Baffinland Phase II Expansion: Identifying Early Warning Indicators and Thresholds
Oct 25, 2019

The Marine Environment Working Group ("MEWG") has requested that DFO provide suggestions for "early warning indicators" (EWI) with respect to the potential impacts related to increased shipping noise (with Phase II expansion) that may occur in marine mammal stocks/populations present in the area of interest. They list potential impacts, and guidance for developing EWI and thresholds, as follows (blue text):

Potential impacts:
- Acoustic disturbance
- Change in animal distribution in the region
- Change in animal abundance in the region
- Alteration of migration patterns
- Availability of marine mammals for harvesting

Selection of early warning indicators:
- The early warning indicators should clearly indicate how the noise from Project-vessels are impacting indicator species (e.g., narwhal) as defined using measurable, quantitative thresholds.
- Indicators could be the number of individuals using an area (regional abundance), the type of individuals using an area (e.g., mother-calves), a change in the timing of the area being used (e.g., arrival date in an area or departure date from an area), or other characteristics of individual marine mammals or populations.
- Indicators should speak to a change that has occurred which is likely, beyond reasonable doubt, to be a direct result of noise from shipping activities.

Determine Appropriate Threshold for Indicator Species:
- Thresholds are limits of "acceptable change".
- Quantitative thresholds need to be identified to determine whether the effect of noise from shipping activities is resulting in "acceptable changes" to an indicator (i.e., marine mammals).
- Examples of thresholds include the number of individuals or type of individuals in a regional population, a percentage decrease in the number of individuals or type of individuals in a regional population, or an arrival or departure date from an area.

BACKGROUND

When developing mitigation measures and adaptive management practices for reducing noise impacts on marine mammals, and associated thresholds for negative impacts, including within the context of an early warning indicator (EWI) system, the full breadth of potential negative impacts needs to be considered. These can include physiological, behavioural ,and ecological effects. Table 1 provides a list of potential effects/responses that anthropogenic noise sources can have on marine mammals as well as the potential impacts/consequences to animals and populations. Though this table was developed to evaluate the impacts of seismic airgun noise on marine mammals, almost all of the potential effects and impacts listed are relevant to ship noise, with the one potential exception being non-auditory physiological effects.

Ship noise can cause temporary hearing threshold shifts (TTS), and in some cases if loud enough, even permeant hearing threshold shifts (PTS). It can also cause changes in the behaviour of the animals that extends beyond displacement (or movement from an area), including the potential behavioural effects listed in Table 1. Ship noise can also mask the vocalizations of animals, such as their social calls as well as echolocation (foraging) clicks; this

may alter their ability to forage, socialize/communicate, and avoid predators (and other anthropogenic activities). If ship noise has any impact on prey distribution or abundance, and if marine mammal foraging behaviour or success is reduced, this may be reflected in reduced reproductive propensity or success, or poor body condition. Exposure to shipping noise can also induce stress responses (e.g., Rolland et al., 2012).

Many of these impacts can cause (directly or indirectly, and cumulatively) reduced fitness/health, reduced reproductive rates and calf production, and survival, and thus may lead to population-level impacts. It is particularly critical to note that any population or density estimates will have sufficient uncertainty that a very high level of change must be demonstrated before an impact is actually detected (e.g., Jewell et al. 2012). With the added confounding factors of climate-related, environmental and prey changes, and newly-invading predators and other invasive species, it will be much harder to conclude that such large observed changes are unequivocally linked to increased shipping; rather, we can say that the risk of such impacts is higher.

SELECTION OF EWIs, THRESHOLDS, AND SOURCES OF UNCERTAINTY

Within the EWI guidance document, the examples of EWIs (and thresholds for indicator species) provided are largely focused on changes in the numbers of animals in the area over time (i.e., displacement from the area). The selection of EWIs should reflect the full range of varying potential effects; there are examples related to other types of potential impacts (e.g., animal health or condition) that should be considered. It should be noted that marine mammal responses to noise are highly species- and context-specific (see Gomez et. al. 2016) and individuals may not always leave an area even if a negative impact is occurring (particularly if it is important to a life history function such as calving or feeding) if animals show a high degree of natal philopatry or site fidelity (e.g. narwhal in Eclipse Sound). Note that if displacement has already occurred (e.g., if a statistically significant number of the animals left the area during the Phase I operations), then the impact has already happened and this may not be a good example of an “early” warning system, unless Phase II results in further avoidance of the area.

In fact, “early” warning indicators are very difficult to establish for long-lived marine mammals, as potential impacts may take years to detect (e.g., population-level impacts). While in some cases marine mammals affected or displaced by noise disturbance may return once the noise source is reduced or removed (observed in some harbour porpoise populations after cessation of windfarm construction), there have been documented cases of noise-producing activities displacing whales with individuals not returning to the area for many years, even after the noise source was removed. For example, known gray whales were displaced from one of their breeding lagoons for over five years when exposed to industrial sounds and they returned only several years after the activities stopped (Jones et al. 1994). Similarly, very few of the beaked whales recorded in the Bahamas prior to the navy sonar-associated stranding have been seen in the area since.

Furthermore, displacement may lead to knock-on consequences that could be catastrophic for the population. For example, over 1,000 narwhals died in Canada and northwest Greenland following ice entrapments that may have been caused by avoidance of seismic surveys (Heide-Jørgensen et al., 2013). In some cases, some species and populations may be unable to leave certain habitats, which may make them especially vulnerable, even if no displacement is observed (see Forney et al. 2017). The community of Pond Inlet has suggested that the 2015 ice entrapment was due to delayed movements of narwhals out of Eclipse as a result of ice breaking and shipping traffic in the shoulder season.

Displacement may be difficult to detect, and certainly to ascribe this response as a direct consequence of increased shipping noise. For example, the Canadian portion of the Baffin Bay population of narwhal consists of at least four narwhal stocks which aggregate in summer: the Somerset Island, Admiralty Inlet, Eclipse Sound and East Baffin Island stocks. It was previously thought that narwhals exhibit strong fidelity to their summering areas; however, recent satellite tagging data has revealed that animals may move between summering areas, both within and between years (as evidenced by tagging data showing movements of narwhals between Eclipse Sound and Admiralty Inlet). These movements may make very localized changes in abundance difficult to detect. Therefore, any changes in localized abundance must be considered within the context of the entire population, assuming we can detect changes in other stocks, and that we can quantify immigration and emigration processes.

It is important to note that there is relatively limited knowledge about the short- and long-term impacts of ship noise exposure on narwhals and other marine mammal species. In particular, our understanding of the potential sub-lethal impacts on individuals and resulting population-level impacts is incomplete. This will hamper our ability to derive "acceptable" thresholds for impacts, and thus when developing EWIs and associated thresholds a precautionary approach needs to be taken.

Finally, although the EWIs appear to focus on noise-related impacts, acoustic impacts are not the only ones that might occur as a result of the proposed increase in shipping activity. For example, increased traffic will lead to increases in routine operational spills, as well as the risk of accidental oil spills/leaks. Likewise, greater shipping traffic also increases the potential for vessel strikes and other direct injuries to local marine mammals, especially given the confines of the area under discussion. Such non-acoustic impacts also merit attention.

Some potential EWIs to consider (relevant for all marine mammals found in the area):

1. Real time monitoring
    - Increase in anthropogenic noise levels/sound exposure levels within the area or an increase in received sound levels (receivers located in critical use areas)
    - Changes in animal vocalization characteristics, rates or patterns (as it has been shown that animals tend to respond to noise acoustically, rather than through observable behavioural reactions; Gomez et al. 2016).
    - Changes in diving or surfacing behavior.
    - Reductions in echolocation or communication space (i.e., level of masking occurring, as determined from modelled/measured noise levels within the area).
    - Ship avoidance behaviour, representing an early indicator of change in population health (Bejder et al. 2006; Williams et al. 2006).

2. Longer-term monitoring
    - Increases in underwater sound level in the environment, , as well as changes in species complement, and social activity of local marine mammals
    - Increases in the level of stress hormones (cortisol, aldosterone, and corticosterone, at a minimum) in the animals as measured in faeces or direct sampling
    - Decreases in body condition (could be indicative of hampered foraging efficiency or displacement from better feeding areas or prey, for example)
    - Changes in calving rates (though this is not really an "early" warning indicator).

- Increases in observed injuries/mortalities (though again, this isn't really an "early" warning)
- Changes in demographic parameters such as reproductive rates, sex ratio, age at maturity, disease, stress, and body condition may be monitored with assistance from community-based sample collection programmes
- One of the first signs of population decline is the decrease in recruitment. The proportion of the number of calves to the number of adults provides an index of the recruitment in the population. This proportion could be calculated by measuring age classes of narwhals in aerial photographs. Age class data is available since 2013 and could be used as a baseline (Charry et al. 2018)
- Harvest age, sex, and size composition may also be an indication of population level change, particularly for those hunts that are more targeted (e.g. male narwhal for tusk)

Frequent assessments, both within (including the shoulder season to capture changes in migration patterns) and between years, of marine mammal abundance/density should be conducted in order to develop a population index, and to detect changes in this index. Methods of assessment could include aerial survey or other type of assessment methods such as mark-recapture methods (Moore et al. 2012). Narwhals utilise the Eclipse Sound summering area for different purposes. A change in narwhal distribution could be an early indication that the summering area does not fulfill their needs anymore. Photographic aerial surveys conducted throughout the summer and into the shoulder seasons would be essential to determine narwhal abundance and distribution (Sheldon et al. 2017)

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Thresholds

"Thresholds" for these impacts cannot currently be identified, as there are no global accepted interpretations of "acceptable change" for any marine mammal characteristic. Therefore, we suggest that any statistically significant change detected in any parameter measured should represent the "warning" indicator. For survey derived indicators, statistical power to detect biologically significant differences is directly dependent on the frequency of those surveys. We also recommend measures of multiple parameters (see examples below). In addition to those discussed above, there are multiple other stressors, associated (or not) with the proposed shipping expansion (e.g., fishing, climate variability, vessel-interaction, pollution), that can also adversely affect marine mammals and/ or their habitat. As a result, there is a need to account for cumulative effects from multiple stressors acting simultaneously, as well as for effects of stressors that accumulate over time.

Baseline Data Collection

To assess the potential impacts to wildlife populations of a given project, adequate baseline data are needed for each EWI and species chosen. In the Baffinland context, data collected after the proposed expansion to Phase II should be compared to data collected during both pre- and post- Phase I development.

