Kiggavik Project
Final Environmental Impact Statement

Tier 2 Volume 7: Marine Environment

September 2014

History of Revisions

Revision Number	Date	Details of Revisions
01	December 2011	Initial release Draft Environmental Impact Statement (DEIS)
02	September 2014	FINAL Environmental Impact Statement

Foreword

The enclosed document forms part of the Kiggavik Project Final Environmental Impact Statement (FEIS) submission, presenting potential environmental and social impacts to determine if the Project should proceed and if so, under what terms and conditions. The submission has been prepared for the Nunavut Impact Review Board by AREVA Resources Canada Inc. to fulfill the requirements of the "Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc.'s Kiggavik Project (NIRB File No. 09MN003)", to include new material or clarity provided during the review of the Draft Environmental Impact Statement, and to address company commitments and direction from the Nunavut Impact Review Board as outlined in the "Preliminary Hearing Conference Decision Concerning the Kiggavik Project (NIRB File No. 09MN003)".

The FEIS submission consists of a number of documents, as shown in the attached road map. These documents have been categorized into tiers, as follows:

- **Tier 1** document (Volume 1) provides a plain language summary of the Final Environmental Impact Statement.

- **Tier 2** documents (Volumes 2 to 10) contain technical information and provide the details of the assessments of potential Project environmental effects for each environmental compartment. Tier 2 Volume 11 contains executive, popular, and volume summaries in Inuktitut.

- The Tier 2 documents each have a number of technical appendices, which comprise the **Tier 3** supporting documents. These include the environmental baseline reports, design reports, modelling reports and details of other studies undertaken to support the assessments of environmental effects. Management plans are provided as Tier 3 documents.

Authorship

Sections 1 and 2 and 3 volume are authored by AREVA, Section 3 by Pat Vonk and Sections 4 to 10 by Janine Beckett, M.Sc., R.P. Bio and Michelle Marcotte, M.Sc., R.P.Bio, both of Stantec Consulting.

Volume 1
Main Document

Volume 2 Project Description and Assessment Basis

- Governance and Regulatory Oversight
- Project Description
- Assessment Basis

2A Alternatives Assessment
2B Drilling and Blasting Design
2C Explosives Management Plan
2D Design of Ore and Mine Rock Pads and Ponds
2E Water Diversion and Collection Design
2F Design of Andrew Lake Dewatering Structure
2G Kiggavik-Sissons Road Report
2H Ore Storage Management Plan
2I Water Management Plan
2J Marine Transportation
2K Winter Road Report
2L All-Season Road Report
2M Roads Management Plan
2N Borrow Pits and Quarry Management Plan
2O Mine Site Airstrip Report
2P Occupational Health and Safety Plan
2Q Radiation Protection Plan
2R Preliminary Decommissioning Plan
2S Waste Management Plan
2T Environmental Management Plan
2U Hazardous Materials Management Plan
2V Mine Geotechnical Reports

Volume 3 Public Engagement and Inuit Qaujimajatuqangit

Part 1
- Public Engagement

Part 2
- Inuit Qaujimajatuqangit

3A Public Engagement Documentation
3B Inuit Qaujimajatuqngit Documentation
3C Community Involvement Plan

Volume 4 Atmospheric Environment

Part 1
- Air Quality and Climate Change

Part 2
- Noise and Vibration

4A Climate Baseline
4B Air Dispersion Assessment
4C Air Quality Monitoring Plan
4D Baker Lake Long-Term Climate Scenario
4E Noise and Vibration Assessment
4F Noise Abatement Plan

Volume 5 Aquatic Environment

- Surface Hydrology
- Hydrogeology
- Water and Sediment Quality
- Aquatic Organisms
- Fish and Fish Habitat

5A Hydrology Baseline
5B Geology and Hydrogeology Baseline
5C Aquatics Baseline
5D Groundwater Flow Model
5E Prediction of Water Inflows to Kiggavik Project Mines
5F Mine Rock Characterization and Management
5G Thermal and Water Transport Modelling for the Waste Rock Piles and Tailings Management Facilities
5H Waste Rock Water Balance
5I Hydrology of Waste Rock Piles in Cold Climates
5J Tailings Characterization and Management
5K Historical and Climate Change Water Balance
5L Kiggavik Conceptual Fisheries Offsetting Plan
5M Aquatics Effects Monitoring Plan
5N Hydrology Assessments
5O Sediment and Erosion Control Plan
5P Technical Assessments of Water Withdrawal Locations and Baker Lake Dock Site

Volume 6 Terrestrial Environment

- Terrain
- Soils
- Vegetation
- Terrestrial Wildlife

6A Surficial Geology and Terrain Baseline
6B Vegetation and Soils Baseline
6C Wildlife Baseline
6D Wildlife Mitigation and Monitoring Plan

Volume 7 Marine Environment

- Marine Water and Sediment Quality
- Marine Mammals
- Marine Fish

7A Marine Environment Baseline
7B Underwater Acoustic Modelling

Volume 8 Human Health

- Occupational Dose Assessments
- Human Health Risk Assessment

8A Ecological and Human Health Risk Assessment
8B Radiation Protection Supporting Document

Volume 9 Socio-Economic Environment and Community

Part 1
- Socio-Economic Environment

Part 2
- Heritage Resources

9A Socio-Economic Baseline
9B Archaeology Baseline
9C Human Resources Development Plan
9D Archaeological Resource Management Plan

Volume 10 Accidents, Malfunctions and Effects of the Environment on the Project

- Risk Assessments
- Effects of the Environment on the Project

10A Transportation Risk Assessment
10B Spill Contingency and Landfarm Management Plan
10C Emergency Response Plan

Volume 11 Executive, Popular and Volume Summaries Translated into Inuktitut

KEY:

Tier 1 Document	Tier 2 Document	Tier 3 Document
Main Documents	Environmental Effects Assessment Report	Technical Appendices, Baseline Reports, Technical Development and Management Plans

Executive Summary

As per the guidelines issued by the Nunavut Impact Review Board (NIRB 2011), AREVA Resources Canada Ltd. has prepared this volume of the Environmental Impact Statement (EIS) to assess the potential environmental effects of marine transportation associated with the Kiggavik Project (the Project). The primary component considered in the marine assessment is vessel operations in Nunavut waters. This includes routine activities associated with marine transport of supplies to support the construction, operation and closure of the Project. Issues associated with accidents and malfunctions in the marine environment are addressed in Volume 10. The dock facility is not assessed for its effect on the selected Marine Environment VECs because it is located within a freshwater environment (i.e., Baker Lake). Potential effects of the Baker Lake dock facility on the freshwater environment are assessed in Volume 5.

Scope of the Assessment

The NIRB developed the scope of assessment for the Project based on input from Inuit, government, and other interested stakeholders.

Inuit stakeholders have played a fundamental role in raising awareness of potential Project interactions with the marine environment. Through Inuit Qaujimajatuqangit (IQ) interviews and engagement activities, AREVA has learned about the importance of the marine environment to Kivalliq community members. This includes the value of marine resources to the Inuit way of life (IQ-CIHT 2009[1]) and importance of protecting the environment (EN-BL NIRB April 2010[2]). Issues and concerns raised about the marine environment were related to underwater noise (IQ-CIHT 2011[3], EN-CI OH Nov 2012[4], IQ-CI04 2009[5]), physical presence and movement of vessels (EN-RI KWB Jun 2012[6], EN-CH OH Nov 2010[7]), bilge and ballast water (EN-CI OH Nov 2013[8]),and effects of climate change on the Project (EN-CH OH Nov 2010[9]).

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[1] IQ-CIHT 2009: *The people of Chesterfield continue to primarily depend on caribou, fish and seal. Consuming country food is not considered 'ritual food' but the daily way of life.*

[2] EN-BL NIRB April 2010: *Important that the company respect and protect the land, water and animals.*

[3] IQ-CIHT 2011: *Heard there would be more barge traffic this summer and this will frighten mammals because they have sensitive ears*.

[4] EN-CI OH Nov 2012: *Underwater mammals can hear from very far away.*

[5] IQ-CI04 2009: *Seals are also affected by noise from marine transportation*

[6] EN-RI KWB Jun 2012: *We never see harp seals any more. With traffic from ships, there will be a lot of disturbance.*

[7] EN-CH OH Nov 2010: *Concerned about amount of barge traffic near the Kivalliq coast. Have noticed fewer seals and beluga in the area.*

[8] EN-CI OH Nov 2013: *What about ballast water and pollution? We need to protect the waters and the project wil affect these things.*

[9] EN-CH OH Nov 2010: *This year there is no ice only a bit so they still have the boats out its not normal. It is because of the climate change, global warming. It's too warm so there is no ice.*

Regulatory considerations pertaining to the marine assessment include the *Fisheries Act* (protects fish and fish habitat), the *Species at Risk Act* (SARA, protects species of conservation concern), the *Nunavut Wildlife Act* (manages wildlife in Nunavut), and the *Nunavut Land Claims Agreement* (land use planning and natural resource management).

Marine transportation activities associated with the Project are not expected to affect marine birds, benthic invertebrates, marine vegetation, sediment quality or water quality. Marine birds are present in the local and regional assessment areas (LAA and RAA), and use the marine environment for part or all of their life cycle. However, the physical presence, movement and noise of marine vessels are not expected to have a measureable effect on bird health, behaviour or habitat, given the short duration of vessel operations (open-water season) and the infrequent number of vessel transits. Marine vessel operations have the potential to interact with benthic invertebrates, marine vegetation, sediment quality and water quality (i.e., vessel wake, potential release of contaminants in ballast water, and introduction of invasive species in ballast water). However, the magnitude of the effects are expected to be low due to the nature and extent of these interactions and implementation of mitigation measures (e.g., operating protocols, best management practices).

Marine mammals and marine fish are valued environmental components (VECs) for the assessment because they have the potential to be affected by marine transportation activities and are of cultural and ecological importance in the Hudson Bay region. Inuit Qaujimajatuqangit and public engagement comments played a fundamental role in the selection and validation of VECs, and identification of potential Project effects for the marine assessment. Key concerns included the sensitivity of marine wildlife to marine vessel traffic in the region (e.g. EN-RI KWB Jun 2012[10], EN-WC OH Nov 2012[11]), and the importance of year-round harvesting of marine mammal and fish species to provide food and clothing for local communities (e.g. IQ-ARVJ 2011[12], IQ-CI08 2009[13]).

The assessment of potential effects of marine transportation activities on marine mammals and marine fish focuses on change in mortality risk due to vessel collisions, and change in behaviour due to sensory disturbance and vessel movement.

Spatial and Temporal Boundaries

The marine assessment is spatially bound by three assessment areas: the Project footprint, the local assessment area (LAA), and the regional assessment area (RAA). The Project footprint is defined as the shipping route used by Project-related vessels transiting from the entrance to Chesterfield Inlet

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[10] EN-RI KWB Jun 2012: *There seem to be a lot less sea mammals in Hudson Bay because of the added traffic of the ships.*

[11] EN-WC OH Nov 2012: *How would the vessels avoid whales? Sometimes whales come after our propeller.*

[12] IQ-ARVJ 2011: *Ring seals are harvested for their meat and hide, bearded seals for their meat and hide, and harp seals for their hide.*

[13] IQ-CI08 2009: *Polar bear are hunted along the coastline.*

from Hudson Bay, through Chesterfield Narrows to the dock site on the north shore of Baker Lake. The LAA is defined as marine waters of Chesterfield Inlet and the adjacent coastal and offshore regions at the mouth of Chesterfield Inlet (including the portion of the shipping route where marine vessels will be transiting to and from the main shipping routes in Hudson Bay). The RAA encompasses the shipping route in Hudson Bay between Churchill and Chesterfield Inlet, and the shipping route through Hudson Strait to the extent of Nunavut territorial waters. It encompasses the zone where vessels are likely to have a measureable effect on the marine environment, and have the potential to act cumulatively with marine activities of other projects. The zone of influence is based on the area where marine animals would sense and respond to sounds from vessel activities, as determined by underwater acoustic modeling.

The temporal boundaries for the assessment are defined based on the timing and duration of potential effects of marine vessel traffic. The assessment covers the construction, operation and closure phases of the Project during which marine activities and transportation. AREVA has considered concerns about the timing of marine transportation (e.g. IQ-CHJ 2011[14]) and is committed to barging during the open water season only (i.e. no ice breaking). . A conservative estimate of 25 years is used to define the temporal extent of Project activities.

Existing Marine Environment

Nine species of marine mammal occur in the RAA. Of these species, three are considered common (beluga whale, ringed seal and polar bear) and six are considered rare or uncommon (bowhead whale, narwhal, bearded and harp seals, walrus and killer whale). The beluga whale and polar bear are designated as special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), while the ringed seal is designated as not at risk.

Beluga whales are an important cultural and ecological species in Nunavut. An estimated 57,300 belugas occur in Western Hudson Bay. They are generally hunted along the coast in the summer and are harvested up to 35 km offshore (Riewe 1992). After spring ice breakup in mid to late June, western Hudson Bay belugas concentrate in the Churchill, Nelson and Seal River estuaries, where they continue to congregate until late July. Along western Hudson Bay, belugas spend summers in shallow coastal areas. Migration northward along the coast of Hudson Bay occurs in late August or early September. Belugas are often found in bays and inlets (including Chesterfield Inlet) during migration (EN-CI HTO 2009[15]).

[14] IQ-CHJ 2011: *If ships travel during the winter months, wildlife will be affected. Summer barging would have less of an impact on marine life.*

[15] EN-CI HTO 2009: *IQ indicates if you want to see beluga, stay along the coast.*

Ringed seals are abundant throughout Nunavut waters and occur year-round along the coast. In spring, the highest densities of breeding adults occur on stable, landfast ice in areas with good snow cover, whereas non-breeders tend to be found at the floe edge or in the moving pack ice. Their ability to maintain breathing holes in ice enables them to occupy areas of Nunavut that are inaccessible to other marine mammals during the colder seasons.

Polar bears from two of the thirteen Canadian sub-populations occur in the LAA and RAA; the Western Hudson Bay and Foxe Basin sub-populations. During the open-water season, polar bears spend several months along the western coastline of Hudson Bay from Southampton Island to Churchill. The Western Hudson Bay sub-population congregates on coastal capes and headlands between Cape Churchill and Arviat. The Foxe Basin sub-population concentrates on the west and northeast coasts of Southampton Island and along the coast of Wager Bay (north of Chesterfield Inlet) during the ice-free season when shipping activities are expected. In the fall, there is a gradual northward movement of the Western Hudson Bay polar bears along the south coast of Hudson Bay.

A variety of marine fish use the sand and boulder benthic habitats around the mouth of Chesterfield Inlet, including Arctic cod, Arctic sculpin, Arctic char, fourhorn sculpin, banded gunnel, and whitefish. Arctic char typically migrate into Chesterfield Inlet when the ice has cleared (IQ-CI02 2009[16]). Greenland halibut is an abundant offshore marine fish species in Hudson Bay. Arctic cod are also abundant. They are found mainly in the upper part of the water column over deep water, and are often associated with drifting pack ice where they spawn in winter.

There are no *SARA* listed fish species or species designated by COSEWIC as species of concern in Chesterfield Inlet and surrounding area. Arctic char, fourhorn sculpin and whitefish are listed under the International Union for the Conservation of Nature (IUCN) red list as species of least concern.

Environmental Effects Assessment for Marine Mammals

Key issues for marine mammals identified by IQ, government and other stakeholders relate predominantly to marine vessel traffic and its potential to physically harm, disrupt, and/or displace the animals from summer habitat in Hudson Bay and Chesterfield Inlet. Project activities and potential effects on marine mammals are assessed with respect to the common species in the area; ringed seal and beluga whale. Marine transportation associated with the Project is not expected to result in environmental effects on polar bears since shipping and barging will only occur during the open-water season. Polar bears have the ability to swim long distances in open water, but are generally forced onto land in the Hudson Bay region for several months during the open-water season to wait for new ice to form; therefore, interactions with marine transportation associated with the Project are expected to be rare.

[16] IQ-CI02 2009: *Char fishing takes place in the spring, and locations include a variety of lakes in the area around Chesterfield.*

Change in Mortality Risk

A variety of Project-related vessels (including fuel tankers, general cargo ships, container ships and articulated tugs with barges) will be active during the construction, operation and closure phases of the Project. There is the potential for whales to be struck by vessels. The risk and severity of marine mammal collision with vessels increases with vessel speed (faster than 14 knots) and is generally more common with larger, slow moving whales. The beluga whale is a relatively mobile and fast swimming animal, and will likely avoid being in the direct path of a moving vessel whenever possible. However, mother-calf pairs spend a great deal of time resting and socializing near the surface (as is the case near Churchill) and may be unresponsive to approaching vessels. Seals are highly maneuverable and can effectively modify their swimming behaviour to avoid slow-moving vessels.

Mitigation measures will be employed to reduce the risk of Project-related vessel-mammal strikes. These include establishing speed restrictions on vessels transiting specific portions of the assessment area where vessels are most likely to encounter marine mammals, use of best operating practices (i.e., avoidance of unnecessary acceleration, maintenance of a constant course), and the use of onboard marine mammal observers (MMOs) to monitor marine activity (EN-CI NIRB May 2010[17]).

The open-water shipping season occurs for only 2 to 3 months per year, and commonly used shipping routes in Hudson Bay presently have a low density of vessel traffic. Consequently, marine mammals are not currently at high risk of mortality due to ship strikes. Given the expected frequency and number of project-associated tug and barge transits each year (7 to 31 transits) to the dock facility and the proposed mitigation, increased mortality risk to marine mammals due to Project-related vessel collisions is expected to be low.

Potential residual environmental effects to marine mammal populations are expected to be site specific, sporadic and low in magnitude. In the case where a lethal or severe vessel-marine mammal collision occurs, the effect is potentially fatal (i.e., irreversible) to the individual animal, but environmental effects on marine mammal populations are expected to be reversible through natural recruitment. Although increased mortality risk due to Project-related vessel collisions will continue until the closure of the Project, given the size of the beluga whale and seal populations, the long-term viability of marine mammal populations in the RAA are unlikely to be affected, even in the unlikely event where one or several animals are lost over the life of the Project. With implementation of mitigation measures (speed restrictions, avoidance of unnecessary acceleration, and use of designated shipping routes), the potential environmental effect of an increase in mortality risk of marine mammals due to vessel collisions is determined to be not significant.

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[17] EN-CI NIRB May 2010: *I would like to see wildlife observers onboard the vessels*

Onboard MMOs from local communities will record marine mammal sightings, as well as near-misses and, while unlikely, vessel collisions with marine mammals. When MMOs are not present, similar information will be recorded by the maritime crew. Ship logs will record speed reductions in important areas.

Change in Behaviour

A change in behaviour such as a startle or alarm response, avoidance or auditory masking is of concern due to the potential to harm, disrupt and/or displace marine mammals from their habitat which, in turn, could increase energy expenditure and reduce foraging efficiency and fecundity.

Acoustic modeling was completed for Project-related vessels and compared with species-specific audiograms to assess the environmental effects of underwater noise on marine mammals. Four scenarios are modelled along the shipping route: near Chesterfield Inlet, Whale Cove, Rankin Inlet, and Arviat. Results from the modeling were compared with species audiograms and assessed according to standard behavioural response criterion. Known audiograms were used for the beluga whale and for harbour seal (as a proxy in the absence of ringed seal data). In the absence of ambient underwater noise data, estimates based on previous models of natural ocean noise are used in the assessment.

Results of the acoustic modelling indicate that beluga whales and ringed seals will be able to detect Project-related vessel traffic noise for up to 29 km from the source (Table 6.2-3) and be exposed to 120 dB_{RMS} re 1 µPa – a likely threshold for behavioural responses -- at distances up to 4.8 km from the transiting vessel. Therefore, behavioural responses may occur for marine mammals that are within 4.8 km of the vessel as it is transiting. With proposed mitigation measures in place, the viability of marine mammal populations in the RAA is not expected to be compromised by Project activities. Change in behaviour due to underwater noise is considered to be not significant based on available information with respect to background noise levels, the frequency and number of marine vessel trips required to support the Project, and the predicted low magnitude of underwater noise generated by Project-related vessels.

Onboard MMOs will record all mammal sightings. In the absence of an MMO, sightings will be recorded by the maritime crew. Incidents such as herding of animals shall be recorded along with mitigation measures (e.g., halting the ship).

Environmental Effects Assessment for Marine Fish

Key issues for marine fish identified by IQ, government and other stakeholders relate predominantly to marine vessel traffic and its potential to physically harm, disrupt, and/or displace the animals from habitat in Hudson Bay and Chesterfield Inlet. A key concern identified by IQ relates to the potential disruption of marine fishing, particularly Arctic char, which occurs at fish camps along Chesterfield

Inlet (IQ -CI04 2009[18]). Project effects on marine fish are assessed for Arctic char due to its importance to the community and availability of acoustic data.

Change in Behaviour

Underwater noise from marine vessels has the potential to cause a startle response, alarm response, avoidance or a lack of response due to auditory masking, and change behaviour and migration patterns. This could reduce foraging efficiency and fecundity, and increase energy expenditure. As with marine mammals, acoustic modeling was completed for Project-related vessels along the shipping route. Results of the modeling were compared with the Arctic char audiogram and assessed according to scientifically based behavioural response criterion.

Underwater noise may be detectable to fish and cause a behavioural response when they are within 500 m of the vessel. Such responses may occur as a result of each vessel transit during the open-water season. With the implementation of mitigation measures (speed restrictions, avoidance of unnecessary acceleration, and use of designated shipping routes), underwater noise disturbance will be low in magnitude, site specific, and reversible. Any changes in behaviour due to underwater noise will be brief and spatially limited, and are not expected to have an effect on fish populations in the RAA. Changes in behaviour due to underwater noise are predicted to be not significant.

Summary of Environmental Effects

Given the frequency of vessel transits, and the low intensity of sensory disturbance that is expected, all environmental effects on the marine environment and marine wildlife populations are expected to be low in magnitude and considered to be not significant. Marine transportation activities associated with the Project are not expected to contribute to cumulative environmental effects on marine mammal or marine fish populations in the RAA.

Effects of Climate Change on the Project

Climate change may cause the open-water season to be extended. This would increase the window of opportunity for marine vessels to transport fuel and goods to the Baker Lake dock facility, which would reduce the net frequency of transiting vessels in the RAA and, in turn, reduce the frequency of exposure of marine mammals and marine fish to transiting vessels.

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[18] IQ -CI04 2009: *Gill nets are used to fish for Arctic char at the camp, south of Chesterfield.*

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ᒪᓕᒃᑕᐅᔭᕆᐊᓕᒃᑎᒍᑦ ᓴᖅᑭᑕᐅᔪᑦ ᓄᓇᕗᒻᒥ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᕿᒥᕐᕈᔨᓄᑦ (NIRB 2011), ᐊᕼᕙᒃᑯᑦ ᐋᕿᒃᓯᐃᓚᐅᖅᑐᑦ ᐊᕙᑎᒥᒃ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᑎᑎᖅᑲᒥᑦ (EIS) ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᖕᓇᖅᑐᓂᒃ ᐃᒪᒃᑯᑦ ᐱᕐᑯᑎᓂᒃ ᐊᓪᔭᖅᑐᐃᓂᐅᔪᓂᒃ ᑭᒡᒐᕕᒃ ᐱᓕᕆᐊᒧᑦ (ᐱᓕᕆᐊᖅ). ᐃᓚᒋᔭᐅᓗᐊᖅᑐᖅ ᐅᖃᐅᓯᐅᔪᖅ ᑕᕆᐅᕐᒥᐅᑕᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐅᒥᐊᕐᔪᐊᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒥᐅᔪᖅ ᓄᓇᕗᑦ ᐃᒪᖏᓐᓂᑦ. ᐃᓚᐅᔪᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᖃᑦᑕᖅᑐᓂᒃ ᐃᒪᒃᑯᑦ ᐱᕐᑯᑎᓂᒃ ᐊᓪᔭᖅᑐᐃᓂᐅᔪᓂᒃ ᓴᓇᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᓂᒃ, ᐊᐅᓲᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᒻᒪ ᐅᒃᑯᐊᕐᓂᕐᒧᑦ ᐱᓕᕆᐊᖅ. ᐱᔾᔪᑕᐅᔪᑦ ᐱᓂᕐᓗᐊᕿᓂᐅᔪᓄᑦ ᐊᒻᒪ ᐊᔪᓕᖅᑐᓄᑦ ᑕᕆᐅᕐᒥᐅᖓᔪᓄᑦ ᐅᖃᐅᓯᐅᔪᑦ ᐅᖃᓕᒫᒐᖅ 10−ᒥᑦ. ᐃᒃᓴᕿᕕᒃ ᖃᐅᔨᓴᖅᑕᐅᓯᒪᙱᑦᑐᖅ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᖓᓄᑦ ᓂᕈᐊᖅᑕᐅᔪᓄᑦ ᑕᕆᐅᕐᒧᑦ ᐊᕙᑎᒧᑦ VEC−ᖑᔪᓄᑦ ᐃᓂᒋᔭᖓ ᐃᒪᕐᒥᐅᖕᒪᑦ ᑕᕆᐅᒥᐅᖏᑦᑐᖅ (ᓱᕐᓗ, ᖃᒪᓂᑦᑐᐊᖅ). ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᑦ ᖃᒪᓂᑦᑐᐊᕐᒥᑦ ᐃᒃᓵᕕᖕᒥᑦ ᐃᒪᕐᒧᑦ ᖃᐅᔨᓴᖅᑕᐅᔪᑦ ᐅᖃᓕᒫᒐᖅ 5−ᒦᑦᑐᑦ.

ᑕᐅᑐᒃᑯᒍ ᖃᐅᔨᓴᐃᓂᖅ

NIRB−ᑯᑦ ᓴᖅᑭᑎᓚᐅᖅᑐᑦ ᑕᐅᑐᒐᐅᔪᒧᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐱᓕᕆᐊᒨᖓᔪᒧᑦ ᐅᖃᐅᓯᐅᔪᓂᒃ ᐃᓄᖕᓂᑦ, ᑲᕙᒪᒃᑯᓐᓂᑦ ᐊᒻᒪ ᐊᓯᖏᓐᓂᑦ ᐱᖃᖃᑕᐅᔪᓂᑦ.

ᐃᓄᐃᑦ ᐱᖃᖃᑕᐅᔪᑦ ᐅᔾᔨᕈᓯᓕᕐᓂᖃᑦᑎᐊᓚᐅᖅᑐᑦ ᐱᓕᕆᐊᒧᑦ ᐊᒃᑑᑎᖃᑦᑕᕐᓂᐅᔪᖕᓇᖅᑐᓂᒃ ᐱᓕᕆᐊᖅ ᐊᒃᑐᐊᓂᖃᖃᑦᑕᕐᓂᖕᒐᓂᒃ ᑕᕆᐅᑉ ᐊᕙᑎᖕᒐᓂᑦ.

ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖕᒋᑦᑎᒍᑦ (IQ) ᐊᐱᖅᓱᐃᓂᖅ ᐃᓚᐅᖃᑕᐅᓂᒃᑯᓪᓗ, ᐊᕼᕙᒃᑯᑦ ᐃᓕᑦᑎᓚᐅᖅᑐᑦ ᐱᒪᓕᒋᔭᐅᓂᖕᒋᓐᓄᑦ ᑭᕙᓪᓕᕐᒥᐅᓄᑦ ᓯᓚᐅᑉ ᐊᕙᑎᖕᒐᓂᑦ. ᐃᓚᐅᔪᑦ ᐱᒻᒪᕆᐅᓂᖕᒋᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᐱᕗᕕᐅᖃᑦᑕᕐᓂᖕᒋᑦ ᐃᓄᐃᑦ ᐃᓅᓯᖕᒋᓐᓄᑦ (IQ-CIHT 2009[19]), ᐊᒻᒪ ᐱᒻᒪᕆᐅᓂᖓ ᒥᐊᓂᕆᔭᐅᓂᕐᒧᑦ ᐊᕙᑎ (EN-BL NIRB ᐆᐳᕆ 2010[20]). ᐱᔾᔪᑕᐅᔪᑦ ᐃᓱᒫᓘᑏᓪᓗ ᐅᖃᐅᓯᐅᔪᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᐊᕙᑎᖕᒋᓐᓄᑦ ᐃᒪᐅᑉ ᐃᓗᐊᓂᑦ ᓂᐱᖃᕐᓂᖅ (IQ-CIHT 2011[21], EN-CI OH ᓄᕕᐱᕆ 2012[22], IQ-CI04 2009[23]), ᐃᓄᐃᑦ ᑕᐃᒪᐅᓂᖕᒋᑦ ᐊᒻᒪ ᐊᐅᓚᓐᓂᖕᒋᑦ ᐅᒥᐊᕐᔪᐊᑦ (EN-RI KWB ᔫᓂ 2012[24], EN-CH OH ᓄᕕᐱᕆ 2010[25]), ᐅᒥᐊᑉ

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[19] IQ-CIHT 2009: ᐃᒡᓗᓕᒑᕐᔪᕐᒥᐅᑕᐃᑦ ᓂᕿᖃᖃᕈᐊᖃᑦᑕᖅᑐᑦ ᑐᒃᑐᓂᒃ, ᐃᖃᓗᖕᓂᑦ ᐊᒻᒪ ᓇᑦᑎᕐᓂᑦ. ᓂᕆᖃᑦᑕᖅᐸᓂ ᐃᓄᐃᑦ ᓂᕿᖕᒋᓐᓂᒃ 'ᑐᒃᓯᐊᕐᓂᕐᒧᑎᑐᑦ' ᐃᓱᒪᒋᔭᐅᖕᒋᑦᑐᖅ ᑭᓯᐊᓂᓕ ᖃᐅᑕᒫᑦ ᐃᓅᓯᐅᔪᖅ.

[20] EN-BL NIRB ᐆᐳᕆ 2010: ᐱᒻᒪᕆᐅᔪᖅ ᑲᒻᐸᓂᐅᑉ ᐃᑉᐱᒋᒃᐸᖕᒋᑦ ᐊᒻᒪ ᒥᐊᓂᕆᓗᒋᑦ ᓄᓇ, ᐃᒪᖅ ᐊᒻᒪ ᓂᕐᔪᑏᑦ.

[21] IQ-CIHT 2011: ᑐᓴᓚᐅᖅᑐᖓ ᓯᑲᐅᓂᒃ ᐃᖕᒋᕋᔭᒃᑐᖃᐅᕐᓂᖅᓴᐅᓂᐊᕐᓂᖕᒐᓂᒃ ᐊᐅᔭᖅ ᕿᒪᓚᑦᑎᓂᐊᖅᑐᖅ ᐃᒪᕐᒥᐅᑕᓂᒃ ᑐᓴᖅᓴᕋᐃᑐᒻᒪᓇᐅᖕᒪᑕ.

[22] EN-CI OH ᓄᕕᐱ3 2012: ᐃᒪᕐᒥᐅᑕᐃᑦ ᐃᒪᐅᑉ ᐃᓗᐊᓃᕈᑎᒃ ᐊᕗᖕᒑᓗᒃ ᑖᓴᔪᑦ.

[23] IQ-CI04 2009: ᓇᑦᑏᑦᑕᐅᖅ ᐅᒥᐊᕐᔪᐊᓂᒃ ᐃᖕᒋᕋᔪᓂᒃ ᐃᒃᐱᒍᓱᒃᑐᑦ.

[24] EN-RI KWB ᔫᓂ 2012: ᖃᐃᕈᓕᖕᓂᒃ ᑕᑯᔪᖕᓇᖖᒋᓕᖅᑐᒍᑦ. ᐅᒥᐊᕐᔪᐊᑦ ᐃᖕᒋᕋᔭᑲᑖᑎᓪᓗᒋᑦ, ᐊᖕᒋᔪᒥᒃ ᐃᓪᓗᐃᓗᑦᑎᐃᑎᓂᐊᖅᑐᑦ.

[25] EN-CH OH ᓄᕕᐱᕆ 2010: ᐃᓱᒫᓘᑎ ᖃᑉᓯᐅᓂᖕᒋᑦ ᓯᑲᐅᑦ ᐃᖕᒋᕋᔭᖃᑦᑕᓕᖅᑐᑦ ᑭᕙᓪᓕᕐᒥᑦ. ᖃᐅᔨᖃᑦᑕᖅᑐᑦ ᓇᑦᑏᑦᑐ ᕿᓇᓗᒐᐃᓗ ᑕᒫᓂ ᐊᒥᓲᖕᒋᓐᓂᖅᓴᐅᓕᕐᓂᖕᒋᓐᓄᑦ.

ᓱᓂᕋᖓ ᐊᒻᒪ ᐃᒪᖅ (EN-CI OH ᓄᓇᐱᕆ 2013[26]), ᐊᒻᒪ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓃᑦ ᓱᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᖓ ᐱᓕᕆᐅᒧᑦ (EN-CH OH ᓄᓇᐱᕆ 2010[27]).

ᒪᓕᒐᓕᕆᓂᕐᒧᑦ ᐃᓱᒪᑎᔪᐅᔪᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᐃᒪᕐᒥᐅᑕᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐃᓚᐅᔪᑦ *ᐃᖃᓗᓕᕆᓂᕐᒧᑦ ᐱᕐᑯᓯᖅ* (ᒥᐊᓂᖅᓯᓂᖅ ᐃᖃᓗᖕᓂᒃ ᐃᓂᑎᓯᖕᒋᓐᓂᒡᓗ), *ᐆᒪᔪᑦ ᐅᓗᕆᐊᓇᖅᑐᕐᑑᓄᑦ ᐱᕐᑯᓯᖅ* (SARA, ᒥᐊᓂᖅᓯᔪᖅ ᐆᒪᔪᓂᒃ ᐊᓯᐅᔨᑦᑕᐃᓕᓂᕐᒧᑦ), *ᓄᓇᕗᑦ ᓂᕐᔪᑎᓄᑦ ᐱᕐᑯᓯᖅ* (ᐊᐅᓚᑦᑎᔪᖅ ᓂᕐᔪᑎᓂᒃ ᓄᓇᕗᒻᒥᑦ), ᐊᒻᒪ *ᓄᓇᕗᒻᒥ ᓄᓇᑖᕐᓂᕐᒧᑦ ᐊᖏᖅᑲᑎᒌᒍᑦ* (ᓄᓇᒥᒃ ᐊᑐᕐᓂᕐᒧᑦ ᐸᕐᓇᐃᓂᖅ ᐊᒻᒪ ᓄᓇᒥᑦ ᐱᔪᓂᒃ ᐊᐅᓚᑦᑎᓂᖅ).

ᐃᒪᒃᑯᑦ ᐊᒡᔭᖅᑐᐃᓕᕆᓂᖅ ᐱᔾᔪᑎᖃᖅᑐᑦ ᐱᓕᕆᐊᒥᑦ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᑦ ᐊᒃᑐᖅᓯᓂᖃᕐᓂᐊᕐᓂᖓᓄᑦ ᑕᕆᐅᕐᒥᐅᑕᓂᒃ ᑎᖕᒥᐊᓂᒃ, ᐆᒪᔪᕋᓛᓂᒃ, ᑕᕆᐅᒥᑦ ᐱᕈᖅᑐᓂᒃ, ᐊᓗᐊᓃᑦᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᕆᓐᓄᑦ ᐅᕙᓘᓃᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ. ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᑎᖕᒥᐊᑦ ᑕᐃᒪᐅᔪᑦ ᖃᓂᑦᑐᒥᑦ ᐊᒻᒪ ᐅᖓᓯᒃᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᓂᑦ (LAA ᐊᒻᒪ RAA), ᐊᒻᒪ ᐊᑐᖅᐸᒃᑲᒍ ᑕᕆᐅᖅ ᐃᓚᖓᓄᑦ ᑕᒪᐃᓐᓄᓪᓘᓃᑦ ᐆᒪᓂᖓᓐᓄᑦ. ᑭᓯᐊᓂ, ᐃᓄᐃᑦ ᑕᐃᒪᐅᓂᖏᑦ, ᐊᐅᓚᓐᓃᑦ ᐊᒻᒪ ᓂᐱᖃᕐᓂᖅ ᐅᒥᐊᕐᔪᐊᓂᑦ ᓂᕆᐅᒋᔭᖏᑦᑐᑦ ᐊᒃᑐᖅᓯᓂᖃᕐᓂᐊᕐᓂᖏᓐᓄᑦ ᑎᖕᒥᐊᑦ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ, ᐃᓕᖅᑯᓯᖏᓐᓄᑦ ᐅᕙᓘᓃᑦ ᐃᓂᖏᓐᓄᑦ, ᓇᐃᑑᓂᐊᕐᓂᖓ ᑕᐅᑐᒃᑯᒍ ᐅᒥᐊᕐᔪᐊᑦ ᐊᐅᓚᑦᑐᑦ (ᐊᐅᔭᒃᑯᑦ) ᐊᒻᒪ ᐊᒥᓱᐃᖅᑕᕐᑲᑦᑕᔾᔮᖏᓐᓂᖏᑦ ᐃᖏᕋᔪᑦ ᐅᒥᐊᕐᔪᐊᑦ. ᐅᒥᐊᕐᔪᐊᑦ ᐊᐅᓚᔪᑦ ᑎᑭᐅᑎᕐᑲᑎᕐᑲᕈᖅᓇᕐᒪᑕ ᐆᒪᔪᕋᓛᓂᒃ, ᐃᒪᕐᒥᑦ ᐱᕈᖅᑐᓂᒃ, ᐊᓗᐊᑕ ᖃᓄᐃᓐᓂᕆᔭᖓᓂᑦ ᐊᒻᒪ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓂᑦ (ᓲᕐᓗ, ᐅᒥᐊᕐᔪᐊᑦ, ᐅᓗᕆᐊᓇᖅᑐᓂᒃ ᐃᒪᕐᒧᐊᖅᓯᓂᖅ, ᐊᒻᒪ ᐊᔾᔨᐅᖏᑦᑐᓂᒃ ᑎᑭᑦᑎᓂᖅ ᐃᒪᕐᒧᑦ). ᑭᓯᐅᓂ, ᐊᖏᓂᖓ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᑉ ᓂᕆᐅᒋᔭᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᐊᕐᓂᖓᓄᑦ ᖃᓄᑎᒋᐅᓂᖓ ᑕᐅᑐᒃᑯᒍ ᑎᑭᐅᑎᕐᑲᑎᕐᑳᕐᑲᑦᑕᕐᓂᐊᕐᓂᖏᑦ ᐊᒻᒪ ᐊᑐᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᖏᕐᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᐅᔪᓂᒃ (ᓲᕐᓗ, ᐊᐅᓛᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᑦ, ᐱᐅᓛᒃᑯᑦ ᐊᐅᓚᑦᑎᓂᕐᒥᒃ ᐊᑐᕐᑲᑦᑕᕐᓃᑦ).

ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ ᐊᒻᒪ ᐃᖃᓗᐃᑦ ᐱᒪᕆᐅᑎᔪᐅᔪᑦ ᐊᕙᑎᒧᑦ ᐃᓚᑎᔪᐅᓂᕐᒧᑦ (VEC) ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᒃᑐᖅᑕᐅᓂᖃᕈᓇᕐᓂᖏᓐᓄᑦ ᐃᒪᒃᑯᑦ ᐃᖏᕋᓂᓕᕆᓂᕐᒧᑦ ᐊᒻᒪ ᐱᖅᑯᓯᑐᖃᒃᑯᑦ ᐆᒪᓂᕐᒧᑦ ᐱᒪᕆᐅᑎᔪᖓᓕᑕ ᑕᓱᐅᔭᕐᔪᐊᕐᒥᐅᑕᐅᔪᓄᑦ. ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ ᐊᒻᒪ ᐃᓄᖕᓂᒃ ᐃᓚᐅᖃᑕᐅᑎᑦᑎᓂᕐᓂᑦ ᐅᖃᐅᓯᐅᔪᑦ ᐃᑲᔪᐃᓂᖃᑦᑎᐊᓚᐅᖅᑐᑦ ᓂᕈᐊᕐᓂᕐᒥᒃ ᐊᒻᒪ ᓇᓗᓇᐃᖅᓯᓂᕐᒥᒃ VEC−ᓂᒃ, ᐊᒻᒪ ᐃᓕᑕᖅᓯᓂᕐᒧᑦ ᐱᓕᕆᐊᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᕈᑕᐅᑐᐃᓐᓇᕆᐊᖃᖅᑐᓂᒃ ᐃᒪᕐᒥᐅᑕᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ. ᐃᓱᒪᓘᑕᐅᔪᓂᒃ ᐃᓚᐅᔪᑦ ᐃᒃᐱᒋᓂᖏᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ ᐅᒥᐊᕐᔪᐊᑦ ᐃᖏᕋᓂᖏᓐᓄᑦ ᑕᒫᓂ (ᓲᕐᓗ, EN-RI KWB ᔫᓂ 2012[28], EN-WC OH ᓄᓇᐱᕆ 2012[29]), ᐊᒻᒪ ᐱᒪᕆᐅᓂᖓ ᐅᑭᐅᓗᒃᑖᖅ ᒪᑲᐃᑕᐅᖃᑦᑕᕐᓂᖏᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ ᐃᖃᓗᐃᓪᓗ ᓂᕿᑎᔪᐅᓂᕐᒧᑦ ᐊᒻᒪ ᐊᓄᕌᓕᐅᖅᑕᐅᓂᕐᒧᑦ ᓄᓇᓕᖕᒥᐅᓂᑦ (ᓲᕐᓗ IQ-ARVJ 2011[30], IQ-CI08 2009[31]).

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[26] EN-CI OH ᓄᓇᐱᕆ 2013: ᖃᓄᕐᓕ ᐃᒪᖅ ᐊᒻᒪ ᐱᐅᔪᖕᓃᖅᑎᑦᑎᔪᖅ? ᒥᐊᓂᖅᓯᔭᕆᐊᖃᖅᑐᒍᑦ ᐃᒪᕐᒥᒃ ᐱᓕᕆᐊᕐᒧ ᐊᒃᑐᖅᓯᓂᖃᕐᓂᐊᖅᑐᖅ ᑕᒪᒃᑯᓂᙵᑦ.

[27] EN-CH OH ᓄᓇᐱᕆ 2010: ᐅᑭᐅᖅ ᓯᑯᑕᖃᙱᑦᑐᖅ ᒥᑭᑦᑐᒥ ᑭᓯᐊᓂ ᐅᒥᐊᓗᓃᑦ ᐃᒫᓃᑦᑐᑦ ᓱᓕ, ᑕᐃᒪᓐᓇᐃᑐᑐᖃᐅᖅᑎᑦᑐᖅ. ᓱᓚ ᐊᓯᐊᙳᖅᐸᓪᓕᐊᓂᖓᓄᓪᓗᙵ, ᓱᓚᕐᔪᐊᖅ ᐆᓇᖅᓯᓂᖓᓄᑦ. ᓂᓪᓕᓇᙱᑦᑐᐊᕐᒪᑦ ᓱᑯᑕᖃᙱᑦᑐᖅ.

[28] EN-RI KWB ᔫᓂ 2012: ᑕᕆᐅᕐᒥᐅᑕᓂᒃ ᓂᕐᔪᑎᑦᑕᖃᙱᓐᓂᖅᓴᐅᔾᔭᓕᖅᑐᖅ ᑕᓱᐅᔭᕐᔪᐊᕐᒥᑦ ᐅᒥᐊᕐᔪᐊᑦ ᐃᖏᕋᔭᑲᓗᐊᕐᓂᑯᖏᓐᓄᑦ.

[29] EN-WC OH Nov 2012: ᖃᓄᖅ ᐅᒥᐊᕐᔪᐊᑦ ᑎᑭᐅᑎᑦᑕᐃᓕᒪᓂᐊᕐᓕᑕ ᕿᓇᓗᖓᓂᒃ? ᐃᓛᓐᓂᒃᑯᑦ ᕿᓇᓗᒐᐃᑦ ᐊᖑᑎᑉᑎᖕᓄᙵᐅᖅᑲᑦᑕᖅᑐᑦ.

[30] IQ-ARVJ 2011: ᓇᑦᑏᑦ ᒪᖃᐃᑕᐅᖃᑦᑕᖅᑐᑦ ᓂᕿᖏᓐᓄᑦ ᐊᒻᒪ ᕿᓯᖏᓐᓄᑦ, ᐅᐃᔭᐃᑦ ᓂᕿᖏᓐᓄᑦ ᐊᒻᒪ ᕿᓯᖏᓐᓄᑦ, ᐊᒻᒪ ᖃᐃᑉᐹᓪ ᕿᓯᖏᓐᓄᑦ.

[31] IQ-CI08 2009: ᓇᓄᐃᑦ ᒪᖃᐃᑕᐅᖃᑦᑕᖅᑐᑦ ᓯᐅᔭᐅᑉ ᖃᓂᑕᖓᓂᑦ.

ᖃᐅᔨᓴᐃᓂᖅ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓐᓇᖅᑐᓄᑦ ᐃᒪᕐᒥᑦ ᐃᖏᕋᔭᖕᓂᕐᒧᑦ ᐃᒪᕐᒥᐅᑕᓄᑦ ᐃᖃᓗᙵᓄᓪᓗ ᑕᐅᑐᒐᖃᖅᑐᖅ ᐊᓯᐊᖑᕐᓂᕐᒥᒃ ᑐᕐᑯᕋᐃᓂᕐᒧᑦ ᐅᓗᕆᐊᓇᖅᑐᓂᒃ ᐅᒥᐊᕐᔪᐊᓄᑦ ᑐᓗᖅᑕᐅᔪᖅᑲᖅᐸᑦ, ᐊᒻᒪᓗ ᐊᓯᐊᖑᕐᓂᖅ ᐃᓕᖅᑯᓯᖏᓐᓄᑦ ᐃᑉᐱᕆᓂᖏᓐᓄᑦ ᐅᒥᐊᕐᔪᐊᓪᓗ ᐊᐅᓚᓐᓂᖏᓐᓄᑦ.

