Baffinland Iron Mines Corporation
Mary River Expansion Project

2016-2017-2018 Milne Port Geotechnical Investigation Factual Data Report

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Document Number Explanation

This report was Approved for Use as Rev. 2 on October 4th, 2017 under the following document number: H352034-1000-229-230-0002. The current revised version of this report was supplemented with the new information associated with the 22 boreholes drilled in 2017 and 4 boreholes drilled in 2018. As a result of this additional information, the document number was revised to H353004-40000-229-230-0009. Although the current project number (H353004) was used to report the new data (borehole reports, test reports, etc.), the former project number (H352034) is still shown on the borehole reports/data sheets from previous investigations.

DISCLAIMER

This Report has been prepared by Hatch Ltd. (“Hatch”) for the sole and exclusive benefit of Baffinland Iron Mines Corporation (the “Client”) for the sole purpose of assisting the Client to identify potential options to increase production from the Mary River mine, and may not be provided to, used or relied upon by any other party without the prior written consent of Hatch.

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This report is meant to be read, and sections should not be read or relied upon out of context. While it is believed that the information contained herein is reliable under the conditions and subject to the limitations set forth herein, this Report is based in part on information not within the control of Hatch and Hatch therefore cannot and does not guarantee the accuracy of such information based in whole or in part on information not within the control of Hatch. The comments in it reflect Hatch’s professional judgment in light of the information available to it at the time of preparation.

This report contains the expression of the professional opinion of Hatch exercising reasonable care, skill and judgment and 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.

Client’s Signature:

Name:

Title:

Date:

Table of Contents

List of Tables

List of Figures

List of Appendices

1. Introduction

Baffinland Iron Mines Corporation (BIM) currently operates the Mary River iron ore mine in Nunavut, Canada. BIM plans to increase the production to 12 Mtpa, shipping the output through Milne Port. This will be achieved by upgrading the mine fleet, constructing a 110 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 second ore dock for ship loading.

Hatch Ltd. (Hatch) was retained by BIM to conduct geotechnical drilling investigations for the design of a railway alignment spanning from Milne Port to the Mine Site, and infrastructures at Milne Port. The drilling program included four phases; the first phase was executed in the Fall of 2016, while the second, third, and fourth phases were, completed in Summer 2017, Fall 2017, and Spring 2018, respectively.

This report summarizes the factual data result of the geotechnical investigation for the port infrastructure, including rail unloading, tanks, crusher, screening, tail pulley, reclaimer berm, reclaim tunnel, conveyors, and module delivery route. The site program, borehole log reports, photographs and laboratory testing results are detailed in the following sections.

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 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), and in 2011 and 2013-2014 by Hatch. Relevant information from these investigations has been included in this report.

1.2 Local Topology and Geology

The site of the proposed Milne Port facilities is located at the southern extent of Milne Inlet. The area where the stockpiles, and the crusher and screener will be located is in the delta of Phillips Creek. The geology of this area is generally mapped as deltaic sediments including clay, silt, sand and gravel. Closer to the water, and comprising the northern extent of the stacker reclaimer foundation, the area is mapped as beach sediments, specifically sand.

The rail unloading area is located on a bedrock ridge which is mapped as undifferentiated gneiss and granitic rock. The ridge rises above the surrounding delta and forms the rock outcrop ridge. The area along the base of the ridge is mapped as glacial end moraine, comprised of or matted by till. The tank farm location is near the boundary between the deltaic sediments and the glacial end moraine provinces.

2. Geotechnical Investigation

2.1 General

This report provides geotechnical investigation information for the Milne Port area. The information associated with the rail alignment is provided in a report entitled, “2016-2017-2018 Rail Geotechnical Investigation Factual Data Report, H353004-10000-229-230-0005”.

2.2 Borehole Locations

A summary of the as-drilled borehole locations for Milne Port infrastructure is provided in Table 2-1. 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-drilled borehole location plan is provided in Appendix A.

