APPENDIX 3-A

Marine Environment Summary

3.A-1 INTRODUCTION

Agnico Eagle Mines Limited – Meadowbank Division (Agnico Eagle) is proposing to develop Whale Tail Pit and Haul Road (Project), a satellite deposit located on the Amaruq property, to continue mine operations and milling at Meadowbank Mine. The Amaruq property is a 408 square kilometre site located on Inuit Owned Land approximately 150 kilometres (km) north of the hamlet of Baker Lake and approximately 50 km northwest of Meadowbank Mine in the Kivalliq Region of Nunavut. The deposit will be mined as an open pit (i.e., Whale Tail Pit), and ore will be hauled to the approved infrastructure at Meadowbank Mine for milling.

The Project, consisting of an extension of the Meadowbank Mine through operations of Whale Tail Pit, will transport supplies required for construction and operation on ocean freight systems to marshalling and storage facilities at Baker Lake. While not a requirement of the Cumberland Environmental Impact Statement (EIS) for the Meadowbank Mine, a description of existing marine resource conditions in the Project area, as well as an assessment of Project effects on the marine environment has been completed for the final environmental impact statement (FEIS) amendment due to IQ concerns around shipping (NIRB 2015), and the most current EIS guidelines issued for mining projects.

3.A-1.1 Purpose

This document summarizes the assessment of Project effects on marine water quality and wildlife (marine fish, marine mammals, and marine birds) and their associated habitats in the Project area. The following sections provide a summary of the existing environment, an analysis of potential Project-related effects on selected Valued Components (VCs) in the marine environment, proposed mitigation measures to minimize or avoid adverse effects, identification of residual impacts following implementation of mitigation, and a determination of significance with respect to Project impacts on marine wildlife VCs.

3.A-2 STUDY AREAS

The Local and Regional study areas (LSA and RSA) for the Marine Environment encompasses the proposed Project shipping corridor in the channel of Chesterfield Inlet, Hudson Bay, and Hudson Strait (Figure 3-A-1). The proposed shipping corridor has been broken down into the following three shipping route segments: i) eastern Hudson Strait to the mouth of Chesterfield Inlet, ii) the mouth of Chesterfield Inlet to Baker Lake via Chesterfield Narrows, and iii) the mouth of Chesterfield Inlet to the Port of Churchill (ocean-going vessel and/or tug-assisted barge).

3.A-3 VALUED COMPONENTS

While the marine environment was not identified as a VC in the FEIS (Cumberland 2005), VCs were identified to facilitate the assessment of the marine environment. Table 3-A-1 lists all VCs selected for Marine Resources and the rationale for their inclusion.

3.A-4 INCORPORATION OF INUIT QAUJIMAJATUQANGIT

The following publicly available Inuit Qaujimajatuqangit (IQ) sources relevant to the Project were reviewed for IQ specific information related to the VCs and incorporated into marine effects assessment:

- IQ studies conducted in 2015 by Golder to support the Project EIS (Volume 7, Appendix 7-A).
- IQ workshop held in the community of Chesterfield Inlet in January 2010 (Agnico Eagle 2013) and meetings with Kivalliq communities (Agnico Eagle 2014a).

- IQ studies conducted by Nanuk Enterprises in 1997-1998 and 2010-2011 in Rankin Inlet, Chesterfield Inlet, and Whale Cove (Nanuk 1999).
- IQ studies conducted by Nanuk Enterprises / Outcrop Ltd. during 2012, consisting of interviews with local hunters, fishers, tour operators, and experienced seamen representing the communities of Rankin Inlet, Chesterfield Inlet, and Whale Cove (Agnico Eagle 2014b).
- Interview conducted on 15 July 2011 by Nunami Stantec in Rankin Inlet with representatives from the Kangiqliniq Hunters and Trappers Organization (Kangiqliniq HTO 2011).
- Interviews by Higdon et al. (2013) summarising information on killer whales gathered during interviews in 11 eastern Nunavut communities (Kivalliq and Qikiqtaaluk regions) between 2007 and 2010.
- A vessel reconnaissance tour to collect IQ on traditional resource use with informal questioning of two Inuit guides conducted by Stantec in 2009 (AREVA 2014).
- Review of literature summarizing historical Traditional Resource Use in the Hudson Bay/ Hudson Strait region including the Nunavut Atlas (CCI 1992) and the Inuit Land and Occupancy Project (Freeman and Murty 1976).

Inuit Qaujimajatuqangit was used in VC selection by reviewing documented Traditional Knowledge (TK) information, consultation with local communities, concerns raised through consultation with regulators (GNDoE and NIRB), and a review of VCs identified in other Nunavut mine projects. The Project Guidelines required that special consideration be given to species of particular social, cultural and economic importance, including those for human consumption (Cumberland 2005).

Inuit Qaujimajatuqangit related to marine wildlife (marine fish, marine mammals and marine birds) in the Project area was incorporated into baseline reporting, including information on marine wildlife abundance and distribution, migration patterns, breeding areas, critical habitat features (e.g. walrus haul-out locations), harvesting patterns, and the effects of climate change on marine wildlife populations and on harvesting activities.

IQ was incorporated in the assessment by considering Project-specific questions and concerns related to marine environment and marine wildlife that were raised by local community members. Particular emphasis was placed on assessing the impacts from shipping on marine wildlife.

3.A-5 PROJECT COMPONENTS ASSESSED

Project components assessed for potential effects on VCs were limited to marine shipping activities including vessel transportation in the shipping corridor within the assessment boundaries (Hudson Bay, Hudson Strait and the channel of Chesterfield Inlet) and ship lightering activities (ship-to-ship transfer / loading).

As an extension of the Meadowbank Mine, the Project will continue to use shipping arrangements already in use for the Meadowbank Mine and will not incur a net increase in shipping volume within Hudson Bay and Hudson Strait or a change in shipping procedures. Meadowbank Mine and Whale Tail operations will rely on marine transportation (sealift) for most of their supplies including fuel, construction and operation equipment, materials and consumables, including dangerous goods, food, household goods, and other non-perishable supplies. Shipping takes place during the open water season between July and early October. The majority of dry cargo for the Meadowbank Mine is delivered to Baker Lake from Becancour, Quebec using three to six cargo shipments per year, representing a total annual cargo volume of ~60,000 m^3. Up to three cargo shipments per year also occurs between the Port of Churchill and Baker Lake. Volume of cargo is anticipated to remain consistent with current shipping requirements. Additional details are provided in Volume 1, Section 1.2.6.

3.A-6 SUMMARY OF EXISTING ENVIRONMENT

3.A-6.1 Physical Environment

Ice cover directly influences the oceanographic and ecological processes in the water column. Other factors that affect oceanographic conditions in Hudson Bay include temperature and salinity driven exchange with the Arctic Ocean, tidal exchange with the Atlantic Ocean, wind-stress during the open-water season, and large freshwater input from both runoff and ice melt. Non-tidal (residual) currents in Hudson Bay are wind-driven and density-driven which creates a general cyclonic (counter-clockwise) movement of surface water in Hudson Bay (Figure 3-A-2). The water column in Hudson Bay is characterized by a seasonal cycle in vertical salinity and temperature distribution at the surface (Figure 3-A-3) and there is a noticeable difference in oceanographic conditions between nearshore and offshore waters in Hudson Bay (Prinsenberg 1986).

Figure 3-A-4 summarizes ice freeze-up and ice break-up for Hudson Bay and Hudson Strait including the frequency of ice occurrence in late winter and late summer. In the channel of Chesterfield Inlet, maximum ice thickness was observed between April and June at between 1.6 and 2.3 metres (m) (Loucks and Smith 1989).

3.A-6.2 Biological Environment

The distribution and abundance of marine biota in Hudson Bay is largely determined by regional ice conditions, with areas of highest biological productivity associated with upwelling areas near polynyas and the edge of the sea ice. Timing of sea ice formation and ice melt influences the seasonal distribution and movement of marine mammals and marine birds including species targeted for subsistence, recreational and commercial harvesting as well as species of special concern.

At least 60 species of fish are known to occur in marine waters of Hudson Bay and at least 88 species are known to occur in Hudson Strait (Canadian Arctic Resources Committee (CARC) 1991; Coad and Reist 2004; Stewart and Lockhart 2004). An overview on the biology and distribution of fish species occurring within the proposed shipping corridor is summarized in Table 3-A-2. Southern Hudson Bay and James Bay support fish communities comprised of marine, estuarine, and freshwater species; while western and northern Hudson Bay support more deep-water species (Stewart and Lockhart 2004). Several marine and anadromous fish within the marine study areas serve as key prey species for marine mammal and bird populations in the study area, and are targeted by human populations through commercial and subsistence harvesting, including Arctic char; Arctic cod, Greenland cod, polar cod, Greenland halibut and capelin. Arctic char are of particular importance to commercial and subsistence harvests. Greenland halibut and capelin are also commercially harvested while Arctic cod, fourhorn sculpin, and capelin are also targeted for subsistence harvest. Information on the distribution of Arctic char and other important fish species (Dolly Varden, anadromous coregonids (whitefish), Pacific herring and landlocked Atlantic cod) is presented in Figure 3-A-5.

