Sabina
GOLD & SILVER CORP.

The BACK RIVER PROJECT

Marine Environment

Volume 7

Prepared by:

Rescan™
an ERM company

December 2013

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Back River Project Fact Sheet

December 2013

Location

- Located in the western Kitikmeot Region of Nunavut at approximately 65° north latitude, and 106° west longitude. About 400 km south of Cambridge Bay and 525 km northeast Yellowknife.
- Primary communities: Kugluktuk, Cambridge Bay, Gjoa Haven, Kugaaruk and Taloyoak
- The closest community areas to the Project are Kingaok, located approximately 160 km north of the Goose Property, and Omingmaktok, located approximately 250 km northeast of the Goose Property

Reserves

- Six mining areas within the Goose and George Properties. Three locations at the Goose Property (Goose, Umwelt, and Llama) and three locations at the George Property (Locale 1, Locale 2, and LCP North).

Site Preparation and Construction Phase

- Site preparation may begin in 2014 (winter roads, fuel depots, laydown areas)
- Full construction of the project could commence as early as 2016 – two years to complete construction
- Approximately $605 M initial capital investment

Operational Phase

- Goose Property: open pit at Llama, Umwelt and Goose deposits; underground at Umwelt deposit
- George Property: Open pits at Locale 1, Locale 2, LCP North

Production

- Production Rate (Ore): 15.0 million tonnes of mill feed for life of mine
- Projected annual 300,000 ounces of gold for about up to 10 years

Processing

- 5,000 tonnes per day
- Standard gravity separation and cyanide leaching circuit
- Tailings facility at Goose Property

Transport

- Gold doré bars shipped out by aircraft

Access Roads

- All-weather roads within George and Goose properties
- Winter road between George and Goose properties
- Winter road to link properties to the Marine Laydown Area at Bathurst Inlet
- Short term winter road link to Tibbett-Contwoyto Winter Road

Re-supply

- Marine supply via open water seasonal shipping (max of 10 ships, average of 3 to 5 per year)
- Year-round by aircraft
- Winter road to the Marine Laydown Area
- Winter road connection to Yellowknife (short term)

Environment

- Extensive baseline studies including terrestrial environment, wildlife (particularly caribou), marine environment, freshwater environment, air quality and resource utilization
- Traditional knowledge information collected and analyzed through an Inuit owned major study - Naonaiyaotit Traditional Knowledge Project
- Will form the foundation of Environmental Impact Statement , and provide information for development of mitigation and management plans

Employment

- Fly-in/fly-out operation
- Direct construction employment up to 1200 person years over a two year period
- Direct operations employment up to 4442 person years for 10 years

Social and Economic Benefits

- Inuit Impact Benefits Agreement with the Kitikmeot Inuit Association
- Opportunities for local businesses
- Royalties and taxes to governments

Closure and Post-closure Phase

- Closure will ensure that the former operational footprint is both physically and chemically stable in the long term for protection of people and the natural environment
- Post closure environmental monitoring will continue sufficient to verify that reclamation has successfully met closure and reclamation objectives

BACK RIVER PROJECT

DRAFT ENVIRONMENTAL IMPACT STATEMENT
Supporting Volume 7:
Marine Environment

December 2013
Project #0194096-0040

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Prepared for:

Sabina Gold & Silver Corp.

Prepared by:

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Vancouver, British Columbia

Executive Summary

Executive Summary

The Back River Project (the Project) is a proposed gold project owned by Sabina Gold & Silver Corp. (Sabina) within the West Kitikmeot region of Nunavut. The Project is composed of three main areas: the Goose Property, the George Property, and a Marine Laydown Area (MLA) situated along the western shore of southern Bathurst Inlet. Sabina has prepared an Environmental Impact Statement (EIS) to identify and assess potential environmental and social effects resulting from the Project, and is consistent with the requirements outlined in the Nunavut Land Claim Agreement (NCLA) and the Nunavut Impact Review Board (NIRB) Guidelines for the Preparation of an Environmental Impact Statement for the Back River Project (NIRB File No. 12MN036; NIRB 2013). This volume of the EIS presents the assessment of potential environmental effects to the marine environment associated with proposed Project activities following the application of mitigation and management measures.

The scoping of potential Valued Ecosystem Components (VECs) involved Sabina-led public consultations, the use of Traditional Knowledge (TK), regulator consultations and regulatory considerations such as conservation status of species or groups, and recommendations presented in the NIRB EIS guidelines (NIRB 2013). The *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project Report* (KIA 2012) was consulted extensively for TK information. Based on these sources, the following marine components were selected as VECs: marine water quality, marine sediment quality, marine fish/aquatic habitat, marine fish communities, seabirds/seaducks, and ringed seals. Marine physical processes were considered a Subjects of Note and all required information noted in the EIS guidelines is included in this volume. Additional information on the commercial shipping route and key migratory bird nesting areas and marine mammals is included in the seabird/seaducks and ringed seals (marine mammals) chapters. A marine diesel fuel spill model was also developed for the Project and can be found in Volume 9 of the DEIS.

Potential effects on VECs were evaluated spatially within a Local Study Area (LSA) and a larger Regional Study Area (RSA). The marine LSA covered 32 km^2 and included the water portion of the Potential Development Area (PDA) for the MLA as well as the over-water portion of the winter road across Bathurst Inlet (~14 km) to the Nunavut mainland. The marine RSA covered 3,000 km^2 and included the marine LSA plus all of Bathurst Inlet as far north as Omingmaktok. All potential Project effects were assessed during the Site Preparation, Construction, Operations, Reclamation and Closure, and Post-closure Project phases. Specific legislation that was considered during the assessment included the *Fisheries Act*, the *Species at Risk Act* (SARA), the *Migratory Birds Convention Act*, and the *Nunavut Wildlife Act*. Canadian Council of Ministers of the Environment (CCME) water and sediment quality guidelines for the protection of marine and estuarine life were used in the water and sediment quality assessments.

The following presents summaries of the existing environment, primary Project activities that are anticipated to interact with the marine VECs, mitigation measures, effects assessment, and if applicable, cumulative effects assessment for each marine VEC.

Marine Physical Processes

The MLA is located on the southwest shore of Bathurst Inlet, which is a deep fjord extending over 200 km in a north-south direction. The navigable corridor is generally very deep, with depths between

100 and 200 m for most of the inlet, although several sills are present midway through the fjord that can rise to depths above 50 m.

Baseline physical oceanographic data have been collected in Bathurst Inlet since 2001 and within the marine LSA in 2013. Results have shown that consolidated first-year sea ice (1.5 to 2 m average thickness) usually covers the inlet from October to June, and ice break-up usually occurs in June or early July. Tidal elevations are very weak in the inlet, with maximum amplitudes below 0.5 m.

The water column structure consists of a strongly stratified two-layer system during the open-water season with a 15 to 20 m warmer, fresher and more oxygenated top layer above a colder, saltier and lower oxygen bottom layer (Rescan 2008, 2012). This stratification is weaker when ice is present due to the absence of freshwater inflow and the presence of salt extrusion during ice formation. Water circulation generally follows a two-layered positive estuarine flow with the surface waters moving north towards Coronation Gulf and the deep water moving south into Bathurst Inlet. The estuarine flow is driven primarily from horizontal pressure gradients generated by the combined freshwater inputs from several rivers along the inlet, such as the Western River at the southern head of the inlet and the Hiukitak River that flows into Gordon Bay. Significant variability in both current speeds and directions is present due to the strong influence of winds on the water column. Average velocities in southern Bathurst Inlet can be less than 10 cm/s in the bottom layer, while in the top layer they can range from 20 to 60 cm/s, with maximum recorded magnitudes reaching over 90 cm/s during strong wind events.

Wave height measurements obtained near the MLA indicate that surface waves are small, generally less than 0.5 m during the open-water season, although maximum heights approaching 1 m have been measured. Most currents were linked to wind-driven forcing, while calculated tidal currents were generally almost negligible.

Marine Water Quality

Baseline marine water quality data have been collected in the marine RSA in Bathurst Inlet since 2001 and within the LSA in 2013. The results showed that the water in southern Bathurst Inlet was typical of pristine Arctic marine waters, with low concentrations of nutrients, suspended solids, and metals. Nutrients were lower in the open-water surface layer than at depth or during the winter due to enhanced biological uptake (e.g., phytoplankton) and freshwater dilution through ice melt and freshwater inflow. Nitrogen was likely the limiting nutrient for primary production as nitrate concentrations were near or below detection limits in the summer surface waters, while phosphorus concentrations were still measureable (>0.01 mg P/L). Metal concentrations were generally below the CCME guidelines for the protection of marine and estuarine aquatic life and were often undetectable. Near-shore sites by stream outflows or in areas of shallow bathymetry sometimes had elevated levels of suspended material and metal concentrations. Cadmium was the only naturally elevated metal above CCME marine water quality guidelines in the LSA. Deep water dissolved oxygen concentrations were occasionally below the CCME dissolved oxygen guideline of 8 mg/L, which is common in deep fjords where deep water renewal is slow and organic material is continually re-mineralized.

Potential Project effects on the marine water quality VEC included shipping activities; sediment introduction to water as a result of site preparation, construction, and reclamation; site contact water; winter roads; explosives; fuels, oils, and polycyclic aromatic hydrocarbons (PAHs); treated discharges; and dust deposition. The potential effects from these activities were assessed based on their potential interaction pathways with the marine environment, including runoff, contact and physical effects (shipping), treated discharge, and aerial deposition. The mitigation and management measures designed to control these pathways, and therefore minimize or eliminate potential Project effects on the marine water quality VEC included: minimizing vessel speeds and restricting vessels to deeper waters, intercepting runoff in ditches and diverting the water to a collection pond at the MLA, using geochemically suitable material for roads and pads, adhering to regulatory guidelines for treated discharges, and using best management practices for the storage, transport, and use of fuels, explosives, and hazardous materials as well as for dust suppression and incineration.

Following the application of mitigation and management measures, three residual effects were identified: marine water quality changes due to shipping (propeller wash), sediment introduction to marine waters as a result of site preparation, construction, and reclamation, and marine water quality changes due to site contact water. The magnitude of the anticipated residual effects is expected to be low, the duration short to medium term (confined to the life of the Project), sporadic in nature, and confined to within the marine LSA. The residual effects are also anticipated to be reversible. Contingent on the implementation of mitigation measures outlined in the Aquatic Effects Management Plan (AEMP; Volume 10, Chapter 19) and the Site Water Monitoring and Management Plan (Volume 10, Chapter 7), the significance of residual effects for marine water quality is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted because residual Project effects were predicted. Due to the fact that Project residual effects are confined to the marine LSA, the closest project that could potentially interact with the Project is located outside the spatial boundary of the cumulative effects assessment and, hence, there are no potential cumulative effects on marine water quality. As the Project residual effects were confined to the marine LSA, which resides entirely within Nunavut, there was no potential for transboundary effects.

<u>Marine Sediment Quality</u>

Sediment quality data have been collected in the marine RSA in Bathurst Inlet since 2001 and directly within the LSA in 2013. The sediment environment in Bathurst Inlet is generally a function of water depth and physical processes, where shallower, near-shore areas are subjected to increased erosion and re-suspension due to the interaction of the wind-driven water currents and the seabed. Thus, the shallower sediments (<5 m) in Bathurst Inlet were composed of coarser sand substrates (60 to >95%) than the finer silts and clays found in the deeper waters 100 m from shore (50 to 90%). Sediments near the MLA within the LSA were sandy (>75%), particularly in the near-shore environment where the majority of Project activities will occur. Metal concentrations in marine sediments were strongly correlated to the relative abundance of silt and clay particles, and therefore were generally greater in the deeper waters. Naturally elevated concentrations of arsenic, chromium, and copper were observed in the deeper sediment samples and were often greater than the CCME sediment quality guidelines for the protection of aquatic life. Sediment metal concentrations near the MLA were observed to be naturally low, as expected because of the relative dominance of sand-size particles.

Potential Project effects on marine sediment quality shared the same pathways and mitigation and management measures as outlined for marine water quality. The primary pathways between the Project activities and the marine sediment quality VEC were identified as runoff, contact and physical effects (shipping), discharge, and aerial deposition. The same mitigation and management measures would be applied as described above in the marine water quality section.

Following the application of mitigation and management measures, three residual effects were identified: marine sediment quality changes due to shipping (propeller wash), sediment introduction to the marine environment as a result of site preparation, construction, and reclamation, and marine sediment quality changes due to site contact water. The magnitude of the anticipated residual effects is expected to be low, the duration short to medium term (confined to the life of the Project), sporadic in nature, and confined to within the marine LSA. The residual effects are also anticipated to be reversible. Contingent on the implementation of mitigation measures outlined in the Aquatic Effects Management Plan (AEMP; Volume 10, Chapter 19) and the Site Water Monitoring and Management Plan (Volume 10, Chapter 7), the significance of residual effects for marine sediment quality is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted because residual Project effects were predicted. Due to the fact that Project residual effects are confined to the marine LSA, the closest project that could potentially interact with the Project is located outside the spatial boundary of the cumulative effects assessment and, hence, there are no potential cumulative effects on marine sediment quality. As the Project residual effects were confined to the marine LSA, which resides entirely within Nunavut, there was no potential for transboundary effects.

Marine Fish/Aquatic Habitat

The VEC marine fish/aquatic habitat comprises both the physical habitat and the biological resources that sustain the productivity of marine fisheries species and the diversity of marine fish communities.

Baseline data on marine habitat have been collected in the RSA in Bathurst Inlet since 2001 and in the LSA in 2012 and 2013. The shoreline of the LSA and the southern section of the RSA are dominated by a shallow water shelf, which extends to a depth of approximately 10 m and a distance of 120 m offshore. Beyond this, the bottom descends steeply to depths greater than 40 m. The substrate in the intertidal zone is dominated by cobble and gravel, while deeper areas feature more mud and silt. Based on nearshore surveys and traditional knowledge, potentially important habitat areas for marine and anadromous fish were identified in the LSA and RSA. The outlet of some rivers are important habitat for Arctic Char (*Salvelinus alpinus*), with some of these areas acting as migratory pathways for anadromous Arctic Char. Intertidal gravel beaches and shallow gravel beds are important spawning habitats for Capelin (*Mallotus villosus*).

The assessment of potential Project-related effects on marine fish/aquatic habitat involved the direct effects of Project activities on the physical habitat of marine fish. Potential indirect effects are addressed as part of the marine water quality and sediment quality assessments. Project activities that have the potential to directly affect marine fish/aquatic habitat include the in-water construction of MLA infrastructure (in-water construction of a seasonal dock and beach ramp).

The following measures are expected to fully mitigate the potential Project effect on marine fish/aquatic habitat: measures in place to eliminate or reduce potential effects to water quality and sediment quality, and the construction of artificial marine shoals to offset the marine fish/aquatic habitat loss as described in the Conceptual Fisheries Offsetting Plan. Therefore, no residual effects are anticipated on the VEC marine fish/aquatic habitat.

As no Project residual effects are anticipated, there are no effects that could act cumulatively with other projects. Therefore no cumulative effects or transboundary effects are expected.

Marine Fish Community

The marine fish community of Bathurst Inlet is characteristic of Arctic marine ecosystems and includes marine, anadromous, and freshwater/estuarine species. Many of these species play important roles in the ecological and cultural health of the area. Nineteen fish species have been captured during baseline studies between 2001 and 2013, or are presumed to occur, in the marine LSA. Dominant species include Fourhorn Sculpin (*Myoxocephalus quadricornis*), Capelin (*Mallotus villosus*), Pacific Herring (*Clupea pallasii*), and Starry Flounder (*Platichthys stellatus*). None of the species sampled during the baseline studies are threatened or endangered. Arctic Char (*Salvelinus alpinus*) were not captured during baseline studies, but are presumed to occur in the LSA due to the presence of char spawning rivers and streams in the marine RSA.

Potential Project effects on the VEC marine fish community focused on Arctic Char and include potential direct mortality from in-water construction and blasting, population effects from introduced species carried by ballast water, and underwater noise from shipping activities. Mitigation measures to eliminate or reduce potential effects to the marine fish community include limiting the amount of in-water construction, eliminating ballast water exchange, and enforcing speed limits for ships navigating through the RSA.

Following the application of mitigation and management measures, one residual effect was identified: effects of shipping noise on marine Arctic Char populations. The magnitude of the anticipated residual effect is expected to be low, the duration medium term (confined to the life of the Project), sporadic in nature (3-10 ships per open-water season, depending on the Project phase), and confined to the marine RSA. The residual effect will be reversible as it will end when shipping associated with the Project ends. Contingent on the implementation of mitigation measures outlined in the Aquatic Effects Management Plan (AEMP; Volume 10, Chapter 19), the Shipping Plan (Volume 10, Chapter 15), and the Noise Abatement Plan (Volume 10, Chapter 18), the significance of the residual effect for marine fish communities as assessed for Arctic Char is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted because a residual Project effect was predicted. There are two potential future projects that could act cumulatively with the Project residual effects: the proposed Bathurst Inlet Port and Road Project (BIPR) and the proposed Hackett River Project which would use the same port location as BIPR. If these two proposed projects would proceed, marine Arctic Char would be exposed to noise from shipping within the marine RSA. The total amount of noise that Arctic Char may be exposed to could increase if ships passed close to each other, but the magnitude of the effect is expected to be low, as noise increases would be confined to within approximately 100 m of the ship location and drop to background levels outside of this area. The frequency of noise may increase, but would continue to be sporadic. The cumulative effect would cease once shipping activity has ended for the Project, so the cumulative effect would be of medium duration and would be reversible. Assuming the mitigation measures that would be in place for the Project as noted above, the significance of the cumulative effect of shipping noise on Arctic Char is predicted to be **Not Significant**.

As the Project residual effect and cumulative effect were confined to the marine RSA, which resides entirely within Nunavut, there was no potential for transboundary effects.

Seabirds/Seaducks

Seabirds and seaducks include migratory bird species that may use marine areas during any time of year and encompass a diverse group of avian species including eiders, scoters, geese and swans, dabbling ducks, diving ducks, loons, and gulls. Seabirds and seaducks and their nests are protected by the federal *Migratory Birds Convention Act* (1994). The following three seabird and seaduck species are listed as “Sensitive” under the Canadian Endangered Species Conservation Council (CESCC) designations for Nunavut: common eider, glaucous gull, and long-tailed duck (CESCC 2010).

Aerial and ground surveys were conducted in the marine wildlife RSA between 2007 and 2013 during breeding (June and July) and staging periods (August) and documented a total of 23 species in the marine RSA in Bathurst Inlet. No evidence of breeding was recorded during breeding surveys in any years. In spring, staging areas appeared to occur in open-water areas and near major river drainages such as the Burnside River and Western River outflows during the spring when the majority of the inlet is ice covered. In late-summer and fall (mid-July and August), large numbers (> 50 birds) of Canada geese and ducks (greater scaup and red-breasted mergansers) were observed in the shallow bay southwest of the MLA footprint in the LSA. The greatest abundances of seabirds and seaducks were observed in late-summer and fall periods.

Two types of Project-related activities were evaluated for potential effects to the VEC seabirds and seaducks, including shipping and Construction and Operation activities at the MLA. Mitigation measures have been implemented to minimize or eliminate the effects of the Project on seabirds and seaducks. For example, the seabird and seaduck staging areas identified during the baseline surveys were included in Project design to avoid these sensitive habitats. These areas will be avoided by developing pre-determined flight paths, when possible, to provide horizontal and vertical buffer distances from staging birds. A flight altitude of 650 m will also be maintained above known staging areas where it is safe to do so. Aircraft landing and take-offs will avoid staging areas for the safety of humans and wildlife.

Consideration of the mitigation and management activities planned to reduce potential Project effects on seabirds and seaducks resulted in the identification of two residual effects after mitigation: disturbance (e.g., noise) and reduced reproductive productivity. These residual effects were expected to be of moderate to low magnitude, of medium duration (confined to the life of the Project), sporadic in nature, confined to within the marine RSA, and reversible. The residual effects were rated as **Not Significant**, contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Volume 10, Chapter 20).

A potential cumulative effects assessment was conducted because residual Project effects were predicted. Project residual effects have the potential to interact with the reasonably foreseeable future BIPR and Hackett River projects as they would be located within the marine RSA. The cumulative residual effects were expected to be of low magnitude, of medium duration (confined to the life of the Project), sporadic in nature, confined to within the marine RSA, and reversible. Overall, the combined significance of the cumulative residual effects was anticipated to be **Not Significant** and a population level effect on seabirds and seaducks is not expected to occur. As the Project residual effects were confined to the marine RSA, which resides entirely within Nunavut, there was no potential for transboundary effects.

<u>Ringed Seals</u>

Aerial surveys were conducted during the spring moulting period (mid-May through mid-July) between 2007 and 2013 in the marine RSA to assess abundance and distribution of ringed seals. Results indicated that ringed seal abundance was spatially variable in Bathurst Inlet, with moderate densities present in most parts of the inlet, except in the southern RSA south of Kingaok where very low densities of adult and 8 to 10-week-old pups were found. Ringed seal lairs were only found in the northern RSA during surveys; no lairs were observed in the southern RSA or the LSA. The low ringed seal abundance in southern Bathurst Inlet and the absence of lairs may be due to the ice having fewer cracks and pressure ridges as these are often used by seals for lairs and access points for breathing holes. During the summer, ringed seal density is anticipated to be very low in Bathurst Inlet based on incidental recordings during other baseline studies conducted in the marine RSA and evidence from literature elsewhere.

Two types of Project-related activities were evaluated for potential effects to the VEC ringed seals, including shipping and Construction and Operation activities at the MLA (e.g., aircraft and traffic on winter roads that overlap marine areas). Mitigation measures will be implemented to minimize or eliminate the effects of the Project on ringed seals. Shipping for the Project will be conducted during the open-water periods only (August 25 to October 31) when ringed seal density in the marine LSA and RSA is anticipated to be very low. Activities occurring at the MLA are expected to be during the open-water shipping period and during the winter when the winter roads are operational (December through March). These time periods correspond to periods when seals are not in the vicinity of the LSA or southern RSA (south of Kingaok). Therefore, the Project is not predicted to result in any residual effects on ringed seals and no cumulative or transboundary effects are anticipated to occur.

ᐃᒪᖓᑕ ᐊᕙᑎᐊᓂ ᖃᓄᐃᓐᓂᖓᓂᒃᓇᐃᓪᓕᕆᐊᓗᒍ ᐅᓂᒃᑳᖅ

ᓴᓐᓂᖓᔪᓕᐅᑉ ᑰᖓᓂ ᓴᓇᕕᐅᔪᒥ (ᓴᓇᕕᐅᔪᖅ) ᐅᔭᕋᓐᓂᐊᕐᒪᑕ ᕿᓂᖅᓯᑎᒃ ᓴᕕᕋᔭᒃᓴᓂᒃ ᒨᓄᖃᖅᑐᓂᒃ ᓄᓇᖁᑎᒋᔭᐅᔪᓂ ᓴᐱᓇᒃᑯᑦ ᒍᓗᓂᒃ ᓴᕕᕋᔭᒃᓴᓂᓗ ᑎᒥᖁᑎᐊᓄᑦ (ᓴᐱᓇ) ᑕᒪᑐᒪᓂ ᕿᑎᕐᒥᐅᓂ ᓄᓇᕗᒥᐅᑦ ᐅᐊᓕᓂᖔᖓᓂ. ᓴᓇᕕᒋᔭᖏᑦ ᐱᖓᓱᐃᓕᖓᔪᓂᒃ ᓄᓇᓕᕋᓕᖅᑲᖅᒪᑕ ᓄᓇᒥ: ᒨᔅᒥ ᓴᓇᕕᐅᔪᖅ, ᔪᐊᔨᒥ ᓴᓇᕕᐅᔪᖅ, ᐊᒻᒪᓗ ᓯᒃᔭᒥ ᓂᐅᕋᐃᕝᕕᖓᑦ (MLA) ᑖᓇᓕ ᐅᐊᓕᓂᖔᖓᓃᑦᑐᖅ ᕿᖓᐅᕐᒥᐅᑦ ᑲᖏᖅᓯᖓᓂ. ᓴᐱᓇᒃᑯᑦ ᐸᕐᓇᐃᓯᒪᔪᑦ ᐊᕙᑎᖓᓄᑦ ᐃᒃᐱᖕᓇᕐᓂᕐᑲᕐᓂᐊᖅᑐᓂᒃ ᐅᓂᒃᑳᓕᐊᖅᓯᒪᓕᖅᑐᑦ ᑕᒪᑐᒧᖓ (EIS) ᓇᓗᓇᐃᔭᐃᑦᑐᑎᒃ ᖃᓄᖅ ᑕᒪᐅᖓᐅᕗᓂᐊᕐᓂᕐᒥᓂᒃ ᐊᒻᒪᓗ ᐊᖅᑯᓵᖅᑕᐅᓂᐊᖅᑐᑦ ᐊᕙᑎᖏᑦ ᐊᑦᑕᕐᓇᕐᓂᖅᑐᑦ ᐊᒻᒪᓗ ᖃᓄᑎᒋ ᑕᒫᓂᕐᒥᐅᑦ ᐃᓕᖅᑯᓯᖏᓐᓄᑦ ᐃᒃᐱᖕᓇᕐᓂᕐᑲᕐᓂᐊᕐᒪᖔᑕ ᑕᒫᓂ ᓴᓇᓂᖏᓐᓂ, ᐊᒻᒪᓗ ᐃᓗᓕᖅᑲᓇᑦᑐᓂ ᓇᓗᓇᐃᔭᐃᔪᒥᒃ ᐊᑐᐊᒐᓕᐊᕆᔭᐅᓯᒪᔪᓂᒃ ᒪᓕᖕᓂᖓᓂᒃ ᐅᓂᒃᑳᓂᒃ. ᓄᓇᕗᑖᕈᑎᐅᑉ ᐊᖏᕈᑎᐊᓂᒃ (NCLA) ᐊᒻᒪᓗ ᓄᓇᕗᒥᐅᓄᑦ ᐃᒃᐱᖕᓇᕐᓂᕐᑲᖅᑐᓄᑦ ᐊᖏᕈᑎᐊᓂᒃ (NIRB) ᐊᑐᐊᒐᖏᑦ ᒪᓕᒃᓯᒋᑦ ᐸᕐᓇᐃᔪᑏᑦ ᐊᕙᑎᒧᑦ ᐃᒃᐱᖕᓇᕐᓂᕐᑲᕐᓂᐊᖅᑐᓂᒃ ᐅᓂᒃᑳᓕᐅᖅᑎᑦᑐᒋᑦ ᓴᓐᓂᖓᔪᓕᐅᑉ ᑰᖓᓂ ᓴᓇᕕᐅᓂᐊᖅᑐᓄᑦ (NIRB File No. 12MN036; NIRB 2013). ᑖᓇ ᐊᕙᑎᒧᑦ ᐃᒃᐱᖕᓇᖅᑐᓂᒃ ᐅᓂᒃᑳᖅᓯᒪᔪᖅ ᐊᒃᑐᐊᔭᐅᓂᐊᖅᑐᓂᒃ ᐊᕙᑎᑦᑎᓂ ᐃᓄᖕᓂᓄᑦ ᐊᕙᑎᐅᔪᓂ ᓴᓇᔪᓄᑦᑐ ᐅᐸᒃᑕᐅᕐᑲᑦᑕᕐᓂᐊᖅᑐᑦ ᑐᒃᓯᕋᐅᑎᒋᓚᐅᖅᑕᕗᑦ ᐱᔪᓐᓇᐅᑎᑖᕈᑎᒋᓪᓗᒋᑦ ᐋᕿᒃᓯᐃᑦᑎᐊᕐᓂᐊᕈᑎᓂᒃ ᐊᐅᓚᑦᑎᔪᑕᐅᓂᐊᖅᑐᓂᓗ.

ᖃᓄᑎᒋ ᐊᑐᕐᓂᐊᕐᓂᐊᕐᒪᖔᑕ ᐱᒃᑯᒥᒋᔭᐅᔪᓄᑦ ᓄᓇᓄᑦ (VSECs) ᖃᐅᔨᓴᖅᑕᐅᓂᐊᖅᑐᑦ ᓴᐱᓇᒃᑯᓐᓄᑦ ᐊᐱᖅᓲᑕᐅᓪᓗᑎᒃ ᓄᓇᓕᖕᒥᐅᓄᑦ, ᐱᖅᑯᓯᑐᖃᕐᓂᖅ (TK), ᒪᓕᒐᑎᒍᑦ ᐊᐅᓚᑦᑎᔨᐅᔪᓂᒃ ᐊᒻᒪᓗ ᖃᓄᑎᒋ ᒪᓕᒐᓕᐅᕈᑕᐅᓂᐊᕐᒪᖔᑦ ᓄᓇᕗᒥᐅᓄᑦ ᐃᓱᒪᒃᓴᖅᓯᐅᕈᑕᐅᔪᓐᓇᕐᓂᐊᕐᒥᔪᑦ ᒪᑯᓄᖓ ᐱᐅᖅᓯᐊᖅᑕᐅᒋᐊᓕᖕᓄᑦ ᓂᕐᔪᑎᓄᑦ ᐃᓚᐃᓐᓇᖏᓐᓄᑦ ᐊᒥᓯᓄᑦᔫᓐᓃᑦ ᑲᑎᖓᔪᓄᑦ, ᐊᒻᒪᓗ ᐊᑐᓕᕐᑯᔭᐅᓂᐊᖅᑐᑦ ᑐᓂᔭᐅᓂᐊᕐᒪᑕ NIRB EIS ᒪᓕᓗᒋᑦ ᐊᑐᐊᒐᖏᑦ ᐅᕙᓂ (NIRB-ᑯᓐᓄᑦ 2013-ᒥ). *ᐃᓄᐃᑦ ᐱᖅᑯᓯᑐᖃᖏᑦ ᖃᐅᔨᓴᖅᑕᐅᑎᓪᓗᒋᑦ ᓴᐲᓇᒥ ᒍᓗᓂᒃ ᓴᕕᕋᔭᒃᓴᓂᓗ ᑎᒥᖁᑎᐊᑕ ᖃᐅᔨᓴᕝᕕᐊᓂ, ᓴᓐᓂᖓᔪᓕᐅᑉ ᑰᖓᓂ ᓴᓇᕕᐅᓂᐊᖅᑐᒥ. ᓇᓗᓇᐅᔭᐅᑏᑦ ᐱᖅᑯᓯᑐᖃᒃᑯᑦ ᐅᓂᒃᑳᓕᐊᕆᔭᐅᓚᐅᕐᒥᔪᑦ* (KIA-ᑯᓐᓄᑦ 2012-ᒥ) ᐊᒃᓯᐊᓗᒃ ᐅᖃᓪᓚᑲᑕᒍᑦᑕᐅᓚᐅᕐᒪᑦ ᐱᖅᑯᓯᑐᖃᒃᑯᑦ ᖃᐅᔨᒪᔭᖏᓐᓂᒃ TK ᑲᑎᖅᓱᐃᓇᓱᐊᖅᓱᑕ. ᑖᒃᑯᐊ ᐊᑐᐊᓇᓪᓗᒋᑦ, ᐅᑯᐊ ᓄᓇᒧᑦ ᐅᔾᔮᖅᓯᕆᑕᐅᒋᐊᓕᖕᓄᑦ ᐊᑐᐊᓚᓕᐅᕐᑕᐅᓚᐅᖅᑐᑦ VECs-ᑯᑎᒍᑦ ᑲᖏᖅᓯᑉ ᐃᒪᖓᖅᑲᓄᐃᒋᐊᖓᓂᒃ, ᑲᖏᖅᓲᑉ ᐃᖅᑲᖓᓄᑦ ᑲᑕᖕᓂᑦᑐᓇᐃᑦ ᖃᓄᐃᐊᓐᓂᖅᑐᑦ, ᑕᓇᐅᕐᒥ ᐆᒪᔪᑦ ᐃᖅᑲᓗᐃᑦ/ᓇᔪᕐᕕᖏᓪᓗ, ᑕᓇᐅᕐᒥᐅᑕᐃᑦ ᐃᖅᑲᓗᐃᑦ ᖃᓄᐃᑦᑑᓂᖏᓪᓗ, ᐃᒪᕐᒥᐅᑕᐃᑦ ᑎᖕᒥᐊᑦ/ᐊᕐᒥᐊᕐᔪᐊᑦ, ᐊᒻᒪᓗ ᓇᑦᑏᑦ. ᑕᓇᐅᕐᒪᓂ ᐃᖅᑲᐅᒪᓐ ᓴᓇᒪᓐ ᕿᒥᕈᔭᐅᓚᐅᕐᒥᔪᖅ ᐱᒃᑯᒥᒋᔭᐅᔪᑦ ᑎᑎᕋᖅᑕᐅᓚᐅᕐᒥᔪᑦ EIS-ᓂ ᐊᑐᐊᓚᐅᖅᑐᑦ ᐃᓚᓕᐅᑎᔭᕗᑦ. ᐊᒻᒪᓗ ᑐᓴᕈᒪᓇᖅᑐᑦ ᐃᒪᖓᓂ ᐅᒥᐊᕐᔪᐊᓄᑦ ᐃᖕᕆᕋᑲᑕᕕᐅᓕᕐᒪᑦ ᐊᖅᑯᑎᒋᔭᐅᔪᓇᖅᑐᑦ ᐊᒻᒪᓗ ᑕᐃᒃᑯᐊ ᑎᖕᒥᐊᓄᑦ ᐊᐅᔭᒃᑯᑦ ᑎᑭᖅᑲᑦᑕᖅᑐᓄᑦ ᓇᔪᖅᑕᖅᑲᑦᑕᖅᑐᓄᑦ ᐃᕙᕕᐅᖅᑲᑦᑕᖅᑐᓄᑦ ᐊᒻᒪᓗ ᐳᐃᔨᓄᑦ ᐃᒪᕐᒥᐅᑕᓄᑦ ᑎᖕᒥᐊᓄᑦ/ᐋᕿᐊᑉᔪᖕᓄᑦ ᓇᔪᓕᓴᐅᔪᑦ ᐊᒻᒪᓗ ᓇᑦᑎᓄᑦ (ᐳᐃᔩᑦ) ᐅᓂᒃᑲᐅᓯᐅᖕᒥᔪᑦ. ᑕᓇᐅᕐᒥ ᐅᓯᐊᓗᖕᒥᒃ ᑯᕕᔪᖅᓯᖅᓯᖅᐸᑦ ᖃᐅᔨᓴᕐᓇᓱᐊᕐᓂᖅ ᐆᒃᑐᕋᖅᑕᐅᔪᓄᑦ ᓴᓇᕕᐅᓂᐊᕐᓂᖓᓄᑦ ᐃᓱᒪᒋᑦᑐᒍ ᐅᓂᒃᑲᐅᓯᐅᕐᒥᔪᑦ ᐃᔾᔪᔪᖅ 9-ᒥ DEIS-ᑯᓐᓂ.

ᖃᖓᑐᐃᓐᓇᖅ ᐃᒃᐱᖕᓇᕐᓂᖅᑐᐃᓐᓇᓇᐊᓕᑦ VEC-ᓂ ᕿᒥᕈᔭᐅᓚᐅᕐᒥᔪᑦ ᐊᒃᑎᒋᓂᖏᑦ ᑕᒪᑐᒪᓂ ᓄᓇᓕᖕᓂ ᖃᐅᔨᓴᕐᑎᑕᐅᑦᑐᑎᑉ (LSA) ᐊᒻᒪᓗ ᐊᖏᓂᖅᕕᒃ ᕿᑎᕐᒥᐅᓂᓕᒫᖅ (RSA). ᑕᓇᐅᕐᒪ ᓄᓇᖓ ᑕᒪᓂ LSA-ᒥ ᓈᓯᖕᒪᑦ 32-ᑭᓚᒥᑐ ᓯᑭᑕᓂᒃ ᐊᒻᒪᓗ ᐃᓗᓕᖅᑲᖅᓯᓂ ᐃᒪᖓᓂᒃ ᖃᐅᔨᓴᖅᕕᐅᔪᒥᒃ ᑕᒫᓂ ᐱᒃᑯᒥᒋᔭᐅᔪᒥ (PDA) ᓂᐅᕋᐃᕝᕕᐅᓂᐊᖅᑐᒥ MLA ᐊᒻᒪᓗ ᐊᖅᑯᑎᓕᐅᕝᕕᐅᓂᐊᖅᑐᒥ ᐅᑭᐅᒃᑯᑦ ᐃᒪᐅᑉ ᕿᖓᐅᒍᑦ ᕿᖏᐅᑉ ᑲᖏᖅᓯᖓᓂ (~14 ᑭᓛᒥᑐᒧᑦ) ᑎᑭᓪᓗᒍ ᓄᓇᕗᒥ ᓄᓇᖓᓄᑦ. ᑕᓇᐅᕐᒥ ᖃᐅᔨᓴᕝᕕᐅᔪᓂ RSA ᓇᓯᔪᖅ 3,000-ᑭᓚᒥᑐ ᓯᑭᑕᒥᒃ ᐊᒻᒪᓗ ᐃᓚᐅᑎᓪᓗᒍ ᓯᒃᔭᒥ ᓂᐅᕋᐃᕙᓪᓕᐊᓂᐊᕐᓂᖓ ᐊᒻᒪᓗ ᑕᒫᓂ ᕿᖓᐅᑉ ᑲᖏᖅᓯᖓᓂ ᑎᑭᓪᓗᒍ ᐅᒥᖓᒃᑑᑦ. ᑕᒪᐃᑕ ᓴᓇᕕᐅᔪᒪᔪᓄᑦ ᐃᒃᐱᖕᓇᕐᓂᕐᑲᕐᓂᐊᖅᑐᑦ ᕿᒥᕈᔭᐅᓂᐊᖅᑐᑦ ᑕᒪᑐᒪᓂ ᒪᓂᕋᖅ ᐸᕐᓇᒃᑕᐅᑎᓪᓗᒍ, ᓴᓇᔭᐅᑎᓪᓗᒍᓗ, ᐊᐅᓚᑕᐅᑎᓪᓗᒍᓗ, ᐅᑎᖅᑎᑕᐅᓕᖅᑎᓪᓗᒍᓗ ᒪᑐᓯᒪᓕᖅᑎᓪᓗᒍ ᓴᓇᕕᐅᔪᖅ, ᐊᒻᒪᓗ ᑭᖑᓂᖓᒍᑦ

ᖃᓄᐃᓕᐅᕈᑕᐅᕆᐊᖃᕈᒫᖅᑐᑦ ᐅᓂᒃᑲᐅᓯᐅᑉᓗᑎᒃ. ᐃᒻᒥᒃᑰᖓᔪᒥᒃ ᒪᓕᒐᓕᐅᕈᑕᐅᕆᐊᖃᕋᓯᕆᔭᐅᔪᔪᑦ ᑕᒪᑐᒪᓂ ᖃᐅᔨᓴᖅᑕᐅᑎᑉᓗᒍ ᐃᓯᒪᕆᑉᓗᒋ *ᐃᖃᓗᓐᓂᐊᕈᑏᑦ ᒪᓕᒐᖓ, ᐊᒻᒪᓗ ᐊᑦᑕᕐᓇᖅᑐᒦᓕᖅᑐᑦ ᓂᕐᔪᑏᑦ ᒪᓕᒐᖓ* SARA), *ᐊᐅᔭᒃᑯᑦ ᑕᒪᐅᖓᖃᑦᑕᖅᑐᓄᑦ ᑎᖕᒥᐊᓄᑦ ᒪᓕᒐᖅ, ᐊᒻᒪᓗ ᓄᓇᕗᒥ ᓂᕐᔪᑎᓄᑦ ᒪᓕᒐᖅ*. ᑲᓇᑕᒥ ᑲᑎᒪᔨᖏᑦ ᒥᓂᔅᑕᐃᑦ ᐊᕙᑎᓕᕆᔨᓄᑦ ᐃᒪᕐᒥ (CCME) ᐊᒻᒪᓗ ᐃᖅᑲᖑᓄᑦ ᑲᑕᖕᓂᕐᓗᑯᐃᑦ ᖃᓄᐃᖏᑦᑎᐊᕐᑯᓪᓗᒋᑦ ᐊᕙᑎᖓᓄᑦ ᐊᑐᐊᒐᖏᑦ ᓴᐳᔾᔨᓯᒪᔪᑕᐅᔪᑦ ᐆᒪᔪᓂᒃ ᐃᒪᕐᒥᐅᑕᓂᒃ ᐊᑐᖅᑕᐅᓚᐅᕐᒥᔪᑦ ᐃᒪᕐᒥ ᑰᓪᓗ ᐊᑯᐊᖏᓐᓂ ᐃᖅᑲᖓᓂᒥᐅᓄᑦ ᖃᓄᐃᖏᑦᑎᐊᕐᑯᓪᓗᒋᑦ ᖃᐅᔨᓴᕈᑕᐅᔪᓂ.

ᐅᑯᐊ ᑕᕝᕙ ᓇᐃᓪᓕᕆᐊᕐᓗᒋᑦ ᐅᓂᒃᑳᓕᐅᕈᑕᐅᓯᒪᔪᑦ ᐊᕙᑎᖓᓄᑦ, ᓯᕗᓪᓕᖅᐹᒥ ᓴᓇᕖᐅᓂᐊᖅᑐᑦ ᕿᓚᓈᓇᔭᐅᔪᓪᓗ ᐃᑉᐱᖕᓇᕐᓂᕐᑲᕐᓂᐊᕐᓂᖏᓐᓄᒃ ᐃᒪᖓᓄᑦ VECs, ᐊᒃᓲᓗᐊᖅᑕᐃᓕᕐᑯᓪᓗᒋᑦ ᐋᕿᒃᓱᖅᑕᐅᔪᑦ ᐃᑉᐱᖕᓇᕐᓂᕐᑲᖅᑐᓄᑦ ᖃᐅᔨᓴᖅᑕᐅᓪᓗᑎᒃ, ᐊᒻᒪᓗ ᐱᔪᓐᓇᕚᖓᑕ ᑲᑎᓪᓗᑎᒃ ᐃᑉᐱᖕᓇᕐᓂᕐᑲᕐᓂᐊᖅᑐᑦ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᕐᒥᔪᑦ ᐊᑐᓂ VSEC-ᓂ.

<u>ᐃᒪᖓᑕ ᐃᖅᑲᖓᓂ ᐋᕿᒃᓱᖅᓯᒪᓂᖓ</u>

ᓂᐅᕿᐃᕝᕕᓚᐊᓇᔭᐅᓂᐊᖅᑐᖅ ᓯᒡᔭᒥ ᓂᒡᒋᖓᖓᓃᒻᒪᑦ ᕿᖓᐅᑉ ᑲᖏᖅᓱᖓᓂ, ᐃᑎᔫᖕᒪᑦ ᑕᒪᑐᒪ ᑲᖏᖅᓱᖓ ᑕᐅᓄᖓᓗᒃ 200-ᑭᓚᒥᑐᒥᒃ ᑕᑭᓂᖅᑲᖅᓱᓂ ᑲᓇᖕᓇᖓᖓᓂᑦ ᓂᒡᒋᖓᖓᓄᑦ. ᐅᒥᐊᔪᐊᓄᑦ ᐊᖅᑯᑎᒋᔭᐅᔪᓐᓇᖅᑐᖅ ᐃᑎᔪᐊᓘᖕᒪᑦ, ᐃᑎᓂᖅᑲᐅᖅᓱᓂ 100-ᒥᑦ 200-ᒦᑐᒥᒃ ᑕᒪᐃᓐᓂᓕᒫᒃᓴᒃ ᑲᖏᖅᓱᖓᓂᒃ ᓈᓯᑦᑐᓂ, ᐃᓚᖏᓚᒃ ᐃᓚᖓᓂ ᐃᖅᑲᖓᓂ ᐳᖅᑐᓂᖅᑲᐅᖅᓱᓂ ᕿᑎᑦᑐᐊᖓᓂ ᑲᖏᖅᓲᒥ ᖃᐃᖅᓲᓖᖏᑦ ᑎᑭᑦᑐᓇᖅᑐᑦ ᐃᑎᓂᖅᑲᖅᑐᒧᑦ 50-ᒦᑐᒥᒃ.

ᑐᓐᖓᕙᒋᔭᐅᔪᓂᒃ ᐃᒪᓐᓂᐊᕈᑎᓄᑦ ᖃᐅᔨᓴᖅᑕᖅᓯᒪᓕᖅᑐᑦ ᐆᒃᑐᕋᖅᑕᖅᓯᑎᒃ ᑕᒫᓂ ᑲᑎᖅᓯᐃᓪᓗᑎᓗ ᕿᖓᐅᑉ ᑲᖏᖅᓱᖓ ᑕᐃᒪᖓᓂᓂᑦ 2001-ᒥᓂᑦ ᐊᒻᒪᓗ ᓯᒡᔭᖓ ᓂᐅᕿᐃᕝᕕᓚᐊᓇᔭᐅᓂᐊᖅᑐᒥ 2013-ᒥ. ᖃᐅᔨᓴᐅᓯᒪᓕᖅᑐᑦ ᓯᑯᖃᑦᑕᖅᓂᖓ ᐃᓱᕙᐅᖃᑦᑕᑦᑐᓪᓗ ᓯᑯᖏᓐᓄᑦ ᐃᑎᓂᖃᕈᑕᐅᖃᖃᑦᑕᖅᑐᑦ (1.5-ᒥᑦ 2-ᒦᑐᒥᒃ ᑕᐃᒪᖓᓂᑲᓴᒃ) ᓯᑯᓯᒪᓕᖃᑦᑕᖅᒪᑦ ᑕᒪᓇ ᐃᑭᐊ ᐅᑰᐸᒥᑦ ᔪᓐᒧᑦ, ᐊᒻᒪᓗ ᓯᑯᐃᖅᐸᓪᓕᐊᓕᖅᐸᒃᓯᓂ ᔪᓐᒥ ᔪᓚᐃᒥᓅᓐᓃᑦ. ᐅᓕᑦᑕᖅᓂᖏᓪᓕ ᑎᓂᑦᑕᖅᓂᖏᓪᓗ ᐊᒃᓲᓗᐊᖑᖏᑦᑐᑦ ᐃᖏᖃᓂᖃᓗᐊᖏᑦᑐᖅ ᑕᒫᓂ ᑲᖏᖅᓱᖓᓂ, ᑎᓂᓐᓂᖃᖅᐸᒃᓯᓂ ᐊᑖᓂ 0.5-ᒦᑐ.

ᐃᒪᖓᑕᓕ ᐃᑭᕐᒥ ᓴᓇᒪᓂᖓ ᐊᔾᔨᒌᖏᑦᑐᓂᒃ ᐊᕕᒃᓯᒪᓂᖅᑲᖅᑐᓂᒃ ᐃᒪᖅᑲᕐᒪᑦ ᒪᕐᕈᐃᓕᖓᓪᓗᓂ ᐊᐅᔭᒃᑯᑦ ᓯᑯᖃᕈᓐᓃᕿᖓᑦ 15-ᒥᑦ 20-ᒧᑦ ᒥᑐᓂ ᐅᖅᑰᓂᖅᓴᐅᓪᓗᓂ, ᐱᐊᖏᓐᓂᖅᓴᐅᓪᓗᓂᓗ ᐊᒻᒪᓗ ᐊᓂᖅᑎᓇᓐᓇᖅᓯᓂ ᐃᖅᑲᓗᖕᓄᑦ ᐆᓇᖅᓂᖅᓴᖅ ᖁᓚᓃᓯᓂ ᓂᓪᓚᓇᖅᓂᖅᓴᐅᑉ ᐊᑖᓂ ᑕᓇᐅᖑᓂᖅᓴᐅᓪᓗᓂ ᐊᓂᖅᑎᓇᓐᓇᖏᓐᓂᖅᓴᐅᓪᓗᓂ ᐃᖅᑲᓗᖕᓄᑦ (Rescan 2008, 2012). ᑕᒪᐃᓐᓇ ᐊᕕᒃᓯᒪᓂᖅᑲᖅᑐᖅ ᐃᒪᖓ ᐊᔾᔨᖅᑲᑦᑕᖅᓯᓂ ᓯᑰᖓᑦ ᑕᒪᓐᓇ ᑲᖏᖅᓱᒃ ᑰᕕᐅᔪᓐᓃᕿᖓᑦ ᐃᒪᑐᐃᓐᓇᕐᒥᑦ ᐊᒻᒪᓗ ᑕᓇᐅᕿᓗᒃ ᑎᑭᒃᑳᖓᑦ ᓯᒡᔭᖓᓄᑦ ᓯᑯᕙᓪᓕᐊᓕᖅᑎᓪᓗᒍ. ᐃᒪᖓᑕᓕ ᐃᖏᕿᓂᖅᑲᕕᒋᔭᖏᑦ ᒪᕐᕈᐃᓕᖓᖕᒥᔪᑦ ᑰᖏᑕ ᐊᑯᐊᖏᓐᓂ ᐃᒪᑦᑎᐊᕙᐅᓂᖅᓴᐅᔪᖅ ᑰᖏᑦ ᑲᓇᖕᓇᖓᒧᑦ ᐃᖏᕿᖕᒪᑕ ᑰᕉᓃᓴᓐ ᐃᑭᖓᓄᑦ ᐊᒻᒪᓗ ᐃᑎᓂᖕᓴᒧᑦ ᑕᒫᓂ ᐃᑭᕐᒥ ᓂᒡᒋᖓᖓᓄᑦ ᑲᖏᖅᓱᖓᓂ ᕿᖓᐅᑉ. ᑰᖕᓂᑦ ᑰᕕᐅᔪᑦᓕ ᓴᓂᒧᖕᓖᖅ ᑰᖕᒪᑕ ᐃᑭᕐᒥᓕᖅᓯᑎᒃ ᖃᖓᓂ ᐃᒪᑦᑎᐊᕙᐅᓂᖅᓴᖅ ᐃᑎᓂᖅᓴᖅᒥ ᑕᓇᐅᖑᓂᖅᓴᐅᓪᓗᓂ ᑕᒫᓂ ᑲᖏᖅᓯᒥ, ᐅᑯᐊ ᑰᖕᒪᑕ ᐅᐊᓚᓂᖅᒥᐅᑦ ᑰᖓ ᓂᒡᒋᖓᖓᓃᑦᑐᖅ ᑲᖏᖅᓰᑉ ᐊᒻᒪᓗ Hᐃᐅᑭᑦᑑᑉ ᑰᖓ ᒍᐊᑕᓐ ᑕᓯᐅᔭᖓᓄᑦ ᑰᒃᓯᓂ. ᐊᒃᓯᑲᓪᓚᒃᑕᐅᖅ ᐃᒪᐅᑉ ᐃᖏᕿᓂᖓ ᐊᓯᔾᔨᖅᑕᖅᒥᔪᖅ ᑕᒪᓂ ᐃᑭᕐᒥ ᐊᓄᓃᖏᑦ ᒪᓕᒃᓯᒋᑦ ᐃᒪᕐᒥ. ᓱᒃᑲᓕᓂᓇᓗᔪᒃᑕᖏᑦ ᑲᖏᑦᓯᒥ ᓂᒡᒋᖓᖓᓂ ᐊᑖᓂ 10 cm/s ᐃᖅᑲᖓᓂ, ᖁᑦᑎᖕᓂᖅᓴᒥᓕ ᑎᑭᑦᑐᓇᖅᒪᑦ 20-ᒥᑦ 60 cm/s-ᒧᑦ, ᓱᒃᑲᓕᓂᖅᐹᖓ ᑎᑎᖅᑲᖅᑕᐅᓯᒪᔪᖅ 90 cm/s-ᒧᑦ ᐊᓄᓕᔪᐊᓘᑎᓪᓗᒍ.

ᒪᓪᓕᖕᓂᖏᓪᓕ ᐳᖅᑐᓂᖅᓴᕐᓇᖅᑐᑦ ᐆᒃᑐᖅᑕᐅᓯᒪᔪᑦ ᖃᓂᒋᔭᖓᓂ ᓂᐅᕿᐃᕝᕕᓕᐅᕝᕕᓯᒪᔫᑉ ᐃᒪᐅᑉ ᖃᖓᓂ ᐳᒃᑭᑦᑑᑎᐅᔪᑦ, ᑕᒪᐃᑎᒍᑦ ᐊᑖᓃᖅᑲᑦᑕᑦᑐᑦ 0.5-ᒥᑐ ᐊᐅᔭᒃᑯᑦ ᓯᑯᖃᖅᒋᑎᓪᓗᒍ, ᐃᓚᓐᓂᒃᑯᑦ ᐳᖅᑐᓂᖅᐹᖅᒥᒃ ᐆᒃᑐᖅᑕᐅᔪᖅᑲᖅᓯᒪᔪᖅ 1-ᒥᑐᒥᒃ. ᒪᓪᓕᖕᓂᖅᑲᔪᖕᒪᑦ ᐊᓄᓕᓂᖓ ᒪᓕᒃᓯᒍ, ᐆᒃᑐᖅᑲᐅᑎᒃᑯᓪᓕ ᐅᓕᑦᑕᖅᓂᖏᓐᓄᑦ ᑎᓂᑦᑕᖅᓂᖏᓐᓄᓪᓗ ᒪᓪᓕᒍᑕᐅᔪᑦ ᐊᒃᓲᓗᐊᖑᖏᑦᑐᑦ.

ᑕᕆᐅᕐᒥ ᐃᒪᖅᑕ ᖃᓄᐃᓐᓂᖅᓴ

ᑐᓐᖓᕕᒋᔭᐅᔪᑦ ᐃᑭᕐᒥ ᐃᒪᖅᑕ ᖃᓄᐃᓐᓂᖅᓴᓄᑦ ᐆᒃᑐᕋᖅᑕᐅᓚᐅᕐᒥᔪᑦ ᑲᑎᖅᓱᐃᓪᓗᑎᒃ ᐃᒪᕐᓂᒃ ᐃᑭᕐᒥᑦ ᑕᒫᓂ RSA-ᒥ ᕿᖓᐅᑉ ᑲᖏᖅᓱᖅᓴᓂ ᑕᐃᒪᖅᓴᓂᑦ 2001-ᒥᓂᑦ ᐊᒻᒪᓗ ᑕᒫᓂ LSA 2013-ᒥᓂᑦ. ᖃᐅᔨᓴᕈᑕᐅᓯᒪᔪᓄᑦ ᑐᑭᑖᕈᑎᖃᖅᓯᒪᔪᑦ ᐃᒪᖅ ᕿᖓᐅᑉ ᑲᖏᖅᓱᖅᓴᑕ ᓂᒡᒋᖅᓵᖅᓴᓂ ᐃᒪᖅ ᓱᕈᔪᒃᓯᒪᖕᒋᑦᑎᐊᕐᒪᑦ ᐅᑭᐅᖅᑕᖅᑐᒥᐅᑦ ᐃᑭᖅᓴᓂᑦ ᐱᔪᖅ, ᐊᒃᓱᓗᐊᖑᖏᓯᑎᒃ ᐅᐊᕈᑎᓯᒪᔪᑦ ᓂᕿᒋᔭᐅᔪᑦ ᐆᒪᔪᓄᑦ, ᐳᒃᑕᓛᖅᑐᑦ ᐃᒪᕐᒥ, ᓴᕕᕋᔭᕈᔪᐃᓪᓗ. ᐆᒪᔪᓄᑦ ᓂᕿᒋᔭᐅᔫᑦ ᐊᒃᓱᓗᐊᖑᓚᐅᖏᒻᒥᔪᑦ ᒪᑐᐃᖅᓴᔪᒥ ᐃᒪᕐᒥ ᖄᖅᓴᓂ ᐃᑎᓂᖅᑲᖅᑐᒥ ᐅᕝᕙᓘᓐᓂᑦ ᐅᑭᐅᒃᑯᑦ ᐊᓯᔾᔨᖅᑕᕐᓂᖅᑭᓐᓄᑦ ᖁᐱᕈᑯᓗᐃᑦ ᑕᒫᓂ ᐱᕈᖃᑦᑕᖅᑐᑦ ᖄᖅᓴᓂ (ᒪᑯᐊ ᐱᕈᖅᑐᑯᓗᐃᑦ) ᐊᒻᒪᓗ ᐃᒪᑦᑎᐊᕙᖅᒥᒃ ᑰᕙᐅᓂᖅᓴᓄᑦ ᐊᐳᑎ ᓯᑯᓗ ᐊᐅᓕᖅᑎᓪᓗᒍ ᑰᕙᐅᓴᒥ. ᓇᐅᑐᔾᖃᕐᓂᖅᓴᓕ ᐃᒪᖅᓴᓂ ᑕᒪᑐᒪᓂᑐᐊᖅ ᑭᓯᐊᓂ ᐊᐅᒃᓯᒪᓕᖅᑎᓪᓗᒍ ᐱᖃᑦᑕᕐᒪᑕ ᖁᐱᕈᑯᓗᖃᐅᕐᓂᖅᓴᓂ ᐊᐅᔾᔪᑦ ᓯᕿᓐᓂᖃᑦᑕᕐᓂᖅᓴᓂᓗ ᐃᒪᐅᑉ ᖄᖅᓴᓄᑦ, ᐸᓯᐳᕆᓪᓕ ᐅᐊᕈᑎᓯᒪᓂᖅᓴ ᐆᒃᑐᕋᖅᑕᐅᓯᒪᖕᒥᔪᑦ (>0.01 mg P/L). ᓴᕙᕋᔾᔭᖃᐅᕐᓂᖅᓴ ᐆᒃᑐᕋᖅᑕᐅᓯᒪᖕᒥᔪᑦ ᐊᑕᓐᓂᓐᓂᕋᑦᑕᐅᓪᓗᓂ CCME ᐊᑐᐊᕕᖅᑭᑕ ᐃᓱᒪᒋᓪᓗᒋᑦ ᓴᐳᑎᔾᔪᓯᒪᒋᐊᖃᕐᒪᑕ ᐃᒪᕐᒥᐅᑕᐃᑦ ᐆᒪᔪᑦ ᐳᐃᓵᓪᓗ ᑰᖅᒥᐅᑕᐃᓪᓗ ᑕᑯᔾᔪᕙᔪᐃᑦᑑᕙᓗᐊᑦ ᐱᑕᖃᕐᒥᖅᒪᑕ ᑰᑦ ᐊᑯᐊᖅᑭᓐᓂ ᑰᕙᐅᔪᓂ ᐃᑭᕐᒥ ᐅᕝᕙᓘᓐᓃᑦ ᐃᒃᑲᕐᓇᓂᖅᑭᓐᓂ ᐃᓛᓐᓂᒃᑯᑦ ᐃᑎᓂᖅᑲᖅᑐᓂ ᐅᓄᕐᓂᖅᓴᐅᓕᖅᑲᑦᑕᖅᓯᑎᒃ ᐳᒃᑕᓚᖅᑐᑦ ᐅᐊᕈᑎᓯᒪᔪᓪᓗ ᐃᒪᕐᒥ ᓴᕙᕋ.ᔭᕈᔪᖃᐅᕐᓂᖅᑭᑦ ᐆᒃᑐᕋᖅᑕᐅᔪᓐᓇᕐᓕᑕ. ᑳᓂᐊᒻᖃᑦᑐᑦ ᑕᒪᔾᔭᑐᐊᖑᓚᐅᖅᑐᑦ ᐃᒪᖅᑕ ᐱᖅᑯᓯᑐᖃᖅ ᒪᓕᒃᓯᒍ ᖁᑦᑎᖅᓂᖅᐹᖑᓚᐅᑦᑐᑦ CCME--ᑯᑦ ᐆᒃᑐᖃᐅᑎᖅᑭᑦ ᐃᒪᕐᒥ ᐊᐅᒃᓯᒪᔪᓄᑦ ᐊᑐᐊᕕᖅᑭᓐᓂ 8 mg/L-ᖑᓚᐅᖅᑐᑦ, ᑕᐃᒪᐃᓱᖑᖅᒪᑕ ᐃᑎᔪᓂ ᑲᖏᖅᓱᓂ ᐃᒪᖅᑕ ᐊᓯᔾᔩᖅᐸᑦᑕᐊᓂᖅᓴ ᓱᒃᑲᐃᑎᓪᓗᒍᓗ ᐊᒻᒪᓗ ᐆᒪᔪᖃᐅᕐᓂᖅᓴᓕ ᑕᐃᒪᖅᓴᓂᑦ ᐊᓯᔾᔩᖅᐸᑦᑕᐊᖅᑭᓐᓇᐅᔭᖅᑐᖅ.

ᐃᒃᐱ`ᖅᓇᕐᓂᖅᑲᕐᓂᐊᕋᓱᒋᔭᐅᔪᑦ ᐃᑭᕐᒥ ᐃᒪᑦᑎᐊᕙᐅᓂᖅᓴᓄᑦ VEC-ᓄᑦ ᒪᑯᐊ ᐅᒥᐊᕐᔪᐊᓄᑦ ᑎᑭᕙᐅᖅᑲᑦᑕᓕᖅᐸᑦ, ᓄᑖᓂᒃ ᐃᖅᑲᖅᓴᓄᑦ ᑲᑕᖅᓂᕐᓗᑯᐃᑦ ᐱᓂᐊᕐᒪᑕ ᐸᕐᓇᐃᓕᖅᐸᑕ ᓂᐅᕋᐃᕝᕙᒃᓴᒥᒃ, ᓴᓇᔭᐅᑎᓪᓗᒍᓗ ᐊᒻᒪᓗ ᑭᖑᓂᖅᓴᓂ ᐅᑎᖅᑎᑕᐅᓕᖅᑎᓪᓗᒍ ᐱᖅᑯᓯᑐᖅᑲᖅᓴᓄᑦ, ᓴᓇᕙᐅᔭᒥᑦ ᐃᒪᕐᒧᑦ ᓱᕐᕇᓕᐅᑕᐅᔨᓐᓇᖅᑐᑦ, ᒪᑯᐊ ᐅᑭᐅᒃᑯᑦ ᐊᖅᑯᑎᖅᑲᕐᕙᐅᔭᓂᑦ; ᖄᖅᑎᑦᑎᕙᐅᖅᑲᑦᑕᖅᑐᓂᑦ ᐱᔪᑦ, ᐅᕐᓱᐊᓗᕈᔭᖅᓂᑦ, ᐊᒻᒪᓗ ᐅᑯᓇᖅᓴᑦ (PAHs); ᖁᕐᕙᓂᑦ ᐃᕐᒥᕈᑎᕙᓂᕐᓂᓪᓗ ᑯᕙᔪᑦ, ᐊᒻᒪᓗ ᐳᔪᐊᕿᔪᓂᑦ ᑎᒃᑕᐅᓂᑯᓂᑦ. ᐃᒃᐱᖅᓇᕐᓂᖅᑲᕐᓂᐊᕋᓱᒋᔭᐅᔪᑦ ᑖᒃᑯᓇᖅᓴᓂᑦ ᓴᓇᕙᐅᔪᓂᑦ ᖃᐅᔨᒪᖅᑕᐅᓚᐅᕐᒥᔪᑦ ᐃᓱᒪᒋᓪᓗᒋᑦ ᑰᓚᓚᑎᒍᑦ ᐊᓯᖏᓐᓄᑦ ᐃᖏᕋᔪᓐᓇᕐᓕᑕ ᑲᖏᖅᓯᑉ ᐃᑭᖅᓴᓄᑦ, ᐃᓚᐅᑎᓪᓗᒋᑦ ᐊᐳᑎ ᐊᐅᓕᕌᖅᓴᑦ ᑰᓚᓛᕙᐅᓲᑦ, ᐅᐸᒃᑕᐅᕐᑲᑦᑕᖅᑐᓂ ᐅᒥᐊᕐᔪᐊᓄᑦ ᐃᖅᑲᖅᓴᓄᑦ ᐃᑎᓕᖅᓱᕈᑕᐅᔪᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᖅᓴᓄᑦ ᐊᒃᑐᐊᓂᖅᑭᕐᓇᕐᒥᖅᑕ ᐊᒃᑦᕐᓗᑯᓂᑦ ᐊᒻᒪᓗ ᓯᓚᒧᑦ ᐳᔪᐊᕿᔪᓂᑦ. ᐊᒃᓱᓗᐊᖅᑕᐃᓕᖅᑯᓪᓗᒋᓪᓕ ᓴᓇᕙᐅᔪᓂ ᐊᑐᐊᕕᓕᐅᕈᑕᐅᓯᒪᓂᐊᕐᒪᑕ ᐊᖅᑯᑎᒋᔭᐅᔪᓂ, ᐊᒻᒪᓗ ᑕᐃᒪᐃᓐᓂᖅᓴᓄᑦ ᐊᒃᓲᓗᐊᔭᐃᒃᑯᑎᖃᐅᓚᖅᓴᔪᑦ ᐊᐅᓚᑕᐅᔪᑎᖅᑭᑎᒍᑦ ᓴᓇᖅᑯᑏᑦ ᑰᕙᐅᕙᒃᑐᓂ ᐊᖅᑯᑎᒋᔭᐅᕙᒃᑐᓂᓗ ᐊᒃᓱᓗᐊᖅᑕᐃᓕᒪᑎᑕᐅᓗᑎᒃ ᓄᖅᑲᖅᓴᑎᑕᐅᓚᐅᖅᐸᓗᑎᓗ ᓴᓇᕙᐅᔪᓂ ᐃᒃᐱᖅᓇᕐᓂᖅᑲᕐᓂᐊᕋᓱᒋᔭᐅᔪᑦ ᐊᕙᑎᖅᓴᓄᑦ ᐃᒪᕐᒧᑦ ᑯᕙᔭᐅᔪᑦ ᐱᐅᓂᖅᐹᖑᕐᑯᓪᓗᒋᑦ VEC-ᓂ ᒪᑯᐊᖑᓚᖅᓴᔪᑦ: ᐅᒥᐊᕐᔪᐊᑦ ᓱᒃᑲᓕᔅᓴᓐᓃᖅᑎᑕᐅᖅᑲᑦᑕᕐᓗᑎᒃ ᐃᓚᐃᓐᓇᖅᑭᓐᓂᓗ ᐊᖅᑯᑎᖅᑭᖅᑎᑕᐅᓗᑎᒃ, ᑰᕙᔪᓪᓕ ᑰᓚᓛᓄᑦ ᐊᓯᐊᓅᖅᑕᐅᕙᓗᑎᒃ ᑕᓯᕐᓗᖅᑲᕐᓗᑎᒃ ᐊᒃᑕᕐᕙᖅᓄᑦ ᓂᐅᕋᐃᕝᕙᖅᒥ, ᐊᑐᖅᑲᑦᑕᕐᓗᑎᒃ ᐊᕙᑎᒧᑦ ᓱᕋᐅᑕᐅᔮᖅᑭᑦᑐᓂᒃ ᓴᓇᖅᑯᑎᓄᑦ ᐅᐊᕈᑎᓂᒃ ᐊᖅᑯᑎᓂ ᐊᒻᒪᓗ ᐃᒡᓗᐃᑦ ᓴᓇᖅᑯᑏᓪᓗ ᒪᓂᕋᖅᑭᓐᓂ, ᐊᑐᐊᖅᓯᑎᐊᖅᑲᑦᑕᕐᓗᑎᒃ ᐊᑐᐊᓚᕆᔭᐅᔪᓂᒃ ᖁᕐᕙᕈᔭᖅᓄᑦ ᐊᒃᑕᕐᕙᓂ, ᐊᒻᒪᓗ ᐊᑐᖅᑲᑦᑕᕐᓗᑎᒃ ᐊᐅᓚᑎᔪᑎᓂᒃ ᓯᕐᓗᐊᖅᑲᕐᕙᐊᔪᓂ ᐊᕙᑎᒧᑦ ᐊᑦᑕᕐᓇᑐᐃᓐᓇᕆᐊᓕᖅᓄᑦ, ᐃᖏᕋᕙᐅᔪᓂᓗ, ᐊᒻᒪᓗ ᐊᑐᖅᑲᑦᑕᕐᓗᑎᒃ ᐅᕐᓱᐊᓗᖅᓂᒃ, ᖄᖅᑎᑦᑎᔪᑎᓂᓗ ᐊᒻᒪᓗ ᐊᑦᑕᕐᓇᖅᑐᓂᒃ ᐊᕙᑎᒧᑦ ᐊᒻᒪᓗ ᐳᔪᐊᕿᒍᐊᔭᐃᒃᑯᑎᖅᑲᐅᕐᓗᑎᒃ ᐊᒻᒪᓗ ᐃᑭᑕᐅᖅᑲᑦᑕᕐᓗᑎᒃ.

ᐅᑯᐊ ᑕᕝᕙ ᐊᑐᐊᕆᓇᔭᐅᓂᐊᖅᑐᑦ ᐊᒃᓱᓗᐊᖅᑕᐃᓕᖅᑯᓪᓗᒋᑦ ᐊᐅᓚᑦᑎᔪᑕᐅᓂᐊᖅᑐᑦ ᐱᓕᕆᕝᕙᓂ, ᐱᖓᓱᐃᓕᖅᓴᔪᓂᒃ ᐃᒃᐱᖅᓇᕐᓂᖅᑲᕈᓐᓇᖅᑐᓂᒃ ᓇᓗᓇᐃᔭᐃᓯᒪᔪᑦ ᐃᑭᕐᒥ ᐃᒪᖅᓴᓄᑦ ᐊᓯᔾᔨᔪᑕᐅᔪᓐᓇᖅᑐᓄᑦ ᐅᒥᐊᕐᔪᐊᖅᑕᐅᖅᑲᑦᑕᕐᓂᖅᑭᓐᓂ (ᐊᐅᓚᐅᑎᖅᓴᓄᑦ ᑲᐃᕙᔪᒧᑦ ᐊᒃᑐᖅᑕᐅᑐᐃᓐᓇᓇᕐᓕᖅᓄᑦ), ᐃᖅᑲᖅᓴᓄᑦ ᑲᑕᖅᓂᕐᓗᑯᐃᑦ ᓴᓇᕙᐅᔪᓂᑦ ᐊᓯᔾᔩᔪᑕᐅᔪᓐᓇᕐᒥᖅᑕ ᐃᒪᑦᑎᐊᕙᖅᒧᑦ ᑕᒪᐅᖅᓴᖅᑲᑦᑕᓕᖅᐸᑕ ᐅᒥᐊᕐᔪᐊᑦ. ᖃᓄᑎᒋᓗ ᐊᒃᑎᒋᔪᒧᑦ ᐃᒃᐱᖅᓇᕐᓂᖅᑲᕈᓐᓇᕐᓂᖅᑭᑦ ᐊᒃᓱᓗᐋᔭᖅᑭᓐᓂᕋᖅᑕᐅᔪᑦ, ᕿᓚᒥᐅᓗᑎᒃ ᐊᑯᓐᓂᐅᓗᐊᖅᑭᓪᓗᑎᒃ (ᑕᒪᑐᒪᓂᑐᐊᖅ ᓴᓇᕙᐅᔪᖅ ᐃᓅᓂᖅᓴᓂ), ᐃᓛᓐᓂᓚᐅᓱᖅᓴᒃᑯᑦ ᑕᒪᑐᒪ ᐱᖅᑯᓯᑐᖅᑲᖅ ᒪᓕᓗᒍ, ᐊᒻᒪᓗ ᐃᓚᐃᓐᓇᖅᓴᓂ ᑕᒫᓂ LSA-ᒥ ᓂᐅᕋᐃᕝᕙᒃᓴᒥ. ᓄᓇᓄᑦ ᐃᒪᕐᓄᓪᓗ ᐳᔪᐊᕿᕙᐅᔪᑦ ᑲᑕᖅᓂᕐᓗᑯᖅᑲᕙᐅᔪᓪᓗ ᕿᓚᒥᕈᓗᒃ ᐱᓂᐊᕐᒪᑕ ᐱᖅᑯᓯᑐᖅᑲᖅᑭᓐᓄᑦ

ᐅᑎᕈᓐᓇᕐᓂᕋᖅᑕᐅᔪᑦ. ᐊᑐᐊᖅᓯᓗᑎᒃ ᐊᑐᐊᒐᓕᐊᕈᑕᐅᓯᒪᔪᓂᒃ ᐊᒃᓱᓗᐊᔭᐃᒃᑯᑎᓂᒃ ᓴᓇᕙᓐᓂ ᓇᓗᓇᐃᔭᖅᑕᐅᓯᒪᔪᓂ ᐃᒪᕐᒧᑦ ᐃᒃᐱᓐᓇᕐᓂᕐᑲᕈᓐᓇᖅᑐᓂᒃ ᐊᐅᓚᑦᑎᔪᑎᓄᑦ ᐸᕐᓇᐃᔪᑕᐅᓯᒪᔪᑦ (AEMP; ᐃᔾᔪᖅ 10 ᐃᓚᖓ 19-ᒥ) ᐊᒻᒪᓗ ᓴᓇᕙᐅᔪᓂ ᐃᒪᓕᕆᔪᑎᓄᑦ ᐊᑐᐊᒐᐃᑦ ᐊᐅᓚᑦᑎᔪᑎᓄᑦ ᐸᕐᓇᐃᔪᑕᐅᓯᒪᔪᑦ (ᐃᔾᔪᖅ 10, ᐃᓚᖓ 7-ᒥ), ᐊᒃᓱᓗᐊᔮᕐᑎᓐᓂᕋᖅᑕᐅᕐᒥᔪᑦ ᐊᒥᐊᒃᑯᑦᓯᔭᐅᔪᑦ ᐃᒪᕐᒥ ᐃᒪᑦᑎᐊᕙᐅᓂᖓᓄᑦ ᐆᒃᑐᕋᐅᑏᓂ ᓇᓚᐅᑖᕈᑕᐅᓯᒪᙱᒥᔪᑦ ᐊᒃᓲᓗᐊᔮᕐᑎᓐᓂᕋᖅᑕᐅᓪᓗᑎᒃ.

ᖃᖓᑐᐃᓐᓇᕐᓕ ᐱᓕᕆᕖᑦ ᐅᓄᖅᓯᕙᓪᓕᐊᓂᖅᐸᑕ ᐊᑯᓚᐃᓐᓂᖅᓴᐅᓕᖅᐸᑕᓗ ᐱᖅᑯᓯᕐᑎᑦ ᖃᐅᔮᓴᕈᑕᐅᓚᐅᕐᒥᔪᑦ ᖃᓄᑎᒋ ᐃᒃᐱᓐᓇᕐᓂᖃᓕᕋᓱᒋᐊᕐᑎᑦ. ᐃᓱᒪᒋᓪᓗᒍ ᓴᓇᕙᐅᔪᖅ ᑕᓵᓂᑐᐊᖅ ᑭᓯᐊᓂ ᐱᓂᐊᕐᒪᑦ ᐃᒪᕐᒥ ᓂᐅᕋᐃᕙᕐᒥ LSA-ᒥ, ᖃᓂᓐᓂᖅᐹᖅ ᐊᒃᑐᐊᓂᖃᕈᓐᓇᖅᑐᖅ ᓴᓇᕙᐅᔪᒧᑦ ᓯᓚᑖᓃᒻᒪᑦ ᐊᒃᑐᐊᓂᕆᔭᐅᔪᓐᓇᖅᑐᑦ ᑭᒻᓚᐊᓂᑦ ᑲᑎᓪᓗᒋᑦ ᐱᓕᕆᕙᓄᑦ ᐃᒃᐱᓐᓇᕐᓂᕐᑲᕈᓐᓇᖅᑐᑦ ᐆᒃᑐᕋᖅᑕᐅᓯᒪᕐᒥᔪᑦ ᐊᒻᒪᓗ ᑕᐃᒪᐃᓐᓂᖓᓄᑦ ᐊᒃᓯᓗᐊᖅ ᐃᒃᐱᓐᓇᕐᓂᕐᑲᔾᔮᕐᑎᒻᒪᑕ ᑲᑎᓪᓗᒋᑦ ᓱᕝᕕᓕᐅᑕᐅᔾᔮᕐᑎᒻᒪᑕ ᐃᒪᑦᑎᐊᕙᐅᓂᖓᓄᑦ ᑲᕐᒋᖅᓯᖓᓂ. ᑕᐃᒪᓐᓇ ᓴᓇᕙᐅᓂᐊᖅᑐᒥᑦ ᐳᔪᐊᕿᔪᓂᑦ ᑲᑦᑕᓂᕐᓗᑯᐃᑦᓗ ᕿᓯᐊᓂ ᑕᒫᓐᓇᓂᐊᖅᑐᑦ ᐊᓯᕐᒋᓐᓂ ᓄᓇᖃᖅᑑᔮᕐᑎᒻᒪᑕ ᐃᒃᐱᓐᓇᕐᓂᕐᑲᔾᔮᕐᑎᒻᒥᔪᑦ.

ᐃᑭᐅᑉ ᐃᒪᖓᑕ ᖃᓄᐃᑦᑑᓂᖓᓄᑦ ᐆᒃᑐᕋᐅᑕᐅᓯᒪᔪᑦ ᓈᓴᐅᑎᖏᑦ ᑲᑎᖅᓯᖅᑕᐅᖃᑦᑕᖠᒪᓕᖅᑐᑦ ᐃᒪᕐᒥ RSA ᑕᐃᓐᓂ ᕿᖓᐅᑉ ᑲᖏᖅᓯᖓᓂ ᑕᐃᒪᖓᓂᓂᑦ 2001-ᒥᑦ ᐊᖅᓴᓄ ᑐᑭᓯᐊᖅᑐᒥᒃ LSA ᐃᓗᐊᓂ 2013-ᒥ. ᑲᑦᑕᓂᕐᓗᑯᐃᑦ ᐃᖅᑲᖓᓄᑦ ᕿᖓᐅᑉ ᑲᖏᖅᓯᖓᓂ ᐆᒃᑐᕋᖅᑕᐅᓗᑎᒃ ᐃᑎᓂᕐᒋᑦ ᒪᓕᒃᓯᒋᑦ ᐊᒻᒪᓗ ᐃᖅᑲᖓᑕ ᓴᓇᒪᓂᖓᓄᑦ ᓯᕗᓪᓕᐅᑕᐅᓂᕐᒋ, ᐃᑎᕐᒋᓐᓂᖅᓴᒥ, ᓯᓪᔭᐅᑉ ᖃᓂᒋᔭᖓᓂ ᓯᐅᕋᖓ ᒪᓪᓕᖓᓄᑦ ᐊᓯᐅᑎᑕᐅᕙᓪᓕᐊᖃᑦᑕᕐᒪᑦ ᐊᒻᒪᓗ ᓄᓇᕋᕈᔪᕐᓂᒃ ᑎᒃᑕᐅᕕᐅᕙᒃᓯᓂ ᐊᓄᓇᒧᑦ ᐃᒪᖓᑕᓗ ᐃᕐᒋᕋᓂᖓᓄᑦ ᓯᕗᓪᓕᐅᑕᐅᖃᑦᑕᕐᒪᑕ ᐃᖅᑲᖓᓂ. ᑕᐃᒪᐃᓐᓂᖓᓄᑦ, ᐃᑎᕐᒋᓐᓂᖅᓴᒥ ᑲᑦᑕᓂᕐᓗᑯᐃᑦ (<5 m) ᕿᖓᐅᑉ ᑲᖏᖅᓯᖓᓂ ᐱᑕᖃᐅᕐᓂᖅᓴᐅᓚᐅᑦᑐᑦ ᐊᕐᒋᔪᑕᐅᓂᖅᓴᓂᒃ ᑐᐊᐸᓂᒃ (60-ᒥᑦ 95-ᐳᓴᖓ) ᐊᒻᒪᓗ ᓯᐅᕋᖃᐅᕐᓂᖅᓴᐅᕆᓪᓗᓂ ᑲᑦᑕᓂᕐᓗᑯᐃᓪᓗ ᒥᕿᔪᑕᐅᓂᖅᓴᐅᕆᓪᓗᑎᒃ ᒪᕐᕋᕈᔪᕐᓂ ᐃᑎᓂᖅᓴᓂ ᐃᑭᕐᒥ 100-ᒦᑐᒧᑦ ᐃᑎᓂᖅᑯᓂ ᓯᓪᔭᒥᑦ (50-ᒥᑦ 90-ᐳᓴᖓᓄᑦ) ᑎᑭᓪᓗᒍ. ᑲᑦᑎᒋᓂᕐᓗᑯᐃᓪᓕ ᓂᐅᕋᐃᕙᒃᓴᒥ MLA-ᒥ ᑕᒪᑐᒪᓂ LSA-ᒥ ᓯᐅᕋᐅᕐᓂᖅᓴᐅᓚᐅᖅᑐᖅ (>75%), ᐱᓗᐊᖑᐊᖅᑐᒥ ᓯᒡ.ᔮᐅᑉ ᖃᓂᒋᔭᖓᓂ ᑕᐃᓐᓂ ᐅᒥᐊᕐᔪᐊᑦ ᓴᓇᔨᓪᓗ ᐱᓕᕆᓂᖅᓴᐅᓂᐊᕐᒪᑕ. ᓴᕙᕋᔭᕈᔪᖃᐅᕐᓂᕐᒋᓪᓕ ᐃᑭᐅᑉ ᐃᖅᑲᖓᓂ ᑲᑦᑕᓂᕐᓗᑯᐃᑦ ᐊᒃᓯᑲᓪᓚᐅᓚᐅᖅᑐᑦ ᑕᒪᓐᓇ ᑰᕙᐅᓂᖓᓄᑦ ᐊᒥᓯᓄᑦ ᑰᖓᓄᑦ ᒪᕐᕋᕈᔪᐃᓐᓇᐅᓪᓗᓂᓗ, ᐊᒃᓯᑲᓪᓚᐅᓂᖅᓴᐅᓚᐅᖅᑐᑦ ᐃᑎᓂᕐᒋᓐᓂ. ᑕᐃᒪᖓᓂᑦ ᐱᖅᑯᓯᑐᕐᑲᖓ ᐊᑐᕐᓗᒍ ᓴᕙᕋᔭᒃᓴᐃᑦ ᑕᒪᐅᖓ ᑎᒃᑕᐅᓂᑯᐃᑦ ᓄᓇᖓᓂᑦ ᐱᔪᑦ ᐱᑕᖃᐃᓐᓇᐅᔭᕐᒪᑕ ᒪᑯᐊ ᐋᓯᓂᒃᖃᖅᑐᑦ, ᑯᕈᓂᐊᓪᖃᖅᑐᑦ, ᐊᒻᒪᓗ ᐅᓗᒃᓴᐅᑎᖃᖅᑐᑦ ᑕᑯᔭᐅᓯᒪᔪᑦ ᐃᑎᓂᖅᓴᓂ ᐃᑭᖓᓂ ᑲᑎᖅᓯᐃᑎᓪᓗᑎᑦ ᒪᕐᕋᕐᒋᓐᓂᒃ ᐱᑕᖃᕐᓂᖕᓴᐅᓪᓗᑎᒃ CCME-ᑯᑦ ᐊᑐᐊᒐᕐᒋᓐᓂᑦ ᑲᑦᑕᓂᕐᓗᑯᓂ ᐱᑕᖃᓇᐅᓕ`ᕐᓂᑦ ᓴᐳᑎᓯᒪᔪᑎᓂ ᐃᒪᕐᒥ ᐆᒪᔪᓄᑦ. ᑲᑦᑕᓂᕐᓗᑯᓂ ᓴᕙᕋᔭᒃᓴᖃᕐᓂᕐᒋᑦ ᖃᓂᒋᔭᖓᓂ ᓂᐅᕋᐃᕙᓕᐅᕐᕙᐅᓂᐊᖅᑑᑉ ᕿᒥᕈᔭᐅᓚᐅᕐᒥᔪᑦ ᐱᖅᑯᓯᑐᖃᖓᓄᑦ ᑐᓐᖓᕙᒋᔭᐅᔪᑦ ᐊᒃᓲᓗᐊᕐᒋᓐᓂᕋᖅᑕᐅᓪᓗᑎᓕ, ᑕᐃᒪᐃᓐᓂᐊᕋᓯᒋᔭᐅᓚᐅᕐᒪᑕ ᑕᑯᓪᓗᒍ ᑕᒪᓐᓇ ᓯᐅᕋᐃᓐᓇᕈᔫᒪᓪᓚᑦ.

ᐃᒃᐱᓐᓇᕐᓂᕐᑲᕋᔭᖅᑐᑦ ᓴᓇᕙᐅᓂᖓᓄᑦ ᑕᒪᓐᓇ ᐃᑭᕐᒥ ᐃᖅᑲᖓᓄᑦ ᑲᑦᑕᓂᖅᑯᑯᓄᑦ ᑕᐃᒪᓴᐃᓐᓇᖅ ᐆᒃᑐᕋᐅᑎᕐᑲᕐᒪᑕ ᐊᖅᑯᑎᕐᑲᕐᓂᐊᖅᓯᑎᒃ ᐊᒃᓱᓗᐊᔭᐃᒃᑯᑎᖏᑦ ᐊᐅᓚᑕᐅᔪᑎᖏᓪᓗ ᓇᓗᓇᐃᔭᖅᑕᐅᓯᒪᔪᑦ ᐃᑭᕐᒥ ᐃᒪᑦᑎᐊᕙᐅᓂᖓᓄᑦ ᐆᒃᑐᕋᐅᑎᐅᓂᐊᖅᑐᓄᑦ. ᓯᕗᓪᓕᖅᐸᒥ ᐊᖅᑯᑎᕐᑲᑦᑕᕐᓂᐊᖅᑐᑦ ᓴᓇᕙᐅᔪᓂ ᐊᒻᒪᓗ ᐃᑭᐅᑉ ᐃᖅᑲᖓᓄᑦ ᑲᑦᑕᓂᕐᓗᑯᕐᑲᓗᐊᔭᐃᒃᑯᑏᑦ ᓴᓇᕙᓂᑦ ᐳᔪᐊᕿᔪᓂᑦ ᐊᒻᒪᓗ ᖃᓄᑎᒋ ᑲᑦᑕᓂᕐᓗᑯᕐᑲᐅᕐᓂᕐᒋᓐᓂᒃ ᐅᒃᑐᕋᐅᑏᑦ VEC-ᓂ ᓇᓗᓇᐃᔭᖅᑕᐅᓯᒪᕐᒥᔪᑦ ᑰᕙᐅᔪᓂ, ᐊᒃᑐᐊᔭᐅᔪᓂ, ᐊᒻᒪᓗ ᓄᓇᖓᑕ ᓴᓇᒪᓂᖓᓄᑦ ᑕᒪᐅᖓᕐᑲᑦᑕᓕᖅᐸᑕ (ᐅᒥᐊᕐᔪᐊᓂᑦ), ᐊᒃᑕᕐᓗᑯᐃᑦ ᑯᕙᔭᐅᔪᑦ ᐃᒪᕐᒧᑦ, ᐊᒻᒪᓗ ᓯᓚᒧᑦ ᐳᔪᐊᕿᔪᑦ. ᑕᐃᒫᓴᐃᓐᓇᖅ ᐊᒃᓱᓗᐊᔭᐃᒃᑯᑎᕐᑲᓚᖓᖓᒥᔪᑦ ᐊᐅᓚᑕᐅᔪᑎᕐᑲᕐᓗᑎᓗ ᓇᓗᓇᐃᔭᖅᑲᐅᔭᑦᑎᓐᓂᒃ ᐆᒪ ᕐᑯᑖᓂ ᐃᑭᕐᒥ ᐃᒪᖃᑦᑎᐊᕈᑎᓂ.

ᐅᑯᐊ ᑕᕝᕙ ᐊᑐᐊᒐᓇᔭᐅᓂᐊᖅᑐᑦ ᐊᒃᓱᓗᐊᔭᐃᒃᑯᑎᓄᑦ ᐊᐅᓚᑕᐅᔪᑎᓄᑦᓗ ᐱᓕᕆᕙᓂ, ᐱᖓᓯᐃᓕᖓᖓᓕᑕ ᐃᒃᐱᓐᓇᕈᑕᐅᔪᓐᓇᖅᑐᑦ ᐃᒪᕐᒥ ᐃᖅᑲᖓᓄᑦ ᑲᑦᑕᓂᕐᓗᑯᓄᑦ ᐊᓯᔿᕈᑕᐅᔪᓐᓇᖅᑐᓂᒃ ᐅᒥᐊᕐᔪᐊᓄᑦ ᐊᒃᑐᐊᔭᐅᓇᔭᖅᑐᑦ (ᐊᐅᓚᐅᑎᖓᑕ ᑲᐃᕙᔪᕐᑯᑎᖓᓄᑦ) ᑲᑦᑕᓂᕐᓗᑯᐃᑦ ᓄᑖᑦ ᖄᖓᓃᑦᑐᑦ ᐆᒃᑐᕋᖅᑕᐅᔪᑎᕐᑲᕐᒥᔪᑦ ᐃᒪᖓᓄᑦ ᐊᕙᑎᖓᓄᑦᓗ ᓴᓇᕙᐅᓂᐊᖅᑐᖅ ᐸᕐᓇᒃᑕᐅᑎᑦᓗᒍ, ᓴᓇᔭᐅᑎᑦᓗᒍ ᐊᒻᒪᓗ ᑭᖑᓂᖓᒍᑦ ᐱᐊᓂᒃᐸᑕ ᐱᖅᑯᓯᑐᕐᑲᖓᓄᑦ ᐅᑎᖅᑎᑕᐅᓕᖅᑎᑦᑐᒋᑦ ᐃᑭᕐᒥ ᐊᓯᔿᕈᑕᐅᔪᓐᓇᖅᑐᓄᑦ ᑕᐃᓐᓂ ᓴᓇᔪᖅᑲᕐᓂᖓᓄᑦ. ᖃᓄᑎᒋᓕ ᐊᒃᑎᒋᓇᔭᕐᓂᕐᒋᑦ

ᐃᒃᐱᖅᓇᕐᓂᖅᓴᑕ ᐊᒃᓱᓗᐊᔾᔨᖅᑎᓐᓂᕋᖅᑕᐅᖅᒥᔪᑦ, ᐊᑯᓂᐅᓂᖅᑎᑦ ᒪᓕᓗᑎᑦ ᕿᓚᒥᐅᓂᐊᕐᒪᑕ ᑕᒫᓂ ᐱᓕᕆᐊᑦ ᐊᑰᓂᖅᓴᓂᓗ (ᑕᒪᑐᒪᓂ ᒪᑐᐃᖅᓴᓂᖅᑎᓐᓂ ᓴᓇᕕᐅᔪᑦ), ᐃᓚᓐᓂᓚᐅᓱᖅᓴᒃᑯᑦ ᐱᖅᑯᓯᑐᕐᑲᖅᑎᑦ ᒪᓕᓗᑎᑦ ᑕᐃᒪᐃᓚᐅᑲᓱᖑᖅᒪᑕ, ᐊᒻᒪᓗ ᑕᒪᑐᒪᓂ ᑭᓯᐊᓂ ᓇᔪᕆᓇᔭᐅᓂᐊᖅᑐᒥ ᐃᒃᐱᖅᓇᓚᖅᓴᑦᓗᑎᒃ ᐃᑭᕐᒥ LSA-ᒥ. ᑭᖑᓂᖅᓴᒍᑦᓕ ᑲᔪᓯᑐᐃᓐᓇᓇᐊᓖᑦ ᐃᒃᐱᖅᓇᕐᓂᖅᑎᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᓯᒪᖅᒥᔪᑦ ᐱᖅᑯᓯᑐᕐᑲᕐᒥᓄᑦ ᐅᑎᕈᓐᓇᕐᒪᑕ. ᐊᑐᐊᕐᓗᑎᑦ ᐋᕿᒃᓯᐃᔪᑎᓄᑦ ᐆᒃᑐᕋᐅᑕᐅᓯᒪᔪᑦ ᓇᓗᓇᐃᔭᖅᑲᐅᔭᕗᑦ ᐃᒪᕐᒥ ᐃᒃᐱᒃᓇᕐᓂᕐᑲᕐᓂᐊᖅᑐᑦ ᐊᐅᓚᑕᐅᔪᑎᒃᓴᖅᑎᓐᓂ ᐸᕐᓇᐃᔪᑕᐅᓯᒪᔪᓂ (AEMP; ᐃᔾᔪᖅ 10, ᐃᓚᖅ 19-ᒥ) ᐊᒻᒪᓗ ᓴᓇᕕᐅᔪᓂ ᐃᒪᓕᓇᔪᑎᓄᑦ ᐅᔾᔮᖅᓯᕈᑕᐅᓗᑎᒃ ᐊᐅᓚᑦᑎᔪᑕᐅᓗᑎᓗ ᐸᕐᓇᐃᔪᑕᐅᓯᒪᓗᑎᒃ (ᐃᔾᔪᖅ 10, ᐃᓚᖅ 7-ᒥ). ᖃᓄᑎᒋ ᐃᒃᐱᖅ`ᓇᕐᓂᕐᑲᕐᓂᐊᕐᓂᖅᑎᑦ ᑕᒫᓂᕐᒥᐅᑦ ᐃᒪᖅᑕᓄᑦ ᑲᑕᖅᓂᕐᓗᑯᓄᓪᓗ ᐃᖅᑲᖅᑕᓄᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᓯᒪᖅᒥᔪᑦ ᐊᒃᓲᓗᐊᔾᔨᖅᑎᓐᓂᕋᖅᑕᐅᓪᓗᑎᒃ.

ᐃᒃᐱᖅᓇᓕᕈᑕᐅᒎᓐᓇᖅᑐᓪᓕ ᑲᑎᓪᓗᑎᑦ ᐅᓄᕐᓂᖅᓴᐅᓕᖅᐸᑕ ᓴᓇᕕᐅᔪᑦ ᐆᒃᑐᕋᖅᑕᐅᓯᒪᖅᒥᔪᑦ ᐱᔭᐅᕐᑯᔭᐅᓚᐅᕐᒪᑕ ᓴᓇᕕᐅᓂᐊᖅᑐᒥ ᐃᒃᐱᖅᓇᕐᓂᕐᑲᕈᑕᐅᔪᓐᓇᖅᑐᑦ ᐃᓯᒪᑎᔭᐅᓚᐅᕐᒪᑕ. ᑕᐃᒪᐃᓐᓄᖅᑕᓄᑦ ᓴᓇᕕᐅᓂᐊᖅᑐᑦ ᐃᒃᐱᖅᓇᕐᓂᕐᑲᕐᓂᐊᕐᒪᑦ ᑕᒫᓂᕐᒥᐅᓄᑦ ᐃᒪᖅᑕᓄᑦ ᑭᓯᐊᓂ LSA-ᓂ, ᖃᓂᓐᓂᖅᐹᖅ ᓴᓇᕕᐅᔪᖅ ᐊᒃᑐᐊᓂᕐᑲᕐᓂᐊᕋᓯᕆᔭᐅᔪᖅ ᓴᓇᕕᐅᔪᓄᑦ ᑕᒫᓂ ᓯᓚᑖᓃᒻᒪᑦ ᖃᐅᔨᓴᕐᕕᐅᔪᒃ ᑭᓪᓕᖅᑕ ᑲᑎᓪᓗᑎᑦ ᓴᓇᕕᐅᔪᑦ ᐃᒃᐱᖅᓇᕐᓂᑎᓇᔭᖅᑕᖅᑎᑦ ᖃᓄᑎᒋ ᐊᒃᑎᒋᓂᕐᑲᕐᓂᐊᕐᒪᖅᑮᑕ ᐊᒻᒪᓗ ᑕᐃᒪᐃᓂᖅᑕᓄᑦ ᐊᒃᓲᓗᐊᔾᔨᖅᑎᓐᓂᕋᖅᑕᐅᖅᒥᔪᑦ ᑲᑎᓪᓗᑎᑦ ᐃᒃᐱᖅᓇᕐᓂᕐᑲᓕᕈᓇᖅᑐᑦ ᑕᒪᓂ ᐃᒪᖅᑕᓄᑦ. ᓴᓇᕕᐅᔪᖅ ᒥᑭᔫᒥᓐᓂᐊᕐᒪᑦ ᑕᕝᕙᓂᑐᐊᖅ ᓴᓇᕕᐅᔪᒥ ᐃᒪᖅᑕᓄᑦ ᐊᒃᑐᐊᓂᕐᑲᕋᔭᖅᑐᖅ, ᑖᒃᑯᐊ ᓄᓇᕗᑦ ᐃᓗᐊᓃᒻᒪᑕ, ᐊᓯᖅᑎᓐᓂ ᓄᓇᓄᑦ ᐃᒃᐱᖅᓇᕐᓂᕐᑲᔩᖅᑎᓐᓂᕋᖅᑕᐅᓚᐅᖅᑐᑦ.

ᐃᑭᕐᒥᐅᑕᐃᑦ ᐃᖃᓗᐃᑦ/ᐆᒪᔪᓄᑦᓗ ᓇᔪᕆᓇᔭᐅᔪᑦ

VEC-ᖅᑎᑦ ᐃᑭᑉᒥ ᐃᖃᓗᖅᓄᑦ/ᐃᒪᕐᒥᐅᑕᐃᑦᓗ ᓇᔪᕆᓇᖅᑲᑦᑕᖅᑕᖅᑎᑦ ᒪᑯᐊᖑᔪᑦ ᑕᒪᓂ ᓄᓇᒥ ᐃᑭᕐᒥᓗ ᐊᒻᒪᓗ ᓂᕿᖃᕕᑎᖅᑲᑦᑕᖅᑕᖅᑎᑦ ᒪᑭᒪᔪᑕᐅᔪᑦ ᑕᒪᓂ ᐃᒪᕐᒥᐅᑕᓄᑦ ᐃᖃᓗᖅᓄᑦ ᓇᔪᕆᓇᔭᐅᖅᑲᑦᑕᖅᑐᓪᓗ.

ᑐᓐᖓᕕᒋᔭᐅᔪᓂᒃ ᖃᐅᔨᓴᓚᐅᕐᒪᑕ ᐃᒪᐅᑉ ᐱᖅᑯᓯᖅᑕᓄᑦ ᑲᑎᖅᓯᐃᓪᓗᑎᒃ ᖃᐅᔨᓴᖅᑕᐅᓂᐊᖅᑐᓂᒃ ᑕᒫᓂ RSA-ᒥ ᕿᖅᑕᐅᑉ ᑲᖅᑎᖅᓯᖅᑕᓂ 2001-ᒥᓂᑦ ᐊᒻᒪᓗ LSA-ᒥ 2012 ᐊᒻᒪᓗ 2013-ᒥ. ᓯᐅᔭᖅᑕᓂᓕ LSA ᐊᒻᒪᓗ ᓂᒡᒋᓛᖅᑕᓂ RSA ᑕᒪᓐᓇᓕᒫᑲᓴᒃ ᐃᒃᑲᕐᓇᑦᑐᓚᐅᕐᒪᑦ ᐳᖅᑐᓂᐊᓗᖅᒦᓯᓂ, ᑎᑭᓐᓂᕐᑲᖅᓯᓂ ᐃᑎᓂᕐᑲᖅᑐᒨᑦ 10-ᒦᑐᒨᑦ ᐊᒻᒪᓗ ᐅᖅᑕᓯᖅᓂᕐᑲᖅᓯᓂ ᓇᓯᓪᓗᓂ 120-ᒦᑐᒨᑦ ᓯᑉᔭᐅᑉ ᐅᖅᑖᓄᑦ ᐃᑭᕐᒨᑦ. ᐅᖅᑖᓄᓪᓗ, ᐃᖅᑲᖅᑕ ᐃᑎᓕᖅᐸᓪᓕᐊᓕᓚᐅᖅᑐᖅ ᐅᖅᑖᓄᑦ 40-ᒦᑐ. ᐊᒻᒪᓗ ᐊᕙᒃᑐᖅᓯᒪᓂᖅᑕ ᐃᒪᐃᑦᑐᖅ ᓯᑉᔭᖅᑕᓄᑦ ᑎᑭᓯᒍ ᑐᐊᐸᐃᓐᓇᐅᖅᒪᑦ ᐊᒻᒪᓗ ᐅᔭᖁᓚᖑᓪᓗᓂ, ᐃᑎᓂᖅᓴᐃᓪᓕ ᒪᖁᐃᓐᓇᕈᔪᓪᓗᑎᒃ ᑲᑕᖅᓂᕐᓗᑯᐃᓪᓗ ᐳᒃᑕᔪᑦ ᐃᒪᖅᑕᓂ. ᐊᑐᐊᖅᓯᕐᑎᑦ ᖃᐅᔨᓴᕈᑕᐅᓚᐅᖅᑐᑦ ᓯᐅᔭᖅᑕᓂᒃ ᐊᒻᒪ,ᓗ ᑕᒫᓂᕐᒥᐅᑦ ᐱᖅᑯᓯᑐᕐᑲᖅᑎᑎᑐᑦ ᖃᐅᔨᒪᔭᐅᔪᑦ, ᑕᒪᒃᑯᓇᓂᑑᖅ ᐆᒪᔪᖅᑲᐅᓚᔪᖅᓂᖅᓴᐅᔪᖅ ᐊᒻᒪᓗ ᐃᖃᓗᖅᑲᐅᓚᔪᖅᓂᖅᓴᐅᖅᒪᑦ ᐃᑭᕐᒨᑎᐊᖅᑲᑦᑕᖅᑐᓂᒃ ᑕᒪᓂ ᖃᐅᔨᓴᕐᕕᐅᔪᒥ. ᐃᓚᖅᑎᑦ ᓯᔭᒥ ᐊᑐᕐᓂᖅᑲᕐᒥᔪᑦ ᒪᑯᐊ ᑰᑦ ᐊᑯᐊᖅᑎᑦ ᐃᖃᓗᒃᐱᖅᑲᐅᕐᒪᑕ, (*Salvelinus alpinus*), ᑕᓯᕐᓄᑦ ᐅᑎᖅᑲᑦᑕᕐᒪᑕ ᑰᒃᑯᑦ ᐃᑭᕐᒥᑦ, ᑕᒪᓐᓇ ᓯᐅᔭᖅᑕ ᕿᑐᖅᑎᐅᕙᐅᖅᒪᑦ ᐃᖃᓗᖅᓄᑦ ᐃᑎᖅᑎᓐᓂᖅᑕᓂ ᑐᐊᐸᓂ ᐃᑦᓕᖅᑲᖅᓯᑎᒃ ᓯᕙᐃᔭᓯᖑᖅᒪᑕ ᒪᑯᐊ ᑮᑉᓚᓐ Capelin (*Mallotus villosus*).

ᕿᒥᕈᔭᐅᓚᐅᖅᑐᑦ ᖃᓄᑎᒋ ᑕᒪᓂ ᓴᓇᓕᖅᐸᑕ ᐊᒃᑐᐊᓂᖅᑲᔭᓇᐊᖅᑎᑦ ᐃᒪᕐᒥᐅᑕᓄᑦ ᐃᖃᓗᖅᓄᑦ/ᐆᒪᔪᓪᓗ ᓇᔪᖅᑲᑦᑕᖅᑕᖅᑎᓐᓄᑦ ᐃᑭᕐᒥ ᐃᓚᐅᓕᑎᓯᒪᖅᒪᑕ ᑐᑭᒧᐊᖅᑐᒥᒃ ᐃᒃᐱᓇᕐᓂᖅᑲᕐᓂᐊᖅᓯᑎᑦ ᓴᓇᕕᐅᔪᓂᑦ ᐃᖃᓗᖅᓄᑦ ᑕᒪᓂ ᐃᑭᕐᒥ. ᑐᑭᒧᐊᖅᑎᑦᑐᒥᓕ ᐃᒃᐱᖅᓇᕐᓂᖅᑲᕐᓂᐊᕐᒥᔪᑦ ᐃᒪᕐᒥᐅᑕᐅᓂᖅᑎᓐᓄᑦ ᐃᑭᕐᒥ ᐃᒪᖅᑕᓂ ᓴᓇᓕᖅᐸᑕ ᐊᒻᒪᓗ ᐃᖅᑲᖅᑕᓄᑦ ᑲᑕᖅᓂᕐᓗᑯᐃᑦ ᐃᓅᕕᒋᖅᑲᑦᑕᖅᑕᖅᑎᑦ ᐃᖃᓗᐃᑦ/ᐃᒪᕐᒥᐅᑕᐃᓪᓗ ᐆᒪᔪᑦ ᓴᓇᕕᐅᓕᖅᐸᑕ ᐃᒪᕐᒥ ᑕᒪᓂ ᓂᐅᕋᐃᕝᕕᓕᐅᕐᕕᐅᓂᐊᖅᑐᒥ ᐊᒻᒪᓗ ᐅᒥᐊᖅᔪᐊᓄᑦ (ᑐᓚᒃᑕᕐᕕᓕᐅᕐᓂᐊᖅᑐᓂ ᐊᐅᔭᒃᑯᑦ ᐊᑐᖅᑕᐅᖅᑲᑦᑕᖅᑐᓂᒃ ᐃᑳᕕᓕᐅᕐᓂᐊᕐᒪᑕ ᓯᐅᔭᒥ).

ᐅᑯᐊ ᑖᒃᑯᐊ ᐊᑐᐊᒐᓕᐊᕆᔭᐅᓂᐊᖅᑐᑦ ᑕᒪᐃᓐᓄᑦ ᐃᒃᐱᖕᓇᕐᓂᖃᖅᑐᓄᑦ ᐊᒃᓲᒍᐊᔭᐃᒃᑯᑎᒃᓴᑦ ᐊᒻᒪᓗ ᑕᐃᒪᖕᒐᓂᑦ ᑕᒪᐅᖕᒐᖃᑦᑕᓕᖅᐸᑕ ᐃᒃᐱ`ᖕᓇᕐᓂᕆᓂᐊᓕᖅᑕᖕᒋᑦ ᑲᑎᓪᓗᒋᑦ ᓴᓇᕙᐅᔪᖃᐅᓕᖅᐸᑦ. ᑕᐃᒪᐃᓐᓂᖕᒐᓄ ᑖᒃᑯᐊ ᑲᑎᓪᓗᒋᑦ ᒫᓐᓇ ᐃᒃᐱᖕᓇᕐᓂᖕᒋᑦ ᑕᒪᓂ ᓄᓇᒋᔭᐅᔪᓄᑦ ᐱᑕᖃᖕᒋᓐᓂᕋᐃᔪᑦ.

<u>ᐃᑭᕐᒥᐅᑕᐃᑦ ᐃᖃᓗᐃᑦ ᓇᔪᒐᖕᒋᑦ</u>

ᐃᑭᕐᒥᐅᑕᐃᑦ ᐃᖃᓗᐃᑦ ᑕᒫᓃᖃᑦᑕᖅᑐᑦ ᕿᖕᒐᐅᑉ ᑲᖕᒋᖅᓯᖕᒐᓂ ᓇᔪᒐᖃᕐᒪᑕ ᐃᒪᕐᒥᐅᑕᐅᓪᓗᑎᒃ ᑕᒫᓂ ᐅᑭᐅᖅᑕᖅᑐᒥᐅᑦ ᐃᒪᖕᒐᓂ ᐊᒻᒪᓗ ᐃᑭᖕᒐᓂ, ᐅᑎᖃᑦᑕᖅᑐᑦ ᑕᓯᕐᓄᑦ ᐊᒻᒪᓗ ᑕᓯᕐᒥᐅᑕᐃᑦ/ᑰᖕᒥᐅᑕᐃᓪᓗ. ᐊᒥᓱᑦ ᐃᖃᓗᐃᑦ ᐊᔾᔨᙯᖕᒋᑦᑐᑦ ᐊᑐᕐᓂᖃᕐᒪᑕ ᐊᔾᔨᙯᖕᒋᑦᑐᓂᒃ ᓄᓇᒥᐅᑕᐃᑦ ᐱᖅᑯᓯᖕᒋᓐᓂ ᐊᒻᒪᓗ ᑕᒪᓐᓇ ᓇᔪᒐᓇᖃᑦᑕᖅᑕᖕᒐ ᐋᓐᓂᐊᕐᓇᖅᑐᖃᖅᑕᐃᓕᖁᓪᓗᒍ. 19-ᓂᒃ ᐊᔾᔨᙯᖕᒋᑦᑐᓂᒃ ᐃᖃᓗᖕᓂ ᓇᓂᓯᓯᒪᔪᑦ ᑎᒍᓯᓯᒪᓪᓗᑎᓗ ᕿᒥᕈᑎᓪᓗᒋᑦ ᑕᒫᓂ ᖃᐅᔨᓴᖅᑏᑦ 2001-ᒥᑦ 2013-ᒧᑦ, ᐅᕝᕙᓘᓐᓃᑦ ᐃᒪᕐᒥᐅᑕᐅᓇᓱᒋᔭᐅᔪᓂᒃ ᑕᒫᓂ ᖃᐅᔨᓴᕆᐅᔪᕙᓂᕐᒥ. ᐅᓄᕐᓂᖅᓴᐅᓚᐅᖅᑐᑦ ᒪᑯᐊ ᑲᓇᔪᐃᑦ (*Myoxocephalus quadricornis*), ᐆᒐᐃᑦ (*Mallotus villosus*), ᐃᒃᑲᕐᓇᐃᓪᓗ (*Clupea pallasii*), ᐊᒻᒪᓗ ᓇᑖᕐᓇᐃᑦ (*Platichthys stellatus*). ᖃᐅᔨᒪᒋᑦᑎ ᖃᐅᔨᓴᕈᑕᐅᓂᐊᖅᑐᓂᒃ ᑲᑎᖅᓱᐃᑎᓪᓗᒋᑦ ᐊᑦᑕᕐᓇᖅᑑᓐᓂᕋᖅᑕᐅᔪᑦ, ᑭᓱᐊᓂᒐ ᑕᒪᓂ ᐅᓄᖅᑑᓚᐅᖅᑐᑦ ᖃᐅᔨᓴᕙᐅᔪᒥ LSA ᑕᒪᓂ ᐃᖃᓗᒃᐲᑦ ᓱᕙᐃᔭᖃᑦᑕᕐᒪᑕ ᑰᖕᒋᓐᓂ ᑰᒐᙵᖕᒋᓐᓂᓗ ᐊᐅᔭᒃᑯᑦ ᐃᑭᕐᒥᐅᑕᐅᖃᑦᑕᖅᑐᑦ.