Table 2-1: Milne Port Borehole Locations

Borehole Number	Easting (m)	Northing (m)	Depth (m)
BH16-M001	503,504	7,976,237	15.2
BH16-M002	503,757	7,975,894	15.2
BH16-M003	503,714	7,975,892	15.2
BH16-M004	503,302	7,975,591	15.2
BH16-M005	503,270	7,975,606	15.2
BH16-M006	503,136	7,975,081	15.2
BH16-M007	503,822	7,974,945	9.1
BH16-M008	503,771	7,974,959	21.3
BH16-M009	503,904	7,974,935	5.3
BH16-M010	503,394	7,974,877	15.2
BH16-M011	503,339	7,974,868	15.2
BH16-M012	503,268	7,974,848	15.2
BH16-M013	503,140	7,974,820	15.2
BH16-M014	503,052	7,974,782	15.2
BH16-M015	503,007	7,974,799	15.2
BH17-RD-1	504,095	7,976,552	6.1
BH17-RD-1A	504,090	7,976,463	4.6
BH17-RD-1B	504,100	7,976,358	4.9
BH17-RD-1C	504,075	7,976,302	6.1
BH17-RD-2	503,872	7,976,162	4.6
BH17-RD-3	503,599	7,975,985	4.6
BH17-RD-4	503,594	7,975,136	4.6
BH17-RD-5	503,596	7,974,811	2.65
BH17-RD-6	503,922	7,974,286	6.1
BH17-RD-7	503,896	7,974,423	3.7
BH17-EBC-8	503,535	7,976,327	39.5
BH17-EBC-9	503,548	7,976,371	39.5
BH17-10	503,476	7,974,905	16.7
BH17-11	503,268	7,976,025	15.2
BH17-12	503,180	7,975,752	15.2
BH17-13	503,159	7,975,912	6.1
BH17-14	503,187	7,975,913	6.1
BH17-15	503,222	7,975,913	6.1
BH17-CAMP-1	503,961	7,976,147	6.1
BH17-M008-R	503,772	7,974,960	22.0

Borehole Number	Easting (m)	Northing (m)	Depth (m)
BH17-EBC-1	503,783	7,974,921	21.7
BH17-EBC-2	503,791	7,974,895	21.8
BH18-M001	503,423	7,974,892	25.9
BH18-M002	503,328	7,974,867	39.6
BH18-M003	503,055	7,974,868	50.3
BH18-004	563,499	7,975,260	77.7

2.3 Drilling and Sampling Methodology

The geotechnical boreholes were developed using a BL100 Mini Sonic Drilling rig manufactured and operated by Boart Longyear, shown in Figure 1. The boreholes were advanced by vibration of the drill string at a high frequency in addition to rotary motion, and pressure by the drilling head (vibracore). Casing, size H, was advanced with the vibracore to keep the hole open between runs. Sonic drilling does not require water at shallow depths in the overburden.

When using vibracore drilling in overburden, a 3 m drilling rod was advanced 1.5 m into the ground for each run. The bottom 1.5 m was collected into a 4 inch split PVC pipe as shown in Figure 2. Soil collected above the bottom 1.5 m, if encountered, was disposed to ensure the collected sample was not contaminated by surface soil “fall in” accumulated at the bottom of the drilled hole. Soil sample were photographed in the PVC split. Once the material in the split was photographed and sampled, the splits were secured using caps and aluminum tape, and stored in a shipping container at the Milne Port site.

Where encountered, bedrock was cored using an HQ-3 triple tube wireline core barrel, which required the use of water and casing. In addition, rock coring required the installation of a high-speed rotary head on the drilling rig every time there was a switch from sonic drilling in soil to rock coring.

Figure 1: Boart Longyear Mini Sonic Drilling Rig

Figure 2: Sample Collected in a PVC Split using a Mini Sonic Drilling Rig

The Hatch field supervisor documented the materials encountered, and determined in situ testing and sampling requirements. When ice was encountered in the borehole, it was documented and classified according to ASTM D4083. 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 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 by BIM and Boart Longyear. A Job Hazard Analysis (JHA), identifying the hazards associated with the work and the controls that were to be used, was developed by Hatch and BIM and reviewed by Boart Longyear. This JHA was reviewed on a periodic basis and when work conditions changed and updated accordingly. A notification procedure was prepared by BIM specifically for the drilling activities in remote areas. A copy of both the final JHA and the notification procedure is presented in Appendix H.

2.5 Laboratory Testing

2.5.1 Soil Testing

All 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). Representative samples were selected for testing including moisture content, particle size distribution, pore water salinity, rock strength tests in accordance with the standard listed in Table 2-2. Full laboratory test results are presented in Appendix D and laboratory results are summarized in Appendix F. 1

Table 2-2: Standards Used for the 2016, 2017, and 2018 Geotechnical Investigation 1

Name	Standard
Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications	ASTM D5731
Standard Test Methods for Laboratory Determination of Water Content of Soil and Rock by Mass	ASTM D2216
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
Standard Test Methods for Pore Water Extraction and Determination of the Soluble Salt Content of Soils by Refractometer	ASTM D4542
Uniaxial Compressive Strength of Intact Rock Core Specimens	ASTM D7012

2.6 Geophysics

GPR Inc. was contracted to undertake a Ground Penetrating Radar (GPR) survey to identify ground ice and ice rich soil in proximity of the proposed area for drive station, dumper, conical stockpile, crushing building, screening building and south end of stacker reclaimer berm. The survey required towing of a GPR unit (Figure 3) in a line over the area to be surveyed. Readings were recorded using a handheld output device, which can be seen in Figure 4. A detailed description of the GPR survey technique can be found in Appendix I.

