SCIENCE REVIEW OF THE FINAL ENVIRONMENTAL IMPACT STATEMENT ADDENDUM FOR THE EARLY REVENUE PHASE OF BAFFINLAND'S MARY RIVER PROJECT

1.0 Context

The Mary River Project is a proposed iron ore mine located at Mary River on North Baffin Island in Nunavut. Planned Project operations include mining, crushing, screening, rail transport and marine shipping of high grade iron ore. The scope of the Project was to produce and ship 18 million tonnes (Mt/a) of high-grade iron ore per annum. Two port facilities would be constructed on Baffin Island, in Milne (Figure 1) and Steensby inlets. The plan, as outlined in the Draft Environmental Impact Statement, was for the Milne Inlet Port to be used mainly during the construction phase of the Project with some ore being shipped during the open-water season. Later the Project was revised such that road haulage and shipping of ore from the Mine Site through the Milne Port was not included in the Final Environmental Impact Statement. At the request of the DFO Habitat Management Program[1], DFO Science conducted technical reviews of the marine component of both the Draft Environmental Impact Statement (DFO 2012a) and the Final Environmental Impact Statement (FEIS) (DFO 2012b), particularly as it related to marine mammals and shipping.

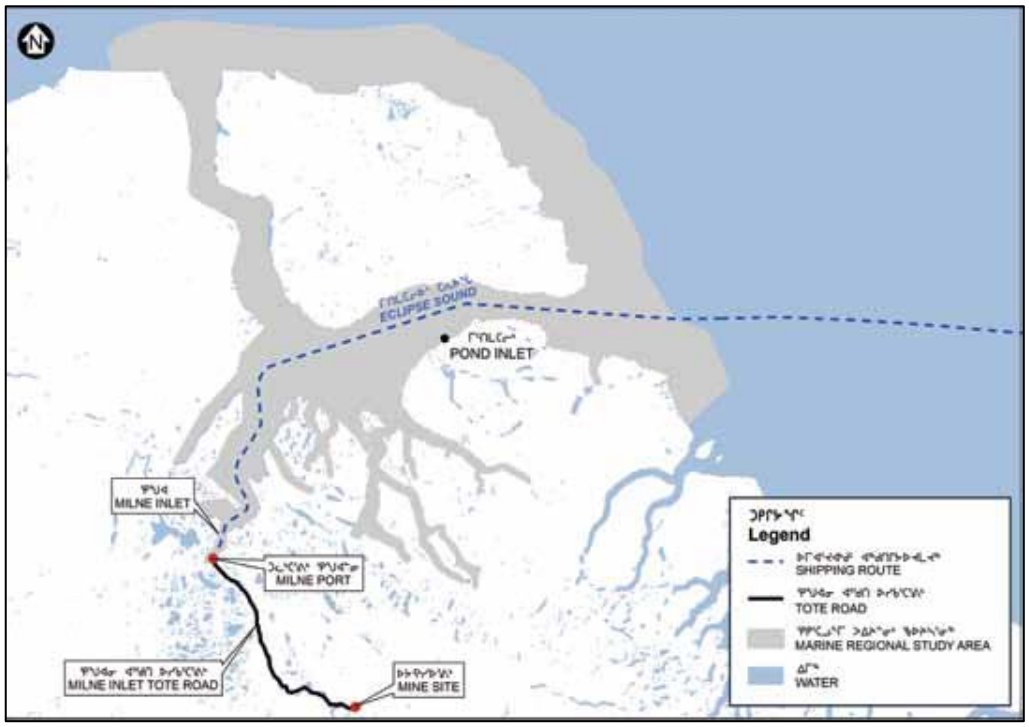

Figure 1. Mary River Mine, Milne Inlet Port site and northern shipping route (from the Addendum to the FEIS popular summary). The regional study area is shaded in grey.

[1] In 2013, the DFO Habitat Management Program became the DFO Fisheries Protection Program.

The Project Certificate was issued by the Nunavut Impact Review Board to Baffinland Iron Mines Corporation (BIM) in December 2012 authorizing the Mary River Project to proceed to the regulatory phase to obtain the necessary permits and licences. However due to various business drivers associated with the Project, BIM decided to take a phased-in approach beginning with a smaller, less-costly option which they have called the Early Revenue Phase (ERP). The ERP would include development of a nominal 3.5 Mt/a road haulage operation from Mary River to a small port facility at Milne Inlet for shipping of iron ore during the open water season (July 15 to October 15).

In late June 2013, BIM submitted their Addendum to the FEIS for the ERP (BIM 2013) to the Nunavut Impact Review Board (NIRB) which describes the activities associated with the ERP and provides an updated effects assessment. Following their internal conformity review, the Board commenced a 60-day public technical review period on August 15, 2013. DFO Science conducted a technical review of the marine component of the FEIS Addendum for the ERP, particularly as it relates to marine mammals and shipping, at the request of the DFO Fisheries Protection Program. Appendix 1 identifies Project Terms and Conditions for the FEIS that apply to or need to be modified for the ERP.

This report results from the Science Response Process of September 19, 2013 on the Science Review of the Addendum to the Final Environmental Impact Statement for Baffinland's Mary River Project.

2.0 Background

The objectives of this review are to assess whether the FEIS Addendum for the ERP provides sufficient evidence to support BIM's conclusions regarding potential ecosystem impacts of the Mary River Project ERP on marine aquatic species and habitats, especially increased shipping activities on marine mammals, by…

1. assessing the quality of information presented in the FEIS Addendum, whether any relevant information is missing and if there are gaps in the analyses,
2. determining if appropriate methods were used in the FEIS Addendum to develop conclusions, and if the information presented supports those conclusions,
3. identifying any terms and conditions in the Mary River Project Certificate, which were developed for Steensby Inlet, Foxe Basin and Hudson Strait as part of the Project outlined in the FEIS that require reconsideration or amendment in light of the Addendum proposal.
4. determining the appropriateness and adequacy of proposed mitigation and monitoring measures in the FEIS Addendum, and
5. if necessary, recommending additional or alternative mitigation measures (that may be more appropriate) to reduce or avoid impacts to fish and fish habitat, including marine mammals.

It should be noted that on its own, the Addendum to the FEIS (BIM 2013) provides neither a complete description of the Mary River Project nor the Early Revenue Phase. The Addendum simply identifies whether it is different from the draft EIS (DEIS) and FEIS, if so, in what way. Therefore, this review required looking back over parts of both documents in order to critique the Addendum, making it difficult to conduct a thorough review of the ERP.

3.0 Analysis and Response

There were gaps in knowledge and inconsistencies in the material presented in the Addendum. In some cases the Addendum identified "no change" when there should have been revisions

resulting from the proposed changes to the Project. Additionally there were cases when material in the Addendum was marked as “no change” though it differed from that presented in the FEIS (e.g., Table 9-3.4). In combination, it was very difficult to assess BIM’s analyses and therefore their conclusions. Regardless, DFO Science evaluated the potential impacts of the ERP of the Project especially shipping on the marine environment including marine mammals to the extent possible given the information presented. Many of the comments and recommendations contained in DFO Science’s technical review of the DEIS and FEIS remain relevant for the ERP.

3.1 Project description – shipping

3.1.1 Ships and shipping route

BIM's position[2]

BIM indicates the shipping route is entirely within the Nunavut territory (Vol. 9 p. 34). The marine spill sensitivity assessment (Addendum Vol. 9 Appendix 9F) identifies the “northern shipping route” ending offshore in the middle of Baffin Bay, 570 km from the Milne Inlet Port.

BIM identifies several types of ore carriers will be used. The actual number of carriers and transits to be made by each is unknown because it depends on the availability of charter vessels (Addendum Vol. 1 Section 2.4.1.1 p. 27). The Addendum states that if available “Handymax and Panamax vessels (approximately 35,000 to 110,000 DWT) will be used.”

“The current shipping window in Milne Inlet is 90 days, July 15 to October 15. Despite this 90-day window, the shipping season should allow for time lost and a conservative 70 days is assumed to account for delays primarily due to ship travel time.” (Vol. 3 Section 2.4.2 p. 20)

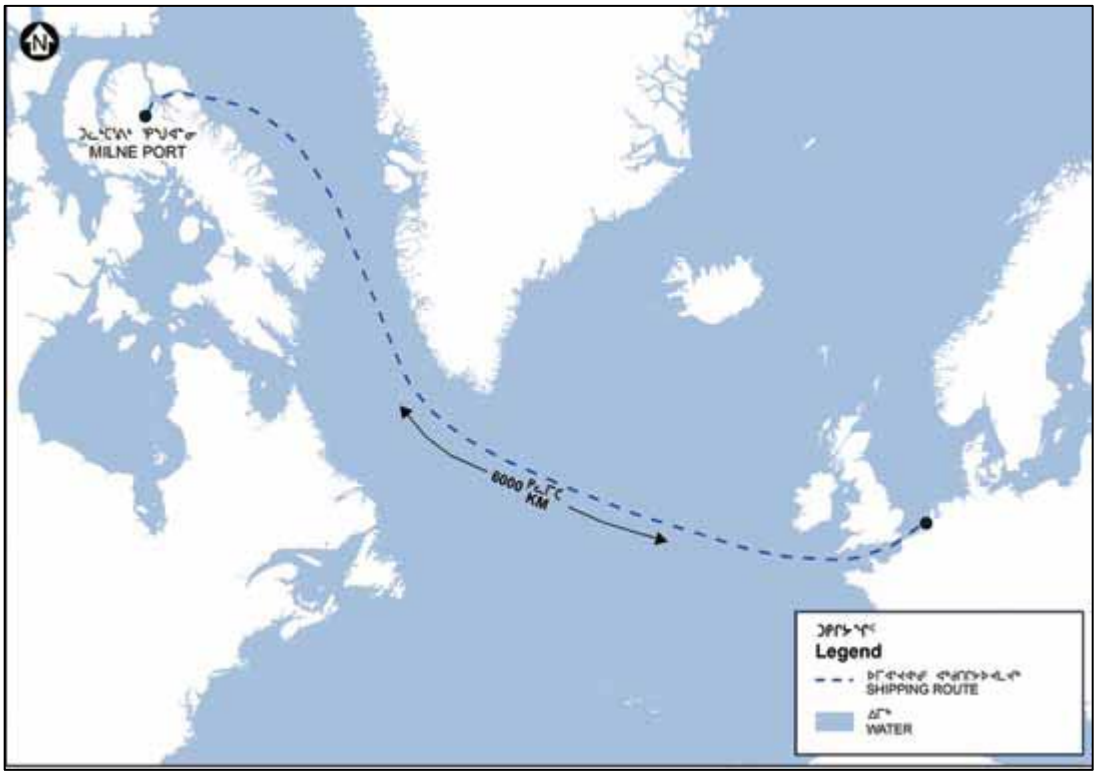

Figure 2. Approximation of Milne Inlet shipping route (from the Addendum to the FEIS popular summary).

[2] For all quotes which do not include a citation, the Addendum to the FEIS is the source.

DFO Science's analysis and assessment

Detailed information on the actually shipping route, as was provided in the FEIS for the Foxe Basin/Hudson Strait route, is missing from the Addendum to the FEIS for the ERP. BIM's assertion that the shipping route is entirely within the Nunavut territory could mean that it runs along Baffin Island within the 12 mile extent of the Nunavut Settlement Area. However, Figure 2 would suggest that the route could be offshore within Zone-I as defined under the Nunavut Land Claims Agreement or could be within Greenland's jurisdiction. This should be clarified.

Given the lack of detailed information on the shipping route it is not possible to evaluate the impact of it on the marine environment particularly marine mammals. The Addendum to the FEIS should indicate where ships enter Canadian waters and the whole route within Canada. The length and width of the ship track including frequency of deviations are needed to assess impacts.

The lack of detailed information on the actual ships (e.g., types, numbers, size) that will be used during the ERP make it difficult to conduct a thorough effects assessment. Ship specifications provided do not include noise standards and specific ballast water requirement although all vessels must be equipped to comply with ballast water handling in compliance with the Baffinland Inuit Impacts and Benefits Agreement.

Contradictory information on the actual volume of shipping is provided in the Addendum. For example, Vol. 3 Appendix 3D p. 8 states "This yields a total shipping window of around 76 days. Allowing for 25% lost time due to weather delays, a total of 57 days have been assumed to be available annually for shipping. Therefore an average daily ship loading rate of around 61,500 tons will be required in order to export 3.5 million tons of ore per year." However, this is lower than the stated 70 of 90 days used in Vol. 3. p. 20. This should be clarified.

Lack of details on the shipping route precludes a thorough effects assessment for all marine mammal species. For example, walrus aggregate around Hoare Bay and Brevoort Island (off southeast Baffin Island). Whether the shipping route will impact these areas is unknown. The FEIS indicates there is a summer concentration of walrus in Davis Strait (Vol. 8 Figure 8.5.5.). Again, whether it will be impacted by the shipping route is unclear.

It is unclear if the environmental conditions in a given year would result in changes to the shipping season (e.g., start earlier and/or end later). If so, this could change the amount of vessel traffic over the course of the shipping season and thus how much impact Project activities (e.g., exposure to noise, disturbance, ore dust dispersion) would have on the marine ecosystem. Ice would be a more of a factor in the effects assessment particularly if the season starts earlier or ends later.

Recommendations

Detailed shipping route location and width (maximum deviation expected) should be identified in the ERP for the entire route of the ship track within Canadian waters.

Clarification on the role that environmental conditions may play in determining start and end dates for the shipping season is needed and the potential for more shipping than has been identified in the Addendum.

Detailed bathymetric data in Milne Inlet and Eclipse Sound should be included in the Addendum.

