



Izok Corridor Project Proposal

SECTION 5

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5 EXISTING BIOPHYSICAL ENVIRONMENT

5.1 Potential Valued Ecosystem Components

Based on regulatory and community engagement conducted in relation to the High Lake Project Draft Environmental Impact Statement (DEIS) and other Part 5 reviews for mining projects in Nunavut, MMG has developed a preliminary list of potential Valued Ecosystem Components (VECs) for the Izok Corridor Project. It is anticipated that this list of VECs will be further refined through the regulatory scoping process and ongoing public engagement. This will include selection of Key Indicator species, species groups or ecosystem functions that represent components of the broader Valued Components, which for practical reasons will be used to focus the assessment of potential residual Project environmental effects and cumulative effects in the DEIS.

Atmospheric Environment

- Air Quality
- Climate
- Noise and Vibration

Terrestrial Environment

- Landforms and Soils
- Vegetation
- Terrestrial Wildlife and Wildlife Habitat
- Terrestrial Birds

Aquatic Environment

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

Marine Environment

- Water and Sediment Quality
- Aquatic Organisms and Habitat
- Marine Mammals and Habitat
- Marine Birds and Habitat



The following sections summarize existing information for each VEC within the Project area. Baseline conditions are described for both local and regional study areas (LSA, RSA) as defined for each VEC.

In most cases, descriptions of the existing environment are based on field data collected in 2004 and 2005 for the High Lake project DEIS, and more recently in 2007 and 2008 for the High Lake project proposal. Additional data are currently being obtained through ongoing (2012) field studies (including associated traditional knowledge) to support preparation of the Izok Corridor Project DEIS and provide baseline for future long-term monitoring programs that will be implemented during the Project.

5.2 Areas of Ecological Interest

There are several terrestrial and marine areas that are recognized for their wildlife and habitat values within the Kitikmeot and North Baffin Land Use Planning regions of Nunavut, and the Inuvialuit Settlement region of the Northwest Territories (NWT). These include National Parks, Territorial Parks, Migratory Bird Sanctuaries (federal protection) and Wetlands of International Importance (Ramsar Sites). These areas are protected through various federal and territorial legislation including the *Nunavut Wildlife Act*, *NWT Wildlife Act*, *Canadian Wildlife Act*, *Migratory Birds Convention Act* and the Ramsar treaty. There are also a number of other sites of importance in the region of the Project, including International Biological Program (IBP) sites, Canadian Heritage Rivers, key marine and terrestrial habitat sites and wildlife areas of special interest and importance. These areas are recognized as conservation areas under Article 9 of the Nunavut Land Claims Agreement (NLCA) but are currently not legally protected.

The footprint of the Izok Corridor Project does not overlap with the boundaries of any protected areas. There are portions of the proposed eastern and western shipping routes that will be in proximity to some marine conservation areas and polar bear areas of importance; however, ship passage will be limited to the ice-free season to limit any potential impacts on wildlife.

5.2.1 Protected Areas

Table 5.2-1 provides a summary of protected areas within the Kitikmeot and North Baffin regions and in the NWT along the proposed shipping routes. The locations of these areas are shown in **Figure 5.2-1**.



Table 5.2-1 Protected Areas within the Region of the Project

Area Name	Ecological Value	Protected Status
Anderson River Delta	Important bird breeding, moulting and staging habitat, including threatened species	Migratory Bird Sanctuary
Cape Parry	Globally significant waterfowl concentrations	Migratory Bird Sanctuary
Banks Island	Home to both the endangered Peary caribou and to the highest density of muskoxen in the world	Banks Island Migratory Bird Sanctuary 1 and 2, Aulavik National Park
Tuktut Nogait	Core calving and post-calving grounds of the Bluenose West caribou herd; major breeding and nesting ground for migratory birds	National Park
Kugluk/Bloody Falls	National historic site	Territorial Park
Ovayok (Mount Pelly)	Archaeological sites; important wildlife habitat	Territorial Park
Queen Maud Gulf	Major waterfowl nesting area	Migratory Bird Sanctuary, Ramsar Site
Thelon River	Unique flora, musk ox habitat, Important Bird Area (IBA); Canadian Heritage River	Game Sanctuary
Rasmussen lowlands	Nesting shorebirds and waterfowl; nesting Peregrine falcons	Ramsar site
Erebus Bay, King William Island	National historic site	Territorial Park
Seymour Island	Supports a population of the nationally vulnerable Ivory Gull	Migratory Bird Sanctuary
North Bathurst Island	Calving ground for Peary Caribou, archaeological sites	Proposed National Park
Port Refuge, Devon Island	National historic site	Territorial Park
Beechy Island	National historic site	Territorial Park
Prince Leopold Island	Major seabird colony	Migratory Bird Sanctuary
Bylot Island	Seabirds, polar bear denning	Bylot Island Migratory Bird Sanctuary, Sirmilik National Park

5.2.2 Conservation Zones

The Draft West Kitikmeot Regional Land Use Plan (NPC 2005) and North Baffin Land Use Plan (NPC 2000) identify a number of conservation zones in the region of the Project (**Figure 5.2-2**). These include key marine and terrestrial habitat sites, and wildlife areas of special interest. The eastern shipping route passes near the Jenny Lind Island key migratory bird habitat site, Creswell Bay Important Bird Area, and polar bear denning locations in Victoria Strait and Larsen Sound. The western shipping route passes near the Lambert Channel Polynya, which is an important ecological habitat feature during the winter months.

None of these areas lie within the Project Development Area.

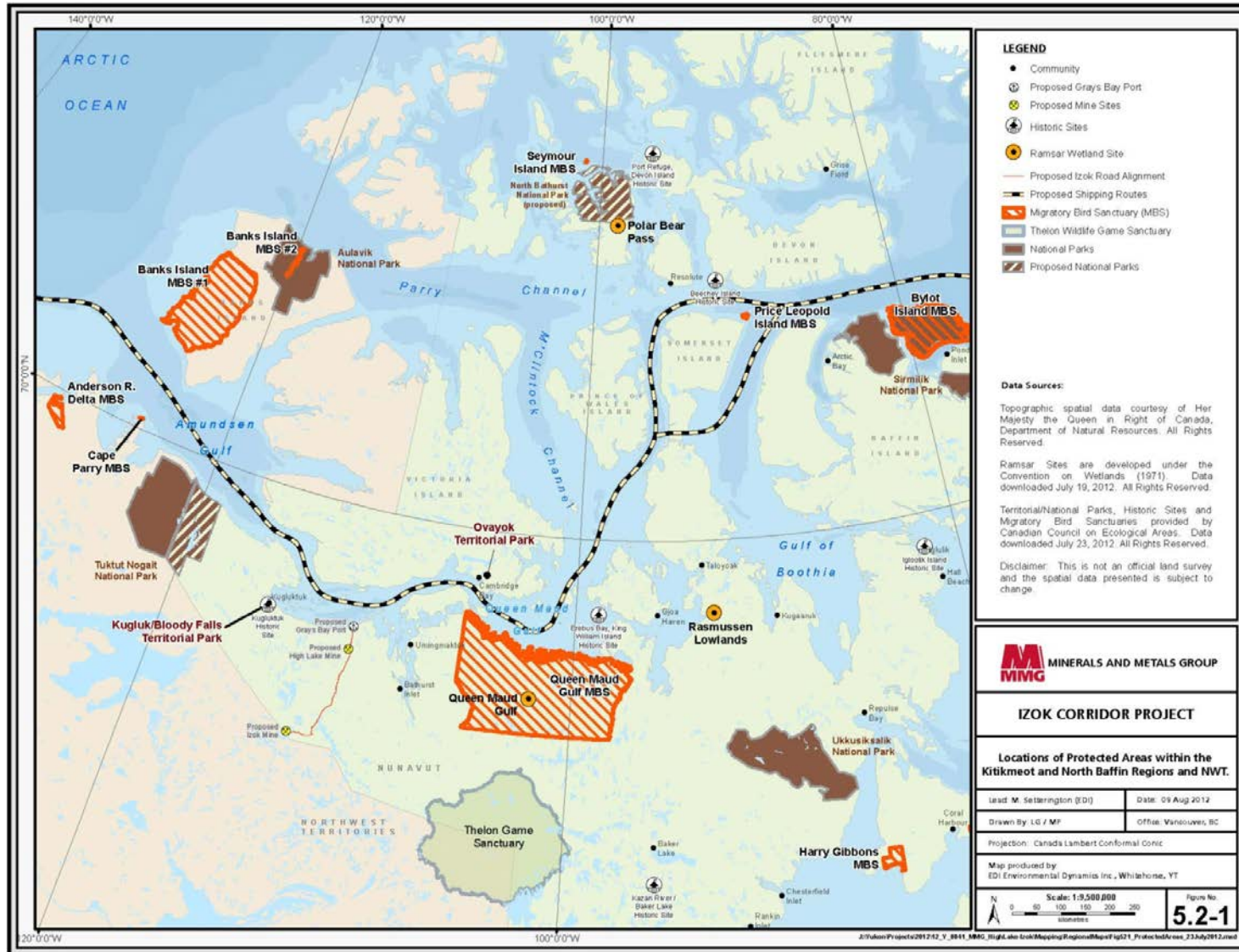


Figure 5.2-1 Protected Areas within the Kitikmeot and North Baffin Regions and NWT

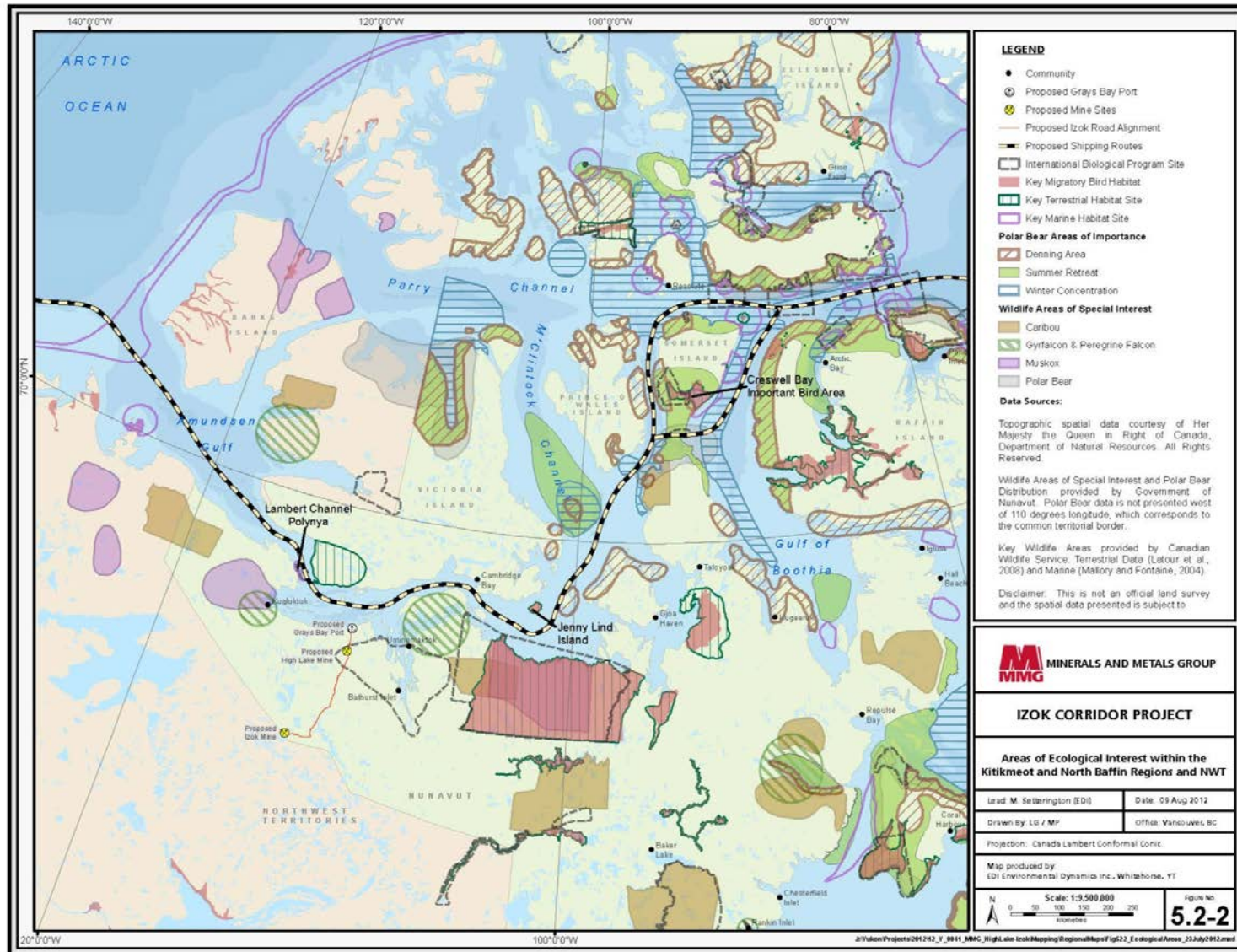


Figure 5.2-2 Areas of Ecological Interest within the Kitikmeot and North Baffin Regions and NWT



5.3 Air Quality

Given the remoteness of the Project, baseline air quality in the vicinity of the Project is essentially unaffected by local industrial, residential and transportation activities. However, ambient air quality in the Arctic, including the Kitikmeot region, is influenced by long-range transport of air contaminants from industrial sources located on other continents.

The Project will result in fugitive sources of dust, as well as atmospheric emissions from diesel combustion during mine operation, haul fleets, processing of ore and operation of the port facility. While carbon dioxide (CO₂) and water vapour (H₂O) are the primary products of combustion, trace amounts of oxides of nitrogen (NO_x), particulate matter with diameter less than 2.5 µm (PM_{2.5}), particulate matter less than 10 µm (PM₁₀), and suspended particulates (TSP) will also be produced. A portion of the particulates produced from combustion of diesel is comprised of metals.

Trace amounts of SO₂, carbon monoxide (CO) and polycyclic aromatic hydrocarbons (PAH) emissions will also be emitted from combustion sources and fugitive emissions of volatile organic compounds (VOCs) may occur.

5.3.1 Study Areas

Local Study Areas

Local Study Areas (LSAs) were defined for each of the main components of the Project (Grays Bay Port, High Lake Mine site, and Izok Mine site) to support assessment of Project effects on air quality. Each LSA is approximately 30 km x 30 km centred on the activity of interest, and includes a portion of Izok Road to consider the effect of haul traffic on air quality. The LSA for the Grays Bay Port also includes a portion of the shipping route. The boundaries of the LSAs were defined based on the area within which predicted concentrations will be 10% or less of maximum predicted concentrations in the LSA.

Air quality modelling will be based on model grid points within each LSA that are graduated with distance from the centre of the activity, approximately as follows.

- 20-m receptor spacing in the general area of the property boundary
- 50-m receptor spacing within 0.5 km from the source
- 250-m receptor spacing within 2 km from the sources of interest
- 500-m spacing within 5 km from the sources of interest
- 1000-m spacing beyond 5 km

Regional Study Area

The Regional Study Area (RSA) encompasses the three LSAs, and is defined as the area within which meteorology will be modelled, as one of the inputs to the dispersion models run within each of the LSAs. Emissions from major current or planned projects will be included in the RSA; however, the effects of these projects will only be modelled within the LSAs where they may interact with Project plumes.



5.3.2 Description of Existing Environment

Measurements of air quality in the RSA are sparse, widely separated, and span various time periods.

A primary source of air quality information is a particulate monitoring program conducted by an MMG predecessor at Izok Lake in September 2008. This information is supplemented by longer term monitoring data from Environment Canada monitoring stations in Yellowknife, Fort Liard, Norman Wells and Inuvik, which provide measurements of criteria gases, and Environment Canada particulate observations at Daring Lake NWT, 2002-2006. These data are expected to be indicative of air quality conditions in the Project Development area.

All available meteorology and climate data for the Project area were collected by MMG or its predecessors. This includes data collected at High Lake (February 2004 – August 2011), Izok Lake (September 2008 – August 2011), and Grays Bay (February 2010 – August 2011).

5.3.2.1 Air Quality Measurements

Criteria Gases

Air quality in the NWT is monitored by Environment Canada, and annual reports are readily available for the 2000 to 2006 period. Continuous ambient air quality monitoring is conducted at stations located in Yellowknife, Fort Liard, Norman Wells and Inuvik.

SO₂ is measured continuously at Yellowknife, Fort Liard, Norman Wells and Inuvik. Recent measurements indicate that background maximum 1-h SO₂ concentrations have ranged from 11 µg/m³ to 16 µg/m³. Similarly, the annual average SO₂ concentrations range from 1 µg/m³ to 5 µg/m³. Expected background concentrations on site are likely to be lower.

NO₂ is measured continuously at Yellowknife and Inuvik. Maximum 1-h NO₂ concentrations measured at the two sites were 50 µg/m³ and 89 µg/m³, respectively. Corresponding annual average concentrations ranged from 5 µg/m³ to 12 µg/m³, respectively. These levels, however, are likely attributable to combustion sources near the monitoring stations (e.g., vehicles, residential heating).

CO is measured continuously at Yellowknife. The maximum measured 1-h CO concentration was 2,000 µg/m³. Most of the hourly concentrations are less than 200 µg/m³.

Particulate Matter

Izok Lake

Measurements of hourly PM_{2.5} were conducted at Izok Lake from 9 to 28 September 2008, resulting in 336 h of valid data. Measurement statistics indicate that most reported concentrations were less than 1 µg/m³ (the median value was zero and the 90th percentile value was 1 µg/m³). Based on very limited data, maximum values were measured before midnight.

Daring Lake

The Environment Canada Daring Lake air quality station is located about 100 km south of Izok Lake. Particulate concentration data collected during the summers of 2002 to 2006 (**Table 5.3-1**) indicated the following.



- The highest measured PM_{2.5} concentration was approximately 42 µg/m³, which occurred in late July 2004 and was attributed to smoke from forest fires burning south of Great Slave Lake.
- The median PM_{2.5} concentration was 2 µg/m³, and the 90th percentile ranged from 2.8 to 14 µg/m³ over the years 2002 to 2006.
- Maximum concentrations of PM_{2.5} and PM₁₀ were measured during the month of July; median concentrations tended to decrease over the summer months.

With the possible exception of 2004 data, Daring Lake data are expected to be representative of PM₁₀ and PM_{2.5} concentrations in the Project area.

Table 5.3-1 Daring Lake 24-Hour Particulate Concentration Statistics (µg/m³), 2002 to 2006

Sample Date	PM ₁₀ 2002	PM _{2.5} 2003	PM _{2.5} 2004	PM _{2.5} 2005	PM _{2.5} 2006
Minimum	0.0	0.14	0.97	0.00	0.31
Median	1.7	1.9	4.7	1.2	1.3
Average	1.6	2.4	7.1	1.5	1.8
90 th Percentile	2.8	5.2	14	3.2	3.8
Maximum	3.3	6.8	41.5	3.8	5.4

5.3.2.2 Meteorology and Climatology Measurements

Wind Speed and Direction

Available wind data for the Project area suggests that:

- Predominant winds at Grays Bay are from the north-northwest. Winds blow along the shoreline relatively infrequently. The strongest winds blow from the north-northwest.
- Predominant winds at High Lake are from the south and about 5% of winds were calm. The frequency of calms is more than 5.1 %. There is little seasonal variation in wind direction frequency.
- Predominant winds at Izok Lake are from the northeast. Winds are calm 7% of the time. There is little seasonal variation in wind direction frequency.

Temperature

Based on hourly average temperatures measured at Grays Bay, High Lake and Izok Lake for their respective periods of record (see above), there was a clear seasonal variation in median and maximum hourly average temperature for the three stations. Further, there was also a slight diurnal variation in median and maximum average temperatures.



Precipitation

Available data on daily total precipitation at Grays Bay (2010-2011), and daily total rainfall at High Lake (2006-2011) and Izok Lake (2008-2011) indicate that the coastal station had the highest daily values. At Grays Bay, monthly total precipitation reached 70 mm and the maximum occurred in July. At High Lake, monthly total rainfall reached 45 mm and the maximum occurred in September. At Izok Lake, monthly total rainfall reached 55 mm and the maximum also occurred in September.

5.3.3 Ongoing and Future Studies

Atmospheric conditions are being monitored continuously in 2012 at the Izok and High Lake Mine sites. These measurements will be compared with data from the Environment Canada monitoring stations to update existing baseline information for the Project. A meteorological model for the Project will be developed using this baseline information.

5.4 Noise and Vibration

Noise is generally defined as an unwanted portion of sound and is one of the unavoidable effects of industrial development. Activities associated with construction, operation, and closure of the Izok Corridor Project will introduce noise into the local environment. Since noise travels through air and water, any increase is treated as a potential effect on organisms living in atmospheric and aquatic environments, including humans, wildlife and fish.

5.4.1 Study Areas

Local Study Areas

The LSA for atmospheric noise is defined as a 3 km radius around the footprints of the major Project components, including the Izok and High Lake Mine sites and associated infrastructure, Izok Road and Grays Bay Port.

For the marine environment, the LSA is based on the extent of possible underwater noise-related effects on marine mammals. This area extends 5 km from the dock site at Grays Bay and 5 km on either side of the shipping routes.

Regional Study Areas

The RSA extends beyond the LSA to encompass Project effects that may interact with similar effects from other projects and activities in the region. This area is defined by a 20 km buffer area extending beyond the LSA for the mine sites and Izok Road.

For the marine environment, the RSA encompasses the coastal areas along the western and eastern shipping routes.



5.4.2 Description of Existing Environment

The Project is located in a pristine, natural area that is remote from established human settlement. The closest community is Kugluktuk, which is located approximately 179 km west of the Grays Bay Port site. There is neither industrial nor resource extraction development within the vicinity of the Project Development area. The closest development project is Lupin Mine, 80 km east of Izok camp, which is currently on care and maintenance. With the exception of exploration activities at the High Lake and Izok sites, the only noise in the area is generated by natural source such as wind and precipitation.

There is no available information to establish baseline vibration within the Project area. With the exception of some limited exploration activities, there are no substantial sources of vibration at the Izok or High Lake Mine sites.

Terrestrial RSA

Background atmospheric noise levels in remote areas are typically low, ranging from about 25 to 40 dBA. Baseline noise surveys conducted for two remote northern mining projects (Diavik and Snap Lake) reported background noise levels ranging from 25 to 40 dBA (Diavik 1998) and 23 to 40 dBA (De Beers 2002). The average hourly noise level reported at the Snap Lake site was 35 dBA (De Beers 2002). These levels were also reviewed and accepted as characteristic of background levels in the Doris North Gold Project (Miramar 2005).

Marine RSA

Limited information is available on noise levels in the marine environment. Measured ambient levels in the open ocean, remote from any anthropogenic noise sources range from 74 to 100 dB (Heathershaw 2001). No measurements of ambient marine noise levels are available for the Canadian Arctic. However, noise levels associated with active ice-breaking activities in the Beaufort Sea have been reported to range from 192 dB (bubbler associated noise) to 205 dB (associated with propeller cavitation) (Erbe and Farmer 2001).