At least 11 species of marine mammals have the potential to occur within the study areas at different times throughout the year (Table 3-A-4). This includes four species of cetaceans, six species of pinnipeds and polar bears (Figure 3-A-6 to Figure 3-A-16). Atlantic walrus, bearded seal, ringed seal, and harbour seal are year-round residents in the area. The distribution of narwhal and beluga in the study area varies seasonally, with key summer habitats identified in Hudson Bay and Hudson Strait for both species. Harp seal, hooded seal and killer whale frequent the study area during the open water season. Bowhead whale mainly utilize Hudson Strait and Hudson

Bay as overwintering habitat and as a migratory corridor between winter and summer seasons. Polar bears move to offshore areas during early November, and retreat inshore to terrestrial summering areas during the ice-free season.

Currently, marine mammals in the region are mainly taken for subsistence harvest and for sport. Marine mammal harvesting is still an important part of the local Aboriginal and Inuit economy and traditional culture (Table 3-A-3). Two species of marine mammals (bowhead and polar bear) are listed under the federal *Species at Risk Act* (SARA), and six species (narwhal, beluga, bowhead, killer whale, polar bear and walrus) are conservation listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). A summary of habitat, seasonal occurrence and status of marine mammal species occurring within the Project shipping corridor is provided in Table 3-A-4 with information on species distribution presented in Figure 3-A-6 to Figure 3-A-16.

Concerns were raised through TK and IQ and expert information interviews and reports regarding changes observed in recent years related to the distribution of marine wildlife species and their habitat use within the study area. Many of these reported changes are associated with climate change, including an increased presence of killer whales in Hudson Bay / Hudson Straight due to declining summer ice, which may in turn effect on other marine mammals (i.e., their prey) (e.g., bowhead whales), as well as increased number of polar bears encountered near human residencies and garbage dumps (Higdon et al. 2013; Kangiqliniq HTO 2011; Agnico Eagle 2014b; AREVA 2014).

A number of ecologically and/or culturally important marine bird species use the study area and are presented in Table 3-A-5. Black guillemot is hunted locally for subsistence purposes. Five bird species present in the region (Ross's gull, ivory gull, red-necked phalarope, peregrine falcon, and red knot) are listed under SARA and by COSEWIC. A number of key marine habitat sites for migratory birds have been identified along the shipping route and are presented in Figure 3-A-17 and Figure 3-A-18.

Protected areas which overlap with the study area include Wapusk and Ukkusiksalik National Parks, the McConnell River Migratory Bird Sanctuary south of Arviat, and the Harry Gibbons and East Bay Migratory Bird Sanctuaries on the southeast coast of Southampton Island. The study areas also contain Ecologically and Biologically Significant Areas and Areas of High Biological Importance distributed throughout Hudson Bay and Hudson Strait (Table 3-A-6; Figure 3-A-19), Bowhead Whale Critical Habitats between Rankin Inlet and eastern Hudson Strait (Figure 3-A-20 and Figure 3-A-21), and areas identified as important habitat for marine birds (Figure 3-A-22). Notable large breeding colonies include colonies of thick-billed murre on Akpatok Island in Hudson Strait, and colonies of lesser snow goose in the McConnell River Migratory Bird Sanctuary and on the islands of Hudson Bay (Table 3-A-7).

3.A-6.3 Shipping and Navigation

The Hudson Bay / Hudson Strait area is a critical corridor for marine transport into and out of Nunavut (LOOKNorth 2014). Vessel traffic occurs mostly during the open-water season extending from July to early October (WWF 2015). Table 3-A-8 summarizes vessel traffic through Hudson Strait for each industry sector between 2007 and 2013. Table 3-A-9 provides a breakdown of vessel types present in the Project area throughout the same period.

Between 2008 and 2014, reported annual landings at Baker Lake ranged between 17 and 45 shipments per year (Agnico Eagle 2014a; Figure 3-A-23), of which only a portion were in direct support of the Meadowbank Mine; the remaining were supporting community of Baker Lake resupply. This includes tug-assisted barges transporting both goods and fuel, as well as shuttle tankers transporting fuel. Aside from barge and shuttle tanker traffic, vessel activities in the channel of Chesterfield Inlet are mainly restricted to small fishing vessels and pleasure crafts, given there is only one small public dock in this area (Aarluk 2011). The total number of annual barge trips arriving at Baker Lake from Chesterfield Inlet between 2008 and 2014 is summarized in Figure 3-A-23.

For vessels to reach Baker Lake, they are required to transit through Chesterfield Narrows, with a minimum clearing distance of 0.04 nautical mile from certain navigational hazards relative to the established safe course of passage in this area (based on high tide conditions for a vessel draught of 4.6 m). The Sailing Directions for Hudson Strait, Hudson Bay and Adjoining Waters indicate that Chesterfield Narrows, and the area east of it, is suitable only for daytime navigation in good visibility due to strong currents. While most shipments through the channel of Chesterfield Inlet are made during daylight, some passages are made during darkness, particularly near the end of the season, when there are fewer daylight hours. Because the transit through Chesterfield Narrows must take place during a 30 to 60-minute window, which occurs about every 12 hours at high water slack tide, the possibilities to pass through the narrows during daylight are limited (TSBC 2012). Since 2007, there have been 4 instances where Canadian Coast Guard (CCG) was notified of vessel groundings in Baker Lake and the channel of Chesterfield Inlet. Two of these groundings occurred in Chesterfield Narrows (TSBC 2012).

3.A-7 PATHWAY ANALYSIS AND POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

Analysis of the potential pathways for potential Project effects on Marine Resource VCs during construction, operations, and closure is provided in Table 3-A-10. Project activities considered in the pathway analysis are limited to those directly associated with marine shipping, which will occur during all phases of the Project (construction, operations, and closure). Only primary pathways relevant to Marine Resources are discussed herein.

The assessment endpoint for Marine Wildlife consists of ‘self-sustaining and ecologically effective marine wildlife populations and on-going marine fisheries productivity’. Marine Water Quality has no assessment endpoint, as it represents a measurement indicator and pathway for Marine Wildlife VCs. Residual effects were analyzed using measurable indicators for Marine Wildlife VCs and are expressed as effects statements, including the following:

- changes in habitat (quality and quantity);
- changes in survival and health risk; and
- changes in behavior.

The primary pathways that require further effects analysis to determine the environmental significance from the Project on Marine Resource VCs are provided in Sections 3.A-8.1, 3.A-8.2, 3.A-8.3, and 3.A-8.4.

3.A-8 EFFECT ANALYSIS

Generic definitions have been provided for each of the impact criteria in the Assessment Approach (Volume 3, Section 3.7.1). For criteria such as geographic extent, duration, frequency, and likelihood, the definitions can be applied consistently across all marine VCs. The likelihood of an impact was determined based on the probability of the event occurring and the implementation of mitigation measures. Reversibility is defined as the likelihood and time required for a component (e.g., population) or system to recover after removal of the stressor and is a function of resilience. Reversibility is applied to all combinations of magnitude, geographic extent, and duration. Definitions for each criterion are provided in Volume 3, Appendix 3-E. A brief summary of the effects on each VC is provided below.

3.A-8.1 Marine Water Quality

3.A-8.1.1 Effects Analysis

Potential environmental effects of the Project on marine water quality include the following:

- Accidental fuel spills may result in changes to marine water quality (e.g. contaminant concentrations in water above ambient water quality guidelines).

A number of fuel types will be present on Project vessels that could accidently be released to the marine environment, including aviation fuel and ultra-low sulfur diesel. Diesel is the largest fuel type by volume that will be transported by fuel tankers. A minimal amount of intermediate and heavy fuel oils (IFOs and HFOs) will also be present on-board the vessels, limited to volumes required for vessel engine consumption during transit. Intermediate and heavy fuel oils are denser and have a higher viscosity than diesel fuels and do not dissipate quickly; they have a tendency to remain for longer periods than lighter fuels, and, therefore, can pose a longer-term threat to the environment (ITOPF 2002). Diesel and aviation fuel, on the other hand, have lower density and viscosity and tend to be less persistent in the environment, albeit more toxic; dispersion and evaporation of diesel and Jet A will occur at a faster rate (Edgerton et al 1987; NOAA 2016).

Accidental spills have the potential to occur throughout the life of the Project. This could include minor fuel spills such as those resulting from leaks from on-board equipment or fuel containers (e.g. fuel drums); or major fuel spills resulting from a malfunction during fuel transfer activities or as a result of a vessel accident, such as sinking, running aground, collisions with other ships, or an on-board fire or explosion. A fuel spill is more likely to occur during vessel lightering operations near Helicopter Island at the head of Chesterfield Inlet than during transit along the shipping corridor in Hudson Strait and Hudson Bay. Also, navigation in the channel of Chesterfield Inlet involves a higher risk of running aground than navigation in Hudson Strait and Hudson Bay due to the narrower passage and stronger tidal currents in this area, and the proximity of rocky shores and small islands along this segment of the navigational route.