As part of the ship specifications for charter bulk carriers (Addendum Volume 10 Appendix 10D-10 Appendix 2) and audit (Addendum Volume 10 Appendix 10D-10 Appendix 4), BIM should require the charter company to provide detailed sound measurements under expected operating conditions (e.g., speed, load). If these details are not available for each type/size of vessel chartered, then BIM needs to collect appropriate sound measurements. This information is

needed to properly monitor and mitigate potential impacts of vessel noise (e.g., disturbance, masking) on marine organisms.

3.2 BIM's assessment methods

3.2.1 Food chain/trophic considerations

BIM's position

There is no mention of "food chain", "trophic interactions" or "food supply" for any of the marine mammals or fishes" in the Addendum of the FEIS.

DFO Science's analysis and assessment

Indirect impacts such as a change in the food sources of marine mammals caused by Project activities may adversely affect marine mammals. These changes should be considered in the Addendum of the FEIS. For example, narwhals and bowhead whales likely forage in their summering grounds in the ERP area. Ringed and bearded seals spend the entire year in Milne Inlet, Koluktoo Bay and Eclipse Sound. Changes in the food available to marine mammals would likely affect their energy budget and thus their fitness.

Indirect impacts through changes in food sources for marine invertebrates and fishes could result from Project activities but are not evaluated.

Recommendations

BIM should have included changes in food supply as a potential impact on marine mammals and other marine organisms in the Addendum of the FEIS.

BIM should develop a monitoring program of the food sources of marine mammals in Milne Inlet and Eclipse Sound. The monitoring should start before the port is built and shipping begins to collect baseline data for future comparisons.

Similarly BIM should develop a monitoring program of the food sources of marine fishes and Arctic Char, an anadromous species, in the Milne Inlet and Eclipse Sound area.

3.2.2 Baseline studies - marine mammals

BIM's position

The baseline data collected by BIM are sufficient to predict the proportion of local and total populations of marine mammals exposed to potential impacts. In addition, the data are sufficient to detect changes in population sizes and structure (i.e., sex, age). Moreover, the data that will be collected will allow BIM to implement effective mitigation measures before serious negative effects are realized within the marine mammal populations.

DFO Science's analysis and assessment

Baseline biological data should document the state of a population or an ecosystem before the population or ecosystem is disturbed (i.e., before the start of a project). The purpose of baseline data is to predict potential impacts of a project and to assess the impact after a project has started. Baseline biological data should describe the species that are present, the number of individuals of each species and their demographics. Baseline data on the age- and sex-structure of populations can inform BIM of the species and habitat that might be affected and the type of individuals (i.e., sex and age classes) most vulnerable to the Project. Variability in baseline data can also be used to inform the design of future monitoring programs.

Here, the baseline data provided by BIM on marine mammals and other marine species cannot fulfill these functions because they lack detail and rigor. Specifically, the methods of the aerial surveys for marine mammals conducted by BIM are questionable. Survey platforms changed in all years in Milne Inlet (App. 8A-2, Table 4.1). Thus, it is difficult to combine surveys to estimate

density. The population estimates for narwhals, bowhead whales, and belugas in either the Milne Inlet/Eclipse Sound Local Study Area (LSA) or Regional Study Area (RSA) (App. 8A-2, S. 4.3.1.1 to 4.3.1.4) were not analysed using standard statistical methods. BIM simply divides the number of animals sighted by the area covered by the survey. BIM should use Distance sampling methods to analyse the survey data and produce better density estimates and assess the confidence intervals associated with their estimates (Buckland et al. 2001). Thus, DFO Science recommends that BIM re-analyse the data from their surveys using Distance sampling methods (Buckland et al. 2001). Other improvements to the method for subsequent surveys include the systematic use of double observers for mark–recapture Distance sampling (Innes et al. 2002, Richard et al. 2010).

Additional effort should also be made to calculate population demographics such as the age- and sex-structure of the populations of marine mammals in the LSA. The disturbance from shipping might affect whales within different sex- and age-classes differently (e.g., females with dependent calves might react differently to shipping noise as adult males). Thus, baseline data and future monitoring efforts should quantify the sex- and age-structure of the populations.

BIM does not correct for availability and perception bias in Appendix 8A-2. However, in App. 8C, the densities in tables 8C 3.6, 3.7 and 3.9 are corrected but there is no indication where the values came from. BIM should use correction factors and provide a scientific justification for the values chosen.

Marine mammal surveys should be conducted and analysed with sufficient precision to be able to detect changes of population decline of 10% or more. Given the low precision of the baseline abundance and distribution data presented, detecting a population decline of 10% would be difficult, especially given the uncertainty about impacts and their potential gravity for some of the species involved.

Recommendations

BIM should improve the precision of their baseline data, assess the species regularly, and/or re-design their monitoring in ways that would allow for rapid detection of changes in marine mammal habitat use or population dynamics, and minimize such impacts.

Whatever monitoring protocols are enacted for the Project, they must be carried out in a scientifically defensible way, and with sufficient precision to ensure that potential effects at or above carefully-chosen threshold levels can be identified. In instances when sufficient precision cannot be assured without extraordinary logistical limitations, the Proponent should adopt precautionary approaches such as diverting ships away from known or newly-discovered whale aggregations or pinniped haulout areas.

3.2.3 Baseline studies – marine forage species

BIM's position

BIM did not evaluate the impacts of the Project on marine forage species.

DFO Science's analysis and assessment

The Proponent did not make predictions about impacts on forage species (marine fishes or invertebrates) such as Arctic Cod (*Boreogadus saida*) or clam species (e.g., *Mya truncata*) in the Milne Inlet area that are ecologically important. The limited survey/sampling was confined to the port locations and was not undertaken along the shipping route. Project impacts, for example from redistribution of sediment at the port site and along the shipping route should be evaluated. The Addendum contains insufficient baseline data to either predict effects or to monitor changes in lower trophic levels, which have higher turnover rates and are therefore faster to react to potential changes than marine mammals. For that reason, monitoring forage species could identify Project effects in time to mitigate impacts on marine mammals.

Recommendations

Surveys of marine forage species should be undertaken following acceptable protocols so that detailed quantitative analysis can be used to monitor species and community trends. Comprehensive baseline quantitative surveys should be undertaken before project activities begin, and these should be designed to allow regular standardized monitoring once the Project starts.

3.2.4 Avoidance

BIM's position

Animals will avoid disturbances associated with the Project, therefore, they will not be impacted by these disturbances. Regardless, animals will habituate to disturbance so any avoidance will be only temporary.

DFO Science's analysis and assessment

Avoidance comes with a cost to the displaced individuals. For example, the primary function of narwhals' summering grounds is still unclear but might include feeding, escape from killer whales and care of calves (Marcoux et al. 2009). For example, on September 17, 2007 narwhals moved from Eclipse Sound to Milne Inlet after killer whales were seen in Eclipse Sound (FEIS Appendix 8A-2 part 3 p. 103, Figure 4.1, Figure 4.5). The shape of Milne Inlet and Koluktoo Bay might make them ideal locations to hide or escape from killer whales. As a result, narwhals displaced by Project activities might experience increased predation risk. They may also have less access to food and increased calf mortality. Thus, the consequences of avoiding the Milne Inlet/Eclipse Sound area could potentially affect the survival and fitness of narwhals. Narwhals show site fidelity and tend to go back to the same fjords each summer (Heide-Jørgensen et al. 2003).

Given the number of ship transits in the LSA, narwhals might permanently avoid Milne Inlet and Eclipse Sound and move to other summering grounds such as Admiralty Inlet, which is the closest. However as a result of displacement, narwhals from Milne and Admiralty inlets may be negatively affected due to competition between the two stocks for potentially limited resources.

As mentioned by BIM, "*Bowhead whales regularly occur along the northern shipping route, and it is thought that this summering area is used for feeding.* (Vol. 8 p.113)". Thus, the avoidance of Milne Inlet and Eclipse Sound by bowhead whales might negatively affect the feeding success of these whales. As a result, displaced bowhead whales might not meet their energy requirements resulting in reduced fitness.

The Addendum has not addressed the issue of displaced animals moving into unsuitable or already-occupied habitat. Consequently, the impact assessment presented is inadequate. Also, the Proponent's assertion that all displacement is temporary is unsubstantiated.

Recommendations

To evaluate avoidance a thorough analysis of displacement-based impacts and follow-up monitoring should be conducted.

3.2.5 Thresholds

BIM's position

BIM widely uses a threshold of 10% of the individuals within a population for an acceptable level of impact. "*Thresholds are limits of acceptable change determined from regulated guidelines or by professional opinion.* (FEIS Vol. 2 p. 45)*"*

DFO Science's analysis and assessment

DFO Science could not find reference to the 10% threshold in Canadian or international EIA guidelines. In addition, there is no scientific reference or rational for a 10% threshold in the Addendum. It is not clear if BIM's threshold is 10% of individuals within the RSA or the LSA. Thresholds would be expected to vary by species and life history type of organisms.

There are standard assessment approaches for determining mortality rates in other marine species (e.g., fishes), the most simple being catch-curve analysis which can be done if an appropriate sample of a given fish stock is captured and aged. More complicated models can be used to estimate maximum sustainable yield (similar to PBR). For Arctic Char, a conservative harvest rate of 5% is typically considered sustainable.

Recommendations

BIM should provide better rationales for the thresholds they used. The rationales need to be supported by quantitative analyses and should include power analysis of monitoring efficacy to ensure the monitoring program has the ability to detect the identified thresholds (e.g., a change in population abundance for narwhal, beluga and bowhead whales).
The Milne Inlet-Eclipse Sound area contains several Arctic Char stocks that could be impacted by Project activities. For that reason, DFO Science recommends a more quantitative approach to evaluating thresholds for them.

3.2.6 Predicted confidence in effects on marine mammals

BIM's position

BIM is highly confident in the predicted residual effects the Project will have on marine mammal species. For narwhals, BIM's level of confidence in its residual effects is medium to high (Addendum, Vol. 8 p. 104). For all other marine mammal species, BIM's level of confidence in the residual effects of the Project are high (Addendum Vol. 8 p. 68, 77, 92, 120, 138).

DFO Science's analysis and assessment

There is a large amount of uncertainty in all of the predictions made by BIM. Here are just a few examples.

1. There is no study on acoustic masking in ringed seals.
2. There is also a lack of studies on the responses of ringed seals to large ore carriers.
3. There is uncertainty in how narwhals will respond to frequent ore carrier traffic in the narrow waterways of Milne Inlet.
4. There are no studies on hearing impairment in narwhals and bowhead whales. There are no published hearing threshold audiograms for narwhals and bowhead whales.
5. There is uncertainty associated with the acoustic modeling results presented by BIM, in part because details of the pile-driving process and the specifications of the ore carriers were limited in the Addendum of the FEIS. Thus, several parameters of the model were estimated because their values were unknown.
6. The baseline data for the marine mammal populations in the EPR region are not sufficient (see section above).

Recommendations

In the absence of clear evidence for no or insignificant effects, a precautionary approach should be adopted.

3.3 Effects of the Project on marine species and habitat

3.3.1 Impact of port construction and operation – blasting

The effects assessment of blasting carried out in the FEIS for Steensby Port was not undertaken for the Milne Inlet Port although it should have been presented given the proposed changes to the Milne Inlet Port facilities. The Addendum (Vol. 8 p. 34) indicates that "No blasting will be conducted in or near marine waters during the construction associated with the ERP" although Table 8-3.13 includes blasting as one of the Project activities associated with the construction phase.

Recommendations

Prior to construction, BIM should undertake an effects assessment of blasting for the Milne Inlet Port on marine species.

3.3.2 Impact of port construction and operation – dust deposition

The effects assessment of dust deposition carried out in the FEIS for Steensby Port (Volume 8 Section 2.5.3) was not changed for the ERP although it should have been given the proposed changes to the Project. Stockpiling and transport of ore from Milne Inlet will lead to increased dust deposition in the Milne Inlet area (Addendum Vol. 8 p. 1, Table 8-1.2), the impact of which is not adequately assessed in the Addendum to the FEIS. Dust deposition is considered in terms of sedimentation. Impact of dust on ice melt is not evaluated.

Recommendations

Prior to construction, BIM should undertake an effects assessment of dust deposition, particularly on ice, for the Milne Inlet-Eclipse Sound area on marine species.

3.3.3 Impact of port construction and operation – pile driving

BIM's position

BIM will use a bubble curtain to reduce sound propagation during pile-driving activities. If marine mammals exhibit avoidance of Milne Port because of pile driving or other construction activities, effects are predicted to be localized and only temporary.

DFO Science's analysis and assessment

DFO Science recommends taking a more conservative approach. The reference source level used in the modeling of sound propagation is likely an underestimate of potential source sound levels. In the model of Appendix 8C the source level used is similar to a 24 inch (0.6 m) steel pile. As mentioned in Appendix 8C, there is a "*correlation of the broadband source levels with the size of the pile*". According to Appendix 3D section 3.1, the diameter of the pile sheet used for the ERP is 30 m which is much larger than the pile sheet used in the simulation model. From Appendix 3D Table 1, there is a difference of 17 dB re 1 µPa in source levels between a steel pile of 3.96 m (156 inches; 226 dB re 1 µPa) and 0.6 m (24 inches; 209 dB re 1 µPa). The source level of pile driving a steel pile of 30 meters is likely higher than the source level of pile driving a steel pile of 0.6 meters. Thus, a new set of simulations would be needed to develop accurate sound propagation maps.

BIM says: *"Based on corrected aerial survey densities, 47 narwhals are predicted to occur within 2 km of the pile driving site at a given time in August"* (Vol. 8 p. 100). To get a more accurate estimate of the number of narwhals affected by pile driving, this number should be multiplied by the number of days pile driving will occur. BIM mentions that pile driving will occur during 340 hours over 4 weeks (Vol. 8 p. 99). Thus, a more conservative estimate of the number of narwhals disturbed by pile driving is 1,316 narwhal-exposures (i.e., 28 days*47 narwhals).