It would be important to identify existing sources of information, including their temporal and spatial coverage, with regards to EWI before some of these are selected for tracking purposes.

Table 1. List of potential effects/responses and potential impacts/consequences of seismic airgun sounds on marine mammal physiology, behavior and ecology (table adapted from Table 1 in *DFO. 2015. Review of Mitigation and Monitoring Measures for Seismic Survey Activities in and near the Habitat of Cetacean Species at Risk. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/005*)

Potential effects/responses	Direct potential impacts/consequences	Indirect potential impacts/consequences
	Physiological effects	
Non-auditory physiological effects	Emboli formation, organ/ tissue damage, neurological effects, increased stress hormones	Stranding/near-stranding/at-sea death, reduced socializing/foraging, malnutrition, reduced reproduction/survival
Auditory physiological effects (*e.g.,* TTS, PTS)	Loss of hearing sensitivity	Reduced socializing/foraging, malnutrition, starvation, increased exposure to threats, reduced reproduction/survival
	Behavioural effects	
Changes in dive and respiratory patterns	Stranding/near-stranding, emboli formation, tissue damage, increased energetic cost, reduced socializing/foraging	Stranding/near-stranding/at-sea death, malnutrition, increased exposure to threats, reduced reproduction/survival
Displacement and migratory diversion	Increased energetic cost, reduced socializing/foraging	Malnutrition, increased exposure to threats, reduced reproduction/survival
Changes in social behavior (*e.g.* hampered parental care and bonding, hampered breeding, etc.)	Reduced socializing/foraging	Calf mortality, reduced reproduction/ survival
Changes in vocalization patterns (*e.g.,* hampered communication and echolocation)	Reduced socializing/foraging	Malnutrition, reduced reproduction/survival
Changes in time budget (*e.g.,* proportion of time spent performing various activities such as resting, foraging, socializing)	Increased energetic cost, reduced socializing/ foraging/resting	Malnutrition, increased exposure to threats, reduced reproduction/ survival
Changes in cognitive processes (*e.g.,* distraction)	Reduced socializing/foraging	Malnutrition, increased exposure to threats, reduced reproduction/ survival
	Ecosystem effects	
Hampered passive acoustic detection of prey, predators, and conspecifics	Predator-related injury/mortality, reduced socializing/foraging	Malnutrition, increased exposure to threats, reduced reproduction/ survival
Hampered avoidance of anthropogenic threats (e.g., ship strikes, bycatch, etc.)	Anthropogenic injury/mortality	Increased exposure to threats, reduced reproduction/ survival
Hampered use of critical habitat/reduced occupancy	Reduced socializing/foraging	Reduced reproduction/ survival

References (not comprehensive)

Bejder, L., Samuels, A., Whitehead, H., Gales, N., Mann, J., Connor, R., Heithaus, M., Watson-Capps, J., Flaherty, C., and Krutzen, M. 2006. Decline in relative abundance of bottlenose dolphins exposed to long-term disturbance. Conserv. Biol. 20(6): 1791–1798.

Charry, B., Marcoux, M., and Humphries, M.M. 2018. Aerial photographic identification of narwhal (Monodon monoceros) newborns and their spatial proximity to the nearest adult female. Arct. Sci. doi:10.1139/AS-2017-0051.

DFO. 2015. Review of Mitigation and Monitoring Measures for Seismic Survey Activities in and near the Habitat of Cetacean Species at Risk. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/005.

Forney, K.A., Southall, B.L., Slooten, E., Dawson, S., Read, A.J., Baird, R.W. and Brownell Jr., R.L. 2017. Nowhere to go: noise impact assessments for marine mammal populations with high site fidelity. Endangered Species Research 32: 391-413.

Gomez, C., Lawson, J.W., Wright, A.J., Buren, A.D., Tollit, D. & Lesage, V. 2016. A systematic review on the behavioural responses of wild marine mammals to noise: the disparity between science and policy. Canadian Journal of Zoology 94: 801–819 (2016) dx.doi.org/10.1139/cjz-2016-0098.

Heide-Jørgensen, M.P., Guldborg Hansen, R., Westdal, K., Reeves, R.R. & Mosbech, A. 2013. Narwhals and seismic exploration: Is seismic noise increasing the risk of ice entrapments? Biological Conservation 158:50-54.

Jewell, R., Thomas, L., Harris, C.M., Kaschner, K., Wiff, R., Hammond, P.S., and Quick, N.J. 2012. Global analysis of cetacean line-transect surveys: detecting trends in cetacean density. Mar. Ecol. Prog. Ser. 453: 227-240.

Jones, M.L., Swartz, S.L., and Dahlheim, M.E. 1994. Census of Gray Whale Abundance in San Ignacio Lagoon: A Follow-Up Study in Response to Low Whale Counts Recorded During an Acoustic Playback Study of Noise Effects on Gray Whales. Report to the U.S. Marine Mammal Commission, Washington, DC. NTIS PB94195062. 32 pp.

Moore, S.E., Reeves, R.R., Southall, B.L., Ragen, T.J., Suydam, R.S., and Clark, C.W. 2012. A new framework for assessing the effects of anthropogenic sound on marine mammals in a rapidly changing Arctic. Bioscience 62(3): 289–295.

Rolland RM, Parks SE, Hunt KE, Castellote M, Corkeron PJ, Nowacek DP, Wasser SK & Kraus SD. 2012. Evidence that ship noise increases stress in right whales. Proceedings of the Royal Society B, 279: 2363-2368

Sheldon, K.E.W., Hobbs, R.C., Sims, C.L., Vate Brattström, L., Mocklin, J.A., Boyd, C., and Mahoney, B.A. 2017. Aerial surveys of beluga whales (Delphinapterus leucas) in Cook Inlet, Alaska, June 2016. AFSC Processed Report, NOAA, Seattle.

Williams, R., Lusseau, D., and Hammond, P.S. 2006. Estimating relative energetic costs of human disturbance to killer whales (Orcinus orca). Biol. Conserv. 133(3): 301–311. doi:10.1016/j.biocon.2006.06.010.

Baffinland

Appendix E:
MEWG Meeting – 10 December 2018

Marine Environment Working Group

Monday December 10, 2018
9:00 am – 5:00 pm (EST)
Delta Hotels Ottawa City Centre
101 Lyon Street North, Ottawa K1R 5T9 Canada
Call-In Number: +1-416-607-0170 **Access Code**: 993 649 525 #

Member Organization	Participants	Member Organization	Participants
Baffinland Iron Mines Corporation (Baffinland)	Megan Lord-Hoyle (MLH)	Parks Canada	Francine Mercier (FM)
	Joe Tigullaraq (JT)	Makivik	Gregor Gilbert (GG)
	Emma Malcolm (EM)		
Qikiqtani Inuit Association (QIA) and Consultants	Stephen Williamson Bathory (SB)	Mittimatalik Hunters and Trappers Organization (MHTO)	Enookie Inuarak (EI)
	Sean Joseph (SJ)		Phanuel Enooagak (PE)
	Fai Ndofor (FN)		
	Rick Hoos (RH)		
	Jeff Higdon (JH)	**Observer Organization**	**Participants**
Fisheries and Oceans Canada (DFO)	Kim Howland (KH)	World Wildlife Fund – Canada (WWF)	Andrew Dumbrille (AD)
			Amanda Hanson Main
	Laura Watkinson (LW)		Brandon Laforest (BL)
Environment and Climate Change Canada (ECCC)	Grant Gilchrist (GG)	Oceans North Canada	Kristen Westdal (KW)
	Anne Wilson (AW)		
			Chris Debicki (CD)
Government of Nunavut	Brad Pirie (BP)	**Baffinland Consultants**	**Participants**
	John Ringrose (JR)	Golder	Patrick Abgrall (PA)
	Alexander Kelly (AK)	Golder	Phil Rouget (PR)

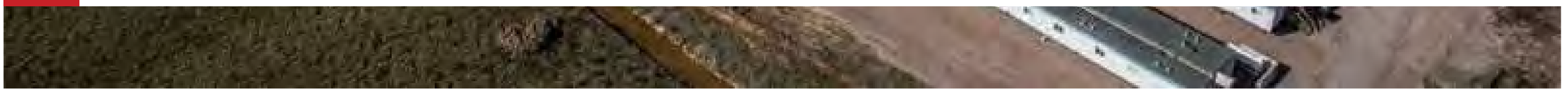
Agenda

Time	Activity
9:00am – 9:30am	Welcome and introductions (Baffinland, All)
9:30am – 10:30am	Baffinland Update (Baffinland) • Overview of 2018 Shipping Season • 6MTPA Application • Phase 2 EIS Submission
10:30am – 10:45am	Health Break
10:45am – 12:30pm	Marine Monitoring Programs (Golder) • Narwhal Tagging Program (2018 and 2017 Report) • Bruce Head Monitoring Program (2018 and 2014–2017 Integration Report) • Ship-Based Observer Program
12:30pm – 1:00pm	Lunch (to be provided)
1:00pm – 2:00pm	Marine Monitoring Program (Golder) - continued • MEEMP and AIS Monitoring Program • Physical Oceanography
2:00pm – 3:15pm	Early Warning Indicators (Golder)
3:15pm – 3:30pm	Health Break
3:30pm – 4:30pm	Early Warning Indicators (Golder) - continued
4:30pm – 5:00pm	Roundtable and Action Items