The expected spill rate per year for the Project was calculated by multiplying the total volume of fuel (ULSD and Jet A) to be transported in a given year for the Project by estimated spill frequencies derived from historical statistics (SL Ross 1999). Approximately 66.8 million litres (66,800 square metres [m^3]) of fuel is delivered per year of operations. Based on this total and the estimated spill rates reported by SL Ross (1999), the overall likelihood of a fuel spill for the Project was predicted to be once every 69 years for a small spill (from 0.17 to 8.3 m^3) and once every 1,000 years for a large spill (more than 167 m^3). Also, historical incident records (e.g., spills, accidents) for the Meadowbank Mine were reviewed to determine if any spills had occurred in the marine environment since the start of mining operation, with no spills identified on-record.

The fate and effect of a fuel spill depends on its chemical properties (specific gravity, pour point, viscosity, and constituent components), volume released, surface area of spreading, and the environmental conditions involved (wind speed and direction, water depth, wave energy, sea state, solar radiation, current speed, water temperature, and distance to land) (ITOPF 2002). Weathering processes[1] include dispersion, evaporation, dissolution,

[1] For light hydrocarbon fuels such as diesel, evaporation and dissolution are the most influential weathering processes (ITOPF 2002).

sedimentation, spreading, biodegradation, emulsification, and photo oxidation. The rate at which a spill will disperse once it enters the marine environment is largely dependent upon the type of fuel released and the sea state conditions at the time of the spill. Dispersion occurs most rapidly with low viscosity oils and in the presence of breaking waves (ITOPF 2002). The rate of evaporation depends on ambient temperatures, wind speeds, and the type of fuel.

Dispersion, evaporation, and spreading are the primary processes for determining fate and transport of diesel fuel, which is the primary fuel type being used for the Project. As diesel fuel has a low viscosity, it will weather rapidly when spilled into the marine environment (NOAA 2006). With a lower density than water, diesel fuel is readily dispersed by wave action. Over 90% of a small spill of diesel in the marine environment is either evaporated or naturally dispersed over a time scale of several hours to days (NOAA 2016). The larger-magnitude impacts from fuel spills are typically encountered when spills occur near land, in shallow waters, or in areas with reduced water circulation (Patin 1999).

Spilled hydrocarbons can deteriorate water quality by contaminating the water with a number of constituents, mainly aromatic hydrocarbons and alkanes, in excess of local and international water quality guidelines and standards. Released hydrocarbons will spread rapidly over the sea surface resulting in a thin layer (a slick) that tends to disperse within the upper layer of water column.

A semi-quantitative risk assessment was undertaken for Agnico Eagle's Meliadine Project FEIS (Agnico Eagle 2014b) to determine the likelihood and extent of a potential ULSD (P-50) fuel spill during fuel transfer activities near Rankin Inlet and during transport along the shipping route. Fuel for the Meliadine Project is delivered to Rankin Inlet (approximately 130 km south of Chesterfield Inlet) at a rate of 122,000 m^3/year. This represents approximately twice as much volume of fuel as that required for the Project. The behavior of a potential fuel spill in the marine environment for the Meliadine FEIS was assessed at six different hypothetical spill locations. Two locations were selected near Melvin Bay corresponding with ship-to-shore and ship-to-ship fuel transfer sites where a higher potential for fuel spills would occur. Four locations were assessed along the shipping route corresponding with known sensitive/important areas for marine mammals and/or marine birds, including Walrus Island, Coats Island, Ungava Peninsula, and Eastern Hudson Strait. The risk assessment considered a worse case spill scenario of 2000 m^3 occurring at each of the 6 sites (representing the total volume of diesel carried by a single tanker), and an additional spill scenario of 100 m^3 occurring at the fuel transfer sites near Melvin Bay, representing smaller spills that could occur during fuel transfer activities.

For both spill scenarios assessed at the fuel transfer locations near Melvin Bay, the weathering half-life of a potential ULSD spill was determined to be <19 hours (h). The time required for the spill to reach shore varied from approximately 6 minutes (0.1 h) to 1 h 20 minutes. It was further predicted that between 89% and 98% of the total volume of spilled diesel fuel would ultimately reach shore if no responsive mitigation was implemented (Agnico Eagle 2014b).

For the spill sites modelled along the shipping route, the weathering half-life was predicted to be less than 19 h for all scenarios. Depending on the distance to shore and wind scenario, the time to shore varied from about 7 h to 94 h (approximately 4 days). Depending on different wind conditions and spill locations, the amount of fuel predicted to be deposited on shore varied from 2% to 26% of the original spill volume. Mean and 50-year (extremal) wind speed estimates and mean fetch values for the four locations along the shipping route were used to estimate the slick distance traveled until the fuel remaining represented 1% of the original quantity. Modeling results indicated that, assuming average wind speed conditions, the fuel slick would travel approximately 26 km over a

48-h period prior to being reduced to 1% of its original spill volume through natural weathering effects. Using 50-year wind speed values, the fuel slick would travel approximately 38 km over a 12-h period prior to being reduced to 1% of its original volume (or 26 km over an 8-hour period prior to being reduced to 7% of its original volume) (Agnico Eagle 2014b).

While it is not appropriate to fully apply the Meliadine FEIS model prediction to determine the behavior of a potential spill for the Project since the fuel volumes for both Projects are not the same, and environmental conditions at the fuel transfer points are also known to be different (hydrodynamic conditions in Chesterfield Inlet are different than those near Rankin Inlet), qualitative inferences can be made to apply this information for assessing the potential impact from a spill on the marine environment and establishing a 'hypothetical spill limit' - or the maximum spatial extent that a diesel fuel slick could potentially reach for the purposes of this assessment. It is most likely that a fuel spill in the channel of Chesterfield Inlet would spread rapidly in a downstream direction (given prevalent current conditions in this area) and reach the shoreline within several hours if no immediate spill response was implemented. In open water areas (Hudson Bay and Hudson Strait), a spill for the Project is likely to behave in a similar way to that described for the Meliadine Project.

3.A-8.1.2 Residual Effect Classification and Significance

Marine Water Quality has no assessment endpoint, as it represents a measurement indicator and pathway for Marine Wildlife VCs with the following assessment endpoints: self-sustaining and ecologically effective marine wildlife populations, and on-going marine fisheries productivity.

Characterization of residual impacts on marine water quality is intended to inform the assessment of residual impacts on marine wildlife VCs, and in particular impacts on habitat quality for marine wildlife VCs. Where there are assessed residual impacts on marine water quality due to Project activities, those changes have been characterized and carried forward, regardless of significance, into the assessment of residual impacts on marine wildlife VCs.

3.A-8.2 Marine Fish and Fish Habitat

3.A-8.2.1 Effects Analysis

Potential environmental effects of the Project on marine fish include the following:

- potential mortality or reduced health due to exposure to accidental fuel spills; and
- loss / degradation of habitat due to altered water quality from potential accidental fuel spills.

In the event of fuel spill, the fate of released hydrocarbon material will primarily depend on the quantities and properties of released materials. The most common fuel type by volume for the Project is marine diesel. Diesel fuel is lighter than water and spreads to a thin film on the water surface once released to the marine environment (NOAA 2016). The fate of diesel spills in marine water and the effectiveness of dispersion and cleaning activities depends on several environmental factors. Because diesel is only moderately volatile, wave actions may disperse the non-evaporated portion of spilled diesel over the area before it can be contained (NOAA 2016). This can leave a residue of up to one-third of the amount spilled after several days. In Alaska, diesel spilled into marine environmental at small volumes (1,900 to 19,000 litres) usually evaporates and disperses naturally into the water column within one day or less, particularly when winds are at 5 to 7 knots and breaking waves are present (NOAA 2016). If a diesel spill reaches lands, it can leave a film on intertidal resources and can potentially cause longer-term bio-contamination if it becomes buried in sediments along the foreshore or on the seabed.

Fuel spills can result in adverse impacts on marine fish through degradation of sensitive fish habitats (e.g., spawning grounds), and through acute and chronic toxicological effects by means of uptake by the gills, ingestion of oil or oiled prey, and reduced survival of eggs and larvae (US FWS 2004). Diesel fuel is considered to be one of the most acutely toxic oil types (NOAA 2016) as it consists primarily of volatile petroleum hydrocarbons, benzene, and other aromatic hydrocarbons (Hoffman 1982). These compounds are highly toxic to aquatic life and there are numerical standards for these chemicals under the Canadian water quality guidelines for the protection of aquatic life (CCME 2014). Fish that come in direct contact with a diesel spill may be killed (NOAA 2016). Spilled fuel accumulated in intertidal sediments can be directly toxic to benthic invertebrates and intertidal organisms (USFWS 2004). Bio-accumulation of toxic compounds within benthic organisms can also result in the transfer of these toxic compounds through the food chain to higher trophic levels. Diesel spills along the shoreline tend to penetrate porous sediments quickly, but will be washed off quickly by waves and tidal flushing (NOAA 2016). Diesel oil is also degraded by naturally occurring microbes, under time frames of one to two months (NOAA 2016).