BIM mentions the possibility of pile driving during the ice-covered period (Vol.8 p.60). However, BIM does not provide any model of sound propagation of pile driving noise under the ice.

Recommendations

Prior to construction, BIM should investigate the impact of pile driving during the ice-covered period. BIM should provide a density estimate for ringed and bearded seals during the ice-covered period. In addition, BIM should provide proper sound propagation models under ice-covered conditions.

Prior to construction, BIM should deploy acoustic recorders around the port and in Koluktoo Bay to measure sound levels from pile driving over broadband frequency. In addition, BIM should monitor the efficiency of the bubble curtain to attenuate noise. If effective, BIM should use bubble curtains to mitigate effects for all species.

BIM should investigate different noise reduction methods such as a vibration pile driver (Matuschek and Betke 2009).

BIM should use marine mammal observers during the entire duration of pile driving. The observers should use both visual and passive acoustic detection to monitor the presence of marine mammals within 10 km of the operation. When a marine mammal is detected, the activity should be stopped until the marine mammal has left the area.

BIM should produce a warning sound before the beginning of each piling operation. This sound should be loud but non-hazardous to warn marine mammals in the area. Alternatively, BIM should use a “soft start” to warn marine mammals in the area. The soft start consists in gradually augmenting the intensity of piling before reaching full impact. Mitigation measures should be carefully monitored to test for their efficacy.

3.3.4 Impact of port construction and operation – dredging

In Vol.2 Section 2.3.5 of Addendum, BIM mentions the possibility of dredging: “Geotechnical drilling carried out to date has indicated that the seafloor is amenable to the proposed construction methodology with no dredging requirement. However, if soft material is encountered unexpectedly, the contingency plan would involve a small amount of dredging with disposal of the dredged material on land within the Milne Port PDA”.

However, BIM does not discuss the impact of dredging on marine mammals. Dredging is often associated with the release of toxic compounds (Sturve et al. 2005), changes to the substrate composition and structure (Cooper et al. 2011), suspension of large quantities of sediments in the water column (Wilber and Clarke 2001) and emission of low frequency noises (Greene Jr. 1987). These consequences of dredging are all likely to impact marine mammal populations in the ERP region. The impact of dredging has been studied in a population of dolphins that were habituated to ship traffic. The dolphins deserted their foraging patch when dredging activity occurred (Pirotta et al. 2013).

Recommendations

Prior to any dredging, BIM should undertake an effects assessment of dredging for the Milne Inlet Port on marine species and provide a map showing the zone of impact.

If dredging should occur, BIM should monitor the effects of this activity on marine species in the vicinity.

3.3.5 Impact of shipping – sea ice

Although shipping is planned for the open-water season, it is likely that shipping will not be limited to ice-free conditions. Although the Addendum to the FEIS indicates the section on sea ice has been changed (Vol. 8 p. 7) referring to Vol. 8 Section 2.3 of the FEIS, no information is included on ice in the northeast Baffin Island area. Sea ice serves as important habitat for

ringed seals (for hauling out and subnivian lairs), bearded seals (hauling out), narwhals and bowhead whales (avoidance of predators). For this reason, information on the type of ice, where and when it will be expected and a thorough effects assessment of the Project on sea ice should have been included in the Addendum to the FEIS for the ERP.

Ice entrapments usually occur when a sudden change in temperature and wind causes rapid formation of ice in bays or passages used by marine mammals. Between 2008 and 2010, four ice entrapments killed between 30-600 narwhals each (Laidre et al. 2012). Ice entrapment is usually a source of natural mortality for Arctic cetaceans. However, there is some evidence that a few recent ice entrapments might have been related to changes in the Arctic environment. The last four reported ice entrapments of narwhals happened close to their summering grounds and it appears the animals had delayed their migration to their wintering grounds (Laidre et al. 2012). In 2008, an extreme ice entrapment occurred in Eclipse Sound (DFO 2012d) which resulted in over 629 narwhal deaths. This event occurred in the same year and season as BIM's bulk ore sample shipments (Addendum, Popular summary p. 15 photo and caption). If shipping of iron ore was to happen in the fall when the ice is starting to form, the constant breaking of ice by the ore carriers might encourage narwhals to stay longer in their summering grounds. Delayed migration might increase the chance of mortality by ice entrapment. Similarly, bowhead whales and belugas are also known to become entrapped in ice and this could occur more frequently if shipping occurs late in the fall (Heide-Jørgensen et al. 2002).

Recommendations

BIM should provide information about when their bulk sample shipments occurred, and discuss the possible impact of those shipments on the narwhal entrapment.

BIM should conduct a thorough effects assessment of the ERP on sea ice and its potential to impact marine mammals, especially narwhals and killer whales, through ice entrapments.

3.3.6 Impact of shipping – noise (disturbance)

BIM's position

The impact of noise on marine mammals in the ERP region will not be significant.

DFO Science's analysis and assessment

In the Addendum to the FEIS, BIM has noted no change in their assessment related to noise from the original FEIS (Appendix 8C-2) yet the original assessment assumed smaller ships and fewer transits than those expected under the ERP (Vol. 3). In addition the original assessment did not include the amount of pile driving planned for the Milne Inlet Port. Therefore the noise assessment is not valid for the ERP.

BIM's evaluation of the impact of noise on marine mammals is simplistic and potentially underestimates the real impact. DFO Science recommends another modeling exercise that is described below.

1. The number of marine mammals impacted by noise presented by BIM is misleading. BIM reports the number of whales affected by shipping noise during each ship transit. However, for a more accurate representation of the potential number of marine mammals affected, BIM should multiply this number by the number of ship transits. It is clear that marine mammals move among the fjords in the RSA. For example, results from the aerial surveys conducted by BIM illustrate the movement of narwhals between bays in Eclipse Sound and Milne Inlet (FEIS Vol.8 Appendix 8A2 figure 4.2). Thus, it is likely that different individuals will be affected during each ship transit.

   For a more precautionary approach, an approximation of the number of marine mammals affected during each transit (or each day of construction disturbance) should be multiplied by the expected number of ship transits. For example, BIM estimates that

"~200-500 narwhals in Milne Inlet and Eclipse Sound avoid an ore carrier during each vessel transit, this represents ~0.1–2.5 % of the narwhals that can occur there during summer". Given that 50-54 ore carrier trips (100-108 transits) are expected, it is possible that 54,000 narwhals will avoid the area along the passage route of ore carriers each year during the ERP. Assuming a population estimate of 20,225 narwhals (Richard et al. 2010)3 the entire population will likely avoid an ore carrier at some point during the summer. Thus, BIM's statement that "*~0.1–2.5 % of the narwhals that can occur there during summer*" will "*avoid an ore carrier during each vessel transit*" is misleading and likely underestimates the actual level of disturbance to the entire stock. In tables 8C-3.6, 8C-3.7, 8C-3.9 of Appendix 8C, BIM reports estimated numbers of whales potentially affected by Project activity noise. These numbers do not match numbers reported in Volume 8.

Here, DFO Science reports the total number of marine mammals that will experience noise levels above 120 dB re 1 µPa ('disturbance onset') from the passage of ore carriers (Table 1). It is assumed that half of the ore carriers will belong to the Handymax class and the other half to Post-Panamax class. Also, it is assumed that half the shipping will happen in August (25 Handymax-size and 25 Post-Panamax-size transits) and half in September (25 Handymax-size and 25 Post-Panamax-size transits) (Tables 8C-3.6, 8C-3.7, 8C-3.9). A criterion for avoidance of continuous sound of 120 dB re 1 µPa was chosen based on a review of marine mammal behavioural responses to noise (Southall et al. 2007).

DFO Science concludes that a significant number of whales will be affected by Project noise. For several whale species, the number of individuals disturbed is larger than the population estimate for the region. For narwhals, there will be around 390,000 individual-exposures to levels of 120 dB. This is almost 20 times the size of the Eclipse Sound stock. For bowhead whales, there will be around 4,800 individual-exposures to levels of 120 dB. Thus, DFO Science disagrees with BIM's conclusion that the impact of Project noise on marine mammal species will be not significant.

Table 1. Estimated numbers of beluga-, narwhal- and bowhead whale-exposure to noise from Project activities at levels of 120 dB re 1 µPa. Estimates are calculated from numbers in tables 8C-3.6, 8C-3.7, 8C-3.8 of Appendix 8C multiplied by 100 transits.

Vessel Class	Beluga		Narwhal		Bowhead	
	per transit	total	per transit	total	per transit	total
August						
Handimax	3	75	2,509	62,725	73	1,825
Post-Panamax	3	75	2,606	65,150	74	1,850
September						
Handimax	5	125	5,039	125,975	22	550
Post-Panamax	6	150	5,452	136,300	23	575
Total		**425**		**390,150**		**4,800**

2. BIM provides separate propagation models for different sound sources such as different vessel and construction noises. However, as stated by BIM, it is likely that animals will experience the cumulative effect of several sound sources. Thus, the sound propagation

[3] This statement assumes only narwhal from the Eclipse Sound summering stock would be affected. However, narwhal from the Admiralty Inlet stock also frequent the Eclipse Sound area at certain times of the year.

models underestimate the potential source level around the port as well as the reach (transmitted distance) of the sound. The models should account for the cumulative impact of multiple sources (Moore et al. 2012).

BIM acknowledges that “Up to seven vessels, including sealifts, tankers and barges, could be present at Milne Port at one time during construction” (Vol.8 p. 114). In addition, BIM states that: “Based on the shipping scenario for the ERP, there would be one ore carrier ~every 24 hours along the northern shipping route and potentially, during peak periods, one vessel every 12 hours. Also, it is possible that an inbound ore carrier may pass an outbound ore carrier near the entrance to Eclipse Sound.” (Vol.8 p.101). Thus, multiple sources are expected to emit sound simultaneously in Milne Inlet and Eclipse Sound. It has been shown that multiple sources of sound increase received sound levels (Gervaise et al. 2012). For example, using average source level estimates, an oil tanker added 24 dB of noise to the ocean noise budget in the Gerry E. Studds Stellwagen Bank National Marine Sanctuary off the coast of Massachusetts (Hatch et al. 2008).

BIM dismisses the fact that multiple sound sources will significantly increase the noise level. BIM rightly states that: “the combined source level of two identical and co-located incoherent noise sources is the value of the source level from one of the sources plus 3 dB (FEIS Vol.8 p.152)”. The decibel is a unit with a logarithmic scale. A change of 3 dB is a doubling of sound level. Given that there could be a carrier passing every 12 hours during the ERP, the chance of two carriers passing each other in Milne Inlet is very likely. As a result, BIM should have provided a model that integrates the noise from multiple sources such as shipping and construction to accurately reflect the noise levels that marine mammals will be exposed to.

3. There is an inconsistency between the size of the ship mentioned in Addendum Vol.3 section 2.4.3 and the ones used for the sound propagation models (Appendix 8C). In section 2.4.3 of Addendum Vol.3, BIM mentions that three types of ore carriers will be used with a maximum of 110,000 DWT, while in Appendix 8C, the largest carrier modeled was 90,000 DWT (Table 3 of Appendix 8C). Since vessel specifications such as the length of the carrier affect the source level of the noise, a larger vessel will have higher sound level at the source (Table 15 of Appendix 8C). Thus, the source level of noise as well as received sound level are underestimated and as a result, the area of disturbance from noise is underestimated in BIM's models.

4. Since ship speed is a major factor that influences the noise produced by a vessel (Arveson and Vendittis 2000, McKenna et al. 2013), noise mitigation measures should include a reduction in ship speed. Moreover, strategies to reduce the impact of noise must consider the cumulative noise exposure over time (McKenna et al. 2013). There is a tradeoff between the noise resulting from the speed of a ship and the duration of exposure to ship noise. For example, a slower ship would produce lower levels of noise over a longer period of time than a faster ship that would produce higher levels of noise over a shorter period of time. BIM should monitor the noise produced by their ore carriers at different speeds and from different orientations since noise radiation from a vessel is often asymmetrical (McKenna et al. 2012). BIM should then assess at which speed the cumulative noise exposure is minimized, also taking into account the risk of ship strikes.

5. BIM states that narwhals exhibited mixed responses to the presence of ships in the LSA (Addendum Vol.8 p. 100). However, the data presented in the Addendum from the aerial surveys are not sufficient to draw any conclusions. For example, BIM needs to provide the shipping routes, the exact timing of ship passages, and the times of the surveys to evaluate the response of narwhals to shipping. Narwhals might move out of Koluktoo

Bay to Milne Inlet or from Milne Inlet to Eclipse Sound to avoid a passing ship. This would result in an increase in the number of narwhals in Milne Inlet or Eclipse Sound during or after the passage of a ship. However, this increase cannot be interpreted as a case for habituation by narwhals because it is possible that this pattern resulted from narwhals avoiding a passing ship.

6. The review of the literature on the impact of acoustic disturbance on marine mammals omits several key elements.

    6.1. First, BIM ignores a large body a research showing a negative effect of noise on marine mammals within the zone of impact. For example, research on other species demonstrates that increased noise levels induce stress in marine mammals. The levels of stress-related faecal hormone metabolites (glucocorticoids) in North Atlantic right whales (*Eubalaena glacialis*) in the Bay of Fundy decreased after a reduction in shipping traffic (Rolland et al. 2012). While BIM might suggest that North Atlantic right whales in the Bay of Fundy habituated, chronically elevated glucocorticoids hormone levels are associated with inhibited reproduction, suppressed immune system function and growth (Sapolsky et al. 2000) (Romero and Butler 2007). Thus, noise disturbance can have non-behavioural effects that negatively affect fitness. Bowhead whales have a low rate of reproduction and thus, any decrease in reproduction might have strong consequences on the population.