ᓴᓇᕙᐅᔪᓂᑦ ᐃᒃᐱᖕᓇᕐᓂᖃᑐᐃᓐᓇᓇᐊᑖᓪᓚ VEC-ᓂ ᐃᑭᕐᒥ ᐃᖃᓗᐃᑦ ᓇᔪᖃᑦᑕᖅᑕᖕᒋᓐᓄᑦ ᐊᒃᓱᕉᑎᖃᖕᓚᓚᐅᕋᑦᑕ ᐃᖃᓗᒃᐱᓂᒃ ᐊᒻᒪᓗ ᑐᑭᒧᐊᖅᑐᒥᒃ ᑐᕐᑯᕋᖅᑕᐅᔪᑎᒋᔪᓐᓇᖅᑕᖕᒋᓐᓂᒃ ᐃᒪᕐᒥ ᐃᑭᕐᒥ ᓴᓇᓕᖅᐸᑕ ᖄᖅᑎᑦᑎᑲᑕᓗᑎᒃ, ᐅᓄᕐᓂᖕᒋᓐᓄᑦ ᐊᒃᑐᐊᓂᖃᖅᑐᑦ ᐊᓯᖕᒋᓐᓂᒃ ᐃᖃᓗᖕᓂᒃ ᐱᔾᔪᓇᖕᒋᓪᓗᑎᒃ ᑕᒪᐅᖕᒐᐅᔫᖃᕐᓂᖅᐸᑦ ᐅᒥᐊᕐᔪᐊᑦ ᐳᒃᑕᓚᐅᑎᖕᒋᓐᓂᑦ, ᐊᒻᒪᓗ ᐃᒃᐱᖕᓇᕐᓂᖃᕈᓐᓇᕐᒥᖕᒪᑕ ᓂᐹᕿᔪᑦ ᐃᑭᕐᒥ ᐅᒥᐊᕐᔪᐊᖅ ᑕᒪᐅᖕᒐᖃᑦᑕᓕᖅᐸᑕ ᓴᓇᖅᑯᑎᓂᒃ ᐅᓯᔪᑦ. ᐊᒃᓲᒍᐊᔭᐃᒃᑯᑎᒃᓴᖕᒋᑦ ᐋᕿᒃᓯᐃᓯᒪᓚᖕᒐᔪᑦ ᐃᒪᕐᒥ ᓴᓇᕙᐅᔪᓂ ᐱᓗᐊᖅᑕᐅᓕᒪᓗᑎᒃ, ᐅᒥᐊᕐᔪᐊᓪᓗ ᐳᒃᑕᐅᑎᖕᒋᓐᓂ ᐃᒪᕐᓂᒃ ᑯᕙᓯᖅᑕᖕᒋᓪᓗᑎᒃ ᑕᒪᐅᖕᒐ, ᐊᒻᒪᓗ ᐊᑐᐊᒐᖅᑲᕐᓗᑎᒃ ᓱᒃᑲᓴᓗᐊᔭᐃᒃᑯᑎᓂᒃ ᑕᒪᐅᓈᓂᕋᖕᒐᑕ ᐅᒥᐊᑦ ᐊᖅᑯᑎᒋᖅᑕᖅᑕᖕᒋᑎᒍᑦ ᐃᖕᒋᕋᑎᓪᓗᒋᑦ.

ᑭᖕᒍᓂᖕᒐᒍᑦ ᐊᑐᐊᒐᓇᔭᐅᓕᖅᑎᓪᓗᒋᑦ ᐊᒃᓲᒍᐊᔭᐃᒃᑯᑏᑦ ᓴᓇᕙᐅᔪᓂ ᐊᐅᓚᑕᐅᔪᑎᖕᒋᓪᓗ ᐊᑐᐊᖅᑕᐅᓗᑎᒃ, ᐊᑕᐅᓯᕐᒥᒃ ᐊᒥᐊᒃᑯᑐᐃᓐᓇᓇᐊᑖᑦ ᐃᒃᐱᖕᓇᕈᑕᐅᔪᓐᓇᖅᑐᒥᒃ ᑕᒫᓂ ᐃᑭᕐᒥ ᐆᒪᔪᓄᑦ ᐅᒥᐊᕐᔪᐊᑦ ᓂᐱᖕᒋᑦ ᐃᖃᓗᒃᐱᓄᑦ ᓇᓗᓇᖕᒋᒻᒪᑦ ᐃᒃᐱᖕᓇᕈᑕᐅᖕᒪᑕ ᐆᒃᑐᕋᖅᑕᐅᓯᒪᔪᑦ ᒥᑭᔪᒥᒃ, ᐊᒃᓲᒐᖕᒋᑦᑐᒥᒃ ᐊᑯᓂᐅᖕᒋᑦᑐᕋ (ᐃᓅᓯᖕᒐᓄᑦ ᓴᓇᕙᐅᔪᑉ), ᐃᓛᓐᓂᓚᐅᓯᖕᒐᒃᑯᑦ ᑕᐃᒪᖕᒐᓂᐅᖕᒋᑦᑐᖅ (3-ᒥᑦ 10-ᓄᑦ ᐅᒥᐊᕐᔪᐊᖅᑕᐅᖃᑦᑕᕐᓂᐊᕐᒪᑦ ᐊᐅᔭᑖᒃ ᑕᒪᓐᓇ ᓱᑯᖃᕈᓐᓃᖕᒐᑦ, ᓴᓇᕙᐅᔪᓂ ᐊᑐᖅᑕᐅᕆᐊᖕᒋᑦ ᒪᓕᓗᒋᑦ), ᐊᒻᒪ ᑖᒃᑯᓂᑐᐊᖅ ᓴᓇᕙᐅᔪᒥ ᐃᒃᐱᖕᓇᕐᓂᖃᕐᓂᐊᖅᓱᑎᒃ ᐃᑭᖕᒐᓂ RSA. ᐃᒃᐱ`ᖕᓇᕐᓂᕆᓇᔭᖅᑕᖕᒋᑦ ᐱᖅᑯᓯᑐᖃᕐᒥᓄᑦ ᐅᑎᕈᓐᓇᕐᓂᐊᕐᒪᑕ ᐃᓱᓕᓐᓂᐊᖅᑐᑦ ᓴᓇᔪᓃᖅᐸᑕ ᑕᒫᓂ ᐅᒥᐊᕐᔪᐊᑦ ᑕᒪᐅᖕᒐᖃᑦᑕᕈᓐᓃᖅᐸᑕ. ᒪᓕᒃᓗᑎᒃ ᐊᑐᐊᒐᓕᐅᕆᔭᐅᓯᒪᔪᓂᒃ ᐃᒃᐱᖕᓇᕐᓂᖃᖅᑐᓄᑦ ᐊᒃᓱᓗᐊᔭᐃᒃᑯᑎᓂᒃ ᓇᓗᓇᐃᔭᖅᑕᐅᓯᒪᔪᓂᒃ ᐃᒪᕐᒥᐅᑕᓄᑦ ᐃᒃᐱᖕᓇᕐᓂᖃᕋᔭᖅᑐᑦ ᐊᐅᓚᑕᐅᔪᑎᖕᒋᓐᓄᑦ ᐸᕐᓇᐃᔪᑕᐅᓯᒪᔪᓂᒃ (AEMP; ᐃᔾᔪᖅ 10, ᐃᓚᖕᒐ 19-ᒥ), ᕿᓪᓚᓇᒃᑐᓄᑦ ᐸᕐᓇᐃᔪᑕᐅᓯᒪᔪᓂ (ᐃᔾᔪᖅ 10, ᐃᓚᖕᒐ 15-ᒥ), ᐊᒻᒪᓗ ᓂᑉᐹᕿᔪᓗᐊᔭᐃᒃᑯᑎᓄᑦ ᓴᓇᕙᐅᔪᓂ ᐸᕐᓇᐃᔪᑏᑦ (ᐃᔾᔪᖅ 10, ᐃᓚᖕᒐ 18ᒥ), ᐃᒃᐱᖕᓇᕐᓂᕆᓂᐊᖅᑕᖕᒋᓪᓚ ᐃᒪᕐᒥᐅᑕᓄᑦ ᐃᖃᓗᖕᓄᑦ ᓇᓚᐅᑦᑖᕈᑕᐅᓯᒪᔪᖅ **ᐊᒃᓱᓗᐊᔭᖕᒋᓐᓂᕋᖅᑕᐅᓪᓗᓂ.**

ᐃᒃᐱᖕᓇᕐᓂᕆᓇᔭᖅᑕᖕᒋᓪᓚ ᑲᑎᓪᓗᒋᑦ ᐅᓄᖅᑐᑦ ᓴᓇᕙᐅᔪᑦ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᕐᒥᔪᑦ ᐊᒥᐊᒃᑯᖕᒋᑦ ᓴᓇᕙᐅᔪᒥ. ᒪᕈᐃᓕᖕᒐᔪᓂᒃ ᐃᒃᐱᖕᓇᕐᓂᖃᕐᓂᐊᕋᓯᒋᔭᐅᔪᑦ ᓯᕗᓂᓂᓂᐊᖅᑕᑦᑎᓐᓂ ᓴᓇᕙᓕᐊᕆᔭᐅᓂᐊᖅᑐᑦ ᑲᑎᓪᓗᒋᑦ ᐃᒃᐱᖕᓇᕐᓂᖃᓕᕐᓂᐊᕐᒪᑕ ᐊᑯᓚᐃᑦᑐᒥᒃ ᑕᐃᒪᐃᓕᐅᖕᒋᓇᓕᖅᐸᑕ. ᕿᖕᒐᐅᑉ ᑲᖕᒋᖅᓱᐊᓂ ᑐᓚᒃᑕᕙᓕᐊᕆᔭᐅᔪᒪᔪᖅ ᐊᒻᒪᓗ ᐊᖅᑯᑎᓕᐊᕆᔭᐅᔪᒪᔪᖅ (BIPR) ᐊᒻᒪᓗ Hᐊᑭᑦᑰᖕᒐᓂ ᐅᔭᕋᖕᓂᐊᕐᕙᒃᓴᖅ ᑖᓯᒥᖕᒐᓴᐃᓐᓇᖅ ᑐᓚᒃᑕᕐᕙᖕᒥ ᐊᑐᖅᑕᐃᓂᐊᕐᒪᑕ ᐊᖅᑯᑎᖕᒐᓂᓗ BIPR. ᑖᒃᑯᐊ ᓴᓇᔭᐅᔪᒪᔪᑦ ᑲᔪᓯᓕᖅᐸᑕ, ᐃᑭᕐᒥᐅᑕᓄᑦ ᐃᖃᓗᖕᓄᑦ ᐃᒃᐱ`ᖕᓇᕐᓂᕐᓂᐊᕐᒪᑕ ᑕᒫᓂᑐᐊᖅ ᓂᐹᕿᔪᓄᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ ᐃᒪᖕᒐᓂ RSA. ᑲᑎᓪᓗᒋᓪᓚ ᐃᒪᕐᒥ ᓂᐹᕿᔪᑦ ᐊᒃᓲᓂᖅᓴᐅᓕᕈᓐᓇᕐᒪᑕ ᐊᒥᓱᑦ ᐅᒥᐊᕐᔪᐊᑦ ᑕᒪᐅᓈᖅᑕᖃᑦᑕᓕᖅᐸᑕ ᖃᓂᒡᒍᓪᓗᑎᒃ ᐃᒃᐱᖕᓇᕐᓂᕈᓐᓇᕐᒪᑕ ᐃᖃᓗᒃᐱᓄᑦ ᑭᓱᐊᓂᒐ ᓇᓚᐅᑦᑖᖅᑕᐅᓯᒪᖕᒥᔪᖅ ᐊᒃᓲᒍᐋᔭᖕᒋᓐᓂᕋᖅᑕᐅᓪᓗᓂ ᐃᓛᓐᓂᓚᐅᓯᖕᒐᖕᒐᓂ ᐱᖃᑦᑕᕐᓂᐊᕐᒪᑕ,

ᓂᐸᕿᑦᑎᓂᖅᓴᐅᓗᑎᒃ ᑭᓴᖅᓯᒪᕕᖕᒥ ᖃᓂᒃᓴᖅᑐᓂ ᐃᒻᒪᖄ 100-ᒦᑐᒥ ᐅᒥᐊᖑᐊᓂᑦ ᐅᕐᕌᓯᕐᓂᓕᕐᒥ ᐊᒻᒪᓗ ᐅᕐᕌᓯᕗᓗᒃᑑᓕᕐᓗᑎᒃ ᓯᓚᑖᓂ. ᐊᑯᓚᐃᓐᓂᖅᓴᐅᓕᕈᓐᓇᕐᒪᑕ ᓂᐸᕿᑦᑎᓂᖅᓴᐅᖃᑦᑕᕐᓂᐊᕐᒪᑕ ᐃᑖᓐᓂᓚᐅᓱᕐᒐᒃᑯᑦ. ᑲᑎᓪᓗᒋᓪᓕ ᓂᐸᕿᔪᑦ ᐃᒃᐱᕐᓇᕐᓂᖏᓇᔾᖅᑕᕐᒋᑦ ᑭᖑᓂᕐᒐᓂ ᐅᒥᐊᖑᐊᑦ ᑕᒫᓃᑦᑐᓐᓃᕐᕋᕐᒪᑕ ᓴᓇᕝᕕᐅᔪᓐᓂᖅᑎᓪᓗᒍ, ᑕᐃᒪᓐᓇ ᐊᒃᑮᓗᐊᕈᓐᓅᕐᓂᐊᕐᒪᑕ ᓴᓇᔪᑦ ᓄᖅᑲᖅᐸᑕ ᐱᖅᑯᓯᑐᕐᑲᕐᒥᓄᑦ ᐅᑎᕈᓐᓇᕐᒪᑕ. ᖃᐅᔨᒪᓇᕐᒪᑦ ᐊᒃᑮᓗᐊᔾᐃᒃᑯᑎᓂᒃ ᓴᓇᕝᕕᐅᔪᓂ ᓂᐸᕿᓗᐊᔾᐃᒃᑯᑎᓂᒃ ᐊᑐᐊᒐᕐᑲᓚᕐᒐᕐᒪᑕ ᓴᓇᕝᕕᐅᔪᓂ ᐅᖃᐅᓯᕆᖅᑲᐅᔾᑎᓐᓂᒃ ᐆᒪ ᕿᑏᓂ, ᐊᒃᓯᕈᓕᕈᑕᐅᙵᕐᒥᒻᒪᑕ ᐃᒃᐱᕐᓇᕐᓂᕐᒋᑦ ᐅᒥᐊᖑᐊᑦ ᐊᖅᑯᑎᒋᖃᑦᑕᖅᑕᕐᒋᓐᓂ ᐃᖃᓗᒃᐱᓄᑦ ᓇᓚᐅᑦᑖᕈᑕᐅᓯᒪᔪᑦ ᐊᒃᓰᓗᐊᙳᕐᒋᓐᓂᕋᖅᑕᐅᓪᓗᑎᒃ.

ᑕᐃᒪᐃᓐᓂᕐᒪᓄᑦ ᓴᓇᕝᕕᐅᓂᐊᖅᑐᒥᑦ ᐃᒃᐱᕐᓇᕐᓂᐅᓇᔾᖅᑐᑦ ᑲᑎᓪᓗᒋᑦ ᐅᓄᖅᓯᒃᐸᑕ ᓴᓇᕝᕕᐅᔪᓪᓗ ᐃᑭᕐᒪᓂ ᐆᒪᔪᓄᑦ RSA-ᒥ, ᓄᓇᕗᒻᒥᒻᒪᑕ ᑭᓯᐊᓂ ᐊᓯᕐᒋᓐᓄᑦ ᓄᓇᓄᑦ ᐃᒃᐱᕐᓇᕐᓂᕐᒋᑦ ᐃᑳᔾᕐᒋᑦᑐᑦ.

<u>ᐃᒪᕐᒥᐅᑕᐃᑦ ᖁᐸᓄᐊᑦ/ᑎᕐᒥᐊᓪᓗ</u>

ᐃᒪᕐᒥᐅᑕᐃᑦ ᖁᐸᓄᐊᑦ ᐊᒻᒪᓗ ᐃᒪᕐᒥᐅᑕᐃᑦ ᑎᕐᒥᐊᑦ ᑕᒪᐅᕐᒐᖃᑦᑕᖅᑐᑦ ᐊᐅᔾᔭᒃᑯᑦ ᐊᑐᖃᑦᑕᕐᒪᑕ ᐃᒪᕐᒐᓂᒃ ᐃᑭᕐᒐᓂᓗ ᖃᕐᒐᑐᐃᓐᓇᒃᑯᑦ ᐅᑭᐅᓕᒫᒥ ᐊᒻᒪᓗ ᓈᓯᒪᓂᖃᖅᓯᑎᒃ ᐊᕐᒋᔭᐊᓗᕐᒥ ᐊᔾᔨᕐᒋᑦᑑᑏᑦ ᑎᕐᒥᐊᑦ ᐋᕐᒋᐊᖑᐃᑦ, ᓂᕆᓖᓪᓗ, ᑲᕗᐃᓪᓗ ᖁᒡᔪᐃᓪᓗ, ᖃᖅᓴᐅᓪᓗ, ᑑᓪᓖᓪᓗ, ᑑᓪᓕᔭᐊᓪᓗ ᐊᒻᒪᓗ ᓇᐅᔭᐃᑦ. ᐃᒪᕐᒥᐅᑕᐃᓪᓕ ᑎᕐᒥᐊᑦ ᐊᒻᒪᓗ ᐋᕐᒋᐊᖑᐃᑦ ᑕᒫᓂ ᐃᕙᕝᕕᖃᐅᕐᒪᑕ ᑕᐃᒪᓐᓇ ᓴᐳᑎᔭᐅᓯᒪᔭᑎᖃᖅᑐᑦ ᒐᕙᒪᑎᑐᖃᒃᑯᑦ ᒪᓕᒐᕐᒋᑎᒍᑦ ᑕᒪᐅᕐᒐᖃᑦᑕᖅᑐᑦ ᖁᐸᓄᐊᑦ ᒪᓕᒐᕐᒐᓄᑦ (1994). ᐅᑯᐊ ᐱᕐᒐᓱᐃᓕᕐᒐᔪᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᑎᕐᒥᐊᑦ ᐋᕐᒋᐊᖑᐃᓪᓗ ᑎᑎᕋᖅᑕᐅᓯᒪᕐᒪᑕ "ᐊᑦᑕᕐᓇᕐᓂᕋᖅᑕᐅᓕᖅᑐᓂ" ᐊᑐᐊᓗᒍ ᑲᓇᑕᒥ ᐊᑦᑕᕐᓇᓕᖅᑐᑦ ᓂᕐᔪᑏᑦ ᓴᐳᑎᔭᐅᓯᒪᔪᑎᕐᒋᑕ ᑲᑎᒪᔨᕐᒋᓐᓄᑦ (CESCC) ᓇᓗᓇᐃᒃᑯᑕᓕᐅᖅᑕᐅᓯᒪᔪᑦ ᓄᓇᕗᒥ ᖃᖅᓴᐅᑦ, ᓇᐅᔭᐃᑦ ᐊᒻᒪᓗ ᐃᓱᖖᒐᐃᑦ (CESCC 2010).

ᖃᕐᒪᑕᓲᒃᑯᑦ ᒪᓂᕋᕐᒐᓂᓗ ᓇᓴᖅᑕᐅᓯᒪᓕᖅᑐᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᐆᒪᔪᑦ RSA-ᒥ ᐊᑯᓐᓂᕐᒐᓂ 2007 ᐊᒻᒪᓗ 2013 ᐃᕙᓐᓇᖅᑎᓪᓗᒍ (ᔪᓐᒥᑦ ᔪᓚᐃᒧᑦ) ᐊᒻᒪᓗ ᐊᐅᓪᓚᕐᓂᐊᓕᖅᑎᓪᓗᒋᑦ (ᐋᒋᓯᒥ) ᐊᒻᒪᓗ ᑎᑎᕋᖅᑕᐅᓚᐅᖅᓯᑎᒃ ᑲᑎᓯᒋᑦ 23-ᖑᕐᒪᑕ ᐊᔾᔨᒌᕐᒋᓐᓂᕐᒋᑦ ᑎᕐᒥᐊᑦ ᑕᒪᐅᕐᒐᖃᑦᑕᖅᑐᑦ ᕿᕐᒐᐅᑉ ᑲᕐᒋᖅᓱᕐᒐᓄᑦ. ᑭᓯᐊᓂᓕ ᑕᒫᓂ ᐃᕙᕝᑯᖃᐅᕐᒋᒻᒪᑕ ᐃᓚᕐᒋᑦ ᐃᕙᕝᕕᓂᒃ ᓈᓴᐃᑎᓪᓗᒋᑦ ᐅᑭᐅᖑᓚᐅᖅᑐᓂ. ᐅᐱᕐᕈᒃᑯᑦ, ᑕᒪᐅᕐᒐᖅᐸᓪᓕᐊᓕᖅᑎᓪᓗᒋᑦ, ᐃᓴᓕᖅᑎᓪᓗᒋᓪᓗ, ᐊᐅᓪᓚᕐᓂᐊᓕᖅᑎᓪᓗᒋᓪᓗ ᐃᒪᕐᒥ ᐱᖃᑦᑕᕐᒪᑕ ᐊᒻᒪᓗ ᑰᕕᐅᔪᑦ ᖃᓂᒋᔭᕐᒋᓐᓂ ᒪᑯᐊ ᑑᓐᓴᐃᑦ ᑰᕐᒐᑕ ᐊᑯᐊᕐᒐᓂ ᐊᒻᒪᓗ ᐅᐊᓕᓂᕐᒥᐅᑦ ᑰᕐᒐᑕ ᐊᑯᐊᕐᒐᓂ ᐅᐱᕐᕐᒃᑯᑦ ᓯᑯᖃᕐᒋᓐᓂᐅᔪᒥ ᐃᑭᖅ ᓱᓕ ᓯᑰᑎᓪᓗᒍ. ᐊᐅᔭᒃᑯᓪᓕ ᐅᑭᐊᒃᓴᓕᖅᑎᓪᓗᒍ (ᕿᑎᕐᒐᓂ ᔪᓚᐃ ᐊᒻᒪᓗ ᐋᒋᓯ), ᐅᓄᖅᑐᐊᓗᐃᑦ (> 50 ᑎᕐᒥᐊᑦ) ᐅᓗᐊᕈᓖᑦ ᓂᕿᓖᑦ ᐊᒻᒪ ᐋᕐᒋᐊᖑᐃᑦ (ᐋᐋᕐᒋᑦ ᒪᒃᓯᑦᑑᓪᓗ) ᑕᑯᔭᐅᖃᑦᑕᓚᐅᕐᒥᔪᑦ ᐃᒃᑲᐃᑦᑐᓂ ᓯᓪᓭᓂ ᓂᒡᕆᕐᓘᕐᒐᓂ ᓂᐅᕋᐃᕝᕕᓕᐅᕝᕕᐅᔪᒪᔪᑉ MLA ᑕᒫᓂ LSA-ᒥ. ᐅᓂᕐᓂᖅᐹᖑᓚᐅᖅᑐᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᖁᐸᓄᐊᑦ ᐃᒪᕐᒥᐅᑕᐃᓪᓗ ᑎᕐᒥᐊᑦ ᐊᐅᔭᖅ ᐃᓱᓕᓕᖅᑎᓪᓗᒍ ᐅᑭᐅᒃᓵᒃᑯᓪᓗ.

ᒪᕿᐃᓕᕐᒐᔪᓂᒃ ᓴᓇᕝᕕᐅᓂᐊᕐᓂᕐᒐᓄᑦ ᐃᒃᐱᕐᓇᕐᓂᖃᕋᔾᖅᑐᓂᒃ ᖃᐅᔨᓴᕈᑎᖃᓚᐅᖅᑐᑦ ᑕᒫᓂ VEC-ᒥ ᓇᔪᖅᑕᐅᕙᒃᑐᓂ ᐃᒪᕐᒥᐅᑕᓄᑦ ᖁᐸᓄᐊᓄᑦ ᑎᕐᒥᐊᓄᓪᓗ, ᐅᒥᐊᖑᐊᕝᕕᐅᕙᖅᑐᒥ ᓴᓇᕝᕕᐅᓂᐊᖅᑐᒥᓗ ᐱᓕᕆᕝᕕᒃᓴᐃᑦ ᓴᓇᔭᐅᑎᓪᓗᒋᑦ ᐊᒻᒪᓗ ᐊᐅᓚᑕᐅᑎᓪᓗᒋᑦ MLA-ᒥ. ᐃᒃᐱᕐᓇᕐᓂᖃᕐᓂᐊᖅᑐᓄᑦ ᐊᒃᓱᐊᔾᐃᒃᑯᑎᓂᒃ ᐊᑐᐊᒐᖅᑎᑕᐅᔪᑦ ᐃᓚᕐᒋᓪᓗ ᐊᑐᖅᑕᐅᖃᑦᑖᔭᓇᑎᒃ ᓴᓇᕙᐊᔪᓂ ᑎᕐᒥᐊᑦ ᑎᑭᓯᒪᓂᕐᒋᓐᓂ. ᐃᒪᕐᒐᐃ, ᐃᒪᕐᒥᐅᑕᐃᑦ ᖁᐸᓄᐊᑦ ᑎᕐᒥᐊᓪᓗ ᓇᔪᒐᕆᖃᑦᑕᖅᑕᕐᒋᑦ ᓇᓗᓇᐃᖅᑕᐅᓚᐅᖅᓯᒪᔪᑦ ᐱᑎᐊᓕᖅᑎᓪᓗᒋᑦ ᖃᐅᔨᓴᕈᑕᐅᓪᓗᑎᒃ ᐋᕿᑎᐊᖅᑕᐅᔪᑕᐅᓪᓗᑎᒃ ᐃᒡᓗᖑᐊᑦ ᓴᓇᕝᕙᒃᓴᐃᑦ ᓴᓇᔭᐅᑎᓪᓗᒋᑦ ᐅᐸᒃᑕᐅᑦᑕᐃᓕᒪᓂᐊᕐᒪᑕ ᐊᐅᔭᐅᓕᕗᕐᒐᑦ ᑕᒫᓅᓐᓂᕐᒋᓐᓂ. ᓇᔪᒐᕆᔭᐅᔪᑦ ᐊᐸᒃᑕᐅᑦᑕᐃᓕᒪᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐊᐅᔭᒃᑯᑦ ᖃᕐᒪᑕᓱᑦ ᐊᖅᑯᑎᕐᒃᑕᖅᑕᕐᒋᑦ ᐊᓯᔾᔨᖅᑕᐅᓗᑎᒃ, ᐊᔪᕐᓇᕐᒋᒃᑳᕐᒐᑦ, ᑐᑭᒍᐊᖅᑐᒥ ᓴᓂᕈᑦᑐᒥᓗ ᐊᑐᐊᒐᓂᒃ ᐋᕿᒃᓯᐃᓯᒪᓗᑎᒃ ᑎᕐᒥᔫᓄᑦ ᐅᐸᒃᑕᐅᕆᐊᖃᕐᒋᑦᑐᓂᒃ ᑎᕐᒥᐊᓄᑦ ᓇᔪᖅᑕᐅᖃᑦᑕᖅᑐᓂ. ᖃᕐᒪᑕᓯᑦ ᖁᑦᑎᕐᓂᕐᒋᑦ ᐃᕐᒋᕋᓕᕇᕐᒪᑕ 6%)-ᒦᑐᒥ ᐊᑐᐊᒐᓇᔭᐅᓂᐊᖅᑐᖅ ᖃᐅᔨᒪᔭᐅᔪᓂ ᑎᕐᒥᐊᓄᑦ ᓇᔪᒐᓇᔭᐅᖃᑦᑕᖅᑐᓂ ᐊᑦᑕᕐᓇᕈᑕᐅᓕᕐᓘᕐᕋᐸᑦ ᖃᕐᒪᑕᓯᓄᑦ. ᖃᕐᒪᑕᓯᓪᓕ ᒥᕆᐊᖅᑐᓕᕇᕐᒪᑕ ᖃᕐᒪᑦᑕᓕᕇᕐᒪᑕᓗ ᐊᖅᑰᓴᖅᓯᕆᐊᖃᕐᒋᑎᑕᐅᓗᑎᒃ ᑎᕐᒥᐊᓄᑦ ᓇᔪᒐᓇᔭᐅᔪᒃ ᐊᑦᑕᕐᓇᖅᑐᖃᖁᓇᒍ ᑕᒪᐃᓐᓄᑦ ᑎᕐᒥᐊᓄᑦ ᖃᕐᒪᑕᓲᓄᓪᓗ (ᑦᕙᓂᑐᐊᖅ ᐊᑐᐊᒐᓇᔭᐅᓂᐊᖅᑐᑦ ᓴᓇᕝᕕᐅᔪᑦ ᒪᑐᐃᕐᒐᓂᕐᒋᓐᓂ), ᐃᑖᓐᓂᓚᐅᓱᕐᒐᒃᑯᑦ ᓄᓇᐅᑉ ᐱᖅᑯᓯᕐᒐ ᒪᓕᒃᓯᒍ, ᑕᒪᐅᕐᒐᑐᐊᖅ ᐃᑭᕐᒥ ᓂᐅᕋᐃᕝᕕᕐᒥ ᐱᔪᑦ, ᐊᒻᒪᓗ ᐱᖅᑯᓯᑐᕐᑲᕐᒋᓐᓄᑦ

ᐅᑎᐳᓐᓇᕐᓂᐊᕆᓪᓗᑎᒃ. ᑭᖑᓂᒐᒍᓪᓕ ᑕᒫᓃᒍᓐᓃᖅᑎᓪᓗᒋᑦ ᐃᒃᐱᖕᓇᕐᓂᖅᑳᓐᓃᕈᒫᕐᒪᑕ ᐊᒃᓱᓗᐋᔾᖏᑦᑐᑦ, ᒪᓕᒐᐃᑦ ᒪᓕᒃᑕᐅᑦᑎᐊᑐᐊᖅᐸᑕ ᐊᑐᐊᒐᓕᐅᕈᑕᐅᓯᒪᔪᑦ ᐊᒃᓲᓗᐊᔭᐃᒃᑯᑎᓄᑦ ᓇᓗᓇᐃᔭᖅᑕᐅᓯᒪᔪᓄᑦ ᐆᒪᔪᓄᑦ ᓱᓗᐊᔭᐃᒃᑯᑎᓂᒃ ᐊᐅᓚᖅᑎᔪᑎᓄᓪᓗ ᐸᕐᓇᐃᔪᑕᐅᓯᒪᔪᓂ (ᐃᔾᔪᔪᖅ 10, ᐃᓚᖓ 20-ᒥ).

ᐃᒃᐱᖕᓇᕐᓂᖅᑲᔾᔭᕐᓂᖏᓪᓕ ᑲᑎᖅᓱᖅᓱᒋᑦ ᓴᓇᕙᐅᔪᑦ ᖃᐅᔨᓴᕈᑕᐅᓚᐅᕐᒥᔪᑦ ᐃᓚᖏᓛᒃ ᐊᑯᓂ ᑲᑎᖅᓱᖅᓱᒋᑦ ᐃᒃᐱᖕᓇᕐᓂᖅᑲᓕᕈᓐᓇᕐᒥᖕᒪᑕ ᓴᓇᕙᐅᔪᑦ ᓇᓚᐅᑦᑖᕈᑕᐅᓪᓗᑎᒃ. ᓴᓇᕙᐅᔪᓄᑦ ᑭᖑᓂᖓᓂ ᐃᒃᐱᖕᓇᕐᓂᖅᑲᓕᕈᓐᓇᖅᑐᑦ ᓯᓚᑎᖓᓄᑦ ᐊᕝᑎᖓᓄᓪᓗ ᑕᒪᑐᒪᓂᑦᑎᐊᖑᓂᐊᖅᑐᒥ ᓱᕗᓂᒃᓴᖓᓂ ᓴᓇᕙᐅᓪᓚᑦᑖᓕᖅᐸᑦ BIPR-ᒥ ᐊᒻᒪᓗ HᐊᑭᑦᏧᖓᓂ ᐅᔭᕋᑉᓂᐊᕐᕙᑉᒥ ᐊᑐᕐᓂᐊᕐᒪᑕ ᕿᖓᐅᑉ ᓯᒡᔭᖓᓂᒃ ᑐᓚᒃᑕᕐᕙᐅᓗᓂ ᓂᐅᕋᐃᙵᐅᓗᓂᓗ RSA-ᒥ. ᑲᑎᖅᓱᕐᓗᒋᑦ ᐃᒃᐱᖕᓇᕐᓂᖅᑲᕐᓂᐊᖅᑐᑦ ᐊᒃᓱᓗᐊᖑᖏᑦᑐᒥᒃ, ᐊᑯᓐᓂᖓᓂᓗ ᐊᑯᓂᐅᓂᖅᑲᖅᑐᒥᒃ (ᑕᒫᓂᑐᐊᖅ ᓴᓇᕙᐅᔪᖅ ᐆᒪᓂᖓᓂ), ᐃᑳᓐᓂᓚᐅᓱᖓᒃᑯᑦ ᓄᓇᐅᑉ ᐱᖅᑯᓱᖓ ᒪᓕᓗᒍ, ᑕᒫᓂᑐᐊᖅ ᐱᑎᑕᐅᓂᐊᕐᒪᑕ ᐃᒪᕐᒥ RSA-ᒥ ᐊᒻᒪᓗ ᐱᖅᑯᓱᑐᕐᑲᕐᒥᓄᑦ ᐅᑎᐳᓐᓇᕐᓂᐊᖅᓱᑎᒃ. ᑕᒪᐃᑎᒍᓪᓕ, ᑲᑎᓪᓗᒋᑦ ᐃᒃᐱᖕᓇᕐᓂᓇᓂᐊᖅᑕᖏᑦ ᑲᑎᓪᓗᒋᓪᓗ ᓱᕚᓪᓕᐅᑕᐅᓂᐊᖅᑐᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᓯᒪᖕᒥᔪᑦ **ᐊᒃᓲᓗᐊᔾᖏᓐᓂᕋᖅᑕᐅᓪᓗᑎᒃ** ᐊᒻᒪᓗ ᐊᓄᕐᓂᖏᓐᓄᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᖁᐸᓄᐊᑦ ᑎᖕᒥᐊᓪᓗ ᐃᒃᐱᖕᓇᕐᓂᖅᑳᓇᑎᒃ. ᓴᓇᕙᐅᔪᓪᓕ ᑭᖑᓂᖓᒍᑦ ᑕᒫᓂ ᑭᓯᐊᓂ ᐱᓂᐊᕐᒪᑕ RSA-ᒥ, ᓄᓇᕗᒥ ᑭᓯᐊᓂ ᐊᓯᖏᓐᓄᑦ ᓄᓇᓄᑦ ᐃᒃᐱᖕᓇᕐᓂᖅᑳᖏᑦᑐᑦ.

<u>ᓇᑦᑎᕐᓄᑦ</u>

ᖃᖓᑕᓱᒃᑯᑦ ᓈᓴᖅᑕᐅᓚᐅᕐᒪᑕ ᑕᒪᑐᒪᓂ ᐅᐱᖕᖠᓇᓚᐅᖅᑕᖓᓂ ᒥᖅᑯᐃᔭᖅᑎᓪᓗᒋᑦ (ᒪᐃ ᕿᑎᐊᓂᑦ ᑎᑭᓪᓗᒍ ᔪᓚᐃ ᕿᑎᐊᓄᑦ) ᐊᑯᓐᓂᖓᓂ 2007 ᐊᒻᒪᓗ 2013 ᐃᒪᕐᒥ ᓯᒡᔭᖓᓂᓗ RSA ᖃᐅᔨᓇᓱᐊᖅᓱᒋᑦ ᓇᒥᖅᑦᑕᕆᐊᖏᑦ ᐊᒻᒪᓗ ᐅᓄᕐᓂᖏᑦ ᓇᑦᑏᑦ. ᖃᐅᔨᕚᓪᓗᓚᐅᖅᑐᑦ ᓇᑦᑏᑦ ᐅᓄᕐᓂᖏᑦ ᑕᒪᓐᓃᒻᒪᑕ ᐊᔾᔨᒌᖏᑦᑐᓂ ᕿᖓᐅᑉ ᑲᖏᖅᓱᖓᓂ, ᐅᓄᓗᐊᕌᓗᖏᓱᑎᒃ ᑕᒪᐃᓐᓂ ᑲᖏᖅᓱᖓᓂ, ᑭᓯᐊᓂ ᓂᒡᖏᖖᖠᖓᓂ ᕿᖓᐅᑉ ᓇᓂᓯᓚᐅᖅᑐᑦ ᐅᓄᖏᑦᑐᓂᒃ ᐃᓐᓇᕐᓂᒃ ᓇᑦᑎᐊᕙᓂᕐᓂᓗ 8-ᓂᑦ 10-ᓄᑦ ᐱᓇᓱᐊᕈᓯᓕᖕᓂᒃ ᓇᑦᑎᐊᓂᒃ. ᓇᑏᑦ ᓄᓇᖅᔭᖅᑲᓱᑦ ᑲᓇᖕᓇᖕᖠᖕᖠᓂ ᑭᓯᐊᓂ RSA ᖃᐅᔨᓴᖅᑕᐅᑎᓪᓗᒋᑦ ᑕᐃᒪᐃᓚᐅᖅᑐᑦ, ᓄᓇᖅᔭᖅᑕᖅᑲᓚᐅᖏᑦᑐᖅ ᓂᒡᖏᖖᖠᖓᓂ ᑲᖏᖅᓱᒥ ᑕᒪᓂ RSA-ᒥ LSA-ᒥᔫᓐᓃᑦ. ᐅᓄᖏᓐᓂᖅᓴᐅᓚᐅᕐᒪᑕ ᓇᑦᑎᑦ ᓂᒡᖏᖖᖠᖓᓂ ᕿᖓᐅᑉ ᑲᖏᖅᓱᖓᓂ ᐊᒻᒪᓗ ᓄᓇᖅᔭᖅᑲᐅᓚᐅᖏᒻᒪᑦ ᑕᒪᓐᓇ ᓱᑯᖓ ᐊᐃᔪᕋᖅᑲᐅᖏᓐᓂᖅᓴᐅᓂᖓᓄᑦ ᐃᕗᐊᖅᑲᐅᖏᓐᓂᖅᓴᐅᓚᐅᕐᒪᑦ ᓇᑦᑎᕐᓄᑦ ᓄᓇᖅᔭᖅᑲᕐᕙᐅᕙᒃᑐᓂᒃ ᐊᓪᓗᖅᑲᐅᖏᓐᓂᖅᓴᐅᓪᓗᓂᓗ. ᐊᐅᔭᒃᑯᓪᓕ, ᓇᑏᑦ ᐅᓄᕐᓂᖏᑦ ᐊᒃᓲᓗᐊᖑᖏᓪᒥᔪᑦ ᕿᖓᐅᑉ ᑲᖏᖅᓱᐊᓂ ᑖᒃᑯᐊ ᖃᐅᔨᔭᐅᓯᒪᔪᑐᖃᐃᑦ ᐅᓂᒃᑳᓂ ᐊᓯᖏᓐᓂᓗ ᑐᓐᖓᕙᕆᔭᐅᔪᓂᒃ ᖃᐅᔨᓴᕈᑕᐅᓯᒪᔪᓂ ᐃᑭᕐᒥ RSA-ᒥ ᑎᑎᕋᐅᓯᐅᓯᒪᔪᓂᑦ.

ᒪᕐᕈᐃᓕᖓᔪᓂᒃ ᑕᒪᓐᓇ ᓴᓇᕙᐅᓂᖓᓄᑦ ᐃᒃᐃᖕ`ᓇᕈᑕᐅᓂᐊᕋᓱᕆᓚᐅᖅᑐᑦ ᓇᑦᑎᕐᓗᑦ VEC-ᒥ, ᐃᓚᐅᑎᓪᓗᒋᑦ ᐅᒥᐊᕐᔪᐊᑦ ᐊᒻᒪᓗ ᓴᓇᕙᐅᓂᐊᖅᑐᑦ ᓴᓇᔭᐅᑎᓪᓗᒋᑦ ᐱᓕᕆᑎᓪᓗᒋᓪᓗ ᓯᒡᔭᒥ ᓂᐅᕋᐃᙵᓕᐅᖅᑎᓪᓗᒋᑦ (ᒪᑯᓇᖓᑦ ᖃᖓᑕᓱᓂᑦ ᐊᒻᒪᓗ ᐅᒥᐊᕐᓂᑦ ᐃᖏᕋᑲᑦᑕᖅᑐᓂᑦ ᐊᒻᒪᓗ ᐅᑭᐅᒃᑯᑦ ᓯᑯᒃᑯᑦ ᐊᖅᑯᑎᖃᕐᕙᐅᔪᓂ). ᐃᒃᐱᖕᓇᖅᑐᑦ ᐊᒃᓱᓗᐊᖅᑕᐃᓕᒪᑎᑕᐅᓚᐅᕐᒥᔪᑦ ᑕᒪᐅᓈᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐅᑭᐅᒃᑯᑦ ᐊᖅᑯᑎᒃᑯᑦ ᐃᒪᕐᒥ ᐃᑭᕐᒥᓗ). ᐃᒃᐱᖕᓇᖅᑐᑦ ᐊᒃᓲᓗᐊᖅᑕᐃᓕᒪᑎᑕᐅᓂᐊᕐᒥᔪᑦ ᐊᑐᐊᒐᖏᑦ ᑲᔪᓯᑎᑕᐅᓗᑎᒃ ᐱᖅᑕᐅᖃᑦᑕᕐᓗᑎᓗ ᐃᒃᐱᖕᓇᕐᓂᖅᑲᓖᔪᑦ ᓴᓇᕙᐅᔪᓂᑦ ᓇᑦᑎᕐᓄᑦ. ᐅᒥᐊᕐᔪᐊᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐅᓯᒐᖅᑕᐅᑕᐅᓗᑎᒃ ᓴᓇᕙᐅᔪᓄᑦ ᐃᒪᒃᑯᑦ ᓱᑯᖃᖏᓐᓂᖓᓂ (ᐋᒋᓯ 25-ᒥᑦ ᐅᒃᑑᐸ 31-ᒧᑦ) ᖃᖓᑐᐃᓐᓇᖅ ᓇᑏᑦ ᐅᓄᕐᓂᖏᑦ ᑕᒪᓂ ᐃᑭᖓᓂ ᐊᒃᓲᓗᐊᖑᖏᑎᓪᓗᒋᑦ. ᐱᓕᕆᓂᖅᓴᐅᖃᑦᑕᕐᓂᐊᕐᒪᑕ ᑕᒪᓂ ᑐᓚᒃᑕᕐᕙᐅᑉ ᓂᐅᕋᐃᙵᐊᓂ ᐊᐅᔭᒃᑯᑦ ᓱᑯᖃᕈᓐᓂᖕᖓᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ ᑎᑭᑕᐅᖃᑦᑕᓚᖓᔪᑦ ᐊᒻᒪᓗ ᐅᑭᐅᒃᑯᑦ ᓯᑯᒃᑯᑦ ᐊᖅᑯᑎᒃᑯᑦ (ᑎᓯᐱᕆᒥᑦ ᒪᔾᔪᒧᑦ). ᑖᒃᑯᐊ ᐱᓕᕆᕙᐅᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᑕᒪᓃᑦᑐᓐᓃᙵᓚ ᓇᑏᑦ ᕿᖓᐅᑉ ᑲᖏᖅᓱᖓᓂ ᓈᒻᒪᓈᖅᓯᓪᓗᐊᖅᓯᑎᒃ LSA -ᒥ ᐅᕝᕙᔫᓐᓃ RSA-ᒥ (ᕿᖓᐅᑉ ᑲᖏᖅᓱᖓᑕ ᓂᒡᖏᖖᖠᖓᓂ). ᑕᐃᒪᐃᓐᓄᖓᓄᑦ, ᓴᓇᕙᐅᔪᖅ ᓇᓚᐅᑦᑖᕈᑕᐅᓯᒪᔪᖅ ᐊᒃᓲᓗᐊᔾᖏᓐᓂᕋᖅᑕᐅᓗᓂ ᐃᒃᐱᖕᓇᕐᓂᖅᑐᑦ ᓴᓇᕙᖕᓂ ᖃᓂᒋᔭᖏᓐᓄᓪᓗ ᐃᑭᕐᒥ ᓇᑦᑎᕐᓄᑦ ᐊᒻᒪᓗ ᑲᑎᓪᓗᒋᑦ ᐃᒃᐱᖕᓇᕐᓂᖅᑳᖏᑉᑭᓪᓗᑎᒃ ᐊᓯᖏᓐᓂᓗ ᓄᓇᖅᑲᖅᑐᓄᑦ ᐃᒃᐱᓇᕐᓂᖅᑳᓇᓂ.

Executive Summary – Inuinnaqtun

Not included in this version

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BACK RIVER PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
Supporting Volume 7: Marine Environment

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Acronyms and Abbreviations

Acronyms and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

ADCP	acoustic Doppler current profiler
AEMP	Aquatic Effects Monitoring Plan
ARD	acid rock drainage
BACI	before-after/Control-impact
BIPR	Bathurst Inlet Port and Road
BMP	best management practice
BWE	ballast water exchange
CCME	Canadian Council of Ministers of the Environment
CEA	cumulative effects assessment
CESCC	Canadian Endangered Species Conservation Council
CHS	Canadian Hydrographic Service
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPUE	Catch-per-unit-effort
CTD	Oceanography instrument for measuring conductivity, temperature, depth. Conductivity is a measure of salinity.
CWS	Canadian Wildlife Service
DFO	Fisheries and Oceans Canada
DWT	deadweight tonnage
EBSA	ecologically and biologically significant area
EEM	environmental effects monitoring
EIS	Environmental Impact Statement
GN DOE	Government of Nunavut Department of Environment
IBA	Important Bird Area
IPS	ice profiling sonar
ISQG	interim sediment quality guideline
KIA	Kitikmeot Inuit Association
KMHS	key marine habitat site
KTHS	key terrestrial habitat site

LSA	Local Study Area
ML	metal leaching
ML/ARD	metal leaching/Acid rock drainage
MLA	Marine Laydown Area
MMER	Metal Mining Effluent Regulations
n	Sample size
NIRB	Nunavut Impact Review Board
NNL	no net loss
NSA	Nunavut Settlement Area
NSIDC	National Snow & Ice Data Center
NTKP	Naonaiyaotit Traditional Knowledge Project
NTU	nephelometric turbidity unit
NU	Nunavut
NWA	*Nunavut Wildlife Act*
NWT	Northwest Territories
PAD	permanent alteration or destruction [of fish habitat]
PAH	polycyclic aromatic hydrocarbons
PAL	protection of aquatic life
PDA	Potential Development Area
PDMS	Polydimethylsiloxane
PEL	Probable Effects Level
Project	The proposed Back River Project.
PSS	practical salinity scale
QA/QC	quality assurance/quality control
RSA	Regional Study Area
SARA	*Species At Risk Act*
SD	standard deviation
SE	standard error
TBT	Tributyltin
TIA	Tailings Impoundment Area
TK	traditional knowledge
TOC	total organic carbon
TSS	total suspended solids

UNESCO	United Nations Educational, Scientific and Cultural Organization
VEC	Valued Ecosystem Component
VSEC	Valued Socio-economic Component
WEMP	Wildlife Effects Monitoring Program

1. Physical Processes

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an ERM company

1. Physical Processes

1.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

1.1.1 General Bathurst Inlet Overview

1.1.1.1 Geographic Setting

Bathurst Inlet is a deep fjord-type inlet along the northern coast of the Canadian mainland, within the territory of Nunavut (Figure 1.1-1). The entrance to the inlet is through Coronation Gulf between Cape Barrow (68° 01' N, 110° 06' W) and Cape Flinders (68° 17' N, 108° 35' W), and the body extends over 200 km southwest into the mainland past the Arctic Circle. It has a large network of irregular shores, and is littered with numerous islands, islets and rocks, most of which are described in greater detail by the Canadian Hydrographic Service (1994). Melville Sound extends eastward from northern Bathurst Inlet into Elu Inlet.

The main channel of Bathurst Inlet is relatively narrow (~2 to 15 km) and deep, with depths generally between 100 and 200 m depth, and maximum depths over 300 m in the northern basin near Omingmaktok (Bay Chimo). The most characteristic oceanographic features of the channel are several sills spread along the inlet, which result in rapid shoaling of the bathymetry to depths shallower than 50 m. The largest sill is near Manning Point at the centre of Bathurst Inlet, and the shallow bathymetry is accompanied by a narrowing of the channel width to less than 1.5 km between Quadyuk Island and the Tinney Hills (Figure 1.1-1). This sill approximately divides Bathurst Inlet in two major basins: the outer inlet that comprises all regions north of Manning Channel and contains the deeper, more complex bathymetry; and the inner inlet that runs landward from near Kingaok and has few islands and relatively simple structure with shallower depths between 100 and 150 m.

As part of the Project, a Marine Laydown Area (MLA) is proposed for the western shore of southern Bathurst Inlet (Figure 1.1-2). The deeply indented rocky shorelines in the region lead to steep bathymetry with narrow near-shore areas, a consequence of the inlet cutting through the massive granite rocks that characterize the surrounding Bathurst Hills Ecoregion. Hence, the MLA site consists of a long cobble/sand beach with a steep shoreline consisting of limited shallow areas (i.e., < 10 m) and follows a general 120 - 125° WSW heading. The water shelf extends orthogonally from the shore at a steep slope of approximately 20% to depths below 50 m about 240 m offshore. Beyond this distance, the seabed slopes more gently to depths below 150 m in the main inlet channel.

1.1.1.2 Climate and Sea Ice Conditions

Meteorological baseline information for southern Bathurst Inlet has been intermittently available since 2001, and is detailed in Volume 4, Chapter 3 Climate and Meteorology and Rescan (2003, 2007, 2012a, 2012c). In general, the climate near the MLA site is characterized by long winter periods from October to May, with limited snow (maximum snow depth ~65 cm) and low mean monthly temperatures varying from -29.0 to -1.3°C. As is typical in the Arctic, the remaining seasons are condensed between June and October, with relatively low mean annual rainfall (206 mm) and mean monthly temperatures ranging from 0.5 to 14.5°C. The lowest mean daily minimum since 2001 was -38.0°C (February 12, 2008) and highest mean daily maximum was 16.8°C (July 20, 2007).

Historically, consolidated first-year ice covers Bathurst Inlet from October to June. Ice break-up usually occurs in the first few weeks of July, after which open waters prevail until thin new ice forms around mid-October. Figure 1.1-3 from Environment Canada (2013b) displays the average sea ice freeze-up and break-up dates within the Canadian Arctic for the past 30 years. There has been significant temporal and spatial variation in the timing of break-up and freeze-up in southern Bathurst Inlet, as well as in the amount of ice present year-to-year. This can be seen in Figure 1.1-4 from Environment Canada (2013a), which shows recent ice coverage data collected between 2005 and 2013 for Barrow Strait, Franklin Strait, and the area between Queen Maud and Coronation Gulfs. The bar graphs show the percent of ice coverage expressed as a percent of the total sea area on a weekly basis compared to the 30-year average of 1981–2010.

Observational evidence from the last few decades indicates that sea ice in the Arctic has been thinning and retreating earlier than historical reports (Stroeve et al. 2012). Figure 1.1-4 illustrates this by showing that most ice concentration records in the last 8 years have been lower than historical averages. The strongest changes occurred in the summer for the more northern straits, with several ice-free periods recently recorded where ice used to be present year-round. In 2012, Arctic sea ice was at the lowest recorded levels since ice monitoring by satellite began three decades ago (NSIDC 2012). Arctic ice concentrations rebounded during the 2013 summer with over 60% more ice cover than the previous year, although the coverage was still much lower than historical averages (NSIDC 2013).

1.1.1.3 Winds and Riverine Discharge

Winds are typically a dominant forcing mechanism in the water circulation of open-water estuaries (Li and Li 2012). Wind speed and direction were logged continuously near Bathurst Inlet at approximately 17 km south of the MLA since 2007 (66°31' N, 107°34' W); the records for these are described in detail elsewhere (Rescan 2012a, 2013c). Yearly wind roses from the currently available wind data are plotted in Figure 1.1-5. Measured wind directions were generally variable year-to-year, but could be classified in two major directions, north-northwest and west-southwest, with south-southeastern winds having secondary importance.

The dominant wind blowing directions in Bathurst Inlet are mainly influenced by high-latitude polar high-pressure systems. When such systems form in the Arctic, the high-pressure points move cold air southward to lower latitudes through types of winds commonly known as Polar Easterlies. The topography and orientation of the inlet plays a large role in funnelling these winds, thus they maintain a northwest-to-southeast alignment in the southern channel. When polar high-pressure systems do not form, westerlies usually dominate the Bathurst Inlet wind compass.

Due to the relative absence of obstructions (e.g., trees, buildings, mountains), wind speeds regularly exceed 5 m/s in southern Bathurst Inlet (Rescan 2012a), with average speeds ranging between 3 and 7 m/s. Stronger winds over 11 m/s occur approximately 7-10% of the time and predominantly come from the north.

Freshwater enters Bathurst Inlet through a number of tributaries, the three largest being the Burnside River that enters the inlet next to Kingaok, the Hiukitak River that flows partly into Gordon Bay to the east of Manning Point, and the Western River that flows into the head of the inlet at the southern tip. Several other smaller rivers flow into the southern inlet, notably the Amagok and No Name creeks, which were extensively studied by Rescan (Rescan 2012d). Both creeks followed the same general pattern of other Arctic watersheds (Woo 1990), namely, peak flows during the spring freshet after the ice melt, followed by low flows in the summer period, and a larger flow surge in late August/September due to increasing rainfall before the surface waters begin to freeze. A similar type of flow pattern is surmised for the larger rivers flowing into Bathurst Inlet.

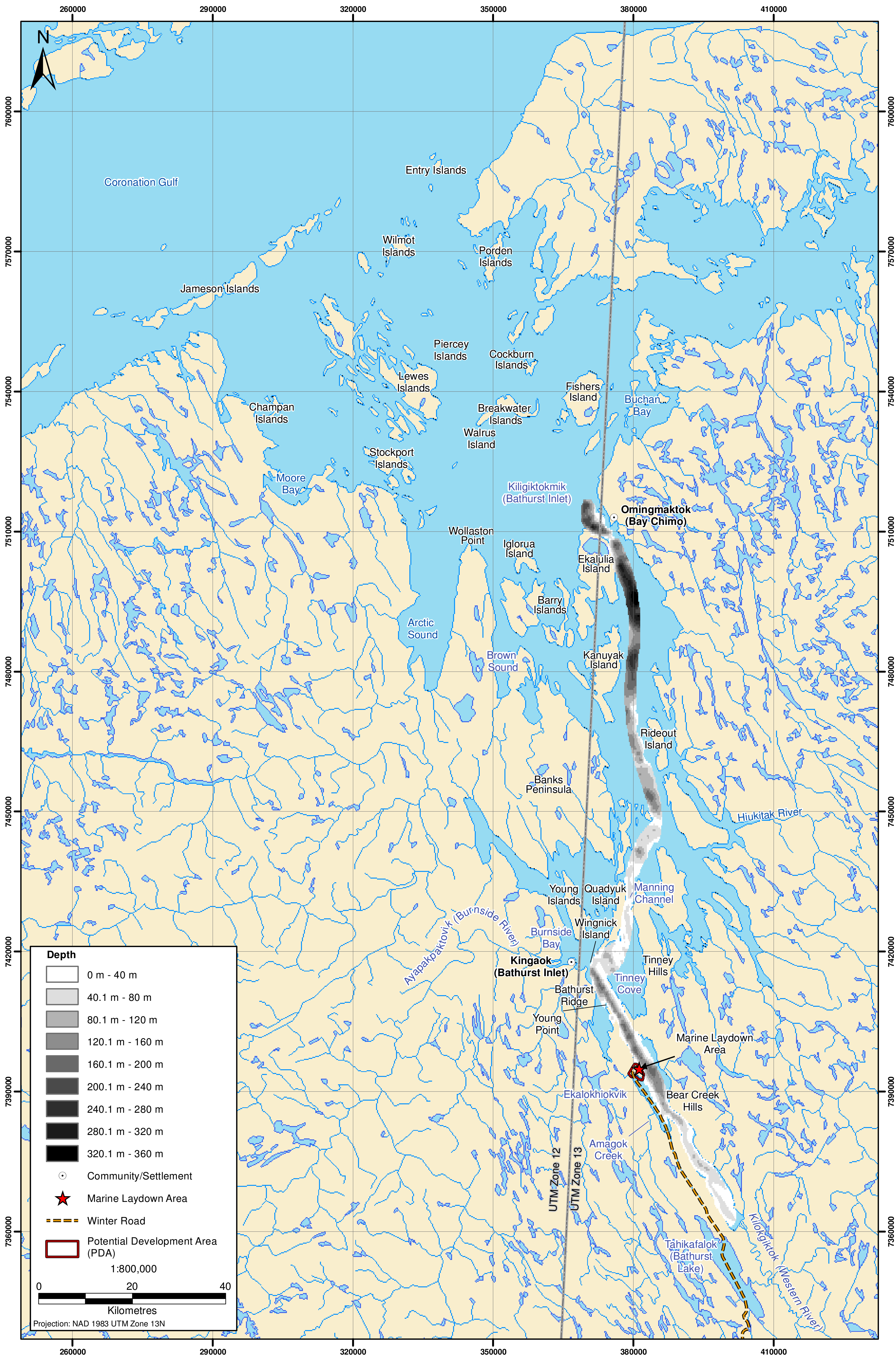


Figure 1.1-1

Sabina GOLD & SILVER CORP.

Figure 1.1-1

Bathurst Inlet Bathymetry and Geographic Setting

Rescan an ERM company

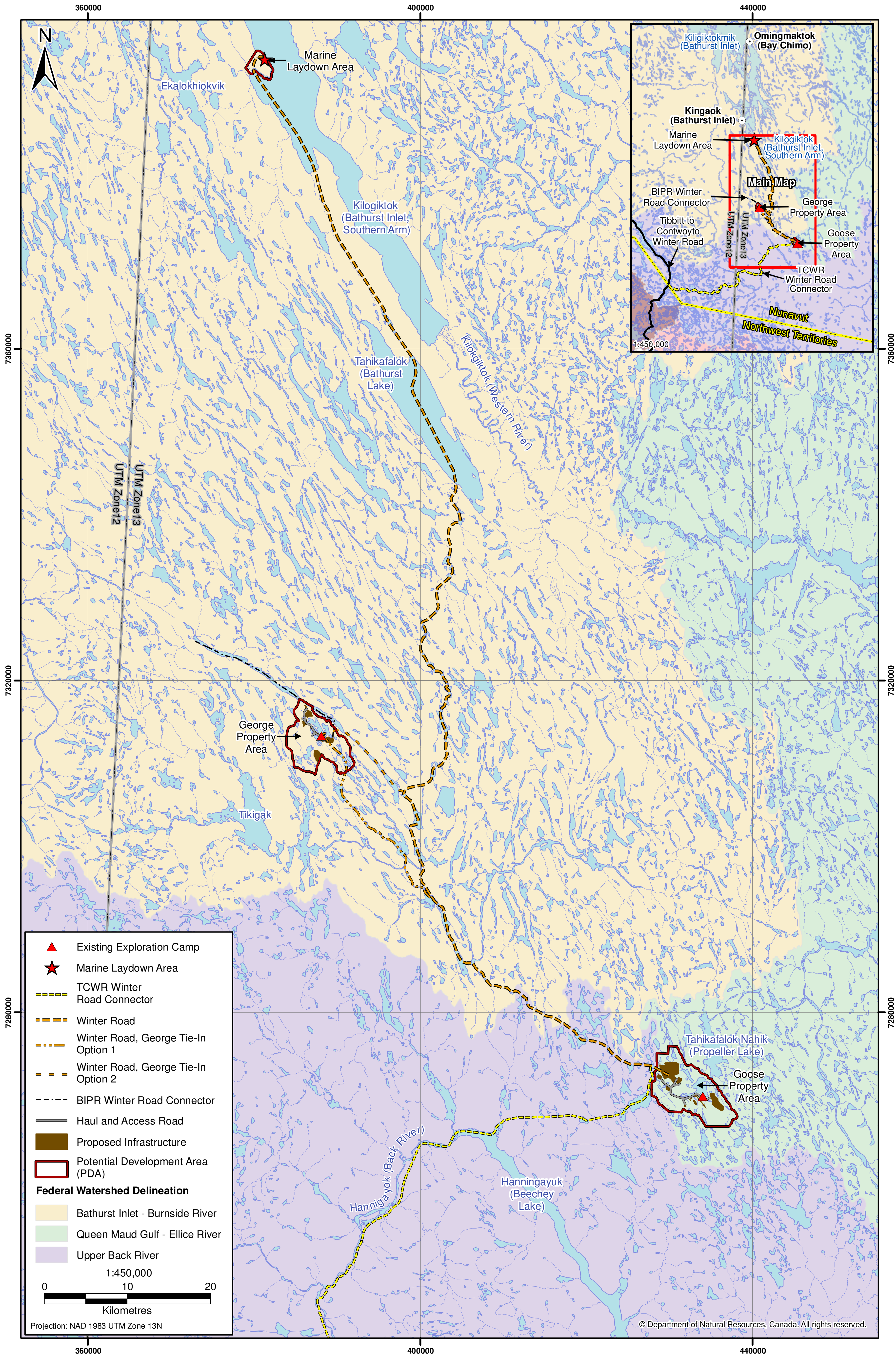
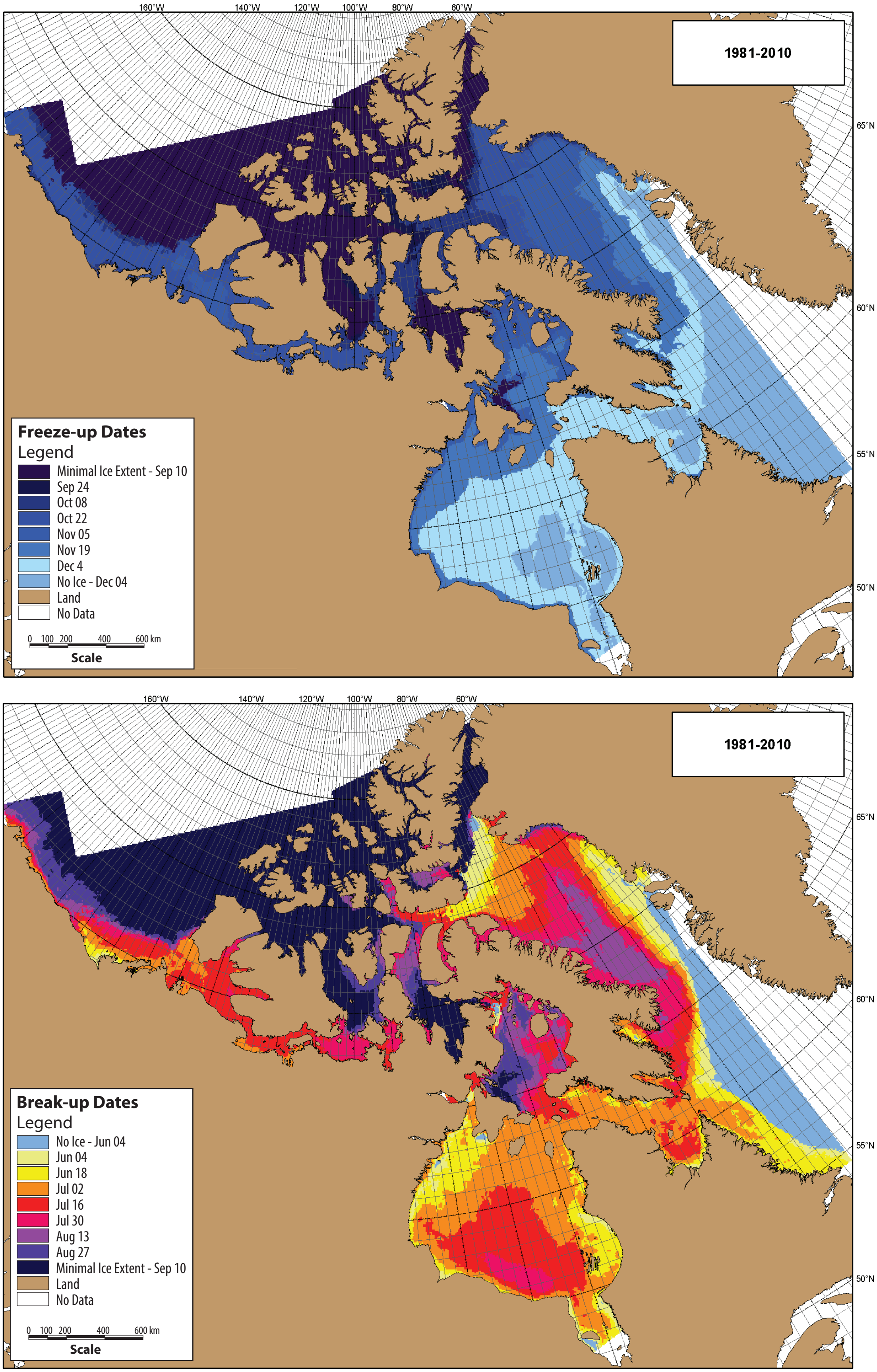


Figure 1.1-2

Sabina GOLD & SILVER CORP.

Back River Project Site Layout

Rescan an ERM company



Source: Environment Canada (2013b).

Figure 1.1-3

Average Canadian Arctic Ice Freeze-up and Break-up Dates, 1981 to 2010

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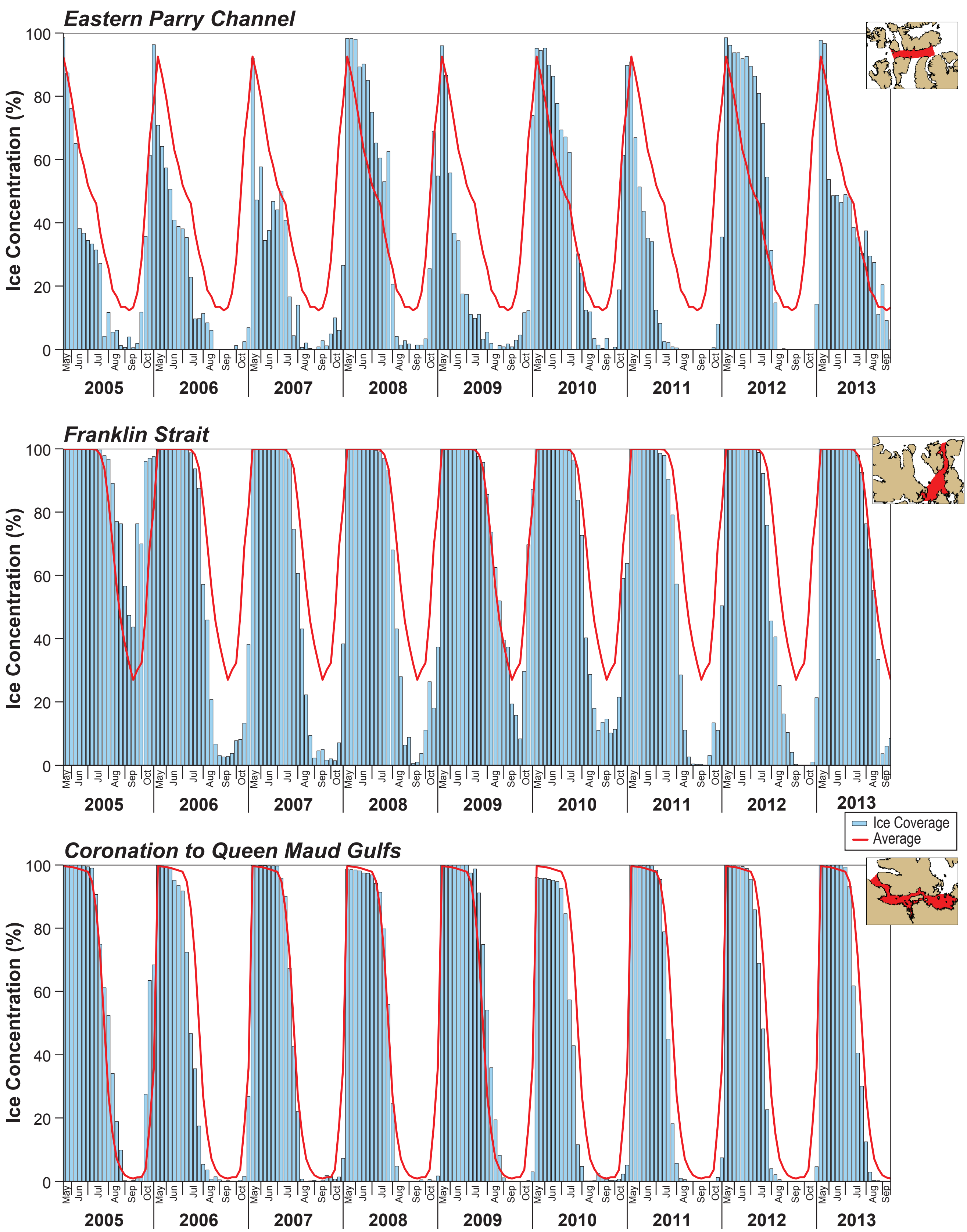
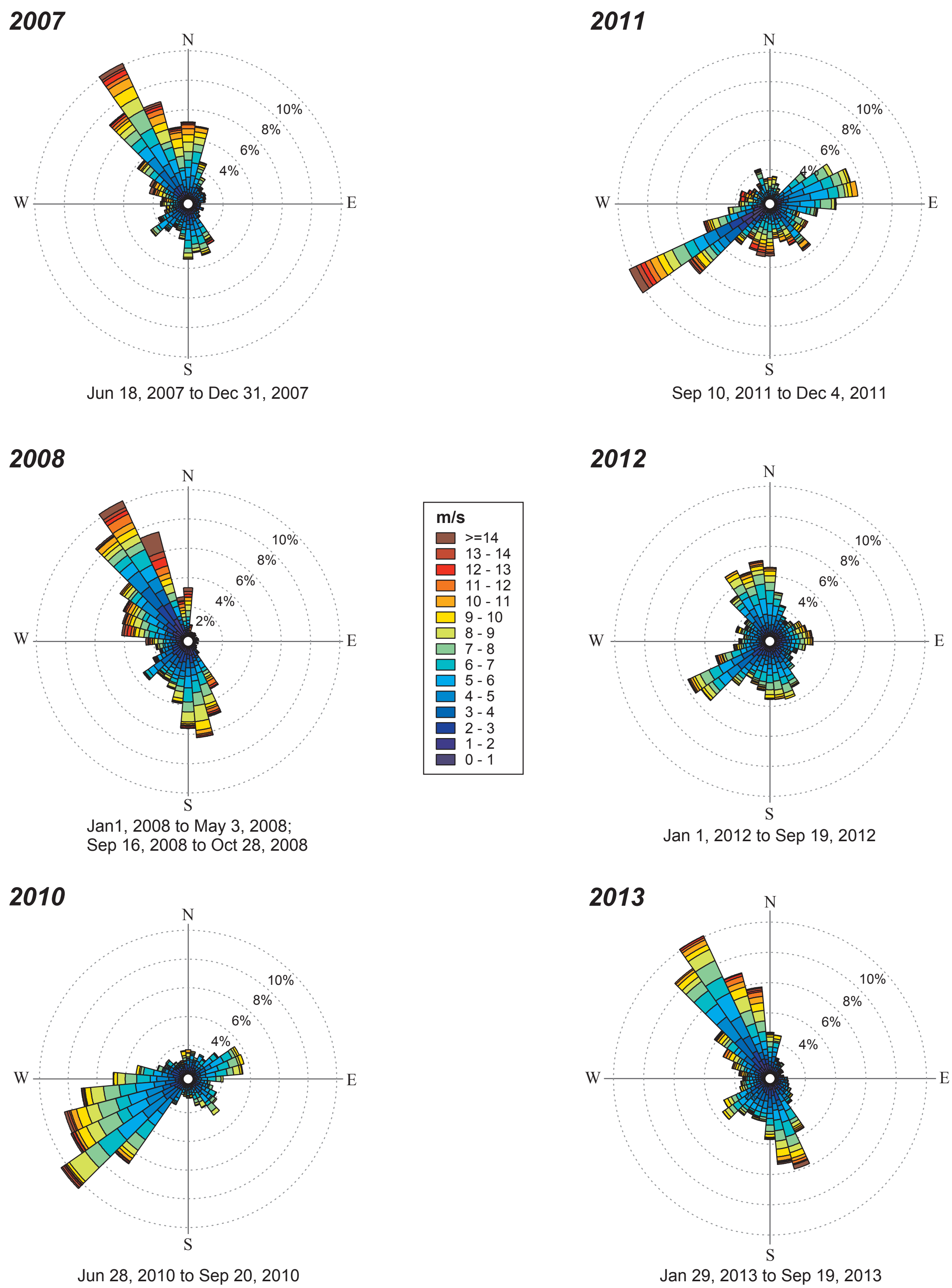


Note: Red line indicates 1981 to 2011 average
Source: Environment Canada (2013a).

Figure 1.1-4

Historical Weekly Ice Coverage in Selected Canadian Arctic Marine Waters, 2005 to 2013



Notes: Wind direction is given as the direction FROM which the wind is blowing.
The dates below each wind rose indicate the available measurement periods for each year.

Source: Rescan 2012a, 2013c.

Figure 1.1-5

Bathurst Inlet Yearly Wind Roses, 2007 to 2013

Sabina GOLD & SILVER CORP.

Rescan Engineers & Scientists

1.1.2 Baseline Study Area

Baseline physical oceanographic surveys have been conducted regularly in Bathurst Inlet since 2001. Open-water surveys have been carried out in the southern basin during 2001/2002, 2007, 2010, and 2012 (Rescan 2002, 2008a, 2012b, 2013a), with sampling near the MLA taking place in 2013 (Rescan 2013b). Under-ice sampling was conducted in 2008, 2012 and 2013 (Rescan 2008b, 2013a), with the 2008 sampling covering the entire inlet. Sampling sites encompassed the near-shore, mid-shore, and the mid-channel habitat. Figure 1.1-6 shows the majority of sampling site locations in Bathurst Inlet, while Figure 1.1-7 shows sites near the proposed MLA that were sampled in 2013.

1.1.3 Proximity to Designated Environmental Areas

No existing or proposed parks or conservation areas are near the proposed Project. The nearest conservation area is the Queen Maud Gulf Migratory Bird Sanctuary approximately 100 km east of Bathurst Inlet on the far side of the Kent Peninsula. The Draft Nunavut Land Use Plan (Nunavut Planning Commission 2012) has no special designation for the marine environment of Bathurst Inlet, but the caribou calving grounds in the region have been designated PSE-R2. The proposed Huikitak River Cultural Area is on the eastern shore of Bathurst Inlet, ~40 km northeast of the MLA.

1.1.4 Baseline Study Methods

The following text presents the sources of the marine baseline data and describes the methods used during the comprehensive marine studies conducted between 2001 and 2013.

1.1.4.1 Information Sources

The baseline physical oceanographic programs collected data on the ice draft, physical water column structure (salinity and temperature), tides, light attenuation, water currents, and wave heights. A summary of the surveys and their physical oceanographic components is presented in Table 1.1-1. Sources of baseline physical oceanography information include the following reports:

- 2012 Marine Baseline Report, Back River Project (Appendix V7-1A; Rescan (2013a)); and
- 2013 Marine Baseline Report (Rescan (2013b)).

Other supplementary physical oceanographic data available included:

- 2001-2002 Marine Environment Baseline Report, BIPR (Rescan 2002);
- 2007 Marine Baseline Report, Hackett River Project (Rescan 2008a);
- 2008 Marine Baseline Report, Hackett River Project (Rescan 2008b);
- 2010 BIPR Project: Marine Aquatic Resources Baseline Study (Rescan 2012b); and
- 2012 BIPR Project: Physical Oceanography Baseline Study (Rescan 2012c).

1.1.4.2 Ice Draft

Ice draft is a measurement of the ice thickness below the surface waterline and serves as a close proxy for the total ice thickness (i.e. approximately 80 to 95% (Toyota 2009)). The thicknesses of the ice cover, as well as the timing of its eventual breakup, are important parameters that drive the changes in seasonal water circulation within the inlet. Ice draft was measured in southern Bathurst Inlet between May and July 2013 using a moored upward-looking ice profiling sonar (IPS; see Fissel, Marko, and Melling (2008)) on a taught-line mooring deployed through an excavated ice hole at station ICE_WAVE_2013 (Table 1.1-1). The ice depth is determined from the return travel time of an acoustic pulse (420 kHz; 1.8° beam at -3 dB) reflected off the underside of the ice. The return time is converted to an acoustic range value through use of the speed of sound in water. When ice is not present, water level can be determined by the reflection from the air-water interface (see Section 1.1.4.7). Acoustic range data was sampled every second and the internal temperature and pressure sensors collected data every 60 seconds.

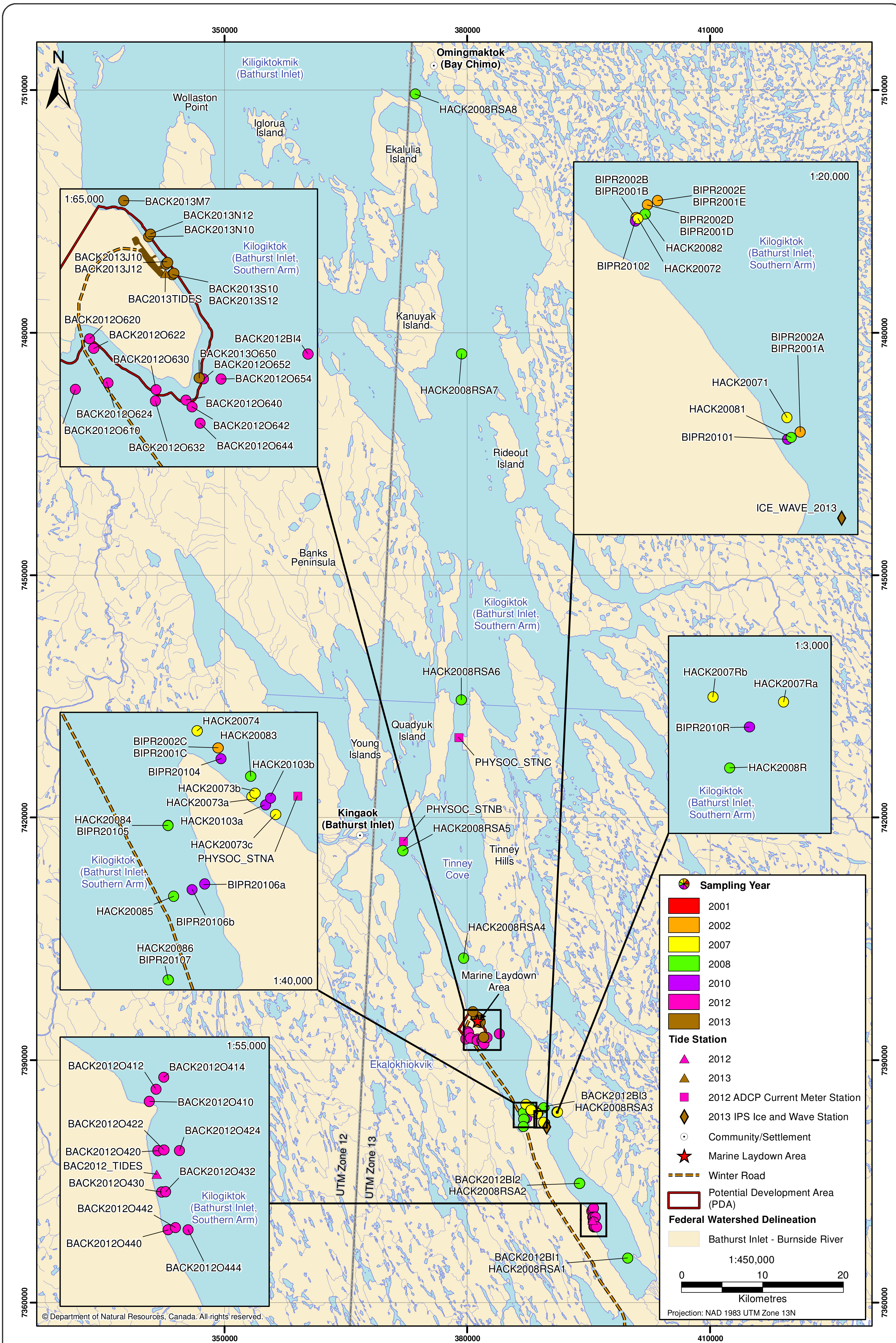


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Figure 1.1-6

Sabina GOLD & SILVER CORP.

Physical Oceanographic Sampling Sites in Bathurst Inlet, 2001 to 2013

Figure 1.1-6

Rescan an ERM company

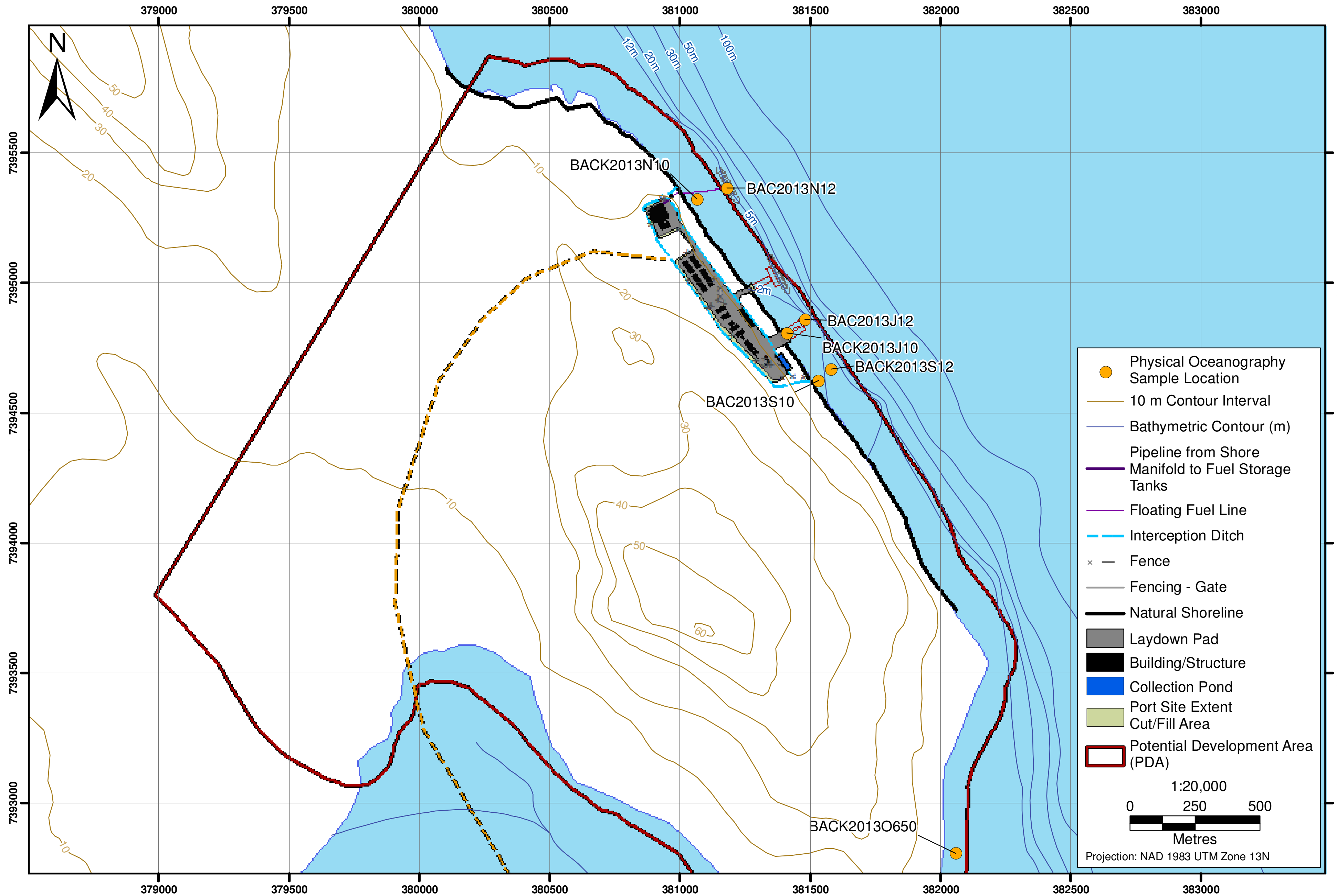

Figure 1.1-7

Sampling Locatons for Physical Oceanography 2013 - Marine Laydown Area

Sabina GOLD & SILVER CORP.

Rescan an ERM company

Table 1.1-1. Marine Baseline Physical Processes Sampling Program, Bathurst Inlet 2001 to 2013

Year	2001	2007	2008	2010	2012	2013
Sampling month(s)	August	August	May	August	April, August, September	May to August
Sampling agency	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.
Sampling method	*In-situ* CTD sonde; Secchi disk	*In-situ* CTD sonde; Secchi disk	*In-situ* CTD sonde	*In-situ* CTD sonde; Secchi disk	*In-situ* CTD sonde; Secchi disk; tide gauge; ADCP current meter; tidal gauge	*In-situ* CTD sonde; Secchi disk; tidal gauge; IPS
Data collected	Water column profile temperature and salinity; light attenuation	Water column profile temperature and salinity; light attenuation	Water column profile temperature and salinity	Water column profile temperature and salinity; light attenuation	Water column profile temperature and salinity; light attenuation; tidal heights; water currents	Water column profile temperature and salinity; light attenuation; tidal heights; ice draft; waves
Site(s) sampled	BIPR2001A BIPR2001B BIPR2001C BIPR2001D BIPR2001E	HACK20071 HACK20072 HACK20074 HACK2007Rb	HACK20081 HACK20082 HACK20083 HACK20084 HACK20085 HACK20086 HACK2008R HACK2008RSA1 HACK2008RSA2 HACK2008RSA3 HACK2008RSA4 HACK2008RSA5 HACK2008RSA6 HACK2008RSA7 HACK2008RSA8	BIPR2010R BIPR20101 BIPR20102 BIPR20103a BIPR20103b BIPR20104 BIPR20105 BIPR20106a BIPR20106b BIPR20107	BACK2012BI1 BACK2012BI2 BACK2012BI3 BACK2012BI4 BACK2012O410 BACK2012O412 BACK2012O414 BACK2012O420 BACK2012O422 BACK2012O424 BACK2012O430 BACK2012O432 BACK2012O440 BACK2012O442 BACK2012O444 BACK2012O610 BACK2012O620 BACK2012O622 BACK2012O624 BACK2012O630 BACK2012O632 BACK2012O642 BACK2012O644 BACK2012O650 BACK2012O652 BACK2012O654 BACK2012_TIDES PHYSOC_STNA* PHYSOC_STNB* PHYSOC_STNC*	BACK2013N10 BACK2013N12 BACK2013J10 BACK2013J12 BACK2013S10 BACK2013S12 BACK2013O650 BACK2013M7 BACK2013_TIDES ICE_WAVE_2013**
Number of replicates per site	Water column profile conducted with continuous *in-situ* sonde lowered at a rate ≤ 0.5 m/s.					

** Stations for ADCP current meter; ** Station for IPS ice and wave measurements*

1.1.4.3 Water Column Structure

Water column structure in the Arctic is principally defined by the vertical stratification, which is driven by the freezing and melting process of surface ice (Rudels, Larsson, and Sehlstedt 1991) and are directly correlated to flow patterns and the strength of mixing. Stratification precludes mixing of nutrients throughout the water column, which contributes to the low primary productivity observed in the region. The physical characteristics involved in assessing water column structure include vertical profiles of water temperature and salinity, which allow profiles of density and stratification to be calculated.

Temperature and salinity profiles were collected at several locations in southern Bathurst Inlet during ice-covered winter (Rescan 2008b, 2013a) and ice-free summer (Rescan 2002, 2008a, 2008b, 2012c, 2012b, 2013a, 2013b) seasons. Baseline sampling was conducted at several sites in southern Bathurst Inlet in 2001/2002, 2007, 2008, 2010, and 2012 (Figure 1.1-6), over the entire inlet during the ice-covered period in April 2008 (Rescan 2008b), and near the MLA in 2013 (Figure 1.1-7). All vertical profiles of temperature and salinity were taken through ice and in the open water using an internally-logging in situ conductivity-temperature-depth (CTD) probe deployed at roughly 0.5 m/s (Table 1.1-1; Rescan (2013a)). Sampling stations varied from year to year according to the various project details (see Table 1.1-1).

1.1.4.4 Water Level and Tides

Water level changes in marine waters come from a combination of tidal (i.e., caused by the gravitational pull of the moon and sun) and non-tidal (i.e. precipitation, river discharges, drought, etc.) inputs. In order to accurately assess those inputs in Bathurst Inlet, tidal gauge stations were operated in 2012 at the BACK2012_TIDES station situated approximately 27 km southeast of the MLA, and in 2013 at the BACK2013_TIDES station located next to the MLA (see Figure 1.1-6). The stations consisted of a 0-5 psi vented PT2X® pressure transducer (Instrumentation Northwest Inc.) attached to a platform and anchored to the ocean bottom. The unit recorded water levels every 10 minutes.

Benchmarks established in 2012 and 2013 for the BACK2012_TIDES and BACK2013_TIDES locations respectively were used as survey control points along the shoreline. The local datum was assumed to have an elevation of 0.0 m and the main benchmark an arbitrary elevation of 100 m relative to the datum. The elevations of the pressure transducer and water level relative to the station datum were surveyed using an engineer's rod and level.

1.1.4.5 Light Attenuation and Euphotic Zone

Baseline information on light attenuation was gathered at several sites during each open-water marine survey from 2001 to 2013. Measurements of light attenuation were collected using a 30-cm, white Secchi disk that was lowered over the shaded side of a boat until it disappeared from sight. The depth of disappearance was identified as the Secchi depth, which was then used to calculate the depth of the euphotic zone using known equations (Parsons, Maita, and Lalli 1984). Euphotic zone depth is the water column depth where 1% of surface radiation reaches, and generally represents the zone where integrated photosynthesis equals the integrated respiration (i.e., compensation depth). Above this depth net primary production is possible given sufficient nutrients.

1.1.4.6 Marine Currents

Marine currents are continuous, directed movements of seawater generated by a variety of forces acting on the water column. In large estuarine settings like Bathurst Inlet, these forcings can include winds, breaking waves, density differences, tides, the Coriolis effect, and shoreline configurations. The largest currents typically observed at the surface of estuaries are wind-driven and can sometimes develop a downward clockwise spiral in the northern hemisphere due to the Ekman motion (Li and Li 2012), although this is usually difficult to observe in shallow coastal areas.

Marine currents were measured in southern Bathurst Inlet between August and September 2012 using moored Acoustic Doppler Current Profilers (ADCP "Sentinel Workhorse"; see Rescan (2012c)) on taught-line moorings deployed from two aluminum boats at three different stations: PHYSOC_STNA, PHYSOC_STNB and PHYSOC_STNC (Table 1.1-1). The ADCPs had pulse frequencies of 600 kHz and measured water velocities at a vertical spacing of 1 m and a period of 10 minutes. Station PHYSOC_STNA was close (i.e., ~ 13 km southeast) to the proposed MLA, Station PHYSOC_STNB was between Tinney Cove and the southern stretch of the inlet, and Station PHYSOC_STNC was at the narrowest point between Quadyuk Island and the Tinney Hills within Manning Channel.

1.1.4.7 Marine Waves

Marine waves are wind-generated surface waves that occur on the free surface of marine waters, either from the near-immediate pressure fluctuations of local winds or from swells advected into the measurement area. In large enclosed bodies of water with a complex shoreline (such as Bathurst Inlet), local winds are the almost entirely responsible for the local wave regime.

Marine surface waves were measured in southern Bathurst Inlet between May and August 2013 using the IPS instrument moored at station ICE_WAVE_2013 (Table 1.1-1; also see Section 1.1.4.2). The IPS resolves marine waves by measuring the time-of-travel for acoustic pulses (420 kHz; 1.8° beam at -3 dB) transmitted by the instrument and reflected off the sea surface. Processing of the wave data sets involves the conversion of the time-of-travel measurements recorded internally by the instrument to an edited time series of wave heights.

1.1.5 Baseline Study Results

The remainder of this section details each of the major collected datasets as they pertain to the Project area.

1.1.5.1 Ice Draft

The hourly mean ice drafts for the measurement period are plotted in Figure 1.1-8. Draft values hovered between 1.5 and 1.6 m for most of May, with an increase in drafts observed in late May culminating with a maximum measured draft of 1.75 m on May 29. This ramping of draft is surmised to be due to slow ice movement rather than ice growth in the measurement area. As air temperatures began to warm in early June, the ice gradually began to melt. Complete ice breakup occurred between June 21 and June 27, and is highlighted in Figure 1.1-8. During this period, mobile ice keels were frequently observed with average drafts of 0.3 to 0.5 m. Open water was first observed on June 22 and was present for the remainder of the measurement period after June 27.

1.1.5.2 Water Column Structure

The differences between winter and summer profiles throughout the inlet is illustrated in Figure 1.1-9, which shows a composite of all water column structure data collected in Bathurst Inlet between 2001 and 2012 (see Table 1.1-1). Winter thermohaline profiles generally approximated a vertically two-layered weakly stratified system comprised of a colder (~-1.5 - -0.5˚C), less saline (26 - 27.5) upper layer of approximately 10 to 15 m depth overlaying a slightly warmer (~-0.5 - 0˚C) and denser bottom layer of higher salinity (> 27). The lack of wind-driven mixing due to the ice cover combined with the contribution of brine inputs from surface ice formation were the most important factors in maintaining the weak water column stratification. In the summer season, the thermohaline structure of the water column was again a two-layered profile for all stations in Bathurst Inlet, with a sharp ~3 to 4 m thick pycnocline present at roughly 15 to 20 m depth that separated a warmer (10 - 14°C), fresher (salinity 12 – 20) upper layer from a cold (2 to -0.5°C) and salty (salinity > 25) oceanic bottom layer. The surface salinity in the inlet is highly dependent on the seasonal riverine inputs (i.e., freshet) and precipitation. The combination of freshwater discharges and wind-driven forcing during the summer months were instrumental in forming the observed surface mixed-layer and maintaining the steep stratification between the top and bottom waters of Bathurst Inlet.

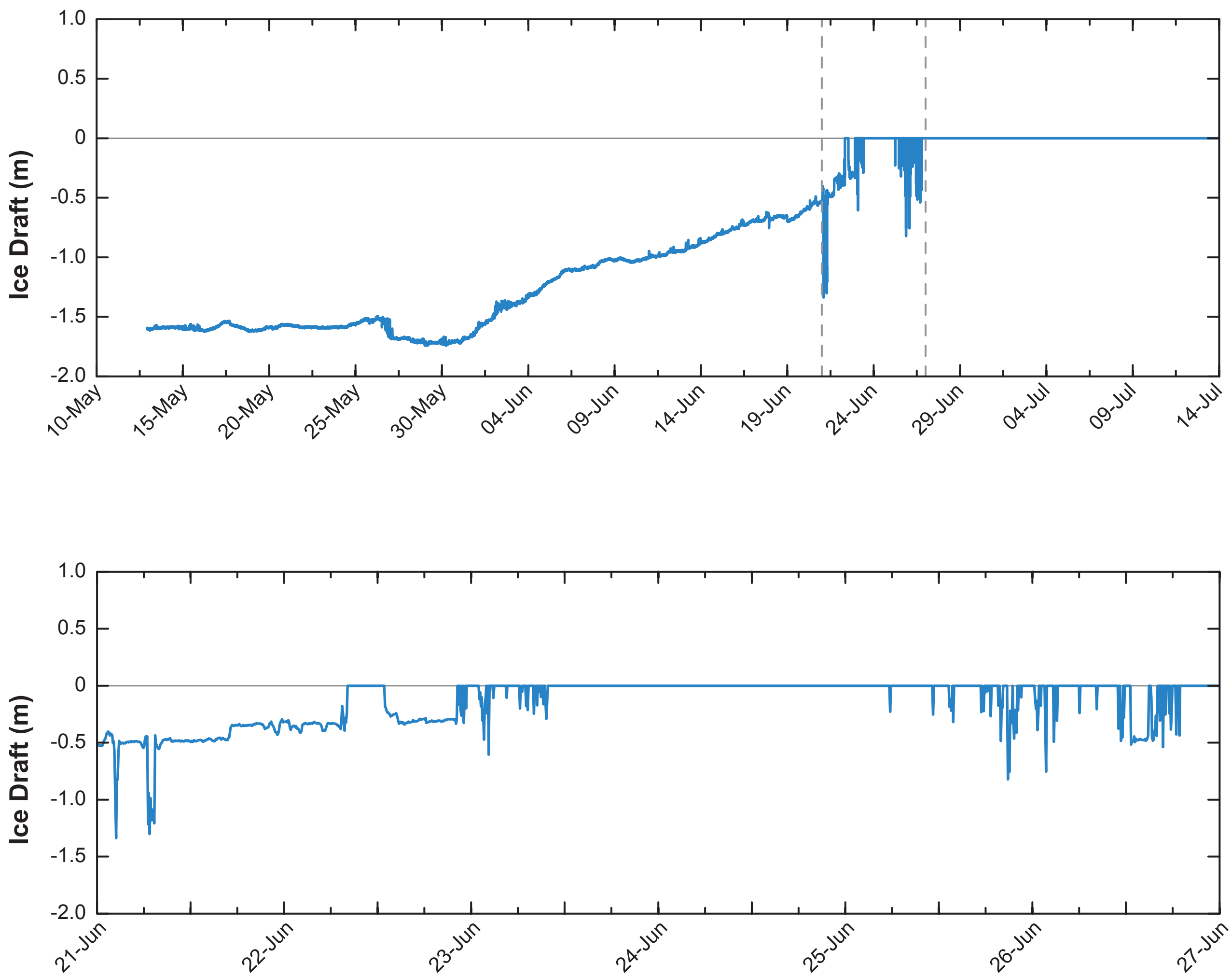

Figure 1.1-8

Ice Draft Measurements in Southern Bathurst Inlet, May to July 2013

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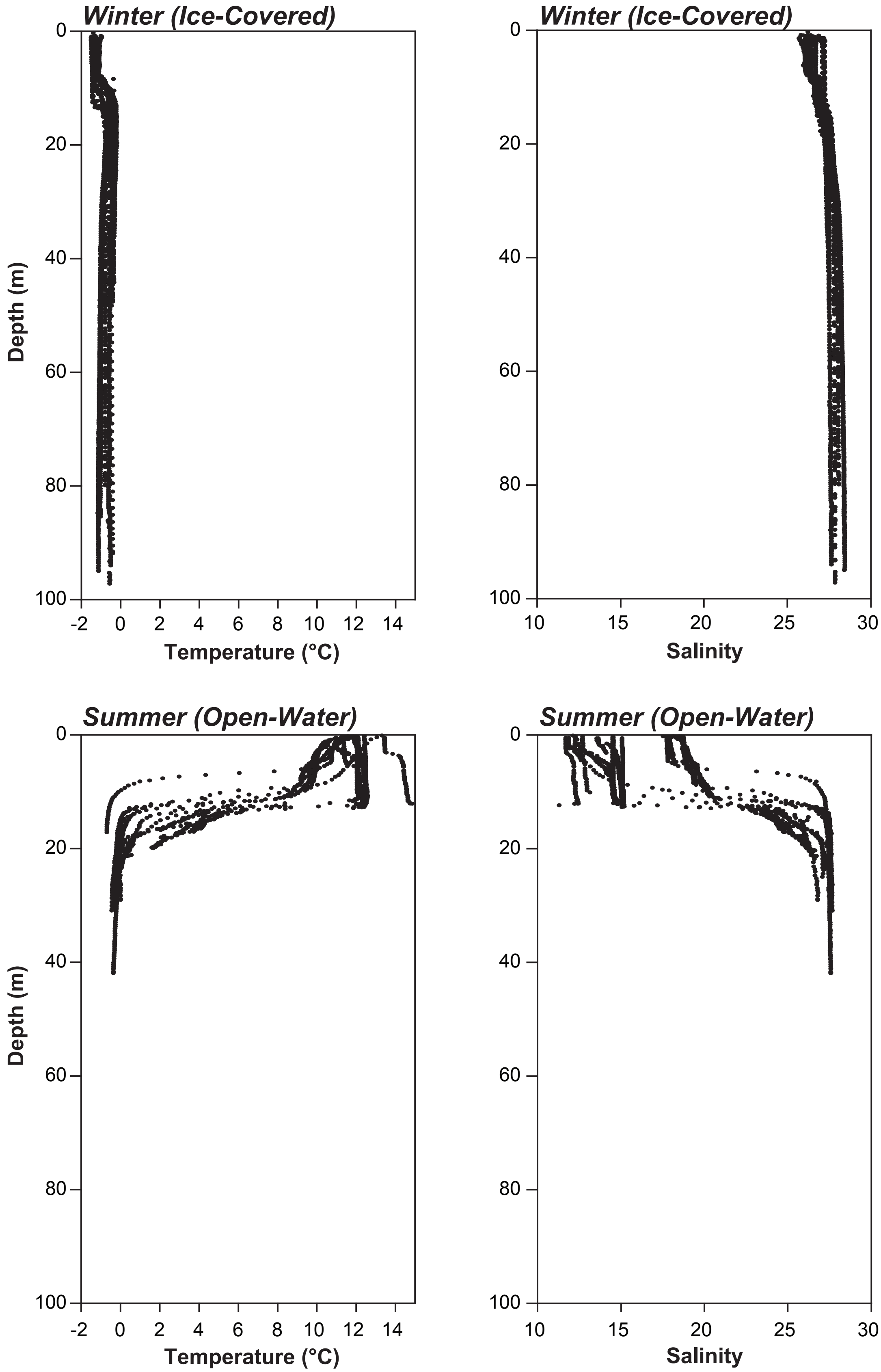

Figure 1.1-9

Scatterplot of all Temperature and Salinity Profiles Taken in Bathurst Inlet, 2001 to 2012

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Typical water structure profiles near the MLA are shown in greater detail in Figure 1.1-10, where temperatures and salinity measured at station BACK2012BI4 during the winter ice-covered season are compared to the summer open-water profiles of station BACK2012O654. While two distinct vertical layers were observed in both seasons, there were large variations in the upper layer characteristics. In summer, both layers were separated by a sharp pycnocline between 10 and 15 m depth with the surface layer comprised of warmer (10 - 12°C) and fresher (salinity: 18 to 20) waters than the cold (0°C) and salty (27 to 28) oceanic bottom layer. The latter varied very little from summer to winter; the deep waters remained relatively isolated throughout the year due to vertical mixing being inhibited by the mid-layer pycnocline. However, the surface layer underwent a large transformation into a much colder (-1.5°C) and more saline (> 27) mixed-layer from summer to winter, with a very thin pycnocline at ~ 14 m depth. This change is surmised to occur shortly after the growing ice cover isolated the water surface from wind mixing and triggered the slow entrainment of bottom waters into the surface through convective exchange and brine rejection, thereby severely weakening the stratification.

While the seasonal variability of temperatures and salinity play a defining role in assessing the physical water column structure of Bathurst Inlet, spatial variability is also an important factor for the dynamics of the inlet. Figure 1.1-9 reveals that spatial variability of temperature and salinity in winter was very low throughout most sampled areas of the inlet. In summer, spatial variability was slightly higher with temperature variations of about 4°C and salinity variations of around 7; however, this was restricted to the upper 10 m of the water column as the deep waters varied little between seasons. In terms of across shore variability, near shore environments shallower than 15 m depth were well-mixed from surface to sediment bottom near the MLA and at sites in southern Bathurst Inlet north and south of the MLA; however, water column profiles were highly stratified at deeper stations (Rescan 2013a).

Spatial bottom water variations are more easily observed by examining the stratification data along the main channel of Bathurst Inlet, which was thoroughly examined by Rescan (2008b) and is represented in the contour plots of Figure 1.1-11. The most apparent feature of Figure 1.1-11 was the difference in bottom water characteristics between the north and southern basins of the inlet that are separated by the shallow sill near Manning Point. In the northern basin, bottom waters were up to 1°C colder and 2 salinity greater than similar waters south of the sill. This difference would be caused by the constrictive effect of the sill and channel on the bottom waters in the inlet: the deep Bathurst Inlet waters are advected from the northern oceanic waters of Coronation Gulf; however, only a fraction of those waters are surmised to reach the southern inlet due to the sill. Thus, the water column structure observed is very similar to a number of Fjord-type estuaries (Kennish 1986) around the world, where deep waters have limited exchange with adjacent layers (also see bottom waters in Figure 1.1-10).

1.1.5.3 Water Level and Tides

Bathurst Inlet is characterized by two main tidal cycles: the fortnightly spring-neap cycle and the daily mixed semidiurnal cycle consisting of two unequal sets of high and low tides per day. Water level measurements recorded for 2012 and 2013 from the tidal gauges on the shores of Bathurst Inlet are shown in Figure 1.1-12. Water level height data in the figure was decomposed into non-tidal and tidal components using classical harmonic analysis (see Pawlowicz, Beardsley and Lentz (2002) for complete details); both the daily mixed signal and the longer period spring-neap signals are clearly shown within the extracted tidal oscillations for both years of sampling. The measured tidal heights for the inlet were small, with a maximum tidal range for spring tides (new and full moon) of around 0.4 m, and between 0.1 and 0.3 m for neap tides (first and third quarter moons). The weak tides displayed in Figure 1.1-12 corroborate earlier preliminary data surveys by the CHS (1994) that indicated Bathurst Inlet water circulation during open-water season was influenced by winds rather than by tides, with tidal currents likely significantly weaker than the down-slope density flows originating freshwater discharge at the inlet surface. Additional information on the tidal constituents in Bathurst Inlet is found in Rescan (2012c).

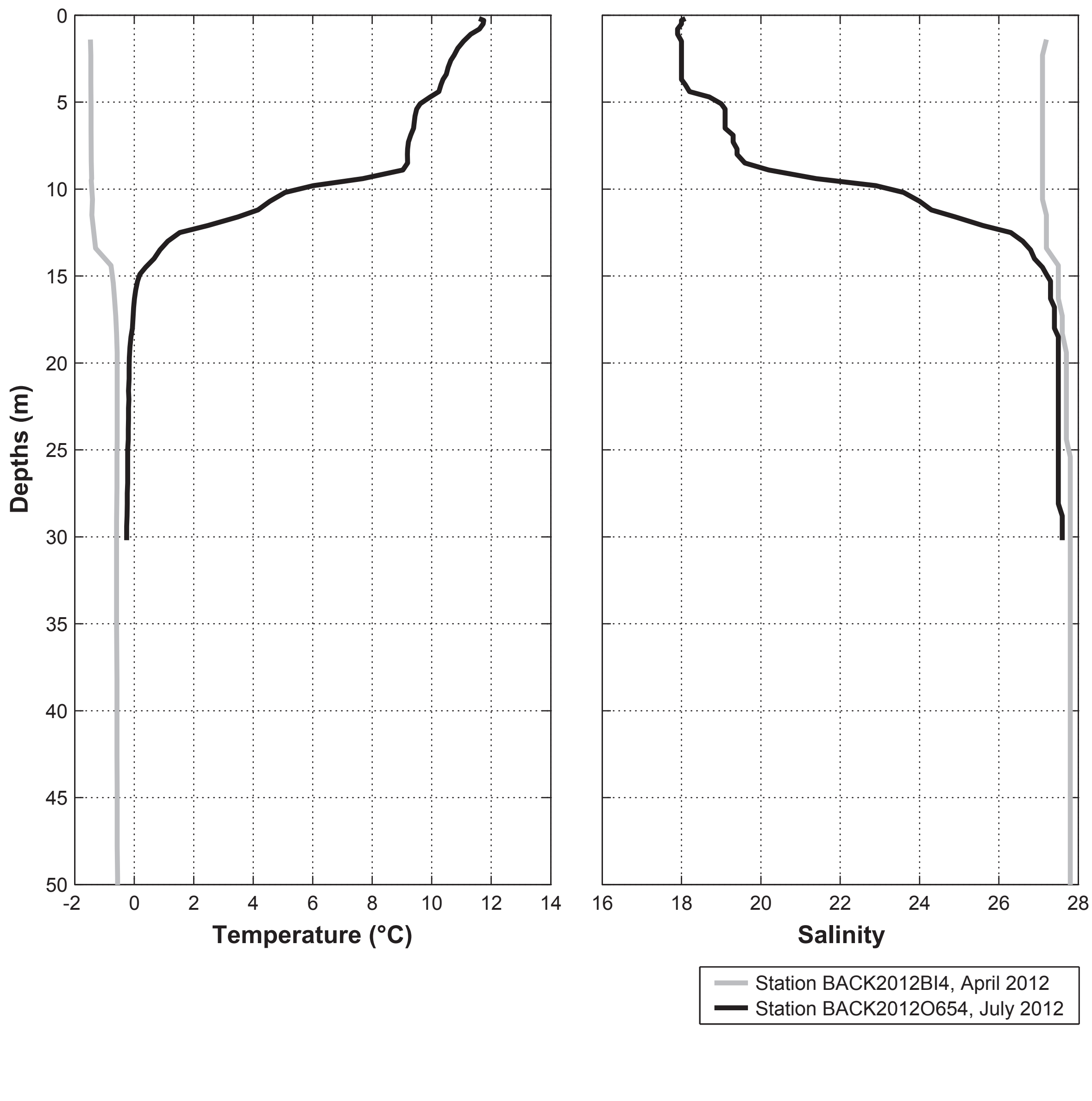

Figure 1.1-10

Temperature and Salinity Profiles at Stations BACK2012BI4 and BACK2012O654 near MLA in Southern Bathurst Inlet

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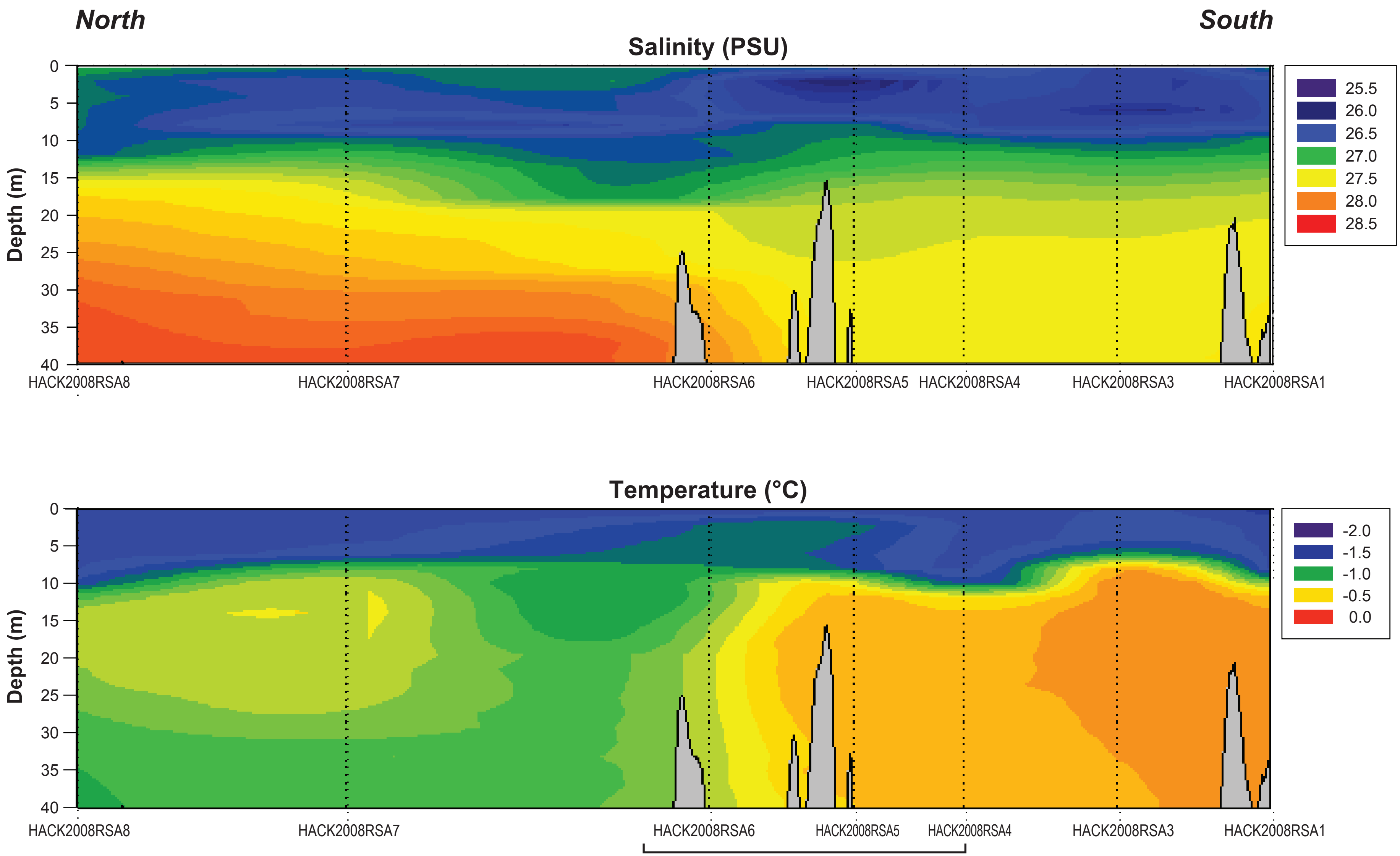


Note: Grey area refers to Bathurst Inlet bathymetry.
Source: Rescan (2008).