ᐃᓂᖃᕐᓂᕐᒧᑦ ᓄᓇᒥᓗ ᑭᒡᓕᐅᔪᑦ

ᐃᒪᕐᒥᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐃᓂᖃᕐᓂᖓᓘᖓᔪᖅ ᐱᖓᓱᓄᑦ ᖃᐅᔨᓴᐃᓂᐅᔪᓂᑦ: ᐱᓕᕆᐊᑉ ᐃᓂᖓ, ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᖅ (LAA), ᐊᒻᒪᓗ ᐅᖓᓯᒃᑐᒥᒃ ᖃᐅᔨᓴᐃᓂᖅ (RAA). ᐱᓕᕆᐊᑉ ᐃᓂᖓ ᑐᑭᓕᐅᖅᑕᐅᔪᖅ ᐊᐅᓚᖅᑎᑕᐃᓂᕐᒧᑦ ᐊᑉᖅᑯᑎᐅᑉᓗᓂ ᐊᑐᖅᑕᐅᔪᖅ ᐱᓕᕆᐊᔫᖓᔪᓂᒃ ᐅᒥᐊᕐᔪᐊᑦ ᐃᖏᕋᓂᖏᓐᓄᑦ ᐃᑎᓇᐊᖅᕙᐊᓂᑦ ᐃᒡᓗᓕᒑᖅᔪᖕᒧᑦ ᑕᓯᐅᔭᖅᔪᐊᕐᒥᑦ, Chesterfield Narrows−ᑰᖅᖢᓂ ᐃᒃᓴᖅᕙᖕᒧᑦ ᐅᐊᖕᓇᖕᓕᓂᑦ ᖃᒪᓂᑦᑐᐊᒧᑦ. LAA ᑐᑭᓕᐅᖅᑕᐅᔪᖅ ᐃᒪᕐᒥᐅᑕᑎᑐᑦ ᐃᒡᓗᓕᒑᖅᔪᖕᒥᑦ ᐊᒻᒪᓗ ᐊᑭᐊᓄᑦ ᓯᒡᔭᓄᑦ ᐊᒻᒪᓗ ᓄᓇᒦᑦᑐᓄᑦ ᐃᒡᓗᓕᒑᖅᔫᑉ ᓵᖓᓂᑦ (ᐃᓚᐅᔪᖅ ᐃᓚᖓ ᐊᐅᓚᖅᑎᑦᑕᕐᓂᕐᒧᑦ ᐊᑉᖅᑯᑎᒋᔭᐅᔫᑉ ᐅᒥᐊᕐᔪᐊᑦ ᐃᖏᕋᓂᖓᓂᐊᖅᑕᖓᑦ ᑕᐃᑯᖓ ᐊᒻᒪᓗ ᑕᐃᑲᙵᑦ ᐊᑉᖅᑯᑎᒋᔭᐅᔪᓂᑦ ᐊᐅᓚᖅᑎᑦᑎᖅᑲᑦᑕᕐᓂᕐᒧᑦ ᑕᓯᐅᔭᖅᔪᐊᕐᒥᑦ). RAA ᐊᕙᓗᓯᔪᖅ ᐊᐅᓚᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᑉᖅᑯᑎᒥᒃ ᑕᓯᐅᔭᖅᔪᐊᕐᒥᑦ ᐊᑯᓐᓂᖓᓂᑦ ᑰᒡᔪᐊᑉ ᐊᒻᒪᓗ ᐃᒡᓗᓕᒑᖅᔫᑉ, ᐊᒻᒪᓗ ᐊᐅᓚᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᑉᖅᑯᑎ Hudson Strait-ᑰᖅᑐᖅ ᑎᑭᐅᑎᑉᓗᓂ ᓄᓇᕗᑦ ᐃᒪᖏᓐᓄᑦ. ᐊᕙᓗᓯᓯᒪᔪᖅ ᐅᒥᐊᕐᔪᐊᑦ ᐆᒃᑐᕋᖅᑕᐅᔪᖕᓇᖅᑐᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᕐᒥᒃ ᐃᒪᕐᒥᑦ, ᐊᒻᒪᓗ ᑲᑎᑉᐸᓪᓕᐊᓂᖅᑕᖅᑲᕈᖕᓇᖅᖢᓂ ᐃᒪᕐᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᐊᓯᖕᒥᓄᑦ ᐱᓕᕆᐊᓄᑦ. ᐃᓂᐅᔪᖅ ᐅᖃᐅᓯᐅᔪᖅ ᐃᓂᒦᑦᑐᖅ ᐃᒪᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ ᖃᐅᔨᔭᕆᐊᖃᖅᑐᑦ ᓂᐱᖃᕐᓂᐅᔭᓄᑦ ᐅᒥᐊᓂᑦ, ᖃᐅᔨᓴᐅᓂᖓᑐᑦ ᐃᒪᐅᑉ ᐃᓗᐊᓂᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᔪᑎᒍᑦ.

ᓄᓇᒥᑦ ᑭᒡᓕᐅᔪᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᑐᑭᓕᐅᖅᑕᐅᔪᑦ ᐊᑐᖅᖢᑎᒃ ᖃᖓᒃᑯᑦ ᐊᒻᒪᓗ ᖃᓄᖅ ᐊᑯᓂᐅᑎᒋᔪᖅ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᑐᐃᓐᓇᕆᐊᓕᖕᓄᑦ ᐅᒥᐊᕐᔪᐊᑦ ᐃᖏᕋᔭᖕᓂᖏᑦ. ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐃᓚᐅᔪᑦ ᓴᓇᓂᖅ, ᐊᐅᓛᕐᓂᖅ ᐊᒻᒪᓗ ᐅᒃᑯᐊᕐᓂᖓ ᐱᓕᐊᑉ ᐅᒥᐊᕐᔪᐊᑦ ᐃᖏᕋᔭᒃᑎᓪᓗᒋᑦ. ᐊᓇᕙᒃᑯᑦ ᐃᓯᒪᕆᓚᐅᖅᑕᖓᑦ ᐃᓯᒫᓗᐃᑦ ᖃᖓᒃᑯᑦ ᐃᒪᒃᑯᑦ ᐃᖏᕋᔭᖕᓃᑦ (ᓱᕐᓗ, IQ-CHJ 2011[32]) ᐊᒻᒪᓗ ᐱᓂᐊᕐᓂᖅᑕᐅᑦ ᓯᑲᐅᓕᕆᓂᕐᒥᒃ ᐊᐅᔭᒃᑯᑐᐃᓇᖅ (ᓱᕐᓗ, ᓯᑯᒥᒃ ᓯᕐᑯᑉᑎᕆᓐᖏᓪᓗᑎᒃ). ᓇᓚᐅᑖᖅᑕᐅᔪᖅ 25 ᐅᑭᐅᓄᑦ ᐊᑐᖅᑕᐅᔪᑦ ᑐᑭᓕᐅᕐᓂᕐᒧᑦ ᐃᓂᐅᔫᑉ ᑎᑭᐅᑎᓂᐊᕐᓂᖓ ᐱᓕᕆᐊᔫᖓᔪᓄᑦ.

ᓚᓐᓇᐅᔪᖅ ᐃᒪᐅᑉ ᐊᕝᑎᖓ

9-ᙳᔪᑦ ᑕᑯᐅᕐᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ ᑕᐃᒪᐅᕐᑲᑦᑕᖅᑐᑦ RAA-ᒥᑦ. ᑖᑉᑯᓇᓂ ᐆᒪᔪᓂᑦ, ᐱᖓᓱᐃᑦ ᐃᓱᒪᒋᔭᐅᔪᑦ ᐊᑐᖅᑕᐅᓯᓖᙳᓂᖅᑭᓐᓄᑦ (ᕿᓇᓗᒐᖅ, ᓇᑦᑎᖅ ᐊᒻᒪᓗ ᓇᓄᖅ) ᐊᒻᒪᓗ ᐊᕝᕙᓂᓖᑦ ᐃᓱᒪᒋᔭᐅᔪᑦ ᐱᑕᖃᓗᐊᖅᑭᓐᓂᖅᑭᓐᓄᑦ ᐅᕙᓘᓃᑦ ᑕᐃᒪᐅᓯᖖᑭᓐᓂᖅᑭᓐᓄᑦ (ᐊᕝᕙᖅ, ᑑᒐᓕᒃ, ᐅᒡᔪᒃ, ᖃᐃᕈᓕᒃ, ᐊᐃᕙᖅ ᐊᒻᒪᓗ ᐋᕐᓗᖅ). ᕿᓇᓗᒐᐃᑦ ᓇᓄᐃᓪᓗ ᐊᔾᔨᐅᖅᑎᑦᑐᑎᑦᑐᑦ ᐃᓱᒪᒋᔭᐅᔪᑦ ᑲᑎᒪᔩᑦ ᓇᓃᓐᓂᖅᑭᓐᓄᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑦᑐᑦ ᓂᕐᔪᑏᑦ ᑲᓇᑕᒥᑦ (COSEWIC), ᓇᑏᑦᑕ ᐅᓗᕆᐊᓇᖅᑭᑦᑑᑎᒋᔭᐅᐸᓗᑎᒃ.

ᕿᓇᓗᒐᐃᑦ ᐱᒪᕆᐅᔪᑦ ᐱᖅᑯᓯᖏᑦ ᐊᒻᒪᓗ ᐆᒪᓂᖅᑭᓐᓄᑦ ᐆᒪᔪᐃᑦ ᓄᓇᕗᒻᒥᑦ. ᓇᓚᐅᑖᖅᑕᐅᔪᑦ 57,300 ᕿᓇᓗᒐᐃᑦ ᑕᐃᒪᐅᕐᑲᑦᑕᖅᑐᑦ ᐱᖓᖕᓇᖅᐸᓯᖓᓂᑦ ᑕᓯᐅᔭᖅᔪᐊᑉ. ᒪᖃᐃᑕᐅᓗᒃᑐᑦ ᓯᒡᔭᖅᐸᓯᖕᓂᑦ ᐊᐅᔭᒃᑯᑦ ᐊᒻᒪᓗ

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[32] IQ-CHJ 2011: ᐅᒥᐊᕐᔪᐊᑦ ᐅᑭᐅᑯᑦ ᐃᖏᕋᔭᖅᑕᕐᓂᐊᖅᐸᑕ ᓂᕐᔪᑏᑦ ᐊᒃᑐᖅᑕᐅᓂᐊᖅᑐᑦ. ᐊᐅᔭᒃᑯᑦ ᓯᑲᐅᑦ ᐃᖏᕋᖅᑕᖅᐸᑕ ᓂᕐᔪᑏᑦ ᐊᒃᑐᖅᑕᐅᓂᖃᙱᓐᓂᖅᓴᐅᓂᐊᖅᑐᑦ.

ᒪᖅᑲᐃᑕᐅᑉᐳᑎᒃ 35 ᑭᓛᒥᑕᒥᒃ ᐅᖓᓯᒃᑎᒋᔪᒥᑦ ᓄᓇᒥᑦ ᐃᒪᓐᓇᕐᒥᑦ (Riewe 1992). ᓱᑯᐃᑦ ᓱᖁᑉᑎᐊᓂᒃᑎᓪᓗᒋᑦ ᕿᑎᐊᓂᑦ ᓄᙳᐊᓄᑦ ᔩᓂ, ᐱᖓᓐᓇᖅᐸᓯᖓᓂᑦ ᑕᓱᐅᔭᕐᔪᐊᑉ ᖃᓇᓗᖓᐃᑦ ᑲᑎᓯᒪᔪᑦ ᑰᔪᐊᕐᒥᑦ, Nelson ᐊᒪᓗ Seal River-ᒥᑦ ᑲᑎᑉᐸᓪᓕᐊᓂᕐᑲᕐᑲᑦᑕᖅᑐᑦ ᑎᒃᑭᒃᓴᑉᐳᒍ ᔪᓚᐃ ᓄᙳᐊᓄᑦ.ᐱᖓᓐᓇᖓᓂᑦ ᑕᓱᐅᔭᕐᔪᐊᑉ, ᕿᓇᓗᒐᐅᕐᑲᑦᑕᖅᑐᑦ ᐊᐅᔭᒃᑯᑦ ᐃᑲᑦᑐᓂᑦ. ᓅᑉᐸᓪᓕᐊᔪᑦ ᐅᐊᓐᓇᖅᐸᓯᓐᒍᑦ ᓯᒡᔭᖅᐸᓯᖓᓂᑦ ᑕᓱᐅᔭᕐᔪᐊᑉ ᐋᒋᓯ ᓄᙳᐊᓂᑦ ᐅᕙᓘᓃᑦ ᓯᑎᐱᓇ ᐱᒋᐊᓵᖅᑎᓪᓗᒍ. ᕿᓇᓗᒐᖅᑕᕐᑲᕋᔫᒃᑐᖅ ᑲᖏᖅᑯᖓᓂᑦ (ᐃᓚᐅᑉᐳᓂ ᐃᒡᓗᓕᒑᕐᔫᒃ) ᓅᑉᐸᓪᓕᐊᑎᓪᓗᒋᑦ (EN-CI HTO 2009[33]).

ᓇᕐᕖᑦ ᐊᒥᓲᕐᑲᑦᑕᖅᑐᑦ ᓄᓇᕗᑦ ᐃᒪᖏᓐᓂᑦ ᐊᒪᓗ ᑕᐃᒪᐅᖏᓐᓇᐅᔭᖅᑯᑎ ᐅᑭᐅᓗᒃᑖᖅ. ᐅᐱᕐᖔᒃᑯᑦ, ᐊᒥᓲᓕᖅᓯᒪᓛᖑᕙᒃᑯᑎᒃ ᐃᕐᓂᐅᖅᑎᓪᓗᒋᑦ ᓄᖅᑲᖓᔪᓂᑦ, ᓄᓈᖅᓯᒪᔪᓂᒃ ᓯᑯᓂᒃ ᐊᐳᑎᕐᑲᑦᑎᐊᖅᑐᓂᑦ, ᐃᕐᓂᐅᖏᑦᑐᓪᓕ ᑕᐃᒪᐅᕐᑲᑦᑕᖅᑐᑦ ᓯᓈᓂᑦ ᐅᕙᓘᓃᑦ ᐃᖏᕐᕋᔪᓂᑦ ᑲᑎᕐᒪᔪᓂᑦ ᓯᑯᓂᑦ. ᐊᒡᓗᐊᓕᐅᕈᓐᓇᕐᓂᖏᑦ ᓯᑯᒥᑦ ᓄᓇᕚᒦᖏᓐᓇᕈᓐᓇᕐᑲᑦᑕᖅᑐᑦ ᐊᓯᖏᓐᓂᑦ ᐃᒪᕐᒥᐅᑕᓄᑦ ᑎᑭᑕᐅᓂᖅ ᐊᔪᖅᑐᓄᑦ ᐃᒃᑮᕐᓇᖅᑎᓪᓗᒍ.

ᓇᓄᐃᑦ ᒪᕐᕉᖏᒃ 13-ᙳᔪᓂᑦ ᑲᓇᑕᒥᑦ ᓇᓄᕐᑲᕐᕕᐅᔪᓂᑦ ᑕᐃᒪᐅᔪᑦ LAA-ᒥᑦ ᐊᒪᓗ RAA-ᒥᑦ; ᐱᖓᓐᓇᖅᐸᓯᖓᓂᑦ ᑕᓱᐅᔭᕐᔪᐊᑉ ᐊᒪᓗ Foxe Basin-ᒥᑦ ᓇᓄᕐᑲᕐᓂᐅᔪᓂᑦ. ᐊᐅᔭᒃᑯᑦ, ᓇᓄᖅᑕᕐᑲᕐᑲᑦᑕᖅᑐᖅ ᖃᑉᓯᐅᕐᔪᖓᓂᒃ ᑕᖅᑭᓄᑦ ᐱᖓᓐᓇᖅᐸᓯᐊᓂᑦ ᑕᓱᐅᔭᕐᔪᐊᑉ ᓯᒡᔭᖓᓂᑦ ᓴᓪᓕᕐᒥᑦ ᑰᔪᐊᕐᒧᑦ. ᐱᖓᓐᓇᖅᐸᓯᖓᓂᑦ ᑕᓱᐅᔭᕐᔪᐊᑉ ᓇᓄᐃᑦ ᑲᑎᕐᑲᑦᑕᖅᑐᑦ ᓯᒡᓚᓂᑦ ᐊᒪᓗ ᓄᓇᓂᑦ ᐊᑯᓐᓂᖏᓐᓂᑦ ᑰᔪᐊᑉ ᐊᒪᓗ ᐊᕐᕕᐊᑦ. Foxe Basin-ᒥᑦ ᓇᓄᐃᑦ ᑲᑎᕐᑲᑦᑕᖅᑐᑦ ᐱᖓᓐᓇᖓᓂᑦ ᐊᒪᓗ ᐅᐊᓐᓇᖅᐸᓯᐊᓂᑦ ᑲᓇᓐᓇᖅᐸᓯᐊᓂᑦ ᓯᒡᔭᓂᑦ ᓴᓪᓕᕐᒥᑦ ᐊᒪᓗ ᓯᒡᓚᖏᓐᓂᑦ ᐅᒃᑯᓯᒃᓴᓕᐅᑉ (ᐅᐊᓐᓇᖓᓂᑦ ᐃᒡᓗᓕᒑᕐᔩᑉ) ᓱᑯᖃᙱᑎᓪᓗᒍ ᐅᒥᕐᔪᐊᑦ ᐃᖏᕋᔭᖕᓂᐊᓕᖅᑎᓪᓗᒋᑦ. ᐅᑭᐊᒃᓵᑯᑦ, ᐅᐊᓐᓇᖅᐸᓯᖕᒧᑦ ᓅᓐᓂᖅᑕᕐᑲᖅᐸᓪᓕᐊᓲᖅ ᐱᖓᓐᓇᖓᓂᑦ ᑕᓱᐅᔭᕐᔪᐊᑉ ᓇᓄᕐᓂᒃ ᓯᒡᔭᖓᒍᑦ ᓂᒋᐊᓂᑦ ᑕᓱᐅᔭᕐᔪᐊᑉ.

ᐊᔾᔨᒌᖕᒋᑦᑐᑦ ᑕᓇᐅᕐᒥᐅᑕᐃᑦ ᐃᖃᓗᐃᑦ ᐊᑐᕐᑲᑦᑕᖅᑐᑦ ᓯᐅᕋᕐᒥᑦ ᐊᒪᓗ ᐅᔭᕋᓱᒡᔪᖕᓂᒃ ᐃᓂᒋᑉᐳᒋᑦ ᐃᒡᓗᓕᒑᕐᔩᑉ ᓵᖓᓂᑦ, ᐃᓚᐅᑉᐳᑎᒃ ᐆᒐᐃᑦ, ᑲᓇᔪᐃᑦ, ᐃᖃᓗᒃᐲᑦ, fourhorn sculpin, banded gunnel, ᐊᒪᓗ ᔾᔪᒃᐸᐅᒐᓖᑦ. ᐃᖃᓗᒃᐲᑦ ᓅᒐᔫᒃᑐᑦ ᐃᒡᓗᓕᒑᕐᔪᖓᒧᑦ ᓱᑯᖃᕈᓐᓃᖖᒐᑦ (IQ-CI02 2009[34]). Greenland halibut ᐊᒥᓲᔪᑦ ᐃᒪᐃᓐᓇᕐᒥᑦ ᑕᓱᐅᔭᕐᔪᐊᕐᒥᑦ. ᐆᒐᐃᑦ ᐊᒥᓲᖕᒥᔪᑦ. ᑕᐃᒪᑕᕐᑲᐅᕐᑲᑦᑕᖅᑐᖅ ᖁᑦᑎᖕᓂᖓᓂᑦ ᐃᑎᓂᕐᒥᑦ, ᐊᒪᓗ ᐃᓚᐅᒐᔫᒃᑐᑦ ᐃᖏᕐᕋᔪᓂᑦ ᓯᑯᓂᑦ ᐅᑭᐅᑯᑦ.

SARA-ᒧᑦ ᑎᑎᕋᖅᑕᐅᓯᒪᔪᖅᑲᙱᑦᑐᖅ ᐃᖃᓗᖏᓐᓂᑦ ᐅᕙᓘᓃᑦ ᐆᒪᔪᓂᒃ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᔪᓂᑦ COSEWIC-ᑯᓐᓄᑦ ᐆᒪᔪᑦ ᐃᓱᒪᒋᔭᐅᓂᖏᓐᓄᑦ ᐃᒡᓗᓕᒑᕐᔪᖕᒥᑦ ᐊᒪᓗ ᖃᓂᑕᖓᓂᑦ. ᐃᖃᓗᒃᐲᑦ, fourhorn sculpin ᐊᒪᓗ ᔾᔪᒃᐸᐅᒐᐃᑦ ᑎᑎᕋᖅᑕᐅᓯᒪᔪᑦ ᓄᓇᕐᔪᐊᕐᒥᑦ ᑲᑐᔾᔨᖃᑎᒌᓄᑦ ᐊᓯᐅᔨᑦᑕᐃᓕᒪᓂᕐᒧᑦ ᐆᒪᔪᓂᒃ (IUCN) ᐊᐅᐸᓗᒃᑯᑎᒃ ᑎᑎᕋᖅᑕᐅᓂᖏᑦ ᐆᒪᔪᑦ ᐃᓱᒪᒋᔭᐅᖏᓛᑦ.

ᐊᕙᑎᒧᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐃᒪᕐᒥᐅᑕᐅᓄᑦ ᓂᕿᑎᓄᑦ

ᐱᔾᔪᑕᐅᔪᑦ ᐃᒪᕐᒥᐅᑕᓄᑦ ᓂᕿᑎᓄᑦ ᐃᓕᑕᕆᔭᐅᔪᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂᑦ ᐊᓯᖏᓐᓇᓪᓗ ᐱᖅᑲᑕᐅᔪᓄᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᐃᒪᒃᑯᑦ ᐃᖏᕐᕋᔭᖕᓂᕐᒧᓗᐊᖅ ᐊᒪᓗ ᓱᕋᒃᓯᑐᐃᓐᓇᕆᐊᖃᕐᓂᖏᑦ, ᐃᓗᐃᓗᑦᑎᐅᑎᓗᑎᒃ,

33 EN-CI HTO 2009: ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ ᐅᖃᖅᓯᒪᔪᑦ ᕿᓇᓗᒐᓂᒃ ᑕᑯᔪᒪᒍᕕᑦ ᓯᒡᔭᐅᑉ ᖃᓂᑕᖓᓃᓗᑎᑦ.

34 IQ-CI02 2009: ᑕᓇᐅᕐᒥᐅᑕᓂᒃ ᐃᖃᓗᒃᓯᐅᕐᓂᖅ ᐅᐱᕐᖔᑰᖅᑲᑦᑕᖅᑐᖅ, ᐃᖃᓗᒃᓯᐅᕐᕖᑦ ᐊᔾᔨᒌᖕᒋᑦᑐᓃᑦᑐᑦ ᑕᓯᕐᓂᑦ ᐃᒡᓗᓕᒑᕐᔩᑉ ᖃᓂᑕᖓᓂᑦ.

ᐊᒪᓗ/ᐅᕙᓘᓃᑦ ᐊᓯᐊᓄᑦ ᓅᑎᓪᓗᒋᑦ ᓂᕐᔪᑏᑦ ᐊᐅᔭᒃᑯᑦ ᐃᓂᒋᖃᑦᑕᖅᑕᖏᓐᓂᒃ ᑕᓯᐅᔭᕐᔪᐊᕐᒥᑦ ᐃᒡᓗᓕᒆᕐᔪᖕᒥᓗ. ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᐊᒪᓗ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᑐᐃᓐᓇᕆᐊᓖᑦ ᐃᒪᕐᒥᐅᑕᓄᑦ ᖃᐅᔨᓴᖅᑕᐅᔪᑦ ᐆᒪᔪᑦ ᐊᑐᖅᑕᐅᒐᔪᓗᐊᖅᑐᑦ ᑕᐃᑲᓂ; ᓇᑦᑏᑦ ᐊᒪᓗ ᕿᓇᓗᒐᐃᑦ. ᐃᒪᕐᒥᑦ ᐃᖏᕐᕋᔾᔪᖕᓂᖅ ᐱᓕᕆᐊᒨᑦ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᖅ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᔮᕆᐊᒃᓴᖅ ᐊᕙᑎᒥᒃ ᓇᓄᕐᓄᑦ ᐊᐅᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᖅ ᐊᒪᓗ ᓯᑲᐅᓕᕆᓂᖅ ᑕᐃᒪᐅᕐᑲᑦᑕᕐᓂᐊᕐᓂᖕᒐᓄᑦ ᐊᐅᔭᒃᑯᑐᐃᓐᓇᖅ. ᓇᓄᐃᑦ ᐊᔪᙱᑦᑐᑦ ᓇᓗᖕᓂᖅ ᐅᖕᒐᓯᒃᑐᒧᑦ ᐃᒪᕐᒥᑦ, ᑭᓯᐊᓂ ᓄᓇᒧᐊᕆᐊᕐᑲᕐᑲᑦᑕᖅᑐᑦ ᑕᓯᐅᔭᕐᔪᐊᕐᒥᑦ ᖃᑉᓯᐊᕐᔪᖕᓄᑦ ᑕᖅᑭᓄᑦ ᐊᐅᔭᐅᑎᓪᓗᒍ ᐅᑕᖅᑭᑉᓗᑎᒃ ᓯᑯᓂᐊᖅᑐᒥᒃ; ᑕᐃᒪᓐᓇᒧᑦ, ᑎᑭᐅᑎᔾᔪᑎᖃᑦᑕᕐᓂᖕᒋᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ ᐱᓕᕆᐊᒧᑦ ᐊᒃᑐᐊᔪᓄᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᑕᐃᒪᐅᔾᔫᖕᒋᓐᓂᖕᒋᓐᓄᑦ.

ᐊᓯᐊᕗᕐᓂᖅ ᑐᕐᑯᕋᐃᓂᕐᒧᑦ ᐅᓗᕆᐊᓇᖅᑐᓂᒃ

ᐊᔾᔨᒌᖕᒋᑦᑐᑦ ᐱᓕᕆᐊᔫᖓᔪᑦ ᐅᒥᐊᕐᔪᐊᑦ (ᐃᓚᐅᑉᓗᑎᒃ ᐅᖅᓯᐊᓗᖕᓂᒃ ᐅᓯᔪᑦ, ᓱᓇᑐᐃᓐᓇᓂᒃ ᐅᓯᔪᑦ, ᑐᖅᑯᖅᓯᓯᒪᕚᑦ ᐊᒪᓗ ᐅᓯᖃᑦᑕᖅᑐᑦ ᓯᑲᐅᓂᒃ) ᐊᐅᓚᓂᖃᕐᓂᐊᖅᑐᑦ ᓴᓇᔭᐅᑎᓪᓗᒍ, ᐊᐅᓛᖅᑎᓪᓗᒍ ᐊᒪᓗ ᐅᒃᑯᐊᖅᑎᓪᓗᒍ ᐱᓕᕆᐊᖅ. ᕿᓇᓗᒐᐃᑦ ᐊᒃᑐᖅᑕᐅᑐᐃᓐᓇᕆᐊᖃᖅᑐᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ. ᐅᓗᕆᐊᓇᕐᓂᐅᑉ ᖃᓄᑎᒋᐅᓂᖓ ᐃᒪᕐᒥᐅᑕᓄᑦ ᓂᕐᔪᑎᓄᑦ ᑐᓇᖅᑕᐅᓗᑎᒃ ᐅᒥᐊᕐᔪᐊᓄᑦ ᐊᖏᒡᓕᒋᐊᕐᓂᖃᖅᑐᖅ ᐅᒥᐊᕐᔪᐊᑦ ᓇᑭᖅᓴᕐᓂᖕᒋᓐᓄᑦ (ᓇᑭᖅᓴᕐᓂᖅᓴᐅᓗᑎᒃ 14 knots-ᓂᒃ) ᐊᒪᓗ ᐊᖏᓂᖅᓴᓄᑦ ᓇᑮᓐᓂᖅᓴᓄᑦ ᕿᓇᓗᒐᓄᑦ ᑕᐃᒪᐅᓂᖅᓴᐅᓚᔾᔭᕗᑎᒃ. ᕿᓇᓗᒐᐃᑦ ᓅᑲᑕᐃᓇᓱᑦ ᐊᒪᓗ ᓇᑭᖅᑲᕗᑎᒃ ᓇᓗᒃᑳᖓᓚᑕ, ᐊᒪᓗ ᐃᖏᕋᔪᓃᑕᐃᓕᖅᑲᑦᑕᖅᑲᕗᑎᒃ ᐊᔪᙱᑦᑕᕌᖓᓚᑕ. ᑭᓯᐊᓂ, ᐊᓈᓇᐅᔪᖅ ᐱᐊᓛᖓᓗ ᐊᑯᓂ ᓄᖅᑲᖕᒐᕋᐅᔭᖃᑦᑕᕐᒪᑕ ᐃᒪᐅᑉ ᖄᖓᓄᑦ ᖃᓂᕗᑎᒃ (ᑕᐃᒪᓐᓇᐃᖃᑦᑕᕐᒪᑐᑦ ᑰᒡᔪᐊᕐᒥᑦ) ᐊᒪᓗ ᖃᓄᐃᓕᒋᐊᖕᒋᑦᑐᖕᓇᖅᑲᕗᑎᒃ ᑎᑭᑉᐸᓪᓕᐊᔪᓄᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ. ᓇᑦᑏᑦ ᓅᑲᑕᒍᖕᓇᑦᑎᐊᖅᑐᑦ ᐊᒪᓗ ᓇᓗᒍᖕᓇᑦᑎᐊᕐᓂᑎᒃ ᐊᑐᕐᓗᒋᑦ ᖃᒡᓕᖕᒋᑦᑐᖕᓇᖅᑲᕗᑎᒃ ᓇᑭᔖᖅᑐᓄᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ.

ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖅ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᖅ ᒥᒃᓵᒋᐊᖅᑎᑦᑎᓂᕐᒧᑦ ᐅᓗᕆᐊᓇᖅᑐᒥᒃ ᐱᓕᕆᐊᒥᑦ ᐅᒥᐊᕐᔪᐊᓅᖕᒐᔪᓄᑦ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᓂᕐᔪᑎᓂᒃ. ᑕᒪᒃᑯᓇᓂ ᐃᓚᐅᔪᑦ ᓴᖅᑭᑦᑎᓂᕐᒥᒃ ᓇᑭᖅᓴᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᐅᒥᐊᕐᔪᐊᓂᒃ ᓅᑐᓂᒃ ᐃᓚᖕᒐᑦᑎᒍᑦ ᐃᓂᐅᔪᓂᑦ ᐊᒃᑐᖅᓯᑐᐃᓐᓇᕆᐊᖃᕐᓂᐅᑐᓂᒃ ᓂᕐᔪᑎᓄᑦ, ᐊᑐᕐᓗᑎᒃ ᐱᐅᓛᓂᒃ ᐊᑐᖅᑕᐅᕙᒃᑐᓂᒃ (ᓲᕐᓗ, ᓇᑭᖅᓴᕆᐊᖅᑳᒋᓪᓗᑎᒃ ᓇᑭᖅᓴᕐᓂᕐᒥᒃ, ᐊᑐᕐᓗᑎᒃ ᐊᔾᔨᒌᒃᑐᒥᒃ ᓇᑭᖅᓴᕐᓂᕐᒥᒃ), ᐊᒪᓗ ᐊᑐᕐᓗᑎᒃ ᐅᒥᐊᕐᔪᐊᕐᒦᑐᓂᒃ ᓂᕐᔪᑎᓂᒃ ᕿᓂᖅᓴᖅᑎᓂᒃ (MMO) ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᐃᒪᕐᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓂᒃ (EN-CI NIRB ᒪᐃ 2010[35]).

ᐊᐅᔭᒃᑯᑦ ᐊᐅᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᐅᑎᓪᓗᒍ ᒪᕐᕉᖕᓄᑦ ᐱᖕᒐᓱᓄᑦ ᑖᖅᑭᓄᑐᐃᓐᓇᖅ ᐅᑭᐅᒥᑦ, ᐊᒪᓗ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᖅ ᐊᐅᓚᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᑉᑯᑎᒋᔭᐅᔪᖅ ᑕᓯᐅᔭᕐᔪᐊᕐᒥᑦ ᐊᒥᓲᓗᐊᖕᒋᑦᑐᓂᒃ ᐃᖏᕋᔪᖅᑕᖃᐅᖅᑐᖅ ᐅᒥᐊᕐᔪᐊᓂᒃ. ᑕᐃᒪᓐᓇᒧᑦ, ᓂᕐᔪᑏᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᓖᓐᓇᐅᔪᖅ ᐅᓗᕆᐊᓇᖅᑐᒦᖕᒋᑦᑐᑦ ᑐᕐᑯᑕᐅᓂᕐᒧᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ ᑐᓗᖅᑕᐅᓗᑎᒃ. ᑕᐅᑐᒃᑲᓗ ᓂᕆᐅᒋᔭᐅᔪᖅ ᖃᑉᔾᔪᖅᑕᖃᑦᑕᕐᓂᖅ ᐱᓕᕆᐊᒨᖕᒐᔪᑦ ᐅᒥᐊᕐᔪᐊᑦ ᐊᒪᓗ ᓯᑲᐅᑦ ᐃᖏᕐᕋᔪᑦ ᐅᑭᐅᒥᑦ (7-ᒥᑦ 31-ᒧᑦ ᐃᖏᕐᕋᔪᑦ) ᐃᒃᓴᕋᖕᒧᑦ ᐊᒪᓗ ᐊᑐᖅᑕᐅᔪᒪᔪᖅ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖅ, ᐊᖏᒡᓕᒋᐊᕐᓂᐅᔪᖅ ᑐᕐᑯᓴᐃᓂᖅ ᐃᒪᕐᒥᐅᑕᓂᒃ ᐅᒥᐊᕐᔪᐊᓄᑦ ᓂᕆᐅᒋᔭᐅᔪᖅ ᐊᑦᑎᒃᑑᓂᐊᕐᓂᖕᒐᓂᒃ.

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35 EN-CI NIRB ᒪᐃ 2010: ᑕᑯᔪᒪᔪᖕᒐ ᓂᕐᔪᑎᓂᒃ ᖃᐅᔨᒋᐊᖃᑦᑕᖅᑐᓂᒃ ᐅᒥᐊᕐᔪᐊᕐᒦᑐᓂᑦ.

ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᕙᑎᒧᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓐᓇᖅᑐᖅ ᐃᒪᕐᒥᐅᑕᐃᑦ ᖃᐸᓯᐅᓂᖏᓐᓄᑦ ᓂᕆᐅᒋᔭᐅᔪᖅ ᐃᓂᐅᔪᒥᑐᐃᓐᓇᐅᓂᐊᕐᓂᖓᓄᑦ, ᖃᑯᑎᒃᑰᖃᑦᑕᕐᓗᓂ ᐊᒻᒪ ᐊᑦᑎᒃᑑᓗᓂ ᐊᖏᓂᖓ. ᐱᐅᖏᑦᑐᒥᒃ ᑐᓗᖅᓯᓂᖅᑕᖃᕋᔭᖅᐸᑦ ᐅᒥᐊᕐᔪᐊᒧᑦ ᓂᕐᔪᑎᒥᑦ, ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓐᓇᖅᑐᖅ ᐊᖏᔫᔪᖅ (ᓲᕐᓗ, ᐅᑎᖅᑎᓐᓂᖅ ᐊᔪᖅᑐᖅ) ᐊᑕᐅᓯᕐᒧᑦ ᓂᕐᔪᑎᒧᑦ, ᑭᓯᐊᓂ ᐊᕙᑎᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᖃᐸᓯᐅᓂᖏᓐᓄᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᐅᑎᕈᖅᓇᕐᓂᖓᓄᑦ ᐃᖏᖅᓂᒃ ᐱᕙᓪᓕᐊᓗᑎᒃ. ᐊᖏᒡᓕᒋᐊᕋᓗᐊᖅᑎᓪᓗᒍ ᑐᑭᕋᐃᓂᖅ ᐅᒥᐊᕐᔪᐊᕐᔫᖓᔪᓄᑦ ᑐᓗᖅᑕᐅᔪᓄᑦ ᑲᔪᓯᓂᐊᖅᑎᓪᓗᒍ ᐅᒃᑯᐊᖅᓴᓂᖓᓄᑦ ᐱᓕᕆᐊᖅ, ᕿᓇᓗᒐᐃᓪᓗ ᓇᑦᑏᓪᓗ ᐊᖏᓂᖓ ᖃᐸᓯᐅᓂᖏᓐᓄᑦ, ᑕᑭᓂᖓ-ᐊᑯᓂᐅᑎᒋᔪᖅ ᖃᐸᓯᐅᓂᖏᓐᓄᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ RAA-ᒥᑦ ᐊᒃᑐᖅᑕᐅᖏᓐᓇᔭᖅᑐᖅ, ᐊᑕᐅᓯᕐᒥᑦ ᖃᐸᔨᐊᕐᔪᖕᓄᑦ ᓂᕐᔪᑎᓂᒃ ᐊᔨᐅᕗᓂᖅᑕᖃᑦᑲᓗᐊᖅᐸᑦ ᐱᓕᕆᐊᐸ ᐊᐅᓵᕐᓂᓗᒃᑖᕐᓂᕆᔭᖓᓂᑦ. ᐊᑐᓕᖅᑎᑦᑎᓂᖅ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᒨᖓᔪᓄᑦ (ᓇᕿᖅᓴᓗᐊᖅᑕᐃᓕᒪᑎᑦᑎᓂᖅ, ᓇᕿᖅᓯᒋᐊᖅᑕᐃᓕᒪᓂᖅ, ᐊᒻᒪ ᐊᑐᕐᓂᖅ ᐊᑐᓇᐊᓕᖅᓂᒃ ᐊᐸᕐᑯᑎᓂᒃ ᐊᐅᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ) ᐊᕙᑎᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓐᓇᖅᑐᖅ ᑐᕐᑯᕋᐃᓂᕐᒧᑦ ᐃᒪᕐᒥᐅᑕᓂᒃ ᑐᓗᖅᑕᐅᓂᖏᓐᓄᑦ ᐊᖏᔫᔭᖏᑦᑐᖅ.

ᐅᒥᐊᕐᔪᐊᕐᒥᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᖅᑏᑦ ᓄᓇᓕᖕᓂᑦ ᑎᑎᕋᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᓂᕐᔪᑎᓂᒃ ᑕᑯᔭᖏᓐᓂᒃ, ᐊᒻᒪ ᐊᒃᑐᖅᑕᐅᖃᔭᖅᑐᓂᒃ, ᑕᐃᒪᓐᓇᐃᔾᔭᖏᑦᑐᒃᓴᐅᑎᓪᓗᒍ, ᐅᒥᐊᕐᔪᐊᕐᓄᑦ ᑐᓗᖅᑕᐅᔪᑦ. ᖃᐅᔨᒋᖃᑦᑕᖅᑏᑦ ᑕᐃᒪᐅᖏᑕᐃᒪᐅᖏᐸᐸᑕ, ᐊᔾᔨᖏᑦ ᑐᑭᓯᐅᒪᔾᔪᑏᑦ ᑎᑎᕋᐅᓯᐅᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐅᒥᐊᕐᔪᐊᕐᒥᑦ ᐱᓕᕆᔨᐅᔪᓄᑦ. ᐅᒥᐊᕐᔪᐊᕐᒥᑦ ᑎᑎᕋᕐᕕᐅᕙᓪᓕᐊᕝᕕᑦ ᑎᑎᕋᐅᓯᖃᕐᓂᐊᖅᑐᑦ ᓇᕿᖅᓴᕐᓂᕐᒥᒃ ᓇᕿᓕᕆᐊᖅᑐᓂᒃ ᐱᒻᒪᕆᐅᔪᓂᑦ ᐃᓂᐅᔪᓂᑦ.

ᐊᓯᐊᕝᔪᕐᓂᖅ ᐃᓕᖅᑯᓯᖏᑦ

ᐊᓯᐊᕝᔪᕐᓂᖅ ᐃᓕᖅᑯᓯᖏᓐᓄᑦ ᓲᕐᓗ ᖁᒃᓴᓪᓚᐃᔭᐅᓃᑦ, ᐃᓱᒪᑦᑕᐃᓕᓂᖅ ᐅᕙᓘᓃᑦ ᑐᓴᖅᓴᐅᓂᖅ ᐃᓱᒫᓘᑕᐅᔪᖅ ᐅᓗᓇᐊᓇᕐᓂᖓᓄᑦ, ᐃᓗᐃᓗᑦᑎᐅᑎᓂᕐᒧᑦ ᐅᒪᓗ/ᐅᕙᓘᓃᑦ ᐊᓯᐊᓄᑦ ᓅᓐᓂᖏᓐᓄᑦ ᐃᓂᒋᔭᖏᓐᓂᒃ ᐃᒪᕐᒥᐅᑕᐃᑦ, ᐊᖏᒡᓕᒋᐊᖅᑎᑦᑎᔪᓐᓇᖅᑐᖅ ᐆᒻᒪᓇᒃᓴᕈᓐᓇᕐᓂᖏᓐᓂᒃ ᐊᒻᒪ ᒥᒃᓵᒋᐊᖅᑎᑦᑐᑎᒃ ᓂᕆᕗᒋᔪᓐᓇᖅᑕᖏᓐᓂᒃ ᐊᒻᒪ ᐃᕐᓂᐅᕈᓐᓇᕐᓂᖏᓐᓂᒃ.

ᓂᐱᖃᕐᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᔪᖅ ᐱᐊᓂᒃᑕᐅᓚᐅᖅᑐᖅ ᐱᓕᕆᐊᒨᖓᔪᓄᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ ᐊᒻᒪ ᖃᓄᐃᓐᓂᖅᓴᐅᓂᖏᓐᓅᖅᑕᐅᐸᓗᑎᒃ ᐆᒪᔪᓄᑦ ᑐᓴᖅᓴᐅᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᕙᑎᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓐᓇᖅᑐᓂᒃ ᐃᒪᐅᑉ ᐃᓗᐊᓂᑦ ᓂᐱᖃᕐᓂᖓ ᐃᒪᕐᒥᐅᑕᓄᑦ. ᓯᑕᒪᓂᒃ ᐊᑐᓚᐅᖅᑐᑦ ᐊᐅᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᐊᑉᐸᑯᑕᐅᔪᓂᑦ: ᐃᒡᓗᓕᓪᓚᕐᔪᑉ ᖃᓂᑕᖓᓂᑦ, ᑎᑭᕋᔪᐊᑉ ᑲᖏᖅᓱᓂᐅᑉ ᐊᒻᒪ ᐊᕐᕕᐊᑦ. ᖃᓄᐃᖓᓂᐅᔪᑦ ᐊᑐᖅᑕᐅᔪᒥᒃ ᖃᓄᐃᓐᓂᖅᓴᐅᓂᖓᓅᖅᑕᐅᓚᐅᖅᑐᖅ ᐆᒪᔪᓄᑦ ᑐᓴᖅᓴᐅᓂᕐᒧᑦ ᐊᒻᒪ ᖃᐅᔨᓴᖅᑕᐅᐸᓗᑎᒃ ᐃᓕᖅᑯᓯᓇᔭᐅᕙᒃᑐᓄᑦ ᖃᓄᐃᓕᓂᖏᓐᓄᑦ. ᖃᐅᔨᒪᔭᐅᔪᑦ ᑐᓴᖅᓴᐅᔾᔪᑏᑦ ᐊᑐᖅᑕᐅᓚᐅᖅᑐᑦ ᕿᓇᓗᒐᓄᑦ ᐊᒻᒪ ᖃᐃᕈᓕᖕᓄᑦ (ᐃᓇᖏᐸᓗᓂ ᓇᑦᑎᓄᑦ ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ ᐱᑕᖄᒋᓐᓂᖏᓐᓄᑦ). ᐃᒪᐅᑉ ᐃᓗᐊᓂᑦ ᓂᐱᖄᒋᑎᓪᓗᒍᒧᑦ ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ, ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᑐᖅᑕᓚᐅᖅᓯᒪᔪᓂᒃ ᑕᕆᐅᒥᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᔪᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ.

ᖃᓄᐃᖓᓂᐅᔪᑦ ᑐᓴᖅᓴᐅᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᔪᓄᑦ ᓇᓗᓇᐃᖅᓯᔪᑦ ᕿᓇᓗᒐᐃᑦ ᓇᑦᑏᓪᓗ ᖃᐅᔨᔪᖅᓇᕐᓂᐊᖅᑐᑦ ᐱᓕᕆᐊᒨᖓᔪᓂᒃ ᐅᒥᐊᕐᔪᐊᓂᒃ ᓂᐱᖓᓐᓂᑦ 29 ᑭᓛᒥᑕᓂᒃ ᐅᖓᓯᒃᑎᒋᔪᒥᑦ (Table 6.2-3) ᐊᒻᒪ ᑐᓴᔅᓴᐅᓂᕐᒧᑦ ᑎᑭᑕᐅᓯᒪᓗᑎᒃ 120 dB_{RMS} re 1 µPa –ᖑᑎᒋᔪᒥᒃ – ᓈᓴᐅᑎ ᐃᓕᖅᑯᓯᖏᓐᓄᑦ ᖃᓄᐃᓕᑎᑦᑎᔪᓐᓇᖅᑐᖅ - ᐅᖓᓯᒃᑎᒋᔪᓄᑦ 4.8 ᑭᓛᒥᑕᒥᒃ ᐅᒥᐊᕐᔪᕐᒥᑦ ᐃᖏᕋᔪᒥᑦ.ᑕᐃᒪᓐᓇᒧᑦ, ᐃᓕᖅᑯᓯᖏᓐᓄᑦ ᖃᓄᐃᓕᔾᔪᑏᑦ ᑕᐃᒪᐅᖃᑦᑕᕈᓐᓇᖅᑐᑦ ᐃᒪᕐᒥᐊᑕᓄᑦ 4.8 ᑭᓛᒥᑕᒥᒃ ᐅᖓᓯᒃᑎᒋᔪᓄᑦ ᐃᖏᕋᔪᓄᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ.

ᐊᖏᕐᓗᐊᖏᕐᕆᐊᖅᑎᑦᑎᓂᐅᔪᒧᑦ, ᐃᒪᕐᒥᐅᑕᐃᑦ ᖃᐱᐅᓂᖏᑦ RAA-ᒥᑦ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᑦ ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᔾᔪᑕᐅᓂᐊᕐᓂᖏᓐᓄᑦ. ᐃᓕᖅᑯᓯᖏᓐᓄᑦ ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᐃᒪᐅᑉ ᐃᓗᐊᓂᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᐃᓱᒪᕆᔭᐅᔪᖅ ᐊᖏᔫᔮᖏᓐᓂᖓᓄᑦ ᐊᑐᖅᓱᒍ ᑐᑭᓯᐅᒪᔾᔪᑎ ᓂᐱᖃᕐᓂᐅᑉ ᒥᒃᓵᓄᑦ, ᖃᐴᖅᑕᕐᓂᐅᔪᑦ ᐅᒥᐊᕐᔪᐊᑦ ᐃᖏᕐᕋᓂᖏᑦ ᐃᑲᔪᐃᓂᕐᒧᑦ ᐱᓕᕆᐊᒥᑦ, ᐊᒻᒪ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᖏᓐᓄᑦ ᐊᖏᓂᐅᑉ ᐃᒪᐅᑉ ᐃᓗᐊᓂᑦ ᓂᐱᖃᕐᓂᐅᔪᓄᑦ ᐱᓕᕆᐊᒨᖓᔪᓄᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ.

ᐅᒥᐊᕐᔪᐊᒥᑦ ᖃᐅᔨᒋᖃᑦᑕᖅᐲᑦ ᑎᑎᕋᐃᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐃᒪᕐᒥᐅᑕᓂᒃ ᑕᑯᔭᖏᓐᓂᒃ. ᖃᐅᔨᒋᐊᖃᑦᑕᖅᑐᓂᒃ ᐱᑕᖃᙱᑉᐸᑦ ᑕᑯᔭᐅᔪᑦ ᑎᑎᕋᐅᓯᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐅᒥᐊᕐᔪᐊᕐᒥᑦ ᐱᓕᕆᔨᐅᔪᓄᑦ. ᑲᑎᑉᐸᓪᓕᐊᔪᖅᑕᖃᖅᐸᑦ ᓂᕐᔪᑎᓂᒃ ᑎᑎᕋᐅᓯᐊᓂᐊᖅᑐᑦ ᐊᖏᕐᓗᐊᖏᕐᕆᐊᖅᑎᑦᑎᓂᖅᑕᖃᕐᓗᓂᓗ (ᓲᕐᓗ, ᓄᖅᑲᖅᑎᓪᓗᒍ ᐅᒥᐊᕐᔪᐊᖅ).

ᐊᕿᑎᒧᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐃᖃᓗᙵᓄᑦ

ᐱᔾᔪᑕᐅᔪᑦ ᐃᒪᕐᒥᐅᑕᓄᑦ ᓂᕐᔪᑎᓄᑦ ᐃᓕᑕᕆᔭᐅᔪᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂᑦ ᐊᓯᖏᓐᓇᓪᓗ ᐱᖃᖃᑕᐅᔪᓄᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᐃᒪᒃᑯᑦ ᐃᖏᕐᕋᔭᖕᓂᕐᒧᓗᐊᖅ ᐊᒻᒪ ᓱᖃᔅᓯᑐᐃᓐᓇᕆᐊᖃᕐᓂᖏᑦ ᐃᓗᐅᓗᑦᑎᐅᑎᓗᑎᒃ, ᐊᒻᒪ/ᐅᕝᕙᓃᑦ ᐊᓯᐊᓄᑦ ᓅᑎᓪᓗᒋᑦ ᓂᕐᔪᑏᑦ ᐊᐅᔭᒃᑯᑦ ᐃᓂᒋᖃᑦᑕᖅᑕᖏᓐᓂᒃ ᑕᓯᐅᔭᕐᔪᐊᕐᒥᑦ ᐃᒡᓗᓕᒫᕐᔪᖕᒥᓗ. ᐃᓱᓖᓗᑎ ᐃᓕᑕᕆᔭᐅᔪᖅ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓄᑦ ᐱᔾᔪᑎᖃᖅᑐᖅ ᐃᓗᐃᓗᑦᑎᐅᑎᓂᕐᒧᑦ ᐃᖃᓗᙵᓄᑦ, ᐱᓗᐊᖅᑐᒥᑦ ᐃᖃᓗᒃᐲᑦ, ᑕᐃᒪᐅᖃᑦᑕᖅᑐᑦ ᐃᖃᓗᐃᑦ ᐃᓂᖏᓐᓂᑦ ᐃᒡᓗᓕᒫᕐᔪᕐᒥᑦ (IQ -CI04 2009[36]). ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᑦ ᐃᖃᓗᙵᓄᑦ ᖃᐅᔨᓴᖅᑕᐅᔪᑦ ᐃᖃᓗᒃᐱᖕᓄᑦ ᐱᒻᒪᕆᐅᓂᖏᓐᓄᑦ ᓄᓇᓕᖕᒧᑦ ᐊᒻᒪ ᒪᓂᒪᔪᑦ ᑐᓴᖅᓴᐅᓂᕐᒧᑦ ᓈᓴᐅᑎᓂᒃ/ᑎᑎᖅᑲᓂᑦ.

ᐊᓯᐊᖑᕐᓂᖅ ᐃᓕᖅᑯᓯᖏᑦ

ᐃᒪᐅᑉ ᐃᓗᐊᓂᑦ ᓂᐱᖃᕐᓂᖅ ᐅᒥᐊᕐᔪᐊᓂᑦ ᖁᒃᓴᓪᓚᐃᔪᖕᓇᖅᑐᑦ, ᑎᑭᐅᑎᑦᑕᐃᓕᑎᑦᑎᓗᑎᒃ ᐅᕝᕙᓃᑦ ᖃᓄᐃᓕᓂᖃᖏᓪᓗᑎᒃ ᑐᓴᖅᓴᐅᓂᖃᖅᑕᐃᓕᒪᑎᑦᑎᓂᕐᒧᑦ, ᐊᒻᒪ ᐊᓯᐊᖑᕐᓂᖅ ᐃᓕᖅᑯᓯᒧᑦ ᐊᒻᒪ ᐊᖏᕐᓗᐊᖏᕐᕆᐊᖅᑎᑦᑎᓂᐅᔪᓄᑦ. ᑕᒪᓐᓇ ᒥᒃᑖᕆᐊᖅᑎᑦᑎᔪᖕᓇᖅᑐᖅ ᓂᕆᕝᕕᕆᔪᖕᓇᖅᑕᖏᓐᓂᒃ ᐊᒻᒪ ᐃᕐᓂᐅᕈᖕᓇᕐᓂᖏᓐᓂᒃ, ᐊᒻᒪ ᐊᖏᓪᓕᕆᐊᖅᑎᑦᑎᔪᖕᓇᖅᑐᖅ ᐆᒪᓂᒃᓴᕈᖕᓇᕐᓂᖏᓐᓂᒃ. ᐃᒪᕐᒥᐅᑕᐃᑦ, ᑐᓴᖅᓴᐅᓂᖓᑦ ᐊᑐᖅᑕᐅᔪᑦ ᐱᐊᓂᒃᑕᐅᓚᐅᖅᑐᖅ ᐱᓕᕆᐊᒨᖓᔪᓄᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ ᐊᐅᓚᖅᑎᑦᑎᓂᒧᑦ ᐊᑉᖁᑎᒋᔭᐅᔪᒧᑦ. ᖃᓄᐃᖓᓂᐅᔪᑦ ᐊᑐᖅᑕᐅᔫᑉ ᖃᓄᐃᓂᖅᓴᐅᓂᖓᓅᖅᑕᐅᓚᐅᖅᑐᖅ ᐃᖃᓗᒃᐲᑦ ᑑᓴᓂᖏᓐᓄᑦ ᐊᒻᒪ ᖃᐅᔨᓴᖅᑕᐅᕙᓗᓂ ᒪᓕᒃᓱᒋᑦ ᖃᐅᔨᒪᔪᕐᔪᐊᑎᒧᑦ ᐃᓕᖅᑯᓯᖏᑦ ᖃᓄᐃᓕᓂᒧᑦ.

ᐃᒪᐅᑉ ᐃᓗᐊᓂᑦ ᑐᓴᖅᓴᐅᓂᖅ ᖃᐅᔨᔭᐅᔪᖕᓇᖅᑐᖅ ᐃᖃᓗᙵᓄᑦ ᐊᒻᒪ ᐃᓕᖅᑯᓯᖏᓐᓂᒃ ᖃᓄᐃᓕᑎᑦᑎᔪᖕᓇᖅᓱᑎᒃ 500m-ᓂᒃ ᐊᖓᔫᒃᑎᒋᓗᑎᒃ ᐅᒥᐊᕐᔪᐊᓄᑦ. ᑕᐃᒪᓐᓇ ᖃᓄᐃᓕᑎᑦᑎᓂᐅᔪᑦ ᑕᐃᒪᐅᖃᑦᑕᕈᓐᓇᖅᑐᑦ ᐅᒥᐊᕐᔪᐊᑦ ᐃᖏᕐᕋᑎᓪᓗᒋᑦ ᐊᐅᔭᒃᑯᑦ. ᐊᑐᓕᖅᑎᑦᑎᓂᖅ ᐊᖏᕐᓗᐊᖏᕐᕆᐊᖅᑎᑦᑎᓂᕐᒨᖓᔪᒥᑦ (ᓇᑭᖅᓴᓗᐊᖅᑕᐃᓕᒪᑎᑦᑎᓂᖅ, ᓇᑭᖅᓯᒋᐊᖅᑕᐃᓕᒪᓂᖅ, ᐊᒻᒪ ᐊᑐᕐᓂᖅ ᐊᑐᕆᐊᓕᖕᓂᒃ ᐊᑦᑯᑎᓂᒃ ᐊᐅᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ) ᐃᒪᐅᑉ ᐃᓗᐊᓂᑦ ᑐᓴᖅᓴᐅᓂᕐᒧᑦ ᐃᓗᐃᓗᑦᑎᐅᑎᓂᖅ ᐊᑦᑎᒃᑑᓂᐊᖅᑐᖅ ᐊᖏᓂᖓᓂᑦ, ᐃᓂᒦᓗᓂ, ᐊᒻᒪ ᐅᑎᖅᑎᑦᑐᙵᖅᓱᓂ. ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᐃᓕᖅᑯᓯᒧᑦ ᐃᒪᐅᑉ ᐊᑖᓂᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᓇᐃᑑᓂᐊᖅᑐᑦ ᐊᒻᒪ ᐊᕗᖓᓪᓘᔾᔭᖏᕈᓂ, ᐊᒻᒪ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᑦ ᐃᖃᓗᐃᑦ ᖃᐱᐅᓂᖏᓐᓄᑦ

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36 IQ -CI04 2009: ᒪᑦᑎᑕᐅᑏᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᑦ ᐃᖃᓗᒃᐱᖕᓄᑦ ᓄᓇᓕᐊᓛᒥᑦ, ᐃᒡᓗᓕᒫᕐᔪᒃ ᓂᕆᐊᓂᑦ.

ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᖃᕐᓂᐊᕐᓂᖓᓄᑦ RAA-ᒥᑦ. ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᐃᓕᖅᑯᓯᒧᑦ ᐃᒪᐅᑉ ᐊᑖᓂᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᖏᔫᔾᔨᖏᓐᓂᖓᓄᑦ.

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Acronyms

ATB	Articulated Tug with Barge
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRA	Commercial, Recreational, or Aboriginal
EIS	Environmental Impact Statement
HT	Hearing Threshold
IUCN	International Union on the Conservation of Nature
IQ	Inuit Qaujimajatuqangit
LAA	Local Assessment Area
MMO	Marine Mammal Observer
NEB	National Energy Board
NIRB	Nunavut Impact Review Board
NLCA	Nunavut Land Claims Agreement
NMFS	National Marine Fisheries Service
NPC	Nunavut Planning Commission
NSA	Nunavut Settlement Area
Pa	pascal
PTS	Permanent Threshold Shift
RAA	Regional Assessment Area
rms	root mean square
SARA	*Species at Risk Act*
SPL	Sound Pressure Level
TTS	Temporary Threshold Shift
VEC	Valued Environmental Component

Glossary

Assessment Glossary

Adaptive environmental management	A process for improving environmental management policies and practices through a structured, iterative process of decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring.
Administrative boundary	Specific aspects of provincial, territorial and federal regulatory requirements, standards, objectives or guidelines, and regional planning initiatives that may be used to establish spatial boundaries for assessing the environmental effects of a project on a Valued Component.
Base Case	The current status of the measurable parameters for the environmental effects at baseline (i.e., prior to the proposed project). Baseline includes all past and present projects and activities in the regional assessment area that may result in similar environmental effects to the project environmental effect. Existing projects include those that have received environmental approval and are in some form of planning, construction and/or commissioning.
Best management practice	A process of developing, following and adapting a standard way of maintaining quality that exceeds mandatory legislated standards, which can be based on self-assessment or used as a benchmark.
Compliance monitoring	Monitoring that is undertaken to ensure that proposed project design features, mitigation measures, environmental protection measures, or benefit agreements are being implemented as proposed and in accordance with regulatory requirements.
Cumulative environmental effects	The effect on the biophysical or socio-economic environment that results from the incremental effect of a project action when added to other past, present, and reasonably foreseeable future actions.
Ecosystem	Relating to the complex of a natural community of living organisms and its environment functioning as an ecological unit in nature.

Environmental effect	Broadly refers to the response (positive or negative) of the biophysical or human system or a component of these systems to disturbance.
Effect linkage	The mechanism through which a project component or activity could result in an environmental effect on a Valued Component.
Environmental management	An activity undertaken with the explicit goal of maintaining and improving the state of an environmental resource affected by human activities. It focuses on the management of the interaction and impact of human societies on the environment.
Far Future Case	The status of the measurable parameters for the environmental effect because of the Future Case, in combination with possible far future developments in the region of the proposed project.
Follow-up environmental monitoring	Biophysical and socio-economic monitoring undertaken to: a) verify predictions of environmental effects; b) determine the effectiveness of mitigation measures, environmental protection measures or benefits agreements in order to modify or implement new measures where required; c) support the implementation of adaptive management measures to address previously unanticipated adverse environmental effects; and d) support environmental management systems used to manage the environmental effects of projects.
Future Case	The status of the measurable parameters for the environmental effect because of the Project Case, in combination with all reasonable foreseeable projects, activities and actions. Reasonably foreseeable projects are defined as future projects, activities and actions that will occur with certainty, including projects that are in some form of regulatory approval or have made a public announcement to seek regulatory approval.
Geographic Extent	The geographic area within which an environmental effect of a defined magnitude occurs (e.g., site specific, local, regional, territorial, national)

Key Indicators (KIs)	Species, species groups, resources or ecosystem functions that represent components of the broader Valued Components. For practical reasons, KIs are often selected where sufficient information is available to assess potential project residual environmental effects and cumulative effects.
Local Assessment Area (LAA)	The maximum area within which project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence. The LAA includes the Project Footprint and any adjacent areas where project-related environmental effects may be reasonably expected to occur.
Magnitude	The amount of change in a measurable parameter or variable relative to the baseline case
Measurable parameters	Parameters used to quantitatively or qualitatively measure a project environmental effect or cumulative environmental effect on a Valued Component (VC) or Key Indicator (KI). The degree of change in a measurable parameter is used to characterize project-related and cumulative environmental effects, and evaluate the significance of these effects.
Mitigation	Measures or strategies employed to minimize or avoid project environmental effects or cumulative effects, including project design features, project policies, specialized mitigation, environmental protection measures and protocols, social or community programs, benefits agreements, and compensation (e.g., habitat compensation, habitat replacement or financial compensation).
Precautionary approach or principle	Where there are threats of serious or irreversible damage, lack of full scientific certainty must not be used as a reason for postponing cost-effective measures to prevent environmental degradation.
Project Case	The status of the measurable parameters for the environmental effect with the proposed project in place, over and above the Base Case. This is usually assessed using the peak environmental effect of the project or maximum active footprint for the project.

Project-Environment interaction	A term used to describe the way in which a project action or activity acts on an environmental component spatially and temporally to cause an environmental effect.
Project inclusion list	A list of all past, present and reasonable foreseeable projects, activities and actions that overlap spatially and temporally with residual environmental effects of a proposed project. This list is used to identify those specific projects, activities or actions that should be considered in assessing potential cumulative environmental effects on a Valued Component.
Project footprint	The most immediate area of the project, including the area of direct physical disturbance.
Reasonably foreseeable future development	Projects or activities that are currently under regulatory review or that will be submitted for regulatory review in the near future, as determined by the existence of a proposed project description, letter of intent, or any regulatory application filed with an authorizing agency.
Regional Assessment Area (RAA)	The area within which cumulative environmental effects on a Valued Component may potentially occur. It is also the area where, depending on conditions (e.g., seasonal conditions, habitat use, more intermittent and dispersed project activities), environmental effects of the proposed project may be more wide reaching.
Residual Effects	Predicted environmental effects that are likely to remain after mitigation measures have been applied.
Reversibility	The ability of a measurable parameters for a Valued Component to recover from an environmental effect.
Scoping	A process that focuses study and analysis on those environment-project interactions with the greatest potential to result in environmental effects. This process aims to identify those components of the biophysical and/or socio-economic environment that may be affected by a proposed project and for which there is public concern.

Significant Environmental Effect	A substantial, irrevocable effect or substantial damage to the environment that cannot be avoided or remedied through mitigation measures
Spatial boundary	The probable geographic extent over which project activities are likely to cause an environmental effect (i.e., zone of influence) on a Valued Component.
Sustainability	Sustainability is an economic, social and environmental concept that involves meeting the needs of the present without compromising the ability of future generations to meet their own needs
Technical boundary	Limitations in scientific and social information, data analyses and data interpretation that may be used to establish spatial boundaries for assessing environmental effects of a project on a Valued Component.
Temporal boundary	The period of time during which project activities are likely to affect a Valued Component or Key Indicator. Temporal boundaries typically include major phases of the project but may, in some cases, be refined to a specific period of time to reflect seasonal variations of life cycle requirements or long-term population cycles for some biological Valued Components, or forecasted trends for socio-economic Value Components.
Transboundary effect	Any effect, not exclusively of a global nature, within an area under the jurisdiction of a Party caused by a proposed activity, the physical origin of which is situated wholly or in part within the area under the jurisdiction of another Party.
Valued Environmental Components (VECs)	Those aspects of the environment considered to be of vital importance to a particular region or community, including: a) resources that are either legally, politically, publicly or professionally recognized as important, such as parks, land selections, and historical sites; b) resources that have ecological importance; and c) resources that have social importance.

Valued Components (VC) — The term is used to refer collectively to VECs and VSECs. They are selected for assessment based on regulatory issues and guidelines, consultation with Inuit, regulators, government agencies and stakeholders, field studies, and professional judgment of the environmental assessment team.

Valued Socio-Economic Components (VSECs) — Those aspects of the socio-economic environment considered to be of vital importance to a particular region or community, including components relating to the local economy, health, demographics, traditional way of life, cultural well-being, social life, archaeological resources, existing services and infrastructure, and community and local government organizations.

Discipline-specific Glossary

Acoustic modeling	An estimate of the area of influence of a sound source based on underwater sound levels, bathymetry of the sea floor, and sound speed profiles.
Acoustic Signature	A term used to describe the noise emissions of a sound source.
Aerial Survey	A dedicated survey using aircraft to determine the distribution of marine mammals.
Agile	Able to move and change directions quickly and easily.
Air bladder	An air-filled organ in fish that is used to maintain buoyancy. Also known as a swim bladder.
Ambient Underwater Noise	Baseline background noise before the input of anthropogenic sound. The primary source in the marine environment is surface agitation (wind and waves).
Amplitude	The maximum height of a wave, measured from the position of equilibrium.
Anadromous	Fish species that migrate up rivers from the sea to spawn in freshwater.
Audiogram	A curve of hearing threshold as a function of frequency that describes the hearing sensitivity of an animal over its normal hearing range.
Audiogram Weighted Noise Level	The noise level resulting from applying an animal's audiogram to sound pressure levels to determine the sound level relative to the animal's hearing threshold (units dB re HT).
Auditory Masking	When the perception of one sound (e.g., marine mammal vocalization) is inhibited by the presence of another sound.
Baleen Whale	Whales that use plates of keratin in the mouth for straining plankton and small fishes from the water.

Ballast Water	Water that is held in tanks and cargo holds of ships to increase stability and maneuverability during transit.
Bathymetry	The measurement of depth of the ocean.
Benthic	Occurring at the bottom of the seafloor. E.g., benthic organisms live on or in the seafloor.
Benthopelagic	Fish that live and feed on or near the bottom, as well as in midwater and near the surface of the sea.
Bilge Water	Water that accumulates from seawater that may seep or flow into the vessel from various points in the structure.
Biota	Animal and plant organisms in a particular region or habitat (i.e. marine biota).
Brackish	Water that is somewhat salty, such as that in estuaries.
Calving	To give birth to a calf (i.e., when the beluga produces its offspring)
Cape	A point or extension of land protruding into the water.
Committee on the Status of Endangered Wildlife in Canada	This committee uses the best available information on wildlife species (including scientific, community, Aboriginal Traditional Knowledge) to assess whether that species is at risk of extinction or extirpation in Canada.
Demersal	Living at or close to the bottom of the sea.
Echolocation	A process of locating objects or orienting using reflected sound.
Endangered	A wildlife species facing imminent extirpation or extinction.
Energy Expenditure	Amount of energy used during an activity.

Engagement Activities	Community engagement is the process of establishing the interaction between the local community and the company or research group. Often involves collaboration, review, or approval from formal leadership.
Estuary	The tidally influenced area of the mouth of a river.
Extinct	A wildlife species that no longer has any remaining living individuals.
Extirpated	A wildlife species that no longer exists in the wild in a region (e.g. Canada), but exists elsewhere.
Fecundity	A measure of fertility, the ability to produce offspring. The number of offspring an organism can produce in its lifetime.
Floe Edge	Where the edge of a mass or sheet of ice meets the water.
Foraging Efficiency	The ratio of energy gained over energy spent while foraging.
Frequency	The number of cycles per unit time. In sound, the number of waves per unit time. Measured in hertz (Hz).
Gregarious	Tending to live and occur in social groups.
Head land	A narrow piece of land protruding from the coast into the sea.
Hearing Threshold	The minimum sound level that an organism can hear with no other sound present.
International Union for the Conservation of Nature	A global environmental network which supports scientific research and influences policy, laws, and best practice in more than 160 countries worldwide.
Invasive Species	A species that is non-native to the ecosystem under consideration and whose introduction is likely to cause harm.
Invertebrate	An animal which lacks a backbone (e.g., sea star, urchin, shrimp)

Knot	A maritime unit of velocity measurement, equal to 1 nautical mile or 1.852 km/h.
Land Use Planning	A method of regulating land use which considers the environment, social, traditional, and economic aspects
Landfast Ice	Sea ice that has frozen to the coast or sea floor. This ice does not move with currents or wind.
Land locked	Surrounded by land with no navigable route to the sea.
Marine Mammal	Mammals that are dependent on marine habitats during part or all of their life cycle (i.e., baleen whales, toothed whales, seals, walrus, and polar bears)
Migrate	The act of an organism moving from one region to another periodically for feeding or breeding.
Mitigation Measures	Methods employed to reduce, offset, or eliminate adverse effects of an activity on the environment.
Natural Recruitment	The natural increase in a population as offspring grow and new individuals arrive.
Nearshore	The zone of the sea extending from the low water line beyond the surf zone and influenced by nearshore currents, including the littoral zone.
Odontocete	Group of whales that have teeth as opposed to baleen.
Offshore	The zone of the sea typically extending beyond the nearshore zone and littoral zone.
Open-water Leads	A transient area of open water in the sea that originates through a combination of oceanic and atmospheric stresses, such as tides, which pull the ice floes apart.
Open-water Season	Time when the shipping routes are ice-free (beginning of August to the end of September).

Otolith	A small calcareous bone in the inner ear of fish which is involved in sensing orientation and movement.
Pack Ice	Large pieces of ice that have been driven together to form a nearly continuous mass over an expansive area.
Pelagic	Living in the mid and upper layers of the open sea.
Pinniped	A group of marine mammals that includes seals, sea lions, and walrus.
Population Integrity	A population which is a balanced, integrated, and adaptive community which is functional compared with other populations in similar habitat in the region.
Probability	The likelihood that something will occur.
Propeller Wash	The current of water that is created by the propeller.
Proxy	A thing that is used to represent, or act in place of, another.
Qualitative	Relating to or measuring something by its quality, or descriptive characteristics, rather than its quantity.
Quantitative	Relating to or measuring something by its quantity (i.e. Numerical values).
Salmonid	A fish belonging to the salmon family.
Shoreline Erosion	Wearing away of the coastal land by wave action, tidal currents or wave currents.
Sound Pressure Level	The decibel ratio of sound pressure to some reference pressure, expressed in units of dB re 1µPa in ocean acoustics. Unless otherwise stated, SPL refers to the root mean square (rms) sound pressure.
Sound Propagation	The movement of sound, or pressure waves, through a media such as air or water.

Source Level	The sound pressure level that would be measured at 1 meter distance from a point-like source that radiates the same total amount of sound power as an actual source. Source levels are expressed in units of dB re 1 µPa at 1 m.
Spawn	Reproductive period of fish; release of eggs and sperm.
Special Concern	A wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats.
Species Specific Audiogram	The relationship between noise frequency and an animal's hearing threshold.
Substrate	The surface or material layer on which an organism lives, grows, or feeds.
Taxonomic Group	A scientific grouping and naming of organisms. A system of classification in which a taxonomic group is one unit.
Thermocline	The point in the sea at which the temperature gradient changes rapidly.
Threatened	A wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.
Threshold	A point of beginning, the boundary beyond which a different state will occur.
Vessel Wake	Occurs when vessel movement creates secondary waves (i.e., free surface waves that propagate out from the vessel).

1 Introduction

1.1 Background

The Kiggavik Project (Project) is a proposed uranium ore mining and milling operation located in the Kivalliq region of Nunavut approximately 80 km west of the community of Baker Lake (Figure 1.1-1). The Project is operated by AREVA Resources Canada Inc. (AREVA), in joint venture partnership with Japan-Canada Uranium Company Limited (JCU) and Daewoo International Corporation..

Within the Kiggavik Project there are two general site areas referred to herein as the Kiggavik site and the Sissons site. The two sites are located approximately 17 km apart. Three uranium ore deposits will be mined at the Kiggavik site: East Zone, Centre Zone and Main Zone. A uranium mill, related facilities, main accommodations, and landing strip will also be located at the Kiggavik site. The Sissons site has two uranium ore deposits to be mined: Andrew Lake and End Grid. Open pit mining will be used to extract the ore from the three Kiggavik deposits as well as the Andrew Lake deposit. Mining of End Grid ore will require underground methods.

All ore extracted from the mine sites will be processed through the Kiggavik mill. Mined out pits at the Kiggavik site will sequentially be used as tailings management facilities (TMFs) with East Zone being the initial TMF. The uranium product will be packaged and transported via aircraft to southern transportation networks. Initially, mill reagents, fuel and other supplies will be transported by barge to Baker Lake and then by truck to the mine site over a winter access road. An all-season road between Baker Lake and the Kiggavik Site is carried through the assessment as an option proposed as a contingency in case the winter road cannot adequately support the Project over its life-span.

Decommissioning of the Project will include demolition of site facilities, clean up and reclamation of any disturbed areas, closure of the TMFs and reclamation of mine rock piles to promote vegetative growth and to provide wildlife access.

Projection: NAD 1983 UTM Zone 14N
Creator: CDC Revised: TL
Date: 9/03/2014 Scale: 1:16,000,000
File:
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Geological Survey of Canada, AREVA Resources Canada Inc.*

FIGURE 1.1-1
GENERAL LOCATION OF PROPOSED KIGGAVIK PROJECT IN CANADA

ENVIRONMENTAL IMPACT STATEMENT
SECTION 1 INTRODUCTION

Kiggavik Project
AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

The Kiggavik Project is subject to the environmental review and related licensing and permitting processes established by the Nunavut Land Claims Agreement (NLCA) (NIRB [Nunavut Impact Review Board] 2011), and to the licensing requirements of the Canadian Nuclear Safety Commission (CNSC). The Minister of Indian and Northern Affairs Canada (now Aboriginal Affairs and Northern Development Canada; AANDC) referred the Kiggavik Project to the NIRB for a Review under Part 5 of Article 12 of the NLCA in March of 2010.

The final NIRB "Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc.'s Kiggavik Project (NIRB File No. 09MN003)" (NIRB 2011) were issued in May of 2011. AREVA submitted the Draft Environmental Impact Statement in December 2011 and again in April 2012 with the NIRB determining that the submission successfully conformed to the EIS guidelines in May 2012. Two review periods followed with the Information Request stage completed in January 2013 and the Technical Review stage completed in May 2013. An in-person technical meeting was hosted in Rankin Inlet, Nunavut by the NIRB in May 2013 with a Community Roundtable and a Pre-Hearing Conference (PHC) hosted in Baker Lake, Nunavut shortly after in June 2013. Following the Pre-Hearing Conference the NIRB issued the "Preliminary Hearing Conference Decision Concerning the Kiggavik Project (NIRB File No. 09MN003)" in July 2013.

1.2 Nunavut Impact Review Board Guidelines for the Environmental Impact Statement

The DEIS, including this volume, was determined by the NIRB on May 4, 2012 to have adequately addressed relevant sections of the NIRB "Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc.'s Kiggavik Project (NIRB File No. 09MN003)" (NIRB 2011).

Greater clarity, consistency and, in some cases, additional design or assessment were provided within AREVA's responses to information requests in January 2013 and technical comments in May 2013. AREVA commitments for the preparation of the FEIS and regulatory review requirements are listed in the NIRB PHC Decision dated July 2013. Changes from the draft to final EIS including the location of information related to information requests, technical comments, and PHC requirements is noted in the Final Environmental Impact Statement (FEIS) conformity table (Tier 1, Volume 1, Technical Appendix 1A..

1.3 Purpose and Scope

The Environmental Impact Statement (EIS) has been prepared in fulfillment of the requirements of the NIRB Guidelines, as applied to the marine environment.

The FEIS has been prepared to fulfil the intent of the NIRB Guidelines and PHC Decision, ultimately providing the information required to confidently proceed with an environmental assessment determination. The assessment has been influenced and reflects input provided from Inuit, Land Claim, Government, community, and other interested stakeholders

1.4 Report Content and Related Documents

In addition to this introduction section (Section 1), this document consists of the following sections:

- Section 2: provides an overview of the project.
- Section 3: describes the assessment approach and methodology
- Section 4: describes the project environmental effects
- Section 5: provides the scope of the assessment
- Section 6: summarizes the existing marine environment

Several Tier 3 documents are appended to this Volume to provide further details. The appendices to this volume are as follows:

- Technical Appendix 7A: Marine Environment Baseline
- Technical Appendix 7B: Underwater Acoustic Modelling

2 Project Overview

2.1 Project Fact Sheet

Location	• Kivalliq Region of Nunavut, approximately 80 km west of Baker Lake. • The Project includes two sites: Kiggavik and Sissons (collectively called the Kiggavik Project). • The Kiggavik site is located at approximately 64°26'36.14"N and 97°38'16.27"W. • The Sissons site is located approximately 17 km southwest of Kiggavik at 64°20'17.61"N and 97°53'14.03"W. • The Kiggavik and Sissons sites are composed of 37 mineral leases, covering 45,639 acres.
Resources	• The total quantity of resources is currently estimated at approximately 51,000 tonnes uranium (133 million lbs U3O8) at an average grade of 0.46% uranium.
Life of Mine	• Approximately 12 years of production, based on studies to date. It is anticipated that pre-operational construction will require three years while remaining post-operational decommissioning activities will require ten years. • Date of Project construction will be influenced by favorable market conditions, completion of detailed engineering, and successful completion of licensing and other Project approvals.
Mining	• There are five individual mines proposed for the Project: East Zone, Center Zone and Main Zone at the Kiggavik site; End Grid and Andrew Lake at the Sissons site. • The three Kiggavik deposits and the Andrew Lake deposit will be mined by truck-shovel open pit, while End Grid will be an underground mine.
Mine Rock	• Mine rock will be segregated into material suitable for use in construction (Type 1), non-acid generating (Type 2), and potentially problematic material (Type 3). • Type 1, Type 2 and Type 3 rock will be managed in surface stockpiles during operation. • Upon completion of mining, Type 3 mine rock will be backfilled into mined-out pits.
Mill	• The ore will be processed in a mill at the Kiggavik site to produce 3,200 to 3,800 tonnes uranium (8.3 to 9.9 million lbs U3O8) per year as a uranium concentrate, commonly referred to as yellowcake.
Tailings	• The mill tailings will be managed at in-pit tailings management facilities constructed using the mined-out East Zone, Centre Zone and Main Zone open pits at the Kiggavik site. • Administrative and action levels will be used to control and optimize tailings preparation performance for key parameters.
Water Management	• A purpose-built-pit will be constructed at the Kiggavik site to optimize water management, storage, and recycling. • All mill effluent, tailings reclaim, and site drainage will be treated prior to discharge to meet the Metals Mining Effluent Regulations and site-specific derived effluent release targets. • Administrative and action levels will be used to control and optimize water treatment plant performance for key elements.
Site Infrastructure	• Power will be supplied by on-site diesel generators. • The operation will be fly-in/fly-out on a 7 to 14 day schedule with on-site employees housed in a permanent accommodations complex.

Access	• Access to the site will be provided by a winter road between Baker Lake and Kiggavik. An all-season road is assessed as an option should the winter road be unable to adequately support the Project. Supplies will be shipped to a dock facility at Baker Lake during the summer barge season and trucked to Kiggavik via the road. • An airstrip will be constructed and operated at site for transportation of personnel and yellowcake.
Environment	• Site-specific environmental studies have been on-going since 2007 • Public engagement and collection of Inuit Qaujimajatuqangit has been on-going since 2006; this information is integrated into the environmental effects assessment reports • AREVA's approach has been to integrate environmental assessment and decommissioning requirements into the Project design cycle to enhance mitigation of effects by design and to support the development of management, mitigation, and contingency plans to protect the environment
Benefits	• AREVA is negotiating an Inuit Impact Benefit Agreement with the Kivalliq Inuit Association • The total taxes and royalties to be paid on the Kiggavik project would be approximately $1 billion, payable to Nunavut Tunngavik Inc., Government of Nunavut, and Government of Canada. • The Project is expected to employ up to 750 people during construction and 400 to 600 people during operation.

The economic feasibility of the Kiggavik Project depends on 1) the production cost for the uranium concentrate including construction, operation and decommissioning costs and 2) the market value of the final product. The latest feasibility study completed for the Kiggavik Project was in November 2011. The study assessed the technical and economic viability of developing and operating a uranium mine and mill site in the Kiggavik area and estimated the capital cost of the Project at $2.1 billion and the operating cost at $240 million per year. This initial feasibility study will be updated and refined prior to a development decision. The market price for uranium concentrate over the last years has been within the range needed for a reasonable return on investment to its owners, however at the time of FEIS preparation was below the threshold needed for Project advancement. AREVA believes future opportunities are strong enough to encourage Project advancement with the intent of development that will coincide with viable future markets

2.2 Assessment Basis

To ensure that the potential environmental and socioeconomic effects of the Kiggavik Project are adequately considered in this environmental assessment, it was determined that it would be advantageous to develop a clear "assessment basis" for the Project. The purpose of the assessment basis is to clearly and consistently define how the design parameters detailed in Tier 2 Volume 2 Project Description encompass the more conservative values for various design features and options. It is consistent with the precautionary principle to assess potential environmental effects conservatively to improve confidence that the Project can be realized within the predicted effects and approved environmental assessment.

The assessment basis is summarized in Table 2.1-1 and presented with greater detail in Tier 2 Volume 2 Section 20. For biophysical and some socio-economic effects, the range value with the greatest potential to result in an adverse effect is used. In the case of socio-economic benefits, the range value resulting in the lowest benefit is used.

Table 2.2-1 Project Assessment Basis

Project Activities/Physical Works	Parameter	Units	Parameter / Assumption Values	
			Base Case (PD)	Assessment Case
Overall	Production Rate	Tonnes U per year	3,200 – 3,800	3,200 - 4,000
	Mill Feed Rate	Kilotonnes per year	71 - 977	1,000
	Project Operating Life	Years	2 years pre-production 12 years production	25
	Project Footprint	Hectares (ha)	938	1,102
	Access Road Route	Not Applicable	Winter Road	Winter Road All-Season Road
	Dock Site Location	Not Applicable	Site 1	Sites 1,2, Agnico Eagle's Meadowbank Dock Site
Milling	Flowsheet	Not Applicable	Resin in Pulp (RIP)	Resin in Pulp (RIP), possibly solvent extraction (SX) and / or calciner
	Final Product	Not Applicable	Non-calcined uranium concentrate	Non-calcined or calcined uranium concentrate
Tailings Management	Containment volume	Million cubic metres (Mm^3)	28.4	30.0
	Total tailings volume (un-consolidated)	Million cubic metres (Mm^3)	21	30.0
	Design		Natural surround, no drain	Various design contingencies

Table 2.2-1 Project Assessment Basis

Project Activities/Physical Works	Parameter	Units	Parameter / Assumption Values	
			Base Case (PD)	Assessment Case
Water Management	Freshwater requirements – no permeate or site drainage recycle	Cubic metres per day (m^3/day)	7,910	8,000
	Freshwater requirements – permeate and site drainage recycle	Cubic metres per day (m^3/day)	2,000	8,000
	Freshwater requirements - Sissons	Cubic metres per day (m^3/day)	60	60
	Treated effluent discharge at base quality – Kiggavik	Cubic metres per day (m^3/day)	2,707	3,000
	Treated effluent discharge – Sissons	Cubic metres per day (m^3/day)	1,700	1,700
Power Generation	Kiggavik peak load	megaWatt (MW)	13.0	13.0 – 16.8
	Sissons peak load	megaWatt (MW)	3.8	0 – 3.8
Logistics & Transportation	Number of barge trips – 5000t & 250 containers	Barge trips / year	9 - 31	31
	Number of barge trips – 7500t & 370 containers	Barge trips / year	7 - 22	22
	Number of truck trips – 56,000L & 48t	Truck trips / year	328 – 3,233	3,300
	Number of truck trips – 70,000L & 60t	Truck trips / year	243 – 2,405	2,500
	Number of yellowcake flights	Flights / year	310 - 350	355
Decommissioning	Period	Years	10	10

Under the *Nunavut Land Claims Agreement* and the *Nunavut Planning and Project Assessment Act*, the transportation of persons or goods does not trigger the definition of a transboundary project for an Article 12 Part 6 federal environmental assessment panel review unless that transportation is a substantial element of the project (NLCA 12.4.7(a)(ii) and NUPPAA 94(3)).

All resource development projects require the transport of goods to the project site and the transport of product to market. Proposed Project logistics and transportation infrastructure for the Kiggavik Project is presented in Tier 2 Volume 2 Section 10. There are existing, charted shipping lanes and flight routes throughout Canada and internationally. Projects with intense shipping programs may have increased the level of information for transportation in the project description and have assessed this in greater detail at the environmental assessment stage (e.g. Mary River), but more typically, the precedent is to focus the environmental assessment on the port or terminal area and, in some cases, immediately adjacent shipping activity (e.g. Irving Refinery, Newfoundland Transhipment, Kitimat LNG or Deltaport 3). Applying the precedent to the proposed Kiggavik Project, this would bound the assessment to include potential effects from barging in Chesterfield Narrows prior to reaching existing shipping routes in Hudson Bay and inclusion of potential accidents and malfunctions including take off and landing at the site airstrip prior to reaching altitude, but not product transport to its final destination.

The Kiggavik Environmental Impact Statement has included additional information on both marine and air transport that would be required to obtain licensing approvals with Transport Canada and the Canadian Nuclear Safety Commission.

Marine Transport

The Kiggavik marine assessment (Tier 2 Volume 7) has focused on the Chesterfield Inlet barging activities to Baker Lake as the main component of the environmental assessment, but has additionally provided information on potential effects to marine VECs in Hudson Bay and Hudson Strait.

Transiting through Hudson Bay and Strait, AREVA will follow established shipping routes recommended by Transport Canada and comply with federal legislation (e.g., *Shipping Act*) and regulations including those pertaining to safe operations, ballast water management, bilge water management, transportation of dangerous goods, and emergency response preparedness.

Air Transport

As a fundamental component of the environmental assessment, the Kiggavik accident and malfunction assessment (Tier 2 Volume 10) includes emergency response for necessities of life, personnel emergencies, natural environment-related emergencies and operational emergencies, as well as response strategies for a variety of spill scenarios. The assessment then considers the potential interactions of accidents and malfunctions with the environment and human safety taking into account the proposed mitigation measures including preventative measures and emergency response capabilities.

In addition, AREVA has provided a risk assessment for uranium ore concentrate (UOC) that would be transported by aircraft from the Kiggavik site airstrip southward to connect with established ground transportation routes currently used for shipments of UOC from existing mines in northern Saskatchewan. The likelihood and consequence of incidents involving the air transport of UOC has been assessed considering the flight path from the Kiggavik site to the airstrip at Points North, Saskatchewan. An assessment of the likelihood and consequence of several incident scenarios occurring during subsequent ground transportation of uranium ore concentrates throughout Canada has further been included.

Transportation of UOC will be in accordance with regulations governing the safe transport of radioactive materials including the *Transportation of Dangerous Goods Regulations* and the *Packaging and Transport of Nuclear Substances Regulations*. Development of an Emergency Response Assistance Plan (ERAP) is a post-environmental assessment requirement that must be accepted by Transport Canada prior to shipment. AREVA currently maintains an ERAP for UOC transport in Canada.

3 Assessment Approach and Methods

3.1 Introduction

This section describes the methods used in the assessment of environmental and socio-economic effects associated with the Kiggavik Project. The methods meet the applicable regulatory requirements while focusing the assessment on the matters of greatest environmental, social, cultural, economic and scientific importance. The methodological approach also recognizes the iterative nature of project-level environmental assessment, considering the integration of engineering design and mitigation and monitoring programs into comprehensive environmental management planning for the life of the Project.

The environmental effects assessment method is based on a structured approach that:

- considers the factors that are required under Nunavut Land Claim Agreement,
- focuses on issues of greatest concern,
- affords consideration of all territorial and federal regulatory requirements for the assessment of environmental effects,
- considers issues raised by the Inuit, regulators, government agencies and public stakeholders, and
- integrates Project design and programs for mitigation and monitoring into comprehensive environmental planning.

The environmental assessment focuses on specific environmental components called Valued Environmental Components (VECs) or Valued Socio-economic Components (VSECs) that are of particular value or interest to Inuit, regulators, government agencies and stakeholders. The term Valued Components (VCs) refers collectively to VECs and VSECs. Valued Components are selected based on regulatory issues and guidelines, consultation with Inuit, regulators, government agencies and stakeholders, field studies, and professional judgment of the study team. Where a VC has various sub-components that may interact in different manners with the Project, the environmental assessment may consider the environmental effects on individual Key Indicators (KIs).

The term “environmental effect” is used throughout the Application and broadly refers to the response of the biophysical or human system or a component of these systems to a disturbance from a Project action or activity or other regional actions (i.e., projects and activities).

The environmental assessment methods address Project-related and cumulative environmental effects. Project-related environmental effects are changes to the biophysical or socio-economic environment that are caused by the Project or activity arising solely because of the proposed principal works and activities, as defined by the Scope of the Project. This includes consideration of the environmental effects of malfunctions or accidents that may occur in connection with the Project. Cumulative environmental effects are changes to the biophysical or socio-economic environment that are caused by an action of the Project in combination with other past, present and future projects and activities.

In this assessment, Project-related environmental effects and cumulative environmental effects are assessed sequentially. The mechanisms through which a Project-specific environmental effect may occur are discussed first, taking into account Project design measures and mitigation that help to reduce or avoid environmental effects. The residual environmental effect is then characterized taking into account planned mitigation. At a minimum, all Project environmental effects are characterized using specific criteria (e.g., magnitude, geographic extent, duration) that are defined for each VC.

A cumulative environmental effects screening is then conducted to determine if there is potential for the Project residual environmental effect to act in a cumulative manner with similar environmental effects from other projects and activities. If there is potential for the Kiggavik Project to contribute to cumulative environmental effects, the environmental effect is assessed to determine if it has the potential to shift a component of the natural or socio-economic environment to an unacceptable state.

The environmental effects assessment approach used in this assessment involves the following steps:

- ***Scoping***: Scoping of the overall assessment, which includes: issues identification; selection of VCs (and KIs, if required); description of measurable parameters; description of temporal, spatial, administrative and technical boundaries; definition of the parameters that will be used to characterize the Project-related environmental effects and cumulative environmental effects; and identification of the standards or thresholds that will be used to determine the significance of environmental effects.
- ***Assessment of Project-related environmental effects***: The assessment of Project-related environmental effects, which includes: description of the mechanism(s) by which an environmental effect will occur; mitigation and environmental protection measures to reduce or eliminate the environmental effect; and evaluation and characterization of the residual environmental effects (i.e., environmental effects remaining after application of mitigation measures) of the Project on the biophysical and socio-economic environment for each development phase.
- ***Evaluation of cumulative environmental effects:*** The evaluation of cumulative environmental effects, which involves two tasks: screening for potential cumulative environmental effects and, if there is potential for cumulative environmental effects, assessment of cumulative environmental effects. Where an assessment of potential cumulative environmental effects is required, the residual cumulative environmental

effects of the Project are evaluated in combination with other past, present and future projects and activities.

- ***Determination of significance***: The significance of Project-related and cumulative residual environmental effects is determined using standards or thresholds that are defined for each VC.
- ***Monitoring***: Several different types of monitoring may be required to confirm compliance with mitigation measures or Project design features, address uncertainties or verify environmental effects predictions and/or assess the effectiveness of mitigation measures.
- ***Summary***: The last step of the assessment of environmental effects on a VC is the development of summaries on Project and cumulative environmental effects (including combined Project environmental effects and combined cumulative environmental effects), mitigation measures and Project design features, and monitoring.

3.2 Scope of the Assessment

3.2.1 Valued Components, Indicators and Measurable Parameters

Valued Components are defined as broad components of the biophysical and socio-economic environments, which if altered by the Project, would be of concern to regulators, Inuit, resource managers, scientists, and public stakeholders.

VECs for the biophysical environment typically represent major components or aspects of the physical and biological environment that might be altered by the Project, and are widely recognized as important for ecological reasons.

Criteria for selection of VCs include:

- Do they represent a broad environmental, ecological or human environment component that may be altered by the Project?
- Are they vulnerable to the environmental effects of the Project and other activities in the region?
- Have they been identified as important issues of concerns of Inuit or stakeholders, or in other assessments in the region?
- Were they identified by the Nunavut Impact Review Board (NIRB), Inuit organizations or departments within the territorial or federal government?

Key indicators (KIs) are species, species groups, resources or ecosystem functions that represent components of the broader VCs. They are selected using the same criteria as described above for VCs. For practical reasons, KIs are often selected where sufficient information is available to assess the potential Project residual environmental effects and cumulative environmental effects.

For each VC or KI, one or more measurable parameters are selected to quantitatively or qualitatively measure the Project environmental effects and cumulative environmental effects. Measurable parameters provide the means of determining the level or amount of change to a VC or KI. The degree of change in the measurable parameter is used to characterize project-related and cumulative environmental effects, and evaluate the significance of these effects. Thresholds or standards are identified for each measurable parameter, where possible, to assist in determining significance of the residual environmental effect.

3.2.2 Key Issues

Issues identification focuses the assessment on matters of greatest importance related to the Project, and assists in determining which factors and the scope of those factors that will be considered in the assessment.

Issues and concern about the possible biophysical or socio-economic effects of the Project have been identified from a variety of sources, including:

- the regulatory requirements applicable to the Project,
- discussions with technical experts from various territorial and federal government agencies,
- input from Inuit and public stakeholders during engagement activities in relation to the Project,
- existing regional information and documentation regarding environmental components found near the Project,
- baseline and assessment studies conducted in the area of the Project, and
- professional judgment of the assessment team, based on experience with similar projects elsewhere and other mining project and activities in Nunavut.

Key Project-related issues are summarized in the scoping section for each discipline considered in the assessment.

3.2.3 Project – Environment Interactions and Environmental Effects

Key Project-related activities that are likely to result in environmental effects are considered for each VC. A matrix of Project activities and environmental components is provided in the scoping section for each discipline to identify where interactions are likely to occur based on the spatial and temporal overlap between Project activities and the VC. Each interaction is ranked according to the potential for an activity to cause an environmental effect. The interactions are ranked according to the following:

- If there is no interaction or no potential for substantive interaction between a Project activity and the VC to cause a potential environmental effect, an assessment of that environmental effect is not required. These interactions are categorized as 0, and are not considered further in the EA. The environmental effects of these activities are thus, by definition, rated not significant.
- If there is likely to be a potential interaction between a Project activity and a VC but not likely to be substantive in light of planned mitigation, the interaction is categorized as 1. Such interactions are well understood and are subject to prescribed mitigation or codified practices. These interactions are subject to a less detailed environmental effects assessment and are rated as not significant. Justification is provided and the mitigation is described for such categorizations. Such interactions can be mitigated with a high degree of certainty with proven technology and practices.
- If a potential interaction between a Project activity and a VC could result in more substantive environmental effects despite the planned mitigation, if there is less certainty regarding the effectiveness of mitigation, or if there is high concern from regulatory agencies, Inuit or stakeholders, the interaction is categorized as 2. These potential interactions are subject to a more detailed analysis and consideration in the environmental assessment in order to predict, mitigate and evaluate the potential environmental effects.

The ranking takes a precautionary approach, whereby interactions with a meaningful degree of uncertainty are assigned a rank of 2 to ensure that a detailed analysis of the potential environmental effect is undertaken.

Justification for ranking the Project-environmental interactions considered for each VC is provided in the scoping section for each discipline.

3.2.4 Assessment Boundaries

Boundaries of the assessment are defined for each VC to allow for a meaningful analysis of the significance of environmental effects. The assessment boundaries are described in terms of temporal, spatial and administrative and technical boundaries.