Baffinland

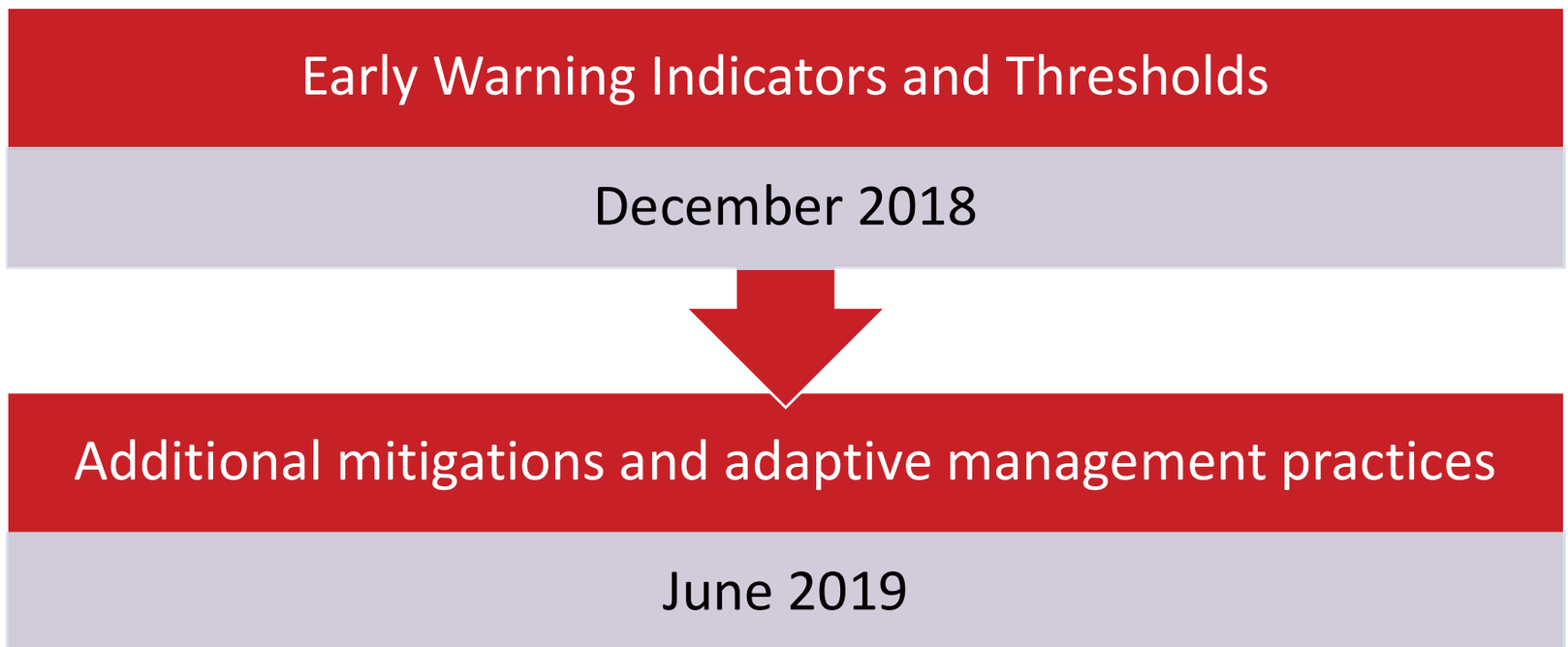
Early Warning Indicators

Fall MEWG Meeting – Ottawa, ON
10 December 2018



Early Warning Indicators (EWIs)

- Project Conditions 110-112
- Timeline



Baffinland

Guidelines

- For marine mammals and marine mammal populations.
- Linked to noise from shipping activities.
- Characteristics of behaviour, population distribution and abundance, or habitat use.
- Can be observed and/or quantified through monitoring programs.
- Can propose more than one EWI for each species.
- Can propose the same EWI for multiple species.
- Thresholds are quantitative limits to “acceptable change”.

Baffinland

MEWG Suggestions – Indicators

- Decrease in regional abundance
- Change in calving rate
- Ship avoidance behaviour
- Change in diving and surface behaviour
- Change in vocalization characteristics
- Increase in stress hormones
- Change in body condition
- Change in harvest data (age, sex)
- Injury/mortality occurrence

Baffinland

Indicator Species

- Suggested: All marine mammal species

- 2012 FEIS identified Key Indicators within the Marine Mammal VEC (see Table 8-1.1)
  - Ringed seal
  - Walrus
  - Beluga
  - Narwhal
  - Bowhead whale
  - Polar bear

Baffinland

Fisheries Act 35 (2)(b) Authorization

- “The Proponent shall develop and implement a monitoring program to confirm the predictions made in the Final Environmental Impact Statement- Addendum, with respect to disturbance impacts of shipping noise on the distribution of marine mammals. The survey shall be designed to monitor effects during the shipping season and include locations in Milne Inlet, Eclipse Sound and Pond Inlet. The survey shall continue over a sufficiently lengthy period of time to determine the extent to which habituation occurs for Narwhal and Bowhead whales. (NIRB T&C 109)”

Baffinland

Thresholds

- Statistical significance?

- FEIS (2012) Evaluation Criteria
  - Level 1 (Low): 1-10 %
  - Level 2 (Moderate): 10-20 %
  - Level 3 (High): >20 %

Appendix F:
MEWG Distribution – EWI and Threshold Screening Table, 26 February 2019

Early-Warning Indicators

As it is not operationally feasible to effectively monitor all of the Early Warning Indicators (EWIs) proposed by MEWG members, and given that the intent of identifying EWIs is not to identify all pathways that could be impacted by the noise produced by Project vessels but rather to select a few key EWIs to focus on, the **bolded** EWIs have been selected to be brought forward. These EWIs were also indicated as being of greatest concern to the Mittimatalik Hunters and Trappers Organization (MHTO), during a community meeting held in Pond Inlet in November 2018.

The monitoring methods indicates the monitoring programs currently or potentially being conducted to provide the data required to identify and assess thresholds related to the selected EWIs. As indicated in the table below, other proposed EWIs that have not been selected are, for the most part, being actively monitored and the potential impact from Project activities are continuously being assessed.

In proposing thresholds for the selected EWIs, it is important to keep in mind that the Final Environmental Impact Statement that was approved for Project Certificate No. 005, indicated that as a result of the project, >10% of animals in Regional Study Area (RSA) could exhibit strong avoidance reactions that lead to (seasonal) abandonment of areas identified as important habitat. Therefore, a change of >10% is considered within the predicted range.

Instructions for Use

Please provide proposed threshold for the selected EWIs using the fourth column in the table below. Include a rationale to support selection of threshold.

Next Steps

Once the MEWG has provided feedback on thresholds for the EWIs, discussion of proposed and selected thresholds will occur at the succeeding MEWG meeting.

Early Warning Indicators	Monitoring Methods	Rationale	Threshold
Narwhal			
Decrease in regional abundance	**Visual and photographic aerial surveys; Shore-based monitoring; Community-based monitoring – Reduced harvest**	**Indicated as important by the MHTO, indicator of potential population-level effects**	
Change in calving rate	**Visual and photographic aerial surveys; Shore-based monitoring**	**Indicated as important by the MHTO, indicator of potential population-level effects**	
Ship avoidance behaviour	Shore-based monitoring; Satellite tagging; Ship-based Observer Program	Local indicator monitoring in proximity to vessels, not population-level indicator	N/A

Early Warning Indicators	Monitoring Methods	Rationale	Threshold
Change in diving and surface behaviour	Shore-based monitoring; Satellite tagging	Local indicator monitoring in proximity to vessels, not population-level indicator	N/A
Change in vocalization characteristics	Underwater passive acoustic monitoring; Acousonde tags	Local indicator monitoring in proximity to vessels, not population-level indicator	N/A
Increase in stress hormones	Community-based monitoring	Very difficult to link directly to impacts of vessel noise	N/A
Change in body condition	Photographic aerial surveys; Community-based monitoring	Very difficult to link directly to impacts of vessel noise	N/A
Change in harvest data (age, sex)	Community-based monitoring	Changes more likely to be initially observed in terms of overall numbers (suggested use of “Decrease in regional abundance” as an EWI).	N/A
Injury/mortality occurrence	Ship-based Observer Program; Shore-based monitoring; Community-based monitoring	Lack of evidence to date of injury/mortality	N/A

Baffinland

Appendix G:
MEWG EWI and Threshold Screening Table – Qikiqtani Inuit Association Response, 31 March 2019

Early-Warning Indicators

As it is not operationally feasible to effectively monitor all of the Early Warning Indicators (EWIs) proposed by MEWG members, and given that the intent of identifying EWIs is not to identify all pathways that could be impacted by the noise produced by Project vessels but rather to select a few key EWIs to focus on, the **bolded** EWIs have been selected to be brought forward. These EWIs were also indicated as being of greatest concern to the Mittimatalik Hunters and Trappers Organization (MHTO), during a community meeting held in Pond Inlet in November 2018.

The monitoring methods indicates the monitoring programs currently or potentially being conducted to provide the data required to identify and assess thresholds related to the selected EWIs. As indicated in the table below, other proposed EWIs that have not been selected are, for the most part, being actively monitored and the potential impact from Project activities are continuously being assessed.

In proposing thresholds for the selected EWIs, it is important to keep in mind that the Final Environmental Impact Statement that was approved for Project Certificate No. 005, indicated that as a result of the project, >10% of animals in Regional Study Area (RSA) could exhibit strong avoidance reactions that lead to (seasonal) abandonment of areas identified as important habitat. Therefore, a change of >10% is considered within the predicted range.

Instructions for Use

Please provide proposed threshold for the selected EWIs using the fourth column in the table below. Include a rationale to support selection of threshold.

Next Steps

Once the MEWG has provided feedback on thresholds for the EWIs, discussion of proposed and selected thresholds will occur at the succeeding MEWG meeting.

Early Warning Indicators	Monitoring Methods	Rationale	Threshold
Narwhal			
Decrease in regional abundance	**Visual and photographic aerial surveys; Shore-based monitoring; Community-based monitoring – Reduced harvest**	**Indicated as important by the MHTO, indicator of potential population-level effects**	
Change in calving rate	**Visual and photographic aerial surveys; Shore-based monitoring**	**Indicated as important by the MHTO, indicator of potential population-level effects**	
Ship avoidance behaviour	Shore-based monitoring; Satellite tagging; Ship-based Observer Program	Local indicator monitoring in proximity to vessels, not population-level indicator	N/A

Early Warning Indicators	Monitoring Methods	Rationale	Threshold
Change in diving and surface behaviour	Shore-based monitoring; Satellite tagging	Local indicator monitoring in proximity to vessels, not population-level indicator	N/A
Change in vocalization characteristics	Underwater passive acoustic monitoring; Acousonde tags	Local indicator monitoring in proximity to vessels, not population-level indicator	N/A
Increase in stress hormones	Community-based monitoring	Very difficult to link directly to impacts of vessel noise	N/A
Change in body condition	Photographic aerial surveys; Community-based monitoring	Very difficult to link directly to impacts of vessel noise	N/A
Change in harvest data (age, sex)	Community-based monitoring	Changes more likely to be initially observed in terms of overall numbers (suggested use of "Decrease in regional abundance" as an EWI).	N/A
Injury/mortality occurrence	Ship-based Observer Program; Shore-based monitoring; Community-based monitoring	Lack of evidence to date of injury/mortality	N/A

QIA comments (Jeff W. Higdon), 31 March 2019

- Re: the FEIS (and Addendum) for the approved project predicting a change of ≥ 10%, the FEIS (Vol. 8, 5.9.1.2 Disturbance) for narwhal disturbance (Table 8-5.13 Measurable Parameters and Threshold Values for Narwhal (p. 215 of 318) states the following:
  - The "Effect" is "Disturbance caused by underwater noise, pulsed or continuous."
  - The "Measureable Parameter" is "Change in occupancy of an area that has been identified as important feeding, nursing, calving, breeding, wintering, or summering habitat."
    - And furthermore to above, for continuous sound (i.e., shipping), "Narwhals exposed to sound levels from shipping, vibratory pile driving, or dredging where the received levels exceed 120 dB re 1 µPa (rms) and 135 dB re 1 µPa (rms) may exhibit "disturbance" and "avoidance" responses, respectively.
  - The "Threshold" is "≥10 % of narwhals in the RSA exhibit strong disturbance and avoidance reactions that lead to (seasonal) abandonment of areas identified as important habitat."