Figure 1.1-11

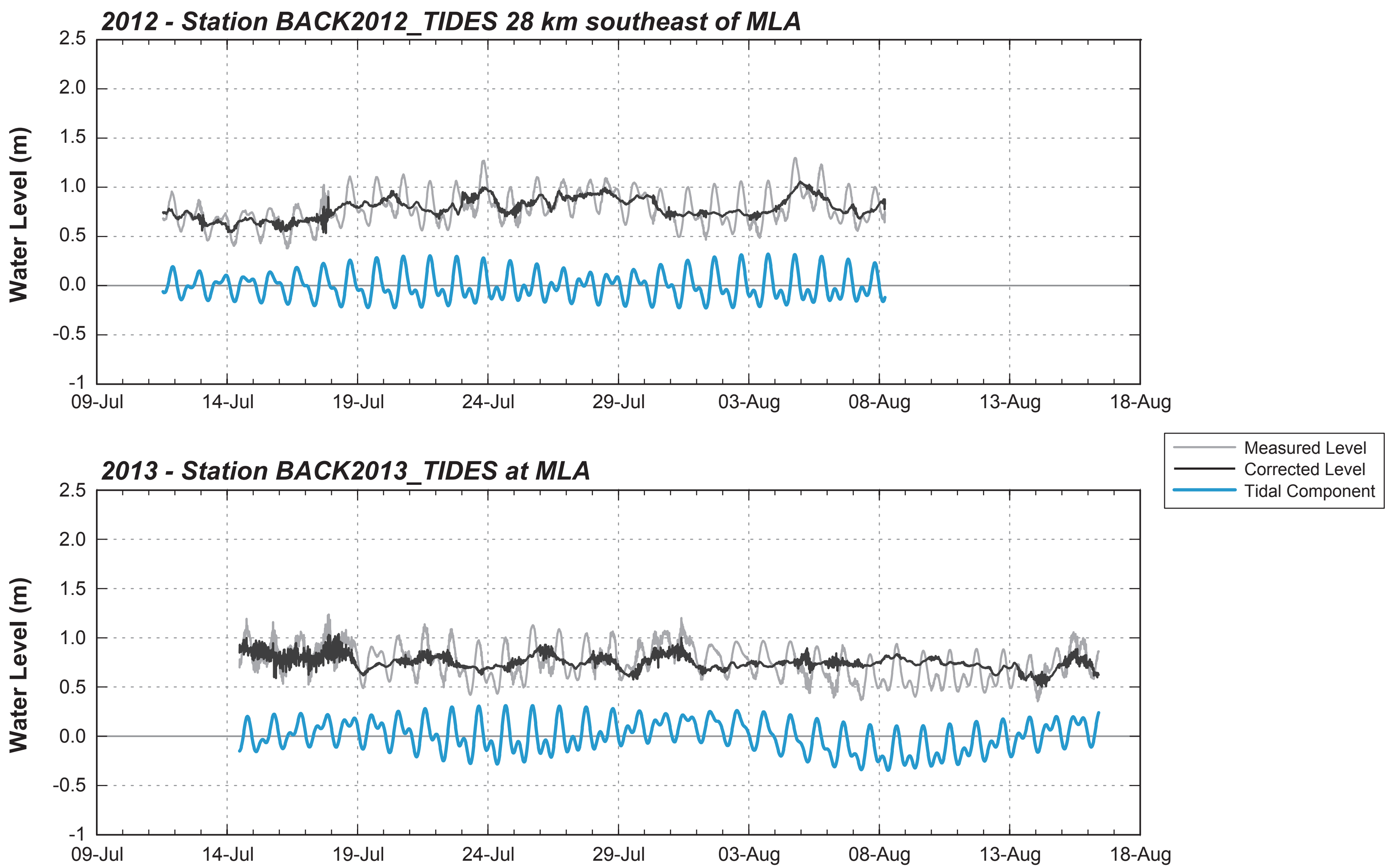
Sabina GOLD & SILVER CORP.

Salinity and Temperature Contours along the Main Channel in Bathurst Inlet, Winter 2008

Figure 1.1-11

Rescan Engineers & Scientists

PROJECT # 0194096-0040-0010 GRAPHICS # BAC-0040-040 October 22, 2013



Note: Measured water levels were corrected to 98 m above sea level datum.

Figure 1.1-12

Water Level Measurements in Southern Bathurst Inlet, with Tidal and Non-Tidal Components

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1.1.5.4 Light Attenuation and Euphotic Zone

Baseline data for light attenuation and the depth of the euphotic zone in southern Bathurst Inlet is presented in Table 1.1-2.

Table 1.1-2. Secchi and Euphotic Zone Depths Measured within Southern Bathurst Inlet

Station	Date	Station Depth (m)	Pycnocline Depth (m)	Secchi Depth (m)	Euphotic Zone Depth (m)
2001					
BIPR2001A	14-Aug-01	40	7.0	3.5	9.5
BIPR2001B	14-Aug-01	17	5.5	3.5	9.5
BIPR2001D	15-Aug-01	64	-	3.0	8.1
BIPR2001E	15-Aug-01	70	4.5	3.5	9.5
BIPR2001C	14-Aug-01	29	5.5	3.5	9.5
2007					
HACK20071	7-Aug-07	30	10	4.7	12.7
HACK20072	6-Aug-07	12	9.0	3.6	9.7
HACK20074	6-Aug-07	30	9.5	3.5	9.5
HACK2007Rb	4-Aug-07	22	8.0	4.5	12.2
2012					
BACK20120410	1-Aug-12	1.2	-	bottom	bottom
BACK20120412	1-Aug-12	8.1	-	5.5	bottom
BACK20120414	1-Aug-12	31.0	11.9	5.1	13.8
BACK20120420	1-Aug-12	1.9	-	1.4	bottom
BACK20120422	1-Aug-12	4.6	-	2.5	bottom
BACK20120424	1-Aug-12	30.3	11.9	5.4	14.6
BACK20120430	1-Aug-12	1.8	-	1.6	bottom
BACK20120432	1-Aug-12	10.0	-	3.3	8.8
BACK20120440	1-Aug-12	2.2	-	bottom	bottom
BACK20120442	1-Aug-12	5.6	-	bottom	bottom
BACK20120444	1-Aug-12	42	12.0	5.4	14.6
BACK20120610	3-Aug-12	2.0	-	1.4	bottom
BACK20120620	3-Aug-12	1.6	-	0.8	bottom
BACK20120622	3-Aug-12	5.9	-	1.2	3.2
BACK20120624	3-Aug-12	17.2	6.1	1.2	3.2
BACK20120630	3-Aug-12	1.9	-	bottom	bottom
BACK20120632	3-Aug-12	6.4	-	4.0	bottom
BACK20120640	3-Aug-12	1.4	-	bottom	bottom
BACK20120642	3-Aug-12	4.9	-	bottom	bottom
BACK20120644	3-Aug-12	12.9	10.6	6.5	bottom
BACK20120650	3-Aug-12	1.7	-	bottom	bottom
BACK20120652	3-Aug-12	6.0	-	6.0	bottom
BACK20120654	3-Aug-12	30.2	8.9	7.1	19.2

South of the MLA, Secchi depths in the 2001 and 2007 sampling programs ranged from 3.0 to 4.7 m, and the estimated euphotic zone depth ranged from 8.1 to 12.7 m (Table 1.1-2). The euphotic depth was always deeper than the pycnocline in the well-mixed, well-oxygenated surface waters. Thus, phytoplankton was consistently suspended in an optimal light regime to support photosynthesis and growth during the open-water season (pending available nutrients). In shallower environments, light usually reached the sediment surface and benthic production was therefore possible (periphyton, macroalgae).

In 2012, Secchi depths at the southern and northern Bathurst Inlet stations varied with station depth, ranging from 0.8 to 7.1 m (Table 1.1-2). The euphotic zone reached the sediment bottom at most stations with depths less than 10 m, except at station BACK2012O622 where the euphotic zone depth was 3.2 m due to sediment re-suspension causing highly turbid waters. At the deeper stations (greater than 10 m), the mean euphotic zone depth at the southern stations near the MLA was 13 m, and at the stations further south the euphotic zone extended to 3.2 (BACK2012O624) and 19.2 m (BACK20120654). The euphotic zone at the deep BACK20120644 station extended to the sediment bottom (17.2 m). Overall, water clarity was high (i.e., low attenuation with depth) and the euphotic zone reached below the pycnocline at deeper (> 10 m water depth) sites and included the sediment surface in the shallower sites. Bathurst Inlet primary producers were thus typically suspended in optimal light regimes such that the potential for benthic production was high.

1.1.5.5 Marine Currents

Under-ice marine currents have yet to be measured in Bathurst Inlet, but an overview of the winter circulation can be surmised from the under-ice water column profiles collected during winter (Rescan 2008b, 2013a) and data reports from geographically similar estuaries, like Roberts Bay near Melville Sound (Rescan 2012d). Typically, a 1 to 2 m thick sea ice layer begins to form in October and remains a persistent and dominant feature of the water column for approximately eight months of the year. Surface water circulation becomes limited because winds driving the circulation are isolated from surface waters by the land-fast ice cover. Marine currents would be generally weak (~5 to 10 cm/s) and would originate from a combination of tidal flows and density shifts due to ice formation brine rejection. These features eventually erode the water column stratification and lead to a water column structure comprised of a colder, fresher layer of 10 to 15 m thickness atop a slightly more saline and warmer layer extending to the bottom. The advection of waters from Coronation Gulf would be slow primarily due to the presence of a sill near Manning Channel, limiting the exchange between the northern and southern portions of the inlet (see Figure 1.1-11).

Marine currents were measured at three stations in southern Bathurst Inlet during the 2012 open-water season (Rescan 2012d). These currents varied in magnitude and direction depending on their location in the inlet. For example, current roses at 3, 13 and 23 m sampling depths are shown in Figure 1.1-13 for each of the moorings deployed in the southern basin in 2012. At the southernmost station ~13 km southwest of the MLA (PHYSOC_STNA), the most apparent feature of the currents was the dominant east/west direction of flow. This flow structure was present at all measured depths. There was a strong disparity in velocity magnitudes between the top and bottom layers; for depths below 15 m, currents rarely reached above 20 cm/s. In shallower waters, magnitudes above 40 cm/s often occurred, with recorded maximums above 80 cm/s at 3 m depth. It appeared that the northwest-to-southeast steep shoreline naturally directed currents generated by north/north-western winds into the southeastern/east direction. Hence, surface currents were naturally strongly correlated with the wind data but the water transport was counter-clockwise to the wind direction; it was assumed that the nearby shoreline inhibited the natural Ekman transport and instead promoted east-to-west lateral water circulation when northern winds persistently blew over the inlet. Tidal currents were also estimated to be weak (i.e., ~< 5 cm/s) compared to the measured current magnitudes, which corroborated earlier preliminary data surveys by the CHS (1994) that wind-driven circulation dominates the Bathurst Inlet currents.

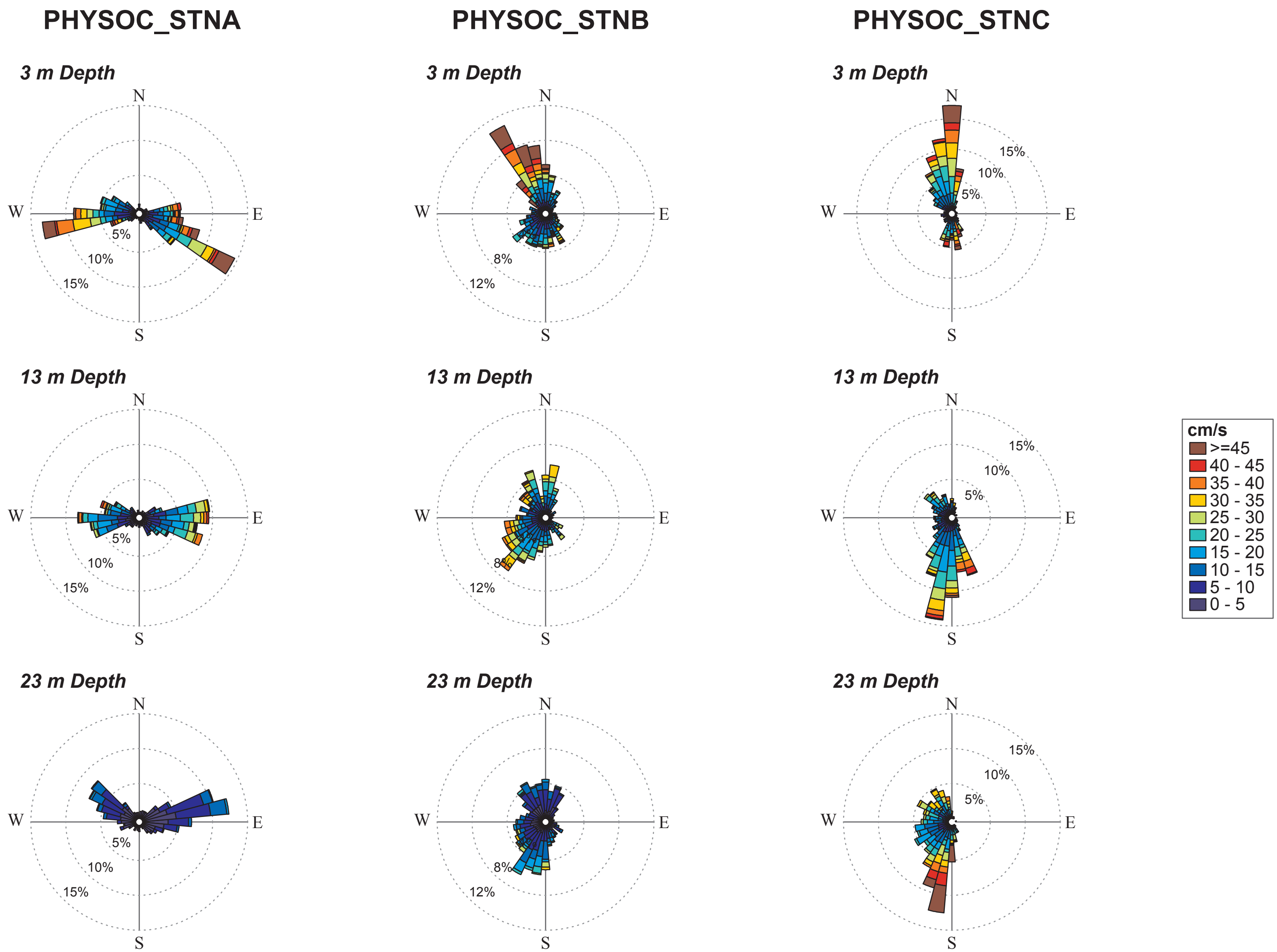

Figure 1.1-13

Measured Current Roses at 3, 13 and 23 m Depths for Bathurst Inlet Sampling Stations, August - September 2012

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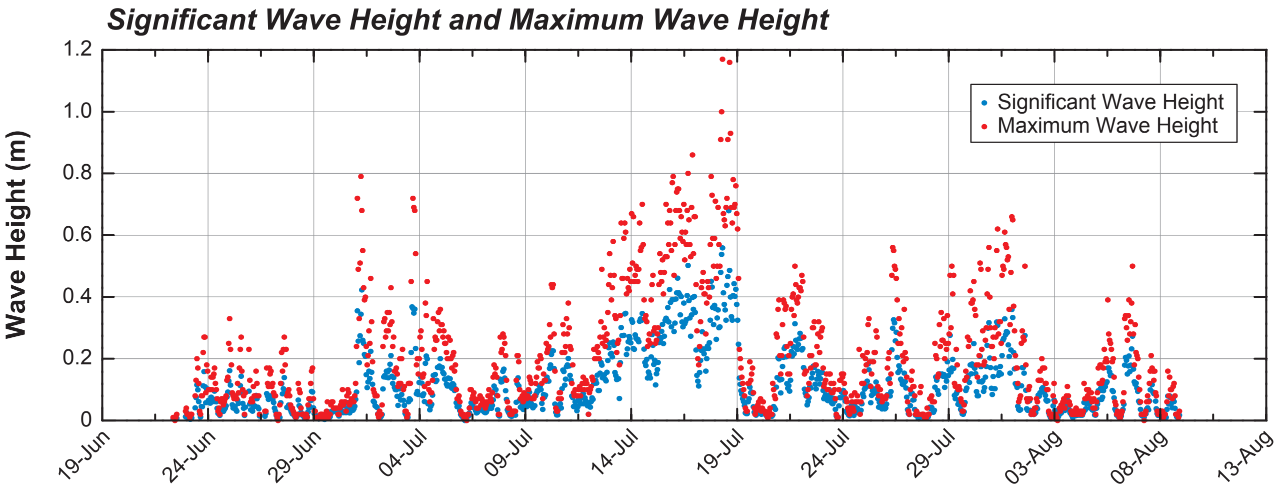
Further north, the measured currents at station PHYSOC_STNB (near Tinney Cove) and PHYSOC_STNC (in Manning Channel) were dominant along the north/south axis, with large inputs from the north-western and south-western directions. The strongest current magnitudes recorded at Station PHYSOC_STNB, reached above 90 cm/s below 3 m depth when a large storm passed over the region. Velocities again displayed a two-layered structure, with the top layer currents being stronger and more northern, while the bottom layer had weaker currents and were proportionally more southern. Tidal dynamics at station PHYSOC_STNB contributed little to the overall current magnitudes, similarly to that was recorded at PHYSOC_STNA.

Station PHYSOC_STNC, situated within Manning Channel south of the bathymetric sill, also had currents above/below 20 m generally flowing northward/southward, and velocities in the east/west directions being 3 to 4 times lower. While overall current velocity magnitudes at the surface were comparable to the other stations, large currents were recorded below 20 m depth with maximum velocities reaching over 90 cm/s. Mean currents hovered between 20 to 30 cm/s at all depths and unlike the other stations that had limited tidal inputs, tidal flows were estimated to reach velocities above 70 cm/s below the surface layer at PHYSOC_STNC. These large flows were surmised to occur due to the bathymetric constriction from the sill, which caused funnelling of the advecting northern waters and thus increased the amplitudes of the tidal currents. Such variability in tidal effects is not unusual for high latitude measurements; tidal current maximums from a few cm/s to over 130 cm/s have been recorded in the Canadian Arctic Archipelago (Hannah, Dupont, and Dunphy 2009).

Given the open-water data accumulated during the 2012 sampling study, the general along-channel vertical flow structure was identified as a positive fjord-type estuarine circulation, where the top layer flowed seaward (i.e., north towards Coronation Gulf and Dease Strait) and the deeper waters flowed southward from the ocean towards the head of the inlet (Rescan 2012c). The estuarine circulation was mostly driven by a combination of freshwater discharges, either from sea ice melting or riverine inputs along the inlet, which generated the horizontal pressure gradients that drove the seaward surface flow. A corresponding deep water landward flow was formed by advection of northern saline oceanic waters into the inlet by mass conservation. This inland flow was somewhat hindered by the large sill present near Manning Point, as can be seen in Figure 1.1-11. The freshwater inputs lowered the salinity of the surface waters of Bathurst Inlet, hence contributing to the vertical stratification seen in CTD profiles (i.e., by forming a two-layer system with less dense water overlaying denser bottom water; see Figure 1.1-9). The temporal and spatial stability of the bottom layer within the southern inlet implied limited vertical exchange within the water column.

1.1.5.6 Marine Waves

Wave heights were previously estimated for the southern Bathurst Inlet region given the strong correlation between winds and currents (Rescan 2012c). Maximum significant wave heights between 0.5 to 1 m were calculated using the average wind velocity and fetch length near the port site. This estimate compares well with the direct time series measurements of significant wave height (H_s), maximum wave height (Hmax) and peak period (T_p) obtained in 2013 and plotted in Figure 1.1-14. Entries for which Hs was less than 0.1 m were discarded due to instrument error. The measured significant waves were small compared to standard open-ocean conditions: over 70% of the wave data was below 0.25 m Hs and less than 1% was above 0.5 m. The largest significant wave height of 0.68 m and largest maximum wave height of 1.17 m occurred on July 18, 2013.



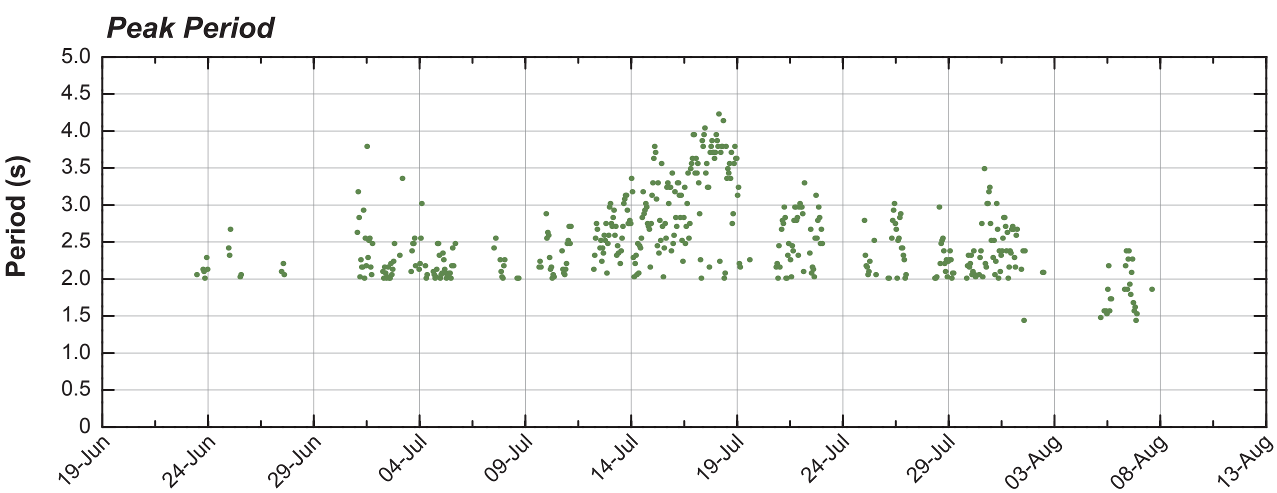


Figure 1.1-14

Significant Wave Height, Maximum Wave Height and Peak Period Measured in Southern Bathurst Inlet, June to August 2013

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1.1.6 Summary

This last section summarizes the marine physical processes discussed in this chapter for both ice-covered and open-water seasons in Bathurst Inlet.

1.1.6.1 Ice-covered Conditions

During the ice-covered season, a 1 to 2 m thick ice layer forms that shelters Bathurst Inlet waters from atmospheric winds. Over time, the under-ice convection generated from the ice growth combined with the advection of waters from Coronation Gulf and the weak tidal flow lead to the formation of a two-layer thermohaline structure with weak stratification in the water column. A colder, fresher layer of 10 to 15 m thickness was observed atop a slightly more saline and warmer layer extending to the bottom for most stations sampled within the inlet. Under-ice currents were not explicitly measured but were surmised to be very weak, given that the currents in the inlet were mostly wind-driven. The presence of a sill near Manning Channel limited the exchange of waters between the northern and southern portions of the inlet and contributed to the lack of variability observed in the deep waters of the inlet.

A schematic interpretation of the general winter circulation along the main channel of Bathurst Inlet can be found in Figure 1.1-15.

1.1.6.2 Open-water Conditions

In early summer, the increased sunlight and warming atmospheric temperatures eventually caused the ice cover to melt, flooding the surface of Bathurst Inlet with a large volume of fresh, warm water. The addition of freshwater produced from ice melting and river inputs, combined with the mixing resulting from wind-generated currents and warmer temperatures, progressively lead to the formation of an alternate two-layered thermohaline structure with a warmer, fresher wind-mixed layer atop a colder more saline bottom layer. The stratification was much stronger than that found in the winter months, with the top layer remaining between 15 and 20 m thickness and being considerably warmer and fresher than the deeper saline waters. Significant wave heights measurements indicated that waves less than 0.5 m were likely present in southern Bathurst Inlet during most of the field sampling.

Current magnitudes, directions and variability were highly dependent on the station locations. At the station south of the MLA, the dominant current direction was strongly influenced by the southeastern-bearing steep shoreline close by. Upper layer currents had recorded maximums at the near-surface of over 80 cm/s during periods of large flow, while current velocities in the deep layer ranged from 5 to 10 cm/s in the north/south directions and between 10 to 35 cm/s in the east/west direction. Currents sampled at the stations north of the MLA revealed similar flow magnitude profiles, except the dominant directions were along the north/south axis since there was no direct shoreline influence. The general water flow in the inlet was defined as a positive fjord-type estuarine circulation, where the top layer flowed seaward (i.e., north towards Coronation Gulf and Dease Strait) and the deeper waters flowed southward from the ocean towards the head of the inlet. Steep stratification at ~15 to 20 m depth separated both layers and implied limited vertical exchange within the water column.

A schematic interpretation of the general summer circulation along the main channel of Bathurst Inlet can be found in Figure 1.1-16.

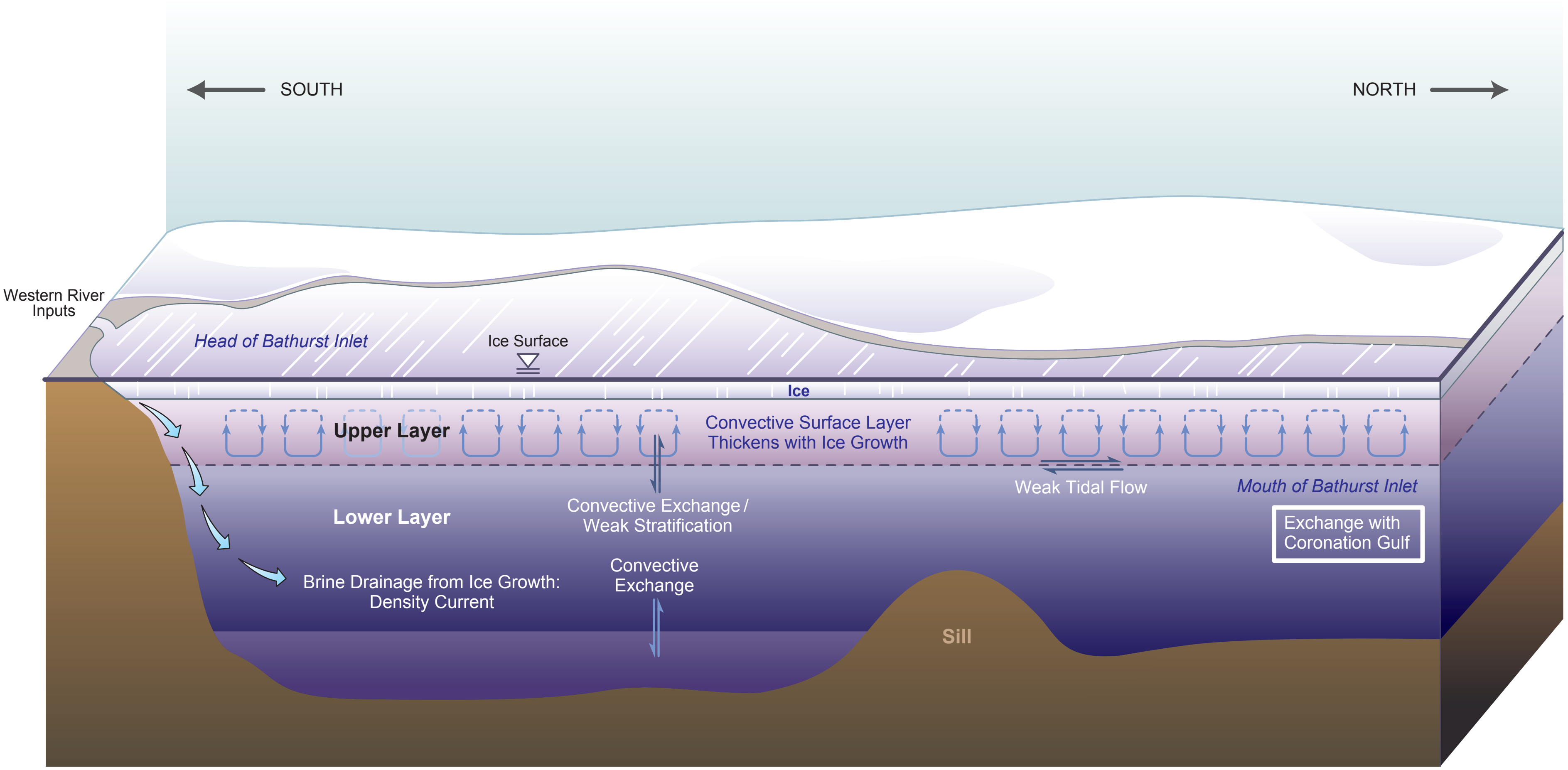

Figure 1.1-15

Example of Bathurst Inlet Main Channel Estuarine Circulation during Winter: Vertical Side View

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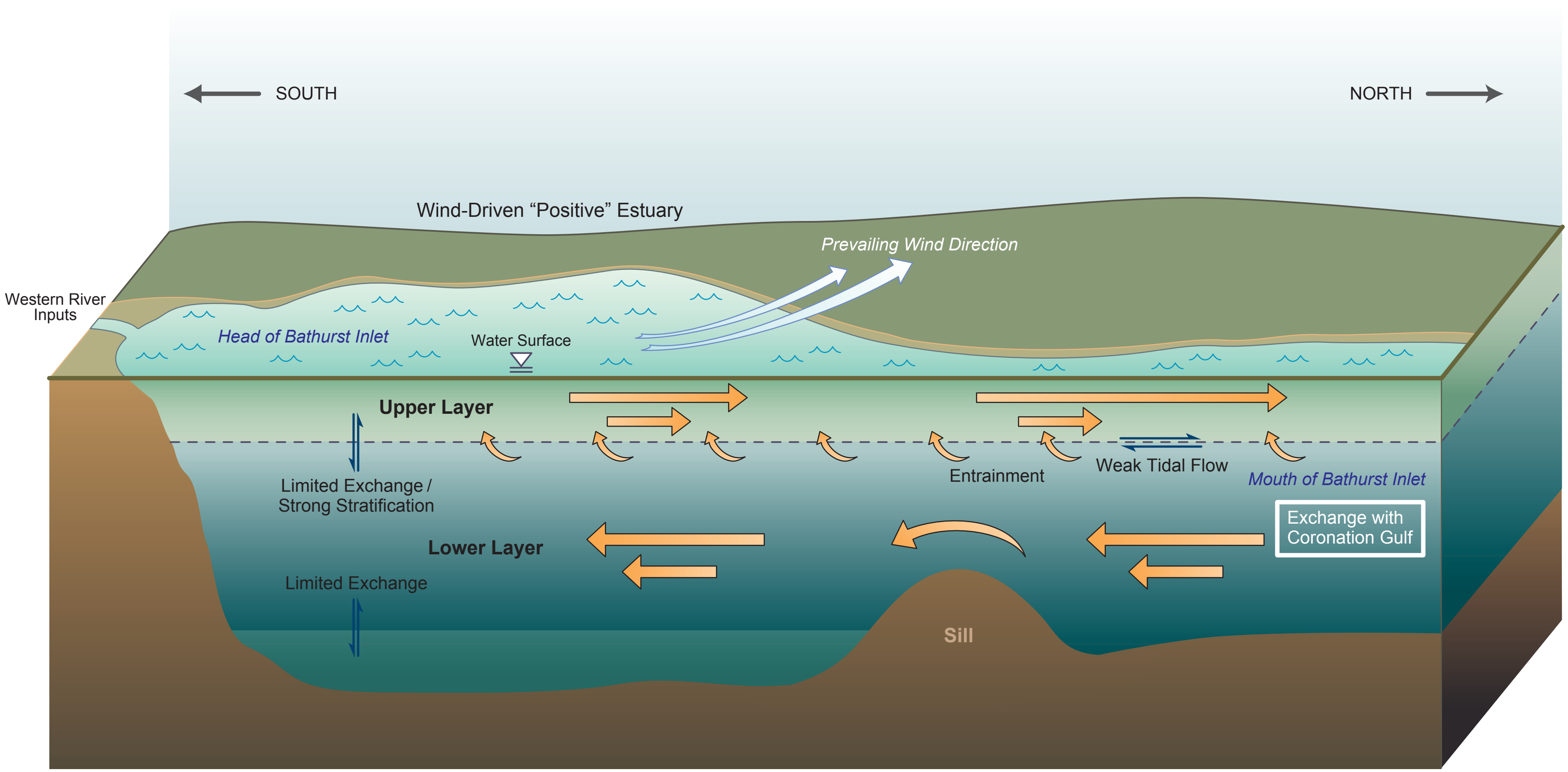

Note: The Prevailing Wind Direction refers to the wind direction that will most easily drive the circulation shown in the figure.

Figure 1.1-16

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Example of Bathurst Inlet Main Channel Estuarine Circulation during Summer: Vertical Side View

Figure 1.1-16

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1.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

1.2.1 Incorporation of TK for Existing Environment and Baseline Information

The *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) Report* (KIA 2012) and *Inuit Qaujimaningit Nanurnut: Inuit Knowledge of Polar Bears Report* (Keith et al. 2005) were reviewed for information on marine physical processes. Most traditional knowledge in each report has been centered on local weather and sea-ice conditions.

In recent years, the Inuit have observed less rain and snowfall, and noted that the ocean has taken longer to freeze in the winter and that permafrost is melting. This view was particularly emphasized in Keith et al. (2005), where there was a consensus among interviewees that sea-ice within Bathurst Inlet and the northern waterways was freezing later and breaking up sooner when compared to the era before the 1970s, which correlates well with ongoing satellite studies (NSIDC 2012). Elders questioned during the study made several observations on the sea-ice changes in the area:

> *"I remember they used to tell us that the trapping season started on November 1, and we used to go out and start putting out our traps and there [were] no dangerous spots on the ocean everything would be frozen over. Now…the first of November there are a lot of open spots in the ocean."*

> *"In the springtime the ice goes away a lot faster now, and it takes a lot longer to freeze up…in the fall. When I was young the ice used to go away in August. Today the ice goes away in mid-July and even in the first week of July."*

Other sea-ice changes remarked on were the times necessary for sea-ice to become safe for travel, and the diminishing overall thickness of sea-ice which renders ice travel more difficult than in the past:

> *"…I notice the difference between now and then, when it comes to the ice and snow conditions. In the old days, there used to be a lot of snow and lots of thick ice around the edge, but these days there is a lot less snow and the ice is not as thick… We have to be able to interpret the ice conditions in order to make it out there, but it's becoming more difficult to do so as the climate changes (Bob Konana)."*

Another change noted by interviewees was the disappearance of icebergs. This change, as with the changes in sea-ice, is associated with the era of changing from dog teams to snowmobiles, around the 1970s. Keith et al. (2005) outline that the exact timing of the disappearance of icebergs is not easy to determine, as the definition of an iceberg is subjective. For instance, what younger hunters may consider a true iceberg (piqalujaq), older hunters may define as a piece of multi-year ice (hikutuqaq).

The NKTP report (KIA 2012) also extensively touched on how the cycle of marine ice formation and melting was a critical factor in the hunting strategies of the local Inuit. Several elders interviewed bemoaned some of the impacts climate change had on their people, for example:

> *"The climate is changing and the weather is different now. Even the lakes have changed. […] Inuit have begun to talk about the changes now. Even to drink out of the river is not very good because the water is changing…"*

Other changes affecting marine processes included shallower lakes and shallower rivers that drained to the ocean, leading to reductions in river flow, smaller fish spawning runs, and that the Arctic Ocean took longer to freeze in general, leading to a reduction in the hunting season duration.

1.2.2 Incorporation of TK for Valued Ecosystem Component (VEC) Selection

The results of the NKTP report (KIA 2012) were used for scoping and refining the potential VEC list. The NTKP report presents clear maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the VEC list.

There were few comments related to physical marine processes in the TK report; therefore, coupled with the Sabina-led public consultation, consultation with regulatory agencies, and regulatory considerations, marine physical processes were classified as Subjects of Note for the DEIS.

1.3 VALUED COMPONENTS

1.3.1 Potential Valued Components and Scoping

Marine physical processes were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK reports (Keith et al. 2005; KIA 2012), consultation with regulatory agencies, and regulatory considerations, marine physical processes were classified as Subjects of Note.

1.3.2 Valued Components Included in Assessment

Marine physical processes are considered Subjects of Note for the DEIS. All information requested in the NIRB-issued EIS guidelines relating to marine physical processes are included in this DEIS.

2. Marine Water Quality

2. Marine Water Quality

2.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

2.1.1 Overview and Regional Setting

The proposed Back River Project (the Project) lies in western Nunavut in the continuous permafrost zone of the continental Canadian Arctic. The Project area is composed of three main areas: the Goose Property Area, the George Property Area, and the Marine Laydown Area (MLA; Figure 2.1-1). The Project will sealift materials and supplies through Bathurst Inlet during the open-water season to the MLA located on the western shore of southern Bathurst Inlet.

Bathurst Inlet itself is a long fjord (~165 km) that is narrow (~2 to 15 km) and deep (> 300 m). It is divided into two major basins separated by a shallow sill midway along the inlet. The outer inlet is the deeper of the two basins and contains many islands and complex bathymetry. The inner inlet runs landward from near Kingaok, has a relatively simple structure with few islands, and is shallower than the outer inlet, with depths between 100 and 150 m. The Western River discharges into the head of the inlet at the south, and the Mara River and Burnside River discharge into the western shoreline of the inlet. Numerous small streams discharge into the inlet along the eastern and western shorelines.

Bathurst Inlet cuts through the Bathurst Hills Ecoregion that is characterized by strong relief built from massive granite rocks. The deeply indented, rocky shorelines lead to steep bathymetry with narrow near-shore areas. Winter is characterized by extreme cold (mean monthly temperatures -33°C), and ice cover is generally present from November to July. Air temperatures are highest in July, reaching a mean monthly temperature of 14°C. Regional meteorological stations report total annual precipitation between 125 mm (2009) to 344 mm (2007) for the interval 2006 to 2012 (see Volume 4, Chapter 3 for additional information). The long cold winters promote the formation of sea-ice across the Inlet, which is typically ice-covered from October through June with up to 2 m of ice (Volume 7, Chapter 1; Rescan 2008b).

Mean annual temperature may increase in Canada's North by approximately 2.0°C for the climate normal period for the years 2010 to 2030 (Volume 4, Chapter 3). Over the same time periods, projections suggest that total annual precipitation could increase from 5 to 8% (Lemmen et al. 2008). The projected increase in mean annual air temperatures would lead to effects on the regional cryosphere. This would likely include alterations to sea, river, and lake ice regimes, permafrost conditions, and winter snow pack, especially during the shoulder seasons of spring and fall.

2.1.2 Proximity to Designated Environmental Areas

No existing or proposed parks or conservation areas are in or border, Bathurst Inlet. The nearest conservation area is the Queen Maud Gulf Migratory Bird Sanctuary approximately 100 km east of Bathurst Inlet on the far side of the Kent Peninsula. The Draft Nunavut Land Use Plan (Nunavut Planning Commission 2012) has no special designation for the marine environment of Bathurst Inlet, but the caribou calving grounds in the region have been designated PSE-R2. The proposed Hiukitak River Cultural Area is on the eastern shore of Bathurst Inlet, and is located 40 km east of Kingaok, 60 km north-east of the proposed Marine Laydown Area (MLA), and 140 km north of the George Property Area.

Figure 2.1-1

Project Location

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2.1.3 Baseline Study Area

The Project will primarily interact with the marine environment locally with the site activities at the MLA (Local Study Area; LSA) in southern Bathurst Inlet, and regionally with the ship travel through Bathurst Inlet (Regional Study Area; RSA). The MLA may include in-water structures (marine ramp and seasonal dock) and will be the location of the majority of Project activities that may interact with the marine environment. For the purposes of the existing environment and baseline information, the sites are divided into those near the proposed MLA (LSA), and those throughout the wider region of Bathurst Inlet (RSA).

Baseline marine water quality data has been collected in Bathurst Inlet by Rescan Environmental Services Ltd. (Rescan) since 2001, with sampling in the LSA being conducted in 2013 (Figure 2.1-2, Table 2.1-1).

2.1.4 Baseline Studies

2.1.4.1 *Information Sources*

The baseline data on marine water quality were compiled from recent site-specific surveys in the Project area. The primary sources of baseline water quality information used in the DEIS were from the LSA that contains the MLA Potential Development Area (PDA; Rescan 2013b) and the RSA in the broader Bathurst Inlet area (Rescan 2002, 2008a, 2008b, 2012c, 2013a). This information can be found in the following reports:

- *Bathurst Inlet Port and Road Project: 2001-2002 Marine Environment Baseline Studies* (Rescan 2002);
- *Hackett River Project: 2007 Marine Baseline Report* (Rescan 2008a);
- *Hackett River Project: 2008 Marine Baseline Report* (Rescan 2008b);
- *Bathurst Inlet Port and Road Project: 2010 Marine Aquatic Resources Baseline Study* (Rescan 2012c);
- *Back River Project: 2012 Marine Baseline Report* (Rescan 2013a; Appendix V7-1A); and
- *Back River Project: 2013 Marine Baseline Report* (Rescan 2013b).

<u>Baseline Study Methods</u>

Baseline marine water quality data have been collected in the southern Bathurst Inlet during 2001, 2002, 2007, 2008, 2010, 2012, and 2013. A summary of the various sampling programs, including the analyzed water quality parameters, sampling locations, and methodologies, is shown in Table 2.1-1. The baseline sampling locations, including those near the MLA, are shown on Figure 2.1-2. Full methodologies can be found in the reports listed above.

Water quality samples were collected using acid-washed Niskin (under ice) or GO-FLO (open water) water sampling bottles. Depths of water quality sampling were determined based on the water column structure (as determined by the temperature-salinity profiles), and whether the sites were deep (> 5 m; several samples per site) or shallow (< 5 m; single sample at 1 m). At the deeper sites, the following four depths were usually sampled based on the vertical stratification that was typically observed: 1 m below the surface, 4 m above the pycnocline, 4 m below the pycnocline, and at the mid-depth of the deep waters. The pycnocline was defined as the depth zone where the density (i.e., salinity and temperature) changed most sharply.

Table 2.1-1. Marine Baseline Water Quality Sampling Program in Bathurst Inlet, 2001 to 2013

Year	2001	2007	2008	2010	2012	2013
Sampling Month(s)	August	August	May	August	April, August	July
Sampling Agency	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.
Sampling Method	CTD**, YSI DO Sonde, Discrete sampling bottles*	CTD, YSI DO Sonde, Discrete sampling bottles*	CTD, YSI DO Sonde, Discrete sampling bottles*	CTD, YSI DO Sonde, Discrete sampling bottles*	CTD, YSI DO Sonde, Discrete sampling bottles*	CTD, YSI DO Sonde, Discrete sampling bottles*
Data Collected	Dissolved Oxygen, Routine Water Quality†, Nutrients, Metals‡	Dissolved Oxygen, Routine Water Quality†, Nutrients, Metals‡	Dissolved Oxygen, Routine Water Quality†, Nutrients, Metals‡	Dissolved Oxygen, Routine Water Quality†, Nutrients, Metals‡	Dissolved Oxygen, Routine Water Quality†, Nutrients, Metals‡	Dissolved Oxygen, Routine Water Quality†, Nutrients, Metals‡
Site(s) Sampled	BIPR2001A	HACK20071	HACK20081	BIPR2010R	BACK2012BI1	BACK2013N10
	BIPR2001B	HACK20072	HACK20082	BIPR20101	BACK2012BI2	BACK2013N12
	BIPR2001C	HACK20074	HACK20083	BIPR20102	BACK2012BI3	BACK2013J10
	BIPR2001D	HACK2007Rb	HACK20084	BIPR20103a	BACK2012BI4	BACK2013J12
	BIPR2001E		HACK20085	BIPR20103b	BACK2012O410	BACK2013S10
			HACK20086	BIPR20104	BACK2012O412	BACK2013S12
			HACK2008R	BIPR20105	BACK2012O414	BACK2013O650
			HACK2008RSA1	BIPR20106a	BACK2012O420	BACK2013M7
			HACK2008RSA2	BIPR20106b	BACK2012O422	
			HACK2008RSA3	BIPR20107	BACK2012O424	
			HACK2008RSA4		BACK2012O430	
			HACK2008RSA5		BACK2012O432	
			HACK2008RSA6		BACK2012O440	
			HACK2008RSA7		BACK2012O442	
			HACK2008RSA8		BACK2012O444	
					BACK2012O610	
					BACK2012O620	
					BACK2012O622	
					BACK2012O624	
					BACK2012O630	
					BACK2012O632	
					BACK2012O642	
					BACK2012O644	
					BACK2012O650	
					BACK2012O652	
					BACK2012O654	
Number of Replicates per Site	Dissolved Oxygen sampled in a profile at 0.5 m depth increments Water Quality samples n = 1; sampled from at least one depth (shallow sites, <5 m) up to four depths (deep sites, > 5 m)					

** Discrete water samples were collected in acid-washed Niskin or GO-FLO sampling bottles.*
*** CTD - conductivity, temperature, and depth probe.*
† Routine water quality analysis includes total suspended solids (TSS), turbidity, pH, and anions.
‡ Metal analysis included both dissolved and total fractions.

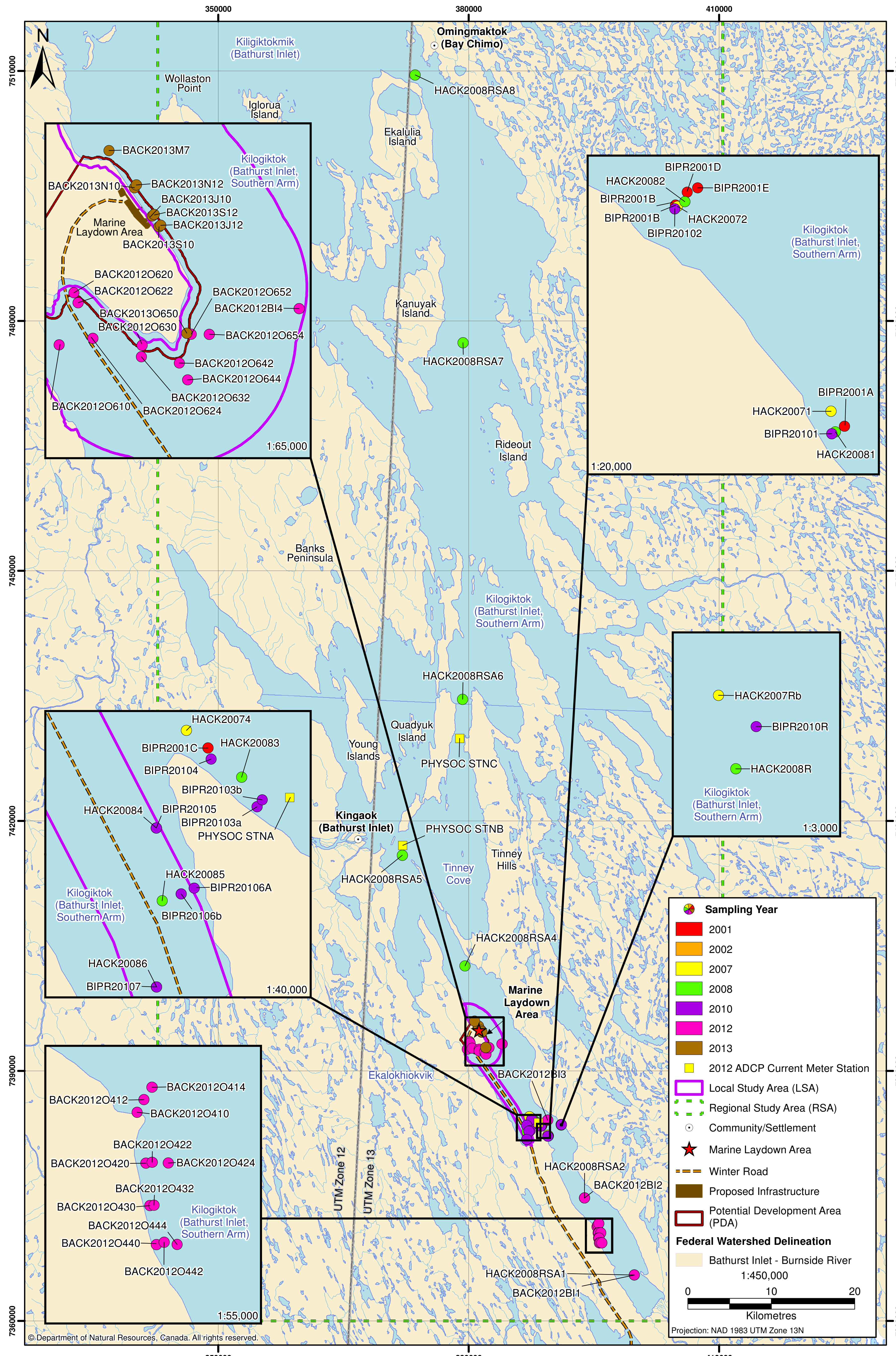

Figure 2.1-2

Baseline Marine Water Quality Sites, 2001 to 2013

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Subsamples for the various water quality parameters (e.g., nutrients and metals) were drawn from the GO-FLO and Niskin sampling bottles, with all scientists wearing powder-free nitrile gloves, and particular care being taken not to bring the bottle or bottle cap into contact with the plastic spigot or other possible sources of contamination. After collection and preservation, all samples were kept cold and in the dark while in the field and refrigerated at camp prior to transport to ALS Environmental (Burnaby, BC) for analysis. Dissolved profiles were recorded at 0.5 to 1 m intervals through the water column using a calibrated YSI dissolved oxygen meter.

Water Quality QA/QC

Field duplicates were collected for approximately 20% of samples during each marine water quality survey. All water quality samples were recorded on chain of custody forms before being sent to the analytical laboratory. Equipment, field, and travel blanks were processed and submitted with the water samples as part of the QA/QC program.

2.1.5 Marine Water Quality

2.1.5.1 *pH*

The pH throughout the water column in the marine baseline sampling program was between 7.7 and 7.9 pH units throughout the baseline sampling program. Vertical profiles of pH collected during the ice-covered season were generally uniform. Samples for surface waters had minor (~0.1 units) increases at some sites during summer, likely due to inorganic carbon uptake by phytoplankton. The pH of all samples in the marine baseline program was within the CCME marine water quality guideline range of 7.0 to 8.7 pH units (Rescan 2002, 2008a, 2008b, 2012c, 2012a, 2013a, 2013b).

2.1.5.2 *Total Suspended Solids and Turbidity*

The concentration of total suspended solids (TSS) and turbidity are related measures describing the quantity of particulate material, primarily sediment, suspended in the water column. Natural variation in TSS concentration and turbidity occur due to spatial differences in terrestrial runoff, bathymetry, currents, and tides, and to temporal changes from season and weather. The spatial and temporal variation in natural TSS and turbidity levels in Bathurst Inlet was evident in the baseline sampling program (Table 2.1-2). During the open-water season, mean total suspended solids (TSS) and turbidity levels tended to be greater in the shallower LSA sites than in the deeper RSA sites, and were greater in the surface waters in the RSA than at depth (Table 2.1-2). Surface TSS and turbidity levels were also greater in open water than under ice. This reflects the influence of wind-driven wave action with the shallower sediments in the LSA, as well as the importance of riverine and aerial inputs into the entire inlet during the open-water season. Baseline surveys have shown that naturally elevated TSS values of greater than 20 mg/L and turbidity values greater than 15 NTU are present near river outflows (e.g., BIPR20107) or in shallow waters (e.g. BACK2012O622; (Rescan 2012c, 2013a).

2.1.5.3 *Dissolved Oxygen*

Dissolved oxygen concentration is an important environmental parameter that has major effects on the aquatic life and chemistry of marine ecosystems. The atmosphere is generally the source of oxygen in marine environments with aquatic photosynthesis supplying oxygen when conditions favour the growth of primary producers. Respiration and the re-mineralization of organic matter consume oxygen. Therefore, the dissolved oxygen concentration, at any moment, is the balance between oxygen consumption (respiration), oxygen production (photosynthesis), and atmospheric influx. Water mixing processes are very important for oxygen concentrations, since the atmospheric influx is the largest source of oxygen for marine systems.

Table 2.1-2. Summary of Marine Water Column TSS at LSA and RSA Sites, 2001 to 2013

		n	Min	Mean	Max
LSA					
TSS (mg/L)	*Surface*				
	Open-water	8	4.4	6.8	10
Turbidity (NTU)	*Surface*				
	Open-water	8	3.4	5.4	7.5
RSA					
TSS (mg/L)	*Surface*				
	Ice-covered	35	1.0*	5.8	18.7
	Open-water	73	1.0*	7.0	23.8
	Deep				
	Ice-covered	38	1.0*	6.3	27
	Open-water	31	1.0*	10.0	16.7
Turbidity (NTU)	*Surface*				
	Ice-covered	35	0.13	0.28	0.65
	Open-water	73	0.52	3.0	18
	Deep				
	Ice-covered	38	0.13	0.34	0.86
	Open-water	31	0.20	0.51	1.9

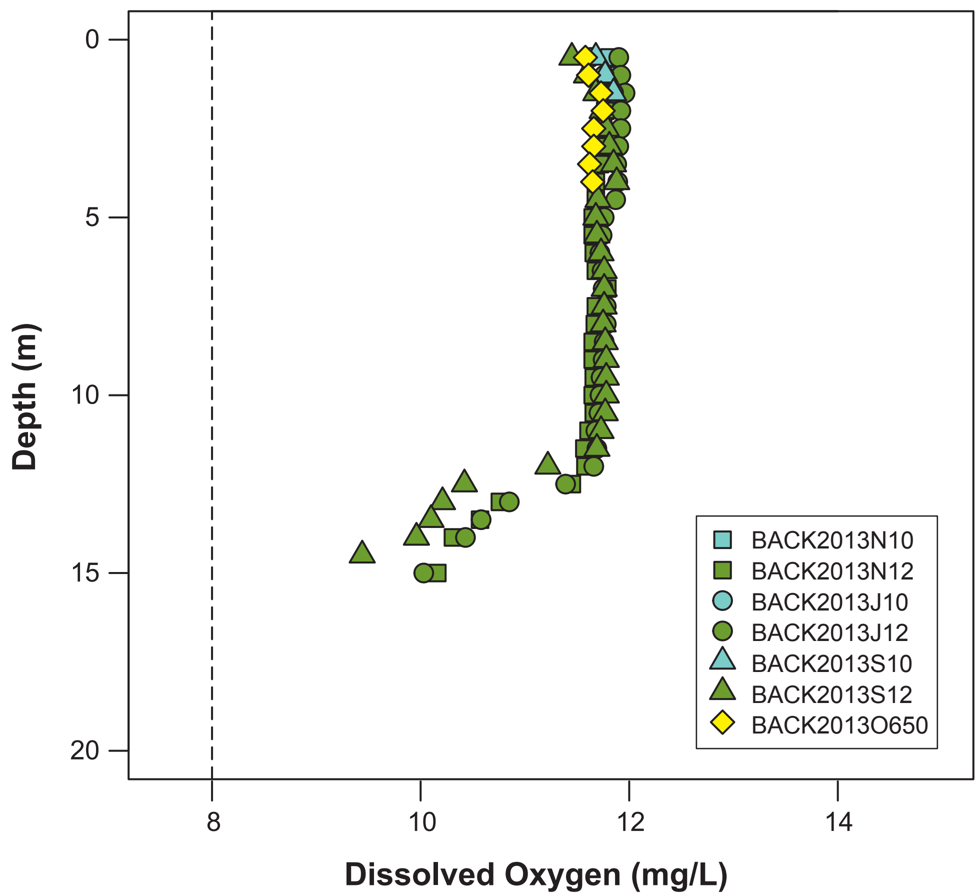
** Analytical detection limit for TSS ranged from 2 to 3 mg/L; the minimum value shown is calculated as ½ of the lowest detection limit.*

Water column dissolved oxygen concentrations in the LSA ranged from ~9 to 12 mg/L during the open-water season in July 2013 (Figure 2.1-3). Shallow near-shore sites (BACK2013N10) were uniformly mixed from the surface to the sediments, with dissolved oxygen concentrations near 12 mg/L and saturation levels near 100%. Deeper sites (BACK2013S12) did have lower (9 to 11 mg/L) dissolved oxygen concentrations in the pycnocline. No dissolved oxygen concentrations were below the CCME interim water quality guideline of 8 mg/L (Rescan 2013b).

In the RSA, dissolved oxygen concentrations were lower in the deep waters (≥ 8 mg/L) of Bathurst Inlet than in the surface (12 to 16 mg/L; Rescan 2002, 2008a, 2008b, 2012c, 2013a). The lower oxygen concentrations observed at depth indicate natural processes of respiration and re-mineralization were exceeding the flux of oxygen from photosynthesis and water mixing (ultimately from the atmosphere). On occasion, these natural processes reduced the dissolved oxygen concentration to below the CCME interim water quality guideline of 8 mg/L, which is a common phenomenon in deep fjords (Rescan 2008b, 2012c, 2013a).

2.1.5.4 *Nutrients*

Nutrients are the chemicals required by photosynthetic organisms for growth and productivity and ultimately serve as building blocks for organic matter flowing through marine food webs. Variation in nutrient concentrations can be caused by periodic mixing, terrestrial and atmospheric inputs, and variations in nutrient uptake (primary producers) and re-mineralization (microbes). Nutrient uptake by phytoplankton is often greatest in the surface mixed layer, and re-mineralization occurs primarily in the sediments and in the deep waters. A classic “nutrient” profile has the lowest concentrations in the surface waters, increasing concentrations through the pycnocline, and the highest concentrations in the deep waters and near the sediments.



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Marine Water Column Dissolved Oxygen Profiles in the Local Study Area, July 2013

Figure 2.1-3

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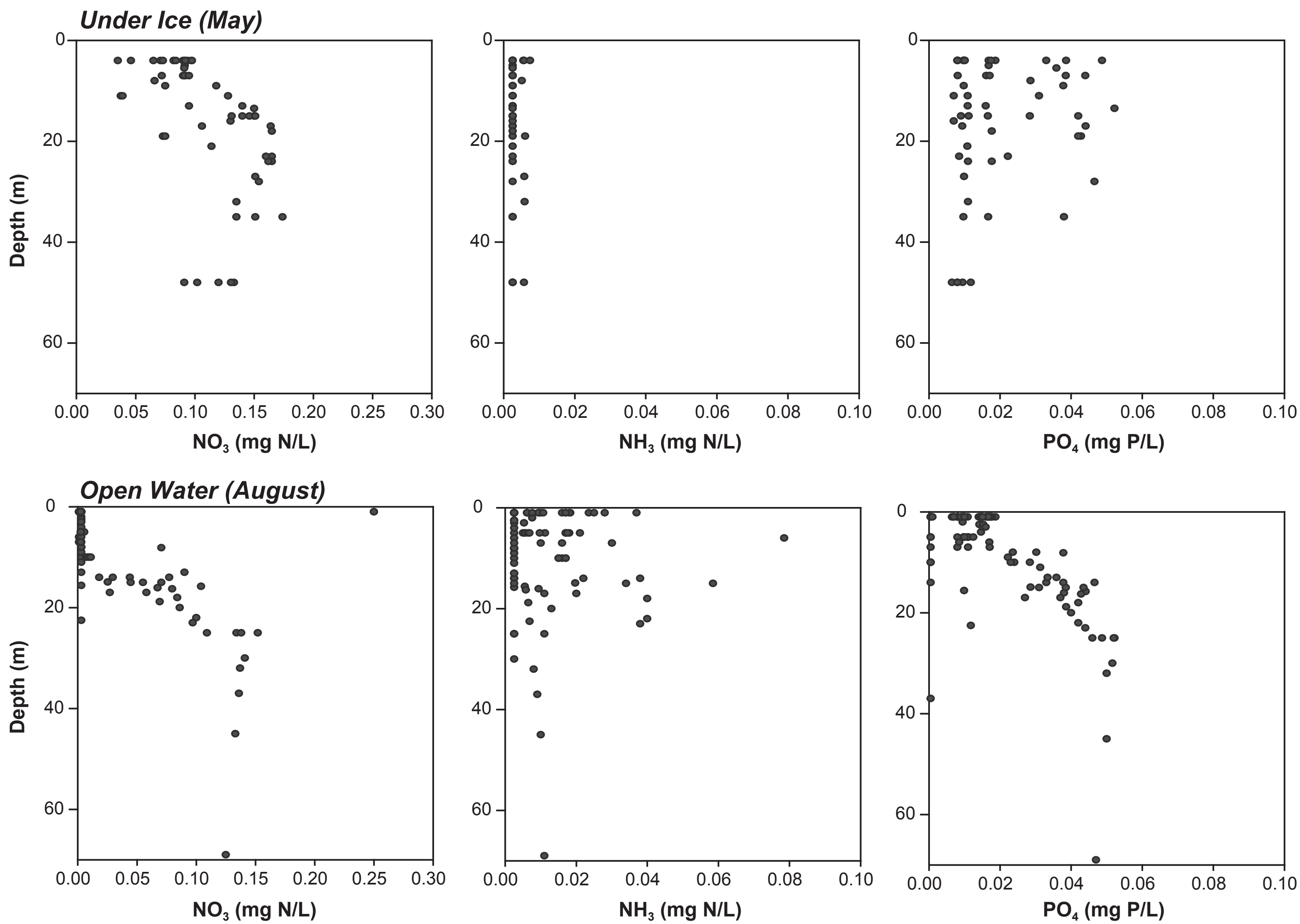
The concentration of nitrogen (ammonia, nitrate, and nitrite) and phosphorus (total phosphorus and orthophosphate) varied in Bathurst Inlet vertically within the water column and seasonally between winter and summer (Table 2.1-3 and Figure 2.1-4). The baseline sampling program found that nutrient concentrations throughout the Bathurst Inlet RSA and the LSA generally followed the classic vertical profile (Figure 2.1-4). Winter nutrient profiles tended to show higher concentrations in the surface waters during the ice-covered season than during the open-water season, likely the result of lower rates of phytoplankton growth during the light-limited winter (Rescan 2002, 2008a, 2008b, 2012c, 2013a).

Table 2.1-3. Summary of Marine Water Nitrogen Concentrations at LSA and RSA Sites, 2001 to 2013

		n	Min	Mean	Max
LSA					
Nitrate-N (mg/L)	*Surface*				
	Open-water	8	0.003*	0.0039‡	0.0093‡
Ammonia-N (mg/L)	*Surface*				
	Open-water	8	0.0025†	0.0025†	0.0025†
RSA					
Nitrate (mg/L)	*Surface*				
	Ice-covered	35	0.035	0.093	0.25
	Open-water	73	0.003*	0.004	0.071
	Deep				
	Ice-covered	38	0.073	0.160	0.530
	Open-water	31	0.003*	0.070	0.150
Ammonia (mg/L)	*Surface*				
	Ice-covered	35	0.0025†	0.0049	0.0220
	Open-water	73	0.0025†	0.0071	0.0180
	Deep				
	Ice-covered	38	0.0025†	0.0120	0.2400
	Open-water	31	0.0025†	0.0230	0.0790

** Analytical detection limit for nitrate was 0.005 to 0.006 mg/L; the minimum value shown is calculated as ½ of the detection limit.*
† Analytical detection for ammonia was 0.005 mg/L; the minimum value shown is calculated as ½ of the detection limit.
‡ Only one of seven samples collected in the MLA were above the analytical detection limit of 0.006.

Nitrate followed the nutrient-type profile in both the ice-covered and open-water seasons throughout the baseline sampling program (Table 2.1-3 and Figure 2.1-4). Nitrate concentrations in the surface waters were ~0.09 mg N/L during the ice-covered season and increased to ~0.15 mg N/L in the deep waters (one observation of 0.53 mg N/L in April 2012; Rescan 2013a). In contrast, summer nitrate concentrations in both the LSA and RSA were near or below the analytical detection limit (0.005 mg N/L) in the surface waters. The very low nitrate concentrations observed in the surface waters of Bathurst Inlet in summer indicated that nitrogen was likely limiting the growth of phytoplankton, which frequently occurs in coastal Arctic ecosystems (Rysgaard, Nielsen, and Hansen 1999). The deep waters in the Bathurst Inlet RSA had similar concentrations of nitrate in summer to winter. Natural nitrate concentrations throughout the baseline sampling programs were much lower than the conservative CCME long-term exposure guideline of 45 mg N/L.



Notes: Includes all data from the Bathurst Inlet except for April 2012 (BACK2012BI1 to BI4) which is not shown because detection limits were high.
MLA 2013 data not shown.

Figure 2.1-4

Seasonal Changes in Water Column Nutrient Concentrations in the Regional Study Area, 2001 to 2012

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Figure 2.1-4

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The other nitrogenous nutrients, nitrite and ammonia, were generally at low concentrations throughout LSA and RSA. Nitrite concentrations were low (< 0.005 mg N/L) in both winter and summer, and were often near or below detection limits throughout the baseline sampling program. Ammonia concentrations were variable between seasons, depths, and years, but average concentrations were generally between 0.01 and 0.02 mg N/L (Table 2.1-3 and Figure 2.1-4).

Phosphorus concentrations also had the expected vertical profiles in the baseline sampling programs. Surface concentrations of total phosphorus during the ice-covered season were ~0.04 mg P/L, and declined to between 0.01 and 0.02 mg P/L in summer (Table 2.1-4 and Figure 2.1-4). Below the pycnocline, total phosphorus concentrations increased to ~0.05 mg P/L, which reflected the decrease in phosphorus demand from phytoplankton and the concomitant increase in re-mineralization of organic matter. The concentration of orthophosphate (PO_4^{3-}), the simple oxidized form of phosphorus, was generally at least 80% of the total phosphorus concentration, except in near-shore sites likely influenced by sediment re-suspension or terrestrial runoff (e.g., BIPR20107, BACK2012O624; Rescan 2012c, 2013a).

Table 2.1-4. Summary of Marine Water Phosphorus Concentrations at LSA and RSA Sites, 2001 to 2013

		n	Min	Mean	Max
LSA					
Orthophosphate (mg/L)	*Surface*				
	Open-water	8	0.006	0.007	0.008
Total phosphorus (mg/L)	*Surface*				
	Open-water	8	0.014	0.015	0.018
RSA					
Orthophosphate (mg/L)	*Surface*				
	Ice-covered	35	0.029	0.038	0.047
	Open-water	73	0.001*	0.013	0.038
	Deep				
	Ice-covered	38	0.037	0.050	0.055
	Open-water	31	0.001*	0.030	0.052
Total phosphorus (mg/L)	*Surface*				
	Ice-covered	35	0.028	0.038	0.049
	Open-water	73	0.001*	0.020	0.045
	Deep				
	Ice-covered	38	0.037	0.049	0.061
	Open-water	31	0.011	0.034	0.054

**Analytical detection limits for orthophosphate and total phosphorus was 0.0005 mg/L; the minimum value shown is 0.001 due to significant digits.*

2.1.5.5 *Metals*

The baseline sampling program in Bathurst Inlet measured dissolved and total metal concentrations in the near-shore LSA and the RSA (Table 2.1-5).

Table 2.1-5. Summary of Marine Water Metal Concentrations at LSA and RSA Sites, 2001 to 2013

		Metal Concentration (mg/L)				% of Samples with Concentrations Greater than CCME Guidelines
		n	Min	Mean	Max	
LSA						
Arsenic		8	0.001[Δ]	0.001[Δ]	0.001[Δ]	0
Cadmium		8	0.000025[†]	0.000064	0.00016	14
Chromium		8	0.00025[‡]	0.00025[‡]	0.00025[‡]	0
Mercury		8	0.000005[◊]	0.000005[◊]	0.000005[◊]	0
RSA						
Arsenic	*All depths*					
	Ice-covered	73	0.0008	0.0010	0.0011	0
	Open-water	104	0.0007	0.0060	0.050	0
Cadmium*	*All depths*					
	Ice-covered	73	0.00003[†]	0.00005	0.00009	0
	Open-water	104	0.00003[†]	0.00007	0.00022	5
Chromium	*All depths*					
	Ice-covered	73	0.0003[‡]	0.0003[‡]	0.0003[‡]	0
	Open-water	104	0.0003[‡]	0.0005	0.0043	3[#]
Mercury	*All depths*					
	Ice-covered	73	0.000005[◊]	0.000005	0.000023	1
	Open-water	104	0.000005[◊]	0.000005[◊]	0.000005[◊]	0

[Δ]The analytical detection limits for arsenic were 0.002 mg/L; the values shown are calculated as ½ the analytical detection limit.
[†] The analytical detection limits for cadmium were 0.00005 mg/L; the minimum value shown is calculated as ½ of the detection limit. The samples collected in 2001 had high detection limits (0.015 mg/L) and are excluded from these summaries.
** 25% of cadmium water concentrations were below analytical detection limits.*
[‡] The analytical detection limits for chromium were 0.0005 mg/L, except in 2001 and 2008 that are excluded from this summary; the minimum shown is calculated as ½ of the detection limit.
[#] Two samples exceeded the CCME guideline for hexavalent chromium, Cr(VI), of 0.0015 mg/L; no samples exceeded the CCME guideline for trivalent chromium, Cr(III), of 0.056 mg/L (CCME 2013).
[◊] The analytical detection limits for mercury were 0.00001 mg/L; the minimum shown is calculated as ½ of the detection limit.

Overall, Bathurst Inlet is naturally low in metals during both the open-water and ice-covered seasons, and in the LSA and RSA. Many metal samples were near or below their analytical detection limits, particularly measurements of arsenic, chromium, copper, iron, lead, mercury, and zinc. Only a few samples had metal concentrations that were greater than the CCME marine water quality guidelines (Table 2.1-5; Rescan 2002, 2008a, 2008b, 2012c, 2013a, 2013b) as a single sample in the LSA had a cadmium concentration that was greater than its CCME guideline level, and no other metal had more than 5% of their samples greater than their respective CCME guideline level in the RSA (cadmium, chromium, and mercury; Table 2.1-5). Seven samples from 2012 had cadmium concentrations that were naturally greater than the CCME guideline of 0.00012 mg/L and all were from deeper samples near the sediments (Table 2.1-6). Similarly, the concentration of mercury was greater than the CCME guideline of 0.000016 mg/L in one sample near the sediments at a near-shore site in May 2008 (HACK20085; Rescan 2008b). Naturally elevated chromium concentrations were also observed in surface waters with moderate quantities of suspended particulate material; one surface sample from 2007 (HACK20071) and one sample from 2010 (BIPR20104) had natural chromium concentrations that were greater than the CCME guideline of 0.0015 mg total hexavalent chromium/L (Rescan 2008a, 2012c; CCME 2013).

Table 2.1-6. Summary of Marine Water Quality Concentrations that were Greater than CCME Guidelines at LSA and RSA Sites, 2001 to 2013

	Metals with Mean Concentrations Greater than CCME Guideline*
LSA	
BACK2013N12	Cd
RSA	
HACK20071	Cr(VI)
HACK20085	Hg
BIPR20104	Cd, Cr(VI)
BACK2012O414	Cd
BACK2012O440	Cd
BACK2012O444	Cd
BACK2012O624	Cd
BACK2012O644	Cd
BACK2012O654	Cd

**Exceedances are listed if the mean for all available samples was greater than the CCME guidelines. Cd = cadmium, Cr(VI) = hexavalent chromium, Hg = mercury (CCME 2013).*

2.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

2.2.1 Incorporation of TK for Existing Environment and Baseline Information

Available TK from the *Inuit Traditional Knowledge of Sabina Gold and Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report* (KIA 2012) was reviewed for information on marine water quality (Volume 3, Chapter 3). There was no direct information on marine water quality in the KIA report (KIA 2012).

Inuit of the central Arctic (Kitikmeot) region are known as "Kitikmiut", which are further classified into three divisions based on their territorial range: the Ocean Inuit, the Nunamiut (Inland Inuit), and the Kiligiktokmiut, or Bathurst Inlet Inuit. Of particular relevance to Kiligiktokmik (Bathurst Inlet), the Kiligiktokmiut have lived adjacent to the inlet, and to the Perry River and Ellice River drainages, on a continuous basis for thousands of years (KIA 2012).

The Kiligiktokmiut have been clearly dependent on the seas and coasts, and particularly on marine life such as ringed seals, ocean fish such as Arctic char and tomcod, crabs, oysters and starfish. Fish were an important part of the Inuit seasonal diet, and essential during times of food shortages. Inuit fished the ocean adjacent to the mainland and island coastlines, at the mouths of major rivers, and through ice cracks. Marine water quality has direct and indirect effects on the abundance and health of marine food resources. The traditional importance of marine resources reinforced the selection of marine water quality as a VEC.

2.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the *Inuit Traditional Knowledge of Sabina Gold and Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report* (KIA 2012) were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The TK report presents clear maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB ftp site. As a result of this process, marine water quality was selected as a VEC.

2.3 VALUED COMPONENTS

2.3.1 Potential Valued Components and Scoping

Marine water quality was identified as a potential VEC from a comprehensive list in the EIS guidelines (Section 7.6.1; NIRB 2013) and was identified as potentially interacting with the Project during the scoping process (see Volume 9, Chapter 1). Although there were few to no comments regarding marine water quality expressed through consultation with communities and TK information, there were moderate to significant comments by regulatory agencies and significant regulatory considerations such as the *Fisheries Act* (1985) and CCME water quality guidelines for the protection of aquatic life that emphasize the importance of water quality in the marine environment (see Volume 9, Chapter 1). As part of this process, marine water quality was selected as a VEC for the DEIS.

2.4 SPATIAL AND TEMPORAL BOUNDARIES

The marine water quality spatial and temporal boundaries define the maximum spatial and temporal extent within which the potential effects assessment was conducted. The boundaries were determined by the criteria specified in the EIS guidelines (NIRB 2013), and outlined in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1).

2.4.1 Spatial Boundaries

The spatial boundaries used for the assessment of the marine water quality VEC included an LSA bounding the PDA of the MLA and a larger RSA bounding the PDA, LSA, and Bathurst Inlet.

2.4.1.1 *Local Study Area*

The marine LSA for the VEC marine water quality contains the PDA of the MLA and its near-shore marine waters, seabed, and shorelines. The boundary extends approximately 1 km away from the proposed marine ramp and seasonal dock and extends south as a 500 m buffer along the proposed winter road alignment across Bathurst Inlet (Figure 2.4-1).

2.4.1.2 *Regional Study Area*

The marine RSA encompasses the PDA, LSA, and marine areas of Bathurst Inlet from the southern-most tip of the inlet to approximately 15 km north of Omingmaktok (Figure 2.4-1). The marine RSA includes the proposed shipping lane within Bathurst Inlet that will bring sealifts into the MLA.

2.4.2 Temporal Boundaries

The temporal boundaries used for the assessment of effects on the VEC marine water quality align with the duration of Project phases outlined in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1) as described below:

- Site Preparation: 2 years;
- Construction Phase: 2 years;
- Operations Phase: 10 years;
- Reclamation and Closure Phase: 10 years;
- Post-closure Phase: 3 years minimum;
- Other potential phases:
  - Temporary Closure: less than 2 years;
  - Care and Maintenance Phase: 2-10 years; and
  - Exploration: included in Construction and Operations phases.

2.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

2.5.1 Methodology Overview

The Project-related effect assessment process for the VEC marine water quality followed a step-wise process detailed in the General Assessment Methodology (Volume 9, Chapter 1), as follows:

1. Identification of potential interactions between the Project and marine water quality;
2. Characterization of the potential effects that could result from these interactions;
3. Identification and description of design, mitigation and management measures that will be taken to eliminate or reduce the potential effects;
4. Characterization of residual effects that will likely remain after mitigation and management measures have been applied; and
5. Determination of the significance of residual effects using eight attributes to rate the residual effects on marine water quality including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence.

The potential effects of the Project on marine water quality are evaluated for all Project phases as described in the General Assessment Methodology (Volume 9, Chapter 1).

If mitigation and management measures were considered entirely effective during any Project phase, effects to the VEC marine water quality were deemed negligible and were not identified as residual effects. Attributes used to characterize residual effects included direction, magnitude, reversibility, confidence, probability, extent, frequency, and duration. The rating criteria used for these attributes are provided in tables in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1). Table 2.5-1 presents the ratings specific for the magnitude of residual effects to the VEC marine water quality. The CCME guidelines for marine water quality were used, when available, as the threshold for determining the magnitude of potential residual effects since they are designed to be protective of all forms of aquatic life and all aspects of aquatic cycles, including the most sensitive species over the long term (CCME 2007, 2013). Under these rating criteria, residual effects from Project activities classified in the *Low* magnitude would result in changes in marine water quality that would be less than the CCME guidelines or within the natural variation observed in the baseline studies (Section 2.1.5).

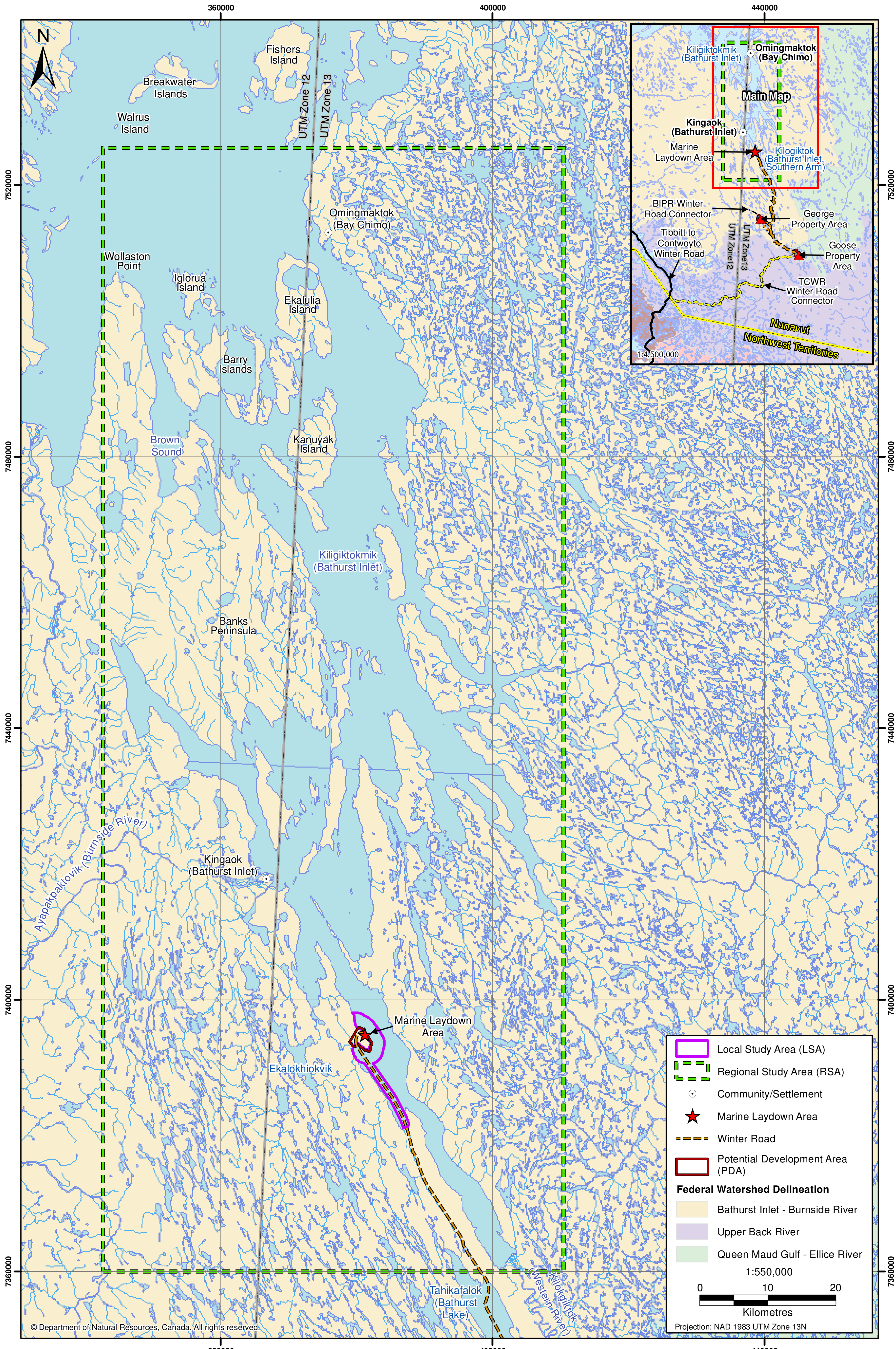

Figure 2.4-1

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Local Study Area and Regional Study Area for Marine Water Quality

Figure 2.4-1

Rescan an ERM company

Table 2.5-1. Rating Criteria for Evaluating the Magnitude of Residual Effects on Marine Water Quality

Rating	Classification
Negligible	No change from baseline values
Low	Within the CCME guideline, *or* less than the 90% percentile of baseline values if indicator is naturally greater than threshold
Moderate	Greater than CCME guideline, *or* greater than the 90% percentile of baseline values if indicator is naturally greater than threshold *Less than 10× threshold*
High	Greater than CCME guideline, *or* greater than the 90% percentile of baseline values if indicator is naturally greater than threshold *Greater than 10× threshold*

For example, naturally elevated cadmium concentrations were observed in the baseline studies (Section 2.1.5.5), and the magnitude ratings criteria were designed to account for this natural variation. *Low* magnitude residual effects would, therefore, be predicted to not result in any effects in aquatic organisms because of the conservative design of the CCME guidelines (CCME 2007, 2013). If the concentration of a metal (e.g., cadmium) was naturally greater than the CCME water quality guideline, then a *Low* magnitude effect would apply as long as the concentration was within the 90% percentile of baseline values (Table 2.5-1). Combined with the probability that the effect will occur, the significance of the effect was rated as positive, not significant, or significant (Table 2.5-2).

Table 2.5-2. Definitions of Significance Ratings for Marine Water Quality VEC

Significance	Descriptor of Significance
Positive	Effect could result in improvements in marine water quality, relative to the baseline within the RSA into the foreseeable future.
Significant	Effect is expected to result in a decline in marine water quality that is long-lasting or permanent within the zone of influence of the Project relative to reference conditions; levels may be variable or stable over years, but significantly lower on average than the natural variation of water quality and compared to reference sites elsewhere. Regional management actions such as research, monitoring, and recovery initiatives may be required should changes to marine water quality be deemed above acceptable thresholds.
Not Significant	Effect may result in a decline in marine water quality within the zone of influence of the Project relative to reference conditions during the life of the Project, but water quality should return to baseline conditions in the shorter-term after Project closure. Monitoring may be initiated to confirm the ratings of the effects assessment.

2.5.1.1 *Water Quality Indicators*

Project activities have the potential to interact with the marine environment through a number of pathways that can be detected through change in key indicators of marine water quality (outlined in Table 2.5-3). For example, runoff from pad areas can carry sediments into the near-shore marine environment, with potential increases in water column TSS or metal concentrations. The marine water quality effects assessment was based on the analysis of eight water quality indicators that represent the most probable and significant potential interactions between Project activities and the marine environment. It is important to note that the key indicators of marine water quality outlined in Table 2.5-3 are subject to natural variation, but thresholds and guidelines have been established to protect aquatic life (Table 2.5-4; CCME 2013). To be conservative, these guidelines and thresholds were applied to the effects analysis. For the purposes of this assessment, the contaminants of potential concern (COPC) identified in the CCME guidelines were used as indicators. The thresholds for the residual effects analysis were based from the CCME guidelines, when available, and detailed in Table 2.5-4.

Table 2.5-3. Marine Water Quality Indicators for Effects Assessment

Indicator	Description	Potential Interactions with Project	Pathways
pH	Acid-base balance of water	Project activities may increase pH outside of natural range through runoff, deposition, and discharge	Runoff, deposition, discharge
TSS	Quantity of suspended material	Project activities may contribute particles to water column through in-water works, runoff, shipping activity, discharge and deposition	Runoff, deposition, discharge, physical
Nutrients	Chemical compounds that may contribute to aquatic plant and algal growth, and/or alter community structure	Project activities may contribute nutrients to marine environment	Runoff, discharge, physical
Metals	Metals suspended or dissolved in water	Project activities may contribute metals in runoff, discharge, shipping activity, and deposition	Runoff, deposition, discharge, physical
Hydrocarbons	Petroleum hydrocarbon compounds	Project activities may contribute hydrocarbons in runoff, discharge, or deposition	Runoff, discharge, deposition
BOD	Organic compounds that may enhance aquatic respiration and reduce oxygen concentrations	Project activities may contribute organic compounds and nutrients to waterbodies by discharge	Discharge
Tributyltin (TBT)	Compound used for antifouling treatments for ships	Shipping related to Project activities may transport TBT into the marine environment in the RSA	Contact
Salinity	Parameters describing the total salt content of water	Discharge of high salinity water from desalination plant may change environmental salt concentrations	Discharge

2.5.2 Potential Interactions with Project and Characterization

Project activities have the potential to influence the VEC marine water quality. Potential interactions between the Project and the VEC marine water quality were based on the matrix provided in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1) and further refined using the EIS guidelines (NIRB 2013) and professional judgement based on extensive experience at other similar projects in Nunavut and the Northwest Territories. Activities that will occur throughout the duration of the Project were considered for their potential interactions with the marine environment.

Table 2.5-4. Indicator Thresholds for Marine Water Quality Effects Assessment

Indicator	Parameter	CCME Guideline Concentration*
pH		7 – 8.7 pH units†
TSS		Narrative
Nutrients	Nitrate N	1,500 mg/L (short term) 200 mg/L (long term)
	Total P	Guidance framework
Metals	Arsenic	0.0125 mg/L
	Cadmium	0.12 mg/L
	Mercury	0.000016 mg/L
Hydrocarbons	Petroleum Hydrocarbons	*range of guidelines for petroleum hydrocarbon compounds (CCME 2013)*
Other indicators	Dissolved Oxygen	8.0 mg/L and narrative
	BOD	*no established CCME guideline*
	TBT	0.000001 mg/L
	Salinity	Narrative

** CCME Water Quality Guidelines for the Protection of Aquatic Life (CCME 2013).*
† Unless change in pH is demonstrated to be a result of natural processes.

The majority of Project interactions with the marine environment are likely to occur through non-point source pathways (e.g., runoff and shipping activities). Many of these pathways have the potential to vary substantially in timing and magnitude during the life of the Project. A qualitative effects assessment using conservative assumptions of Project effects with quantitative baseline environmental information was generally used for the effects assessment analysis.

The interactions of Project activities and the VEC marine water quality were grouped by related Project activities (termed Project interaction group), shared pathways to the marine environment, and shared key water quality indicators for the effects assessment (Table 2.5-5). For example, the construction of the construction of the collection pond at the MLA and clearing of vegetation for pad construction were grouped in the *Site Preparation, Construction, and Decommissioning Activities* Project interaction group because both activities will be occurring during similar stages of the Project and both activities have the potential to contribute the deposition of sediments in the near-shore marine environment through the pathway of runoff. The identified Project interaction groups are:

- *Shipping Activities* – activities related to the operation of marine shipping traffic, including antifouling compounds, wake effects, propeller wash, and ballast water discharge.
- *Site Preparation, Construction, and Decommissioning Activities* – Project activities that include the clearing of overburden, earthworks, and construction activities for pads and infrastructure.
- *Site Contact Water* – the runoff from Project infrastructure including pad areas, laydown areas, roads, and airstrips.
- *Winter Roads* – Project activities related to the construction and operation of winter roads.
- *Fuels, Oils, and PAHs (Polycyclic aromatic hydrocarbons)* – Project activities related to the storage of fuels, fueling and maintenance operations, and the combustion of waste.
- *Treated Discharges* – discharge of domestic water treatment and desalination facilities.
- *Dust Deposition* - Project activities that generate dust, including vehicle traffic, airstrip activity, and quarry and borrow pit activities that can then be deposited in marine receiving environments.

Table 2.5-5. Definition of the Components of the Project's Interactions with the VEC Marine Water Quality

		Project Interaction Group						
Project Phase	**Project Activity**	**Shipping**	**Site Preparation, Construction, Decommissioning Activities**	**Site Contact Water**	**Winter Roads**	**Fuels, Oils, and PAH**	**Treated Sewage Discharge**	**Dust Deposition**
Site Preparation and Construction	Machinery and vehicle refueling; fuel storage and handling					X		
	Winter Road				X			
	Sewage treatment plant and discharge	X					X	
	Landfill construction and solid waste management		X	X				X
	Chemical and hazardous material storage and management			X				
	Marine Laydown Area: on-land laydown areas and fuel storage		X	X		X		X
	In-water infrastructure		X					
	Marine transport of goods	X					X	
Operations	Road use and maintenance			X				X
	Winter Road				X			
	Sewage treatment and discharge						X	
	Solid waste management			X				
	Equipment maintenance, vehicle refueling, and fuel storage and handling			X		X		
	Chemical and hazardous material storage and management			X				
	Marine transport of goods	X						
Reclamation and Closure	Winter Road				X			
	Equipment maintenance, vehicle refueling, and fuel storage and handling			X		X		
	Marine Laydown Area reclamation		X					

The timing of Project activities were considered in the effects assessment by incorporating information on the magnitude of potential effects and the timing of mitigation and management measures. For example, once the collection pond is completed at the MLA, site contact water (e.g., runoff from site pad areas) will be diverted to the water management facilities and will not directly reach the marine environment. As a result, the assessment of effects from site contact water would be different in the Operations phase than during the Construction phase.

Pathway was the term used to describe the linkage between each Project interaction group and the VEC marine water quality. The five identified pathways for interactions between Project activities and the marine environment are:

- *runoff*, which describes the transport of material or compounds from the terrestrial environment into the marine environment by precipitation or snowmelt.
- *discharge*, which is the direct input of Project water into the marine environment.
- *contact*, which is the presence of Project-related infrastructure or vehicles (such as ships and barge) in the marine environment.
- *physical*, which is the direct physical effect of Project activities in the marine environment.
- *aerial deposition*, which is the direct input of material and chemical compounds from the air into the marine environment.

The pathways for each Project interaction group were identified (Table 2.5-6) and then used to describe the potential effects, identify mitigation and management measures, and characterize the residual effects from Project activities.

Table 2.5-6. Key Indicators of Project Activity Interactions with the Marine Water Quality for the Effects Assessment

Project Activity	Pathways	Indicators	Project Phases
Shipping activities (wakes, propeller wash, antifouling toxins, ballast water)	Physical, contact, discharge	TSS, nutrients, metals, hydrocarbons, TBT	Site Preparation, Construction, Operations, Reclamation and Closure
Site preparation, construction, and reclamation	Runoff, physical	pH, TSS, nutrients, metals, hydrocarbons	Site Preparation, Construction, Operations, Reclamation and Closure
Site Contact Water	Runoff, discharge	pH, TSS, nutrients, metals, hydrocarbons	Site Preparation and Construction, Operations, Reclamation and Closure, Temporary Closure, Care and Maintenance, Post-closure
Winter roads	Runoff	TSS, nutrients, metals	Site Preparation, Construction, Operations, Reclamation and Closure
Fuels, Oils, and PAH	Runoff, discharge, aerial deposition	TSS, hydrocarbons	Site Preparation, Construction, Operations, Reclamation and Closure
Treated Discharges	Discharge	TSS, nutrients, hydrocarbons, BOD	Site Preparation, Construction, Operations, Reclamation and Closure
Dust deposition	Aerial deposition	TSS and metals	Site Preparation, Construction, Operations, Reclamation and Closure

The potential effects for each of the Project activities listed in Tables 2.5-5 and 2.5-6 are characterized in Sections 2.5.2.1 to 2.5.2.8.

2.5.2.1 *Shipping Activities*

Vessel Wakes

The currents created by moving vessels have the potential to change marine water quality. The interaction between vessel wakes and the sediment environment is the physical pathway. The currents created by vessel wakes could disturb and rework sediments, which may cause changes in the water column concentrations of TSS, nutrients, and metals. Potential effects from vessel wakes may occur during the Site Preparation, Construction, Operations, and Reclamation and Closure phases.

Propeller Wash

Propellers create jets of water that can contact and disturb sediments. Like vessel wakes, propeller wash interacts with the marine environment through the physical pathway. The jets created by propellers could disturb and rework sediments, which may cause changes in the water column concentrations of TSS, nutrients, and metals. Potential effects from propeller wash may occur during the Site Preparation, Construction, Operations, and Reclamation and Closure phases.

Ballast Water Discharge

Ballast water is used to improve the stability of vessels when not fully loaded, and can be taken on in one port and discharged or exchanged in another. The pathway of interaction is discharge. Ballast water can contain TSS, nutrients, hydrocarbons, and metals. The discharge of ballast water has the potential to change water quality. Vessels will follow the Canadian regulatory requirements for the management of ballast water described in the Shipping Management Plan, Appendix A (Volume 10, Chapter 15). The effects of ballast water discharge were not considered further in this assessment.

Antifouling Agents

The hulls of ships historically have been treated with antifouling paints to prevent the buildup of sessile marine organisms that can increase drag, slow down the ship, and decrease fuel efficiency. Since its development in the 1960s, the use of tributyltin (TBT) became prevalent in antifouling paints used on the majority of international shipping. Leaching from these paints may cause increased concentrations of TBT in marine environments. Potential effects from ballast water discharge may occur during the Site Preparation, Construction, Operations, and Reclamation and Closure phases.

2.5.2.2 *Site Preparation, Construction, and Decommissioning Activities*

Ground preparation and limited in-water works will be required in the Site Preparation and Construction phases throughout the MLA to construct necessary Project infrastructure, including buildings, roads, and a small marine ramp. Site preparation will involve vegetation clearing, the removal and relocation of surficial materials, the creation of quarries and borrow pits, and the construction of pad areas from surficial material, borrow material, and quarried rock. The site preparation activities would also include the construction of water management structures, such as interception ditches, diversion structures, and berms to mitigate runoff, and earthworks for the collection pond at the MLA. Limited in-water and near-water works will take place with the construction of a small marine ramp and a seasonal dock. The decommissioning and reclamation of Project infrastructure during the Reclamation and Closure phase will similarly require surface contact and the transportation and relocation of surficial materials. The production of methylmercury will be negated by stripping and stockpiling organic material as part of site preparation and construction activities.

Landscape contact (ground works) has the potential for effects on the VEC marine water quality. The primary pathway for these potential effects would through runoff that could lead to siltation and physical in-water disturbance that could lead to sediment re-suspension into the water column. Runoff would occur primarily during snowmelt and freshet in the spring, during precipitation events in the summer and fall, and would be absent in the winter. In-water and near-water activities would occur during the open-water season.

Runoff from prepared and reclaimed areas could affect the VEC marine water quality by changing pH (interaction with surficial material), and contributing TSS (erosion and disturbance), metals (TSS and dissolution), nutrients (vegetation removal and blasting residue), and hydrocarbons (mechanical use of fuel, oil, and grease) into the marine environment.

2.5.2.3 *Site Contact Water*

Site contact water was defined as the runoff from snowmelt and precipitation events that interacts with site surfaces including roads, laydown areas, and buildings. The interaction between runoff and Project infrastructure could transport suspended material (siltation), metals, organic matter, and petroleum hydrocarbon compounds into the marine environment if not managed or mitigated. The potential for effects from site contact water could occur during all phases of the Project.

2.5.2.4 *Winter Roads*

Winter roads will be used to connect the MLA to the George Property Area, with approximately 14 km travelling along the western portion of southern Bathurst Inlet. Winter roads will be used in the Site Preparation, Construction, and Operations phases, and possibly in the Reclamation and Closure phase, and the pathways of interaction are through runoff. The construction of winter roads may affect vegetation cover along the shores of waterbodies, which could increase runoff and erosion. Marine water quality may be affected by the TSS, nutrients, and metals transported in the runoff.

2.5.2.5 *Fuels, Oils, and PAH*

The Fuels Project interaction group was defined as the Project activities that include the storage and transport of fuels and petroleum hydrocarbons, fueling and maintenance operations that have the potential for introducing hydrocarbons into the marine environment, and the incineration of waste that may create PAH by incomplete combustion. Up to 45 ML of fuel is expected to be stored on land at the MLA or off shore in vessels or barges during the Operations Phase (complete breakdown detailed in the Fuel Management Plan, Volume 10, Chapter 4). Fuel will be delivered via a sealift during the open-water season and transferred to on-shore storage facilities.

The primary pathways of interactions between these sources of hydrocarbons and the marine environment are runoff and aerial deposition. Activities at facilities, laydown areas, fuel storage areas, fueling stations, and waste management areas can deposit hydrocarbon compounds, such as oil or grease, onto surfaces that can subsequently be transported into the marine environment in runoff.

Combustible waste, including the solids from sewage treatment, will be combusted using an incinerator. Incomplete combustion can create airborne hydrocarbons that can be deposited into the marine environment via deposition or runoff.

The potential effects from fuels and other hydrocarbons on the VEC marine water quality may occur during the Site Preparation, Construction, Operations, and Reclamation and Closure phases.

2.5.2.6 *Treated Discharges*

Treated wastewater from camp domestic use will be treated and discharged to either a disposal pit (treated greywater) or to the terrestrial environment (treated sewage water). Vessels are to have an approved sewage treatment plant meeting Canadian standards (Shipping Management Plan, Volume 10, Chapter 15). Holding tanks with the capacity for all grey and treated sewage while in port are expected to be part of the ship's infrastructure. Sewage sludge from the sewage treatment plant can be incinerated in the on-board incinerator. Therefore, no sewage from vessels was anticipated to be discharged to the marine environment, and vessel wastewater discharges were not considered further in the effects assessment.

Potable water for domestic uses at the MLA will be provided by a desalination facility. The desalination facility will discharge brine as a product of the desalination process. The interaction pathway is discharge. Discharges could affect the VEC marine water quality by depositing organic material, hydrocarbon compounds, or brine salts to the marine environment. These discharges would take place during the Site Preparation, Construction, Operations, and Reclamation and Closure phases.

2.5.2.7 *Dust Deposition*

Dust can be generated by a variety of Project activities, including vehicle traffic, airstrip activities, blasting activities, and quarry operations. Areas cleared for infrastructure (i.e., laydown areas) can also be sources of dust. The aerial deposition of the Project-generated dust is the primary pathway of interaction. Dust deposition into the marine environment could affect the VEC marine water quality by introducing TSS and associated metals into the marine environment. The potential effects from dust deposition may occur during all phases of the Project. However, no residual effects from dust deposition were predicted in the Environmental Risk Assessment (Volume 8, Chapter 6), so no further assessment of potential dust deposition effects on the VEC marine water quality was conducted.

2.5.3 Identification of Mitigation and Management Measures

The following section details mitigation and management measures designed to reduce or eliminate adverse Project effects on the VEC marine water quality. If mitigation and management measures were considered entirely effective, potential Project-related effects to the VEC marine water quality were deemed negligible and not identified as residual effects. Once these were taken into account, any remaining residual Project effects on the VEC marine water quality were evaluated in Section 2.5.4.

Mitigation and management measures to eliminate or reduce Project effects on the VEC marine water quality included design and planning, engineered structures, the application of control technologies, Best Management Practices (BMPs), regulatory requirements, and monitoring and adaptive management. The relevant mitigation and management measures, including the spatial and temporal boundaries of the proposed actions, are considered and described for each Project activity in Sections 2.5.3.1 to 2.5.3.6.

The Aquatic Effects Management Plan (Volume 10, Chapter 19) contains the management plans that will be in place to reduce or eliminate potential effects to the marine receiving environment including marine water quality. The Site Water Monitoring and Management Plan (Volume 10, Chapter 7) is the key plan for site contact water. In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects from indirect sources (e.g., air quality). These mitigation and management measures will also serve to protect the marine environment including marine water quality. Details of these strategies as they directly and indirectly apply to the VEC marine water quality can also be found in the following DEIS chapters:

- Marine Sediment Quality (Volume 7, Chapter 3);
- Marine Fish/Aquatic Habitat (Volume 7, Chapter 4); and
- Air quality (Volume 4, Chapter 1).

Other management plans will also be implemented to protect the marine environment, details of which are found in the following chapters of Volume 10:

- Risk Management and Emergency Response Plan (Chapter 3);
- Fuel Management Plan (Chapter 4);
- Spill Contingency Plans (Chapter 5);
- Oil Pollution Emergency Plan (Chapter 6);
- Landfill and Waste Management Plan (Chapter 10);
- Incinerator Management Plan (Chapter 11);
- Hazardous Materials Management Plan (Chapter 12);
- Explosive Management Plan (Chapter 13);
- Road Management Plan (Chapter 14);
- Shipping Management Plan (Chapter 15);
- Borrow Pits and Quarry Management Plan (Chapter 16);
- Air Quality Monitoring and Management Plan (Chapter 17);
- Conceptual Fish Offsetting Plan (Chapter 21);
- Metal Leaching and Acid Rock Drainage Management Plan (Chapter 22); and
- Mine Closure and Reclamation Plan (Chapter 29).

2.5.3.1 *Shipping Activities*

<u>Vessel Wakes</u>

The physical interaction pathway will be mitigated by directly managing the Project activity. The potential effects of wakes by ships will be mitigated by reducing ship speed within the LSA and in areas with restricted depths in Bathurst Inlet.

The potential effects of vessels moving within Bathurst Inlet and the wider RSA were analyzed using an empirical equation developed by Kriebel, Seelig, and Judge (2003) to predict maximum ship-generated wake heights using a "modified Froude number". This approach successfully unified a high degree of variation in 1200+ data points from a wide range of vessel types. This equation is as follows:

$$gH/V^2 = \beta(F_*-0.1)^2(y/L)^{-0.33}$$

where the "modified Froude number" $F_*=F_L\exp(\alpha \times T/d)$
H = wake height
V = ship speed
y = distance from sailing line
L = length of ship

D = water depth
T = draft of ship
g = gravitational acceleration
F_L = length based Froude number = $V/(gL)^{0.5}$

where α and β are coefficients related to variation in shape of ships.

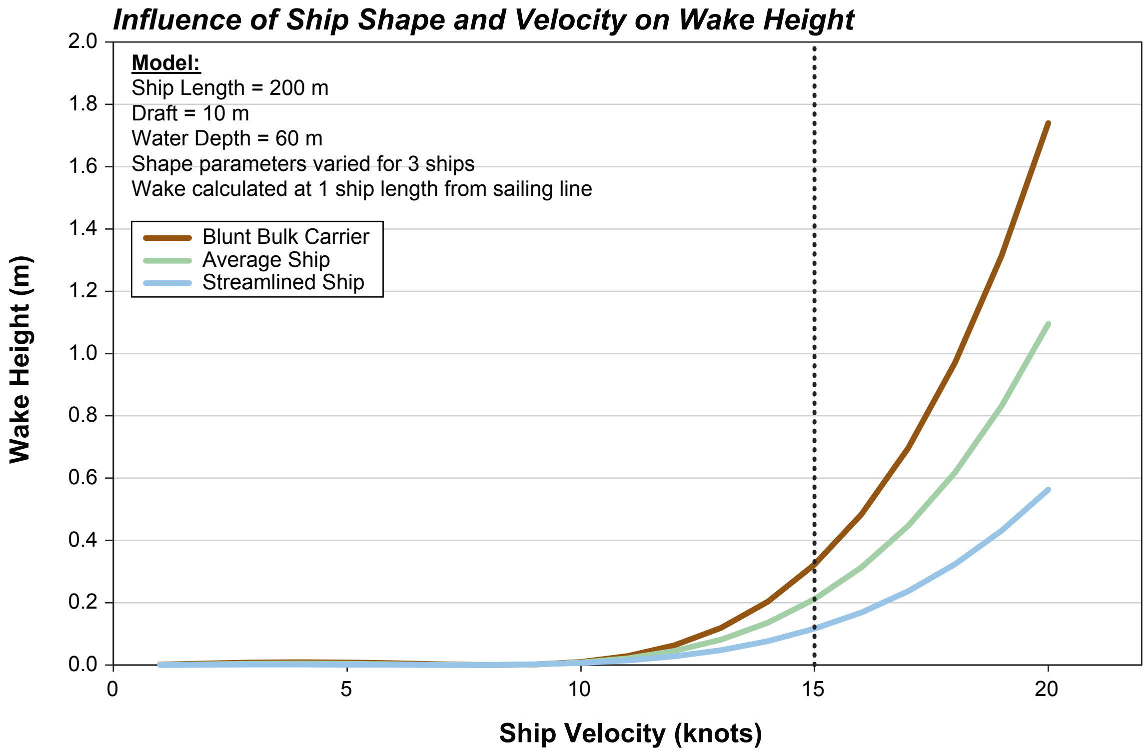
Using the above equations, maximum predicted wake heights were calculated for varying ship speed assuming a ship of 200 m length and 10 m draft, operating in 60 m of water depth. Ship shape parameters were set to a typical 30,000 DWT (deadweight tonnage) vessel with a blunt bow, and were varied to simulate "average" or "streamlined vessels" of the same dimensions (Figure 2.5-1A). Wake height is influenced by vessel speed and shape of ship, with the blunt bow vessel generating a wake of about 0.3 m at 15 knots (Figure 2.5-1A) decreasing to just over 0.1 m at 5 km from the sailing line (Figure 2.5-1B). Wakes were predicted to be mitigated substantially by a relatively modest reduction in ship speed; the bulk carrier operating at 10 knots would theoretically generate a wake of only 0.01 m at one ship length from the sailing line, declining to 0.003 m at 5 km.

Wind generated waves for Bathurst Inlet can be hind-cast from Cambridge Bay climate statistics, with average wind speeds of 5.5 to 6.4 m/s mainly from north and north-west. Wind speeds in excess 17.5 m/s occurred on average between 0.5 and 1.7 days per month between July and October. Direct measurements in Bathurst Inlet during the 2012 field season showed a persistent pattern of winds dominated by north and northwesterlies, and speeds typically in the range 2 to 7 m/s, sometimes exceeding 11 m/s, particularly from the north (Rescan 2012a). Maximum wave heights of ~1.2 m were observed in the physical oceanography baseline program in 2013 (Section 1.1.5.6, Physical Processes; Volume 7, Chapter 1). These observations agree with the analysis of Bornhold (2008) who suggested that sustained wind speeds in excess of 20 m/s and fetches of over 10 km could generate wave heights of approximately 1 to 3 m.

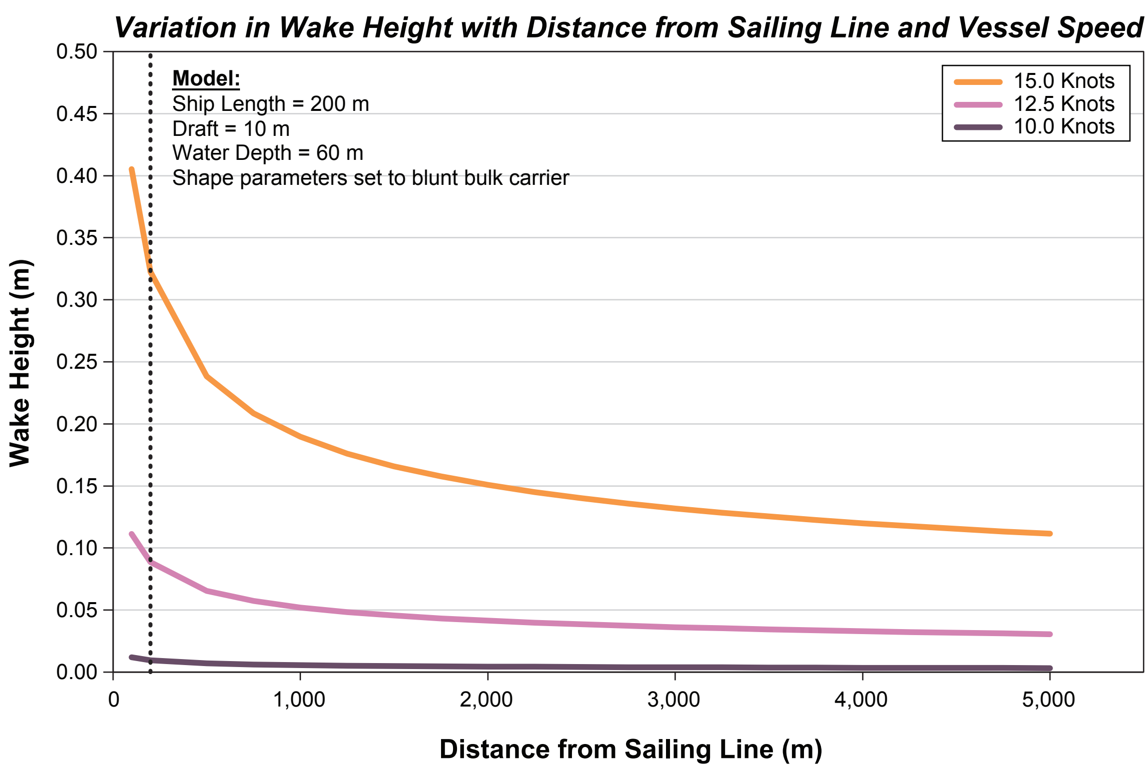
For the purpose of comparison of wakes with wind waves, the approach of Bornhold (2008) was adopted; the power of the calculated wake of height 0.3 m with wave periods of 2 to 8 s was between 0.18 and 0.70 kW/m, which was considerably lower than the power of between 2.92 and 4.87 kW/m for the observed wind-generated waves of 1.2 m height and wave periods of 2 to 5 s (Volume 7, Chapter 1).

The effect of ships wakes on shorelines was also examined using the concept of "closure depth", which is a measure of the depth (assuming a given grain size) to which wave reworking of sediments is significant (Bornhold 2008). Using the calculated ship generated wake of 0.3 m in height with wave periods of 2 to 8 s, a closure depth of between 0.53 and 0.67 m was calculated. This is lower than the closure depth of 1.5 to 2.0 m for wind waves of 1.0 m height and 2 to 5 s periods. The measure of closure depth assumes that wave conditions that result in changes in seafloor morphology occur over a minimum time period of 12 hours per year (Hallermeier 1981). However, Project-related shipping volume is projected to be low (10 vessels per year or less), and the resulting wakes will persist only for seconds or minutes each year. In contrast, wind-generated waves at least 1 m in height are likely to occur 1 day per month or more during open-water season.

Much of the worldwide concern for environmental effects of ship wakes have been associated with narrow channels such as rivers and estuaries, where wake effects become relatively amplified by proximity to the shore, and the reduced wind induced waves resulting from lack of fetch. In a river channel in Sweden of 8 m average depth (Althage 2010), wakes of the order of 0.2 to 0.4 m generated short-term increases (1 to 2 h) in turbidity averaging 3.3 NTU (range between 0 and 16.9 NTU). This is of the same order of magnitude of turbidity for the RSA, which averaged 3.02 (range between 0.52 and 17.9 NTU; see Table 3.2, Section 2.1.5.2).



Note: Dotted line shows typical speed of 15 knots for bulk carrier.



Note: Dotted line shows distance of one ship length from sailing line.

Figure 2.5-1

Modelled Wake Heights Generated by Ships

Sabina GOLD & SILVER CORP.