3.2.4.1 Spatial Boundaries

Spatial boundaries are established for assessing the potential Project-related environmental effects and cumulative environmental effects on each VC. The primary consideration in establishing these boundaries is the probable geographical extent of the environmental effects (i.e., the zone of influence) on the VC.

Spatial boundaries represent the geographic extent of the VC, as they pertain to potential Project-environment interactions. Spatial boundaries are selected for each VC to reflect the geographic extent over which Project activities will or are likely to occur, and as such, they may be different from one VC to another depending on the characteristics of the VC. For this assessment, the spatial boundaries are referred to as ‘assessment areas’ to differentiate the areas from the local and regional study areas referred to in many baseline studies.

Three assessment areas are defined for each VC.

The ***Project Footprint*** is the most immediate area of the Project. The Project Footprint includes the area of direct physical disturbance associated with the construction or operation of the Project.

The ***Local Assessment Area*** (LAA) is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence. The LAA includes the Project Footprint and any adjacent areas where Project-related environmental effects may be reasonably expected to occur.

The **Regional Assessment Area** (RAA) is a broader area within which cumulative environmental effects on the VC may potentially occur. This will depend on physical and biological conditions (e.g., air sheds, watersheds, seasonal range of movements, population unit), and the type and location of other past, present or reasonably foreseeable projects or activities. For the socio-economic environment, the RAA may be much broader (planning areas, regions, territories etc.) based on the potential geographic extent over which socio-economic effects are likely to occur. It is also the area where, depending on conditions (e.g., seasonal conditions, habitat use, more intermittent and dispersed Project activities), Project environmental effects may be more wide reaching.

3.2.4.2 Temporal Boundaries

The temporal boundaries for the assessment are defined based on the timing and duration of Project activities and the nature of the interactions with each VC. Temporal boundaries encompass those periods during which the VCs and KIs are likely to be affected by Project activities.

For the Kiggavik Project, temporal boundaries include the following Project phases.

- construction
- operations
- final closure
- post closure

The operations phase includes consideration of maintenance, planned exploration and temporary closure (care & maintenance) of the Project. The final closure phase considers decommissioning and reclamation, and post-closure phase includes management of restored sites.

In some cases, temporal boundaries are refined to a specific period of time beyond simply limiting them to a specific phase of the Project. This is carried out as necessary within each environmental effects analysis section. Temporal boundaries for the assessment may reflect seasonal variations or life cycle requirements of biological VCs, long-term population cycles for some biological VECs, or forecasted trends for socio-economic VSECs.

3.2.4.3 Administrative and Technical Boundaries

Administrative and technical boundaries are identified and justified for each VC or KI, as appropriate. Administrative boundaries include specific aspects of provincial, territorial and federal regulatory requirements, standards, objectives, or guidelines, as well as regional planning initiatives that are relevant to the assessment of the Project's environmental effects on the VC. Administrative boundaries may be selected to establish spatial boundaries.

Technical boundaries reflect technical limitations in evaluating potential environmental effects of the Project, and may include limitations in scientific and social information, data analyses, and data interpretation.

3.2.5 Environmental Effects Criteria

Where possible, the following characteristics are described quantitatively for each VC to assist in the assessment of residual environmental effects. Where these residual environmental effects cannot be defined quantitatively, they are described using qualitative terms. If qualitative descriptions are used, definitions are provided for each VC or KI, as appropriate, in the scoping section of the environmental assessment for that VC or KI.

- ***Direction:*** the ultimate long-term trend of the environmental effect (e.g., positive, neutral or adverse)
- ***Magnitude:*** the amount of change in a measurable parameter or variable relative to the baseline case (i.e., low, moderate, high)
- ***Geographical Extent:*** the geographic area within which an environmental effect of a defined magnitude occurs (site-specific, local, regional, territorial, national, international)
- ***Frequency:*** the number of times during the Project or a specific Project phase that an environmental effect may occur (i.e., once, sporadically, regular, continuous)
- ***Duration:*** this is typically defined in terms of the period of time that is required until the VC returns to its baseline condition or the environmental effect can no longer be measured or otherwise perceived (i.e., short term, medium term, long term, permanent)
- ***Reversibility:*** the likelihood that a measurable parameter for the VC will recover from an environmental effect (i.e., reversible, irreversible)
- ***Ecological or socio-economic context:*** the general characteristics of the area in which the Kiggavik Project is located (i.e., undisturbed, disturbed, urban setting)

3.2.6 Standards or Thresholds for Determining Significance

Where possible, threshold criteria or standards for determining the significance of environmental effects are defined for each VC or KI to represent that limit beyond which a residual environmental effect would be considered significant. In some cases, standards or thresholds are also defined for specific environmental effects on a VC or KI.

Standards are recognized federal and territorial regulatory requirements or industry objectives that are applicable to the VC, and that reflect the limits of an acceptable state for that component. Where standards, guidelines or regulatory requirements do not specifically exist, thresholds are defined for the measurable parameters for an environmental effect on a VC based on resource management objectives, community standards, scientific literature, or ecological processes (e.g., desired states for fish or wildlife habitats or populations).

Potential changes in a measurable parameter or VC resulting from residual Project or cumulative environmental effects are evaluated against these standards or thresholds. Environmental effects are rated as either *significant* or *not significant*.

3.2.7 Influence of Inuit Qaujimajatuqangit and Engagement on the Assessment

Engagement undertaken to date with regulators, Inuit and public stakeholders in relation to the Project is described in Volume 3. Issues raised during these engagement activities and Inuit Qaujimajatuqangit (IQ) sessions were documented, and reviewed for consideration in each discipline-specific assessment, including scoping of baseline data collection, selection of VCs and KIs, use of traditional ecological knowledge (TEK) and IQ in the environmental effects assessment, mitigation and monitoring.

3.3 Assessment of Project Environmental Effects

3.3.1 Existing Conditions

The existing conditions for each VC are described according to the status and characteristics of the VC within its defined spatial and temporal assessment boundaries. This is based on a variety of sources, including:

- information from past research conducted in the region;
- IQ and information from community engagement; and
- knowledge gained from the collection of baseline data through literature review, qualitative and quantitative analyses, and field programs carried out as part of the environmental assessment.

In general, the description of existing conditions is limited to information directly relevant to the potential VC interactions with the Project to support the environmental effects analysis.

3.3.2 Project Effect Linkages

The mechanisms or linkages through which the Project components and activities could result in an environmental effect on a VC, and the spatial and temporal extent of this interaction is described based on the existing conditions of the VC. Because the assessment focuses on residual environmental effects, effects prior to mitigation are not characterized or quantified and the significance of the effect is not determined.

3.3.3 Mitigation Measures and Project Design

Where Project activities are likely to cause an environmental effect on a VC, mitigation measures are identified to minimize or avoid environmental effects of the Project. This includes measures or strategies that are technically and economically feasible and that would reduce the extent, duration or magnitude of the environmental effect.

Mitigation includes Project design features to change the spatial or temporal aspect of the Project, specialized mitigation, and environmental protection measures and protocols.

Where mitigation is identified, a brief discussion of how the measure(s) will help to minimize the residual environmental effect on the VC is provided. Where possible, this includes a description of how effective the measure is expected to be in minimizing the change in the measurable parameters for the environmental effect.

3.3.4 Residual Project Effects Assessment

Taking into account the mitigation and expected effectiveness of the measure(s), the residual environmental effects of the Project are described according to their probable magnitude, geographic scope, duration, frequency, reversibility and ecological context, where appropriate. The residual effect is characterized in the context of the existing condition for the measureable parameter(s) and how it is likely to change as a result of the Project environmental effect. For some residual environmental effects, the change in the measurable parameter is described relative to each Project phase.

Where possible, the magnitude, geographic extent and duration of the residual environmental effect are quantified. If a residual effect cannot be quantified, qualitative terms are used to describe the attributes of the effect.

3.3.5 Significance of Residual Project Environmental Effects

Significance of a residual Project environmental effect is determined based on standards or thresholds that are specific to the VEC, KI and/or the measurable parameters used to assess the environmental effect. Determination of whether a residual environmental effect is considered to be significant or not significant is based on a comparison of the predicted change in the VC or measurable parameter to the defined threshold or standard. This includes an indication of the likelihood that a significant residual environmental effect on a VC will occur based on probability of occurrence (i.e., based on past experience) and level of scientific uncertainty.

Determination of significance also includes a discussion of the confidence of the prediction with respect to:

- the characterization of environmental effects, and
- the success of Project design features, mitigation measures, and environmental protection measures in effectively reducing the environmental effect.

Prediction confidence for the environmental effect and the success of mitigation measures is ranked as low, moderate or high.

3.3.6 Monitoring of Residual Project Environmental Effects

Based on analysis of the residual Project environmental effect, it may be necessary to conduct a monitoring program. Monitoring is recommended in cases where there is a need to address Project-related issues of public concern, test the accuracy of the assessment predictions, verify the success of the mitigation measures, or gain additional scientific knowledge related to prediction of the Project environmental effect.

Two types of monitoring are considered: compliance and follow-up environmental monitoring.

Compliance monitoring is undertaken to confirm that Project design features, mitigation measures, environmental protection measures, or benefit agreements are being effectively implemented.

Biophysical and socio-economic monitoring programs are used to:

- verify predictions of environmental effects;
- determine the effectiveness of mitigation measures, environmental protection measures or benefits agreements in order to modify or implement new measures where required;
- support the implementation of adaptive management measures to address previously unanticipated adverse environmental effects; and
- support environmental management systems used to manage the environmental effects of projects.

Where a monitoring program for a specific VC or KI is identified, the following aspects of the program are defined:

- parameters to be measured,
- methods and equipment to be used,
- location and timing of surveys, and
- how the results of the monitoring will be applied, including consideration of an adaptive management approach.

3.4 Assessment of Cumulative Environmental Effects

3.4.1 Screening for Potential Cumulative Effects

Cumulative environmental effects are only assessed if the following criteria are met for the residual Project effect under consideration:

- The Project will result in a measurable, demonstrable or reasonably-expected residual environmental effect on a component of the biophysical or socio-economic environment,
- The Project-specific residual environmental effect on the component will likely act in a cumulative fashion with the environmental effects of other past or future projects or activities that are likely to occur (i.e., Is there overlap of environmental effects?), and
- There is a reasonable expectation that the Project's contribution to cumulative environmental effects will be substantive, measurable or discernible such as that it will affect the viability or sustainability of the resource.

If, based on these criteria, there is potential for cumulative environmental effects, the effect is assessed further to determine if it is likely to shift the component to an unacceptable state. Where there is no potential for the environmental effect of the Project to spatially or temporally overlap with similar effects of other projects and activities, justification for not carrying these environmental effects forward to the assessment of cumulative environmental effects is provided.

3.4.2 Project Inclusion List

The project inclusion list includes all past, present and reasonable foreseeable projects, activities and actions in the region of the Kiggavik Project. Only projects and activities that overlap with the Project residual environmental effects both spatially and temporally are considered in the assessment of potential cumulative environmental effects.

The specific projects, activities and action considered for each environmental effect are described in the assessment for the VC or KI.

3.4.3 Description of Cumulative Environmental Effects

The first step in the assessment of cumulative environmental effects involves describing the environmental effect, the mechanisms by which the Project environmental effect may interact cumulatively with other projects and activities in the RAA (from the Project Inclusion List), and the geographic and temporal scope of the cumulative environmental effect.

For this assessment, cumulative environmental effects are described for four cases.

- ***Base Case:*** the current status of the measurable parameters for the environmental effects at baseline (i.e., prior to the Project). Baseline includes all past and present projects and activities in the RAA that may result in similar environmental effects to the Project environmental effect, including ongoing mineral exploration. Existing projects include projects that have received environmental approval and are in some form of planning, construction and/or commissioning.
- ***Project Case:*** the status of the measurable parameters for the environmental effect with the Project in place, over and above the Base Case. This is usually assessed using the peak environmental effect of the Project or maximum active footprint for the Project.
- ***Future Case:*** the status of the measurable parameters for the environmental effect because of the Project Case, in combination with all reasonable foreseeable projects, activities and actions. Reasonably foreseeable projects are defined as future projects, activities and actions that will occur with certainty, including projects that are in some form of regulatory approval or have made a public announcement to seek regulatory approval.

  For this assessment, future projects include proposed mines that are currently under NIRB review:

  - Hope Bay Gold Project
  - Meliadine
  - Mary River
  - Hackett River
  - Back River

  High Lake The combination of the Project Case with the Future Case allows determination of the Project's contribution to cumulative effects of all past, present and reasonably-foreseeable projects and activities.

- ***Far Future Case:*** the status of the measurable parameters for the environmental effect because of the Future Case, in combination with possible far future developments in the Kiggavik region.

  It is recognized that exploration activities will continue in the vicinity of the Kiggavik Project, and that there is the potential for additional resources to be discovered during the life of the Project. To address such a possibility, a potential far future development scenario is considered. This scenario assumes additional deposits within a 200 km radius of the Kiggavik site, and the development of a non-uranium operation located within the Kiggavik RSA. The Meadowbank gold operation is used as the model for this. It assumes additional resources are found in the Meadowbank area, and that operation of

Meadowbank continues. The following projects and activities are included in the development scenario.

Component	Locations
Uranium mines	3 mines within 200 km of Kiggavik
Uranium mills	Kiggavik mill
Gold mines	1 mine within Kiggavik RSA Meadowbank region
Gold mills	Meadowbank region Additional mill within Kiggavik RSA
Access Roads	Meadowbank region Additional mill within Kiggavik RSA
Exploration	Induced exploration near the access road(s) and in the Kiggavik area

Due to the lack of information regarding the specific details of potential future developments (i.e., footprint of projects and activities), the assessment of cumulative environmental effects under this Case is by definition qualitative and is limited to a description of how these projects, activities and actions could affect the magnitude, duration and extent of cumulative environmental effects.

3.4.4 Mitigation of Cumulative Environmental Effects

Mitigation measures that would reduce the Project's environmental effects are described for cumulative environmental effects, with emphasis on measures that should limit the interaction of environmental effects of the Project with similar environmental effects from other projects. Three types of mitigation measures are considered, where appropriate:

- measures that can be implemented solely by AREVA,
- measures that can be implemented by AREVA, in cooperation with other project proponents, government, Aboriginal organizations and/or public stakeholders, and
- measures that can be implemented independently by other project proponents, government, Aboriginal Organizations and/or public stakeholders.

For the latter two types of mitigation, the degree to which AREVA can or cannot influence the implementation of these measures is noted.

Mitigation measures that could assist in reducing potential cumulative environmental effects are identified for each environmental effect, including a discussion of how these measures may potentially modify the characteristics of an environmental effect.

3.4.5 Residual Cumulative Environmental Effects Assessment

Residual cumulative environmental effects are described, taking into account how the mitigation will change the environmental effect. Where possible, cumulative environmental effects are characterized quantitatively or qualitatively in terms of the direction, magnitude, duration, geographic extent, frequency and reversibility. This includes characterization of:

- the total residual cumulative environmental effects based on the Future Case (i.e., the environmental effects of all past, present and reasonably foreseeable project and activities), in combination with the environmental effects of the Project, and
- the contribution of the Project to the total residual cumulative effects (i.e., how much of the total residual cumulative effects can be attributed to the Project).

3.4.6 Significance of Residual Cumulative Environmental Effects

The significance of cumulative environmental effects is determined using standards or thresholds that are specific to the VC, KI and/or measurable parameters used to assess the Project environmental effect. Determinations of significance are made for:

- the significance of the total residual cumulative environmental effect, and
- the significance of the contribution of the Project to the total residual cumulative environmental effect.

The determination of residual cumulative environmental effects includes a discussion of the confidence of the prediction based on scientific certainty relative to:

- quantifying or estimating the environmental effect (i.e., quality and/or quantity of data, understanding of the effects mechanisms), and
- the effectiveness of the proposed mitigation measures.

As for residual Project environmental effects, prediction confidence for the cumulative environmental effect and the success of mitigation measures is ranked as low, moderate or high.

3.4.7 Monitoring of Cumulative Environmental Effects

Based on the evaluation of residual cumulative environmental effects, it may be necessary to conduct monitoring programs. Monitoring programs are designed to:

- confirm the effectiveness of a broad range of approved mitigation techniques,
- determine whether different or an increased level of mitigation is required to achieve the mitigation or reclamation goals, and
- identify and address any cumulative effects that occur but were not predicted.

Two types of monitoring are considered:

- Compliance Monitoring: to confirm that Project design features, mitigation measures, environmental protection measures, or benefit agreements are being effectively implemented.
- Biophysical or Socio-economic Monitoring: to confirm the environmental effect prediction and/or effectiveness of a Project design feature, mitigation measure, environmental protection measure, or benefit agreement.

3.5 Summary of Residual Environmental Effects

Residual Project and cumulative environmental effects are briefly summarized for each VC. This includes a discussion of the overall combined environmental effect of the Project on the VC and its significance, as well as a discussion of the overall combined effect of all cumulative effects on the VC and its significance. For biophysical VECs, this relates to the sustainability of the resource or populations being considered. For socio-economic VSECs, this relates to the ability of the community, the Kivalliq region and/or Nunavut to adapt to or manage the environmental effect. A discussion of the Project's contribution to the combined cumulative effect is also provided.

In addition, this summary section presents an assessment of the effects of climate change on residual Project and cumulative effects. Where possible, the effects are described quantitatively, and include a description of how likely climate changes in the region will likely influence Project and cumulative residual effects.

3.6 Assessment of Transboundary Effects

As required by the NIRB EIS Guidelines, the assessment includes consideration of transboundary effects, where residual environmental effects are likely to extend beyond Nunavut into federal waters and/or other provincial or territorial jurisdictions. As this is based largely on the cumulative effects assessment, the transboundary effects are characterized qualitatively or semi-quantitatively.

3.7 Summary of Mitigation

A detailed description of the mitigation measures proposed to minimize or avoid project-related and cumulative effects on VCs is provided based on the scoping and effects analyses. This includes:

- relevant Project design features to reduce environmental effects,
- Project policies (e.g., Inuit hiring policy),
- specialized mitigation measures to minimize environmental effects on VECs,
- social or community programs to minimize environmental effects on VSECs,
- Environmental Protection plans,
- broader agreements (e.g., benefits agreements), and
- compensation.

3.8 Summary of Monitoring

Monitoring programs to address uncertainties associated with the environmental effects predictions and environmental design features and mitigation proposed for residual Project effects and cumulative effects are described in detail. This includes all compliance monitoring and environmental monitoring that may be applied during the life of the Project, and that will form the:

- Compliance Monitoring Program Framework,
- Environmental Monitoring Program Framework,
- Socio-Economic Monitoring Program Framework,
- Post-Project Analysis Program Framework, and
- Follow-up Monitoring Programs.

4 Scope of the Assessment for the Marine Environment

This section describes the scope of the environmental effects assessment for the marine environment.

Project activities associated with the construction, operation and decommissioning of the Kiggavik Project have the potential to result in environmental effects on the marine environment. Routine vessel operations within the NSA, and routine activities associated with construction, operation, and decommissioning of the proposed dock facility are considered. Marine transportation activities outside of the NSA are not considered within the scope of the assessment. Accidents and malfunctions (including accidental releases) at the terminal or during vessel transit are addressed in Volume 10.

4.1 Issues and Concerns Identified During Inuit, Government and Stakeholder Engagement

The NIRB EIS Guidelines for the Project (Nunavut Impact Review Board 2011) incorporated advice from the public and interested parties on the proposed scope of assessment for the marine environment, including identification of Valued Environmental Components (VECs) and issues that should be considered in the EIS. Specifically, the guidelines require an analysis of the potential environmental effects of shipping activities on marine wildlife and marine habitat, as well as an assessment of how the Project may contribute to regional cumulative environmental effects of marine transportation activities in Hudson Bay.

Public engagement was used to help identify and select Valued Ecosystem Components (VECs). AREVA determined it was important to examine and understand which VECs are important to Inuit stakeholders. To gain a better understanding of the value associated with specific VECs, AREVA conducted a number of public engagement programs. In 2009 and 2010, AREVA undertook community meetings throughout the Kivalliq region to introduce AREVA and project team members, provide information on the proposed Kiggavik Project, provide information on AREVA's mining and transportation experience, encourage public input and participation, and learn more about important values and concerns to help identify valued ecosystem and socioeconomic components for the environmental assessment.

The following are Project-specific issues and concerns regarding the marine environment that were identified during Inuit, government, and stakeholder engagement:

- underwater noise associated with marine vessel movement, and its environmental effects on marine biota. A community member commented *"A walrus will hear a rifle shot while underwater. Will the noise you mention from shipping protect marine mammals?"* (EN-CI OH 2012). Hunters have also voiced their *concerns over the current impacts of barges and ships to marine mammals and have noticed that Whale are further away from the hunting areas because of the noises from the barges and ships*. (EN-CI NIRB 2010)
- physical presence and movement of marine vessels and effects on the health of marine biota (accidental injuries and mortality from ship strikes) and shoreline habitat (due to propeller wash, wake). A community member asked, *"How would the vessels avoid the Whale? Sometimes Whale come after our propeller*" (EN-WC OH 2012). *Community members stressed that the barge traffic be minimized in the area to reduce impacts to marine wildlife. Concerns over impacts to migration routes (for example beluga migration route is usually towards Southampton Island)* (EN-CH NIRB 2010).
- potential environmental effects of bilge and ballast water[37], changes in sediment transport and accidental spills of hazardous materials on coastal and marine habitat and marine wildlife. Community members are *curious about the potential impacts of spills on fish, seal and wildlife from the ships* (EN-RI NIRB 2010).

4.2 Regulatory Setting

4.2.1 *Arctic Waters Pollution Prevention Act*

The *Arctic Waters Pollution Prevention Act (Transport Canada 2014a)* is a zero discharge act which states "no person or ship shall deposit or permit the deposit of waste of any type in the Arctic waters". Under the *Act*, the Arctic Waters Pollution Prevention Regulations *(Transport Canada 2014b)* and the Arctic Shipping Pollution Prevention Regulations *(Transport Canada 2014c)* aim to prevent the pollution of Canadian Arctic waters by regulating the operations and management of ship-produced wastes while sailing in Arctic coastal waters under Canadian jurisdiction.

[37] While concerns were raised about contaminants in both bilge and blast water, bilge water is not permitted to be discharged within the Territorial waters of Canada. Our assessment therefore focuses on ballast water.

4.2.2 *Fisheries Act*

Fisheries and Oceans Canada (DFO) regulates activities that might affect fish or fish habitat, which are protected under the *Fisheries Act* (2012). Under Section 2(1) of this Act, 'fish' includes fish and shellfish, any parts of fish or shellfish, crustaceans, other marine animals; and the eggs, sperm, spawn, larvae, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals. By this definition, marine mammals are considered as 'fish'. A number of sections of the *Fisheries Act (2012)* apply to activities and developments associated with the proposed Kiggavik Project. Section 35 of the *Act* states that "no person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery" (Government of Canada 2012). . Serious harm to fish is defined under subsection 2(2) of the *Act* as "the death of fish or any permanent alteration to, or destruction of, fish habitat". Section 36 prohibits deposits of any substances considered deleterious to fish. The Marine Mammal Regulations (1993), under the *Fisheries Act*, apply to the management and control of fishing for marine mammals in Canadian waters. The regulations state that, for industrial projects, no person shall disturb a marine mammal except when fishing for marine mammals under the authority of those regulations.

4.2.3 *Species at Risk Act*

The *Species at Risk Act* (SARA) provides legal protection of wildlife species and the conservation of biological diversity. It is a federal commitment to prevent wildlife species at risk from becoming extinct and to implement the necessary actions for their recovery. Under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), species are ranked according to conservation concern (i.e., extinct, extirpated, endangered, threatened, special concern, not at risk or data deficient). Schedule 1 of SARA is the official list of wildlife species at risk in Canada; it contains species that are extirpated, endangered, threatened, and of special concern.

4.2.4 *Nunavut Wildlife Act*

The *Nunavut Wildlife Act* is territorial legislation, under the Nunavut Land Claims Agreement, established for the management of wildlife and habitat in Nunavut, including the conservation, protection and recovery of species at risk. The Act applies to all terrestrial and aquatic wildlife and their habitat. It does not cover fish, as defined in Section 2 of the *Fisheries Act* (see section 4.2.1). The Department of Environment Wildlife Management division has a legislated mandate for the management of terrestrial species in Nunavut and is responsible for fulfilling Government of Nunavut responsibilities under federal legislation, and national and international agreements and conventions.

Although the polar bear is generally considered a marine mammal because it is dependent on the marine environment for survival, it also uses terrestrial habitats for some life stages and is therefore protected and managed under this *Act*.

4.2.5 *Nunavut Land Claims Agreement Act*

The *Nunavut Land Claims Agreement* (NLCA) is a 1993 land claims agreement between the Inuit of the Nunavut Settlement Area (NSA) and the Government of Canada, which allowed for the creation of a new territory and the Government of Nunavut. Under the terms of the agreement, jurisdiction over some territorial matters was transferred to the new government including wildlife management, land use planning, and natural resource management.

The Nunavut Planning Commission (NPC) was established under the NLCA, and is responsible for land use planning in the NSA. “Land” use in this context also includes the management of coastal and offshore marine and wildlife resources. The provisions of the NLCA include respecting wildlife, habitat, and the rights of Inuit in relation to wildlife and habitat. The NPC has developed the *Keewatin Regional Land Use Plan*[38]*,* which encompasses the LAA and RAA for the marine assessment (Nunavut Planning Commission 2000). Objectives under this land use plan of relevance to the marine assessment include:

- Residents should know what others are doing, or are planning to do, in the area used by their community, inside and outside of municipal boundaries.
- Residents should have major input into the regulation and management of these activities.
- Non-renewable resource development should have environmental effects that are not significant on the environment, wildlife or wildlife habitat.
- The continued development of appropriate land, air and marine transportation for the safe, accessible and reliable movement of people and goods, to serve the social, economic and political needs of the Keewatin people.

Under the NLCA, the NPC has the authority and responsibility to review any project proposal within the region and confirm that it conforms to this plan and to make a determination accordingly. The land use plan encourages the use of Inuit monitors on board any ship travelling through the region, and improved communications to reduce interference with people and wildlife. Appendix J of the NPC land use plan outlines marine transportation corridor guidelines to be used in the assessment of a new transportation corridor (Nunavut Planning Commission 2000).

[38] Kivalliq became the official name in 1999 when Nunavut became a territory. It existed as Keewatin Region, Northwest Territories and the name has been phased out in Nunavut.

4.3 Project–Environment Interactions

4.3.1 Project-Environment Interactions

Interactions are expected to occur between the marine environment and construction, operations and decommissioning activities of the Project. These are ranked according to the potential for an activity to interact with one or more components of the marine environment (Table 4.3-1). The components of the marine environment considered include marine wildlife (marine mammals, marine fish, marine birds, marine benthic invertebrates, marine Species at Risk) and biophysical features of the marine environment (sediment and water quality, and marine vegetation).

Table 4.3-1 Identification of Project-Environment Interactions

Project Component	Project Activities/Physical Works	Marine Mammals	Marine Fish	Marine Birds	Marine Benthic Invertebrates	Marine Vegetation	Marine Sediment Quality	Marine Water Quality	Marine Species at Risk
Construction									
Economic Activities	Construction workforce management; Contracts and taxes; Advance training of operations workforce	0	0	0	0	0	0	0	0
In-Water Construction	Construct freshwater diversions and site drainage containment systems (dykes, berms, collection ponds)	0	0	0	0	0	0	0	0
	Construct in-water/shoreline structures[39]	0	0	0	0	0	0	0	0
	Water transfers and discharge	0	0	0	0	0	0	0	0
	Freshwater withdrawal	0	0	0	0	0	0	0	0
On-Land Construction	Site clearing and pad construction (blasting, earth moving, loading, hauling, dumping, crushing)	0	0	0	0	0	0	0	0
	Road and Airstrip Construction	0	0	0	0	0	0	0	0
	Aggregate Sourcing	0	0	0	0	0	0	0	0
	Construct foundations	0	0	0	0	0	0	0	0
	Construct buildings	0	0	0	0	0	0	0	0
	Install equipment	0	0	0	0	0	0	0	0
	Install and commission fuel tanks	0	0	0	0	0	0	0	0
	Mill dry commissioning (water only)	0	0	0	0	0	0	0	0
Supporting Activities	Transport fuel and construction materials (transfers, barging)	2	2	1	1	1	1	1	1
	Air transport of personnel and supplies	0	0	0	0	0	0	0	0
	Hazardous materials storage and use	0	0	0	0	0	0	0	0
	Explosives storage and use	0	0	0	0	0	0	0	0
	Waste incineration and disposal	0	0	0	0	0	0	0	0
	Industrial machinery operation	0	0	0	0	0	0	0	0
	Power generation	0	0	0	0	0	0	0	0
Operation									
Economic Activities	Workforce management; Employment; Contracts and taxes	0	0	0	0	0	0	0	0
Mining	Mining ore (blasting, loading, hauling)	0	0	0	0	0	0	0	0
	Ore stockpiling	0	0	0	0	0	0	0	0
	Mining special waste (blasting, loading, hauling)	0	0	0	0	0	0	0	0
	Special waste stockpiling	0	0	0	0	0	0	0	0
	Mining clean waste (blasting, loading, hauling)	0	0	0	0	0	0	0	0
	Clean rock stockpiling	0	0	0	0	0	0	0	0
	Mine dewatering	0	0	0	0	0	0	0	0
	Underground ventilation	0	0	0	0	0	0	0	0
	Backfill production and underground placement	0	0	0	0	0	0	0	0

[39] Potential effects of in-water/shoreline structures on the aquatic environment are assessed in Volume 5. There is not expected to be any substantive interaction between marine species or habitat and activities associated with the dock facility in Baker Lake.

Table 4.3-1 Identification of Project-Environment Interactions

Project Component	Project Activities/Physical Works	Marine Mammals	Marine Fish	Marine Birds	Marine Benthic Invertebrates	Marine Vegetation	Marine Sediment Quality	Marine Water Quality	Marine Species at Risk
Milling	Transfer ore to mill	0	0	0	0	0	0	0	0
	Crushing and grinding	0	0	0	0	0	0	0	0
	Leaching and U recovery	0	0	0	0	0	0	0	0
	U purification	0	0	0	0	0	0	0	0
	Yellowcake drying and packaging	0	0	0	0	0	0	0	0
	Tailings neutralization	0	0	0	0	0	0	0	0
	Reagents preparation and use	0	0	0	0	0	0	0	0
Tailings Management	Pumping and placement of tailings slurry	0	0	0	0	0	0	0	0
	Consolidation of tailings	0	0	0	0	0	0	0	0
	Pumping of TMF supernatant	0	0	0	0	0	0	0	0
Water Management	Create and maintain water levels	0	0	0	0	0	0	0	0
	Freshwater withdrawal	0	0	0	0	0	0	0	0
	Potable water treatment	0	0	0	0	0	0	0	0
	Collection of site and stockpile drainage	0	0	0	0	0	0	0	0
	Water and sewage treatment	0	0	0	0	0	0	0	0
	Discharge of treated effluents (including grey water)	0	0	0	0	0	0	0	0
Waste Management	Disposal of industrial waste	0	0	0	0	0	0	0	0
	Management of hazardous waste	0	0	0	0	0	0	0	0
	Management of radiologically contaminated waste	0	0	0	0	0	0	0	0
	Disposal of domestic waste	0	0	0	0	0	0	0	0
	Incineration and handling of burnables	0	0	0	0	0	0	0	0
	Disposal of sewage sludge	0	0	0	0	0	0	0	0
General Services	Generation of power	0	0	0	0	0	0	0	0
	Operate accommodations complex	0	0	0	0	0	0	0	0
	Recreational activities	0	0	0	0	0	0	0	0
	Maintain vehicles and equipment	0	0	0	0	0	0	0	0
	Maintain infrastructure	0	0	0	0	0	0	0	0
	Operate airstrip	0	0	0	0	0	0	0	0
	Hazardous materials storage and handling (reagents, fuel and hydrocarbons)	0	0	0	0	0	0	0	0
	Explosives storage and handling	0	0	0	0	0	0	0	0

Table 4.3-1 Identification of Project-Environment Interactions

Project Component	Project Activities/Physical Works	Marine Mammals	Marine Fish	Marine Birds	Marine Benthic Invertebrates	Marine Vegetation	Marine Sediment Quality	Marine Water Quality	Marine Species at Risk
Transportation	Marine Transportation: loading barges, barging, off-loading (fuel, reagents and supplies), Baker Lake and Churchill/Chesterfield, back-haul	2	2	1	1	1	1	1	1
	Truck transportation	0	0	0	0	0	0	0	0
	General traffic (Project-related)	0	0	0	0	0	0	0	0
	Controlled public traffic	0	0	0	0	0	0	0	0
	Air transportation of personnel, goods and supplies	0	0	0	0	0	0	0	0
	Air transportation of yellowcake	0	0	0	0	0	0	0	0
	General air transportation support	0	0	0	0	0	0	0	0
Ongoing Exploration	Aerial surveys	0	0	0	0	0	0	0	0
	Ground surveys	0	0	0	0	0	0	0	0
	Drilling	0	0	0	0	0	0	0	0
Final Closure									
Economic Activities	Decommissioning Workforce management; Employment; Contracts and taxes	0	0	0	0	0	0	0	0
General	Hazardous materials storage	0	0	0	0	0	0	0	0
	Industrial machinery operation	0	0	0	0	0	0	0	0
	Ongoing withdrawal, treatment and release of water, including domestic wastewater	0	0	0	0	0	0	0	0
In-water Decommissioning	Remove freshwater diversions; re-establish natural drainage	0	0	0	0	0	0	0	0
	Remove surface drainage containment	0	0	0	0	0	0	0	0
	Remove in-water/shoreline structures[40]	0	0	0	0	0	0	0	0
	Water transfers and discharge	0	0	0	0	0	0	0	0
	Construct fish habitat as per FHCP	0	0	0	0	0	0	0	0

[40] Potential effects of in-water/shoreline structures on the aquatic environment are assessed in Volume 5. There is not expected to be any substantive interaction between marine species or habitat and activities associated with the dock facility in Baker Lake

Table 4.3-1 Identification of Project-Environment Interactions

Project Component	Project Activities/Physical Works	Marine Mammals	Marine Fish	Marine Birds	Marine Benthic Invertebrates	Marine Vegetation	Marine Sediment Quality	Marine Water Quality	Marine Species at Risk
On-land Decommissioning	Remove site pads (blasting, earth moving, loading, hauling, dumping)	0	0	0	0	0	0	0	0
	Backfilling	0	0	0	0	0	0	0	0
	Contouring	0	0	0	0	0	0	0	0
	Covering	0	0	0	0	0	0	0	0
	Revegetation	0	0	0	0	0	0	0	0
	Remove foundations	0	0	0	0	0	0	0	0
	Remove buildings	0	0	0	0	0	0	0	0
	Remove equipment	0	0	0	0	0	0	0	0
	Remove fuel tanks	0	0	0	0	0	0	0	0
	Marine Transportation: loading barges, barging, off-loading (fuel, reagents and supplies), Baker Lake and Churchill/Chesterfield, back-haul	2	2	1	1	1	1	1	1
Post Closure									
General	Management of restored site	0	0	0	0	0	0	0	0

NOTES:

0 = If there is no interaction or no potential for substantive interaction between a Project activity and the VEC to cause a potential environmental effect, an assessment of that environmental effect is not required. These interactions are categorized as 0, and are not considered further in the EA. The environmental effects of these activities are thus, by definition, rated not significant.

1 = If there is likely to be a potential interaction between a Project activity and a VEC but not likely to be substantive in light of planned mitigation, the interaction is categorized as 1. Such interactions are well understood and are subject to prescribed mitigation or codified practices. These interactions are subject to a less detailed environmental effects assessment and are rated as not significant. Justification is provided and the proposed mitigation is described for such categorizations. Such interactions can be mitigated with a high degree of certainty with proven technology and practices.

2 = If a potential interaction between a Project activity and a VEC could result in more substantive environmental effects despite the planned mitigation, if there is less certainty regarding the effectiveness of mitigation, or if there is high concern from regulatory agencies, Inuit or stakeholders, the interaction is categorized as 2. These potential interactions are subject to a more detailed analysis and consideration in the environmental assessment in order to predict, mitigate and evaluate the potential environmental effects

Justification for ranking interactions as a ‘0’ or ‘1’ is provided below. Those interactions designated as ‘2’ (potential for adverse environmental effect even with mitigation) are addressed in detail in subsequent sections of the marine assessment.

4.3.1.1 Project Activities with No Interaction with VECs

The construction, operation and decommissioning of the dock facility and the mine will not interact with marine mammals, marine vegetation, or marine species at risk since the dock will be located within Baker Lake (freshwater habitat). These interactions are therefore scored a ‘0’ in Table 4.3-1. Potential effects of the Baker Lake dock facility on the aquatic environment are assessed in Volume 5.

While the movement of all vessels to and from the dock facility will result in the release of air emissions associated with the combustion of bunker or diesel oil, no environmental effects of concern on the marine environment are expected given low vessel frequency, the low volume of emissions, and the mobile nature of the emission sources. This effect is not addressed further in the assessment. Details regarding the effect of air emissions on the atmospheric environment are provided in Volume 4.

4.3.1.2 Project Activities with Non-Substantial Interaction with VECs

Routine operations of marine transportation (including construction and decommissioning related activities) associated with the Project are not expected to substantially affect marine birds, benthic invertebrates, marine vegetation, sediment quality, water quality, or species at risk.

Marine birds use the marine environment for part or all of their life cycle, and there is the potential for the physical presence, movement and noise of marine vessels to adversely affect bird health, behaviour and their habitat. Accepted guidelines indicate disturbance at a nesting colony is likely if human activity is audible, or is visible within 1 km (Chardine and Mendenhall 1998).

Specific mechanisms through which marine transportation could affect marine bird populations and their habitat have been summarized for a similar Arctic environment, the Beaufort Sea (Environment Canada 2006; Dickson and Gilchrist 2002). These potential environmental effects pathways and the rationale for not assessing them further in the assessment are discussed below.

- *Development activity in key offshore habitat (open-water leads)*: vessel transit through open leads may result in long-term loss of critical foraging habitat for migrating marine birds. Marine transportation associated with the Kiggavik Project will occur in the open-water season, and therefore will not interact with marine birds using open water leads.

- *Development activities in key coastal habitat*: The majority of oceangoing vessels proposed for the project will have equipment onboard for lightering of cargo and fuel directly to the barges, therefore, no new infrastructure will be constructed along the Hudson Bay or Chesterfield Inlet coast. The existing Port of Churchill terminal will be used for transshipment of cargo or fuel from vessels without these capabilities to barges. Therefore, environmental effects on availability of key coastal habitat are not expected to occur.
- *Disturbance:* sensory disturbance from development activities, such as operation of marine vessels, may result in temporary displacement of birds from important habitat. Marine shipping associated with the Project will be infrequent (maximum of 31 barge deliveries to Baker Lake over 60 days of the open-water season). Routine operation of marine vessels will be in compliance with standard management practices (e.g., *Canada Shipping Act*), and is not expected to affect marine bird populations.

Key migratory bird marine habitat sites have been identified adjacent to the existing shipping route through Hudson Strait (Mallory and Fontaine 2004); however, the existing shipping route does not pass through any of these areas. For the most part, the key marine areas are associated with key terrestrial habitat, which means the key marine areas identified are primarily coastal marine habitat. The main shipping route transits along the middle of Hudson Strait and therefore vessels will maintain a minimum distance of approximately 30 km from key migratory bird marine habitat sites.

Given the seasonal occurrence of marine birds, the timing and extent of Project-related marine vessel traffic, the distance from vessel traffic to coastal areas, and the relative size of potential foraging areas in comparison to the locations that might be disturbed by routine activities of vessel traffic, substantive effects on marine birds and their habitat (including Important Bird Areas (IBA), Migratory Bird Sanctuaries (MBS) and key migratory bird habitat sites) are not expected to occur. In addition, the proposed shipping route has been adjusted so that vessels travelling past Coats Island will remain greater than 30 km from the Key Migratory Bird Habitat Site 26 identified at Cape Pembroke (Mallory and Fontaine 2004). Therefore, Project interactions were all ranked as 1 in Table 4.3-1 and not considered further in the marine assessment.

Transportation associated with all phases of the Project has the potential to interact with benthic invertebrates, marine vegetation, sediment quality, and water quality. Potential interactions may include vessel wake, release of contaminants in bilge and ballast water, and introduction of invasive species in ballast water (EN-CI OH 2013[41]).

Vessel wake occurs when vessel movements create secondary waves (i.e., free surface waves that propagate out from the vessel). This could result in increased wave activity along the shoreline and

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[41] EN-CI OH Nov 2013: "*What about ballast water and pollution? We need to protect the waters and the project will affect these things*"

cause shoreline erosion which could, in turn, affect benthic invertebrates, marine vegetation, and sediment quality. Given that vessels will be moving slowly within Chesterfield Inlet (8 to 10 knots; see mitigations, Section 6.6), secondary wave heights will likely be less than 20-30 cm at 500-1000 m from the vessel (Moffatt and Nichol 2010). These wave heights are within the normal variation experienced during tidal cycles and storms within the inlet. Further, habitat along the shoreline of Chesterfield Inlet is generally composed of bedrock and boulder or cobble beaches, which is not highly susceptible to erosion and unlikely to have a high abundance or diversity of benthic invertebrates and vegetation due to annual ice scour. Various sizes of dry cargo ships, tugs, barges and tankers have been studied and proposed for the Kiggavik Project ranging from articulating tug barge (ATB) configurations to 1,000 TEU container ships and ice class 30,000 DWT fuel tankers (Tier 3, Technical Appendix 2J). Marine vessels in Hudson Bay and Hudson Strait will use designated (routinely used) shipping routes in deep open water (200 m to 4,000 m). The main route through the Hudson Strait runs down the middle of the strait, approximately 60 km from shore at its narrowest point. The route to Churchill then runs south of Coats Island, travelling approximately 52 km at the closest point to shore (Transport Canada 2012) Waves generated by these vessels are expected be within the range of naturally occurring waves and are unlikely to affect shorelines adjacent to these areas due to the distance of the shipping routes offshore. As a result, environmental effects of vessel wake on benthic invertebrates, marine vegetation, and sediment quality are not assessed further.

Propeller wash and wake are not expected to alter the sediment transport regime or result in any change to surficial sediment and seabed. As a result, effects on sediment quality (including the sediment transport regime, surficial sediment and seabed), are not assessed further. Furthermore, effects on marine water quality resulting from changes in the sediment transport regime are not expected.

Accidental release of contaminants and pathogens in bilge and ballast water could result in physiological stress or mortality of marine biota and could compete with or harm native marine biota. However, Canadian operating protocols and best practices have been developed to prevent such discharges from Project vessels. All foreign ships entering Canadian waters are required by Canadian law to adhere to the Ballast Water Control and Management Regulations of the *Canada Shipping Act 2001*, designed to prevent foreign ballast water and sediments from being released in Canada's Exclusive Economic Zone. The regulations include mandatory exchange of foreign ballast water at least 200 nautical miles from shore and in water depths greater than 2000 m. The intake of ballast water (should it be required) will be conducted in deep water in Hudson Bay and will adhere to the *Canada Shipping Act* and regulations.

Bilge water accumulates from seawater that may seep or flow into the vessel from various points in the structure, and may become contaminated with oil and other substances from machinery. All marine vessels will comply with the Arctic Shipping Pollution Prevention Regulations, 2006 and the *Arctic Waters Pollution Prevention Act, 1985,* which include provisions that prohibit the release of oily bilge water into Arctic waters. All bilge water generated on board vessels will be retained for discharge at a licensed reception facility. Given that vessels are required to follow bilge and ballast water guidelines under Canadian law, little to no interaction with marine biota, sediment quality, or water quality is expected.

Non-Indigenous and Invasive Species

A non-indigenous species is an introduced species living outside of its native distributional range. An invasive species is a non-indigenous species which adversely affects the new ecosystem's structure and/or function, resulting in ecological, social or economic harm to the area (Lui et al. 2007, Molnar et al. 2008, Chan et al. 2012). Not all non-indigenous species are considered invasive.

The biological invasion process includes a number of factors required for the establishment of a non-indigenous or invasive species into a new area (Chan et al. 2012, DFO 2012a, DFO 2012b):

1. Transport - founding individuals must be taken up by, and survive conditions within, a transport vector to be moved from the source region to a new environment.
2. Survival - once released, the founding individuals must survive in the new environment.
3. Establishment - enough individuals of a species successfully arrive, survive, and form a reproductive population.
4. Expansion – established population may then spread from the initial, localized area by various means to become widespread in a region.

It is widely recognized that the most efficient and cost effective approach to mitigate the potential introduction of invasive species is to prevent transport of a potentially invasive species into a new environment (Invasive Species Specialist Group 2001, CCFAM-AISTG 2004, Molnar et al. 2008, Chan et al. 2012, DFO 2012a, DFO 2012b). As described above, transport is the first step in the biological invasion process.

In order to prevent transport of invasive species the main pathways should be considered and managed on a project-specific basis. For the Kiggavik Project, the primary pathway for marine invasive species is through transportation, specifically shipping (Molnar et al. 2008, CCFAM-AISTG 2004). Shipping includes two main vectors for marine invasive species: ballast water and hull fouling (Molnar 2008, DFO 2012a). Potential introduction of non-indigenous or invasive species into the LAA and RAA via ballast water and hull fouling are considered below within the context of existing research on non-indigenous and invasive species in Canada's Arctic.

Non-Indigenous and Invasive Species Research Priorities

To date, there have been no published reports of ship-mediated non-indigenous species established in the Canadian Arctic (Casas-Monroy et al. 2014, Goldsmit et al. 2014). This may be due to a combination of factors including: the relatively low level of shipping activity compared to more temperate areas of Canada (e.g. the Great Lakes), the inability of non-indigenous species to survive harsh Arctic environmental conditions, and paucity of marine biological community data for the Arctic Ocean (DFO 2012b, Goldsmit et al. 2014).

To better understand potential risks of non-indigenous species introductions, Transport Canada (Marine Safety) requested Fisheries and Oceans Canada (DFO) provide science advice on the level of risk posed by the commercial shipping vector for invasive species into Canadian Arctic waters.

A draft research document evaluating the biological risk associated with ship-mediated introductions of aquatic non-indigenous species to the Canadian Arctic was produced (Chan et al. 2012). A meeting was held in order to peer review this draft document as per the Canadian Science Advisory Secretariat (CSAS) peer-review process. The proceedings of the peer-review meeting were published (DFO 2012a). Finally, DFO issued a Science Advisory Report (2012b) which incorporated the peer-review comments (DFO 2012a) on Chan et al.'s (2012) draft research document.

DFO's Science Advisory Report (DFO 2012b) assessed the level of risk posed by ships transiting to, or from, Arctic ports for the introduction of aquatic invasive species to Canadian waters. The risk assessment was based on 2005-2008 shipping data. Ship-mediated risk was assessed for species transported by both ballast water and by hull fouling. The probability of non-indigenous species introduction and magnitude of consequences were subsequently combined to determine the final relative invasion risk at top Arctic ports.

Science Advisory Report Findings- Ballast Water

Neither Baker Lake nor Chesterfield Inlet were ranked as top ports for ballast-mediated transport of non-indigenous species (DFO 2012b). In general, ships traveling to Baker Lake and Chesterfield Inlet do not contain much, or any, ballast water. Ships arriving at these ports are typically fully loaded with material (cargo, fuel) for delivery.

