GAHCHO KUÉ PROJECT

ENVIRONMENTAL IMPACT STATEMENT

SECTION 11.12

SUBJECT OF NOTE: SPECIES AT RISK AND BIRDS

December 2010 09-1365-1004

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11.12 SUBJECT OF NOTE: SPECIES AT RISK AND BIRDS

11.12.1 Introduction

11.12.1.1 Context

This section of the Environmental Impact Statement (EIS) for the Gahcho Kué Project (Project) consists solely of the Subject of Note: Species at Risk and Birds. In the *Terms of Reference for the Gahcho Kué Environmental Impact Statement* issued on October 5, 2007, the Gahcho Kué Panel (2007) pointed out that the Project will be located closer to the tree line than previous diamond mines in the Northwest Territories. The Gahcho Kué Panel identified a greater potential for different species to be present in the Project area and defined species at risk and birds as a subject of note.

This subject of note contains a comprehensive assessment of the effect of the Project on birds and bird habitat. This aspect of the subject of note may overlap slightly with the following biophysical key lines of inquiry and subjects of note:

- Alternative Energy Sources (Section 11.3);
- Waste Management and Wildlife (Section 11.9);
- Water Quality and Fish in Kennady Lake (Section 8); and
- Downstream Water Effects (Section 9).

Potential effects from the Project on birds and bird habitat may also have an indirect effect on the following socio-economic subjects of note:

- Tourism Potential and Wilderness Character (Section 12.7.3);
- Proposed National Park (Section 12.7.4); and
- Culture, Heritage, and Archaeology (Section 12.7.5).

The Subject of Note: Species at Risk and Birds also contains summaries of the effects of the Project on species at risk. However, individual species that are at risk are often part of a larger community of animals or plants that are assessed separately in a different key line of inquiry or subject of note. That is, this subject of note selects one (or a few) species out of a larger community of species. The following key lines of inquiry and subjects of note provide a broader context related to the effect of the Project on the communities that contain the species at risk and their habitat:

- Caribou (Section 7);
- Carnivore Mortality (Section 11.10);
- Fish and Water Quality in Kennady Lake (Section 8);
- Downstream Water Effects (Section 9); and
- Vegetation (Section 11.7).

The above key lines of inquiry and subjects of note contain the primary in-depth assessment of the effects from the Project on species at risk, including barren-ground caribou (*Rangifer tarandus groenlandicus;* caribou), grizzly bear (*Ursos arctos*), wolverine (*Gulo gulo*), fish, and rare plants. The Subject of Note: Species at Risk and Birds contains the primary in-depth assessment of the Project impact on bird species that are at risk and summaries of the effects of the Project on all other species at risk.

11.12.1.2 Purpose and Scope

The purpose of the Subject of Note: Species at Risk and Birds is to meet the Terms of Reference for the EIS issued by the Gahcho Kué Panel. The table of concordance for the applicable Terms of Reference for this subject of note are shown in Table 11.12-1. The entire Terms of Reference document is included in Appendix 1.I and the complete table of concordance for the EIS is in Appendix 1.II of Section 1, Introduction of the EIS.

This subject of note includes a detailed assessment of effects on any species listed under the following:

- Federal *Species at Risk Act* (SARA 2010, internet site); and
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2009, internet site, 2010, internet site).

Table 11.12-1 Terms of Reference Pertaining to Species at Risk and Birds

Terms of Reference Requirements		Applicable EIS Sub-section
Section	**Description**	
3.1.3 Existing Environment: Birds and Bird Habitat	Describe species present, and for each describe	
	- abundance, distribution, seasonal movements, and habitat requirements;	11.12.2
	- areas of specific use at various life stages; and	11.12.2
	- any sensitive time periods or habitat	11.12.2
	Describe key species used for traditional harvesting activities	11.12.2.3
	Describe any known issues currently affecting birds and bird habitat in the development area (e.g., contamination of food sources, parasites, disease)	11.12.2
3.1.3 Existing Environment: Biologically Vulnerable Species	Describe any species present or potentially present in the Project area that are listed under the federal Species At Risk Act as Special Concern, Threatened, or Endangered	11.12.2
	Describe any species present or potentially present in the Project area that are under consideration or are listed by the Committee on the Status of Endangered Wildlife in Canada	11.12.2
	For species present, describe the specific locations, critical habitat, residences, population status, limits and size, sensitivities, and other limiting factors	11.12.2.1, 11.12.2.2, 11.12.2.3
5.2.4 Biophysical Subjects of Note: Species at Risk and Birds	The analysis provided in the EIS must be of sufficient detail to allow the Panel, as well as relevant other parties, to discharge its responsibilities under the Species at Risk Act, which includes	
	- determining whether the proposed development (Project) is likely to affect a listed species or its critical habitat;	11.12.3.2, 11.12.7.1, 11.12.7.2, 11.12.7.3, 11.12.8, 11.12.9
	- identifying the adverse effects on the species and its critical habitat;	11.12.3.2, 11.12.7.1, 11.12.7.2, 11.12.7.3, 11.12.8, 11.12.9
	- ensuring that measures are taken to avoid or lessen those effects, consistent with any applicable recovery strategy and action plan; and	11.12.3.2, 11.12.8, 11.12.9
	- monitoring the effects	11.12.11
	For birds, the EIS must provide the following information	
	- all potential disturbances during nesting, rearing, molting, staging and migration (e.g., from construction -activities, air traffic, and downstream effects of water flow changes)	11.12.4.1, 11.12.4.2, 11.12.5.1, 11.12.5.2, 11.12.6.1, 11.12.6.2, 11.12.7.1, 11.12.7.2

Table 11.12-1 Terms of Reference Pertaining to Species at Risk and Birds (continued)

Terms of Reference Requirements		Applicable EIS Sub-section
Section	**Description**	
5.2.4 Biophysical Subjects of Note: Species at Risk and Birds (continued)	- the potential for increased predation facilitated by the development	11.12.4.2, 11.12.5.2, 11.12.6.2, 11.12.7.2
	- identification and quantification of all contaminant exposure routes and possible changes in contaminant levels, particularly in harvested species	11.12.4.2, 11.12.5.2, 11.12.6.2, 11.12.7.2
	- identification of all potential alterations to bird habitat, including loss of habitat within the mine footprint, the creation of new habitat, and any downstream effects of water flow changes, with particular emphasis on waterfowl	11.12.4.1, 11.12.4.2, 11.12.5.1, 11.12.5.2, 11.12.6.1, 11.12.6.2, 11.12.7.1, 11.12.7.2
7 (Table 7-1) Wildlife Issues	Remaining wildlife issues pertaining to birds include	
	- disturbance;	11.12.4.1, 11.12.4.2, 11.12.5.1, 11.12.5.2, 11.12.6.1, 11.12.6.2, 11.12.7.1, 11.12.7.2
	- exposure to contaminants; and	11.12.4.2, 11.12.5.2, 11.12.6.2, 11.12.7.2
	- habitat impacts	11.12.4.1, 11.12.4.2, 11.12.5.1, 11.12.5.2, 11.12.6.1, 11.12.6.2, 11.12.7.1, 11.12.7.2
	Remaining wildlife issues pertaining to changing water levels include	
	- dewatering impacts on habitat;	11.12.3.2
	- downstream impacts; and	11.12.3.2
	- wildlife impacts from freeze- and break-up timing changes	11.12.3.2

Table 11.12-1 Terms of Reference Pertaining to Species at Risk and Birds (continued)

Terms of Reference Requirements		Applicable EIS Sub-section
Section	**Description**	
3.2.7 Follow-up Programs	The EIS must include a description of any follow up programs, contingency plans, or adaptive management programs the developer proposes to employ before, during, and after the proposed development, for the purpose of recognizing and managing unpredicted problems. The EIS must explain how the developer proposes to verify impact predictions. The impact statement must also describe what alternative measures will be used in cases were a proposed mitigation measure does not produce the anticipated result.	11.12.11
	The EIS must include a proposal of how monitoring activities at the Gahcho Kué diamond mine can be coordinated with monitoring programs at all other diamond mines in the Slave Geological Province to facilitate cumulative impact monitoring and management. This proposal must also consider reporting mechanisms that could inform future environmental assessments or impact reviews. The developer is not expected to design and set up an entire regional monitoring system, but is expected to describe its views on a potential system. The developer must also state its views on the separation between developer and government responsibilities.	11.12.11

Source: Terms of Reference for the Gahcho Kué Environmental Impact Statement (Gahcho Kué Panel 2007).

EIS = Environmental Impact Statement.

GNWT = Government of the Northwest Territories.

This subject of note includes experience from existing diamond mines in the assessment of species at risk and birds. Species at risk that are included in the effects analysis include caribou, which are also assessed in Section 7, grizzly bears, which are also assessed in Section 11.10, wolverines, which are also assessed in Section 11.10, and several bird species. This subject of note proposes mitigation practices and policies to reduce potential effects that are consistent with applicable recovery strategies and action plans.

11.12.1.3 Study Areas

11.12.1.3.1 General Location

The Project is located north of the eastern arm of Great Slave Lake in the Northwest Territories (NWT) in the barrenlands of the Slave Geologic Province at Longitude 63° 26' North and Latitude 109° 12' West. The Project site is about 140 kilometres (km) northeast of the nearest community, Łutselk'e, and 280 km northeast of Yellowknife (Figure 11.1-1).

11.12.1.3.2 Study Area Selection

To assess the potential effects of the Project on species at risk and birds, it is necessary to define appropriate spatial boundaries. The study area for this subject of note was identified in the final Terms of Reference as follows:

> *The geographical scope for this Subject of Note includes the development area, all access routes, and downstream areas.*

Baseline studies relating to wildlife, fish and vegetation, including species at risk, were conducted within various spatial boundaries, and were completed before the Terms of Reference were issued. These spatial boundaries were based on life history attributes and/or the expected extent of the Project-related effects (i.e., the boundaries were set so that the expected effects would lie within the boundaries). Although the location and size of the terrestrial and aquatic baseline study areas were different, baseline studies for wildlife, fish, and vegetation were completed within the following spatial boundaries:

- Regional Study Area (RSA);
- Local Study Area (LSA); and
- Winter Access Road Study Area.

The LSA was selected to assess the immediate direct and indirect effects of the Project on individual species at risk and birds. The RSA was selected to capture any effect that may extend beyond the LSA, and subsequently influence the abundance and distribution of populations. The Winter Access Road Study Area was surveyed to identify potentially sensitive habitat within the associated rights-of-way. Survey intensity varied within each spatial boundary depending on the anticipated magnitude of the effect and the baseline study objectives for each species. Broader baseline studies were completed within the RSA and detailed studies were completed in the LSA (Section 6.4).

11.12.1.3.3 Species at Risk and Birds Study Area

The Subject of Note: Species at Risk and Birds was completed within the following spatial boundaries:

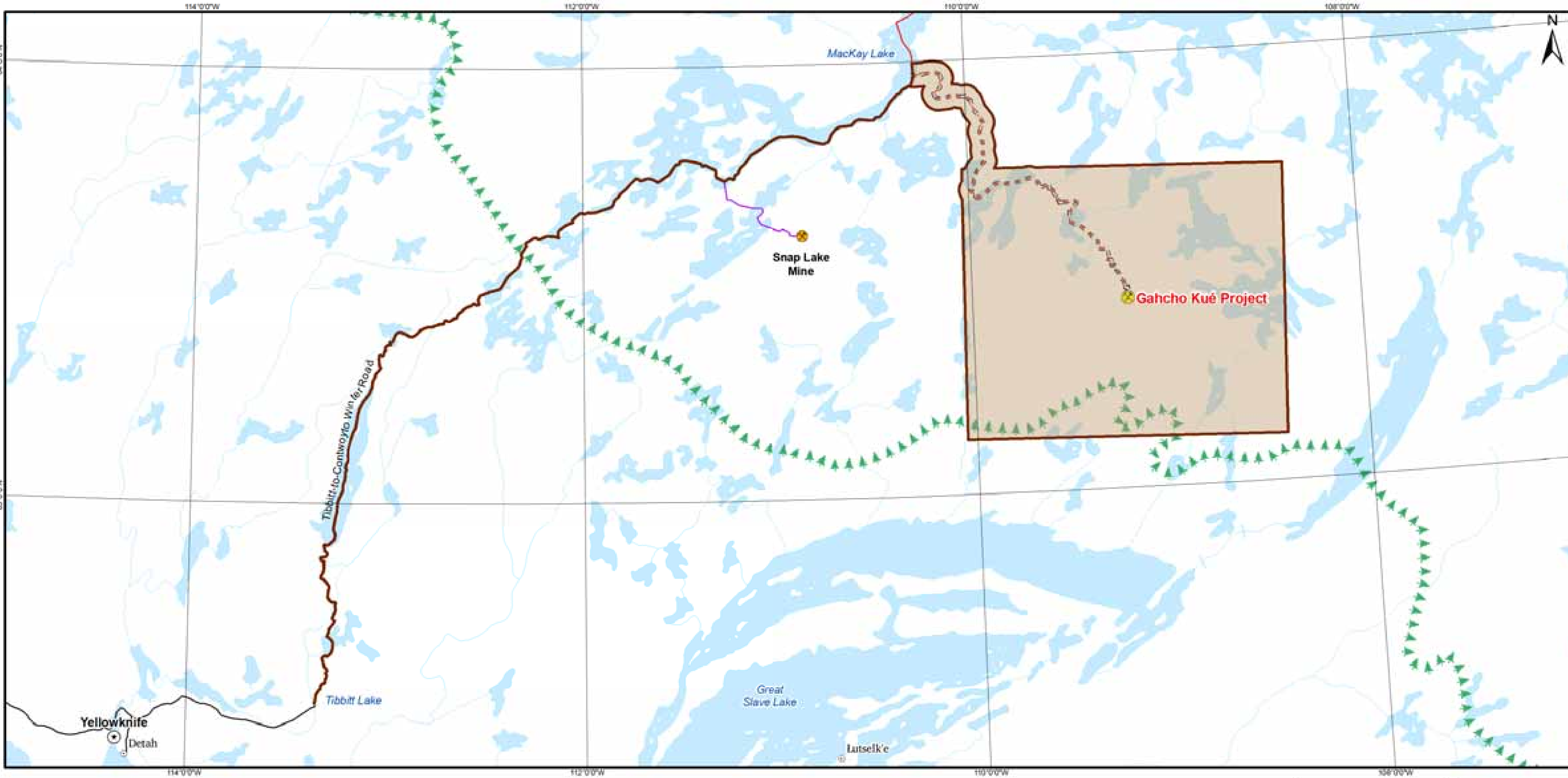
- wildlife baseline RSA;
- Winter Access Road (from MacKay Lake to Kennady Lake); and
- Tibbitt-to-Contwoyto Winter Road (from Tibbitt Lake to MacKay Lake).

The three spatial areas within which this subject of note was completed are collectively identified as the Species at Risk and Birds Study Area.

The effects analysis and assessment for species at risk and birds was completed largely within the same spatial boundaries as the baseline study areas for wildlife, with the addition of a portion of the Tibbitt-to-Contwoyto Winter Road. The wildlife baseline RSA was used in this subject of note, because the aquatics baseline LSA lies mainly within the wildlife baseline RSA. The aquatics LSA included the watersheds from Kennady Lake downstream (northwards) to Kirk Lake.

Regional Study Area

The RSA is approximately 5,700 square kilometres (km^2) in size (Figure 11.12-1). The approximate boundaries of the RSA are delineated by the following lakes: Reid Lake in the northwest, MacLellan Lake in the southwest, Cook Lake in the southeast, and Fletcher Lake in the northeast. The RSA was defined to capture the large-scale direct and indirect effects of the Project on species at risk and birds. The study area is home to several wildlife species including upland breeding birds, water birds (includes waterfowl, grebes, and loons), and raptors, some of which are species at risk. Other wildlife species at risk that occur within the RSA include caribou, grizzly bears, and wolverine.



LEGEND

- Gahcho Kué Project
- Existing Mine
- Territorial Capital
- Populated Place
- Highway
- Existing Winter Road
- Tibbitt-to-Contwoyto Winter Road
- Winter Access Road
- Proposed Winter Access Road
- Watercourse
- Waterbody
- Treeline
- Species at Risk and Birds Study Area

NOTES
Base data source: The Atlas of Canada

GAHCHO KUÉ PROJECT

Species at Risk and Birds Study Area

PROJECTION: Canadian Lambert Conf. Conic	DATUM: NAD83
Scale: 1:1,000,000 (10 5 0 10 Kilometres)	DE BEERS CANADA
FILE No: SON-11.11-001 - GIS	DATE: October 15, 2010
JOB NO: 09-1365-1004	REVISION NO: 2
OFFICE: GOLD-SAS	DRAWN: ANK
CHECK: JV	

Figure 11.12-1

The scale and boundaries of the RSA capture the diversity of habitats that support the seasonal requirements of upland breeding birds, water birds, and raptors. The boundary includes all of the downstream area expected to be affected by the Project, so downstream effects on water birds (e.g., relating to water flow and level changes), and regionally sensitive fish species can be appropriately assessed. Rare plants are expected to be affected only by the actual footprint of the Project; therefore, the RSA in combination with the Winter Access Road areas provide spatial boundaries that are appropriate for the assessment of plant species at risk. A portion of the Winter Access Road is contained within the RSA.

The assessment of Project effects on birds and associated species at risk is completed at the scale of the RSA, which is likely large enough to contain all or most individuals that comprise the breeding populations that inhabit the area for part or all of the year. Here, the population (or population area) is defined by a group of individuals of the same species occupying an area of sufficient size so that emigration and immigration are infrequent, and most of the changes in abundance and distribution are determined by reproduction and survival (Berryman 2002). For species with small to moderate breeding home ranges (e.g., waterbirds, songbirds, and raptors), the population should be primarily affected by natural and human-related factors that change survival and reproduction of individuals within the RSA, and should be little influenced by dispersal. In other words, developments outside of the RSA should have no or little influence on these populations while they inhabit the area for part or all of the year.

Winter Access Road Study Area

The Winter Access Road to the Project is a spur road of the Tibbitt-to-Contwoyto Winter Road south of MacKay Lake (Figure 11.12-1). The Winter Access Road extends 120 km from the Tibbitt-to-Contwoyto Winter Road southeast to Kennady Lake. The width of the Winter Access Road Study Area varies; the study area for wildlife is 6 km wide while the study area for vegetation is 1 km wide. The Winter Access Road crosses over several small, unnamed lakes, as well as Reid, Munn, Margaret, and Murdock lakes, before reaching Kennady Lake.

Tibbitt-to-Contwoyto Road Study Area

The Tibbitt-to-Contwoyto Winter Road has been constructed annually since 1982, from the end of the Ingraham Trail about 70 km northeast of Yellowknife at Tibbitt Lake in the NWT to the Lupin Mine on Contwoyto Lake, Nunavut. The road is usually open from January to March (about 8 to 12 weeks). The portion of the Tibbitt-to-Contwoyto Winter Road used for the Subject of Note: Species at

Risk and Birds measures about 271 km long. Including this portion of the Tibbitt-to-Contwoyto Winter Road allows for the assessment of potential cumulative effects of the Project, in combination with previous, existing, and future developments, on species at risk and birds.

11.12.1.4 Content

Section 11.12 provides details of the effects analysis and assessment related to species at risk and birds. The headings in this section are arranged according to the sequence of steps in the assessment. The following briefly describes the content under each heading of this subject of note:

- **Existing Environment** summarizes baseline information for bird species and other plant, wildlife, and fish species at risk, including the general environmental setting in which the Project occurs, methods used to collect the baseline data, and baseline results (Section 11.12.2).
- **Pathway Analyses** identifies all the potential pathways by which the Project could affect birds and other species at risk, and provides a screening level assessment of each identified pathway after applying environmental design features and mitigation that should reduce or eliminate these effects (Section 11.12.3).
- **Upland Breeding Birds** explains the scientific methods that were used to predict changes to upland breeding bird populations as a result of the Project's activities, identifies the effects of the Project's activities on upland breeding bird populations (including effects on habitat quality and quantity, behaviour and distribution, and survival and reproduction), identifies the effects on listed upland bird species, and identifies the effects that flow to people as a result of the Project's effects on upland breeding bird populations (Section 11.12.4).
- **Water birds** explains the scientific methods that were used to predict changes to water bird populations, which included water birds, grebes ad loons, as a result of the Project's activities, identifies the effects of the Project's activities on water birds populations (including effects on habitat quality and quantity, behaviour and distribution, and survival and reproduction), identifies the effects on listed water bird species, and identifies the effects that flow to people as a result of the Project's effects on water birds populations (Section 11.12.5).
- **Raptors** explains the scientific methods that were used to predict changes to raptor populations as a result of the Project's activities, identifies the effects of the Project's activities on raptor populations (including habitat quality and quantity, behaviour and distribution, and survival and reproduction), identifies effects on listed raptor species, and identifies the effects that flow to people as a result of the Project's effects on raptor populations (Section 11.12.6).

- **Residual Effects Summary** summarizes the effects on birds and other species at risk populations, and related effects on people, that are predicted to remain after all environmental design features and mitigation to eliminate or reduce effects have been incorporated into the Project design (Section 11.12.7).
- **Residual Impact Classification** describes methods used to classify residual effects and summarizes the classification results (Section 11.12.8).
- **Environmental Significance** summarizes the overall impacts from the Project on other species at risk and birds, and considers the entire set of pathways to evaluate the significance of impacts from the Project on species at risk and birds (Section 11.12.9).
- **Uncertainty** discusses sources of uncertainty surrounding the predictions of effects on upland breeding birds, water birds, raptors, and other species at risk (Section 11.12.10).
- **Monitoring and Follow-up** describes monitoring programs, contingency plans, and adaptive management strategies that will be implemented for upland breeding birds, water birds, raptors, and other species at risk (Section 11.12.11).
- **References** lists all documents and other material used in the preparation of this section (Section 11.12.13).
- **Glossary, Acronyms, and Units** explains the meaning of scientific, technical, or other uncommon terms used in this section. In addition, acronyms and abbreviated units are defined (Section 11.12.14).

11.12.2 Existing Environment

11.12.2.1 General Setting

The Project is located at Kennady Lake (63˚ 26’ North; 109˚ 12’ West), a headwater lake of the Lockhart River watershed in the NWT. Kennady Lake is about 280 km northeast of Yellowknife, and 140 km northeast of the Dene Community of Łutselk’e on the eastern arm of Great Slave Lake. The Project is 84 km east of the Snap Lake Mine, the only active mine in the Lockhart River watershed. The Diavik Diamond Mine and Ekati Diamond Mine are located about 127 and 158 km northeast of Kennady Lake, respectively, in the Coppermine River watershed.

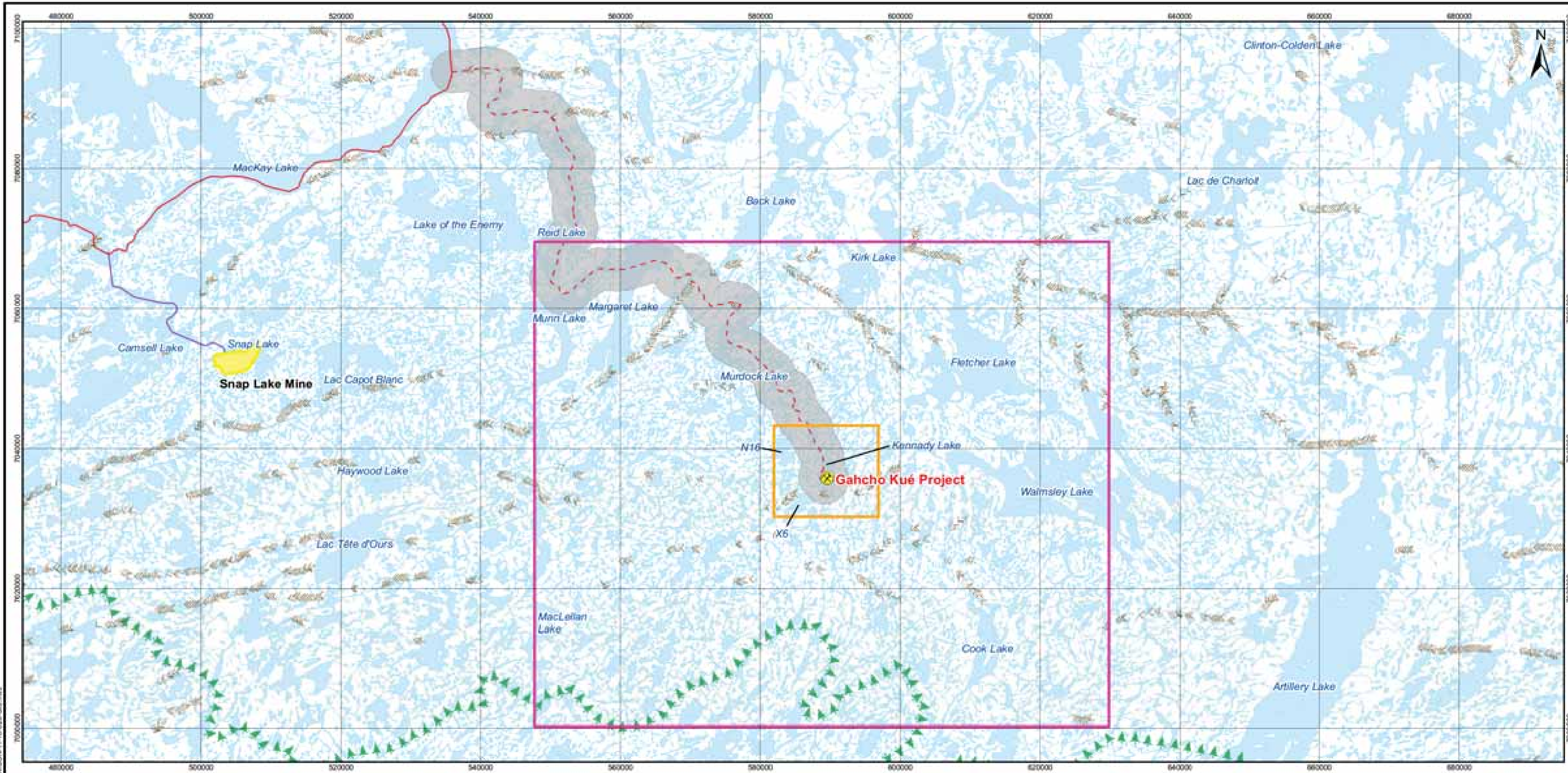
The RSA, approximately 5,700 km^2 in size, was defined to capture the indirect effects of the Project on wildlife valued components (VCs) (Figure 11.12-2). The Project is within the transition zone between the tundra and the treeline, and species that are characteristic of both habitat types may occur within the RSA.

Shrubs of willow and birch occur in drainages, and in some areas may reach over 2 metres (m) in height. Heath tundra covers most upland areas, and conifer stands occur in patchy distribution above the treeline, in lowland sheltered areas, and riparian habitats. Conifer stands are found within the RSA as far north as Kirk Lake.

An extensive esker system stretches from Margaret Lake in the northwest, across the northern portion of the RSA, and beyond the eastern boundary. Numerous smaller esker complexes and glaciofluvial deposits such as kames and drumlins are scattered throughout the RSA. Habitat types within the RSA were based on the broad-scale Ecological Landscape Classification (ELC) developed by Matthews et al. (2001) for the Slave Geological Province (SGP) (Section 11.7).

The LSA encompasses the Project, which includes the proposed development of the anticipated core mine footprint. The LSA is approximately 200 km^2, centered on Kennady Lake (Figure 11.12-2). The LSA was designed to assess direct effects from the Project footprint (e.g., habitat loss) and small-scale indirect effects on individuals from Project activities (e.g., changes in habitat quality resulting from dust deposition). The LSA contains habitat that is characteristic of regional habitat conditions, including eskers and other glaciofluvial deposits, wetlands, riparian habitats, lakes, and vegetation that is typical of the tundra.

Terrain is less varied within the LSA, and habitat is characterized primarily by low relief with rolling hills, boulder fields, and a few bedrock outcrops. The dominant waterbodies are Kennady Lake, Lake N16 and Lake X6. Water covers 20 to 30 percent (%) of the LSA, and a major esker complex stretches across its southern portion. Small conifer stands are located in the southern portion of the LSA. Habitat types within the LSA were based on the broad-scale ELC developed by Matthews et al. (2001) for the Slave Geological Province and finer scale ecosystem units (Section 11.7).



LEGEND

- Gahcho Kué Project
- Existing Winter Road
- Tibbitt-to-Contwoyto Winter Road
- Winter Access Road
- Watercourse
- Waterbody
- Esker
- Treeline
- Snap Lake Mine
- Local Study Area
- Regional Study Area
- Winter Access Road Study Area

NOTES
Base data source: National Topographic Base Data (NTDB) 1:250,000

GAHCHO KUÉ PROJECT

Boundaries for the Regional, Local, and Winter Access Road Study Areas

PROJECTION: UTM Zone 12	DATUM: NAD83	DE BEERS CANADA
Scale: 1:550,000 (10 5 0 10 Kilometres)		
FILE No: SON-11-10-028-GIS		DATE: November 10, 2010
JOB NO: 09-1365-1004	REVISION NO: 2	Figure 11.12-2
OFFICE: GOLD-SAS	DRAWN: ANK	CHECK: JV

The Project is accessed in the winter by a 120-km-long Winter Access Road that extends from the Tibbitt-to-Contwoyto Winter Road at MacKay Lake to Kennady Lake. The Winter Access Road to Kennady Lake crosses Reid, Munn, Margaret, and Murdock lakes as well as several smaller lakes and streams. Northwest of the RSA boundary, habitat conditions along the Winter Access Road resemble the undulating terrain of the barren tundra. Within a 6-km right-of-way (corridor) along the Winter Access Road, water covers about 37% of the corridor area (approximate corridor area = 700 km^2). Within a 2-km corridor, about 48% of the Winter Access Road is comprised of water (approximate corridor area = 238 km^2).

Rocky terrain is less common farther north along this route and a few minor esker systems are present. The tundra landscape along the Winter Access Road is characterized by low-growing vegetation such as lichens, mosses, and stunted shrubs. Closer to Munn Lake and Margaret Lake, the habitat becomes more varied with extensive boulder fields, steep cliffs, and esker complexes.

Baseline studies on wildlife species and wildlife habitat were completed in the RSA, LSA, and along the proposed Winter Access Road from 1996 to 2007. Addtional surveys for water birds and raptors were completed in 2010 (Annex F, Addendum FF). Ground and aerial surveys were designed to provide estimates of the natural variation in wildlife presence, abundance, distribution, and movement. The baseline data collected on wildlife are presented in Annex F.

11.12.2.2 Methods

The following section integrates a historical and regional perspective on birds and species at risk populations in the study area from available literature and existing knowledge. Baseline survey data were supplemented with ecological information from other baseline studies, published and unpublished scientific literature, discussions with wildlife experts, and traditional knowledge (TK). Secondary source TK information was obtained using various, previously completed reports on experiences and expertise of the Elders from each of the potentially affected Aboriginal communities (Annex M). Results of regional effects monitoring and research programs in the NWT and Nunavut (e.g., the Diavik Diamond Mine, the Ekati Diamond Mine, and the Snap Lake Mine) are also included. Information obtained from each of these data sources is used for the assessment of potential effects on birds and species at risk from the Project, and as a basis for bird and species at risk wildlife mitigation and monitoring plans.

11.12.2.2.1 Gahcho Kué Project Baseline Study

The following sections describe the methods and results of baseline studies for species at risk and birds including the following species and species groups:

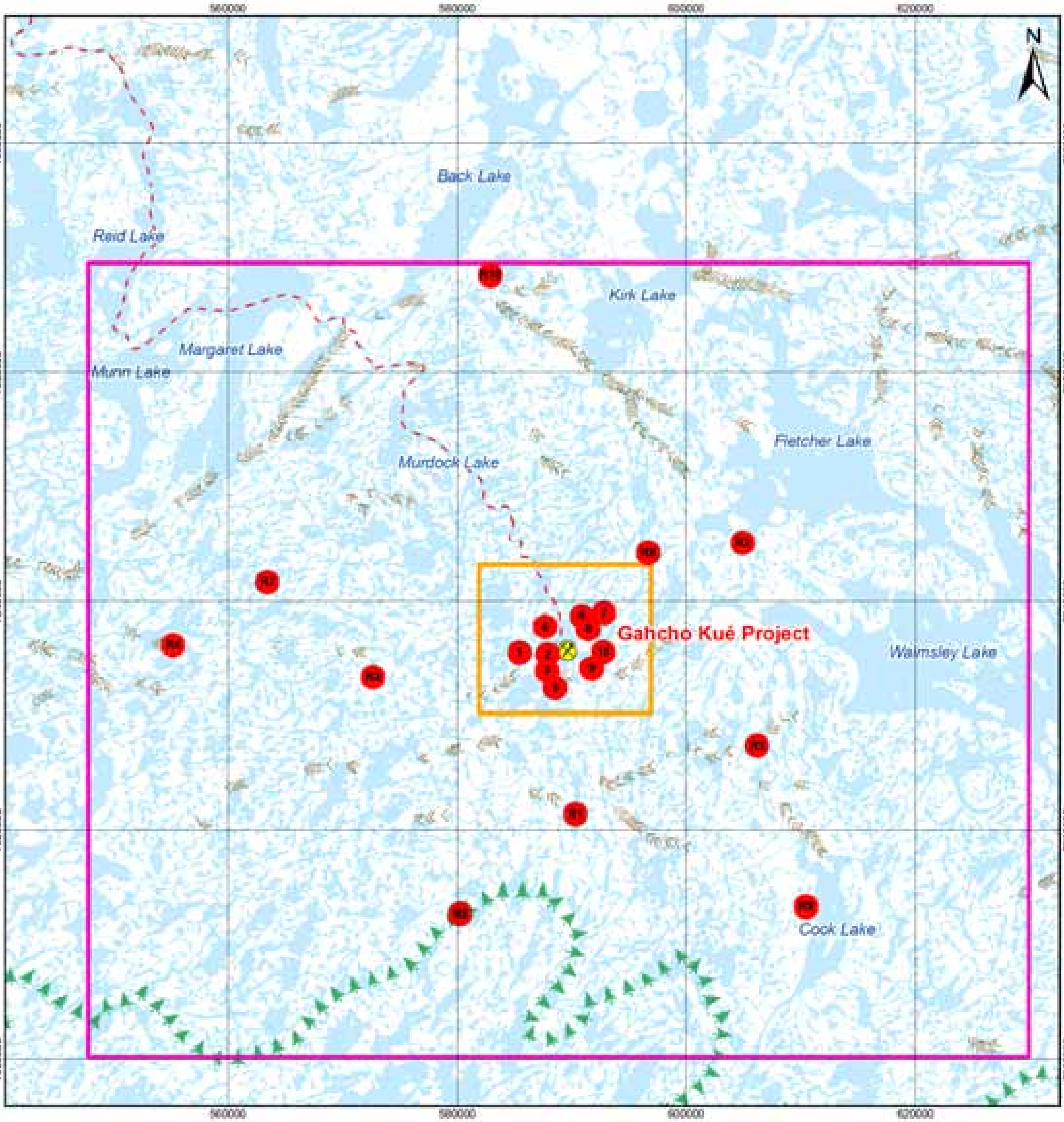
- upland breeding birds;
- water birds;
- raptors;
- barren-ground caribou;
- barren-ground grizzly bear;
- wolverine;
- fish species at risk; and
- plant species at risk.

Upland Breeding Birds

Rapid assessment breeding bird surveys were completed in June from 1998 to 2001 in the RSA. Observations from these surveys were used to provide a comprehensive species list for the RSA, but were excluded from statistical analyses. In 2004 and 2005, permanent sample plots were established within the RSA. The objectives of the 2004 and 2005 baseline study for upland breeding birds were to:

- document the natural variation in upland bird species density, diversity, and richness within the RSA and LSA; and
- assess the importance of habitats in the LSA for upland bird nesting.

Ten survey plots were located more than 10 km from the potential Project footprint and were designated as control plots. Another ten survey plots were located less than 10 km from the Project footprint and were designated as mine plots (Figure 11.12-3). The mine plots were located within the LSA. Each plot was 0.25 km^2 in size. All twenty plots were surveyed in 2005 from June 15 to 23. Only eleven plots (eight mine and three control) were surveyed in 2004 from June 16 to 23 due to poor weather conditions (cold spring weather). Nesting success during spring 2004 was reduced by the cold spring conditions during the breeding season (Alison 2004).



LEGEND

- Gahcho Kué Project
- Winter Access Road
- Watercourse
- Waterbody
- Esker
- Treeline
- Sample Plot
- Local Study Area
- Regional Study Area

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000

GAHCHO KUÉ PROJECT

Upland Breeding Bird Survey Plots in the Regional Study Area 2004 and 2005

PROJECTION: UTM Zone 12	DATUM: NAD83	DE BEERS CANADA
Scale 1:500,000 (10 5 0 10 Kilometres)		
FILE No: SON-11-12-003-GIS		DATE: October 22, 2010
JOB NO: 09-1365-1004	REVISION NO: 4	**Figure 11.12-3**
OFFICE: GOLD-SAS	DRAWN: MGD / CHECK: JV	

Within each plot, five 100-m-wide by 500-m-long transects were walked over a minimum period of 2.5 hours. Two experienced bird biologists and a local assistant from Łutselk'e Dene First Nation (LKDFN) walked side by side covering an equal proportion of each transect. The surveyor on the outside line of the previous transect adopted the inside line of the adjacent transect to reduce double-counting of birds located on the edge of the previous transect. This sampling protocol resulted in 100% coverage of each plot.

All birds seen or heard within each plot were recorded. Flyovers and birds observed outside the survey area were recorded as incidentals. Incidental observations were used to provide a comprehensive species list, but were not included in the statistical analyses. Universal Transverse Mercator (UTM) location and habitat were noted for each plot. For each bird observation, biologists recorded an observation number, time, species, number of individuals, and behavioural activity (i.e., flush, territorial call, display, nest).

The 2004/2005 survey data were filtered to remove all incidental sightings (birds occurring outside the survey plot or fly-overs) and all birds that are not considered to be passerines (perching birds), shorebirds, or upland game birds. The resulting bird observations were included in the summary and analyses. Sixteen plots were located in sedge wetland habitat, fourteen in heath tundra, and one in riparian. A species level analysis compared the density of individual species among different habitat types. A community-level analysis compared the density, richness, and diversity of birds among different habitat types.

Species diversity was measured using two indices: the Fisher's alpha index which is more sensitive to richness, and the Simpson's inverse index which is more sensitive to evenness (Magurran 1988). Species diversity and richness are influenced by the number of individuals in a sample so rarefaction techniques were used to generate estimates for these metrics (Gotelli and Colwell 2001). Maximum observed richness or the asymptote of the rarefaction curves were used as the estimate for species richness. Rarefaction curves and associated 95% confidence intervals were used to examine variation between habitat types.

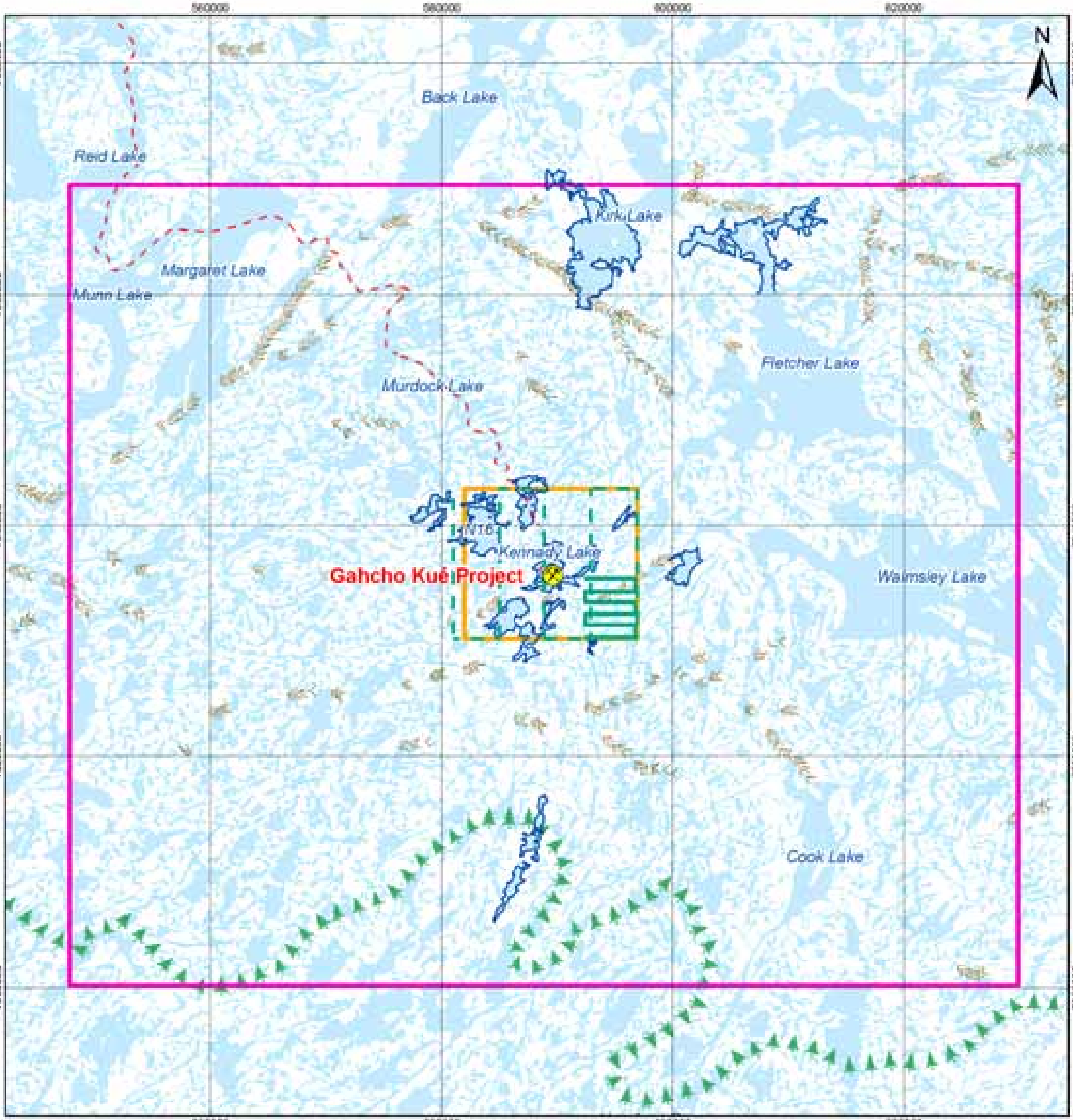
Water Birds

The lakes and wetlands of the tundra host a large number of migratory water bird species, comprising a breeding assemblage of tundra swans, loons, sandhill cranes, geese, and ducks. The breeding distribution of several species including the yellow-billed loon, tundra swan, and greater white-fronted goose are exclusive to the tundra region. Species richness of water birds is considered a valuable indicator of the quality of wetlands habitat. Different species of water birds using wetlands can represent multiple facets of wetlands productivity. For example, loons will nest and raise their young on a lake that supports fish; while ducks eat aquatic insects, emergent plant seeds, benthic organisms, and submergent plants; and tundra swans eat submergent plant tubers and roots (Cox 1990; Korschgren and Dahlgren 1992). Aside from food, wetland attributes such as size, shape, and emergent vegetation structure and composition are important for water bird nesting territories, and safety from predators.

In the baseline study, migration stops were defined as short-duration lay-overs for a few hours to forage, for an overnight rest, or for a pause in migration because of adverse weather. Staging by water birds refers to a gathering of birds at a particular site for an extended period of time (days to weeks) before continuing migration. Staging areas provide seasonally suitable habitat requisites such as early open water and associated foraging areas. Individual birds may remain at a site for several days or a continual turnover of birds may occur at the same wetlands site. These sites often have a traditional seasonal use and are considered important habitats used by migrating water bird species.

Water bird surveys were completed in 2004 to document species occurrence, relative abundance, and habitat use during the spring migration, breeding season, and fall migration. Water bird aerial surveys were completed in the LSA in late May of 2004, and were timed to coincide with the spring migration and staging period (Figure 11.12-4). However, due to a late spring, water birds were observed migrating through the LSA rather than congregating at staging areas. Because large aggregations of birds were not stopping within the LSA, water bird species were recorded along survey transects during aerial surveys for caribou. A fall migration survey was completed in September 2004 in the LSA and at selected lakes in the RSA (Figure 11.12-4). Species and estimated densities were recorded to provide information on those species that are expected to routinely migrate and stage within the LSA.

Summer surveys for water bird breeding pairs were completed to record the status of water birds nesting within the LSA. On June 20, 2004 large lakes were open for 10 to 20 m along the shoreline. In many areas ice was still land fast, which potentially affected breeding within the LSA. Small shallow wetlands were ice free. The perimeters of two lakes, Kennady Lake (46.9 km) and Lake N16 (27.3 km), were flown by helicopter at 30 to 50 metres above ground level (magl). Helicopter speeds varied between 40 and 80 kilometres per hour (km/h), depending on shoreline complexity. Aerial surveys were completed by a crew consisting of two trained biologists and a local assistant from LKDFN. Ground surveys of water bird nesting activity occurred concurrently with the upland breeding bird surveys when plots were located near small wetlands or lakes.



LEGEND

- Gahcho Kué Project
- Winter Access Road
- Watercourse
- Waterbody
- Esker
- Treeline
- Survey Transect
- Perimeter of Lake Flown
- Local Study Area
- Regional Study Area

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000

GAHCHO KUÉ PROJECT

Water Bird Aerial Surveys Completed in the Local Study Area 2004

PROJECTION: UTM Zone 12	DATUM: NAD83		DE BEERS CANADA
Scale 1:500,000 (10 5 0 10 Kilometres)			
FILE No: SON-11-12-004-GIS			DATE: October 22, 2010
JOB NO: 09-1365-1004	REVISION NO: 4		**Figure 11.12-4**
OFFICE: GOLD-SAS	DRAWN: ANK	CHECK: JV	

A small survey block located in the south-eastern portion of the LSA was also flown in June, 2004 to assess water bird density in wetlands habitat. The survey block consisted of five, 4-km-long transects, each oriented in an east-west direction and spaced 1 km apart. Height was maintained at about 60 magl, at a speed of about 80 km/h. The navigator, occupying the front left seat, would record observations and guide the pilot using a hand-held global positioning system (GPS) unit preprogrammed with the survey routes. A distance of 300 m was surveyed on each side of the helicopter, resulting in 60% coverage of the survey block.

Large lakes within the LSA were free of ice during the fall migration survey, which was completed on September 10 and 11, 2004. The fall migration survey was completed in the LSA and at selected lakes in the RSA (Figure 11.12-4). To determine if water birds were moving through the RSA at this time, the survey was extended to include large and small lakes north and south of Kennady Lake.

