REPORT

Mary River Project

Year 5 Freight Dock Offset Habitat Monitoring Report (Fisheries Act Authorization 18-HCAA-00160)

Submitted to:

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Executive Summary

Baffinland Iron Mines Corporation (Baffinland, the Proponent) constructed a Freight Dock in Milne Port in 2019, involving a permanent causeway and a seasonal floating barge. Installation of the Freight Dock resulted in unavoidable loss of fish habitat amounting to 26,449 m^2 (2,170 Habitat Equivalent Units [HEUs]; Baffinland 2019a). To offset the loss of fish habitat, Baffinland installed coarse rock material around the perimeter of the Freight Dock to increase habitat complexity and hard substrate for attachment and growth of macroalgae and invertebrate taxa in 2019.

Baffinland submitted a Fisheries Act Authorization (FAA) application to Fisheries and Oceans Canada (DFO) on February 27, 2019 for construction of the Freight Dock under paragraph 35(2)(b) of the *Fisheries Act*. DFO issued Fisheries Act Authorization 18-HCAA-00160 (FAA) for the proposed works on March 21, 2019, which included requirements for offsetting measures in addition to a prescribed 5-year monitoring program conducted over 10 years (years 1, 2, 5, 8, and 10) and reporting requirements for the Freight Dock offset habitat. The first two years of habitat monitoring occurred in 2020 (Year 1) and 2021 (Year 2). Year 5 of the habitat monitoring occurred between July 30 and August 7, 2024. As part of Year 5 monitoring, biophysical surveys were conducted in the Freight Dock offset habitat area and in a suitable Reference Area approximately 2.25 km northeast of the Freight Dock. Biophysical surveys comprised the following components, designed to achieve compliance with Section 5 of the FAA:

- A visual assessment at the Freight Dock during low tide (0.6 m chart datum [CD]) to document intertidal offset habitat and inspect coarse substrate stability.
- Mapping of as-built Freight Dock offset habitat.
- Mapping of a nearby Reference Area for comparison with offset habitat.
- Subtidal dive transect/quadrat surveys to quantitatively evaluate macroalgae, sessile and motile invertebrates and fish occurrence within both the Freight Dock offset habitat and Reference Area.
- Opportunistic observations of macroalgae, fish and motile/sessile invertebrates during habitat mapping.
- Subtidal assessment of stability of the coarse substrate along the perimeter of the Freight Dock offset habitat.

Survey results from 2024 indicate that macroalgae colonization was moderate to high in the Freight Dock offset habitat and, in general, the Reference Area showed relatively higher areal cover and taxa richness, as expected in Year 5 of a 10-year monitoring program. An overview of the macroalgae results of the Freight Dock offset habitat included: (1) low cover of sugar kelp (*Saccharina latissima* - understory kelp) in the shallow subtidal depth contour which was also recorded in the Reference Area, and (2) turf macroalgae in generally low to moderate cover consisting of three taxa of green algae (dominated by *Spongomorpha aeruginosa* and *Acrosiphonia* sp.), six taxa of brown algae (dominated by *Pylaiella* sp. and acid weed [*Desmarestia* sp.]), and one taxon of red algae (*Savoiea arctica*). Taxa occurring exclusively in the Reference Area included one taxon of a brown filamentous turf algae (*Chaetopteris plumosa*), crustose coralline algae (Order Corallinales), and five red turf algae taxa (dominated by *Odonthalia dentata* and *Coccotylus truncatus*).

In the Freight Dock offset habitat area, sessile invertebrates occurred in low coverage across all depth contours and included unidentified tunicates (Subphylum Tunicata), calcareous tube worms (Family Serpulidae), sabellid worms (Family Sabellidae), barnacles (Class Balanomorpha), and cone worms (*Cistenides granulata*). In the Reference Area, sessile invertebrates observed included tunicates, mussels (*Mytilus* sp.), and wrinkled rock-borer clams (*Hiatella arctica*). Motile invertebrates were limited to the shallow subtidal zone in both the Freight Dock offset habitat area and the Reference Area, with slightly higher species densities and taxa richness observed in the Reference Area. Species observed in the Freight Dock offset habitat area included one individual each of green urchin (*Strongylocentrotus droebachiensis*) and brittle star (Family Ophiuroidea). Species observed in the Reference Area included a limpet (Family Lottidae) and brittle stars.

Analyzed fish density and taxa richness were low (average = <0.5 org./m^2 and <1 taxa, respectively) in both the Freight Dock offset habitat and the Reference Area, compared to Year 2, but slightly higher in the Reference Area. A Shorthorn Sculpin (*Myoxocephalus scorpius*) was recorded in the offset habitat area while a Fish Doctor (*Gymnelus viridis*) was recorded in the Reference Area. Fourhorn Sculpin (*Myoxocephalus quadricornis*), a juvenile Shorthorn Sculpin (*Myoxocephalus scorpius*), an Arctic Sculpin (*Myoxocephalus scorpioides*) and two unidentified adult cod (Family Gadidae) were recorded opportunistically within the Freight Dock habitat offset during habitat mapping.

Overall, Year 5 of habitat offset monitoring indicates that the three-dimensional structure of the constructed offset habitat at the Freight Dock is providing a suitable and stable substrate for continued colonization and growth of marine organisms including macroalgae, fish and motile/sessile invertebrates. However, some qualitative substrate shifting was observed, including minor slumping on the northern face, exposed rockfill foundation, and areas where rock armour had been slightly displaced. Several sections of rock armouring around the fender pilings and an observed offshore pile on the north apron edge were identified as potential areas of erosional and/or navigational concern and are recommended for specific monitoring during future offset habitat monitoring years. Increased sedimentation was observed throughout the habitat, particularly on the eastern side of the Freight Dock, potentially due to natural sediment deposition from Creek M11-1 or from other environmental factors, with observed burial of subtidal hard substrate which may require continued monitoring in future years. The stability assessment and offset habitat biophysical surveys planned for Year 8 (i.e., in 2027) will provide additional information on the physical stability and colonization of the offset habitat area and whether any remedial work may be appropriate.

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ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Definition
Baffinland	Baffinland Iron Mines Corporation
CD	Chart datum
CPR	Cardiopulmonary resuscitation
DFO	Fisheries and Oceans Canada
FAA	*Fisheries Act* Authorization
FD	Freight Dock offset habitat
GIS	Geographic information system
GPS	Global positioning system
HEU	Habitat equivalency unit
in	Inches
km	Kilometres
LPL	Lowest practical taxonomic level
m	Metres
m^2	Square metres
mm	Millimetres
MEEMP	Marine Environmental Effects Monitoring Program
MFEAP	Marine Foreshore Environmental Assessment Procedure
Mtpa	Million tonnes per annum
NAD	North American Datum
NIRB	Nunavut Impact Review Board
No.	Number
Org/m^2	Organisms per square metre
Q	Quadrat
QA/QC	Quality assurance/quality control
REF	Reference Area
SCUBA	Self contained underwater breathing apparatus
SE	Standard error
sp.	Single or unconfirmed multiple species within a genus, used when the specimen has not been identified to the species level
T	Transect
The Project	Mary River Project
The Proponent	Baffinland Iron Mines Corporation
UTM	Universal Transverse Mercator
WAAS	Wide Area Augmentation System
%	Percent
>	Greater than
<	Less than

1.0 INTRODUCTION

1.1 Project Background

1.1.1 Description of the Mary River Project

Baffinland Iron Mines Corporation (Baffinland, the Proponent) operates the Mary River Project (the Project), an iron ore mine located in the Qikiqtani Region of Nunavut, Canada (Figure 1). The operating mine site is connected to Milne Port, located at the head of Milne Inlet, via the 100 km long Milne Inlet Tote Road.

The Project's Operating Certificate (Project Certificate 005) was issued by the Nunavut Impact Review Board in 2012. In 2014, Baffinland received approval (Project Certificate 005, Amendment 1) to operate the Early Revenue Phase (ERP) of the Project. The ERP authorized Baffinland to transport 4.2 million tonnes per annum (Mtpa) of ore by truck to Milne Port for shipping through the Northern Shipping Route (encompassing Milne Inlet, Eclipse Sound, and adjacent water bodies) using chartered ore carrier vessels. Baffinland shipped ~918,000 tonnes of iron ore from Milne Port during the first year of ERP operations in 2015, 2.6 Mtpa in 2016, and 4.1 Mtpa in 2017. Following approval of production increases allowing Baffinland to ship 6.0 Mtpa in 2018-2022 (Amendments 2, 3 and 4), annual totals of 5.1 Mtpa (2018), 5.9 Mtpa (2019), 5.5 Mtpa (2020), 5.6 Mtpa (2021) and 4.7 Mtpa (2022) of iron ore were shipped from Milne Port. In 2023, Amendment 5 (Sustainable Operations Proposal) was approved, and remained in effect until December 31, 2024. This amendment allowed a maximum of 6.0 Mtpa of iron ore to be transported on the Tote Road in any calendar year, with provision for an additional 0.9 Mtpa of 'stranded ore' to be shipped in the 2023 and 2024 shipping seasons. 'Stranded ore' is defined as iron ore that was delivered to Milne Port in the previous year but was not shipped due to weather or other shipping constraints. Amendment 5 also set the maximum number of ore carriers as 84 ore carriers per year in the 2023 and 2024 shipping season. In 2023, 6.02 Mtpa of iron ore was shipped from Milne Port using a total of 75 ore carriers. In 2024, 6.05 Mtpa of iron ore was shipped from Milne Port using a total of 70 ore carriers.

1.1.2 Freight Dock

On February 27, 2019, Baffinland submitted a Fisheries Act Authorization (FAA) application to Fisheries and Oceans Canada (DFO) for authorization of the Freight Dock construction project under paragraph 35(2)(b) of the *Fisheries Act* (Baffinland 2019a). The Freight Dock was required to support the import of containerized supplies, break-bulk, and special cargos. The Freight Dock, comprising a permanent causeway and seasonal floating spud barge, was a component of the Approved Project that was assessed previously by the NIRB (NIRB Project Certificate 005). The construction of the Freight Dock was determined to result in unavoidable loss of fish habitat and serious harm to fish amounting to 26,449 square metres (m^2) (2,170 Habitat Equivalent Units [HEUs] of marine fish habitat [Baffinland 2019a]). To offset the loss of fish habitat, Baffinland proposed the addition of coarse rock material around the perimeter of the Freight Dock to increase habitat complexity and hard substrate for attachment and growth of macroalgae and invertebrate taxa and provide fish habitat. On March 21, 2019, DFO issued *Fisheries Act* Authorization 18-HCAA-00160 for the proposed works (Appendix A). The construction of the Freight Dock, and addition of coarse rock around its perimeter as an offsetting measure, was completed in 2019 (Golder 2020a). Habitat offset monitoring was required to be conducted five times (in Years 1, 2, 5, 8 and 10) over a 10-year period to confirm the coarse rock habitat constructed as a fish habitat offset was functioning as intended. The first year of offset habitat monitoring occurred in August 2020 (Golder 2021a). Year 2 of offset habitat monitoring was undertaken in August 2021 (Golder 2022a). In 2024, Baffinland completed Year 5 of monitoring between July 30 and August 7, 2024, as per Condition 5.1.2 of the FAA (Appendix A). In each monitoring year, biophysical surveys were conducted in the Freight Dock offset habitat area and in a Reference Area which is located approximately 2.25 kilometres (km) northeast of the Freight Dock.

1.1.2.1 FAA Monitoring Requirements

DFO issued a FAA for the Freight Dock on March 21, 2019 (#18-HCAA-00160; Appendix A) that included the following Conditions applicable to monitoring of the offset habitat:

4. Conditions that relate to the offsetting of the serious harm to fish likely to result from the authorized work, undertaking or activity:

4.1 Scale and description of offsetting measures:

4.1.1 Coarse rock substrate will be placed around the perimeter of the Freight Dock and moorings at Milne Inlet to provide 2729 HEUs of potential fish habitat

5. Conditions that relate to monitoring and reporting of implementation of offsetting measures (described above in section 4):

5.1. The Proponent shall conduct monitoring of the implementation of offsetting measures according to the approved timeline and criteria in the Freight Dock Application, Section 9 in addition to an approved updated monitoring plan as follows:

5.1.1. The Proponent shall submit an updated offsetting monitoring plan for the proposed offsetting for review by DFO on or before May 31, 2019. The Monitoring plan must satisfy DFO's requirements to demonstrate through clear and measurable criteria, fisheries productivity changes as a result of the offsetting measures. To address uncertainty in the effectiveness of the proposed offsetting measures, the proposed monitoring must have sufficient statistical power to determine if changes to productivity are occurring as a result of the offsetting measures within a defined timeframe, and must employ the most up-to-date and proven methodologies demonstrated to be effective under Arctic conditions.

5.1.2. Monitoring of offsetting shall be conducted over ten years, with a five year monitoring program (years 1, 2, 5, 8, 10) as outlined in the Freight Dock Application, Section 8, or as outlined in an updated monitoring plan and/or subsequent versions and as approved by DFO.

5.1.3 In addition to the outlined criteria, a digital photographic record of pre-construction, during construction and post-construction conditions using the same vantage points and direction to show that the approved works have been completed in accordance with the Freight Dock Application and subsequent plans approved by DFO[1]*.*

5.2. List of reports to be provided to DFO: The Proponent shall report to DFO on whether the offsetting measures were conducted according to the conditions of this authorization by providing the following:

5.2.1. Post-construction evaluation report shall be submitted to the DFO-Yellowknife Office within three months of the completion of the Freight Dock construction[1]*.*

5.2.2. Monitoring reports shall be submitted to the DFO-Yellowknife Office by March 31 following each monitoring year, as will be outlined in the approved monitoring plan.

[1] Conditions 5.1.3 and 5.2.1were met with submission of the *Environmental Monitoring Completion Report: Milne Port Freight Dock Construction Project* (Golder 2020a).

LEGEND

- OFFSET HABITAT EXTENT
- REFERENCE AREA

0 250 500
1:15,000 METRES

REFERENCE(S)
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PROJECTED COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – YEAR 5 FREIGHT DOCK MON ITORING

CONSULTANT

YYYY-MM-DD	2025-03-27
DESIGNED	NO
PREPARED	AA
REVIEWED	NO
APPROVED	AL

TITLE
FREIGHT DOCK OFFSET HABITAT AND REFERENCE AREA LOCATION

PROJECT NO.	CONTROL	REV.	FIGURE
CA0026317.6821	86200-04	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
25mm

1.2 Objectives

In accordance with the conditions outlined in the FAA, this report summarizes methods and results for Year 5 offset habitat monitoring undertaken between July and August 2024. Monitoring completed in Year 5 aimed to satisfy DFO's requirement to demonstrate how the introduced offsetting measures have influenced fisheries productivity in the local marine environment using clear and measurable criteria (Condition 5.1.1). To this end, an 'Effectiveness Monitoring Plan' for the proposed coarse rock offset habitat was developed and submitted to DFO as a Condition of the FAA (Golder 2019a; Appendix B; hereafter referred to as 'the Monitoring Plan').

As outlined in the Monitoring Plan, the following objectives were used to evaluate the Freight Dock offset habitat (Appendix B):

- Documentation of the offset habitat using repeatable photographs and videos taken on an annual basis along established transects across a range of depths to demonstrate the extent of community establishment compared to similar coarse rock habitat (i.e., similar depth and habitat features) near Milne Port.
- Assess abundance[2], density[3], and diversity of taxa and functional groups.
- Assess presence and habitat usage by fish and motile invertebrates.
- Delineate the offset habitat to confirm that the introduced coarse rock habitat was constructed as designed and was shown to remain structurally stable over the 10-year monitoring period.
- Assess the functionality of the coarse rock, identify any structural failures or problems with the offset habitat, and implement actions to remediate any identified problems with the offset habitat.

1.2.1 Indicators and Metrics

To address the objectives of the program and evaluate the functionality of the offset habitat, effectiveness monitoring of the offset habitat includes an evaluation of the following indicators:

- Recruitment of propagules to rock substrate.
- Primary producers - diatoms, seaweed propagules, perennial/ephemeral macroalgae species, canopy/non-canopy-forming bladed kelps.
- Sessile colonizers - bryozoans, polychaetes, spirorbids, barnacles, anemones, sponges and coralline algae, trophic level, biological traits, habitat influence.
- Fish and motile invertebrate use.
- Arctic Char (*Salvelinus alpinus*) prey species e.g., krill, mysid shrimp, other fish species.
- Physical stability of coarse rock habitat.

[2] Abundance refers to a quantity or amount of the taxa/functional group.

[3] Density refers to a quantity of the taxa/functional group per unit area.

Table 1 outlines the habitat offset monitoring activities completed to date relevant to the selected indicators for the Freight Dock habitat offset monitoring program

Table 1: Milne Port Freight Dock – 10-year Offset Habitat Monitoring Schedule Showing Monitoring Activities Completed to Date

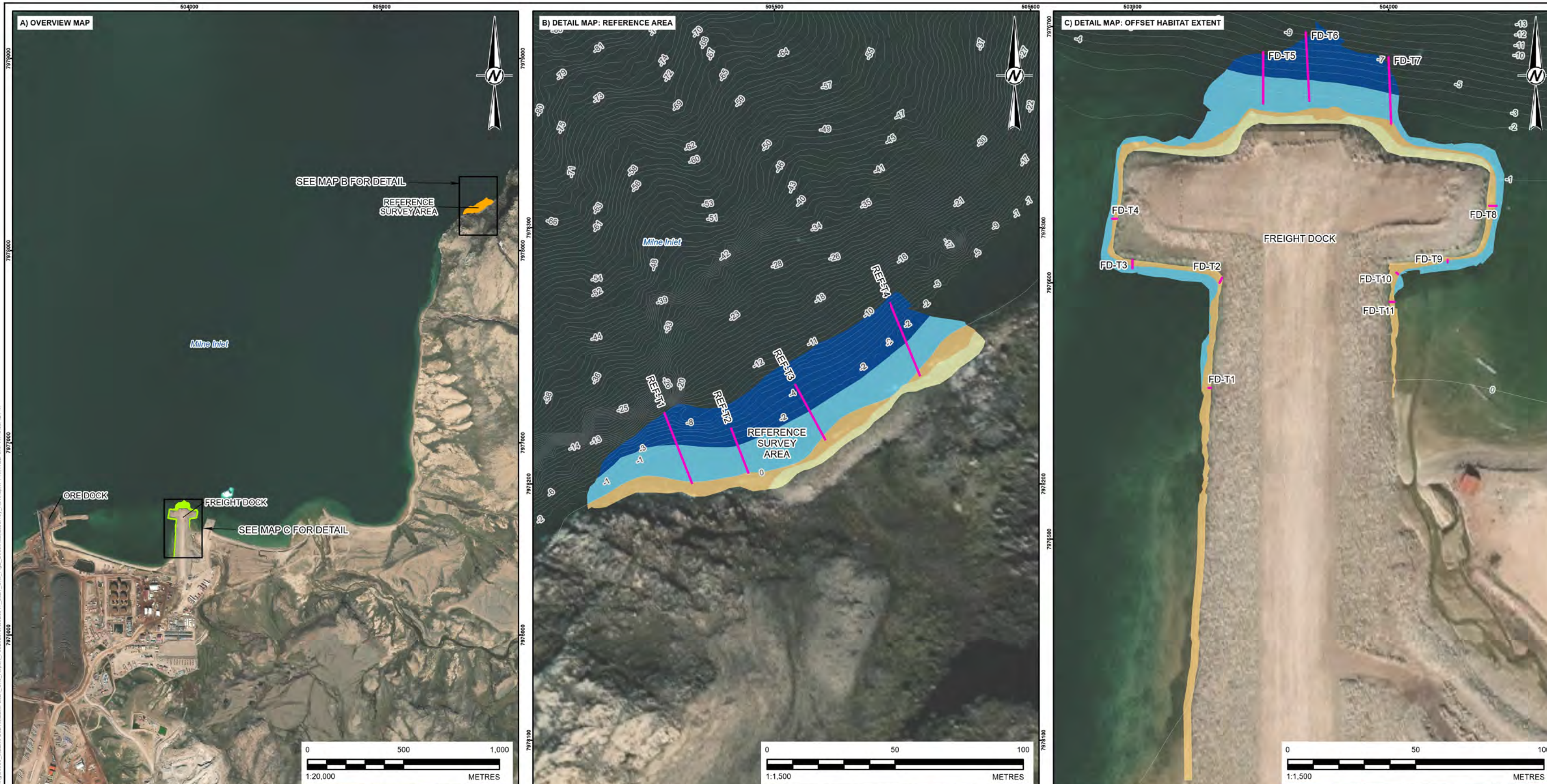
Indicators - Metrics	FAA Condition/ The Monitoring Plan (Golder 2019a)	Monitoring Event				
		Year 1 (2020)	Year 2 (2021)	Year 5 (2024)	Year 8 (2027)	Year 10 (2029)
Structural integrity: visual assessment	FAA Condition 5.1.1/ Section 2.3.4	√	√	√		
Macroalgae: percent (%) cover, diversity	FAA Condition 5.1.1/ Section 2.3	√	√	√		
Sessile invertebrates: % cover, diversity	FAA Condition 5.1.1/ Section 2.3	√	√	√		
Motile invertebrates: density, diversity	FAA Condition 5.1.1/ Section 2.3	√	√	√		
Fish: density, diversity	FAA Condition 5.1.1/ Section 2.3	√	√	√		
Arctic Char prey species: density, diversity	FAA Condition 5.1.1/ Section 2.3	√	√	√		

2.0 METHODS

2.1 Survey Areas

Surveys were conducted within the intertidal and subtidal footprint of the freight dock, and in an established Reference Area located in south Milne Inlet (Figure 2).

- **Freight Dock offset habitat**: The perimeter of the offset habitat was mapped and 11 shore-perpendicular transects were established with one to seven quadrats per transect surveyed depending on the length of the transect.
- **Reference Area**: The Reference Area, located approximately 2.25 km northeast of the Freight Dock location, included four (4) shore-perpendicular transects with five to seven quadrats per transect surveyed depending on the length of the transect.



LEGEND

- BATHYMETRY CONTOUR (1 m INTERVAL)
- TRANSECT
- OFFSET HABITAT EXTENT
- REFERENCE AREA

HABITAT TYPE

- ADDITIONAL INTERTIDAL (+2.3 TO 0 m CD)
- INTERTIDAL (+2.3 TO to 0 m)
- UPPER SUBTIDAL (0 m TO -3 m)
- SHALLOW SUBTIDAL (-3.1 TO -15 m CD)

REFERENCE(S)

BATHYMETRY CREATED BY GOLDER FROM MULTIPLE DATA SOURCES. CHART 7212 AND 4013647 OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE AND PURSUANT TO CHS DIRECT USER LICENCE NO. 2017-0531-1260-G. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. IMAGERY COPYRIGHT © 20240718 ESRI AND ITS LICENSORS. SOURCE: MAXAR. USED UNDER LICENSE, ALL RIGHTS RESERVED.
PROJECTED COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – YEAR 5 FREIGHT DOCK MON ITORING

CONSULTANT
wsp

YYYY-MM-DD	2025-03-27
DESIGNED	NO
PREPARED	AA
REVIEWED	NO
APPROVED	AL

TITLE
MILNE PORT FREIGHT DOCK – LOCATION OF DIVE SURVEYS IN OFFSET HABITAT AREA AND REFERENCE AREA

PROJECT NO.	CONTROL	REV.	FIGURE
CA0026317.6821	86200-04	0	2

2.2 Overview of Field Surveys

Field surveys undertaken in the Freight Dock offset habitat area and Reference Area in 2024 followed the methodology established in Year 1 (Golder 2021a) and Year 2 (Golder 2022a). Year 5 effectiveness monitoring was conducted between July 30 and August 7, 2024 by WSP's three-person SCUBA-based marine biologist dive team, using Baffinland's 30-foot Research Vessel. The dive team was certified[4] in accordance with Canadian Standard Association (CSA) Z275:4-97 (CSA 2020) and WorkSafe BC Regulations Part 24 (WorkSafeBC 2022).

Field surveys included the following components:

- A visual assessment at the Freight Dock conducted during low tide (0.6 m chart datum [CD]) from shore to delineate (i.e., map) and document the stability of the intertidal offset habitat (i.e., coarse rock substrate) to the extent possible.
- The assessment area delineated at the Freight Dock offset habitat and Reference Area to document survey extent.
- Subtidal dive transect/quadrat surveys conducted to describe and quantify the occurrence of macroalgae, sessile and motile invertebrates and fish in both the offset habitat area and Reference Area.
- Opportunistic observations[5] of macroalgae, fish and motile/sessile invertebrates recorded during habitat perimeter mapping.
- A subtidal assessment along the perimeter of the Freight Dock offset habitat conducted to delineate and document the stability of the subtidal offset habitat (i.e., coarse rock substrate).

Biophysical surveys conducted in the offset habitat area and the Reference Area are outlined in Table 2.

Table 2: Biophysical Surveys Conducted in the Freight Dock Offset Habitat Area and Reference Area

Survey Location	Survey Type	Date of Survey
Freight Dock Offset Habitat	Survey and visual assessment at Low Tide (0.6 m CD)	Jul 27, 2024
	Dive Transect/Quadrat Survey (FD-T1 to FD-T7)	Jul 30, 2024
	Dive Transect/Quadrat Survey (FD-T8 to FD-T11)	Aug 1, 2024
	Offset Habitat Mapping	Aug 1, 2024
Reference Area	Dive Transect/Quadrat Survey (REF-T1 to REF-T4)	Aug 7, 2024
	Survey Area Habitat Mapping	Aug 7, 2024

Note: CD = Chart datum; FD = Freight Dock offset habitat; m = metres; REF = Reference Area; T = Transect.

[4] Certifications for all divers included Occupational SCUBA (self-contained underwater breathing apparatus) Diver with the Diver Certification Board of Canada, first aid and CPR (cardiopulmonary resuscitation), oxygen therapy, dive accident management, and a valid dive medical certificate (CSA 2020; WorkSafeBC 2022).

[5] Opportunistic observations refer to observations that were recorded during diver-collected video to document presence/absence in a qualitative manner rather than quantitatively assessed during the transect/quadrat survey.

2.3 Habitat Mapping

To fulfill FAA Condition 4.1.1, the outer and inner perimeters of both the Freight Dock offset habitat and Reference Area were mapped by divers. The dive team first surveyed the outer perimeter of the placed coarse rock material within the subtidal zone using a taut-line buoy attached to surface Garmin WAAS[6]-enabled Global Positioning System (GPS)[7] that tracked the diver position at 5 second intervals. The mapping exercise included recording start and end coordinates as well as coordinates of additional points of interest. One diver maintained the taut-line buoy system while the other diver recorded video of the survey area using an underwater digital video camera[8] and took general notes of habitat features. The inner perimeter of the placed coarse rock material within the intertidal was then surveyed by the dive team to complete mapping of the habitat offset polygon (Appendix D – Photo 1). The placed coarse rock material was distinguishable from naturally existing coarse substrate (i.e., gravel, cobble) by its angular appearance. Because the offset habitat mapping was conducted during a low to mid tidal event, a limited portion of the intertidal area was not able to be mapped. This portion of the polygon was estimated using an ortho-rectified digital aerial photograph taken of the coarse rock offset habitat during a high tide event.

Habitat mapping in the Reference Area followed a similar approach to the Freight Dock offset habitat, with the offshore extent of the survey area consistent with the offshore extent of the Freight Dock offset habitat. The reference area selected offered similar substrate and habitat features within similar depth as the Freight Dock offset habitat area, as confirmed by the dive team.

2.4 Transect/Quadrat Surveys

To fulfill FAA Condition 5.1.1 and Section 2.3 of the Monitoring Plan (Golder 2019a), quantitative data were collected in general accordance with DFO's Marine Foreshore Environmental Assessment Procedure (MFEAP; Appendix C). Quadrats were placed along a series of standardized transects (established during Year 1 monitoring in 2020) that extended from the offshore survey perimeter to the intertidal zone in each survey area (Freight Dock offset habitat and Reference Area). The beginning and end of each transect were recorded using a handheld GPS. The location and depth range of each transect are provided in Table 3.

Transects within each survey area were placed using a weighted measuring tape and beginning at the outer (offshore) margin of the survey area (progressing shoreward). A 1.0-m^2 quadrat was placed at 1-m to 5-m intervals along the transect, depending on overall transect length (Appendix C; Appendix D – Photo 2). Transects longer than 10-m in length had 5-m intervals between the quadrats and transects shorter than 10-m in length had 1-m intervals between the quadrats. The first quadrat (Q1) was placed at the offshore extent of the transect, with all transects positioned perpendicular to shore and surveyed in an offshore to inshore direction (Figure 2; Appendix C). Transect/quadrat data were recorded on customized datasheets, according to the following criteria:

- Substrate type was visually estimated according to the size ranges: bedrock; boulder (>256 mm diameter); cobble (64 to 256 mm); gravel (2 to 64 mm); sand (0.0625 to 2 mm); silt/mud/clay (<0.0625 mm)[9] and relative composition (i.e., as a percentage areal cover).

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[6] Wide Area Augmentation System

[7] The accuracy of this GPS format can be up to ±10 m in this region.

[8] Divers operated a SONY RX100 V camera in a Fantasea underwater housing with a dive light for all underwater surveys. The camera has high-definition video capability and still photography features.

[9] Sand (0.0625 to 2 mm) and silt/mud/clay (<0.0625 mm) were estimated as a single category of soft sediment due to constraints in the field determining exact grain size through dive gloves.

- Other notable features such as debris accumulation were recorded.
- Macroalgae was identified to the lowest practical level (LPL) and areal cover was estimated.
- Sessile animals, such as clams and mussels, were identified to LPL and areal cover was estimated.
- Motile animals (e.g., fish, urchins, limpets) were identified to LPL and enumerated.
- Photographs showing representative biological features and aiding in species identification were taken.

Table 3: Survey Transect Locations and Depth Ranges in Offset Habitat Area and Reference Area

Area	Transect	Location (NAD 83 UTM 17N)		Transect Length (m) [No. of Quadrats]	Depth (m below CD)[1]	
		Inshore	Offshore		Start	End
Freight Dock Offset Habitat (FD)	FD-T1	503931 7976559	503930 7976559	1.0 [2]	0.2	1.0
	FD-T2	503935 7976602	503934 7976600	2.2 [4]	-0.5	1.1
	FD-T3	503900 7976606	503900 7976609	3.4 [4]	-0.6	1.1
	FD-T4	503894 7976625	503892 7976625	2.0 [3]	-0.7	1.0
	FD-T5	503951 7976670	503951 7976690	20.0 [5]	-7.3	-2.5
	FD-T6	503969 7976671	503968 7976698	26.8 [7]	-9.7	-1.2
	FD-T7	504001 7976662	504000 7976688	26.0 [7]	-9.0	-0.5
	FD-T8	504039 7976630	504042 7976630	3.0 [4]	-0.7	0.8
	FD-T9	504023 7976609	504023 7976608	1.0 [2]	-0.2	0.8
	FD-T10	504003 7976604	504004 7976603	1.0 [2]	0.2	1.2
	FD-T11	504000 7976593	504002 7976593	2.0 [1]	0.0	1.0
Reference Area (REF)	REF-T1	505468 7978200	505457 7978228	32 [7]	-9.9	-0.3
	REF-T2	505490 7978204	505483 7978222	24 [5]	-6.8	0.1
	REF-T3	505520 7978217	505508 7978239	27 [6]	-5.6	0.6
	REF-T4	505557 7978242	505545 7978271	29 [6]	-9.9	-0.6

Note: CD = chart datum; m = metres; No. = number; UTM = Universal Trans Mercator.

[1] Diver depth gauge was converted to meters (m) chart datum (CD), estimated using tide table for Milne Inlet, Nunavut (http://www.tides.gc.ca/eng [accessed September 2024]). The negative (-) numbers indicate ‘below’ CD and positive (+) numbers indicate ‘above’ CD. End depths (m) indicate the shallowest depth surveyed, predominantly at the waterline.

2.5 Physical Stability

To fulfill Section 2.3.4 of the Monitoring Plan (Golder 2019a), physical stability of the introduced coarse rock substrate was photographed and qualitatively evaluated for indication of movement, slumping, crumbling or where algae showed signs of abrasion, according to the following criteria:

- Exposure of crushed rockfill
- Rock armouring extending outside of the coarse substrate footprint (i.e., indicating movement of the coarse substrate)

- Obvious signs of slumping or pockets evident in the coarse rock armouring
- Other physical alteration that may affect the suitability of the substrate.

Measurements of the approximate area were recorded and estimated from the available photographs and underwater video footage.

2.6 Data Analysis

Mapped polygons of the Freight Dock offset habitat area and the Reference Area were downloaded from the GPS and plotted by geographic information system (GIS) software using aerial images, base map (hydrographic map) and/or bathymetry, where appropriate[10] .

Diver-collected transect/quadrat data were entered into an Excel spreadsheet by a WSP marine biologist and verified by a second WSP marine biologist for transcription errors. For both areas, quadrat data that contained >50% soft sediments were removed from the analysis to allow for a more effective comparison of coarse substrate (i.e., bedrock, boulder, cobble) between the two survey areas.

To fulfill FAA Condition 5.1.1 and Sections 2.3 and 2.4 in the Monitoring Plan (Golder 2019a; Appendix B), the following monitoring parameters were measured and/or analyzed in the offset habitat area and the Reference Area:

- Relative abundance of macroalgae and epifauna (areal percent [%] cover and/or organisms [org/m^2]) in survey quadrats presented by depth category, representative of intertidal (+2.3 to -0.5 m CD), upper subtidal (<-0.5 to -3 m CD) and shallow subtidal (< -3 m CD) zones, including mean[11], standard error (SE) of the mean, and range[12].
- Mean taxa richness (mean number of unique taxa[13]) by depth category as above.

2.7 Quality Assurance/Quality Control

The following quality assurance and quality control (QA/QC) measures were implemented:

- Field survey data sheets were verified and cross-validated in the field
- Dive survey video and photographs, GIS tracks and survey waypoints were saved to a laptop computer and external hard drive at the end of each field day
- Taxa identifications, including common and species names, were verified using established reference sources[14]

---

[10] Data references are provided on figures under 'References'.

[11] Overall means were calculated using mean values per transect for the area surveyed.

[12] Range represents the lowest and highest number of percent cover (or density, as applicable) and taxa observed.

[13] Did not include higher order taxa for which there exists a lower order identification. For example, does not include *Mya* sp. if *Mya truncata* is found in the same quadrat.