Rescan Engineers & Scientists

In short, episodic storm events are likely to generate waves of the order of 1 m or greater, on a time scale of hours or days per month, whilst wakes of 0.3 m in height generated by a 200 m length vessel operating at 15 knots would be generated on a timescale of minutes per month. Wake heights depend strongly on the speed of ship, and proximity to shore, and will be fully mitigated by reductions in vessel speed. Therefore, there are no predicted residual effects to the VEC marine water quality from vessel wakes.

Propeller Wash

The physical interaction pathway will be mitigated by directly managing the Project activity. The potential effects of propeller by ships will be mitigated by reduction in ship speed within the LSA and in areas with restricted depths in Bathurst Inlet. The potential for residual effects from propeller wash was predicted after the application of these mitigation and management measures.

Antifouling Agents

The contact interaction pathway will be mitigated by eliminating the potential for contact with the marine environment. The use of the anti-fouling agent TBT is banned under the *Canada Shipping Act* (2001). This ban extends to all Canadian ships, and to all ships operating in Canadian waters. Moreover, the International Convention on the Control of Harmful Anti-fouling Systems on Ships was brought into force in 2008 by the International Maritime Organization (IMO 2008). This convention prohibits the use of harmful antifouling paints on ships operating under the authority of member states, or requires a barrier coating to older underlying non-compliant treatments. Compliance with these regulations will prevent or minimize the introduction of TBT into marine environment of the LSA or RSA. Therefore, there are no predicted residual effects to the VEC marine water quality from antifouling agents.

2.5.3.2 *Site Preparation, Construction, and Decommissioning Activities*

The primary pathway of interaction between the Project activities in the Site Preparation interaction group and the marine environment is runoff. The proposed extensive mitigation and management measures will minimize the potential for erosion and the transport of material in runoff (Site Water Monitoring and Management Plan; Volume 10, Chapter 7), and involve project design, BMPs, and monitoring and adaptive management. Infrastructure has been designed to minimize footprint and therefore confines the potential influence on the marine environment to as small an area as possible. Infrastructure will be at least 30 m away from the marine environment. Infrastructure will be located, whenever feasible, on competent bedrock or appropriate base material that will limit permeability and transport of potentially poor quality water into the active layer or along surfaces, and ultimately to the marine environment. Only geochemically suitable rock quarries and borrow sources will be used to construct laydown areas and infrastructure (Metal Leaching and Acid Rock Drainage Management Plan, Volume 10, Chapter 22). The development and operation of borrow pits and quarries will be managed through the Borrow Pit and Quarry Management Plan (Volume 10, Chapter 16) and all site water will be managed through the Site Water Monitoring and Management Plan (Volume 10, Chapter 7).

The Project will also use BMPs drawn from governmental organizations and specific Arctic experience to minimize erosion and reduce the entrainment of potential chemical compounds into runoff (Fisheries and Oceans Canada 2009). As much as possible, erosion potential will be reduced by working during periods of low runoff, and activities scheduled to minimize the area of exposed landscape, and for progressive reclamation. Where possible, exposed landscape surfaces will be protected by re-vegetation, and by the installation of covering material like riprap, aggregate, or rolled erosion control products.

The primary mitigation to control site runoff will be the interception ditch that surrounds the MLA (Figure 2.4-1). Runoff may also be controlled by a combination of the following measures:

- installation of synthetic permeable barriers and/or fibre rolls to reduce runoff velocities and retain sediments;
- check dams, gabions, energy dissipation structures, and sediment basins to reduce flow velocities in channels;
- preservation of riparian zones to trap sediment and to reduce flow velocities;
- slope texturing/grading to slow runoff and reduce effect slope lengths; and
- stockpiles, laydown areas, and storage areas will be located well away, where feasible, from shoreline and within interception ditch perimeter.

Visual monitoring will be conducted by Environmental personnel on a regular basis to ensure drainage and erosion controls are effective. All necessary repairs and adjustments will be conducted in a timely manner. Once collected, all potentially poor-quality site water will be directed to interception ditches and to the collection pond. Water in the collection pond will be discharged at an approved location, and only if the water quality meets the future Type A Water Licence criteria. Non-contact water will be diverted around infrastructure, as much as feasible, and directed to the ocean.

The potential for in-water disturbance of sediments will be mitigated, where possible, by the use of silt curtains and by the monitoring and adaptive management of in-work activities to ensure TSS concentrations are within acceptable range of CCME water quality guidelines.

During wharf installation and in-water construction, vibrating pile-drivers may be used to minimize tremor effects. Although quarrying is not planned for the MLA, any potential quarries will be set-back at least 30 m from the marine shoreline, and potential and energy of blasting tremors will therefore be minimized.

The reclamation of the MLA will be managed through the Mine Closure and Reclamation Plan (Volume 10, Chapter 29). Changes to marine water quality from Project initiation to Reclamation and Closure will be monitored under the Site Water Monitoring and Management Plan (Volume 10, Chapter 7) and the Aquatic Effects Management Plan (Volume 10, Chapter 19). Previously designed and executed Aquatic Effects Management Plans have been shown to be effective at monitoring site activities at other Arctic projects (Rescan 2012b). Necessary repairs and adjustments to operations will be conducted as needed to ensure marine water quality does not surpass the CCME guidelines for marine water quality parameters and is maintained within baseline variability (Table 4.5-3; CCME 2013). The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis.

Potential residual effects from site preparation, construction, and decommissioning activities were predicted after the application of these mitigation and management measures.

2.5.3.3 *Site Contact Water*

Runoff is the interaction pathway for site contact water. The primary mitigation measure will be to intercept and divert site contact water before it reaches the marine environment (Site Water Monitoring and Management Plan; Volume 10, Chapter 7). Infrastructure will be designed such that its footprint is minimized to limit the changes to local drainage patterns. All roads and surfaces will be constructed using geochemically suitable material (i.e., non-acid-drainage-generating rock;

Metal Leaching and Acid Rock Drainage Management Plan, Volume 10, Chapter 22). Non-contact water will be diverted around infrastructure, as much as is feasible, and directed to natural downstream drainage networks to maintain local drainage patterns. Site contact water will be directed to a collection pond and will not contact the surrounding marine environment. Clean water and snow will be managed such that they do not contribute to potentially poor quality water and will be diverted to maintain natural drainage networks as much as possible. If soil, snow or ice contains potentially poor-quality water, they will be removed for appropriate disposal.

Monitoring and adaptive management will be used to ensure the goals of the Site Water Monitoring and Management Plan and Aquatic Effects Management Plan are met (Volume 10, Chapters 7 and 19). During construction, all contact water will be monitored and treated to meet CCME guidelines in the receiving environment. Regular inspections of water management facilities will be conducted by Environmental Personnel under the Site Water Monitoring and Management Plan (Volume 10, Chapter 7). The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis.

Potential residual effects from site contact water were predicted after the application of these mitigation and management measures.

2.5.3.4 *Winter Roads*

The interaction pathway for potential effects from winter roads on the VEC marine water quality is from runoff (during ice off). Project effects from winter roads through runoff will be mitigated by:

- being constructed during the winter months;
- application of the BMP for the construction of ice bridges and winter roads (Fisheries and Oceans Canada 2009);
- by the maintenance and repair of any potential leaks of fuels and petroleum hydrocarbons (Fuel Management Plan; Volume 10, Chapter 4); and
- the BMP for refueling and the operation of vehicles on the winter roads (Road Management Plan; Volume 10, Chapter 14).

The effects from winter roads on the VEC marine water quality through the runoff pathway were predicted to be negligible because winter road operations will be in compliance with regulations and guidelines. Thus, no residual effects from winter roads are predicted on the VEC marine water quality.

2.5.3.5 *Fuels, Oils, and PAH*

The fuels, oils, and PAH Project interaction group activities will interact with the marine environment through runoff and aerial deposition (for PAH). The potential effects from the storage and use of fuels, oils, and PAHs at the MLA will be mitigated according to the procedures detailed in the Fuel Management Plan and the Oil Pollution Emergency Plan (Volume 10, Chapters 4 and 6). Measures to control fuels in runoff will include:

- machinery will be, where feasible, routinely inspected for leaks and refuelling will occur at a designated refuelling point with drainage capture/collection installed. In the event that refuelling occurs elsewhere, drip trays may be used under vehicles and equipment;
- appropriate secondary containment systems may be used for petroleum product storage tanks to prevent spills and releases to water, including the prevention of diesel release from pickups carrying tidy-tanks;

- bulk fuel storage areas and hazardous materials storage areas will be bermed and lined with impermeable barriers to minimize leaks and spills; and
- Oily water treatment plants at equipment maintenance facilities may be used to minimize water and surface hydrocarbon compounds.

In the event that hydrocarbons are transported in runoff from camp pads, laydown areas, and waste management areas, the runoff will be intercepted and directed to the MLA collection pond and will not be discharged into the marine environment unless it meets receiving water quality standards. Fuels, oils, and PAHs will be managed under the Fuel Management Plan (Volume 10, Volume 4), the Oil Pollution Emergency Plan (Volume 10, Chapter 6), and the Hazardous Materials Management Plan (Volume 10, Chapter 12). Spills will be managed under the Spill Contingency Plans (Volume 10, Chapter 5).

Bulk fuel storage areas, hazardous materials storage areas, and explosives storage facilities will be bermed and lined with impermeable barriers to minimize leaks and spills reaching the marine environment. The bulk fuel storage facility and all transfer-related equipment will be inspected and maintained, with complete documentation. The mitigation and management measures for fuel transfers are detailed in the Fuel Management Plan (Volume 10, Chapter 4).

For the aerial deposition pathway, the primary mitigation measure will be the efficient operation of the incinerator (Incineration Management Plan; Volume 10, Chapter 11). The operation of the incinerator will comply with Nunavut guidelines (Government of Nunavut 2012), Canada-Wide Standards for Dioxins and Furans (CCME 2001) and Canada-Wide Standards for Mercury Emissions (CCME 2000). Management measures will include the following:

- a waste segregation program will be implemented (i.e., materials that are unsuitable for incineration, e.g., chlorinated plastics, will be diverted to alternate waste disposal facilities);
- personnel will be properly trained in incinerator operations; and
- stack testing during commissioning and adaptive management to ensure compliance with standards.

Project activities related to fuels and other petroleum hydrocarbons were predicted to have negligible effects on the VEC marine water quality through the runoff and aerial deposition pathways because of the proposed mitigation and management measures. No hydrocarbon compounds or sediments from Project activities in the MLA camp, laydown areas, fuel areas, or waste storage areas were predicted to reach the marine environment because of the BMPs for vessel operations, fuel transfers, machinery operation, maintenance, and fueling. The incinerator will be operated according to guidelines and standards, and therefore negligible aerial deposition of PAH into the marine environment were predicted. The potential effects from spills along the shipping route to marine water quality are assessed in the Accidents and Malfunctions chapter (Volume 9). Therefore, no residual effects from fuels, oils, and PAHs are predicted on the VEC marine water quality.

2.5.3.6 *Treated Discharges*

Discharge of brine water to surface water in Bathurst Inlet will meet CCME salinity guideline for the protection of marine life and will not cause the salinity of the receiving environment to fluctuate by more than 10% of the natural expected salinity (Appendix V7-2A; CCME 2013).

Discharge of effluent will be mitigated by project design; there will be no direct discharge of treated sewage effluent or camp greywater to the marine environment. Sewage will be treated, and then discharged on land or backhauled.

It is anticipated there will be no residual effects from treated discharges on the VEC marine water quality due to the application of the mitigation and management measures.

2.5.4 Characterization of Residual Effects

In Section 2.5.3, seven potential effects were evaluated for whether they would result in residual effects after mitigation. Residual effects are those effects predicted to remain after the application of mitigation and management. Three of these potential effects were identified as residual effects: 1) *shipping activities* (*propeller wash*); 2) *site preparation, construction, and decommissioning activities*; and 3) *site contact water*. The significance of these residual effects is evaluated below. Each residual effect is described in this section in terms of eight descriptors (Volume 9, Chapter 1), including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability, and confidence. The magnitude of the residual effect was evaluated by using the information in Table 2.5-1. Table 2.5-2 provides a description of the significance ratings used for residual effects.

2.5.4.1 *Shipping Activities*

Ship Propeller Wash

The wash from propellers of large vessels can be large enough to disturb marine sediments, with potential effects on introduction of TSS into the water column, and exchange of nutrients and metals. To estimate the potential significance to Bathurst Inlet, maximum bottom velocities in the propeller wash of a maneuvering vessel have been calculated using the equations of Maynord (1998):

Jet velocity (U_0) of water exiting a propeller:

$$U_0 = C \times [P_d / D_p^2]^{0.33}$$

and the maximum velocity ($V_b$max) of the propeller wash on the sea bottom:

$$V_b(max) = CU_0D_p/H_p$$

Where U_0 = jet velocity of water exiting the propeller (feet/sec)
$V_b(max)$ = maximum bottom velocity
D_p = propeller diameter in feet
H_p = distance from propeller shaft to channel bottom
P_d = applied engine power/propeller in (hp)
C_1 = 0.30, and C_2 =7.68 for ducted propellers (Maynord 1998)

A vessel displacement of 30,000 DWT was assumed, with 10,000 hp engine power and a 5 m diameter propeller. The outputs of the calculations were then converted into metric units. The applied engine power to the propeller is one of the more difficult parameters to estimate (Maynord 1998), and so bottom velocities were calculated for a range of 10 to 100% available engine power.

With sand mobilized in bottom sediments at a water velocity of approximately 0.25 m/s, sediment re-suspension is unlikely to occur at the average depths of Bathurst inlet (60 m or greater), where such a vessel operating at full power would generate bottom water velocities of the order of 0.19 m/s or less. A vessel operating between 10 and 50% of full power could mobilize sediments to some extent above approximately 20 m to 35 m depth (Figure 2.5-2). Although tidal movements are relatively weak in Bathurst Inlet, the predominantly wind-driven currents are typically between 0.05 and 0.35 m/s, and in shallower waters can exceed 0.9 m/s (Rescan 2012a). The estimated velocities of propeller wash deeper than 10 to 20 m are therefore of the same order or less as those observed for wind-driven currents during the open-water season. In the shallower waters in the LSA (< 20 m), the maneuvering of vessels is more likely to produce bottom velocities greater than naturally observed currents, even when mitigated by reduced engine power (Figure 2.5-2). Here, some sediment mobilization and exchange with the water column may be observed.

Although natural levels of chromium, arsenic and copper were greater than the CCME sediment quality guidelines in some mid-shore and offshore sediments (Volume 7, Chapter 3), concentrations of arsenic, cadmium and chromium were also greater than CCME guidelines in a small number of water quality samples. Therefore, the concentration of these metals in the water column can be naturally high and unlikely to be significantly increased by mixing processes with these sediments. Furthermore, propeller wash could create some localized increases in the concentration of TSS and nutrients into near surface waters. For all indicators, the predicted magnitude of the residual effect is l*ow* because concentrations will likely be less than the CCME guidelines or within baseline levels. However, these processes would occur within the footprint (the PDA) or *local* (restricted to the LSA), and would occur only *sporadically* with less than one ship per week, on average, projected for the open-water season. These sporadic incidences of propeller wash in the LSA would potentially occur during vessel operations throughout the Construction, Operations, and Reclamation and Closure phases, and therefore the duration was *medium-term*. The potential residual effects from propeller wash were predicted to be fully *reversible* because sediment is naturally re-suspended by waves and currents in the shallow, near-shore area, and any addition re-suspension caused by propeller wash would be reversed by the same natural processes.

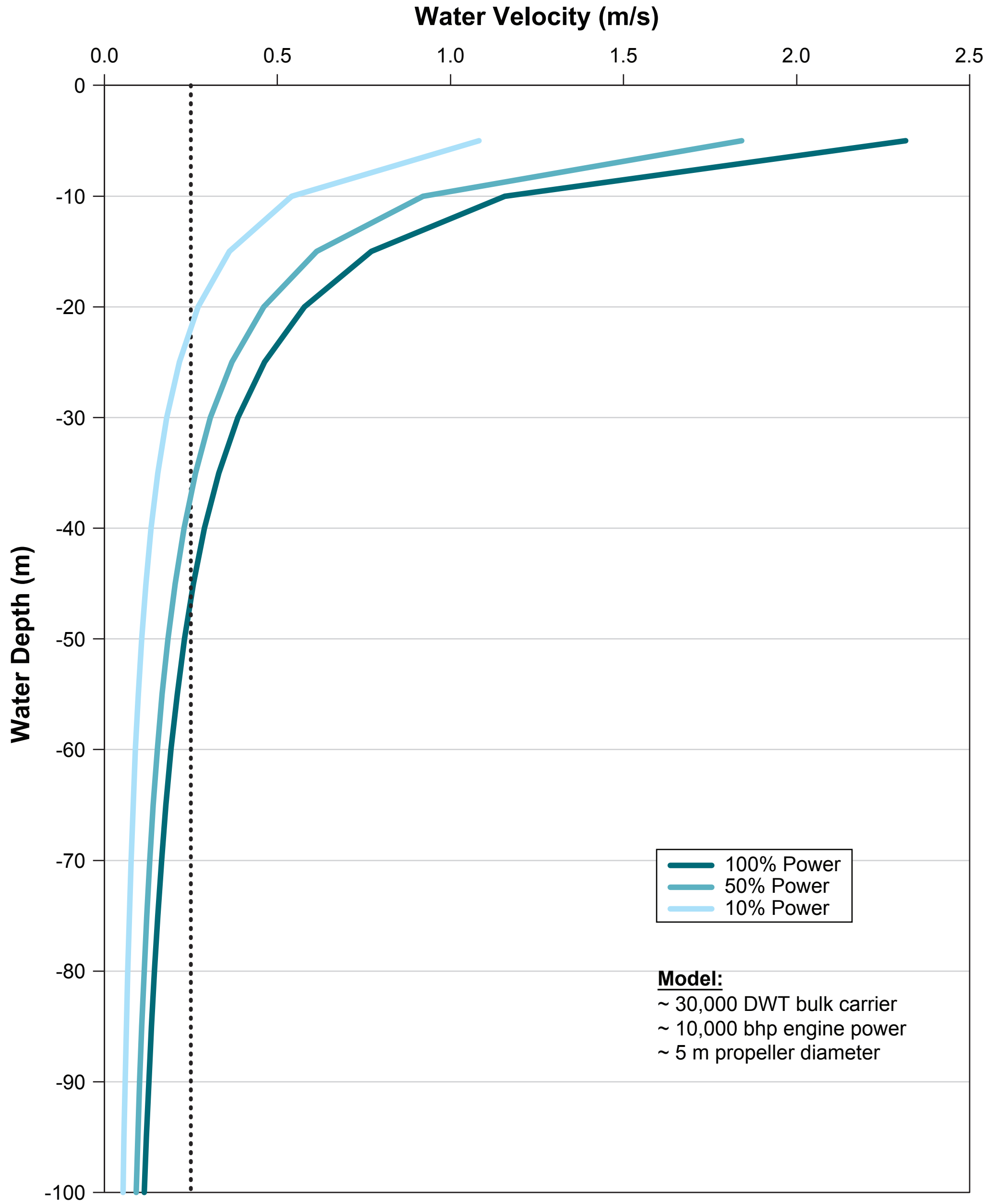
The probability of occurrence was estimated to be *moderate*, and confidence was *high* because of the quantitative input from the baseline environmental data and the confidence in the mitigation and management strategies.

The residual effect of propeller wash on the VEC marine water quality is predicted to be **Not Significant**.

2.5.4.2 *Site Preparation, Construction, and Decommissioning Activities*

The mitigation and management measures were predicted to effectively minimize the potential effects from runoff associated with site preparation, construction, and decommissioning activities. The use of only geochemically suitable material for construction of roads and pads will eliminate the potential for acid-rock drainage (Metal Leaching and Acid Rock Drainage Management Plan; Volume 10, Chapter 22). The proposed mitigation and management measures will minimize the quantity of material transported in runoff (e.g., TSS, metals) and the likelihood of runoff reaching the marine environment. Some runoff into nearby waterbodies could be possible during the early stages of site preparation and construction (Site Preparation and Construction phases) before water management structures are fully operational (e.g., collection pond, and diversion ditches). Once the water management structures are in place, any runoff from cleared areas is expected to be fully mitigated.

Only small amounts of runoff would be expected to reach the marine environment in the PDA while the water management features are being constructed. The extensive mitigation and management measures incorporating design, BMPs, and adaptive management were predicted to minimize the transport of sediments through runoff. The predicted magnitude of the residual effect was *low*. Therefore, the residual effects on the VEC marine water quality from site preparation, construction, and decommissioning activities were predicted to be within natural variation for the indicators of marine water quality.



Note: dotted line shows typical velocity (0.25 m/s) for mobilisation of sand.

Figure 2.5-2

Depth Variation in Modelled Water Velocity Generated by Propeller Wash

The overall effects of site preparation, construction, and decommissioning activities were predicted to be footprint (within the PDA) or *local* (restricted to the LSA), *short-term* in duration, and *sporadic* as runoff would only occur during snowmelt and episodic large precipitation events and vibrations would only occur during pile-driving operations. The marine environment was predicted to be *resilient* and the effects were predicted to be fully *reversible*. The probability of occurrence was estimated to be *moderate* due to the uncertainties related to precipitation that would result in runoff, and confidence was *moderate* because of the quantitative baseline environmental data, the predictable nature of the potential effects, and the confidence in the mitigation and management strategies.

The residual effect of site preparation on the VEC marine water quality is predicted to be N**ot Significant**.

2.5.4.3 *Site Contact Water*

The mitigation and management measures were predicted to effectively minimize the potential effects from runoff associated with site contact water. Project activities will occur when the site water management infrastructure is not functional (e.g., before commissioning during the Site Preparation and Construction phases). Some runoff into the marine environment could be possible during this period. In the event that site contact water did contact the marine environment, the water quality indicators were predicted to be within the range of natural variation and within CCME water quality guidelines. Once the site water management infrastructure is complete (Site Water Monitoring and Management Plan; Volume 10, Chapter 7), all site contact water will be diverted to the collection pond and will only contact the marine environment if it meets the CCME water quality guidelines.

Any site contact water that reaches the marine environment was predicted to meet the CCME water quality guidelines. Therefore, the predicted magnitude of the residual effect was *low*. The effects were predicted to be footprint (within the PDA) or *local* (restricted to the LSA), *medium-term* in duration, and *sporadic* because the timing of site contact water reaching the marine environment will depend on the timing of snowmelt and large precipitation events. The marine environment was predicted to be *resilient* and the effects were predicted to be fully *reversible*. The probability of occurrence was estimated to be *moderate* due to the uncertainties related to precipitation, and confidence was *high* because of the quantitative input from the baseline environmental data and the confidence in the mitigation and management strategies.

The residual effect of site contact water on the VEC marine water quality is predicted to be **Not Significant**.

2.5.5 Significance of Residual Effects

Three residual effects for the VEC marine water quality were assessed and resulted in the following significance ratings:

- Shipping (propeller wash) – rated Not Significant;
- Site Preparation, Construction, and Decommissioning Activities – rated Not Significant; and
- Site Contact Water – rated Not Significant.

The criteria used in the determination of the significance of each residual effect is detailed in Section 2.5.4 and summarized in Table 2.5-7.

Table 2.5-7. Summary Table of Predicted Residual Effects on the VEC Marine Water Quality and Overall Significance Rating

Description of Residual Effects	Project Phase	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
		Direction	Magnitude	Duration	Frequency	Extent	Reversibility	Probability	Confidence	Significance
Shipping – Propeller Wash	Construction, Operations, Reclamation and Closure	Negative	Low	Medium-term	Sporadic	Local	Reversible	Moderate	High	Not Significant
Site Preparation	Site Preparation, Construction, Reclamation and Closure	Negative	Low	Short-term	Sporadic	Local	Reversible	Moderate	High	Not Significant
Site Contact Water	Site Preparation, Construction, Reclamation and Closure	Negative	Low	Medium-term	Sporadic	Local	Reversible	Moderate	High	Not Significant

2.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

2.6.1 Methodology Overview

The potential for cumulative effects arises when residual effects of the Project affect (i.e., overlap and interact with) the same resource/receptor that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities. When residual effects were identified for the Project, the Cumulative Effects Assessment (CEA) followed the process detailed in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1) and was comprised of the following steps:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For marine water quality, the boundary was the Project-related effects assessment on the marine water quality RSA (Figure 2.4-1).
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

The cumulative residual effects were analyzed using the same criteria as the Project-related effects assessment (Section 2.5.1): direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions. The magnitude of potential cumulative effects applied the same criteria as the Project-related effects assessment (Table 2.5-1). Using a weight of evidence and relative ranking approach, combined with best professional judgement, the cumulative residual effect was characterized as significant, not significant, or positive in the same manner as the Project-related effects assessment (Table 2.5-2).

Past, existing, and reasonably foreseeable major projects with potential residual effects that occur within the RSA for the VEC marine water quality were considered and are listed in Table 2.4-1 in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1). The list includes projects within Nunavut and the Northwest Territories to consider the outermost spatial boundary, and reflects a comprehensive evaluation of potential interactions. As per the EIS guidelines (NIRB 2013), the list of projects considered conforms to the requirement to consider a larger spatial boundary for the CEA as well as a longer temporal scale.

The expected timing and duration of Project-related residual effects was compared with that of residual effects from other past, existing, and future human activities to identify temporal overlap. As identified in the EIS guidelines (NIRB 2013), a longer timeline than the development and operations phases of the Project were considered.

2.6.2 Potential Interactions of Residual Effects with Other Projects

The following residual Projects effects on the VEC marine water quality were identified:

- Shipping (propeller wash);
- Site preparation, construction, and decommissioning activities; and
- Site contact water.

The spatial boundary of the CEA is the marine water quality RSA (see Section 3.4.1). The temporal boundary for the CEA is any past, present, or reasonably foreseeable future projects (see list of projects in Volume 9, Chapter 1). The projects that could interact with the Back River Project marine water quality residual effects are the proposed Bathurst Inlet Port and Road (BIPR) project and the proposed Hackett River project. Both projects propose seasonal shipping traffic through Bathurst Inlet to a port site ~30 km south of the MLA. There is no predicted spatial overlap between the Project residual effects that were confined to the marine water quality LSA and any potential effects from the BIPR and Hackett River projects that would be confined to the proposed shipping corridor in the middle of Bathurst Inlet. Therefore, no potential cumulative effects on the VEC marine water quality were predicted.

2.7 TRANSBOUNDARY EFFECTS

Transboundary effects may be expected to occur if residual effects from the Project were identified and extend beyond the LSA. However, all residual effects to the VEC marine water quality were confined to the LSA, which lies entirely within Nunavut. Therefore, no transboundary residual effects from Project activities on the VEC marine water quality were predicted.

2.8 MITIGATION AND ADAPTIVE MANAGEMENT

Mitigation and management measures will be used to eliminate or minimize Project effects on the marine environment. The measures include mitigation by Project design, conformity to existing regulations and guidelines, BMPs, and the application of monitoring and adaptive management plans. The specific mitigation and management measures for marine water quality are shown in Table 2.8-1.

Table 2.8-1. Mitigation and Adaptive Management Measures for Potential Project Effects on Marine Water Quality

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	
	Only geochemically suitable rock quarries and borrow sources will be used to construct roads, pads, and structures
	Contact water will be directed to the collection pond (MLA).
	Infrastructure will be located, whenever feasible, on competent bedrock or appropriate base material that will limit permeability and transport of potentially poor quality water into the active layer, and ultimately to the marine environment
	The Project has been designed to use winter road only access corridors thereby limiting dust emissions and hence the potential influence on water and sediment quality
	Erosion potential will be reduced by working during periods of low runoff as much as possible.
	Ships will be conventional double-hulled, compartmentalized petroleum tankers, with Shipboard Oil Pollution Emergency Plans and appropriate response gear.
	Water will be recycled / reused where possible.
2. Regulatory Requirements	
	The operation of incinerators will comply with Nunavut standards, Canada-Wide Standards for Dioxins and Furans and Canada-Wide Standards for Mercury emissions. Modern incineration equipment will be installed to minimize airborne contaminant loading of polycyclic aromatic hydrocarbons.
	Adherence to guidelines for vessel discharges and anti-fouling surface treatments; • Organotin compounds are prohibited for vessels in Canadian waters. • Vessels must treat sewage prior to discharge, or discharge offshore. • Vessels travelling in international water must exchange ballast water offshore.

(continued)

Table 2.8-1. Mitigation and Adaptive Management Measures for Potential Project Effects on Marine Water Quality (continued)

Mitigation Category	Mitigation Measures
2. Regulatory Requirements *(cont'd)*	
	Ships will carry out their operations in accordance with federal and international Transport of Dangerous Goods Regulations (International Maritime Dangerous Goods), including the *Transportation of Dangerous Goods Act* (1992) and the *Canada Shipping Act* (2001).
	The bulk fuel storage facility and all transfer-related equipment will be inspected and maintained, with complete documentation.
	Culvert maintenance will be conducted following the DFO Nunavut Operational Statement for Culvert Maintenance (Fisheries and Oceans Canada 2009).
	In-water work will be conducted during approved timing windows presented in the DFO Nunavut Operational Statement for Timing Windows (Fisheries and Oceans Canada 2009).
	Winter road construction will follow the DFO Nunavut Operational Statement for Ice Bridges and Snow Fills (Fisheries and Oceans Canada 2009).
	Water withdrawal will follow permit conditions.
3. Best Management Practices	
	Clean water and snow will be managed such that they do not contribute to potentially poor quality water and be diverted to maintain natural drainage networks as much as possible.
	Potentially poor quality site water will be directed to the collection pond (MLA).
	Sewage will be treated and treated sewage effluent will be discharged on land. There will be no direct discharge of treated sewage effluent or camp greywater to the marine environment.
	The discharge of brine water to Bathurst Inlet will be designed such that the salinity of Bathurst Inlet waters will remain within natural variability or CCME guidelines in any sensitive marine areas.
	Water in the collection pond (MLA) will be discharged on the tundra, and only if the water quality meets the future water license criteria
	Bulk fuel storage areas, hazardous materials storage areas, and explosives storage facilities will be bermed and lined with impermeable barriers to minimize leaks and spills.
	Modern incineration equipment will be installed to minimize airborne contaminant loading of dioxins, furans, and polycyclic aromatic hydrocarbons.
	Non-contact water will be diverted around infrastructure, as much as feasible, and directed to natural downstream drainage networks.
	Oily water treatment plants at equipment maintenance facilities will be used to minimize water and surface hydrocarbon contaminants.
	Disposal of excavated material will be in a location above the high water mark to ensure that this material does not enter the marine environment.
	Efforts shall be made to minimize the duration of any in-water works and minimize disturbance of riparian vegetation.
	Prevent the release of sediment or sediment laden water into water frequented by fish.
	Regular inspections will be conducted to ensure erosion and sediment control measures are functioning properly; all necessary repairs and adjustments will be conducted in a timely manner.
	Exposed landscape surfaces will be protected, where possible, by the installation of covering material like riprap, aggregate, or rolled erosion control products.
	If water held in control devices is turbid but chemically-unaltered, it may infiltrate to the ground rather than storing it in an excavation.

(continued)

Table 2.8-1. Mitigation and Adaptive Management Measures for Potential Project Effects on Marine Water Quality (continued)

Mitigation Category	Mitigation Measures
3. Best Management Practices ***(cont'd)***	
	Runoff will be controlled, where applicable, by a combination of measures, which include: • slope texturing/grading to slow runoff and reduce effect slope lengths; • installation of synthetic permeable barriers and/or fibre rolls to reduce runoff velocities and retain sediments; and • check dams, gabions, and energy dissipation structures to reduce flow velocities in channels.
	Sediment loading in runoff may be minimized by the application of measures to intercept TSS before it reaches the marine environment. Sediment control measures may include: • preservation of riparian zones to trap sediment and to reduce flow velocities; and • stockpiles will be located well away from watercourses.
	Visual monitoring will be conducted by the Environmental personnel on a regular basis to ensure drainage and erosion controls are effective.
	Both the ship and the MLA spill response equipment and personnel will be prepared for deployment prior to fuel transfer operations.
	Environmental personnel will check for surface sheens in marine habitat during fuel transfer.
	Speed limits will be followed for vessel operations to minimize propeller wash and wake effects.
	The Oil Pollution Emergency Plan will describe the response and clean-up measures, which will include: • measures to protect personnel; • communication, spill response management, and reporting structures; • description of the spill containment and skimming equipment and deployment plans; and • training and auditing programs.
	Construct ice bridge and snow fill approaches using clean, compacted snow and ice to a sufficient depth to protect banks of lakes, rivers or streams.
	Vehicular access across a watercourse or waterbody will be by road or bridge, or other acceptable method according to DFO Operational Statements and Standards and Best Practices for Instream Works (Fisheries and Oceans Canada 2009).
	All temporary works, silt curtains, construction material or debris, etc. are to be completely removed from the waterway when work is completed.
	Appropriate secondary containment systems will be used for petroleum product storage tanks to prevent spills and releases to water. This includes prevention of diesel release from pickups carrying tidy-tanks.
	Refueling and maintenance activities will not occur, where feasible, within 30 m of a watercourse or waterbody except where required due to equipment breakdown or approved activities near water.
	Refueling will occur, where feasible, at a refueling point with drainage capture/collection installed, in the event that refueling occurs elsewhere, drip trays may be used under vehicles and equipment.
4. Adaptive Management	
	The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include: • if results from the Surveillance Network monitoring program (which will be outlined in the future Type A Water License) show non-compliance; or • if results from the Aquatic Effects Monitoring Program, which will monitor the receiving environment around the mine infrastructure and activities, show adverse effects to the marine environment.

(continued)

Table 2.8-1. Mitigation and Adaptive Management Measures for Potential Project Effects on Marine Water Quality (completed)

Mitigation Category	Mitigation Measures
5. Monitoring	
	An Aquatic Effects Monitoring Plan will be in place that outlines the Aquatic Effects Monitoring Program (AEMP) that will be carried out during all phases of the Project. The AEMP will include the following: • monitoring the marine environment at locations potentially affected by the Project and at reference areas well away from Project activities; • monitoring marine water quality, sediment quality, and aquatic biology; • monitoring fish populations and shellfish tissues.
	Regular inspections of water management facilities will be conducted by Environmental Personnel.
	There will be a Site Surveillance Network Monitoring Program that will be outlined in the future Type A Water License. This Program will consist of all of the site compliance monitoring that will be required for managing/moving and releasing water from all potential containment areas.

Mitigation and management measures for other aspects of the Project, such as air quality and site water management, are detailed in Volume 10 of the DEIS and in the following plans:

- Site Water Monitoring and Management Plan (Volume 10, Chapter 7);
- Fuel Management Plan (Volume 10, Chapter 4);
- Spill Contingency Plan (Volume 10, Chapter 5);
- Landfill and Waste Management Plan (Volume 10, Chapter 10);
- Incineration Management Plan (Volume 10, Chapter 11);
- Hazardous Materials Management Plan (Volume 10, Chapter 12);
- Explosives Management Plan (Volume 10, Chapter 13);
- Road Management Plan (Volume 10, Chapter 14);
- Borrow Pits and Quarry Management Plan (Volume 10, Chapter 16);
- Air Quality Monitoring and Management Plan (Volume 10, Chapter 17);
- Metal Leaching and Acid Rock Drainage Management Plan (Volume 10, Chapter 22); and
- Mine Closure and Reclamation Plan (Volume 10, Chapter 29).

2.9 PROPOSED MONITORING PROGRAMS

2.9.1 Conceptual Aquatic Effects Management Plan

The Aquatic Effects Management Plan describes the specific measures that will be taken to minimize or eliminate potential adverse effects on the marine environment. The Plan includes the following components:

- planning and implementation processes for the Plan, including personnel and their responsibilities;
- mitigation and adaptive management measures;

- the Aquatic Effects Monitoring Program (AEMP); and
- processes for adaptive management, checking, recordkeeping, reporting, and QA/QC.

The AEMP will monitor the freshwater and marine environments around Project infrastructure and activities at a network of sites located in streams, lakes, and the near-shore marine environment. The sites were chosen on the basis of their proximity to Project activities and their suitability as sentinel sites in the monitoring program. Appropriate freshwater and marine reference sites were also identified to distinguish potential Project-related effects from natural processes. The AEMP will measure key physical, chemical, and biological parameters to determine if existing mitigation and management measures are adequate and will provide an opportunity for adaptive management on an annual basis. The program is designed for provide adequate spatial and temporal coverage to accurately identify and characterize any Project-related effects.

2.10 IMPACT STATEMENT

Eight potential effects were identified for the VEC marine water quality as a result of the Project: shipping activities; site preparation, construction, and decommissioning activities; site contact water; winter roads; explosives; fuels, oils, and PAH; treated discharges; and dust deposition. Potential effects were characterized by using key indicators of marine water quality and quantitative thresholds for predicted effects as well as experience from other Northern projects and best professional judgement. Mitigation and management measures were described and their effectiveness was evaluated in the process of identifying residual effects. Three residual effects were identified after mitigation and management:

- Shipping (propeller wash);
- Site preparation, construction, and decommissioning activities; and
- Site contact water.

Using the thresholds identified for the key indicators, each of these residual effects were rated with *low* magnitude and ultimately were rated as Not Significant because of the implementation of the extensive mitigation and management measures outlined in the Aquatic Effects Management Plan (Volume 10, Chapter 19) and in other management plans in Volume 10. All residual effects to marine water quality were predicted to be restricted to the LSA. Residual effects are expected to be reversible with water quality returning to baseline conditions because of the resiliency of the marine environment to the predicted residual Project effects.

No interactions between other past, present, or future projects and the Back River Project marine water quality residual effects were expected and no cumulative effects were predicted to occur.

3. Marine Sediment Quality

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3. Marine Sediment Quality

3.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

3.1.1 Overview and Regional Setting

The proposed Back River Project (the Project) lies in western Nunavut in the continuous permafrost zone of the continental Canadian Arctic. The Project area is composed of three main areas; the Goose Property Area, the George Property Area and the Marine Laydown Area (MLA; Figure 3.1-1). The Project will sealift materials and supplies through Bathurst Inlet during the open-water season to the MLA located on the western shore of southern Bathurst Inlet.

Bathurst Inlet itself is a long fjord (~165 km) that is narrow (~2 to 15 km) and deep (>300 m). It is divided into two major basins separated by a shallow sill midway along the inlet. The outer inlet is the deeper of the two basins and contains many islands and complex bathymetry. The inner inlet runs landward from near Kingaok, has a relatively simple structure with few islands, and is shallower than the outer inlet, with depths between 100 and 150 m. The Western River discharges into the head of the inlet at the south, and the Mara River and Burnside River discharge into the western shoreline of the inlet. Numerous small streams discharge into the inlet along the eastern and western shorelines.

Bathurst Inlet cuts through the Bathurst Hills Ecoregion that is characterized by strong relief built from massive granite rocks. The deeply indented, rocky shorelines lead to steep bathymetry with narrow near-shore areas. Winter is characterized by extreme cold (mean monthly temperatures -33°C), and ice cover is generally present from November to July. Air temperatures are highest in July, reaching a mean monthly temperature of 14°C. Regional meteorological stations report total annual precipitation between 125 mm (2009) to 344 mm (2007) for the interval 2006 to 2012 (see Volume 4, Chapter 3 for additional information). The long cold winters promote the formation of sea-ice across the Inlet, which is typically ice-covered from October through June with up to 2 m of ice (Rescan 2008b).

Mean annual temperature may increase in Canada's North by approximately 2.0ºC for the climate normal period for the years 2010 to 2030 (Volume 4, Chapter 3). Over the same time periods, projections suggest that total annual precipitation could increase from 5 to 8% (Lemmen et al. 2008). The projected increase in mean annual air temperatures would lead to effects on the regional cryosphere. This would likely include alterations to sea, river, and lake ice regimes, permafrost conditions, and winter snow pack, especially during the shoulder seasons of spring and fall.

3.1.2 Proximity to Designated Environmental Areas

No existing or proposed parks or conservation areas are in, or border, Bathurst Inlet. The nearest conservation area is the Queen Maud Gulf Migratory Bird Sanctuary approximately 100 km east of Bathurst Inlet on the far side of the Kent Peninsula. The Draft Nunavut Land Use Plan (Nunavut Planning Commission 2012) has no special designation for the marine environment of Bathurst Inlet, but the caribou calving grounds in the region have been designated PSE-R2. The proposed Hiukitak River Cultural Area is on the eastern shore of Bathurst Inlet, and is 40 km east of Kingaok, 60 km north-east of the proposed MLA, and 140 km north of the George Property Area.

Figure 3.1-1

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Project Location

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3.1.3 Baseline Study Area

The Project will primarily interact with the marine environment locally with the site activities at the MLA (Local Study Area; LSA) in southern Bathurst Inlet, and regionally with the ship travel through Bathurst Inlet (Regional Study Area; RSA). The MLA may include in-water structures (marine ramp and seasonal dock) and will be the location of the majority of Project activities that may interact with the marine environment. For the purposes of the existing environment and baseline information, the sites are divided into those near the proposed MLA (LSA), and those throughout the wider region of Bathurst Inlet (RSA).

Baseline marine sediment quality data has been collected in Bathurst Inlet by Rescan Environmental Services Ltd. (Rescan) since 2001, with sampling in the LSA being conducted in 2013 (Figure 3.1-2, Table 3.1-1).

Table 3.1-1. Marine Baseline Sediment Quality Sampling Program in Bathurst Inlet, 2001 to 2013

Year	2001	2002	2007	2010	2012	2013
Sampling Month(s)	August	August	August	August	August	July
Sampling Agency	Rescan	Rescan	Rescan	Rescan	Rescan	Rescan
Sampling Method	Petite Ponar	Petite Ponar	Petite Ponar	Petite Ponar	Petite Ponar	Petite Ponar
Data Collected	Particle Composition, Organic Carbon, Metals	Particle Composition, Organic Carbon, Metals	Particle Composition, Organic Carbon, Metals	Particle Composition, Organic Carbon, Metals	Particle Composition, Organic Carbon, Metals	Particle Composition, Organic Carbon, Metals, PAH*
Site(s) Sampled	BIPR2001A BIPR2001B BIPR2001C BIPR2001D BIPR2001E	BIPR2002A	HACK2007Ra HACK20073b HACK20073c	BIPR2010R BIPR20103a BIPR20103b BIPR20104 BIPR20105 BIPR20106a BIPR20106b BIPR20107	BACK2012O410 BACK2012O412 BACK2012O420 BACK2012O422 BACK2012O430 BACK2012O432 BACK2012O440 BACK2012O442 BACK2012O610 BACK2012O620 BACK2012O622 BACK2012O630 BACK2012O632 BACK2012O642 BACK2012O650 BACK2012O652	BACK2013N12 BACK2013J10 BACK2013S10 BACK2013O650 BACK2013M7
Number of Replicates per Site	n = 3	n = 3	n = 3	n = 3	n = 3	n = 3

** Polycyclic Aromatic Hydrocarbons (PAH)*

3.1.4 Baseline Studies

3.1.4.1 Information Sources

The baseline data on marine sediment quality were compiled from recent site-specific surveys in the Project area. The primary sources of baseline marine sediment quality information used in the DEIS were from the LSA that contains the MLA Potential Development Area (PDA; Rescan 2013b) and the broader southern Bathurst Inlet area within the RSA (Rescan 2002, 2008a, 2008b, 2012, 2013a). This information can be found in the following reports:

- *Bathurst Inlet Port and Road Project: 2001-2002 Marine Environment Baseline Studies* (Rescan 2002);
- *Hackett River Project: 2007 Marine Baseline Report* (Rescan 2008a);
- *Hackett River Project: 2008 Marine Baseline Report* (Rescan 2008b);
- *Bathurst Inlet Port and Road Project: 2010 Marine Aquatic Resources Baseline Study* (Rescan 2012b);
- *Back River Project: 2012 Marine Baseline Report* (Rescan 2013a; Appendix V7-1A); and
- *Back River Project: 2013 Marine Baseline Report* (Rescan 2013b).

3.1.5 Baseline Study Methods

Baseline marine sediment quality data have been collected in the southern Bathurst Inlet during 2001, 2002, 2007, 2008, 2010, 2012, and 2013. A summary of the various sampling programs, including the analyzed sediment parameters, sampling locations, and methodologies, is shown in Table 3.1-1. The baseline sampling locations, including those in the LSA, are shown on Figure 3.1-2. Full methodologies can be found in the reports listed above.

In general, sediment quality samples in the baseline sampling program were collected in triplicate using a Petite Ponar grab sampler (Table 3.1-1). Replicates were spaced roughly 10 to 40 m apart to avoid pseudo-replication and each sediment sample was carefully transferred into a rinsed white plastic tray after retrieval. The surface 2 cm of the sediments were then scraped into a plastic bowl and fully homogenized with a plastic spoon before being transferred to Whirl-Pak bags. All samples were refrigerated in darkness until shipment to ALS Environmental (Burnaby, BC) where the sediments were analyzed.

3.1.5.1 Sediment Quality QA/QC

The sediment quality QA/QC program included the use of chain of custody forms for all samples, and the collection of three replicate sediment samples at all sites to account for within-site variability.

3.1.6 Marine Sediment Quality

Sediment quality is a set of important parameters for marine life—many marine organisms live in or on the sediments, or feed on benthic organisms. The Canadian Council of Ministers of the Environment (CCME) has established interim guidelines for sediment quality parameters to monitor and protect marine life from acute and chronic toxicity (CCME 2013). The CCME guidelines are conservative empirical thresholds that are meant to be protective of all forms of aquatic life and all aspects of aquatic cycles, including the most sensitive species over the long term (CCME 1999, 2013). A summary of the baseline sediment quality data collected in southern Bathurst Inlet to date is presented below.

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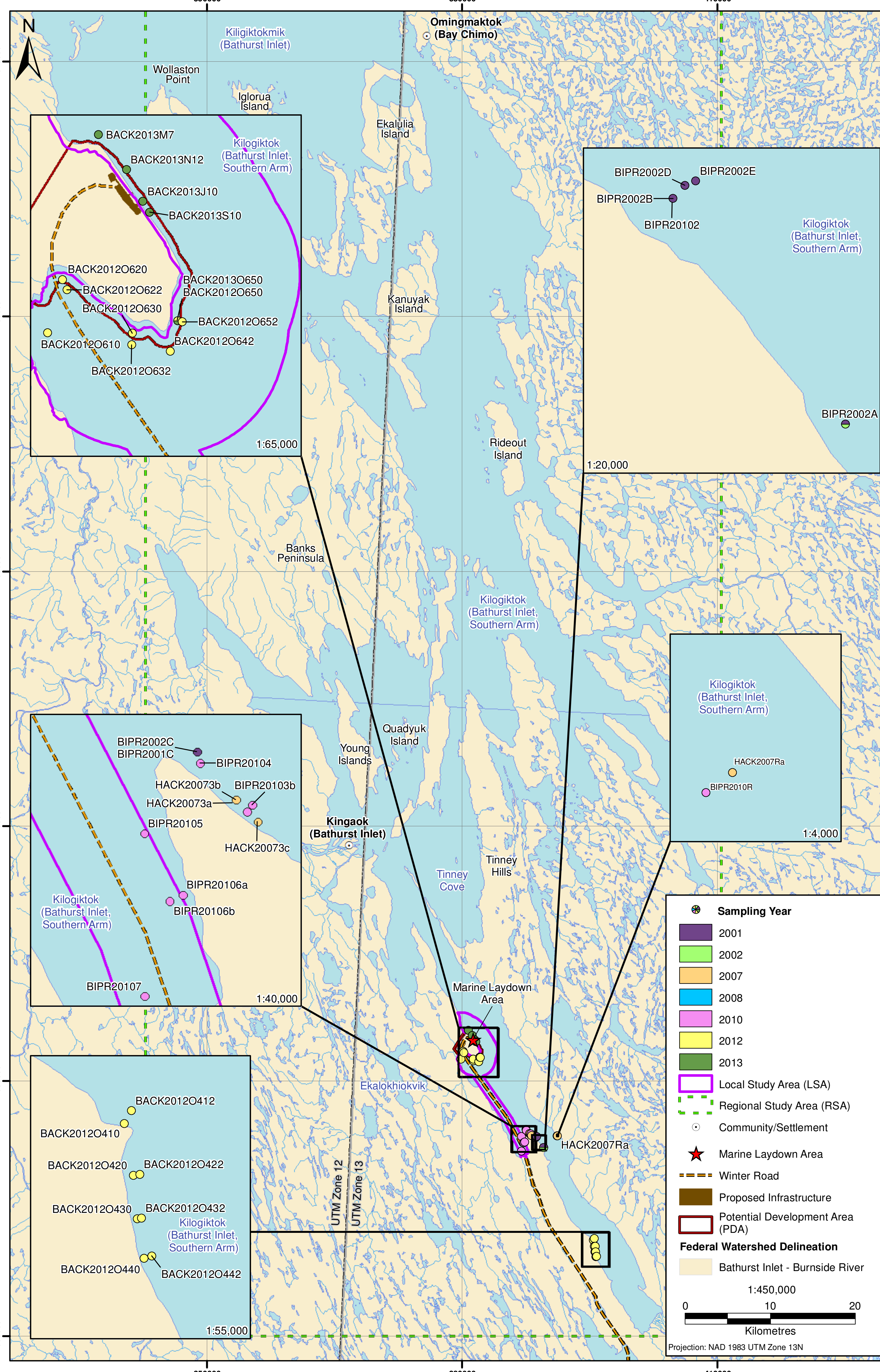

Figure 3.1-2

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Baseline Marine Sediment Quality Sites, 2001 to 2013

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3.1.6.1 Sediment Composition

The particle size composition of sediments is important for determining the type and variety of benthic organisms (Volume 7, Chapter 4), and estimating the metal adsorption potential and organic carbon content of the sediments. Coarser sediments composed of gravel and sand tend to have lower concentrations of organic carbon and metals.

Overall, the shallower near-shore sites (<5 m depth) in Bathurst Inlet usually had more sand (60 to >95% by weight) than the deeper off-shore sites (>5 m) that were composed of a mix of silt and clay particles (50 to 90% by weight; Table 3.1-2). Shallow sites are more prone to wave action, mixing, and erosion. Local features, such as sheltering peninsulas and river outflows, had significant effects on the sediment particles size composition (e.g., BIPR20107 and BACK2012O622; Rescan 2012b, 2013a). The shallow LSA sites (Rescan 2013b) and RSA sites clearly had a much coarser-grained distribution than the deeper RSA sites (Table 3.1-2; Rescan 2013b). The LSA sites, BACK2013N12, BACK2013S10 and BACK2013J10, were composed of 89–92% sand (Rescan 2013b).

Table 3.1-2. Summary of Marine Sediment Compositions at LSA and RSA Sites, 2001 to 2013

	Min	Mean	Max
LSA (n = 5)			
% Gravel	0.05	4.1	8.0
% Sand	51	76	92
% Silt	1.8	14	33
% Clay	1.5	6.2	14
RSA (n = 35)			
% Gravel	0	1.2	6.8
% Sand	1.7	41	98
% Silt	1	26	61
% Clay	0.6	30	70

3.1.6.2 Total Organic Carbon

Total organic carbon (TOC) concentrations in the sediments were negatively correlated with the proportion of sand-sized particles in the sediments of the Bathurst Inlet RSA and the MLA LSA ($R^2 = 0.65$, $n = 33$). The sandy sediments of Bathurst Inlet had TOC concentrations between 0.05 and 0.34 g/kg with an average of 0.17 g/kg. Sediments of Bathurst Inlet with at least 50% silt or clay, such as sites in deeper (> 10 m) waters, had more than three times the average organic carbon concentration (average = 0.54 g/kg, SE = 0.14 g/kg, $n = 16$) than sandy sediments. Sandy sediments in the Bathurst Inlet RSA had a very similar range of TOC concentrations as those within the LSA (Table 3.1-3; Rescan 2008a, 2012b, 2013a, 2013b).

Table 3.1-3. Summary of Marine Sediment Organic Carbon Concentrations at LSA and RSA Sites, 2001 to 2013

	Min	Mean	Max
LSA (n = 5)			
TOC (g/kg)	0.05	0.15	0.32
RSA (n = 35)			
TOC (g/kg)	0.05	0.38	0.86

3.1.6.3 Sediment Metals

The analysis of marine sediment metal concentrations was informed by the CCME guidelines. The Interim Sediment Quality Guidelines (ISQG) are conservative empirical thresholds below which no effects on marine benthic organisms are predicted to occur. The CCME Probable Effects Level (PEL) thresholds describe the sediment concentration at which biological effects are likely to occur. Many metals readily adsorb to the surfaces of silt and clay particles, and it was expected that sediment metal concentrations would be correlated with sediment composition. The concentrations of metals in sediments in the LSA and RSA are summarized in Table 3.1-4.

Table 3.1-4. Summary of Marine Sediment Metals Concentrations at LSA and RSA Sites, 2001 to 2013

	Metal Concentration (mg/kg)			% of Samples Concentrations Greater than ISQG*	% of Samples Concentrations Greater than PEL*
	Min	Mean	Max		
LSA (n=5)					
Arsenic	1.1	2.2	3.9	0	0
Cadmium†	0.025	0.044	0.098	0	0
Chromium	5.2	11	19	0	0
Copper	2.7	5.5	9.1	0	0
Lead	1.4	2.5	4.0	0	0
Mercury‡	0.0025	0.0043	0.0057	0	0
Zinc	6.2	12	22	0	0
RSA (n=35)					
Arsenic	0.76	6.8	16	31	0
Cadmium◊	0.025	0.07	0.2	0	0
Chromium	2.2	34	69	20	0
Copper	1.1	16	28	46	0
Lead	0.91	7.6	27	0	0
Mercury°	0.0025	0.013	0.025	0	0
Zinc	2.9	35	66	0	0

Note: Where data was < DL, 0.5×DL was used to calculate summary statistics. 129 samples were included in the analysis.
** CCME marine sediment quality guidelines for the protection of aquatic life (CCME 2013).*
† 75% of cadmium sediment concentrations in LSA were below analytical detection limits.
‡ 50% of mercury sediment concentrations in LSA were below analytical detection limits.
◊ 92% of cadmium sediment concentrations in RSA were below analytical detection limits.
° 66% of mercury sediment concentrations in RSA were below analytical detection limits.

Local Study Area

Cadmium, mercury, lead, and zinc sediment concentrations were low in the LSA, and often near or below the analytical detection limits. In contrast to the RSA, the concentrations of arsenic, chromium, and copper in sediments at all LSA sites were below CCME ISQG (and PEL) guidelines. This is likely related to the sand-dominated sediments around the MLA, with consequentially reduced potential for adsorption of metals (Table 3.1-5; Rescan 2013b).

Regional Study Area

Cadmium, mercury, lead, and zinc concentrations were uniformly low, and often near or below the analytical detection limits throughout the sediments of Bathurst Inlet (Table 3.1-4; Rescan 2002, 2008a, 2008b, 2013a, 2013b). Arsenic, chromium, and copper sediment concentrations were naturally elevated in sediments, and were strongly correlated with each other (linear model multiple R^2 = 0.94, n = 35), and with the proportion of fine particles (silts and clays; linear multivariate regression model with arcsine-transformed proportion (silt + clay), multiple R^2 = 0.91, n = 35). Arsenic concentrations were naturally greater than the CCME ISQG (ISQG; CCME 2013) at 14 of the 35 sampled sites, chromium concentrations were naturally greater than the ISQG at 7 of 35 sampled sites, and copper concentrations were greater than the ISQG at 16 of 35 sampled sites (Table 3.1-4 and Table 3.1-5). No metal concentration was greater than the CCME PEL guideline concentrations in Bathurst Inlet (CCME 2013). The close correspondence between the three naturally elevated metals, arsenic, chromium, and copper, suggests a common geological source for those metals either in the terrestrial environment or the underlying geology of Bathurst Inlet.

Table 3.1-5. Summary of Marine Sediment Quality Concentrations that were Greater than CCME Guidelines at LSA and RSA Sites, 2001 to 2013

	Dominant Particle Size	Metals with Mean Greater than ISQG[1]	Metals with Mean Greater than PEL
LSA			
BACK2013J10	sand	-	-
BACK2013S10	sand	-	-
BACK20130650	sand-silt	-	-
BACK2013N12	sand	-	-
BACK2013M7	sand-silt	-	-
RSA			
BIPR20011	clay	As, Cr, Cu	-
BIPR20012	clay	As, Cr, Cu	-
BIPR20013	clay	As, Cr, Cu	-
BIPR20014	clay	As, Cr, Cu	-
BIPR20015	clay	As, Cr, Cu	-
BIPR20022	clay	As, Cr, Cu	-
BIPR20101	sand-silt-clay	Cu	-
BIPR20102	silt-clay	As, Cu	-
BIPR20103b	clay	As, Cr, Cu	-
BIPR20104	silt-clay	As, Cu	-
BIPR20105	silt	As, Cu	-
BIPR20106b	silt	As, Cu	-
BIPR20107	silt	As, Cu	-
BIPR2010R	silt-clay	Cu	-
BACK2012O622	silt	As, Cu	-
BACK2012O632	silt	As, Cu	-

[1] Exceedances are listed if the mean for all available samples was greater than the CCME marine sediment quality guidelines (CCME 2013).
As = arsenic, Cr = chromium, Cu = copper.

A number of sampling sites in the baseline programs were spatially proximate and from similar water depths: BIPR2001B and BIPR20102 (20 m), BIPR2001A and BIPR20101 (80 m), and BIPR20103a and BIPR20103b (90 m). These pairs of sites indicate the length-scales of variation in sediment composition and quality (Table 3.1-6). There was little spatial correlation observed between sites greater than 80 metres apart, even during the same sampling year. These observations suggest that the local sediment quality heterogeneity in Bathurst Inlet is on a scale between 20 and 80 m, although more uniformity was observed between sites with similar sediment composition (e.g., the coarse sand/gravel sediments in BACK2013J10 and BACK2013S10, Table 3.1-6).

Table 3.1-6. Local-scale Marine Baseline Sediment Quality Variation at LSA and RSA Sites

Station	Distance (m)	Sediment Silt + Clay (%)	Arsenic Concentration (mg/kg)	Chromium Concentration (mg/kg)	Copper Concentration (mg/kg)
BIPR20012	20	97	11	65	25
BIPR20102		83	12	51	25
BIPR20011	80	96	14	65	27
BIPR20101		63	7	39	20
BIPR20103a	90	33	5	26	13
BIPR20103b		92	14	55	27
HACK20073c	150	17	1	13	8
BIPR20103a		33	5	26	13
BACK2013J10	220	4	1	5	3
BACK2013S10		3	1	5	4

Although there was little spatial correlation at sites greater than 80 m apart in the Bathurst Inlet RSA, this length scale for variation in metals appeared to be greater in the LSA (Table 3.1-6) where sediments were more completely dominated by sand.

3.1.6.4 Polycyclic Aromatic Hydrocarbons (PAHs)

The PAH content of sediments in the LSA were measured at three sites in 2013 (BACK2013J10, BACK2013O650, BACK2013M7; Rescan 2013b). The analysis examined the concentrations of a suite of 18 PAH compounds, all of which were below their respective analytical detection limit. These low levels were consistent with the remote location of the LSA and the very low levels of human activities in the region.

3.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

3.2.1 Incorporation of TK for Existing Environment and Baseline Information

Available TK from the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) Report* (KIA 2012) was reviewed for information on marine sediment quality (Volume 3, Chapter 3). There was no direct information on marine sediment quality in the KIA report (KIA 2012).

Inuit of the central Arctic (Kitikmeot) region are known as “Kitikmiut”, which are further classified into three divisions based on their territorial range: the Ocean Inuit, the Nunamiut (Inland Inuit), and the Kiligiktokmiut, or Bathurst Inlet Inuit. Of particular relevance to Kiligiktokmik (Bathurst Inlet), the Kiligiktokmiut have lived adjacent to the inlet, and to the Perry River and Ellice River drainages, on a continuous basis for thousands of years (KIA 2012).

The Kiligiktokmiut have been clearly dependent on the seas and coasts, and particularly on marine life such as ringed seals, ocean fish such as Arctic char and tomcod, crabs, oysters and starfish. Fish were an important part of the Inuit seasonal diet, and essential during times of food shortages. Inuit fished the ocean adjacent to the mainland and island coastlines, at the mouths of major rivers, and through ice cracks. Many marine organisms live in or near the sediments, and sediment quality has direct and indirect effects on the abundance and health of marine food resources (KIA 2012).

3.2.2 Incorporation of TK for VEC and VSEC selection

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) Report* (KIA 2012) were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The TK report presents clear maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB ftp site. As a result of this process, marine sediment quality was selected as a VEC.

3.3 VALUED COMPONENTS

3.3.1 Valued Components Included in Assessment

Marine sediment quality was identified as a potential VEC from a comprehensive list in the EIS guidelines (Section 7.6.1; NIRB 2013) and was identified as potentially interacting with the Project during the scoping process (Volume 9, Chapter 1). Although there were few to no comments regarding marine sediment quality expressed in consultation with communities, TK information, or regulatory agencies (Volume 9, Chapter 1), there are regulatory considerations, such as the *Fisheries Act* (1985) that emphasize the importance of sediment quality in the marine environment. As a result of the scoping process, marine sediment quality was selected as a VEC for the DEIS.

3.4 SPATIAL AND TEMPORAL BOUNDARIES

The marine sediment quality spatial and temporal boundaries define the maximum spatial and temporal extent within which the potential effects assessment was conducted. The boundaries were determined by the criteria specified in the EIS guidelines (NIRB 2013), and outlined in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1).

3.4.1 Spatial Boundaries

The spatial boundaries used for the assessment of the VEC marine sediment quality included an LSA bounding the Potential Development Area (PDA) of the MLA and a larger RSA bounding the PDA, LSA, and Bathurst Inlet.

3.4.1.1 Local Study Area

The marine LSA for the VEC marine sediment quality contains the PDA of the MLA and its near-shore marine waters, seabed, and shorelines. The boundary extends approximately 1 km away from the proposed marine ramp and seasonal dock and extends south as a 500-m buffer along the proposed winter road alignment across Bathurst Inlet (Figure 3.4-1).

3.4.1.2 Regional Study Area

The marine RSA encompasses the PDA, LSA, and marine areas of Bathurst Inlet from the southern-most tip of the inlet to approximately 15 km north of Omingmaktok (Figure 3.4-1). The marine RSA includes the proposed shipping lane within Bathurst Inlet that will bring sealifts into the MLA.

3.4.2 Temporal Boundaries

The temporal boundaries used for the effects assessment on the VEC marine sediment quality align with the duration of Project phases outlined in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1) as described below:

The temporal boundaries for the Project phases were defined as follows:

- Site Preparation: 2 years;
- Construction Phase: 2 years;
- Operations Phase: 10 years;
- Reclamation and Closure Phase: 10 years;
- Post-closure Phase: 3 years minimum;
- Other potential phases:
  - Temporary Closure: less than 2 years,
  - Care and Maintenance Phase: 2-10 years,
  - Exploration: included in Construction and Operations phases.

3.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

3.5.1 Methodology Overview

The Project-related effect assessment process for the VEC marine sediment quality followed a step-wise process detailed in the General Assessment Methodology (Volume 9, Chapter 1), as follows:

1. Identification of potential interactions between the Project and marine sediment quality;
2. Characterization of the potential effects that could result from these interactions;
3. Identification and description of design, mitigation and management measures that will be taken to eliminate or reduce the potential effects;
4. Characterization of residual effects that will likely remain after mitigation and management measures have been applied; and
5. Determination of the significance of residual effects using eight attributes to rate the residual effects on marine sediment quality including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence.

The potential effects of the Project on marine sediment quality are evaluated for all Project phases as described in the General Assessment Methodology (Volume 9, Chapter 1).

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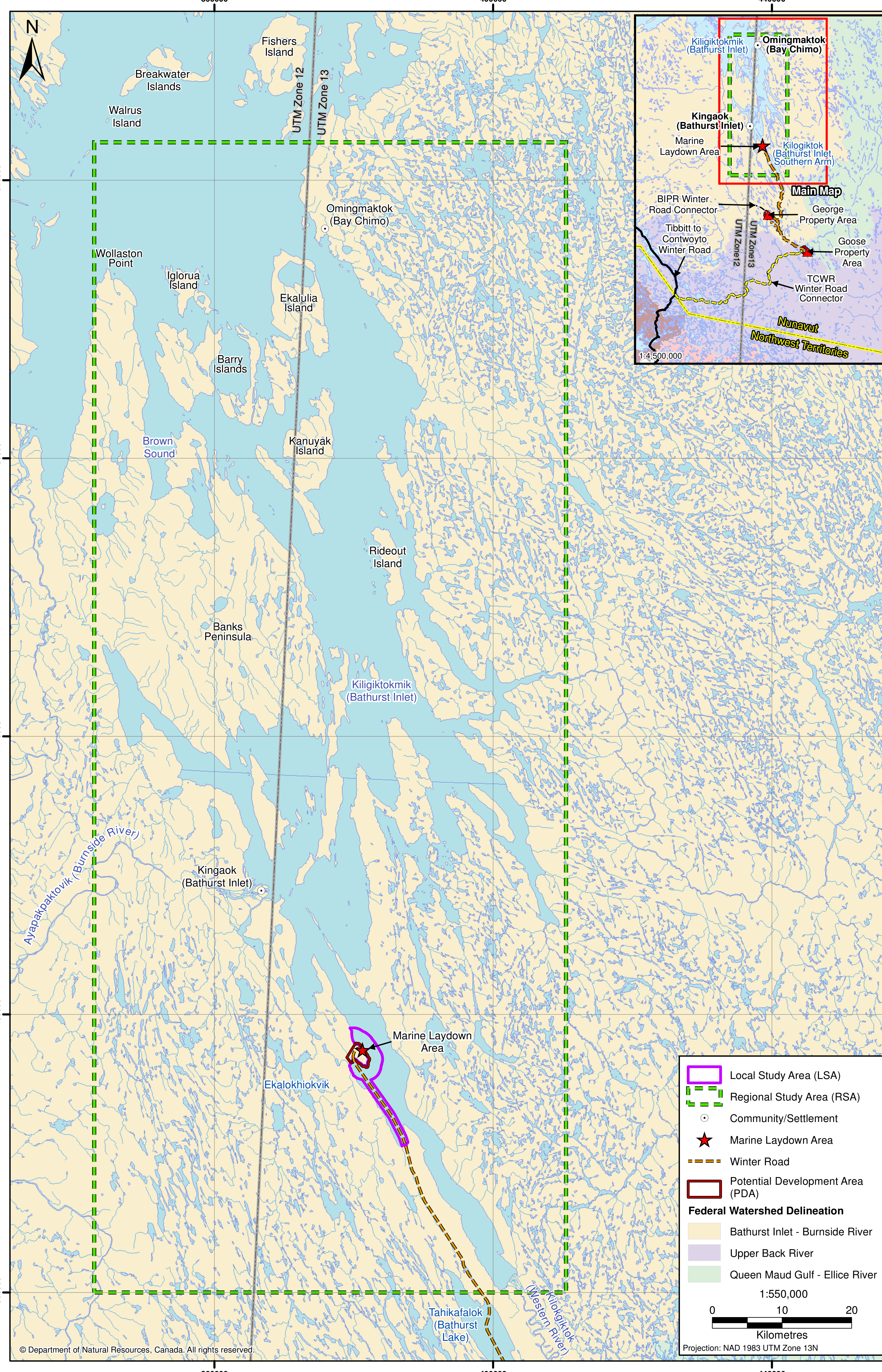

Figure 3.4-1

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Local Study Area and Regional Study Area for the VEC Marine Sediment Quality

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Figure 3.4-1

If mitigation and management measures were considered entirely effective during any Project phase, effects to the VEC marine sediment quality were deemed *negligible* and were not identified as residual effects. Attributes used to characterize residual effects included direction, magnitude, reversibility, confidence, probability, extent, frequency, and duration. The rating criteria used for these attributes are provided in tables in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1). Table 3.5-1 presents the ratings specific for the magnitude of residual effects to the VEC marine sediment quality. The CCME guidelines for marine sediment quality were used, when available, as the threshold for determining the magnitude of potential residual effects since they are designed to be protective of all forms of aquatic life and all aspects of aquatic cycles, including the most sensitive species over the long term (CCME 1999, 2013). Under these rating criteria, residual effects from Project activities classified in the *Low* magnitude would result in changes to marine sediment quality that would be less than the CCME guidelines. *Low* magnitude residual effects would, therefore, be predicted to not result in any effects in aquatic organisms because of the conservative design of the CCME guidelines (CCME 1999, 2013). In the case of naturally elevated metal concentrations (e.g., arsenic), the magnitude of a predicted residual effect would be low if the predicted concentrations were within the 90% percentile of baseline values (Table 3.5-1). Combined with the probability that the effect will occur, the significance of the effect was rated as Positive, Not Significant, or Significant (Table 3.5-2).

Table 3.5-1. Rating Criteria for Magnitude of Marine Sediment Quality Residual Effects

Rating	Classification
Negligible	No change from baseline values
Low	Within the CCME guideline, *or* less than the 90% percentile of baseline values if indicator is naturally greater than threshold
Moderate	Greater than CCME guideline, *or* greater than the 90% percentile of baseline values if indicator is naturally greater than threshold *Less than 10× threshold*
High	Greater than CCME guideline, *or* greater than the 90% percentile of baseline values if indicator is naturally greater than threshold *Greater than 10× threshold*

Table 3.5-2. Definitions of Significance Ratings for the VEC Marine Sediment Quality

Significance	Descriptor of Significance
Positive	Effect could result in improvements in marine sediment quality, relative to the baseline within the RSA into the foreseeable future.
Significant	Effect is expected to result in a decline in marine sediment quality that is long-lasting or permanent within the zone of influence of the Project relative to reference conditions; levels may be variable or stable over years, but significantly lower on average than the natural variation of sediment quality and compared to reference sites elsewhere. Regional management actions such as research, monitoring, and recovery initiatives may be required should changes to marine sediment quality be deemed above acceptable thresholds.
Not Significant	Effect may result in a decline in marine sediment quality within the zone of influence of the Project relative to reference conditions during the life of the Project, but sediment quality should return to baseline conditions in the shorter-term after Project closure. Monitoring may be initiated to confirm the ratings of the effects assessment.

3.5.1.1 Sediment Quality Indicators

Project activities may interact with the marine environment along a number of pathways that can be detected through changes in key indicators of the VEC marine sediment quality. For example, if unmitigated, the erosion of shoreline may carry suspended material and metals into the receiving marine environment. The deposition of that suspended material, and the associated metals, may increase sediment concentrations beyond natural levels. The sediment quality effects assessment was based on the analysis of four sediment quality indicators that represent the most probable and significant potential interactions between Project activities and the marine benthic environment (Table 3.5-3). It is important to note that the key indicators of marine sediment quality outlined in Table 3.5-3 are subject to natural variation, but thresholds and guidelines have been established to protect aquatic life (CCME 2013). To be conservative, these guidelines and thresholds were applied to the effects analysis. For the purposes of this assessment, the contaminants of potential concern (COPC) identified in the CCME sediment quality guidelines were used as indicators. The thresholds for the residual effects analysis were based from the CCME guidelines, when available, and detailed in Table 3.5-4.

Table 3.5-3. Marine Sediment Quality Indicators for Effects Assessment

Indicator	Description	Interaction with Project	Pathway(s)
Particle Size	The relative proportion of silt-, clay-, sand-, and gravel-sized particles	Contribute particles to marine environment (siltation); disturb and re-distribute sediments	Runoff, deposition, discharge, physical
TOC	Organic material in sediments	Contribute TOC to marine sediments	Runoff, discharge, physical
Metals	Metals adsorbed to sediment particles or dissolved in sediment interstitial water	Contribute metals dissolved in water or adsorbed to particles	Runoff, deposition
Hydrocarbons	Petroleum hydrocarbon compounds	Contribute petroleum hydrocarbons to marine sediments	Runoff, deposition, discharge

Table 3.5-4. Indicator Thresholds for Marine Sediment Quality Effects Assessment

		CCME Guideline Concentration (mg/kg)	
Indicator	**Parameter**	**ISQG†**	**PEL†**
Particle size	Particle size	*No regulatory threshold value; threshold set to 90th percentile of baseline values*	
TOC	TOC	*No regulatory threshold value; threshold set to 90th percentile of baseline values*	
Metals	Arsenic	7.24	41.6
	Cadmium	0.7	4.2
	Chromium	52.3	160
	Copper	18.7	108
	Lead	30.2	112
	Mercury	0.13	0.7
	Zinc	124	271
Hydrocarbons	Petroleum hydrocarbons	*range of guidelines for petroleum hydrocarbon compounds (CCME 2013)*	

† CCME marine sediment ISQG and PEL for the protection of aquatic life (CCME 2013).

3.5.2 Potential Interactions with Project and Characterization

Project activities have the potential to influence the VEC marine sediment quality. Potential interactions between the Project and the VEC marine sediment quality were based on the matrix provided in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1) and further refined using the EIS guidelines (NIRB 2013) and professional judgement based on extensive experience at other similar projects in Nunavut and the Northwest Territories. Activities that will occur throughout the duration of the Project were considered for their potential interactions with the marine environment.

The majority of Project interactions with the marine environment are likely to occur through non-point source pathways (e.g., sediment re-suspension from ship propeller wash). Non-point source pathways were assessed within the Project as a whole, rather than considering each potential instance. Many of these pathways have the potential to vary substantially in timing and magnitude during the Project. A qualitative effects assessment approach using conservative assumption of effects was used for the effects assessment. The effects of dust deposition were assessed in the Environmental Risk Assessment Chapter (Volume 8, Chapter 5) and the results of the quantitative analysis were applied to the assessment of dust deposition effects on the VEC marine sediment quality (see Section 3.5.2.6).

The interactions of Project activities and the VEC marine sediment quality were grouped by related Project activities, shared pathways to the marine environment, and shared key sediment quality indicators for the effects assessment (Table 3.5-5). For example, the construction of the collection pond at the MLA and the clearing of surfaces for pad construction were grouped into the *Site Preparation, Construction, and Decommissioning* Project Interaction Group because both activities will be occurring during similar stages in the Project development and both activities have the potential to contribute to erosion and deposition of suspended material into marine receiving environment through the shared pathway of runoff. The identified Project interaction groups are:

- *Shipping activities* – Project activities related to shipping that includes wake effects, propeller wash, ballast water, and antifouling agents.
- *Site Preparation, Construction, and Decommissioning* Activities - Project activities that include the clearing of overburden, earthworks, and construction activities for pads and infrastructure.
- *Site Contact Water* - the runoff from Project infrastructure including pad areas, laydown areas, roads, and airstrips.
- *Fuels, Oils, and PAHs* - Project activities related to the storage of fuels, fueling and maintenance operations, and the combustion of waste.
- *Treated Wastewater Discharge* - discharge of treated camp greywater, treated camp sewage water, and from incoming vessels.
- *Dust Deposition* - Project activities that generate dust, including vehicle traffic, airstrip activity, and quarry and borrow pit activities that can then be deposited in marine receiving environments.

The timing of Project activities were considered in the effects assessment by incorporating information on the magnitude of potential effects and the timing of mitigation and management measures. For example, once the collection pond is completed at the MLA, site contact water (e.g., runoff from site pad areas) will be diverted to the water management facilities and will not directly reach the marine environment. As a result, the assessment of effects from site contact water would be different in the Operations phase than during the Construction phase.

Table 3.5-5. Definition of the Components of the Project's Interactions with the VEC Marine Sediment Quality

		Project Interaction Group						
Project Phase	**Project Activity**	**Shipping**	**Site Preparation, Construction, Decommissioning Activities**	**Winter Roads**	**Site Contact Water**	**Fuels, Oils, and PAH**	**Treated Wastewater Discharge**	**Dust Deposition**
Site Preparation and Construction	Machinery and vehicle refueling; fuel storage and handling					X		
	Sewage treatment plant and discharge, vessel sewage discharges	X					X	
	Landfill construction and solid waste management		X		X			
	Chemical and hazardous material storage and management				X			
	Explosives storage and handling							
	Marine Laydown Area: on-land laydown areas and fuel storage		X		X	X		
	In-water infrastructure		X					
	Marine transport of goods	X				X	X	
Operations	Road use and maintenance				X			X
	Sewage treatment and discharge						X	
	Solid waste management				X			
	Equipment maintenance, vehicle refueling, and fuel storage and handling					X		
	Chemical and hazardous material storage and management				X			
	Marine transport of goods	X				X	X	
Reclamation and Closure	Equipment maintenance, vehicle refueling, and fuel storage and handling					X		
	Marine Laydown Area reclamation		X					

Pathway was used as the term describing the linkage between each Project interaction group and the VEC marine sediment quality. The identified pathways for interactions between Project activities and the marine sediment environment are:

- *runoff*, which describes the transport of material or compounds from the terrestrial environment into the marine environment by precipitation or snowmelt;
- *discharge*, which is the direct input of Project water into the marine environment;
- *contact*, which is the presence of Project-related infrastructure or vehicles (such as ships and barge) in the marine environment;
- *physical*, which is the direct physical effects of Project activities in the marine environment; and
- *aerial deposition*, which is the direct input of material and chemical compounds from the air into the marine environment.

The pathways for each Project interaction group were identified (Table 3.5-6) and then used to describe the potential effects, identify mitigation and management measures, and characterize the residual effects from Project activities.

Table 3.5-6. Key Indicators of Project Activity Interactions with the Marine Environment for Effects Assessment

Project Activity	Pathway	Indicators	Project Phases
Shipping activities (wakes, propeller wash, antifouling agents, ballast water)	Discharge, contact, physical	Particle size, TOC, metals, hydrocarbons	Site Preparation, Construction, Operations, Reclamation and Closure
Site preparation, construction, and decommissioning activities	Runoff, physical	Particle size, TOC, metals, hydrocarbons	Site Preparation, Construction, Operations, Reclamation and Closure
Site contact water	Runoff	Particle size, TOC, metals	Site Preparation and Construction, Operations, Reclamation and Closure, Temporary Closure, Care and Maintenance, Post-closure
Fuels, oils, PAH	Runoff and aerial deposition	TOC, hydrocarbons	Site Preparation, Construction, Operations, Reclamation and Closure
Treated wastewater discharge	Discharge	TOC, hydrocarbons	Site Preparation, Construction, Operations, Reclamation and Closure
Dust deposition	Aerial deposition	Particle size, metals	Site Preparation, Construction, Operations

3.5.2.1 Shipping Activities

<u>Vessel Wakes</u>

The currents created by moving vessels have the potential to change marine sediment quality. The interaction between vessel wakes and the sediment environment is the physical pathway. The currents created by vessel wakes could disturb and rework sediments, which may cause changes in the grain-size composition of sediments (siltation) and change the concentrations of metals and organic carbon. Potential effects from vessel wakes may occur during the Site Preparation, Construction, Operations, and Reclamation and Closure phases.

Propeller Wash

Propellers create jets of water that can contact and disturb sediments. Like vessel wakes, propeller wash interacts with the marine sediment environment through the physical pathway. The jets created by propellers could disturb and rework sediments, which may cause changes in the grain-size composition of sediments (siltation) and change the concentrations of metals and organic carbon. Potential effects from propeller wash may occur during the Site Preparation, Construction, Operations, and Reclamation and Closure phases.

Ballast Water Discharge

Ballast water is used to improve the stability of vessels when not fully loaded, and can be taken on in one port and discharged or exchanged in another. The pathway of interaction is discharge. Ballast water can contain suspended sediments and therefore its discharge by ships has the potential to cause siltation in marine sediments. Vessels will follow the Canadian regulatory requirements for the management of ballast water described in the Shipping Management Plan, Appendix A (Volume 10, Chapter 15). The effects of ballast water discharge were not considered further in this assessment.

Antifouling Agents

The hulls of ships historically have been treated with antifouling paints to prevent the buildup of sessile marine organisms that can increase drag, slow down the ship, and decrease fuel efficiency. Since its development in the 1960s, the use of tributyltin (TBT) became prevalent in antifouling paints used on the majority of international shipping. Leaching from these paints may cause increased concentrations of TBT in sediments, so the pathway of potential effects is contact between the treated surfaces and the marine environment. Potential effects from ballast water discharge may occur during the Site Preparation, Construction, Operations, and Reclamation and Closure phases.

3.5.2.2 Site Preparation, Construction, and Decommissioning Activities

Ground preparation and limited in-water works will be required in the Site Preparation and Construction phases throughout the MLA to construct necessary Project infrastructure, including buildings, roads, and a small marine ramp. Site preparation will involve vegetation clearing, the removal and relocation of surficial materials, and the construction of pad areas from surficial material, borrow material, and quarried rock. The site preparation activities would also include the construction of water management structures, such as interception ditches, diversion structures, and berms to mitigate runoff, and earthworks for the collection pond at the MLA. Limited in-water and near-water works will take place with the construction of a small marine ramp and a seasonal dock. The decommissioning and reclamation of Project infrastructure during the Reclamation and Closure phase will similarly require surface contact and the transportation and relocation of surficial materials. The production of methylmercury will be negated by stripping and stockpiling organic material as part of site preparation and construction activities.

Landscape contact (ground works) has the potential for effects on the VEC marine sediment quality. The primary pathway for these potential effects would through runoff that could lead to siltation and in-water disturbance that could lead to sediment re-suspension and redistribution. Runoff would occur primarily during snowmelt and freshet in the spring, during precipitation events in the summer and fall, and would be absent in the winter. In-water and near-water activities would occur during the open-water season.

Runoff from prepared and decommissioned areas could affect the VEC marine sediment quality by changing pH (interaction with surficial material), and contributing TSS (erosion and disturbance), metals (particles and dissolution), and hydrocarbons (use of fuel, oil, and grease) into the marine environment.

The physical effect pathway linking the site preparation and construction activities and the marine environment is tremors from local blasting and pile driving. During construction activity, these physical vibration effects may affect sediment quality by disturbing the sediment and affecting the particle size distribution. Disruption of natural sedimentation patterns could affect near-shore subsea permafrost.

3.5.2.3 Site Contact Water

Site contact water was defined as the runoff from snowmelt and precipitation events that interacts with site surfaces including roads, laydown areas, and buildings. The interaction between runoff and Project infrastructure could transport suspended material (siltation), metals, organic matter, and petroleum hydrocarbon compounds into the marine environment if not managed or mitigated. The potential for effects from site contact water could occur during all phases of the Project.

3.5.2.4 Fuels, Oils, and PAHs

The Fuels Project interaction group was defined as the Project activities that include the storage and transport of fuels and petroleum hydrocarbons, fueling and maintenance operations that have the potential for introducing hydrocarbons into the marine environment, and the incineration of waste that may create PAHs by incomplete combustion. Up to 45 ML of fuel is expected to be stored on land at the MLA or off shore in vessels or barges during the Operations Phase (complete breakdown detailed in the Fuel Management Plan, Volume 10, Chapter 4). Fuel will be delivered via a sealift during the open-water season and transferred to on-shore storage facilities.

The primary pathways of interactions between these sources of hydrocarbons and the marine environment are runoff and aerial deposition. Activities at facilities, laydown areas, fuel storage areas, fueling stations, and waste management areas can deposit hydrocarbon compounds, such as oil or grease, onto surfaces that can subsequently be transported into the marine environment in runoff.

Combustible waste, including the solids from sewage treatment, will be combusted using an incinerator. Incomplete combustion can create airborne hydrocarbons that can be deposited into the marine environment via deposition or runoff.

The potential effects from fuels and other hydrocarbons on the VEC marine sediment quality may occur during the Site Preparation, Construction, Operations, and Reclamation and Closure phases.

3.5.2.5 Treated Wastewater Discharge

Treated wastewater from camp domestic use will be treated and discharged to either a disposal pit (treated greywater) or to the terrestrial environment (treated sewage water). Treated wastewater from vessels may be discharged into the marine environment. Vessels are to have an approved sewage treatment plant meeting Canadian standards (Shipping Management Plan, Volume 10, Chapter 15). Holding tanks with the capacity for all grey and treated sewage while in port are expected to be part of the ship’s infrastructure. Sewage sludge from the sewage treatment plant can be incinerated in the on-board incinerator. As a result of these regulatory requirements and planned wastewater measures, no residual effects on marine sediment quality from wastewater discharge were anticipated, and no further assessment of wastewater discharge effects was conducted.

3.5.2.6 Dust Deposition

Dust can be generated by a variety of Project activities, including vehicle traffic, airstrip activities, blasting activities, and quarry operations. Areas cleared for infrastructure (i.e., laydown areas) can also be sources of dust. The aerial deposition of the Project-generated dust is the primary pathway of interaction. Dust deposition into the marine environment could affect the VEC marine sediment quality by introducing suspended material and associated metals into surrounding waterbodies. The potential effects from dust deposition may occur during all phases of the Project. However, no residual effects from dust deposition were predicted in the Environmental Risk Assessment (Volume 8, Chapter 6), so no further assessment of potential dust deposition effects on the VEC marine sediment quality was conducted.

3.5.3 Identification of Mitigation and Management Measures

The following section details mitigation and management measures designed to reduce or eliminate adverse Project effects on the VEC marine sediment quality. If mitigation and management measures were considered entirely effective, potential Project-related effects to the VEC marine sediment quality were deemed negligible and not identified as residual effects. Once these were taken into account, any remaining residual Project effects on the VEC marine sediment quality were evaluated in Section 3.5.4.

Mitigation and management measures—to eliminate or reduce Project effects on the VEC marine sediment quality—include design and planning, engineered structures, the application of control technologies, Best Management Practices (BMPs), regulatory requirements, and monitoring and adaptive management. The relevant mitigation and management measures, including the spatial and temporal boundaries of the proposed actions, are considered and described for each Project activity in Sections 3.5.3.1 to 3.5.3.5.

The Aquatic Effects Management Plan (Volume 10, Chapter 19) contains the management plans that will be in place to reduce or eliminate potential effects to the marine environment including marine sediment quality. The Site Water Monitoring and Management Plan (Volume 10, Chapter 7) is the key plan for site and mine contact water. In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to sediment quality, water quality and air quality. These mitigation and management measures will also serve to protect the marine environment including marine sediment quality. Details of these strategies as they directly and indirectly apply to the VEC marine sediment quality can also be found in the following DEIS chapters:

- Marine Water Quality – Volume 7, Chapter 2;
- Marine Fish/Aquatic Habitat – Volume 7, Chapter 4; and
- Air quality – Volume 4, Chapter 1.

Other management plans will also be implemented to protect the marine environment, details of which are found in the following chapters of Volume 10:

- Risk Management and Emergency Response Plan (Chapter 3);
- Fuel Management Plan (Chapter 4);
- Spill Contingency Plans (Chapter 5);
- Oil Pollution Emergency Plan (Chapter 6);
- Landfill and Waste Management Plan (Chapter 10);
- Incinerator Management Plan (Chapter 11);

- Hazardous Materials Management Plan (Chapter 12);
- Explosive Management Plan (Chapter 13);
- Road Management Plan (Chapter 14);
- Shipping Management Plan (Chapter 15);
- Borrow Pits and Quarry Management Plan (Chapter 16);
- Air Quality Monitoring and Management Plan (Chapter 17);
- Conceptual Fish Offsetting Plan (Chapter 21);
- Metal Leaching and Acid Rock Drainage Management Plan (Chapter 22); and
- Mine Closure and Reclamation Plan (Chapter 29).

3.5.3.1 Shipping Activities

Vessel Wakes

The physical interaction pathway will be mitigated by directly managing the Project activity. The potential effects of wakes by ships will be mitigated by reduction in ship speed within the LSA and in areas with restricted depths in Bathurst Inlet. The analysis of vessel wakes with mitigation in the marine water quality effects assessment (Chapter 2, Section 2.5.4.1) predicted marine water quality residual effects from wakes to be within the range of natural variability. Since no significant water quality effects are predicted, no residual effect on the VEC marine sediment quality is predicted from vessel wakes.

Propeller Wash

The physical interaction pathway will be mitigated by directly managing the Project activity. The potential effects of propeller by ships will be mitigated by reduction in ship speed within the LSA and in areas with restricted depths in Bathurst Inlet. The analysis of propeller wash with mitigation in the marine water quality effects assessment (Chapter 2, Section 2.5.4.1) predicted marine water quality residual effects from propeller wash for vessels operating in waters greater than 10 to 20 m of depth to be within the range of natural variability. All portions of the shipping route except in the PDA will be deeper than this minimum depth, so no significant water quality effects are predicted and no residual effect on the VEC marine sediment quality is predicted from propeller wash for Project vessel operations outside of the PDA. However, potential residual effects on the VEC marine sediment quality may occur due to vessel operations within the PDA.

Antifouling Agents

The contact interaction pathway will be mitigated by eliminating the potential for contact with the marine environment. The use of the anti-fouling agent TBT is banned under the *Canada Shipping Act* (2001). This ban extends to all Canadian ships, and to all ships operating in Canadian waters. Moreover, the International Convention on the Control of Harmful Anti-fouling Systems on Ships was brought into force in 2008 by the International Maritime Organization (IMO 2008). This convention prohibits the use of harmful antifouling paints on ships operating under the authority of member states, or requires a barrier coating to older underlying non-compliant treatments. Compliance with these regulations will prevent or minimize the introduction of TBT into sediments of the LSA or RSA. Therefore, there are no predicted residual effects to the VEC marine sediment quality from antifouling agents.

3.5.3.2 Site Preparation, Construction, and Decommissioning Activities

The primary pathway of interaction between the Project activities in the Site Preparation interaction group and the marine environment is runoff. The extensive number of proposed mitigation and management measures will minimize the potential for erosion and the transport of material in runoff (Site Water Monitoring and Management Plan; Volume 10, Chapter 7), and involve project design, BMPs, and monitoring and adaptive management. Infrastructure has been designed to minimize the Project footprint and therefore confines the potential influence on the marine environment to as small an area as possible. Infrastructure will be located, whenever feasible, on competent bedrock or appropriate base material that will limit permeability and transport of potentially poor quality water into the active layer, and ultimately to the marine environment. Only geochemically suitable rock quarries and borrow sources (non-acid-drainage-generating rock) will be used to construct laydown areas and infrastructure (Metal Leaching and Acid Rock Drainage Management Plan, Volume 10, Chapter 22). The development and operation of borrow pits and quarries will be managed through the Borrow Pit and Quarry Management Plan (Volume 10, Chapter 16) and all site water will be managed through the Site Water Monitoring and Management Plan (Volume 10, Chapter 7).

The Project will also use BMPs drawn from governmental organizations and specific Arctic experience to minimize erosion and reduce the entrainment of potential chemical compounds into runoff. As much as possible, erosion potential will be reduced by working during periods of low runoff, and activities scheduled to minimize the area of exposed landscape, and for progressive reclamation. Where possible exposed landscape surfaces may be protected by the installation of covering material like riprap, aggregate, or rolled erosion control products.

The primary mitigation to control site runoff will be the interception ditch that surrounds the MLA (Figure 3.4-1). Runoff may also be controlled by a combination of the following measures:

- installation of synthetic permeable barriers and/or fibre rolls to reduce runoff velocities and retain sediments;
- check dams, gabions, energy dissipation structures, and sediment basins to reduce flow velocities in channels;
- preservation of riparian zones to trap sediment and to reduce flow velocities;
- slope texturing/grading to slow runoff and reduce effect slope lengths; and
- stockpiles, laydown areas, and storage areas will be located, where feasible, away from shoreline and within interception ditch perimeter.

Once collected, all potentially poor-quality site water will be directed to interception ditches and to the collection pond. Water in the collection pond will be discharged at an approved location, and only if the water quality meets the future Type A Water Licence criteria. Non-contact water will be diverted around infrastructure, as much as feasible, and directed to the ocean.

The potential for in-water disturbance of sediments will be mitigated, where applicable, by the use of silt curtains and by the monitoring and adaptive management of in-work activities to ensure TSS concentrations are within the acceptable range of CCME water quality guidelines.

During wharf installation and in-water construction, vibrating pile-drivers may be used to minimize tremor effects. Although quarrying is not planned for the MLA, any potential quarries will be set-back at least 30 m from the marine shoreline, and potential and energy of blasting tremors will therefore be minimized.

The decommissioning of the MLA will be managed through the Mine Closure and Reclamation Plan (Volume 10, Chapter 29). Changes to marine sediment quality from Project initiation to Reclamation and Closure will be monitored under the Site Water Monitoring and Management Plan (Volume 10, Chapter 7) and the Aquatic Effects Management Plan (Volume 10, Chapter 19). Previously designed and executed Aquatic Effects Management Plans have been shown to be effective at monitoring site activities at other Arctic projects (Rescan 2012a). Necessary repairs and adjustments to operations will be conducted as needed to ensure marine sediment quality does not surpass the CCME guidelines for marine sediment quality parameters and is maintained within baseline variability (Table 3.5-4; CCME 2013). The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis.

Potential residual effects from site preparation, construction, and decommissioning were predicted after the application of these mitigation and management measures.

3.5.3.3 Site Contact Water

Runoff is the interaction pathway for site contact water. The primary mitigation measure will be to intercept and divert site contact water before it reaches the marine (and freshwater) environment (Site Water Monitoring and Management Plan; Volume 10, Chapter 7). Infrastructure will be designed such that its footprint is minimized to limit the changes to local drainage patterns. All roads and surfaces will be constructed using geochemically suitable material (i.e., non-acid-drainage-generating rock; Metal Leaching and Acid Rock Drainage Management Plan, Volume 10, Chapter 22). Non-contact water will be diverted around infrastructure, as much as is feasible, and directed to natural downstream drainage networks to maintain local drainage patterns. Site contact water will be directed to a collection pond and will not contact the surrounding marine environment. Clean water and snow will be managed such that they do not contribute to potentially poor quality water and will be diverted to maintain natural drainage networks as much as possible. If soil, snow or ice contains potentially poor-quality water, they will be removed for appropriate disposal.

Monitoring and adaptive management will be used to ensure the goals of the Site Water Monitoring and Management Plan and Aquatic Effects Management Plan are met (Volume 10, Chapters 7 and 19). During construction, all contact water will be monitored and treated to meet CCME guidelines in the receiving environment. Regular inspections of water management facilities will be conducted by Environmental Personnel under the Site Water Monitoring and Management Plan (Volume 10, Chapter 7). The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis.

Potential residual effects from site contact water were predicted after the application of these mitigation and management measures.

3.5.3.4 Fuels, Oils, and PAHs

The fuels, oils, and PAH Project interaction group activities will interact with the marine environment through runoff and aerial deposition (for PAH). The potential effects from the storage and use of fuels, oils, and PAHs at the MLA will be mitigated according to the procedures detailed in the Fuel Management Plan and the Oil Pollution Emergency Plan (Volume 10, Chapters 4 and 6). Measures to control fuels in runoff will include:

- machinery will be, where feasible, routinely inspected for leaks and refuelling will occur at a designated refuelling point with drainage capture/collection installed. In the event that refuelling occurs elsewhere, drip trays may be used under vehicles and equipment;

- appropriate secondary containment systems may be used for petroleum product storage tanks to prevent spills and releases to water, including the prevention of diesel release from pickups carrying tidy-tanks;
- bulk fuel storage areas and hazardous materials storage areas will be bermed and lined with impermeable barriers to minimize leaks and spills; and
- Oily water treatment plants at equipment maintenance facilities may be used to minimize water and surface hydrocarbon compounds.

In the event that hydrocarbons are transported in runoff from camp pads, laydown areas, and waste management areas, the runoff will be intercepted and directed to the MLA collection pond and will not be discharged into the marine environment unless it meets receiving water quality standards. Fuels, oils, and PAHs will be managed under the Fuel Management Plan (Volume 10, Chapter 4), the Oil Pollution Emergency Plan (Volume 10, Chapter 6), and the Hazardous Materials Management Plan (Volume 10, Chapter 12). Spills will be managed under the Spill Contingency Plans (Volume 10, Chapter 5).

The bulk fuel storage facility and all transfer-related equipment will be inspected and maintained, with complete documentation. The mitigation and management measures for fuel transfers are detailed in the Fuel Management Plan (Volume 10, Chapter 4).

For the aerial deposition pathway, the primary mitigation measure will be the efficient operation of the incinerator (Incineration Management Plan; Volume 10, Chapter 11). The operation of the incinerator will comply with Nunavut guidelines (Government of Nunavut 2012), Canada-Wide Standards for Dioxins and Furans (CCME 2001) and Canada-Wide Standards for Mercury Emissions (CCME 2000). Management measures will include the following:

- a waste segregation program will be implemented (i.e., materials that are unsuitable for incineration, e.g., chlorinated plastics, will be diverted to alternate waste disposal facilities);
- personnel will be properly trained in incinerator operations; and
- stack testing during commissioning and adaptive management to ensure compliance with standards.

Project activities related to fuels and other petroleum hydrocarbons were predicted to have negligible effects on the VEC marine sediment quality through the runoff and aerial deposition pathways because of the proposed mitigation and management measures. No hydrocarbon compounds or sediments from Project activities in the MLA camp, laydown areas, fuel areas, or waste storage areas were predicted to reach the marine environment because of the BMPs for fuel transfers, machinery operation, maintenance, and fueling. The incinerator will be operated according to guidelines and standards, and therefore negligible aerial deposition of PAH into the marine environment were predicted. The potential effects from spills along the shipping route are assessed in the Accidents and Malfunctions chapter (Volume 9). Therefore, no residual effects from fuels, oils, and PAHs are predicted on the VEC marine sediment quality.

3.5.3.5 Treated Wastewater Discharge

Discharge of effluent will be mitigated by project design; there will be no direct discharge of treated sewage or camp greywater to the marine environment. Sewage will be treated, and then discharged on land or backhauled. It is anticipated there will be no residual effects from treated wastewater discharge on the VEC marine sediment quality due to the application of the mitigation and management measures.

3.5.4 Characterization of Residual Effects

In Section 3.5.3, five potential effects were evaluated for whether they would result in residual effects after mitigation. Residual effects are those effects predicted to remain after the application of mitigation and management. Three of these potential effects were identified as residual effects: 1) s*hipping – propeller wash*, 2) s*ite preparation, construction, and decommissioning activities* and 3) *site contact water*. The significance of these residual effects is evaluated below. Each residual effect is described in this section in terms of eight descriptors (Volume 9, Chapter 1), including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability, and confidence. The magnitude of the residual effect was evaluated by using the information in Table 3.5-1. Table 3.5-2 provides a description of the significance ratings used for residual effects.

3.5.4.1 Shipping Activities

<u>Propeller Wash</u>

The effect of a typical vessel on water velocities generated by propeller wash has been analyzed in the water quality section (Section 2.5.4.1). The estimated velocities of propeller wash in waters deeper than 10 to 20 m are therefore of the same order or less as those observed for wind-driven currents. In the shallower waters in the PDA (<20 m), the maneuvering of vessels is more likely to produce bottom velocities that are greater than naturally observed currents, even when mitigated by reduced engine power. These shallow-water operations could lead to some mobilization of sediments, although in the LSA, sediments are strongly dominated by sand (Section 3.1.6.1) that will resettle quickly. Some reworking of sediments may occur close to shore around the MLA, but with low projected shipping activity and the presence of coarse-grained sediments, the residual effects of siltation from propeller wash was predicted to be minimal and within the 90% percentile of baseline values.

Therefore, the predicted magnitude of the residual effect was *low*. The effects were predicted to be footprint (within the PDA) or *local* (restricted to the LSA), *medium-term* in duration, and *sporadic* due to the infrequent and sporadic timing of vessel operations in the LSA. The marine environment was predicted to be resilient and the effects were predicted to be fully *reversible*. The probability of occurrence was estimated to be *moderate*, and confidence was *high* because of the quantitative input from the baseline environmental data and the confidence in the mitigation and management strategies.

The residual effect of propeller wash on the VEC marine sediment quality is predicted to be **Not Significant**.

3.5.4.2 Site Preparation, Construction, and Decommissioning Activities

The mitigation and management measures were predicted to effectively minimize the potential effects from runoff associated with site preparation, construction, and decommissioning activities. The use of only geochemically suitable material for construction of roads and pads will eliminate the potential for acid-rock drainage (Metal Leaching and Acid Rock Drainage Management Plan; Volume 10, Chapter 22). The proposed mitigation and management measures will minimize the quantity of material transported in runoff (e.g., TSS, metals) and the likelihood of runoff reaching the marine environment. Some runoff into nearby waterbodies could be possible during the early stages of site preparation and construction (Site Preparation and Construction phases) before water management structures are fully operational (e.g., collection pond, and diversion ditches). Once the water management structures are in place, any runoff from cleared areas is expected to be fully mitigated.

Only small amounts of runoff would be expected to reach the marine environment in the PDA while the water management features are being constructed. The extensive mitigation and management measures incorporating design, BMPs, and adaptive management were predicted to minimize the transport of sediments through runoff. The predicted magnitude of the residual effect was *low*. Therefore, the residual effects on the VEC marine sediment quality from site preparation, construction, and decommissioning activities were predicted to be within natural variation for the indicators of marine sediment quality.

Changes in sedimentation patterns resulting from activities during construction and operations activities around the MLA could impact near-shore subsea permafrost by altering pore water dynamics. Subsea permafrost occupies vast areas of Arctic shelves exposed to increasing temperatures and coastal erosion. It appears that geocryological conditions cannot be explained by heat conduction alone (Are 2003), and processes such as pore water convection, and ion diffusion and convection, can also be important. Although free convection may be associated with rapid thawing of permafrost in very coarse-grained coastal zones, this is of little importance in sands and finer-grained sediments (Are 2003), as found to be prevalent in Bathurst Inlet. In terms of effects on subsea permafrost, the natural erosion and degradation of some Arctic near-shore environments, and isostatic rebound in others, are likely to be much more significant than highly localized sedimentation effects around the proposed MLA. The potential effects of in-water activities on sedimentation and subsea permafrost are predicted to be negligible and no further analysis is required.

The overall effects of site preparation, construction, and decommissioning activities were predicted to be footprint (within the PDA) or *local* (restricted to the LSA), *short-term* in duration, and *sporadic* as runoff would only occur during snowmelt and episodic large precipitation events and vibrations would only occur during pile-driving operations. The marine environment was predicted to be *resilient* and the effects were predicted to be fully *reversible*. The probability of occurrence was estimated to be *moderate* due to the uncertainties related to precipitation, and confidence was *moderate* because of the quantitative baseline environmental data, the predictable nature of the potential effects, and the confidence in the mitigation and management strategies.

The residual effect of site preparation on the VEC marine sediment quality is predicted to be **Not Significant**.

3.5.4.3 Site Contact Water

The mitigation and management measures were predicted to be effective and minimize the potential effects from runoff associated with site contact water. Project activities will occur when the site water management infrastructure is not functional (e.g., before commissioning during the Site Preparation and Construction phases). Some runoff into the marine environment could be possible during this period. In the event that site contact water did contact the marine environment, the water quality indicators were predicted to be within the range of natural variation and within CCME water quality guidelines. Once the site water management infrastructure is complete (Site Water Monitoring and Management Plan; Volume 10, Chapter 7), all site contact water will be diverted to the collection pond and will only contact the marine environment if it meets the CCME water quality guidelines.

Any site contact water that reaches the marine environment was predicted to meet the CCME water quality guidelines and therefore any residual effects to marine sediment quality would be predicted to be within the CCME sediment quality guidelines. Therefore, the predicted magnitude of the residual effect was *low*. The effects were predicted to be footprint (within the PDA) or *local* (restricted to the LSA), *medium-term* in duration, and *sporadic* because the timing of site contact water reaching the marine environment will depend on the timing of snowmelt and large precipitation events. The marine environment was predicted to be *resilient* and the effects were predicted to be fully *reversible*. The probability of occurrence was estimated to be *moderate* due to the uncertainties related to precipitation, and confidence was *high* because of the quantitative input from the baseline environmental data and the confidence in the mitigation and management strategies.

The residual effect of site contact water on the VEC marine sediment quality is predicted to be **Not Significant**.

3.5.5 Significance of Residual Effects

Three residual effects for the VEC marine sediment quality were assessed and resulted in the following significance ratings:

- Shipping (propeller wash) – rated Not Significant;
- Site Preparation, Construction, and Decommissioning Activities – rated Not Significant; and
- Site Contact Water – rated Not Significant.

The criteria used in the determination of the significance of each residual effect is detailed in Section 3.5.4 and summarized in Table 3.5-7.

3.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

3.6.1 Methodology Overview

The potential for cumulative effects arises when residual effects of the Project affect (i.e., overlap and interact with) the same resource/receptor that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities. When residual effects were identified for the Project, the Cumulative Effects Assessment (CEA) followed the process detailed in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1) and was comprised of the following steps:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For marine sediment quality, the boundary was the RSA for the Project-related effects assessment on marine sediment quality.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

The cumulative residual effects were analyzed using the same criteria as the Project-related effects assessment (Section 3.5.1): direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions. The magnitude of potential cumulative effects applied the same criteria as the Project-related effects assessment (Table 3.5-1). Using a weight of evidence and relative ranking approach, combined with best professional judgement, the cumulative residual effect was characterized as either significant (S), not significant (N), or positive (P) in the same manner as the Project-related effects assessment (Table 3.5-2).

Table 3.5-7. Summary Table of Predicted Residual Effects on the VEC Marine Sediment Quality and Overall Significance Rating

Description of Residual Effects	Project Phase	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
		Direction	Magnitude	Duration	Frequency	Extent	Reversibility	Probability	Confidence	Significance
Shipping – Propeller Wash	Construction, Operations, Reclamation and Closure	Negative	Low	Medium-term	Sporadic	Local	Reversible	Moderate	High	Not significant
Site Preparation	Site Preparation, Construction, Reclamation and Closure	Negative	Low	Short-term	Sporadic	Local	Reversible	Moderate	High	Not significant
Site Contact Water	Site Preparation, Construction, Reclamation and Closure	Negative	Low	Medium-term	Sporadic	Local	Reversible	Moderate	High	Not significant

Past, existing, and reasonably foreseeable major projects with potential residual effects that occur within the RSA for the VEC marine sediment quality were considered and are listed in Table 3.4-1 in the Effects Assessment Methodology (Volume 9, Chapter 1). The list includes projects within Nunavut and the Northwest Territories to consider the outermost spatial boundary, and reflects a comprehensive evaluation of potential interactions. As per the EIS guidelines (NIRB 2013), the list of projects considered conforms to the requirement to consider a larger spatial boundary for the CEA as well as a longer temporal scale.

The expected timing and duration of Project-related residual effects was compared with that of residual effects from other past, existing, and future human activities to identify temporal overlap. As identified in the EIS guidelines (NIRB 2013), a longer timeline than the development and operations phases of the Project were considered.

3.6.2 Potential Interactions of Residual Effects with Other Projects

The following residual Projects effects on the VEC marine sediment quality were identified:

- Shipping (propeller wash);
- Site preparation, construction, and decommissioning activities; and
- Site contact water.

The spatial boundary of the CEA is the marine sediment quality RSA (see Section 3.4.1). The temporal boundary for the CEA is any past, present, or reasonably foreseeable future projects (see list of projects in Volume 9, Chapter 1). The projects that could interact with the Back River Project marine sediment quality residual effects are the proposed Bathurst Inlet Port and Road (BIPR) project and the proposed Hackett River project. Both projects propose seasonal shipping traffic through Bathurst Inlet to a port site ~30 km south of the MLA. There is no predicted spatial overlap between the Project residual effects that were confined to the marine sediment quality LSA and any potential effects from the BIPR and Hackett River projects that would be confined to the proposed shipping corridor in the middle of Bathurst Inlet. Therefore, no potential cumulative effects on the VEC marine sediment quality were predicted.

3.7 TRANSBOUNDARY EFFECTS

Transboundary effects may be expected to occur if residual effects from the Project were identified and extend beyond the LSA. However, all residual effects to the VEC marine sediment quality were confined to the LSA, which lies entirely within Nunavut. Therefore, no transboundary residual effects from Project activities on the VEC marine sediment quality were predicted.

3.8 MITIGATION AND ADAPTIVE MANAGEMENT

Mitigation and management measures will be used to eliminate or minimize Project effects on the marine environment. The measures include mitigation by Project design, conformity to existing regulations and guidelines, BMPs, and the application of monitoring and adaptive management plans. The specific mitigation and management measures for marine sediment quality are shown in Table 3.8-1.

Mitigation and management measures for other aspects of the Project, such as air quality and site water management, are detailed in Volume 10 of the DEIS and in the following plans:

- Site Water Monitoring and Management Plan (Volume 10, Chapter 7);
- Fuel Management Plan (Volume 10, Chapter 4);

- Spill Contingency Plan (Volume 10, Chapter 5);
- Landfill and Waste Management Plan (Volume 10, Chapter 10);
- Incineration Management Plan (Volume 10, Chapter 11);
- Hazardous Materials Management Plan (Volume 10, Chapter 12);
- Explosives Management Plan (Volume 10, Chapter 13);
- Road Management Plan (Volume 10, Chapter 14);
- Borrow Pits and Quarry Management Plan (Volume 10, Chapter 16);
- Air Quality Monitoring and Management Plan (Volume 10, Chapter 17);
- Metal Leaching and Acid Rock Drainage Management Plan (Volume 10, Chapter 22); and
- Mine Closure and Reclamation Plan (Volume 10, Chapter 29).

Table 3.8-1. Mitigation and Adaptive Management Measures for Potential Project Effects on the VEC Marine Sediment Quality

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	
	Only geochemically suitable rock quarries and borrow sources will be used to construct roads, pads, and structures
	Contact water will be directed to the collection pond (MLA).
	Infrastructure will be located, whenever feasible, on competent bedrock or appropriate base material that will limit permeability and transport of potentially poor quality water into the active layer, and ultimately to the marine environment
	The Project has been designed to use winter road only access corridors thereby limiting dust emissions and hence the potential influence on water and sediment quality
	Erosion potential will be reduced by working during periods of low runoff as much as possible.
	Ships will be conventional double-hulled, compartmentalized petroleum tankers, with Shipboard Oil Pollution Emergency Plans and appropriate response gear.
	Water will be recycled / reused where possible.
2. Regulatory Requirements	
	The operation of incinerators will comply with Nunavut standards, Canada-Wide Standards for Dioxins and Furans and Canada-Wide Standards for Mercury emissions. Modern incineration equipment will be installed to minimize airborne contaminant loading of polycyclic aromatic hydrocarbons.
	Adherence to guidelines for vessel discharges and anti-fouling surface treatments; • Organotin compounds are prohibited for vessels in Canadian waters. • Vessels must treat sewage prior to discharge, or discharge offshore. • Vessels travelling in international water must exchange ballast water offshore.
	Ships will carry out their operations in accordance with federal and international Transport of Dangerous Goods Regulations (International Maritime Dangerous Goods), including the *Transportation of Dangerous Goods Act* (1992) and the *Canada Shipping Act* (2001).
	The bulk fuel storage facility and all transfer-related equipment will be inspected and maintained, with complete documentation.
	Culvert maintenance will be conducted following the DFO Nunavut Operational Statement for Culvert Maintenance (DFO 2009).
	In-water work will be conducted during approved timing windows presented in the DFO Nunavut Operational Statement for Timing Windows. (DFO 2009).