- If the FEIS is to be used for guidance, the threshold, whatever it is, needs to be linked to "important feeding, nursing, calving, breeding, wintering, or summering habitat[s]"
- Thresholds, if linked to FEIS predictions, need to consider changes in narwhal abundance at appropriate spatiotemporal scales to determine whether "seasonal abandonment" occurs
- The "decrease in regional abundance" listed in the Table as an EWI needs to be fleshed out in additional detail, for example scale of assessment (see above)
- Thresholds need to be biologically appropriate and logistically feasible (with the first factor the most important of the two - effort can be increased to increase power to detect change, for example)
    - As such, we cannot suggest thresholds without additional information
- Ringed seal should be included. What is MHTO position on ringed seal inclusion?

Appendix H:
MEWG Meeting Presentation Materials – 21 June 2019

Marine Environment Working Group

Friday June 21, 2019
9:00pm – 5:00pm (EST)
Frobisher Inn – Koojesse North Boardroom, Iqaluit, NU
Call-In Number: +1-416-607-0170 **Access Code**: 997 187 780 #

Member Organization	Participants	Member Organization	Participants
Baffinland Iron Mines Corporation (Baffinland)	Megan Lord-Hoyle (MLH)	Parks Canada	Allison Stoddart (AS)
			Chantal Vis (CV)
			Jacquie Bastick (JB)
	Joe Tigullaraq (JT)	Makivik	Gregor Gilbert (GG)
	Emma Malcolm (EM)		
	Genevieve Morinville (GM)		
Qikiqtani Inuit Association (QIA) and Consultants	Stephen Williamson Bathory (SB)	Mittimatalik Hunters and Trappers Organization (MHTO)	Caleb Sangoya (CS)
	Jared Ottenhof (JO)		
	Bruce Stewart (BS)		
	David Qamaniq (DQ)		
	Jeff Higdon (JH)	**Observer Organization**	**Participants**
Fisheries and Oceans Canada (DFO)	Kim Howland (KH)	World Wildlife Fund – Canada (WWF)	Andrew Dumbrille (AD)
	Laura Watkinson (LW)		
	Marianne Marcoux (MM)		Amanda Main Hanson (AMH)
			Brandon Laforest (BL)
Environment and Climate Change Canada (ECCC)	Grant Gilchrist (GG)	Oceans North Canada (Oceans North)	Kristin Westdal (KW)
	Anne Wilson (AW)		Chris Debicki (CD)
		Nunavut Impact Review Board (NIRB)	Solomon Amuno (SA1)
			Cory Barker (CB)
Government of Nunavut	Brad Pirie (BP)	**Baffinland Consultants**	**Participants**
	Alexander Kelly (AK)	Golder	Patrick Abgrall (PA)
	John Ringrose (JR)		
	Stephen Atkinson (SA)		Phil Rouget (PR)

Agenda

Time	Activity
9:00am – 9:30am	Welcome and Introductions
9:30am – 10:30am	Baffinland Update (Baffinland) • 2019 Shipping Season Overview • Shipping Mitigation and Management Review • Restricted Areas and Drifting Zone Review • 2019 Communications Protocol • Shipping Monitors • MEWG Mandate and Effectiveness • Incorporation of IQ in Monitoring Programs
10:30am – 10:45am	Health Break
10:45am-11:15am	2019 Marine Monitoring Program Overview • 2017 Narwhal Tagging Program Report – Updates Review • Aerial Survey Program
11:15am – 12:30pm	2019 Marine Monitoring Program Overview • Bruce Head Shore-based Monitoring Program • Ship-Board Observer Program
12:30pm – 1:00pm	Lunch
1:00pm - 3:00pm	2019 Marine Monitoring Program Overview • Acoustic Monitoring • Marine Ecological Effects Monitoring Program • Aquatic Invasive Species • Habitat Offset Monitoring
3:00pm – 3:15pm	Health Break
3:15pm – 3:30pm	2019 Marine Monitoring Program Overview • Physical Oceanography
3:30pm – 4:30pm	Early Warning Indicators • Indicator Development Update • Feedback from Group
4:30pm – 5:00pm	Roundtable and Action Item Review

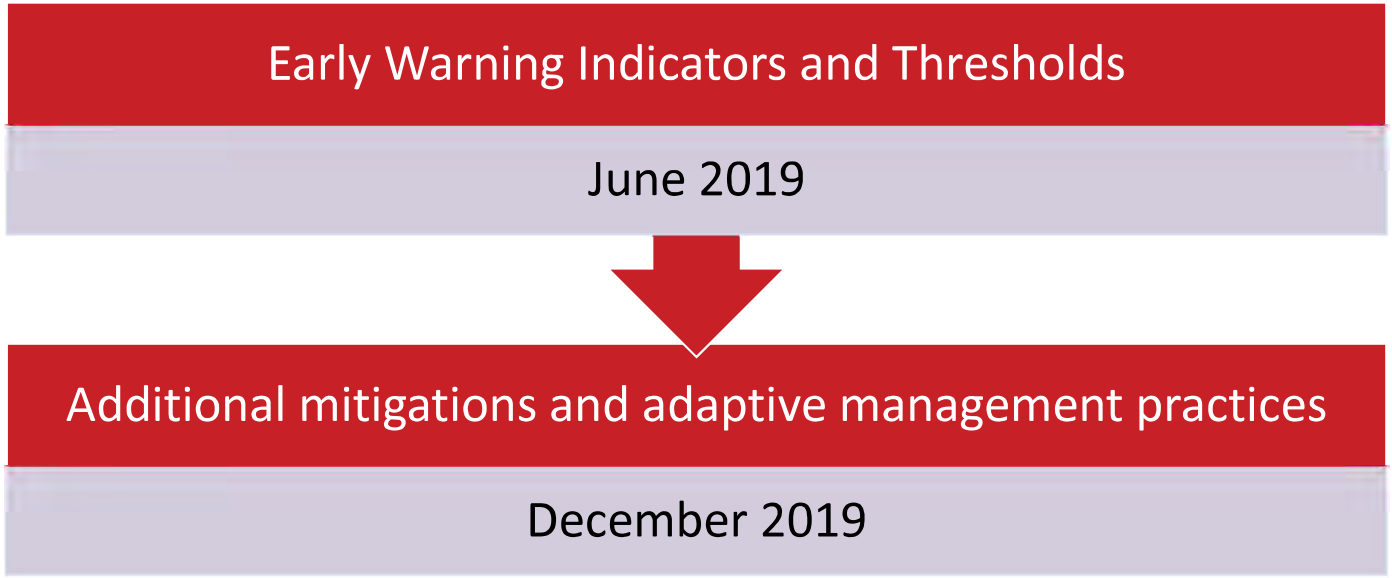
Baffinland

Early Warning Indicators

Spring MEWG Meeting – Iqaluit, NU
21 June 2019

Early Warning Indicators (EWIs)

- Project Conditions 110-112
- Timeline



Baffinland

Early Warning Indicators	Monitoring Methods	Threshold
Narwhal		
Decrease in regional abundance	Visual and photographic aerial surveys; Shore-based monitoring; Community-based monitoring – Reduced harvest	
Change in calving rate	Visual and photographic aerial surveys; Shore-based monitoring	
Ship avoidance behaviour	Shore-based monitoring; Satellite tagging; Ship-based Observer Program	
Change in diving and surface behaviour	Shore-based monitoring; Satellite tagging	
Change in vocalization characteristics	Underwater passive acoustic monitoring; Acousonde tags	
Increase in stress hormones	Community-based monitoring	
Change in body condition	Photographic aerial surveys; Community-based monitoring	
Change in harvest data (age, sex)	Community-based monitoring	
Injury/mortality occurrence	Ship-based Observer Program; Shore-based monitoring; Community-based monitoring	

Attachment 5

Term and Condition No. 134 Correction

Mary River 2019 Employment (Headcount)

Geographic headcount data as per the requirements of Term and Condition No: 134

	Baffinland		Contractors		**Total**	
	Inuit	Non-Inuit	Inuit	Non-Inuit	**Inuit**	**Non-Inuit**
Arctic Bay	33	1	27	0	**60**	**1**
Clyde River	25	0	30	0	**55**	**0**
Sanirajak	23	0	36	0	**59**	**0**
Igloolik	15	0	32	0	**47**	**0**
Iqaluit	32	1	53	1	**85**	**2**
Pond Inlet	27	0	33	0	**60**	**0**
Other Qikiqtani communities	6	0	3	0	**9**	**0**
Kivalliq communities	0	0	1	0	**1**	**0**
Kitikmeot communities	0	0	0	0	**0**	**0**
Alberta	0	68	1	62	**1**	**130**
British Columbia	1	44	0	31	**1**	**75**
Manitoba	1	20	0	7	**1**	**27**
New Brunswick	0	54	0	17	**0**	**71**
Newfoundland & Labrador	2	172	1	33	**3**	**205**
Northwest Territories	0	0	0	7	**0**	**7**
Nova Scotia	0	127	0	21	**0**	**148**
Ontario	18	384	4	91	**22**	**475**
Prince Edward Island	0	10	0	1	**0**	**11**
Quebec	2	55	1	56	**3**	**111**
Saskatchewan	1	23	0	6	**1**	**29**
Yukon	0	1	0	1	**0**	**2**
International	0	0	0	0	**0**	**0**
Unknown	0	1	9	220	**9**	**221**

Attachment 6

Summary of Results for the 2019 Marine Mammal Monitoring Programs Memo – May 25, 2020

TECHNICAL MEMORANDUM

DATE 25 May 2020 1663724-186-TM-Rev3-38000

TO Lou Kamermans
Baffinland Iron Mines Corporation

FROM Phil Rouget, Golder Associates Ltd. **EMAIL prouget@golder.com**

SUMMARY OF RESULTS FOR THE 2019 MARINE MAMMAL MONITORING PROGRAMS

1.0 INTRODUCTION

This technical memorandum serves as an update to an earlier technical memorandum entitled '2019 Marine Mammal Monitoring Programs – Updated Preliminary Results' (Golder 2020a) submitted to the Nunavut Impact Review Board (NIRB) on 21 February 2020. Newly presented information includes additional and updated analyzed data for the 2019 marine mammal monitoring programs. Details on methodology are provided in the earlier version of the report (Golder 2019a) and in the respective annual reports for each monitoring program.