[14] References used during the surveys, included: Coad and Reist 2018; Küpper et al. 2016; Guiry and Guiry 2025; WoRMS 2025; the annual Baffinland marine environmental effects monitoring program (MEEMP) and non-indigenous/aquatic invasive species (NIS/AIS)

- Transect/quadrat data were entered into an electronic database where a second biologist conducted a data quality check and review for detection of transcription errors
- Summary statistics calculations were verified by a second biologist for errors as part of the data review process.

3.0 RESULTS

Transect and quadrat sampling locations are shown in Figure 3 and Figure 4. Representative photographs and stills from underwater video footage are included in Appendix D. Quadrat/transect data are tabulated in Appendix E. A list of taxa with common and scientific names is provided in Appendix F.

3.1 Habitat Mapping

Freight Dock

Habitat mapping at the Freight Dock offset habitat was conducted on August 1, 2024. The outer perimeter mapping was conducted along the largely subtidal extent of the offset substrate with depths ranging from -8.6 m CD to +0.8 m CD. The intertidal inner perimeter mapping was conducted via a snorkel swim at the surface along the waterline of the Freight Dock offset habitat substrate at a tide of approximately 0.8 m (DFO 2025). Offset substrate consisted largely of boulder/rip rap from the intertidal through the subtidal with smaller percentage areal cover of cobble at the outer extents of the subtidal perimeter.

Table 4 summarizes the size (m^2) of the habitat areas surveyed by the dive team in the Freight Dock offset habitat area, presented by depth category.

Table 4: Coarse Material Substrate Area Estimates from Freight Dock Mapping

Substrate Type	Depth Contour	Area Estimate (m^2)
Intertidal	+2.3 to -0.5 m CD	1,310
Upper subtidal	<-0.5 to -3 m CD	1,760
Shallow subtidal	<-3 m CD	830
Total mapped area (total estimated coarse material area)		**3,900 (4,368)**

In addition to the 3,900 m^2 of total mapped (by divers) coarse substrate, an additional intertidal portion of the north face of the Freight Dock offset habitat was estimated to measure 467 m^2, resulting in a total survey footprint of 4,368 m^2 (Figure 3). This area comprised intertidal coarse material that was not accessible during the time of the dive survey due to tide height.

monitoring program reports (Golder 2021b; Golder 2022b; WSP 2023); and expert opinion from the laboratory of Dr. Gary Saunders at the University of New Brunswick.

Reference Area

The spatial boundaries of the survey grid in the Reference Area were approximate as there was no defined coarse substrate berm for divers to use as a point of reference such as that available in the Freight Dock offset habitat area (Figure 3). However, the dive team confirmed that the transect/quadrat sampling encompassed the three established depth contours in substrate type directly comparable to that available in the offset habitat area. Table 7 summarizes the size (m^2) of the habitat areas surveyed by the dive team in the Reference Area presented by depth category.

Table 5: Coarse Material Substrate Area Estimates from Reference Area Mapping

Substrate Type	Depth Contour	Area Estimate (m^2)
Intertidal	+2.3 to -0.5 m CD	753
Upper subtidal	<-0.5 to -3 m CD	1,856
Shallow subtidal	<-3 m CD	2,178
Total mapped area (total estimated Reference Area)		**4,787 (5,184)**

In addition to the 4,787 m^2 of total mapped coarse substrate, an additional intertidal portion of the Reference Area was estimated to measure 397 m^2, resulting in a total survey footprint of 5,184 m^2. This area comprised intertidal coarse substrate that was not accessible during the time of the dive survey due to tide height and angle of coarse material (substrate consisted of shallow, low gradient boulders).

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LEGEND

QUADRAT LOCATION

BATHYMETRY CONTOUR (1 M INTERVAL)

TRANSECT

HABITAT TYPE

ADDITIONAL INTERTIDAL (+2.3 TO 0 M CD)

INTERTIDAL (+2.3 M TO 0 M)

UPPER SUBTIDAL (0 M TO -3 M)

SHALLOW SUBTIDAL (-3.1 TO -15 M CD)

0 25 50

1:1,000 METRES

REFERENCE(S)

BATHYMETRY CREATED BY GOLDER FROM MULTIPLE DATA SOURCES. CHART 7212 AND 4013647 OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE AND PURSUANT TO CHS DIRECT USER LICENCE NO. 2017-0531-1260-G. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. IMAGERY COPYRIGHT © 20240718 ESRI AND ITS LICENSORS. SOURCE: MAXAR. USED UNDER LICENSE, ALL RIGHTS RESERVED. PROJECTED COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N

CLIENT

BAFFINLAND IRON MINES CORPORATION

PROJECT

MARY RIVER PROJECT – YEAR 5 FREIGHT DOCK MON ITORING

TITLE

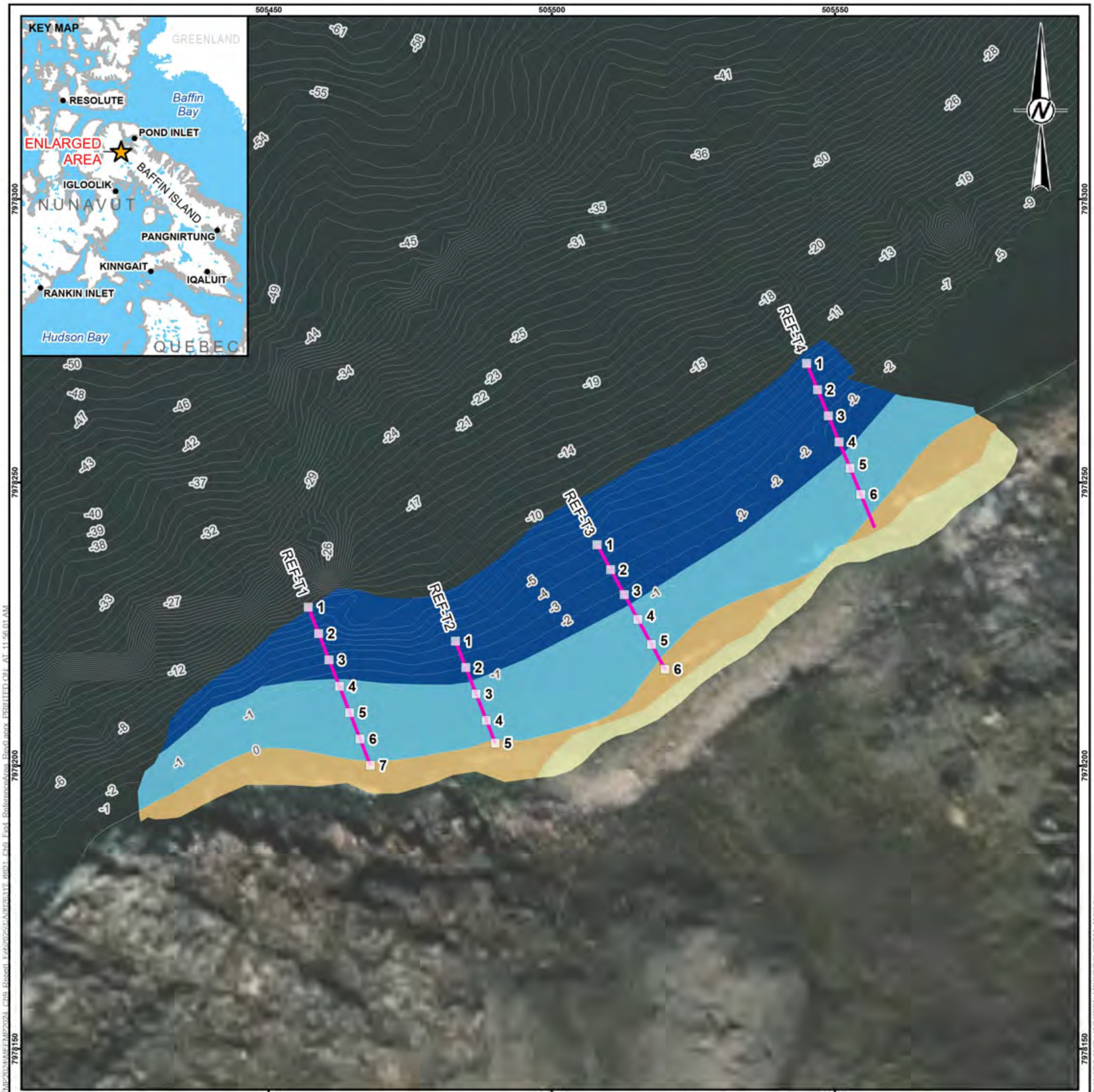
TRANSECT/QUADRAT SAMPLING LOCATIONS IN FREIGHT DOCK OFFSET HABITAT AREA IN MILNE PORT

CONSULTANT

YYYY-MM-DD	2025-03-27
DESIGNED	NO
PREPARED	AA
REVIEWED	NO
APPROVED	AL

PROJECT NO.	CONTROL	REV.	FIGURE
CA0026317.6821	86200-04	0	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



LEGEND

- QUADRAT LOCATION
- BATHYMETRY CONTOUR (1 m INTERVAL)
- TRANSECT

HABITAT TYPE

- ADDITIONAL INTERTIDAL (+2.3 TO 0 m CD)
- INTERTIDAL (+2.3 TO to 0 m)
- UPPER SUBTIDAL (0 m TO -3 m)
- SHALLOW SUBTIDAL (-3.1 TO -15 m CD)

0 25 50

1:1,000 METRES

REFERENCE(S)

BATHYMETRY CREATED BY GOLDER FROM MULTIPLE DATA SOURCES. CHART 7212 AND 4013647 OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE AND PURSUANT TO CHS DIRECT USER LICENCE NO. 2017-0531-1260-G. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. IMAGERY COPYRIGHT © 20240718 ESRI AND ITS LICENSORS. SOURCE: MAXAR. USED UNDER LICENSE, ALL RIGHTS RESERVED.
PROJECTED COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – YEAR 5 FREIGHT DOCK MON ITORING

CONSULTANT
wsp

YYYY-MM-DD	2025-03-27
DESIGNED	NO
PREPARED	AA
REVIEWED	NO
APPROVED	AL

TITLE
TRANSECT/QUADRAT SAMPLING LOCATIONS IN OFFSET HABITAT REFERENCE AREA IN MILNE PORT

PROJECT NO.	CONTROL	REV.	FIGURE
CA0026317.6821	86200-04	0	4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
25mm

3.2 Macroalgae Colonization

3.2.1 Overview

Mean percent areal cover of macroalgae in the Freight Dock habitat offset area was generally moderate. The highest occurrence of macroalgae was within the shallow subtidal zone with a mean areal cover of 52.4 ± 6.7% (Table 6; Figure 5). In the Reference Area, macroalgae mean percent areal cover was more variable between zones, with the greatest mean percent areal cover in the upper subtidal zone with 96.4 ± 2.8%. As in previous years, macroalgae cover was driven primarily by turf algae cover (Section 3.2.3). Taxa richness in the Freight Dock offset habitat area was lower compared to the Reference Area in all zones, with the largest difference in taxa richness observed within the shallow subtidal (3.8 ± 0.4 taxa and 9.0 ± 1.5 taxa, respectively).

Diatoms, consisting largely of tube-dwelling diatoms (Appendix D – Photo 3), were recorded along most of the transects in the Freight Dock offset habitat area and in the Reference Area. For consistency with Years 1 and 2 monitoring, the diatoms were not included as part of the macroalgae percent areal cover estimates but may have limited macroalgae attachment to the substrate due to competition for attachment space.

Table 6: Macroalgae – Percent Cover and Taxa Richness by Survey Area and Depth Contour

Survey Area	Analyzed Quadrats (Total Quadrats)[1]	Areal Cover (%)		Taxa Richness	
		Mean ± SE	Range	Mean ± SE	Range
Intertidal (-0.5 to +2.3 m CD)					
Freight Dock	19 (20)	42.2 ± 5.0	0 - 75	1.6 ± 0.2	0 - 3
Reference	3 (3)	22.3 ± 6.7	12 - 35	3.0 ± 0.0	3
Upper subtidal (<-0.5 to -3 m CD)					
Freight Dock	7 (7)	39.7 ± 8.8	9 - 62	2.3 ± 0.4	1 - 3
Reference	7 (9)	96.4 ± 2.8	80 - 100	3.6 ± 0.2	3 - 4
Shallow subtidal (<-3 m CD)					
Freight Dock	13 (14)	52.4 ± 6.7	22 - 91	3.8 ± 0.4	2 - 7
Reference	3 (12)	77.3 ± 10.9	56 - 92	9.0 ± 1.5	6 - 11

Note: CD = chart datum; SE = Standard error; % = percent.

[1] Quadrat data was omitted from analysis when the dominant substrate was soft (>50% areal cover). Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.

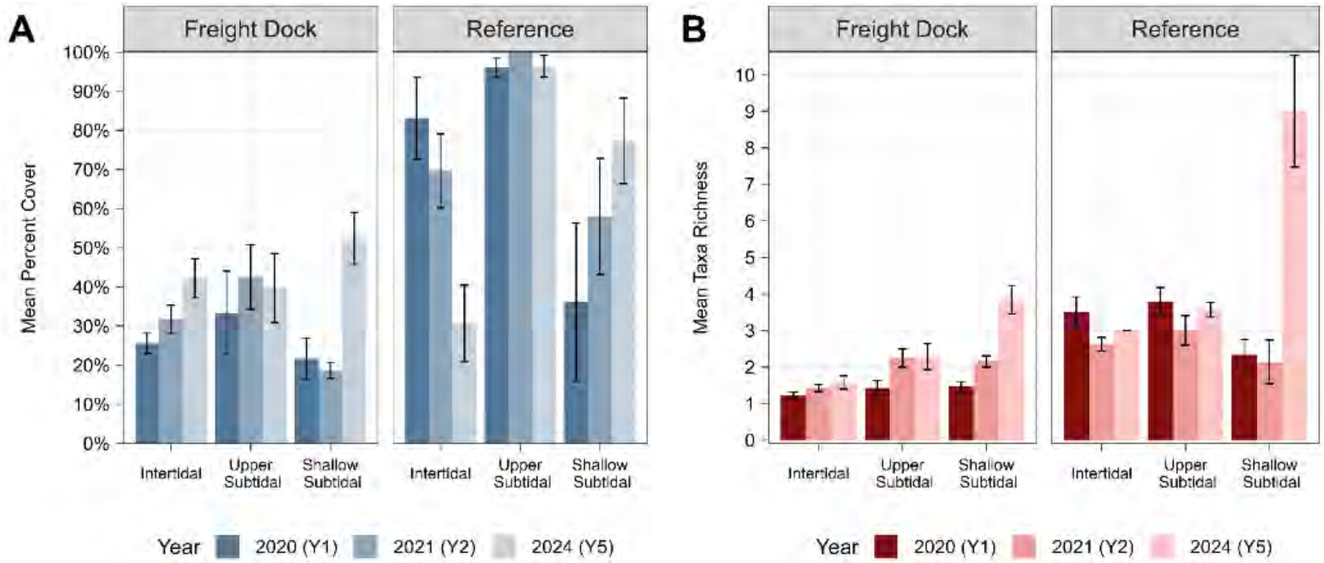


Figure 5: Total Macroalgae A) Mean Percent Cover and B) Taxa Richness by Survey Area and Depth Contour. Error bars are based on standard error.

3.2.2 Understory Kelp

One taxon of brown-bladed understory kelp – sugar kelp (*Saccharina latissima)* – was recorded in the shallow subtidal zone of both areas at low percent cover, generally in depths greater than -5 m CD (Table 7; Figure 6; Appendix D – Photo 4). Year 5 is the second year of monitoring where kelp was observed at the constructed Freight Dock; however, unlike in Year 2 (2021), sieve kelp (*Agarum clathratum*), was not observed within the Reference Area. Mean cover and taxa richness were generally higher in 2025 due to more quadrats containing understory kelp than seen in Year 2 (Figure 6).

Table 7: Understory Kelp - Percent Cover and Taxa Richness by Survey Area and Depth Contour

Survey Area	Analyzed Quadrats (Total Quadrats)[1]	% Areal Cover		Taxa Richness	
		Mean ± SE	Range	Mean ± SE	Range
Intertidal (-0.5 to +2.3 m CD)					
Freight Dock	19 (20)	0.0 ± 0	0	0.0 ± 0	0
Reference	3 (3)	0.0 ± 0	0	0.0 ± 0	0
Upper subtidal (<-0.5 to -3 m CD)					
Freight Dock	7 (7)	0.0 ± 0	0	0.0 ± 0	0
Reference	7 (9)	0.0 ± 0	0	0.0 ± 0	0
Shallow subtidal (<-3 m CD)					
Freight Dock	13 (14)	4.0 ± 1.5	0 - 15	0.6 ± 0.1	0 - 1
Reference	3 (12)	5.0 ± 5.0	0 - 15	0.3 ± 0.3	0 - 1

Note: CD = chart datum; SE = Standard error; % = percent.

[1] Quadrat data was omitted from analysis when the dominant substrate was soft (>50% areal cover). Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.

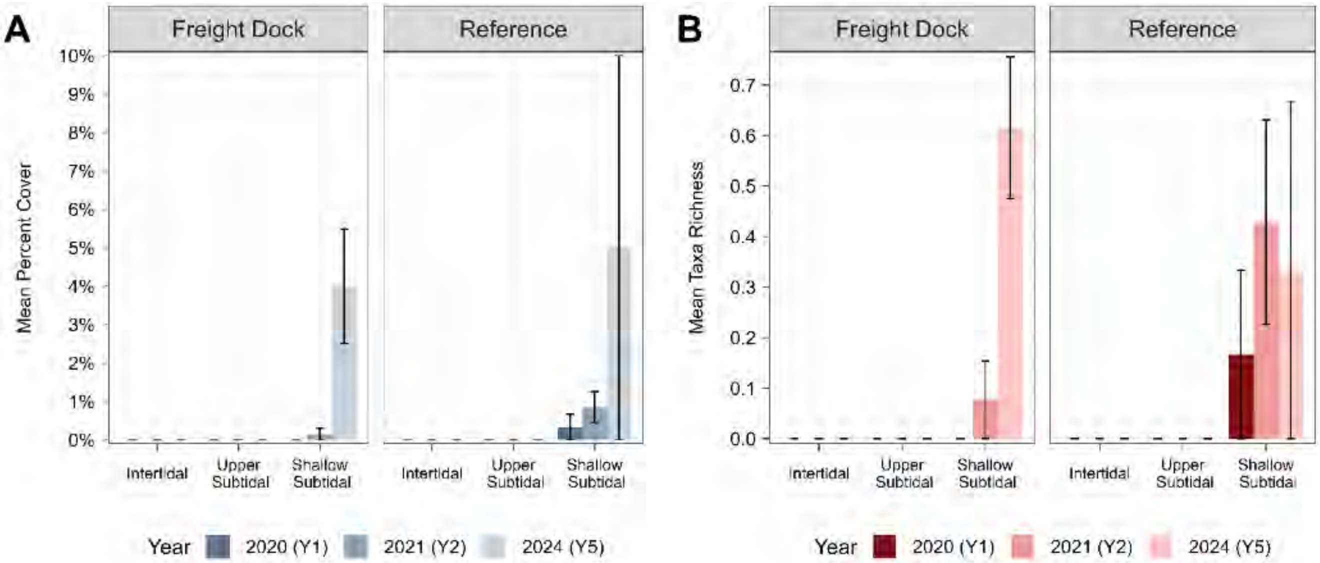


Figure 6: Understory Kelp A) Mean Percent Cover and B) Taxa Richness by Survey Area and Depth Contour. Error bars are based on standard error.

3.2.3 Turf Macroalgae

Turf macroalgae had moderate mean cover in the Freight Dock offset habitat area and ranged from moderate to high cover in the Reference Area (Table 8).The intertidal zones of both areas were dominated by green filamentous algae with *Acrosiphonia* sp. and *Spongomorpha aeruginosa* (Appendix D – Photo 5) dominant along the Freight Dock and *Chaetomorpha melagonium* (Appendix D – Photo 6) and rockweed (*Fucus distichus*; Appendix D – Photo 7) dominant within the Reference Area.

The epilithic[15] brown filamentous algae *Pylaiella* sp. (Appendix D – Photo 7) was ubiquitous and abundant within each of the two deeper depth contours (upper and shallow subtidal) and observed at both the Freight Dock offset habitat area and Reference Area. *Pylaiella* sp., along with rockweed and brown filamentous *Battersia* sp. (Appendix D – Photo 8) were dominant within the upper subtidal Reference Area at low to high covers, while *S. aeruginosa* and *Pylaiella* sp. remained dominant within the Freight Dock offset habitat upper subtidal zone at low to moderate covers.

Within the shallow subtidal zone of the Freight Dock, *Pylaiella* sp. dominated at low to moderate cover with acid weed (*Desmarestia* sp.; Appendix D – Photo 9) while several taxa of brown algae dominated at low to moderate cover within the Reference Area shallow subtidal zone with low cover of a variety of other algae taxa. Overall, seven (7) brown turf algae, seven (7) red turf algae, and three (3) green turf algae taxa were observed among both areas (Appendix E). Additionally, three macroalgae taxa were recorded for the first time in Milne Port during the MEEMP-NIS/AIS and Offset Habitat Monitoring programs:

- *Chaetopteris plumosa* (Appendix D – Photo 10), a brown filamentous alga that has been documented in historical records in northern Baffin Island (Küpper et al. 2016).

[15] Epilithic is defined in Küpper et al. (2016) as an algae taxon that grows on rock or hard substrate.

- *Ahnfeltia plicata* (referred to as Landlady's wig [Guiry 2024] or black sour weed [MarLIN 2025]; Appendix D – Photo 11), a red branched alga that has been documented in historical records in northern Baffin Island (Küpper et al. 2016).
- *Odonthalia dentata* (referred to as Northern tooth weed [MarLIN 2025]; Appendix D – Photo 12), a red branched alga with a well-documented distribution in northern Baffin Island (Küpper et al. 2016) with observations of this species as close as Pond Inlet (Saunders 2023) and Steensby Inlet[16].

Year 5 mean turf macroalgae cover was generally within the range of standard error from previous years (Year 1 and 2) except within the shallow subtidal of the Freight Dock habitat offset area where Year 5 values were much higher than in previous years and the intertidal of the Reference Area where Year 5 values were much lower than in previous years (Figure 7). The increase in shallow subtidal turf macroalgae cover at the Freight Dock is driven largely by increased *Pylaiella* sp. cover (Golder 2022a). The decrease in intertidal Reference Area turf macroalgae may be due to fewer analyzed quadrats or due to natural environmental variability given factors such as sediment transport processes (e.g., clay was observed along the intertidal portion of the Reference Area between boulders), ice scour, and/or competition for light or attachment from annually dynamic taxa.

Taxa richness in the Freight Dock offset habitat area was lower than that in the Reference Area for all zones, with the highest number of taxa observed within the shallow subtidal for both areas (Table 8). Similar to areal cover, mean taxa richness was generally within the range of standard error from previous years (Year 1 and 2) except for the shallow subtidal zones of both areas, where taxa richness increased in Year 5 (Figure 7). Increases in taxa richness may be due to interannual variability but the addition of an M.Sc. student studying taxonomy of Arctic macroalgae[17] on site during surveys may have also improved real-time taxonomic identification capabilities.

Overall, the Freight Dock offset habitat supported 10 unique turf macroalgae taxa across the zones while the Reference Area supported 17 unique turf algae taxa, including nearly all observations of red algae (Table 10; Appendix E).

Table 8: Turf Macroalgae - Percent Cover and Taxa Richness by Survey Area and Depth Contour

Survey Area	Analyzed Quadrats (Total Quadrats)[1]	Areal Cover (%)		Taxa Richness		Dominant Taxa
		Mean ± SE	Range	Mean ± SE	Range	
Intertidal (-0.5 to +2.3 m CD)						
Freight Dock	19 (20)	42.2 ± 5.0	0 - 75	1.6 ± 0.2	0 - 3	*Acrosiphonia* sp., *S.aeruginosa*
Reference	3 (3)	30.7 ± 9.8	12 - 45	3.0 ± 0.0	3	Rockweed, *C.melagonium*
Upper subtidal (<-0.5 to -3 m CD)						
Freight Dock	7 (7)	39.7 ± 8.8	9 - 62	2.3 ± 0.4	1 - 3	*Pylaiella* sp., *S. aeruginosa,*
Reference	7 (9)	96.4 ± 2.8	80 - 100	3.6 ± 0.2	3 - 4	Rockweed, *Pylaiella* sp.
Shallow subtidal (<-3 m CD)						
Freight Dock	13 (14)	48.4 ± 6.3	11 - 76	3.2 ± 0.4	2 - 7	*Pylaiella* sp., Acid weed,
Reference	3 (12)	55.7 ± 18.3	34 - 92	8.3 ± 1.2	6 - 10	Rockweed, *Pylaiella* sp.

Note: CD = chart datum; SE = Standard error; % = percent.

[1] Quadrat data was omitted from analysis when the dominant substrate was soft (>50% areal cover). Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.

[16] Species was observed during the Steensby Port baseline monitoring program conducted by WSP biologists in 2021 via ROV surveys and in 2022 via dive survey (unpublished data).

[17] A M.Sc. student from the University of New Brunswick (Dr. Gary Saunder's macroalgal taxonomic laboratory) was on site for the majority of surveys to collect samples as part of her research in collaboration with WSP and the MEEMP and NIS/AIS programs in 2024.

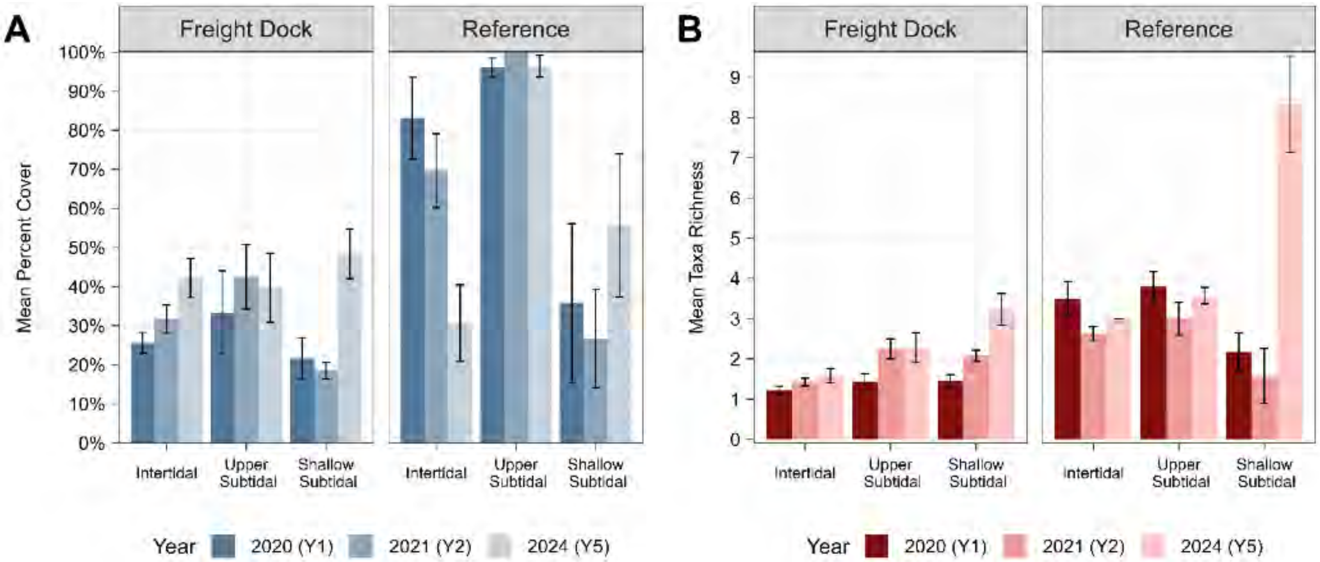


Figure 7: Turf Algae A) Mean Percent Cover and B) Taxa Richness by Survey Area and Depth Contour. Error bars are based on standard error.

3.2.4 Encrusting Algae

Encrusting algae, specifically, a crustose coralline algae (Order Corallinales), was not observed in the Freight Dock offset habitat area but was observed within one quadrat in the Reference Area in the shallow subtidal on bedrock (Table 9; Appendix D – Photo 13). This is a decrease in observations of encrusting coralline algae from Year 1 and Year 2, which each had three quadrats containing crustose coralline algae within the shallow subtidal zone of the Reference Area (Figure 8). Reduced observations may be due to slight offsets of quadrats from previous years or deposition of finer sediment over areas of hard substrate that supported encrusting algae, as was also observed at nearby permanent quadrat sites in Milne Inlet as part of the MEEMP program (i.e., interannual variability in encrusting algae cover across sample quadrats; WSP 2024).

Table 9: Encrusting Algae - Percent Cover and Taxa Richness by Survey Area and Depth Contour

Survey Area	Analyzed Quadrats (Total Quadrats)[1]	% Areal Cover		Taxa Richness	
		Mean ± SE	Range	Mean ± SE	Range
Intertidal (-0.5 to +2.3 m CD)					
Freight Dock	19 (20)	0.0 ± 0	0	0.0 ± 0	0
Reference	3 (3)	0.0 ± 0	0	0.0 ± 0	0
Upper subtidal (<-0.5 to -3 m CD)					
Freight Dock	7 (7)	0.0 ± 0	0	0.0 ± 0	0
Reference	7 (9)	0.0 ± 0	0	0.0 ± 0	0
Shallow subtidal (<-3 m CD)					
Freight Dock	13 (14)	0.0 ± 0	0	0.0 ± 0	0
Reference	3 (12)	16.7 ± 16.7	0 - 50	0.3 ± 0.3	0 - 1

Note: CD = chart datum; SE = Standard error; % = percent.

[1] Quadrat data was omitted from analysis when the dominant substrate was soft (>50% areal cover). Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.

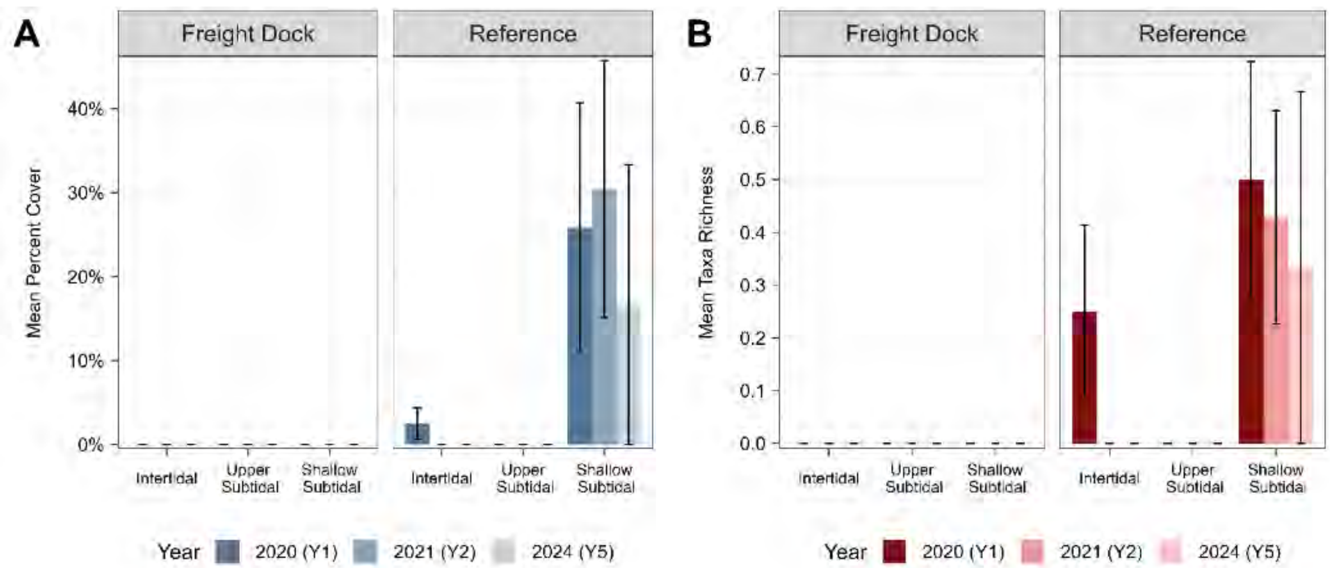


Figure 8: Encrusting Coralline Algae Mean Percent Cover by Survey Area and Depth Contour. Error bars are based on standard error.

Table 10: Opportunistic Macroalgae[1] Taxa Observations during Habitat Mapping and Review of Video

Taxon	Freight Dock	Reference Area
Brown Algae (Ochrophyta)		
Sugar kelp (*Laminaria saccharina*)	√	√
Rockweed (*Fucus distichus*)	√	√
Acid weed (*Desmarestia* sp.)	√	√
Pylaiella sp.	√	√
Red Algae (Rhodophyta)		
Coccotylus truncatus	-	√
Dilsea socialis	-	√
Savoiea arctica	-	√
Encrusting coralline (Order Corallinales)	√	√
Green Algae (Chlorophyta)		
Spongomorpha aeruginosa	√	-
Chaetomorpha melagonium	-	-
Acrosiphonia sp.	√	√

[1]Taxa are provided here as a qualitative assessment of presence/absence of organisms.

3.3 Invertebrates

Sessile Invertebrates

In the Freight Dock habitat offset area, a small patch of calcareous tube worms (Family Serpulidae) was observed in the intertidal zone. No sessile invertebrates had been recorded in the Freight Dock habitat offset area intertidal zone in Years 1 (Golder 2021a) and 2 (Golder 2022a). Similar to Year 2, unidentified tunicates (Subphylum Tunicata; Appendix D – Photo 14) were observed at very low cover in the both the upper and shallow subtidal zones of the Freight Dock offset habitat. Additionally, low cover of sabellid worms (Family Sabellidae; Appendix D – Photo 15), barnacles (Class Balanomorpha; Appendix D – Photo 16), and cone worms (*Cistenides granulata*; Appendix D – Photo 17) was observed within the shallow subtidal of the Freight Dock offset habitat (Table 11; Appendix E).