(continued)

Table 3.8-1. Mitigation and Adaptive Management Measures for Potential Project Effects on the VEC Marine Sediment Quality (continued)

Mitigation Category	Mitigation Measures
2. Regulatory Requirements (*cont'd*)	
	Winter road construction will follow the DFO Nunavut Operational Statement for Ice Bridges and Snow Fills (DFO 2009).
	Water withdrawal will follow permit conditions.
3. Best Management Practices	
	Clean water and snow will be managed such that they do not contribute to potentially poor quality water and be diverted to maintain natural drainage networks as much as possible.
	Potentially poor quality site water will be directed to the collection pond (MLA).
	Sewage will be treated and treated sewage effluent will be discharged on land. There will be no direct discharge of treated sewage effluent or camp greywater to the marine environment.
	The discharge of brine water to Bathurst Inlet will be designed such that the salinity of Bathurst Inlet waters will remain within natural variability or CCME guidelines in any sensitive marine areas.
	Water in the collection pond (MLA) will be discharged on the tundra, and only if the water quality meets the future water license criteria
	Bulk fuel storage areas, hazardous materials storage areas, and explosives storage facilities will be bermed and lined with impermeable barriers to minimize leaks and spills.
	Modern incineration equipment will be installed to minimize airborne contaminant loading of dioxins, furans, and polycyclic aromatic hydrocarbons.
	Non-contact water will be diverted around infrastructure, as much as feasible, and directed to the ocean.
	Oily water treatment plants at equipment maintenance facilities will be used to minimize water and surface hydrocarbon contaminants.
	Disposal of excavated material will be in a location above the high water mark to ensure that this material does not enter the marine environment.
	Efforts shall be made to minimize the duration of any in-water works and minimize disturbance of riparian vegetation.
	Prevent the release of sediment or sediment laden water into water frequented by fish.
	Regular inspections will be conducted to ensure erosion and sediment control measures are functioning properly; all necessary repairs and adjustments will be conducted in a timely manner.
	Exposed landscape surfaces will be protected, where possible, by the installation of covering material like riprap, aggregate, or rolled erosion control products.
	If water held in control devices is turbid but chemically-unaltered, it may infiltrate to the ground rather than storing it in an excavation.
	Runoff will be controlled where applicable by a combination of measures, which include: • slope texturing/grading to slow runoff and reduce effect slope lengths; • installation of synthetic permeable barriers and/or fibre rolls to reduce runoff velocities and retain sediments; and • check dams, gabions, and energy dissipation structures to reduce flow velocities in channels.
	Sediment loading in runoff may be minimized by the application of measures to intercept TSS before it reaches the marine environment. Sediment control measures may include: • preservation of riparian zones to trap sediment and to reduce flow velocities; and • stockpiles will be located well away from watercourses.
	Visual monitoring will be conducted by Environmental personnel on a regular basis to ensure drainage and erosion controls are effective.

(continued)

Table 3.8-1. Mitigation and Adaptive Management Measures for Potential Project Effects on the VEC Marine Sediment Quality (completed)

Mitigation Category	Mitigation Measures
3. Best Management Practices (*cont'd*)	
	Environmental personnel will check for surface sheens in marine habitat during fuel transfer.
	Speed limits will be followed for vessel operations to minimize propeller wash and wake effects.
	The Oil Pollution Emergency Plan will describe the response and clean-up measures, which will include: • measures to protect personnel; • communication, spill response management, and reporting structures; • description of the spill containment and skimming equipment and deployment plans; and • training and auditing programs.
	Construct ice bridge and snow fill approaches using clean, compacted snow and ice to a sufficient depth to protect banks and shores.
	Vehicular access across a watercourse or waterbody will be by road or bridge, or other acceptable method according to DFO Operational Statements and Standards and Best Practices for Instream Works.
	All temporary works, silt curtains, construction material or debris, etc. are to be completely removed from the waterway when work is completed.
	Appropriate secondary containment systems will be used for petroleum product storage tanks to prevent spills and releases to water. This includes prevention of diesel release from pickups carrying tidy-tanks.
	Refueling and maintenance activities will not occur, where feasible, within 30 m of a watercourse or waterbody except where required due to equipment breakdown or approved activities near water.
	Refueling will occur, where feasible, at a refueling point with drainage capture/collection installed, in the event that refueling occurs elsewhere, drip trays may be used under vehicles and equipment.
4. Adaptive Management	
	The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include: • if results from the Surveillance Network monitoring program (which will be outlined in the future Type A Water License) show non-compliance; or • if results from the Aquatic Effects Monitoring Program, which will monitor the receiving environment around the mine infrastructure and activities, show negative effects to the marine environment.
5. Monitoring	
	An Aquatic Effects Monitoring Plan will be in place that outlines the Aquatic Effects Monitoring Program (AEMP) that will be carried out during all phases of the Project. The AEMP will include the following: • monitoring the marine environment at locations potentially affected by the Project and at reference areas well away from Project activities; • monitoring marine water quality, sediment quality, and aquatic biology; • monitoring fish populations and shellfish tissues.
	Regular inspections of water management facilities will be conducted by Environmental Personnel.
	There will be a Site Surveillance Network Monitoring Program that will be outlined in the future Type A Water License. This Program will consist of all of the site compliance monitoring that will be required for managing/moving and releasing water from all potential containment areas.

3.9 PROPOSED MONITORING PROGRAMS

3.9.1 Conceptual Aquatic Effects Management Plan

The Aquatic Effects Management Plan describes the specific measures that will be taken to minimize or eliminate potential negative effects on the marine and freshwater environments (presented in full in Volume 10, Chapter 19). The Plan includes the following components:

- planning and implementation processes for the Plan, including personnel and their responsibilities;
- mitigation and adaptive management measures;
- the Aquatic Effects Monitoring Program (AEMP); and
- processes for adaptive management, checking, recordkeeping, reporting, and QA/QC.

The AEMP will monitor the freshwater and marine environments around Project infrastructure and activities at a network of sites located in streams, lakes, and the near-shore marine environment. The sites were chosen on the basis of their proximity to Project activities and their suitability as sentinel sites in the monitoring program. Appropriate freshwater and marine reference sites were also identified to distinguish potential Project-related effects from natural processes. The AEMP will measure key physical, chemical, and biological parameters to determine if existing mitigation and management measures are adequate and will provide an opportunity for adaptive management on an annual basis. The program is designed for provide adequate spatial and temporal coverage to accurately identify and characterize any Project-related effects.

3.10 IMPACT STATEMENT

Seven potential effects were identified for the VEC marine sediment quality as a result of the Project: shipping; site preparation, construction, and decommissioning activities; site contact water; explosives; fuels, oils, and PAH; treated wastewater discharge; and dust deposition. Potential effects were characterized by using key indicators of marine sediment quality and quantitative thresholds for predicted effects as well as experience from other Northern projects and best professional judgement. Mitigation and management measures were described and their effectiveness was evaluated in the process of identifying residual effects. Three residual effects were identified after mitigation and management:

- shipping (propeller wash);
- site preparation, construction, and decommissioning activities; and
- site contact water.

Using the thresholds identified for the key indicators, each of these residual effects were rated with *low* magnitude and ultimately were rated as *not significant* because of the implementation of the extensive mitigation and management measures outlined in the Aquatic Effects Management Plan (Volume 10, Chapter 19) and in other management plans in Volume 10. All residual effects to marine sediment quality were predicted to be restricted to the LSA. Residual effects are expected to be reversible with sediment quality returning to baseline conditions because of the resiliency of the marine environment to the predicted residual Project effects.

No interactions between other past, present, or future projects and the Back River Project marine sediment quality residual effects were expected and no cumulative effects were predicted to occur.

4. Marine Fish/Aquatic Habitat

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4. Marine Fish/Aquatic Habitat

4.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

4.1.1 Overview and Regional Setting

The proposed Back River Project (the Project) lies in western Nunavut in the continuous permafrost zone of the continental Canadian Arctic. It is composed of three main areas: the Goose Property Area, the George Property Area, and the Marine Laydown Area (MLA; Figure 4.1-1). The Project will sealift materials and supplies through Bathurst Inlet during the open-water summer season to the MLA, which is located on the western shore of Southern Bathurst Inlet.

Bathurst Inlet is a fjord that is long (~165 km), narrow (~2 to 15 km), and deep (>300 m). This waterbody is divided into two major basins separated by a shallow sill. The outer inlet is the deeper of the two basins and contains many islands and a complex bathymetry. The inner inlet runs landward from the vicinity of Kingaok, has a relatively simple structure with few islands, and is shallower than the outer inlet, with depths between 100 and 150 m. The Western River discharges into the head of the inlet at the south, and the Mara River and Burnside River discharge into the western shoreline of the inlet. Numerous small streams discharge into the inlet along eastern and western shorelines. Bathurst Inlet cuts through the Bathurst Hills Ecoregion, which is characterized by strong relief built from massive granite rocks. The deeply indented, rocky shorelines lead to steep bathymetry with narrow nearshore areas.

Bathurst Inlet is typical of oligotrophic Arctic marine ecosystems, i.e., oxygenated throughout the water column, low in nutrients and metals, and low in phytoplankton biomass levels. Benthic invertebrates are both diverse and abundant in Bathurst Inlet, characteristics shared with other Arctic marine ecosystems. Mud and fine sediments dominate the benthic environment.

Winter is characterized by extreme cold (mean monthly temperatures -33°C), and ice cover is present on lakes between October and July (Rescan 2012a). Air temperatures are highest in July, reaching a mean monthly temperature of 14°C (see Volume 4, Chapter 3). The long dark winters promote the formation of sea-ice across the Inlet, which is typically ice-covered from October through June with up to 2 m of ice (Rescan 2011, 2012b, 2013a).

4.1.2 Regulatory Framework

4.1.2.1 The Fisheries Act

Fish and fish habitat are protected under the *Fisheries Act* (1985), as well as other federal regulatory acts and principles. In 2012, the *Fisheries Act* was amended to establish into legislation the federal government's direction to focus efforts on protecting the productivity of commercial, recreational, and Aboriginal fisheries; to institute enhanced compliance and protection tools that are more easily enforceable; to provide clarity, certainty, and consistency of regulatory requirements; and to enable enhanced partnerships with stakeholders.

The changes to the *Fisheries Act* include a prohibition against causing serious harm to fish that are part of or support a commercial, recreational, or Aboriginal fishery (Section 35), provisions for flow and passage (Sections 20 and 21), and a framework for regulatory decision-making (Sections 6 and 6.1).

The new Purpose section states that the fisheries protection provisions of the *Fisheries Act* aim to provide for the sustainability and ongoing productivity of commercial, recreational, and Aboriginal fisheries.

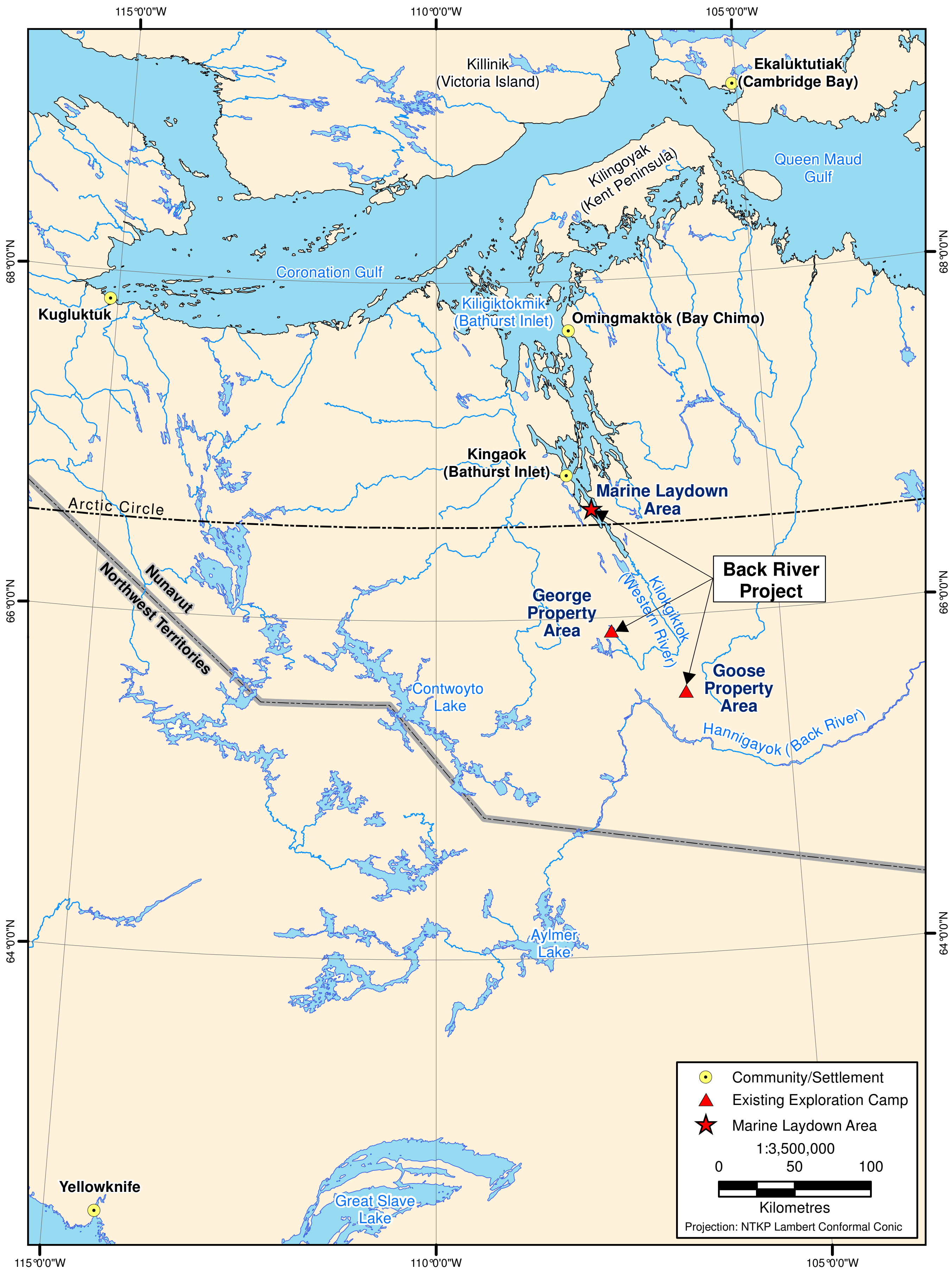

Figure 4.1-1

Project Location

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The four factors in Section 6 and 6.1 to be taken into account by the Minister in decision-making (e.g., issuing authorizations) or making regulations are:

- the contribution of the relevant fish to the ongoing productivity of commercial, recreational, or Aboriginal fisheries;
- fisheries management objectives;
- whether there are measures and standards to avoid, mitigate, or offset serious harm to fish that are part of a commercial, recreational, or Aboriginal fishery; and
- the public interest.

For the purposes of the *Fisheries Act*, serious harm to fish includes the death of fish or any permanent alteration to, or destruction of, fish habitat (PAD). The *Fisheries Act* defines fish habitat as "spawning grounds and any other areas, including nursery, rearing, food supply, and migration areas, on which fish depend directly or indirectly in order to carry out their life processes." The term "fish" includes parts of fish; shellfish, crustaceans, marine animals, and any parts of shellfish, crustaceans, or marine animals; and the eggs, sperm, larvae, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals.

On November 1, 2013, The Fisheries Protection Policy Statement (DFO 2013) was issued and replaced the earlier Policy for the Management of Fish Habitat (DFO 1986). Although the new policy statement does not include the "no net loss" principle, as outlined in the earlier policy, application of this NNL principle provides some useful guidance when considering "serious harm to fish." In addition, the direction found within the 2013 scientific guidance document (Koops et al. 2013; Randall et al. 2013) has been consulted and followed.

Any project or activity that causes a serious harm to fish that are part of, or support, a commercial, recreational, or Aboriginal fishery requires an authorization from DFO. Regulations have been developed to guide the application for this authorization: Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations. DFO has issued additional guidance in the "The Fisheries Protection Program Operational Approach."

4.1.2.2 Metal Mining Effluent Regulations

In 1996, Environment Canada undertook an assessment of the aquatic effects of mining in Canada. This assessment provided recommendations regarding the review and amendments of the Metal Mining Liquid Effluent Regulations, currently titled the *Metal Mining Effluent Regulations* (MMER; SOR/2002-222), and the design of a national Environmental Effects Monitoring (EEM) program for metal mining. The MMER, under the *Fisheries Act*, instruct metal mines to conduct EEM as a condition governing the authority to deposit effluent (MMER, Part 2, section 7).

The MMER (SOR/2002-222) permit the deposition of mine effluent into water containing fish if the effluent pH is within a defined range, if the concentrations of the MMER deleterious substances in the effluent do not exceed authorized limits, and if the effluent is demonstrated to be non-acutely lethal to Rainbow Trout (*Oncorhynchus mykiss*). These discharge limits were established to be minimum national standards based on best available technology economically achievable at the time that the MMER were promulgated. To assess the adequacy of the effluent regulations for protecting the aquatic environment, the MMER include EEM requirements to evaluate the potential effects of effluents on fish, fish habitat, and the use of fisheries resources.

Regulations Amending the MMER were published in the Canada Gazette, Part II, in October 2006 (Canada Gazette 2006). The purpose of these amendments was to clarify the regulatory requirements by addressing matters related to the interpretation and clarity of the regulatory text that had emerged from the implementation of the Regulations.

Additional amendments to the MMER were published in the Canada Gazette, Part II, in March 2012 (Canada Gazette 2012). The following changes were made to improve the EEM provisions of the MMER:

- modifications to the definition of an "effect on fish tissue" in order to be consistent with the Health Canada fish consumption guidelines and to clarify that the concentration of total mercury in tissue of fish from the exposure area must be statistically different from and higher than its concentration in fish tissue from the reference area;
- addition of selenium and electrical conductivity to the list of parameters required for effluent characterization and water quality monitoring;
- exemption for mines, other than uranium mines, from monitoring radium 226 as part of the water quality monitoring, if 10 consecutive test results showed that radium 226 levels are less than 10% of the authorized monthly mean concentration (subsection 13(2) of the Regulations; SOR/2002-222);
- change to the time frame for the submission of interpretative reports for mines with effects on the fish population, fish tissue, and benthic invertebrate community from 24 to 36 months;
- change to the time frame for the submission of interpretative reports for magnitude and geographic extent of effects, and for investigation of cause of effects, from 24 to 36 months; and
- minor changes to the wording for consistency within Schedule 5.

4.1.3 Proximity to Designated Environmental Areas

No existing or proposed parks or conservation areas are in, or border, Bathurst Inlet. The nearest conservation area, the Queen Maud Gulf Migratory Bird Sanctuary is located approximately 100 km east of Bathurst Inlet on the far side of the Kent Peninsula. The Draft Nunavut Land Use Plan (Nunavut Planning Commission 2012) has no special designation for the marine environment of Bathurst Inlet, but the caribou calving grounds in the region have been designated PSE-R2. The proposed Huikitak River Cultural Area is located on the eastern shore of Bathurst Inlet, and is situated approximately 40 km east of Kingaok, 60 km north-by-northeast of the proposed MLA, and 140 km north of the George Property Area (Figure 4.1-1).

4.1.4 Baseline Study Area

The Project will interact with marine fish/aquatic habitat primarily due to ship travel into Bathurst Inlet and by loading and unloading activities at the MLA (Figure 4.1-2). The MLA may include in-water structures (a beach ramp and temporary dock) and will be the location of the majority of Project activities that may interact with marine fish/aquatic habitat. For the purposes of the existing environment and baseline information, the MLA and sites in the immediate vicinity of the proposed MLA constitute the Local Study Area (LSA), which includes areas where there exists the reasonable potential for immediate effects due to Project activities, ongoing normal activities, or to possible abnormal operating conditions (NIRB 2013). In the case of the Back River Project MLA, the LSA also includes the area where the winter road crosses Bathurst Inlet (Figure 4.1-2). The Regional Study Area (RSA) includes the LSA plus additional areas within which there is the potential for indirect or cumulative effects. The marine fish/aquatic habitat RSA includes all of Bathurst Inlet and is the same RSA for all of the marine VECs.

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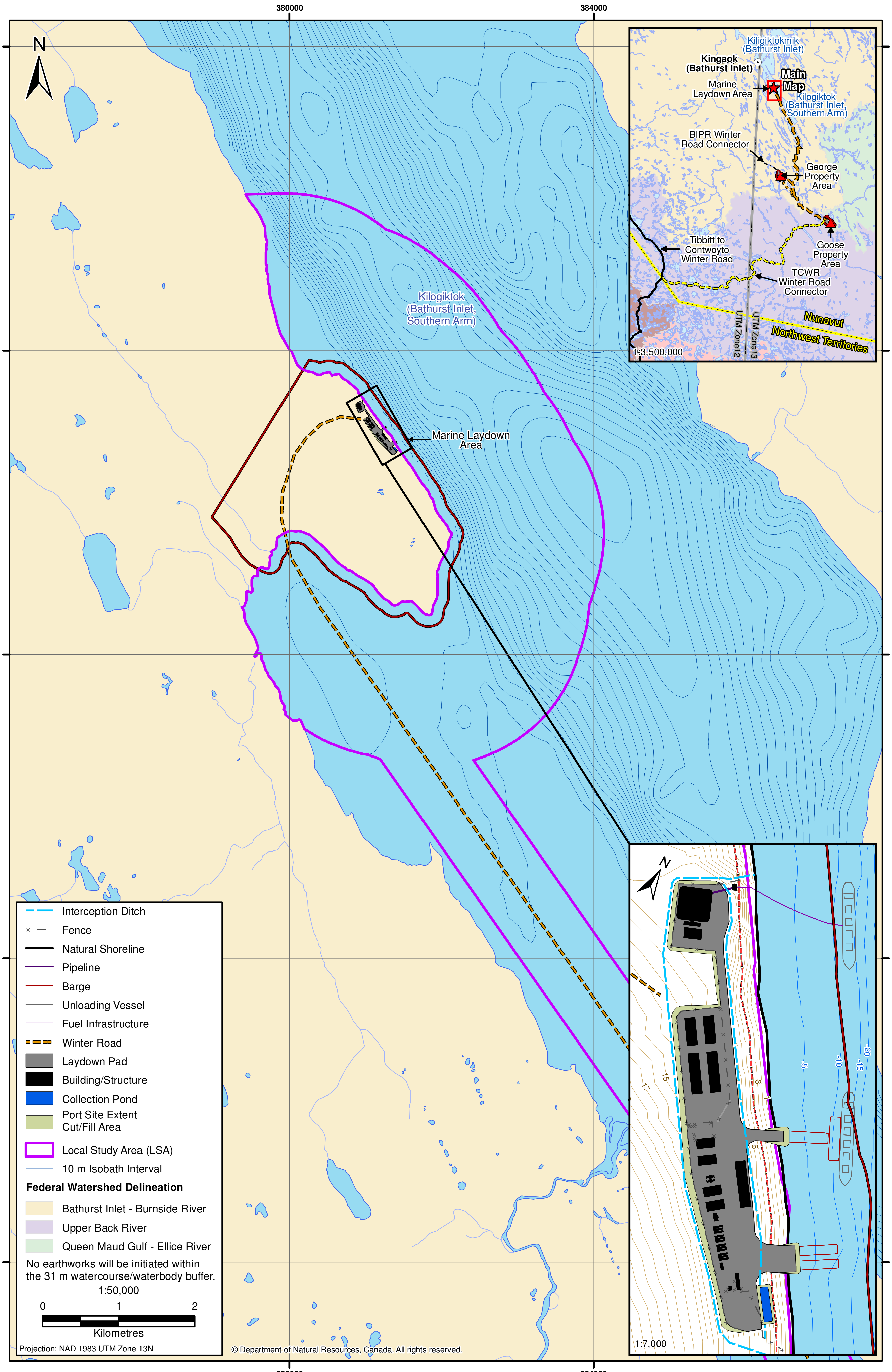

Figure 4.1-2

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Project Site Layout for Marine Laydown Area

Figure 4.1-2

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4.1.5 Baseline Studies

4.1.5.1 Information Sources

Data used for the assessment of potential impacts on marine fish/aquatic habitat were collected from various sources. The primary sources of information for the marine fish habitat at the LSA were two baseline studies conducted in 2012 and 2013 (Rescan 2012c, 2013b). Baseline information in the RSA was also collected in studies conducted in 2001, 2002, 2007, 2008, and 2010 through 2013 (Rescan 2002, 2007a, 2007b, 2007c, 2008a, 2008b, 2012d, 2012e, 2012f, 2012b, 2013c, 2013d). The objectives of baseline sampling varied from year to year based on the potential Project plans. Full details of the baseline program for the marine fish habitat are described in the following Back River Project reports:

- *Back River Project: 2012 Marine Fish and Fish Habitat Baseline Report* (Rescan 2012c, Appendix V7-4A);
- *Back River Project: 2013 Marine Fish and Fish Habitat Baseline Report* (Rescan 2013b);
- *Back River Project: 2013 Marine Physical Processes Baseline Report* (Rescan 2013c); and
- *Back River Project: 2013 Preliminary Desalination Assessment at the Marine Laydown Area, Bathurst Inlet, NU, Memo* (Rescan 2013d, Appendix V7-2A).

Baseline data was supplemented using the following Rescan reports were from other projects located within Bathurst Inlet:

- *Bathurst Inlet Port and Road Project: Marine Environment Baseline Studies, 2001-2002* (Rescan 2002);
- *Bathurst Inlet Port and Road Project: Marine Environment Baseline Study, 2007* (Rescan 2007a);
- *Bathurst Inlet Port and Road Project: Marine Physical Processes Study, 2007* (Rescan 2007b);
- *Hackett River Project: 2007 Marine Baseline Report* (Rescan 2007c);
- *Bathurst Inlet Port and Road Project: Draft Environmental Impact Statement – Volume VI* (Rescan 2008a);
- *Hackett River Project: 2008 Marine Baseline Report* (Rescan 2008b);
- *Bathurst Inlet Port and Road Project: Marine Aquatic Resources Baseline Study, 2010* (Rescan 2012d);
- *Bathurst Inlet Port and Road Project: Marine Fish and Fish Habitat Baseline Study, 2010* (Rescan 2012e);
- *Bathurst Inlet Port and Road Project: Marine Shellfish and PAH Content Study, 2012* (Rescan 2012f); and
- *Bathurst Inlet Port and Road Project: Physical Oceanography Baseline Study, 2012* (Rescan 2012b).

In addition, information from historical sources pertaining to fish habitat or species composition, and other relevant information regarding the RSA, was gathered through the review of government documents and databases, academic papers, books, and reports prepared for resource development purposes.

4.1.5.2 Baseline Study Methods

Baseline information on marine fish/aquatic habitat has been collected since 2001 in Bathurst Inlet, with information collected at nearshore LSA sites near the MLA in 2012 and 2013 (Figure 4.1-3). The baseline sampling program collected data on fish habitat, physical water column and substrate structure, dissolved oxygen concentrations, water quality, and marine aquatic life (biological resources).

Marine Fish Habitat – Physical Characteristics

The physical characteristics of marine fish habitat (e.g., type and arrangement of different substrates, climate, and water quality and chemistry) have important influences on the diversity and abundance of the fish species that constitute a fish community inhabiting at any given marine site in the Arctic (DFO 1989; Waldichuk 1993; Gutt 2001; Grebmeier et al. 2006). Baseline studies of the physical characteristics of habitat for Arctic marine fish were conducted in Bathurst Inlet in 2001, 2010, 2012, and 2013 (Rescan 2002, 2012c, 2012d, 2012e, 2012f, 2012b; 2013d; Appendices V7-4A and V7-4B) and near the MLA in both 2012 and 2013 (Rescan 2012c; 2013b; Appendix V7-4A). Physical habitat characteristics of the intertidal and nearshore habitat were assessed within the physical habitat study areas (Figure 4.1-3). The methods employed in these studies were designed to collect biologically relevant characteristics of habitat, with the objective of identifying major habitat units and habitat types found in southern Bathurst Inlet.

In baseline reports, the intertidal zone was defined as all habitat between the high water line and 1 m below the low tide line. This zone actually reflects both the intertidal and beach zones along the shoreline. Description of the substrate in the intertidal/beach was accomplished by first dividing it into habitat units identified by similar shoreline characteristics. Next, the units were further divided along a vertical transect. Finally, observations were made of the length, substrate composition, abundance and type of cover, and other permanent habitat characteristics within each zone and unit.

Nearshore habitat was characterized using observations collected through aerial, hydroacoustic, underwater video, and snorkel sampling (Table 4.1-1). Aerial surveys were conducted in 2001, when nearshore habitat types were photographed during a low altitude helicopter flight and dominant substrate types were identified. Hydroacoustic surveys were conducted in 2010, 2012, and 2013. These surveys were conducted along transects in the nearshore area between depths of approximately 1 m and 40 m, with greater effort in areas of particular interest. The hydroacoustic surveys characterized substrate composition based on the ratio between the first and second bottom echo, creating an estimate of dominant substrate types along the transect lines.

Table 4.1-1. Summary of Marine Physical Habitat Surveys Conducted in Bathurst Inlet, 2001 to 2013

		Sampled Environment		Survey Type			
Year	Location	Intertidal	Nearshore	Hydroacoustic	Snorkel	Aerial	Underwater Video
2001	RSA	X	X	-	-	X	-
2010	RSA	X	X	X	X	-	X
2012	LSA and RSA	X	X	X	-	-	X
2013	LSA	X	X	X	-	-	X

Note: X = survey completed, - = survey not completed

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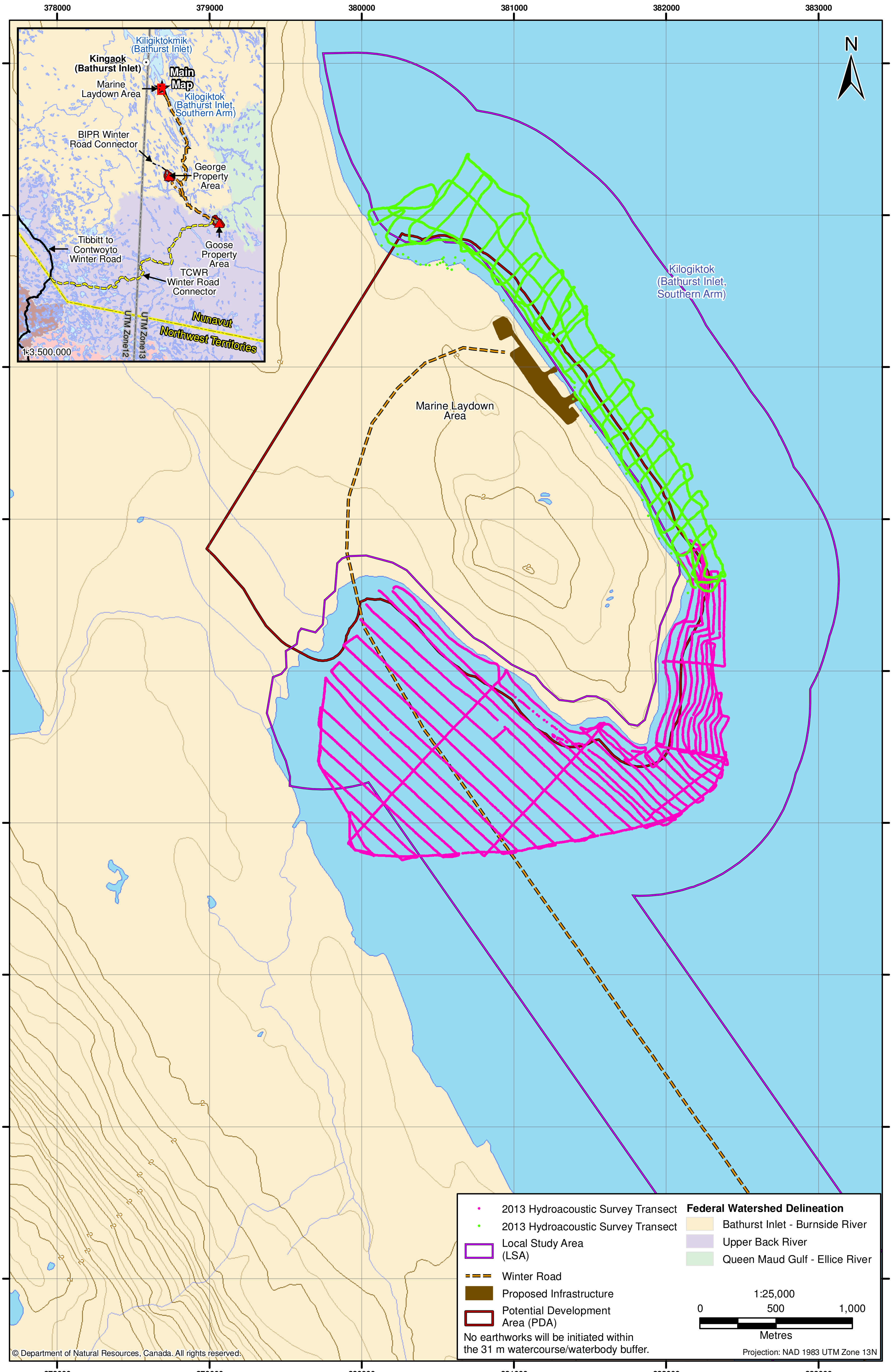

Figure 4.1-3

Baseline Marine Bathymetric and Substrate Surveys at the Marine Laydown Area

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Underwater video sampling was used to ground truth the hydroacoustic survey findings in 2010, 2012, and 2013, and to provide additional information regarding substrate composition and characteristics. In 2011, snorkeling surveys were performed along transects in the intertidal and littoral zone.

Marine Fish Habitat – Biological Resources

Phytoplankton

Species of phytoplankton constitute one of the key bases for the food webs that support communities of Arctic marine fishes, which include important marine fishery species (Horner and Schrader 1982; Huse et al. 2004; McMeans et al. 2013). Baseline studies of marine phytoplankton were conducted in the RSA in 2001, 2007, 2010, and 2012 (Rescan 2002, 2007a, 2012c; 2012d; Appendices V7-4A and V7-4B) and in the LSA 2012 and 2013 (Rescan 2012c; 2013b; Table 4.1-2; Figure 4.1-4). Phytoplankton biomass (as chlorophyll *a*) and taxonomy samples were collected by Niskin sampling bottles (ice-covered sampling) or GO-FLO sampling bottles (open-water sampling). All samples were transferred into 1 L plastic bottles and stored in a cooler (i.e., cool, dark environment) until return to camp. Once at camp, the biomass samples were filtered onto 0.45 µm filters, which were then wrapped in aluminum foil and stored frozen. Chlorophyll a samples were frozen and then hand carried to Vancouver (BC) to ensure they remained frozen; these samples were then sent to the analytical laboratory for analysis. Taxonomy samples were preserved with Lugol's iodine solution once back at camp. These samples were sent immediately to the analytical laboratory for enumeration and identification.

Zooplankton

Marine zooplankton communities are key sources of food for planktivorous fish species, and they form important trophic linkages between primary producers and higher trophic levels in marine food webs, including those occupied by omnivorous and piscivorous fish species (Horner and Murphy 1985; Huse et al. 2004; McMeans et al. 2013). Baseline zooplankton studies were conducted in the RSA in 2001 and 2007 (Rescan 2002, 2007c) and in the LSA in 2013 (Rescan 2013b; Table 4.1-3; Figure 4.1-5). Zooplankton abundance and taxonomy samples were collected at each site, with three replicate vertical hauls taken using a plankton net with a mesh size of 118 µm. The net was lowered to 1 m above the sediment and brought to the surface at a speed of 0.5 m/s. An internally-mounted flowmeter was used to record the volume of water that passed through the net during all hauls. Zooplankton samples were preserved with 10% buffered formalin and sent to a qualified taxonomist for enumeration and identification.

Benthic Invertebrates

Marine benthic invertebrates (i.e., benthos) are both an important direct source of food for benthic-feeding fishes and an important linkage for energy transfer from lower trophic levels in marine food webs (e.g., primary producers) to higher-trophic levels, including those ultimately occupied by piscivorous fishes, birds, and mammals (Hobson and Welch 1992; DFO 2008; McMeans et al. 2013). Baseline benthic invertebrate studies were conducted in the RSA in 2001, 2002, 2007, 2010, and 2012 (Rescan 2002, 2007c; 2012c; Appendix V7-2A) and in the LSA in 2013 (Rescan 2013b; Table 4.1-4; Figure 4.1-6). All samples were collected with a Petite Ponar dredge. Triplicate sampling was performed at each site, with replicates being collected approximately 20 to 50 m apart. The Petite Ponar dredge was carefully set open, lowered gradually onto the sediment using a metred cable line, and triggered closed. Once recovered, each sediment sample was transferred into a 500 µm sieve bucket and rinsed with site-specific water until free of sediment particles smaller than this size. The material retained within the sieve was then transferred to a labelled plastic jar and filled with 10% buffered formalin. All benthos samples were sent to the analytical laboratory for enumeration and identification. Benthos density was calculated by dividing total benthos counts by the surface area of the Petite Ponar sampler (0.0225 m^2).

Table 4.1-2. Marine Baseline Phytoplankton Sampling Program in Bathurst Inlet, 2001 to 2013

Year	2001	2007	2010	2012	2013
Sampling Month(s)	August	August	August	April, August	July
Sampling Agency	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.
Sampling Method	GO-FLO sampling bottle	GO-FLO sampling bottle	GO-FLO sampling bottle	Niskin sampling botlle (April); GO-FLO sampling bottle (August)	GO-FLO sampling bottle
Analytical Lab	ALS Environmental Ltd. (chl *a*); Fraser Environmental Services Ltd. (taxonomy)	ALS Environmental Ltd. (chl *a*); Biologica Environmental Services Ltd. (taxonomy)	ALS Environmental Ltd. (chl *a*)	ALS Environmental Ltd. (chl *a*); EcoAnalysts Inc. (taxonomy)	ALS Environmental Ltd. (chl *a*); EcoAnalysts Inc. (taxonomy)
Data Collected	Phytoplankton biomass as chl *a*; phytoplankton taxonomy;	Phytoplankton biomass as chl *a*; phytoplankton taxonomy;	Phytoplankton biomass as chl *a*;	Phytoplankton biomass as chl *a*; phytoplankton taxonomy;	Phytoplankton biomass as chl *a*; phytoplankton taxonomy;
Site(s) Sampled	BIPR2001A BIPR2001B BIPR2001C BIPR2001D BIPR2001E	HACK20071 HACK20072 HACK20074 HACK2007Rb	BIPR2010R BIPR20101 BIPR20102 BIPR20103a BIPR20103b BIPR20104 BIPR20105 BIPR20106a BIPR20106b BIPR20107	BACK2012BI1 BACK2012BI2 BACK2012BI3 BACK2012BI4 BACK2012O410 BACK2012O414 BACK2012O420 BACK2012O424 BACK2012O430 BACK2012O440 BACK2012O444 BACK2012O610 BACK2012O620 BACK2012O624 BACK2012O640 BACK2012O644 BACK2012O650 BACK2012O654	BACK2013N12 BACK2013J12 BACK2013S12 BACK2013O650
Depths Sampled and Number of Replicates per Site	For chl *a*: 4 depths (near surface, mid-euphotic zone, deep-euphotic zone, below euphotic zone), n = 3; For taxonomy: 1 surface (1 m) sample	For chl *a*: 3 depths (1 m, mid-euphotic zone, base of the euphotic zone) , n = 3; For taxonomy: 1 surface (1 m) sample	For chl *a*: 1 surface (1 m) sample, n = 3	For chl *a*: 1 surface (1 m) sample, n = 3; For taxonomy: 1 surface (1 m) sample	For chl *a*: 1 surface (1 m) sample, n = 3; For taxonomy: 1 surface (1 m) sample
Composition of a Single Replicate	Single discrete sample	Single discrete sample	Single discrete sample	Single discrete sample	Single discrete sample

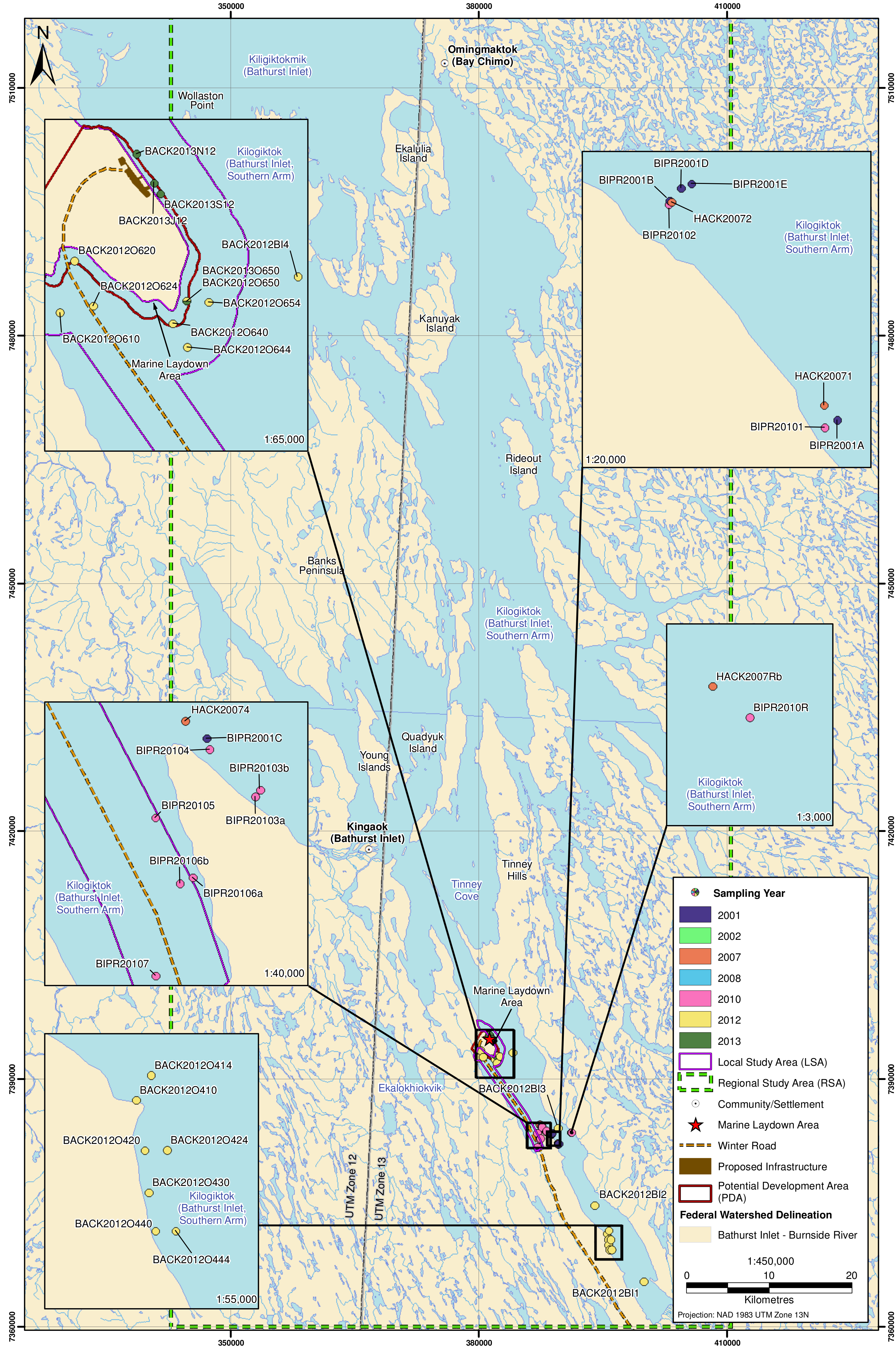


Figure 4.1-4

Sabina GOLD & SILVER CORP.

Baseline Phytoplankton Sampling (2001 to 2013), Bathurst Inlet

Rescan an ERM company

PROJECT # 0194096-0040 GIS # BAC-28-013b December 18 2013

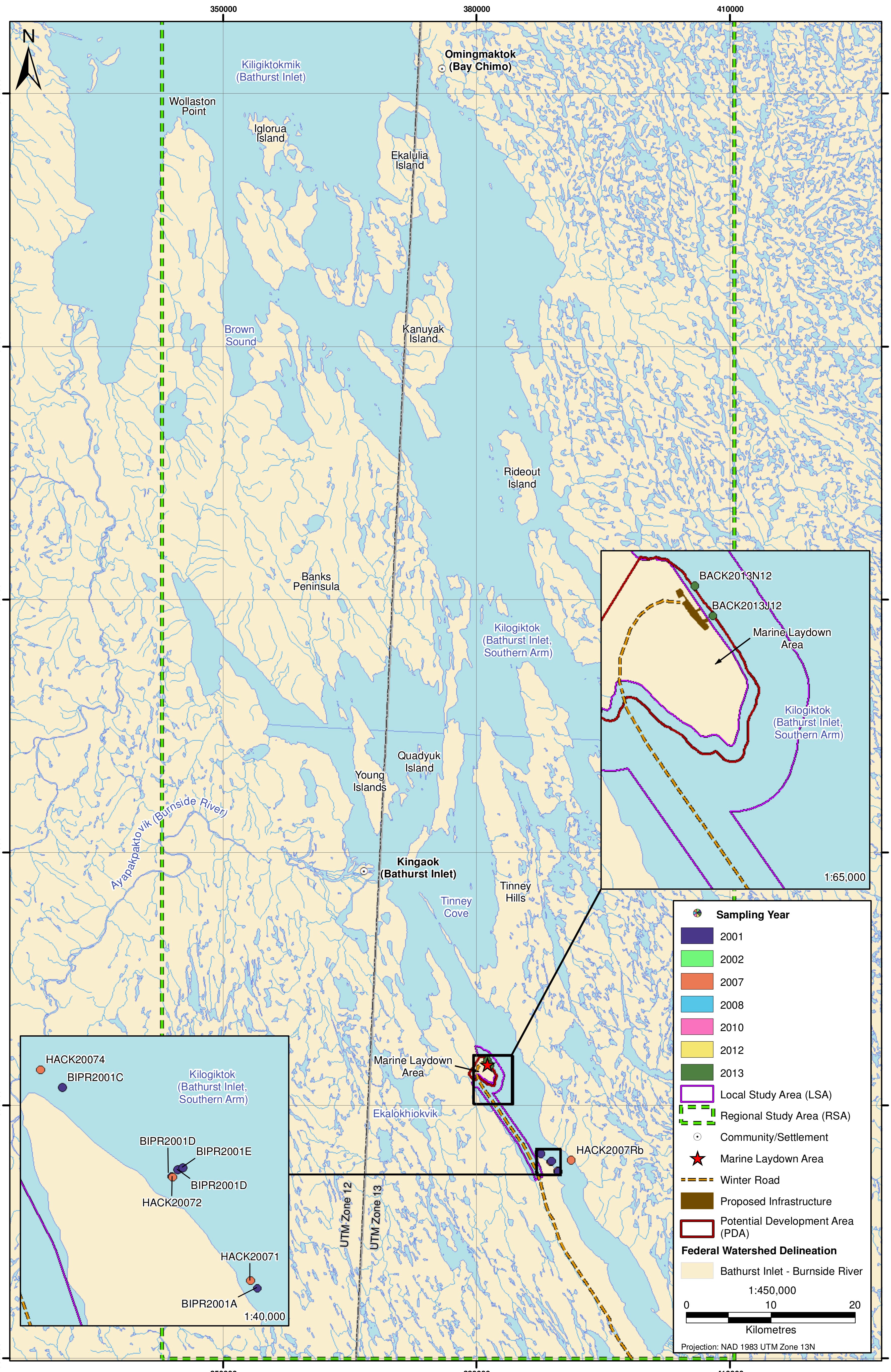
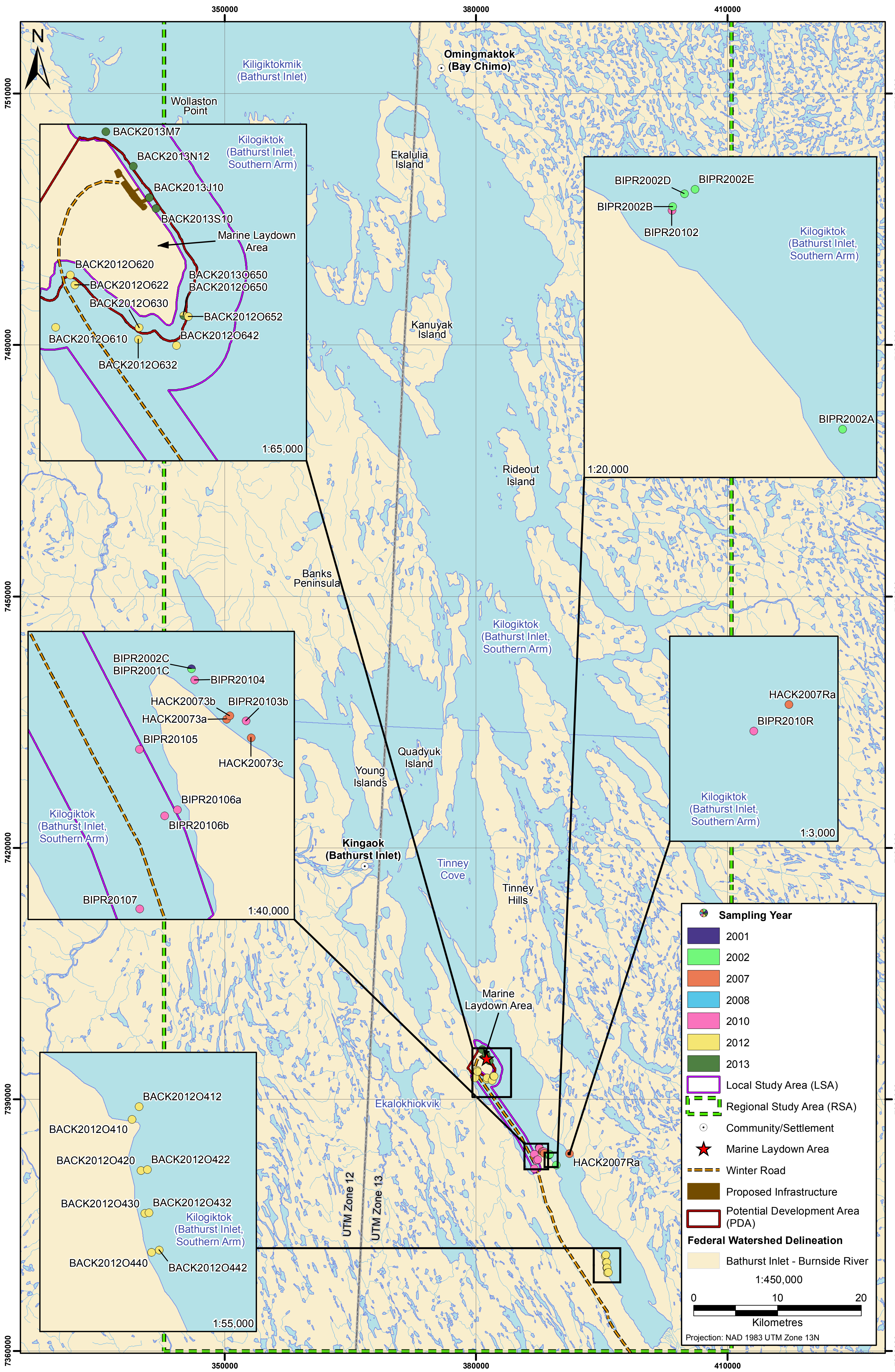


Figure 4.1-5

Sabina GOLD & SILVER CORP.

Baseline Zooplankton Sampling (2001 to 2013), Bathurst Inlet

Rescan an ERM company



Sabina GOLD & SILVER CORP

Baseline Benthic Invertebrate Sampling (2001 to 2013), Bathurst Inlet

Figure 4.1-6

Rescan an ERM company

Table 4.1-3. Marine Baseline Zooplankton Sampling Program in Bathurst Inlet, 2001 to 2013

Year	2001	2007	2013
Sampling Month(s)	August	August	July
Sampling Agency	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.
Sampling Method	Plankton net, 118 µm mesh, 1.5 m	Plankton net, 118 µm mesh, 1.5 m	Plankton net, 118 µm mesh, 1.5 m
Analytical Lab	Applied Technical Services Ltd.	Biologica Environmental Services Ltd.	EcoAnalysts Inc.
Data Collected	Zooplankton density and taxonomy	Zooplankton density and taxonomy	Zooplankton density and taxonomy
Site(s) Sampled	BIPR2001A BIPR2001B BIPR2001C BIPR2001D BIPR2001E	HACK20071 HACK20072 HACK20074 HACK2007Rb	BACK2013N12 BACK2013J12
Depths Sampled and Number of Replicates per Site	Three replicate tows	Three replicate tows	Three replicate tows
Composition of a Single Replicate	Single tow from near-bottom to surface	Single tow from near-bottom to surface	Single tow from near-bottom to surface

Table 4.1-4. Marine Baseline Benthos Sampling Program in Bathurst Inlet, 2001 to 2013

Year	2001	2002	2007	2010	2012	2013
Sampling Month(s)	August	August	August	August	August	July
Sampling Agency	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.	Rescan Environmental Services Ltd.
Sampling Method	Petite Ponar (0.0225 m^2)	Petite Ponar (0.0225 m^2)	Petite Ponar (0.0225 m^2)	Petite Ponar (0.0225 m^2)	Petite Ponar (0.0225 m^2)	Petite Ponar (0.0225 m^2)
Analytical Lab	Applied Technical Services Ltd.	Applied Technical Services Ltd.	Maxxam Analytics	Columbia Science	Columbia Science	Columbia Science
Data Collected	Benthos density and taxonomy	Benthos density and taxonomy	Benthos density and taxonomy	Benthos density and taxonomy	Benthos density and taxonomy	Benthos density and taxonomy
Site(s) Sampled	BIPR2001C	BIPR2002A BIPR2002B BIPR2002C BIPR2002D BIPR2002E	HACK20073a HACK20073b HACK20073c HACK2007Ra	BIPR2010R BIPR20102 BIPR20103b BIPR20104 BIPR20105 BIPR20106a BIPR20106b BIPR20107	BACK2012O410 BACK2012O412 BACK2012O420 BACK2012O422 BACK2012O430 BACK2012O432 BACK2012O440 BACK2012O442	BACK2013N12 BACK2013J10 BACK2013S10 BACK2013O650 BACK2013M7

(continued)

Table 4.1-4. Marine Baseline Benthos Sampling Program in Bathurst Inlet, 2001 to 2013 (completed)

Year	2001	2002	2007	2010	2012	2013
Site(s) Sampled (*cont'd*)					BACK2012O610 BACK2012O620 BACK2012O622 BACK2012O630 BACK2012O632 BACK2012O642 BACK2012O650 BACK2012O652	
Depths Sampled and Number of Replicates per Site	3 replicates per site	3 replicates per site	3 replicates per site (except only one rep. at HACK20073a)	3 replicates per site	3 replicates per site	3 replicates per site
Composition of a Single Replicate	Single discrete sample	Single discrete sample	Single discrete sample	Single discrete sample	Single discrete sample	Single discrete sample

4.1.5.3 Fish/Aquatic Habitat QA/QC

Chain of custody forms were used for all aquatic biology samples. All samples had replication; triplicate samples were taken for chlorophyll *a* (phytoplankton biomass), phytoplankton taxonomic analysis, and benthos. Additional QA/QC measures were used by the benthic invertebrate taxonomist to ensure consistent and accurate sorting of benthos samples.

As part of the QA/QC program, the re-sorting of benthic sample residues was conducted on a randomly selected 10% of the samples of benthos to determine the level of sorting efficiency. The criterion for an acceptable sorting was that more than 90% of the total number of organisms found in both the initial and QA/QC sorts were recovered during the initial sort, as required by Environment Canada for invertebrate community surveys (Environment Canada 2002). This was calculated by the following equation:

$$\%\, sorting\ efficiency = \left(1 - \frac{\#\ in\ QA/QC\ re\text{-}sort}{\#\ sorted\ originally + \#\ in\ QA/QC\ re\text{-}sort}\right) \times 100$$

Any sample not meeting the 90% removal criterion was re-sorted a third time. The 90% minimum efficiency was attained for all samples of benthos.

4.1.6 Setting – Marine Habitat

Marine Fish Habitat – Physical Characteristics

Shoreline habitat in the LSA and the southern section the RSA in Bathurst Inlet is dominated by a shallow water shelf which extends at a slope of 8% to a depth of approximately 10 m and a distance of 120 m offshore (Figures 4.1-7 and 4.1-8). Beyond this distance, the shoreline drops off steeply at a gradient of 30% to depths greater than 40 m.

During the spring freshet, sediment enters the LSA from various streams, on the west side of the peninsula. This sediment settles to the bottom and provides a fine, marine clay substrate characteristic of the LSA, and RSA as a whole (Plate 4.1-1). Sediment may be deposited along the shoreline; however, yearly ice scour prevents significant amounts of fine sediment from occurring in the intertidal and beach zone.

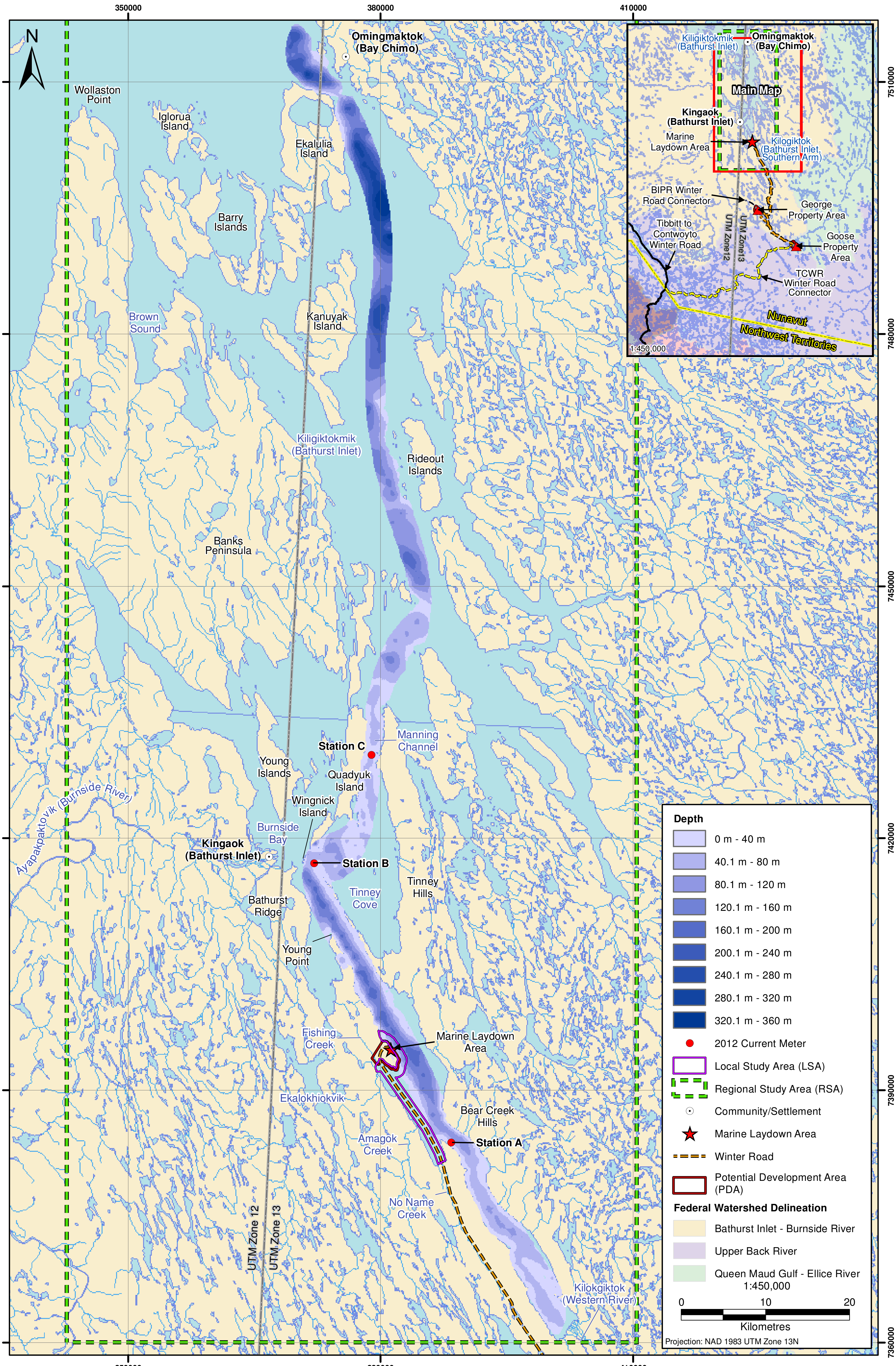


Figure 4.1-7

Sabina GOLD & SILVER CORP.

Bathymetry around the Local and Regional Study Areas

Figure 4.1-7

Rescan an ERM company

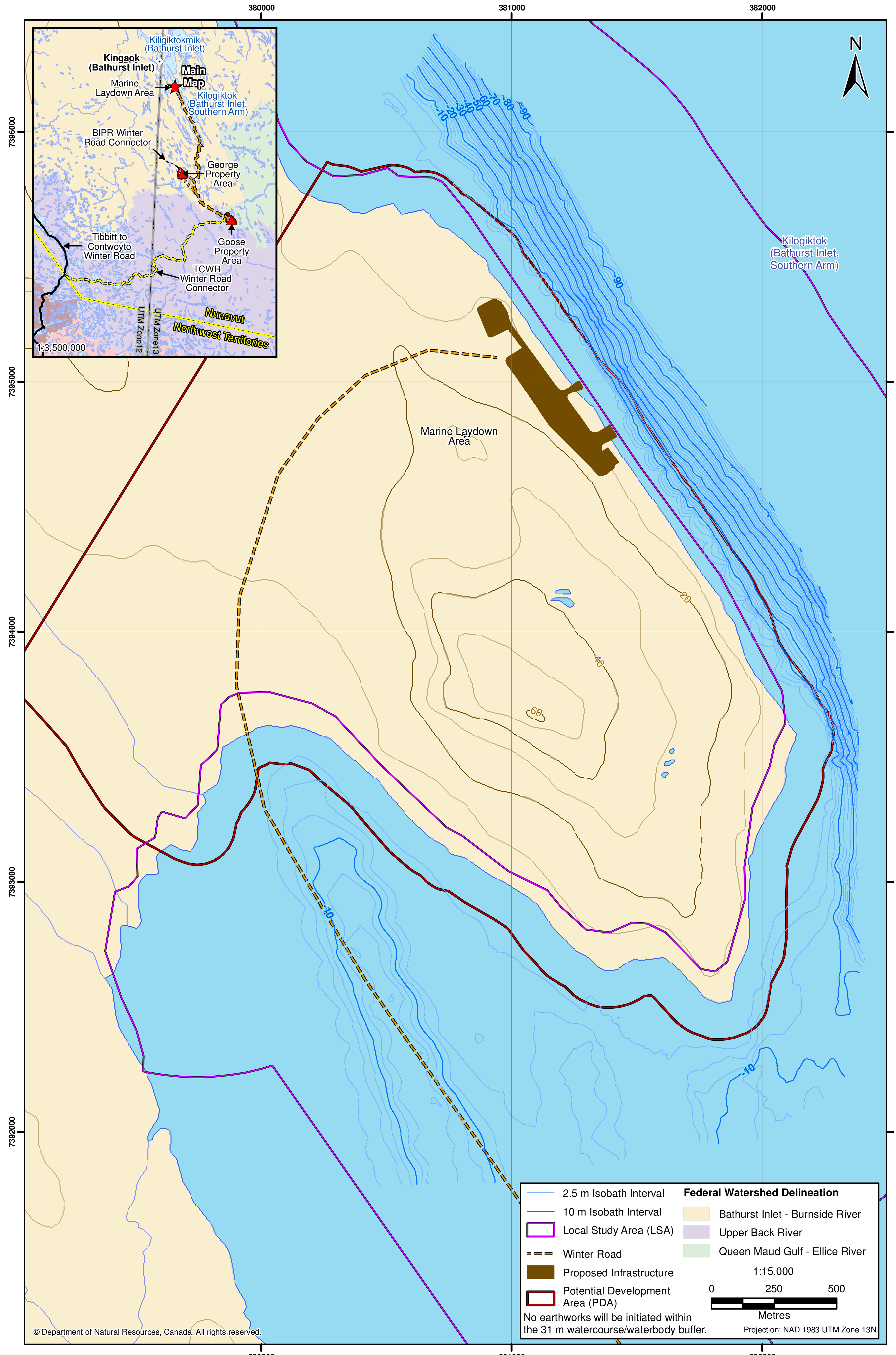


Figure 4.1-8

Sabina GOLD & SILVER CORP.

Bathymetry around the Potential Development Area at the Marine Laydown Area

Rescan an ERM company

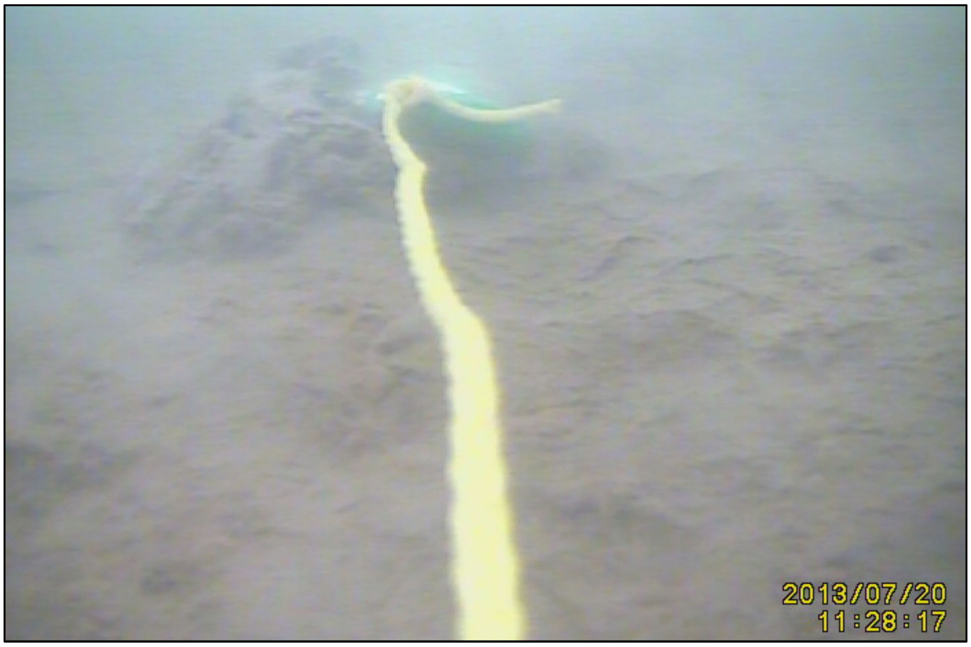


Plate 4.1-1. Marine clay substrate at the LSA, Bathurst Inlet, July 20, 2013.

Habitat at the LSA varies along the shoreline from sheltered bays to headlands. Ice scour and wave action are reduced in the two sheltered areas (at the north and south ends of the LSA; Figure 4.1-8), allowing sediment to remain in nearshore areas. The shoreline in these areas has a lower gradient, and the bays are generally shallow. The intertidal/beach zones in more wave exposed headlands areas contain gravel, cobble, and boulder substrates (Plate 4.1-2), whereas sheltered zones are primarily composed of mud and other fine sediments (Figure 4.1-9).

Plate 4.1-2. Exposed intertidal zone with a low gradient, Bathurst Inlet, July 16, 2013.

Mud, sand/gravel, and cobble/rock substrates were found in the southern bay within the LSA sites surveyed using hydroacoustic sampling (Figure 4.1-9). Mud is the most common substrate type found in the LSA, accounting for 49% of the sampled area on average. Mud was the primary substrate type in sheltered areas and deep water.

Mixed cobble/large rock substrate was distributed unevenly, ranging between 3 and 45% of the total substrate composition at surveyed sites. Cobble, sand, gravel, and rock were most commonly observed in hydroacoustic and snorkel surveys in very shallow depths (<5 m) and in areas with more exposure to wave and ice scour, as well as in the intertidal and beach zone. Although cobble and rock was identified as the second most common habitat type by hydroacoustic surveys, underwater video observations of cobble and rock were rare. Cobble or boulders were the predominant substrate type at only two of the 125 sites where video observations were made along the southern bay of the LSA.

In the northern section of the LSA the intertidal and beach zone was comprised primarily silt/sand, gravel, and cobble. These were among the most common substrate types in the shallow depths of the LSA as well (Figure 4.1-9). A small stream contributes freshwater to the LSA approximately 1 km north of the proposed infrastructure proposed for the PDA. At the northern limit of the LSA gravel, cobble, and sand were still predominant, but boulders were also present in this area.

Potentially important habitat areas for marine fish and anadromous fish along the shipping routes within Bathurst Inlet were identified through TK (KIA 2012) and nearshore surveys. Coastal areas near the outlet of 'char run' rivers were identified through TK as important habitat for Arctic Char. These habitats are part of the migratory pathway for anadromous Arctic Char. Also identified were intertidal gravel beaches and shallow demersal gravel habitats, which are important spawning habitat for Capelin (Nakashima and Wheeler 2002). Capelin have been observed spawning within the PDA, which contains these kinds of habitats (Figure 4.1-8). No other specific habitat locations were identified as being important to marine and anadromous fish along the shipping route. Environment Canada (2002) did not cite critical fish shoreline habitat in their report documenting sensitive Arctic habitat.

Marine Fish Habitat – Biological Resources

Phytoplankton

Phytoplankton are pelagic photosynthetic microorganisms. Primary production by phytoplankton is an important source of organic matter for coastal marine environments in the Arctic, and provides much of the energy for pelagic and benthic food webs and fisheries in this setting (Rysgaard, Nielsen, and Hansen 1999; Michel, Ingram, and Harris 2006). Baseline sampling of the phytoplankton community in Bathurst Inlet has been conducted since 2001 (Table 4.1-2).

Like many Arctic waters, Bathurst Inlet is characterized by low phytoplankton abundance and biomass. Baseline sampling in ice-covered winter conditions in Bathurst Inlet found very low phytoplankton biomass and cell concentrations (chl *a* concentration < 0.5 g/L; phytoplankton cell density < 100 cells/L; 2012 baseline sampling, Appendix V7-2A). The phytoplankton community in the under-ice sampling in 2012 was dominated by dinoflagellates (*Katodinium* and *Protoperidinium* spp.) and diatoms (*Fragilaria* and *Nitzschia* spp.). The abundances of these phytoplankton species were likely limited by light. Ice and snow cover, combined with short day lengths, greatly restricted the light available to phytoplankton, thus minimizing their photosynthesis and potential growth.

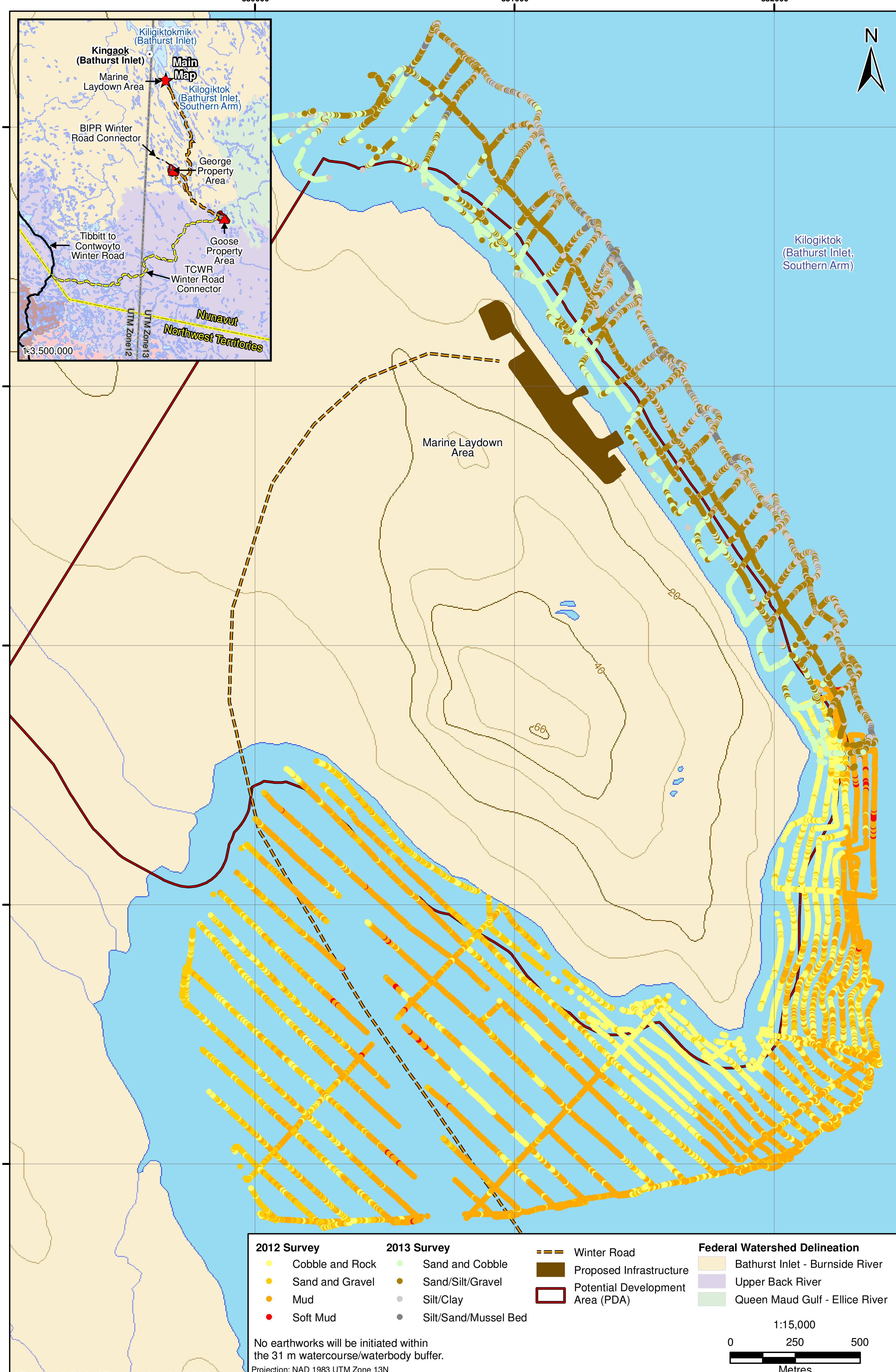


Figure 4.1-9

Sabina GOLD & SILVER CORP.

Substrate Type around the Potential Development Area at the Marine Laydown Area

Rescan an ERM company

Seasonally ice-covered marine systems in the Arctic usually experience a spring phytoplankton bloom associated with the break-up of the ice cover and the lengthening of days (Rysgaard, Nielsen, and Hansen 1999; Leu et al. 2011). This spring bloom consists primarily of diatoms and provides an important energy source for the pelagic food web. Given the abundant nutrients observed in Bathurst Inlet during the ice-covered season (Marine Water Quality, Chapter 3 of Volume 7 of the DEIS), a substantial and ecologically-important spring bloom likely occurs in most years, but the timing of the bloom is likely variable due to variable weather conditions.

By August, the water column has a stable pycnocline, and only nearshore areas are fully-mixed down to the sediments (Marine Physical Processes, Chapter 1 of Volume 7 of the DEIS). The phytoplankton community in these conditions is more abundant in August than in winter (biomass 0.3 to 1.5 µg chl *a*/L; 1,000 to 1,000,000 cells/L). In general, however, the biomass and abundance of phytoplankton remains low. Phytoplankton biomass in the nearshore environment near the MLA in July 2013, for example, ranged from 0.7 to 1.0 µg chl *a*/L (Rescan 2013b). The stable pycnocline prevents the replenishment of nutrients into the sun-lit surface waters, where it is likely that nitrogen limitation restricts the growth of phytoplankton. Dinoflagellates, chlorophytes, and cryptophytes were the dominant taxa in the baseline data from the stable summer conditions. Many of these flagellated phytoplankton are capable of vertical migration in the water column, allowing such phytoplankters to seek and obtain nutrients from the pycnocline or sediments. Moreover, many of these taxa are mixotrophic and gather energy from organic matter or other plankton, as well as through photosynthesis.

The summer phytoplankton community is also characterized by substantial inter-annual variability. Cell abundances ranged from ~2,000 cells/L, observed in Bathurst Inlet in 2007, to almost 1,000,000 cells/L observed in Bathurst Inlet in 2001. Taxa dominating in summer were generally similar between sites during the same sampling period, yet phytoplankton community structure varied substantially between years. Small chlorophyte and cryptophyte phytoplankton were dominant in 2001, in contrast to the communities dominated by the dinoflagellates *Dinophysis* and *Gymnodinium* in 2007, *Heterocapsa* in 2012, or *Dinobryon* in 2013 in the nearshore MLA environment. All of these different taxa were likely selected for by different environmental conditions. The estuarine nature of Bathurst Inlet means that the marine waters of the Inlet are closely coupled to terrestrial runoff and river inputs; these freshwater inputs — along with wind, storms, and other environmental factors — help to drive temporal variation in phytoplankton community structure.

Zooplankton

Zooplankton are small aquatic organisms that feed on bacteria, phytoplankton, other zooplankton, and particulate organic matter, and so are a crucial component of marine food webs. Grazing zooplankton, like many copepod taxa, can efficiently transfer energy from the photosynthetic phytoplankton to higher trophic levels, and ultimately fisheries and marine mammals (Horner and Murphy 1985; Huse et al. 2004; McMeans et al. 2013). Calanoid copepods were the dominant taxa in baseline samples of zooplankton from Bathurst Inlet, and in the nearshore environment of the MLA in July 2013. Sampling was conducted in the open-water season (August 2001, August 2007, and July 2013; Table 4.1-3). Total zooplankton abundance was generally similar between baseline sampling years (6,000 to 14,000 organisms/m^3; Appendix V7-2A). Estuarine zooplankton taxa, like certain cladocerans, were present in many samples. The presence of copepods and cladocerans indicate a robust pelagic food web. It is likely that zooplankton abundances are higher earlier in the open-water season, and during the ice-out period, due to the coupling of zooplankton growth to the spring phytoplankton bloom (Michel, Ingram, and Harris 2006).

Benthic Invertebrates

The community of benthic marine invertebrates (benthos) is a crucial component of marine ecosystems in the Arctic. In the shallow waters of coastal environments (< 40 m depth), like the sheltered bays of Bathurst Inlet, benthic organisms can be responsible for 80% of the total ecosystem primary production (Rysgaard and Nielsen 2006). Therefore, benthic production is an important source of energy for marine food webs, as well as serving as the site for the re-mineralization of organic matter that recycles nutrients necessary for primary production (Glud et al. 2000; Link et al. 2011). Arctic benthic communities of sponges and corals also serve as important nursery and host habitats for many marine organisms (Kenchington et al. 2011).

Bathurst Inlet was identified as an Ecologically and Biologically Significant Area (EBSA) for benthic communities due to the presence of polynyas and their associated hotspots of productivity (Kenchington et al. 2011). However, potential Project impacts in Bathurst Inlet are far inland from the identified area of polynyas near the ocean entrance to Bathurst Inlet, and no polynyas have been reported for the inner basin of Bathurst Inlet (KIA 2012).

Baseline sampling of the benthos in the nearshore environment of Bathurst Inlet (depths < 10m) has been conducted since 2001 (Table 4.1-4). Benthos were sampled from a variety of substrate habitats (see Physical and Chemical Sediment Quality Parameters, Section 3.1.6 of Chapter 3 of Volume 7). Spatial heterogeneity in physical processes and sediment composition is important to promote the diversity and production of benthic communities (Kenchington et al. 2011). In general, benthic environments closest to shore were composed primarily of sand. Such habitats selected for benthos communities dominated by bivalves, such as *Astarte borealis* and *Macoma balthica* (Rescan 2002, 2008a, 2008b, 2012c, 2013b). The nearshore environment at the MLA was dominated by *Macoma* bivalves, which was perhaps due to the generally sandy sediment environment there (Rescan 2013b). Diversity and richness tended to be lower in the samples from the sand-bivalve community (Simpson's D <0.5 and <10 taxa/sample). Further off-shore, the sediment composition tended to include finer particles as well as a greater diversity of benthos (Simpson's D >0.7 and >15 taxa/sample). Polychaetes, cumaceans, and amphipods were dominant members of the benthos at these deeper sites. Local features like peninsulas and river outflow were observed to change the benthic habitat and likely had effects on community composition of the benthos.

4.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Traditional Knowledge (TK) information was gathered by the Kitikmeot Inuit Association (KIA 2012). This report provides recorded and georeferenced TK pertaining to the Project by means of interviews conducted between 1995 and 2000.

4.2.1 Incorporation of TK for Existing Environment and Baseline Information

Available Traditional Knowledge (TK) from the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) was reviewed for existing environment and baseline information on marine fish habitat.

In general, few of the identified, traditionally-used fish habitat sites in the TK Report are marine sites. This is also true with respect to traditional fishing for anadromous Arctic Char (*Salvelinus alpinus*), a species which requires both freshwater and marine habitats. As described in the TK Report, marine fishing in the region occurs at coastal locations including Daniel Moore Bay (west of Bathurst Inlet), near the Kent Peninsula, Perry Island, in Queen Maud Gulf, and near Fishers Island (all located outside of Bathurst Inlet). Within Bathurst Inlet itself, coastal fishing only occurred at the outlets of large rivers, with specific fishing (Arctic Char) habitat identified near the following: Western River, Fishing Creek, Burnside River, Back River, and Mara River. The following information is included in the TK Report:

Ekalukpik (Arctic charr) were the main fish species for Ocean Inuit and Kiligiktokmiut. Ekalukpik and hiugyuktok (tomcod) were the two main ocean fish. Other ocean fish included sculpins, smelt, flounders (called turbot), wolf eel, crabs, oysters and starfish.

... The only lake with Arctic charr that I know of is the one south of Bathurst Inlet (Bathurst Lake). That lake has lots of Arctic charr and we speared the fish. The river (Ki/ogiktok (Western River)) is also very good for fishing. We fished there with hooks baited for overnight fishing and we caught a few (charr)...

… The fish look (healthy) when they are going up river (from the ocean to the lakes). At Ekalolialok and Kilanaktokvik there are lots of cracks in the rocks. Some of these fish get stuck trying to go up or down the rivers, and the fish may become injured…

… Fishing Creek (near Kingaok) and Burnside River (Ayapakpaktokvik) have Arctic charr... Ekalukpik return to the lakes in the fall and they return to the sea in the spring…

… The red charr taste different... Some people like them when they are red but I prefer the regular Arctic charr... Charr Lake too has red ones. Charr Lake is close to the ocean. We could walk down to the ocean from that lake...

… These fish that are found further inland are very good to eat. The Arctic charr where I lived long ago (Tahikyoak and Kiligiktokmik (Bathurst Inlet)), and from some of the areas around here (Killinik (Victoria Island)) are very good to eat, just before the fall migration...

In the spring the Arctic charr that are coming from the lakes are very skinny. When they are coming down river they are not very good to eat. Sometimes they are found around here on the ocean. The charr don't like the food at the lakes. It's just like caribou during the rutting season; the charr don't taste very good when they are coming from the lakes.

… When the charr from the ocean are going up river, they are very nice and very tasty, and also very fat. I know of the charr being like that all over. When the lake trout that are coming down river reach the ocean, they get skinny, just like the charr in the lakes...

… There are Arctic charr at Hiukkittak. They are all sea run charr…

… We fished for charr at Ekalolialok (lake on island of same name)... They must be sea run. They migrate to the lake in the fall and return to the sea in the spring…

… Some lakes that have rivers to the ocean contain Arctic charr. There are many lakes with Arctic charr; so many that I can't name them all. Some of these lakes are further inland. In the spring the charr that have been in the lakes during the winter return back to the ocean, while others are going to the lakes...

… It's very hard to say if the charr move to the ocean every year. I'm sure there are some that come all the way from the ocean to these lakes and rivers because all are connected to some of the major lakes that are in the area…

Back (Hannigayok), Mara (Hanimok) and Burnside (Ayapakpaktokvik) are the main rivers with Arctic charr around myarea. They all connect to the ocean. Mara River is connected to the Back River and the Back River is connected to the Burnside River.

… This Back River connects to Garry Lakes and just south of Gjoa Haven in Nunavut. I believe the charr could make it up to the lakes through some of those rivers. I suppose there are charr that winter at some of those lakes because there are charr around Tahikyoak (Contwoyto Lake), where they are more abundant...

... This place has Arctic cod (west shore of Labyrinth Bay, off Etibliakyok (Kent Peninsula isthmus) and this place (south of Kigaotagyok or Turnagain Point, east side of peninsula) also has cod. This bay (at Peginganik) has cod as does this bay (northeast Kaogyok (Quadyuk Island).)…

There are cod also along the side of this island (Kikiktakafalok) and here (east through the inlet where a river empties into it). There are Arctic cod that are very big where it's salty at the river mouth. Right by the side (southwest of Panaktak on Koagyok), where it's deep under the cliff, about fifteen feet below the ice, there is a spot that when you hit it you could be catching fish all day by jigging. When you try to touch the bottom, you cannot. Where those cod fish stay it's very deep...

… During the summer when we fished at Mackenzie Point (Tigigak) I wasn't expecting to catch lake trout. I checked the nets the next day and there were lots of lake trout. My wife said, 'I didn't know the ocean had lake trout. I was quite amazed. We caught lots of lake trout in the nets and some of the fish were quite large…

... Some rivers, and even the ocean, have fish that are usually found in the lakes. They got caught in our nets. Inuit sometimes caught lake trout in the rivers and sometimes in the ocean. If there are fish around you really can catch lots when you are using nets…

Hulukpaugan were found throughout streams, rivers and in some lakes on the mainland. One consultant thought that grayling did not occur on Killinik (Victoria Island) but another said they did, in the ocean adjacent to the coastline. No locations on Killinik or in the ocean were mapped, although a few coastal streams on the mainland were said to contain grayling.

… People fished the ocean by jigging mostly. Now they use a lot of gill nets. They ice fish today with fishing rods. There are Arctic charr and some trout close to the ocean. Some trout are really close to the ocean. There are also jackfish or pike close to the mouth of Coppermine River. In the ocean there are whitefish, what they call the broad whitefish, lots of broad whitefish, and those flat fish called flounders, tomcod, Thompson eel and sculpins...

... The fish go further up into the lakes using the rivers. All kinds of fish do this. They also use the same river to go down to the ocean…

... The people from Kingaok and Omingmaktok must know about that river (Hiukkittak). It is really sandy from all the way up here (at the mouth) downstream... People fish the ocean at the mouth of the river. I have nets at Ehokhikhiovik (initial river section of Hiukkittak)... I usually have nets at this place...

…They net fish near Kingaok every fall Ayapakpaktokvik ((Burnside River)). This lake (Ekalokhiokvik (Tahikafalok Lake)) has a small river to the ocean (Aniakhiokvik (Fishing Creek)). That is another area that they mainly fish, I know this because my grandfather liked fishing there..."

4.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) were reviewed for refining the potential VEC/VSEC list (see Volume 9, Chapter 1). Clear maps of valued fisheries species are present in Chapter 7 of the TK Report (Figures 31 and 32) and, consequently, marine fish habitat was assigned as a VEC. In addition, valued, marine fish species, Arctic Char, was assigned as a VEC and are treated individually within the marine fish community chapter (Volume 7, Chapter 5).

4.2.3 Incorporation of TK for Spatial and Temporal Boundaries

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) were reviewed. The Project footprint does not overlap with marine fishing habitat as identified in Figures 31 and 32 within Chapter 7 of the TK Report, nor do important fishing areas occur within the marine fish/aquatic habitat LSA. Some important fishing areas are located within the northern reaches of the Western River which form the outer limits of the Regional Study Area for the VEC marine fish/aquatic habitat.

4.2.4 Incorporation of TK for Mitigation and Adaptive Management

As a result of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012), marine fish habitat was considered when developing mitigation and adaptive management plans. The TK Report included information on important areas for marine fishing in the Bathurst Inlet. The Project has been designed such that infrastructure will not located on important marine fishing habitat. Additional mitigation of Project-related effects may be achieved by a Draft Conceptual Fish Offsetting Plan, which also considers TK. Ongoing consultation with DFO, and future engagement with the KIA and other stakeholders, regarding the further development of the Conceptual Fish Offsetting Plan, including the development of additional or alternative options that could provide value to the local communities, is intended through 2014.

4.3 VALUED COMPONENTS

4.3.1 Potential Valued Components and Scoping

Valued Ecosystem Components (VECs) are specific attributes of the biophysical environment that are regarded as crucial to the scientific, economic, or cultural heritage of a location. The determination of marine fish/aquatic habitat VECs and potential effects for inclusion in this effects assessment considered, and was informed by:

- The EIS Guidelines (NIRB 2013);
- The public, during public consultation and open house meetings held in the Kitikmeot communities;

- Local land users, during focus group and mapping sessions with residents of Kugluktuk, Cambridge Bay, Omingmaktok, and Bathurst Inlet;
- Meetings with regional Inuit groups; and
- Kitikmeot Community Advisory Group (CAG) meetings composed of local stakeholders (e.g., Hunters and Trappers Organization [HTO] representatives).

Marine fish/aquatic habitat was included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Marine fish/aquatic habitat was identified as a potential VEC that encompassed the marine habitat, marine aquatic ecology, and marine biota supporting Aboriginal, recreational, or commercial fisheries (NIRB 2013). Here, each of the VEC selections was recognized as belonging to one of two broader categories of VECs: 1) marine fish/aquatic habitat; and 2) marine fish community, each of which encapsulates the moderate concerns identified in the TK Report and through community consultation (Volume 9, Chapter 1).

4.3.2 Valued Components included in Assessment

The VECs selected to assess the potential effects of the Project on important marine fisheries species in the LSA and RSA include:

- marine fish/aquatic habitat; and
- marine fish community (Arctic Char).

This chapter (Chapter 4) assesses potential Project effects on the VEC marine fish/aquatic habitat. These include only the direct effects of the Project on physical aspects of the marine environment that provide distinct habitat for fisheries species. Chapter 5 of this volume (Volume 7) assesses Project potential effects on the identified marine fish community VEC, Arctic Char.

The marine fish/aquatic habitat VEC comprises both the physical habitat and the biological resources that are essential to the productivity of marine fisheries species. This chapter (Chapter 4) evaluates the *direct* effects of Project activities on the physical habitat of marine fish, but excludes the assessment of *indirect* effects of Project activities on the biological resources utilized by marine fish. Biological resources, as defined here and informed by the EIS Guidelines (NIRB 2013), include primary producers (e.g., marine phytoplankton) and secondary producers (marine zooplankton and benthic invertebrates) making up the lower trophic levels that form the base of marine fish food webs and provide fish with dietary resources (Horner and Schrader 1982; Glud et al. 2000; Rysgaard and Nielsen 2006; DFO 2008; Link et al. 2011; McMeans et al. 2013). The exclusion, from this chapter, of Project related *indirect* effects on biological resources is rationalized through the following logic:

1. Potential Project-related effects on marine fish habitat are mediated *indirectly* through trophic interactions between fish and their biological/dietary resources (primary and secondary producers).
2. Potential Project-related effects on primary and secondary producers arise *indirectly* from changes to water and sediment quality.
3. Potential Project-related effects on marine water and sediment quality arise *directly* from Project activities and are assessed individually, as the VECs Marine Water Quality (Volume 7, Chapter 2) and Marine Sediment Quality (Volume 7, Chapter 3).
4. Finally, no significant residual effects are predicted for Marine Water Quality and Marine Sediment Quality after mitigation, management, and monitoring measures are considered (Volume 7,

Chapters 2 and 3 respectively). Moreover, Project design ensures that marine water and sediment quality in receiving environments will meet the conservative empirical thresholds of CCME guidelines, below which no adverse effects on marine aquatic life are predicted to occur.

Water and sediment quality also form part of the aquatic ecology of marine fish and may, therefore, be considered under the marine fish/aquatic habitat VEC. However, as stated above for biological resources, marine water quality and marine sediment quality are treated independently in separate chapters, and no significant residual effects are predicted on marine water or sediment quality (Volume 7, Chapters 2 and 3).

4.4 SPATIAL AND TEMPORAL BOUNDARIES

4.4.1 Spatial Boundaries

The spatial boundaries used for the assessment of the VEC marine fish/aquatic habitat included a Local Study Area (LSA) and a Regional Study Area (RSA), both of which are shown in Figure 4.4-1.

4.4.1.1 Local Study Area

The boundaries of the marine Local Study Area (LSA) for marine fish/aquatic habitat were set to encompass the following:

- the shoreline where the Marline Laydown Area (MLA) Potential Development Area (PDA) is proposed; and
- the proposed winter road where it crosses the inlet.

The marine fish/aquatic habitat LSA is the same as the marine LSA boundary as the marine fish community, marine water quality, marine sediment quality, and marine wildlife chapters: (Volume 7, Chapters 2 to 5), and is defined by a 1 km buffer surrounding the shoreline where the proposed MLA is located, and a 500 m buffer on either side of the proposed winter road (marine portion only). The marine fish/aquatic habitat LSA covers an area of approximately 2,100 ha of marine habitat (Figure 4.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to fish habitat due to Project infrastructure typically occur.

4.4.1.2 Regional Study Area

The marine fish/aquatic habitat RSA encompasses the marine PDA, LSA, as well as the marine areas of Bathurst Inlet from the southern-most tip of the Inlet to approximately 15 km north of Omingmaktok. The marine fish/aquatic habitat RSA is approximately 75 km in width, covering an area of 299,971 ha, of marine habitat within Bathurst Inlet (Figure 4.4-1).

4.4.2 Temporal Boundaries

The temporal boundaries used for the assessment of effects on the VEC marine fish/aquatic habitat align with the duration of Project phases as described in Volume 9, Chapter 1, as follows:

- Site Preparation – 2 years;
- Construction phase – 2 years;
- Operations phase – 10 years;
- Reclamation and Closure phase – 10 years;
- Post-closure phase - 5 years minimum;

- other potential phases:
  - Temporary Closure – less than 2 years;
  - Care and Maintenance Phase – 2 to 10 years; and
  - Exploration: included in Construction and Operations phases.

4.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

4.5.1 Methodology Overview

The Project-related effects assessment for the VEC marine fish/aquatic habitat followed the process detailed in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1):

1. Project activities were grouped on the basis of shared interaction pathways and by the timing and magnitude of the interactions with the marine environment.
2. The potential effects were then evaluated on the nature of the interaction, the magnitude and frequency of the Project activities, and the biophysical characteristics of the receiving marine environment; site-specific data from the Existing Environment and Baseline was synthesized and applied to understand the natural variation within, and resiliency of the environment.
3. The effects of mitigation and management measures to eliminate or reduce the potential effects were considered.
4. Residual effects were determined as the potential effects that would remain after the application of mitigation and management measures.
5. The significance of the residual effects were determined by the direction (i.e., positive, neutral, or negative), magnitude, confidence, and probability.

4.5.1.1 Determining the Magnitude and Significance of Residual Effects

The significance of residual effects on the VEC marine fish/aquatic habitat was determined using the ratings and classifications described in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1, Table 2.4-3). First, the direction of a residual effect was determined to be positive, neutral, or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect (Table 4.5-1) and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria; and the certainty and probability of an event used as qualifying criteria.

Table 4.5-1. Magnitude Rating for Evaluating Residual Effects on the VEC Marine Fish/ Aquatic Habitat

Magnitude Rating	Classification
Negligible	Habitat changes are unlikely to have an effect on productive capacity that is distinguishable from natural variation.
Low	Habitat changes affect less than 10% of the waterbody area, and resulting reductions in productive capacity are unlikely to affect the entire fish population of a waterbody.
Moderate	Habitat changes affect up to 20% of the available habitat area in a waterbody, such that resulting reductions in productive capacity may affect fish populations in the entire waterbody.
High	Habitat changes are expected to affect more than 20% of the waterbody area and may result in changes to the productive capacity of habitat within and beyond the waterbody, affecting an entire fish population or more than one fish population.

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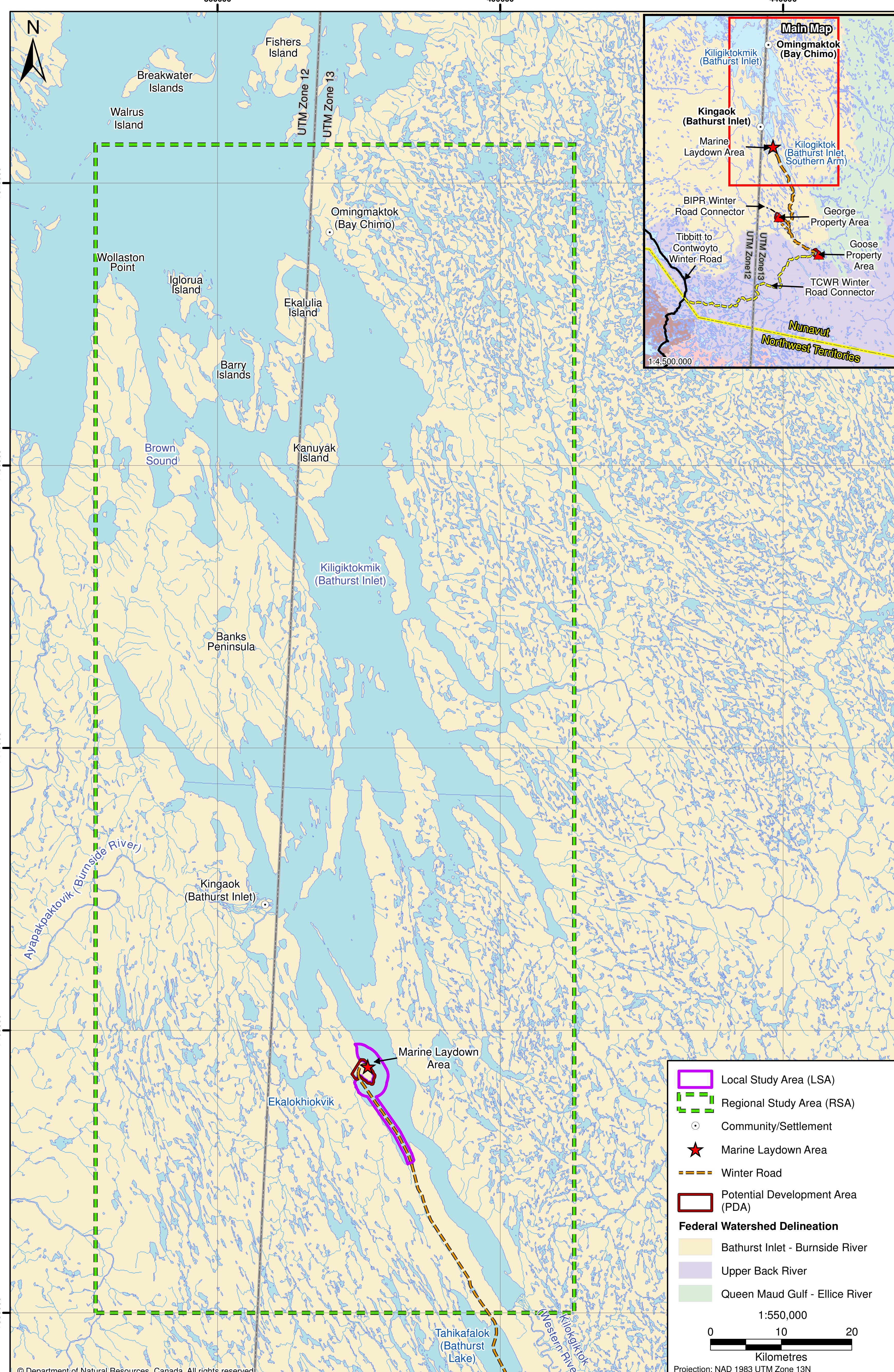

Figure 4.4-1

Sabina GOLD & SILVER CORP.

Local Study Area and Regional Study Area for Marine Fish/Aquatic Habitat

Figure 4.4-1

Rescan an ERM company

The significance of a residual effect was rated as Positive, Not Significant, or Significant (Table 4.5-2). For example, residual effects receive a rating of 'Not Significant' if they are expected to be one of the following: negligible or low magnitude, confined to LSA, moderate to high reversibility, or short duration (Volume 9; Chapter 1).

Table 4.5-2. Definitions of Significance Ratings for the VEC Marine Fish/Aquatic Habitat

Significance	Descriptor of Significance
Positive	Effect could result in an increase in fish/aquatic habitat, relative to the baseline within the RSA into the foreseeable future.
Significant	Effect is expected to result in a decrease in in fish/aquatic habitat that is not mitigated through Project design and management, and is long-lasting or permanent within the zone of influence of the Project relative to reference condition.
Not Significant	Effect may result in a decrease in in fish/aquatic habitat, but one that is fully mitigated through Project design and management, or fully reversible to baseline conditions in the shorter term after Project closure.

4.5.2 Potential Interactions with the Project and Characterization

Activities throughout the duration of the Project were considered for their potential interactions with the VEC marine fish/aquatic habitat. Potential interactions were based on the initial matrix provided in the Project Description, and further refined using the EIS guidelines (NIRB 2013), professional judgement, and experience at other similar projects in Nunavut and the Northwest Territories.

The VEC marine fish/aquatic habitat may interact with and be affected by the Project in two ways: through a loss or reduction of fish habitat by permanent alteration or destruction (PAD), or through changes to water and sediment quality arising from the deposition of deleterious substances (Table 4.5.3).

Table 4.5-3. Potential Interactions with the Marine VEC Fish/Aquatic Habitat

Potential Interactions/Effects	Cause	Description	General Project Activity	Regulations
PAD of fish/aquatic habitat	Permanent alteration or destruction (PAD) of fish habitat	Loss or damage of fish habitat through encroachment of infrastructure Loss or damage of fish habitat due to mechanical forces	Project Footprint Shipping	*Fisheries Act* (1985) Section 35(2)
Changes in water and sediment quality resulting in: 1. Direct fish mortality or reduction in fish health 2. Indirect reduction in biological resources of fish through trophic interactions	Deposition of deleterious substances*	Water, brine, effluent, and dust management	Management of Contact Water, Effluent, and Dust	*Fisheries Act* (1985), Section 32, 36 Metal Mining Effluent Regulations (SOR/2002-222)

*Note: * Potential effects on the VEC marine fish/aquatic habitat arising from the deposition of deleterious substances are assessed for the VECs marine water quality and marine sediment quality (Volume 7; Chapters 2 and 3) as well as in the marine fish community chapter (Volume 7; Chapter 5).*

A PAD is a *direct* loss or reduction of fish habitat area potentially incurred through planned construction (e.g., encroachment of infrastructure on existing fish habitat), or accidents and malfunctions (e.g., slope failures, spills). Accidents and malfunctions are assessed in Volume 9, Chapter 3.

The introduction of deleterious substances could alter fish habitat *directly* by reducing water and sediment quality to the extent that fish health decreases and mortality occurs, or *indirectly*, through trophic interactions with biological resources used by fish. The direct effect on fish health and mortality potentially caused by the introduction of deleterious substances in water is assessed in Volume 7, Chapter 5. The *indirect* effect on fish/aquatic habitat potentially resulting from the introduction of deleterious substances into water and sediment is assessed in two chapters: Volume 7, Chapters 2 and 3 for water and sediment quality, respectively, and it is not discussed further in this chapter. Table 4.5-4 describes the specific Project activities that link to potential interactions with the VEC marine fish/aquatic habitat identified in Table 4.5-3.

Table 4.5-4. Project Activities and Phases Interacting with the Marine Fish/Aquatic Habitat VEC

General Project Activity	Specific Project Activity	Project Phases
Project Infrastructure Footprint	1. Locations of barge landing infrastructure 2. Winter road construction and use	1. Site Preparation, Construction 2. All phases
Shipping Effects	1. Wake effects 2. Propeller wash	1. Construction, Operational, Reclamation and Closure 2. Construction, Operational, Reclamation and Closure

4.5.2.1 Loss of Fish Habitat: Project Infrastructure Footprint

Locations of Barge Landing Infrastructure

Potential effects on the VEC marine fish/aquatic habitat are anticipated during the Site Preparation and Construction phases during which the building of most infrastructure takes place.

The in-water works, a marine ramp and a seasonal dock (landing infrastructure), will result in the alteration or loss of the habitat where the landing infrastructure will be constructed, and potentially the habitat in the immediate vicinity. A marine ramp and seasonal dock at the proposed Marine Laydown Area in southern Bathurst Inlet will be constructed for annual resupply and seasonal transport during the open-water season to bring in equipment, supplies, and fuel. The beach ramp and dock will be rock-filled structures built perpendicular to shore with above water dimensions measuring approximately 30 by 30 m and 20 by 20 m, respectively. The side-slope of constructed infrastructure is assumed to be approximately 2:1, with a maximum depth below high water of 5 m, resulting in a total area of in-water infrastructure of 0.15 ha and 0.08 ha, respectively.

The total loss of habitat to construction of in-water works at the MLA has been calculated as 0.23 ha. Full details on the habitat that will be lost at the MLA are provided in the Draft Conceptual Fish Offsetting Plan (Volume 10, Chapter 21).

Shoreline processes and long-shore transport may be disrupted by the construction of the landing infrastructure that extends into the marine environment. Structures which interrupt the transport of materials either long-shore or vertically on/off shore, may lead to erosion; down-drift areas are deprived of sediment while up-drift sediment accumulates, extending into the marine environment (Brown and McLachlan 2002).

Land based site preparation activities have the potential for adverse effects on the marine environment, primarily through the transport of material in overland flow in runoff. Potential effects on marine fish/aquatic habitat arising from land based site preparation would result from changes to water and sediment quality through the deposition of deleterious substances, which is assessed in Volume 7, Chapters 2 and 3.

Winter Road Construction and Use

Potential alteration and loss to fish habitat along the shoreline can occur if slow driving speeds are not maintained. The weight of a truck driven too fast may result in waves forming under the surface of the ice, potentially dislodging of the ice from the shoreline. This increases the possibility of ice scour and potentially degrades fish habitat in the immediate area.

Potential impacts to marine fish/aquatic habitat may also arise from the construction and operation of winter roads as a result of accidents and malfunctions, including fuel spills, and vehicle accidents. These potential effects are covered under Accidents and Malfunctions (Volume 9, Chapter 3).

The adherence to DFO protocols (DFO 2007, 2009) during construction will mitigate any potential affects, and no residual effect of winter roads is anticipated to occur on the VEC marine fish/aquatic habitat.

4.5.2.2 Loss of Fish Habitat: Shipping

Ship Wakes and Propeller Wash

The potential effects of ship wake and propeller wash on marine fish/aquatic habitat result from the erosion, deposition, and re-suspension of sediments into the water column and subsequent changes to water and sediment quality. Potential Project effects on the VECs marine water quality and marine sediment quality are found in Volume 7, Chapters 2 and 3, respectively.

4.5.2.3 Deposition of Deleterious Substances

Potential effects of Project activities on the VEC marine fish/aquatic habitat may occur through the deposition of deleterious substances. As justified in Section 4.3.2.1, Project activities that affect biological resources through the deposition of deleterious substances result from *indirect* trophic level interactions which are ultimately due to changes in water and sediment quality. The assessment of Project effects on water and sediment quality were completed in Volume 7, Chapters 2 and 3. Please refer to Section 4.3.2.1 for the rationalization to exclude the water and sediment quality in the effects assessment for the VEC marine fish/aquatic habitat. The deposition of deleterious substances is not carried forward into subsequent sections of the assessment of the VEC marine fish/aquatic habitat.

4.5.3 Identification of Mitigation and Adaptive Management Measures

Mitigation measures will be in place to avoid or minimize the potential effects of the Project on the VEC marine fish/aquatic habitat. Mitigation measures are supplemented by the use of additional management. For example, alternative siting locations may be identified along with changes in Project design and the use of best management practices. The mitigation and management measures presented in this chapter are considered to be technically, environmentally, and economically feasible.

4.5.3.1 Loss of Fish Habitat: Project Infrastructure

Locations of Barge Landing Infrastructure

The majority of Project infrastructure has been sited to avoid fish bearing water and, wherever possible, to avoid encroaching on marine fish habitat by adhering to a 31 m setback from all water. In areas where encroachment is unavoidable (landing infrastructure), best management practices will be followed to avoid unnecessary or excessive effects on marine fish/aquatic habitat.

Where fish habitat loss is expected due to construction of the beach ramp and seasonal dock, mitigation for lost habitat has been incorporated into the Conceptual Fish Offsetting Plan (Volume 10, Chapter 21). The objective of the Conceptual Fish Offsetting Plan is to compensate for the alteration or destruction of fish-bearing habitat by creating or modifying fish habitat elsewhere on the landscape.

During in-water works, disposal of excavated material will be in a location above the high water mark to ensure that this material does not enter the marine environment. No equipment will be located in-water while working. All efforts will be made to minimize the duration of any in-water works and minimize the disturbance of riparian vegetation.

As a result of mitigation and offsetting through the Draft Conceptual Fish Offsetting Plan (Volume 10, Chapter 21), there are *no residual effects* anticipated on the VEC marine fish/aquatic habitat due to Project infrastructure. Unavoidable habitat losses due to Project infrastructure will be restricted to within the bounds of the PDA.

Winter Road Construction and Use

Winter road construction will follow the DFO Nunavut *Operational Statement for Ice Bridges and Snow Fills* (DFO 2007). Water withdrawal for the construction of winter roads will follow DFO's *Protocol for Winter Water Withdrawal from Ice-Covered Waterbodies in the Northwest Territories and Nunavut* (DFO 2010) and DFO's *Operational Statement on Mineral Exploration Activities* (DFO 2009). The construction of ice bridges and snow fill approaches at the land-water interface will utilize only clean, compacted snow and ice to a sufficient depth to protect the shoreline. Speed limits will be enforced to prevent ice scour along shorelines.

As a result of mitigation, there are *no residual effects* anticipated on the VEC marine fish/aquatic habitat due to winter road construction and use.

4.5.3.2 Loss of Fish Habitat: Shipping

Ship Wakes and Propeller Wash

Generation of wakes by ships is unavoidable; potential effects of wakes will be mitigated by reduction in the speed at which the ships travel within the LSA (the more sheltered and shallow regions of Bathurst Inlet).

Generation of propeller wash by ships is also unavoidable. Similarly, the potential effects of propeller wash will be mitigated by reduction in the speed at which the ships travel within the LSA.

No significant residual effects are anticipated to occur on the VEC marine fish/aquatic habitat from potential changes to water and sediment quality due to ship wakes and propeller wash (see Volume 7, Chapters 2 and 3).

4.5.3.3 Deposition of Deleterious Substances

The mitigation and management measures to avoid potential Project effects on the VEC marine fish/aquatic habitat can be found in assessment of Project effects on water and sediment quality in Volume 7, Chapters 2 and 3. As justified in Section 4.3.2.1, Project activities that affect biological resources through the deposition of deleterious substances result from *indirect* trophic level interactions which are ultimately due to changes in water and sediment quality. Please refer to Section 4.3.2.1 for the rationalization to exclude the water and sediment quality in the effects assessment for the marine fish/aquatic habitat VEC.

The primary mitigation for effects on marine water and sediment quality is contained within the AEMP (Volume 10, Chapter 19). In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects from indirect sources (e.g., air quality and noise and vibration). See section 4.8 for a full list of mitigation and management measures.

4.5.4 Characterization of Residual Effects

With mitigation measures in place, including the Conceptual Fish Offsetting Plan, there are no anticipated residual effects on the VEC marine fish/aquatic habitat from the Project.

4.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

4.6.1 Methodology Overview

The potential for cumulative effects arises when residual effects of *the Project* affect (i.e., overlap and interact with) the same resource/receptor that is affected by the residual effects of other past, existing, or reasonably foreseeable projects or activities. When residual effects are present, the Cumulative Effects Assessment (CEA) followed the process detailed in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1).

4.6.2 Potential Interactions of Residual Effects with Other Projects

There are no anticipated residual effects on the VEC marine fish/aquatic habitat due to the Project. Therefore, there are no potential effects on fish habitat from the Project that could act additively or synergistically with other projects. A CEA was not conducted (see CEA Methodology; Volume 9, Chapter 1).