    6.2. In many instances, BIM suggests that marine mammals will habituate to the vessel traffic and associated noise in Eclipse Sound and Milne Inlet (e.g., Vol.8 p. 101 *"It is possible that narwhals will habituate to frequent, non-threatening vessel transits and exhibit less avoidance behaviour close to the ship track"*). BIM argues that marine mammals and vessels cohabit in many regions, thus, they suggest that they can also co-habit in Eclipse Sound and Milne Inlet.

    The marine mammals that would be exposed to the Project are industrially-naïve populations. Considering that the time elapsed between successive ore carriers transits will be less than one day during the proposed ERP, and thus shorter than the time documented for belugas and narwhals to return to normal activity in Lancaster Sound (Finley et al. 1990), DFO Science is concerned about the long-term impacts of this new, and unprecedented, scale of shipping activity for marine mammals in this pristine environment.

    Even if there are examples of cetaceans in some locations that show habituation, it is not always the case. For example, gray whales deserted Laguna Guerrero Negro for more than a decade when commercial shipping and dredging activity took place in the lagoon (Bryant et al. 1984). Bottlenose dolphins that seemed habituated to commercial shipping traffic abandoned Aberdeen harbour when dredging activity took place (Pirotta et al. 2013). Killer whales where displaced from the Broughton Archipelago after noise pollution was introduced into their environment (Morton and Symonds 2002)

    6.3. In many instances, BIM mentioned the study by Finley et al. (1990) in Lancaster Sound to argue that "*the duration of avoidance of icebreakers was shorter for narwhals than for belugas, and that narwhals were more likely to return to normal behaviour sooner than belugas.*" The context of the Lancaster Sound study was highly different from the context in Milne Inlet. For example, in the Lancaster Sound study, narwhals were migrating and groups were mainly composed of males. This is different from groups found in Milne Inlet during the summer. They do not migrate and their groups are mixed in composition (female, male, calf) (Marcoux et al. 2009). Groups with females and calves are

less mobile and thus may react differently to a potential threat. The reaction to ships is highly dependent on the context and on the behaviour the whale was engaged in prior to disturbance (Ellison et al. 2012) (Southall et al. 2007). In addition, Finley et al. (1990) described a “freeze” response of narwhals when they were disturbed by the icebreaker. This response was different from belugas' response but Finley et al. (1990) do not imply that narwhals' reaction is more or less strong than the belugas' reaction. In addition, the reaction of both narwhals and belugas was highly variable and hard to predict. Adding to this, Milne Inlet is a relatively narrow body of water which may restrict the ability of narwhals to avoid disturbance. Thus, BIM should have been more cautious in their interpretation of the study by Finley et al. (1990).

The impacts of noise on other species, like Gadids (e.g., Arctic Cod), was not evaluated.

Recommendations

Prior to commercial shipping of iron ore, BIM should develop a monitoring protocol that includes, but is not limited to, acoustical monitoring that provides an assessment of the negative effects of vessel noise on marine mammals. Once the protocol has been developed, pre-operation baseline data should be collected.

BIM should conduct sound verification studies to ground-truth their sound propagation models and estimated zones of impact. These studies should be done with different environmental conditions (wind, waves) and should be based on the real dissipation of sound from the sources (ships and pile driving).

BIM should monitor the noise produced by their ore carriers at different speeds and from different orientations. They should assess at which speed the cumulative noise exposure is minimized taking into account the risk of ship strikes. Pre-construction deployment of PAM (passive acoustic monitor) sensors in Milne Inlet is recommended so monitoring can occur during the construction and operation phases.

BIM should test the efficacy of the bubble curtain at the Milne Port.

BIM should follow the Population Consequence of Acoustic Disturbance (PCAD) program (Wartzok and Tyack 2008) in the design of their acoustic monitoring program.

BIM should also develop an on-shore monitoring program to be conducted both prior to and during Project operations. This program could involve a mix of observations by on-shore observers as well as by camera-traps located at strategic locations. Cameras are a low-cost non-invasive method. If located at strategic points, they could cover the width of Milne Inlet (e.g., Bruce Head in Koluktoo Bay). In addition, they could allow live-monitoring of marine mammals and help to mitigate the impact of shipping traffic.

Studies should be done to monitor the effects of shipping noise by various means. For example, narwhals could be equipped with satellite tags to document their movements in response to ship passages. In addition, acoustic tags could be deployed on narwhals to monitor noise levels received by the animals. This acoustic data would also fill important gaps in the knowledge of narwhal acoustics and decrease uncertainty in modeling of the zone of impact.

Impacts of noise on marine fishes should be evaluated.

3.3.7 Impact of shipping – noise (masking)

BIM's position

BIM suggests that masking effects are considered fully reversible and that the residual environmental effect of masking on marine mammals is predicted to be “Not Significant”.

DFO Science's analysis and assessment

BIM underestimates the effect of noise pollution on masking in marine mammals.

1. BIM states that: "*Along the shipping route, any masking would occur as a vessel passed by, which likely will be a short time relative to the interval between transits*." (Vol.8, p. 104). In contrast to this assertion, it is likely that marine mammals in Eclipse Sound might be exposed to shipping noise constantly during the ERP. For example, according to sound propagation models, the sound pressure level of noise 71.2 km away from a Post-Panamax-size ore carrier could be 120 dB re 1 µPa (Appendix 8C-2 Table 29). Assuming that carriers move at 13 km/hour (7 knots), a whale would experience the sound of 120 dB re 1 µPa from a single carrier for over 11 hours (142.4 km divided by 13 km/hour). In addition, there might be up to one carrier every 12 hours (Vol.8 p. 101). Thus, marine mammals might be exposed to the noise of ore carriers almost continuously (11 of every 12 hours).
2. BIM acknowledges that "*There is some overlap in frequency between shipping sounds and narwhal communications; therefore, there is a potential for masking, out to an unknown distance from the vessel(s)*" and that "*Low-frequency (<10 kHz), narrow-band click signals are the prevalent sounds produced by narwhals in Lancaster Sound along with pulsed toned calls (Finley et al., 1990)*". But this statement contradicts another statement by BIM: "*Given that sounds important to narwhals are predominantly at much higher frequencies than shipping noise and the intermittent nature of construction activities sounds, it is unlikely that masking would significantly affect narwhals*."

   DFO Science disagrees with this last statement. Masking is likely to significantly affect narwhals since they emit communication calls at frequencies similar to the frequencies of shipping noise. Two studies on narwhal communication have been carried out in Koluktoo Bay. The frequencies of narwhals' communication calls ranged from 0.3 kHz to 24 kHz (Ford and Fisher 1978, Marcoux et al. 2011). So the noise produced by shipping and construction in Milne Inlet and Eclipse Sound overlaps narwhal calls, therefore masking is likely to occur. The amount of acoustic reflection and refraction that occurs in a waterbody is dependent in part on the type of substrate, water surface and size of the sound channel. Milne Inlet and Eclipse Sound are relatively narrow bodies of water (ranging roughly from 1.9 km to 30 km across) with steep hard sides. In addition, the proposed shipping could have multiple ships travelling within Milne Inlet and/or Eclipse Sound simultaneously. All these factors increase the potential for sound amplification and consequently masking. Given the level of noise and call masking likely to occur in Milne Inlet, narwhals may be forced into areas where they would be more vulnerable to killer whale predation.
3. BIM acknowledges that there will be overlap between bowhead calls and shipping noise: "*The potential effect of auditory masking for bowhead whales is increased by the large amount of overlap between the predominant frequencies produced by ship noise and construction activities (<1 kHz) and the frequencies at which bowhead whales call and presumably hear* " (Addendum Vol.8 p. 116). However, BIM suggests that "*Along the shipping route, any masking would occur as a vessel passed by, which likely will be a short time relative to the interval between transits*" (Addendum Vol.8 p. 116). As mentioned above, bowhead whales might be exposed to ore carrier noise for 11 of every 12 hours at levels of 120 dB re 1 µPa. Thus, bowhead whales in Eclipse Sound might experience masking almost constantly during the ERP.
4. Ringed seals produce calls below 1 kHz (Stirling et al. 1983) and most energy of their calls are below 4 kHz (Cummings et al. 1984). Thus, their calls will overlap with construction activity and ship noise and will potentially be masked by noises produced during the ERP. The sound source levels of some calls produced by ringed seals are

relatively low (95 to 130 dB re 1 uPa,1 m) (Cummings et al. 1984) compared to calls of most marine mammals, making them more sensitive to masking.

5. BIM suggests that narwhals and bowhead whales can adapt to masking (Vol.8, p. 91, 116). However, BIM does not recognize the fact that if narwhals and bowheads did adapt, it may come with a cost. Altered vocal behaviour might be less efficient for communication. For example, calls emitted at higher frequencies travel shorter distances and more energy is required to produce louder calls. In addition, the risk that competitors, predators, or parasites may detect the calls is greater when whales give louder calls (Tyack 2008).
6. BIM only mentions masking of sounds produced by individuals of their own species. However, BIM does not mention masking of sounds from other species (predators, prey) and sounds from the environment (wave, distant shoreline, ice) (Schusterman et al. 2000). These sounds may be as important as within-species communication calls even if these sounds might not overlap with the frequency range of the communication calls of a species. This is an important concern for the Milne Inlet and Eclipse Sound region since shipping noise might be heard for 11 of every 12 hours during the ERP. Thus, BIM also needs to investigate masking from sounds other than the communication calls of a species.

Recommendations

BIM should have evaluated the impact of masking more rigorously. A complementary way to estimate the impact of masking in a given habitat is by comparing the range at which a signal reaches its limit of detectability or interpretability under given noise conditions compared to natural noise conditions. Examples of this method are given in Clark et al. (2009). DFO Science recommends that BIM use this approach to evaluate the effect of masking. In addition, BIM should investigate masking of environmental sounds as well as sounds from other species.

Prior to the commencement of commercial shipping, BIM should conduct passive acoustic monitoring to document baseline noise levels in the ERP area and the acoustic behaviour of marine mammals present. Passive acoustic monitoring should continue during commercial shipping to measure received sound level and changes in acoustic behaviour.

3.3.8 Impact of Shipping – whale strikes

BIM's position

Whale mortality is not expected to occur as a result of ERP activities. Narwhals and belugas are small relative to vessels, especially ore carriers, and are capable of very high swimming speeds, which will allow them to avoid collisions. Bowhead whales will maintain distances that would prevent ship strikes.

DFO Science's analysis and assessment

BIM underestimated the risk of ship strikes during the ERP.

BIM compares bowhead whales to North Atlantic right whales for their risk of ship strikes because ship strikes in North Atlantic right whales are well documented and represent more than half the cases of human-induced mortality in this species. BIM concludes that bowhead whales lack the behavioural characteristics that make North Atlantic right whales susceptible to ship strikes (individuals interacting at the surface with frequent physical contact, swimming slowly at the surface with mouth open, and resting motionlessly at the surface). Thus, according to BIM, bowhead whales are not susceptible to ship strikes. DFO Science questions the validity of this statement since many other whale species that do not show the behavioural characteristics proposed by BIM also experience ship strikes. Several documents reports ship strikes in many cetacean species, small and large, for both mysticetes and odontocetes (Laist et

al. 2001, Jensen et al. 2004, Van Waerebeek et al. 2007). In addition, DFO Science believes that bowhead whales have many characteristics that make them particularly susceptible to ship strikes (i.e., relatively slow swimming speed, small group size, mid-water or surface feeding strategy, and positive buoyancy due to high body fat content).

A mathematical area-interaction model was performed to estimate the strike risk for different whale species. This model is simplistic since it does not take into account spatial and temporal variation. However, the model provides a first step in understanding of the risk of ship strikes. In short, the volume of water swept by one ore carrier is multiplied by the total transit length which contains cetaceans, then by local cetacean density estimates and body sizes, and the number of ship transits during periods of overlap between these mammals and the ships.

The model assumes the following:

1. The vulnerable parts of the whale can be represented as a line of the same length as the whale.
2. The whale's orientation relative to the direction of travel of the ore carrier is random.
3. The whale does not tend to move into or out of the carrier's path (they may avoid the carriers, but their mobility can be constrained by shallow waters, or two vessels passing each other).
4. The carrier transit route has an overall density of whales that is the same as some larger area from which a survey has given a density estimate.
5. Ore carriers do not avoid whales (it is unlikely they would see them unless in daylight and open water, and their speed and size makes avoidance manoeuvering difficult).

The whale strike risk estimation model requires the following inputs (bowhead whale values given as an example):

L = whale length, m

T = fraction of whale time at surface, %

W = damaging width of the ore carrier, m (used 30 meters, width of an average Panamax vessel, no vessel dimensions were provided in the Addendum).

P = whale population density – animals per sq. km. in a survey area including the ore carrier transit route

D = distance traveled by the carriers per transit within the population survey area, km (used 250 km which represents a rough estimate of the length of one transit calculated from the map in Figure 3-2.11 of Addendum Vol. 3).

Y = yearly number of transits by the ore carriers (used 100 from Addendum Vol. 3 p.21)

The model uses the whale as a horizontal linear target at random orientation to the carrier's line of travel, and which would present an average "target size" of 0.64 * whale's length. Given the size of the vessels, the whale could be viewed as a point and half the "target size" of the whale can then be added to both sides of the "damaging width" of the ore carrier to give a "collision strip width" of W + 1.27L. From the length of the ore carrier transit a "collision area" can then be derived: (W + 1.27L) * D/1000 km^2. With the number of transits per year and the density of whales at risk, the annual number of whale collisions/vessel in the modelled area would equal (W + 0.64L)*D/1000*Y*T*P.

Using this model, 123 narwhals and 1 bowhead whales are estimated to be at risk of being struck by an ore carrier per year (Table 2). These numbers probably represent the upper boundary since individual whales will probably move out of the path of an approaching vessel.

However, DFO Science concludes that there is a non-negligible chance that whales (especially narwhals) will be seriously injured or killed by strikes from ore carriers each year.