In the Reference Area, sessile invertebrates were not recorded in the intertidal zone and were recorded at very low cover in the upper and shallow subtidal zones (Table 11). Within the upper subtidal, cone worms and tunicates were the only observed taxa at very low cover (Table 11; Appendix E). In the shallow subtidal, numerous taxa were recorded but were not included in analyses as they were colonizing soft substrate rather than hard substrate analogous to the constructed habitat. Considering only hard substrate colonization, taxa richness was highest in the shallow subtidal zone for analyzed quadrats (12.3 ± 4.1, range: 1 - 8 taxa). On hard substrate, sessile invertebrates observed included low cover of wrinkled rock-borers (*Hiatella arctica*; Appendix D – Photo 13) and very low cover of barnacles, sabellid worms, cone worms, an anemone (*Urticina* sp.), hydrozoans (Order Leptothecata; Appendix D – Photo 17), a burrowing anemone (Order Ceriantharia; Appendix D – Photo 18), blunt gaper (*Mya truncata*), mussels (*Mytilus* sp.; Appendix D – Photo 19), and an articulated brachiopod (*Hemithiris psittacea*).

Mean cover of sessile invertebrates was lower in Year 5 than in previous years for all depth zones in both areas (Figure 9), potentially explained by interannual variation with decreased sessile cover in both areas. Mean taxa richness was higher within the shallow subtidal zone of both areas, but generally lower in all other zones of both areas (Figure 9). As with macroalgae, diatoms, consisting largely of tube diatoms, recorded at high cover along most of the transects in the Freight Dock offset habitat area, may have limited sessile invertebrate attachment to the substrate due to competition for space.

Table 11: Sessile Invertebrates Recorded During Transect/Quadrat Surveys by Survey Area and Depth Contour

Survey Area	Analyzed Quadrats (Total Quadrats)[1]	Area Cover (%)		Taxa Richness		Dominant Taxa
		Mean ± SE	Range	Mean ± SE	Range	
Intertidal (-0.5 to +2.3 m CD)						
Freight Dock	19 (20)	0.1 ± 0.1	0 - 1	0.1 ± 0.1	0 - 1	Calcareous tube worm
Reference	3 (3)	0.0 ± 0	0	0.0 ± 0	0	None
Upper subtidal (<-0.5 to -3 m CD)						
Freight Dock	7 (7)	0.3 ± 0.3	0 - 2	0.1 ± 0.1	0 - 1	Tunicate
Reference	7 (9)	0.7 ± 0.7	0 - 5	0.1 ± 0.1	0 - 1	Cone worm, tunicate
Shallow subtidal (<-3 m CD)						
Freight Dock	13 (14)	4.2 ± 1.1	0 - 13	1.1 ± 0.2	0 - 2	Sabellid worm, tunicate
Reference	3 (12)	12.3 ± 4.1	5 - 19	4.3 ± 2.0	1 - 8	Wrinkled rock-borer

Note: CD = chart datum; SE = Standard error; % = percent.

[1] Quadrat data was omitted from analysis when the dominant substrate was soft (>50% areal cover). Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.

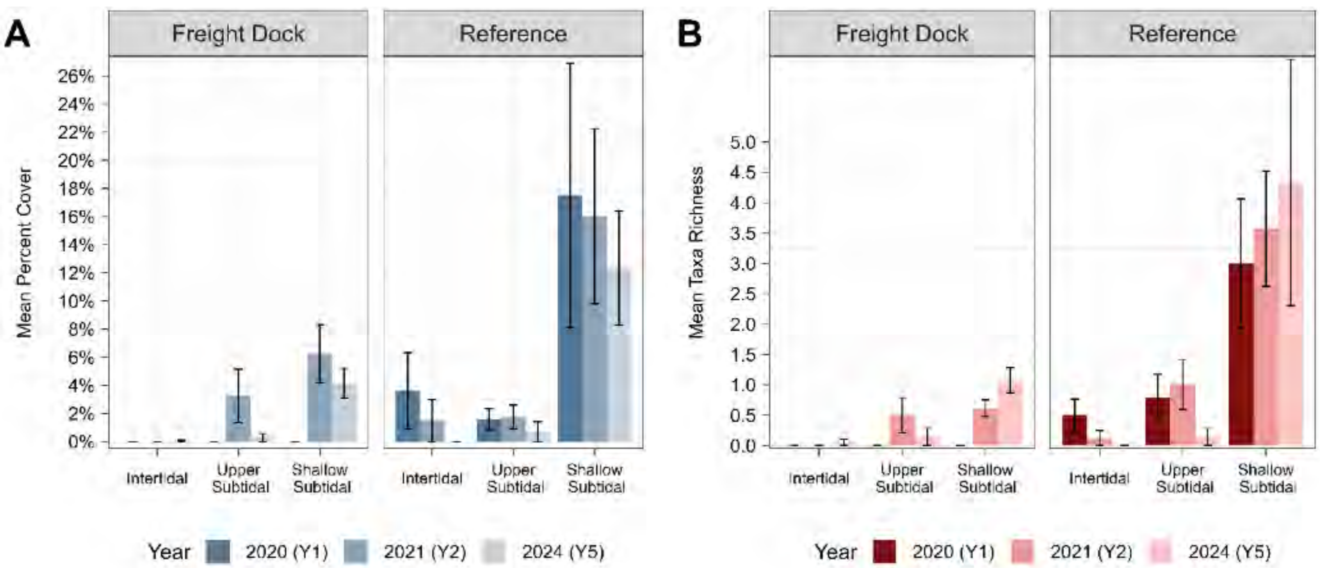


Figure 9: Sessile Invertebrate A) Mean Percent Cover and B) Taxa Richness by Survey Area and Depth Contour. Error bars are based on standard error.

Motile Invertebrates

Motile invertebrates were not observed within the intertidal or upper subtidal zones in either the Freight Dock offset habitat area or the Reference Area (Table 12). However, several taxa were recorded in the shallow subtidal zone in both areas. Mean density was very low (0.2 ± 0.2 organisms/m^2 [org/m^2]) in the shallow subtidal zone of the Freight Dock, with two taxa observed: green urchin (*Strongylocentrotus droebachiensis*; Appendix D – Photo 20) and brittle star (Family Ophiuroidea; Appendix D – Photo 21). In contrast, mean density was slightly higher in the shallow subtidal zone of the Reference Area (0.7 ± 0.3 org/m^2), with observed species including a limpet (Family Lottiidae; Appendix D – Photo 13) and a brittle star. Taxa richness was similar for motile invertebrates in both survey areas but slightly higher in the Reference Area due to fewer quadrats analyzed (Table 12). Both mean density and mean taxa richness were comparable to or slightly less than those calculated for previous years (Figure 10; Golder 2021a, 2022a).

Table 12: Motile Invertebrates Recorded during Transect/Quadrat Survey by Survey Area and Depth Contour

Survey Area	Analyzed Quadrats (Total Quadrats)[1]	Density (org/m^2)		Taxa Richness		Dominant Taxa
		Mean ± SE	Range	Mean ± SE	Range	
Intertidal (-0.5 to +2.3 m CD)						
Freight Dock	19 (20)	0.0 ± 0	0	0.0 ± 0	0	None
Reference	3 (3)	0.0 ± 0	0	0.0 ± 0	0	None
Upper subtidal (<-0.5 to -3 m CD)						
Freight Dock	7 (7)	0.0 ± 0	0	0.0 ± 0	0	None
Reference	7 (9)	0.0 ± 0	0	0.0 ± 0	0	None
Shallow subtidal (<-3 m CD)						
Freight Dock	13 (14)	0.2 ± 0.2	0 - 2	0.2 ± 0.2	0 - 2	Green urchin, brittle star
Reference	3 (12)	0.7 ± 0.3	0 - 1	0.7 ± 0.3	0 - 1	Green urchin, limpet

Note: CD = chart datum; m^2 = square metres; org = organisms; SE = Standard error.
[1] Quadrat data was omitted from analysis when the dominant substrate was soft (>50% areal cover). Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.

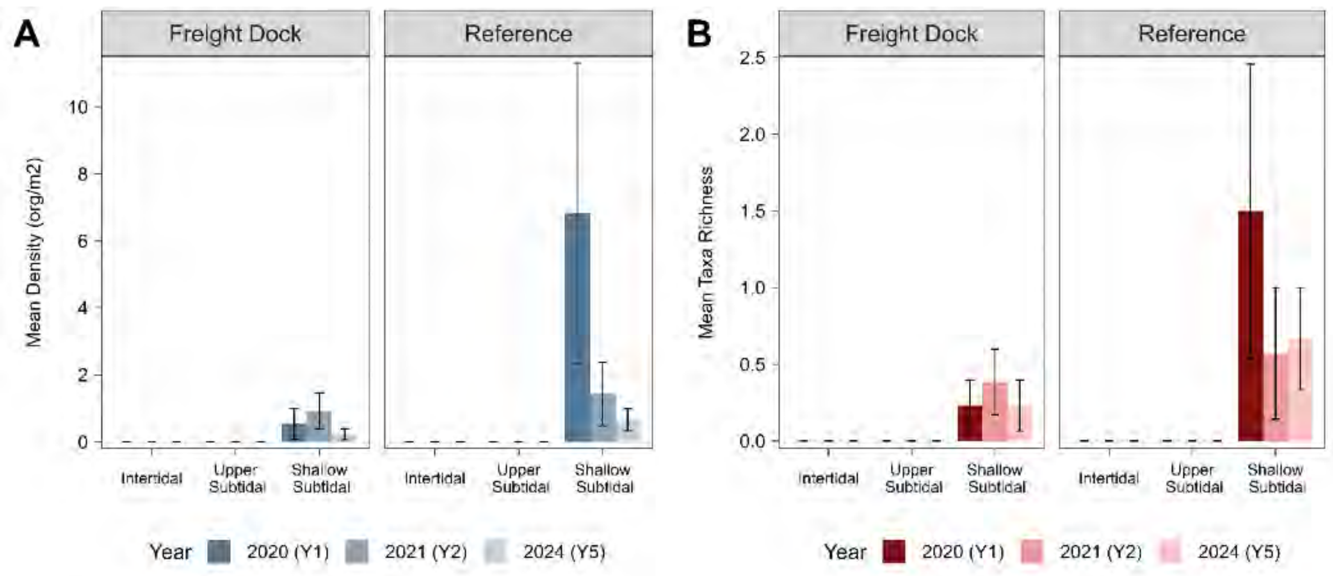


Figure 10: Motile Invertebrate A) Mean Density (org/m²) and B) Taxa Richness by Survey Area and Depth Contour. Error bars are based on standard error.

Mysid (opossum) shrimp (Order Mysida; Appendix D – Photo 22) were observed in all depth zones of the Freight Dock offset habitat area and in the upper subtidal zone of the Reference Area (Table 13). Mean densities of mysid shrimp in both areas were lower than those reported in Year 1 of monitoring (Golder 2021a) but higher than in Year 2 (Golder 2022a). Mysid shrimp were generally recorded in small swarms in both survey areas (Figure 11). Mysid shrimp were also noted to be abundantly present during the habitat mapping of both areas in all zones.

Table 13: Summary Metrics of Mysid Shrimp Recorded during Transect/Quadrat Survey by Survey Area and Depth Contour

Survey Area	Number of Quadrats Analyzed (Total number of quadrats)[1]	Density (org/m²)	
		Mean ± SE	Range
Intertidal (-0.5 to +2.3 m CD)			
Freight Dock	19 (20)	1.8 ± 1.1	0 - 20
Reference	3 (3)	0.0 ± 0	0
Upper subtidal (<-0.5 to -3 m CD)			
Freight Dock	7 (7)	0.1 ± 0.1	0 - 1
Reference	7 (9)	14.3 ± 14.3	0 - 100
Shallow subtidal (<-3 m CD)			
Freight Dock	13 (14)	15.4 ± 15.4	0 - 200
Reference	3 (12)	0.0 ± 0	0

Note: CD = chart datum; m² = square metres; org = organisms; SE = Standard error.

[1] Quadrat data was omitted from analysis when the dominant substrate was soft (>50% areal cover). Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.

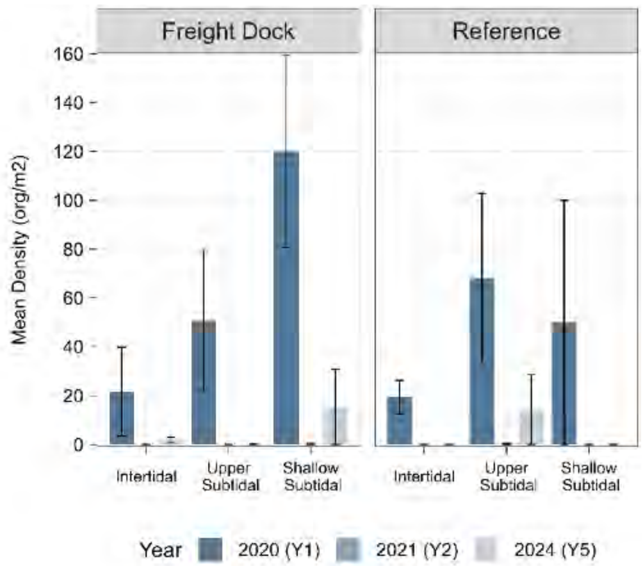


Figure 11: Mysid Mean Density (org/m^2) by Survey Area and Depth Contour. Error bars are based on standard error.

Note: As only one taxon of mysid was distinguishable within a year, taxa richness is not included in the figure.

Other opportunistic observations of taxa recorded outside the transect/quadrat survey are summarized in Table 14, including occurrences of sea angels (*Clione limacina*), Arctic comb jelly (*Mertensia ovum*; Appendix D – Photo 23), northern comb jelly (*Bolinopsis infundibulum*; Appendix D – Photo 24), and Icelandic scallops (*Chlamys islandica*) in both areas and sea butterflies (*Limacina helicina*) in the Reference Area (Table 14).

Table 14: Opportunistic Invertebrate[1] Taxa Observations during Habitat Mapping and Review of Video

Taxa List	Freight Dock	Reference Area
Annelida		
Sabellid worm (Family Sabellidae)	√	√
Cone worm (*Cistenides granulata*)	-	√
Arthropoda		
Barnacle (Class Balanomorpha)	√	-
Mysid (Order Mysida)	√	√
Copepod (Class Copepoda)	√	-
Cnidaria		
Burrowing anemone (Order Ceriantharia)	-	√
Hydromedusa (Class Hydrozoa)	√	√
Ctenophora		
Arctic comb jelly (*Mertensia ovum*)	√	-
Common northern comb jelly (*Bolinopsis infundibulum*)	√	-
Unidentified ctenophore (Phylum Ctenophora)	√	√

Taxa List	Freight Dock	Reference Area
Echinodermata		
Brittle star (Family Ophiuridae)	√	√
Green urchin (*Strongylocentrotus droebachiensis*)	√	-
Mollusca		
Icelandic scallop (*Chlamys islandica*)	√	√
Sea angel (*Clione limacina*)	√	√
Wrinkled rock-borer (*Hiatella arctica*)	√	√
Sea butterfly (*Limacina helicina*)	-	√
Blunt gaper (*Mya truncata*)	√	√
Mussel (*Mytilus* sp.)	√	√
Tunicata		
Family Pyuridae	√	-
Tunicate	√	√

[1]Taxa are provided here as a qualitative assessment of presence/absence of organisms.

3.4 Fish

Only three fish were observed during transect and quadrat surveys: a Fish Doctor (*Gymnelus viridis*; Appendix D – Photo 25) within the Reference Area intertidal, a Shorthorn Sculpin (*Myoxocephalus scorpius*; Appendix D – Photo 26) within the Freight Dock offset habitat area shallow subtidal, and a juvenile eelpout (Family Zoarcidae) within the Reference Area shallow subtidal (Appendix E); however, the juvenile eelpout was identified on soft substrate and was not included in density and cover analyses. Consequently, both mean density and taxa richness of fishes were very low for both areas at all depth contours (Table 15), generally consistent with previous years (Figure 12).

Table 15: Fish Recorded during Transect/Quadrat Survey by Survey Area and Depth Contour

Survey Area	Analyzed Quadrats (Total Quadrats)[1]	Abundance	Density (fish/m^2)		Taxa Richness	
			Mean ± SE	Range	Mean ± SE	Range
Intertidal (-0.5 to +2.3 m CD)						
Freight Dock	19 (20)	0	0.0 ± 0	0	0.0 ± 0	0
Reference	3 (3)	1	0.3 ± 0.3	0 - 1	0.3 ± 0.3	0 - 1
Upper subtidal (<-0.5 to -3 m CD)						
Freight Dock	7 (7)	0	0.0 ± 0	0	0.0 ± 0	0
Reference	7 (9)	0	0.0 ± 0	0	0.0 ± 0	0
Shallow subtidal (<-3 m CD)						
Freight Dock	13 (14)	1	0.1 ± 0.1	0 - 1	0.1 ± 0.1	0 - 1
Reference	3 (12)	0	0.0 ± 0	0	0.0 ± 0	0

Note: v. Abundance indicates total number of fish recorded.

[1] Quadrat data was omitted from analysis when the dominant substrate was soft (>50% areal cover). Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.

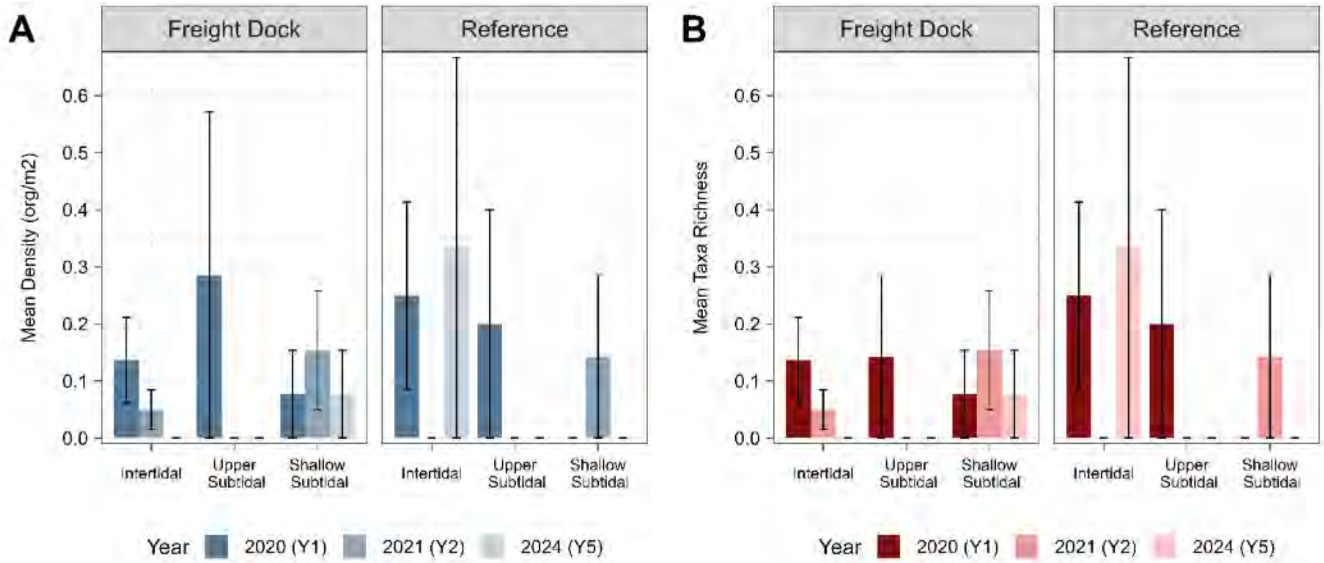


Figure 12: Fish Mean Density (fish/m²) by Survey Area and Depth Contour. Error bars are based on standard error.

During habitat mapping of the Freight Dock offset habitat area, several Fourhorn Sculpin (*Myoxocephalus quadricornis*), a juvenile Shorthorn Sculpin (*Myoxocephalus Scorpius*), and two unidentified adult cod (Family Gadidae) were recorded opportunistically (Table 16). Additionally, an Arctic Sculpin (*Myoxocephalus scorpioides*) was observed outside of a quadrat during transect/quadrat surveys on FD-T1 (Table 16). Unlike in Year 2, Arctic Char (*Salvelinus alpinus*) was not observed along the Freight Dock offset habitat (Golder 2022a). No fish were opportunistically observed within the Reference Area during habitat mapping (Table 16).

Table 16: Opportunistic Fish[1] Taxa Observations during Habitat Mapping and Review of Video

Taxa List	Freight Dock	Reference Area
Cod (Family Gadidae)	√	-
Fourhorn Sculpin (*Myoxocephalus quadricornis*)	√	-
Arctic Sculpin (*Myoxocephalus scorpioides*)	√	-
Shorthorn Sculpin (*Myoxocephalus scorpius*)	√	-
Sculpin (Family Cottidae)	√	-

[1] Taxa are provided here as a qualitative assessment of presence/absence of organisms.

3.5 Physical Stability

The Freight Dock offset habitat design consisted of a crushed rockfill foundation protected by armour rock in areas in direct contact with seawater (Baffinland 2019a). Physical stability of the Freight Dock coarse rock substrate was qualitatively assessed during a low tide visual assessment from shore, habitat mapping, and transect/quadrat surveys. The results of the qualitative assessment with photographs are presented in Table 17 and representative photographs and locations of physical stability points, anthropogenic debris, and Picture 1 viewpoints are presented in Figure 13.

The Freight Dock offset habitat appears to be physically stable. Physical manipulation (i.e., pushes) by divers at various locations along the offset structure during habitat mapping and surveys did not result in movement of offset materials. However, there were noticeable areas of substrate movement around certain sections of the upland and subtidal areas of the Freight Dock offset habitat. Minor slumping was observed along the northern face of the Freight Dock, including slumping of rock armouring with exposed rockfill foundation, slumping of rockfill foundation towards the intertidal, and slumping of rockfill within the eastern fender's metal bracket (Table 17: No. 13). Within the subtidal, several small sections along the Freight Dock (specifically on the southwestern arm, north face, and eastern corner) appear to have been pulled away from the outer rock armour apron of the Freight Dock when comparing monitoring results between Years 2 and 5 (Figure 13; Table 17: No. 1, 2, and 18), potentially caused by sea ice movement during winter. A minor rock armouring slump has exposed the rockfill foundation adjacent to FD-T11 on the eastern arm (Figure 13).

During the upland survey of the offset habitat in August 2024, minor slumping of rock armour on both sides of the fender pilings was observed on the northern face of the Freight Dock. Notes from the Freight Dock construction environmental monitoring conducted in early August 2019 (Golder 2020a) indicated that rock armouring was intentionally removed in these locations (Figure 13; Table 17: No. 8 and 12) to better accommodate vessel and barge drafts during offloading. The lack of rock armouring along the fender pilings was documented in the Freight Dock Construction Summary Report (Hatch 2019) as a potential concern for erosion and was recommended for regular inspections by Hatch (2019). The areas around the pilings that lack rock armouring were surveyed as part of Year 2 offset monitoring conducted by Golder (2022a), but no issues were identified at that time. Specific monitoring of these locations in Year 8 of offset monitoring would be appropriate to confirm if the potential for erosion exists.

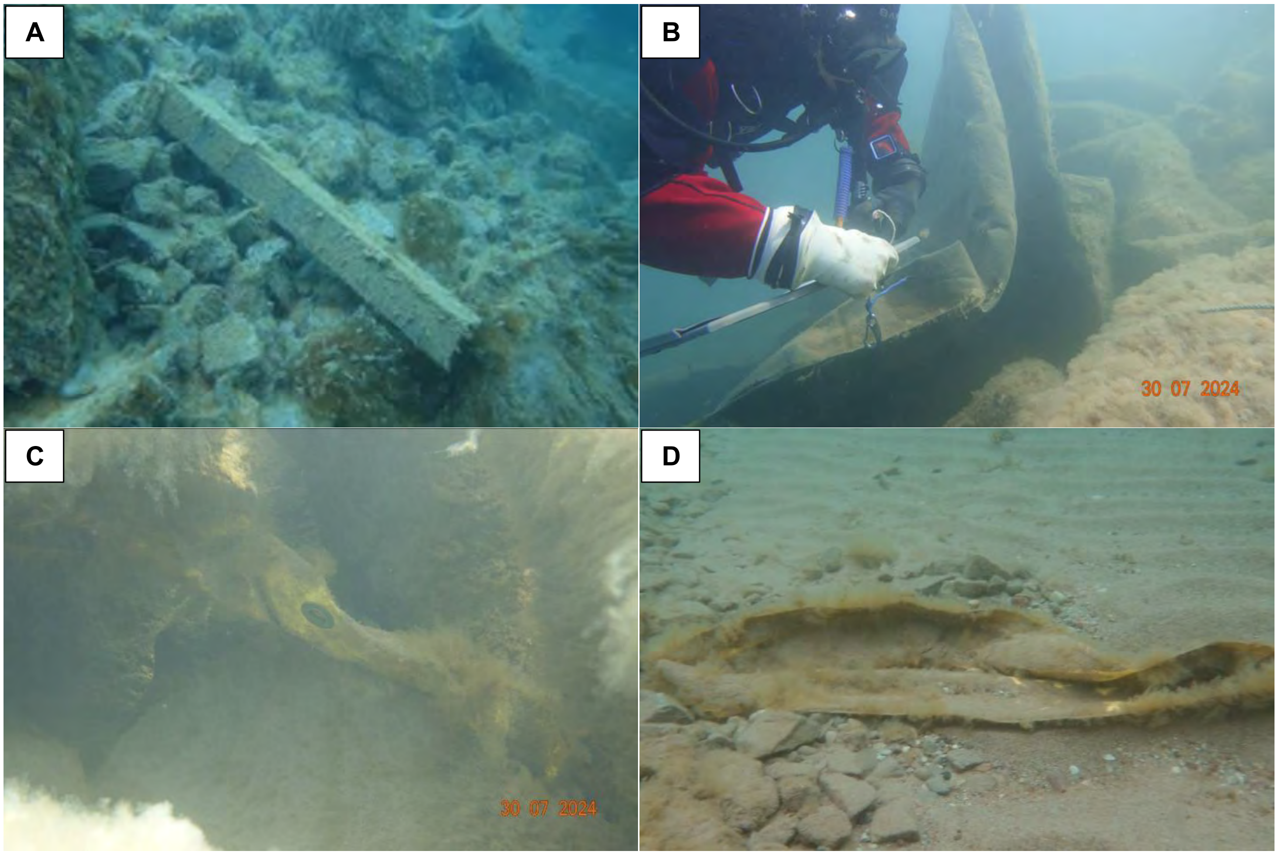
During outer perimeter habitat mapping along the Freight Dock offset habitat, a rock armour pile was observed at the farthest north extent of the apron at approximately -8.4 m CD at the deepest portion (Table 17: No. 9; Figure 13). The pile appeared to be connected to the apron but was observed to contain more rock armouring than the apron substrate immediately south toward the Freight Dock. Additionally, a portion of the pile appeared to slump on the northern face. Based on available information, it cannot be determined if this rock pile existed in previous years or was the result of potential environmental influence (e.g., sheet ice movement). Bathymetry surveys conducted after construction of the Freight Dock did not extend to this area. Bathymetry data were only reported to a distance of approximately 10-15 m off the northern face (Hatch 2019) and it is estimated this pile is approximately 20-30 m off the northern face. While potentially not an indication of substrate movement per the physical stability of the Freight Dock, the pile could potentially pose a hazard to navigation in front (north) of the Freight Dock.

Evidence of sedimentation was observed all along the Freight Dock offset habitat in Year 5 (Figure 13). Areas of higher sediment loading included the inner corner of the west bund (Table 17: No. 3 and 4; Figure 13), the exposed northeast faces of the Freight Dock offset habitat (Table 17: No. 7, 9, 11, and 15; Figure 13), and all along the inner east bund (Table 17: No. 19; Figure 13). Additionally, during data analysis and review of the Year

5 surveys, it was found that transects situated on hard substrate on the eastern side of the Freight Dock offset habitat (FD-T8 to FD-T11) were shorter (Table 3) than in previous monitoring years (Golder 2021a, 2022a). A review of the Year 2 monitoring data and report (Golder 2022a) showed the extent of upper subtidal crushed rockfill footprint was larger throughout the base of the eastern Freight Dock inner corner in Year 2 than what was observed in Year 5 (Picture 1). The suspected cause of the loss of subtidal hard substrate is higher rates of sedimentation within the eastern Freight Dock area. Aerial photographs from the Freight Dock construction in 2019 and the Year 2 Freight Dock Habitat Offset Report (Golder 2022a) also noted observations of natural sediment deposition from Creek M11-1, south of FD-T11. It is possible that sediment depositional processes from the creek may be causing gradual accumulation and covered the previously observed crushed rockfill since Year 2 monitoring. Creek M11-1 (site MP-C-H) is monitored for turbidity and total suspended solids and there has been no elevation of these parameters (Baffinland 2017, 2018, 2019b, 2021, 2022), therefore, sediment deposition forming a small delta at the creek mouth is most likely the result of natural fluvial processes. Soft sediment (sand, silt) may have also been deposited in these areas due to natural marine environmental conditions, such as predominant northeasterly wave action or ice floes relocating sediments within Milne Inlet (Pejrup and Andersen 2000).

Picture 1: Southeastern extent of Freight Dock Offset Habitat Area in 2021 (Year 2) and 2024 (Year 5), facing south (see Figure 13 for photograph locations).

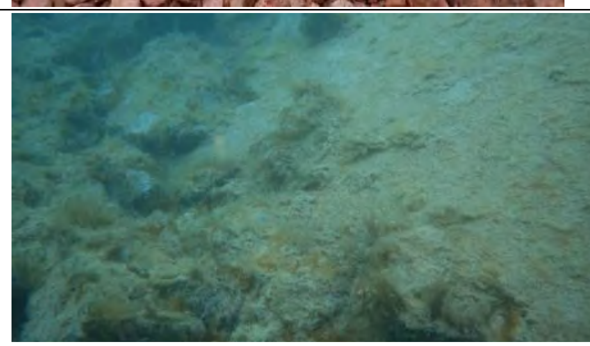
Several pieces of anthropogenic debris were also observed during habitat mapping and transect/quadrat surveys, including a piece of lumber (estimated to be 15-cm by 15-cm) on the northern apron adjacent to the pile and two small pieces of soft yellow plastic of unknown origin adjacent to FD-T7 and on the eastern bund tip (the eastern bund piece was also observed in Year 2 in the mapping videos [Golder 2022a]; Figure 13; Picture 2A, C, D). Additionally, as in Year 1 (Golder 2021a), a large section of geotextile material was recorded on the northern face of the Freight Dock offset habitat, adjacent to FD-T7 in the upper subtidal (Appendix D – Photo 27; Figure 13; Picture 2B).



Picture 2: Anthropogenic Debris Observed in Freight Dock Offset Habitat Area, A) 15-cm by 15-cm Piece of Lumber; B) Geotextile; C) Secondary Containment; and D) Unidentified Plastic.

Table 17: Physical Stability Observations at Freight Dock Offset Habitat

Number	Description	Photo Documentation
01	Southern extent of a section of rock armouring (rip rap boulders) movement away from the offset habitat on the west side of Freight Dock. Located near FD-T1. Approximate location Easting: 503922 Northing: 7976570	
02	Northern extent of a section of rock armouring (rip rap boulders), crushed rockfill (cobble), and gravel fill movement away from the offset habitat on the west side of Freight Dock. Located between FD-T1 and FD-T2. See Figure 13. Approximate location Easting: 503931 Northing: 7976579	
03	Area of sedimentation on rock armouring and crushed rockfill on the inner west corner of the Freight Dock. Approximate location Easting: 503930 Northing: 7976602	
04	Area of sedimentation on rock armouring, crushed rockfill, and gravel fill on the inner west arm of the Freight Dock. See Figure 13. Approximate location Easting: 503905 Northing: 7976606	

Number	Description	Photo Documentation
05	Area of exposed crushed-rockfill after suspected rock armouring slump on the northwest face of Freight Dock. See Figure 13. Approximate location Easting: 503925 Northing: 7976650	
06	Area of exposed crushed-rockfill after suspected small rock armouring slump on the northwest face of Freight Dock. See Figure 13. Approximate location Easting: 503942 Northing: 7976655	
07	Area of sedimentation on rock armouring and crushed rockfill on the northwest face of the Freight Dock, near Baffinland's AIS program settlement station West-S (WSP 2023). Approximate location Easting: 503932 Northing: 7976678	
08	Area identified with less rock armouring on both sides of the western fender. Construction notes for early August 2019 indicate purposeful removal of armouring ('Type A' material) to accommodate ship drafts. Records do not indicate if armouring was replaced. Missing armouring may be a potential erosional concern but additional monitoring is required to confirm. Approximate location Easting: 503955 Northing: 7976665	

Number	Description	Photo Documentation
09	Suspected section of rock armouring movement away from the offset habitat on the north face of Freight Dock into a mound with observed sedimentation. Located between the outer extents of FD-T6 and FD-T7. See Figure 13. Approximate location Easting: 503977 Northing: 7976698	
10	Suspected section of rock armouring slump away from the offset habitat on the north side of the mound (see above). Located between the outer extents of FD-T6 and FD-T7. Approximate location Easting: 503975 Northing: 7976706	
11	Area of sedimentation on crushed rockfill and gravel fill on the north face of the Freight Dock. Located between the outer extents of FD-T6 and FD-T7. Approximate location Easting: 503989 Northing: 7976693	
12	Area identified with less rock armouring on both sides of the eastern fender. Construction notes for early August 2019 indicate purposeful removal of armouring (‘Type A’ material) to accommodate ship drafts. Records do not indicate if armouring was replaced. Missing armouring may be a potential erosional concern but additional monitoring is required to confirm. Approximate location Easting: 503978 Northing: 7976666	

Number	Description	Photo Documentation
13	Deep gravel fill slump at east Freight Dock buttress. Appears to have occurred due to crushed rock fill and rock armour settlement. See Figure 13. <u>Approximate location</u> Easting: 503980 Northing: 7976656	
14	Exposed crushed-rockfill after minor rock armour slump at northeast corner of Freight Dock. <u>Approximate location</u> Easting: 503988 Northing: 7976651	
15	Area of sedimentation on rock armouring on the northeast face of the Freight Dock. <u>Approximate location</u> Easting: 504027 Northing: 7976656	
16	Slump of crushed rockfill and rock armouring on the northeast corner of the eastern bund of Freight Dock. <u>Approximate location</u> Easting: 504026 Northing: 7976646	

Number	Description	Photo Documentation
17	Exposed crushed-rockfill after minor rock armour slump at northeast corner of the eastern bund of Freight Dock. See Figure 13. <u>Approximate location</u> Easting: 504031 Northing: 7976641	
18	Section of rock armouring movement away from the offset habitat on the outer eastern arm extent of Freight Dock. Located between FD-T8 and FD-T9. <u>Approximate location</u> Easting: 504038 Northing: 7976609	
19	Area of sedimentation on rock armouring, crushed rockfill, and gravel fill on the inner east corner of the Freight Dock. Located adjacent to FD-T9. See Figure 13. <u>Approximate location</u> Easting: 504023 Northing: 7976606	
20	Area of rockfill foundation exposed after minor rock armouring slump on the eastern leg of the Freight Dock, adjacent to FD-T11 (red circle). <u>Approximate location</u> Easting: 504001 Northing: 7976593	

Notes: Gravel fill is categorized as 1-64 mm angular rock, crushed rockfill was cobble-sized (64 to 256 mm angular rock), and rock armour was boulder sized, >256 mm, angular rock. Approximate location presented in UTM Zone 17W.