4.7 TRANSBOUNDARY EFFECTS

After mitigation and management, there are no anticipated residual effects on the VEC marine fish/aquatic habitat. Thus, no transboundary effects on the VEC marine fish/aquatic habitat are expected to occur.

4.8 MITIGATIVE AND ADAPTIVE MANAGEMENT

Numerous mitigation or management plans will be in place to eliminate or minimize the potential effects on the VEC marine fish/aquatic habitat. These plans can be found in Volume 10 and include:

- Draft Conceptual Fish Offsetting Plan (No Net Loss Plan) (Chapter 21);
- Aquatic Effects Management Plan (Chapter 19);
- Overall Environmental Management Plan (Chapter 1);
- Environmental Protection Plan (Chapter 2);
- Fuel Management Plan (Chapter 4);

- Spill Contingency Plans (Chapter 5);
- Oil Pollution Emergency Plan (Chapter 6);
- Site Water Monitoring and Management Plan (Chapter 7);
- Mine Waste Rock and Tailings Management Plan (Chapter 9);
- Landfill and Waste Management Plan (Chapter 10);
- Incineration Management Plan (Chapter 11);
- Road Management Plan (Chapter 14);
- Borrow Pits and Quarry Management Plan (Chapter 16);
- Air Quality Monitoring and Management Plan (Chapter 17);
- Metal Leaching and Acid Rock Drainage Management Plan (Chapter 22); and
- Mine Closure and Reclamation Plan (Chapter 29).

Mitigation by Project Design

The Project has been designed to avoid impacts on marine fish/aquatic habitat in as many areas as possible. This includes locating infrastructure away from Bathurst Inlet where possible (the exception being the in-water structure), directing site contact water to the water management facility, and directing sediment-laden water through diversion ditches to a control pond. Further examples of mitigation by project design are presented in Table 4.8-1.

Best Management Practices

The Project will be constructed and managed following government guidelines and industrial best management practices as much as possible to avoid unnecessary impacts to marine fish/aquatic habitat. Government guidelines to avoid harm to fish/aquatic habitat include DFO operational statements and protocols, federal and territorial guidelines to preserve water and air quality, and federal and territorial environmental protection regulations. In addition, standard industrial best management practices will be developed, including sediment and erosion control plans, water management plans, and construction plans. Further details on best management practices are presented in Table 4.8-1.

Monitoring

Monitoring of construction activities and environmental compliance will be achieved through a Site Surveillance Network Monitoring Program that will be outlined in the future Type A Water Licence. This program will consist of all of the site compliance monitoring that will be required for managing/moving and releasing water from all potential containment areas.

In addition, an Aquatic Effects Monitoring Program (AEMP) will be carried out during all phases of the Project (Volume 10, Chapter 19), and a monitoring program will be developed to monitor the effectiveness of the Conceptual Fish Offsetting Plan (Volume 10, Chapter 21). The monitoring program will be developed in conjunction with regulatory agencies and the KIA, and will assess the effectiveness of the compensation activities over time in reference to specific performance objectives.

Offsetting

A Draft Conceptual Fish Offsetting Plan is presented in Volume 10, Chapter 21. This plan will be adapted to offset any and all PADs of fish habitat, and will be reviewed and approved by DFO, the KIA, and other interested parties.

Adaptive Management

The need for any corrective actions to on-site emission management or installation of additional control measures will be determined on a case-by-case basis. Triggers for developing adaptive management measures may include:

- non-compliance results from the Surveillance Network Monitoring Program;
- adverse effects on marine fish/aquatic habitat as suggested by AEMP results;
- adverse results from the monitoring of the Draft Conceptual Fish Offsetting Plan.

Table 4.8-1. Summary of Mitigation and Management Measures for Marine Fish/Aquatic Habitat

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	
	The Project has been designed to employ winter road only access corridors, thereby limiting dust emissions and hence the potential influence on marine fish habitat. There are no all-weather roads connecting the MLA to the Goose and George Properties.
	Infrastructure has been designed to minimize footprint and therefore confines the potential influence on marine fish habitat to as small an area as feasible.
	The area of landscape disturbance will be minimized, and restoration will occur as soon as possible in order to minimize erosion potential.
2. Best Management Practices	
	Winter road construction will follow the DFO Nunavut Operational Statement for Ice Bridges and Snow Fills (DFO Nunavut Operational Statement: Ice Bridges and Snow Fills, version 3.0 (2007)).
	In water work will take not take place from mid-July through mid-August during the Capelin spawning migration.
	Speed limits will be followed for vessel operations to minimize propeller wash and wake effects.
3. Adaptive Management	
	The need for any corrective actions to on-site emission management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include the following: • finding that results from the Surveillance Network Monitoring Program (which will be outlined in the future Type A Water License) show non-compliance; • finding that results from the Aquatic Effects Monitoring Program, which will monitor the receiving environment around the mine infrastructure and activities, show adverse effects to marine fish or fish habitat; or • finding that results from the Fish Offsetting Monitoring Program show that the offsetting program is not successful.
4. Monitoring	
	The Aquatic Effects Monitoring Program will consist of the following components: • water quality and sediment quality monitoring; • monitoring primary producers and benthic invertebrates; and • monitoring fish and shellfish populations, as well as shellfish tissues.
	The Monitoring Program for the Conceptual Fish Offsetting Plan will consist of the following components: • assessment of fish presence/habitat use; • assessment of habitat stability and the monitoring of constructed habitat; • assessment of primary productivity; and • assessment of the benthic invertebrate community.

(continued)

Table 4.8-1. Summary of Mitigation and Management Measures for Marine Fish/Aquatic Habitat (completed)

Mitigation Category	Mitigation Measures
5. Offsetting or Enhancement	
	A Fish Offsetting Plan will be in place that has been approved by DFO, the KIA, and other interested parties, to offset or enhance for the permanent alteration or destruction of fish habitat. Marine offsetting may include the following methods: • enhancement of fish aggregation, refuge, production, and habitat complexity through the building of artificial marine reefs.

4.9 PROPOSED MONITORING PROGRAMS

4.9.1 Aquatic Effects Management Plan

An Aquatic Effects Monitoring Program (AEMP) will be in place and is outlined in the Aquatic Effects Management Plan (Volume 10, Chapter 19). The AEMP will be undertaken during all phases of the project and will include the following:

- monitoring the marine environment at locations potentially affected by the Project and at reference areas well away from the Project activities;
- monitoring marine water quality, sediment quality, and aquatic biology; and
- monitoring of fish populations and shellfish tissue.

4.9.2 Conceptual Fish Offsetting Plan

The approved Fish Offsetting Monitoring Program for the Project will consist of the following components within the Draft Conceptual Fish Offsetting Plan (Volume 10, Chapter 21):

- fish presence and habitat use;
- local density or population size estimates for fish species;
- habitat stability monitoring of constructed habitat;
- assessment of primary productivity; and
- assessment of benthic invertebrate community.

4.10 IMPACT STATEMENT

The VEC marine fish/aquatic habitat comprises both the physical habitat and the biological resources that are essential to the productivity of fisheries species. This chapter (Volume 7, Chapter 4) evaluates the *direct* effects of Project activities on the physical habitat of marine fish. Project activities can only affect the biological resources of marine fish (primary and secondary producers) through *indirect* trophic-level interactions stemming from changes to marine water and sediment quality. The effects assessments of Project activities on the VECs marine water quality and marine sediment quality are completed in separate chapters (Volume 7, Chapters 2 and 3).

The VEC marine fish/aquatic habitat may be affected the *direct* effects of Project activities through a loss or reduction of fish habitat by permanent alteration or destruction (PAD). PADs occur whenever there is loss or damage of fish habitat. At the LSA, the direct loss of fish habitat (PAD) could potentially result from Project infrastructure (in-water construction of a dock and beach ramp). Additional loss of habitat is possible due to winter road and shipping activity, both of which would result from the erosion or deposition of sediment into fish habitat located at the nearshore seabed of the PDA.

As a result of mitigation, there are no residual effects anticipated on the VEC marine fish/aquatic habitat due to Project infrastructure. The primary mitigation measures include fisheries compensation through the Draft Conceptual Fish Offsetting Plan, siting Project infrastructure to avoid fish-bearing water, and the Aquatic Effects Monitoring Plan.

The lack of residual effects on the VEC marine fish/aquatic habitat arising from the Project results in no opportunity for effects to act additively or synergistically with other projects, and no cumulative or transboundary effects are expected to occur.

5. Marine Fish Community

5. Marine Fish Community

5.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

5.1.1 Overview and Regional Setting

The proposed Back River Project (the Project) lies in western Nunavut in the continuous permafrost zone of the continental Canadian Arctic. It is composed of three main areas: the Goose Property Area, the George Property Area, and the Marine Laydown Area (MLA; Figure 5.1-1). The Project will sealift materials and supplies through Bathurst Inlet during the open-water summer season to the MLA, which is located on the western shore of Southern Bathurst Inlet.

Bathurst Inlet is a fjord that is long (~165 km), narrow (~2 to 15 km), and deep (> 300 m). This waterbody is divided into two major basins separated by a shallow sill. The outer inlet is the deeper of the two basins and contains many islands and a complex bathymetry. The inner inlet runs landward from the vicinity of Kingaok, has a relatively simple structure with few islands, and is shallower than the outer inlet, with depths between 100 and 150 m. The Western River discharges into the head of the inlet at the south, and the Mara River and Burnside River discharge into the western shoreline of the inlet. Numerous small streams discharge into the inlet along eastern and western shorelines. Bathurst Inlet cuts through the Bathurst Hills Ecoregion, which is characterized by strong relief built from massive granite rocks. The deeply indented, rocky shorelines lead to steep bathymetry with narrow near-shore areas.

The marine fish community of Bathurst Inlet is characteristic of Arctic marine ecosystems and includes marine, anadromous, and freshwater/estuarine species. Many fish species serve roles in the ecological and cultural health of the area. Dominant fish families in southern Bathurst Inlet include the cod, sculpin, salmonid, and eelpout families.

Nineteen species are known to inhabit Bathurst Inlet (Richardson 1833; Senate of Canada 1888; Walters 1955; Ellis 1962; Rescan 2008); within the marine local study area (LSA), Fourhorn Sculpin (*Myoxocephalus quadricornis)* is typically the dominant species (by number) sampled. Pacific Herring (*Clupea pallasii*), Starry Flounder (*Platichthys stellatus*), Arctic Cisco (*Coregonus autumnalis*), Capelin (*Mallotus villosus*), and Saffron Cod (*Eleginus gracilis*) are also common to the LSA. Fish captured in southern Bathurst Inlet were primarily nearshore, shallow water species that are typically demersal. Other species captured in the LSA prior to 2012 include: Arctic Flounder (*Liopsetta glacialis*), Broad Whitefish *(Coregonus nasus*), Ninespine Stickleback (*Pungitius pungitius*), Rainbow Smelt (*Osmerus mordax*), and Slender Eelblenny (*Lumpenus fabricii*). The Slender Eelblenny was not previously recorded in southern Bathurst Inlet prior to sampling in 2012. Arctic cod (*Arctogadus glacialis*) were previously reported as common (McGowan, Low, and Pike 1993; Stewart et al. 1993), but were not captured in the LSA or in southern Bathurst Inlet. No Arctic Char (*Salvelinus alpinus*) were captured during the baseline sampling program in Bathurst Inlet.

None of the species sampled during the baseline studies between 2001 and 2013 were threatened or endangered, however the Bering Wolffish *(Anarhichas orientalis*), which is known to occur in Bathurst Inlet, is listed on Schedule 3 (special concern) of the *Species at Risk Act* (2002). Found from Hokkaido throughout the Sea of Okhotsk to Alaska, the three collected specimens from Bathurst Inlet (collected in 1964, 1965, and 1969) are the only three confirmed Bering Wolffish specimens from the Canadian Arctic (Houston and McAllister 1990; COSEWIC 2002). The collection of only three specimens suggests this species is rare, as surveys in Bathurst Inlet have been conducted extensively by Fisheries and Oceans Canada (DFO), Canadian Museum of Nature (CMN), and various consulting firms.

Sockeye Salmon (*Oncorhynchus nerka*) have also been recorded as being present in southern Bathurst Inlet; a single individual was observed in 1965 (Stewart et al. 1993). The observation of the sockeye salmon was likely the result of a group of individuals straying outside the normal geographic range (as opposed to a resident population).

5.1.2 Regulatory Framework

5.1.2.1 The Fisheries Act

Fish and fish habitat are protected under the *Fisheries Act* (1985a), as well as other federal regulatory acts and principles. In 2012, the *Fisheries Act* was amended to establish into legislation the federal government's direction to focus efforts on protecting the productivity of commercial, recreational, and Aboriginal fisheries; to institute enhanced compliance and protection tools that are more easily enforceable; to provide clarity, certainty, and consistency of regulatory requirements; and to enable enhanced partnerships with stakeholders.

The changes to the *Fisheries Act* include a prohibition against causing serious harm to fish that are part of or support a commercial, recreational, or Aboriginal fishery (Section 35), provisions for flow and passage (Sections 20 and 21), and a framework for regulatory decision-making (Sections 6 and 6.1).

The new Purpose section states that the fisheries protection provisions of the *Fisheries Act* aim to provide for the sustainability and ongoing productivity of commercial, recreational, and Aboriginal fisheries.

The four factors in Section 6 and 6.1 to be taken into account by the Minister in decision-making (e.g. issuing authorizations) or making regulations are:

- the contribution of the relevant fish to the ongoing productivity of commercial, recreational, or Aboriginal fisheries;
- fisheries management objectives;
- whether there are measures and standards to avoid, mitigate, or offset serious harm to fish that are part of a commercial, recreational, or Aboriginal fishery; and
- the public interest.

For the purposes of the *Fisheries Act*, serious harm to fish includes the death of fish or any permanent alteration to, or destruction of, fish habitat (PAD). The *Fisheries Act* defines fish habitat as "spawning grounds and any other areas, including nursery, rearing, food supply, and migration areas, on which fish depend directly or indirectly in order to carry out their life processes." The term "fish" includes parts of fish; shellfish, crustaceans, marine animals, and any parts of shellfish, crustaceans, or marine animals; and the eggs, sperm, larvae, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals.

On November 1, 2013, The Fisheries Protection Policy Statement (DFO 2013) was issued and replaced the earlier Policy for the Management of Fish Habitat (DFO 1986). Although the new policy statement does not include the "no net loss" principle, as outlined in the earlier policy, application of this NNL principle provides some useful guidance when considering "serious harm to fish". In addition, the direction found within the 2013 scientific guidance document (Koops et al. 2013; Randall et al. 2013) has been consulted and followed.

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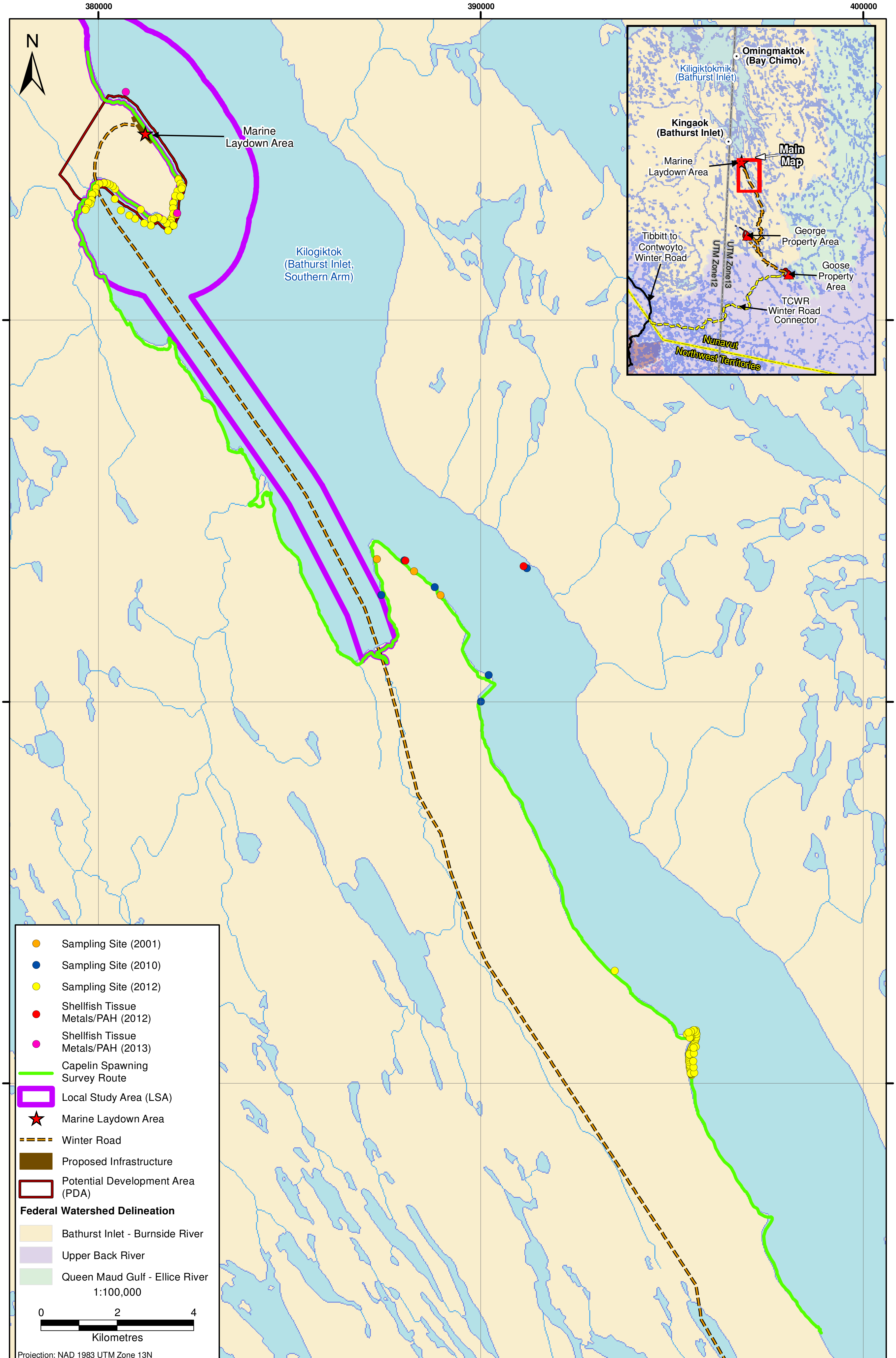

Figure 5.1-1

Sabina GOLD & SILVER CORP.

Baseline Marine Fish Community and Tissue Metal Sampling (2001 to 2013)

Figure 5.1-1

Rescan an ERM company

Any project or activity that causes a serious harm to fish that are part of, or support, a commercial, recreational, or Aboriginal fishery requires an authorization from DFO. Regulations have been developed to guide the application for this authorization: Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations. DFO has issued additional guidance in the "The Fisheries Protection Program Operational Approach".

5.1.2.2 Metal Mining Effluent Regulations

In 1996, Environment Canada undertook an assessment of the aquatic effects of mining in Canada. This assessment provided recommendations regarding the review and amendments of the Metal Mining Liquid Effluent Regulations, currently titled the *Metal Mining Effluent Regulations* (MMER; SOR/2002-222), and the design of a national Environmental Effects Monitoring (EEM) program for metal mining. The MMER, under the *Fisheries Act*, instruct metal mines to conduct EEM as a condition governing the authority to deposit effluent (MMER, Part 2, section 7).

The MMER (SOR/2002-222) permit the deposition of mine effluent into water containing fish if the effluent pH is within a defined range, if the concentrations of the MMER deleterious substances in the effluent do not exceed authorized limits, and if the effluent is demonstrated to be non-acutely lethal to Rainbow Trout (*Oncorhynchus mykiss*). These discharge limits were established to be minimum national standards based on best available technology economically achievable at the time that the MMER were promulgated. To assess the adequacy of the effluent regulations for protecting the aquatic environment, the MMER include EEM requirements to evaluate the potential effects of effluents on fish, fish habitat, and the use of fisheries resources.

Regulations Amending the MMER were published in the Canada Gazette, Part II, in October 2006 (Canada Gazette 2006). The purpose of these amendments was to clarify the regulatory requirements by addressing matters related to the interpretation and clarity of the regulatory text that had emerged from the implementation of the Regulations.

Additional amendments to the MMER were published in the Canada Gazette, Part II, in March 2012 (Canada Gazette 2012). The following changes were made to improve the EEM provisions of the MMER:

- modifications to the definition of an "effect on fish tissue" in order to be consistent with the Health Canada fish consumption guidelines and to clarify that the concentration of total mercury in tissue of fish from the exposure area must be statistically different from and higher than its concentration in fish tissue from the reference area;
- addition of selenium and electrical conductivity to the list of parameters required for effluent characterization and water quality monitoring;
- exemption for mines, other than uranium mines, from monitoring radium 226 as part of the water quality monitoring, if 10 consecutive test results showed that radium 226 levels are less than 10% of the authorized monthly mean concentration (subsection 13(2) of the Regulations; SOR/2002-222);
- change to the time frame for the submission of interpretative reports for mines with effects on the fish population, fish tissue, and benthic invertebrate community from 24 to 36 months;
- change to the time frame for the submission of interpretative reports for magnitude and geographic extent of effects, and for investigation of cause of effects, from 24 to 36 months; and
- minor changes to the wording for consistency within Schedule 5.

5.1.3 Proximity to Designated Environmental Areas

No existing or proposed parks or conservation areas are in or border Bathurst Inlet. The nearest conservation area, the Queen Maud Gulf Migratory Bird Sanctuary is located approximately 100 km east of Bathurst Inlet on the far side of the Kent Peninsula. The Draft Nunavut Land Use Plan (Nunavut Planning Commission 2012) has no special designation for the marine environment of Bathurst Inlet, but the caribou calving grounds in the region have been designated PSE-R2. The proposed Huikitak River Cultural Area is located on the eastern shore of Bathurst Inlet, 40 km west of Kingaok.

5.1.4 Baseline Study Area

Marine fish community baseline studies were conducted in the Bathurst Inlet marine Regional Study Area (RSA) in 2001, 2010, and in the LSA in 2012 (Rescan 2003; 2012a (Appendix V7-4A); 2012c). Figure 5.1-1 shows the location of the marine LSA and RSA, and locations where fish community information is available.

5.1.5 Baseline Studies

5.1.5.1 Information Sources

Data used for the assessment of potential effects on the marine fish community were collected from various data sources. The primary data sources were baseline studies conducted by Rescan in 2012 at the marine LSA (Rescan 2012a; Appendix V7-4A). Historical data was also used to supplement baseline information and give a more complete assessment. Full details of the baseline programs used to collect information are described in the following reports:

- *Marine Environment Baseline Studies, Bathurst Inlet Port and Road Project 2001-2002* (Rescan 2002);
- *Bathurst Inlet Port and Road Project Draft Environmental Impact Statement – Volume VI* (Rescan 2002);
- *Marine Aquatic Resources Baseline Study, 2010, Bathurst Inlet Port and Road Project* (Rescan 2012c);
- *Marine Fish and Fish Habitat Baseline Study, 2010, Bathurst Inlet Port and Road Project* (Rescan 2012d);
- *Marine Shellfish Metal and PAH Content Study, 2012, Bathurst Inlet Port and Road Project* (Rescan 2012e);
- *Physical Oceanography Baseline Study, 2012, Bathurst Inlet Port and Road Project* (Rescan 2012f);
- *Back River Project: 2012 Marine Fish and Fish Habitat Baseline Report* (Rescan 2012a; Appendix V7-4A);
- *Back River Project: 2013 Marine Fish and Fish Habitat Baseline Report* (Rescan, in prep); and
- *Marine Physical Processes Study, 2013, Bathurst Inlet Port and Road Project* (Rescan 2013; Chapter 1 of this volume).

5.1.5.2 Baseline Study Methods

<u>Fish Community</u>

The marine fish community in the LSA and RSA (Figure 5.1-1) was assessed using a suite of gear chosen to sample a variety of habitats, fish body sizes, and habitat use patterns to sample a diversity of species. Sampling gear included gillnets, minnow traps, beach seines, crab traps and long-lines.

Captured fish were identified to species and life stage. Fork length was measured and each fish was weighed. A subset of fish was sacrificed for age analysis estimated by counting the number of annuli (yearly rings) from each otolith.

Capelin (*Mallotus villosus*) spawning surveys were undertaken in 2012 to map spawning areas on the west shoreline of southern Bathurst Inlet in the LSA and RSA. Capelin spawning schools were identified during a low-altitude aerial survey. Within the LSA, capelin spawning schools locations were also confirmed in a shoreline survey conducted on foot.

Fish Tissue Metals

Tissue metal and polycyclic hydrocarbons (PAHs) samples were collected in the LSA from Bay Mussels (*Mytilus trossulus*). Tissue samples were taken from a potential exposure site as well as a reference location (Figure 5.1-1). Bay mussels were collected using a petite Ponar grab sampler. For each of the mussels selected for tissue sampling, physical characteristics including shell length, shell width, shell height, and whole body wet weight were measured. The tissue of each selected mussel was removed using a clean scalpel and forceps while wearing powder-free nitrile gloves. Mussel tissue samples were weighed and transferred into a Whirl-Pak bag. Additional mussels were added until a composite sample weighed at least 5 g (i.e., sufficient for PAH analysis). The Whirl-Pak bag was then sealed, labelled, and frozen. Ten 5 g tissue samples were collected for each site.

Tissue samples were transferred to ALS laboratory in Burnaby, British Columbia where they were analyzed for metals and PAHs. In some cases, high levels of interfering parameters required a sample dilution that resulted in a detection limit that was greater than the theoretical minimum. Mussel tissue samples for metal concentration were used for the Country Foods assessment (Volume 8, Chapter 5).

5.1.6 Baseline Study Results

5.1.6.1 Fish Community

Nineteen fish species have been captured during baseline studies, or are presumed to occur in the LSA (Table 5.1-1). Fourhorn Sculpin (Plate 5.1-1) were the most abundant species in 2001 and 2010, but were the third most abundant species in 2012. Capelin (Plate 5.1-2) were the most abundant, followed by Pacific Herring (Plate 5.1-3) in 2012. Capelin were not captured on any previous sampling occasions, and their dominance in the community sampling is attributed to the date of sampling coinciding with the capelin spawning period in 2012. Adult Capelin are generally associated with offshore habitat and are not expected to be present year-round in the nearshore areas of the LSA. Pacific Herring (*Clupea pallasii*), Starry Flounder (*Platichthys stellatus*), Arctic Cisco (*Coregonus autumnalis*) and Saffron Cod (*Eleginus gracilis*) were captured in all years and on average comprised 10% or greater of the total catch.

Table 5.1-1. Fish Species Captured or Presumed to Occur in Bathurst Inlet

Common Name	Scientific Name	Primary Habitat	Depth Range
Arctic Char	*Salvelinus alpinus*	Freshwater/Anadromous	Benthopelagic
Arctic Cisco	*Coregonus autumnalis*	Freshwater/Brackish	Benthopelagic
Arctic Cod	*Arctogadus glacialis*	Marine	Bathypelagic
Arctic Flounder	*Liopsetta glacialis*	Marine	Demersal
Bering Wolffish	*Anarhichas orientalis*	Marine	Demersal
Broad Whitefish	*Coregonus nasus*	Freshwater/Brackish	Benthopelagic

(continued)

Table 5.1-1. Fish Species Captured or Presumed to Occur in Bathurst Inlet (completed)

Common Name	Scientific Name	Primary Habitat	Depth Range
Capelin	*Mallotus villosus*	Marine	Pelagic
Fourhorn Sculpin	*Myoxocephalus quadricornis*	Marine/Brackish	Demersal
Lake Trout	*Salvelinus namaycush*	Freshwater/Anadromous	Benthopelagic
Least Cisco	*Coregonus sardinella*	Marine/Anadromous	Pelagic
Ninespine Stickleback	*Pungitius pungitius*	Freshwater/Estuarine	Benthopelagic
Ogac (Greenland Cod)	*Gadus ogac*	Marine	Demersal
Pacific Herring	*Clupea pallasii*	Marine	Pelagic
Rainbow Smelt	*Osmerus mordax*	Anadromous	Pelagic
Round Whitefish	*Prosopium cylindraceum*	Freshwater/Brackish	Demersal
Saffron Cod	*Eleginus gracilis*	Marine/Brackish	Demersal
Slender Eelblenny	*Lumpenus fabricii*	Marine	Demersal
Sockeye Salmon	*Oncorhynchus nerka*	Anadromous	Pelagic
Starry Flounder	*Platichthys stellatus*	Marine/Brackish	Demersal

Note:
Species highlighted in grey were not captured during Baseline sampling in 2010 and 2012, but they have an historic precedence of capture in Bathurst Inlet and are presumed to occur in Bathurst Inlet (Richardson 1833; Senate of Canada 1888; Walters 1955; Ellis 1962, Stewart et al. 1993).

Plate 5.1-1. Fourhorn Sculpin, Bathurst Inlet. July 15, 2012.

The list of species captured during sampling was relatively homogenous and stable among multiple years and sampling sites. The community composition listed in Table 5.1-1 is representative of the nearshore fish community in the RSA.

Plate 5.1-2. Adult Capelin, Bathurst Inlet. July 15, 2012.

Plate 5.1-3. Pacific Herring, Bathurst Inlet. August 9, 2012.

The community composition also reflects the influence of freshwater in the system: 13 species captured have been observed in freshwater, brackish or estuarine habitats during at least one part of their life history. The only species not normally associated with low salinity environments (Scott and Scott 1988) was the Slender Eelblenny (*Lumpenus fabricii*), a species with largely unknown life history traits. However, the Slender Eelblenny have been observed in brackish waters at Wemindji, in eastern James Bay (Morin, Hudon, and Whoriskey 1992).

None of the captured species are currently considered endangered, threatened, or are listed under Canada's *Species at Risk Act* (2002; Government of Canada 2002).

5.1.6.2 Fish Biology

The Capelin captured were all similar in fork length suggesting the sample was composed of all spawning adults. The average length for capelin in the LSA was 137 mm, and the range in lengths was similar to those observed in the southern basin of Bathurst Inlet and elsewhere (Vandeperre and Methven 2007).

Fourhorn Sculpin ranged in size from 25 mm to 237 mm. The length-frequency distribution showed two modes: one comprised of small juveniles and centred on the 20 to 30 mm range, and a second of adults centred on the 220 to 230 mm range. A few individuals of intermediate sizes were captured as well. The lengths of sculpin in the mode comprised of the larger adult sculpin were similar to modes reported for other populations (Percy 1975).

Pacific Herring length frequency distribution shows one predominant mode around the average length of 189 mm. There was also an additional second smaller grouping of individuals in the 90 to 130 mm range. Captured Pacific Herring may be smaller than populations studied elsewhere in the Arctic (Percy 1975).

Saffron Cod length distribution was unimodal and represented a wide range of sizes. The mode of the frequency distribution was similar to the mode of adult Saffron Cod captured in the Mackenzie Delta (Percy 1975). Very few small young fish were captured, in contrast to many small Saffron Cod caught using similar sampling methods in the Beaufort Sea (Wiswar and Frugé 2006). Saffron Cod were observed preying on the spawning Capelin and may have been following the Capelin schools. This may explain both their abundance in the LSA near Capelin schools and the prevalence of a unimodal large size class able to capture and eat adult Capelin. Salinity differences between the Beaufort Sea and Bathurst Inlet could also be responsible for the lack of juvenile Saffron Cod caught at the LSA.

5.1.6.3 Metals in Fish Tissue

Tissue metal concentrations in shellfish were comparable between the LSA site and the reference site (Table 5.1-2). Shellfish tissue mercury levels from the LSA (mean: 0.014 mg/kg) and the reference site (mean: 0.012 mg/kg) were similar and were well below the Canadian Standards (Maximum Levels) for Various Chemical Contaminants in Foods (0.5 mg/kg).

The concentration of other metals in mussel tissue was slightly higher at the reference site than at the LSA site. These metals included arsenic (21% higher), cadmium (36%), chromium (9%), copper (10%), iron (37%), lead (22%), and zinc (17%; Table 5.1-2). The only metal that was higher at the LSA site was mercury (15%; Table 5.1-2). Overall, this information shows that the metal concentrations were largely similar between the two sites.

5.1.6.4 Polycyclic Aromatic Hydrocarbons (PAH)

PAH concentrations in shellfish tissue were below analytical detection limits in all samples, except naphthalene and phenanthrene (Table 5.1-2). Naphthalene was detected at low levels in one sample from the LSA site, and five samples from the reference site. Phenanthrene was detected at low levels in seven samples from the LSA site, and one sample from the reference site. The mean concentrations of naphthalene and phenanthrene in detectable samples were comparable between the LSA site and the reference site.

Table 5.1-2. Summary of Metal and Polycyclic Aromatic Hydrocarbon (PAH) Concentrations in Shellfish Tissue Collected in Bathurst Inlet

	Reference Site (n = 23)					LSA Site (n = 22)				
Parameter	Minimum	Maximum	Mean	Median	Standard Error	Minimum	Maximum	Mean	Median	Standard Error
Metals										
Arsenic (As)	0.882	1.73	1.396	1.400	0.090	0.901	1.69	1.128	1.090	0.073
Cadmium (Cd)	0.475	1.70	1.045	1.040	0.137	0.466	1.31	0.723	0.642	0.090
Chromium (Cr)	0.185	0.365	0.269	0.269	0.018	0.151	0.479	0.247	0.197	0.034
Copper (Cu)	0.989	1.45	1.209	1.235	0.053	0.911	1.33	1.092	1.090	0.043
Iron (Fe)	39.4	180	107.9	110.5	13.1	39.1	153	74.3	52.9	13.6
Lead (Pb)	0.145	0.347	0.191	0.165	0.020	0.0807	0.291	0.154	0.144	0.018
Mercury (Hg)[a]	0.008	0.017	0.012	0.012	0.001	0.009	0.0250	0.014	0.012	0.002
Zinc (Zn)	10.3	19.3	14.6	15.4	1.0	9.32	17.8	12.37	12.30	0.83
Polycyclic Aromatic Hydrocarbons										
Acenaphthene	<0.010	<0.040	NA	NA	NA	<0.010	<0.15	NA	NA	NA
Acenaphthylene	<0.010	<0.010	NA	NA	NA	<0.010	<0.045	NA	NA	NA
Anthracene	<0.010	<0.010	NA	NA	NA	<0.010	<0.045	NA	NA	NA
Benz(a)anthracene	<0.010	<0.010	NA	NA	NA	<0.010	<0.045	NA	NA	NA
Benzo(a)pyrene	<0.010	<0.020	NA	NA	NA	<0.010	<0.045	NA	NA	NA
Benzo(b)fluoranthene	<0.010	<0.010	NA	NA	NA	<0.010	<0.20	NA	NA	NA
Benzo(g,h,i)perylene	<0.010	<0.010	NA	NA	NA	<0.010	<0.045	NA	NA	NA
Benzo(k)fluoranthene	<0.010	<0.010	NA	NA	NA	<0.010	<0.045	NA	NA	NA
Chrysene	<0.010	<0.010	NA	NA	NA	<0.010	<0.045	NA	NA	NA
Dibenz(a,h)anthracene	<0.010	<0.010	NA	NA	NA	<0.010	<0.045	NA	NA	NA
Fluoranthene	<0.010	<0.010	NA	NA	NA	<0.010	<0.045	NA	NA	NA
Fluorene	<0.010	<0.020	NA	NA	NA	<0.010	<0.045	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	<0.010	<0.010	NA	NA	NA	<0.010	<0.045	NA	NA	NA
2-methylnaphthalene	<0.010	<0.010	NA	NA	NA	<0.010	<0.045	NA	NA	NA
Naphthalene	<0.010	<0.020	0.014	0.014	0.001	<0.010	<0.045	0.013	0.013	NA
Phenanthrene	<0.020	<0.050	0.035	0.035	NA	<0.010	0.132	0.044	0.029	0.015
Pyrene	<0.010	<0.050	NA	NA	NA	<0.010	<0.045	NA	NA	NA

** All units are in mg/kg wwt.*
< = concentrations was below the specified detection limit.
[a] *Mercury Canadian Standards (Maximum Levels) for Various Chemical Contaminants in Foods guideline 0.5 mg/kg.*
NA = not applicable

5.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

5.2.1 Incorporation of TK for Existing Environment and Baseline Information

References to marine fish in the *Inuit Traditional Knowledge of Sabina Gold & Silver Corporation's Back River (Hannigayok) Project NTKP Report* (KIA 2012) are limited to the Ocean Inuit and Kiligiktokmiut. The majority of the identified traditionally used fish in the NTKP are freshwater (both rivers and lakes). This is true even for the VEC Arctic Char.

The NTKP identified Arctic Char and Tomcod (Arctic Cod) as the main fish species for Ocean Inuit and Kiligiktokmiut. Other marine fish species that were identified as being culturally important were sculpins, smelt, flounders (called turbot), Wolf Eel, crabs, oysters, and starfish. The report did not focus on specific fish species.

Within the NTKP, Arctic Char was primarily discussed with reference to freshwater fishing. However, some coastal areas of char habitat (fishing grounds) were identified. Many of the fishing grounds for sea run char take place on the larger rivers entering Bathurst Inlet within the RSA (Fishing Creek, Mara River, and the Western River) and occur when the char were migrating from the ocean to the freshwater habitat. Additional areas outside of the RSA are also identified: Daniel Moore Bay and Burnside River.

Tomcod were identified as a traditionally important species, though their use by coastal Inuit was typically described as being outside of Bathurst Inlet. Labyrinth Bay, and offshore of Kent Peninsula, were two of the locations identified as important Tomcod fishing locations outside of Bathurst Inlet. However, Tomcod use occurred around Quadyuk Island, northeast of Kingaok, within Bathurst Inlet. Traditional cod fishing areas were also located at the southern end of Kikiktakafalok Island on the eastern shore of Bathurst Inlet, and in Gordon Bay, also along eastern Bathurst Inlet, as well as at Kangihikvik, located northwest of Kingaok.

The following information is included in the TK Report:

> *… The only lake with Arctic charr that I know of is the one south of Bathurst Inlet (Bathurst Lake). That lake has lots of Arctic charr and we speared the fish… The river (Kilogiktok (Western River)) is also very good for fishing. We fished there with hooks baited for overnight fishing and we caught a few (charr)…*
>
> *When the fish went up the river (Arctic charr fall migration) at Hiukkittak, Hakvaktok (chain of lakes at coast) and Kangihoakyok (Daniel Moore Bay), Inuit speared them or used baskets to scoop them up.*
>
> *The fish look (healthy) when they are going up river (from the ocean to the lakes). At Ekalolialok and Kilanaktokvik there are lots of cracks in the rocks. Some of these fish get stuck trying to go up or down the rivers, and the fish may become injured.*
>
> *… At that lake (Ekalolialok; on island of same name) there are mostly Arctic charr…*
>
> *The charr come up right up the Burnside River (Ayapakpaktokvik). They spend the winter in the river.*
>
> *Fishing Creek (near Kingaok) and Burnside River (Ayapakpaktokvik) have Arctic charr… Ekalukpik return to the lakes in the fall and they return to the sea in the spring.*

At Fishing Creek there are red Arctic charr, 'evitagok'. We don't get them this way (at Kingaok) only at Fishing Creek… We hardly see them anywhere else. Only at Fishing Creek do we see them.

The red charr taste different… Some people like them when they are red but I prefer the regular Arctic charr… Charr Lake too has red ones. Charr Lake is close to the ocean. We could walk down to the ocean from that lake…

There are Arctic charr there too (in a lake to the east of Tinney Hills).

There is a lot of fish there (large area at Charr Lake), here at Kukiviakyok and here at Hikgakvik.

These fish that are found further inland are very good to eat. The Arctic charr where I lived long ago (Tahikyoak and Kiligiktokmik (Bathurst Inlet)), and from some of the areas around here (Killinik (Victoria Island)) are very good to eat, just before the fall migration.

In the spring the Arctic charr that are coming from the lakes are very skinny. When they are coming down river they are not very good to eat. Sometimes they are found around here on the ocean. The charr don't like the food at the lakes. It's just like caribou during the rutting season; the charr don't taste very good when they are coming from the lakes.

When the charr from the ocean are going up river, they are very nice and very tasty, and also very fat. I know of the charr being like that all over. When the lake trout that are coming down river reach the ocean, they get skinny, just like the charr in the lakes…

There are Arctic charr at Hiukkittak. They are all sea run charr.

We fished for charr at Ekalolialok (lake on island of same name)… They must be sea run. They migrate to the lake in the fall and return to the sea in the spring.

Some lakes that have rivers to the ocean contain Arctic charr. There are many lakes with Arctic charr; so many that I can't name them all. Some of these lakes are further inland. In the spring the charr that have been in the lakes during the winter return back to the ocean, while others are going to the lakes…

It's very hard to say if the charr move to the ocean every year. I'm sure there are some that come all the way from the ocean to these lakes and rivers because all are connected to some of the major lakes that are in the area.

Back (Hannigayok), Mara (Hanimok) and Burnside (Ayapakpaktokvik) are the main rivers with Arctic charr around my area. They all connect to the ocean. Mara River is connected to the Back River and the Back River is connected to the Burnside River.

This Back River connects to Garry Lakes and just south of Gjoa Haven in Nunavut. I believe the charr could make it up to the lakes through some of those rivers. I suppose there are charr that winter at some of those lakes because there are charr around Tahikyoak (Contwoyto Lake), where they are more abundant…

> *… This place has Arctic cod (west shore of Labyrinth Bay, off Etibliakyok (Kent Peninsula isthmus) and this place (south of Kigaotagyok or Turnagain Point, east side of peninsula) also has cod. This bay (at Peginganik) has cod as does this bay (northeast Kaogyok (Quadyuk Island)).*
>
> *There are cod also along the side of this island (Kikiktakafalok) and here (east through the inlet where a river empties into it). There are Arctic cod that are very big where it's salty at the river mouth. Right by the side (southwest of Panaktak on Koagyok), where it's deep under the cliff, about fifteen feet below the ice, there is a spot that when you hit it you could be catching fish all day by jigging. When you try to touch the bottom, you cannot. Where those cod fish stay it's very deep…*
>
> *During the summer when we fished at Mackenzie Point (Tigigak) I wasn't expecting to catch lake trout. I checked the nets the next day and there were lots of lake trout. My wife said, 'I didn't know the ocean had lake trout.' I was quite amazed. We caught lots of lake trout in the nets and some of the fish were quite large.*
>
> *… Some rivers, and even the ocean, have fish that are usually found in the lakes. They got caught in our nets. Inuit sometimes caught lake trout in the rivers a sometimes in the ocean. If there are fish around you really can catch lots when you are using nets.*
>
> *People fished the ocean by jigging mostly. Now they use a lot of gillnets. They ice fish today with fishing rods. There are Arctic charr and some trout close to the ocean. Some trout are really close to the ocean. There are also jackfish or pike close to the mouth of Coppermine River. In the ocean there are whitefish, what they call the broad whitefish, lots of broad whitefish, and those flat fish called flounders, tomcod, Thompson eel and sculpins…*

5.2.2 Incorporation of TK for VEC and VSEC Selection

Results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) Report* (KIA 2012) were used for scoping and refining the potential VEC list (see Volume 9, Chapter 1). Maps clearly identify valued fisheries species and the locations and are present in chapter 7 of the TK Report (Figures 31 and 32).

The NTKP identified Arctic Char and Tomcod (Arctic Cod) as the main fish species for Ocean Inuit and Kiligiktokmiut. Neither species was caught during sampling near the marine LSA and RSA; however, Arctic Char was identified as a VEC for the marine fish community.

5.2.3 Incorporation of TK for Spatial and Temporal Boundaries

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report* (KIA 2012) were reviewed. Based on this review, it was found that the Project footprint does not overlap with marine fishing habitat as identified in Figures 31 and 32 in Chapter 7 of the TK Report (or elsewhere in the report), nor do important fishing areas occur within the LSA for the VEC Arctic Char. However, some traditional fishing areas are located in the RSA near the mouths of char-run rivers, for example the mouth of the Western River.

5.2.4 Incorporation of TK for Mitigation and Adaptive Management

As a result of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012), marine fish habitat was considered when developing mitigation and adaptive management plans for the marine fish community. The TK Report included information on important areas for marine fishing in the Bathurst Inlet. The Project has been designed such that infrastructure will not located on important marine fishing habitat. Additional mitigation of Project-related effects may be achieved by a Conceptual Fish Offsetting Plan, which also considers TK. Ongoing consultation with DFO, and future engagement with the KIA and other stakeholders, regarding the further development of the Draft Conceptual Fish Offsetting Plan, including the development of additional or alternative options that could provide value to the local communities, is intended through 2014.

5.3 VALUED COMPONENTS

5.3.1 Potential Valued Components and Scoping

Valued Ecosystem Components (VECs) are specific attributes of the biophysical environment that are regarded as crucial to the scientific, economic, or cultural heritage of a location. The determination of marine VECs and potential effects for inclusion in this effects assessment considered and was informed by:

- the EIS Guidelines (NIRB 2013);
- the public, during public consultation and open house meetings held in the Kitikmeot communities;
- Local land users, during focus group and mapping sessions with residents of Kugluktuk, Cambridge Bay, Omingmaktok, and Bathurst Inlet;
- meetings with regional Inuit groups; and
- Kitikmeot Community Advisory Group (CAG) meetings comprised of local stakeholders (e.g., Hunters and Trappers Organization [HTO] representatives).

Arctic Char was identified as the potential VEC that encompassed the health, distribution and population of Aboriginal, recreational or commercial fisheries for which moderate to significant concerns were identified (see Assessment Methodology: Volume 9, Chapter 1). Arctic Char were identified as an important commercial and subsistence food source for the Inuit. This information, along with public consultation, government engagement, regulatory consideration, and TK information, was used in the scoping process. As a result of the scoping process (Volume 9, Chapter 1), Arctic Char was identified as a VEC.

5.3.2 Valued Components Included in Assessment

The VECs selected to assess the potential effects of the Project on important marine fisheries species in the LSA and RSA include:

- marine fish/aquatic habitat (assessed in Volume 7, Chapter 4); and
- marine fish community (Arctic Char).

This chapter evaluates the effects of Project activities on the *direct* mortality and population abundance of Arctic Char, but excludes the assessment of *indirect* effects of Project activities on individual fish health and mortality. Individual fish health and *indirect* mortality are potentially affected by Project activity through the contamination of water or sediment as well as through contaminants that may bioaccumulate in fish through trophic interactions with primary and secondary producers (see Figure 6.4-8 in Volume 8, Chapter 6).

The potential for bioaccumulation in the Arctic Char VEC is quantitatively assessed in the Country Foods assessment (Volume 8, Chapter 5) and in the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6). In addition, by using Canadian guidelines to protect aquatic life — Water Quality Guidelines for the Protection of Aquatic Life (Freshwater and Marine; CCME 2013b); Interim Sediment Quality Guidelines (ISQGs) and Probable Effects Levels (PELs) for the Protection of Aquatic Life (Freshwater and Marine; CCME 2013b) — the potential for acute and chronic toxicity in Arctic Char is considered in the marine water and sediment quality VECs (Volume 7, Chapters 2 and 3).

5.4 SPATIAL AND TEMPORAL BOUNDARIES

5.4.1 Spatial Boundaries

The spatial boundaries used for the assessment of the VEC Arctic Char included a Local Study Area (LSA) and a Regional Study Area (RSA), both of which are shown in Figure 5.4-1.

5.4.1.1 Local Study Area

The boundaries of the marine LSA for marine fish/aquatic habitat were set to encompass the following:

- the shoreline where the Marline Laydown Area (MLA) Potential Development Area (PDA) is proposed; and
- the proposed winter road where it crosses the inlet.

The Arctic Char LSA is the same as the marine LSA boundary for marine fish/aquatic habitat, marine water quality, marine sediment quality, and marine wildlife chapters: (Volume 7, Chapters 2 to 5), and is defined by a 1 km buffer surrounding the shoreline where the proposed MLA is located, and a 500 m buffer on either side of the proposed winter road (marine portion only). The Arctic Char LSA covers an area of approximately 2,100 ha of marine habitat (Figure 5.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to fish habitat due to Project infrastructure typically occur.

5.4.1.2 Regional Study Area

The Arctic Char RSA encompasses the marine PDA, LSA, as well as the marine areas of Bathurst Inlet from the southern-most tip of the Inlet to approximately 15 km north of Omingmaktok. The marine fish/aquatic habitat RSA is approximately 75 km in width, covering an area of 299,971 ha, of marine habitat within Bathurst Inlet (Figure 5.4-1).

5.4.2 Temporal Boundaries

The temporal boundaries used for the assessment of effects on the VEC Arctic Char align with the duration of Project phases as described in Volume 9, Chapter 1, as follows:

- Site Preparation — 2 years;
- Construction phase — 2 years;
- Operations phase — 10 years;
- Reclamation and Closure phase — 10 years;
- Post-closure phase — 5 years minimum;
- other potential phases:
  - Temporary Closure — less than 2 years;
  - Care and Maintenance Phase — 2 to 10 years; and
  - Exploration — included in Construction and Operations phases.

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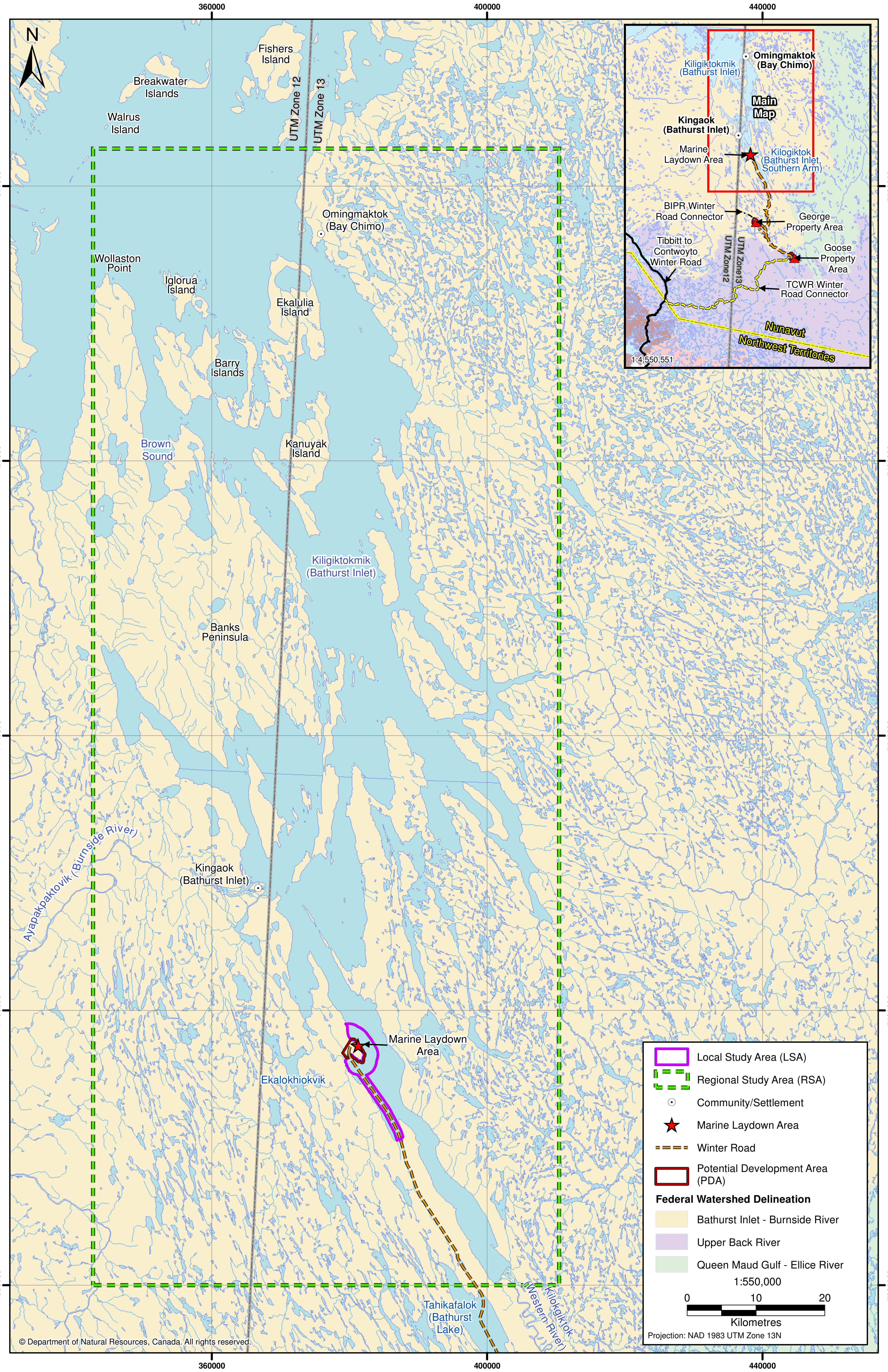

Figure 5.4-1

Sabina GOLD & SILVER CORP.

Local Study Area and Regional Study Area for Arctic Char

Figure 5.4-1

Rescan an ERM company

5.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

5.5.1 Methodology Overview

The Project-related effects assessment for the VEC Arctic Char followed the process detailed in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1):

1. Project activities were grouped on the basis of shared interaction pathways and by the timing and magnitude of the interactions with the marine environment.
2. The potential effects were then evaluated on the nature of the interaction, the magnitude and frequency of the Project activities, and the biophysical characteristics of the receiving marine environment; site-specific data from the Existing Environment and Baseline was synthesized and applied to understand the natural variation within, and resiliency of the environment.
3. The effects of mitigation and management measures to eliminate or reduce the potential effects were considered.
4. Residual effects were determined as the potential effects that would remain after the application of mitigation and management measures.
5. The significance of the residual effects were determined by the direction (i.e., positive, neutral, or negative), magnitude, confidence, and probability.

5.5.1.1 Determining the Magnitude and Significance of Residual Effects

The significance of residual effects on the VEC Arctic Char was determined using the ratings and classifications described in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1, Table 2.4-3). First, the direction of a residual effect was determined to be positive, neutral, or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect (Table 5.5-1) and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria; and the certainty and probability of an event used as qualifying criteria.

Table 5.5-1. Rating Criteria for Evaluating the Magnitude of Residual Effects on the Marine Fish Community

Magnitude Rating	Classification
Negligible	Habitat changes are unlikely to have an effect on productive capacity that is distinguishable from natural variation.
Low	Habitat changes affect less than 10% of the waterbody area, and resulting reductions in productive capacity are unlikely to affect the entire fish population of a waterbody.
Moderate	Habitat changes affect up to 20% of the available habitat in a waterbody, such that resulting reductions in productive capacity may affect fish populations in the entire waterbody.
High	Habitat changes are expected to affect more than 20% of the waterbody area and may result in changes to the productive capacity of habitat within and beyond the waterbody, affecting an entire fish population or more than one fish population.

The significance of a residual effect was rated as Positive, Not Significant, or Significant (Table 5.5-2). For example, residual effects receive a rating of Not Significant if they are expected to be one of the following: negligible or low magnitude, confined to LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1).

Table 5.5-2. Rating Criteria for Evaluating the Significance of Residual Effects on the Marine Fish Community

Significance	Descriptor of Significance
Positive	Effect could result in an increase in productive capacity of Arctic Char, relative to the baseline within the RSA into the foreseeable future.
Significant	Effect is expected to result in a decrease in productive capacity of Arctic Char that is not mitigated through Project design and management, and is long-lasting or permanent within the zone of influence of the Project relative to reference condition.
Not Significant	Effect may result in a decrease in productive capacity of Arctic Char, but one that is fully mitigated through Project design and management, or fully reversible to baseline conditions in the shorter-term after Project closure.

5.5.2 Potential Interactions with the Project and Characterization

Activities throughout the duration of the Project were considered for their potential interactions with the VEC Arctic Char. This list of potential interactions was based on the initial matrix provided in the Project Description (Rescan 2012b), and further refined using the EIS guidelines (NIRB 2013), professional judgement, and experience at other similar projects in Nunavut and the Northwest Territories.

Arctic Char may be affected in two ways: 1) through direct mortality and changes to population abundance, or 2) through decreased health and indirect mortality (Table 5.5-3). Direct mortality and changes to population abundance of the Arctic Char VEC may potentially be caused by construction of the beach ramp and seasonal dock, as well as Project activities that physically harm fish (including fishing).

The introduction of deleterious substances could alter individual health and cause indirect mortality due to changes to water and sediment quality. These changes potentially lead to increased toxicity (bioaccumulation), decreased food supply, or decreased production (survival and reproduction) of fish species. The potential for bioaccumulation in the marine fish community VEC Arctic Char is quantitatively assessed in the Country Foods assessment (Volume 8, Chapter 5) and in the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6). In addition, the potential for acute and chronic toxicity in the Arctic Char VEC is assessed in the marine water and sediment quality VECs (Volume 7, Chapters 2 and 3) using the following Canadian guidelines to protect aquatic life: Water Quality Guidelines for the Protection of Aquatic Life (Freshwater and Marine; CCME 2013b); and Interim Sediment Quality Guidelines (ISQGs) and Probable Effects Levels (PELs) for the Protection of Aquatic Life (Freshwater and Marine; CCME 2013a) and are, therefore, not discussed further in this chapter.

Table 5.5-4 describes the specific Project activities that link to potential interactions with the Arctic Char VEC identified in Table 5.5-3.

5.5.2.1 Project Infrastructure Footprint

<u>Locations of Barge Landing Infrastructure</u>

Potential effects on the VEC Arctic Char are anticipated during the Site Preparation and Construction phases during which the building of most infrastructure takes place. A marine ramp and seasonal dock at the proposed Marine Laydown Area in southern Bathurst Inlet will be constructed for annual resupply and seasonal transport during the open-water season to bring in equipment, supplies, and fuel. The beach ramp and dock will be rock-filled structures built perpendicular to shore with above water dimensions measuring approximately 30 by 30 m and 20 by 20 m, respectively. The side-slope of constructed infrastructure is assumed to be approximately 2:1, with a maximum depth below high water of 5 m, resulting in a total area of in-water infrastructure of 0.15 ha and 0.08 ha, respectively.

Table 5.5-3. Potential Interactions for the VEC Arctic Char

Fish Community Effects	Cause	Description	General Project Activity	Regulation
Direct mortality and population abundance	In-water construction, blasting, fishing, introduced species	Any impact that causes the death of fish directly (i.e., in-water construction, fishing) or reduction in population abundance (i.e., stress effects on migration).	1. Project infrastructure footprint 2. Shipping activities	*Fisheries Act* (1985), Sections 32, 36.
Reduction in water and sediment quality resulting in: • Indirect mortality • Reduction in health	Deposition of deleterious substances*	Any impact that affects individual health and longevity, tissue quality, or parasite load.	1. Management of Contact Water, Effluent, Dust	Metal Mining Effluent Regulations (SOR/2002-222)

** Project effects on the Arctic Char VEC arising from the deposition of deleterious substances are assessed in the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6) and VECs freshwater water and sediment quality (Volume 6, Chapters 4 and 5).*

Table 5.5-4. Summary of Potential Interactions between the VEC Arctic Char the Project

General Project Activity	Specific Project Activity	Project Phases
Project infrastructure footprint	1. In-water construction of barge landings	1. Site Preparation, Construction, Operations phases.
Shipping Activities	1. Ballast water discharge 2. Ship noise 3. Propeller wash	1. Site Preparation, Construction, Operations, Reclamation and Closure. 2. Site Preparation, Construction, Operations, Reclamation and Closure. 3. Site Preparation, Construction, Operations, Reclamation and Closure.

The construction of the barge landings may result in direct mortality of fish though crushing or smothering if they are unable to escape the area. In contrast, the establishment of complex sub-tidal habitat along the side slopes of the beach ramp and dock may increase productivity and draw Arctic Char to the area to exploit food resources (DFO 1990).

5.5.2.2 Shipping Activities

Ballast Water Discharge

Ballast water could potentially introduce species that compete for resources with, or transmit disease to, Arctic Char, negatively affecting their population abundance. Nonindigenous species regularly enter coastal waters in the ballast waters of commercial ships, a leading vector of aquatic species invasions (CCFAM 2004; Hulme 2009; Briski et al. 2013). These aquatic invasions have been indicated as causing or contributing to declines in populations of threatened and endangered species, habitat alteration and loss, shifts in food webs and nutrient cycling, declines in fish populations, disease outbreaks, species extinctions, and biotic homogenization (Tang 2013). The effects of invasive species may become enhanced by climate change, with northern climates becoming more at risk from invasion by southern species as temperatures become warmer (Rahel, Bierwagen, and Taniguchi 2008).

Noise

Offshore shipping activities often produce sound waves that can be high enough in amplitude to potentially affect some members of nearshore fish communities, even after the sound waves propagate several kilometres through the marine environment (McKenna et al. 2012). Hearing specialists would experience the strongest such effects (Popper 2003). In contrast, the magnitude of such effects would be smaller on hearing generalists such as salmonids, which have poorer hearing than specialists (Popper 2003). For some fish species, anthropogenic noise produced by shipping activities may cause stress-induced reduction in growth and reproductive output, and interfere with critical functions such as acoustic communication, predator avoidance, and prey detection (Slabbekoorn et al. 2010). Other indirect effects of introduced noise may result in the fish leaving a feeding ground or an area in which they would normally reproduce (Popper 2003). Based on the closely-related species Atlantic salmon (*Salmo salar*), the marine fish/aquatic habitat VEC Arctic Char (also a salmonid) could potentially hear shipping activities in the vicinity of the PDA (Hawkins and Johnstone 1978). Arctic Char in the vicinity of the PDA may elicit startle responses to very high amplitude noise caused by the propellers of ships arriving at or departing from the MLA (Knudsen, Enger, and Sand 1992, 1994). Arctic Char are not known to produce sounds for communication; therefore, the anthropogenic sounds of shipping activity have no opportunity to interfere with the Arctic Char communication.

Ship Wake and Propeller Wash

The potential effects of ship wake and propeller wash on Arctic Char would result from the erosion, deposition and re-suspension of sediments into the water column and subsequent changes to water and sediment quality. Potential Project effects on the VECs marine water quality and marine sediment quality are found in Volume 7 chapters 2 and 3 respectively and are not discussed further in this chapter.

5.5.3 Identification of Mitigation and Adaptive Management Measures

Mitigation measures will be in place to avoid or minimize the potential effects of the Project on the marine fish community VEC Arctic Char. Mitigation measures are supplemented by the use of additional management. For example, alternative siting locations may be identified along with changes in Project design and the use of best management practices. The mitigation and management measures presented in this chapter are considered to be technically, environmentally, and economically feasible.

5.5.3.1 Project Infrastructure Footprint

Locations of Barge Landing Infrastructure

The majority of Project infrastructure has been sited to avoid fish bearing water and, wherever possible, to avoid encroaching on marine fish habitat by adhering to a 31 m setback from all water. In areas where encroachment is unavoidable (landing infrastructure), best management practices will be followed to avoid unnecessary or excessive effects on Arctic Char.

Where potential Arctic Char habitat loss is expected due to construction of the beach ramp and seasonal dock, mitigation for lost habitat has been incorporated into the Draft Conceptual Fish Offsetting Plan (Volume 10, Chapter 21). The objective of this Conceptual Fish Offsetting Plan is to compensate for the alteration or destruction of fish-bearing habitat by creating or modifying fish habitat elsewhere on the landscape.

During in-water works, disposal of excavated material will be in a location above the high water mark to ensure that this material does not enter the marine environment. No equipment will be located in-water while working. All efforts will be made to minimize the duration of any in-water works and minimize the disturbance of riparian vegetation.

As a result of mitigation and offsetting via the Draft Conceptual Fish Offsetting Plan (Volume 10, Chapter 21), there are no residual effects anticipated on the VEC Arctic Char due to Project infrastructure. Unavoidable habitat losses due to Project infrastructure will be restricted to within the bounds of the PDA.

Fishing will be banned within all Project areas and, thus, will not result in fish mortality.

5.5.3.2 Shipping Activities

Ballast Water Discharge

Both the US and Canada have implemented regulations requiring mid-ocean ballast water exchange (BWE) of filled, and saltwater flushing of empty, ballast tanks (SOR/2011-237; USCG-2001-10486, 77 FR 17306). Any vessels entering the RSA and LSA will be subject to the Ballast Water Control and Management Regulations administered under the *Canada Shipping Act* (1985b). Under the *Shipping Act*, foreign ships must exchange ballast water before entering Canadian waters, and for foreign vessels entering Bathurst Inlet this exchange would probably take place in the North Atlantic or the Labrador Sea. These regulations are designed to minimize the potential transfer of nutrients, sediments, and aquatic organisms including exotic species and pathogens into Bathurst Inlet from an outside location. Exchange of ballast water before entering Canadian waters means that any nutrients or potential contaminants from foreign coastal waters are discharged into the open ocean and replaced with open ocean water. Subsequent discharge of ballast into the RSA or LSA will therefore be of relatively clean, low nutrient waters of open ocean origin. There should also be no difference in the temperature, and little difference in the salinity between the open ocean water to be discharged into the RSA or LSA and the water of the area in Bathurst Inlet that would receive the ballast discharge.

The management of ballast water and its contents is the responsibility of the ship owner, and federal guidelines set forth by Transport Canada (2007) are expected to be adhered to.

Even after mitigation by adherence to regulations, a potential effect of introduction remains from residual populations in ballast water tanks and attached to hulls. Recently, invasion models based on global shipping patterns combined with environmental conditions and biogeography have provided a first step towards understanding patterns of ship-mediated bio-invasion (Keller et al. 2011; Seebens, Gastner, and Blasius 2013). These approaches can be used to model the probability of invasion of a range of organisms.

The following calculations assume a worst-case scenario, in which no prophylactic ballast water exchange occurs in the open ocean; it is therefore likely that the following scenario overestimates the invasion risk. In this model, the probability of a native species in one port being a non-native in another port can be estimated by biogeographical dissimilarity (Seebens, Gastner, and Blasius 2013) and is a function of distance between the two ports. The probability that a given species is an alien in the recipient port increases with distance from the host port. In Arctic waters like Bathurst inlet, the majority of vessels would be travelling more than 1,000 km, and so for most donor ports, the probability of a species being alien to the recipient port would be relatively high (probabilities of 0.004 to 0.46 at 1,000 to 10,000 km away).

For a species in the donor port that is non-native to the recipient port, the probability of introduction depends on the survival within ballast tanks (Seebens, Gastner, and Blasius 2013) which decays exponentially with travel time, but increases with volume of ballast water discharged. For the proposed project in Bathurst Inlet, with typical vessels of ca. 30,000 DWT, maximum discharge per vessel would be about 10,000 m^3 (or metric tons). With typical journey times of about 30 days for international vessels, the probability of introduction would be relatively high, as observed for other international ports (Seebens, Gastner, and Blasius 2013).

Once introduced, the probability of establishment of a given non-native species increases with the environmental similarity between ports, and this can be modelled as a function of the differences in temperature and salinity between the ports (Seebens, Gastner, and Blasius 2013). In the case of Arctic waters such as Bathurst Inlet as a recipient port, the environmental similarity will be low for most international donor ports, and temperature and salinity differences will be high. In summer, surface water temperature can be high and salinity low in Bathurst Inlet, but the strong gradients observed in the pycnocline (about 10 m depth) mean that dense oceanic ballast water will mix with deeper water of very low temperature and higher salinity. With a temperature difference between host and recipient ports of about 10°C, the probability of establishment of an alien species decreases.

The product of these three probabilities determines the overall likelihood of an invasion of a non-native species through ballast water release. Assuming a full ballast discharge of 10,000 m^3, overall probability of an invasion increases as a function of distance between ports. Journey times of 10 and 30 days have little influence on overall probability of invasion, but a temperature difference of 10°C and salinity difference of 20 decrease likelihood of invasion by a factor of approximately 10^6.

The mandatory offshore exchange of ballast water and the vast dissimilarity of habitat in Bathurst Inlet from source ports make it very unlikely that introduced species will have a residual effect on the marine fish community VEC Arctic Char. Therefore, no residual effects are anticipated.

<u>Noise</u>

Generation of underwater noise from shipping activities is unavoidable. Potential effects will be mitigated by reducing the speed at which ships travel within the LSA.

<u>Ship Wakes and Propeller Wash</u>

Generation of wakes and propeller wash by ships is unavoidable. The potential effects of wakes and propeller wash will be mitigated by reduction in the speed at which the ships travel within the LSA (particularly in the more sheltered and shallow regions of Bathurst Inlet). With this mitigation in place, no significant residual effects are anticipated to occur on the marine fish community VEC Arctic Char.

5.5.4 Characterization of Residual Effects

After the application of mitigation measures, the following residual effect has been identified:

- effects of shipping noise on Arctic Char populations.

Noise from shipping will likely be infrequent since shipping traffic is expected to involve less than one ship per week during the open-water period. The magnitude of the effect of shipping noise on Arctic Char is predicted to be *low*. The geographical extent of shipping noise is predicted to be *regional* (occurring wherever ships travel within the RSA), and the effect will occur *sporadically* and will continue for the *medium-term* with a *moderate* probability of occurrence. The effect will be *reversible* as soon as ships leave the area. Based on these ratings, the effect of shipping noise on Arctic Char is predicted to be **Not Significant**, with a *moderate* level of confidence.

5.5.5 Significance of Residual Effects

The assessment of residual effects resulted in a **Not Significant** rating for the residual effects of Shipping (noise) on the VEC Arctic Char (see Table 5.5-5).

5.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

5.6.1 Methodology Overview

The potential for cumulative effects arises when residual effects of the Project affect (i.e., overlap and interact with) the same resource/receptor that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities. When residual effects are present, the Cumulative Effects Assessment (CEA) followed the process detailed in the General Methodology for Project Effects Assessment (Volume 9, Chapter 1).

5.6.2 Potential Interactions of Residual Effects with other Projects

For the marine fish community VEC, the potential cumulative effects that result from interactions between the Project and other human activities are shown in Table 5.6-1. The table carries forward all of the potential residual effects identified in Section 5.5.5. The only residual effect that extended past the boundaries of the LSA was the effect of shipping noise on Arctic Char mortality and population abundance.

Shipping noise associated with the Back River Project is predicted to affect Arctic Char throughout the RSA on a sporadic basis. The magnitude of the residual effect is predicted to be low and the effect will only occur when ships are traveling through Bathurst Inlet and docking at the MLA. Interactions with other projects that require shipping in Bathurst Inlet may increase the frequency of the noise effect as the number of ships entering Bathurst Inlet increases. Two other future projects are anticipated that may increase the frequency of shipping in Bathurst Inlet:

- the Bathurst Inlet Port and Road Project (BIPR); and
- the Hackett River Project.

Table 5.5-5. Summary Table of Predicted Residual Effects and Overall Significance Rating on the VEC Arctic Char

	Qualifier	Primary Criteria		Secondary Criteria			Qualifier	Significance Rating	Qualifier
Residual Effect	**Direction** ***(positive, neutral, negative)***	**Magnitude** ***(low, moderate, high)***	**Reversibility** ***(reversible, reversible with effort, irreversible)***	**Duration** ***(short, medium, long)***	**Frequency** ***(once, sporadic, continuous)***	**Geographic Extent** ***(footprint, local, regional, beyond regional)***	**Probability** ***(unlikely, moderate, likely)***	***Not Significant (N); Significant (S); Positive (P)***	**Certainty** ***(low, medium, high)***
Direct Mortality and Population Abundance: Shipping Noise	Negative	Low	Reversible	Medium	Sporadic	Regional	Moderate	N	High

Table 5.6-1. Interaction of Marine Fish Community Residual Effects from the Back River Project

	Description of Residual Effect
Project Residual Effect	Direct Mortality and Population Abundance: Shipping Noise
Potentially-interacting Past Project(s) or Activity(ies)	None
Potentially-interacting Existing Project(s)	None
Potential-interacting Future Project(s)	BIPR, Hackett River Project
Type of Potential Cumulative Effect	*Increased frequency of shipping noise*

5.6.3 Identification of Mitigation and Management Measures

Mitigation of the cumulative effects of shipping noise on Arctic Char will be achieved by limiting the number of ships traveling through Bathurst Inlet, and by enforcing speed limits on ships travelling through Bathurst Inlet.

5.6.4 Characterization of Cumulative Residual Effects

The magnitude of the potential cumulative effect of shipping noise on Arctic Char may increase when ships pass in close proximity to one another (i.e., temporarily increasing the underwater sound level); however, the magnitude of the effect will continue to be low because effects will only occur within a few hundred metres of ships as they pass.

The frequency of the effect may increase, but will continue to occur *sporadically* since shipping will only occur during the open-water season. Cumulative effects will be *regional* in scope. The cumulative effect will cease to occur once shipping has ended. Therefore, the cumulative effect is immediately *reversible*. The probability of the cumulative effect is moderately likely to occur. The cumulative effect is predicted to be **Not Significant** due to the *low magnitude* and *sporadic* nature. Because literature on potential effects of noise on Arctic Char is only available for closely related species of salmonids (Hawkins and Johnstone 1978), there is a moderate certainty to this conclusion of significance.

5.6.5 Significance of Cumulative Residual Effects

As a result of mitigation and the sporadic nature of the effects of underwater noise on fish, the cumulative effect of shipping noise on the VEC Arctic Char is predicted to be **Not Significant** (Table 5.6-2).

5.7 TRANSBOUNDARY EFFECTS

As outlined in Section 4 of Volume 9 (Chapter 1), the potential for transboundary effects of the Project were determined based on whether residual project effects could operate cumulatively with effects of projects in other jurisdictions. Transboundary effects can occur when VECs or the zone of influence of a project moves across jurisdictional borders external to the Nunavut Settlement Area (NSA). Residual and cumulative Project effects on the VEC Arctic Char are expected to be confined to the RSA that lies within the LSA; therefore, no transboundary effects are predicted.

5.8 MITIGATION AND ADAPTIVE MANAGEMENT

Numerous mitigation and management plans will be in place to eliminate or minimize potential effects on the marine fish community VEC. These plans can be found in Volume 10 and include the:

- Draft Conceptual Fish Offsetting Plan (No Net Loss Plan) (Chapter 21);
- Aquatic Effects Management Plan (Chapter 19);
- Overall Environmental Management Plan (Chapter 1);
- Environmental Protection Plan (Chapter 2);
- Fuel Management Plan (Chapter 4);
- Spill Contingency Plans (Chapter 5);
- Oil Pollution Emergency Plan (Chapter 6);
- Site Water Monitoring and Management Plan (Chapter 7);
- Mine Waste Rock and Tailings Management Plan (Chapter 9);

- Landfill and Waste Management Plan (Chapter 10);
- Incineration Management Plan (Chapter 11);
- Road Management Plan (Chapter 14);
- Borrow Pits and Quarry Management Plan (Chapter 16);
- Air Quality Monitoring and Management Plan (Chapter 17);
- Metal Leaching and Acid Rock Drainage Management Plan (Chapter 22); and
- Mine Closure and Reclamation Plan (Chapter 29).

Mitigation by Project Design

The Project has been designed to avoid impacts on fish communities in as many areas as possible. This includes locating infrastructure away from Bathurst Inlet where possible (the exception being the in-water structure). Further examples of mitigation by project design are presented in Table 5.8-1.

Best Management Practices

The Project will be constructed and managed following government guidelines and industrial best management practices as much as possible to avoid unnecessary impacts to fish and aquatic habitat. Government guidelines to avoid harm to fish and aquatic habitat include DFO operational statements and protocols, federal and territorial guidelines to preserve water and air quality, and federal and territorial environmental protection regulations. In addition, standard industrial best management practices will be developed, including sediment and erosion control plans, water management plans, and construction plans. Further details on best management practices are presented in Table 5.8-1.

Monitoring

Monitoring of construction activities and environmental compliance will be achieved through a Site Surveillance Network Monitoring Program that will be outlined in the future Type A Water License. This program will consist of all of the site compliance monitoring that will be required for managing/moving and releasing water from all potential containment areas.

In addition, an Aquatic Effects Monitoring Program (AEMP) will be carried out during all phases of the Project (Volume 10, Chapter 19) and a monitoring program will be developed to monitor the effectiveness of the Conceptual Fish Offsetting Plan (Volume 10, Chapter 21). The monitoring program will be developed in conjunction with regulatory agencies and the KIA, and will assess the effectiveness of the compensation activities over time in reference to specific performance objectives.

Offsetting

A Draft Conceptual Fish Offsetting Plan is presented in Volume 10. This plan will be adapted to offset any and all PADs of fish habitat, and will be reviewed and approved by DFO, the KIA, and other interested parties.

Adaptive Management

The need for any corrective actions to on-site emission management or installation of additional control measures will be determined on a case-by-case basis. Triggers for developing adaptive management measures may include:

- non-compliance results from the Surveillance Network Monitoring Program;
- adverse effects on fish and aquatic habitat as suggested by AEMP results; and
- adverse results from the monitoring of the Conceptual Fish Offsetting Plan.

Table 5.6-2. Summary of Cumulative Residual Effects and their Significance on the VEC Arctic Char

Cumulative Residual Effects	Evaluation Criteria			Likelihood of Occurrence of Cumulative Residual Effects			Significance of Cumulative Residual Effects		
	Direction ***(positive, neutral, negative)***	**Magnitude** ***(low, moderate, high)***	**Duration** ***(short, medium, long)***	**Frequency** ***(once, sporadic, continuous)***	**Geographic Extent** ***(local, regional, beyond regional)***	**Reversibility** ***(reversible, reversible with effort; irreversible)***	**Probability** ***(unlikely, moderate, likely)***	**Confidence** ***(low, medium, high)***	***Not Significant (N); Significant (S); Positive (P)***
Direct Mortality and Population Abundance: Shipping Noise	Negative	Low	Short	Sporadic	Regional	Reversible	Moderate	Medium	N

Table 5.8-1. Summary of Mitigation and Management Measures for Marine Fish and Aquatic Habitat

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	
	The Project has been designed to employ winter road only access corridors, thereby limiting dust emissions and hence the potential influence on the marine fish community. There are no all-weather roads connecting the MLA to the Goose and George Properties.
	Infrastructure has been designed to minimize footprint and therefore confines the potential influence on the marine fish community to as small an area as possible.
2. Best Management Practices	
	Winter road construction will follow the DFO Nunavut Operational Statement for Ice Bridges and Snow Fills (DFO Nunavut Operational Statement: Ice Bridges and Snow Fills, version 3.0 (2007)).
	In water work will take not take place from mid-July through mid-August during the Capelin spawning migration.
	All water intakes will be screened to avoid entrainment of fish.
	Speed limits will be followed for vessel operations to minimize propellor wash and wake effects.
	Guidelines for vessel discharges and anti-fouling surface treatments will be adhered to. These guidelines include the following requirements: • organotin compounds are prohibited for vessels in Canadian waters; • vessels must treat sewage prior to discharge, or discharge offshore; • vessels travelling in international water must exchange ballast water offshore.
3. Adaptive Management	
	The need for any corrective actions to on-site emission management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include the following: • finding that results from the Surveillance Network monitoring program (which will be outlined in the future Type A Water Licence) show non-compliance; • finding that results from the Aquatic Effects Monitoring Program, which will monitor the receiving environment around the mine infrastructure and activities, show adverse effects to the marine fish community; or • finding that results from the Fish Offsetting Monitoring Program show that the offsetting program is not successful.
4. Monitoring	
	The Aquatic Effects Monitoring Program will consist of the following components: • water quality and sediment quality monitoring; • monitoring primary producers and benthic invertebrates; and • monitoring fish and shellfish populations, as well as shellfish tissues.
	The Monitoring Program for the Conceptual Fish Offsetting Plan will consist of the following components: • assessment of fish presence/habitat use; • assessment of habitat stability and the monitoring of constructed habitat; • assessment of primary productivity; and • assessment of the benthic invertebrate community.
5. Offsetting or Enhancement	
	A Conceptual Fish Offsetting Plan will be in place that has been approved by DFO, the KIA, and other interested parties, to offset or enhance for the permanent alteration or destruction of fish habitat. Marine offsetting may include the following methods: • enhancement of fish aggregation, refuge, production, and habitat complexity through the building of artificial marine reefs.

5.9 PROPOSED MONITORING PROGRAMS

5.9.1 Aquatic Effects Management Plan

An Aquatic Effects Monitoring Program (AEMP) will be in place and is outlined in the Aquatic Effects Management Plan (Volume 10, Chapter 19). The AEMP will be undertaken during all phases of the project and will include the following:

- monitoring the marine environment at locations potentially affected by the Project and at reference areas well away from the Project activities;
- monitoring marine water quality, sediment quality, and aquatic biology; and
- monitoring of fish populations and shellfish tissue.

5.9.2 Conceptual Fish Offsetting Plan

The approved Fish Offsetting Monitoring Program for the Project will consist of the following components within the Draft Conceptual Fish Offsetting Plan (Volume 10, Chapter 21):

- fish presence and habitat use;
- local density or population size estimates for fish species;
- habitat stability monitoring of constructed habitat;
- assessment of primary productivity; and
- assessment of benthic invertebrate community.

5.10 IMPACT STATEMENT

The marine fish community VEC (Arctic Char) was assessed for: 1) *direct* effects of Project activities on mortality and population abundance, and 2) *indirect* Project effects on mortality and individual health. This chapter (Volume 7, Chapter 5) evaluates the *direct* effects of Project activities on the mortality and population abundance of Arctic Char. However, this chapter excludes the assessment of *indirect* effects of Project activities on mortality and individual fish health, which are potentially caused by the contamination of water or sediment as well as by the bioaccumulation of contaminants in fish through trophic interactions with primary and secondary producers.

The effects assessments of Project activities on the VECs marine water quality and marine sediment quality were completed in separate chapters (Volume 7, Chapters 2 and 3 respectively). In addition, effects assessments of bioaccumulation and toxicity were completed in Volume 8, Chapter 5 (Country Foods) and Volume 8, Chapter 6 (Human Health and Environmental Risk Assessment).

Population abundance of the marine fish community VEC (Arctic Char) may be affected by Project activities in several ways, including: project infrastructure, blasting, ballast discharge, noise and ship wake and propeller wash. As a result of proposed mitigation and management, one non-significant residual effect on the marine fish community VEC Arctic Char was anticipated to arise from Project activities. The primary mitigation measures include fisheries compensation through the Draft Conceptual Fish Offsetting Plan, ballast water management, and regulating ship speed.

The predicted residual effects of ship noise on Arctic Char include area avoidance and physical stress. Ship noise is anticipated to have an effect of *low magnitude* and is predicted to be *moderate in* *duration* (for the life of the mine), *sporadic* (isolated to ship movement), and *reversible with no effort*. Overall, the residual effect is predicted to be **Not Significant**.

The predicted residual effect of ship noise on Arctic Char may interact with similar effects of the proposed, future projects: Bathurst Inlet Port and Road Project (BIPR) and the Hackett River Project. Both of these projects propose shipping facilities in Bathurst Inlet. While the frequency of the effect may increase with added shipping traffic, the *sporadic* nature, *low magnitude*, and *reversible* effects of shipping noise make the cumulative effect **Not Significant**. The effects of shipping noise are predicted to be contained within the RSA and NSA; therefore, no transboundary effects are predicted.

6. Seabirds and Seaducks

6. Seabirds and Seaducks

6.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

6.1.1 Introduction

For the purposes of this assessment, "seabirds and seaducks" is used as a collective term to describe all migratory bird species that may use marine areas during any time of the year. As such, seabirds and seaducks encompass a very diverse group of avian species, from eider ducks and scoters that have a strong association with marine habitats through the breeding, staging, and migration periods, to geese, dabbling ducks, and other diving ducks that may only use marine habitats during the staging and migration periods. Several of the species in the latter category are also considered to be migratory waterbirds (Volume 5, Chapter 9), as they breed in terrestrial habitats at distance from the ocean. The seabirds and seaducks assessment only considers potential effects of the Project to species using marine habitats surrounding the Project.

The specific species included in this assessment are those that have been documented in marine habitats during baseline surveys for the Back River Project (the Project) within the marine wildlife Regional Study Area (RSA; Section 6.1.5), which includes four geese species, five species of dabbling ducks, seven species of diving ducks, four species of loon, two gull species, and tundra swan. Potential effects to this species group will vary temporally as fewer species are expected to use marine habitats during the nesting and brood-rearing period as compared to migration periods. Additional seabird and seaduck species occur outside of the marine wildlife RSA; these species are not considered within the effects assessment but are addressed in Section 6.11 (Supporting and Supplemental Information).

6.1.2 Population Trends and Conservation

Because of the difficulty in conducting surveys over the vast remoteness of the Arctic, regional estimates of population trends are not available for most species of migratory birds that breed in the Arctic (NABCI 2012). However, the direction of species-level population trends have been estimated from population tracking of birds during their migration and on wintering grounds; the magnitude of trends are less certain. Regulatory organizations that track and assign conservation status based on population trend and other criteria for seabirds and seaducks include the North American Waterbird Conservation Plan (Kushlan et al. 2002), the North American Waterfowl Management Plan (North American Waterfowl Management Plan (NAWMP) 2004), and the Sea Duck Joint Venture Strategic Plan (Sea Duck Joint Venture Management Board 2008).

Information on the population trends of migratory waterbirds, several of which use marine habitats during some portion of the breeding or migration periods, can be found within Volume 5, Chapter 9. Species not considered to be part of the migratory waterbirds group include common eider, surf scoter, white-winged scoter, and black scoter — which are defined as seaducks (Sea Duck Joint Venture 2003c). Black scoter have been observed within terrestrial habitats during baseline studies (Volume 5; Chapter 9); however, they are more strongly associated with marine habitats.

Common eiders nesting in the western and central Arctic declined by more than 50% from 1976 to 1996, based on spring migration counts in Alaska (Goudie, Robertson, and Reed 2000; Suydam et al. 2000). More recent spring migration counts (2002 and 2003) suggest that common eider populations may be stabilizing and possibly rebounding (Suydam et al. 2009). However, the local population of Pacific common eider in Bathurst Inlet still seem to be experiencing a population decline. Surveys were conducted within the northern portion of Bathurst Inlet in 1995 and again in 2006 to 2008.

Approximately 9,494 Pacific common eiders were counted in 2008 within the northern portion of Bathurst Inlet, Melville Sound, Elu Inlet, and Parry Bay, just over half (57%) the number counted in the same area in 1995 (Raven and Dickson 2009). Very little is known about the population status of all three scoter species in the Arctic, primarily on account of limited success of traditional surveys for waterfowl (e.g., waterfowl breeding survey) at recording seaducks such as scoters. Survey data does suggest that all three species may be declining across their North American range (Sea Duck Joint Venture 2003c).

Seabirds and seaducks, and their nests are protected by the federal *Migratory Birds Convention Act* (1994), which prohibits killing migratory birds and their eggs, taking their nests, and also prohibits the deposition of harmful substances in areas frequented by migratory birds (which include seabirds and seaducks). In addition, seabirds and seaducks in Nunavut are protected under the *Nunavut Wildlife Act* (2003), which prohibits destruction of bird nests when these are being used for breeding by birds, as well as disturbance to a 'substantial number' of birds, such as to flocks of birds that amass during the spring and fall staging periods.

None of the species considered in the seabirds and seaducks effects assessment are listed as species at risk under the federal Species at Risk Act (SARA). Several species that breed in the Arctic but do not occur in Bathurst Inlet are listed under SARA (see Section 6.11 for more information).

The conservation status of seabirds and seaducks in Nunavut has been assigned by the Canadian Endangered Species Conservation Council (CESCC). Species designated as "Sensitive" by CESCC rankings are species that may require special attention to prevent population declines (CESCC 2010). CESCC rankings for species in Nunavut are administered by the Government of Nunavut, Department of Environment, and are currently in draft form until future review by the Nunavut Wildlife Management Board. The following four seabird and seaduck species are listed as "Sensitive" under the CESCC designations for Nunavut: common eider, glaucous gull, and long-tailed duck (CESCC 2010).

6.1.3 Habitat Use and Diet

Information on the habitat use and diet of migratory waterbirds can be found within Volume 5, Chapter 9. Information on the ecology of species not considered in Volume 5, Chapter 9 is detailed below.

Eider ducks tend to nest near water (predominately seawater) on low tundra or bare rock microhabitats (Kellett and Alisauskas 1997). For common eider, small, coastal islands are important nesting habitat (Goudie, Robertson, and Reed 2000). Nests are rarely more than a scrape in the ground, lined with vegetation in the immediate vicinity of the nest (Goudie, Robertson, and Reed 2000; Powell and Suydam 2012). Very little is known about the nesting ecology of scoter species; the few nests that have been found have been well concealed under vegetation that are usually within a few hundred metres of water (Sea Duck Joint Venture 2003a, 2003b, 2004).

Fishes and aquatic invertebrates are primary prey items of seabirds and seaducks (Karpouzi, Watson, and Pauly 2007). Aquatic vegetation is included in the diets of eider ducks while they are nesting (Goudie, Robertson, and Reed 2000; Powell and Suydam 2012). Eider ducks move to coastal areas post-breeding to moult and stage for fall migration, during which time aquatic invertebrates are the largest component of their diet. Scoters primarily feed on aquatic invertebrates during most of the breeding season (Sea Duck Joint Venture 2003a, 2003b, 2004).

Polynyas are habitats of particular importance for marine birds; polynyas are areas where the sea ice opens up before the formal ice break-up in the summer. Many species that breed in the Arctic rely heavily on the persistence of regularly-occurring polynyas as a spring stopover location to feed before moving to breeding grounds (Mallory and Fontaine 2004). Several polynyas occur in the Arctic, including the Lambert Channel Polynya in the Coronation Gulf, the Franklin Strait Polyna, the Bellot Strait Polyna in Peel Sound, and the Lancaster Sound Polynya between Baffin and Devon Islands (Mallory and Fontaine 2004; Hannah, Dupont, and Dunphy 2009). For instance, the Lambert Channel Polynya is a regular stopover point for a subspecies of common eider (Pacific common eider; *Somateria mollissima v-nigra*) that breed in the Bathurst Inlet and Elu Inlet areas (Dickson 2012).

6.1.4 Distribution and Movement Patterns

Seabirds and seaducks are generally present in the Arctic from May through October, with some variation within species in the lengths of time spent on their breeding grounds along the coasts of the Arctic. The spring migration period spans from May through early June, while the fall migration period lasts from August through October (Mallory and Fontaine 2004). Most species have initiated nesting by June and spend the next one to two months raising their young, after which many species will move to marine staging areas to moult and gain resources for the upcoming migration.

The timing of arrival on marine habitats, and the degree of habitat use varies among species. For some species, such as long-tailed duck, common eider, and red-breasted merganser, the males do not participate in brood rearing and depart for marine habitats shortly after the females have started incubation of eggs (~early to mid-July; Titman 1999; Dickson 2012). During this time, males generally form large groups and undergo a moult; moulting areas may be located near breeding grounds but can be located upwards of a few hundred kilometers from breeding grounds in coastal areas along the Arctic mainland. Males may remain in moulting areas right until their departure for southern wintering grounds, or they may move to other fall staging areas along the coasts. In these same species, the females and young begin congregating in marine areas later in July, whereupon they will either move to moulting areas, or will remain near breeding areas to moult and depart for wintering grounds by September or, in the case of common eider, in early October (Dickson 2012). In other species, such as geese, pairs remain together during the nesting and brood reading periods, and move with young to freshwater or marine habitats in coastal areas to stage in large groups prior to migration (Mowbray et al. 2002).

Many breeding areas and marine staging areas (used for moulting or foraging) are identified as Key Terrestrial Habitat Sites (KTHSs) and Key Marine Habitat Sites (KMHSs) for migratory birds by the Canadian Wildlife Service (Mallory and Fontaine 2004; Latour et al. 2008), or are designated as Important Bird Areas (IBAs) by partnership of conservation organizations including Bird Studies Canada, Nature Canada, and Birdlife International (IBA 2012a). Key Habitat Sites (Terrestrial and Marine) are areas that support at least 1% of the Canadian population of at least one migratory species (Mallory and Fontaine 2004; Latour et al. 2008). IBAs identify habitats that are important to species of conservation concern, to large congregations of migratory birds, and to species that are limited by range or habitat (IBA 2012a). A small portion of the Bathurst and Elu Inlets KMHS overlaps the marine wildlife RSA. This KMHS, and the associated KTHS that encompasses many of the island chains in northern Bathurst Inlet and Elu Inlet to the east, are important breeding areas for Pacific common eider (Dickson 2012). At least 9,000 individuals breed in this area, and northern Bathurst Inlet is used by moulting males in July, as well as females with young in the late summer and early fall (Dickson 2012). Victoria Island, Bathurst Inlet, Elu Inlet, and the central Queen Maud Gulf support more than 80% of the Canadian population of Pacific common eiders, which breed in these and nearby areas (Dickson et al. 2005). Traditional Knowledge supports these observations; Inuit have commented on the abundance of eider ducks in the Elu inlet area, where they hunt for eiders in the spring (KIA 2012). The Inuit also noted that eider ducks (presumably common eider) as well as other bird species nest as far south in Bathurst Inlet as Kingaok (KIA 2012).

6.1.5 Baseline Information on Seabirds and Seaducks

To generate baseline data on seabirds and seaducks, aerial surveys within Bathurst Inlet near the Marine Laydown Area (MLA) were conducted during staging and breeding periods from 2011 to 2013 for the Back River Project. In addition, ground surveys were conducted to record evidence of breeding.

Specific sources of baseline seabird and seaduck information used in this section include the following Back River reports:

- *Back River Project: 2011 Wildlife Baseline Report* (Rescan 2012a, Appendix V5-5D); and
- *Back River Project: 2012 Wildlife Baseline Report* (Rescan 2013b, Appendix V5-5C).

The results of the 2013 wildlife baseline program will be available in early 2014 (Rescan 2014).

Other sources of supplementary wildlife data used in this section include:

- *Back River Project: Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012);
- *Bathurst Inlet Port and Road Project: Songbird and Shorebird Baseline Study, 2007* (Rescan 2007);
- *Bathurst Inlet Port and Road Project: Marine Bird Baseline Study, 2010* (Rescan 2012b).

6.1.5.1 Methods

<u>Aerial Surveys</u>

Aerial surveys have been conducted in 2007, 2010, 2011, 2012, and 2013 to document seabirds and seaducks using marine habitat in southern Bathurst Inlet. Generally, surveys were timed during the spring through fall to record the presence of breeding individuals (June and July) and the presence of staging and migrating birds (August).

In 2007, a single aerial flight was flown in June for the Proposed Bathurst Inlet and Road (BIPR) Project in areas surrounding the proposed port site in southern Bathurst Inlet (Rescan 2007). In 2010, surveys were conducted in July and August for the BIPR project in the southern portion of the marine wildlife RSA in two survey blocks totalling 75 km of overwater distance in each survey block (Figure 6.1-1). Flight altitude and speed during these flights was 45 m (150 ft) and 80 to 100 km/h, respectively (Rescan 2012b).

In 2011 and 2012, aerial surveys were conducted in July and August for the Project in the marine wildlife RSA along shoreline transects; marine transects were also flown in August 2011 (Figure 6.1-1). Flight altitude and speed was similar to those in 2010 except for during the 2011 marine transect surveys where flights altitude as 150 m (500 ft). The only difference between 2011 and 2012 shoreline transects were that only the western shoreline of Bathurst Inlet from Kingaok south to the Western River outflow was surveyed in 2012 (Figure 6.1-1).

In 2013, aerial surveys were flown along the shoreline of Bathurst Inlet in June, July, and August. Similar to 2011 shoreline surveys, habitat on both shorelines of southern Bathurst Inlet were surveyed except that no habitat north of Kingaok was surveyed.

During all surveys, observers noted all seabirds and seaducks within 500 m of either side of the aircraft during these surveys. Incidental observations of birds in marine habitats were also noted during other environmental baseline studies for the Project, as well as those recorded on all ferry flights to and from survey locations.

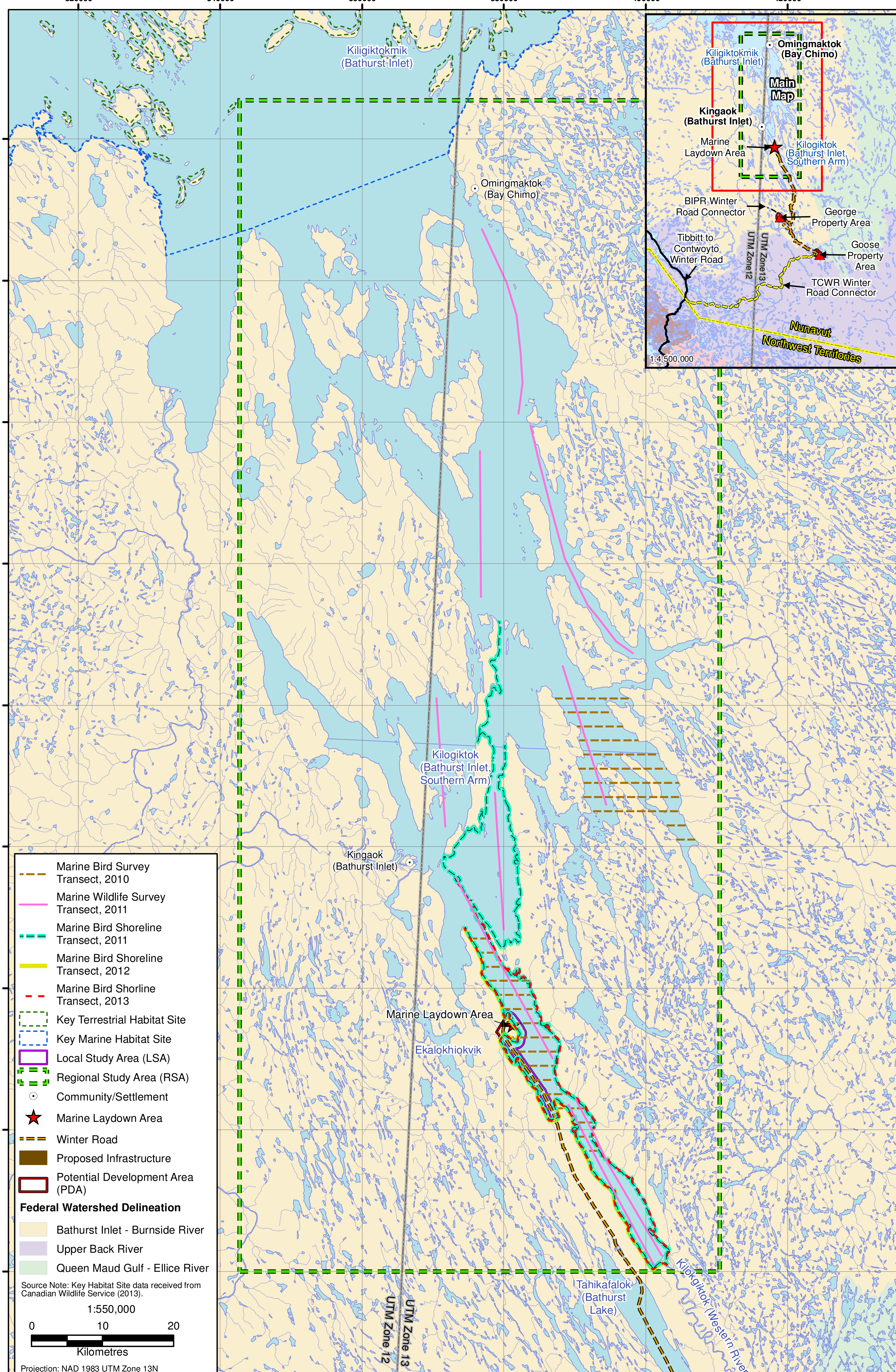

Figure 6.1-1

Transects Flown during Seabird and Seaduck Surveys in Bathurst Inlet, 2010 to 2012

Sabina GOLD & SILVER CORP.

Rescan an ERM company

Ground Surveys

In 2011, ground surveys were conducted in the marine wildlife RSA during the breeding season to locate marine bird nests along the shoreline. Surveys were conducted within 100 m of the shoreline of Bathurst Inlet. Two observers spaced 25 m apart walked along the shoreline searching for nests of seabirds and seaducks. Surveys were conducted for 30 minutes; because shoreline topography was not consistent along transects, transect length varied between 1 and 1.8 km. When nests were detected, the observers recorded the location, species, nest contents, and observations of birds flying along shorelines and on the water.

6.1.5.2 Results

A total of 23 species have been recorded from 2007 to 2013 within marine habitats in Bathurst Inlet, either during the aerial flight (2007), aerial surveys (2010 to 2013), or incidentally (2007; 2010–2013; Table 6.1-1). No evidence of seabird and seaduck breeding was recorded during ground surveys in 2011, nor has evidence of breeding been recorded during aerial surveys in June and July.

Table 6.1-1. Seabird/Seaduck Species Recorded during Surveys or Incidentally in Bathurst Inlet, 2007 and 2010 to 2013

		Year Detected				
Species	**Scientific Name**	**2007**	**2010**	**2011**	**2012**	**2013**
Geese and Swans						
Brant	*Branta bernicla*			X		X
Canada Goose	*Branta canadensis*	X	X	X	X	X
Greater-white fronted Goose	*Anser albifrons*					X
Snow Goose	*Chen caerulescens*					X
Tundra Swan	*Cygnus columbianus*					X
Dabbling Ducks						
Gadwall	*Anas strepera*			X		
Green-winged Teal	Anas crecca	X		X	X	X
Mallard	*Anas platyrhynchos*					X
Northern Pintail	*Anas acuta*					X
Northern Shoveler	*Anas clypeata*					X
Diving Ducks						
Black Scoter	*Melanitta nigra*		X	X		
Common Eider	*Somateria mollissima*		X	X		X
Greater Scaup	*Aythya fuligula*	X	X	X	X	X
Long-tailed Duck	*Clangula hyemalis*	X				X
Red-breasted Merganser	*Mergus serrator*		X	X	X	X
Surf Scoter	*Melanitta prespicillata*		X	X		X
White-winged Scoter	*Melanitta fusca*			X		
Gulls						
Glaucous Gull	*Larus hyperboreus*		X	X	X	X
Herring Gull	*Larus argentatus*	X	X	X	X	X

(continued)

Table 6.1-1. Seabird/Seaduck Species Recorded during Surveys or Incidentally in Bathurst Inlet, 2007 and 2010 to 2013 (completed)

		Year Detected				
Species	**Scientific Name**	**2007**	**2010**	**2011**	**2012**	**2013**
Loons						
Common Loon	*Gavia gavia*	X				
Pacific Loon	*Gavia pacifica*		X	X		X
Red-throated Loon	*Gavia stellata*	X	X	X	X	X
Yellow-billed Loon	*Gavia adamsii*		X	X	X	X

Survey effort as well as the areas surveyed varied between years, which limit the comparisons that may be made between datasets. Therefore, general trends in species abundance and diversity in areas of southern Bathurst Inlet are discussed below. A notable spatial trend in survey observations was that most birds were recorded in close proximity to the shorelines, despite survey effort being devoted all throughout marine habitats in Bathurst Inlet in 2010 and 2011.

During June of 2007, approximately an hour of survey time was used to fly over areas of Bathurst Inlet roughly 15 km to the south of the MLA. A total of eight species were recorded, the most common being herring gull and Canada goose (Table 6.1-2). At the time of the survey, very little open water was present within the Inlet and all birds were recorded in a narrow strip of open water along the shoreline (Rescan 2007).

Table 6.1-2. Number of Seabirds and Seaducks recorded during Aerial Flight in June, 2007

Group	Species	Number
Geese and Swans	Canada Geese	12
Dabbling Ducks	Green-winged Teal	2
Diving Ducks	Long-tailed Duck	1
	Greater Scaup	3
Gulls	Herring Gull	40
Loons	Common Loon	10
	Red-throated Loon	2
	Yellow-billed Loon	1

Of the species recorded during aerial surveys from 2010 to 2013, several have been regularly recorded in relatively large abundances (> 50 individuals) in most years, including Canada goose, greater scaup, and red-breasted merganser (Table 6.1-3; Rescan 2012a, Appendix V5-5D; Rescan 2013b, Appendix V5-5C; Rescan 2014). Other species have been regularly recorded in lower numbers, including gull and loon species. Dabbling ducks were rarely documented within marine habitats in any year, and scoters and common eider were also irregularly documented. Land users regularly collect duck eggs, including eider eggs, in areas to the east of Kingaok, suggesting that eiders regularly occur in the area (KIA 2012).

Species diversity and abundance do appear to vary temporally. Open water in Bathurst Inlet is very limited during the spring migration period, when large numbers of seabirds and seaducks pass through the region. In late May 2013 during the spring migration period, little to no open water was noted within Bathurst Inlet. Large numbers of seabirds and seaducks, primarily snow goose, Canada goose, and greater white-fronted goose, were recorded incidentally at this time at the outflows of major river drainages, such as the Burnside River outflow at Kingaok and the Western River outflow at the base of

Bathurst Inlet (Rescan 2014). Open water was present in varying quantities in these two areas, and larger numbers of geese and ducks were using the open water and associated sandbars as a stopover point. These spatial and temporal patterns and abundance of species in the spring is supported by local TK. The Inuit have noted that areas around Kingaok are used by geese as they migrate, both in the spring and the fall (KIA 2012). The Inuit also observe that geese species generally arrive in abundance before other species (e.g., ducks) begin to pass through the Bathurst Inlet area (KIA 2012). Therefore, habitat use of marine areas by migrating seabirds and seaducks during the spring is expected to be very minimal in areas surrounding the MLA.

As the ice retreats in June, open water is generally present along most of the shorelines of Bathurst Inlet, which may offer some habitat for late migrating individuals, as well as foraging habitat for local breeders. Survey data is limited during this period (2007 and 2013); however, preliminary results from 2013 suggest that species diversity is similar or higher within some species groups (e.g., dabbling ducks) in comparison to other breeding or staging surveys conducted in 2013 or other years (Table 6.1-3; Rescan 2014).

Table 6.1-3. Number of Seabirds and Seaducks recorded on Aerial Surveys from 2010 to 2013

Species	Number of Individuals Recorded in Year and Survey								
	2010		2011		2012		2013[1]		
	Summer Jul 12/13	Fall Aug 19/23	Summer Jul 6	Fall Aug 5/6	Summer Jul 15	Fall Aug 27	Spring Jun 19	Summer Jul 20	Fall Aug 26
Geese and Swans									
Brant				5					X
Canada Goose	229	139	612	187		240	X	X	X
Greater-white fronted Goose							X	X	
Snow Goose									
Tundra Swan								X	X
Dabbling Ducks									
Gadwall			1						
Green-winged Teal			9				X	X	
Mallard								X	
Northern Pintail							X	X	X
Northern Shoveler							X		X
Diving Ducks									
Black Scoter	8		21	0*					
Common Eider	1	11	20	0*			X	X	
Greater Scaup	50	97	257			107	X	X	X
Long-tailed Duck							X	X	
Red-breasted Merganser	238	256	653	45	1	52	X	X	X
Surf Scoter	3	11	27	0*				X	
White-winged Scoter			43	0*					
Gulls									
Glaucous Gull	75	55	22	169**		14	X	X	X
Herring Gull	70	65	107			7	X	X	X

(continued)

Table 6.1-3. Number of Seabirds and Seaducks recorded on Aerial Surveys from 2010 to 2013 (completed)

	Number of Individuals Recorded in Year and Survey								
	2010		2011		2012		2013[1]		
Species	Summer Jul 12/13	Fall Aug 19/23	Summer Jul 6	Fall Aug 5/6	Summer Jul 15	Fall Aug 27	Spring Jun 19	Summer Jul 20	Fall Aug 26
Loons									
Pacific Loon	4	10	3				X		X
Red-throated Loon	4	5	17			9	X	X	X
Yellow-billed Loon	5	3	4		1		X	X	X

[1] Number of individuals recorded during 2013 surveys are currently being analyzed and will be available in early 2014 (Rescan 2014).
** A number of unknown scoter (n = 238) and unknown eider (n = 30) were observed during the fall staging survey in 2012. Thus, it was likely that common eider and up to three species of scoter were present during the time of the survey.*
*** Glaucous and Herring gull were not differentiated between during the fall staging aerial survey in 2012, this total includes all unknown gulls.*

During surveys conducted in mid to late July, ice cover was generally minimal or completely absent. For surveys conducted at this time, five species — Canada goose, glaucous gull, greater scaup, herring gull, and red-breasted merganser — made up over 90% of the survey observations (Table 6.1-3). Surveys conducted in 2010 to 2013 coincided with the period when males from several species of seabird/seaduck begin congregating in marine habitats to moult (Section 6.1.4). Therefore, large groups recorded during this time likely represent moulting and staging areas used by males. Areas where large flocks of individuals have been observed during baselines are shown in Figure 6.1-2. One area of particular importance to seabirds and seaducks in July is the shallow, protected bay located roughly 1.5 km to the southwest of the MLA (Figure 6.1-2). A number of species, including Canada goose; greater scaup; white-winged, surf, and black scoter; red-breasted merganser; glaucous and herring gull; and pacific, red-throated, and yellow-billed loon have been recorded in this marine habitat in July (Rescan 2012a, Appendix V5-5D; Rescan 2013b, Appendix V5-5C). Particularly large groups (> 50 individuals) of Canada geese and greater scaup occur in this area with regularity. Based on the time of the year and number of individuals recorded, this area is being used by multiple species for moulting and staging purposes.

Surveys in August have for the most part recorded similar species within marine habitats as recorded earlier in July (Table 6.1-3). Canada goose, greater scaup, red-breasted merganser, and herring and glaucous gulls remain to be the most abundant species recorded, accounting for approximately 90% or more of the survey observations (Rescan 2012a, Appendix V5-5D; Rescan 2013b, Appendix V5-5C). The surveys coincide with the fall staging period when many species that breed in the area can be expected to congregate in marine areas, including females with their young of the year (Section 6.1.4). A notable observation is the Brant goose, which was observed in two survey years in August. Brant geese breed to the north of the Project. Therefore, their infrequent presence suggests that this species is using habitat in southern Bathurst Inlet as stopover points during their southward migration. Areas with large flocks at this time of the year are mapped on Figure 6.1-2. Large numbers of geese and duck species have been observed in the shallow bay to the southwest of the MLA (Plate 6.1-1), which is the same location where large numbers of individuals have been recorded in July. Based on preliminary results from 2013, approximately 500 greater scaup (primarily male) were recorded in the marine wildlife LSA within this shallow bay. Therefore, this area continues to be important for staging individuals into the fall. In addition, shallow, shoreline areas to the north of the MLA may also be important for staging and moulting birds at this time of the year; approximately 200 greater scaup were observed along the shoreline roughly 1.2 km north of the MLA in 2013 (Rescan 2014).