The toxic effect of spilled fuel depends on their chemical properties, volume released, surface area of spreading and the environmental conditions involved (ITOPF 2002). Small spills in open water are rapidly diluted with the result that fish kills in this type of environment have never been reported; however, fish kills have been reported for small spills in confined, shallow water (NOAA 2016). Fish species in shallower and nearshore areas are more susceptible to toxic effects than fish in deeper offshore areas (Schreiber and Burger 2002). An accidental fuel spill occurring in the nearshore environment or in shallow or confined waters such as the channel of Chesterfield Inlet could result in high mortality of adult fish, fish eggs, and larvae (Boertman and Mosbech 2011). An offshore spill may have less extensive adverse effects on marine fish due to higher dispersion rates in this environment. Local fisheries may be impacted by nearshore spills through temporary closures of affected fisheries due to concerns of toxic fish (Yender et al. 2002) and potentially damaging the reputation of the fisheries within the affected area (Schreiber and Burger 2002).

3.A-8.2.2 Residual Effect Classification

The potential adverse residual impacts of the Project on marine fish include loss or alteration of fish habitat due to an accidental spill, as well as potential mortality or health risk due to exposure to an accidental fuel spill. Table 3-A-11 summarizes the rating classifications for all residual Project impacts on marine fish.

A minor diesel spill is likely to result in temporary localized exceedances of water quality guidelines for the protection of aquatic life (CCME 2014), and therefore there exists the potential for acute or chronic effects on fish within the immediate area of the spill, but not at levels beyond natural variability. A major diesel spill would result in measurable effects in excess of water quality standards (CCME 2014) and potential for mortality of adult fish, eggs and larvae at levels beyond natural variability, thus representing a potential change of state from baseline conditions. Under both spill scenarios, the effect is considered fully reversible, due to the rapid rate of dispersion and evaporation of diesel fuel in the marine environment, as well as the natural degradation of landed diesel by microbes and normal wave / tidal action. Further, any resulting acute effects on fish are predicted to be reversible through natural recruitment, meaning the number of new fish that will enter the population over time will offset the number of fish mortalities or injuries potentially resulting from a spill. Changes at the population level are not anticipated. Given the estimated spill rate for both spill types, and taking into consideration that no marine spills have occurred on the Meadowbank Mine since the start of the mine (Section 3.A-8.1.1), the likelihood of an accidental spill (major or minor) in the marine environment is considered low (unlikely) provided prescribed industry-standard prevention and response measures are in place.

3.A-8.3 Marine Mammals

3.A-8.3.1 Effects Analysis

Potential environmental effects of the Project on marine mammals include the following:

- mortality and health risk due to accidental fuel spills;
- loss / degradation of habitat due to altered water quality from potential accidental fuel spills;
- mortality and injury risk due to collisions with vessels; and
- change in behaviour due to underwater noise from Project vessels.

3.A-8.3.1.1 Accidental Fuel Spills

A number of known sensitive habitat areas for marine mammals overlap or are adjacent to the shipping route and could potentially be affected in the event of an accidental major fuel spill along the shipping corridor (Figure 3-A-6 to Figure 3-A-16). Modelling conducted for Meliadine FEIS (Agnico Eagle 2014b) identified a zone extending 26-km on either side of the shipping route as a 'hypothetical spill limit' - or the maximum spatial extent that a diesel fuel slick could potentially reach. The most likely travel direction of the plume identified was southeast due to the northwest wind direction that is prevalent during summer.

A hypothetical diesel spill occurring along the western portion of the Project shipping route was shown to more likely affect sensitive marine mammal habitats than a spill in the eastern portion of the Project shipping route. The coastal waters near Southampton Island and the north end of Coats Island are identified as bowhead whale and beluga summer concentration areas. These areas also support important haul-out areas for walrus year-round. Core summer habitat areas for narwhal are also present near Southhampton Island and near Repulse Bay (Figure 3-A-11). Killer whales commonly frequent waters offshore of Chesterfield and Rankin Inlets during summer (Figure 3-A-15). Modeling conducted for Meliadine FEIS (Agnico Eagle 2014b) indicated that the slick from a diesel fuel spill could extend as far south as the north end of Coats Island (located ~ 37 km south off the shipping route) under 50-year wind conditions, but not under average wind conditions. Southhampton Island and Repulse Bay were shown to be outside of the modelled spill limit under all wind condition scenarios, and opposite of the expected plume trajectory given prevalent wind direction during summer.

Marine mammals reported in the channel of Chesterfield Inlet during summer include beluga whale, walrus, seals and polar bear, with many of these species harvested by local communities (Agnico Eagle 2008, 2009; AREVA 2014). Using worst case assumptions, these species would therefore be at highest risk from a potential fuel spill in this area during the open-water shipping season.

Important marine mammal areas (e.g. beluga whale core summer estuarine habitats) are also located along the southwestern coast of Hudson Bay, southeastern coast of Hudson Bay, Frobisher Bay, and Ungava Bay. These coastal areas would not likely be impacted by a spill event given their location relative to the modelled hypothetical spill limits, assuming that fuel transport for the Project would not include transits between Churchill and the mouth of Chesterfield Inlet.

Potential effects of hydrocarbon exposure to marine mammals include the following:

- direct contact of oil / fuel with eyes may cause eye irritation / inflammation;

- direct contact of oil / fuel with skin or coat may reduce thermoregulation abilities; cause skin irritation / inflammation;
- inhalation of hydrocarbon vapours could result in inflammation of mucous membranes, pneumonia, and neurological damage;
- ingestion of oil or oil contaminated prey may result in toxicological effects, gastrointestinal inflammation, ulcers, bleeding, diarrhea, or maldigestion;
- oil in the water could foul the baleen of baleen whales, leading to reduced filtering / feeding efficiency;
- oil / fuel in the water could cause marine mammals to avoid the area, thus potentially resulting in temporary displacement from some feeding or migratory areas (temporary habitat loss /degradation); and
- reduced prey availability through prey displacement.

Whales are generally not considered to be at a great risk for adverse thermoregulation effects as a result of oiling of the skin as they rely on blubber for insulation (Geraci 1990). However, hydrocarbons can foul the coat of seals or fur of polar bears, thus reducing its natural insulation properties. Heavy oil may also coat the baleen of baleen whales, such as the bowhead whale, impacting their feeding ability and efficiency (Geraci and St Aubin 1988). Polar bears may also ingest hydrocarbons as a result of grooming themselves (Stirling 1990; Neff 1990). Hydrocarbons can also cause severe irritation to the eyes and other mucous membranes, which may reduce hunting and foraging abilities in these species (Short 2003; Geraci and St. Aubin 1988).

Inhalation of light hydrocarbon compounds above certain levels may cause toxic effects in all marine mammals, such as central nervous system disorders, brain degeneration, liver damage, and reproductive failure (Engelhardt 1983; Geraci and St. Aubin 1980 in Short 2003; Geraci 1990, Geraci and St Aubin 1988; Matkin et al. 2008). However, light compounds generally dissipate during the first few days of a spill. Due to the content of the diesel fuel to be shipped, the majority of the components would likely dissipate within several days of the spill event.

Individual marine mammals occurring in open-water areas directly overlapping with the plume would be at risk of direct exposure to diesel fuel (e.g., oiling effects) for a relatively short period. The Meliadine FEIS oil spill modeling provides a maximum conservative period of up to 48 h after which 99% of spilled fuel would have dissipated (Agnico Eagle 2014b). However, indirect effect on marine mammals (e.g., reduced health due to ingestion of oiled prey) may last for an undetermined period thereafter.

3.A-8.3.1.2 Collision with Vessels

There is a potential for accidental collisions of Project-related ships with marine mammals. Most marine mammals are fast and manoeuvrable in the water, and have sensitive underwater hearing, enabling them to avoid approaching vessels. Odontocetes (toothed whales, e.g., beluga whale) and pinnipeds (seals and walrus) are known to be highly manoeuvrable 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 a vessel strike (Richardson et al. 1995a). Of all records, mysticetes (baleen whales, e.g., bowhead whale) are the most commonly struck by transiting vessels (Laist et al. 2001; Jensen and Silber 2003). Baleen whales are relatively large and slow-moving and perhaps unable to exhibit a rapid avoidance response to approaching vessels.

A vessel strike on a marine mammal may result in either injury or direct mortality. Injuries are typically the result of two mechanisms: either blunt force trauma from impact with the vessel or from lacerations from contact with the propellers. Depending on the severity of the strike and the injuries inflicted, the mammal may or may not recover. Most strikes occur between slow moving whales, when ships are 80 m and longer and are travelling at 14 knots or faster (Laist et al. 2001). Recent research shows that vessel speed is positively correlated with the probability of a vessel strike (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). Serious or lethal strikes to 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).

Marine mammals that spend a considerable amount of time at or near the surface are at increased risk of vessel strikes. 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 further shows that underwater sound levels may be lowest directly off the bow ahead of an oncoming vessel, compared to the sides and behind stern (Terhune and Verboom 1999). Baleen whales, therefore, are more likely susceptible to potential ship strikes when occurring in the direct path of a vessel than other whales.

3.A-8.3.1.3 Disturbance by Underwater Vessel Noise

Marine mammals rely on underwater sound as a primary method of communication, navigation, and prey detection. Therefore, underwater anthropogenic noise is considered an important stressor for marine mammals because of their reliance on underwater hearing (Richardson et al. 1995a; Ketten 1998). Effects of underwater sound on marine mammals are generally measured through observations of behavioral responses to sounds used as a surrogate measure for sensitivity or susceptibility (McCauley 1994, Richardson et al. 1995a). Potential effects range from subtle changes in behaviour at low received levels to strong disturbance effects or temporary/permanent hearing impairment (injury) at high received levels.