LEGEND

- ANTHROPOGENIC DEBRIS
- REPORT PHOTO LOCATION
- SEDIMENTATION
- SUBSTRATE MOVEMENT
- SUBSTRATE MOVEMENT/SEDIMENTATION

0 25 50

1:1,250 METRES

REFERENCE(S)

IMAGERY COPYRIGHT © 20240718 ESRI AND ITS LICENSORS. SOURCE: MAXAR. USED UNDER LICENSE, ALL RIGHTS RESERVED.
PROJECTED COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – YEAR 5 FREIGHT DOCK MON ITORING

TITLE
PHYSICAL STABILITY LOCATIONS IN FREIGHT DOCK OFFSET HABITAT AREA

CONSULTANT
wsp

YYYY-MM-DD	2025-03-27
DESIGNED	NO
PREPARED	AA
REVIEWED	NO
APPROVED	AL

PROJECT NO.	CONTROL	REV.	FIGURE
CA0026317.6821	86200-04	0	13

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

3.6 Summary of Results

Table 18 provides a summary of the Year 5 and Year 2 monitoring results in comparison to the 10-year productivity metric targets (± 20% of values observed in the Reference Area). The Reference Area is considered to represent the late successional stage that the Freight Dock offset habitat is expected to reach by Year 10. These results indicate that the Freight Dock offset habitat is continuing to be colonized but colonization may be impacted by interannual variability and successional processes.

Table 18: Summary of Year 5 Habitat Offset Monitoring Results

Indicators: Metrics[1]	Year 5 and Year 2 Monitoring Results Relative to Target as % of Reference Area[2,3]						Colonization Timing[4]
	Intertidal		Upper Subtidal		Shallow Subtidal		
	Year 5 (2024)	Year 2 (2021)	Year 5 (2024)	Year 2 (2021)	Year 5 (2024)	Year 2 (2021)	
Structural integrity	Areas of exposed rockfill foundation. Areas of rock armouring, crushed rockfill, and rockfill foundation slumping. Sedimentation.						Not applicable
Macroalgae: % cover	**137%**	46%	41%	43%	68%	32%	Immediate to medium; short to medium for kelp
Macroalgae: diversity	53%	54%	64%	75%	43%	**101%**	
Sessile invertebrates: % cover	**Pres**	0%	40%	**186%**	34%	39%	Immediate to medium
Sessile invertebrates: diversity	**Pres**	0%	**100%**	50%	25%	17%	
Motile invertebrates: density	Abs	Abs	Abs	Abs	35%	65%	Immediate to medium
Motile invertebrates: diversity	Abs	Abs	Abs	Abs	35%	67%	
Fish: density	0%	**Pres**	Abs	Abs	**Pres**	**108%**	Immediate to medium
Fish: diversity	0%	**Pres**	Abs	Abs	**Pres**	**108%**	
Arctic char prey species: density	**Pres**	Abs	1%	0%	**Pres**	**Pres**	Immediate to medium

Notes: **Bold** text indicates results relative to target were achieved. Abs = Indicator organism was not recorded at either the Freight Dock offset habitat or Reference Area; Pres = indicator organism was recorded within the Freight Dock offset habitat but not within the Reference Area, therefore, % could not be calculated but the observed colonization of the offset habitat surpassed observed Reference Area colonization; 0% = indicator organism was absent from the Freight Dock offset habitat and present (quantified) in the Reference Area; % = percent.

[1] All indicator metrics targets are outlined in the FAA (Appendix A) Condition 5.1.1 and in the Monitoring Plan (Golder 2019a; Appendix B) Section 2.3 (structural integrity is specifically outlined in Section 2.3.4).

[2] 10-year productivity targets include ongoing visual assessment for structural integrity and colonization to ± 20% of Reference Area (Golder 2019a; Appendix B) which in the above table would be represented by 80% or greater.

[3] Color indicates an increase (green), decrease (red), or comparable result (white; within 10% of Year 2 results) relative to Year 2 Freight Dock offset habitat area metric results relative to the 10-year Target (± 20% of Reference Area).

[4] Colonization Timing: Immediate (1 to 2 years), short (5 to 6 years), and medium (9 to 10 years) terms (Golder 2019a).

4.0 DISCUSSION

The 2024 habitat offset monitoring program conducted for the Milne Port Freight Dock was designed to fulfill Year 5 monitoring requirements under Sections 5.1 and 5.2 of FAA #18-HCAA-00160 using diver-based transect/quadrat survey methods supplemented with photographs and video documentation. The objectives outlined in Section 1.2 were achieved, including documenting macroalgae, sessile and motile invertebrate and fish occurrence, and qualitatively comparing productivity metrics (i.e., percent cover, density, diversity) of the coarse substrate habitat between the Freight Dock offset habitat area and the established Reference Area.

Year 5 monitoring indicates that macroalgae, motile invertebrates, and fish continue to colonize the Freight Dock offset habitat, as expected. In general, taxa identified at the offset habitat were similar to or represented a subset of those identified in the Reference Area. Colonization of rocky substrate in the Beaufort Sea has been demonstrated to take at least a decade to fully develop to an equilibrium or climax successional stage (Konar 2012).

For macroalgae, the Freight Dock offset habitat supported variable but generally moderate to high cover at all depth contours and documented taxa were predominantly ephemeral and faster growing macroalgae varieties (e.g., *Pylaiella* sp., *Desmarestia* sp., *S. aeruginosa*) (Küpper et al. 2016). Macroalgae taxa observed at the Freight Dock offset habitat were generally consistent with those observed during offset monitoring of the Ore Dock in Years 4 and 6[18] (Golder 2018, 2020b).

Sugar kelp was recorded within the shallow subtidal zone of both areas at low percentage cover. Year 5 is the second year of monitoring where understory kelp, a foundational habitat-forming taxon common along Arctic rocky shores (Niedzwiedz et al. 2024), was observed within the Freight Dock offset habitat. Kelp was observed between 0 to 15% at depths below -5 m CD in the shallow subtidal of the offset habitat, consistent with observations of low cover (<10 to 25%) of sugar kelp during the Year 6[18] existing Ore Dock offset habitat monitoring at the offshore, deeper extents of the habitat (Golder 2020b). Consistent with Year 2, depth stratification of kelp as seen in the Reference Area occurred as expected based on available literature on Arctic kelp, with an upper habitat limit of approximately -5 m (Küpper et al. 2016).

Total average macroalgae cover, driven primarily by turf algae, increased for all depth contours of the Freight Dock offset habitat compared to Year 2 (Golder 2022a) while Reference Area cover was more variable compared to Year 2 results. Total average macroalgae taxa richness in both areas was comparable to Year 2 results for the top depth contours but increased in Year 5 in the shallow subtidal. Taxa richness may have increased due to the presence of a member of Dr. Gary Saunder’s macroalgae taxonomic laboratory (University of New Brunswick) on site during the majority of surveys to aid macroalgal identification. In Year 5, both macroalgae mean cover and taxa richness were lower in the top depth contours compared to the shallow subtidal, potentially due to ice scour or ice sheet influences that impact shallow surface (to -3 m CD) perennial vegetation growth in Arctic regions (Küpper et al. 2016; Zacher et al. 2009). At the Freight Dock offset habitat, this was evident with very low cover of rockweed growing in crevices between boulders and absent from exposed areas. Rockweed, a slower growing perennial and indicators of later stages of colonization (Golder 2019b), was observed at higher cover at the offset habitat in Year 5 compared to Year 2 (Golder 2022a). Overall, total average macroalgae cover achieved the comparative colonization target ± 20% of the Reference Area within the intertidal zone but did not yet achieve the target for other mean cover depth contours or any depth contours for diversity. While cover and diversity at the offset habitat have not yet achieved that of the Reference Area, both indices have generally increased from or are

[18] Year 5 monitoring of the existing Ore Dock did not include analysis of the type or cover of marine vegetation observed during ROV surveys (Golder 2019b); therefore, the next closest years of monitoring (Years 4 and 6) were used for comparisons.

comparable to Year 2 results and they are expected to continue to improve over the remaining years of monitoring.

In Year 5, tube-dwelling diatoms were observed and recorded at most transect locations, though were not included as part of the macroalgae percent cover estimates. Diatoms, which are a component of detrital veneers observed in Years 1 and 2 (Golder 2021a, 2022a), are a natural biological component of the Arctic marine environment and occur in many different habitats and depths (Lobban 1984). The amount of marine organic matter is largely seasonally influenced (Mohan et al. 2016); therefore, the high cover observed in Year 5 is likely due to interannual variability.

Sessile invertebrates were not present in the Freight Dock offset habitat area within the intertidal zone during Years 1 and 2 of monitoring, but very low cover of calcareous tube worms (Family Serpulidae) were observed in Year 5 of monitoring on the southwestern corner of the offset habitat. Similar to Year 2, unidentified tunicates (Subphylum Tunicata) were observed at very low cover within the upper subtidal zones of the Freight Dock offset habitat and the Reference Area. Low cover of cone worms were also observed within the Reference Area upper subtidal zone in Year 5.

Mean cover and mean taxa richness of sessile invertebrates were lower within the lower depth contours (upper and shallow subtidal) within the Freight Dock offset habitat in Year 5, but generally within standard error margins. However, sessile invertebrate mean taxa richness was higher in the offset habitat's shallow subtidal zone. Where only unidentified tunicates were observed in Year 2, four taxa were recorded in Year 5 within the offset habitat's shallow subtidal: sabellid worms, barnacles, cone worms, and unidentified tunicates. As previously noted, tube-dwelling diatom cover was high in Year 5 on most transects, which may have outcompeted sessile invertebrates for colonization space. It is expected that the coarse rock offset habitat will be increasingly colonized by sessile invertebrate taxa over time, similar to colonization reported for the existing Ore Dock offset habitat by barnacles, bryozoans, tunicates, and scallops (e.g., *C. islandica*) in comparative years (Golder 2018, 2019b, 2020b). Overall, sessile invertebrate cover and diversity achieved the comparative colonization target ± 20% of the Reference Area within the intertidal zone of the Freight Dock offset habitat as no sessile invertebrates were observed within the intertidal zone of the Reference Area. Sessile invertebrate diversity also achieved the comparative colonization target within the upper subtidal zone.

Motile invertebrates were not observed within the intertidal or upper subtidal zones in either the Freight Dock offset habitat area or the Reference Area, consistent with Years 1 and 2 of monitoring (Golder 2021a, 2022a). However, several taxa were recorded in the shallow subtidal zone in both areas. Mean density was very low in the shallow subtidal zone of the Freight Dock, with a single individual from two taxa (green urchin and brittle star) observed in Year 5. Taxa richness was slightly higher in the Reference Area due to fewer quadrats analyzed (e.g., prevalent soft substrate recorded within Reference Area shallow subtidal quadrats), but overall mean density and mean taxa richness were comparable to or slightly less than those calculated for Year 2 (Golder 2022a). Overall, motile invertebrate density and diversity did not yet achieve the comparative colonization target ± 20% of the Reference Area for any depth contour.

Only three fish were observed during transect and quadrat surveys: a Shorthorn Sculpin within Freight Dock offset habitat, a Fish Doctor, and a juvenile eelpout, both observed within the Reference Area; however, the juvenile eelpout was identified on soft-substrate and therefore not included in analyses. Mean density and taxa richness were very low for both survey areas and at all depth contours, but generally consistent with previous years in which five and nine total fish, (Year 2 and Year 1, respectively), were observed between the two survey areas. Shorthorn Sculpin, Fourhorn Sculpin, Arctic Sculpin, and unidentified cod were also opportunistically observed within the Freight Dock offset habitat area during transect surveys and/or habitat mapping events. Overall, fish density and diversity achieved the comparative colonization target ± 20% of the Reference Area within the shallow subtidal zone in Year 5 due to no fish being observed within the analyzed quadrats of the Reference Area.

Fish prey densities, particularly mysid shrimp, were also recorded in the Freight Dock offset habitat area and Reference Area. Mean densities of mysid shrimp in both areas were lower than those reported in Year 1 of monitoring (Golder 2021a) but higher than what was observed in Year 2 (Golder 2022a). Mysid shrimp are an important food source during the open-water season for marine birds and anadromous fishes, including Arctic char (Dunton et al. 2006). Mysid shrimp were opportunistically observed at very high densities throughout the offset habitat and Reference Area during habitat mapping events. Overall, fish prey density achieved the comparative colonization target ± 20% of the Reference Area only within the intertidal and shallow subtidal zones due to no organisms observed within the intertidal zone of the Reference Area.

In general, the marine Freight Dock offset habitat appeared stable. However, some qualitative substrate shifting was observed, possibly due to ice movement and/or expansion. Increased sedimentation was observed throughout the habitat, particularly on the eastern side, potentially due to natural sediment deposition from Creek M11-1, other natural marine environmental factors, or ship movements within the area. The loss of subtidal hard substrate in this area suggests ongoing sediment accumulation, which may require continued monitoring in future years. Additionally, several areas were noted of potential erosional (Hatch 2019) and navigational concerns and are recommended for specific monitoring during Year 8 offset habitat monitoring surveys to confirm the extent of any potential hazard or concern.

Overall, the Freight Dock offset habitat appears to be providing a suitable and stable substrate for continued colonization and growth of marine organisms. The stability assessment and offset habitat biophysical surveys planned for Year 8 (i.e., in 2027) will continue to assess the physical stability and colonization of the offset habitat area.

5.0 CLOSURE

We trust this information is sufficient for your needs at this this time. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

WSP Canada Inc.

Karac Lindsay
Biological Technician

Niallan O'Brien, BSc, BIT
Marine Biologist

Reviewed by:

Andrea Locke, PhD
Lead Marine Biologist

Phil Rouget, MSc, RPBio
Principal Marine Biologist

KL/NOB/AL/BD/lih

https://wsponlinecan.sharepoint.com/sites/ca-ca00263176821/shared documents/06. deliverables/issued to client_for wp/3.0_issued/ca0026317.6821-045-r-rev0/ca0026317.6821-045-r-rev0-86000 year 5 freight dock offset rpt 27mar_25.docx

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APPENDIX A

Paragraph 35(2)(b) Fisheries Act Authorization (18-HCAA-00160)

PATH No.: 18-HCAA-00160

Other DFO File No.:

PARAGRAPH 35(2)(*b*) *FISHERIES ACT* AUTHORIZATION

Authorization issued to
Baffinland Iron Mines Corporation (hereafter referred to as the "Proponent")

Attention to: Phil Dutoit
2275 Upper Middle Road East Suite 100
Oakville, ON
L6H 0C3

Location of Proposed Project
The project is located at Milne Port, which is located 134 km southwest of Pond Inlet.

Nearest community (city, town, village): Pond Inlet
Municipality, district, township, county: Baffin Region
Territory: Nunavut
Name of watercourse, waterbody: Milne Inlet
Longitude and latitude, UTM Coordinates: 71.889403°, Longitude: -80.887592°, Zone: 17 W, Easting: 503900 m E, Northing: 7976600 m N

Description of Proposed Project

The proposed project is the construction of a Freight dock at the port in Milne Inlet. The work, undertaking or activity authorized is associated with The Mary River Project, an operating iron ore mine located on Baffin Island in the Qikiqtani Region of Nunavut. The Early Revenue Phase of the Mary River Project will involve mining and shipment of iron ore via the port at Milne Inlet. The new freight dock will allow more efficient use of the port for shipping purposes.

Description of Authorized work(s), undertaking(s) or activity(ies) likely to result in serious harm to fish

The work(s), undertaking(s), or activity(ies) associated with the proposed project described above, that are likely to result in serious harm to fish, are:

> The infilling of fish habitat in Milne Inlet resulting from the construction of the freight dock and mooring structures. Construction activities for the Freight Dock include:
>
> - Construction of a rock-fill berm
> - Removal of Sea Ice
> - Dredging and disposal of dredged material
> - Placement of rock/fill
> - Vibratory Pile driving

The serious harm to fish likely to result from the proposed work(s), undertaking(s), or activity(ies), and covered by this authorization includes

Permanent destruction of 26,449 m^2 ([2,170] Habitat Equivalent Units) of fish habitat in Milne Inlet including:

- 12,829m^2 Intertidal marine habitat
- 12,357m^2 Subtidal marine habitat
- 1,263m^2 Intertidal unnamed stream

Conditions of Authorization

The above described work, undertaking or activity that is likely to result in serious harm to fish must be carried on in accordance with the following conditions.

1. **Conditions that relate to the period during which the work, undertaking or activity that will result in serious harm to fish can be carried on**

   The work, undertaking or activity that results in serious harm to fish is authorized to be carried on during the following period:

   From the date of issuance to June 1, 2020

   If the Proponent cannot complete the work, undertaking or activity during this period, Fisheries and Oceans Canada (DFO) must be notified in advance of the expiration of the above time period. DFO may, where appropriate, provide written notice that the period to carry on the work, undertaking or activity has been extended.

   The periods during which other conditions of this authorization must be complied with are provided in their respective sections below. DFO may, where appropriate, provide written notice that these periods have been extended, in order to correspond to the extension of the period to carry on a work, undertaking, or activity.

2. **Conditions that relate to measures and standards to avoid and mitigate serious harm to fish**

2.1 Sediment and erosion control: Sediment and erosion control measures must be in place and shall be upgraded and maintained, such that release of sediment is avoided at the location of the authorized work, undertaking, or activity.

2.1.1 Before commencing any works, undertakings and/or activities that have the potential to release sediment into Milne Inlet or the unnamed stream, the Proponent shall prepare and implement site specific sediment and erosion control plans for any near or in-water works under the guidance of a certified Professional in erosion and sediment control (CPESC or equivalent). This plan shall be provided to DFO for review and approval before commencement of construction.

2.1.2 The erosion and sediment control plans shall include, but not to be limited to, the following:

- Delineation of areas of work;
- Plan for construction staging and storage logistics, including disposal of spoils;
- Anticipated construction schedule and construction duration;
- A description of erosion and sediment control measures to be used during and following construction (purpose, type, location, dimensions and design considerations);
- A description of the inspection and maintenance program and schedule; and
- Areas of the site susceptible to erosion problems

2.1.3 Turbidity levels shall be monitored in water adjacent to the work zone as the ice melts to evaluate potential movement of sediments. DFO shall be notified immediately of any exceedances of the current version of the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Aquatic Life for suspended sediment (TSS) levels, temperature, and dissolved oxygen in water released from the site into any fish bearing waterbodies. Monitoring and regular reporting of the incident and corrective actions must be made to DFO until stabilization of the work site and construction areas is completed, and the situation has passed.

2.1.4 A qualified on-site environmental inspector shall be employed by the Proponent and be present throughout construction to ensure adherence to the proper codes of environmentally responsible construction practice. The environmental inspector shall ensure that all mitigation is implemented properly, photograph (with dates) and record construction activities and conduct suspended sediment monitoring. A report detailing the nature of the works or undertakings, the construction methods used, the mitigation measures employed, the effectiveness of the mitigation works, and the results of any monitoring programs undertaken shall be included in the annual report as per Condition 5.

2.2 Measures and standards to avoid and mitigate serious harm to fish resulting from the construction of the freight dock shall be implemented prior to the commencement of in or above water works (in the case of on ice work) as described below and as set out in the Proponent's Baffinland Iron Mines Corp. Mary River Project, Floating Freight Dock Application For *Fisheries Act* Authorization, dated February 27, 2019 or any subsequent, DFO approved, versions (hereafter referred to as the "Freight Dock Application"):

2.2.1 All blasting activities shall be conducted following Cott and Hanna's 'Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002' (2005).

2.2.2 All construction activities shall be undertaken as outlined in the Freight Dock Application to minimize the potential for stress related behaviour or death of fishes and marine mammals

2.2.3 While conducting vibratory pile driving, dredging and infilling, a marine mammal exclusion zone of 200m radius shall be established. The marine mammal exclusion zone will be monitored for marine mammal presence starting 30 minutes prior to the commencement of vibratory pile driving, dredging or infilling activities. All activities shall cease if marine mammals are observed within the exclusion zone and shall not recommence until 30 minutes after the marine mammal was last observed or 30 minutes after the marine mammal is seen leaving the exclusion zone.

2.2.4 Field measurements shall be undertaken to verify that underwater sound pressure and noise levels at the edge of the exclusion zone shall not exceed 100 dB re 1 µPa root-mean-square (rms) sound pressure level (SPL) to prevent auditory injury to marine mammals during construction. If measured underwater noise levels exceed the 100db threshold, the following contingency measures shall be implemented: expansion of the marine mammal exclusion zone and the installation of bubble curtains.

2.2.5 In-air sound levels during the iced-season shall not exceed the in-air acoustic threshold of 100dB re 20µPa root-mean-square (rms) when pinnipeds are observed on the ice during construction activities.

2.3 Works shall be halted if monitoring required in condition 3 and 4 below indicated that the measures and standards to avoid and mitigate serious harm to fish are not successful.

2.4 Measures and standards to avoid and mitigate serious harm to fish shall be implemented prior to the commencement of construction.

3. **Conditions that relate to monitoring and reporting of measures and standards to avoid and mitigate serious harm to fish from the ore dock construction**

3.1 The Proponent shall monitor the implementation of avoidance and mitigation measures referred to in section 2 of this authorization and provide a report to DFO, by February 28, 2020, and indicate whether the measures and standards to avoid and mitigate serious harm to fish were conducted according to the conditions of this authorization. This shall be done, by:

3.1.1 Providing inspection reports supported by dated photographs to demonstrate effective implementation and functioning of mitigation measures and standards described above to limit the serious harm to fish to what is covered by this authorization.

3.1.2 Providing details of any contingency measures that were followed, to prevent impacts greater than those covered by this authorization in the event that mitigation measures did not function as described.

4. **Conditions that relate to the offsetting of the serious harm to fish likely to result from the authorized work, undertaking or activity**

4.1 Scale and description of offsetting measures:

4.1.1 Course rock substrate will be placed around the perimeter of the freight dock and moorings at Milne Inlet to provide 2729 HEUs of potential fish habitat

4.2 Contingency measures: If the results of monitoring indicates that the offsetting measures are not completed and/or functioning according to the monitoring criteria as outlined in the approved monitoring plan, as referenced in 5.1.1, the Proponent shall give written notice to DFO and shall implement the contingency measures and associated monitoring measures, as contained within an approved contingency plan, to ensure the implementation of the offsetting measures is completed and/or functioning as required by this authorization. The following conditions relate to the contingency measures:

4.2.1 The Proponent shall submit an updated contingency plan to DFO by February 28, 2020. The updated contingency plan shall be agreed by DFO and shall be informed by Inuit and/or indigenous groups and shall demonstrate viability.

4.2.2 The Proponent shall develop a monitoring plan for the contingency measures. The plan shall be developed specifically for monitoring of contingency measures. The plan shall be submitted to DFO and approved, in writing, by February 28, 2020 and shall be reviewed and approved by DFO, in writing, as required.

4.3 The Proponent shall not carry on any work, undertaking or activity that will adversely disturb or impact the offsetting measures.

5. **Conditions that relate to monitoring and reporting of implementation of offsetting measures (described above in section 4):**

5.1 The Proponent shall conduct monitoring of the implementation of offsetting measures according to the approved timeline and criteria in the Freight Dock Application, Section 9 in addition to an approved updated monitoring plan as follows:

5.1.1 The Proponent shall submit an updated offsetting monitoring plan for the proposed offsetting for review by DFO on or before May 31, 2019. The monitoring plan must satisfy DFO's requirements to demonstrate through clear and measurable criteria, fisheries productivity changes as a result of the offsetting measures. To address uncertainty in the effectiveness of the proposed offsetting measures, the proposed monitoring must have sufficient statistical power to determine if changes to productivity are occurring as a result of the offsetting measures within a defined timeframe, and must employ the most up-to-date and proven methodologies demonstrated to be effective under Arctic conditions.

5.1.2 Monitoring of offsetting shall be conducted over ten years, with a five year monitoring program (years 1, 2, 5, 8, 10) as outlined in the Freight Dock Application, Section 8, or as outlined in an updated monitoring plan and/or subsequent versions and as approved by DFO.

5.1.3 In addition to the outlined criteria, a digital photographic record of pre-construction, during construction and post-construction conditions using the same vantage points and direction to show that the approved works have been completed in accordance with the Freight Dock Application and subsequent plans approved by DFO

5.2 List of reports to be provided to DFO: The Proponent shall report to DFO on whether the offsetting measures were conducted according to the conditions of this authorization by providing the following:

5.2.1 Post-construction evaluation report shall be submitted to the DFO-Yellowknife Office within three months of the completion of the Freight Dock construction.

5.2.2 Monitoring reports shall be submitted to the DFO-Yellowknife Office by March 31 following each monitoring year, as will be outlined in the approved monitoring plan.

6. **Conditions that relate to the letter(s) of credit as part of the application for this authorization**

6.1 Letter of credit: DFO may draw upon funds available to DFO as the beneficiary of the letters of credit provided to DFO as part of the application for this authorization, to cover the costs of implementing the offsetting measures required to be implemented under this authorization, including the associated monitoring and reporting measures included in section 6, in instances where the Proponent fails to implement these required measures.

6.1.1 A letter of credit in the amount of $3,000,000 has been provided to cover the costs of implementing the offsetting measures required to be implemented under this authorization.

6.1.2 A letter of credit in the amount of $500,000 has been provided to cover the costs of implementing the monitoring required to be implemented under this authorization.

6.1.3 A letter of credit in the amount of $250,000 has been provided to cover the costs associated with the development and implementation of an adequate offsetting monitoring plan, which will be returned to the Proponent once an approved monitoring plan is finalized and approved in writing by DFO as referenced in section 5.1.1.

6.1.4 A letter of credit in the amount of $500,000 has been provided to cover the costs of the development and implementation of contingency measures, which includes costs associated with Indigenous consultation. If the Proponent fails to provide a feasible and acceptable contingency plan, this letter of credit shall be used for the cost of DFO to solicit, consult, and hire a consultant to develop a contingency plan. This will be returned to the Proponent once an approved contingency plan is finalized and approved by DFO as referenced in section 4.3.

Authorization Limitations and Application Conditions

The Proponent is solely responsible for plans and specifications relating to this authorization and for all design, safety and workmanship aspects of all the works associated with this authorization.

The holder of this authorization is hereby authorized under the authority of Paragraph 35(2)(*b*) of the *Fisheries Act*. R.S.C., 1985, c.F. 14 to carry on the work(s), undertaking(s) and/or activity(ies) that are likely to result in serious harm to fish as described herein. This authorization does not purport to release the applicant from any obligation to obtain permission from or to comply with the requirements of any other regulatory agencies.

This authorization does <u>not</u> permit the deposit of a deleterious substance in water frequented by fish. Subsection 36(3) of the *Fisheries Act* prohibits the deposit of any deleterious substances into waters frequented by fish unless authorized by regulations made by Governor in Council.

This authorization does not permit the killing, harming, harassment, capture or taking of individuals of any aquatic species listed under the *Species at Risk Act* (SARA) (s. 32 of the SARA), or the damage or destruction of residence of individuals of such species (s. 33 of the SARA) or the destruction of the critical habitat of any such species (s. 58 of the SARA).]

At the date of issuance of this authorization, no individuals of aquatic species listed under the *Species at Risk Act* (SARA) were identified in the vicinity of the authorized works, undertakings or activities.

The failure to comply with any condition of this authorization constitutes an offence under Paragraph 40(3)(*a*) of the *Fisheries Act* and may result in charges being laid under the *Fisheries Act*.
This authorization must be held on site and work crews must be made familiar with the conditions attached.

This authorization cannot be transferred or assigned to another party. If the work(s), undertaking(s) or activity(ies) authorized to be conducted pursuant to this authorization are expected to be sold or transferred, or other circumstances arise that are expected to result in a new Proponent taking over the work(s), undertaking(s) or activity(ies), the Proponent named in this authorization shall advise DFO in advance.

Date of Issuance: march 21, 2019

Approved by: [signature]

Scott Gilbert
A/Regional Director General
Central and Arctic Region
Fisheries and Oceans Canada

APPENDIX B

Revised Effectiveness Monitoring Plan for Coarse Rock Offsetting Habitat as a Condition of Fisheries Act Authorization

REPORT

Floating Freight Dock Project

Revised Effectiveness Monitoring Plan for Coarse Rock Offsetting Habitat as a Condition of the Fisheries Act Authorization (18-HCAA-00160)

Submitted to:

Baffinland Iron Mines Corporation
2275 Upper Middle Road East
Suite 300
Oakville, ON
L6H 0C3

Submitted by:

Golder Associates Ltd.
2nd floor, 3795 Carey Road, Victoria, British Columbia, V8Z 6T8, Canada

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1663724-121-R-Rev0-30000

31 May 2019

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1.0 INTRODUCTION

1.1 Background

Baffinland Iron Mines Corporation (Baffinland) is the owner and operator of the Mary River Project (the Project), an operational open-pit iron ore mine located on North Baffin Island in the Qikiqtani Region of Nunavut. Project Certificate No. 005, amended by the Nunavut Impact Review Board (NIRB) on 27 May 2014, authorized Baffinland to mine up to 22.2 million tonnes per annum (Mtpa) of iron ore from Deposit No. 1. Of this 22.2 Mtpa, Baffinland is currently authorized to transport 18 Mtpa of ore by rail to Steensby Port for year-round shipping through the Southern Shipping Route (via Foxe Basin and Hudson Strait), and 4.2 Mtpa of ore by truck to Milne Port for open water shipping through the Northern Shipping Route using chartered ore carrier vessels (the Approved Project). A Production Increase to ship 6.0 Mtpa from Milne Port was approved for 2018 and 2019.

The approved Project included construction of an ore dock and loading facility at Milne Port for loading iron ore, as well as a Freight Dock to allow for import of containerized supplies, break bulk, and special cargo (Figure 1). The ore dock was constructed in 2014 and has been operational since 2015. Construction of the original ore dock at Milne Port was predicted to result in serious harm to fish through the permanent loss of 24,847 m^2 of marine fish habitat. Baffinland submitted to Fisheries and Oceans Canada (DFO) an application for a paragraph 35(2)(b) *Fisheries Act* Authorization (FAA) including a Marine Habitat Offset Plan (Offset Plan), which proposed the addition of coarse rock material around the perimeter of the ore dock for installation of the ore dock. DFO issued a FAA for the ore dock on 30 June 2014 (#14-HCAA-00525). One of the conditions of the FAA was for Baffinland to undertake monitoring and reporting of the structural stability and biological utilization of offsetting measures at the Milne Port ore dock; effectiveness monitoring of the offset habitat is currently in Year 4 (2018) of an annual six-year monitoring program.

The Freight Dock, currently being constructed, will comprise a floating spud barge and a permanent causeway. The Freight Dock will result in localised infilling of intertidal and subtidal habitat and was determined to result in serious harm to fish through the permanent alteration and destruction of 26,449 m^2 marine fish habitat. As a result, Baffinland submitted to DFO a FAA application (27 February 2019, Rev 4) that included measures to offset for the permanent loss of fish habitat due to installation of the Freight Dock. The application included a similar Marine Habitat Offset Plan, which proposed the addition of coarse rock material around the perimeter of the Freight Dock to increase habitat complexity in Milne Port and serve as functional habitat for marine benthic invertebrate and fish species. DFO issued a FAA for the Freight Dock on 21 March 2019 (#18-HCAA-00160, Appendix A), which included a requirement for habitat offset monitoring to be conducted five times over a of 10-year period to confirm the coarse rock habitat is functioning as intended. One condition of the FAA, related to offset monitoring, was to provide an updated offsetting monitoring plan:

5. Conditions that relate to monitoring and reporting of implementation of offsetting measures (described above in section 4):

5.1. The Proponent shall conduct monitoring of the implementation of offsetting measures according to the approved timeline and criteria in the Freight Dock Application, Section 9 in addition to an approved updated monitoring plan as follows:

5.1.1. The Proponent shall submit an updated offsetting monitoring plan for the proposed offsetting for review by DFO on or before May 31, 2019. The Monitoring plan must satisfy DFO's requirements to demonstrate through clear and measurable criteria, fisheries productivity changes as a result of the offsetting measures. To address uncertainty in the effectiveness of the proposed offsetting measures, the proposed monitoring must have sufficient statistical power to determine if changes to productivity are occurring as a result of the offsetting measures within a defined timeframe, and must employ the most up-to-date and proven methodologies demonstrated to be effective under Arctic conditions.

In accordance with Condition 5.1 of the FAA, this revised effectiveness monitoring plan aims to satisfy DFO's requirements to demonstrate through clear and measurable criteria, fisheries productivity changes as a result of the proposed offsetting measures. To address uncertainty in the effectiveness of the proposed offsetting measures, a monitoring framework is presented that employs sufficient statistical power to determine if changes to productivity are occurring as a result of the introduced offsetting measures within a defined time frame, using up-to-date and proven monitoring methods that are demonstrated to be effective under Arctic conditions.

1.2 Offsetting Plan for Freight Dock

Determination of offset requirements for the Freight Dock largely followed methodology used in the FAA application for the original ore dock. Over half of the anticipated habitat that will be lost due to the Freight Dock footprint is located in the intertidal zone (+2.3 m to 0.0 m chart datum), an area where habitat is generally associated with very low productivity due to seasonal ice impacts (e.g. ice scour), extreme air temperatures during low tides, and high wave exposure which limits biotic growth and recruitment. The remainder of the footprint is located primarily within the upper subtidal zone (0 m to -3 m), which in the Arctic is generally associated with low fish productivity due to the dynamic nature of this habitat. A relatively minor proportion of the habitat losses will occur in the moderately productive shallow subtidal zone (-3 m to -15 m). The majority of the substrate of the impacted subtidal area is a mix of fine and coarse materials (sand, gravel and cobble). There is limited large three-dimensional coarse material in or near Milne Port that provides a stable hard surface habitat for colonizing species, specifically macroalgae and invertebrate species. Baffinland determined that coarse rock (riprap 0.5 m to 1.0 m) installed along the sideslopes of the causeway as part of its construction has the potential to offset for the substrate being lost by providing higher productivity habitat relative to the soft substrate currently present in Milne Port. The addition of larger and more structurally complex substrates provides three-dimensional habitat with greater surface area for organisms to colonize and more complex cover than soft substrates (Appendix B). During five years of the Marine Environmental Effects Monitoring Program, sediment along three transects, one extending approximately 4.2 km along the eastern shore of Milne Inlet (Figure 2-1 in Golder 2019), was predominantly soft substrate along the 15 m depth contour. A large proportion of the coarse rock will be placed in the shallow subtidal zone, increasing the amount of higher-valued habitat within the more productive depth range, where there is currently limited higher value substrate.