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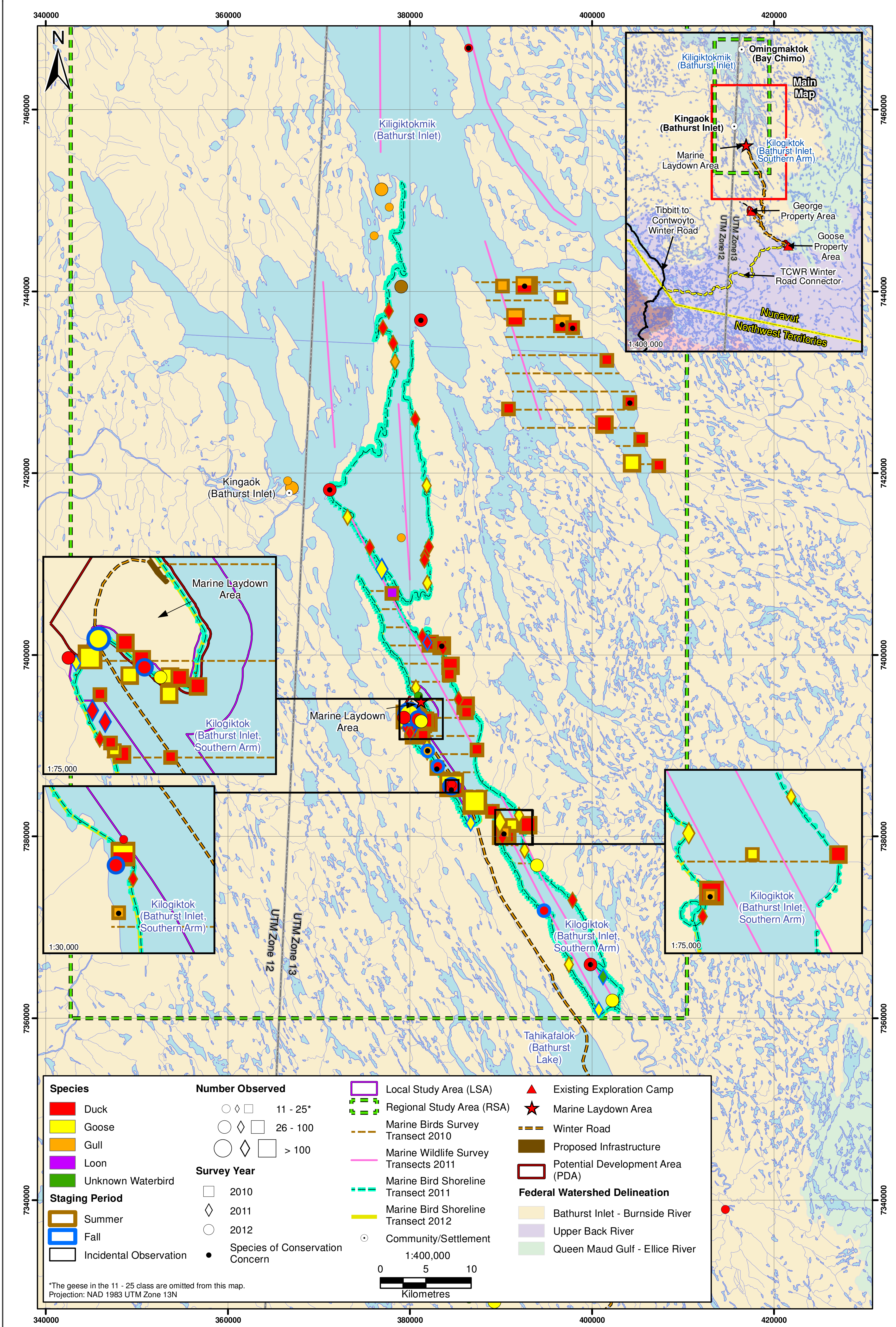

Figure 6.1-2

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Flocks of Seabirds and Seaducks Documented in the Marine WildlifeStudy Areas, 2010 to 2012

Figure 6.1-2

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Plate 6.1-1. Flocks of greater scaup (primarily male) observed in August 2012 within the marine wildlife LSA approximately 1.5 km to the southwest of the MLA.

The presence and importance of the moulting/staging area to the southwest of the MLA may be explained by the ecology of this particular area. Firstly, this bay is protected by the peninsula on which the MLA is proposed. Therefore, the waters are generally calmer along the shoreline than in the middle of the Bathurst Inlet, thereby providing an area where birds can rest or forage with relative ease even in windy conditions. In addition, the shoreline in this area is gently sloped and shallow; this shallow, gently sloping shoreline extends along much of the western shore of southern Bathurst Inlet to the Western River outflow.

In general, shallow areas are more productive in terms of aquatic vegetation and fish communities. As more light is able to penetrate to the bottom, this then promotes the growth of aquatic vegetation, which in turns provides cover and feeding areas for fish species (Horne and Goldman 1994). In addition, shallow areas are generally associated with a higher abundance and diversity of aquatic invertebrates such as bivalves and gastropods (Horne and Goldman 1994; Bluhm et al. 2005). Therefore, shallow shoreline areas, such as the ones located on the western shores of Bathurst Inlet, likely support diverse marine community and species with different foraging strategies may all find accessible and preferred forage in the area. This may explain the presence of several larger congregations of birds along the western shoreline from 2010 to 2013.

6.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Inuit TK was adapted from the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report, commissioned by Kitikmeot Inuit Association (KIA 2012). Seabirds and seaducks are important food sources for the Inuit, particularly when they are migrating through in large numbers in the spring and fall (KIA 2012). Information regarding seabird and seaduck knowledge and the current and traditional use of this species group, was provided during a series of Focus Group Sessions (Rescan 2013a) with hunters from the Kitikmeot study communities.

Traditional knowledge, land user knowledge, and concerns raised by the KIA and land users were incorporated into the seabird and seaduck effects assessment chapter in six primary ways:

1. Seabirds and seaducks were included as a VEC for a number of reasons (Section 6.3.2), including that they are a culturally and socially important species to Inuit.

2. Landusers provided insights on seabird and seaduck behaviour and habitat use.
3. Landusers worked with Rescan biologists in the field to conduct seabird and seaduck aerial studies in Bathurst Inlet (Section 6.1.5).
4. Habitat use information from TK and landusers was included in the environmental setting (Section 6.1.3) and effects assessment where habitat loss (Section 6.5.2.1) and disturbance (Section 6.5.2.2) is evaluated.
5. Concerns that were raised by the KIA and landusers about whether seabirds and seaducks would be affected by shipping and other Project-related disturbance were addressed by the inclusion of the "Effects of Disturbance" (Sections 6.5.2.2) and "Effects of Direct Mortality" (Section 6.5.2.3) sections.
6. TK and landuser information was included in the preparation of management plans to reduce the effect of Project-related disturbance and mortality on seabirds and seaducks.

The following reports were reviewed for TK specific information related to seabirds and seaducks:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013a) with hunters from the Kitikmeot communities.

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, assessing potential effects, and recommendations for mitigation and adaptive management.

6.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of marine wildlife identified as important to Inuit, along with estimated productive capacity where practical. Marine wildlife habitat use within the marine wildlife LSA and RSA, including the identification of important habitat features such as breeding and staging areas for seabirds and seaducks and pupping and moulting areas for ringed seals was also documented. These studies were guided by TK including the help of land users in the field to assist with surveys in areas deemed as important habitat for marine wildlife. This information was also used as baseline information around which the human and environmental risk assessments (Volume 8, Chapter 6) were developed.

6.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The TK report presents maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB FTP site. As part of this process, seabirds and seaducks were included as a VEC for the EIS.

6.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Marine wildlife field studies were completed during the baseline program within a study area that will encompass the measurable effects on marine wildlife resulting from development of infrastructure and other activities such as shipping and transportation associated with the Project. The marine wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods: Volume 8, Chapter 5). Marine wildlife species such as seabirds and seaducks that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The marine wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities during their lifetime.

6.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of thoughts from Inuit into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap with the Project in these areas.

6.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013a), concerns regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including marine physical environment, marine fish, and marine wildlife and Valued Socio-economic Components (VSECs) that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, only open-water season shipping (no ice-breaking) will occur so as to avoid potential negative effects on wildlife dependent on ice, and the design of in-water infrastructure minimizes the footprint of the permanent in-water infrastructure in order to minimize habitat loss for marine wildlife.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the DEIS. The information can be found in the following volumes and chapters:

- Air Quality: Volume 4, Chapter 1;
- Marine Water Quality: Volume 7, Chapter 2;
- Marine Sediment Quality: Volume 7, Chapter 3;
- Marine Fish Habitat: Volume 7, Chapter 4;
- Marine Fish Community: Volume 7, Chapter 5;

- Terrestrial Wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 7 (muskox), Chapter 8 (wolverine and furbearers), Chapter 9 (migratory birds), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds and seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

6.3 VALUED COMPONENTS

The VECs and VSECs for the DEIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the DEIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013) and other information and processes as described below. The VECs were selected based on the following information:

- potential Interaction with the proposed Project;
- consultation with communities;
- available Traditional Knowledge information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

In addition, wildlife VECs were considered as potential wildlife VECs by considering one or more of the following criteria:

- species at risk or of conservation concern (i.e., species listed by COSEWIC or under SARA, or by CESCC or by NWA;
- species or focal groups requiring enhanced consideration under the mandates of regulatory agencies, such as caribou and carnivores (Nunavut Department of the Environment [NU DOE]), and migratory birds (Canadian Wildlife Service [CWS]);
- species identified as having a strong biological importance in the ecosystem in the Project marine wildlife RSA, including importance as keystone, indicator and umbrella species; and
- species identified as being culturally, socially and economically important to the Inuit and other community members through TK.

6.3.1 Valued Components Included in Assessment

Seabirds and seaducks were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations, seabirds and seaducks were selected as a VEC for the effects assessment.

Several species of seabirds and seaducks were scoped out of the assessment as they do not regularly occur in Bathurst Inlet where the MLA portion of the Project is located. The northern Arctic is home to many seabirds and seaduck species, such as thick-billed murre, black-legged kittiwake, and northern fulmar. A short discussion on where these and other species that are found outside the marine wildlife RSA along the proposed shipping route in the summer and fall is included in the Supporting and Supplemental Information Section (Section 6.11).

Seabirds and seaducks have been identified as a VEC because of their importance as food sources for Inuit people (KIA 2012), their territoral conservation status and protected status under the Migratory Birds Convention Act, and because they are effective indicators of overall ecosystem function and health (Niemi and McDonald 2004). Birds often respond rapidly to environmental change and are thus sensitive indicators of habitat degradation and other disturbances (Koch, Derver, and Martin 2011).

Seabirds and seaducks were and continue to be an important food source for Inuit. Spring staging birds, especially eider ducks and loons, are hunted along coastal areas where the birds foraged in early-opening ice before migrating to nesting areas. In the summer, adult birds are hunted during the flightless period when they moulted their feathers. Inuit travel to coastal areas to collect the eggs of waterbirds, likely of eiders, along the coast and on small coastal islands, particularly within Elu Inlet.

6.4 SPATIAL AND TEMPORAL BOUNDARIES

6.4.1 Spatial Boundaries

The seabird and seaduck effects assessment considered two study areas for marine wildlife inventory for the Project: a Local Study Area (LSA) and a Regional Study Area (RSA; Figure 6.4-1).

6.4.1.1 Local Study Area

The boundaries of the marine Local Study Area (LSA) for seabirds and seaducks were set to encompass the following:

- the shoreline where the Marline Laydown Area (MLA) PDA is proposed; and
- the proposed winter road where it crosses the inlet.

The marine wildlife LSA is the same as the marine LSA boundary for Marine Water Quality, Marine Sediment Quality, Marine Fish Habitat and Marine Fish Community Chapters: (Volume 7, Chapters 2-5), and is defined by a 1-km buffer surrounding the shoreline where the proposed MLA is located, and a 500-m buffer on either side of the proposed winter road (marine portion only). The marine wildlife LSA covers an area of approximately 2,100 ha of marine habitat (Figure 6.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species due to Project infrastructure typically occur.

Seabirds and seaducks will be absent from Bathurst Inlet during the winter (November – April); therefore, the portion of the marine wildlife LSA around the winter road is not considered for this species group.

6.4.1.2 Regional Study Area

The marine wildlife RSA for seabirds and seaducks encompasses the marine wildlife LSA as well as the marine areas of Bathurst Inlet from the southern-most tip of the Inlet to approximately 15 km north of Omingmaktok and is approximately 75 km in width, covering an area of 299,971 ha of marine habitat within Bathurst Inlet (Figure 6.4-1).

6.4.2 Temporal Boundaries

The temporal boundaries used for the seabird and seaduck effects assessment follow the time periods of the phases of the Project as presented in Table 6.4-1.

Table 6.4-1. Temporal Boundaries — Project Phase Durations

Activities	Duration
Site Preparation	2 years
Construction phase	2 years
Operational phase	10 years
Reclamation and Closure phase	10 years
Post-closure phase	5 years
Other Potential Phases	
Temporary Closure	Less than 2 years
Care and Maintenance phase	2 to 10 years

6.5 PROJECT-RELATED EFFECTS ASSESSMENT

6.5.1 Methodology Overview

The effect assessment process comprises a step-wise method to assess the potential effects of the Project on seabirds and seaducks as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

1. Identification of potential interactions between the Project and seabirds and seaducks.
2. Characterization of the potential effects that could result from these interactions.
3. Identification and description of design, mitigation and management measures that will be taken to eliminate or reduce the potential effects.
4. Characterization of residual effects that will likely remain after mitigation and management measures have been applied.
5. Determination of the significance of residual effects using eight attributes to rate the residual effects on seabirds and seaducks including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability, and confidence.

The potential effects of the Project on seabirds and seaducks are evaluated for all Project phases as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, the phase associated with the worst-case scenario for the effect is evaluated and the results of the effect during all other Project phases are expected to be less than the effect rating for the worst-case phase assessed.

6.5.1.1 Indicators Used to Characterize Potential Residual Effects

Sustained population health of wildlife VECs was used as the key criterion to assess potential Project-related residual effects (Table 6.5-1). For each potential effect, various indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger the assessment of residual effects. For other potential effects, indicator values were qualitative in nature in the form of “yes” or “no” where triggering of residual effects assessment occurred if the indicator value was ‘yes’.

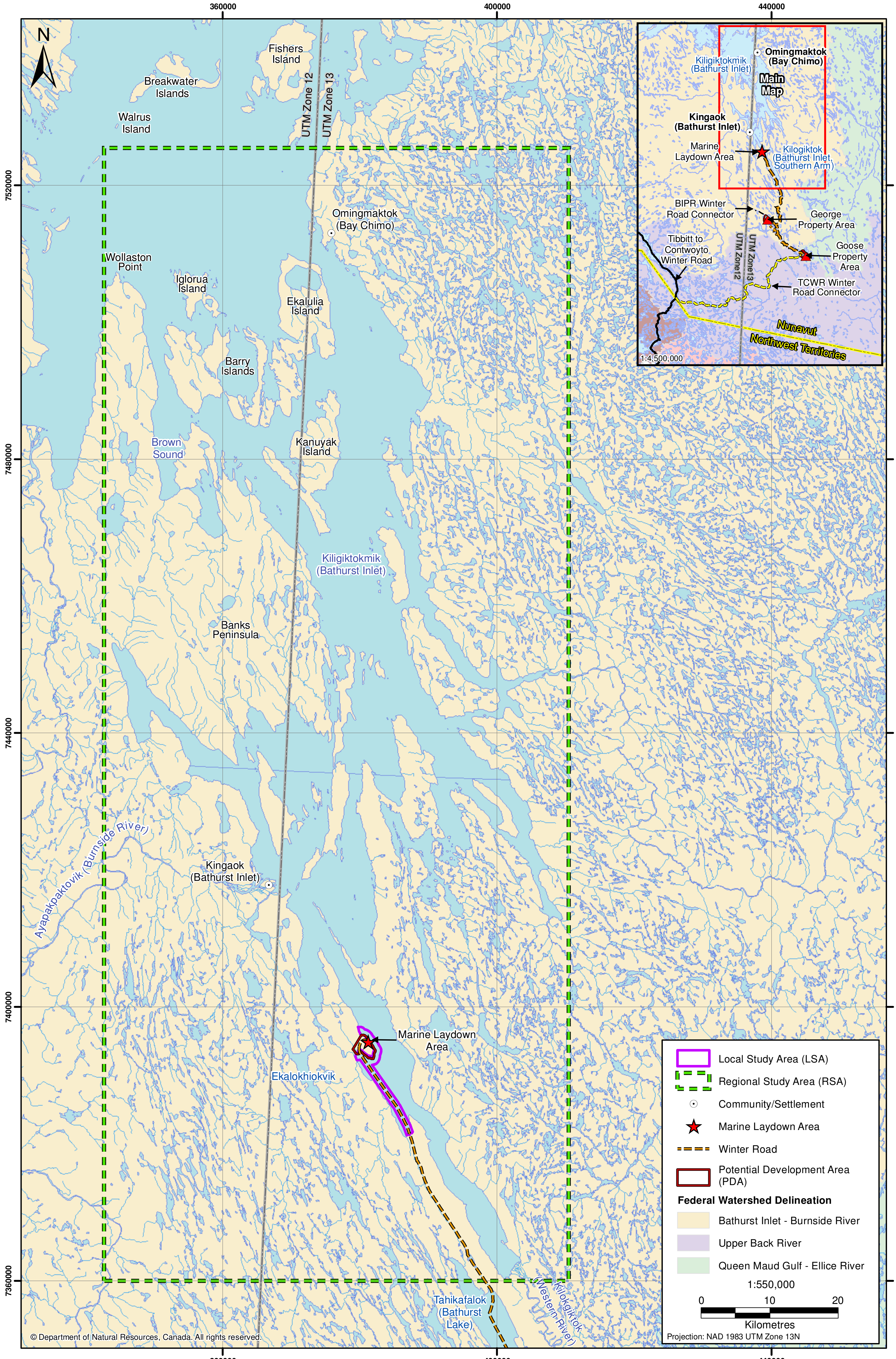

Figure 6.4-1

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Local Study Area and Regional Study Area for Seabirds/Seaducks

Figure 6.4-1

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Table 6.5-1. Criteria and Indicators Used to Characterize Potential Effects on Seabirds and Seaducks

Potential Effect	Criteria	Indicator
Habitat Alteration	Change in Population Health	Amount (ha) of habitat altered
Disturbance due to Noise	Change in Population Health	Amount (ha) of habitat altered
Direct Mortality and Injury	Change in Population Health	Collisions of seabirds and seaducks with vehicles (aircraft or ship) occurs elsewhere
Indirect Mortality	Change in Population Health	Predicted increase in human access to marine wildlife RSA
Exposure to Contaminants	Change in Population Health	Predicted Hazard Quotients for metals in environmental media and wildlife
Reduction in Reproductive Productivity	Change in Population Health	Literature suggests combined residual effects on seabirds and seaducks

6.5.1.2 Magnitude Ratings for Residual Effects

The magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. The effect is designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects was developed (Table 6.5-2).

Table 6.5-2. Definitions of the Magnitude Ratings for Population Health Criterion

Magnitude Rating	Magnitude Descriptor of Criteria (Population Health)
Negligible	No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat alteration, a negligible magnitude would occur if the ratio of area altered to the area of the marine wildlife RSA was < 0.1%.
Low	Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat alteration, a low magnitude would occur if the ratio of area altered to the area of the marine wildlife RSA was 0.1 to 4.9%.
Moderate	Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat alteration, a moderate magnitude would occur if the ratio of area altered to the area of the marine wildlife RSA was 5 to 20%.
High	Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat alteration, a high magnitude would occur if the ratio of area altered to the area of the marine wildlife RSA was > 20%.

Note: Quantitative indicator thresholds for Habitat Alteration and Disturbance were included for determining the effect on the sub-population. For all other effects professional judgement and literature review was used to determine the effect on the sub-population and thus the magnitude of the effect.

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Population health can be measured using various criteria, either indirectly using measures of change in habitat and habitat use, or directly through measures of distribution, and abundance. Data on these measures were collected during baseline studies for seabirds and seaducks, which provide benchmark measures, as well as estimates of the natural variability. Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

6.5.1.3 Overall Significance Ratings for Residual Effects

To assess the significance of residual effects, eight attributes for evaluating residual biophysical effects including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence were used and defined in Volume 9, Chapter 1. The definitions of magnitude in Table 6.5-2 were used as part of the determination of the significance rating.

First, the direction of a residual effect was determined to be positive, neutral, or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria.

Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as positive, not significant, or significant (Table 6.5-3). For example, a residual effect receives a rating of “not significant” if it is expected to be one of the following: negligible or low magnitude, confined to marine wildlife LSA, reversible without effort, or short duration (Volume 9, Chapter 1).

Table 6.5-3. Definitions of Significance Ratings for Residual Effects on Seabirds and Seaducks

Significance	Descriptor of Significance
Positive	Residual effect could result in improvements in population health, relative to the baseline within the marine wildlife RSA into the foreseeable future.
Significant	Residual effect is expected to result in a decline in sub-population health that is long-lasting or permanent within the zone of influence of the Project relative to reference conditions; levels may be variable or stable over years, but significantly lower on average than the natural variation of the population and compared to reference sites elsewhere. Regional management actions such as research, monitoring, and recovery initiatives may be required should changes to population health be deemed above acceptable risk thresholds.
Not Significant	Residual effect may result in a decline in population health within the zone of influence of the Project relative to reference conditions during the life of the Project, but population health should return to baseline conditions in the shorter-term after Project closure. Monitoring may be initiated to confirm the ratings of the effects assessment.

Finally, the degree of uncertainty in the rating was provided as a qualifier.

6.5.2 Potential Interactions with Project and Characterization

A matrix showing various components of the Project by Project phase along with the possible effects on each VEC are presented in Table 2.4-1 of Volume 9. Potential project-related effects were only considered from activities resulting from the use of the MLA since these activities are the only Project-related activities that could interact with the marine environment, where seabirds and seaducks are found. Potential effects on seabirds and seaducks and their habitat from the Project have been included in the assessment based on professional judgement, experience at other similar projects in Nunavut and the Northwest Territories, and a review of scientific literature of the effects of developments on seabirds and seaducks.

The potential effects of the project were evaluated spatially (MLA facilities and the proposed shipping route in the marine wildlife RSA) and temporally (Construction, Operations, and Reclamation/Closure phases) for seabirds and seaducks. Interactions of seabirds and seaducks with Project components were evaluated to determine which of the following potential effects may occur (Table 6.5-4):

- Habitat Alteration;
- Disturbance;
- Direct Mortality and/or Injury;
- Indirect Mortality;
- Exposure to Contaminants; and
- Reduction in Reproductive Productivity.

Table 6.5-4. Potential Project-related Effects to Seabirds and Seaducks Related to Activities at the Marine Laydown Area and Shipping

Potential Development Area	Project Component	Habitat Alteration	Disturbance	Direct Mortality and Injury	Indirect Mortality	Exposure to Contaminants	Reduction in Reproductive Productivity
Marine Laydown Area							
	Camp				X	X	X
	Barge landing	X				X	X
	On-site roads					X	X
	Other infrastructure					X	X
	Other Activities (Air Traffic)		X	X			X
Shipping							
	Vessel Traffic		X	X		X	X

Two Project-related activities have the potential to result in the effects described above including:

- Project activities at the MLA; and
- Shipping within the marine wildlife RSA.

Project-related activities at the MLA that could affect seabirds and seaducks include the construction of the docking structures at the MLA, aircraft over-flights and landing during the open-water season, small spills during fuel transfer, water and sediment contamination, and air contamination. Construction of the docking structures will not involve marine blasting or pile driving.

Vessel traffic associated with the Project includes barges and large (up to 50,000 DWT) tankers capable of carrying oil/bulk and ice strengthened to Type B to CAC 2 Ice Class. Vessel cruising speed is documented at 13.5 knots (25 km/h). Tug-assisted, 1,000 to 2,000-tonne capacity ocean barges will carry construction materials and camp supplies through Bathurst Inlet to the MLA during the

Construction phase. Air support at the MLA during Construction and Operations will consist of small turboprop (e.g., Twin Otter) planes equipped with floats. All traffic (ship or aircraft) related to fuel and supply for the Project will be scheduled between August 25 and October 31 during the open-water period. There will not be any ice-breaking activities associated with vessel traffic. Therefore, an assessment of ice-breaking activities was not conducted for the Project.

Each potential effect is described below, and then evaluated as to whether or not it will occur. Potential effects that will likely occur are then evaluated for whether or not they are predicted to result in a residual effect after mitigation actions are implemented.

6.5.2.1 Habitat Alteration

Habitat alteration and degradation can result from exclusion of animals from high-quality habitat. The greatest quantities of seabirds and seaducks recorded within Bathurst Inlet during the breeding and staging periods were observed along the shorelines of Bathurst Inlet, as opposed to marine habitats mid channel (Rescan 2012a, Appendix V5-5D; Rescan 2012b; Rescan 2013b, Appendix V5-5C). Therefore, the docking facilities at the MLA may remove shoreline habitat for seabirds and seaducks during the breeding and staging periods and the effect of habitat alteration is considered. Ship vessels that are travelling are not considered for habitat alteration as their position is continually changing, but are considered under the effects of disturbance to seabirds and seaducks (Section 6.5.2.2).

Habitat alteration may also result from the degradation of habitat quality due to contamination. The effects due to contaminants will be assessed in the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6) and summarized in Section 6.5.2.5.

Calculation of Habitat Alteration

Habitat alteration for seabirds and seaducks was calculated by comparing the total area of the docking structure footprint at the MLA to the total area that would potentially be available in the marine wildlife RSA. The amount of habitat potentially available within the marine wildlife RSA considered the total amount of marine (open water) habitat.

Evaluation of Habitat Alteration

A marine ramp and seasonal dock at the proposed MLA will be constructed for annual resupply and seasonal transport to bring in equipment, supplies, and fuel; the shipping window for the Project will be from August 25 to October 31. The beach ramp and dock will be rock-filled structures built perpendicular to shore with above water dimensions measuring approximately 30 × 30 m and 20 × 20 m, respectively. The side-slope of constructed infrastructure is assumed to be approximately 2:1, with a maximum depth below high water of 5 m, resulting in a total area of in-water infrastructure of 0.15 ha and 0.08 ha, respectively. Thus, the total habitat alteration due to Project infrastructure is equivalent to 0.23 ha.

The docking structure footprint (0.23 ha) accounts for less than 0.01% of the marine wildlife LSA and RSA. Therefore, the overall alteration of habitat is very minimal to the area available for use. Seabirds and seaducks are mobile animals, and no large congregations of seabirds or seaducks (> 50 individuals) have been recorded within or up to 1 km of the docking structure footprint at the MLA during the fall staging period when the MLA would be operational (August 25 to October 31; Figure 6.1-2). A staging area does occur roughly 1.5 km to the southwest of the MLA that has been consistently used by large flocks of birds during the summer and fall; large flocks have also been documented along the shoreline roughly 1.2 km to the north of the MLA in the fall (Section 6.1.5). Therefore, it is unlikely that any birds will consistently or exclusively use habitat within the docking structure footprint during shipping window. Seabirds and seaducks in southern Bathurst Inlet may preferentially use the staging area to the southwest of the MLA or others area identified through TK (e.g., Burnside River outflow at Kingaok; KIA 2012). Furthermore, habitat alteration at the MLA did not trigger a residual effect for fish and benthic invertebrate communities near the MLA (Volume 7, Chapter 4 and 5), suggesting that there will be no changes in the forage availability (e.g., fish, bivalves) for seabirds and seaducks in the area of the MLA. Therefore, habitat alteration is not anticipated to result in a residual effect on seabirds and seaducks.

6.5.2.2 Disturbance

The key issues for seabirds and seaducks related to sensory disturbance are the effects of the presence and noise associated within ships and aircraft on behaviour and health. A number of studies have recorded a number of responses of seabirds and seaducks to aircraft and ship traffic, ranging from alert postures to flushing and temporary avoidance of habitats (A. L. Brown 1990; Frimer 1994; D. H. Ward, Stehn, and Derksen 1994; Mosbech and Boertmann 1999; Schwemmer et al. 2011). Because of their sensitivity, seabirds and seaducks are evaluated for disturbance caused by ship and air traffic within the marine wildlife RSA.

Sea and air traffic volumes used to evaluate the effects of disturbance on seabirds and seaducks are described in the Project Description (Volume 2). It is anticipated that there will be a total of 5 to 10 ships (or equivalent barges) per year during the Construction phase (up to 20 one-way sailings) and a total of 3 to 5 ships (or equivalent barges) per year during the Operations phase (up to 10 one-way sailings) through the marine wildlife RSA for the Project. The tankers will also carry cargo and diesel fuel to the MLA during the Operations phase, and carry away non-combustible and hazardous waste (if any). Aircraft support to exchange crew and goods at the MLA during the open-water season may be required during the Construction and Operations phases. If required, there may be up to a maximum of six flights per week landing on the water near the MLA using small turboprop aircraft equipped with floats during the period when the MLA is operational (August 25 to October 31).

Shipping during the Construction phase was used to assess the effects of disturbance to seabirds and seaducks as it represents the worst-case scenario. The maximum number of aircraft flights (6) during Construction and Operations was used as the worst-case scenario to assess the effects of disturbance to seabirds and seaducks.

<u>Calculation of Disturbance due to Noise in Seabirds and Seaducks</u>

Disturbance to seabirds and seaducks was evaluated quantitatively and qualitatively. Noise threshold values (where available) were applied to generate a quantitative measure of the amount of habitat that may be disturbed by noises associated with ship passage and aircraft overflights. A qualitative assessment of the reaction of seabirds and seaducks to ships and aircraft was conducted using a literature review. Both quantitative and qualitative measures were used in combination as the key indicator to assess the potential effect, if possible.

Vessel Traffic

No quantitative noise threshold value for ship noise is available for seabirds and seaducks. Therefore, the assessment of the effects of ship traffic on seabirds and seaducks relied on a qualitative assessment.

A variety of responses were recorded in common eider along shipping lanes in Norway, ranging from no response to flushing upwards of 1,000 m from passing ships (median flush distance: 208 m; Schwemmer et al. 2011). The study also documented responses from several other species, including long-tailed duck, white-winged scoter, and black scoter, all of which had longer flush distances than common eiders. Flush distance was positively related to flock size in most species, with larger groups flying farther from vessels. Species capable of sustaining long dives (e.g., scoters, eiders) also commonly dive in response to ship traffic. In some cases, individuals did not return to the area of disturbance until three hours following the ship passage (Schwemmer et al. 2011). Scoters and eiders showed some habituation to regular shipping traffic whereby the reactions of individuals were not as strong within shipping lanes in comparison to outside of normal shipping lanes. However, habituation to ships with irregular transiting frequencies within an area was considered to be unlikely, because of their unpredictable nature (Schwemmer et al. 2011).

Air Traffic

A number of studies have recorded the responses of seabird and seaduck species to events such as low-level aircraft overflights; however, few have recorded the precise level of noise associated with a negative response. Those studies that have suggested that responses vary with species and threshold values associated with a negative response (e.g., alert posture, flushing, temporary habitat avoidance) ranged from 62 dBA to 85 dBA (A. L. Brown 1990; D. H. Ward and Stehn 1990). For this assessment, a conservative value of 70 dBA was applied as the threshold to evaluate the amount of habitat within which seabirds and seaducks may exhibit adverse behaviours from noise disturbance associated with air traffic.

Noise Modeling was conducted for in-air sound levels from de Havilland Canada DHC-6 Twin Otter aircraft at the George airstrip (Volume 4, Chapter 2; Appendix V4-2B). The effects of disturbance to seabirds and seaducks as a result of aircraft overflights was assessed by overlaying the aircraft noise model (Volume 4, Chapter 2; Appendix V4-2B) generated for Twin Otter planes (used for the George Property) over the section of Bathurst Inlet east of the MLA. The amount of marine habitat exposed to 70 dBA or greater as a result of aircraft landings and take-offs on the water in Bathurst Inlet was calculated. The area of disturbance (≥70 dBA) is also compared to the proportion of the marine wildlife RSA available to seabirds and seaducks without disturbance.

The response of seabirds and seaducks to aircraft noise and presence of aircraft appears to vary with distance. Most birds in marine habitats detect aircraft and react by becoming alert at distances greater than 1 km (Mosbech and Boertmann 1999; D. H. Ward et al. 1999). As aircraft approach, the most common response of birds in marine habitats is flushing (D. H. Ward et al. 1999; Wyle 2008). Aircraft altitude and lateral distance of the aircraft from the birds appears to be an imporant predictor of a flushing response. Studies of staging geese (Brant and Canada goose) exposed to aircaft overflights in southwestern Alaska showed an inverse relationship between elevation and response (i.e., geese reacted more frequently to lower flying aircraft than high flying aircraft) and the incidences of alert behaviour and flushing responses decreased with increasing lateral distance (D. H. Ward et al. 1999).

It is possible that some species may habituate to aircraft noise disuturbance. Conomy et al. (1998) found that American black ducks (*Anas rubripesa*; a dabbling duck) acclimated to aircraft noise within a period of roughly two weeks, while wood duck (*Aix sponsa*, a diving duck) did not acclimate at all to aircraft disturbance within the study period. In the fall, staging black brant reacted to fixed wing and helicopter traffic at greater distances than Canada goose in southwestern Alaska (D. H. Ward et al. 1999). Moulting scoters were more sensitive to helicopter overflights than long-tailed ducks (J. Ward and Sharp 1974). Therefore, there appears to be species-specific response to aircraft disturbance.

Disturbances by ships may cause more consistent and prolonged responses in searbirds and seaducks in comparison to other disturbances, such as aircraft overflights, though noise associated with aircraft appears to cause stronger adverse responses (e.g., birds become alert and/or flush at greater distance; D. H. Ward, Stehn, and Derksen 1994). Staging black brant (*Branta bernicla nigricans*) in coastal Alaska reacted more consistently by flushing to boat traffic than to aircraft overflights; however, they were exposed to proportionately more boat traffic than airplane and helicopter overflights (D. H. Ward, Stehn, and Derksen 1994).

Evaluation of Disturbance

Vessel Traffic

It is estimated that a maximum of 10 vessels will potentially access the MLA per year during Construction, resulting in a total of 20 one-way trips to and from the MLA along the Bathurst Inlet shipping route from August 25 to October 31 (68 days), or one trip every three to four days. During the Operations phase the ship traffic will decrease to three to five ships per year thus the number of seabirds and seaducks affected by vessel noise is estimated to be half that occurring during the Construction phase.

Most seabird and seaduck species are expected to respond adversely to passing ships, particularly during the periods when large flocks of birds are present in marine habitat, such as the moulting and staging period in the fall. The shipping route in the northern marine wildlife RSA does transit through a portion of a KMHS for Pacific common eider. Some eider using these island chains within the marine wildlife RSA for breeding may use adjacent marine habitats for moulting and staging from mid-July through early October, although Parry Bay and Melville Sound within Elu Inlet well to the northeast of the marine wildlife RSA appears to be the principle moulting and staging area for male and female eiders breeding in northern Bathurst Inlet and Elu Inlet (Dickson 2012). Larger flocks (~200 individuals) of greater scaup were recorded along the shoreline roughly 1.2 km to the north of the MLA during late August in 2013 (Rescan 2014). Therefore, birds may be using areas to the north of the MLA for staging or moulting purposes and may be exposed to disturbance from passing vessels accessing the MLA.

The moulting period represents a time when many seabird and seaduck species, principally waterfowl, replace flight feathers prior to fall migration, and are flightless for a period of up to four weeks. Therefore, during this time flocks of individuals are not as mobile, which may increase the risks of collisions with ships (see Section 6.5.2.3; Direct Mortality and Injury). In addition, flightless individuals, particularly in species that are not capable of sustaining long dives (e.g., geese), may expend more energy undertaking escape behaviours in response to passing ships, which could result in lower individual fitness, which is considered in Reduction in Reproductive Productivity (Section 6.5.2.6).

Disturbance from ship traffic is expected to result in a residual effect on seabirds and seaducks during the moulting and staging periods (mid-July through early October; Section 6.1.4), which coincides with the shipping window for the MLA. Some habitat may be functionally lost due to ship disturbance (i.e., avoidance of habitat resulting in functional habitat loss). Birds may move upwards of a kilometre or more from the ship as it passes. However, most responses recorded appear to be temporary in nature, and some habituation can be expected (Schwemmer et al. 2011). Therefore, it is expected that seabirds and seaducks will reoccupy areas disturbed by passing ships within several hours following exposure.

Air Traffic

The portion of marine habitat that will be disturbed due to aircraft noise (≥ 70 dBA) is 28,874 ha. This area falls outside of the marine wildlife LSA and is equal to approximately 10% of the marine wildlife RSA (Figure 6.5-1).

The abundance and diversity of species in marine habitats generally remains low during the breeding period while birds are nesting and raising young, and increases during the summer and fall as individuals move to marine habitats to moult and gain resources for the fall migration. The moulting and staging period (mid-July through early October; Section 6.1.4) coincides with the operational window of the MLA (August 25 to October 31).

Several staging areas were identified in the marine wildlife RSA. The most notable of these staging areas occurs approximately 1.5 km to the southwest of the MLA within the marine wildlife LSA. Large flocks (> 100 birds) of Canada geese and scaup (mostly male) were consistently observed across all three survey years in this area during the moult and fall staging periods (Rescan 2012a, Appendix V5-5D; Rescan 2012b;

Rescan 2013b, Appendix V5-5C). This area was also used by a number of species throughout the open-water season, including flocks of northern pintail, all three scoter species, and pairs of red-throated and pacific loon. The shallow waters along the western shores of Bathurst Inlet to the north and south of the MLA also appear to be used by larger numbers of seabird and seaduck species from mid-July through late August (Rescan 2012a, Appendix V5-5D; Rescan 2012b; Rescan 2013b, Appendix V5-5C). Therefore, aircraft noise is expected to affect areas used by flocks of moulting and staging birds, and particularly within the staging area south of the MLA.

Moulting birds, principally waterfowl, are flightless for a period of three to four weeks as they replace flight feathers. During this time, birds may not be able to avoid landing and departing aircraft in Bathurst Inlet as effectively, which puts them at elevated risks of collisions with aircraft (Section 6.5.2.3). As well, flightless birds engaging in escape behaviours may expend more energy responding to disturbances, which may be costly in terms of their energy balance and overall fitness (Section 6.5.2.3).

The amount of habitat within which seabirds and seaducks may be disturbed by aircraft noise covers a moderately small portion of the habitat available for use outside of disturbed areas. However, aircraft noise will affect seabirds and seaducks using a staging area directly to the south of the MLA throughout the late summer and fall. Therefore, a residual effect due to aircraft noise on seabirds and seaducks is anticipated.

6.5.2.3 Direct Mortality and Injury

Seabirds and seaducks may be at risk of injury or mortality resulting from Project activities; therefore, this effect is included in this assessment. Specifically, potential sources of direct mortality and injury for seabirds and seaducks associated with Project activities include collisions with ships and aircraft when the MLA is operational (September 25 to October 31).

Evaluation of Direct Mortality and Injury

A common response of birds to ship disturbance is becoming alert followed by an escape behaviour, either diving or flight (Frimer 1994; Schwemmer et al. 2011). These responses suggest that while in the water, collisions of seabirds and seaducks with ships within the marine wildlife RSA would be rare. Even young of the year that may stage within Bathurst Inlet are not expected to be at an elevated risk of ship collisions. For several species, such as eiders, young are precocial and behave like adults soon after hatching. In species with altricial young (e.g., geese), young are raised in terrestrial (freshwater) environments and by the time they may arrive in marine habitats to stage, they are essentially capable of responding similar to adults.

Similar to ship disturbance, seabirds and seaducks often take flight in response to aircraft disturbance. For the most part, birds are expected to become alert and/or engage in avoidance behaviours while the aircraft is relatively far away (around 1 km; Mosbech and Boertmann 1999; D. H. Ward et al. 1999), limiting the likelihood of close proximity encounters of flying birds with aircraft. The majority of collisions of seabirds and seaducks with aircraft (mostly waterfowl species) occur at night at high altitudes, when birds are migrating (Dolbeer 2006). Strikes at lower elevations (< 150 m) more often occur with flocks of geese foraging along airstrips (DeVault et al. 2011). As aircraft servicing the MLA will principally fly during daylight hours and many seabird and seaduck species migrate at night at altitude, collisions of aircraft with high-flying birds are unlikely. A staging area occurs roughly 1.5 km to the southwest of the MLA and therefore is adjacent to a marine landing area within Bathurst Inlet (Figure 6.1-2). Congregations of multiple seabird and seaduck species, including geese and diving ducks, can be expected to occur here each year in the fall, based on baseline survey results from 2010 to 2013 (Section 6.1.5). Therefore, approaching and departing aircraft may have a higher likelihood of encountering low-flying birds in this area. Larger flocks of searbirds and seaducks (greater scaup) have been observed approximately 1.2 km to the north of the MLA in late August, suggesting that low flying individuals may also be found in areas to the north of the MLA as well.

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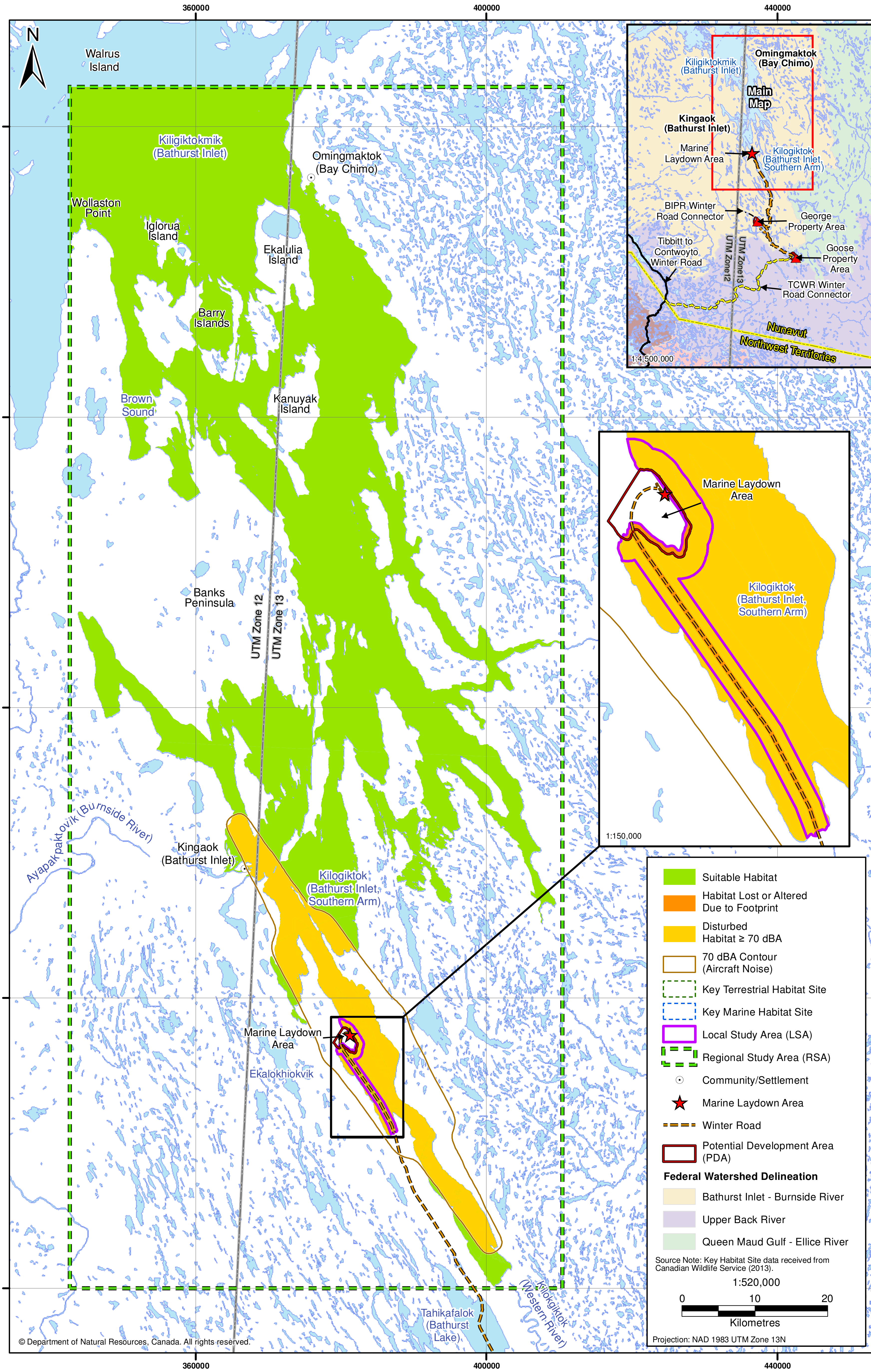

Figure 6.5-1

Seabird and Seaduck Habitat Altered or Disturbed due to the Project

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Seabirds and seaducks would be most susceptible to collisions during the fall moult. Birds are flightless for a three to four week period while they replace flight feathers; individuals often form large flocks during this time as well. Therefore, flocks of moulting birds, principally geese and ducks, may not be able to avoid ships and aircraft as effectively during this time. The staging area to the southwest of the MLA is likely used for moulting by scaup and possibly Canada goose. The majority of the birds observed in this area remained concentrated in the shallow, protected bay west of the peninsula on which the MLA is proposed. Therefore, these flightless birds are not expected to come in close contact with ships docking at the MLA nor aircraft landing or departing within Bathurst Inlet adjacent to the MLA.

Incidences of bird collisions with ships and aircraft servicing the MLA are expected to be rare, although birds may be at greater risk during the fall during the moult. Mitigation and management measures will lessen the likelihood of collisions, and may include the use of buffers between aircraft flight paths and sensitive habitats for seabirds and seaducks (e.g., moulting and staging areas) wherever it is safely possible to institute such buffers (Volume 10, Chapter 20). In addition, takeoffs and landings may be restricted within the staging area located to the southwest of the MLA so that aircraft can avoid encountering large groups of potentially flightless birds during the late summer and fall. With mitigation, no residual effect of direct mortality and injury on seabirds and seaducks is anticipated.

6.5.2.4 Indirect Mortality

In addition to direct mortality (Section 6.5.2.3), indirect mortality to seabirds and seaducks may occur as a result of increased hunting facilitated by Project related activities.

Hunting restrictions may be instituted for Project employees at the MLA (Volume 10, Chapter 20). Furthermore, there will only be winter road access to the MLA, a period when seabirds and seaducks are absent from the area. Therefore, it is considered unlikely that indirect mortality due to increased hunting of seabirds and seaducks will occur and this effect is not evaluated further in the assessment.

6.5.2.5 Exposure to Contaminants

Exposure to contaminants in seabirds and seaducks due to the Project was evaluated in the environmental risk assessment (Volume 8, Chapter 6). Results of these assessments indicated that all contaminant hazard quotients in seabirds and seaducks or its respective food chain components and surroundings (e.g., water, sediment, invertebrates, fish) were predicted to be below a value of one. A hazard quotient less than one indicates that an increase in contaminants in these media relative to baseline conditions is unlikely. Thus, a residual effect due to exposure to contaminants in seabirds and seaducks is not anticipated and is not considered further in the assessment.

6.5.2.6 Reduction in Reproductive Productivity

Reproductive productivity is quantified as the number of surviving young produced per year per female. Disturbances to seabirds and seaducks resulting from Project activities (Section 6.5.2.2) are expected to disrupt normal behaviours and exclude birds from feeding or staging habitats for relatively short periods of time. These effects, though short term, may in turn impose a negative effect on the energetic balance of adults and young, which may result in poorer body condition. Adults in poorer body condition produce fewer young; while young in poor body condition are more susceptible to mortality.

Any changes in foraging success could affect the ability of seabirds and seaducks to prepare for the fall moult. Moulting requires significant body resources to complete (Lindström, Visser, and Daan 1993; Guillemette et al. 2007). During the moult, metabolic rates increased in female common eider without any increase in foraging effort, suggesting that females are stressed during the moult and lose weight (Guillemette et al. 2007). Therefore, disturbances during the moult could affect individuals to a greater degree due to the increased energetic demands at this time of year. These changes may manifest as lower individual fitness, thus reducing reproductive success.

The effects of climate change on seabirds and seaducks could exacerbate the effect of reduction in reproductive productivity. Many species of migrating seabirds and seaducks are highly dependent on the presence of regularly-occurring polynyas in the spring; these areas are key stopover points for birds to forage and rest prior to arriving on their breeding grounds. For example, the Lambert Sound Polynya is a key stopover point for the population of Pacific common eider breeding in Bathurst and Elu Inlets (Dickson, Mallory and Fontaine). In addition, for species such as eiders, nesting and brooding is done entirely by the female, and any extra fat stores gained just prior to nesting help the female to fast completely during the incubation period (Bolduc and Guillemette 2003). Therefore, changes in the extent and concentration of sea ice may alter the patterns of migration, nutritional status, reproductive success, and ultimately the abundance of some seabird and seaduck species. The absence or late emergence of several polynyas in the Arctic have been linked to die offs and reproductive failures in several seabird and seaduck species (Barry 1968; R. G. B. Brown and Nettleship 1981; Fournier and Hines 1994; Robertson and Gilchrist 1998).

Mitigation cannot eliminate the effects of disturbance (ship and aircraft presence and noise) on seabirds and seaducks staging in areas surrounding the MLA and along the proposed shipping route within the marine wildlife RSA. As birds (females in particular) may be energetically stressed during the fall moulting period, they have a lower capacity to buffer additional stresses at this time. Therefore, a residual effect on the reproductive productivity of seabirds and seaducks resulting from Project activities at the MLA is expected.

6.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Monitoring Plan (Volume 10 Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including seabirds and seaducks. In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to the environment detailed in Volume 10.

A residual effect of the Project on seabirds and seaducks is anticipated resulting from disturbance due to noise and reduction in reproductive productivity. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Project-related effects to seabirds and seaducks. Since reduction in reproductive productivity is considered a possible consequence of the other potential effects, no mitigation or management is included specifically for this potential effect.

6.5.3.1 Mitigation for Habitat Alteration

The primary mitigation and management strategies to minimize the effects of marine habitat alteration for marine wildlife are addressed by the design of the Project (see Project Description; Volume 2). Mitigation measures specific to minimizing the effects of habitat alteration to seabirds and seaducks may include the following:

- Project infrastructure designed to avoid, where possible, identified wildlife sensitive areas such as moulting and staging areas; and
- Project infrastructure designed to minimize the footprint of infrastructure to reduce habitat loss for seabirds and seaducks.

6.5.3.2 Mitigation for Disturbance

The primary mitigation and management strategies to minimize the effects of disturbance to wildlife are addressed in the Noise and Vibration Chapter (Volume 4, Chapter 2) and the Noise Abatement Plan (Volume 10, Chapter 18). Additional wildlife specific measures to minimize the effect of disturbance to seabirds and seaducks may include:

- pre-determined flight paths developed, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats (e.g., staging areas);
- a prescribed aircraft flight altitude during horizontal (point to point) flights wherever it is safe to do so to reduce disturbance to important staging areas; and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude when possible, wherever flocks of birds are observed.

6.5.3.3 Mitigation for Direct Morality and Injury

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2), the Wildlife Mitigation and Monitoring Plan and the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to seabirds and seaducks may include:

- pre-determined flight paths developed to provide horizontal as well as vertical buffer distances between flight paths and sensitive habitats (e.g., staging areas);
- the marine landing area monitored prior to take-off and landings to ensure concentrations of seabirds and seaducks are not present in the area, and to ensure safety to aircraft passengers; and
- aircraft landings and departures in the staging area south of the MLA restricted such that aircraft avoid encountering large groups of potentially flightless birds during the late summer and fall.

6.5.3.4 Mitigation for Indirect Mortality

The primary mitigation and management strategies to minimize the effects of indirect mortality to wildlife are addressed in the Socio-Economic Assessment (Volume 8, Chapter 3) and in the Socio-economic Monitoring Plan (Volume 10, Chapter 23). Measures to minimize the effect of indirect mortality specific to seabirds and seaducks may include:

- a policy prohibiting hunting by Project employees and contractors, while on site.

6.5.3.5 Mitigation for Exposure to Contaminants

Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (only if water quality criteria in the future water licence are met) will also serve to minimize potential effects to the quality of the marine environment within the marine wildlife LSA and RSA and thus, will help to minimize the effect of exposure of contaminants to seabirds and seaducks.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife, including seabirds and seaducks from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20). These measures may include:

- only geochemically suitable rock quarries and borrow sources used to construct roads, pads, and structures to minimize potentially poor quality water entering the environment;
- all chemicals stored in secure areas, in order to keep potentially harmful chemicals out of the receiving environment and from being accessed by searbirds and seaducks;
- a Spill Contingency Plan and a Risk Management and Emergency Response Plan implemented in order to minimize the potential for chemical contaminants to enter the environment; and
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20).

6.5.4 Characterization of Residual Effects

In Section 6.5.2, six potential effects were evaluated to determine whether they would result in residual effects after mitigation. Residual effects are those effects predicted to remain after the application of mitigation and management. Two of these effects were rated as having the potential for residual effects: 1) disturbance and 2) reduction in reproductive productivity. The significance of residual effects is evaluated here for these two effects. Each residual effect is described in this section in terms of eight descriptors (see Volume 9, Chapter 1), including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence. The magnitude of the residual effect was evaluated by using the information in Table 6.5-1. Table 6.5-2 provides a description of the significance ratings used for residual effects.

6.5.4.1 Disturbance

The residual effect of disturbance to seabirds and seaducks is considered negative, as it could result in altered behaviours of individuals and temporary avoidance of habitats (i.e., functional habitat loss on a small temporal scale). It is likely that no flights to the MLA will be required during the open-water season either during Construction or Operations, thereby eliminating the potential for disturbance due to aircraft noise. Based on the precautionary principle, both ship and aircraft disturbance are evaluated here.

The magnitude of the effect is anticipated to be moderate, as noise may affect up to 10% of the marine wildlife RSA (Table 6.5-2). However, the duration of the effect is expected to be medium, as the effect is expected to last until the MLA is decommissioned. The frequency of the effect is anticipated to be sporadic. A ship may pass through Bathurst Inlet to the MLA once every six days during Construction and once every 12 days during Operations. Aircraft disturbance during the open-water season (overflights and landings/take-offs) may occur more regularly (up to once a day during Construction and Operations). The effect is anticipated to be regional in extent because both disturbance due to ship and aircraft (presence and noise) will take place outside the marine wildlife LSA but within the marine wildlife RSA.

The effect of disturbance is expected to be reversible as the disturbance due to ships and aircraft use will be removed when the MLA is closed. Furthermore, seabirds and seaducks may return to disturbed areas within relatively short periods of time following disturbance, and some individuals or species may acclimate to regularly occurring disturbance. The likelihood that disturbance to seabirds and seaducks will occur is likely, as and concentrations of seaducks and seabirds occur in close proximity to the MLA and thus will be exposed to disturbance associated with the presence and noise of ships and aircraft. The confidence in the effect rating is high as disturbance to seabirds and seaducks as a result of ship traffic and aircraft overflights is well documented in the literature.

Overall, the effect of disturbance to seabirds and seaducks is assessed as Not Significant.

6.5.4.2 Reduction in Reproductive Productivity

The residual effect of reduction in reproductive productivity is considered negative, as it could result in a decrease to the population of seabirds and seaducks within the marine wildlife RSA.

The magnitude of this effect is not expected to exceed the limits of natural variation and is therefore rated as low. The duration of the effect is expected to be medium as the effect of disturbance will last until the MLA is decommissioned. The frequency of the effect is anticipated to be sporadic once shipping and aircraft traffic commences, as it is expected that seabirds and seaducks may be temporarily disturbed by passing ships, aircraft overflights, and aircraft take-offs/landing during the operational window of the MLA (August 25 to October 31). These disturbances could then result in lower female or juvenile fitness that may affect the reproductive health of subsequent generations. The extent of the effect is regional, as the population of seabirds and seaducks breeding and staging within the marine wildlife RSA may be affected by shipping and aircraft traffic associated with the Project.

The effect of reduction of reproductive productivity is anticipated to be reversible as disturbances will cease when the MLA is closed. The likelihood that a reduction in reproductive productivity of seabirds and seaducks will occur is unlikely, as disturbances due to ship and air traffic will be brief in nature and because of the large availability of undisturbed habitat within the marine wildlife RSA. The confidence in the effect rating is medium as it is unknown how the effects of the Project on reproduction of seabirds and seaducks may interplay with the effects of climate change.

Overall, the effect of reduction of reproductive productivity in seabirds and seaducks is assessed as Not Significant.

6.5.5 Significance of Residual Effects

Two residual effects for seabirds and seaducks were assessed and resulted in the following significance ratings:

- disturbance, rated Not Significant; and
- reduced reproductive productivity, rated Not Significant.

The criteria used in the determination of the significance of each residual effect is detailed in Section 6.5.4 and summarized in Table 6-5-5. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10; Chapter 20), the combined significance of residual effects for seabirds and seaducks is predicted to be Not Significant.

6.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

6.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities. Following the methodology outlined in Volume 9 Chapter 1, a cumulative effects assessment is conducted as there are residual effects for the VEC seabirds and seaducks. The following residual effects are included in the potential cumulative effects assessment: disturbance and reduction in reproductive productivity.

Table 6.5-5. Summary of Residual Effects on Seabirds and Seaducks and Overall Significance Rating

Description of Residual Effects	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
	Direction (positive, neutral, negative)	Magnitude (negligible, low, moderate, high)	Duration (short, medium, long)	Frequency (once, sporadic, continuous)	Geographic Extent (footprint, local, regional, beyond regional)	Reversibility (reversible, reversible with effort, irreversible)	Probability (unlikely, moderate, likely)	Confidence (low, medium, high)	Not significant (N); Significant (S); Positive (P)
Disturbance	Negative	Moderate	Medium	Sporadic	Regional	Reversible	Likely	High	N
Reduction in Reproductive Productivity	Negative	Low	Medium	Sporadic	Regional	Reversible	Unlikely	Medium	N

The cumulative effects assessment (CEA) is detailed in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season within which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be apportioned to the Project as compared to other project and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's incremental contribution to the cumulative residual effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators used for assessing the magnitude of residual cumulative effects were the same as those used for assessing the magnitude of Project-related residual effects (Section 6.5.1.1).

Magnitude ratings for cumulative effects were based on the same criteria used to rate the magnitude of Project-related effects (Section 6.5.1.2), with the exception that for habitat-based indicators, values were compared to the amount of habitat available within the CEA boundary for seabirds and seaducks (Section 6.6.1.1).

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 6.5.1.3).

6.6.1.1 Spatial Boundaries for Cumulative Effects Assessment

The marine wildlife RSA was used as the spatial boundary for the cumulative effects assessment boundary (see Section 6.4.1.2). The marine wildlife RSA boundary was selected as seabirds and seaducks breeding in terrestrial habitats within the marine wildlife RSA would likely also use adjacent marine habitats for foraging, moulting, and staging purposes (i.e., their home range during the breeding and migration periods could be contained within the marine wildlife RSA). Generally, seabird and seaduck species breeding in Bathurst Inlet could forage from 15 to 30 km from their nest site (Mallory and Fontaine 2004). During the moulting and staging periods, birds can travel distances of 15 to 45 km. Moulting (flightless) birds are capable of swimming more than 15 km between coastal moulting sites (Flint et al. 2004). Male Pacific common eiders breeding in northern Bathurst Inlet and Elu Inlet appear to moult and stage near areas used for nesting. Female common eiders may move upwards of 45 km from their nesting site (Mosbech et al. 2006; Dickson 2012), but females from the population breeding in Bathurst and Elu Inlets moulted within Parry Bay and Melville Sound in close proximity to their terrestrial nesting areas (Dickson 2012).

Therefore, seabirds and seaducks that use habitat near the MLA when the facility is operational (August 25 to October 31) could be expected to use marine habitats upwards of 45 km from the MLA (i.e., within the marine wildlife RSA) and thus interact with other development projects in that area.

6.6.1.2 Temporal Boundaries for Cumulative Effects Assessment

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 9, Chapter 1.

6.6.2 Potential Interactions of Residual Effects with other Projects

Two residual Project-related effects were identified during seabirds and seaducks effects assessment: disturbance due to noise and reduction in reproductive productivity. Other projects with marine related residual effects (in Bathurst Inlet) may contribute cumulatively to the effects of disturbance due to noise and reduction in reproductive productivity in seabirds and seaducks.

Two reasonably foreseeable future projects occur within the wildlife marine RSA, the Bathurst Inlet Port and Road (BIPR) project and the Hackett River project. Both projects propose seasonal shipping through Bathurst Inlet. The BIPR port site is located roughly 15 km to the southeast of the MLA. The Hackett River project may use this port site if the BIPR project is approved by NIRB; otherwise, a port facility for the Hackett River may be built roughly 30 km southeast of the MLA. For the purposes of this assessment, both projects are assumed to operate from the BIPR port site.

There is a small amount of shipping that presently occurs within Bathurst Inlet. Typically, the Bathurst Inlet Lodge at Kingaok receives an annual sealift via tug assisted barge or small cargo ship from Hay River, Northwest Territories. Guests of the Bathurst Inlet Lodge may participate in tours to view wildlife and heritage sites by boat along the shoreline of Bathurst Inlet both to the north and south of Bathurst Inlet Lodge. The Elu Inlet Lodge, located in Elu Inlet which connects to Bathurst Inlet in the north, may also receive an annual sealift, and guests can participate in local wildlife viewing and heritage site tours along the shores of Elu Inlet. In addition, some local land users from Cambridge Bay access Bathurst Inlet by boat throughout the summer and fall to hunt, fish, and trap (Volume 8; Chapter 4). These local shipping activities were not considered within the seabirds and seaducks cumulative effects assessment, as they are not associated with a past, existing, or reasonably foreseeable future development identified in the cumulative effects assessment methodology outlined in Volume 9, Chapter 1. However, these shipping activities have occurred within Bathurst Inlet for many years and are expected to continue occurring into the future with regularity either by sealift or other means.

6.6.2.1 Disturbance

The effect of disturbance in searbirds and seaducks due to the Back River Project was rated as Not Significant with a moderate (aircraft disturbance) to low (ship disturbance) magnitude in the effects assessment. Potential disturbance resulting from ship and air traffic if the BIPR and Hackett River projects are developed may contribute to an additive effect on seabirds and seaducks in marine habitat disturbed by the Back River Project (Section 6.5.2.2). Increased disturbance to seabirds and seaducks is expected to result in increased alert behaviours and incidences of flushing and flight, which could result in more permanent avoidance of habitat due to increased frequency of exposure.

Calculation of Cumulative Disturbance to Seabirds and Seaducks

Vessel Traffic

Cumulative disturbance due to vessel traffic was evaluated qualitatively using similar methods as outlined in the effects assessment (Section 6.5.2.2). The operational window of the BIPR port site is from mid-July to late October, which will overlap the operational window of the MLA (August 25 to October 31).

Aircraft Traffic

Cumulative disturbance due to aircraft was evaluated quantitatively and qualitatively using similar methods as outlined in the effects assessment (Section 6.5.2.2). The area in which seabirds and seaducks may be affected by aerial disturbance was calculated and used as a key indicator of this potential effect.

To calculate the area of cumulative disturbance due to aircraft, it was assumed that the aircraft used for the construction and use of the BIPR port are similar to that used for Back River Project (Twin Otter). The aircraft noise modeling profile for the aircraft centered on the Inlet directly east of the MLA was overlaid with the same profile centered on the BIPR port site. The area of overlap between these two aircraft noise profiles was calculated.

Evaluation of Cumulative Disturbance to Seabirds and Seaducks

Vessel Traffic

It is estimated that a maximum of 20 one-way trips travelling to and from the MLA for the Back River Project during the Constructions phases, and up to 10 one-way trips during Operations. The frequency of vessel traffic travelling through Bathurst Inlet associated with the Back River Project is one trip every three to four days during Construction, and one trip every seven days during Operations (assuming ship transits are evenly spaced during the 68 day operational window of the MLA between August 25 and October 31).

Shipping traffic from the BIPR port site for the BIPR and Hackett River projects will include barges and large (up to 50,000 DWT) tankers capable of carrying oil/bulk and ice strengthened to Type B to CAC 2 Ice Class. It is assumed that up to 10 round trips per year (20 one-ways trips) would be required for the Hackett Project to deliver supplies and export concentrate. The vessel traffic associated with the BIPR project includes up to 6 round trips per year (12 one-way trips) for the purposes of community resupply and delivering supplies to users of the BIPR all-weather road.

Assuming that ship transits are evenly spaced during the operational window of the BIPR port (mid-July to late October), there may be one trip every three days travelling through Bathurst Inlet for the BIPR and Hackett River projects. Vessel traffic associated with these two projects will increase the number of trips through Bathurst Inlet by roughly 19 one way trips during the operational window the Back River Project MLA (August 25 to October 31).

Therefore, during Construction of the Back River Project, there may be one ship every two days passing through Bathurst Inlet if the BIPR and Hackett River projects are developed at the same time, with that number decreasing to one trip every three days during Operations of the MLA. Alternatively, it is possible that there may be multiple passage per day, with greater than two to three days separating trips.

Cumulatively, there is roughly a two-fold increase in the amount of shipping through Bathurst Inlet during the period when the MLA will be used if the BIPR and Hackett River projects are developed relative to the Back River Project alone. Therefore, moulting and staging birds using habitat, such as the staging areas in the vicinity of the MLA (e.g., 1.2 km to the north, 1.5 km to the southwest) will experience more frequent disturbances due to vessels transiting to the BIPR port. For this reason, a cumulative residual effect due to vessel traffic on seabirds and seaducks is expected.

Air Traffic

During the Construction and Operations phase of the Back River Project, there will be up to six flights per week with a Twin Otter (or equivalent) when the MLA is active between August 25 and October 31. During closure of the MLA, there will be a maximum of three flights per week. It is assumed that there would be approximately three flights per week for the BIPR project in addition to those for the Back River Project. Thus, the total cumulative number of flights per week is expected to be approximately nine flights per week, resulting in greater than one flight per day during the open-water season.

The total area for the cumulative effects of aircraft disturbance due to the Back River Project and BIPR project is 31,577 ha, while the area of disturbance overlap (i.e., the area where noise from aircraft servicing the Back River Project and BIPR project would overlap) is equivalent to 18,122 ha. Cumulatively, the total area accounts for approximately 11% of the wildlife marine RSA, while the area of overlap accounts for 6% (Figure 6.6-1).

The effect of disturbance is anticipated to result in a cumulative residual effect on seabirds and seaducks. A moderately small proportion of marine habitat within the marine wildlife RSA (11%) will be subject to intermittent noise from aircraft; seabirds and seaducks within these areas are expected to react primarily with short-term responses (e.g., flight), although long-term responses (avoidance or habituation) may occur due to the increased frequency of flights.

6.6.2.2 Reduction in Reproductive Productivity

The potential for a reduction in reproductive productivity in seabirds and seaducks was rated as Not Significant with a low magnitude in the effects assessment. This potential effect is included in the cumulative effects assessment because a reduction in reproductive productivity can be interpreted as the cumulative effect of all other effects on seabirds and seaducks, such as disturbance and the effects of climate change combined.

The contribution of the Back River Project to cumulative effects of reduction of reproductive productivity on seabirds and seaducks is anticipated to be small relative to the effects related to the use of the BIPR port site. If the BIPR port site becomes operational, then there will in an increase in air traffic to the south of the MLA that has a large overlap with areas disturbed by air traffic for the Back River Project. Furthermore, if the BIPR project becomes operational, the Hackett River Project will also use this port for shipping of fuel, supplies, and concentrate, which will have a two-fold increase in the number of ships transiting through Bathurst Inlet. It is likely that increase ship and air traffic will result in increased disturbance of seabirds and seaducks using marine habitat in lower Bathurst Inlet. This could have large consequences on the reproductive health of these seabird and seaduck populations during sensitive periods (e.g., moulting, staging), if frequent disturbances have high energetic costs that lower individual fitness.

Reduction in reproductive productivity is very difficult, or impossible to measure, but is rated as a residual effect based on a conservative assessment of the potential for other effects to interact and cause a reduction in reproductive productivity.

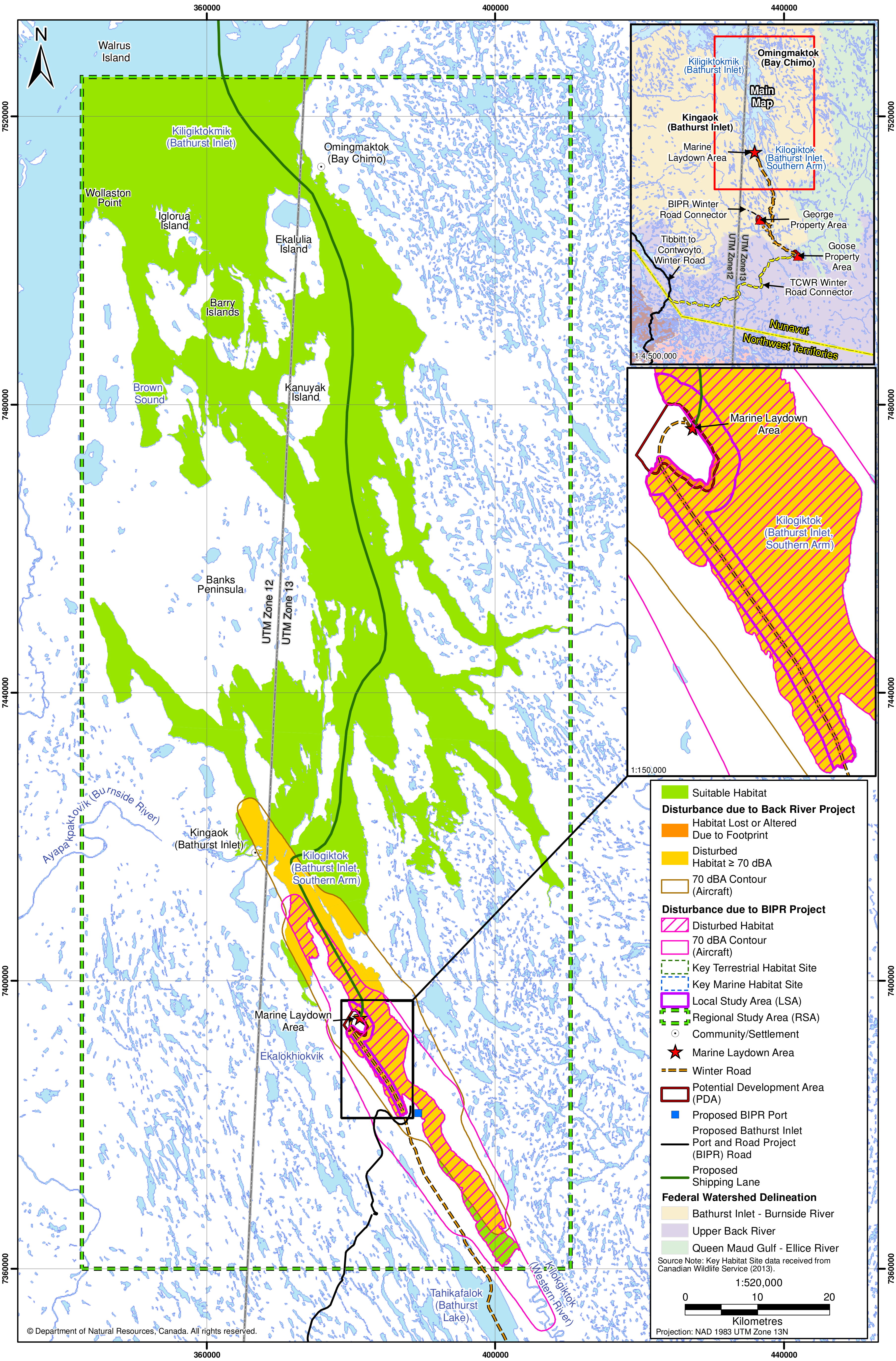

Figure 6.6-1

Habitat Altered due to All Project Footprints and Noise within the Seabirds and Seaducks Cumulative Effects Assessment Boundary

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6.6.3 Identification of Mitigation and Management Measures

It is assumed that mitigation measures for the Hackett and BIPR projects will be similar to those applied for the Back River Project and will meet or exceed best management practices. For a list of mitigation and management measures applied for seabirds and seaducks at the Back River Project, see Section 6.5.3 and Volume 10, Chapter 20.

6.6.4 Characterization of Cumulative Effects

6.6.4.1 Disturbance

The residual effect of disturbance is considered negative, as it could result in altered behaviours of individuals and potentially avoidance of habitats, albeit only for short periods of time.

Noise from the Back River Project and the BIRP project will cumulatively disturb approximately 11% of the marine wildlife RSA, though the area where disturbance would overlap between the two projects is 6% of the marine wildlife RSA (Table 6.5-2). Mitigation measures will be in place to avoid distance in known staging areas for seabirds and seaducks and flights will occur intermittently (approx. nine flights per week). Thus, although the area of cumulative disturbance is greater than 4.9% of the marine wildlife RSA (which would be rated as a moderate magnitude), the overall magnitude of the effect of cumulative disturbance is expected to be low. The duration of the effect is expected to be medium term, as the effect of cumulative disturbance from ships and air traffic will cease once the MLA is closed (i.e., life of the Back River Project). The frequency of the effect is anticipated to be sporadic. The effect of disturbance is anticipated to be reversible, as birds are expected to resume normal behaviours following the cessation of disturbance events (e.g., once MLA and BIPR port site are closed). The effect is anticipated to be regional in extent because both disturbance due to ship and aircraft (presence and noise) will take place outside the marine wildlife LSA but within the marine wildlife RSA.

The likelihood that disturbance to seabirds and seaducks will occur is likely, as concentrations of seaducks and seabirds occur in close proximity to the MLA and along the shallow, western shoreline of Bathurst Inlet between the MLA and BIPR port site. Therefore, large groups of birds will be exposed to cumulative disturbance associated with the presence and noise of ships and aircraft from the Back River Project and the BIPR and Hackett River projects. The confidence in the effect rating is high as disturbance to seabirds and seaducks as a result of ship traffic and aircraft overflights is well documented in the literature.

Overall, the cumulative residual effect of disturbance for seabirds and seaducks is assessed as Not Significant.

6.6.4.2 Reduction in Reproductive Productivity

The residual effect of reduction in reproductive productivity is considered negative, as it could result in a decrease to the population of seabirds and seaducks in the regional area.

The magnitude of this effect is not expected to exceed the limits of natural variation and is therefore rated as low. The duration of the effect is expected to be medium term (life of the Back River Project). The frequency of the effect is anticipated sporadic once shipping and aircraft traffic commences, as it is expected that seabirds and seaducks may be temporarily disturbed by passing ships, aircraft overflights, and aircraft take-offs/landing. These disturbances could then result in lower female or juvenile fitness that may affect the reproductive health of subsequent generations. The extent of the effect is regional, as the population of seabirds and seaducks breeding and staging within the marine wildlife RSA may be affected by shipping and aircraft traffic associated with the Project.

The effect of reduction of reproductive productivity is anticipated to be reversible as disturbances will cease when the MLA and BIPR port site are closed, after which seabird and seaduck populations are expected to return to baseline conditions within a few years. The likelihood that a reduction in reproductive productivity seabirds and seaducks will occur is unlikely, as disturbances due to ship and air traffic will be brief in nature and because of the large availability of undisturbed habitat within the marine wildlife RSA. The confidence in the effect rating is medium as it is unknown how the effects of the Project on reproduction of seabirds and seaducks may interplay with the effects of climate change.

Overall, the cumulative effect of reduction of reproductive productivity for seabirds and seaducks is assessed as Not Significant.

6.6.5 Significance of Cumulative Residual Effects

Following methodology in Volume 9 Chapter 1 for determining significance, as well as the wildlife definitions for magnitude (Table 6.5-2) and significance (Table 6.5-3), the two residual cumulative effects on seabirds and seaducks are expected to have the following significance:

- disturbance, rated Not Significant; and
- reduction in reproductive productivity, rated Not Significant.

The criteria used in the determination of the significance of each cumulative residual effect is detailed in Section 6.5.4 and summarized in Table 6.6-1. Overall, the combined significance of residual cumulative effects on seabirds and seaducks is predicted to be Not Significant.

6.7 TRANSBOUNDARY EFFECTS

As outlined in Section 4 of Volume 9 (DEIS Methods), the potential for transboundary effects of the Project were determined based on whether residual project effects could operate cumulatively with effects of projects in other jurisdictions. Transboundary effects can occur when VECs or the zone of influence of a project moves across jurisdictional borders.

All seabird and seaduck species that breed within the marine wildlife RSA migrate outside of Nunavut. Exposure to disturbance from the Back River Project and the reasonably foreseeable future BIPR and Hackett River projects is expected to result in short term alterations in behaviour and distribution of seabirds and seaducks that may ultimately affect the reproductive health of these regional, breeding populations as a whole. However, reduction in reproductive productivity is considered unlikely, even at the cumulative scale. Therefore, the only effect that may cross jurisdictional boundaries, i.e., lowered productivity that may affect the overall population health of seabirds and seaducks, is not expected, and transboundary effects are not evaluated further.

6.8 MITIGATION AND ADAPTIVE MANAGEMENT

6.8.1 Mitigation Measures

Extensive mitigation and management plans will be in place to minimize or eliminate potential effects on the VEC seabirds and seaducks. The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including seabird and seaducks. Mitigation measures specific to seabirds and seaducks are listed in Section 6.5.3 and are summarized in Table 6.8-1 at the end of this section.

Table 6.6-1. Summary of Cumulative Residual Effects to Seabirds and Seaducks and their Significance

Cumulative Residual Effects	Evaluation Criteria			Likelihood of Occurrence of Cumulative Residual Effects			Significance of Cumulative Residual Effects		
	Direction (positive, neutral, negative)	Magnitude (negligible, low, moderate, high)	Duration (short, medium, long)	Frequency (once, sporadic, continuous)	Geographic Extent (local, regional, beyond regional)	Reversibility (reversible, reversible with effort, irreversible)	Probability (unlikely, moderate, likely)	Confidence (low, medium, high)	Not Significant (N), Significant (S), Positive (P)
Disturbance	Negative	Low	Medium	Sporadic	Regional	Reversible	Likely	High	N
Reduction in Reproductive Productivity	Negative	Low	Medium	Sporadic	Regional	Reversible	Unlikely	Medium	N

In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, marine water/sediment quality, and marine habitat quality. These mitigation and management measures will also serve to protect wildlife including seabirds and seaducks. Details of these strategies can also be found in the following chapters:

- Noise and Vibration: Volume 4, Chapter 2. The Noise Abatement Plan can be found in Volume 10, Chapter 18;
- Air Quality: Volume 4, Chapter 1. The Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incinerator Management Plan can be found in Volume 10, Chapter 11; and
- Marine Water, Sediment, and Fish: marine water, sediment, and fish: Volume 7, Chapters 2, 3, 4, and 5. The Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

Other management plans will also be implemented to protect the environment, details of which are found in the following chapters of Volume 10:

- Overall Environmental Management Plan: Chapter 1.
- Environmental Protection Plan: Chapter 2.
- Risk Management and Emergency Response Plan: Chapter 3.
- Fuel Management Plan: Chapter 4.
- Spill Contingency Plans: Chapter 5.
- Oil Pollution Emergency Plan: Chapter 6.
- Site Water Monitoring and Management Plan: Chapter 7.
- Ore Storage Management Plan: Chapter 8.
- Mine Waste Rock and Tailings Management Plan: Chapter 9.
- Landfill and Waste Management Plan: Chapter 10.
- Hazardous Materials Management Plan: Chapter 12.
- Explosive Management Plan: Chapter 13.
- Road Management Plan: Chapter 14.
- Shipping Management Plan: Chapter 15.
- Borrow Pits and Quarry Management Plan: Chapter 16.
- Fish Offsetting Plan: Chapter 21
- Metal Leaching and Acid Rock Drainage Management Plan: Chapter 22.
- Socio-economic Monitoring Plan: Chapter 23.
- Mine Closure and Reclamation Plan: Chapter 29.

6.8.2 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat (e.g., staging areas for seabirds and seaducks). The process of Project design and avoidance was conducted during the preparation phase for the DEIS, and the DEIS evaluates the potential for effects given the locations of Project infrastructure and timing of Project activities in the redesign of Project elements. Table 6.8-1 at the end of this section lists mitigation measures that have been incorporated into the Project design to minimize effects on seabirds and seaducks.

6.8.3 Best Management Practices

The Wildlife Mitigation and Monitoring Plan (Volume 10 Chapter 20) includes eight separate plans designed to eliminate or minimize effects of the Project on wildlife. The plans are focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects to seabirds and seaducks are listed in Section 6.5.3 and in Table 6.8-1 at the end of this section.

6.8.4 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these will need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and scientific knowledge. Newly-devised best management guidelines from collaborating organizations or regulators will be integrated should these become available. The mitigation and management strategies in the Wildlife Mitigation and Monitoring Plan may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or
- if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The Wildlife Mitigation and Monitoring Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

6.8.5 Monitoring

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring: facility-specific monitoring, and focal species monitoring.

6.8.6 Summary Table of Mitigation and Adaptive Management Measures

Table 6.8-1 includes all planned mitigation and adaptive management measures applicable for all seabirds and seaducks.

Table 6.8-1. Summary of Mitigation and Management Measures Applicable to Seabirds and Seaducks

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	
	1. Project infrastructure designed to avoid, where possible, identified seabird and seaduck sensitive areas, such as identified moulting and staging habitat. 2. Infrastructure designed to minimize the Project footprint. 3. Winter road access corridors only (no all-weather roads for re-supply routes or between the Goose and George Properties). 4. Buildings designed and maintained to exclude wildlife. 5. Only geochemically suitable rock quarries and borrow sources used to construct roads, pads, and structures.
2. Best Management Practices	
	1. Pre-determined flight paths developed to provide horizontal as well as vertical buffer distances between flight paths and sensitive seabird and seaduck habitats (e.g., moulting and staging areas). 2. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude when possible wherever seabirds and seaducks are observed. 3. Wildlife given the right-of-way on all roads at all times. 4. A waste and wildlife attractant management protocol developed. 5. A policy of no feeding and no intentional attraction of wildlife developed, disseminated to all Project and contractor employees during employee orientation, and enforced. 6. A policy of no littering developed disseminated to all Project and contractor employees during employee orientation and enforced. 7. A policy prohibiting hunting from and within a buffered area along all infrastructure developed and enforced. 8. An Employee Wildlife Education Program developed for all site staff and contractors to ensure awareness of applicable wildlife sensitive issues and mitigation measures.
3. Adaptive Management	
	1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may be included: • if negative wildlife interactions become a concern, or • if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife. 2. The Wildlife Effects Monitoring Program (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

(continued)

Table 6.8-1. Summary of Mitigation and Management Measures Applicable to Seabirds and Seaducks (completed)

Mitigation Category	Mitigation Measures
4. Monitoring	
	Facility-specific monitoring program to assess the effectiveness of mitigation measures used to minimize effects of the Project on wildlife. This plan may include:
	1. footprint monitoring to monitor habitat loss;
	2. noise monitoring to monitor disturbance to wildlife;
	3. human activity monitoring of Project site roads and winter roads;
	4. nest avoidance monitoring to identify active bird nests at risk of disturbance from vegetation clearing;
	5. wildlife-vehicle interaction monitoring to document wildlife-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions; and
	6. incidental wildlife reporting to record general wildlife activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to wildlife and adaptively manage conflicts where possible.
	Focal-species monitoring program to monitor Project-related effects on specific terrestrial wildlife species including:
	1. monitoring migratory birds (upland birds, waterbirds, and seabirds and seaducks) near the Goose and George Properties as well as the MLA to assess the zone of influence of the Project on these species.

6.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

1. Facility-specific monitoring is designed to:
   - monitor wildlife interactions with Project Infrastructure;
   - monitor mitigation actions and their efficacy; and
   - identify opportunities for adaptive management.
2. Focal-species monitoring is designed to:
   - evaluate impact predictions in the effects assessment;
   - continuously reduce uncertainty of Project effects on wildlife; and
   - collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). Strategies specific to seabirds and seaducks are summarized in the following sections.

6.9.1 Wildlife Mitigation and Monitoring Plan

6.9.1.1 Facility-specific Monitoring

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented and are effective.

Facilities that will be monitored for wildlife interactions may include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property and George Property;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program may include the following and is detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20):

- Footprint monitoring;
- Noise Monitoring;
- Human activity monitoring;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- Skirting/Fencing Monitoring;
- Wildlife-vehicle Interactions Monitoring;
- On-ice Monitoring at the MLA; and
- Incidental Wildlife Monitoring.

6.9.1.2 Focal-species Monitoring

The focal-species monitoring program is proposed to include monitoring seabirds and seaducks by aerial and ground-based survey. Incidental observations of seabirds and seaducks detected during other wildlife monitoring surveys will continue to be recorded.

The objective of this monitoring program will be to monitor trends over time in the distribution and productivity of seabirds and seaducks spatially in relation to the MLA.

Methods for data management and analysis will follow those for waterbirds (Volume 10, Chapter 20).

6.10 IMPACT STATEMENT

Six potential effects on the VEC seabirds and seaducks due to the Project were identified. These six potential effects are: habitat alteration, disturbance, direct mortality, indirect mortality, exposure to contaminants, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions between the other potential effects.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. Thus, sustained population health of seabirds and seaducks was used as the key criterion to assess potential residual effects.

Consideration of the mitigation and management activities planned to reduce potential effects on seabirds and seaducks resulted in the evaluation of two potential effects as likely having residual effects after mitigation: disturbance and reduced productivity. These effects are rated with a moderate to low magnitude and are rated as **Not Significant**, contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20).

Potential cumulative effects to seabirds and seaducks resulting from the Back River Project and reasonably foreseeable future BIPR and Hackett River projects were assessed. Overall, the combined significance of the cumulative residual effects (both for disturbance and reduced productivity) is anticipated to be **Not Significant**. Cumulative residual effects were rated as moderate to low magnitude and were reversible. Therefore, the cumulative effect of the Back River Project and BIPR and Hackett River projects is not expected to affect seabirds and seaducks on a population level.

6.11 SUPPORTING AND SUPPLEMENTAL INFORMATION

This section provides information on seabirds and seaducks requested by the NIRB guidelines or a regulator that was not included in the effects assessment. Specifically, this section includes information on shipping outside of the marine wildlife RSA, both in the context of existing shipping traffic and additional shipping traffic for the Back River Project, and the potential seabird and seaduck species that may occur along this shipping route outside the marine wildlife RSA during the open-water season.

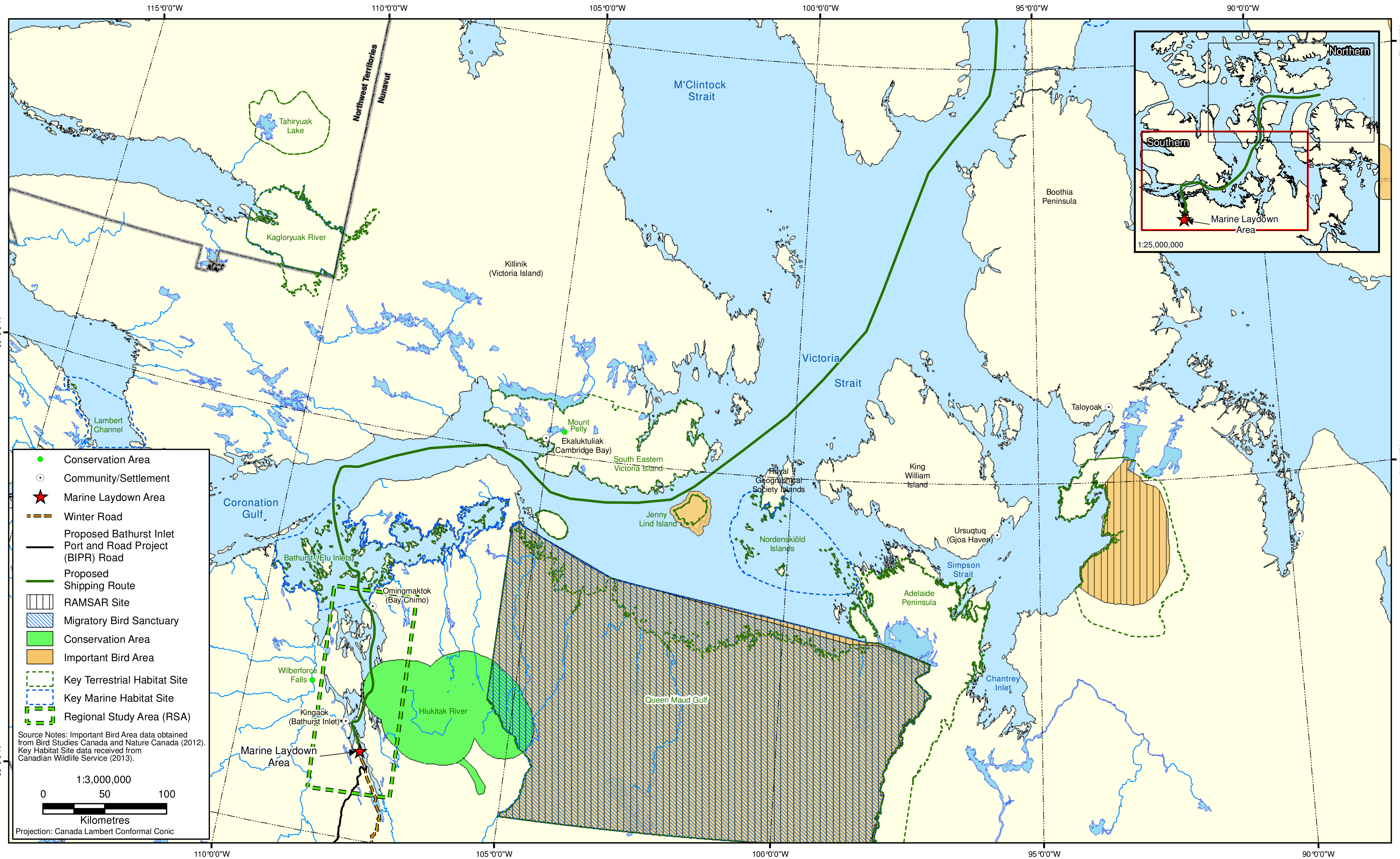
The Back River Project will include shipping outside of the marine wildlife RSA. Shipping will occur along an existing shipping route through the Northwest Passage from Bathurst Inlet through Coronation Gulf, Dease Strait, Queen Maud Gulf, Victoria Strait, Franklin Strait, Peel Sound, Barrow Strait, and out through Lancaster Sound during the open-water season (August through October). The existing shipping traffic through Lancaster Sound in the Northwest Passage is on average 17 ships and up to 36 ships between September 1 and October 31 (Baffinland 2012). The Back River Project will increase this number by 5 to 10 ships (up to 20 one-way sailings) during this time. A total of 5 to 10 ships per year (up to 20 one-way trips) may occur during the Construction phase and 3 to 5 ships per year (up to 10 one-way trips) may occur during the Operations phase (see details in Volume 2).

Several species of seabirds and seaducks in addition to those discussed in Section 6.1 occur along the Northwest Passage, including black-legged kittiwake (*Rissa tridactyla*), black guillemot (*Cepphus grille*), king eider (*Somateria spectabilis*), northern fulmar (*Fulmarus glacialis*), Ross's goose (*Chen rossii*), and thick-billed murre (*Uria lomvia*). Other species may also occur, though their presence would be infrequent. Some species may only use marine areas along the Northwest Passage during one part of the open-water season (e.g., staging), and others occur in low numbers or have restricted breeding ranges in the Arctic. These species include Atlantic puffin (*Fratercula arctica*), dovekie (*Alle alle*), ivory gull (*Pagophila eburnean*), Ross's gull (*Rhodostethia rosea*), Sabine's gull (*Xema sabini*), and Thayer's gull (*Larus glaucoides*). Ivory and Ross's gulls have reached critically low population numbers in the Canadian Arctic. The *Species at Risk Act* (SARA) lists these two species on Schedule 1 as Endangered (ivory gull) and Threatened (Ross's gull; Government of Canada 2012).

The Arctic is an important breeding area for many seabird and seaduck species. Several areas along the coasts of the Arctic mainland host large numbers of breeding waterfowl, such as the Queen Maud Gulf Migratory Bird Sanctuary and the Kent Peninsula (Mallory and Fontaine 2004; Zinifex 2007; Dickson 2012). The islands of the Arctic Archipelago also contain breeding and staging habitat for a large number of seabirds and seaducks. In particular, the coastal areas and islands within the vicinity of Barrow Strait/Lancaster Sound contain several well-known breeding colonies. The Barrow Strait/Lancaster Sound area supports large percentages of the Canadian Arctic population of thick-billed murre (27%), northern fulmar (57%), and black-legged kittiwake (35%; Mallory and Fontaine 2004).

Breeding areas for seabirds and seaducks that are adjacent to or near the Northwest Passage are mapped in Figures 6.11-1 and 6.11-2. Most of these areas are identified as Key Marine and Terrestrial Habitat Sites (KMHS and KMTS), or have been identified as IBAs (Section 6.1.4). KMTS surrounding terrestrial breeding sites were delineated using a 15 or 30 km buffer from land, the buffered areas relating to the species occupying the terrestrial site and primary area in which that species forage while nesting and raising young (roughly from June through early August). For example, marine habitats extending 30 km from nesting sites were used for long ranging species such as thick-billed murre and black legged kittiwakes, while 15 km buffers were used for species known to forage closer to nesting colonies, such as black guillemots and common eider (Mallory and Fontaine 2004). Some KMHSs were identified as important staging or moulting areas used on a regular basis during migration. These are sites which are integral to sustaining bird populations either during the pre-breeding spring migration (May and June) or post-breeding fall migration (August through October). For example, the Bathurst and Elu Inlet KMHS is important for moulting and staging purposes; male and female Pacific common eider use marine habitat in this area from July through early October. In addition, areas of national importance to migratory birds are designated as Migratory Bird Sanctuaries (MBS). MBS, and other areas with territorial or federal protection that are important to seabirds and seaducks, are shown on Figures 6.11-1 and 6.11-2. The approximate numbers of seabirds and seaducks using these KTHSs or IBAs and other known nesting areas during the breeding season are shown in Table 6.11-1.

There are several areas along the Northwest Passage commercial shipping route where it is likely that vessels will pass in close proximity to breeding or staging areas used by a number of seabirds and seaducks. In part, the route itself will lessen the frequency of interactions, as ships pass well offshore or in mid-channel except in Bathurst Inlet itself, whereas many of the breeding or staging areas are located in marine habitats within 30 km from the shores of the mainland and Arctic Islands (Figures 6.11-1 and 6.11-2). Shipping for the Project will take place between August 25 and October 31, which corresponds with the time when many seabird and seaduck species congregate in larger numbers in marine habitats to moult and stage for their southward migration.



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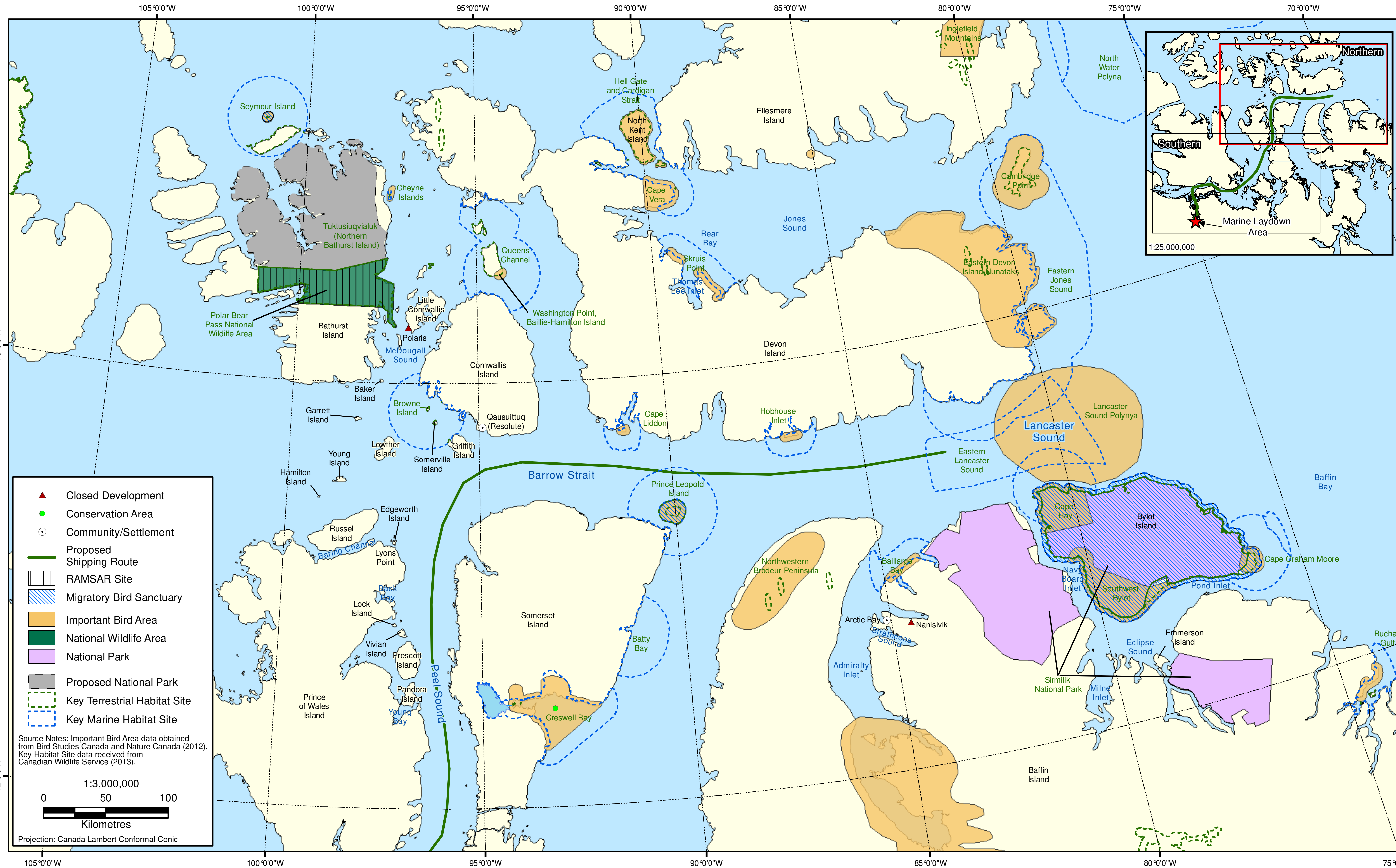
Important Breeding and Staging Habitat for Seabirds and Seaducks along the Northwest Passage - Southern, Arctic Mainland

Figure 6.11-1



Important Breeding and Staging Habitat for Seabirds and Seaducks along the Northwest Passage - Northern, Arctic Islands

Figure 6.11-2

Table 6.11-1. Breeding Areas for Seabirds and Seaducks along the Northwest Passage in the Southern and Northern Arctic

Name	Designation[1]	Principle Nesters	Estimated Number of Birds[2]	Date of Estimate
Southern Arctic/Mainland				
Melbourne Island	KMHS, KTHS	Greater white-fronted goose, Snow Goose, Canada Goose	Not available	
Queen Maud Gulf	MBS, IBA, KTHS	Snow Goose, Ross's Goose, Cackling Goose, Brant, Greater White-fronted Goose, Tundra Swan, Common Eider, King Eider, Long-tailed duck, Northern Pintail, Sandhilll Crane	1,463,650	1990, 1998
Jenny Lind Island	IBA, KTHS	Snow Goose, Ross's Goose, Cackling Goose	20,500	1990, 1998
Nordenskiöld Islands[3]	KMHS, KTHS	Pacific Common Eider	11,500	1995
Northern Arctic/Arctic Islands				
Seymour Island	IBA, KMHS, KTHS	Ivory Gull*	110	2005
Cheyne Islands	IBA, KTHS	Ross's Gull*, Northern Common Eider, Arctic Tern	1,230	2002, 2006
Washington Point, Baillie-Hamilton Island	IBA, KTHS	Black-legged Kittiwake, Black Guillemot, Glaucous Gull	3,000	1975
Cornwallis Island	none	Ivory Gull*	3	2005
Browne Island	KTHS, KMHS	Black-legged Kittiwake	Not available	
Prince Leopold Island	MBS, IBA, KMHS, KTHS	Thick-billed Murre, Northern Fulmar, Black Guillemot, Black-legged Kittiwake, Brant, Common Eider, Parasitic Jaeger, Glaucous Gull	362,400	1977
Northwestern Brodeur Peninsula	IBA,KTHS	Ivory Gull*	0**	2005
Cape Hay	MBS, IBA, KMHS	Thick-billed Murre, Black-legged Kittiwake	640,000	1975
Southwest Bylot Island	MBS, IBA, KTHS	Snow Goose, Long-tailed Duck, King Eider	156,000	1993
Cape Liddon	IBA, KMHS	Northern Fulmar, Black Guillemot	20,200	1977
Hobnose Inlet	IBA, KMHS	Northern Fulmar, Glaucous Gull, Thayer's Gull, Black Guillemot	50,000	1977
Cambridge Point, Coburg Island	IBA, KTHS, National Wildlife Area	Black-legged Kittiwake, Thick-billed Murre, Northern Fulmar, Black Guillemot, Glaucous Gull, Common Eider, Atlantic Puffin	381,130	2000, 2004
Eastern Devon Island Nunataks	IBA, KTHS	Ivory Gull*	3	2005

Notes:
[1] KMHS = Key Marine Habitat Site, KTHS = Key Terrestrial Habitat Site, IBA = Important Bird Area, MBS = Migratory Bird Sanctuary.
[2] Rounded to nearest 10.
[3] Some habitat sites polygons provided by CWS encompassed both terrestrial and marine habitat, where terrestrial habitats were generally clusters of small islands. In these cases, terrestrial habitat sites were mapped with ArcGIS around the outer edge of all islands within the boundaries of the polygon as per direction from the CWS.
** Species listed under Schedule 1 of SARA (2002).*
*** No ivory gull were counted on the Brodeur Peninsula in 2005; however, 54 individuals counted in 2004 (COSEWIC 2006).*
Sources: Mallory and Fontaine (2004), IBA (2012b), Latour et al. (2008), COSEWIC (2006), Raven and Dickson (2009), Environment Canada (unpublished data).

7. Ringed Seals

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7. Ringed Seals

7.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

7.1.1 Introduction

Two species of marine mammals occur within the Back River Project marine wildlife RSA in Bathurst Inlet – the ringed seal (*Phoca hispida*), and in less number, the bearded seal (*Erignathus barbatus*). For the purpose of the environmental assessment ringed seal is considered the representative species for marine mammals as it is more abundant relative to the bearded seal in the assessment area.

7.1.2 Population Trends and Conservation

Canadian populations of ringed seals are not currently listed under the *SARA* and are designated as Not at Risk by COSEWIC (COSEWIC 2012); however the US NMFS raised the status of Arctic ringed seal to threatened on December 21, 2012 (NOAA 2012), and COSEWIC listed the ringed seal as a "candidate wildlife species" of high priority on December 17, 2012 (COSEWIC 2012).

Ringed seals are the most abundant marine mammal in the Canadian Arctic. Accurate population estimates are difficult to obtain and are based on surveys of visible seals hauled out on the ice in spring. These estimates, although typically corrected for seals that are not visible at the time of the survey, may substantially underestimate the actual size of the populations. Published estimates include:

- at least 40,000 ringed seals in the Canadian Beaufort Sea (Stirling, Kingsley, and Calvert 1981);
- 50,000 in northern Amundsen Gulf (Kingsley 1990);
- 49,000 in Prince Albert Sound (Kingsley 1990); and
- 90,000 in the Canadian High Arctic (Kingsley, Stirling, and Calvert 1985; Kingsley 1990).

Large natural fluctuations in ringed seal numbers have been documented over short periods of time (Stirling, Archibald, and DeMaster 1977). For example, in 1974 to 1975, there was a marked decrease (50%) in the abundance and productivity of seals in the Canadian Beaufort Sea and Amundsen Gulf (Stirling, Archibald, and DeMaster 1977; Smith and Stirling 1978). Stirling et al. (1982) noted a doubling of the same population between 1974 and 1979. Another decrease in this same population was reported between 1982 and 1985 (Harwood and Stirling 1992). Unusual thick ice conditions were identified as a possible cause of the decrease in the seal population, while large-scale immigration was a factor attributed to the increase (Stirling, Kingsley, and Calvert 1982).

There are few population estimates in the literature based on open-water surveys, likely because ringed seals are only visible during aerial surveys over open-water in ideal conditions (e.g., low sea state, no forward glare). Densities estimated under such conditions are lower than those in spring, and highly variable. Estimated densities of ringed seals in the Beaufort Sea during the open-water season (late summer) were $0.42/km^2$ in 1982, $0.15/km^2$ in 1984, $0.08/km^2$ in 1985, and $0.19/km^2$ in 1986 (Harwood and Stirling 1992). However, it is unclear whether seals were missed on these surveys as they are difficult to see during aerial surveys or whether the densities during the open-water season are generally lower due to seals dispersing.

No published population estimates are available for Bathurst Inlet. However, surveys conducted in late June 2007 during the ice-covered period provided an uncorrected ringed seal density of $0.3/km^2$ in

Bathurst Inlet (LGL Limited 2007). This survey estimate is well within the range of densities for ringed seals seen on the ice during studies in other areas in the Canadian and US Arctic (Table 7.1-1). Ringed seals were observed in most parts of the Inlet; however density was considerably lower in the southern portion.

Table 7.1-1. Observed Ringed Seal Densities on Ice from Other Studies in the Alaskan and Canadian Arctic

Year	Country	Location	Number/km^2	Citation
1975	Canada	Central Arctic (early June)	1.32	Finley (1976)
1975	Canada	Central Arctic (late June)	0.67	Finley (1976)
1978	Canada	Baffin Island Fiords	1.72	Finley et al. (1983)
1979	Canada	Northwest Baffin Island	1.31	Finley et al. (1983)
1980, 1981	Canada	Central Arctic	0.27, 0.41	Kingsley et al. (1985)
1981 to 1983	Canada	Beaufort, Amundsen, Prince Albert Sound	0.06 to 0.41	Kingsley (1984)
1985 to 1999	US	North Slope, Alaska	0.58 to 1.67	Frost et al. (2002)
1997	Canada	Barrow Strait Fiords	8.70	Finley (1979)
1997 to 2002	US	Prudhoe Bay Area	0.39 to 0.83	Moulton et al. (2005)
2004	Canada	Coronation Gulf	0.69	LGL Ltd., (2005)
2007	Canada	Bathurst Inlet	0.30	LGL Ltd., (2007)

Additional surveys were conducted during the moulting season (when seals were basking in the sun on the ice) in June 2012 as part of the Back River Project wildlife baseline program (Rescan 2013b; Appendix V5-5C). An additional survey was conducted in Bathurst Inlet in 2013 as part of a baseline program for a neighboring project (Rescan unpublished). Results of these surveys are discussed in Section 7.1.5. Currently there are no marine mammal studies reported in the literature that have mapped the summer abundance or distribution of ringed seals in Bathurst Inlet.

7.1.3 Migration Patterns and Distribution

Ringed seals are year-round residents of the Arctic and are highly adapted for living in the winter fast-ice environment. Unlike other northern seals such as harp and hooded seals, the ringed seal is completely adapted to ice-covered waters and does not migrate to open-water areas in the winter (Siegstad et al. 1998). Ice conditions influence ringed seal distribution and abundance (Smith and Stirling 1975, 1978; Moulton et al. 2002). During winter and late spring (roughly November to mid-June), when virtually the entire Canadian Arctic Archipelago is ice-covered, only ringed seals and bearded seals could occur in Bathurst Inlet in fast-ice conditions. Ringed seals use the ice as a platform for building lairs to birth and raise pups, and during the spring to bask in the sun during the moulting period (see Section 7.1.3). Ringed seal movement during this time is usually relatively small (Kelly et al. 2010). Ice begins to break up in June (late spring), and the open-water period in Bathurst Inlet usually lasts throughout July, August, and September or October. Ringed seals disperse during the open-water period and occur in lower abundance in the marine wildlife RSA in Bathurst Inlet.

Although not considered a migratory species, ringed seals are capable of moving distances of 1,000 km or more from their wintering grounds to summer habitat (Heide-Jørgensen, Stewart, and Leatherwood 1992; Kapel et al. 1998; Teilmann, Born, and Acquarone 1999). Summer movements of up to 1,800 km from winter to spring ranges have been recorded (Kelly et al. 2010). Site fidelity has also been documented in this species, with tagged seals returning to the same 1 to 2 km^2 areas during the winter months over multiple years (Teilmann, Born, and Acquarone 1999; Kelly et al. 2010).

During summer, ringed seals are distributed throughout open-water areas. Some disperse to offshore areas after the ice breaks up in summer (Heide-Jørgensen, Stewart, and Leatherwood 1992), while some move into coastal waters. Ringed seals encountered in the Alaskan Beaufort Sea during open-water seismic exploration were broadly dispersed as individuals or small groups (Harris et al. 1997; Harris et al. 1998; Lawson and Moulton 1999; Moulton and Lawson 2001; Moulton et al. 2002). In the Bathurst Inlet, it is unclear how far ringed seals disperse from their winter habitat. However, during aerial surveys conducted during baseline studies in the summer months (June, July, and August) for marine birds and other marine species (e.g. marine fish), ringed seals were only observed on rare occasions and appear to be more dispersed than during the winter (see Section 7.5.1).

Recent tag information suggests winter habitat partitioning between adults and subadult ringed seals in Alaska. Crawford et al. (2012) found subadults traveled south to the ice edge during the late-fall and winter, returning north as ice receded in the spring; adult movements were more limited and farther from the ice edge. These data suggest that subadults, unhampered by breeding requirements for territory maintenance or pup rearing, may move to areas that afford better feeding opportunities, require less energetic costs, and limit predation exposure.

7.1.4 Habitat Use and Diet

Ringed seal utilize stable ice platforms for pupping and nursing (I. A. McLaren 1958, 1962; Smith and Stirling 1975; Finley et al. 1983; Kelly 1988). Ringed seals prefer to breed on ice that has frozen to coast lines (landfast ice) and extends from land into the sea (I. A. McLaren 1958; Kelly 1988), but they also breed in the pack ice (Finley et al. 1983; Kelly 1988). As the ice forms in late autumn, ringed seals maintain breathing holes in new thin ice and cracks with the claws of their foreflippers (Smith and Stirling 1975; Smith and Hammill 1981). Lairs are constructed as early as mid-March (Smith, Hammill, and Taugbol 1991) below the snow on the ice often where snow accumulates, such as near pressure ridges (Chapskii 1940; I. A. McLaren 1958; Smith and Stirling 1975). Lairs are usually excavated above breathing holes to allow access to the sea while providing a stable terrestrial platform with which the species may give birth, raise young, and rest, while being sheltered from Arctic winter and early spring climate conditions, and predators. Ringed seal lairs have been observed in the marine wildlife RSA, including the northern portion of Bathurst Inlet among the islands southwest of Omingmaktok and in areas north of Omingmaktok (Rescan unpublished).

Lair construction is dependent on snow accumulations between 65 and 75 cm (Smith and Stirling 1975; Lydersen and Gjertz 1986). An individual seal maintains numerous breathing holes, and several seals may utilize the same cavity (Smith and Stirling 1975). Inuit hunters have reported finding two pups in one lair suggesting that pupping lairs may not be exclusive to one mother-pup pair (Smith and Stirling 1975), and individual seals may use more than one lair (Kelly and Quakenbush 1990).

Ringed seal pups are born in the birth lairs between mid-March and late April, and nursing extends to mid-June (38 to 44 days; Smith, Hammill, and Taugbol 1991). Nursing pups can and do enter the water to escape predation and to forage, but return to the birth lair to prevent hypothermia (Smith, Hammill, and Taugbol 1991). Pups are subject to intense predation by foxes and polar bears and in some areas, mortality from fox predation may be as high as 40% (Smith 1976; Kingsley 1990).

Ringed seals also use the sea ice during the moulting period from approximately mid-May through mid-July, depending on the region and annual conditions, to haul out on and rest (Vibe 1950; I. A. McLaren 1958; Smith 1973; Smith and Hammill 1981; Smith 1987; Kunnasranta et al. 2002). Ringed seals in Bathurst Inlet have been observed basking on the ice near the MLA between mid-May and early-July in 2012 (Rescan 2013b; Appendix V5-5C) and in 2013 (Rescan unpublished). Ringed seals can spend more than 60% of their time on the ice in June when they are actively moulting (Kelly et al. 2010).