An aerial survey was completed on June 28, 2010, to determine the presence of water birds on Kennady Lake and Lake X6 (a referenece lake), by a crew consisting of one trained biologist and a community technician (Pete Enzoe from Łutselk'e). The survey was performed by helicopter at 50 m agl and at a speed of 80 km/h. The survey route followed the shoreline contour of each lake and associated islands (Annex F, Addendum FF).

Raptors

Raptors are birds of prey and include falcons (*Falco* spp.), eagles , hawks, and owls. Common ravens (*Corvus corax*) are passerines but are considered functional raptors for this study (Poole and Bromley 1988). Effects on raptor populations can be reflected throughout the ecosystem because they occupy a top trophic level (Kennedy 1980). As such, raptors are commonly used as indicators of ecosystem health in baseline and monitoring programs. Raptors are known to be sensitive to disturbances during the breeding season, and declines in raptor populations have been attributed to human activities and developments (Craighead and Mindell 1981).

In 1996, and from 1998 to 2005 (excluding 2004), raptors were recorded incidentally within the RSA as part of other wildlife surveys. In 2004, an intensive survey for raptor nests within the RSA was completed. Specific survey objectives were to document raptor nesting sites and breeding success. Nest sites that were incidentally recorded during other wildlife surveys prior to and during 2004 were visited for verification of breeding activity. Consistent with raptor studies in the north, surveys were focused on areas that were deemed to have the most suitable nest sites, such as prominent rock outcrops, cliff faces, and ledges.

On June 20 and 21, 2004, an aerial reconnaissance was flown to locate suitable nesting habitat in the RSA. The presence of raptor pairs, a single adult exhibiting territorial behaviour, old nest sites, and evidence of use (i.e., scraps and perches) were recorded.

On July 24, 2004, nest sites identified in the study area prior to and during 2004 were investigated to determine species and nesting status. Nests were considered occupied if at least one adult was observed. Eggs were counted if visible. Nests were recorded as successful if at least one chick was observed in the nest. The number of chicks was also recorded.

In 2010, the presence of adults, eggs and young were determined by a helicopter survey of known nest locations during late-May to mid-June. A second survey of occupied nests was completed in July to determine nest success (Annex F, Addendum FF). Surveys were completed by a trained biologist and a community technician (Pete Enzoe from Łutselk'e).

11.12.2.2.2 Other Species at Risk

In the Terms of Reference, the Gahcho Kué Panel (2007) defined "species at risk" as including all species listed under any applicable schedule of the Species at Risk Act (SARA 2009, 2010 internet site), as well as any species listed by COSEWIC (2009 internet site, 2010 internet site). Therefore, aside from the species at risk identified for birds, other species at risk include wildlife, fish, and plants.

Other Species At Risk that are confirmed to occur in the RSA, or have the potential to occur in the RSA, include:

- barren-ground caribou – listed as Sensitive by NWT General Status Ranking Program (2010 internet site);
- barren-ground grizzly bear listed as Special Concern by COSEWIC (2009, internet site) and Sensitive by NWT General Status Ranking Program (2010 internet site);
- wolverine – listed as Special Concern by COSEWIC (2009, internet site) and Sensitive by NWT General Status Ranking Program (2010 internet site);
- Arctic grayling listed as Sensitive by NWT General Status Ranking Program (2010 internet site);

- slimy sculpin – listed as Undetermined Status by NWT General Status Ranking Program (2010 internet site);and
- several potential plant species.

Although, there are several plant species that have the potential to occur in the RSA, no observations of rare plants or rare plant communities were observed.

Barren-ground Caribou

Baseline field studies for barren-ground caribou were initiated in 1996, and completed annually from 1999 through 2005 in the RSA, LSA, and Winter Access Road Study Area (Section 7). In addition, satellite collar data from the Bathurst, Ahiak, and Beverly herds were assessed from 1995 to 2010. The objectives of the studies were to estimate the natural range of variation in the following parameters:

- annual and seasonal occurrence, abundance, distribution, group size, and group composition of caribou in the study areas;
- habitat associations, caribou movement patterns, and important movement corridors in the study areas; and
- annual and seasonal likelihood of the Bathurst, Ahiak, and Beverly herds interacting with the Project.

Satellite collar data (courtesy of Department of Environment and Natural Resources [ENR]) suggests that the annual range of three barren-ground caribou herds may overlap the Project:

- Bathurst herd;
- Queen Maud Gulf or Ahiak herd; and
- Beverly herd.

Annual and seasonal ranges were calculated for satellite-collared caribou in the Bathurst, Ahiak, and Beverly herds using satellite data from 1995 to 2010. Annual and seasonal ranges for the Bathurst herd were calculated based on satellite collar data from January 1, 1996 through March 31, 2010. The temporal extent of satellite collar data for the Beverly herd is from January 1, 1995 through October 31, 2007, whereas the Ahiak is based on data from January 1, 2001 to October 31, 2007. Data from the Ahiak and Beverly herds were combined from November 2007 to March 2010 because of overlapping ranges. These data are reported separately. Caribou distribution for each herd was classified into six periods based on inspection of annual movements of satellite collared caribou (ENR 2010a internet site):

- northern migration (May 1 to 31);
- calving (June 1 to 15);
- post-calving aggregation (June 16 to July 1);
- summer dispersal (July 2 to August 31);
- rut and fall migration (September 1 to October 31); and
- winter dispersal (November 1 to April 30).

Initial aerial reconnaissance surveys that documented caribou and caribou sign in the RSA and along the Winter Access Road were completed in 1996 and 1998. Additional aerial reconnaissance surveys were completed from 1999 to 2003 within the RSA, LSA, and along the Winter Access Road (Table 11.12-2). In 2004 and 2005, systematic aerial surveys were completed within the RSA, LSA, and along the Winter Access Road. The 2004 aerial surveys were unbounded (i.e., not a fixed-width transect; all animals seen were recorded), and survey coverage was estimated at 25% of the RSA. In 2005, a fixed width of 600 m on either side of the helicopter was used to correspond with other regional aerial survey methods. Survey coverage for aerial surveys completed in 2005 was estimated at 15% of the RSA (Section 7).

Table 11.12-2 Caribou Aerial Survey Dates from 1999 to 2005

Year	Date
1999[a]	May 6 to 9; July 17 to 22; October 3 to 4
2000[a]	September 10; October 13
2001[a]	May 10; October 25
2002[a]	May 8; July 2 to August 31; September 25
2003[a]	May 13; August 4; October 4
2004[a]	May 4 to 7; May 26 to 28; July 27 to 30; October 8 to 9
2005[b]	March 28 to 31; April 30 to May 2; May 18 to 20; July 28 to 31; September 22 to 25

[a] unbounded surveys.

[b] fixed-width surveys.

Survey periods for the 2004 and 2005 surveys were selected to coincide with the peak movement of caribou through the area during the northern and rut/fall migration periods (Table 11.12-2). Information on movements of satellite collared caribou, provided by ENR, was used to help determine the timing of surveys. As well, the timing of each aerial survey was determined from Project camp observations and incidental reports, historical information on caribou movements, and reports from personnel at the Snap Lake Mine, Ekati Diamond Mine, and Diavik Diamond Mine.

Estimates of caribou group size, direction of movement, behaviour (i.e., feeding, bedding, standing, walking, trotting, or running), and group composition (i.e., groups with calves, groups without calves) were collected during the 2004 and 2005 aerial surveys. When large aggregations were observed, ground observations were used to confirm herd composition and approximate size. Habitat information was collected for each caribou observation during snow-free periods, and determined using the regional land cover classification during snow cover conditions (Section 7).

Friction modelling or least cost path analysis was competed to identify the location of potential caribou movement pathways within the RSA during the northern and fall migrations. Results were compared to caribou trails recorded in the LSA during the summer and fall aerial surveys.

Habitat preferences during the northern migration, summer, and fall seasons within the RSA were determined using pooled caribou observations from 1996 through 2005. The proportion of caribou observed in each habitat was compared to the proportion of each habitat available. Although some aerial surveys were unbounded, habitat area calculations were based on a 1.2-km transect width (600 m either side of the helicopter).

Barren-ground Grizzly Bear

The presence of bear sign within and adjacent to seasonal high-quality (i.e., preferred) habitats has been used as an index of relative activity by grizzly bears within study areas for several projects in the NWT and Nunavut (Golder 2005; Miramar 2007; BHPB 2010; DDMI 2010; De Beers 2010).

Habitat surveys were completed in 2005 and 2007 to determine the natural variation in the relative use of seasonally preferred habitat by grizzly bears in the RSA (Section 11.10). The study design and survey protocols followed the methods used at several projects in the NWT, including the Diavik Diamond Mine, Ekati Diamond Mine, and the Snap Lake Mine. Surveys focused on ground searches for bear sign in plots within sedge wetlands and riparian habitats. In 2005, searches were completed within 30 sedge wetlands habitat plots, and within 30 willow riparian/birch seep habitat plots. Habitat surveys completed in August 2007 involved re-sampling the 30 riparian habitat plots established in 2005.

Baseline studies were also completed to identify den sites used for winter hibernation within the RSA, and to assess the importance of potential den habitats within the LSA (Section 11.10). Caribou aerial surveys completed from 1999 to 2005, recorded bear observations and bear den locations within the RSA and LSA. Survey efforts focused on all mapped and many unmapped esker complexes and glaciofluvial deposits to locate active grizzly bear den sites. Surveys for grizzly bear sign along eskers were also completed in 2007 because eskers may be sources of gravel material for the Project (Section 11.10).

Wolverine

A baseline study was completed to determine the natural variation in the relative annual activity and abundance of wolverine within the RSA (Section 11.10). Observations of wolverine and wolverine sign within the RSA, LSA, and the Winter Access Road Study Area were recorded during surveys completed for other wildlife species from 1999 to 2005. Incidental observations were also recorded during the esker surveys completed in 2007.

Ground-based winter track count surveys were completed in 2004 and 2005 to determine wolverine presence in the LSA (Section 11.10). A track density index (expressed as tracks per kilometre surveyed per days since snow or threshold wind speed (track density index [TKD]) was calculated to determine the relative abundance of wolverines in the LSA for each survey period. In addition, the proportion of wolverine tracks observed in each habitat in each year was compared to availability. Pooling of habitat categories was required as the observed counts within all habitats were too few for analyses. Analyses compared the proportion of tracks observed in each pooled habitat to the expected proportion of tracks in each pooled habitat, based on the amount of habitat available.

To estimate the annual changes in abundance of wolverines in a study area, the ENR of the Government of the Northwest Territories (GNWT) has developed and implemented a successful program for estimating the abundance, density, and demographic parameters of wolverine at several mining projects in the NWT (Boulanger and Mulders 2007; Mulders et al. 2007). The study design uses baited posts, arranged in a sampling grid, to capture wolverine hair, which are then analyzed using deoxyribonucleic acid (DNA) finger printing techniques. The method has been incorporated into the wildlife effects monitoring programs for the Ekati Diamond Mine and the Diavik Diamond Mine in the NWT, and the Jericho Diamond Mine and Doris North Projects in Nunavut, and was part of the baseline studies for the Project.

The wolverine DNA hair snagging program was completed within a circular 1,600 km^2 study area centred on the Project camp (Section 11.10). Scent posts were wrapped in barbed wire and positioned within a 3 by 3 km grid cell, based on similar protocols used for Ekati Diamond Mine and Diavik Diamond Mine. Following the initial set-up period, each post was sampled twice during two 10 day sessions. Hair samples collected from the barbed wired were submitted for DNA analysis.

Fish

Fish species listed on the NWT Species Monitoring Infobase (NWT General Status Ranking Program 2010, internet site) and on Schedules 1, 2, and 3 of the federal *Species At Risk Act* (SARA 2010, internet site) and by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2009, internet site, 2010, internet site) were compared to fish species known to exist in Kennady Lake, the LSA (i.e., the Kirk Lake watershed), and RSA (i.e., the Lockhart River watershed) (Section 8) to determine the potential for fish species at risk to occur within the RSA.

Plants

Rare plant surveys were undertaken in 2004 and 2005 within the proposed Project footprint (Section 11.7). Habitats with limited distribution due to the presence of uncommon terrain features within the LSA were sampled as well. A complete list of plant species was compiled for each site using patterned and meander searches.

11.12.2.3 Results

11.12.2.3.1 Upland Birds

Habitat Use and Distribution

Upland breeding birds (passerines, ptarmigan, and upland breeding shorebirds) are commonly used in baseline and monitoring programs because they represent an abundant and diverse group of species that are relatively easy to observe and monitor. Birds are also an important resource for Aboriginal people in the NWT and Nunavut, and have provided food and materials, such as feathers, which were used to make blankets and pillows (LKDFN 2001).

The spring migration of birds to the NWT begins in early May and peaks around mid-to-late May. The breeding season for small perching birds (passerines) typically starts during the first week of June and continues for about three weeks. Fall migration begins in mid-August for some species such as sandpipers, and continues through to mid-September for late migrants such as horned larks.

Species-level Results

Lapland longspurs were the most common birds observed in heath tundra and sedge wetlands, while savannah sparrows (*Passerculus sandwichensis)*, Harris' sparrow (*Zonotrichia querula)*, and American tree sparrow (*Spizella arborea)* were also abundant. Similar results were documented during baseline studies at the Snap Lake Mine (De Beers 2002), and during effects monitoring at the Ekati Diamond Mine (Smith et al. 2005; BHPB 2007). The highest individual species densities observed in the RSA were Lapland longspur in sedge wetlands (34.1 birds/0.25 km^2) and savannah sparrows in sedge wetlands (12.7 birds/0.25 km^2) (Table 11.12-3). Sedge wetlands had more shorebird species than other habitats, including four species primarily detected in wetlands: pectoral sandpiper, short-billed dowitcher, semi-palmated sandpiper, and white-rumped sandpiper.

Table 11.12-3 Mean (± 1 Standard Error) Density (individuals per 0.25 km^2 plot) of Upland Breeding Bird Species by Habitat

Common Name	Scientific Name	Heath Tundra	Sedge Wetlands	All Plots
Willow ptarmigan	*Lagopus lagopus*	2.50 ± 1.07	0.50 ± 0.33	1.42 ± 0.53
Short-billed dowitcher	*Limnodromus griseus*	0	0.25 ± 0.19	0.13 ± 0.10
American golden plover	*Pluvialis dominica*	0.07 ± 0.07	1.56 ± 0.32	0.90 ± 0.21
Semi-palmated plover	*Charadrius semipalmatus*	0.07 ± 0.07	0	0.03 ± 0.03
White-rumped sandpiper	*Calidris fuscicollis*	0.07 ± 0.07	0.38 ± 0.13	0.29 ± 0.09
Stilt sandpiper	*Calidris himantipus*	0.29 ± 0.16	0.06 ± 0.06	0.16 ± 0.08
Semi-palmated sandpiper	*Calidris pusilla*	0	1.06 ± 0.40	0.55 ± 0.23
Least sandpiper	*Calidris minutilla*	1.43 ± 0.44	1.75 ± 0.30	1.55 ± 0.25
Pectoral sandpiper	*Calidris melantos*	0	0.06 ± 0.06	0.03 ± 0.03
Red-necked phalarope	*Phalaropus lobatus*	0.14 ± 0.10	0.38 ± 0.38	0.26 ± 0.20
Common snipe	*Gallinago delicata*	0.79 ± 0.33	1.50 ± 0.66	1.16 ± 0.37
Horned lark	*Eremophila alpestris*	1.29 ± 0.38	2.00 ± 0.48	1.61 ± 0.31
American robin	*Turdus migratorius*	0.36 ± 0.20	0.13 ± 0.09	0.23 ± 0.10
Gray-cheeked thrush	*Catharus minimus*	0.93 ± 0.40	1.56 ± 0.84	1.42 ± 0.49
American pipit	*Anthus rubescens*	0.36 ± 0.25	0.56 ± 0.30	0.55 ± 0.21
Blackpoll warbler	*Dendroica striata*	1.71 ± 1.04	2.50 ± 1.80	2.29 ± 1.04
Yellow warbler	*Dendroica petechia*	0	0.06 ± 0.06	0.03 ± 0.03
Yellow-rumped warbler	*Dendroica coronata*	0.71 ± 0.30	0.13 ± 0.09	0.52 ± 0.19
Smith's longspur	*Calcarius pictus*	1.71 ± 0.74	0.69 ± 0.31	1.13 ± 0.38
Lapland longspur	*Calcarius lapponicus*	18.50 ± 5.09	34.06 ± 3.34	25.94 ± 3.26
American tree sparrow	*Spizella arborea*	7.64 ± 1.68	9.06 ± 2.51	8.45 ± 1.48
Lincoln's sparrow(a)	*Melospiza lincolnii*	0	0	0.06 ± 0.06
Savannah sparrow	*Passerculus sandwichensis*	7.86 ± 0.92	12.69 ± 1.47	10.23 ± 0.98
White-crowned sparrow	*Zonotrichia leucophrys*	0.29 ± 0.16	0.13 ± 0.13	0.19 ± 0.10

Table 11.12-3 Mean (± 1 Standard Error) Density (individuals per 0.25 km^2 plot) of Upland Breeding Bird Species by Habitat (continued)

Common Name	Scientific Name	Heath Tundra	Sedge Wetlands	All Plots
Harris' sparrow	*Zonotrichia querula*	9.29 ± 2.56	8.88 ± 1.77	9.39 ± 1.48
Rusty blackbird(a)	*Euphagus carolinus*	0	0	0.03 ± 0.03
Common redpoll	*Carduelis flammea*	0	0.06 ± 0.06	0.03 ± 0.03
Hoary redpoll	*Carduelis hornemanni*	0.71 ± 0.30	1.13 ± 0.50	0.90 ± 0.29

[a] occurred in single riparian plot.

± = plus or minus; km^2 = square kilometre.

Community-level Results

Relative abundance and observed species richness were determined for each habitat and for all plots combined. Mean relative abundance (birds per plot) and observed richness (species per plot) were higher in sedge wetlands (Table 11.12 4). Overall, the abundance of birds per plot ranged from 24 to 173, and the number of species per plot ranged from 5 to 17. Results from baseline studies at the Snap Lake Mine for 1999 and 2000 showed similar trends in density and observed richness across habitats. For example, the mean number of birds per plot in heath tundra ranged from 57.5 to 79.2 birds per 0.25 km^2, while sedge wetlands contained an average of 115.0 to 175.3 birds per 0.25 km^2 (De Beers 2002). Species richness was highest in riparian habitat (7 to 8 species), and similar between heath tundra and sedge wetlands (5 to 7 species). Density in riparian habitat also was greatest (230 to 294 birds/0.25 km^2), but likely over-estimated due to small plot size (0.01 to 0.02 km^2).

Table 11.12-4 Relative Abundance (Birds/0.25 km^2 Plot) and Observed Species Richness (per plot) of Upland Birds

Habitat Type	Number of Plots	Relative Abundance		Species Richness	
		Mean ± 1SE	Range	Mean ± 1SE	Range
Sedge wetlands	16	81.7 ± 7.5	54 to 173	10.0 ± 0.8	6 to 17
Heath tundra	14	56.9 ± 5.3	24 to 101	8.4 ± 0.7	5 to 12
All plots	31	69.8 ± 5.0	24 to 173	9.4 ± 0.5	5 to 17

SE = standard error; ± = plus or minus; km^2 = square kilometre.

Species richness curves were plotted by habitat (after pooling data across years) using rarefaction results from the statistical program EstimateS (Colwell 2005) (Figure 11.12-5). The rarefaction curves did not asymptote within the current sample range, indicating that further sampling is required to obtain more accurate and precise estimates of species richness. Therefore, species richness (Sobs) was estimated using the highest number of species observed (Table 11.12-5). Species richness was higher in wetlands where 25 species were detected, as compared to heath tundra plots where 21 species were observed.

Diversity indices combined information on species richness and abundance in the community, and were generated for each habitat and habitats combined (Table 11.12-5). Sedge wetlands plots had a higher mean Fisher's-alpha (α) index but a lower Simpson' inverse index, suggesting that these plots may be richer in species, but numbers are less evenly distributed across species than in the heath tundra plots.

Figure 11.12-5 Species Richness Curves (with 95% Confidence Intervals [dotted lines]) for All Breeding Bird Plots, and Heath Tundra and Sedge Wetlands Plots

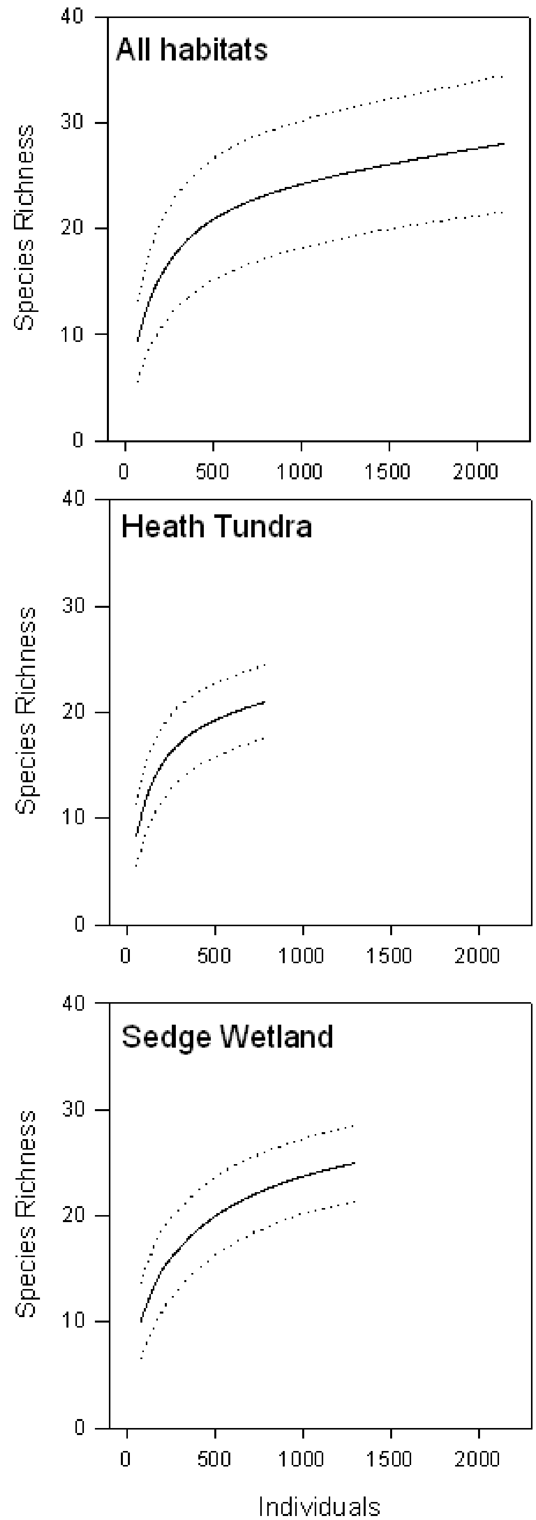


Table 11.12-5 Estimated Species Richness (and 95% Confidence Interval) Indices for Upland Breeding Birds

Habitat	N plots	Sobs	95% CI	Fisher's (± 2SE)	Simpson's (± 2SE)
Sedge wetlands	16	25	21.4 to 28.6	4.16 ± 0.18	4.49 ± 0.08
Heath tundra	14	21	17.5 to 24.5	3.82 ± 0.16	5.44 ± 0.19
All plots	31	28	21.6 to 34.4	4.38 ± 0.12	5.05 ± 0.06

N = number; Sobs = estimated species richness; CI = confidence intervals; SE = standard error: ± = plus or minus; % = percent.

Population Characteristics

In the RSA, upland breeding bird surveys were completed in 11 plots in June of 2004 and 20 plots in June 2005. A total of 28 species of songbirds, shorebirds, and ptarmigan were detected within survey plots. The rusty blackbird was the only federal listed species of special concern (COSEWIC 2009, internet site) observed during the surveys. In the NWT, this species is listed as may be at risk (NWT General Status Ranking Program 2010, internet site). A complete list of species identified during rapid assessment surveys (1998, 1999, and 2001) and systematic surveys (2004 and 2005) is provided (Annex F, Appendix F.I).

During baseline studies at the Snap Lake Mine from 1999 to 2000, 22 species of upland breeding birds were detected among 38 plots (De Beers 2002). The rusty blackbird (*Euphagus carolinus*) was the only listed species observed. Studies at the Ekati Diamond Mine have identified 31 species of upland breeding birds from 1996 to 2006 (BHPB 2007).

Traditional and Non-traditional Use

Ptarmigan are the only upland breeding bird species taken in non-traditional harvest in the RSA. Total ptarmigan harvest in the NWT by hunters has decreased from 5,530 birds in 1990/1991 to 1,325 birds in 2005/2006 (Annex N, Non-traditional Land Use and Resource Use Baseline). Willow ptarmigan (*Lagopus lagopus*) and rock ptarmigan (*Lagopus mutus*) depend on open tundra or shrubby habitat on the tundra for breeding (Hannon et al. 1993; Montgomerie and Holder 2008, internet site) and therefore may be disturbed by Project development in the RSA.

According to the reviewed sources of information containing traditional knowledge and traditional land-use, upland birds are an important resource for First Nation people in the area. They provide food and materials such as feathers that are used to make blankets and pillows. In *Habitats and Wildlife of Gahcho Kué and Katth'l Nene* (LKDFN 1999), traditional knowledge holders from

Łutselk'e identified eleven upland bird species that are known to use habitat existing in the RSA. These include:

- chickadee (*Poecile* sp.);
- northern flicker (*Colaptes auritus*);
- downy woodpecker (*Picoides pubescens*);
- lesser yellowlegs (*Tringa flavipes*);
- red-bellied woodpecker (*Melanerpes carolinus*);
- semi-palmated plover (*Charadrius semipalmatus)*;
- snowbird (lapland longspur) (*Calcarius lapponicus)*;
- solitary sandpiper (*Tringa solitaria*);
- spruce grouse (*Dendragapus canadensis*;
- willow ptarmigan; and
- yellow-bellied sapsucker (*Sphyrapicus varius*).

The semi-palmated plover, spruce grouse, and willow ptarmigan are considered to be edible. In addition to the list above, the North Slave Métis identified the robin (*Turdus migratorius*) as inhabiting the North Slave Region (NSMA 1999, internet site).

Based on a review of the existing sources, ptarmigan and grouse appear to be the upland bird species that are of particular importance for traditional use. The barrenlands were discussed as important bird habitat, especially in the summertime when they migrate to the area to lay their eggs.

> *In the wintertime, they go south. In the summertime, I see they're coming from back down this way. That's where they lay eggs, on the tundra, the barrenlands. That's the most important part* (Anon in NSMA 1999:146-147, internet site).

Based on reports by LKDFN (2003, internet site, 2005, internet site), the favourite fall hunting spots for grouse and ptarmigan are Stark River, Murky Lake, Łutselk'e Bay, Duhamel Lake, and around Łutselk'e.

The reviewed sources suggest that many of the birds that inhabit the area are migratory and can be found in the area only during certain times of the year, depending on the weather.

> *I used to hear all kinds of birds. I saw longspurs and snowbirds. The snowbirds go there all year* (LA in LKDFN 2002).

> *They [ptarmigan] stay all year round on the tundra and come down to Åutsÿl K'e [in the spring]. The grouse come back [around Autsyl K'e] in April to October, then go south for the winter* (LA in LKDFN 2002).

The traditional knowledge study program identified several concerns that traditional knowledge holders have expressed in the past about potential effects on birds, due to mining activities. These concerns include:

- loss of habitat;
- dust or spills that the birds might ingest; and
- dust or spills that might coat bird's feathers and then kill them (by poison or by affecting their insulation capabilities).

> *We should also look at the vegetation –berries. We don't want to it spoiled. We eat it –and the little birds eat it too* (AM in LKDFN 2001).

11.12.2.3.2 Water Birds

Habitat Use and Distribution

The RSA provides habitat for a variety of both breeding and staging water birds. Boreal and tundra wetlands offer foraging and nesting opportunity for water birds, loons, terns, gulls, and rails. Early in the spring, migrants use ice-free areas, especially those near riverine inflows and outflows. As the season progresses, water bird assemblages use wetland resources specific to their life history requirements. For most water birds, the breeding season (encompassing nesting, incubation, brood rearing and the post-fledge period) represents the most vulnerable or sensitive period for these species. The strong association between water birds and the aquatic habitats they occupy during the breeding season strengthens the importance of these wetlands to water bird populations.

The spring migration of water birds to the NWT begins in early May, and in some years, at the end of April (LKDFN 2003, internet site). Swans and arctic breeding geese stage in the region before continuing their northern migration. Dabbling ducks seek nutrient-rich waters for forage and brood rearing, typically nesting in adjacent upland sites. Diving ducks including scaup spp., canvasback (*Aythya valisineria*), long-tailed ducks (*Clangula hyemalis)*, white-winged scoter (*Melanitta fusca)*, common goldeneye (*Bucephala clangula*), and red-breasted mergansers (*Mergus serrator*) typically breed on larger, moderately productive, or low productive lakes. Water birds will nest in a variety of habitats including islands, shoreline edge, riparian areas, upland sites, and even wood or rock cavities.

Loon (*Gavia* spp.) pairs typically breed on the edge of a lake or pond that is well-distanced from other pairs of breeding loons. This same waterbody hosts the pairs' nesting, brooding, and post-fledge period. Loon home ranges include immediate breeding waters and may include local waters that offer foraging opportunity via parental flights during the brood rearing period (Ball 2004). Gulls (*Larus* sp.) and terns (*Sterna* sp.) are colonial nesting species and usually concentrate nest sites on rookeries or sparsely vegetated islands as a means to avoid mammalian predators. Home ranges for gulls and terns generally include immediate and local waters that provide fish (Pierotti and Good 1994, internet site). Jaegers (*Stercorarius* sp.) will typically nest on islands, as pairs, or in loose colonies (Wiley and Lee 1998, internet site).

Tundra wetlands are shallower in depth than most lakes, and therefore generally open earlier in the spring. These wetlands also usually contain considerable emergent vegetation, which may contribute to the higher number of water birds observed in these areas. Similarly, shallow bays, meltwater ponds, and shoreline leads, in the Diavik Diamond Mine study area, were identified as important areas for migrant water birds (DDMI 1998) as they provide habitat requisites such as open water. Water birds may use wetlands near to nesting sites for brood rearing and moult, or may move broods overland to other waters.

Water bird distribution is driven by access to seasonal wetlands providing foraging opportunity for broods (Hansen and McKnight 1964; Murdy 1966; Smith 1971; Stroudt 1971). Most North American water birds exhibit annual latitudinal migration to northern breeding grounds that offer available wetland and nesting habitat, reduced predator densities, and foraging opportunity for broods (Sargeant and Raveling 1992). The timing of reproduction in water birds is dictated by the availability of food for young (Lack 1947; Lack 1954; Immelmann 1971).

Most water birds arrive to breeding grounds in the central Canadian Arctic primarily via the Central and Mississippi Flyways of North America. Loons and sea duck species (i.e., long-tailed duck [*Clangula hyemalis*], black scoter [*Melanitta nigra*], surf scoter [*Melanitta perspicillata*], white-winged scoter [*Melanitta fusca*]) practice lateral migrations to coastal wintering grounds. At the local scale, nest site selection is driven by factors including species-specific preference of waterbody size, upland cover density, and habitat structure influencing predation (Metcalfe 1984; Whittingham and Evans 2004).

Wetland ecosystem function and structure is controlled primarily by the timing, amplitude, rates of flow and source of the water regime (Kadlec and Smith 1984; Mitsch and Gosselink 1986). Wetland abundance and water levels directly influence nutrient provisioning, vegetative growth, and invertebrate abundance. In turn these biophysical processes directly influence water birds reproductive effort and brood survival (Kadlec and Smith 1984; Mills 2006). Water bird density and distribution is strongly correlated with wetland abundance (Niemuth and Solberg 2003).

Behavioural responses to sensory disturbances differ widely between water bird groups. However, common across the broad spectrum of water birds found in the RSA is that human disturbance is a negative stimuli. Water birds are vulnerable to disturbance and react negatively to anthropogenic (man-made) noise or motion (Rodgers and Burger 1981; Korschgren and Dahlgren 1992; Bélanger and Bédard 1990). Loons seem to avoid nesting on shores near human activity (Vermeer 1973; Ream 1976; Heimberger et al. 1983). Though reputed to be the least wary grebe with respect to human interactions, the horned grebe has been observed taking flight when approached by humans on foot or in boats (Stedman 2000, internet site).

Among other water birds within the RSA, gulls breed near human developments and commonly scavenge human refuse for food (Pierotti and Good 1994, internet site). Jaegers practice nest defense and will respond to humans venturing within 200 m of active nests through aerial attacks (Wiley and Lee 1988, internet site). Likewise, Arctic tern (*Sterna paradisaea*) practice nest defense toward humans intruders with the intensity of attacks dependent on both the stage of breeding and familiarity with humans, increasing during incubation, and peaking when earliest eggs are hatching (Hatch 2002, internet site). While little is known about the behaviour of the yellow rail (*Coturnicops noveboracensis*), this secretive bird generally avoids human activity (Bookhout 1995, internet site).

Population Characteristics

Water bird observations have been recorded within the RSA since 1998. From 1998 to 2003, water bird-specific surveys were not completed, but general observations were recorded during other wildlife surveys in the area. Over 7,200 water birds were recorded in 2004 during an intensive survey, with 6,900 documented during the spring migration. The yellow rail is the only species listed under Schedule 1 of SARA (2010, internet site) that is known to reside within the RSA. Horned grebe (*Podiceps auritus*) is listed as a species of special concern under COSEWIC (2009, internet site).

Between 1998 and 2005, 22 water bird species were documented in the RSA (Table 11.12-6). The most common water bird species recorded were the greater white fronted geese (*Anser albifrons*), Canada geese (*Branta canadensis*), and snow geese (*Chen caerulescens*) (Table 11.12-6). During baseline studies at the Diavik Diamond Mine (1995 to 1997), 17 water bird species were identified as migrants, summer residents, or uncommon visitors (DDMI 1998). Similarly, 18 water bird species were recorded during the two years of baseline studies at the Snap Lake Mine (De Beers 2002). Since 1998, the snow goose accounted for 56% of all goose species observed in the RSA. Greater white-fronted geese (21% of observations) and Canada geese (23% of observations) potentially breed within the RSA, while snow geese are considered migrants and travel further north to breed.

Thirteen duck species (plus one unidentified duck species) have been recorded within the RSA from 1998 to 2005 (Table 11.12-6). The most common species observed during the water bird surveys were the northern pintail (628 observations), followed by long-tailed ducks and red-breasted mergansers at 102 and 98 observations, respectively (Table 11.12-6). All duck species documented are expected breeders within the RSA, with the exception of the black scoter. Although the RSA is located at the northern limit of redhead duck (*Aythya americana*) habitat (Working Group on General Status of NWT Species 2006), 23 redhead ducks were recorded during miscellaneous wildlife surveys (Table 11.12-6).

Table 11.12-6 Water Bird Observations within the Regional Study Area, 1998 to 2005

Common Name	Scientific Name	Number of Water Birds Observations							Total
		1998	1999	2001	2002	2003	2004	2005	
Geese									
Greater white-fronted goose	*Anser albifrons*	0	0	149	0	999	927	92	2,167
Snow goose	*Chen caerulescens*	0	10	0	0	76	3,813	1,855	5,754
Canada goose	*Branta canadensis*	1	166	75	0	24	1,559	446	2,271
Unknown goose species		0	80	0	0	0	0	100	180
Swans									
Tundra swan	*Cygnus columbianus*	0	0	0	8	0	89	1	98
Ducks									
Mallard	*Anas platyrhynchos*	0	0	1	0	0	0	0	1
Northern pintail	*Anas acuta*	0	10	17	0	0	600	1	628
Green-winged teal	*Anas crecca*	0	0	3	0	0	14	4	21
Redhead	*Aythya americana*	0	0	0	0	0	23	0	23
Greater scaup	*Aythya marila*	0	0	2	0	0	0	0	2
Lesser scaup	*Aythya affinis*	0	0	8	0	0	24	0	32
Surf scoter	*Melanitta perspicillata*	0	10	4	0	0	0	2	16

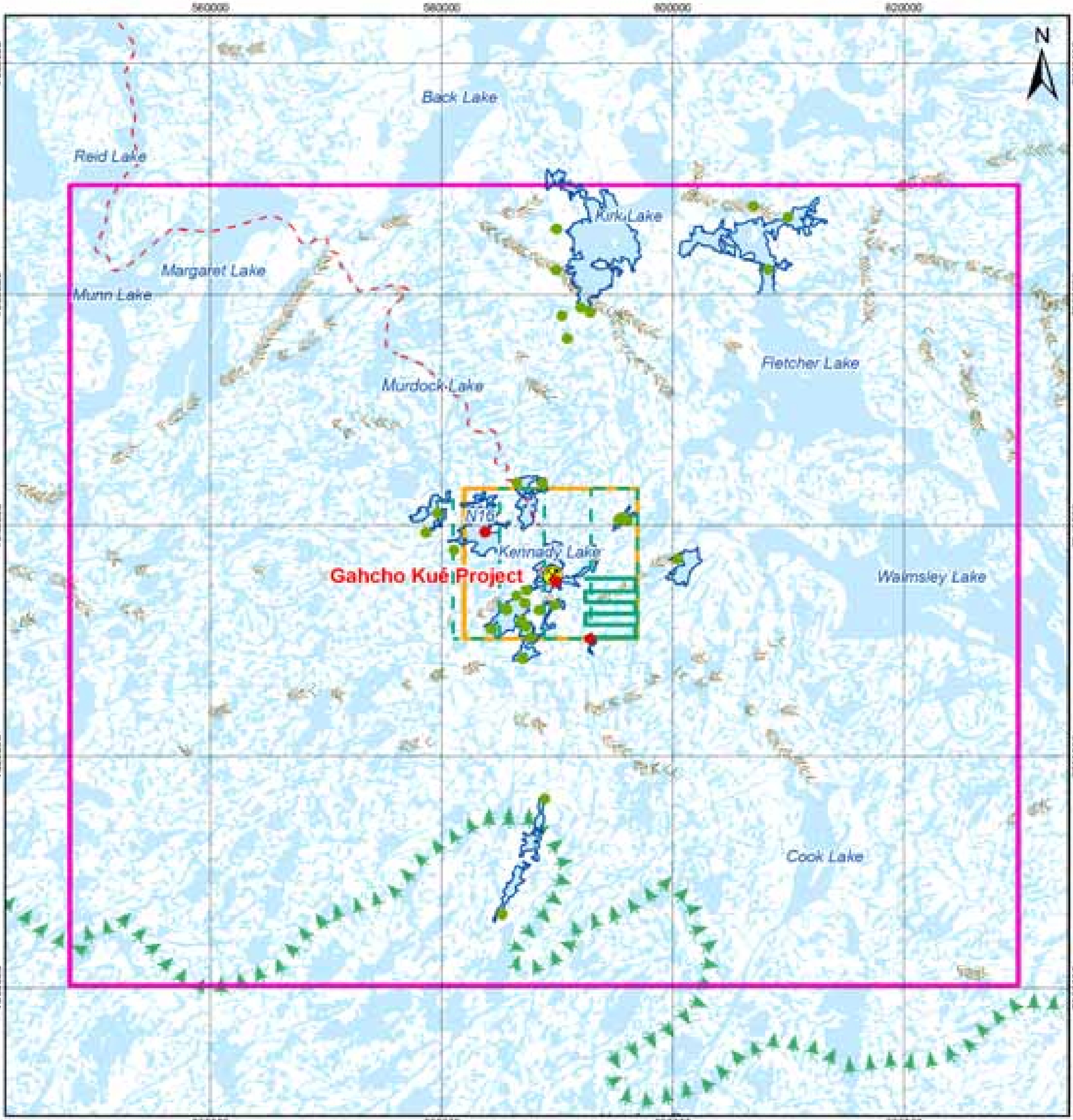
Table 11.12-6 Water Bird Observations within the Regional Study Area, 1998 to 2005 (continued)

Common Name	Scientific Name	Number of Water Birds Observations							Total
		1998	1999	2001	2002	2003	2004	2005	
White-winged scoter	*Melanitta fusca*	0	0	0	0	0	21	0	21
Black scoter	*Melanitta nigra*	1	2	19	0	0	19	0	41
Long-tailed duck	*Clangula hyemalis*	0	23	25	0	0	36	18	102
Common merganser	*Mergus merganser*	0	0	1	0	0	13	0	14
Red-breasted merganser	*Mergus serrator*	4	2	18	0	0	74	0	98
Merganser species	*Mergus spp.*	0	0	0	0	0	0	2	2
Unknown duck species		0	47	0	0	0	2	0	49
Loons									
Red-throated loon	*Gavia stellata*	0	0	0	0	0	5	0	5
Pacific loon	*Gavia Pacifica*	0	1	4	0	0	5	7	17
Common loon	*Gavia immer*	0	2	3	0	0	11	0	16
Yellow-billed loon	*Gavia adamsii*	0	0	12	0	0	20	2	34
Grebes									
Horned grebe[(a)]	*Podiceps auritus*	0	2	0	0	0	0	0	2
Total		**6**	**358**	**341**	**8**	**1,099**	**7,269**	**2,534**	**11,615**

(a) Species of special concern (COSEWIC 2009, internet site).

Four loon species, red-throated (*Gavia stellata*), yellow-billed (*Gavia adamsii*), common (*Gavia immer*), and Pacific loon (*Gavia pacifica*) were observed in the RSA (Table 11.12-6). Yellow-billed, Pacific, and red-throated loons are known to breed throughout the RSA, whereas common loons are presumed to be breeding within the southern, forested area of the RSA. Although common loons are occasionally seen at the northern edge of the treeline, no nests or breeding attempts could be confirmed within the RSA.

A linear estimate of the number of water birds observed per lake was calculated for Kennady Lake and Lake N16 during the June surveys. On Kennady Lake, 30 water bird observations totalled 0.64 birds per kilometre of shoreline (Figure 11.12-6). Fewer water bird observations (17 observations) were noted at Lake N16 than at Kennady Lake, however, the linear estimate was similar at 0.62 birds per kilometre of shoreline. Eight species were recorded at Kennady Lake and four species were recorded at Lake N16. Water bird estimates were also calculated for the 20 km of tundra wetlands surveyed. Sixty-six observations, representing seven water bird species, generated a linear estimate of 3.3 birds per kilometre of shoreline.



LEGEND

- Gahcho Kué Project
- Winter Access Road
- Watercourse
- Waterbody
- Esker
- Treeline
- June
- September
- Survey Transect
- Perimeter of Lake Flown
- Local Study Area
- Regional Study Area

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000

GAHCHO KUÉ PROJECT

Observations of Waterbirds in the Regional Study Area During 2004 Surveys

PROJECTION: UTM Zone 12	DATUM: NAD83
Scale 1:500,000 (10 5 0 10 Kilometres)	DE BEERS CANADA
FILE No: SON-11-12-005-GIS	DATE: October 22, 2010
JOB NO: 09-1365-1004	REVISION NO: 4
OFFICE: GOLD-SAS	DRAWN: ANK / CHECK: JV

Figure 11.12-6

Baseline water bird surveys completed at the Diavik Diamond Mine calculated species densities (0.58 birds per kilometre of shoreline) similar to Kennady Lake and Lake N16 (Penner and Associates Ltd. 1998). At the Snap Lake Mine, baseline surveys of lakes during June recorded an average density of 2.2 and 2.4 individuals per kilometre of shoreline (N=18 lakes) in 1999 and 2000, respectively (De Beers 2002). The average density during the July 1999 survey was 1.4 individuals per kilometre of shoreline (N=10 lakes) (De Beers 2002).

In 2010, common merganser, common loon, Canada goose, were observed on Kennady Lake. Common merganser, common loon, black scoter, and scaup were recorded on Lake X6. Scaup species were the only water birds observed at the small waterbodies adjacent to Kennady Lake or Lake X6 (Annex F, Addendum FF). The number of birds was less than or equal to 10 individuals for any of the species observed on the lakes.

The low density of water birds among lakes within the RSA may be due to limited high-quality nesting habitat (both upland and water nesting species) and low abundance of food resources. For example, Lake N16 represents a very nutrient poor lake situated at the headwaters of a watershed.

Other characteristics that may contribute to low water bird numbers at Lake N16 could include:

- prolonged ice coverage in the spring;
- few bays;
- no emergent vegetation; and
- a boulder shoreline.

Traditional and Non-traditional Use

Traditional knowledge holders from the LKDFN identified 35 bird species that are known to inhabit the RSA, 18 of which are edible (LKDFN 1999). Geese, ducks, and loons are important for traditional use. According to traditional knowledge, geese and ducks are a favourite food source for communities, and the feathers are used for making blankets and pillows (LKDFN 2001). Harvest includes a variety of duck and goose species including Canada goose, northern pintail (*Anas acuta*), white-winged scoter, long-tailed duck, scaup spp., mallard (*Anas platyrhynchos*), and tundra swan (*Cygnus columbianus*) (LKDFN 2005, internet site; Parlee et al. 2005).

According to Łutsel K'e elder testimony, water bird harvest occurs primarily during spring migration and begins the Denesǫłıne harvest calendar (Parlee et al. 2005). Primary harvesting areas include Thubun River, Rocher River, Basile Bay, Reliance, Stark River, Snowdrift River, the Gap, Łutselk'e Bay, McLean

Bay, Basile Bay, Stark Lake, Murky Channel, Back Bay, and Pekanatui Point (LKDFN 2001). During the spring, ice-free areas on Great Slave Lake provide foraging opportunity for congregating water birds. People travel to these water bird staging areas in the spring to harvest the migrating birds (LKDFN 2002), and in the summer, they travel to the barren-lands where birds migrate to lay eggs (NSMA 1999, internet site).

Relative abundances of water birds during the spring harvest period offer the Denesǫłıne an indication of relative health for migratory birds for that season (LKDFN 2002). Traditional knowledge reports have indicated large numbers of water birds have historically passed through the study area on route to northern breeding grounds. Recent accounts suggest both water birds diversity and abundance in the RSA have declined (Parlee et al. 2005). Observations of water birds numbers specifically note a marked decline in both black scoter and white-winged scoter populations (Parlee et al. 2005).

11.12.2.3.3 Raptors

Habitat Use and Distribution

Consistent with raptor studies in the Arctic, cliffs are the main feature of raptor habitat in the RSA. Raptors hunt in a variety of habitat types in relation to areas frequented by their prey, but have stringent requirements for nesting sites. Typically, nesting sites encompass the most rugged terrain available in the area. Nests are commonly built near water and are well protected against access by predators. It is normal for some falcon nests to be active most years, while others are only used in unusually good years.