Effect of the underwater noise on marine mammals depends on the sound pressure level received and the effect threshold or sensitivity of the animal to the sound. Marine mammal sensitivity to sound levels depends on their physiological characteristics and varies from one group to another. Marine mammals are acoustically diverse, with wide variations in ear anatomy, frequency and hearing range and amplitude sensitivity (Ketten 1998).

Vessels in transit generate underwater noise resulting from a combination of the ship's machinery, propellers, and water flow around the hull. Most noise originates from propeller cavitation, or the formation of bubbles from the rotation of the blades (Mitson 1995). The ship noise depends on the ship characteristics and, in general, increases with ship size, power, load and speed (Mitson 1995; Nowacek et al. 2007; JASCO 2010; McKenna et al. 2012). Literature sources available suggest that the ships of the sizes used for the Project, travelling at the speed of 14 knots and less will generate sound levels below the marine mammal injury threshold levels (180 decibels (dB) for cetaceans and 190 dB for pinnipeds (NOAA 2014)). The highest sound level produced by a chemical tanker (26,200 gross tonnage) traveling at a speed of 13.1 knots, available from literature, is 177 dB re 1 µPa@1m (0.02-1 kHz)(McKenna et al 2012). Therefore it is unlikely that the Project ships will generate noise-related injuries in marine mammals.

The behavioural disturbance acoustic threshold for all marine mammals is 120 dB re 1 µPa@1m for non-pulsed (continuous) noise sources such as shipping noise (NOAA 2014). The sound levels produced by the Project ships at the source (1 m) are above this threshold. Noise attenuation modeling studies and field measurements conducted for similar or larger ships than used for the Project in open-ocean background conditions demonstrated that noise levels can exceed the behavioral acoustic threshold for marine mammals at distances up to 5 km from the source (JASCO 2006; JASCO 2011; McKenna et al. 2012; AREVA 2014).

The rate of exposure of a marine mammal to ship's noise is impossible to predict because marine mammals may travel at various speed and directions. However, a stationary individual marine mammal in the way of a Project ship travelling at 14 knots will be exposed to the sound level above the behavioral threshold (120 dB) for a maximum of 23 minutes (while the ship travels for 10 km), assuming the animal remains stationary. It is highly unlikely that the same animal will be exposed to underwater noise generated by two or more ships traveling days apart due to high mobility of marine mammals. In addition, the sound levels emitted forward of the ship are typically much lower than those emitted in the stern direction (McKenna et al. 2012).

3.A-8.3.2 Residual Effect Classification

The potential adverse residual impacts of the Project on marine mammals include loss or alteration of habitat due to an accidental spill, potential mortality or health risk due to an accidental spill, potential mortality / injury due to vessel collisions, and potential changes in behavior due to underwater noise from vessel operations. Table 3-A-11 summarizes the rating classifications for all residual Project impacts on marine mammals.

A minor diesel spill along the proposed shipping corridor is not likely to result in measurable effects on marine mammals in the Project area, although a major spill could result in a number of adverse impacts on marine mammals including habitat degradation, decreased prey availability, decreased health, or death. Potential species most at risk are bowhead whales (SARA-listed species), beluga, narwhal and killer whale, as the proposed shipping route overlaps with important summer habitat (e.g. foraging and migratory areas) for each of these species. Other marine mammal species potentially affected include walrus, seals (5 species) and polar bear.

Given the estimated spill rate for both spill types, and taking into consideration that no marine spills have occurred on the Meadowbank Mine since the start of the mine (Section 3.A-8.1.1), the likelihood of an accidental spill (major or minor) in the marine environment is considered low (unlikely) as prescribed industry-standard prevention and response measures are in place.

Whenever a vessel is in transit through known marine mammal habitat, the potential exists for a marine mammal/vessel interaction. Project shipping will occur throughout the life of the Project, so the potential for a marine mammal vessel strike will persist over this same period. Baleen whales such as bowhead whales would be most susceptible to this impact, due to their large size, slower travel and maneuvering speeds, lower avoidance capability, and use of summer foraging areas and migratory corridors that overlap with the shipping route. The shipping route also overlaps with summer habitat for killer whale, beluga whale, and narwhal; however, core summer concentration areas for beluga whale and narwhal are located outside the LSA and RSA, thereby further limiting the potential for vessel strikes with these populations.

To date, no vessel strikes on marine mammals have been recorded since the start of the Meadowbank Mine. The proposed frequency of shipping for the extension of the Meadowbank Mine through development of the Whale Tail Pit will remain the same as that for Meadowbank (no net increase in shipping activity). To further minimize the potential for a vessel strike, Agnico Eagle has developed a Shipping Management Plan (Volume 8, Appendix 8-D.5) that includes specific mitigation measures for interactions with marine wildlife, including vessel speed restrictions (<14 knots), and minimum approach distances from any observed marine mammals. Given application of the proposed mitigation, the likelihood of a vessel strike is considered low. In the rare event that a marine mammal strike were to occur, the consequence would likely be a non-lethal injury (laceration from propeller and/or blunt force injury) than direct mortality. The low vessel speeds that prevail during operations will greatly reduce the likelihood of ship strikes on marine mammals by providing ample time for animals to avoid oncoming vessels, as well as time for crew on Project vessels to detect and avoid marine mammals during active vessel operations.

The total cumulative increase in shipping in the region as a result of the Whale Tail Project in combination with Meliadine, Kiggavik, and other reasonably foreseeable future development (RFFD) Projects is estimated at 79% to 85% during operations (Agnico Eagle 2014b), thus increasing the potential for a vessel-mammal interaction. As such, the potential cumulative effect of ship strikes on marine mammals is considered moderate in magnitude and regional to beyond regional in geographic scale. Effects may be measurable in other parts of the home range of all marine mammal species, if outside of Nunavut. The effects of any injuries or fatalities on marine mammal populations are expected to be reversible through natural recruitment, meaning the number of new young marine mammals that will enter the populations over time will offset the number of marine mammal mortalities or injuries resulting from potential vessel strikes. With proposed mitigation in place (e.g., reduced speeds, minimum safety distances), the probability of a fatality or injury from a vessel strike is considered low although possible. In the event that one or several animals were lost over the lifetime of the Project, the long-term viability of marine mammal populations in the RSA are unlikely to be affected.

Underwater noise generated by Project vessels during shipping will likely exceed the acoustic threshold for eliciting changes in marine mammal behaviour, albeit these changes are difficult to predict. Behavioral changes may include evasive maneuvers such as diving or changes in swimming direction and/or speed. The period of exposure to shipping noise above the disturbance threshold will vary depending on the speed and direction of travel of both the animal and the ship. The maximum propagation distance for ship noise above the disturbance threshold is predicted to be less than 5 km. Based on available literature, marine mammals will either habituate to vessel sounds and remain in area, or leave temporality and return once the noise has subsided. Changes in behavior, therefore, are considered to be temporary and reversible with no effects at the population level anticipated.

3.A-8.4 Marine Birds

3.A-8.4.1 Effects Analysis

Potential environmental effects of the Project on marine birds include the following:

- potential mortality and health risk due to accidental fuel spills;
- loss / degradation of habitat due to altered water quality from accidental fuel spills;
- potential mortality and injury risk from collision with vessels due to sensory disturbance from ship lighting; and
- change in behaviour due to sensory disturbance from in-air noise and ship lighting.

3.A-8.4.1.1 Accidental Spills

Marine birds are particularly sensitive to hydrocarbons and may be indirectly or directly affected by an accidental fuel spill through coating of their plumage, ingestion of polluted food sources and/or loss of food sources (Robertson et al. 2012). Some species of marine birds in the RSA (e.g., murres, alcids, eiders) are relatively weak flyers, dive for their prey, and have flightless feather-moulting stages, making them particularly susceptible to spills (Lock et al. 1994; Piatt et al. 1985, Dickins et al. 1987). In addition, thick-billed murres (alcid family) may be particularly susceptible to spills during their flightless swimming migration in August when molting adult birds and fledglings depart from colonies in the Hudson Bay on a swimming migration through Hudson Strait to offshore areas of Newfoundland and Labrador (Mallory and Fontaine 2004).

Depending on the magnitude of the spill, effects can occur at the individual, population or ecosystem level (Mazet et al. 2002). Hydrocarbon spills affect marine birds through a number of pathways. Direct exposure can result in eye and skin irritation, burns, and coating of plumage by hydrocarbons resulting in a loss of insulating and buoyancy properties. The resulting reduced ability to swim, fly and feed, can lead to a reduced ability to meet metabolic needs, potentially leading to death by hypothermia, starvation or drowning (Mazet et al. 2002, Albers 2003, Islam and Tanaka 2004; O'Hara and Morandin 2010). Hydrocarbon ingestion is known to cause a range of lethal, sub-lethal, and chronic effects in marine birds, including effects on behaviour, blood, liver, and kidney disorders, impaired immunity, salt gland function and reproduction and reduced egg hatching success (Mazet et al. 2002, Albers 2003, Islam and Tanaka 2004; O'Hara and Morandin 2010). Marine birds may also be indirectly affected by changes in water quality or food availability. Contamination or loss of food sources may occur by causing direct mortality of fish and other lower trophic organisms on which birds feed themselves and their young feed. The magnitude of the effect of diesel on marine birds is comparatively lower than of other heavier types of fuel because of the shorter residency time of diesel on the water surface, and the lower viscosity and potential for heavy coating of individuals. Reports of small diesel spills in Alaskan waters indicate that that relatively few birds are directly affected by diesel spills (NOAA 2016). If a major diesel fuel spill were to occur in the marine environment, there would potentially be a localized increase in mortality, and a temporary loss in habitat (foraging grounds or staging areas) immediately following the spill event. Potential loss or degradation of marine bird habitat is an indirect effect from reduced water quality and contamination of forage fish prey species.