Time spent on ice decreases (to approximately 30% in the Alaskan Beaufort Sea) into late June and July (Kelly et al. 2010) as the condition of ice deteriorates.

Ringed seals feed primarily on fish (especially Arctic cod, *Boreogadus saida*) and large amphipods (e.g., *Themisto libellula*), mysids (e.g., *Mysis oculata*), euphausiids (e.g., *Thysanoessa* spp.), shrimps (e.g., *Eualus, Lebbeus,* and *Pandalus* spp.), and squids (e.g., *Gonatus* sp.). These species can be very important for ringed seal diet in some regions, at least seasonally (Chapskii 1940; Dunbar 1941; I. A. McLaren 1958; Fedoseev 1965; Söderberg 1971; Lowry, Frost, and Burns 1980; Bradstreet and Finley 1983; Gjertz and Lydersen 1986; Smith 1987; Weslawski et al. 1994; Siegstad et al. 1998; Holst, Stirling, and Hobson 2001; Dehn et al. 2007).

7.1.5 Baseline Data for Ringed Seals

Baseline surveys were conducted in the marine wildlife RSA for seals in 2004 (LGL Limited 2005), 2007 (LGL Limited 2007), 2012 (Rescan 2013b; Appendix V5-5C), and 2013 (Rescan unpublished) to determine their distribution and population size in Bathurst Inlet. In 2004, surveys were conducted in early September (September 8), while surveys conducted in 2007, 2012, and 2013 were conducted in late May or June to coincide with the peak period of seal on ice during the spring moulting period. Additionally, ringed seals were recorded if they were observed incidentally in summer months (July and August) in 2010 and 2011 during marine bird surveys in Bathurst Inlet (Rescan 2012b, 2012a) and in July 2012 during other environmental baseline surveys (Rescan 2013b; Appendix V5-5C).

Specific sources of baseline ringed seal information used in this section include the following Back River Project baseline reports:

- Back River Project: 2011 Wildlife Baseline Report (Rescan 2012a, Appendix V5-5D); and
- Back River Project: 2012 wildlife Baseline Report (Rescan 2013b, Appendix V5-5C).

Other sources of supplementary wildlife data used in this section include:

- Back River Project: Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project Naonaiyaotit Traditional Knowledge Project (NTKP) Report (KIA 2012);
- Bathurst Inlet Port and Road Project: Marine Bird Baseline Study, 2010 (Rescan 2012b); and
- Hackett River Project: Wildlife Baseline Report, 2013 (Rescan unpublished).

7.1.5.1 Methods

Aerial surveys for ringed and bearded seals were conducted in 2004 (LGL Limited 2005), 2007 (LGL Limited 2007), 2012 (Rescan 2013b; Appendix V5-5C), and 2013 (Rescan unpublished), in the marine wildlife RSA in Bathurst Inlet using strip transect methodology following previously established methods (Stirling, Kingsley, and Calvert 1982; Kingsley, Stirling, and Calvert 1985; Lunn, Stirling, and Nowicki 1997; Frost et al. 2002). Aerial surveys were flown by fixed wing aircraft (DeHavilland Twin Otter in 2004, 2012, and 2013; DeHavilland Beaver in 2007). In September 2004, during the open-water season, surveys were conducted at an altitude of approximately 152 m (500 ft) above sea level and a ground speed of approximately 220 km/h (120 knots). All other surveys were conducted during the ice-covered season at an altitude of 91 m (300 ft) above sea level and at a ground speed of approximately 130 to 157 km/h (70 to 85 knots). Surveys in 2007, 2012, and 2013 were usually flown during mid-day, when numbers of seals hauled out on the ice were expected to be highest.

In addition to the two pilots, three to four observers were on all survey flights including two experienced wildlife biologists who were the primary observers and sat on opposite sides of the aircraft - two seats behind the pilot and co-pilot, and one or two assistants who sat one or two seats behind the wildlife biologists and recorded observations during the flight.

Transect lines (approximately 2.8 km apart during all years and areas surveyed, except south of Kingaok in 2012 and 2013 where transects were 1.4 km apart) were flown in Bathurst Inlet (Figure 7.1-1). The transect strip width (i.e., the area surveyed) was approximately 500 m surveyed on either side of the aircraft. Strip boundaries were marked on the aircraft's windows with tape or marker and seals observed beyond the upper strip width were recorded as incidentals. However, seals that were directly under the plane to approximately 100 m from the centerline on either side of the aircraft during the surveys were not visible to the observers. Thus, the effective survey strip width was approximately 400 m of either side of the aircraft.

During the flight, observers noted the number of seal breathing holes and number of animals present, species (ringed or bearded seal), age (adult or pup), and in 2012 and 2013, the approximate distance that the animals were observed from the aircraft in 50 m increments (termed distance bins). Environmental conditions were noted during the sure flight, including the location and extent of ice cover, ice condition, air temperature, wind speed, visibility, and survey time.

7.1.5.2 Results

The density (uncorrected density) of ringed seals in Bathurst Inlet was relatively consistent among all years surveyed during baseline studies conducted in the ice-covered season and ranged between 0.5 and 1.2 seals/km^2 (Table 7.1-2). However, uncorrected densities do not consider the proportion of seals that were hauled out on the ice but were missed during the survey (detection bias) or those that were in the water under the ice (availability bias). While a corrected density estimate corrects for detection bias, it is impossible to correct for availability bias, thus corrected densities are a minimal estimate of ringed seal density (Thomas et al. 2010). Since, visibility of seals is expected to decrease with distance from the observer in the aircraft, using a corrected density for ringed seals is a more conservative approach to estimating the number of seals in the area that may be affected by Project-related activities. Corrected density estimates were calculated using Distance software in 2012 (Buckland et al. 2001; Thomas et al. 2006) to correct for detection bias using the half normal cosine model as it fit the data best (lowest AIC criteria). The corrected density of ringed seals in the marine wildlife RSA using seal count data from 2012 was estimated to be 2.05 seals/km^2.

Table 7.1-2. Survey Effort, Ringed Seal Abundance and Density in Bathurst Inlet 2004 to 2013

Survey Year	Survey Timing	Survey Effort: Time (h)	Survey Effort: Distance (km)	# Ringed Seals Observed	# Pups	# Potential Lairs	Uncorrected Density (seals/km^2)	Corrected Density (seals/km^2)	Reference
2004	Sept 8 – 19*	58.8	13,119.5	54	NA	NA	NA	NA	LGL 2004
2007	June 27 – July 1	25.1	3,585	841	NA	NA	0.3	NA	LGL 2007
2012	June 13 – 16	7.3	1,001.7	284	17	NA	0.5	2.05	Rescan 2012
2013	June 1 - 3	8.8	1,250	1,173	34	43	1.2	In prep	Rescan 2013

**Surveys in 2004 were conducted in open-water season in Bathurst Inlet and were only conducted inside the inlet on September 8. Data for 2004 represents all seals observed throughout Bathurst Inlet, and the waters of Dease Strait, Queen Maud Gulf, Victoria Strait, Albert Edward Bay, Larsen Sound, St. Roch Basin, Rasmussen Basin, Franklin Trench, and Peel Sound.*

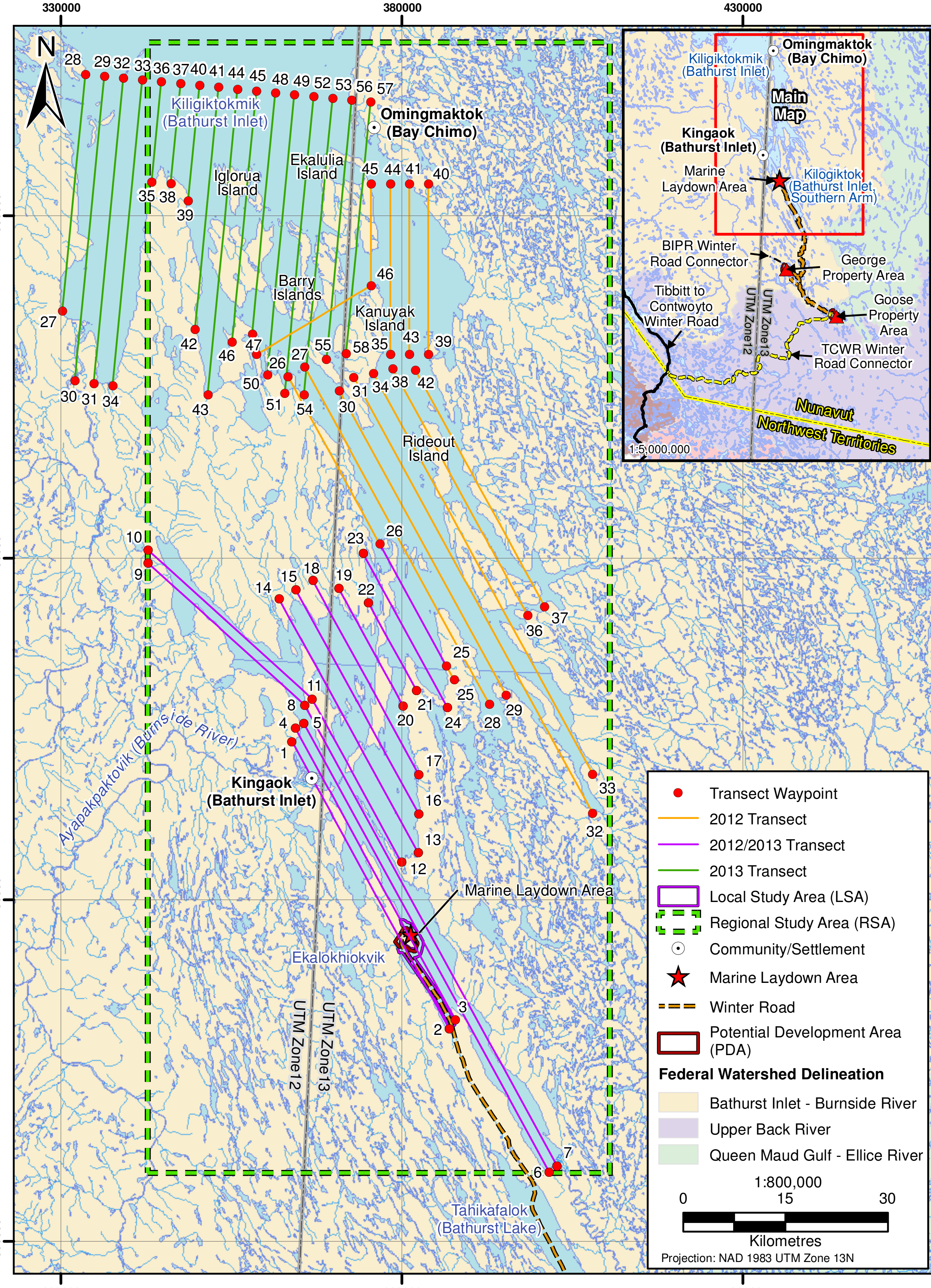

Figure 7.1-1

Transects for Ringed Seal Surveys Conducted in 2012 and 2013

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Ringed seal pups between the ages of 8 and 10 weeks of age were observed during aerial surveys conducted in 2012 and 2013. Fewer pups were observed in the southern portion of the marine wildlife RSA relative to the northern portion (west of Omingmaktok). In addition, several ringed seal lairs were observed in the northern portion of the marine wildlife RSA during seal surveys conducted in 2013 (Figure 7.1-2). No lairs were observed in the southern portion of the Inlet (south of Kanuyak Island) or near the MLA during all years surveyed. Furthermore, no lairs were observed incidentally in the inlet south of Kingaok during wolverine DNA surveys conducted near the MLA in March and April 2013.

A large number of breathing holes were observed in the marine wildlife RSA during all years surveyed. Ringed seals maintain an average of 3.4 breathing holes per adult seal (Hammill 2009). Using this statistic, the density of ringed seals in the marine wildlife RSA is approximately twice the number of seals calculated using the corrected density calculation of seals (using Distance software) and is approximately 4 seals/km^2. However some of the breathing holes observed may have been old and not used anymore thus providing an overestimate of seals in the marine wildlife RSA.

Ringed seals were widely distributed throughout Bathurst Inlet during all years surveyed in June. However, the density of seals in the southern portion of the marine wildlife RSA near the proposed MLA was lower than that in the northern section of the marine wildlife RSA. Densities of ringed seals were also correlated to ice condition with highest densities associated with cracked ice and solid ice and the lowest density in areas of high ice deformation and extensive melt water. Thus, a lower density of ringed seals in the southern portion of the marine wildlife RSA may be attributed to ice condition, and not necessarily to the area alone. It is possible that density of seals in the southern portion of the inlet may have been higher earlier in the spring, prior to deformation of ice cover.

The ice cover in Bathurst Inlet was in various stages of break up during the June surveys but was not far advanced. The ice cover was relatively consistent among years with small areas of open-water observed near the mouths of larger rivers (Western River and Burnside River) and several narrow channels between islands. There was varying degrees of ice deformation (rough vs. smooth) and amounts of melt water on top of the ice surface and several cracks throughout the inlet. Ice deformation was generally more advanced in the southern portion of the marine wildlife RSA near the MLA. However, in 2013, ice deformation was less advanced relative to other survey years and areas of open-water were much smaller.

Ringed seals were also observed during marine mammal aerial surveys conducted in the marine wildlife RSA in late summer (September 2004) in the open-water season (LGL Limited 2005) as well as incidentally in July and August during other environmental baseline studies conducted between 2010 and 2013 (Rescan 2012a, Appendix V5-5D; Rescan 2012b; Rescan 2013b, Appendix V5-5C; unpublished). Most of the observations during these months were of individual seals although four groups of seals (two to three individuals) were observed during 2004 surveys conducted in September (LGL Limited 2005). Results of the 2004 survey and incidental sightings of ringed seals indicated that these animals use the Bathurst Inlet during the summer. However, results of the 2004 survey should not be interpreted as indicative of the true distribution and abundance of ringed seals, as seals in open-water are very difficult to detect from a fast moving aircraft and densities would be greatly underestimated.

7.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Inuit TK was adapted from the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report, commissioned by Kitikmeot Inuit Association (KIA 2012). Traditional Knowledge indicates that ringed seals were central to the lives of coastal Inuit and were the primary species harvested by coastal Inuit (KIA 2012). Information regarding ringed seal knowledge and the current and traditional use of this species, was provided during a series of Focus Group Sessions (Rescan 2013a) with hunters from the Kitikmeot study communities.

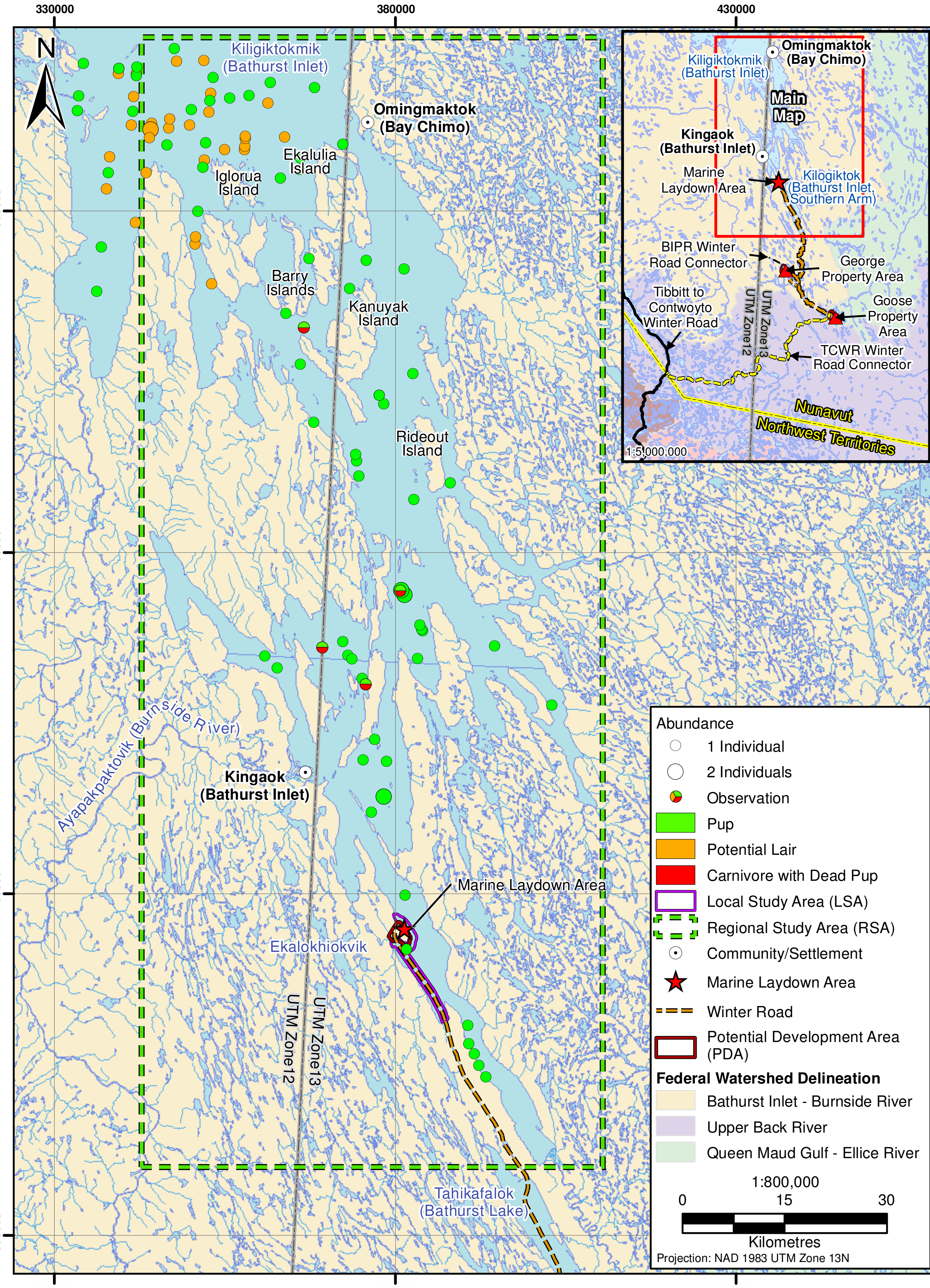

Figure 7.1-2

Ringed Seal Pups, and Lairs Observed on Marine Mammal Aerial Surveys and Incidentally in 2012 and 2013

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Traditional knowledge, land user knowledge, and thoughts raised by the KIA and land users were incorporated into the ringed seal effects assessment chapter in six primary ways:

1. Ringed seals were included as a VEC for a number of reasons (Section 7.3.2), including that they are a culturally and socially important species to Inuit.
2. Landusers provided insights on ringed seal behaviour and habitat use.
3. Traditional Knowledge and landuser information were used to plan survey transects within Bathurst Inlet. Landusers worked with Rescan biologists in the field to conduct marine mammal aerial studies in Bathurst Inlet (Section 7.1.5).
4. Habitat usage information from TK and landusers was included in the environmental setting (Section 7.1.3) and effects assessment where habitat loss (Section 7.5.2.1) and disturbance (Section 7.5.2.2) is evaluated.
5. Concerns that were raised by the KIA and landusers about whether ringed seals would be affected by shipping and other Project-related disturbance were addressed by the inclusion of the "Effects of Disturbance" (Sections 7.5.2.2) and "Effects of Direct Mortality" (Section 7.5.2.3) sections.
6. TK and landuser information was included in the preparation of management plans to reduce the effect of Project-related disturbance and mortality on ringed seals.

The following reports were reviewed for TK specific information related to ringed seals:

- *Inuit TK of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) ;
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013a) with hunters from the Kitikmeot communities.

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, and recommendations for mitigation and adaptive management.

7.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of marine wildlife identified as important to Inuit, along with estimated productive capacity where practical. Marine wildlife habitat use within the marine wildlife LSA and RSA, including the identification of important habitat features such as breeding and staging areas for seabirds/seaducks, and pupping and moulting areas for ringed seals was also documented. These studies were guided by TK including the help of land users in the field to assist with surveys in areas deemed as important habitat for marine wildlife. This information was also used as baseline information around which the human and environmental risk assessments (Volume 8, Chapter 6) were developed.

7.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The TK report presents maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, were used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB FTP site. As part of this process, ringed seals were identified as a VEC for the EIS.

7.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Marine wildlife field studies were completed during the baseline program within a study area that will encompass the measurable effects on marine wildlife resulting from development of infrastructure and other activities such as shipping and transportation associated with the Project. The marine wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods: Volume 8, Chapter 5). Ringed seal is the most harvested marine mammal by coastal Inuit in the Kitikmeot region and many families from the region supplement their diet with ringed seal or rely on it as a main food source (Rescan 2013a). Inuit TK on ringed seal indicated that ringed seal pupping in winter overlaps with the marine wildlife RSA and moulting in spring overlap with both the marine wildlife LSA and RSA and the Country Foods LSA (Volume 8, Chapter 5). In addition, other marine wildlife species such as seabirds/seaducks that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The marine wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities during their lifetime.

7.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of thougts from Inuit into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap with the Project in these areas.

7.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013a), concerns regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including marine physical environment, marine fish, and marine wildlife and Valued Socio-economic Components (VSECs) that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, only open-water season shipping (no ice-breaking) will occur so as to avoid potential negative effects on wildlife dependent on ice, and the design of in-water infrastructure minimizes the footprint of the permanent in-water infrastructure in order to minimize habitat loss for marine wildlife.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the DEIS. The information can be found in the following volumes and chapters:

- Air Quality: Volume 4, Chapter 1;
- Marine Water Quality: Volume 7, Chapter 2;
- Marine Sediment Quality: Volume 7, Chapter 3;
- Marine Fish Habitat: Volume 7, Chapters 4;
- Marine Fish Community: Volume 7, Chapter 5
- Terrestrial Wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 7 (muskox), Chapter 8 (wolverine and furbearers), Chapter 9 (migratory birds), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds/seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

7.3 VALUED COMPONENTS

7.3.1 Potential Valued Components and Scoping

The VECs and VSECs for the DEIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the DEIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013) and other information and processes as described below. The VECs were selected based on the following information:

- Potential Interaction with the proposed Project;
- Consultation with communities;
- Available Traditional Knowledge information;
- Consultation with regulatory agencies;
- Regulatory considerations; and
- Practicality of measuring and monitoring.

The following aspects of potential wildlife VECs were also considered:

- species at risk or of conservation concern (i.e., species listed by COSEWIC or under SARA, or by CESCC or by NWA;
- species or focal groups requiring enhanced consideration under the mandates of regulatory agencies, such as caribou and carnivores (Nunavut Department of the Environment [NU DOE]), and migratory birds (Canadian Wildlife Service [CWS]);
- species identified as having a strong biological importance in the ecosystem in the Project study area, including importance as keystone, indicator and umbrella species; and
- species identified as being culturally, socially and economically important to the Inuit and other community members through TK.

7.3.2 Valued Components Included in Assessment

Marine mammals including whales and seals were included in the potential VEC list.

Whales were scoped out of the assessment as they do not overlap with the Project and do not regularly occur in the marine wildlife RSA in Bathurst Inlet where the Project is located. However, a short discussion on where marine mammals, including whales are found along the commercial Northwest Passage shipping route during the summer is included in the Supporting and Supplemental Information Section (Section 7.11).

Two types of seals occur in Bathurst Inlet and may interact with the Project: ringed seals and bearded seals. Bearded seals occur in small number during the moulting period (mid-May through mid-July) and are excluded from the assessment as they are generally found only in the northern part of Bathurst Inlet near Omingmaktok during the moulting period and not near the MLA.

Ringed seals were selected as a VEC in this assessment because of their cultural significance to the Inuit as a hunted species, and because they provide an important ecological role in Arctic ecosystems as a key prey species for top predators in the food chain such as polar bears, foxes, wolves, and other carnivore species. In addition, while they are not currently listed under the *SARA* and are designated as “Not at Risk” by COSEWIC (COSEWIC 2012), they have recently been listed as a “candidate wildlife species” of high priority for reassessment due to evidence that climate change may threaten this species’ productivity and survival (COSEWIC 2012).

7.4 SPATIAL AND TEMPORAL BOUNDARIES

7.4.1 Spatial Boundaries

The ringed seal effects assessment considered two study areas for marine wildlife inventory for the Project: a Local Study Area (LSA) and a Regional Study Area (RSA; Figure 7.4-1).

7.4.1.1 Local Study Area

The boundaries of the marine Local Study Area (LSA) for ringed seals were set to encompass the following:

- the shoreline where the Marline Laydown Area (MLA) PDA is proposed; and
- the proposed winter road where it crosses a bay south of the MLA in Bathurst inlet.

The marine wildlife LSA is the same as the marine LSA boundary for Marine Water Quality, Marine Sediment Quality, Marine Fish Habitat and Marine Fish Community Chapters: (Volume 7, Chapters 2-5), and is defined by a 1 km buffer surrounding the shoreline where the proposed MLA is located, and a 500 m buffer on either side of the proposed winter road (marine portion only). The marine wildlife LSA covers an area of approximately 2,100 ha of marine habitat (Figure 7.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species due to Project infrastructure typically occur.

7.4.1.2 Regional Study Area

The marine wildlife RSA for ringed seals encompasses the marine wildlife LSA as well as the marine areas of Bathurst Inlet from the southern-most tip of the Inlet to approximately 15 km north of Omingmaktok and is approximately 75 km in width, covering an area of 299,971 ha, of marine habitat within Bathurst Inlet (Figure 7.4-1).

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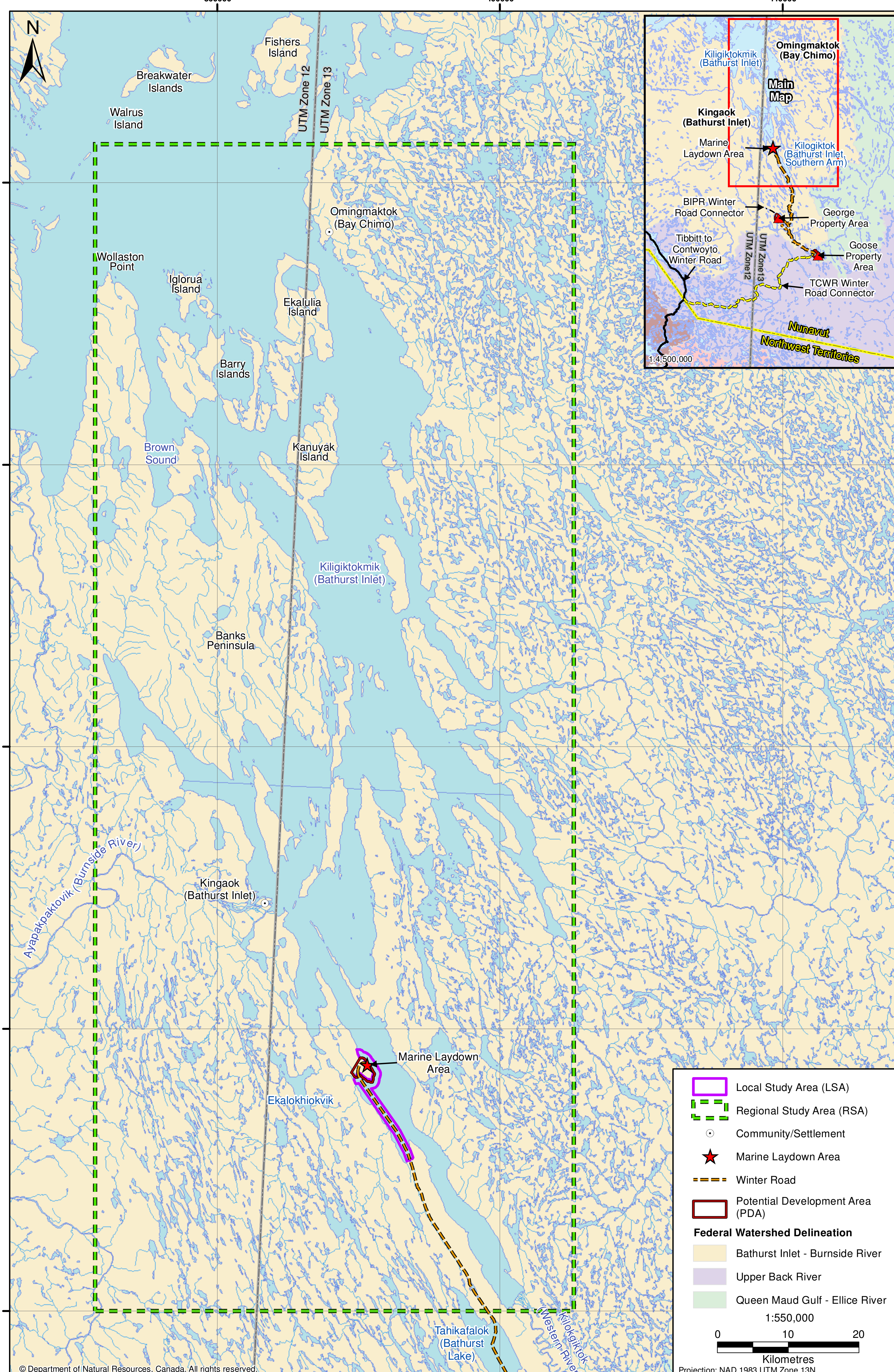

Figure 7.4-1

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Local Study Area and Regional Study Area for Ringed Seals

Figure 7.4-1

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7.4.2 Temporal Boundaries

The temporal boundaries used for the ringed seal effects assessment align with the time periods of the phases of the Project as presented in Table 7.4-1.

Table 7.4-1. Life of Project

Activities	Duration
Site Preparation	2 years
Construction phase	2 years
Operational phase	10 years
Reclamation and Closure phase	10 years
Post-Closure phase	5 years
Other Potential phases	
Temporary Closure	Less than 2 years
Care and Maintenance phase	2 to 10 years

7.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

7.5.1 Methodology Overview

The effect assessment process comprises a step-wise method to assess the potential effects of the Project on ringed seals as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

1. Identification of potential interactions between the Project and ringed seals;
2. Characterization of the potential effects that could result from these interactions;
3. Identification and description of design, mitigation and management measures that will be taken to eliminate or reduce the potential effects;
4. Characterization of residual effects that will likely remain after mitigation and management measures have been applied; and
5. Determination of the significance of residual effects using eight attributes to rate the residual effects on ringed seals including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence.

The potential effects of the Project on ringed seals are evaluated for all Project phases as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, the phase associated with the worst-case scenario for the effect is evaluated and the results of the effect during all other Project phases are expected to be less than the effect rating for the worst-case phase assessed.

7.5.1.1 Indicators Used to Characterize Potential Residual Effects

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 7.5-1). For each potential effect, various indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger assessment of residual effects (e.g. habitat loss > 0 ha). For other potential effects, indicator values were qualitative in nature in the form of ‘yes’ or ‘no’ where triggering of residual effects assessment occurred if the indicator value was 'yes' (e.g., an increase in human access to the wildlife RSAs would trigger a residual effect of indirect mortality to ringed seals).

Table 7.5-1. Criteria and Indicators Used to Characterize Residual Effects on Ringed Seals

Potential Effect	Criteria	Indicator
Habitat Alteration	Change in Population Health	Amount (ha) of high-quality habitat altered
Disturbance due to Noise	Change in Population Health	Amount (ha) of high-quality habitat altered
Direct Mortality and Injury	Change in Population Health	Traffic timing, and traffic volume, and vehicle speed
Indirect Mortality	Change in Population Health	Predicted increase in human access to wildlife RSAs
Exposure to Contaminants	Change in Population Health	Predicted Hazard Quotients for metals in environmental media and wildlife
Reduction in Reproductive Productivity	Change in Population Health	Literature suggests combined residual effects on ringed seals

7.5.1.2 Magnitude Ratings for Residual Effects

The magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. The effect is designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects was developed (Table 7.5-2).

Table 7.5-2. Definitions of the Magnitude Ratings for Residual Effects based on Population Health Criterion

Magnitude Rating	Magnitude Descriptor Residual Effect
Negligible	No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the marine wildlife RSA was < 0.1%.
Low	Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the marine wildlife RSA was 0.1 to 4.9%.
Moderate	Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the marine wildlife RSA was 5 to 20%.
High	Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the marine wildlife RSA was > 20%.

Note: Quantitative indicator thresholds for Habitat Loss and Disturbance were included for determining the effect on the sub-population. For all other effects professional judgement and literature review was used to determine the effect on the sub-population and thus the magnitude of the effect.

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Population health can be measured using various criteria, either indirectly using measures of change in habitat and habitat use, or directly through measures of distribution, and abundance. Data on these measures were collected during baseline studies for ringed seals, which provide benchmark measures, as well as estimates of the natural variability. Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

7.5.1.3 Overall Significance Ratings

To assess the significance of residual effects, eight attributes for evaluating residual biophysical effects including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence were used and defined in Volume 9, Chapter 1. The definitions of magnitude in Table 7.5-2 were used as part of the determination of the significance rating.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria.

Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as positive, not significant, or significant (Table 7.5-3). For example, a residual effect receives a rating of 'not significant' if it is expected to be one of the following: negligible or low magnitude, confined to LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1).

Table 7.5-3. Definitions of Significance Ratings for Residual Effects on Ringed Seals

Significance	Descriptor of Significance
Positive	Residual effect could result in improvements in population health, relative to the baseline within the marine wildlife RSA into the foreseeable future.
Significant	Residual effect is expected to result in a decline in sub-population health that is long-lasting or permanent within the zone of influence of the Project relative to reference conditions; levels may be variable or stable over years, but significantly lower on average than the natural variation of the population and compared to reference sites elsewhere. Regional management actions such as research, monitoring, and recovery initiatives may be required should changes to population health be deemed above acceptable risk thresholds.
Not Significant	Residual effect may result in a decline in population health within the zone of influence of the Project relative to reference conditions during the life of the Project, but population health should return to baseline conditions in the shorter-term after Project closure. Monitoring may be initiated to confirm the ratings of the effects assessment.

Finally, the degree of uncertainty in the rating was provided as a qualifier.

7.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions with the VEC ringed seal and the Project is provided in Volume 9, Chapter 1. Potential project-related effects were only considered from activities resulting from the use of the MLA since these activities are the only Project-related activities that could interact with the marine environment, where ringed seals are found. Potential effects on ringed seal and ringed seal habitat from the Project have been included in the assessment based on professional judgement, experience at other similar projects in Nunavut and the Northwest Territories, and a review of scientific literature of the effects of developments on ringed seal.

The potential effects of the project were evaluated spatially (MLA facilities and the proposed shipping route in the marine wildlife RSA) and temporally (Construction, Operation and Reclamation/Closure phases) for ringed seals. Interactions of ringed seals with Project components were evaluated to determine which of the following potential effects may occur (Table 7.5-4):

- Habitat Alteration and/or Degradation;
- Disturbance due to Noise;
- Direct Mortality and/or Injury;
- Indirect Mortality;
- Exposure to Contaminants; and
- Reduction in Reproductive Productivity.

Table 7.5-4. Potential Project-related Effects to Ringed Seal Related to Activities at the Marine Laydown Area and Shipping

Potential Development Area	Project Component	Habitat Alteration	Noise Disturbance	Direct Mortality and Injury	Indirect Mortality	Exposure to Contaminants	Reduction in Reproductive Productivity
Marine Laydown Area							
	Camp		X		X	X	X
	Barge landing	X	X			X	X
	On-site roads		X				X
	Winter Roads	X	X	X	X		X
	Other infrastructure		X			X	X
Shipping							
	Vessel Traffic	X	X	X		X	X

Two Project-related activities have the potential to result in the effects described above including:

- Project Activities at the MLA; and
- Shipping within the marine wildlife RSA.

Project-related activities at the MLA that could affect ringed seals include the construction of the docking structures at the MLA, construction of the winter roads and landing strips during the ice-covered season, aircraft over-flights and landing, small spills during fuel transfer, water and sediment contamination, and air contamination. Construction of the docking structures will not involve marine blasting or pile driving.

Vessel traffic associated with the Project includes barges and large (up to 50,000 DWT) tankers capable of carrying oil/bulk and ice strengthened to Type B to CAC 2 Ice Class. Vessel cruising speed is documented at 13.5 knots (25 km/h). All vessel traffic related to fuel and supply for the Back River

Project will be during the summer open-water period only. There will not be any ice-breaking activities. Therefore, an assessment of ice-breaking activities was not conducted for the Project. Tug-assisted, 1,000 to 2,000-tonne capacity ocean barges will carry construction materials and camp supplies through Bathurst Inlet to the MLA during the Construction phase. It is anticipated that there will be a total of 5 to 10 tanker ships per year during Construction for the Project in Bathurst Inlet; equivalent to 10 to 20 one-way sailings per year (during the shipping period: August 25 – October 31). The tankers will also carry cargo and diesel fuel to the MLA during the Operations phase, and carry away non-combustible and hazardous waste (if any). There is anticipated to be three to five ships per year (during the shipping season) during the Operational phase; equivalent to 6 to 10 one-way sailings.

The Construction and Operation phases of the Marine Laydown Area (MLA) and shipping could result in the largest effects on ringed seals relative to other Project phases and these two phases represent worst-case scenarios. Reclamation/closure, care and maintenance, temporary closure, and post-closure phases of the MLA are expected to have minimal effects, and will likely only involve reduced noise levels during these phases. Therefore, only effects from Construction and Operation phases are discussed in detail below.

Each potential effect is described below, and then evaluated as to whether or not it will occur. Potential effects that will likely occur are then evaluated for whether or not they are predicted to result in a residual effect after mitigation actions are implemented.

7.5.2.1 Habitat Alteration

Habitat alteration and degradation can result from exclusion of animals from high-quality habitat. Ringed seals may experience habitat alteration during the summer open-water season and during the winter ice-covered season. During the open-water season, ringed seal habitat may be altered or degraded due to the barge ramp and any vessels that may be anchored in the marine wildlife LSA. Ship vessels that are travelling are not considered for habitat alteration as their position is continually changing, but are considered under the effects of disturbance to ringed seals (Section 7.5.2.2).

During the winter, ringed seal habitat will be affected by the construction of the ice road (the portion that overlaps the marine areas directly adjacent to and in the bay south of the MLA), construction of the aircraft landing strip on Bathurst Inlet during the ice-covered period, the overwintering of fuel vessels in Bathurst Inlet, and the barge ramp associated with the barge docking at the MLA. The effect of disturbance (e.g., noise disturbance causing an animal to flee) due to these activities is evaluated in the disturbance section (Section 7.5.2.2).

Habitat alteration may also result from the degradation of habitat quality due to contamination. The effects due to contaminants will be assessed in the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6 and summarized in Section 7.5.2.5).

<u>Calculation of Habitat Alteration</u>

Habitat alteration for ringed seals was calculated for the open-water season (summer), and for the ice-covered season (winter). The areas that will be altered during each season were compared to the total area that would potentially be available in the marine wildlife RSA.

During the summer open-water season, the total area of the permanent docking structure footprint in the MLA was calculated to determine how much seal habitat may be altered.

During the winter ice-covered season, four Project components were considered in the calculation of habitat alteration: 1) the total area of the docking structure (as calculated for summer habitat);

2) the area that a vessel will occupy (i.e., that will remain over winter and therefore limit the formation of ice surface); 3) the area of the airstrip; and 4) the area of the winter road on the marine portion of ice at the southern end of Bathurst Inlet.

In addition, exclusion from prey resources resulting from Project infrastructure was also incorporated into the assessment, based on results of the Marine Fish Communities Assessment (Volume 7, Chapter 5). For example, a decrease in marine fish abundance, a change in distribution, or a residual effect for marine fish due to habitat alteration would trigger a residual effect of habitat alteration on ringed seals due to exclusion from prey. Any ancillary habitat alteration due to disturbance (noise and/or lighting) as a result of Project-related activities at these infrastructure sites are addressed in the disturbance section (Section 7.5.2.5).

<u>Evaluating Habitat Alteration</u>

Open-water Season (Summer)

A marine ramp and seasonal dock at the proposed MLA in southern Bathurst Inlet will be constructed for annual resupply and seasonal transport during the open-water season (August 25 to October 31) to bring in equipment, supplies, and fuel. The beach ramp and dock will be rock-filled structures built perpendicular to shore with above water dimensions measuring approximately 30 x 30 m and 20 x 20 m, respectively. The side-slope of constructed infrastructure is assumed to be approximately 2:1, with a maximum depth below high water of 5 m, resulting in a total area of in-water infrastructure of 0.15 ha and 0.08 ha, respectively. Thus, the total habitat loss during the open-water summer season due to Project infrastructure is equivalent to 0.23 ha (< 0.1% of both the marine wildlife LSA and the RSA). This amount of habitat loss did not trigger a residual effect for fish communities near the MLA (the main prey species of ringed seal), thus, would not trigger habitat loss for ringed seals as summer habitat for ringed seals is dependent on prey availability.

Abundance and distribution of ringed seals in Bathurst Inlet during the open-water season is not well understood, as ringed seals are difficult to observe from aircraft surveys in the open-water season. However, ringed seal density and distribution data during the open-water season is expected to be much lower than that calculated in the ice-covered season during baseline studies conducted in 2012 and 2013 as seals generally disperse to offshore areas at this time (Heide-Jørgensen, Stewart, and Leatherwood 1992).

Due to the minimal amount of habitat altered as a result of Project infrastructure, the expected low density of ringed seals in the southern portion of Bathurst Inlet (south of Kingaok) during the open-water season, and the large ranges that seals can maintain during the open-water season, habitat alteration is not anticipated to result in a residual effect on ringed seals during the open-water season.

Ice-covered Season (Winter)

During the winter, the marine ramp and underwater dock structure at the MLA (equivalent to 0.23 ha of under ice habitat alteration), the section of winter road that crosses the marine area south of the MLA, the aircraft landing strip on the ice, and the fuel vessel that may be frozen into the ice will result in habitat alteration for ringed seals during the ice-covered season (November to late-June). The portion of the winter road that crosses the marine area south of the MLA is 14 km resulting in 280 ha of marine ice habitat alteration. The aircraft landing strip on ice is anticipated to result in an additional 1 ha of habitat alteration assuming a landing strip 360 m long (minimal for Twin Otter Aircraft) and 30 m wide to accommodate the width of the aircraft plus a 5 m buffer on either side. The assumed size of the vessel that will be frozen into the ice at Bathurst Inlet could be approximately 0.5 ha assuming a length of 183 m and a beam of 32.2 m (using a large ship size as a conservative approach).

Together, these Project infrastructure amount to a total of approximately 282 ha of habitat altered during the ice-covered season. Most (> 99 %) of this habitat alteration is anticipated to be localized to the marine wildlife LSA with the exception of the ice strip for aircraft landing. The 282 ha of habitat altered represents 13% of the available ice habitat in the marine wildlife LSA and < 0.01% of the marine wildlife RSA.

The estimated ringed seal density (corrected for detection bias) on the ice in the marine wildlife RSA during the moulting period in June is 2.05 seals/km^2 or 2 seals per 100 hectares (Section 7.1.5; Rescan 2013b; Appendix V5-5C). Therefore, approximately six seals may be affected by the alteration of 282 ha of winter habitat. Home range sizes based on a tagging study on ringed seals in the Beaufort Sea (Kelly et al 2010) ranged between < 1 km^2 and approximately 28 km^2 (median approx. 0.65 km^2) during the ice-covered season with the vast majority (94%) of home ranges less than 3 km^2. Based on the median home range size (i.e., 0.65 km^2, or 65 ha), the habitat altered due to Project infrastructure accounts for approximately four ringed seal home ranges. However, the density of seals in the southern portion of Bathurst Inlet (south of Kingaok) was proportionally less than that in the northern portion of the marine wildlife RSA (Section 7.1.5; Rescan 2013b; Appendix V5-5C), thus the number of seals that may be affected is anticipated to be minimal.

Due to the small amount of habitat altered as a result of Project infrastructure in the ice-covered season, and the few seals that may be affected, habitat alteration is not anticipated to result in a residual effect on ringed seals during the ice-covered season.

Exclusion from prey

The marine fish assessment reported that a decrease in abundance, distribution, and habitat loss for marine fish as a result of Project-related activities at the MLA is unlikely (Marine Fish Community Assessment; Volume 7, Chapter 5). Thus, construction and operation of the marine ramp and dock structure at the MLA during both the open-water and ice-covered seasons, and ice roads, ice aircraft landing strip, and mooring of barges in the marine wildlife LSA during the ice-covered season is not anticipated to prevent seals from accessing prey. Habitat alteration would be minimal and is therefore not anticipated to result in a residual effect on ringed seals.

7.5.2.2 Disturbance

The key issues for ringed seals related to sensory disturbance are the effects of underwater noise and airborne noise on behaviour and health. Seals in general have effective low-frequency hearing. Underwater audiograms (i.e., results of hearing tests on seals) suggest that although they can hear underwater sounds at frequencies up to 60 kHz and make calls between 90 Hz and 16 kHz, they have very little hearing sensitivity below 1 kHz (Richardson et al. 1995). Southall et al. (2007) suggest that the auditory bandwidth for seals in water should be considered to be 75 Hz to 75 kHz. Project-related activities at the MLA that could result in disturbance to ringed seals include:

- Construction activities at the MLA;
- Vessel traffic;
- Vehicle traffic on the winter road (over marine areas); and
- Aircraft overflights.

Construction Activities at the MLA

Disturbance from acoustic and anthropogenic activities during Construction and Operations may impact ringed seals, generating avoidance reactions in the southern portion of the marine wildlife RSA. Construction activities at the MLA are anticipated to include the construction of a 100 person camp, all-weather site roads built from construction materials from locally developed geochemically suitable rock quarries, and laydown areas. In addition, two small in-water structures will be constructed including a marine ramp (30 x 30 m) and seasonal dock (20 x 20 m) at the proposed Marine Laydown Area in southern Bathurst Inlet for annual resupply and seasonal transport during the open-water season. No pile driving activities will be conducted for any in-water works at the MLA.

Yearly construction activities during the Operations phase when the MLA is active will include the construction of an ice airstrip and a winter road (over a small portion of the marine habitat). Thus, avoidance due to disturbance during construction activities can occur throughout the Construction phase of the MLA in both the open-water and ice-covered season, and during the ice-covered season only during the Operations phase when the MLA is active.

Vessel Traffic

It is anticipated that there will be a total of five to 10 ships (or equivalent barges) per year during the Construction phase (up to 20 one-way sailings) and a total of three to five ships (or equivalent barges) per year during the Operations phase (up to 10 one-way sailings) through the marine wildlife RSA in Bathurst Inlet for the Project. The vessels will carry cargo and fuel to the MLA in Bathurst Inlet during the Construction and Operations phases, and may carry away non-combustible and waste (if any). Commercial vessels cruising in open-water emit relatively loud, low-frequency underwater noise especially in the 10 to 100 Hz range (NRC 2003; Hildebrand 2009; McKenna et al. 2012). Shipping during the Construction phase was used to assess the effects of disturbance to ringed seals as it represents the worst-case scenario.

Disturbance from acoustic and anthropogenic activities along the shipping route in Bathurst Inlet may impact ringed seals, resulting in a temporary avoidance to the area. Since shipping will only occur during the open-water season (August 25 – October 31), there will not be any effect of disturbance to ringed seals due to shipping during the ice-covered period when ringed seals are birthing and rearing pups in their lairs or basking in the sun on the ice during the moulting period. Because vessel activities will only occur during the open-water summer season, no assessment of shipping impacts in an iced environment was conducted.

Vessel cruising speed is estimated at 13.5 knots (25 km/h). Tug-assisted, 1,000 to 2,000-tonne capacity ocean barges will carry construction materials and camp supplies to Bathurst Inlet during the Construction phase, and could make five to 10 round-trips annually during the two years of the Construction phase and three to five round-trips annually during the Operations phase when the MLA is active. Underwater Sound Pressure Levels (SPL) were determined for vessels that may be used for the Project (Table 7.5-5).

Seals do not appear to respond strongly to ships and, in some areas, are commonly observed close to vessels (Harris, Miller, and Richardson 2001; Miller and Davis 2002; Miller and Moulton 2003). Some seals are likely to avoid approaching vessels by a few metres to tens of metres, whereas some curious seals are likely to swim toward vessels.

Table 7.5-5. Underwater Sound Pressure Levels (SPL) Determined for Potential Vessels Used for the Project

Vessel	Specifications	Broadband *SPL* (dB re: 1 µPa @ 1 m)
Bulk Ore Carrier with Ore-Bulk-Oil (OBO) option	52,000 DWT, Length 190 m, Draft 12.5 m, Containers 300 TEU	186
Lightering Barge	Non-ice class, up to and including series 1500, 1,500 DWT, Length 60 m, Draft 2 m	181
"Beluga Class" Cargo Vessel	Ice Class 1A, 10,000- 13,000 DWT, Length 140 m, Draft 8-12 m, Containers 700 TEU	185
Handy Max Fuel Tanker	Ice Class 1A, 10,000- 13,000 DWT, Length 140 m, Draft 8-12 m, Up to 15 ML	185
Large Fuel Tanker	Ice Class 1A, 53,000 DWT, Length 183 m, Draft 8.5 m, up to 50 ML (example: Torm Lotte)	186

Vehicle Traffic on the Winter Road

During the winter months during the Construction and Operation phases of the Project, an ice road will be constructed from the MLA to the Goose and George Properties and will be used from January through April. A small portion of this road will cross a bay in Bathurst Inlet south of the MLA. Vehicle traffic and human-related activities on the ice road could disturb ringed seals on the ice. Sporadic anthropogenic noise and visual stimuli from traffic driving on the ice could cause adult seals to dive into the water, resulting in increased energy expenditure in adults and decreased nursing of pups if they are present.

Aircraft Overflights

The Project proposes a maximum of six flights per week to the MLA using small turboprop aircraft during the Construction and Operations phases when the MLA is active during the ice-covered season and potentially during the open-water season if needed (see Project Description: Volume 2). During the winter birthing and pupping period, adult seals could abandon lairs or pups. Aircraft over-flights during spring moulting period could disturb ringed seals to the extent that they enter the water, thus using additional energy stores. During the open-water period, over-flights could disturb ringed seals near the flight paths. The reactions of swimming ringed seals to aircraft over-flights have not been documented. However, swimming seals are generally considered to be less susceptible to airborne disturbance than are seals that are hauled-out (Richardson et al. 1989); therefore, the assessment of effects of aircraft overflights on ringed seals is conducted for the ice-covered season only as the effect is anticipated to be "worst case" at that time.

Ringed seals hauled out on the ice may retreat to the water when approached by a low-flying aircraft or helicopter (Burns and Harbo 1972; Alliston 1981; Burns and Frost 1983), although they do not always respond by diving into the water (Burns et al. 1982). Finley (1976) flew aerial survey transects over ringed seals hauled out in Barrow Strait 31 times at an altitude 91 m, and was unable to detect any decline in seal numbers that could be attributed to the aircraft disturbance. During aerial surveys of Bathurst Inlet in June 2007 from a single-engine Beaver flying at 91 m, most ringed seals did not exhibit any obvious negative response to the aircraft as it flew overhead (LGL Limited 2007). Almost half (43.8%) showed no obvious response, 37.2% looked up at the aircraft, 9.5% moved on the ice, and 8.7% dove into their holes or cracks in apparent response to the aircraft (LGL Limited 2007). Noise levels in lairs are reduced by snow, especially at high frequencies (e.g., ~10 kHz; Cummings and Holliday 1983). Generally, seals exposed to intense (~110 to 120 dB re: 20 µPa) non-pulse sounds in air tended to leave haulout areas and seek refuge temporarily (minutes to a few hours) in the water, whereas seals exposed to received noise levels of between ~60 to 70 dB re: 20 µPa tended to ignore the noise.

Calculation of Disturbance on Ringed Seals

Hearing limits for seal species have been estimated to be 75 Hz to 30 kHz in air and 75 Hz to 75 kHz in water (Mohl 1968; Terhune and Ronald 1971, 1972; Kastak and Schusterman 1999; Reichmuth 2008; Kastelein et al. 2009). There are no data on the sensitivity of ringed seals to airborne sounds (EDI 2012) and limited data on the underwater hearing sensitivity of ringed seals (Terhune and Ronald 1975). However, underwater and in-air hearing abilities of ringed seals are expected to be similar to harbour seals (Richardson et al. 1995) as these species are close relatives (Árnason et al. 1995). Thus, the hearing thresholds and disturbance criteria for harbour seal were used for ringed seal in the assessment of disturbance due to noise where ringed seal specific data were unavailable.

No minimum exposure criteria for underwater noise levels exist for the protection of marine mammals in Canada. However, ringed seals exposed to continuous sounds resulting from shipping or dredging where the noise sensation levels (noise levels experienced by the animal) exceed 100 dB re 1 μPa are anticipated to result in hearing impairment, whereas continuous sounds with noise sensation levels between 80 dB re 1 μPa and 100 dB re 1mPa would exhibit an avoidance response (R.A. Davis and Malme 1997). Some seals are assumed to exhibit minor behavioural responses (e.g., changes in swim speed) at 70 dB sensation levels. Avoidance responses are anticipated to be temporary in nature, returning to normal conditions with the cessation of the noise source. Thus, a threshold of 70 dBA was used as an indicator of disturbance to ringed seals in this assessment.

There are no minimum exposure criteria for the protection of ringed seals to airborne sounds in air in either Canada or the U.S. For this effects assessment a conservative estimate of greater than 70 dB re: 20 μPa was used to assess the potential disturbance to ringed seals exposed to in-air noise, although a less protective SEL of 100 dB re (20 μPa).s has been recommended as the threshold to predict effects to seals in air in other studies (Southall et al. 2007).

Construction Activities at the Marine Laydown Area

Disturbance to ringed seals as a result of Project-related activities was assessed by comparing the estimated noise disturbance resulting from construction of the MLA to noise disturbance and resulting effects on ringed seals reported in literature.

Vessel Traffic

Disturbance to ringed seals due to vessel traffic was calculated for the open-water season only, as no winter shipping will occur. To assess the effects of shipping traffic on ringed seals, a zone of effect was determined as the ships travel along the shipping routes.

In the absence of sound propagation models developed specifically for the vessels that will be used by the Project in Bathurst Inlet, vessel traffic disturbance to ringed seals was estimated based on modelled disturbance distances calculated for similar vessels used for the Mary River Project (EDI 2012). Disturbance distance from the vessel to the ringed seal receptor for the Mary River Project was assumed to be approximately 200 m whereby the sound from the source would attenuate to the 70 dB sensation level. Noise sensation levels attenuating to greater than 80 dB, resulting in avoidance and or injury onset were not anticipated during the open-water shipping season.

Disturbance was also calculated by estimating the amount of time any one point along the shipping route would be disturbed assuming that ships followed the exact alignment each trip. This calculation uses an assumed ship speed of 25 km/h and distance that each marine mammal species reacts to vessels (e.g., 200 m for ringed seals) to calculate the length of time it takes the ship to leave the zone of impact. This is essentially the length of time any one point along the route is affected by ship traffic noise.

Vehicle Traffic on Ice Roads

To assess the effects of disturbance to ringed seals due to vehicle traffic on the portion of the winter road that overlies the marine habitat, the 45 dBA noise buffer determined during noise modelling for the winter roads conducted as part of the Noise and Vibration Assessment (Volume 4, chapter 2) was applied as a buffer around the winter road PDA alignment, and the area calculated within the buffered area was calculated as the area of disturbed ringed seal habitat. This buffer is a conservative estimate for ringed seals but is based on the Environment Canada human health standards (Environment Canada 2010) used for terrestrial wildlife in Volume 5.

Disturbance was also calculated by estimating the amount of time any one point along the road would be disturbed. This calculation uses the projected traffic volumes on the winter road from the MLA to the Goose and George PDAs, and assumes a conservative vehicle speed of 40 km/h (when wildlife are present within 250 m of the road). A 200 m buffer distance derived from the 45 dBA noise contour around the winter road PDAs (from the Noise and Vibration Assessment; Volume 4, Chapter 2) was used to calculate the length of time any one point along the road will be affected by noise produced by vehicle traffic.

Aircraft Overflights

The assessment of aircraft overflight noise on seals focuses on the winter (ice-covered) season when seals are hauled out on ice. Ringed seals are more abundant in Bathurst Inlet during the ice-covered season relative to the open-water period. Therefore, since the density of seals is greater in the ice-covered season and transmission of noise due to aircraft is anticipated to result in a greater effect in air, the effect of aircraft overflights on swimming ringed seals is anticipated to be less than that of ringed seals on the ice and was not further assessed.

Noise Modeling was conducted for in-air sound levels from de Havilland Canada DHC-6 Twin Otter aircraft at the George airstrip as part of the Noise and Vibration Assessment (Volume 4, Chapter 2: Appendix V4-2B). The effects of disturbance to ringed seals as a result of aircraft overflights was assessed by overlaying the aircraft noise model (Volume 4, Chapter 2; Appendix V4-2B) generated for Twin Otter planes (used for the George Property) over the section of Bathurst Inlet east of the MLA. Since the airstrip will be constructed on the ice during the winter, to calculate a maximum disturbance scenario for ringed seals it was assumed that the ice strip would be constructed in the middle of the portion of the inlet directly east of the MLA, so that noise profiles would cover the maximum amount of ice coverage possible. This assumption ensures that the maximum potential disturbance over ice is calculated.

The number of seals potentially disturbed due to aircraft overflights is calculated by the area contained within the 70 dBA contour line and the density of seals calculated during baseline studies. This area of disturbance is also compared to the proportion of the marine wildlife RSA available to seals without disturbance.

Evaluation of Disturbance on Ringed Seals

Construction Activities at the Marine Laydown Area

Received noise levels from construction activities at the MLA were not anticipated to exceed either the 45 dBA conservative criteria for human health (Environment Canada 2010) or the 70 dBA criteria for disturbance onset to ringed seals and avoidance of the MLA and thus, were not modelled in the Noise and Vibration Assessment (see Volume 4, Chapter 2). However, it is possible that seals in the vicinity may exhibit localized and temporary avoidance of the area.

Studies conducted at other industrial developments have demonstrated that ringed seals adapt to Project-related noise and visual disturbance. Ringed seal reactions to industrial activities vary by individual depending on the context. For example, ringed seals that swam in open-water close to underwater construction activities became habituated to underwater sounds, and active breathing holes and lairs were still observed within ~1 km of industrial activities (Moulton et al. 2003; Moulton et al. 2005) including pile driving. Construction activities at the MLA will not include noise levels as loud as pile driving, which did not evoke a response in seals at other studies; therefore, construction activities at the MLA are not anticipated to disturb ringed seals and no residual effect is anticipated.

Vessel Traffic

Ringed seal habitat covers the marine area within the marine wildlife RSA from the southern end of Bathurst Inlet near the Western River to just north and west of Omingmaktok covering an area of 299,971 ha. Thus, the proposed shipping lane was assumed to fall within ringed seal habitat. The largest ship that may access the MLA will be approximately 190 m long, and adding 200 m on either side to account for potential seal avoidance due to noise results in a diameter of 590 m (0.59 km), and an area of 0.273 km^2 contained within this diameter, which is equivalent to the zone of influence for ringed seals around the vessel.

The diameter of the zone of influence by a vessel can be used to calculate the resulting period of time that any one ringed seal may be exposed to the zone of influence at any one point along the shipping route by dividing this number by the speed of the vessel. Assuming a vessel speed of 25 km/h, this period of time for any one seal in the zone of influence (assuming the seal doesn't move) lasts 1.4 minutes per ship. It is estimated that a maximum of 10 vessels will potentially access the MLA per year during Construction, resulting in a total of 20 one-way trips to and from the MLA along the Bathurst Inlet shipping route during the shipping period (August 25 – October 31) or, on average, one trip every six days. The number of one-way trips (20) is then multiplied by the duration of the zone of influence for ringed seals (1.4 minutes), resulting in a maximum of 28.3 minutes per year (60 day period) of disturbance to any one seal at any one point along the eastern shipping route.

During the Operations phase the ship traffic will decrease to three to five ships per year thus the number of seals affected by vessel noise is estimated to be half that occurring during the Construction phase and estimated to result in a maximum of 14.1 minutes of vessel disturbance per year (between August 25 and October 31) to any one seal at any point along the shipping route.

Any disturbance to ringed seals along the shipping route would be transitory. Given the estimated source levels, infrequency of traffic, and seal distributions, the disturbance will be minor or brief, lasting less than 30 minutes per year on the shipping route and affecting only those seals within 250 m of the ship. As ringed seal density is anticipated to be low in the marine wildlife RSA during the summer when shipping will occur and seals are generally anticipated to avoid ships, no residual effect is anticipated.

Vehicle Traffic on Ice Roads

The portion of the winter road that covers the marine habitat in the bay directly south of the MLA is 14.5 km in length. Results of Project noise modelling (using 45 dBA_{night} contours from Noise Modelling; Volume 4, Chapter 2; Appendix V4-2B) indicates that a 200 m noise buffer exists around winter roads where traffic noise would attenuate to 45 dBA. Applying this buffer to either side of the winter road (the portion that crosses marine habitat) results in 580 ha of ringed seal winter habitat that will be disturbed due to vehicle traffic (Figure 7.5-1).

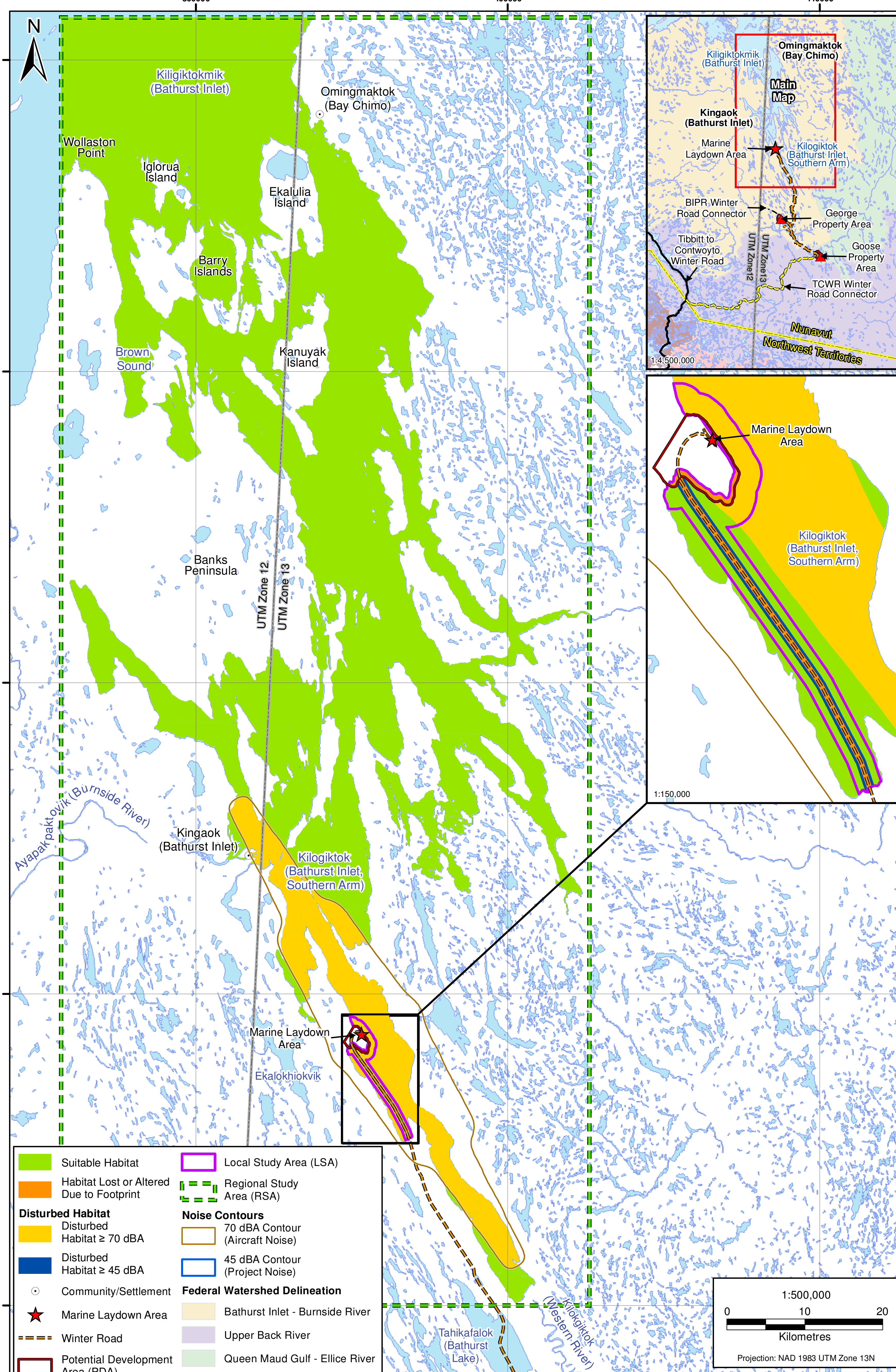

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Figure 7.5-1

Sabina GOLD & SILVER CORP.

Figure 7.5-1

Ringed Seal Habitat Altered or Disturbed due to the Project

Rescan an ERM company

The average density of ringed seals in the marine habitat during the winter is approximately 2.05 seals/km^2 or 2 seals/100 ha, although fewer seals were observed in the portion of marine habitat south of Kingaok. Using this density as a conservative approach results in approximately 12 seals that may be potentially disturbed by the vehicle noise along the road. However, it is anticipated that this number will be much less since: 1) the density of seals in the southern portion of Bathurst Inlet (south of Kingaok) is anticipated to be lower than 2 seals per 100 ha; 2) seals are not anticipated to be disturbed at noise levels below 70 dBA; and 3) seals are not anticipated to be using the Road PDA itself as breathing holes would be frozen over to maintain the road.

The winter road is anticipated to begin construction in early December with operations of the road commencing in January through March. During this time, it is anticipated that there will be a total of 84 truck trips per day (75 days per year) on these roads to carry supplies to and from the Goose and George Properties and an additional 80 trips per day (6,000 trips per year) to transport fuel to these Properties for a total of 164 truck trips per day. Assuming vehicles will be in operations over the entire 24 hour period, this equates to 6.8 trucks per hour on the ice road. Ringed seals are not anticipated to be in the southern portion of Bathurst Inlet at this time, as the timing and use of the winter roads corresponds with the pupping season when seals are anticipated to be in lairs further north in the inlet. To date, very few lairs, if any, have been reported in the southern portion of Bathurst Inlet (south of the Islands west of Omingmaktok). Thus, the effect of disturbance due to traffic on winter roads is not anticipated to result in a residual effect.

Aircraft Overflights

The portion of marine habitat that will be disturbed due to aircraft noise (≥ 70 dBA) is 28,874 ha (Figure 7.5-1). This area falls outside of the marine wildlife LSA and is equal to approximately 1% of the marine wildlife RSA. The average density of ringed seals during the winter in the marine habitat is approximately 2.05 seals/km^2, although fewer seals were observed in the portion of marine habitat south of Kingaok. Using this density as a conservative approach results in approximately 592 seals that may be potentially affected by noise due to aircraft overflights (take-offs and landings).

As there have been no ringed seal lairs observed in the southern portion of Bathurst Inlet (south of Kingaok), pups and nursing adults inside of seal lairs are not anticipated to be disturbed by aircraft noise. However, in the event that lairs are built in the southern portion of Bathurst Inlet, it is anticipated that airborne sounds will be diminished inside of seal lairs and will not result in disturbance events. For example, below a snow cover depth of 70 cm, the received level of airborne noise over the 105-200 Hz frequency band is reduced by an average of 11 dB (Cummings and Holliday 1983). Evidence from the literature supports this finding. Active seal structures (breathing holes and lairs) were detected within ~1 km of a drilling site, Northstar, and one pupping lair was located between two ice roads, as close as 140 m from the nearest road (Williams, Coltrane, and Perham 2001).

Ringed seals move into the southern portion of Bathurst Inlet during the moulting season (mid-May through mid-July). However, the MLA is anticipated to be closed during the moulting period (mid-May through mid-July), and also in the fall (October and November), thus no residual effect is anticipated due to aircraft noise.

In the event that the MLA is open during the spring moulting period (mid-May through mid-July) there may be some potential for the effect of disturbance to ringed seals. During the Construction and Operations phases, there will be up to six flights per week of small aircraft capable of landing on ice and water when the MLA is active. During closure of the MLA, there will be a maximum of three flights per week. Given the estimated source levels, infrequency of flights, and seal density, the disturbance will be minor and brief; designated flight patterns will reduce low level arrival and departure traffic over marine areas.

Given that the majority of Project-related activities potentially causing disturbance to ringed seals will occur when seals are not likely to be in the southern portion of Bathurst Inlet (summer, and early winter), Project-related disturbance due to noise is not anticipated to result in a residual effect to ringed seals.

7.5.2.3 Mortality and/or Injury

Direct mortality or injury effects are physical injuries, extreme physiological stress, or the mortality of an individual resulting from interactions with anthropogenic activities.

Three types of Project-related activities that may lead to direct mortality and/or injury to ringed seals include:

- Ship strikes during the open-water season;
- Vehicle strikes on the ice road during Construction and Operation phases in the ice-covered season; and
- Aircraft strikes on the marine ice strip and in the open-water (float plane landings) during both the open-water and ice-covered seasons.

The most common mortality and direct injury to marine mammals results from ship strikes. Mortality and injury due to vessel strikes is most commonly reported for large whales (Jensen, Silber, and Calambokidis 2003), although evidence of vessel strikes have recently been reported for seals in the UK (Thompson et al. 2010). The characteristic spiral injuries observed on dead seals in the UK were consistent with ducted propeller injuries that are common to a wide range of ships including tugs, self-propelled barges and rigs, various types of offshore support vessels and research boats. Seals with similar characteristic spiral injuries have also been reported on Canada's Atlantic coast over the last 15 years (Thompson et al. 2010). However, shipping will occur only in the summer (between August 25 and October 31) when the density of ringed seals is expected to be really low in Bathurst Inlet as seal disperse to off-shore areas. Thus, shipping activities are not anticipated to result in a residual effect to ringed seals and are not considered further.

Mortality and injury to ringed seals may also occur as a result of winter road construction and vehicle strikes on the portion of the proposed winter road connecting the MLA and the Goose and George Properties that aligns over the ice on Bathurst Inlet just south of the MLA.

Aircraft will be used to service passenger and large-cargo to the Project area during Site preparation, Construction, and Closure. During the winter, an aircraft landing strip will be constructed on Bathurst Inlet near the Marine Laydown Area. Ringed seals hauled out on the ice may be at risk of collisions with aircraft if they haul out on the ice strip. In addition, access by float planes during the open-water season at Bathurst Inlet may be used when necessary. Seals may be affected by float planes if they are unable to move out of the way (e.g. swim, dive) in time for aircraft landings. However, to ensure the safety of aircraft passengers and wildlife, the aircraft landing areas will be monitored prior to landings and take-off by aircraft, and if wildlife are observed flight activities will avoid these areas until they are clear of wildlife. Thus, the effects of mortality due to aircraft were not assessed further.

<u>Calculation of Ringed Seal Mortality and Injury</u>

To assess the likelihood and population-level significance of ringed seal mortality and injury resulting from interactions between ringed seals and the Project, the timing and volume of vehicle traffic and vehicle speed were used to assess the potential for mortality to ringed seals. The seasonal density of ringed seals determined during baseline studies conducted in the marine wildlife RSA (see Section 7.1.5) was used to determine whether potential exists for interaction with these Project-related activities. A literature based review was also conducted, and estimates of ringed seal mortality rates due to Project-related activities were summarized.

Evaluation of Mortality and/or Injury to Ringed Seals

Vehicle Strikes

The winter road is anticipated to begin construction in early December with operation of the road occurring in January through April. During this time frame of approximately 75 days per year, 6.8 trucks per hour are anticipated to be on the ice road in Bathurst Inlet.

From December through April, ringed seals use ice for reproduction events including birthing and pup rearing. Lairs are constructed in mid-March at the earliest (Smith, Hammill, and Taugbol 1991); however, no lairs were observed during baseline surveys south of the islands west of Omingmaktok. Therefore lairs are not likely to be affected by the construction and use of the winter road. Furthermore, since the construction of roads is anticipated to begin in December and maintenance and vehicle use of these roads are anticipated to continue through to the end of April, it is anticipated that snow will not accumulate in these areas due to road clearing, and ringed seals will not construct lairs along the road corridor. Therefore, seals will only be exposed to vehicle traffic at breathing holes from December through March, if present, in the southern end of Bathurst Inlet.

Adult ringed seals facing traffic on the ice are expected to respond to construction and vehicle noise and in most cases avoid collisions, (Tarasoff et al. 1972). In addition, use of the ice road is proposed to cease at the end of April prior to the ringed seal haul out period for moulting. Thus, it is expected that mortality to ringed seals due to construction of the ice road and vehicular traffic on the road will not result in a residual effect.

7.5.2.4 Indirect Mortality

In addition to direct mortality (Section 7.5.2.3), indirect mortality to ringed seals may result from project related activities including:

- increased hunting; and
- increased predation by natural ringed seal predators.

Wildlife mortality may indirectly result from the Project if hunting is facilitated by easier access to game along the winter road. Indirect mortality from increased hunting pressure resulting from Project-related activities will be assessed based on the results of the socioeconomic assessment (Volume 8, Chapter 3). An increase in public access to the Kitikmeot area resulting from Project development will trigger a residual effect of indirect mortality to ringed seals due to increased hunting.

Natural ringed seal predators including foxes, wolves, wolverine, and grizzly bears may become attracted to the MLA due to odours affiliated with human-related activities and wastes at the proposed camp (discussed in Volume 5, Chapter 6 and Chapter 8). Mortality of seals due to fox predation has been estimated to be as high as 40% (Smith 1976). An increase in seal predators to the MLA may result in increased predation on ringed seals and their pups in the marine areas directly adjacent to the facilities at the MLA. Indirect mortality resulting from increased attraction of predators to the camp associated with the MLA will be assessed based on the results of attraction to these predators (wolverine and furbearers, and grizzly bear) and the typical territorial behaviours of these predators. An increase in the number of predators to the MLA as a result of Project development will trigger a residual effect of indirect mortality to ringed seals due to increased predation.

Indirect mortality resulting from disturbance is discussed in on the disturbance section (Section 7.5.2.2).

Evaluation of Indirect Mortality to Ringed Seals

Socio-economic studies conducted in the Kitikmeot Region report that an increase in human immigration and hunting is unlikely in the wildlife RSAs (Volume 8, Chapter 3). Further, hunting will not be permitted by Project employees. Thus, construction and operation of the ice roads and Project Development is not expected to cause an increase in ringed seal mortality due to facilitation of hunter access. Increased hunting is unlikely and is therefore not anticipated to result in a residual effect on ringed seal.

Results of the assessment of the effects of attraction to ringed seal predators (wolverine and furbearers, and grizzly bears) indicate that there could be a residual effect of attraction to these predators due to the Project (Volume 5, Section 6.5.2.6 and 8.5.2.6). This is largely a result of odours and wastes that are affiliated with the camps. However, the effect of attraction is anticipated to affect only those animals that are already in the vicinity (within a few kilometers) of Project infrastructure. The MLA is located within an area that already supports a high abundance of ringed seal predators including foxes, wolves, and grizzly bears. No additional animals are anticipated to be drawn to this area as a result of Project development. In addition, ringed seals are largely anticipated to avoid marine areas immediately adjacent to the MLA and along the ice roads due to noise and disturbance related to Project activities (Section 7.5.2.2). Thus, increased predation to ringed seals is unlikely and is therefore not anticipated to result in a residual effect on this species.

7.5.2.5 Exposure to Contaminants

Exposure to contaminants in ringed seals due to the Project was evaluated in the Country Foods Effects Assessment (Volume, Chapter 5) and in the Environmental Risk Assessment (Volume 8, Chapter 6). Results of these assessments indicated that all contaminant hazard quotients in ringed seals or its respective food chain components and surroundings (e.g. water, fish, sediment etc.) were predicted to be below a value of one. A hazard quotient less than one indicates that an increase in contaminants in these media relative to baseline conditions is unlikely. Thus, a residual effect due to exposure to contaminants in ringed seal is not anticipated and is not considered further in the assessment.

7.5.2.6 Reduction in Reproductive Productivity

Reproductive productivity is quantified as the number of surviving young produced per year per female. The additive effect of all residual effects of the Project may result in declines in reproductive productivity of ringed seals. Ringed seals are most likely to be affected by the Project through disturbance from aircraft. Research suggests effects on reproduction are most likely to occur through abandonment of pups in extreme cases, but more commonly through increased disturbance behaviors, leading to decreased pup attendance in lairs and provisioning of food and warmth to young. These effects may in turn impose a negative effect on the energetic balance of adults and young, which may result in poorer body condition. Adults in poorer body condition produce fewer young; while young in poor body condition are more susceptible to mortality.

There are three relatively distinct time periods in which development activities may affect aspects of seal ecology. Those include the open-water, birthing, and winter periods. Seals are present throughout the study area primarily during the ice-covered season. Activities that may affect the winter and birthing ecology of seals would include all ice road related Operations and Construction, and low-level aircraft flights.

Given that ringed seals are most dependent on ice for survival and population viability, potential impacts from industrial development that most influence the environment and characteristics of this ice cover would have the greatest effect on ringed seal populations. Project-related activities that are in close proximity to ringed seals in lairs and during moulting have the greatest potential to disturb reproduction events such as birthing, seal rearing, and copulation.

The effects of climate change on ringed seals could exacerbate the effect of reduction in reproductive productivity. Changes in the extent and concentration of sea ice may alter the seasonal distributions, geographic ranges, patterns of migration, nutritional status, reproductive success, and ultimately the abundance and stock structure of some species. Over the past two to three decades, sea ice has been breaking-up earlier in the spring and freezing later in the fall (Tynan and DeMaster 1997). In addition, minimal sea ice extent throughout the Arctic has declined by 45,000 km^2/year (Post et al. 2009). Recent episodes of unusually early spring rain in the Canadian Arctic have led to melting, collapse, and washout of birth lairs of ringed seals, leaving newborn pups exposed on bare ice, increasing their vulnerability to hypothermia and predation (Post et al. 2009).

Species that are dependent on the sea ice, such as ringed seals, may be directly affected by habitat loss and seasonal changes in the availability of ice-associated habitat (Tynan and DeMaster 1997). Alteration in the extent and productivity of ice-edge systems may affect the density and distribution of important ice-associated prey of marine mammals (Tynan and DeMaster 1997). Ringed seals may have to travel further to find prey as well as pupping habitat in a warmer Arctic environment. In the Canadian Arctic, habitat loss may occur along all boundaries of ringed seal range, constricting their range and leading to a subsequent population decline. In one Arctic study area, Parkinson (2000) calculated a shortening of the coastal sea ice season by 0.5 days/year, and another study in western Hudson Bay determined that the break-up of annual ice occurs approximately 2.5 weeks earlier than in the 1970's (Derocher, Lunn, and Stirling 2004). Habitat loss and a shortening of the ice season increases the distance seals need to travel to find food as well as breeding habitat, may create a concentrated food resource for bears or other carnivores, and will likely lead to a decline in the populations.

Since ringed seals depend on both the duration of the ice cover and snow depth for the building of subnivean lairs, temporal and spatial changes to sea ice formation may result in lower productivity (Tynan and DeMaster 1997; Smith and Harwood 2001; Stirling and Smith 2004). During the breeding season, ringed seals are territorial, and as the ice-free areas increase, seal productivity will likely decrease due to the loss of possible birthing habitat (Derocher, Lunn, and Stirling 2004). Ferguson, Stirling, and McLoughlin (2005) found that decreased snow depth and earlier spring break-up of sea ice resulted in a significant decrease in pup survival. In addition, warm temperatures and spring rains have washed away ringed seal birth lairs, exposing pups to predation and decreasing recruitment rates of the species (Hammill and Smith 1991; Stirling and Smith 2004). As there are few species in the Arctic, there is little overlap among the role of species in the Arctic ecosystem. Range shifts in the Arctic may precipitate larger and more fundamental changes in ecosystem dynamics compared to those ecosystems with more species with similar positions in the ecosystem, where loss of individual species may have less immediate consequence for ecosystem processes. For example, the loss of ringed seal (the main prey for polar bears) in the Arctic could have severe consequences to the population dynamics of polar bears.

In most cases, the impact of project-related effects is limited to relatively short term time periods and small areas, which will not affect such parameters as ice features and marine productivity, thus a residual effect of reduced reproductive productivity is not anticipated as a result of Project-related activities.

7.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Monitoring Plan (Volume 10 Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including ringed seals. In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to the environment and are included in Volume 10.

The following sections describe the mitigation and management measures that will be conducted to minimize or eliminate potential Project-related effects to ringed seals. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this potential effect.

7.5.3.1 Mitigation for Habitat Alteration

The primary mitigation and management strategies to minimize the effects of marine habitat alteration for marine wildlife are addressed by the design of project (see Project Description; Volume 2). Mitigation measures specific to minimizing the effects of habitat alteration to ringed seals may include the following:

- infrastructure designed to minimize the Project footprint to reduce habitat loss for ringed seals;
- Project infrastructure designed to avoid, where possible, identified wildlife sensitive areas, such as areas where birth lairs are found;
- construction and operation of the winter road over marine habitat outside of ringed seal pupping (mid-March through late-April), nursing (mid-March through mid-June) and moulting periods (mid-May through mid-July), where possible.

7.5.3.2 Mitigation for Disturbance due to Noise

The primary mitigation and management strategies to minimize the effects of disturbance to wildlife are addressed in the Noise and Vibration Chapter (Volume 4, Chapter 2) and the Noise Abatement Plan (Volume 10, Chapter 18). Additional wildlife specific measures to minimize the effect of disturbance to ringed seals may include:

- open-water season shipping only (no ice-breaking) to avoid disturbance to ringed and bearded seals during periods when seals are dependent on ice (e.g., during pupping (mid-March through late-April), nursing (mid-March through mid-June), and moulting (mid-May through mid-July) periods (Volume 10, Chapter 20);
- minimum prescribed flight elevations maintained over ringed seals and their pups, where possible (Volume 10, Chapter 20);
- vehicles restricted to site roads, winter roads and quarry footprints during Construction and Operations (December to April) to avoid unnecessary disturbance to wildlife habitat (Volume 10, Chapter 20);
- pre-determined flight paths developed to provide horizontal and vertical buffer distances between flight paths and sensitive habitats (Volume 10, Chapter 20); and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining minimum prescribed altitude, when possible, wherever wildlife species are observed (Volume 10, Chapter 20).

7.5.3.3 Mitigation for Mortality

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2), the Wildlife Mitigation and Monitoring Plan and the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to ringed seals may include:

- pre-construction surveys conducted for ringed seals and pupping lairs prior to and within 7 days of construction of the winter road over Bathurst Inlet (Volume 10, Chapter 20);
- vehicles restricted to site roads, winter roads and quarry footprints during Construction and Operations to minimize mortality to ringed seals on the ice (Volume 10, Chapter 20);
- truck speed limits developed, signage installed to alert drivers of speed limits, and speed limits enforced (Volume 10, Chapter 20);
- wildlife given the right-of-way on all roads at all times (Volume 10, Chapter 20); and
- airstrips monitored prior to take-off and landings to ensure wildlife are not present on the landing strip, and to ensure safety to aircraft passengers (Volume 10, Chapter 20).

7.5.3.4 Mitigation for Indirect Mortality

The primary mitigation and management strategies to minimize the effects of indirect mortality to wildlife are addressed in the Socio-economic Assessment (Volume 8, Chapter 3) and in the Socio-economic Monitoring Plan (Volume 10, Chapter 23). Measures to minimize the effect of indirect mortality specific to ringed seals may include:

- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic, and road use restricted only to persons required for Project Construction, Operations, and Maintenance (Volume 10, Chapter 20);
- a policy prohibiting hunting by Project employees and contractors while on site to prevent an increase in mortality to ringed seals (Volume 10, Chapter 23);
- a waste and wildlife attractant management protocol developed to minimize attraction of ringed seal predators to the camp at the MLA and other attractants (Volume 10, Chapter 20);
- the use of wildlife-attracting dust suppressants avoided, where possible (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation and enforced (Volume 10, Chapter 20);
- a policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced (Volume 10 Chapter 20); and
- a protocol for human-wildlife interactions developed and disseminated to all Project and contractor employees as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists, and conservation officers (Volume 10, Chapter 20).

7.5.3.5 Mitigation for Exposure to Contaminants

Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (only if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of the marine environment within the marine wildlife LSA and RSA and thus, help to minimize the effect of exposure of contaminants to ringed seals.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife, including ringed seals from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20). These measures may include:

- the use of wildlife-attracting dust suppressants avoided, wherever possible (Volume 10, Chapter 20);
- all Project roads closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20);
- all chemicals stored in secure areas, in order to keep potentially harmful chemicals out of the receiving environment (Volume 10, Chapter 20); and
- a Spill Contingency Plan, and a Risk Management and Emergency Response Plan (Volume 10, Chapter 5) implemented to minimize the potential for chemical contaminants to enter the environment.

7.5.4 Characterization of Residual Effects

No residual effects of the Project are anticipated for ringed seals.

7.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

No residual effects for ringed seal are anticipated as a result of Project-related activities. This assumes that the MLA is not active during the seal moulting period between mid-May and mid-July. Therefore, there is also no potential for cumulative effects to occur and no cumulative effects assessment is required (Volume 9, Chapter 1).

7.7 TRANSBOUNDARY EFFECTS

As outlined in Section 4 of Volume 9 (DEIS Methods), the potential for transboundary effects may occur if residual effects from the Project are identified and extend beyond the marine wildlife RSA. However, no Project-related residual effects or cumulative residual effects for ringed seal were identified, so there is no potential for residual effects to extend beyond the marine wildlife RSA. Therefore, there is no potential for transboundary effects to occur.

7.8 MITIGATION AND ADAPTIVE MANAGEMENT

Mitigation and management plans will be in place to minimize or eliminate potential effects on the VEC ringed seal. The Wildlife Mitigation and Monitoring Plan (Volume 10 Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including ringed seals. Mitigation measures specific to ringed seals for potential Project effects are listed in Section 7.5.3, and summarized in Table 7.8-1 in Section 7.8.5.

In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, marine water/sediment quality. These mitigation and management measures will also serve to protect wildlife including ringed seals. Details of these strategies can also be found in the following chapters:

- Noise and Vibration: Volume 4, Chapter 2. The Noise Abatement Plan can be found in Volume 10, Chapter 18;
- Air Quality: Volume 4, Chapter 1. The Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incinerator Management Plan can be found in Volume 10, Chapter 11; and
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7. The Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

Other management plans will also be implemented to protect the environment, details of which are found in the following chapters of Volume 10:

- Overall Environmental Management Plan: Chapter 1.
- Environmental Protection Plan: Chapter 2.
- Risk Management and Emergency Response Plan: Chapter 3.
- Fuel Management Plan: Chapter 4.
- Spill Contingency Plans: Chapter 5.
- Oil Pollution Emergency Plan: Chapter 6.
- Site Water Monitoring and Management Plan: Chapter 7.
- Ore Storage Management Plan: Chapter 8.
- Mine Waste Rock and Tailings Management Plan: Chapter 9.
- Landfill and Waste Management Plan: Chapter 10.
- Hazardous Materials Management Plan: Chapter 12.
- Explosive Management Plan: Chapter 13.
- Road Management Plan: Chapter 14.
- Shipping Management Plan: Chapter 15.
- Borrow Pits and Quarry Management Plan: Chapter 16.
- Fish Offsetting Plan: Chapter 21.
- Metal Leaching and Acid Rock Drainage Management Plan: Chapter 22.
- Socio-economic Monitoring Plan: Chapter 23.
- Mine Closure and Reclamation Plan: Chapter 29.

7.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy for the Project is to coordinate shipping activities outside of the sensitive periods for wildlife dependent on marine habitat (e.g. ice-covered season for ringed seals). The process of Project design and avoidance was conducted during the preparation phase for the DEIS, and the DEIS evaluates the potential for effects given the locations of Project infrastructure and timing of Project activities in the redesign of Project elements. Table 7.8-1 in Section 7.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on ringed seals.

7.8.2 Best Management Practices

The Wildlife Mitigation and Monitoring Plan (Volume 10 Chapter 20) includes eight separate plans designed to eliminate or minimize effects of the Project on wildlife. The plans are focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects to ringed seals are listed in Section 7.5.3, and summarized in Table 7.8-1 in Section 7.8.5.

7.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these may need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and scientific knowledge. Newly-devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and available. The mitigation and management strategies in the Wildlife Mitigation and Monitoring Plan may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or
- if results from the Wildlife Effects Monitoring Program, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The Wildlife Mitigation and Monitoring Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

7.8.4 Monitoring

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10; Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring: facility-specific monitoring, and focal species monitoring.

7.8.5 Summary Table of Mitigation and Adaptive Management Measures

Table 7.8-1 includes all mitigation and adaptive management measures that may be applicable to mitigate the effects of the Project on ringed seals.

Table 7.8-1. Summary of Mitigation and Management Measures Applicable to Wildlife

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	
	1. Infrastructure designed to minimize the Project footprint in marine habitat.
	2. Project infrastructure designed to avoid, where possible, identified wildlife sensitive areas, such as areas where birth lairs are found.
	3. Open-water season shipping only (no ice-breaking).
	4. Winter roads will be designed to avoid known ringed seal lairs within 1 km of the proposed alignment.
2. Best Management Practices	
	1. Construction and operation of the winter road over marine habitat will occur outside of ringed seal pupping (mid-March through late-April), nursing (mid-March through mid-June) and moulting periods (mid-May through mid-July), where possible.
	2. Pre-construction surveys conducted for ringed seals and pupping lairs prior to construction of the winter road over Bathurst Inlet.
	3. Minimum prescribed flight altitudes maintained over ringed seals and their pups, where possible.
	4. Pre-determined flight paths developed to provide horizontal and vertical buffer distances between flight paths and sensitive habitats, where possible.
	5. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining minimum prescribed altitude, when possible, wherever wildlife species are observed.
	6. Airstrips monitored prior to take-off and landings to ensure wildlife are not present on the landing strip.
	7. Vehicles restricted to site roads, winter roads and quarry footprints during Construction and Operations (December to April).
	8. Truck speed limits developed, signage installed to alert drivers of speed limits, and speed limits enforced.
	9. Wildlife given the right-of-way on all roads at all times.
	10. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic, and road use restricted only to persons required for Project Construction, Operations, and Maintenance.
	11. A policy prohibiting hunting by Project staff and contractors while on site, and enforced.
	12. A waste and wildlife attractant management protocol developed, and enforced.
	13. The use of wildlife-attracting dust suppressants avoided, where possible.
	14. A policy of no feeding and no intentional attraction of wildlife developed, disseminated to all Project and contractor employees during employee orientation, and enforced.
	15. A policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced.
	16. A protocol for human-wildlife interactions developed and disseminated to all Project and contractor employees as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists, and conservation officers.

(continued)

Table 7.8-1. Summary of Mitigation and Management Measures Applicable to Wildlife (completed)

Mitigation Category	Mitigation Measures
3. Adaptive Management	
	1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include: • if negative wildlife interactions become a concern, or • if results from the Wildlife Mitigation and Monitoring Program, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife. 2. The Wildlife Effects Monitoring Program (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.
4. Monitoring	
	Facility-specific monitoring program to assess the effectiveness of mitigation measures used to minimize effects of the Project on wildlife. This plan will include several mitigation measures relevant to ringed seals including: 1. footprint monitoring to monitor habitat loss; 2. noise monitoring to monitor disturbance to wildlife; 3. human activity monitoring of Project use of winter roads on marine habitat; 4. waste management monitoring to ensure that wastes are being properly disposed of and that wildlife do not have access to these wastes; 5. wildlife-vehicle interaction monitoring to document wildlife-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions; and 6. on ice monitoring to document the presence of ringed seal lairs prior to construction and use of winter roads and the airstrip; 7. incidental wildlife reporting to record general wildlife activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to wildlife and adaptively manage conflicts where possible. Focal-species monitoring program to monitor Project-related effects on specific terrestrial wildlife species including: 1. monitoring ringed seals near the MLA to assess the zone of influence of the Project on this species; and 2. incidental reporting of ringed seal observations during other wildlife and environmental monitoring programs.

7.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10; Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

1. Facility-specific monitoring is designed to:
   - monitor wildlife interactions with Project Infrastructure;
   - monitor mitigation actions and their efficacy; and
   - identify opportunities for adaptive management.

2. Focal-species monitoring is designed to:
   - evaluate impact predictions in the effects assessment;
   - continuously reduce uncertainty of Project effects on wildlife; and
   - collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). Strategies specific to ringed seals are summarized in the following sections.

7.9.1 Wildlife Mitigation and Monitoring Plan

7.9.1.1 Facility-specific Monitoring

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented and are effective.

Facilities that will be monitored for wildlife interactions include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property Area and George Property Area;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10; Chapter 20):

- Footprint monitoring;
- Noise Monitoring;
- Human Activity Monitoring;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- Skirting/Fencing Monitoring;
- Wildlife-vehicle Interactions Monitoring;
- On-ice Monitoring at the MLA; and
- Incidental Wildlife Monitoring.

7.9.1.2 Focal-species Monitoring

The focal-species monitoring program is proposed to include monitoring ringed seals by aerial survey. Incidental observations of ringed seal detected during other wildlife monitoring surveys will continue to be recorded.

The five objectives of this monitoring program are to:

- monitor the Project site to examine how ringed seals interact with Project facilities (e.g., on winter roads, ice landing strip);
- monitor the Project site at areas with and without mitigation structures or activities to evaluate the efficacy of mitigation activities;
- monitor areas identified as important for ringed seals from land user knowledge (e.g., areas for pupping, nursing, and moulting);
- assess Project-related changes in the density and distribution of ringed seals in the marine wildlife RSA; and
- record the times at which ringed seals use the marine wildlife RSA during the year.

Methods for data management and analysis will follow previously established methods for ringed seal monitoring during the ice-covered season (Stirling, Kingsley, and Calvert 1982; Kingsley 1984; Lunn, Stirling, and Nowicki 1997; Frost et al. 2002) and will be conducted once during Construction and will be continued on a three to five year schedule during Operations while the MLA is active (Volume 10, Chapter 20).

7.10 IMPACT STATEMENT

Ringed seals were included as a valued ecosystem component due to their importance to the Inuit, and their importance to the ecology of the Arctic. Ringed seals are not currently listed under the *SARA* and are designated as “Not at Risk” by COSEWIC (COSEWIC 2012), but have recently been listed as a “candidate wildlife species” of high priority for reassessment due to evidence that climate change may threaten this species’ productivity and survival (COSEWIC 2012).

A review of the Project activities identified six potential effects on ringed seals. These six potential effects are: alteration of habitat, disturbance, direct mortality and injury, indirect mortality, exposure to contaminants, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions between the other five potential effects.

The effects assessment included the identification of key indicators and quantitative thresholds for determining whether an effect was residual and included effects ratings of the magnitude of residual effects. The assessment described the mitigation and management activities planned to reduce or eliminate potential effects on ringed seals. After mitigation, no residual effects were anticipated for ringed seals. This assumes that the MLA is not active during the seal moulting period between mid-May and mid-July. Therefore, the Project is not anticipated to result in any residual effects on the VEC ringed seals and no cumulative effects or transboundary effects are anticipated to occur.

7.11 SUPPORTING AND SUPPLEMENTAL INFORMATION

This section provides information requested by the NIRB guidelines or a specific regulator that was not included in the effects assessment for ringed seals. The Back River Project will include shipping outside of the marine wildlife RSA. Shipping will occur along an existing shipping route through the Northwest Passage from Bathurst Inlet through Coronation Gulf, Dease Strait, Queen Maud Gulf, Victoria Strait, Franklin Strait, Peel Sound, Barrow Strait, and out through Lancaster Sound during the open-water season (August 25 through October 31). A discussion on current shipping traffic through the Northwest Passage, additional shipping traffic for the Back River Project, and the potential marine mammal species that may occur along this shipping route during the open-water season is included here.

The existing shipping traffic through the Northwest Passage to the east through Nunavut is on average 17 ships and up to 36 ships between September 1 and October 31 (approximately 60 days; Baffinland 2012). The Back River Project will increase this number by five to 10 ships (up to 20 one-way sailings) during the Construction phase and three to five ships per year (up to 10 one-way trips) during the Operations phase (see details in Volume 2).

Several species of marine mammals (in addition to ringed seals, discussed in Section 7.1), likely occur along the commercial Northwest Passage shipping route including: walrus (*Odobenus rosmarus*), narwhal (*Monodon monoceros*), beluga whale (*Delphinapterus leucas*), bowhead whale (*Balaena mysticetus*), polar bear (*Ursus arctos*). In addition, several other species may occur on a small proportion of the commercial Northwest Passage shipping route including, bearded seal (*Erignathus barbatus*), harp seal (*Phoca groenlandica*), hooded seal (*Crystophora cristata*), and killer whales (*Orcinus orca*). Spatial and temporal distributions of these species along the shipping lanes are presented in Table 7.11-1 and Figures 7-11.1 and 7.11-2.

Table 7.11-1. Spatial and Temporal Distribution of Marine Mammals along the Northwest Passage Shipping Route

Species	Typical Spatial Distribution with Potential for Overlap with Shipping Route[1]	Temporal Distribution	References
Main Species Occurring on the Proposed Shipping Route			
Ringed Seal	Arctic Archipelago	year-round	(I. A. McLaren 1958; Heide-Jørgensen, Stewart, and Leatherwood 1992; Harris et al. 1997; Harris et al. 1998; Kapel et al. 1998; Lawson and Moulton 1999; Teilmann, Born, and Acquarone 1999; Moulton and Lawson 2001; Moulton et al. 2002; Kelly et al. 2010)
Walrus	Lancaster Sound and Barrow Strait	Spring Migration: June – early-August	(R. A. Davis, Koski, and Finley 1978; Koski and Davis 1979; Koski 1980a, 1980b; Stewart 2008)
		Summer: August and September	(S. R. Johnson et al. 1976; Koski and Davis 1979)
		Fall Migration: end-September - October	(Koski 1980a)
	Baffin Bay	Wintering: late-October - June	(Riewe 1976; R. A. Davis, Koski, and Finley 1978; Kiliaan and Stirling 1978; Sjare and Stirling 1996) (Stewart 2008)
Narwhal	Lancaster Sound	Spring Migration: April – July	(Finley et al. 1990)
		Fall Migration: mid-September – early October	(Heide-Jørgensen, Dietz, et al. 2003)
	North of Baffin Island, Prince Regent Inlet, Somerset Island, Gulf of Boothia, Barrow Strait, and Peel Sound	Summer: August and September	(Finley and Johnston 1977; Fallis, Klenner, and Kemper 1983; Smith et al. 1985; Koski and Davis 1994; Richard et al. 1994; Heide-Jørgensen, Dietz, et al. 2003; Heide-Jørgensen, Richard, et al. 2003; Marcoux, Auger-Méthé, and Humphries 2009)
	Davis Strait and Baffin Bay	Winter: October - June	(P. L. McLaren and Davis 1982)

(continued)

Table 7.11-1. Spatial and Temporal Distribution of Marine Mammals along the Northwest Passage Shipping Route (completed)

Species	Typical Spatial Distribution with Potential for Overlap with Shipping Route[1]	Temporal Distribution	References
Main Species Occurring on the Proposed Shipping Route (cont'd)			
Beluga (Eastern High Arctic-Baffin Bay stock)	Lancaster Sound (April – July)	Spring Migration: late-April/early May – July	(R. A. Davis and Finley 1979; Finley and Renaud 1980; Koski, Davis, and Finley 2002)
		Fall Migration: early-September- November	(Richard et al. 2001; Heide-Jørgensen, Richard, et al. 2003)
	Barrow Strait, Peel Sound, Franklin Strait, Prince Regent Inlet, Somerset Island	Summer: mid-July – mid-August	(Finley 1976; Smith et al. 1985; Richard et al. 2001; Koski, Davis, and Finley 2002)
	Baffin Bay	Wintering: late-September - early-May	(R. A. Davis and Finley 1979; Finley and Renaud 1980; P. L. McLaren and Davis 1983; Heide-Jørgensen, Richard, et al. 2003)
Bowhead Whale (Davis Strait-Baffin Bay stock)	Lancaster Sound, Gulf of Boothia, Prince Regent Inlet	Spring Migration: early/mid-May – early-August	(R. A. Davis and Koski 1980; Reeves et al. 1983; Moore and Reeves 1993)
		Fall Migration: late-August - October	(Koski and Davis 1980)
	Milne Inlet, and Admiralty Inlet (summer)	Summer: August and September	(R. A. Davis and Koski 1980; Koski and Davis 1980; Finley 1990, 2001)
	Hudson Strait, Baffin Bay	Wintering: October – May/June	(Koski, Heide-Jørgensen, and Laidre 2006)
Polar Bear	Northern Arctic Archipelago	Summer: August – September	(Amstrup et al. 2000)
	Ice-Covered Waters across Arctic Archipelago as far south as Larsen Sound	Winter: October – June/July	(LGL Limited 2005)
Other Species that May Occur on the Proposed Shipping Route			
Bearded Seal	Northern circumpolar	year-round, moves with ice as ice retreats and reforms	(Fedoseev 1965; M. L. Johnson et al. 1966; Burns and Frost 1979; Burns 1981; Kelly 1988)
Harp Seal	Lancaster sound, Peel Sound	Spring Migration: July – late-August Fall Migration: late-September-early October	(Finley 1976; Koski and Davis 1980)
	Davis Strait, Baffin Bay, Lancaster Sound, Prince Regent Inlet, Barrow Strait, Peel Sound	Summer: late-August – late-September	(S. R. Johnson et al. 1976; Koski and Davis 1979; Fallis, Klenner, and Kemper 1983; Lavigne and Kovacs 1988)
	Labrador coast	Winter: October – mid-June/July	(Koski and Davis 1980)
Hooded Seal	Lancaster Sound, Baffin Bay, Davis Strait	Summer: August and September	(Sergeant 1976)
	Newfoundland/Labrador/Davis Strait	Winter/Spring: late-September – late-July	(Sergeant 1976)
Killer Whale	Lancaster Sound, Prince Regent and Admiralty Inlets	Summer: mid-August – early-October, but rare	(Koski and Davis 1979; Baird 2001; Reeves et al. 2002)
	North Atlantic (open-water)	Winter: early-October through August	(R. A. Davis, Finley, and Richardson 1980)

[1] Spatial Distribution only includes distribution of populations and areas with potential for overlap with the proposed shipping route.

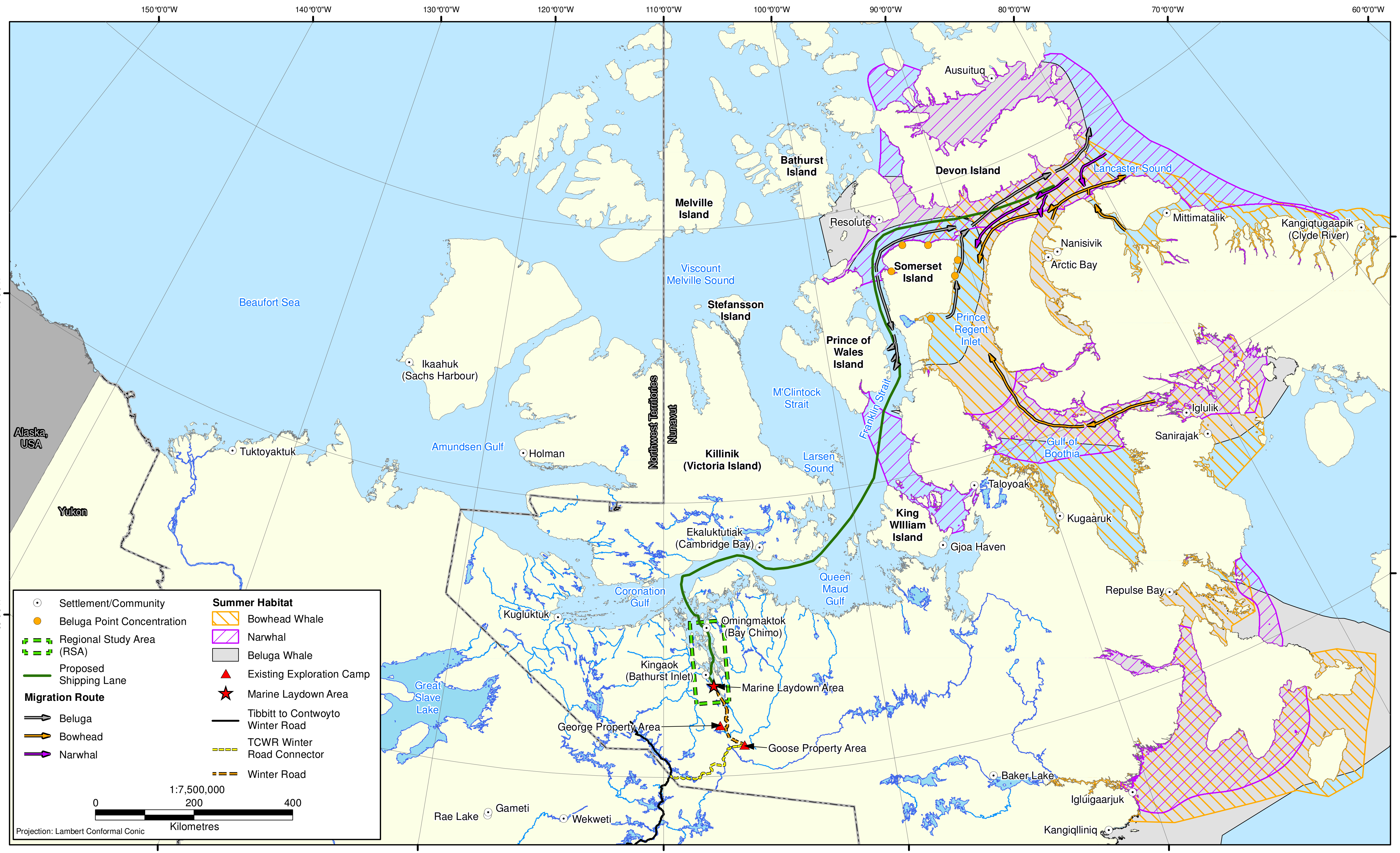

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Figure 7.11-1

Migratory Routes and Main Summering Areas of Whales along the Northwest Passage

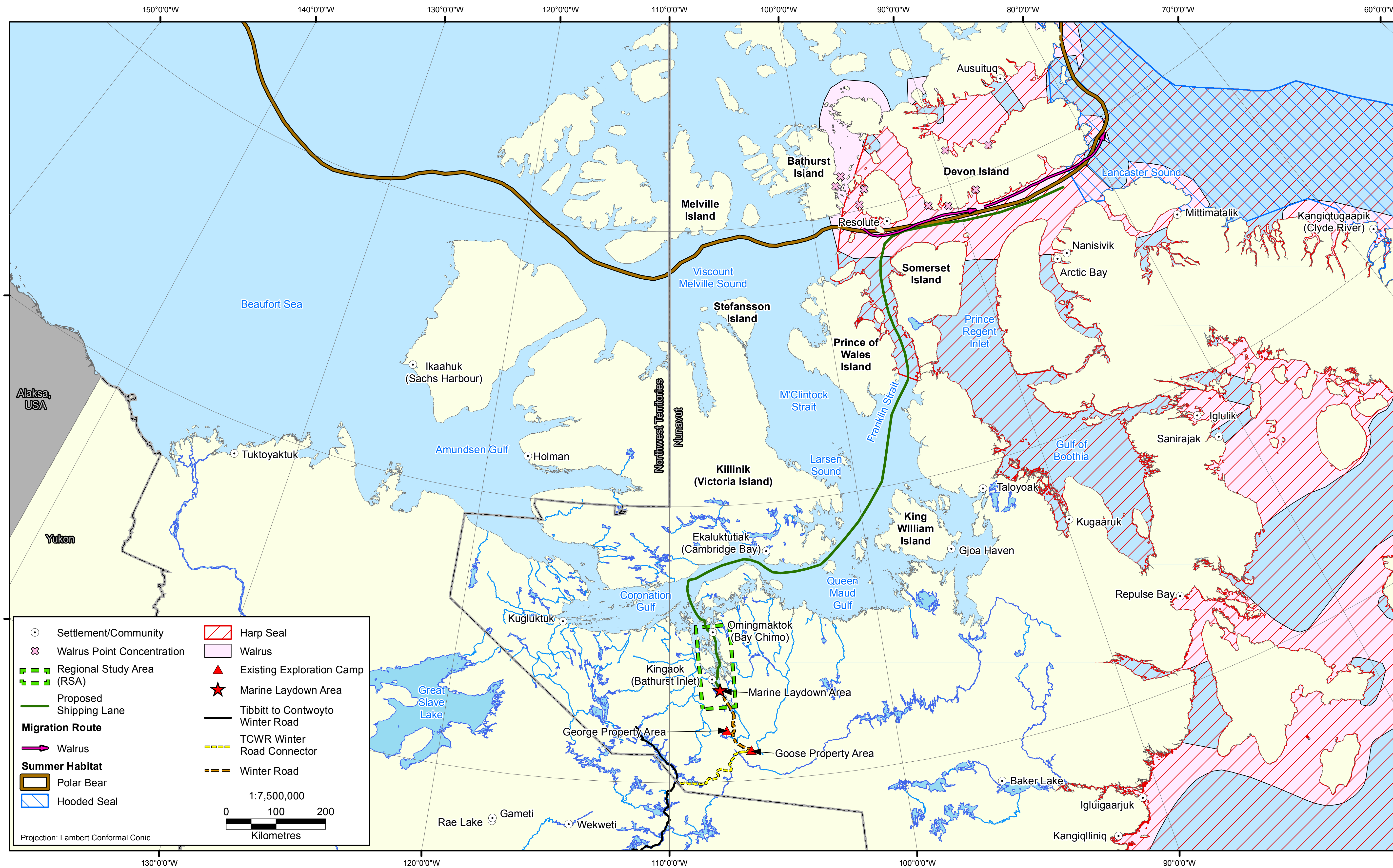

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Figure 7.11-2

Main Summering Areas of Seals, Walrus, and Polar Bears along the Northwest Passage

Most of the marine mammals along the commercial Northwest Passage shipping route likely would not come into close contact with vessels, regardless of the number of vessels, because of their distribution or preferred habitats. The commercial Northwest Passage shipping route is located well offshore or in mid-channel, whereas many of the marine mammals are coastal and some are found only in low numbers along the commercial Northwest Passage shipping route.

The relatively few times and locations when marine mammals could occur near the commercial Northwest Passage shipping route during the shipping season are as follows:

- A few bowhead whales occur in the Peel Sound/Franklin Strait area and in Barrow Strait during August and September. The Eastern Arctic bowhead population is present in Lancaster Sound and Prince Regent Inlet from late June through September as ice conditions allow.
- Beluga whales occur in deep-water areas offshore in Peel Sound called the Franklin Trench from mid-August to early/mid-September. The Eastern Beaufort Sea beluga population is in the western Mackenzie River estuary and delta from June to late August.
- Narwhals occur only in small numbers in Barrow Strait and Peel Sound during August and September. During fall migration back to Baffin Bay via Lancaster Sound, narwhal are dispersed in open-water and remain there as long as open-water permits.
- Very few walrus use the offshore waters and south shores of Barrow Strait, the west shores of Prince Regent Inlet and the Gulf of Boothia, or Peel Sound.

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Acronyms and Abbreviations section.

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