Notification of Errata in original version of Golder Technical Memorandum No. 1663724-186-TM-Rev2-38000 (Golder 2020f): Please note that Table 22 (page 68) has been revised in this version of the technical memorandum. The correction applied to Table 22 relates specifically to the 'Probability' and 'Certainty' qualifiers for combined Project effects on bowhead whale. The 'Probably' qualifier was initially identified as a Level 1 (unlikely); this has been corrected to 'no qualifier' (blank cell). The 'Certainty' qualifier was initially identified as a Level III (High) – this has been corrected to a Level II (medium).

2.0 PROJECT OVERVIEW

In 2019, the following marine mammal programs were undertaken by Baffinland:

- Marine Mammal Aerial Survey Program
- Bruce Head Shore-based Monitoring Program
- Passive Acoustic Monitoring (PAM) Program
- Ship-based Observer (SBO) Program
- 2017/2018 Narwhal Tagging Study (integrated data analysis and reporting completed in 2019)

Golder Associates Ltd.
Suite 200 - 2920 Virtual Way, Vancouver, British Columbia, V5M 0C4, Canada T: +1 604 296 4200 F: +1 604 298 5253

3.0 2019 MARINE MAMMAL AERIAL SURVEY PROGRAM

This section presents a summary of the results of the 2019 Marine Mammal Aerial Survey Program which substantiate the conclusions of the assessment of Project effects on marine mammals relative to Baffinland's Phase 2 Proposal (see Section 7.0).

Marine mammal aerial surveys were conducted by Golder Associates Ltd. (Golder) in the North Baffin area during August 2019 in collaboration with Inuit researchers from Pond Inlet and Arctic Bay. The objectives of the surveys were to obtain abundance and density estimates of narwhal during the peak open-water season for the Eclipse Sound summer stock area. Aerial surveys were conducted using visual/observer-based line-transect sampling combined with aerial photography surveys. Survey design, methodology and analysis were finalized in consultation with DFO Science. Results from two of the aerial surveys (Aug 21-22 and Aug 25-27) completed in Eclipse Sound during the open-water season were used to generate a 2019 abundance estimate for the Eclipse Sound narwhal summer stock. These surveys were considered to have high precision as they were conducted in optimal survey conditions and were largely based on photographic results. A detailed description of data collection and analytical methodology for the 2019 Marine Mammal Aerial Survey Program is provided in Golder (2019a; 2020e).

3.1 Summary of Results

A total of five surveys were attempted in the Eclipse Sound survey grid during the open-water season (Figures B-6 through B-10 in Golder 2020e) between 17–30 August 2019. Each survey included data collected by on-board Marine Mammal Observers (MMOs) as well as photographic surveys for segments of the survey grid with high concentrations of narwhal. Survey tracklines are presented in Golder 2020e (Appendix B - Figures B-1 through B-15) along with locations of marine mammal sightings recorded by the onboard observers (uncorrected for distance from trackline). Four of the five surveys (Surveys 1,3,4 and 5) achieved complete coverage of the survey grid. Survey conditions were good to moderate for the majority of the five surveys. Survey 2 could not be completed due to logistical issues (aviation fuel closure at Pond Inlet airport). The total number of marine mammals recorded on each survey, based on observer-based data only, is presented in Table 1. Photographic surveys were flown in these strata on Surveys 1, 3, 4, and 5; photographic results are presented in

Table 2.

Narwhal were concentrated in Tremblay Sound and in Milne Inlet South / Koluktoo Bay during the open-water season, as shown in Figure 1A and 1B (Survey 3), Figure 2A and 2B (Survey 4) and Figures 3A and 3B (Survey 5) which depict observer-based and photographic data combined (note these figures present sightings data for both Admiralty Inlet and Eclipse Sound survey grids, although the present memorandum is focused specifically on the Eclipse Sound area). During Survey 5, large numbers of narwhal were recorded in Milne Inlet North but not in dense enough aggregations to warrant a photographic survey (Figures B-9 and B-10 in Golder 2020e). Relatively few narwhal were recorded in Eclipse Sound or Navy Board Inlet during the five surveys conducted in August. Four bowhead whales were observed in the RSA during the open-water surveys on August 17. Three of the bowheads were observed opportunistically by observers during a photographic survey in Tremblay Sound and one was observed on-transect near the entrance to Tremblay Sound.

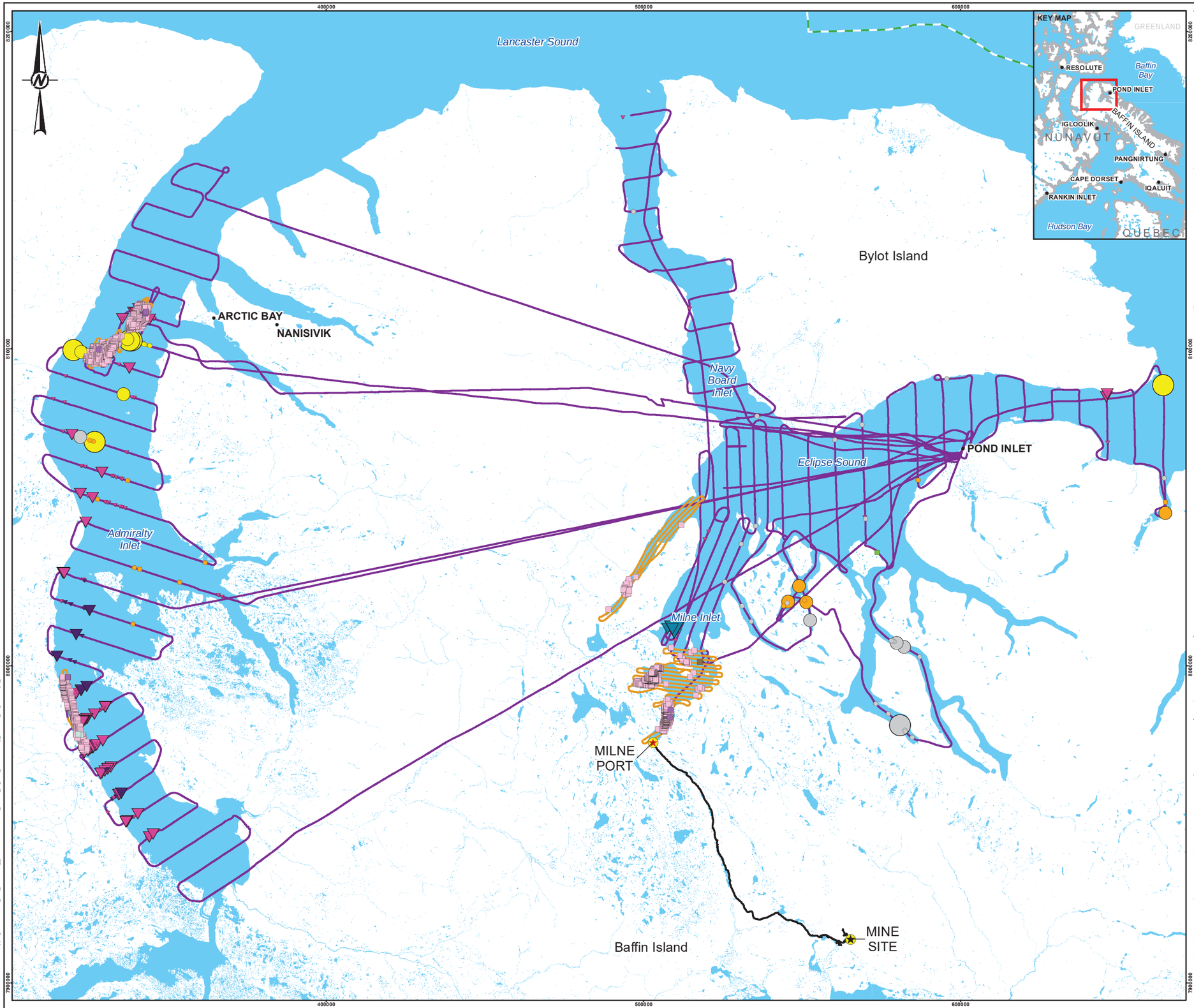
Table 1: Marine mammal sightings (on and off-effort) recorded during visual-surveys in Eclipse Sound - August 2019

Species	Survey 1		Survey 2		Survey 3		Survey 4		Survey 5	
	No. Sightings	No. Animals	No. Sightings	No. Animals	No. Sightings	No. Animals	No. Sightings	No. Animals	No. Sightings	No. Animals
Narwhal	39	172	4	4	9	11	101	265	37	64
Bowhead Whale	4	4	0	0	0	0	0	0	0	0
Beluga Whale	1	1	0	0	0	0	0	0	0	0
Killer Whale	0	0	0	0	1	11	1	3	1	15
Unidentified Whale	1	1	0	0	0	0	0	0	0	0
Ringed Seal	5	5	0	0	8	14	0	0	4	4
Harp Seal	30	404	0	0	1	15	8	96	6	154
Bearded Seal	0	0	0	0	0	0	0	0	2	2
Unidentified Seal	9	11	23	23	26	72	5	9	16	46
Polar Bear	2	4	0	0	1	1	2	7	2	2
Total	**91**	**602**	**27**	**27**	**46**	**124**	**117**	**380**	**68**	**287**

Table 2: Photographic survey sightings in the Eclipse Sound grid during August 2019