Table 2 Parameters used in the model to estimate the risk of narwhals and bowhead whales being struck by a Project ore carrier within the Milne Inlet - Eclipse Sound portion of the proposed shipping route.

Species	Body length (m)	Proportion of time at surface (%)	Population density (n/km^2)	Modelled N at risk of ship strike/year
Narwhal	4.25	25[1]	0.6[2]	123
Bowhead	15.0	20[3]	0.004[4]	0.8

[1] Heide-Jørgensen et al. 2001

[2] Averaged values from 2007-2008 from Table 4.2 and 4.3 Appendix 8A-2, values corrected for perception (1.1) and availability bias (2.9) (Richard et al. 2010)

[3] Dorsey et al. 1989

[4] Averaged values from 2007-2008 from Table 4.2 and 4.3 Appendix 8A-2, values corrected for availability bias (3.84) (Dueck et al. 2007)

There are a number of sources of error in our estimates due to the assumptions used in our model, and the general nature of the model itself. However, the magnitude of these potential sources of error has been reduced by using the average densities calculated from aerial surveys, an average body length size for the species, and by using the amount of time whales are actually at the surface rather than a few metres below the surface where they are still susceptible to being struck. Moreover, it is assumed that the loss of an individual from a ship strike does not affect the survival of dependent offspring. The largest source of error probably comes from the estimates of local densities of the whale species of interest.

DFO uses the Potential Biological Removal (PBR) approach (Wade 1998) to determine the allowable rates of anthropogenic-induced mortality in marine mammals. The PBR is a conservative approach that produces a single threshold value. The PBR is the preferred method when the level of uncertainty is high or the data are insufficient (Hammill and Stenson 2007). For example, for the Eclipse Sound narwhal stock, the PBR is about 1.5% (1.5% of 20,000 = 300 narwhals) (Table 1). Currently, the main potential sources of human-induced mortality for narwhals are hunting, environmental contaminants, climate change, and industrial activities such as commercial fishing (COSEWIC 2004). Potential mortality arising from the proposed Project will be cumulative and additional to these sources.

Residual allowable harm is derived from PBR which takes into account population size, uncertainty around the density estimates and conservation status. Residual allowable harm represents the allowable mortality caused by humans that is not related to subsistence harvesting (number harvested plus number lost during harvesting).

Total allowable landed catch (TALC) is the number of animals that can be landed after hunt losses are removed from PBR without allowing for any other human-induced mortality. If the full TALC is not taken by the subsistence hunt then some residual allowable harm would remain. For example, TALC for belugas from the Eastern High Arctic-Baffin Bay population is 292 animals (Table 1). The annual harvest in recent years has been around 50 belugas leaving a residual allowable harm of about 240 animals. However, if the full TALC is taken then no residual allowable harm remains for other human-induced mortality such as ship strikes. For example, using the IWC (2008) abundance estimate the TALC for the Eastern Canada-West Greenland bowhead whale population is six (Table 3). In recent years as many as six or seven bowheads have been landed annually from this population (≤ three in Nunavut, ≤ one in Nunavik and ≤ three in Greenland). This means no residual harm is available for other human-induced mortality. The residual allowable harm for Eclipse Sound narwhals is uncertain because several communities likely harvest from this stock. Somewhere between 100 and 300 (i.e.,

PBR) narwhals are probably removed from the stock annually as a result of subsistence harvesting. So the amount of residual allowable harm may range from 0 to 200 narwhals.

Recommendations

BIM should evaluate the risk of ship strikes within the context of PBR (i.e., all sources of human-caused mortality), taking into account the ongoing subsistence harvest. Assuming Inuit have first priority for access to wildlife for subsistence harvesting, any additional mortality must fall within the residual (i.e., remaining) allowable harm.

Additionally, BIM should optimize the shipping route to reduce the risk using a temporally- and spatially-explicit model. In addition, BIM should clearly plan and detail the shipping route. There was no clear description of the Milne Inlet-Eclipse Sound shipping route in the Addendum.

BIM should immediately report any accidental contact by Project vessels. In addition, BIM should summarize and report annually any accidental contact by Project vessels with marine mammals through the applicable monitoring report. This should be addressed by Project term and condition 121 (Appendix 1).

BIM should provide sufficient marine mammal observers on project vessels to ensure that collisions with marine mammals are observed and reported throughout the ERP. The marine wildlife observer protocol should include, but should not be limited to, protocols for marine mammals, and environmental conditions and immediate reporting of significant observations to the ship masters of other vessels along the shipping route. Ore carriers should be equipped with climate controlled stations and shipboard lighting to permit visual sightings by marine mammal observers during all weather conditions. This should be addressed by Project term and condition 123 (Appendix 1).

BIM should ensure that measures to reduce the potential for interaction with marine mammals are identified and implemented prior to commencement of shipping operations.

BIM should revise their proposed “surveillance monitoring” to improve the likelihood of detecting avoidance behaviours by marine mammal responses that are too far ahead of the ship to be detectable by observers aboard the ore carriers. A baseline study early in the shipping operations could employ additional surveillance to detect potential changes in distribution patterns and behaviour. At an ambitious scope, this might be achieved using unmanned aircraft flown well ahead of ships. Live cameras along the shipping route might also be used to monitor the presence of marine mammals in the track of a ship, at least in narrower parts such as in the entrance of Koluktoo Bay.

Table 3. Estimates of potential biological removal (PBR) and total allowable landed catch (TALC) for cetacean species in the ERP area. CV is the coefficient of variation, CI is the confidence interval and N_{min} is the 20th percentile of the log-normal distribution of the population abundance estimate in Canada.

Species	Stock or population	Abundance estimate	CV	95% CI	COSEWIC Status	N_{min}	Recovery Factor	PBR[1]	TALC[2]	Source
Beluga	Eastern High Arctic-Baffin Bay	21,213[†]	0.25	10,985–32,619	Special Concern	17,241	1.0	345	292	Innes et al. 2002, Richard 2008
Bowhead whale	Eastern Canada-West Greenland	6,344		3,119–12,906	Special Concern	3,119	0.1	6		IWC 2008
Bowhead whale	Eastern Canada-West Greenland	14,400[†]	0.606	4,810–43,105	Special Concern	8,991	0.1	18		Dueck 2008
Narwhal	Eclipse Sound	20,225[†]	0.36	9471–37,096	Special Concern	15,074	1.0	301[‡]	236	Richard 2008, Richard 2010

[1]PBR is the number of animals that can be removed from the stock by human-caused activities (e.g., hunting, hunt losses, ship strikes, net entanglement) and still allow stock abundance to increase.

[2]TALC is the number of animals that can be landed after hunt losses are removed without allowing for any other human-induced mortality.

[†]Fully corrected for perception and availability biases.

[‡] Narwhals are killed locally on their summer range and elsewhere during spring and fall migrations. Individual community harvest limits are allocated in a manner that ensures that catches on each management unit are within the corresponding TALC recommendation. The Eclipse Sound stock may be harvested by the communities of Pond Inlet, Arctic Bay, Clyde River, Qikiqtarjuaq, Pangnirtung and Iqaluit.

BIM should initiate a long-term monitoring program using photo-identification to estimate marine mammal population sizes, compositions and trends. This method would be especially useful for bowhead whales and narwhals (Rugh et al. 1992, Auger-Méthé et al. 2010, Schweder et al. 2010). The occurrence of scars resulting from collisions with ships could be quantified on the photographs and an estimation of the rate of collision could be calculated (Van Waerebeek et al. 2007). In addition, landed animals from subsistence hunt of narwhals and bowhead whales should be examined for the presence of scars indicating a collision with a ship.

3.3.9 Impact of shipping – ballast water

Two new appendices were included in the Addendum to the FEIS, Appendix 8B-3 ballast water dispersion at Milne Inlet and Appendix 8B-4 risk assessments – Ballast water and hull biofouling.

BIM's position

Ballast water discharged from the port in Milne Inlet in summer will merge into a single gravity current which will flow downslope with offshore pooling. The gravity currents will diffuse due to the effects of background turbulence and current associated with tidal, wind-driven and estuarine circulation. The horizontal extension of the initial plume can likely occupy the full southern narrow part of Milne Inlet (Assomption Harbour). Vertical mixing during the summer operational season and winter ice-covered conditions will extend the thickness of the initial plume up to 20-50 m. The expansion of the plume leads to a decrease in the concentration of the ballast water in the plume. This decrease in concentration, in turn, will adjust the physical parameters inside the plume to natural values. The final (year-round) change in water properties will contribute only a small fraction (about 0.1%) of typical natural changes of water properties occurring in the inlet on an annual basis.

In Milne Inlet, the environmental effect of the discharge of ballast water during operation and Closure Phases (see 3.5.3.3) will be of low magnitude (Level 1), confined to areas within the LSA (Level 1), frequent (Level 2) of medium duration (Level 2) and fully reversible (Level 1). The environmental effect of the discharge of ballast water on water and sediment quality in Milne Inlet is predicted to be "Not Significant".

BIM has included a risk assessment that estimates 662,000 t per year is anticipated to be discharged into Milne Port during the shipping season each year.

DFO Science's analysis and assessment

There is large seasonal variation in salinity (Appendix 8B-3 p.7-9) from June and September. BIM should have collected CTD data for other months, especially July given the large difference in surface values from June to August. Data interpolation would be difficult and likely inaccurate given that data are sporadic (different months, years and stations). Ideally data to be used in modelling should be collected for different months within a given year(s) at consistent stations. It is not clear what baseline values (e.g., mean salinity, temperature and density over three months) have been used to calculate the projected changes in water properties (shown in Table 13). Ideally data should be modelled and presented on a month by month basis as well as on the overall open water season to determine if there is seasonal variation in the magnitude of the effect. For example, there may be more of an effect of releasing warm highly saline water in June when baseline conditions are typically colder and less saline, as opposed to later in the season when baseline conditions are more similar to the ballast water that is being released.

Data for wind induced bottom currents (Appendix 8B-3 p. 23) was taken from Steensby Inlet. No justification was given for why Milne and Steensby inlets should be considered similar. They indicate there is no simple method for estimating bottom currents related to wind forcing, but

there are data for Steensby. As the methods used to collect or estimate the values for Steensby Inlet are not provided it is difficult to evaluate BIM's conclusions. That having been said, the dispersion modelling report (Appendix 8B-3) seems to match DFO's findings in the Great Lakes. The discharged ballast water does move downstream as a cohesive "ribbon" in areas of high flow. Little mixing would be expected right after discharge due to the temperature differences between the ballast water and the receiving water. DFO Science has concerns about the statement that effects are reversible. This may be true for the direct effects of salinity and temperature on the benthic habitat, but if invasive species are considered, then it would not be true.

BIM acknowledge that "accurate estimation of vertical mixing can only be made using detailed high resolution observations and/or high resolution numerical modeling", however it appears this was not done (p. 23-24). DFO Science is concerned with their use of generic estimates and lack of explanation for the effects this may have on outcome of modelling results. A sensitivity analysis using the full range of possible mixing coefficients should have been presented.

There are uncertainties associated with the amount of ballast water discharge. It is unclear why two different upper ranges for total ballast water are given: 27,000 tonnes for 70,000 DWT vessels, and 21,600 for maximum discharge at dock (Appendix 8B-4 p. 2). It is also unclear why BIM uses an average value to calculate total vessel discharge (Appendix 8B-4 p. 2). More precise estimates of total discharge should have been included. The actual amount of ballast discharge could be substantially higher (or lower) depending on proportions of transits with different vessel types.

In Appendix 8B-4 (p. 6) BIM has used Bailey et al 2011 to substantiate that mid-ocean exchange drastically reduces propagule supply. However, it has been shown that this is mainly the case for ships entering freshwater such as in the Great Lakes. Other studies, not mentioned by BIM (e.g., Carver and Mallet 2002, Cordell et al. 2009, Roy et al. 2012) have shown that in some cases mid-ocean exchange can actually increase nonindigenous species propagule supply for marine ports (such as Milne Inlet) because the environmental conditions of exchanged water and the destination port can be similar (i.e., marine-marine transfer as opposed to marine-freshwater or freshwater-marine). Thus, until effective ballast treatment systems are in use, transoceanic vessels may still play a role in the introduction of aquatic nonindigenous species, particularly in the case of transiting vessels picking up water in cold Atlantic waters which have high environmental similarity to Arctic waters such as those found in Milne Inlet (DFO 2014).

The methods used by BIM in their risk assessment for ballast water and hull fouling are relatively consistent with DFO's regional risk assessment for ship-mediated introductions of aquatic nonindigenous species to the Canadian Arctic (Chan et al. 2012, DFO 2012c). However, it is unclear why the risk assessment considers the ballast discharged in the port separate from that discharged while on approach to the port. The 20% ballast water discharged prior to tying up at port would still be close enough to shore to be considered in the calculation. There also seems to be some discrepancies between the numbers of ship arrivals in the introduction to the addendum and that used in the calculation. The risk assessment estimates 662,000 tonnes per year, but this could be as high as 812,625 tonnes per year depending on the assumptions used. This does not change the results, as both of these values are ranked *Highest* probability of arrival.

BIM used a depth of 30 m for calculating survival of aquatic nonindigenous species. However, if ballast water is released at the surface, a value from within the first 10 m would be more appropriate, as used by Chan et al. 2012. The environmental similarity (and thus overall risk) would likely be higher if surface rather than bottom values were used. Use of surface values would also provide a more appropriate comparison to the Chan et al. 2012 results. If one uses

the same environmental data utilized by Chan et al. (2012) to calculate environmental distance between Milne Inlet and Rotterdam, the value is 3.87, which results in an *Intermediate* ranking for survival potential, which does not match the value in the BIM risk assessment (5.39, *Lower*). DFO Science has recently undertaken a national ballast water risk assessment, which incorporates ballast water exchange into the calculation for environmental similarity - International transoceanic ships arriving to Arctic ports were ranked *Highest* survival in that assessment (DFO 2014). The national risk assessment also indicates that survival potential may increase under climate change.