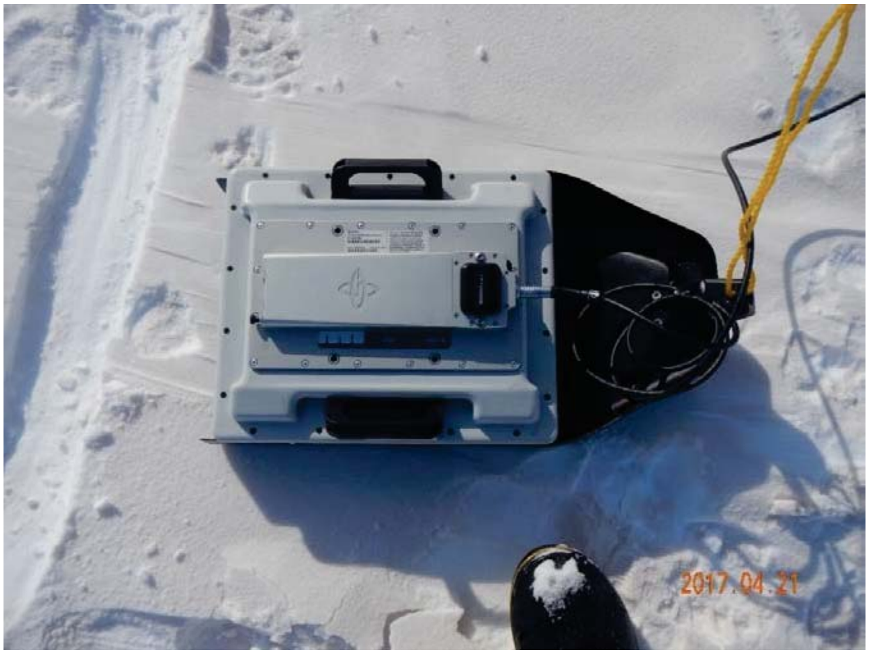

Figure 3: Ground Penetrating Radar Survey Unit

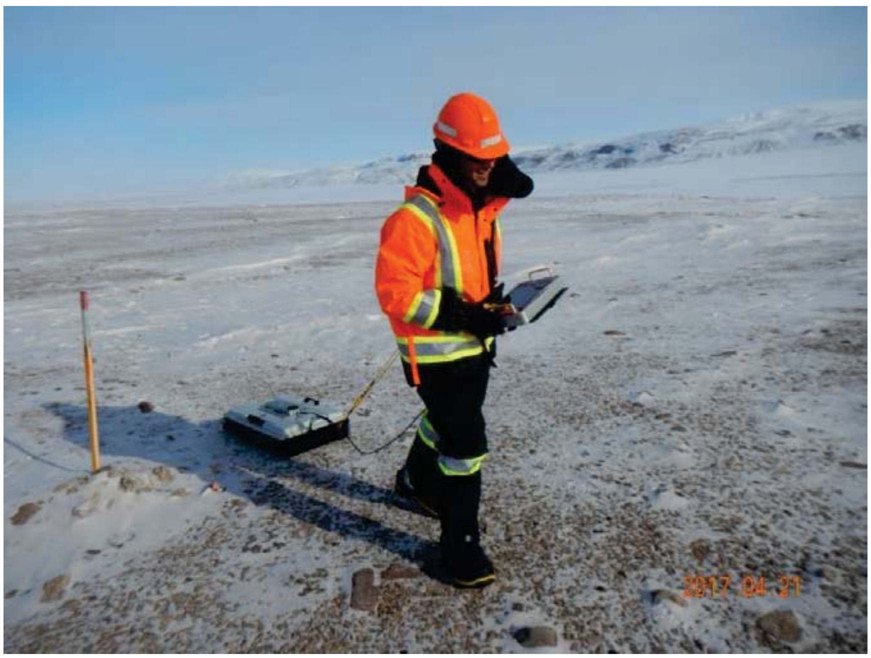

Figure 4: GPR Survey in Progress

3. Results of Field Investigations

3.1 Milne Port Infrastructure Boreholes

A total of 15 boreholes were drilled in 2016 geotechnical investigation program at Milne Port Site. In 2017, 22 boreholes were drilled to support design of the proposed infrastructure including rail unloading dumper, module delivery routes (MDR), crushing plant, screening plant, stacker/reclaimer berm, stockpile reclaim load-out tunnel. Another 4 boreholes were drilled in 2018 to support design of the proposed conical stockpile, crusher pads, and the stocker / reclaimer berm. Fence diagrams have been made for select areas and are presented in Appendix E.