1.3 Objective

The objective of the effectiveness monitoring program is to evaluate the coarse rock offsetting habitat for stability and function as productive fish habitat, and to demonstrate it is functioning as anticipated. The following will be used to evaluate the offset habitat:

- Document the offset habitat using repeatable photographs and videos taken annually along established transects at a range of depths to demonstrate extent of community establishment compared to similar coarse rock habitat (i.e. similar depth and habitat features) near Milne Port, and relative to soft-bottom habitat similar to substrate under the Freight Dock footprint. If a suitable coarse rock reference site cannot be found, only the soft-bottom habitat reference site will be used.
- Assess abundance, diversity and biomass for taxa and functional groups.
- Assess presence and habitat usage by fish and motile invertebrates.

- Delineate the offset habitat to confirm the coarse rock habitat has been constructed as designed and assess stability over the 10-year monitoring period.
- Assess the functionality of the coarse rock, identify any structural failures or problems with the offset habitat, and implement actions to remediate problems.

1.3.1 Indicators

To address the objectives and evaluate the functionality of the offsetting coarse rock habitat, the effectiveness monitoring program will include the following indicators:

- Recruitment of propagules to rock substrate
- Primary producers - diatoms, seaweed propagules, perennial/ephemeral macroalgae species, canopy/non-canopy forming bladed kelps
- Sessile colonizers - bryozoans, polychaetes, spirorbids, barnacles, anemones, sponges and corallines, trophic level, biological traits, habitat influence
- Fish and motile invertebrate use
- Arctic char prey species e.g. krill, mysid shrimp, other fish species
- Physical stability of coarse rock habitat.

2.0 EFFECTIVENESS MONITORING PLAN

The goal of the effectiveness monitoring plan is to determine whether the coarse rock offset habitat is functioning from a biological perspective (Bradford et al. 2017). Monitoring will involve visual observations and measurements of habitat quantity, and parameters of physical and biological condition. Given the relatively narrow open-water timing window and challenges with frequent and continual disturbance of shallow Arctic marine environments by ice scour, the monitoring plan has been designed to generate results useful for evaluating success of the coarse rock offset habitat in the Arctic environment. Choosing an appropriate experimental design and an appropriate scale were considered for the monitoring plan.

2.1 Sampling Frequency and Period

Once construction of the habitat offset is complete, monitoring will be conducted during five years over a 10-year period (in years 1, 2, 5, 8 and 10) to evaluate colonisation and trend. Due to the logistics of site access, and the short open-water season in the Arctic, sampling can only occur during the summer months from late July to early September.

Monitoring will be scheduled during August or September coinciding with the open water season and at which time peak growth for macroalgae and invertebrates is anticipated, which will facilitate species identification. Monitoring will occur along the constructed coarse rock habitat and at reference sites at a range of depths between 0 m and -15 m chart datum (CD), reflective of the depths of the offset habitat.

2.2 Sampling Locations and Design

As observed during year 4 (2018) of the 6-year offset habitat effectiveness monitoring program for the existing ore dock (SEM 2015, 2016; Golder 2017, 2018), coarse rock colonization varies depending on the location along the ore dock i.e. east or west side. A higher percent cover of aquatic vegetation was observed on the west side of the ore dock than on the east side, and the distribution of vegetation types varied spatially throughout the coarse rock substrate. Sessile fauna such as barnacles and serpulids were also observed in higher densities on the west side.

Similarly, there will likely be differences in coarse rock colonization around the Freight Dock based on the presence of the unnamed stream on the east side, vessel activity on the north side, and partial protection from the existing ore dock on the west side. Sample locations will be selected and observations will be conducted on the east, north, and west side of the Freight Dock to account for these differences.

Evaluation of offset sample locations will be compared to:

1) Reference site similar in substrate, at a comparable range of depths and with similar habitat features as the Project site footprint prior to construction of the Freight Dock. As part of the ongoing Phase 1 Marine Ecological Effects Monitoring Program (MEEMP), sediment characterization, benthic infauna identification, and macroflora, benthic epifauna and fish observations have been conducted in and adjacent to the Freight Dock footprint. The MEEMP provides baseline information and will continue to collect baseline information adjacent to the Freight Dock until 2026, which will be used for comparison. To supplement this information and ensure sampling is conducted in the same years and using the same methods as this monitoring plan, additional sampling sites will be selected to the east of the Freight Dock and representative of the impacted or “built-over” habitat. A before-after control-impact (BACI) design will be used for the comparison.

2) Rock habitat reference site – a reference site will be selected if a rock reef or subtidal rock shoreline can be identified within 5 km of the Project and with a similar depth range, aspect, fetch, and salinity as the offset habitat. Coarse rock habitat was chosen as an offset option as the MEEMP studies indicate this habitat type is likely limiting in Milne Inlet, which also means that a suitable reference site may not be found. If suitable rock habitat reference site is not found, the offsetting habitat may only be compared to soft substrate habitat as above.

3) Temporal trend analysis to show colonization and increased fish use of the coarse rock habitat over the 10-year monitoring period.

2.3 Methods

The selected metrics (Table-1) are considered habitat offsetting currency of the “habitat characteristics and function” and “habitat suitability for select species” type as described by Bradford et al. (2017). Measurements of density, abundance, diversity, and biomass are proposed to compare productivity of the offsetting habitat to an impacted reference site representative of the built-over habitat type, and if available, a rock habitat reference site. The criterion for fish usage is presented as a qualitative presence/absence because the presence of migratory and seasonal fish such as Arctic char can be highly variable due to factors unrelated to the specific habitat conditions, as acknowledged by Bradford et al. (2017). Habitat suitability will also be considered in the context of Arctic char behaviour, habitat preferences and prey species, which include other fish species, while in the marine environment.

Success of the offset habitat will be confirmed if it is physically stable, and macroalgae growth, motile species use, and invertebrate colonization of the coarse rock substrate is similar to that measured at the reference site, or habitat quality/functionality of the coarse rock represents an improvement to that recorded at the "built-over" reference site (Section 2.5). Reference sites will be identified during summer of 2019 or the next summer following completion of the Freight Dock construction.

Table-1: Selection of Species and Functional Groups for Monitoring as a Performance Standard for Coarse Rock Offset Habitat

Indicators (Species/Functional Group)	Metric of Productivity	Target	Colonization Timing
Artificial Substrate (Recruitment)			
Primary Producers	Density, Diversity, Abundance, Biomass	>10% of impact site or ±20% of reference site	Immediate to Medium
Sessile colonizers			
Bladed kelps			Short to Medium
Towed Video and Fixed Transects			
Primary Producers - diatoms, seaweed propagules, perennial/ephemeral macroalgae species, canopy / non-canopy forming	% Cover	>10% of impact site or ±20% of reference site	Immediate to Medium
Sessile colonizers - bryozoans, polychaetes, spirorbids, barnacles, anemones, sponges and corallines, trophic level, biological traits, habitat influence			
Bladed kelps			Short to Medium
Fish and motile invertebrate use	Diversity, Abundance		Immediate to Medium
Arctic char prey species			

Note: immediate (1 to 2 years), short (5 to 6 years), and medium (9 to 10 years) terms (Smokorowski et al. 2015)

The methods described below are adapted from DFO's Marine Foreshore Environmental Assessment Procedure (Appendix to G3 Consulting Ltd. 2003) and from methods used in similar environments to measure colonisation, habitat use, and succession on rocky reefs. Due to the differences in comparing offset habitat to coarse rock or soft sediment reference habitats, more detailed methodology will be determined following the identification of suitable reference sites.

2.3.1 Recruitment

Many early colonizer species are cryptic and not readily identifiable from photographs or video, or settle to surfaces that may not be readily photographed such as the sides and undersides of rocks. Recruitment will be evaluated using the following procedures:

1) Sets of artificial substrate of similar size and texture to the rocks used for the coarse rock habitat or settlement baskets filled with rocks of the same size and shape will be placed among the coarse rock substrate at -3 m,

-8 m and -15 m, along the east, north and west sides of the Freight Dock, as well as at similar depths at the reference sites. Placing all the artificial substrates for the subsequent survey years at the start of monitoring will allow for measurements of short- to medium-term colonisation during later survey years.

2) Settlement substrate at the soft sediment reference sites will include sediment trays containing substrate similar to the soft bottom habitat. Each set deployed at the offset habitat and reference sites will contain five artificial substrates/settlement baskets, one of which will be retrieved for analysis during each survey year.

3) During each survey year, the retrieved substrate will be photographed from multiple angles and the biota on the artificial substrate will be scraped off and sent for identification to the lowest taxonomic level and the artificial substrate redeployed. Measurements of biomass will also be made for each. In subsequent survey years, the redeployed substrate will be compared to substrates deployed from the start of monitoring to determine differences in immediate-term colonisation to short- and medium-term colonisation.

4) Observations will be made of the percent cover, density, diversity, abundance and biomass of primary producers and sessile invertebrates, by species and as functional groups, relative to reference sites, with a focus on bladed kelp species, particularly in the later monitoring years. It is presumed that diversity of function will be increased by the addition of coarse rock habitat relative to soft-substrate habitat.

2.3.2 Macroalgae and Sessile Invertebrate Colonization

The coarse rock habitat on the east, north and west sides of the Freight Dock will be monitored using dive surveys and towed underwater video along transect lines that will be established following construction of the Freight Dock.

1) In the first sampling year, a total of 18 1-m quadrats will be placed randomly on the coarse rock substrate at -3 m, -8 m and -15 m, focusing on the expected productive range between -3 m and -15 m. Permanent markers will be placed at the quadrat corners, allowing for repeat measurements of the same quadrats in subsequent sample years, similar to methods used by Beuchel and Gulliksen (2008) to monitor Arctic benthic community development over a 20-year period.

2) A high-resolution underwater camera will be used to photograph the area within each quadrat, using the permanent quadrat markers as a guide to ensure the quadrat is photographed at similar angles during each survey. The photographs will be examined and organisms identified to the lowest possible taxonomic level, and classified by functional groups. Functional groups of primary producers will include ephemeral/perennial categories, as well as canopy/non-canopy formers. Invertebrate functional groups will be determined by traits such as feeding mechanism (suspension feeders, detritivores, herbivores, predators), biological traits (fecundity, longevity, colonisers, body shape), and habitat influencers (builders, burrowers, bioturbators, providers). It is presumed that diversity of function will be increased by the addition of coarse rock habitat relative to soft-substrate habitat.

3) Additionally, percent cover of macroalgae and sessile invertebrates will be visually estimated and assigned to percent cover categories (i.e., >0 to 5%; >5 to 25%; >25 to 50%; >50 to 75%; and >75 to 100%). The habitat will also be photographed from several viewpoints during each sampling event to provide photo documentation of changes to the habitat over time. A permanent belt transect will be installed along the coarse rock substrate and towed underwater video will be used to monitor presence and abundances of macroalgae and invertebrates during sample years and to monitor change between sample years.

4) If suitable rock habitat sites are identified, up to two sites will be selected as reference and will be sampled in the same manner as described above with a total of 12 quadrats placed at each location at a similar depth range as on the coarse rock habitat. The reference areas will be selected at the time of sampling and may include a location representative of a natural rocky subtidal habitat in Milne Inlet in addition to a soft-bottom habitat comparable to the substrate built over by the Freight Dock.

2.3.3 Motile Macrofaunal Colonisation

Motile macrofauna utilisation and colonisation of the coarse rock substrate will be evaluated by examining the quadrat photographs and the video transect footage.

1) Macrofaunal organisms (e.g., urchins, fish) will be identified to the lowest possible taxonomic level and enumerated. Diversity and abundance of fish and motile invertebrates will be quantified relative to reference sites, with a particular focus on prey species of Arctic char such as mysid shrimp, krill and other fish species, determined through literature review and documented stomach contents of fish caught in Milne Port during MEEMP studies.
2) Observation of the usage of the offset habitat will be made to determine the association between the macrofauna and the coarse rock habitat. The selected reference sites will be sampled in the same manner.

2.3.4 Physical Stability

The coarse rock habitat will be surveyed using photographic and towed underwater video methods as part of the offset monitoring program. Video footage and photos of the coarse rock habitat will be compared to previous survey years and assessed for signs of potential slumping, failure, or movement of the coarse rock or other physical alteration that may affect the suitability of the substrate. Observations of sedimentation or siltation will also be noted.

2.4 Statistical Analysis

Statistical analysis will be based on recommendations listed in Smokorowski et al. (2015; Table 2) by comparing differences between the offset habitat and the reference sites in the immediate (1 to 2 years), short (5 to 6 years), and medium (9 to 10 years) terms.

Temporal trend analysis will also be presented in the final monitoring report (year 10) to evaluate the colonisation and fish use of the coarse rock offset habitat. Trend analysis can be used to show if metrics are trending towards being greater than the “built-over” reference site or within 20% of the rock habitat reference sites.

2.5 Summary

During the 10-year effectiveness monitoring program for the coarse rock offset habitat, productivity will be measured using indicators as summarised in Table-2.

Table-2: Analytical Methods for Determining Productivity of Coarse Rock Offset Habitat

Indicators (Species/Functional Group)	Methods	Metrics	Schedule
Recruitment	Artificial Substrate	Taxa identification Functional group identification Percent cover, density, diversity, abundance and biomass	Years 1, 2, 5, 8, 10
Macroalgae/Sessile Invertebrate Colonization	Towed Underwater Video Fixed Quadrats	Taxa identification Functional group identification Percent Cover	
Motile Macrofauna Colonisation	Towed Underwater Video Fixed Quadrats	Taxa identification Diversity and abundance Habitat association and use	
Physical Stability	Towed Underwater Video Fixed Quadrats	Evidence of slumping, sedimentation, siltation	

3.0 EVALUATING SUCCESS OF THE OFFSETTING HABITAT

The observations and measurements of the coarse rock offset habitat during each monitoring event will be compared to equivalent measurements made at soft substrate habitat adjacent to the freight dock and or rock habitat reference sites near Milne Port. Potential rock habitat reference sites for offset monitoring will be identified during summer field programs undertaken as part of the 2019 Marine Environmental Effects Monitoring Program (MEEMP) scheduled at Milne Port during August 2019. Reference sites will have similar coarse rock habitat at a comparable range of depths and contain similar habitat features as the offset habitat. Soft-substrate habitat reference sites will also be located. These sites will act as the sole reference sites in the event suitable rock habitat cannot be located. The soft-substrate habitat will be similar in substrate, at a comparable range of depths and would contain similar habitat features as the Project site footprint prior to construction of the Freight Dock. The soft-substrate reference site will be used to assess changes in productivity relative to the baseline, with success being measured as greater productivity, and diversity of function compared to the soft-substrate habitat.

Success of the offset coarse rock as fish habitat will not be defined as “statistically similar” to the reference sites, rather species and functional group diversity / assemblages and percent areal cover will be used for comparison as outlined in Table-1 and Table-2.

Although Bradford et al. (2016) characterize the uncertainty associated with “habitat characteristics and function” type metrics as moderate (i.e., ±10 to 50%), a success metric of mean ± 20% for colonisation is considered appropriate because:

- The success of coarse rock habitat creation is well documented
- The proposed habitat offsetting is to create a heterogenous structure in an area dominated by homogenous lower productivity and commonly-occurring soft substrate in Milne Inlet
- Unequal variance in the “population” of data collected from the reference habitat versus the constructed habitat could result in statistical “dissimilarity” when the offsetting habitat is in fact providing similar function where a majority of the measurements are reflective of reference conditions

Table-3: Decision Criteria for Evaluating Success of Constructed Offsetting Habitat

Category	Decision Criteria
Recruitment	Density, diversity, abundance and biomass on artificial substrate placed among the coarse rock habitat is within 20% of the mean of the reference rock habitat. Function group diversity is within 20% of the reference rock habitat.
Macroalgae and Sessile Invertebrate Colonization	The mean percent cover of the offset habitat by primary producers and sessile colonizing invertebrates is within 20% of the mean of the reference rock habitat, and greater than 10% on soft-substrate reference habitat
Motile Macrofauna Colonisation	Diversity and abundance of motile macrofauna using and associating with the offset habitat is within 20% of the reference rock habitat. Diversity and abundances of known Arctic char prey species observed around the coarse rock habitat is within 20% of the mean at the reference rock habitat Functional group diversity is greater than 10% on soft-substrate reference habitat
Bladed Kelp Abundance	The mean density, biomass, abundance and diversity of perennial canopy forming bladed kelp species is within 20% of the mean of the reference rock habitat, and greater than 10% on soft-substrate reference habitat
Physical Stability	The coarse rock habitat is structurally stable and shows no signs of potential slumping, failure, movement, or other physical alteration.

4.0 REPORTING

A monitoring report will be submitted to DFO by 31 March of the following year for each of the five years that monitoring will be conducted, as required by the FAA. Annual reports will include:

- Assessment of the coarse rock structural integrity. Identification of any slumping, deterioration and or sedimentation using video surveys will be documented in the annual monitoring report. If repairs are required, the report will outline recommendations and timelines of repairs.
- Results of the video surveys of the coarse rock structure to document colonisation of the types and percent cover of aquatic vegetation.
- Fish and benthic invertebrates recorded in the video, and photographs will be identified and quantified, with results included in the annual monitoring report.
- Retrieval of artificial substrates and settlement plates and taxonomic identification of biota colonising the substrate.

The report for the fifth monitoring year will also include a summary of the 5 years of sampling over the 10-year period and include a description of any revisions to methodology, and all observations and results. The report will provide a professional opinion based on the performance standards, data collected, and other relevant observations to determine success of the coarse rock offset habitat, including a temporal trend analysis.

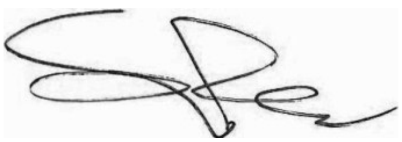
5.0 CLOSURE

We trust that this technical memorandum provides sufficient information for your present needs. If you have any questions, please contact the undersigned at 604-296-4200.

Golder Associates Ltd.

Christine Bylenga, PhD
Biologist

Derek Nishimura, MSc, RPBio
Senior Biologist



Shawn Redden, RPBio
Associate, Senior Fisheries Biologist

CB/DN/SR/lih/lmk

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LEGEND

- MILNE INLET TOTE ROAD
- PROPOSED NORTH RAILWAY
- WATERCOURSE
- EXISTING ORE DOCK
- PROPOSED FREIGHT DOCK AND CAUSEWAY
- PROPOSED SECOND ORE DOCK AND CAUSEWAYS
- PDA / QIA COMMERCIAL LEASE
- REVISED PDA FOR PHASE 2 PROPOSAL
- INAC FORESHORE LEASE
- WATERBODY

DRAFT

0 5 10

1:250,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA OBTAINED FROM CLIENT, MAY 28, 2018, AND BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY AND TOPOGRAPHY DATA BY EAGLE MAPPING (2005), RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE, MAY 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – FREIGHT DOCK HABITAT OFFSETTING

TITLE
LOCATION OF THE FREIGHT DOCK IN MILNE PORT AND RELEVANT LOCATIONS

CONSULTANT	YYYY-MM-DD	2019-05-08
GOLDER	DESIGNED	CB
	PREPARED	AA
	REVIEWED	
	APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	32000-04	A	1

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APPENDIX A

Paragraph 35(2)(b) *Fisheries Act* Authorization (18-HCAA-00160)

PATH No.: 18-HCAA-00160

Other DFO File No.:

PARAGRAPH 35(2)(*b*) *FISHERIES ACT* AUTHORIZATION

Authorization issued to
Baffinland Iron Mines Corporation (hereafter referred to as the "Proponent")

Attention to: Phil Dutoit
2275 Upper Middle Road East Suite 100
Oakville, ON
L6H 0C3

Location of Proposed Project
The project is located at Milne Port, which is located 134 km southwest of Pond Inlet.

Nearest community (city, town, village): Pond Inlet
Municipality, district, township, county: Baffin Region
Territory: Nunavut
Name of watercourse, waterbody: Milne Inlet
Longitude and latitude, UTM Coordinates: 71.889403°, Longitude: -80.887592°, Zone: 17 W, Easting: 503900 m E, Northing: 7976600 m N

Description of Proposed Project

The proposed project is the construction of a Freight dock at the port in Milne Inlet. The work, undertaking or activity authorized is associated with The Mary River Project, an operating iron ore mine located on Baffin Island in the Qikiqtani Region of Nunavut. The Early Revenue Phase of the Mary River Project will involve mining and shipment of iron ore via the port at Milne Inlet. The new freight dock will allow more efficient use of the port for shipping purposes.

Description of Authorized work(s), undertaking(s) or activity(ies) likely to result in serious harm to fish

The work(s), undertaking(s), or activity(ies) associated with the proposed project described above, that are likely to result in serious harm to fish, are:

> The infilling of fish habitat in Milne Inlet resulting from the construction of the freight dock and mooring structures. Construction activities for the Freight Dock include:
>
> - Construction of a rock-fill berm
> - Removal of Sea Ice
> - Dredging and disposal of dredged material
> - Placement of rock/fill
> - Vibratory Pile driving

The serious harm to fish likely to result from the proposed work(s), undertaking(s), or activity(ies), and covered by this authorization includes

Permanent destruction of 26,449 m^2 ([2,170] Habitat Equivalent Units) of fish habitat in Milne Inlet including:

- 12,829m^2 Intertidal marine habitat
- 12,357m^2 Subtidal marine habitat
- 1,263m^2 Intertidal unnamed stream

Conditions of Authorization

The above described work, undertaking or activity that is likely to result in serious harm to fish must be carried on in accordance with the following conditions.

1. **Conditions that relate to the period during which the work, undertaking or activity that will result in serious harm to fish can be carried on**

   The work, undertaking or activity that results in serious harm to fish is authorized to be carried on during the following period:

   From the date of issuance to June 1, 2020

   If the Proponent cannot complete the work, undertaking or activity during this period, Fisheries and Oceans Canada (DFO) must be notified in advance of the expiration of the above time period. DFO may, where appropriate, provide written notice that the period to carry on the work, undertaking or activity has been extended.

   The periods during which other conditions of this authorization must be complied with are provided in their respective sections below. DFO may, where appropriate, provide written notice that these periods have been extended, in order to correspond to the extension of the period to carry on a work, undertaking, or activity.

2. **Conditions that relate to measures and standards to avoid and mitigate serious harm to fish**

2.1 Sediment and erosion control: Sediment and erosion control measures must be in place and shall be upgraded and maintained, such that release of sediment is avoided at the location of the authorized work, undertaking, or activity.

2.1.1 Before commencing any works, undertakings and/or activities that have the potential to release sediment into Milne Inlet or the unnamed stream, the Proponent shall prepare and implement site specific sediment and erosion control plans for any near or in-water works under the guidance of a certified Professional in erosion and sediment control (CPESC or equivalent). This plan shall be provided to DFO for review and approval before commencement of construction.

2.1.2 The erosion and sediment control plans shall include, but not to be limited to, the following:

- Delineation of areas of work;
- Plan for construction staging and storage logistics, including disposal of spoils;
- Anticipated construction schedule and construction duration;
- A description of erosion and sediment control measures to be used during and following construction (purpose, type, location, dimensions and design considerations);
- A description of the inspection and maintenance program and schedule; and
- Areas of the site susceptible to erosion problems

2.1.3 Turbidity levels shall be monitored in water adjacent to the work zone as the ice melts to evaluate potential movement of sediments. DFO shall be notified immediately of any exceedances of the current version of the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Aquatic Life for suspended sediment (TSS) levels, temperature, and dissolved oxygen in water released from the site into any fish bearing waterbodies. Monitoring and regular reporting of the incident and corrective actions must be made to DFO until stabilization of the work site and construction areas is completed, and the situation has passed.

2.1.4 A qualified on-site environmental inspector shall be employed by the Proponent and be present throughout construction to ensure adherence to the proper codes of environmentally responsible construction practice. The environmental inspector shall ensure that all mitigation is implemented properly, photograph (with dates) and record construction activities and conduct suspended sediment monitoring. A report detailing the nature of the works or undertakings, the construction methods used, the mitigation measures employed, the effectiveness of the mitigation works, and the results of any monitoring programs undertaken shall be included in the annual report as per Condition 5.

2.2 Measures and standards to avoid and mitigate serious harm to fish resulting from the construction of the freight dock shall be implemented prior to the commencement of in or above water works (in the case of on ice work) as described below and as set out in the Proponent's Baffinland Iron Mines Corp. Mary River Project, Floating Freight Dock Application For *Fisheries Act* Authorization, dated February 27, 2019 or any subsequent, DFO approved, versions (hereafter referred to as the "Freight Dock Application"):

2.2.1 All blasting activities shall be conducted following Cott and Hanna's 'Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002' (2005).

2.2.2 All construction activities shall be undertaken as outlined in the Freight Dock Application to minimize the potential for stress related behaviour or death of fishes and marine mammals

2.2.3 While conducting vibratory pile driving, dredging and infilling, a marine mammal exclusion zone of 200m radius shall be established. The marine mammal exclusion zone will be monitored for marine mammal presence starting 30 minutes prior to the commencement of vibratory pile driving, dredging or infilling activities. All activities shall cease if marine mammals are observed within the exclusion zone and shall not recommence until 30 minutes after the marine mammal was last observed or 30 minutes after the marine mammal is seen leaving the exclusion zone.

2.2.4 Field measurements shall be undertaken to verify that underwater sound pressure and noise levels at the edge of the exclusion zone shall not exceed 100 dB re 1 μPa root-mean-square (rms) sound pressure level (SPL) to prevent auditory injury to marine mammals during construction. If measured underwater noise levels exceed the 100db threshold, the following contingency measures shall be implemented: expansion of the marine mammal exclusion zone and the installation of bubble curtains.

2.2.5 In-air sound levels during the iced-season shall not exceed the in-air acoustic threshold of 100dB re 20μPa root-mean-square (rms) when pinnipeds are observed on the ice during construction activities.

2.3 Works shall be halted if monitoring required in condition 3 and 4 below indicated that the measures and standards to avoid and mitigate serious harm to fish are not successful.

2.4 Measures and standards to avoid and mitigate serious harm to fish shall be implemented prior to the commencement of construction.

3. **Conditions that relate to monitoring and reporting of measures and standards to avoid and mitigate serious harm to fish from the ore dock construction**

3.1 The Proponent shall monitor the implementation of avoidance and mitigation measures referred to in section 2 of this authorization and provide a report to DFO, by February 28, 2020, and indicate whether the measures and standards to avoid and mitigate serious harm to fish were conducted according to the conditions of this authorization. This shall be done, by:

3.1.1 Providing inspection reports supported by dated photographs to demonstrate effective implementation and functioning of mitigation measures and standards described above to limit the serious harm to fish to what is covered by this authorization.

3.1.2 Providing details of any contingency measures that were followed, to prevent impacts greater than those covered by this authorization in the event that mitigation measures did not function as described.

4. **Conditions that relate to the offsetting of the serious harm to fish likely to result from the authorized work, undertaking or activity**

4.1 Scale and description of offsetting measures:

4.1.1 Course rock substrate will be placed around the perimeter of the freight dock and moorings at Milne Inlet to provide 2729 HEUs of potential fish habitat

4.2 Contingency measures: If the results of monitoring indicates that the offsetting measures are not completed and/or functioning according to the monitoring criteria as outlined in the approved monitoring plan, as referenced in 5.1.1, the Proponent shall give written notice to DFO and shall implement the contingency measures and associated monitoring measures, as contained within an approved contingency plan, to ensure the implementation of the offsetting measures is completed and/or functioning as required by this authorization. The following conditions relate to the contingency measures:

4.2.1 The Proponent shall submit an updated contingency plan to DFO by February 28, 2020. The updated contingency plan shall be agreed by DFO and shall be informed by Inuit and/or indigenous groups and shall demonstrate viability.

4.2.2 The Proponent shall develop a monitoring plan for the contingency measures. The plan shall be developed specifically for monitoring of contingency measures. The plan shall be submitted to DFO and approved, in writing, by February 28, 2020 and shall be reviewed and approved by DFO, in writing, as required.

4.3 The Proponent shall not carry on any work, undertaking or activity that will adversely disturb or impact the offsetting measures.

5. **Conditions that relate to monitoring and reporting of implementation of offsetting measures (described above in section 4):**

5.1 The Proponent shall conduct monitoring of the implementation of offsetting measures according to the approved timeline and criteria in the Freight Dock Application, Section 9 in addition to an approved updated monitoring plan as follows:

5.1.1 The Proponent shall submit an updated offsetting monitoring plan for the proposed offsetting for review by DFO on or before May 31, 2019. The monitoring plan must satisfy DFO's requirements to demonstrate through clear and measurable criteria, fisheries productivity changes as a result of the offsetting measures. To address uncertainty in the effectiveness of the proposed offsetting measures, the proposed monitoring must have sufficient statistical power to determine if changes to productivity are occurring as a result of the offsetting measures within a defined timeframe, and must employ the most up-to-date and proven methodologies demonstrated to be effective under Arctic conditions.

5.1.2 Monitoring of offsetting shall be conducted over ten years, with a five year monitoring program (years 1, 2, 5, 8, 10) as outlined in the Freight Dock Application, Section 8, or as outlined in an updated monitoring plan and/or subsequent versions and as approved by DFO.

5.1.3 In addition to the outlined criteria, a digital photographic record of pre-construction, during construction and post-construction conditions using the same vantage points and direction to show that the approved works have been completed in accordance with the Freight Dock Application and subsequent plans approved by DFO

5.2 List of reports to be provided to DFO: The Proponent shall report to DFO on whether the offsetting measures were conducted according to the conditions of this authorization by providing the following:

5.2.1 Post-construction evaluation report shall be submitted to the DFO-Yellowknife Office within three months of the completion of the Freight Dock construction.

5.2.2 Monitoring reports shall be submitted to the DFO-Yellowknife Office by March 31 following each monitoring year, as will be outlined in the approved monitoring plan.

6. **Conditions that relate to the letter(s) of credit as part of the application for this authorization**

6.1 Letter of credit: DFO may draw upon funds available to DFO as the beneficiary of the letters of credit provided to DFO as part of the application for this authorization, to cover the costs of implementing the offsetting measures required to be implemented under this authorization, including the associated monitoring and reporting measures included in section 6, in instances where the Proponent fails to implement these required measures.

6.1.1 A letter of credit in the amount of $3,000,000 has been provided to cover the costs of implementing the offsetting measures required to be implemented under this authorization.

6.1.2 A letter of credit in the amount of $500,000 has been provided to cover the costs of implementing the monitoring required to be implemented under this authorization.

6.1.3 A letter of credit in the amount of $250,000 has been provided to cover the costs associated with the development and implementation of an adequate offsetting monitoring plan, which will be returned to the Proponent once an approved monitoring plan is finalized and approved in writing by DFO as referenced in section 5.1.1.

6.1.4 A letter of credit in the amount of $500,000 has been provided to cover the costs of the development and implementation of contingency measures, which includes costs associated with Indigenous consultation. If the Proponent fails to provide a feasible and acceptable contingency plan, this letter of credit shall be used for the cost of DFO to solicit, consult, and hire a consultant to develop a contingency plan. This will be returned to the Proponent once an approved contingency plan is finalized and approved by DFO as referenced in section 4.3.

Authorization Limitations and Application Conditions

The Proponent is solely responsible for plans and specifications relating to this authorization and for all design, safety and workmanship aspects of all the works associated with this authorization.

The holder of this authorization is hereby authorized under the authority of Paragraph 35(2)(*b*) of the *Fisheries Act*. R.S.C., 1985, c.F. 14 to carry on the work(s), undertaking(s) and/or activity(ies) that are likely to result in serious harm to fish as described herein. This authorization does not purport to release the applicant from any obligation to obtain permission from or to comply with the requirements of any other regulatory agencies.

This authorization does <u>not</u> permit the deposit of a deleterious substance in water frequented by fish. Subsection 36(3) of the *Fisheries Act* prohibits the deposit of any deleterious substances into waters frequented by fish unless authorized by regulations made by Governor in Council.

This authorization does not permit the killing, harming, harassment, capture or taking of individuals of any aquatic species listed under the *Species at Risk Act* (SARA) (s. 32 of the SARA), or the damage or destruction of residence of individuals of such species (s. 33 of the SARA) or the destruction of the critical habitat of any such species (s. 58 of the SARA).]

At the date of issuance of this authorization, no individuals of aquatic species listed under the *Species at Risk Act* (SARA) were identified in the vicinity of the authorized works, undertakings or activities.

The failure to comply with any condition of this authorization constitutes an offence under Paragraph 40(3)(*a*) of the *Fisheries Act* and may result in charges being laid under the *Fisheries Act*.
This authorization must be held on site and work crews must be made familiar with the conditions attached.

This authorization cannot be transferred or assigned to another party. If the work(s), undertaking(s) or activity(ies) authorized to be conducted pursuant to this authorization are expected to be sold or transferred, or other circumstances arise that are expected to result in a new Proponent taking over the work(s), undertaking(s) or activity(ies), the Proponent named in this authorization shall advise DFO in advance.