There also appears to be an error in the calculation of consequences. Chan et al. (2012) use a cumulative measure to calculate the number of high impact NIS potentially transported per year; in the case of Rotterdam to Milne Inlet, the calculation is 51 NIS multiplied by 55 transits (2,805; *Highest* ranking). Arctic international transoceanic shipping also received a *Highest* ranking for consequences using the refined methods of the national risk assessment.

Using the above results, the final invasion risk ranking for ballast water at Milne Inlet should be *Highest* (see Table X). Similarly, there are some details in the hull fouling risk assessment that don't match Chan et al (2012), most notably in the calculation of consequences. Reanalysis by DFO Science indicates that the final invasion risk ranking for hull fouling at Milne Inlet should also be *Highest*.

In summary, the proposed ERP would make Milne Inlet the top Arctic port at risk for aquatic nonindigenous species by both ballast water and hull fouling invasions (Table 4).

Table 4 Ballast water invasion risk ranking for transits between Milne Inlet and Rotterdam, as recalculated by DFO Science using methods and environmental data from Chan et al. (2012).

Ballast Discharge Volume	Arrival Potential Ranking	Environmental Distance	Survival Potential Ranking	Number of High Impact NIS in source Ecoregion	Magnitude of Consequence Ranking	Final Invasion Risk Ranking
66,200 – 81,263[1]	Highest	3.87[2]	Intermediate	2,805	Highest	Highest

[1]Correction factor (0.1) applied to account for risk reduction due to ballast water exchange
[2]Euclidean distance between Milne and Rotterdam, using environmental data in Chan et al. (2012)

Further, BIM included only ballast water exchange to mitigate invasion risk. Vessels will have to install ballast water management systems when the International Convention enters into force and due diligence must be taken to ensure that selected systems will meet discharge standards under the environmental conditions and timeframe of Arctic voyages, and that discharged ballast water will not negatively impact the receiving waters. DFO Science is aware that some treatment systems may require ballast water to be heated to ensure proper operation/disinfection, and that some biocides have a longer neutralization period at cold temperatures, both of which could have significant impact on the environment when ballast is discharged.

BIM does indicate that discharge of ballast water at Milne Port has the potential to alter water or sediment quality at Milne Inlet (Addendum 3.5.2). This could impact lower trophic levels including eggs and larval stages of benthic organisms.

If ballast water discharge results in the release and survival of nonindigenous species, the effect will be non-reversible.

Recommendations

When a decision about ballast treatment options is made, BIM should consider the following:

1. time required for effective treatment and the duration of the voyage from the exchange point to Milne Inlet (to determine if the treatment will have sufficient time to be fully effective),
2. source and receiving port characteristics, and
3. potential effects of treated ballast on marine organisms and communities in the Milne Inlet-Eclipse Sound area.

A contingency plan should be developed in the event that ballast water exchange or treatment is not effective.

Ships should undertake exchange plus treatment to achieve the highest risk reduction possible.

A clear standardized approach and methods need to be developed for the collection of baseline information and future monitoring in order to have the ability to detect changes in invertebrate communities that may occur as a result of species introductions or habitat alteration. Ideally methods should be consistent with those used in port surveys elsewhere in Canada by DFO and the Canadian Aquatic Invasive Species Network. Adequate baseline and monitoring of marine invertebrates requires proper coverage of different habitat types and depths and use of different complementary capture methods.

Attention to proper coverage is particularly important for benthic communities which can vary substantially by depth and habitat type (Pohle and Thomas [no date]). DFO Science recommends the use of methods that allow for the collection of infaunal (e.g., coring) as well as epifaunal (e.g., quadrat clearings) organisms in the intertidal and subtidal zones. Offshore areas should also be sampled if effects are expected to extend into greater depths. Ideally benthic surveys should be conducted as late in the season as possible to allow time for intertidal communities to fully establish following ice out.

For establishment of an adequate baseline and monitoring of zooplankton DFO Science recommends the use of complementary towing methods and mesh sizes, and sampling across seasons. Oblique tows with a larger mesh size (e.g., 250-500 µm) should be done in addition to vertical tows with a smaller mesh size (e.g., 80-160 µm) as these will encounter different species (larger, faster species in oblique versus vertical tows). Under ice sampling should be conducted in addition to open water sampling to characterize these communities which are likely to differ from open water fauna. This is particularly important given the potential environmental changes with ballast discharge that could affect ice conditions in Milne Inlet. In all cases standardization and appropriate replication should be used (consistent with published standards (e.g., see Deibel [no date], Pohle and Thomas [no date]).

3.3.10 Other impacts - increased killer whale predation

With a changing climate and a longer ice-free period, there has been an increase in the number of killer whale sightings in the Arctic (Higdon and Ferguson 2009). A pod of killer whales was observed in Milne Inlet in August 2013 (DFO unpubl. data). Killer whales are the main natural predators for narwhals and bowhead whales. Increased shipping might displace narwhals to locations where they are more at risk of killer whale predation. Shipping noise might also mask killer whales calls and decrease the chances that narwhals and bowhead whales will detect them. In addition, if shipping of iron ore was to happen early in the spring, or late in the fall, while the ice has not totally melted, or is starting to form, respectively, the constant breaking of ice by the ore carriers might allow killer whales access to narwhals and bowhead whales for longer periods.

Recommendations

BIM should monitor killer whales along the shipping route to assess impacts of the Project on killer whales and any concomitant effects on other marine mammals.

3.4 Cumulative effects

3.4.1 Cumulative effects assessment

BIM's position

BIM's position is that there is no change in the cumulative effects assessment related to noise (Vol. 9 section 1.4.1.3 and Table 9-1.4). The ERP will result in greater noise emissions at Milne Port for a longer period, but these effects do not overlap with effects from other known or reasonably foreseeable projects or activities. The only change in the Cumulative Effects Summary (Table 9-1.4) relates to whales and consequences of changes in habitat, disturbance and masking though BIM deems these impacts reversible.

DFO Science's analysis and assessment

The Government of Canada plans to develop the old Nanisivik port and plant to build a military deep-sea port in Nunavut's High Arctic. This will increase traffic and noise in the north Baffin Island area especially if construction at Nanisivik coincides with that at Milne Inlet. This may displace whales. DFO Science questions the reversibility of impact as relying on the whales to return to a habitat that has been too noisy over the life of the Project (20+ years) is a tenuous prediction.

BIM should have considered the cumulative effects of the ERP in combination with the Foxe Basin-Hudson Strait component of the Project. Various populations and stocks of marine mammal species use Baffin Bay-Davis Strait and Hudson Strait-Foxe Basin thus could be impacted by both components of the Project. The Eastern Canada-West Greenland population of bowhead whales relies on both Baffin Bay-Davis Strait and Hudson Strait-Foxe Basin making them particularly vulnerable to the overall footprint of the Project. They may be displaced to less suitable habitat or they may habituate but have reduced fitness.

The sea ice may change in the Milne Inlet RSA considering dust (e.g., from stockpiled ore) at the port all winter. This could lead to impacts on ringed seals and bearded seals which are found in the RSA year-round. Section 1.4.4.2 on marine water and sediment quality ignores the relationship between dust, albedo and ice melting. BIM does identify that the ERP will involve minor changes in marine habitat and biota and marine habitat will be altered and lost. Other habitat alterations will occur due to construction activities including propeller-generated currents and underwater noise. Dust deposition will occur from the transportation, storage and transfer of ore. Propeller-generated currents as well as underwater noise from vessels will also continue, along with the discharge of ballast water, which can alter temperature and salinity of the water column. There is also the possibility of the introduction of invasive species through ballast water discharges and hull biofouling. Similar but reduced effects will result during site closure activities such as ore dock removal. BIM considers each effect independently and predicts all are negligible. From an ecological perspective there will be cumulative effects from the combination of each of these which may not be negligible.

Recommendations

BIM must develop a monitoring plan to verify the accuracy of their conclusion about within-project cumulative effects on marine organisms.

DFO Science recommends the use of PBR to assess the cumulative impact of the proposed Project on marine mammal populations. Assuming Inuit have first priority for access to wildlife

for subsistence purposes, any additional mortality must fall within the residual (i.e., remaining) allowable harm.

3.5 Shipping

3.5.1 Accidents and malfunctions

BIM's position

The Addendum to the FEIS indicates "no change" for Volume 9 Section 3.8 Major Diesel Spill at Port or along the Shipping route. BIM concludes in the FEIS (Section 3.8 p. 101) that in 18 hours, 37% of an instantaneous release of approximately 16,000 L of diesel fuel evaporated under conditions of 10 knot winds and a water temperature similar to what could be expected during the open water shipping season. This process would be slowed in colder water and accelerated in higher winds.

Vol. 9 Section 3.9.4.2 p. 34 indicates the assessment considers fate and persistence of diesel fuel. In open water, due to weathering, over 90% of the fuel is likely to weather within 96 hour, that is, approximately 60% of the 5,000 tonnes spill would evaporate and another 30% would disperse in the water column. In a worse case, persistence of the slick would be one to two weeks. It is highly probable that 98% of the trajectories of the slick will be largely confined to a 15 km swath on each side of the spill location. Shoreline outside the swath is unlikely to be impacted.

DFO Science's analysis and assessment

In the FEIS Appendix 9C (revised Appendix 9F in the Addendum to the FEIS) figures 3 and 4 indicate the percent evaporation at 2°C over 18 hours is about 5 to 15% (not 37%) depending on fuel type which suggests that spilled fuel will remain in the environment for longer than indicated elsewhere in the document. This means that fuels spill have the potential for greater impacts on marine organisms than BIM concludes in the Addendum.

The ERP will result in significantly higher amount of shipping for the Milne Inlet Port than was considered in the FEIS. DFO Science would expect that the assessment of accidents and malfunctions would change as a result. There are changes (risk rating increases) identified in the Major Accident and Malfunctions Risk Summary in the Addendum (Table 9-3.4) contrary to BIM's indication of No Change. DFO Science does agree with BIM's evaluation of High risk of major diesel spills resulting in contamination of marine and coastal environments along the shipping route are possible with critical consequences (Table 9-3.4) which is changed from BIM's assessment in the FEIS (FEIS Table 9-3.2). However DFO Science would consider the worst-case scenario for modelling a fuel spill should be the full load of fuel rather than 10% which would change the fate and persistence of diesel fuel spill predictions. In addition, although the risk of a fuel spill is higher in port many accidents happen when navigational errors are made and response time is likely to increase the further from port this occurs. So species that occur just outside of the ship route should not have been left out of the analysis.

Recommendations

The Emergency Response and Spill Contingency Plan for marine spills must include spills that may occur along the shipping lane, not just at the port sites. Proposed spill response procedures for wildlife protection must address mitigation for marine mammals including narwhals, bowhead whales, walrus, belugas, and bearded and ringed seals.

4.0 Conclusions

Insufficient information about the entire shipping route, length of the shipping season and bulk carriers (number, types and size) is provided in the Addendum to allow a thorough assessment of Project effects on marine organism within the local and regional study areas. The shipping route from Milne Inlet through Eclipse Sound is currently relatively unexposed to industrial development and is important for several marine mammal species particularly bowhead whales and narwhals, as well as the marine communities that support them. Ringed and bearded seals use this area year-round.

DFO Science challenges BIM's predictions of no significant impacts for marine species in the Addendum to the FEIS in light of uncertainties. A scientifically rigorous approach to baseline data collection and monitoring is lacking. The baseline information presented and proposed thresholds are, in some cases, inadequate to assess potential Project effects on the marine environment either to make predictions or to monitor and, as necessary, mitigate them. Many key components of the ecosystem received little consideration in the Addendum. There was limited or no discussion of trophic or sub-lethal effects resulting from the Project. The Addendum also does not adequately address the issue of displacement of marine mammals or the long-term effects of habituation on fitness of individual animals and consequences to the stock/population as a whole. Impacts of vessels on marine mammals through noise (disturbance and acoustic masking) and ship strikes were not adequately assessed and proposed monitoring and mitigation measures are unlikely to address the impacts that may occur. The proposed ERP would make Milne Inlet the top Arctic port at risk for aquatic nonindigenous species by both ballast water and hull fouling invasions. If ballast water discharge results in the release and survival of nonindigenous species, the effect will be non-reversible. More consideration needs to be given to the potential for accidents and malfunctions along the shipping route where emergency response will be more difficult.

DFO Science disagrees with BIM's overall conclusion that the proposed project operations will cause no significant impacts on the marine environment. The cumulative effects assessment is not sufficiently comprehensive or quantitative to allow for a thorough environmental impact assessment of the Project. Given gaps in current knowledge, inclement weather, remoteness, the potential for unexpected accidents and malfunctions, and uncertainty in the effects assessment, DFO Science recommends that the Proponent undertake additional well-designed baseline studies and develop effective monitoring and mitigations plans as a precautionary approach before the Project gets underway. Baseline studies and monitoring plans must have sufficient precision to allow early detection and effective mitigation of project impacts.

Many of the concerns identified during the review of the FEIS (DFO 2012b) would also apply to the Project proposed for the ERP.

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(Approved 15 October 2013).

7.0 Sources of Information

This Science Response Report results from the Science Response Process of September 19, 2013 on the science review of the addendum to the final environmental impact statement for Baffinland's Mary River Project.

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Appendix 1.

NIRB Project Certificate No. 005 for the Baffinland Iron Mines Corporation development of the Mary River Project Proposal in the Qikiqtani Region of Nunavut, December 28, 2012.

Project-specific terms and conditions related to marine aquatic species and habitats were evaluated. Those that should apply to the Early Revenue Phase of the Mary River Project are identified and any changes needed for the ERP described.