Falcons typically nest on ledges or cliff faces. The continental gyrfalcon population breeds exclusively in the North American Arctic, especially on the north coast and arctic islands. The peregrine falcon (*Falco peregrinus*) has adapted to many North American habitats and breeds throughout the continent. Short-eared owls (*Asio flammeus*) typically nest in marsh habitat or open tundra (National Geographic 1983; Wiggins et al. 2006, internet site). Both subspecies of peregrines are tolerant of human disturbance and have nested near human development including mine sites (BHPB 2010; DDMI 2010).

With respect to disturbance, short-eared owls are sensitive to habitat loss and fragmentation. This owl is a ground nester requiring large breeding territories. Fragmentation of these landscapes increase nest predator efficiency resulting in decreased nest success (Wiggins et al. 2006, internet site).

In general, the topography within the RSA can be described as gentle undulating terrain; therefore, quality raptor nesting habitat is limited. Quality nesting habitat was restricted to the northwest corner, in the region of Margaret Lake and the western half of the RSA (Figure 11.12-7).

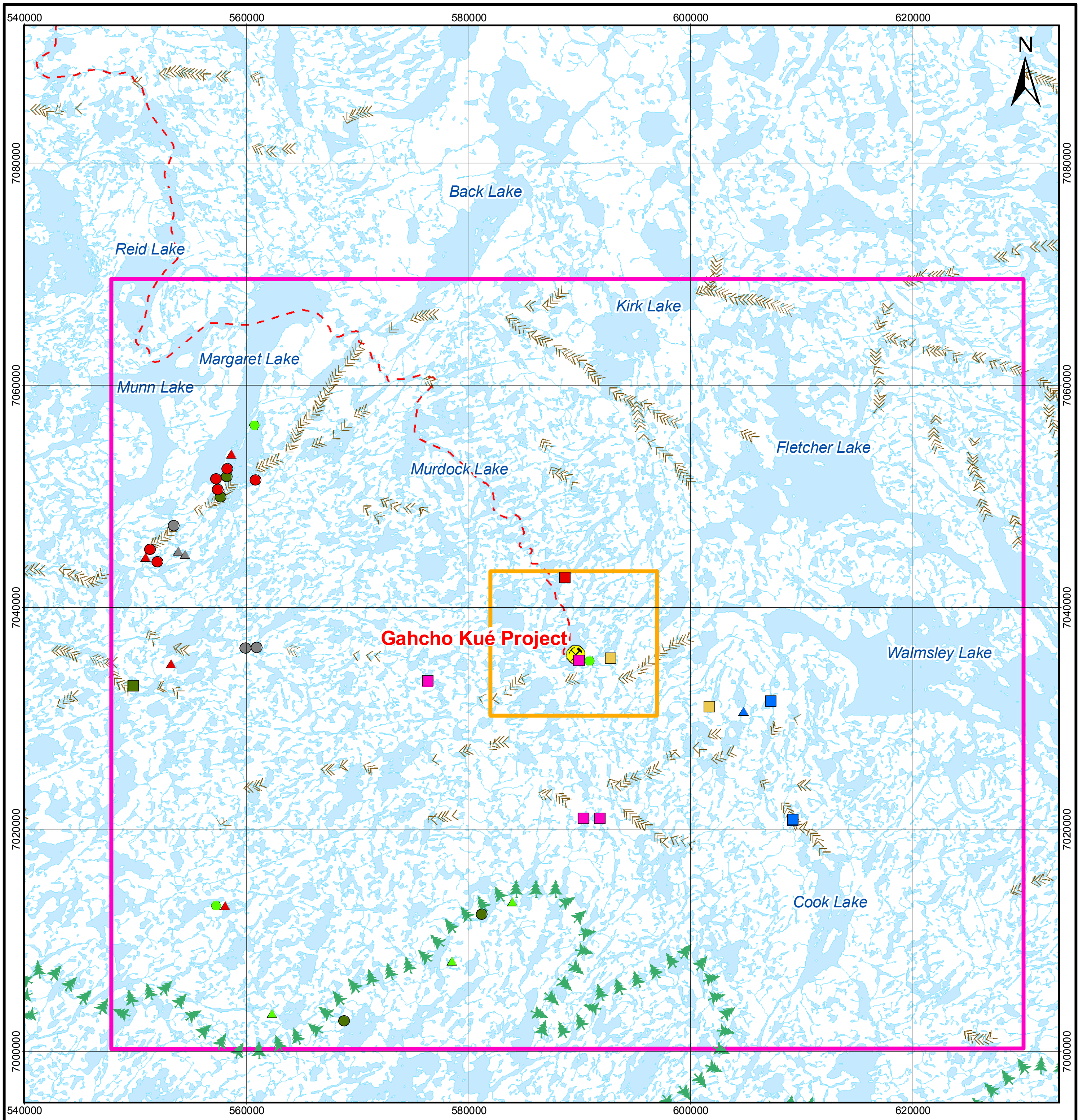
Population Characteristics

The short-eared owl and the peregrine falcon are both listed as a species of special concern under COSEWIC (2009, internet site) and Schedule 3 of SARA (2010, internet site). These species are also listed in NWT as sensitive (NWT General Status Ranking Program 2010, internet site). Recently, peregrine populations in the Canadian Arctic have increased due to the decline in the use of organochlorine pesticides in their wintering areas (Shank et al. 1993). In addition to the peregrine falcon, the gyrfalcon (*Falco rusticolus*) is also a high-profile species in the north and the official bird of the NWT.

Since 1996, ten raptor species and ravens were recorded within the RSA (Table 11.12-7). Ravens are passerines but are considered functional raptors for this study. In 1996, and from 1998 to 2005 (excluding 2004), 97 incidental raptor observations were recorded (Table 11.12-7). These observations included nine raptor species and one raven species. The most frequently observed species were the common raven, followed by the peregrine falcon, and bald eagle (*Haliaeetus leucocephalus*). Observations of raptors recorded during nest surveys in 2004, and incidental observations recorded in 2005 are presented in Figure 11.12-8.

Table 11.12-7 Raptor Observations within the Regional Study Area

Common Name	Scientific Name	Number of Raptor Observations per Year							
		1996	1998	1999	2001	2002	2003	2004	2005
Unknown raptor		0	0	2	0	2	1	2	0
Unknown falcon	*Falco spp.*	2	0	0	0	0	0	0	0
Gyrfalcon	*Falco rusticolus*	0	0	0	0	0	3	9	3
Peregrine falcon	*Falco peregrinus*	7	0	2	0	1	1	26	4
Rough-legged hawk	*Buteo lagopus*	0	1	1	0	0	5	10	0
Short-eared owl	*Asio flammeus*	0	0	0	3	0	0	4	5
Bald eagle	*Haliaeetus leucocephalus*	0	0	7	1	0	1	6	6
Golden eagle	*Aquila chrysaetos*	0	0	0	0	0	0	3	5
Common raven	*Corvus corax*	0	1	2	26	3	7	12	3
Merlin	*Falco columbarius*	0	0	0	0	0	0	1	1
Northern hawk owl	*Surnia ulula*	0	0	0	0	0	0	3	0
Northern harrier	*Circus cyaneus*	0	0	0	0	2	6	18	1
Snowy owl	*Bubo scandiacus*	0	0	0	0	2	2	0	1
Total		**9**	**2**	**14**	**30**	**10**	**26**	**94**	**29**



LEGEND

- Gahcho Kué Project
- Winter Access Road
- Watercourse
- Waterbody
- Esker
- Treeline
- Active Nest
- Unoccupied Nest
- Breeding Attempt
- Raven
- Peregrine Falcon
- Owl
- Northern Hawk Owl
- Northern Harrier
- Hawk
- Gyrfalcon
- Local Study Area
- Regional Study Area

NOTES
Base data source: National Topographic Base Data (NTDB) 1:250,000
The colour of the Active Nest, Unoccupied Nest, and Breeding Attempt symbols represent the species

GAHCHO KUÉ PROJECT

Locations of Active Nests, Unoccupied Raptor Nests, and Observed Breeding Attempts in the Regional Study Area 2004 and 2005

PROJECTION:	DATUM:
UTM Zone 12	NAD83

Scale: 1:500,000
10 5 0 10
Kilometres

DE BEERS CANADA

FILE No:	DATE:
SON-11-12-007-GIS	October 22, 2010

JOB NO:	REVISION NO:
09-1365-1004	2

OFFICE:	DRAWN:	CHECK:
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Figure 11.12-7

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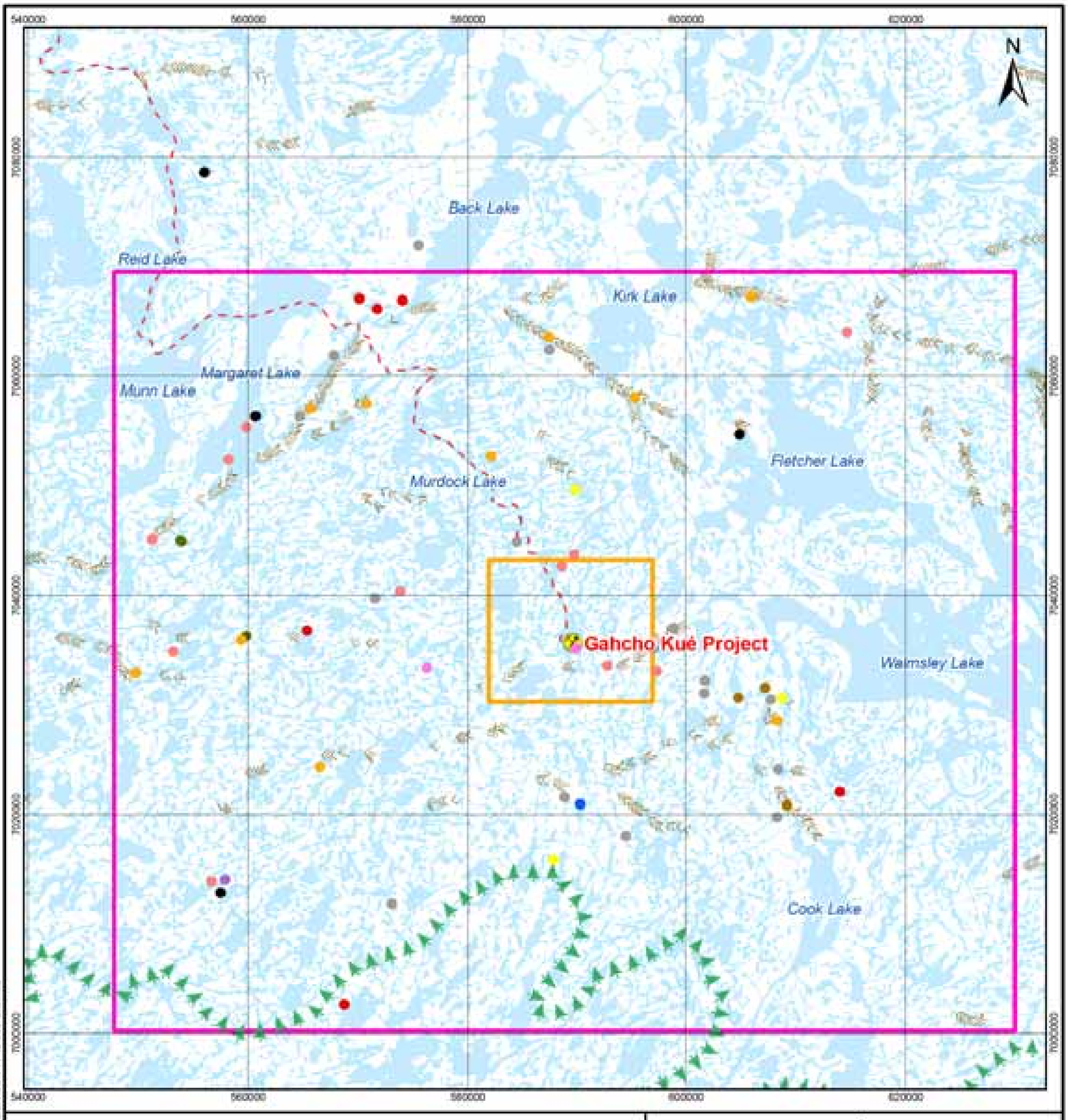


LEGEND

- Gahcho Kué Project
- Winter Access Road
- Watercourse
- Waterbody
- Esker
- Treeline
- Bald Eagle
- Common Raven
- Golden Eagle
- Gyrfalcon
- Merlin
- Northern Harrier
- Northern Hawk Owl
- Peregrine Falcon
- Rough-legged Hawk
- Short-eared Owl
- Unidentified Raptor
- Local Study Area
- Regional Study Area

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000

GAHCHO KUÉ PROJECT

Observations of Raptors in the Regional Study Area 2004 and 2005

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:500,000

10 5 0 10

Kilometres

DE BEERS CANADA

FILE No.	DATE
SON-11-12-006-GIS	October 22, 2010

JOB NO.	REVISION NO.
09-1365-1004	2

OFFICE	DRAWN	CHECK
GOLD-SAS	MGD	JV

Figure 11.12-8

The higher number of raptor observations within the RSA in 2004 (94 observations) relative to other years was likely associated with a change in survey methods. In 2004, an intensive aerial survey of all suitable raptor nesting habitat within the RSA was completed. Surveys prior to and after 2004 concentrated on other wildlife (e.g., caribou, breeding birds, and water birds), and recorded raptors incidentally.

In 2004, the most common species observed within the RSA were peregrine falcon, northern harrier (*Circus cyaneus*), common raven, rough-legged hawk (*Buteo lagopus*), gyrfalcon, and bald eagle (Table 11.12-7). Only a limited number of sightings of short-eared owls, golden eagles (*Aquila chrysaetos*), northern hawk owls (*Surnia ulula*), snowy owls (*Bubo scandiacus*), and merlins (*Falco columbarius*) were documented (Figure 11.12-8).

Baseline studies at the Snap Lake Mine identified eight raptor species in 1999 and 2000 (De Beers 2002). Baseline surveys completed at the Diavik Diamond Mine recorded nine raptor species between 1995 and 1997; however, these surveys focused primarily on peregrine falcon and gyrfalcon species (Penner and Associates Ltd. 1998). Merlins were observed on four occasions in 1995. Forty two rough-legged hawks and 44 northern harriers were observed in the Lac de Gras area between 1995 and 1997. In addition, a high number of bald eagles (79 observations) were noted; however, no active nests were observed. Golden eagles (11 observations), snowy owls (21 observations), and short-eared owls (41 observations) were also observed (Penner and Associates Ltd. 1998).

Ten active raptor nests, including 22 nestbound chicks, were observed in 2004 and 2005. Ten breeding attempts were also recorded (Table 11.12-8; Figure 11.12-7). A breeding attempt is defined as an area that is actively defended. In instances where a nest could not be located, it was assumed that a breeding attempt was occurring if the adult exhibited signs of defending the area. Active nesting was recorded when adults were observed incubating or nests contained eggs.

A total of 15 falcon nests have been identified in the RSA, including four gyrfalcon and 11 peregrine falcon nests (Table 11.12-8). In the Snap Lake Mine study area (3,000 km^2), 12 falcon nest sites were identified from 1999 to 2006 (De Beers 2007). During baseline studies (1999 to 2004), occupancy rates at Snap Lake by species were 47% peregrines, 25% gyrfalcons, 3% ravens, and 25% unoccupied (N=68) (De Beers 2007). From 2005 to 2006, occupancy rates by species were 58% peregrines, 8% gyrfalcons, 8% rough-legged hawks, 8% ravens and 17% unoccupied (N=24) (De Beers 2007).

Table 11.12-8 Raptor Active and Unoccupied Nest Observations and Breeding Attempts in the Regional Study Area in 2004 and 2005

Species	Active Nest	Number of Chicks	Unoccupied Nest	Breeding Attempt
Gyrfalcon	2	5	2	0
Peregrine	4	8	7	1
Rough-legged hawk	0	0	5	1
Short-eared owl	1	0	0	2
Bald eagle	0	0	0	0
Golden eagle	0	0	0	0
Common raven	3	9	3	0
Merlin	0	0	0	1
Northern hawk owl	0	0	0	3
Northern harrier	0	0	0	2

From 1995 to 2006, 19 nest sites were monitored for occupancy and productivity in the Ekati Diamond Mine and Diavik Diamond Mine study areas (combined area = 2,800 km^2). In addition, a formal program for monitoring bird nesting activity within pit walls was completed from 2004 to 2006. Six raptor nests were monitored within the open pits. Since 1995, 29 to 90% of all nests were occupied by peregrine falcons, and 5 to 69% were occupied by gyrfalcons (BHPB 2007).

A total of 22 chicks were identified in the RSA from 2004 to 2005, including eight peregrine falcon, five gyrfalcon, and nine raven chicks. At the Snap Lake Mine, peregrine falcon production ranged from 2 (2005 and 2006) to 13 (2003) chicks between 2000 and 2006 (De Beers 2007). Gyrfalcon production at the Snap Lake Mine ranged from no chicks in 2001 and 2006, to six chicks in 2003. At the Ekati Diamond Mine, falcon chick productivity was highest in 1998 when all monitored breeding sites produced chicks. Between 1998 and 2006, the number of falcon chicks observed ranged from 16 in 1998 and 2000, to none in 2005 (BHPB 2007). Peregrine falcon productivity ranged from 2 to 12 chicks between 2003 and 2006 (BHPB 2007). Gyrfalcon production was similar, ranging from zero chicks in 2005 and 2006 to 10 chicks in 1998.

Survey results from 2010 determined that nine nests were occupied by raptors, five of which contained at least one chick (Annex F, Addendum FF). Successful nests included two rough-legged hawks, one peregrine falcon, one gyrfalcon, and one unknown species. Two nests were occupied by common raven (*Corvus corax*) and were also successful. Overall 28% (9 of 30) of available raptor (i.e., excluding common ravens) nests were occupied by raptors and 55% (5 of 9) hatched at least one egg. Currently, all known raptor nests in the RSA occur greater than 18 km from the anticipated Project site and 69% (22 of 32) are located in the west-north-western part of the study area near Margaret Lake.

Traditional and Non-traditional Use

Raptors have played a substantial role in the culture and spirituality of the Denesǫłıne (LKDFN 2001). Of note, the eagle is of cultural importance and is featured on the LKDFN band crest.

11.12.2.3.4 Other Species at Risk

Barren-ground Caribou

Barren-ground caribou have a significant social, cultural, and economic value for the people and communities of the Canadian Arctic. Aboriginal people have a strong connection with caribou, and rely on the animals for food, clothing and cultural wellness. In addition, caribou influence the landscape through their movements and feeding, and provide food for predators and scavengers such as wolves, grizzly bears, wolverines, and foxes. As a result, the barren-ground caribou in the NWT (with the exception of the Dolphin and Union herd) are listed as sensitive (NWT General Status Ranking Program 2010, internet site). The Bathurst, Ahiak, and Beverly herds are not listed federally (COSEWIC 2009, internet site, 2010, internet site).

Caribou populations with ranges that potentially overlap with the RSA are the Bathurst, Ahiak (Queen Maud), and the Beverly herds. For the purposes of the Project, the locations of satellite-collared cows from the Bathurst (1996 to 2010), Beverly (1995 to 2007), Ahiak (2001 to 2007), and combined Ahiak and Beverly herds (2008 to 2010) were used to define the annual and seasonal ranges for each herd (Section 7).

The estimated annual range for the Bathurst herd (1996 to 2007) is 400,435 km^2. Satellite collar data also indicates that the Bathurst population has the greatest likelihood of interacting with the Project. From January 1996 through March 2010, 81 collared cows (and 182 point locations) from the Bathurst herd were located in the RSA during the winter dispersal, northern migration, summer dispersal, and rut/fall migration periods. In addition, the likelihood of the Bathurst herd occurring in the RSA was similar across the winter dispersal, northern migration, summer dispersal, and fall migration periods. No collared animals were located in the RSA during the calving and post-calving seasons.

The estimated annual range for the Beverly herd (1995 to 2007) is 282,000 km^2. From January 1995 through October 2007, one collared animal from the Beverly herd was recorded in the RSA during the winter dispersal period. No collar locations were observed in the RSA during the other seasons. The estimated seasonal ranges also suggest that the Beverly herd has a low likelihood of occurring in the RSA during the northern migration, calving, post-calving, and summer dispersal periods, but may interact with the Project during the rut/fall migration and winter dispersal periods. However, these results are based on a maximum of one collared cow from January 1995 to May 2006, five to six collared animals from June 2006 to December 2006, and two cows during the late winter northern migration of 2007 (no collar data for calving and post calving in 2007). Increasing the number of collared animals (as was done in summer 2007) will increase the accuracy and precision of seasonal distribution estimates for the Beverly herd (Section 7).

The estimated area of the annual home range of the Ahiak herd is 443,717 km^2. From January 2001 through October 2007, three collared caribou from the Ahiak herd were recorded in the RSA during the winter dispersal period, and one during the northern migration period. The estimated seasonal distributions also suggest that the Ahiak herd may occur in the RSA during the summer dispersal, rut/fall migration, winter dispersal, and northern migration periods. Similar to the Bathurst and Beverly herds, no collared animals were located in the RSA during the calving and post calving periods (Section 7).

From November 2007 to March 2010, nine collared caribou from the Ahiak and Beverly herds were recorded within the RSA during the winter dispersal period. No collar locations were observed in the RSA during the other seasons. The estimated seasonal ranges for the combined Ahiak/Beverly herd suggest there is a low likelihood of the herd occurring in the RSA during the seasons.

Caribou generally first appear near the Project in late April and early May. From 1999 to 2005, 100 to over 3,000 caribou (with the exception of 2002 when nine caribou were observed) were observed in the RSA during the northern migration. Satellite collar data suggests that caribou observed in the RSA during the northern migration were likely from the Bathurst and Ahiak herds. Similar estimates were reported in the Ekati Diamond Mine and Diavik Diamond Mine study areas (combined area = 2,800 km^2), as over 2,500 individuals were observed each year from 1998 to 2002 (with the exception of 2001 when over 1,672 individuals were recorded) (Golder 2005). Similarly, over 14,000 caribou were estimated to be in the Snap Lake Mine study area (3,000 km^2) during the 2000 and 2002 northern migrations (De Beers 2007).

Surveys completed at the start of the northern migration (late April to early May) in 2004 and 2005, documented 42 and 29%, respectively, of the caribou groups foraging and resting, while the remaining groups were observed walking. The proportion of caribou groups observed foraging and resting near the end of the northern migration (mid-to-late May) was 13 and 38% in 2004 and 2005, respectively. The remaining 87 and 62% of the caribou groups were walking in 2004 and 2005, respectively (Section 7).

The Project is not located near the calving grounds for the Bathurst, Beverly, or Ahiak caribou herds and no observations of caribou were reported in the RSA during this time. Although few caribou were observed in the RSA during the post-calving period, no satellite-collared caribou from the Bathurst, Beverly, and Ahiak herds were recorded in the RSA from 1995 to 2010.

Caribou were observed within the RSA during the summer dispersal period; however, the number of caribou present within the RSA during the summer of any give year varied greatly (ranged from 104 to 30,000). Satellite collar data suggests that caribou observed in the RSA during the summer dispersal were likely from the Bathurst herd. Although surveys completed in the summer of 2003 found few caribou in the RSA (104 individuals), the results suggest that there is high likelihood of caribou occurring in the RSA during the summer dispersal period. In late July 1999, almost 7,000 caribou were observed and 28,000 estimated in the Snap Lake Mine study area (3,000 km^2) (De Beers 2007).

The timing of fall movements towards wintering grounds also varied among years; however, surveys completed from 1999 to 2005 indicated that caribou were usually present in the RSA in late September or early October. Large aggregations of caribou were observed in the RSA in 1999, 2000, and 2005, which corresponds to the satellite-collared caribou data recorded for the RSA. Satellite data indicated that no caribou from the Beverly or Ahiak herds were present within the RSA during the fall migration; however, collared individuals from the Bathurst herd were recorded in several years. Less than 1,000 caribou were estimated in the RSA during the fall migration from 2001 to 2004. Few caribou were counted along the Winter Access Road route in 2004 and 2005 (Section 7).

The estimated number of caribou in the Snap Lake Mine study area (3,000 km^2) during the summer to fall migration periods has also varied among years. For example, less than 2,000 caribou were estimated within the Snap Lake Mine study area during the post-calving migration (defined as July to October) in 2000 and 2006, while approximately 27,000 caribou were estimated in 1999, and 40,000 in 2005 (De Beers 2007). Similar results for the post-calving migration are also reported for the Diavik Diamond Mine and the Ekati Diamond Mine study areas (combined area = 2,800 km^2), where caribou estimates have ranged from over 14,000 in 1999 to less than 2,000 caribou in 2000 (Golder 2005). Estimates for these areas in 1998, 2004, and 2006 exceeded 5,000 caribou.

The proportion of nursery groups (groups with calves) within the RSA in 2004 and 2005 was similar to nursery groups observed near the Ekati Diamond Mine and Diavik Diamond Mine. Eleven percent of the caribou groups observed within the RSA in 2004 had calves, while the average proportion of groups with calves in the Lac de Gras region was 8% (6 to 12% [95% confidence interval]) (Golder 2005). In 2005, very few calves were observed within the RSA, and the proportion of caribou groups with calves was about 4%. The Ekati Diamond Mine also reported relatively low proportions of nursery groups at 7% in 2005 (BHPB 2007). In contrast, the proportion of groups with calves in the Snap Lake Mine study area (3,000 km^2) in 2004 and 2005 was 37 and 34%, respectively (De Beers 2007).

Fall movement towards the wintering grounds was not evident in 2004 and 2005, as most animals were observed foraging and resting. In 2004, 37% of the caribou groups were observed walking, while 50% were foraging and resting. One group of caribou was running as they were being pursued by a single wolf. Evidence of rutting activity was not observed. In 2005, 22% of the 86 caribou groups were walking, while 78% were foraging and resting. Track evidence suggested that animals had not reached the southwest corner of the RSA. Rutting activity was evident during the 2005 survey.

Although aerial surveys were not completed during the winter dispersal period, satellite-collared caribou data indicates that, over the years, caribou from the Beverly (2006), Bathurst (1996, 2003, 2005, and 2006), and Ahiak (2002, 2006, and 2007) herds were present in the RSA. In addition, observations from wildlife log books recorded caribou in the LSA during the winter. Snow track surveys completed in late winter 2004 also provided evidence of caribou feeding and foraging in the LSA. Most of the observed cratering (digging for vegetation) occurred in elevated and well-drained areas, where snow was shallow in depth (Section 7).

During the northern and fall migrations, historic caribou movements have been identified based on trails that scar the landscape. The general paths of the observed trails in the LSA were similar to the predicted fall migratory routes generated from the least cost path analyses. For example, several of the caribou pathways predicted for the fall migration travel through the LSA, near Kennady Lake and Lake N16. Landscape scarring that is indicative of historic caribou water crossing was documented near both of these lakes during aerial surveys. Although it was not possible to determine how frequently caribou preferred to use these crossings, their presence suggests that large numbers of caribou moved through this area in the past (Section 7).

Habitat selection and caribou behaviour are frequently the result of their response to environmental conditions; therefore, caribou can be found in a variety of habitat types at any one time (Case et al. 1996). The selection of habitat appears to be related to food availability, ease of travel, relief from insects, and predation (Curatolo 1975). Analysis indicated that caribou were found more often than expected on frozen lakes during the northern migration, which were used for travel through the RSA ($\chi^2 2=22.84$, $P=0.04$). During summer, caribou used peat bog, heath tundra, and tussock-hummock habitats more often ($\chi^2 2=62.58$, $P<0.01$). In the fall, caribou selected heath tundra, sedge wetlands, and tussock-hummock habitats relative to their availability ($\chi^2 2=86.95$, $P<0.01$) (Section 7).

Barren-ground Grizzly Bear

Barren-ground grizzly bears have the largest home ranges and likely the lowest population density of brown bears studied in North America (McLoughlin et al. 1999). Currently, the grizzly bear population in the SGP appears stable, but increased losses associated with illegal hunting or the killing of nuisance bears may place the population at risk of decline (McLoughlin et al. 2003). Grizzly bears in the NWT are listed as sensitive (NWT General Status Ranking Program 2010, internet site), and as a species of special concern by COSEWIC (2009, internet site).

The population of barren-ground grizzly bears was estimated at 800 ± 200 (standard error [SE]) individuals within an approximate area of 235,000 km^2, which is roughly the area of the SGP (McLoughlin et al. 2003). Barren-ground grizzly bears may be at risk of population decline because they have low production rates and live in areas of low forage productivity and extreme environmental conditions. However, factors other than adaptation to natural conditions appear to govern the life history of central arctic populations, such as harvest biased towards male bears (McLoughlin 2000), and limited ability for range expansion because of increased human development (McLoughlin et al. 1999). As a result, population size and distribution may be affected by both natural and human factors.

In the SGP, McLoughlin et al. (2002) found the mean annual range of adult male grizzly bears was 7,245 km^2 and the mean annual range of females was 2,000 km^2. The larger home range size for males is likely due to higher energy requirements and wandering to search for females for mating (McLoughlin et al. 2003). No differences in annual or seasonal range size were found between females with or without cubs (McLoughlin et al. 2003).

Recent GPS collar data for grizzly bears located within or adjacent to the RSA is not available, therefore the estimation of collared bear distribution was based on studies completed from 1995 to 1999 (McLoughlin et al. 1999). Based on the GPS-collared grizzly bear data, two grizzly bears maintained home ranges and den sites close to the RSA (Section 11.10). Based on density estimates of 3.5 bears per 1,000 km^2 (McLoughlin and Messier 2001), up to 20 individual bears may inhabit portions of the RSA.

Grizzly bears and bear sign have been documented in the RSA from 1999 through 2005. Although no bears were observed within the RSA in 1998 or 1999, three sets of grizzly bear tracks were identified in 1999. In 2004, eight different grizzly bears (five adults and three cubs) were observed within the RSA and a minimum of six different grizzly bears were present in 2005 (Section 11.10). In the RSA, most sightings occurred during the spring, with observations decreasing during the late summer and fall. No negative encounters with exploration personnel or field survey crews occurred.

In the Snap Lake Mine study area, 13 incidental observations of grizzly bears were made from 1999 through 2006 (De Beers 2007). Environment personnel at the Diavik Diamond Mine recorded 33 individual bears on 21 separate occasions in 2006 (DDMI 2007). Incidental observations of grizzly bears near the Ekati Diamond Mine collected since 2001 ranged from 36 in 2001 to 76 in 2005 (BHPB 2007).

The number of bear signs per plot in the RSA, calculated from habitat surveys completed in 2005 and 2007, was slightly lower in riparian habitats (0.80 and 0.77) as compared to wetlands plots (1.07). Grizzly bear sign per plot during baseline studies completed at the Snap Lake Mine averaged 0.71 and 0.83 sign per plot in sedge wetlands and riparian plots, respectively. For 2005 and 2006 (i.e., during Snap Lake Mine construction), the average number of bear signs per sedge wetlands or riparian plots (pooled habitats) was 0.47 and 0.53, respectively (De Beers 2007).

In 2005, the occurrence of grizzly bear sign in sedge wetlands plots ranged from 23 to 60% and from 12 to 46% in riparian plots in the RSA (Section 11.10). In 2007, the proportion of riparian plots with sign increased to 31 to 69%. Annual variation was evident in riparian habitats, as the proportion of plots with fresh sign was higher in 2007 than in 2005. Monitoring studies completed at mine sites in the Lac de Gras region (2000 to 2004) found that the average annual proportion of plots with bear sign was 33 to 53% for wetlands plots and 27 to 77% for riparian plots (combined area = 2,800 km^2) (Golder 2005). Further analyses completed for the Ekati Diamond Mine (study area = 1,600 km^2) from

2000 through 2006 found 33 to 66% of wetlands plots and 27 to 83% of riparian plots contained recent bear sign (BHPB 2007).

Grizzly bear habitat selection will vary spatially and temporally depending on the availability and quality of den locations and foraging resources. Proportionate to areas of availability, grizzly bears will select home ranges that contain more riparian habitat, habitats that support upland tundra vegetation growth (i.e., shrub land habitats), and esker habitat (McLoughlin et al. 1999, 2002). Surveys for grizzly bear sign along eskers completed in the RSA in 1999 located 14 grizzly bear den sites (13 inactive and 1 active) on eskers, while the majority of the 24 dens sites (19 inactive, 3 active, and 2 test dens) recorded during the 2004 and 2005 surveys were located adjacent to an esker (Section 11.10).

Of the four active dens recorded since 1999, one was located in heath tundra, one in tussock-hummock, one in heath-boulder, and one adjacent to the esker. The test den identified in 2004 was located in tussock hummock, while the test den located in 2005 was found in a small glaciofluvial deposit located adjacent to a lake. Esker use surveys completed in the RSA in 2007, documented 59 observations of grizzly bear sign on eskers, resulting in 0.76 sign per km surveyed (Section 11.10).

Wolverine

Wolverine, the largest member of the weasel family, has a circumpolar distribution in the tundra, taiga, plains, and boreal forests of North America (Weir 2004). The animals are an important cultural and economic resource for people of the NWT. Traditional knowledge indicates that wolverines were harvested primarily for their fur, although historically, they were sometimes killed as an emergency food source. Wolverines are annual residents in the RSA, and are listed as a *species of special concern* by COSEWIC (2009, internet site) and sensitive by the NWT General Status Ranking Program (2010, internet site). This species currently has no status under the *Species at Risk Act* (SARA 2010, internet site).

Wolverines are highly adaptable, tending to change their location and distribution over time. Satellite-collared wolverine studies on the central Canadian Arctic barrens estimated that adult female wolverines had a home range of 126 km^2, while the home range of adult males was 404 km^2 (Mulders 2000). Populations generally exhibit low densities. Wolverines occur primarily where there are large ungulate populations.

From 1998 through 2005, 27 wolverines were documented in the RSA (Section 11.10). Wolverine activity and frequency of sightings coincided with the major spring and fall caribou migrations. There were 23 incidental observations of wolverine reported at the Ekati Diamond Mine in 2006, which decreased from 128 observations in 2005 (BHPB 2007). Incidental observations of wolverine in and around the Diavik Diamond Mine were similar to the Ekati Diamond Mine, with a reported 31 sightings in 2006 (DDMI 2007).

Habitat use typically depends on adequate food resources and den site availability. In tundra habitats, the availability and quality of reproductive den sites is not likely a limiting factor in wolverine production. Wolverine dens can vary from simple resting sites to complex natal dens with extensive tunnel networks that are frequently associated with rocky outcrops and deep snowdrifts.

Habitat within the RSA appears to provide adequate availability of potential den locations (Section 11.10). Bedrock outcrops are relatively common, particularly farther south and west in the RSA. During spring, areas of deep snow are available along the base of eskers, in conifer stands, and in terrain depressions. The LSA is less varied in terrain features; however, den habitat does not appear to be limiting in this area. Since 1999, four wolverine dens were located within the RSA, ranging from 7 to 15 km from the Project site.

Den site fidelity is not clearly understood, although wolverines have been observed to reoccupy den sites or habitats for consecutive years. One active den site located in the RSA showed signs of long-term use with an abundance of feeding sign, including scattered caribou antlers that were of varying ages and stages of decay.

Wolverine snow track data were used to provide an annual index of abundance within the LSA, and to determine if annual changes in wolverine distribution around Kennady Lake could be detected. Track count surveys completed in May 2004, recorded 73 wolverine tracks over 237 km. Standardized (normalized for days since last snowfall) track density was 0.08 wolverine track density index (TKD). In March 2005, poor weather conditions prevented completion of all survey transects. Wind and snow resulted in seven wolverine track observations over 195 km. Wolverine track density in 2005 was 0.01 and 0.12 TKD for March and April, respectively (Section 11.10). In 2004, fewer tracks were located near the proposed Project site than in 2005. There was no evidence in either year that the wolverine tracks appeared in habitats in a different proportion than expected. Habitat use in the LSA also was similar between the two years.

The results from the track counts completed in May 2004 and April 2005 are similar to track count density reported during baseline and monitoring studies at the Snap Lake Mine. From 1999 through 2004, the mean annual TKD reported at the Snap Lake Mine varied from 0.04 to 0.23, for an overall average of 0.14 ± 0.03 (1SE) (De Beers 2007). Data from 2005 and 2006 (i.e., during Snap Lake construction) was 0.15 ± 0.08 (2SE) and 0.16 ± 0.08 (2SE), respectively (De Beers 2007).

Monitoring studies at the Diavik Diamond Mine and Ekati Diamond Mine also generated similar estimates of wolverine activity using snow track methods. From 2003 through 2006, average annual TKD in the Diavik study area ranged from 0.05 to 0.07 (Golder 2007). In the Ekati study area, wolverine track density ranged from 0.04 to 0.13 TKD from 1997 through 2003 (BHPB 2004).

The use of genetic markers (DNA and allozymes) to study wolverine populations in the NWT has provided insight into the distribution and connectivity of these populations (Kyle and Strobeck 2002). Wolverine DNA hair snagging completed near Daring Lake in 2004 identified 53 individual wolverine in a 2,500 km^2 study area for a population estimate of up to 37 males and 24 females. Results from Daring Lake in 2005 and 2006 detected 38 wolverines (17 females, 21 males) and 33 wolverines (16 females, 17 males), respectively (Boulanger and Mulders 2007). Similar studies at the Diavik Diamond Mine and Ekati Diamond Mine each sampled an area of 1,300 km^2 in 2005 and identified 24 wolverines (13 females and 11 males) and 21 wolverines (9 females and 12 males), respectively. In 2006, 22 wolverines (14 females, 8 males) were identified at the Diavik Diamond Mine, and 14 wolverines (9 females, 5 males) were detected at the Ekati Diamond Mine (Boulanger and Mulders 2007).

Similar studies were completed for the Project in 2005 and 2006 within a 1,600 km^2 sampling area that covered the LSA and part of the RSA. In 2005, nine female and eight male wolverines were identified. Results from 2006 detected 17 individuals (11 females, 6 males) (Boulanger and Mulders 2007). Population estimates for the Project suggest that the number of wolverine in the Kennady Lake region is lower than the Lac de Gras region.

Fish

None of the fish species present in Kennady Lake or in the local or regional study areas are listed on any of the three SARA (2009, internet site, 2010, internet site) schedules or by COSEWIC (2009, internet site, 2010, internet site) as endangered, threatened, or of special concern (Section 8). Arctic grayling are listed as sensitive in the NWT (NWT General Status Ranking Program 2010, internet site) because they are sensitive to climate change, habitat degradation, and sport over-fishing (NWT General Status Ranking Program 2010, internet site). All other fish species present in Kennady Lake, and in the local and regional study areas are considered *secure* or *undetermined* (e.g., Arctic lamprey, slimy sculpin, lake chub).

Arctic Grayling

Arctic grayling have been included as a valued component for the assessment of effects of the Project on fish and fish habitat because they are important to local First Nations and a valuable sport fish in the NWT. Specifically, the effects of the Project on stream flows is assessed for its effect on the reproduction, growth, distribution, and behaviour of Arctic grayling, the only fish species in Kennady Lake that spawns and rears exclusively in streams.

Plants

Rare plant species considered for study included any plant species listed as rare in:

- "NWT Species 2000: General Status Ranks of Wild Species in the Northwest Territories" (GNWT 2000, internet site); and
- "The Rare Vascular Plants in the Northwest Territories" (McJannet et al. 1995), as well as those listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2007).

Lists of rare species are dynamic and change as new information becomes available or as the status of the population changes. The list of species considered is shown in Table 11.12-9.

Table 11.12-9 Rare Plants Potentially Present in the Local Study Area

Species Name	Common Name	Global Rank
Acorus calamus	sweetflag	G5
Alisma plantago-aquatica	water-plantain	G5
Arabis holboellii var. *pinetorum*	rock-cress	G5
Callitriche anceps	water starwort	G5
Caltha palustris var. *palustris*	marsh-marigold	G5
Carex arcta	narrow sedge	G5
Carex crawfordii	Crawford's sedge	G5
Carex heleonastes	Hudson Bay sedge	G4
Carex prairea	prairie sedge	G5
Carex retrorsa	turned sedge	G5
Carex sychnocephala	one-beaked sedge	G4
Carex trisperma	three-seeded sedge	G5
Cornus suecica	dogwood	G5
Crassula aquatica	pigmyweed	G5

Table 11.12-9 Rare Plants Potentially Present in the Local Study Area (continued)

Species Name	Common Name	Global Rank
Danthonia spicata	povery oat grass	G5
Descurainia pinnata ssp. *brachycarpa*	green tansy mustard	G5
Draba norvegica	Norwegian draba	G5
Dryopteris carthusiana	spinulose shield fern	G5
Elatine triandra	waterwort	G5
Elymus canadensis	Canada wild rye	G5
Epilobium leptophyllum	willow-herb	G5
Erigeron acris var. *debilis*	northern daisy fleabane	G5
Erigeron yukonensis	fleabane	G3
Hudsonia tomentosa	sand heather	G5
Juncus stygius ssp. *americanus*	marsh rush	G5
Juncus vaseyi	big-head rush	G3
Lycopus uniflorus	bugleweed	G5
Myriophyllum alterniflorum	water-milfoil	G5
Najas flexilis	naiad	G5
Nymphaea tetragona	white water lily	G5
Pedicularis macrodonta	lousewort	G4
Phegopteris connectilis	shield-fern	G5
Poa secunda	Sandberg blue grass	G5
Potamogeton foliosus var. *foliosus*	leafy pondweed	G5
Potamogeton illinoensis	pondweed	G5
Potamogeton obtusifolius	blunt-leaved pondweed	G5
Potamogeton robbinsii	Robbin's pondweed	G5
Potamogeton subsibiricus	pondweed	G3
Ranunculus pensylvanicus	buttercup	G5
Rhynchospora alba	white beak-rush	G5
Rorippa crystallina	marsh yellow cress	G1
Sarracenia purpurea	pitcher-plant	G5
Valeriana dioica var. *sylvatica*	northern valerian	G5

Rare plant surveys were conducted during 2004 and 2005 in the LSA and did not result in the identification of any rare plants. The absence of rare plant observations does not preclude the potential for rare plants to inhabit the area. Even the best-conducted plant survey can miss rare plant occurrences at a site because the abundance of a species can vary annually. For example, some plant species have the ability to withstand stresses by storing seed for extended periods. Climatic fluctuations may not allow the species to produce flowers, making them difficult to spot and identify. A general vegetation management plan and several follow-up monitoring programs (including one addressing effects to species at risk specifically) have been recommended for the Project

(Section 11.7.12) and could easily incorporate additional, targeted rare plant surveys. Appropriate mitigation measures and protocols will be implemented should any rare plants be identified.

Based on the rare plant surveys, ecosystem types present in the LSA, and habitat requirements of listed species, ecosystem types were ranked according to their ability to support rare plant species in the LSA (Table 11.12-10). Areas with a high habitat potential, that could potentially support 15 to 19 rare plant species, cover approximately 10.4% of the LSA (Table 11.12-11). Only 0.2% of the area was considered to have moderate potential. The remainder of the LSA (89.4%) has low to very low potential or no potential to support rare plant species.

Table 11.12-10 Rare Plant Habitat Potential for Ecosystem Types in the Local Study Area

Ecosystem Type	Description	Total Potential Rare Plant Species	Rank[a]
LA	lake	0	nil
PD	pond	0	nil
BC	riparian, scrub birch – bluejoint shrub tundra	1	very low
BL	upland, scrub birch – Labrador tea tundra	1	very low
RR	rural/camp	1	very low
BE	upland, scrub birch – crowberry tundra	2	very low
BR	wetlands, scrub birch – cloudberry low shrub bog	2	very low
RB	riparian, scrub birch – riparian shrub	–[b]	very low
RO	upland, rock outcrop	3	very low
RP	upland, road	3	very low
BF	upland, boulderfield	4	very low
PE	upland, spruce – lichen woodland	4	very low
SS	upland, saxifrage – moss campion xerophytic tundra	4	very low
SR	riparian, willow – nagoonberry shrub	6	low
OW	shallow open water	8	low
SH	wetlands, willow – sedge low shrub fen	9	low
FA	wetlands, floating aquatic – shallow open water	11	moderate
CA	wetlands, water sedge – narrow-leaved cottongrass fen	14	moderate
CE	wetlands, round-fruited sedge – Chamisso's cottongrass fen	16	high
EA	wetlands, sheathed cottongrass – bog-rosemary sedge fen	17	high
EM	wetlands, water sedge – horsetail shallow shore marsh	18	high

(a) Very low = 1 to 4 plants; low = 5 to 9 plants; moderate = 10 to 14 plants; high = 15 to 19 plants; very high = 20+ plants.

(b) No data. Therefore, assumed same ranking as scrub birch – cloudberry low shrub bog ecosystem type.

Table 11.12-11 Rare Plant Habitat in the Local Study Area

Habitat Potential	Potential Number of Rare Plants Species	Total Area (ha)	Percent of Total Area (%)
nil	0	5,767.9	29.6
very low	1 to 4	11,490.9	58.9
low	5 to 9	166.1	0.9
moderate	10 to 14	47.4	0.2
high	15 to 19	2,027.6	10.4
Total	n/a	19,499.8	100.0

Note: Some numbers are rounded to the nearest 10th decimal place for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

ha = hectare; % = percent; n/a = not applicable.

11.12.3 Pathway Analysis

11.12.3.1 Methods

Pathway analysis identifies and assesses the issues and linkages between the Project components or activities, and the correspondent potential residual effects on birds (i.e., upland breeding bird, waterbirds, and raptors) and species at risk. Pathway analysis is a three-step process for determining linkages between Project activities and environmental effects that are assessed in Sections 11.12.6 to 11.12.8. Potential pathways through which the Project could influence birds and species at risk were identified from a number of sources including:

- the *Terms of Reference for the Gahcho Kué Environmental Impact Statement* (Gahcho Kué Panel 2007) and the Report of Environmental Assessment (MVEIRB 2006);
- a review of the Project Description and scoping of potential effects by the environmental assessment and Project engineering teams for the Project; and
- consideration of potential effects identified for the other diamond mines in the NWT and Nunavut.

The first part of the analysis is to produce a list of all potential effects pathways for the Project. Each pathway is initially considered to have a linkage to potential effects on birds and species at risk. This step is followed by the development of environmental design features and mitigation that can be incorporated into the Project to remove the pathway or limit (mitigate) the effects to birds and species at risk. Environmental design features include Project designs and environmental best practices, and management policies and procedures.

Environmental design features were developed through an iterative process between the Project's engineering and environmental teams to avoid or mitigate effects.

Knowledge of the ecological system and environmental design features and mitigation is then applied to each of the pathways to determine the expected amount of Project-related changes to the environment and the associated residual effects (i.e., after mitigation) on birds and species at risk. For an effect to occur there has to be a source (Project component or activity) a change to the environment, and a correspondent effect on birds and species at risk.