Grid	Survey	Stratum[a]	Narwhal		Bowhead[b]		Polar Bear [b]		Unidentified Seal	
			No. Sightings	No. Animals	No. Sightings	No. Animals	No. Sightings	No. Animals	No. Sightings	No. Animals
Eclipse	3	MIS	1,417	3,176	1	1	0	0	0	0
Eclipse	3	TS	93	240	0	0	0	0	0	0
Eclipse	4	MIS	1,901	3,644	0	0	0	0	85	87
Eclipse	4	MIN	751	997	0	0	0	0	15	15
Eclipse	4	TS	218	424	0	0	1	1	57	58
Eclipse	5	MIS	924	1,558	0	0	0	0	107	129
Eclipse	5	TS	163	463	0	0	0	0	43	57

[a] MIN=Milne Inlet North, MIS=Milne Inlet South, TS=Tremblay Sound
[b] Not including re-sightings



LEGEND

- COMMUNITY
- MILNE PORT
- MINE SITE

PHOTOGRAPHIC SURVEY MARINE MAMMAL SPECIES OBSERVATIONS

- BELUGA
- BOWHEAD
- NARWHAL
- SEAL

VISUAL SURVEY MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE
- 1
- 2 - 10

HARP SEAL
- 1
- 2 - 10
- 10+

KILLER WHATE
- 1
- 2 - 10
- 10+

NARWHAL
- 1
- 2 - 10

POLAR BEAR
- 1

RINGED SEAL
- 1
- 2 - 10

UNIDENTIFIED SEAL/PINNIPED
- 1
- 2 - 10
- 10+

- MILNE INLET TOTE ROAD

AERIAL SURVEY TRACK TYPE
- PHOTOGRAPHIC
- VISUAL
- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

0 25 50
1:1,200,000 KILOMETRES

NOTE(S)

1. CONDITIONS GOOD WITH BF 0-3 FOR MUCH OF THE SURVEY AREA AND NO FOG. BF 4-5 ENCOUNTERED ON EASTERN THREE TRANSECTS IN ECLIPSE SOUND. NARWHALS CONCENTRATED IN SOUTHERN END OF TREMBLAY SOUND AND DISPERSED THROUGHOUT SOUTH MILNE INLET/KOLUKTOO BAY AREA.
2. CONDITIONS GOOD WITH BF 0-3 AND FOG ON THREE OF THE NORTHERN TRANSECTS. NARWHALS CONCENTRATED IN THE SOUTHERN PORTION OF ADMIRALTY INLET ALONG THE WESTERN SHORE AND IN THE CENTRAL PORTION OF THE INLET CLOSE TO ARCTIC BAY. FOUR PHOTOGRAPHIC SURVEYS WERE FLOWN.

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 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

TITLE
DISTRIBUTION OF MARINE MAMMAL SPECIES DURING LEG 2, SURVEY 3 ON AUGUST 21-22, 2019 IN THE ECLIPSE SOUND AND ADMIRALTY INLET GRIDS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-05-08
DESIGNED	KK
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
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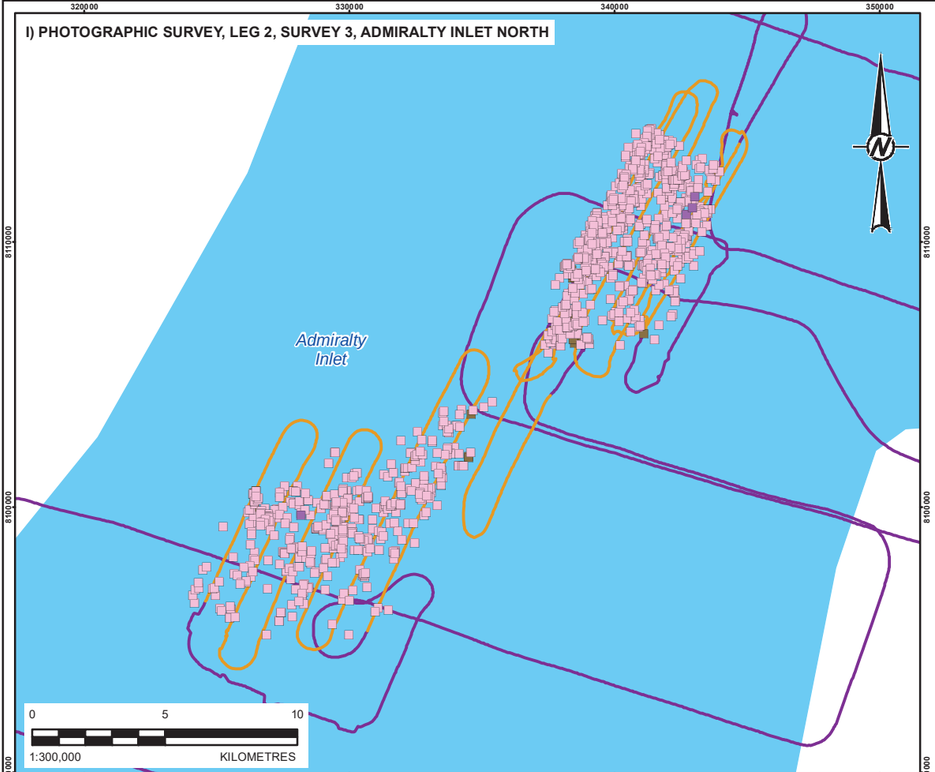
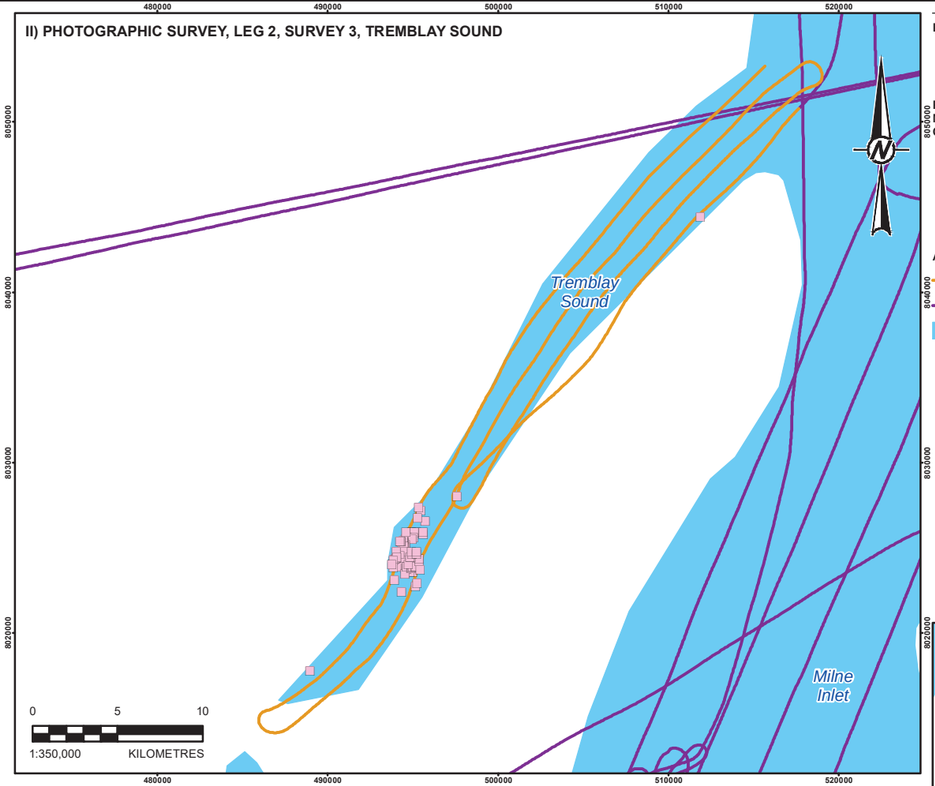
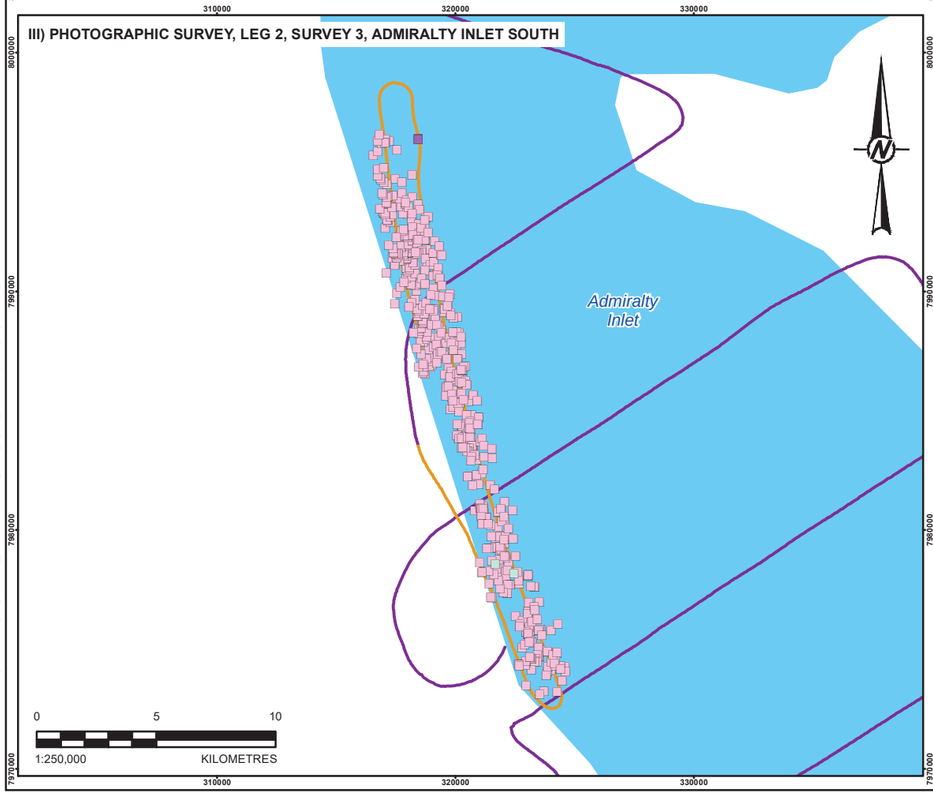
I) PHOTOGRAPHIC SURVEY, LEG 2, SURVEY 3, ADMIRALTY INLET NORTH