PROJECT-SPECIFIC TERMS AND CONDITIONS

Ecosystemic Terms and Conditions

Meteorology and Climate (including Climate Change)

Term and Condition No.	**1** – Should be updated to include the Milne Inlet Port because of its potential impacts on timing and duration of shipping season and relationship to shipping impacts.
Term or Condition:	The Proponent shall use GPS monitoring or a similar means of monitoring at both port sites and will also use tide gauges at the Steensby Port *and Milne Inlet Port sites* to monitor the relative sea levels and storm surges at these sites.

Term and Condition No.	**2** – General condition that should apply to the ERP.
Term or Condition:	The Proponent shall provide the results of any new or revised assessments and studies done to validate and update climate change impact predictions for the Project and the effects of the Project on climate change in the Local Study Area and Regional Study Area as defined in the Proponent's Final Environmental Impact Statement.

Air Quality

Term and Condition No.	**10** – Should also monitor dust at the Milne Inlet Port site where ore will be stockpiled and out from the port site to confirm the extent of dust deposition.
Term or Condition:	The Proponent shall update its Dust Management and Monitoring Plan to address and/or include the following additional items: a. Outline the specific plans for monitoring dust along the first few kilometres of the rail corridor leaving the Mary River mine site *and at the Milne Inlet Port site*. b. Identify the specific adaptive management measures to be considered should monitoring indicate that dust deposition from trains transporting along the rail route *and from the Milne Inlet Port site are* greater than initially predicted.

Marine Environment, Marine Water/Ice and Sediment Quality

Term and Condition No.	**76** – General condition that should apply to the ERP.
Term or Condition:	The Proponent shall develop a comprehensive Environmental Effects Monitoring Program to address concerns and identify potential impacts of the Project on the marine environment.

Term and Condition No.	**77** – General condition that should apply to the ERP.
Term or Condition:	A Marine Environment Working Group ("MEWG") shall be established to serve as an advisory group in connection with mitigation measures for the protection of the marine environment, and in connection with the Project Environmental Effects Monitoring program, as it pertains to the marine environment. Membership on the MEWG will include the Proponent, Environment Canada, Fisheries and Oceans Canada, the Government of Nunavut, the Qikiqtani Inuit Association and other agencies or interested parties as determined to be appropriate by these key members. Makivik Corporation shall also be entitled to membership on the MEWG at its election. The MEWG members may consider the draft terms of reference for the MEWG filed in the Final Hearing, but they are not bound by them.

Term and Condition No.	**78** – This would only be applicable to the ERP if shipping occurred while there was landfast and/or pack ice present in the Milne Inlet -Eclipse Sound area.
Term or Condition:	The Proponent shall update the baseline information for landfast ice using a long-term dataset (28 years), and with information on inter-annual variation. The analysis for pack and landfast ice shall be updated annually using annual sea ice data (floe size, cover, concentration) and synthesized and reported in the most appropriate management plan.

Commentary: The annual update for pack and landfast ice includes not only identification of naturally-occurring effects, but also must include information on effects on floe size, cover and concentration of pack and landfast ice that may be attributed to icebreaking activities.

Term and Condition No.	**79** –This term and condition will apply to the ERP but needs to be revised as indicated below.
Term or Condition:	*The Proponent shall coordinate with the Canadian Hydrographic Service (CHS) to ensure modern bathymetric data and other relevant information is collected to CHS standards in order to support the development of nautical charts for those Canadian waters affected by the Project.*

Term and Condition No.	**80** – General condition that should apply to the ERP.[4]
Term or Condition:	Prior to commercial shipping of iron ore, the Proponent shall conduct a detailed risk assessment for Project-related shipping accidents, noting areas along the ship tracks where vessels may be particularly vulnerable to environmental conditions such as sea ice, and any seasonal differences in risk. This assessment shall inform mitigation and adaptive management plans.

Term and Condition No.	**81** – General condition that should be applied to the ERP.
Term or Condition:	The Proponent shall reassess the potential for ship wake impacts to cause coastal change following any further changes to the proposed shipping routes.

Term and Condition No.	**82** – Although this relates to the new- build Steensby ore carriers, ship wake characteristics may be considerations for evaluating impacts of various bulk carriers. This should be a characteristic identified in the checklist.
Term or Condition:	The Proponent is strongly encouraged to have its ore carriers subjected to sea trials to measure wake characteristics at various vessel speeds and distances from the vessel.

Term and Condition No.	**83** – This should be revised to include the Milne Inlet Port site.
Term or Condition:	The Proponent shall install tidal gauges at the Steensby Inlet Port *and Milne Inlet Port sites* to monitor relative sea level and storm surges.

Term and Condition No.	**84** – This applies to the Steensby new-build ore carriers.
Term or Condition:	The Proponent shall update its sediment redistribution modeling once ship design has been completed and sampling should be undertaken to validate the model and to inform sampling sites and the monitoring plan.

[4] The Canadian Hydrographic Service was identified as a Responsible Party for this Term and Condition but their mandate is not to provide navigational advice.

Term and Condition No.	**85** – This should apply for the ERP. Bathymetric charts are needed to verify the location of shallow areas.
Term or Condition:	The Proponent shall develop a monitoring plan to verify its impact predictions associated with sediment redistribution resulting from propeller wash in shallow water locations along the shipping route. If monitoring detects negative impacts from sediment redistribution, additional mitigation measures will need to be developed and implemented.

Term and Condition No.	**86** – This should be revised to apply to Milne Inlet. Modelling has now been done for both ports so the sampling to validate the model, inform sampling sites and the monitoring plan remains.
Term or Condition:	Prior to commercial shipping of iron ore, the Proponent shall use more detailed bathymetry collected from Steensby Inlet *and Milne Inlet* to model the anticipated ballast water discharges from ore carriers. The results from this modeling shall be used to update ballast water discharge impact predictions and should account for density dependent flow and annual timescales over the Project life. Additional sampling should also be undertaken to validate the model and to inform sampling sites and the monitoring plan.

Term and Condition No.	**87** – Should be revised to apply to the ERP.
Term or Condition:	The Proponent shall develop a detailed monitoring program at a number of sites over the long term to evaluate changes to marine habitat and organisms and to monitor for non-native introductions resulting from Project-related shipping. This program needs to be able to detect changes that may have biological consequences and should be initiated several years prior to any ballast water discharge into Steensby Inlet *and Milne Inlet* to collect sufficient baseline data and should continue over the life of the Project.

Term and Condition No.	**88** – Should be applied to the ERP. A preliminary risk assessment was undertaken, it should be updated once accurate details on the number, type of ships, location of ports, etc., are known.
Term or Condition:	Prior to commercial shipping of iron ore and in conjunction with the Marine Environment Working Group, the Proponent shall complete a risk analysis regarding ballast water discharge to assess the adequacy of treatment and implications on the receiving environment. This risk analysis shall consider, but not be limited to: a. Invasive species; b. Seasonal oceanography; c. Ballast water quality and quantity; d. Receiving water quality; and e. Residual physical, chemical, and/or biological effects.

Term and Condition No.	**89** – Should be applied to the ERP.
Term or Condition:	The Proponent shall develop and implement an effective ballast water management program that may include the treatment and monitoring of ballast water discharges in a manner consistent with applicable regulations and/or that may exceed the regulations if the regulations are determined to be ineffective for providing the desired and predicted results.

Term and Condition No.	**90** – Should be applied to the ERP. This should be updated as the Convention is updated.
Term or Condition:	The Proponent shall incorporate into its Shipping and Marine Mammals Management Plan provisions to achieve compliance with the requirements under the International Convention for the Control and Management of Ship's Ballast Water and Sediment (2004).

Term and Condition No.	**91** – Should be applied to the ERP.
Term or Condition:	The Proponent shall develop a detailed monitoring plan for fouling that includes sampling areas on ships where antifouling treatment is not applied such as the areas where non-native species are most likely to occur.

Term and Condition No.	**92** – Should be applied to the ERP.
Term or Condition:	The Proponent shall ensure that it maintains the necessary equipment and trained personnel to respond to all sizes of potential spills associated with the Project in a self-sufficient manner.

Term and Condition No.	**93** – If vessel-based fuel storage at Milne Inlet is planned then this would apply. This would be a high risk activity in the Milne Inlet-Eclipse Sound area.
Term or Condition:	Prior to construction, based on vessel selection and if so required, the Proponent shall reassess the risk analysis of using vessel-based fuel storage, including the potential environmental impacts of containment failure under a range of winter ice conditions, how a spill might spread and the impact of fuel if it does not volatilize to the atmosphere.

Term and Condition No.	**95** – If vessel-based fuel storage at Milne Inlet is planned then this would apply. This would be a high risk activity in the Milne Inlet-Eclipse Sound area.
Term or Condition:	The Proponent shall meet or exceed all regulatory regulations and requirements as apply to the practice of overwintering a fuel vessel at Steensby Inlet, with reporting to the NIRB and Transport Canada.

Term and Condition No.	**97** – This should be revised for the ERP.
Term or Condition:	Prior to the commercial shipping of iron ore, the Proponent shall conduct fuel spill dispersion modeling that will, at a minimum, consider: a. Modeling of oil spills in the following areas: I. Pinch points, including: the mouth of Hudson Strait, the Resolution Island Area, the West End of Hudson Strait and Nottingham Island Area; and for Milne Inlet route: Assomption Harbour-southern Milne Inlet, Bruce Head, Stephens Island, Pisiktarfik Island-Ragged Island, and narrow portion of Pond Inlet; II. The approach into Steensby Inlet and Milne Inlet; III. iShallow water and shorelines; and, IV. Areas that have been identified as having high flows and/or high concentrations of marine mammals, marine fish or seabirds. b. Open water and ice-covered conditions; c. Spill volumes up to and including loss of a full tanker cargo; and d. Differences in the quantity and properties of each type of bulk fuel transported by vessels when they are at, or in transit to, the ports at Steensby Inlet and Milne Inlet.

Term and Condition No.	**98** – This should be applied to the ERP.
Term or Condition:	The Proponent shall incorporate the results of revised fuel spill dispersion modeling into its impact predictions for the marine environment and its spill response and emergency preparedness plans.

Marine Wildlife and Marine Habitat

Term and Condition No.	**99** – This should be revised for the ERP.
Term or Condition:	The Proponent, working with the Marine Environment Working Group, shall consider and identify priorities for conducting the following supplemental baseline assessments: a. Establish an all-season, inter-annual baseline in Steensby Inlet *and Milne Inlet-Eclipse Sound* that enables effective monitoring of physical and chemical effects of ballast water releases, sewage outfall, and bottom scour by ship props, particularly downslope and downstream from the docks. This shall include the selection and identification of physical, chemical, and biological community/indicator components. The biological indicators shall include both pelagic and benthic species but with emphasis on relatively sedentary benthic species (e.g. sculpins). b. The collection of additional baseline data in Steensby Inlet on walrus, beluga, bearded seal and anadromous Arctic Char abundance, distribution ecology and habitat use. *The collection of additional baseline data in Milne Inlet-Eclipse Sound on narwhal, bowhead whales, bearded and ringed seals, and anadromous Arctic Char using the best survey techniques (e.g., double platform line transect surveys corrected for biases for marine mammals).* c. Enhance baseline data on marine wildlife (fish, invertebrates, birds, mammals, etc.) and to provide more details on species abundance and distribution found in the Project area. This shall include, but not be limited to the following: i. Aerial surveys for basking ringed seals throughout the landfast ice of Steensby Inlet and at appropriate control location; and ii. ii. Shore-based observations of pre-Project narwhal *and bowhead whale* behavior in Milne Inlet-*Eclipse Sound*. d. Enhance the baseline for affected marine systems, which includes control sites to detect Project-related changes before they cause significant harm.

Term and Condition No.	**100** – Should be applied to the ERP for the start and end of the open-water shipping season when ice occurs.
Term or Condition:	The Proponent shall update its Shipping and Marine Wildlife Management Plan, to include avoidance of polynyas and mitigation measures designed for potential fuel spills along the shipping lane during the winter months, with consideration for the impact of spilled fuel on marine mammals when they might be less mobile or able to avoid contact with spilt fuel or fumes.

Term and Condition No.	**101** – Should apply for the ERP (b, c, d, e, g, i).
Term or Condition:	The Proponent shall incorporate into the appropriate monitoring plans the following items: a. A monitoring program that focuses on walrus use of Steensby Inlet and their reaction to disturbance from construction activities, aircraft, and vessels; b. Efforts to involve Inuit in monitoring studies at all levels; c. Monitoring protocols that are responsive to Inuit concerns; d. Marine monitoring protocols are to consider the use of additional detecting devices to ensure adequate monitoring through changing seasonal conditions and daylight; e. Schedule for periodic aerial surveys as recommended by the Marine Environment Working Group; f. Periodic aerial surveys for basking ringed seals throughout the landfast ice of Steensby Inlet, and a suitable control location. Surveys shall be conducted at an appropriate frequency to detect change inter-annual variability; g. Shore-based observations of pre-Project narwhal behavior in Milne Inlet; h. Conduct landfast ice monitoring for the duration of the Project Operations phase, which will include: i. The number of ship transits that are able to use the same track; and, ii. The area of landfast ice disrupted annually by ship traffic; and i. Monitoring strategy focused on assessing and mitigating interaction between humans and wildlife at the port site(s).

Term and Condition No.	**103** – Should be applied to the ERP.
Term or Condition:	The Proponent shall report annually to the NIRB regarding project-related ship track and sea ice information, including: a. A record of all ship tracks taken along both shipping routes covering the entire shipping season; b. An overlay of ship tracks onto ice imagery to determine whether ships are effectively avoiding shore leads and polynyas; c. A comparison of recorded ship tracks to the expected nominal shipping route, and probable extent of year-round shipping during periods of ice cover and open-water; d. An assessment of the level of adherence to the nominal shipping route and the spatial extent of the shipping zone of influence; and e. Marine bird and mammal species and number of individuals attracted to ship tracks in ice.