Project activity → change in environment → effect on VC

Pathway analysis is a screening step that is used to determine the existence and magnitude of linkages from the initial list of potential effects pathways for the Project. This screening step is largely a qualitative assessment, and is intended to focus the effects analysis on pathways that require a more comprehensive assessment of effects on birds and species at risk. Pathways are determined to be primary, secondary (minor), or as having no linkage using scientific and traditional knowledge, logic, and experience with similar developments and environmental design features. Each potential pathway is assessed and described as follows:

- no linkage – pathway is removed by environmental design features and mitigation so that the Project results in no detectable environmental change and, therefore, no residual effects to a VC relative to baseline or guideline values;
- secondary - pathway could result in a measurable and minor environmental change, but would have a negligible residual effect on a VC relative to baseline or guideline values; or
- primary - pathway is likely to result in a measurable environmental change that could contribute to residual effects on a VC relative to baseline or guideline values.

Primary pathways require further effects analysis and impact classification to determine the environmental significance from the Project on the persistence of bird and species at risk populations, and continued opportunity for traditional and non-traditional use of birds and species at risk. Pathways with no linkage to bird and species at risk populations or that are considered minor are not analyzed further or classified in Sections 11.12.6 to 11.12.8 because environmental design features and mitigation will remove the pathway (no linkage) or residual effects can be determined to be negligible through a simple qualitative evaluation of the pathway (secondary). Pathways determined to have no linkage to birds and species at risk or those that are considered secondary are not predicted to result in environmentally significant effects on the persistence of bird and species at risk populations and continued opportunity for traditional and non-traditional use of birds and species at risk. Primary pathways are assessed in more detail in Sections 11.12.6 to 11.12.8.

11.12.3.2 Results

Pathways potentially leading to effects on birds and species at risk include direct and indirect changes to habitat, and survival and reproduction (Table 11.12-12). These changes may ultimately affect the persistence of bird and species at risk populations, and continued opportunity for traditional and non-traditional use of birds and species at risk. Evaluation of effects on birds and species at risk also considers changes to hydrology, water quality, air quality, soil quality, and vegetation during the construction, operation, and closure of the Project, as well as effects remaining after closure.

Because potential pathways are based primarily on public concerns identified during the Mackenzie Valley Environmental Impact Review Board (MVEIRB) scoping process (MVEIRB 2006). Many environmental design features were incorporated during the development of the Project to address these issues by reducing or eliminating potential effects. Also, preliminary analysis may have shown that potential effects considered during issue scoping are so small that they are not relevant. Other potential pathways are considered to be primary and are included in the effects analysis. The following sections discuss the potential pathways relevant to birds and species at risk.

Table 11.12-12 Potential Pathways for Effects to Birds and Species at Risk

<table>
<tr><th>Project Component/Activity</th><th>Effects Pathways</th><th>Environmental Design Features and Mitigation</th><th>Pathway Assessment</th></tr>
<tr><td rowspan="2">Project Footprint (e.g., pits, Fine PKC Facility , Coarse PK Pile, and mine rock piles, Winter Access Road and Tibbitt-to-Contwoyto Winter Road)</td><td>• direct loss and fragmentation of wildlife habitat from the physical footprint of the Project may alter species at risk and bird movement and behaviour</td><td rowspan="2">• backfilling the mined-out pits with PK and mine rock will decrease the on-land Project footprint
• compact layout of the surface facilities will limit the area disturbed at construction and increase site operations efficiency
• mine rock will be used as the source of aggregate production, thereby, reducing the need for separate quarries
• blasting in pits will be carefully planned and controlled to maintain a safe workplace and reduce the throw of ore bearing materials
• where practical, natural drainage patterns will be used to reduce the use of ditches or diversion berms
• to the extent practical, the total amount of area disturbed by Project activities at any one time will be reduced through the use of progressive reclamation.
• ramps to facilitate the access and egress of species at risk from the mine rock pile will be constructed during closure
• culverts or stream-crossing structures will be removed and natural drainage re-established
• at closure, transportation corridors and the airstrip will be scarified and loosened to encourage natural revegetation, and re-contoured where required
• at closure, the entire site area will be stabilized and contoured to blend with the surrounding landscape
• conditions will be monitored over time to evaluate the success of the Closure and Reclamation Plan and, using adaptive management and newer proven methods as available, adjust the Plan, if necessary
• De Beers will actively liaise with other mine operators in the Canadian Arctic to understand the challenges and successes they have encountered with respect to reclamation.</td><td>Primary</td></tr>
<tr><td>• physical hazards from the Project may increase the risk of injury/mortality to individual animals, which can affect species at risk and bird population size</td><td>Secondary</td></tr>
</table>

Table 11.12-12 Potential Pathways for Effects to Birds and Species at Risk (continued)

Project Component/Activity	Effects Pathways	Environmental Design Features and Mitigation	Pathway Assessment
Construction and Operations (e.g., equipment operation, aircraft/vehicles, airstrip, processing and storage facilities) Winter Access Road and Tibbitt-to-Contwoyto Winter Road	• dust deposition may cover vegetation and decrease abundance of forage for species at risk and birds(i.e., habitat quantity)	• a program of carbon and energy management will be implemented once the generators are commissioned • generator efficiencies and equipment will be tuned for optimum fuel-energy efficiency • load management will allow for the optimization of the load factors on the generators • pumping circuits will be operated and efficiencies will be optimized to minimize noise disturbances • power and heat use to reduce energy use, and therefore air emissions, will be reviewed on a regular basis • piping will be insulated for heat conservation • personnel arriving at or leaving the site will be transported by bus, therefore, reducing the amount of traffic between the airstrip and the accommodation complex • compact layout of the surface facilities will reduce traffic, and therefore dust and air emissions, around the site • watering of roads, airstrip, and laydown areas will facilitate dust suppression • enforcing speed limits will assist in reducing production of dust	Secondary
	• dust deposition may cover vegetation and change the amount of different quality habitats, and alter species at risk and bird movement and behaviour		Primary
	• dust deposition and air emissions may change the amount of different quality habitats (through chemical changes in soil and vegetation), and alter species at risk and bird movement and behaviour		Secondary
	• ingestion of soil, vegetation, and water, or inhalation of air that has been chemically altered by air emissions (including NO_X and PAI deposition) or dust deposition, may affect species at risk and bird survival and reproduction		No Linkage

Table 11.12-12 Potential Pathways for Effects to Birds and Species at Risk (continued)

Project Component/Activity	Effects Pathways	Environmental Design Features and Mitigation	Pathway Assessment
Construction and Operations (continued) Winter Access Road and Tibbitt-to-Contwoyto Winter Road (continued)	• sensory disturbance (e.g., presence of buildings, people, lights, smells, aircraft, and on-site vehicles) changes the amount of different quality habitats, and alters species at risk and bird movement and behaviour, which can influence survival and reproduction	• compact layout of the surface facilities will limit the area disturbed at construction and reduce traffic around the site • a minimum flying altitude of 300 m above ground level (except during takeoff, landing, and field work) will be maintained for cargo, passenger aircraft, and helicopter outside of the Project site. • limit the amount of noise from the Project site to the extent practical • equipment noise sources will be limited by locating them inside buildings, to the extent possible	Primary
	• sensory disturbance (e.g., presence of buildings, people, lights, smells, and noise) changes the amount of different quality habitats, and alters species at risk and bird movement and behaviour, which can influence survival and reproduction (continued)	• downward directional and low impact lighting will be used to reduce light pollution • a minimum 200-m distance from wildlife will be maintained, when possible • environmental sensitivity training for personnel • at closure, the entire site area will be stabilized and contoured to blend with the surrounding landscape	Primary
	• aircraft/vehicle collisions may cause injury/mortality to individual animals	• personnel arriving at or leaving the site will be transported by bus, which will decrease the amount of traffic between the airstrip and the accommodations complex • speed limits will be established and enforced • wildlife will be provided with the “right of way” • levels of private traffic using the Project Winter Access Road will be monitored • the site will be designed to limit blind spots, where possible, to reduce the risk of accidental wildlife-human encounters • drivers will be warned when wildlife are moving through an area using signage and radio • safe, effective methods will be used to species at risk from the airstrip before aircraft land or takeoff	Secondary

Table 11.12-12 Potential Pathways for Effects to Birds and Species at Risk (continued)

Project Component/Activity	Effects Pathways	Environmental Design Features and Mitigation	Pathway Assessment
Construction and Operations (continued) Winter Access Road and Tibbitt-to-Contwoyto Winter Road (continued)	• chemical spills (including de-icing fluid run off) may cause negative changes to health or mortality of individual animals	• processing of the kimberlite ore will be mechanical, with limited use of chemicals • hazardous, non-combustible waste and contaminated materials will be temporarily stored in the waste storage transfer area in sealed steel or plastic, wildlife-resistant drums, and shipped off-site for disposal or recycling • chemicals such as de-icing fluid, acids, solvents, battery acids, and laboratory agents will be collected in lined trays and drums, and stored in suitable sealed containers in the waste transfer area • the waste transfer storage area will include a lined and enclosed pad for the collection and subsequent return of hazardous waste to suppliers or to a hazardous waste disposal facility • emulsion materials will be stored at the emulsion plant where spills would be 100% contained within the building • all fuel storage tanks will be designed and constructed according to the American Petroleum Institute 650 standard and placed in a lined and dyked containment area to contain any potential fuel spills • aviation fuel will be stored in self-contained, Underwriters Laboratories Canada-rated envirotanks mounted on an elevated pad at the air terminal shelter • aviation fuel for helicopters will be stored in sealed drums inside a lined berm area near the airstrip • to prevent accumulation and/or runoff of de-icing fluid at the airstrip from aircraft de-icing operations, aircraft will be sprayed in a specific area that will be equipped with swales to collect excess fluids as necessary • puddles of de-icing fluid in the swales will be removed by vacuum truck and deposited into waste de-icing fluid drums for shipment to recycling facilities • an Emergency Response and Contingency Plan has been developed • spill containment supplies will be in designated areas • any spills will be isolated and immediately cleaned up by a trained spill response team consisting of on-site personnel who will be available at all times.	No Linkage

Table 11.12-12 Potential Pathways for Effects to Birds and Species at Risk (continued)

Project Component/Activity	Effects Pathways	Environmental Design Features and Mitigation	Pathway Assessment
Construction and Operations (e.g., equipment operation, aircraft/vehicles, airstrip, processing and storage facilities)	• attractants to site (e.g., food waste, oil products) may increase predator numbers and increase predation risk	• separate bins will be located throughout the accommodations complex, processing plant, shops, and other facilities on-site for immediate sorting of domestic wastes • food wastes will be collected from the food waste bins in the accommodations complex, service complex, and other facilities and immediately placed and sealed in plastic bags. The plastic bags will be stored in sealed containers at each facility before transport directly to the incinerator storage area for incineration • chemicals such as de-icing fluid, acids, solvents, battery acids, and laboratory agents will be collected in lined trays and drums and stored in suitable sealed containers in the waste transfer area. Chemicals that cannot be incinerated will be shipped off-site for disposal or recycling • incinerator ash from combustion of kitchen and office waste will go to the landfill • inert solid waste will be deposited into a small area of the mine rock piles or Fine PKC Facility. • care will be taken to prevent the inclusion of wastes that could attract wildlife	Secondary
Construction and Operations (continued)	• attractants to site (e.g., food waste, oil products) may increase predator numbers and increase predation risk (continued)	• two dual-chambered, diesel-fired incinerators will be provided for the incineration of combustible waste, including kitchen waste. The incinerators will also be used to burn waste oil. Incinerator ash will be collected in sealed, wildlife-resistant containers and transported to the landfill • a fenced area will be established for the handling and temporary storage of wastes. Fencing will be 2 m high, slatted-type, and partially buried to prevent animals from burrowing underneath • education and reinforcement of proper waste management practices will be required for all workers and visitors to the site • the efficiency of the waste management program and improvement through adaptive management will be reviewed as needed	Secondary

Table 11.12-12 Potential Pathways for Effects to Birds and Species at Risk (continued)

<table>
<tr><th>Project Component/Activity</th><th>Effects Pathways</th><th>Environmental Design Features and Mitigation</th><th>Pathway Assessment</th></tr>
<tr><td>Mine Rock Management</td><td>• leaching of PAG mine rock may change the amount of different quality habitats, and alter species at risk and bird movement and behaviour</td><td rowspan="4">• mine rock used to construct the dykes will be non-acid generating (NAG)
• any mine rock containing kimberlite will be separated from the tundra by at least 2 m of inert and kimberlite-free rock to prevent drainage with low pH
• any PAG mine rock, as well as any barren kimberlite, will be sequestered within the interior of the mine rock piles in areas that will allow permafrost to develop or will be underwater when Kennady Lake is refilled
• till from ongoing pit stripping will be used to cover PAG rock placed within the interior of the structure to keep water from penetrating into the portion of the repository
• the PAG rock will be enclosed within enough NAG rock that the active frost zone (typically two metres) will not extend into the enclosed material and water runoff will occur on the NAG rock cover areas
• to confirm the lower levels remain frozen, temperature monitoring systems will be placed in the mine rock piles as they are being constructed
• minimal water is expected to penetrate to the PAG rock areas
• only non-reactive mine rock will be placed on the upper and outer surfaces of the mine rock piles. The thickness of the cover layer is predicted to be sufficient so that the active freeze-thaw layer remains within the non-reactive mine rock
• thermistors will be installed within the mine rock piles to monitor the progression of permafrost development. The upper portion of the thick cover of mine rock over the waste repository will be subject to annual freeze and thaw cycles, but the PK and PAG rock sequestered below are expected to remain permanently frozen
• mine rock piles will not be covered or vegetated to limit attraction of wildlife to them after Project closure</td><td>No Linkage</td></tr>
<tr><td rowspan="3">Mine Rock Management (continued)</td><td>• ingestion of soil, vegetation, or water that has been chemically altered by leaching of PAG mine rock may affect species at risk and bird survival and reproduction</td><td>No Linkage</td></tr>
<tr><td>• leaching of PAG mine rock may change the amount of different quality habitats, and alter species at risk and bird movement and behaviour</td><td>No Linkage</td></tr>
<tr><td>• ingestion of soil, vegetation, or water that has been chemically altered by leaching of PAG mine rock may affect species at risk and bird survival and reproduction</td><td>No Linkage</td></tr>
</table>

Table 11.12-12 Potential Pathways for Effects to Birds and Species at Risk (continued)

Project Component/Activity	Effects Pathways	Environmental Design Features and Mitigation	Pathway Assessment
Site Water Management	• release of seepage and surface water runoff (including erosion) from the Fine PKC Facility, Coarse PK Pile, and mine rock piles may change the amount of different quality habitats, and alter species at risk and bird movement and behaviour	• the performance of the dykes will be monitored throughout their construction and operating life. Instrumentation monitoring together with systematic visual inspection will provide early warning of many conditions that can contribute to dyke failures and incidents. Additional mitigation will be applied, if required • a system of ditches and sumps will be constructed, maintained, and upgraded throughout the operation phase of the Project to manage groundwater from the open pits • site runoff will flow naturally to the dewatered areas of Kennady Lake that will act as a control basin for storage of water. Within this basin, water flows can be managed. Where practical, natural drainage patterns will be used to reduce the use of ditches or diversion berms • no substantial runoff and seepage from the mine rock piles is expecteda soil-bentonite slurry cutoff wall through a till fill zone placed over the overburden and the overburden to the bedrock surface has been adopted as the main seepage control for the diversion dyke separating Areas 7 and 8 • the cut-off wall for the dyke separating Areas 7 and 8 will be protected by a downstream filter zone and mine rock shell zone • for the retention dyke that separates Areas 3 and 4, Areas 5 and 6, and Areas 4 and 6, a wide till core has been selected as the main seepage control • the water retention dyke separating Area 2 and Lake N7, as well as diversion dykes dealing with Lakes A3, A4, B1, N13, D2, E1, and E3 will have a liner keyed into the competent frozen ground or bedrock to control seepage • the curved filter dyke to retain the particles in the fine PK placed in Areas 1 and 2 will be construction material and will be free of roots, organics, and other materials not suitable for construction	No Linkage
	• ingestion of seepage and surface water runoff from the PK and mine rock piles, or ingestion of soil, vegetation, or water that has been chemically altered by seepage and runoff, may affect species at risk and bird survival and reproduction		No Linkage

Table 11.12-12 Potential Pathways for Effects to Birds and Species at Risk (continued)

Project Component/Activity	Effects Pathways	Environmental Design Features and Mitigation	Pathway Assessment
Site Water Management (continued)	• ingestion of seepage and surface water runoff from the PK and mine rock piles, or ingestion of soil, vegetation, or water that has been chemically altered by seepage and runoff, may affect species at risk and bird survival and reproduction (continued)	• the PAG rock will be enclosed within enough NAG rock to prevent the active zone (typically 2 m) from extending into the enclosed material and water runoff will occur on the NAG rock cover areas • thermistors will be installed within the mine rock piles to monitor the progression of permafrost development. The upper portion of the thick cover of mine rock over the waste repository will be subject to annual freeze and thaw cycles, but the PK and PAG rock sequestered below are expected to remain permanently frozen • only non-reactive mine rock will be placed on the upper and outer surfaces of the mine rock pile. The thickness of the cover layer is predicted to be sufficient so that the active freeze-thaw layer remains within the non-reactive mine rock	No Linkage
	• Release of seepage and surface water runoff (including erosion) from the PK and mine rock piles may change the amount of different quality habitats, and alter species at risk and bird movement and behaviour (continued).		No Linkage
Winter Access Road and Tibbitt-to-Contwoyto Winter Road	• road footprint decreases habitat quantity and may cause fragmentation, which can alter species at risk and bird movement and behaviour	• low profile roads will be used so that they do not act as a barrier to movement for wildlife • winter road snow berms will be removed so that they do not act as a barrier to movement for wildlife	Primary
	• road footprint may cause changes to the amount of different quality habitats (e.g., degradation to vegetation), and alter species at risk and bird movement and behaviour	• use of proven best practices for winter road construction	Secondary
	• increased access for traditional and non-traditional harvesting may alter species at risk and bird movement and behaviour, which can affect survival and reproduction	• seasonal use of the Winter Access Road • prohibit firearms of any type, bows, and crossbows at the Project • prohibit hunting, trapping, harvesting, and fishing by employees and contractors and enforce this prohibition	Secondary

Table 11.12-12 Potential Pathways for Effects to Birds and Species at Risk (continued)

Project Component/Activity	Effects Pathways	Environmental Design Features and Mitigation	Pathway Assessment
Dewatering of Kennady Lake	• ingestion of exposed sediments and riparian/aquatic vegetation in the dewatered lakebed of Kennady Lake may affect species at risk and bird survival and reproduction	• none	No Linkage
	• injury or mortality to individual animals getting trapped in sediments		Secondary
Dewatering of Kennady Lake (continued)	• changes in downstream flows (e.g., isolation and diversion, altered drainage patterns) and water levels from dewatering of Kennady Lake may affect the quantity of riparian habitat, which could alter species at risk and bird movement and behaviour	• Lake N11 is capable of accepting water at the proposed discharge rate without erosion damage to downstream watercourses	Secondary
	• dewatering may result in newly established vegetation on the exposed lakebed sediments and increase habitat quantity, which may alter species at risk and bird movement and behaviour	• dykes will be constructed to divert fresh water from entering areas of Kennady Lake • the height of the diversion structures will be designed such that the excess water from the surrounding sub-watershed will remain in the original N watershed • dewatering and operation discharges will be limited so that pumping will not increase discharges above the baseline two-year flood levels in downstream lakes and channels	Secondary
	• changes in downstream flows (e.g., isolation and diversion, altered drainage patterns) and water levels from dewatering Kennady Lake may cause injury/mortality to individual animals		No Linkage
	• changes in the timing of freeze and break-up downstream may alter species at risk and bird movement and behaviour, and could cause injury/mortality to individual animals		No Linkage

Table 11.12-12 Potential Pathways for Effects to Birds and Species at Risk (continued)

Project Component/Activity	Effects Pathways	Environmental Design Features and Mitigation	Pathway Assessment
Closure and Reclamation	• changes in downstream flows (e.g., isolation and diversion, altered drainage patterns) and water levels from the refilling of Kennady Lake may affect the quantity of riparian habitat, which could alter species at risk and bird movement and behaviour	• mined-out pits will be backfilled with PK and mine rock to reduce the time required for filling these portions of Kennady Lake because less water is required to refill the partially backfilled pits • Kennady Lake will be refilled using natural runoff and supplemental water drawn from Lake N11 • while fine PK is being discharged in the mined-out pits (primarily Hearne, but potentially 5034), process water will not be reclaimed from the pits. Instead the slurry discharge water will be used to accelerate the infill of the mined-out pits. The process will facilitate a more rapid re-filling and progressive reclamation of Area 6 within Kennady Lake • the 5034 Pit will be backfilled to the extent possible with mine rock and the remaining space will be eventually filled with water once mining in the Tuzo Pit is complete • the Tuzo Pit will be allowed to flood following the completion of the operations phase. Natural watershed inflows will be supplemented by pumping water from Lake N11 • the pumping rates are anticipated to be managed such that the total outflow from Lake N11 does not drop below the 1 in 5-year dry conditions	Secondary
	• long-term seepage from the Coarse PK Pile and mine rock piles may cause local changes to habitat quality, and alter species at risk and bird movement and behaviour	• the PAG rock will be enclosed within enough non-AG rock to prevent the active zone (typically 2 m) from extending into the enclosed material and water runoff will occur on the NAG rock cover areas • thermistors will be installed within the mine rock piles to monitor the progression of permafrost development. The upper portion of the thick cover of mine rock over the waste repository will be subject to annual freeze and thaw cycles, but the PK and PAG rock sequestered below are expected to remain permanently frozen • the Coarse PK Pile will be shaped and covered with a layer of mine rock of a minimum 1 m to limit surface erosion • only non-reactive mine rock will be placed on the upper and outer surfaces of the mine rock piles. The thickness of the cover layer is predicted to be sufficient so that the active freeze-thaw layer remains within the non-reactive mine rock • no substantial runoff and seepage from the mine rock piles is expected	No Linkage

Notes: CCME = Canadian Council of Ministers of the Environment; m = metre; NAG = non-acid generating; NO_X = nitrogen oxide; PK = processed kimberlite; PKC = processed kimberlite containment; PAG = potentially acid generating; PAI = potential acid input.

11.12.3.2.1 Pathways with No Linkage

A pathway may have no linkage if the activity does not occur (e.g., effluent is not released), or if the pathway is removed by environmental design features so that the Project results in no detectable (measurable) environmental change and residual effects to birds and species at risk. The following pathways are anticipated to have no linkage to birds and species at risk, and will not be carried through the effects assessment.

Changes to Habitat Quality, Movement, and Behaviour

The pathways described in the following bullets have no linkage to habitat quality, movement, and behaviour of birds and species at risk. To be conservative, it is assumed that habitats within the Project footprint that have not been used for construction or storage of material are available to wildlife but of no value.

- Leaching of potentially-acid generating (PAG) mine rock may change the amount of different quality habitats, and alter bird and species at risk movement and behaviour.

Any PAG mine rock, as well as any barren kimberlite, will be sequestered within the interior of the mine rock piles in areas that will allow permafrost to develop or will be underwater when Kennady Lake is re-filled (Table 11.12-12). Overburden, including lakebed sediments, will be used to cover any areas in the core of the mine rock piles where PAG mine rock is sequestered. The overburden (including sediments), which consist mainly of till, will provide a low permeability barrier that will limit infiltration and encourage water to flow over the surface of the mine rock pile, rather than through it. Water quality will be monitored on site, and additional mitigation will be applied if required to limit changes to the environment.

Further, the PAG rock will be enclosed with enough non-acid generating (NAG) rock that the active zone (typically 2 m) will not extend into the enclosed material, and water runoff will occur on the NAG rock cover areas (Table 11.12-12). While all water will not be stopped completely from penetrating the till and NAG rock envelop, the amounts that may penetrate deeper into the pile are expected to be trapped in void spaces and likely freeze. Minimal water is expected to penetrate to the PAG rock areas. To confirm the lower levels remain frozen, temperature monitoring systems will be placed in the mine rock piles as they are being constructed (Table 11.12-12).

Experience at the Ekati Diamond Mine suggests that coarse kimberlite in direct contact with the naturally acidic tundra soils can lead to drainage with low pH.

Therefore, barren kimberlite or mine rock mixed with kimberlite will not be placed directly on the tundra soils, and will be separated from the tundra by at least 2 m of inert and kimberlite-free clean rock (Table 11.12-12).

Progressive closure and reclamation of the mine rock piles will involve contouring and re-grading. The piles will not be covered or vegetated, consistent with the approaches in place at the Ekati Diamond Mine and Diavik Diamond Mine. Thermistors will be installed within the mine rock piles to monitor the progression of permafrost development (Table 11.12-12). The upper portion of the thick cover of mine rock over the waste repository will be subject to annual freeze and thaw cycles, but the processed kimberlite (PK) and PAG rock sequestered below are predicted to remain permanently frozen.

Overall, leaching of PAG mine rock is not expected to result in a detectable change to habitat quality relative to baseline conditions. Consequently, this pathway was determined to have no linkage to effects on the persistence of bird and species at risk populations, and continued opportunity for traditional and non-traditional use of birds and species at risk.

- Release of seepage and surface water runoff from the PK and mine rock piles may change the amount of different quality habitats, and alter movement and behaviour.
- Long-term seepage from the Coarse PK Pile and mine rock piles may cause local changes to habitat quality, and alter movement and behaviour.

Water-borne chemicals can adversely affect habitat quality through surface water runoff and seepage. Environmental design features and mitigation have been incorporated into the Project to eliminate or reduce potential effects from surface water runoff and seepage (Table 11.12-12). Runoff and seepage from the Fine PKC Facility, Coarse PK and mine rock piles will not be released to the environment outside of the Project footprint during construction, operations, with the exception of a monitored discharge to Lake N11. Runoff from the coarse PK and mine rock piles will be contained in the affected basins and drain to either Area 3 or to one of the mined-out pits using natural drainage channels (Table 11.12-12). Natural drainage channels will provide opportunities for monitoring runoff quality, and additional mitigation will be applied if required to limit changes to the existing environment outside of the footprint.

The Coarse PK Pile will not be designed to have a single point of release for seepage and runoff. Any runoff will flow through natural channels within the watershed and be retained in the controlled basin associated with Area 4, which in later years represents the Tuzo pit area. Groundwater entering the open pits during mining will be routed by ditches to a series of sumps (Table 11.12-12). Groundwater inflows collected in the pit dewatering systems will be discharged to either Area 5 or the process plant where groundwater will be incorporated in the fine PK and pumped to the Fine PKC Facility.

As part of reclamation, the Fine PKC Facility will be covered with a 1 to 2 m layer of NAG mine rock (Table 11.12-12). The facility will be graded so that surface runoff will flow towards Area 3. The final geometry of the cover layer will be graded to limit ponding of water over the mine rock covered fine PK in Areas 1 and 2 of the Fine PKC Facility. Permafrost development in the Fine PKC Facility and underlying talik is expected to occur over time. Thermistors will be installed in the Fine PKC Facility to monitor the formation of permafrost in the solids. The Coarse PK Pile will also be shaped and covered with a layer of mine rock of approximately 1 m thick to limit surface erosion. Runoff will be directed to Area 4.

Overall, release of seepage and surface water runoff from the PK and mine rock piles, and long-term seepage from the Coarse PK Pile and mine rock piles is not expected result in a detectable change to habitat quality relative to baseline conditions. Consequently, this pathway was determined to have no linkage to effects on the persistence of bird and species at risk populations, and continued opportunity for traditional and non-traditional use of birds and species at risk.

Changes to Survival and Reproduction

The pathways described in the following bullets have no linkage to the survival and reproduction of birds and species at risk.

- Ingestion of soil, vegetation, and water, or inhalation of air that has been chemically altered by air emissions (including nitrogen oxide [NO_X] and potential acid input [PAI] deposition) or dust deposition, may affect bird and species at risk survival and reproduction.
- Ingestion of soil, vegetation, or water that has been chemically altered by leaching of PAG mine rock may affect bird and species at risk survival and reproduction.
- Ingestion of seepage and runoff from the PK and mine rock piles, or ingestion of soil, vegetation, or water that has been chemically altered by seepage and runoff, may affect bird and species at risk survival and reproduction.
- Ingestion of exposed sediments and riparian/aquatic vegetation in the dewatered lakebed of Kennady Lake may affect bird and species at risk survival and reproduction.

Birds and species at risk within the RSA may be directly and indirectly exposed to airborne chemicals through fugitive dust and air emissions from the Project. Direct exposure to chemicals includes inhalation of fugitive dust and air emissions, drinking of water, inadvertent ingestion of soil while foraging or grooming, and ingestion of vegetation. Airborne chemicals may deposit directly onto the surface of plants or may deposit onto soils and be subsequently taken up through plant roots (vascular plants) or tissues (lichen). Therefore, birds and species at risk may be indirectly exposed to chemicals from fugitive dust and air emissions by intentionally or inadvertently consuming vegetation that has accumulated chemicals through the soil or air.

There is a general concern that birds and species at risk may drink from the collection ponds or associated containment ditches, which may result in negative changes to bird and species at risk health. As such, environmental design features have been incorporated into the Project to eliminate or reduce potential effects from surface water runoff and seepage (Table 11.12-12). Runoff and seepage from the Fine PKC Facility, Coarse PK and mine rock piles will not be released beyond the Project footprint during construction and operations, with the exception of a monitored discharge to Lake N11. Runoff from the Coarse PK Pile and mine rock piles will be contained and drain to either Area 3 or to one of the mined-out pits using natural drainage channels (Table 11.12-12). Natural drainage channels will provide opportunities for monitoring runoff quality, and additional mitigation will be applied if required to limit changes to the existing environment outside of the footprint. Any runoff from Coarse PK Pile will flow through natural channels within the watershed and be retained in the controlled basin associated with Area 4, which in later years represents the Tuzo Pit area (Table 11.12-12).

Any PAG mine rock, as well as any barren kimberlite, will be sequestered within the interior of the mine rock piles. Overburden, including lakebed sediments, will be used to cover any areas in the core of the mine rock piles where potentially reactive mine rock is sequestered (Table 11.12-12). Limited water is expected to penetrate to the PAG rock areas. To confirm the lower levels remain frozen, temperature monitoring systems will be placed in the mine rock piles as they are being constructed (Table 11.12-12). Experience at the Ekati Diamond Mine suggests that coarse kimberlite in direct contact with the naturally acidic tundra soils can lead to drainage with low pH. Therefore, barren kimberlite or mine rock mixed with kimberlite will not be placed directly on the tundra soils, and will be separated from the tundra by at least 2 m of inert and kimberlite-free clean rock.

As part of reclamation, the Fine PKC Facility will be covered with a 1 to 2 m layer of NAG mine rock. The facility will be graded to encourage surface runoff and limit infiltration. Progressive closure and reclamation of the mine rock piles will involve contouring and re-grading. The piles will not be covered or vegetated, consistent with the approaches in place at the Ekati Diamond Mine and Diavik Diamond Mine. Thermistors will be installed within the mine rock piles and Fine PKC Facility to monitor the progression of permafrost development (Table 11.12-12). The Coarse PK Pile will also be shaped and covered with a layer of mine rock of approximately 1 m thick to limit surface erosion and infiltration into the pile (Table 11.12-12).

While lake-bed sediments will be exposed following the dewatering of Kennady Lake, it is predicted they will form a hardpan crust and will not be a substantial source of dust (Section 11.7). However, dust from Project activities may settle on the exposed portion of the lake-bed sediments, and be inadvertently ingested by birds and species at risk foraging in this area. Birds and species at risk may be indirectly exposed to chemicals by consuming vegetation that has accumulated chemicals through the sediment.

An ecological risk assessment was completed using water quality predictions that were developed to evaluate the potential for adverse effects to individual animal health associated with exposure to chemicals from the Project. Emission sources considered in the assessment included those outlined above (i.e., fugitive dust, air emissions, surface water runoff and seepage, leaching of PAG rock, and exposed sediments), and potential exposure pathways included changes in air, water, soil, and vegetation quality. The result of the assessment indicated the potential for effects to occur to aquatic-dependent species (i.e., waterfowl and shorebirds) as a result of boron levels in Kennady Lake after refilling. No other impacts were predicted for waterfowl and shorebirds. The risk assessment also indicated that these pathways would have no impact on the persistence of other bird species and species at risk.

The ecological risk assessment was completed assuming that there was no isolation of the fine PKC material located at the base of the Fine PKC Facility, and that all waters travelling over the facility would come into contact with this material, which is the predominate source of boron to the refilled lake. Processes that would modify the degree of contact between the fine PK and the runoff waters were not considered, including the aggradation of permafrost and/or the application of cover material to limit infiltration. In addition, the water quality predictions used in risk assessment were developed by setting parameter concentrations in the runoff waters to the maximum concentrations observed in the geochemical investigations completed in support of the EIS. Consequently, the results of the risk assessment correspond to an extreme condition that has a low likelihood of occurring.

De Beers is committed to further study of this potential issue in 2011, and will incorporate mitigation into the Project design to the extent required to maintain boron levels in Kennady Lake below those that may be of environmental concern, including the potential application of less permeable cover material to limit infiltration through the Fine PKC Facility. Given these commitments and the low likelihood of the assessed situation actually occurring, the pathways described above were considered, for the purposes of the effects analysis outlined herein, to have no linkage to the health of waterfowl and shorebirds. However, as a result of this approach, the environmental significance rating outlined in Section 11.12.9 is contingent on the results of further study and the implementation of mitigation to the extent required to prevent effects to waterfowl and shorebirds through these pathways.

- Chemical spills (including de-icing fluid runoff) within the Project footprint, the airstrip or along the Winter Access Road or Tibbitt-to-Contwoyto Winter Road may cause negative changes to health or mortality of individual animals.

Chemical spills have not been reported as the cause of wildlife mortality at the Ekati Diamond Mine, Diavik Diamond Mine, Jericho Diamond Project, or Snap Lake Mine (Tahera 2007a; BHPB 2010; DDMI 2010; De Beers 2010). Chemical spills are usually localized, and are quickly reported and managed. Mitigation practices identified in the Emergency Response and Contingency Plan (Section 3, Appendix 3.I, Attachment 3.I.1), and environmental design features will be in place to limit the frequency and extent of chemical spills at the Project, and along the winter access roads (Table 11.12-12). The following are examples of environmental design features and mitigation practices that will be used to reduce the risk to wildlife from chemical spills.

- – Hazardous, non-combustible waste, and contaminated materials will be temporarily stored in the waste storage transfer area in sealed steel or plastic, wildlife-resistent drums, and shipped off-site for disposal or recycling.
- – Chemicals such as de-icing fluid, acids, solvents, battery acids, and laboratory agents will be collected in lined trays and drums and stored in suitable sealed containers in the waste transfer area.
- – All fuel storage tanks will be designed and constructed according to the American Petroleum Institute 650 standard.
- – The design of the containment area for tanks will be based on the requirements of the Canadian Council of Ministers of the Environment (CCME) Environmental Code of Practice for Above-Ground Storage Tanks Systems Containing Petroleum Products

(2003 internet site), the National Fire Code of Canada, and any other standards that are required.

- Aviation fuel for helicopters will be stored in sealed drums inside a lined berm area at the helipad.
- Aircraft will be sprayed with de-icing fluids in a specific area at the airstrip that will be equipped with swales to collect excess fluids if necessary.
- Puddles of de-icing fluids in the swales will be removed by a vacuum truck and deposited into waste de-icing fluid drums for shipment off-site and recycling if necessary.
- Soils will be sampled during closure and analyzed for contaminants. Any contaminated soil will be excavated and either permanently encapsulated in a secure area, treated on-site to an acceptable standard, or stored in appropriate sealed containers for off-site shippment and disposal.
- Any spills will be isolated and immediately cleaned up by a trained spill response team consisting of on-site personnel who will be available at all times.

The implementation of the Emergency Response and Contingency Plan (Section 3, Appendix 3.I, Attachment 3.I.1), environmental design features, mitigation, and monitoring programs is expected to result in no detectable change to health or mortality of birds and species at risk. Consequently, this pathway was determined to have no linkage to effects on the persistence of bird and species at risk populations, and continued opportunity for traditional and non-traditional use of birds and species at risk.

- Changes in downstream flows (e.g., isolation and diversion, altered drainage patterns) and water levels from dewatering of Kennady Lake may cause injury/mortality to individual animals.

Bird and species at risk mortality from stream flooding is not anticipated to increase beyond the number of animals drowning that occur naturally. Dewatering and operation discharges will be limited so that pumping will not increase discharges above the baseline 2-year flood levels in downstream lakes and channels (Table 11.12-12). Consequently, bird and species at risk mortality from dewatering of Kennady Lake is determined to have no linkage to effects on the persistence of bird and species at risk populations.

- Changes in the timing of freeze and break-up downstream may alter bird and species at risk movement and behaviour, and could cause injury/mortality to individual animals.

Dewatering and operation discharges will be limited so that pumping will not increase discharges above the baseline 2-year flood levels in downstream lakes and channels (Table 11.12-12). It is anticipated that pumping will begin in June immediately after ice-out and will continue until ice-begins to form on the shorelines. Dewatering and pumped discharge over the life of the Project may result in a thaw period extending into November for Lake N11 and the interlake system. However, the extended thaw period is not anticipated to affect the movement and behaviour of birds and species at risk. It is expected that the dewatering of Kennady Lake will have no measurable influence on the freeze and break-up cycle downstream. Consequently, this pathway was determined to have no linkage to effects on the persistence of bird and species at risk populations.

11.12.3.2.2 Secondary Pathways

In some cases, both a source and a pathway exist, but the Project is anticipated to result in a minor environmental change, and would have a negligible residual effect on birds and species at risk relative to baseline or guideline values (e.g., a slight increase in a soil quality parameter above CCME guidelines, that would not affect wildlife health). The following pathways are anticipated to be secondary, and will not be carried through the effects assessment.

Changes to Habitat Quantity and Fragmentation

The pathways described in the following bullets are expected to result in minor changes to habitat quantity and fragmentation.

- Dust deposition may cover vegetation and decrease abundance of forage for birds and species at risk (i.e., habitat quantity).

Accumulation of fugitive dust (i.e., total suspended particulate [TSP] deposition) produced from the Project may result in a direct loss of vegetation ecosystems and plants. Air quality modelling was completed to predict the extent of dust deposition (Section 11.4). Sources of dust deposition include blasting activities, haul roads, processing plant, and mine pits. While lake-bottom sediments will be exposed following the dewatering of Kennady Lake, it is expected they will form a hardpan crust and will not be a substantial source of dust (Section 11.7, Appendix 11.7.I).

As per the Terms of Reference, a construction case was modeled for the Project. Typically, the construction phase will have lower emissions than the operations phase of a project (Section 11.4). As expected, the construction case emissions are much lower than the application case emissions, and therefore, result in lower predictions than those for the application case (Section 11.4). The assessment of the application case (i.e., operations) is anticipated to capture the maximum effects resulting from the Project.

Sources of dust deposition modelled in the application case include blasting activities, haul roads, the processing plant, activities at the mine pits and other ancillary facilities (e.g., mine rock piles, Coarse PK Pile, and Fine PKC Facility), and vehicle traffic along the Winter Access Road (Section 11.4). Environmental design features and mitigation have been incorporated into the Project to reduce potential effects from dust deposition (Table 11.12-12). For example, the watering of roads, airstrip, and laydown areas will facilitate dust suppression (Table 11.12-12). Although these environmental design features and mitigation will be implemented to reduce dust deposition, assumptions incorporated into the model are expected to contribute to conservative estimates of deposition rates (Section 11.4).

A CALPUFF plume dispersion model was used to predict ambient ground-level concentrations and deposition distribution patterns. Assumptions incorporated into the model (e.g., deposition velocity, and particle size) are expected to contribute to conservative estimates of deposition near the Project emission sources (Section 11.4).

The results of the air quality modelling predicted that the maximum annual dust deposition resulting from the Project is 6,292 kg/ha/y within the Project development area boundary (i.e., Project footprint) and 5,520 kg/ha/y outside of the Project development area boundary (Table 11.12-13). The maximum deposition that occurs is mostly associated with the mine pits and haul roads. The maximum deposition rate for dust is predicted to occur within 100 m of the Project footprint. The strongest effects from dust are generally confined to the immediate area adjacent to the dust source, such as roads (Walker and Everett 1987).

Table 11.12-13 Summary of Key Predicted Annual Deposition Rates from the Project

Substance	Criteria	Maximum Predicted Deposition Rate		
		Local Study Area Baseline	Application	
			Outside Project Development Area Boundary	Distance to Maximum from the Project Development Area Boundary (m)
TSP Annual (kg/ha/y)	none	0.00	5,520	0
PAI Annual (keq/ha/y)	0.25[a]	0.06	0.96	0.2

[a] Threshold is based on the Clean Air Strategic Alliance (CASA 1999).

km = kilometres; kg/ha/y = kilograms per hectare per year; keq/ha/y = kiloequivalent per hectare per year; PAI = potential acid input.

Increased dust deposition has been documented to have varying effects on plants (Forbes 1995; Walker and Werbe 1980; Spatt and Miller 1981; Walker and Everett 1987). However, Auerbach et al. (1997) states that although the species composition may change and the aboveground biomass is lowered due to dust deposition, the ground cover is still maintained. Some species such as cloudberry (*Rubus chamaemorus*), willow (*Salix* sp.), and cottongrass (*Eriophorum* spp.) were observed to be more abundant as a result of dust deposition (Forbes 1995).

Overall, direct effects from dust deposition are predicted to be largely confined to the Project development area boundary and are anticipated to result in a minor change to habitat quantity relative to baseline conditions (secondary pathway; Table 11.12-12). Subsequently, residual effects to the persistence of birds and species at risk, and the continued opportunity for traditional and non-traditional use of birds are predicted to be negligible.

- Changes in downstream flows (e.g., isolation and diversion, altered drainage patterns) and water levels from dewatering of Kennady Lake may affect the quantity of riparian habitat, which could alter bird and species at risk movement and behaviour.
- Changes in downstream flows (e.g., isolation and diversion, altered drainage patterns) and water levels from refilling of Kennady Lake may affect the quantity of riparian habitat, which could alter bird and species at risk movement and behaviour.

Changes to downstream habitat quantity (i.e., riparian vegetation) from the discharge of water to Lake N11 (i.e., throughout construction and operations) are anticipated to be minor. Environmental design features and mitigation have been included to limit erosion, and subsequently, reduce the potential for loss of riparian habitat (Table 11.12-12). For example, discharges will be limited so that pumping will not increase discharges above the baseline 2-year flood levels in downstream lakes and channels. These levels were selected to reduce potential bank erosion and limit the changes to habitat quantity (Section 9).

Construction of dykes will cause changes to drainage flow patterns and surface water elevations in some lakes. For example, the construction of Dykes E and D will divert drainage flows from Lake B1 to N6 (Section 3). Construction of Dykes F and G will divert water from Lakes D3, D2, E1, and N14 through Lake N17. The construction of Dyke C will divert water from Lake A3 through Lake N9. In addition to diversion of drainage flows, the construction of these dykes will also raise baseline surface water elevations in Lakes D2, D3, E1, and A3. For example, it is anticipated that surface water elevations in Lakes D2 and D3 will increase from approximately 424.2 m and 425.4 m at baseline, respectively, to

427.0 m throughout the construction and operational phases (Section 3). Surface water elevation in Lake E1 is anticipated to increase from 425.2 m to 426.0 m. The greatest increase in lake levels is predicted to be in Lake A3 where surface water elevations will increase from 423.0 m to 426.5 m after the construction of Dyke C. Because of the anticipated changes in lake levels, riparian vegetation surrounding Lakes D2, D3, E1, and A3 will be removed during the construction of the diversion dykes, prior to flooding (Section 3).

Vegetation ecosystems and plants downstream of Kennady Lake that could be affected by the dewatering process include sedge-dominated wetlands and riparian areas, and upland tundra comprised primarily of dwarf woody vegetation (Section 11.7). Wetlands and riparian plant species are better adapted to fluctuating water levels and should be able to withstand and recover from high water level conditions more successfully than their upland counterparts. Upland ecosystem types with more freely drained soils and dwarf vegetation will likely be less resilient to prolonged flooding, and are expected to display a more adverse response to these conditions (Section 11.7). In addition, the margins of Kennady Lake are composed primarily of boulder and cobble substrates (Section 8). Portions of the lake margin that are vegetated may die back if they are sensitive to water table declines resulting from dewatering. However, as the margins become drier, the species composition may shift to plants more commonly found in upland areas.

The progressive reclamation strategy will be extended to the water management of Kennady Lake, where portions of the lake will be isolated and brought back to original water levels and compliant water quality as quickly as possible. The closure water management plan requires annually pumping water from Lake N11 to Area 3 to reduce the overall time for the closure phase. The pumping rates are anticipated to be managed such that the total outflow from Lake N11 does not drop below the 1 in 5-year dry conditions (Table 11.12-12). At closure, dykes will be breached to return drainage flows and water levels to baseline conditions. While most changes are predicted to revert back to natural conditions, it is anticipated that the drainage flow from Lake A3 to Lake N9 will remain permanently and the surface water elevation in Lake A3 will remain above baseline conditions (Section 3).

Overall, the increase in drainage flows and surface water elevations associated with the dewatering and refilling of Kennady Lake is localized and is expected to have a minor influence on habitat quantity for birds and species at risk relative to baseline conditions. Therefore, the residual effects to the persistence of bird and species at risk populations from the dewatering and refilling of Kennady Lake are predicted to be negligible.

- Dewatering may result in newly established vegetation on the exposed lakebed sediments.

The development of the Project will require the dewatering of Kennady Lake, resulting in the exposure of a portion of the lake-bed. Although it is anticipated that the sediment would solidify and form a hardpan crust, there is potential for vegetation to establish on the exposed lake-bed sediments. The exposure of bare, nutrient-rich lakebed sediments can provide a substrate that may favour the establishment of rapid colonizing plants, some of which could be weedy, invasive species (Shafroth et al. 2002). If the substrate remains moist during the initial stages of plant colonization, then riparian plant species may become established on the exposed lakebed. Over time as the substrate becomes drier, the species composition may shift to plants more commonly found in upland areas (Section 11.7).

The lack of fine sediment around the periphery of Kennady Lake, and the consistent presence of boulder and cobble through the shallow areas of the lake, will effectively limit colonization of the lakebed by terrestrial vegetation through vegetative propagation (i.e., root growth). Vegetation is more likely to be established through seed dispersal and subsequent germination, with the seeds being dispersed across the nearshore rocky habitat to colonize the fine sediments that are currently located in the deeper sections of the lake (Section 8). Vegetation is expected to establish slowly and coverage would be patchy. Initial colonizers are thought to be graminoids (grasses and sedges).