There is no regular ship traffic within the Project area and background marine noise levels are expected to be associated with natural sources (e.g., marine life, wave action) and within the range identified for the open ocean (74 to 100 dB). Sound levels in marine environments are referenced to a base pressure of 1 μ Pa and are not perceived at the same level as dBA reported for atmospheric noise.

5.4.3 Future Studies

No further field work is planned to collect ambient noise data for the Project Development area. A terrestrial noise model will be prepared for the terrestrial assessment using publically available regional information.

A marine noise model will also be developed for the marine assessment using publically available data for the region. Ambient noise levels will be measured prior to construction of the port site and these data will be used as input into the model to management local noise effects. Mitigation measures will be designed to meet all regulatory thresholds.



5.5 Hydrogeology

The proposed Project lies within a continuous permafrost region of western Nunavut. Within continuous permafrost regions, groundwater flow occurs beneath the permafrost, within taliks (unfrozen ground beneath lakes), and in the shallow active layer above the permafrost. Bedrock geology, permafrost and lake taliks play a critical role in defining the deep groundwater flow system.

5.5.1 Study Areas

Local Study Areas

A Local Study Area (LSA) was identified for both the Izok Mine and the High Lake Mine based on the maximum possible area that may be susceptible to changes in groundwater quality and quantity.

The depth of the LSA is also important to define because of the underground mining component of the Project. The open pit at the Izok Mine is anticipated to be on the order of 180 m deep, and the Inukshuk underground mine will be on the order of 280 m deep. The AB and D open pits at the High Lake Mine are anticipated to be on the order of 155 m and 90 m deep, respectively. The maximum depth of the West Zone underground mine at High Lake is anticipated to be 540 m below ground surface (bgs). A maximum LSA depth of 800 m bgs at the Izok Mine and 1300 m bgs at the High Lake Mine is thought to be adequate because it is the expected maximum depth to which potential effects on groundwater flow patterns and groundwater quality are possible.

Within the Izok Mine LSA, there is approximately 95 m of variation in surface water elevations. Ground surface elevations range from approximately 410 m above seas level (asl) to 500 m asl. Izok Lake has a surface elevation of approximately 417.4 m asl. Iznogoudh Lake, located upstream of Izok Lake, has a surface elevation of 424 m asl. Itchen Lake, located downstream of Izok Lake, has a surface elevation of 411 m asl.

Within the High Lake Mine LSA, there is approximately 150 m elevation change in surface water elevations. The ground surface elevation is approximately 365 m asl near the West Zone, and at 200 m asl at the shore of the Kennarctic River. High Lake has a water surface elevation of 283 m above mean sea level (amsl).

Regional Study Area

Because the deep groundwater system at both the Izok Mine and High Lake Mine is anticipated to move very slowly as a result of permafrost and low conductivities of the rock mass, there is no need to define a Regional Study Area (RSA) for the hydrogeological component of the Izok Corridor Project.

5.5.2 Description of Existing Environment

Field investigations have been conducted at the Izok and High Lake Mine sites to determine pre-mining hydraulic heads, groundwater flow directions, groundwater temperatures and groundwater quality. For the High Lake Mine site, pre-mining hydraulic heads, groundwater flow directions, and groundwater velocities have also been estimated using a numerical groundwater model.



Three supporting documents describe in detail, the field work and numerical groundwater modelling work undertaken at both the Izok Mine and the High Lake Mine.

- Izok Lake Project - Draft Hydrogeological Technical Report (2011)
- Hydrogeological Modelling of the Proposed High Lake Mine (2006)
- Hydrogeology Field Reports, High Lake (2005 and 2006)

5.5.2.1 Surficial Geology

Izok Mine LSA

The surficial geology of the Izok Mine area was mapped in 1996 (Dredge et al. 1996). The area was last glaciated approximately 10,000 years ago during the late Wisconsinan glaciation. Glaciers eroded the upper layers of highly weathered bedrock and covered them with till deposits up to 10 m thick. Composition of the till is highly variable and contains large boulders and a fine grained-ice rich matrix. Less abundant surficial deposits include sand and gravel deposits from glaciofluvial processes and organic (peat and mud) deposits.

High Lake Mine LSA

Rees (1994) and Rampton and Thomas (1993) describe the general recent geological history of the High Lake Mine area. Surficial geology of the High Lake Mine area was previously described by Gartner Lee Limited (GLL) (2005a, 2006a) and BGC Engineering (2006a). The High Lake area was glaciated by the Keewatin section of the Wisconsin Laurentide Ice Sheet. Ice advanced in the area from the east to the northwest, scouring the rocky surface and depressing the ground surface due to the weight of the ice. As the ice started to retreat from the area, thick marine sediments were deposited near the coast and in low areas connected to the sea. It is estimated that the sea level during deglaciation was 210 m higher than present. The removal of the ice allowed the ground to rebound, stranding the marine sediments in the lower areas such as in the Kennarctic River valley, downstream of High Lake and a few other areas near the coast. Streams are now eroding many of these areas of thick marine silt and clay.

Melting glacial ice resulted in the deposition of an unsorted, boulder rich diamicton that forms thin morainal deposits over most of the area surrounding High Lake. Morainal deposits in the High Lake area are usually thin veneers, blankets and felsenmeers (boulder fields) that cover most of the surface of the study area. Meltwater channels associated with deglaciation are filled with glaciofluvial material, comprising a mixture of boulders, cobbles, gravel and sand. In some areas, the till surface has been washed by post-glacial melt water, leaving a granular veneer.

5.5.2.2 Bedrock Geology

Izok Mine LSA

The Izok deposit is situated within the Slave Structural Province of the Canadian Precambrian Shield. The Slave Structural Province is composed of Archean volcano-sedimentary rocks, which have been grouped into two formations; the Contwoyto and the Lower Point Lake. The Point Lake Formation is comprised of felsic to mafic tuffs and metasediments, whereas the Contwoyto Formation is composed of equivalently



metamorphosed greywackes and mudstones (turbidites). These formations were later intruded by late Archean bodies and crosscut by the Helikian-aged diabase dykes called the Mackenzie Swarm.

The Izok Lake volcanogenic massive sulphide (VMS) deposit is hosted within or near the top of the Point Lake Formation. It is comprised predominantly within felsic volcanic (rhyolitic) rocks with lesser intermediate (dacite) and mafic (gabbro) volcanic rock and metasedimentary rock. Exposed bedrock outcrops around Izok Lake consist of granitic rock (north and west), volcanic rock (south) and metasediments (east).

The target ore bodies, referred to as the Izok and Inukshuk deposits, are situated directly underneath and just east of Izok Lake. The VMS deposits contain commercial quantities of zinc, copper and lead and to a lesser extent silver. Structural geology reports have described the mineralized gossan zones as intensely deformed by folding and faulting making delineation of the deposit complicated.

A detailed structural report based on surficial bedrock measurements and drill core suggests four different structural domains within the Project area on the basis of the orientation of the dominant foliation and degree of refolding (SRK 2010). Subsequent detailed bedrock mapping was conducted over a small area east of Izok Lake by Stibley (2011). MMG's borehole database and available geologic mapping have since been synthesized into a geologic model of the Izok deposit (AMC 2012) that illustrated two primary discontinuities in the vicinity of the open pit and underground mine: one trending north-south, and the second trending northwest-southeast.

High Lake Mine LSA

The High Lake West Zone, AB Zone and D Zone deposits are hosted within the High Lake greenstone belt, which is located in the northern part of the Slave Structural Province. It is broadly located within the Archean Slave Province consisting of a basement gneiss overlain by thick successions of greywacke, turbidites and basalt. The general bedrock geology units are felsic to ultramafic metavolcanic rock (country rock) and intrusive hornblende/biotite granodiorite and diabase dykes. The belt is greenschist facies (chlorite) with amphibolites facies (andalusite) rocks occurring to both the north and south. The bedding planes of the volcanic country rock are near vertical and trend north to south. Intrusive granodiorite and diabase dyke are hosted within the volcanic country rock. The High Lake deposit is located near the eastern margin of the western domain of the greenstone belt, and within the Rush Lake Sequence. This sequence consists of felsic-intermediate flows and tuffs that have been hydrothermally altered in places. The sequence consists mainly of intermediate and felsic volcanic and non-bedded volcanoclastic rocks. It is marked by a horizon of chemical sedimentary rocks including a banded iron formation and marble. Rocks in the Western domain are of greenschist grade and characterized by an abundance of gossans and syn-volcanic base metal occurrences. Several massive sulphide deposits contain substantial gold. A more detailed bedrock geology description can be found in Henderson et al. (2000).

5.5.2.3 Permafrost

Both mine sites are located within the continuous permafrost zone, with open taliks (unfrozen zones beneath lakes) providing the only connection between surface water and the deep (sub-permafrost) groundwater flow system. Permafrost is highly variable and depends on the surficial soil thickness and type, the depth and proximity of surface water bodies and slope aspect. Frozen ground is considered



relatively impermeable to groundwater flow, with permafrost reducing the hydraulic conductivity of the rock by at least one to two orders of magnitude (Burt and Williams 1976).

Izok Mine LSA

Several thermistor strings were installed as part of the 1993 geotechnical investigation (EBA 1994) and the 2008 hydrogeological investigation (AECOM 2011). In 2008, a number of thermistor strings outfitted with dataloggers were installed to continuously monitor ground temperatures over time both within Izok Lake and surrounding it. Available ground temperature data from thermistor strings installed within and surrounding Izok Lake suggest a through talik exists underneath Izok Lake. The base of permafrost surrounding Izok Lake is estimated to be 251 m to 300 m bgs. Preliminary thermistor data suggests that the active layer may be up to 8 m thick. Ongoing data collection and analysis is focused on characterizing the seasonal and spatial variability in ground temperatures surrounding the mine site to support engineering studies.

High Lake Mine LSA

A number of thermistor strings were installed as part of geotechnical investigations in 2004, 2005 and 2006 (BGC 2006a) and hydrogeological investigations conducted in 2005 and 2006 (GLL 2005a, 2006a). Thermistors indicate that, in the vicinity of the West Zone at the High Lake Mine, the base of the permafrost is at 440 m bgs. This is equivalent to about 75 m below mean sea level. Thermal modelling indicates that through taliks connecting surface water and the underlying groundwater system exist below lakes where the surface water depth is greater than 2 to 2.5 m. Below smaller lakes where the talik is surrounded by permafrost, closed taliks are present and permafrost occurs at a depth below the talik. Below larger lakes, where the talik extends to the base of the permafrost, through taliks are present. Elongated lakes with a width greater than 240 m that do not freeze to the bottom in winter have a through talik. Round lakes that do not freeze to the bottom in winter with a diameter greater than 470 m also have a through talik. As a result, a through talik exists below High Lake and a number of other lakes in the LSA.

Beneath the Kennarctic River, near High Lake, permafrost conditions are near freezing. Thermal modeling and thermistor data beneath the edge of the Kennarctic River indicate that the ground temperature is marginally below freezing. These results indicate there may be pockets of unfrozen ground that permit groundwater exchange between the shallow surface water system and the deep groundwater flow system underlying the Kennarctic River. The working assumption is that a through talik exists underneath the Kennarctic River in the wider sections of the riverbed. There are two sections that are adjacent to High Lake and Lake L34 where a through talik is expected to exist because of the proximity to the larger lakes and the wider width of the Kennarctic River.

5.5.2.4 Permeability Testing

Hydrogeological field investigations were conducted at the High Lake Mine in 2005 and 2006 (GLL 2005a, 2006b). A separate investigation was conducted at the Izok Mine in 2008. Ongoing investigations are focused on collecting additional hydraulic conductivity information, monitoring groundwater elevations, characterizing permafrost and determining baseline groundwater quality at both the Izok and High Lake Mines.



Izok Mine LSA

A total of 21 packer tests were conducted by AECOM during the advancement of six NQ sized (76 mm) diamond drill exploration boreholes in 2008. Two slug tests were conducted to characterize the hydraulic conductivity of the overburden. Boreholes tested were up to 647 m deep in the vicinity of the proposed open pit and underground mines at the Izok Mine.

Two falling head slug tests were conducted on overburden soils as part of the hydrogeological investigations, with hydraulic conductivity values ranging from 2.5×10^{-4} m/s to 3.0×10^{-4} m/s. The geometric mean hydraulic conductivity for overburden is 2.7×10^{-4} m/s, which is equivalent to a silty or clean sand unit (Freeze and Cherry 1979).

Two packer tests were conducted over an interval where the dominant geological unit was weathered bedrock. Weathered bedrock hydraulic conductivity values ranged from 1.1×10^{-7} m/s to 2.0×10^{-7} m/s with a geometric mean of 1.5×10^{-7} m/s, which is within the range of literature reported hydraulic conductivity values for fractured igneous and metamorphic bedrock (Freeze and Cherry 1979).

A total of 19 packer tests were conducted on relatively unweathered (fresh) bedrock units. Fresh bedrock hydraulic conductivity values ranged from 2.8×10^{-10} m/s to 5.0×10^{-7} m/s with a geometric mean for all bedrock units of 1.8×10^{-7} m/s. This value is within the range of literature reported hydraulic conductivity values for unfractured and fractured igneous and metamorphic bedrock (Freeze and Cherry 1979).

High Lake Mine LSA

Hydraulic conductivity testing was completed in lake taliks underlying High Lake and L12, and in deep exploration boreholes extending up to 900 m and below the base of permafrost near the West Zone underground mine.

Packer testing was conducted in the following locations: two boreholes in the talik below High Lake, one borehole in lake talik near the West Zone (below Lake L12), and two deep boreholes near the West Zone (beneath the permafrost). The hydraulic conductivities measured in shallow volcanic country rock ranged from about 1×10^{-6} m/s to 3×10^{-9} m/s, with a most representative value (geometric mean) of 5×10^{-8} m/s. The hydraulic conductivities measured in deep volcanic country rock ranged from about 10^{-9} m/s to 10^{-11} m/s, with a most representative value (geometric mean) of 5×10^{-10} m/s.

5.5.2.5 Shallow Groundwater Flow Regime

Shallow groundwater flow is expected within the seasonally active layer above the permafrost from June to September. When temperatures are above freezing, the active layer becomes thawed (typically late spring to late summer). Shallow groundwater is anticipated to flow from topographic highs to topographic lows along the top of permafrost within the active layer, and eventually discharge to surface creeks or lakes. Permafrost is inferred to restrict recharge and encourage surface runoff wherever it is present. The active layer has no direct hydraulic connection with the deep groundwater flow system.



Izok Mine LSA

Preliminary data collected from thermistor strings and shallow groundwater monitoring wells installed during September 2008 suggests that the active layer ranges in thickness from 0 m to 8 m at the Izok Mine. The active layer consists predominantly of overburden material with lesser amounts of weathered bedrock. Relatively high overburden permeability and porosity values may permit groundwater to flow easily through this unit during the unfrozen months.

There is potential for substantial groundwater flux from adjacent lakes to enter the proposed pit shell through unfrozen taliks underlying both the inlet and outlet of Izok Lake. Additional ongoing investigation will help understand permafrost and groundwater flow beneath the inlet and outlet channels of Izok Lake.

High Lake Mine LSA

At the High Lake Mine, the depth of the active layer is estimated to be 5 m for exposed bedrock and 2 m for overburden such as till. The shallow groundwater flow has little to no hydraulic connection with the deep groundwater flow system below the permafrost at High Lake. However, deep groundwater flow can occur beneath lakes via taliks, connecting surface water to the deeper, regional groundwater flow system. Shallow groundwater flow in the active layer from one lake to another is expected to occur in areas where containing topography is at a lower elevation than the active layer depth.

5.5.2.6 Deep Groundwater Flow Regime

The deep groundwater flow system is the flow system beneath permafrost. It interacts with surface water bodies through open taliks beneath large lakes and rivers. During unfrozen months, shallow groundwater will flow rapidly through overburden along the top of bedrock (or permafrost). Permafrost acts as an impermeable unit creating semi-confining conditions within the deep system. Groundwater within the generally low permeability deep system travels primarily through a series of connected rubble zones and fractured rock zones. It appears that hydraulic conductivity decreases with depth although additional factors (bedrock type, weathering etc.) appear to affect hydraulic conductivity on the local scale. The weathering potential decreases with depth and overburden pressures increase. As a result, the quantity of fractures and the fracture aperture may decrease, resulting in lower porosity and hydraulic conductivity with depth. Several vibrating wire piezometers have been installed to monitor seasonal fluctuations in groundwater levels and temperatures at both the Izok Mine and High Lake Mine and establish both vertical and horizontal groundwater flow gradients.

Izok Mine LSA

Four hydrostratigraphic units have been identified in the vicinity of the Izok Mine including overburden, weathered bedrock, fresh bedrock and faults.

Bedrock hydraulic conductivity values vary over four orders of magnitude but are within the range of literature reported hydraulic conductivity values for unfractured and fractured igneous and metamorphic bedrock (Freeze and Cherry 1979). Higher hydraulic conductivity values were observed in testing intervals that exhibited a greater degree of fracturing, while lower hydraulic conductivity values were observed in areas of competent, unfractured and silicified rock.



Groundwater heads indicate downwards groundwater flow from the lake to the deep groundwater system. They also indicate a relatively low horizontal groundwater flow gradient of 0.001 from beneath Izok Lake towards Itchen Lake. Based on measured hydraulic heads the deep groundwater flow system is assumed to be completely saturated with regional flow from Izok Lake towards the south east. The deep groundwater elevation beneath Izok Lake is similar to that of Itchen Lake, which may indicate a hydraulic connection between the two lakes.

High Lake Mine LSA

Three hydrostratigraphic units have been identified in the vicinity of the Izok Mine including overburden, weathered bedrock and fresh bedrock. Although faults have been identified based on geologic mapping, they have not been tested or included in the conceptual groundwater model.

Thermal modelling identified the following lakes within the LSA as those that were likely to have a through talik connecting the lake to the deep groundwater flow system: L16 (High Lake), L4 (Granite Lake), L5, Duck Lake, L34, and L718. In addition, thermal modelling indicates a through talik could exist beneath sections of the Kennarctic River. The pre-mining groundwater elevation (hydraulic head) beneath the permafrost was determined using three-dimensional groundwater modelling. Groundwater flow surrounding the High Lake Mine is generally to the northeast and toward the Kennarctic River through a very low permeability bedrock system. All groundwater that recharges through taliks, must travel approximately 440 m vertically downward before entering the deep groundwater flow system and travelling horizontally toward the point of groundwater discharge (e.g., Kennarctic River or lake).

5.5.2.7 Groundwater Quality

Izok Mine LSA

Multiple shallow groundwater samples were collected from monitoring wells installed in the active layer (GLL08-1 and GLL08-2) in 2008. GLL08-1 is located southwest Izok Lake and the ore body. Highly elevated concentrations of physical parameters, anions and dissolved metals exist within shallow groundwater and are attributed to calcium chloride brine drilling fluids. GLL08-2 is located east of Izok Lake and ore body. Analytical results for major anions (bicarbonate, chloride and sulphate) and major cations (calcium, magnesium, sodium) indicate that groundwater is a dilute calcium-magnesium-bicarbonate groundwater. These concentrations are presumed to be representative of background concentrations within the active layer. Ongoing studies will attempt to characterize the quality of groundwater within the Izok Lake talik and the active layer surrounding Izok Lake to support development of a site-wide water balance.

High Lake Mine LSA

During the 2006 hydrogeology field program, a water quality sample was collected from the talik boreholes drilled below High Lake in the volcanic country rock. Groundwater quality was measured in the High Lake talik in early 2006 at a depth of about 25 m below the top of the bedrock and compared to surface water quality. Groundwater within the High Lake talik exhibited a pH of 7.4, conductivity of 132 $\mu\text{S}/\text{cm}$, and a hardness as CaCO_3 of 53 mg/L. Median High Lake surface water pH was 6.95,



conductivity was 89.4 $\mu\text{S}/\text{cm}$, and hardness as CaCO_3 was 34.6 mg/L. Dissolved concentrations are reported for metals in groundwater and surface water.

In terms of major ions, groundwater in the High Lake talik is geochemically similar to High Lake surface water. In contrast, trace metals including cadmium, copper and zinc are considerably lower in the talik groundwater than High Lake surface water. This reduction suggests an attenuation mechanism exists within the High Lake talik, as groundwater flow is downward. However, molybdenum is considerably higher in the talik groundwater than the surface water. The measured talik groundwater quality exceeds the CCME water quality guideline (protection of Aquatic Life) for cadmium and copper. The remaining trace metal constituents measured in the talik groundwater are below CCME water quality guidelines.

Deep groundwater quality has not been sampled in or near the LSA for High Lake. As a result, the best source of information available is published values for deep underground mines in the Canadian Shield. It is well known that groundwater quality deteriorates with increasing depth in the Canadian Shield (Frape and Fritz, 1987). At a depth of about 1,000 m, groundwater is often saline, with calcium-sodium-chloride dominating. The proposed West Zone underground mine will extend to almost 900 m below ground surface (bgs), while the base of the permafrost is expected to be 440 m bgs.

The main literature source available for the estimation of deep groundwater quality is Frape and Fritz (1987). Additional information was obtained from the Lupin mine project (Ruskeeniemi et al. 2002, Ruskeeniemi et al. (2004), and personal communication with T. Ruskeeniemi). Estimates of deep groundwater quality were made based on available literature data and indicate that baseline concentrations of some parameters including cadmium, lead, copper, aluminum, nickel, iron and zinc may exceed CCME guidelines and exhibit total dissolved solids concentrations between 5,000 and 50,000 mg/L. As part of ongoing work, information available from other new mines will be included in the interpretation of deep groundwater quality at the High Lake Mine.

5.5.3 Ongoing Studies

The 2012 hydrogeology field program includes:

- A baseline hydrotechnical surface water field program to characterize the hydrological baseline conditions of the Project area
- A snow pack survey and stream flows during freshet and the early, mid and late summer periods
- Surveys of large streams at Izok and High Lake Mine sites that are likely to flow throughout the year

5.6 Freshwater Environment

5.6.1 Surface Hydrology

An understanding of the hydrology of the Project area requires knowledge of the climate, including precipitation and evaporation/evapotranspiration, as well as stream flows. Factors such as topography, soils, permafrost, ground cover and vegetation greatly influence the paths of water taken as part of the hydrologic cycle, including surface flow and groundwater inflow. Stream flow is a key parameter used to understand the hydrology of a particular area, as it is the only part of the hydrologic cycle in which surface water is so confined as to permit reasonably accurate measurements of quantities involved. For



the Izok Corridor Project, the design, construction and operation of the various components of the mine plan will involve consideration of surface water quantities with respect to the design of dams, tailings impoundments, settling ponds, culverts, bridges, water treatment facilities, potable water demands and storm water management systems. As such, any potential changes to the long-term annual and seasonal spatial and temporal characteristics of existing surface water regimes created by these Project components need to be identified and quantified to the degree possible to allow for development of appropriate mitigation.