Date of Issuance: March 21, 2019

Approved by: [signature]

Scott Gilbert
A/Regional Director General
Central and Arctic Region
Fisheries and Oceans Canada

APPENDIX B

Rationale for Placement of Coarse Rock as A Habitat Offsetting Measure in High Latitude Marine Environments

TECHNICAL MEMORANDUM

DATE 31 May 2019 **Reference No.** 1663724-122-TM-Rev0-30000

TO Lou Kamermans, Director of Sustainability
Baffinland Iron Mines Corporation

FROM Derek Nishimura; Christine Bylenga **EMAIL Derek_Nishimura@golder.com**

RATIONALE FOR PLACEMENT OF COARSE ROCK AS A HABITAT OFFSETTING MEASURE IN HIGH LATITUDE MARINE ENVIRONMENTS (DRAFT)

1.0 INTRODUCTION

1.1 Background

Baffinland Iron Ore Mines Corporation (Baffinland) submitted an application for a paragraph 35(2)(b) *Fisheries Act* Authorization (FAA), including a Marine Habitat Offset Plan, for the permanent alteration and destruction of fish habitat due to installation of the Freight Dock. The original application for an FAA was submitted to Fisheries and Oceans Canada (DFO) on 22 February 2018. A final application revision (Revision 4) was submitted on 27 February 2019 (Knight Piésold 2019). DFO issued an FAA for the Freight Dock on 21 March 2019 (18-HCAA-00160). However, prior to issuing the FAA, DFO (2018) indicated during their application completeness review that “there is substantial uncertainty respecting the functioning of the current proposed offsetting option” i.e., placement of coarse rock around the Freight Dock. Additionally, DFO “does not have enough evidence to support the conclusion that placing additional rock over the naturally occurring substrate (primarily sand with low gravel, silt and clay composition) will provide a sufficient increase in fisheries productivity in Milne Inlet to adequately offset the losses” (DFO 2018, Appendix A).

This technical memorandum presents a scientific rationale on how placement of coarse rock as offset habitat in the marine environment at Milne Port can be successful at enhancing local habitat productivity based on existing site conditions at Milne Port. The memo is a comprehensive literature review that focuses on marine colonization (e.g., species, temporal, succession, physical factors) and productivity of rocky reef habitats in similar environments (Arctic/Antarctic), and on results from the ongoing offsetting habitat effectiveness monitoring and Project effects monitoring completed at Milne Port (i.e., ore dock) to date. The scientific rationale was used to inform the revised effectiveness monitoring plan as required in Condition 5.1.1 of the FAA (18-HCAA-00160).

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1.2 Offsetting Plan for Freight Dock

Determination of offset requirements for the Freight Dock largely followed methodology in the application for an FAA for the original ore dock. Over half of the anticipated footprint that will be lost due to the Freight Dock is located in the intertidal zone (+2.3 m to 0.0 m chart datum), an area where habitat is generally considered to be associated with very low productivity due to seasonal ice impacts (e.g., scour) and high wave exposure which limits biotic growth and recruitment (see Section 3.0). Most of the remainder of the footprint (44%) is located within the upper subtidal zone (0 m to -3 m), which in the Arctic is generally associated with low fish productivity due to this habitat being subjected to dynamic conditions such as ice scour. A relatively minor proportion (<3%) of the habitat losses will occur in the moderately productive shallow subtidal zone (-3 m to -15 m). The majority of the substrate of the impacted upper and shallow subtidal area is a mix of fine and coarse materials (sand, gravel and cobble). There are limited large three-dimensional coarse materials in or near Milne Port that provide a stable hard surface habitat for colonizing species, specifically macroalgae and invertebrate species (Golder 2018b). Baffinland determined that coarse rock (riprap 0.5 m to 1.0 m) installed along the sideslopes of the causeway as part of its construction has the potential to offset for the substrate being lost by providing higher productivity habitat. The addition of larger and more structurally complex substrates provides a greater surface area for organisms to colonize and more complex cover than fine substrates, providing higher value habitat. Additionally, a large proportion of the coarse rock will be placed in the upper subtidal zone (0 m to -3 m), increasing the amount of stable and protective higher-valued habitat within this depth range.

1.3 Purpose

The placement of coarse rock in the marine environment has been successful along the coasts of British Columbia, Newfoundland and other maritime provinces for the creation of rocky reef habitat, which provides high value habitat for the attachment of macroalgae and invertebrates, substrate and crevasses for invertebrate and fish refuge, rearing, and spawning, and biogenic habitat for macroalgae colonization (Naito 2001; Warren and Roberge 2017). Preliminary results from the fish habitat monitoring program in Roberts Bay for the Doris North Project in Nunavut indicate colonization of artificial rocky reef structures and fish use comparable to reference habitats (Rescan 2010).

The objectives of this technical memorandum are to present results of a literature review that focused on substrate colonization in high latitude environments that presents the current state of knowledge regarding colonization potential of rocky reef and foreshore substrate in this environment, and to indicate the viability and benefits of using coarse rock placement in the marine environment as a suitable habitat offsetting option. The suitability of creating rocky reef habitat for offsetting purposes was based on:

- A literature review of high latitude marine habitat with a focus on rocky reef structures in the intertidal and shallow subtidal, as well as the species that use and depend on rocky reefs in the Arctic.
- Observations from effectiveness monitoring of offset habitat provided for the original ore dock (i.e., coarse rock placement) in a similar environment, and from the Marine Environmental Effects Monitoring Program (MEEMP).

2.0 DESCRIPTION OF MILNE PORT MARINE ENVIRONMENT

Baseline studies conducted in support of the Approved Project (Baffinland 2012) and subsequent environmental effects monitoring programs conducted for the Project were referenced to describe existing conditions in Milne Port and the south end of Milne Inlet (Figure 1). Conditions in this area were described as typical of a fjord carved into bedrock, with a landfast ice dominated regime. The area in the vicinity of the proposed Freight Dock was described as a coarse-grained deltaic front, with substrate primarily dominated by ice-impacted sand. The shoreline consisted of a mix of coarse sediment beaches characterized by ice push features such as raised ridges. Ice gouging was less apparent below -10 m, although gouges were apparent at up to -40 m, indicating the likely occasional presence of grounded icebergs in this area. Sediment in Southern Milne Inlet was described as a mix of sand and silt, with substrate in the subtidal area near the Port described as sandy gravel and gravely sand, with finer grained sediment observed in the deeper subtidal area (Photos 1, 2, and 3) (Golder 2017, 2018).

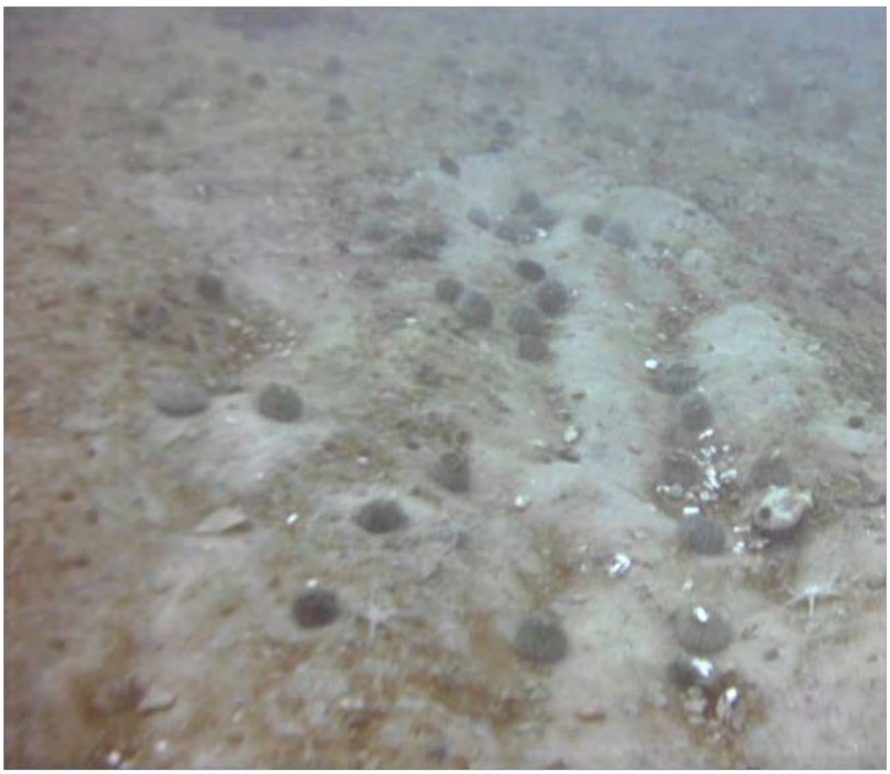

Photo 1: Sea urchins and brittle stars observed on soft substrate from underwater video along West Transect at -15 m depth contour in Milne Port, 3 September 2017 (Golder 2018b)

Photo 2 Sea colander and bivalves from underwater video along West Transect at -15 m depth contour, 3 September 2017 (Golder 2018b)

Photo 3 Brittle star and deep sea scallop from underwater video along East Transect at -15 m depth contour, 2 September 2017 (Golder 2018b)

2.1 Biological

Phytoplankton primary production in the southern end of Milne Inlet was low overall, generally higher during ice cover season, but within range for other Arctic waters (Baffinland 2012). Maximum chlorophyll *a* concentrations were typically found near the bottom of the mixing layer. Zooplankton community composition was comparable to nearby Lancaster Sound, dominated by cyclopoid and calanoid copepods.

Intertidal biota in southern Milne Inlet near the proposed location for the Freight Dock was typical for ice-dominated areas; generally sparse and discontinuous (Baffinland 2012). Where present, marine vegetation in the nearshore environment was mainly macroalgae (bladed kelps and foliose red algae) and was noted to be less abundant than observed in Steensby Inlet, on Baffin Island. Overall, percent cover of algae was shown to be low; drop camera surveys indicated <5% cover between 0 m and -3 m (primarily filamentous brown algae), bladed kelps were the most abundant between -3 m to -15 m but still less than 40% cover. Highest algal cover was observed between -3 m to -15 m. Below -15 m, algal cover decreased but the community composition remained similar to shallower depths. Coralline algae was only observed on boulders in the deeper regions (> -15 m).

Like many places at high latitudes, epifauna was depth-stratified, being more abundant in deeper areas, and generally sparse, with the most dominant epifaunal taxa being clams, brittle stars and sea urchins. Benthic infauna abundances also generally increased with water depth, however relative abundances between taxa varied at different depth gradients. Infauna at Milne Port was found to decrease in density with depth and was dominated by polychaetes, ostracods, copepods, amphipods and clams.

The nearshore fish community was considered low in abundance and diversity (Baffinland 2012). The nearby Tugaat and Robertson rivers support Arctic char (*Salvelinus alpinus*) populations which spend time in the nearshore marine environment along the coast of Milne Inlet to feed. Char in these rivers are harvested by local communities and are considered an important domestic sustenance fishery for the region. Tugaat and Robertson rivers have also supported small commercial fisheries in the past, which were closed in 1993 and the mid-1970s, respectively, following noted population declines in the area. Stomach content analysis of Arctic char collected at Milne Port indicated prey preference of amphipods and Cottid larvae during their marine seasonal residency period.

3.0 LITERATURE REVIEW OF HIGH LATITUDE MARINE ENVIRONMENTS

The shallow subtidal and intertidal marine environment at high latitudes is a highly dynamic and disturbed environment. Extreme temperatures, ice scouring and other abiotic factors govern the extent of recruitment, colonization, and the formation of biotic communities in these ecosystems (Campana et al. 2009). On a local scale, disturbance is more frequent and intense than in temperate and tropical environments, and depth-stratified communities often develop based on ice dynamics (Conlan et al. 1998). Generally, high latitude organisms are adapted for these disturbances, however, recolonization and growth are slow relative to temperate organisms, and “climax” or mature communities may not develop in areas with more frequent ice disturbances (Barnes and Conlan 2007; Campana et al. 2009). For example, sheltered bays, or deeper and less disturbed areas generally result in a change in the distribution of kelp species towards higher diversity, particularly in epiphytic species (Campana et al. 2009; Küpper et al. 2016).

The Arctic shallow benthos has a well-developed depth zonation, largely governed by sea ice (Gutt 2001). Iceberg grounding and scouring can lead to large scale and frequent disturbances in shallow environments, the impacts of which are comparable to trawling and dredging (Conlan et al. 1998). Areas with high levels of ice scouring tend not to recover due to the slow growth rates in polar fauna, relative to temperate species (Gutt 2001). In some deep areas, the scars are still notable millennia after the disturbance (Conlan et al. 1998). In areas of frequent ice movements, such as the Beaufort Sea, scouring can occur over all areas shallower than -40 m, and it is estimated that the area between -6 m to -14 m is completely disturbed every 50 years (Conlan et al. 1998).

There are relatively few macroalgal species endemic to the Arctic, and the majority are a subset of Atlantic species, particularly in European Arctic waters (Lee 1973; Wulff et al. 2009). The Canadian High Arctic, primarily the Baffin Bay area, has approximately 55 species of algae identified, with a large proportion of these being of Pacific lineage (Wulff et al. 2009).

Generally, there is a trend for small scattered algal communities across the Canadian Arctic, attributable to the infrequency of exposed boulder and bedrock substrate providing suitable substrate for settlement (Lee 1973). Unattached communities may form in areas where there is ample nutritional input (Lee 1973). Large populations of a single species may form in some cases; however, this is considered to be due to a general lack of competition rather than a specific adaptation giving one species an edge. Recruitment in these environments is still limited by other factors such as silt cover, sedimentation and light regime.

3.1 Intertidal Environment

The intertidal area in the Arctic is dynamic. Succession is largely driven by exposure to extreme mechanical disturbance due to ice foot formation, ice grounding and movement, and wave action, in addition to a wide range of other abiotic factors including thermal extremes, UV exposure, freeze/thaw cycles, and freshwater input (Campana et al. 2009). Development of assemblages in the intertidal area is very limited, typically remaining in the early stages of colonization with the majority of organisms not reaching reproductive age (Kukliński 2009). Intertidal algae is generally absent or sparse, typically limited to areas sheltered from ice impacts, such as platforms or between boulders, as well as generally being composed of annual species (Zacher et al. 2009; Küpper et al. 2016). However, even in areas with suitable and stable substrate, recolonization is slow compared to temperate rates and populations that can form are sparse, potentially due to the extreme air temperatures these areas may be exposed to (Lee 1973). Species abundances generally mirror the meroplankton, being composed of the organisms that happen to settle. There is a general lack of organisms that are Arctic intertidal specialists.

3.2 Subtidal Environment

Similar to the intertidal, the subtidal area is controlled by abiotic factors like ice scouring in addition to biotic factors like competition (Kukliński 2009). In soft-bottom areas, shallow subtidal assemblages in scours are dominated by deposit feeders and predators (Conlan et al. 1998).

In hard-bottom areas, where conditions allow, the top surfaces of rocks in the photic zone are colonized by calcareous algae, which outcompetes most organisms (Kukliński 2009). Generally, algal colonization occurs between -5 m and -10 m, due to upper bounds of ice scour and lower bounds of light availability (Zacher et al.

2009), although the depth of the photic zone in the Arctic is dependent on multiple factors including the thickness, structure, extent, snow cover and seasonality of sea ice (Laney et al. 2017). Most macroalgae are in the subtidal area in polar regions, as conditions in the intertidal zone generally are too dynamic to support their growth (Campana et al. 2009). Few macroalgae are found on rocks and pebbles in the first 3 m below low tide level, with kelps and other macroalgae found within the photic zone below -3 m; by -15 m, where light penetration dissipates, the algal community is dominated by coralligenous species (Küpper et al. 2016). Generally, perennial macroalgae diversity decreases with ice presence, however, overall algal diversity may increase due to opportunistic colonization by annual species (Gutt 2001).

3.3 Rocky Reefs

Rocky reefs provide a three-dimensional structure that increases habitat availability and influences local biodiversity. Many biotic and functional groups rely on, or are enhanced by, the presence of these structures (Wilce and Dunton 2014), and their diversity is improved. A diversity of functional groups may be more important than a diversity of species in these environments, as functionally diverse communities are more resistant to biological invasion, and are more productive, more efficient, and provide more ecosystem services (Meyer 2016).

In the Arctic, areas of hard substrate generally support communities that are significantly more productive, diverse and abundant than neighbouring soft sediment (Yesson et al. 2017), due to a more stable structure. Hard substrate allows for the establishment of algal communities, as it provides suitable complex substrate for settlement of a variety of species and recruitment of fish species (Lee 1973; Hamilton and Konar 2007). Macroalgal canopies formed of perennial species provide habitat stability for fish and support diverse invertebrate communities. Within the photic zone, hard-strata algal communities are generally formed of perennial algae rather than ephemeral species. In most cases, macroalgae require hard substrate in order to settle and develop.

Only a few limited algal species are capable of settling in soft sediments (Wulff et al. 2009). This is notable in areas such as the Boulder Patch in the Beaufort Sea, where localised rock accumulations support diverse macroalgal communities in contrast to surrounding soft sediment (Wilce and Dunton 2014). Within the Boulder Patch, ephemeral and annual algal species were notably few among the 78 identified species during a comprehensive survey, with the dominant algae being large kelp, crustose algae, and delicate and coarse thalloid red and brown algae (Wilce and Dunton 2014).

In high latitude environments, algae typically dominate upward-facing strata, while fauna dominate the more light-limited vertical or downward-facing sides (Barnes and Kukliński 2003; Konar and Iken 2005, Campana et al. 2009). Macroalgae are major primary producers with the capacity to form large standing stocks in nearshore polar waters where substrate and conditions are stable enough (Gutt 2001; Küpper et al. 2016). Macroalgae support diverse communities through the provision of habitat and protection, where greater macroalgal community complexity is reflected in greater densities and diversity of fish and invertebrate species (Hamilton and Konar 2007; Cárdenas et al. 2016; Küpper et al. 2016).

Perennial algae may be of particular importance to grazer and detritivore species, such as mysid crustaceans, as kelp detritus provides a source of carbon during the dark, winter months when phytoplankton are absent from the water column (Dunton and Schell 1987). Sponges are also an important part of high latitude rocky reefs; however, difficulties with in-situ identification has led to a general underestimation of their abundances (Campana et al. 2009). Recruitment on rock structures is generally positively correlated with stone size, with smaller stones typically being in a state of constant transformation as they are more likely to be overturned. Larger, more stable stones have a higher probability of fauna being present, generally also supporting greater species assemblages and competition (Kukliński 2009).

Within the Arctic, climax communities may not form above -15 m, due to slow recruitment and the frequencies of disturbance above -15 m, even within more protected areas. Areas with no protection, such as soft bottom communities, are generally dominated by more motile or ephemeral species. Rocky reefs offer protection within the ice dominated intertidal and shallow subtidal, allowing for the establishment of longer-term communities of sessile and perennial species.

Between 1980 and 1983, the Baffin Island Oil Spill (BIOS) Project, an experimental oil spill project, took place at Cape Hatt, near Ragged Island, 75 km north of Milne Port. As part of this project, a baseline assessment of the nearshore shallow water was undertaken. The baseline described the substrate as a mix of silt, sand, gravel and boulders (Snow et al. 1987). Macroalgae was noted attached to hard substrate but the majority was loose on softer substrate (Cross et al. 1987). Notably, during the assessment, it was observed that at depths between -10 m and -30 m, a dominant macroalgae (*Agarum cribrosum*, accepted as *A. clathratum*) formed clumps on large boulders. This macroalgae supported large numbers of mysids, shrimp, juvenile and adult fish, along with a variety of other species. During observations, it was noted that all the benthic species, including fish, were observed to use some form of cover which included algal cover, hiding amongst rocks, or in crevices (Snow et al. 1987), indicating the importance of hard substrates to community structure in the Milne Port area. The use and importance of rocky reefs by various fish species observed in the Milne Port area is detailed further in Knight Piésold 2019 as part of the FAA application.

3.3.1 Methods of Recruitment and Succession on Rocky Reefs

Recruitment of propagules to high-latitude rocky reefs may be dependent on factors such as geography, bathymetry, fish species composition and life history stage, larval supply, sedimentation, season, and substrate (Barnes and Conlan 2007; Kukliński 2009; Campana et al. 2009; Meyer et al. 2017), and occurs through the settlement of propagules and by vegetative growth (Konar 2013). Recruitment by larval transport is dependant on meroplankton composition. If there are few hard-bottom communities in relatively close proximity to the cleared hard substrate, meroplankton may be dominated by soft-bottom community species which may not recruit to hard surfaces (Kukliński et al. 2013). Recruitment may instead rely on larval transport from hard-bottom community sources further away.

Following disturbance events in the Arctic, percent cover by settled organisms has been observed to remain low (<10%) years following the disturbance, and recovery to pre-disturbance abundances may take over a decade (Beuchal and Gulliksen 2008; Konar 2013). Small scale disturbances may recover faster due to colonization by vegetative growth from neighbouring communities (Konar 2007). Recruitment may also be positively influenced by microhabitat heterogeneity (Barnes and Kukliński 2005).

Unlike temperate environments, grazers do not appear to play a significant role on recruitment in the Arctic, although they do alter competitive interactions between algal species, generating open space and increasing spatial heterogeneity (Konar 2007, 2013; Campana et al. 2009).

3.3.2 Successional Timing

Due to the dynamic nature of high latitude subtidal environments, as well as the slow growth rates of polar organisms, succession and recovery on rocky reefs may be a lengthy process. Recovery to pre-disturbance total abundances in hard-substrate communities has been observed to be slower when compared to soft-bottom communities following disturbances from bottom trawling (Yesson et al. 2017). However, this may be due to organism abundances being initially high in soft-bottom communities due to motile scavengers appearing quickly following disturbance events. Colonization rates on rocky reefs following disturbance have been observed to vary from slow, but continual growth, to no colonization followed by a rapid mass colonization event (Barnes and Kukliński 2005; Barnes and Conlan 2007; Konar 2007). A return to pre-disturbance levels of abundance and diversity may take years or even decades (Konar 2007, 2013; Gutt 2001).

The pattern of succession may be dependent on environmental condition, where shifts in community occur in response to changing temperature and light regimes (Renaud and Bikkby 2013). Depth may also influence site recovery rates. For example, shallow intertidal sites at Jan Mayen, Svalbard, Norway had communities on new substrate resemble natural habitats within 15 years, while deeper sites (>15 m) were still not recovered after 30 years (Renaud and Bikkby 2013).

Recruitment and succession will also be dependent on the timing of local reproduction and spawning. In the Arctic, larval abundances in the water column are generally highest in late spring through early summer to coincide planktotrophic larval development with phytoplankton blooms; however, settlement can occur even in winter months (Kukliński et al. 2013; Konar 2013; Meyer et al. 2017). Underrepresentation of some taxa is sometimes observed during colonization, which may be related to seasonally dependent settlement, or temporally rare and variable larval pools (Barnes and Conlan 2007; Konar 2013).

3.3.3 Patterns of Succession

Successional growth on cleared substrate has been observed to occur in stages. Settlement assemblages also may vary significantly between sites, even with similar conditions (Meyer et al. 2017). Generally, motile grazers and scavengers such as crustaceans, molluscs and echinoderms are typically the first fauna to appear in recently cleared areas, followed by bivalves (Campana et al. 2009; Beuchel and Gulliksen 2008; Renaud and Bikkby 2013; Yesson et al. 2017). These species may dominate areas where disturbances are frequent. However, these organisms are generally more opportunistic and their presence may not represent the recovery of an area. Early sessile colonizers to hard substrates vary with location, depth, as well as the resolution of the observation method, but generally include small bryozoans, polychaetes, spirorbids, barnacles, anemones, sponges and corallines (Barnes and Kukliński 2005; Konar 2007; Beuchel and Gulliksen 2008). These are typical early colonizer species, and their abundances in the first successional stages may not be represented or reflected in mature communities (Konar 2013; Meyer et al. 2017).

Early succession may be marked by a low diversity of higher taxonomic levels while maintaining high species richness (Barnes and Kukliński 2005). Underrepresentation of certain taxa may be observed during early stages of succession, despite observed local occurrences of adults of the same species. This may be related to life history with settlement favouring propagules from broadcast spawners rather than brooders (Meyer et al. 2017). Later successional species may coincide with a decrease in abundance of early colonizers to be replaced with higher abundances of other species such as perennial algae and urchins (Beuchel and Gulliksen 2008).

Alternatively, late successional communities may be characterised by overall lower abundances, but greater overall biomass, due to establishment of larger or colonial species (Yesson et al. 2017).

Recolonization of algal species is generally slow, with diatoms, seaweed propagules and ephemeral macroalgae species represented among early colonizers (Meyer 2016, Campana et al. 2009). Macroalgal diversity in both early and late successional stages may be impacted by UV exposure (Campana et al. 2009). In one study, seven years following disturbance, no regrowth of coralline or foliose algae was observed (Konar 2013).

3.4 Arctic Char

Arctic char are an important part of sustenance fishing in the Arctic, and populations originating from the Tugaat and Robertson Rivers, less than 30 km north of Milne Port, support sustenance fisheries for residents of nearby Pond Inlet. Following noted declines, commercial fisheries targeting populations in the Tugaat River were closed in the 1970s, followed by closures of Robertson River commercial fisheries in the 1990s (Baffinland 2012). Arctic char are anadromous and spend the majority of their lives in a freshwater environment. Juvenile Arctic char spend the first 2 to 9 years in freshwater, dependent on latitude, before out-migrating in spring prior to ice breakout in the marine environment (Mulder 2018). Adult char typically spend only a few weeks feeding in the marine environment before returning to freshwater to avoid sub-zero seawater temperatures (Moore et al. 2016). Arctic char are generally supported by freshwater systems that have year-round unfrozen and oxygenated water required for spawning and overwintering (Harwood and Babaluk 2014).

Research indicates that a short time spent in marine habitat can balance the energetic costs of migration, support spawning, and maintain the fish through relatively low food availability in winter months (Harwood and Babaluk 2014; Mulder 2018). Marine food sources may account for over 90% of the total annual diet in Arctic char and up to 44% of total productivity within the population (including non-anadromous char), despite the short time spent in the marine environment, indicating marine prey availability is critical for this species (Swanson et al. 2011). When in the marine environment, Arctic char, females and juveniles in particular, tend to remain in shallower water close to shore and typically within 30 km of their natal river, having a preference for reduced movement in the marine environment (Harwood and Babaluk 2014; Moore et al. 2016; Mulder 2018; Spares et al. 2015). When char are mobile in the marine environment away from their natal river system, they generally travel between adjacent estuaries which appear to be critical habitat areas. Char have been reported to hold in estuarine areas for several days between their transitory movements in saltwater (Moore et al. 2016; Spares et al. 2015). During marine travel, char display a preference for nearshore habitat (Moore et al. 2016)

Arctic char are shallow water feeders in the marine environment, preferring the upper three metres of the water column (Mulder 2018; Rikardsen et al. 2007). High energy, as well as large and slow prey, are favoured including amphipod, capelin, sandlance, cod, and sculpin. Char have been shown to consume up to 7.5% of their body mass per day while in the marine environment (Harwood and Babaluk 2014; Spares et al. 2012). Stomach analysis of char caught in Milne Port indicates a diet that included amphipods, mysid shrimp, copepods, polychaete worms, Arctic cod, and sculpin (SEM 2016, 2017; Golder 2018b, 2019). In order to avoid drops in internal body temperature, Arctic char descend to feed at depth using short repetitive dives with long rests near the surface or in the intertidal area, generally following the diel migration of their prey (Mulder 2018; Rikardsen et al. 2007, Spares et al. 2012). Smaller fish are more susceptible to cold and are generally limited by dive time (Mulder 2018). Prey availability at shallower depths such as in the intertidal and shallow subtidal optimizes feeding in the marine environment (Mulder 2018; Spares et al. 2012).

4.0 REVIEW OF THE HABITAT OFFSET EFFECTIVENESS MONITORING FOR THE EXISTING ORE DOCK

The Early Revenue Phase (ERP) of the Project included construction of an ore dock at Milne Port during the 2014 open water season. It was anticipated that the construction would result in the permanent destruction of 24,847 m^2 of fish habitat. The substrate at the site of the ore dock was described as homogenous in character, with low relief, and was determined to be relatively unproductive fish habitat composed mostly of soft silt and sand, sediments, and gravel. The loss of habitat was offset by the addition of coarse rock material to the base of the ore dock mooring structures between 0 and -15 m that would increase habitat complexity and heterogeneity, similar to habitat offsetting being proposed for the Freight Dock. This coarse rock was anticipated to be analogous to a rocky reef structure, serving as functional habitat for invertebrates and fish, in turn enhancing productivity and food supply for resident fish including Arctic char and Arctic cod.

4.1 Monitoring Results

Initial monitoring of the rocky reef habitat began in 2015 following completion of ore dock construction and has occurred annually to 2018. Monitoring included an assessment of the stability of the offset habitat and effectiveness of the offsetting measures. The coarse rock substrate was observed to be stable and compliant with the FAA conditions (SEM 2015). Monitoring in 2016, 2017, and 2018 consisted of video surveys to assess structural stability of the coarse rock habitat, sedimentation and siltation of coarse rock surfaces, and biological utilization of the offset habitat (SEM 2017).

During surveys, the coarse rock was found to be stable with no indications of slumping or movement of the substrate. Minor silt deposits were observed in some locations, but these were attributed to coastal transport. Locations with heavier silt deposition were attributed to sheltering from propwash from vessels along the ore dock.

Marine organisms recorded during offset monitoring are presented in Table-1. Video surveys in 2017 recorded large amounts of unidentified algal growth on the west and east sides of the ore dock, and to a lesser extent on rocks directly adjacent to the caisson, comparable to observations in 2016 (Golder 2017). Large numbers of sessile invertebrates were observed in video surveys, as well as adult Arctic cod and sculpin species (Table-1). Full identification of algae and faunal species in the area was limited by video resolution, preventing an accurate estimate of species diversity.

Observations of large schools of juvenile Arctic cod suggested successful recruitment of the species in the vicinity. Additionally, high abundances of mysid shrimp or krill were noted in certain locations along the coarse rock. Similar to juvenile Arctic cod, mysid shrimp and krill are an important link between trophic levels. Overall, monitoring indicated that the offset habitat was functioning as anticipated with utilization by a wide variety of taxa, and that the ore dock was supporting biological productivity across multiple trophic levels.

2018 marked the fourth year of offset monitoring. Underwater video was used to identify vegetation type and broad categories of percent cover, as well as to identify and enumerate marine biota (Golder 2018a). Aquatic vegetation cover was high and generally comparable to previous years. However, type and distribution differed between years with larger kelps being observed on the west side, where they were not observed in 2016. The high density of kelp was considered an indication of the stability of the coarse rock substrate. Notably, where present, density of bladed kelps was estimated at 50% to 75% cover, higher than observations during baseline studies in Milne Port where bladed kelps were most abundant between -3 m and -15 m, but were still less than 40% cover (Baffinland 2012). Overall, a greater diversity and abundance of invertebrates was observed compared to 2016, although a direct comparison could not be made as species abundance was not previously quantified.

Table-1: Species Recorded on Video Surveys During Habitat Offset Monitoring for Original Ore Dock at Milne Port

Year	Classification	Taxa	Common Name	Abundance[1]
2016	Mammals	*Pusa hispida*	Ringed Seal	1
	Fish	Cottidae	Unidentified sculpin	7
		Zoarcidae	Unidentified eelpout	1
		Boreogadus saida	Arctic cod (juveniles)	Abundant
	Invertebrates	Cnidaria	Unidentified jellyfish	18
		Ctenophora	Unidentified sea gooseberry	6
		Limacina helicina	Sea butterfly	31
		Strongylocentrotus sp.	Unidentified sea urchin	9
		Ophiuroidea	Unidentified brittle stars	312
		Pandalus sp.	Unidentified shrimp	1
		Euphausiacea	Unidentified euphausiid	Abundant
	Zooplankton	N/A	Various species	Abundant
	Algae	*Urospora* sp.	Unidentified green algae	Patchy/Dense
		Desmarestia sp.	Unidentified brown algae	Heavy-full
		Chorda filum	Brown algae	Low
		Fucus sp.	Unidentified wrack	Low
2017	Fish	*Gadus odac*	Greenland cod (adult)	1
		Gadidae	Unidentified cod (adult)	2
		Cottidae	Unidentified sculpin	3
	Invertebrates	Cnidaria	Unidentified hydroids	Abundant
		Echinoidea	Unidentified sea urchins	Not specified
		Ophiuroidea	Unidentified brittle stars	Not specified
		Cirripedia	Unidentified barnacles	Abundant
		Euphausiacea	Unidentified euphausiid	Abundant
		Polychaeta	Unidentified tube worms	Not specified
		Porifera	Unidentified sponges	Abundant
2018	Fish	*Myoxocephalus scorpius*	Shorthorn sculpin	1
		Myoxocephalus quadricornis	Fourhorn sculpin	5
		Gadus odac	Greenland cod	1
	Invertebrates	Cnidaria	Unidentified jellyfish	Abundant
		Hiatella arctica	Wrinkled rock borer	15
		Bivalvia	Unidentified bivalve	11
		Limacina helicina	Sea butterfly	24
		Buccinidae	Unidentified whelk	1

Year	Classification	Taxa	Common Name	Abundance[1]
		Echinoidea	Unidentified sea urchins	8
		Ophiura sp.	Unidentified brittle star	2
		Balanomorpha	Unidentified barnacles	0-50% cover
		Euphausiacea	Unidentified euphausiid	Abundant
		Serpulidae	Unidentified calcareous tube worm	33
		Bryozoa	Unidentified bryozoan	0-25% cover
		Polycarpa sp.	Unidentified tunicate	7
	Algae	*Desmarestia* sp.	Sour weed species	0-75% cover
		Laminaria sp.	Bladed brown kelp species	50-75% cover
		Urospora sp.	Unidentified green algae	0-75% cover
		Fucus sp.	Unidentified rockweed	0-10% cover

[1] specific areas were not indicated and were likely variable between years due to differences in survey methodology.

Settlement baskets were deployed in 2016 to monitor recruitment of propagules. Upon recovery of the baskets in 2017, invertebrate colonization was determined to be too limited for analysis so the baskets were redeployed with additional settlement plates. It was noted that the lack of colonization observed in the settlement baskets suggested that the coarse rock along the ore dock was providing more suitable invertebrate habitat in comparison to the settlement baskets. The settlement baskets were retrieved again during 2018 surveys along with the settlement plates added in 2017. Settlement baskets were only examined for epifaunal abundance (algal presence and abundance was not recorded). A summary of the species observed with recorded abundances is provided in Table 2. The majority of individual organisms identified on the settlement baskets were barnacles with the most diverse taxa group being bryozoans. In total, 1,733 encrusting organisms were counted from eight different taxa. Resolution of observation is much finer with the settlement baskets when compared to the video surveys, therefore comparison of the successional patterns between the methods was not possible.