The anticipated effects on riparian vegetation will be localized, and it is expected that dewatering will result in a minor change to the quantity of forage available for birds and species at risk relative to baseline conditions (secondary pathway; Table 11.12-12). Therefore, the residual effects to the persistence of bird and species at risk populations resulting from the dewatering of Kennady Lake are predicted to be negligible.

Changes to Habitat Quality, Movement, and Behaviour

The pathways described in the following bullets are expected to result in minor changes to habitat quality, movement, and behaviour of birds and species at risk.

- Dust deposition and air emissions may change the amount of different quality habitats (through chemical changes in soil and vegetation), and alter bird and species at risk movement and behaviour.

Accumulation of dust (i.e., TSP deposition) and concentrations of air emissions produced from the Project may result in a local indirect change on the quality of habitat available within the LSA. Air quality modelling was completed to predict the spatial extent of dust deposition and air emissions from the Project. Air quality modeling was completed for the baseline case, the construction case, and the application case (Section 11.4). The baseline case includes background concentrations of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and particulate matter (PM), as well as background PAI depositions from the regional modelling network. The baseline case also includes air emissions from the Snap Lake Mine (Section 11.4).

Sources of dust deposition and air emissions modelled in the application case (maximum effects case) include blasting activities, haul roads, the processing plant, activities at the mine pits and other ancillary facilities (e.g., mine rock piles, Coarse PK Pile and Fine PKC Facility), and vehicle traffic along the Winter Access Road (Section 11.4). Environmental design features and mitigation have been incorporated into the Project to reduce potential effects from dust deposition (Table 11.12-12). For example, the watering of roads, airstrip, and laydown areas will facilitate dust suppression (Table 11.12-12). In addition, programs will be instituted to review power and heat use to reduce energy use. Although these environmental design features and mitigation will be implemented to reduce dust deposition and air emissions, assumptions incorporated into the model are expected to contribute to conservative estimates of emission concentrations and deposition rates (Section 11.4).

Haul trucks travelling on the Winter Access Road have the potential to transfer dust from vehicles and loads during the winter months (e.g., dust deposited on wheels and undercarriage while at mine sites and in Yellowknife). However, the relative contribution of these loads to the overall dust accumulation in the area along the roads is considered to be negligible. During the winter, dust that accumulates on snow may settle on vegetation during the spring melt. Although snow melting does not result in “washing away” of dust, the dust that has accumulated on snow during the winter may be diluted during snow melt and spring freshet, and eventually removed by rain (Section 11.7). The air emissions from the Winter Access Road were included in the application case and assumed that the road was in operation for 63 days (Section 11.4). In general, emissions from the Winter Access Road are small, and if extended over whole year, a negligible effect on annual depositions was predicted (Section 11.4). Annual emissions from the Winter Access Road are anticipated to result in no detectable changes to vegetation (Section 11.7).

The results of the air quality modelling predicted the maximum annual dust deposition resulting from the Project is 6,292 kg/ha/y within the Project development area boundary (i.e., Project footprint) and 5,520 kg/ha/y outside of the Project development area boundary (Table 11.12-13). The maximum deposition that occurs is mostly associated with the mine pits and haul roads. The maximum predicted dust deposition rate outside the Project development area boundary is predicted to occur within 100 m of the Project footprint (Table 11.12-13). The strongest effects from dust are generally confined to the immediate area adjacent to the dust source, such as roads (Walker and Everett 1987). Walker and Everett (1987) and Everett (1980) reported that effects were confined to a 50-m buffer on either side of a road. Moreover, Meininger and Spatt (1988) found that most of effects occurred within 5 to 50 m of a road, with less obvious effects observed between 50 m and 500 m from a road.

The PAI modelling results indicates maximum deposition rates of 0.06 kiloequivalent per hectare per year (keq/ha/y) and 0.96 keq/ha/y 0.2 m beyond the Project development area boundary for the baseline and application case, respectively (Table 11.12-13). The maximum deposition occurs near the three mine pits and around of the plant site, where haul road emissions are coupled with those from the power generation plant. Interpretation of PAI predictions is based on the Clean Air Strategic Alliance (CASA 1999) deposition loading benchmarks, including the critical threshold of 0.25 keq/ha/y for the most sensitive ecosystems. The area outside the Project development area boundary that is predicted to have above the critical load of 0.25 keq/ha/y is estimated at 169 hectares (ha), extending up to 500 m from the development area boundary.

The air emissions modelling results show that predicted peak concentrations for SO_2 are below the Ambient Air Quality Standards for NWT for the application case (Table 11.12-14). Annual peak concentrations for NO_2 are predicted to slightly exceed guidelines at 64.3 micrograms per cubic metre (μg/m^3). The area of exceedances is predicted to occur near the South Mine Rock Pile and the haul roads along the south side of the development area (Table 11.10-7). The Annual maximum TSP concentration outside the Project development area boundary is predicted to be 604.8 μg/m^3, compared to the NWT standard of 60 μg/m^3. The area that is predicted to exceed the NWT standard extends no further than approximately 1 km from the Project development area boundary.

Table 11.12-14 Summary of Key Predicted Peak Annual Air Quality Concentrations in the Regional Study Area

Substance	Criteria ($\mu g/m^3$)	Maximum Predicted Concentration			
		Baseline		Application	
		Concentrations in the Regional Study Area ($\mu g/m^3$)	Distance to Peak Predictions (km)	Concentrations Outside Project Development Area Boundary ($\mu g/m^3$)	Distance to Peak Predictions (km)
NO_2 Annual	60	11.9	86.1	**64.3**	1.6
SO_2 Annual	30	3.0	86.1	4.8	2.9
TSP Annual	60	7.1	8.5	**604.8**	1.6
$PM_{2.5}$ Annual	none	2.2	86.1	24.1	1.6

Note: A predicted value that exceeds a criterion is accentuated in **bold**.

$\mu g/m^3$ = micrograms per cubic metre; NO_X = nitrogen oxides; NO_2 = nitrogen dioxide; SO_2 = sulphur dioxide; $PM_{2.5}$ = particulate matter; TSP = total suspended particulate.

Although concentrations are predicted to be above baseline conditions, the anticipated changes to habitat quality are localized and considered minor. The maximum predicted annual TSP deposition rate is expected to occur within 100 m of the Project footprint. When comparing changes to the elemental concentrations in soil from TSP deposition, predictions are be below CCME (2007) soil quality guidelines. Therefore, changes to the chemical content of soil should not affect the soils ability to support vegetation (habitat quality). In addition, the deposition predictions are considered to be conservative and therefore, the presented deposition rates are likely overestimated. Overall, changes in habitat quality (and associated changes to bird and species at risk movement and behaviour) due to dust deposition and air emissions are anticipated to be minor relative to baseline conditions (secondary pathway; Table 11.12-12). Consequently, residual effects to the persistence of bird and species at risk populations, and continued opportunity for traditional and non-traditional use of these species from dust deposition and air emissions are predicted to be negligible.

- Road footprint may cause changes to the amount of different quality habitats (e.g., degradation to vegetation), and alter bird and species at risk movement and behaviour.

Construction and operation of the Winter Access Road connecting the Project with the Tibbitt-to-Contwoyto Winter Road will follow best practices (e.g., use of snow or ice pads of sufficient thickness to limit damage to overland portages between lakes, and discontinued use of the road when the ground surface becomes too soft). These practices are implemented in the design, construction, and operation of the Tibbitt-to-Contwoyto Winter Road and have proven to be successful in limiting the effects to vegetation (EBA 2001) (Section 11.7). Only minor compression of vegetation comprising the portages is anticipated. Some degradation to vegetation along the boundary between lakes and shorelines may also occur.

Overall, the Winter Access Road is anticipated to have a minor influence on habitat quality relative to baseline conditions (Table 11.12-12). Therefore, the residual effects to the persistence of bird and species at risk populations are predicted to be negligible.

Changes to Survival and Reproduction

The pathways described in the following bullets are expected to result in a minor change to the survival and reproduction of birds and species at risk.

- Physical hazards from the Project may increase the risk of injury/mortality to individual animals, which can affect species at risk (e.g., caribou, grizzly bear, wolverine, and peregrine falcon) and bird population size.
- Injury or mortality to animals getting trapped in exposed sediments.

The presence of physical hazards (e.g., open pits, ditches, blasting, and exposed sediments) on-site may result in an increased frequency of injury or mortality to birds and species at risk. However, the implementation of environmental design features (Table 11.12-12) and the Wildlife Effects Mitigation and Management Plan (Appendix 7.I), are expected to decrease the risk to animals from physical hazards on-site.

- – Blasting in pits will be carefully planned and controlled to reduce the throw of ore bearing materials.
- – Overhead lines were not considered for power distribution to any of the facilities.
- – At closure, the entire site area will be re-contoured to reduce hazards to wildlife.
- – Non-salvageable and non-hazardous components from demolition of the site buildings, structures, and equipment will be dismanteled and deposited in the inert materials landfill within the mine rock pile, and will then be covered with a layer on NAG mine rock.
- – Ramps to facilitate the access and egress of wildlife from the mine rock pile will be constructed during closure.

Wildlife deterrent actions will be also implemented by knowledgeable and trained personnel. The goal of these deterrents is to respond to wildlife situations using humane management methods in ways that will keep both humans and animals safe. Although caribou mortalities have occurred near pits and facilities, there have been no confirmed mortalities as a result of direct interaction with pits or containment facilities at other mines in the NWT. Caribou mortalities associated with containment facilities are presumed to be the result of predation by wolves or bears (BHPB 2006, 2007). No bird or other species at risk mortalities have been recorded at pits or facilities at other mine sites in the NWT and Nunavut.

Monitoring results from other diamond mines in the NWT and Nunavut have documented few mine-related mortality of birds. At the Ekati mine site, between 1997 and 2009, two unidentified sparrows, one savannah sparrow, three common redpolls, one American robin, one peregrine falcon, and one red-throated loon have been killed by mine-related activities (BHPB 2008, 2009, 2010). One of the sparrows died after being tangled in a telephone line, one sparrow was found dead in the Panda Diversion Channel fish box, the red-throated loon drowned after becoming tangled in a net in Kodiak Lake, and the peregrine falcon died after being electrocuted by a power line. The causes of death for the other birds were not determined.

At the Diavik mine from 2000 to 2009, two common ravens, one red-throated loon, one Lapland longspur, six rock ptarmigan, one snowy owl, and one peregrine falcon have been killed by mine-related activities. One of the common ravens died of starvation resulting from a blockage caused by the ingestion of plastic, the other common raven was killed after falling out of its nest, and the red-throated loon died after becoming entangled in gill nets during the 2006 A418 fishout (DDMI 2006). The causes of death for the other bird species were not determined. At the Snap Lake Mine, one American kestrel was found dead, probably from starvation, in 2004, and an unidentified raptor was found dead in 2008; the cause of death was not determined (De Beers 2009). No other bird mortalities have been reported on the Snap Lake mine site from 1999 to 2009 (De Beers 2010).

The frequency of mine-related mortality on caribou is extremely low. For example, at the Lupin Mine, three mine-related caribou deaths were recorded from 1980 through 1996. At the Diavik Diamond Mine, one grizzly bear and one wolverine have been intentionally destroyed and one caribou was accidentally killed from 1996 to 2009 (DDMI 1998, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010). No bird or other species at risk mortalities have been reported at the Diavik mine site. At the Ekati Diamond Mine four wolverine and three grizzly bears have been intentionally destroyed and three caribou were accidentally killed from 1998 to 2009 (BHBP 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010). In addition, two unintentional bird mortalities have also been reported at the Ekati Diamond Mine site.

One wolverine has been accidentally killed on the Snap Lake mine site from 1999 to 2009 (De Beers 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010). No birds or other species at risk have been accidentally or intentionally killed on the Snap Lake mine site since the beginning of exploration through current production. One wolverine has been intentionally destroyed and one wolverine was accidentally killed on the Jericho mine site from 2000 to 2007 (Tahera 2000, 2006, 2007a, 2007b, 2008).

Although there is a potential for mortality or injury to occur, the implementation of the Wildlife Effects Mitigation and Management Plan (Appendix 7.I) is anticipated to reduce the risk to bird and species at risk mortality from physical hazards on-site. Changes in mortality are predicted to be minor relative to baseline conditions (secondary pathway; Table 11.12-12). As such, individual mortality from physical hazards on-site is expected to have a negligible residual effect on the persistence of bird and species at risk populations.

- Aircraft/vehicle collisions may cause injury or mortality to individual animals.

There is potential for an increase in the risk of injury or death to birds and species at risk (e.g., caribou, grizzly bear, wolverine, and peregrine falcon) through collisions with aircraft and on-site vehicles. For example, eleven willow ptarmigan, one rock ptarmigan, eight ptarmigan species, one green-winged teal (*Anas crecca*), (one unidentified bird, and one rough-legged hawk have been killed by vehicle collisions on the Ekati mine site between 1997 and 2009 (BHBP 2008, 2009, 2010). One unidentified duck and approximately six individuals of rock ptarmigan have been killed by vehicle collisions on the Diavik mine site from 2000 to 2009 (DDMI 2007, 2008, 2009, 2010). No birds have been killed by vehicle collisions on the Snap Lake mine site from 1999 to 2009 (De Beers 2010). Aircraft collisions have not been the cause of any recorded wildlife injuries or mortalities at the Ekati Diamond Mine, Diavik Diamond Mine, Jericho Diamond Mine, or the Snap Lake Mine (Tahera 2007a; BHPB 2010; DDMI 2010; De Beers 2010).

Similar to other mining operations in the region, access to the Project will be via a 120 km winter spur road, connecting with the Tibbitt-to-Contwoyto Winter Road at kilometre 271, just north of Lake of the Enemy. The Winter Access Road will typically be in operation for about 8 to 12 weeks per year. From 1998 to 2007, traffic volume on the Tibbitt-to-Contwoyto Winter Road increased from 2,543 loaded trucks in 2000 to 10,922 in 2007 (GNWT 2006 internet site; Tibbitt-to-

Contwoyto Winter Road Joint Venture 2007 internet site). Traffic volume on the Tibbitt-to-Contwoyto Winter Road decreased during 2008 through 2010 (3,506 northbound loads in 2010; Section 11.8.2.5).

The predominant factors that contribute to road-related wildlife deaths are traffic volume and vehicle speed (EBA 2001). These factors directly affect the success of an animal reaching the opposite side of the road. An increase in either factor reduces the probability of an animal crossing safely (Underhill and Angold 2000). However, implementation of the Winter Road Policy and Rules and Procedures for the Tibbitt-to-Contwoyto Winter Road is anticipated to reduce the potential for injury/mortality of wildlife from vehicle collisions (Tibbitt-to-Contwoyto Tibbitt-to-Contwoyto Winter Road Joint Venture 2000). For example, from 1996 to 2009, there have been three reported road-related wildlife mortalities along the Tibbitt-to-Contwoyto Winter Road. In 1996, a wolverine was killed by a pick-up truck (Banci 2001). In March 1999, five caribou were killed by a grocery (meat) truck on a portage near Gordon Lake (EBA 2001). In 2009, a red fox was killed on the Tibbitt-to-Contwoyto Winter Road (Madsen 2010 pers. comm.)

Mitigation strategies have been established to reduce the potential for vehicle and aircraft collisions at the Project and along the Winter Access Road (Table 11.12-12). These strategies are outlined in the Wildlife Effects Mitigation and Management Plan (Appendix 7.I), and are similar to management practices and policies implemented at other diamond mines in the NWT and Nunavut. The following environmental design features and mitigation are expected to limit the risk from vehicle and aircraft collisions with birds and species at risk:

- personnel arriving at or leaving the site will be transported by bus, which will reduce the amount of traffic between the airstrip and the accommodation complex;
- levels of private traffic using the Project Winter Access Road will be monitored;
- all wildlife have the “right-of-way”;
- the site will be designed to limit blind spots where possible to reduce the risk of accidental wildlife-human encounters;
- speed limits will be established and enforced;
- drivers will be warned when wildlife are moving through an area using signage and radio; and
- safe, effective methods will be used to remove species at risk from the airstrip before aircraft land or takeoff.

The implementation of the Winter Road Policy, Rules and Procedures, and the Wildlife Effects Mitigation and Management Plan (Appendix 7.I) is anticipated to limit bird and species at risk mortality from vehicle collisions at the Project along the Winter Access Road. As such, bird and species at risk mortality from vehicle and aircraft collisions is expected to have a negligible residual effect on the persistence of bird and species at risk populations, and the continued opportunity for traditional and non-traditional use of birds and species at risk.

Due to the success of mitigation and management practices used at operating mines in the NWT, the environmental design features and mitigation implemented for the Project are anticipated to reduce bird and species at risk mortality from vehicle and aircraft collisions. Bird and species at risk mortality from vehicle and aircraft collisions is expected to have a negligible residual effect on the persistence of bird and species at risk populations.

- Attractants to site (e.g., food waste, oil products) may increase predator numbers and increase predation risk.

Carnivores have a keen sense of smell and can be attracted from long distances to the Project if food items are frequently present. Carnivores are also attracted to aromatic waste material such as oil and aerosols, in addition to infrastructure that can serve as a temporary refuge to escape extreme heat or cold.

Environmental design features and mitigation have been established to reduce the attraction of wildlife to the Project. Based on the results from monitoring programs for other mining projects in the NWT and Nunavut, it is anticipated that not all wildlife will be deterred from the site. For example, wildlife effects monitoring programs completed at the Ekati Diamond Mine (2000 through 2009), the Diavik Diamond Mine (2002 through 2009), the Jericho Diamond Mine (2000, 2005 through 2007), and the Snap Lake Mine (2001 through 2009) have reported attractants (e.g., non-burned food items, oil products, and food packaging) in the landfill. Most of the animals and sign observed during these landfill surveys were associated with foxes. Grizzly bears, wolverine, and wolf tracks were occasionally observed (Section 11.9).

Human presence and activities can alter interspecific interactions, such as rates of predation (Bergerud et al. 1984; Rich et al. 1994; James and Stuart-Smith 2000; Marchand and Litvaitis 2004). The increased presence of carnivores can result in an increased frequency of predation on individual birds and species at risk, and change survival and reproduction. However, environmental design features and mitigation strategies have been established to reduce the numbers of carnivores attracted to the Project (Table 11.12-12). These strategies are outlined in the Wildlife Effects Mitigation and Management Plan (Appendix 7.I), and are similar to management practices and policies implemented at other diamond mines in the NWT and Nunavut. The following wildlife-specific environmental design features are included in the Waste Management Plan (Section 11.9) and the Wildlife Effects Mitigation and Management Plan should reduce the numbers of carnivores attracted to the Project.

- Education and reinforcement of proper waste management practices will be required for all workers and visitors to the site will be provided.
- Separate bins will be located throughout the accommodations complex, processing plant, shops, and other facilities on-site for immediate soring of domestic waste.
- Food waste will immediately be planced and sealed in plastic bags. The plastic bags will be stored in sealed, wildlife-resistant containmers before transport directly to the incinerator storage area for incineration.
- Incinerator ash from combustion of kitchen and office waste will be stored in wildlife-resistant containers and transported to the landfill.
- The landfill will be covered regularly with crushed or mine rock.
- A fenced area will be established for the handling and temporary storage of wastes. Fencing will be 2 m high, slatted-type, and partially buried to prevent animals from burrowing underneath.
- People will be educated on the risks associated with feeding wildlife and careless disposal of food garbage.
- Ongoing review of the efficiency of the waste management program and improvement through adaptive management.

At the Snap Lake Mine, there were no reported waste or attractant-related incidents or mortalities to carnivores from 1999 to 2009 (De Beers 2010), which indicates a low frequency of attractants at site. The implementation of the Waste Management Plan and the Wildlife Effects Mitigation and Management Plan are expected to limit the numbers of carnivores attracted to the site. Based on the effectiveness of mitigation at the Snap Lake Mine, predation of birds and species at risk by carnivores is not anticipated to increase above baseline conditions as a result of attractants to the site (Section 11.9). Therefore, bird and species at risk mortality from increased predation is expected to have a negligible residual effect on the persistence of bird and species at risk populations.

- Increased access for traditional and non-traditional harvesting may alter bird and species at risk movement and behaviour, which can affect survival and reproduction.

Because the Winter Access Road leading to the Project connects with the Tibbitt-to-Contwoyto Winter Road, the improved access may lead to an increase in harvest rates on birds and species at risk (e.g., caribou, grizzly bear, and wolverine). Caribou is the most important resource harvested by Aboriginal groups with traditional lands near the Project (Section 7.3). Case et al. (1996) estimated that between 14,500 and 18,500 caribou were harvested annually from 1982 to 1995. Non-aboriginal harvest of caribou is regulated by the ENR of the Government of the Northwest Territories. Non-resident hunters can only harvest caribou during August 15 to November 30 (ENR 2010b, internet site), which is not within the winter road season. Non-resident hunters are allowed to hunt grizzly bears and wolverines when the winter roads are in operation (approximately 8 to 12 weeks each year). The non-resident hunting season for grizzly bears is from September 1 to May 31 and for wolverines is from December 1 to March 15 (ENR 2010b, internet site). Non-residents can harvest ptarmigan and grouse from September 1 to April 30 (ENR 2010b internet site).

Another caribou harvest period for resident hunters occurs from November 15 to April 30 when the winter roads are in operation (approximately 8 to 12 weeks each year). Resident hunters were allowed to hunt black bear (*Ursos americanus*), wolves, and wolverines when the winter roads are in operation. The harvest period for wolverines is from July 25 to April 30 (ENR 2010b internet site). Residents can harvest ptarmigan and grouse from September 1 to April 30 (ENR 2010b internet site). Although no harvest data exists for the Tibbitt-to-Contwoyto Winter Road, Ziemann (2007, internet site) tracked the level of hunting activity for 2004 through 2006. The number of vehicles travelling for hunting on the Tibbitt-to-Contwoyto Winter Road showed a decline from 573 vehicles in 2004 to 284 vehicles in 2006 (Ziemann 2007, internet site). Decreases in hunting traffic may have been due to high volumes of mine-related vehicles on the road (e.g., 2,543 loaded trucks in 1998 versus 11,740 in 2007 [Section 11.8.2.5]).

Increased access from the Winter Access Road may increase the number of bird and species at risk individuals harvested from the RSA by non-residents, residents, and traditional land users (i.e., communities). However, the increase in access to the region associated with the winter roads is limited to an eight to 12 weeks each year, and should result in minor changes to the annual harvest rate of birds and species at risk relative to baseline conditions. The number of animals harvested by residents and non-residents is regulated. Policies implemented by De Beers will prevent people at the Project site from using the Winter Access Road for hunting birds and species at risk (while they are at site). Therefore, increased access for harvesting along the winter roads is expected to have a negligible residual effect on the persistence of bird and species at risk populations, and the continued opportunity for traditional and non-traditional use of birds and species at risk.

11.12.3.2.3 Primary Pathways

The following primary pathways are analyzed and classified in the effects assessment.

Changes to Habitat Quantity and Fragmentation

- Direct loss and fragmentation of wildlife habitat from the physical footprint of the Project may alter bird and species at risk movement and behaviour.
- Road footprint decreases habitat quantity and may cause fragmentation, which can alter bird and species at risk movement and behaviour.

Changes to Habitat Quality, Movement, and Behaviour

- Dust deposition may cover vegetation and change the amount of different quality habitat, and alter bird and species at risk movement and behaviour.
- Sensory disturbance (e.g., presence of buildings, people, lights, smells, and noise) changes the amount of different quality habitats, and alters movement and behaviour, which can influence survival and reproduction.

11.12.4 Effects on Population Size and Distribution of Upland Breeding Birds

The effects analysis considers all primary pathways that result in expected changes to population size and distribution of upland breeding birds, after implementing environmental design features and mitigation. Thus, the analysis is based on the residual effects from the Project. Residual effects to upland breeding birds are analyzed using measurement endpoints and are expressed as effects statements, including:

- effects from changes in habitat quantity and fragmentation; and
- effects from changes in habitat quality, movement, and behaviour.

The magnitude, spatial extent, and duration of changes in measurement endpoints (e.g., habitat quantlty and quality) from the Project and other developments are expected to be similar to or greater than the actual effects to the abundance and distribution of populations. Effects statements may have more than one primary pathway that link a Project activity with a change in birds. For example, the pathways for effects on bird habitat quality, movement, and behaviour include changes due to noise, dust deposition, and the presence of vehicles and mine infrastructure, which ultimately affect bird population size and distribution.

Detailed descriptions of the spatial and temporal boundaries, and methods used to analyze residual effects from the Project on upland breeding birds are provided in the following sections. The analyses were quantitative, where possible, and included data from field studies, scientific literature, government publications, effects monitoring reports, and personal communications. Traditional knowledge and community information were incorporated where available. Due to the amount and type of data available, some analyses were qualitative and included professional judgement or experienced opinion.

11.12.4.1 Habitat Quantity and Fragmentation

11.12.4.1.1 Methods

The incremental and cumulative direct habitat effects to bird populations from the Project footprint and other previous, existing, and future developments in the RSA were analyzed through changes in the area and spatial configuration of habitat types on the landscape (i.e., landscape metrics). Landscape metrics for each habitat included total area, number of patches, and mean distance to the nearest similar patch. Decreases in habitat area and number of similar quality habitat patches can directly influence population size by reducing the carrying capacity of the environment. Changes in the number of patches and distance between similar habitat patches can influence the distribution (and abundance) of birds and species at risk by affecting the ability of animals to travel across the land. For some bird species, fragmentation can also influence several ecological processes including movement between nesting and foraging areas, nest predation and parasitism along habitat edges, encounter rate between potential breeders, and dispersal between local populations.

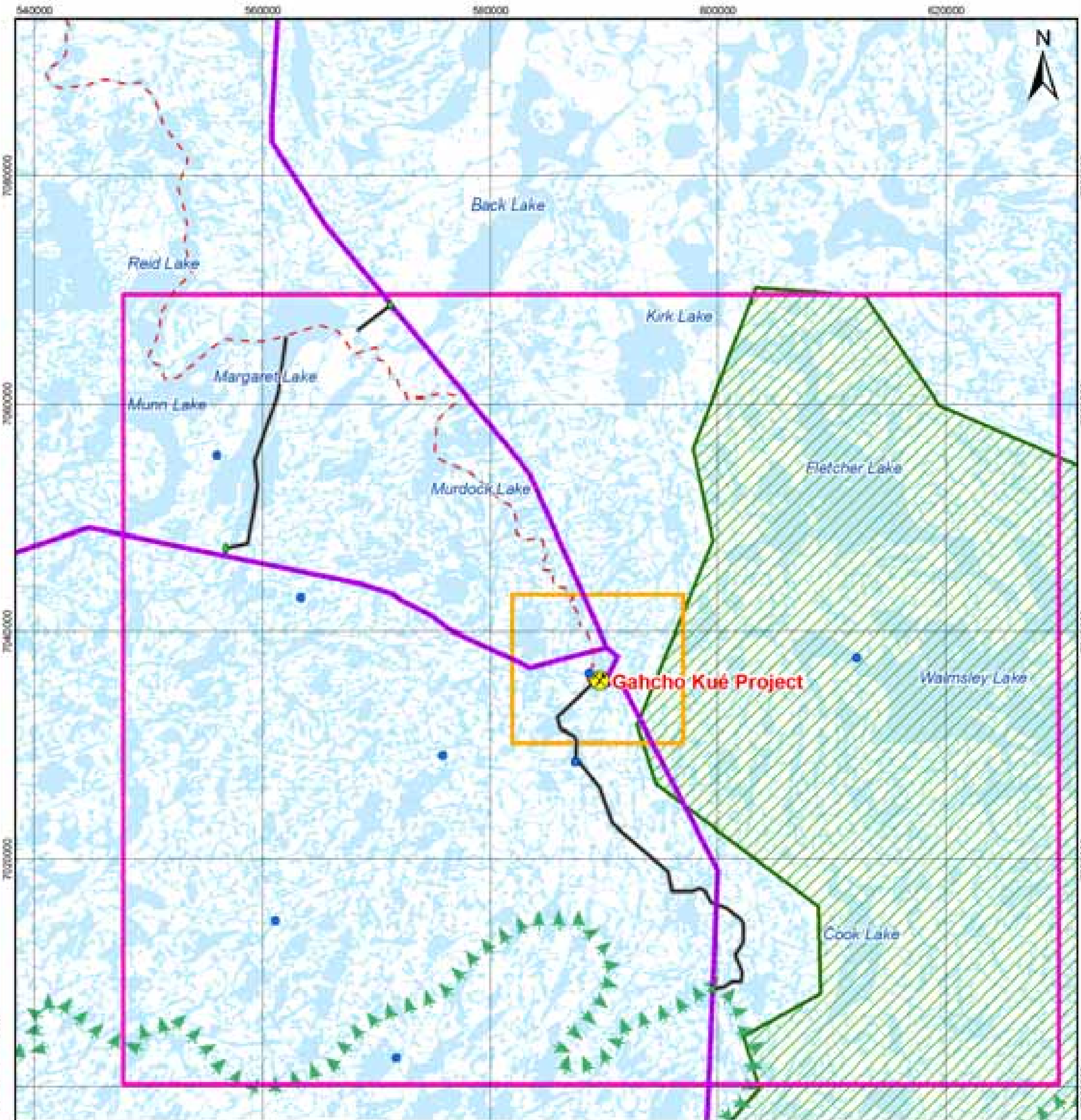
The change in landscape metrics from the development of the Project was determined for the spring through autumn period, which does not include the Winter Access Road. Pathway analysis determined that there was no linkage for effects from the Winter Access Road and Tibbitt-to-Contwoyto Winter Road on the population size and distribution of birds (Section 11.12.3.2).

Landscape metrics were determined using the program FRAGSTATS (Version 3.0; McGarigal et al. 2002, internet site) within a Geographic Information System (GIS) platform. The analysis determined the extent of landscape fragmentation by calculating statistical outputs based on the values of each raster cell. Raster cells (25 m x 25 m) for habitats with extensive coverage in the RSA (including disturbed areas) were based on the Ecological Landscape Classification (ELC) of broad ecosystem units (Section 11.7).

Previous and existing developments in the RSA include eight mineral exploration programs (including the Kennady Lake exploration program) (Figure 11.12-9). Currently, four of these sites have active land use permits (including the Kennady Lake exploration program). Data on the location and type of developments were obtained from the following sources:

- Mackenzie Valley Land and Water Board (MVLWB): permitted and licensed activities within the NWT;
- Indian and Northern Affairs Canada (INAC): permitted and licensed activities within the NWT;
- INAC: contaminated sites database;
- company websites; and
- knowledge of the area and project status.

Initially, data indicating permitted and licensed activities were obtained in spreadsheet format. The file was examined for duplication of information (e.g., a water license and a land use permit for the same development). In cases where two or more pieces of location information for the same activity were present, the extra information was deleted from the file so that it contained only one point per development. Data associated with the location attributes (e.g., permit status, feature name) also were edited in some instances to update the information for running modelling scenarios efficiently.



LEGEND

- Gahcho Kué Project
- Watercourse
- Waterbody
- Treeline
- Local Study Area
- Regional Study Area

Previous and Existing Development

- Mineral Exploration
- Winter Access Road

Future Development

- Taltson Staging Area
- Taltson Transmission Line
- Winter Road
- Proposed East Arm National Park

NOTES
Base data source: National Topographic Base Data (NTDB) 1:250,000

GAHCHO KUÉ PROJECT

Previous, Existing and Reasonably Foreseeable Future Developments in the Regional Study Area

PROJECTION: UTM Zone 12	DATUM: NAD83
Scale: 1:500,000 (10 5 0 10 Kilometres)	DE BEERS CANADA
FILE No: SON-11-12-009-GIS	DATE: October 25, 2010
JOB NO: 09-1365-1004	REVISION NO: 4
OFFICE: GOLD-SAS	DRAWN: ANK; CHECK: JV

Figure 11.12-9

The information was used to generate a development layer within a GIS platform. Because the database contains no information on the size of the physical footprint for exploration programs, a 500 m radius was used to estimate the area of the footprint for exploration sites (78.5 ha), which likely overestimates the amount of habitat directly disturbed by exploration activities. Exploration programs typically contain temporary shelters for accommodations and storage of equipment, and are elevated to limit the amount of disturbance to the soil and vegetation. Drilling is usually carried out with portable drill rigs (5 m x 5 m area) at one location at a time.

Footprints for linear disturbances (e.g., proposed Taltson transmission line) consisted of a 25 m right-of-way. Footprints with overlapping areas on the landscape were not counted twice. The Project footprint was derived from the Project Description, and includes both the terrestrial and aquatic areas of disturbance. For all developments (including the Project), the physical footprint was carried through each assessment case (Section 6.6.2) as it was assumed that direct effects to the landscape had not yet been reversed. The development layer was then applied to the landscape classification of the study area for the baseline, application, and future cases (Table 11.12-15).

Table 11.12-15 Contents of Each Assessment Case

Baseline Case	Application Case	Future Case
Range of conditions from little or no development to all previous and existing projects[a] prior to the Gahcho Kué Project	Baseline case plus the Gahcho Kué Project	Application case plus reasonably foreseeable projects

[a] Includes approved projects.

The baseline case includes the temporal changes in the number of previous and existing projects known to occur within the study area, which can include little or no previous development (Section 6.6.2). Environmental conditions on the landscape before human development (i.e., reference conditions) were also included in the analysis. Analyzing a range of temporal conditions on the landscape is fundamental to understanding the cumulative effects of increasing development on wildlife populations. The application case occurs in the anticipated year of construction of the Project, through the duration of predicted effects (i.e., until the effects are reversed or are deemed irreversible).

The future case includes the baseline case, application case, and reasonably foreseeable developments (Section 6.6.2). Currently, there are two known, reasonably foreseeable developments that may generate incremental changes on vegetation ecosystems (habitat) in the study area for species at risk and birds:

- Taltson Hydroelectric Expansion Project; and
- proposed East Arm National Park.

The temporal boundary for cumulative effects from future developments is a function of the duration of effects from the Project on birds. At a minimum, the time period for effects from the Project, and reasonably foreseeable developments would occur over 22 years (construction through closure). Except for the Taltson Hydroelectric Expansion Project (for which the anticipated footprint is known), effects analyses for the future case are mostly qualitative due to the large degree and number of uncertainties. There are uncertainties associated with the rate, type, and location of developments in the study area. There are also uncertainties in the direction, magnitude, and spatial extent of future fluctuations in vegetation (i.e., habitat), independent of Project effects. Consequently, potential cumulative effects from reasonably foreseeable developments (future case) other than the Taltson Hydroelectric Expansion Project are discussed in the section on uncertainty (Section 11.12.10).

Landscape metrics were determined for the reference, 2010 baseline, application, and future case. As mentioned above, reference conditions represent the initial period of baseline conditions (as far back as data are available). Here, the 2010 baseline case includes all previous, existing, and approved developments up to 2010. The incremental and cumulative changes from the Project and other developments on the loss and fragmentation of habitat were estimated by calculating the relative difference between the 2010 baseline and reference case, between the application and 2010 baseline case, and between the future and application case. The following equations were used:

- (2010 baseline value – reference value) / reference value
- (application value – 2010 baseline value) / 2010 baseline value
- (future case – application value) / application value

The resulting value was then multiplied by 100 to give the percent change in a landscape metric for each comparison. The result provides both the direction and magnitude of the effect. For example, a high negative value for habitat area would indicate a substantial loss of that habitat type. Alternately, a negative value for mean distance to nearest neighbour indicates an increase in patch connectivity. Appendix 11.12.I (Table 11.12.I-1) provides absolute values per habitat type and assessment case (i.e., reference, 2010 baseline, application, and future).

11.12.4.1.2 Results

The total area of the Project footprint is estimated to be 1,235 ha. This includes 853.3 ha of mine and infrastructure that will directly affect terrestrial and aquatic resources (Section 11.7). An additional 382.1 ha of water (shallow and deep water) is not expected to be directly altered by the Project during construction and operation. Approximately 68% of the Project footprint is aquatic habitat and 32% is terrestrial habitat.

At the local scale, the Project footprint will alter 4.4% of the baseline LSA. Terrestrial habitat types that will be disturbed most include tussock-hummock, sedge wetland, and peat bog (all decreased by 0.4%). These habitats are some of the most abundant vegetation communities within the LSA (and RSA). Other terrestrial habitats altered by the Project footprint include heath tundra, heath tundra with bedrock or boulders, birch seep, and riparian tall shrub (all decreased by less than 0.4% relative abundance in the LSA). No esker is expected to be altered. During construction and operation, the Project footprint will decrease the lake surface area within the LSA by 2.2%.

Although progressive reclamation will be integrated into mine planning as part of De Beers' design for closure policy, arctic ecosystems are slow to recover from disturbance. In addition, not all of the areas will be reclaimed. For example, as a result of locally expressed concerns, the Fine PKC Facility will not be vegetated to prevent the facility from becoming attractive to wildlife (Section 11.7). The mine rock piles, Coarse PK Pile and Fine PKC Facility will be permanent features on the landscape, covering approximately 302.7 ha.

Upland breeding birds use a variety of habitat types and patches within their seasonal home ranges. For some species, vegetation communities that provide vertical vegetation structure and cover such as heath tundra, birch seep, tall shrub, spruce forest, tussock-hummock, and sedge wetlands may represent higher quality habitats. At the regional scale and under reference conditions, the study area is mainly comprised of waterbodies (25%), peat bog (9%), tussock-hummock (10%), and sedge wetlands (11%). Heath tundra, heath boulder and heath bedrock each constitute less than 10% of the RSA. Birch seep and tall shrub each account for about 5% of the landscape.

At the scale of the RSA, the relative change in the amount of habitat from reference to 2010 baseline conditions is less than 0.2% for each habitat type during the non-winter period (Table 11.12-16). The anticipated incremental loss of any habitat type from the Project relative to 2010 baseline conditions is less than or equal to 0.5% of the RSA. The decrease in the amount of high quality habitat ranges from 0.11 to 0.29%, relative to 2010 baseline conditions

(Table 11.12-16). Overall, the Project is expected to disturb approximately 2.6% of the landscape in the RSA.

Similarly, incremental habitat-specific changes from the Taltson Hydroelectric Expansion Project (future case) are expected to be less than 0.2%. The total combined loss of all habitats in the RSA from the Taltson Hydroelectric Expansion Project is 0.9%. The cumulative direct disturbance to the landscape from the Project and other previous, existing and future developments is predicted to be about 4.7% relative to reference conditions (Table 11.12-16).

Increasing development on the landscape has also resulted in marginal changes to the number and distance between similar habitat patches in the RSA during the spring to autumn period. For a particular habitat, development of previous and existing projects decreased the number of habitat patches on the landscape from 0 to 0.1% relative to reference conditions (Table 11.12-16). Habitat-specific changes in the mean distance to nearest neighbour were estimated to be less than 0.1%.

Similarly, application of the Project and other reasonably foreseeble projects changed the number and distance between patches on the landscape by less than 0.5%. The increase in mean distance to nearest neighbour is 0.1 m for heath tundra, tussock-hummock, and sedge wetland habitats. The exception was for the future project case, which increased the number of esker patches by 1.4% and decreased the distance between eskers by 2% (Table 11.12-16).

Table 11.12-16 Change (%) in Area and Configuration of Habitat Types from Development within the Regional Study Area during Baseline, Application, and Future Conditions in the Spring to Autumn

Habitat	Area (ha)	% Change to			Number of Patches	% Change to			Mean Nearest Neighbour Distance (m)	% Change to		
	Reference	2010 Baseline	Application	Future	Reference	2010 Baseline	Application	Future	Reference	2010 Baseline	Application	Future
Esker Complex	624	0.00	0.00	-0.02	145	0.00	0.00	1.38	769	0.00	0.00	-2.02
Spruce Forest	32,224	-0.08	-0.15	-0.07	96659	-0.08	-0.18	0.01	78	0.01	0.04	0.02
Birch Seep	27,670	-0.10	-0.11	-0.09	63001	-0.08	-0.13	0.02	88	0.03	0.03	0.01
Peat Bog	48,410	-0.10	-0.20	-0.08	84575	-0.06	-0.10	0.08	76	-0.01	0.03	-0.03
Tussock Hummock	51,708	-0.11	-0.21	-0.07	99588	-0.08	-0.15	0.04	73	0.01	0.06	0.00
Heath Bedrock	38,657	-0.09	-0.11	-0.08	55211	-0.08	-0.11	0.07	85	0.01	0.01	-0.04
Heath Tundra	24,419	-0.02	-0.29	-0.12	30635	-0.04	-0.08	0.08	122	-0.02	0.05	-0.05
Heath Boulder	44,559	-0.11	-0.07	-0.06	81460	-0.09	-0.09	0.03	78	0.01	0.00	-0.01
Boulder Assoc.	18,930	-0.09	-0.07	-0.06	62187	-0.09	-0.09	0.00	99	0.03	-0.01	0.01
Bedrock Assoc.	24,679	-0.08	-0.02	-0.05	59630	-0.08	-0.07	0.03	94	0.00	-0.03	-0.02
Tall Shrub	31,334	-0.08	-0.14	-0.08	83741	-0.09	-0.17	0.04	79	0.03	0.02	-0.01
Sedge Wetland	56,197	-0.11	-0.24	-0.06	53616	-0.06	-0.21	0.12	84	0.02	0.09	-0.04
Shallow Water	37,151	-0.10	-0.50	-0.06	19091	-0.03	-0.32	0.20	115	-0.01	0.29	-0.15
Deep Water	96,981	-0.13	-0.46	-0.02	3566	0.06	-0.36	0.23	258	0.02	0.01	-0.36

Note: % Change was measured as the relative incremental change from one time period to the next (e.g., reference [no to little development] to 2010 baseline, 2010 baseline to application, and application to future).

ha = hectares; m = metres.

11.12.4.2 Habitat Quality, Behaviour, and Movement

11.12.4.2.1 Methods

In addition to direct habitat effects, indirect changes to habitat quality from the Project have the potential to affect the population size and distribution of upland breeding birds in the RSA. Most wildlife species are likely to exhibit some degree of sensitivity to human disturbance, such as noise, lights, and the presence of human activity. Sensory disturbance can cause indirect changes to habitat suitability, which can affect the movement and behaviour of individuals. To estimate the change in habitat quality associated with the Project and other developments, habitat suitability (HS) modelling methods were applied to the RSA. Habitat suitability models are analytical tools for determining the relative potential of an area to provide quality habitat to support wildlife species.

One of the objectives of the approach was to highlight differences between direct and indirect changes from the Project and other developments on the quantity of suitable habitat, and subsequent effects on upland bird abundance. The HS model for upland breeding birds was based on observed densities per community type and not necessarily on a synthesis of the literature on key life requisites (e.g., food, nesting habitat). Because this group represents a diverse array of species with a range of habitat requirements, the proposed method used a less complex approximation of the effect from the Project and other developments on upland breeding bird habitat suitability and abundance.

During baseline studies, 500 m x 500 m plots were surveyed for upland breeding birds in upland and wetland vegetation communities (Section 11.12.2.3.1). The proportion of habitat types associated with the surveyed upland and wetland vegetation communities were deteremined from the broad ecosystem ELC (25 m raster cell size) for the RSA (Table 11.12-17). Upland plots were comprised of 61% upland habitat types (e.g., heath tundra, heath tundra-boulder, tall shrub, and spruce forest) and 36% wetland habitat types (e.g., sedge wetland, tussock-hummock, birch seep, and peat bog). In contrast, wetland plots contained 45% wetland habitat types and 52% upland habitat types (Table 11.12-17).

Table 11.12-17 Proportion of Habitat Types Associated with Upland and Wetland Vegetation Communities Surveyed for Upland Breeding Birds

Habitat Type (Community Type)	Upland Community (%)	Wetland Community (%)	Regional Study Area	
			Area (ha)	Percent (%)
Sedge wetland (WC)	4.4	8.6	56,198	9.9
Tussock-hummock (WC)	14.8	17.6	51,646	9.1
Birch seep riparian (WC)	5.8	6.4	27,618	4.8
Peat bog (WC)	11.3	12.2	48,334	8.5
Heath tundra (UC)	10.8	17.7	24,354	4.3
Heath boulder (UC)	11.7	6.2	44,502	7.8
Heath bedrock (UC)	15.2	13.2	38,570	6.8
Tall shrub (UC)	6.6	2.2	31,324	5.5
Spruce forest (UC)	3.9	6.1	32,360	5.7
Bedrock association (UC)	9.5	2.4	24,678	4.3
Boulder association (UC)	0.0	0.0	18,929	3.3
Esker complex (UC)	0.1	0.0	621	0.1
Deep water	0.0	0.0	96,880	17.0
Shallow water	1.5	2.1	37,128	6.5
Unclassified	1.0	1.0	35,401	6.2
Total			**569,678**	**100**

Note: Some numbers are rounded to the nearest 10th decimal place for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

% = percent; WC = wetland community type; UC = upland community type. Deep water, shallow water, and unclassified habitat were excluded from the analysis.

Effects from the Project and other developments in the RSA on upland breeding birds were estimated using relative abundance (density) data from baseline studies and a disturbance modifier response curve with a zone of influence (ZOI) of 1,000 m. All calculations were completed using raster file types within a GIS platform. For the reference case, regional abundance estimates for upland breeding birds were calculated by multiplying upland and wetland baseline density estimates by the area of upland and wetland vegetation communities within the RSA (Table 11.12-18). The areas for upland and wetland vegetation communities were determined by summing the areas of habitat types associated with each vegetation community (Table 11.12-17). Each 25 x 25 m raster cell in the RSA that represented a habitat type linked to a wetland or upland vegetation community was assigned a density value equal to the vegetation community.

Table 11.12-18 Relative Abundance (Mean ± 1SE) of Upland Breeding Birds in Wetland and Upland Vegetation Communities

Vegetation Community	Number of Plots	Relative Abundance (Birds / 0.25 km^2)	Area in RSA (km^2)	Estimated Number of Birds in RSA
Wetland	16	81.7 ± 7.5	1,838	600,646
Upland	14	56.9 ± 5.3	2,153	490,109
Total				**1,090,755**

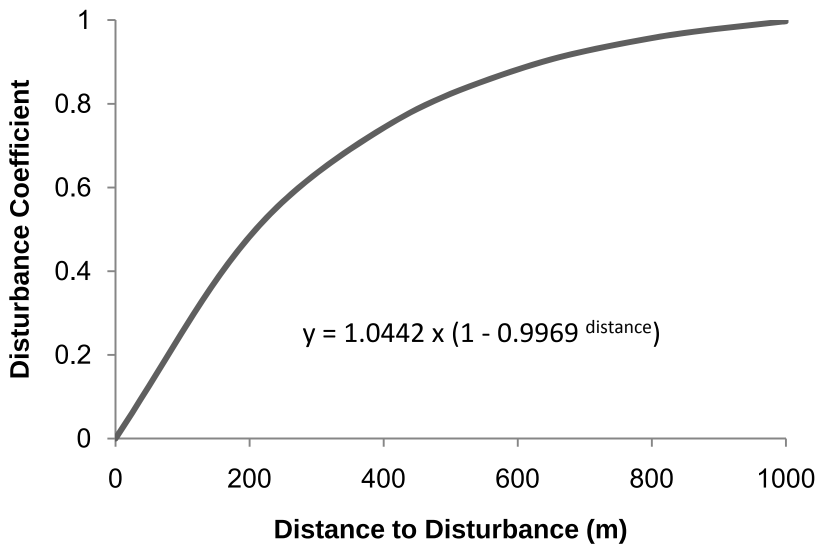
SE = standard error; ± = plus or minus; km^2 = square kilometre; RSA = Regional Study Area.