3.1.1 Stacker/Reclaimer Berm and Tail Pulley

Eight (8) boreholes (BH16-M001, BH16-M004, BH16-M005, BH16-M006, BH16-M014, BH16-M015, BH18-M003, BH18-004) were drilled along the longitudinal alignment of the berm from north (near shoreline) to south. The tail pulley is located near the south end of the berm. The overall site is relatively flat over the footprint of the berm.

The subsurface conditions encountered at the site are highlighted as follows:

- Near the south end of the berm, the deposit consists of a sandy layer (sand to sand and gravel) with a thickness of 6 m to 9 m, overlying a silt deposit extending to the borehole termination depths of about 15.2 m (BH16-M006, BH16-M014 and BH16-M015, BH18-M003). BH18-M003 extends to a termination depth of about 50 m and encountered the same silt deposit (silt with sand) extending to a depth of about 46 m. Below 46 m to the termination of BH18-M003 was a deposit of till.
- In the middle of the berm, the sandy deposit dominates the encountered overburden (BH16-M004 and BH16-M005). A 1.5 m silt layer was encountered in BH16-M004 from a depth of 10.6 m to 12.1 m.
- Near the north end of the berm, a sandy deposit (sand to sand and gravel) was encountered in BH16-M001 down to the termination of the borehole (at about 15 m depth) and in BH18-004 down to about 42 m depth. Below 42 m in BH18-004, some silt layers between 0.7 m and 2.5 m in thickness were encountered between layers of sandy deposits (sand to silty sand). A silty deposit (sandy silty to silty clay) was encountered in BH18-004 below about 68 m to the termination of the borehole.
- No bedrock was encountered during the investigation.

Table 3-1 presents the depth of soil/ice encountered in the boreholes. The following summarizes the soils encountered during investigation. Typical samples for sandy deposit and silty deposits are presented in Figure 5, Figure 6 and Figure 7.

- The sandy deposit contains sand (silty sand to sand and gravel), with a varying amount of gravel and silt. Ice content in this layer typically ranges from 10% to 20% by weight.

- The silty deposit contains predominantly silt (silt to sandy silt), trace to some sand, trace gravel, trace organics. This layer was likely formed from a delta sediment deposit. The silt is generally well bonded and contains thin ice lenses with a typical ice content ranging from 20% to 40% by weight.
- Ground ice was not encountered in the boreholes listed above. However, the presence of occasional ground ice layer is likely in the Milne Inlet Port area, particularly near the depth of the active zone.

3.1.2 Stockpile Reclaim Tunnel, Crushing and Screening Plants

Seven (7) boreholes (BH17-10, BH 16-M010, BH 16-M011, BH 16-M012, and BH16-M013, BH18-M002, BH18-M001) were drilled in the vicinity of the stockpile reclaim tunnel and crushing/screening plants. In particular, the stockpile tunnel is located close to BH18-M001. The crusher plant is close to BH16-M011 and the screening plant is near BH16-M013. Table 3-1 summarizes the depth of soil/ice encountered in the boreholes.

The subsurface conditions encountered are highlighted as follows:

- The deposit at the site comprise a thin sandy layer overlying a thick silt deposit. Below this is likely a till layer which was encountered in BH17-10, BH18-M001, and BH18-M002.
- The sandy layer contains sand, with a varying amount of gravel, trace to some silt and trace cobbles. The thickness of the sandy layer varies from zero to about 3.5 m.
- The silt layer contains predominantly silt, trace to some fine sand, trace gravel, trace organics, with a thickness of about 12 m to 24 m (BH17-10, BH18-M001, BH18-M002). This layer is likely a deltaic sediment sequence deposit. The frozen silt is general well bonded and contains trace thin ice lenses with a typical ice content from 20% to 40% by weight.
- A 1.4 m thick layer of ground ice was encountered from 1.0 m to 2.4 m depth in BH16-M010. A 5.4 m thick layer of ground ice was also encountered in BH18-M001 from about 0.8 m to 6.2 m. All other boreholes in this area did not encounter ground ice.
- A till layer (sand till with some silt and some gravel) was encountered in BH17-10, BH18-M001, BH18-M002 at a depth of 13.7 m to 29.5 m underlying the silt deposit. The till layer is well graded and has a relatively low ice content of about 8%.
- Bedrock was not encountered in all of the drilled boreholes (to their end of holes up to 39.6 m depth).