Table 2: Observed Taxa and Epifauna Abundance Recorded on Settlement Baskets in Milne Port in 2017/2018

Classification	Taxa	Abundance
Barnacles	Balanomorpha sp.	1,674
Bivalves	*Hiatella arctica*	29
	Mya sp.	2
Bryozoans	*Alcyonidium gelatinosum*	1
	Alcyonidium disciforme	1
	Disporella sp.	16
	Disporella hispida	7
	Infundibulipora prolifera	1
Polychaetes	*Circeis* sp.	2

5.0 COARSE ROCK AS ROCKY REEF OFFSET HABITAT

An effectiveness monitoring plan should include clearly articulated measures of success that are linked to the objective of the offsets and that provide benchmarks for measuring progress (Smokorowski et al. 2015). Another important monitoring objective is to understand whether or not the offsetting habitat functions as designed (Smokorowski et al. 2015).

The majority of the marine area that will be impacted by the proposed Freight Dock is a mix of intertidal (53%) and upper subtidal (44%), with a small shallow subtidal component (<3%). The substrate in these areas is classified as fine sand, gravel and cobble. The creation of a rocky reef structure provides fish rearing and refuge habitat to support increasing overall fisheries productivity in the area, as well as a substrate for the recruitment and establishment of lower trophic levels, such as algae, epifauna and infauna that serve as food sources for fish species. The overall objective of the structure is to increase fish habitat quality relative to the current local intertidal and subtidal areas.

Habitat offsetting in comparable environments to Milne Port area is underperformed, therefore it is difficult to draw conclusions about what form of offsetting may be most successful or lead to greater improvements in habitat use by marine species in Arctic environments. It may be better to consider what habitat types are most beneficial to fish species that may be impacted by Project activities.

5.1 Fish Productivity Increases

Results from the literature review indicate the viability of coarse rock reefs as an offsetting option for the Milne Port area. The creation of a rocky reef structure in the subtidal area of Milne Port would help to support Arctic char populations from the Tugaat and Robertson Rivers during their marine residency period. These fish are part of important sustenance fish stocks for the nearby community of Pond Inlet. Arctic char are not known to be directly benefited by reef structures, however they display a marked preference for productive shallow water habitats close to estuaries and their natal streams, which would be created by the establishment of the coarse rock habitat in the Milne Port area. Offsetting habitat for the original ore dock has been shown to support species that have been found in the stomachs of char collected in Milne Port, indicating that rocky reefs have the potential to improve prey availability for Arctic char and act as important marine habitat for this species.

Rocky reefs may appear to be slower developing when compared to soft sediment communities, however, biotic abundances and diversity are greater on coarse rock structures, and soft sediment communities more ephemeral. In general, a reef in the early stages of succession may be more productive than an undisturbed soft sediment community. At a variety of depths, rocky reef structures can have greater levels of productivity compared to low-profile soft bottom habitats in the Arctic. Rocky reefs provide protection from ice scour and grounding of ice, particularly when composed of larger sized rocks. They also provide solid, stable substrates upon which algae and sessile species can recruit. Perennial algal species are more likely to be found on rocky reefs, and on these structures can form large standing stocks of primary producing biomass. Macroalgae support diverse communities through the provision of habitat and protection, where greater macroalgal community complexity is reflected in greater densities and diversity of fish and invertebrate species (Hamilton and Konar 2007; Cárdenas et al. 2016; Küpper et al. 2016). The larger perennial algae also provide a food source during winter months to grazer and detritivore species such as mysid crustaceans, which in turn are an important food source for fish species.

Recruitment to rocky reef structures may be dependent on there being suitable propagules, which are dependent on the availability of adult stock in the vicinity. An assessment of macroalgal biomass in Milne Port during baseline studies indicated that overall biomass was low (Baffinland 2012). Drop camera surveys indicated that between a depth of 0 m and -3 m, cover was less than 5%, primarily consisting of filamentous brown algae. Bladed kelps were the most abundant between a depth of -3 m to -15 m, but were still less than 40% cover. Despite relatively low kelp cover, recruitment and growth of bladed kelp to the coarse rock offset habitat between 0 and -15 m at Milne Port was observed by Year 4 of monitoring (Golder 2018a), indicating that propagule abundances were sufficient for recruitment to coarse rock habitat in this area. Propagules may originate from nearby habitats with established benthic communities. The BIOS project recorded 60 species of benthic algae in the upper subtidal at Cape Hatt. The algae was mostly filamentous brown algae (76% of biomass), but larger species, including bladed kelps, made up approximately 13% of the biomass (Cross et al. 1987; Snow et al. 1987). Cape Hatt is located near Ragged Island, indicating the site may be a potential propagule source for Milne Port.

Within the first years of offset monitoring for the Phase 1 Ore Dock at Milne Port, multiple species of sessile and motile invertebrates, as well as perennial algal species were observed on offset habitat, in addition to observations of use of the structure by juvenile and adult fish species. Additionally, in some areas, percent cover was notably higher than observed on soft bottom communities in Milne Port during the baseline studies, notably for bladed kelp. This indicates that recruitment and establishment to hard substrates of a range of species and functional groups is possible in Milne Port in densities greater than on current substrate, supporting the use of rocky reef habitat as an offsetting option in Milne Port.

5.2 Metrics and Indicators for Monitoring Effectiveness

Monitoring of the offset habitat for the Freight Dock will occur over 10 years following the construction of the habitat, in years 1, 2, 5, 8 and 10, as required by the Paragraph 35(2)(*b*) of the FAA for the Freight Dock (18-HCAA-00160). Indicators will be identified to monitor colonization and use of the offset habitat relative to comparable reference sites with similar substrate and depths as the proposed coarse rock habitat in Milne Inlet and to the soft-sediment habitat where the Freight Dock was constructed.

Primary producers are expected to be among the early colonizers of the coarse rock substrate, with diatoms, seaweed propagules and ephemeral macroalgae colonizing initially, succeeding to perennial algal species and bladed kelps in later years. During offset monitoring for the original ore dock, abundances and diversity measurements from settlement baskets were limited to invertebrate colonizers (SEM 2015, 2017, Golder 2017, 2018). Offset monitoring for the Freight Dock will include observations and measurements from the settlement baskets and/or artificial substrates, photographs and towed video footage. Parameters will include percent cover, density, diversity, abundance and biomass of primary producers, by species and as functional groups, relative to reference sites, with a particular focus on perennial bladed kelp species, due to their role as later colonizers in successional timing. Functional groups of primary producers will include ephemeral/perennial categories, as well as canopy/non-canopy formers.

Early colonizers also include sessile invertebrates such as polychaetes, bryozoans and barnacles, among others. As with primary producers, observations will be made of the percent cover, density, diversity, abundance and biomass of sessile invertebrates, by species and as functional groups, relative to reference sites. Functional groups will be determined by traits such as feeding mechanism (filter feeders, detritivores, herbivores, predators), biological traits (fecundity, longevity, colonizers, body shape), and habitat influence (builders, burrowers, bioturbators, providers).

Fish and motile invertebrates such as brittle stars and urchins are anticipated to be associated with the coarse rock habitat throughout all succession stages. Their relative abundances and diversity will likely vary depending on the succession and condition of the coarse rock habitat. Motile scavengers may have high abundances during early colonization or disturbance events, with numbers that decrease over time. Other species such as sculpin may increase as the habitat and macroalgal cover becomes more complex. Observations will be made of the diversity and abundance of fish and motile invertebrates, relative to reference sites, with a particular focus on prey species of Arctic char.

Monitoring programs should be designed to assess effectiveness of offsetting at meeting success criteria (biological targets) and ultimately to determine if the offsetting habitat is ecologically stable and self-sustaining (Smokorowski et al. 2015). Based on the literature review and results of the effectiveness monitoring undertaken to date for the original ore dock offsetting habitat, potential metrics, indicators, and targets to determine likelihood of success for the coarse rock placed adjacent to the Freight Dock have been selected (Table 3).

Table 3: Selection of Potential Species/Functional Groups to Monitor as a Performance Standard for Coarse Rock Placement

Species/Functional Group (Metric)	Indicator	Target	Colonization Timing
Settlement Baskets and Artificial Substrate			
Primary Producers	Density, Diversity, Abundance, Biomass	>10% of impact site or ±20% of reference site	Immediate to Medium
Sessile colonizers			
Bladed kelps			Short to Medium
Towed Video and Fixed Transects			
Primary producers - diatoms, seaweed propagules, perennial/ephemeral macroalgae species, canopy/non-canopy forming	% Cover	>10% of impact site or ±20% of reference site	Immediate to Medium
Sessile colonizers - bryozoans, polychaetes, spirorbids, barnacles, anemones, sponges and corallines, trophic level, biological traits, habitat influence			
Bladed kelps			Short to Medium
Fish and motile invertebrate use	Diversity, Abundance		Immediate to Medium
Arctic char prey species			

Note: immediate (1 to 2 years), short (5 to 6 years) and medium (9 to 10 years) terms (Smokorowski et al. 2015)

6.0 CONCLUSIONS

High latitude coarse rocky reefs provide complex habitat that shelters marine biota from ice impacts. Stable and large heterogeneous stone structures allow for growth and development of perennial species of macroalgae, which in turn support diverse, higher-trophic level communities through the provision of habitat, food and protection. These provisions can, in turn, create greater densities and diversity of fish and invertebrate species during their different life stages.

The habitat in the vicinity of the proposed Freight Dock is currently homogenous and prone to frequent and regular ice impact and scour. It is likely that communities that currently develop here are largely ephemeral and composed of the more opportunistic early colonizer species. The intertidal community is generally sparse and discontinuous, with subtidal vegetation described as less than other comparable areas. The nearshore fish community reflects the intertidal and subtidal community, being low in abundance and diversity.

Juvenile and adult fish use of the coarse rock habitat as well as the level of invertebrate and perennial algal recruitment observed during offset habitat monitoring for the original ore dock indicates that rocky reefs are a viable offset option in Milne Port, with the structure observed to be stable in subsequent years. The offset habitat has exhibited recruitment of perennial algal species in densities greater than observed during baseline studies of the soft sediment habitat, in addition to recruitment of invertebrates. Evidence of fish occupancy/use of the existing offset habitat for the original ore dock has been observed, including schools of juvenile fish.

Construction of a rocky reef in Milne Port to offset anticipated serious harm to fish and fish habitat due to the construction of the proposed Freight Dock would provide a heterogenous structure to a homogenous community, with the expectation of improved diversity and abundance of benthic biota. This would support the nearshore fish community, providing feeding, rearing and refuge habitat. Arctic char from the nearby Tugaat and Robertson Rivers would be among the species with potential to benefit by this improved habitat.

Species diversity and abundance metrics have been linked to productivity and creation of an ecosystem for use by fish, including Arctic Char and juvenile Arctic cod.

7.0 CLOSURE

We trust the information in this report is sufficient for your current needs. Should you have any additional questions regarding the project, please do not hesitate to contact Derek Nishimura at 604-296-7327.

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Attachments: Figure 1 – Location of the Freight Dock in Milne Port and Relevant Locations

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LEGEND

- MILNE INLET TOTE ROAD
- PROPOSED NORTH RAILWAY
- WATERCOURSE
- EXISTING ORE DOCK
- PROPOSED FREIGHT DOCK AND CAUSEWAY
- PROPOSED SECOND ORE DOCK AND CAUSEWAYS
- PDA / QIA COMMERCIAL LEASE
- REVISED PDA FOR PHASE 2 PROPOSAL
- INAC FORESHORE LEASE
- WATERBODY

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REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA OBTAINED FROM CLIENT, MAY 28, 2018, AND BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY AND TOPOGRAPHY DATA BY EAGLE MAPPING (2005), RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE, MAY 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – FREIGHT DOCK HABITAT OFFSETTING

TITLE
LOCATION OF THE FREIGHT DOCK IN MILNE PORT AND RELEVANT LOCATIONS

CONSULTANT		
GOLDER	YYYY-MM-DD	2019-05-08
	DESIGNED	CB
	PREPARED	AA
	REVIEWED	
	APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

APPENDIX A

Communication with DFO Regarding Coarse Rock as Offset Habitat

Fisheries and Oceans Canada | Pêches et Océans Canada

501 University Crescent,
Winnipeg, Manitoba
R3T 2N6

March 29, 2018

Our file *Notre référence*
18-HCAA-00160

Megan Lord-Hoyle
Director, Sustainable Development
Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Suite 300
Oakville, ON
Canada L6H 0C3

Dear Megan Lord-Hoyle:

Subject: Application for a Paragraph 35(2)(b) *Fisheries Act* Authorization – Incomplete

Further to the receipt of your application for a Paragraph 35(2)(b) *Fisheries Act* authorization on February 22, 2018, the Fisheries Protection Program of Fisheries and Oceans Canada (DFO-FPP) has reviewed the application. Our review has determined that some of the information and documentation set out in the *Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations* has not been provided and as such, the application is incomplete.

The following information and documentation is required in order for the application to be complete:

- Please provide documentation of consultation and engagement conducted with local communities regarding the specific offsetting plan for the proposed new freight dock as a separate project. Under paragraph 8 (1)(d) of the Applications for Authorization under Paragraph 35 (2) b of the Fisheries Act Regulations, consultation is required with Aboriginal groups potentially affected by DFO's decision under paragraph 35(2)(b) the Fisheries Act authorization. (See Attachment 1)
- Please provide clarification on the origin of the Habitat Suitability Indices (HSIs) that were used to calculate the Habitat Equivalent Units and provide the rationale for the HSI values that were used in the application.
- DFO-FPP notes that loss of fish habitat for all species is of importance to DFO. DFO-FPP also notes that only 2 out of the 11 fish species identified in the project area were accounted for when calculating habitat losses. Both fished species and fish that support higher trophic levels are important. Please consider all fish species when calculating

habitat losses. In the event that HSI values are not available for all species, please provide information on how species specific habitat losses will be accounted for.

- Please provide the complete breakdown of habitat losses and gains associated with the project. This should include the breakdown of losses from specific works including infilling, pile driving, spuds, anchors, stream diversion, etc. Raw data and calculations can be provided to aid DFO-FPP in the review of your application.
- DFO-FPP is unclear if habitat losses associated with the unnamed stream have been accounted for. Please clarify these losses and provide further information on the unnamed stream, including, but not limited to stream width, length and depth of channel.
- DFO-FPP notes that there is no mention of the design of the unnamed stream re-alignment. Please provide details on the proposed stream diversion channel and any fish habitat features proposed for the new alignment, which could help to mitigate the proposed losses.
- DFO-FPP is unclear on the design and effectiveness of the proposed sediment curtains. DFO-FPP notes that on page 26 of the application, it states: "Develop and implement an Erosion and Sediment Control Plan for the site that minimizes risk of sedimentation of the waterbody during all phases of the project." Please provide DFO-FPP with a fully developed Erosion and Sediment Control Plan as part of the Application for Authorization, which includes sediment curtain placement designs and contingencies.
- Section 3 (b) of the Application for Authorization under Paragraph 35(2) (b) of the *Fisheries Act* Regulations requires that an irrevocable letter of credit issued by a recognized Canadian financial institution to cover the costs of implementing the offsetting plan. (See Attachment 1 and 2)

Upon receipt of this outstanding information and documentation, The Program will notify you to confirm receipt. Within a period of 60 days beginning on the date of receipt of this outstanding information and documentation, the Program will notify you as to whether the application is complete.

If your plans have changed or if the description of your proposal is incomplete or changes during the review of your application, you should contact this office to avoid any unnecessary delays in the review of your application.

If you have any questions, please contact Laura Watkinson at our Yellowknife office at 867-669-4920, or by email at Laura.Watkinson@dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

Bev Ross
Regional Manager, Regulatory Reviews
Central and Arctic Region
Fisheries and Oceans Canada

Attachment 1 - Applications for Authorization under Paragraph 35 (2) b of the Fisheries Act Regulations, SOR/2013-191

Attachment 2 – An Applicant's Guide to Submitting an Application for Authorization under Paragraph 35(2)(b) of the Fisheries Act.

cc.

Laura Watkinson, DFO

Oscar Gustafson, Knight Piésold Consulting

Fisheries and Oceans Canada | Pêches et Océans Canada

501 University Crescent,
Winnipeg, Manitoba
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June 07, 2018

Our file *Notre référence*
18-HCAA-00160

Megan Lord-Hoyle
Director, Sustainable Development
Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Suite 300
Oakville, ON
Canada L6H 0C3

Dear Megan Lord-Hoyle:

Subject: Time Limit Ceased to Apply to the Review of your Application for a Paragraph 35(2)(b) *Fisheries Act* Authorization

The Fisheries Protection Program (the Program) of Fisheries and Oceans Canada has been reviewing your application for a paragraph 35(2)(b) *Fisheries Act* authorization.

This is to notify you that, pursuant to the *Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations*, the time limit for the review of your application has ceased to apply due to the following circumstance.

- Under paragraph 8 (1)(d) of the Regulations, consultation is required with Aboriginal groups potentially affected by our decision under paragraph 35(2)(b) the *Fisheries Act* authorization

In addition, your application can not be considered complete until the following have been provided:

1) Updated, detailed calculations of Habitat Suitability Indices (HSI) that include but are not limited to:

  - Revised calculations of habitat /fisheries productivity losses and gains that include representation from all fish species and trophic levels (i.e. gains and losses of potential food sources for marine mammals; benthic and forage species). This information requirement is set out in (SOR/2013 -191) '*Schedule 1 – Information and documentation to be provided for a paragraph 35(2)(b) Fisheries Act Authorization – checklist*':
    - Section 8(1) of Schedule 1requires a description of the likely effects of the proposed work, undertaking or activity on fish that are part of a

commercial, recreational, or Aboriginal fishery, or on fish that support such a fishery, and the likely effect on the habitat on those fish. The description must include:
a) the fish species likely to be affected and the life stages of the individuals of those species ..[and]..

- 8(2) a description of how the effects referred to in subsection (1) are likely to result in serious harm to fish that are part of CRA fishery or fish that support such a fishery.

- Please refer to attached addendum for further details and description of information gaps that were noted in your submitted '*Application for a Paragraph 35(2)(b) Fisheries Act Authorization*' .

2) An irrevocable Letter of Credit (LOC) that adequately covers the costs of implementing the proposed offsetting plan(s);

3) Updated contingency offsetting measures (as per SOR/2013-191, Section 13(f) of Schedule 1) that are informed by adequate Indigenous consultation and engagement / advice that describe contingency measures, and associated monitoring measures that will be put into place should any approved offsetting plan not successfully offset the serious harm to fish.

The Program will notify you in writing of the next steps once the above-noted requirements are addressed.

If your plans have changed or if the description of your proposal is incomplete, or changes during the review of your application, you should contact this office to avoid any unnecessary delays in the review of your application.

If you have any questions, please contact Laura Watkinson at our Yellowknife office at 867-669-4920 or by email at Laura.Watkinson@dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

Bev Ross
Regional Manager, Regulatory Reviews
Central and Arctic Region
Fisheries and Oceans Canada

Attached: Addendum – *Application for a Paragraph 35(2)(b) Fisheries Act Authorization* detailed review comments and informational gaps

cc. Oscar Gustafson, Knight Piésold Consulting

Laura Watkinson, DFO

Addendum

Application for a Paragraph 35(2)(b) Fisheries Act Authorization detailed review comments and informational gaps

Further to the Fisheries Protection Program of Fisheries and Oceans Canada's (DFO-FPP) 'Time Limit Ceased to Apply to the Review of your Application for a Paragraph 35(2)(b) *Fisheries Act* Authorization' letter to Baffinland, dated June 07, 2018, the following are Fisheries and Oceans Canadas detailed review comments and informational gaps:

1. DFO-FPP notes that in Baffinland's updated Application for *Fisheries Act* Authorization, section 7.1 on page 36, it states "*HSIs were developed based on the methodology presented in Kelly et al. (2009 draft).*" DFO-FPP notes that Baffinland has altered the HSI methodology used in the reference document, titled "A System for Characterizing and Quantifying Coastal Marine Habitat in Newfoundland and Labrador", and DFO-FPP is currently unclear how HSI values and subsequently habitat unit values were reached. DFO-FPP acknowledges recent email correspondence from Baffinland on May 18, 2018, outlining more details on the process used to calculate HSI values. However, DFO-FPP reiterates the need to review specific calculations and the steps used to arrive at the final HSI numbers. DFO-FPP recommends that Baffinland provide tables similar to those provided in the referenced document Kelly et al. (2009 draft), as part of the "*Example: Marine Habitat Classification and Quantification"* discussed on pages 45 through 65; specifically tables 15, 17, 19, 21, 23, 25 and 27 for each representative species. Providing this amount of data in a similar format to the reference document will aid DFO-FPP in the review of your application.

2. DFO-FPP notes that the intertidal area is assigned a nil (0) HSI value. However, in section 1.6 of Appendix D of the updated *Application for Fisheries Act Authorization*, it states: "*the preferred marine habitat of juvenile and adult Arctic char can be characterized as that area along the coastline ranging out to the 10 m contour within 25 km of freshwater breeding areas*." DFO-FPP notes that Arctic char prefer to reside along the coastline, and that the intertidal area is the nearest to the coastline. Please reconsider the intertidal habitat for Arctic char and provide updated calculations to reflect the usage of the intertidal zone.

3. DFO-FPP notes that Baffinland has applied a temporal factor while calculating the HSI values for Arctic char and Arctic cod. Under the notes for Table 7-2 on page 37, in section 7 of the updated *Application for Fisheries Act Authorization*, it states: "*As juvenile and adult Arctic char only utilize the marine environment for a three month period (mid-June to mid – September inclusive) values have been adjusted by a factor of 0.25*." However, in Table 7-6 on page 40, in

section 7 of the updated *Application for Fisheries Act Authorization*, the HSI value has not been adjusted by a factor of 0.25 when accounting for fish habitat offsetting gains. DFO-FPP notes that if this temporal factor is applied for fish habitat losses, it will be required to be applied to any habitat offsetting gains as well, as Arctic char will still only utilize the marine environment for a three month period, despite substrate changes. Please provide updated HSI and HEU values, which reflect consistent HSI calculations for fish habitat losses and gains.

4. Loss of fish habitat for all species is of importance to DFO. Section 35 (1) of the *Fisheries Act* states: "*No person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery,* ***or to fish that support such a fishery****."* DFO-FPP notes that only 2 out of the 11 fish species identified in the project area were accounted for when calculating habitat losses. DFO-FPP recognizes Baffinland's use of Arctic char and Arctic cod as the two representative species; however, DFO-FPP notes that fish that support the Arctic char and Arctic cod fisheries, such as forage and benthic species are not represented in the calculation of fish and fish habitat losses. DFO-FPP also notes that potential impacts on habitat /fisheries productivity from all trophic levels (i.e. gains and losses of potential food sources for marine mammals) have not been adequately assessed or discussed. Including all fish species and representative trophic levels are required to accurately assess and offset all potential impacts to fish habitat/ fisheries productivity losses within the project area. Please consider all fish species and trophic levels when calculating habitat losses and gains.

5. Table 11-1 on page 56, section 11 of Baffinland's updated Application for *Fisheries Act* Authorization, outlines the "*cost estimate for three years of effectiveness monitoring*" and the total proposed amount for a Letter of Credit as required under Section 3 (b) of the Application for Authorization under Paragraph 35(2) (b) of the *Fisheries Act* Regulations. DFO-FPP notes that this amount may need adjusting as the letter of credit must be sufficient to cover the cost for implementing all elements of the offsetting plan, including monitoring measures. DFO-FPP also notes that costing of an LOC must consider mobilization of equipment and personnel for both construction, implementation and monitoring of the offsetting plan to Milne Inlet.

6. Adequate contingency offsetting measures that were informed by Indigenous consultation and engagement have not been provided. Section 13(f) of Schedule 1 states *"a description of the contingency measures and associated monitoring measures that will be put into place if the measures referred to in paragraph (a) are not successful in offsetting the serious harm to fish".* Section 13 (g) of Schedule 1 "*an estimate of the cost of implementing each element of the offsetting plan*".

If you have any questions, please contact Laura Watkinson at our Yellowknife office at 867-669-4920, or by email at Laura.Watkinson@dfo-mpo.gc.ca.

Fisheries and Oceans Canada
Pêches et Océans Canada

501 University Crescent,
Winnipeg, Manitoba
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August 17, 2018

Our file *Notre référence*
18-HCAA-00160

Megan Lord-Hoyle
Director, Sustainable Development
Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Suite 300
Oakville, ON
Canada L6H 0C3

Dear Megan Lord-Hoyle:

Subject: Application for a Paragraph 35(2)(b) *Fisheries Act* Authorization – Incomplete

Further to the receipt of your updated application for a Paragraph 35(2)(b) *Fisheries Act* authorization on August 1, 2018, the Fisheries Protection Program (the Program) of Fisheries and Oceans Canada has reviewed the updated information.

DFO-FPP recognizes that Baffinland has provided additional information for items 2-5 of the Addendum – *Application for a Paragraph 35(2)(b) Fisheries Act Authorization detailed review comments and informational gap*, as part of DFO-FPP's correspondence dated June 7, 2018. This included reconsideration of the intertidal zone, updated Habitat Suitability Indices (HSI) and Habitat Equivalency Units (HEU) values, reconsideration of fish species and trophic levels, and an updated proposed letter of credit.

Additionally, DFO-FPP acknowledges receipt of letters of support for the freight dock project from the Mittimatalik Hunters & Trappers Organization and from the Qikiqtani Inuit Association.

However, our review has determined that some of the information and documentation set out in the *Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations* has still not been provided, or is not deemed sufficient, and as such, the application remains incomplete.

The following information and documentation is required in order for the application to be complete:

- Adequate contingency offsetting measures that were informed by Indigenous consultation and engagement have not yet been provided. Section 13(f) of Schedule 1 states *"a description of the contingency measures and associated monitoring measures that will be put into place if the measures referred to in paragraph (a) are not successful in offsetting the serious harm to fish".* Section 13 (g) of Schedule 1 "*an estimate of the cost of implementing each element of the offsetting plan*". DFO-FPP notes that this was requested as item 6 in DFO-FPP's correspondence dated June 7, 2018: Addendum – *Application for a Paragraph 35(2)(b) Fisheries Act Authorization detailed review comments and informational gap.* DFO-FPP reiterates the importance of providing contingency measures as part of an application for a Paragraph 35(2)(b) *Fisheries Act* authorization.
- DFO-FPP notes that as part of Baffinland's updated Application for *Fisheries Act* Authorization, section 7.4 on page 46 "*The net habitat balance of fish habitat losses (-1,845 HEUs) plus fish habitat gains (1,448 HEUs) is negative*." DFO-FPP understands this to mean that the current proposed offsetting plan does not adequately offset the losses from the proposed project. DFO-FPP also notes in section 9.1, on page 49 that "*Baffinland proposes to create an additional 398 HEUs of fish habitat by placing coarse rock substrate in the upper subtidal and shallow subtidal areas adjacent to the proposed freight dock. This coarse rock placement will occur as part of construction for the freight dock. The total amount of offsetting measures is equivalent to 1,845 HEUs*." DFO-FPP further notes conflicting information respecting the habitat function in the area of offsetting; in section 5.1.1 on page 22, it reads "*while in the marine environment adult Arctic char have no specific substrate preferences"* and section 5.1.2 on page 23 states "*YOY, juvenile and adult Arctic cod have no specific substrate preferences although Craig (1984) did note that, in a study from the Beaufort Sea, the diversity and abundance of fishes was lower in an area of rocky bottom than adjacent areas with mud and sand substrates*." Therefore, DFO-FPP notes there is substantial uncertainty respecting the functioning of the current proposed offsetting option. DFO-FPP does not have enough evidence to support the conclusion that placing additional rock over the naturally occurring substrate (primarily sand with low gravel, silt and clay composition) will provide a sufficient increase in fisheries productivity in Milne Inlet to adequately offset the losses. DFO-FPP recommends that Baffinland consider additional offsetting options to account for the net habitat losses. In addition, DFO-FPP requires that Baffinland account for the uncertainty in the proposed offsetting (i.e. consider a higher offsetting ratio).
- DFO-FPP acknowledges Baffinland provided an updated Letter of Credit valuation. DFO-FPP is unclear on how Baffinland arrived at the proposed costs outlined in the current rationale and provided table in Baffinland's updated Application for *Fisheries Act* Authorization in section 11, on page 62. DFO-FPP recommends Baffinland provide

additional rationale and/or cost breakdown for the proposed values for DFO-FPP to review.

Upon receipt of this outstanding information and documentation, The Program will notify you to confirm receipt. Within a period of 60 days beginning on the date of receipt of this outstanding information and documentation, the Program will notify you as to whether the application is complete.

If your plans have changed or if the description of your proposal is incomplete or changes during the review of your application, you should contact this office to avoid any unnecessary delays in the review of your application.

If you have any questions, please contact Laura Watkinson at our Yellowknife office at 867-669-4920, or by email at Laura.Watkinson@dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

Stephanie Martens
A/Regional Manager, Regulatory Reviews
Central and Arctic Region
Fisheries and Oceans Canada

cc. Oscar Gustafson, Knight Piésold Consulting
Laura Watkinson, DFO
Mark D’Aguiar, DFO

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APPENDIX C

DFO's Marine Foreshore Environmental Assessment Procedure

MARINE FORESHORE ENVIRONMENTAL ASSESSMENT PROCEDURE

Marine development projects have the potential to effect fish[1] and fish habitat[2]. Fisheries and Oceans Canada (DFO) is responsible for the protection and management of fish habitats under the authority of the *Fisheries Act* and may request plans, specifications and environmental assessments specific to marine projects where more detailed information is required. Assessments may be necessary for all types of projects, including, but not limited to aquaculture, log handling, industrial port development, marinas, private moorage facilities, marine repair facilities, pipeline or outfall installations, vessel launches or barge ramps, dredging projects and shoreline protection projects (breakwaters and seawalls). Presented below are standardized, transect-based assessment procedures intended to provide DFO with the basic information required to determine the potential effects of a development project on fish habitat.

Assessment Area

For comparative purposes, the assessment area should include both the foreshore site proposed for development as well as the adjacent foreshore. This will provide a context for the project and may provide data about cumulative effects if similar developments already occur on-site. A large scale site plan, preferably an enlargement of the hydrographic chart, with a small scale insert of the general geographic location will serve as a base map of the study area.

Tidal Height and Water Depth Measurements

The lowest normal tide (0.0 m), or chart datum, will be used as the reference point for the measurement of tidal height and water depth. Tidal height is recorded as positive relative to chart datum, while water depth below chart datum will be recorded as a negative value. For example, if the assessment is made when the tide is at 2 m, and observations are taken at a water depth of 6 m, then the depth will be recorded as -4 m. Tidal height will be corrected using the closest secondary port to the reference port found in the Canadian Tide and Current Tables, with further correction made for daylight savings time as required.

Transect Layout

Transects should be established perpendicular to the shoreline at regular intervals both within and adjacent to the proposed or active development area so as to sample representative fish habitat conditions. A preliminary low water reconnaissance or dive survey may be advisable to establish

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[1] shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals;

[2] shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals;

appropriate boundaries for the assessment. Transects should begin at the highest high water mark (HHWM: distance referenced as Station 0.0 m) and, at a minimum, extend to a depth of -20 m (–30 m if the development has the potential to effect deeper benthic habitats). Though small-scale intertidal projects may only require intertidal transects, care must be taken to ensure that a representative sample is collected across the proposed development area. Procedural manuals are available from DFO if sampling of intertidal clam or benthic invertebrates is required. To ensure complete assessment of marine plants and animals in the photic zone, deeper transects may be necessary, especially to determine the effects of sunken debris or woodwaste accumulations resulting from existing developments. Transects should be spaced approximately 25 m apart, although this interval may vary depending on the width of the site. The number of transects required will depend on the nature of the foreshore development proposed, anticipated effects of the development, and local site conditions (tides and currents, geography, fetch, geology, etc.). Transects should be individually numbered and indicated on the site plan, and their commencement point referenced to benchmarks, where possible.

Recording Observations

Habitat inventories should be conducted during the more productive spring and summer months. At that time, algae and saltmarsh species are more readily identifiable, enabling a better assessment of the productive capacity of the site.

Observations should be recorded every 5 m along the transect or at significant changes in habitat type. Observations should include substrate type and composition, presence and relative abundance of marine animals and plants, and any other notable features (e.g., debris accumulations) using the following format:

Substrate

Substrate types are to be subdivided into the following size class categories:

- Bedrock
- Boulder (>256 mm diameter)
- Cobble (64-256 mm diameter)
- Gravel (2-64 mm diameter)
- Sand (0.0625-2 mm diameter)
- Silt/Mud/Clay (<0.0625 mm diameter)

Substrate types are recorded cumulatively as percentages out of a total of 100% (e.g., Boulder 5%; Cobble 15%; Gravel 60%, Sand 20%)

Marine Plants

Marine plants include rooted vascular vegetation (e.g., eelgrass, saltmarsh vegetation, etc.) and marine algae (e.g., rockweed, kelp, etc.). Marine plant observations are recorded as percent areal coverage estimated per 5 m × 1 m transect segment. Observations can be recorded as percentages (5%, 10%, 15%, etc.) or by utilizing the following areal coverage classes:

+	<5%
1	5-25%
2	>25-50%
3	>50-75%
4	>75-100%

Sessile Animals

Many marine animals permanently attached to substrates function as important fish habitat (e.g., barnacles, bay mussels, etc.). Sessile animals are recorded as percent areal coverage along the transect line using either estimated percentages or by areal coverage classes, as presented above.

Motile Animals

Motile animals include fish and marine invertebrates such as crabs and snails. These can be individually counted along the transect or, where too numerous, their estimated numbers can be recorded. Population estimates will most likely be applied to species such as herring or mysid shrimp that naturally occur in large numbers.

Other Features

Accumulations of wood bark and debris, sunken logs or other waste materials arising from onsite or nearby development activities should also be recorded. For wood bark and related small size debris, observations are recorded as percent areal coverage estimates per 5 m × 1 m transect segment and estimated deposition depth (e.g., 15% / 10 cm). For larger materials (sunken logs, wood chunks, etc.), observations can be recorded by individual piece count or by estimate of percent areal coverage.

Observations should be correlated to the transect distance from the HHWM and (corrected) tidal height or water depth (e.g., Sta. 0+80 m / +4.5 m), with information compiled in tabular form, by transect. Common names of observed animals and plants are acceptable for the data table; a species list with scientific names should, however, be appended to the report.

General marine plant categories (e.g., rockweed, eelgrass, bull kelp, saltmarsh, etc.) and any other notable features should be sketched to scale directly on a copy of the site plan, drawings or photographs of the site. A site profile should be prepared for each transect showing the slope of the foreshore and the location of indicator marine plants or invertebrates. A sketch of the proposed marine development should be superimposed over the site plan so that any potential effect of the project on fish habitat is clear. Compensatory habitat proposed for offsetting altered habitat should also be sketched on site maps and profiles to enable review of the positioning of replacement habitat relative to the project.