5.6.1.1 Study Areas

Local Study Areas

LSAs for the Izok Mine site, High Lake Mine site and Izok Road were based on the maximum possible spatial extent of Projects effects on surface water flow.

The LSA for the Izok Mine lies within the Nunavut territory and includes:

- Izok Lake and its watershed
- Iznogoudh Lake
- Itchen Lake
- Ham Lake

The LSA for the High Lake Mine encompasses three primary drainages.

- High Lake, its basin area plus its outlet to the Kennarctic River
- Granite Lake, its basin area plus its outlet to the Kennarctic River
- The Kennarctic River above and below the High Lake outlet, as well as the Kennarctic River below the Granite Creek outlet
- All water courses within the Project footprint extending to the upstream extent of their catchments

The Izok Road LSA encompasses an area three times the channel width upstream and downstream of each stream crossing, or 100 m, whichever is greater.

Regional Study Area

The RSA is bounded by the maximum spatial extent of potential Project effects on surface water regimes, which could extend beyond the LSA boundaries and act cumulatively with effects of other projects in the region. The RSAs for the three major Project components are defined as follows.

- Izok Mine - The Itchen Lake watershed including upstream surface runoff contributions from Izok Lake, Iznogoudh Lake and Ham Lake, and downstream to its outflow to Point Lake
- High Lake Mine - The Kennarctic River from its confluence with High Lake outflow, downstream to its outlet at Grays Bay at the Arctic Ocean
- Izok Road - Water bodies up to 1 km on either side of the road alignment centerline



5.6.1.2 Description of Existing Environment

Izok Mine - Based on a gap analysis of surface water information for the Izok Project area (GLL 2008a), it was concluded that almost no information existed within the study area to characterize its hydrology sufficiently so as to relate it to distant long-term stations. Within the Izok area, some short-term baseline hydrology and climate data exist for the years 1993-1994 and 2001-2002, with some additional data and analysis available from the Lupin and Jericho mine projects. To address these data gaps, additional baseline data were collected in 2008, including seven snow courses prior to the 2008 runoff period, and installation of 11 stream water level loggers and two lake level loggers (included in this total was re-activation of a WSC station 10PB002 on Izok Lake inflow) followed by measurement of stream discharges.

High Lake Mine - Baseline hydrology information was collected over three summer seasons (2004 to 2006) as part of the High Lake project. Five snow courses were completed in 2004: three at the High Lake Mine site, and two in the Ulu area. Sixteen snow courses completed in 2005: five were at the High Lake site, and four in the Ulu area. No snow course measurements were conducted in 2006.

In 2004, water level recorders were installed at three locations at the High Lake site and two locations at Ulu. In 2005, seven water level recorders were installed at High Lake and two at Ulu. In 2006, eight water level recorders were installed at the High Lake site.

In addition to recorded water levels, channel cross sections were surveyed and discharge measurements were made, where it was safe to do so.

Izok Road - Baseline hydrology information was collected along the road route in 2004 to 2006 in support of the High Lake project DEIS. This involved the completion of snow courses, as well as installation of water level recorders and discharge measurements at various road stream crossing sites. Seven snow courses were completed in 2005. In 2004 and 2005, three water level recorders were installed at three stream crossing sites, and a discharge measurement was made at 15 stream crossings. In 2006, only one water level recorder was installed at a road crossing.

Izok Mine LSA

Iznogoudh Lake

Outflow from Iznogoudh Lake is conveyed via a short channel into Izok Lake. The lake drainage area is 338 km². A Water Survey of Canada (WSC) gauge No. 10PB002, which operated at the outlet in 1993, 1994 and 2008, shows outflow beginning during the period 22 May to 01 June when daily mean temperatures rise and stay above zero; the peak occurred two to three weeks later and the base-length of the snowmelt component of the hydrograph was about 10 weeks. Later hydrograph peaks occurred in September and October due to rainfall. Depths of runoff from the basin were in the range of 100 mm to 200 mm. It appears that the volume and perhaps the duration of snowmelt runoff are controlled by the initial availability of snow on the ground plus minor amounts of rainfall in late May and early June. The timing and magnitude of the peak, however, may be greatly affected by temperatures in the first week or two of freshet runoff.



Izok Lake

Izok Lake has a local drainage area of 8.6 km², of which 2.7 km² is lake area. Average and dry year precipitation is tentatively estimated to be 393 and 218 mm; corresponding lake evaporation depths are 285 and 350 mm. The dry year values suggest a deficit condition. Given the small local basin area and the current plan to divert Iznogoudh Lake outflows around Izok Lake, it will be important to determine the time required for Izok Lake to refill after mine closure.

Given the relatively small size of Izok Lake and its small local drainage area, it is likely that outflow from the lake is largely unaffected by storage effects so that inflows to Itchen Lake are essentially represented by outflows from Iznogoudh Lake.

Ham Lake

As Ham Lake outflows into Iznogoudh Lake, hydrologic parameters generated for this lake will also be applicable to Ham Lake.

High Lake Mine LSA

High Lake

The High Lake drainage is typical of drainages in the region, consisting of steep terrain and short streams connecting many small lakes. These channels typically experience substantial flows during the freshet season and dry up by mid July. The drainage basin area upstream of the High Lake outlet is 3.35 km² and is dominated by High Lake, which flows into the Kennarctic River. The majority of the mine development area and associated infrastructure will be contained within this basin, although the West Zone underground mine will be located within an adjacent drainage system immediately north of the High Lake basin. Approximately 26.2 % of the High Lake basin area is made up of lakes. Based in part on hydrometric and climate data collected within the LSA during the period 2004 to 2007, it was determined that:

- estimated runoff coefficients (depth of runoff as a ratio of total precipitation over a 12-month period) were in the range of 0.42 to 0.77
- the average distribution of runoff per month as a percentage of the summer runoff period was 47% in June; 29% in July; 14% in August; 8% in September and 4% in October
- spring freshet begins in late May to the end of June
- stream flows typically began receding by the end of June
- mean annual precipitation is 280 mm, with 53 % being rainfall and 47 % snowfall (394 mm and 164 mm in extreme wet and dry years)
- mean annual evaporation is 235 mm

The baseline hydrology data were sufficient to enable extrapolation to existing regional hydrometric station data.



Granite Lake

The Granite Lake basin, a tributary of the Kennarctic River, is located immediately north of and contiguous with the High Lake basin. It drains 48.4 km², of which 23.8 % is made up of lake area. Topographic features and drainage characteristics are similar to those described for High Lake. The timing and temporal distribution of surface runoff is similar to High Lake. Maximum discharge measured during 2004 and 2005 summer seasons was in the order of 5 cms, with corresponding depths of up to 0.4 m.

Kennarctic River

The Kennarctic River basin area is 330 km² upstream of the High Lake outlet, 400 km² downstream of the Granite Lake inflow confluence and 1380 km² at its mouth. It flows into Grays Bay 3 km east of the Grays Bay dock site. The river is relatively straight with much of its shoreline confined by steep cliffs and hills. The channel typically consists of a sequence of boulder bed deposits that create slope controls that create rapids, followed immediately downstream by deeply scoured beds. Peak discharges measured upstream of the High Lake confluence during the 2005 and 2006 field seasons were about 65 and 28 cms, respectively. In both years, discharge diminished to less than 1 cms by the end of September.

Izok Road LSA

Existing Information under the current (base case) route alignment, Izok Road is expected to cross 25 substantial water crossings between Izok and Lupin plus an additional 115 water crossings along the Lupin to High Lake segment and 14 crossings along the High Lake to Grays Dock segment (refer to **Figures 2.6-5 to 2.6-8**). Typically, channels at crossings consist of wide boulder beds, with flows persisting through the summer months only for the larger streams.

Two streams situated north of the High Lake Mine site were included in the 2005 and 2006 hydrology program. The data indicated that runoff coefficients were in the range of 0.45 and 0.57; average runoff as a percentage of 12-month runoff was the same as for the High Lake site.

Six streams at road crossings in the Lupin to High Lake segment were included in the 2008 hydrometric program. **Table 5.6-1** summarizes flow velocities measured at the road crossing sites.

Table 5.6-1 Flow Velocities at Road Crossing Sites along the Lupin to High Lake Section, 2008

Stream Name	Date	Surface Velocity (m/s)
Frayed Knots	12/06/2008	2.7
Hood River	14/09/2008	1.2
Un-named Creek (Site 4)	12/06/2008	1.8
Un-named Creek (Site 5)	11/09/2008	1.1
Un-named Creek (Site 12)	14/06/2008	0.9
Un-named Creek (Site 13)	14/06/2008	2.4



5.6.1.3 Ongoing Studies

Izok Mine LSA

Although information from baseline studies conducted in 2007 and 2008 was not complete enough to estimate runoff volumes during these years, the data collected will be used to establish stream flow rating curves for those gauging sites that will be maintained during future baseline programs.

The 2012 field program involves re-establishing a baseline collection network within the Izok Mine LSA. This includes:

- conducting seven snow courses in the Izok Mine LSA to obtain a second year of baseline data (a repeat of the 2008 program)
- establishing 11 water level recorders (seven stream and four lake level stations), which will include measurement of stream flows and survey of channel cross sections
- re-activation of the WSC station that records flow out of Iznogoudh Lake into Izok Lake

In addition, a detailed bathymetrical and ground survey of the proposed Diversion Channel inlet and outlet between Iznogoudh Lake and Itchen Lake will be conducted.

High Lake Mine LSA

The 2012 field program also involves conducting seven snow courses in the High Lake Mine LSA to obtain a second year of baseline data (a repeat of the 2008 program), and establishing 11 water level recorders (seven stream and four lake level stations), which will include measurement of stream discharge where possible and/or surface velocity measurements.

Izok Road LSA

During the 2012 field program, six level loggers will be installed along the road route, and discharge measurements and channel surveys will be conducted. In addition, all substantial stream crossings along the road route were observed during the spring runoff period via helicopter. Photographs are being collected to observe high water conditions and determine where ice might be an influence at crossings.

As with previous field programs at these sites, the fisheries and water quality studies will be coordinated with the hydrology program. For example, stream gauging sites will be coordinated with water quality sample sites.

5.6.2 Surface Water Quality and Sediment Quality

Water and sediment are important components of aquatic habitat, and changes in their quality may affect the health of aquatic organisms, including fish, the quality of habitat for wildlife (e.g., waterfowl, drinking sources), the quality of drinking water for human use, and the quality of water for cultural uses. Baseline water quality and sediment quality are influenced by geology, climate, landscape topography, landscape cover, watershed disturbance and runoff within the catchment. These factors can influence yearly, seasonal and spatial variability in water quality and spatial variability in sediment quality.



The proposed Izok Corridor Project has the potential to affect freshwater quality and sediment quality, particularly as it relates to the protection of aquatic life, wildlife, drinking water sources, and cultural uses. Works and activities related to the Project must be carried out in a manner such that the integrity of the aquatic system is maintained, and effects on freshwater and sediment quality are minimized.

5.6.2.1 Study Areas

Local Study Area

The main components of the Izok Corridor Project that are relevant to assessing effects on freshwater and sediment quality include the Izok Mine, High Lake Mine, and Izok Road corridor. The Grays Bay Port site is not included within the study area for this discipline, as it is addressed within the marine component of the environment (section 5.8.2).

The LSA is defined as the area within which there is the potential for the Project to directly affect the aquatic ecosystem. It encompasses the direct Project footprint, the spatial extent of effects from effluent discharge, upstream areas that contribute surface water to the Project area, and areas of direct dust deposition.

The LSA for the Izok Mine is within the Nunavut territory and includes the following.

- Izok Lake watershed
- Iznogoudh Lake
- Ham Lake
- Itchen Lake (eastern portion down to the territorial border)
- Other small lakes and tributaries within the zone of aerial deposition

The LSA for the High Lake Mine includes three main drainage areas (High Lake, Granite Lake, Kennarctic River) and the reference lakes. Specifically, this includes:

- All watercourses within the Project footprint extending to the upstream extent of their catchments
- High Lake and the outlet of High Lake to the Kennarctic River to a point 1 km downstream of the outflow (to account for complete mixing of High Lake and any mine discharge with the Kennarctic River)
- Other small lakes and tributaries within the zone of aerial deposition

The Izok Road LSA includes the portion of watercourses within 100 m of either side of the centreline of the road alignment.

Regional Study Area

The RSA includes waterbodies that may be affected beyond the LSA boundary, and areas that could be affected by residual effects of the Izok Corridor Project in combination with effects of other projects in the area. Freshwater quality and sediment quality effects are generally limited in distribution to watershed boundaries, but aerial deposition of dust could extend beyond watershed boundaries. The RSAs for the three Project components are defined as follows.



- Izok Mine - the Itchen Lake watershed including upstream contributing sources (Izok Lake, Iznogoudh Lake, and Ham Lake) and downstream to its outflow to Point Lake, and extending to the outflow of Point Lake to the Coppermine River
- High Lake Mine - the Kennarctic River watershed including upstream contributing sources (High Lake and Granite Lake) to the outlet of the Kennarctic River at Grays Bay
- Izok Road - water bodies 1 km to either side of the centreline of the road alignment

5.6.2.2 Description of Existing Environment

Izok Mine - Many aquatic studies have been completed in the vicinity of the Izok Mine since the 1970s. These are summarized in the Izok Project Gap Analysis (GLL 2008a), as well as various other reports (GLL 2006b, 2006c, 2006d). The gap analysis was used to inform the study design for 2007 and subsequent field surveys. Some of the earlier data can only be used in a descriptive manner because there is either insufficient detail about the collection and analysis methods or the analytical detection limits are too high for the data to be useful in an environmental assessment. Additional field programs are being undertaken in 2012 to complete the baseline description.

High Lake Mine - The aquatic environment in the High Lake Mine study area was summarized in the High Lake DEIS (GLL 2006d). It was based on an environmental inventory of the High Lake area (Rees 1994), preliminary investigations completed in 2003, and detailed field programs completed in 2004 and 2005. Some additional data were collected in 2006 and 2007 to address gaps identified during review of the DEIS. Limited additional field programs are being undertaken in 2012 to complete the baseline description.

Izok Road – Izok Road will be studied in three sections: Izok to Lupin, Lupin to High Lake, and High Lake to the port. Watercourses along the portion of the road between Izok and Lupin were sampled as part of the Bathurst Inlet Port and Access Road (BIPAR) project (Rescan 2002). A reconnaissance survey of a proposed all-season road corridor alignment was completed in September 2006 (GLL 2006b), and field water quality data were collected. Watercourses along the portion of the road between High Lake and Grays Bay were sampled for water quality in 2005 as part of baseline studies for the High Lake project (GLL 2006c). Until 2007, there was little information on watercourses along the portion of the road between Lupin and High Lake except for smaller areas corresponding to proposed mining projects such as Ulu (EBM 1997) and Jericho (Tahera 2003). Watercourses along the road alignment were sampled for water quality in the fall of 2007 (GLL 2008c) and spring of 2008 (Golder 2011).

Izok Mine LSA

Surface water quality in the Izok Mine LSA typically has low conductivity, neutral pH, soft water, and high sensitivity to acid deposition. The waters are well oxygenated during open-water periods but, in some of the lakes, oxygen concentrations can drop below values considered necessary to support aquatic life during the ice-covered period. Nutrients are very low, such that waterbodies are classified as oligotrophic.

Metal concentrations in surface water are low, although there were exceedances of Canadian Water Quality Guidelines (CWQG; CCME 2011a) for a few metal parameters in some of the waterbodies (GLL 2008c; Golder 2011). Metal concentrations in lakes within the study did not exceed CWQG; however,



aluminum, cadmium, copper and zinc levels exceeded guidelines in some samples collected from tributaries within the study area.

Sediments in the lakes are predominantly silty-clay. Metal concentrations vary within and between lakes. While arsenic was above Canadian Sediment Quality Guidelines (CSQG; CCME 2011b) in all samples, cadmium, chromium, lead and zinc levels were found to exceed CSQG in sediments from only some waterbodies.

High Lake Mine LSA

The High Lake Mine area drains to the north, and the small lakes in the LSA flow to the Kennarctic River. The river comprises a series of wide, deep pools linked together by more shallow, fast moving reaches.

The water quality observed in the study area is in keeping with the geology of the region. Generally, the lakes and rivers have very soft water (low in dissolved solids), are very low in nutrients, and are circumneutral but sensitive to acidic inputs. The lakes typically have very low metal concentrations, but the High Lake area also reflects the mineralized geology with slightly elevated chloride, sodium, copper and zinc concentrations compared to the rest of the Slave Province (Puznicki 1996, 1997).

During the open-water season, the lakes are well mixed, well oxygenated, of a generally homogenous thermal nature and relatively clear with Secchi depths of at least 6 m. During under-ice conditions, the lakes are relatively well oxygenated although dissolved oxygen falls below the CCME guideline of 6.5 mg/L at the bottom in some lakes. Under-ice concentrations of some parameters are also observed at higher concentrations than during the open-water season: such “cryo-concentration” of solutes under ice-cover is a common observation in Arctic lakes.

Streams and lakes within the High Lake Mine LSA are similar to those with the Izok LSA. The exception is High Lake itself, and one stream and two seeps that flow to High Lake.

- Water quality in Seep 1 is indicative of acidic drainage from an oxidized, sulphide rich, mineralized region, with low pH, elevated levels of hardness ions and sulphate and metals concentrations in the mg/L range.
- Water quality in Seep 2 is very soft, with near neutral pH, a high acid sensitivity and metals concentrations that exceed CCME guidelines but which are lower than those in Seep 1.
- Water quality in Stream S35 is in keeping with water that flows through a highly mineralized zone, showing elevated concentrations of sulphate and hardness, circumneutral pH, and metals concentrations consistently above CCME guidelines.
- High Lake itself is highly enriched by trace metals. Copper, cadmium and zinc in the lake water exceed CCME Guidelines by 50 to 100 times such that it is acutely toxic to fish. Rainbow trout died within the first 24 hours of a standard toxicity test. Water quality in the High Lake outflow is consistent with that of High Lake: soft, sensitive to acidic inputs, and nutrient poor with elevated concentrations of cadmium, copper and zinc.

Sediments in the lakes are predominantly silty-clay with arsenic, zinc, cadmium, chromium, lead, zinc and, occasionally, mercury concentrations above CSQG.



Water quality in the Kennarctic River is circumneutral, soft, oligotrophic and sensitive to acid inputs. Metals are present at detectable levels upstream of High Lake and increase downstream of High Lake such that Cu occasionally exceeds the CCME guideline. Sediment metal concentrations indicate the influence of the metal-rich discharge from High Lake, with concentrations below the High Lake outflow being higher than those upstream. Arsenic, zinc, cadmium, copper and lead are generally present in Kennarctic River sediment at concentrations above the guideline values.

Izok Road LSA

Surface waters within the Izok Road LSA have low conductivity, neutral pH, soft water, and high sensitivity to acid deposition. The waters are well oxygenated during the open-water period; data for the ice-covered period are not available. Nutrients are very low, and waterbodies are oligotrophic.

Metal concentrations in surface water are low, and aluminum and copper exceeded CWQG in some of the tributaries (GLL 2008c; Golder 2011). In most samples, the metal was present primarily in the dissolved form as opposed to the particulate form.

5.6.2.3 Ongoing Studies

Izok Mine LSA

Additional field studies being conducted in the Izok Lake LSA in 2012 are focusing on waterbodies within the direct footprint of Izok Mine, downstream of the proposed diversion channel between Iznogoudh and Itchen lakes, and downstream of the proposed treated effluent discharge point in Itchen Lake. These include:

- Collection of water samples for field chemistry and lab analysis from main tributaries within the Iznogoudh, Izok and Itchen Lake basins
- Conduct of water column profiles for temperature, pH, dissolved oxygen and conductivity from various locations within Ham, Iznogoudh, Izok, Itchen and a reference lake
- Collection of surface and bottom water column samples for lab analysis of water quality (e.g., alkalinity, hardness, nutrients, and metals)
- Collection of water samples from various locations within Ham, Iznogoudh, Izok, Itchen and a reference lake for analysis of chlorophyll *a* concentration, phytoplankton, zooplankton and benthic invertebrates
- Collection of surface sediment samples from various locations within Iznogoudh, Izok, Itchen and a reference lake for analysis of sediment chemistry (e.g., grain size and metals) and diatom composition
- Collection of sediment cores from various locations with Iznogoudh, Itchen and a reference lake for analysis of long-term changes in diatom community composition and interpretation of long-term changes and variance in water quality



High Lake Mine LSA

The baseline water quality program for the High Lake Mine LSA is considered to be almost complete. Additional field work in 2012 includes:

- Measurements of water quality (particularly dissolved oxygen) under ice in the pools of the Kennarctic River
- Sampling of water quality in the two seeps, Stream S35 and High Lake to determine whether acid and metals conditions have changed since 2006
- Collection of sediment cores from High Lake and a reference lake for analysis of long-term changes in diatom community composition and interpretation of long-term changes and variance in water quality

Izok Road LSA

The baseline water quality program within the Izok Road LSA is considered to be almost complete as data have been collected from a subset of watercourses during two different field programs (fall 2007 and spring 2008). Additional field studies being conducted in 2012 involve collecting samples for water quality, sediment quality and benthic invertebrates at 10 selected water crossing locations.

Collection and paleolimnological analysis of cores from Itchen Lake, High Lake and a reference lake will allow comparison of variance in water quality over the past 200 years to short-term (2004-2012) variance to provide a clear documentation of baseline conditions and any trends due to climate change or other regional factors that may influence subsequent interpretations. Further sampling of water quality will be required during the pre-construction phase to refine the project baseline, address any specific potential effects that are identified, and inform the EEM (Environmental Effects Monitoring) program and Aquatic Effects Monitoring Program (AEMP) study designs.

The water quality studies will be coordinated with the fisheries and hydrology programs. For example, stream and benthic sampling sites will be coordinated with sediment sampling and sample sites.

5.6.3 Freshwater Aquatic Organisms and Habitat

Fish species present in Nunavut lakes and rivers typically include Arctic grayling (*Thymallus arcticus*), Arctic char (*Salvelinus alpinus*), lake trout (*Salvelinus namaycush*), round whitefish (*Prosopium cylindraceum*), slimy sculpin (*Cottus cognatus*), burbot (*Lota lota*), lake cisco (*Coregonus artedii*) and stickleback (*Pungitius sp.*). Fish habitat usage varies depending on seasonal flow regimes, watercourse depth and ice thickness. Typically, rivers and streams provide migratory habitat during freshet flows, as well as spawning and rearing habitat during the open-water season. Lakes provide spawning, nursery, rearing and foraging habitat, and in waterbodies with sufficient depth, overwintering habitat.



5.6.3.1 Study Areas

Local Study Areas

Three LSAs have been defined for freshwater aquatic organisms and habitat; the Izok and High Lake Mine sites and the Izok Road footprint. The Grays Bay Port site is not included as this is being addressed in the marine component of the study.