Estimated number = relative abundance (number of birds / 0.25) x area in RSA.

The ZOI that was predicted for upland breeding birds was based on published literature (Male and Nol 2005; Smith et al. 2005; Bayne et al. 2008) and a previous environmental assessment in Nunavut (Miramar 2005). For example, studies at the Ekati Diamond Mine found limited effects within 1 km on the upland bird community, and no measurable effect on the reproductive success of Lapland longspurs (Male and Nol 2005; Smith et al. 2005). Bayne et al. (2008) detected changes in abundance within 300 m of a gas compressor station (75 to 90 dBA) for about 33% of the boreal songbirds monitored.

For all development scenarios, the quality of habitats (i.e., raster cell bird density values) associated with upland and wetland vegetation communities (Table 11.12-17) within the footprints for previous and existing exploration sites and the Project was reduced to zero (direct effects). Density was reduced by 75% for habitats located directly under the Taltson transmission line as the project is not expected to completely alter the physical nature of habitat. Bird density values of raster cells outside the footprint were then reduced as a function of distance from active developments using a sensory disturbance modifier curve (i.e., indirect effects) (Figure 11.12-10). For example, at 100 m from an active development, the baseline value for bird density was multiplied by a disturbance modifier equal to about 0.20, which reduced the density of birds by 80%. At a distance of approximately 800 m from a development, there is a correspondent 5% decrease in density.

Figure 11.12-10 Sensory Disturbance Curve and Zone of Influence for the Assessment of Breeding Birds in the Regional Study Area



Next, the adjusted densities were multiplied by the habitat area within the zone of influence. Abundances were then summed by habitat type within the footprint and across the zone of influence to estimate the reduction in bird abundance caused by direct and indirect effects from the Project and other developments. Effects were expressed as the absolute and relative differences in upland bird abundance between the 2010 baseline and reference case, between the application and 2010 baseline case, and between the future and application case. A coefficient of variation (CV) of 30% was applied to the resulting effect size values to approximate the uncertainty in modeled (sensory disturbance-adjusted) density estimates.

Although the indirect effects from dust deposition and sensory disturbance are included in the HSI modelling, the potential effects on muskoxen from each stressor are also assessed separately. Accumulation of dust (i.e., TSP deposition) produced from the Project may result in a local indirect change on the quality of habitat available within the LSA. Air quality modelling was completed to predict the spatial extent of dust deposition from the Project. Air quality modeling was completed for the baseline case, the construction case, and the application case. The assessment of the application case is anticipated to capture the maximum effects resulting from the Project.

Sources of dust deposition modelled in the application case include blasting activities, haul roads, the processing plant, activities at the mine pits and other ancillary facilities (e.g., mine rock piles, Coarse PK Pile, and Fine PKC Facility).

Assumptions incorporated into the model are expected to contribute to conservative estimates of deposition near the Project emission sources (Section 11.4).

Mining activities and associated infrastructure generate noise that may influence the movement and behaviour of upland breeding birds. Therefore, a noise assessment was completed to identify the sound emissions associated with the Project activities and the potential effects on birds. The focus of the noise assessment is on determining changes to the existing ambient noise levels due to Project operation, and comparing the results with noise regulations and guidelines from North American jurisdictions (Section 7; Appendix 7.II). Because there are no noise level guidelines for wildlife, human noise level guidelines were applied to predicting effects on birds. The evaluation of the noise effects focused on evaluating the noise levels associated with the fully developed operations. Model scenarios were established to calculate normal Project operations that could potentially affect noise levels (e.g., blasting, crusher, mill, workshop, power plant, and auxiliary equipment).

11.12.4.2.2 Results

Direct loss of habitat affected wetland habitats more than upland habitats (Table 11.12-19). Direct habitat loss decreased the amount of wetland bird abundance by 0.1% from reference to 2010 baseline conditions (Table 11.12-19). The addition of the Project to the landscape decreased the amount of wetland bird abundance by an additional 0.2%. Future developments are expected to decrease wetland bird abundance by an additional 0.1%. The total decrease in wetland bird abundance that is expected from previous and existing developments, the Project, and future developments is 0.4%.

Previous and existing developments have decreased the amount of upland bird habitat (and associated abundance) on the landscape by 0.1% relative to reference conditions (Table 11.12-19). The Project is expected to decrease the amount of upland habitat by an additional 0.2% and future developments are expected to decrease bird abundance by an additional 0.1%. The largest change in bird abundance from direct effects, according to the 30% CV, is expected for wetland habitat with the application of the Project, and cumulative effects from the Project and other developments (Table 11.12-19).

Indirect habitat effects from the Project had a greater influence on upland breeding bird abundance than direct habitat loss (Table 11.12-19). Indirect habitat effects from previous and existing developments have decreased the amount of habitat-specific wetland and upland bird abundance by 0.12% and 0.09%, respectively, relative to reference conditions (Table 11.12-19). The increase in sensory disturbance from the Project is expected to decrease bird abundance in wetland habitats by 0.26% relative to 2010 baseline conditions. Similarly, disturbance from the Project to upland habitat is predicted to decrease bird abundance by 0.25% relative to 2010 baseline conditions.

Indirect effects from future developments are expected to decrease habitat-specific wetland and upland bird abundance by an additional 1.33 and 1.30%, respectively, relative to application conditions. Indirect effects from previous and existing developments, the Project, and future developments are expected to decrease the amount of wetland and upland bird abundance by 1.70 and 1.65%, respectively, relative to reference conditions (Table 11.12-19). The largest cumulative change in bird abundance from indirect effects (using CV = 30%) is expected for wetland habitat (Table 11.12-19).

The combined direct and indirect effects from previous and existing developments, the Project, and future developments are expected to decrease habitat-specific wetland and upland bird abundance by 2.1% and 1.9%, respectively, relative to reference conditions. The total (i.e., based on the regional population) combined direct and indirect effects from previous and existing developments, the Project, and future developments are expected to decrease bird abundance between 1.4% and 2.6% (30% CV) relative to reference conditions.

Table 11.12-19 Relative Changes in the Abundance of Upland Breeding Birds in the Regional Study Area from Reference to Reasonably Foreseeable Projects

Effects / Habitat Type	Bird Abundance (Reference Conditions)	% Change Reference to 2010 Baseline	% Change 2010 Baseline to Application	% Change Application to Future	Cumulative % Change Reference to Future
Direct Effects					
Wetland	600646	-0.10 (0.03)	-0.24 (0.07)	-0.06 (0.02)	-0.40 (0.12)
Upland	490109	-0.08 (0.02)	-0.15 (0.05)	-0.06 (0.02)	-0.28 (0.08)
Total	**1090755**	**-0.09 (0.03)**	**-0.20 (0.06)**	**-0.06 (0.02)**	**-0.35 (0.11)**
Indirect Effects					
Wetland	600646	-0.12 (0.04)	-0.26 (0.08)	-1.33 (0.40)	-1.70 (0.51)
Upland	490109	-0.09 (0.03)	-0.25 (0.08)	-1.30 (0.39)	-1.65 (0.50)
Total	**1090755**	**-0.10 (0.03)**	**-0.26 (0.08)**	**-1.32 (0.40)**	**-1.68 (0.50)**

Note: Values in parentheses represent 30% coefficient of variation.
Direct effects are due to physical disturbance from development footprints while indirect effects are related to sensory disturbance (i.e., zone of influence).
Reference conditions = baseline conditions prior to any development in the study area.
2010 Baseline Case = previous and existing developments in the regional study area up to 2010.
Application Case = Gahcho Kué Project plus 2010 baseline conditions.
Future = Taltson Hydroelectric Expansion Project plus application case.

ha = hectares; % = percent.

Construction and operation of the Project may cause an accumulation of dust within the study area. Therefore air quality modelling was completed to estimate the extent of deposition. The results of the air quality modelling predicted the maximum annual dust deposition resulting from the Project is 6,292 kg/ha/y within the Project development area boundary (i.e., Project footprint) and 5,520 kg/ha/y outside of the Project development area boundary. The maximum deposition that occurs is mostly associated with the mine pits and haul roads. The maximum predicted dust deposition rate is expected within 100 m of the Project footprint.

The most deleterious effects of dust are generally confined to the immediate area adjacent to the dust source (e.g., a haul road) (Everett 1980; Walker and Everett 1987). Walker and Everett (1987) and Everett (1980) reported that effects were confined to a 50-m buffer on either side of a road. Meininger and Spatt (1988) found that the majority of effects occurred within 5 to 50 m of a road, with less obvious effects observed between 50 and 500 m from the road.

Noise will be generated from mobile and stationary mining equipment, blasting, and aircraft at the Project. The recommended maximum value for the nighttime noise level for undeveloped areas is 40 (dBA). This is the average nighttime (23:00 to 07:00) sound level L_{eq} in dBA, that includes both project related noises and the ambient sound level (existing sound levels without project related noises). The typical nighttime ambient sound level in rural Alberta is 35 dBA Leq[1] with higher winds, precipitation, and thunder being the principal sources of increase above this value (Section 7; Appendix 7.II). During daytime hours these levels can be higher, due to higher levels of human activity and associated tolerance for noise levels. The projected noise levels from the various Project activities are compared with benchmarks in Table 11.12-20. The results show that while noise will be generated by the Project, the projected levels at identified noise receptors are below the benchmarks (with the exception of the 40 dBA limit at 1.5 km from the Project due to mine operations).

[1] ERCB 2007, Directive 038, Noise Control

Table 11.12-20 Summary of Noise Effects from the Project

Receptor	Mine Operations[c] L_{eq} (dBA)		Winter Road L_{eq} (dBA)		Airstrip L_{max} (dBA)	
	Prediction	Benchmarks	Prediction	Benchmarks	Prediction	Noise Event Benchmarks
Accommodations Complex (west side)	69	55[a]	35	55[a]	68	70[a]
Accommodations Complex (east side)	58	55[a]	35	55[a]	69	70[a]
East Arm National Park Boundary Location[d]	38	40[b]	35	40[b]	90	-
1.5 km Boundary Location[d]	44	40[b]	35	40[b]	92	-

[a] World Health Organization 1999

[b] ERCB 2007.

[c] Highest cumulative noise levels calculated at each receptor.

[d] Location with highest projected noise level along the length of the boundary.

L_{eq} = equivalent continuous sound and noise level; dBA = A-weighted decibel; L_{max} = maximum sound and noise level;

km = kilometre; ≥ = greater than or equal to; - = not applicable.

The analysis of blasting activity indicates that the maximum distances at which the criteria for peak ground (12.5 millimetres per second [mm/s]) and airborne vibration levels (120 linear decibels [dBL]) would be met are at 596 and 730 m, respectively. A summary of the maximum distances for Project noise to attenuate to background levels are shown in Table 11.12-21. The distances indicate the area within which Project-related noises may be found to be distinguishable from the natural environment by people. When Project noise predictions diminish to levels below background, they are not expected to be distinguishable from natural noises.

Table 11.12-21 Distance for Noise Attenuation to Background Sound Levels for the Project

Background Noise Level	Mine Operations (km)	Winter Access Road (km)	Airstrip (km)
Continuous (35 dBA)	3.5 [a]	–	–
Noise Event	–	3.0 [b]	5.5

[a] Based on the distance to the nearest noise sources

[b] Based on maximum pass-by level.

n/a = not applicable; dBA = decibels; km = kilometres.

The distance for noise attenuation to background levels for core mining operations (including blasting) is 3.5 km. Few studies have focused on the effects of noise and disturbance to upland bird behaviour and movement. Behaviours most likely to be affected are nest site selection, territory selection, mate attraction, and foraging. Studies at the Ekati Diamond Mine revealed no difference in upland bird density, richness, or diversity between mine and control plots (Smith et al. 2005; BHPB 2007). This lack of change suggests that noise and human activity are not influencing nest site and territory selection.

According to Trombulak and Frissell (2000), disturbances such as roads have the potential to change the reproductive success of wildlife species. Conversely, a study by Canaday and Rivadeneyra (2001) found noise to be a disturbance to birds only over distances less than 300 m. A study of Lapland longspurs by Male and Nol (2005) showed no difference in nest success between sites with high and low levels of human noise at the Ekati Diamond Mine. According to Jalkotzy et al. (1997), many studies have found a relationship between traffic volume and bird densities adjacent to roads. For example, a 12 to 15% reduction in bird densities was observed within 500 m of roads with more than 50 cars per day (Reijnen et al. 1996). Overall, it appears as though some bird species may benefit from human disturbance (i.e., roads) while others do not (Spellerberg and Morrison 1998). The most noticeable effects are in previously undisturbed areas.

Aircraft will be used for the movement of personnel and supplies to the Project site year-round. Aircraft noise will be limited to a few minutes during take off and landing, and a maximum of two round-trip flights per day are expected during Project construction and operation. The distance for noise to reach background levels from the airstrip is 5.5 km (Table 11.12-21). However, disturbance from large aircraft is expected to be infrequent and short-term (less than five minutes) in duration.

11.12.4.3 Related Effects on People

Upland birds play an integral role in the wilderness value of an area and provide opportunities for bird watchers and naturalists. Ptarmigan provide a food source for people during winter. The Project is expected to decrease ptarmigan and other upland breeding bird abundance by 0.3% to 0.6% (based on 30% CV) relative to reference conditions. The Project and other developments are expected to decrease ptarmigan and other upland breeding bird abundance by 1.4% to 2.6% (based on 30% CV) relative to reference conditions. It is predicted that the effects from the Project and other developments on traditional and non-traditional use of upland birds will not be detectable relative to baseline values.

11.12.5 Effects on Population Size and Distribution of Water Birds

The effects analysis considers all primary pathways that result in expected changes to the population size and distribution of water birds, after implementing environmental design features and mitigation. Thus, the analysis is based on the residual effects from the Project. Residual effects to water birds are analyzed using measurement endpoints and are expressed as effects statements, including:

- effects from changes in habitat quantity and fragmentation; and
- effects from changes in habitat quality, movement, and behaviour.

The magnitude, spatial extent, and duration of changes in measurement endpoints (e.g., habitat quantlty and quality) from the Project and other developments are expected to be similar to or greater than the actual effects to the abundance and distribution of populations.

11.12.5.1 Habitat Quantity and Fragmentation

11.12.5.1.1 Methods

The incremental and cumulative direct habitat effects from the Project footprint and other previous, existing, and future developments in the RSA were analyzed through changes in the area and spatial configuration of habitat types on the landscape (i.e., landscape metrics). The change in landscape metrics from the development of the Project was determined for the spring through autumn period. Detailed methods for the habitat fragmentation analysis completed for upland breeding birds are also applicable for water birds and are found in Section 11.12.4.1.1.

11.12.5.1.2 Results

The Slave Geological Province (SGP) encompasses both the Central and Mississippi Flyways of North America. This area represents an important migration corridor between staging areas in the south (i.e., Peace Athabasca Delta and Great Slave Lake), and northern breeding grounds in the central Canadian Arctic (e.g., Victoria Island, Back River, Thelon River).

The RSA provides breeding and/or staging habitat for a variety of dabbling ducks, diving ducks, sea ducks, loons, gulls, terns, and waders (e.g., American bittern and yellow rail) comprising some 17 water bird species (Table 11.12-7). These species occupy a wide variety of habitats, but all share strong associations to aquatic habitat. Dabbling ducks and waders occupy littoral and shoreline habitat while both diving ducks and sea ducks use open-water habitat. Lakes in the region provide breeding habitat for loons, gulls, and terns. Habitat loss and fragmentation can affect both locally breeding and staging water bird populations (Allen 1952; Ramirez et al. 1993; Leafloor et al. 1996). Habitat fragmentation can lead to effects on the dispersal and movement of water bird metapopulations.

Results of the fragmentation analysis indicate that the study area is a heterogeneous landscape and is comprised of patchily distributed habitats. Approximately 68% of the Project footprint is aquatic habitat and 32% is terrestrial habitat. At the local scale, the Project footprint will alter 4.4% of the baseline LSA. Terrestrial habitat types that will be disturbed most include tussock-hummock, sedge wetland, and peat bog (all decreased by 0.4%). These habitats are some of the most abundant vegetation communities within the LSA (and RSA). Other terrestrial habitats altered by the Project footprint include heath tundra, heath tundra with bedrock or boulders, birch seep, and riparian tall shrub (all decreased by less than 0.4% relative abundance in the LSA). During construction and operation, the Project footprint will decrease the lake surface area within the LSA by 2.2%.

Important habitats for water birds include vegetation communities that tend to have a wetter moisture regime including shallow and deep water, and sedge wetlands. These habitat types make up about 36% of the RSA under reference conditions. Other important habitats include tussock-hummock, heath tundra, tall shrub, and birch seep. However, these terrestrial habitat types are considered most suitable when they occur within 100 m of water.

Relative habitat-specific decreases from reference to 2010 baseline conditions is less than 0.2% in the RSA (Table 11.12-16). The anticipated incremental loss of any habitat type from the Project relative to 2010 baseline conditions is less than or equal to 0.5% of the RSA. The cumulative disturbance to habitats on the landscape from the Project and previous, existing and potential future developments is 4.7% (Table 11.12-16).

Development of the Project is expected to directly decrease highly suitable habitat (i.e., deep water, shallow water and sedge wetland habitats) for water birds in the RSA by 1.2%, relative to 2010 baseline conditions (Table 11.12-16). The greatest reduction in highly suitable habitat is to deep water (446 ha). The cumulative direct disturbance to highly suitable habitat in the RSA from the Project and other developments is estimated to be 1,066 ha or 1.7%, relative to reference conditions (Table 11.12-16).

Increasing development on the landscape has also resulted in marginal changes to the number and distance between similar habitat patches in the RSA during the spring to autumn period. For a particular habitat, development of previous and existing projects decreased the number of habitat patches on the landscape from 0 to 0.1% relative to reference conditions (Table 11.12-16). Habitat-specific changes in the mean distance to nearest neighbour were estimated to be less than 0.1%.

Similarly, application of the Project and other reasonably foreseeble projects changed the number and distance between patches of water bird habitat on the landscape by less than 0.5% (Table 11.12-16). The increase in mean distance to nearest neighbour is about 0.1 m for heath tundra, tussock-hummock, and sedge wetland habitats, and 0.3 m for shallow water habitat.

11.12.5.2 Habitat Quality, Behaviour, and Movement

11.12.5.2.1 Methods

In addition to direct habitat effects, changes to habitat quality from the Project have the potential to affect the population size and distribution of water birds in the RSA through altered movement and behaviour of individuals. To estimate the indirect effects of the Project on water birds, a habitat suitability index (HSI) model was used to quantify habitat changes between the 2010 baseline and reference case, between the application and 2010 baseline case, and between the future and application case. Estimates of habitat requirements and suitability for water birds are provided in Table 11.12-22.

Table 11.12-22 Habitat Suitability Index Values for Water Birds for Habitats within 100 Metres of Waterbodies

Habitat Type	Habitat Suitability (Index Value; 0 – 3)
Esker complex	poor (0)
Boulder association	poor (0)
Bedrock association	poor (0)
Heath tundra	good (2)
Heath bedrock	low (1)
Heath boulder	low (1)
Birch seep	good (2)
Tall shrub	good (2)
Spruce forest	poor (0)
Peat bog	low (1)
Tussock-hummock	good (2)
Sedge wetland	high (3)
Shallow water	high (3)
Deep water	high (3)
Disturbance	poor (0)
Unclassified	poor (0)

A ZOI and associated disturbance coefficient (DC) was applied to estimate the direct and indirect effects (e.g., fugitive dust disposition, and sensory disturbance from noise and human activities) from development footprints on water birds. For all development scenarios, habitat quality within all development footprints was reduced to zero (direct effects). To estimate indirect effects, the ZOI and DC predicted for water birds were based on professional opinion and previous environmental assessments in Nunavut (Miramar 2005). The ZOI for water birds applies to all habitats within 1,000 m of all active disturbances within the RSA and reduced all habitats to low, with the exception of poor-quality habitats, which remained as poor.

The following equations were used to calculate the relative change in the amount of different quality habitats for the different conditions on the landscape.

- (2010 baseline area – reference area) / total area x 100
- (application case area – 2010 baseline area) / total area x 100
- (future case area - application case area) / total area x 100

Although the indirect effects from dust deposition and sensory disturbance are included in the HSI modelling, the potential effects on water birds from each stressor are also discussed separately. Methods used to assess the effects from dust deposition and noise on the habitat quality, movement, and behaviour of water birds are similar to upland breeding birds, and are described in Section 11.12.4.2.1.

11.12.5.2.2 Results

The total amount of suitable habitat (i.e., low, good, and high) in the RSA for water birds is roughly 27% and changes little throughout all assessment cases (Table 11.12-23). Previous and existing developments have decreased the amount of high and good quality by less than 0.5%. Similarly, the estimated incremental reduction of suitable habitat from the Project relative to 2010 baseline conditions is less than 0.5%. The cumulative decrease of high and good quality habitat for water birds from reference conditions through potential future developments in the RSA is predicted to be about 1.4%. Habitat suitability modelling for reference conditions, 2010 baseline conditions, the application case, and future case are shown in Figure 11.12-11 to Figure 11.12-14.

Table 11.12-23 Relative Changes in the Availability of Different Quality Habitats in the Regional Study Area for Water Birds from Reference to Reasonably Foreseeable Projects

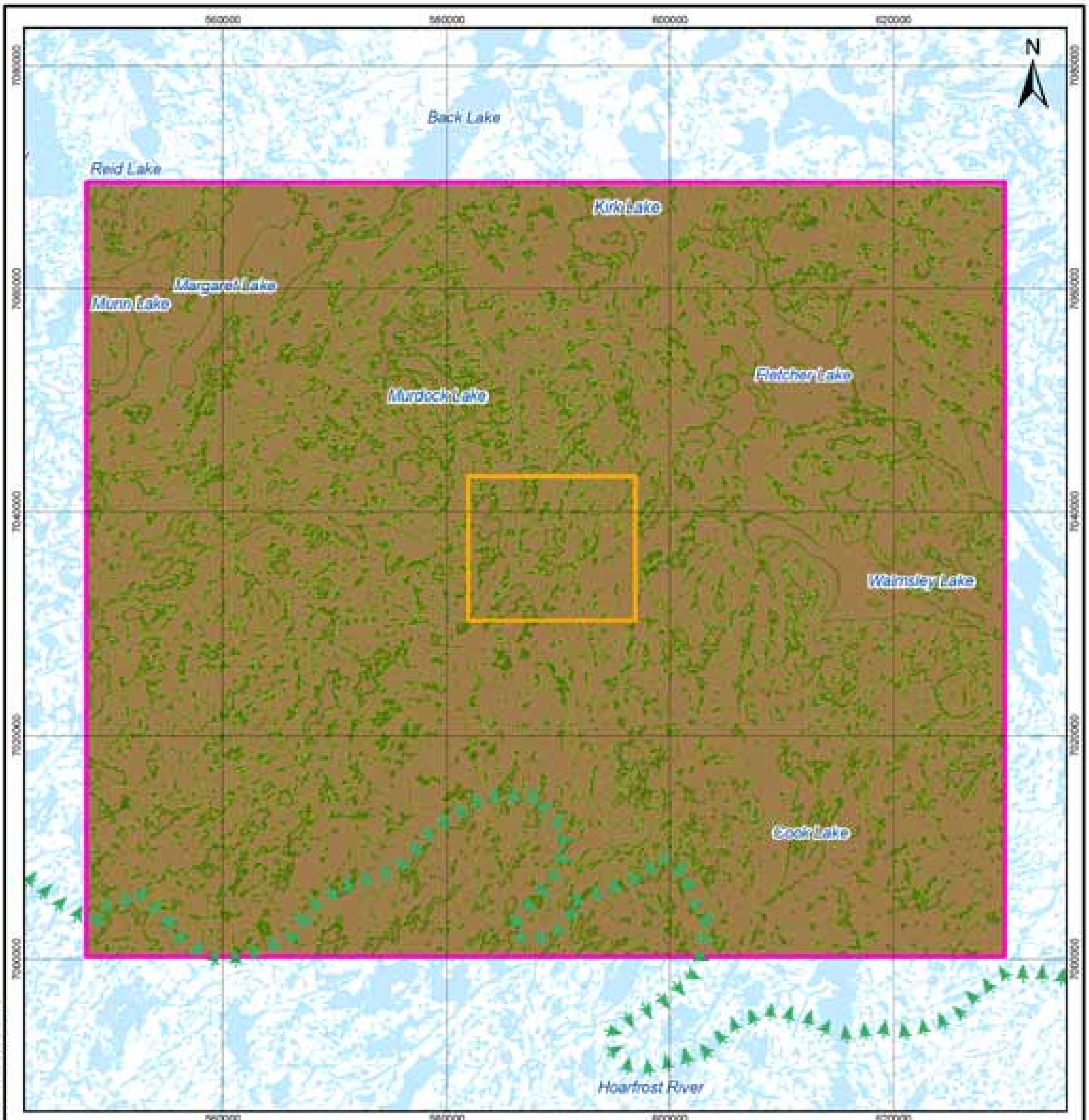
Habitat Category	Reference (ha)	% Change Reference to 2010 Baseline	% Change 2010 to Application	% Change Application to Future	Cumulative % Change Reference to Future
High	108,287	-0.11	-0.17	-0.80	-1.08
Good	28,109	-0.03	-0.05	-0.26	-0.34
Low	14,755	0.12	0.11	1.04	1.27
Poor	417,393	0.03	0.12	0.02	0.16
Total	**568,544**				

Note: Percent change per habitat category was calculated as area lost or gained divided by the area of the habitat category in the previous time period. Cumulative values may not exactly sum due to rounding.
Reference conditions = baseline conditions prior to development.
2010 Baseline Case = previous and existing developments up to 2010.
Application Case = Gahcho Kué Project plus 2010 baseline conditions.
Future = Taltson Hydroelectric Expansion Project plus application case.

ha = hectares; % = percent.

Construction and operation of the Project may cause an accumulation of dust within the study area. Therefore air quality modelling was completed to estimate the extent of deposition. The results of the air quality modelling predicted the maximum annual dust deposition resulting from the Project is 6,292 kg/ha/y within the Project development area boundary (i.e., Project footprint) and 5,520 kg/ha/y outside of the Project development area boundary. The maximum deposition that occurs is mostly associated with the mine pits and haul roads. The maximum predicted dust deposition rate is expected within 100 m of the Project footprint.

The most deleterious effects of dust are generally confined to the immediate area adjacent to the dust source (e.g., a haul road) (Everett 1980; Walker and Everett 1987). Walker and Everett (1987) and Everett (1980) reported that effects were confined to a 50-m buffer on either side of a road. Meininger and Spatt (1988) found that the majority of effects occurred within 5 to 50 m of a road, with less obvious effects observed between 50 and 500 m from the road.



LEGEND

Watercourse
Waterbody
Treeline

Habitat Suitability Index

High
Good
Low
Poor
Local Study Area
Regional Study Area

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000

GAHCHO KUÉ PROJECT

Habitat Suitability for Water Birds: Reference Conditions

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:500,000

10 5 0 10

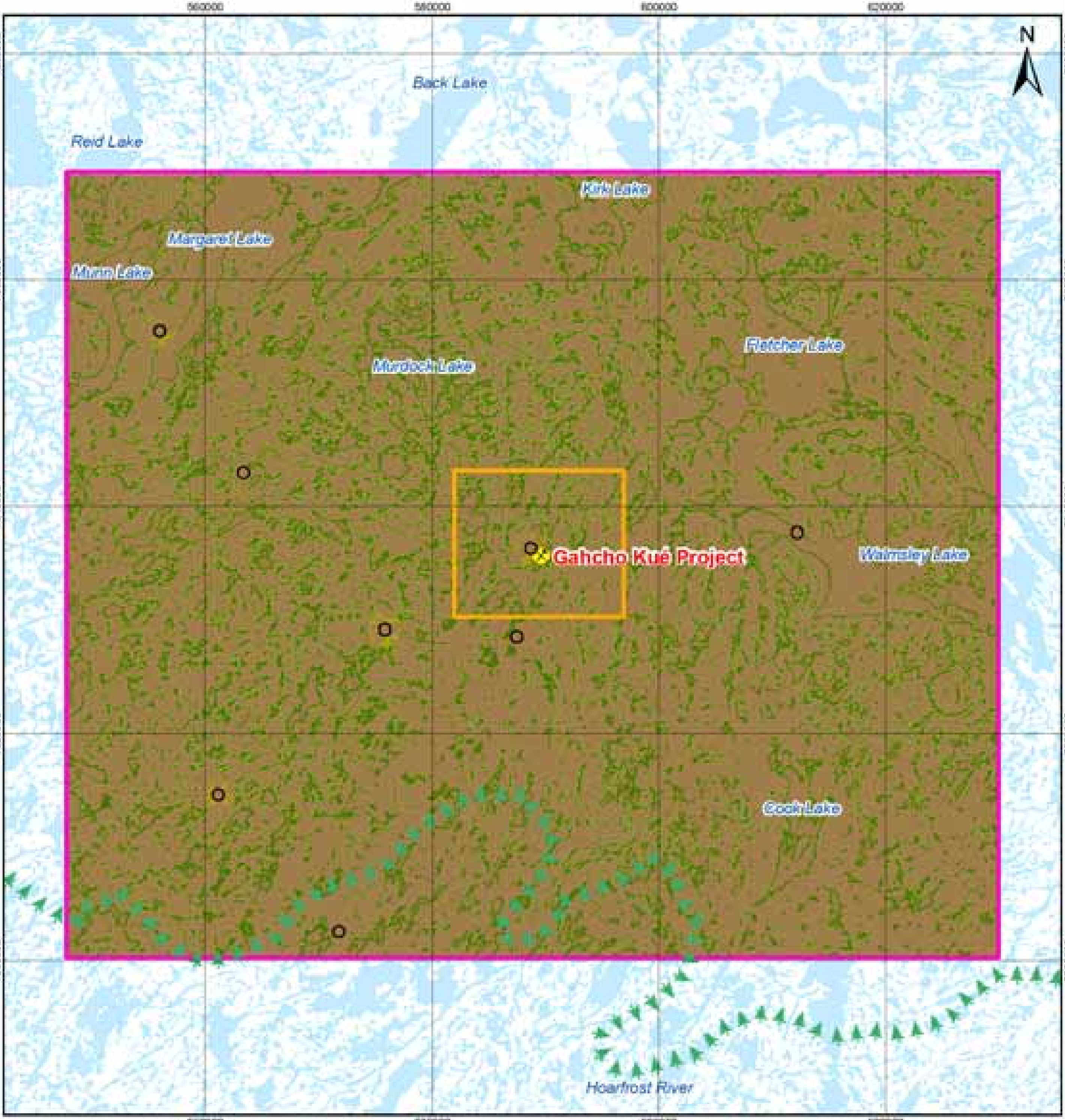
Kilometres

DE BEERS CANADA

FILE No.	DATE
SON-11-12-014-GIS	October 25, 2010

JOB NO.	REVISION NO.		
09-1365-1004	3		
OFFICE	DRAWN	CHECK	
GOLD-SAS	ANK	JV	

Figure 11.12-11



LEGEND

- Gahcho Kué Project
- Watercourse
- Waterbody
- Treeline
- Development Footprint

Habitat Suitability Index

- High
- Good
- Low
- Poor
- Local Study Area
- Regional Study Area

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000

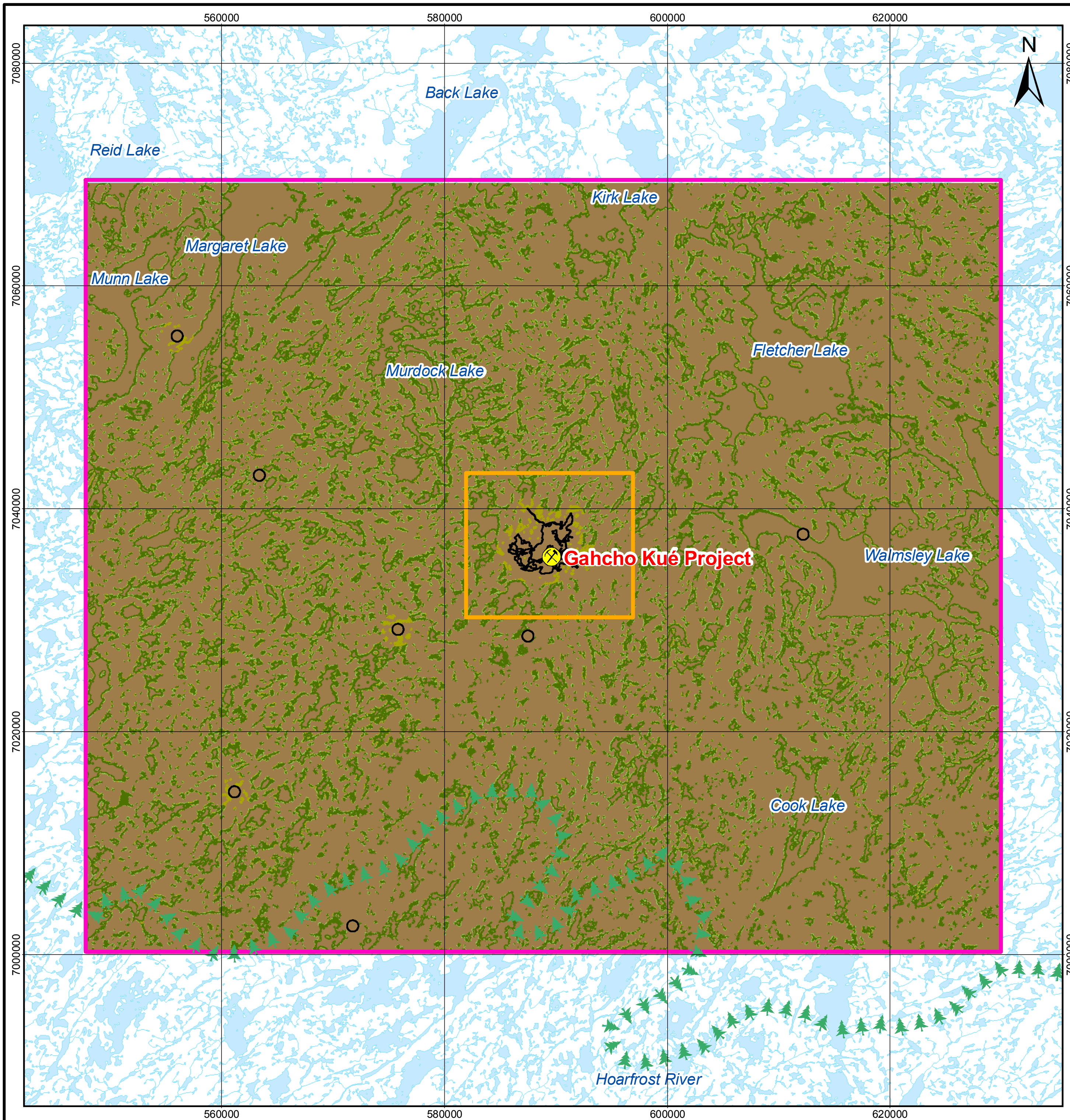
GAHCHO KUÉ PROJECT

Habitat Suitability for Water Birds: 2010 Baseline Conditions

PROJECTION: UTM Zone 12	DATUM: NAD83
Scale: 1:500,000 (10 5 0 10 Kilometres)	
FILE No: SON-11-12-015-GIS	DATE: October 25, 2010
JOB NO: 09-1365-1004	REVISION NO: 4
OFFICE: GOLD-SAS	DRAWN: ANK / CHECK: JV

DE BEERS CANADA

Figure 11.12-12



LEGEND

- Gahcho Kué Project
- Watercourse
- Waterbody
- Treeline
- Development Footprint

Habitat Suitability Index

- High
- Good
- Low
- Poor
- Local Study Area
- Regional Study Area

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000

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GAHCHO KUÉ PROJECT

Habitat Suitability for Water Birds: Application Case

PROJECTION: UTM Zone 12	DATUM: NAD83	DE BEERS CANADA
Scale: 1:500,000 (10 5 0 10 Kilometres)		
FILE No: SON-11-12-016-GIS		DATE: October 25, 2010
JOB NO: 09-1365-1004	REVISION NO: 4	Figure 11.12-13
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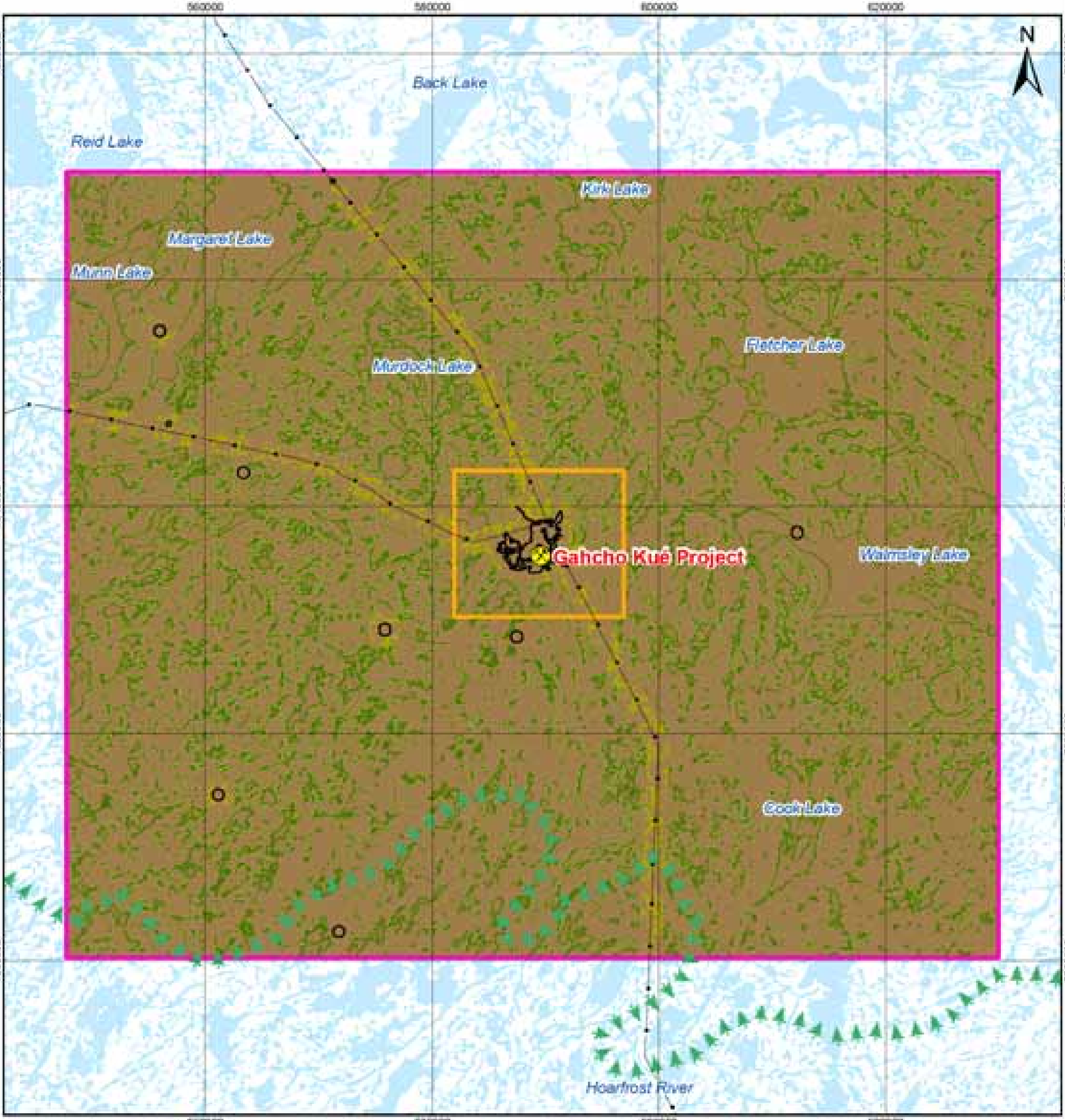


LEGEND

- Gahcho Kué Project
- Watercourse
- Waterbody
- Treeline
- Proposed Taltson Transmission Line
- Development Footprint

Habitat Suitability Index

- High
- Good
- Low
- Poor
- Local Study Area
- Regional Study Area

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000

GAHCHO KUÉ PROJECT

Habitat Suitability for Water Birds: Future Case

PROJECTION: UTM Zone 12	DATUM: NAD83
Scale: 1:500,000 (0 5 10 Kilometres)	DE BEERS CANADA
FILE No: SON-11-12-020-GIS	DATE: November 4, 2010
JOB NO: 09-1365-1004	REVISION NO: 4
OFFICE: GOLD-SAS	DRAWN: ANK / CHECK: JV

Figure 11.12-14

Noise will be generated from mobile and stationary mining equipment, blasting, and aircraft at the Project. The results show that while noise will be generated by the Project, the expected levels at identified noise receptors are below relevant criteria established for remote areas (with the exception of the 40 dBA limit at 1.5 km from the Project due to mine operations) (Table 11.12-20). The analysis of blasting activity indicates that the maximum distances at which the criteria for peak ground (12.5 mm/s) and airborne vibration levels (120 dBL) would be met are at 596 and 730 m, respectively.

The distance for noise attenuation to background levels for mine operations (including blasting) is 3.5 km. Few studies have focused on the effects of noise and disturbance to water bird behaviour and movement. However some studies (Korschgren et al. 1985; Ward and Stein 1989; Dahlgren and Korschgren 1992) have found that noise and motion disturbances originating from man-made sources can negatively affect water bird behaviour. Disturbance effects on water birds may include displacement, nest abandonment, reduced nest success, or reduced foraging efficiency (Craven and Ellis 1982; Hockin et al. 1992; Korschgren and Dahlgren 1992; Thomas et al. 2002). The concern regarding noise and birds includes noises that startle or disturb nesting birds and noises that mask mating calls, affecting the ability of males to attract a mate.

Although noise and sensory disturbance can alter the movement and behaviour of wildlife, particularly hunted species like water birds (Bommer and Bruce 1996), the specific effects of Project-related sensory disturbance on many species of water birds are unknown. A relatively low density of water birds is expected near the site. Analysis of information collected at the Ekati Diamond Mine suggested that the level of mining activities had not negatively influenced the presence of loons adjacent to the mine site (BHPB 2003), although loons are relatively sensitive to human disturbance (Ehrlich et al. 1988). No data are available for comparing the reaction of loons with other water birds species to mine-related activities. Minimum distance recommendations to reduce the effects to water bird behaviour from man-made noise are for 200 to 300 m for traffic disturbance (Fruzinski 1977; Mooij 1982; Madsen 1985a, b) and 3 to 4 km for aircraft disturbances (Davis and Wisely 1974; Berger 1977).

Aircraft will be used for the movement of personnel and supplies to the Project site year-round. Aircraft noise will be limited to a few minutes during take off and landing, and a maximum of two round-trip flights per day are expected during Project construction and operation. The distance for noise to reach background levels from the airstrip is 5.5 km (Table 11.12-21). However, disturbance from large aircraft is expected to be infrequent and short-term (less than five minutes) in duration.

11.12.5.3 Related Effects on People

Traditional knowledge holders from the LKDFN identified 35 bird species that are known to inhabit the RSA, 18 of which are edible (LKDFN 2005, internet site). Geese, ducks, and loons are important to communities. According to traditional knowledge, geese and ducks are a favourite food source for communities, and the feathers are used for making blankets and pillows (LKDFN 2001).

The spring migration of water birds to the NWT begins in early May, and in some years, at the end of April (LKDFN 2003, internet site). Throughout generations, people have depended upon ducks and geese to use the same migration routes to reach their staging and nesting areas in the NWT. People travel to these water bird staging areas in the spring to harvest the migrating birds (LKDFN 2002), and in the summer, they travel to the barren-lands where birds migrate to lay eggs (NSMA 1999). Egg collection during the breeding season is the primary use of water bird resources by the LKDFN.

Baseline data from the RSA, the Snap Lake Mine, and Diavik Diamond Mine suggested that water bird breeding (nesting) densities in the barren lands are low, although these areas do provide staging and nesting areas for migrating birds. Analysis indicated that the cumulative direct loss of quality water bird habitats from the Project and other developments in the RSA is about 1.7%, relative to reference conditions. The Project and other developments are expected to indirectly decrease high and good quality water bird habitat by 1.4% relative to reference conditions. It is predicted that the effects from the Project and other developments on traditional and non-traditional use of upland birds will not be detectable relative to baseline values.

11.12.6 Effects on Population Size and Distribution of Raptors

The effects analysis considers all primary pathways that result in expected changes to the population size and distribution of raptors, after implementing environmental design features. Thus, the analysis is based on the residual effects from the Project. Residual effects to raptors are analyzed using measurement endpoints and are expressed as effects statements, including:

- effects from changes in habitat quantity and fragmentation; and
- effects from changes in habitat quality, movement, and behaviour.

The magnitude, spatial extent, and duration of changes in measurement endpoints (e.g., habitat quantlty and quality) from the Project and other developments are expected to be similar to or greater than the actual effects to the abundance and distribution of populations.

11.12.6.1 Habitat Quantity and Fragmentation

11.12.6.1.1 Methods

The incremental and cumulative direct habitat effects on raptors from the Project footprint and other previous, existing, and future developments in the RSA were analyzed through changes in the area and spatial configuration of habitat types on the landscape (i.e., landscape metrics). The change in landscape metrics from the development of the Project was determined for the spring through autumn period. Detailed methods for the habitat fragmentation analysis completed for upland breeding birds are also applicable for raptors and are found in Section 11.12.5.1.1.

11.12.6.1.2 Results

Approximately 68% of the Project footprint is aquatic habitat and 32% is terrestrial habitat. At the local scale, the Project footprint will alter 4.4% of the baseline LSA. Terrestrial habitat types that will be disturbed most include tussock-hummock, sedge wetland, and peat bog (all decreased by 0.4%). These habitats are some of the most abundant vegetation communities within the LSA (and RSA). Other terrestrial habitats altered by the Project footprint include heath tundra, heath tundra with bedrock or boulders, birch seep, and riparian tall shrub (all decreased by less than 0.4% relative abundance in the LSA). No esker is expected to be altered. During construction and operation, the Project footprint will decrease the lake surface area within the LSA by 2.2%.