The boreholes for this infrastructure are summarized in Table 3-1.

Table 3-1: Summary of Boreholes in Stacker/Reclaimer, Crusher and Screener Areas

Borehole ID (Infrastructure)	Depth Material Encountered			
	Sandy Deposit (Sandy Gravel to Gravelly Sand)	Sandy Deposit (Sand to Silty Sand)	Silty Deposit (Sandy Silt to Silt)	Ice / Till with low ice content
BH16-M001 (Reclaimer)	0 – 15.2*			
BH16-M004 (Reclaimer)	6.1 – 10.6	0 – 6.1; 12.1 – 15.2*	10.6 – 12.1	
BH16-M005 (Reclaimer)	0 – 3.0; 10.4 – 15.2*	3.0 – 10.4		
BH16-M006 (Reclaimer)	0 – 3.0	3.0 – 9.1	9.1 – 15.2*	
BH16-M010 (Stockpile reclaim load-out tunnel)	2.4 – 3.0	3.0 – 4.0	0 – 1.0; 4.0 – 15.2*	1.0– 2.4 (Ice)
BH17-10 (Stockpile reclaim load-out tunnel)	-	-	0-13.7	13.7-16.7* (Low Ice Content Till)
BH16-M011 (Crusher)	3.0 – 3.7	0 – 3.0	3.7 – 15.2*	
BH16-M012 (Conveyor)	0 – 1.5	-	1.5 – 15.2*	
BH16-M013 (Screener)	0.3 – 3.0	-	3.0 – 15.2*	
BH16-M014 (Tail Pulley)	0 – 2.4	2.4 – 7.6	7.6 – 15.2*	
BH16-M015 (Tail Pulley)	0 – 3.0	3.0 – 6.1	6.1 – 15.2*	
BH18-M001 (Conical Stockpile)			0 – 0.7 6.2 – 18.3	0.7 – 6.2 (Ice) 18.3 – 25.9* (Low Ice Content Till)
BH18-M002 (Crusher Pads)	0 – 3.7	4.6 – 4.9 29.0 – 29.5	3.7 – 4.6 4.9 – 29.0	29.5 – 39.6* (Low Ice Content Till)
BH18-M003 (Reclaimer)	0 – 1.5	1.5 – 11.1	11.1 – 46.0	46.0 – 50.3* (Low Ice Content Till)
BH18-004 (Reclaimer)	0 – 3.0 13.6 – 18.3 21.3 – 42.7	3.0 – 13.6 18.3 – 21.3 43.5 – 62.5 65.0 – 68.6	42.7 – 43.5 62.5 – 65.0 68.6 – 77.7*	

* Indicates termination depth

Figure 5: Typical Sandy Deposit at The Northern End of the Berm (BH16-M001)

Figure 6: Typical Silty Deposit found at the Crusher Location (BH16-M011)

Figure 7: Typical Sandy Deposit at the Middle of the Berm (BH16-M004)

In the crusher, generator and screener areas and the southern end of the reclaimer, the stratigraphy followed a consistent pattern of silt underlying coarser sand and gravel layers. In BH16-M004 and BH16-M005 coarser material also underlies finer material, which may be indicative of paleo channels.

3.1.3 *Tank Area*

Two additional tanks are proposed for the Milne Port, south of the existing tank farm. Two boreholes, BH16-M002 and BH16-M003 were drilled at the proposed locations for the east tank and west tank, respectively. The results of the boreholes are summarized in Table 3-2.

Table 3-2: Summary of Boreholes in Tank Area

Borehole ID (Infrastructure)	Depth Material was Encountered		
	Sand and Silt	Silt	Gravelly Sand to Sandy Gravel
BH16-M002 (East Tank)	0 – 3.8	4.6 – 7.6	3.8 – 4.6; 7.6 – 15.2*
BH16-M003 (West Tank)	0 – 2.5	2.5 – 12.1	12.1 – 15.2*

* Denotes termination depth

3.1.3.1 *Silt and Sand*

In both boreholes the uppermost soil encountered contained approximately equal parts of silt and sand with trace to some gravel. In BH16-M002 from 3.0 m to 3.8 m, the silt and sand was highly organic. This material is likely a fill.