The Izok Mine LSA includes watercourses and waterbodies within the mine footprint, as well as the potential receiving environment: Ham Lake, “Izok Bay” of Iznogoudh Lake, Iznogoudh Creek, Izok Lake, Izok Creek, and “Izok Bay” of Itchen Lake.

The High Lake Mine LSA encompasses the immediate west side of the Kennarctic River, approximately 50 km inland of Grays Bay.

The Izok Road LSA is generally defined by a 2 km wide corridor along the road alignment from the Izok Mine site to the proposed dock facility at Grays Bay. It extends up to 4 km in areas where the routing of the two temporary winter roads (Grays Bay to High Lake, and Lupin to Izok) crosses lakes that are larger than 2 km in width.

Regional Study Area

The RSA provides the regional context for assessing incremental changes in fish abundance and distribution as a result of the Project in combination with effects of other projects and activities. It includes:

- Aquatic fish habitats in the vicinity of waters affected by the Project, including upstream and downstream waters that fish may use for migration and meeting life history requirements.
- The spatial extent of a population unit within the LSA, which for species such as Arctic grayling and lake trout, will extend beyond waterbodies and watercourse where fish may be either directly affected by the Project footprint or indirectly affected by upstream Project-related activities.

The RSA includes watersheds underlying the Izok mine footprint, including Izok, Itchen, Iznogoudh, Ham lakes, and the waters draining into these waterbodies; the Kennarctic River watershed; and watercourses that intersect the road corridor from Izok Mine to the Grays Bay Port site.

5.6.3.2 Description of Existing Environment

Izok Mine - Existing information on freshwater aquatic organisms and habitat within the Izok Mine LSA includes previous baseline field programs in support of the High Lake project and Izok project (RL&L 1992, 1993; Golder 2003a, 2003b; GLL 2008c; RC BioSolutions Ltd. 2011).

High Lake Mine - Available information on freshwater aquatic organisms and habitat within the High Lake Mine LSA includes that summarized in Rees (1994) and Scott and Crossman (1998), as well as data collected during baseline programs conducted between 2004 and 2006 (GLL 2006e).

Izok Road - Aerial reconnaissance surveys of the road corridor were completed at various times over the period 2001 to 2008. The Grays Bay to High Lake segment was completed in 2005 (GLL 2005b), while the



High Lake to Lupin segment was completed in the fall of 2007 and in 2008 (RC BioSolutions 2011). The section from Lupin to Izok Lake was completed in 2001 and 2002 (Rescan 2003).

Izok Mine LSA

Studies of the four lakes within the LSA (Iznogoudh, Izok, Itchen and Ham lakes) reported the presence of Arctic grayling, lake trout, round whitefish, longnose sucker, burbot, ninespine stickleback, lake cisco and slimy sculpin. Among the fish species captured, round whitefish and lake trout were numerically the most abundant species in the LSA (RL&L 1993; Golder 2003a, b). Mark-recapture sampling in Izok Lake in 2003 enumerated a population of about 544 lake trout (for fish greater than 350 mm) (RL&L 1993). Captured lake trout ranged in length from 115 to 710 mm, and in age from 2 to 15 years old (GLL 2008b). Captured round whitefish ranged in length from 107 to 443 mm, and in age from 1 to 17 years old (GLL 2008c). Arctic grayling were relatively low in abundance throughout the LSA (GLL 2008c; Golder 2003a, b; RL&L 1993), and those sampled ranged in length from 365 to 450 mm (GLL 2008c).

Potential forage fish habitat was identified in all the lakes surveyed, and potential large-bodied fish habitat was identified in seven of the small lakes in the Izok Lake sub-drainage (GLL 2008b). Most streams assessed had poor to no habitat potential for fish due to seasonal intermittent flow, poorly defined channels, steep gradients and/or lack of connectivity to other watercourses. None of the sub-drainages appeared to provide satisfactory passage for fish moving upstream from Izok Lake. However, Arctic grayling movements have been recorded from Izok Lake to Iznogoudh Lake and from Izok Lake to Itchen Lake (Golder 2003a). It is thought that Arctic grayling prefer stream habitat for summer feeding/holding over lake habitats in the LSA. Iznogoudh Creek does not appear to be an important spawning area for Arctic grayling, nor do the tributaries draining into Izok Lake (RL&L 1993).

Although dated (mostly 20 years old), there is an adequate database for describing metal concentrations in tissues of lake trout from the Izok Mine LSA. For other species, the database may be less than adequate for describing baseline metal conditions. The most recent baseline report indicates that metal levels in lake trout and round whitefish tissue samples can exceed United States Environmental Protection Agency (USEPA) thresholds for the protection of fish for aluminum, cadmium, copper, nickel, and selenium (GLL 2008c). GLL (2008b) reported that selenium concentrations in liver of lake trout can exceed the British Columbia Water Quality Criteria (1.0 mg/Wkg in tissue, BC MOE 2001); however, the levels did not exceed the USEPA draft criterion for aquatic life (7.91 mg/Dkg, USEPA 2000).

High Lake Mine LSA

Fish community composition and life history data have been collected from the High Lake Mine LSA, including one control lake in the region. Scott and Crossman (1973) indicate that the following fish species are potentially present in the LSA: broad whitefish (*Coregonus nasus*), anadromous and resident Arctic char (*Salvelinus alpinus*), lake trout (*Salvelinus namaycush*), Arctic grayling (*Thymallus arcticus*), round whitefish (*Prosopium cylindraceum*) and northern pike (*Esox lucius*).

Only Arctic char, lake trout, slimy sculpin (*Cottus cognatus*) and ninespine stickleback (*Pungitius pungitius*) were captured during previous sampling programs. Despite extensive sampling efforts in High Lake (Lake L16) in 2004 and 2005 involving both standard scientific collection methods and traditional Inuit fishing methods, no fish were captured. There is compelling evidence that High Lake does not support local fish populations.



Lake structure and substrates throughout the LSA are generally similar. Littoral areas have predominantly boulder substrates, with intermittent bedrock and cobble areas. The boulders change grade to cobbles and fines with an increase in depth and gradient. Based on local observations, the boulder/cobble zone in deeper lakes (>5 m depth) generally ends abruptly at an average depth of 4.5 m.

The nearby Kennarctic River supports populations of lake trout and slimy sculpin, as well as both anadromous and land-locked Arctic char. The river is characterized by a gradient of less than 5% with boulders generally dominating the substrate.

Analysis of metal levels in fish tissues indicate that some metals tissue loads can exceed guidelines primarily for fish from the High Lake drainage. Results of metals analysis of fish livers and tissues tended to be generally similar between the two lakes that support fish in this sub drainage, while maximum copper levels sampled in Lake L18 lake trout liver were higher than those found throughout the LSA (GLL 2006e).

Izok Road LSA

Watercourse crossings span six major drainage basins. All six drainages enter the Arctic Ocean at various locations. The Coppermine River enters the Arctic Ocean near Kugluktuk; the Burnside, Hood and James rivers enter Bathurst Inlet; and the Kennarctic River and an unnamed river drainage enter near Grays Bay.

Many streams along the road route were determined to be ephemeral, having no defined bed or banks and contained flow only during spring freshet. All crossings that were determined to have potentially defined bed and banks were also assessed from the ground.

Potentially sensitive areas such as spawning, migration, and rearing were identified using the fish habitat data and relating it to physical habitat requirements of the fish VECs. Most of the watercourses with adequate flow and absence of physical barriers along the road route typically provide habitat for migration movements and seasonal rearing. Use of these habitats is generally low and of short and/or seasonal duration. Arctic char, Arctic grayling, lake trout, ninespine stickleback, round whitefish, and slimy sculpin use some of the watercourses in the study area during the ice-free season. Arctic grayling were not observed or captured in any drainages north of the Burnside River drainage. This is important to note because they are the only spring spawning fish VEC in the LSA.

5.6.3.3 Ongoing Studies

Izok Mine LSA

The following field studies are currently ongoing within the Izok Mine LSA.

- Detailed assessment of habitat and Arctic grayling use of streams that are likely to be directly affected by the Project within the Izok Lake basin, including Izok and Iznogoudh creeks
- Hydroacoustic population survey of Izok Lake and standard index gill netting (i.e., broad-scale fish community monitoring) of Izok Lake, upper bays of Itchen Lake, portions of Iznogoudh Lake and a reference lake



- Bathymetry and fish habitat (i.e., substrate) inventory of lakes in the Izok Lake sub-drainages, including Izok Lake, portions (or specific bays) of Itchen Lake, portions (or specific bays) of Iznogoudh Lake and a reference lake
- Fish composition surveys of several lakes and streams within sub-basins of Izok Lake where baseline data is incomplete
- Opportunistic fish tissue sample collection from Itchen Lake and a reference lake for metals analysis
- Collection of benthic invertebrate samples

High Lake Mine LSA

Field studies are currently ongoing to confirm fish presence in various watercourses and waterbodies in the High Lake LSA, including the South sub drainage.

Izok Road LSA

Several changes to the road corridor occurred in 2007 and 2008, which resulted in new watercourse crossing options that require assessment. All watercourse crossings that have not been assessed to date are being assessed during the 2012 field season. This includes summer fisheries surveys at all stream crossing locations along the alternate road alignment.

The 2012 field program include fish sampling and habitat mapping for watercourse crossings in and around the Izok Lake LSA that were not previously sampled in any detail. Lake bathymetry data will also be collected from the small lakes along the proposed temporary winter road routes

5.7 Terrestrial Environment

5.7.1 Soils and Landforms

Soils and landforms are important components of the terrestrial environment in the area, and changes in their quantity and quality may affect the health of the ecosystem, including the quality of vegetation and wildlife habitat.

5.7.1.1 Study Areas

Local Study Area

The LSA encompasses the area within which all direct effects and indirect effects of Project activities on the landforms and soils are likely to occur. The LSA includes a 5 km radius surrounding the proposed Izok Mine site and facilities, a 5 km radius surrounding the proposed High Lake Mine site and facilities, a 1 km wide buffer on either side of the centreline of the proposed all-season road and winter road corridors, and a 1 km wide buffer around the Grays Bay Port site (Kestrel Research Inc. 2011).

Regional Study Area

The RSA is the area within which indirect effects of the Project are likely to occur. It is defined as a 30 km wide buffer around Project facilities, infrastructure and road corridors, which is considered sufficiently



broad to encompass the maximum spatial extent of possible changes in soil quality from the deposition of airborne contaminants.

5.7.1.2 Description of Existing Environment

Common Landforms and Soils

Field surveys of soils and landforms within the Project area were initiated in 2005 and continued in 2008 (GLL 2007, 2008b). The field assessments evaluated key features of the landscape including topography, parent material, slope, aspect, drainage, depth of water table, moisture regime, site position, stoniness, erosion and vegetative cover. Important or abnormal occurrences encountered at the site such as permafrost features, erosion, compaction or ground cover were recorded. Other information collected included surface stoniness and depth to permafrost, bedrock and water table. Soil pits were dug (approximately 1 m deep or to depth of permafrost or rock) within or next to each vegetation survey plot (Kestrel Research Inc. 2011). Soil profile descriptions included horizon depth, colour, mottles (abundance) texture, structure, root abundance and size, and percent and size of coarse fragments. These soils and landscapes were described in accordance with 'The Canadian System of Soil Classification' - Third Edition (Soil Classification Working Group 1998).

Vegetation information is available in the 2008 Vegetation Field Report (Kestrel Research Inc. 2011), and contaminant information exists in the Field Report for High Lake Project Contaminant Sampling (GLL 2007).

Regional Study Area

The Izok Corridor Project is situated in the treeless southern arctic tundra. The granitic bedrock underlying the region is part of the northern edge of the Bear Slave Upland on the Canadian Shield. The upland surface is incised by two major valleys, namely the north-trending Kennarctic River valley to the east, and the east-trending James River valley. Glaciation by the Wisconsinan Laurentide Ice Sheet was the major influence in forming the characteristic rugged terrain typical of well-glaciated shield topography.

The majority of the RSA contains undulating to rolling bedrock overlain by thin covers of till, felsenmeer and colluvium. Till deposits are mainly stony, sandy to silty loams and either less than 1 m deep (veneers) or 1 to 2 m deep (blankets, depressional). Frost churning and permafrost influence soil development, resulting in the formation of Brunisolic and Turbic Cryosolic soils in uplands. Gleysolic and Histic Cryosols occupy depressions and toe slopes where water is seasonally perched.

Within 13 km of the Arctic coast, sediments of marine origin occur on lower slopes and valley floors. These fine-grained silt and clay rich sediments were originally deposited in a marine environment and are now exposed due to an uplift of the surface once glaciers retreated. Ice content of these sediments is estimated at 40%. The most common soils are Brunisolic Turbic Cryosols and Orthic Regosols.

A large, east-west-oriented esker complex crosses the area just north of Ham Camp. It is composed of gravelly sand with locally high coarse fragment content. Smaller eskers and glacial complexes occur elsewhere, including the Izok Mine area and along Izok Road. Deflation is widespread on these deposits, resulting in Orthic Regosolic and Regosolic Static Cryosolic soils.



Minor occurrences of fluvial deposits of cobbles and boulders exist along water courses occurring in shallow drainage pathways between lakes. Riparian soils are mainly RegoGleysols.

There is variation in landforms (percent of area and associated soils) among the four LSAs. This is described below.

Izok Mine LSA

Deposits within the Izok Lake Mine LSA are dominantly till veneers, depressions, and blankets (61%). Bedrock (6%) and glaciofluvial material (3%) occur in localized areas. Approximately 25% of the area is covered by water. The surficial materials in the Izok Lake Mine site suggest a low to moderate sensitivity to permafrost. Wet areas contain Gleysolic and Histic Cryosols covering 97 ha of the area (12.9%).

Turbic Cryosols are commonly associated with both till and glaciofluvial materials. Brunisolic Eutric and Dystric Static Cryosols are also common with glaciofluvial deposits. Eskers account for some of the glaciofluvial deposits observed in the Izok Lake Mine site.

High Lake Mine LSA

The High Lake Mine site is located on glaciated till veneer or till blanket (59%) and to a lesser extent colluvium (7%) and bedrock (5%). Water occupies 28% of the area. Material is mostly coarse grained or bouldery and therefore not highly sensitive to permafrost. Only 1% of the area is considered poorly drained and very little evidence of permafrost activities was observed.

Soils associated with till blanket and till veneer are most likely to be Gleysolic, Brunisolic Eutric, Brunisolic Dystric, Orthic Dystric, Orthic Eutric, and Regosolic Turbic Cryosols. These soils are all affected by cryoturbation.

Wetlands contain Gleysolic and Histic Cryosols covering 3.2 ha of the area (1.9%).

Izok Road LSA

Grays Bay to High Lake - Landforms occurring within the Grays Bay to High Lake section of Izok Road include, in order of decreasing extent, marine (25%) > bedrock (19%) > colluvium (16%) > water (14%) > glaciofluvial (12%) > till (11%).

Near Grays Bay, ice-rich fine grained, well sorted marine clays and silt are present, often located on long, gentle slopes where solifluction and soil creep related to permafrost are present. Ice content in the marine sediments has been estimated at 30% (Kerr et al. 2005). Thicker till and ice rich fine grained marine sediments are present north of the High Lake area. The most common upland soils are Orthic and Brunisolic Eutric Turbic Cryosols.

Wet soils, namely Gleysolic and Histic Cryosols, make up 16 ha of the area (4.9%).

High Lake to Ulu - Along the High Lake to Ulu section of the road, the major landforms are till (61%) > bedrock (10%) and water (10%) > glaciolacustrine (9%). Till veneer (<1 m thick) and blankets (1 to 2 m thick) exhibit permafrost features, being more pronounced in the latter. Bedrock is often frost shattered. Surface boulders are common on the till and bedrock. Solifluction stripes are widespread on the silty to fine sandy lacustrine materials blanketing the underlying till north of Ulu. The most common upland soils are Brunisolic Turbic Cryosols and Orthic Regosols. Poorly drained areas containing Gleysolic and Histic Cryosols cover 19ha (0.9% of the area).



Ulu to Izok Lake - This area resembles the High Lake to Ulu section but has more glaciofluvial deposits. Landforms consist of till (69%) > bedrock (12%) > glaciofluvial (9%) > water (7%). Associated upland soils include Brunisolic Turbic Cryosols and Orthic Regosols. Poorly drained areas with Gleysolic and Histic Cryosols cover 173 ha (11.6%).

Grays Bay Port LSA

The land-based port infrastructure will be predominantly located on bedrock exposures or thin ice-rich marine sediments, a mixture of clay, silt, sand and boulders. Marine deposits make up most of the genetic material (34%), and 40% of the marine deposits are classified as fine-grained and therefore permafrost sensitive (Dredge et al. 1996). Bedrock makes up 15%, and the rest is water (51%). Soils commonly associated with marine deposits include Orthic Eutric Turbic Cryosols, which tend to be highly affected by cryoturbation, and Gleysolic Turbic Cryosols, which develop on poorly drained areas. Bedrock deposits are often associated with little to no soil; however, soil types observed on bedrock include Brunisolic Eutric Turbic Cryosols and Orthic Regosols. Wetlands are characterized by Gleysolic and Histic Cryosols making up 6.2 ha of the area (18.4%).

Uncommon or Valuable Landforms

Uncommon or valuable landforms have been assigned a high value in terms of habitat potential in the LSA. Rare plant species and animal habitats are often associated with an uncommon landform, and concerns about these landforms have been expressed during the consultation process. Three types of landforms (steep bedrock cliffs, fluvial floodplains and eskers) have been identified as particularly valuable.

Steep bedrock cliffs are identified as valuable landforms by Project biologists as preferred nesting sites for several species of raptors such as peregrine falcon, golden eagle, gyrfalcon, rough-legged hawks, and for ravens. Steep bedrock cliffs have been identified on 9.2 ha of the LSA (0.3%).

Fluvial floodplains located along rivers are considered valuable because they are uncommon in the LSA and have high habitat value. River corridors are known to have high value to animals and humans as migration corridors, they provide access to fishing opportunities, are in close proximity to fish habitat and may sustain unusual plants and plant communities. Undifferentiated landforms (a bouldery surface acting as channel for intermittent, diffuse, flow between waterbodies) are also included in this section because of the stream like behavior and important effects they have on the hydrology of the water bodies they connect. Fluvial floodplains and undifferentiated channels cover about 51 ha of the LSA (1.7%).

Eskers have been identified as a valuable landform during consultations with local communities, elders, regulators and Project scientists. Eskers are identified as uncommon landforms or landforms of value separately from other glaciofluvial features. They are often associated with archaeological resources, denning sites for small and large mammals (such as wolves and grizzly bears), rare or unusual plant communities or plant species, and are generally valued as an aesthetic landmark. They are also commonly used as migration routes for caribou (Traynor 2001). Eskers cover 17 ha of the LSA (0.5% of LSA).



5.7.1.3 Ongoing Studies

The objective of the 2012 field program is to delineate and characterize the landforms and associated soils in the LSAs in order to assess potential Project effects on their abundance, diversity and stability and determine appropriate mitigation measures. The following work is being undertaken as part of the field program.

- Determine permafrost conditions (relate processes and active layer, surface water bodies and topography)
- Locate special sensitive or unique landform features
- Develop soils and landforms associations to support the completion of ecosystem mapping and description
- Relate/check mapped soils and landforms units and associations delineated during preliminary air photo interpretation with field soil and landform descriptions data
- Link soil descriptions with vegetation communities to establish soil vegetation relationships in terms of reclamation targets
- Detect evidence for potential for ground and rock instability
- Determine the suitability of topsoil and overburden for use in the re-vegetation of surface-disturbed areas
- Determine bedrock lithology, morphology, geomorphology and soils at proposed borrow and quarry sites, and other areas where earthworks are proposed
- Determine potential for acid rock drainage and evaluate possible mitigation techniques
- Sample soils to determine characteristics for vegetation growth and sensitivity to potentially acidifying inputs
- Investigate the quantity and quality of soils and deposited sediments in lakes to prepare for actions needed once water bodies are drained. Reclamation suitability must be assessed and plans to vegetate the areas might need to be considered to avoid erosion
- Examine reclamation at other projects for techniques and success rates
- Mapping and sampling in areas not previously/adequately covered by earlier field programs
- Describe soils at all vegetation plots and collect soil samples (about 25 sites with analysis of 2 horizons per site) for physical and chemical analyses

5.7.2 Vegetation

The diversity and distribution of vegetation plays a key role in ecosystem function. Vegetation patterns on the land are influenced by climate, substrate, terrain and water patterns. Characteristic groupings of vegetation occur at the landscape scale and at smaller scales. Different vegetation associations provide a variety of habitats used by wildlife. Wildlife and people can influence vegetation abundance and diversity, and industrial development in particular has the potential to affect vegetation ecosystem health.



The objective of the vegetation program is to develop descriptions of common ecological units on the landscape, including their component landforms, vegetation associations and soils. Maps are developed to identify the baseline cover and diversity of ecological units and vegetation associations at a local scale and land cover at a regional scale. This information will provide the basis for predicting Project-related effects and developing mitigation measures for construction, operations and closure-related activities. It will also be used to assist with planning of environment monitoring programs during the closure phase.

5.7.2.1 Study Areas

Local Study Area

The LSA is defined as the area within which direct and indirect effects of the Project on vegetation are predicted to occur. The LSA includes a 5 km radius surrounding the Izok Mine site and facilities, a 5 km radius surrounding the High Lake Mine site and facilities, a 1 km wide buffer on either side of the centreline of the proposed Izok Road and winter road corridors, and a 1 km wide buffer surrounding the Grays Bay Port site.

Regional Study Area

The RSA represents vegetation diversity at a landscape scale and includes the area within which any regional effects of Project activities are predicted to occur. The RSA includes a 30 km wide buffer around all Project facilities, infrastructure and road corridors.

5.7.2.2 Description of Existing Environment

Regional Study Area

The Izok Corridor Project is located in the Takijua Lake Upland Ecoregion of the Southern Arctic Ecozone. This ecoregion is located in the eastern half of the Bear-Slave Upland south of Coronation Gulf. Vegetation in the area is characterized by shrub tundra that consists of dwarf birch, willow, northern Labrador tea, *Dryas* spp. and *Vaccinium* spp. Depressional sites are dominated by willow, sphagnum moss and sedge tussocks and spruce stands occur scattered along the southern boundary of the ecoregion (Environment Canada 2005).

A land cover classification has been developed for the northern portion of the RSA but not for the southern portion. The landscape around the High Lake Mine and the road to Grays Bay is strongly influenced by the underlying bedrock systems. Glacial till and boulders form a thin cover on and between bedrock outcrops. The most common vegetation classes in the northern area of the RSA are heath bedrock/boulder and bedrock/boulders. Fresh water lakes, streams and rivers cover 15% of the area. Within about 13 km of the arctic coast, fine sediments of marine origin occur in valleys. Relatively well-drained areas of marine sediment or glacial till support heath tundra. In areas of flowing water on or below the ground surface, a riparian tall shrub class occurs. Shallow water along the edges of streams, lakes and perched ponds support a non-tussock sedge class. Lichen veneer forms on relatively level, dry, well-drained substrates including glacio-fluvial outwash terraces, raised beaches and thin dry soils associated with bedrock outcrops.