Science Advisory Report Findings- Hull Fouling

The Science Advisory Report (DFO 2012b) indicated that coastal domestic non-merchants arriving at both Baker Lake and Chesterfield Inlet have a relatively low invasion risk associated with hull fouling. Since Baker Lake is a freshwater port, marine invasive species were assigned a very low probability of survival. This pathway is for ships travelling to Baker Lake.

Due to the relatively high number of ships departing from Baker Lake and Chesterfield Inlet, these ports were ranked as having high potential for hull-mediated secondary spread. This means that species indigenous to these ports may adhere to a ship's hull and subsequently be transported to another port. However, for Baker Lake in particular it was noted that any freshwater species that may foul ship hulls at Baker Lake are likely to die in transit as vessels travel through marine waters to the next port (DFO 2012b).

Science Advisory Report Recommendations

The Science Advisory Report's final recommendation was that biological sampling of ship vectors and recipient port habitats be conducted to quantify/calibrate invasion risk with consideration of species-specific and site-specific characteristics (DFO 2012b). High quality, robust baseline data on marine benthic invertebrate communities is necessary in order to assess potential changes over time (Goldsmit et al. 2014).

Kiggavik - Ballast Water

Vessels take on ballast water for reasons of trim, stability and safety. When ballast water is taken on in one part of the world, and then discharged in another it may be an unintentional source of non-indigenous aquatic species that may threaten the marine ecosystem of the receiving area.

The Kiggavik Project Marine Transportation plan (Tier 3, Appendix 2J) notes that dry cargo and fuel may be transported from southern ports (Rotterdam, Netherlands; Houston, Texas, USA; Halifax, Nova Scotia, Canada and Montreal, Quebec, Canada) and/or from Churchill, Manitoba. Larger ocean-going vessels may be required to anchor near Chesterfield Inlet for transfer of material to the Baker Lake dock via smaller vessels. It is important to note that unloaded vessels are not travelling to the area to support the Kiggavik Project.

As outlined in Tier 3, Appendix 2J, vessels arriving from southern ports or outside the RAA will be transiting in a loaded condition. As such, minimal ballast water will be carried on vessels arriving into the LAA.

Given that proper management of ballast water is essential to minimize the risk of introduction of non-indigenous species in the marine environment, AREVA is committed to adherence to Ballast Water Control and Management Regulations of the *Canada Shipping Act,* 2001. The Shipping Federation of Canada also has a Code of Best Practices for Ballast Water Management that will also be consulted. The existing laws and best practices on ballast water exchange provide an excellent framework for mitigating pathways of introduction for non-indigenous and/or invasive species into Arctic marine environments.

Kiggavik - Hull Fouling

Canada does not currently have domestic hull fouling regulations, although it has supported the adoption of international guidelines for control and management of ships' biofouling (Chan et al. 2012). In Tier 3, Appendix 2J, AREVA notes that the underwater areas of all vessels will be coated with approved tributyl tin (TBT) free anti-fouling coatings.

Given that global research indicates that hull fouling is an important vector for coastal marine ports but not freshwater ports, the probability of survival of propagules at potential recipient Arctic ports was estimated to be lowest if the recipient port was freshwater, e.g. Baker Lake (DFO 2012b). Any freshwater non-indigenous species that may foul ship hulls at Baker Lake are likely to die in transit through marine waters to the next port (DFO 2012b). The potential remains for hull fouling at Chesterfield Inlet since this is a marine port.

Comparison to Baffinland Marine Shipping in Nunavut

Baffinland Iron Mines Corporation's (Baffinland's) Mary River Project is a proposed iron ore mine located on North Baffin Island in the Qikqtani Region of Nunavut. As part of their project review, Baffinland conducted a risk assessment to examine the potential introduction of nonindigenous species through ballast water discharge associated with seasonal, early revenue phase shipping (Baffinland 2013).

There are numerous differences between the Mary River Project and the Kiggavik Project's marine shipping plans. These differences highlight the fact that a detailed risk assessment on introduction of nonindigenous or invasive species for AREVA's marine shipping is not required.

Baffinland's nonindigenous species risk assessment only considered charter ships for transport of iron ore to a European port, possibly in Denmark; potential for introduction of nonindigenous species via other vessels such as cargo ships and fuel tankers was not considered. For Baffinland's early revenue phase, it was estimated that ballast water would be exchanged at Port Milne 53 times per year resulting in an average release of 662,000 tonnes of ballast water each season (Baffinland 2013).

Baffinland's early revenue phase shipping is vastly different from the Kiggavik Project's proposed marine shipping plan. One of the main differences originates from the fact that Baffinland is direct shipping iron ore. This means that charter ships arrive at Port Milne in an unloaded (empty) condition and likely contain ballast water for oceangoing navigational stability. Once at port, vessels will release ballast water to allow for loading of iron ore. In comparison, AREVA's Kiggavik Project is anticipating marine shipping to include cargo and fuel only. Yellowcake will be flown south (Tier 2, Volume 2 Project Description, Section 10) and will not be barged out using ships. Since most vessels travelling to Chesterfield Inlet or Baker Lake dock will be loaded (e.g. carrying cargo or fuel), they will not contain much, if any, ballast water. Another difference between these shipping programs is the fact that Baker Lake is a freshwater lake. When vessels travel between ports and areas of variable salinity, this can mitigate nonindigenous species introduction risk (DFO 2012b). AREVA estimates up to 12 ships for cargo and 6 ships for fuel (depending on vessel capacity) will arrive annually at Chesterfield Inlet during the peak operating year. Fuel and cargo will be lightered onto barges for transport through the Chesterfield Narrows to the Baker Lake dock (Tier 3, Technical Appendix 2J). The number of ships associated with Kiggavik's cargo and fuel shipping is much lower than charter ships associated with Baffinland's early revenue shipping alone.

These differences highlight the fact that a detailed risk assessment for potential introduction of nonindigenous species (similar to Baffinland 2013) is not necessary for Kiggavik Project marine shipping activities.

AREVA's Marine Shipping Commitments

The discussion above suggests there is limited potential for introduction of marine nonindigenous or invasive species through marine shipping activities; however, AREVA is committed to promoting best practices in marine shipping and contributing to government-led, regional nonindigenous species research initiatives. These commitments are in addition to those outlined in the marine shipping plan (Tier 3, Technical Appendix 2J Marine Transportation):

1. AREVA will work with DFO, Transport Canada, and related groups such as the Canadian Aquatic Invasive Species Network (CAISN) to contribute, where possible, to the database and knowledge on marine invasive species. This research will be conducted to help determine if current ballast water management regulations and anti-fouling coatings provide sufficient protection against ship mediated aquatic invasive species introductions.

    a. It is ideal for AREVA to contribute project monitoring efforts to a larger, regional monitoring program lead by regulatory agencies. An example of a recent regional monitoring program is CAISN's surveillance project sampling marine species in open water and under ice at Canadian Arctic ports (NSERC CAISN 2014, Goldsmit et al. 2014). Creating a baseline inventory of marine species at ports is important to help monitor for future changes. AREVA will consider co-funding collection of baseline benthic invertebrate data at Chesterfield Inlet in collaboration with other organizations, such as industry members (Agnico), and government agencies (GN DoE, DFO, TC).

2. One of the findings from DFO's Science Advisory Report (DFO 2012b) was that biological sampling of ship vectors should be conducted to further quantify/calibrate invasion risk with consideration of species-specific and site-specific characteristics. Similarly, Casas-Monroy (2014) recommended future biological sampling of ballast water should be prioritized for shipping pathways with limited data, with specific mention of Arctic pathways.

    b. To foster and support scientific research sampling programs and analysis, AREVA will:

        i. Request contract shipping companies provide on-board access to facilitate testing of ballast water and ship hulls by DFO staff or CAISN researchers.

ii. Request contract shipping companies provide information on vessel type, ballast water status, and any ballast water discharge volumes as applicable to DFO and Transport Canada.

3. AREVA will encourage contract shipping companies to participate in the Green Marine program (www.green-marine.org). Green Marine is a voluntary, transparent and inclusive environmental certification program for the North American marine industry. One of the maritime industry's greatest challenges is to find ballast water management solutions that are safe for both the ship and its crew, while reducing the risk of introducing exotic species. An objective for companies participating in the Green Marine program is to reduce the risk of introducing and propagating aquatic organisms and harmful pathogens through shipping activities.

The interaction of the Project with marine nonindigenous and invasive species is not considered further in the marine assessment.

Species at Risk

SARA listed species whose range may overlap with the spatial boundaries of the Project are shown in Table 4.3-2. Three species of marine fish (the Northern, Atlantic, and spotted wolfish) are listed on Schedule 1 of SARA; however, Hudson Strait is designated as 'probable' range. There is insufficient information on the distribution, habitat use and abundance of the wolffish populations in the RAA to consider these species specifically in the assessment. It is, therefore, assumed that environmental effects would be similar to those described in Section 8. Two listed marine bird species potentially occur in Hudson Strait: the Harlequin duck and Peregrine falcon. The distribution range of the Peregrine falcon has a northern limit of the southern coast of the Hudson Strait and has a low likelihood of occurring in the Strait. Given that this species nests and largely hunts on land, Peregrine falcon is also unlikely to interact with marine vessels. While the range of the Harlequin duck includes the northern coast of the Hudson Strait, it is the northern edge of their distribution range. Due to limited spatial overlap with the Project and the fact that routine activities associated with marine transportation are unlikely to affect bird health, behavior or habitat (Section 4.3.1.2), these species at risk are not considered further in the assessment.

Table 4.3-2 Species at Risk on Schedule 1 of *SARA*

Common Name	Scientific Name	COSEWIC Status	*SARA* Status
Northern Wolffish	*Anarhichas denticulatus*	Threatened	Threatened, Schedule 1
Atlantic Wolffish	*Anarhichas lupus*	Special Concern	Special Concern, Schedule 1
Spotted Wolffish	*Anarhichas minor*	Threatened	Threatened, Schedule 1
Harlequin Duck	*Histrionicus histrionicus*	Special Concern	Special Concern, Schedule 1
Peregrine Falcon	*Falco peregrinus anatum*	Non-active	Threatened, Schedule 1

4.3.2 Potential Project Environmental Effects

Based on the issues and concerns identified in consultation with government representatives, Inuit communities and stakeholders (Section 4.1), professional experience of the assessment team and screening results of the interaction matrix, consideration has been given to the following Project activities and disturbances that could result in adverse environmental effects on marine mammals and marine fish.

- ***Underwater noise***: marine vessels will generate underwater noise that could result in sensory disturbance to marine animals (IQ-CIHT 2011[42]). Marine mammals and marine fish affected by underwater noise may temporarily move away from suitable habitat (habitat abandonment), resulting in a change in behaviour for that species.
- ***Vessel movements and collisions***: physical presence and movements of the various vessels associated with the Project (e.g., tug and barge, container vessels) could deter animals from the shipping route, resulting in energetic stress and altered movement patterns (EN-CH NIRB 2010)[43]; EN-CI NIRB 2010[44];IQ-RIJ 2011[45] . Animals such as whales, seals and walrus could also be physically injured or die as a result of collisions with marine vessels (EN-WC OH 2012)[46].

In summary, the marine assessment for the Project addresses the following potential environmental effects of marine transportation activities on marine mammals and marine fish.

- Change in mortality risk due to vessel collisions.
- Change in behaviour due to sensory disturbance and vessel movement.

Specific issues for each of the selected Valued Environmental Components (VECs) for the Marine Environment are described in the scope of assessment for each VEC.

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[42] IQ-CIHT (2011): "*Heard there would be more barge traffic this summer and this will frighten mammals because they have sensitive ears*."

[43] EN-CH NIRB (2010): *Concerns over the potential effects of the barges travelling in the area, the amount (23 times in the year) travelling/year and accumulation of effects on the marine wildlife and their migration routes.*

[44] EN-CI NIRB (2010): *Concerned over the barges travelling through the Chesterfield Inlet to Baker Lake and travelling close to the community of Chesterfield Inlet. Have already seen impacts to marine wildlife (decrease) from barges and ships travelling in the area and into the Hudson Bay.*

[45] IQ-RIJ (2011): *"Beluga travel along both the coast and in more open water. So, any shipping will disturb beluga migration."*

[46] EN-WC OH (2012): *"How would the vessels avoid the Whale? Sometimes Whale come after our propeller*"

4.4 Valued Components, Indicators and Measurable Parameters

Valued Environmental Components (VECs) are broad components defined for the marine environment that, if altered by the Project, would be of concern to regulators, Inuit, resource managers, scientists, and the general public. VECs for the marine environment are chosen to represent major components or aspects of the physical and biological environment that may be altered by the Project, and are widely recognized as important for ecological reasons.

Selection of marine VECs is based on the following criteria.

- Do they represent a broad environmental, ecological or human environment component that may be affected by the Project?
- Are they vulnerable to the environmental effects of the Project and other activities in the region?
- Have they been identified as important issues or concerns during Inuit, government and stakeholder engagement, or in other assessments in the region?

Based on the main groups of marine organisms identified in the area, the criteria listed above, and the expected Project-environment interactions identified in Table 4.3-1, two VECs are identified for the marine assessment.

- Marine mammals
- Marine fish

4.4.1 Marine Mammals

For the purposes of this assessment, marine mammal refers to mammals that are dependent on marine habitats during part or all their life cycle. This broad group includes baleen whales (e.g., bowhead whales), toothed whales (e.g., beluga whales), seals (e.g., ringed seal), and polar bears.

Potential environmental effects of marine transportation on marine mammals include behavioural change due to underwater noise from vessels, and change in mortality risk from injury due to ship strikes.

Environmental effects on marine mammals are assessed by determining the total duration of exposure to noise levels due to marine transportation during the open-water season (i.e., the percentage of time that underwater noise will occur), and by determining the predicted sound pressure levels from the vessels and potential for communication masking.

Table 4.4-1 lists the measurable parameters used to assess environmental effects on marine mammals and the rationale for their selection.

Table 4.4-1 Measurable Parameters for Marine Mammals

Environmental Effect	Measurable Parameter(s)	Rationale for Selection
• Change in mortality risk	• number of vessel strikes	• potential to affect marine mammal populations due to vessel strikes • community, government, stakeholder engagement • regulatory drivers • professional judgment
• Change in behaviour	• change in distribution and abundance of populations • underwater sound levels • mammal noise exposure criteria • total duration of exposure to noise levels due to marine transportation	• potential to affect marine mammal populations through acoustic disturbance • community, government, stakeholder engagement • regulatory drivers • professional judgment

4.4.2 Marine Fish

The coast of Hudson Bay and Chesterfield Inlet are used by a variety of marine fish species for feeding, spawning and rearing, and as a migratory route.

Potential environmental effects of marine transportation on marine fish include changes in behaviour due to acoustic disturbance. Underwater noise from vessels can potentially disturb or displace marine fish from their preferred habitat.

Environmental effects on marine fish are assessed by determining the total duration of exposure to noise levels due to shipping during the open water season (i.e., the percentage of time that underwater noise will occur) and by determining the predicted sound pressure levels from the vessels.

Table 4.4-2 lists the measurable parameters used to assess environmental effects on marine fish and the rationale for their selection.

Table 4.4-2 Measurable Parameters for Marine Fish

Environmental Effect	Measurable Parameter(s)	Rationale for Selection
• Changes in behaviour	• underwater sound levels • fish noise exposure criteria • total duration of exposure to noise levels due to marine shipping	• potential to affect marine fish populations through acoustic disturbance • community, government, stakeholder engagement • regulatory drivers • professional judgment

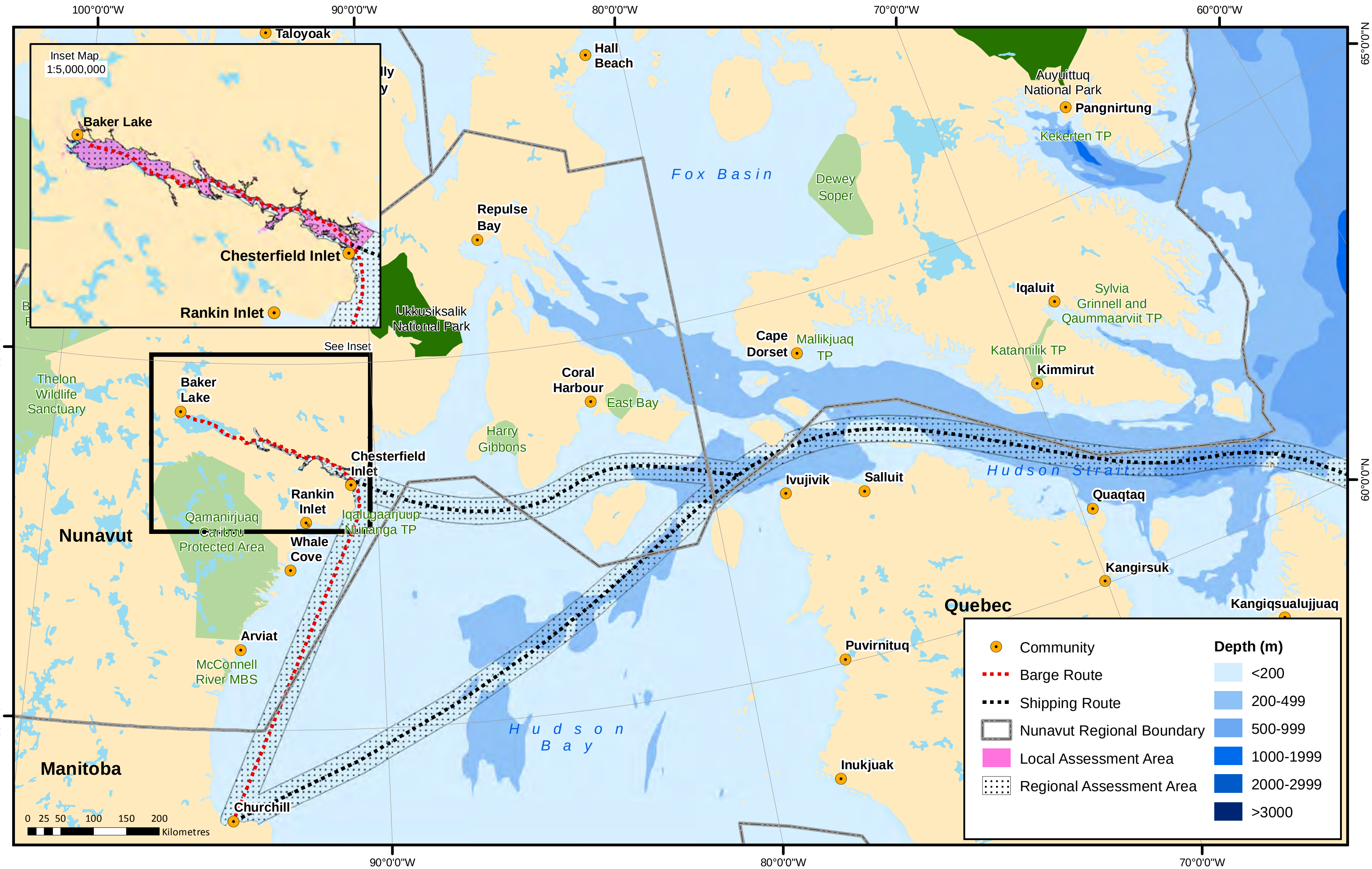
4.5 Spatial Boundaries

4.5.1 Project Footprint

The Project footprint for the marine assessment is defined as the shipping route used by the vessels transiting from the entrance to Chesterfield Inlet from Hudson Bay, through Chesterfield Narrows to AREVA's dock facility on the north shore of Baker Lake.

4.5.2 Local Assessment Area

The marine local assessment area (LAA) is defined as marine waters of Chesterfield Inlet and the adjacent coastal and offshore regions at the mouth of Chesterfield Inlet where measureable environmental effects from Project-related marine vessel traffic are most likely to occur. This area includes portions of the shipping route where marine vessels will be transiting to and from the main shipping routes in Hudson Bay (see Figure 4.5-1).



Projection: NAD 1983 UTM Zone 15N
Creator: SS
Date: 12/01/2009 Scale: 1:8,000,000
File: 1038926.04-020
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Areva Resources Canada Inc.*

FIGURE 4.5-1
Spatial Boundaries for the Assessment of the Marine Environment

Volume 7 - Marine Environment

Kiggavik Project

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4.5.3 Regional Assessment Area

The marine regional assessment area (RAA) includes the LAA and extends beyond to encompass the shipping route in Hudson Bay between Churchill and Chesterfield Inlet, and the shipping route through Hudson Bay and Hudson Strait to the extent of Nunavut Territorial waters (Figure 4.5-1). The RAA encompasses the zone where Project vessels are likely to have a measureable effect on the marine environment, and have the potential to act cumulatively with marine activities of other projects. The boundaries of the RAA were developed using a 20 km wide buffer around the proposed shipping and barge routes. This buffer represents the conservative zone of influence, which is based on the maximum area where marine animals could sense and respond to sounds from vessel activities, as determined by underwater acoustic modeling (Tier 3, Technical Appendix 7B). It also encompasses the considerably smaller zone of influence that is associated with the potential for vessel collisions with marine mammals, particularly during migration periods (EN-CH KIA 2010)[47].

4.6 Temporal Boundaries

The temporal boundaries for the marine assessment are defined based on the timing and duration of potential environmental effects of marine transportation associated with the Project. The assessment covers the period of all major Project phases including construction, operation, and decommissioning during which marine activities and transportation will occur. While the expected life of the Project is influenced by available ore reserves and the production rate, the operational life of the Project is estimated to be 14 years, given current resource estimates. However, as there are up to 25 years of tailings storage capacity in the TMFs, the assessment assumes 25 years of operations and associated marine transport. While the number, frequency and timing of vessel movements may differ among these Project phases, the types of environmental effects that may arise as a result of vessel movements are similar. Open water conditions can occur from the beginning of June to late November (EN-CH OH 2010 [48];IQ-CIHT 2011[49] IQ-WCCR 2011 [50]). While Project related marine transportation is expected to occur mainly in August and September, the marine assessment addresses potential environmental effects that may occur during the more conservative time frame of June to November to account for annual variability in sea ice break-up and freeze-up.

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[47] EN-CH KIA (2010): *"The shipping route from Churchill to Hudson's Straight is a major migrating route for sea mammals."*

[48] EN-CH OH (2010): "*It is November and we still have boats out across the bay. They are hunting for seal. Normally by this time of the year the ice is pretty thick and we hunt for seal by skidoo and foot over the ice. This year there is no ice only a bit so they still have the boats out its not normal. It is because of the climate change, global warming. It's too warm so there is no ice."*

[49] IQ-CIHT (2011): "*Near Chesterfield Inlet freeze-up occurs mid-November to early December and breakup June 25 to July 5 approximately."*

[50] IQ-WCCR (2011): "*Ice freeze-up is in late November and breakup in mid-June. Freeze-up is later now than in the past. Not as much change for break-up."*

4.7 Administrative and Technical Boundaries

The marine environment assessment is subject to some technical limitations due to a lack of scientific information with which to form effects predictions or mitigations. These technical limitations have been considered in the assessment and pertain to the following:

- Hearing thresholds for Arctic species of fish are largely unknown and knowledge about the behavioural responses of fish to underwater sound are poorly understood.
- Species-specific behavioural response thresholds for disturbance from underwater noise are not available for marine species.

These technical limitations were overcome by using conservative estimation techniques and professional judgment in a manner that likely results in an overestimate of potential effects to the marine environment and marine species.

4.8 Environmental Effects Criteria

Characterizing Project environmental effects on marine wildlife populations in quantitative terms is difficult due to complex ecological interactions in the marine environment (i.e., unpredictable population cycles and predator-prey dynamics) and challenges associated with obtaining accurate population estimates. While quantitative criteria such as noise thresholds have been developed for marine mammals (Section 6.1.2), most residual environmental effects on the marine environment have been described qualitatively according to the criteria below.

- ***Direction:*** the ultimate long-term trend of the environmental effect (i.e., positive means enhancement of population; neutral means maintains population; or adverse means detrimental effect to population)
- ***Magnitude:*** the degree of change in a variable relative to baseline case. (low means effect is within the range of natural variance or less than reference criteria; moderate means the environmental effect is at or slightly above the range of natural variation or reference criteria; high means the environmental effect exceeds the upper limit of natural variation or reference criteria)
- ***Geographical extent:*** the geographic area within which an environmental effect of a defined magnitude occurs. Where possible this is quantified (e.g., km^2) but otherwise qualitative terms are used (site-specific, local, regional, territorial, national, international).
- ***Frequency:*** the number of times during the Project that an environmental effect may occur (i.e., once, sporadically, regular, continuous)
- ***Duration:*** the period of time that is required until the VEC returns to its baseline condition or the environmental effect can no longer be measured or otherwise perceived (i.e., short

term means hours to days; medium term means months; long term means years or permanent)

- ***Reversibility:*** the likelihood that a measurable parameter for the VEC would recover from an environmental effect. Reversible means that the VEC would be able to recover from the environmental effect to a state similar to that existing before the Project. Depending on the environmental effect considered, reversibility may be assessed on both an individual (immediate) and population (long-term) level. Irreversible means that the VEC would be unable to recover from the environmental effect.
- ***Ecological context:*** the general characteristics of the area in which the Project is located (i.e., undisturbed, disturbed, urban setting).

4.9 Standards or Thresholds for Determining Significance

Under the NIRB Guidelines (Nunavut Impact Review Board 2011), the environmental assessment must include a determination of the significance of environmental effects. Where possible, significance criteria are identified for each VEC, above which a residual environmental effect would be considered significant.

4.10 Influence of Inuit and Stakeholder Engagement on the Assessment

Inuit and stakeholder engagement over the past seven years has consistently identified marine mammals as a VEC, based on their ecological and cultural importance in the Hudson Bay region. In particular, concerns were raised about the potential for marine vessel traffic associated with the Project to affect marine mammal presence and distribution, which would affect traditional harvesting activities. Further detail is provided in Section 6.1.1. In response to these concerns, baseline surveys provided information on marine mammal species presence and distribution in western Hudson Bay during late summer and early fall period when marine transportation activities are anticipated to interact with the beluga whale migration. These data support the assessment of marine vessel disturbance on the behaviour and mortality risk of marine mammal species present in the area, with particular consideration given to beluga whales and ringed seals. Local people and HTOs provided information on presence/absence, abundance and migration timing of marine mammals that used in the design of the 2008 and 2009 open-water field programs (Tier 3, Technical Appendix 7A, EN-CI HTO 2009[51]).

[51] EN-CI HTO Jul 2009: *IQ indicates if you want to see Beluga, stay along the coast. Community member stated he advised this last year as well. The program was adjusted last year based on this advice and it is part of this years design*

4.11 Influence of Inuit Qaujimajatuqangit on the Assessment

Inuit Qaujimajatuqangit (IQ) has been fundamental in selection of VECs for the marine assessment, and identification of potential environmental effects. Specifically, it has highlighted concern regarding the sensitivity of marine wildlife to marine vessel traffic in the region and the importance of year-round harvesting of marine mammal and fish species in providing food and clothing for local communities. IQ indicates that there is general concern about how increased marine vessel traffic may affect the distribution of marine wildlife populations (EN-CH NIRB 2010[52]; EN-CI NIRB 2010[53]). These issues and concerns have been considered in scoping of the marine assessment and in the prediction confidence associated with the determination of significance for marine VEC's. Additional information on how IQ influenced the assessment of the Marine Environment is provided in Section 6.1.1 and Section 7.1.1.

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[52] EN-CH NIRB (2010): *Community members stressed that the barge traffic be minimized in the area to reduce impacts to marine wildlife. Concerns over impacts to migration routes (for example beluga migration route is usually towards Southampton Island).*

[53] EN-CH NIRB (2010): *Concerns over the current impacts of barges and ships to marine mammals and have noticed that Whale are further away from the hunting areas because of the noises from the barges and ships.*

5 Summary of Existing Marine Environment

5.1 Protected Areas and Other Designated Sites

Parks Canada has identified key areas in Nunavut as part of an International Biological Program (IBP) (Nettleship and Smith 1975). These areas have been selected because they represent a diverse community. Six of these IBP sites occur along the Hudson Strait shipping route (Hantzsch Island, Button Islands, Akpatok Island, Digges Sound, Coats Island and Boas River) and one site is located south of Arviat (McConnell River). These IBP areas are identified as sensitive habitat. Many of the areas identified as important habitat by different agencies are overlapping or identical areas.

5.2 Marine Mammals

Aerial surveys and a literature review determined the state of the existing marine environment. Surveys for marine mammals were conducted in 2008 and 2009 over eleven days and resulted in over 10,900 km of transect data. Beluga whales, seals, and walrus were spotted in the open water and polar bears were spotted on the coast. Bowhead whales, killer whales, and narwhals were not spotted at any time during the surveys, which suggests they are a rare occurrence in the area. This assumption is confirmed by both IQ and the literature, which supports evidence for preferred habitat north of the study area (EN-AR HTO 2010[54]; IQ CHT 2011[55]; IQ-RBJ 2011[56]]; Tier 3, Technical Appendix 7A). IQ and the literature also support the results of the survey by confirming the abundance and presence of ringed and harp seals, and belugas in the area (although belugas tended to be present along the near-shore coast)(EN-CI HTO 2009[57]). However, community members have reported that "*we are seeing reduced numbers of harp seal, ring seal and Beluga in the Chesterfield bay."* (EN-CI OH 2013). While walrus were observed during the surveys, they were spotted close to Churchill and not near Chesterfield Inlet. Walrus are likely to be farther north of Chesterfield Inlet and are known to stay at Rock Island, which was confirmed by both IQ (IQ-RIJ 2011[58]; Nunami Stantec 2010) and the literature.

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[54] EN-AR HTO Nov 2010: "*Killer Whale are seen every 3-4 years around mid-August".*

[55] IQ CHT 2011 "*Whale nets are normally used to catch beluga and seals. But he caught a narwhal in his whale net which was an unexpected and rare event"*

[56] IQ-RBJ 2011: *Narwhals stay north*

[57] EN-CI HTO (2009): *IQ indicates if you want to see Beluga, stay along the coast.*

[58] IQ-RIJ 2011: *There used to be a lot of walrus. He was born further north and marks location on maps and marks where they were hunted.*

Nine species of marine mammal occur in the RAA (Table 5.1-1). Of these species, three are considered common (beluga whale, ringed seal and polar bear) and six are considered less common or rare (bowhead whale, narwhal, bearded and harp seals, walrus and killer whale). A brief overview of the conservation status of these nine marine mammal species within the LAA and RAA is provided in Table 5.1-1.

Table 5.2-1 Conservation Status of Marine Mammals Present in the RAA

Species	Scientific Name	Species at Risk Act (SARA) Schedule	Committee on the Status of Endangered Species in Canada (COSEWIC) Status
Beluga whale (Western Hudson Bay population)	*Delphinapterus leucas*	Not Listed	Special Concern
Ringed seal	*Phoca hispida*	Not Listed	Not at risk
Polar Bear	*Ursus maritimus*	Not Listed	Special Concern
Bowhead Whale	*Balaena mysticetus*	Not Listed	Special Concern
Bearded Seal	*Erignathus barbatus*	Not Listed	Data Deficient
Harp Seal	*Phoca groenlandica*	Not Listed	Not Listed
Walrus	*Odobenus rosmarus*	Not Listed	Special Concern
Narwhal	*Monodon monoceros*	Not Listed	Special Concern
Killer Whale	*Orcinus orca*	Not Listed	Special Concern

Beluga Whale

Beluga whales are an important cultural and ecological species in Nunavut (Fisheries and Oceans Canada (DFO) 2000). An estimated 57,300 belugas occur in Western Hudson Bay (Richard 2005). *Belugas are generally hunted along the coast in the summer and are harvested up to 35 km offshore* (IQ-Riewe 1992). Over the five-year period from 1996 to 2001, the total annual mean number of belugas taken through hunting was 1,339 for all of Nunavut, while annual rates of belugas harvested from the community of Chesterfield Inlet ranged from three (2001) to 31 (1996) (Priest and Usher 2004).

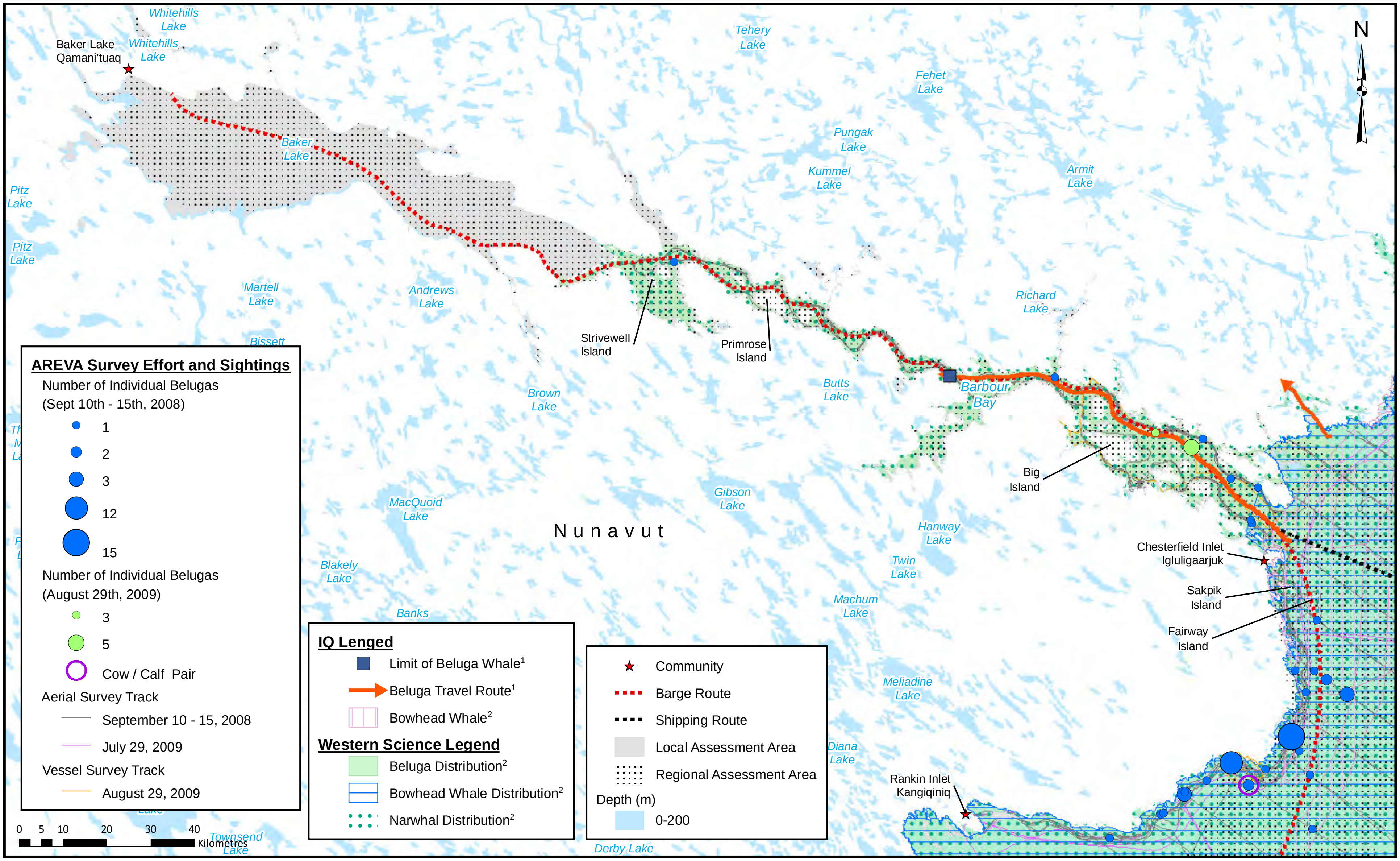
After spring ice breakup in mid to late June, western Hudson Bay belugas concentrate in the Churchill, Nelson and Seal River estuaries, where they increase in abundance until late July (Richard et al. 1990). In this region, *belugas are speculated to give birth south of Arviat in June, and then travel north* (IQ-ARVJ 2011). Along western Hudson Bay, belugas spend summers in shallow coastal areas (Martin et al. 2001). Migration northward along the coast of Hudson Bay generally occurs in late August or early September (COSEWIC 2004). Satellite tag data show the population moving towards wintering habitat in Hudson Strait; however, the routes taken between summering and wintering habitats are not well known (IQ-ARVJ 2011[59]). In fact, *beluga whale continue to be seen in the late summer, and hunters are not sure if the local population migrates* (IQ-CHAH 2009). Belugas have been observed travelling north within the eastern portion of Chesterfield Inlet during the fall migration. Although few records of belugas in the western portion of Chesterfield Inlet exist, the Baker Lake Hunters and Trappers Organization have recorded the migration of five animals through Chesterfield Inlet into Baker Lake (Hunters and Trappers Association of Nunavut 1992). Figure 5.2-1 and Figure 5.2-2 summarize information from available IQ and whale sightings compiled from baseline field surveys.

Ringed Seal

The ringed seal is a year-round resident in Hudson Bay (Nunami Stantec, 2010), and is the most common and abundant seal species (Stewart and Lockhart 2005). Based on historic aerial surveys of Hudson Bay between Churchill and Chesterfield Inlet, there were approximately 455,000 ringed seals in that portion of the Bay (Smith 1975). More recently, aerial systematic strip transect surveys extending from the Nelson River estuary to Rankin Inlet estimated 38,340 ringed seals in 1994 and 140,880 ringed seals in 1995 (Lunn et al. 1997). Estimates from aerial surveys are conservative because they are based on the number of seals hauled out on the ice and were not corrected for seals that were submerged. The total population of the area may be twice as large (Stirling and Øritsland 1995).

In spring, the highest densities of breeding adults occur on stable, landfast ice in areas with good snow cover, whereas non-breeders tend to be found at the floe edge or in the moving pack ice (Stewart and Lockhart 2005). *Seal pups are born around March anywhere close to the shore, and typically in water with strong currents* (IQ-RBH 2011; IQ-CI02 2009; IQ CHJ 2011).Their ability to maintain breathing holes in ice enables them to occupy areas of Nunavut that are inaccessible to other marine mammals during the colder seasons.

[59] IQ-ARVJ 2011: *Hunters only see the beluga travelling north, and do not see what routes the Whale travel southbound.*



Projection: NAD 1983 UTM Zone 15N
Creator: RC
Date: 29/08/2014 Scale: 1:1,250,000
File: 1038926.04-019
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Areva Resources Canada Inc.*

FIGURE 5.2-1
WHALE SIGHTINGS AND IQ IN THE LAA

KIGGAVIK PROJECT - EIS

Source of IQ:
[1]AREVA 2014. Kiggavik Environmental Impact Statement. Tier 3, Technical Appendix 3B: IQ Documentation

[2]Kivalliq Inuit Association (KIA). 1994. KIA Land Management Database. (GIS features consolidated from multiple sources by the KIA). Rankin Inlet, NU. Application: http://184.70.38.178/kia.publicwebapplication/

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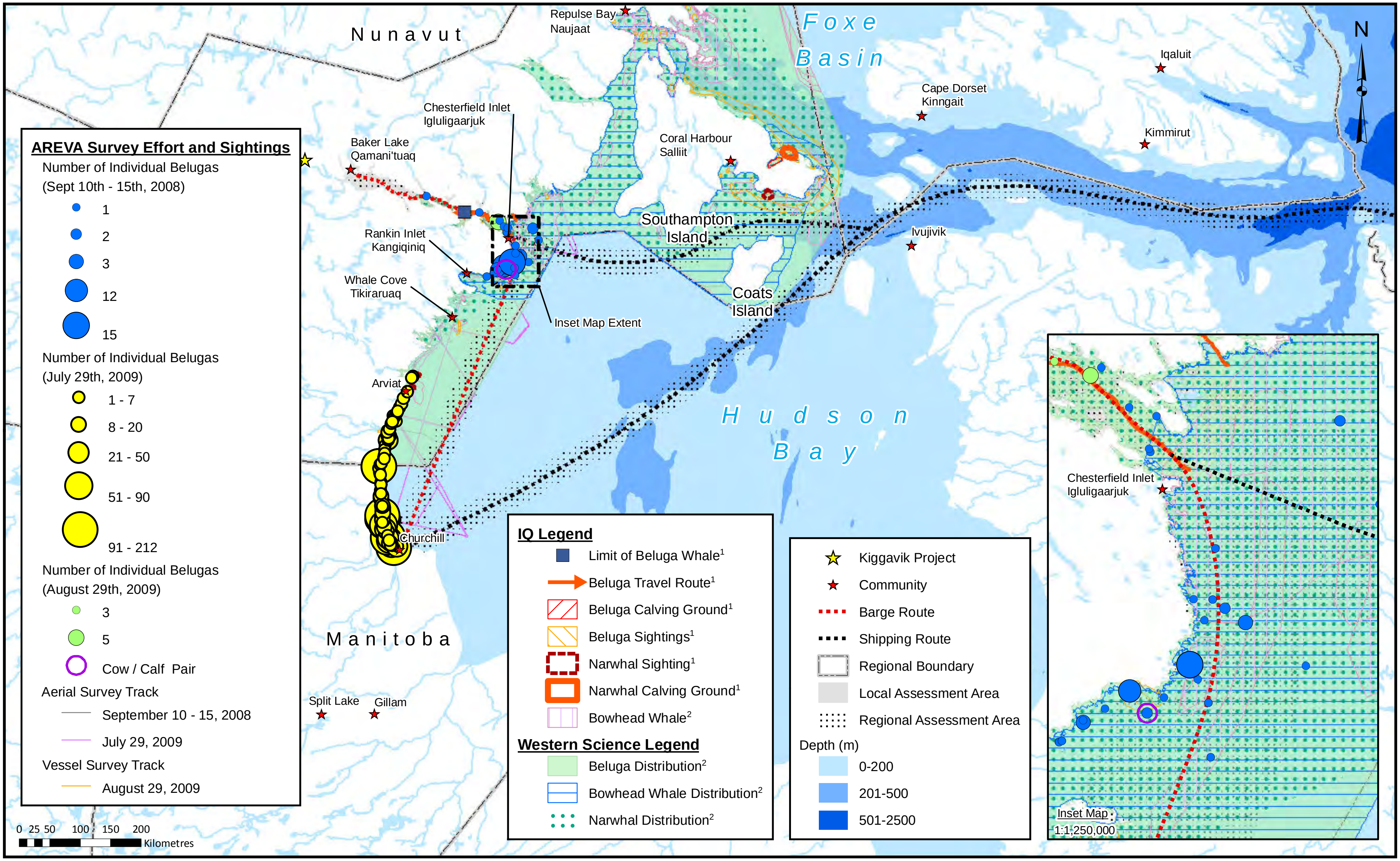

Projection: NAD 1983 UTM Zone 15N
Creator: RC
Date: 19/02/2014 Scale: 1:9,000,000
File: 1038926.04-019
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Areva Resources Canada Inc.*

FIGURE 5.2-2
WHALE SIGHTINGS AND IQ IN THE RAA

KIGGAVIK PROJECT - EIS

Source of IQ:
[1]AREVA 2014. Kiggavik Environmental Impact Statement. Tier 3, Technical Appendix 3B: IQ Documentation

[2]Kivalliq Inuit Association (KIA). 1994. KIA Land Management Database. (GIS features consolidated from multiple sources by the KIA). Rankin Inlet, NU. Application: http://184.70.38.178/kia.publicwebapplication/

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Some IQ indicates that there has been a decline in the number of seals in Hudson Bay and Chesterfield Inlet (EN-RI KWB 2012[60]; EN-RI KIA 2013[61]; EN-AR KWB 2013[62]; EN-CI OH 2013[63]; IQ-CIHT 2011[64]; IQ-RIJ 2011[65]; IQ-RIE 2009[66]). Recent studies by Chambellant et al (2012a,b) and Ferguson (2005) suggest that western Hudson Bay ringed seal population dymanics shift in response to environmental fluctuations such as sea ice regime, ocean productivity, and predation pressure and that recently observed declines in the region may be due to a combination of variation in climatic variables and a natural decadal cycle pattern in ringed seal recruitment.

Figure 5.2-3 and Figure 5.2-4 summarize information from available IQ and seal sightings compiled from baseline field surveys.

Walrus

Walrus are known to be present along the Hudson Strait shipping route, occurring on the north side of Chesterfield Inlet in the springtime (absent in the summer), and present year-round in northern Hudson Bay and western Hudson Strait (Orr and Rebizant 1987; COSEWIC 2006). Sensitive habitat for walrus includes the largest known Canadian haulout, located in northern Hudson Bay on Southampton Island (DFO 2002). Walrus typically follow the loose pack ice in the summer season (IQ-RIJ 2011[67]); however they can also use terrestrial haulouts. Southampton Island is a well-known historical place where walrus occur in large numbers in the summer (Orr and Rebizant 1987; COSEWIC 2006). Nearby Coats Island has also been identified as an important summer haulout (DFO 2002). Walrus haul out on land primarily for resting and are more susceptible to disturbance than while in the water (Richardson et al. 1995a). Figure 5.1-3 and Figure 5.1-4 summarize information on walrus from available IQ.

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[60]EN-RI KWB June 2012: *In 2007 there are a lot fewer seals in each community*.

[61] EN-RI KIA Sep 2013: *There are no more seals around Chesterfield Inlet.*

[62] EN-AR KWB Oct 2013: *There are hardly any seals or Whale. No harp seals or bearded seals.*

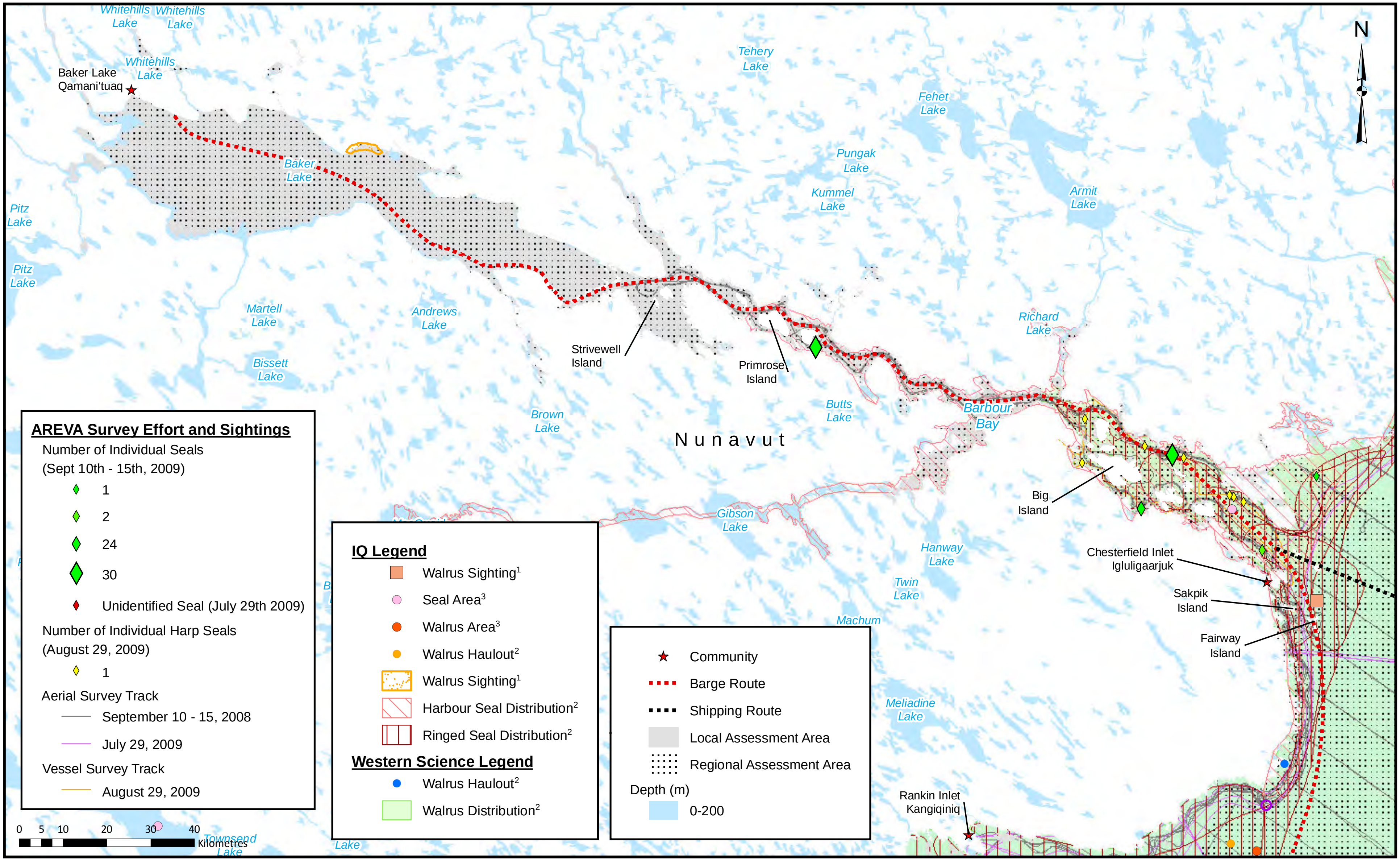
[63] EN-CI OH Nov 2013: *We are seeing reduced numbers of harp seal, ring seal and Beluga in the Chesterfield bay*.