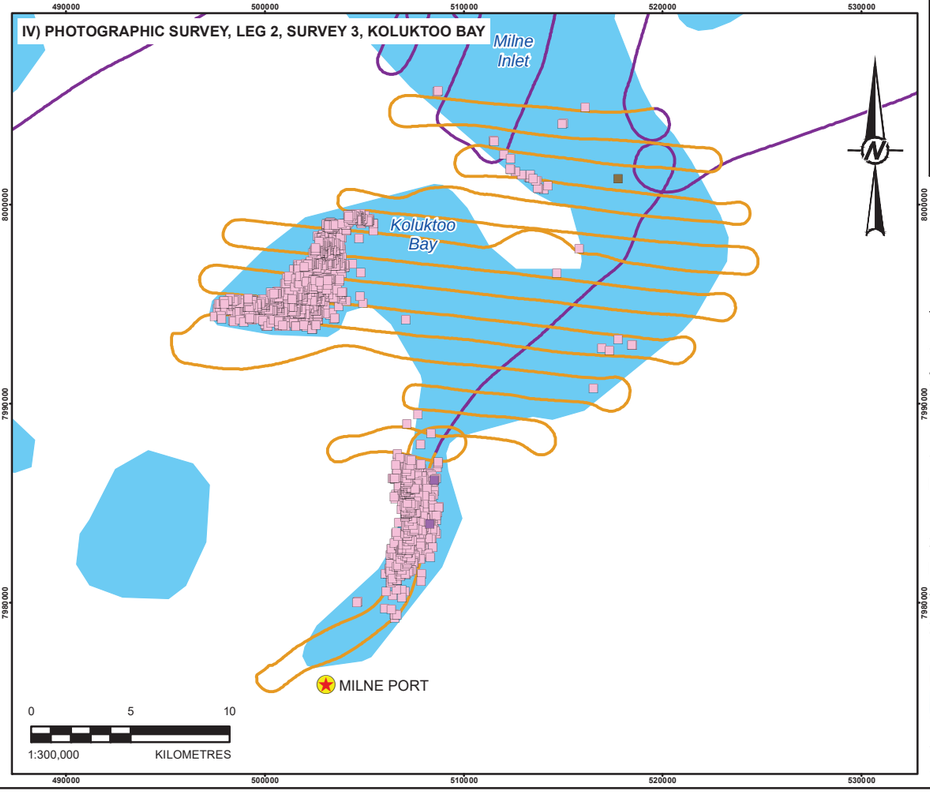
II) PHOTOGRAPHIC SURVEY, LEG 2, SURVEY 3, TREMBLAY SOUND



III) PHOTOGRAPHIC SURVEY, LEG 2, SURVEY 3, ADMIRALTY INLET SOUTH



IV) PHOTOGRAPHIC SURVEY, LEG 2, SURVEY 3, KOLUKTOO BAY



LEGEND

- COMMUNITY
- MILNE PORT

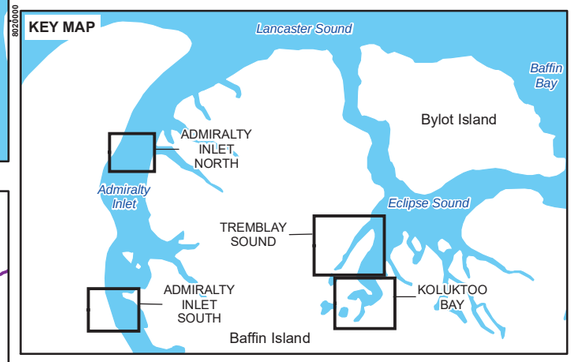
PHOTOGRAPHIC SURVEY MARINE MAMMAL SPECIES OBSERVATIONS

- BELUGA
- BOWHEAD
- NARWHAL
- SEAL

AERIAL SURVEY TRACK TYPE

- PHOTOGRAPHIC
- VISUAL
- WATERBODY

KEY MAP



REFERENCE(S)

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PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT

TITLE
PHOTOGRAPHIC SURVEYS DURING LEG 2, SURVEY 3 ON AUGUST 21-22, 2019 IN THE ECLIPSE SOUND AND ADMIRALTY INLET GRIDS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-05-08
DESIGNED	TT
PREPARED	AA
REVIEWED	PR
APPROVED	PR

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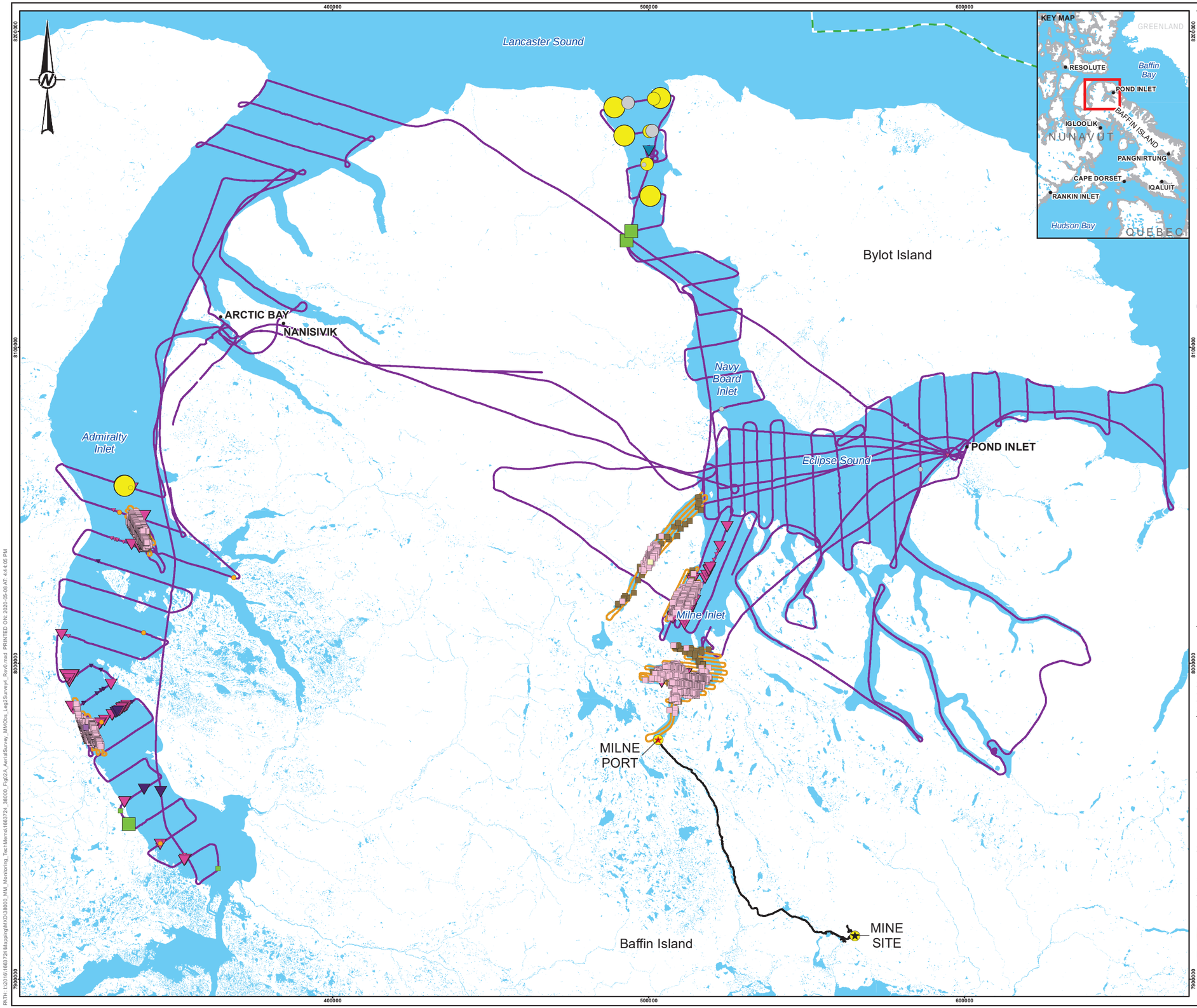

LEGEND

- COMMUNITY
- MILNE PORT
- MINE SITE

PHOTOGRAPHIC SURVEY MARINE MAMMAL SPECIES OBSERVATIONS

- BOWHEAD
- NARWHAL
- POLAR BEAR
- SEAL

VISUAL SURVEY MARINE MAMMAL SPECIES OBSERVATIONS (GROUP SIZE)

BOWHEAD WHALE
- 1
- 2 - 10

HARP SEAL
- 1
- 2 - 10
- 10+

KILLER WHATE
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NARWHAL
- 1
- 2 - 10
- 10+

POLAR BEAR
- 1
- 2 - 10

RINGED SEAL
- 1

UNIDENTIFIED SEAL/PINNIPED
- 1
- 2 - 10

- MILNE INLET TOTE ROAD

AERIAL SURVEY TRACK TYPE
- PHOTOGRAPHIC
- VISUAL

- NUNAVUT SETTLEMENT AREA BOUNDARY
- WATERBODY

0 25 50

1:1,200,000 KILOMETRES

NOTE(S)

1. CONDITIONS GOOD WITH BF 0-3 FOR MUCH OF THE SURVEY AREA AND NO FOG. BF 4-5 ENCOUNTERED ON EASTERN PORTION OF ECLIPSE SOUND AND PORTIONS OF NAVY BOARD INLET. NARWHALS CONCENTRATED IN THE CENTRAL PORTION OF TREMBLAY SOUND AND DISPERSED THROUGHOUT SOUTH MILNE INLET/KOLUKTOO BAY AREA. KILLER WHALES OBSERVED IN NORTHERN NAVY BOARD INLET.
2. CONDITIONS MODERATE WITH BF 0-5 AND NO FOG. NARWHALS CONCENTRATED IN THE SOUTHERN PORTION OF ADMIRALTY INLET ALONG THE WESTERN SHORE AND IN THE CENTRAL PORTION OF THE INLET NORTH OF YEOMAN ISLAND. TWO PHOTOGRAPHIC SURVEYS WERE FLOWN.