Local Study Area

Ecological Land Classifications

LSA mapping is based on 1:20,000 scale, high resolution aerial photography. Ecological Land Classification (ELC) field surveys are being conducted to confirm and complete the vegetation mapping for the LSA. ELC standards are based on the British Columbia’s Resource Inventory Committee (RIC) (1998) mapping standards (where appropriate).

Data collected during field programs completed in 2004, 2005 and 2008 have been used to characterize and map vegetation associations in the LSA. Twenty-four (24) vegetation association units were mapped within the area). The characterization of several units is incomplete based on the number of full plots completed to date.

Rare Plants The potential for occurrences of rare and at risk plant species, rare ecological communities are investigated based on SARA Public Registry searches, existing records (Canadian Museum of Nature 2005) and the General Status Rankings of Vascular Plants in Nunavut (Government of Nunavut, 2010) list of elements by ecozone. Reconnaissance rare plant surveys are undertaken to assess the baseline distribution and associated habitat of “at risk”, “may be at risk” and “sensitive” plant species within the Izok Corridor Local Study Area and the project footprint.

Observations of seven “may be at risk” plant species and 27 “sensitive” plant species (GN 2005) were made during field surveys of the general area of the Project in 2004, 2005 and 2008 (**Table 5.7-1**). Observations of four plant species not currently recorded for Nunavut were made as well. No “at risk” species were observed.

Table 5.7-1 Records for Sensitive and May Be at Risk Plants from the Izok Corridor Project LSA

Scientific Name	Common Name	Nunavut 2005 Status Rank	Habitat	Habitat or Vegetation Association	# of Records
<i>Arnica frigida</i>	Snow arnica	May be at Risk	Snowbank and riparian area blow snowbank	HS	2
<i>Carex canescens</i>	Silvery sedge	Maybe at risk	River meadows, lake shores and wet places		7
<i>Carex podocarpa</i>	Graceful mountain sedge	Maybe at risk	Snowbank communities and riparian areas	HS, BF, BR, HR	28
<i>Cerastium cerastoides</i>	Mountain chickweed	Maybe at risk	Moist tundra		2
<i>Gentianella propinqua</i>	Four-part gentian	May be at Risk	Marine backshore on sand/silt	Coastal Communities	3
<i>Pyrola minor</i>	Snowline wintergreen	Maybe at risk	Moist lake shores		7
<i>Subularia aquatica</i>	Water awlwort	Maybe at risk	sandy bottom of shallow, clear standing water		1
<i>Viola species</i>		Maybe at risk to Sensitive	Tall Riparian shrub vegetation communities and gravelly lakeshores		12



Scientific Name	Common Name	Nunavut 2005 Status Rank	Habitat	Habitat or Vegetation Association	# of Records
<i>Argentina egedii</i>	Egede Cinquefoil	Sensitive	Marine backshore tidal flats on clay	Coastal Communities	1
<i>Agrostis mertensii</i>	Northern bent grass	Sensitive	Sand and fluvial rock as well as at the base of eskers	HB, OD	16
<i>Betula occidentalis</i>	Water birch	Sensitive	Low wet areas and sedge associations		2
<i>Bromus pumpellianus</i>	Pumpelly's Brome	Sensitive	Sandy and gravelly river banks and islands, Avens association on old Inuit camp	Coastal Communities	5
<i>Callitriche palustris</i>	Marsh water-starwort	Sensitive	Aquatic along sheltered sandy lakeshores within 30 cm of water		3
<i>Carex capitata</i>	Capitate Sedge	Sensitive	At the base of eskers and in low wet places	HB, OD	3
<i>Carex gynocrates</i>	Northern bog sedge	Sensitive	Within boulder field growing on limited substrate between boulders		
<i>Carex tenuiflora</i>	Sparse-flowered sedge	Sensitive	Along rocky and sandy lakeshores	ST	13
<i>Dasiphora fruticosa</i>	Shrubby cinquefoil	Sensitive	Open tundra, riparian areas and snowbank associations	BF, HS	12
<i>Festuca saximontana</i>	Rocky mountain fescue	Sensitive	Dry grassy and rocky places		1
<i>Galium trifidum</i>	Small bedstraw	Sensitive	Along peat moss dominated shore		6
<i>Isoetes echinospora</i>	Spiny-spored Quillwort	Sensitive	Sandy lake shores within shallow water		3
<i>Juncus filiformis</i>	Thread rush	Sensitive	Moist, sandy lake shores		2
<i>Lathyrus japonicus</i>	Beach pea	Sensitive	Marine beach and backshore on fine gravels and sand	Coastal Communities, GC	4
<i>Luzula spicata</i>	Spiked woodrush	Sensitive	Sandy tall riparian shrub areas		1
<i>Lycopodium clavatum</i>	Running clubmoss	Sensitive	Sandy lakeshores	BS, Coastal Communities	9
<i>Oxytropis deflexa</i>	Pendant-pod point-vetch	Sensitive	Lichen veneer and avens communities on exposed thin soils (silt, sand and gravel)	HS, OH, GE, GC, BL, HT, HR, ML	10
<i>Pinguicula</i>	Hairy butterwort	Sensitive	Sphagnum Hummocks	BR	32



Scientific Name	Common Name	Nunavut 2005 Status Rank	Habitat	Habitat or Vegetation Association	# of Records
<i>villosa</i>			and Riparian associations with hummocks.		
<i>Rubus arcticus</i>	Arctic raspberry	Sensitive	Tussock sedge association and Riparian areas	BF, ST	4
<i>Rumex arcticus</i>	Arctic dock	Sensitive	Tussocks sedge and riparian associations	Coastal Communities, MT, ST, SN	6
<i>Salix pulchra</i>	Tea-leaved willow	Sensitive	Low shrub communities on areas of sub-surface water movement, hummocky ground	BF, ST, HT	11
<i>Saxifraga nelsoniana</i>	Heart-leaved saxifrage	Sensitive	Snowbank associations	HS, UE, RB, BF, Coastal Communities, OD	26
<i>Sibbaldia procumbens</i>	Creeping Sibbaldia	Sensitive	Snowbank association in sandy soils on glacio-fluvial complex	HS, OD	5
<i>Sparganium natans</i>	Small burreed	Sensitive	Rocky shoreline		2
<i>Vaccinium oxycoccos</i>	Small cranberry	Sensitive	Sphagnum Hummocks	OD, OH	25
<i>Viola macloskeyi</i>	Smooth White violet	Sensitive	Tall riparian shrub vegetation	BF	1
<i>Galium tinctorium</i>	Stiff marsh bedstraw	Not listed	Tall riparian shrub areas	BF	
<i>Lycopodium alpinum</i>	Alpine clubmoss	Not listed	Snow bank communities and sandy lakeshores	HS	1
<i>Phegopteris connectilis</i>	Long beech-fern	Not listed	Tall shrub areas		1
<i>Sagina caespitosa</i>	Tufted pearlwort	Not listed	Gravelly places		1

5.7.2.3 Ongoing Studies

Regional Study Area

Regional Study Area mapping will be developed based on regional scale Land Cover Classification (LCC) mapping for Landsat scenes covering the Izok Corridor Project RSA. The image classification will be a supervised classification based on field data collected in 2005, 2006 and 2008 and the existing LCC mapping for the northern portion of the Izok Corridor Project. The resolution of the mapping will be a 30-m cell size. Additional field data will be collected to improve the accuracy of the draft LCC.



Local Study Area

The footprints of some Project components are different from that proposed for the High Lake (2004-2005) and Izok (2008-2009) projects. Where extensions of the 1 km wide buffer area around currently proposed roads, quarries, infrastructure and the 5 km area around mines is necessary, LSA mapping will be expanded. This includes Izok Road and winter road alignments, quarry and granular sources, and mine infrastructure.

Ecological Land Classification (ELC) surveys are being conducted in 2012 to:

- Verify the accuracy of new 1:20,000 scale ecosystem mapping
- Increase the number of full ELC plots to improve the characterization of several under-sampled ecosystem units (MT, ML, MH, HS, BS, RB, UE)

ELC standards are based on the British Columbia's RIC (1998) mapping standards (where appropriate)

The current footprints of the proposed all-season and winter road alignments, borrow sources and mine infrastructure have also changed from that proposed for the previous High Lake and Izok projects. Limited reconnaissance level rare plant surveys are being conducted in 2012 to:

- Assess the associated habitat of "may be at risk" and "sensitive" plant species within the borrow pits identified in 2008
- Survey vegetation associations along new sections of the proposed Project footprint
- Determine the extent of rare plant populations affected by the footprint once the footprint is finalized

During the 2012 field program, existing industry disturbance in the area will be monitored to:

- Characterize the effects of permafrost degradation on vegetation community composition and structure in sensitive, ice rich marine silt landforms
- Gather information on the characteristics and suitability of soils for revegetation
- Identify colonizing and early successional plant species and processes of natural revegetation

5.7.3 Wildlife and Wildlife Habitat

5.7.3.1 Study Areas

Local Study Area

The LSA for terrestrial wildlife studies was selected to describe the habitat immediately adjacent to the Project footprint that may be subject to direct effects. This area includes a 1 km buffer around the footprint of all project facilities, infrastructure and road corridors.

Regional Study Area

The RSA includes a 30 km buffer surrounding major Project components (the Izok Mine site, the High Lake Mine site, and the Grays Bay Port site), and a 20 km buffer on either side of the Izok Road corridor.



It was designed particularly to address issues relating to caribou, while ensuring that the area was sufficiently large to address other species inhabiting the area.

The current RSA is relatively unchanged from that used during the 2008 and 2010 studies, other than some minor alterations due to road re-alignments, and the exclusion of a previous road alignment option from Izok to east of Kugluktuk.

5.7.3.2 Description of Existing Environment

Wildlife habitat within the Izok Corridor Project area consists of a variety of tundra plant communities, varying from bare rock to large expanses of heath tundra, to less common riparian-shrub systems (Gould et al. 2003). Abiotic features such as cliffs and eskers also provide unique wildlife habitats and contribute to biodiversity in the area. Many species of wildlife are migratory and, as such, their abundance varies seasonally. The terrestrial wildlife species found within this region are largely representative of the entire species assemblage found in the central Low Arctic. Species guilds include ungulates, large- and medium-sized carnivores, small mammals, raptors, waterfowl and shorebirds, and upland birds and songbirds. Caribou (*Rangifer tarandus*), muskoxen (*Ovibos moschatus*), grizzly bears (*Ursus arctos*), wolves (*Canis lupus*) and wolverines (*Gulo gulo*) are among the more common large mammals present in the area.

A number of western science studies have occurred in the West Kitikmeot region. Along with Inuit Qaujimagatuqangit (IQ), these provide background information on the ecology of wildlife and the diversity of habitats in the region. To supplement this regional knowledge, field studies for the previous High Lake (2004) project and Izok (2007) project were conducted periodically between 2004 and 2010, and are being undertaken in 2012 for the Izok Corridor Project.

Species at Risk

Table 5.7-2 lists Species at Risk that potentially occur within the Izok Corridor RSA. These species are described in more detail below.

Table 5.7-2 Terrestrial Mammal Species at Risk in the Izok Corridor RSA

Species	Scientific Name	Species Status		
		Nunavut ¹	SARA Schedule ²	COSEWIC ³
Barren-ground Caribou (Dolphin and Union caribou)*	<i>Rangifer tarandus groenlandicus</i>	Secure	Schedule 1	Special Concern
Grizzly Bear	<i>Ursus arctos</i>	Sensitive	Not currently scheduled	Special Concern
Wolverine	<i>Gulo gulo</i>	Secure	Not currently scheduled	Special Concern

* The SARA and COSEWIC listings for barren-ground caribou only apply to the Dolphin and Union caribou; other caribou herds present within the RSA have not been assessed by COSEWIC and are not currently scheduled under SARA.

1 CESCC (2011)

2 Environment Canada (2011)

3 COSEWIC (2011)



Ungulates

There are three ungulate species present within the Izok Corridor RSA: caribou, muskoxen and moose (*Alces alces*).

Caribou play a pivotal role in the lives of Aboriginal people and other residents of the north. They continue to be central to the culture, identity and diet of the West Kitikmeot, and local Inuit have hunted these animals for millennia (Thorpe et al. 2001). Caribou within the region also play a key role in food chain dynamics, particularly as a prey source for carnivorous and omnivorous animals. Caribou are numerous and widespread throughout the Arctic regions; however, their current status is a concern as several herds have undergone dramatic declines in recent years (Adamczewski et al. 2009).

Caribou from three herds are known to occur within the Izok Corridor RSA on a seasonal basis including the Dolphin and Union herd, Bathurst herd, and Bluenose-East herd. These caribou are highly migratory and often winter great distances from calving and summer grounds. In general, they migrate to their calving grounds in April and May, and calve during the first two weeks of June. Following calving, the animals disperse throughout their summer ranges and gradually begin moving back to their wintering grounds. The rut occurs in October, generally during fall migration. For all caribou herds, the timing of movements and main movement paths vary annually.

Dolphin and Union caribou (*R. t. groenlandicus x pearyi*) calve and summer on Victoria Island and cross the Coronation Gulf and Dease Strait to winter on the mainland on both sides of Bathurst Inlet (Nishi and Gunn 2004, Poole et al. 2010). They can be found in the Izok Corridor RSA from late October to early June; during that time they are found from the James River and Ulu areas north to the mainland coast. In general, Dolphin and Union caribou are widely distributed during winter, although they tend to congregate closer to the coast in late winter (April-May). The herd appears roughly stable or slightly declining in numbers (~22,000 animals [estimate within the survey zone from 2007 census]; M. Dumond, GN DoE, pers. comm.). The herd is experiencing greater harvest pressure, perhaps due to lower numbers of mainland caribou, and is being affected by later freezing of the straits between Victoria Island and the mainland (Poole et al. 2010).

Bathurst caribou (*R. t. groenlandicus*) winter south of the treeline within a broad area from northern Saskatchewan to south of Great Bear Lake before migrating north in spring to calve along the Hood and Burnside rivers west of Bathurst Inlet (Gunn et al. 2001, Nishi et al. 2010). The Izok Corridor RSA overlaps portions of the migration route, post-calving, summer, and early fall range for this herd, as well as the western edge of recent calving grounds. The 2009 estimate for the Bathurst herd (~32,000 ± 5,300 [SE] caribou; Nishi et al. 2010) represents a >90% decline from surveys from the mid 1980s. There are indications from recent reconnaissance calving ground surveys that Bathurst numbers may have stabilized, and a census will be conducted in June 2012 (B. Croft, GNWT ENR, pers. comm., May 2012.).

The Bluenose-East caribou herd is generally found west of the Izok Corridor RSA, but may occur in the southwestern sections of the RSA during summer and fall (Nagy et al. 2005; GNWT ENR, unpubl. data). However, the western portions of the study area are likely at the eastern limit of the Bluenose-East caribou range, and occurrence will be variable among years. Previous project surveys documented probable Bluenose-East caribou in the study area in August 2010. The 2010 survey of the Bluenose-East caribou herd indicated a population of 98,650 ± 7,125 (post-calving photo survey; J. Adamczewski, GNWT ENR, pers. comm.), an increase since 2006 (66,800 ± 5,200; Nagy and Tracz 2006).



Muskoxen are an important source of local food and meat for commercial export, and are increasingly used for guided sport hunts as well as a resource for tourism and wildlife viewing. Muskoxen occur within the general area throughout the year. Comparison with a 2005 muskox survey by Nunavut Government biologists that covered from Kugluktuk to Bathurst Inlet and from Jericho north to the coast indicates that the Izok Corridor RSA occurs within a low density area, which held an estimated 365 ± 209 muskoxen and only 4% calves (Dumond 2007). More recently, project-related aerial surveys in 2008 have observed up to 167 muskoxen within the RSA at a time.

Moose densities on the tundra are typically low. The presence of moose in the Izok Corridor RSA has been confirmed by project surveys throughout the years, but the species has been observed in very limited numbers, and nearly all of the observations have been within 30 km of the coast, associated with shrub habitats in low-elevation valleys. No population estimates are available for the region.

Carnivores

Several species of large- and medium-sized carnivores are present in the Izok Corridor RSA, including grizzly bears, wolverines, wolves (*Canis lupus*), Arctic fox (*Alopex lagopus*) and red fox (*Vulpes vulpes*). These animals are typical of the Low Arctic and generally occur at low densities throughout the Kitikmeot region. Many of them are harvested by Inuit hunters, and represent a source of income for local people. Additionally, grizzly bears and wolverine are high-profile species of local and national interest and conservation concern. Ermine (*Mustela ermine*), and least weasel (*M. nivalis*) may also be present within the RSA.

Grizzly bears are found throughout the mainland of the Kitikmeot region, with increasing sightings on Victoria Island. They are adapted to preying on caribou and muskoxen, but also feed on vegetation and roots and will hunt small mammals such as Arctic ground squirrels (*Spermophilus parryii*; Gau et al. 2002). Grizzly bears in this area use habitats such as eskers in spring for early season vegetation and berries, and heath tundra and shrub habitats in summer for foraging (McLoughlin et al. 2002a). Denning areas for bears are typically in well-drained, steep-sloped heath tundra, heath-boulder habitats, or esker habitats, often under tall shrubs that help to support the ceiling, and on all but north exposures (McLoughlin et al. 2002b). Project surveys have observed grizzly bears throughout the RSA and have documented local denning. Bears may concentrate closer to calving Bathurst caribou and along the coast during spring, but overall, the animals appear to be widely distributed. Densities in this region are unknown; however, grizzly bear DNA studies are currently underway at several projects within and adjacent to the Kitikmeot region, including the grizzly bear hair snare program planned for the Izok RSA during the summer of 2012.

Wolves are the predominant predators of both caribou (Kuyt 1972, Williams 1990) and muskoxen (Heard 1992, Gunn and Adamczewski 2003). Wolves also will forage on small mammals such as lemmings, voles, and Arctic ground squirrels, and they play a pivotal role in all levels of the food web within the Arctic ecosystem. While most carnivores are territorial, wolves that depend largely on barren-ground caribou do not maintain regular territories. With the exception of the denning period, these wolves will migrate with caribou to maintain a year-round food source. Recent estimates of wolf numbers associated with the Bathurst herd are unknown, but annual wolf den surveys suggest that wolf numbers and productivity have fallen rapidly in recent years as the caribou herds have declined (Adamczewski et al. 2009). Wolf denning in the tundra tends to occur closer to treeline, likely a strategy



to optimize timing and access to caribou for rearing pups (Heard and Williams 1992, Cluff et al. 2002), and is predominantly in eskers and other glacial formations (Cluff et al. 2002, McLoughlin et al. 2004). Previous surveys have observed wolves throughout the study area, associated with both the Bathurst and Dolphin and Union herds. Two active wolf dens have been documented within the RSA.

Wolverines are wide-ranging carnivores that inhabit all portions of the Canadian Arctic in low densities. They have large home ranges and depend primarily on carrion, in particular caribou, as their major food source (Mulders 2000). Wolverines are an important cultural and economic resource for the people of the NWT and Nunavut, and are hunted for their valued pelts for parka trim (owing to the frost-resistant fur) and for sale to auction houses. Regulators have raised concerns about the health of wolverine populations in the Arctic (Mulders et al. 2007). In past decades, a number of mining developments have proven to be detrimental to local wolverine populations (e.g., DDMI 2003, BHP Billiton 2006). In 2008, a wolverine DNA inventory program was successfully conducted in the High Lake area, resulting in 29 unique captures of wolverines within a 3,000 km² study area. A similar study is being completed in the Izok area in 2012.

Arctic foxes and red foxes are both found within the Kitikmeot region. Both species are trapped for their pelts (Thorpe et al. 2001), with Bathurst Inlet residents taking roughly equal numbers of red foxes and Arctic foxes and residents of other West Kitikmeot communities taking more Arctic fox (Priest and Usher 2004). Foxes in Arctic environments fluctuate widely in number, following the three to five year cycle in vole and lemming populations, their primary food source (MacPherson 1969, Garrott and Eberhardt 1987, Voigt 1987). They also feed on ground squirrels, Arctic hares (*Lepus arcticus*), birds, eggs, berries, and most other prey available, and scavenge ungulate meat from kills made by larger predators (MacPherson 1969, Thorpe et al. 2001, Cypher 2003). They typically den in sandy soils near riverbanks and on eskers. Previous work in the Izok Corridor RSA has found evidence of both species within the study area; however, observations indicate that red fox are more numerous than Arctic fox in this area.

Small Mammals

Small mammals, including lemmings, voles and ground squirrels, are found throughout the study area, and are a recognized part of the food chain in supporting larger wildlife species. Arctic hare, while not usually considered among small mammals, are also ubiquitous throughout the study area. Carnivores such as weasels, foxes, wolves, wolverines, grizzly bears, and raptors depend on these animals as prey species throughout the year. Some small mammal populations, lemmings and voles in particular, undergo synchronous population fluctuations (Krebs et al. 2002) and form the basis for much of the terrestrial trophic dynamics in the Canadian Arctic (Krebs et al. 2003). Such population cycles may peak every three to four years, and may be influenced by weather patterns (Leslie 1959), predation (Myrbeget 1973, Ydenberg 1987) and/or dispersal events of juveniles.

Small mammal trapping and other surveys previously completed for the project have documented Arctic hare, Arctic ground squirrels, northern red-backed voles, meadow voles, masked shrew and lemming species within the RSA. Northern red-backed vole and Arctic ground squirrel appear to be some of the more abundant species.

5.7.3.3 Ongoing Studies

The following ungulate and carnivore surveys are being conducted in 2012.



- A series of aerial ungulate (caribou, muskox, moose) distribution surveys in March through September
- Aerial ungulate track and trail surveys in March, April and July
- Expanded aerial transect surveys for ungulates (caribou and muskox) along the alternate route alignment
- Grizzly bear and wolverine DNA inventories using hair-snare sampling
- Aerial surveys to inventory carnivore (grizzly bear, wolf, fox) den sites along the proposed road alignment

No further studies related specifically to terrestrial species at risk are planned.

Although no small mammal studies are being conducted in 2012, small mammals will be documented whenever they are encountered during other wildlife field work.

5.7.4 Birds and Habitat

5.7.4.1 Study Areas

The study areas used for terrestrial bird studies for the Izok Corridor Project are the same as for the terrestrial wildlife studies (refer to section 5.7.3.1).