[64] IQ-CIHT 2011: *Number of seals are down the past couple of years*

[65] IQ-RIJ 2011: *There are few harp seals around this year (2010), especially near Chesterfield.*

[66] IQ-RIE 2009: *Elders said there are few seals around and that this may be due to mining*.

[67] IQ-RIJ 2011: *They are brought in by ice; they come from the north and travel south There used to be a lot of walrus. They don't go to this area any more. When ice starts moving, they sometimes go to this area (near Wager Bay) but not as many as before. May, June, July. Walrus catch a ride on the ice flow south.*



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Creator: RC
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File: 1038926.04-019
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Areva Resources Canada Inc.*

FIGURE 5.2-3
SEAL AND WALRUS SIGHTINGS AND IQ IN THE LAA

KIGGAVIK PROJECT - EIS

[1] *AREVA 2014. Kiggavik Environmental Impact Statement. Tier 3, Technical Appendix 3B: IQ Documentation*

[2] *Kivalliq Inuit Association (KIA). 1994. KIA Land Management Database. (GIS features consolidated from multiple sources by the KIA). Rankin Inlet, NU. Application: http://184.70.38.178/kia.publicwebapplication/*

[3] *Riewe IQ Reference: Riewe, Rick (Editor). 1992. Nunavut Atlas. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut. Edmonton, AB Art Design Printing Inc.*

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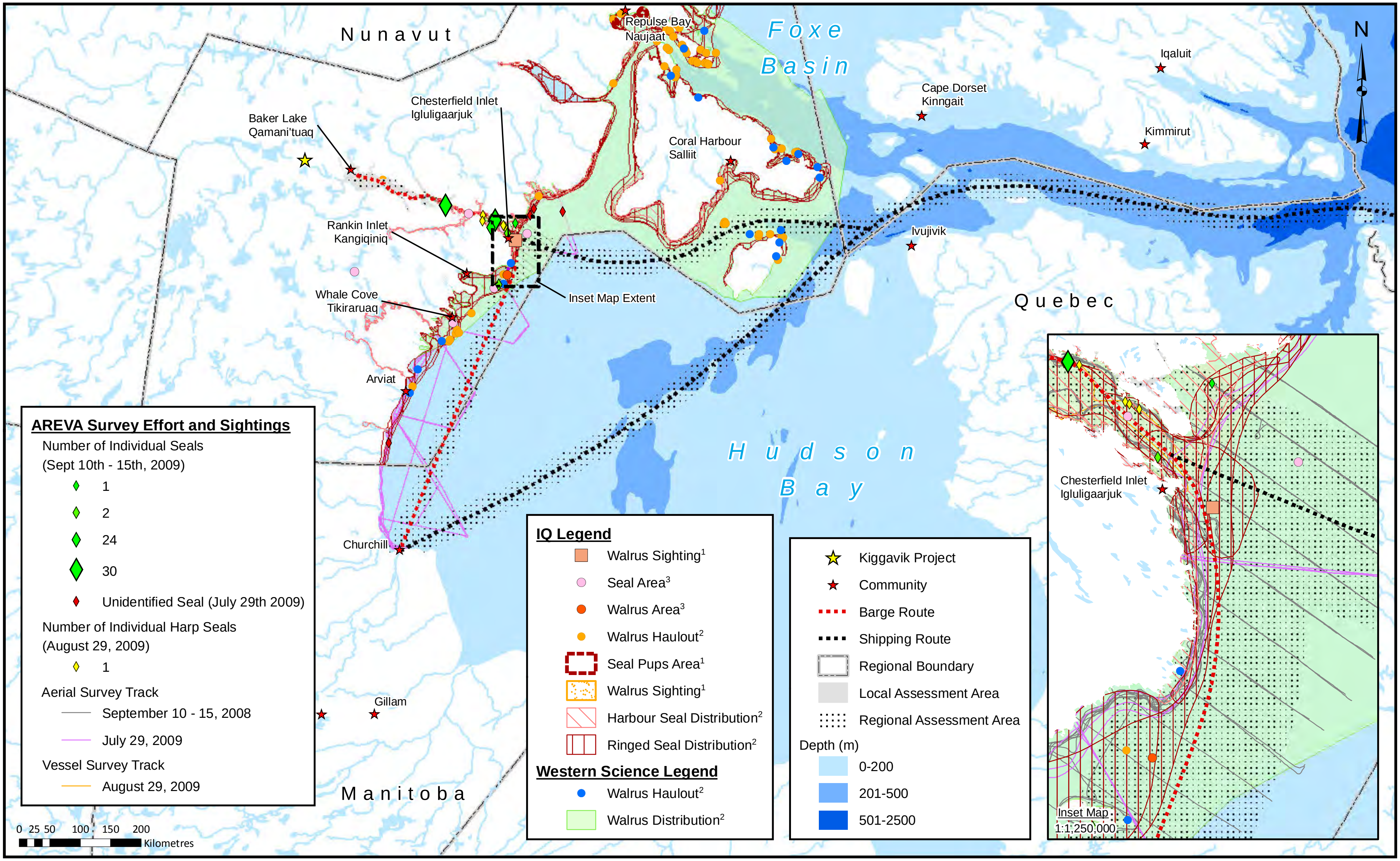

Projection: NAD 1983 UTM Zone 15N
Creator: RC
Date: 02/09/2014 Scale: 1:9,000,000
File: 1038926.04-019
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Areva Resources Canada Inc.*

FIGURE 5.2-4
SEAL AND WALRUS SIGHTINGS AND IQ IN THE RAA

KIGGAVIK PROJECT - EIS

[1]*AREVA 2014. Kiggavik Environmental Impact Statement. Tier 3, Technical Appendix 3B: IQ Documentation*

[2]*Kivalliq Inuit Association (KIA). 1994. KIA Land Management Database. (GIS features consolidated from multiple sources by the KIA). Rankin Inlet, NU. Application: http://184.70.38.178/kia.publicwebapplication/*

[3]*Riewe IQ Reference: Riewe, Rick (Editor). 1992. Nunavut Atlas. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut. Edmonton, AB Art Design Printing Inc.*

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Polar Bear

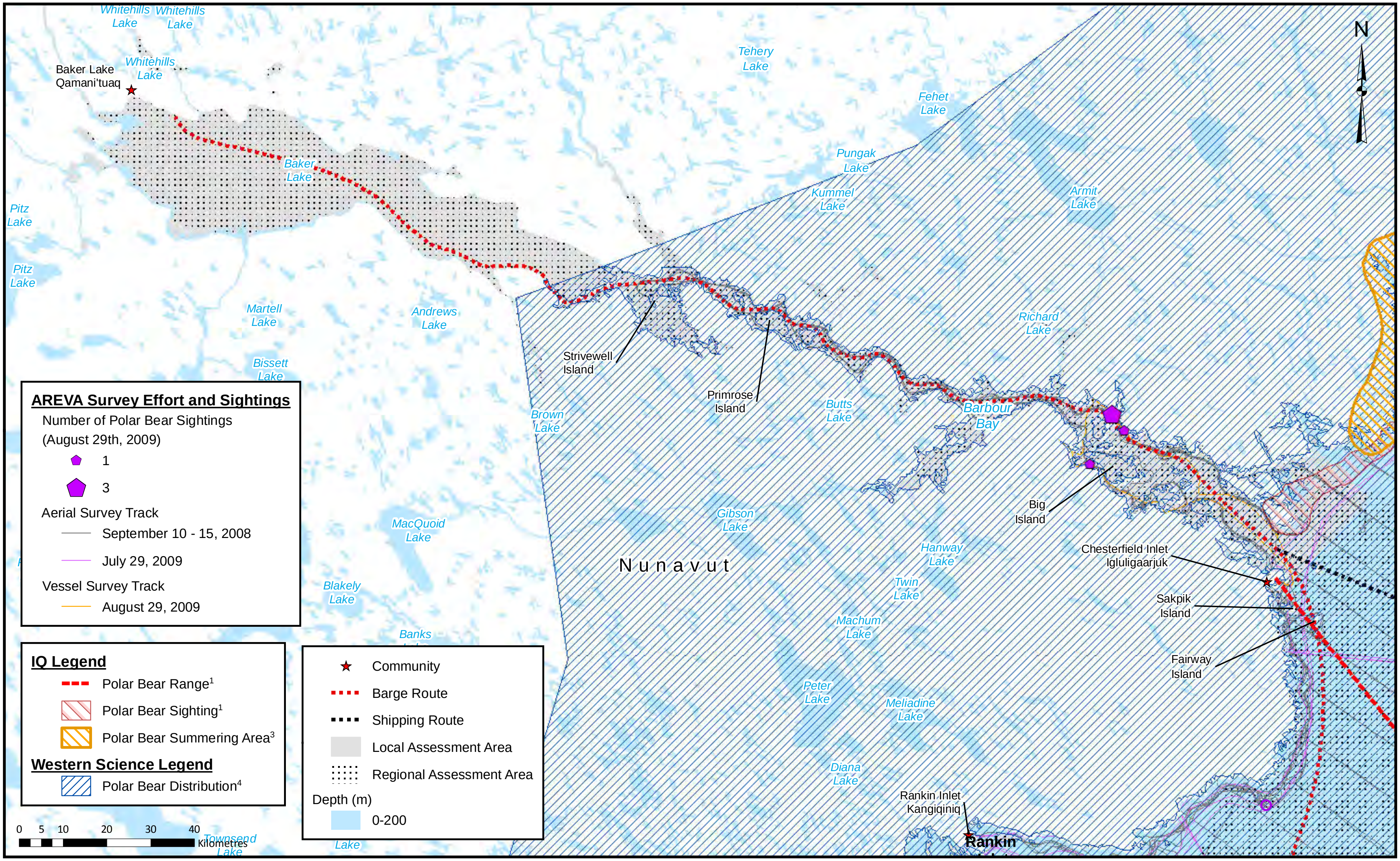
Polar bears from two of the thirteen Canadian sub-populations occur in the LAA and RAA: the Western Hudson Bay and Foxe Basin sub-populations (IQ-CI01 2009)[68]. Polar bears migration typically follows ice formation pattern; moving north across the coast during ice formation, and back south towards Churchill during ice-break (Nunami Stantec 2010). During the open-water season, polar bears spend several months along the western coastline of Hudson Bay from Southampton Island to Churchill (COSEWIC 2008). The Western Hudson Bay sub-population tends to congregate on coastal capes and headlands between Cape Churchill and Arviat (Stirling et al. 1999). *Preferred denning areas are places where there are steep hills and deep snow* (IQ-CI01 2009; CI03 2009; CI06 2009)The Foxe Basin sub-population concentrates on the west and northeast coasts of Southampton Island and along the coast of Wager Bay (north of Chesterfield Inlet) during the season of minimum ice density when shipping activities are expected (Campbell et al. 2012). In the fall, there is a gradual northward movement of the Western Hudson Bay polar bears along the south coast of Hudson Bay, as they gather to await the formation of new sea ice in November. *Some bears tagged in the Churchill region move northward along the Kivalliq Coast as far as Chesterfield Inlet* (IQ-CL01 2009; IQ-ARVJ 2011[69]; Stirling et al. 1999).

Polar bears den in the Wager Bay area, and to a lesser degree at Cape Silumiut. They also den on Southampton Island. Preferred denning areas are places where there are steep hills and deep snow (IQ-CI01 2009; IQ-CI03 2009; IQ-CI06 2009). IQ data suggest that polar bear numbers are increasing in the Chesterfield Inlet area (IQ-CI03 2009; IQ-CI05 2009; IQ-CI06 2009; IQ-CI04 2009; IQ-ARVJ 2011[70]); however, the most recent estimate of the Western Hudson Bay sub-population indicates that overall abundance has declined from 1,294 in 1987 to 935 in 2004 (COSEWIC 2008; Nunami Stantec 2010). Figure 5.2-5 and Figure 5.2-6 summarize information from available IQ and polar bear sightings compiled from baseline field surveys.

[68] IQ-CI01 2009: *There are two large groups of polar bears: 'Western Hudson Bay' polar bears and 'Foxe Basin' polar bears*

[69] IQ-CL01 2009; IQ-ARVJ 2011: *Polar bears move north from Churchill when the ice forms in November, and move south in the spring, carried by the counter-clockwise current in Hudson Bay.*

[70] IQ-CI03 2009; IQ-CI05 2009; IQ-CI06 2009; IQ-CI04 2009; IQ-ARVJ 2011: *Many of the Elders believe that there are more polar bears now than there used to be and that they have also become more dangerous.*



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Creator: RC
Date: 02/09/2014 Scale: 1:1,250,000
File: 1038926.04-019
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Areva Resources Canada Inc.*

FIGURE 5.2-5

POLAR BEAR SIGHTINGS AND IQ IN THE LAA

KIGGAVIK PROJECT - EIS

Source of IQ:

[1]AREVA 2014. Kiggavik Environmental Impact Statement. Tier 3, Technical Appendix 3B: IQ Documentation

[2]Kivalliq Inuit Association (KIA). 1994. KIA Land Management Database. (GIS features consolidated from multiple sources by the KIA). Rankin Inlet, NU. Application: http://184.70.38.178/kia.publicwebapplication/

[3]Riewe IQ Reference: Riewe, Rick (Editor). 1992. Nunavut Atlas. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut. Edmonton, AB Art Design Printing Inc.

[4]Department of Environment., Government of Nunavut

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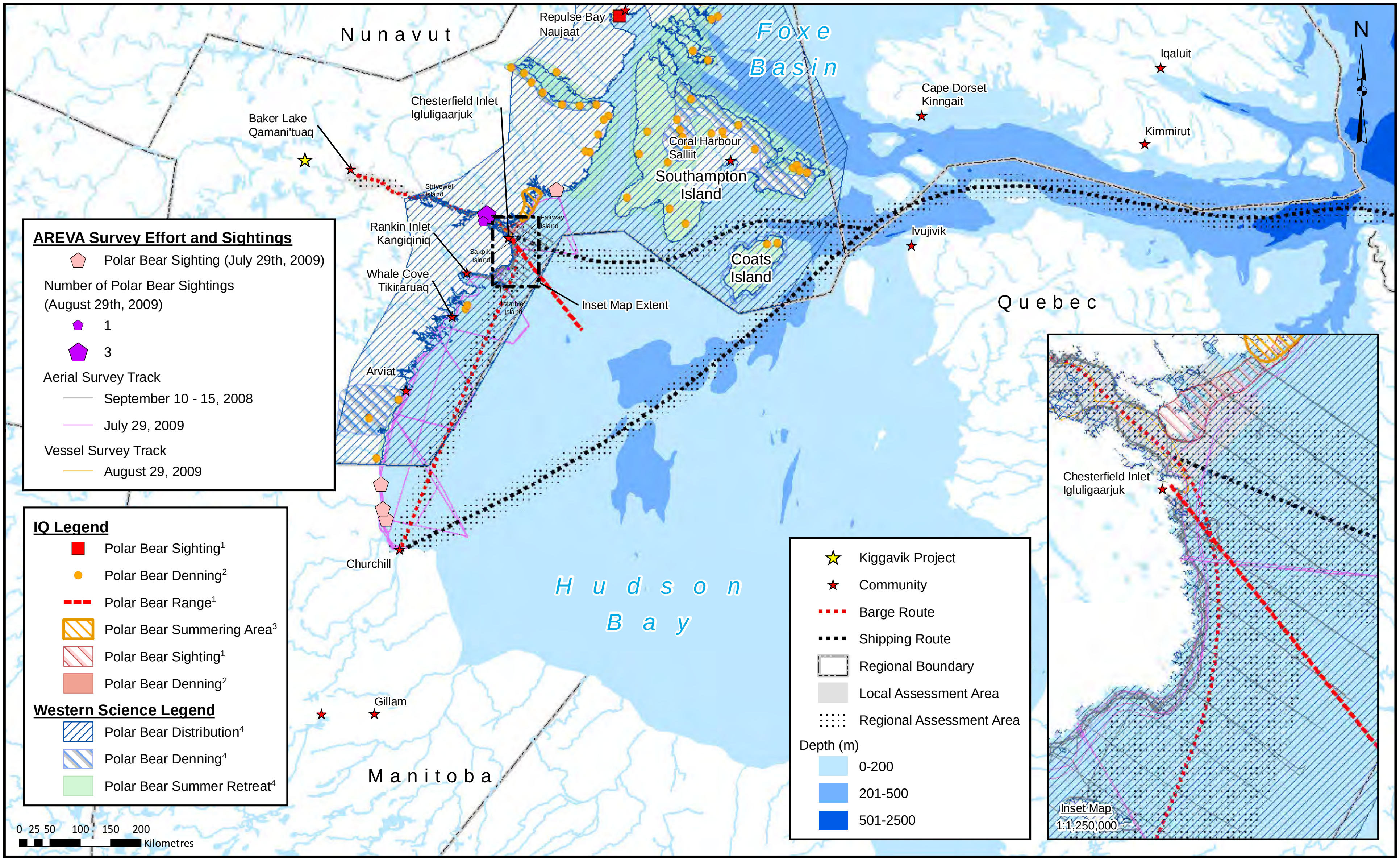

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Creator: RC
Date: 02/09/2014 Scale: 1:9,000,000
File: 1038926.04-019
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Areva Resources Canada Inc.*

FIGURE 5.2-6
POLAR BEAR SIGHTINGS AND IQ IN THE RAA

KIGGAVIK PROJECT - EIS

Source of IQ:
[1]AREVA 2014. Kiggavik Environmental Impact Statement. Tier 3, Technical Appendix 3B: IQ Documentation

[2]Kivalliq Inuit Association (KIA). 1994. KIA Land Management Database. (GIS features consolidated from multiple sources by the KIA). Rankin Inlet, NU. Application: http://184.70.38.178/kia.publicwebapplication/

[3]Riewe IQ Reference: Riewe, Rick (Editor). 1992. Nunavut Atlas. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut. Edmonton, AB Art Design Printing Inc.

[4]Department of Environment., Government of Nunavut

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5.3 Marine Fish

Eleven species of fish have been recorded in Baker Lake including Arctic grayling (*Thymallus arcticus)*, burbot (*Lota lota*), cisco (*Coregonus artedi)*, lake trout (*Salvelinus namaycush)*, ninespine stickleback (*Pungitius pungitius*), round whitefish (*Prosopium cylindraceum)*, slimy sculpin (*Cottus cognatus*), Arctic char (*Salvelinus alpinus)*, fourhorn sculpin (*Myoxocephalus quadricornis*), lake whitefish (*Coregonus clupeaformis*, and longnose sucker (*Catostomus catostomus*). No Arctic char spawning areas were identified in Baker Lake and very few juvenile fish were captured in baseline surveys, suggesting that spawning does not occur at any of the proposed dock facility locations. There are no SARA listed fish species or species designated by COSEWIC as species of concern in Chesterfield Inlet and surrounding area. Arctic char, fourhorn sculpin and whitefish are listed under IUCN (International Union for the Conservation of Nature)[71] red list as a species of least concern. A brief overview of conservation status and distribution of common marine fish species within the LAA and RAA is provided in Table 5.3-1.

Table 5.3-1 Conservation Status of Marine Fish Present in Western Hudson Bay, Chesterfield Inlet, and Baker Lake

Common Name	Scientific Name	Likely Found	Habitat Type	Status
Arctic cod	*Boreogadus saida*	Mouth of Chesterfield Inlet; Hudson Bay Coast	Demersal; anadromous; brackish; marine; 0–1383 m	Not listed
Arctic sculpin	*Myoxocephalus scorpioides*	Mouth of Chesterfield Inlet; Hudson Bay Coast	Demersal; brackish; marine; 0–275 m; rocky bottoms among algae	Not listed
Arctic char	*Salvelinus alpinus*	Chersterfield Inlet; Hudson Bay; Baker Lake	Benthopelagic; anadromous; brackish; marine; 30–70 m	IUCN Red List (Least Concern)
Fourhorn sculpin: marine form	*Triglopsis quadricornis* or *Myoxocephalus quadricornis*	Chersterfield Inlet; Hudson Bay;	Marine; 0–100 m	IUCN Red List (Least Concern)
Banded gunnel	*Pholis fasciata*	Chersterfield Inlet; Hudson Bay;	Demersal; marine; 0–94 m	Not listed

[71] The IUCN is an international conservation network. The IUCN red list is a classification system to identify species of conservation concern at a global level.

Table 5.3-1 Conservation Status of Marine Fish Present in Western Hudson Bay, Chesterfield Inlet, and Baker Lake

Common Name	Scientific Name	Likely Found	Habitat Type	Status
Whitefish	*Coregonus nasus*	Chersterfield Inlet; Hudson Bay	Demersal; anadromous; brackish; marine	IUCN Red List (Least Concern)
Arctic grayling	*Thymallus arcticus*	Baker Lake	Freshwater; benthopelagic; 30 m –unknown	IUCN Red List (Least Concern)
Burbot	*Lota lota*	Baker Lake	Freshwater; brackish; 1-700 m	IUCN Red List (Least Concern)
Cisco	*Coregonus artedi*	Baker Lake	Marine; freshwater; brackish; 50 m – unknown	IUCN Red List (Low Risk/Least Concern)
Lake trout	*Salvelinus namaycush*	Baker Lake	Freshwater	Not Listed
Ninespine stickleback	*Pungitius pungitius*	Baker Lake	Marine; freshwater; brackish; 70–77 m	IUCN Red List (Least Concern)
Round whitefish	*Prosopium cylindraceum*	Baker Lake	Freshwater; brackish; unknown –37 m	Not Listed
Slimy sculpin	*Cottus cognatus*	Baker Lake	Freshwater; brackish; 6–128 m	Not listed
Fourhorn sculpin	*Myoxocephalus quadricornis*	Baker Lake	Marine; freshwater; brackish; 0–100 m	IUCN Red List (Least Concern)
Lake whitefish	*Coregonus clupeaformis*	Baker Lake	Marine; freshwater; brackish; 18–128 m	Not listed
Longnose sucker	*Catostomus catostomus*	Baker Lake	Freshwater; brackish; unknown –180 m	Not listed

Very little is known throughout most of the Arctic regarding fish species occurrence and distribution, but at least 49 species of fish occur in the marine ecosystem of Hudson Bay (Stewart and Lockhart 2005). The absence of commercially exploitable resources in Hudson Bay as well as physical limitations (such as a short ice-free season) has likely restricted research efforts on fish populations in the region (Stewart and Lockhart 2005). IQ has been limited mostly to observations from shallow nearshore waters and stomach contents of harvested fish, leaving the offshore marine fish resources virtually unknown (Stewart and Lockhart 2005). Although the commercial fisheries are limited, subsistence harvest for a variety of species, such as Arctic char, can be substantial (Stewart and Lockhart 2005).

Several fish species of Baker Lake and Chesterfield Inlet play important roles in the ecological, economic and cultural health of the local communities. Arctic cod (*Boreogadus saida*), Arctic sculpin (*Myoxocephalus scorpioides*), Arctic char, fourhorn sculpin, banded gunnel (*Pholis fasciata*), and whitefish use sand and boulder benthic habitats around the mouth of Chesterfield Inlet. Arctic char typically migrate into Chesterfield Inlet in the first weeks of July when the ice has cleared (Nunami Jacques Whitford Limited 2008). Capelin (*Mallotus villosus*) and starry flounder (*Platichthys stellatus*) are abundant nearshore species in Hudson Bay. Starry flounder occasionally enter river mouths where they are believed to spawn during the winter months (Percy et al. 1985). Capelin spawn inshore during the summer months (Scott and Scott 1988). Fourhorn sculpin is abundant in shallow waters (below 45 m) throughout Nunavut and are often associated with brackish waters of river mouths (Coad and Reist 2004). Clams, blue mussels, and Icelandic scallops occur along the coast and an Icelandic scallop bed is identified in the mouth of Chesterfield Inlet (Mercier et al. 1994).

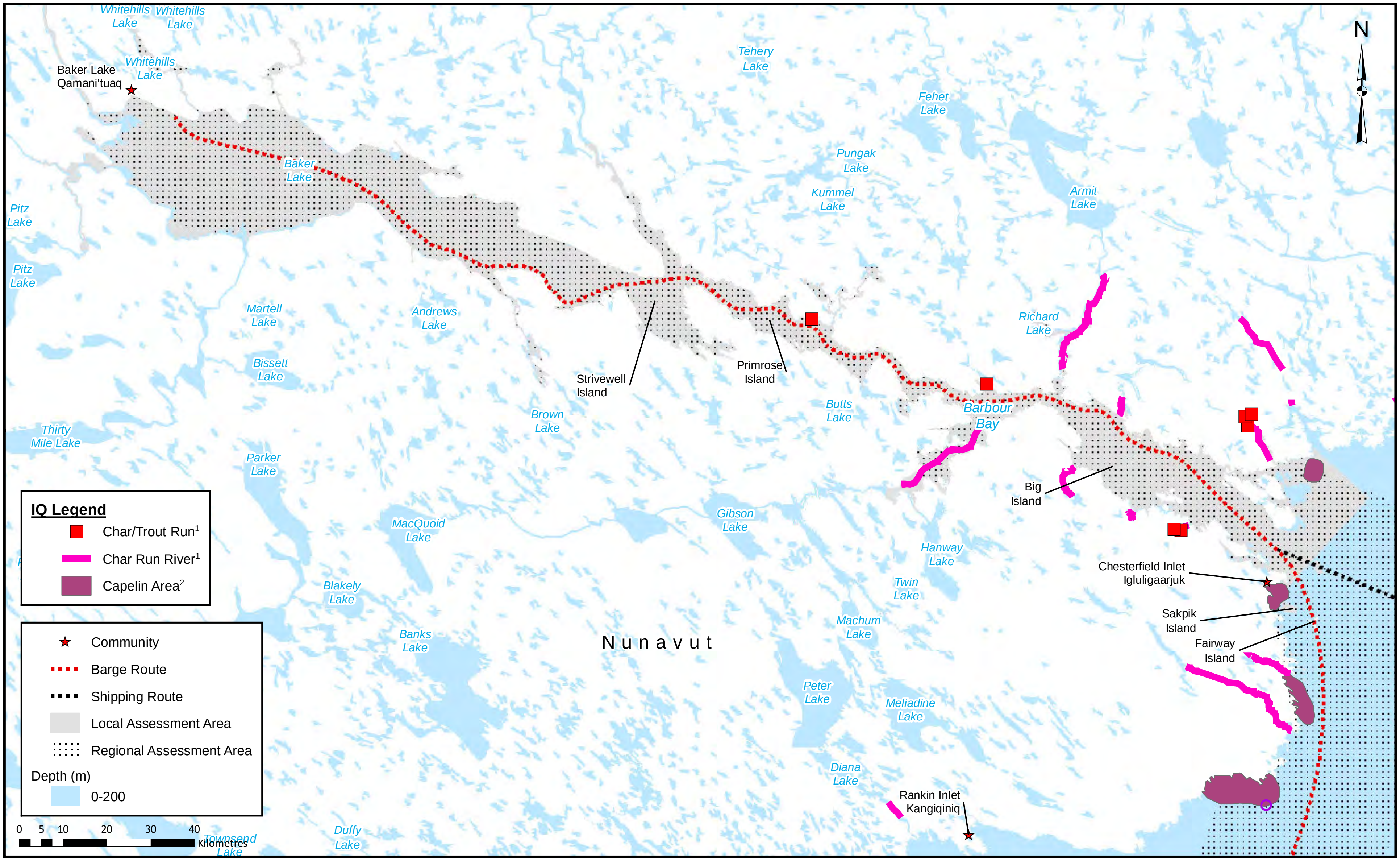
Greenland halibut (Reinhardtius hippoglossoides) is an abundant offshore marine fish species in Hudson Bay (Coad and Reist 2004) and are commonly found in deep water at the eastern entrance to Hudson Strait (Stephenson and Hartwig 2010). This area overlaps with shrimp (northern, striped and pink) area of abundance (Mercier et al. 1994; Stephenson and Hartwig 2010). These species are harvested commercially and therefore this area is considered sensitive habitat. Northern shrimp is fished in Hudson Strait between May and December of most years (DFO 2013). Arctic cod are also very abundant. They are found mainly in the upper part of the water column over deep water, and are often associated with drifting pack ice where they spawn in winter (Bradstreet et al. 1986).

Arctic Char

Arctic char are the most abundant and dominant salmonid species throughout the Arctic; however they are not found much farther south than 60°N due to competition from other species (Mercier et al. 1994). They can be both anadromous and landlocked. The anadromous char migrate out to Hudson Bay for summer feeding during ice break-up from mid-June to early July, and migrate back upstream from mid-August to mid-September to spend the winter in fresh water (IQ-ARVJ

2011[72];Stewart and Lockhart 2005). They spawn in late August to early October, preferring gravel substrate with sufficiently deep water to prevent the eggs from freezing and sufficient current to keep them clean (Stewart and Lockhart 2005). After spawning, they will overwinter in the lake and migrate to the ocean to feed the following spring. While they are in the Bay during the summer they are known to feed on other marine fish including capelin, sand lance (*Ammodytes americanus*), Arctic cod, and Greenland cod (*Gadus ogac*) (Johnson 1989). In the Kivalliq region, they are harvested from the Thlewiaza River north to Daly Bay and into Chesterfield Inlet (Stewart and Lockhart 2005). Community members have mentioned that "*there are way fewer arctic char in fisher bay the past couple of years. Less than 5-10 a day now. Five years ago was 30 a day.*" (IQ-CIHT 2011) indicative of a change in population trend in the region. Figure 5.3-1 and Figure 5.3-2 summarize information on Arctic char and capelin from available IQ.

[72] IQ-ARVJ (2011): *In August, char go up the rivers to the lakes, although some will stay year-round in the bay.*



Projection: NAD 1983 UTM Zone 15N
Creator: RC
Date: 02/09/2014 Scale: 1:1,250,000
File: 1038926.04-019
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Areva Resources Canada Inc.*

FIGURE 5.3-1
ARCTIC CHAR AND CAPELIN IQ IN THE LAA

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[1]*AREVA 2014. Kiggavik Environmental Impact Statement. Tier 3, Technical Appendix 3B: IQ Documentation*

[2]*Kivalliq Inuit Association (KIA). 1994. KIA Land Management Database. (GIS features consolidated from multiple sources by the KIA). Rankin Inlet, NU. Application: http://184.70.38.178/kia.publicwebapplication/*

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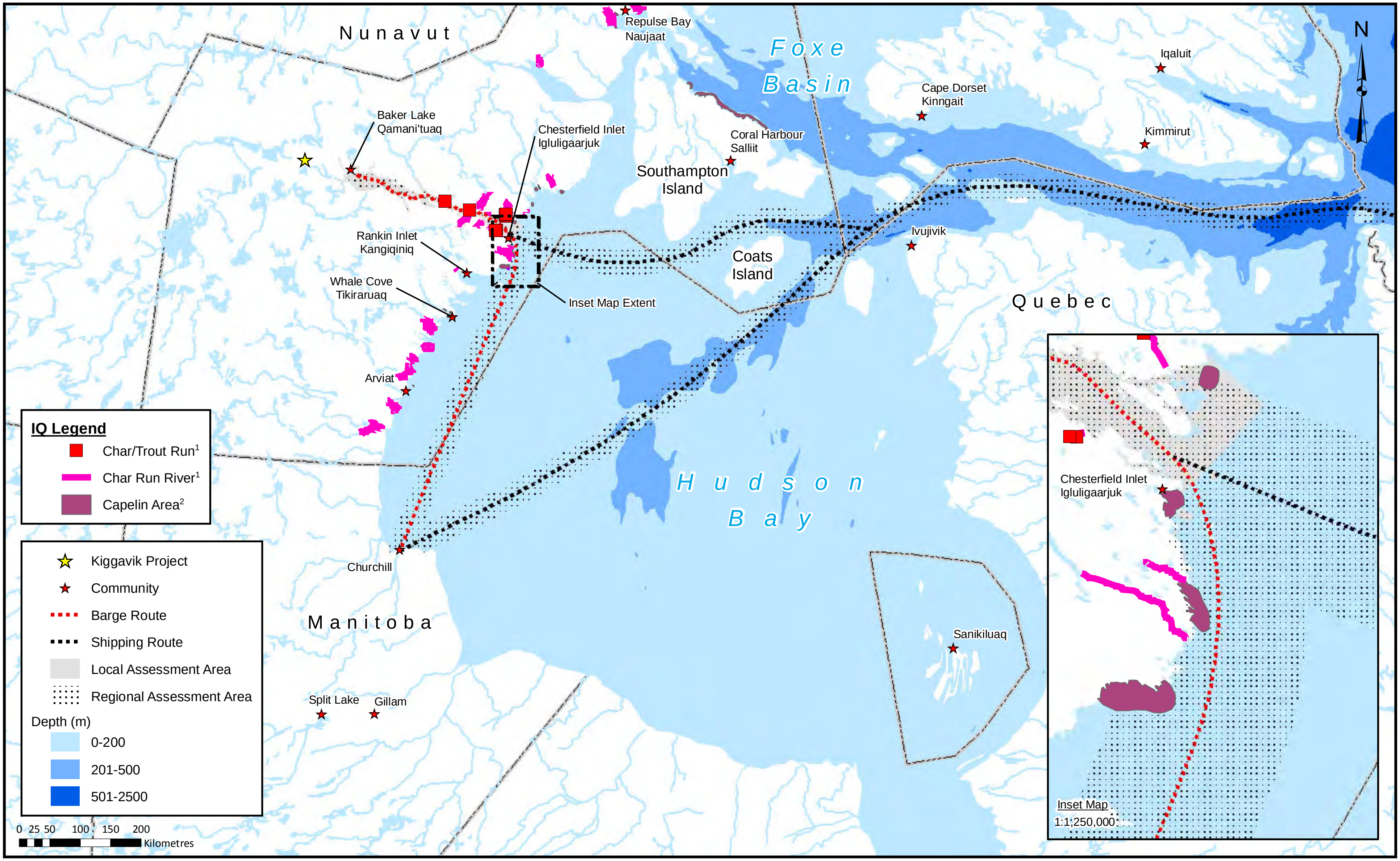

Projection: NAD 1983 UTM Zone 15N
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Date: 02/09/2014 Scale: 1:9,000,000
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Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Areva Resources Canada Inc.*

FIGURE 5.3-2
ARCTIC CHAR AND CAPELIN IQ IN THE RAA

KIGGAVIK PROJECT - EIS

[1]*AREVA 2014. Kiggavik Environmental Impact Statement. Tier 3, Technical Appendix 3B: IQ Documentation*

[2]*Kivalliq Inuit Association (KIA). 1994. KIA Land Management Database. (GIS features consolidated from multiple sources by the KIA). Rankin Inlet, NU. Application: http://184.70.38.178/kia.publicwebapplication/*

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6 Environmental Effects Assessment for Marine Mammals

6.1 Scope of the Assessment for Marine Mammals

Three taxonomic groups of marine mammals are present within the LAA and RAA during the open-water season: whales (e.g., belugas from the Western Hudson Bay population), seals (e.g., ringed), and polar bears. While various other marine mammal species are known to occur in the area (e.g., bowhead whale, walrus, killer whale, harp seal, narwhal), these species are considered less common in the LAA and RAA and interactions with the Project will be less frequent.

Marine transportation for the Kiggavik Project is not expected to result in environmental effects on polar bears since shipping and barging will only occur during the open-water season and will not overlap substantially with the seasonal habitat of the bears.

Although polar bears use coastal habitats during the summer months, vessels will typically be in the range of 30-60 km offshore when transiting past shorelines in Hudson Bay and Hudson Strait. As a result, transiting vessels are not expected to result in effects on polar bears from acoustic or vessel wake disturbance. To ensure that potential disturbance of shipping activities on summering bears along coastlines is minimized, AREVA will maintain a maximum safe distance from shorelines so that acoustic disturbance is minimized between Southampton Island and Coats Island where sensitive marine habitat and higher densities of polar bears during summer months has been noted.

Polar bears have the ability to swim long distances in open water, but are generally forced onto land in the Hudson Bay and Hudson Strait region for several months during the open-water season to wait for new ice to form; therefore, interactions with marine transportation associated with the Project are expected to be rare. Any observations of polar bear during marine transportation activities will be recorded. Vessels will be navigated to avoid the path of a swimming bear as long as the navigational safety of the vessel is maintained (see Section 6.2.1.6). Precautions to protect wildlife (including polar bears) in the event of a spill are addressed in Tier 2, Volume 10 Accidents and Malfunctions .

Environmental effects are assessed with respect to the most common marine mammal species in the area during the open-water season; ringed seal and beluga whale (Table 6.1-1). These two species are used as indicators for assessing Project effects on marine mammals.

Table 6.1-1 Potential Environmental Effects on Marine Mammals

Project Activities/Physical Works	Potential Environmental Effects	
	Change in Mortality Risk	Change in Behaviour
Construction Transport fuel and construction materials (transfers, barging)	✓	✓
Operations Marine transportation: loading barges, barging, off-loading (fuel, reagents and supplies), Baker Lake and Churchill/Chesterfield, back-haul	✓	✓
Final Closure Marine transportation: fuel and construction materials (transfers, barging)	✓	✓
NOTE: See definitions of rankings in section 4.3.1		

6.1.1 Key Issues for Marine Mammals

Key issues for marine mammals relate predominantly to marine vessel traffic and its potential to physically harm, disrupt, and/or displace the animals from summer habitat in Hudson Bay and Chesterfield Inlet. IQ indicates concerns related to Project shipping including the potential for disruption of marine mammal harvesting, in particular beluga whale and ringed seal. Effects on harvesting are addressed in Tier 2, Volume 9 Socio-economic Assessment. Supporting IQ information is summarized below:

Vessel presence and noise

- *Seals are affected by noise from marine transportation and increased barge traffic in Chesterfield Inlet* (IQ-CI042009; IQ-CI05 2009).
- *The amount of barge traffic has increased over the last two years, and this has also negatively affected the beluga whale population* (IQ-CI04 2009; IQ-CI08 2009).
- *Beluga whale appear to have declined in the area* (IQ-McDonald et al. 1997).
- *A resident of Repulse Bay noted that the noise of ships is affecting the animals, and that beluga whales do not come in anymore* (IQ-McDonald et al. 1997).
- *There are fewer beluga whales or other sea mammals near the community when there are ships close by, and beluga whales are trying to get away from the ships* (IQ-McDonald et al. 1997).
- *There are few harp seals around this year (2010), especially near Chesterfield. This is attributed to the shipping going on in the area* (IQ-RIJ 2011).
- *Belugas travel along both the coast and in more open water, so any shipping will disturb beluga migration* (IQ-RIJ 2011).

- *Beluga whale enter Chesterfield Inlet during their northern migration* (IQ-CI01 2009; IQ-CI03 2009).

Marine mammal hunting

- *Hunters travel to Repulse Bay for whale hunting* (IQ-RBJ 2011; IQ-RIJ 2011).
- *Killer whales are not hunted because people fear them* (IQ-RBJ [2011]).
- *Beluga are hunted year round* (IQ-CHJ 2011).
- *Walrus hunting occurs during winter months at the ice flow edge* (IQ-CHJ 2011).
- *There are two herds of beluga whale near Chesterfield Inlet: one comes north from Churchill and arrives at Chesterfield Inlet around August or September, the other herd comes south from Foxe Basin in the early summer* (IQ-CI01 2009; IQ-CI03 2009).
- *During focus groups, hunters noted there were lots of polar bear around and that the scientists have not done a good job of counting them. The scientists do the counts in July, when there are few polar bear around. In October and November, there are so many polar bear around Arviat that patrols are needed to protect people. Because they are not allowed to hunt polar bear, guiding activity has declined and the few tourists that do come hunt caribou. The hunters believe that collaring polar bear affects the bear's ability to hunt and changes it nature. The animals can learn to live with disturbances from vehicles and boats, but are harmed by the methods biologists use to count and track animals* (IQ-ARHT [2009]).

As discussed in section 4.10, IQ has been fundamental in selection of VECs for the marine assessment, and identification of potential environmental effects. These issues and concerns are addressed in the following effects assessment and, where appropriate, mitigation has been proposed to reduce or eliminate potential effects.

6.1.2 Standards or Thresholds for Determining Significance

The significance of biophysical effects can often be quantitatively determined based on standards and/or other quantitative methods. However, in the absence of this, the significance of environmental effects must be determined qualitatively on the basis of professional judgment. Determination of whether a Project residual effect on marine mammals is considered to be significant or not is based on whether an effect adversely affects the long-term viability of a population or delays its recovery (e.g., due to a substantial increase in mortality risk, change in abundance and distribution). A residual environmental effect is considered to be not significant if the environmental effect causes a change in condition of an individual or group of marine mammals (or their habitat) that is within the range of natural variability, or does not affect the integrity of a population in a measurable way.

Change in mortality risk is considered significant if the number of marine mammals struck by vessels affects the long-term viability of a population or delays its recovery.

6.2 Environmental Effects Assessment for Marine Mammals

6.2.1 Assessment of Change in Mortality Risk

Marine shipping in the Project area may increase the risk of direct mortality or injury to marine mammals from collision with vessels. Most marine mammals are fast swimming, agile, and have sensitive underwater hearing, enabling them to avoid approaching vessels. In particular, toothed whales and pinnipeds are highly maneuverable and are rarely struck by vessels (Laist et al. 2001; Jensen and Silber 2003). There are very few documented cases of seal mortality as a result of collision with a vessel (Richardson et al. 1995a). Of all records, baleen whales are the most commonly struck because they are relatively large, and some species are slow-moving, and perhaps unable to exhibit a rapid avoidance response to approaching vessels (Laist et al. 2001; Jensen and Silber 2003).

6.2.1.1 Baseline Conditions for Change in Mortality Risk

Marine transportation remains the primary method for delivery of goods in the north, even though the window of opportunity for shipping during the open-water season only extends for 2-3 months (60 days of open water is used as a conservative estimate, see Tier 3, Technical Appendix 2J). Relative to other major marine transportation corridors in Canada, commonly used shipping routes in the RAA are subject to a much lower density of vessel traffic and, accordingly, marine mammal populations are not currently at high risk of mortality due to collision with vessels.

6.2.1.2 Effect Mechanism and Linkages for Change in Mortality Risk

A variety of Project-related vessels will be active within the RAA and LAA during the construction, operation, and decommissioning of the Project. Ocean-going vessels include fuel tankers, general cargo ships, container ships and articulated tugs with barges (ATB). ATBs will be used to transport dry cargo and fuel from the transshipment point at either Helicopter Island or Ellis Island in Chesterfield Inlet to AREVA's Baker Lake dock facility. They will also be used to transport goods and fuel from the Port of Churchill to the Baker Lake dock facility, or to transport fuel and dry goods from southern ports directly to the Baker Lake dock facility. ATBs will travel north from Churchill and then navigate through Chesterfield Inlet to Baker Lake. Ocean-going vessels such as fuel tankers and cargo ships will transit through Hudson Strait to the Port of Churchill or Chesterfield Inlet where they will transfer cargo to ATBs for delivery to Baker Lake. All vessels operating in Chesterfield Inlet and the waters of Hudson Bay and Hudson Strait have the potential to collide with a marine mammal; however, the risk is substantially reduced with reduced vessel speed.

Vessel-mammal collisions may result in either injury or direct mortality. Most injuries are the result of two mechanisms; either blunt force trauma from collision with the bow of the vessel or from lacerations from contact with the propellers. Depending on the severity of the collision and the injuries inflicted, the marine mammal may or may not recover. Most lethal and severe injuries from collisions with vessels involve ships that are 80 m and longer and those travelling at 14 knots or faster (Laist et al. 2001). Recent research shows that vessel speed is positively correlated with both the probability and severity of a vessel collision (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). Serious or lethal collisions with whales are infrequent at vessel speeds of less than 14 knots, and are rare at speeds of less than 10 knots (Laist et al. 2001). As noted below, AREVA will require vessels to reduce speeds to reduce the risk of fatal collisions. Mathematical models from current vessel-mammal collision probability research support the reduced probability of a vessel-mammal collision with reduced speeds. At a speed of 10 knots, the models predicted a 30% chance of a vessel collision when the whale is directly in the vessel path (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007).

Marine mammals that spend a considerable amount of time at or near the surface are at increased risk of vessel collision. They are physically in the way of approaching vessels and research has shown that sound levels are lower near the surface, potentially explaining why baleen whales are often unresponsive to approaching vessels (Richardson et al. 1995b). Acoustic modeling around the hull of a ship also shows that sound levels may be lower ahead of a vessel, compared to the sides and behind (Terhune and Verboom 1999).

The beluga whale is a relatively mobile and fast swimming animal, and has a much lower probability than baleen whales of being struck by a vessel in transit. Beluga whales will likely avoid vessels whenever possible. However, mother-calf pairs spend a great deal of time resting and socializing near the surface (as is the case near Churchill) and may be unresponsive to approaching vessels. Pinnipeds are highly maneuverable and there are very few documented cases of seal mortality as a result of vessel collisions (Richardson et al. 1995a). Seals can effectively modify their swimming behaviour to avoid slow-moving (less than 14 knots) vessels.

6.2.1.3 Mitigation Measures and Project Design for Change in Mortality Risk

A variety of strategies will be employed to reduce the potential of a Project related vessel-mammal collision occurring. Mitigation measures apply to all Project-related vessel types operating within the confined waters of Chesterfield Inlet, or operating in marine mammal habitat in the RAA that is deemed to be sensitive for migration, calving, or feeding. Recommended vessel speeds are based on information cited above regarding the correlation between vessel speed and likelihood of vessel collision with mammals (Kite-Powell et al. 2007; Laist et al. 2001; Vanderlaan and Taggart 2007). Marine mammal observers (MMO) from local communities will be present onboard tugs and vessels to monitor marine activities when transiting through the LAA. Mitigation measures to reduce the likelihood of vessel-mammal collisions are summarized as follows.