3.1.3.2 *Silt*

A layer of silt with trace to some sand and with organics was encountered in both boreholes. In BH16-M003, the silt was noted to contain ice inclusions including randomly/irregularly oriented ice formations.

3.1.3.3 *Gravelly Sand to Sandy Gravel*

In BH16-M002, a gravelly sand was encountered between the silt and sand strata, and also below the silt. This layer was described as light brown to grey with rounded to subangular gravel, similar to the deltaic sediments noted above. In BH16-M003, the sandy gravel layer was found to be angular and reddish brown to grey, which may indicate a different origin for this material, possibly as a glacial end moraine.

3.1.4 *Dumper (Rail Unloading) Area*

A total of six boreholes (BH16-M007, BH16-M008, and BH17-M008R, BH16-M009, BH17-EBC-1, and BH17-EBC-2) were drilled in the vicinity of the dumper (rail unloading area). BH17-M008R was drilled at the same location but slightly offset from BH16-M008 to obtain more detailed bedrock information at this location.

The subsurface conditions encountered at the site are highlighted as follows:

- The deposit at the hill crest comprises of a layer of sandy deposit described as silty sand, sand, or sand and gravel overlying till and then bedrock. A cobble and gravel layer was encountered right above bedrock in BH BH17-EBC-1 and BH17-EBC-2. The presence of cobbles and boulders were also inferred within the overburden in BH16-M008 and BH16-M009.
- Ground ice was encountered in borehole BH17-EBC-1. About 6 m of thick ground ice was encountered close to the surface of the native deposit. BH17- EBC-1 is located on the slope near the crest of the hill. A 3 m thick fill was placed to allow the access of the drilling rig. Under a 0.4 m thick surficial native gravel, the ground ice was encountered from el. 48.2 m to el. 42.2 m, with a 0.3 m thick interbedded sand layer from el. 46.5 m to el. 46.2 m. Below this interbedded sequence is a sand layer and a till deposit overlying a cobble and gravel layer and then bedrock. No ground ice was found at the corresponding elevations in the two nearby boreholes located approximately 30 m north (BH16-M-008) and 40 m south (BH17-EBC-002) of BH17-EBC-001. It is possible that the ground ice found in BH17-EBC-1 formed from a run-off stream.
- The bedrock at the site generally dips from east to west down the hill. The bedrock is granitic gneiss with RQD values varying from 64% to 68% as encountered in BH17-M-008R, which is the most close to the dumper. The unconfined compressive strength of the bedrock ranges from 23.6 MPa to 100.7 MPa with an average of about 60 MPa, classifying the rock as weak to very strong.

The overburden layers from the abovementioned boreholes are summarized in Table 3-3.

Table 3-3 Summary of Boreholes at the Rail Unloading Area

Borehole ID (Infrastructure)	Depth Material was Encountered				
	Fill	Ice	Sand and Gravel	Sand to Silty Sand	Granitic Gneiss Bedrock
BH16-M007 (Rail Unloading)			0 – 1.5	1.5 – 6.1	6.1 – 9.14*
BH16-M008 (Rail Unloading)			0 – 1.5; 4.6 – 10.6	1.5 – 4.6; 10.6 – 18.8	18.8 – 21.3*
BH16-M009 (Rail Workshop)			0.5 – 3.0	3.0 – 3.7	3.7 – 5.2*
BH17-M008R (Rail Unloading)**	-	-	-	-	17.42-22*
BH17-EBC-1 (Rail Unloading)	0.0-3.0	3.4-5.1 5.4-9.4	3.0-3.4 10.2-14	5.1-5.4 9.5-10.2	14-21.7*
BH17-EBC-2 (Rail Unloading)	-	-	0.0-1.52 3.55-13.3	1.52-3.55	13.3-21.8*

Notes: *Denotes termination depth. **BH17-M008R was drilled to only confirm bedrock condition. No sample was collected from overburden.