5.7.4.2 Description of Existing Environment

Terrestrial birds within the Kitikmeot region consist of both migratory and resident species, and include a diverse array of species and species guilds. Longer periods of daylight and seasonally abundant food supply from May through August generally support the breeding and rearing periods for most species. Relatively few species are present outside of the breeding period because long, cold winters and limited food availability limit populations. Those species that remain include gyrfalcons (*Falco rusticolus*), ptarmigan (*Lagopus sp.*), and common ravens (*Corvus corax*). Migrant species occupy wintering areas extending from the Canadian boreal forest to the southern extent of South America. Because of the vast distances covered by many species between summer and winter habitats, factors and effects occurring far beyond the breeding range often affect populations. However, environmental factors within the breeding range are undoubtedly important to the survival of all species breeding within the region. Birds are prominent in Inuit culture, and several species (e.g., including ducks, geese, and ptarmigan) are regularly hunted for food (Priest and Usher 2004).

Prior to baseline studies for proposed mines in this region, information detailing species distribution and presence within the mainland area was often based on limited field data. However, baseline studies previously conducted for the High Lake and Izok projects, as well as other projects in the area, have provided much better information for local bird populations.

Species at Risk

Table 5.7-3 lists bird Species at Risk that are potentially present within the Izok Corridor RSA. Of these, only the Eskimo curlew is currently listed under Schedule 1 of SARA. COSEWIC and SARA have



designated the Eskimo curlew as Endangered, and the GN lists this species as At Risk. However, nesting of this species has not been confirmed for over a century, and the RSA is east of the historic probable breeding area of the species (COSEWIC 2009). Two other species are listed under Schedule 3 of SARA: peregrine falcon, which is designated as Secure by the Government of Nunavut (GN), and as a Species of Special Concern by COSEWIC, and short-eared owl, which is considered Sensitive by the GN and as Special Concern by COSEWIC. Both of these species were documented within the RSA in previous studies. Peregrine falcon is a ubiquitous breeder in suitable habitat throughout the region. Additionally, barn swallow, while not currently scheduled under SARA, is under consideration for addition to Schedule 1 (Environment Canada 2011) and has been listed as Threatened by COSEWIC. A single barn swallow was observed during previous surveys within the RSA.

The remaining bird species listed in **Table 5.7-3** are not currently scheduled under SARA and have either not been assessed or are considered Not at Risk by COSEWIC. All are designated as Sensitive by the GN, and in most cases, this designation is likely because of perceived small populations on the periphery of distribution ranges.

Table 5.7-3 Bird Species at Risk within the Izok Corridor RSA

Species	Scientific Name	Species Status		
		Nunavut ¹	SARA Schedule ²	COSEWIC ³
Common Eider	<i>Somateria mollissima</i>	Sensitive	Not currently scheduled	Not assessed
King Eider	<i>Somateria spectabilis</i>	Sensitive	Not currently scheduled	Not assessed
Long-tailed Duck	<i>Clangula hyemalis</i>	Sensitive	Not currently scheduled	Not assessed
Golden Eagle	<i>Aquila chrysaetos</i>	Sensitive	Not currently scheduled	Not at Risk
Rough-legged Hawk	<i>Buteo lagopus</i>	Sensitive	Not currently scheduled	Not at Risk
Gyr Falcon	<i>Falco rusticolus</i>	Sensitive	Not currently scheduled	Not at Risk
Peregrine Falcon (tundra)	<i>Falco peregrinus tundrius</i>	Secure	Schedule 3	Special Concern
American Golden-plover	<i>Pluvialis dominica</i>	Sensitive	Not currently scheduled	Not assessed
Black-bellied Plover*	<i>Pluvialis squatarola</i>	Sensitive	Not currently scheduled	Not assessed
Eskimo Curlew	<i>Numenius borealis</i>	At Risk	Schedule 1	Endangered
Ruddy Turnstone*	<i>Arenaria interpres</i>	Sensitive	Not currently scheduled	Not assessed
Sanderling	<i>Calidris alba</i>	Sensitive	Not currently scheduled	Not assessed
Semipalmated Sandpiper	<i>Calidris pusilla</i>	Sensitive	Not currently scheduled	Not assessed
Least Sandpiper	<i>Calidris minutilla</i>	Sensitive	Not currently scheduled	Not assessed
Buff-breasted Sandpiper*	<i>Tryngites subruficollis</i>	Sensitive	Not currently scheduled	Not assessed
Red Phalarope*	<i>Phalaropus fulicarius</i>	Sensitive	Not currently scheduled	Not assessed
Red-necked Phalarope	<i>Phalaropus lobatus</i>	Sensitive	Not currently scheduled	Not assessed
Glaucous Gull	<i>Larus hyperboreus</i>	Sensitive	Not currently scheduled	Not assessed
Thayer's Gull	<i>Larus thayeri</i>	Sensitive	Not currently scheduled	Not assessed
Arctic Tern	<i>Sterna paradisaea</i>	Sensitive	Not currently scheduled	Not assessed
Short-eared Owl	<i>Asio flammeus</i>	Sensitive	Schedule 3	Special Concern



Species	Scientific Name	Species Status		
		Nunavut ¹	SARA Schedule ²	COSEWIC ³
Barn Swallow	<i>Hirundo rustica</i>		Not currently scheduled	Threatened
Northern Wheatear*	<i>Oenanthe oenanthe</i>	Sensitive	Not currently scheduled	Not assessed
American Pipit	<i>Anthus rubescens</i>	Sensitive	Not currently scheduled	Not assessed
American Tree Sparrow	<i>Spizella arborea</i>	Sensitive	Not currently scheduled	Not assessed
Harris's Sparrow	<i>Zonotrichia querula</i>	Sensitive	Not currently scheduled	Not assessed
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	Sensitive	Not currently scheduled	Not assessed
Snow Bunting	<i>Plectrophenax nivalis</i>	Sensitive	Not currently scheduled	Not assessed
Hoary Redpoll	<i>Acanthis hornemanni</i>	Sensitive	Not currently scheduled	Not assessed

* The Izok Corridor RSA is outside of the main range for these species

1 CESSC (2011)

2 Environment Canada (2011)

3 COSEWIC (2011)

Raptors

There are nine species of raptors potentially present in the RSA including ravens, which although true passerines, are considered “functional raptors” (Poole and Bromley 1988) because they nest on cliffs where they interact with raptors for nesting territories and build stick nests that can be used by raptors for nesting. Three of these species can be considered ground-nesting raptors (short-eared owl, snowy owl (*Nyctea scandiaca*), and northern harrier (*Circus cyaneus*)). The remaining species (golden eagle, bald eagle (*Haliaeetus leucocephalus*), gyrfalcon, peregrine falcon, rough-legged hawk, and common raven) breed and occupy nests on cliffs in the region. Of these species, the bald eagle is at the edge of its established range, and would be expected to occur as accidental or vagrant only.

The Izok Corridor RSA has an abundance of rocky outcrops that form ridges, mesas and canyons. Many of these have steep faces providing suitable nesting sites for cliff-nesting raptors, and previous surveys have found that nesting raptors are comparatively abundant wherever cliffs are present. In particular, high numbers of peregrine falcons and gyrfalcons have been found in the RSA. Common raven, rough-legged hawk, and golden eagle are also common, with breeding numbers of rough-legged hawks following the three to four-year small mammal cycles (Poole and Bromley 1988). In comparison, ground-nesting raptors appear to be less common throughout the RSA; no ground-nesting sites have been documented during surveys.

Waterfowl

Waterfowl (ducks, loons, geese, and swans) are migratory species and, as such, are protected under the federal Migratory Birds Convention Act. The Arctic is known to provide critically important areas for waterfowl, which use Arctic habitats for migration and staging, breeding, and moulting. Large congregations of waterfowl can occur in certain locations for any of these three purposes. These congregation areas are important since there may be periods when a large proportion of a local



population is present, making them potentially vulnerable to predators, human activities, or severe weather events.

Based on known species ranges and previous field surveys in the Izok Corridor RSA, over 20 species of waterfowl have the potential to inhabit that RSA. Although the RSA contains many small inland lakes and ponds with potential breeding and feeding sites for waterfowl, survey results have indicated that bird densities are relatively low. To date, no large congregations of waterfowl have been found within the terrestrial RSA. The most common species documented in the region during previous surveys include yellow-billed loon (*Gavia adamsii*), red-throated loon (*Gavia stellate*), common merganser (*Mergus merganser*), long-tailed duck (*Clangula hyemalis*) and greater white-fronted goose (*Anser albifrons*).

Tundra Breeding Birds

Tundra breeding birds refers to migratory birds that are not raptors, waterfowl or sea ducks. Songbirds (i.e., passerines) are typical of this category, but shorebirds (e.g., plovers and sandpipers), gulls and terns and upland game birds (ptarmigan) are also included in this group. With the exception of some ptarmigan, birds in this group are seasonal migrants and, similar to waterfowl populations, are protected under the federal Migratory Birds Convention Act. Collectively, tundra breeding birds are an important prey for raptors (Poole and Bromley 1988) and land mammals such as foxes.

Previous work conducted for the Izok and High Lake projects, as well as the Jericho (Hubert and Associates Ltd. 2002) and the Ulu (Echo Bay Mines Ltd. 1997) properties, has documented almost 40 species of upland breeding birds in the region. Some of the most common species appear to be lapland longspur (*Calcarius lapponicus*), savannah sparrow (*Passerculus sandwichensis*), American tree sparrow (*Spizella arborea*), horned lark (*Eremophila alpestris*), and hoary redpoll (*Carduelis hornemanni*). Wet tundra habitats such as sedge and riparian tall shrub are among the most productive habitats for upland breeding birds within this region.

5.7.4.3 Ongoing Studies

Aerial raptor surveys are being conducted in 2012 to document distribution and baseline productivity of raptor species in the study area (i.e. peregrine falcon, gyrfalcon, golden eagle, rough-legged hawk and common raven). The program will involve an aerial survey in early June to document nest site occupancy, and a survey in late July or early August to document site productivity. A single aerial survey is also being conducted in 2012 to document the abundance and breeding distribution of loons and other waterfowl along interior habitats within the Project area. These surveys have been expanded to include the alternate road alignment.

Tundra breeding bird surveys are being conducted to document species composition, distribution and density of passerines, shorebirds and other breeding birds inhabiting terrestrial habitats within the proposed Izok Corridor Project. Surveys will include methods such as the rapid PRISM (Program for Regional and International Shorebird Monitoring) method developed by CWS.

No further studies specifically related to bird species at risk are planned for 2012.



5.8 Marine Environment

5.8.1 Physical Processes and Ice Climate

5.8.1.1 Study Areas

Local Study Area

The LSA for marine physical processes is limited to the footprint of the Grays Bay dock.

Regional Study Area

As there is no potential for the Project to affect marine physical processes beyond the LSA, no RSA has been defined.

5.8.1.2 Description of Existing Environment

Grays Bay is sheltered from Coronation Gulf by Hepburn Island, which is located about 10 km north of the mainland. The high cliffs of the island form an effective wind break for winds blowing out of the north into Grays Bay, and limit the fetch distance for wind-generated waves as compared to conditions out in the gulf.

The Canadian Hydrographic Service publishes tide tables for Kugluktuk and Cambridge Bay, which provide an indication of the potential tidal range at Grays Bay. The 2012 tidal range at Kugluktuk is 0.2-0.5 m, and at Cambridge Bay is 0.2-1.0 m (Canadian Hydrographic Service Tide Tables). Actual measurements will be made at the Grays Bay dock site as part of ongoing engineering work at the port.

Grays Bay is usually ice covered, except for a brief period between mid July and early November. The actual shipping season is much shorter, however, due to ice conditions elsewhere in the Arctic. This is particularly true at the western and eastern ends of Coronation Gulf where ships are forced to navigate into higher latitudes in order to traverse the Northwest Passage. The Annual Ice Atlas (Canadian Ice Service) reported that ice melted completely in Coronation Gulf in July 2011. Ice began forming along the shores of Coronation Gulf during the second week of November, and freeze-up progressed quickly. The Western Arctic was completely ice covered by the third week of November, which was three weeks later than normally reported. Landfast ice began to retreat from shore at Grays Bay in early June 2012, while ice thickness was >1 m within 50 m of shore.

Ice thickness is measured by the Canadian Ice Service at Cambridge Bay. Since 2000, maximum ice thickness at Cambridge Bay has been slightly greater than 2 m. This is considered to be a good approximation of expected ice thickness at Grays Bay.

A preliminary bathymetric survey was undertaken in Grays Bay in 2004 (Challenger Geomatics Ltd. 2004). The survey included the approaches to Grays Bay from Coronation Gulf, as well as Grays Bay itself to confirm a viable shipping channel. The survey was conducted across the site based on a 20 m by 20 m grid. It was determined that water in excess of 20 m deep was present at a distance of less than 100 m from shore, confirming that the site provided the minimum water depth required for ship berthing. Further site investigations were undertaken in 2005 (BGC Engineering Inc. 2006b) to obtain greater detail on bathymetry. Results of the 2005 survey indicated that the bedrock sub-bottom contours



parallel the shoreline shape of the peninsula, dropping to 45 m approximately 100 m offshore (average slope of 24°). In the proposed dock site area, the bedrock slope averages about 20° from the shoreline to a water depth of approximately 15 m, then steepens to about 30° below 15 m.

5.8.1.3 Ongoing Studies

The tidal range at the Grays Bay dock site will be measured as part of ongoing engineering work at the port site. Currents and waves in the LSA around Grays Bay are also under investigation. Instruments (bottom mounted acoustic Doppler current meters) to measure currents and waves near the proposed dock site were deployed in the summer of 2008. The data from those deployments are being processed. A second deployment is planned for the ice-free period of 2012.

5.8.2 Marine Water and Sediment Quality

The study of marine water and sediment quality includes a spatial and temporal characterization of baseline conditions. Water and sediment quality are important components of the marine habitat and changes in their quality may affect the health of marine organisms, and the quality of habitat.

5.8.2.1 Study Areas

Local Study Area

The LSA for water and sediment quality is defined as a 500 m radius from the dock site. This area encompasses the expected maximum extent of direct effects of the Project on marine water and sediment quality.

Regional Study Area

The RSA is arbitrarily set at 2 km from the dock site. Cumulative effects are not expected given the remoteness of the area, and distance from any existing anthropogenic disturbances. Any indirect Project effects are anticipated to be undetectable beyond 2 km from shore.

5.8.2.2 Description of Existing Environment

Water quality in Grays Bay was sampled in August 2005 and August 2008 in support of the High Lake and Izok projects. The 2005 data was presented in the High Lake DEIS (GLL 2006b). The 2008 data was collected as part of baseline investigations conducted by OZ Minerals and has not been previously reported.

Grays Bay is located hundreds of kilometers from any anthropogenic point sources of contamination. The largest influences on water quality are the formation and melting of ice, and inputs of freshwater from the Kennarctic River and smaller streams.

The Kennarctic River carries a relatively high suspended sediment load that produces a plume of turbid water in the ocean. The low salinity and warmer temperature of the river water produce a low density surface layer that overrides the high density oceanic water. The plume location is affected by wind and tide. At times, the turbid water plume extends to the potential dock site location. At other times, the plume is carried to the northeast away from the dock site, and clear water is present at the dock site.



During the August 2008 water quality sampling program, water at the dock site was clear, with a Secchi depth of 8-10 m.

Ice formation and melting mainly affects surface water salinity. During ice formation, salt is excluded from the ice and a high salinity surface layer is formed that is denser than the sub-surface water, which causes it to sink and readily mix with sub-surface water. During ice melt, a low salinity surface layer forms and persists because it is less dense than the sub-surface layer, and requires wind mixing to erode the vertical salinity gradient.

Total metal concentrations in water at Grays Bay are highly dependent on the level of suspended sediments, since sediments typically have elevated metals levels compared to background dissolved metal levels. With a few exceptions, water quality in Grays Bay is reported to be below CCME (2007) marine water quality guidelines for the protection of aquatic life (GLL 2006b). Some samples collected in 2005 had mercury levels greater than the CCME marine guideline of 16 ng/L inorganic Hg. Results of analyses carried out on the 2008 samples indicated that mercury levels were less than the detection limit of 0.5 ng/L. Levels of all other metals analyzed were below guidelines. Dissolved metal levels were in the range that is typical of open ocean water, and lower than CCME guidelines for total metals (Table 5.8-1).

Table 5.8-1 Comparison of Metal Concentrations in 2008 samples with Regulatory Guidelines

Element	Concentration (µg/L)		
	2008 range	Typical Seawater Composition ¹	CCME Marine Guideline
Arsenic	0.54 - 1.23	2.6	12.5
Cadmium	<0.02 - 0.035	0.11	0.12
Copper	0.31 - 0.598	0.9	
Iron	<10	3.4	
Lead	<0.050	0.03	
Mercury	<0.010	0.15	0.016 ²
Molybdenum	6 - 9.6	10	
Nickel	0.057 - 0.558	6.6	
Zinc	<0.5 - 1.08	5	

¹ Turekian (1968)
² Inorganic mercury

Sediments within Grays Bay were sampled in 2004, 2005 and 2008 as part of baseline studies for High Lake and Izok Lake projects. The particle size distribution of samples collected in 2008 indicated that surface sediment is composed primarily of fine sand and silt. Sediment quality analyses found that arsenic, copper and chromium were above the Interim Sediment Quality Guidelines (CCME 2002) at some sites in Grays Bay and the mouth of the Kennarctic River. However, all metal concentrations measured were below Probable Effects Level (PEL).

Water and sediment quality results from sites sampled beyond the LSA were similar to that found within the Grays Bay LSA.



5.8.2.3 Ongoing Studies

Baseline water quality sampling in the Grays Bay Port LSA is being conducted in June and September 2012. Samples will be collected from near surface and near bottom waters. Baseline sediment quality sampling is planned for September 2012 and will coincide with benthic invertebrate sampling. The 2012 data will increase the robustness of the baseline dataset, and permit an inter-annual comparison of results.

5.8.3 Marine Aquatic Organisms and Habitat

5.8.3.1 Study Area

Local Study Area

For marine habitat, the Project Development Area (PDA) is the project footprint under the dock and any other areas where marine habitat will be potentially lost. For marine fauna, the PDA is considered to be part of, and indistinguishable from the Local Study Area (LSA), which is defined as that area where immediate direct and indirect effects of the Project could potentially occur. The boundaries of the area are based on expected dispersal of sediments from Project activities, particularly concentrate, around the dock site in Grays Bay, a distance expected to be a few km from the dock site.

Regional Study Area

The Regional Study Area (RSA) for marine fauna is defined as Grays Bay, as Project effects are not expected to occur beyond the immediate area of the dock site).

5.8.3.2 Description of Existing Environment

The description of marine fauna and habitat within the RSA is based largely on studies conducted in other arctic marine locations.

- A study of test fisheries of the Coppermine River (Gillman and Kristofferson 1984)
- A study conducted during the summer and fall in Coronation Gulf near Kugluktuk (KCC 1993)
- A study conducted during the summer in Melville Sound (RL&L and Golder 2003)
- A study of the status of Cambridge Bay anadromous arctic char stocks conducted for the Canadian Science Advisory Secretariat (Day and de March 2004)

Other field work was conducted in 2002 and 2003 for the Bathurst Inlet Port and Road Project EIS; however, these studies are not publicly available.

Information on the LSA was collected as part of the High Lake Project DEIS, and included reconnaissance-level field sampling at four potential dock sites in summer 2004 and at the preferred dock site in summer 2005 (GLL 2006e).



Regional Study Area

Zooplankton

Zooplankton is responsible for much of the secondary production that occurs in arctic marine waters because most groups and species are herbivores that form a direct link between phytoplankton and higher vertebrate consumers (e.g., fish, birds and marine mammals). Some zooplankton groups contain species that are carnivores, and they compete directly for the secondary production with higher vertebrates.

Zooplankton species composition is generally homogeneous through the Canadian Arctic (Grainger 1965), although it is broadly related to water depth, temperature and salinity (Griffiths et al. 1987; Griffiths and Thomson 2002). Grainger (1965) described two major groups of zooplankton in Beaufort Sea waters <100 m deep based on horizontal and vertical distribution patterns and physical measurements. One characterizes the upper 100 m of arctic surface waters, and has a widespread offshore and inshore distribution. Included are the hydrozoans *Aglantha digitale* and *Aeginopsis laurentii*, the ctenophore *Beroe cucumis*, and several species of copepods: *Calanus hyperboreus*, *C. glacialis*, *Pseudocalanus minutus*, *Metridia longa*, and *Oithona similis*. The second, characteristic of shallow, inshore brackish waters, includes the hydrozoans *Euphysa flamma*, *Halitholus cirratus*, and *Sarsia princeps*; the ctenophore *Obelia* spp.; and the copepods *Limnocalanus macrurus*, *Acartia clausi*, *Eurytemora herdmani*, and *Derjuginia tolli*.

Copepods dominate the zooplankton in the Beaufort Sea and elsewhere in the Arctic (e.g., in Lancaster Sound and Baffin Bay, Buchanan and Sekerak 1982; off the Mackenzie Delta and Herschel Island, Grainger and Grohe 1975; along the Yukon coast, Bradstreet and Fissel 1986, Bradstreet et al. 1987).

Benthic Fauna

Benthic fauna are divided into two main groups based on the habitat that they occupy: epifauna and infauna (Thorson 1957). Epifauna (or epibenthos) inhabit the upper surface of the substrate, and are separated into sessile forms (e.g., sea anemones) and mobile forms (e.g., mysids and some amphipods). Infauna (e.g., bivalves and polychaetes) are found in the bottom sediments, and are usually sedentary.

Sessile epifauna are restricted, for the most part, to hard surfaces, which are rare in the western Arctic. Mobile epifauna are often abundant in inshore areas of the Beaufort Sea during the open-water period (Griffiths and Dillinger 1981; Griffiths and Buchanan 1982; Bradstreet and Fissel 1986). Certain localized habitats in the Beaufort region appear to be very productive, particularly in protected areas on the outer islands of the Mackenzie Delta (e.g., Slaney 1973; Wacasey 1975). Epifauna of the shallow inshore zone of the Beaufort Sea are important ecologically because they comprise major components of the diets of fish, birds, and marine mammals (Divoky 1978; Lowry et al. 1978; Craig et al. 1984).

In the Beaufort Sea, infaunal species diversity and biomass generally increase with depth and distance from shore, from at least beyond the 20-m depth contour to the edge of the continental shelf (Wacasey 1975). Minimum numbers occur at depths of 15–20 m, which correspond closely to the shear zone, the boundary between landfast ice and the moving ice pack. Low densities also occur in depths <2 m, primarily because the landfast ice freezes to the bottom.



Marine Fish

Most arctic marine fish have a predominantly offshore, marine distribution year round. However, there are three species that migrate near shore during summer and inhabit brackish water environments in large numbers. They are the fourhorn sculpin, arctic flounder, and saffron cod. The arctic cod is abundant throughout the Arctic Ocean and can be quite abundant in nearshore areas.