The Hudson Bay ecosystem is an environmentally sensitive area for marine birds, particularly during the summer, as it provides important habitat for breeding, feeding, and molting activities for colonies of birds. These birds and their habitats are particularly vulnerable to hydrocarbon spills (Schreiber and Burger 2002). A number of key marine habitat sites for migratory birds have been identified along the shipping route (Figure 3-A-17). The majority are located more than 50 km from the proposed shipping route. Four of these sites are located in closer proximity or overlap with the shipping route: Coats Island, Digges Sound, Frobisher Bay, and Button Islands. These marine areas delineate key feeding areas for marine birds; however, marine birds may forage beyond these areas (Mallory and Fontaine 2004). Marine birds nesting at these sites are particularly sensitive to pollution of their feeding areas (Mallory and Fontaine 2004). Depending on the spatial extent of an offshore spill, key marine habitat sites including offshore feeding areas as well as land-based breeding and moulting habitats could be temporarily or permanently disrupted. Nesting areas of marine birds are generally located in areas where they would not be directly impacted by a spill event if it reached shore. Nesting and chick survival may also be disrupted should parents become oiled while out at sea (Eppley and Rubega 1990).

The coastal areas and islands of Chesterfield Inlet contain important habitat for a number of marine bird species. The entire length of Chesterfield Inlet contains nesting habitat for thousands of oldsquaw (AREVA 2014). The eastern end (mouth) of Chesterfield Inlet and the surrounding islands contain nesting and breeding habitat for common eiders; the southern coast in particular has been identified as an important bird rearing area (CCI 1992). The area near Primrose Island and Barbour Bay contains large numbers of marine birds during certain times of the year including, but not limited to, Arctic terns, whistling swans, and various species of loon. Canadian geese and snow geese are also known to use the channel of Chesterfield Inlet during their migration. Several species of marine birds were sighted in waters and coastal areas of Chesterfield Inlet and Baker Lake during summer navigation months by marine wildlife observers onboard Meadowbank Mine supply vessels. This included gulls, snow geese, Arctic terns, ducks, and swans (Agnico Eagle 2008; 2009; 2012 and 2013). These birds and their habitats have the potential to be adversely affected in the event of a fuel spill in the channel of Chesterfield Inlet.

3.A-8.4.1.2 Light Disturbance

Ship lighting in low visibility conditions may represent a risk for marine birds. Under conditions of poor visibility such as low cloud cover or fog, nocturnal migrating birds have difficulty navigating; they may lose celestial navigation aids and become attracted or confused by artificial lights possibly resulting in collisions with structures and/or exhaustion (Montevecchi et al. 1999). Birds are also known to become disoriented by lights, particularly during overcast or foggy conditions, and fly continuously around them consuming energy and delaying foraging or migration (Avery et al. 1978; Bourne 1979; Sage 1979; Wood 1999). Factors, such as magnitude of bird movement and weather, may enhance bird injury and mortality from collision with artificial structures (Crawford 1981). Moisture droplets in the air during conditions of drizzle and fog refract the light and greatly increase the illuminated area thus enhancing the attraction (Montevecchi et al. 1999). Injury or mortality may also be higher during migration periods, when large numbers of birds may be forced down to a lower flight path or to the ground by inclement weather. Some nocturnal predators of marine birds are more successful when hunting in illuminated areas, potentially increasing the risk of bird predation in areas with anthropogenic lighting (Crawford 1981).

Vessel lighting at night may also attract migrating birds to the lightering area. Birds may also become disoriented by bright lighting, particularly during overcast or foggy conditions, and fly continuously around ships consuming energy and delaying foraging or migration (Avery et al. 1978; Bourne 1979; Sage 1979; Wood 1999).

However, the lightering area is located approximately 1 km away from the nearest shore (Helicopter Island) and no large concentrations of birds were observed in this area by Inuit marine wildlife observers onboard Meadowbank Mine supply vessels (Agnico Eagle 2008; 2009; 2012 and 2013). Therefore, it is predicted that a relatively low number of marine birds may potentially be displaced from feeding areas due to in-air vessel noise. Also, the operations take place during the Arctic summer when periods of low to no light are relatively brief.

3.A-8.4.1.3 In-Air Noise Disturbance

In-air noise generated by cargo and fuel transfer activities during ship lightering may result in sensory disturbance to marine birds, including avoidance and displacement behavior. This could potentially include disruptions of migration, and consequently their availability for harvest.

3.A-8.4.2 Residual Effects Classification

The potential adverse residual impacts of the Project on marine birds include loss or alteration of habitat due to an accidental spill, potential mortality or health risk due to an accidental spill, potential mortality or injury due to collisions with ships due to sensory disturbance from ship lighting, and behavioural changes due to sensory disturbance (in-air noise and lighting). Table 3-A-11 summarizes the impact rating classifications of Project impacts on marine birds.

The potential residual effects from a diesel spill on marine birds depends on a number of situational and environmental factors. Given the relatively small scale of a minor spill and preparedness for its containment, the magnitude of its effect on marine birds is predicted to be low, short-term in duration and local in geographic extent for both incremental and cumulative scenarios. The magnitude of a major spill on marine birds is considered high for both incremental and cumulative scenarios, since the spill could potentially result in the death of a SARA listed species and would be likely to impact key marine bird habitat areas with large aggregations of migratory birds, many of which have a reduced ability to actively avoid the affected area due to sensitive moulting stages (particularly the thick-billed murre). Also, a major spill has the potential to result in population-level effects beyond the rate of natural variability, and may result in mortalities of SARA-listed species, such as Ross's gull and the

Ivory gull. The effect of a major spill on marine birds is considered medium-term in duration, and beyond regional (incremental and cumulative) in geographic extent, due to extensive home ranges of most birds species in the RSA. For both major and minor spills, the frequency of the effect is considered isolated in occurrence, and effects are reversible through natural processes. Given the estimated spill rate for both spill types, and taking into consideration that no marine spills have occurred on the Meadowbank Mine since the start of the mine (Section 3.A-8.1.1), the likelihood of an accidental spill (major or minor) in the marine environment is considered low (unlikely) provided prescribed industry-standard prevention and response measures are in place.

The potential for injury or mortality of marine birds by means of striking the ship as a result of sensory disturbance due to vessel lighting is considered to be low in magnitude, medium-term (over the life of the Project), and isolated in frequency for both incremental and cumulative scenarios. The effects of any injuries or fatalities on a marine bird population as a whole are expected to be reversible through natural recruitment. With proposed mitigation in place (e.g., shielded lights), the probability of a fatality or injury from a collision with vessels due to lighting is considered unlikely.

The potential for behavioral changes (sensory disturbance) in marine birds due to in-air noise from lightering activities (e.g., vessel operations and spud barge installation) is considered low for the incremental effect, since the lightering operations area is located away from important birds' nesting and breeding areas and no considerable aggregations of birds in this area have been observed (Agnico Eagle 2008, 2009, 2012, 2013), and moderate for cumulative effect. Limiting operations to day-light hours and reducing illumination during non-operation hours will also limit a potential effect from lighting.

3.A-9 CUMULATIVE EFFECTS

Cumulative effects were considered in all pathways based on the summary of past, present and RFFDs (Appendix 3-D). The main sources of cumulative effects are shipping operations for residential and mineral and oil and gas exploration supplies, commercial shipping, shipping for commercial, recreational and subsistence fisheries and wildlife harvest, research vessels, governmental activities and tourism. Figure 3-A-1 provides an outline of shipping lanes used in past, present and RFFDs in the marine study area.

Considering the RFFDs, all of the eight possible future projects considered in Appendix 3-D will definitely or likely use shipping lanes through the study area at some extent and, thus, have valid assessment pathways. Therefore, all of these projects were considered in the cumulative effect assessment. Table 3-A-11 provides a summary of cumulative effects.

3.A-10 ASSESSMENT OF SIGNIFICANCE

Significance ratings are presented in Table 3-A-11 along with residual impact classifications. Project effects of low to high magnitude are anticipated, extending to 'beyond regional' in scale when considering the effects of a major fuel spill. The effects will be short-term to medium term in duration. High magnitude impacts were predicted to be isolated in frequency and unlikely to occur. Conversely, the majority of low magnitude Project pathways were predicted to be likely to highly likely to occur.

Overall, the weight of evidence indicates that the identified Project-environment pathways for marine VCs are predicted to not result in significant impacts on marine fisheries productivity, or the structure and function of self-sustaining and ecologically effective marine wildlife populations relative to natural factors occurring over the same period of time and space. The scale of combined impacts from the Project pathways, independently or cumulatively with other RFFDs, will not be large enough to result in irreversible changes at the population level.