Term and Condition No.	**104** – Should be applied to the ERP summarizing all incidences of deviations from the nominal shipping route that should be identified in the Addendum to the FEIS for the ERP.
Term or Condition:	Subject to safety considerations and the potential for conditions as determined by the crew of transiting vessels, to result in route deviations, the Proponent shall require project vessels to maintain a route to the south of Mill Island to prevent disturbance to walrus and walrus habitat on the northern shore of Mill Island. Where project vessels are required to transit to the north of Mill Island owing to environmental or other conditions, an incident report is to be provided to the Marine Environment Working Group and the NIRB within 30 days, noting all wildlife sightings and interactions as recorded by shipboard monitors. The Proponent shall summarize all incidences of deviations from the nominal shipping route as presented in the FEIS to the NIRB annually, with corresponding discussion regarding justification for deviations and any observed environmental impacts.

Term and Condition No.	**105** – Should be applied to the ERP. Section A and B apply. A. should not be limited to Hudson Strait.
Term or Condition:	The Proponent shall ensure that measures to reduce the potential for interaction with marine mammals, particularly in Hudson Strait, are identified and implemented prior to commencement of shipping operations. These measures could include, but are not limited to: a. Changes in the frequency and timing (including periodic suspensions) of shipping during winter months, i.e., when interactions with marine mammals are likely to be the most problematic; b. Reduced shipping speeds where ship-marine mammal interactions are most likely; and c. Identification of alternate shipping routes through Hudson Strait for use when conflicts between the proposed routes and marine mammals could arise. Repeated winter aerial survey results showing marine mammal distribution and densities in Hudson Strait would greatly assist in this task.

Commentary: Unless otherwise stated, the term "marine mammals" as used throughout the Project Certificate includes polar bears.

Term and Condition No.	**106** – Should be applied to the ERP.
Term or Condition:	The Proponent shall ensure that shipboard observers are employed through all seasons and provided with the means to effectively carry out assigned duties. The role of shipboard observers in shipping operations should be taken into consideration during the design of ore carriers, with climate controlled stations and shipboard lighting incorporated to permit visual sightings by shipboard observers during all seasons and conditions.
Term and Condition No.	**107** – Should be applied to the ERP.
Term or Condition:	The Proponent shall revise the proposed "surveillance monitoring" to improve the likelihood of detecting strong marine mammal responses occurring too far ahead of the ship to be detectable by observers aboard the ore carriers. A baseline study early in the shipping operations could employ additional surveillance to detect potential changes in distribution patterns and behavior. At an ambitious scope, this might be achieved using unmanned aircraft flown well ahead of ships, or over haul-out sites in the case of walruses.

Term and Condition No.	**108** – Should be applied to the ERP.
Term or Condition:	The Proponent shall ensure that data produced by the surveillance monitoring program is analysed rigorously by experienced analysts (in addition to being discussed as proposed in the FEIS) to maximize their effectiveness in providing baseline information, and for detecting potential effects of the Project on marine mammals in the Regional Study Area. It is expected that data from the long-term monitoring program be treated with the same rigor.

Term and Condition No.	**109** – Should be applied to the ERP.
Term or Condition:	The Proponent shall conduct a monitoring program to confirm the predictions in the FEIS with respect to disturbance effects from ships noise on the distribution and occurrence of marine mammals. The survey shall be designed to address effects during all seasons of the year, and include locations in Hudson Strait and Foxe Basin. The survey shall continue over a sufficiently lengthy period to determine the extent to which acclimation occurs for narwhal, beluga, bowhead and walrus. *Studies should be done with different environmental conditions (wind, waves) and should be based on the real dissipation of sound from sources (ships and pile driving).*

Term and Condition No.	**110** – Should be applied to the ERP (e.g., should follow the Population Consequence of Acoustic Disturbance (PCAD) program in the design of their acoustic monitoring program).
Term or Condition:	The Proponent shall develop a monitoring protocol that includes, but is not limited to, acoustical monitoring, to facilitate assessment of the potential short term, long term, and cumulative effects of vessel noise on marine mammals and marine mammal populations. The Proponent is expected to work with the Marine Environment Working Group to determine appropriate early warning indicator(s) that will ensure rapid identification of negative impacts.

Term and Condition No.	**111** – Should be applied to the ERP.
Term or Condition:	The Proponent shall develop clear thresholds for determining if negative impacts as a result of vessel noise are occurring. Mitigation and adaptive management practices shall be developed to restrict negative impacts as a result of vessel noise. This shall include, but not be limited to: a. Identifications of zones where cumulative noise could be mitigated due to biophysical features (e.g., water depth, distance from migration routes, distance from overwintering areas etc.); and b. Vessel transit planning, for all seasons, to determine the degree to which cumulative sound impacts can be mitigated through the seasonal use of different zones.

Term and Condition No.	**112** – Should be applied to the ERP.
Term or Condition:	Prior to commercial shipping of iron ore, the Proponent, in conjunction with the Marine Environment Working Group, shall develop a monitoring protocol that includes, but is not limited to, acoustical monitoring that provides an assessment of the negative effects (short and long term cumulative) of vessel noise on marine mammals. Monitoring protocols will need to carefully consider the early warning indicator(s) that will be best examined to ensure rapid identification of negative impacts. Thresholds shall be developed to determine if negative impacts as a result of vessel noise are occurring. Mitigation and adaptive management practices shall be developed to restrict negative impacts as a result of vessel noise. This shall include, but not be limited to: a. Identification of zones where noise could be mitigated due to biophysical features (e.g., water depth, distance from migration routes, distance from overwintering areas etc.); b. Vessel transit planning, for all seasons. c. A monitoring and mitigation plan is to be developed, and approved by Fisheries and Oceans Canada prior to the commencement of blasting in marine areas.

Term and Condition No.	**113** – Should be revised for the ERP.
Term or Condition:	The Proponent shall conduct monitoring of marine fish and fish habitat, which includes but is not limited to, monitoring for Arctic Char stock size and health condition in Steensby Inlet *and Milne Inlet*, as recommended by the Marine Environment Working Group.

Term and Condition No.	**114** – This should be revised for the ERP. Several areas are important for Arctic Char fisheries and there may be other possibilities for other fisheries in Milne Inlet-Eclipse Sound area.
Term or Condition:	In the event of the development of a commercial fishery in the Steensby Inlet *and Milne Inlet-Eclipse Sound areas*, the Proponent, in conjunction with the Marine Environment Working Group, shall update its monitoring program for marine fish and fish habitat to ensure that the ability to identify Arctic Char stock(s) potentially affected by Project activities and monitor for changes in stock size and structure of affected stocks and fish health (condition, taste) is maintained.

Term and Condition No.	**115** – Should be revised for the ERP and meet all provisions of the new *Fisheries Act.*
Term or Condition:	The Proponent is encouraged to continue to explore off-setting options in both the freshwater and marine environment to offset the Harmful Alteration, Disruption or Destruction of Fish and Fish Habitat (HADD).

Term and Condition No.	**116** – Should be applied to the ERP.
Term or Condition:	Prior to construction, the Proponent shall develop additional mitigation measures to minimize the effects of blasting on marine fish and fish habitat, marine water quality and wildlife that includes, but is not limited to compliance with the Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky, 1998) as modified by Fisheries and Oceans Canada for use in the North.

Term and Condition No.	**117** – Should be applied to the ERP.
Term or Condition:	The Proponent shall ensure that blasting in, and near, marine water shall only occur during periods of open water. Blasting in, and near, fish-bearing freshwaters shall, to the greatest degree possible, only occur in open water. If blasting is required during ice-covered periods, it must meet requirements established by Fisheries and Oceans Canada.

Term and Condition No.	**118** – General condition that should apply to the ERP.
Term or Condition:	The Proponent shall incorporate into the appropriate mitigation plan prior to construction, thresholds for the use of specific mitigation measures meant to prevent or limit marine wildlife disturbance, such as bubble curtains for blasting, and nitrate removal.

Term and Condition No.	**119** – As there is no ice-breaking identified for the ERP this condition as written would not apply to the ERP.
Term or Condition:	The Proponent shall, in conjunction with the Marine Environment Working Group, monitor ringed seal birth lair abundance and distribution for at least two years prior to the start of icebreaking to develop a baseline, with continued monitoring over the life of the Project as necessary to test the accuracy of the impact predictions and determine if mitigation is needed. Monitoring shall also include a control site outside of the Project's zone of influence.

Term and Condition No.	**120** – General condition that should apply to the ERP.
Term or Condition:	The Proponent shall ensure that, subject to vessel and human safety considerations, all project shipping adhere to the following mitigation procedures while in the vicinity of marine mammals: a. Wildlife will be given right of way; b. Ships will when possible, maintain a straight course and constant speed, avoiding erratic behavior; and c. When marine mammals appear to be trapped or disturbed by vessel movements, the vessel will implement appropriate measures to mitigate disturbance, including stoppage of movement until wildlife have moved away from the immediate area.

Commentary: As noted previously, unless otherwise stated, the term "marine mammals" as used throughout the Project Certificate includes polar bears.

Term and Condition No.	**121** – Should be applied to the ERP.
Term or Condition:	The Proponent shall immediately report any accidental contact by project vessels with marine mammals or seabird colonies to Fisheries and Oceans Canada and Environment Canada respectively, by notifying the appropriate regional office of the: a. Date, time and location of the incident; b. Species of marine mammal or seabird involved; c. Circumstances of the incident; d. Weather and sea conditions at the time; e. Observed state of the marine mammal or sea bird colony after the incident; and, f. Direction of travel of the marine mammal after the incident, to the extent that it can be determined.

Term and Condition No.	**122** – Should be applied to the ERP.
Term or Condition:	The Proponent shall summarize and report annually to the NIRB regarding accidental contact by project vessels with marine mammals or seabird colonies through the applicable monitoring report.

Term and Condition No.	**123** – Should be applied to the ERP.
Term or Condition:	The Proponent shall provide sufficient marine mammal observer coverage on project vessels to ensure that collisions with marine mammals and seabird colonies are observed and reported through the life of the Project. The marine wildlife observer protocol shall include, but not be limited to, protocols for marine mammals, seabirds, and environmental conditions and immediate reporting of significant observations to the ship masters of other vessels along the shipping route, as part of the adaptive management program to address any items that require immediate action.

Term and Condition No.	**124** – Should apply to Milne Inlet.
Term or Condition:	The Proponent shall prohibit project employees from recreational boating, fishing, and harvesting of marine wildlife in project areas, including Steensby Inlet and Milne Inlet. The Proponent is not directed to interfere with harvesting by the public in or near project areas, however, enforcement of a general prohibition on harvesting in project areas by project employees during periods of active employment (i.e. while on site and between work shifts) is required.

Other Terms and Conditions

Accidents and Malfunctions

Term and Condition No.	**172** – If vessel-based fuel storage at Milne Inlet is planned then this would apply. This would be a high risk activity in the Milne Inlet-Eclipse Sound area.
Term or Condition:	The Proponent is encouraged to provide the Government of Nunavut with evidence that the vessel that it intends to use for the overwintering of fuel has been designed and certified for use under the conditions which it is expected to operate, and that it be required to provide copies of the vessel owners' insurance policies.

Term and Condition No.	**173** – General condition that should apply to the ERP.
Term or Condition:	The Proponent shall employ full containment booms during all ship-to-shore and other marine-based fuel transfer events.

Term and Condition No.	**176** – Should be revised to include specific spill trajectory models for the ERP.
Term or Condition:	The Proponent is required to revise its spill planning to include additional trajectory modeling for areas of Hudson Strait, such as Mill Island, where walrus concentrate, as well as for mid-Hudson Strait during winter conditions, *and Milne Inlet-Eclipse Sound-Pond Inlet*.

Term and Condition No.	**177** – General condition that should apply to the ERP.
Term or Condition:	The Proponent shall enroll any foreign flagged vessels commissioned for Project-related shipping within Canadian waters into the relevant foreign program equivalent to Transport Canada's Marine Safety Delegated Statutory Inspection Program.

Alternatives Analysis

Term and Condition No.	**178** – Does not apply to the ERP.
Term or Condition:	Subject to safety considerations and the potential for conditions, as determined by the crew of transiting vessels, to result in route deviations, the Proponent shall require project vessels to maintain a route to the south of Mill Island to prevent disturbance to walrus and walrus habitat on the northern shore of Mill Island.

Operational Variability

Term and Condition No.	**179** – Should apply to the ERP. It is unclear in the Addendum how many transits are planned but presumably the same restrictions for open-water transits should also apply to Milne Inlet.
Term or Condition:	Baffinland shall not exceed 20 ore carrier transits to Steensby Port per month during the open water season and 242 transits per year in total.

Transboundary Effects

Term and Condition No.	**180** – Should be updated for transboundary effects with Greenland if the shipping route crosses into Greenland waters.
Term or Condition:	The Marine Environment Working Group established for this Project shall invite a representative from Makivik Corporation to be a member of the Group.

Term and Condition No.	**181**– Should be updated for transboundary effects with Greenland if the shipping route crosses into Greenland waters.
Term or Condition:	Regardless of whether Makivik Corporation participates as a member of the Marine Environment Working Group, the Marine Environment Working Group will provide Makivik Corporation with regular updates regarding the activities of the Marine Environment Working Group throughout the Project life cycle.

Term and Condition No.	**182**– Should be updated for transboundary effects with Greenland if the shipping route crosses into Greenland waters.
Term or Condition:	Baffinland shall make available to Makivik Corporation any ship route deviation reports provided to the NIRB in accordance with the terms and conditions set out in Section 4.12.4 of the Final Hearing Report.

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