*Arctic Cod (*Boreogadus saida*)* - The arctic cod has a circumpolar distribution and is ubiquitous in marine waters of arctic Canada and Alaska (e.g., Bradstreet et al. 1986; Welch et al. 1993; Hop et al. 1997). In nearshore coastal waters, arctic cod abundance during summer is highest where salinities are highest, and lowest where conditions are more brackish. Schooling likely affects local abundance. Arctic cod are often observed in large age-segregated schools (e.g., Welch et al. 1993) that may form under ice to feed (e.g., Moulton and Tarbox 1987), or as protection against predators (e.g., Hop et al. 1997). The movement of the large schools into coastal areas can be either short lived (Craig and Haldorson 1981) or sustained (Glass et al. 1990).

The arctic cod is an important food item in the diets of marine mammals, birds and fish, and is considered to be a primary component of the arctic marine food chain (Bradstreet et al. 1986; Hobson and Welch 1992). Arctic cod feed on planktonic and epibenthic fauna; dominant prey items are mysids, amphipods, and copepods (e.g., Craig and Haldorson 1981; Coyle et al. 1997).

Arctic cod was the fourth most numerous harvested fish recorded in Kitikmeot (Priest and Usher 2004). Average annual catches recorded for Kugluktuk and Cambridge Bay between 1996–1997 and 2001–2002 were 768 and 56, respectively.

*Fourhorn Sculpin (*Myoxocephalus quadricornis*)* - The fourhorn sculpin is a demersal species that has a circumpolar nearshore distribution in brackish and moderately saline waters (Scott and Crossman 1973; Morrow 1980). This species migrates onshore into brackish coastal habitats during summer to feed, and can travel considerable distances up rivers. Fourhorn sculpins live permanently near the coast and do not undergo extensive migrations. They rarely occur deeper than 15–20 m (Andriyashev 1954).

The fourhorn sculpin was taken in relatively high numbers near Kugluktuk (KCC 1993) and in relatively low numbers in Melville Sound (RL&L and Golder 2003). Although they have no commercial or subsistence use, they serve as forage for fish and birds (Griffiths et al. 1975; Kendel et al. 1975; Craig and Haldorson 1981).

*Flounder (*Pleuronectes glacialis*)* - The arctic flounder is a bottom-dwelling circumpolar marine species, typically found in shallow coastal waters during summer when it commonly enters low-salinity habitats (e.g., Morrow 1980). It is uncommon east of Cape Bathurst (Stewart et al. 1993).

Arctic flounder were taken in relatively low numbers near Kugluktuk (KCC 1993) and in Melville Sound (RL&L and Golder 2003). The starry flounder *Platichthys stellatus* ranges east to the Coronation Gulf, Melville Sound, and Bathurst Inlet (Stewart et al. 1993). Off the Coppermine River, Gillman and Kristofferson (1984) found starry flounder but not arctic flounder. Starry flounder were taken in relatively low numbers near Kugluktuk (KCC 1993) but not in Melville Sound (RL&L and Golder 2003).

*Saffron Cod (*Eleginus gracilis*)* - The saffron cod is found in brackish and marine waters of the Beaufort Sea east to Bathurst Inlet (Walters 1955). It frequently enters rivers and can go considerable distances upstream (Morrow 1980). Saffron cod can be found both nearshore and offshore during summer (e.g.,



Byers and Kishino 1980). It is the least abundant of the "onshore" marine species. Off the Coppermine River, Gillman and Kristofferson (1984) found small numbers of saffron cod. They were taken in relatively high numbers near Kugluktuk (KCC 1993) and in Melville Sound (RL&L and Golder 2003).

Bering Wolffish (Anarhichas orientalis) - The only Canadian records of the Bering wolffish were three individuals recorded in Bathurst Inlet (Houston and McAllister 1990). For that reason, the species was considered a threatened species by COSEWIC in 2001, although its status has since been downgraded because of a lack of data (NPC 2004). Because of its highly specialized and localized habitat, the NPC has recommended that the species deserves special management consideration (NPC 2004). A probable Bering wolffish (specimen photographed, but not retained) was caught near Kugluktuk in summer 2004 (T. Gordanier, DFO, in litt. 2005). The Bering wolffish is usually found in shallower water than other wolffish, and it prefers algae-covered rocky bottoms. It moves into deeper waters when ice forms.

Offshore Marine Species (excluding arctic cod) - There have been only a few offshore surveys of demersal fish in the western Arctic, and these have been focused on the Beaufort Sea. Surveys of demersal fish in the offshore waters (>50 km offshore) of the western and central Beaufort Sea have identified 17 species of marine fish (Frost and Lowry 1983). Incidental takes from nearshore studies have identified an additional dozen or so "deepwater species". They include 10 species of sculpin, 2 poachers, 4 snailfish, 10 eelpouts, 5 pricklebacks, 2 wolffishes, and 1 species of gunnel. They reflect a numerically low, yet geographically extensive, marine faunal assemblage throughout arctic marine waters. McAllister (1962) suggested that this "Innuvit" faunal assemblage extends continuously from the central Canadian Arctic westward through the Beaufort, Chukchi, East Siberian, Laptev, Kara, and Barents seas.

Anadromous Fish

Anadromous fishes are hatched and initially reared in freshwater river systems before migrating to sea, where they spend most of their lives before returning to their natal streams as adults to spawn.

Arctic Cisco (Coregonus autumnalis) - Arctic cisco remains associated with drainages that are extensive enough to provide sufficient habitat during winter. In the eastern Beaufort Sea, only the Mackenzie River appears large enough to support substantial stocks of sub-adult and adult fish as well as juveniles and fry (Bond 1982). Arctic cisco was the second and fifth most abundant fish found near Kugluktuk (KCC 1993) and off the Coppermine River (Gillman and Kristofferson 1984), respectively. It is rarely reported in Kitikmeot in the Nunavut Wildlife Harvest Study (Priest and Usher 2004).

Rainbow Smelt (Osmerus mordax) - Most coastal fish surveys report taking small to moderate numbers of rainbow smelt, but catch rates are typically the lowest of the anadromous and amphidromous species. Rainbow smelt was the sixth most abundant fish found near Kugluktuk (KCC 1993), but was not found off the Coppermine River (Gillman and Kristofferson 1984) or in Melville Sound (RL&L and Golder 2003). It is not reported in the Nunavut Wildlife Harvest Study (Priest and Usher 2004).

Amphidromous Fish

Amphidromous fish cycle annually between freshwater and coastal marine environments. Amphidromous fish spawn and overwinter in rivers and streams but migrate out into coastal waters for several months each summer to feed.

Arctic char (Salvelinus alpinus) and Dolly Varden (Salvelinus malma) - Arctic char is the most northerly-distributed freshwater fish in Nunavut, and has a circumpolar presence in marine waters, lakes, and



rivers. Arctic char can exist as landlocked and anadromous forms, with the latter moving to salt water in the spring and returning to spawn in the summer to early fall. The Dolly Varden is common along much of the Beaufort Sea coast during summer (Fechhelm et al. 2000), but abundance drops markedly east of Phillips Bay on the Yukon coast (Kendel et al. 1975).

Arctic char was the fourth most abundant fish taken near Kugluktuk (KCC 1993), and the third most abundant fish taken in Melville Sound (RL&L and Golder 2003). Arctic char was the most numerous harvested fish recorded in Kitikmeot (Priest and Usher 2004). Average annual catches recorded for Kugluktuk and Cambridge Bay between 1996-1997 and 2001-2002 were 8518 and 6461, respectively. The commercial char fishery in Cambridge Bay, carried out at the mouths of various rivers in the area, averaged 41,000 kg round weight per year during 1960-2003 (Day and de March 2004). The Draft West Kitikmeot Regional Land Use Plan highlighted the need for special management of the species and its habitat in areas located near communities and those used by the commercial fishery (NPC 2005).

Least Cisco (Coregonus sardinella) - Amphidromous least cisco have a discontinuous distribution in the Beaufort Sea (Craig and McCart 1975; Craig 1984, 1989); eastern populations are associated primarily with the Mackenzie River watershed. Eastward of the Mackenzie Delta, fry, juveniles, and adults are found along the Tuktoyaktuk Peninsula, and have been reported to be quite abundant beyond Cape Dalhousie at Wood Bay (Bond and Erickson 1993). Least ciscos were found in small numbers off the Coppermine River (Gillman and Kristofferson 1984). They were rarely reported in Kitikmeot (except for Goa Haven) in the Nunavut Wildlife Harvest Study (Priest and Usher 2004).

Whitefish (Coregonus clupeaformis complex) - Humpback whitefish have a discontinuous distribution in the river systems of the Beaufort Sea. Eastern populations are associated with the Mackenzie River and several smaller rivers of western arctic Canada (Craig 1984). They are intolerant of high salinity conditions and remain in brackish nearshore waters and river deltas during summer. The only whitefish reported in the Nunavut Wildlife Harvest Study was lake whitefish, and it was the second most numerous fish recorded in Kitikmeot (Priest and Usher 2004). Lake whitefish was the fifth most abundant fish found near Kugluktuk (KCC 1993) and the fifth most abundant fish found off the Coppermine River (Gillman and Kristofferson 1984).

Inconnu (Stenodus leucichthys) - Amphidromous inconnu are present in most of the Mackenzie River drainage and east to the Anderson River (Morrow 1980). They were rarely reported in Kitikmeot in the Nunavut Wildlife Harvest Study, and according to hunters from Kugluktuk, inconnu are not found near there (Priest and Usher 2004).

Freshwater Fish

Many freshwater fish can tolerate low levels of salt water such as are commonly found in brackish water estuaries or where large rivers may enter the sea. Several species of freshwater aquatic organisms are occasionally found in shallow coastal habitats of Coronation Gulf, including lake trout and arctic grayling.

Local Study Area

During August/September 2004 and July 2005, plankton, benthos, intertidal, water quality, bottom trawls, gill net surveys were conducted in the vicinity of proposed dock facilities in Grays Bay. Sampling effort in 2004 extended from Dock Site 1 to Dock Site 4 and included zooplankton, benthic and sediment sampling, intertidal surveys, and fishing with gill nets. In 2005, sampling activities focused at Dock Site 2,



the proposed location of the Izok Corridor Project dock, and included benthic sampling, diver-operated underwater video, temperature-salinity profiles, and fishing with gill nets and a bottom trawl.

Temperature, Salinity, and Oxygen

In July 2005, water temperature decreased and salinity increased with depth. There was evidence of a thermocline and a halocline at various depths and times. Water temperatures ranged from 4.2 to 6.7°C at the surface to 0.5°C at 15 m. Salinity was relatively low and variable at the surface (15.6–20.4 ppt), but more constant at depths of 5 to 10 m depths. The highest salinity was recorded at 15 m. Dissolved oxygen content was high (12.5–13.6 mg/L) and increased slightly with depth, likely because oxygen is more soluble in cold water. At all depths and locations, the water was supersaturated (110–117%) with oxygen.

Zooplankton

The zooplankton collected in Grays Bay had a similar species composition to zooplankton described earlier by Grainger (1965) as characteristic of the upper 100 m of arctic surface waters, with a widespread offshore and inshore distribution. Density and biomass were similar to those reported in other arctic locations (e.g., Buchanan and Sekerak 1982).

Copepods dominated zooplankton numbers (90.5%) and biomass (44.9%). Larvaceans (mostly *Fritillaria borealis*) ranked second in terms of numbers (6.0%) but contributed little to biomass (1.2%) because of their small size. Other larger but less numerous taxa contributed to the rest of zooplankton biomass. Echinoderm larvae and barnacle larvae contributed very little to biomass and numbers.

Benthos

Samples of infaunal benthos collected in 2004 and 2005 were similar in terms of biomass, densities, and group and species composition. Somewhat lower densities and biomasses were reported in 2004, which is likely attributable to the deeper depths sampled in that year; the minimum density and biomass in 2004 were from the deepest depth sampled (30 m).

The group and species composition of infauna collected in Grays Bay were generally similar to those collected in other arctic locations (e.g., Thomson 1982). Biomasses were also similar, but densities were higher than those found at similar depths in other arctic locations (e.g., Cross and Thomson 1981, 1987; Thomson 1982).

Epibenthos

The bottom trawl used to capture demersal fish also sampled larger epibenthic invertebrate species, which included starfish (*Urasterias lincki*) and sea urchins *Strongylocentrotus* spp.).

Observations of substrate and biota were made in 12 intertidal sample areas. Substrate varied from fine sand to bedrock, with the following observed: biota none (five samples), encrusting green algae (six samples), brown filamentous algae (four samples), and small numbers of amphipods (three samples).

Marine Habitat

Based on underwater video recordings, substrates in deep (>10 m) water were found to be composed a silt with widely scattered small rocks on the surface. Numerous siphon holes of infaunal bivalves were evident. At depths of 10–20 m, sea urchins were numerous, large starfish were less numerous but



common, and crabs were seen in low numbers on most transects. In some areas, there were patches of anemones. At >20 m depths, brittle stars and large bivalve siphons were abundant and there appeared to be a mat of filamentous algae on the sediment surface.

As water depth decreased, there were increasing amounts of gravel and rock with generally the same fauna. Farther inshore (<5 m depth), rocks and boulders covered the bottom completely, with patches of seaweed (*Fucus* sp.) and filamentous algae attached to them, in some places widely scattered and in others very dense. In very shallow water (<2 m), the substrate consisted of bedrock or large boulders, and the only visible biota were filamentous algae.

Based on analysis of the underwater video, areas of low-, medium-, and high-quality marine habitat within the PDA were 70.8 ha (88% of total area), 2.8 ha (3.4%), and 6.9% (8.6%), respectively. Ratings were assigned according to bottom features, which were in turn related to water depth. Habitat was of low quality at 0–2 m (bedrock or large boulder) and >10 m deep (few biota, sediment with occasional rocks); high quality at 2–5 m deep (some biota, mixed large rock substrate); and 50% low and 50% medium quality at 5–10 m deep (gravel of small rocks on sediment with gravel patches).

Fish

During the 2004 surveys, a total of 53 arctic char, 20 arctic cisco, 2 unidentified cod, and 1 lake trout were captured in 27 gillnet sets. During the July 2005 surveys, 6 arctic char, 2 arctic cisco, 1 saffron cod, and 1 least cisco were captured during 4 gillnet sets at the preferred dock site. Only 2 fish were captured in 8 bottom trawls. Both specimens were the spatulate sculpin (*Icelus spatula*).

Two other studies conducted near Grays Bays had similar levels of gillnetting effort as the 2004/2005 surveys (KCC 1993; RL&L and Golder 2003). Overall standardized catch rate in Grays Bay (33.9) was intermediate between those observed near Kugluktuk (187) and in Melville Sound (8.6). The standardized catch rates for arctic char in Grays Bay (23 in each of 2004 and 2005) were similar to that near Kugluktuk (23), but much higher than in Melville Sound (<1). However, fish species diversity at Grays Bay was 42% and 71% of that observed at Kugluktuk and Melville Sound, respectively. Lake whitefish, arctic grayling, pacific herring, rainbow smelt, fourhorn sculpin, arctic flounder, starry flounder, longhead dab, and Greenland cod were absent in catches from Grays Bay.

Traditional knowledge and harvest studies have indicated that Grays Bay is not an important location for subsistence or commercial harvest of arctic char. This lack of use may be attributable to the remote location of Grays Bay from communities in West Kitikmeot.

5.8.3.3 Ongoing Studies

The 2012 field program includes sampling within Grays Bay to characterize the infaunal benthos and demersal fish and macroinvertebrates in and near the proposed dock footprint, and establish a baseline for a future infaunal benthos monitoring program off the proposed dock site and at a nearby control site.



5.8.4 Marine Mammals and Habitat

5.8.4.1 Study Area

Local Study Area

The Project Development Area (i.e., the project footprint) is considered to be part of, and indistinguishable from, the LSA which encompasses that area where immediate direct and indirect effects of the Project could potentially occur based on modelled pressure level thresholds of underwater sound produced by Project activities. The LSA for marine mammals is defined as distances, expected to be on the order of tens of kilometers, around the dock site in Grays Bay and on either side of the shipping route from Grays Bay to the boundaries of Nunavut in Amundsen Gulf and Lancaster Sound.

Regional Study Area

The RSA for marine mammals is defined as the marine waterways from shore to shore and coastal areas west along the existing shipping route in Coronation Gulf through Dolphin and Union Strait to the boundary of Nunavut in Amundsen Gulf, and east from the existing shipping route in Coronation Gulf through Peel Sound to Lancaster Sound.

For most of the year, virtually all of the RSA is icebound. The proposed shipping period is during the open-water period. However, even during that period, the entire RSA is rarely ice free. Heavy ice cover typically remains in the central Arctic Archipelago (e.g., Larsen Sound). The distribution and abundance of marine mammals in the LSA and RSA are highly dependent on the extent and nature of the ice cover.

5.8.4.2 Description of Existing Environment

There is little existing information on marine mammals in Coronation Gulf. There is only one previous publication (Stewart and Burt 1994), which reported extralimital occurrences of beluga and walrus. In addition, the High Lake Kitikmeot Inuit Qaujimagatuqangit (IQ) study (GLL 2006f) contains some information on marine mammals. Indirect evidence of their presence is found in the Nunavut Wildlife Harvest Study (Priest and Usher 2004). Reports of belugas and narwhals in Coronation Gulf in 2011 appeared in the northern newspaper Nunatsiaq.

Field studies were conducted in Coronation Gulf in spring and summer 2004 in support of the High Lake Project DEIS (GLL 2006g). This included aerial seal surveys in Grays Bay and adjacent ice-covered water, covering an area of 608 km² at longitudes 110.3–111.4°W and an east-west distance of 46 km from the mainland coast to about 35 km offshore.

Information on marine mammals in the RSA includes existing literature reviews (e.g., CCG 1990; Thomson et al. 1992; CAC 1993; Thomson et al. 1995), as well as research publications. There are considerable data from earlier studies on the distribution and abundance of marine mammals from western Amundsen Gulf and westward, and from Peel Sound eastward. However, those studies covered primarily areas of the eastern and western High Arctic. The most substantial data gap is the area from eastern Amundsen Gulf through Coronation Gulf and Queen Maud Gulf north into Larsen Sound.

Field studies were conducted along the proposed shipping routes in spring and summer 2004 in support of the High Lake Project DEIS (GLL 2006g). These included aerial surveys to gather reconnaissance-level



information on the occurrence of marine mammals in the west-central High Arctic, where relatively few surveys of marine mammals had been conducted. The surveyed area included both the LSA and the RSA. Survey coverage extended from Amundsen Gulf east to southwestern Devon Island and Somerset Island.

Regional Study Area

Baseline conditions for key marine mammal species within the RSA are described below. **Table 5.8-2** summarizes the status of all species in the RSA under the *Species at Risk Act* (SARA) (Government of Canada 2003), the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and the Government of the Northwest Territories (GNWT).

Table 5.8-2 Conservation Status of Marine Mammals that occur in the RSA

Species	Population	Status		
		SARA ¹	COSEWIC ²	GNWT ³
Ringed seal (<i>Pusa hispida</i>)	Arctic Ocean	NL	NAR	NL
Bearded seal (<i>Erignathus barbatus</i>)	Arctic Ocean	NL	DD	NL
Harp seal (<i>Phoca groenlandica</i>)	Canada	NL	NL	NL
Walrus (<i>Odobenus rosmarus</i>)	Atlantic	NL	SC	NL
Beluga whale (<i>Delphinapterus leucas</i>)	E Beaufort Sea	NL	NAR	NL
	E High Arctic-Baffin Bay	S3: SC ⁴	SC	NA
Bowhead whale (<i>Balaena mysticetus</i>)	Eastern Arctic	S2: EN	NA	NA
	E Canada-W Greenland	NA	SC	NA
	Bering-Chukchi-Beaufort	S1: SC	SC	SC
Narwhal (<i>Monodon monoceros</i>)	Arctic Ocean	NL	SC	NL
Polar Bear (<i>Ursus maritimus</i>)	Canada	S1: SC	SC	SC

NA = Not applicable

1 Species at Risk Act: S1=Schedule 1, S2=Schedule 2, S#=#Schedule 3, NL=Not listed, SC=Special Concern, EN=Endangered

2 COSEWIC (2011): NL=Not Listed; NAR=Not at Risk; SC=Special Concern; DD = Data Deficient

3 GNWT (2012): NL=Not Listed, NA=Not Applicable, SC=Special Concern

4 Under consideration for addition to Schedule 1

Ringed Seal

The ringed seal has a continuous circumpolar distribution and is the most abundant marine mammal in the Canadian Arctic. The numbers of seals hauled out on the ice in spring have been estimated, but the estimates may substantially underestimate the actual population sizes: at least 40,000 in the Canadian Beaufort Sea (Stirling et al. 1981a); 50,000 in northern Amundsen Gulf (Kingsley 1990); and 90,000 in the Canadian High Arctic (Kingsley 1985, 1990). There can be large natural variations in their numbers in an area over short periods (Stirling et al. 1977, Smith and Stirling 1978, Harwood and Stirling 1992).

Ringed seals are year-round residents in the Arctic and are highly adapted for living in arctic conditions. Ice conditions influence ringed seal distribution and abundance (Smith and Stirling 1975, 1978; Moulton et al. 2002) as they haul out on sea ice to moult and rest. They maintain breathing holes in landfast sea ice through the ice-covered period, and give birth to young on the ice in subnivean lairs in April. Newborn pups rely on their white fur, high metabolic rates, and the birth lair for protection from the cold. Newborn pups enter the water to escape predation, however, they must return to the birth lair to prevent hypothermia (Smith et al. 1991). Ringed seals also breed in the pack ice (Finley et al. 1983; Kelly 1988).



During the spring moulting season, ringed seals are dispersed at low densities on top of the ice, and seem to prefer areas with high ice cover and water depths of 50–75 m (Stirling et al. 1982). During summer, they are dispersed throughout open-water areas. Ringed seals are capable of moving distances of 1,000 km or more during summer, although they tend to show site fidelity (Teilmann et al. 1999).

Ringed seals feed primarily on fish (especially arctic cod) and large crustacean zooplankton such as amphipods, euphausiids, epibenthic mysids, and decapods (Lowry et al. 1980; Bradstreet et al. 1986; Smith 1987).

During the 2004 field surveys, there were 47 sightings of 59 ringed seals. Nine sightings of 10 bearded seals were also observed throughout the survey area. One harp seal was tentatively identified, along the coast of the Boothia Peninsula. These results must be interpreted with caution, as seals are difficult to detect in the open water from a fast-moving aircraft flying at an altitude of 500 feet; most individuals were probably not detected.

Beluga Whale

The beluga has a circumpolar distribution, with two populations that summer in the RSA: the Eastern Beaufort Sea (EBS) and Eastern High Arctic–Baffin Bay (EHA-BB) stocks (COSEWIC 2011). The former stock summers in the Canadian Beaufort Sea and Amundsen Gulf, and winters in the Bering and Chukchi seas (Finley et al. 1987). The latter stock summers in the Canadian High Arctic and winters in Baffin Bay.