3.1.5 Module Delivery Routes (MDR)

A total of ten (10) boreholes have been drilled along the proposed MDR; the borehole logs and test reports are presented in Appendix B and Appendix D, respectively. The subsurface conditions reported along the road alignments are highlighted as follows:

- The boreholes drilled south of the existing barge off loading area (BH17-RD-1, BH17-RD-1A, and BH17-RD-1B), showed a layer of sand and gravel as road topping overlying a layer of rockfill of up to 4.5 m thick. This fill layer is underlain by a sandy layer which contains sand, with a varying amount of gravel, trace to no silt.
- In the area between the new permanent accommodation camp and the existing camp, three (3) new boreholes (BH17-RD-1C, BH17-RD-2, and BH17-RD-3) were drilled. A layer of sand and gravel of up to 0.5 m as road topping was encountered overlying a layer of sand with various gravel content. The thickness of the sand layers varies between 1 to 1.5 m. Below this sand layer, a layer of “silt and sand” to “sand trace silt” was recorded to the target depth of the boreholes (4.6 m to 6.1 m below existing ground surface).
- On the portion of the MDR alignment overlapping the existing haul road, four (4) boreholes (BH17-RD-4, BH17-RD-5, BH17-RD-6 and BH17-RD-7) were drilled. All boreholes showed a sand and gravel road topping of approximately 0.3 m thick, overlying a layer of rockfill with varying thickness of 1 to 3 m. Below this rockfill layer, a layer of “silt and sand” to “sand with silt” was reported. A layer of ice-rich soil (approximately 60% ice content) was observed in BH17-RD-4 between 1.4 m and the termination depth of the borehole at 4.6 m below existing ground surface. Also, a layer of ice (trace silt/sand) was reported in BH17-RD-6 between depths of 2.4 and 6 m.

- On the portion of the MDR alignment running along the proposed stacker/reclaimer berm, the subsurface condition was extracted from the boreholes drilled in that area in 2016 (BH16-M004, -M005, and -M006). In general, the material encountered ranged from "silt trace to some sand" to "sand and gravel".
- In the area in vicinity of the stockpile reclaim tunnel and crusher/screening plants, seven (7) boreholes (BH17-10, BH16-M010, BH16-M011, BH16-M012, BH16-M013, BH18-M001, and BH18-M002) were drilled. The deposit at this area comprise a thin sandy layer overlying a thick silt deposit. Below this layer is likely a till deposit as inferred from the findings in BH17-10, BH18-M001, and BH18-M002. The sandy layer contains sand, with a varying amount of gravel, trace to some silt and trace cobbles. The thickness of the sandy layer varies from zero to about 3.5 m. The silt layer also contains trace to some fine sand, trace gravel, trace organics. The frozen silt is generally well bonded and contains trace of thin ice lenses with a typical ice content from 20% to 40% by weight. A till layer (sand till with some silt and some gravel) was encountered at a starting depth of 13.7 m to 29.5 m underlying the silt deposit. The till layer is well graded and has a relatively low ice content of about 8%. A 1.4 m thick layer of ground ice was encountered from 1.0 m to 2.4 m depth in BH16-M010, and a 5.2 m thick layer was encountered from 0.8 m to 6.2 m depth in BH18-M001. All other boreholes in this area did not encounter ground ice.
- During the site investigations carried out in 2016, 2017, and 2018, bedrock was encountered at depth of 3.7 m at the proposed Rail Workshop area, and at the depth ranging between 6.1 m and 18.8 m at the proposed Dumper area. Bedrock was not encountered at other drilling locations within the port area.

The overburden layers encountered in the boreholes drilled for the MDR are summarized in Table 3-4.

Table 3-4: Summary of Boreholes for Module Delivery Routes (MDR)

Borehole ID (Infrastructure)	Depth Material was Encountered					
	Fill	Rock Fill	Ice	Sand and Gravel	Sand to Silty Sand	Gravel some Sand
BH17-RD-1	0.0-0.3	0.3-3.8	-	3.8-6.1	-	-
BH17-RD-1A	-	0.0-0.6	-	0.6-4.57	-	-
BH17-RD-1B	0.0-0.3	0.3-4.9	-	-	-	-
BH17-RD-1C	0.0-0.5	-	-	0.5-0.8	0.8-6.1	-
BH17-RD-2	0.0-0.3	0.3-1.1	-	1.5-2.5	1.1-1.5 2.5-4.57	-
BH17-RD-3	0.0-0.15	0.15-0.4	-	0.4-4.57	-	-
BH17-RD-4	0.0-0.3	0.3-1.1	1.3-4.57	1.1-1.3	-	-
BH17-RD-5	0.0-0.3	0.3-1.2	-	-	1.7-2.4	1.2-1.7 2.4-2.7
BH17-RD-6	0.0-0.2	0.2-2.9	3.4-6.1	3.3-3.4	2.9-3.3	-
BH17-RD-7	0.0-0.3	0.3-1.7	-	1.7-3.65	-	-

3.1.6 Fines Stockpile

Five boreholes (BH 17-11 to BH17-15) were drilled near the fines stockpiles. In general, the deposit consists of a surficial layer of iron ore and rockfill with a depth from 0 to 0.8 m. Underlying that, the deposits are silt and sand, silty sand, sand to sand and gravel, trace organics, containing ice content ranging from 6% to 32%. BH 17-12 encountered a sand and ice from 0.7 to 1.7m and ice from 1.7 m to 3.4 m. Table 3-5 summaries the soil layers encountered in this area.

