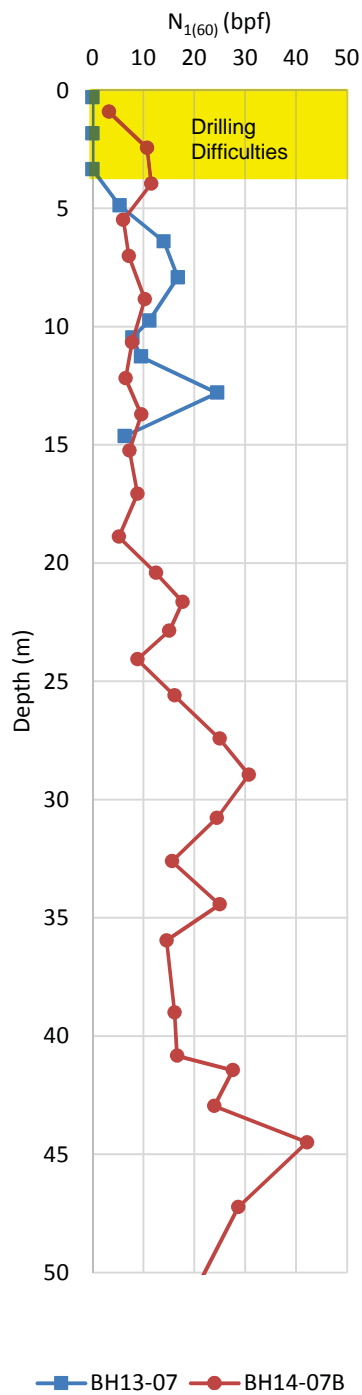
Notes:

Diamond Rotary with water includes data from BH13-03, BH13-05, BH13-07, BH13-08, BH13-09 and BH13-011

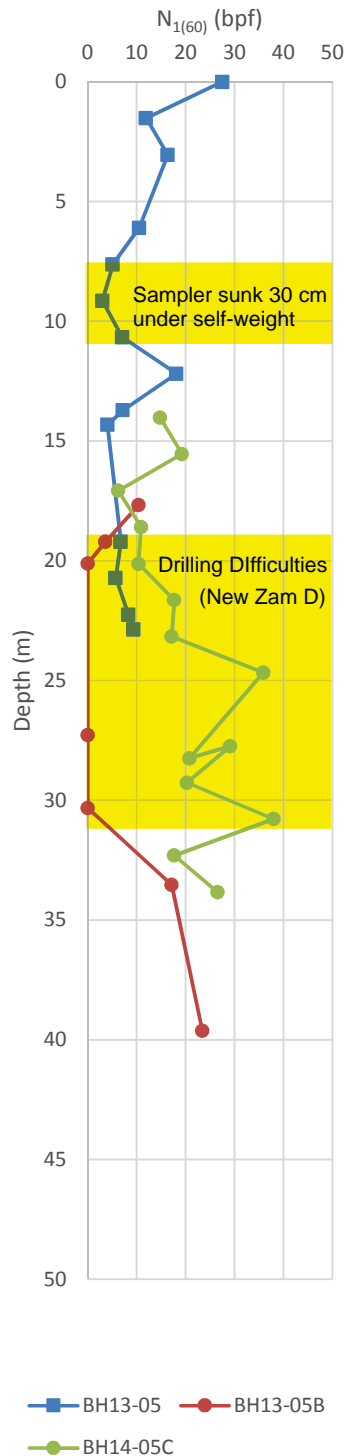
Diamond Rotary with Mud includes data from BH14-05C, BH14-06, BH14-07B, BH14-12 and BH14-13

Sonic with Water includes data from BH17-D001, BH17-D002, BH17-D003, BH17-D004, BH17-D005 and BH17-D006.

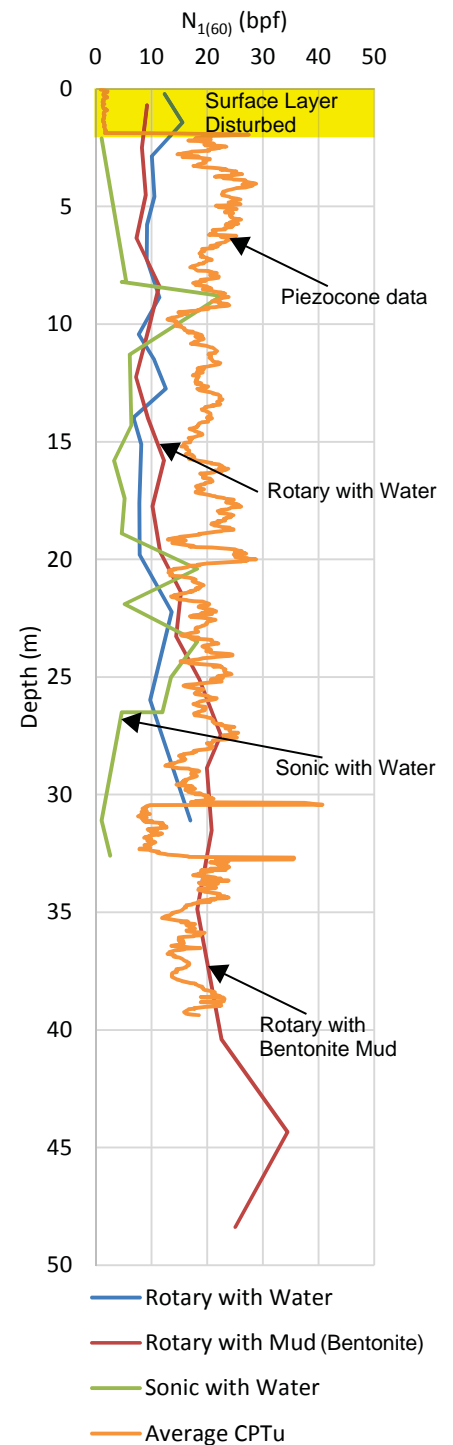
BH13-07
 Water vs. Mud
 $N_{1(60)}$ Comparison



BH13-05
 Water vs. Mud
 $N_{1(60)}$ Comparison



$N_{1(60)}$ Comparison
 Drilling Methods



Notes:

BH13-05B was drilled with New Zam D Mud Only
 BH14-05C and BH14-07B were drilled with New Zam D Mud and Bentonite
 CPTu was averaged using data from CPT-D001, CPT-D002 and CPT-D003