The EBS stock occurs along the proposed shipping route from Grays Bay to the west. The most recent population estimate for the EBS Stock, based on surveys in 1992 (Harwood et al. 1996) corrected for animals below the water surface, is 39,258 (Allen and Angliss 2011). The spring migration from the Bering Sea occurs primarily in April/May through leads off northern Alaska and the Yukon. The belugas arrive off Banks Island and Cape Bathurst in late spring (Fraker 1977, 1979), and move back along the seaward edge of the landfast ice off the Tuktoyaktuk Peninsula toward the Mackenzie River estuary (Fraker and Fraker 1982; Norton and Harwood 1986). Typically, they begin arriving in late June to early July (FJMC 2001) and concentrate in the generally ice-free waters in greatest numbers during late June to mid July. By late July and early August, relatively few whales are present in the estuary. The autumn migration from the Canadian Beaufort Sea begins during late August–early September, with the majority of autumn migrants traveling through offshore waters, near and within the pack-ice edge (Davis and Evans 1982; Frost et al. 1988; Hazard 1988; Clarke et al. 1993; FJMC 2001).

The summer range of the EHA-BB stock overlaps in part with the proposed eastern shipping route. Innes et al. (2002) provided an abundance estimate of 21,213. Belugas typically do not occur in the central Arctic Archipelago but there are extralimital records of beluga whales in Coronation Gulf at Kugluktuk, Cambridge Bay, and Bathurst Inlet, and at Taloyoak.

The EHA-BB stock winters in loose pack ice along the west coast of Greenland (e.g., McLaren and Davis 1983), and in the North Water polynya in northern Baffin Bay (e.g., Richard et al. 1998, 2001; Heide-Jørgensen et al. 2003a). They enter Lancaster Sound between late April and early May (Finley and Renaud 1980) and late June/July (Davis and Finley 1979; Koski et al. 2002). The core summering range is in offshore and coastal waters around Somerset Island: in Prince Regent Inlet, Barrow Strait, and Peel Sound. During mid July to mid August, belugas concentrate in large groups of up to several thousand in a few shallow estuaries on Somerset Island (e.g., Smith et al. 1985; Koski et al. 2002).



Most belugas leave the estuaries by mid August, and a large proportion shifts to Peel Sound and Franklin Strait (Richard et al. 2001; Koski et al. 2002), using several bays on Prince of Wales Island and the Boothia Peninsula and making daily trips to the Franklin Trench, frequently diving to the seabed (Smith and Martin 1994; Richard et al. 2001; Heide-Jørgensen et al. 2003a). They migrating out of the central High Arctic in mid to late September mostly within 400 m of the south coast of Devon Island (Davis and Finley 1979; Koski and Davis 1979, 1980; Heide-Jørgensen et al. 2003a). Most pass through Lancaster Sound in less than a week (Koski et al. 2002).

During the 2004 field surveys, belugas were observed at either end of the survey area, in eastern Amundsen Gulf and Dolphin and Union Strait, and in Peel Sound and Radstock Bay, southwestern Devon Island. No belugas were seen between Dolphin and Union Strait and southern Peel Sound.

To the west, 56 belugas were observed in eastern Amundsen Gulf, including adults, calves and possibly subadults. Four belugas were sighted in Dolphin and Union Strait. To the east, belugas were observed along the southeastern coast of Prince of Wales Island, in Peel Sound, and in Radstock Bay, Devon Island. No belugas were seen in Peel Sound south of Coningham Bay, in Prince Regent Inlet from Creswell Bay to Lancaster Sound, or in Barrow Strait. Along the southeastern coast of Prince of Wales Island, a large group estimated at about 120 individuals was sighted along the coast between Willis Bay and Coningham Bay. Between Willis Bay and Cape Brodie, 52 belugas were sighted along the coast. North from Cape Brodie, there were 12 sightings of 21 belugas along the centre line of Peel Sound, including single animals, adult-young pairs, and groups of 3 or 4. In Radstock Bay, about 270 belugas were sighted, including adults and calves.

Narwhal

The narwhal inhabits deep marine waters of the eastern Canadian Arctic from northern Hudson Bay and Davis Strait west to the central Arctic Archipelago (Reeves et al. 2002). It does not traditionally occur in the Beaufort Sea or elsewhere in the western Canadian Arctic, although it was seen off Cambridge Bay in August 2011. Those that summer in the Canadian High Arctic winter in Baffin Bay.

Innes et al. (2002) estimated that 45,358 narwhals summer around Somerset Island. Up to 10,000 can summer in Admiralty Inlet, 3000 in Eclipse Sound, and 10,000 in Prince Regent Inlet. About 2000 narwhal summer in Peel Sound and 1000 in Barrow Strait. Numbers in each area vary from year to year (Fallis et al. 1983; Smith et al. 1985; Koski and Davis 1994; Richard et al. 1994).

Narwhals winter in very heavy pack ice in northern Davis Strait and southern Baffin Bay (McLaren and Davis 1982). In spring, they move north through the loosening pack ice and appear near and in Lancaster Sound in April, entering Pond Inlet and Lancaster Sound in late June/July after breakup of the ice edge, with the peak movement westward into the central High Arctic occurring in late June and July. In summer, they do not frequent shallow waters or estuaries (as do many belugas) but prefer deep-water fiords, inlets and channels (Born et al. 1994; Dietz et al. 1994; Kingsley et al. 1994; Richard et al. 1994; Heide-Jørgensen et al. 2003b). Most narwhals summer in the fiords of northern Baffin Island and others summer in Prince Regent Inlet and the Gulf of Boothia, with smaller numbers in Barrow Strait and Peel Sound (Fallis et al. 1983; Smith et al. 1985; Koski and Davis 1994; Richard et al. 1994; Heide-Jørgensen et al. 2003b). During summer, narwhals do not move great distances (Heide-Jørgensen et al. 2003b).

Narwhals return to Baffin Bay via Lancaster Sound at a much slower pace than do belugas (Finley and Johnston 1977). Initially, they are dispersed in open water and remain there as long as open water



permits, mostly in offshore waters of the passages among the central Arctic islands. By mid to late September, most have moved into Lancaster Sound near the north and south coasts during at least the first part of the migration (Koski and Davis 1980; Heide-Jørgensen et al. 2003b). The pace of outbound migration then becomes very rapid, and most have left by mid October (Heide-Jørgensen et al. 2003b).

During the 2004 field surveys, narwhals were recorded only on 17 September, when one group of about 12 was observed north of Prince Leopold Island in western Lancaster Sound, and another 25 were seen in Radstock Bay.

Bowhead Whale

The bowhead whale is a large, slow-moving arctic baleen whale that is well adapted for living in ice-covered waters. Two stocks are found in the RAA: the Bering-Chukchi-Beaufort Sea (BCB) Stock and the Davis Strait-Baffin Bay (DS-BB) Stock (Davis and Koski 1980; Finley 2001). The most recent abundance estimate for the BCB Stock is 10,545 (Allen and Angliss 2011). This population has been increasing in recent decades (George et al. 2004). The DS-BB Stock has increased in size from the early 1980s (Koski et al. 2006; Heide-Jørgensen et al. 2007) to the present; the currently accepted estimate is 6344 (IWC 2009), but that estimate could be negatively biased.

Bowhead whales of the BCB stock winter in the central and western Bering Sea, and most of the stock summers in the Canadian Beaufort Sea and Amundsen Gulf (Moore and Reeves 1993). The spring migration across the western Beaufort Sea occurs through offshore ice leads, generally during mid April to mid June (Braham et al. 1984; Moore and Reeves 1993). Most whales remain in offshore waters (>200 m deep) among the pack ice in the central and eastern Beaufort Sea until they begin to move toward coastal and nearshore areas during late July to mid August (Davis et al. 1982). There, they feed in dense patches of zooplankton (Bradstreet et al. 1987) that are associated with fronts and discontinuities in the ocean (Thomson et al. 1986). Fall migration out of the Canadian Beaufort Sea to the Bering Sea typically occurs from early September to late October. The Inupiat people of northern Alaska hunt bowhead whales during the spring and fall migrations.

Bowheads from the DS-BB Stock apparently winter primarily in Hudson Strait, and in smaller numbers in Baffin Bay (Koski et al. 2006). They summer in northern Hudson Bay-Foxe Basin and in the central High Arctic. Migration into the eastern and central High Arctic occurs through Lancaster Sound from early/mid May to early August, with a peak in late June (Davis and Koski 1980). About half of the existing DS-BB Stock summer in the bays and passages of the central and eastern High Arctic islands during August and September (Davis and Koski 1980; Koski and Davis 1980), especially Isabella Bay (eastern Baffin Island), Eclipse Sound (northern Baffin Island), Milne Inlet, Admiralty Inlet, and Prince Regent Inlet, with the latter area considered to be a major nursery area (Lubbock 1937). A few bowheads occur in the Peel Sound/Franklin Strait area and in Barrow Strait (Davis and Koski 1980; Davis et al. 1980). Fall migration out of the eastern Arctic Archipelago occurs during late August/October. In late August/September, whales that summer in Prince Regent Inlet and areas to the west migrate to the north coast of Baffin Island, and those that summer in Eclipse Sound move north through Navy Board Inlet then east along Bylot Island (Koski and Davis 1980) and the east coast of Baffin Island (Finley 1990, 2001). The migration is within 1.5 km of the coast and rapid, averaging 5 km/h (Koski and Davis 1980).

During the 2004 field surveys, only one group of two bowhead whales (a large individual and a smaller animal (adult and young)) was sighted in Radstock Bay, southwestern Devon Island.



Polar Bear

The polar bear is distributed throughout the circumpolar Arctic in a number of relatively discrete populations (Stirling et al. 1984), four of which occur along the proposed shipping routes: the Lancaster Sound (population size 1700) and M'Clintock Channel (240) populations to the east, and the Northern Beaufort Sea (1200) and Southern Beaufort Sea (1800) populations to the west (Lunn et al. 2002).

The local distribution and abundance of polar bears vary through the year, and are strongly influenced by those of their principal prey, the ringed seal, and by the presence or absence, distribution and quality of sea ice. During winter and spring, most polar bears are found on the sea ice (Amstrup 2000). They tend to concentrate along pressure ice that parallels the coasts and near floe edges, where they are able to hunt seals most effectively (Stirling et al. 1984). In summer, when the pack ice retreats offshore, polar bears are found along the edge of the pack ice (DeMaster and Stirling 1981; Amstrup 1995). During years with little or no pack ice near the coast, polar bears are often found along the coastline and on barrier islands (Stirling 1974).

In December, females give birth in snow dens in coastal areas or on the ice. Polar bear dens are concentrated in some areas, but throughout the central Arctic, denning occurs at low densities along most coastlines that have been investigated (Stirling et al. 1979, 1981b; Schweinsburg et al. 1981). In the Beaufort Sea, most denning occurs on heavy pack ice (Lentfer 1975, Amstrup and Gardner 1989). In late March to early April, females with cubs return to the sea ice to hunt seals, usually concentrating in places where ringed seals are pupping (Davis et al. 1980).

During the 2004 field surveys, there were two sightings of polar bears on 18–19 September, one a single individual pulling itself out of the water onto an ice pan off the western coast of the Boothia Peninsula south of Weld Harbour, and an adult and two cubs feeding on a seal northwest of Gateshead Island in southern M'Clintock Channel. Both sightings were in areas of heavy ice cover (95–99%). In addition, five kill sites (presumably by polar bears) were seen in eastern Larsen Sound and southern Franklin Strait (two kills) and in the vicinity of Gateshead Island (three kills) during surveys on 17–19 September. Polar bear tracks were seen in two locations: north of Prince Leopold Island in western Lancaster Sound, and off the western coast of the Boothia Peninsula very near the first bear sighting. All the kill sites and one set of tracks were in areas of heavy ice cover (>90%). The tracks in Lancaster Sound were in <20% ice cover.

Local Study Area

Ringed Seal

During the 2004 field surveys, ringed seals were widely distributed throughout the LSA. A total of 1936 ringed seals were seen on transect, many undoubtedly the same individuals seen on other days. The surveys covered 2802 km² of fast ice habitat. The observed overall uncorrected density of seals was 0.69/km² for the combined survey replicates. This density is well within the normal range of densities for ringed seals seen during studies in other landfast-ice areas in the Canadian and U.S. Arctic. Ringed seals were observed in most parts of the study area, but there was an obvious tendency for lower densities in the shallowest parts of the bay and along the shoreline.

During the period from 1996 to 2001, ringed seal harvests were reported for all four communities on Coronation Gulf (Priest and Usher 2004). A low number of seals harvested from Bathurst Inlet and



Umingmaktok. Kugluktuk recorded the highest harvest, with an average of ~280 per year, most (76%) of which were harvested in August and September with smaller numbers harvested in every other month. The harvest in Cambridge Bay increased from 38 in 1996/1997 to 277 in 2000/2001, with an average of about 96 per year. These were harvested mostly in July to September and May and June), with small numbers taken in November, December, March and April. The peninsula immediately southeast of Hepburn Island was identified as an area where seals are hunted in spring or summer (GLL 2006g).

Bearded Seal

During the 2004 field surveys, there were a total of 33 sightings of bearded seals (35), some possibly re-sightings of the same individuals on different days. Sightings appeared to be well dispersed within the LSA.

Bearded seal harvests were reported for all communities on Coronation Gulf except Cambridge Bay during 1996–2001 (Priest and Usher 2004). The numbers of seals harvested were low in all communities. Kugluktuk recorded the highest harvest, with an average of two bearded seals per year. Bearded seals were taken from May to September, with the majority harvested in July.

Beluga Whale

Belugas usually do not penetrate the area between Dolphin and Union Strait and Victoria Strait (Stewart and Burt 1994). However, in some years, probably because of favourable ice conditions, they have been observed or harvested. Stewart and Burt (1994) noted that only one beluga was harvested at Kugluktuk during 1962–1971, none were taken during 1988–1993, and one was sighted at Cambridge Bay in 1977. In late July 1989, two were sighted in Bathurst Inlet. Over the period from 1996 to 2001, belugas were only harvested in Coronation Gulf from Kugluktuk in 1996. In 1999, belugas were sighted just north of Hepburn Island, and three were harvested. On 6 August 2011, hundreds were seen near Kugluktuk, and 13 of these were harvested (NNSO 2011).

Narwhal

Narwhals generally do not occur west of the central High Arctic. However, numerous groups of narwhals were seen off Cambridge Bay in August 2011. Groups were seen until about 29 August, and several were harvested (NO 2011).

5.8.4.3 Ongoing Studies

A considerable amount of information is available on the distribution of marine mammals (e.g. belugas, narwhal, bowheads, ringed seal, bearded seal, walrus, and harp seals) along parts of the shipping routes, from the Beaufort Sea to the west and Barrow Strait, Lancaster Sound, and Baffin Bay to the east. Little or no information is available for the parts of the shipping route in between. Aerial transect surveys in Grays Bay and in the area of the shipping lanes into Grays Bay will be undertaken in 2012 to characterize summer use by marine mammals.



5.8.5 Marine Birds and Habitat

5.8.5.1 Study Areas

Project ships will travel along existing surveyed routes through the Northwest Passage. From the west, ships will travel through the Bering Strait, Beaufort Sea and Amundsen Gulf to the Coronation Gulf. From the east, ships will travel through Davis Strait and Baffin Bay through Lancaster Sound to Peel Sound then Victoria Strait to the Coronation Gulf. Study areas for marine birds will extend along the shipping routes to the extent of the Nunavut Territorial waters.

Local Study Area

The LSA for marine birds includes a 1 km buffer on either side of the Project footprint of all port facilities and the eastern and western shipping routes.

Regional Study Area

The RSA for the marine bird studies consists of a 50 km buffer on either side of the Project footprint.

5.8.5.2 Description of Existing Environment

Marine birds are birds that occupy saltwater environments during large portions of their annual cycle; these may include pelagic birds (i.e., those characteristic of offshore waters), seaducks (i.e., ducks that live primarily at sea when not on their breeding grounds) and other waterfowl, and larids (jaegers, gulls, terns, etc.). Although not generally considered marine birds, shorebirds (e.g., plovers and sandpipers) are also considered in this section.

A diversity of birds relies on marine habitats for migration and staging, breeding, moulting, and some for over-wintering. Nearly 100 species of marine birds, waterfowl, waterbirds and shorebirds can be found along Canada's marine coastline and offshore habitats, and approximately 10 million pairs of breeding marine birds use marine habitats in Nunavut and the Northwest Territories (Mallory and Fontaine 2004).

Marine Birds

Marine habitats within the Izok Corridor region (i.e., eastern Amundsen Gulf, Dolphin and Union Strait, Coronation Gulf, Bathurst Inlet, Dease Strait, Queen Maud Gulf) support a variety of waterfowl and seabird species. Common species in this region include several species of geese, tundra swan (*Cygnus columbianus*), king eider (*Somateria spectabilis*), common eider (*Somateria mollissima*), surf scoter (*Melanitta perspicillata*) white-winged scoter (*Melanitta fusca*), long-tailed duck (*Clangula hyemalis*), northern pintail (*Anas acuta*), red-breasted merganser (*Mergus serrator*), several species of loons (*Gavia* sp.), glaucous gulls (*Larus hyperboreus*), and Arctic terns (*Sterna paradisaea*; e.g., Dickson and Gilchrist 2002, Mallory and Fontaine 2004, Raven and Dickson 2006, Latour et al. 2008, Groves and Mallek 2011). Pelagic seabird populations appear to be limited in this region (e.g., Dickson and Gilchrist 2002). An aerial survey of marine birds along the southern shoreline of the Coronation Gulf conducted by the Canadian Wildlife Service (CWS) in June 1995 (L. Dickson, CWS, pers. comm., April 2006) found that numbers were generally low in this area, but that Grays Bay harboured a greater concentration than elsewhere (mainly common eider, long-tailed duck, and red-breasted merganser) likely due to



open water appearing earlier in the spring between Hepburn Island and the mainland compared to elsewhere (L. Dickson, CWS, pers. comm., April 2006).

The common eider has become a concern in the central and western Arctic over the last decades due to declines in the breeding population (more than 50% between 1976 and 1996; Dickson et al. 2003). In June 1995, a survey of the southern shoreline of the Coronation Gulf indicated that up to 25% of the Canadian breeding population of common eider occurs within the Bathurst Inlet area (including the Grays Bay area, Raven and Dickson 2006). Surveys conducted in the area from 2006 to 2008 detected a substantial decline in the number of common eiders breeding in this area (Raven and Dickson 2006).

Species at Risk

Table 5.8-3 lists Species at Risk that could potentially occur within the RSA and interact with Project shipping. Most of the species listed are designated as Sensitive by the GN, but are not currently scheduled under SARA and have not been assessed by COSEWIC. In many cases, the Sensitive designation by the GN is likely due to the presence of perceived small populations on the periphery of natural ranges. Three species or subspecies, however, are currently listed under Schedule 1 of SARA, and are designated as Endangered or Threatened by COSEWIC. These three species are the red knot, ivory gull, and Ross’s gull.

Table 5.8-3 Marine Bird Species at Risk Potentially Occurring within Project Shipping Corridors

Species	Scientific Name	Species Status		
		Nunavut ¹	SARA Schedule ²	COSEWIC ³
Common Eider	<i>Somateria mollissima</i>	Sensitive	Not currently scheduled	Not assessed
King Eider	<i>Somateria spectabilis</i>	Sensitive	Not currently scheduled	Not assessed
Long-tailed Duck	<i>Clangula hyemalis</i>	Sensitive	Not currently scheduled	Not assessed
American Golden-plover	<i>Pluvialis dominica</i>	Sensitive	Not currently scheduled	Not assessed
Black-bellied Plover	<i>Pluvialis squatarola</i>	Sensitive	Not currently scheduled	Not assessed
Whimbrel	<i>Numenius phaeopus</i>	Sensitive	Not currently scheduled	Not assessed
Ruddy Turnstone	<i>Arenaria interpres</i>	Sensitive	Not currently scheduled	Not assessed
Sanderling	<i>Calidris alba</i>	Sensitive	Not currently scheduled	Not assessed
Red Knot	<i>Calidris canutus</i>	At Risk	Roselaari ssp – Schedule 1, Rufa&Islandica ssp - Not currently scheduled	Roselaari ssp – Threatened Rufa ssp - Endangered Islandica ssp – Special Concern
Dunlin	<i>Calidris alpina</i>	Sensitive	Not currently scheduled	Not assessed
Semipalmated Sandpiper	<i>Calidris pusilla</i>	Sensitive	Not currently scheduled	Not assessed
Least Sandpiper	<i>Calidris minutilla</i>	Sensitive	Not currently scheduled	Not assessed
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>	Sensitive	Not currently scheduled	Not assessed
Red Phalarope	<i>Phalaropus fulicarius</i>	Sensitive	Not currently scheduled	Not assessed
Red-necked Phalarope	<i>Phalaropus lobatus</i>	Sensitive	Not currently scheduled	Not assessed



Species	Scientific Name	Species Status		
		Nunavut ¹	SARA Schedule ²	COSEWIC ³
Glaucous Gull	<i>Larus hyperboreus</i>	Sensitive	Not currently scheduled	Not assessed
Thayer's Gull	<i>Larus thayeri</i>	Sensitive	Not currently scheduled	Not assessed
Ivory Gull	<i>Pagophila eburnea</i>	At Risk	Schedule 1	Endangered
Ross's Gull	<i>Rhodostethia rosea</i>	At Risk	Schedule 1	Threatened
Arctic Tern	<i>Sterna paradisaea</i>	Sensitive	Not currently scheduled	Not assessed
Northern Fulmar	<i>Fulmarus glacialis</i>	Sensitive	Not currently scheduled	Not assessed

1 CESSC (2011)

2 Environment Canada (2011)

3 COSEWIC (2011)

Important Marine Bird Habitats

There are several marine and near shore areas within the Izok Corridor Project area that are designated as Important Bird Areas, Key Marine Habitats, or Key Migratory Bird Habitats (see section 5.2). These areas are known to seasonally support large concentrations of marine birds such as common eider, king eider, several species of geese, tundra swan and others. Among others, they include the Amundsen Gulf and Cape Bathurst Polynya along the south and western coast of the Amundsen Gulf, Lambert Channel located between the Dolphin and Union Strait and the Coronation Gulf, southwestern Victoria Island, the Queen Maud Gulf Bird Sanctuary, and Jenny Lind Island in the Queen Maud Gulf (Mallory and Fontaine 2004, Latour et al 2008, Important Bird Areas Canada 2010).

5.8.5.3 Ongoing Studies

Seabird surveys associated with the proposed port site at Grays Bay will be undertaken in 2012 focusing on the ground-based surveys of the shoreline adjacent to the port site and one or more control areas, and aerial transect surveys in Grays Bay and the Coronation Gulf. The ground-based work will be conducted will take place as a part of concurrent terrestrial songbird and shorebird surveys in the area. The aerial transect surveys will be performed in conjunction with the marine mammal aerial transect surveys.