The physical footprint of the Project includes all land displaced by on-site roads, buildings, mine pits, and other structures. The development of the Project will lead to a reduction in the quantity of habitat and fragmentation of habitat for raptors. Raptors tend to have home ranges that encompass a variety of habitat types. This makes it difficult to determine habitat use from raptor surveys. However, nest locations are likely the more critical information regarding raptor distribution and abundance in the RSA. Because cliffs, rock outcrops, and large trees are limited in the RSA, the RSA does not have an abundance of suitable nesting sites for most raptor species.

The nearest confirmed nest site is 16 km from the aniticipated Project footprint. If nest sites are occupied near the Project during construction and operation, then appropriate mitigation and monitoring will be implemented (see Wildlife Effects Mitigation and Management Plan [Appendix 7.I, Section 7]). For example, ravens will be deterred from nesting on mine facilities. If other raptors (e.g., peregrine falcon) are detected nesting within the Project site, then mitigation will be implemented to limit disturbance and the site will be monitored for nest success.

The relative habitat-specific decrease from reference to 2010 baseline conditions is less than 0.2% in the RSA (Table 11.12-16). The anticipated incremental loss of any habitat type from the Project relative to 2010 baseline conditions is less than or equal to 0.5% of the RSA. The cumulative disturbance to habitats on the landscape from the Project and previous, existing and potential future developments is 4.7% (Table 11.12-16).

Increasing development on the landscape has also resulted in marginal changes to the number and distance between similar habitat patches in the RSA during the spring to autumn period. For a particular habitat, development of previous and existing projects decreased the number of habitat patches on the landscape from 0 to 0.1% relative to reference conditions (Table 11.12-16). Habitat-specific changes in the mean distance to nearest neighbour were estimated to be less than 0.1%.

Similarly, application of the Project and other reasonably foreseeble projects changed the number and distance between patches of water bird habitat on the landscape by less than 0.5% (Table 11.12-16). The increase in mean distance to nearest neighbour is about 0.1 m for heath tundra, tussock-hummock, and sedge wetland habitats, and 0.3 m for shallow water habitat.

11.12.6.2 Habitat Quality, Behaviour, and Movement

11.12.6.2.1 Methods

In addition to direct habitat effects, changes to habitat quality from the Project have the potential to affect the population size and distribution of raptors in the RSA through altered movement and behaviour of individuals. A resource selection function (RSF) model (see Manly et al. 2002) was developed to predict habitat quality for raptor nests in the RSA. The model was built using spatial data on confirmed nest locations (occupied and unoccupied; N = 25) collected in summer 2010 and then added to a spatial database in ESRI® ArcMapTM 9.3. The study design included 250 available locations (Manly et al. 2002) that were randomly distributed throughout the RSA and created using Hawth's Tools (Beyer 2004, internet site). Available locations were positioned so that they were 2 km from one another.

Next, the nest locations were combined with environmental data. Canadian digital elevation data and a supervised ELC using broad ecosystem units (Section 11.7) were used to describe the suitability of habitat at the local scale, as well as at the regional scale. The selection of environmental parameters was based on previously completed assessments in the NWT and Nunavut, published literature (e.g., Court et al. 1988; Penner and Associates Ltd. 1998; DDMI 1998; Miramar 2005), as well as a preliminary examination of the field data. At the local scale, data were collected on slope (degrees) and elevation around the nest site. At the regional scale, data were collected on the proportion of heath boulder, spruce forest, and deep water within a 1 km radius of each nest site. It was predicted that the heath boulder and spruce forest variables were correlates of landscapes with abundant prey and hunting opportunities, and that slope, elevation, and deep water described the ruggedness of the terrain and the location of suitable cliffs for nests. Upon creation of environmental raster layers (with 25 x 25 m pixel resolutions), the used and available locations were intersected with each raster layer.

Following Manly et al. (2002), a fixed-effects exponential RSF was developed, with coefficients ($\hat{\beta}_n$) estimated from logistic regression (Table 11.12-24). The predictive performance of the top model was evaluated using five-fold cross validation (Boyce et al. 2002). For each data fold, the withheld set was assessed against the model predictions of the training data set using Spearman correlation tests between ordinal ranks of predictive RSF values (five habitat bins or categories) and the frequency of independent, withheld (i.e., validation) observations in the same bin rank standardized for sample size (Boyce et al. 2002). Validation methods indicated that the model was accurate and precise. There were successively more validation observations in higher value habitat bins. The Spearman r-value was positive (r_s=0.9) and significant at an alpha level of 0.05.

Table 11.12-24 Coefficients and 95% Confidence Intervals (CI) from the proposed Resource Selection Function Model for Raptor Nests in the Regional Study Area

Variable	Coefficient	Lower 95% CI	Upper 95% CI
Slope (degrees)	0.4707	0.3048	0.6367
Elevation (m)	0.05677	0.01201	0.1015
Deep water within 1 km (%)	3.967	-0.855	8.789
Spruce forest within 1 km (%)	20.66	3.74	37.59
Heath boulder within 1 km (%)	7.405	-1.908	16.719

Note: Correlation analyses suggested no multicollinearity in the model; in other words, highly significant correlations among variables were not observed (i.e., Pearson r values were less than 0.7); also the reported pseudo-R2 for the logistic model was 0.58.

Similar to upland breeding birds and water birds, a ZOI and associated DC was applied to estimate the combined direct and indirect effects (e.g., fugitive dust disposition, and sensory disturbance from noise and human activities) from development footprints. For all development scenarios, habitat quality within all development footprints was reduced to zero (direct effects). To estimate indirect changes to raptor habitat, the predicted ZOI and DC were based on professional opinion and from previous environmental assessments in the NWT and Nunavut (DDMI 1998; Miramar 2005). The ZOI for raptors applies to habitats within 1,000 m of all active development footprints within the RSA and reduces the quality of each habitat by a single category (e.g., high to good; low to poor), except for poor quality habitats, which remain poor.

The following equations were used to calculate the relative change in the amount of different quality habitats for the different conditions on the landscape.

- (2010 baseline area – reference area) / total area x 100
- (application case area – 2010 baseline area) / total area x 100
- (future case area - application case area) / total area x 100

Although the indirect effects from dust deposition and sensory disturbance are included in the RSF modelling, the potential effects on raptors from each stressor are also discussed separately. The methods used to assess the potential indirect effects (i.e., fugitive dust deposition, and noise) from the Project on the habitat quality, movement, and behaviour of raptors are similar to that used for upland birds and water birds.

11.12.6.2.2 Results

The total amount of suitable habitat (i.e., low, good, and high) in the RSA for raptors is 75% and changes little throughout all assessment cases (Table 11.12-25). Previous and existing developments decreased the habitat quality in the RSA by less than 0.3%. The anticipated incremental decrease of high and good quality habitat from the Project relative to 2010 baseline conditions is less than 0.2%. The cumulative decrease of high and good quality habitat for raptors from the Project and previous, existing and potential future developments in the RSA is approximately 1.6% (Table 11.12-25). Habitat suitability modelling for reference conditions, 2010 baseline conditions, baseline case, application case, and future case are shown in Figure 11.12-15 to Figure 11.12-18.

Table 11.12-25 Relative Changes in the Availability of Different Quality Habitats in the Regional Study Area for Raptors from Reference to Reasonably Foreseeable Projects

Habitat Category	Reference (ha)	% Change Reference to 2010 Baseline	% Change 2010 to Application	% Change Application to Future	Cumulative % Change Reference to Future
High	142,094	-0.24	-0.05	-0.75	-1.04
Good	141,880	0.00	-0.09	-0.49	-0.58
Low	143,339	0.09	-0.40	-0.01	-0.32
Poor	141,231	0.16	0.54	1.25	1.94
Total	**568,544**				

Note: Percent change per habitat category was calculated as area lost or gained divided by the area of the habitat category in the previous time period. Cumulative values may not exactly sum due to rounding.

Reference conditions = baseline conditions prior to development.

2010 Baseline Case = previous and existing developments up to 2010.

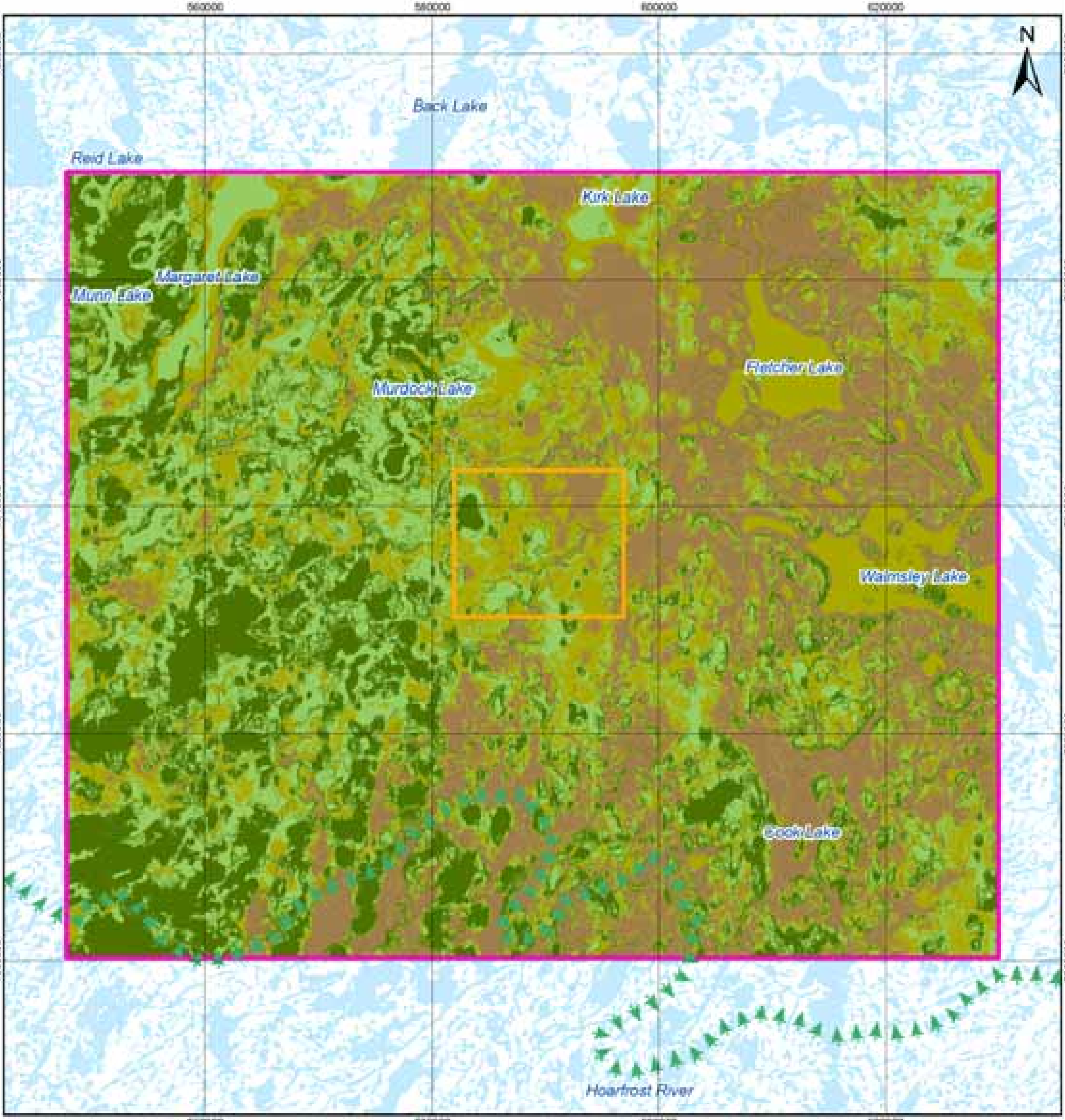
Application Case = Gahcho Kué Project plus 2010 baseline conditions.

Future = Taltson Hydroelectric Expansion Project plus application case

ha = hectares; % = percent.

Construction and operation of the Project may cause an accumulation of dust within the study area. Therefore air quality modelling was completed to estimate the extent of deposition. The results of the air quality modelling predicted the maximum annual dust deposition resulting from the Project is 6,292 kg/ha/y within the Project development area boundary (i.e., Project footprint) and 5,520 kg/ha/y outside of the Project development area boundary. The maximum deposition that occurs is mostly associated with the mine pits and haul roads. The maximum predicted dust deposition rate is expected within 100 m of the Project footprint.

The most deleterious effects of dust are generally confined to the immediate area adjacent to the dust source (e.g., a haul road) (Everett 1980; Walker and Everett 1987). Walker and Everett (1987) and Everett (1980) reported that effects were confined to a 50-m buffer on either side of a road. Meininger and Spatt (1988) found that the majority of effects occurred within 5 to 50 m of a road, with less obvious effects observed between 50 and 500 m from the road.



LEGEND

Watercourse
Waterbody
Treeline

Resource Selection Function

High
Good
Low
Poor
Local Study Area
Regional Study Area

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000

GAHCHO KUÉ PROJECT

Habitat Suitability for Raptors: Reference Conditions

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:500,000

10 5 0 10

Kilometres

DE BEERS CANADA

FILE No.	DATE
SON-11-12-017-GIS	October 25, 2010

JOB NO.	REVISION NO.
09-1365-1004	3

OFFICE	DRAWN	CHECK
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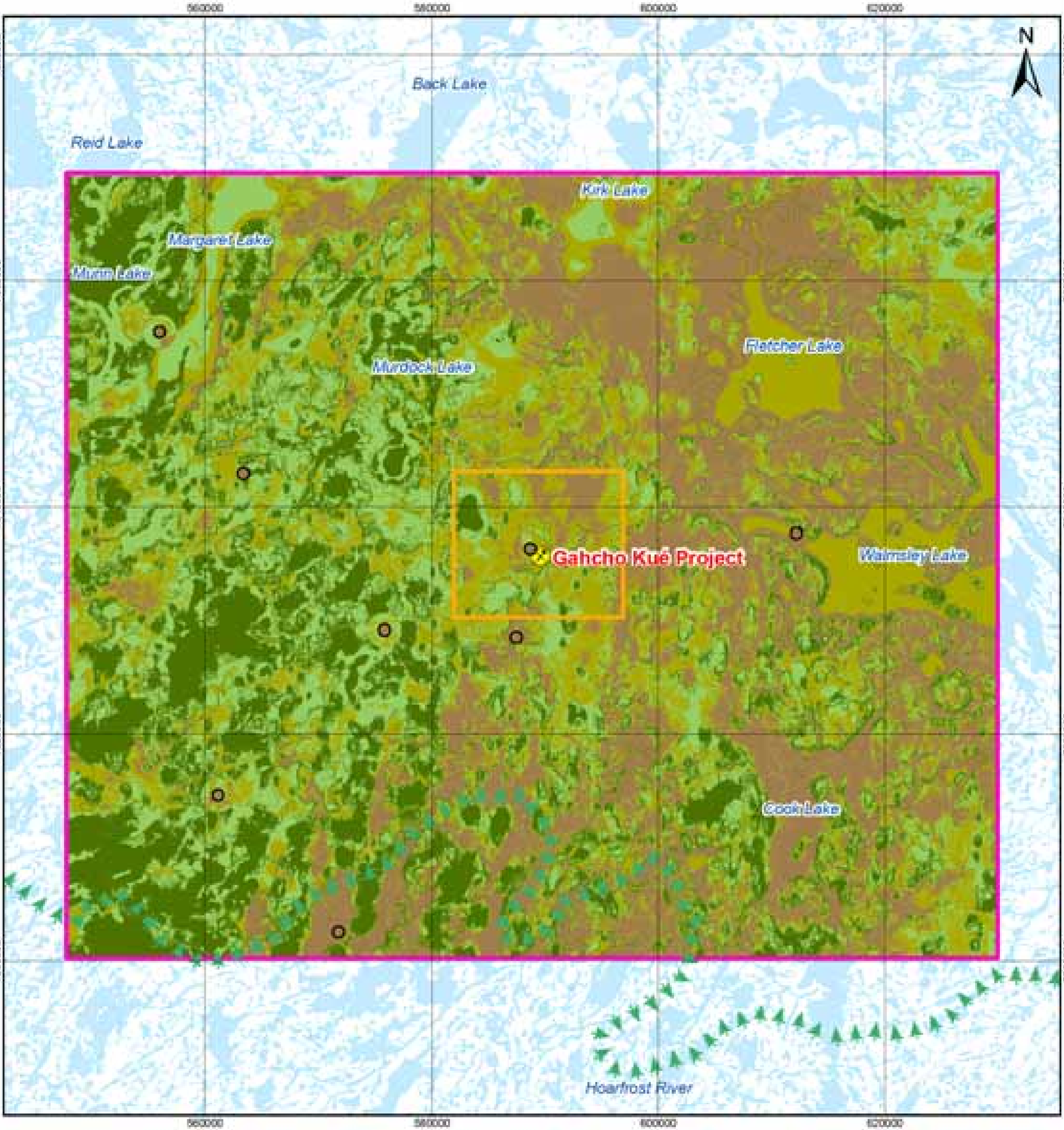
Figure 11.12-15



LEGEND

- Gahcho Kué Project
- Watercourse
- Waterbody
- Treeline
- Development Footprint

Resource Selection Function

- High
- Good
- Low
- Poor
- Local Study Area
- Regional Study Area

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000

GAHCHO KUÉ PROJECT

Habitat Suitability for Raptors: 2010 Baseline Conditions

PROJECTION: UTM Zone 12	DATUM: NAD83
Scale: 1:500,000 (10 5 0 10 Kilometres)	
FILE No: SON-11-12-018-GIS	DATE: October 25, 2010
JOB NO: 09-1365-1004	REVISION NO: 4
OFFICE: GOLD-SAS	DRAWN: ANK; CHECK: JV

DE BEERS CANADA

Figure 11.12-16

GAHCHO KUÉ PROJECT

Habitat Suitability for Raptors: Application Case

LEGEND

- Gahcho Kué Project
- Watercourse
- Waterbody
- Treeline
- Development Footprint

Resource Selection Function

- High
- Good
- Low
- Poor
- Local Study Area
- Regional Study Area

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:500,000

10 5 0 10

Kilometres

DE BEERS CANADA

FILE No:			DATE:
SON-11-12-019-GIS			October 25, 2010
JOB NO:	REVISION NO:		
09-1365-1004	4		
OFFICE:	DRAWN:	CHECK:	
GOLD-SAS	ANK	JV	

Figure 11.12-17

LEGEND

- Gahcho Kué Project
- Watercourse
- Waterbody
- Treeline
- Proposed Taltson Transmission Line
- Development Footprint

Resource Selection Function

- High
- Good
- Low
- Poor
- Local Study Area
- Regional Study Area

NOTES

Base data source: National Topographic Base Data (NTDB) 1:250,000

GAHCHO KUÉ PROJECT

Habitat Suitability for Raptors: Future Case

PROJECTION	DATUM
UTM Zone 12	NAD83

Scale: 1:500,000

10 5 0 10

Kilometres

DE BEERS CANADA

FILE No.			DATE
SON-11-12-021-GIS			November 4, 2010
JOB NO.	REVISION NO.		
09-1365-1004	2		
OFFICE	DRAWN	CHECK	
GOLD-SAS	ANK	JV	Figure 11.12-18

Noise will be generated from mobile and stationary mining equipment, blasting, and aircraft at the Project. The results show that while noise will be generated by the Project, the expected levels at identified noise receptors are below relevant criteria established for remote areas (with the exception of the 40 dBA limit at 1.5 km from the Project due to mine operations) (Table 11.12-20). The analysis of blasting activity indicates that the maximum distances at which the criteria for peak ground (12.5 mm/s) and airborne vibration levels (120 dBL) would be met are at 596 and 730 m, respectively. The distance for noise attenuation to background levels for core mining operations (including blasting) is 3.5 km.

Noise from construction and mining activity has the potential to influence raptor behaviour and movement in the RSA. Noise can disturb raptors and create changes in migratory paths and breeding territory selection. Some falcon studies have documented declines in populations that have been attributed to human activities and developments (Craighead and Mindell 1981). However, determining the effects of human disturbance and activity on raptor populations in the tundra environment can be difficult due to confounding factors. Tundra-nesting raptors face various pressures related to inclement weather conditions (Court et al. 1988; Poole and Bromley 1988; Olsen and Olsen 1989; Bradley et al. 1997) and prey population abundance (Steenhof et al. 1999), which can have noticeable effects on raptor productivity. In addition, the proximity of other occupied nests can also influence peregrine falcon (and likely other raptor species) nest occupancy and success (Wightman and Fuller 2006). The concern regarding noise and birds includes noises that startle or disturb nesting birds and noises that mask birdsong, affecting the ability of males to attract a mate.

Aircraft will be used for the movement of personnel and supplies to the Project site year-round. Aircraft noise will be limited to a few minutes during take off and landing, and a maximum of two round-trip flights per day are expected during Project construction and operation. The distance for noise to reach background levels from the airstrip is 5.5 km (Table 11.12-21). However, disturbance from large aircraft is expected to be infrequent and short-term (less than five minutes) in duration.

Although noise and sensory disturbance can alter the movement and behaviour of wildlife, the specific effects of Project-related sensory disturbance on many species of raptors are unclear. For example, at the Snap Lake Mine, variation in nest site occupancy and success was not strongly related to distance from the project. Although weather and prey abundance also were not highly correlated with nest success, these environmental variables had stronger associations with nest success relative to distance from the mine (Golder 2008a). However, raptor nest occupancy and success in the Lac de Gras region increased with increasing distance from the Diavik Diamond Mine (Golder 2008b). Nest success also was related to spring rainfall, and appeared to decline from construction through current operations (Golder 2005, 2008b). Nest success at Daring Lake (no development), Snap Lake, and Hope Bay, Nunavut have showed declining trends in nest success during the past decade (Golder 2008a, b). Larger scale factors may be more important at influencing regional nest success in raptors than local mine-related disturbances. Sensory effects to raptor movement and behaviour, which can influence nest site occupancy and success, from the Project and other developments in the region are expected to be within the range of baseline values.

11.12.6.3 Related Effects on People

Traditional knowledge holders from the LKDFN identified several bird species that are known to inhabit the RSA and are of importance for traditional use (LKDFN 2005, internet site) However, most of these identified birds are geese and ducks. There was little mention of raptor species by traditional users, except that eagles are a particularly respected bird and have spiritual importance.

Areas with high raptor densities have the potential to draw recreational birders. However, the RSA is difficult to access and has a relatively low density of raptors compared to other areas in the Arctic. The incremental and cumulative effects from the Project and other developments on traditional and non-traditional use of raptors are not expected to be measurable relative to baseline conditions.

11.12.7 Residual Effects Summary

The residual effects summary for this Species at Risk and Birds Subject of Note will only be conducted for birds and associated species at risk in bird communities. The residual effects summary for fish, plants, caribou, grizzly bear, and wolverine are presented in their respective sections (Section 8; Section 11.7; Section 7; Section 11.10). However, a summary of the environmental significance of effects from the Project for these other species at risk is provided in Section 11.12.9.3.

In addition to the environmental design features used for limiting effects to birds from the Project (Section 11.12.3.2), key mitigation practices and policies that will be implemented for birds and bird species at risk include the following:

- clearing land outside of the breeding season;
- avoiding disturbance to active nest sites; and
- preventing birds from nesting on man-made structures.

11.12.7.1 Habitat Quantity and Fragmentation

The area directly disturbed by the Project is a local scale effect. However, the combined direct changes from the Project and other developments on habitat extend to the populations, communities, and associated species at risk within the RSA (i.e., geographic extent is regional). The rusty blackbird, horned grebe, peregrine falcon, and short-eared were the only listed bird species observed in the RSA during baseline studies.

The total area of the Project footprint is estimated to be 1,235 ha. This includes 853.3 ha of mine and infrastructure that will directly affect terrestrial and aquatic resources (Section 11.7). An additional 382.1 ha of water (shallow and deep water) is not expected to be directly altered by the Project during construction and operation. Approximately 68% of the Project footprint is aquatic habitat and 32% is terrestrial habitat.

At the local scale, the Project footprint will alter 4.4% of the baseline LSA. Terrestrial habitat types that will be disturbed most include tussock-hummock, sedge wetland, and peat bog (all decreased by 0.4%). During construction and operation, the Project footprint will decrease the lake surface area within the LSA by 2.2%. Although progressive reclamation will be integrated into mine planning, arctic ecosystems are slow to recover from disturbance. In addition, not all the areas will be reclaimed. For example, as a result of locally expressed concerns, the Fine PKC Facility will not be vegetated to prevent the facility from becoming attractive to wildlife (Section 11.7). The mine rock piles, Coarse PK Pile and Fine PKC facility will be permanent features on the landscape, covering approximately 302.7 ha of terrestrial habitat.

The magnitude of the incremental loss of habitat on the landscape within the RSA from the Project relative to 2010 baseline conditions is anticipated to be 2.6%. Overall, the magnitude of incremental and cumulative changes to habitat area and configuration (e.g., number and distance between similar patches) from the Project and other previous, existing, and future developments are estimated to be about 5% relative to a landscape with no development. This includes less common habitats such as forest, wetlands, and riparian areas that are important for some species, and is well below the 40% threshold value for habitat loss associated with predicted declines in bird and mammal species (Andrén 1994, 1999; Fahrig 1997; Mönkkönen and Reunanen 1999; Swift and Hannon 2010).

In addition to direct loss of habitat, the application of the Project will also result in fragmentation (or perforation of habitats from a point source of disturbance such as mine sites) of the existing landscape. Fragmentation (or breaking apart of the landscape) can influence several ecological processes including movement between nesting and foraging areas, nest predation and parasitism along habitat edges, encounter rate between potential breeders, and dispersal between local populations. Although fragmentation can influence individual, population, and community processes, fragmentation effects have less influence than habitat loss when there is is a large proportion of natural habitat on the landscape (Fahrig 1997, 2003; Andrén 1999; Flather and Bevers 2002; Swift and Hannon 2010). Studies using simulation models found that the effect of habitat fragmentation on a species depends on its habitat requirements, amount of habitat remaining, and dispersal ability or vagility (With and Crist 1995; Flather and Bevers 2002; Swift and Hannon 2010).

For example, a species with very specific habitat requirements and low dispersal ability (or ability to move) is more likely to be negatively affected by habitat fragmentation. Species that can move effectively (such as most birds) may consider habitat patches to be connected even when covering only 35 to 40% of the landscape (With and Crist 1995). In other studies, effects from habitat fragmentation on populations are small until habitat amounts decrease below a threshold level (10 to 30% habitat remaining) related to population persistence (Flather and Bevers 2002; Swift and Hannon 2010).

Distances of 50 to 200 m have been reported to effectively isolate birds in forested landscapes (Desrochers and Hannon 1997; Schmiegelow et al. 1997; St. Clair et al. 1998). The ability and willingness of a bird to cross a matrix (i.e., less preferred habitat portions of the landscape) may also be influenced by the quality of the matrix. That is, a matrix may decrease the survival probability of an individual because of increased risk of predation or collision with a vehicle (Swift and Hannon 2010). Arctic birds are likely less affected by the distance between habitat patches because much of existing landscapes are still intact, and naturally have relatively little vegetation structure and more open areas than forested landscapes.

For example, in the RSA, the mean distance to nearest similar habitat patch for vegetation communities (except eskers) ranged from 70 m to 120 m with no development on the landscape (i.e., reference conditions). Distance to similar habitat patches increased marginally (0.01 to 0.03%) from reference to 2010 baseline conditions. With the addition of the Project, the distance between similar patches of highly suitable habitat (i.e., spruce forest, birch seep, tussock/hummock, heath tundra, tall shrub, and sedge wetland) increased by less than 0.1% (less than 1 m). Similarly, the distance between similar patches from future potential projects is expected to increase from 0.01 to 0.02% for birch seep and spruce forest habitats, respectivley, while no change is expected for tussock-hummock habitat. Mean distances to nearest neighbour are expected to decrease by 0.01 to 0.04% for tall shrub and sedge wetland habitat.

Habitat fragmentation can also increase edge habitat, which can increase nest predation and parasitism (Robinson and Wilcove 1994). Brood parasitism from species such as brown-headed cowbirds is not likely to occur in the RSA (i.e., cowbirds were not observed during baseline studies and are not expected to occur in the RSA). Although some studies have detected increased predation rate on nests near edges in forested and non-forested landscapes, other studies have shown no effect of distance from disturbed edge on nest success (Johnson and Temple 1990; Hanski et al. 1996; Donovan et al. 1997; Winter et al. 2000; Chalfoun et al. 2002). At the Ekati Diamond Mine, Male and Nol (2005) found that nest success of Lapland longspurs was independent of distance to roads. In the RSA, approximately 5% of habitat has been disturbed by development, which results in little change relative to the natural degree of habitat edges on the landscape (Fahrig 2003). The effect from the increase in edge habitat in the RSA from the Project and other developments on birds is predicted to be within the range of baseline conditions.

11.12.7.2 Habitat Quality, Behaviour, and Movement

In addition to direct habitat effects, indirect changes to habitat quality from the Project and other developments have the potential to affect the population size and distribution of birds and associated species at risk through altered movement and behaviour. To estimate the effects of development on birds, habitat suitability models were used to quantify habitat changes from reference conditions through application of the Project and reasonably foreseeable developments. Because most wildlife species are likely to exhibit some degree of sensitivity to human disturbance, zones of influence and disturbance coefficients were applied to estimate indirect effects (e.g., fugitive dust disposition, and sensory disturbance from noise and human activities) from the Project and other active projects in the RSA. The estimates include the loss of available habitat from direct disturbance associated with development footprints. The indirect effects from dust deposition and sensory disturbance were also analyzed separately.

Habitat modeling predicted that the maximum spatial extent of indirect changes to habitat quality (i.e., zone of influence) from the Project and other active developments in the RSA is 1 km. Habitat quality was reduced around each active project within 1 km from the edge of the footprint to estimate of potential effects from sensory disturbance (e.g., noise, lights, and dust) on upland breeding birds, water birds, and raptors. Although the incremental changes to habitat quality from each active development occur at the local scale, the cumulative effect to the movement and behaviour of birds extends to the population within the RSA (i.e., regional geographic extent). The duration of the effects to bird populations from changes in habitat quality and altered movement and behaviour are expected to occur over a 27 to 32 year period (i.e., effects should be reversed within 5 to 10 years following final closure).

Relative to 2010 baseline conditions, the Project is expected to reduce the amount of high and good quality habitat in the RSA for water birds and raptors by less than 1.0%. Similarly, incremental changes in habitat quality from the Project are predicted to reduce the overall abundance of upland breeding birds by less than 1.0% (i.e., regional upland and wetland communities). The cumulative decrease in quality habitat from reference conditions through potential future developments in the RSA is predicted to be about 1.4% for water birds and 1.6% for raptors. Cumulative decreases in habitat quality from the Project and previous, existing, and potential future developments are predicted to reduce the abundance of upland breeding birds in the RSA by 1.4 to 2.6%.

The results of the air quality modelling showed that the maximum annual dust deposition resulting from the Project is predicted to occur within 100 m of the Project footprint, and is mostly associated with the mine pits and haul roads. The distance for noise attenuation to background levels for mining operations (including blasting) and the airstrip is 3.5 km and 5.5 km, respectively. Noise associated with the airstrip will be intermittent and limited to take-off and landings, whereas the frequency of noise levels from mining operations are continuous.

11.12.7.3 Related Effects on People

Water birds would likely be the focus of harvesting activities among all bird groups. Ptarmigan also are likely to be hunted in the region. Baseline data from the Project RSA, the Snap Lake Mine, and Diavik Diamond Mine suggested that water bird breeding (nesting) densities in the barren lands are low, although these areas do provide staging and nesting areas for migrating birds. Analysis indicated that the cumulative loss and fragmentation of upland and water bird habitats from the Project and previous, existing, and future developments in the RSA is approximately 5%. Similarly, cumulative effects from decreases in habitat quality are predicted to be 1.4% for water birds and between 1.4 and 2.6% for upland birds. Effects from dust and noise on birds are also localized around the Project footprint, and should have a negligible influence on the abundance and distribution of the ptarmigan and water bird populations in the region. It is predicted that effects from the Project and other developments on traditional and non-traditional use of ptarmigan and water birds (and other bird groups) in the RSA will not be detectable relative to baseline conditions.

Aylmer Lake Lodge operates an outpost camp on Cook Lake, about 25 km southeast of the Project area. The next closest camp is on Walmsley Lake, 55 km from the Project, which is an outpost camp to the Aylmer Lake hunting camp. Given the distance of the Project from these camps, no noticeable change in the potential for wilderness viewing of birds and associated species at risk is anticipated. All residual effects related to the use of birds by people are expected to be reversible within five years following final closure of the Project.

11.12.8 Residual Impact Classification

The residual impact classification for this Species at Risk and Birds Subject of Note will only be completed for birds and associated species at risk in bird communities. The residual impact classification for fish, plants, caribou, grizzly bear, and wolverine are presented in their respective sections (Section 8; Section 11.7; Section 7; Section 11.10). However, a summary of the environmental significance of impacts from the Project for these other species at risk is provided in Section 11.12.9.3.

The purpose of the residual impact classification is to describe the residual effects from the Project on birds and associated species at risk using a scale of common words (rather than numbers or units). The use of common words or criteria is a requirement in the Terms of Reference for the Project (Gahcho Kué Panel 2007). The following criteria must be used to assess the residual impacts from the Project:

- direction;
- magnitude;
- geographic extent;
- duration;
- reversibility;
- frequency;
- likelihood; and
- ecological context.

Generic definitions for each of the residual impact criteria are provided in Section 6.7.2.

11.12.8.1 Methods

In the EIS, the term “effect”, used in the effects analyses and residual effects summary, is regarded as an “impact” in the residual impact classification. Therefore, in the residual impact classification, all residual effects are discussed and classified in terms of impacts to birds and associated species at risk.

The effects analyses and residual effects summary presented both the incremental and cumulative changes from the Project and other developments on the environment, birds and associated species at risk, and the use of birds by people. Incremental effects represent the Project-specific changes relative to baseline values in 2010. Project-specific effects typically occur at the local scale (e.g., habitat loss due to the Project footprint) and/or regional scale (e.g., combined habitat loss, dust, noise, and sensory disturbance from Project activities [i.e., zone of influence]) (Section 6.7.4).

Cumulative effects are the sum of all changes from reference values through application of the Project and future developments. In contrast to Project-specific (incremental) effects, the geographic extent of cumulative effects is determined by the distribution of the defined population(s). This is because the local and regional effects from the Project and other developments overlap with the distribution of birds and associated species at risk populations.

For birds and associated species at risk, the assessment and classification of residual impacts was based on the predicted cumulative changes from reference conditions through application of the Project (and into the future case). The spatial boundary of the assessment is at the regional scale or distribution of the populations, which is a requirement in the Terms of Reference (Gahcho Kué Panel 2007). The incremental effects from the Project relative to 2010 baseline conditions are also classified. Essentially, the only difference in the outcome of impact criteria between incremental and cumulative effects from the Project is in the magnitude and geographic extent of impacts. The magnitude for cumulative impacts involves changes from reference conditions through application of the Project (and into the future case), while incremental impacts are based on changes from the Project relative to 2010 baseline values. Cumulative impacts from the Project and other developments influence the entire distribution of the populations. In contrast, the geographic extent of incremental impacts from the Project may have a local and/or regional influence on the populations.

Effects statements are used to focus the analysis of changes to birds and species at risk that are associated with one or more primary pathways. The residual effects summary (Section 11.12.7) presents a numerical assessment for criteria such as magnitude, geographic extent, duration, and frequency. From the summary of residual effects, pathways associated with each effects statement are then classified using scales (categorical values such negligible, low, or high) for each impact criterion (e.g., magnitude).

To provide transparency in the EIS, the definitions for these scales were ecologically or logically based on birds and species at risk. Although professional judgement is inevitable in some cases, a strong effort was made to classify impacts using scientific principles and supporting evidence. The scale for the residual impact criteria for classifying effects from the Project are specifically defined for birds and species at risk, and definitions for each criterion are provided in Table 11.12-26. More detailed explanations for magnitude, geographic extent, and duration are provided below.

11.12.8.1.1 Magnitude

Magnitude (i.e., intensity of the impact) for Project-specific (incremental) effects is scaled to the expected change (quantified or qualified) from 2010 baseline conditions to application of the Project. Magnitude for cumulative effects is scaled to the expected quantified and/or qualified cumulative change from reference conditions (no development) through application of the Project and reasonably foreseeable developments. Baseline conditions represent the historical and current environmental selection pressures that have shaped the observed patterns in bird populations. Environmental selection pressures include both natural (e.g., weather, changes in gene frequencies, predation, and competition) and human-related factors (e.g., mineral development, traditional harvest, and sport hunting).

Depending on which selection pressures are currently driving changes to birds and the system, baseline conditions typically fluctuate within a range of variation through time and space. The fluctuations are generated by variation in natural factors (natural variation) and variation associated with human influences. Relative to ecological time and space, baseline conditions are in a constant state of change due to the pushing and pulling of environmental selection pressures. Thus, baseline conditions can be thought of as a distribution of probability values, and the location of the value (e.g., middle or ends of the distribution) is dependent on which environmental factors are currently playing a key role in the trajectory of bird populations.

Table 11.12-26 Definitions of Criteria Used in the Residual Impact Classification of Pathways for Effects on Population Size and Distribution of Birds and Species At Risk

Direction	Magnitude(a)	Geographic Extent	Duration	Frequency	Reversibility(b)	Likelihood
Negative: a decrease relative to baseline values **Positive:** an increase relative to baseline values	**Negligible:** no predicted detectable change from baseline values **Low:** impact is predicted to be within the range of baseline values **Moderate:** impact is predicted to be at or slightly exceeds the limits of baseline values **High:** impact is predicted to be beyond the upper or lower limit of baseline values so that there is likely a change of state from baseline conditions	**Local:** small-scale direct and indirect impacts from the Project (e.g., footprint, physical hazards, dust deposition, and lake dewatering) **Regional:** the predicted maximum spatial extent of combined direct and indirect impacts from the Project that exceed local-scale effects (can include cumulative direct and indirect impacts from the Project and other developments at the regional scale) **Beyond Regional:** cumulative local and regional impacts from the Project and other developments extend beyond the regional scale	**Short-term:** impact is reversible at end of construction **Medium-term:** impact is reversible at end of closure (i.e., upon completion of refilling Kennady Lake) **Long-term:** impact is reversible within a defined length of time (e.g., animal life spans) beyond closure	**Isolated:** impact confined to a specific discrete period **Periodic:** impact occurs intermittently but repeatedly over the assessment period **Continuous:** impact will occur continually over the assessment period	**Reversible:** impact will not result in a permanent change of state of the population compared to "similar" environments not influenced by the Project **Irreversible:** impact is not reversible (i.e., duration of impact is unknown or permanent)	**Unlikely:** the impact is likely to occur less than one in 100 years **Possible:** the impact will have at least one chance of occurring in the next 100 years **Likely:** the impact will have at least one chance of occurring in the next 10 years **Highly Likely**: the impact is very probable (100% chance) within a year

(a) baseline includes range of expected values from reference conditions (no development) through 2010 baseline conditions.
(b) "similar" implies an environment of the same type, region, and time period.

The approach used to classify the magnitude of changes in measurement endpoints (and related impacts) was based on scientific literature and professional opinion, and incorporated conservatism. Other environmental assessments often use the universal effect size approach for categorizing magnitude such as negligible changes (0 to 10%), small changes (10 to 25%), and medium changes (25 to 40%) (Munkittrick et al. 2009). Ideally, effect threshold values would be known, and measurement endpoints could be quantified accurately with a high degree of confidence. However, little is known about ecological thresholds, and biological parameters are typically associated with large amounts of natural variation. Therefore, the classfication of magnitude included a level of conservatism so that the impacts would not be underestimated.

The definition of magnitude provided in Table 11.11-17 is applicable for more qualitative results (e.g., impacts on bird movement and behaviour, and related impacts to people). For quantitative analyses and results (e.g., loss and fragmentation of habitat, and changes to habitat suitability), the following definition for magnitude is applied:

- negligible: less than a 1% change from the Project relative to baseline values;
- low: 1 to 10% change from the Project relative to baseline values;
- moderate: greater than 10% to 20% change from the Project relative to baseline values; and
- high: more than 20% change from the Project relative to baseline values.

The proposed scale is consistent with the 20% rule for the severity of effects from chemical exposure on varying spatial scales of ecological effects (i.e., a 20% change in a measurement endpoint constitutes an ecological effect) (Suter et al. 1995). The scale is also consistent with and below thresholds identified by empirical and theoretical work on the relationship between loss of suitable habitat and the likelihood of population decline (Andrén 1994, 1999; Fahrig 1997; Mönkkönen and Reunanen 1999; Flather and Bevers 2002). These studies suggested that critical thresholds for changes in rates of population parameters in non-tropical bird and mammal species occur between 10% and 60% of original habitat. In other words, a measurable decrease in species abundance and diversity may be observed when the amount of suitable habitat that is lost exceeds a threshold value of 40%. In a recent review, Swift and Hannon (2010) found that most empirical studies demonstrated negative effects on insects, plants, birds, and mammals when remaining habitat cover ranged from 10 to 30% (i.e., more than 70% habitat loss).

11.12.8.1.2 Geographic Extent

Geographic extent is the area or distance influenced by the direct and indirect effects from the Project, and is different from the spatial boundary (i.e., study area) for the effects analysis and impact assessment. The study area for the effects analysis represents the maximum area used for the assessment and is related to the spatial distribution and movement (i.e., population boundary) of birds and species at risk (i.e., the RSA).

However, the geographic extent of impacts can occur on a number of scales within the spatial boundary of the assessment. As defined in Table 11.12-26, geographic extent for classifying impacts is based on three scales: local, regional, and beyond regional. Local-scale impacts mostly represent incremental (Project-specific) changes to bird population size and distribution that are directly related to the Project footprint and activities (e.g., physical disturbance to vegetation (habitat), mortality of individual animals). Local impacts may also include small-scale indirect effects such as noise, and dust deposition on vegetation.

Changes at the regional scale (population level) are largely associated with cumulative direct and indirect impacts on birds and associated species at risk from the Project and neighbouring developments (which is the study area or spatial boundary for the assessment). Cumulative impacts from the Project also occur at the regional scale for traditional and non-traditional use of birds.

11.12.8.1.3 Duration

Duration has two components. It is the amount of time between the start and end of a Project activity or stressor (which is related to Project development phases), plus the time required for the impact to be reversible. Essentially, duration is a function of the length of time that birds and species at risk are exposed to Project activities, and reversibility.

Although it is common to describe construction, operation, and closure as discreet phases, these activities will overlap at Kennady Lake. For example, there is less than one year when construction activities are the only activities at the Project site. Progressive reclamation and closure activities will begin during operation, and continue for eight years at the end of operation, which will include the initial refilling of Kennady Lake. The time from construction to intial closure is 16 years. The total length of the Project (i.e., end of final closure) is 22 years.

By definition, impacts that are short-term, medium-term, or long-term in duration are reversible. Project activities may end at closure, but the impact on populations of birds and associated species at risk may continue beyond Project closure. Some impacts may be reversible soon after removal of the stressor, such as effects on air quality from power generation and equipment operation (e.g., medium-term impact).

For birds and species at risk, the amount of time required for the impact to be reversed (i.e., duration of the effect) is presented in context of the number of life spans that birds may be influenced. The anticipated duration of effects on birds and species at risk are then used to determine the number of human generations that may be affected by the related changes to traditional and non-traditional land use practices (e.g., waterfowl hunting, wildlife viewing). In this manner, the impact assessment links the duration of Project impacts on birds and species at risk to the amount of time that human use of ecological resources may be influenced.

For impacts that are permanent, the duration of the effect is determined to be irreversible. An example of an irreversible impact includes the localized loss of vegetation and habitat due to the mine rock piles, Coarse PK Pile and Fine PKC Facility.

11.12.8.2 Results

Direct incremental impacts from the Project footprint (i.e., habitat loss) are local in spatial extent. At the local scale, the magnitude of incremental impacts from the Project footprint on species at risk and birds is predicted to be low (i.e., the Project will alter 4.4% of the LSA). However, individuals from bird populations may interact with other developments and activities in the RSA. Therefore, the cumulative impacts from direct habitat loss and fragmentation from the Project and other developments on population size and distribution are expected to be regional in geographic extent (Table 11.12-27). The frequency of the direct impacts to birds and species at risk will occur continuously over the assessment period. Cumulative impacts of direct disturbance from the Project and other developments are expected to be low (4.7%) in magnitude (Table 11.12-27).

Table 11.12-27 Summary of Residual Impact Classification of Primary Pathways for Incremental and Cumulative Effects on Population Size and Distribution of Birds and Species at Risk, and Related Effects to People

Pathway	Direction	Magnitude		Geographic Extent		Duration	Frequency	Reversibility	Likelihood
		Incremental	Cumulative	Incremental	Cumulative				
Physical footprint decreases habitat quantity and causes fragmentation	negative	low	low	local	regional	permanent	continuous	irreversible	highly likely
The combined indirect effects (i.e., dust deposition, noise, and and human activity-sensory effects) from the Project changes the amount of different quality habitats, and alters movement and behaviour	negative	negligible to low	low	local	regional	long-term	continuous	reversible	highly likely
Effects on population size and distribution changes the availability of animals for traditional and non-traditional use	negative	negligible	negligible	local	regional	long-term	continuous	reversible	possible

Although progressive reclamation will be integrated into mitigation and management plans for the Project, and is part of the land use permits for existing developments, arctic ecosystems are slow to recover from disturbance. In addition, not all the areas for the Project will be reclaimed. For example, as a result of locally expressed concerns, the mine rock cap on the Fine PKC Facility will not be vegetated to prevent it from becoming attractive to wildlife. The Fine PKC Facility, Coarse PK Pile, and mine rock piles will be permanent features on the landscape, covering approximately 302.7 ha. Development footprints and related loss of habitat on the landscape was assumed to be permanent (i.e., not reversible within the temporal boundary of the assessment) (Table 11.12-27).

The Project is expected to cause indirect changes to the amount of different quality habitats for bird populations and communities in the region. These incremental changes are expected to result from the combination of dust, noise, and other sensory disturbance from the Project, and are local in geographic extent (Table 11.12-27). For example, dust deposition is anticipated to have impacts within 100 m of the Project footprint (a local impact). Impacts from blasting are predicted to decrease to background levels within 1 km of the Project, while noise from general mining operations and aircraft should reach background levels within 3.5 km and 5.5 km of the Project, respectively. All of these Project pathways can combine with similar localized impacts from other developments in the region and decrease the amount of quality habitat for bird populations (geographic extent is regional for cumulative impacts).