Photographic Documentation

It is essential to produce a photographic record along the intertidal and subtidal transects. A videographic record of subtidal transects is also recommended. Photos and videos provide a real-time record of characteristic fish habitat at the proposed site and can be invaluable to future post-development site monitoring. Photographic records also facilitate comparison of the productivity of natural habitats with any compensatory habitat constructed to offset habitat losses. As visibility may be a problem, careful attention should be given to appropriate tidal levels, and midday lighting conditions are recommended. Aerial photos, taken at low tide, are often useful to put the site into context with the surrounding area and to verify information provided from other sources.

Assessment reports should include photographs of representative fish habitat types. Depending upon the scope of the proposed foreshore development, an unedited, labelled copy of the assessment video may also be required for the report submission. The video footage should be referenced with pertinent information (e.g., time, date, depth, heading, etc.), and a written or recorded interpretation should accompany the video.

Summary of information to be submitted

1. Basemap showing tenure area boundaries, surrounding area, transect locations and sampling stations
2. Shoreline video/photographs of intertidal zone
3. Underwater video/photographs of transects
4. Tabular data for each transect describing substrate type and composition, marine plants, sessile and motile marine animals, and other notable features
5. Habitat map showing location of different substrate types, plants, animals and operational infrastructure
6. Profile diagrams of each transect showing slope, sediment types and the major marine plants or animals observed
7. Photographs of site and aerial photographs if available.

APPENDIX D

Photographs

Photo 1: Habitat mapping along the inner perimeter of the Freight Dock offset habitat conducted by WSP (1 August 2024)

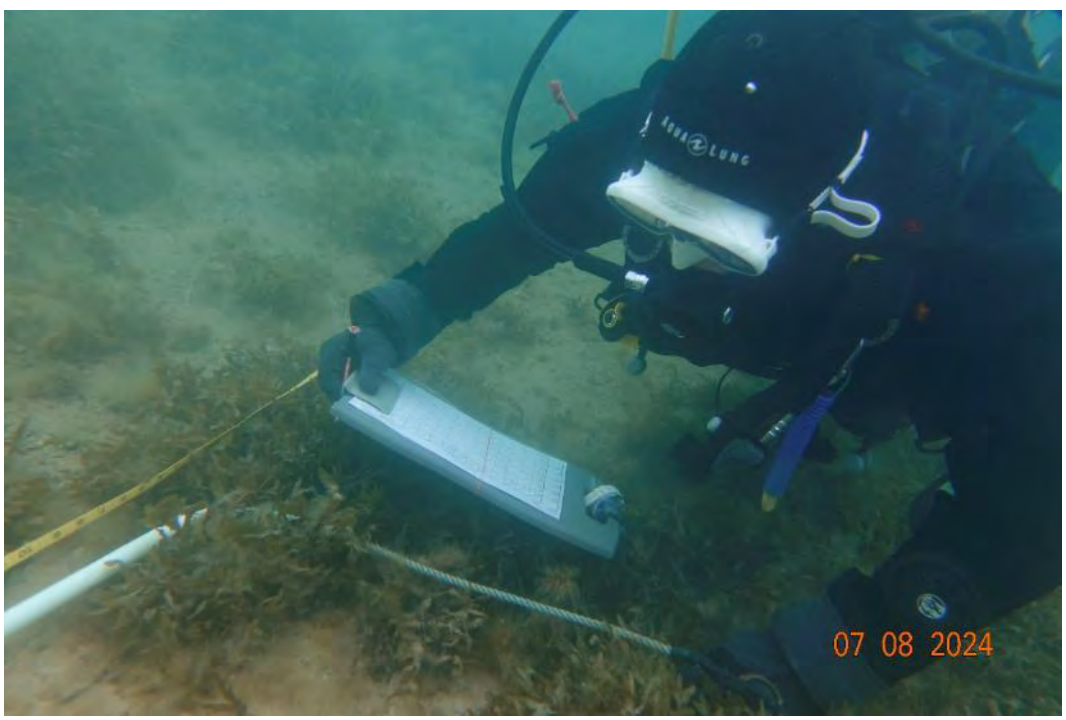

Photo 2: Biophysical survey conducted by WSP within the shallow subtidal of the Reference Area (FD-T11).

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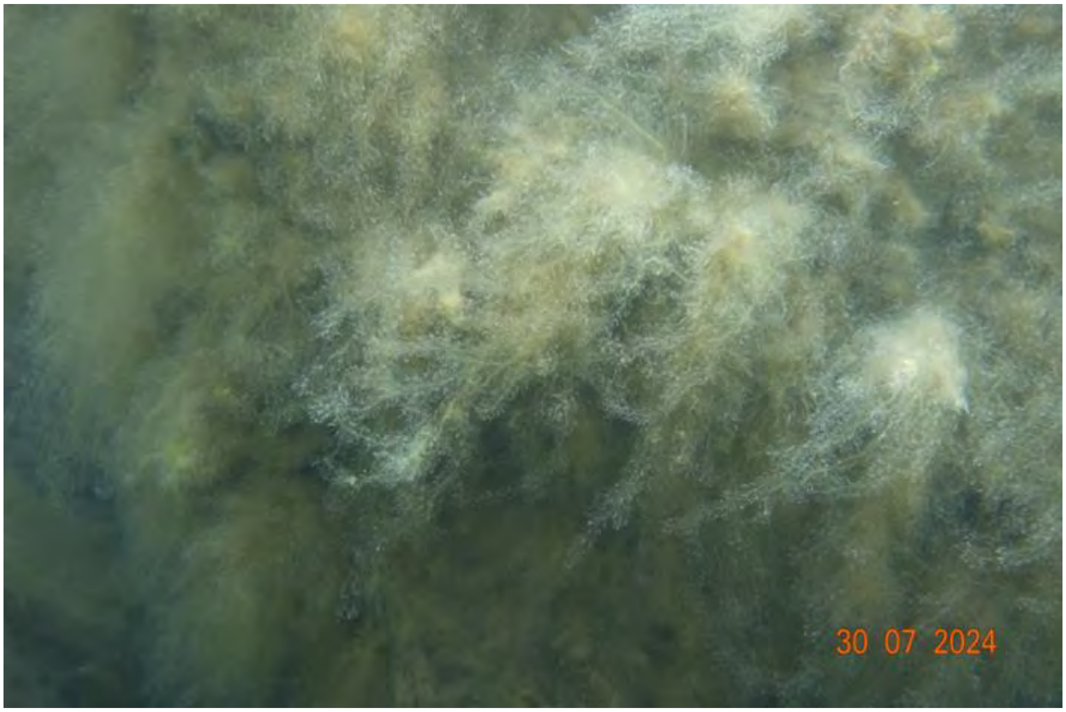

Photo 3: Tube-dwelling diatoms growing on a rock armour boulder of the Freight Dock habitat offset area in the shallow subtidal (FD-T7).

Photo 4: Sugar kelp (*Saccharina latissima*) growing between the rock armour boulders of the Freight Dock (FD) habitat offset area in the shallow subtidal zone (FD-T5).

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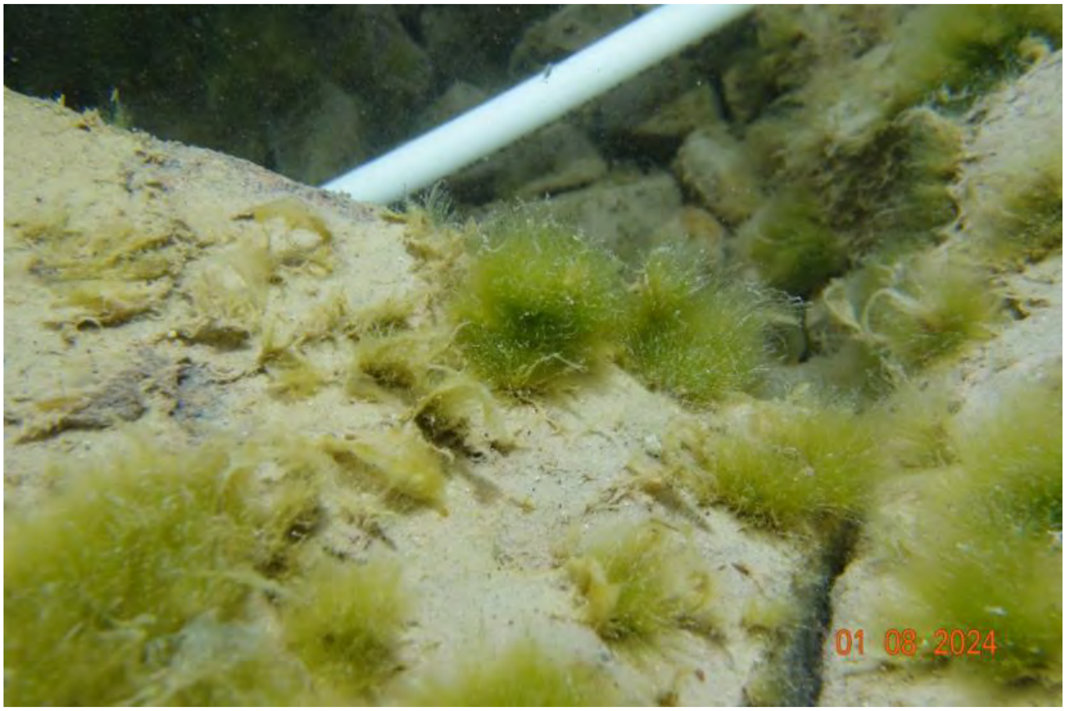

Photo 5: *Spongomorpha aeruginosa* growing on rock armouring within the upper subtidal zone of the Freight Dock habitat offset area (FD-T8).

Photo 6: *Stictyosiphon tortilis* and *Chaetomorpha melagonium* (red arrow) within the shallow subtidal of the Reference Area (REF-T1).

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Photo 7: Rockweed (*Fucus distichus*) covered by *Pylaiella sp.* on the substrate of the intertidal zone of Freight Dock habitat offset area (FD-T3).

Photo 8: *Coccotylus truncatus* with *Battersia* sp. in the subtidal area of the Reference Area (REF-T1).

Photo 9: Acidweed (*Desmarestia* sp.) growing on subtidal cobble (rockfill) of the Freight Dock habitat offset area in the shallow subtidal (FD-T6).

Photo 10: *Chaetopteris plumosa* within the shallow subtidal of the Reference Area (REF-T1).

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Photo 11: Landlady's wig (*Ahnfeltia plicata*) within the Reference Area intertidal zone (REF-T4).

Photo 12: Northern tooth weed (*Odonthalia dentata*) within the Reference Area shallow subtidal zone (REF-T1).

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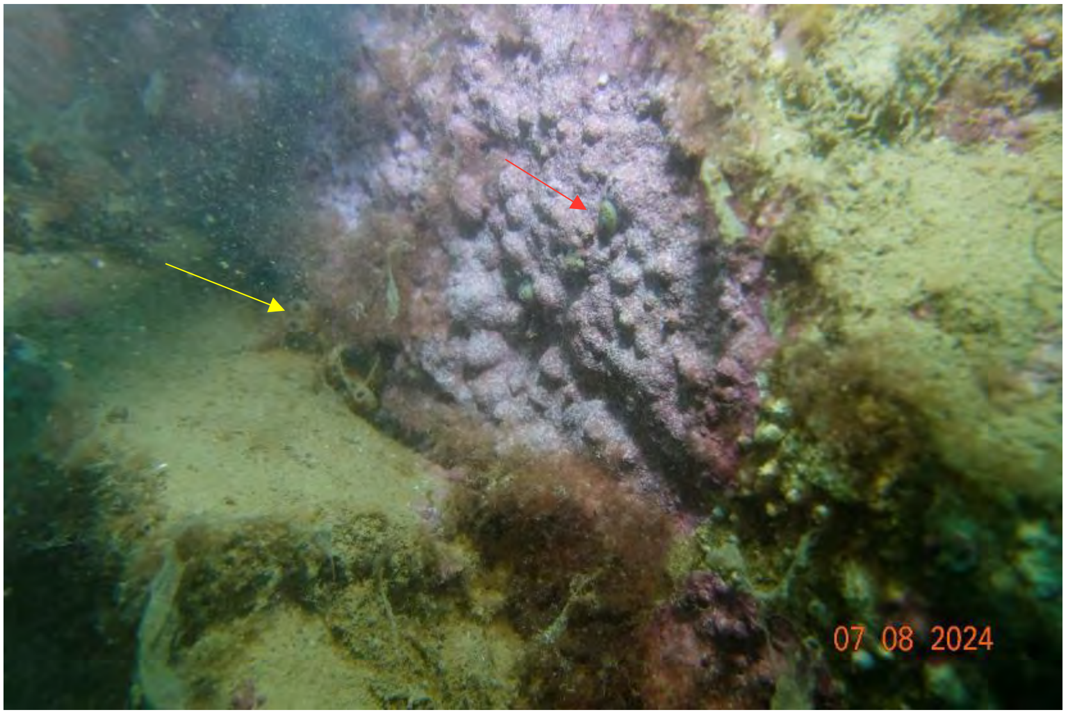

Photo 13: Encrusting coralline algae (Order Corallina) with limpets (red arrow; Family Lottiidae) and wrinkled rock-borers (*Hiatella arctica*; yellow arrow) on bedrock in the shallow subtidal of the Reference Area (REF-T1).

Photo 14: Unidentified tunicates (Phylum Tunicata) attached to shallow subtidal rock armour of the Freight Dock habitat offset area (FD-T6).

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Photo 15: Small sabellid worms (Family Sabellidae) on subtidal rock armouring within Freight Dock habitat offset area (FD-T5).

Photo 16: Unidentified barnacles (Class Balanomorpha) attached to shallow subtidal rock armouring of the Freight Dock habitat offset area (FD-T6).

Photo 17: Cone worm (*Cistenides granulata*) and an unidentified hydroid (Order Leptothecata) observed on gravel substrate in the shallow subtidal of the Reference Area (REF-T2).

Photo 18: Burrowing anemone (*Ceriantharia indet*.) near quadrat border and sugar kelp (*Saccharina latissima*) blade within Freight Dock reference area (Reference Area Transect 2 [REF-T2]; -6.8 to 0.1 m CD).

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Photo 19: Mussel (*Mytilus* sp.) burrowed within soft substrate within the shallow subtidal of the Reference Area (REF-T3).

Photo 20: Green urchin (*Strongylocentrotus droebachiensis*) on shallow subtidal cobble stones of the Freight Dock habitat offset area (FD-T7).

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Photo 21: Brittle star (Family Ophiuridae) on shallow subtidal cobble stones of the Freight Dock habitat offset area (FD-T7).

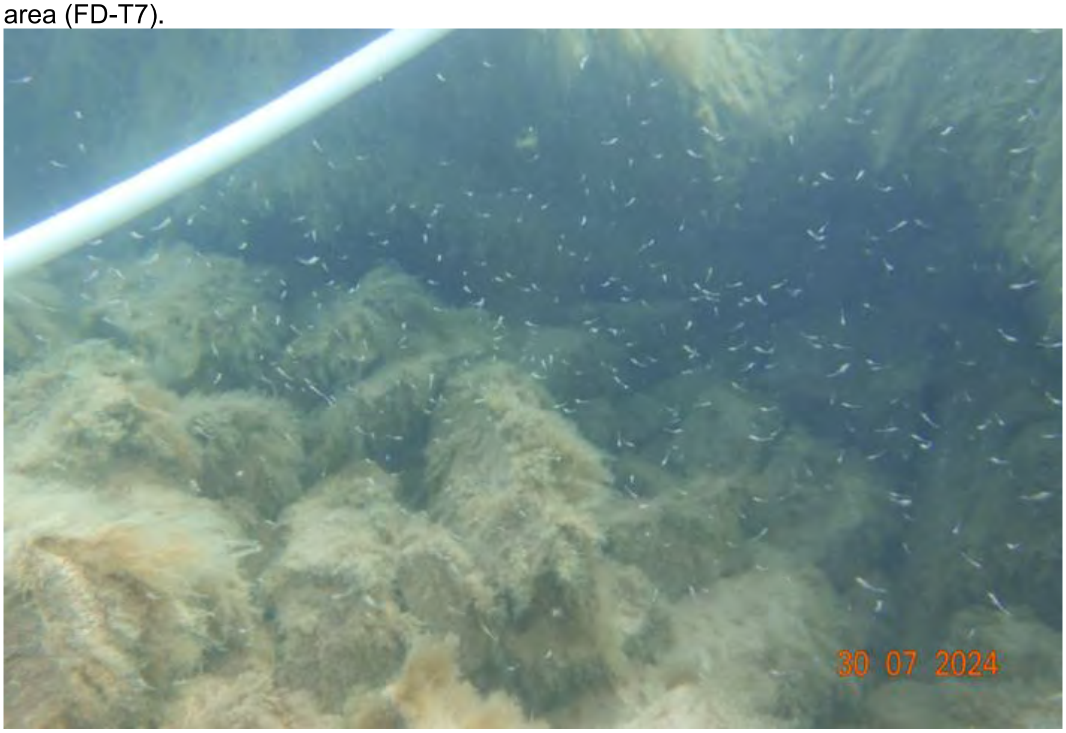

Photo 22: Mysids (Order Mysida) above shallow subtidal boulders within Freight Dock habitat offset area (FD-T5)

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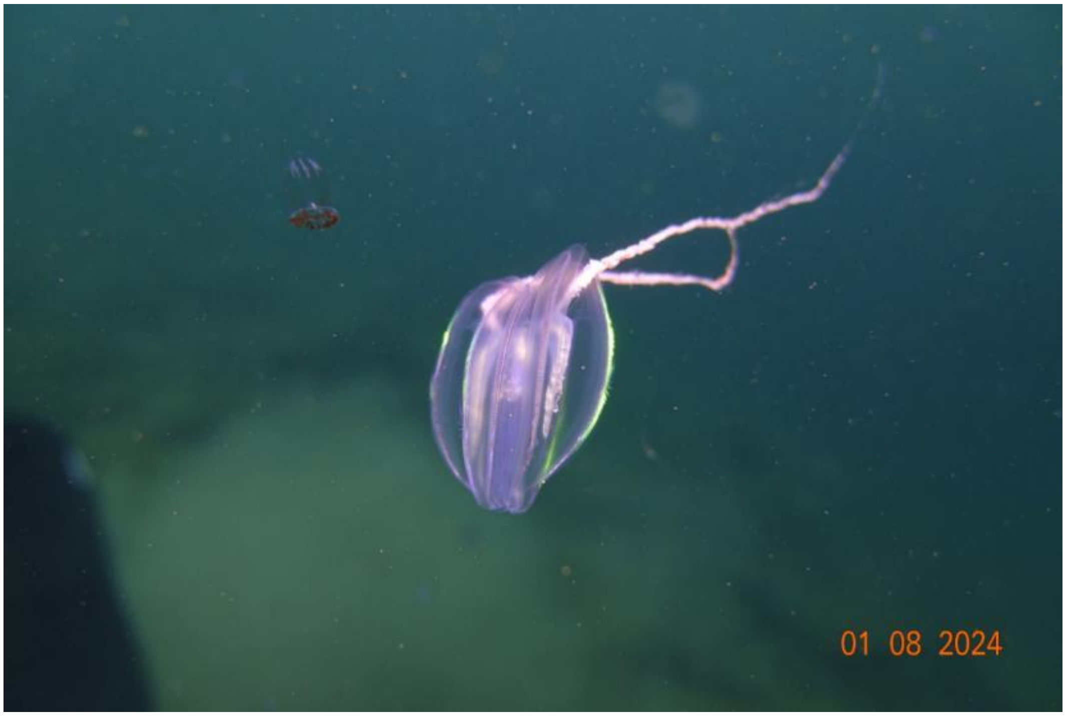

Photo 23: Arctic comb jelly (*Mertensia ovum*) observed during the outer shoreline mapping survey of Freight Dock habitat offset area.

Photo 24: Common northern comb jelly (*Bolinopsis infundibulum*) observed during outer shoreline mapping survey of Freight Dock habitat offset area in the upper subtidal.

Photo 25: Fish Doctor (*Gymnelus viridis*) within the intertidal Reference Area (REF-T3).

Photo 26: Juvenile Shorthorn Sculpin (*Myoxocephalus scorpius*) within shallow subtidal cobble stones and boulders of the Freight Dock habitat offset area (FD-T7).

APPENDIX E

Transect/Quadrat Survey Data

Appendix E
Transect/Quadrat Survey Data

Survey Location	Transect Number	Total Transect Length (m)	Quadrat Number	Distance Along Transect (m)	Date (2024)	Depth (m CD)[1]	Zone[2]	Substrate (% cover)[3]								Algae (% cover)																				Sessile Invertebrates (% cover); Motile Invertebrates (number)																					Fish (number)		
																	Brown								Red								Green			Crustacean		Annelid			Echinoderm		Cnidarian			Tunicata	Mollusca						Ctenophore	Brachiopoda			
								Bedrock	Boulder	Cobble	Gravel	Soft Substrate (Sand/Silt)	Shell	Diatoms	Debris	Detrital algae	Sugar kelp *Saccharina latissima*	Rockweed *Fucus distichus*	Acidweed *Desmarestia* sp.	*Pylaiella* sp.	*Halosiphon tomentosus*	*Battersia* sp.	*Stictyosiphon tortilis*	*Chaetopteris plumosa*	Landlady's wig *Ahnfeltia plicata*	Coccotylus truncatus	*Dilsea socialis*	*Phycodrys fimbriata*	*Polysiphonia* sp.	Northern tooth weed *Odonthalia dentata*	*Savoiea arctica*	Encrusting coralline Order Corallinales	*Spongomorpha aeruginosa*	*Chaetomorpha melagonium*	*Acrosiphonia* sp.	Mysid Order Mysida	Unid. Barnacle Class Balanomorpha	Sabellid worms Family Sabellidae	Calcareous tube worm Family Serpulidae	Cone worm *Cistenides granulata*	Green urchin *Strongylocentrotus droebachiensis*	Brittle star Family Ophiuridae	Anemone *Urticina* sp.	Hydroid Order Leptothecata	Burrowing anemone Order Ceriantharia	Tunicate Subphylum Tunicata	Wrinkled rock-borer *Hiatella arctica*	Northern astarte *Astarte borealis*	Blunt gaper *Mya truncata*	Limpet Family Lottiidae	Discord mussel Musculus discors	Mussel *Mytilus* sp.	Ctenophore Phylum Ctenophora	Articulated brachiopod *Hemithiris psittacea*	Shorthorn Sculpin *Myoxocephalus scorpius*	Fish Doctor *Gymnelus viridis*	Juvenile Eelpout Family Zoarcidae
Freight Dock Offset Habitat	T1	2.5	1	0	30-Jul	0.2	Intertidal	0	85	0	5	10	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	25	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2	1		0.7	Intertidal	0	90	0	10	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T2	4	1	0	30-Jul	-0.5	Intertidal	0	10	0	10	80	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2	1		0.1	Intertidal	0	90	0	10	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			3	2		0.1	Intertidal	0	100	0	0	0	0	80	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	20	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			4	3		0.6	Intertidal	0	100	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	20	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T3	4.2	1	0	30-Jul	-0.6	Upper Subtidal	0	70	5	25	0	0	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2	1		-0.2	Intertidal	0	90	0	10	0	0	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			3	2		0.6	Intertidal	0	95	5	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			4	3		0.6	Intertidal	0	95	5	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T4	3.3	1	0	30-Jul	-0.7	Upper Subtidal	0	60	0	5	35	0	50	0	0	0	5	0	15	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2	1		-0.5	Intertidal	0	85	0	15	0	0	50	0	0	0	<1	0	5	2	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			3	2		0.0	Intertidal	0	100	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	55	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T5	23	1	0	30-Jul	-7.3	Shallow Subtidal	0	100	0	0	0	0	50	0	0	12	0	10	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2	5		-5.5	Shallow Subtidal	0	100	0	0	0	0	60	0	0	12	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			3	10		-3.8	Shallow Subtidal	0	100	0	0	0	0	60	0	0	0	1	0	60	1	1	5	0	0	0	0	0	0	0	1	0	1	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			4	15		-2.6	Upper Subtidal	0	100	0	0	0	0	70	0	0	0	1	0	1	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			5	20		-2.5	Upper Subtidal	0	100	0	0	0	0	80	0	0	0	0	1	5	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T6	33	1	0	30-Jul	-9.7	Shallow Subtidal	0	20	5	0	75	0	5	0	2	0	0	15	15	<1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2	5		-8.5	Shallow Subtidal	0	85	15	0	0	0	40	0	0	2	0	5	60	3	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			3	10		-6.9	Shallow Subtidal	0	100	0	0	0	0	60	0	0	15	<1	10	60	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
			4	15		-4.7	Shallow Subtidal	0	100	0	0	0	0	30	0	0	0	1	2	70	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			5	20		-4.5	Shallow Subtidal	0	95	5	0	0	0	50	0	0	0	0	3	40	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			6	25		-3.2	Shallow Subtidal	0	95	5	0	0	0	80	0	0	0	<1	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
			7	30		-1.2	Upper Subtidal	0	100	0	0	0	0	60	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T7	34	1	0	30-Jul	-9.0	Shallow Subtidal	0	0	50	20	29	1	40	0	0	2	0	2	15	2	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
			2	5		-7.5	Shallow Subtidal	0	70	25	5	0	0	40	0	0	5	0	2	40	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			3	10		-6.2	Shallow Subtidal	0	100	0	0	0	0	50	0	0	2	0	0	60	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			4	15		-5.7	Shallow Subtidal	0	99	0	0	0	1	40	0	0	2	0	0	30	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
			5	20		-3.9	Shallow Subtidal	0	100	0	0	0	0	60	0	0	0	2	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
			6	25		-1.6	Upper Subtidal	0	100	0	0	0	0	10	0	0	0	1	0	60	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
			7	30		-0.5	Intertidal	0	100	0	0	0	0	10	10	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T8	4.3	1	0	01-Aug	-0.7	Upper Subtidal	0	10	45	45	0	0	30	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
			2	1		-0.5	Intertidal	0	60	20	20	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			3	2		-0.2	Intertidal	0	60	10	30	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
			4	3		0.3	Intertidal	0	90	10	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T9	2.1	1	0	01-Aug	-0.2	Intertidal	0	60	0	10	30	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2	1		0.3	Intertidal	0	100	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T10	2.2	1	0	01-Aug	0.2	Intertidal	0	60	20	5	15	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2	1		0.7	Intertidal	0	75	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T11	1.2	1	0	01-Aug	0.0	Intertidal	0	15	45	35	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	50	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reference Area	T1	32	1	0	07-Aug	-9.9	Shallow Subtidal	100	0	0	0	0	0	80	0	0	0	<1	10	5	0	1	0	0	0	10	<1	2	3	0	0	50	0	1	0	0	<1	0	0	0	0	0	1	0	0	0	10	0	0	1	0	0	0	1	0	0	0
			2	5		-6.7	Shallow Subtidal	0	0	0	10	87	3	10	0	2	10	10	<1	16	3	<1	<1	0	0	0	0	0	0	10	0	0	0	<1	<1	0	0	1	0	5	0	0	0	0	0	0	0	0	2	0	1	1	0	0	0	0	0
			3	10		-4.6	Shallow Subtidal	0	0	0	30	68	2	70	0	0	0	25	0	30	0	10	0	1	0	0	2	0	0	<1	0	0	0	<1	0	0	<1	0	0	5	0	0	0	0	0	1	0	0	0	0	0	2	3	0	0	0	1
			4	15		-2.9	Upper Subtidal	0	0	87	0	10	3	40	0	0	0	95	0	20	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
			5	20		-1.6	Upper Subtidal	0	30	40	30	0	0	60	0	0	0	75	0	30	2	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			6	25		-0.8	Upper Subtidal	0	20	30	50	0	0	30	0	0	0	40	0	20	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			7	30		-0.3	Intertidal	0	0	10	90	0	0	0	0	0	0	2	0	7	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T2	24	1	0	07-Aug	-6.8	Shallow Subtidal	0	30	10	20	39	1	10	0	2	15	5	4	0	<1	3	0	7	0	7	10	0	0	1	2	0	0	<1	0	0	2	2	0	3	1	0	0	1	1	0	2	0	1	0	0	7	0	0	0	0	0
			2	5		-3.7	Shallow Subtidal	0	0	30	10	58	2	40	0	0	0	60	5	10	0	30	0	0	0	7	0	0	0	3	0	0	0	<1	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
			3	10		-2.1	Upper Subtidal	0	0	20	20	60	0	10	0	0	0	50	0	20	0	20	0	0	0	0	0	0	0	<1	2	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
			4	15		-0.8	Upper Subtidal	0	0	40	40	20	0	0	0	0	0	80	0	10	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			5	20		0.1	Intertidal	60	0	0	10	30	0	5	0	0	0	30	0	5	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T3	27	1	0	07-Aug	-5.6	Shallow Subtidal	0	0	0	20	80	0	0	0	0	<1	2	40	0	0	2	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	1	0	0	0	0	0	1	0	1	2	0	0	1	0	0	0	0	0
			2	5		-4.1	Shallow Subtidal	0	0	0	20	78	2	30	0	0	0	40	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	2	0	0	<1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
			3	10		-3.3	Shallow Subtidal	0	0	0	30	66	4	30	0	0	0	60	0	30	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
			4	15		-2.5	Upper Subtidal	0	0	10	30	60	0	20	0	0	0	30	0	60	0	3	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	10	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
			5	20		-1.1	Upper Subtidal	0	0	10	40	50	0	5	0	0	0	75	5	20	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			6	25		0.6	Intertidal	0	80	20	0	0	0	0	0	0	0	5	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	T4	29	1	0	07-Aug	-9.9	Shallow Subtidal	0	0	0	5	92	3	25	0	5	1	0	7	5	5	0	3	2	0	0	0	0	0	<1	0	0	0	2	0	0	0	2	0	5	0	3	0	0	7	0	2	0	1	0	1	0	0	0	0	0	0
			2	5		-7.2	Shallow Subtidal	0	0	10	10	75	5	60	0	0	10	0	<1	5	30	0	0	3	0	2	0	0	0	0	1	0	0	3	0	0	0	5	0	2	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0
			3	10		-4.6	Shallow Subtidal	0	0	0	10	85	5	70	0	20	<1	10	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			4	15		-3.7	Shallow Subtidal	0	0	45	20	35	0	40	0	0	0	60	5	10	0	10	0	2	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			5	20		-2.3	Upper Subtidal	0	0	50	45	5	0	30	0	5	0	85	0	25	0	30	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			6	25		-0.6	Upper Subtidal	0	0	90	10	0	0	15	0	0	0	95	0	15	0	30	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes: Grey highlighting indicates sessile invertebrates. m = metres; sp. = Single or unconfirmed multiple species within a genus, used when the specimen has not been identified to the species level; % = percent.

[1] Diver depth gauge was converted to meters (m) chart datum (CD), estimated using tide table for Milne Inlet, Nunavut (http://www.tides.gc.ca/eng [accessed September 2024]). The negative (-) numbers indicate 'below' CD and positive (+) numbers indicate 'above' CD. End depths (m) indicate the shallowest depth surveyed, predominantly at the waterline.

[2] Intertidal: +2.3 to -0.5 m CD; Upper subtidal: <-0.5 to -3 m CD; Shallow subtidal: < -3 m CD.

[3] Substrate size ranges: bedrock; boulder (>256 mm diameter); cobble (64 to 256 mm); gravel (2 to 64 mm); sand (0.0625 to 2 mm); silt/mud/clay (<0.0625 mm).

APPENDIX F

Taxa List

Appendix F
Taxa List

Common Name	Scientific Name
Macroalgae	
Brown Algae / Kelp (Ochrophyta)	
Sugar kelp	*Saccharina latissima*
Rockweed	*Fucus distichus*
-	*Pylaiella* sp.
-	*Halosiphon tomentosus*
-	*Battersia* sp.
-	*Stictyosiphon tortilis*
-	*Chaetopteris plumosa*
Acidweed	*Desmarestia* sp.
Red Algae (Rhodophyta)	
Landlady’s wig	*Ahnfeltia plicata*
-	*Coccotylus truncatus*
-	*Dilsea socialis*
-	*Phycodrys fimbriata*
-	Polysiphonia sp.
Northern tooth weed	*Odonthalia dentata*
-	*Savoiea arctica*
Encrusting coralline algae	Order Corallinales
Green Algae (Chlorophyta)	
-	*Spongomorpha aeruginosa*
-	*Chaetomorpha melagonium*
-	*Acrosiphonia* sp.

Fish	
Unidentified Cod*	Family Gadidae
Fourhorn Sculpin*	*Myoxocephalus quadricornis*
Arctic Sculpin*	*Myoxocephalus scorpioides*
Shorthorn Sculpin	*Myoxocephalus scorpius*
Unidentified Sculpin*	Family Cottidae
Fish Doctor	*Gymnelus viridis*
Juvenile eelpout*	Family Zoarcidae

Note: ‘-‘ indicates no existing or unknown common name; ‘*’ indicates opportunistically observed during transect/quadrat and/or habitat mapping surveys and were not included in analyses.

Marine Invertebrates	
Annelida	
Cone worm	*Cistenides granulata*
Sabellid worm	Family Sabellidae
Calcareous tube worm	Family Serpulidae
Arthropoda	
Barnacle	Class Balanomorpha
Copepod*	Class Copepoda
Mysid	Order Mysida
Brachiopoda	
Articulated brachiopod	*Hemithiris psittacea*
Cnidaria	
Burrowing anemone	Order Ceriantharia
Hydromedusa*	Class Hydrozoa
Hydroid	Order Leptothecata
Anemone	*Urticina* sp.
Ctenophora	
Arctic comb jelly*	*Mertensia ovum*
Common northern comb jelly*	*Bolinopsis infundibulum*
Ctenophore	Phylum Ctenophora
Echinodermata	
Brittle star	Family Ophiuridae
Green urchin	*Strongylocentrotus droebachiensis*
Mollusca	
Icelandic scallop*	*Chlamys islandica*
Sea angel*	*Clione limacina*
Wrinkled rock-borer	*Hiatella arctica*
Northern astarte	*Astarte borealis*
Sea butterfly*	*Limacina helicina*
Limpet	Family Lottiidae
Discord mussel	*Musculus discors*
Blunt gaper	*Mya truncata*
Mussel	Mytilus sp.
Tunicata	
Tunicate*	Family Pyuridae
Unidentified tunicate	Subphylum Tunicata

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