- IQ indicates, *"If ships travel during the winter months, wildlife will be affected. Summer barging would have less of an impact on marine life."* (IQ-CHJ [2011]). Marine shipping is planned to occur only during the open-water season.
- The area surrounding Churchill is important beluga whale habitat, and there are known concentrations of animals in this area during the open-water shipping season (IQ-CI02 [2009][73]; IQ-RIHT [2009][74]). To reduce the potential of a vessel-mammal collision, vessels will travel at a maximum speed of 8 to 10 knots when transiting this area during the open-water season, unless otherwise required for safe navigation.
- Along established shipping routes in western Hudson Bay and Hudson Strait, vessel speeds will not exceed 13 knots, unless otherwise required for safe navigation, and are likely to be much less than that while transiting Chesterfield Inlet.
- Vessels will avoid unnecessary acceleration and maintain a constant course, whenever possible.
- Upon the advice of the onboard local MMO, vessels will halt if marine mammals appear to be herded by an approaching vessel within Chesterfield Inlet, unless conditions present a risk to vessel and human safety.

6.2.1.4 Residual Environmental Effects for Change in Mortality Risk

Over the life of the Project, between 7 and 31 vessel transits are expected to be required annually to deliver fuel and dry cargo to the dock facility. Vessels will only be travelling during the open-water season (typically August through September). Given the duration of marine vessel operations and the frequency of transiting vessels, there is potential that a vessel-mammal collision could occur over the life of the Project. With the proposed mitigation in place, vessel-mammal collisions will be rare and would be more likely to result in non-lethal incisions from propellers and non-lethal blunt force trauma, except in the case of collisions involving calves and young animals, where injuries may be more severe.

Potential residual environmental effects from increased mortality risk to marine mammal populations are expected to be low in magnitude, site specific (along the shipping route), long term, sporadic (restricted to the open-water season when vessels are transiting), and low in frequency. Larger, faster vessels have the potential to strike whales with greater force, causing greater physical injury and trauma (as discussed in section 6.2.1.2). However, with implementation of the above mitigation measures, the probability of a lethal or severe vessel-mammal collision is expected to be low. The effect of a vessel collision with a marine mammal is potentially fatal (i.e., irreversible), but environmental effects on marine mammal populations are expected to be reversible through natural

[73] IQ-CI02 [2009]: *Beluga Whale calve in an area between Arviat and Churchill.*

[74] IQ-RIHT 2009) *Hunters believe the best place to hunt beluga whale is close to Churchill in early July, when they are starting to migrate.*

recruitment. Increased mortality risk due to Project-related vessel-mammal collision will continue until the termination of the Project.

6.2.1.5 Determination of Significance for Change in Mortality Risk

The probability of a lethal or severe vessel collision is considered to be low at speeds of less than 14 knots. Increased mortality risk to marine mammals due to Project-related vessel-mammal collisions are considered to be low. Because of this, the long-term viability of marine mammal populations in the RAA are unlikely to be affected, even in the unlikely event where one or several animals are lost over the lifetime of the Project. With implementation of mitigation measures outlined in Section 6.2.1.3, the potential environmental effect of an increase in mortality risk of marine mammals due to vessel collision is determined to be not significant. Confidence in this prediction is high because effects of the Project on marine mammals will be limited to the RAA and are not expected to affect the viability of the population.

6.2.1.6 Compliance and Environmental Monitoring for Change in Mortality Risk

Onboard marine mammal observers (MMOs) on vessels transiting through the LAA shall record all marine mammal sightings, near-misses, and incidents of vessel-mammal collisions with marine mammals. In the absence of MMOs while transiting the RAA, incidents shall be recorded by the maritime crew. Ship logs will record course adjustments to avoid sensitive habitat (i.e. near Coats Island), vessel speed, and speed reductions in important areas (i.e. Port of Churchill).

6.2.2 Assessment of Change in Behaviour

The assessment of change in marine mammal behaviour due to underwater noise is based on Project-specific modeling of sound propagation associated with marine transportation during operation and decommissioning of the Project. The discussion includes available behavioural change criteria, and known marine mammal responses to vessels. Key potential environmental effects resulting from the Kiggavik Project relate to underwater noise and its potential to disrupt and/or displace marine mammals from their preferred habitat.

Marine mammals that are common in the LAA and RAA are likely tolerant to some level of underwater noise from existing vessel traffic and natural acoustic sources. Marine mammal reactions to sensory disturbance may range from subtle to obvious behavioural changes (e.g., from no effect or a small change in respiration rate to avoidance and change of travel route).

6.2.2.1 Analytical Methods for Change in Behaviour

Acoustic modelling undertaken for the Project predicts the level of underwater noise that could be generated by marine vessels associated with the Project (Tier 3, Technical Appendix 7B). Modelling scenarios simulated the articulated tug and barge (ATB) transiting with two barges at 13 knots (based on a conservative consideration that vessels may operate at a maximum speed of 13 knots). Four locations are modelled along the planned tug and barge transportation route, which correspond to the closest approach to each of the four local communities in Western Hudson Bay. Scenario one modelled the ATB transiting in Chesterfield Inlet (inside the LAA) and scenarios two to four modelled three locations in the RAA (Rankin Inlet, Whale Cove, and Arviat)(Tier 3, Technical Appendix 7B). Results from acoustic modelling of sound source levels are compared with known behavioural response criterion and analysed against species-specific audiograms to determine how Project-related underwater noise may affect marine mammals. Results from the Western Hudson Bay modeling locations are used as a proxy for the rest of the shipping route in the RAA. The zone of influence for audibility and behaviour thresholds for marine mammals may show some spatial variability due to site specific parameters such as bathymetry and sea floor characteristics that influence sound propagation. However, the frequency and magnitude of the underwater sound produced will be similar along the shipping route within the RAA and potential effects within species groups are expected to be consistent.

The interpretation and propagation of sound in the marine environment depends on physical oceanographic features such as the thermal conditions of the water, the depth of the thermocline, and the structure of the seabed and sea surface. For example, soft sediments absorb noise easily, whereas hard bedrock reflects noise. Noise transmission also depends on the type of noise (i.e., the frequency). Lower frequencies travel great distances through sea water with little absorption, whereas higher frequencies decrease in amplitude with distance.

Ambient noise was not measured in the LAA or RAA. No published data or information was located regarding underwater ambient noise levels in Hudson Bay. For modelling purposes, underwater ambient noise levels are estimated based on empirical models of ocean noise based on the surface agitation component for sea state 1 conditions (Tier 3, Technical Appendix 7B). The zones of audibility for each species are considered to be the region where the audiogram-weighted noise levels exceeded these estimated noise levels (Tier 3, Technical Appendix 7B).

The National Marine Fisheries Service (NMFS) has developed a conservative behavioural response criterion of 120 dB_{RMS} re 1 Pa for all marine mammals in the presence of continuous sound sources, such as noise from vessels (Federal Register 2005). Specifically, if the noise is received by the animal at 120 dB or more, it is likely to induce a behavioural change. This criterion is used to predict the area of habitat over which behavioural change for marine mammals from Project-related marine transport noise may occur.

To assess potential changes in behaviour, the acoustic modelling defines a quantified spatial area where underwater sound will be transmitted and audible to beluga whales and ringed seals, and where it exceeds available behavioural response criteria. Details on the acoustic modelling are presented in the Marine Acoustics Technical Data Report (Tier 3, Technical Appendix 7B. Modelling locations were selected based on proximity of the planned transportation route to each community. The acoustic signature was modelled for the ATB at the following four locations along the transit route from Churchill to Chesterfield Inlet (Figure 6.2-1):

- Scenario 1: ATB transiting in Chesterfield Inlet
- Scenario 2: ATB transiting off Rankin Inlet
- Scenario 3: ATB transiting off Whale Cove
- Scenario 4: ATB transiting off Arviat

6.2.2.2 Baseline Conditions for Change in Behaviour

Numerous physical, biological and anthropogenic sources of noise currently exist in the marine environment that contribute to ambient noise levels. Physical sources of ambient noise include wind and rainfall, ocean waves, natural seismic activity under the seabed, thermal, and icebergs (ice cracking and collisions). Biological sources may include the movement and sounds of other animals (IQ-ARVJ [2011][75]). Anthropogenic sounds are the result of recreational and small commercial vessels, tug and ship machinery, propellers, water flow around the hull, and discharges of water from a ship.

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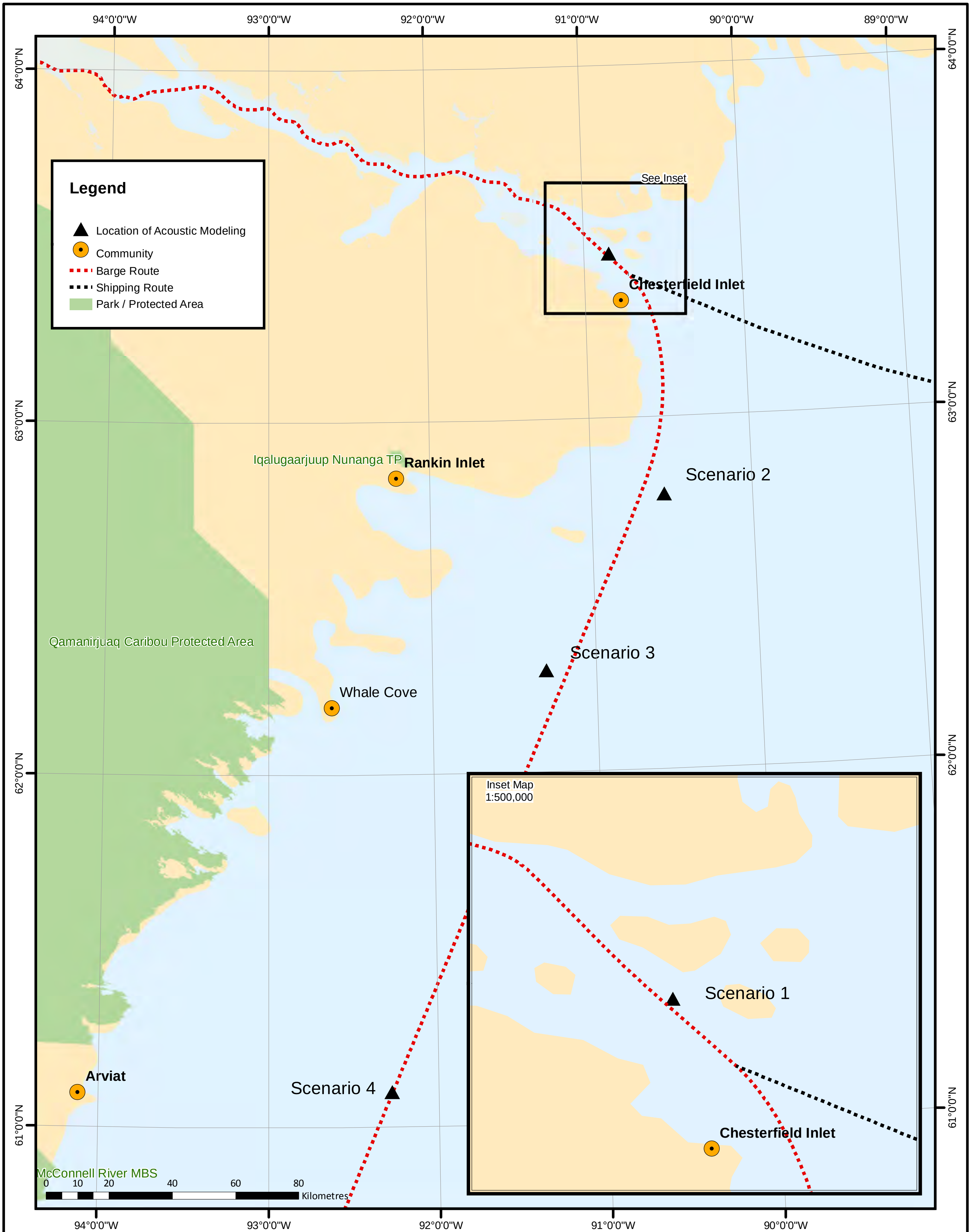
[75]IQ-ARVJ (2011): "*Sea mammals will swim closer to shore if there are killer Whale in the area".*



Projection: NAD 1983 UTM Zone 15N
Creator: BA
Date: 21/09/2011 Scale: 1:1,600,000
File: 1038926.04-029
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Areva Resources Canada Inc.*

FIGURE 6.2-1
Locations of the Four Acoustic Modeling Scenarios Along the Proposed Tug and Barge Route.

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6.2.2.3 Effect Mechanism and Linkages for Change in Behaviour

The presence of marine vessels has the potential to cause a startle response, alarm response, avoidance, or auditory masking, which could result in a change in behaviour and migration patterns (IQ-RIJ [2011][76]). In addition, underwater vessel noise has the potential to harm, disrupt, and/or displace marine mammals from their habitat, which in turn could reduce foraging efficiency and fecundity, and increase energy expenditure. The majority of underwater noise from vessels is generated by the propeller; however, the flow in pumps and piping, hull roughness and hull protrusions, main engines, generators, and other machinery can contribute to the noise level (Mitson 1995). The operational aspects of speed control also play an important role in the level of noise; a constant speed maintains an even level of noise output, whereas rapid changes in velocity generate greater noise outputs (Mitson 1995). The vessel speed and amount of load carried or towed are important factors in determining the noise signature. Tugs and barges transiting through the LAA and RAA at 13 knots would contribute primarily low frequency underwater sounds (10 Hz to 31.5 kHz) to the marine environment.

Changes in behaviour resulting from vessel-related noise can include changes in swim direction, swim speed, dive duration, surfacing duration, respiration (blow rate), movement towards or away from noise, or changes in acoustic behaviour (i.e., vocalization frequency). The degree of effect depends on how the animal interprets the sound received and its sensitivity, which varies with noise frequency. A species' audiogram is the relationship between noise frequency and an animal's hearing threshold. If a noise is at a frequency that the animal cannot hear well (i.e., where the hearing threshold is high), it is unlikely to affect the animal's behaviour. Noise levels decrease with distance from the source due to propagation loss. A noise is no longer audible if the noise drops either below the animal's audiogram or below the ambient noise levels. A change in behaviour may not occur simply because a sound is audible.

Increases in noise levels with similar frequencies to those used by marine mammals can result in the masking of these sounds or a decrease in the distances over which they can be detected. Masking, in turn, may inhibit a whale's ability to communicate with conspecifics, forage, detect predators and navigate. An anthropogenic sound source will mask the effective communication or echolocation distance of a marine mammal only if it overlaps the sound signal in time and frequency. If little or no overlap occurs between the sound and the frequencies used, communication and echolocation are not expected to be disrupted or masked (Abgrall et al. 2008).

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[76] IQ-RIJ (2011): "*Beluga travel along both the coast and in more open water. So, any shipping will disturb beluga migration."*

Beluga Whales

Chesterfield Inlet is a narrow passage, which is extremely shallow in sections. There is potential for animals to be herded within the narrow confines as the vessels are travelling westward or cause reverse migration of belugas out of the Inlet during the eastward return of the vessels. During migration, beluga whales tend to remain within 20–30 km of the shore. In Hudson Bay, there is potential to shift beluga migration if the noise disturbance is within this area.

Beluga whales are widely recognized as highly gregarious animals, traveling in large, dense herds during migration or occurring in concentrations in estuaries in midsummer (Finley et al. 1987). Belugas have extremely acute hearing within the mid frequency range, between 32–108 kHz (Klishin et al. 2000; Southall et al. 2007). They communicate vocally and have well-developed echolocation (Harwood and Smith 2002). Echolocation uses sound to detect prey for foraging and orient themselves in the marine environment (Mooney 2008). They use forward-projecting pulsed sounds of high intensity, spaced so an echo from the target is received before the next pulse is emitted (Au 1993). Echolocation clicks have the highest source levels of any recorded marine mammal sounds. While foraging, beluga whales have been known to remain in acoustic contact over distances of 300 to 500 m (Bel'kovich and Sh'ekotov 1992). It is plausible that exposure to underwater noise may disrupt social behaviour, including activities such as mating, cooperative feeding, play, aggressive interactions, and communication.

No frequency-specific studies on beluga whales in Hudson Bay were identified during the literature review. Therefore, for the purpose of this assessment, it is assumed that beluga whales in this region have similar acoustic signatures to those studied in captivity. Studies examining captive whales suggest that their hearing is most sensitive between 32–108 kHz (Klishin et al. 2000) but extends as low as 0.04–0.075 kHz, although their sensitivity at these low frequencies is considered poor (Richardson et al. 1995a).

Odontocete sounds are classified into three general categories: tonal whistles; pulsed sounds of very short duration used in echolocation; and less distinct pulsed sounds such as cries, grunts and barks (see Table 6.2-1 below) (Richardson et al. 1995a). Belugas are one of several odontocete species that produce whistle vocalizations, a characteristic of extremely social species. Echolocation frequencies are typically within the 40–60 kHz range; however, with higher ambient noise levels or more distant targets, they emit stronger pulses at 100–120 kHz (Richardson et al. 1995a).

Table 6.2-1 Frequency of Underwater Sounds Heard by Beluga Whales

Signal Type	Frequency Range (kHz)	Dominant Frequency (kHz)
Whistles	0.26–20	2–5.9
Pulsed Tones	0.4–12	1–8
Other Vocalizations	0.5–16	4.2–8.3
Echolocation	40–60, 100–120	–
SOURCE: Richardson et al. 1995a		

Seals

Generally, seal vocalizations are believed to be associated with mother-pup interactions, territoriality and mating (Richardson et al. 1995a). Underwater audiograms indicate that phocid seals are most sensitive to noise between 760 Hz and 60 kHz (Terhune and Ronald 1975). There are no reported ringed seal calls associated directly with the reproductive season, but call frequencies do change with the seasons (Richardson et al. 1995a). Ringed seal vocalizations range between 0.4–16 kHz, with the majority of frequencies below 5 kHz (Stirling et al. 1983; Richardson et al. 1995a). The hearing threshold of ringed seals is between 60 and 85 dB re 1µPa (Terhune and Ronald 1975). Source levels of ringed seal calls are between 95–130 dB re 1µPa (Richardson et al. 1995a), and those of bearded seals can reach 178 dB re 1µPa (Richardson et al. 1995a). It is a reasonable assumption that if these animals are vocalizing at these frequencies, then those frequencies constitute their minimum hearing range.

Behavioural Response Criteria

The National Marine Fisheries Service (NMFS) compiled data on underwater noise and marine mammal hearing and behavioural responses, and developed a conservative behavioural response criterion of 120 dB_{RMS} re 1 µPa for all marine mammals in the presence of continuous underwater sound sources (Federal Register 2005). This general criterion is applicable to all marine mammals, and is used to predict the area of behavioural change.

A study by Lesage et al. (1999) measured the vocal behaviour of beluga whales in the St. Lawrence in the absence and presence of a ferry and a small motorboat. It concluded that belugas are able to change the volume and spectral characteristics of signals they emit in response to noise disturbance. The whales emitted calls repetitively, changed the types of calls used, and shifted the mean call frequency during noise exposure. Similarly, dolphins have been shown to echolocate louder and change the frequency spectrum of emitted clicks in the presence of noise (Au 1993). It is unknown whether the animals manage to communicate the same information during noise exposure or whether calls heard are simply ‘‘alarm calls’’ (Erbe and Farmer 2000).

Hearing Threshold Shifts

The ability to detect predators/prey could be impaired if a beluga whale is suffering either temporary or permanent reductions in auditory sensitivity. When Permanent Threshold Shift (“PTS”) occurs, there is physical trauma to the sound receptors in the ear, which can result in total or partial deafness or in an animal not being able to hear sounds of certain frequencies (Abgrall et al. 2008). It is generally accepted that permanent hearing loss in marine mammals may occur when exposed to sounds equal to or greater than 180 dB $_{RMS}$ re 1μPa for prolonged periods (Abgrall et al. 2008). Underwater noise from marine shipping is not a source of strong, pulsed noise and is therefore unlikely to cause PTS.

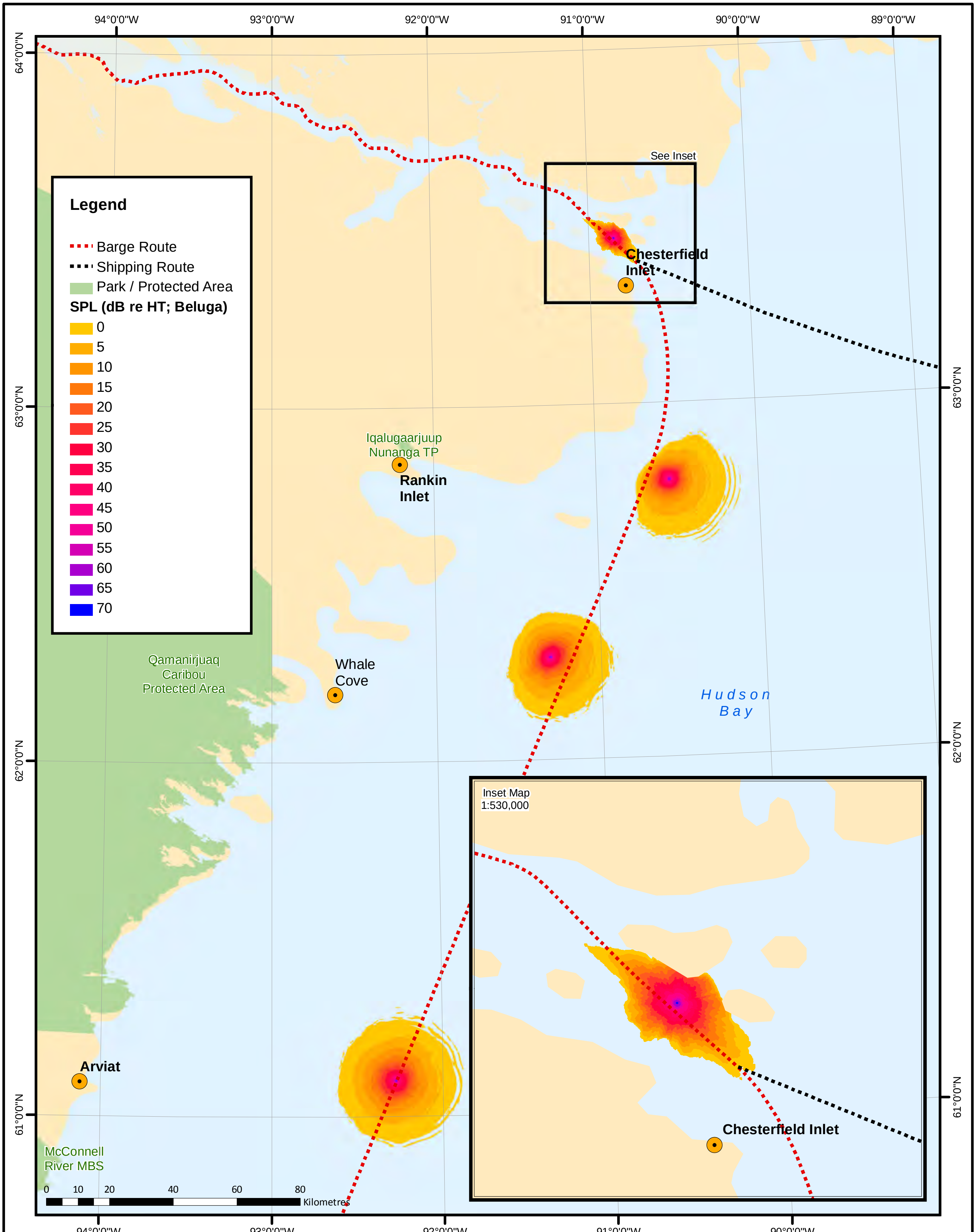
Temporary Threshold Shift (“TTS”) is the mildest form of hearing impairment that can occur during exposure to a strong sound. While experiencing TTS, the hearing threshold rises and a sound must be stronger to be heard (Abgrall et al. 2008). Under experimental conditions, sub-lethal, temporary elevations in hearing thresholds (TTS) have sometimes been observed in captive marine mammals exposed to pulsed sounds. Pulsed sounds, such as those from seismic surveys have been known to cause mild TTS (Finneran et al. 2002). The noise generated by marine shipping is well below this range and therefore unlikely to cause a hearing threshold shift (PTS or TTS). This effect will not be considered further in the assessment.

Transit through Hudson Bay

Tugs and barges may be transiting from Churchill to the mouth of Chesterfield Inlet through Hudson Bay during the open-water season (approximately 60 days during August and September). There will be a maximum of 31 ATB trips to the entrance of Chesterfield Inlet each open-water season. For the acoustic assessment, it was assumed that each tug will bring two barges from Churchill to the mouth of Chesterfield Inlet. Audiogram weighted results for beluga whale are presented in Figure 6.2-2 and for seal (based on bearded seal audiogram) are provided in Figure 6.2-3. Tables 6.2-2 and Table 6.2-3 present the underwater noise levels above hearing threshold for beluga whale and seal (based on bearded seal audiogram).

Arviat

When an ATB is transiting off Arviat, a beluga whale will begin to hear the vessel-based noise 19.2 km from the source. The sound pressure level (SPL) will be just above 0 dB re HT (hearing threshold of beluga; i.e., barely detectable) at this distance. At half that distance (9.6 km), the beluga whale will hear 10 dB re HT. At 461 m from the transiting vessel, the beluga whale will hear 60 dB re HT of sound. The ringed seal will hear the noise at 20 dB re HT (hearing threshold of ringed seal) from a distance of 28.8 km. At 141 m from the transiting vessel, the ringed seal will hear 60 dB re HT of sound.



Projection: NAD 1983 UTM Zone 15N
Creator: BA
Date: 21/09/2011 Scale: 1:1,600,000
File: 1038926.04-029
Data Sources: *Natural Resources Canada, Geobase®, Nat Topographic Database, Areva Resources Canada Inc.*

FIGURE 6.2-2
Beluga Audiogram-Weighted SPL
(Computed Frequency Band: 40 Hz - 31.5 kHz)
Contours for Tug and Barge Scenarios.

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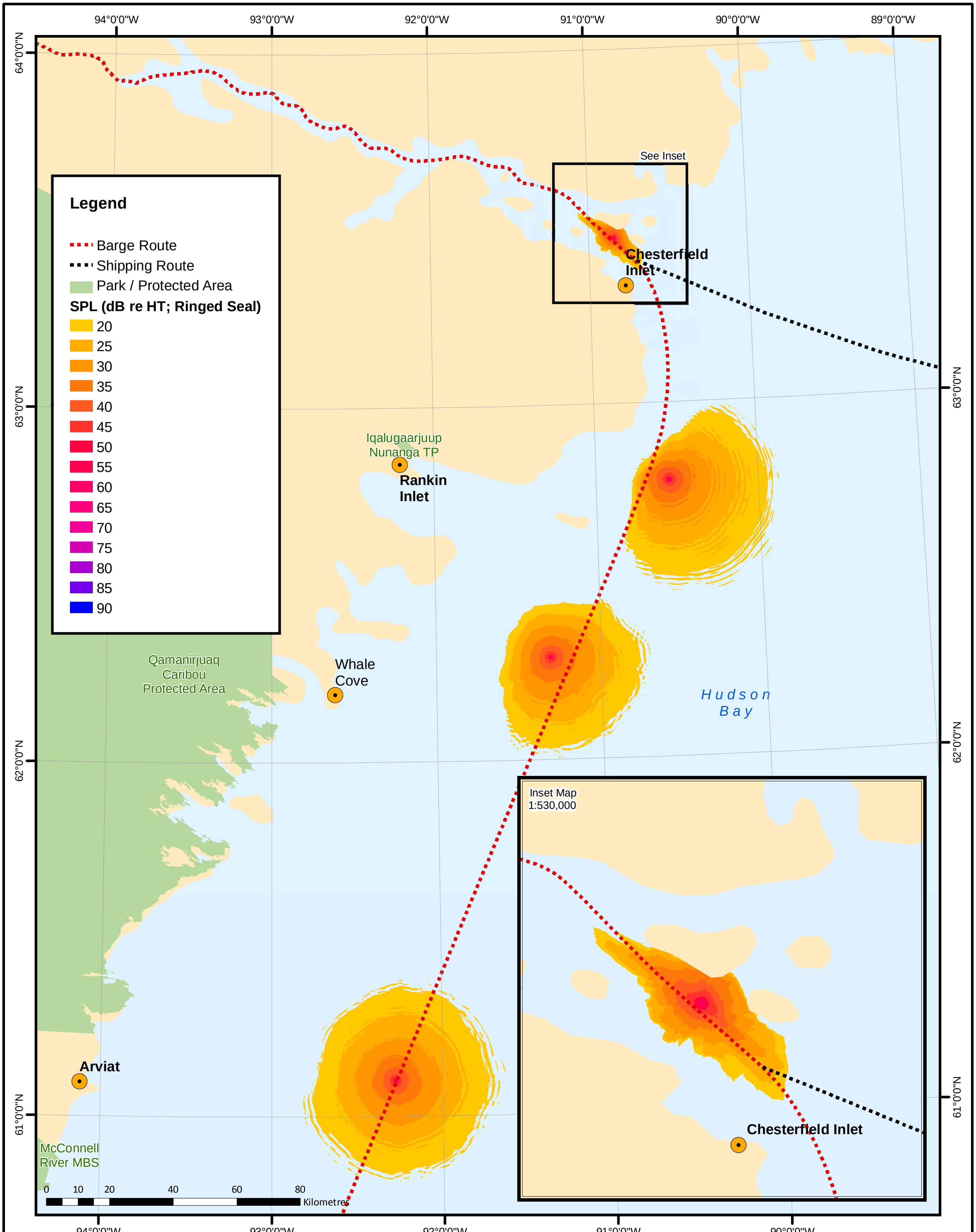

Projection: NAD 1983 UTM Zone 15N
Creator: BA
Date: 16/09/2014 Scale: 1:1,600,000
File: 1038926.04-107
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Areva Resources Canada Inc.*

FIGURE 6.2-3
Ringed Seal Audiogram-Weighted SPL (Computed Frequency Band: 80 Hz - 31.5 kHz) Contours for Tug and Barge Scenarios.

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Table 6.2-2 Underwater Noise Levels and Radii of Beluga Whale Hearing

Sound Pressure Level (dB re HT)	Scenario 1: Chesterfield Inlet R95% (km)[1]	Scenario 2: Off Rankin Inlet R95% (km)[1]	Scenario 3: Off Whale Cove R95% (km)[1]	Scenario 4: Off Arviat R95% (km)[1]
0	9.0	18.7	18.1	19.2
10	5.7	7.6	9.0	9.9
20	3.8	4.7	5.3	5.8
30	2.6	3.0	3.3	3.4
40	1.5	1.7	1.8	1.8
50	0.7	0.8	0.7	0.7
60	0.4	0.3	0.4	0.5
≥70	<0.1	<0.1	<0.1	<0.1

NOTE:
[1] The 95th percentile radius is the radius of the circle that encompasses 95% of the grid points whose value is equal or greater than the threshold value. Measured in kilometers.

Table 6.2-3 Underwater Noise Levels and Radii of Ringed Seal Hearing

SPL (dB re HT)	Scenario 1: Chesterfield Inlet R95% (km)[1]	Scenario 2: Off Rankin Inlet R95% (km)[1]	Scenario 3: Off Whale Cove R95% (km)[1]	Scenario 4: Off Arviat R95% (km)[1]
20	11.2	31.5	27.5	28.8
30	7.0	14.4	13.3	13.3
40	3.0	4.2	3.9	4.0
50	0.7	0.9	0.8	0.8
60	0.1	0.1	0.1	0.1
≥70	<0.1	<0.1	<0.1	<0.1

NOTE:
[1] The 95th percentile radius is the radius of the circle that encompasses 95% of the grid points whose value is equal or greater than the threshold value. Measured in kilometers.

Whale Cove

When the ATB is transiting off Whale Cove, a beluga whale will begin to hear the vessel-based noise 18.1 km from the source. The SPL will be just above 0 dB re HT (beluga) at this distance. At half that distance (9.0 km), the beluga whale will hear 10 dB re HT. At 424 m from the transiting vessel, the beluga whale will hear 60 dB re HT of sound. The ringed seal will hear the noise at 20 dB re HT (ringed seal) from 27.5 km distance. At 141 m from the transiting vessel, the ringed seal will hear 60 dB re HT of sound.

Rankin Inlet

When the ATB is transiting off Rankin Inlet, a beluga whale will begin to hear the vessel-based noise 18.7 km from the source. The SPL will be just above 0 dB re HT (beluga) at this distance. At about half that distance (7.7 km), the beluga whale will hear 10 dB re HT. At 320 m from the transiting vessel, the beluga whale will hear 60 dB re HT of sound. The ringed seal will hear the noise at 20 dB re HT (ringed seal) from 31.5 km distance. At 141 m from the transiting vessel, the ringed seal will hear 60 dB re HT of sound.

Transit through Chesterfield Inlet

One barge per tug will transit from the mouth of Chesterfield Inlet to the dock facility. Due to physical restrictions of Chesterfield Narrows (tidal height and strength of tidal currents), a conservative estimate of two cargo barges/vessels will transit per high tide through Chesterfield Narrows.

The following assumptions are made regarding transiting restrictions:

- The open-water season is assumed to be 60 days; however, annual variation in sea-ice regimes may result in the open-water season being longer or shorter.
- Navigation through Chesterfield Narrows is assumed to be at high tide slack water only.
- Navigation through Chesterfield Narrows is assumed to occur during daylight hours only.
- A total of 90 high tides corresponding with daylight hours occur in the assumed 60-day open-water window.
- Assume an average of seven days will be lost per season due to foul weather (high winds and other issues that limit visibility); 14 high tides are assumed to be lost due to weather.
- A total of 76 high tides are available to transit Chesterfield Narrows each open-water season.
- A maximum of 31 barge trips through Chesterfield Narrows will be made to the dock facility each year. This results in a total of 62 transits through Chesterfield Narrows.

Chesterfield Inlet

When the ATB is transiting through Chesterfield Inlet, a beluga whale will begin to hear the vessel-based noise 9.0 km from the source. The SPL will be just above 0 dB re HT (beluga) at this distance. At 5.7 km away, the beluga whale will hear 10 dB re HT. At 364 m from the transiting vessel, the beluga whale will hear 60 dB re HT of sound. The ringed seal will hear the noise at 20 dB re HT (ringed seal) from 11.2 km distance. At 141 m from the transiting vessel, the ringed seal will hear 60 dB re HT of sound.

Based on results from the acoustic modelling study, noise levels associated with the increase in Project-related marine vessel traffic within the marine RAA are expected to exceed the NMFS threshold for behavioural disruption (i.e., 120 dB_{RMS} re 1 µPa). SPLs above this threshold are predicted to extend for no more than 4.8 km ($R_{95\%}$) from the ATBs (Table 6.2-4). As the vessels will be moving continuously along the proposed route; noise associated with Project-related vessels will be transient at any particular location.

Table 6.2-4 Radii of Unweighted Underwater Sound Pressure Level Contours for Scenarios 1 – 4

RMS SPL (dB re: 1 µPa)	Scenario 1 (Chesterfield Inlet)		Scenario 2 (off Rankin Inlet)		Scenario 3 (off Whale Cove)		Scenario 4 (off Arviat)	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
120	5.37	4.03	5.17	4.81	5.14	4.81	4.88	4.62
130	1.63	1.35	1.64	1.56	1.39	1.33	1.24	1.20
140	0.36	0.35	0.461	0.48	0.40	0.40	0.29	0.29

SOURCES:

Results taken from Table 4 in Technical Appendix 7B. Only radii for SPL values up to 140 dB re: 1 µPa (where calculated $R_{95\%}$ distances drop to 500 m or less) are summarized here. Radii for SPLs up to 150 dB re: 1 µPa are presented in Table 8 as referenced above.

NOTES:

- SPL = Sound Pressure Level
- R_{max} is the maximum distance (in km) from the source to the given noise threshold in any direction (equivalent to $R_{100\%}$). For cases where the ensonification to a specific level is discontinuous and small pockets of higher received levels occur far beyond the main ensonified volume (*e.g.,* due to convergence of sound rays), R_{max} would be much larger than $R_{95\%}$ and could therefore be misleading if not given alongside $R_{95\%}$.
- $R_{95\%}$ is the radius of a circle that encompasses 95% of the grid points whose value is equal to or greater than the threshold value. For a given threshold level, this radius always provides a range beyond which no more than 5% of a uniformly distributed population would be exposed to sound at or above that level, regardless of the geometrical shape of the noise footprint. Distances to various SPL thresholds discussed in this assessment will always refer to the $R_{95\%}$ values.

Given that vessels will follow designated shipping routes, many areas of the Marine RAA will not be exposed to Project-related SPLs sufficient to cause sensory disturbance (i.e., portions of the Marine RAA further than 4.8 km from the vessel). However, marine mammals may be able to detect Project-related vessel traffic noise for up to 29 km from the source (Tables 6.2-2 and 6.2-3). SPLs below NMFS behavioural disruption threshold may still reduce an animal's communication space (*i.e.,* the predicted area over which they can communicate (Clark *et al.* 2009); or cause physiological stress responses (Rolland *et al.* 2012).

It is not possible to quantify how much time an individual or population of marine mammals may be exposed to noise resulting specifically from the increase in Project-related vessels, as both the vessels and marine mammals are in a near constant state of motion, and at any one time, their occurrence may or may not overlap. However, some general predictions regarding time of exposure can be made. Under a hypothetical scenario, a stationary marine mammal in proximity to the shipping route during a single Project-related vessel pass could be exposed to sensory disturbance for up to 24 minutes (see Table 6.2-5). Most studies report that marine mammal behaviour returns to normal after sound production ceases (Richardson *et al.* 1995a, Southall *et al.* 2007). It is therefore expected that the time between vessel transits (i.e., an estimated 2 days to 15 days, see Tier 3, Technical Appendix 2J) would allow marine mammals to recover from the sensory disturbance before the next transit of a Project-related vessel. Given that beluga whales are migrating through the marine RAA, it is unlikely that the same animal would be exposed to underwater noise from Project-related vessels more than once in any given year.

Table 6.2-5 Length of Exposure to Sound Levels Capable of causing Sensory Disturbance to a Stationary Whale for Scenarios 1 – 4

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Length of Exposure (in minutes) of a Stationary Marine Mammal to SPLs Exceeding Sensory Disturbance Thresholds (i.e., > 120 dB re: 1 µPa)	20	24	24	23

SOURCES:

Calculated based on values presented in Table 6.2-4, assuming a single transit of Project-related vessels travelling at 13 knots, passing a stationary marine mammal in close proximity to the shipping lane, and exposed to SPLs > 120 dB re: 1 µPa both before and after the passing of the vessel (*i.e.,* two times the R95% distance).

NOTES:

SPL = Sound Pressure Level

6.2.2.4 Mitigation Measures and Project Design for Change in Behaviour

The following mitigation measures will be employed to reduce the potential for behavioural changes such as avoidance of underwater noise and changes in migration routes or herding due to vessel presence.

- Marine mammal observers (MMO) from local communities will be onboard vessels travelling through the LAA.
- In consultation with the local MMO, standard operating protocols (to be developed with the selected shipping contractor prior to Project licensing) will be implemented by the vessel captain when individual or groupings of marine mammals are observed within specific radii of the vessel.
- Vessels will avoid unnecessary acceleration and maintain a constant course, whenever possible.
- Propellers will be routinely maintained to reduce unnecessary noise.
- Vessels will travel at a maximum speed of less than 13 knots, unless otherwise required for safe navigation. In the Churchill area, vessels will travel at a maximum speed of 8 to 10 knots during the open-water season, unless otherwise required for safe navigation.
- Vessels will use designated vessel transit routes to limit acoustical inputs to similar and predictable areas during marine transportation, unless otherwise required for safe navigation.
- Upon the advice of the onboard MMO, vessels will halt if marine mammals appear to be herded by an approaching vessel, unless conditions present a risk to vessel and human safety.

6.2.2.5 Residual Environmental Effects for Change in Behaviour

Results of the acoustic modelling indicate that beluga whales and ringed seals will be able to detect Project-related vessel traffic noise for up to 29 km from the source (Table 6.2-3) and be exposed to noise levels that may result in behavioural changes (i.e., 120 dB_{RMS} re 1 µPa or more) at distances up to 4.8 km from the transiting vessel. Individual or small groups of marine mammals that are within 4.8 km of the vessel as it is transiting may therefore exhibit a behavioural response such as avoidance or change in feeding activity.

With proposed mitigation measures in place, particularly the use of local MMOs and reduced vessel speeds, the viability of marine mammal populations in the RAA is not expected to be compromised by Project shiping activities. Overall, residual effects are expected to be moderate in magnitude, short-term in duration, sporadic, and reversible.

6.2.2.6 Determination of Significance for Change in Behaviour

Both the likelihood and severity of biological effects on marine mammals that could result from marine transportation are likely to vary with local environmental conditions (e.g., ice coverage, bottom topography, sea state), as well as the condition of the animals (e.g., breeding state, nutritional state). However, based on available information with respect to background noise levels, the frequency and number of marine vessel trips required to support the Project and the predicted magnitude of underwater noise generated by Project-related vessels, any change in behaviour of beluga whales and ringed seals due to noise disturbance is not expected to affect the long-term viability of these populations and, therefore, is considered to be not significant.

The level of confidence associated with this significance determination is moderate (Table 6.4-1). Project-related vessel source levels were not directly measured but surrogate vessels from the literature are deemed appropriate, and acoustic modeling followed standard practices. IQ indicates that disturbance to marine mammals from vessels is a concern and local community members have noted that observed changes in marine mammal use of habitat in the region may be due to the recent increase in marine vessel traffic in the region (see Section 6.1.1). Specific effects of underwater noise on marine mammals are also not fully understood. Nevertheless, assumptions used in the modeling and analysis of underwater noise provide conservative estimates of the potential zone of influence for disturbance. In addition, the recommended mitigation and follow-up strategies are conservative and, therefore, likely to reduce the potential residual effects.

6.2.2.7 Compliance and Environmental Monitoring for Change in Behaviour

AREVA will develop and implement a monitoring program to further describe i) the distribution and abundance of marine mammals in the LAA and approaches to Chesterfield Inlet and ii) augment the onboard monitoring program described below. Marine mammal surveys will be completed during the open water season prior to the start of Project shipping operations. The final design of the monitoring program will be developed in collaboration with government agencies and the Chesterfield Inlet Hunters and Trappers Organization (HTO).

Marine mammal observers (MMO) will be present onboard tugs and vessels to monitor marine activities when transiting through the LAA. Upon the advice of the onboard MMO, vessels will halt if marine mammals appear to be herded by an approaching vessel within Chesterfield Inlet, and if it is navigationally safe to do so. MMOs shall record all marine mammal sightings, near misses, and incidents of vessel collisions with marine mammals. In the absence of MMOs, any sightings or incidents shall be recorded by the maritime crew. Ship logs will record course adjustments to avoid sensitive habitat (i.e. near Coats Island), vessel speed, and speed reductions in important areas (i.e. Port of Churchill).

AREVA will share all information collected from the marine mammal monitoring program with local HTOs and government regulators. Additionally, AREVA is open to contributing this data to a larger, regulator led program to address concerns regarding potential cumulative effects in the region.

6.3 Cumulative Environmental Effects Analysis for Marine Mammals

Project-related marine transportation within the LAA and RAA will contribute anthropogenic sound and increased vessel presence into the marine environment. These sounds and vessel presence have the potential to act cumulatively with underwater noise and physical presence from existing and future vessel traffic within the LAA and RAA. Recently, a hunter reported, "*Chesterfield Inlet is already affected by barges*. *There are hardly any seals or Whale*" (EN-AR KWB [2013]). Other community members believe that *there are fewer beluga whale or other sea mammals near the community when there are ships close by, and are trying to get away from the ships* (IQ-McDonald et al. 1997).

6.3.1 Screening for Cumulative Environmental Effects

Vessels associated with the Project will increase the risk of marine mammal mortality resulting from potential collision with ships and potentially result in change in behaviour due to underwater noise, therefore residual effects are anticipated. Measures to reduce Project effects on marine mammals will partially mitigate these effects and residual effects are expected to be not significant. Project effects will likely be similar to effects from current and future marine transportation activities in the region that could interact with the Project, and will overlap in time and space. The cumulative effect of change in mortality risk and change in behaviour are assessed below.

Marine mammals in the RAA are currently exposed to low levels of disturbance from vessel traffic, including commercial vessels, supply barges, and small vessels for local use. The current shipping route through Hudson Strait provides access for resupply for a number of communities along the coast of Hudson Bay, industrial activities (e.g., Meadowbank Mine, exploration), and the import and export of goods and supplies from the Port of Churchill (which has been operating since 1931) (Port of Churchill 2012). Community re-supply involves a variety of vessel types including tankers, general cargo, container ships, and tug/barge combinations. As with community re-supply vessels, Project-related shipping will follow established shipping routes through Hudson Strait and west across northern Hudson Bay to Chesterfield Inlet or directly southwest to the Port of Churchill.

The majority of vessel traffic in the RAA is concentrated into an open-water season of 2 – 3 months. The Project Inclusion List identifies projects and activities in Nunavut that include some component of marine transportation or use (Volume 1, Appendix 1E). Current human disturbance that overlaps with the marine RAA that could contribute to effects on marine mammals in the RAA include:

- Meadowbank Mine — The currently operating mine is expected to close in 2017, at which time, marine transportation associated with the mine would be substantially reduced, and only limited marine transportation would be required for decommissioning of the project. Operations at the Kiggavik Mine are not expected to begin until after 2017 which means that there will be minimal temporal overlap in operational marine transportation of the two projects.
- Baffinland Mary River Project— During operations, vessels will be transporting ore to market using shipping routes originating out of Milne Inlet or Steensby Inlet on Baffin Island. It is estimated that 10 to 12 ore carriers may complete up to 102 round trips per year (year-round shipping)(NIRB 2012). Vessels using the Steensby Inlet port will be transiting through Hudson Strait.
- Meliadine Gold Project - The proposed project is currently undergoing review by NIRB. If the project is approved and developed, it is expected that 8 – 12 vessels will be used to deliver dry goods and diesel fuel to Rankin Inlet each year during the open water season. The majority of the shipping will be from Eastern Canada, through Hudson Strait.
- Local Communities — The communities of Coral Harbour, Cape Dorset, Repulse Bay, Sanikiluaq, Arviat, Whale Cove, Rankin Inlet, Chesterfield Inlet and Baker Lake all receive annual sealift deliveries via marine barging during the open water season. Each community receives one to two sealift deliveries each year. In addition, vessels are used both recreationally and for traditional harvest of marine resources throughout the open water season in the region.

Although there will only be limited temporal overlap with marine transportation activities associated with the Meadowbank mine,a the cumulative effects assessment for marine mammals takes a conservative approach and considers marine transportation activities associated with the Meadowbank Project. The assessment also considers vessel activity associated with the Baffinland Mary River Project, Meliadine Gold Project, and commercial and recreational vessel traffic associated with local communities.

6.3.2 Assessment of Cumulative Effects: Changes in Mortality Risk

Project-related marine transportation will contribute to increased vessel presence in Hudson Bay, Hudson Strait, and Chesterfield Inlet. All vessels operating within the RAA have the potential to strike marine mammals. Residual effects of change in mortality risk resulting from the Project are expected to be of low magnitude and not significant; however, when acting cumulatively with other marine transportation activities in the marine RAA, marine mammal populations in the region could potentially be affected.

6.3.2.1 Effects Mechanisms and Linkages for Cumulative Changes in Mortality Risk

As described in Section 6.2.1.4 and Section 6.2.2.3, marine transportation for the Project is estimated at a maximum of 31 barge trips (return) through Chesterfield Inlet during the open-water season. Vessels will follow specific mitigation measures, including reduced speeds to minimize risk of vessel-marine mammal collisions. Although the likelihood of vessel-marine mammal collision is low, operation of the ATBs has the potential to cause non-lethal injury and trauma, and possible mortality of individuals. The risk of mortality resulting from vessel activity associated with other marine activities in the region is expected to be similarly low, although other vessels do not currently reduce speeds to minimize the risk of injury or fatal strikes.