By extension, the Project should not have a significant adverse impact on the continued opportunity for traditional and non-traditional use of marine resources in the region.

3.A-11 UNCERTAINTY

Potential uncertainties in the present assessment are related to the following elements:

- adequacy of baseline data, in particular, for understanding current conditions and future changes unrelated to the Project (e.g., extent of future developments, climate change, catastrophic events);
- limited available data in the region that would provide better understanding of potential impacts;
- understanding/forecasting of future developments in the area, both human-related (e.g., mining, energy development, market conditions, climate change and etc.) and natural (climate change, sea level rise and etc.);
- understanding of Project-related impacts on complex ecosystems that contain interactions across different scales of time and space (e.g., how the Project will impact migratory marine birds and mammals); and
- knowledge of the effectiveness of the environmental design features and mitigation for reducing or removing impacts (e.g., vessel speed restrictions).

Uncertainty has been addressed by applying a conservative estimate of effects in the residual impact classification and in the determination of significance. Like all scientific results and inferences, residual impact predictions must be tempered with uncertainty associated with the data and the current knowledge of the system. It is anticipated that the baseline data is moderately sufficient for understanding existing conditions, and that there is a moderate level of understanding of Project-related impacts on the ecosystem. Some uncertainties may be addressed through monitoring and follow-up activities.

3.A-12 MONITORING AND FOLLOW UP

Agnico Eagle will require all contracted shipping companies to provide full-time marine mammal and seabird monitoring during shipping operations using trained observers and established data collection and recording protocols. Monitoring plans will include provisions for all marine mammal and seabird species listed under the SARA and for the COSEWIC. Any incidents of bird mortalities associated with lighting infrastructure, construction activities, and Project vessel operations will be recorded and reported to Environment Canada (Canadian Wildlife Services). Additional monitoring and follow-up will be conducted in the channel of Chesterfield inlet by Inuit marine wildlife monitors onboard the Project vessels. Any incidents of vessel strikes with marine mammals will be recorded and reported to Fisheries and Oceans Canada.

In the unlikely event of a major spill, follow-up monitoring on marine mammals and their habitats, seabirds and their habitats and fish species and their habitats would be proposed. The scope of such follow-up monitoring would be decided at the time of the event and determined in consultation with Fisheries and Oceans Canada at the time of the event.

3.A-13 MITIGATION MEASURES

Following is a summary of mitigation measures proposed to minimize, eliminate and/or offset adverse effects from the Project on marine resources in the Project area:

- Agnico Eagle has developed and implemented a Shipping Management Plan (Volume 8, Appendix 8-D.5) outlining management practices and procedures for all Project shipping and lightering activities with respect to marine navigational safety, accidents and collisions, spill prevention and response, pollution prevention measures, ballast water management, waste management, marine wildlife management, radio equipment and communications, and occupational health and safety. This plan has been developed in accordance with federal legislation, notably the Canada Shipping Act and the Arctic Waters Pollution Prevention Act, as well as all other applicable national and international safety regulations, such as requirements established by the International Maritime Organization, the International Convention for the Safety of Life at Sea (SOLAS 1974), and Guidelines for Ships Operating in Polar Waters (IMO 2010).
- The Project's Shipping Management Plan, in accordance with Spill Contingency Plan and Emergency Response Plan, will address a range of spill prevention and control measures including engineering design, personnel training and competence, documented procedures, inspection and maintenance, record keeping and adequate resource allocation.
- Each ship will have onboard emergency notification and response equipment, including alarm systems, fire-fighting equipment, and spill response kits. All vessels will have a Shipboard Oil Pollution Emergency Plan (SOPEP) or Shipboard Marine Pollution Emergency Plan in accordance with MARPOL 73/78, Annex I, IMO Res. MEPC. 78(43). Each ship has an Emergency Response Team consisting of competent and trained personnel responsible to deal with emergency situations including fire, explosions, and oil spills.
- The Shipping Management Plan will include marine routes hazard identification and risk analysis addressing navigation safety in the Arctic waters particularly in the channel of Chesterfield Inlet and Chesterfield Narrows.
- The Shipping Management Plan will include mitigation measures to eliminate or reduce potential adverse effects of Project shipping on marine wildlife including, but not limited to, provision of full-time marine mammal and seabird monitoring onboard Project vessels, speed restrictions (<14 knots), safe approach distances from marine mammals, wildlife sightings record-keeping, ship lighting modifications, adherence to ballast water regulations.
- The proposed shipping route has been selected to avoid the majority of the key marine habitat areas for migratory birds, migratory bird sanctuaries, and known important bird areas to the extent possible, as safe navigation allows.

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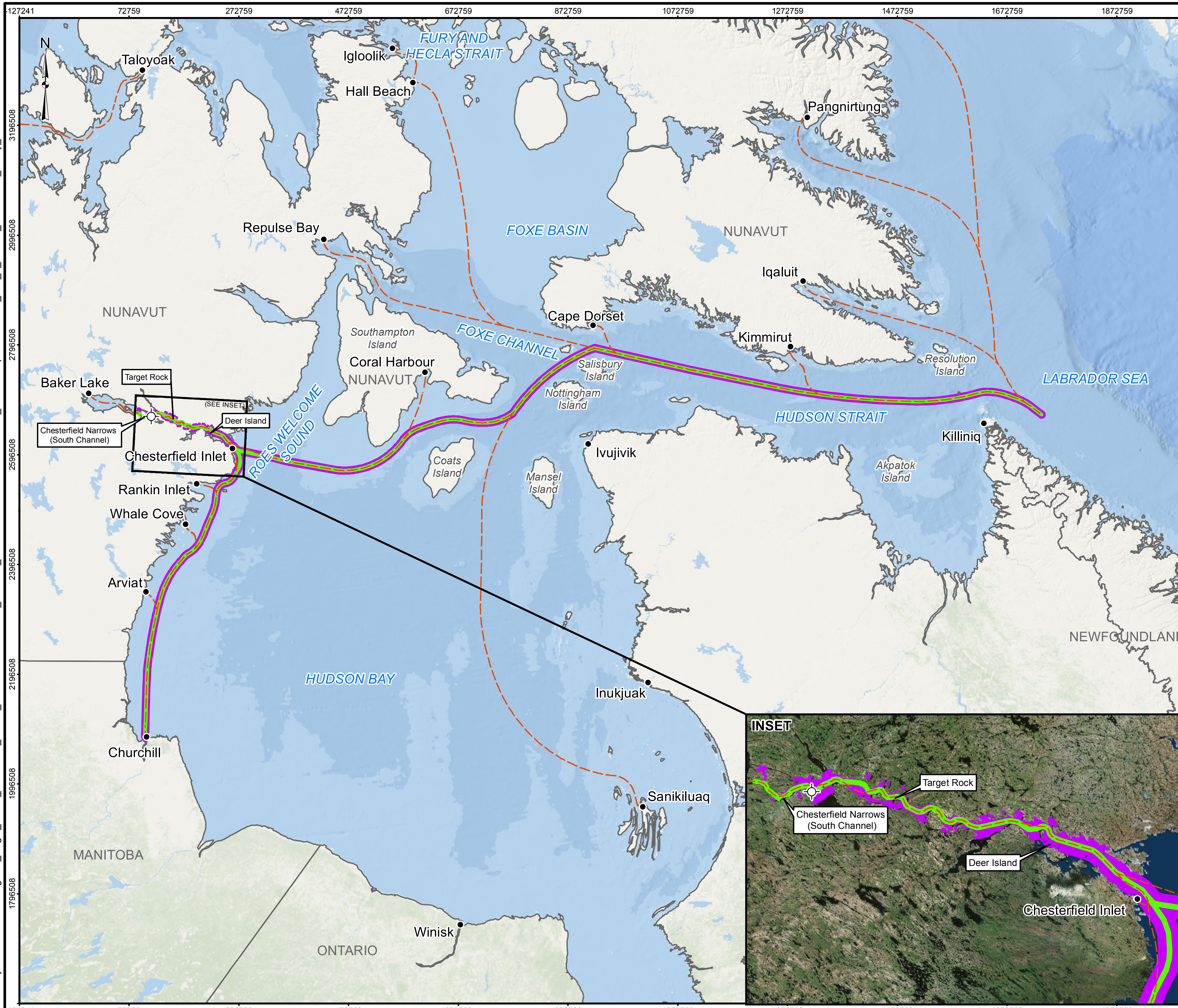
ATTACHMENT 3-A.1

Figures



LEGEND

- POPULATED AREA
- LIGHTERING POINT (HELICOPTER ISLAND)
- MAJOR ARCTIC NAVIGATION ROUTES
- LOCAL STUDY AREA (LSA)
- REGIONAL STUDY AREA (RSA)
- PROVINCE / TERRITORY BOUNDARY

REFERENCE

1. BASE DATA ESRI, DELORME, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS
2. SHIPPING ROUTE DATA OBTAINED FROM THE DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
3. PROVINCE AND POPULATED AREA DATA OBTAINED FROM ESRI.

DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

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KILOMETRES

PROJECT
AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

MARINE RESOURCES STUDY AREA

Golder Associates

PROJECT		1541520	FILE No.	
DESIGN	KA	15 OCT. 2015	SCALE AS SHOWN	REV. 0
GIS	MH	11 MAY 2016	**FIGURE 3.A.1**	
CHECK	AO	06 Jun. 2016		
REVIEW	PR	06 Jun. 2016		

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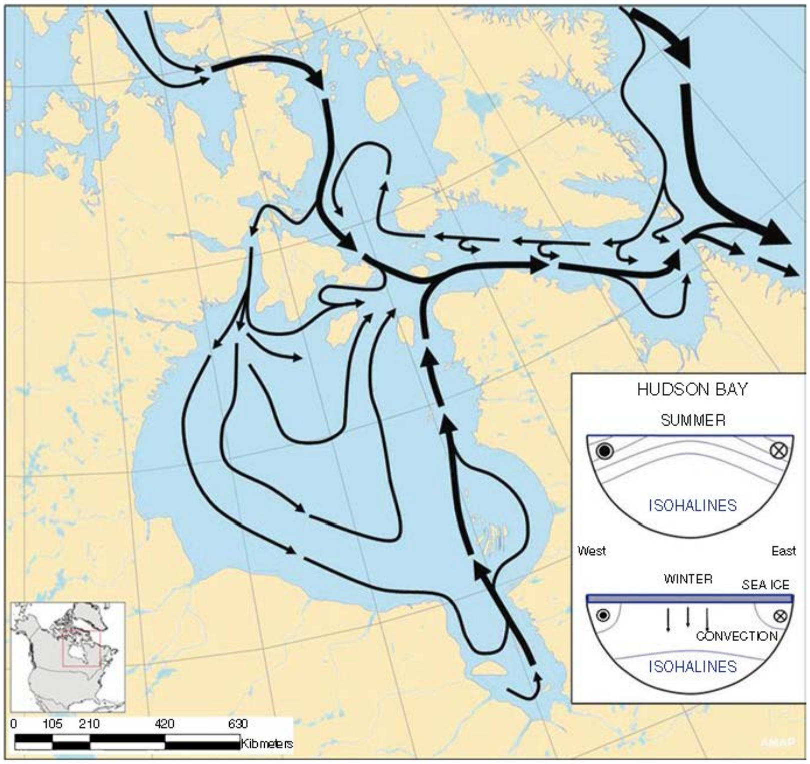


Figure 3-A-2: Summer Circulation of Water in the Hudson Bay Complex. (Extracted from Stewart and Barber (2010); inset after Ingram and Prinsenberg (1998))

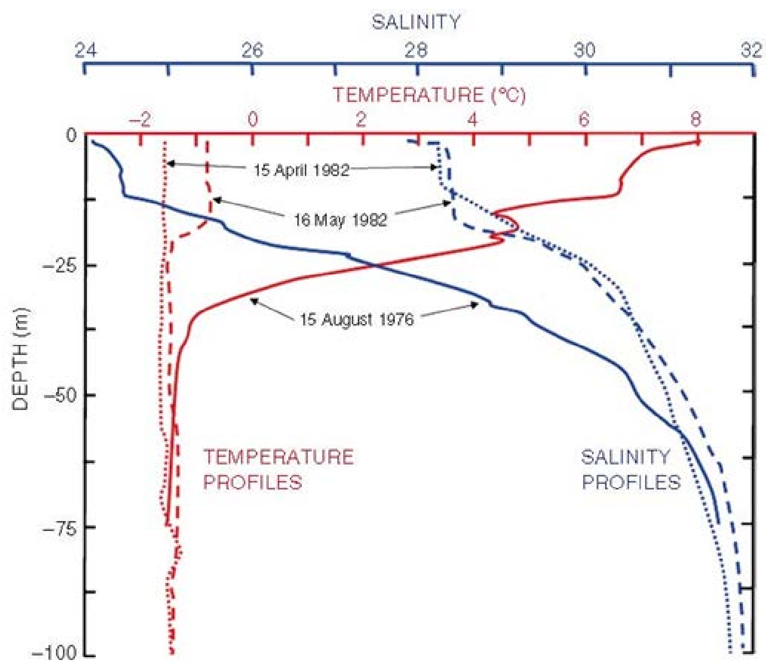
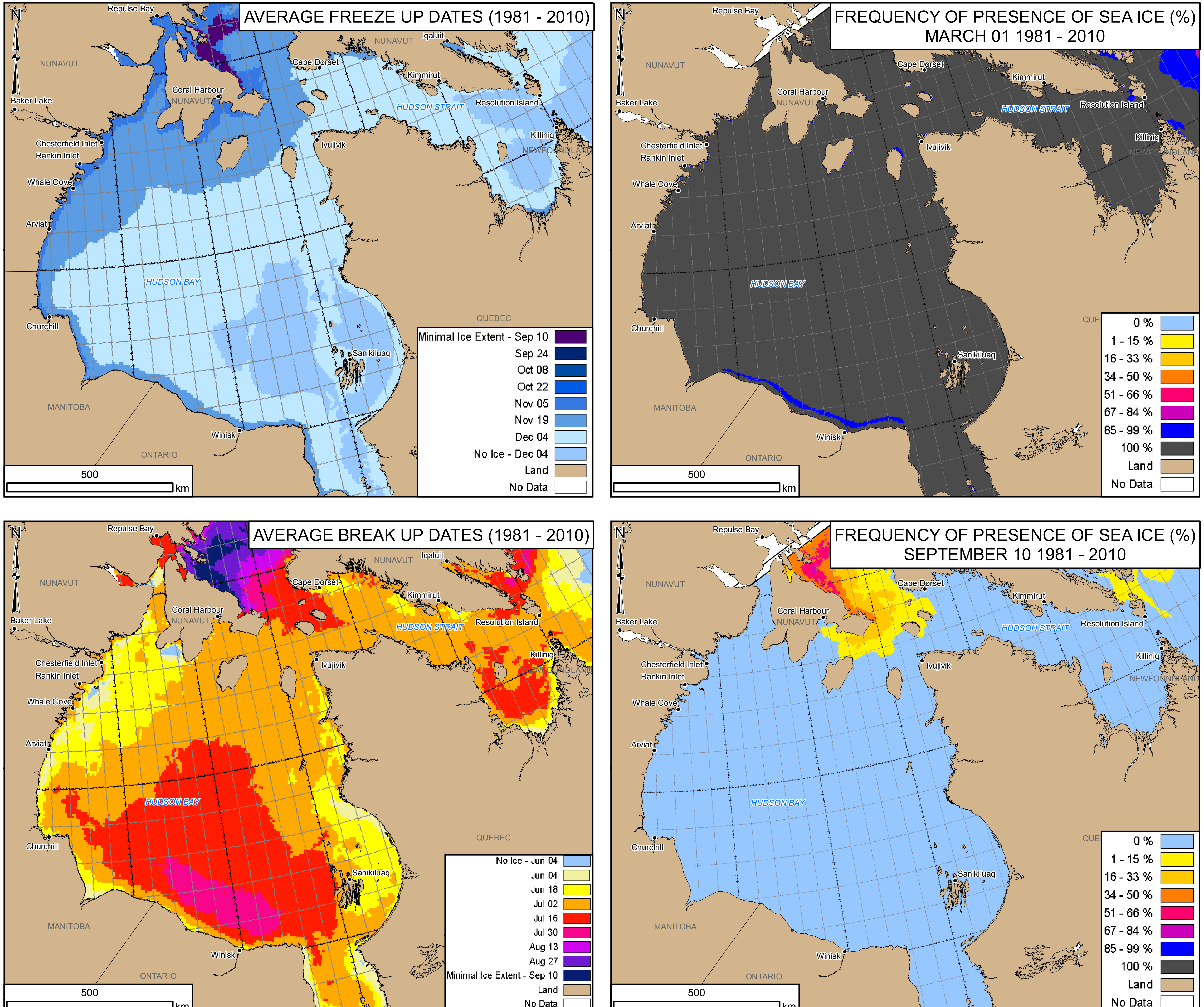


Figure 3-A-3: Representative Vertical Profiles of Temperature and Salinity in Southeastern Hudson Bay in April (dashed line), May (dashed-dotted line), and August (solid line). (Extracted from Ingram and Prinsenberg (1998))



LEGEND

- ● POPULATED AREA
- PROVINCE / TERRITORY BOUNDARY

REFERENCE

1. SEA ICE DATA OBTAINED FROM THE GOVERNMENT OF CANADA 30 YEAR SEA ICE ATLAS.
2. PROVINCE AND POPULATED AREA DATA OBTAINED FROM ESRI.

DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

ICE FREEZE UP AND BREAK UP, AND FREQUENCY OF SEA ICE IN LATE WINTER AND SUMMER, IN HUDSON BAY AND HUDSON STRAIT BASED ON 30 YEARS OF ICE DATA

Golder Associates

PROJECT		1541520	FILE No.	
DESIGN	KA	15 OCT. 2015	SCALE AS SHOWN	REV. 0
GIS	CD	21 OCT. 2015		
CHECK	AO	06 Jun. 2016	FIGURE 3.A.4	
REVIEW	PR	06 Jun. 2016		

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