REFERENCE(S)

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CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT

TITLE
DISTRIBUTION OF MARINE MAMMAL SPECIES DURING LEG 2, SURVEY 4 ON AUGUST 25-27, 2019 IN THE ECLIPSE SOUND AND ADMIRALTY INLET GRIDS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-05-08
DESIGNED	KK
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
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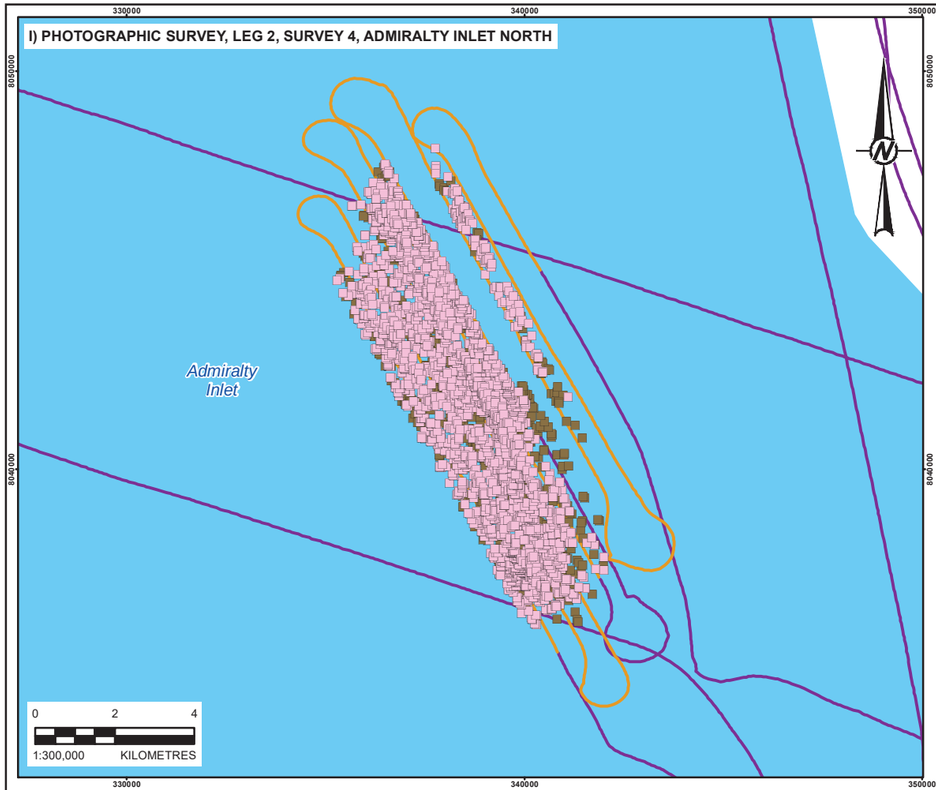
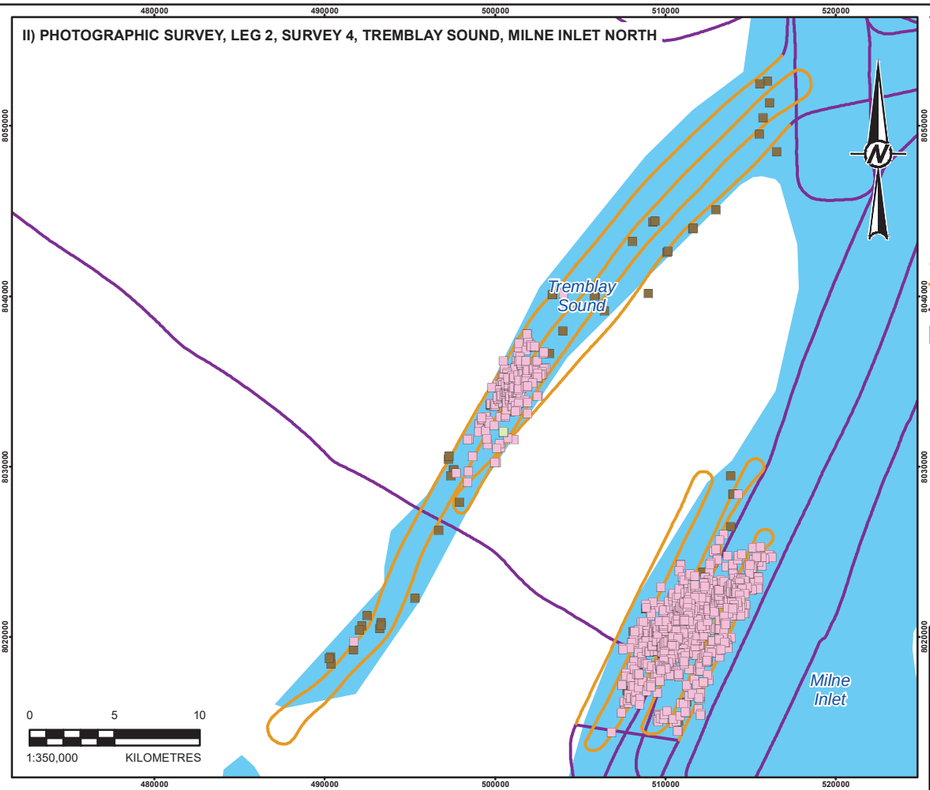
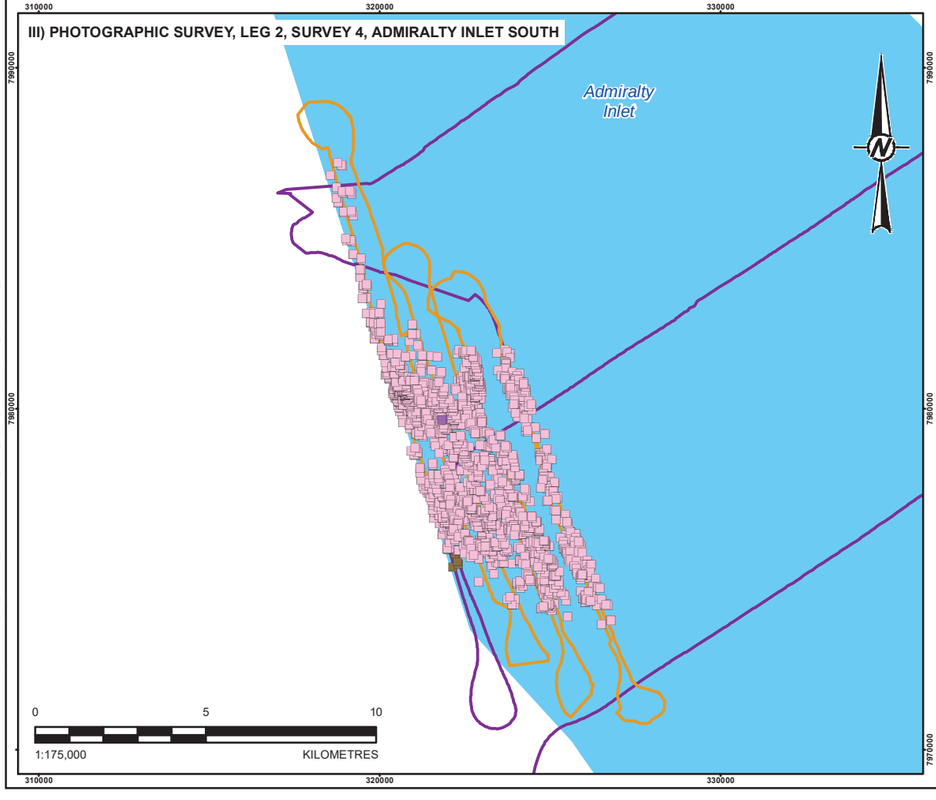
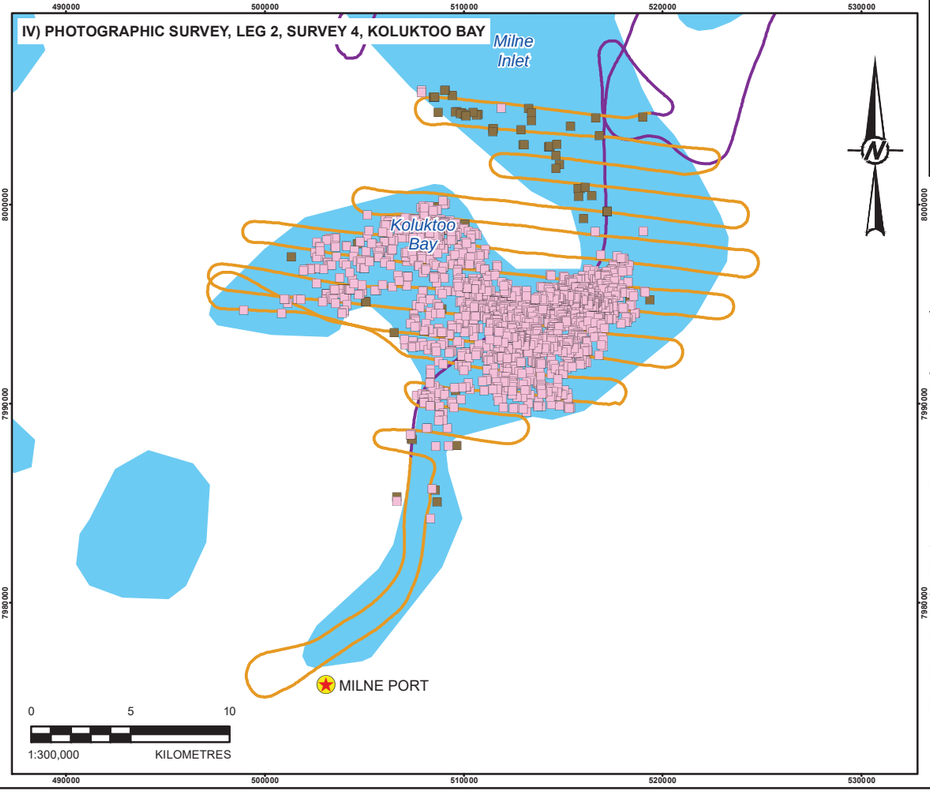








LEGEND

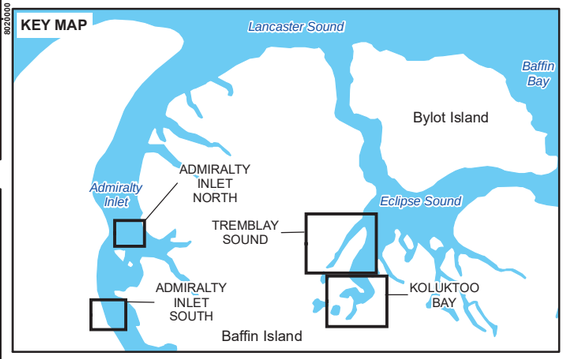
- COMMUNITY
- MILNE PORT

PHOTOGRAPHIC SURVEY MARINE MAMMAL SPECIES OBSERVATIONS

- BOWHEAD
- NARWHAL
- POLAR BEAR
- SEAL

AERIAL SURVEY TRACK TYPE

- PHOTOGRAPHIC
- VISUAL
- WATERBODY



REFERENCE(S)

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PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT

TITLE
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CONSULTANT
GOLDER

YYYY-MM-DD	2020-05-08
DESIGNED	TT
PREPARED	AA
REVIEWED	PR
APPROVED	PR

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