3.1.7 New Accommodation Camp

One borehole (BH 17-Camp-1) was drilled at the proposed new accommodation camp. The deposit consists of 0.15 m road topping fill, overlying a sand and gravel layer to a depth of 1.8 m. Below that is a silt and sand deposit with trace clay and trace organics. No ground ice was encountered. Table 3-5 summaries the soil layers encountered at the proposed location for the new accommodation camp.

Table 3-5: Summary of Milne Port Supplementary Boreholes

Borehole ID (Infrastructure)	Depth Material was Encountered					
	Iron Ore	Rock Fill	Ice	Sand and Gravel	Sand to Silty Sand	Granitic Gneiss Bedrock
BH17-11 (fines stockpile)	0.0-0.76	0.76-1.52	-	1.52-8.60 10.7-15.20	8.60-10.70	-
BH17-12 (fines stockpile	0.0-0.5	0.5-0.7	0.7-3.4	3.6-4.6 6.1-15.2	4.6-6.1	-
BH17-13 (fines stockpile	0.0-0.4	0.4-0.8	-	0.8-6.09	-	-
BH17-14 (fines stockpile	0.0-0.3	0.3-0.4	-	0.4-6.1	-	-
BH17-15 (fines stockpile	0.0-0.7	-	-	0.7-6.1	-	-
BH17-CAMP-1 (Camp)	-	-	-	0.0-1.6	1.6-6.1	-

3.1.8 New Drive House

Two boreholes (BH17-EBC-8 and BH17-EBC-9) were drilled near the proposed new drive house. The deposit mainly consists of sand to sand and gravel, trace silt, trace to some organic interbedded layers. The ice content typically ranges from 10% to 20%. It is noted that unfrozen samples were retrieved from 14.5 m to 15.7 m in BH17-EBC-9 (a high salinity of 88 parts per thousand (ppt) was measured from the sample at a depth of 15.2 m). In BH17-EBC-8, the unfrozen samples were retrieved from 12.15 m to 12.76 m and from 13.68 m to 15.20

m. In BH17-EBC-8, the corresponding salinity measurement range from 14 ppt to 13 ppt for the samples at 12 m and 15 m depths. Table 3-6 summaries the soil layers encountered in the above boreholes.

Table 3-6: Summary of Boreholes for New Drive House

Borehole ID (Infrastructure)	Depth Material was Encountered		
	Sand and Gravel	Sand to Silty Sand	Granitic Gneiss Bedrock
BH17-EBC-8	0.0-16.7 23.0-25.2	16.7-23.0 25.2-39.52	-
BH17-EBC-9	0.0-8.4 11.0-39.52	8.4-11.0	-

3.2 Laboratory Testing

Select soil samples collected during the investigations were tested to confirm the field classification of the soil (completed by Hatch in a laboratory located in Niagara Falls, Ontario). These test results have been included in the borehole reports contained in Appendix B. Full test results are included in Appendix D. Appendix F also summarized the results of the moist test, grain size tests, salinity tests, rock strength tests (UCS and point load tests).

Samples of the granitic gneiss were taken from the rock core recovered in BH16-M007 as representative of the bedrock at the train unloading area. The rock test results from physical testing on the samples can be found in the 2016-2017-2018 Rail Geotechnical Investigation Factual Data Report. 1

3.3 Geophysics Results

The GPR (ground penetration radar) investigations were undertaken in proximity of the proposed area for drive station, dumper, conical stockpile, crushing building, screening building and south end of stacker reclaimer berm in order to investigate ice rich soil zones. The results of the geophysics investigation are presented in Appendix I.

In general, the GPR survey lines didn’t identify any ground ice. Georadar penetration of the surface appeared shallow with poor signal attenuation, possibly due to the soil in the subsurface in the port area as per the GPR report in Appendix I. It is noted that the encountered ice in BH16-M010 was not identified in the GPR investigation. As such, the application of GPR may not be suitable to investigate ground ice at the Milne Inlet site.

4. References

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Appendix A

Borehole Location Plan