Habitat modeling predicted that the maximum spatial extent of indirect changes to habitat quality (i.e., zone of influence) from the Project and other active developments in the RSA is 1 km. Habitat quality was reduced around each active project within 1 km from the edge of the footprint to estimate of potential effects from sensory disturbance on upland breeding birds, water birds, and raptors. The magnitude of the effect from changes to habitat quality, movement, and behaviour on birds and species at risk is predicted to be negligible to low. The cumulative decrease to high and good quality habitats ranged from 1 to 3% (low magnitude) among species groups (Table 11.12-27). Incremental changes to habitat from the Project were less than 1% for each species group (negligible magnitude).

The impact from sensory disturbance is anticipated to be reversible within 5 to 10 years after final closure (i.e., after Kennady Lake is refilled). Assuming that the average life span of upland birds is 5 years (based on songbirds), and 10 years for water birds and raptors (Canada goose and peregrine falcon), the duration of the impacts is 27 to 32 years or about 6 life spans for upland birds, and 3 life spans for water birds and raptors. Thus, the duration of the impact from cumulative changes to habitat, movement, and behaviour on population size and distribution of birds and species at risk is reversible in the long-term (Table 11.12-27).

Changes in the population size and distribution of birds may influence harvesting activities, particularly hunting for waterfowl and ptarmigan. Based on the magnitude of effects from development on bird populations, it is predicted that impacts from the Project and other developments on traditional and non-traditional harvesting of birds in the RSA will be negligible relative to baseline conditions (Table 11.12-27).

Changes in the population size and distribution of birds and species at risk in bird communities also may influence wilderness value and wildlife viewing opportunities. Aylmer Lake Lodge operates an outpost camp on Cook Lake, about 25 km southeast of the Project site. The next closest camp is on Walmsley Lake, 55 km from the Project, which is an outpost camp to the Aylmer Lake hunting camp. Given the distance of the Project from these camps, no detectable change in the potential for wilderness viewing of birds and associated species at risk is anticipated (negligible magnitude). The duration of the impacts to birds and species at risk is expected to last for 27 to 32 years, which is equivalent to about one and half human generations (assuming human generation time is 20 years). The impact to traditional and non-traditional use of birds and species at risk in bird communities is anticipated to be reversible in the long term (Table 11.12-27).

11.12.9 Environmental Significance

11.12.9.1 Approach and Method

The Terms of Reference require that “the developer must provide its views on the significance of impacts” (Section 3.2.2; Gahcho Kué Panel 2007). Environmental significance was used to evaluate the significance of incremental and cumulative impacts from the Project and other developments on birds and associated species at risk, and by extension, on the use of birds by people. The evaluation of significance was based on ecological principles, to the extent possible, but also involved professional judgement and experienced opinion.

The classification of residual impacts on primary pathways provides the foundation for determining environmental significance from the Project on the persistence of birds and species at risk. Magnitude, geographic extent, and duration are the principal criteria used to predict significance (Section 6.7.3). Other criteria, such as frequency, ecological context, and likelihood are used as modifiers (where applicable) in the determination of significance.

Frequency may or may not modify duration, depending on the magnitude of the impact. Because the EIS assesses impacts to key VCs of concern, the ecological context is high, by definition. However, ecological context may be used to modify the environmental significance if the societal value is associated with traditional land use.

Likelihood will also act as a modifier that can influence environmental significance. Environmental impact assessment considers impacts that are likely or highly likely to occur; however, within the definition of likelihood there can be a range of probabilities that impacts will occur. In special circumstances, the environmental significance may be lowered if an impact is considered to have a very low likelihood of occurring, and increased for impacts with a very high likelihood of occurring.

Duration of impacts, which includes reversibility, is a function of ecological resilience, and these ecological principles are applied to the evaluation of significance. Although difficult to measure, resilience is the capacity of the system to absorb disturbance, and reorganize and retain the same structure, function, and feedback responses (Section 6.7.3). Resilience includes resistance, capability to adapt to change, and how close the system is to a threshold before shifting states (i.e., precariousness).

The evaluation of significance for birds and associated species at risk considers the entire set of primary pathways that influence the assessment endpoint (i.e., persistence of bird populations and communities). The relative contribution of each pathway is used to determine the significance of the Project on birds, which represents a weight of evidence approach (Section 6.7.4). For example, a pathway with a high magnitude, large geographic extent, and long-term duration is given more weight in determining significance relative to pathways with smaller scale effects. The relative impact from each pathway is discussed; however, pathways that are predicted to have the greatest influence on changes to the persistence of bird populations would also be assumed to contribute the most to the determination of environmental significance.

Environmental significance is used to identify predicted impacts that have sufficient magnitude, duration, and geographic extent to cause fundamental changes to birds and associated species at risk. The following definitions are used for assessing the significance of impacts on the persistence of birds, and the associated continued opportunity for traditional use of these populations.

Not significant – impacts are measurable at the individual level, and strong enough to be detectable at the population level, but are not likely to decrease resilience and increase the risk to population persistence.

Significant – impacts are measurable at the population level and likely to decrease resilience and increase the risk to population persistence. A number of high magnitude and irreversible impacts at the population level (regional scale) would likely be significant.

11.12.9.2 Results

The results predict that the incremental and cumulative impacts from the Project and other developments should not significantly influence the persistence of birds and associated species at risk. For all primary pathways influencing population size and distribution, cumulative impacts were determined to be regional in geographic extent, which implies that at least some portion of the populations are affected. For incremental impacts, the geographic extent of pathways is expected to be local. Local impacts to habitat were associated with the Project footprint, dust deposition, and noise, and will continuously influence individuals that travel through or occupy habitats within 3.5 km from the Project, and periodically up to 5.5 km (e.g., during take-off and landing of aircraft).

The likelihood of the impacts occurring is expected to be possible to highly likely for pathways, which does not change the expected magnitude and duration (or environmental significance). Similarly, the frequency of impacts is anticipated to occur continuously throughout the life of the Project (Table 11.12-27). The duration of impacts on birds and species at risk from changes in habitat quality, movement, and behaviour is anticipated to be reversible over the long term (27 to 32 years [2 to 6 life spans depending on the species]) (Table 11.12-27). Alternately, impacts from changes in habitat quantity (i.e., development footprints) were assumed to be irreversible within the temporal boundary of the assessment.

The magnitude for the two primary pathways impacting the persistence of bird populations and associated species at risk ranged from negligible to low (Table 11.12-27). The magnitude of the cumulative impact from direct habitat loss associated with the Project and other developments is expected to be about 5% of the RSA. The decrease in high and good quality habitats in the region is predicted to impact less than 3% of upland breeding bird, water bird, and raptor populations. The incremental impact from the Project on direct and indirect changes to habitat is less than 1% relative to existing conditions.

Overall, there is a moderate to high degree of confidence in the predictions of environmental significance of incremental and cumulative impacts from the Project on birds and associated species at risk. The current level of activity (i.e., four active exploration sites) in the region and residual impacts from the Project should not negatively influence the resilience of bird and species at risk populations. Most species are migratory, and will be influenced by the Project and other developments for 4 to 5 months each year during spring to autumn. This is a time of year in the Kennady Lake region when weather conditions are typically less harsh and food is abundant, which increases resistance in individuals to natural and human-related stressors. Upland and water bird populations have high reproductive rates that provide flexibility to adapt to different environmental selection pressures. Similarly, raptors display life history traits (variation in time between egg laying and hatching of young) that provides adaptability and resilience for populations experiencing different extremes of prey abundance and weather patterns. However, the predictions of environmental significance with respect to waterfowl and shorebirds are dependent on the execution of further study of the ingestion pathways discussed in Section 11.2.3 and the commitment that mitigation will be incorporated into the Project design to the extent required to limit the effects from these pathways.

Impacts from different projects in the region should be limited to individuals within local populations around each footprint. For species with small breeding ranges (e.g., songbirds and water birds), an increase in distance among local populations can decrease the ability to successfuly disperse between local populations, and result in populations that fluctuate independently of each other (Schlosser 1995; Steen et al. 1996; Sutcliffe et al. 1996; Ranta et al. 1997; Bjørnstad et al. 1999). In other words, changes in the number of individuals within local populations over time are more related to local factors that influence reproduction and survival rates than the movement of individuals between populations.

Within the region, impacts from each project on a local population should not influence other sub-populations that have little to no exchange of individuals between them. It is predicted that the cumulative local impacts from development should be reversible and not significantly affect the future persistence of bird and species at risk populations in the region. Subsequently, cumulative impacts from development also are not predicted to have a significant adverse effect on continued opportunities for use of birds by people that value these animals as part of their culture and livelihood.

11.12.9.3 Summary of Impacts to Other Species At Risk

11.12.9.3.1 Fish

The Arctic grayling is the only fish Species At Risk known to occur in the Project area. Areas 2 to 7 of Kennady Lake will be dewatered to allow mining to proceed, resulting in the consequential loss of fish from these basins until they have been refilled and the aquatic community has recovered. The fish community of Area 8 will also be affected by the Project, as detailed in Section 8.10. When mining is complete, the B, D and E watersheds will be rediverted to Kennady Lake and Kennady Lake will be refilled. Flow patterns within the reconnected Kennady Lake watershed will be similar to existing conditions, and the aquatic ecosystem in Kennady Lake will re-establish itself, as described in Section 8.11. The expected time-frame for recovery of the phytoplankton community is projected to be approximately five years after refilling is complete. Zooplankton community development is projected to closely follow recovery of the phytoplankton community, whereas the recovery of the benthic invertebrate community is expected to take up to ten years after refilling is complete. During this time, the forage fish community will also develop, followed by a slower recovery of the large-bodied fish community once the fish screens have been removed from the upper watershed and dyke A is removed from between Areas 7 and 8.

Arctic grayling are expected to become established in Kennady Lake earlier than most other large-bodied fish, with migrants originating from the B and D watersheds and the downstream M watershed. The recovery of the planktonic community will provide a stable food source for Arctic grayling, and stream spawning habitat will be available to Arctic grayling from Kennady Lake and the upstream lakes.

Arctic grayling begin to reach maturity in about four years and have a life expectancy of 6 to 10 years. A self-sustaining population of Arctic grayling reared in Kennady Lake should be present about 5 to 10 years after the fish fences have been removed or about 50 years after the start of construction. At that time, the abundance of Arctic grayling is expected to be substantially less than current abundance. However, given the relatively short time to maturity, the opportunities for immigration, and the initial reduction in predation by lake trout, the population is projected to increase in the next 50 years, which represents 5 to 10 generations.

The projected impacts on the abundance of Arctic grayling were classified over two time periods:

- from the start of the Project to 100 years later, which is based on the worst condition that occurred during the first one hundred years since the start of the Project; and
- after the first 100 years, which is based on the ability of the fish community to recover to a state comparable to other similar lakes in the area.

During the first 100 year time period, the projected impacts are negative in direction, high in magnitude, long-term in duration, and reversible. The geographic extent is local, because, as noted in EIS Section 9, no measurable effects to Arctic grayling populations are expected beyond the Kennady Lake watershed. As such, the projected impacts are considered to be of moderate environmental consequence. They are continuous in nature, likely to occur, and of high ecological context. They are not, however, considered to be environmentally significant.

During the second time frame, the projected impacts are of negligible magnitude, because of the expected ability of Arctic grayling to re-colonize the lake and the substantial number of generations that will occur during the post closure phase. Although a precise prediction of fish abundance cannot be developed for an equilibrium state that will develop after 100 years, the re-established Arctic grayling community is expected to resemble that which currently occurs in the lake, with similar levels of standing stock and annual production rates. As such, projected impacts of the Project on the abundance of Arctic grayling 100 years after the start of construction are considered to be of negligible environmental consequence and not environmentally significant.

The consumption of water and/or fish from Area 8 is projected to result in negligible impacts to human and wildlife health during the life of the Project. Similar findings were reported for the remainder of Kennady Lake after refilling and for other natural waterbodies located in the Kennady Lake watershed outside of the Project footprint. As such, projected impacts of the Project on the suitability of water and fish for human or wildlife consumption were rated as negative in direction but negligible in magnitude. The same rating applied to both time periods considered for the classification of impacts (i.e., from the commencement of construction to 100 years, and from that point onward). Consequently, the projected impacts to this assessment endpoint were determined to be of negligible environmental consequence and not environmentally significant.

11.12.9.3.2 Plants

For all Project pathways influencing vegetation ecosystems and plants, the geographic extent of impacts was determined to be mostly local, with some regional-scale impacts. The likelihood of the impacts occurring is expected to be possible to highly likely for Project pathways, which does not change the expected magnitude and duration (or environmental significance). The frequency of impacts to vegetation is anticipated to be periodic throughout the life of the Project, which also does not change the predicted environmental significance of impacts on traditional use of culturally important plants or the persistence of listed plant populations.

At the local scale, the magnitude of the impact to vegetation ecosystems and plants from the Project is predicted to be low for most communities, and high for one community. Impacts from the permanent features of the Project (Fine PKC Facility, Coarse PK Pile, and mine rock piles) are irreversible. Local-scale impacts of low to moderate magnitude, which are reversible in the long term, included effects to vegetation ecosystems from lake dewatering and refilling (i.e., margin effects due to flooding and dewatering). Local-scale impacts of low magnitude include colonization by weedy species within the dewatered lake bed, which are reversible in the long-term.

Based on the expected direct and indirect impacts from the Project on vegetation ecosystems and plants, it is predicted that the magnitude of impacts to the traditional use of plants, and the persistence of listed plant populations will be low to moderate (Table 11.12-29). The geographic extent is anticipated to be mostly local, with some regional impacts (due to other developments in the RSA). Similarly, the duration of most impacts should be reversible in the long term (Table 11.12-29).

Overall, the Project is not anticipated to result in significant adverse impacts to the persistence of vegetation ecosystems and listed plant species, and the use of traditional plants (Table 11.12-29). Most changes from the Project should result in local-scale impacts to plants. The previous and current level of activity in the region and residual impacts from the Project should not negatively influence the resilience of vegetation communities, and traditional and listed plant populations. Subsequently, most Project impacts on the populations are predicted to be reversible and not have a significant adverse affect on the future use of traditional plants, or the persistence of listed plant populations.

Table 11.12-29 Summary of Environmental Significance to Assessment Endpoints of Vegetation Ecosystems and Plants

Valued Component Assessment Endpoints	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Environmental Significance
Persistence of vegetation ecosystems and listed plant populations	negative	low to high	local to regional	long-term to permanent	reversible to irreversible	not significant
Continued opportunity for traditional use of plants	negative	low to moderate	local to regional	long-term	reversible	not significant

11.12.9.3.3 Caribou

Impacts from the Project, other previous and existing developments, harvesting, and natural environmental variables on caribou population size and distribution were evaluated. For all pathways, cumulative impacts were determined to extend across most of the seasonal ranges (beyond regional in geographic extent), with the exception of the calving range (Table 11.12-30). In contrast, the geographic extents of incremental impacts from the Project were local to regional. Regional incremental impacts included sensory disturbance from the anticipated mine site and from vehicles along the Tibbitt-to-Contwoyto Winter Road and the Winter Access Road.

The duration of incremental and cumulative impacts from the Project and other developments on caribou for the majority of pathways is anticipated to be reversible over the long term (27 to 32 years). The duration of impacts associated with the winter roads are expected to be reversible within the medium term (before the end of final closure). The pathways were associated with impacts to habitat quality, movement and behaviour, and vital rates. However, impacts from direct disturbance to habitats associated with development footprints are predicted to be irreversible within the temporal boundary of the assessment.

Overall, the impacts from the Project should be reversible, and not have a significant adverse affect on the persistence of caribou populations (Table 11.12-30). The scale of magnitude for assessing environmental significance considered the range of outcomes for five different pathways, and the amount of conservatism incorporated into the methods of the effects analyses, particularly the habitat and energetics models. For example, the magnitude of the cumulative impact from changes in the relative amount of preferred (i.e., high and good quality) habitats and carrying capacity among seasonal ranges is estimated to be low (reduction is less than or equal to 7.2% from reference conditions [no development]). However, for habitat suitability analyses, the zone of influence (ZOI) was similar for all operating mines (i.e., 15 km), regardless of the level of activity among mine sites. In addition, the extent of the ZOI for exploration camps was set at 5 km for the duration of the permit period (i.e., 5 years) even though exploration activities typically do not occur continuously throughout the year. Disturbance coefficients with the highest values were used to decrease habitat quality in overlapping zones of influence instead of averaging the values. All of these model attributes were expected to overestimate impacts to caribou from development.

Incremental effects from the Project affected caribou population size by about 1.5%, which was not significant relative to 2010 baseline conditions. Population models indicated that cumulative impacts from development influenced the viability of the herd and reduced the final projected herd size by 12.2% (moderate magnitude) relative to reference conditions. However, it was assumed that female caribou would experience one major disturbance event for every day they are located within a zone of influence. A major disturbance event causes caribou to increase movement (and feed less), run away, and become excited. This degree of response has typically been observed within 1 to 5 km from the Ekati Diamond Mine, which is currently the largest operating mine (both in size and activity level) in the seasonal ranges of the Bathurst herd. The model assumed this degree of response for all female caribou within 15 km of all operating mines, and 5 km from active exploration sites. The reason for applying these ecologically conservative decisions was to increase confidence that the assessment would not underestimate impacts to caribou populations.

Continued opportunities for traditional and non-traditional use of caribou are related to population size and distribution of caribou. Therefore, the geographic extent of the cumulative impacts from development on the use of caribou by people is beyond regional (Table 11.12-30). Given that the duration of the cumulative impacts from the Project and other developments are anticipated to occur over two caribou generations (or a little more than one human generation), the impacts to people should also be reversible in the long term (Table 11.12-30). Incremental impacts from the Project on should have a negligible influence on opportunities for hunting and trapping, and viewing caribou in the region. Similarly, changes to traditional and non-traditional use of caribou from the cumulative impacts of development and current harvesting in the Bathurst range are expected to be within the range of baseline conditions (low magnitude).

Table 11.12-30 Summary of Environmental Significance of Incremental and Cumulative Impacts to Caribou and Use of Caribou by People

Assessment Endpoints	Direction	Magnitude		Geographic Extent		Duration	Reversibility	Environmental Significance	
		Incremental	Cumulative	Incremental	Cumulative			Incremental	Cumulative
Persistence of caribou populations	negative	negligible to low	low to moderate	local to regional	beyond regional	medium term to permanent	reversible to irreversible	not significant	not significant
Continued opportunity for traditional and non-traditional use of caribou	negative	negligible	low	regional	beyond regional	long term	reversible	not significant	not significant

The persistence of caribou herds during previous large fluctuations in population abundance indicates that the species has the capability to adapt to different disturbances and environmental selection pressures. Migration routes and survival and reproduction rates appear to have the flexibility to respond to changes through time and across the landscape, which enables the population to resist further declines in abundance and the associated increased risk to persistence. This resilience in caribou populations suggests that the impacts from the Project and existing developments should be reversible and not significantly affect the future persistence of caribou populations. Subsequently, cumulative impacts from development also are not predicted to have a significant adverse affect on continued opportunities for use of caribou by people that value the animals as part of their culture and livelihood.

11.12.9.3.4 Grizzly Bear and Wolverine

The results predict that the incremental and cumulative impacts from the Project and other developments should not significantly influence the persistence of grizzly bear and wolverine populations. Mitigation practices and policies to reduce the number of negative interactions between carnivores and mine sites have continuously improved since diamond mining began in the SGP in 1998. Currently the direct mortality rate is low (i.e., two grizzly bear and four wolverine mortalities among all operating mines from 2005 through 2009).

For all pathways influencing population size and distribution of grizzly bear and wolverine, cumulative impacts were determined to be beyond regional in geographic extent, which implies that at least some portion of the populations are affected. For incremental impacts, the geographic extent of pathways ranged from local to regional. At the local scale, the Project footprint will alter 4.4% of the landscape (low magnitude impact in the LSA). Physical changes in habitat quantity due to development are predicted to be irreversible within the temporal boundary of the assessment. However, the cumulative direct disturbance to the landscape in the Slave Geological Province (study area) from the Project and other previous, existing, and future developments is predicted to be about 2% relative to reference conditions (low magnitude impact beyond the regional scale). Further, the incremental and cumulative direct disturbance was estimated to be less than 1% per habitat type (negligible magnitude) (Table 11.12-31).

The magnitude of incremental and cumulative impacts from decreases in quality habitat due to the Project and other developments is predicted to be negligible to moderate (Table 11.12-31). For grizzly bear, the largest decline in preferred habitat (i.e., good and high quality habitat combined) across seasons was during spring (12.4%). The largest incremental change from the Project on the area of preferred habitat was recorded for the early summer period, where preferred habitats declined by 0.8%. For wolverine, the largest predicted cumulative decline in preferred habitat was during winter (18.8%), which was mostly due (10%) to the temporary operation of winter roads (particularly the Tibbitt-to-Contwoyto Winter Road). The incremental decrease in preferred habitat from the Project was 1.5% relative to existing conditions. The duration of indirect impacts from changes in habitat quality is predicted to occur over a 27 to 32 year period (i.e., impacts should be reversed within 5 to 10 years following final closure). The duration of impacts associated with the winter roads are expected to be reversible within 5 years following intitial closure (i.e., near the end of closure).

Both the grizzly bear and wolverine population analyses could not demonstrate a statistically significant incremental effect from the Project on population viability relative to 2010 baseline conditions. In addition, analyses could not detect an incremental impact from the Project and future developments on the risk to persistence of wolverine or grizzly bear populations. However, the probability of abundance declines differed significantly between future and reference scenarios, but only for low to moderate declines in population abundance. The results indicate that previous, existing, and proposed developments on the landscape and the current harvest of bears and wolverines can influence the persistence of grizzly bear and wolverine populations. Reducing the current regulated number of harvested bears and wolverines statistically reduced the risk of population decline.

Results from the habitat and population viability analyses predict that the incremental and cumulative impacts from the Project and other developments should not significantly affect the resilience and persistence of grizzly bear and wolverine populations (Table 11.12-31). Incremental impacts from the Project on grizzly bear and wolverine should have a negligible influence on opportunities for hunting and trapping, and viewing carnivores in the region. Similarly, changes to traditional and non-traditional use of grizzly bear and wolverine from the cumulative effects of development and current harvesting in the Slave Geological Province are expected to be within the range of baseline conditions. Subsequently, cumulative impacts from development also are not predicted to have a significant adverse affect on continued opportunities for use of grizzly bear and wolverine by people that value these animals as part of their culture and livelihood (Table 11.12-31).

Table 11.12-31 Summary of Environmental Significance of Incremental and Cumulative Impacts to Grizzly Bears and Wolverines and Use of Grizzly Bears and Wolverines by People

Assessment Endpoints	Direction	Magnitude		Geographic Extent		Duration	Reversibility	Environmental Significance	
		Incremental	Cumulative	Incremental	Cumulative			Incremental	Cumulative
Persistence of grizzly bear and wolverine populations	negative	negligible to low	negligible to moderate	local to regional	beyond regional	medium term to permanent	reversible to irreversible	not significant	not significant
Continued opportunity for traditional and non-traditional use of grizzly bears and wolverines	negative	negligible	low	regional	beyond regional	long term	reversible	not significant	not significant

11.12.10 Uncertainty

The purpose of the uncertainty section is to identify the key sources of uncertainty and to discuss how uncertainty has been addressed to increase the level of confidence that impacts are not worse than expected. Confidence in the assessment of environmental significance is related to the following elements:

- adequacy of baseline data for understanding current conditions and future changes unrelated to the Project (e.g., extent of future developments, climate change, catastrophic events);
- model inputs (e.g., zone of influence and disturbance coefficients from developments);
- understanding of Project-related impacts on complex ecosystems that contain interactions across different scales of time and space (e.g., exactly how the Project will influence birds and species at risk); and
- knowledge of the effectiveness of the environmental design features (mitigation) for reducing or removing impacts (e.g., revegetation of wildlife habitat).

Like all scientific results and inferences, residual impact predictions must be tempered with uncertainty associated with the data and current knowledge of the system. It is anticipated that the baseline data are sufficient for understanding current conditions and future changes not related to the Project, and that there is a moderate to high level of understanding of Project-related impacts on the ecosystem. There is good information on the effects from mining activity on upland birds and raptors, yet limited information is available for water bird populations. Subsequently, there remains some uncertainty surrounding the degree to which some effects may occur (e.g., magnitude and duration).

It is understood that development activities will directly and indirectly affect habitat, and the behaviour and movement of birds and associated species at risk. However, long-term monitoring studies documenting the resilience of these species to development and the time required to reverse impacts are lacking. Although direct disturbance from development footprints were calculated to be about 5% of the regional habitat for the populations, there remains a high degree of uncertainty in the effectiveness of revegetation techniques for reversing the impact to habitat. De Beers will develop an adaptive management approach to reclamation that will incorporate results of the reclamation trials completed throughout the mine life, as well as new research and reclamation approaches that are being developed as part of other mining operations in the Arctic.

Adding to the challenges of understanding complex systems is the difficulty of forecasting a future that may be outside the range of observable baseline environmental conditions such as factors related to climate change (Walther et al. 2002). Migratory bird species are also under pressures from factors on their wintering grounds. Potential future developments such as the Taltson Hydroelectric Expansion Project and the proposed East Arm National Park also generate uncertainty in impact predictions.

The Taltson Hydroelectric Expansion Project will be a transmission line linking the Twin Gorges hydroelectric station on the Taltson River with the existing and proposed mines north of Great Slave Lake. The transmission line would pass through the RSA. Infrastructure required for the Taltson Hydroelectric Expansion Project in the study area includes the placement of transmission towers. The magnitude of incremental changes to bird habitat quantity and quality from the Taltson Hydroelectric Expansion Project was predicted to be negligible to low. Most impacts should be associated with localized changes in behaviour and movement during the construction phase. There is the possibility of bird interactions with transmission lines (i.e., bird strikes) and the use of transmission towers as perch sites by raptors. However, it is assumed that the proponent for the Taltson Hydroelectric Expansion Project would incorporate best management practices during construction, and the use of bird strike mitigation methods.

The proposed national park at the east arm of Great Slave Lake is representative of the North Western Boreal Uplands. At its closest point, the study area for the proposed park comes to within 1 km of the Project. Depending upon the length of time for the feasibility study, and the time to negotiate the remaining stages of the park planning process, the proposed East Arm National Park may not be created until the Project is well into the operations phase. There is also uncertainty in predicting the status of the existing fishing and hunting lodges and camps in the proposed park. The assessment assumes that the existing lodges would no longer allow hunting, but would remain as tourist lodges. Overall, the proposed East Arm National Park would likely be beneficial to birds and associated species at risk from a conservation perspective.

Although quantitative and less biased than models based on expert opinion, HSI-based habitat maps have numerous sources of uncertainty; these include the structure of the models, the accuracy and precision of underlying data layers, and biases associated with the chosen GIS algorithms (Burgman et al. 2005). Further, habitat maps are a static view between a species and its environment, ignoring changes over time with ecological succession and natural disturbances such as harmful climatic events. However, when considering the predictions on the effects of the Project on bird and species at risk habitat, sources of uncertainty were reduced by using multiple habitat mapping methods (Burgman et al. 2005). For example, the assessment included both fragmentation analyses and the use of HSI models, which together limit bias and imprecision in predictions.

To reduce uncertainty associated with changes in habitat quality conservative estimates of the zones of influence and disturbance coefficients were applied to the HSI models. For example, a 500 m radius was used to estimate the area of the footprint for exploration sites (78.5 ha). This likely overestimates direct habitat loss as drilling activities are generally completed in the winter to avoid rutting from the rig and on-site vehicles (unless a heli-portable drill rig is used).

Zones of influence were also applied to all active exploration sites in the RSA for the entire permit period even though activities typically do not occur throughout the year, and some sites may have been abandoned before permit expiration. Disturbance coefficients (used for reducing habitat quality in the zones of influence) with the greatest effect were applied in cases where zones of influenced overlapped, rather than using the average of two or more coefficients. All of these attributes provide confidence that the assessment has not underestimated the environmental significance of the incremental and cumulative impacts from the Project on birds and species at risk, and the people that value these species for their livelihood.

11.12.11 Monitoring and Follow-up

Upon approval of the Project, a wildlife effects monitoring program (WEMP) will be implemented to test impact predictions and reduce the level of uncertainty related to each prediction. The principal goal of the WEMP is to provide information required for the Project's Environmental Management System to adaptively manage the Project to protect wildlife and wildlife habitat. In this context, data collected on measurement endpoints will be used to evaluate the impacts from the Project on the persistence of populations, and the continued opportunity for traditional and non-traditional use (i.e., assessment endpoints). Based on the definitions of monitoring in the Terms of Reference (Section 3.2.7, Gahcho Kué Panel 2007), the WEMP would consist of environmental monitoring and follow-up programs.

Measurement endpoints for testing impact predictions (i.e., monitoring effects) from the Project will likely include:

- direct habitat effects (changes in habitat quantity from the Project footprint);

- indirect habitat effects (changes in habitat quality, and animal abundance and distribution from sensory disturbance within the predicted zone of influence); and
- direct mine-related mortality (i.e., number of interactions, injuries, mortality) linked to Project infrastructure and activities.

Specific objectives of the WEMP would be:

- to verify the accuracy of impact predictions made in the EIS, and identify unanticipated effects;
- to implement a wildlife effects mitigation and management plan designed to reduce the risks and disturbance to wildlife and wildlife habitats;
- to determine the effectiveness of the wildlife effects mitigation and management plan;
- to consider and incorporate, where possible, traditional knowledge into the WEMP;
- to design studies and data collection protocols that are consistent with other monitoring programs in the Arctic (e.g., Snap Lake Mine, Diavik Diamond Mine, and Ekati Diamond Mine), and can be used to understand and manage cumulative effects, and participate in regional and/or collaborative programs;
- to develop and review the WEMP in collaboration with the Department of the Environment and Natural Resources, Canadian Wildlife Service (Environment Canada), and the communities; and
- to provide an annual report that will satisfy the appropriate government agencies responsible for wildlife and will provide the opportunity for feedback from communities, governments, and the public.

Species selected for effects monitoring would be based on recent and current environmental assessments and monitoring programs in the NWT and Nunavut, and will likely include species at risk. Following the principles of adaptive management, species selected for monitoring may be periodically reviewed by government, community, and regulatory agencies, and changed as necessary.

Similarly, study designs and sampling protocols would follow the current methods accepted for monitoring effects on wildlife and habitat at mine sites in Nunavut and the NWT. By consistently using standardized and up-to-date methods, direct comparisons can be made among projects that differ in the spatial extent of the footprint and level of mining activity. Such a meta-analysis can be used to help understand and manage the cumulative effects from development on wildlife population size and distribution.

The WEMP represents an adaptive approach to understanding the effects of the Project on the landscape and the species that live there. In this context, the WEMP is considered as a continually evolving process that relies not only on the efficiency of data collection and analytical results, but is also dependent on feedback from the communities, government, and the public. Having an adaptive and flexible program allows for appropriate and necessary changes to the design of monitoring studies, and the mitigation and management plans. Some changes may come about through the observation of unanticipated effects. Other changes may result from ecological knowledge acquired through working with Aboriginal community members.

De Beers is committed to considering and incorporating TK into the WEMP. The incorporation of TK would occur throughout all stages of the WEMP, including identification of mitigation practices and policies, data collection, and follow-up programs to obtain feedback Results of any relevant community-based monitoring studies would be incorporated into the annual WEMP report (with permission from the communities). As with all aspects of the WEMP, the incorporation of TK would be a continuously evolving process.

Community members will be invited to participate in data collection programs. This includes specific species monitoring programs (e.g., surveys for caribou, grizzly bears, and wolverine). The involvement of community members in field data collection is expected to contribute to overall efficiency as well as provide feedback and ideas. For example, sampling methods may be changed based on knowledge of wildlife behaviour or ecology provided by community participants during the field programs. Where appropriate, elders may be brought on site to further contribute to field monitoring programs.

11.12.12 References

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11.12.13 Acronyms and Glossary

11.12.13.1 Acronyms

CASA	Clean Air Strategic Alliance
CCME	Canadian Council of Ministers of the Environment
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DC	disturbance coefficients
De Beers	De Beers Canada Inc.
EIS	environmental impact statement
ELC	ecological land classification
ENR	Department of Environment and Natural Resources
GHL	General Hunting Licence
GIS	geographic information system
HSI	habitat suitability index
INAC	Indian and Northern Affairs Canada
L_{eq}	equivalent continuous sound and noise level
LKDFN	Łutsel K'e Dene first Nation
L_{max}	maximum sound and noise level
LSA	local study area
MVEIRB	Mackenzie Valley Environmental Impact Review Board
MVLWB	Mackenzie Valley Land and Water Board
MVRMA	*Mackenzie Valley Resource Management Act*
NO_2	nitrogen dioxide
NO_x	nitrogen oxide
NWT	Northwest Territories
PAG	potentially acid-generating
PAI	potential acid input
PK	processed kimberlite
PKC	processed kimberlite containment
PM	particulate matter
PM_{10}	particulate matter with particle diameter nominally smaller than 10 μm
$PM_{2.5}$	particulate matter with particle diameter nominally smaller than 2.5 μm
Project	Gahcho Kué Project
RSA	regional study area
SGP	Slave Geological Province

SO_2	sulphur dioxide
spp.	species
Terms of Reference	*Terms of Reference for the Gahcho Kué Environmental Impact Statement*
TK	traditional knowledge
TSP	total suspended particulates
VC	valued component
WEMP	Wildlife Effects Monitoring Program
ZOI	zone of influence

11.12.13.2 Units of Measure

%	percent
<	less than
>	greater than
$\geq$	greater than or equal to
$\pm$	plus or equal to
$\mu g/m^3$	micrograms per cubic metre
cm	centimetre
dBA	decibels
dBL	linear decibels
ha	hectare
keq/ha/y	kiloequivalent per hectare
kg/ha/y	kilograms per hectare per year
km	kilometre
km^2	square kilometres
m	metre
mm/s	millimetres per second

11.12.13.3 Glossary

Barren kimberlite	Kimberlite that does not contain diamonds.
Bog	Sphagnum or forest peat materials formed in an ombrotrophic environment due to the slightly elevated nature of the bog, which tends to disassociate it from the nutrient-rich groundwater or surrounding mineral soils. Characterized by a level, raised or sloping peat surface with hollows and hummocks. Mineral-poor, acidic and peat-forming wetlands that receives water only from precipitation.
Boreal forest	The northern hemisphere, circumpolar, tundra forest type consisting primarily of black spruce and white spruce with balsam fir, birch, and aspen.
Conifer	Trees in the division Pinophyta of the plant kingdom. These are cone-bearing trees with no true flower (e.g., white spruce, black spruce, balsam fir, jack pine and tamarack).

Cratering	The act of creating depressions, or craters in the snow when foraging for food. Usually done by elk or other ungulates.
Critical load	A quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge. For waterbody acidification, the critical load represents an estimate of the amount of acidic deposition below which significant adverse changes are not expected to occur in a lake's ecosystem.
Drumlins	A long narrow hill, made up of till, which points in the direction of the glacier movement.
Ecological land classifications	A means of classifying landscapes by integrating landforms, soils and vegetation components in a hierarchical manner.
Ecosite	Ecological units that develop under similar environmental influences (climate, moisture and nutrient regime). Ecosites are groups of one or more ecosite phases that occur within the same portion of the moisture/nutrient grid. Ecosite is a functional unit defined by the moisture and nutrient regime. It is not tied to specific landforms or plant communities, but is based on the combined interaction of biophysical factors that together dictate the availability of moisture and nutrients for plant growth.
Ecosystem	An integrated and stable association of living and non-living resources functioning within a defined physical location. A community of organisms and its environment functioning as an ecological unit. For the purposes of assessment, the ecosystem must be defined according to a particular unit and scale.
Esker	Long, narrow bodies of sand and gravel deposited by a subglacial stream running between ice walls or in an ice tunnel, left behind after melting of the ice of a retreating glacier.
Eutrophic	The nutrient-rich status (amount of nitrogen, phosphorus and potassium) of an ecosystem.
Eutrophication	Excessive growth of algae or other primary producers in a stream, lake or wetlands as a result of large amounts of nutrient ions, especially phosphate or nitrate.
Exposure ratios	A comparison between total exposure from all predicted routes of exposure and the exposure limits for chemicals of concern. This comparison is calculated by dividing the predicted exposure by the exposure limit. Also referred to as hazard quotient (HQ).
Freshet	A sudden overflow of a stream caused by heavy rain or nearby thawing of snow or ice.
Friction modelling	A type of optimal path analysis that deals with finding the least-cost route between two locations, based on the measurements of resistance or friction related to physical or environmental conditions. It is a type of GIS model often used when the application requires finding a path across a terrain that may not have any predefined paths. Also known as least cost path analysis.
Geographic Information System (GIS)	Computer software designed to develop, manage, analyze and display spatially referenced data.
Glaciofluvial	Sediments or landforms produced by melt waters originating from glaciers or ice sheets. Glaciofluvial deposits commonly contain rounded cobbles arranged in bedded layers.
Groundwater	That part of the subsurface water that occurs beneath the water table, in soils and geologic formations that are fully saturated.

Habitat fragmentation	Occurs when extensive, continuous tracts of habitat are reduced by habitat loss to dispersed and usually smaller patches of habitat. Generally reduces the total amount of available habitat and reduces remaining habitat into smaller, more isolated patches.
Habitat Suitability Index (HSI) Model	Analytical tools for determining the relative potential of an area to support individuals or populations of a wildlife species. They are frequently used to quantify potential habitat losses and gains for wildlife as a result of various land use activities.
Headwater(s)	The source and upper reaches of a stream; also the upper reaches of a reservoir. The water upstream from a structure or point on a stream. The small streams that come together to form a river. Also may be thought of as any and all parts of a river basin except the mainstem river and main tributaries.
Heath tundra	A closed mat plant community that grows on moderate to well-drained soils, covering most of the upland areas. Plants generally belong to the heath family, the Ericaceae. The vegetation layer forms a mat of low shrubs dominated by dwarf birch and Labrador tea.
Home range	The area within which an animal normally lives, and traverses as part of its annual travel patterns.
Hydrology	The science of waters of the earth, their occurrence, distribution, and circulation; their physical and chemical properties; and their reaction with the environment, including living beings.
Kames	Ice contact deposits associated with the concurrent processes of melting ice and flowing meltwater.
Key line of inquiry	Areas of the greatest concern that require the most attention during the environmental impact review and the most rigorous analysis and detail in the environmental impact statement. Their purpose is to ensure a comprehensive analysis of the issues that resulted in significant public concern about the proposed development.
Landscape	A heterogeneous land area with interacting ecosystems that are repeated in similar form throughout. From a wildlife perspective, a landscape is an area of land containing a mosaic of habitat patches within which a particular “focal” or “target” habitat patch is embedded.
Least cost path analysis	A type of optimal path analysis that deals with finding the least-cost route between two locations, based on the measurements of resistance or friction related to physical or environmental conditions. It is a type of GIS model often used when the application requires finding a path across a terrain that may not have any predefined paths. Also known as friction modelling.
Littoral	The zone in a lake that is closest to the shore. It includes the part of the lake bottom, and its overlying water, between the highest water level and the depth where there is enough light (about 1% of the surface light) for rooted aquatic plants and algae to colonize the bottom sediments.
Lowland	Areas with ground slopes of less than 0.5% and typically poorly drained.
Mesotrophic	Trophic state classification for lakes characterized by moderate productivity and nutrient inputs (particularly total phosphorus).
Natal dens	A lair, typically underground, used for the birthing and initial rearing of young; often occur in esker complexes.
Oligotrophic	Trophic state classification for lakes characterized by low productivity and low nutrient inputs (particularly total phosphorus).

Polycyclic Aromatic Hydrocarbon (PAH)	A chemical by-product of petroleum-related industry. Aromatics are considered to be highly toxic components of petroleum products. PAHs, many of which are potential carcinogens, are composed of at least two fused benzene rings. Toxicity increases along with molecular size and degree of alkylation of the aromatic nucleus.
Potential Acid Input (PAI)	A composite measure of acidification determined from the relative quantities of deposition from background and industrial emissions of sulphur, nitrogen and base cations.
Patch	A particular unit of habitat with identifiable boundaries that differs from its surroundings in one or more ways. These can be a function of vegetative composition, structure, age or some combination of the three.
Mean Patch Size (MPS)	The area of an ecosystem type divided by the number of patches of that type. For total undisturbed areas, it is the mean size of the undisturbed patches.
Peat	A material composed almost entirely of organic matter from the partial decomposition of plants growing in wet conditions.
Permafrost	Permanently frozen ground (subsoil). Permafrost areas are divided into more northern areas in which permafrost is continuous, and those more southern areas in which patches of permafrost alternate with unfrozen ground.
pH	The degree of acidity (or alkalinity) of soil or solution. The pH scale is generally presented from 1 (most acidic) to 14 (most alkaline). A difference of one pH unit represents a ten-fold change in hydrogen ion concentration.
Polygon	The spatial area delineated on a map to define one feature unit (e.g., one type of ecosite phase).
Rare plants	A native plant species found in restricted areas, at the edge of its range or in low numbers within a province, state, territory or country.
Relative abundance	The proportional representation of a species in a sample or a community.
Riparian	Refers to terrain, vegetation or simply a position next to or associated with a stream, floodplain or standing waterbody.
Runoff	The portion of water from rain and snow that flows over land to streams, ponds or other surface waterbodies. It is the portion of water from precipitation that does not infiltrate into the ground, or evaporate.
Rut	A general term that refers to the breeding period of mammals, especially the ungulates. During the rut, males exhibit specific behaviours to establish harems or to attract females to mate with.
Sedge	Any plant of the genus Carex, perennial herbs, often growing in dense tufts in marshy places. They have triangular jointless stems, a spiked inflorescence and long grass-like leaves which are usually rough on the margins and midrib. There are several hundred species.
Species	A group of organisms that actually or potentially interbreed and are reproductively isolated from all other such groups; a taxonomic grouping of genetically and morphologically similar individuals; the category below genus.
Species diversity	A description of a biological community that includes both the number of different species and their relative abundance. Provides a measure of the variation in number of species in a region.
Species richness	The number of different species occupying a given area.
Staging birds / areas	Refers to key locations, often wetlands, along their migratory routes where birds concentrate in huge numbers to replenish the body fat and energy reserves needed for their migration.

Test den	A den constructed by carnivores which was not ultimately used for over-wintering or raising offspring.
Till	Sediments laid down by glacial ice.
Total edge	A measure of the total length of all patch boundaries. Total edge differs from the total perimeter of a patch because each edge represents the boundary of two patches, whereas perimeter refers to only one patch.
Total suspended particulate	A measure of the total particulate matter suspended in the air. This represents all airborne particles with a mean diameter less than 30 μm (microns) in diameter.
Treeline	An area of transition between the tundra and boreal forest to the south.
Trophic	Pertaining to part of a food chain, for example, the primary producers are a trophic level just as tertiary consumers are another trophic level.
Total Suspended Particulate (TSP)	A measure of the total particulate matter suspended in the air. This represents all airborne particles with a mean diameter less than 30 μm (microns) in diameter.
Tundra	A type of ecosystem dominated by lichens, mosses, grasses, and woody plants; a treeless plain characteristic of the arctic and subarctic regions.
Tussock - hummock	A tussock is a tuft of grass or grasslike plants like sedges. Tussock – hummock refers to a type of tundra consisting of acre upon acre of sedge tussocks, usually located on flat, poorly drained land or gentle slopes.
Ungulate	Belonging to the former order Ungulata, now divided into the orders Perissodactyla and Artiodactyla, and composed of the hoofed mammals such as horses, cattle, deer, swine and elephants.
Valued component	Represent physical, biological, cultural, and economic properties of the social-ecological system that are considered to be important by society.
Vascular plants	Plants possessing conductive tissues (e.g., veins) for the transport of water and food.
Volatile Organic Compounds (VOC)	Volatile Organic Compounds include aldehydes and all of the hydrocarbons except for ethane and methane. VOCs represent the airborne organic compounds likely to undergo or have a role in the chemical transformation of pollutants in the atmosphere.
Watershed	The entire surface drainage area that contributes water to a lake or river.
Wetlands	Wetlands are land where the water table is at, near or above the surface or which is saturated for a long enough period to promote such features as wet-altered soils and water tolerant vegetation. Wetlands include organic wetlands or "peatlands," and mineral wetlands or mineral soil areas that are influenced by excess water but produce little or no peat.

APPENDIX 11.12.I

ABSOLUTE VALUES FOR CHANGES IN LANDSCAPE METRICS IN THE REGIONAL STUDY AREA FOR SPECIES AT RISK AND BIRDS

Table 11.12.I-1 Reference, Baseline, Application, and Future Landscape Metrics for Vegetation Communities (Ecotypes) and Developments in the Regional Study Area (Spring to Autumn)

Habitat Type	Area (ha)				Number of Patches				Mean Distance to Nearest Neighbour (m)			
	Reference	Baseline	Application	Future	Reference	Baseline	Application	Future	Reference	Baseline	Application	Future
Esker Complex	624	624	624	624	145	145	145	147	769	769	769	754
Spruce Forest	32,224	32,199	32,150	32,128	96,659	96,583	96,411	96,425	78	78	78	78
Birch Seep	27,670	27,641	27,610	27,586	63,001	62,953	62,872	62,886	88	88	88	88
Peat Bog	48,410	48,363	48,264	48,227	84,575	84,526	84,442	84,513	76	76	76	76
Tussock Hummock	51,708	51,650	51,543	51,506	99,588	99,506	99,353	99,391	73	73	73	73
Heath Bedrock	38,657	38,622	38,582	38,551	55,211	55,167	55,108	55,148	85	85	85	85
Heath Tundra	24,419	24,414	24,344	24,316	30,635	30,624	30,600	30,626	122	122	122	122
Heath Boulder	44,559	44,508	44,476	44,450	81,460	81,389	81,316	81,339	78	78	78	78
Boulder Association	18,930	18,913	18,900	18,889	62,187	62,130	62,076	62,078	99	99	99	99
Bedrock Association	24,679	24,659	24,653	24,640	59,630	59,584	59,541	59,557	94	94	94	94
Tall Shrub	31,334	31,309	31,266	31,242	83,741	83,664	83,520	83,557	79	79	79	79
Sedge Wetland	56,197	56,136	56,001	55,965	53,616	53,583	53,472	53,535	84	84	84	84
Shallow Water	37,151	37,115	36,927	36,906	19,091	19,086	19,025	19,063	115	115	116	115
Deep Water	96,981	96,855	96,409	96,392	3,566	3,568	3,555	3,563	258	258	258	257

ha = hectares; m = metres