The assessment of effects on marine mammals for the Baffinland Mary River Project determined that mortality of marine mammals due to vessel collisions was not expected and effects were determined to be not significant (Knight Piésold Consulting 2012). The assessment of effects on marine mammals for the Meliadine Gold Project determined that the risk of injury or direct mortality of marine mammals due to vessel collision was possible but determined to be not significant (Golder Associates 2014).

6.3.2.2 Mitigation Measures for Cumulative Changes in Mortality Risk

AREVA has proposed reduced speeds as well as the use of Marine Mammal Observers from local communities to minimize risks of injury and fatal vessel-marine mammal collisions (Section 6.2.1.3). As appropriate, other projects could apply the same suite of mitigation measures in sensitive areas for marine mammals that are transited by vessels associated with their projects.

6.3.2.3 Residual Cumulative Changes in Mortality Risk

Few marine activities and projects are expected to overlap temporally with the Marine RAA. As described in Section 6.2.1, increased mortality risk in marine mammals as a result of Project-related marine transportation will be sufficiently low to reasonably conclude that its contribution to the cumulative environmental effects with other existing and future projects will not affect the viability of marine mammal populations.

6.3.2.4 Determination of Significance for Cumulative Changes in Mortality Risk

Marine transportation activities associated with the Meadowbank mine and resupply of regional communities are currently the greatest sources of increased mortality risk for marine mammals. Once the Baffinland Mary River project begins operations, and if the Meliadine Mine is approved and developed, vessel activity in Hudson Strait will overlap with vessel activity associated with the Kiggavik project. The addition of the Kiggavik Project to these disturbances is not expected to measurably increase mortality risk for marine mammals. The predicted magnitude for cumulative changes in mortality risk for marine mammals is rated as low because there are few marine activities in the region that will overlap temporally and spatially with the Kiggavik Project. The cumulative change to mortality risk for marine mammals as a result of the Kiggavik Project is therefore assessed as not significant. Confidence in this prediction is high because effects of the Project on marine mammals will be limited to the RAA and will not affect the viability of marine mammal populations. Mitigation measures proposed by AREVA will also minimize risk of mortality to marine mammals.

6.3.2.5 Compliance and Environmental Monitoring for Cumulative Change in Mortality Risk

Compliance and environmental monitoring for cumulative changes in mortality risk are the same as those presented for the Assessment Case in Section 6.2.1.6.

6.3.3 Assessment of Cumulative Effects: Change in Behaviour

Noise from shipping is likely to act cumulatively with existing and proposed projects during construction, operations, and decommissioning. This is expected to increase the spatial and temporal extent of behavioural effects. The zone of behavioural avoidance will vary depending on the species, the source level and the frequency of activity for each project, and the degree of overlap with zones of ensonification from other projects.

6.3.3.1 Effects Mechanisms and Linkages for Cumulative Change in Behaviour

Transiting vessels associated with the Project are expected to result in a temporary increase in underwater noise at a given location, resulting in potential behavioural effects for less than half an hour with the passing of each individual vessel. However, cumulatively, an increase in traffic levels could increase the duration over which portions of the RAA are ensonified, potentially causing longer term avoidance of high traffic areas by marine mammals. Masking could also occur as a result of cumulative increases in traffic, potentially affecting the ability of marine mammals to find prey or communicate. Effects are expected to overlap spatially and temporally with vessel traffic associated with the Baffinland Mary River Project (in Hudson Strait), Meliadine Gold Project (in Hudson Strait and Hudson Bay), Meadowbank Mine (Chesterfield Inlet, Hudson Bay, and Hudson Strait) and existing local vessel traffic (in Chesterfield Inlet), which could act cumulatively to affect behaviour over larger areas and for longer durations.

6.3.3.2 Mitigation Measures for Cumulative Change in Behaviour

AREVA has proposed to reduce vessel speed (which reduces underwater noise levels), as well other mitigation measures to reduce underwater noise from project vessels (see Section 6.2.2.4), and minimize the associated change in behaviour of marine mammals. As appropriate, other projects could apply the same suite of mitigation measures in sensitive areas for marine mammals that are transited by vessels associated with their projects.

6.3.3.3 Residual Cumulative Change in Behaviour

Marine transportation activities associated with the Meadowbank mine and resupply of regional communities are currently the greatest sources of underwater noise disturbance for marine mammals. Once the Baffinland Mary River project begins operations, and if the Meliadine Mine is approved and developed, vessel activity in Hudson Strait will overlap with vessel activity associated with the Kiggavik Project. The addition of the Kiggavik Project to these disturbances may increase the duration and spatial extent to which marine mammals are exposed to underwater noise levels that could result in behavioural disturbance. However, it is expected that individual animals would be exposed to noise levels predicted to cause a behavioural change for only a short period of time (i.e., less than 30 minutes) and that they would recover to normal behaviour shortly (i.e., within minutes) after these noise levels cease. Most animals (e.g., beluga whales) are likely to be migrating through the area and are unlikely to encounter similar disturbances from vessels more than 1 - 2 times per year.

Few activities and projects are expected to overlap temporally with the Project in the Marine RAA. As described in Section 6.2.2, change in behaviour in marine mammals as a result of Project-related marine transportation will be sufficiently low to reasonably conclude that its contribution to the cumulative environmental effects with other existing and future projects will not affect the viability of marine mammal populations. Mitigation measures proposed by AREVA will also minimize underwater noise and associated effects on marine mammal behaviour.

6.3.3.4 Determination of Significance for Cumulative Change in Behaviour

The predicted magnitude for cumulative changes in behaviour for marine mammals is rated as low because there are few marine activities in the region that will overlap temporally and spatially with the Kiggavik Project, and it is unlikely that any one animal would be subject to underwater noise disturbance for a sustained period of time. The cumulative change in behaviour for marine mammals as a result of the Kiggavik Project is therefore assessed as not significant. Confidence in this prediction is high because effects of the Project on marine mammals will be limited to the RAA and will not affect the viability of marine mammal populations.

6.3.3.5 Compliance and Environmental Monitoring for Cumulative Change in Behaviour

Compliance and environmental monitoring for cumulative changes in behaviour are the same as those presented for the Project Case in Section 6.2.2.7.

6.3.4 Summary of Residual Cumulative Environmental Effects on Marine Mammals

The Project is expected to contribute to cumulative effects including change in mortality risk and change in behaviour for marine mammals. However, these effects are not expected to affect population viability of any species, given the large geographic ranges of those species likely to be affected, the overlap of shipping routes with those ranges, and the short duration that individuals of a population are likely to be affected. Therefore, the Project's contribution to the cumulative effect of change in mortality risk and change in behaviour of marine mammals is predicted to be not significant.

6.4 Summary of Residual Environmental Effects on Marine Mammals

6.4.1 Project Effects

Potential environmental effects on marine mammals associated with the Kiggavik Project relate primarily to the presence of marine shipping vessels and associated risk of vessel-mammal collision and underwater noise. Given the availability of accepted mitigation measures and best practices (e.g., vessel speed restrictions and avoidance of sensitive habitat by vessels), meaningful or measurable environmental effects on marine mammal populations are not likely to occur (Table 6.4-1).

Table 6.4-1 Summary of Project Residual Environmental Effects: Marine Mammals

Project Phase	Mitigation/ Compensation Measures	Residual Environmental Effect (Y/N)	Direction	Residual Environmental Effects Characteristics						Significance	Likelihood	Prediction Confidence	Recommended Follow-up and Monitoring
				Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context				
Change in Mortality: Project-related shipping has the potential to collide with marine mammals													
Construction:	See section 6.2.1.3 for a complete list	Y	A	L	S	ST	R	R	U	N	N/A	H	• MMOs on board vessels in the LAA • Record all incidents of vessel-mammal collisions
Operation:	See section 6.2.1.3 for a complete list	Y	A	L	S	ST	R	R	U				
Final Closure: Decommissioning and Abandonment	See section 6.2.1.3 for a complete list	Y	A	L	S	ST	R	R	U				
Residual environmental effects for all phases		Y	A	L	S	ST	R	R	U				
Change in Behaviour: Project-related underwater noise due to shipping has the potential to change behaviour of marine mammals													
Construction	See section 6.2.2.4 for a complete list	Y	A	M	R	ST	S	R	U	N	N/A	M	• MMOs on board vessels in the LAA • Monitoring program in the LAA
Operation:	See section 6.2.2.4 for a complete list	Y	A	M	R	ST	S	R	U				
Final Closure: Decommissioning	See section 6.2.2.4 for a complete list	Y	A	M	R	ST	S	R	U				
Residual environmental effects for all phases		Y	A	M	R	ST	S	R	U				

KEY

Direction:
P Positive
A Adverse

Magnitude:
Use quantitative measure; or
L Low: effect is within the range of natural variance or less than reference criteria
M Moderate: effect is at or slightly above the range of natural variation or reference criteria
H High: effect exceeds upper limit of natural variation or reference criteria

Geographic Extent:
Use quantitative measure; or
S Site-specific: effect is limited to the Project footprint
L Local: effect is limited to the Local Assessment Area (LAA)
R Regional: effect is limited to the Regional Assessment Area (RAA)

Duration:
Use quantitative measure; or
ST Short term: Hours to days
MT Medium term: Months
LT Long term: Years
P Permanent: permanent

Frequency:
Use quantitative measure; or
O Occurs once.
S Occurs sporadically at irregular intervals.
R Occurs on a regular basis and at regular intervals.
C Continuous.

Reversibility:
R Reversible
I Irreversible

Environmental Context:
U Undisturbed: Area relatively or not adversely affected by human activity
D Developed: Area has been substantially previously disturbed by human development or human development is still present

N/A Not Applicable

Significance:
S Significant
N Not Significant

Prediction Confidence:
Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation
L Low level of confidence
M Moderate level of confidence
H High level of confidence

Likelihood:
Of a significant effect occurring
N/A not applicable
L Low probability of occurrence
M Medium probability of occurrence
H High probability of occurrence

6.4.2 Cumulative Environmental Effects

Cumulative effects on the risk of mortality due to vessel-mammal collisions are expected to be low in magnitude, due to potential increases in injury and risk of mortality to marine mammals caused by overlap in marine transportation activities with other reasonably foreseeable projects. This is not expected to have an effect on population viability and is therefore predicted to be not significant.

Marine transportation activities will act cumulatively with other projects, increasing the spatial and temporal extent over which marine mammal behaviour could be affected. Marine mammals could experience behavioural effects over larger areas and for longer periods of time as a result of concurrent marine transportation activities. These effects are not expected to affect population viability due to the large area of available habitat and are therefore predicted to be not significant.

6.4.3 Effects of Climate Change on the Project

Climate change is expected to result in warming temperatures, and a corresponding increase in sea levels from increased melting of snow and ice (IPCC 2007). Tier 3, Technical Appendix 5K explored 23 climate change ensembles, which reflect different combinations of models and emission scenarios. Most models predict an increase in temperature throughout the year, however the magnitude of the warming in the winter is highest. The models output an average predicted change in temperature of 4.7 °C from model baseline conditions. This warming is highest in winter, with December temeratures predicted to warm by an average 8.4 °C (Technical Appendix 5K). This is consistent with IQ from the Nunavut Climate Change Centre and the Arctic Climate Impact Assessment Report (ACIAR 2005). Local Arviat Hunters and Trappers have also noted that temperatures are warmer and ice formation is affected (EN-AR HTO November 2010[77]). With increased melting, it is reasonable to anticipate a longer open-water season along the shipping route in the RAA over the long term. Environment Canada Canadian Ice Service provides Seasonal Summary reports for North American Arctic Waters (EC 2014). Spring and summer ice conditions are compiled annually that provide an indication of the average open water season in Chesterfield Inlet over the past ten years. In 2011, the lowest ice coverage over Canadian Arctic waters since 1968 was observed. The conclusion drawn from these reports is that an extended operating season from mid-July to mid-October is likely to occur in future years. The expected number of vessels required for the Project are determined based on what is needed to supply construction, operation and decommissioning activities of the proposed mine. This frequency is not expected to increase over the life of the Project. If the open-water season were extended, this would increase the window of opportunity for vessels to transport fuel and goods to the dock facility, which could reduce the net

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[77]EN-AR HTO November 2010: *About the winter road and global warming. There used to be ice on the bay by now but it is not frozen yet. The change is noticeable*.

frequency of transiting vessels in the RAA and, in turn, would reduce the frequency of exposure of marine mammals to transiting vessels.

6.5 Transboundary Effects

Effects of underwater noise, surface noise and other sensory stimuli on marine biota are predicted to be transitory and of short duration (i.e., during the passing of a vessel, an animal in a single location will only be subject to the stimuli for less than 30 minutes), and restricted to a radius within less that 4.8 km from the vessel. Injury and mortality resulting from vessel-mammal collisions is expected to be rare and would not affect the viability of any marine mammal population. As discussed above, effects and cumulative effects on marine mammals are predicted to be not significant. In addition, AREVA has committed to mitigation measures that are proven and effective (i.e., route selection, reduced vessel speeds in Chesterfield Inlet and the Port of Churchill, onboard marine mammal observers).

It is recognized that shipping traffic is increasing in the Eastern Arctic, particularly in areas such as Hudson Strait. Existing vessel traffic associated with the Port of Churchill, community resupply in Nunavut, Manitoba and Quebec, and mining projects such as the Meadowbank Mine already use Hudson Strait as the main shipping route into and out of Hudson Bay. Proposed projects such as this Project, the Baffinland Mine, and the Meliadine Mine will further increase vessel traffic in Hudson Strait. To address potential conflicts between shipping traffic and environmentally sensitive areas, particularly for marine mammals, AREVA is prepared to work with federal agencies, Nunavut, shipping companies and other marine transportation users to identify preferred shipping routes and seasonal timing constraints to minimize shipping effects onenvironmentally sensitive areas. Implementation of mitigative measures such as vessel speed reductions may also be effective in reducing the potential for vessel – marine mammal interactions, as well as reducing underwater noise.

6.6 General Mitigation Measures for Marine Mammals

As described in Section 6.2.1.4 and Section 6.2.2.4, local marine mammal observers (MMO) will be present onboard tugs and vessels to monitor and record marine activity when transiting through the LAA.

Mitigation measures to reduce the likelihood of vessel-mammal collision are summarized as follows:

- The area surrounding Churchill is important beluga whale habitat, and there are known concentrations of animals in this area during the open-water shipping season. To reduce chances of a vessel collision, vessels will travel at a maximum speed of 8 to 10 knots when transiting this area at all times during the open-water season, unless otherwise required for safe navigation.

- Vessel speeds will not exceed 13 knots along established shipping routes in western Hudson Bay and Hudson Strait.
- Vessels will avoid unnecessary acceleration and maintain a constant course, whenever possible.
- Upon the advice of the onboard MMO, vessels will halt if marine mammals appear to be herded by an approaching vessel within Chesterfield Inlet, unless conditions present a risk to vessel and human safety.

Mitigation measures will be applied to reduce behavioural changes such as avoidance of underwater noise and changes in migration routes or herding due to vessel presence. The following mitigation measures will be applied:

- Operating protocols, such as reduction in vessel speed, to be implemented by the vessel captain in consultation with the MMO when individual or groupings of marine mammals are observed within specific radii of the vessel (to be developed with the shipping contractor at the time of Project licensing).
- Avoidance of unnecessary acceleration and routine maintenance of propellers.
- Vessel speed restrictions of less than 13 knots in the RAA, unless otherwise required for safe navigation.
- Using designated vessel transit routes, taking into account navigational safety, so that acoustical inputs are limited to similar and predictable areas during marine transportation.
- Maintaining a constant course whenever possible.
- Halting of vessels if marine mammals appear to be inadvertently herded by an approaching vessel, and it is navigationally safe to do so.

6.6.1 Mitigation by AREVA and Others

AREVA is prepared to cooperate with other future project operators, participating Inuit communities in the Nunavut Settlement Area (NSA) (Baker Lake, Repulse Bay, Coral Harbour, Chesterfield Inlet, Arviat, Whale Cove and Rankin Inlet), government and other stakeholders to minimize environmental effects of vessel presence and increased mortality risk due to vessel collision with marine mammals.

6.7 Compliance and Environmental Monitoring for Marine Mammals

AREVA will develop and implement a monitoring program to further describe i) the distribution and abundance of marine mammals in the LAA and approaches to Chesterfield Inlet and ii) augment the onboard monitoring program described below. Marine mammal surveys will be completed during the open water season prior to the start of Project shipping operations. The final design of the monitoring program will be developed in collaboration with government agencies and the Chesterfield Inlet HTO.

Marine mammal observers (MMO) will be present onboard tugs and vessels to monitor marine activities when transiting through the LAA. Upon the advice of the onboard MMO, vessels will halt if marine mammals appear to be herded by an approaching vessel within Chesterfield Inlet and it is navigationally safe to do so. MMOs shall record all incidents of marine mammal sightings, near-misses, and vessel collisions with marine mammals. In the absence of MMOs, all sightings and incidents shall be recorded by the maritime crew. Ship logs will record course adjustments to avoid sensitive habitat (i.e. near Coats Island), vessel speed, and speed reductions in important areas (i.e. Port of Churchill).

AREVA will share all information collected from the marine mammal monitoring program with local HTOs and government regulators. Additionally, AREVA is open to contributing this data to a larger, regulator led program to address concerns regarding potential cumulative effects in the region.

7 Environmental Effects Assessment for Marine Fish

7.1 Scope of the Assessment for Marine Fish

Marine fish contribute to overall ecosystem health in the RAA and provide social, cultural and economic benefits to the coastal communities. In particular, Arctic cod (*Boreogadus saida*), Arctic sculpin (*Myoxocephalus scorpioides*), Arctic char (*Salvelinus alpines*), fourhorn sculpin (*Triglopsis quadricornis*), banded gunnel (*Pholis fasciata*), and whitefish (*Coregonus nasus*) are important to the communities and the ecosystem in the Project assessment area. Potential environmental effects of the Project on fish populations are identified in Table 7.1-1.

Table 7.1-1 Potential Environmental Effects on Marine Fish

Project Activities/Physical Works	Potential Environmental Effects Change in Behaviour
Construction: Transport fuel and construction materials (transfers, barging)	✓
Operations: Marine transportation: loading barges, barging, off-loading (fuel, reagents and supplies), Baker Lake and Churchill/Chesterfield, back-haul	✓
Final Closure: Decommissioning Marine transportation: fuel and construction materials (transfers, barging)	✓
NOTE: See definitions of rankings in section 4.3.1 Check marks indicate potential effects ranked as 2 in Table 4.3-1	

7.1.1 Key Issues for Marine Fish

Key issues concerning Project-related marine transportation on marine fish relate predominantly to underwater noise and its potential to physically harm, disrupt, and/or displace fish from habitat in Hudson Bay and Chesterfield Inlet.

IQ comments support these key issues and extend to include concerns regarding disruption of marine fishing, which occurs at fish camps along Chesterfield Inlet. Arctic char are an important species, both commercially and traditionally.

Traditional fishing camps:

- *One of the Elders said there are not many fish anymore, and she hardly gets enough for her own use. Others said that they no longer make much money selling fish to the fish processing plant (IQ-WCE [2009]).*
- *Arctic char run from the middle to the end of August, and spawn later in October, after the ice forms (IQ-BL01 [2008]).*
- *Arctic char used to be fished heavily year-round near the community of Repulse Bay, and were also caught in the rivers adjacent to Ross Bay (Riewe [1992]).*
- *People from Rankin Inlet have fished as far north as Barbour Bay and Chesterfield Inlet (IQ-Riewe 1992).*
- *The coastal areas and the inland area north of Chesterfield Inlet is an important fishing area for both Baker Lake and Chesterfield Inlet residents. In particular, fishing would occur on the Connery and Lorillard rivers during the spring and fall Arctic char runs, and summer gill netting would occur along the coast (IQ-Riewe [1992]).*
- *During the winter months along the coastal area, fishing supplemented trapping and caribou hunting. After the spring break-up of ice, the shore area is heavily fished for Arctic char and trout (IQ-Riewe 1992).*
- *During the summer, residents fished with nets in salt water, especially in Rankin Inlet (IQ-Freeman [1976]).*
- *Coastal fishing south of Rankin is also conducted, but the offshore fishing is heavier for Arctic char and trout after the ice break-up (IQ-Riewe [1992]).*

Commercial fishing:

- *Some commercial fishing occurs. The Hunters and Trappers Organization (HTO) hired two men to fish for the Rankin fish plant, which only wants char (IQ-RBH [2011]).*
- *Arctic char are often sold to the fish processing plant in Rankin Inlet, and hunters said this is one of the few ways to earn an income (IQ-CIHT [2009]).*

While it is possible that individual fish might be physically injured or die as a result of collisions with Project-related vessels, it is expected that almost all fish will move away from an approaching vessel in response to the physical presence and noise from the vessel; therefore, this interaction is not considered further in this assessment.

The assessment of environmental effects on marine fish focuses on the potential change in behaviour due to sensory disturbance.

Arctic char is used as the indicator species for assessing the environmental effects of underwater noise (Tier 3, Technical Appendix 7B) due the availability of appropriate hearing data. Results from acoustic modeling are presumed to apply broadly to fish species that use habitat in the RAA.

7.1.2 Standards or Thresholds for Determining Significance

An environmental effect on marine fish is considered to be significant if it alters habitat within the RAA either physically, chemically or biologically, in quality or extent, in such a way as to cause a change or decline in the ecological function of that habitat, or a change or decline in the distribution or abundance of a fish population that is dependent upon that habitat, such that natural recruitment will not re-establish the population to its original level within one generation.

An environmental effect is considered not significant if it affects a population or specific group of individuals in a localized area over a short period of time (one generation) in a manner similar to natural variation and that has no measurable effect on the integrity of the population as a whole.

7.2 Environmental Effects Assessment for Marine Fish

Project-related shipping has the potential to affect marine fish from underwater noise associated with vessel movement.

7.2.1 Assessment of Changes in Behaviour due to Marine Shipping

Key environmental effects on marine fish relate to underwater noise from marine vessels transporting fuel and cargo to AREVA's Baker Lake dock facility. Noise disturbance could change behaviour and cause fish to temporarily move away from suitable habitat (displacement) or change their natural movements (diversion from a migratory path).

7.2.1.1 Analytical Methods for Changes in Behaviour

The potential change in behaviour of a fish from vessel-related noise depends on how the animal interprets the sound received. An animal's sensitivity varies with frequency. A species' audiogram is the relationship between frequency and an animal's hearing threshold. If a noise is at a frequency which the animal cannot hear well (i.e., where the hearing threshold is high), it is unlikely to affect the animal's behaviour. Noise levels decrease with distance from the source due to propagation loss. A noise is no longer audible if the noise drops either below the animal's audiogram or below the ambient noise levels. A change in behaviour may not occur simply because a sound is audible. Changes in behaviour resulting from a 'disturbance' include changes in swim direction, swim speed, or movement towards or away from noise.

Acoustic modelling for the Project predicts the underwater noise signature of 4500 BHP, twin-screw, ice-class tugs for transporting barges. Because barge thrusters are not expected to be used while transiting, barges are not expected to contribute substantially to underwater noise. Modelling scenarios simulated the articulated tug and barge (ATB) transiting with two barges at 13 knots. These scenarios are used as a conservative proxy for other Project-related vessels that will be operating along the Hudson Strait route.

Four locations are modelled along the planned tug and barge transportation route, which correspond to the closest approach to each of the four local communities. Scenario one modelled the ATB transiting in Chesterfield Inlet (inside the LAA) and scenarios two to four modelled three locations in the RAA (Rankin Inlet, Whale Cove, and Arviat) (Technical Appendix 7B). Results of this modelling are presented in Section 7.2.1.3.

7.2.1.2 Baseline Conditions for Changes in Behaviour

Arctic char are the most abundant and dominant salmonid species throughout the Arctic. The anadromous char migrate out to Hudson Bay for summer feeding during the ice break-up from mid-June to early July, and migrate back upstream from mid-August to mid-September to spend the winter in fresh water (Stewart and Lockhart 2005). They spawn in late August to early October, and prefer gravel substrate with sufficiently deep water to prevent the eggs from freezing and sufficient current to keep them clean (Stewart and Lockhart 2005). Broad whitefish (*Coregonus nasus*) belongs to the second largest group of anadromous fish in the Arctic, the coregonids (Mercier et al. 1994). They are known to occur in the Chesterfield Inlet area (FishBase 2011). Migration to spawning grounds in freshwater typically occurs in late July to early August (FishBase 2011). Project-related marine transportation will overlap spatially and temporally with habitat utilized by fish populations in the RAA.

A description of the baseline conditions for the underwater ambient noise is presented in Section 6.2.2.1.

7.2.1.3 Effect Mechanism and Linkages for Changes in Behaviour

Underwater noise from marine vessels has the potential to cause a startle response, alarm response, avoidance or a lack of response due to auditory masking, and change behaviour and migration patterns. Underwater noise has the potential to harm, disrupt, and/or displace marine fish from their habitat, which in turn could reduce foraging efficiency and fecundity, and increase energy expenditure. Tugs and barges transiting through the LAA and RAA will contribute low frequency underwater sounds (conservatively 10-31.5 kHz) to the marine environment (see Section 6.2.2.3).

Research supports the fact that fish can detect noise from ships at long distances when ambient noise is low but are unlikely to move away until the noise is relatively high (i.e., when the distance is a few hundred meters) (Mitson 1995). The ability of fish to detect sound varies with species and is dependent on a number of factors, including the presence of an air bladder, structure of the internal hearing system, size of the otoliths, distance from the sound source and depth of water. Fish do not “hear” as mammals hear. Sound is interpreted by the otoliths of the inner ear, which respond to the kinetic components of the sound wave rather than the sound pressure (Mitson 1995). For fish species with a swim bladder, the organ sends the sound waves to the otolith. Because the bladder increases with the size of the fish, it has been suggested that sensitivity to sound may increase in proportion to the size of the fish (Mitson 1995). If this is the case, vessel-generated noise may cause a size-dependent reaction amongst fish.

Hearing thresholds for arctic species of fish are largely unknown. Sound pressure can cause behavioural, physiological, or mortality changes. Changes in fish behaviour, physiological effects and fatalities have the potential individually, or in combination, to cause a change in fish populations or communities. Behavioural changes have the potential to disrupt migration patterns, disrupt spawning events or cause movement away from valuable food sources, particularly if these changes occur over a critical period of time when fish have only a short window of opportunity to complete an activity.

Knowledge about the behavioural responses of fish to underwater sound are poorly understood (Popper and Hastings 2009). The intensity of the response of a fish to vessel noise depends on the species, its physiological conditions and its environment. Pelagic fish may dive deeper, while benthic fish may move laterally away from the noise source. Arctic char, which are benthopelagic have a greater flexibility for movement in a three dimensions and may move deeper and laterally. Most research has investigated the responses of captive fish to high intensity sounds from seismic air guns and pile driving (Popper et al. 2005; Popper et al. 2006). Research has shown that the intensity of a fish’s response is reduced with increased swimming depth of the fish and decreased speed of the vessel (Mitson 1995). A review of available literature on fish reaction to vessel noise supports fish behavioural responses to vessels when their hearing threshold is exceeded by 30 dB or more (Mitson 1995). While this criterion is used in the current assessment, there are uncertainties in the available research. The findings were from fish trawlers and reactions recorded on different fish species. They noted the vessel caused a reaction between 100 to 200 m and up to 400 m for noisier vessels (Mitson 1995). While localized behavioural responses may be observed, the geographic extent over which these responses occur and how individual or population-level fitness is affected have not been quantified.

Transit through Hudson Bay and Chesterfield Inlet

For details on transit routes through Hudson Bay and Chesterfield Inlet, refer to Section 6.2.2.3. The sections below describe the general modelling results of the audiogram-weighted SPL for Arctic char. Detailed results of the modelling are presented in Table 7.2-1 and in the Marine Acoustics Technical

Data Report (Tier 3, Appendix 7B. Audiogram-weighted results for Arctic char are presented in Figure 7.2-1.

Arviat

When the ATB is transiting adjacent to Arviat, an Arctic char will begin to hear the vessel-based noise 15.3 km from the source. The sound pressure level (SPL) will be just above 0 dB re HT (hearing threshold of Arctic char) at this distance. At 5.7 km, the Arctic char will hear 10 dB re HT. Based on the model, the behavioural change threshold of 30 dB re HT will be met when the fish is within 492 m of the noise source.

Whale Cove

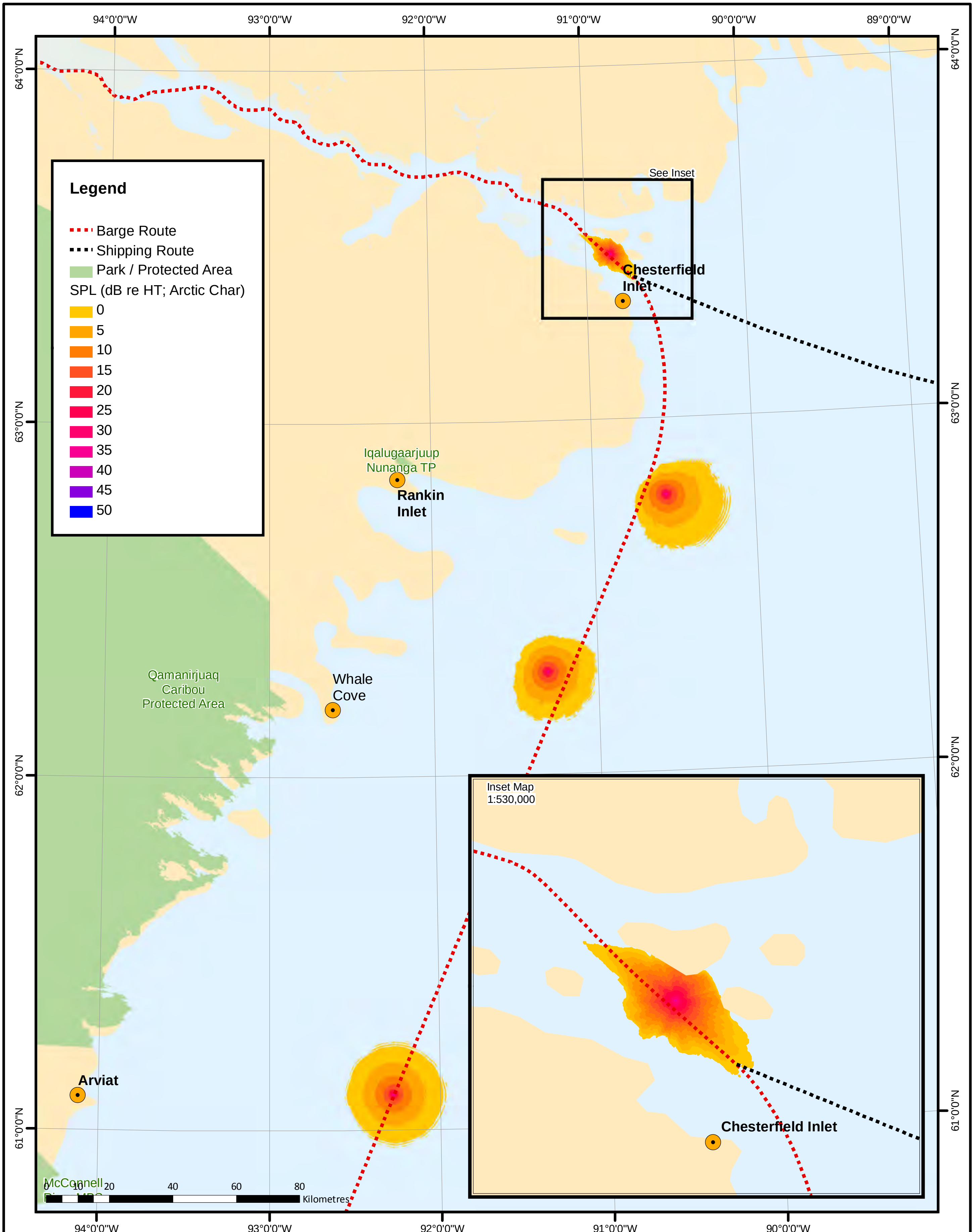
When the ATB is transiting adjacent to Whale Cove, an Arctic char will begin to hear the vessel-based noise 14.6 km from the source. The SPL will be just above 0 dB re HT (Arctic char) at this distance. At 5.6 km, the Arctic char will hear 10 dB re HT. Based on the model, the behavioural change threshold of 30 dB re HT will be met when the fish is 474 m radius from the noise source.

Rankin Inlet

When the ATB is transiting off Rankin Inlet, an Arctic char will begin to hear the vessel-based noise 18.1 km from the source. The SPL will be just above 0 dB re HT (Arctic char) at this distance. At 5.7 km, Arctic char hear 10 dB re HT. The behavioural change threshold of 30 dB re HT will be met when the fish is 500 m from the noise source.

Chesterfield Inlet

When the ATB is transiting through Chesterfield Inlet, an Arctic char will begin to hear the vessel-based noise 10.3 km from the source. The SPL will be just above 0 dB re HT (Arctic char) at this distance. At 4.6 km, the Arctic char hear 10 dB re HT. The behavioural change threshold of 30 dB re HT will be met when the fish is within a 500 m radius from the noise source.



Projection: NAD 1983 UTM Zone 15N
Creator: BA
Date: 21/09/2011 Scale: 1:1,600,000
File: 1038926.04-029
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Areva Resources Canada Inc.*

FIGURE 7.2-1
Arctic Char Audiogram-Weighted SPL
(Computed Frequency Band: 40 Hz - 31.5 kHz)
Contours for Tug and Barge Scenarios.

Volume 7 - Marine Environment

Kiggavik Project

AREVA

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Table 7.2-1 Underwater Noise Levels and Radii of Arctic Char Hearing

Sound Pressure Levels (dB re HT)	Scenario 1: Chesterfield Inlet R95% (km)[1]	Scenario 2: Off Rankin Inlet R95% (km)[1]	Scenario 3: Off Whale Cove R95% (km)[1]	Scenario 4: Off Arviat R95% (km)[1]
0	10.3	18.1	14.6	15.3
10	4.6	5.7	5.6	5.7
20	1.6	1.7	1.7	1.6
30	0.5	0.5	0.5	0.5
40	0.2	0.2	0.2	0.2
≥50	0	0	0	0

NOTE:
1 The 95th percentile radius is the radius of the circle that encompasses 95% of the grid points whose value is equal or greater than the threshold value. Measured in kilometers.

7.2.1.4 Mitigation Measures and Project Design for Changes in Behaviour

Mitigation measures to reduce changes in behaviour of marine fish due to underwater noise will be similar to those implemented to reduce environmental effects of underwater noise on marine mammals, such as speed restrictions, avoidance of unnecessary acceleration, and use of designated shipping routes (see Section 6.2.2.4 for details).

7.2.1.5 Residual Environmental Effects for Changes in Behaviour

Although underwater noise may be detectable to fish in the immediate vicinity of the vessel and is expected to occur at regular intervals throughout the open-water season, the potential for behavioural change is expected to occur within a relatively small radius from the source (less than 500m). Underwater noise disturbance will be low in magnitude, site specific, and reversible. Any changes in behaviour due to underwater noise will be brief and spatially limited, and are not expected to have an effect on fish populations in the RAA.

7.2.1.6 Determination of Significance for Changes in Behaviour

Based on available information with respect to background noise levels, the relatively low frequency and number of marine vessel trips required to support the Project, and the predicted magnitude of underwater noise generated by Project-related vessels, changes in behaviour due to underwater noise from Project-related marine transportation are predicted to be not significant.

7.2.1.7 Compliance and Environmental Monitoring for Changes in Behaviour

No environmental monitoring is recommended for marine fish.

7.3 Cumulative Environmental Effects Analysis for Marine Fish

Because all vessels operating within the RAA have the potential to result in behavioural change in fish due to sensory disturbance, vessel traffic associated with the Project may act cumulatively with existing and future vessel traffic in the RAA. As discussed in section 6.3.1, Marine biota in the RAA are currently exposed to low levels of disturbance from vessel traffic, including recreational vessels, supply barges, and commercial vessels. The current shipping route through Hudson Strait provides access for resupply for a number of communities along the coast of Hudson Bay (Nunavut, Manitoba, and Quebec), industrial activities (e.g., Meadowbank Mine, Meliadine Mine), and the import and export of goods and supplies from the Port of Churchill (which has been operating since 1931) (Port of Churchill, 2012). However, as described in Section 7.2.1, the residual environmental effect of a change in behaviour will be sufficiently low to reasonably conclude that the contribution of marine transportation to the cumulative environmental effects of other existing and future projects will not affect the viability of marine fish populations. As a result, cumulative environmental effects of change in behaviour due to marine transportation are not considered further in this assessment.

7.4 Summary of Residual Environmental Effects on Marine Fish

Potential environmental effects of the Kiggavik Project on marine fish relate to sensory disturbance caused by underwater noise of marine vessels. Given the localized nature of the effect, the low magnitude of the effect and the availability of accepted mitigation measures and best practices (e.g., vessel speed restrictions and avoidance of sensitive habitat by vessels), environmental effects on marine fish are expected to be not significant (Table 7.4-1).

Table 7.4-1 Summary of Project Residual Environmental Effects: Marine Fish

Project Phase	Mitigation/ Compensation Measures	Residual Environmental Effect (Y/N)	Direction	Residual Environmental Effects Characteristics						Significance	Likelihood	Prediction Confidence	Recommended Follow-up and Monitoring
				Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context				
Change in Behaviour: Project-related underwater noise due to shipping has the potential to change the behaviour of marine fish													
Construction:	See section 6.2.2.4 for a complete list	Y	A	L	S	ST	R	R	U	N	N/A	H	None
Operation:	See section 6.2.2.4 for a complete list	Y	A	L	S	ST	R	R	U				
Final Closure: Decommissioning	See section 6.2.2.4 for a complete list	Y	A	L	S	ST	R	R	U				
Residual environmental effects for all phases		Y	A	L	S	ST	R	R	U				

KEY

Direction:
P Positive
A Adverse

Magnitude:
Use quantitative measure; or
L Low: effect is within the range of natural variance or less than reference criteria
M Moderate: effect is at or slightly above the range of natural variation or reference criteria
H High: effect exceeds upper limit of natural variation or reference criteria

Geographic Extent:
Use quantitative measure; or
S Site-specific: effect is limited to the Project footprint
L Local: effect is limited to the Local Assessment Area (LAA)
R Regional: effect is limited to the Regional Assessment Area (RAA)

Duration:
Use quantitative measure; or
ST Short term: Hours to days
MT Medium term: Months
LT Long term: Years
P Permanent: permanent

Frequency:
Use quantitative measure; or
O Occurs once.
S Occurs sporadically at irregular intervals.
R Occurs on a regular basis and at regular intervals.
C Continuous.

Reversibility:
R Reversible
I Irreversible

Environmental Context:
U Undisturbed: Area relatively or not adversely affected by human activity
D Developed: Area has been substantially previously disturbed by human development or human development is still present

N/A Not Applicable

Significance:
S Significant
N Not Significant

Prediction Confidence:
Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation
L Low level of confidence
M Moderate level of confidence
H High level of confidence

Likelihood:
Of a significant effect occurring
N/A Not applicable
L Low probability of occurrence
M Medium probability of occurrence
H High probability of occurrence

7.4.1 Project Residual Environmental Effects

Environmental effects on marine fish resulting from marine transportation activities are limited to change in behaviour due to underwater noise. Although acoustic modelling determined that underwater noise from transiting vessels will be audible to marine fish and may elicit a behavioural reaction, the short-term nature of the response and the low magnitude of the environmental effect will not result in any long-term or irreversible changes to the distribution or abundance of fish populations in the LAA or RAA. Environmental effects on marine fish from Project activities associated with marine transportation are expected to be not significant.

7.4.2 Residual Cumulative Environmental Effects

Marine transportation associated with the Project is not expected to contribute to cumulative environmental effects on marine fish in the LAA or RAA.

7.4.3 Effects of Climate Change on the Project

Climate change is expected to result in a longer open-water season along the shipping route in the RAA over the long term (see Section 6.4.3). If the open-water season is extended due to warming weather, this would increase the window of opportunity for vessels to transport fuel and goods to the dock facility, which could reduce the net frequency of transiting vessels in the RAA and, in turn, reduce the frequency of exposure of marine fish to transiting vessels.

7.5 Transboundary Effects

Effects of underwater noise, surface noise and other sensory stimuli on marine biota are predicted to be transitory and of short duration. As discussed above, effects and cumulative effects on marine fish are predicted to be not significant.

It is recognized that shipping traffic is increasing in the Eastern Arctic, particularly in areas such as Hudson Strait. Existing vessel traffic associated with the Port of Churchill, community resupply in Nunavut, Manitoba and Quebec, and mining projects such as the Meadowbank Mine already use Hudson Strait as the main shipping route into and out of Hudson Bay. Proposed developments such as this Project, the Baffinland Mine and the Meliadine Mine will further increase vessel traffic in Hudson Strait. To address potential conflicts between shipping traffic and environmentally sensitive areas, AREVA is prepared to work with federal agencies, Nunavut, shipping companies and other marine transportation users to identify preferred shipping routes and seasonal timing constraints to minimize shipping effects on environmentally sensitive areas. Implementation of mitigative measures such as vessel speed reductions may also be effective in reducing underwater noise.

7.6 General Mitigation Measures for Marine Fish

- Mitigation measures for change in behaviour of marine fish due to underwater noise will be similar to those noted in Section 6.6 for marine mammals. The following mitigation measures will be implemented to reduce environmental effects of underwater noise on marine fish.
- Vessels will avoid unnecessary acceleration and maintain a constant course, whenever possible.
- Propellers will be routinely maintained to reduce unnecessary noise.
- Vessels will travel at a maximum speed 13 knots, unless otherwise required for safe navigation.
- Vessels will use designated vessel transit routes to limit acoustical inputs to similar and predictable areas during marine transportation, unless otherwise required for safe navigation.

7.7 Compliance and Environmental Monitoring for Marine Fish

There are no monitoring programs recommended for marine fish.

8 Summary of Residual Environmental Effects on the Marine Environment

8.1 Project Effects

Environmental effects on the marine environment and marine wildlife populations resulting from marine transportation are expected to be low. Given the low frequency of vessel transits in the RAA and the low intensity of sensory disturbance that is expected, environmental effects on the marine environment are predicted to be not significant.

8.2 Cumulative Environmental Effects

Because all vessels operating within the RAA have the potential to result in behavioural change (marine fish and mammals) or mortality risk (marine mammals) vessel traffic associated with the Project may act cumulatively with existing and future vessel traffic in the LAA and RAA. As discussed in section 6.3.1, marine populations in the RAA are currently exposed to low levels of disturbance from vessel traffic, including commercial vessels, community supply barges, and local vessels, . However, these effects are not expected to affect the population viability of any species, given the large geographic ranges of those species likely to be affected, the limited overlap of shipping routes with these ranges, and the short duration that individuals of a population are likely to be affected. Therefore, the Project's contribution to cumulative effects on the marine environment is predicted to be not significant.

8.3 Effects of Climate Change on the Project

If the open-water season is extended due to climate change, this would increase the window of opportunity for vessels to transport fuel and goods to the Baker Lake dock facility, which could reduce the net frequency of transiting vessels in the RAA and, in turn, reduce the frequency of exposure of marine mammals and marine fish to transiting vessels.

9 Summary of Transboundary Effects for the Marine Environment

The RAA encompasses the shipping route in Hudson Bay between Churchill and Chesterfield Inlet, and the shipping route through Hudson Strait to the extent of Nunavut Territorial waters, and therefore overlaps with marine waters under territorial (Nunavut), and Federal jurisdiction. With the exception of local vessels for recreational and traditional use, most of the commercial and resupply vessels travel from southern ports, into Nunavut waters, and to specific destinations in Nunavut, Manitoba, and Quebec to deliver goods and, in some cases, pick up goods. The same vessels then return out through Nunavut waters to southern ports.

As summarized in Tier 1, Volume 1, Section 8, transboundary effects are predicted to be not significant. The presence of barges and ocean-going vessels may result in some Project residual effects on marine mammals due to vessel-mammal collisions. Further, underwater noise from marine vessel activities may cause residual effects on marine mammals and marine fish. However, these effects are not expected to result in significant adverse effects on marine populations or habitat that occurs in adjacent transboundary waters of Hudson Bay and Hudson Strait.

As discussed in section 4.3.1.2, given the timing and extent of Project-related marine vessel traffic, the distance from vessel traffic to coastal areas, and the relative size of potential foraging areas in comparison to the locations that might be disturbed by routine activities of vessel traffic, substantive effects on marine birds and their habitat are not expected to occur. The proposed shipping route has been adjusted so that vessels will remain greater than 30 km from Key Migratory Bird Habitat Sites. Significant adverse effects on marine bird populations and their habitat are not expected in the adjacent transboundary waters of Hudson Bay and Hudson Strait.

10 Summary of Mitigation Measures for the Marine Environment

Mitigation measures to reduce the likelihood of environmental effects on the marine environment and marine wildlife resulting from marine transportation activities include:

- Limiting vessel speeds in sensitive areas and confined navigation routes.
- Using best practices regarding vessel operations (avoid unnecessary acceleration, maintain a constant course, routine maintenance of propellers).
- Using designated vessel transit routes, taking into account navigational safety, so that acoustical inputs are limited to similar and predictable areas during marine transportation.
- Presence of a local MMO on board vessels travelling through Chesterfield Inlet to monitor for marine mammals during transit and implement mitigation measures to prevent inadvertent modification of animal behaviour or movement.
- Upon the advice of the onboard MMO, vessels will halt if marine mammals appear to be herded by an approaching vessel within Chesterfield Inlet, unless conditions present a risk to vessel and human safety.
- Vessels travelling along the proposed shipping route past Coats Island will remain greater than 30 km from Cape Pembroke to avoid disturbance of this key marine habitat site for migratory birds.

11 Summary of Monitoring for the Marine Environment

AREVA will develop and implement a monitoring program to further describe i) the distribution and abundance of marine mammals in the LAA and approaches to Chesterfield Inlet and ii) augment the onboard monitoring program described below. Marine mammal surveys will be completed during the open water season prior to the start of Project shipping operations. The final design of the monitoring program will be developed in collaboration with government agencies and the Chesterfield Inlet Hunters and Trappers Organization.

Marine mammal observers (MMO) will be present onboard tugs and vessels to monitor marine activities when transiting through the LAA. Upon the advice of the onboard MMO, vessels will halt if marine mammals appear to be herded by an approaching vessel within Chesterfield Inlet, and it is navigationally safe to do so. MMOs shall record all marine mammal sightings, near misses, and incidents of vessel collisions with marine mammals. In the absence of MMOs, sightings and incidents shall be recorded by the maritime crew. Ship logs will record course adjustments to avoid sensitive habitat (i.e. near Coats Island), vessel speed, and speed reductions in important areas (i.e. Port of Churchill).

AREVA will share all information collected from the marine mammal monitoring program with local HTOs and government regulators. Additionally, AREVA is open to contributing this data to a larger, regulator led program to address concerns regarding potential cumulative effects in the region.

Given that marine transportation associated with the Project is not expected to result in significant residual effects on marine fish, nor contribute to cumulative environmental effects on marine fish in the RAA, there are no monitoring programs recommended for marine fish. As discussed in section 4.3.1.2, three species of wolffish have probable ranges that overlap with the RAA and are listed on Schedule 1 of SARA. AREVA will endeavour to record and report any sightings or incidental catches of wolffish made during construction, operation, or Project associated monitoring programs conducted in the RAA in order to improve current understanding of their distribution, habitat use, and abundance.

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